Reference Manual

E60
COMPLETE VEHICLE

Technical Training

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E60 Complete Vehicle

Initial Print Date: 08/03 Revision Date: 09/03

E60 Complete Vehicle

Model: E60 - 525i, 530i, 545i

Production: Start of Production MY 2004

This intent of this workbook is to assist you with diagnosis and testing in addition to the detailed information found in the the latest Diagnosis and TIS of the DISplus/GT1.

This section will be instructor led for a brief review of the E60 Complete Vehicle. You are encouraged to use this workbook with the latest Diagnosis and TIS information to make notes during diagnosis and testing of the ***new components/systems of the E60.*** This will be valuable to you as supplementary information or a memory refresher when performing diagnosis in the future.

Note: For more in depth and detailed information about the E60 Complete Vehicle, refer to the ST046 E60 Complete Vehicle training CD.

For additional and updated information, always refer to:

www.bmwcenternet.com
- Diagnosis and TIS information/updates
- Service Information Bulletins
- DCS messages

Objectives:

After completion of this module you will be able to:

- Properly remove, install and adjust the front bumper system
- Properly remove, install and adjust the head lights
- Properly remove, install and adjust the rear light clusters
- Properly remove, install and adjust the rear bumper system
- Properly remove and install the exterior door handles

E60 Complete Vehicle

Purpose of the System

The E60 is the fifth edition of the BMW 5 Series replacing the E39. The automobile revolution in design and engineering initiated by the E65/E66 now finds its logical continuation in the E60. Virtually all the significant innovations of the 7 Series are also offered in the 5 Series.

However the E60 also offers new features of its own, some of which will make their appearance in other model series in due time. The most important of these new features are:

- Active steering system, whose variable reduction ratio adapts itself to the relevant driving situation.

- Lightweight design with a front-end structure of bonded and riveted aluminum (GRAV).

- Head-up display, which projects the most important information such as vehicle speed or navigation arrows in the form of a virtual image directly into the driver's field of vision.

- Adaptive directional headlight system, which adapts itself continuously to the steering angle and thus illuminates the approaching bend.

BMW 5 Series - Brief History

The E12

The first BMW to be christened the "5 Series" was the E12. In 1972 this model in the form of the "520" began the system of model designation which has remained to this day: The first number stands for the model series, while the second and third numbers represent the cubic capacity.

A total of 702,242 E12s from the 518 to the 535i were produced in Dingolfing and Munich until 1985.

KT-9494

The E28

The successor model E28, which at first glance appeared to have only minor modifications, brought the production figures to 723,001 with the model designations 518i to 535i between 1980 and 1990.

From January 1983 production of the 5 Series - with the exception of the M5 offered for the first time - was confined exclusively to Dingolfing. 1983 was also the year when the 524td became the first 5 Series to feature a diesel engine.

KT-9490

The E34

The 3rd generation 5 Series registered a major increase in production volume: Between 1987 and 1996 a total of 1,330,661 E34s came off the Dingolfing production line. The engine range of four- and six-cylinder models was extended to include a V8 (518i to 540i) and rounded off by diesel engines (525td and 525tds) and the high-performance M5.

A second bodystyle was also introduced in the form of the 5 Series touring, which also included a version that ran on liquefied petroleum gas (518g touring). A four-wheel drive was also produced in both saloon and touring versions in the form of the 525ix.

KT-9489

The E39

The current 5 Series was launched in 1995, of which to date 1,362,884 have been built (as at: 30 September 2002). In addition to the standard saloon and touring, there is also a safety saloon version of the E39 (540i Protection).

The engine options available range from the 518i to the 540i (diesel: 520d to 530d), as well as the M5.

KT-9473

The new E60 - Highlights and Design

The BMW Group's new design strategy with its broadening of the family resemblance lends future BMW model series still more individual character. It is thus possible for the E60 to embody the values of the 3 Series (dynamic and sporty) as well as those of the 7 Series (successful, top of the range and sporty) and yet remain an individual and original car within the scope of traditional BMW model series.

Unlike its competitors - and also its predecessors at BMW in previous years - the new 5 Series demonstrates its own clearly recognizable lines: The unique character of the individual model series within the overall range of the BMW marque will in future be increasingly accentuated. The new 5 Series therefore comes across neither as a small 7 Series nor as a big 3 Series.

KT-11013

The front end makes a bold and dynamic statement.

The most striking features are the new twin headlights and the dramatically sloping hood lines on both sides which now already begin at the level of the earlier swage line.

Flowing lines run from the headlights along the sides to the rear end of the E60.

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The side line is a logical extension of the front-end design. Thus the E60 is the first BMW model not to have the previously typical side swage line. Its place is taken by a character line, an edge of light which lends the side view a whole new character. Various light reflections above and below this line produce a play of light and shadow, thereby giving the impression of a very low side panel.

KT-11014

The transition from the hood to the side panel occurs in the imaginary extension of the character line. ***Thus the E60 has the lowest front end ever of any BMW.*** The sculpture-like appearance of the side view is consolidated by the fact that there are no protective strips in the door areas.

Despite its increased height, the passenger cell has a coupe-like appearance thanks to the sweeping design of the C-pillar. Short overhangs and generously dimensioned wheel arches accentuate the dynamic, bold overall appearance. The clear shaping of the wheel lips as a typical BMW design element emphasize the wide track of the E60.

The rear end conveys an at once wide and compact effect due to the fact that there are no visible joints. Under the high deck lid with integrated spoiler lies ***the biggest luggage compartment in the current BMW range.*** The rear lights are mounted in brilliant optical housings, the tops of which are sloping in appearance.

The large rear apron of the E60 is subdivided by additional reflector elements and thus gives the impression of being lighter.

A distinctive diffuser lip not only ensures optimum aerodynamics but also reduces the amount of dirt which accumulates on the vehicle rear end.

The overall impression communicates an unmistakable sense of the E60's power and strength to road-users driving behind it.

KT-11016

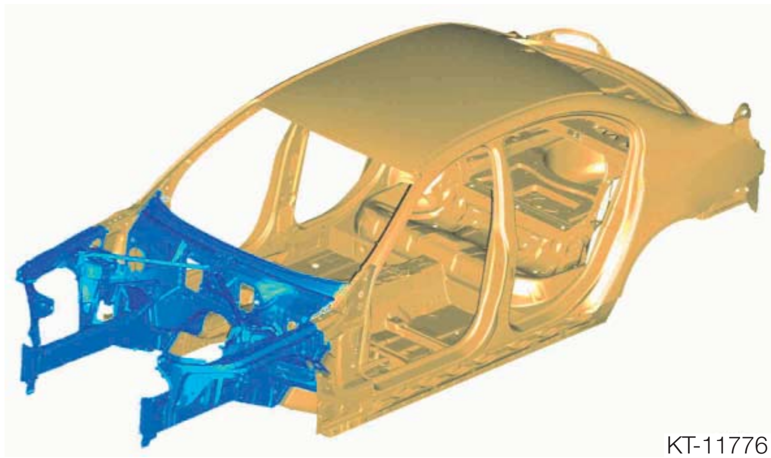
System Components

Body Structure

The body dimensions have been increased to improve roominess in the rear compartment (+ 5 cm knee room) and to increase the luggage compartment capacity (at 520 L the largest capacity of all the BMW vehicles including the E65).

In order to make the E60 significantly lighter than the current 5 Series, BMW designed a "reduced-weight aluminum front end" (GRAV).

The front end consists almost entirely of aluminum while the transition to steel occurs in the front bulkhead area. Aluminum components are shown in darker shaded (front clip) section.



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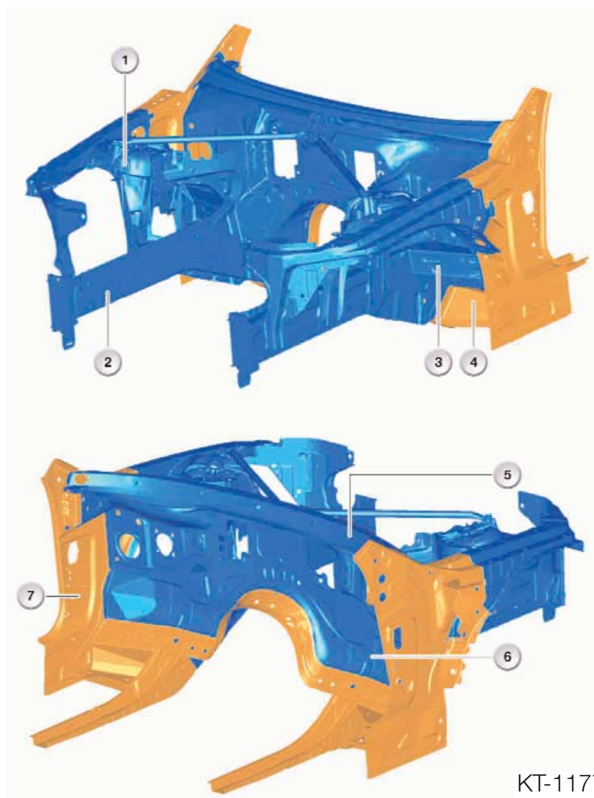
The weight saving at the front end not only reduces the total weight of the vehicle but is also a significant factor in the E60 attaining the ideal axle-load distribution of 50/50.

On the one hand, an aluminum body section offers reduced shielding against external electrical radiation, making it necessary for separate shielding of the wiring harnesses and electronic control units.

On the other hand, riveted and bonded aluminum components do not always provide a guaranteed circuit to ground. This results in individual front end components being connected (in production) with small EMC safety weld seams and in the event of repair, with grounding straps.

1. Spring Support
2. Engine Support
3. Bulkhead carrier support
4. Outer connection (steel)
5. Bulkhead Cross Member
6. Bulkhead
7. Inner A-pillar (steel)



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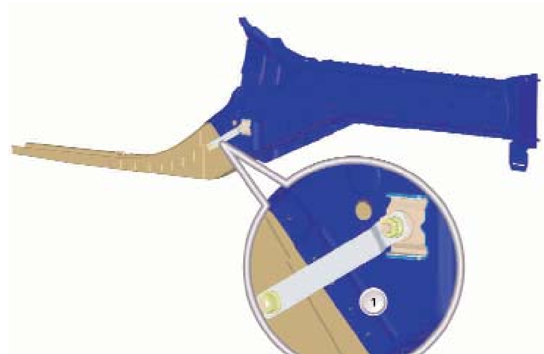
The transition from the aluminum front engine support rail to the steel rail section joint (connection) is produced by bonding and punch riveting.

To increase conductivity, ground points are located on the two rails and are connected with a ground strap.

In addition to the underhood strut tower V- struts (2 lower left), the bumper carrier (1 lower right) and thrust panel (2 lower right) provide additional reinforcement and structural rigidity.



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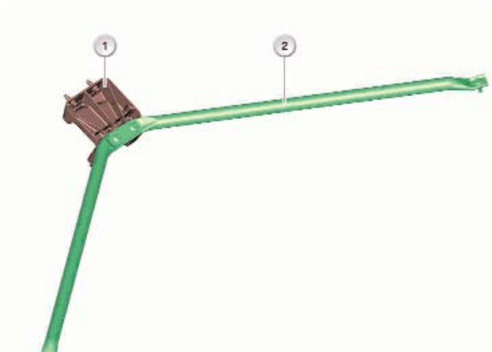

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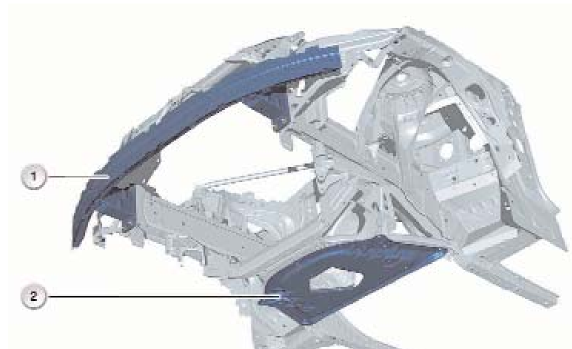

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Note: The V-struts, bumper carrier and thrust panel must be installed and properly torqued before the vehicle is driven. If not, the rigidity of the front end will be considerably reduced leading to noise and <u>structural damage</u>.

The crash box is a deformation element specially developed for the E60.

The crash box is part of the side frame and is secured at the bottom of the A-pillar.

In the event of a frontal crash, the crash box absorbs forces that are transmitted via the front wheel into the side frame in the sill area.

KT-11780

The E60 also integrates the familiar side impact protection gards (steel).

These are bolt on parts that must be replaced when damaged.

KT-02600

Body Repair

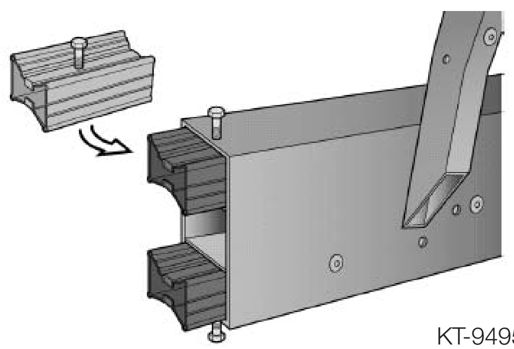
Repairing an aluminum body requires completely new repair methods in body shops with properly trained personnel, as well as proper tools and equipment.

Aluminum materials can not be “stretched”, this rules out the possibility of pulling on a straightening bench. Components deformed as a result of an accident ***must always be replaced***, which incurs more extensive training, tools and assembly procedures than is the case with steel bodies.

Using the frame rail as an example, deformed E60 aluminum components must be cut off at permanently defined points and replaced by new components.

Special insert repair elements made of aluminum are required to ensure that the replacement parts are safely and securely held in place.

The insert element for repairing aluminum (top left) is inserted into profile chambers and then expanded into place by bolts (refer to the E60 SIP for more details).



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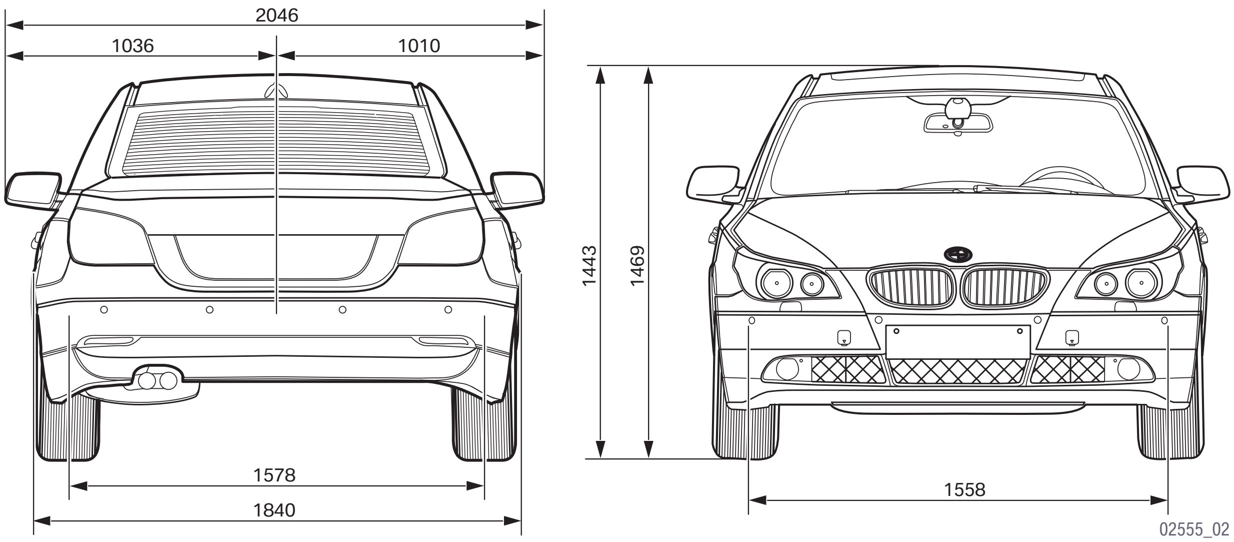
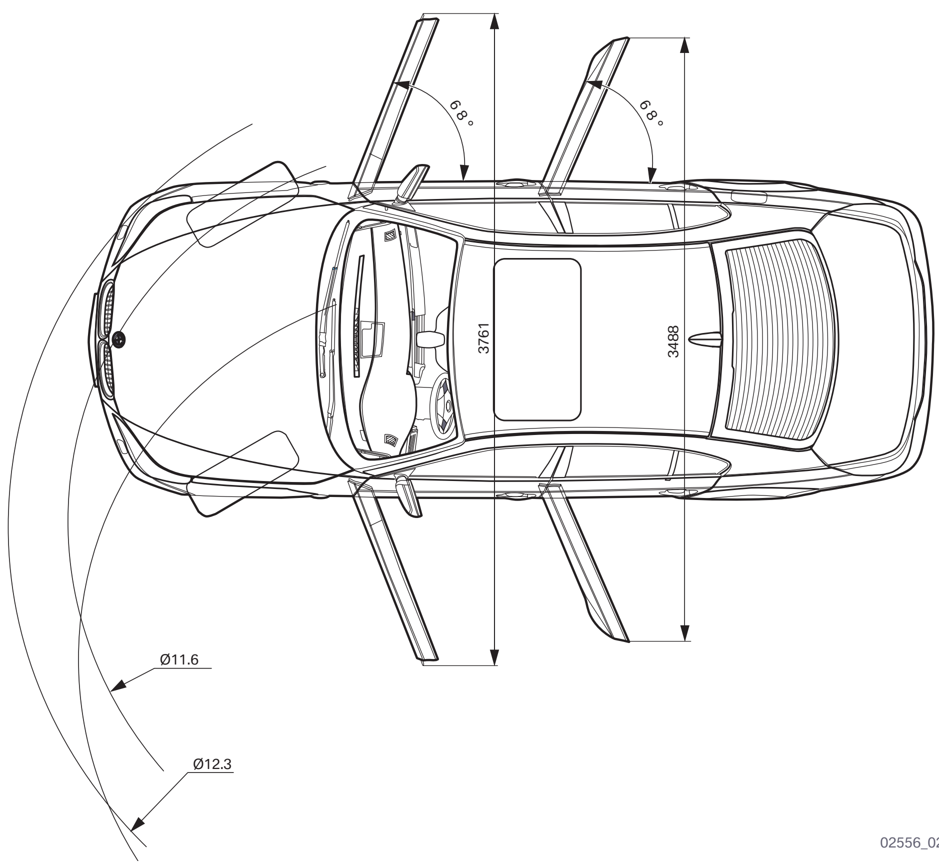
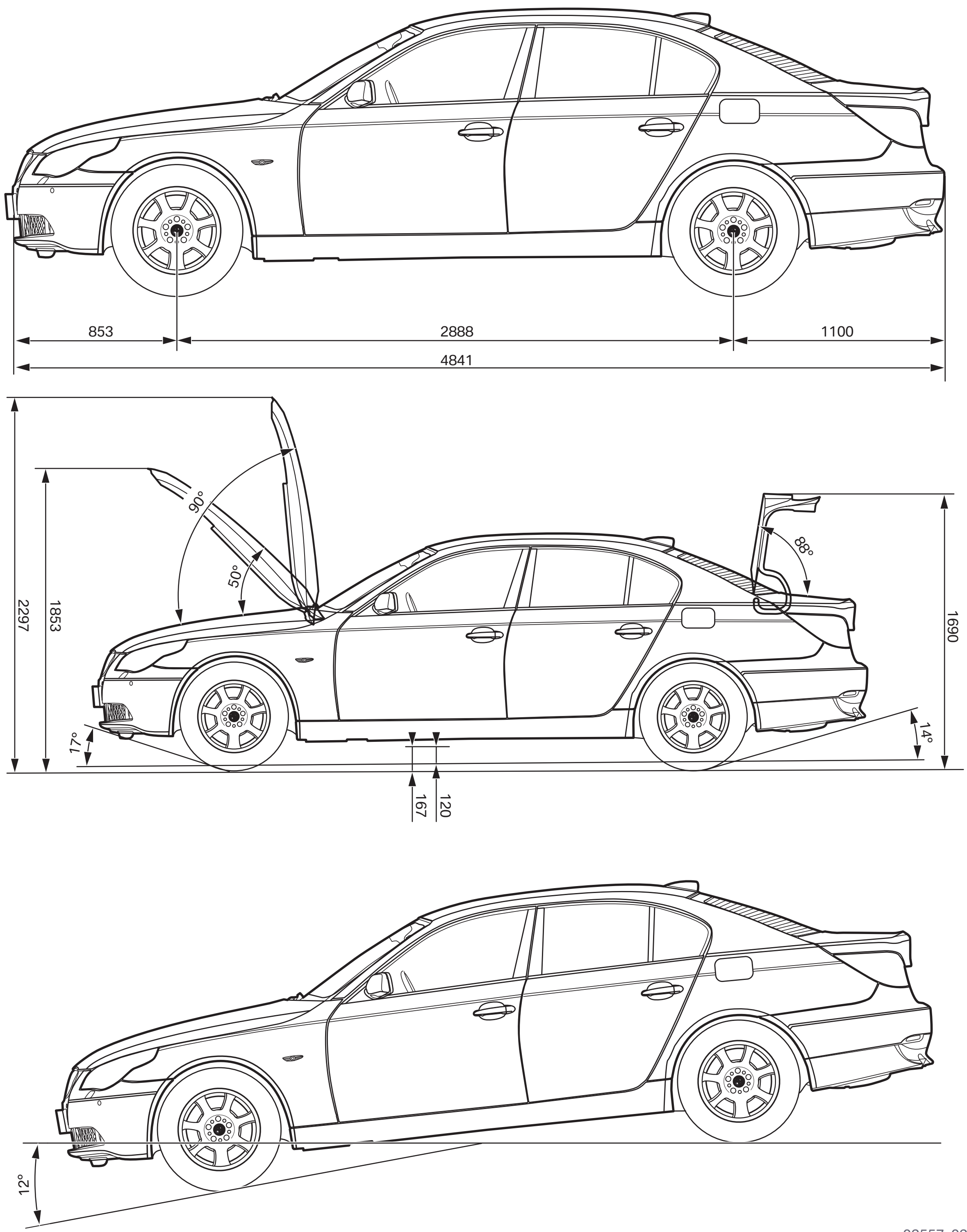
Notes:

Vehicle Data Views - Heights / Widths / Door Angles / Turning Circle





Vehicle Data Views - Lengths / Heights / Hood - Luggage Comp. Angles / Overhang Angle



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Technical Data - Comparison with Predecessor

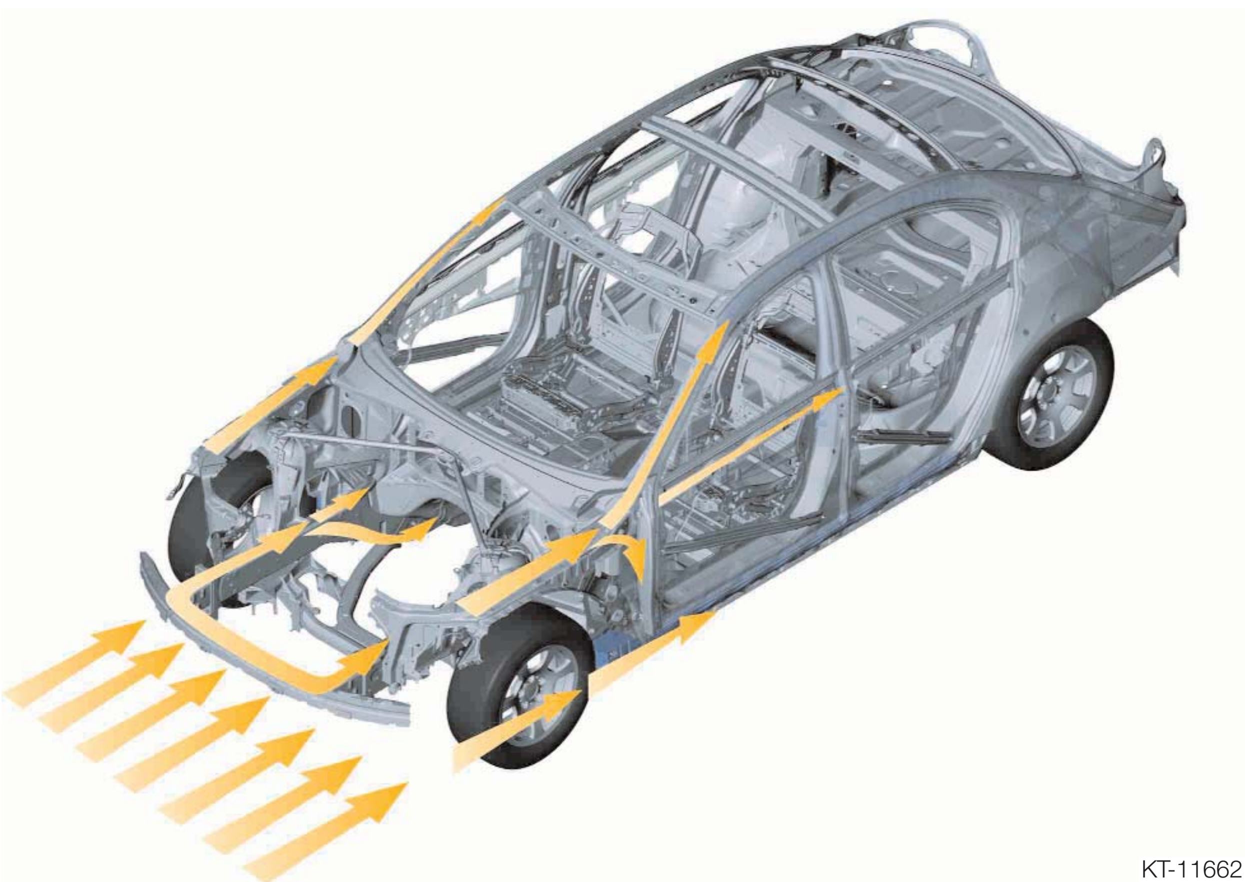
Model (5) Series	E39	E60
Number of doors / seats	4 / 5	4 / 5
Length (mm)	4775	4841
Width (mm)	1800	1846
Height, unladen (mm)	1435	1469
Wheelbase (mm)	2830	2888
Turning circle (m)	11.3	11.4
Track width, front (mm)	1512	1558
Track width, rear (mm)	1530	1578
Shoulder room, front / rear (mm)	1442 / 1420	1455 / 1454
Elbow room, front / rear (mm)	1472 / 1487	1481 / 1496
Head room, front / rear (mm)	984 / 960	991 / 962
Luggage compartment capacity (L)	460	520
Unladen weight as 530i (kg)	1606	1570 (545i = 1695)
Maximum load as 530i (kg)	540	560
Fuel tank capacity L (gal)	70 (18.5)	70 (18.5)

Technical Data - E60

E60 Model Variants (US)	525i / 530i	545i
Engine	M54B25 / M54B30	N62B44
Cylinders, valves per cylinder	In line 6, 4	V8, 4
Capacity (cc)	2494 / 2979	4398
Stroke / bore (mm)	75 / 84 89.6 / 84	82.7 / 92
Power output (bhp) at engine speed (rpm)	184 / 225 6000 / 5900	325 5900
Maximum torque (lb ft) at engine speed (rpm)	175 / 214 3500	330 3600
Compression ratio (:1)	10.5 / 10.2	10.0
Engine management system	Siemens MS45.1 (US)	Bosch ME 9.2
Fuel requirement	Premium unleaded	Premium unleaded

Technical Data - E60 (continued)

E60 Model Variants (US)	525i /530i	545i
Maximum engine speed (rpm)	6500	6500
Manual transmission (6 spd)	GS6-37BZ	GS6-53BZ
Automatic transmission (6 spd)	ZF GA6HP19	ZF GA6HP26
Final Drive Ratio (:1)	3.15 (M) 3.73 (A) / 2.93 (M) 3.46 (A)	2.93 (M) 3.38 (A)
Aerodynamic drag	.28 / .29	.29
Wheels (std)	Cast Alloy 17 x 7.5	Cast Alloy 17 x 7.5
Tires (std)	225/55 R16 225/50 R17	225/55 R17
Battery (Ah/A/CCA)	110, 850A, 850CCA	110, 850A, 850CCA
Alternator (A/W)	140 / 1960	170 / 2380



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Front Bumper System

The bumpers are integrated in the vehicle structure. The front and rear one-piece plastic bumper panels are finished in body color and wrap around as far as the wheel arches. There are differences between the EU and US country-specific versions due to the different legal requirements regarding certain impact speeds (4 and 8 km/h). The front cross-panel is made entirely of aluminum. The components of the cross-panel are finished in an electrodeposition dip-coating process.

Removing and Refitting the Front Bumper Trim Panel

- Remove the screws attaching the trim panel to the wheel-arch liners

- Remove the three lower grill inserts (snap out) and remove the lower trim panel screws (under the bumper cross member)

- Un-snap and remove the hood seal assembly (flat blade screw driver will assist in releasing the snaps)

- Remove the bolts attaching the trim panel to the top mounting bracket (front cross-panel)

CAUTION!
Once all fasteners have been removed, push the bumper trim panel rearwards (at each corner) and pull the corners out to slide it out of the side mounting brackets (the trim panel has locking hooks). ***Failure to do so will cause damage!***

- When refitting the front bumper trim panel, the headlamps must first be adjusted and aligned with the side panels (see headlight section)

- The bumper trim panel is clipped into the side mounting brackets

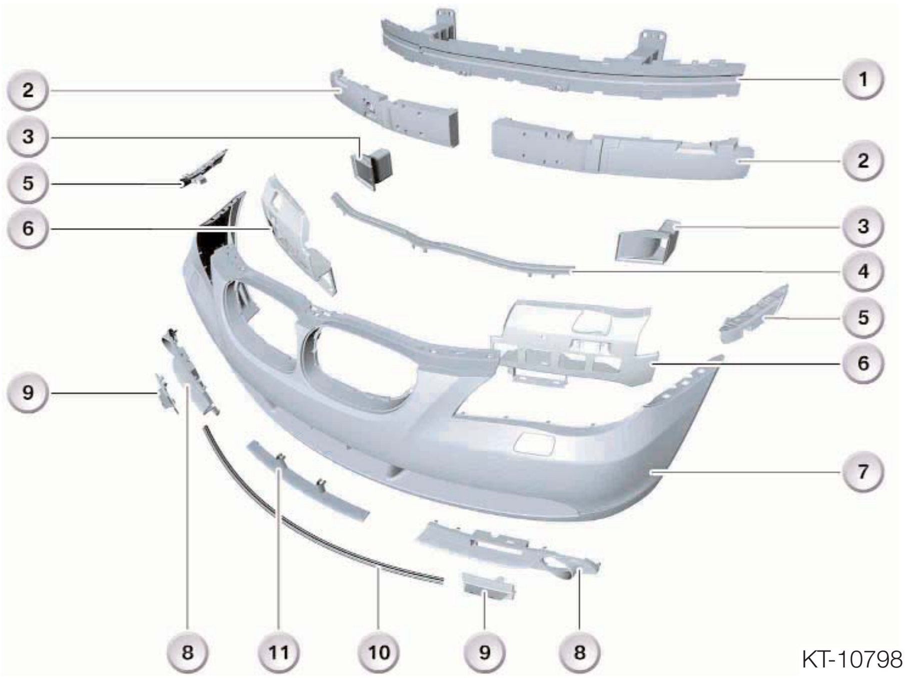
- The bumper trim panel is aligned with the headlamps

- Tighten all bolts and wheel-arch liner screws.

Replacing the Kidney Grille

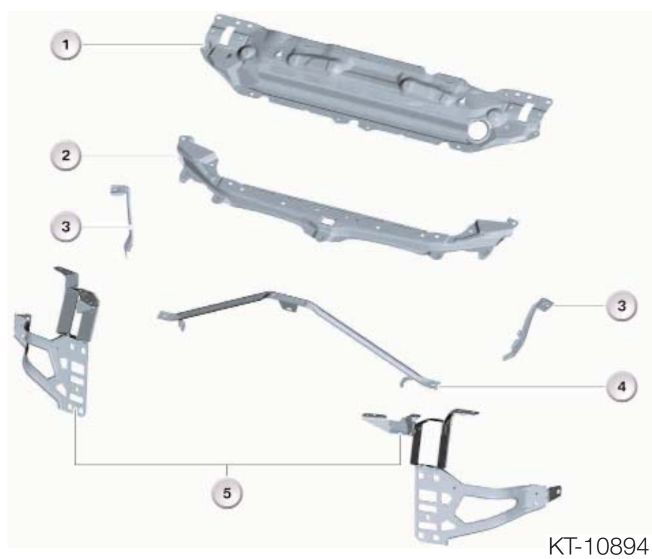
- The bumper trim panel must be removed in order replace the kidney grille.

Workshop Exercise - Front Bumper System Removal



1. Bumper cross-member with deformation elements
2. Impact absorber
3. Brake air cowl
4. Hood seal
5. Bumper trim panel side mounting brackets
6. Side bumper inserts
7. Bumper trim panel
8. Side air grilles
9. Blanking plates for the brake air cowls (model specific)
10. Vibration damper strip
11. Center air grille

Record the steps and fasteners removed during those steps as you remove the front bumper system:



1. Top connecting plate
2. Top mounting bracket for bumper trim panel
3. Lower side panel bracket
4. "V" brace
5. Side supports

Headlights

The Adaptive Headlight (AHL) function is available as an option. It is offered in combination with the Bi-xenon headlights. This feature allows the low beam headlamps to swivel around the vertical axis. This means that the headlights can illuminate the curve of the road more effectively when negotiating bends.

Adaptive Headlights improve night-time visibility by continual adjustment of headlight aim to suit the curvature of the road. Illumination of the curve of the road allows the driver to follow its course more easily instead of having to drive into a "black hole." Dynamic headlamp aim adjustment improves peripheral awareness and reduces the risk of accidents.

1. Design feature (with bi-xenon headlights contains LEDs for side marker light)
2. Direction indicators
3. Reflector for low headlights
4. Fibre-optic ring lights for side lights
5. Reflector for high beam headlight

KT-11137

Halogen Headlights

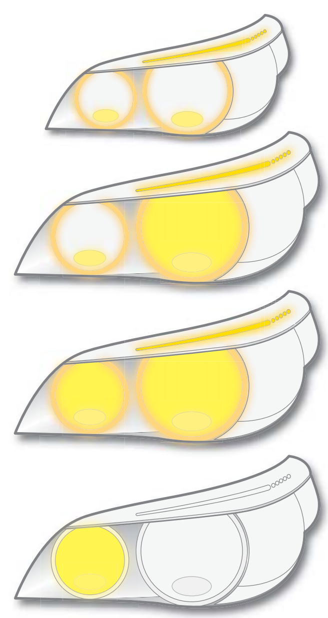
The headlamp reflectors are framed by fiber-optic ring lights. The side light function is effected by the two reflectors. Above the direction indicators is a PCB with 6 LEDs and a fiber-optic tube to perform the side marker light function (not separately replaceable). The direction indicator function is performed by a 21W long-life bulb.

For parking lights, a 5W bulb supplies the fiber-optic ring light and produces a hot spot in the lower part of the reflector.

The low beam headlight function is performed by an H7 long-life bulb in each of the outer reflectors.

The high beam headlight function is performed by an H7 long-life bulb in each of the inner reflectors.

The flash to pass simply uses the high beam light only.



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Bi-xenon Headlights (optional)

Bi-xenon headlights are only available as an option in combination with the Adaptive Headlights feature (for additional detailed information, refer to AHL section). A dynamic beamheight adjustment function is also incorporated in the Bi-xenon headlight package.

The Bi-xenon bulbs are fitted in the outer reflectors. On each Bi-xenon headlight there is a stepper motor for adjusting the position of the Bi-xenon bulb. The Bi-xenon control units and the stepper motor controllers (SMCs) are located next to each other on the underside of the headlamp units.

The stepper motors are not fitted with motor position sensors, the zero position is detected by the zero position sensor (below the Bi-xenon bulb). The zero position is sensed by changes in inductivity.

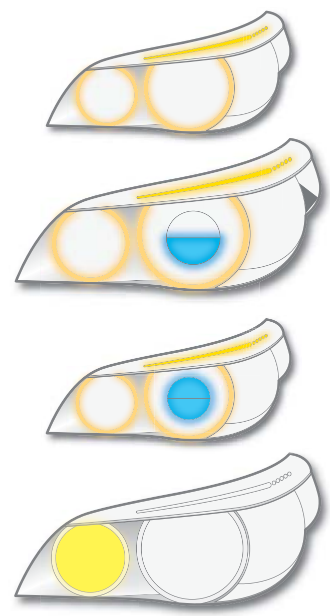
The direction indicator function is performed by a 21W long-life bulb. Above the direction indicators is a PCB with 6 LEDs and a fiber-optic tube to perform the side marker light function (not separately replaceable).

For parking lights, the headlamp reflectors are framed by fiber-optic ring lights. The ring lights are supplied by a 10W bulb with a reflector. The reflector is in the headlamp unit near the high beam headlight.

The low beam headlight function is performed by a Bi-xenon bulb (D2S) in each of the outer reflectors. The Xenon control unit controls the Bi-xenon bulb function (low beam/high beam).

The high beam headlight function is performed only by the Bi-xenon lights and not by the halogen lights in the inner reflectors.

In each inner reflector there is an H7 long-life bulb, which is used for the flash to pass function.



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Notes:

US-Version System Functions

The country-specific US version incorporates the following functions that differ from the EU version:

- High beam headlights. If Bi-xenon bulbs are fitted, the high beam headlight function is performed only by the Bi-xenon lights and not by the halogen lights in the inner reflectors.

- Daytime lights. The daytime lights function is performed by the fiber-optic ring lights.

Workshop Hints

The lens is permanently bonded to the headlight unit casing. The headlight units are adjustable along the x, y and z axes. Vertical adjustment of the headlight units is performed by the inner socket-head adjuster screws. Horizontal adjustment of the headlight units is performed by the outer socket-head adjuster screws.

- The bulbs in the halogen headlights can be replaced with the headlight unit in place.

- ***Replacement of the bulbs in the Bi-xenon headlights requires removal of the headlight unit.***

Headlight Unit Removal and Installation

Note: It is suggested to mark the headlight location around the adjustment mounts and attaching screws before removal.

- The headlight unit is removed by removing the top 2 screws from the front crosspanel and the bottom 2 screws from the mounting bracket.

- The headlight unit is removed forwards and then lifted upwards, detaching one main harness connection. The stepper motor for the Adaptive Headlights is replaceable.

- For installation, the headlamps must first be adjusted and aligned with the side panels (slides in adjustment slots with bolts loose, up/dn adjustment by a threaded mount). The bumper trim panel is then aligned to the headlamp units.

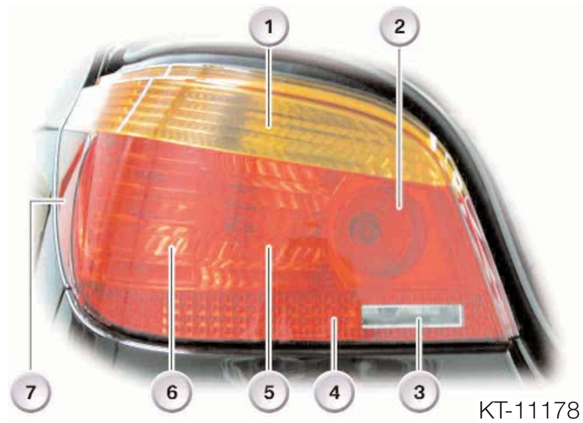
Notes:

Rear Bumper System

Rear Light Clusters

Each rear light cluster is attached to the body by 4 bolts and nuts. Between each rear light cluster and the body there is a gasket seal. The rear light clusters are subdivided into compartments:

1. Direction indicator
2. Brake force light
3. Reverse light
4. Reflector
5. Tail light/brake light
6. Tail light/brake light
7. Side marker light



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The bulbs for the for the tail light, brake light, direction indicator and brake force light are all held in a common bulb holder with a central connector. All of those lights use 21W long-life bulbs. The reverse light has a separate bulb holder (16W bulb). The lower part of the rear light cluster contains a reflector.

The tail light function is performed by two of the rear light cluster compartments. The light is provided by the 21W long-life bulbs in each compartment, which are dimmed to 6 to 7 Watts.

The brake light function is performed by a 21W long-life bulb in the outer compartment of each rear light cluster. For the Brake Force Display system, the inner rear light cluster compartment is used as an additional brake light.

The direction indicator function is performed by a 21W long-life bulb. The reverse light function is performed by a 16W long-life bulb on each side (which is replaced with the holder).

US-Version System Functions

- Side marker light. The outer partition of the outer compartment of the rear light cluster has an opening through which the tail light illuminates the rear side marker light.

- Brake Force Display. To improve the reaction of other drivers in a panic stop, the E60 has a Brake Force Display System. If an extreme deceleration rate or ABS signal is detected, the bulbs will receive the full 21 Watts of power and the brake light plus Brake Force Display function is illuminated.

Removing and Refitting the Rear Bumper Trim Panel

- The rear lamp units must be removed before removing or refitting the rear bumper trim panel
- Remove the 4 self-tapping screws on each side of the wheel-arch liners to the bumper trim panel through the side mounting brackets
- Remove the expander rivet on each side of the vehicle attaching the bumper trim panel to each side mounting bracket (below the wheel-arch liners)
- Remove 4 self tapping screws that are screwed through the bodywork into each bumper trim panel side insert from inside the luggage compartment
- The bumper trim panel must be unclipped from the bottom guide (flat blade screw driver will assist in releasing the clip)

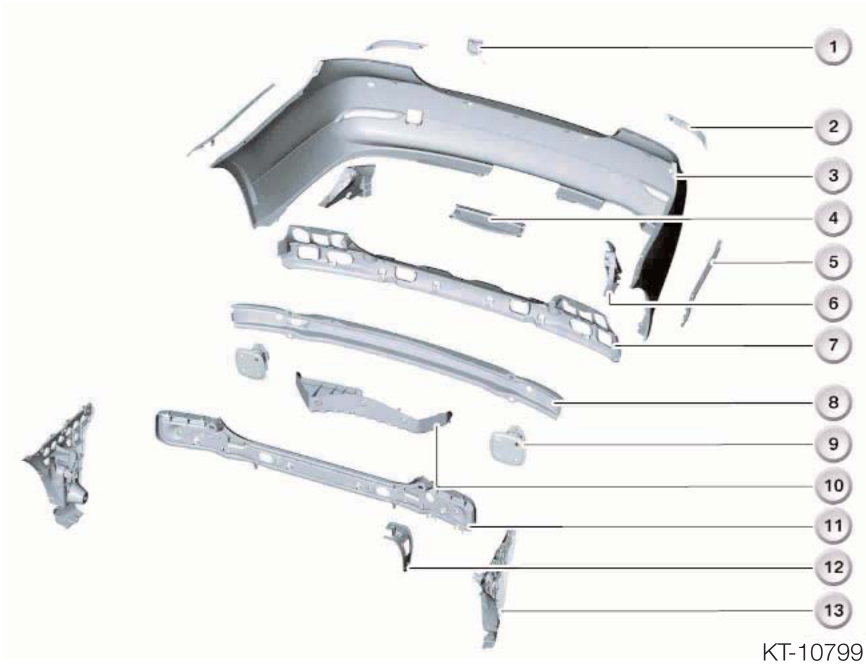
The following points should be noted when refitting:

- From inside the luggage compartment, an Allen key is used to adjust the gap between the bumper trim panel and the body by squaredrive socket-head adjuster bolts in the bumper trim panel side inserts
- After adjusting the bumper trim panel position using the Allen key, the 4 self tapping screws are screwed into the bumper trim panel side inserts from inside the luggage compartment through the same holes in the body panel that were used to access the adjuster bolts.
- Install the rear lamp units and align with the luggage compartment lid and the side panels.

Notes:

Workshop Exercise - Rear Bumper System Removal

1. Bumper trim
2. Bumper cross-member
3. Deformation elements
4. Bumper trim panel bottom guide
5. Bumper trim panel center mounting bracket
6. Bumper trim panel side mounting brackets
7. Locating bracket for bumper left side mounting bracket
8. Bumper cross-member
9. Impact dampers
10. Bracket
11. Support shell
12. Bracket
13. Side mounting bracket



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Record the steps and fasteners removed during those steps as you remove the rear bumper system:

Luggage Compartment and Door Attaching Hardware

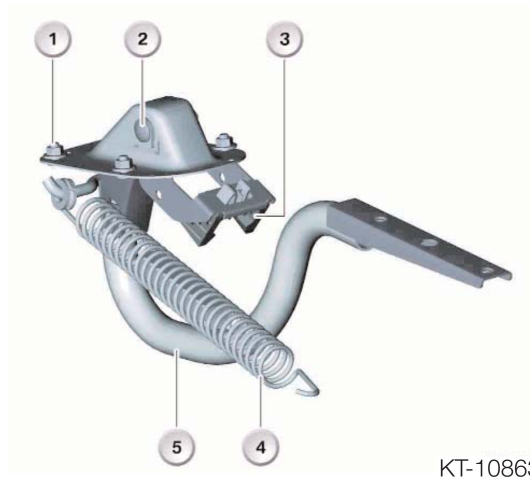
Luggage Compartment Lid Hinges

The hinges (3) are attached to the body attachment flange of the luggage compartment bulkhead by four bolts with self-locking nuts (1). The force of the spring (4) in its effective direction is 700 N.

The hinge arms (5) are attached by carriage bolts (2). These bolts do not have to be held when adjusting the luggage compartment lid height (up/dn).

Only the nuts have to be loosened, which can be accessed through plugs in the upper shelf (under the rear window) from the luggage compartment (as shown by arrow on right).

There are 3 attachment points in the spring holder (1) for the spring (2) which change the opening and closing force of the luggage compartment lid.



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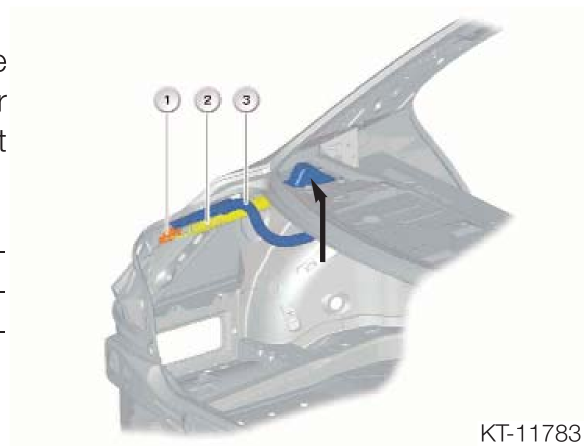

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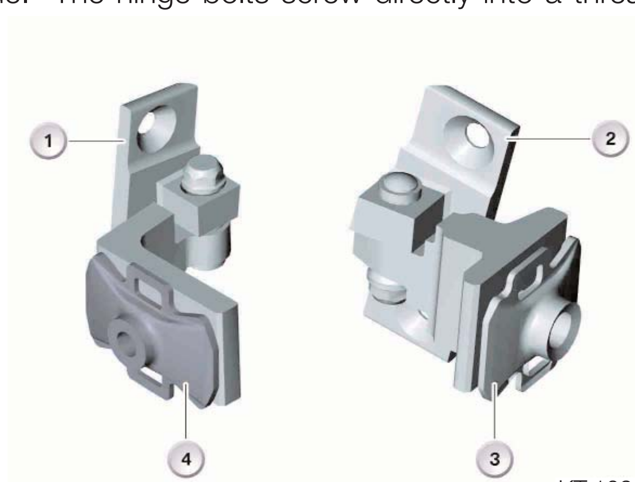
Door Hinges

The front doors are attached to the A-pillar by two hinges each held by a central bolt (M12) and a specially shaped brace plate. The brace plates are inside the A-pillars. The hinges are bolted onto the pillars from the outside. The hinge bolts screw directly into a thread inside the brace plates.

Like the front doors, the rear doors use the new hinge design with a central hinge bolt (M12). In this case, however, the bolt is inserted through the B-pillar from the inside. It then screws directly into a thread inside the hinge backplate.

1. Door attachment plate, front door hinge
2. Door attachment plate, rear door hinge
3. Hinge brace plate (attaches to B-pillar), rear door
4. Hinge brace plate (attaches to A-pillar), front door

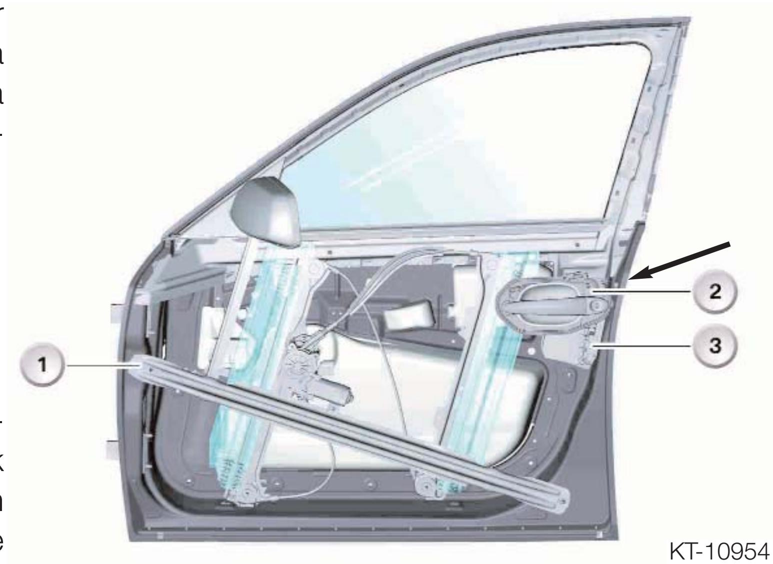


KT-10957

Doors and Exterior Door Handles

The doors are composed of a door outer panel, a door inner panel, a door outer skin reinforcing bar, a lock plate and a diagonally mounted side-impact bar.

1. Diagonally mounted side-impact bar
2. Exterior door handle mounting plate with door handle and recess plate
3. Lock



KT-10954

The door control module is integrated in the door. The door lock is an L-type lock that has been used on the basic version of the E65 since 09/02.

The exterior door handle is a three-piece assembly. It consists of a mounting plate fitted from the inside, a handle recess plate fitted from the outside and the handle fitted and screwed onto the recess plate from the outside (access screw from outside - arrow, above).

Workshop Exercise - Exterior Door Handle Removal

The Instructor will demonstrate the proper door handle release and attachment procedure using mockup parts and special tool. This will familiarize you before attempting "on vehicle" removal. After the demonstration is completed, proceed to "on vehicle" removal and installation.

Caution: Lift handle until access hole (to screw) is exposed and insert tool to engage in screw, <u>do not overtighten securing screw in either direction!</u>

1. *To remove door handle, turn screw counter clockwise against stop. Pull rear of handle out, pivot and pull handle off of front pin.*

2. *To install handle, position on front pin and swivel into place. Push rear of handle into socket (lightly) until it snaps in (slight resistance). Turn screw clockwise until it seats. Remove tool, release door handle.*

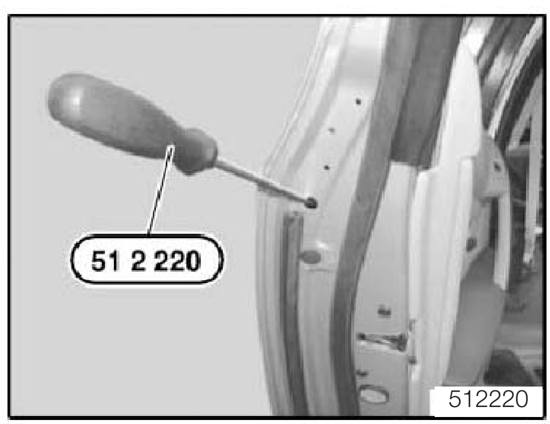


Table of Contents

E60 Engines

Initial Print Date: 08/03 Revision Date: 09/03

E60 Engines

Model: E60 - 525i, 530i, 545i

Engines: M54B25, M54B30, N62B44

Production: Start of Production MY 2004

Objectives:

After completion of this module you will be able to:

- Identify the changes on the M54 Engine as applied to the E60.
- Remove and install the Electric fan.
- Familiarize yourself with the N62B44 from the E65.

M54 Engine

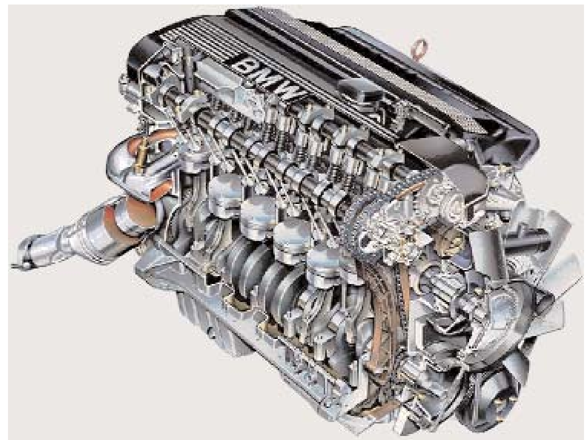
Purpose of the System

The E60 530i is equipped with the M54 engine. The M54 engine is adapted for use in the E60 and the changes include:

- Engine peripherals:
  - Fresh air system Cooling system
  - Exhaust system
  - Ancillary components and belt drive
  - Cooling module (without viscous fan)

- MS45.1 Engine Management System

- Fuel system



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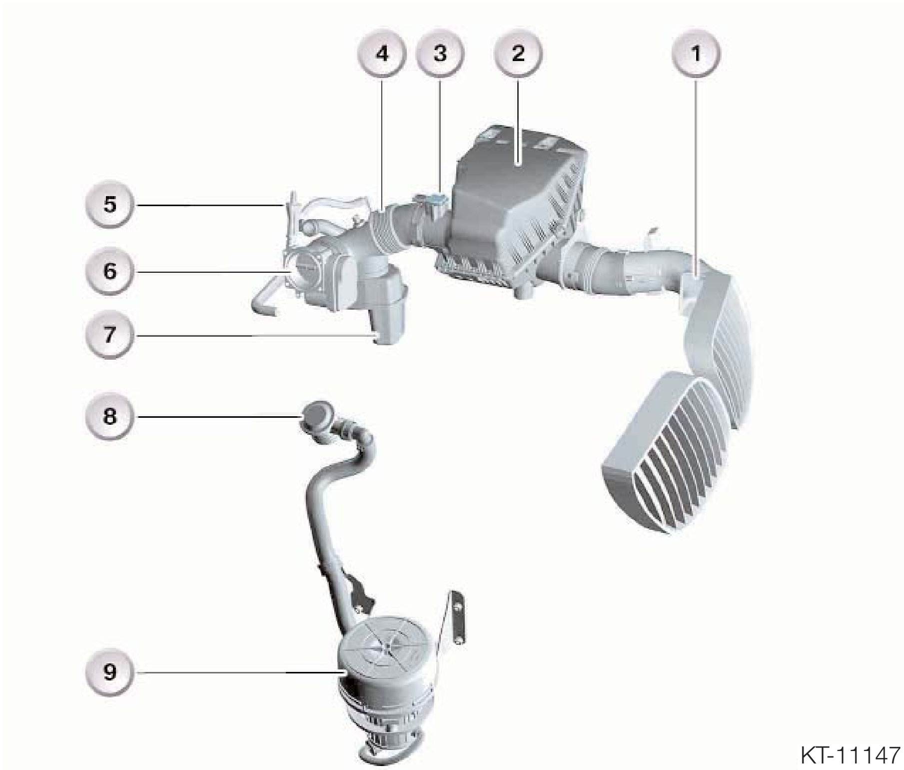
Technical Data

Engine	M54B25 / M54B30
Configuration	6-cylinder in-line
Displacement (cc)	2494 / 2979
Bore / stroke (mm)	84 x 75 / 84 x 89.6
Power output (bhp) at engine speed (rpm)	184 / 225 6000 / 5900
Torque (ft lb) at engine speed (rpm)	175 / 214 3500
Idle speed (rpm) Max. engine speed (rpm)	640 6500
Compression ratio (:1)	10.5 / 10.2
Valves per cylinder	4
Fuel requirement	Premium unleaded
Knock control	yes
Engine management system	Siemens MS45.1 (US)
Emission compliance	ULEV II (US)
Firing order	1-5-3-6-2-4

System Components

Fresh Air System



1. Intake snorkel
2. Air filter housing
3. Hot film air mass sensor (HFM)
4. Intake air boot
5. Suction-jet pump
6. Electronic throttle (EDK)
7. Intake noise resonator
8. Secondary air valve
9. Secondary air pump

Hot Film Air Mass Sensor (HFM)

The HFM is a compact plug in design, it is mounted directly into the clean air outlet of the air filter housing. This design eliminates the grille in front of the HFM. This reduces flow resistance in the air intake ducting, resulting in lower fuel consumption.

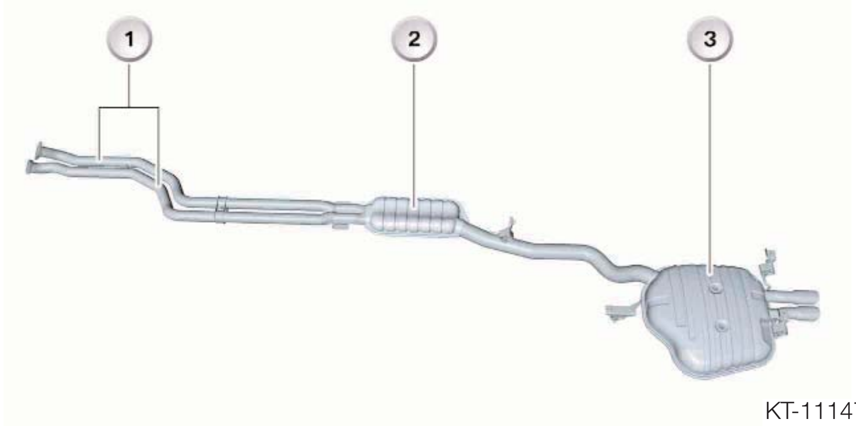
Air Filter

The intake air filter housing has a volume of approximately 13 litres.

Exhaust System

The E60 exhaust system has been specifically developed for the M54 engine.

1. Front pipe
2. Middle silencer
3. Rear silencer



KT-11147

Silencer

The exhaust system is made of stainless steel and is designed as a single unit up to the exhaust manifolds. The exhaust system consists of a middle silencer with a volume of 4.8 litres and a rear silencer with a volume of 26.2 litres.

Note: Regarding service repairs, the middle and rear silencers can be ordered and replaced separately.

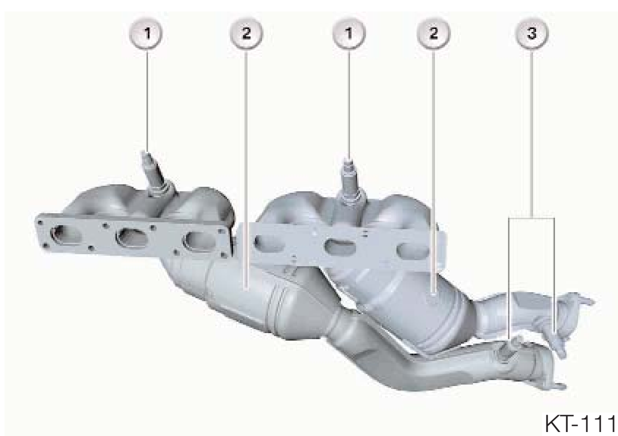
Variants

The shape of the stainless steel exhaust system is the same up to the exhaust manifolds for all engine (M54) and transmission variants.

Exhaust Manifolds

The exhaust manifolds with upstream catalytic converters have been used in previous M54 applications.

1. Oxygen sensors (pre-catalyst)
2. Catalytic converters
3. Catalyst Monitoring (post) oxygen sensors



KT-11152

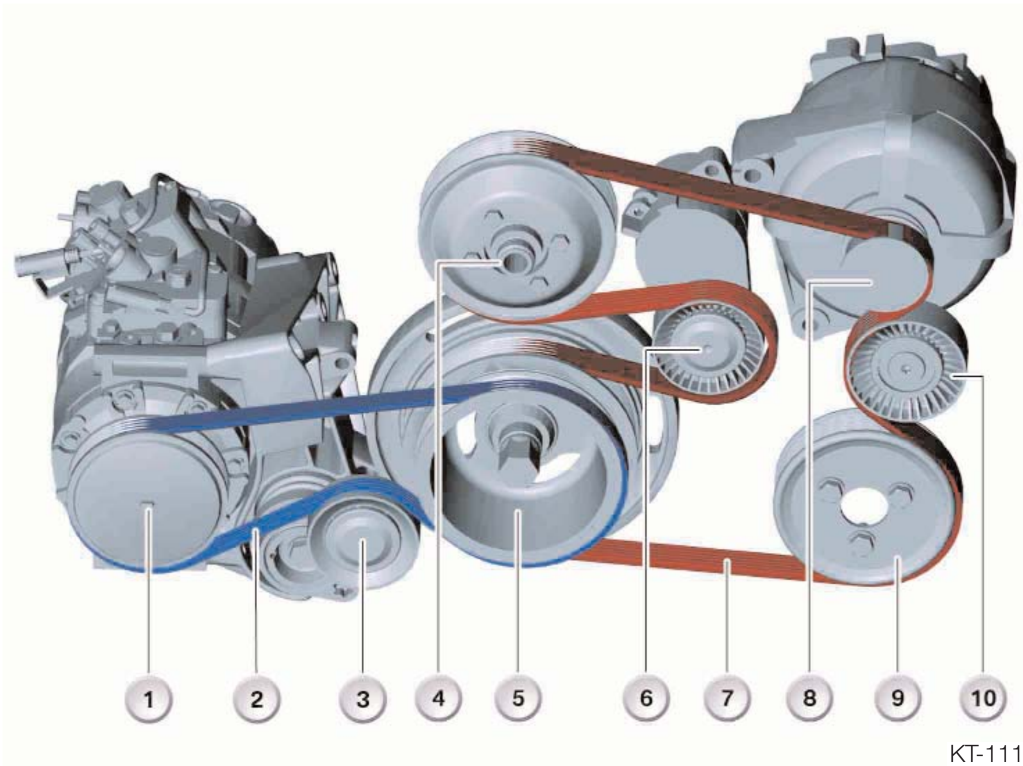
Variants

Depending on the exhaust emissions legislation, the exhaust manifolds have different catalyst coatings (world wide).

Ancillary Components and Belt Drive

Modifications

The alternator is fitted with a deflection pulley. The width of the ribbed V-belt for the A/C compressor drive has been reduced from 5 to 4 ribs.



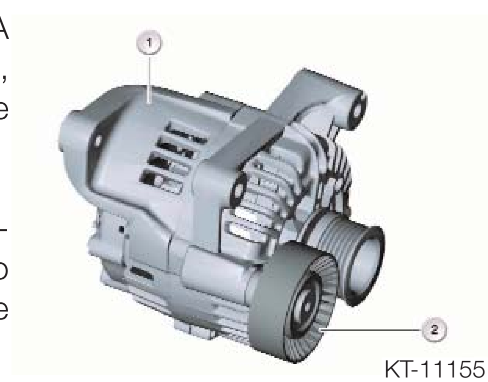
KT-11154

1. A/C compressor
2. Ribbed V-belt, A/C compressor drive
3. Tensioning pulley
4. Belt pulley, water pump
5. Vibration damper
6. Tensioning pulley
7. Ribbed V-belt, main drive
8. Alternator
9. Belt pulley, power-steering pump
10. Deflection pulley

Alternator

A Bosch alternator (1) with a charging current of 140 A is used on the M54. Due to the high alternator output, the alternator is fitted with a deflection pulley (2) for the ribbed V-belt.

The deflection pulley is a component part of the alternator and ensures that the ribbed V-belt is looped to better effect round the alternator pulley. Refer to the ST045 E85 Training Handout for alternator control.



KT-11155

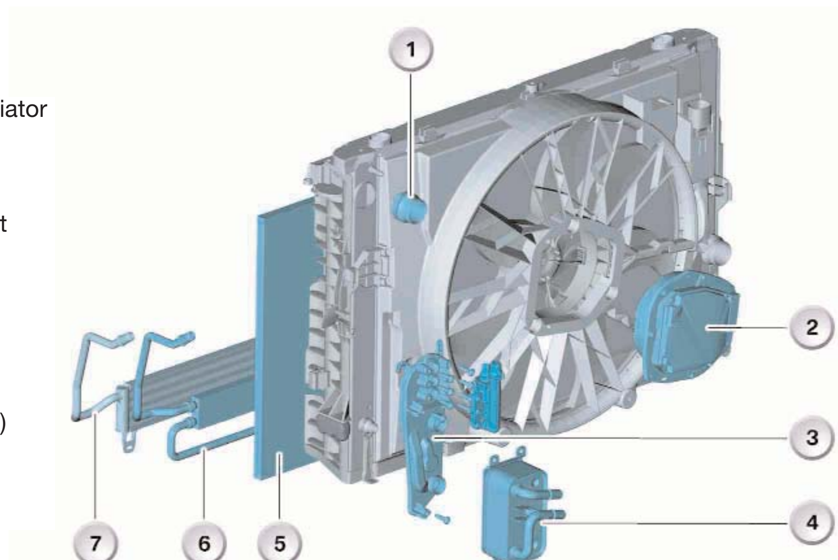
Cooling System

Only the modifications to the cooling system of the M54 for use in the E60 are addressed. The cooling module is similar in design to the E65. The transmission oil cooler for the automatic transmission is identical to that of the E65. ***An engine oil cooler and viscous fan are not used in the E60 with M54 engine.*** No modifications have been made to the cooling system on the engine side.

New Features

- Coolant expansion tank with facility for draining off leakage at the expansion tank cap.
- Lifetime coolant, routine flushing is not required.

1. Coolant connection (upper radiator hose)
2. Electric fan motor
3. Mounting plate with thermostat (transmission-oil cooler)
4. Transmission oil cooler
5. A/C condenser
6. Power steering cooler
7. Cooler for active steering (AFS)



KT-11157

The electric fan is mounted on the fan cowl and acts by drawing air through the radiator. The speed is variably regulated by the ECM.

Note: Automatic transmission equipped E60's with M54 have a 600 W fan.

The coolant expansion tank is located outside the cooling module on the right hand strut tower. The tank is made of black plastic and incorporates a float rod with min. and max. markings to determine the coolant level. A float with a reed contact is located in the base of the tank for the low level warning.

The cap on the expansion tank limits the pressure in the cooling system. The cap incorporates two valves. The pressure relief valve opens from a cooling system pressure of 2 bar. The vacuum valve opens in the event of a small vacuum pressure in the cooling system.

Note: The opening pressures of the cap for the coolant expansion tank differ depending on the type of engine used. The caps for the coolant expansion tank are engine specific and must not be mixed up. The value of the opening pressure is cast into the inside of the cap and can be read off there (e.g. 200 = 2 bar opening pressure).

When the cap opens at a system pressure of 2 bar, it allows pressure to escape and with it coolant from the side. In the previous model series, the coolant left behind contaminants on the expansion tank.

The coolant expansion tank of the E60 is provided with a drain edge all round the cap. This drain edge serves to catch the escaping coolant.

Inside the drain edge is a drain channel which passes through the expansion tank. The escaping coolant is routed through this drain channel to the right-hand wheel-arch trim, where it evaporates.

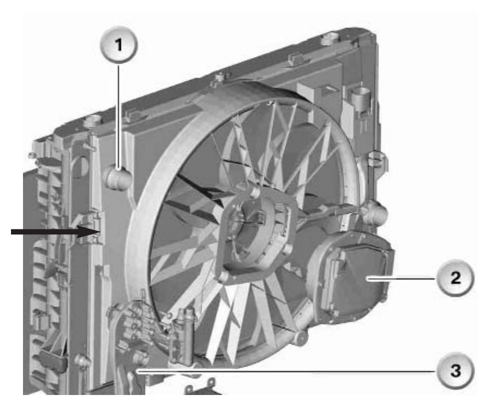
KT-061603

Workshop Exercise - Electric Fan Removal

The electric fan can be removed without removing the coolant connection (1) and the mounting plate with thermostat (3).

With Instructor's assistance, remove the electric fan.

1. ***Remove the top connecting plate (complete vehicle section) and radiator top cover.***
2. ***Lift the fan (slightly) out of the "U" shaped retaining brackets (left and right) and fold in the "hinged" tab (left side - arrow) to gain clearance.***
3. ***Then the electric fan can be removed the rest of the way. The electric fan motor (2) remains in place until the fan assembly is removed from vehicle.***



KT-11157 B

Note: When installing electric fan, remember to unfold the "hinged" tab before fitting into "U" shaped brackets.

N62 Engine

Purpose of The System

The E60 545i is equipped with the N62B44 (NG - New Generation) engine used in the E65. Please refer to ST042 E65 Complete Vehicle Part 2 for additional details and information.

The development objectives were:

- Reduction in fuel consumption
- Reduction in emissions
- Increased power
- Improved torque and torque curve
- Improved engine acoustics

To achieve these objectives, enhancements were made in the following areas:

- Engine mechanicals
- Treatment of exhaust emissions
- Valve timing
- Engine management control
- Intake air flow
- Electric fan only (no viscous fan)

The most important features of the new N62 engine are:

- 8 cylinders in a 90º V configuration
- 2 four-valve cylinder heads
- Light-alloy design
- Newly-developed variable intake manifold
- Valvetronic system

43-02-01

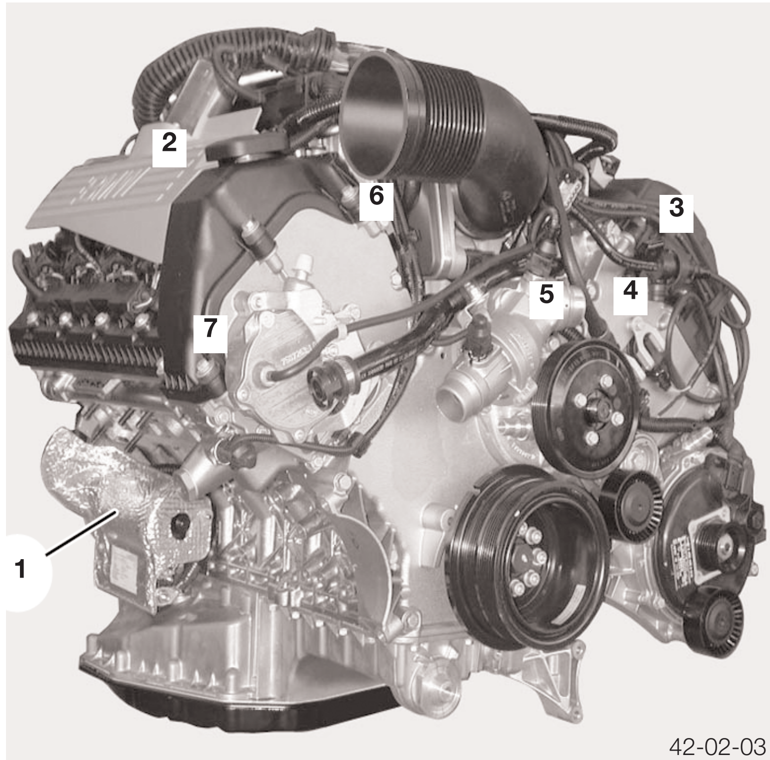
In conjunction with the Variable Intake Manifold, the Valvetronic system adapts the intake valve lift to ensure optimum cylinder filling. The throttle valve use is limited during engine operation to maintain a constant intake manifold vacuum.

Technical Data

Engine	N62B44
Design	8 Cylinder V
V Angle	90°
Displacement (cm3)	4,398
Bore/Stroke (mm)	92/82.7
Cylinder Gap (mm)	98
Main Crankshaft Bearing Diameter (mm)	70
Output (HP) at speed (rpm)	325 5,900
Torque (FT.LBS) at Speed (RPM)	330 3,600
Cut-off speed (RPM)	6.500
Compression Ratio	10.0
Valves / Cylinders	4
Intake Valve Diameter (mm)	35
Exhaust Valve Diameter (mm)	29
Intake Valve Lift (mm)	0.3 – 9.85
Exhaust Valve Lift (mm)	9.7
Cams Open Period (° crankshaft)	282/254
Engine Weight (kg)	213
Fuel	Premium unleaded
Firing Order	1-5-4-8-6-3-7-2
Knock Sensor	Yes
Variable Intake Manifold	Yes
Digital Motor Electronics	ME 9.2 with Valvetronic Control Unit
Complies with Exhaust Emission Regulations	EU-3 EU-4 LEV (US)
Engine Length (mm)	704
Fuel Consumption Saving Compared with the M62	14%

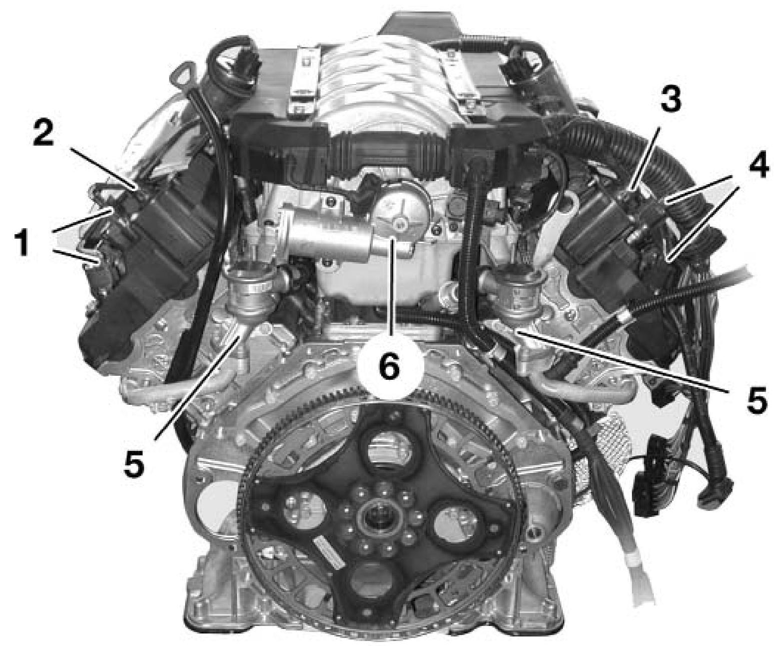
System Components

1. Starter Motor
2. Valvetronic Motor
3. Evaporative Emission Valve
4. VANOS Solenoid Valve
5. Thermostat Housing
6. Throttle Unit
7. Vacuum Pump



N62B44 Engine (Front View)

1. Camshaft Position Sensor Cylinder Bank 5-8
2. Valvetronic Eccentric Shaft Position Sensor, Cylinder Bank 5-8
3. Valvetronic Eccentric Shaft Position Sensor, Cylinder Bank 1-4
4. Camshaft Position Sensor Cylinder Bank 1-4
5. Secondary Air Non-return Valves
6. Servomotor for Variable Intake Manifold



N62B44 Engine (Rear View)

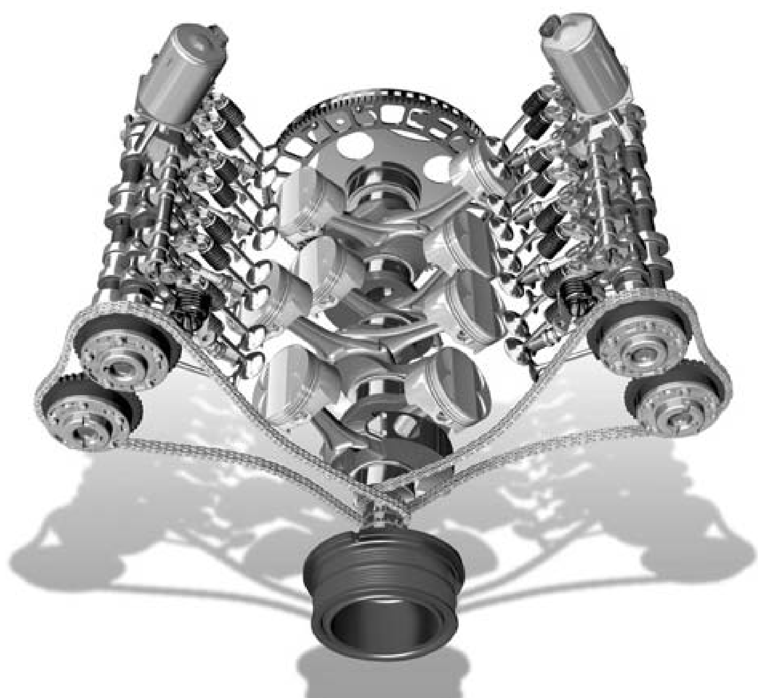
42-02-04

Valvetronic

Over the entire speed and load range, the gasoline engine needs a combustible fuel-air mixture within the ideal ratio (Lambda = 1). The mixture quantity must be altered to vary the speed and output. This variation is effected by the throttle valve. The mixture, which falls within the narrow range of Lambda = 1, is formed outside the combustion chamber using the fuel injection system (external mixture formation).

The mixture control is influenced by the throttle valve and is not optimal in all the different load ranges. This is particularly true in the idle to part-load ranges, since the throttle valve is only opened slightly in these ranges. The consequences are less than optimal cylinder filling, torque and increased fuel consumption.

Technical measures were previously introduced; such as the optimization of air/fuel mixing, improved valve overlap, introduction of DISA and the steady improvement of mixture control all depend on the throttle valve. This is where the completely unique Valvetronic design comes in.



43-02-27

The Valvetronic system simultaneously varies the valve opening time and the valve opening lift between 0.3 mm and 9.85 mm, according to engine speed and load. This means that the air/fuel mixture volume is controlled according to engine requirements. This type of mixture and volume control makes the typical throttle valve control unnecessary.

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E60 Engine Management

Initial Print Date: 08/03 Revision Date: 09/03

E60 Engine Management

Model: E60 - 525i, 530i, 545i

Engine Management:
- **M54B25, M54B30 Engine / Siemens MS45.1**
- **N62B44 Engine / Bosch ME 9.2**

Production: Start of Production MY 2004

Pin Connector: 134 Pins - 5 Modular Connectors

Objectives:

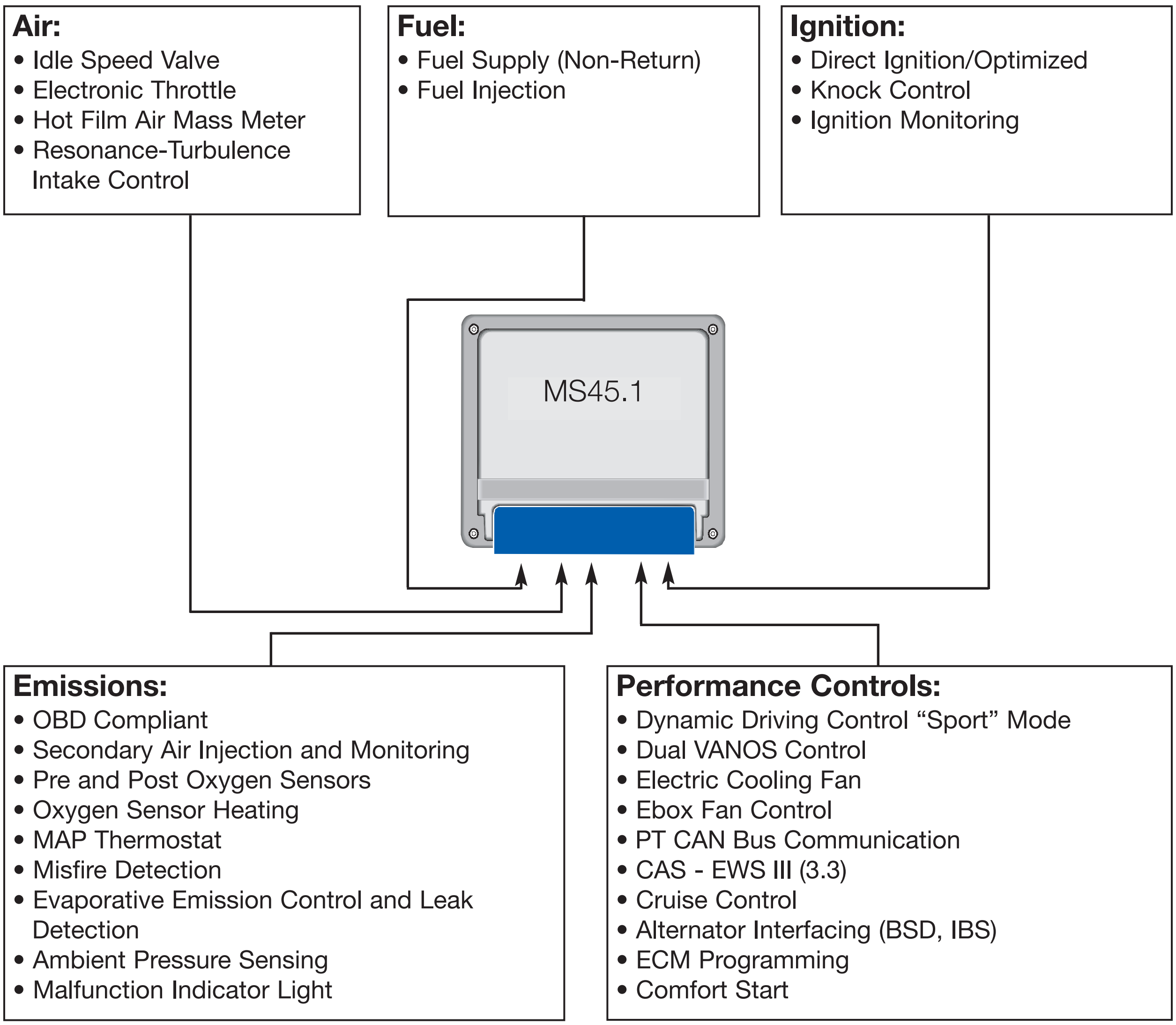
After completion of this module you will be able to:

- Diagnose the IBS via the ECM.
- Understand the Fuel Delivery System including service access.
- Explain the Filler Venting System.
- Diagnose the Mini HFM.
- Explain FDC influence on performance.

