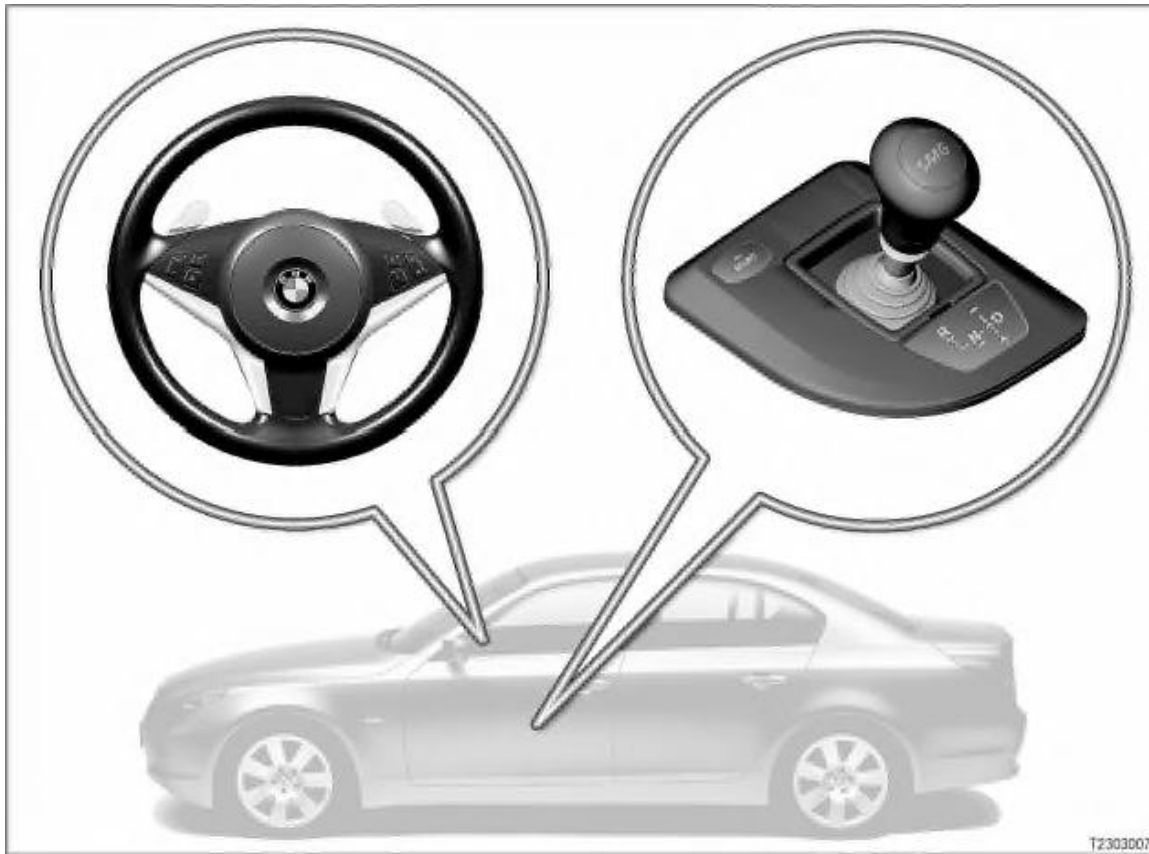


Sequential manual transmission (SMG)

E60



Introduction

The sequential manual transmission (SMG) has its origins in motor racing and has in time been modified for use in series production.

In detail, SMG means that in contrast to a conventional manual transmission, the clutch control and gear change are automated. An electrohydraulic control system takes over the clutch operation and gearshifts.

The SMG can be driven in manual mode or in automatic mode, as follows:

- Manual mode: sequential, manual gearshifts

Gears are selected in sequence (sequentially) by briefly pressing "+" or "-". Gears can be skipped by rapidly pressing the button repeatedly.

Gears are changed by one of the following means:

- Gear lever in the center console, or
- 2 gearshift paddles on the steering wheel.

The shift pulse is transmitted electrically to the SMG control unit. With this gearshift method ("shift-by-wire") there is no mechanical linkage between the gear lever or gearshift paddles and the transmission.