MS45.1

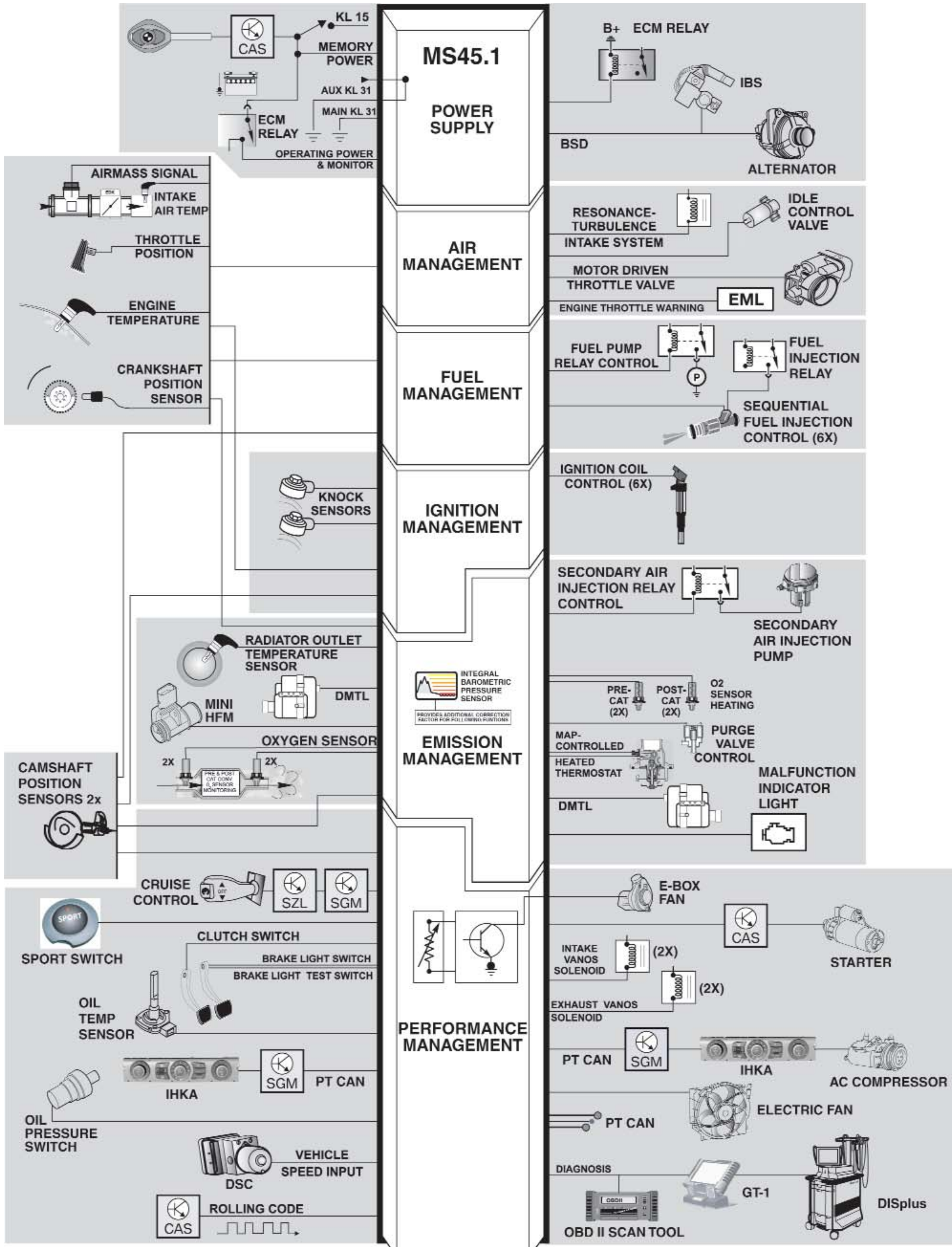
Purpose of the System

The MS45.1 system is a further enhancement of the MS45 system currently used on M54 engines and manages the following functions:



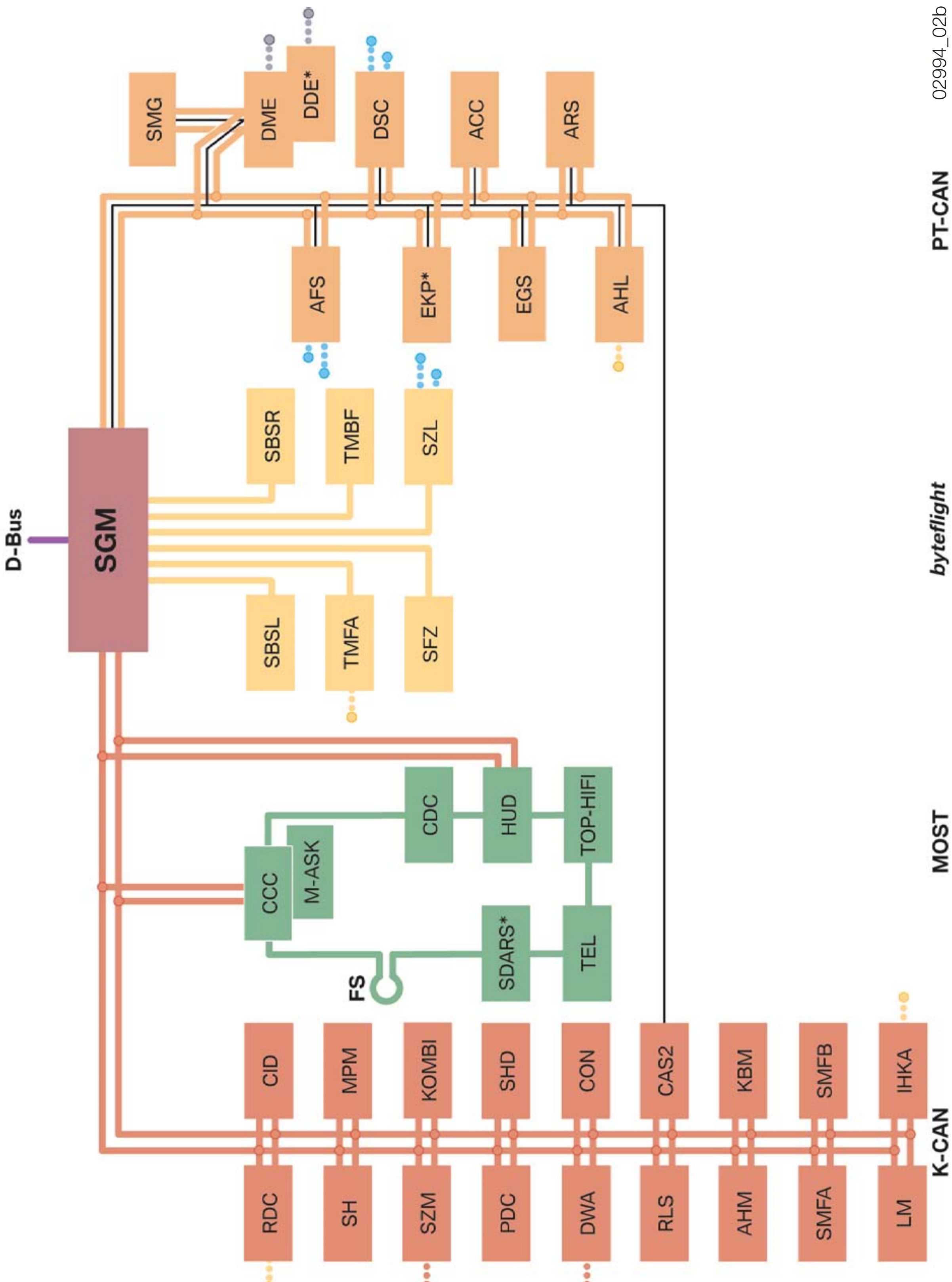
The basic engine management inputs, processes and outputs are not included in this module because they have not changed, refer to the ST055 Engine Electronics Technical Training hand out for additional detailed information. Also, refer to ST045 E85 Technical Training hand out for additional detailed information on the MS45 Engine Management System. *The following section is based on new controls / functions for MS45.1 system.*

System Components: Inputs - Processing - Outputs



MS45.1 Shaded

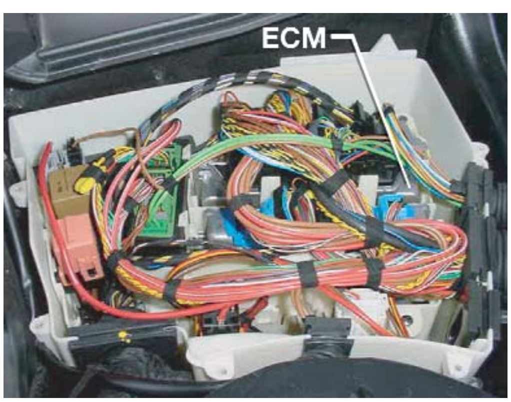
System Components: Bus Overview

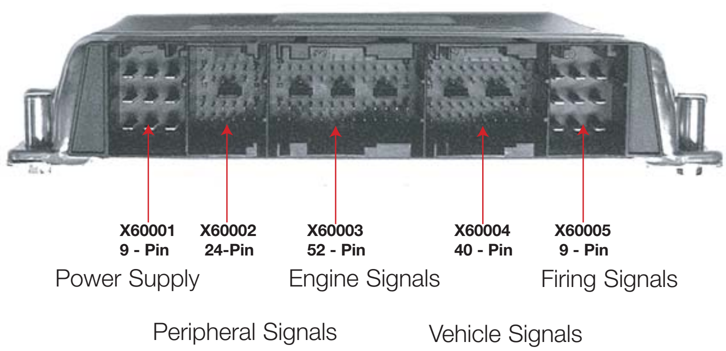


New System Components / Functions

MS45.1 Engine Control Module: The ECM is located in the under hood E box (below). The following modified controls / functions have been made to MS45.1 for use in the E60.

- New hot film air mass sensor (HFM).
- Changed data record variant (matched to E60).
- Lead to the CAS for start enable (starting relay is integrated in the CAS). (automatic/SMG transmissions only).
- The Driving Dynamics control (FDC) signal is transmitted via the PT-CAN.
- The cruise control (FGR) signal is sent from the MFL via the PT-CAN to the ECM.
- Connection of the intelligent battery sensor (IBS) to the bit-serial data interface (BSD).
- The software for power management (vehicle electrical system) is integrated in the ECM.
- The A/C compressor is activated via the PT-CAN.
- Fault diagnosis is performed through the SGM via the PT-CAN to the ECM.
- Activation of the ECM main relay (525i / 530i in E box, 545i in IVM).
- Bosch LSU 4.2 linear lambda oxygen sensors (pre-catalyst as in N62).
- Mini hot film air mass sensor (HFM) in the secondary air system.





The 134 pin ECM is manufactured by Siemens to BMW specifications. The ECM is the SKE (standard shell construction) housing and uses 5 modular connectors. ***For testing, use the Universal Adapter Set (break-out box) Special Tool # 90 88 6 121 300.***

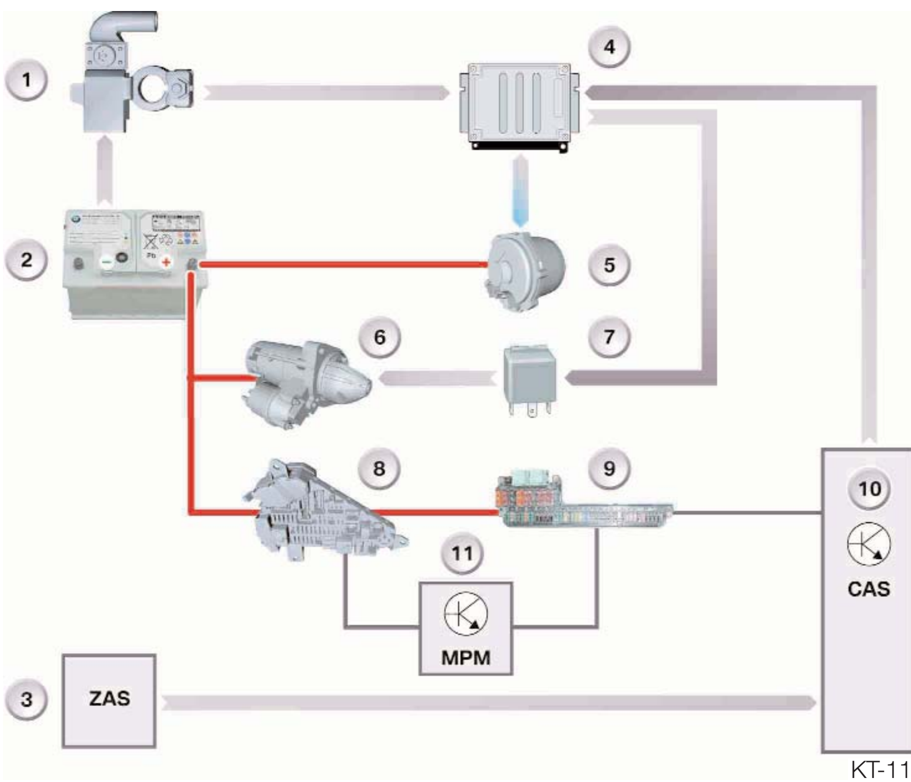
Power Supply

ECM Main Relay

The ECM main relay in the E60 is supplied with power by the ECM throughout the PT-CAN bus activity. Voltage is supplied to all the output actuators (which receive power via KL 87 from the relay) throughout the PT-CAN bus activity.

The activation of main relay (525i / 530i in E box, 545i in IVM) KL 87 is necessary for the function of the bit-serial data interface (BSD). The BSD is supplied with power by the ECM via KL 87 and a pull up resistor. The following components communicate with the ECM via the bit-serial data interface:

- Alternator
- Intelligent Battery Sensor (IBS - refer to Voltage Supply and Bus Systems for more detailed information)



KT-11047

1. Intelligent Battery Sensor (IBS)
2. Battery
3. Ignition / Starter Switch (ZAS)
4. ECM
5. Alternator
6. Starter
7. Integral Starter Relay (525i / 530i in CAS, 545i in IVM)
8. Rear Power Distribution Box w/ Terminal 30g Relay
9. Front Power Distribution Box
10. Car Access System (CAS)
11. Micro-Power Module (MPM)

Lead to Car Access System (CAS)

A lead is installed between the ECM and the CAS for vehicles with automatic or SMG transmissions and the comfort starting function. The CAS contains the function of the electronic immobilizer (EWS - as in the E65) and the starter relay.

The ECM supplies the CAS with the signal for start enable. This facilitates the comfort starting function and prevents starter engagement while the engine is running.

Intelligent Battery Sensor (IBS)

The IBS sends the calculated battery values to the ECM via the BSD. The IBS calculates changes in battery SoC/SoH based on information received from the ECM on the battery during the period of time between engine "OFF" and deactivation of the ECM main relay. After the ECM main relay has been switched off, the IBS continues to constantly observe the SoC of the battery.

Terminal IBS Wake-up

When the key is switched off, before the ECM enters sleep mode, the ECM informs the IBS of the current SoC of the battery. The IBS monitors the SoC and when it drops below the programmed threshold, a terminal 15 wake-up signal is sent to the ECM. The ECM wakes up, obtains information on the current SoC of the battery from the IBS and requests the auxiliary electrical loads to switch off.

After one wake-up sequence the IBS is prohibited from waking the vehicle again during this key off cycle. The vehicle subsequently reassumes sleep mode.

The ECM reads the histogram after starting the vehicle. A corresponding entry is made in the ECM fault code memory if a closed-circuit current infringement is determined.

IBS Diagnosis

The IBS features a fault code memory that is read out by the ECM. Self diagnosis checks the voltage, current, temperature measurement, terminal 15 wake up as well as system errors in the IBS.

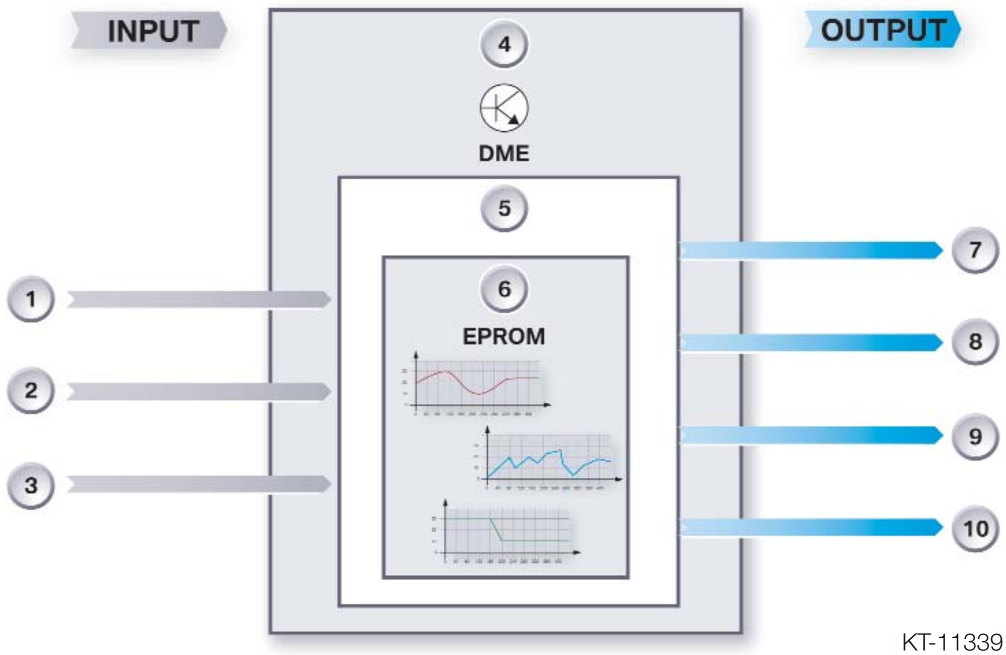
Alternator

Bosch and Valeo alternators are installed in the E60. The alternators are fitted depending on the type of engine and equipment configuration. They differ with regard to their rating of 140 A and 170 A and are aircooled.

Power Management

The power management software is contained in the ECM. When the vehicle is at rest, the IBS is partially responsible for power management. The tasks of the power management system include:

- Adaptation of the alternator charging voltage
- Idle speed boost for increasing the power output of the alternator
- Reduction of peak loads in the event of a shortfall in coverage provided by the vehicle electrical system
- Deactivation by means of bus messages of electric loads such telephone, on reaching the start capability limit of the vehicle



KT-11339

1. Battery Voltage
2. Current Input
3. Temperature Input
4. ECM
5. Power Management
6. EPROM with maps for Voltage,Current and Temp
7. Idle Speed control
8. Specified Alternator Charging Voltage
9. Deactivation of Electrical Loads
10. Peak Load Reduction

Variable Battery Charging Voltage

The variable battery charging voltage function ensures improved charging management of the battery in unfavorable driving situations. The power management controls the temperature dependent voltage for the charging voltage of the alternator via the BSD line.

Idle Speed Boost
The idle speed can be increased in situations where the battery does not cover power requirements. When the specified voltage alone is no longer sufficient, the ECM boosts the idle speed corresponding to the engine status.

Reducing Peak Loads
The peak load of the vehicle electrical system is reduced when there is still a shortfall in battery coverage despite boosting idle speed. Peak load reduction is accomplished by:

- Reducing power output, e.g. by controlling the clock cycles of the rear window defogger
- If reducing the power output is not sufficient, individual electric loads can be switched off in extreme situations

Electric Load Cutout
The electric loads in the E60 are divided into the following categories:

- Comfort loads, e.g. window defogger, seat heating, steering wheel heating

Electric loads switch off automatically after engine "OFF." These electric loads can be activated again after the vehicle has been restarted.

- Legally required auxiliary electric loads, e.g. side lights, hazard warning lights

Legally required auxiliary loads must be operational for a certain period of time after engine "OFF." These legally required electric loads are not switched off even on reaching the start capability limit of the battery.

- Auxiliary electric loads, e.g. independent heating, independent ventilation, communication components such as central information display, telephone, telematic services

Auxiliary loads can be switched on after engine "OFF." The comfort electric loads switch off automatically on reaching the start capability limit of the battery. Switch off is requested by the ECM in the form of a CAN message.

- System related afterrunning loads, e.g. electric cooling fan

System related afterrunning loads can maintain operation for a defined period of time.

Battery Charge Management

There are 2 "counters" in the ECM power management module. One counter is responsible for the battery charge and the other for the battery discharge level. The state of charge (SoC) of the battery is formed by the difference between the charge acceptance and draw level.

The power management calculates the current SoC value on restarting the vehicle. The power management receives the corresponding data from the IBS via the BSD.

Battery State of Health

The IBS measures the drop in the battery terminal voltage and the starting current of the starter when the vehicle is started. The IBS detects vehicle start based on current draw in excess of 200A. The engine running signal is made available by the ECM. Internal resistance of the battery is calculated from the current and voltage drop.

Starting current and voltage drop determined during the start phase are transferred via the BSD to the ECM. From this data, the power management calculates the battery state of health (SoH).

Data Transfer to the IBS

The following data is transferred via the BSD to the IBS before the ECM assumes sleep mode:

- Battery SoC
- Battery SoH
- Outside (ambient) temperature
- Available discharge level
- Terminal IBS wake-up enable
- Terminal IBS wake-up disable
- ECM enters sleep mode

Notes:

Workshop Exercise - Power Supply

1. Where are these components located (in the vehicle) and what are the component numbers?

	525i / 530i	(545i)
ECM Main Relay		
Starter Relay		
Fuel Injector Relay		

2. Where are the Engine Management power supply fuses located?

525i / 530i ______________________

(545i) ______________________

3. Does the 525i / 530i have Comfort Start? ______________________

If yes, what component controls this function? ______________________

(545i) ______________________

4. What new functions do you observe about the mechanical ignition switch (with the key)?

____

____

____

____

____

5. Disconnect the B+ power wire for the IBS (at the battery), is there a Test Plan available?

____

What Diagnosis, Operation and component selection path(s) did you select to discover if a Test Plan was available? ______________________

6. Select Control Unit Functions, Diagnosis Requests. Is there a status under the "Part Functions" column for observing the "Messages and Results" of the IBS? ____________

Air Management

Hot Film Air Mass Sensor (HFM)

A new hot film air mass sensor (HFM) manufactured by Siemens is used for the M54 in the E60. The HFM is located behind the air filter housing in the intake air ducting.

1. Intake air temperature sensor
2. Hot film air mass sensor
3. O-ring

KT-10819

The HFM is inserted in the air filter housing (plug in) and secured with two screws. In this position the HFM is freely suspended in the intake air flow. The HFM is more compact in design than its predecessor and the grill is now omitted. This compact design decreases pressure loss in the intake track.

Its operation and output signals are the same as the previous HFM. The intake air temperature sensor is integrated in the HFM.

Notes:

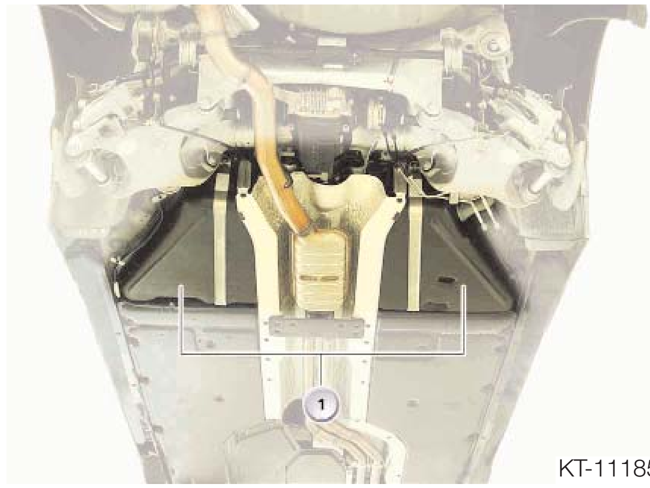
Fuel Management

Fuel Tank

The fuel tank is made of high density polyethylene (reduced weight) layers which is manufactured to meet safety requirements.

The fuel tank has a capacity of 70 litres (18.5 gal), including a reserve capacity of 10 litres.

A mid-chassis mounted "saddle" type tank (1) is used providing a tunnel for the driveshaft but creates two separate lower chambers.



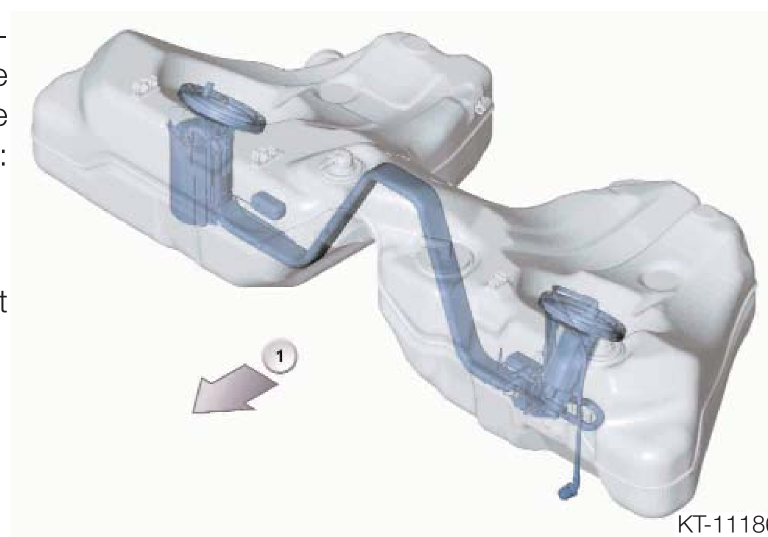
KT-11185

The E60 fuel tank design reduces the potential evaporative emissions. This design reduces the number of external connections and openings by increasing the amount of "in tank" or integral components including molding the filler pipe to the tank.

The fuel tank is held in place by 2 retaining bands. The tank is secured in the middle by a plastic lug formed into the tank. All body contact points are insulated with foam or rubber.

The service access caps are located at the top of the fuel tank. The following components can be accessed from the vehicle interior:

- Right swirl pot, fuel pump, fuel level sensor, suction-jet pump, fuel lines to left tank half and left suction-jet pump.
- Left fuel level sensor, fuel filter and fuel pressure regulator.



1. Towards front of vehicle

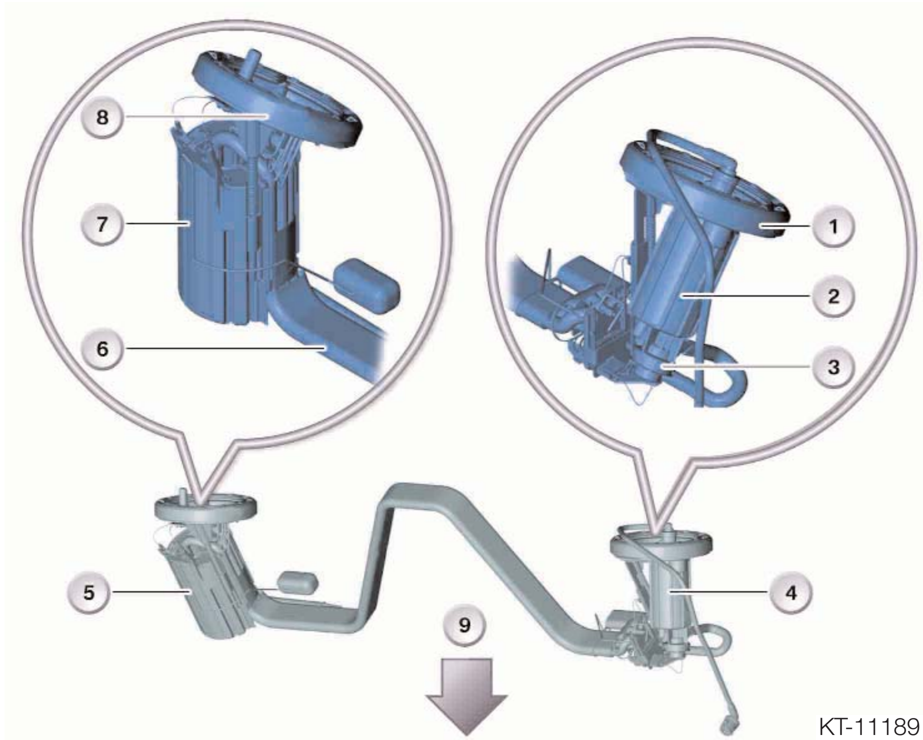
KT-11186

The six pin wiring harness connector is located on the right service cap. The six pin wiring-harness connector has 2 wires for the fuel pump power supply and 2 wires for both fuel level sensors. The fuel feed line is connected to the left service cap with a quick release coupling.

Fuel Delivery Unit

The fuel delivery unit located in the fuel tank ensures bubble free fuel delivery under all operating conditions. In case of service, the left and right fuel delivery units can be removed completely. The two fuel level sensors can be replaced individually.

1. Service access, left
2. Fuel filter
3. Fuel pressure regulator **(3.5 bar)**
4. Fuel delivery unit, left
5. Fuel delivery unit, right
6. Cross over lines
7. Swirl pot
8. Service access, right
9. Tank bottom



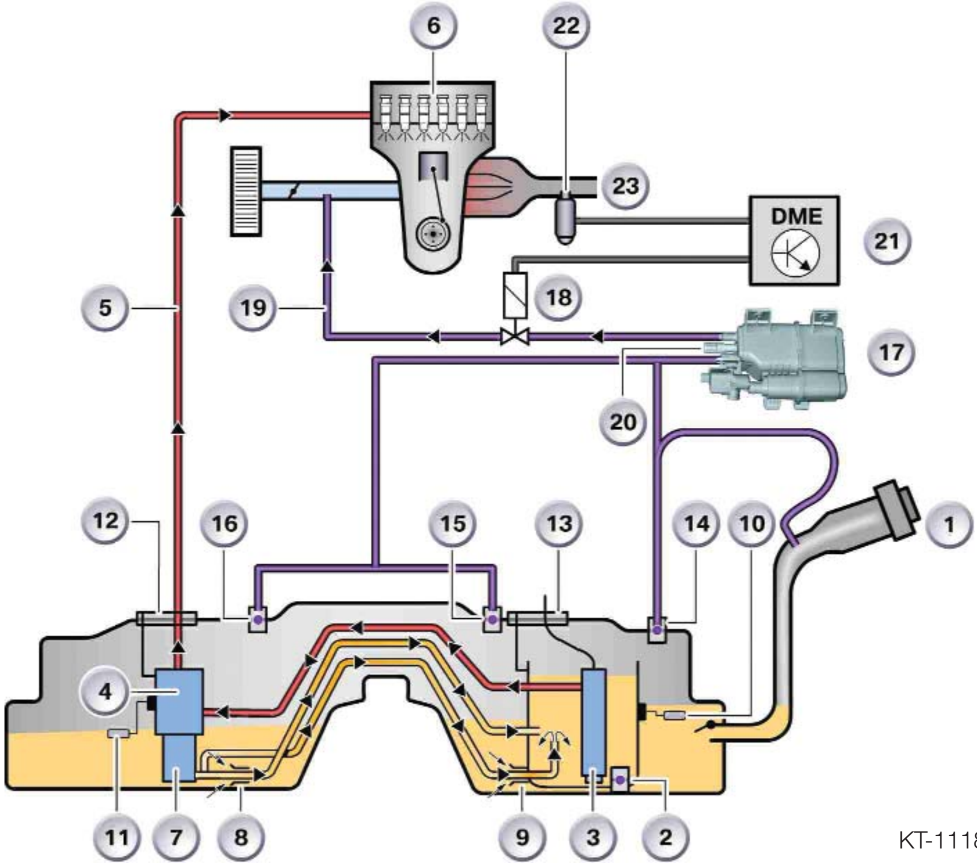
Swirl Pot

The swirl pot contains the electric fuel pump and a suction-jet pump and is open at the top. The base of the swirl pot features an outlet protection valve, which allows fuel to flow from the right tank half into the swirl pot. It prevents the fuel from flowing back into the right tank half (trap).

The swirl pot ensures that the fuel pump is always immersed in fuel so that the pump does not draw in air. Bubble free fuel delivery is very important particularly at low fuel levels and under high driving dynamics conditions when the tank is almost completely empty.

Notes: ____

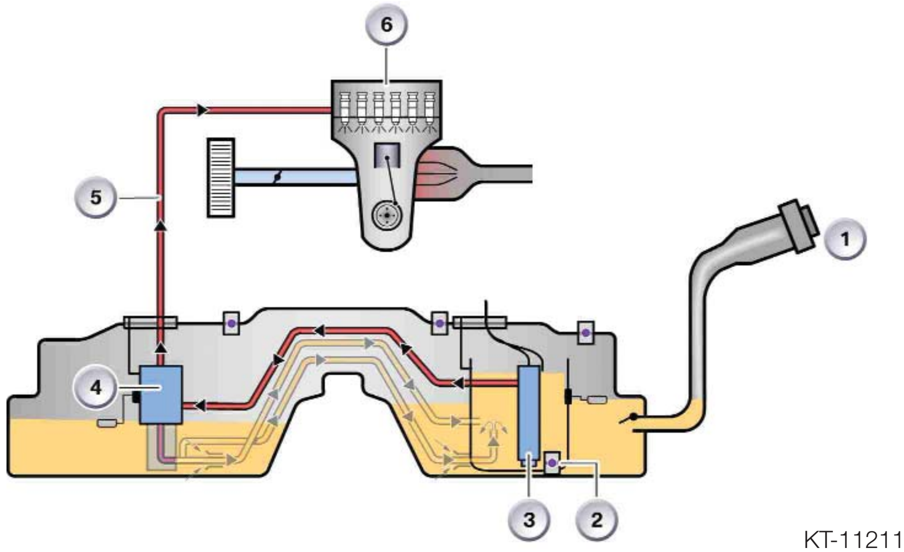
Fuel System



KT-11184

1. Filler neck
2. Outlet protection valve
3. Electric fuel pump
4. Fuel filter
5. Fuel supply line
6. Fuel injectors/rail
7. Fuel pressure regulator
8. Suction-jet pump, left
9. Suction-jet pump, right
10. Fuel level sensor, right
11. Fuel level sensor, left
12. Service access cap, left
13. Service access cap, right
14. Filling vent valve
15. Service vent valve
16. Service vent valve
17. DMTL with activated carbon canister
18. Tank vent valve (evap. purge)
19. Evaporative purge air
20. Air filter
21. ECM
22. Oxygen sensor (pre-catalyst)
23. Exhaust manifold

Fuel Delivery



1. Filler pipe
2. Outlet protection valve
3. Electric fuel pump
4. Fuel filter
5. Feed line
6. Fuel injectors/rail

Fuel Flow: Right tank half => swirl pot => fuel pump => fuel filter => fuel rail.

The fuel is pumped into the right tank half. The swirl pot contains the electric fuel pump. Fuel passes through the valve incorporated in the base of the swirl pot into the swirl pot. When the fuel level is higher, fuel also enters the swirl pot from the top.

The electric fuel pump draws in the fuel from the swirl pot ***(fuel pump relay located in glove-box)***. It pumps the fuel into the fuel filter in the left tank half. The fuel flows from the fuel filter through the feed line to the fuel rail.

Fuel Level Sensors

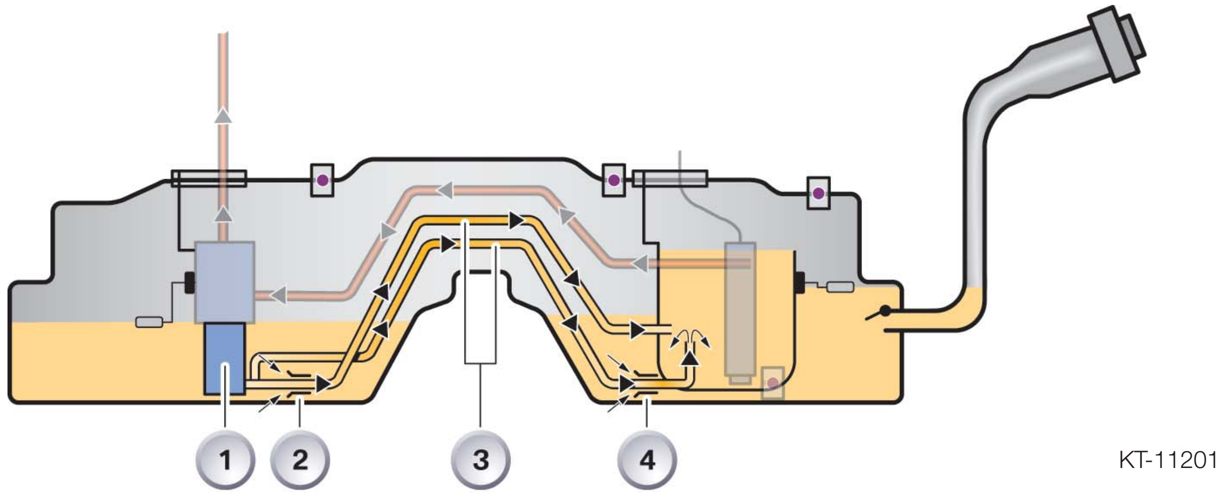
The fuel tank contains 2 sensors, one in each tank half. The tank sensors operate with float elements, which are attached to a pivoted arm (angle measurement). A specific angle of the sensor joint corresponds to each tank chamber fill level.

The sensor joint incorporates a potentiometer with wipers and resistor paths. Every angle has a specific resistance value. The sensor is supplied with 5 Volts by the instrument cluster and measures the voltage drop by the current resistance on which the wiper is resting.

The voltage drop measured is processed in the instrument cluster as follows:

- Conversion into a fuel level for the two chambers (on the basis of a comparison table)
- Display of the fuel level

Fuel Pressure Regulation



1. Fuel pressure regulator **(3.5 bar)**
2. Suction-jet pump, left
3. Return line
4. Suction-jet pump, right

Fuel Flow: From pressure regulator => suction-jet pump in left tank half and suction-jet pump in right tank half => swirl pot in right tank half.

The suction-jet pumps direct the fuel from the left and right tank halves into the swirl pot. This ensures that the electric fuel pump always has a sufficient supply of fuel available.

The fuel filter incorporates the pressure regulator. The pressure regulator is a spring loaded diaphragm regulator, which limits the pressure in the fuel feed line to ***3.5 bar*** (for M54).

When the pressure rises above 3.5 bar, the pressure regulator opens a discharge port. The excess fuel flows back through the discharge port into the right tank half (swirl pot) and drives the two suction-jet pumps (non-return fuel system). The fuel feed line delivers the fuel at 3.5 bar to the fuel rail.

Workshop Exercise - Fuel Management

Using the mock up cut away fuel tank assembly:

1. Remove the service access caps, fuel pump and fuel filter.

Emissions Management - M54B25 / M54B30 Ultra Low Emission Vehicle II (ULEV II)

LEV II - Amendments to Low-Emission Vehicle regulations

At its November 1998 meeting, the Air Resources Board (ARB) amended California's Low-Emission Vehicle (LEV) regulations. The new amendments, known as LEV II, will advance the state's clean air goals through improved emission reduction standards for automobiles. The ARB first adopted LEV standards in 1990. These first LEV standards run from 1994 through 2003.

LEV II regulations, running from 2004 through 2010, represent continuing progress in emission reductions. As the state's passenger vehicle fleet continues to grow and more sport utility vehicles and pickup trucks are used as passenger cars rather than work vehicles, the new, more stringent LEV II standards are necessary for California to meet federally-mandated clean air goals outlined in the 1994 State Implementation Plan (SIP).

LEV II brings the advanced emission controls of passenger cars to light trucks and sport utility vehicles;

- Near-zero evaporative emissions
- Advanced electronic engine management and on-board diagnostic systems
- More efficient catalysts
- Increased engine durability

The SIP is the state's "road map" to attain federal clean air standards by 2010 and includes among its measures strategies to further reduce air pollution from automobiles and other mobile sources. When LEV II is fully implemented in 2010, it is estimated that smog-forming emissions in the Los Angeles area will be reduced by 57 tons per day, while the statewide reduction will be 155 tons per day.

The U.S. EPA has proposed the adoption of more stringent "Tier 2" (II) exhaust emission standards to start with the 2004 model year. The current federal evaporative emission standards are very similar to the current California standards. The more stringent California LEV I and LEV II programs are necessary to attain the national and state ambient ozone standards, and to fulfill the requirements of state and federal law.

Evaporative Emissions Standards

Evaporative emissions from motor vehicles account for approximately half of the reactive organic gas (ROG) motor vehicle emission inventory in the state, and are classified into three types - running loss, hot soak and diurnal emissions.

- Running loss emissions occur when the vehicle is driven.
- Hot soak emissions occur immediately after a fully-warmed up vehicle is stationary with the engine turned off.
- Diurnal (daily, happening every day) emissions occur when a vehicle is parked and are caused by daily ambient temperature changes. Most of these emissions result during increasing ambient temperatures which cause an expansion of the vapor in the fuel tank.

Exhaust Emission Reductions

The LEV II amendments include three major interrelated elements designed to reduce to exhaust emissions:

- Restructuring the light-duty truck category so that most SUVs, mini-vans and pick-up trucks are subject to the same low-emission vehicle standards as passenger cars
- Strengthening the NOx standard for passenger car and light-duty truck LEVs and ULEVs, and changing other emission standards
- Establishing more stringent 2004 and subsequent model year phase-in requirements for passenger cars, lightduty trucks and medium-duty vehicles. They also contain various other changes, including elimination of the TLEV standard after the 2003 model year.

The LEV II Amendments

The LEV II amendments affect passenger cars, light-duty trucks, and medium-duty vehicles. The main elements are:

- Extension of passenger car emission standards to heavier sport utility vehicles and pick up trucks (with gross vehicle weight up to 8,500 pounds) which formerly had been regulated under less stringent emission standards.
- Extension and tightening of the fleet average emission standards during 2004-2010 (a fleet includes all new vehicles from an auto manufacturer)
- Creation of a new super-ultra low emission vehicle (SULEV) category for light-duty vehi cles (SULEV's will only emit a single pound of hydrocarbons during 100,000 miles of driving - about the same as spilling a pint of gasoline)

- Significantly lower oxides of nitrogen emission standards for the low and ultra-low emission vehicle categories, a reduction of 75% from the current LEV standards

- Increased emission control durability standards from 100,000 miles to 120,000 miles for passenger cars and light trucks

- Further reduction of evaporative emissions

- Creation of partial zero-emission vehicle (ZEV) credits for vehicles that achieve near zero emissions. The credits would include full ZEV credit for a stored hydrogen fuel cell vehicle, 0.7 credit for methanol reformer fuel cell vehicles, 0.4 credit for a compressed natural gas SULEV and 0.2 for a gasoline fueled SULEV

- Changes in how the smog index is calculated

- Amendments to the zero-emission and hybrid electric vehicle test procedures

- Removal of a less stringent emission standard that would have resulted in increased sales of new diesel cars, pickups, and SUVs.

E60 Evaporative Emissions

The control of the evaporative fuel vapors (Hydrocarbons) from the fuel tank is important for the overall reduction in vehicle emissions. The evaporative system has been combined with the ventilation of the fuel tank, which allows the tank to breath (equalization). The overall operation provides:

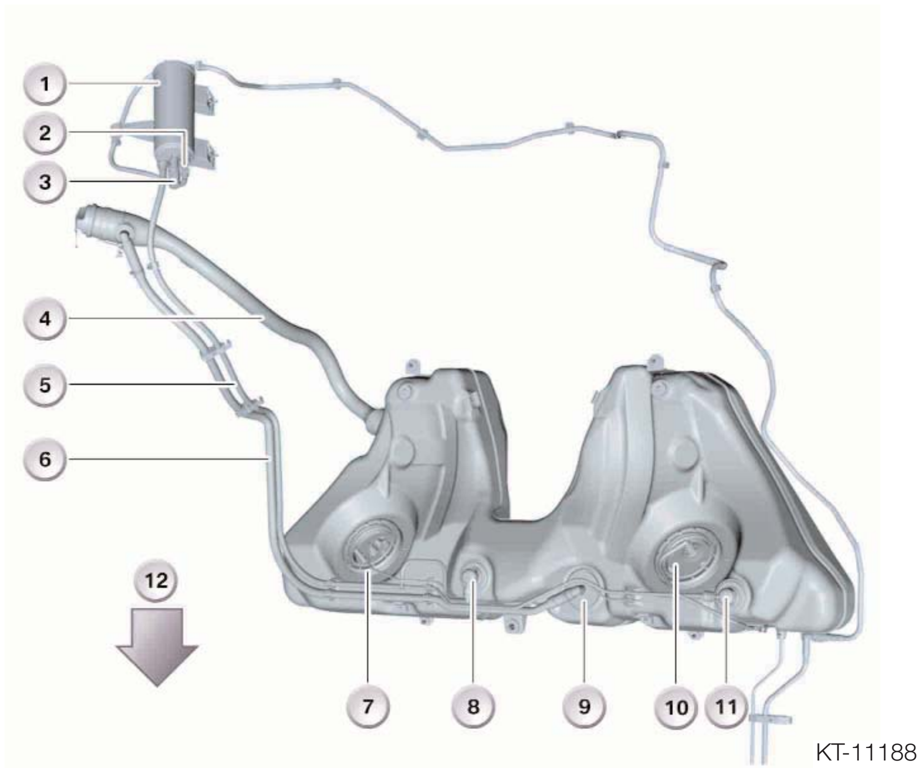
- An inlet vent, to an otherwise "sealed" fuel tank, for the the entry of air to replace the fuel consumed during engine operation.

- An outlet vent with a storage canister to " trap and hold" fuel vapors that are produced by the expansion/evaporation of the fuel in the tank, when the vehicle is stationary.

The canister is then "purged" using the engine vacuum to draw the fuel vapors into the combustion chamber. This "cleans" the canister allowing for additional storage. Like any other form of combustible fuel, the introduction of these vapors on a running engine must be controlled.

The ECM controls the Evaporative Emission Valve which regulates purging of evaporative vapors. The evaporative system must be monitored for correct purge operation and Leak Detection.

The E60 fuel tank design reduces the potential evaporative emissions. This design reduces the number of external connections and openings by increasing the amount of “in tank” or integral components including molding the filler pipe to the tank. In addition, the plastic walls of the fuel tank are made up of several layers.



1. Activated carbon canister (with DMTL)
2. Port, purge air line
3. Fresh air filter
4. Filler neck
5. Service vent line
6. Filler vent line
7. Service access cap, right
8. Service vent valve
9. Filler vent valve
10. Service access cap, left
11. Service vent valve
12. Towards front of vehicle

Note: The distinction between the following vent gases:

- Service vent gases - service vent gases are created at high ambient temperatures by heating of the fuel.

- Filler vent gases - filler vent gases are created by the air displaced by fuel during refuelling.

Service Venting System

The service venting system is integrated in the tank system and ensures pressure compensation in the tank for the following situations:

Reduction of Excess Pressure
Excess pressure is generated by heating of fuel. The gases rising from the tank flow through the service vent valves and the vent lines to the activated carbon filter.

Compensation of Negative Pressure
Negative pressure is generated by the fuel pump pumping off the fuel. The air is routed in the opposite direction for pressure compensation. Fresh air is routed to the fuel tank via the DMTL fresh air filter on the activated carbon filter.

Valves for Ventilation and Venting

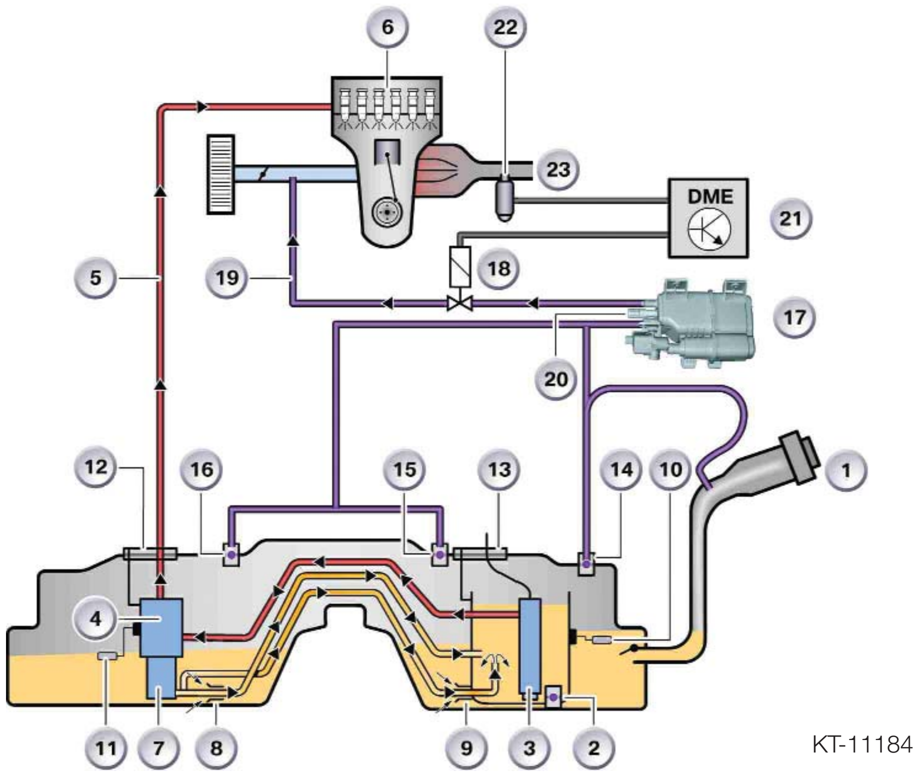
Service Vent Valves
The fuel tank incorporates 2 service vent valves with a rollover function: if the car is inclined at an angle exceeding 45° (impending or actual rollover situation), the floats in the service vent valves close off the vent apertures. This prevents any fuel from escaping through the activated carbon filter.

A compensating volume is required in the fuel tank for the service venting function. This compensating volume is the space above the fuel level when the fuel tank is completely full (approx. 6 liters). The compensating volume remains unfilled when automatic cutout of the fuel pump nozzle is triggered.

Pressure Relief Valve
Any damage to the vent lines or the activated carbon filter may result in a pressure increase in the fuel tank. To prevent such a pressure increase, the filler cap incorporates a 300 mbar pressure relief valve.

Notes:

Filler Venting System



1. Filler neck
2. Outlet protection valve
3. Electric fuel pump
4. Fuel filter
5. Fuel supply line
6. Fuel injectors/rail
7. Fuel pressure regulator
8. Suction-jet pump, left
9. Suction-jet pump, right
10. Fuel level sensor, right
11. Fuel level sensor, left
12. Service access cap, left
13. Service access cap, right
14. Filling vent valve
15. Service vent valve
16. Service vent valve
17. DMTL with activated carbon canister
18. Tank vent valve (evap. purge)
19. Evaporative purge air
20. Air filter
21. ECM
22. Oxygen sensor (pre-catalyst)
23. Exhaust manifold

Refuelling

The following safety requirements are met when the tank is filled:

- Grounding - The filler neck is provided with a metal bayonet collar which accommodates the filler cap or the fuel pump nozzle. The filler neck is grounded by the cap or fuel nozzle insertion.

- Prevention of fuel sloshing back - A slosh baffle is fitted where the filler neck enters the tank. This prevents the fuel from sloshing back into the filler pipe.

On-Board Refueling Vapor Recovery (ORVR - DM TL Equipped Vehicles)
The ORVR system recovers and stores hydrocarbon fuel vapor during refueling. When refueling the E60, the pressure of the fuel entering the tank forces the hydrocarbon vapors through the Filling Vent Valve (14) and the large tank ventilation line into the Carbon Canister (17). The HC's are stored in the Carbon Canister and the system can then "breathe" through the DM TL and the fresh air filter.

Note: A small diameter connection to the filler neck is provided and is necessary for checking the filler cap/neck during Evaporative Leak Testing.

The ventilation continues until the rising fuel level lifts the float in the Filling Vent Valve (14) and closes the outlet. When the ventilation outlet is closed, a pressure cushion (vapor area) is created in the fuel tank. This creates a backup of fuel into the filler neck and the tank is full.

This leaves a vapor area of approximately 6 liters above the fuel level. This area provides integral liquid/vapor separation. The vapor condensates separate and drain back into the fuel. The remaining vapors exit the fuel tank (when sufficient pressure is present) through the Service Vent Valves (15 & 16) to the Carbon Canister.

Note: The Service Vent Valves are also equipped with protection floats in the event of an "overfill" situation.

E60 Exhaust Emissions

The combustion process of a gasoline powered engine produces Carbon Monoxide (CO), Hydrocarbons (HC) and Oxides of Nitrogen (NOx).

- Carbon Monoxide is a product of incomplete combustion under conditions of air deficiency. CO emissions are dependent on the air/fuel ratio.
- Hydrocarbon are also a product of incomplete combustion which results in unburned fuel. HC emissions are dependent on air/fuel ratio and the ignition of the mixture.
- Oxides of Nitrogen are a product of peak combustion temperature (and temperature duration). NOx emissions are dependent on internal cylinder temperature affected by the air/fuel ratio and ignition of the mixture.

Control of exhaust emissions is accomplished by the engine and engine management design as well as after-treatment.

- The ECM manages exhaust emissions by controlling the air/fuel ratio and ignition.
- The ECM controlled Secondary Air Injection further dilutes exhaust emissions leaving the engine and reduce the catalyst warm up time.
- The Catalytic Converter further reduces exhaust emissions leaving the engine.

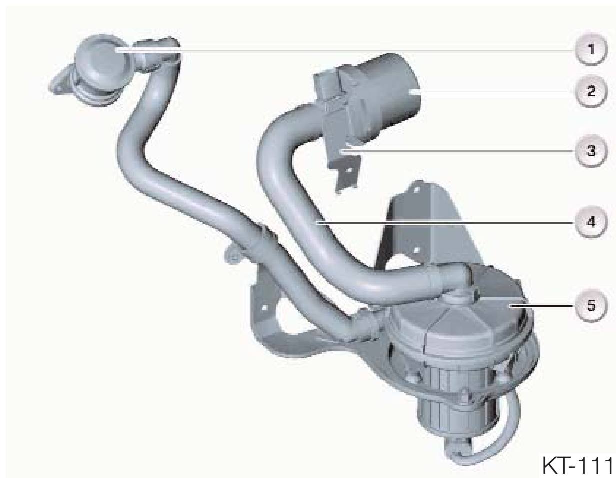
Secondary Air Injection

Injecting ambient air into the exhaust stream after a cold engine start reduces the warm up time of the catalysts and reduces HC and CO emissions. The ECM controls and monitors the Secondary Air Injection.

An Electric Secondary Air Pump and Air Injection Valve direct fresh air through an internal channel in the cylinder head into the exhaust ports.

The Air Injection Valve is opened by air pressure (from the pump) and is closed by an internal spring.

1. Secondary air (injection) valve
2. Secondary air filter
3. Mini Hot film air mass sensor (HFM)
4. Intake hose
5. Secondary air pump (SLP)



KT-11179

The secondary air pump is equipped with an additional intake hose (4) to accommodate a secondary air filter with the mini HFM (3). The mini HFM is secured in the secondary air cleaner with two screws.

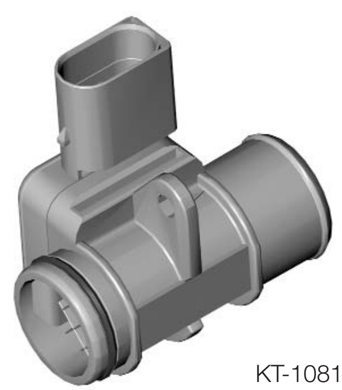
Mini Hot Film Air Mass Sensor (HFM)

A compact mini hot film air mass sensor (HFM manufactured by Siemens) is used in the secondary air system for the M54 in the E60 (US market).

The mini HFM detects the air mass supplied by the secondary-air pump. This function monitors the secondary air system for OBD compliance.

When the mini HFM detects no air mass or insufficient air mass, a fault is stored in the ECM and the Malfunction Indicator Light (MIL) is activated.

The mini HFM has a compact pipe shaped design with O-ring connections.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The “Malfunction Indicator Light” (MIL) will be illuminated under the following conditions:

- Upon the completion of the ***next consecutive driving cycle*** where the previously faulted system is monitored again and the emissions relevant fault is again present.

- Immediately if a “Catalyst Damaging” fault occurs.

KT-10888

The illumination of the light is performed in accordance with the Federal Test Procedure (FTP) which requires the lamp to be illuminated when:

- A malfunction of a component that can affect the emission performance of the vehicle occurs and causes emissions to exceed the standards required by the (FTP).

- Manufacturer-defined specifications are exceeded.

- An implausible input signal is generated.

- Catalyst deterioration causes HC-emissions to exceed the standard (FTP) limit.

- Misfire faults occur.

- A leak is detected in the evaporative system, or “purging” is defective.

- ECM fails to enter closed-loop oxygen sensor control operation within a specified time interval.

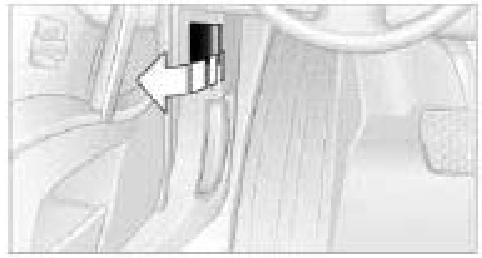
- Engine control or automatic transmission control enters a "limp home" operating mode.

- Ignition is on (KL15) position before cranking = ***Bulb Check Function***.

Within the BMW system the illumination of the Malfunction Indicator Light is performed in accordance with the regulations set forth in CARB and as demonstrated via the Federal Test Procedure (FTP).

The "Malfunction Indicator Light" can be diagnosed with an aftermarket Scan Tool that allows Technicians without BMW Special Tools or Equipment to Diagnose an emission system failure.

With the use of a universal scan tool, connected to the ***"OBD" DLC (located in the driver's side lower A-pillar area)*** an SAE standardized DTC can be obtained, along with the condition associated with the illumination of the "Malfunction Indicator Light".



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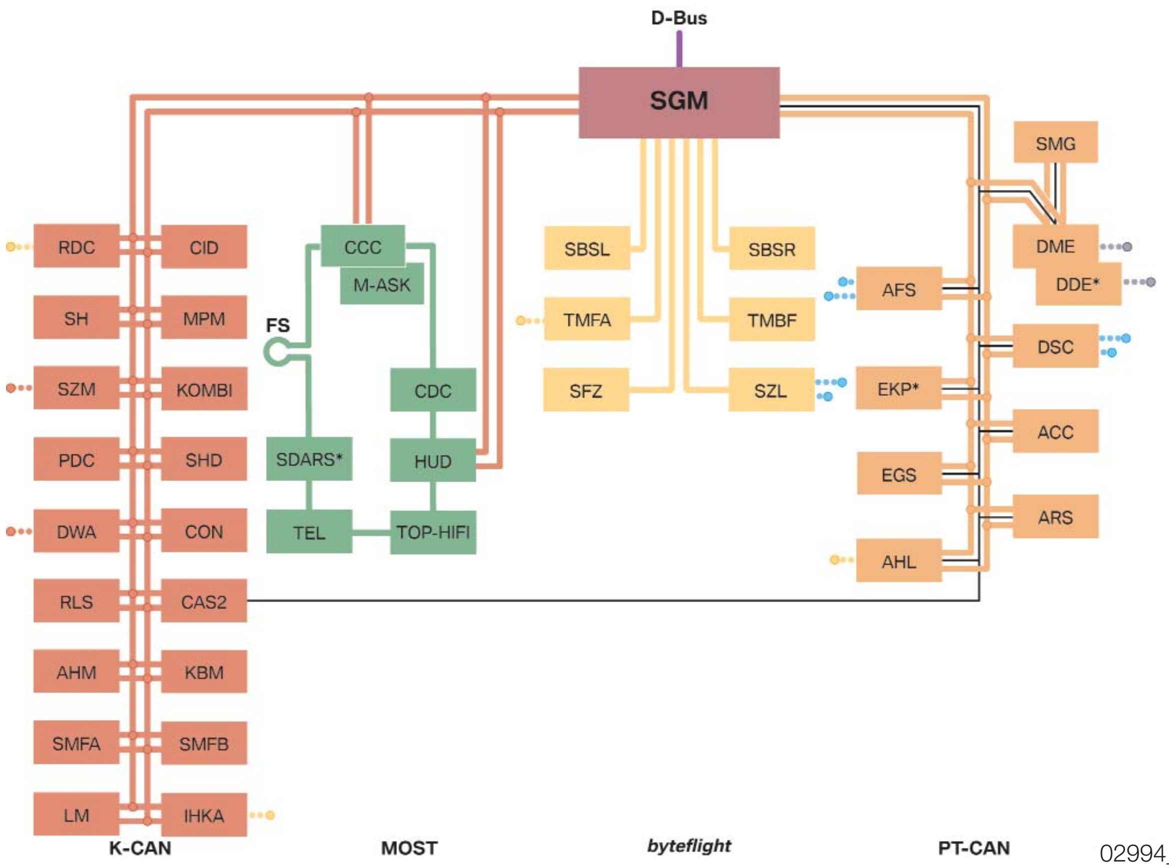
Using the DISplus or GT1, a fault code and the conditions associated with its setting can be obtained prior to the illumination of the "Malfunction Indicator Light".



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There is no direct connection to the OBD diagnostic connector. The ECM is connected to the SGM via the PT-CAN Bus. The OBD diagnostic connector is connected to the SGM via the Diagnosis Bus.

The hardwire shown above between the CAS2 and the PT-CAN control modules is the KL15 (w up) signal.

Workshop Exercise - Emissions Management

1. What are the pin and connector numbers at the ECM for the Mini HFM?

2. Is there a Test Plan available for the mini HFM?

If so, disconnect the Mini HFM and activate the Test Plan.

Reconnect the Mini HFM, clear fault codes and activate the Test Plan again. What do you observe?

3. Select Control Unit Functions, Diagnosis Requests. Is there a status under the "Part Functions" column for observing the "Messages and Results" of the Mini HFM?

4. Is there a "Component Activation" feature for the Secondary Air Pump?

If so, install the appropriate break out box and observe voltage at the ECM on the circuit that measures the Mini HFM signal.

With the voltmeter displayed, Component Activate the Secondary Air Pump, what voltage did you observe?

Note: QC1 Test Drive

With the introduction of Seimens MS45 and MS45.1 engine management systems the QC1 test drive shall now include the following procedure. This procedure needs to be performed prior to vehicle delivery to ensure all emission relevant adaptations are validated within the ECM (DME).

From a stop, accelerate moderately in 1st gear (M1 for automatic). Shift to 2nd gear (M2 for automatic) and accelerate to 4500rpm minimum. Leaving car in gear, allow vehicle to decelerate without touching brakes or accelerator pedal until 1000 rpm is seen. During the deceleration there will be a small bump (load reversal) felt at approximately 1200rpm.

These engine management systems will be in many future products so it is important to get into the habit of performing this procedure prior to new vehicle delivery. This procedure is not necessary on existing vehicles or those programmed at a Center.

Performance Controls

Driving Dynamics Control (FDC with SMG - if equipped)

The MS45.1 ECM contains two different throttle progression functions (Sport and Normal). The FDC function is selected by pressing the “SPORT” button located in the center console (1).

KT-11846

When pressed, the button provides an input signal to the center console switch center (SZM). The signal is transmitted from the SZM via the K-CAN > SGM > PT-CAN to the ECM and the power steering.

This activates the sport characteristics for the Electronic throttle control (EDK). This provides an increase in throttle opening and response time over the non-sport position.

When this function is activated, “SPORT” appears in the LC display in the instrument cluster. When the ignition is cycled, this function resets back to the non-sport function (it must be re-selected by the driver).

Workshop Exercise - Performance Controls

1. What are the pin and connector numbers at the SZM for the SPORT button?

2. Is there a Test Plan available for FDC ?

3. Select Control Unit Functions, Diagnosis Requests. Is there a status under the “Part Functions” column for observing the “Messages and Results” for the SPORT button?

If so, what status did you observe (activate and deactive function with the button)?

ME 9.2

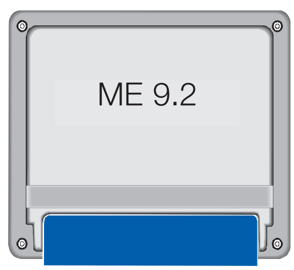
Purpose of the System

The ME 9.2 system (in the N62 equipped E60 - 545i) manages the following functions:

Air:
- Valvetronic
- Electronic Throttle Valve
- Hot-Film Air Mass Meter
- Variable Intake Manifold

Fuel:
- Fuel Supply
- Fuel Injection

Ignition:
- Direct Ignition
- Knock Control
- Ignition Monitoring



Emissions:
- Secondary Air Injection
- Pre and Post Catalyst Oxygen Sensing
- Oxygen Sensor Heating
- Misfire Detection
- Evaporative Purge Control/Leak Testing
- Malfunction Indicator Light

Performance Controls:
- Bi-VANOS
- Oil Condition
- Electric Cooling Fan
- Alternator
- E-Box Cooling Fan
- Comfort Start
- Cruise Control

The basic engine management inputs, processes and outputs are not included in this module because they have not changed, refer to the ST055 Engine Electronics Technical Training hand out for additional detailed information. Also, refer to ST042 E65 Part 2 Technical Training hand out for additional detailed information on the ME 9.2 Engine Management System.

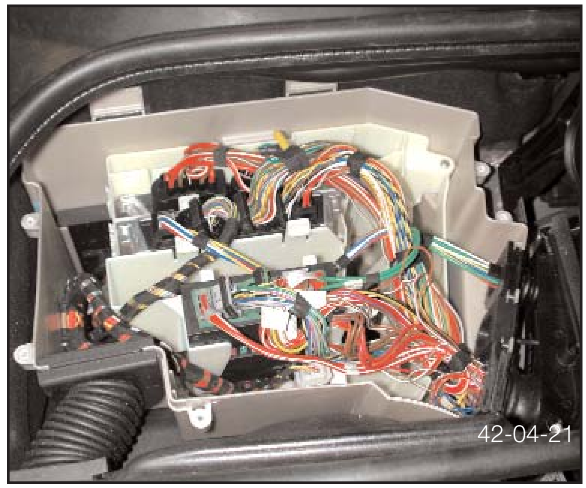
System Components

ME 9.2 Engine Control Module - Features: This Bosch engine management system is introduced for more stringent emission requirements as well as reducing fuel consumption and increasing driving performance. A flash EEPROM is used as the storage medium for the program data, fault code memory as well as the adaptation values. The ECM works in combination with the Valvetronic Control Module. Both Control Modules control the N62 engine:

- ME 9.2 ECM - overall engine management
- Valvetronic Control Module - intake valve lift

The ECM is located in the electronic box in the engine compartment together with the Valvetronic Control Module and the Inte-grated Voltage Supply Module.

The ECM controls an electric cooling fan in the base of the electronic box to draw in cool air from the passenger compartment.



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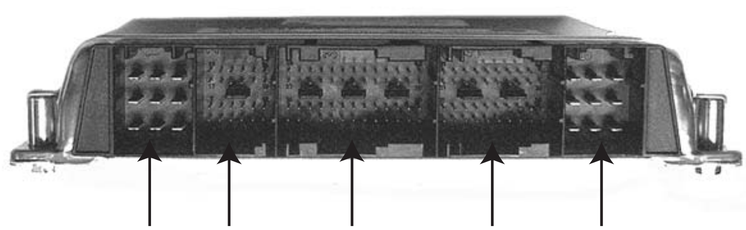
The 134 pin ME 9.2 ECM is manufactured by Bosch to BMW specifications. The ECM is the SKE (standard shell construction) housing and uses 5 modular connectors.



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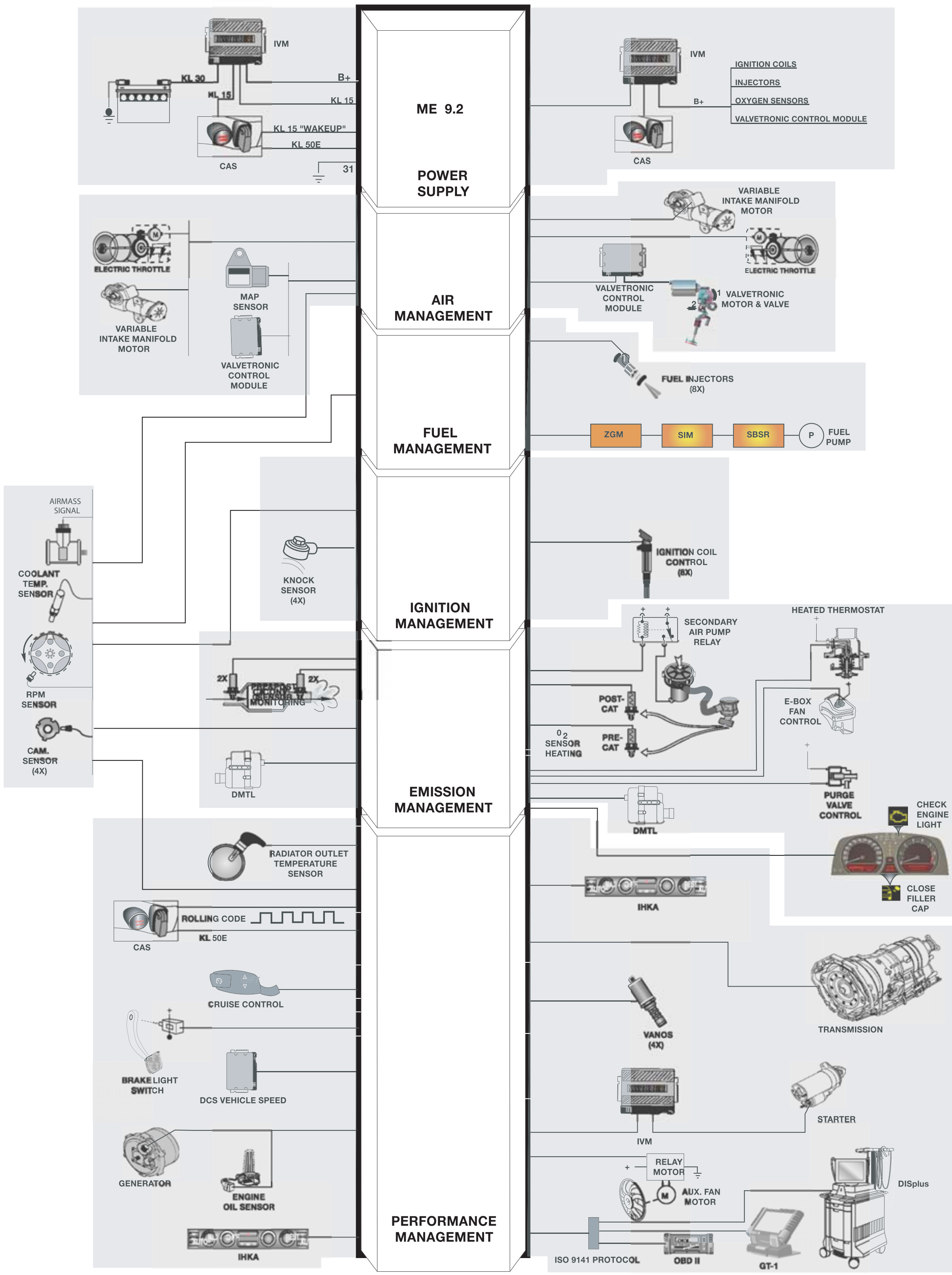
For testing, use the Universal Adapter Set (break-out box) Special Tool: ***# 90 88 6 121 300***

Starting with the ME 9.2 system, a ***Multichannel Adapter Tool*** is used in conjunction with the DISplus to perform the complete N62 Engine Test (found under Service Functions).

The Multichannel Adapter Tool is installed (in series) between the ECM and the engine harness connectors (1, 3 and 5). In addition, the four cables of MFK2 plug into the adapter surface.

W12 1 310

ME 9.2 ECM Inputs - Processing - Outputs (example from E65)



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E60 Driveline

Subject **Page**

Initial Print Date: 08/03 Revision Date: 09/03

E60 Driveline

Model: E60 - 525i, 530i, 545i

Production: Start of Production MY 2004

Objectives:

After completion of this module you will be able to:

- Describe the changes to the Automatic Transmissions for use in the E60.
- Identify the two types of Manual Transmissions used in the E60.
- Explain the changes to SMG Transmission / operation for use in the E60.
- Identify the correct Driveline components for the different engine / gearbox combinations.

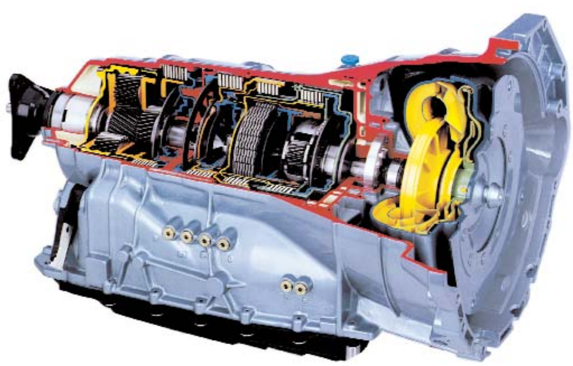
E60 Driveline - Automatic Transmissions GA6HP19Z / GA6HP26Z

Purpose of the System

BMW has developed an automatic six speed gearbox together with ZF (Zahnradfabrik Friedrichshafen), designated the GA6HP19Z / GA6HP26Z for the E60. It represents a further development of transmission technology in BMW automatic gearboxes. These gearboxes make an important contribution to the features of the E60.

The mechanical power transmission of the gearbox has been optimized with regard to gearshift comfort, quality and reduced fuel consumption. The engine torque is transferred to the gearbox by a torque converter with a controlled lockup clutch. The six forward gears and the reverse gear are produced by a Lepelletier planetary gear train. The gears are shifted by multi-disc clutches.

The GA6HP19Z and GA6HP26Z transmissions are based on the same design, they feature different torque converters and clutches. On the E60, the drive stages and the parking lock are controlled directly by the selector lever in the center console. This section addresses the changes necessary for the E60. For additional detailed information on the GA6HP operation and workshop hints (repair procedures), refer to the ST042 E65 Part 2 training hand out.



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The E60 automatic gearboxes have the following advantages:

- Designed as a 6-speed gearbox with an overdrive ratio in 5th and 6th gear, reducing fuel consumption.
- The 6-speed gearbox allows for more gear spread, improving vehicle acceleration.
- The number of interfaces has been reduced by using the Mechatronics Module for the electronic transmission.
- Lifetime oil fill.

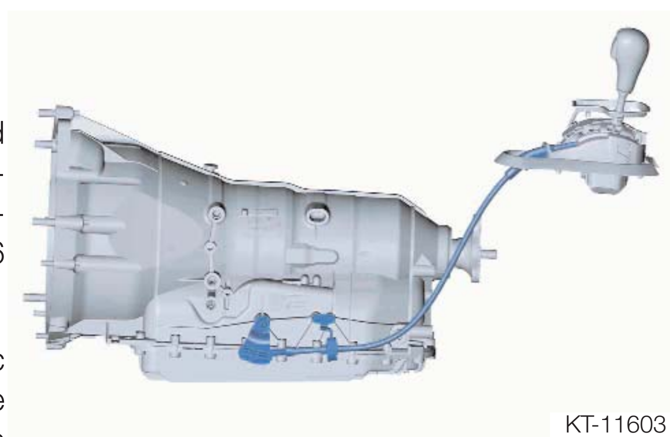
Technical Data

Index	Explanation
Type	Passenger vehicle automatic gearbox with 6 forward gears and one reverse gear in standard arrangement with adaptive Electrohydraulic control
525i, 530i - GA6HP19Z: Max. torque at 4000 rpm Max. power output at 5500 rpm	 350 Nm 180 kW
545i - GA6HP26Z: Max. torque at 4200 rpm Max. power output at 5800 rpm	 600 Nm 320 kW
Torque converter Max. permissible continuous speed	With slip-controlled torque converter lockup clutch in the gears 1 to 6 7000 rpm
Gear ratio, 1st gear Gear ratio, 2nd gear Gear ratio, 3rd gear Gear ratio, 4th gear Gear ratio, 5th gear Gear ratio, 6th gear Gear ratio, reverse gear	4.171 2.34 1.521 1.143 0.867 0.691 3.403
Weight	GA6HP19Z: 72 to 76.7 kg including oil GA6HP26Z: 84 to 89 kg including oil

System Components

Parking Lock Operation

On the E60, the parking lock is operated via the selector lever in the center console. A cable assembly provides the connection to the gearbox (as on the E46 and E39).



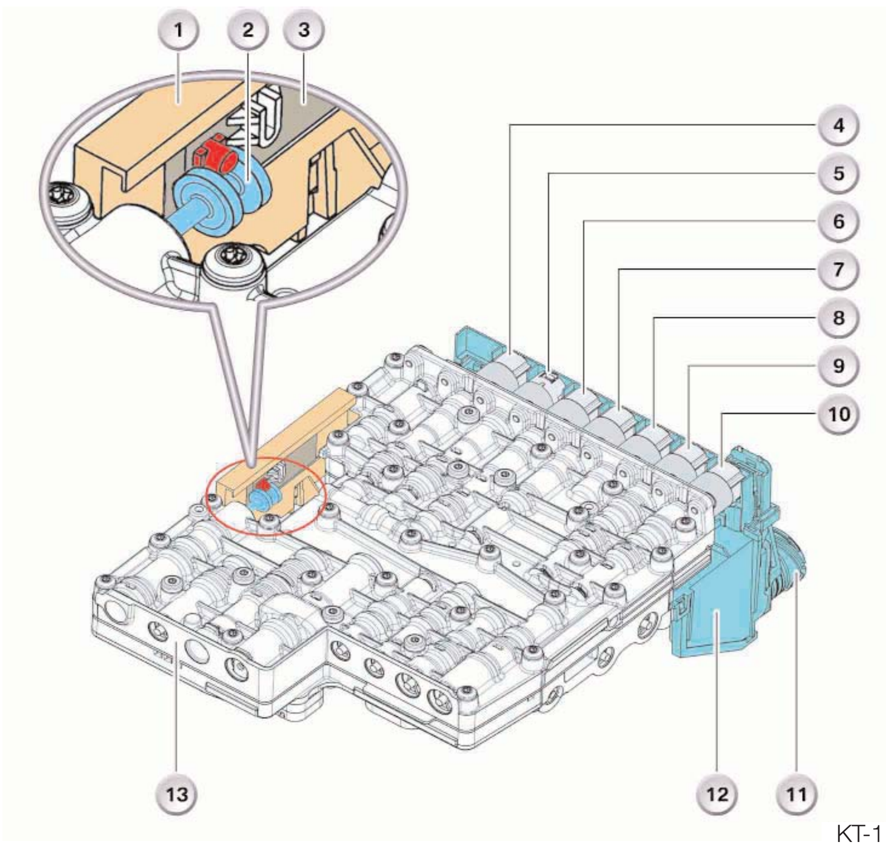
KT-11603

The drive range switch and the hydraulic selector are operated together by the selector lever in connection with the cable assembly.

Mechatronics Module

The mechatronic module is a combination of the hydraulic valve body and electronic control module which are installed in the oil sump. This offers the advantages of improved shift quality, increased driving comfort and increased reliability due to the reduced number of electrical connections and interfaces.

The hydraulic valve body contains valves, springs, dampers and electric solenoid valves. ***The electronic control module manages the complete electronic control of the transmission and is an integral part of the valve body (replaceable as a complete unit).*** The electronic control module is completely sealed and oil tight.



KT-11865

1. Drive range switch with 4 Hall sensors
2. Hydraulic selector (shaft)
3. Slide
4. EDS 6
5. Solenoid valve 1
6. EDS 4
7. EDS 5
8. EDS 3
9. EDS 2
10. EDS 1
11. Gearbox electrical connector (to harness)
12. Electronic transmission control unit (EGS)
13. Valve body

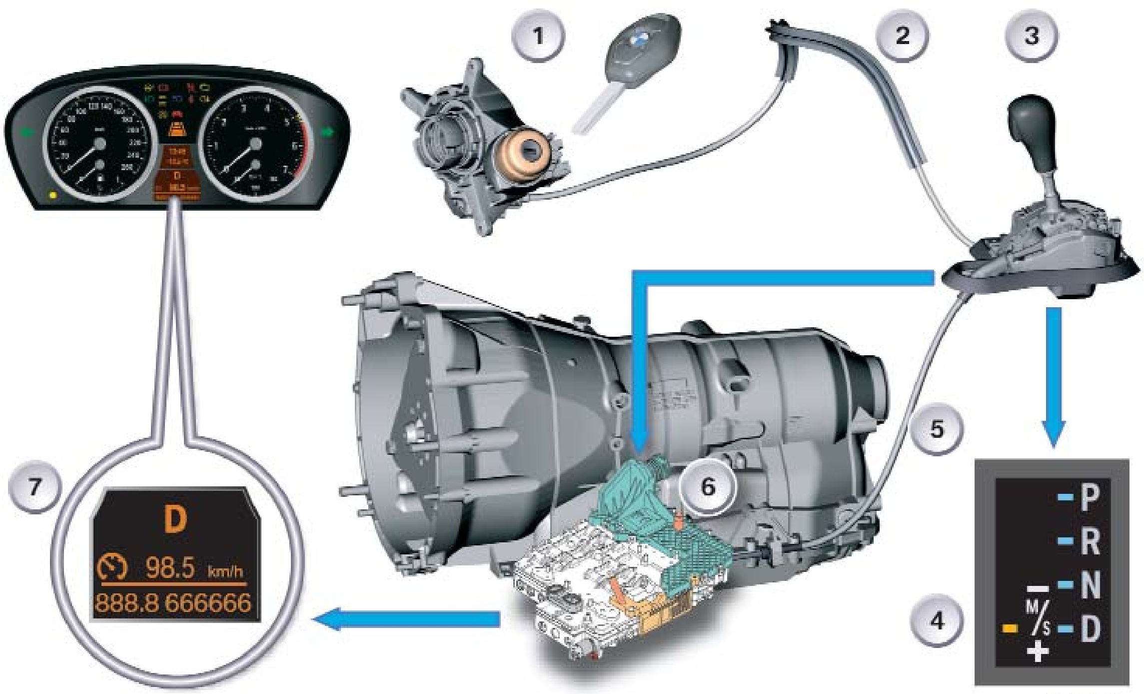
Principle of Operation

Transmission Control

The GA6HP19Z / GA6HP26Z gearbox is controlled by the mechatronics module that is made up of a combination of the valve body and electronic transmission control unit (EGS). The drive range switch (for drive ranges P, R, N and D) is located in the mechatronics module. It is operated by the selector lever in connection with a bowden cable assembly.

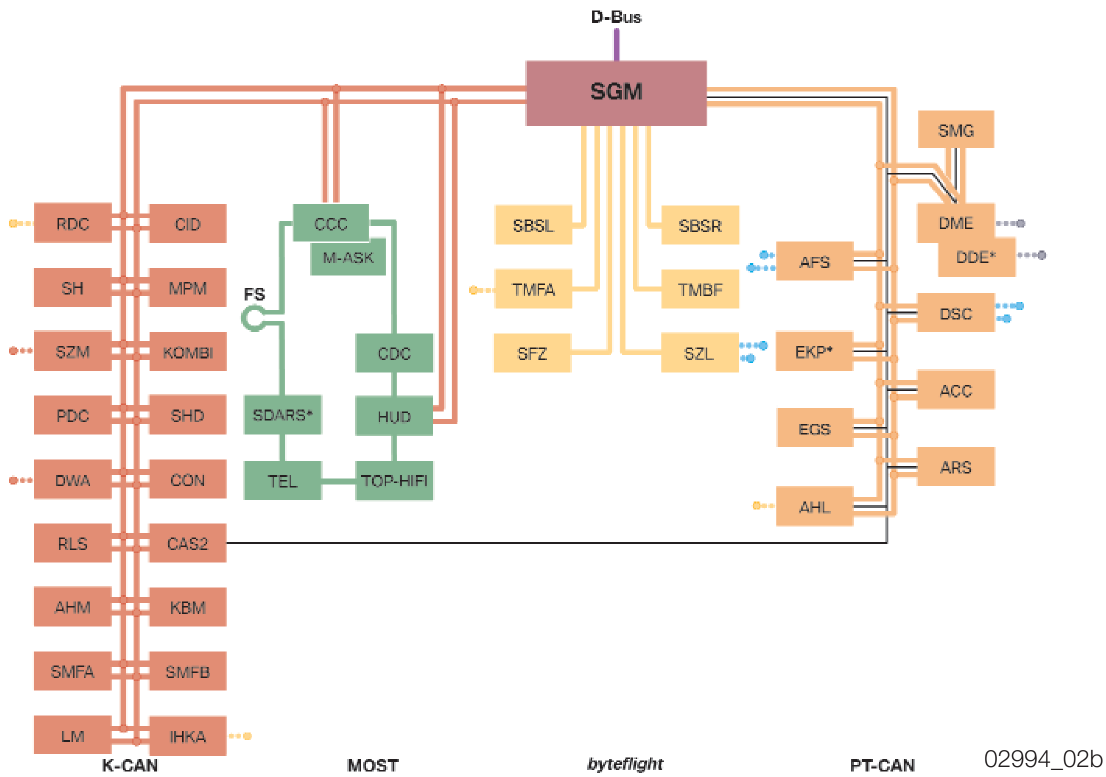
The electrical signals of the drive range switch are evaluated in the mechatronics module and used for the purpose of controlling the solenoid valves and pressure regulator. The hydraulic selector (shaft in the valvebody) is shifted (P, R, N, D) and the parking lock is operated by the bowden cable assembly.

The sequential gearshift takes place electrically by a switch on the selector lever mechanism (see automatic and Steptronic mode).



1. Ignition lock
2. Bowden cable assembly for interlock
3. Selector lever
4. Lighting of gate pattern on selector lever
5. Bowden cable assembly (drive range switch/parking lock)
6. Mechatronics module
7. Display in instrument cluster

The electronic transmission control unit is an integral part of the mechatronics module (installed in the oil sump of the gearbox). The electronic inputs are evaluated in the control unit and electronic output signals control the actuators. The control unit is integrated in the E60 PT-CAN system.



The data that the EGS requires for shifting gears, such as injection timing, engine speed, throttle valve angle, engine temperature and engine intervention, are transmitted on the PT-CAN bus. The solenoid valves and the pressure actuator are activated directly by the Mechatronics Module. Messages that are sent via the PT-CAN bus to the EGS control unit and from the EGS control unit are:

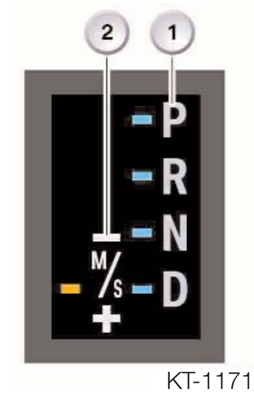
Signals	*Transmitter*	*Receiver*
Ignition terminal status	CAS	EGS
Transmission data	EGS	CAS
Engine data	ECM	EGS
Wheel speeds	DSC	EGS
Display, transmission data	EGS	Instrument cluster
Check control message	EGS	Instrument cluster

Hall sensors detect the turbine and output speed of the gearbox. The signal from the drive range switch is also routed via 4 Hall sensors to the mechatronics module. Two temperature sensors are used for acquiring the transmission fluid temperature.

Automatic and Steptronic Mode

The shift gate pattern is located in the selector lever panel. The engaged drive range is highlighted on the shift gate pattern. The background highlighting is activated by the sliding contact on the selector lever.

1. Automatic shift gate
2. Steptronic shift gate



KT-11711

Selecting Lever Positions in Automatic Mode

The gears are shifted automatically as part of the EGS program in the automatic shift gate (1) selector lever position D. The display in the instrument cluster shows D. The signal for the display in the instrument cluster is provided by the Mechatronics Module.

Selecting Lever Positions in Steptronic Mode

The S-program is selected by shifting the selector lever out of position D into the manual shift gate (2). The display in the instrument cluster changes to D S. Steptronic mode is activated by tapping the selector lever forward or backward and the transmission is shifted one gear up or down.

The display in the instrument cluster changes to M1 - M6. In Steptronic mode, the respective gear is maintained up to just before reaching the governed engine cutoff speed. An upshift then takes place automatically. Automatic downshifts are performed at kick-down and speed-dependent to 3rd and 2nd gear.

If a chosen gearshift is not permitted because of the engine and vehicle speed, the display in the instrument cluster initially changes to the chosen gear and then to the actual gear. The chosen gear is not shifted before reaching the permissible engine speed or vehicle speed. This function prevents engine overrevving.

The required gear is stored by tapping the selector lever several times and subsequently holding the position. The transmission shifts in succession up to the gear indicated in the instrument cluster. The selector lever must be held in position until the required gear is reached.

Plausibility Check - Since the selector lever can be moved into the manual shift gate only from position D, detection of the "manual shift gate" signal is permitted only together with the "position D" signal. Detection of the + or - signals for upshift or downshift is permitted in the manual shift gate only. If a fault occurs, a corresponding fault code is entered in the fault code memory and the S-program as well as Steptronic mode are deactivated.

Selector Lever Display in the Instrument Cluster

KT-10888

The engaged drive range is displayed in the instrument cluster (same as on the E46/E39) and is controlled by the Mechatronics Module.

Shift Lock

The shift lock prevents moving the selector lever from the drive ranges “P and N” when the service brake (pedal) is not operated. This function is accomplished by an electromagnetic lock on the selector lever.

Interlock

A cable assembly is fitted between the selector lever and ignition lock (in the steering column). It ensures the ignition key can be removed only when the selector lever is in position “P” (same as on the E38).

Notes:

Workshop Hints

Checking Oil Level

- The vehicle must be parked on a flat and level surface
- Check the oil level corresponding to the Repair Instructions
- Observe the oil temperature - the permissible operating temperature is between -30 ºC and +130 ºC oil sump temperature

Diagnosis of this gearbox can be carried out with DISplus/GT1. Gearbox operation can be checked by means of the fault code memory, test programs or control unit functions.

The processor of the transmission control unit features a 448 KB internal flash memory and a 256 KB external flash memory (on the main PCB). Approx. 480 KB of this are taken up by the basic transmission program. The remainder of the memory location contains the vehicle specific application data (performed during Programming).

Pressure Adaptation

Pressure adaptation takes place automatically while driving. After conducting repairs on the gearbox or replacing the gearbox, it is necessary to reset the pressure adaptation with the DISplus/GT1. A test drive should then be performed for the purpose of driving through all gears.

Manual Transmissions GS6-37BZ / GS6-53BZ

Manual Gearboxes

The following 6-speed manual gearboxes are used in the E60:

- GS6-37BZ for the 525i, 530i
- GS6-53BZ for the 545i

For additional detailed information on the 6-speed manual gearbox (including Workshop Hints), refer to the ST045 E85 Complete Vehicle Technical Training Handout.

E60 Driveline - Sequential Manual Gearbox SMG

Purpose of the System

The optional Sequential Manual Gearbox (SMG) is an automated manual gearbox with which clutching and shifting is assumed by an electro-hydraulic system. The SMG is operated via two shift paddles on the steering wheel and the selector lever in the center console. It offers the following functions:

- Sequential shifting mode and automated Drive mode
- Ability to choose between two different driving programs: Standard, Sport
- Operating safety through protection against mis-shifting
- Automatic upshifts in the Drive mode
- Automatic downshifts at minimum engine rpm
- Kick-down function in the Drive mode
- Acceleration assistant

There are two sequential manual gearboxes (SMG) that are used for the E60:

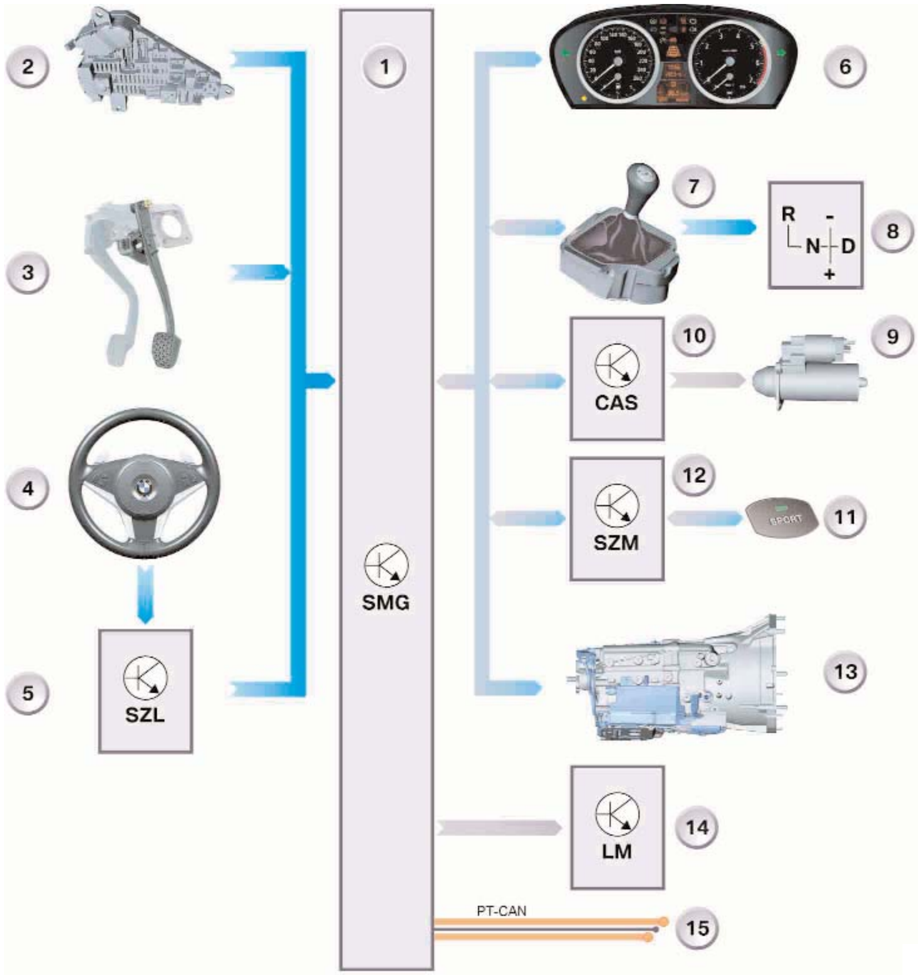
- H-SMG (GS6S37BZ) for the M54B25, M54B30 engine
- G-SMG (GS6S53BZ) for the N62B44 engine

The 6-speed manual gearboxes GS6-37BZ, GS6-S53BZ are the foundations for the SMGs in the E60. The G-SMG differs from the H-SMG. It uses a more powerful clutch actuator, different shaped hydraulic tank and the GS6-S53BZ gearbox.

In combination with this option, the customer also obtains the Driving Dynamics Control function (FDC). This function provides a “Sport” effect on driving by influencing the Engine Management, transmission (SMG) and steering control systems. This function is activated with the “SPORT” button.

The SMG gearboxes are already known from the E46 and E85 model series. For additional detailed information on the SMG gearbox, refer to the ST045 E85 Complete Vehicle Technical Training Handout. Only the new features of the system are described in the following module.

System Components

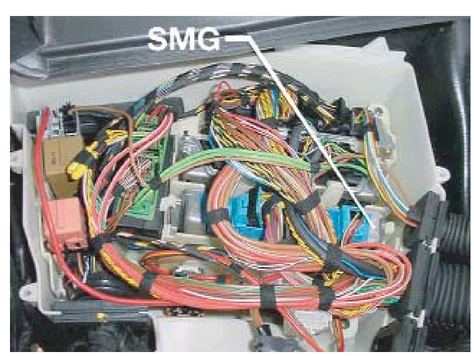


KT-11843

1. SMG control unit
2. Current distributor
3. Brake-light switch
4. SMG steering wheel with shift paddles
5. Steering column switch cluster (SZL)
6. Instrument cluster
7. Gearshift lever
8. Illuminated shift lever position indicator
9. Starter motor
10. Car access system (CAS)
11. FDC button
12. Centre console switch center (SZM)
13. Gearbox with hydraulic unit, shift-travel sensor, Selector angle sensor, Gearbox input speed sensor, Clutch travel sensor
14. Light module (LM)
15. Powertrain (PT) CAN

SMG Control Module

The SMG Control Module is a single-board unit with a modular connector system (SKE with 5 sockets) and is located next to the ECM in the E box.



Gearshift Lever

The gearshift lever accommodates a Micro-Quadlock system with a 12-pin electrical connector which includes the illuminated gearshift lever position indicator next to the gearshift lever on the center console.

KT-11846

The lever is connected to the gearbox by electric leads only. The gearshift lever works the same as the previously used version (E46, E85).

A downshift is performed when the lever is pressed forward. An upshift is performed when the lever is pulled backward.

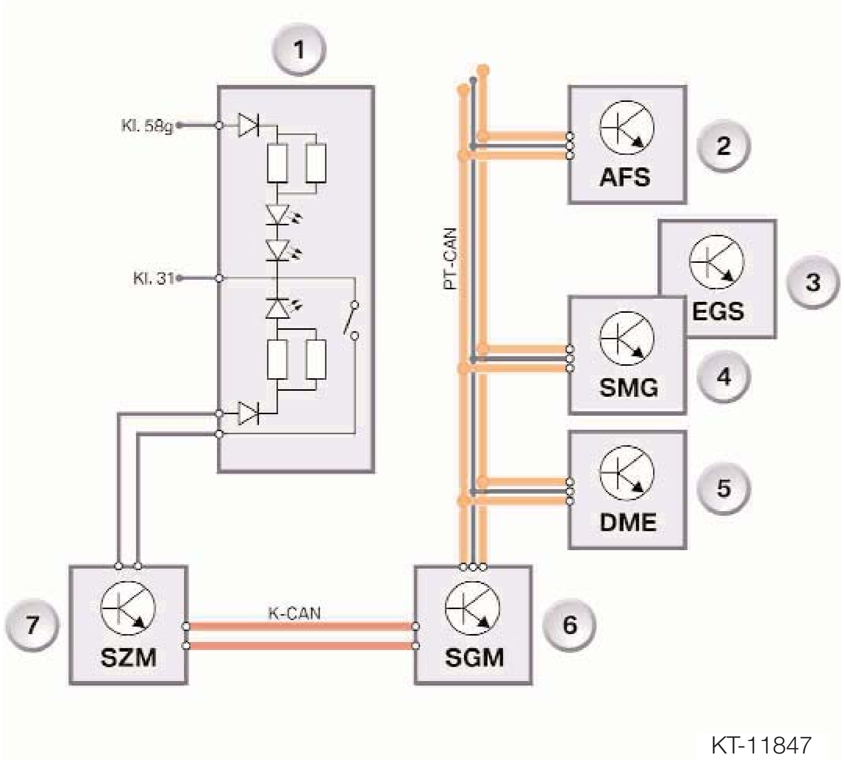
The signal for the reverse light is routed from the SMG Control Module via the PT-CAN > SGM > K-CAN to the light module.

Driving Dynamics Control (FDC)

The Driving Dynamics Control function (FDC) is standard with the SMG gearbox. In all other transmission systems, it is available with the sport package. By pressing the "SPORT" button (1 above), the FDC function changes overall vehicle characteristics to a sportier drive. The following systems are influenced:

Control Module	FDC Effect
ECM (DME)	Response characteristic of the accelerator pedal module to the electronic throttle is more progressive.
EGS	Higher gearshift speeds and a more sport oriented characteristic.
SMG	The shift procedure and shift time are shortened. Higher gearshift speeds and a more sport oriented characteristic in the automatic mode.
FGR	Cruise control accelerates faster.
Servotronic	More sport oriented steering characteristic.
AFS	Standard characteristic

The FDC button is located in the center console next to the gearshift or selector lever and is identified by the lettering "SPORT". "SPORT" appears in the LC display in the instrument cluster when the FDC function is active.



1. FDC (SPORT) button
2. Active steering (AFS)
3. Electronic transmission control
4. Sequential manual gearbox
5. Digital Motor Electronics
6. Safety and gateway module
7. Center console switch center

The signals from the FDC (SPORT) button are read by the SZM. The SZM sends the signals via the K-CAN > SGM > PT-CAN to the Control Modules ECM, EGS/SMG, Servotronic and AFS.

If there are no faults stored in these control modules, the SZM provides a ground and the "SPORT" button illuminates. When illuminated, the button indicates that the sport mode is activated.

When the ignition switch is cycled "OFF", this function resets back to the non-sport function. "SPORT" must be reselected by the driver the next time the ignition is cycled back on.

SMG Steering Wheel with Shift Paddles

The SMG steering wheel with shift paddles can also perform a gear change.

- To upshift, pull one of the shift paddles
- To downshift, push one of the shift paddles

You accelerate from higher gears, e.g. during passing, by manually downshifting.

KT-11844

Displays/Indicators in Instrument Cluster

1. Program indicator
2. Gear indicator
3. Failsafe indicator

KT-11860

In automatic mode, the program indicator (1) shows drive stage "D" engaged for automatic mode. The gear indicator (2) shows the shifted gear.

The program indicator (1) is faded out when the manual program is selected. The gear indicator (2) shows the shifted gear.

The word "SPORT" (3) appears in the display when the FDC function is active.

A transmission fault is indicated by a corresponding CC message (refer to Instrument Cluster, CC messages).

Workshop Hints

Working on Hydraulic System

Prior to any work on the hydraulic system, the system pressure must be reduced with the Service Function "Before working on hydraulic system" using the DISplus/GT1. The hydraulic pump relay must be removed to prevent the hydraulic pump from starting.

The Service Function "After working on hydraulic system" must be performed with the DISplus/GT1. The hydraulic system is vented. The service function "Teach gearbox" must be performed.

The hydraulic pump must not run dry! The relay must not be reconnected for the entire duration of the repair work. After work is completed on the hydraulic system, the hydraulic-fluid level must be checked and topped up if necessary. The hydraulic pump relay can be reconnected. The hydraulic fluid level must be checked again.

Teaching Gearbox

The Service Function "teaching gearbox" must be implemented with the DISplus/GT1 when the following components are replaced or repaired:

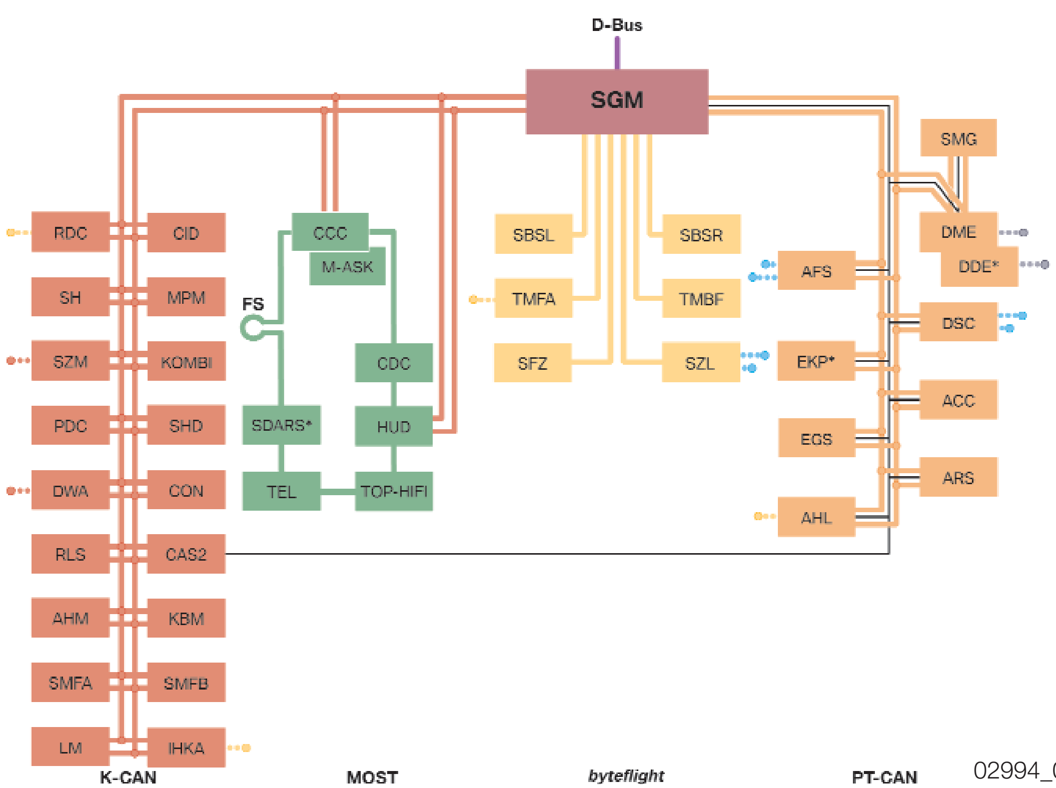
- SMG Control Module
- Gearbox
- Clutch
- Gearbox sensors

The SMG Control Module learns the clutching characteristic during the drive-off operations. There may therefore be impaired comfort during the initial gearshift operations.

Diagnosis

Diagnosis of the SMG corresponds to diagnosis of the E85 and includes the following:

- Read identification
- Read fault memory
- Delete fault memory
- Diagnosis check
- Sensor signals at gearbox
- Signals from vehicle
- Bus signals
- Programming



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E60 Driveline - Propeller (drive) shaft, Final Drive, Output Shafts

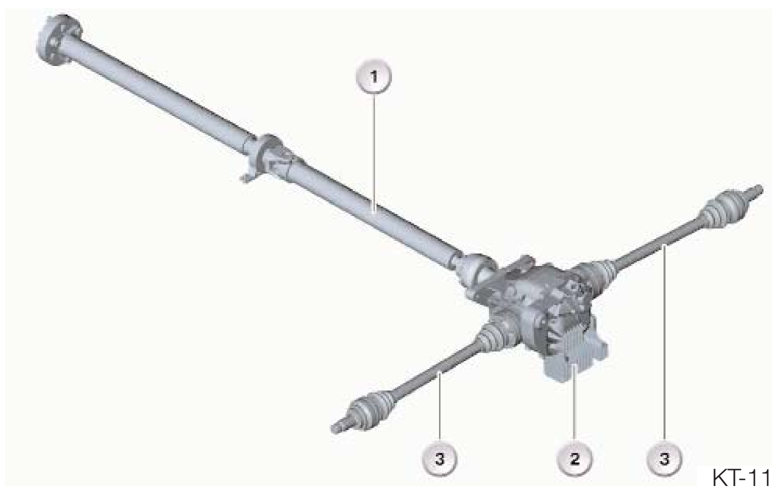
Purpose of the System

In addition to the variations of the manual, SMG and automatic transmissions available in the E60, there are two variations of the final drive (rear axle differential). The final drive size depends on the engine/gearbox combination:

Engine	Manual	Automatic	SMG	Final Drive
M54B25, M54B30	GS6-37BZ	GA6HP19Z	H-SMG	188K
N62B44	GS6-53BZ	GA6HP26Z	G-SMG	215K

Various drive trains are used depending on the engine/gearbox combination installed in the E60. Either steel, aluminum or hybrid propeller (drive) shafts are fitted. The propeller shafts are equipped with deformation elements.

If displaced in the event of an accident, the engine/gearbox unit or the rear axle cause the propeller shaft to compress. This feature enhances the passive safety of the vehicle occupants. The propeller shaft takes up a defined force and transmits it to the engine/gearbox unit or the final drive.



1. Propeller shaft with center bearing
2. Final Drive
3. Output shafts

KT-11713

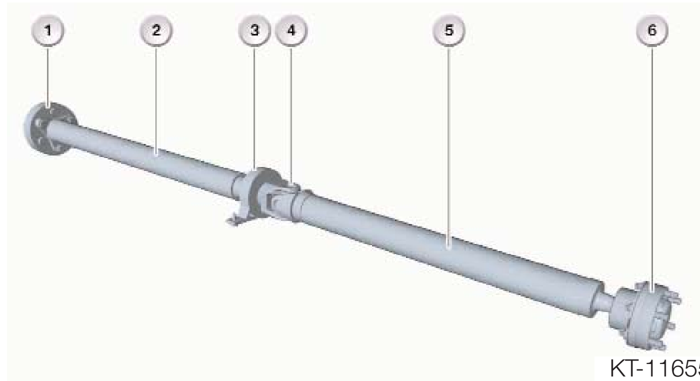
System Components

Propeller Shaft

Steel, aluminum or hybrid propeller shafts are used corresponding to the type of engine/gearbox combination installed. In the case of the hybrid propeller shafts, the front half of the shaft is made of steel and the rear half of the shaft is aluminum.

Engine	Transmission	Propeller Shaft	Weight (kg)
M54B25, M54B30	GS6-37BZ	Aluminum	8.5
M54B25, M54B30	GA6HP19Z	Hybrid	8.9
N62B44	GS6-53BZ	Steel	12.6
N62B44	GA6HP26Z	Steel	12.3

1. Flexible coupling
2. Front propeller shaft section
3. Center bearing
4. Universal joint
5. Rear propeller shaft section
6. Constant velocity joint



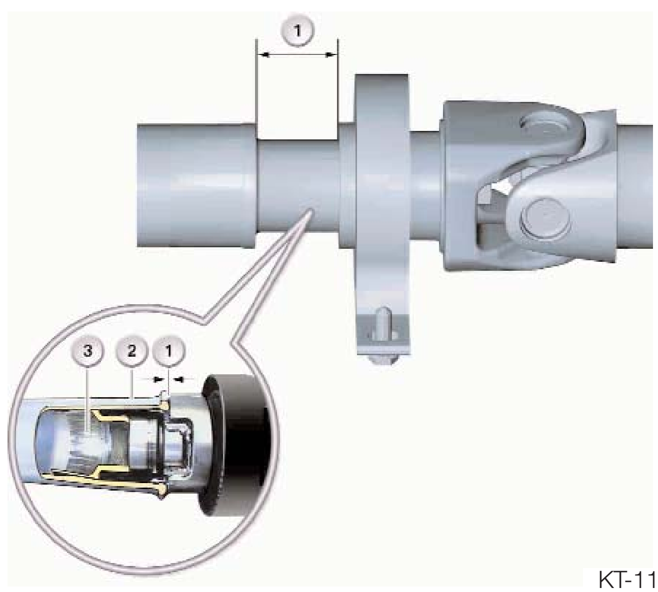
There are three different sizes (hole diameter of 96 and 105 mm) of the flexible coupling (1) used on the E60. The flexible coupling features a separate rubber bushing with a softer degree of rigidity. At very high torque, this rubber bushing is bridged by an internal stop.

The rigidity of the flexible coupling changes from soft to hard (as load is increased), thus protecting the soft rubber bush from overload or irreparable damage. The function is similar to that of a progressive spring.

The center bearing assembly is comprised of an aluminum bracket with integrated rubber fold-type seal.

The propeller shaft is equipped with a crash element that is located at the center bearing on the front section of the propeller shaft. In the event of an accident, the engine/gearbox unit or the rear axle is displaced, the bearing journal (3) is pressed into the propeller shaft (see item 1) specifically reducing the impact energy.

1. Deformation travel (approx. 100 mm)
2. Aluminum tube
3. Bearing journal (steel)



The bearing journal (3) serving as a mount for the crash element is made of steel.

The bearing journal is secured to the aluminum tube (2) by friction welding.

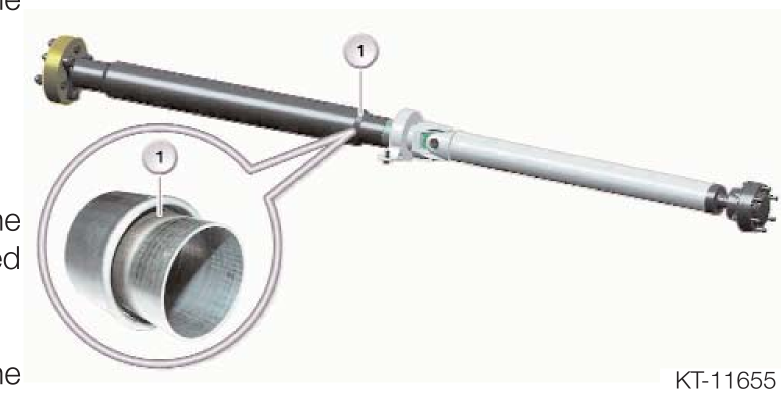
The two parts are spun into each other until the heat generated by the friction seizes them together.

The steel and hybrid propeller shafts are also pushed together (same as aluminum shafts) in the event of a crash.

1. Slip tube (shown after deformation in detail view)

The end of the front half of the steel and hybrid shafts is designed as a slip tube (1).

The slip tube (1) collapses if the engine/gearbox unit or the rear axle are displaced in the event of an accident.



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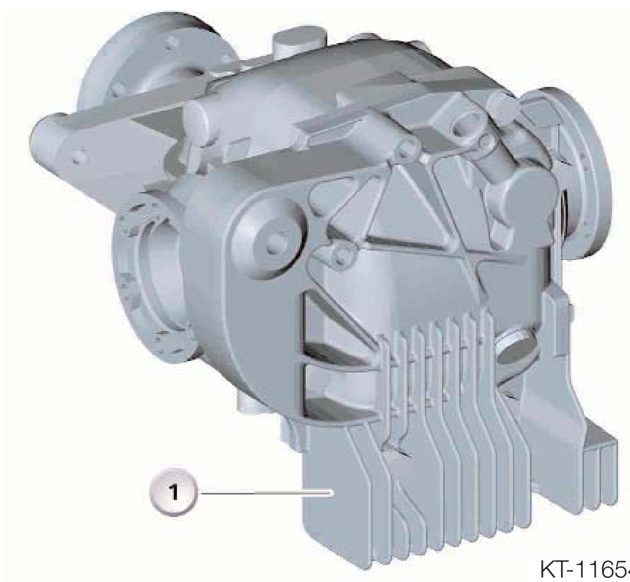
Note: The crash element/slip tube of the propeller shafts may be deformed after an accident. If so, the propeller shaft must be replaced. After an accident, the propeller shafts must always be checked to establish whether the crash element/slip tube is pushed together (collapsed).

Final Drive (Rear Axle Differential)

Two different final drive sizes are used depending on the type of engine/gearbox combination is installed. The 6 cylinder models use the 188K and the 8 cylinder models use the 215K.

In the 188K, the gear ratio varies between 2.35 and 4.10 depending on the engine/gearbox combination.

In the 215K, the gear ratio varies between 2.47 and 3.46 depending on the engine/gearbox combination.



KT-11654

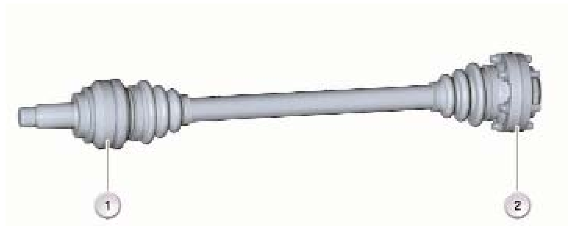
The aluminum cover features cooling fins (1) to provide adequate cooling for the final drive. The cooling fins increase the surface area and therefore increase heat dissipation. This achieves a 7 ºC reduction in the oil temperature in the final drive. ***The final drive has a lifetime oil fill.***

Output Shafts

Various output shafts are used on the E60, for example:

- With the M54B30 engine, the constant velocity joints are the same size both at the wheel and final drive ends.
- Manual transmission M54 vehicles are equipped with torsionally rigid output shafts to improve the load change characteristics. The torsionally rigid output shafts have a larger wall thickness and outside diameter than the standard rigid output shafts. This feature avoids drumming noises caused by torsional vibration.
- M54 vehicles with automatic transmission are equipped with "standard" rigid output shafts.

1. Constant velocity joint, wheel end
2. Constant velocity joint, final drive end



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Notes:

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E60 Chassis Dynamics

Initial Print Date: 08/03 Revision Date: 10/03

Subject	Page

Model: E60

Production: Start of Production MY 2004

Chassis Dynamics

Objectives:

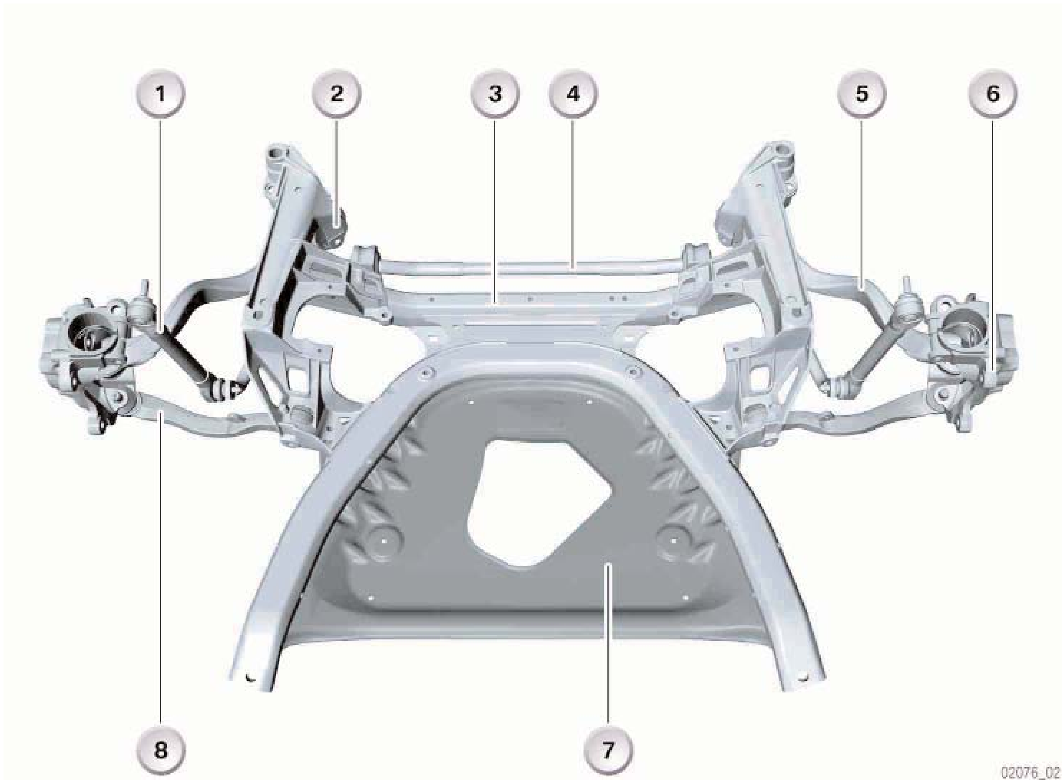
After completion of this module you will be able to:

- Understand E60 Front and Rear Suspension layout
- Understand operation of DSC 8
- Understand parking brake operation
- Understand RPA operation

E60 Chassis Dynamics

Front Axle

The double-joint spring strut axle with tension struts is essentially the same as the front axle of the E65. The complete front axle is made from aluminum. It has been possible to save on weight and space compared with the E39 thanks to the use of the reinforcement plate. The reinforcement plate ensures a high degree of transversal vehicle rigidity.



1. Stabilizer link
2. Hydro-mount
3. Front axle carrier
4. Stabilizer bar
5. Tension strut
6. Swivel bearing
7. Reinforcement plate
8. Control arm

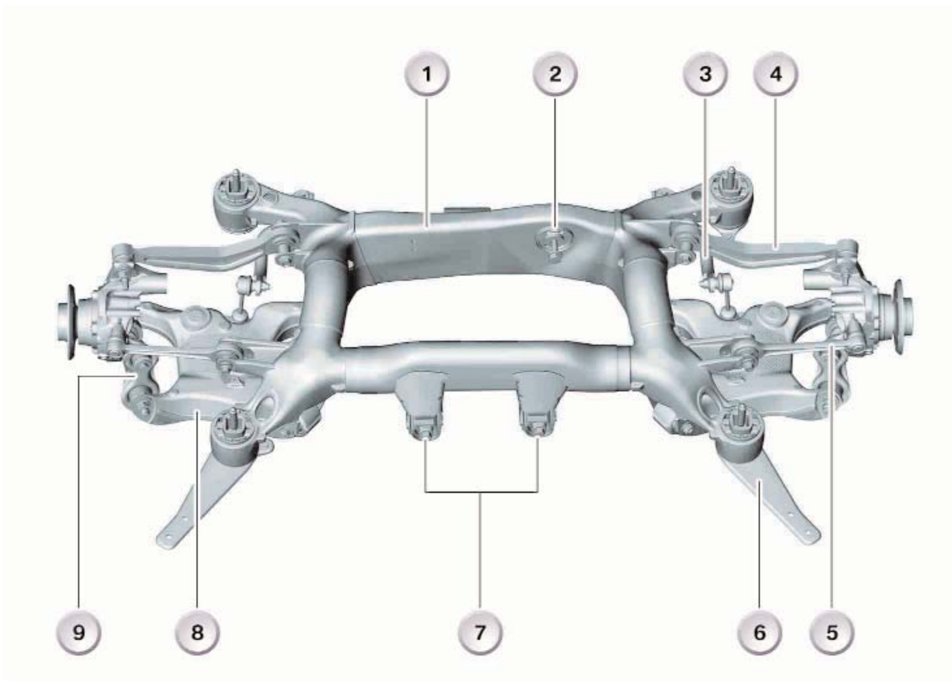
Axle alignment is performed at the tie rods. If necessary, the camber is corrected by removing the pin on the upper support bearing.

The car must not be driven without the reinforcement plate in place! The reinforcement plate ensures the transversal rigidity of the car and contributes in conjunction with the front axle carrier to the strength of the front axle.

Rear Axle

The rear axle carrier, the control arms and the swinging arms are made of aluminum. The concept is that of the Integral 4 rear axle. All the bearings used on the rear axle are rubber bearings. Tension struts serve to increase body rigidity.

The stabilizer bar is fitted behind the rear axle carrier. The ride level sensors have been moved forward.



1. Axle carrier
2. Rear axle differential bearing, rear
3. Stabilizer bar
4. Control arm
5. Traction strut
6. Thrust rod
7. Rear axle differential bearing, front
8. Swinging arm
9. Integral link

Technical Data for Alignment

Wheels	7x16; 7.5x17; 8x17; 8x18
Caster angle	7°51'
Caster offset (mm)	28
Camber	-0.2°
Total toe-in	10' +/- 8'
Toe difference angle	1.66° at 20° steer angle
Kingpin inclination	14°32'
Rim offset (mm)	20
Kingpin offset (mm)	+2
Track width (mm)	1558
Maximum steering angle inner	inner 43°22' outer 34°1'

Suspension and Damping

Spring struts with coil springs and twin-tube gas-pressure dampers are used on the front and rear axles. The sports suspension available as an option is 15 mm lower at the front and rear axles compared with the standard suspension. The sports suspension has been equipped with harder springs, sportier damper tuning and stiffer stabilizer bars.

Brakes

The E60 has a hydraulic dual-circuit brake system with "front/rear split". The electric precharging pump for the DSC function has been omitted. The 525i is fitted with conventional floating calipers on the front and rear axles. The 530i is fitted with floating calipers with frames on the front axle and conventional floating calipers on the rear axle. With the exception of the floating calipers on the 545i all caliper housing are made of aluminum.

The new lightweight brake rotors are used on the E60. The braking surface is made from grey cast iron, while the hubs are made from aluminum. The hubs are mated to the rotor using a series of rivets. The following configuration is used:

Model	Front Rotor (mm)	Rear Rotor (mm)
525i	310 X 24	320 X 20
530i	324 X 30	320 X 20
545i	348 X 30	345 X 24

All brake discs are coated with geomet. M12 studs are used to bolt the wheel.

Pedals

The pedal bracket is a glass-fibre-reinforced molded plastic part. The brake and clutch pedals are mounted on axle shafts, which are also made of glass-fibre-reinforced plastic. These axle shafts are secured by retaining lugs in the axial direction in the bracket.

Notes for Service:

Because it is not always possible to remove axle shafts without damaging them, they must not be reused once they have been removed.

Because the pedal bracket/brake pedal connection is particularly critical to safety, the brake pedal is not to be removed on its own. The entire component must be replaced instead.

Dynamic Stability Control DSC8

Dynamic Stability Control DSC8 manufactured by Bosch is used for the first time in the E60.

New system features:

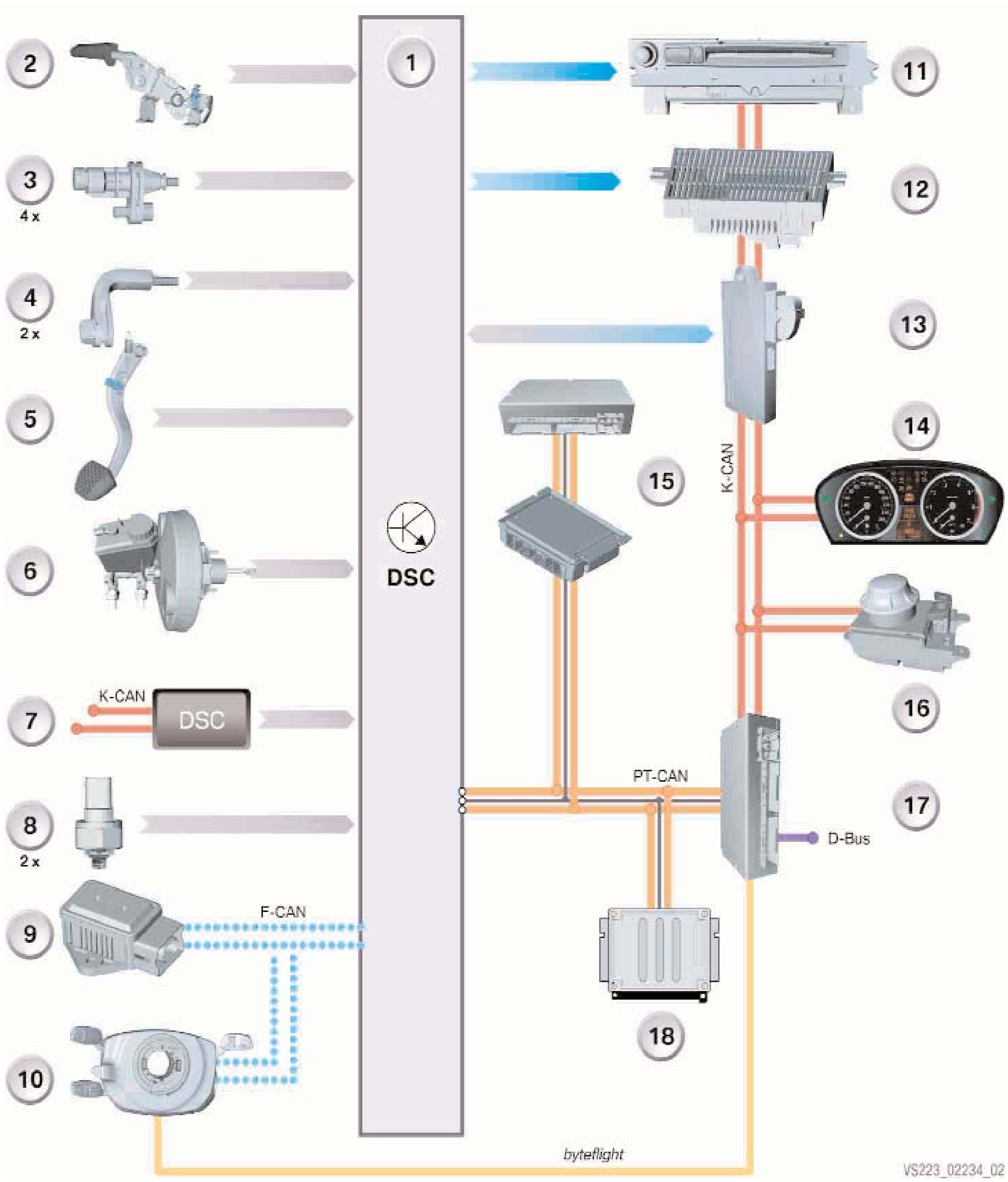
- The hardware component of DSC8 is a newly developed component.
- The electric precharging pump (eVLP) has now been omitted.
- The DSC module is connected to the Powertrain CAN (PT-CAN) and to the Chassis CAN (F-CAN).
- 2 new pressure sensors are incorporated in the brake lines in the ACC optional extra.

Advantages of System Over DSC5.7

DSC8 has the following advantages over DSC5.7:

- 25% lower structural volume
- 30% lighter (saving 700 g in the module, saving of 1.8 kg through omission of the electric precharging pump)
- Control-unit memory 768 kB ROM (previously 256 kB ROM)
- Processor computing cycle time 5 to 10 ms (previously 20 ms)

DSC System Overview

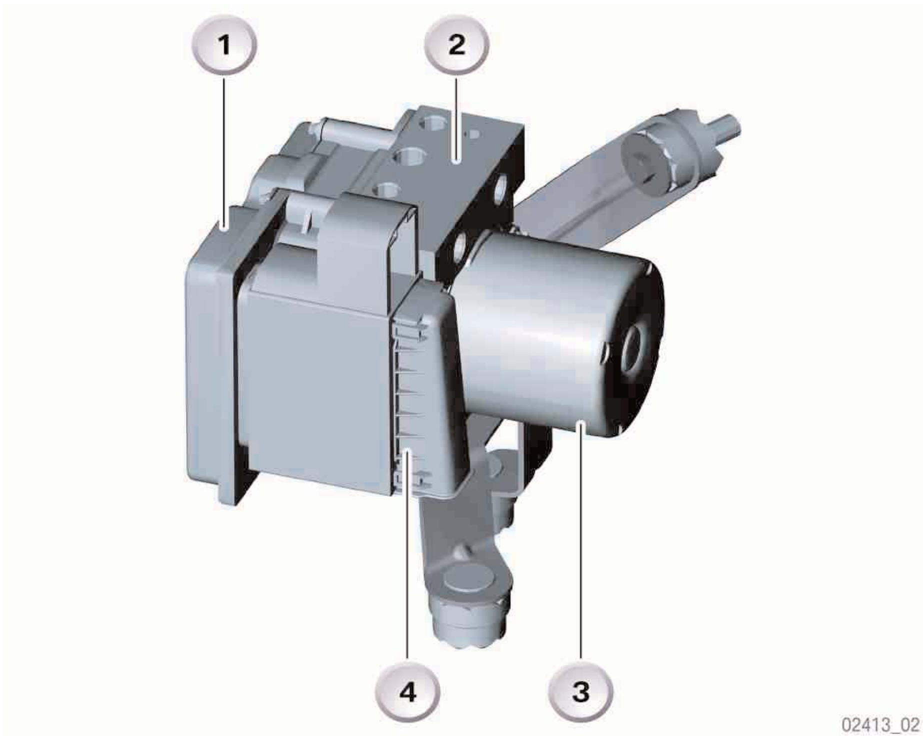


1. DSC Module
2. Parking brake input
3. Wheel speed sensor
4. Brake pad wear sensors
5. Brake light switch
6. Brake fluid level switch
7. DSC Switch
8. Brake pressure sensor
9. DSC sensor
10. Steering angle sensor (SZL)
11. M-ASK
12. Light switch module
13. Car access system
14. Instrument cluster
15. EGS or SMG
16. Controller
17. Safety and Gateway module (SGM)
18. DME

Components

DSC Module

The DSC module is located on the right side of the engine compartment between the coolant expansion tank and the cooling module.



1. DSC control unit
2. Valve block
3. Electric motor/pump
4. Plug connector

In a DSC control operation, the braking pressure is built up with the aid of an electric motor. A pressure sensor integrated in the valve block senses the braking pressure established when the driver applies the brake.

Brake Pressure Sensors

If the car is equipped with ACC, the left front-axle and rear-axle brake lines each incorporate a brake pressure sensor.

The brake pressure sensor for the front-axle brake circuit is located on the front right wheel arch.

The brake pressure sensor for the rear-axle brake circuit is located on the left side of the engine compartment at the rear.

System Functions

DSC calculates the current driving status using sensor signals. DSC corrects identified instances of driving instability through active brake interventions. For example, in the event of vehicle oversteering, a stabilizing torque is effected by means of brake intervention at the outer cornering front wheel which counteracts the unstable torque. In the event of vehicle understeering, active interventions at the inner cornering wheels provide a stabilizing counter-torque.

Drive stabilization by DSC is performed in all driving situations, i.e. free rolling, accelerating and (ABS) braking.

The system comprises the following functions:

- ABS Anti-lock Braking System
- ASC Automatic Stability Control
- MSR Engine drag-torque control
- DSC Dynamic Stability Control
- DBC Dynamic Brake Control
- CBC Cornering Brake Control
- ECD Electronically Controlled Deceleration (with ACC only)
- EBV Electronic brake-force distribution
- FLR Driving-performance reduction
- DTC Dynamic Traction Control
- BTM Brake Temperature Model
- RPA Tyre defect indicator
- BBV Brake-pad wear indication

Anti-Lock Braking System (ABS)

ABS distinguishes between a full system and a fallback level.

Full ABS System:

- Full ABS system with intact system: The vehicle controller achieves through active braking-pressure increase at the individual wheels a stabilizing effect beyond the driver's choice.
- The formation of the speed reference is supported, in addition to the information of all the wheel speeds, by the information of the yaw rate and the steering angle.
- Especially in speed ranges < 60 km/h it is possible through individual control that meets requirements (control in relation to the wheel with the greater slip) to achieve shortening of the braking distance for different friction coefficients.

ABS Fallback Level:

- In the event of a drop-out of the yaw-rate, lateral-acceleration or steering-angle signal or a CAN fault, ABS adopts the so-called fallback level. In this case, the vehicle speed is only determined by way of the wheel-speed sensors.

Differences from the Full System:

- No supporting active interventions on brake application.
- On account of the lack of information from the additional sensors, there is a con vergence with the Select Low control at the rear axle for the purpose of increasing stability.
- No ASC function.
- No MSR function.

Automatic Stability Control (ASC)

ASC prevents wheelspin during acceleration on all types of road surface.

Control is effected at a control threshold stored in the control unit. Brake interventions are performed as well as intervention in engine management for the purpose of reducing the tractive force.

The ASC function can be deactivated by pressing the DSC button for a longer period (3 s).

Engine Drag-Torque Control (MSR)

The MSR function prevents the rear of the vehicle from swerving in the event of sudden throttle closure or unadapted downshifting to a lower gear by lessening heavy load changes through brief engine-torque increases.

The MSR function is only activated from a driving speed of 15 km/h.

Dynamic Stability Control (DSC)

The control unit uses the vehicle speed, steering angle and lateral acceleration signals to calculate the setpoint yaw angle of the vehicle while cornering. The DSC sensor supplies the actual value. A comparison is made in the control unit between the calculated yaw value and the actual yaw value. A DSC control operation is performed if a deviation is detected which is above the control threshold stored in the control unit.

A DSC control operation is performed depending on whether the vehicle is oversteering or understeering. The control operation consists of an intervention in engine management in order to reduce the tractive forces. Braking pressures are built up at the wheels which serve to stabilize the vehicle again.

The DSC function can be deactivated by means of the DSC button.

Dynamic Brake Control (DBC)

The DBC (Dynamic Brake Control) function is divided into 3 subfunctions:

- Dynamic Brake Support (DBS)
- Maximum Brake Support (MBS)
- Fading Brake Support (FBS)

Dynamic Brake Support (DBS):

DBS assists the driver in emergency-braking situations.

The DBS function is triggered by a sufficiently quick actuation of the brake pedal (6 bar per 1/1000 s). The braking pressure generated by the driver is increased by the hydraulic system to such an extent that the front and rear axle go into ABS control mode. The driver can thus achieve full deceleration with low pedal force.

Maximum Brake Support (MBS):

MBS assists the driver in normal, non-emergency braking situations. When the ABS control range is reached at the front axle, MBS increases the pressure at the rear axle until the ABS control limit is reached here as well. Optimum braking deceleration is thus achieved here as well as normally the driver stops pressing the brake in this situation.

Fading Brake Support (FBS):

If the driver is unable to make use himself of full vehicle deceleration on account of poor brake-pad friction coefficients, e.g. due to high thermal loads, he is supported by the FBS function. The requirement is a high braking pressure with a simultaneously low vehicle deceleration and high brake-disc temperature.

The FBS function compensates for the brake-force loss through an increase in temperature.

The diminishing braking effect when brakes are hot requires the driver to press the brake pedal more firmly. This increase in pressure is now assumed by an activation of the hydraulic pump.

The brake-disc temperature is not measured but rather calculated by means of the following input variables:

- Wheel speed
- Individual wheel brake pressure
- Ambient temperature
- Number of brake applications over time

Cornering Brake Control (CBC)

CBC is a subfunction of DSC.

The CBC function is activated at medium to high lateral acceleration.

If a vehicle goes into a curve as it is being braked and threatens to oversteer, an increase in stability is achieved through partial release of the inner cornering rear-wheel brake.

In the case of braking on bends, the pressure in the rear-axle wheelbrake cylinders is individually controlled. Essentially this prevents the vehicle from oversteering.

When decelerating on bends, CBC ensures the best possible directional stability by means of optimum brake-force distribution.

CBC:

- performs its control function ahead of ABS or DSC
- also functions when DSC is deactivated
- is deactivated only in the event of an ABS failure

Electronically Controlled Deceleration (ECD)

ECD responds to the requests of the ACC (Active Cruise Control) signals.

DSC executes braking retardation when deceleration is requested by ACC.

This is performed by way of an automatic brake intervention at the four disc brakes, dependent on the vehicle speed, the distance and the speed of the vehicle travelling in front, with max. 3 m/s2 deceleration.

On downhill gradients at a preselected driving speed, ECD maintains the driving speed continuously at the preset value by way of automatic brake intervention.

The new brake pressure sensors can guarantee more uniform braking at the front and rear axles. This allows longer activation without compromising on comfort or overheating of the brakes on one axle.

In the case of automatic braking, the brake lights are activated in line with legal requirements.

Only from a deceleration > 1 m/s2 will a brake-light activation be performed by the light module (LM). This prevents the brake lights from coming on frequently and for brief periods.

Electronic Brake-Force Distribution (EBV)

Electronic brake-force distribution prevents overbraking of the rear axle when the system is intact (rear-axle influencing function, HAB) and in the event of an ABS failure (EBV emergency operation). The HAB function prevents the rear wheels from going into ABS control mode before the front wheels when the vehicle is braked both in straight ahead driving and with sufficiently high deceleration and also when cornering. This ensures a high level of vehicle stability.

The EBV emergency operation function prevents overbraking in the event of ABS failure under the following combinations:

- Effective until the failure of 2 wheel-speed sensors. The failure can occur in any order.
- Effective with intact pump-motor activation (pressure-holding function or pressure decrease meeting requirements at the rear axle).
- Effective even if the admission-pressure sensor fails.

In the event of system malfunctions or additional sensor faults, the driver is alerted by the red brake warning lamp in the instrument cluster.

Driving-Performance Reduction (FLR)

The FLR function protects the brakes against overloading in the event of misuse.

If a temperature in excess of 600 ºC is determined, the engine power is reduced to a defined value (dependent on the type of vehicle) in order to limit the vehicle's accelerating performance. When the temperature drops below a lower limit (typically 500 ºC), the reduced engine torque is increased as a function of time on a ramp basis to the maximum torque again. Driving-performance reduction should only be active from a speed of 60 km/h.

This reduction of the engine torque is stored as a fault (driving performance reduction active). Should the customer find fault with the lack of engine power, this can be established by the garage/workshop and explained as brake overloading.

Dynamic Traction Control (DTC)

The DTC function can be activated by means of the DSC button. The active DTC function increases the ASC slip thresholds for improving propulsion up to a speed of 70 km/h. Basically the permissible slip is doubled but there is a program map in the background. This function offers advantages when driving on poor roads and thick fresh snow.

Driving is not safety- but rather traction-orientated. With increasing transversal dynamics, measured by the yaw-rate sensor, the slip thresholds are reduced back to the normal mode for stability reasons.

When the DTC traction mode is activated, the letters DTC are displayed in the cluster.

Brake Temperature Model (BTM)

The BTM function determines by way of a calculation model integrated on a software basis in the DSC control unit the temperatures of all four brake discs as a function of the input variables:

- Wheel speed
- Individual wheel brake pressure
- Ambient temperature

If the critical brake-disc temperature is exceeded (t > 600 ºC) at a wheel, DSC functions are limited as a function of the prevailing driving conditions:

- Locking interventions are reduced to zero for each individual wheel.
- Symmetrical braking torques on the corresponding axle are prohibited.
- The engine torque is limited temporarily via an algorithm for driving performance reduction.

The restrictions are lifted again when the temperature drops below a further threshold (t < 500 ºC).

Tire Defect Indicator (RPA)

The RPA function is integrated in the DSC control unit. The system uses the wheel speeds to compare the deviations in the rolling circumferences of the wheels.

In the event of the same pressure loss in a diagonal tire pair, the wheel speeds change to the same extent and the pressure loss is not detected.

The RPA system does not monitor the uniform diffusion loss over all 4 tires.

Customers must monitor tyre inflation pressures themselves on a regular basis.

Brake-Pad Wear Indication (BBV)

The evaluation of the 2-stage brake-pad wear sensors is integrated in the DSC control unit.

Operation

The DTC and DSC functions can be activated and deactivated by means of the DSC button in the centre-console switch centre (SZM). Briefly pressing the button activates the DTC function. Press the button for a longer period (approx. 3 s) deactivates the DSC function. The ABS function remains active however. The activated DTC function and the deactivated DSC function are indicated by means of warning and telltale lamps in the instrument cluster.

If the DSC button is pressed for longer than 10 s, the DSC function is activated and cannot be deactivated until the next ignition ON. This is a safety function for such a scenario where an object placed on the centre console (e.g. a handbag) presses down on the DSC button.

Notes for Service

Service Information

An open circuit to the rotation-rate sensor is not detected.

After the battery has been disconnected, the steering-angle sensor must re-learn its offset. The steering angle is only learned by the DSC control unit when the vehicle is driven off. If the DSC control unit does not receive the steering-angle offset before the vehicle reaches 25 km/h, the DSC telltale in the instrument cluster lights up.

A different DSC control unit is used in vehicles equipped with active steering. The control units for vehicles with active steering and without active steering differ in the matching resistors they use.

Diagnosis

Diagnosis is performed by means of the PT-CAN.

Programming

Flash programming of the control unit is possible by means of the PT-CAN.

Coding

The DSC control unit detects automatically whether the relevant vehicle is fitted with ACC, Dynamic Drive or Active Front Steering.

The RPA function must be coded.

Tire Defect Indicator (RPA)

The RPA function is integrated in the DSC control unit. The system compares by way of the wheel speeds the tire-tread circumferences of the 4 wheels.

The RPA system does not monitor the uniform diffusion loss over all 4 tires. If the same pressure loss occurs in the 4 tires, the wheel speeds change to the same extent and the pressure loss is not detected. The customers must regularly monitor inflation pressures themselves.

The system must be re-initialized when tire inflation pressures are changed or when the tires are changed. The RPA is initialized by means of the controller at terminal 15 ON. The system switches to the "Learning phase" status. This status is shown in a status line in the Central Information Display (CID). After a brief driving time, the system learns the new wheel speeds as reference values.

For the RPA there are 2 variable warning lamps with 2 associated Check Control messages (CC messages) which are displayed in the instrument cluster:

- "Tire puncture!" signals a loss of pressure of more than 30% in a tire. This is accompanied by a gong sound.
- "Run Flat Indicator failure!" signals that the system is inactive due to a fault and can not detect any tire failures.

Explanatory notes pertaining to the relevant CC messages appear in the CID.

Variable warning lamp	Notes in CID
 Red	Stop vehicle carefully and change wheel, see owners handbook. Safety tires: Possible to continue at max speed of 80km/h (50 mph). Distance limit, see Owners Handbook. Have the problem checked at the nearest BMW service.
 Yellow	Tire punctures are not identified. Have fault checked by BMW service as soon as possible.

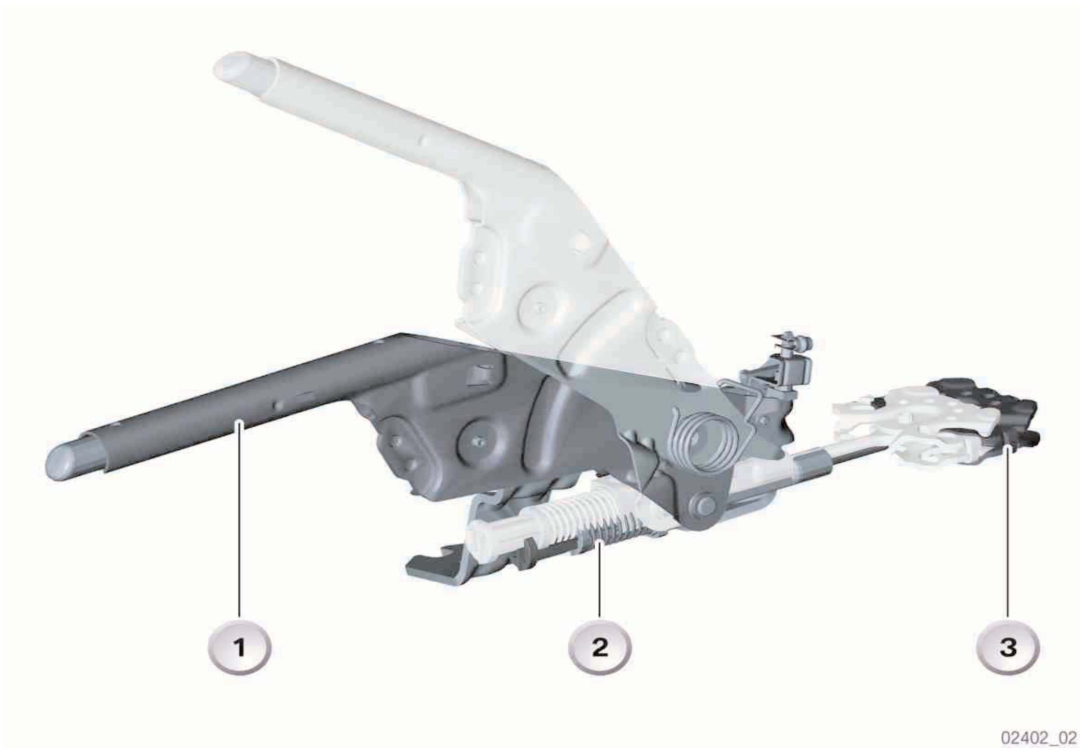
The RPA submenu in the CID also features a status line which indicates the current RPA status.

- "Learning phase," i.e. the system is standardized. The learning phase is indicated until RPA is ready for operation the first time after the start of standardization.
- "Inactive" because there is a fault in the system and thus no tire failure can be detected.
- "Active" when the system can detect a tire failure.

Parking Brake

The parking brake is actuated by means of a conventional handbrake lever. The handbrake lever is located on the centre console and bolted to the floor pan.

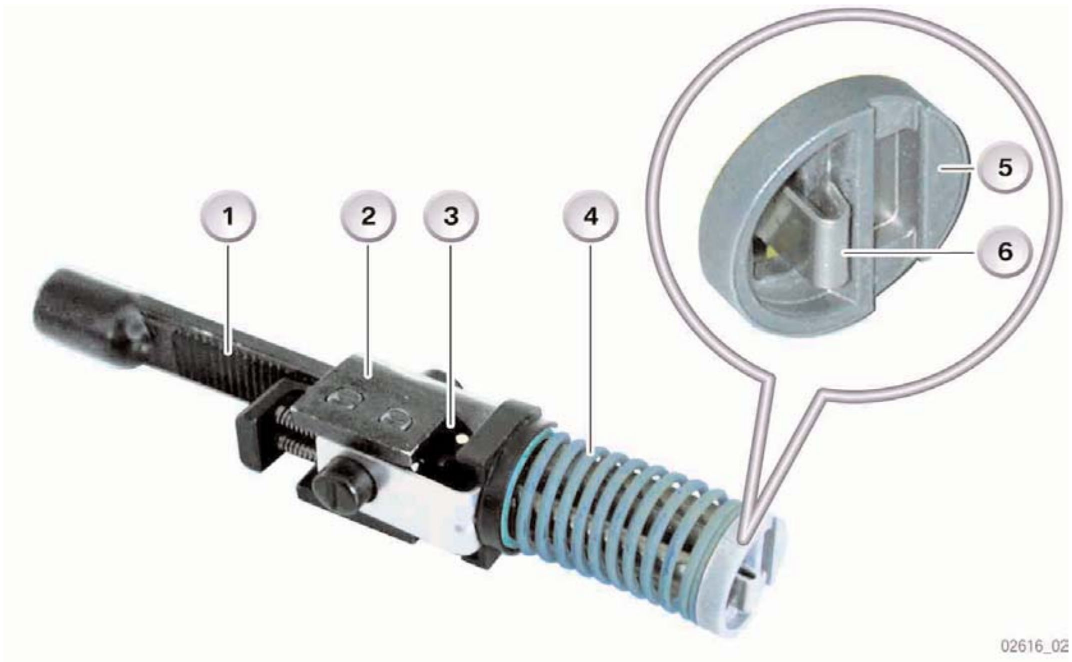
The parking brake is equipped with an automatic cable adjuster (ASZE) and a compensating element.



1. Parking-brake lever 2. Automatic cable adjuster
3. Compensating element with mounting clip

The mounting clip locks the cables in the compensating element. The duo-servo brakes correspond to the duo-servo brakes of the E65 (dia. 185 x 30 mm).

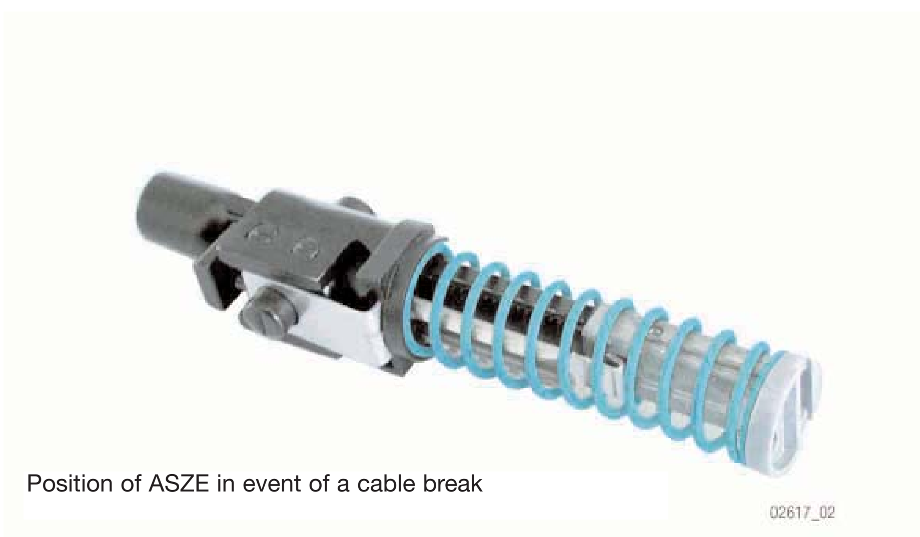
The function of the ASZE is to adjust the handbrake cables and compensate longitudinal variations and settling. It does not however adjust the wear on the duo-servo brake. This must, as before, be adjusted at the expander lock in the brake. The function of the compensating element is to distribute the actuating force uniformly to both handbrake cables.



1. Rack
2. ASZE housing
3. Clamping jaw
4. Tensioning spring
5. Locking clip
6. Locking hook

Notes for Service:

If there is a cable break, the automatic cable adjuster is in the most untensioned position.



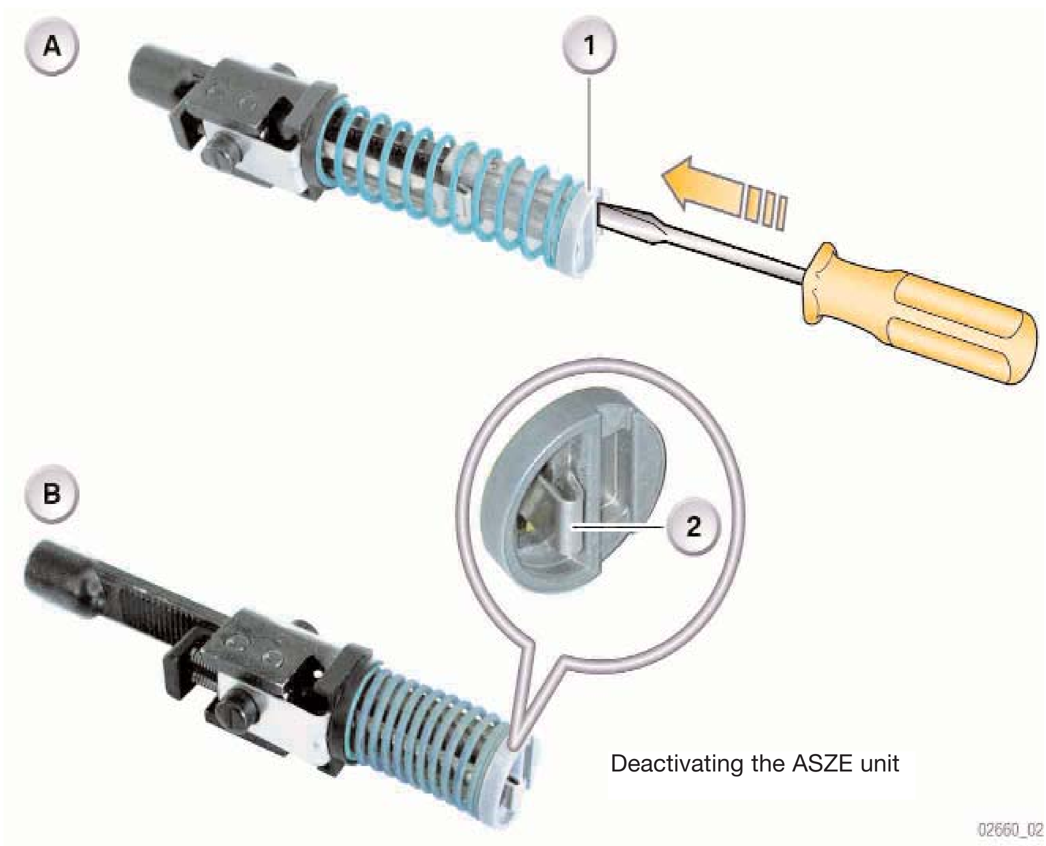
Position of ASZE in event of a cable break

Removing the cables:

- To replace the cables, it is necessary to remove the centre console and the rear-compartment ventilation ducts.
- For the cables to be removed, the parking-brake lever must be in the released position.
- For the cables or the duo-servo brakes to be changed, the ASZE unit must be deactivated.

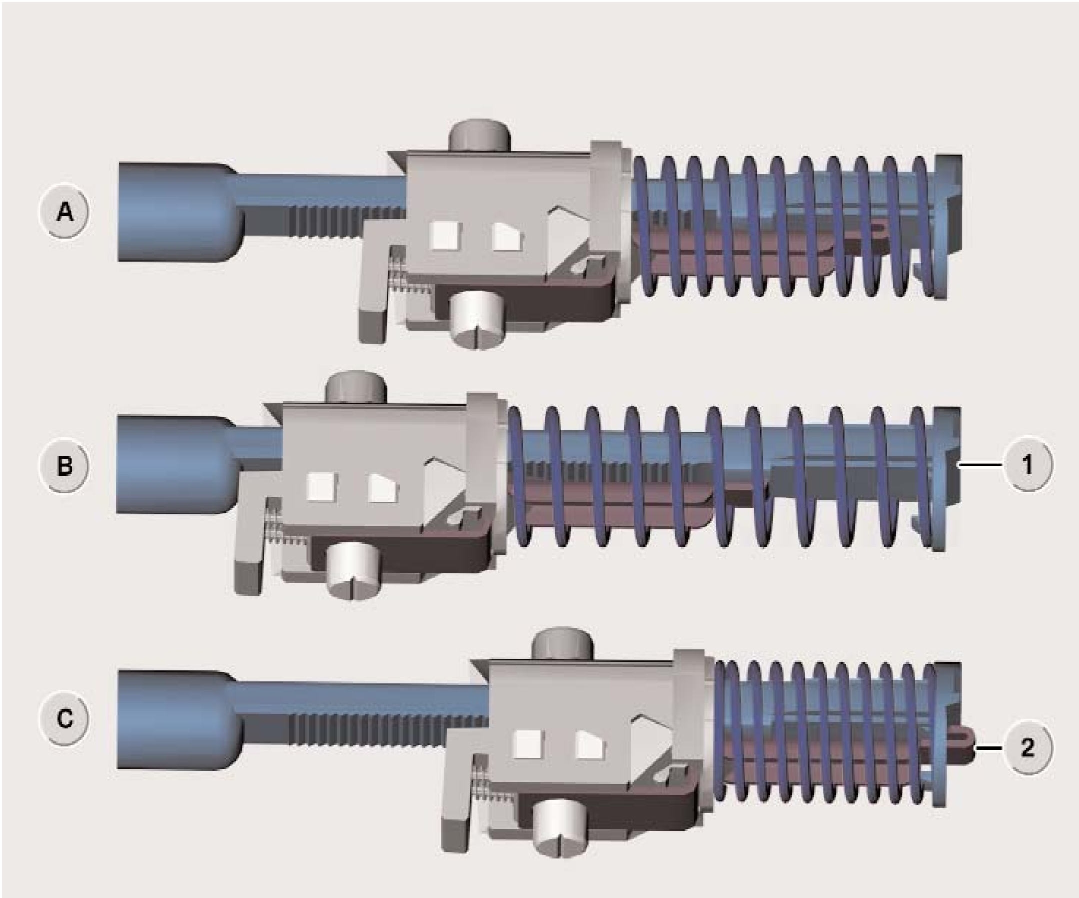
Deactivating the ASZE unit:

A screwdriver must be used to press back the locking clip of the tensioning spring until the locking hook engages the locking clip of the tensioning spring.



1. Locking clip
2. Locking hook
A. Cable break position
B. Assembly position

The cables can now be disconnected from the duo-servo brakes. To be able to disconnect the cables, it is necessary to remove the mounting clip.



A. Operating position
B. Position in case of a cable break
C. Assembly position

1. Locking clip
2. Locking hook

Installing the cables:

- For the cables to be installed, the parking-brake lever must be in the "released" position. The cables do not automatically feed themselves into the compensating element on insertion but rather must be guided with a screwdriver into the correct position.
- To secure the cables in the compensating element, it is necessary to attach the mounting clip.
- The cables are connected to the duo-servo brakes.
- The ASZE can be reactivated by levering the locking hook out of the locking clip.

Adjusting the duo-servo brakes:

The basic clearance of the duo-servo brake is adjusted at the adjusting screw of the duo-servo brake shoes. The parking brake is automatically adjusted when the ASZE unit is activated.

Table of Contents

E60 Active Front Steering

Initial Print Date: 08/03 Revision Date: 09/03

Model: E60

Production: Start of Production MY 2004

Active Front Steering

Objectives:

After completion of this module you will be able to:

- Understand basic AFS operation
- Locate and Identify AFS components
- Perform AFS Initialization/Start-up procedure
- Perform Wheel Alignments on AFS equipped vehicles

Active Front Steering

Conventional rack-and-pinion power steering is used in the E60. Two items of options (SA) are also available:

- Servotronic
- The active front steering system (AFS)

The active front steering option is only available in conjunction with the Servotronic option.

The design and operating principle of the Servotronic option have remained the same as in previous models.

The active front steering system is introduced on BMW vehicles for the first time on the E60.

The electronic controlled steering system assists the driver beyond the usual assist of the power steering with a variable steering ratio. The core element of the steering system is the so-called superimposing gear. The superimposing gear is a ring gear which is part of a simple planetary gear set integrated into the steering rack between the steering spindle and the pinion gear. An electric motor engages the ring gear via a worm gear drive as a function of the vehicle speed. In this way, the steering system can modify the front wheel angle by changing the output ratio of the steering rack. The electric motor can be run in forward or reverse depending on the needs of the AFS system. When the motor is run in the forward direction, the steering is more direct. When the motor is run in reverse, the steering is less direct.

In critical situations, the steering system can specifically modify the wheel angle engaged by the driver and thereby stabilize the vehicle more quickly than the driver. The active front steering system is integrated in the vehicle electrical system via the Powertrain CAN (PT-CAN) and the new Chassis CAN (F-CAN).

The active front steering system is very closely linked to the Dynamic Stability Control (DSC) drive-control system. Sensors and signals used by DSC are also used by the active front steering control unit.

New System Features

The flow rate supplied by the hydraulic pump is adjusted by means of an electrically controllable valve, known as an Electrically Controlled Orifice (ECO). It is controlled as a function of engine speed, road speed and steering wheel angle.

Advantages of the System

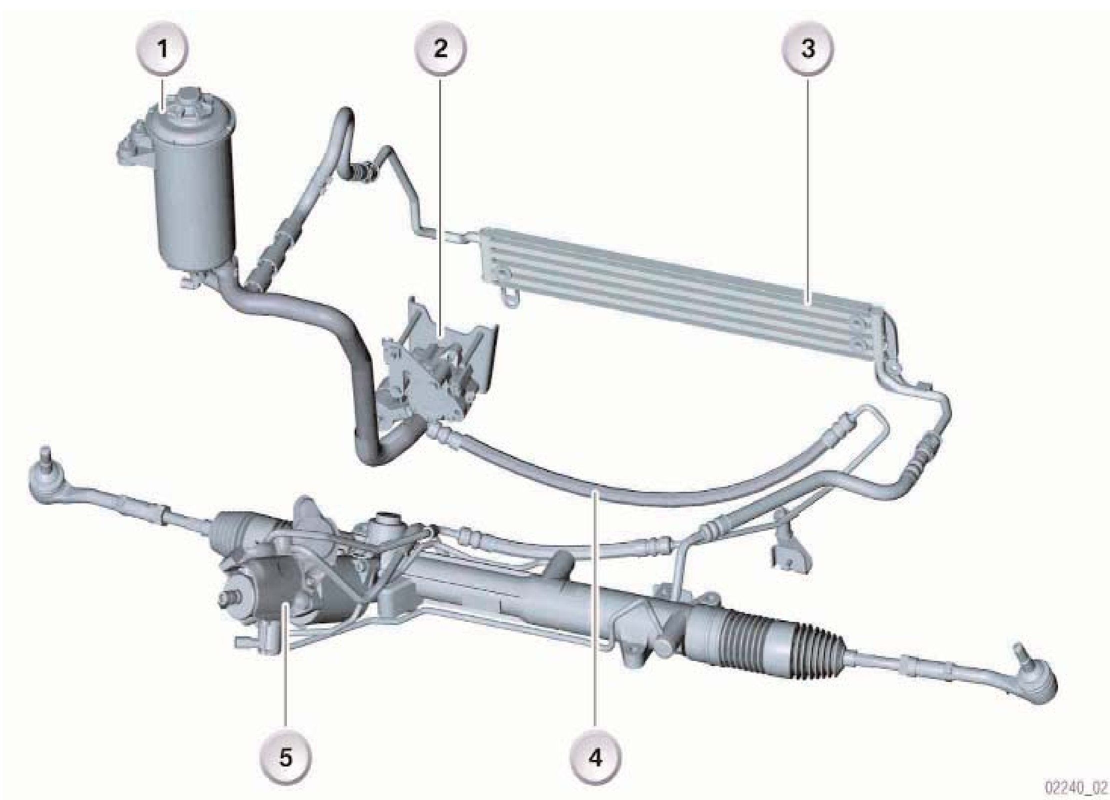
The active front steering system assists the driver in steering movements and actively introduces additional steering angles into the steering as a function of driving-dynamic variables.

When the vehicle is being parked, only minimal steering wheel movements are needed to deliver large steering angles. Less than 2 turns are needed to move the steering wheel from one lock to the other.

At high speeds, on highways for instance, the steering gear ratio becomes increasingly more indirect right up to the level of conventional steering and even beyond. The simultaneously increasing steering-wheel torque level prevents unintentional steering movements and the driver can feel the improvement in directional stability.

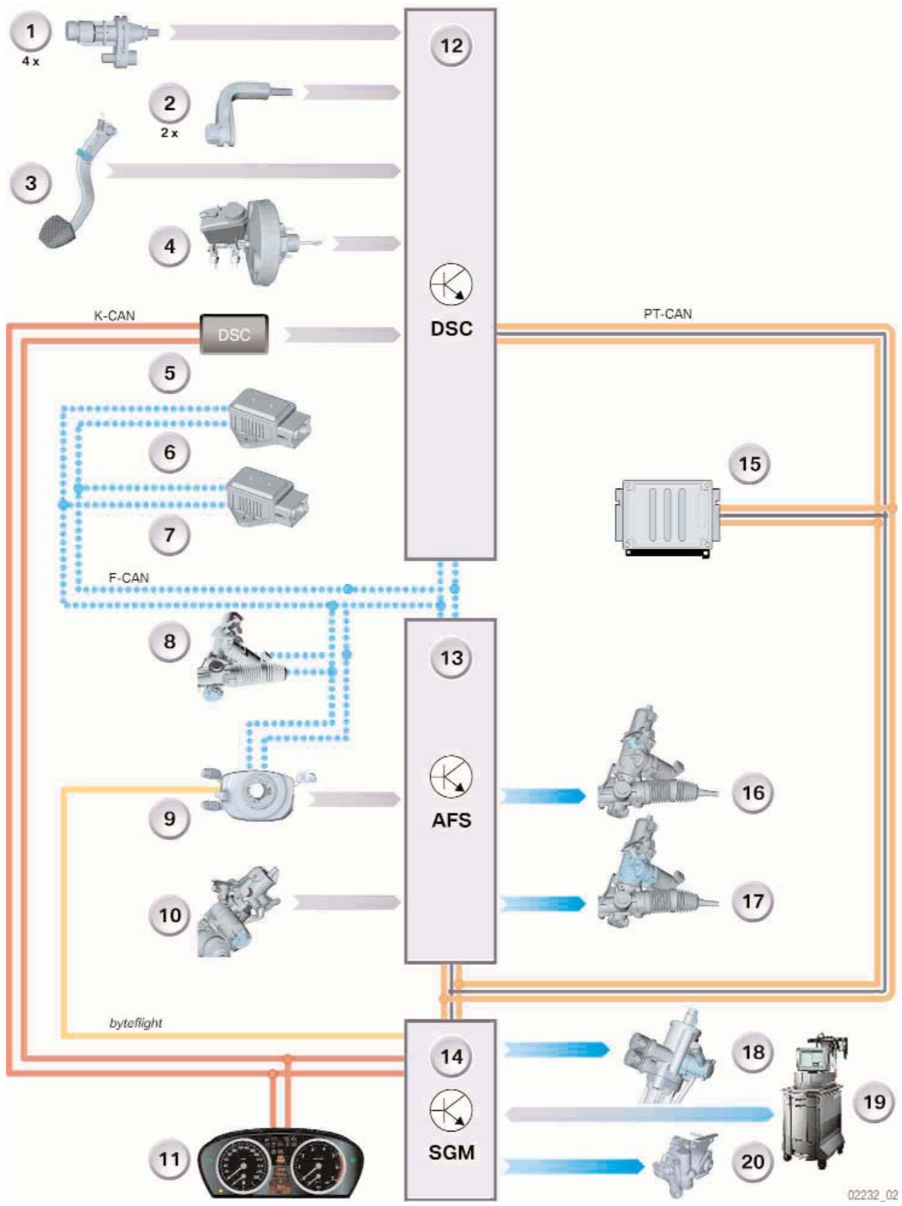
Unintentional vehicle motion, e.g. oversteering, is compensated by the active front steering system without the driver having to take corrective action to maintain the desired course.

Mechanical System Overview



1. Hydraulic fluid reservoir
2. Hydraulic pump with ECO valve
3. Power steering cooler for hydraulic fluid
4. Hydraulic hose
5. Steering gear with actuating unit

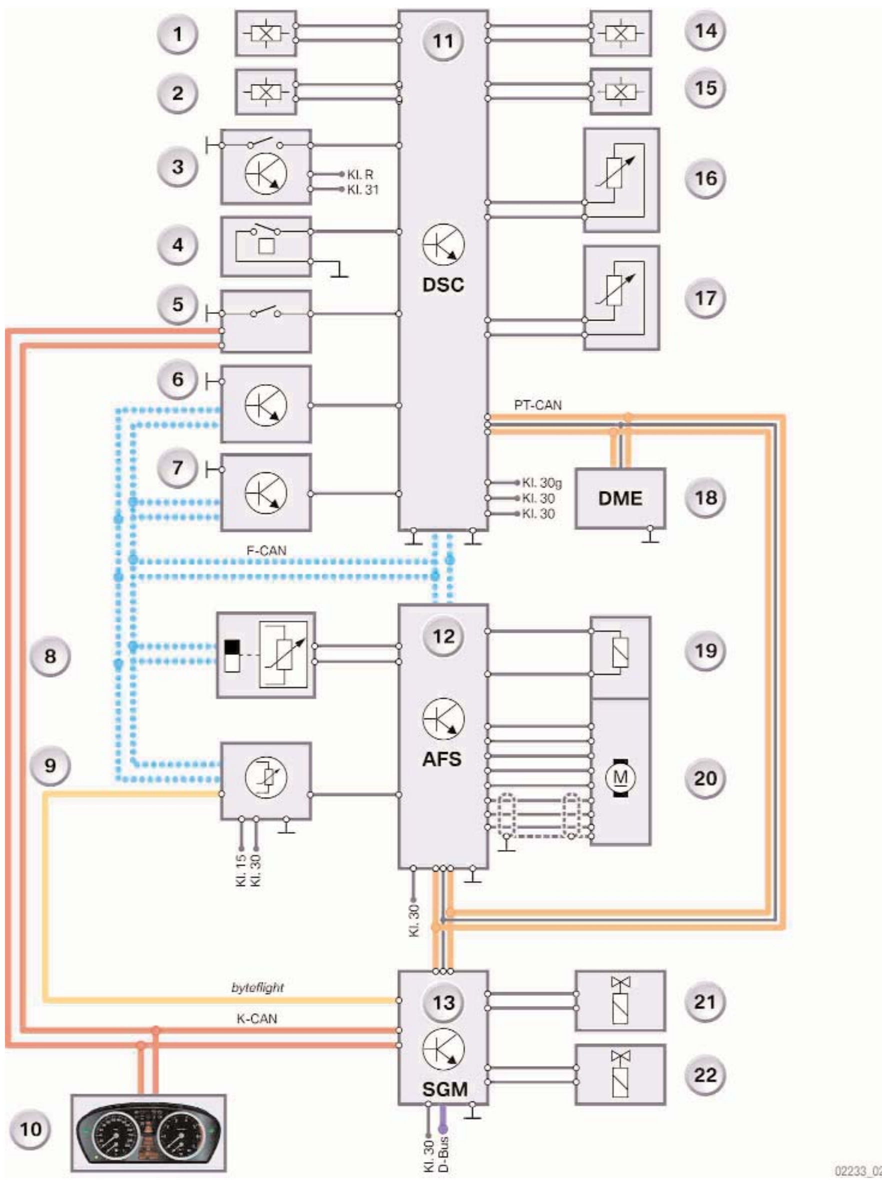
System I-P-O



1. Wheel speed sensor
2. Brake pad wear sensors
3. Brake light switch
4. Brake fluid level switch
5. DSC button
6. DSC sensor 1
7. DSC sensor 2
8. Summation steering angle sensor
9. Steering angle sensor
10. Motor position sensor, actuating unit
11. Instrument cluster
12. DSC control unit
13. AFS Active front steering control unit
14. Safety and Gateway Module (SGM)
15. DME Control unit
16. Lock, actuating unit
17. AFS Actuating unit
18. Servotronic valve
19. BMW diagnostic system (DISplus/GT-1)
20. Hydraulic pump with ECO valve

PT-CAN Powertrain CAN
F-CAN Chassis CAN
K-CAN Body CAN

System Schematic



1. Wheel speed sensor, front left
2. Wheel speed sensor, rear left
3. Brake light switch
4. Brake fluid level switch
5. DSC button
6. DSC sensor 1
7. DSC sensor 2
8. Summation steering angle sensor
9. Steering angle sensor
10. Instrument cluster
11. DSC control unit
12. AFS Active front steering control unit
13. Safety and Gateway Module (SGM)
14. Wheel speed sensor, front right
15. Wheel speed sensor, rear right
16. Brake pad wear sensor
17. Brake pad wear sensor
18. DME control unit
19. Lock, actuating unit
20. Electric motor, actuating unit
21. Servotronic valve
22. ECO valve, hydraulic pump

Components

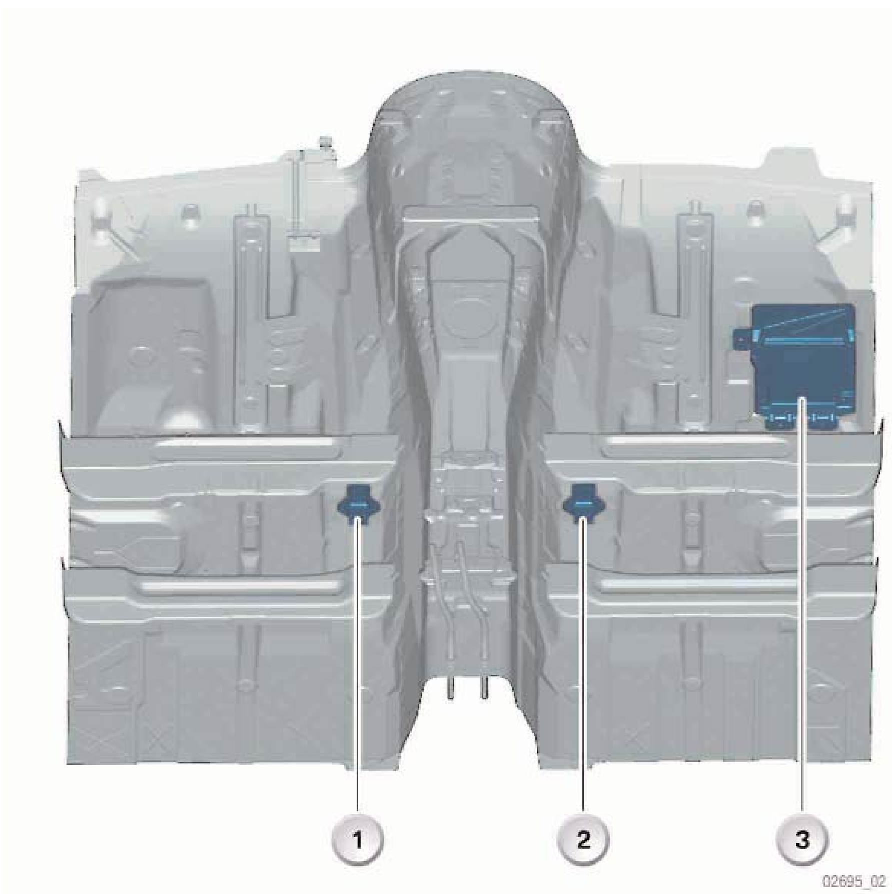
DSC Sensor

The lateral-acceleration and yaw-rate sensors are combined in a single housing and designated the DSC sensor. The active front steering system is also provided with a second DSC sensor in addition to the DSC sensor fitted as standard.

DSC sensor 1 is located under the right front seat. DSC sensor 2 is located under the left front seat.

The two DSC sensors are technically identical but coded by means of the software so that they cannot be mixed up. DSC sensor 2 is used for redundant signal acquisition of yaw rate and lateral acceleration.

Both sensors supply yaw-rate and lateral acceleration signals. The use of two DSC sensors makes it possible to perform the plausibility check.



Installation locations of DSC sensors and active front steering control unit

1. DSC sensor 2 for active front steering
2. DSC sensor 1 for brake system
3. Active front steering control unit

Active Front Steering Control Unit

The active front steering control unit is located in the right footwell and screwed down to the floorpan.

The control unit is protected by a kickplate housing.

The kickplate housing incorporates a pin for connecting the shielding for the 3 phases of the active front steering actuating unit.

The control unit is integrated in the vehicle electrical system via the PT-CAN and the F-CAN.

The active front steering control unit calculates the signals for activating the active front steering actuating unit from the various input signals.

Input Signals

- DSC signals (wheel speeds, yaw rate and lateral acceleration)
- Steering angle
- Total (summation) steering angle
- Position of electric servomotor of actuating unit

The active front steering control unit is initialized when the ignition is turned on.

The active front steering actuating unit cannot be activated during the initialization procedure. The sensor signals are checked and calibrated if necessary.

If faults are detected, either the "Error" fault status is adopted or yaw rate control is deactivated. In the case of the "Error" fault status, it is not possible to activate the actuating unit. The "Drive" status is adopted after successful initialization.

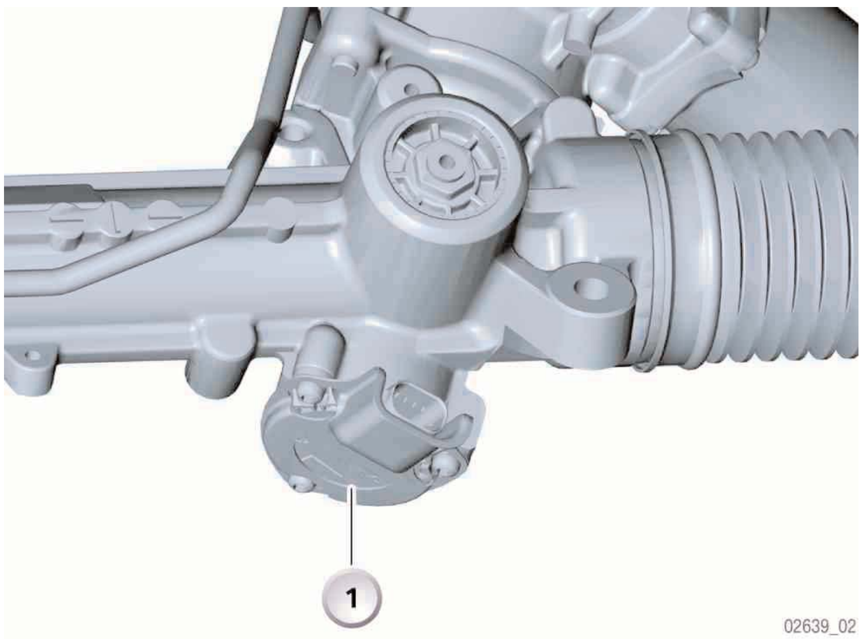
The active front steering control unit sends the current message corresponding to the required flow rate to the SGM via the PT-CAN.