- Automatic mode = D:

In automatic mode, the shift points are automatically controlled according to characteristic curves and are adapted to the driving situation. [System overview ...]

The SMG is available as special equipment (option 206) and is employed in the E60 with the following engine/transmission versions:

- GS6S37BZ for engine M54B30
- GS6S53BZ for engine N62B44

The GS6S53BZ differs from the GS6S37BZ by having a more powerful clutch actuator and modified geometry in the expansion tank.

The SMGs are based on the 6-speed manual transmissions GS6-53BZ and GS6-37BZ.

The principal benefits of the SMG compared to a conventional manual transmission:

- No clutch pedal as the clutch is operated automatically
- Selection of 4 operating modes:
 - Manual mode
Sequential, manual gearshift via gear lever or gearshift paddles
 - Manual mode with Dynamic Driving Control (FDC) via SPORT button
Sporty driving style by power steering being adapted (only with Servotronic) and intervention in engine and transmission control
 - Automatic mode = D ("Drive")
 - Automatic mode with Dynamic Driving Control (FDC) via SPORT button
Sporty driving style by power steering being adapted (only with Servotronic) and intervention in engine and transmission control
- Short and precise gearshifts, no incorrect gearshifts possible (gear change in approx. 0.15 seconds)
- Safety and comfort: Because the gearshift paddles are on the steering wheel, you can keep your hands on the steering wheel when you change gear.

Launch date:

Launch date is 11/2003.

Brief description of components

The SMG system comprises the following components:

- Gear lever with mounting block and gear lever cover

The gear lever allow gears to be changed in sequence (sequentially) by brief pressing.

The gear lever has 6 positions:

- 3 engaging positions for neutral ("N"), reverse gear ("R") and manual mode (" -" symbol between "N" and "D").
- 3 one-touch positions for "+", "-", "D".

The gear lever lock (shift-lock) is also installed in the mounting block.

The illuminated gear lever position indicator is located in the gear lever cover. [more ...]

- Steering wheel with 2 gearshift paddles

The steering wheel with 2 gearshift paddles allows manual gear changes without the driver having to take his hands from the steering wheel. When one or both of the gearshift paddles is pulled, the transmission will shift up, when one (or both) is pressed, the transmission will shift down. [more ...]

- SPORT button for Dynamic Driving Control (FDC)

Dynamic Driving Control (FDC) is activated with the SPORT button: Gearshift times are shortened and the shift characteristics are made more sporty. The engine responds more spontaneously to movements of the accelerator pedal. The steering and retaining forces on the steering wheel are configured to be more sporty (only with Servotronic, option 216).

FDC is always deactivated when the engine is started. [more ...]

- **Hydraulic unit with sensors**

Clutch actions and gear changes are automatically executed by the hydraulic unit and the sensors.
[more ...]

- **Gearshift and selector angle actuator**

The gearshift and selector angle actuator shifts the selector shaft along its longitudinal axis and turns the selector shaft to change shift gate. [more ...]

- **Shift travel sensor and selector angle sensor**

The gear engaged is recognised from the shift travel sensor and the selector angle sensor:

The shift travel sensor detects the forwards and backwards movements of the selector shaft in the respective shift gate.

The selector angle sensor recognises how far the selector shaft turns, and so recognises a change of shift gate. [more ...]

- **Pressure accumulator**

The pressure accumulator is fitted on the bottom left of the transmission and makes sure that there is always sufficient oil pressure for a gearshift to be executed.

A freely moving piston subdivides the pressure accumulator into 2 chambers. One chamber is charged with nitrogen at approx. 27 bar and -25 °C (lifelong charge). The other chamber takes up oil from the hydraulic pump. Here, the oil exerts pressure on one side of the piston, compressing the nitrogen. In this way, the compressed nitrogen retains the oil pressure for gearshifts.

- **Hydraulic pressure sensor**

The hydraulic pressure sensor is installed directly on the hydraulic unit valve block and reports the current oil pressure to the SMG control unit. The hydraulic pump is switched on and off as required.

- **Clutch actuator with clutch travel sensor**

The clutch actuator executes the clutch operations. The release travel is recorded by the clutch travel sensor. [more ...]