Total Steering-Angle Sensor

The total (summation) steering-angle sensor is only fitted in the vehicle if the active front steering system is fitted.

The total steering-angle sensor records the rotation angle of the steering pinion and thus the wheel deflection (or actual steering angle) of the vehicle.

The total steering-angle sensor is flange-mounted at the bottom of the steering gear.



1. Total steering angle sensor

Steering-Angle Sensor

The steering-angle message is directed from the steering column switch cluster (SZL) to the active front steering control unit via a serial interface and via the F-CAN.

The SZL incorporates a second processor for redundant steering-angle calculation. This second processor is only fitted if the active front steering system is fitted and serves to monitor the plausibility of the signal.

The steering-angle sensor is integrated in the steering column switch cluster.

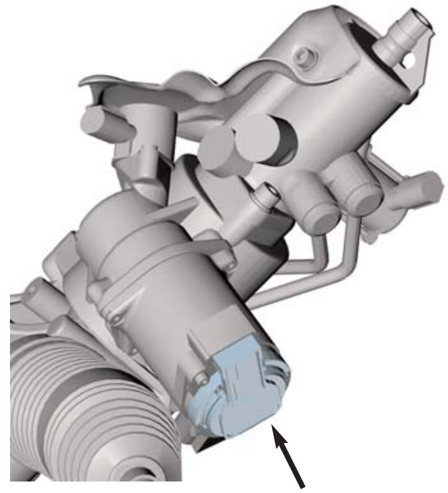
Motor Position Sensor of Actuating Unit

The motor position sensor of the actuating unit is located on the rear side of the electric motor of the active front steering actuating unit.

The motor position sensor consists of a sensor chip and a magnet.

The sensor chip records the position of the electric motor according to the magneto-resistive principle.

The information on the rotor position is sent to the active front steering control unit via a direct line in pulse width modulated form.



Motor position sensor

Safety and Gateway Module (SGM)

The SGM consists of a combination of the Central Gateway Module (ZGM) known from the E65 and the Safety and Information Module (SIM).

The SGM is located in the equipment carrier behind the glovebox.

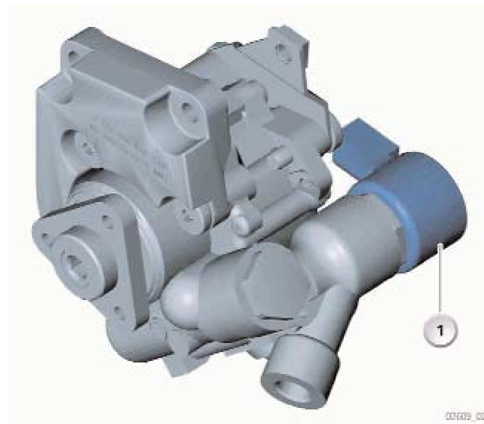
The SGM receives from the active front steering control unit the specified setpoint current for activating the Servotronic valve and the ECO. The SGM activates the Servotronic valve and the ECO in pulse width modulated form.

In vehicles without active front steering, the software for activating the Servotronic valve and the ECO is implemented in the SGM.

Hydraulic Pump

The hydraulic pump is a vane pump and is equipped with an electrically controllable valve for regulating the flow rate of the hydraulic fluid. This valve is called the Electrically Controlled Orifice (ECO).

The active front steering system can generate higher wheel-angle speeds compared with conventional rack-and-pinion power steering systems. High hydraulic system flow rates must be maintained in the hydraulic system for the high wheel-angle speeds. In order to deliver the needed hydraulic requirements, a larger power steering pump would need to be installed. However this would increase fuel consumption. An alternative would be to install a controllable hydraulic pump. A conventional pump with the added ECO valve has been installed on the E60.



1. ECO Valve

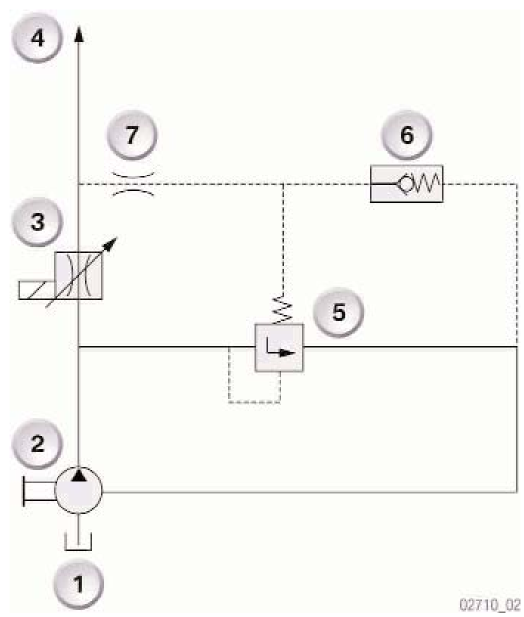
The hydraulic pump with the ECO regulates the flow rate according to requirements and reduces the dynamic pressure in the steering system.

Hydraulic Schematic with ECO Valve

The low power consumption of the hydraulic pump helps to reduce vehicle fuel consumption and thus CO2 emissions.

The ECO is sprung closed and powered open by the SGM. When the ECO is fully energized, the pump can deliver the maximum flow rate of 15 l/min dependent upon engine speed.

When deactivated and de-energized, the ECO valve is closed and pump delivers a reduced flow rate of approx. 7 l/min for steering-effort support.



1. Hydraulic reservoir
2. Hydraulic pump
3. ECO valve
4. Rack and pinion power steering
5. Pressure control valve
6. Pressure limiting valve
7. Restrictor orifice

Power-Steering Cooler

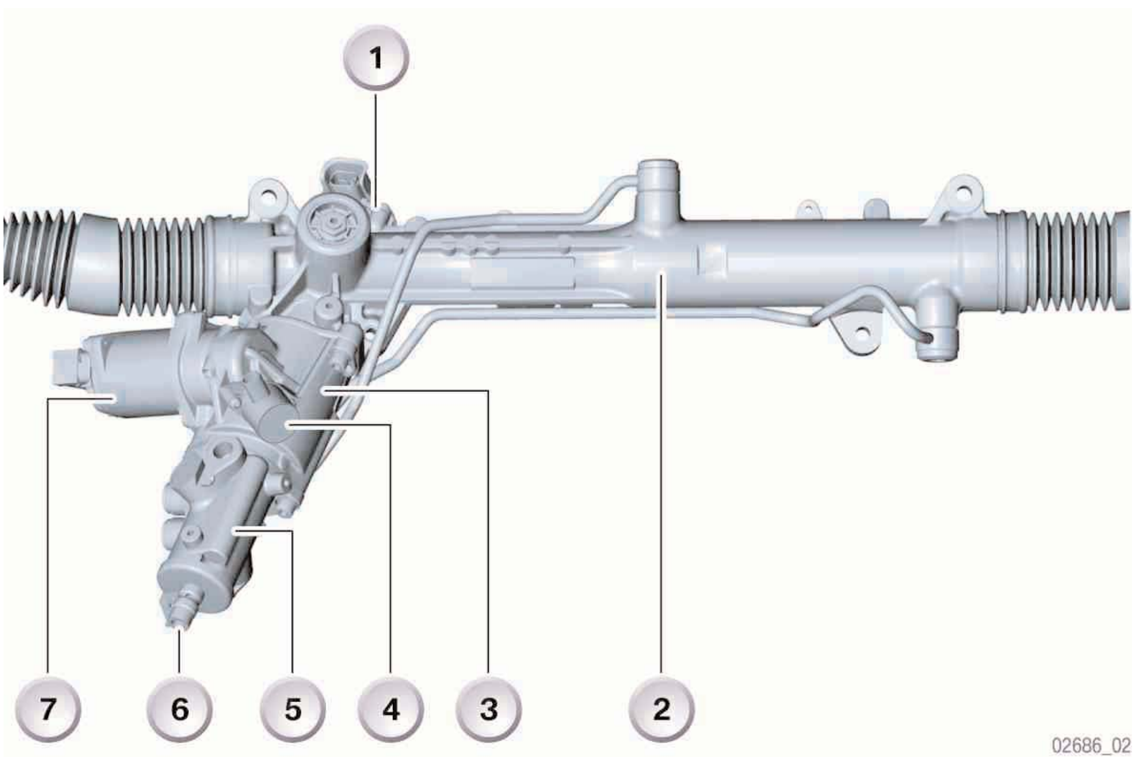
The power-steering cooler is located on the engine-cooling module. This cooler consists of 4 tubes of rectangular cross-section and soldered fins. The cooler is needed due to the increased hydraulic power needed to deliver higher wheel angle speeds.

Active Front Steering Actuating Unit

The active front steering actuating unit is located on the steering gear. It is integrated in the split steering column between the Servotronic valve and the rack.

This actuating unit comprises a brushless synchronous DC motor and a planetary gear.

The core component of the active front steering actuating unit is a planetary gear with 2 inputs. One input is from the driver via the steering spindle, the other is from the ring gear via the actuator motor



1. Summation steering-angle sensor
2. Rack
3. Planetary-gear housing
4. Magnetic lock
5. Servotronic valve
6. Steering spindle
7. Electric motor

One input shaft is connected via the Servotronic valve to the lower steering spindle. This input shaft is connected to the "sun" gear of the planetary set. The second input comes from the ring gear. The ring gear is driven by the electric motor via a self-locking worm-gear drive as a step-down stage. The wormgear drive actuates the ring gear which superimposes the steering angle of the front wheels specified by the driver.

An electromagnetically controlled safety interlock is fitted. The safety interlock is spring loaded and engages the worm gear drive on the actuator motor when no voltage is applied.

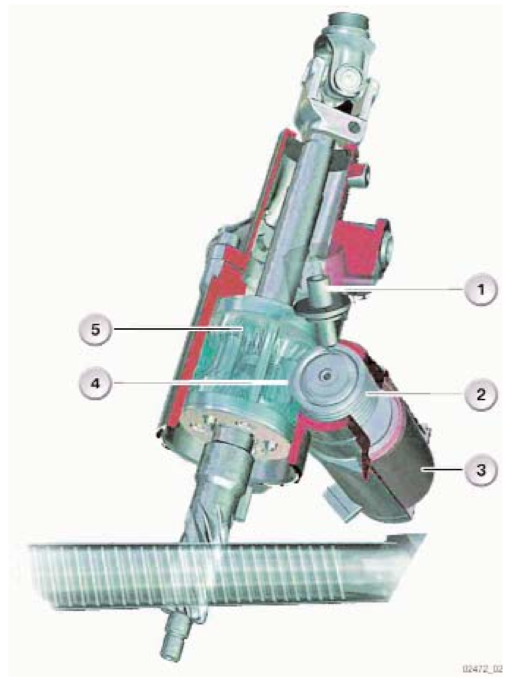
The safety interlock is released at a current of approx.1.8 A.

The rotor position of the electric motor is recorded by the motor position sensor on the motor itself.

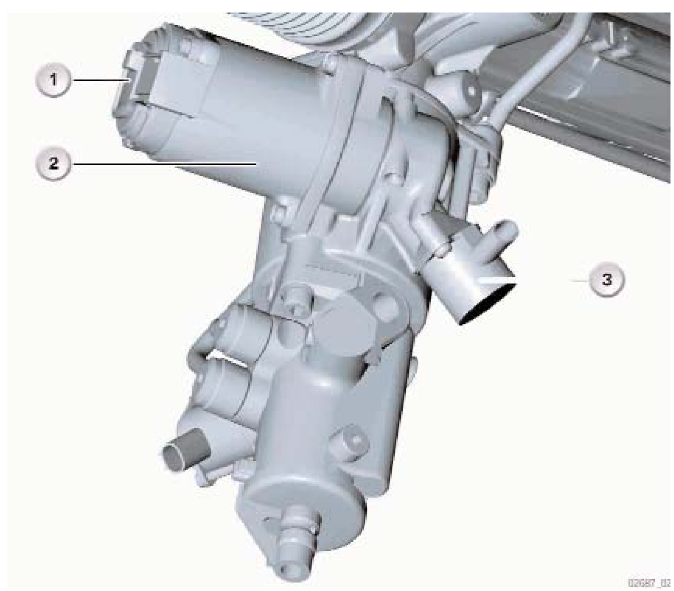
The electric motor is powered by way of 3 phases. The 3 phases are energized alternately by the electronics of the active front steering control unit.

The shielding is furnished by the ground connection of the electric motor housing to the body.

However, the actuating forces for the steering angle are not applied by the electric motor but rather by the power steering system.



1. Lock
2. Worm-gear drive
3. Electric motor
4. Worm gear
5. Planetary gear



1. Motor position sensor
2. Electric motor
3. Electro-magnetic lock

Principle of Operation

Functions of Active Front Steering

Active front steering, which specifically changes the steering angle of the front wheels specified by the driver, sets new standards in terms of agility, comfort and safety.

The system comprises the following functions:

- Variable steering gear ratio
- Yaw-rate control (support of DSC)
- Power-steering support (assist)

Variable Steering Gear Ratio

The variable steering gear ratio adapts the steering gear ratio to the road speed and the steering angle requested by the driver. The steering is designed to be indirect at high speeds and direct at low speeds.

Vehicle maneuverability is significantly increased at slow speeds or when parking by the active front steering actuating unit. The driver no longer needs to grip the steering wheel excessively. When the vehicle is stationary, 2 turns are enough to move the steering wheel from one lock to the other.

At high speeds (> 75 mph), active steering allows a more indirect steering gear ratio than do conventional steering systems. The servomotor operates in the opposite direction to the steering-wheel angle at high speeds.

Unintentional steering movements are prevented in conjunction with the increased steering-torque level (Servotronic).

Yaw-Rate Control

The active front steering system supports the stability functions of DSC.

In dynamic critical situations, active front steering system can specifically modify the steering angle of the front wheels specified by the driver and stabilize the vehicle much more quickly than the driver.

The intervention thresholds of DSC are much higher than those of active front steering. If vehicle oversteering is detected, the active front steering system intervenes first in order to stabilize the vehicle. DSC intervenes only if the steering system is not enough to stabilize the vehicle.

Power-Steering Support

Power-steering support is implemented by a conventional rack-and pinion power steering system. Servotronic is available as an option. The electronics and the software for Servotronic are incorporated in the SGM if active front steering is not fitted.

For the active front steering system, the software for power-steering support is incorporated in the active front steering control unit. The output stage for activating the Servotronic valve and the valve in the hydraulic pump (ECO) is located in the SGM. The ECO regulates the hydraulic flow rate in the hydraulic pump in order to provide only the flow rate currently required for the power steering.

System Safety

Unintentional system self-steering is classified as safety-critical behavior by the active front steering system.

The safe system status (failsafe) is the lowest-energy status of the actuating-unit servomotor. Regardless of whether the safe status is brought about by a power loss or by intentional deactivation by the system, it is essential to ensure that the actuating unit does not engage the steering system. The actuating unit is blocked by a lock, which engages the unit's worm-gear drive. The lock is preloaded by a spring and held against the preload by the voltage supply. An interruption of the voltage supply will thus cause the lock to engage the worm-gear drive of the actuating unit.

The locked superimposing gear ensures that manual steering by the driver via the steering column is still possible. The steering then responds like conventional steering. The purely mechanical gear ratio between the steering wheel and the front wheels is maintained.
The electric motor of the active front steering actuating unit is connected with 3 phases. A short circuit to ground thus prevents the electric motor from completing a full rotation as the motor can only rotate a maximum of 120° (360° : 3).

The Servotronic valve switches at zero current to the fast-driving curve. Power-steering support is reduced accordingly. When the ECO is at zero current, the flow rate is 7 l/min.

If the active front steering control unit does not send a valid message on the PT-CAN, the SGM operates after 100 ms with a road speed-dependent substitute curve. The substitute curve ensures sufficient steering properties for the passive active front steering system.

The driver is alerted to system faults by way of a warning lamp, a variable warning lamp and Check Control messages in the instrument cluster.

The Check Control message runs as follows: ***AFS failure! Steer with care.***

The following information appears in the control display:

Steering behavior altered! Possible to continue the journey. Steering wheel may be at angle. Have the problem checked by the nearest BMW Service.

Switch-on Conditions

The switch-on conditions for the active front steering system are terminal 15 On and a running engine.

When the engine is started, the system performs a synchronization of the steering-wheel position and the steering angle. This ensures that steering-wheel position and steering angle match up after steering wheel movements when the system is deactivated (passive status). Steering-wheel movements or movements by the wheels can be discerned.

Service Information

AFS Initialization/Adjustment

The technician must perform the initialization/adjustment procedure after performing the following work:

- Any alignment adjustments or steering component replacement
- Steering column work
- After replacement or programming of the AFS control module
- After replacement or programming of the SZL control module

A steering-angle adjustment (offset) must be carried out if the SZL or the steering rack is replaced. This must be carried out on the KDS (alignment equipment).

The total steering-angle sensor on the steering gear is calibrated to the middle of the rack at the steering-gear manufacturer.

The AFS adjustments can be found in the service functions menu of the DISplus/GT-1.

Wheel Alignment

If the vehicle requires a wheel alignment, the initialization procedure must be started before beginning the alignment. Using the DISplus/GT-1, complete the following steps:

- Access the test module for “Startup adjustment/AFS. When prompted, answer “Yes” to the alignment question.
- Center steering rack and check alignment marks on the steering gear
- Install tool # 324150 and lock steering wheel
- Proceed with alignment
- After completing the last steps of the alignment (front toe adj), remove 324150.
- Proceed with the remaining portion of the test module.

This will set the total steering angle to 0 degrees by locking the superimposing gear (ring gear). The AFS control module will de-energize the electromagnetic lock which will hold the AFS actuator motor which will in turn hold the superimposing gear stationary. If alignment is attempted without performing this procedure, the steering will be off-center by a considerable amount. Special tool # 324150 is used to hold the steering wheel in the center position. Failure to use the special tool will result in an off-center steering wheel.

Interference in Radio Reception

Interference in radio reception can be caused by there being no connection of the shielding of the 3 phases of the actuating unit to the housing of the active front steering control unit.

Diagnosis, Coding

Servotronic

Servotronic is activated in diagnosis as an independent control unit, the output stage for Servotronic is located in the SGM. Only the vehicle-specific configuration is entered by way of coding.

Workshop Exercise - AFS Adjustments

Remove underbody panels and thrust plate from vehicle and install special tool # 324150. Why is tool # 324150 needed to perform an alignment?

Remove special tool # 324150. Leave underbody panels and thrust plate off.

Using DISplus/GT-1 perform short test. Access test plan for "Startup Adjustment/AFS". Answer "Yes" to alignment question.

List the sequence of components adjusted during this procedure:

What is the difference between answering Yes or No at the beginning of this procedure?

When should the Startup/Adjustment be performed?

List the steps for performing an alignment on a vehicle equipped with AFS:

What 2 special tools are specific to the E60 wheel alignment?

Workshop Exercise - AFS Adjustments

With the engine running, How many turns of the steering wheel are required to go from lock to lock?

Under control unit functions page, locate the status request for "Value Steering Angle".

With the steering wheel in the straight ahead position, note the values for:

Driver's steering angle

Total steering angle

With the engine running, turn the wheel from lock to lock and note the changes in the above angles. What is observed regarding the difference between these angles?

Turn the steering wheel to the left lock position and disconnect the AFS motor connection. Turn the steering wheel back to the straight ahead position and note the new steering angle values:

Driver's steering angle

Total steering angle

Are the values the same for the straight ahead position? Why or Why not?

Reconnect AFS motor connection, clear fault codes and perform "Startup Adjustment/AFS".

List the path taken to access the test plan for "Startup Adjustment/AFS".

Re-install underbody panels and thrust plate on vehicle.

Table of Contents

E60 Dynamic Drive

Subject **Page**

Table of Contents

Model: E60

Production: Start of Production MY 2004

Dynamic Drive

Objectives:

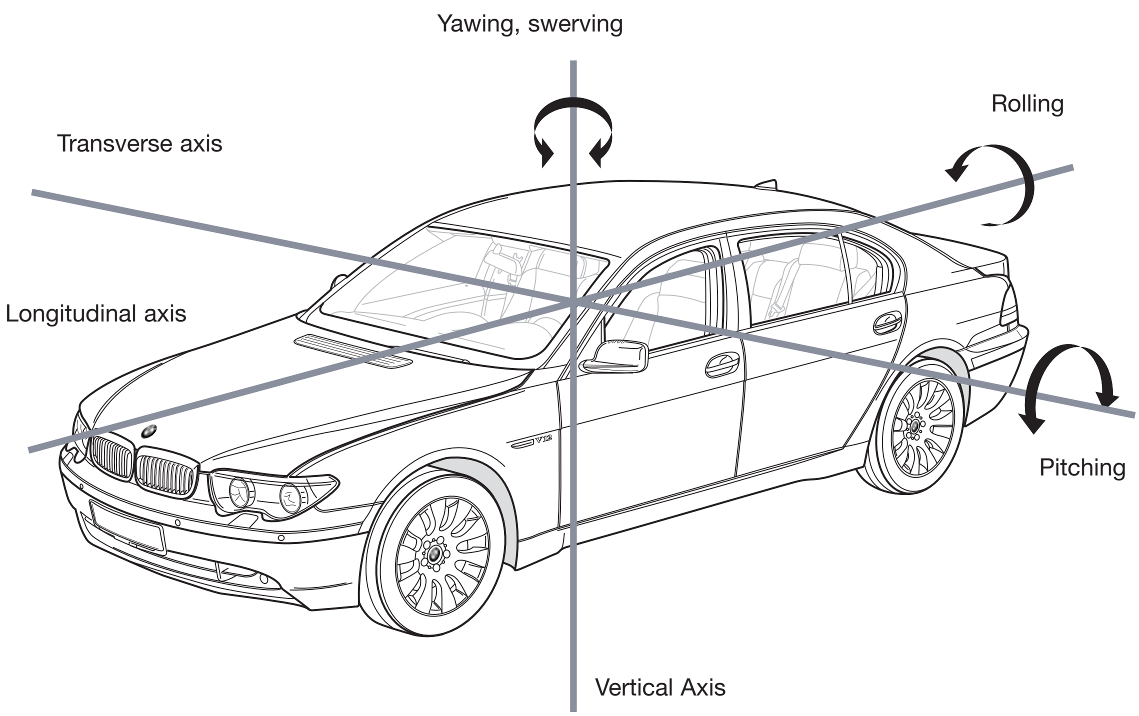
After completion of this module you will be able to:

- Identify and locate components of the Dynamic Drive System
- Understand Operation of the Dynamic Drive System
- Understand diagnosis and service operation of Dynamic Drive

Purpose of the System

Dynamic Drive

The design of the Dynamic Drive is the same as the system fitted in the E65. The function of the Dynamic Drive in the E60 is identical to the function of the Dynamic Drive in the E65. The disadvantage of a passive stabilizer bar is that the basic suspension hardens in the case of straight-ahead driving and one sided jouncing. This reduces comfort.



Roll, yaw and pitch axis

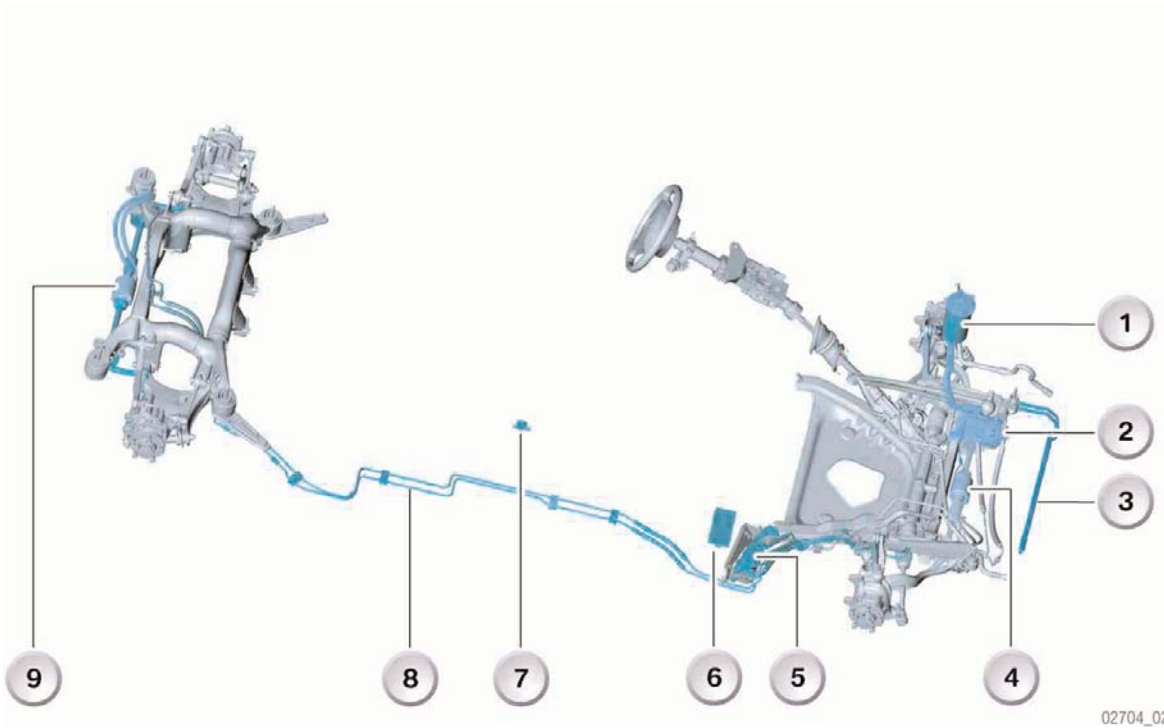
Dynamic Drive has two active stabilizer bars which have a positive effect on the roll tilt angle and handling.

Split stabilizer bars on the axles act as the basis of the Dynamic Drive. The halves of the stabilizer bars are joined by way of a hydraulic oscillating motor. One half of the stabilizer bar is connected to the oscillating motor shaft while the other is connected to the oscillating motor housing.

When you are driving straight ahead, the system improves suspension comfort because the stabilizer bar halves are non-interacting and therefore do not harden the basic suspension when suspension is used on one side.

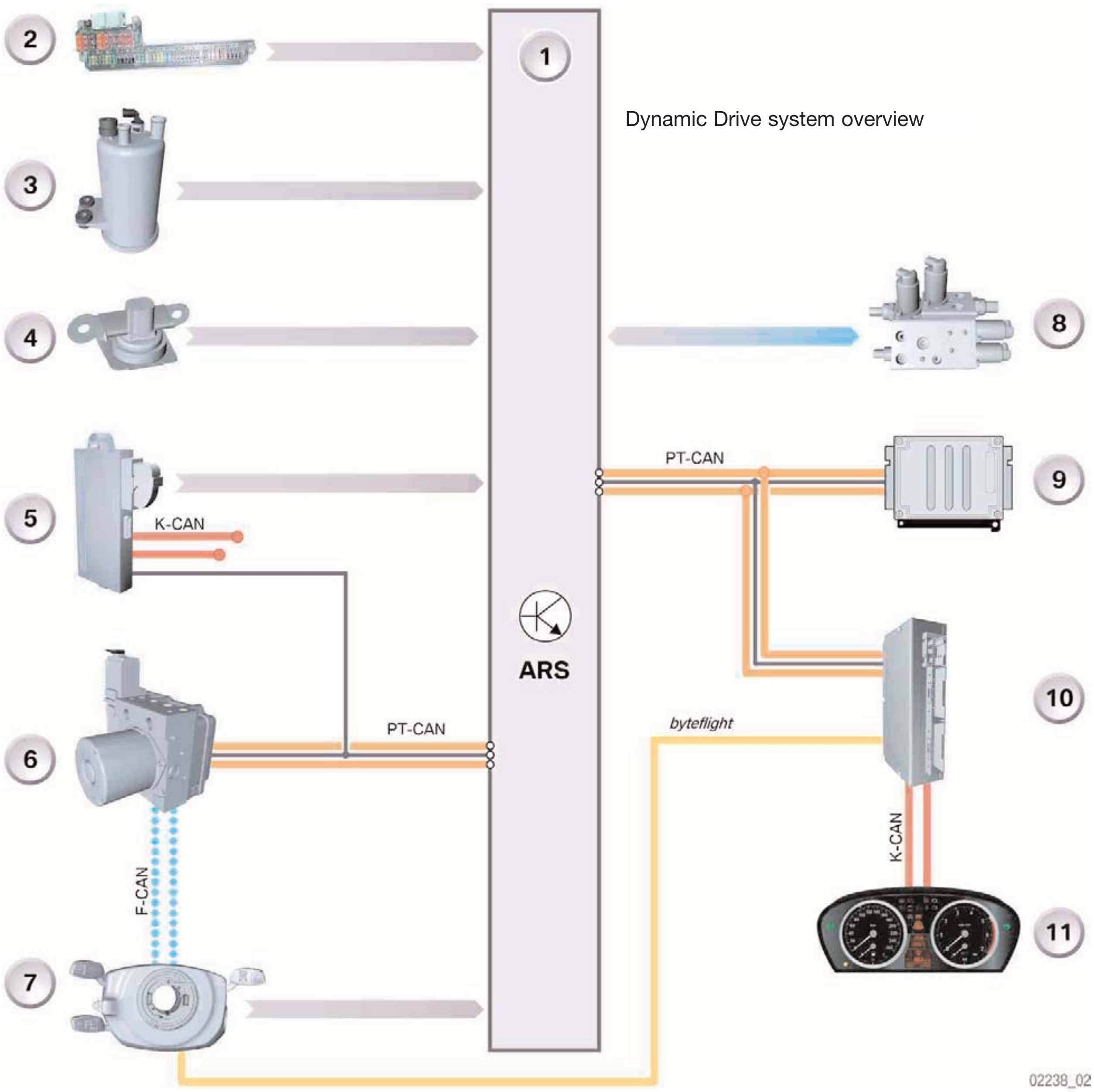
System Overview

Mechanical Components



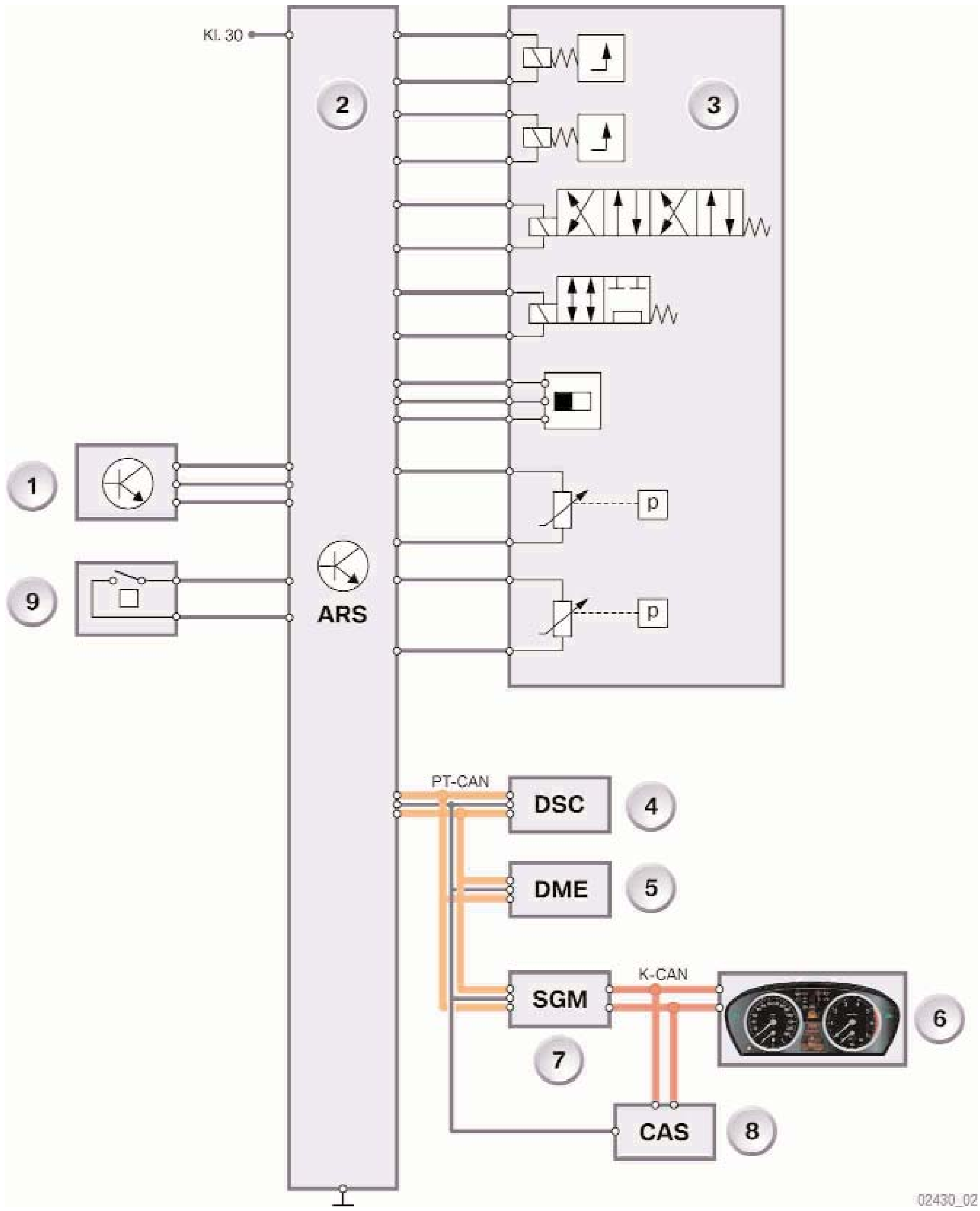
1. Hydraulic-fluid reservoir
2. Tandem pump
3. Hydraulic-fluid cooler
4. Front oscillating motor
5. Valve block
6. Control unit
7. Lateral-acceleration sensor
8. Hydraulic lines
9. Rear oscillating motor

Inputs/Outputs



1. Dynamic Drive control unit
2. Current distributor, front, power supply
3. Hydraulic reservoir, fluid level
4. Lateral-acceleration sensor
5. Car Access System control unit
6. DSC module
7. Steering-angle sensor
8. Dynamic Drive valve block
9. Digital Motor Electronics
10. Safety and Gateway Module
11. Instrument cluster

System Schematic



1. Lateral-acceleration sensor
2. Dynamic Drive control unit
3. Dynamic Drive valve block
4. DSC control unit
5. Digital Motor Electronics
6. Instrument cluster
7. Safety and Gateway Module
8. Car Access System control unit
9. Hydraulic-fluid level sensor

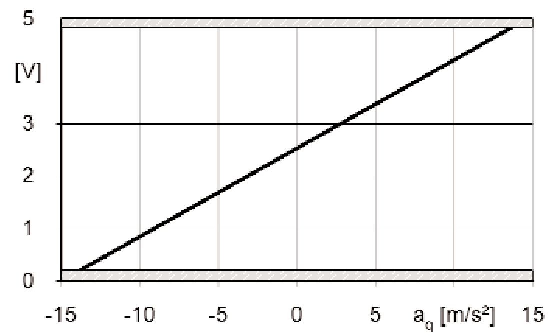
PT-CAN Powertrain CAN
K-CAN Body CAN

Components

Lateral-Acceleration Sensor

The lateral-acceleration sensor supplies the main sensor signal. When cornering, it measures the vehicle's lateral acceleration up to a measuring range of }1.1 g. It is mounted beneath the right-hand front seat on the floor plate.

Lateral-acceleration sensor;natural color connector, individual connector coding



Lateral-acceleration sensor,characteristic curve

Fluid Level Sensor

The fluid level sensor detects the fluid supply in the fluid reservoir. The fluid level sensor is mounted on the fluid reservoir. Short circuits/open circuits cannot be detected by the fluid level sensor. A line break is interpreted as a loss of fluid.

Dynamic Drive Control Unit

The Dynamic Drive control unit is located on the right side of the passenger compartment in the A-pillar area.

The control unit is supplied with power via terminal 30 and is protected by a 10 A fuse.

A vehicle authentication process takes place when the system is started. This compares the vehicle identification number from CAS with the vehicle identification number which is encoded in the Dynamic Drive control unit.

Then the control unit's hardware and software is checked.

All the outputs (valve magnets) are subjected to a complex check for short circuits and breaks. If there is a fault, the system switches the actuators into a safe driving condition.

The control unit switches off if there is undervoltage or overvoltage.

The control unit learns the offset for the steering angle and the lateral acceleration during startup and during driving.

Active Stabilizer Bar

The active stabilizer bar consists of the oscillating motor and the halves of the stabilizer bar with press-fitted roller bearings which are mounted on the oscillating motor for connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces.

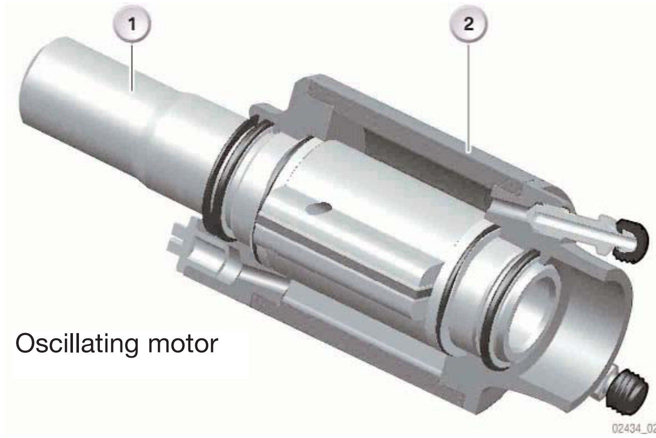
The oscillating motor and the oscillating motor housing are joined by one half of the stabilizer bar.

The oscillating motor of the front-axle stabilizer bar is fitted with 2 pressure relief valves.

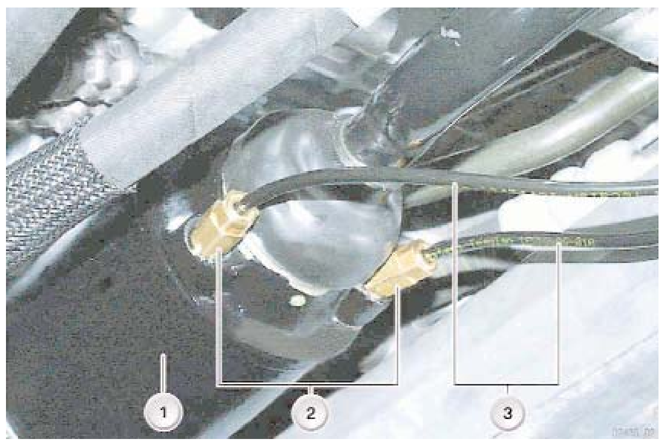
Pneumatic lines are connected to the pressure relief valves. These pneumatic lines end in a filter element (conventional fuel filter) which is inserted in the diagonal strut on the left wheel arch.

The filter element is located in different positions in the engine compartment depending on the mounting position of the various engines.

The positions for the pressure relief valves are fitted with screw plugs on the oscillating motor of the rear-axle stabilizer bar.



1. Oscillating motor shaft 2. Oscillating motor housing



1. Oscillating motor 3. Pneumatic lines
2. Pressure relief valves

1. Filter element

Function of Pressure Relief Valves

When the vehicle is driven on poor road surfaces, the stabilizer-bar movements give rise to brief vacuum pressures (cavitation) in the oscillating motors which in turn cause rattling noises.

Pressure relief valves have been fitted on the front oscillating motor in order to eliminate these noises. These pressure relief valves allow filtered air to flow into the oscillating motor through the connected pneumatic lines. This prevents cavitation.

This small quantity of air is absorbed by the hydraulic fluid (Pentosin) to form an emulsion, which is discharged during the next activations of the oscillating motor. The air is separated in the expansion tank.

Because no noises can be heard at the rear axle, the pressure relief valves have been omitted from the rear oscillating motor.

Operating Principle of Oscillating Motors

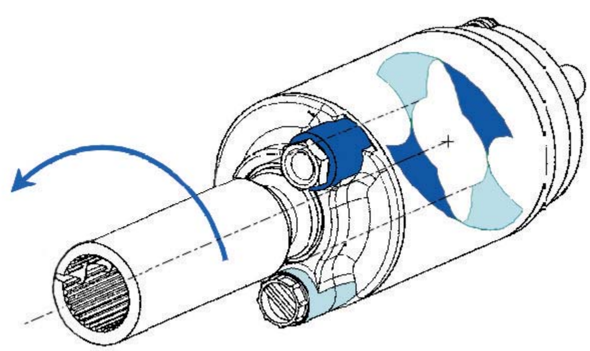
The oscillating motor has three functions to perform:

- It guides the torque into the two halves of the stabilizer bar.
- It decouples the two halves of the stabilizer bar.
- In the event of system failure (failsafe mode), the front axle stabilizer bar creates sufficient damping via the oscillating motor hydraulic fluid (hydraulic locking). It now works like a conventional stabilizer bar.
  Exception: If the oscillating motor chambers no longer contain any fluid as a result of a leak, the front axle stabilizer bar can no longer create damping.

Since one half of the stabilizer bar is connected to the shaft, and the other with the housing, the two halves turn in opposite directions.

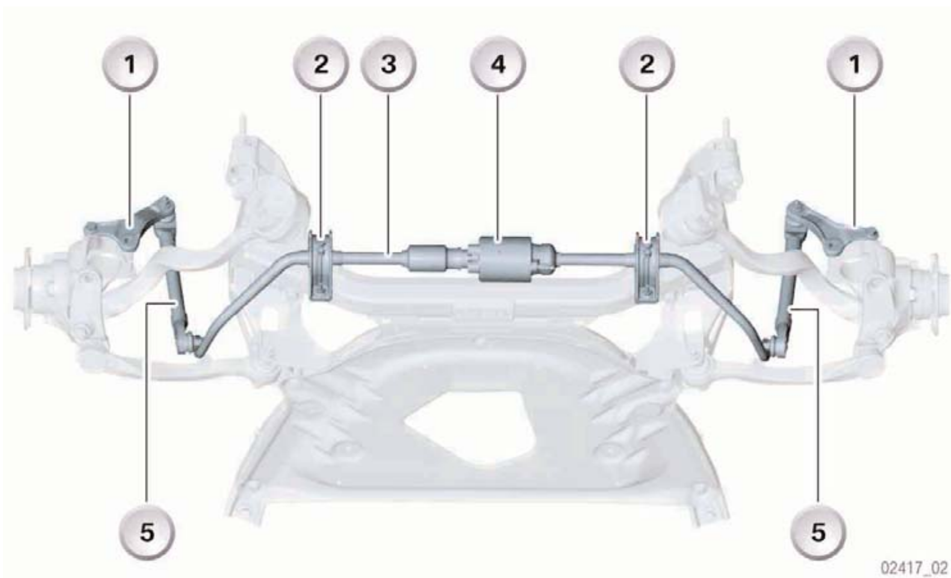
The shell is forced upwards on the outside of a curve, and dragged down on the inside of a curve.

The maximum body torque on the front and rear axle occurs when there is a high degree of lateral acceleration. The system pressure is then 180 bar at the front axle and 170 bar at the rear axle.



Front-Axle Stabilizer Bar

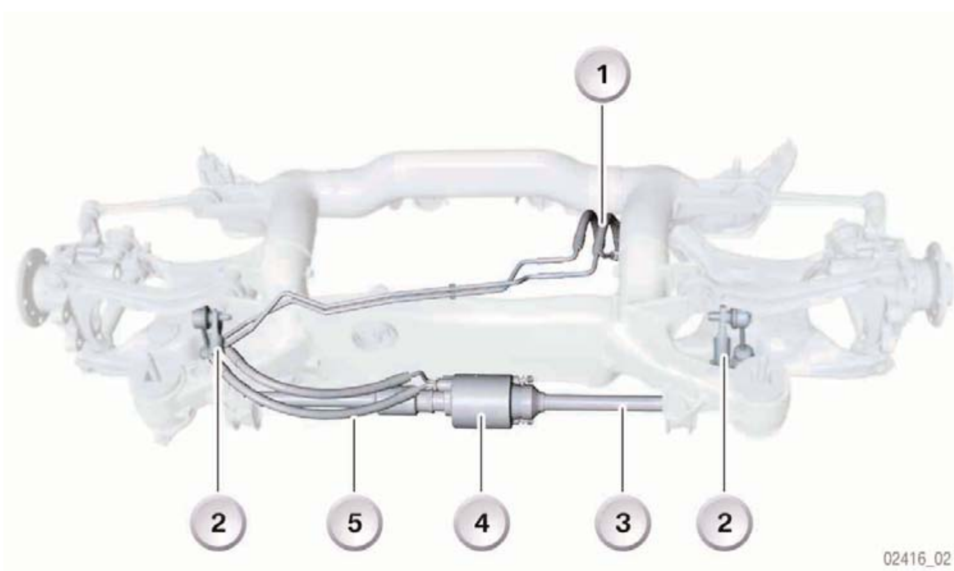
The stabilizer bar is mounted on the front-axle carrier. The stabilizer links are connected to the "goose-necks" of the swivel bearings.



1. Stabilizer-link connection to swivel bearing
2. Stabilizer-bar bracket
3. Stabilizer bar
4. Oscillating motor
5. Stabilizer links

Rear-Axle Stabilizer Bar

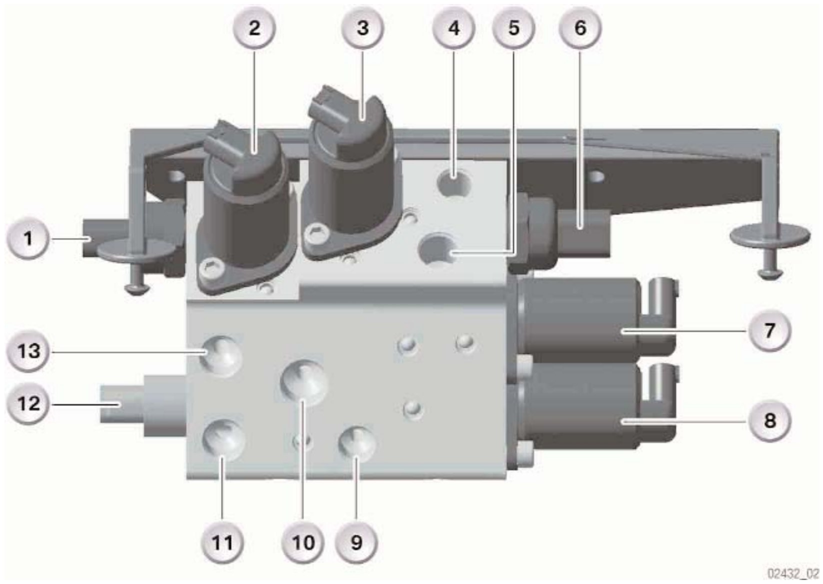
The stabilizer bar is mounted behind the rear-axle carrier. The stabilizer links are connected to the rear-axle swinging arms.



1. Hydraulic lines from valve block
2. Stabilizer links
3. Stabilizer bar
4. Oscillating motor
5. Hydraulic lines

Valve Block

The valve block is located on the floor plate behind the front right wheel-arch trim.



1. Rear-axle pressure sensor
2. Rear-axle pressure-limiting valve
3. Front-axle pressure-limiting valve
4. Line 1, front-axle oscillating motor
5. Front-axle pressure sensor
6. Line 2, front-axle oscillating motor
7. Failsafe valve
8. Directional valve
9. Line 1, rear-axle oscillating motor
10. Hydraulic reservoir
11. Line 2, rear-axle oscillating motor
12. Selector-position recognition sensor
13. Tandem pump connection

Pressure Control Valves

There is a pressure control valve on both the front and rear axles. They both adjust the actuation pressures for the front- and rear-axle stabilizer bars.

Directional Valve

The directional valve is electrically actuated. It specifies the direction of the high-pressure fluid (active pressures) and the reservoir fluid for right-hand and left-hand bends.

Failsafe Valve

The failsafe valve (safety valve) is electrically actuated. The failsafe valve responds in the event of a power-supply failure or an identified fault in the system. The failsafe valve shuts off the front-axle oscillating motor when de-energized. Thus the active stabilizer bar behaves like a normal mechanical stabilizer bar and brings about understeering.

Selector-Position Recognition Sensor

The task of this sensor is to detect the specific position of the directional valve.

2 positions can be detected:

- Left-hand control
- Right-hand control

Front-Axle/Rear-Axle Pressure Sensors

The pressure sensors are responsible for detecting the front and rear axle stabilizer bar hydraulic pressures. The sensors are mounted on the valve block. The pressure sensor offset values are taught-in by the control unit once, during commissioning.

Tandem Pump

The tandem pump, which is driven by the engine via a ribbed V-belt, consists of a radial-piston part for the Dynamic Drive and a vane part for the power steering.

When the engine is idling, the pump speed is approxImately. 750 rpm.

The pump's minimum fluid flow rate is 4.5 l/min at approxImately. 5 bar and 3.3 l/min at 200 bar. This means that sufficient system dynamics are also guaranteed when the engine is idling.

From a pumping speed of approxImately. 1165 rpm, the maximum fluid flow rate is limited to 7 l/min.

Dynamic Drive and power steering have a joint fluid reservoir and fluid cooler.

Fluid Reservoir

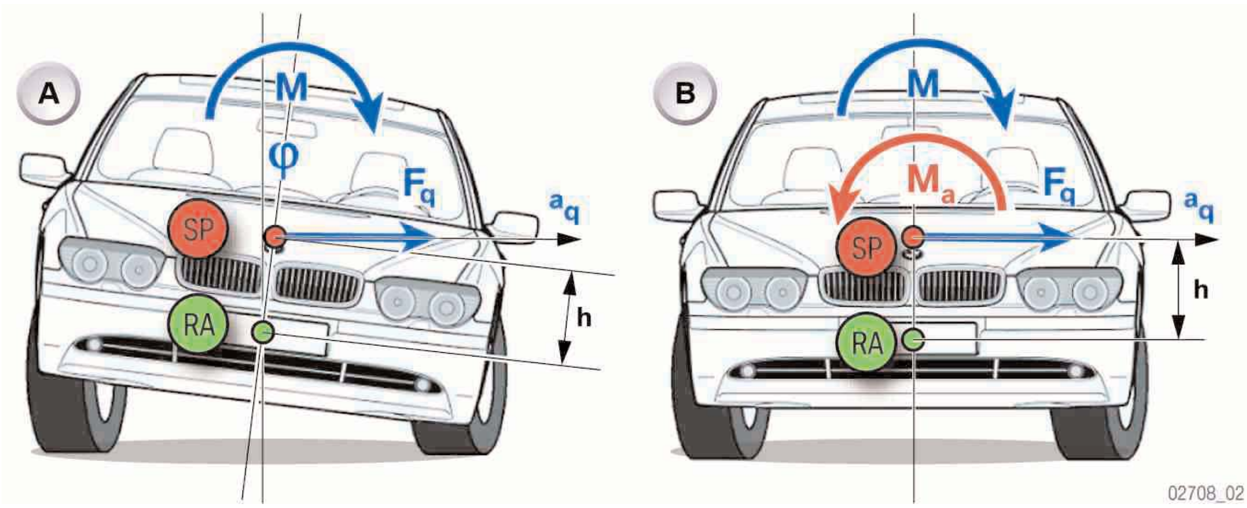
The fluid reservoir is identical on all vehicles, whether they have the Dynamic Drive function or not. The reservoir incorporates a fluid filter. A fluid level sensor is provided for the minimum quantity.

Cooler

The cooler ensures a long-term fluid temperature of < 120 °C and a short-term fluid temperature of < 135 °C in all hydromechanical components under all conditions.

System Functions

The car sets lateral acceleration while cornering (aq) which affects the vehicle body at the centre of gravity (SP). The body rolls around the roll axis (RA) which is predefined by the front and rear axle kinematics. This sets the roll angle (max. 5°). This produces a maximum change in level on the wheel arch of +/-10 cm.



A. Car without Dynamic Drive
B. Car with Dynamic Drive
M. Rolling moment
aq. Lateral acceleration
φ Roll angle
Ma. Body torque
SP. Centre of gravity
RA. Roll axis
Fq. Lateral force
h. Lever arm centre of gravity height

In the vehicle with Dynamic Drive, the rolling moment M can be compensated for by the active stabilizer bars up to a lateral acceleration aq of approxImately. 3 m/s^2 (0.3 g).

Note: The tire suspension created by the rolling moment (M) is not compensated for.

The distribution of the active body torque between the front and rear axle depends on the road speed.

Affect of the Self-Steering Behavior

The self-steering behavior can be decisively influenced by the distribution of the stabilizing torque on the axles. The greater the stabilizing torque on an axle, the lower the lateral forces transmitted on this axle.

Two cases are described below with different distribution of stabilizing torque on the axles:

1. Identical stabilizing torque on both axles

Handling is "NEUTRAL."

The front wheels can apply about the same amount of lateral force on the road as the rear wheels without drive torque. The handling conditions are neutral.

A vehicle which is tuned to neutral handling conditions provides very agile handling, the steering reacts very quickly. The driver experiences precise handling.

Even an inexperienced driver can control a vehicle which is tuned to neutral handling very well at low speeds.

2. Larger stabilizing torque on the front axle

Handling is "UNDERSTEERING."

The front axle wheels cannot apply the same amount of lateral force on the road as the rear axle wheels. The vehicle suffers understeer.

A larger steering-wheel angle is required to be able to follow the desired course.

A vehicle with understeer can generally also be controlled well by an inexperienced driver at higher speeds and higher cornering speeds.

This very sensitive handling reduces the vehicle's agility.

Dynamic Drive sets the stabilizing torque on the front and rear axles such that a different handling characteristic is produced for low and high speeds.

The passive vehicle is configured as slightly understeering irrespective of the speed range. Dynamic Drive is neutral in the low speed range. The driver has to steer less in order to negotiate the same bend. This results in optimum handling and agility.

In the upper speed range, both vehicles behave almost identically with regard to the required steering angle on the same bend.

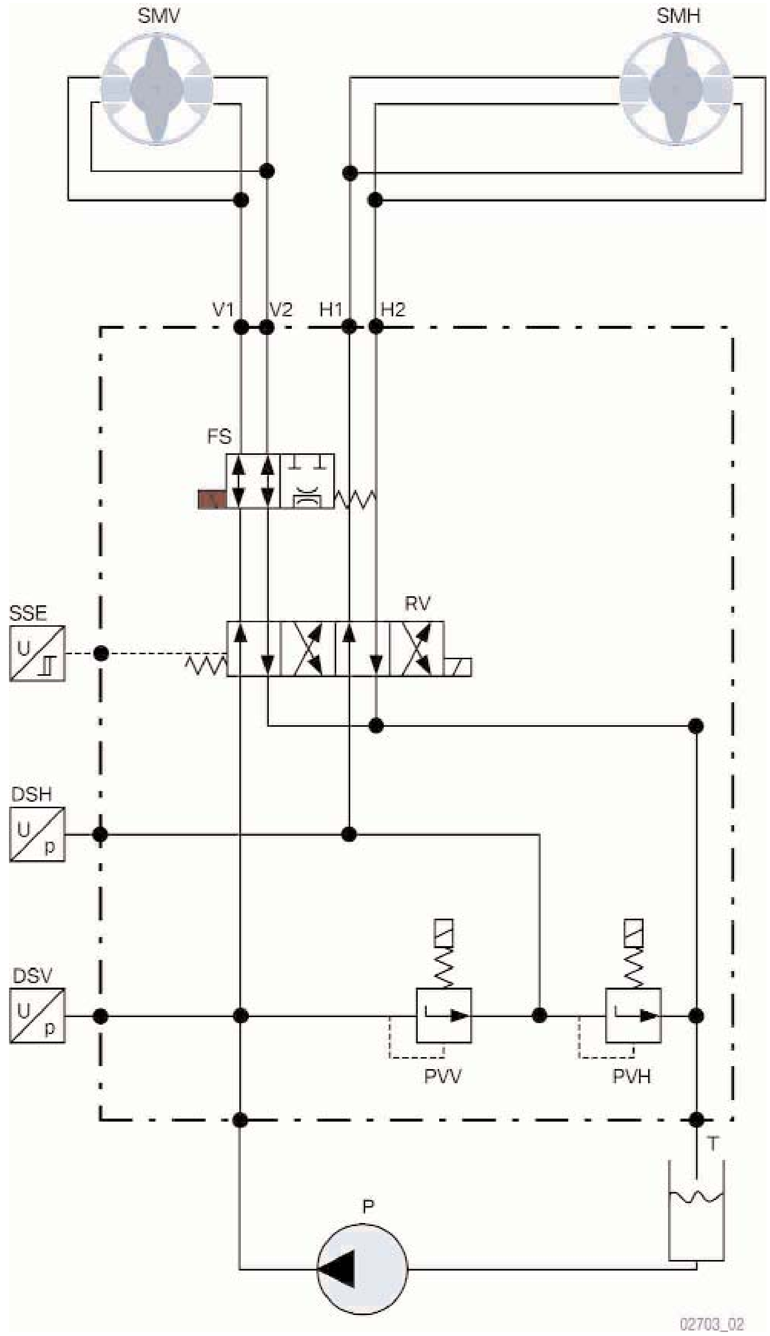
The hydromechanical concept is designed so that a larger active stabilizing torque cannot occur on the rear axle than on the front axle under any circumstances. This means that mechanically and hydraulically the vehicle with Dynamic Drive is safeguarded such that no oversteering and therefore for normal customers no critical handling characteristics can occur under any circumstances.

Comparison Between the Conventional Stabilizer Bar and the Active Stabilizer Bar

Active stabilizer bars introduce fewer comfort-reducing forces into the body than passive stabilizer bars. In this case a differentiation must be made depending on the frequency with which the forces were introduced.

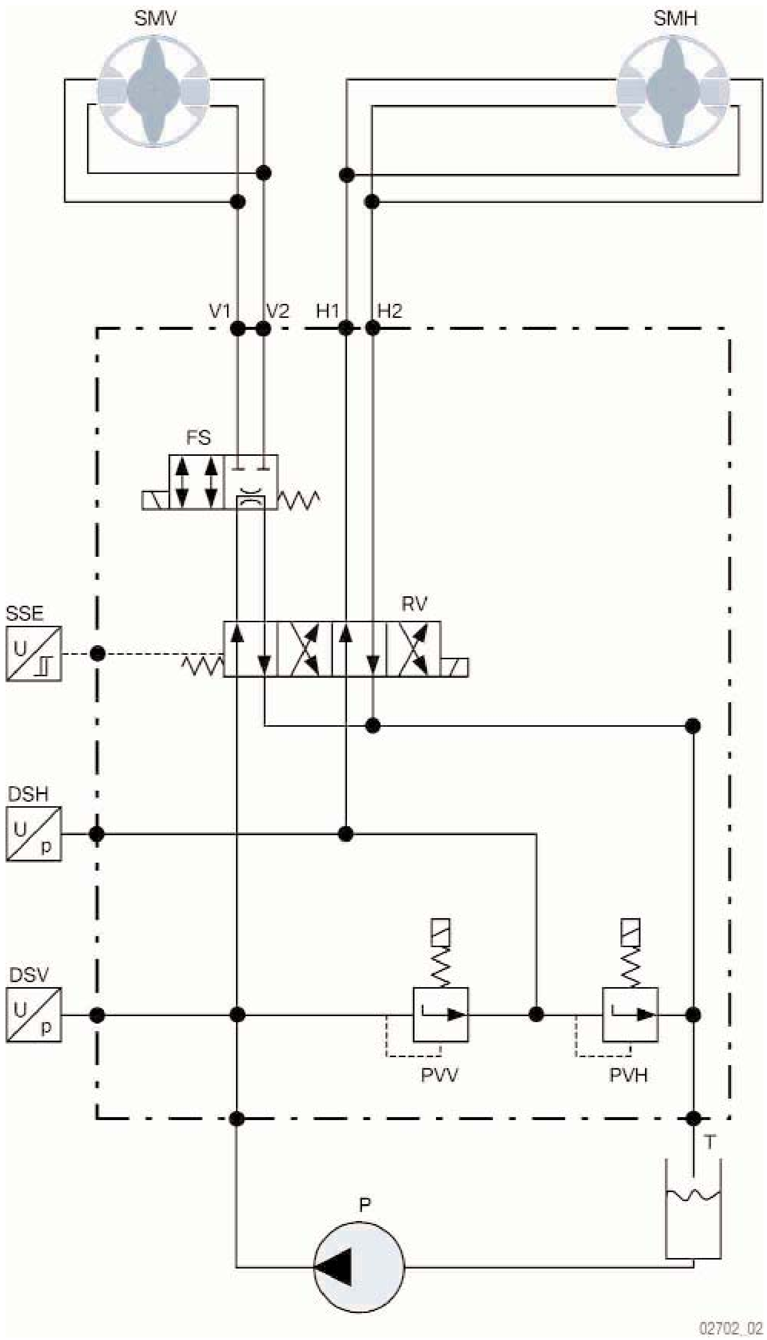
Road stimulus	Stabilizer bar behavior
At approxImately. 1 Hz (body natural frequency)	At smaller strokes the active stabilizer bar is easier to turn than a conventional stabilizer bar. The forces introduced into the body are fewer, the vehicle becomes more comfortable and body sound is improved
From 8 Hz (wheel natural frequency)	Both stabilizer bars behave in a similar way. On a vehicle with an active stabilizer bar this is because the fluid is not displaced so quickly.

Operating States



Hydraulic schematic normal function, failsafe valve energized

SMV	Front oscillating motor
SMH	Rear oscillating motor
V1	Front-axle hydraulic circuit 1
V2	Front-axle hydraulic circuit 2
H1	Rear-axle hydraulic circuit 1
H2	Rear-axle hydraulic circuit 2
FS	Failsafe valve
SSE	Selector-position recognition sensor
RV	Directional valve
DSH	Rear-axle pressure sensor
DSV	Front-axle pressure sensor
PVV	Front-axle pressure valve
PVH	Rear-axle pressure valve
P	Tandem pump
T	Fluid reservoir



Hydraulic schematic, failsafe function or rest position

SMV Front oscillating motor
SMH Rear oscillating motor
V1 Front-axle hydraulic circuit 1
V2 Front-axle hydraulic circuit 2
H1 Rear-axle hydraulic circuit 1
H2 Rear-axle hydraulic circuit 2
FS Failsafe valve
SSE Selector-position recognition sensor
RV Directional valve
DSH Rear-axle pressure sensor
DSV Front-axle pressure sensor
PVV Front-axle pressure valve
PVH Rear-axle pressure valve
P Tandem pump
T Fluid reservoir

Notes for Service

Service Information

If the Dynamic Drive fails, DSC can no longer be deactivated or if it is already deactivated it does not switch back on automatically.

The connections for all the hydraulic components are designed in different dimensions and lengths so that they cannot be transposed.

A faulty acoustic transmission in the vehicle interior predominantly occurs through the assembly and cable connections. The cables must not appear on the surface, they must lie correctly in the supports without any slack or tension. They are covered by the under-body covering.

Steering-Angle Adjustment

After working on the steering, it is necessary to carry out a steering angle adjustment with the steering-column switch cluster (SZL) control unit!

The Dynamic Drive system is dependent on the exact zero balance of the steering angle!

The maximum tolerance for a deviation is +/- 1°. Precise performance of a wheel-alignment check and adjustment is essential!

Steering-angle adjustment must always be performed on the KDS and in accordance with the BMW specifications! Each time the Dynamic Drive or SZL control unit is flashed results in a loss of the zero position! A steering-angle adjustment is necessary!

Dynamic Drive Commissioning

The commissioning procedure must always be carried out once the system has been opened or a part has been replaced. This also applies after the lateral-acceleration sensor has been replaced.

The following conditions must be guaranteed for matching the lateral acceleration sensor and the two pressure sensor offset values:

- The vehicle must be stand level on all four wheels
- The vehicle must be unladen
- The engine must be idling
- Rest status (doors closed, persons are not allowed in the vehicle)

No persons may remain within the vicinity of moving chassis parts during the commissioning (both in the works and the workshop). In addition you must ensure that the basic commissioning conditions (temperature range, constant engine speed etc.) are maintained. The ground clearance must not be limited and the doors must be closed. The arms of the hoist may no longer be situated beneath the car.

The commissioning procedure is split into five stages which follow on from each other automatically:

I: direction valve test (from 3 to 3.4 s)	First the direction valve is tested by evaluating the signal of the selector-position recognition sensor.
II: low-pressure test (from 3.4 to 4.3 s)	The failsafe and direction valves are without power during this stage. Then tests are carried out with pressure control valves with and without power on the front and rear axle. The body is then tilted. The sides of the vehicle must be clear.
III: front-axle high pressure test (from 4.3 to 9.9 s)	Pressure of 180 bar is applied to the front-axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor are detected.
IV: rear-axle high pressure test (from 9.9 to 15 s)	Pressure of 170 bar is applied to the rear-axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor are detected.
V: pressure-control valve test (from 15 to 25 s)	The characteristic curves of the front and rear axle are checked (setpoint/actual-value comparison). Faulty pressure control valves are detected.

Dynamic Drive Venting

A venting routine must be carried out using the diagnostic tester if the Dynamic Drive system was opened hydraulically.

The venting operation is performed exclusively by way of the commissioning routine of the diagnostic tester and not at the pressure relief valves or at the screw plugs of the oscillating motors!

If the test still detects air in the system, a short movement trip should be made if necessary.

The commissioning routine must then be repeated after the short trip.

In the event of an extreme leak or suspected subfunction of the pressure relief valves (noticeable by the rattling noises in the front end), the pressure relief valves and the pneumatic lines must be replaced with new components.

Diagnosis

The following faults can be detected at the components:

Component	Fault type	Fault detection via:
Control unit	De-energized or faulty	Instrument cluster through absence of alive counter, VIN not recognized during authentication, watchdog
Pump	No pressure	Setpoint/actual-value comparison pressures
Directional valve	Stuck in "energized" position (spring break, swarf) Stuck in "de-energized"position (line break)	Directional-valve sensor Directional-valve sensor and current monitoring
FA pressure control valve	Open (de-energized, p = pRA) Closed (mechanical fault) (pFA= pmax)	Setpoint/actual-value comparison, pressure,front axle, current measurement Setpoint/actual-value comparison, pressure,front axle
RA pressure control valve	Open (de-energized) (p = 0) Closed (mechanical fault) (pRA and pFA = pmax)	Setpoint/actual-value comparison, pressure,rear axle, current measurement Setpoint/actual-value comparison, pressure,rear axle,
Failsafe valve	Stuck open Stuck closed(line)	Pre-drive check Current measurement
Actuator front/rear axle	Leaking (no torque) Blocked	Setpoint/actual-value comparison pressure Setpoint/actual-value comparison pressure
CAN bus	Omitted completely (line disconnected)	CAN timeout
Steering angle, vehicle speed lateral acceleration	Implausible or omitted	Plausibility monitoring and fault detection,CAN bus signals

Component	Fault type	Fault detection via:
Sensor aq (lateral acceleration)	Omitted completely (line disconnected) Incorrect signal	Voltage monitoring Check plausibility via CAN signals
Fluid level sensor	No signal (line)	
Front-axle pressure sensor	No signal (line) Incorrect signal	Voltage monitoring Setpoint/actual-value comparison, pressure, front axle
Rear-axle pressure sensor	No signal (line) Incorrect signal	Voltage monitoring Setpoint/actual-value comparison, pressure, RA
Directional-valve sensor	No signal Incorrect signal	Voltage monitoring Setpoint/actual-value comparison, direction valve and selector-position recognition sensor

System Shutdown (Failsafe Status)

Depending on the fault, the system displays one of the following responses.

The following faults result in system shutdown, i.e. all output stages are de-energized:

- Fault in the front-axle stabilizer bar
- Fault at the front-axle pressure sensor
- Fault in the pressure build-up (pump, pressure-limiting valve on the front axle)
- Fault in the control unit
- VIN is not sent via the CAS / omitted / incorrect
- Direction-valve position fault, faulty selector-position recognition sensor
- No PT-CAN signal

The de-energized failsafe valve shuts off the chambers of the active stabilizer bar. A fluid compensation is only performed by way of internal leakage of the oscillating motor and the valve block. The non-return valves in the valve block permit additional suction of fluid so that no cavitation occurs in the front-axle oscillating motor.

The chambers of the rear-axle oscillating motor must not be shut off. The handling corresponds virtually to that of a conventional vehicle. The crossover to the failsafe status can also be controlled in the event of extreme maneuvering.

Warning message	**Handling instruction**
Cornering stability! Drive slowly around bends 	Driving-stability system not functioning, driving stability restricted. No high cornering speeds. Continued driving possible, contact BMW Service immediately
In the event of a fluid loss in the Dynamic Drive hydraulic system or in the steering circuit, the fluid level sensor in the fluid reservoir responds. The driver is alerted so that damage to the tandem pump caused by continued driving is avoided.	
Warning message	**Handling instruction**
Fluid loss! Caution Stop, engine off 	Fluid loss in the chassis and steering systems. Continued driving not possible, contact BMW Service immediately

Restricted Control Comfort

A lateral acceleration is calculated from the road speed and steering wheel angle from the CAN signals. This signal is faster than the actual lateral acceleration and compensates the time delay of the hydromechanical system. In the event of a fault in these two signals, the system responds with a delayed roll compensation. This arises only in the case of extremely quick steering maneuvers and is barely noticeable in normal cornering maneuvers.

In the event of a faulty lateral-acceleration sensor, the lateral acceleration is calculated exclusively from the CAN signals. No impairment of function can be detected by the customer.

In the event of a fault in the rear-axle circuit, i.e. a stabilization at the front axle only, the customer notices that the vehicle is subject to larger rolling motions. Agility diminishes at road speeds < 120 km/h.

The system also responds if the fault "Failsafe valve stuck open" is detected in the pre-drive check.

An electrical fault in the rear-axle pressure sensor may result in minor failures in roll-angle compensation. To be on the safe side, slightly more stabilizing torque is exerted on the front axle than in normal operation. This can be felt by the driver.

Warning message	Handling instruction
Cornering stability slightly restricted	Chassis stabilization slightly restricted around bends. Continued driving possible, contact BMW Service at next opportunity

Restricted System Monitoring

Dynamic Drive receives via PT-CAN the following sensor signals from DSC and SZL:

- Lateral acceleration
- Yaw velocity
- Road speed
- Steering-wheel angle

These signals are used to check the lateral-acceleration sensor.

Drop-out of the engine-speed signal (DME) results in restricted control comfort.

In the event of a fault in the lateral acceleration and yaw velocity CAN signals, the system is lacking two items of redundant information. Since this information is used exclusively for checking the other signals, the Dynamic Drive function is preserved with full control comfort.

Although the Dynamic Drive function is not impaired, the driver receives the display "Chassis control comfort restricted." He/she is prompted to visit a garage/workshop at the next available opportunity.

Warning message	Handling instruction
Cornering stability slightly restricted	Chassis stabilization slightly restricted around bends. Continued driving possible, contact BMW Service at next opportunity

A "dynamic" driver will notice the absence of the steering-angle signal.

The warning messages must be acknowledged by the driver. Each warning message goes out only after it has been acknowledged.

Once the cause of the fault has been rectified, the control unit can be returned to full function.

There are two reset conditions depending on how fast a fault is to be detected:

- All faults which are no longer present are reset with "ignition off." It is necessary here to wait until the sleep mode has been obtained before "ignition on" is activated again.

- Sporadic faults which can mostly be traced back to communication faults in the CAN bus are then automatically reset while the vehicle is moving straight ahead or stationary provided they have only occurred briefly and rarely. In this case, the customer cannot detect the activation while the vehicle is moving or stationary.

- The associated faults with important additional information are stored in the fault memory. This additional information contains the kilometer reading/mileage at which the fault occurred, whether the fault is currently present and the frequency with which the fault in question has occurred. Thus, when the vehicle is brought into the garage/workshop, it is possible to carry out a specific analysis of the currently pre sent fault and also an analysis of a sporadic fault.

Programming

The Dynamic Drive control unit is programmed.

Coding

The Dynamic Drive control unit is coded.

Table of Contents

E60 Climate Control

Initial Print Date: 08/03 Revision Date: 09/03

Model: E60

Production: Start of Production MY 2004

Climate Control

Objectives:

After completion of this module you will be able to:

- Identify and locate the components of the E60 Climate Control System
- Understand the differences between E39 and E60 IHKA
- Understand LIN bus operation
- Understand Condensation Sensor Operation
- Operate Features of the E60 IHKA System

E60 Automatic Heating and Air Conditioning System

Purpose of the System

The E60 IHKA system is designed using the same criteria as the E65. There are technological improvements as well as new or modified functions. As with E65, the design objectives were to meet the requirements of customers worldwide for heating and cooling capacity.

New System Components and Features

- Condensation Sensor (Mist Sensor) - The Condensation sensor evaluates the humidity level of the windshield area and implements control measures to reduce windshield fogging.
- New Bus System - The Local Interconnect Network (LIN Bus) connects all 9 stepper motors and the blower controller.
- Modified Control Concept (As compared to E39) - Similar to E65, there is a reduction in the number of primary controls. The temperature and air volume are controlled by rotary knobs. Extended air conditioning functions such as air stratification are selected and activated by means of the controller in the CID.

Additional System Features

- Modified Display Concept - The Scope of display elements for the extended AC functions in the CID are similar to those in the E65. The required fan and temperature settings are not shown in the CID. The set values for temperature and air volume can be read from scale rings on the IHKA panel. Air distribution is set by means of the controller in the CID.

- Elimination of LCD Display - The LCD display from the E39 has been eliminated.

- No Bowden Cables - All flap positions are set by stepper motors which are controlled via the LIN bus.

- Separate Footwell Flaps for Left and Right

- Separate Ventilation Flaps for Left and Right

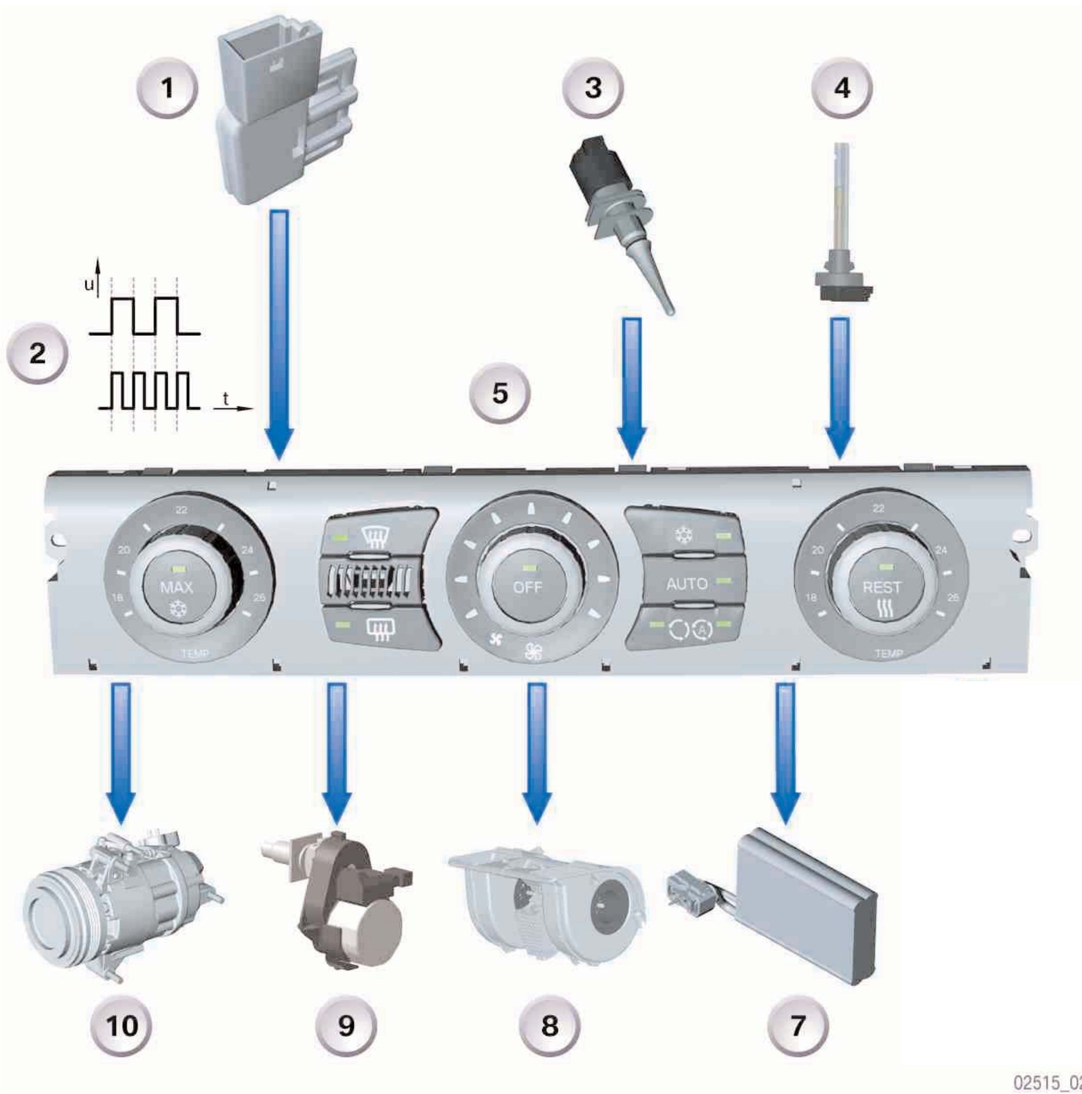
- New Suction Action Blower arrangement - The new blower arrangement allows for a more compact IHKA housing. The blower is arranged behind the evaporator. The heat exchanger for the heating system is positioned at right angles with respect to the evaporator and is arranged over the blower. The blower motor and blower motor housing can be removed without removal of the complete dashboard assembly.

- Clutchless A/C Compressor - The clutchless compressor is externally actuated and output regulated. The component and operation are carried over from the E65.

- AUC-2 Sensor - The AUC sensor is carried over from the E65.

- Solar Sensor - The solar sensor is located in the center of the dashboard and is also carried over from the E65/E66.

System Overview



1. Mist sensor
2. Mist sensor signal
3. Ambient temperature sensor
4. Face vent temperature sensor
5. IHKA control panel
6. Not shown
7. Evaporator and expansion valve
8. Blower and controller (on LIN bus)
9. Stepper motors (9 on LIN bus)
10. Clutchless AC compressor

System Components

The E60 Climate Control System consists of the following components:

Components Located in Passenger Compartment

- IHKA Control Panel/Module
- *Condensation (Mist) Sensor*
- Solar Sensor
- *CID and Controller*
- *Face Vent Temperature Sensor*

Components Located in (or on) IHKA Housing

- *9 Stepper Motors (all on LIN Bus)*
- *Blower Motor with Controller (on LIN Bus)*
- Evaporator Temperature Sensor
- 2 Heater Core Temperature Sensors (Left and Right)
- Heater Core (Heat Exchanger)
- Evaporator
- Expansion Valve

Components Located in Engine Compartment

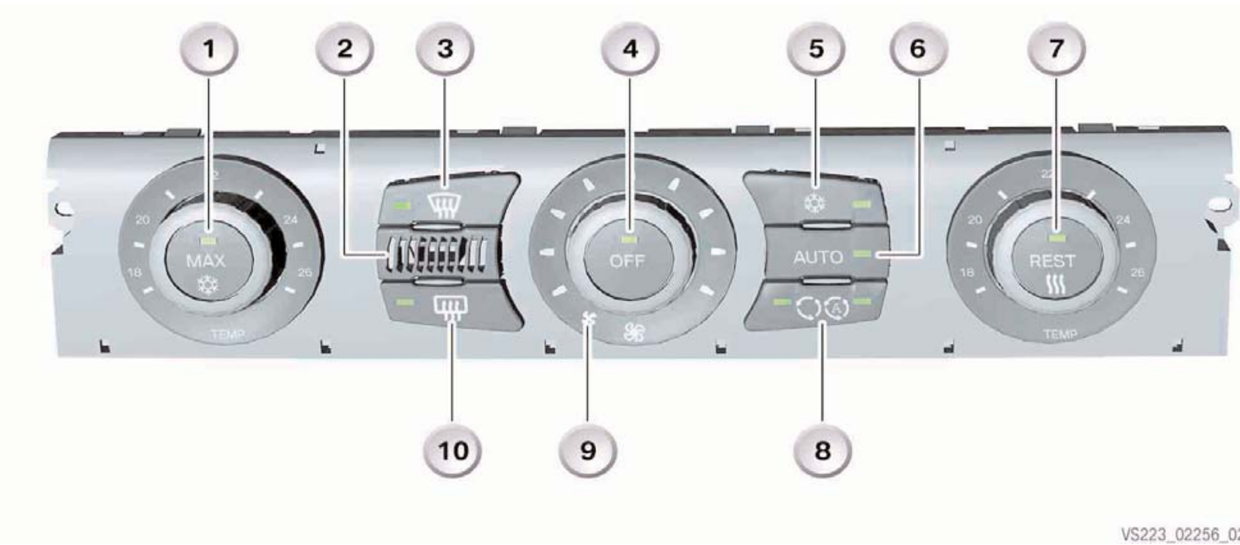
- A/C Compressor
- AUC Sensor
- Water Valves
- Auxiliary Water Pump
- A/C Condenser (with Integrated Receiver/Dryer)
- Auxiliary Cooling Fan
- A/C Pressure Sensor
- Refrigerant Lines
- Microfilter System

IHKA Control Panel/Module

The IHKA Control Panel/Module controls the following functions:

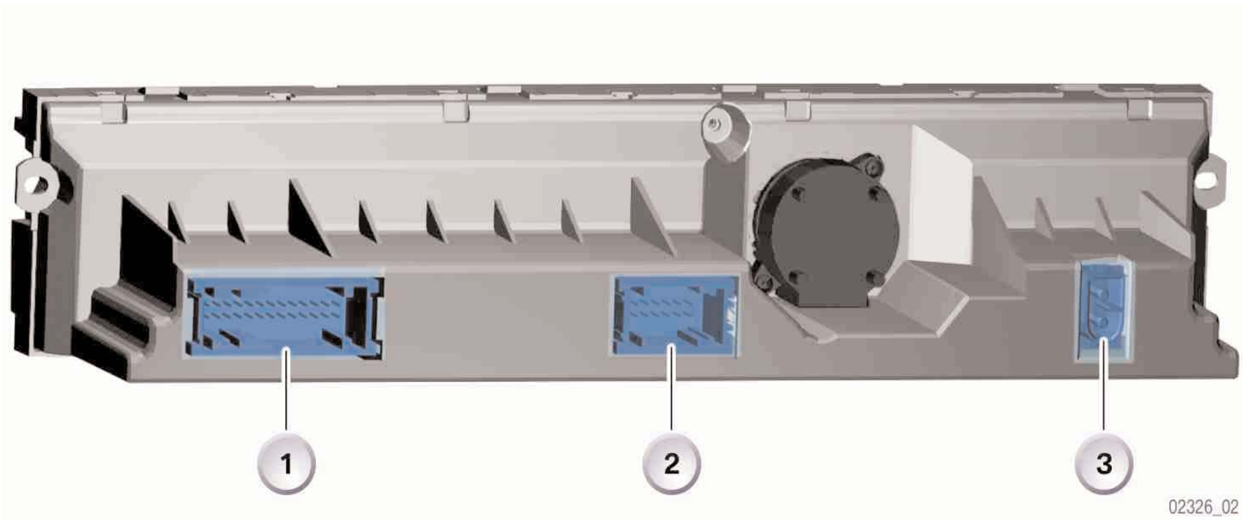
- Desired Temperature Setting, Left/Right
- Air Volume (Automatic and Manual Blower Settings)
- A/C On/Off Switch
- Recirculation Control (Including AUC)
- Rear Window Defogger
- MAX A/C
- Defrost Function

There are additional functions such as air distribution (defrost, face and footwell) and air stratification that are selected and controlled with the controller in the CID.



1. Rotary control for left side temperature setting with MAX AC button.
2. Opening for interior temperature sensor.
3. DEFROST Button
4. Rotary control for blower setting with OFF button.
5. A/C Button
6. AUTO Button (Automatic flap and blower function).
7. Rotary control for right side temperature setting with REST button.
8. AUC recirculating air button
9. Independent Heating Indicator (Not for US Market)
10. Rear window defogger button

Workshop Exercise - IHKA Control Panel



1. 26 Pin plug connection to vehicle electrical system
2. 12 Pin plug connection to heater/air conditioner
3. 2 Pin plug connection to front of power distribution box

Remove IHKA panel and connect breakout boxes

Record the steps and fasteners (if any) used to remove the IHKA control panel/module:

List part numbers of breakout boxes and cables used:

List the connector numbers for the following connectors:

26 Pin ______________ *12 Pin* ______________ *3 Pin* ______________

Workshop Exercise - IHKA Control Panel

List the connector and pin #'s of the power supply and ground connections to the IHKA panel:

KL 15 ______________________

KL 30 ______________________

KL 31 ______________________

List the Bus interface connections to the IHKA control panel:

How does the IHKA panel receive outside temperature information?

Can the interior temp sensor fan be replaced as a separate item?

Describe the AC compressor control circuit (list connectors, pins, etc.):

Condensation Sensor

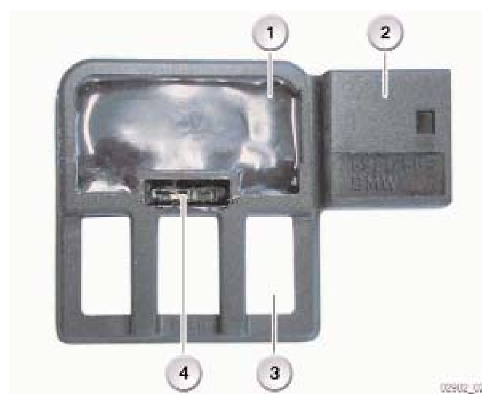
The condensation sensor is new to BMW climate control systems. The sensor is used to measure air humidity and temperature in the windshield area.

This information is sent to the IHKA control unit via a digital signal with a varying frequency. This information is evaluated by the IHKA control module, which then implements a series of countermeasures to prevent windscreen fogging. The countermeasures are implemented in the following sequence:

Measures	Action
1	Defroster flaps opened further
2	Recirculating air/AUC/automatic recirculating air switched to fresh air
3	Partial fresh air in connection with recirculating air/AUC/automatic recirculating air switched to fresh air
4	Minimum evaporator temperature (progressive evap temperature de-activated)
5	Blower air volume increased
6	Footwell share decreased
7	Temperature setpoint increased

These measures are implemented one after another until windscreen fogging is eliminated. Further steps are initiated if one measure proves to be ineffective. After successfully eliminating windscreen fogging, the measures are gradually cancelled in steps.

The sensor is located beneath the RLS on the windshield below the cover for the base of the rear view mirror. A special locating tool is used to install the new sensor, this tool is supplied with the replacement sensor. The sensor is affixed to the windscreen with an adhesive. If the sensor needs to be removed from the windshield it must be replaced.



1. Sensor Electronics
2. 3 Pin Connection
3. Moisture measuring cell
4. Well for laser adjusted resistors

Workshop Exercises - Condensation Sensor

Using the DISPlus or GT-1, record the following information:

What type of signal is sent from the condensation sensor to the IHKA module?

What is the pin and connector number for the condensation sensor signal at the IHKA control panel/module?

Measure and record the following signal information from the condensation sensor:

Frequency ____________ *Duty Cycle* ____________ *Voltage* ____________

What is the observed condensation sensor values on status requests?

While observing status requests, place a cup of hot water near the condensation sensor and observe the new signal information.

What happens to the value on Status requests? ____________

What other observation can be made when the mist sensor signal changes?

Is there a test plan available for the mist sensor?

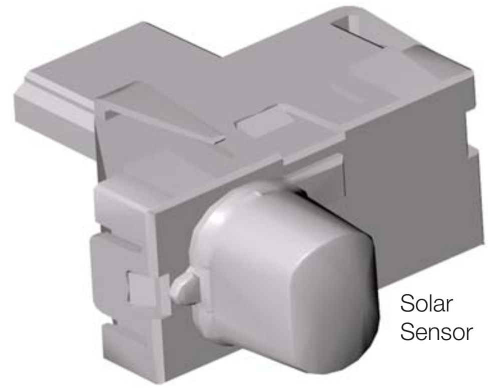
What is the special tool # used to install the condensation sensor?

Solar Sensor

The solar sensor is located in the center of the dashboard to the right of the center speaker grill.

The solar sensor operation is identical to the past models such as E65/E66.

As on previous models, the solar sensor signals will influence blower output, air stratification and ventilation flap operation.



Solar Sensor

AUC-2 Sensor

The AUC-2 sensor is located on the cooling fan housing at the top. The sensor operation is identical to the E65. The AUC-2 sensor will signal the IHKA to activate recirculation mode when the sensor detects oxidizable gases such as hydrocarbons, carbon monoxide and nitrogen oxides.

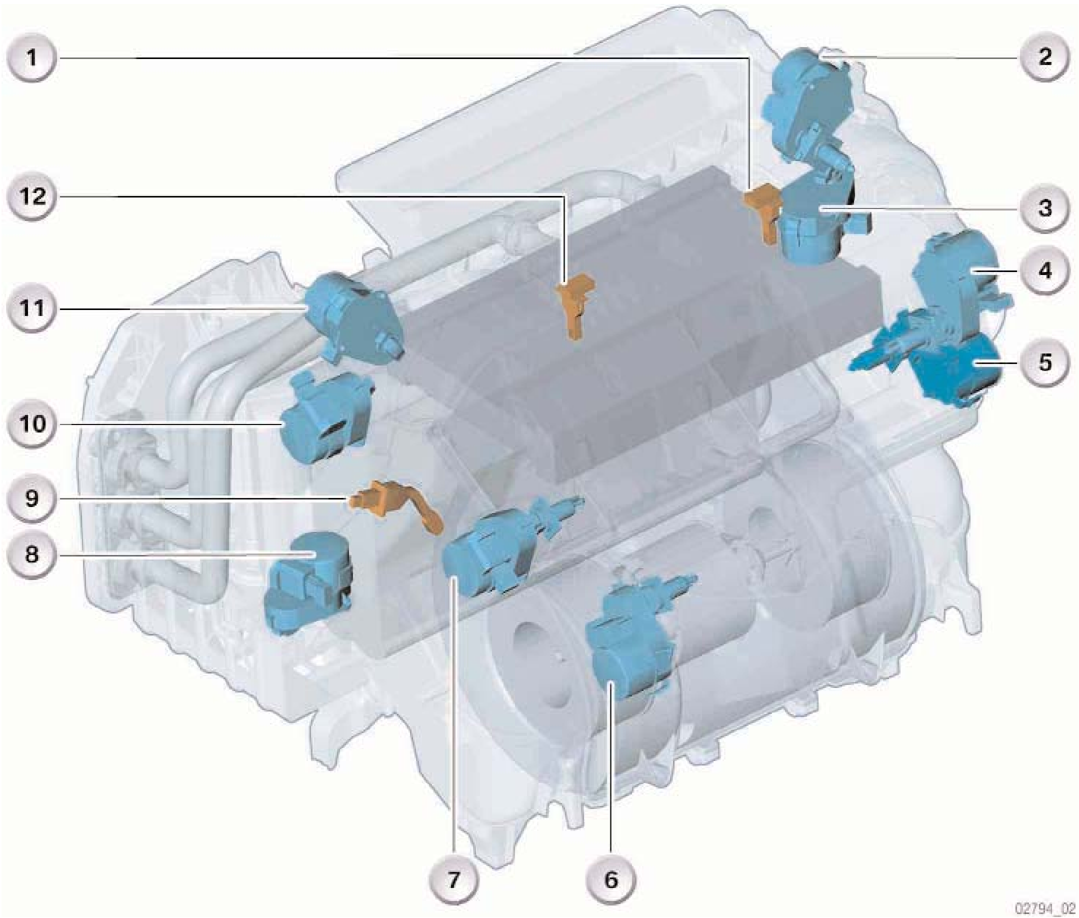
AUC-2 Sensor

CID and Controller

The CID and Controller are used for air distribution adjustments, air stratification and for the parked car ventilation features. The air volume for face vent, foot well and defrost can be adjusted independently for the driver and passenger.

1. Air volume, defrost
2. Air volume, face vent
3. Air volume, footwell

Components Located on IHKA Housing



1. Heater Core Temperature Sensor (RH)
2. Stepper Motor, right footwell
3. Stepper Motor, fresh air/recirc air (RH)
4. Stepper Motor, right side ventilation
5. Stepper Motor, air stratification
6. Stepper Motor, rear compartment (center)
7. Stepper Motor, left side ventilation
8. Stepper Motor, fresh air/recirc air (LH)
9. Evaporator Temperature Sensor
10. Stepper Motor, defrost
11. Stepper Motor, left footwell
12. Heater Core Temperature Sensor (LH)

Stepper Motors

These stepper motors are MUX5 motors (multiplex motor type 5).

There are 9 stepper motors used on the E60 IHKA system. All motors are connected to the LIN Bus. The LIN bus circuit consists of three wires, power (B+), ground and the LIN bus signal wire.

The stepper motors for the fresh air/recirculating air flaps are designed as high speed motors.

This system does not use any bowden cables for flap actuation.

Blower Motor with Blower Controller

The blower motor for generating the necessary air volume is fitted in the heater air conditioner. The blower features a symmetrical design and is equipped with two dual suction action radial fan wheels (four flute blower).

The blower controller is mounted directly on the housing of the blower motor. The controller features self diagnosis capabilities and is actuated by the control unit in the IHKA panel via the LIN bus. It is possible to replace the fan motor without the need to disassemble the instrument panel.

1. Blower controller on blower motor

Temperature Sensors

All temperature sensors used in the E60 IHKA system are NTC type. The E60 IHKA system uses the following temperature sensor inputs:

- Interior Temperature Sensor - Located in the IHKA control panel faceplate. The IHKA panel also incorporates a sensor fan which is removable and can be replaced as a separate part. The temperature sensor itself is not replaceable separately.

- Ambient (outside) Temperature - The ambient temperature sensor is an NTC sensor which is an input to the instrument cluster. The temperature signal is then sent to the IHKA control module via K-CAN.

- Two Heater Core Temperature Sensors - The Heater core temperature sensors can be accessed by removing the CID. The temperature sensors are used to monitor the temperature of the left and right side of the heat exchanger.

- Evaporator Temperature Sensor - As on previous models, the evaporator temp sensor is used to prevent evaporator freeze-up.

- Face Vent Temperature Sensor - There is one face vent temperature sensor located behind the center face vent. It can be accessed by removing the center face vent, IHKA panel and M-ASK.

Workshop Exercise - LIN Bus

List the LIN bus connections (Pin # and connector #) at the IHKA control panel:

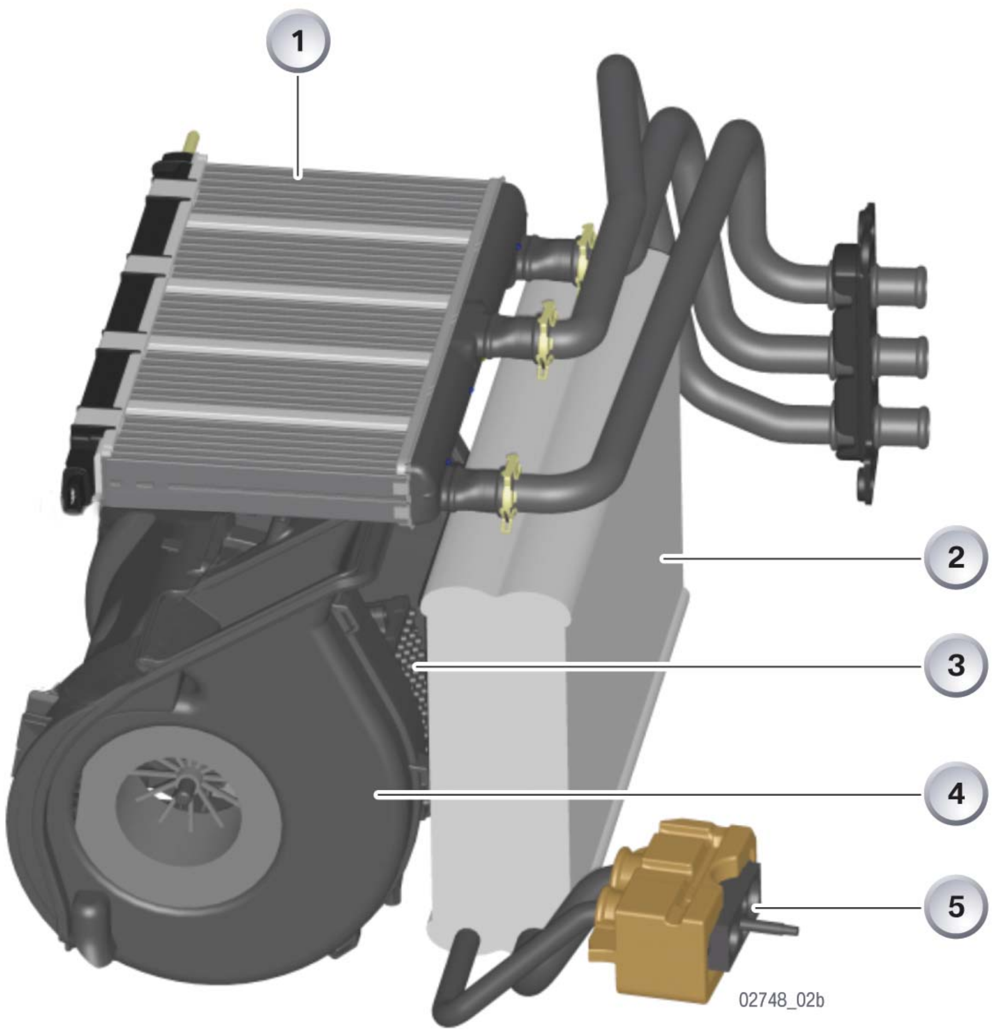
How many LIN bus connection are there at the IHKA panel?

Ground the LIN bus signal wire to the blower controller and record observations:

Ground the LIN bus signal wire to the stepper motors and record observations:

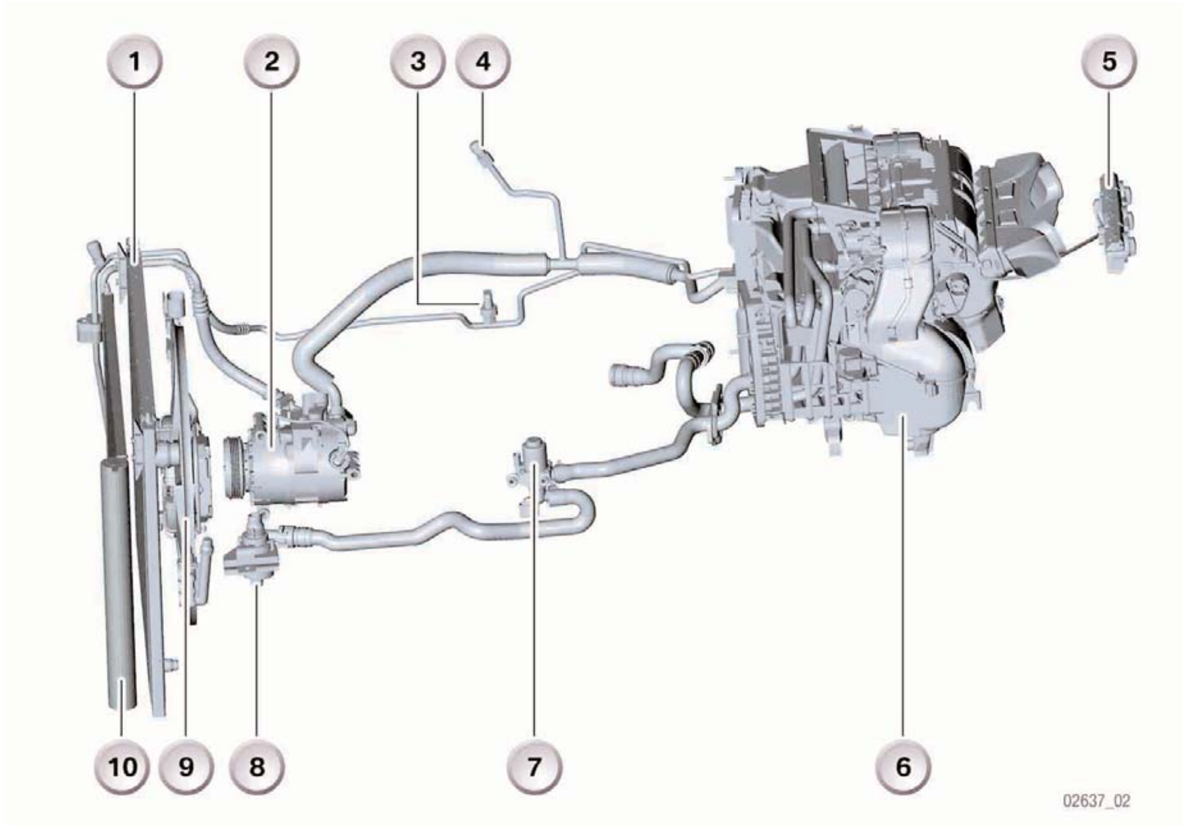
Notes:

Component Layout



1. Heater core
2. Evaporator core
3. Blower motor controller
4. Blower motor with housing
5. Expansion Valve

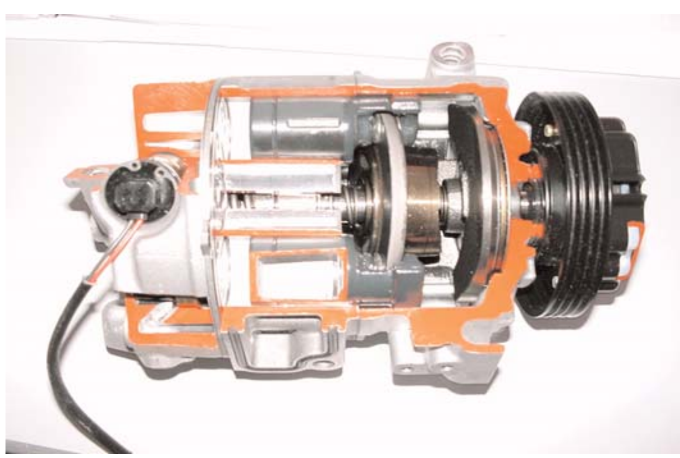
A/C System Component Layout



1. Radiator
2. A/C Compressor
3. Pressure Sensor
4. Service Connection,
5. IHKA Control Panel
6. Heater/AC Housing
7. Water Valve(s)
8. Auxiliary Water Pump
9. Electric Fan
10. Condenser with Dryer

A/C Compressor

The A/C compressor in the E60 is identical to the clutchless design introduced on the E65/E66



Pressure Sensor

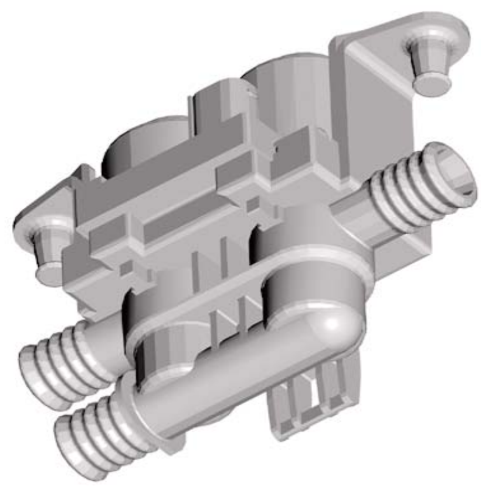
The pressure sensor is located in the high side pressure line between the condenser and the evaporator near the passenger side strut tower.

The sensor sends the IHKA control module an analog signal between 0.4V and 4.6V as a representation of system pressure.

The 5V supply is provided by the IHKA control module and the sensor current consumption is < 20mA.

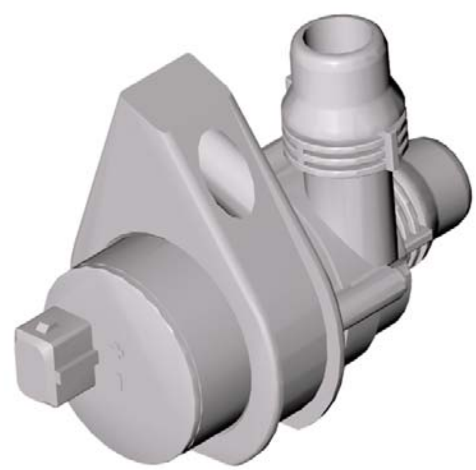
Water Valves

The water valves on the E60 are of the same design as used on previous models. The valves are normally sprung open and are pulse width modulated by the IHKA control unit. The IHKA control unit controls the valves via the B+ circuit, both valves are grounded at a common location. The valves are powered closed by the IHKA module when full cooling is needed. They are located on the driver's side strut tower.



Auxiliary Water Pump (ZWP)

The auxiliary water pump is mounted on the drivers side frame rail near the alternator. The ZWP enhances hot water flow through the heater core particularly when the engine is idling.

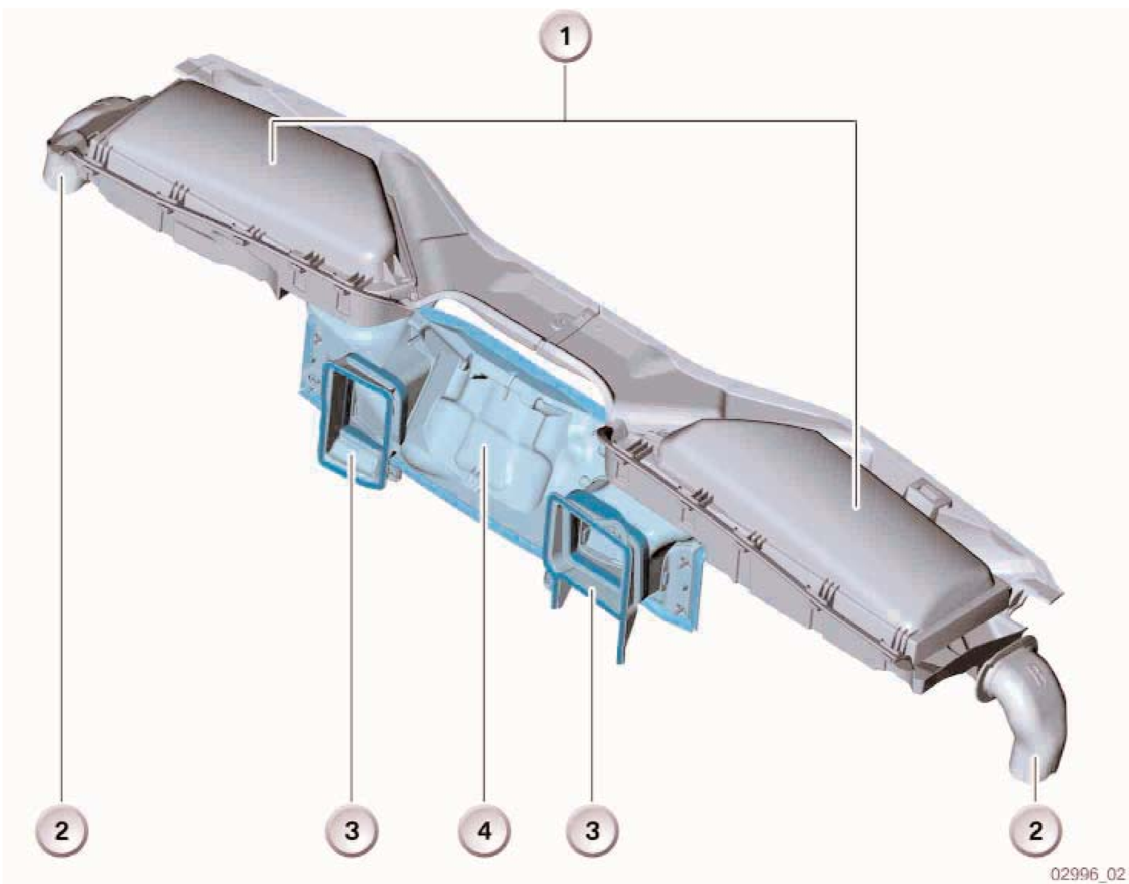


Microfilter System

An activated carbon microfilter is fitted on the E60 IHKA system. Microfilter replacement intervals are based on CBS data. Based on operating time and operating parameters, the “filter condition detection” system determines the load status of the filter without additional sensors. In this way, due dates for filter service are calculated together with other wear-registering components. After changing the filter, the CBS system must be reset via the instrument cluster or in the tester (DISplus/GT-1).

The following are recorded parameters for determining the filter load status:

- Blower Voltage
- Outside Temperature
- Sun Intensity
- Mileage
- Road Speed
- Rain Intensity
- Day Counter

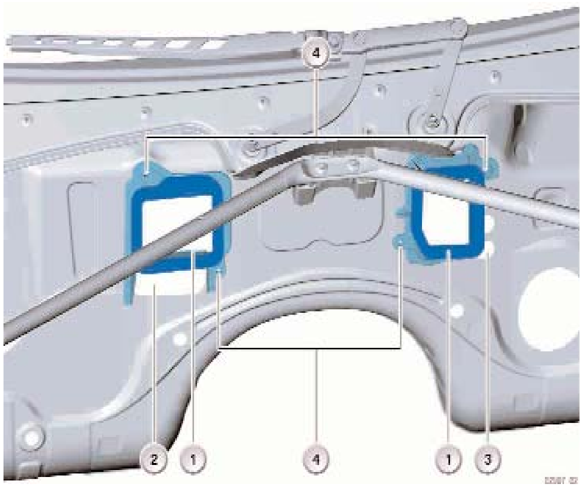


1. Microfilter Compartment
2. Water Drain
3. Bulkhead/filtered air duct seal
4. Filtered air duct

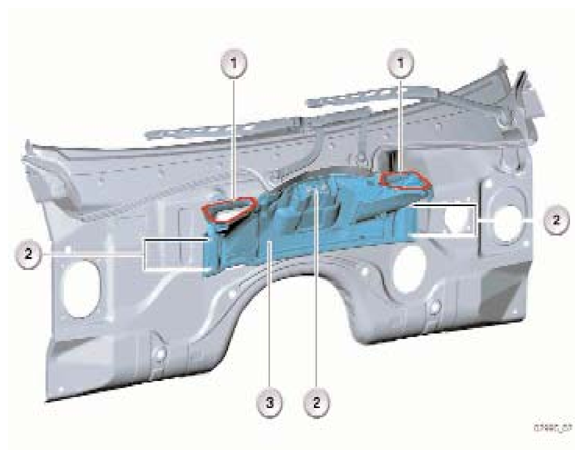
Workshop Hints

AC Housing Installation

Particular care must be taken when mounting the air conditioner on the inner side of the bulkhead to ensure the seals are fitted correctly. The butyl beading on the seal provides a tight seal with the bulkhead. When assembling, make sure the repair instructions are followed precisely. Failure to adhere to the procedure could result in interior water leakage.



1. Bulkhead/filtered air duct seal
2. Aperture for expansion valve
3. Aperture for water connections, heating circuit
4. Aperture for air conditioner and screw mounting points and seals



1. Intake/filter compartment seal
2. Threaded connection, filtered air duct
3. Filtered air duct

In the same way as for the seals, particular care must be taken when installing the filtered air duct and the filter compartment covers. Secondary (unfiltered) air may be drawn in from the engine compartment if the seal between the duct components is defective.

Initial Operation After Replacing the Refrigerant Compressor (Compressor Run-in)

In order to prevent compressor damage after installation, the compressor run-in procedure must be performed.

The “Run-in” procedure is identical to E65/E66 and can be found in the service functions menu.

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E60 Advanced Safety Electronics

Initial Print Date: 08/03 Revision Date: 09/03

Table of Contents

Model: E60

Production: Start of Production MY 2004

Advanced Safety Electronics

Objectives:

After completion of this module you will be able to:

- Identify and locate components in the ASE system
- Understand Seat Occupancy Detection (OC-3 Sensor)
- Understand diagnostic procedures of the ASE system

Advanced Safety Electronics

Advanced Safety Electronics ASE is the new passive safety system for the E60 and its variants. ASE is the successor to the Multiple Restraint Systems (MRS). The system is based on the same technology as the Intelligent Safety and Integration System (ISIS) of the E65/E66. ASE has been brought in line with the requirements specific to the E60.

Innovations of Advanced Safety Electronics

Like the E65/66, the E60 features the new byteflight fiber-optic technology.
The ASE system consists of a main control unit, the Safety and Gateway Module SGM, and various satellites. Distributed with their sensors at strategic points around the vehicle, the satellites exchange information with the SGM.

The advantages of the new safety technology can be summarized as follows:

- High-speed data acquisition and transmission (10Mbit/s)
- More exact crash detection
- Networked airbag control system
- Selective triggering
- More precise control of the intelligent airbags
- Dependable triggering
- Immunity to electromagnetic interference
- Battery cable diagnosis with cutoff of the safety battery terminal when required

Advantages of the System

Multiple acceleration sensors installed at strategic points around the vehicle provide data for more exact analysis of crash situations than the MRS.

The deceleration detected by the acceleration sensors in the vehicle are all transmitted to the Safety and Gateway Module. The SGM exchanges the acceleration data with all its satellites. This provides an exact picture of the crash situation, enabling a timely and selective triggering of the actuators depending on the crash situation.

In the event of a crash, only those actuators are triggered that are necessary for optimum protection of the car's occupants. This serves to lower repair costs and reduce insurance premiums.

New Features

The following is a list of new features specific to the E60. Due to the different legal requirements in the USA, additional features for the passive safety system ASE were required.

The new features consist of the following:

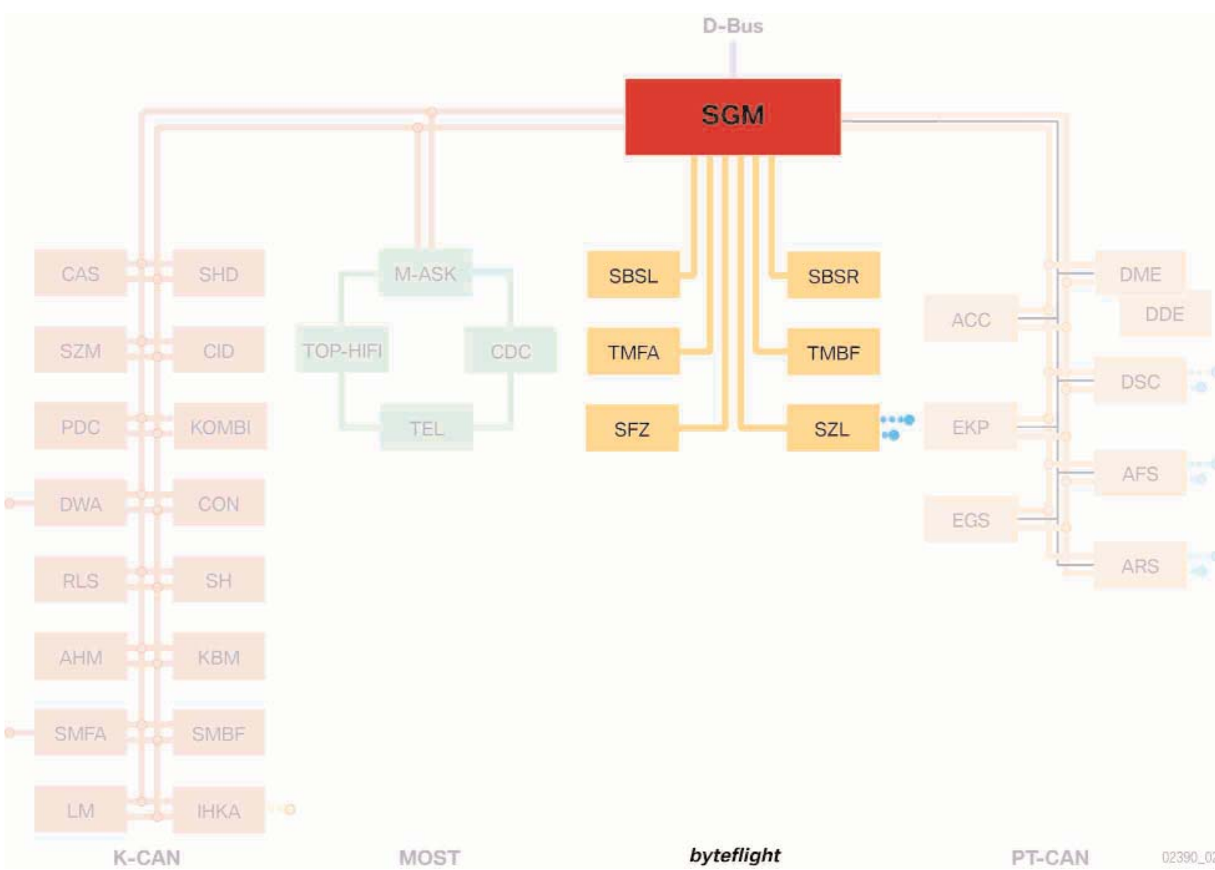
- Up-front sensors for detecting a front-end crash and adequate provision made for occupant not a wearing seat belt when the front passenger's airbag triggers

- Passive knee protection on driver's and passenger's sides, because occupants are not required to wear seat belts by law in all 50 states

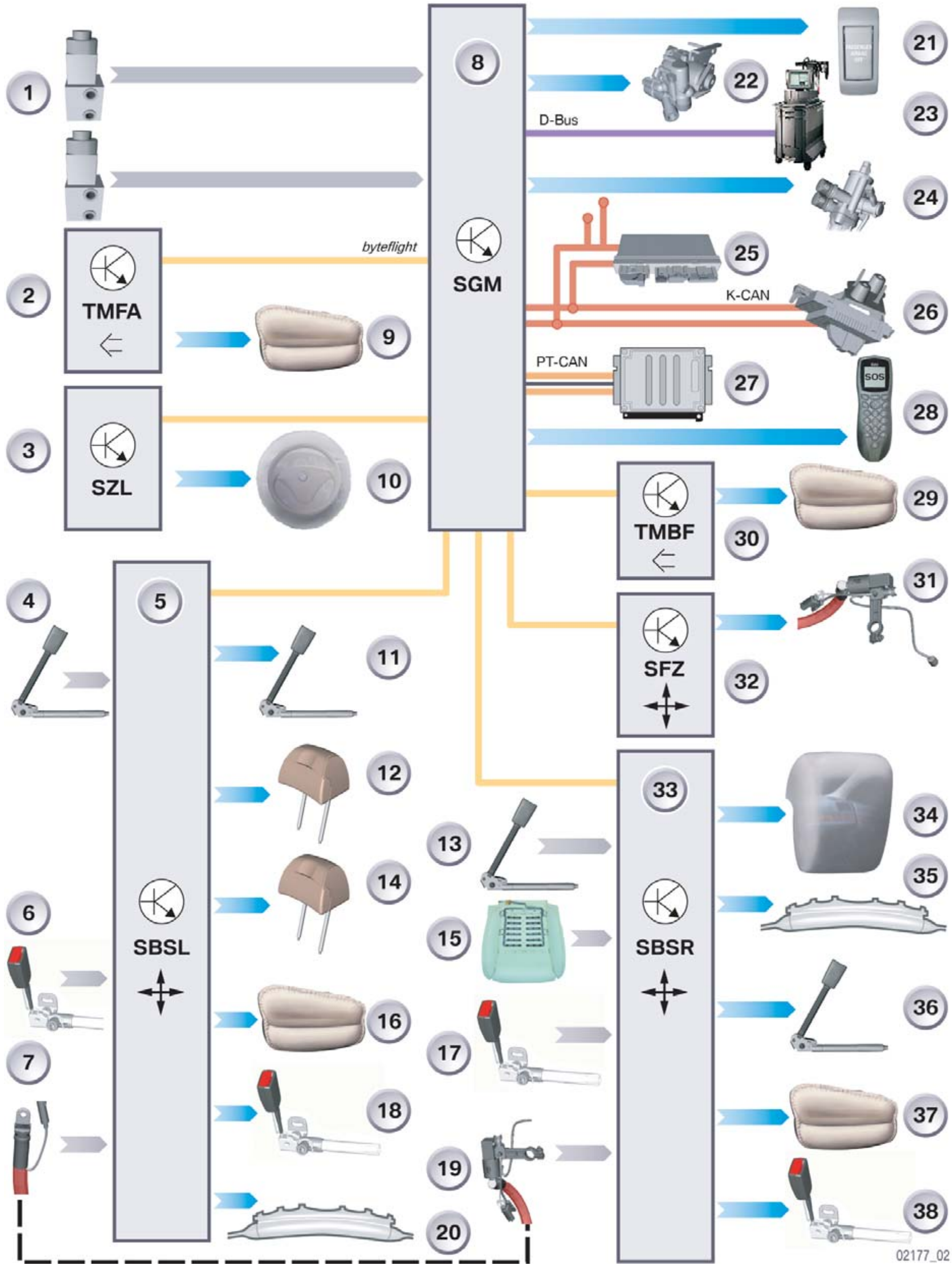
- Automatic deactivation of the airbags on the passenger side if the seat is occupied by a child restraint system holding a child up to one year old (weight dependent).

- Visual and acoustic seat-belt warning

- The cars have an emergency-call button as standard, so that occupants can call for assistance at any time in the event of a crash or a breakdown



System Overview Schematic



Classroom Exercise - System Overview

Identify the components on the facing page and complete the chart below.

Index	Explanation	Index	Explanation
1		22	
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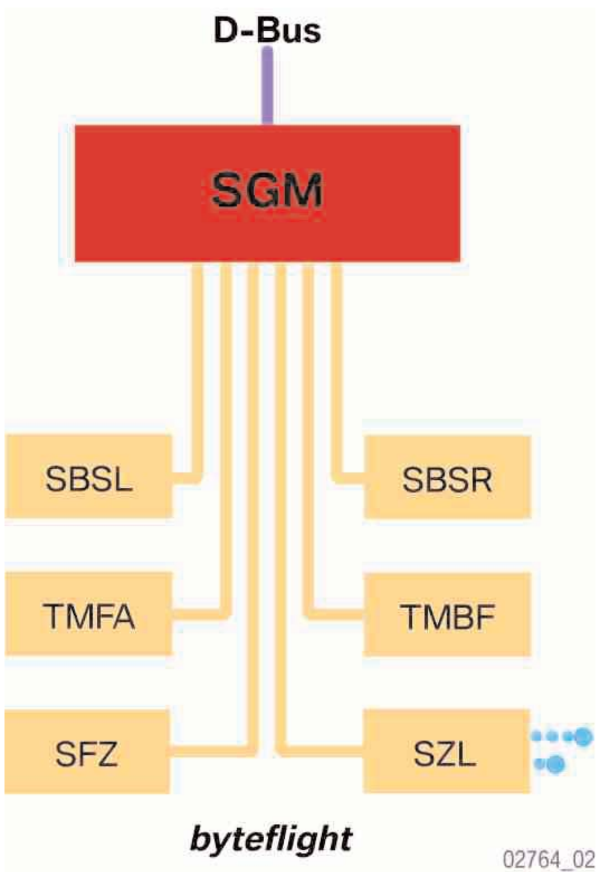
System Components

byteflight

The familiar byteflight fiber optic bus that previously established a firm reputation in the E65/66 has been carried over to the E60. Extremely fast and dependable data communication is essential, given the steadily increasing numbers of sensors and actuators.

The bus system consists of the central Safety and Gateway Module SGM, and the satellites. There is a reduction in the number of satellites as compared to the E65/E66. A fiber optic star bus interconnects the satellites with the SGM. Data communication is bi-directional and very high data rates are achieved (10 Mbit/s). Each satellite has a transmitter/receiver module. The SGM has a separate transmitter/receiver module for each satellite.



SGM Safety and Gateway Module

SBSL B-pillar satellite, left

SBSR B-Pillar satellite, right

TMFA Door module, driver’s door

TMFB Door module, passenger’s door

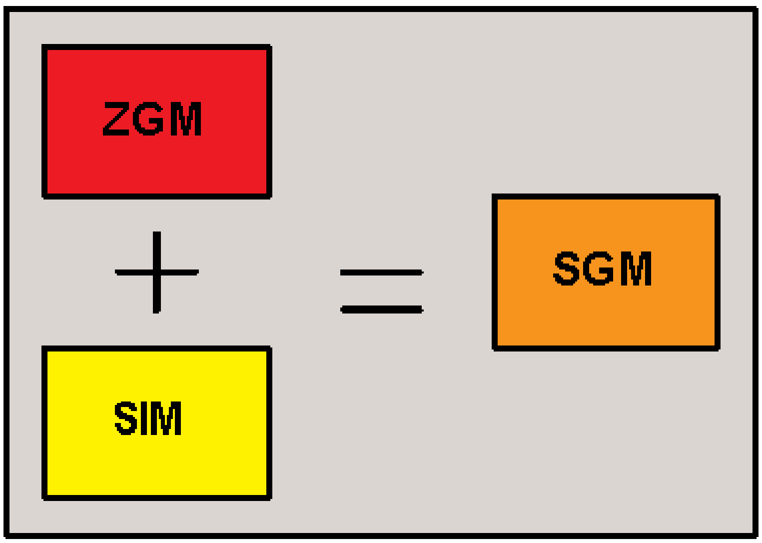
SFZ Vehicle center satellite

SZL Steering column switch cluster

Special safety protocols (telegrams) are used to provide increased system reliability and to virtually exclude the possibility of unintended triggering. In any given situation, the satellites trigger only such actuators as are necessary on receipt of a special telegram (alarm mode) from the SGM.

Safety and Gateway Module SGM

The SGM is a combination of the Safety Information Module (SIM E65) and the Central Gateway Module (ZGM E65). The SGM uses the software of the ZGM, and carries out the ZGM functions. The functions of the SIM have also been integrated and a number of new functions added.



Control units combined in the SGM

The Safety and Gateway Module is responsible for the following functions:

- Voltage supply of the satellites
- Provision of the 60 V energy reserve (SIM 400 V) in the event of failure of the power supply during an accident
- Function of the star coupler and the bus master of the byteflight
- Gateway function to the other bus systems K-CAN, PT-CAN and diagnostic bus
- The history memory has been integrated into the SGM
- Provision of the crash telegram for activating various functions in other systems (see Gateway functions)
- Drive for the Servotronic valve in the power-assisted steering
- Drive for the ECO valve of the hydraulic pump

The Safety and Gateway Module is in the module carrier behind the glove compartment and has been adapted to the ASE system.

The modules of the ZGM have been accommodated on the printed circuit board of the SIM. The ZGM has its own microprocessor and its own diagnosis address. An electrical connection takes the place of what was formerly the fiber-optic connection between ZGM and SIM. A byteflight controller is used to transmit the same telegrams as are used for communication by means of an optical link.

Note: *As far as diagnosis is concerned, note that two control units are addressed, despite the fact that they share a common housing.*

Voltage Supply

The SGM is supplied with voltage via terminal 30 and terminal 31. A voltage transformer (10.2 V) and an intelligent distributor with overcurrent protection carry voltage to the satellites. If a fault occurs, the distributor can shut off the supply to individual satellites.

Energy Reserve

At the same time the energy reserve is charged. The energy reserve consists of a storage capacitor (60 V). If the vehicle voltage drops below a defined threshold, power is tapped from the energy reserve. In this way, the entire functionality of the safety system is maintained for approximately 1 second, the time it takes to drain the energy reserve.

Note*: When carrying out work on the safety system, always bear in mind that the storage capacitors take a few seconds to discharge after the battery has been disconnected, and the safety system remains operational for this period of time.*

Star Coupler

The star coupler with the 6 transmitter/receiver modules receives its power supply (5 V) from a secondary voltage transformer. The same applies for the two microprocessors. The individual byteflights to the satellites are connected to the star coupler. The star coupler transmits a synchronization pulse every 250 microseconds. Between these synchronization pulses, the telegrams are sent from and to the satellites (bi-directional communication) on the byteflight.

The satellites accommodate acceleration sensors and pressure sensors. These are the sensors that detect a crash. The satellites send the sensor data to the star coupler. The star coupler distributes the information to all the satellites. In this way, all the satellites have the same information at their disposal.

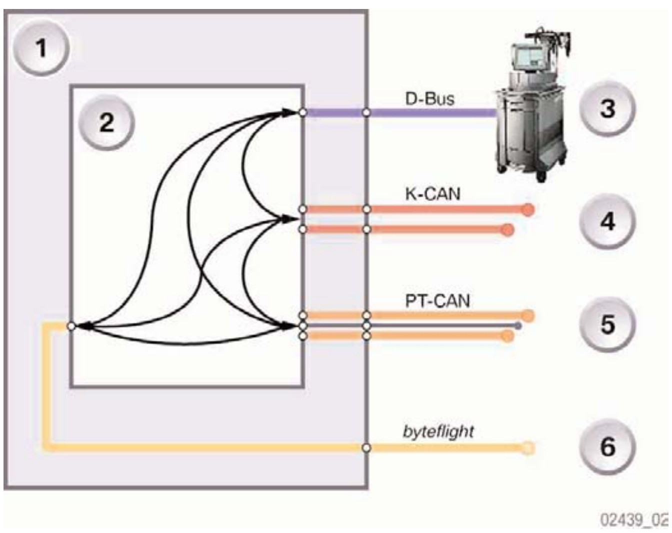
The SGM uses the information it receives to recognize a crash when it happens. The SGM compares the values with the algorithm in its processor and, if the impact is of sufficient severity, it uses the synchronization pulse to initiate the alarm mode. The alarm mode places the satellites in a triggerable state. The actuators required in any given situation are actuated, depending on the crash severity and the algorithms stored in the satellites.

Gateway

All the functions of the Central gateway Module of the E65 are integrated into the SGM. The purpose of the gateway function is to interface the various bus systems of the E60.

The bus system used in the E60 are as follows:

- Byteflight
- K-CAN
- PT-CAN
- Diagnosis bus
- MOST (by a separate gateway in the M-ASK on the K-CAN)



1. Safety and Gateway Module
2. Gateway Function
3. Diagnosis Bus
4. K-CAN
5. PT-CAN with wake-up line
6. **byteflight**

History Memory

A non-volatile memory is implemented in the SGM so that the following responses can be logged:

- Which bus originated the incorrect wake-up call that woke the entire system
- Which node prevented the bus system from entering sleep mode following shut down of terminal R and expiration of the run-on time (30 min).

Each entry in the history memory identifies the originator, and logs the time of day and the odometer reading. In this way, dependable diagnosis can subsequently be performed.

B-Pillar Satellite Left/Right SBSL/SBSR

The SBSL controls and monitors the following trigger circuits:

- Head airbag AITS II, left
- Active headrests left and right
- Side airbag in rear left door (optional)
- Seatbelt tensioner, left
- Seatbelt tensioner, rear left (optional)

The SBSR controls and monitors the following trigger circuits:

- Front airbag, passenger
- Head airbag (AITS II) right
- Side airbag in rear right door (optional)
- Seatbelt tensioner, right
- Seatbelt tensioner, rear right (optional)

The left/right B-pillar satellites are located low in the B pillars in the vicinity of the sill and are connected to the SGM by the byteflight.

The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the byteflight, the power supply of the satellites is deactivated by the SGM.

Each satellite has an acceleration sensor for longitudinal acceleration and one for lateral acceleration. The sensor provides a voltage as measured variable. This voltage is a measure for the positive and negative car acceleration and it is evaluated in the satellite.

The sensors continuously provide the values determined. The measured values are transferred by the byteflight to the SGM and all the satellites.

When the SGM detects a critical range, the alarm mode is set by means of the synchronization pulse.

The alarm mode places the satellites in a triggerable state. The trigger matrix stored in the satellites activates the necessary actuators depending on the crash severity.

The trigger circuits of the actuators are connected to ignition final stages in the satellites and are ignited by discharging capacitors.

The self-diagnosis of the trigger circuits during the pre-drive check and in normal operation is the same for all satellites.

Battery cable diagnosis is performed by both satellites. The connection of the monitoring line in the engine compartment is to the SBSL. The connection of the monitoring line to the battery in the luggage compartment is to the SBSR.

A precise description of the battery cable diagnosis can be found in the section on battery cable diagnosis.

Operating voltage	10.2...10.7 V	Full function
Operating voltage	10.7 ... 16 V	Restricted function, diagnosis of trigger circuits not possible
Power intake	Typ. 90 mA	Normal operation

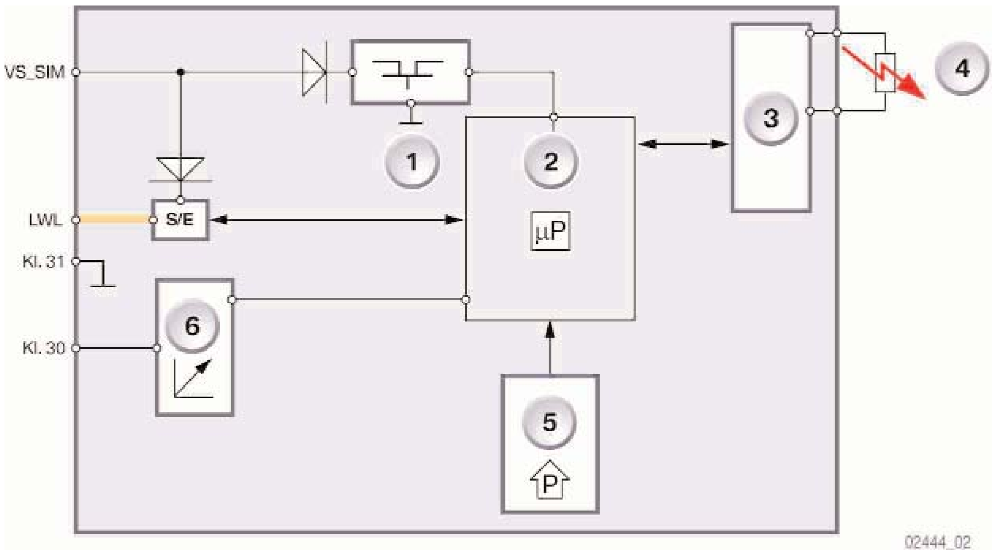
Door Module, Driver's Door/Passenger Door, TMFA/TMFB

The driver's door/passenger door door module is a combination of the door module with the body electrics functions and the front-door satellite.

The driver's door/passenger door door module controls and monitors the trigger circuits for the door-mounted side airbag. The pressure sensor in the door module registers a side impact by measuring pressure increases in the door cavity.

1. Mounting screw holes
2. Inlet port to the pressure sensor
3. Connector for the switch block
4. Connector for the power supply
5. Connector for the input signals
6. Connector for the outside mirror
7. Connector for the ASE system

The description below describes only the functions that are relevant to the ASE system. The other functions are described in the section entitled General Vehicle Electrics.



1. Voltage regulator	VS_SIM. Voltage supply
2. Microprocessor	LWL. byteflight
3. Ignition final stage	Kl.30. Terminal 30
4. Igniter pellet for side airbag	Kl.31. Terminal 31 ground, carried by the load connector to the door module
5. Pressure sensor	S/E. Transmitter/receiver modules

The door modules with the function of the front-door satellites are connected to the SGM by the byteflight. The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the byteflight, the power supply of the satellites is deactivated by the SGM. The door functions (FH, ASP, ZV) are sustained by means of a separate terminal 30.

A pressure sensor is integrated in the front door module. The sensor permanently measures the pressure at the door. In the event of a crash, penetration of the door outer skin reduces the volume of the door. This results in a significant pressure rise. The relative pressure change and rise in pressure evaluated over time are the most important factors for the crash evaluation.

Triggering and monitoring of the trigger circuits are similar to the criteria for the B-pillar satellites.

Operating voltage	10.2...10.7 V	Full function
Operating voltage	10.7 ... 16 V	Restricted function, diagnosis of trigger circuits not possible
Power intake	Typ. 90 mA	Normal operation

Vehicle Center Satellite SFZ

The vehicle center satellite controls and monitors the trigger circuit for the safety battery terminal.

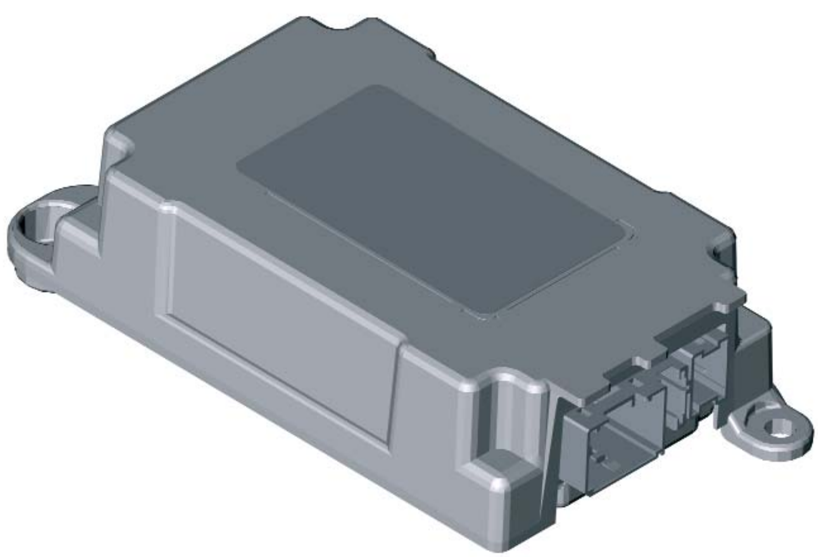
The vehicle center satellite is connected to the SGM by the byteflight. The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the byteflight, the power supply of the satellite is deactivated by the SGM.

The satellite has an acceleration sensor for longitudinal acceleration and one for lateral acceleration. The sensor provides a voltage as measured variable. This voltage is a measure for the positive and negative car acceleration and it is evaluated in the satellite.

The sensors continuously provide the values determined. The measured values are transferred by the byteflight to the SGM and all the satellites.

Triggering and monitoring of the trigger circuits are similar to the operation of the B-pillar satellites.

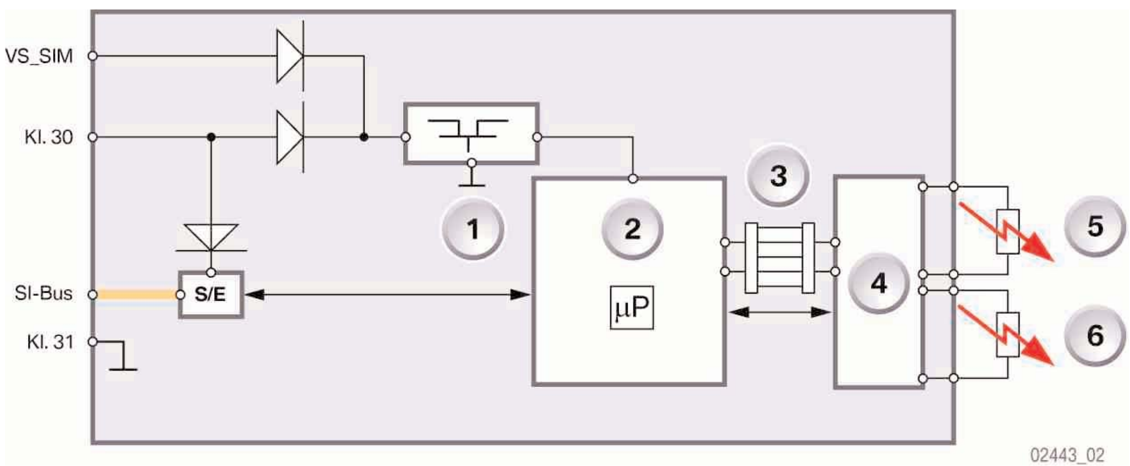
Operating voltage	10.2...10.7 V	Full function
Operating voltage	10.7 ... 16 V	Restricted function, diagnosis of trigger circuits not possible
Power intake	Typ. 90 mA	Normal operation



Steering Column Switch Cluster SZL

The steering column switch cluster consists of two modules, the steering column electronics (LSE) and the steering wheel electronics (LRE). The two electronic components are connected to each other by a coil spring.

The steering column switch cluster controls and monitors the two trigger circuits for the front airbag on the driver's side.



1. Voltage regulator
2. Microprocessor
3. Coil spring
4. Steering wheel electronics with trigger output stage
5. Igniter pellet for front airbag 1st stage
6. Igniter pellet for front airbag 2nd stage

VS_SIM	Voltage Supply
KL 30	Terminal 30
SI_Bus	***byteflight***
KL 31	Terminal 31
S/E	Transmitter/Receiver Modules

The components connected directly to the steering column electronics are listed below:

- Connection to the *byteflight*
- The steering-angle sensor
- The direction of travel dip switch
- The wiper switch
- The switch for the cruise-control system (tempomat)

The coil spring establishes the connection to the steering wheel electronics (LRE). The coil spring carries signals and power.

The components connected directly to the steering wheel electronics are:

- The steering wheel heating with temperature sensor
- The Steptronic buttons
- The horn buttons for the fanfare horns
- The multifunction switch arrays
- The trigger output stage for the driver's side front airbag

The steering column switch cluster also features the following components:

- The switch for steering wheel heating
- The switch for steering wheel adjustment

The steering-column electronics unit (LSE) is connected to the SGM by the byteflight. Terminal 30 carries the power supply and load current.

The satellite's emergency supply is via terminal V_SIM of the SGM, with a storage capacitor as buffer. This supply is sustained even in sleep mode.
Terminal 15 is provided for the sake of redundancy. The two fanfares (horns) are powered directly by the steering wheel electronics from terminal R.

The steering column switch cluster accommodates the steering angle sensor, which sends its data by the F_CAN bus to the DSC and AFS. The data is also transmitted by the byteflight and the SGM to the PT-CAN bus. There is also a serial connection to the control unit for the Active Front Steering system.

A coil spring interconnects the steering column electronics and the steering wheel electronics. The trigger output stage and capacitor are in the steering wheel electronics. The two trigger circuits for stages 1+2 of the driver's front airbag are connected to the trigger output stage.

Triggering and monitoring of the trigger circuits are similar to the processes for the B-pillar satellites.

Operating voltage	10.2...10.7 V	Full function
Operating voltage	10.7 ... 16 V	Restricted function, diagnosis of trigger circuits not possible
Power intake	Typ. 120 mA	Normal operation

Belt Buckle Switch

The belt buckle switch is used to detect whether the seatbelt has been fastened or not. The detection arrives as a signal at the relevant satellites. The signal is used for evaluation for the "Seat Belt Reminder SBR" function and for selective triggering of actuators in the event of a crash.

The belt buckle switch is located in the belt tensioner of the driver's and passenger seats. If the side airbag for rear seat passengers option is installed, seat belt tensioners with belt buckle switches are installed on left and right.

The belt buckle switch is a two-wire Hall switch. The Hall switch is supplied with voltage by the satellite. The current intake of the switch is the signal for the switch position.

To reduce the general power consumption, the switch is queried in cycles. The belt buckle switch is permanently diagnosed and monitored as of terminal R.

The SBR function is an extension of the seat belt icon that remains ON for a certain period of time (6 sec) after terminal 15 ON.

If the driver pulls away without buckling the seat belt, a visual and acoustic warning is issued after the car has covered about 100 meters. The same applies for the front passenger, if the sensors indicate that the front seat is occupied, but the belt has not been buckled.

The belt reminder lights up and the acoustic warning (gong) sounds for 90 sec, unless the belt is buckled in the meantime.

The belt buckle is permanently monitored. A warning is issued if status changes while the car is on the move, in other words if the belt buckle is opened.

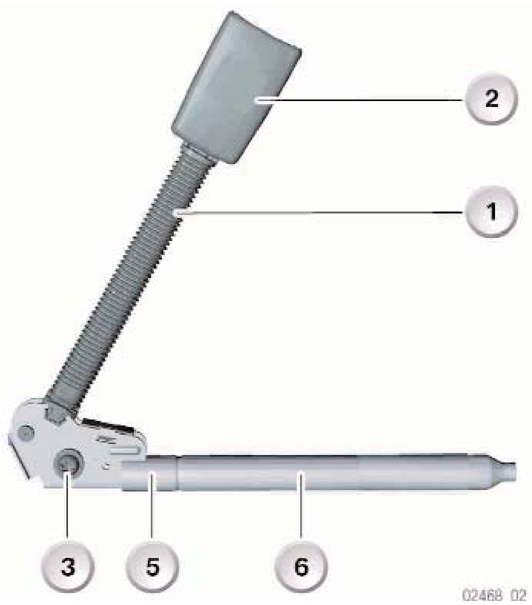
The seatbelt warning lamp is switched on as of terminal 15 On until the driver inserts the seatbelt in the seatbelt buckle.

If the seatbelt buckle is opened while the vehicle is being driven, the seatbelt warning lamp is activated again.

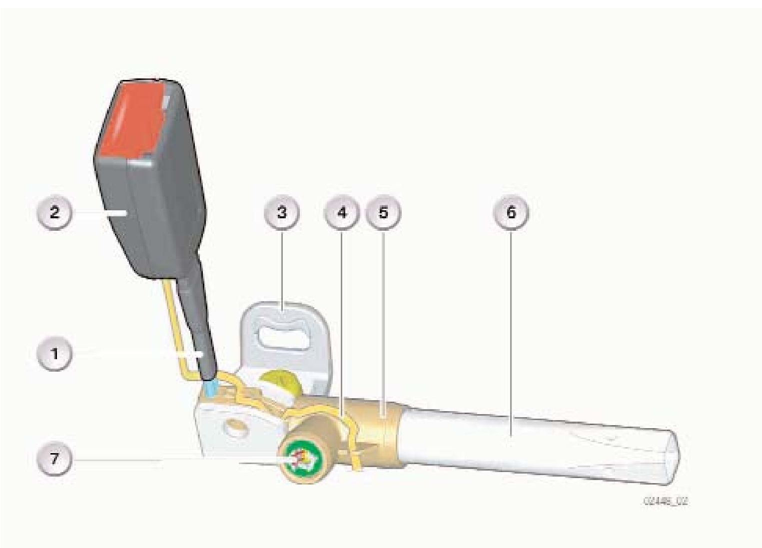
An acoustic warning is also issued. The acoustic signal is intermittent and is output for up to 90 seconds.

Seatbelt Tensioner

The pyrotechnic seatbelt tensioner is designed to minimize any belt slack in the pelvic and shoulder region in the event of a crash. The seatbelt tensioner is located on the driver's and/or passenger seat. In combination with the mechanical force limiter in the inertia reel, this reduces the chest load for the seat occupants.



1. Buckle strap
2. Seat belt buckle with switch
3. Bracket
4. Not Used
5. Gas generator
6. Tensioning tube



1. Buckle Strap
2. Seat belt buckle with switch
3. Bracket
4. Connection for buckle switch
5. Gas generator
6. Tensioning tube
7. Connection for igniter pellet

If the rear side airbag option is installed, seat belt tensioners are installed at the rear left and right as well. The seat belt tensioners form a unit with the seat belt buckle. In combination with the option, the inertia reels have mechanical force limiters.

Technically, the front and rear seat belt tensioners are identical. The seatbelt tensioners consist of igniter pellet, generator, plunger and operating cable.

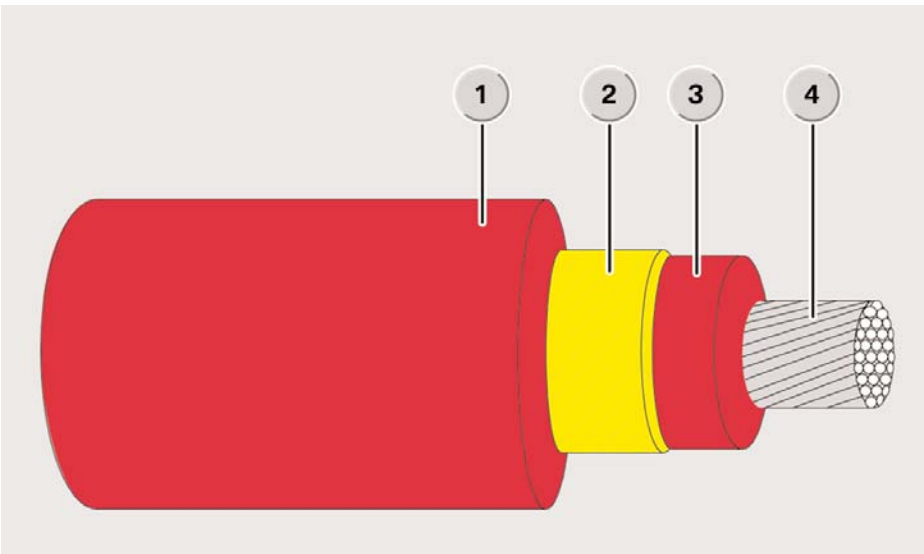
In the event of a crash of sufficient severity, the gas generator is ignited. The gas spreads and shifts the plunger in the tensioning pipe. The cable connected to the plunger thus pulls the seatbelt buckle downwards and takes the slack from the seat belt.

The belt buckle switch is integrated in the seatbelt buckle. The rear seat-belt buckle switch is used to check whether the seat is occupied and evaluate this information.

Battery Cable Diagnosis

For the E60, the battery cable is routed from the luggage compartment outside on the underbody of the vehicle into the engine compartment.

If the cable is damaged in an accident or when driving over an obstacle (e.g. crash barrier), the battery cable is disconnected from the battery and the alternator is switched off. This prevents a short-circuit and the risk of sparks.

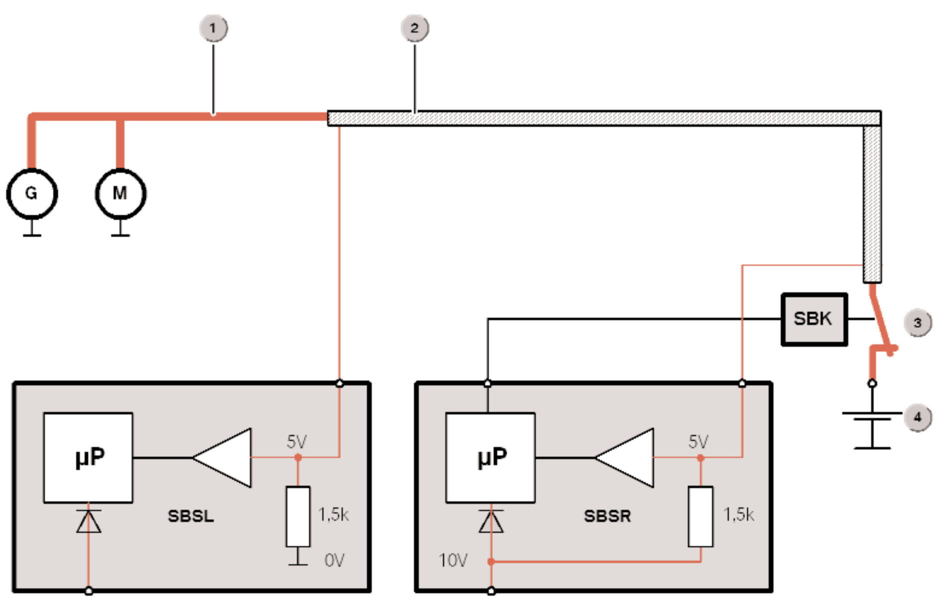


1. Outer insulation
2. Monitoring shield
3. Insulation of aluminum cable
4. Aluminum cable 120mm²

The battery cable is fitted with a low-impedance metal mesh, which is insulated against the body and against the battery cable. This metal mesh is referred to as the monitoring shield.

The battery cable is diagnosed by a special circuit between the SBSL and SBSR satellites.

The following circuit shows the functional principle of the battery cable diagnosis.



Battery cable diagnosis takes place by means of the low-impedance metal braiding of the battery cable (= monitoring shield). A connection cable exits from each end of the monitoring shield (at the safety battery terminal in the luggage compartment and at the battery earth point in the engine compartment).

The connection at the safety battery terminal in the luggage compartment is connected to the right B pillar satellite. The second connection cable in the engine compartment is connected to the left B-pillar satellite.

The satellites contain analog/digital converters that are connected to the microprocessor of the satellite. The connection cables of the battery cable diagnosis are connected to the analog/digital converters. The right B-pillar satellite contains a pull-up resistor. The left B-pillar satellite contains a pull-down resistor of the same size.

The voltage supply of the satellite (approx. 10 V) is applied at the pullup resistor. Ground is applied at the pull-down resistor. The very low-impedance cable and the resistors of the same size mean that around half the voltage (approx. 5 V) is applied at the A/D converters.

In the event of a fault, significantly different measured values result as follows:

State	Measured value SBSL	Measured value SBSR
Battery cable OK	Approximately 5V	Approximately 5V
Interruption of the diagnosis connection	Approximately 0V	Approximately 10V
Short circuit to earth	Approximately 0V	Approximately 0V
Short to battery positive	Approximately 10V +	Approximately 10V +

Every 250 microseconds, the values are measured, triggered by the synchronization pulse. If the battery cable is OK, the values are transferred every 20 ms to the SIM. If a significant deviation of the values occurs, the new values are transferred immediately.

In the following cases, the battery cable is cut off by the safety battery terminal from the battery:

- Short circuit to earth (body)
- Short circuit to battery positive

The alternator and the electric fuel pump are also de-energized at the same time.

Special Case

If the outer insulation is damaged (e.g. due to friction/scuffing), but the monitoring shield has no connection to earth, the following case could occur.

Moisture (rain) would mean that the voltage would gradually fall. A short circuit to earth would be detected, but the safety battery terminal would not be triggered.

The entry "Implausible measured value" is set in the fault code memory. This would be indicated to the driver by the airbag warning lamp.

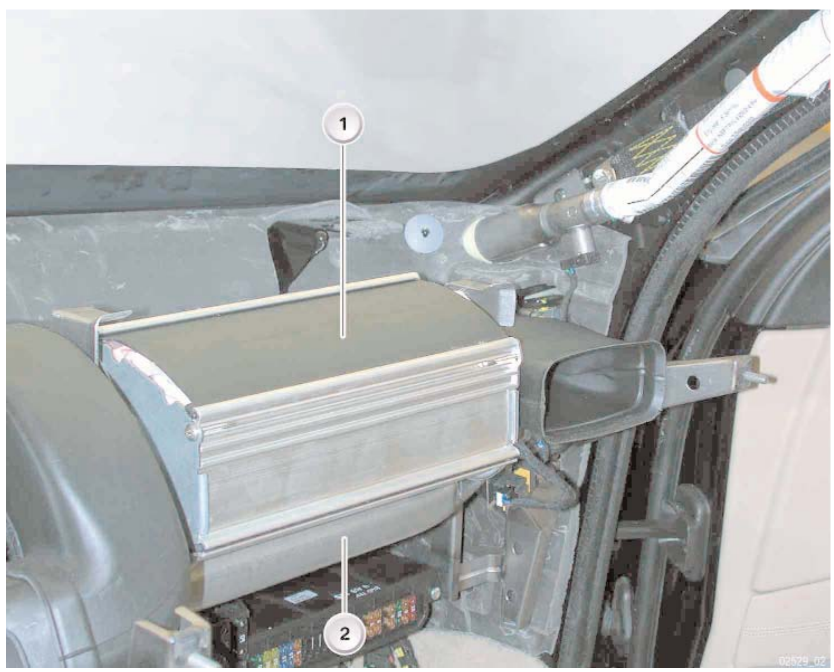
Front Airbag, Driver

The purpose of the front airbag is to reduce the risk of the driver suffering injury in the event of a crash. The front airbag module for the driver's side is located in the impact pad of the steering wheel. The front airbag for the driver is equipped with a 2-stage gas generator.

Front Airbag, Passenger

The purpose of the passenger-side front airbag is to reduce the risk of the front-seat passenger suffering injury in the event of a crash.

The front airbag is located beneath an invisible flap in the dashboard.
The airbag is a 2-stage airbag with gas generator.

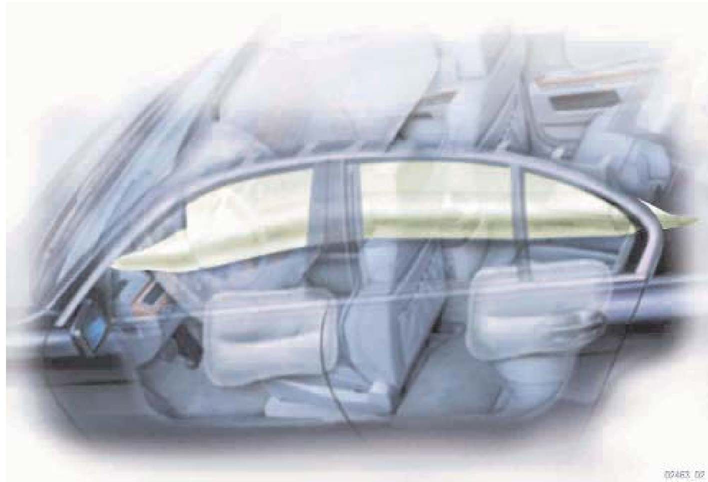


Note: If the passenger airbag module (1) is triggered, the supporting tube (2) has to be checked. During a collision with airbag deployment, the supporting tube is exposed to considerable force. Consequently, the supporting tube has to be checked and, if necessary, replaced.

Advanced ITS (Head Airbag)

Standard equipment in the E60 includes the Advanced ITS Inflatable Tubular Structure (AITS II) the advanced-design head airbag from the E65.

The differences between it and the head-protection system installed in the E39 are:



- One-part head airbag extending all the way from the A-pillar to the C-pillar
- ITS extended by a sail between ITS and roof frame

The AITS II extends all the way from the A-pillar to the C-pillar and covers the entire side zone.

In conjunction with the thorax airbags in the front and rear doors, it provides optimum side protection for all passengers.

The Advanced ITS prevents the head and other extremities of the occupants from swinging outwards. This leads to less severe neck backlash forces and less severe head injuries.

Advantages of the system:

- Extended covered area for side windows front and rear.
- Protection against glass splinters and penetrating objects.
- Optimized protection area, also for very large occupants.

Side Airbag

The side airbags in the doors reduce the risk of occupant injury in the torso region of the body in the case of a side-on crash. The side airbags are folded into an aluminum housing with a plastic cover behind the door trim. In the area of the side airbag in the door trim is a tear seam.

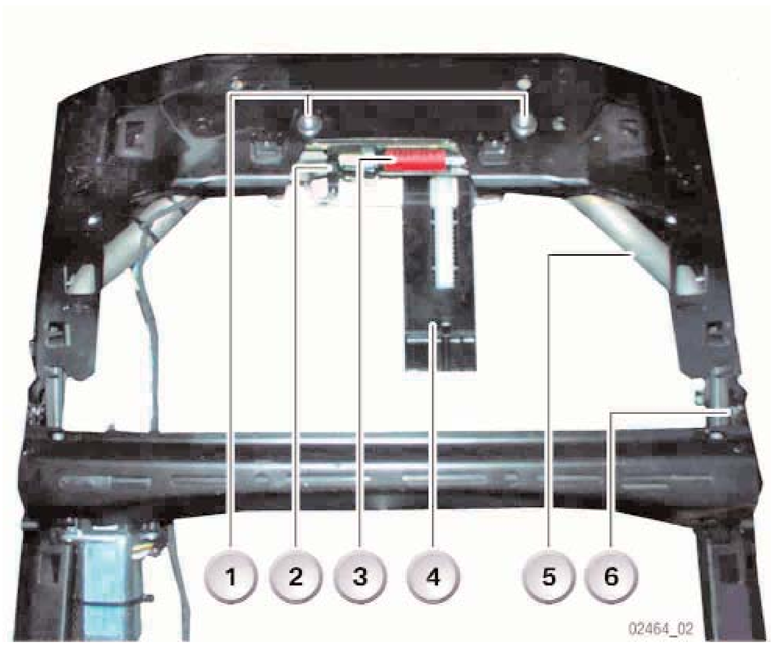
The side airbags are secured to the inner door panel with 3 screws. The plastic cover has defined breaking points.

In a side impact of sufficient severity, the side airbag is triggered. The side airbag exits through the split line and deploys between the door and the seat occupants.

Active Headrest

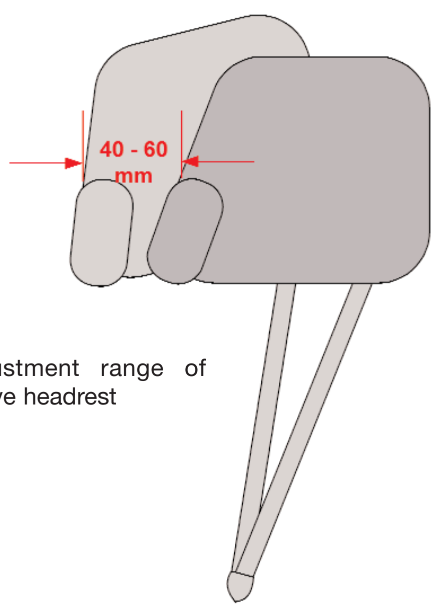
The E60 has active headrests for driver and front-seat passenger included in the multi-function seat option.

No active headrest is installed on the basic seat, as the fixed positioning of the backrest and headrest mean that the head is *always* near the headrest.



1. Mounting of the active headrest
2. Connection for igniter pellet
3. Gas Generator
4. Headrest height adjustment
5. Support tube
6. Center of rotation

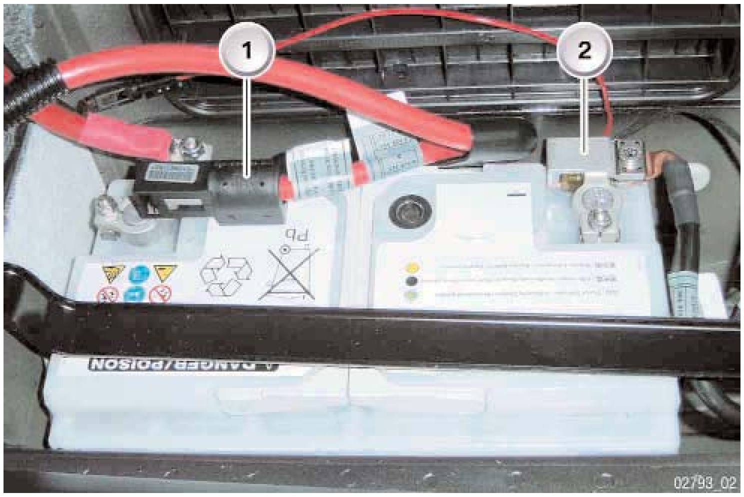
In the case of the multifunction seat, the adjustment of the headrest means that there is the possibility that the gap between the headrest and head increases. In the event of a crash, the gap would be relatively large, leading to greater strain on the cervical vertebrae. For this reason, the active headrest was developed. In the event of a crash, this reduces the gap between the headrest and head and thus the rate of cervical vertebrae injuries.



Adjustment range of active headrest

Depending on the vertical adjustment of the headrest, different adjusting paths result. The adjustment of the headrest, measured on the cushion, is approx. 40 mm when the headrest is retracted. When the headrest is fully extended, the adjustment is approx. 60 mm.

Safety Battery Terminal, SBK



The safety battery terminal is located directly at the positive terminal of the battery. The structure of the safety battery terminal is technically identical to that of the MRS system.

Note: If the safety battery terminal is triggered, the battery cable has to be replaced all the way back to the main adapter point in the luggage compartment.

1. Safety battery terminal, SBK   2. Intelligent battery sensor, IBS

Up-Front Sensors

Not all federal states require car occupants to wear seat belts, so adequate provision must be made to ensure that the airbag can reliably restrain the occupant in the event of a crash.

The up-front sensors in the vicinity of the front left and right engine bearers detect deformation in the crumple zone and thus register energy absorption. The up front sensors are acceleration sensors that measure longitudinal acceleration (deceleration). The measured values are transmitted to the SGM and taken into account by the algorithm.

Note: In the event of a crash that triggers the airbags, the up-front sensors have to be replaced. The sensors might be damaged internally, even though no external damage is perceptible. Always comply with the instructions in the repair manual when replacing the up-front sensors.

Seat Occupancy Detection (OC-3 Mat)

Legislation in the USA makes it imperative for the system employed to detect occupancy of the front passenger seat to distinguish between occupancy by a small person and use of the seat to anchor a child restraint system.

A straightforward seat occupancy detector recognizes a certain weight as proof that the seat is occupied. In order to meet legislative requirements, the seat occupancy detector (SBE) was developed into an intelligent occupant classifier (Occupant Classification OC). This was achieved by means of the following measures:

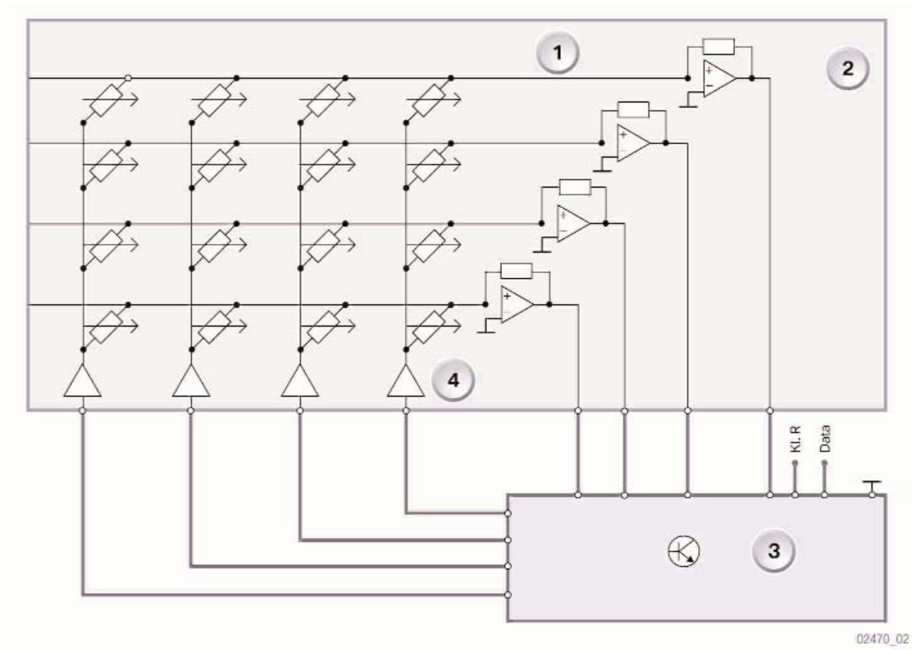
- By a larger number of sensor elements
- By detection over the entire seat area
- By an intelligent electronic analyzer

Comparison between the OC-3 sensor mat (left) and the conventional seat occupancy detection mat (right)

The OC-3 mat is capable of distinguishing between a one-year-old child in a child's seat and a light person.

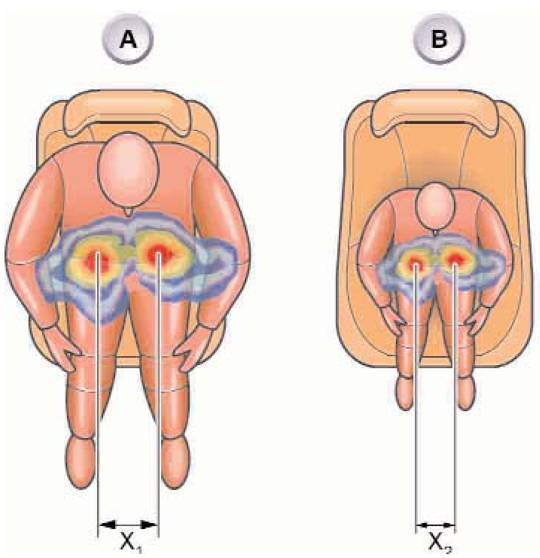
The OC-3 mat is integrated into the seat area of the passenger seat. The OC-3 mat consists of conductors with pressure-dependent resistor elements (FSR, or Force Sensitive Resistance elements). The conductors are connected to the electronic analyzer.

The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases electrical resistance decreases and the measurement current changes accordingly.



1. FSR elements
2. Output monitoring
3. Electronic analyzer
4. Input monitoring

By analyzing the signals from the individual sensors, the analyzer maps the occupancy of the seat surface and can identify the local concentrations of weight. The distances between the areas and the concentrations of weight indicate whether the occupant is small or large. An algorithm computes the weight class and decides whether the seat is occupied by a person or by a child's seat.



The width between the hip bones is related to the weight of the person. Consequently, the analyzer can distinguish between a light person and a heavy person.

The electronic analyzer of the OC-3 mat sends a telegram to the SBSR. If the occupant is identified as a child (based on weight) in a child's seat, the airbags on the passenger side are deactivated. The SBSR sends a telegram to the SGM, and the SGM responds by activating the airbag illuminated indicator. The airbag illuminated indicator lights up to indicate that the airbags on the passenger side have been deactivated.

Workshop Exercise

Using the DISplus/GT-1, access the control unit functions page.

Where can the status pages for the OC-3 sensor mat be found?

What module receives input "telegram" from the "electronic analyzer"?

Access the test module for the OC-3 sensor mat and list the steps below:

Locate the data line between the sensor mat and the SBSR. Interrupt the data line by grounding the signal. (to access data line, remove b-pillar trim to access SBSR or go to connector under seat from the OC-3 mat/analyzer)

What fault code is set when the data line is grounded?

Status of airbag deactivation indicator light

Perform test module for airbag deactivation indicator light.

What test cable is used for testing the indicator light circuit?

What is the voltage to the airbag indicator light (light disconnected)?

What module controls the airbag indicator light?

Why are there 2 diagnostic addresses for the SGM?

Principle of Operation

Trigger Algorithm

The Advanced Safety Electronics ASE safety system has been developed for the E60. ASE is derived from the Intelligent Safety and Integration System ISIS in the E65/66. The triggering philosophy is identical. Various degrees of crash severity and triggering thresholds are distinguished.

Crash Severity

Numerous crash and road tests under extreme conditions have been used to set the BMW triggering thresholds for all possible types of accidents. The trigger thresholds are dependent on crash severity.

Crash severity is divided into 4 groups:

- CS 0: no pyrotechnic restraint systems needed
- CS 1: light crash
- CS 2: crash of medium severity
- CS 3: severe crash

Triggering Thresholds

The triggering thresholds have been set depending on the crash severity and including other factors such as direction, overlap on collision, and depending on the evaluation as to whether the occupant was wearing a seatbelt or not.

This results in the various trigger thresholds for the activation of the various restraint systems. The various trigger thresholds means that triggering for the second stage of the front airbag can be varied,depending on the severity of the crash.

Triggering in the Event of Errors

If a fault is detected in the seatbelt buckle detection system, it is assumed that the seatbelt is not fastened. The triggering threshold is lowered. In spite of the fault recognition, an attempt is made to activate the seatbelt lock tensioner.

If a fault is detected in the seat occupation detection system, it is assumed that the seat is occupied. The restraint systems are activated.

Triggering in the Event of a Crash

The following examples illustrate the actuators that can be activated:

- Front-end crash
- Side-on collision
- Rear crash

Front-End Crash

In a front-end crash, a distinction is drawn between "light to medium severity collisions"(CS 1/CS 2) and "severe collisions" (CS 3).

Crash Severity CS1

In a crash severity CS1 collision, (light collision), the seatbelt tensioners are triggered. The driver/front passenger's airbag are not deployed if the sensors indicate that the occupants are wearing their seat belts.

Exception: If the occupants are not wearing seatbelts, the driver and passenger airbags are triggered.

Crash Severity CS2

As of crash severity CS 2, (medium-severity collision) the driver's/front passenger's airbags are deployed and the seatbelt tensioners are triggered.

The safety battery terminal is activated, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Crash Severity CS3

In a crash severity CS3 collision, (severe collision), the the driver's/front passenger's airbags are deployed and the seatbelt tensioners are triggered, but the time delay is different.

Example of Airbag Deployment

The time transient for a front-end crash is graphed here. The seat-belt buckle switch and the seat occupancy detector provide the information indicating that the passenger seat is occupied.

The collision occurs at t0. The mechanical lock of the seat belt prevents it unreeling. The sensors detect the deceleration forces. At t1 the actuators are triggered by the satellites (trigger phase). The pyrotechnical actuators are triggered. The driver and passenger belt tensioners are triggered, as is the first stage of the driver's-side and passenger-side airbags.

In a crash of severity 2 or higher, the safety battery terminal is triggered at the same time, in order to prevent the battery cable from causing a short-circuit in the engine compartment.

This is followed by the deployment phase, i. e. the in flowing gas inflates the airbags. In the seat belt tensioner, the plunger is displaced by the gas in the tensioning tube. The cable connected to the plunger pulls the seatbelt buckle downward and takes up the slack in the seat belt.
At t2 the process for the seat belt tensioners is completed and restraint by the seat belt has commenced. Gas is still inflating the two airbags.

The restraint phase starts for the driver at t4. Both stages of the two stage airbags can be triggered at as early a juncture as t2, depending on the severity of the crash. The delay between triggering of the two stages renders the airbags less likely to cause injury to the occupants.

The recoil movement of the occupants starts at time t8. The forward movement of the occupants ceases and they drop back into their seats.

Side-on Collision

In the event of a side-on collision, a crash severity distinction is made between light and medium-severity collisions.

If the crash severity is CS 1 (light collision) or worse, the AITS II head protection system and the side airbag on the impact side are deployed. In the event of crash severity CS 2 (medium-severity collision), the safety battery terminal is also triggered, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Rear Crash

As of crash severity CS 1, (light collision) the active headrests (if fitted) and the seatbelt tensioners are triggered. In the event of crash severity CS 2 (medium-severity collision), the safety battery terminal is also triggered, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Emergency Call, US

The E60 US offers the customer as standard a number of emergency call functions as well as a breakdown call. The emergency call functions available include the manual emergency call as well as the automatic emergency call in the event of a crash.

Even if no telephone has been ordered, every vehicle has a Telematic Control Unit TCU, a telephone aerial, a hands-free unit as well as a GPS aerial for localization.

Manual Emergency Call

The emergency call switch (4) is connected directly to the telephone. Pressing the emergency call switch sets up a voice connection with the provider "Cross Country." The voice connection is indicated by a flashing LED in the switch.

Automatic Emergency Call

In the event of a crash with corresponding crash severity, the SIM transmits a crash telegram to the TCU (via the K bus). The Global Positioning System informs the TCU of the location of the vehicle. The TCU places an emergency call, which at the same time contains the location of the vehicle.

A voice connection is set up with the provider "Cross Country" to obtain more information on the accident (severity of the accident, number of injured) so that rescue operations can be initiated.

Breakdown Call

The Breakdown call button is in the Central Information Display. Selection can be activated by means of the controller. If the breakdown call button is activated, a connection to the BMW Emergency Service of the relevant country is set up.

Airbag Indicator Lamp

The airbag illuminated indicator (3) is set in the front overhead console near the interior lights. The airbag illuminated indicator lights up if the front airbags on the passenger side have been deactivated. The emergency call switch and the two hands-free microphones are beside the airbag illuminated indicator in the overhead console.

Passive Knee Protection

The E60 US has plastic absorbers on the driver's side and passenger side. In the event of a crash, the passive knee protectors restrain the lower legs, especially if the driver or passenger are not wearing seat belts. This initiates a controlled forward shift of the upper body, which is cushioned by the relevant airbag.

Service Information

The following must be observed by Service:

- Safety and Gateway Module diagnosis
- Passenger airbag module
- Battery cable diagnosis
- Safety battery terminal
- Door module, driver's door/passenger door
- Up-front sensors

Safety and Gateway Module Diagnosis

As far as diagnosis is concerned, note that two control-unit functions (ZGM, SIM) are addressed, despite the fact that they share a common housing. Each function has its own microprocessor and its own diagnosis address.

Passenger Airbag Module

If the passenger airbag module is triggered, the supporting tube has to be checked. The forces to which it is exposed are high, and the possibility of the supporting tube deforming cannot be excluded. Consequently, the supporting tube has to be checked and, if necessary, replaced.

Battery Cable Diagnosis

If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to repair the shielding.

Safety Battery Terminal

If the safety battery terminal is triggered, the battery cable has to be replaced all the way back to the main adapter point in the luggage compartment. Repair is not intended.

Door Module, Driver’s Door/Passenger Door

When removing the door module, it is essential to ensure that the two inner screws (2) of the door module are not removed. These screws hold the housing of the door module together and ensure that the pressure sensor is sealed. If the screws are slackened there is a possibility that the pressure sensor will no longer operate correctly.

Up-Front Sensors

In the event of a crash that triggers the airbags, the up-front sensors have to be replaced. The sensors might be damaged internally, even though no external damage is perceptible. Always comply with the instructions in the repair manual when replacing the up-front sensors.

Synchronization of New Modules

When new satellite modules are fitted, these modules have no system time. Transmission of the two system time telegrams allows the module to adapt the system time. This is only possible when the stored system time in the satellite modules is smaller than the time sent.

If the system time in a module is greater than the time sent, (Ex. trying a part from another vehicle), the system time is not adopted and an entry is made into fault memory.

When the SIM or any satellite is replaced, the system time must be entered. As the system time is available in all ASE modules, it can be transferred into the new module.

This takes place via the Diagnosis Program (Service Functions). To do so, the DISplus /GT1, requests the system time from all satellites and selects the largest.

The DISplus/GT1 add an amount to this time and transmits the result into the new module as the system time. The correction amount compensates for the run time between reading from the satellites and entry into the new module.

This prevents fault messages from the satellites because the system time transferred by the new module is smaller than that stored in the satellites.

Table of Contents

E60 Voltage Supply and Bus Systems

Initial Print Date: 08/03 Revision Date: 10/03

Model: E60

Production: Start of Production MY 2004

Voltage Supply and Bus Systems

Objectives:

After completion of this module you will be able to:

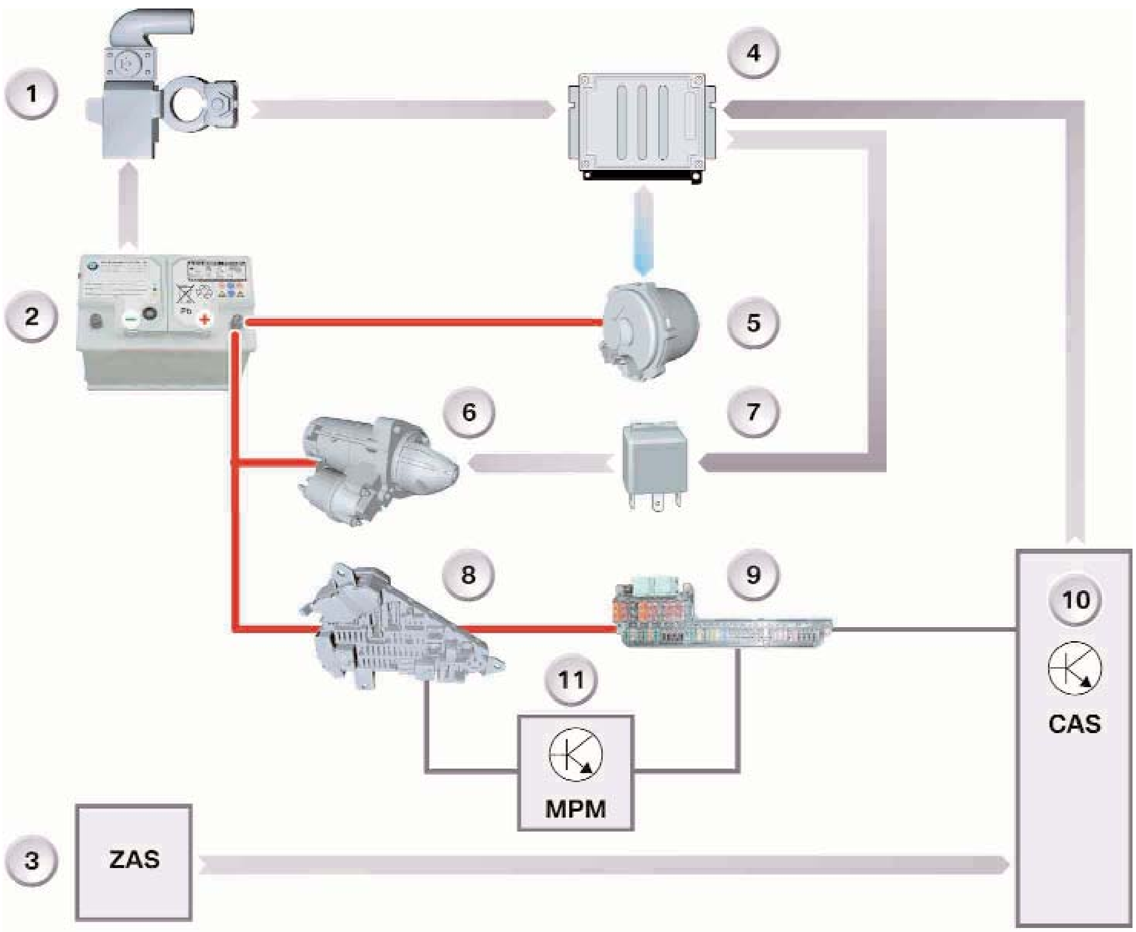
- Understand IBS operation.
- Explain Power Management.
- Recognize the different bus systems.
- Diagnose Voltage Supply Faults.

Voltage Supply and Bus Systems

Voltage Supply

The voltage supply system on the E60 is similar to that of the E65. The E60, however, is ***Not*** fitted with a power module, therefore there is no main power switch. Supply voltage is monitored during both driving and parked conditions to reduce the possibility of unwanted closed current draws and insure that adequate voltage is available as needed.

The "State of Charge" (SoC) and the "State of Health" (SoH) of the battery are determined continuously with the E60 power management system.



Typical Voltage Supply for 6 Cylinder Vehicles

1. Intelligent Battery Sensor (IBS)
2. Battery
3. Ignition/Starter Switch (ZAS)
4. DME
5. Alternator
6. Starter
7. Starter Relay
8. Rear Power Distribution Box w/ Terminal 30g Relay
9. Front Power Distribution Box
10. Car-access System (CAS)
11. Micro-Power Module (MPM)

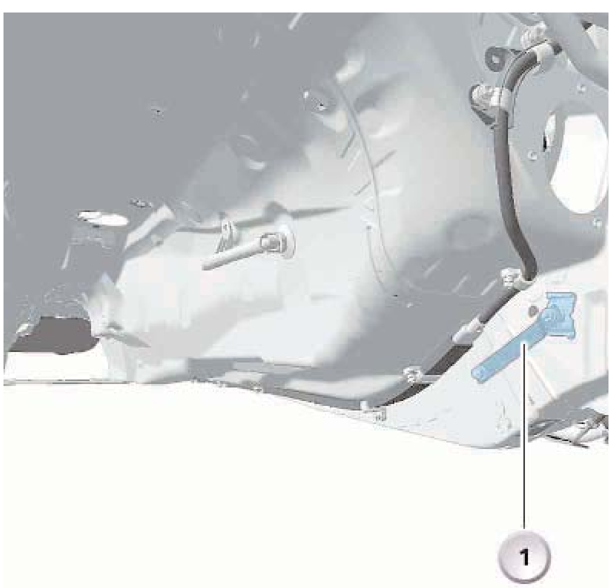
System Components

The power supply system consists of the following components:

- Vehicle Ground Points
- Battery
- Battery Cable
- Intelligent Battery Sensor with ground Lead (IBS)
- Terminal 30g Relay
- Micro-Power Module (MPM)
- DME
- Car Access System (CAS)

Ground Points

The ground point (GRAV) improves the electromagnetic compatibility (EMC) of the vehicle. Ageing connections between the front end and the remaining car body do not affect the EMC. The contact resistances between the front end and the remaining car body are bridged by means of the ground lead.



Battery

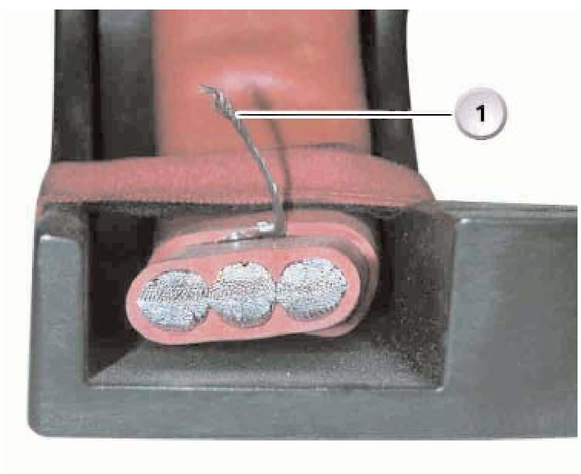
The battery size in the E60 depends on the engine and equipment configuration.

Battery Service Information
The battery size is coded in the DME. Replacement batteries must be the same capacity rating as the original Battery.

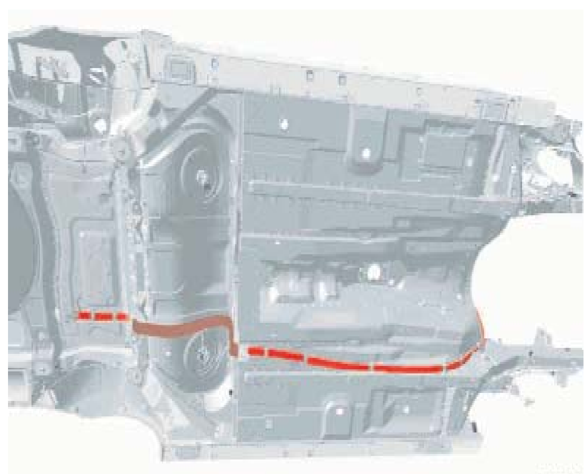
Particular attention must be paid to the cables and the IBS when replacing a battery. Irreparable damage may occur if the cables and IBS are subjected to high mechanical stress and strain. Refer to service information for the IBS.

As on the E65, the power management system is to be initialized by means of the diagnosis job "Control_battery_replacement_register." Follow the repair instructions.

Battery Cable
The battery cable is installed on the underside of the vehicle. The battery cable is monitored by the ASE system as in the E85. Sensor leads are routed from the battery cable to the left and right B Pillar satellites.
Battery cable size is dependent on engine. Most US vehicles use 120mm^2 aluminum Ribbon cable.



Cross Section Battery Cable w/ Sensor lead



Under car Routing of Ribbon Battery Cable

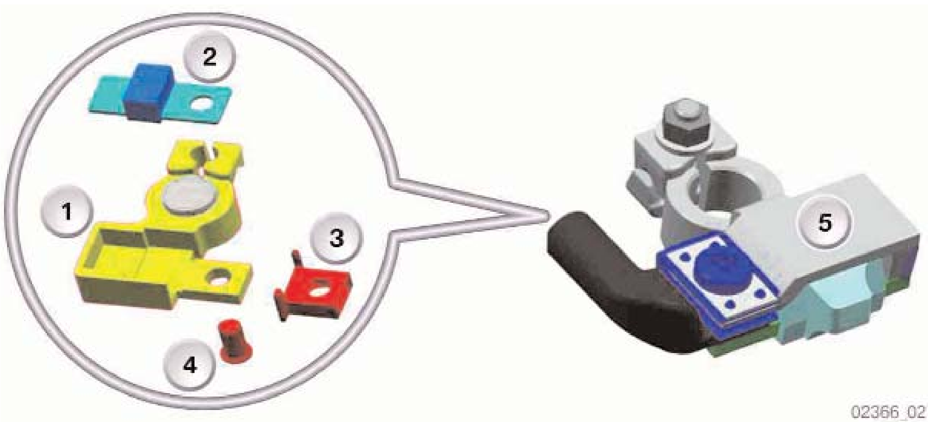
Intelligent Battery Sensor

The IBS (1) is a mechatronic intelligent battery sensor with its own microcontroller. It constantly measures the following:

- Battery terminal voltage
- Battery charge/discharge current
- Battery acid temperature

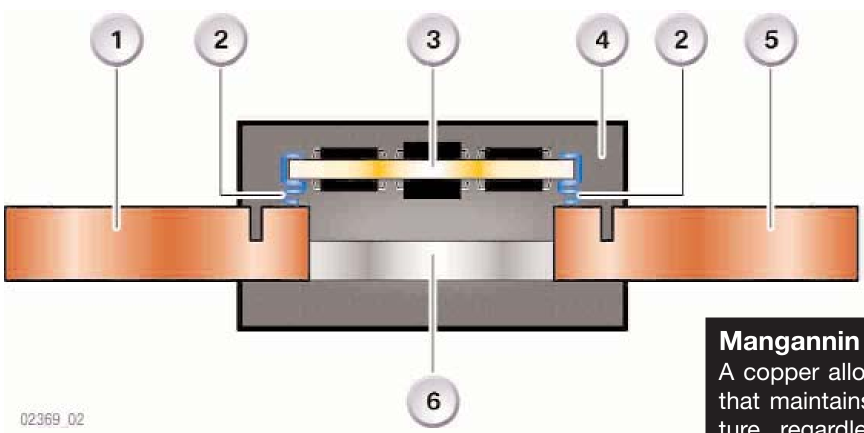
Installed directly at the negative battery terminal, care should be used when removing and installing the negative battery cable.

The IBS consists of 3 functional elements:
- Mechanical section,
- Hardware
- Software



Exploded View of IBS

1. Pole Terminal
2. Shunt
3. Spacer
4. Screw
5. IBS



IBS Hardware

1. Copper
2. Gull Wings
3. PC Board w/evaluator
4. Injection Molding
5. Copper
6. Mangannin

Mangannin
A copper alloy resistor of low resistance value, that maintains an extremely constant temperature, regardless of current flow. Used as the shunt resistor to measure current flow by the evaluation electronics of the IBS.

Mechanical Section

The mechanical part of the IBS consists of the battery terminal for the negative pole with ground cable. Tasks of the mechanical section of the IBS:

- Providing electrical contact of the car body with the negative pole of the battery
- Acceptance of the sensor element for current measurement
- Acceptance of the hardware
- Providing sufficient thermal contact between the temperature sensor of the hardware and the negative pole of the battery
- Providing protection for the sensitive electronic components
- The battery terminal is the ground connection for IBS

IBS Measuring Ranges

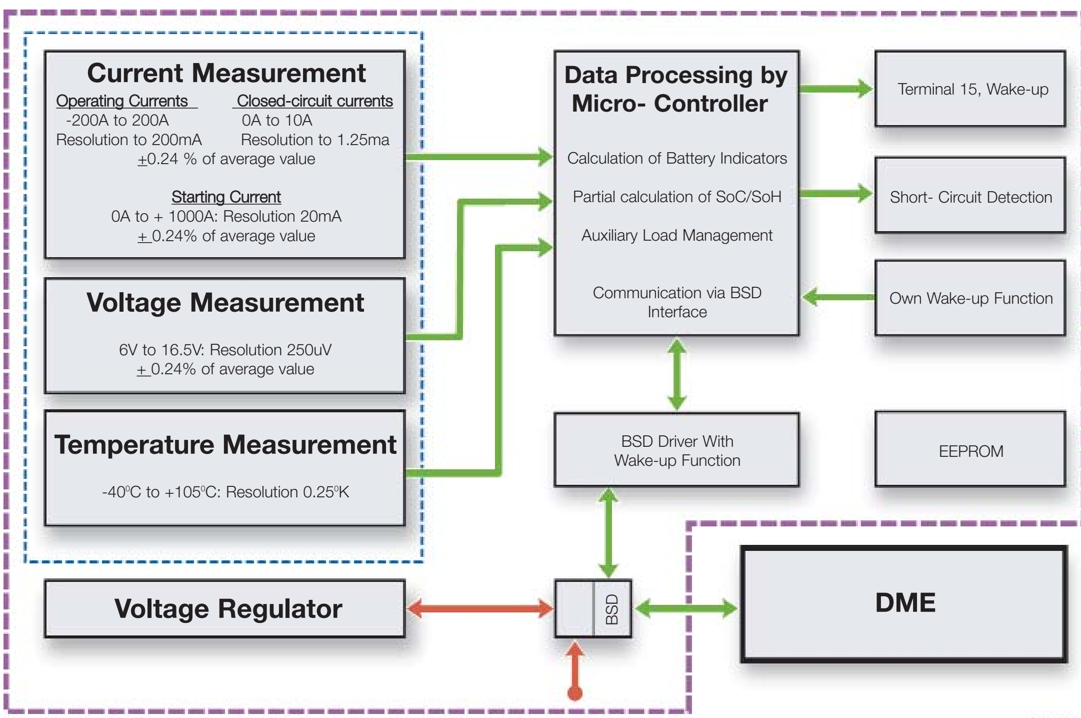
- Voltage 6 V to 16.5 V
- Current -200 A to +200 A
- Closed circuit current 0 A to 10 A
- Starting current 0 A to 1000 A
- Temperature -40°C to 105°C

Electronic Evaluation Module

The electronic evaluation module of the IBS continuously registers the measured data. The IBS uses these data to calculate the following battery indicators.

- Voltage
- Current
- Temperature

The IBS sends the calculated battery indicators to the DME via the BSD. The IBS calculates changes in battery SoC/SoH based on information received from the DME on the SoC of the battery during the period of time between engine "OFF" and deactivation of the DME relay. After the DME relay has been switched off, the IBS continues to constantly observe the SoC of the battery.



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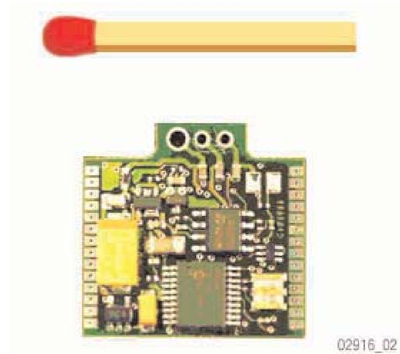
IBS Hardware

IBS Hardware consists of the following:
- Shunt for current measurement
- Temperature Sensor
- Multi-layer pc-board as the electronic circuit including the electronic components.

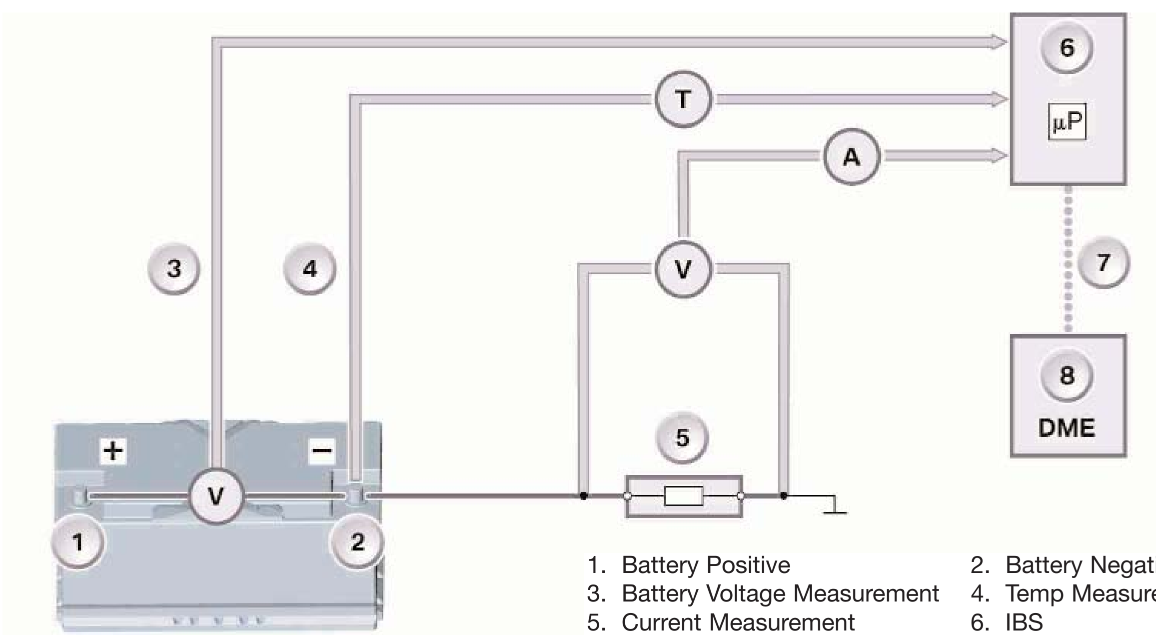


PC-board of IBS

IBS Software

The software in the PC-board of the IBS calculates State of Charge and State of Health of the battery and sends the information to the DME. Communication with the DME, which takes place via the BSD, allows the DME to obtain data constantly from the IBS during vehicle operation.

The following functions are integrated in the IBS:
- Continuous measurement of current, voltage and temperature of the battery under all vehicle operating conditions
- Calculation of battery indicators as basis for SoC and SoH
- Monitoring of battery charge/discharge current
- Monitoring of SoC and notification to DME of critical SoC
- Partial calculation of SoH Based on starter draw
- Closed-circuit current monitoring in vehicle
- Data transfer to DME
- Self-diagnosis
- Self wake-up capability during sleep mode



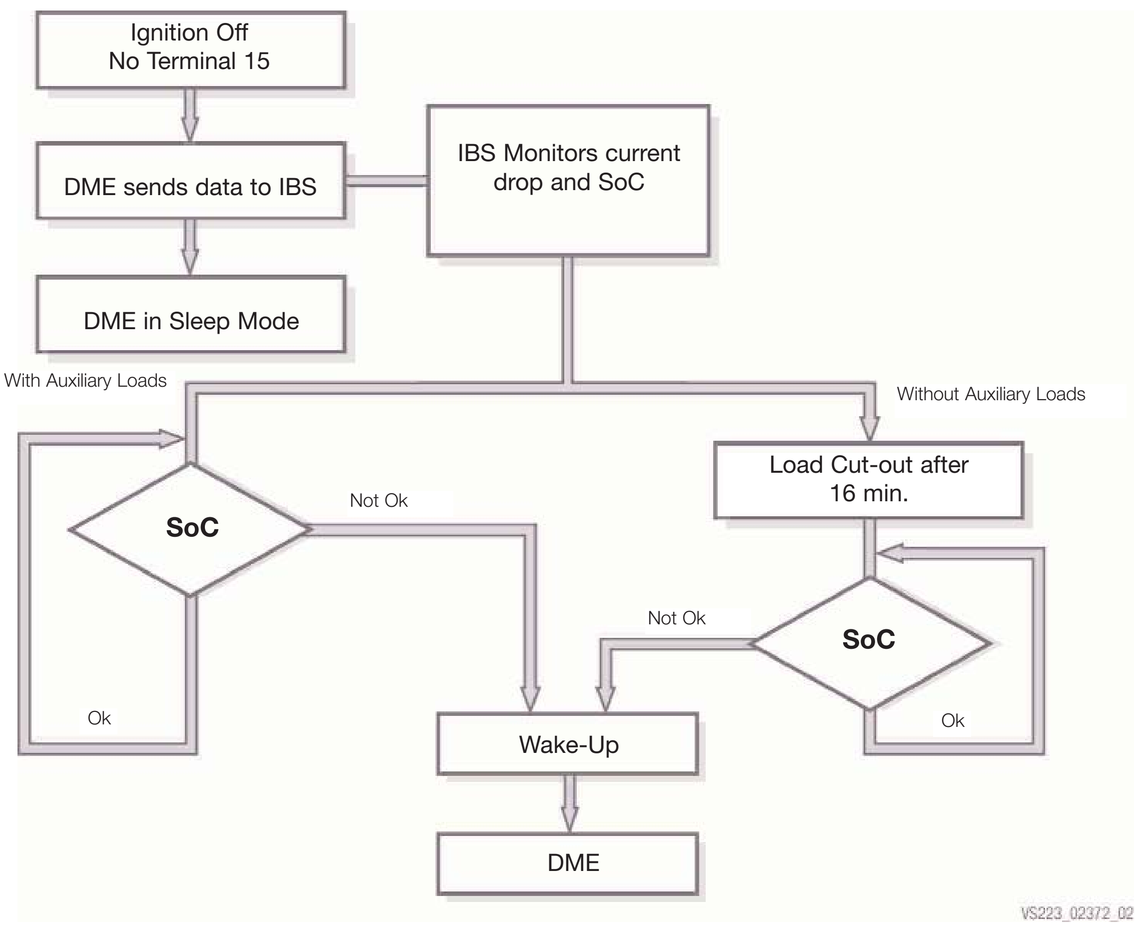
1. Battery Positive
2. Battery Negative
3. Battery Voltage Measurement
4. Temp Measurement
5. Current Measurement
6. IBS
7. BSD
8. DME

IBS Charge Management

The IBS continuously manages the charge status of the battery when the key is off. The current SoC is stored in the IBS every 2 hours.
When the IBS receives the terminal 15 “wake up signal” the DME is updated with the current values of the battery indicators.

Closed-Circuit Monitoring

When the vehicle is off the IBS is programmed to wake up every 40 s so that it can update the measured values (Voltage, current, temperature). The measuring time of the IBS is approx. 50 ms.
The DME reads the history of the measurements on start-up. An entry is made in the fault code memory of the DME if a closed-circuit current draw was present.



IBS Wake-up

When the key is switched off, before the DME enters sleep mode, the DME informs the IBS of the current SoC of the battery. The IBS monitors the SoC and when it drops below the programmed threshold, a wake-up signal is sent to the DME via the BSD. The DME wakes up, obtains information on the current SoC of the battery from the IBS and requests the auxiliary electrical loads to switch off.
After one wake-up sequence the IBS is prohibited from waking the vehicle again during this key off cycle. The vehicle subsequently reassumes sleep mode.

Servicing the IBS

The IBS is very sensitive to mechanical stress and strain. It is serviced as a complete unit with the ground cable. The ground cable also serves as a heat dissipater for the IBS.

Particular attention should be paid to the following points in service:

- Do not make any additional connections at the negative terminal of the battery
- Do not modify the ground cable
- Do not make any connections between the IBS and the sensor screw
- Do not use force when disconnecting the ground terminal from the battery
- Do not pull at the ground cable
- Do not use the IBS as a pivot point to lever off the ground terminal
- Do not use the connections of the IBS as a lever
- Use only a torque wrench as described in the repair manual
- Do not release or tighten the sensor screw

A fault code is stored in the DME when the IBS is defective. The DME adopts a substitute value and assumes IBS emergency mode. IBS emergency mode boosts the idle speed in order to sufficiently charge the battery.

Note:
The software in the DME and that of the IBS must match. To ensure this requirement it may be necessary to replace the IBS in connection with a software update.

IBS Diagnosis

The IBS features a fault code memory that is read out by the DME. Self diagnosis checks the voltage, current, temperature measurement, terminal 15 wake up as well as system errors in the IBS.
Direct diagnosis of the IBS is not possible, it must be diagnosed through the DME.

Voltage Measurement
If the IBS is shorted to ground, a DME fault code will display “Voltage Fault DME ON”. The IBS will be unable to wake up the DME.

If the IBS is shorted to B+, a DME fault code will display “Voltage fault, DME not ON” and no charging current. The vehicle will NOT enter sleep mode.

Current Measurement
Current measurement is a very dynamic process, indicated by the measuring range of mA to kA.
The fault code “Current Fault” is entered in fault memory when an implausible value is determined during the plausibility check of the various measuring ranges of the IBS.

Terminal 15 Wake-up Signal Faults
The IBS recognizes wake-up line faults. The IBS can detect a wake-up line error under the following conditions:
- DME “ON”
- Terminal 15 “ON” (voltage high at IBS)
- Terminal 15 running via BSD

If Terminal 15 at the IBS and Terminal 15 via the BSD are not equal, a fault is indicated in the BSD line or an IBS Fault.

The IBS fault may be caused by:
- Terminal 15 Driver in the IBS has a short to ground
- Terminal 15 Driver in the IBS has a short to B+ or is defective.

SoC/SoH

State of Charge
SoC is a calculated condition showing the current charge in the battery. The SoC calculations are performed by the DME. SoC is used during key off periods to insure the battery maintains a sufficient charge to start the engine at least one more time.

State of Health
SoH tracks the history of the battery in the vehicle. Charge/discharge cycles and times are monitored. SoH helps the DME determine the proper charging rates and anticipated battery life.
The IBS detects vehicle start based on current draw in excess of 200A. The engine running signal is made available by the DME via the BSD. Internal resistance of the battery is calculated from the current and voltage dip. These indicators are forwarded to the DME. From this data, the DME the state of health (SoH) of the battery.

Workshop Exercise - IBS

Vehicle has been brought into shop for dead battery. A closed current draw exceeding limits was found and repaired. However a fault is stored in the DME regarding the IBS.
The fault is

1. *Interrogate the DME for Faults. What are the faults found?* ______________________

    ____

2. *How does the IBS communicate with the DME?* ______________________

3. *Perform a pin out of the IBS terminals with the key off and with the key on.*

	Pin 1	Pin 3
Key ON		
Key OFF		

4. *Perform the test plan B1362 as outlined in the DISplus.* ______________________

5. *Scope the signal on the line coming from IBS and the line coming from DME.*

    ____

    Why do you get these voltage readings? ______________________

6. *Monitor voltage (or scope pattern of BSD). Observe BSD entering sleep mode. How long did it take for the BSD line to go to sleep?* ______________________
    What is the BSD voltage during sleep mode? ______________________

7. *Lower the terminal 30 input to the IBS through the stimulation mode of the DISplus. What happens to the BSD?* ______________________

8. *Why is it important that replacement batteries be the same type and capacity as the factory installed battery?* ______________________

9. *What measurements are performed directly by the IBS?* ______________________

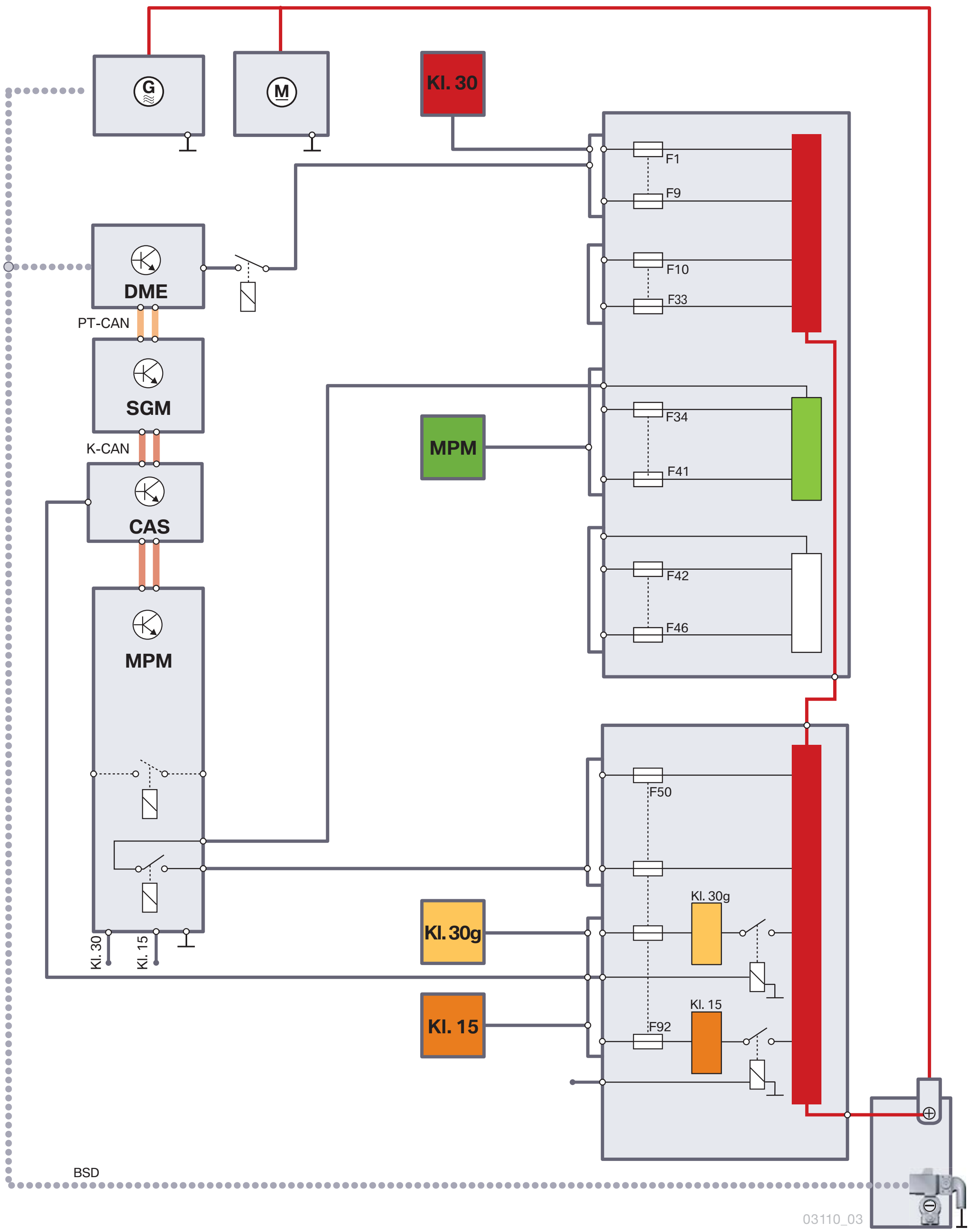
10. *Which control unit calculates the SoC/SoH of the battery while the engine is running?*

    ____

11. *How often is the battery conditioned monitored while the vehicle is "OFF"?* __________

12. *How does the IBS signal the DME of significant changes in SoC during "OFF" time?* ______________________

30g and MPM System Schematic



Terminal 30g Relay

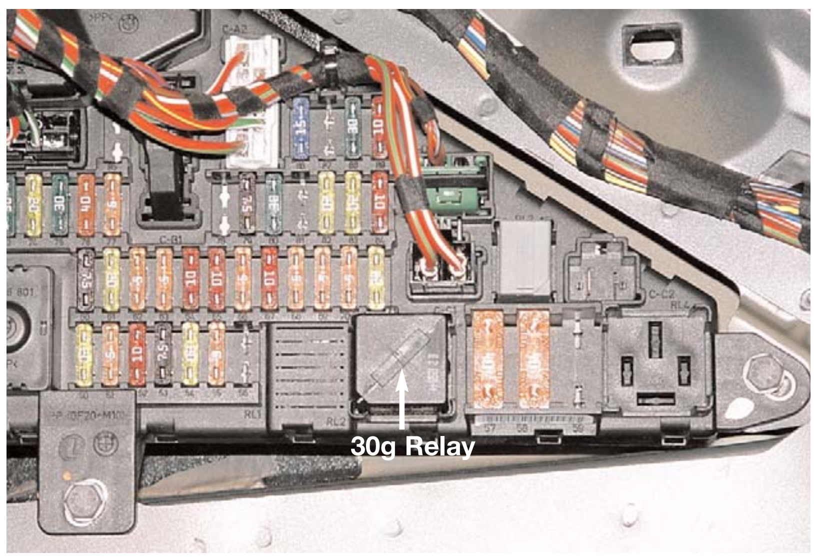
The Terminal 30g Relay prevents increased closed-circuit current consumption by switching off electric loads.

The switch-off procedure disconnects various electric loads in a defined manner from the vehicle electrical system. This happens approx. 60 min after terminal R "OFF." The deactivated electric loads are activated again together with terminal 30g "ON."

The terminal 30g relay is actuated by the car access system.

Power to the following control units is managed by the terminal 30g relay:

- Center console switch center
- Rain and low beam sensor
- Controller
- Central information display
- Slide/tilt sunroof
- Satellite radio
- TOP HiFi amplifier
- Telephone
- Head-up display
- Active cruise control
- Electronic transmission control/SMG
- Dynamic stability control
- Adaptive cornering light



Terminal 30g Relay Location

30g Switch On Conditions

The switch-on conditions for terminal 30g relay are as follows:

- Unlock vehicle or
- Terminal R or
- Status change of door contacts or of trunk contact or
- Telephone wake-up line for telematic services or
- Service applications

30g Switch Off Conditions

The switch-off conditions for terminal 30g relay are as follows:

- 60 min after terminal R "OFF" or
- Service applications
- Power Management Switch off

Notes:

Workshop Exercise - Terminal 30g Relay

Vehicle is brought into the shop with a “No Start” condition.

1. *Verify the complaint.*

2. *Perform short test on vehicle.*

3. *What control modules where not interrogated during the short test?*

4. *What are the possible causes of this “No Start” condition?*

5. *Check the status of the Key Recognition, EWS Line release.*

6. *Activate starter position while observing status in the CAS. What is the status of the 50E and 50 L?*

7. *Print FB for the 30g Relay. Observe the modules which are supplied power via the relay.* ____

8. *Is there a module on the list which could cause the no start condition?*

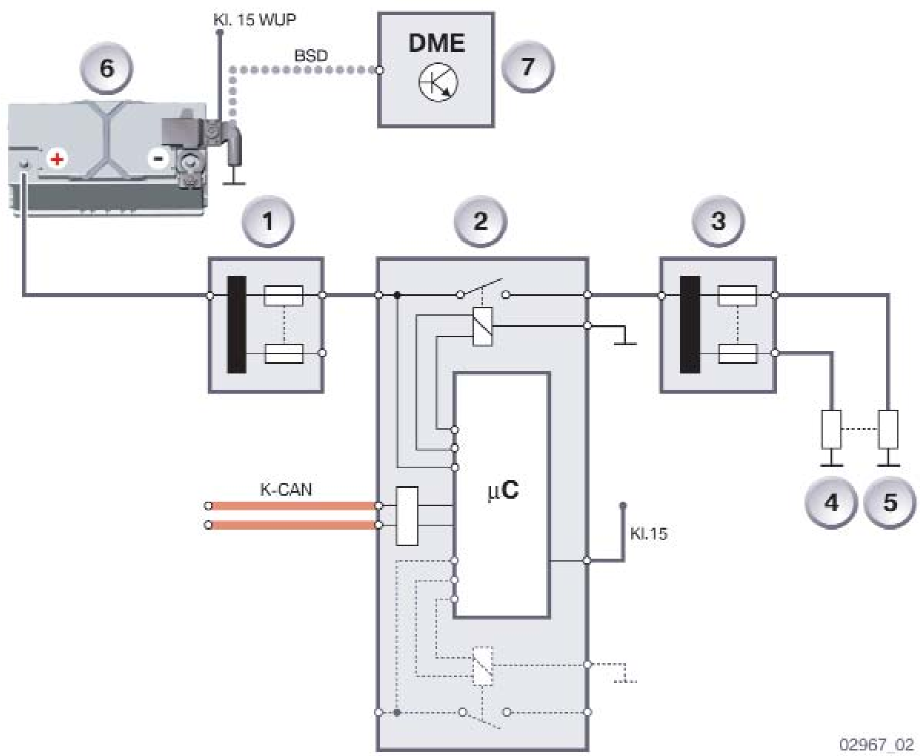
9. *Repair fault, perform quick delete and now observe status of 50E and 50L.*

10. *How long after terminal R “OFF” is the terminal 30g relay switched off?*

11. *Terminal 30g relay is actuated by the* ____.

Micro-Power Module

In the same way as with terminal 30g, the micro-power module (MPM) facilitates defined deactivation of electric loads.
The MPM is installed in the spare wheel recess and operates in 3 modes, normal mode, sleep mode and service mode



Block Diagram of MPM

1. Rear Power Distribution Box
2. MPM
3. Front Power Distribution Box
4. Electrical Load
5. Electrical Load
6. Battery
7. DME

K-CAN	Body CAN
Kl.15	Terminal 15
Kl.15 WUP	Terminal 15, Wake Up

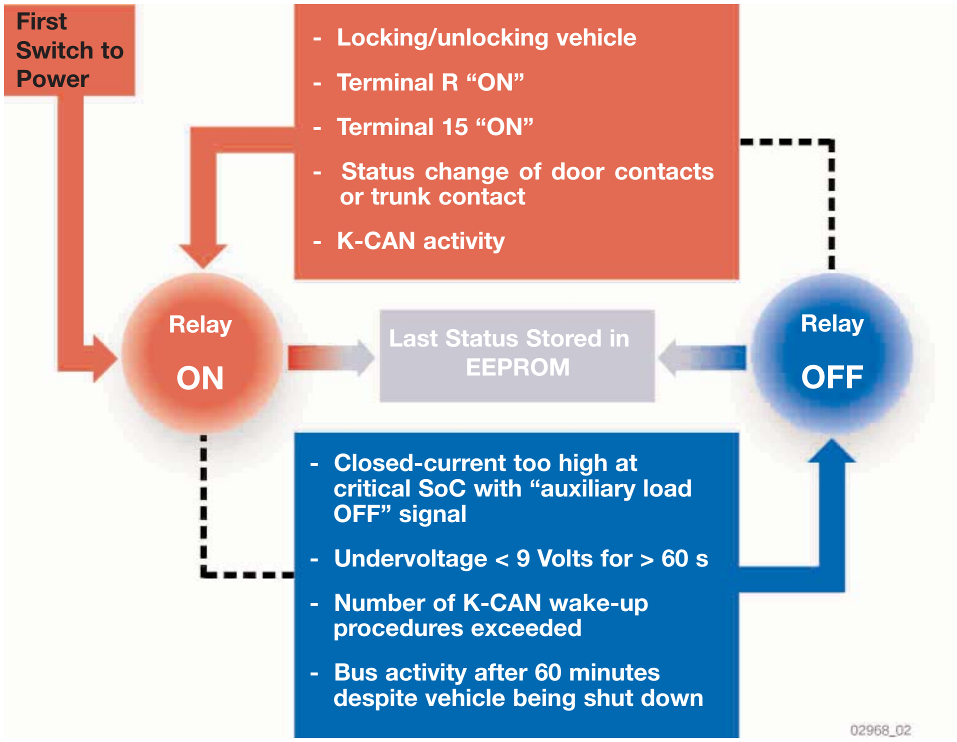
Normal Mode

All functions of the MPM are available in normal mode.
The MPM switches on/off the voltage supply to the electric loads involved in communication. Loads are switched on and off only when a fault occurs during the vehicle rest period. The MPM switches the voltage supply on and off in the following control units:

- Multi-audio system controller M-ASK
- Car communication computer CCC
- CD disc changer CDC
- DVD changer DVD

The supply voltage is switched on and off by means of a bistable (switchover type) relay. The relay is set to "ON" when it leaves the factory. This type of relay has two positions, On and OFF. When ON voltage is passed from Fuse 57 through the MPM to the above consumers. When OFF, the connection to F57 is broken. This type of relay does not need power (coil energized) to maintain either switch position. Power is only needed to cause the relay to switch from ON to OFF or OFF to ON.

Switch on/off conditions for micro-power module



The MPM communicates with the vehicle through the K-CAN and is supplied power by both a KL 30 and a KL 15. If terminal 30 voltage is lost, operation continues with the voltage supplied by terminal 15, and a fault is registered.

Sleep Mode

The MPM assumes sleep mode approx.1 s after the K-CAN has gone into sleep mode. The current switching status of the relay is stored before the MPM assumes sleep mode.

The MPM is woken by the terminal 15 signal via the K-CAN or by activation of terminal 15. On waking, the switching status of the relay last stored is reestablished.

Service Information for MPM

A fault code is stored in the fault code memory when the MPM disconnects the electric loads from the vehicle electrical system. The following fault codes can be read out in diagnosis:

- Terminal 15 fault
- Deactivation with information on the switch-off condition

The information on the switch-off condition is stored in the info memory:

- Undervoltage
- Contact fault of relay contacts

Workshop Exercise - Micro Power Module

Vehicle is brought into shop with the radio not working.

1. *Verify the complaint.*
2. *Perform short test. Are there any faults stored which could be associated with this problem?* ______
3. *Which control modules did not respond during the short test?* ______
4. *Which bus or busses do these modules use for communication?* ______
5. *What are the pin numbers of the connectors at the TCU that supply power to the TCU?* ______

   Where does the power come from? ______
6. *What are the pin numbers of the M-ASK that provide K-Can communication?* ______
7. *If the M-ASK is not recognized during the short test would the OPPS tester be useful?* ______
8. *What fuse supplies power to the M-ASK ?* ______
9. *Is the fuse OK?* ______
10. *What is the voltage source of the fuse?* ______
    Print the ETM.
11. *Pin out all terminals of the MPM.*
12. *What should the scope pattern be on terminals 3 and 11?* ______
13. *Is communication possible with the MPM?* ______
14. *What information is available through Diagnosis Requests?* ______
15. *Is operation of the MPM possible through component activation?* ______

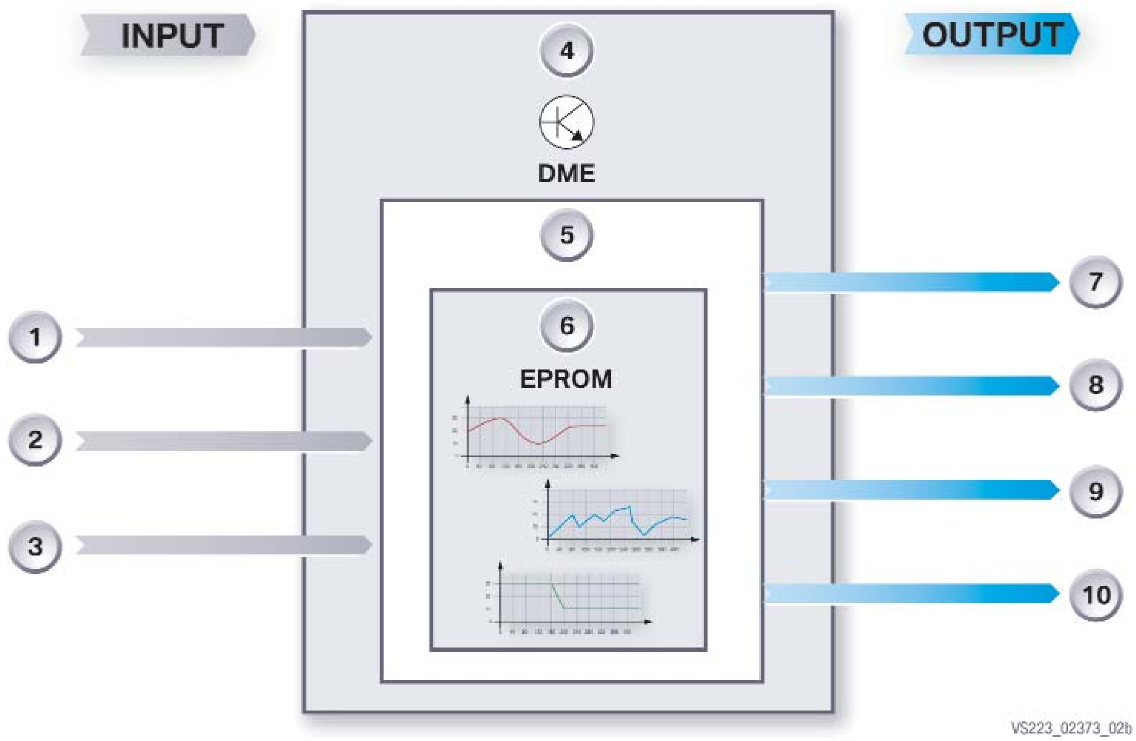
Alternator

Bosch and Valeo alternators are installed in the E60. The alternators are fitted depending on the type of engine and equipment configuration. They differ with regard to their rating of 140 A and 170 A and are aircooled.

Digital Motor Electronics

The power management software is contained in the DME. When the vehicle is at rest, the IBS is partially responsible for power management.
The tasks of the power management system include:

- Adaptation of the alternator charging voltage
- Idle speed boost for increasing the power output of the alternator
- Reduction of peak loads in the event of a shortfall in coverage provided by the vehicle electrical system
- Deactivation by means of bus messages of electric loads such telephone, on reaching the start capability limit of the vehicle
- Closed-circuit current diagnosis



1. Battery Voltage
2. Current Input
3. Temperature Input
4. DME
5. Power Management
6. EPROM with maps for Voltage,Current and Temp
7. Idle Speed control
8. Specified Alternator Charging Voltage
9. Deactivation of Electrical Loads
10. Peak Load Reduction

Variable Battery Charging Voltage

The variable battery charging voltage on system ensures improved charging management of the battery in unfavorable driving situations. The power management controls the temperature-dependent voltage for the charging voltage of the alternator via the BSD line.

Idle Speed Boost

The idle speed can be increased in situations where the battery does not cover power requirements. When the specified voltage alone is no longer sufficient, the DME boosts the idle speed corresponding to the engine status.

Reducing Peak Loads

The peak load of the vehicle electrical system is reduced when there is still a shortfall in battery coverage despite boosting idle speed.
Peak load reduction is realized by:
- Reducing power output, e.g. by correspondingly controlling the clock cycles of the rear window defogger
- If reducing the power output is not sufficient, individual electric loads can be switched off in extreme situations

Electric Load Cutout

The electric loads in the E60 are divided into the following categories:

- Comfort loads, e.g. window defogger, seat heating, steering wheel heating

Electric loads switch off automatically after engine "OFF." These electric loads can be activated again after the vehicle has been restarted.

- Legally required auxiliary electric loads, e.g. side lights, hazard warning lights

Legally required auxiliary loads must be operational for a certain period of time after engine "OFF." These legally required electric loads are not switched off even on reaching the start capability limit of the battery.

- Auxiliary electric loads, e.g. independent ventilation,communication components such as central information display, telephone, telematic services

Auxiliary loads can be switched on after engine "OFF." The comfort electric loads switch off automatically on reaching the start capability limit of the battery. Switch-off is requested by the DME in the form of a CAN message.

- System-related afterrunning loads, e.g. electric radiator fan

System-related afterrunning loads can maintain operation for a defined period of time.

Data Transfer to the IBS

The following data are transferred via the BSD to the IBS before the DME assumes sleep mode:

- State of charge of the battery SoC
- State of health of the battery SoH
- Outside temperature
- Available discharge level
- Terminal 15 wake-up enable
- Terminal 15 wake-up disable
- DME close

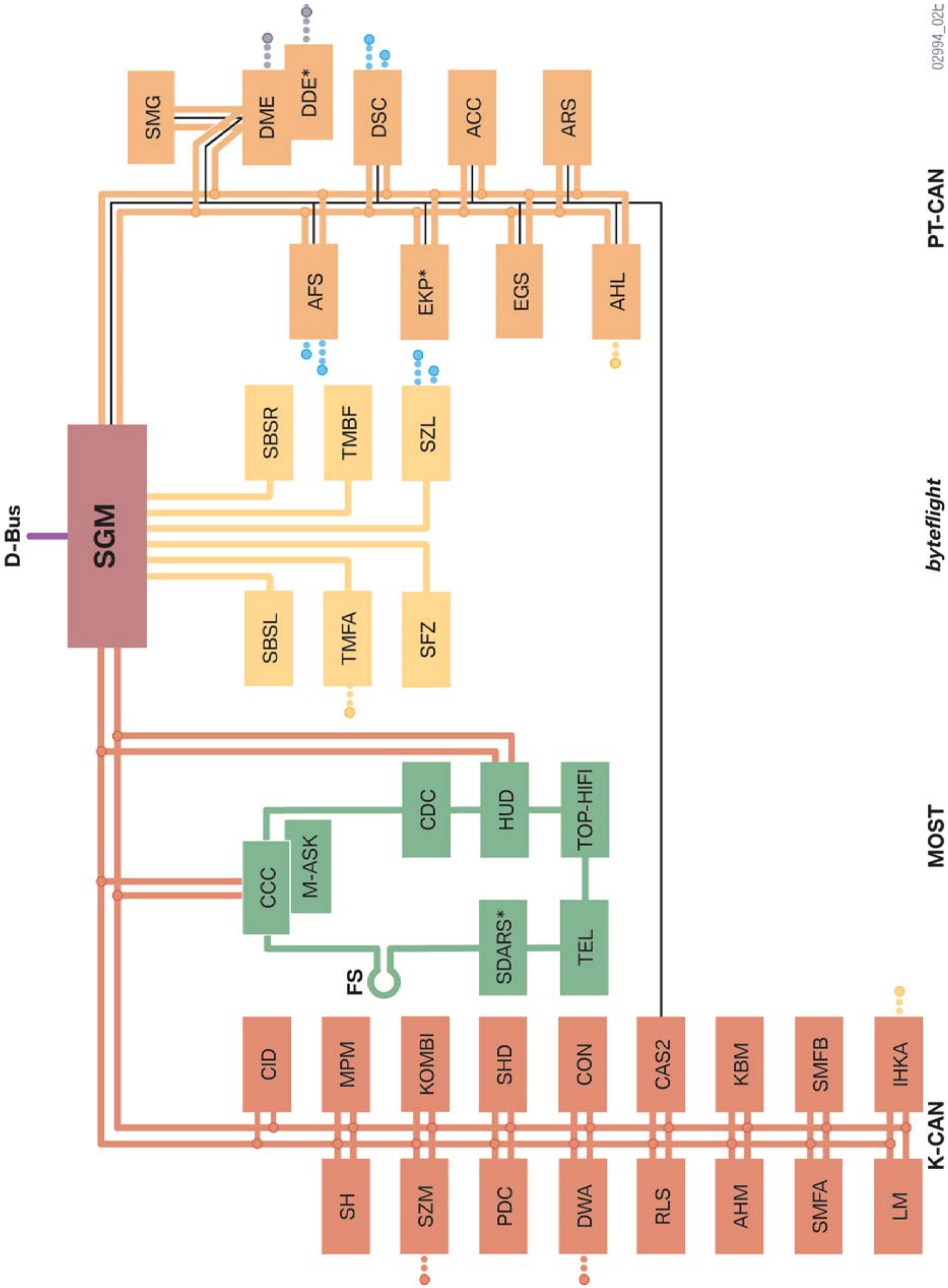
Closed-Circuit Current Diagnosis

A fault code is stored in the DME when the battery current exceeds a defined value during the vehicle rest phase. The vehicle should be analyzed accordingly.

Terminal 30g Relay

The terminal 30g relay is actuated by the CAS at an excessively high closed-circuit current or on reaching the start capability limit of the battery.

Notes


D-Bus
SGM
SMG
DME
DDE*
DSC
ACC
ARS
AFS
EKP*
EGS
AHL
SBSR
TMBF
SZL
SBSL
TMFA
SFZ
CDC
HUD
TOP-HIFI
CCC
M-ASK
SDARS*
TEL
FS
CID
MPM
KOMBI
SHD
CON
CAS2
KBM
SMFB
IHKA
SH
SZM
PDC
DWA
RLS
AHM
SMFA
LM
PT-CAN
byteflight
MOST
K-CAN
02994_02t

Bus Systems

K-CAN

K-CAN Changes
In the E60, the bus systems K-CAN-S and K-CAN-P of the E65 were combined to form the K-CAN.

The car access system CAS is no longer used as a repeater between K-CAN-S and K-CAN-P. CAS is now only a K-CAN user. The internal designation is CAS 2.

The instrument cluster and the central information display are now connected to K-CAN. They no longer serve as a gateway between K-CAN-S and MOST.

The door modules are no longer connected to K-CAN-P but rather to byteflight.

The controller CON is connected directly to K-CAN and no longer via the centre console switch centre SZM.

MOST

Most Changes
MOST has less users than on the E65. Components such as the instrument cluster and central information display CID are connected to other bus systems. The MOST additionally features the satellite radio (SDARS).

A large MOST system extending up to the luggage compartment is installed if the E60 is equipped with a telephone, or Top HiFi system.

byteflight

byteflight Changes
The SIM and ZGM functions have been combined in the SGM. The door modules adopt the functions of the front door satellites.

byteflight Comparison

byteflight E65	byteflight E60
Central Gateway Module ZGM	Safety and Gateway Module SGM
Safety and Information Module	Combined in SGM
Steering column switch cluster SZL	SZL
Center Satellite SFZ	SFZ
A-Pillar Satellite Left SASL	Not used
A-Pillar Satellite Right SASL	Not used
Front Door Satellite Left STVL	Driver’s Door Module TMFA
Front Door Satellite Right STVR	Passenger’s Door Module TMBF
B-Pillar Satellite left SBSL	SBSL
B-Pillar Satellite Right SBSR	SBSR
Driver’s Seat Satellite SSFA	Not used
Passenger’s Seat Satellite SSBF	Not used
Rear Seat Satellite SSH	Not used

PT-CAN

No changes

Bus system parameters

Bus System	Data Rate		Bus Structure
	kBd	MBd	
K-CAN	100		Linear/Two Wire
PT_CAN	500		Linear/Two Wire
byteflight		10	Star/Fiber Optic
MOST		22.5	Ring/Fiber Optic
D-Bus	10.5/115		Linear/Single Wire

Subbus Systems

LIN-Bus

The LIN-bus was developed to provide a standard network for the automobile industry. The LIN-bus is a standardized serial single-wire bus system. The LINbus facilitates fast and simple data transmission. The use of LIN-bus technology reduces the number of lines in the vehicle.

LIN-bus systems in E60

Main Controller	Server Unit
IHKA	Flap Motors and Blower Motor
Door Module	Driver's Switch Block SBFA
AHL	Stepper Motor Controller SMC

A typical LIN-bus system includes the following components:
- 1 Main Controller
- Several Server Units
- Single-wire line

The LIN-bus uses a bi-directional single-wire bus line as the transmission medium. The bus contains only one Main Controller while many server units are possible. The transfer rate on the LIN-bus can be up to 19.2 kBaud.

The following transfer rates are possible:

9.6 kBaud for IHKA 19.2 kBaud for other systems

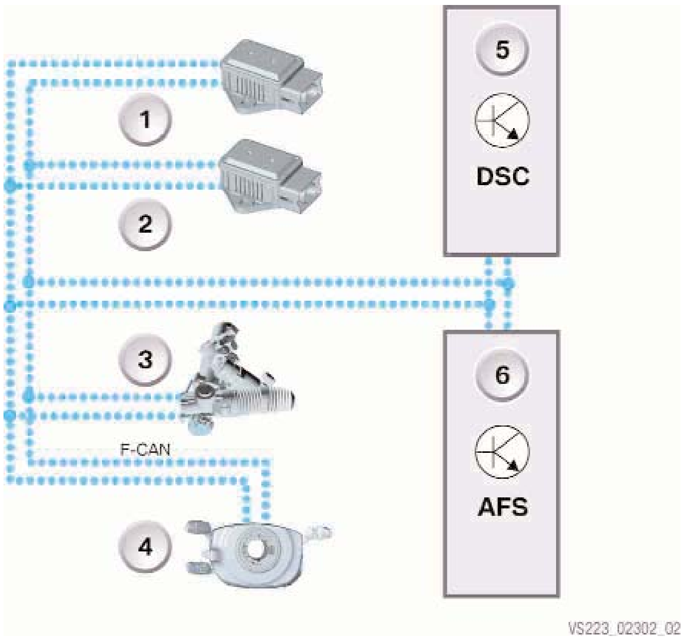
LIN-Bus Main Controller

The LIN-bus Main Controller transfers the control unit requests to the server units of the system. The LIN-bus Main Controller controls the message traffic on the bus line.

LIN-bus server units of the air conditioning systems include:
- Actuator motors for the air distribution flaps
- Blower controller

The LIN-bus server units wait for commands from the LIN-bus Main Controller and communicate with it only on request.

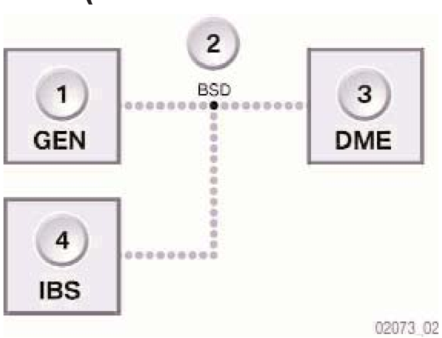
F-CAN



1. DSC Sensor 1
2. DSC Sensor 2
3. Active Steering Actuator
4. SZL
5. DSC
6. AFS

The F-CAN enables fast data transfer between the components, e.g.active steering.

BSD (Bit-Serial Data Interface)



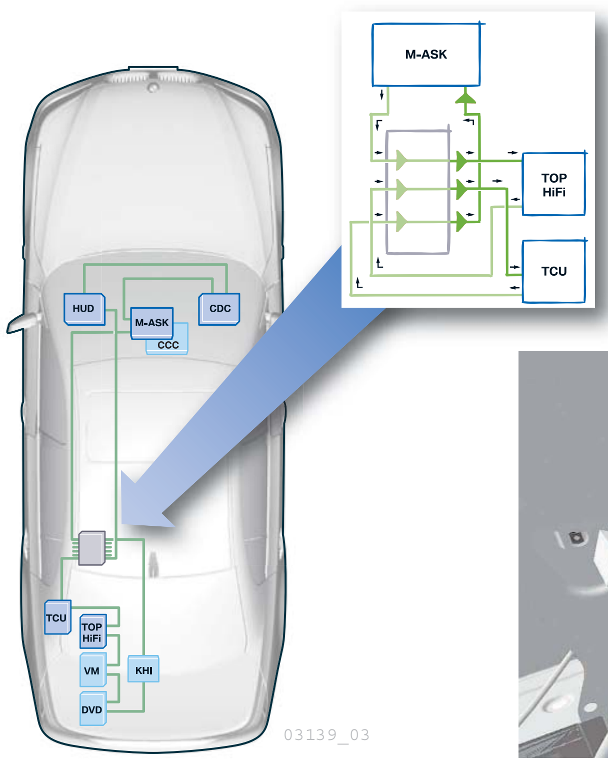
1. Alternator GEN
2. Bit-serial data interface BSD
3. DME
4. IBS

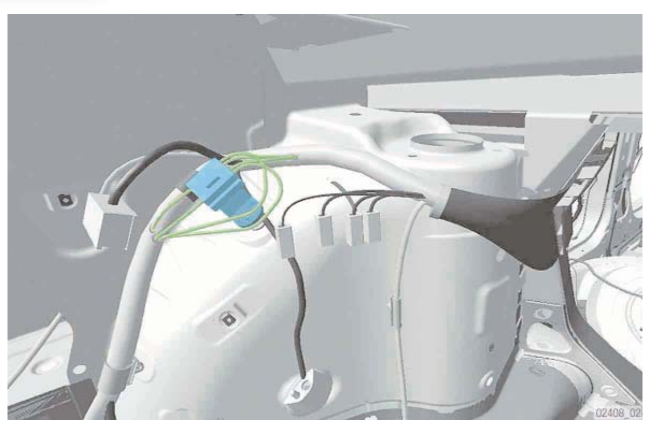
Sub-bus System Parameters

Sub-bus	Data Rate kBd	Bus Structure	Components
BSD	9.6	Linear/Single Wire	DME, IBS, Alternator
DWA-bus	9.6	Linear/Single Wire	UIS, DWA Siren w/Tilt Sensor
K-bus seat	9.6	Linear/Single Wire	Seat adjustment switch unit, Center Console switch unit
LIN bus A/C	9.6	Linear/Single Wire	IHKA,All A/C stepper motors blower motor, PTC
Lin-bus RDC	9.6	Linear/Single Wire	RDC, Wheel arch antennas
Lin-bus AHL	19.2	Linear/Single Wire	AHL Control Unit, Stepper Motor Controller
Lin-bus TMFA	19.2	Linear/Single Wire	Door Module, Driver’s Switch Block
F-CAN	100	Linear/Two Wire	AFS, ARS, Yaw rate sensors SZL,DSC, LWS

MOST Connector Junction

The MOST connector junction facilitates quick connection of new control units.





Workshop Exercise - Power Management/Bus System

1. *What are the power management tasks performed by the DME?*

2. *Under what conditions (concerning the electrical system) does the DME boost the idle?*

3. *How does the DME determine SoC?*

4. *What is the difference is between SoC/SoH?*

5. *How does the IBS detect starter operation?*

6. *Explain IBS wake-up disable.*

7. *List the components of a typical LIN-bus system.*

8. *Name the Bus or sub-bus systems that are two wire busses.*

9. *What is the purpose of the MOST connector junction?*

10. *What are some of the symptoms of a failed MOST Bus?*

11. *What modules are connected to the MOST Bus?*

12. *Which control module is the gateway from the K-Can to the MOST?* ____________

13. *How does a short test help in MOST Bus diagnosis?* ____________

14. *What test plans are available for MOST Bus diagnosis in the DISplus or GT1?*

15. *Where is the OPPS connection point located?* ____________
What is special about this access point? ____________

16. *How is the MOST Bus affected by a blown fuse to the:*

TCU ____________
CD Changer ____________
M-ASK ____________

17. *What is the order of light travel in the MOST Bus?* ____________

18. *Does the MOST Bus respond differently (if faulted) in the E-60 depending on vehicle equipment?*

Table of Contents

E60 General Vehicle Electrical Systems

Initial Print Date: 08/03 Revision Date: 10/03

Subject	Page

Model: E60

Production: Start of Production MY 2004

General Vehicle Electrical

Objectives:

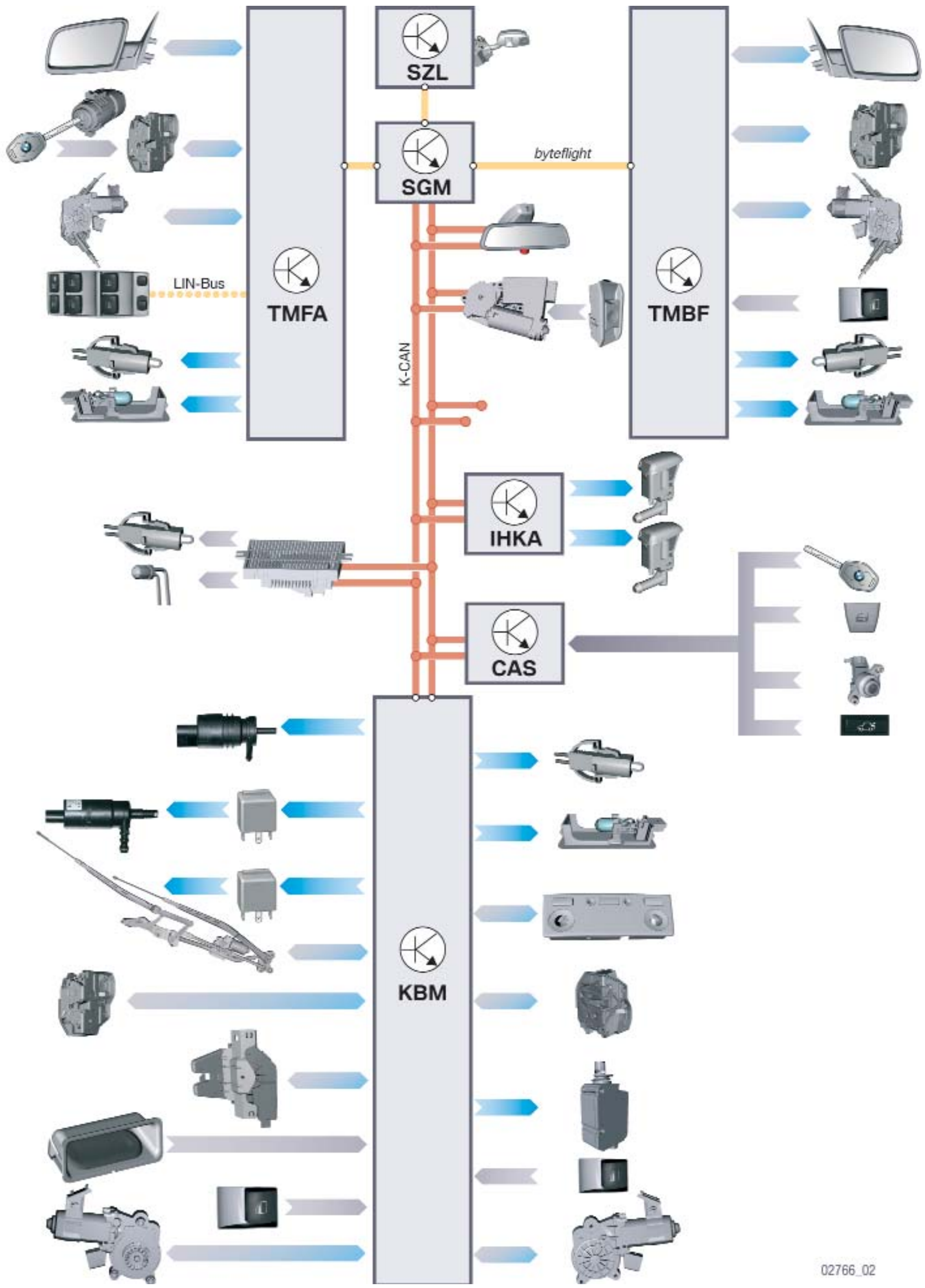
After completion of this module you will be able to:

- Locate electrical control modules in the car.
- Explain the operation of the electrical systems.
- Understand window standardization and initialization.
- Adjust wiper pressure.

General Vehicle Electrical Systems

Components and operation of the following electrical systems will be presented:

- KBM
- Central locking system
- Anti-theft alarm system
- Exterior lighting
- Interior lighting
- Power windows
- Wipe/wash system
- Park distance control
- AHL
- Roller sunblind
- Slide/tilt sunroof
- Car Access System
- Active cruise control



General Electrical New Features

KBM (Body Base Module)

The KBM controls the following functions:
- Rear Power Windows
- Central Locking (Rear Doors, Trunk/Tailgate and Fuel Filler Flap)
- Windshield Wiping/Wash System
- Interior Lighting
- Consumer Shutdown

Door Modules

The Door Module is integrated into the ASE. It communicates with other vehicle systems via the byteflight.
The Door Modules contain the following functions:
- Mirror Adjustment, Heating, Memory, Folding and Lighting
- Central Locking (Front Doors Only)
- Front Power Windows (with indirect anti-trapping)
- Connection to Driver's Door Switch Block
- Connection to Passenger's Door Power Window Switch)
- Door Entry Lights and Switch Illumination
- Recording of Front Door Pressure Sensor Information

CAS System

The Car Access System (CAS2) is based on the CAS of the E65, however in the E60 the ignitions starter switch and the CAS are two separate components. The E60 CAS is connected directly to the K-Bus and does not perform any repeater functions.

PDC

The signal from the PDC button is forwarded to the PDC Control Unit via the K-CAN.

RDW (FTM)

E60 uses RDW (FTM) for low tire warning. Information concerning low tire is based on wheel speed and is received from the DSC.

Roller Sunblind

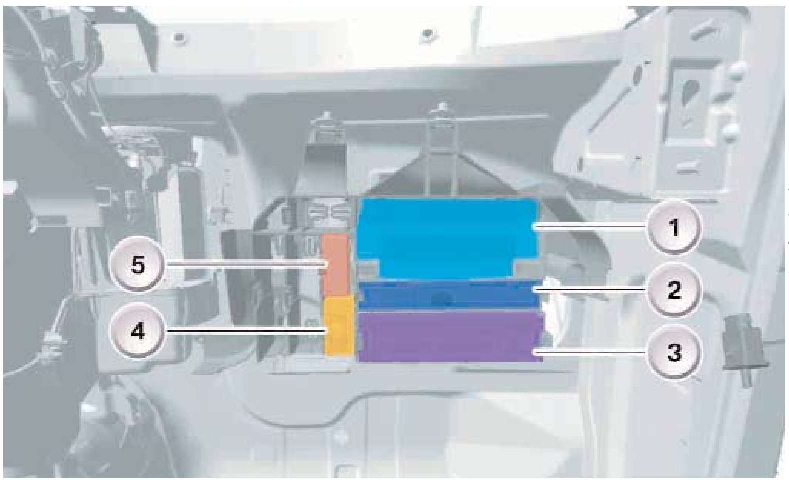
The rear window roller sunblind is controlled from the center console switch panel. The roller sunblinds for the side windows are manually operated.

Multifunction Seat

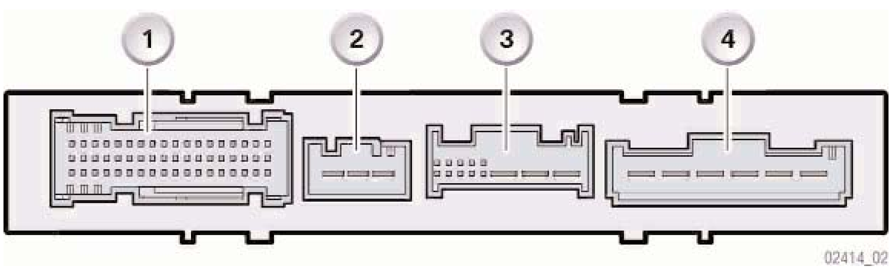
The multifunction seat makes it easier to get in and out of the vehicle. The backrest width and seat cushion depth are retracted for this purpose.

KBM

Located in the equipment frame at the glove box, the KBM has 4 electrical connectors



1. CDC (Compact Disc Changer)
2. KBM (Body Base Module)
3. SGM (Safety and Gateway Module)
4. AHL (Adaptive Headlights)
5. Not for USA.



1. X13252
2. X13254
3. X13253
4. X13255

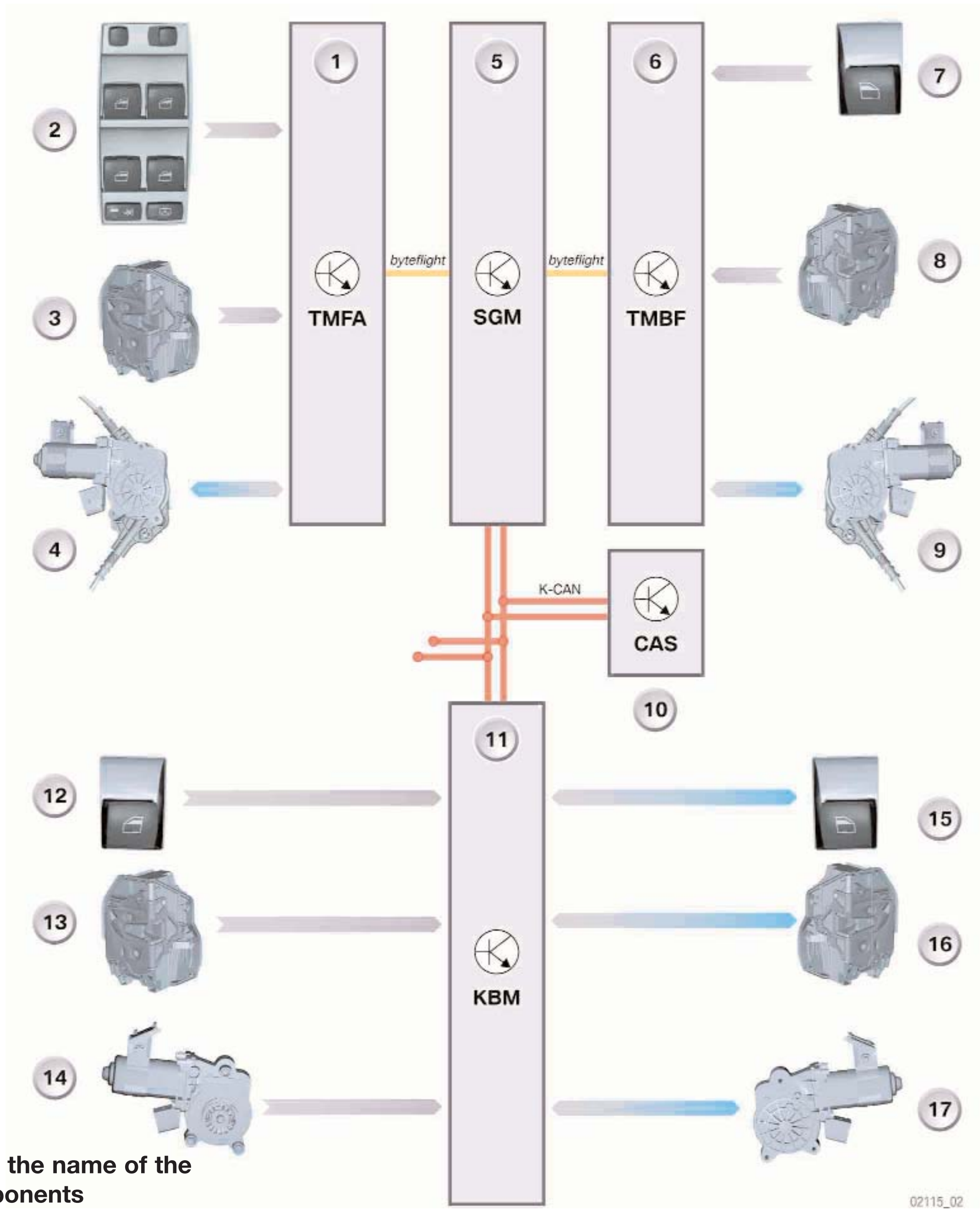
(X13252 54-pin, X13254 3-pin, X13253 13-pin, X13255 6-pin) and an operating voltage range of 9-16 Volts. The KBM is internally protected against shorts to terminal 30 or 31 and equipped with reverse polarity protection.

Power Windows

The front power windows are activated by the door modules of the respective door.

The rear power windows are activated by the basic body module KBM.

The power windows are operated as usual from the switch block in the driver's door (SBFA) and the switches in the other doors. Various safety functions and statutory requirements have been taken into consideration.

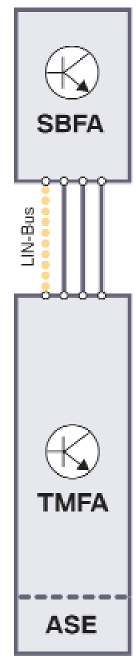


Fill in the name of the components

1.	**10.**
2.	**11.**
3.	**12.**
4.	**13.**
5.	**14.**
6.	**15.**
7.	**16.**
8.	**17.**
9.	

Components

- Switch block, SBFA
- LIN Bus
- Switches, passenger door, front/rear Doors
- Door modules, driver's door (TMFA)/passenger door (TMBF)
- ***byteflight***
- Safety and Gateway Module (SGM)
- Body controller area network (K-CAN)
- Basic body module (KBM)
- Power-window motors with incremental sensor
- Door contacts of all doors
- Car Access System (CAS)



Switch Block SBFA

All the windows may be operated from the SBFA. The Switch Block passes all window requests to the TMFA via the LIN Bus.

LIN Bus

The LIN Bus is a sub bus allowing communication between the TMFA and the SBFA.

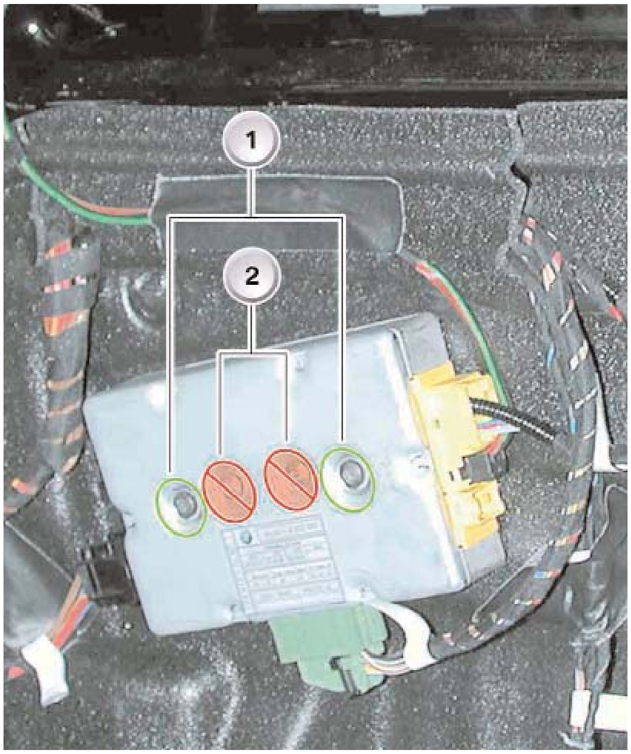
Door Modules

The door module contains separate "modules" for the door module electronics and the Advanced Safety Electronics.

The door module is the interface between:
- Switch block, driver's door
- Switch, passenger side
- Door contact
- Incremental sensor in power-window motor
- ***byteflight***
- Power-window motor

The driver's door switch block is linked to the driver's door module by means of an LIN bus. Control of mirror adjustment, heating and front area light is also integrated in the door modules.

The ASE system is integrated in the Door Modules. The door modules also incorporate the activation system for side air bag deployment.



Door side View of Door Module
1. Mounting Holes
2. Input Channel to pressure sensor
3. Connection for Switch Block
4. Connection for Power Supply
5. Connection for Input Signals
6. Connection for Exterior Mirror
7. Connection for ASE

Note:
When removing the door module, only unscrew the two outer screws(1). The inner screws(2) are exclusively for holding the door module housing together. Loosening the inner screws will cause operation of the door module to fail.

The door module is powered with 10 V from terminal 30. and with 10 V by the SGM. The 10 V supply is buffered for the function of the ASE system. When replacing the door module, bear in mind that the capacitor needs a few minutes to discharge. The airbag might be deployed if you replace the door module with the capacitor still charged.

byteflight

The ***byteflight*** bus system is involved in window operation as a method for door modules to communicate with the SGM.

SGM

The SGM converts and forwards messages to/from the byteflight and K-Can.

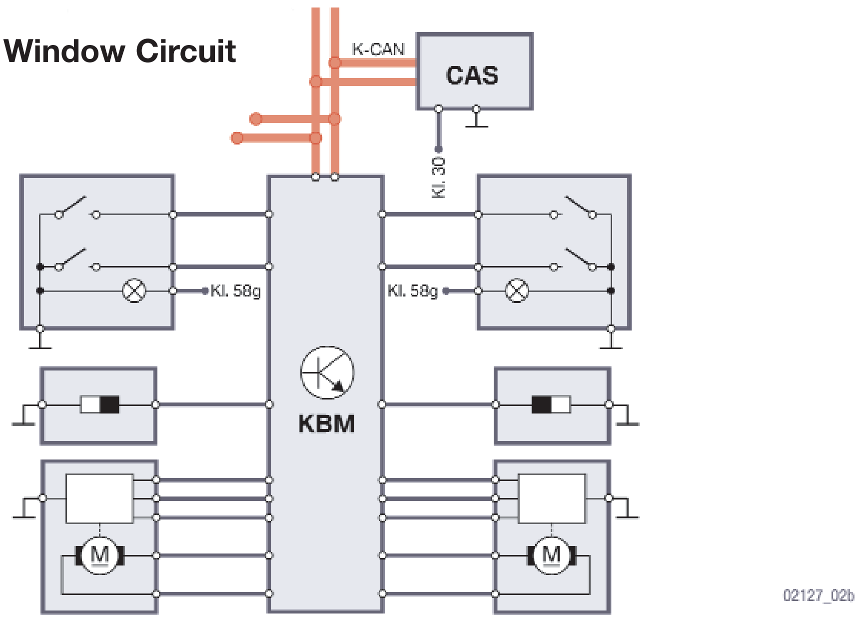
K-CAN

The K-CAN provides a communication path between the SGM, the CAS and the KBM as well as body modules.

KBM

The KBM receives input from the rear door window switches and the rear door contact switches and provides output to the rear window motors. The KBM also monitors the incremental sensor (hall sensors) in the rear window motors for position, speed and rotation.
Additionally the KBM allows also for contact and control of the rear windows through CAN communication with the SGM.
The KBM provides both power and ground to the rear window motors.

Rear Window Circuit



Power Window Motors

The drive mechanism of a power window lift is a cable lift mechanism consisting of:

- A DC motor
- A reduction gear with incremental sensor (Hall sensor)
- Evaluation Circuit
- A shrouded connection

1. Power window system, front
2. Power window system, rear

The drive mechanism incorporates two Hall sensors, which are addressed by a magnet wheel mounted on the armature shaft.
The two Hall sensors and the magnet wheel determine with the aid of the door module or the KBM the direction of rotation, the speed and the position of the window.

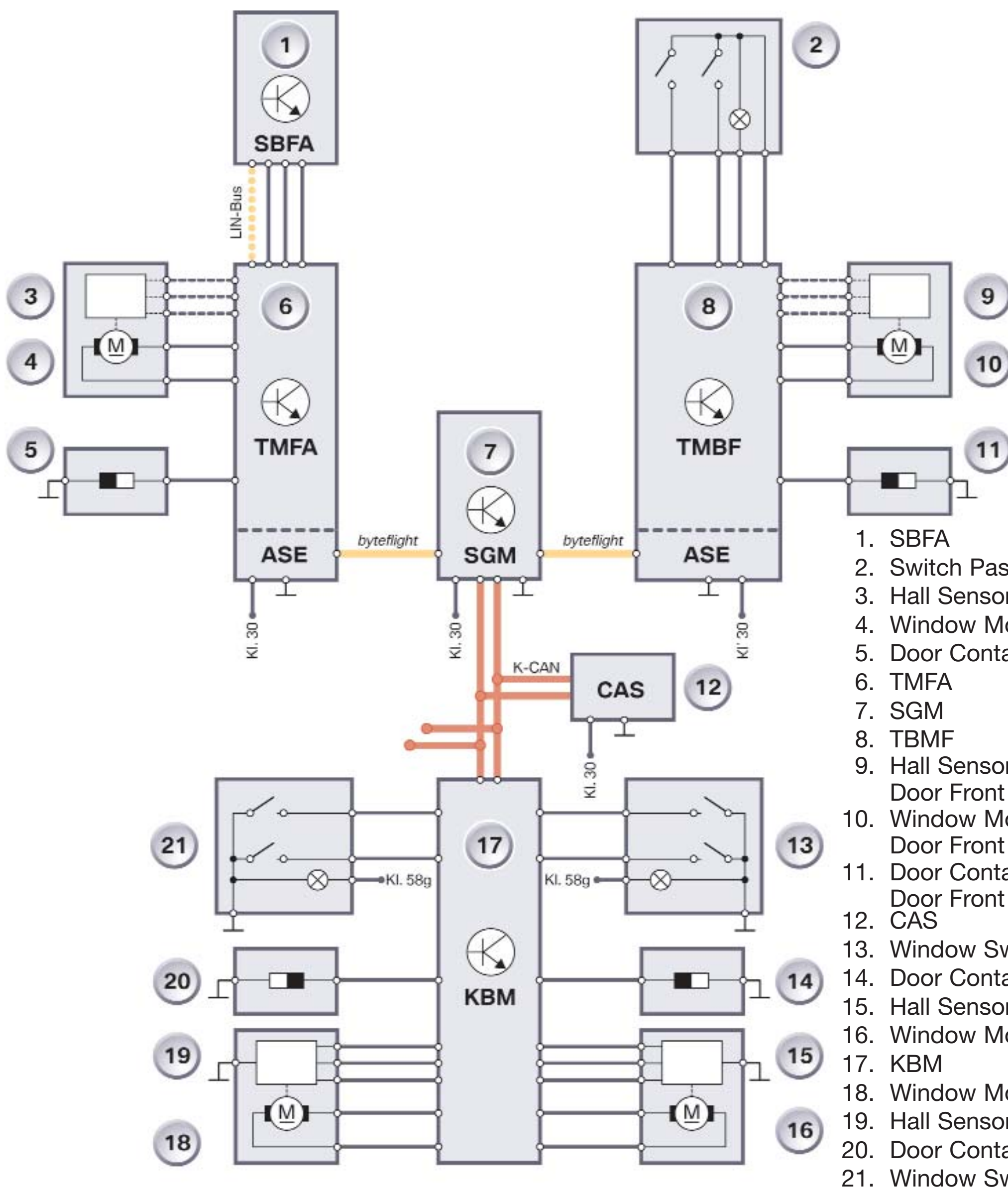
Door Contacts

The door contact switches, incorporated in the door latch mechanisms, provide door open/close data to the Door Modules/KBM.

CAS

The Car Access System control unit functions as the master for power window functions:

- Operation by radio remote control key
- Comfort functions (One-Touch)
- Central-locking interface
- Child lock
- Country-specific programming



1. SBFA
2. Switch Passenger Front
3. Hall Sensor Drivers Door
4. Window Motor Drivers Door
5. Door Contact Drivers Door
6. TMFA
7. SGM
8. TBMF
9. Hall Sensor Passenger Door Front
10. Window Motor Passenger Door Front
11. Door Contact Passenger Door Front
12. CAS
13. Window Switch R/R
14. Door Contact R/R
15. Hall Sensor R/R
16. Window Motor R/R
17. KBM
18. Window Motor L/R
19. Hall Sensor L/R
20. Door Contact L/R
21. Window Switch L/R

Operation

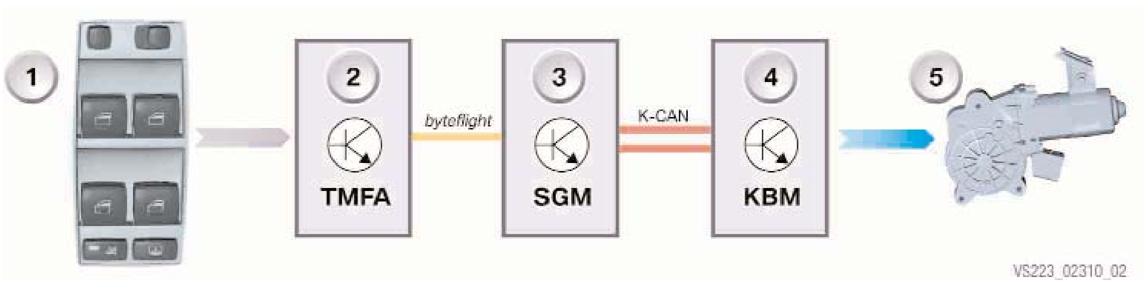
Opening of Passenger Front by Driver

The signal triggered in the SBFA when the button is pressed is sent via a LIN Bus to the TMFA. The TMFA sends the signal via the byteflight to the SGM.

The SGM converts the signal and sends it on the K-CAN to the CAS(the master for the front windows). The CAS evaluates the signal and sends a command to the SGM on the K-CAN. The SGM forward the command via the byteflight to the TMBF.

The TMBF receives the command for window movement, and a check signal from the Hall-sensor in the window motor and if necessary calculates indirect trapping protection. The window is then moved per the request.

Opening of Rear Window by Driver



Indirect Anti-Trapping

Anti-trapping protection is active over the entire window travel in the closing direction. Indirect anti-trapping protection does not eliminate trapping completely but rather restricts it to a maximum permissible trapping force.

For each subsequent closing operation, the currently required closing force is determined and compared with the stored value. If the difference between the two force values is over the specified trigger threshold, the direction of window movement is reversed immediately. The reversing procedure is country- and function-dependent (emergency mode).

In order to ensure safe closing of the window glass, the drive mechanisms are briefly operated to their full extent when the zero position is reached at the upper stop.

Power-window anti-trapping protection has been developed in accordance with legal requirements in order to reliably prevent injury to vehicle occupants. When an object is detected in the path of the window, window travel is stopped and the window rolled down slightly.
Anti-trapping protection is deactivated by the emergency close function (panic mode). The control sequence is divided into two phases.

Phase 1:
The closing position is overpressed until the emergency close mode is activated after a specific response time. The window is closed at maximum speed and with increased anti-trapping protection force. Anti-trapping protection remains activated even during emergency closing. If trapping is detected, the window is reversed only a short distance.

Phase 2:
The button is released and overpulled again in 4 s. The window is now closed without anti-trapping protection with full force. In the event of blocking, the power-window motor is supplied with power until thermal protection is engaged.
In the event of faulty anti-trapping protection, there is the option of emergency-closing the windows.
If fully operational anti-trapping protection cannot be detected, e.g. faulty sensors, automatic operation is not permitted.

Power Detection

The system adapts itself to changes in the weather and environmental influences. The closing force is recorded by indirect sensors (Hall sensors) and limited accordingly.

Initialization of Power Windows

Front Windows	Rear Windows
On Initial start-up, only the upper window stop has to be learned. For this purpose the window must be held for 500ms at the upper stop position. ***Move window to full closed position and hold for at least 500ms.***	The rear windows must be initialized. During the initialization the end positions of the window travel are determined by limit runs into the upper window seal and to the lower window stop. ***Move window to full closed position and hold for at least 500ms.*** ***Move window to lower window stop and hold for 17 seconds.*** ***Move window to full closed and continue to hold the switch in the window closing direction.*** ***The Window will open the close to confirm proper initialization.*** ***Note: This procedure is the same as E65.***

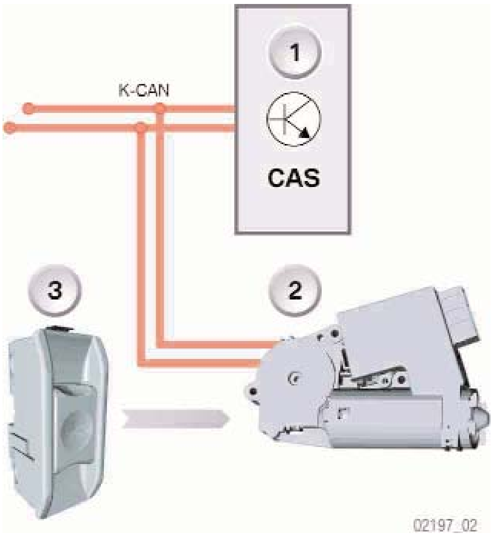
Learns upper limit | **Learns speed, amperage and direction**

Workshop Exercise - Power Windows

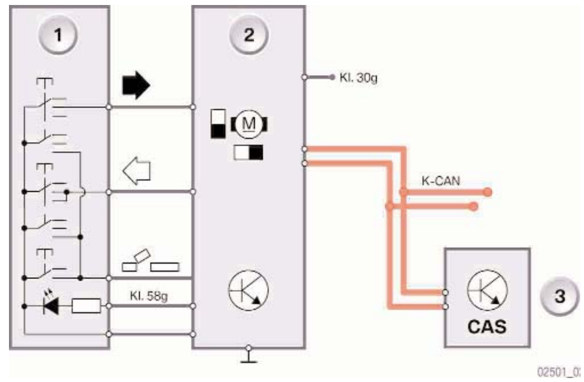
1. *Remove drivers side door panel.*
2. *Scope LIN Bus from switch assembly to door module.*
3. *What is the voltage range of the LIN Bus?* ______
4. *What happens when the LIN Bus is shorted to B+ or B-?* ______
5. *Perform Initialization on front windows.*
6. *Perform Initialization on rear windows.*
7. *Check the anti-trap feature on both the front and rear windows.*
8. *Is the anti-trap closing force approximately the same on both the front and rear?* ______
9. *Is the anti-trap closing force the same for the entire window travel?* ______
10. *Perform the anti-trap test again quickly after performing the test a first time.*
11. *Is the closing force the same as on the first test?* ______

Notes:

Slide/Tilt Sunroof



1. Car Access System (CAS)
2. Slide/tilt sunroof module with integrated electronics
3. Slide/tilt sunroof push-button



1. Slide/Tilt Sunroof Switch
2. Slide/tilt sunroof module with integrated electronics
3. CAS

Slide/Tilt Sunroof Push-Button

The push-button for the slide/tilt sunroof (SHD) switches to ground. The power supply of the push-button features polarity reversal protection and is disconnected from the power supply in the event of overvoltage and in sleep mode.

Slide/Tilt Sunroof Module

The SHD module controls and monitors the electric motor and therefore the movement of the slide/tilt sunroof. The commands the driver selects with the push-button are transferred directly to the slide/tilt sunroof module.
Communication with the vehicle is controlled via the K-CAN. The SHD module receives information relating to terminal 58g via the K-CAN from the light module. The SHD module controls the LEDs of the SHD push-button. Terminal 58g has a clock cycle of 200 Hz for the purpose of dimming the lighting.

Car Access System

The CAS contains the master function for auto-remote opening.

Functions

Panic Mode

Panic Mode is triggered by pressing and holding the SHD button in the 2nd notch position. With this function, the sunroof is closed without anti-trap or closing force limitation protection. Panic close is possible only at speeds under 16 km/h.

Emergency Operation

In Emergency Mode, the sunroof only moves for 750ms at a time. The emergency function is only available when the CAS has signaled the SHD control module, “Emergency Mode Enable”, via the K-CAN.
Emergency operation is active under the following conditions:

- Coding Invalid
- Defective Hall-sensor
- Initialization incomplete

If initialization is incomplete operation is permitted based on scaling or characteristic curves.
With no scaling, movement is allowed only in the direction of the scaling position.
With no characteristic curve learned, movement is only is the closing direction.

Initialization

Initialization of the Sunroof is performed as follows:

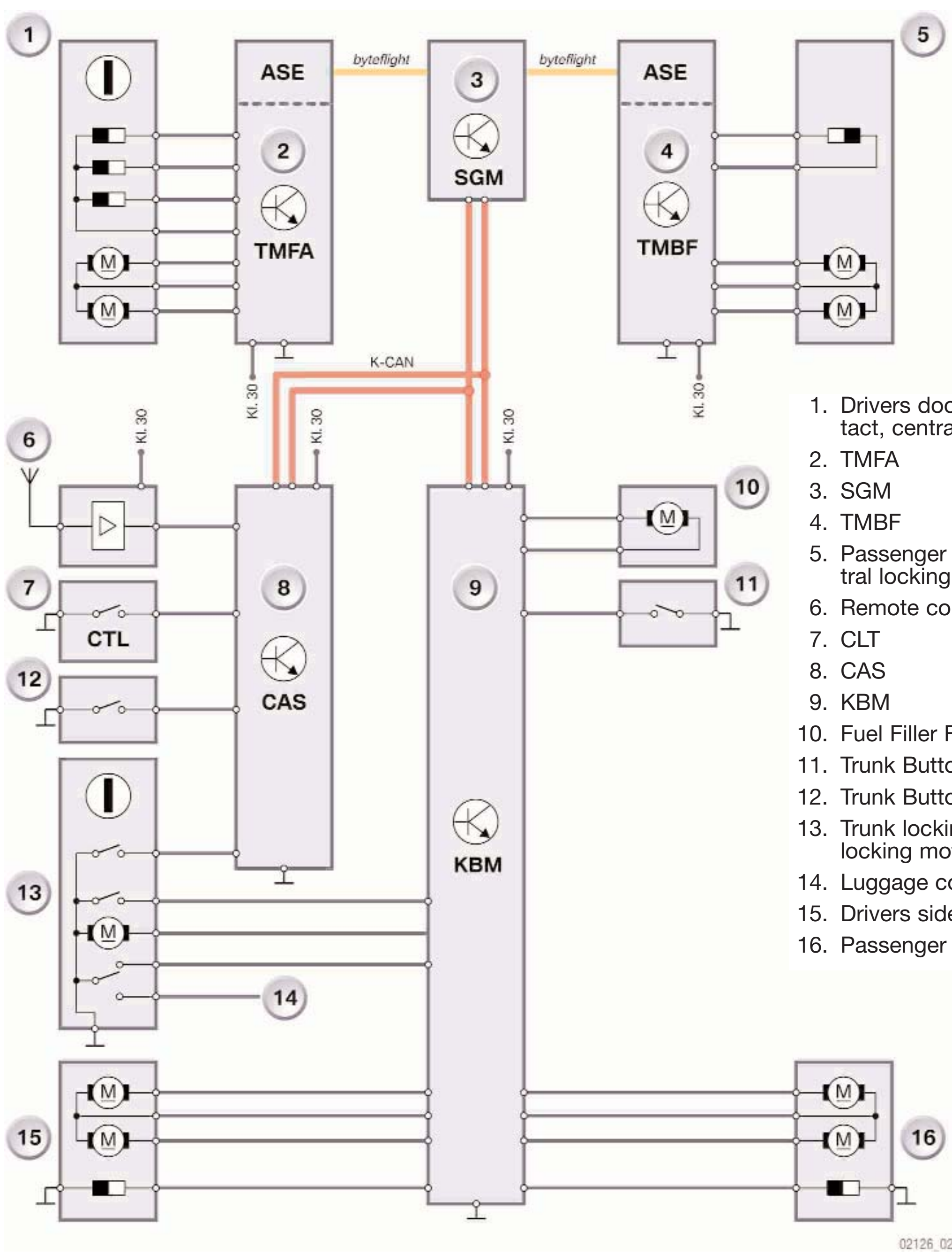
- Press the operating switch to the “Lift” position and hold.
- After 15 seconds, the sunroof will “Lift”. Continue to hold the switch.
- After approximately 5 seconds the sunroof will close. Continue to hold the switch.
- The sunroof will then open completely and close completely.
- If the switch is released at any time during the procedure the operation must be repeated.

Note:

Anti-trapping protection does not function during the initialization process.

Central Locking System

The central locking system ZV involves the actuation/evaluation of the doors, trunk and fuel filler flap. The central locking facilities of the doors are equipped with double lock functions and operate in accordance with the two-motor principle.
The door modules control the central locking facilities of the front doors. The basic body module controls the central locking in the rear area.



1. Drivers door lock cylinder, contact, central locking motors
2. TMFA
3. SGM
4. TMBF
5. Passenger door contact, central locking motors
6. Remote control
7. CLT
8. CAS
9. KBM
10. Fuel Filler Flap
11. Trunk Button, Exterior
12. Trunk Button, Interior
13. Trunk locking cylinder, central locking motor
14. Luggage compartment lighting
15. Drivers side, rear door
16. Passenger side, rear door

The central locking system consists of the following control points:
- Driver's door lock cylinder
- Center-lock button
- Remote control key
- Trunk lock cylinder

The system can be additionally unlocked via the crash sensor and forced release is possible by means of the "key inserted" signal in the CAS. A function is triggered when a status change at the respective input is detected. If several new ZV commands are given while a command is being carried out, only the last command will be subsequently executed.
The CAS is the central locking master and is responsible for enabling all central locking procedures in the vehicle.

The central locking can assume following statuses:

Status	Explanation
Unlocked	All locks are in the unlocked position. Outer and inner door handles are operational.
Selective Unlocked	The driver’s door is unlocked. All other locks are in the lock position.
Locked	All locks are in the lock position. Outer door handle not operational, inner door handle operational.
Secured	All locks are in the lock position. Outer and inner door handles are not operational.
Opened	At least one lock is in the unlocked position.

Secure Lock (Double Lock)

The secure lock function (locking of the vehicle from the outside using either the remote or the drivers door lock cylinder) uses a mechanical coupling to uncouple the locking pin of the door from the lock. The vehicle can then no longer be opened by the following actions:
- Pulling the locking buttons
- Pulling the inner door handle
- Pulling the outer door handle
- Pressing the center-lock button

Secure lock is only possible:
- At terminal R off and key not inserted
- After opening and closing the driver's door or Opening the passenger's door

No action takes place following the secure lock request when the driver's door is open.
A secure locked (secured) vehicle cannot be unlocked via diagnosis functions.
A secure locked (secured) vehicle can be changed to “Lock status” by pressing the center console lock button (CLT).

The vehicle lock status is changed from secure to unlocked when the CAS recognizes a valid transponder key has been inserted.

Automatic Locking

If the system is not yet locked or if a door was opened with the ZV locked, a lock command is executed on exceeding a speed of 16 km/h.

Crash Unlock

In the event of a crash, the safety and gateway module (SGM) releases the central locking system (ZV) via the bus network at terminal R or 15.
The ZV assumes "crash mode" even when the central locking was already unlocked.
Crash unlock is disabled when the vehicle status is secure lock.
Crash mode is released when an unlock/lock request is made. This corresponds to deactivation of crash mode.

Power on Status

The central locking status does not change by disconnecting and reconnecting the supply voltage. There is no reaction if command inputs are active while reconnecting the supply voltage (reset).

DWA - Central Lock Interface

The anti-theft alarm system DWA is not an integral part of the central locking system, however, it requires commands and signals from this system. The central locking system (ZV) monitors the status of the doors, hood,trunk, fuel filler flap and terminals. The DWA monitors the tilt alarm sensor NG as well as the ultrasonic interior protection system USIS.
The DWA is armed by means of any valid ZS command from an authorized control point or via the remote control. An LED provides an optical signal of the DWA status.
The tilt alarm sensor and interior protection are switched off if a ZS command is initiated within 3 s after initially arming the DWA.
The luggage compartment is accessible without triggering alarm even when the DWA is armed via the remote control. An alarm is triggered if the lock cylinder on the trunk is operated mechanically with the DWA armed.

Remote Control FBD

Evaluation of the logic remote control (FBD) signals is integrated in the CAS control unit. In addition to various other functions, the central locking functions that can be coded in the key memory can be selected "personalized" in the CAS control unit.
It is possible to actuate the central locking by means of a second remote control with the key inserted.

Different personalized functions can be selected depending on the type of remote control key used. The functions "selective ZV", "lock as from 16 km/h" as well as "lock after 2 min" can be coded in the CAS.
The remote control number identifies the key on which the "unlock" button was last pressed. Irrespective of this function, the currently used key is always identified as the control point in connection with the "unlock trunk" function.

Trunk Locking

The trunk can be unlocked and opened via:
- Radio remote control FBD
- External trunk button on boot lid handle
- Internal trunk button in driver's footwell
- Lock cylinder on trunk; purely mechanical

Hotel Setting

The hotel setting is initiated via the lock cylinder of the trunk. The following control points are deactivated when the hotel setting is initiated:
- Trunk button via remote control
- Exterior trunk button
- Interior trunk button

The trunk remains locked even when the vehicle is unlocked. The hotel setting is indicated to the customer by means of the switch position.
The push-button on the trunk is therefore only active when the vehicle is unlocked and stationary and not when the hotel setting is initiated.
The interior button is additionally active even when the vehicle is locked but only up to the specified speed threshold.
The system can always be unlocked via the remote control with the ignition key removed without the hotel setting engaged.

Automatic Relock

The central locking unlocks (selective or global, corresponding to coding) when a release command is triggered inadvertently via the remote control. If no door or hood/trunk is opened within 2 min, the central locking reassumes the locked status in connection with the coding "automatic relock."

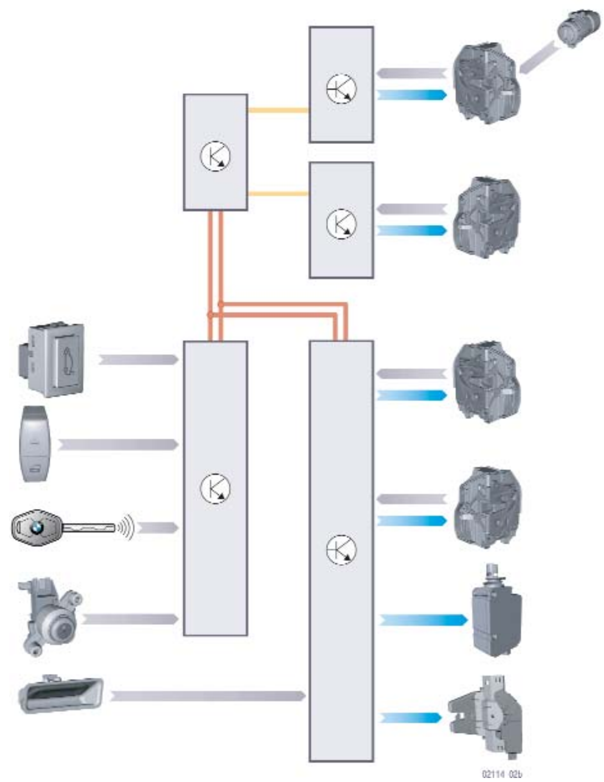
Car & Key Memory

The central individualization elements are the coding data of the vehicle. Certain codeable functions are enabled for the car memory as part of the individualization procedure.
In connection with the personalization, individual functions depending on the vehicle key, maximum 4, used to unlock the system, are also controlled for the central locking. Otherwise the central locking operates in accordance with the coded basic setting.

The central locking functions therefore depend on the personalization of the 4 vehicle keys and on the standard coding for the vehicle.

Codeable Key Memory Functions:

Coding	Description
Automatic relock	Relock after 2 min
Speed Lock	Lock from 16 km/h
Selective unlock	Only the drivers door is unlocked



Codeable Car Memory Functions:

Coding	Description
Terminal R prohibits Trunk operation	The trunk is not opened when terminal R is engaged
Unlock on removing Key	The vehicle unlocks after the key is removed IF the system was locked via the speed lock or terminal R Lock.
Cross over operation disabled	A vehicle locked via the remote can not be unlocked with the key.

Wipe/Wash System

The wipe/wash system is a conventional wipe/wash system with reset contact. All wipe/wash functions can be activated with the wiper switch once terminal R is on. The wipe/wash functions are controlled as a function of vehicle speed.

The rain and light sensor is fitted as standard.

To reduce noise and wear, the load circuit of the wiper motor has been designed as an external double relay. A power semiconductor is integrated in the body base module (KBM) for the washer fluid pump.

Headlight Cleaning System (SRA)

The headlight wipe/wash function is controlled by the KBM.

Rain and Light Sensor

If the rain and light sensor should fail or be faulty, the KBM will take control. The KBM will switch to an emergency mode. Emergency mode is a speed-dependent intermittent mode.

Safety and Gateway Module

The SGM switches the wiper switch signal from the byteflight to the K-CAN.

Body Base Module

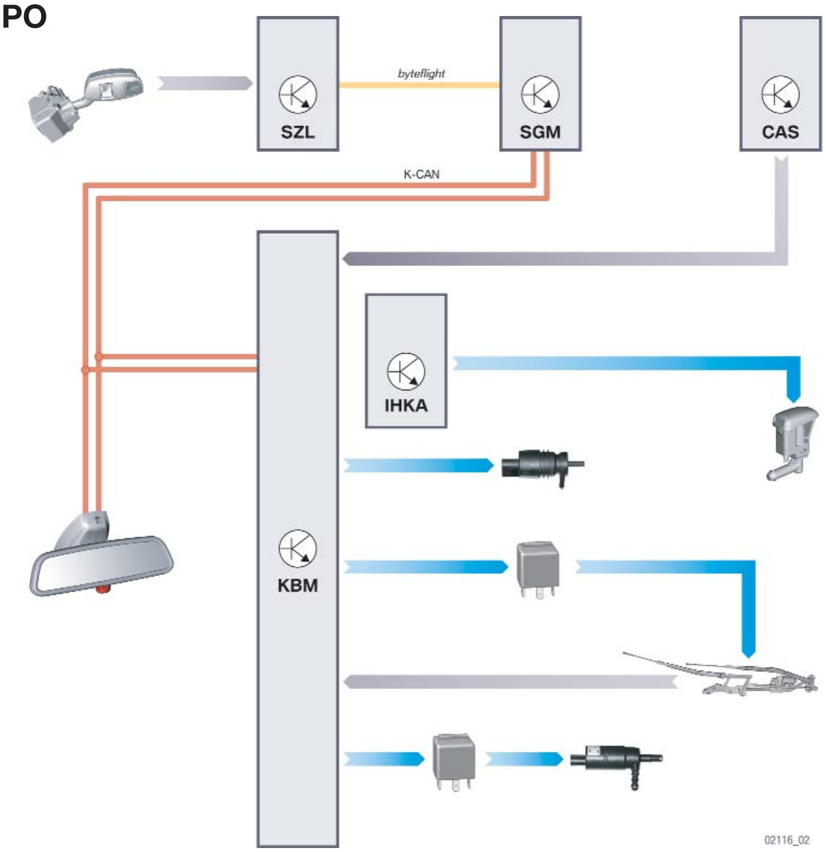
The body base module receives all the information that is required for operation of the wipe/wash system.
The body base module activates the following components:

- Dual relay module for the wiper motor
- Relay for the headlight cleaning system
- Washer fluid pump

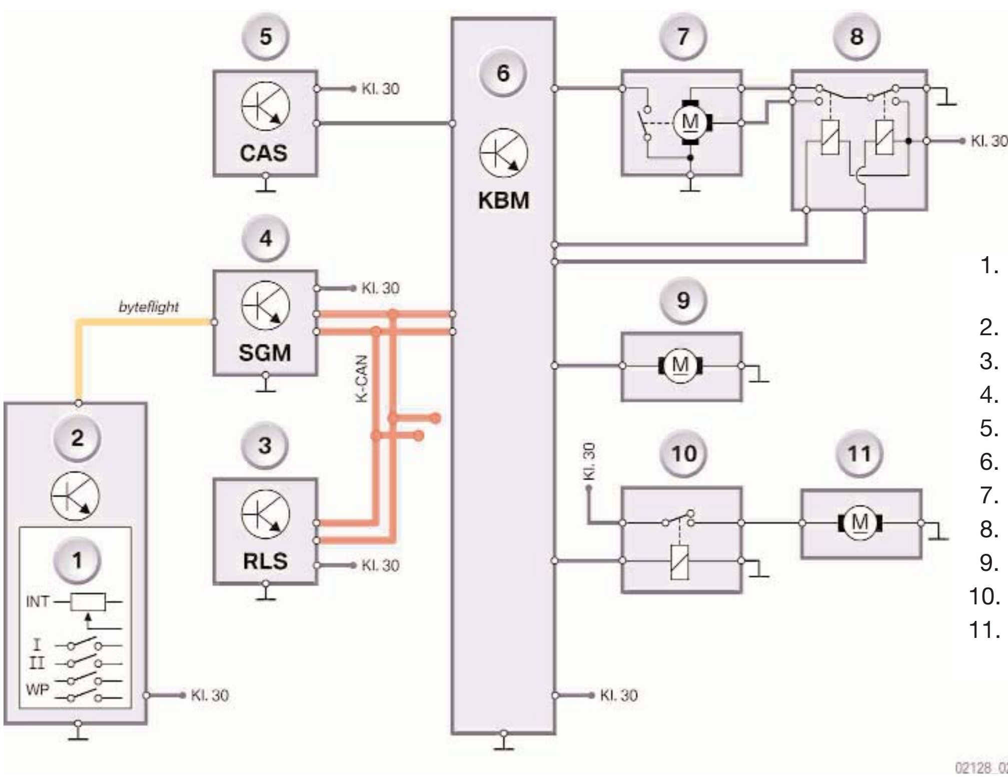
Washer Nozzle Heating

The IHKA activates the heated jets.

Wiper IPO



Wiper Schematic



1. SteeringColumn Switch
2. SZL
3. RLS
4. SGM
5. CAS
6. KBM
7. Wiper Motor
8. Wipe/Wash Relay
9. Washer Fluid Pump
10. SRA Relay
11. SRA Pump

Workshop Exercise - Wipers

1. *Find and print the Repair Instructions for windshield wiper adjustment.*

2. *List the special tools required to perform the adjustment.*

3. *Adjust the wiper arms per the instructions.*

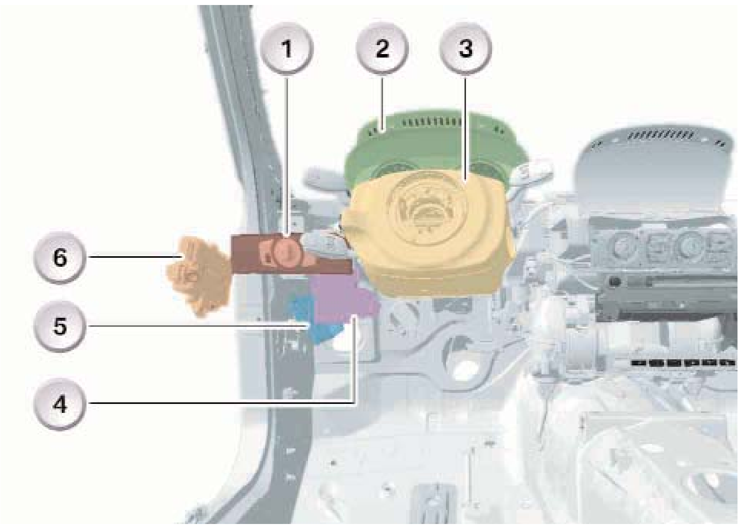
4. *Observe new style wiper blades.*

Notes:

Car Access System

The CAS of the E60 is based on the CAS of the E65. The internal designation is CAS 2. The following changes have been made compared with the CAS of the E65:

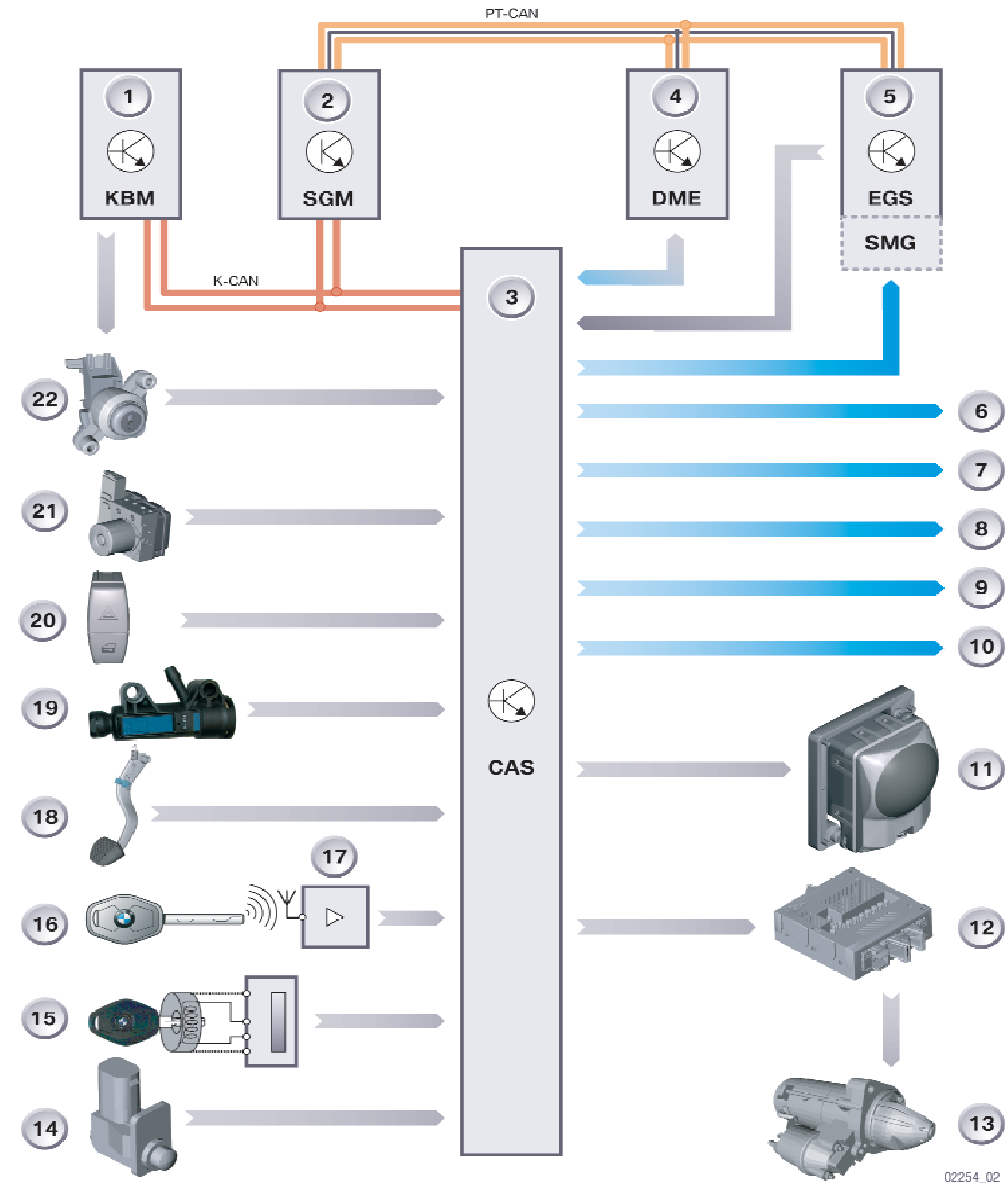
- Direct connection to the K-CAN
- Repeater function has been omitted
- Ignition starter switch and the CAS are 2 separate components
- Data transfer as part of the Condition Based Service



1. Light Switch with Control Panel
2. Instrument Cluster
3. SZL
4. CAS
5. Light Module
6. TMFA

The CAS includes the following functions:

- Reading in ignition starter switch (ZAS)
- Transponder authentication
- Terminal control
- Electronic immobilizer
  enable to injection system
- Master function for central locking system (ZV)
- Master function for power windows (FH) and slide/tilt sunroof (SHD)
- Remote control services (FBD)
- Internal CAS functions
  - Wake-up signals
  - Sleep signals
- Vehicle functions
  - Personalization
  - Auto encoding of vehicle model/transmitter
  - Vehicle order
  - Total distance recorder
  - Condition Based Service CBS
  - Voltage supply, brake-light switch



1. KBM
2. SGM
3. CAS
4. DME
5. EGS/SMG
6. Output EWS
7. Output Terminal R
8. Output Terminal 15 Wake up
9. Output Terminal 15-1 to 15-3
10. Output Terminal 30g Relay
11. ACC Wake up line 15WUP_RS
12. Integrated Power Supply Module
13. Starter
14. Hood Contact
15. Ignition/Starter Switch
16. Remote
17. Radio Receiver
18. Brake Light Switch
19. Clutch Switch Module
20. Centerlock Button
21. DSC
22. Trunk Lock Cylinder

Workshop Exercise - CAS

Vehicle is brought into the shop with a complaint of no start.

1. *Verify the complaint.*

2. *Does the engine crank?* ______________________________

3. *Is the key recognized?* ______________________________
   What is the quickest way to confirm that the key has been recognized? __________
   Where could you find that information in the DISplus or GT1? __________

4. *Are there any relevant fault codes stored?* ______________________________

5. *What pin at the CAS provides the EWS release to the DME?* __________
   Check this signal at the DME.

6. *Continue to Diagnose this problem.*

7. *Repair the fault.*

8. *What pin at the CAS provides the KL50E signal to the DME?* __________

9. *What kind of signal is this? (High/low, PWM, Analog...)* __________

10. *What pin of the CAS controls the 30g Relay?* ______________________________
    Is this B+ or B- control of the relay? ______________________________

11. *What pin of the CAS provides power to the brake light switch?* __________

12. *What pin of the CAS provides power to the OC3 Mat?* __________

Condition Based Service

The data for Condition Based Service (CBS) is updated during each journey. The fault memory data is also updated during each journey. The conditions for this are:

- Activation of terminal 15, speed exceeded 50 km/h and speed dropped below 30km/h
- The data is updated after a distance of 10 km has been covered and after speed has dropped below 30 km/h

Manual Update of CBS Data

The procedure for transferring current data to the key during servicing is as follows:

- Insert key in ignition and turn to position "R"
- Press and hold Centerlock button
- After 15 s the CBS data will have been transferred to the key
- Read out the key

Manual Update of Fault Memory Data

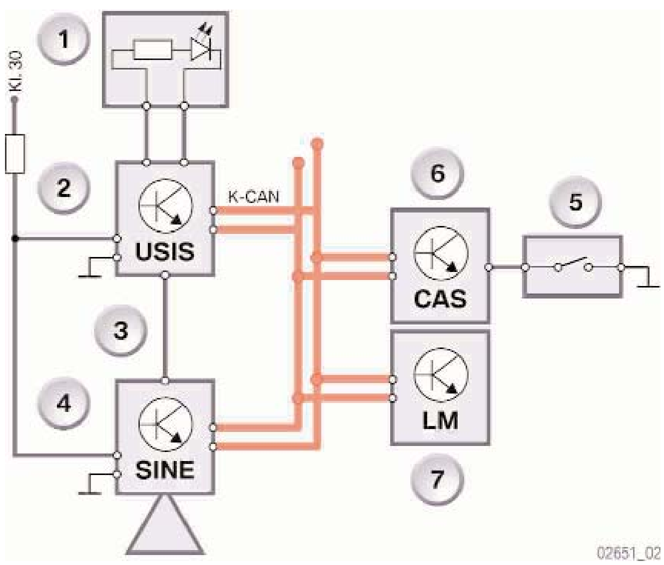
- Press and hold Centerlock button
- Insert key in ignition
- Turn key from position "0" to position "R"
- After 15 s, the fault memory data will have been transferred to the key
- Read out the key

Notes:

Antitheft Alarm System

The alarm system detects and warns of any attempts to break in or tamper with the vehicle.

The DWA comprises the following components:
- Interior sensor with integrated DWA logic
- Emergency siren with integrated tilt sensor
- DWA LED
- Door, Trunk and Hood Switches (fed via K-CAN)
- Car Access System (CAS)
- Light module (LM)
- K-CAN
- Local DWA bus line leading to emergency siren.



1. DWA LED
2. Interior Motion Sensor (USIS)
3. DWA Bus
4. Siren with integrated Tilt Sensor
5. Hood Contact
6. CAS
7. Light Module

System Functions

The following are monitored:
- Doors
- Hood
- Trunk
- Vehicle interior
- Vehicle inclination
- DWA bus line to the emergency siren
- Voltage supply for vehicle electrical system
- Voltage level at the emergency siren

To prevent false alarms, the sensitivity of the DWA can be adapted. For this purpose, the following vehicle conditions are evaluated:
- Status of auxiliary ventilation
- Position of power windows
- Position of slide/tilt sunroof

The alarm system sends the following status messages:
- System status via the DWA LED in the passenger compartment
- Visual arm/disarm via hazard warning lights
- Audible arm/disarm via an acknowledgement signal from the emergency sirenElectrical/

The alarm system outputs the following alarms:
- Audible alarm via emergency siren
- Visual alarm via hazard warning lights, dipped headlights, main beam headlights

Independent Voltage Supply

Thanks to the independent voltage supply, the emergency siren can issue an alarm even when the vehicle voltage supply is disconnected. The independent voltage supply is provided by Li cells. The Li cells are not rechargeable. The status of the batteries can be read out via the diagnostics system.

System Operation

Monitoring of the Vehicle Battery
The emergency siren detects:
- A drop in voltage from the vehicle battery due to a break in the wiring
- A voltage > 17 V
- A voltage drop from a value of 7.5 V to 6.5 V in less than 40 mins

The emergency siren monitors the B+, GND and DWA bus connection leads. If these leads are cut through, the independent alarm will be issued immediately.

In accordance with ECE regulations, the emergency siren will not issue an alarm if, as a result of the vehicle being immobile for a long time, the battery is being continually discharged and the vehicle electrical system voltage drops by 0.5 V/h to 3 V in the process.

System Power-Down for Storage
If the emergency siren is disarmed and without an external power supply, the batteries switch to a low power status. Current consumption is then a maximum of 25 µA.
The electronics return the emergency siren to its normal operating status when the vehicle battery is reconnected.

Reverse Polarity Detection

The reverse polarity detection system detects reverse polarity in the event of the vehicle being jump-started and stores this in its information memory.

Tilt Sensor

The tilt sensor monitors the position of the vehicle. It detects and warns of any attempt to steal the tires and wheels or to tow the vehicle away.
The tilt sensor is integrated in the emergency siren. The tilt sensor is triggered and evaluated by the microprocessor used in the emergency siren. The tilt sensor has diagnostic capability.

DWA LED

As before, the DWA LED is activated directly by the DWA (positive switching).

DWA Bus

The DWA bus is a local sub bus with K bus specification. The DWA communicates with the emergency siren and the tilt sensor via the DWA bus.

DWA Arming Sequence

Immediately after arming the emergency siren is armed and monitors its voltage supply. The DWA commences line monitoring on the local DWA bus.

3 s after arming each of the door and tailgate contacts to be monitored is included in the alarm table. Faulty contacts are evaluated as closed, but are not included in the alarm table. The tyre pressure monitoring system is included in the alarm table.

3 s after centrally locking the vehicle or after locking the last door or tailgate the referencing phase of the tilt sensor commences. During this period, the ultrasonic sensors are verified for signal plausibility. The sensitivity level is set in accordance with the window and slide/tilt sunroof positions.

30 s after locking the last door or tailgate the tilt sensor is included in the alarm table upon expiration of its referencing period.

If no acknowledgement message is received from the tilt sensor within 60 s of arming, this sensor is deleted. If at least one input signal is not in idle state or if a sensor is defective, this is signalled by the flashing LED.
If the emergency siren does not acknowledge the "arm" command, this is also indicated by the LED.

CAS Authentication to Prevent Tampering

To prevent the DWA from being easily disarmed by the central locking and tailgate status message "Central locking control" using a CAN tool, the CAS authenticates itself with the DWA.

Each time an unlocked vehicle is locked for the first time, the CAS sends an authentication to the DWA. Any further "locking" signals are then no longer accepted.

When the system is disarmed, the DWA expects the CAS to again send authentication with the first locking operation.

The system permits two disarming attempts with the wrong authentication, after which an alarm is issued.

Forced Disarming

The DWA is forcibly disarmed if a person located in the vehicle centrally locks the vehicle and then inserts the key into the ignition. The CAS evaluates this action and transmits a "locked" message. The DWA is thus disarmed.

Deletion of Cross-Wise Operation

Where cross-wise operation is deleted, the alarm is triggered if the DWA is armed by the remote control and disarmed by the door lock. This occurs because, even though the CAS recognizes when the lock is unlocked, it does not transfer the signal to the K-CAN. The DWA therefore remains armed and triggers the alarm when the door is opened. This function is encoded in the CAS.

Bus Monitoring

If the DWA detects messages on the local DWA bus that indicate attempts to disarm or tamper with the emergency siren or the tilt sensor, an alarm will be triggered.

Park Distance Control PDC

The E60 is equipped with the 8-channel PDC system already known from the E65. The PDC button is integrated in the center console switch center SZM. In the E60 the button signal is forwarded via the K-CAN to the PDC control unit.

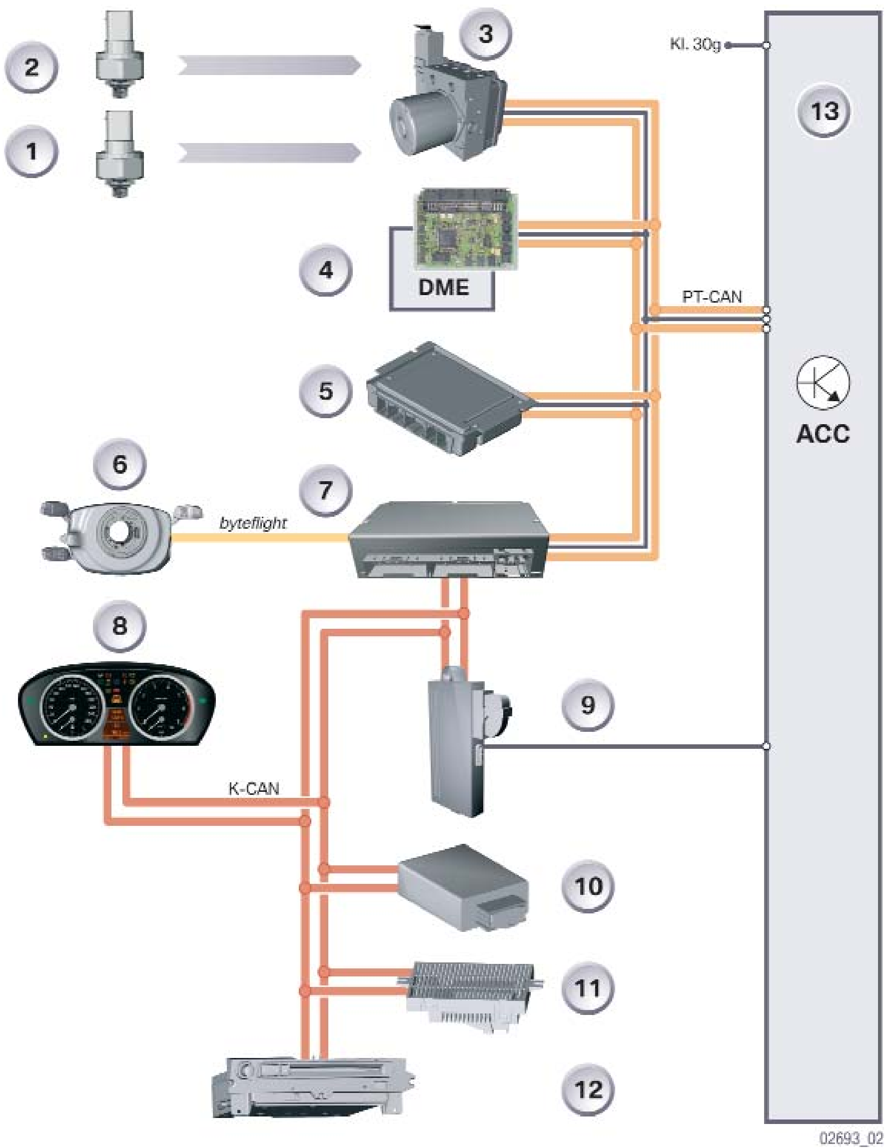
The PDC sensors for front and rear introduced in the E65 are used as sensors here.

For a manual gearbox, the signal for reverse gear is made available by the light module by way of a K-CAN message.

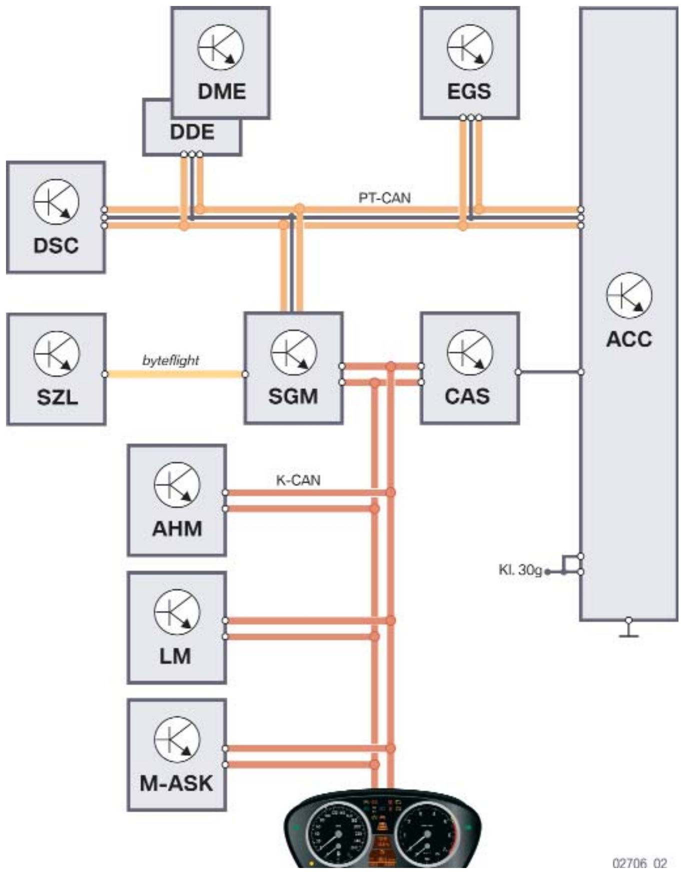
For an automatic gearbox, the signal for reverse gear is made available by the transmission control unit by way of a K-CAN message.

Active Cruise Control

The Active Cruise Control system (ACC) is the same as that in the E65.
The ACC has the following defining properties:
- Operated from a steering column stalk
- Statuses are shown in the instrument cluster display
- Four selectable increment stages
- Speed preselection in 1 km/h stages
- Sheet steel bracket in the E60 with plastic intermediate holder for the sensor control unit
- Audible instructions to the driver have been omitted



1. Rear Brake Pressure Sensor
2. Front Brake Pressure Sensor
3. DSC
4. DME
5. EGS
6. SZL
7. SGM
8. Instrument Cluster
9. CAS
10. Trailer Module (Not for U.S.)
11. Light Module
12. M-ASK
13. ACC Control Unit



Exterior Lights

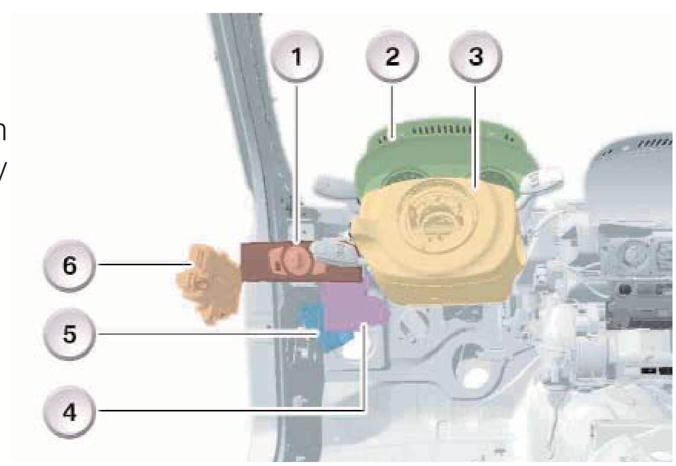
The exterior lighting is based on the exterior lighting of the E65 and available in the following versions:

- Basic version with halogen headlights
- Adaptive cornering light with bi-xenon headlights

Voltage for all the lights is regulated by the light module. This regulation compensates for fluctuations in vehicle voltage.

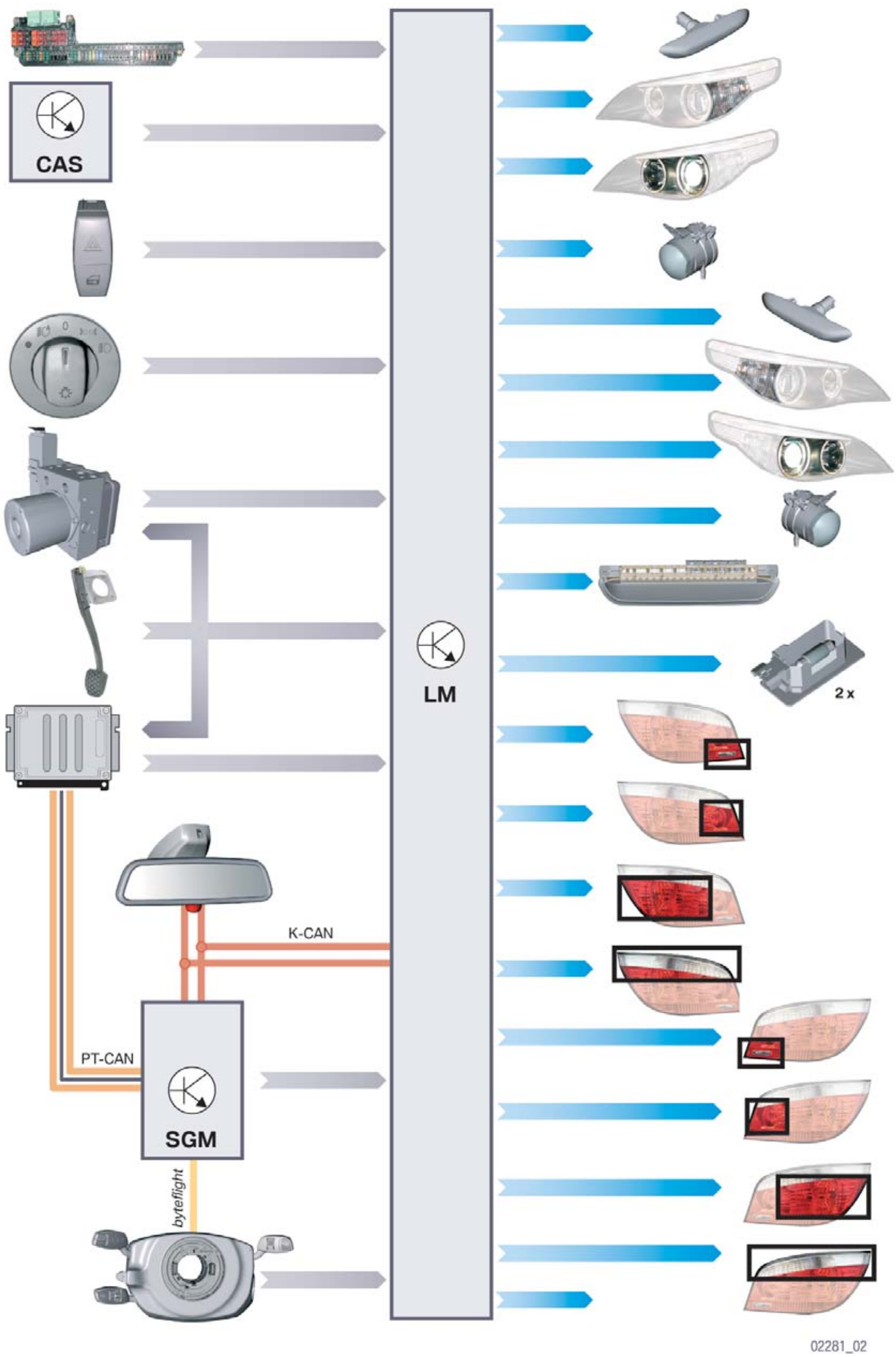
Light Switch with Control Panel Unit

The light switch is remotely mounted from the light module. They are connected by means of a ribbon cable.

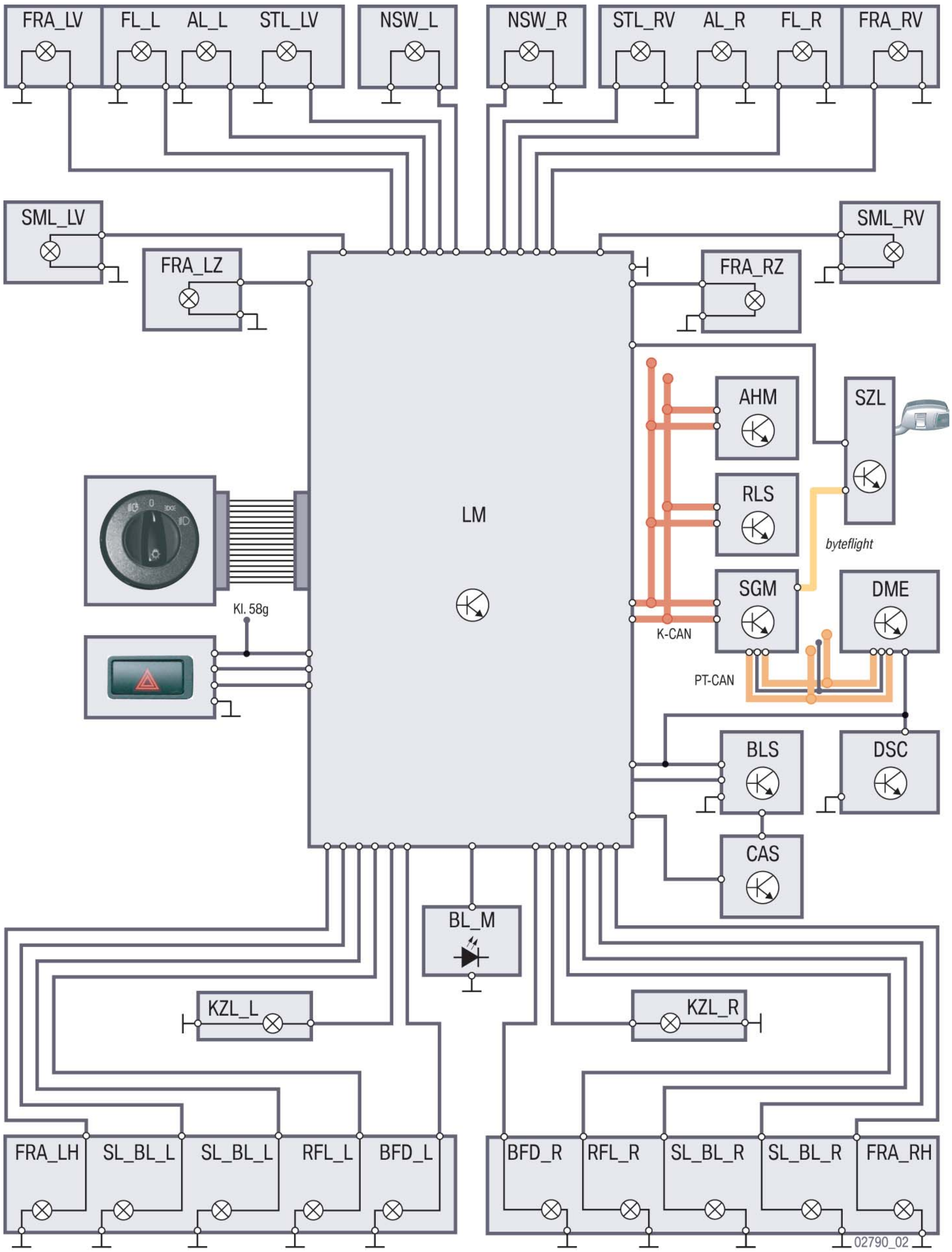


1. Light switch
2. Instrument Cluster
3. SZL
4. CAS
5. Light Module
6. TMFA

Light System IPO



Lighting Schematic

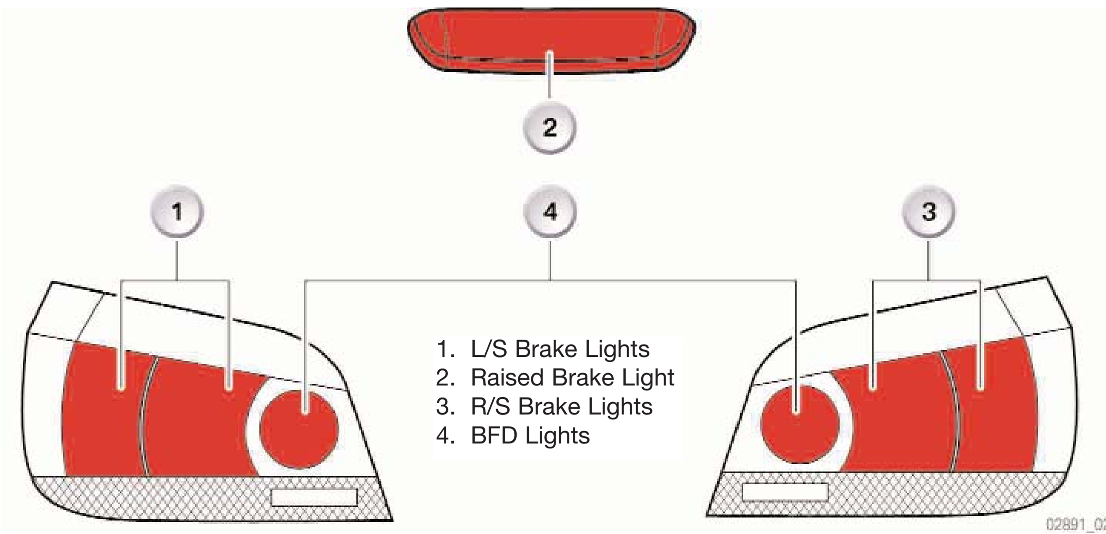


Brake Light Switch

The car access system supplies the brake light switch with voltage. Signals from the brake light switch are used by the Light Module to activate the brake lights.
The Light Module also supplies the brake signal to other systems via the K-CAN.

Reverse Lights

On manual transmission vehicles, the signal is made available via a switch from the gear selector lever. The light module controls the reversing lights accordingly.
On automatic transmission vehicles, the signal is made available by the transmission control unit via the PT-CAN.
The signals for reverse gear and the brake light are made available to other subscribers by the light module via the K-CAN.



Brake Force Display

The segments of the rear fog light are used as the BFD as of a deceleration of 5 m/sec^2

Service Information

In the E60, the light switch contributes to improved protection for the occupants. This increased level of protection is achieved by artificially enlarging the impact surface of the light switch.
In the event of an accident, a person sitting behind the steering wheel could knock against the light switch with his/her knee for instance. While retaining full functionality, the light switch can be shifted towards the rear. This increases the impact surface about the light switch. After being pressed back, the light switch must be pulled out to move it into the forward position again.

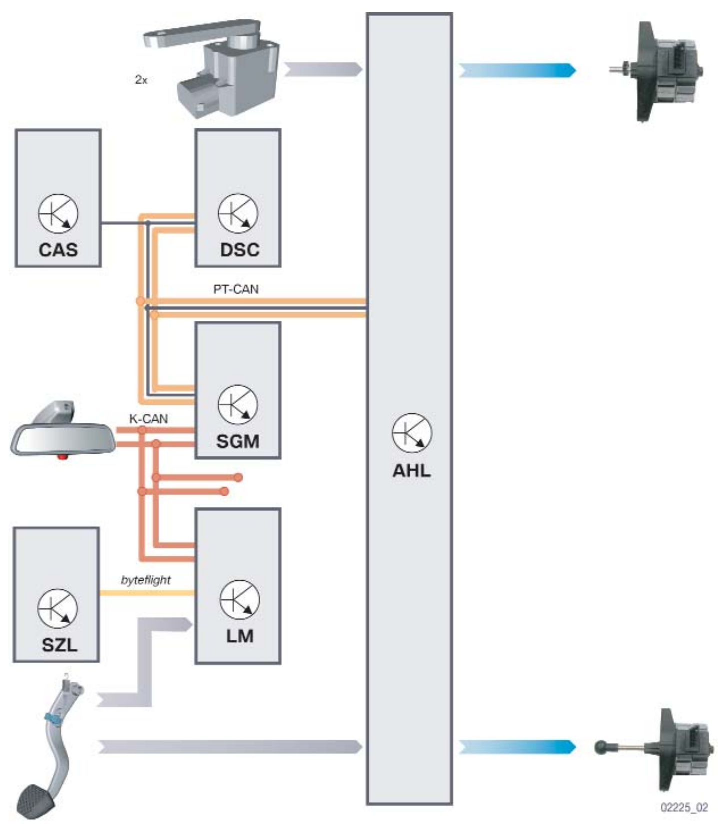
AHL

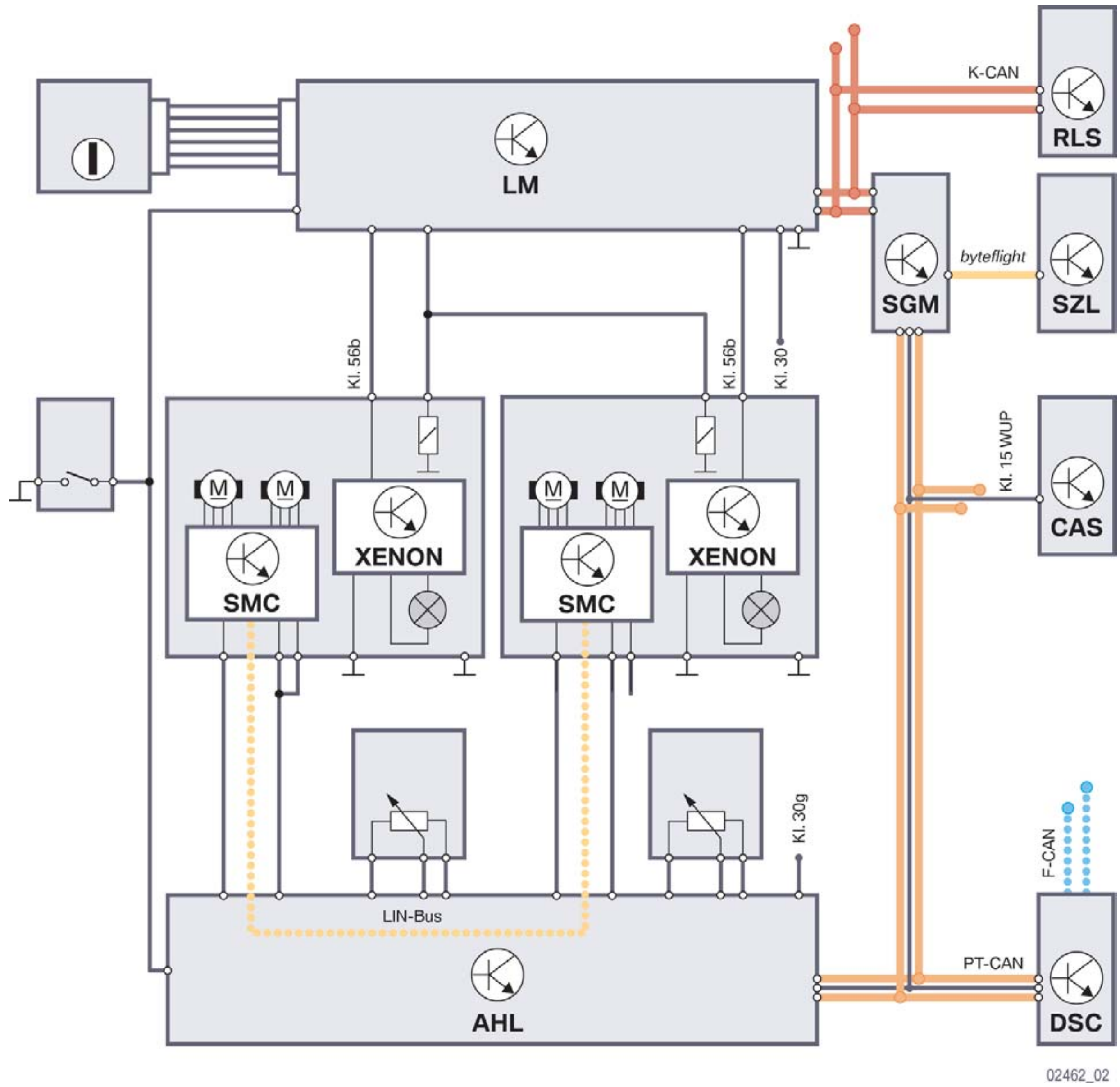
The AHL control unit is linked to the following components:

- Front and rear level sensor
- Brake pedal switch
- Steering angle sensor
- Yaw rate sensor
- DSC control unit, supplies speed signal
- Car Access System
- Safety and gateway module
- Light module
- Steering column switch cluster
- Swivel module for bi-xenon headlights
- Stepper motor controller
- Stepper motors for AHL and steering angle sensor (LWR)
- LIN bus

AHL Control Unit

The AHL control unit is the master control unit for vertical and horizontal adjustment of the bi-xenon headlights. The stepper motor controllers actuate the stepper motors of the bi-xenon headlights. The AHL control unit is installed on the carrier plate behind the glove compartment.





Function Indicator

The function of the AHL is indicated by the FLC LED lighting permanently. A fault in the AHL system is indicated by the FLC LED flashing with the AHL active.
The low beam headlight and the headlight vertical aim control (LWR) remain active in the case of fault. The swivel function of the bi-xenon modules is deactivated.
A reference run is performed during every new start. If a defect is found, the bi-xenon headlights are switched off to ensure oncoming traffic cannot be dazzled. The fog lights are switched on as a substitute
function.

Repairs

Various repairs may be necessary during the course of vehicle's service life. As a consequence of repair work, it may be that the system parts for the AHL are installed with different software and hardware versions. In each case, the replaced components must be adapted to the specific requirements of the vehicle.

AHL Control Unit
After replacing an AHL control unit, it is necessary to enter the vehicle identification number and to encode the control unit depending on specific vehicle data.
The complete AHL function will not be operative if adaptation to the vehicle is not performed.

Replacing SMC
After replacing the SMC, it is necessary to enter the vehicle identification number and headlight-dependent coding in the SMC control unit.
The complete AHL function will remain inoperative if this adaptation is not performed.
Particular care must be taken when replacing the SMC to ensure that the housing seal of the SMC is fitted correctly.

Replace Bi-Xenon Headlights
After replacing the bi-xenon headlights, it is necessary to encode the corresponding SMC depending on the headlights.
If this adaptation is not performed, the function will appear to be operative but not correct. The swivel range and zero point can vary from vehicle model to vehicle model and the bi-xenon headlight can have a different status!
The headlights must be adjusted and checked.

Diagnosis

The AHL system must be set to diagnosis mode in order to perform the following jobs:

- Read out of relevant bus signals with vehicle stationary
  - -Road speed
  - -Yaw rate
  - -Steering angle
- Checking signal plausibility
- Checking that conditions for activation are fulfilled
  - -Rain and light sensor status
  - -Light switch status

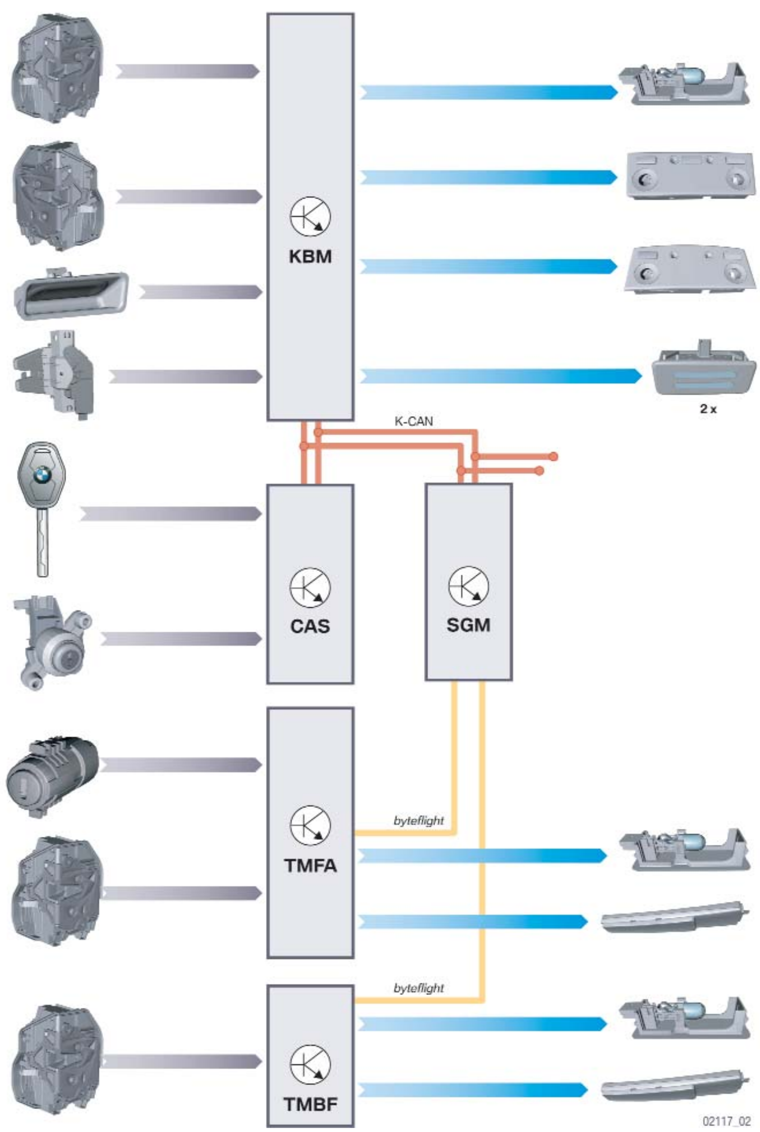
Missing or non-plausible BUS signals are stored in the form of fault codes in the AHL control unit. The types of fault are stored in the SMC. The SMCs are accessed via the AHL control unit.

Interior Lighting

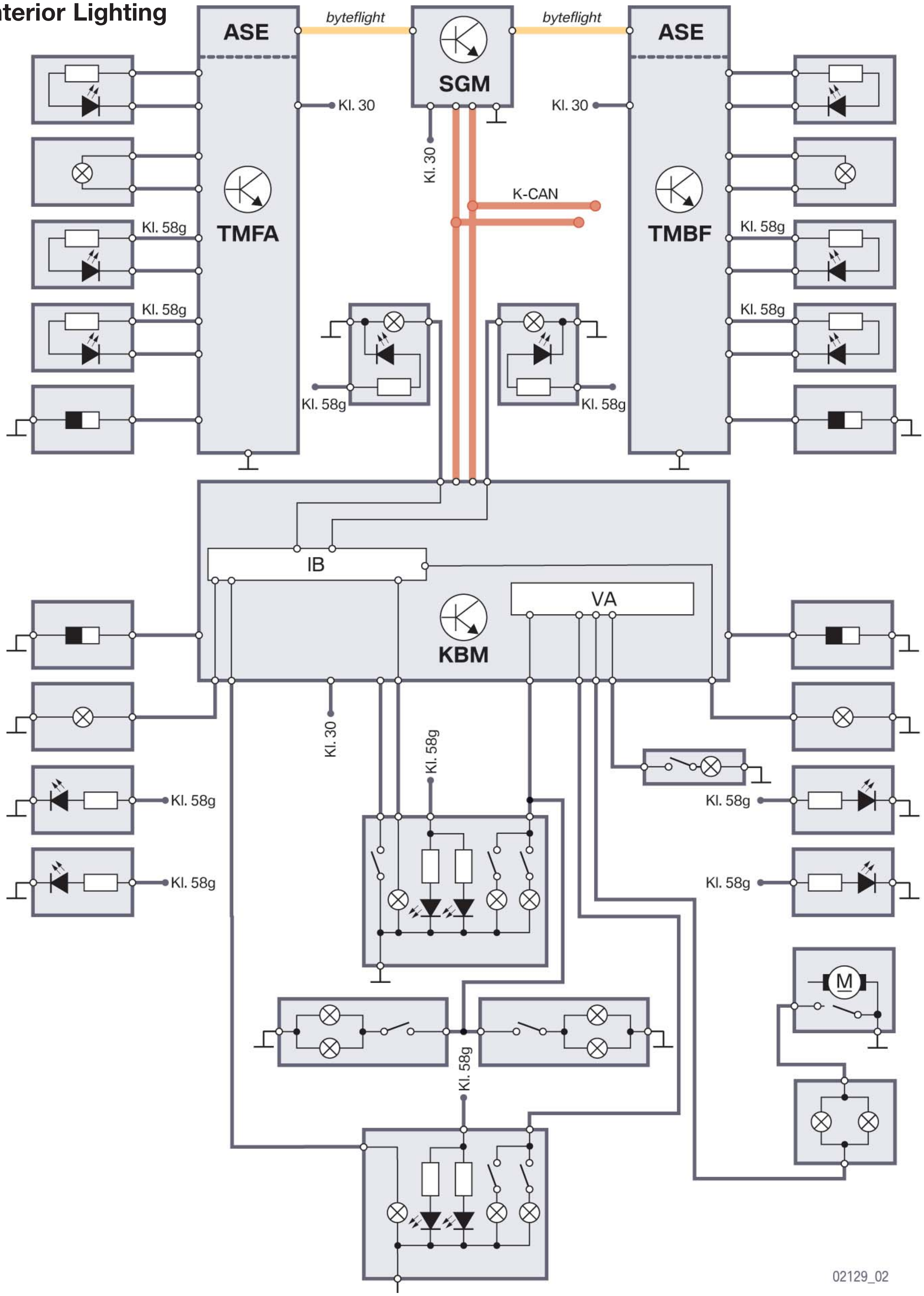
The interior lights of the E60 are pulse width modulated and automatically controlled by various inputs.

PWM Control

The output is active from terminal 15 with a permanent clocking in a frequency of 100 Hz. In this way the power output is controlled. From a voltage of 12.8 V the pulse width modulation is adjusted in such a way as to provide a power output of 100% as for 12.8 V.
In the case of voltage drops in the vehicle electrical system of up to 1 V, the pulse width modulation is corrected and thus a constant brightness of the lamps connected at the consumer shutdown output is ensured.
Below 12.8 V voltage regulation is no longer corrected. The brightness can fluctuate with the battery voltage level.



Interior Lighting



Consumer Shutdown Terminal

Some loads/consumers such as reading, glovebox and luggage compartment lights can remain switched on when the car is stopped. In order to protect the battery, these consumers are shut down after a drop at terminal R with a delay of 16 mins. or immediately with the diagnosis telegram.

Consumer Shutdown

Power outputs are made available by the KBM 2 for consumer shutdown.

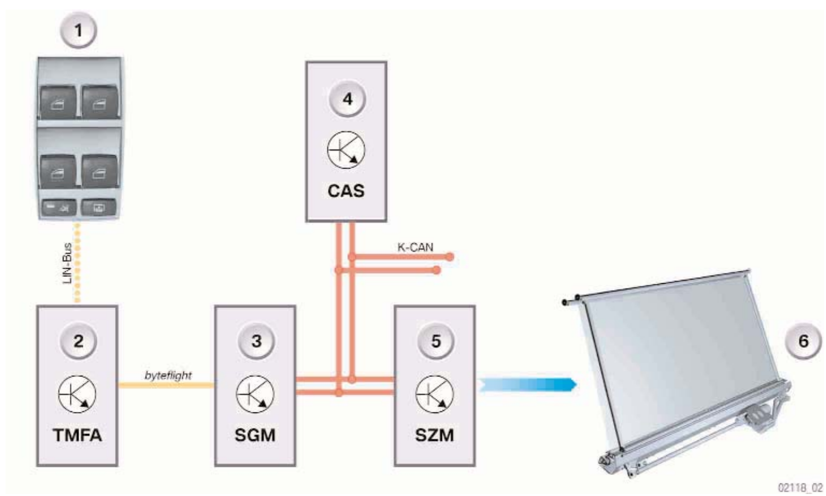
- VA 1:
  - Reading lights
  - Vanity lights
  - Boot
- IB 2:
  - Glovebox light

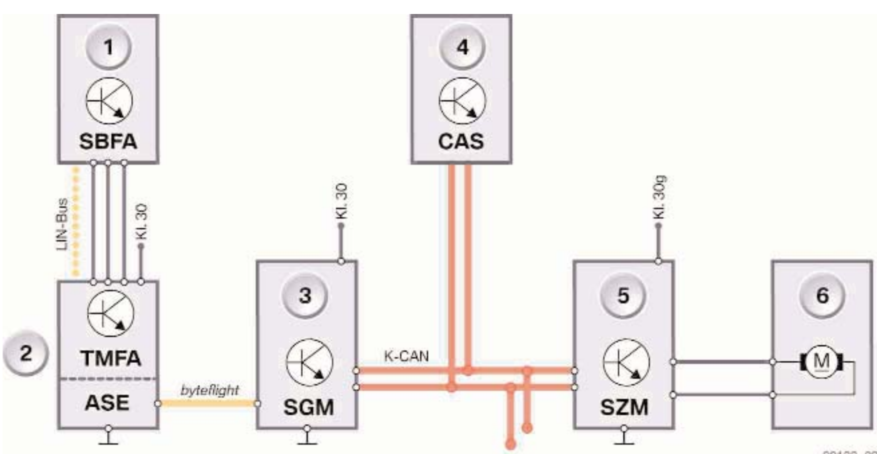
Roller Sunblind

An electric roller sunblind is available for the rear window of the E60. Mechanical roller sunblinds are also available for the side windows of the E60.

System Function

The roller sunblind is operated from the switch in the driver's side switch block.





Seats

Seat Variants

Three different seat versions are available for the E60.
- Electric basic seat with memory
- Electric sports seat with memory
- Multi-function seat with memory

Provision is also made for the installation of various options:
- Electric seat heater
- Seat ventilation system
- Active seat option
- Lumbar support option

Electrical Interfaces

One 8-pin and one 25-pin connector are used to connect the system to the vehicle electrical system. The pin assignment of the 10 compartment plug connections has not changed from those for the seats in the E65. The 6 compartment plug connections for the seat modules have not changed either.

Electric, Sport and Multi-Function Seats

The signals required for seat adjustment are generated with the aid of the adjustment switches. The signals are forwarded to the center console switch centre (SZM) by means of an interface similar to a K bus. The centre console switch centre then forwards the data to the seat modules via the K-CAN.
Signals are processed in the seat modules. With the aid of the output stage in the seat modules, the motors in the seat are activated for seat adjustment.

Seat Heating

The heating circuits vary depending on the equipment fitted. The multifunction seat and the option seat ventilation system have 4 heating circuits. In a 4 heating circuit system, the backrest and seat cushion each have a rapid-heat area and a secondary heat area. Each heat area is fitted with a temperature sensor. Current is applied to a maximum of two heating circuits at any one time.
Seat variants that are not based on the multi-function seat and that are not fitted with the option seat ventilation system have 2 heat circuits. In a 2 heating circuit system, the backrest and seat cushion each have one heat area.

Lumbar Support

The seats are fitted with a pneumatically operated lumbar support adjustment.

Active Seat

The active seat is already described in the training material for the E65. To provide support and relieve the strain on the spinal column and back muscles during long journeys, the active seat can be installed in the vehicle. The up and down movement of the seat surface is initiated at the ischiatic tuberosity.

Entry/Exit Function for the Multi-Function Seat

There is an entry/exit aid for both the driver and passenger. The entry/exit aid is available in conjunction with the multi-function seat. The entry/exit aid system uses the backrest width (LBV) and seat cushion depth (STV) adjustment functions.
The backrest width is retracted to allow entry/exit into the vehicle. This creates more space in the area of the backrest. The seat cushion depth is reduced. This creates more space around the seat area.

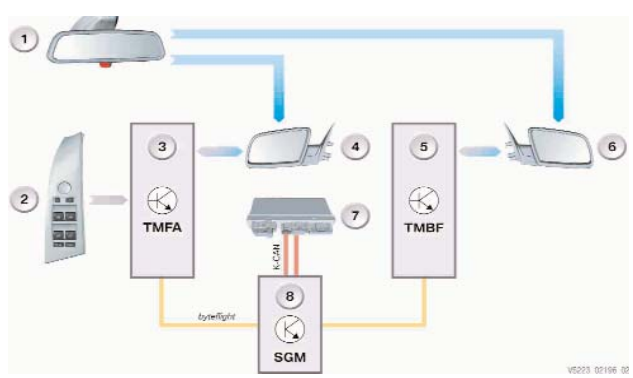
Functional Principle

One example in which the entry/exit aid is activated:
The customer stops the vehicle. The vehicle is not in gear, the engine is either running or switched off. The vehicle door is opened. The door contact indicates this. The exit aid is activated. The LBV and then the STV are retracted. The customer gets out and the door is closed. The exit aid remains in that position and is used to assist entry when the customer gets back in the car.

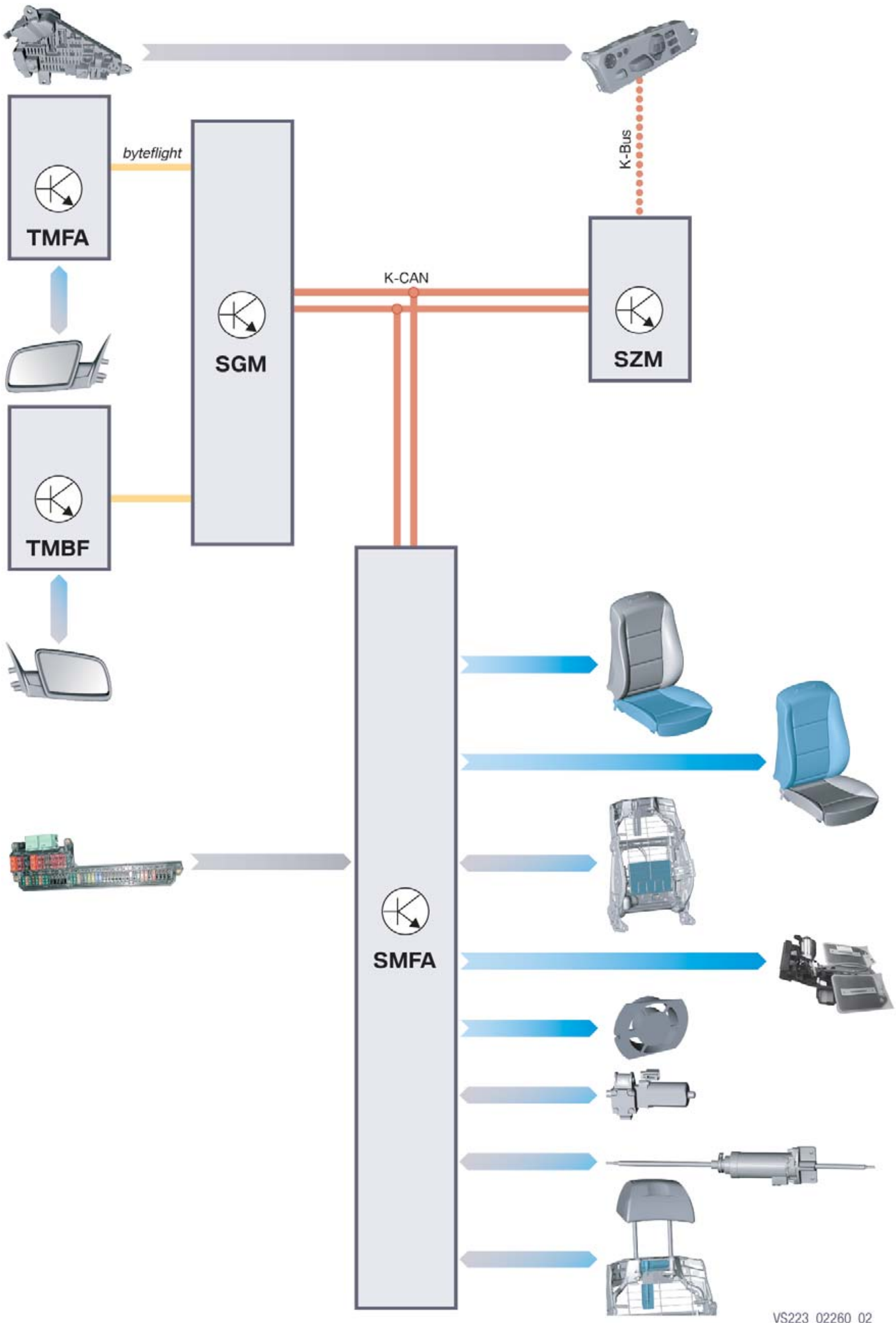
Outside Mirrors

Activation of the wing mirrors is performed by the door modules by means of the local electronics in the front doors. All the mirror functions, except for electrochrome wing mirror and mirror heating, are active with terminal R on through to consumer shutdown.
The mirror functions are controlled exclusively in the door modules, which communicate with each other via the byteflight. All the mirror adjustment functions are served by the adjusting switches in the switch block in the driver's door.
The following options are available:

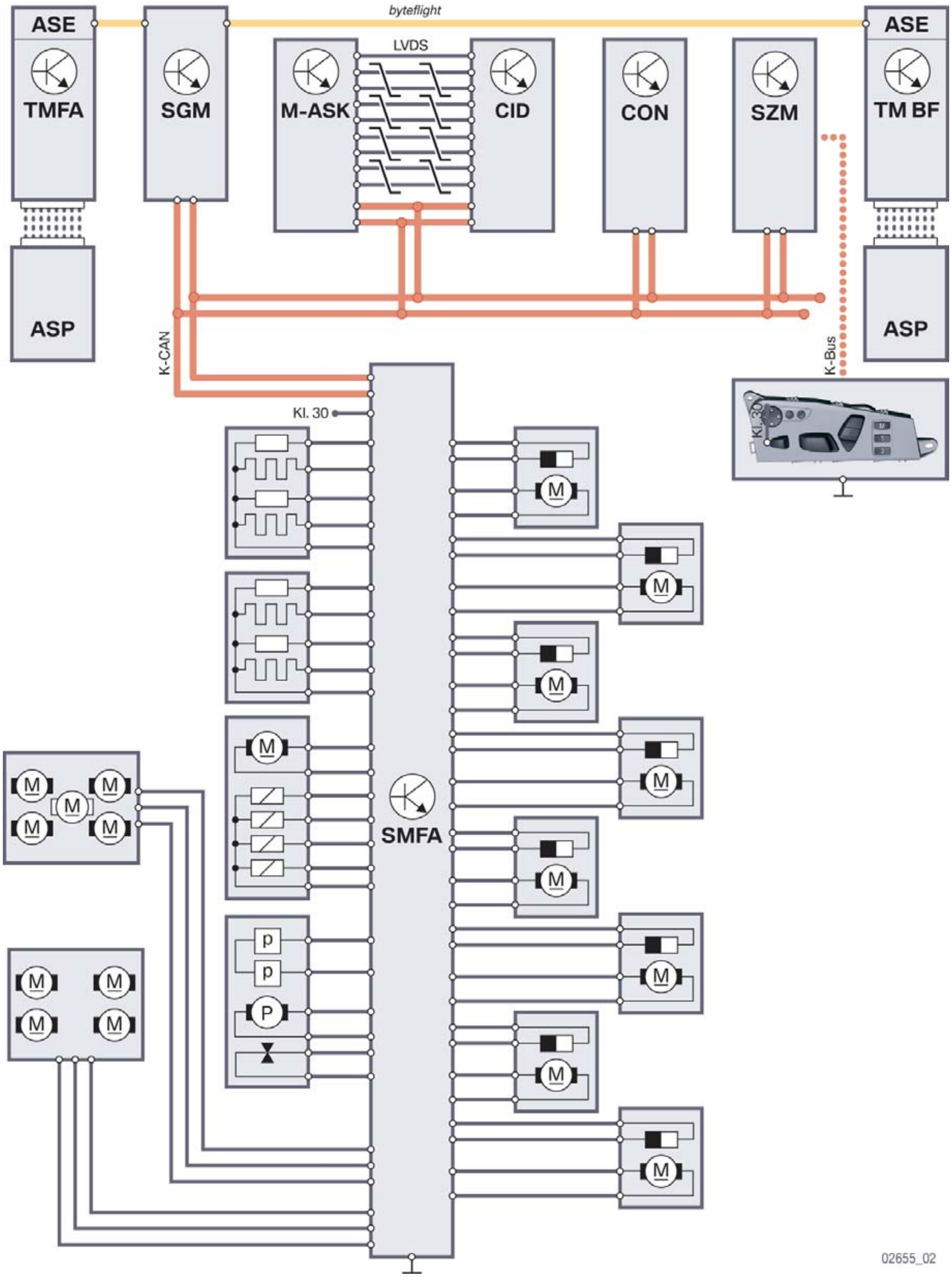
- Electrochrome interior rearview and wing mirrors
- Electrochrome interior rearview mirror
- Light package including front-area lights in wing mirrors
- Wing-mirror memory in conjunction with seat memory

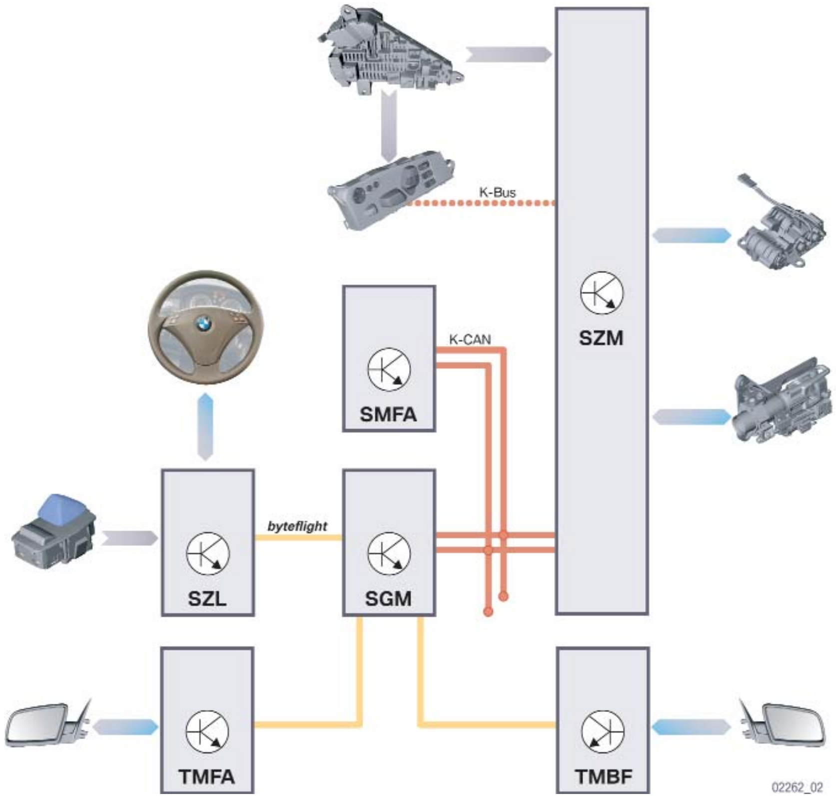


Seat IPO (Typical)



Seat Schematic

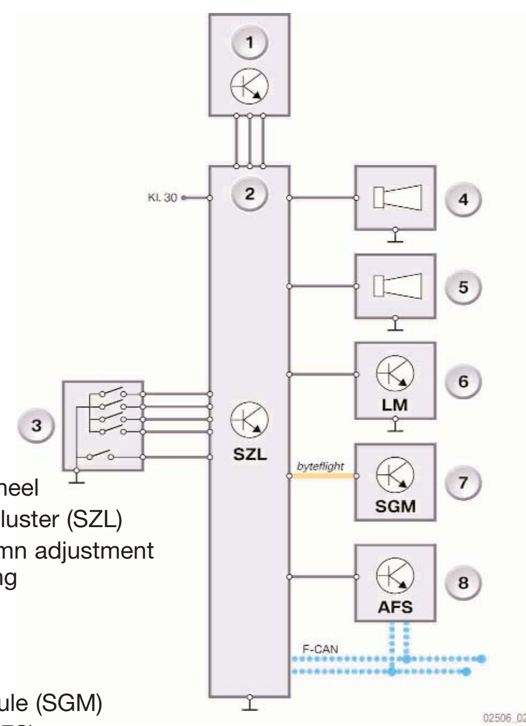




Steering Column

The steering column adjustment function is described in the information for the E65. Possible functions of steering column adjustment are:

- Height adjustment
- Reach adjustment
- Entry/exit aid
- Steering-column memory
- Motor protection



System Circuit Diagram

1. Multi-function steering wheel
2. Steering column switch cluster (SZL)
3. Buttons for steering column adjustment and steering wheel heating
4. Fanfare horn
5. Fanfare horn
6. Light Module (LM)
7. Safety and gateway module (SGM)
8. Active steering system (AFS)

K-CAN - Bodyshell CAN
F-CAN - Chassis CAN

Workshop Exercise - Seats

Vehicle is brought into shop with drivers seat non-operational.

1. *Verify the complaint.*
2. *Does the passenger seat operate?* ______________________________
3. *Perform a short test and note the stored fault codes.*

   ____
4. *Are either of the seats able to be operated through component activation?* __________
5. *What is the path of the signal from the seat switch to the seat modules?*

   ____
6. *What is the best place to check the seat switch operation request signal?* __________
7. *What is the problem with the seat?* ______________________________

   ____

   ____

   ____

   ____

Table of Contents

E60 Driver Information

Model: E60

Production: Start of Production MY 2004

Driver Information

Objectives:

After completion of this module you will be able to:

- Identify the instrument cluster warning symbols.
- Reset the Condition Based Service Indicators.
- Navigate through all screens of the CID with the controller.
- Explain the new CID screens.

Instrument Cluster

Annular indicators used for the first time by BMW for the two main instruments represent an innovation in display technology. This system has enabled the displays for the cruise control system set speed and the variable engine speed warning zone to be visually illustrated.

The pendulum dial layout for the analogue fuel gauge and fuel consumption indicator augments the compact appearance and design of the instrument cluster.

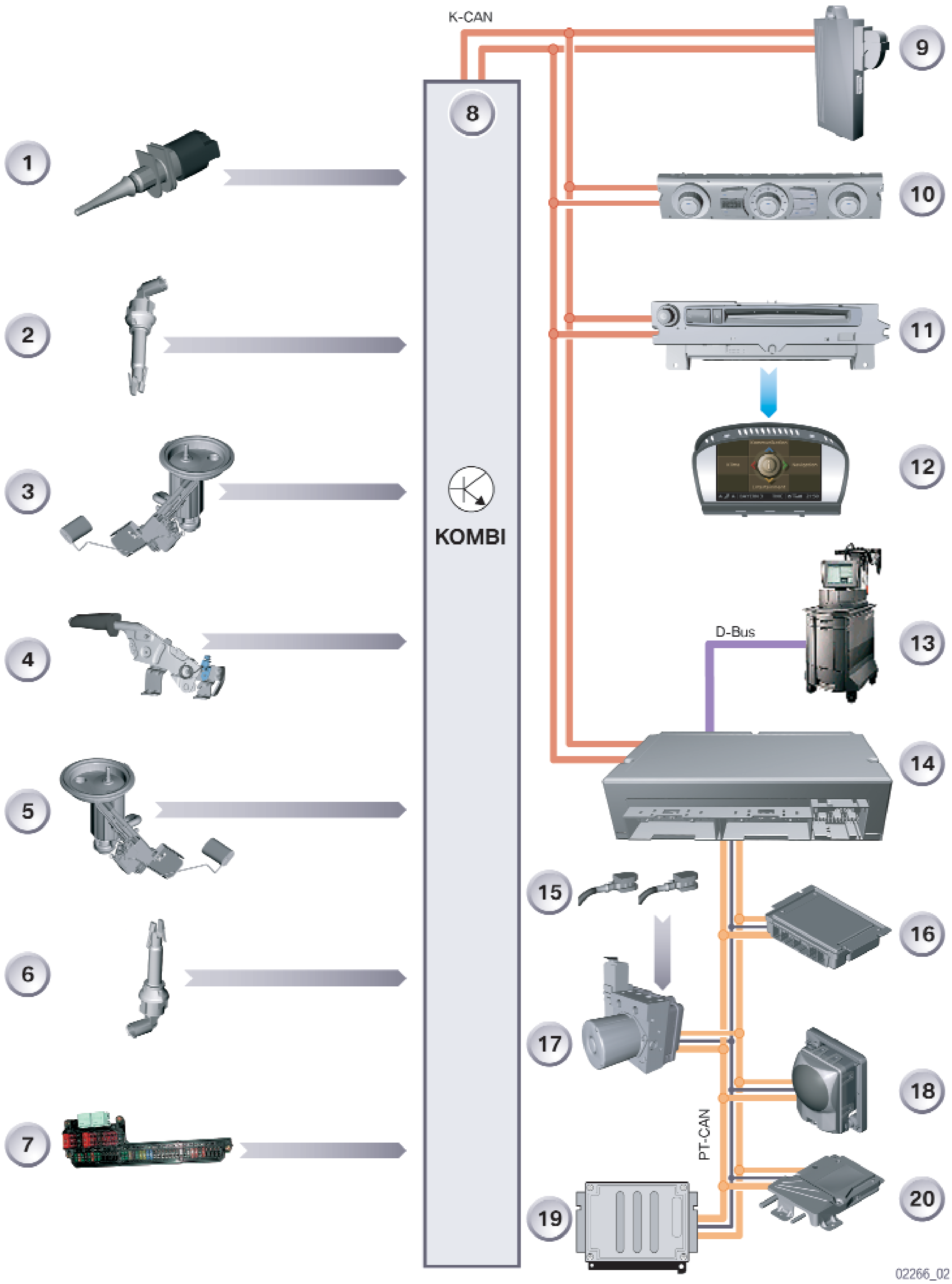
The indicator lamp for the fuel reserve has been replaced by a Check Control message in text and graphics. Likewise, the Check Control texts are no longer displayed in the instrument cluster but in the status bar of the Central Information Display (CID).

Two large instrument dials show vehicle speed and engine speed. Two smaller pointer instruments display fuel level and current fuel consumption. The scales on the instrument cluster are specific to each country, vehicle and engine. Most of the indicator lamps are located in the centre at the top between the two large instrument dials. Also in the centre between the two large instrument dials are the two LC Displays.

Components

The instrument cluster comprises the following components:
- Instrument dials
- Indicator and warning lamps
- LC display
- Program and gear displays for automatic gearbox and SMG Sequential Manual Gearbox
- Setting button for resetting the trip meter and operating the Condition Based Service, CBS menu
- Connected components which serve to activate the displays in the instrument cluster

Instrument Cluster IPO



Display Areas

The instrument cluster is divided into the following display areas:

- Instrument dials
- Indicator and warning lamps
- LC display
- Program and gear displays for automatic gearbox and SMG Sequential Manual Gearbox

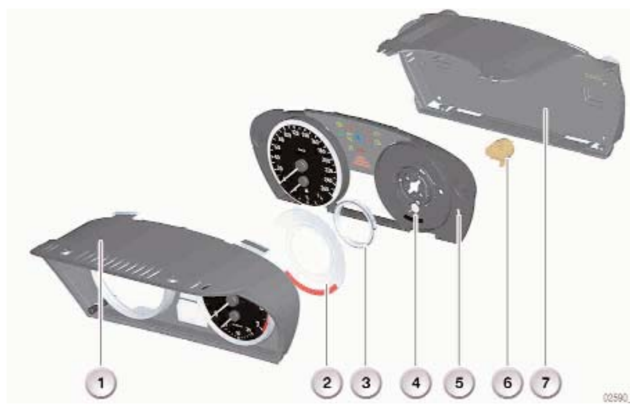
Instrument Dials

The instrument cluster includes the following dials:

- Speedometer
- Rev counter
- Fuel gauge
- Fuel consumption (economy) indicator

The set speed for the cruise control system and the tach warning are displayed by means of annular indicators (moving rings).

1. Set Speed for Cruise Control
2. Speedometer
3. Tach
4. Tach Warning Zone
5. Fuel Guage
6. Fuel Consumption Indicator



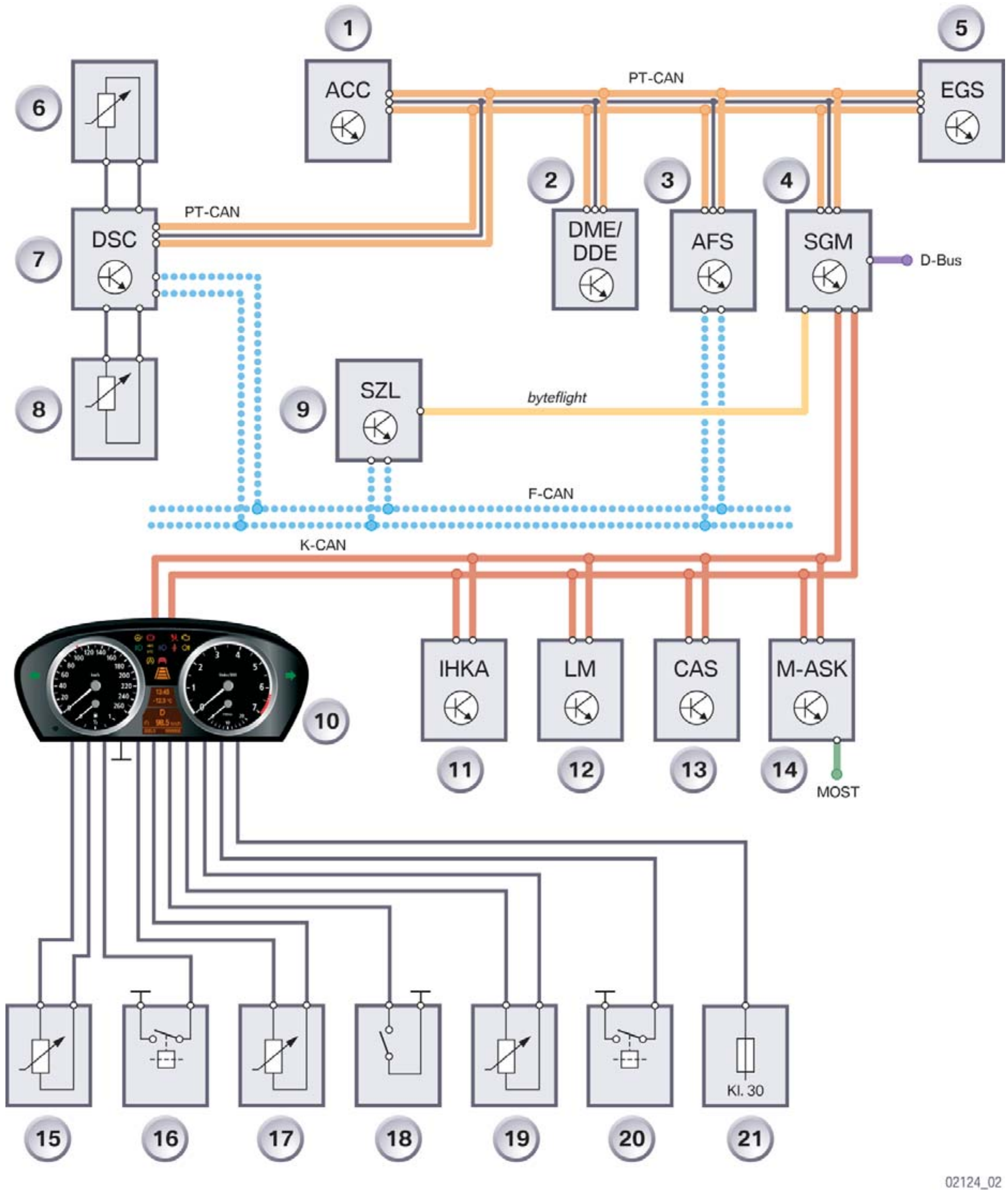
1. Front Frame
2. Annular Indicator
3. Ring Gear
4. Pinion
5. Light Duct
6. Stepper Motor
7. Base with Printed Circuit Board and Display

The annular indicator is moved by means of the ring gear, connected to the indicator, the pinion and the stepper motor which is attached to the rear of the light duct.

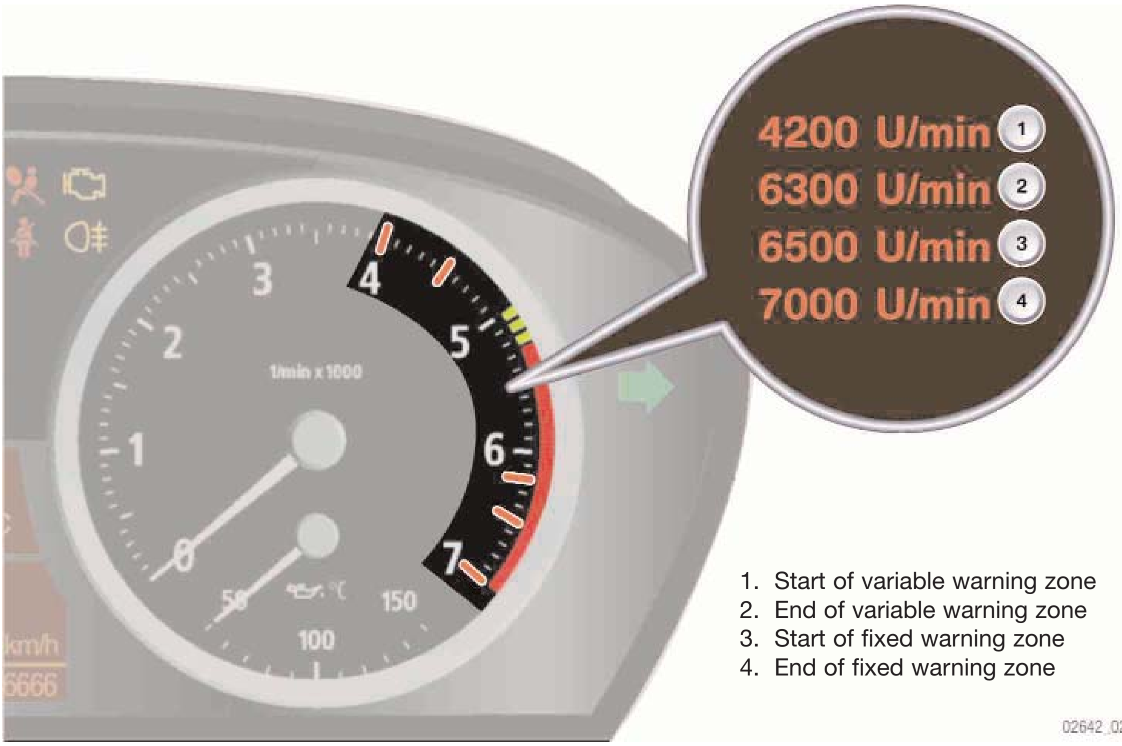
U.S. vehicle will have speedometers with 0-160 MPH and 0-7000 RPM displays.

The maximum engine speed warning display is indicated by the tach as a function of engine temperature.

Instrument Cluster Schematic



1.	8.	15.
2.	9.	16.
3.	10.	17.
4.	11.	18.
5.	12.	19.
6.	13.	20.
7.	14.	21.



Indicators and Warning Lamps

The indicator and warning lamps are activated by the processor in the instrument cluster. The main indicator and warning lamps are activated in the Predrive Check when terminal 15 is switched on. The indicator lamps and warning symbols are lit by soldered-in LEDs (replacement of LEDs not possible).

LC Display

The LC display is located between the speedometer and the rev counter. The LC display is divided into two areas. The time and outside temperature are displayed in the upper window, along with the set speed for the ACC, check control messages and CBS displays. The on-board computer functions, trip distance counter and CBS messages are output to the lower window. A manipulation dot indicates if there are different vehicle identification numbers in the light module and in the instrument cluster.

Program and Gear Display

On vehicles with automatic transmission or sequential manual transmission (SMG), the program and gear selected are shown in the center of the lower window of the LC display. The program and gear display is activated when terminal 15 is on. At terminal 15 off, run-on operation of the display is possible provided the SMG is still transmitting CAN messages.

The information between the control units for the automatic gearbox or SMG and the instrument cluster are exchanged via the K-CAN. The program and gear display shows letters and numbers. The program mode is displayed all the time and is not overwritten by other information.

Note:
With SMG, the selector-lever position "N" flashes after the engine is turned off. This indication serves as a visual reminder that the car could still roll away.

Condition Based Service (CBS)

With the series launch of the new 5 Series, BMW will also be offering service intervals that are geared towards the current condition of selected critical components - i.e. servicing that depends on the condition of components and maintenance requirements; this is known as Condition Based Service (CBS). CBS means thus: maintenance only for the component which is worn.

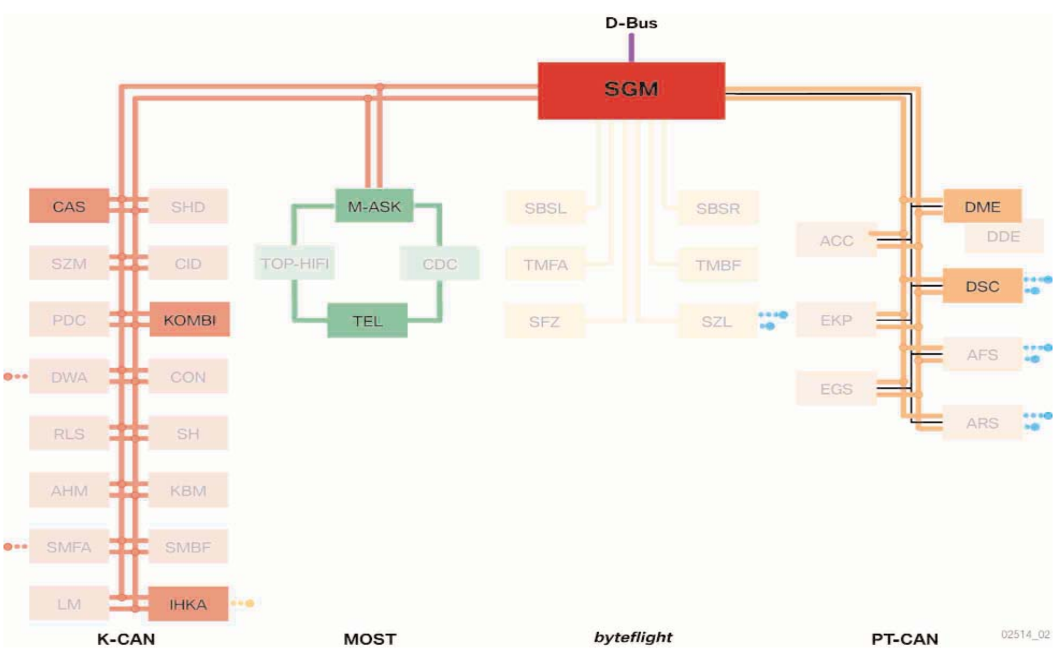
The system calculates when a service operation, e.g. an oil change or emissions inspection, is due and informs the customer of this via the LC display in the instrument cluster. CBS sorts all the data according to date due and can determine when the vehicle should be taken into BMW Service.

The instrument cluster sends the sorted data to the Central Information Display (CID). There, the data can be selected for display in the Service menu. There are ten different types of service, with each of these types being assigned to a specific service group.

The system involves the following components:

- Instrument cluster
- External units (DME, IHKA, DSC)
- Car Access System (CAS) 2
- Central Information Display (CID)

All information that the CBS system requires is sent on the K-CAN bus. The instrument cluster is a subscriber on the K-CAN and acts as the CBS master control unit. The CBS requests from all the control units are therefore sent via the K-CAN to the instrument cluster and to the Central Information Display.



CBS Displays

Displays in the Instrument Cluster

The CBS display always comprises the following two separate displays:

- A colored symbol in the upper display
  - -Orange for normal
  - -Yellow for service due
  - -Red for service overdue
- And information on remaining distance and/or due date in the lower display.

1. CBS Symbol
2. Final Date Information
3. Remaining Distance Display

Displays in the Central Information Display (CID)

All information on the individual service operations can be displayed in the CID. The CBS functions are stored in the "Settings" menu item which is used exclusively for individual user settings.

Press the Controller, the "Settings" menu will appear.

Turn the controller until "Service" is highlighted, then press to activate the CBS menu.

The CBS menu window will appear; this is divided into the following control and display fields:

- Status bar
- First menu bar
- Second menu bar
- Display field for CBS symbol
- Display field for service operation

Note:
All screen shots shown are derived from a simulation of a version with featuring a 6.5" medium-resolution colour LC display and correspond to the status at the time of going to press. Further changes are possible to the contents and the layout.

Index	Explanation
1	First Menu Bar -Service Requirement, Check Control Messages -Service
2	Second Menu Bar -Status
3	Display Field For CBS Symbols
4	Status Bar
5	Display Field for Service Operation

The service operation display field always shows the first five messages.

The displays are colour-coded and some also have a symbol. The displays mean the following:

- Red - The service operation is overdue
- Yellow - The service operation is due shortly
- Green - No service operation required

Any overdue service operations and symbols marked in red in the list are always at the top of the list of messages.
You can scroll through the list of the service operations from top to bottom by turning the controller (left/right).
To display the information concerning a specific service operation on the CID, turn the controller to select the required service operation and display the selection by pressing the controller.

Resetting the Service Operations

When one or more operations have been carried out, e.g. front pads have been changed, these operations must be reset to their full service interval.

There are two options for resetting the service operations:

- Legally required service operations
  Legally required service operations such as the Statutory vehicle inspection (HU) and the Statutory exhaust test (AU), can only be reset in the "Service" menu.
- Maintenance service operations
  All service operations for the purpose of maintenance are reset by means of the reset button of the trip distance counter in the instrument cluster. If the reset button is pressed for longer than ten seconds, the reset mode opens automatically. "Reset?" is displayed in the lower display window.

In the upper display window, the CBS symbol , e.g. for "engine oil service overdue" will be displayed. Press the reset button until the time/distance-dependent displays in the lower display window are replaced with dashes. Reset is no longer possible once more than 80 percent of the interval has expired. A reset lock will be shown in the display with "OK".

1. Reset button for trip counter
2. Upper Display Window
   - CBS Symbol
3. Lower Display Window
   - Gear Indicator
   - Reset Mode

Diagnostics

There are three possible combinations for replacing the instrument clusters and Car Access System.

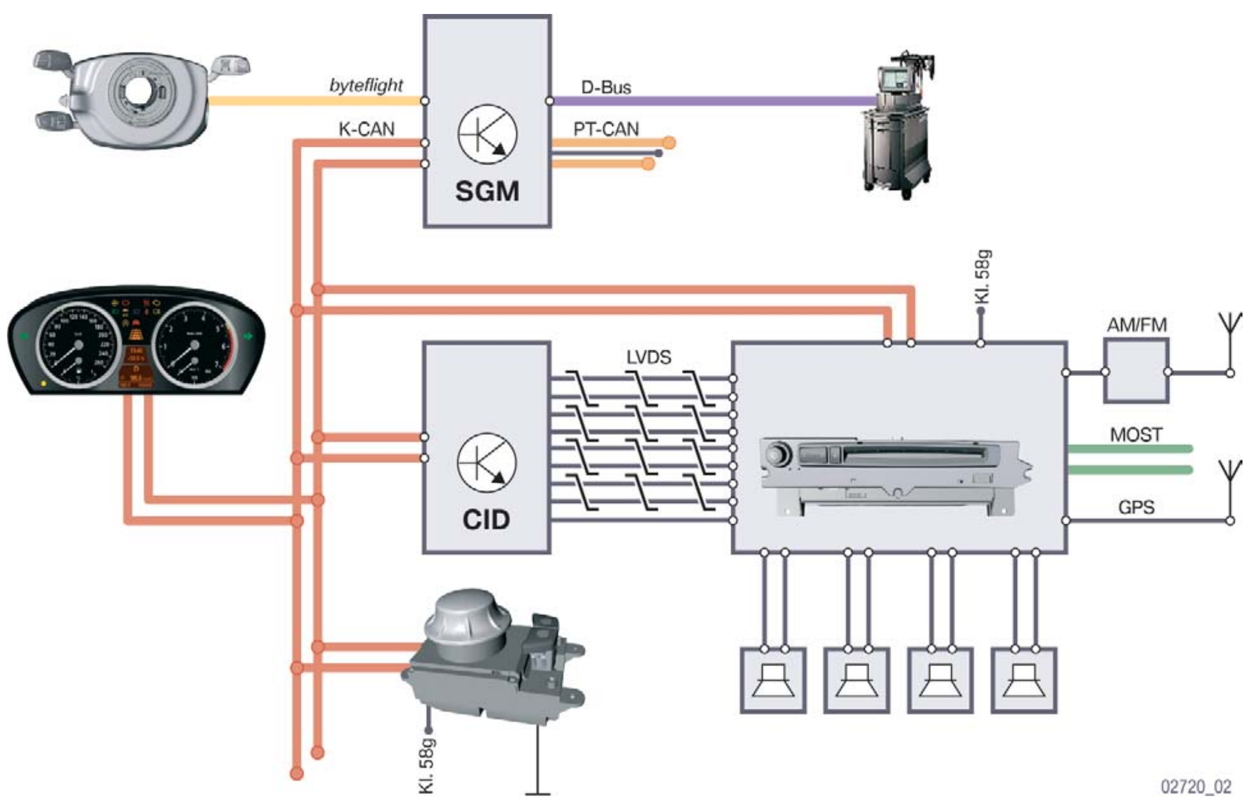
- Instrument cluster faulty, Car Access System OK
- Car Access System faulty, instrument cluster OK
- Car Access System and instrument cluster must be replaced.

Simultaneous replacement of the Car Access System and the instrument cluster must be avoided. The odometer reading will be lost as a result. In principle it is also possible to carry out a trial replacement of the instrument cluster/Car Access System.

Central Information Display (CID)

The Central Information Display is an integrated display and operating panel for the following functions:

- Audio systems such as radio, CD, MC
- Computer, journey computer
- Check Control messages
- Navigation
- Needs-based service (BOS)
- Vehicle info
- Brief info
- Telephone and data services
- CD-ROM or DVD
- Personalized functions such as station selection
- Heating and air conditioning system
- Vehicle functions such as DSC, EDC, PDC, RDC
- Service mode



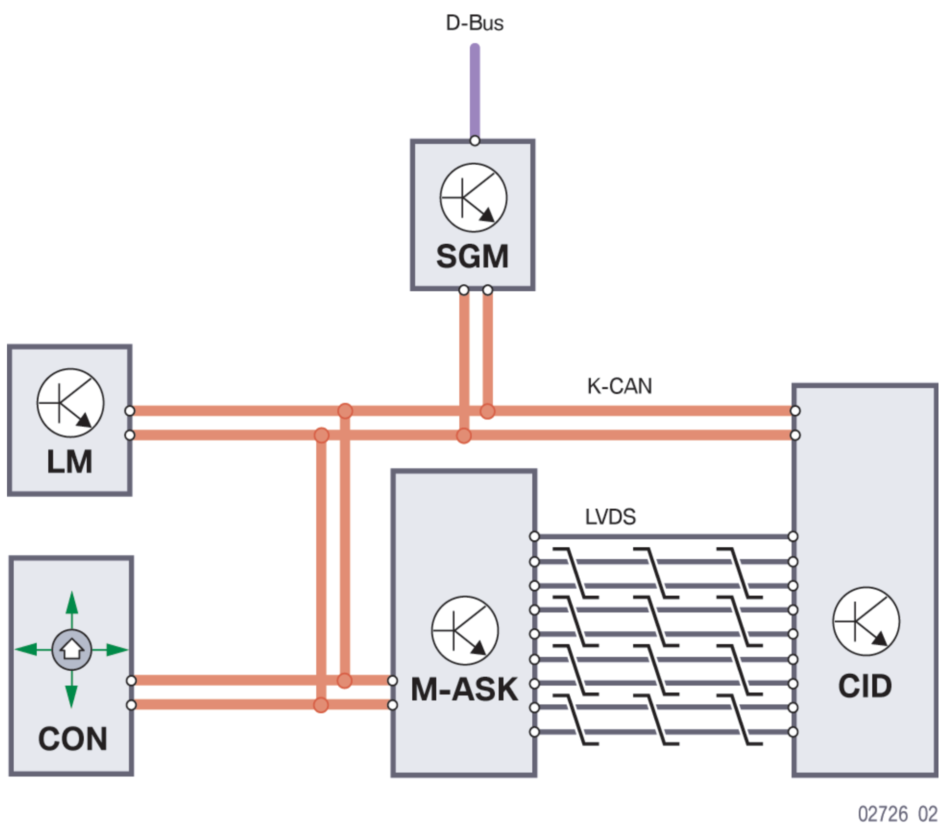
New Features

The CID of the E60 has new features or modified features:

- Main Menu reduced to four selections
  - Communication
  - Car Data (unless equipped with Navigation)
  - Entertainment
  - Climate Control
- User settings available in an additional menu setting
- Two variants of controller
- New Menu button
- Voice Input button on center console

Bus Network

The M-ASK generates the LVDS data (Low Voltage Differential Signaling) for the graphic display in the Central Information Display.
The central operating control for the Central Information Display is the controller. The controller is connected to the CID via the centre console control centre (SZM) and the K-CAN system.
The safety base module (SGM) provides the diagnostics interface for the CID via the diagnostics bus.



Components

The Central Information Display (CID) comprises the following components:

- Casing with integral electronic module
- LC display
- Casing attachment (tube) with cover glass
- Controller, a connected component which controls the displays in the CID.

1. Casing w/ Electronic Module
2. LC Display
3. Casing w/ Glass

LC Display

In order to cope with the various equipment specifications, the following variants are used for the E60:

- CID with 6.5" medium-resolution colour LCD (400 x 240 pixels)
- CID with 8.8" high-resolution colour LCD (640 x 240 pixels)
  The LCD also features a help window.

The casing is designed to be able to accommodate all screen variants offered.
The entire Central Information Display assembly is fixed to the dashboard by two screws.

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Controller

The controller is the central operating control for all comfort functions and selected options for some vehicle functions that are displayed on the Central Information Display.
The controller is located in the centre console immediately behind the gear selector lever, within reach of the user (driver and front passenger).
For the first time, the controller will be available in the following two variants for the E60:

- Variant A
  The base variant has a mechanical latch system with 24 latches per full turn.
- Variant B
  On the high-end version, the tactile feedback for the rotational movement of the controller is generated electrically. The tactile feedback for the rest position, the main directions of movement and the depressed position is created by mechanical means.

The operating principle of the controller is identical with that of the E65.
The controller is slid from a rest position (centre position) to which it always returns again when it is released.

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The main features of the operating principle are:
- The centre is the rest position (centre position)
- Slide to select the four main directions of movement
- Turn to select the function
- Press to select or confirm entry.

There is also a panel of buttons immediately behind the controller. There are two variants, as follows:
- Basic variant
  This version comprises a menu button which is used to call up the main menu in the Central Information Display.
- High-end variant
  This version has two buttons. In addition to the menu button, there is a button for activating/deactivating the voice input system (SVS). The button signals are read into the controller and converted into K-CAN telegrams.

The four menu items are displayed in a cross pattern on the Central Information Display corresponding to the four main directions in which the controller can be moved.
In addition to these four main menu items, there is a fifth menu item used exclusively for individual user settings. The screen can also be switched on and off from this menu.

Status Bar

The status bar displays the main information on the various functions, such as the telephone signal strength or the time; this information is permanently displayed after Ignition ON.

1. Automatic A/C activated
2. Audio Source activated
3. TMC (Not for USA)
4. Unread Text Message
5. Telephone Signal Strength
6. Time


BMW Assist
BMW Info
Meldungen aktualisieren
Telefon
SMS
BMW Assist
BMW
0 1 2 3 4 5 6 7 8 9
PIN eingeben
T-Mobile
SOS 10:35
Navigation
Bordinfo
Adressbuch
neues Ziel
HAMBURG, HELLBROOKSTR.
14:27
Navigation
Karten-DVD einlegen
BAYERN3
TP TMC
SOS 14:26
Kommunikation
Navigation
Klima
Entertainment
BAYERN 3
TMC
21:50
Standheizung / -lüftung
Direktbetrieb
Einschaltzeiten
Luftverteilung
Heizverteilung Sitz
Fahrer
auto
BAYERN3
TP TMC
SOS 10:54
FM
Suche
Set
88 90 92 94 96 98 100 102 104 106 108
BAYERN3
T-Mobile
TP TMC
SOS 10:45
SOS 10:46
Bildschirm aus
Einstellungen Entertainment
Verkehrsinfo
Einstellungen Anzeige
Einstellungen Fahrzeug
BMW Service
Kommunikationsschnittstelle
BAYERN3
TP TMC
SOS 10:23
RDC
PDC
Reifendruck
2.0 bar
2.1 bar
2.1 bar
BAYERN3
TP TMC
SOS 9:26

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Communications

In this menu, entries in the telephone directory can be displayed and sorted according to various criteria. Here too, the user can query his SMS (Short Message Service) inbox for incoming text messages or display any calls that were not answered.
This menu also contains the BMW services such as BMW Assist and BMW Online. Certain services are only available to customers once released.

Navigation

This menu provides access to all functions necessary to operate the navigation system. The computer can also be selected from this menu item. Certain services are relevant to specific equipment and are only available to customers after appropriate authorization. The main menu is activated as soon as terminal 15 ON is on.

Entertainment

The Entertainment menu is a frequently used function. Certain services are relevant to specific equipment and are only available to customers once released. The main menu is activated as soon as terminal 15 ON is on.

Climate

As on the E65, the extended conditioning functions such as mixture control and automatic heater can be selected and activated from the Central Information Display. The main menu is activated as soon as terminal 15 ON is on.

Settings

The individual user settings can be adjusted from this menu. The main menu is activated as soon as terminal 15 ON is on.

Service Mode

Service mode is a special facility which provides information about the status of the display and user control system. The function is designed for use by BMW Service and is not intended to be accessible to vehicle owners. Service mode provides access to details of the hardware/software versions for the Central Information Display and the control units in the M-ASK network. As an addition to the comprehensive facilities of the diagnosis system, Service mode acts as a simple means of quickly accessing diagnostic data without the need for a diagnosis tester.

Activating Service Mode

In the main menu, press and hold the controller. Tactile feedback will then be generated.
- Turn controller 3 stops clockwise
- Turn controller 3 stops anti-clockwise
- Turn controller 1 stop clockwise
- Turn controller 1 stop anti-clockwise
- Turn controller 1 stop clockwise
- Press the controller to confirm, Service mode will then appear in the CID.

Workshop Exercise - Driver Information

1. *List the steps necessary to set a preset radio station.* ______________________

2. *What information is found under the heading "Car Data"?* ______________________

3. *What are the possible "program" options for the "Star" MFL Button?*

4. *List the steps necessary to reset the average speed reading.*

5. *Using the Controller and CID, set the door locks to "Relock door if not Opened"*

6. *What is the current setting of the speed dependent volume?* ______________________

7. *What is the current setting of the pathway lighting?* ____ *Increase the time setting by 2 increment levels. What is the setting?* ______________________

8. *Access the check control messages. What is the current message?* ______________________

Table of Contents

E60 Communication Systems

Subject **Page**

Model: E60

Production: Start of Production MY 2004

Communication Systems

Objectives:

After completion of this module you will be able to:

- Identify MOST system components and locations.
- Understand M-ASK functions.
- Recognize the HiFi and Top HiFi Systems.
- Know the Telematics System.

Information/Communication Technology IKT

New Features Compared to E39

- Multi-audio system controller M-ASK
- Car communication computer CCC (optional)
- Controller with simplified operation
- Navigation system integrated in CCC
- Top-HiFi amplifier with LOGIC7
- New fixed installation telephone system with GSM dual band and telematics
- Head-up display
- Voice input system integrated as software (CCC only)
- Rear compartment entertainment center with a second display and DVD changer
- Headset interface (not from series launch)

Multi-Audio System Controller

The multi-audio system controller M-ASK is the central control unit of the information and communications systems. The M-ASK combines up to four control units in one, used as the central control unit in the basic version.

M-ASK

CCC

The M-ASK combines the following control units in one housing:

- ASK
- Aerial amplifier/tuner
- MOST CAN gateway, interface to control display

In the E65, these modules are installed in separate control units.

The following advantages are achieved by combining several control units in one component:

- Fewer plug connections therefore fewer sources of fault
- Improved overall quality
- Less installation area required for control units
- Weight saving of control units
- Low closed-circuit current requirement

M-ASK Variants
Corresponding to the optional equipment configuration, the multi-audio system controller is installed in one of the following hardware variants:

- The M-ASK with CD drive features a single tuner and can be used worldwide. The M-ASK CD corresponds to the previous BMW radio Business CD and is fitted as standard.

- The M-ASK with CD-ROM drive can play back MP3 files and features a single tuner. It additionally receives the Weatherband in the US version. The M-ASK CD-ROM corresponds to the previous BMW radio Professional. (Not Available at SOP)

M-ASK Functions

The M-ASK undertakes the most important and central functions as well as control tasks in the communication network. It is responsible for the control and communication of the individual systems among each other. These tasks comprise the following main functions:

- MOST-CAN gateway
- LVDS driver
- MOST functions
- Radio function
- Audio master function
- Audio output stages

MOST-CAN Gateway

The M-ASK forms a gateway (interface) between the MOST bus and the K-CAN. The gateway connects the various bus systems of the vehicle network. The bus systems operate with different transmission rates and data formats. The information must be converted in the gateway in order to be able to use it in the various systems.

LVDS Driver

The LVDS driver (low voltage differential signal) receives the digital RGB signals from the graphic processor. The LVDS driver converts the RGB signals into LVDS signals and sends them via the LVDS cable to the central information display thus providing digital image signals on the display.

MOST Functions

System Master

The system master function that was still part of the control display on the E65/66 is now integrated in the M-ASK.

Power Master

In the E65/66 the power master function is in the control display and is now integrated in the M-ASK. The power master has following functions:

Wake-up, initialization, power-down

The power master wakes the bus and is responsible for ensuring correct initialization of the network. The network master is also responsible for initiating the power-down. Each power-down is requested at this master and initialized by it.

Network Master

The M-ASK is the network master for the MOST bus. The network master undertakes all control and monitoring tasks of the MOST bus. It performs following functions:

Configuration Control
The network master detects the exact system configuration each time that the network is started and compares it to a stored target configuration.

Fault Code Memory
The network master contains the central fault code memory of the MOST network. In addition to deviations from the specified configuration, all faults that occur during operation of the network are stored in this fault code memory.

Car Communication Computer

The car communication computer CCC is the central control unit of the High equipment. The CCC comprises the functions of the M-ASK, plus some additional functions. Voice control of the systems and the Professional navigation system with map presentation are additionally possible in connection with the CCC. The CCC also contains the driver for the rear passenger compartment display.
The CCC (to be introduced at a later date) will perform all the functions of the M-ASK as well as offering the High Navigation and additional programming possibilities.

Controller

The controller is the central control/operating element for all comfort and several car functions. The operating principle is identical to that of the E65. The directions in which the controller can be pushed has been reduced to four.
The controller comes in two versions, i.e. basic and High. The basic version is fitted with a mechanical locating mechanism for the checkback signal while in the High version the controller function is electrically generated for the check-back signal.

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Navigation System

The Professional navigation system features a map display in the central information display. The E60 no longer features a separate navigation computer. The navigation computer has been integrated in the CCC.

Top-HiFi Amplifier with LOGIC7

The E60 offers two different audio systems to choose from: HiFi and Top-HiFi. In the Top-HiFi version, the amplifier has a LOGIC7 function, i.e. there is optimum surround sound.

Telephone System

The E60 is equipped with the new fixed installation telephone system based on the Everest platform. It features various telematics functions.

Voice Input System

The CCC is combined with a voice input system, which can be used to execute most of the functions by way of voice commands in the communications network.

Head-Up Display

A further innovation in the E60 is the head-up display. Here additional information is beamed into the driver's field of vision. The driver can read this information without having to take his/her eyes off the road ahead, this representing an effective safety feature.

Rear-Compartment Entertainment Center

A rear-compartment entertainment centre will be provided at a later stage in conjunction with the CCC. This entertainment centre will allow the rear passengers to watch a DVD film on a second display in the rear compartment while the car is moving. TV reception with videotext will also be possible.

Headset Interface

The headset interface will allow passenger to listen simultaneously to different audio sources in the car (not at series launch).

Radio

The radio function is integrated in the M-ASK. The tuner is also located in the M-ASK. The tuner serves as the receiver. It converts the RF signal into an audio signal and transfers this signal via the audio output stages to the speakers.
The radio is controlled by means of the controller in the centre console and the menu in the central information display. The familiar control functions are available.
The M-ASK is offered with the following tuner variants:

- BMW radio with CD drive and single tuner
- BMW radio with CD-ROM drive and double tuner (Single Tuner at SOP)
- BMW radio with DVD drive and double tuner (Single Tuner at SOP)

The radios are world tuners, i.e. they can be programmed for all frequencies. The radios feature the familiar functions.

1. M-ASK
2. CID
3. Audio Speaker
4. Controller
5. AM/FM Antennas

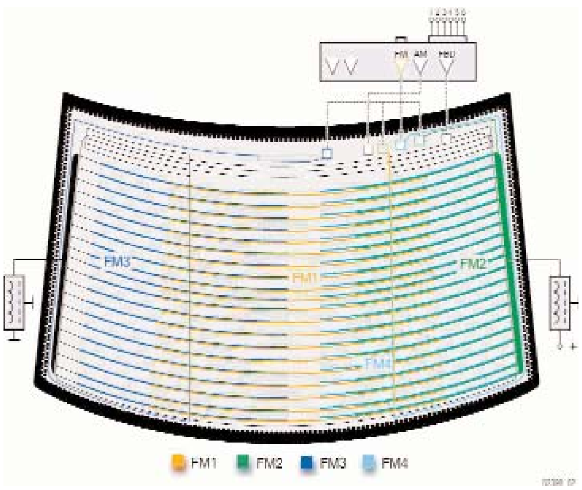
Antennas

The tuner is connected to the antenna diversity of the rear window via an antenna connector (Fakra) and a coaxial cable. The following antennas are located in the rear window:

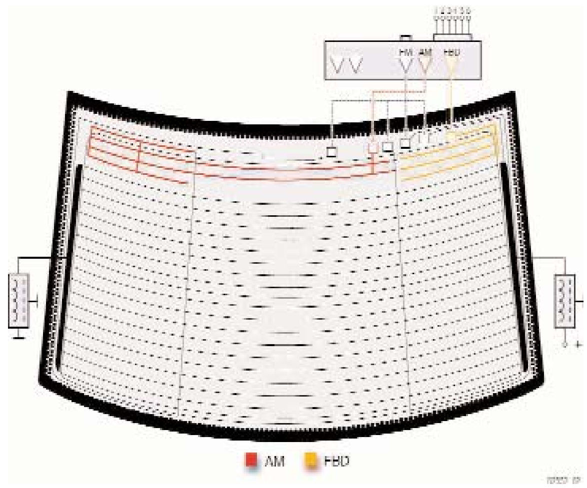
- FM antennas FM1-4
- AM antennas LW, MW, SW
- Remote control services (FBD) antenna

In addition to the antennas in the rear window, there is also a roof antenna for the telephone, GPS and satellite radio (US only).

The antenna structures are located on the inside and are the same on all rear windows. They are applied in a screen print process. The heating conductors of the rear window defogger are integrated in the antenna structures.
The carrier frame for the antenna diversity module is bonded at the top right directly to the rear window. The antenna diversity module is clipped onto the carrier frame and is connected by means of spring contacts to the antenna structure.



FM antenna arrangement in the E60



AM/FBD antenna arrangement in the E60

Note: Particular care must be taken when removing the antenna diversity module to ensure that the clips of the carrier frame do not break off, otherwise the rear window will have to be renewed.

Audio Master Function

One of the main functions of the M-ASK is the audio master. The task of the audio master is to collect, process and output all audio signals in the vehicle.
A further task of the audio master is to generate and make available the audio signals (with exception of the direction indicator noise) required by the various systems in the vehicle. The special acoustic signals are required for warnings or as information for the driver such as the PDC signal, jingles (gong).
In addition to the generated audio signals, the following audio signals are processed and output or made available on the MOST bus.

- Radio
- CD changer
- Telephone
- Navigation message
- AUX-In
- SDARS (US only)

The M-ASK controls all sound and acoustic setting requirements of the customer. The level of a signal is not changed abruptly but rather smoothly, e.g. by mixing, fading in and fading out or intermittent attenuation of the signal in the sink for the purpose of achieving high quality overall acoustics.
The M-ASK ensures clear cut acoustic changeover between the sources when a control unit is requested to output an information or warning signal. The acoustic signals or audio sources requested in the M-ASK are output in accordance with a defined priority structure.

Connection Master

The task of the connection master is to make available the channels for the audio sources and the acoustic signals.
The audio signals are distributed over speakers defined in a list.

- Example 1: entertainment sources at all speakers
- Example 2: hands-free telephone front left and right

Audio Output Stage

The multi-audio system controller M-ASK features 4 audio output stages each with a 25W output rating. The output stages are designed as bridgetype output stages. An electric fan feeds cooling air to the output stages and processors to ensure they do not cause the M-ASK to heat up. The electric fan is temperature-controlled and is regulated in three stages.

Audio Systems

Two audio systems are available:

- HiFi audio system
- Top-HiFi audio system

The further developed central bass system have realized a distinct improvement in the bass range compared to the E39. The Top-HiFi audio systems offers additional features such as 7-band graphic equalizer and surround sound.

HiFi

HiFi Components

The HiFi audio system is the standard system in the E60 and consists of the following components:

- Multi-audio system controller M-ASK
- Central information display CID
- Controller
- Front left and right mid-range speaker
- Left and right central woofer
- Rear left and right mid-range speaker
- HiFi Amplifier
- Front left and right tweeter (high-range speaker)
- Rear left and right tweeter (high-range speaker)

Multi-Audio System Controller

The M-ASK controls the stereo audio system. It contains the tuner for radio reception. Furthermore, the output stages for the audio outputs are integrated in the M-ASK. The M-ASK features four output stages each with an output power of 25 W.

Central Information Display

The CID serves the purpose of displaying and controlling the radio and audio functions.

Controller

The menus in the CID are selected and activated via the controller.

Mid-Range Speakers

The front and rear mid-range speakers are identical. In the HiFi audio systems, the speakers have a load rating of 25 W. The midrange speaker is equipped with a paper diaphragm. The effective frequency range is from 100 Hz to 15000 Hz.
The front mid-range speakers are located in the doors. The rear midrange speakers are mounted under the rear window shelf.

Central Woofers

High sound pressures can be achieved with the aid of the central woofers. A sufficiently large space for the resonance volume is made available by connecting the central bass housing to the sill area of the vehicle. The high sound pressures of the central woofers create a distortion-free bass in the low frequency range.
The two central woofers are located in the vehicle floor under the driver's and passenger's seats. The output of the central woofers is directed upward under the seats.
Modified central woofers are used in connection with the HiFi audio system. The central woofers have a diameter of 200 mm and a load bearing capacity of 40 W. The transmitted frequency is between 30 Hz and 500 Hz.

HiFi Amplifier

The HiFi amplifier is designed as an analogue two-channel amplifier with an output power of 2x40 W. The HiFi amplifier is connected via two channels to the M-ASK. The input signals are amplified via integrated band filters and bridge-type output stages to 2x40 W and output to the central woofers.
The control takes place via the M-ASK. Due to the distribution of the output stages in the M-ASK and in the HiFi amplifier, the output stages must be switched on/off synchronously. The time required to switch on the output stages must not exceed 25 ms to ensure no crackling or clicking noise is heard.
The HiFi amplifier does not feature diagnostic capabilities.
The HiFi amplifier is installed on the rear left in the luggage compartment.

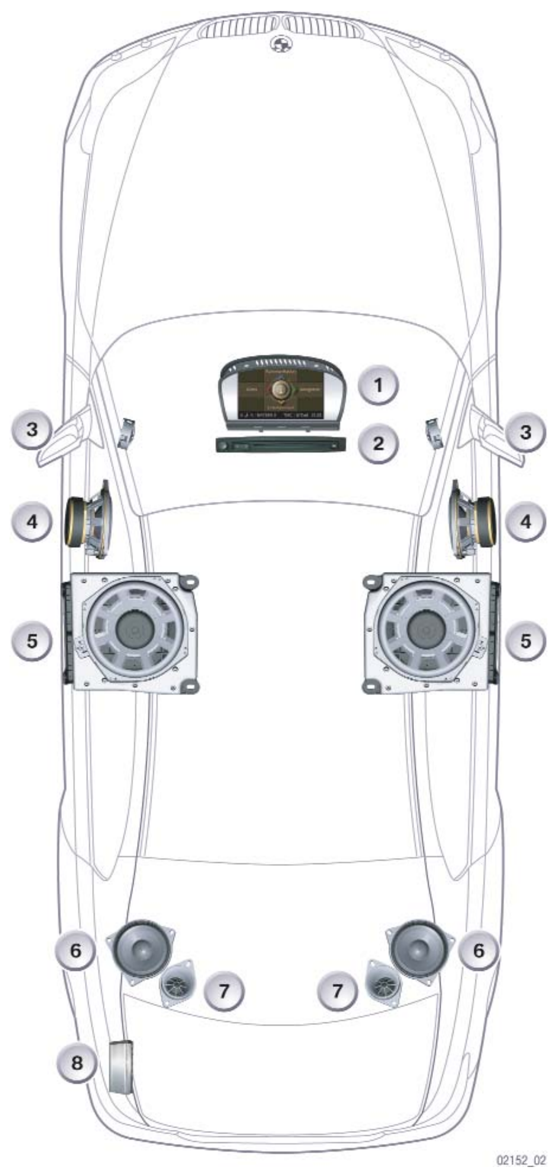
Tweeters (High-Range Speakers)

The HiFi audio system features additional tweeters (high-range speakers) at the front and rear. In connection with the HiFi audio system, the speakers are designed with a load rating of 25 W. The tweeters are equipped with spherical caps made of silk. The effective frequency range is from 5000 Hz to 20000 Hz.

The tweeters are connected in parallel with the supply line of the front mid-range speakers. The frequency range is determined by means of capacitors in the supply line. The tweeters feature an enclosed selfcontained design, i.e. the speakers and resonance volume form one unit.

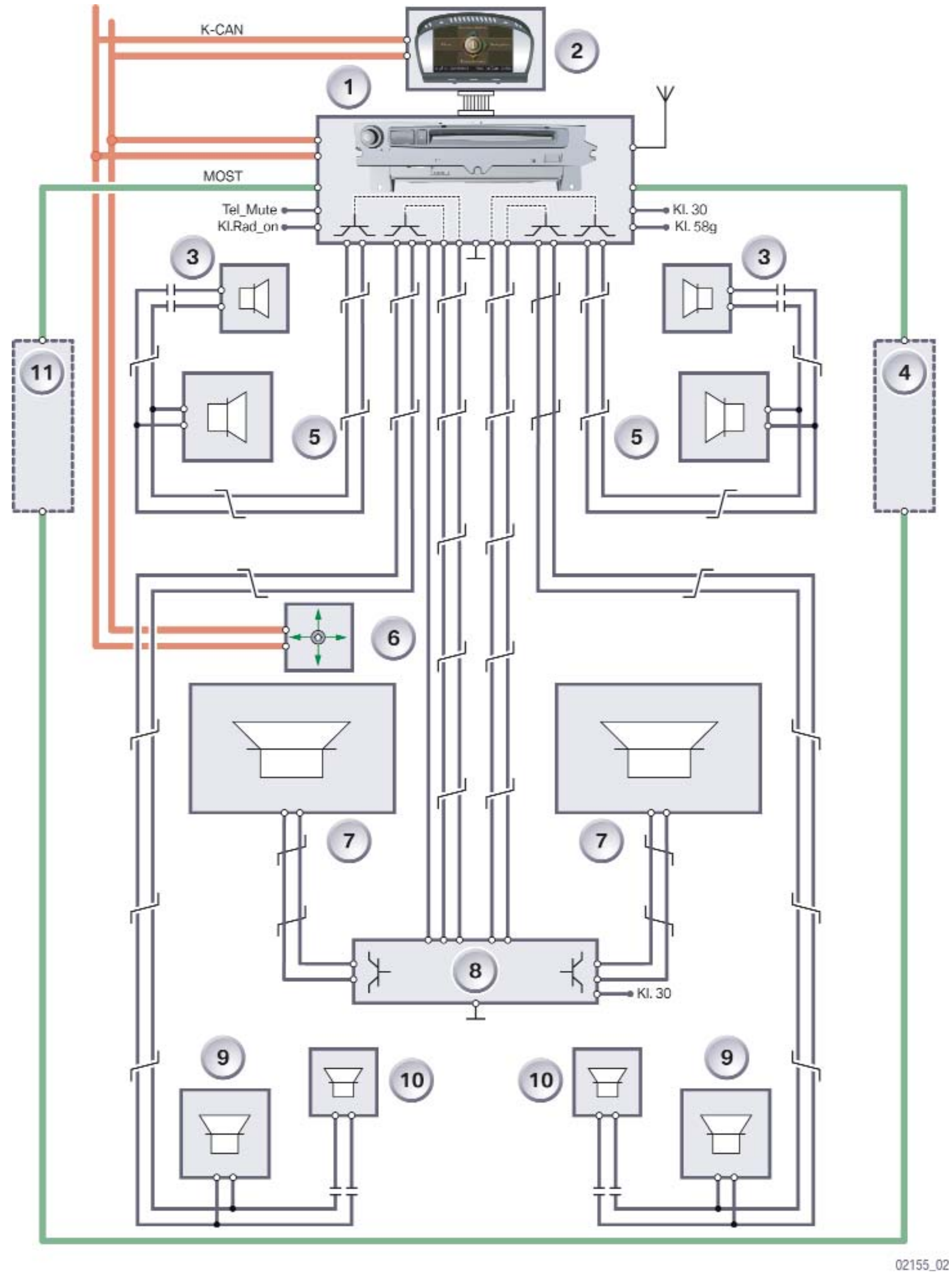
The front tweeters are located in the mirror triangles while the rear tweeters are mounted under the rear window shelf.

HiFi System Speaker Layout



1. CID
2. M-ASK
3. Tweeter, Front
4. MidRange, Front
5. Central Woofer
6. Mid Range Rear
7. Tweeter, Rear
8. HiFi Amplifier

Hi-Fi System Schematic



1. M-ASK
2. CID
3. Tweeter, Front
4. Other MOST Bus users
5. Mid Range, Front
6. Controller
7. Central Woofer
8. HiFi Amplifier
9. Mid Range, Front
10. Tweeter, Rear
11. Other MOST Bus users

Top HiFi

Top HiFi Components

The Top-HiFi audio system differs from the HiFi audio system by higher grade speakers and the addition of following components:

- Top-HiFi amplifier
- Front mid-range speaker mounted centrally in instrument panel
- Mid-range speakers in rear left and right doors

Higher grade speakers are used in the Top-HiFi audio system. The midrange speakers are equipped with aluminum diaphragms, the tweeters with aluminum spherical caps. The speakers were adapted corresponding to the higher output power of the Top-HiFi amplifier.

Top-HiFi Amplifier

The Top-HiFi amplifier is designed as an analogue 7-channel amplifier (LOGIC7). It features 7 bridge-type output stages with an output power rating of 7x40 W at 2 and a bandwidth of 200 Hz - 20 kHz. In addition, two bridge-type output stages rated 2x70 W at 4 and a bandwidth of 20 Hz - 200 Hz are available for the central woofers.
This amplifier is connected via the MOST bus to the M-ASK. All audio signals are transmitted from the M-ASK via the MOST bus. The Top-HiFi amplifier is equipped with the LOGIC7 function.

LOGIC 7

LOGIC7 is a registered trademark of Lexicon, Inc., a company of the Harman International Group. It was especially developed for applications in motor vehicles.
LOGIC7 is a sound system that creates a 7-channel surround sound from 2-channel audio sources (radio, CD, CC). The incoming stereo signals are decoded in the digital sound processor (DSP), distributed over 7 channels and remixed. The entire transmission width is used on each channel, thus creating perfect surround sound that gives the listener the impression of being in the middle of the space.

Mid-Range Speakers

The load rating of the mid-range speakers was increased to 40 W for the Top-HiFi audio system. The mid-range speakers are equipped with aluminum diaphragms. aluminum diaphragms are particularly lightweight and feature a higher rigidity. These properties result in improved inherent dynamics and a clearer sound over the entire frequency range.
The effective frequency range is from 100 Hz to 10000 Hz. The Top-HiFi audio system was extended by three mid-range speakers. A mid-range speaker was positioned in the center of the instrument panel in order to realize the surround sound function in the vehicle. Two further mid-range speakers were integrated in the rear doors.

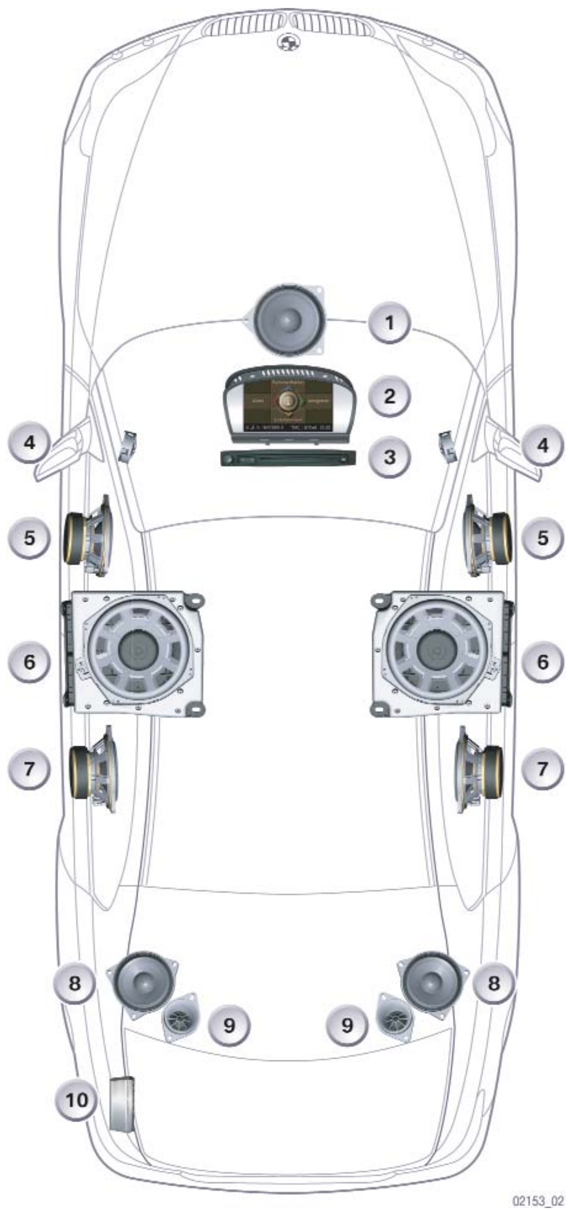
Tweeters (High-Range Speakers)

The tweeters (high-range speakers) have also been adapted. The load rating was increased to 40 W. The tweeters are equipped with aluminum spherical caps. They feature sealed design. The effective frequency range is from 5000 Hz to 20000 Hz.

Central Woofers

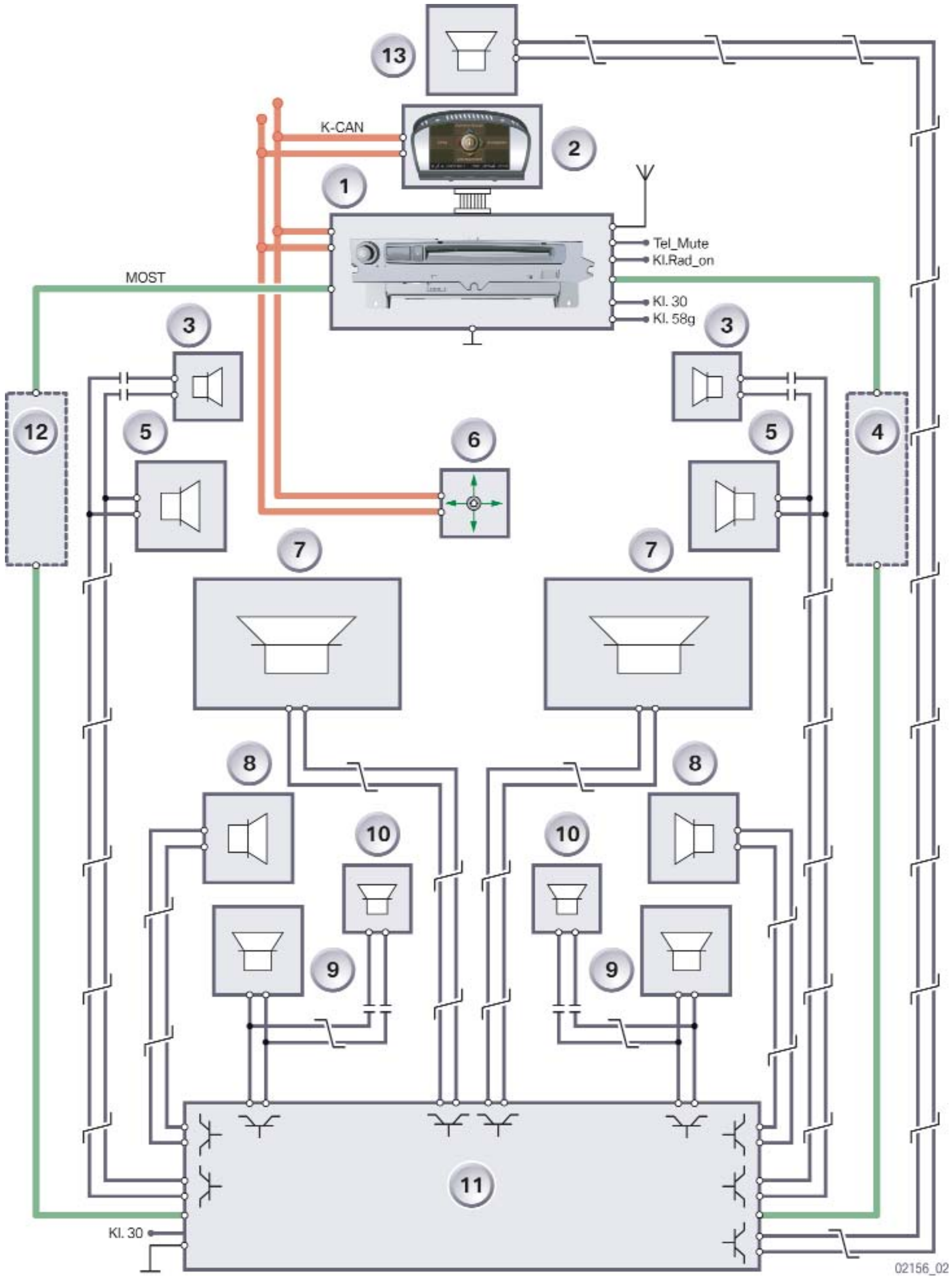
Compared to the HiFi audio system, further modified central woofers are used in the Top-HiFi audio system. The central woofers have a diameter of 200 mm and a load bearing capacity of 70 W. The transmitted frequency is between 30 Hz and 500 Hz.

Top-HiFi Speaker Layout



1. Front Center Speaker
2. CID
3. M-ASK
4. MidRange, Front
5. Tweeter, Front1
6. Central Woofer
7. Mid Range Center
8. Mid Range, Rear
9. Tweeter, Rear
10. Top HiFi Amplifier

Top HiFi Schematic



1. M-ASK
2. CID
3. Tweeter, Front
4. Other MOST Bus users
5. Mid Range, Front
6. Controller
7. Central Woofer
8. Mid Range, Center
9. Mid Range, Front
10. Tweeter, Rear
11. Top HiFi Amplifier
12. Other MOST Bus users
13. Mid Range, Front Center

Audio CD Changer

The audio CD changer in the E60 is a new development. The following details have changed:

- The housing dimensions are smaller and more lightweight
- The magazine is newly designed
- The CD changer has an optical bus link

The magazine is newly designed and now features a transparent cover making it possible to see what compartment is loaded with a CD. The new design now also differentiates distinctly from the DVD magazine.
As before, the CD changer is designed as a 6-compartment changer with magazine. The housing dimensions have been distinctly reduced so that less space is required, making it possible to fit he CD changer in the glove compartment.

The CD changer is located in the units carrier behind the glove compartment. The glove compartment must be opened in order to change the magazine.

A new feature is the optical link to the MOST bus. The CD changer sends the digital audio signals via the MOST bus to the multi-audio system controller.
In the Top-HiFi audio system, the digital audio signals are sent directly to the Top-HiFi amplifier. All controls and operating signals are also sent via the MOST bus.

Telephone Systems

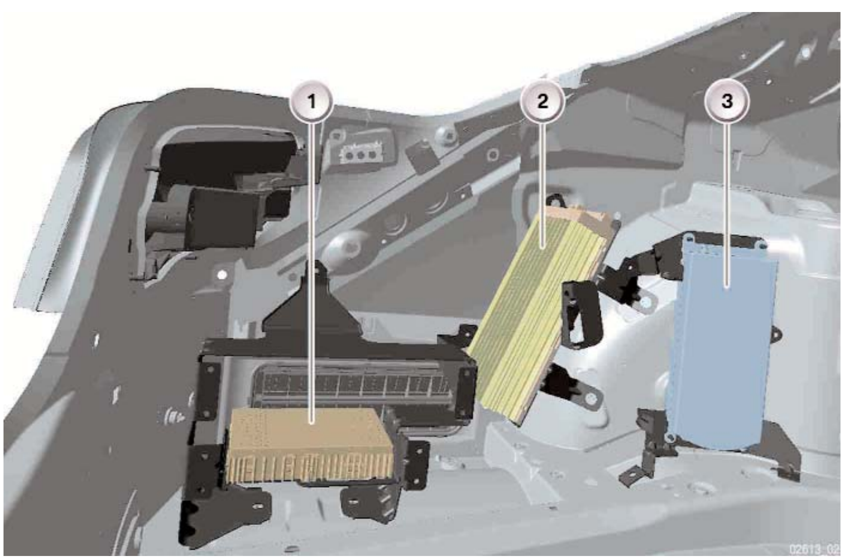
In the country-specific version US, the option comprises the complete telephone preparation including telematics. A part of the telephone preparation is installed ex-factory, the remainder is retrofitted in the USA. The complete preparation consists of the following components:

- Telematic control unit TCU (standard)
- Telephone antenna (standard)
- SOS antenna (standard)
- GPS antenna (standard)
- Bluetooth antenna (standard)
- Hands-free microphones (standard)
- Eject box (retrofitted in USA)
- Motorola mobile phone Phoenix V60 (retrofitted in USA)
- Compensator (retrofitted in USA)
- Emergency call included for one year, then optional customer pay.

Telematic Control Unit

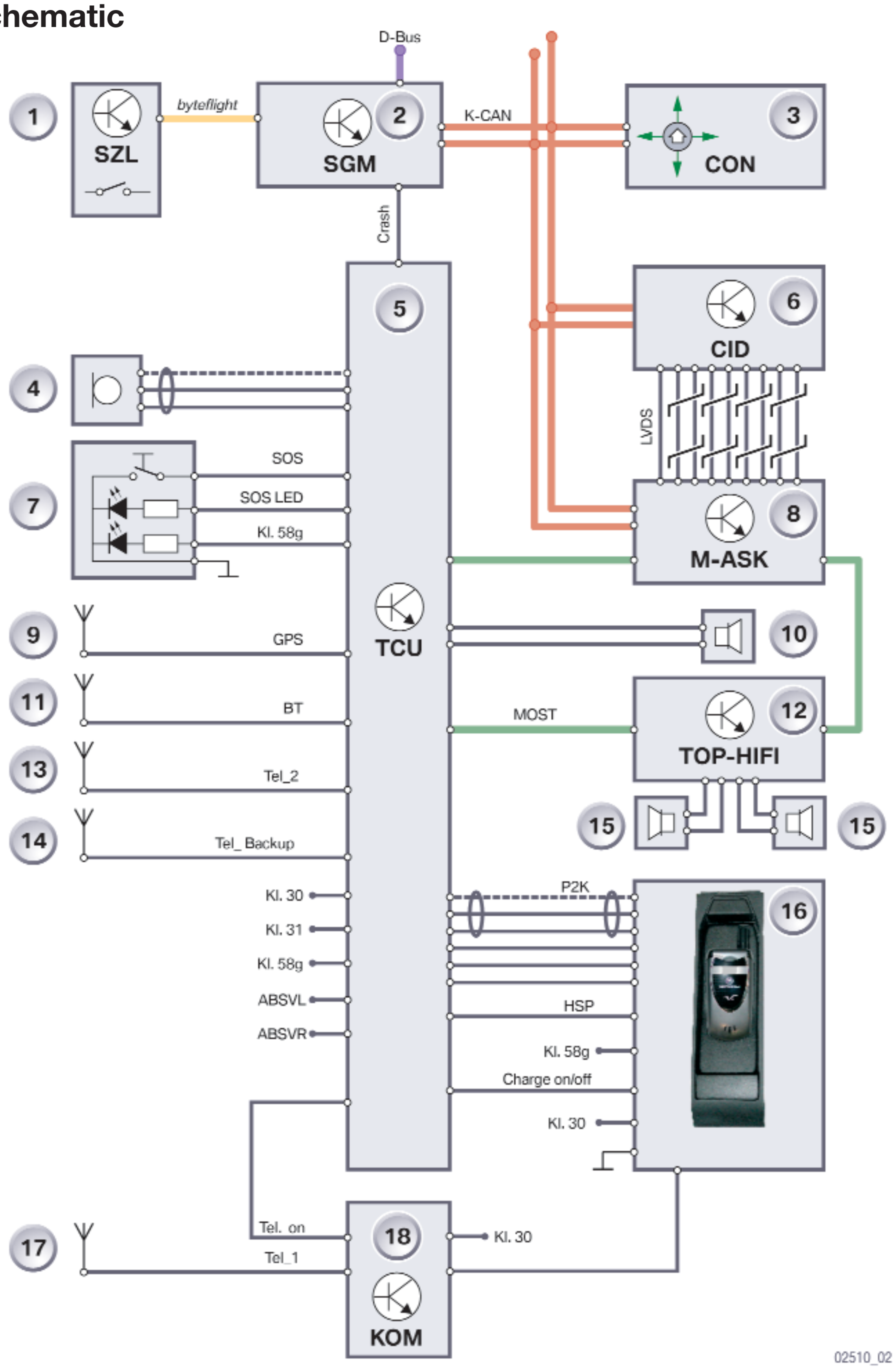
The TCU is always installed in the country-specific version US even if no telephone was ordered. The telematic functions emergency call and breakdown call are standard features. The scope of functions differs from the EU version by following features:

- The TCU is always installed to facilitate the emergency call even if no telephone is fitted
- Dual band 800 MHz and 1900 MHz
- Combined transceiver module NAD (network access device) for the analogue AMPS standard (American Mobile Phone Standard) and the digital CDMA standard (Code Division Multiplex Algorithm)
- Eject box with charger for Motorola Phoenix V60
- Telematics Unit (E/B) Call
- GPS Receiver



1. Satellite Radio Receiver
2. Top HiFi Amp
3. Telematic Control Unit

Telephone Schematic



1. Transmit/Receive Button
2. SGM
3. Controller
4. Hands free microphone
5. TCU
6. CID
7. Emergency Call Button
8. M-ASK
9. GPS Antenna
10. SOS Speaker
11. Bluetooth Ant.
12. Top HiFi Amp
13. CDMA Ant.
14. SOS Ant.
15. Speaker
16. Eject Box
17. AMPS Ant.
18. Compensator

Voltage Supply and Power Management

The power management module in the TCU monitors and controls the voltage supply of the telephone system. The telephone system is switched off in the event of undervoltage/overvoltage in the system network.

MOST Bus Interface

The TCU is connected via the MOST bus interface to the MOST bus and therefore to the bus systems of the vehicle. Control data (e.g. telephone book entries) and audio signals for voice output (voice of call partner) are transmitted via the MOST interface. The TCU is woken up by the MOST bus.

Bluetooth Antenna

The Bluetooth antenna operates in the ISM band (industrial science medical band) on a frequency of 2.45 GHz. It is located under the rear window shelf. It is connected directly to the TCU.

Note: To ensure unrestricted reception, care should be taken to ensure that no objects are placed on the rear window shelf as they could considerably influence the reception capability of the Bluetooth antenna. *(Not available at SOP)*

Multifunctional Steering Wheel

The multifunction steering wheel has a send/receive button for accepting and ending a call. The TCU switches to hands-free mode if the call is accepted by pressing the receive button.

Multi-Audio System Controller M-ASK

The multi-audio system controller is responsible for the control of the MOST bus and channel allocation. It also controls the audio output at the speakers.

Controller

The controller is used to operate the telephone functions. Various menus can be selected and the functions executed with the aid of the controller.

Design

The design of the TCU in the US version is identical to that of the EU version (Everest platform). The difference is in a different transceiver module (NAD) that is adapted to the specific requirements. The TCU features a modular design and is equipped corresponding to the country-specific version and requirements.

Operating Principle

In the US version, the telematic control unit features a combined transceiver module NAD (network access device). The NAD operates in accordance with the AMPS/CDMA standard with the frequencies 800/1900 MHz.

The TCU features an antenna selector switch for the AMPS/CDMA antenna. The TCU operates in the digital CDMA network. If a sufficient network supply cannot be ensured, the TCU switches over to the AMPS network. The widespread AMPS network is used especially in rural areas.
If the option Professional navigation system is not installed, the TCU will be fitted with an internal GPS receiver. The GPS receiver is connected to the GPS antenna that is integrated in the roof antenna. In the US version, the telephone/telematics functions are available in three stages:

- Basic
- Business
- Professional

Eject Box

The eject box is an additional component that must be retrofitted in the USA. The eject box serves the purpose of accepting the Motorola Phoenix V60 mobile phone and is located in a compartment in the centre console.

The charger for the mobile phone is integrated in the eject box. The antenna connection for the AMPS antenna is also located directly in the eject box. Data transfer from the mobile phone to the TCU takes place by means of a multi-core cable (P2K, point to connect).

Motorola Mobile Phone Phoenix V60

The Motorola Phoenix V60 mobile phone is the standard telephone in the US version. The mobile phone is also a component part of the retrofit.
All functions are available only when the mobile phone functions are provided. The telephone book is integrated in the mobile phone. SMSs can only be sent with the mobile phone.

Compensator

The compensator is connected in the antenna line between the roof antenna and the mobile phone. The task of the compensator is to compensate for losses on the antenna line and to ensure the full transmit power of the mobile phone is available at the roof antenna. The compensator is not an amplifier that boosts the transmit power output.

SOS Antenna

The SOS antenna is fitted as standard under the rear window shelf. It ensures an emergency call can be sent even after a crash and failure of the roof antenna.

GPS Antenna

The GPS antenna is integrated in the roof antenna. It receives the signals from the satellites of the global positioning system and sends these signals to the GPS receiver.

Workshop Exercise - Communications

1. *Why does the Basic Controller NOT include the Speech Recognition Button?*

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2. *What happens to the radio sound when the MOST Bus fails in a vehicle equipped with*
   Top HiFi? ______________________________
   HiFi? ______________________________

3. *Does the SOS call function operate if the MOST Bus is down?* ______________

4. *What is the location of the SOS antenna?* ______________________

5. *Why does the TCU include a GPS receiver in vehicles equipped with Navigation?*

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