- **Hydraulic pump with electric motor**

The hydraulic pump with electric motor builds up a system pressure of up to 55 bar for the gearshifts and is actuated by the SMG control unit.

- **Inductive sensor for transmission input speed**

The inductive sensor measures the transmission input speed. The SMG control unit compares this speed with the engine speed and computes the closing speed of the clutch (i.e. how fast the clutch can establish the optimal power flow between the engine and the transmission).

- **Expansion tank**

The expansion tank makes sure that there is always sufficient hydraulic fluid available in the system. The expansion tank has maximum and minimum marks for checking the oil level.

- **Valve block**

The valve block contains the solenoid valves, the hydraulic pressure sensor, the pressure accumulator and a check valve.

- **Solenoid valves**

A total of 4 solenoid valves are installed in the valve block.

3 solenoid valves control the clutch actuator and the gearshift and selector angle actuator.

1 solenoid valve controls the selector angle brake (to change shift gate). At the same time, the solenoid valve serves as a pressure relief valve for the hydraulic system.

- **SMG control unit (sequential manual transmission)**

The SMG control unit (GS35) computes the actuation of the solenoid valves for clutch operation and gear change. Moreover, the SMG control unit sends information to various control units, e.g. to the engine speed adjustment, to the transmission program indicator. [more ...]

- **Reversing light**

The reverse light is switched on on the basis of messages from the SMG control unit to the light module (LM).

Signal path: Signals from shift travel sensor and from selector angle sensor --> SMG control unit --> PT CAN --> Safety and gateway module (SGM) --> K CAN --> Light module (LM)

- **Transmission**

The transmission housings of the 6-speed manual transmission GS6-37BZ and GS6-53BZ have been modified to accommodate the following components:

The hydraulic unit with actuators for clutch operation and gear change, plus additional sensors (shift travel sensor, selector angle sensor, inductive sensor for transmission input speed).

The construction of the transmission and clutch are unchanged.

- **Instrument cluster display**

The following information is displayed on the LCD display (liquid crystal display) in the instrument cluster: The selected drive position, transmission program, Check-Control messages and use of emergency program. [more ...]

Additional measured variables from the following components:

- **Brake light switch**

The brake-light switch signal is transmitted through the PT-CAN (powertrain controller area network) by the DME control unit. For reasons of safety, the signal is also transmitted by a direct wire from the brake light switch to the SMG control unit.

The brake-light switch signal is used for the following operations:

- To release the shift lever lock (shift-lock)
- To detect a brake application
- To shift to "N" when the engine is shut-down

- **Starter inhibitor**

The car access system (CAS) does not enable the starter motor until the SMG control unit emits the release signal. The following conditions must be satisfied for the start to be enabled:

- The gear lever must be in position "N".
The LCD display in the instrument cluster must show "N", indicating that the transmission is also in "N".
- The SMG control unit enables the start, the clutch is opened.

- **Servotronic (option 216)**

The Servotronic controls the power steering assistance depending on the current driving speed. The electronic adaptation of the system pressure in the power-steering pump ensures a high level of power steering assistance at low speeds and lower levels of power steering assistance at higher speeds.

When Dynamic Driving Control (FDC) is active, the Servotronic is switched to a more sporty map by the safety and gateway module (SGM).

System functions

The SMG comprises the following functions:

- Engine start
- Gearshift

- Driving in gear lever position "D" (automatic mode)
- Launch control (acceleration assist system)
- Rock free, e.g. from snow
- Vehicle standstill
- Gear lever position neutral and ignition off
- Emergency program

Engine start

To start the engine, the gear lever and transmission must both be in "N" (neutral).

When the engine is started, sufficient system pressure must immediately be built up to open the clutch. For this reason, the SMG control unit is activated by a wake-up signal from the car access system (CAS) when the vehicle is unlocked. The SMG control unit measures the system pressure via the hydraulic pressure sensor. If the system pressure is too low, the hydraulic pump will be actuated. The hydraulic pump will build up pressure. When the system pressure has been reached, the SMG control unit will switch the hydraulic pump off again.

With the "wake-up signal", the gear lever position indicator in the centre console is activated. If terminal 15 (wake-up wire) has not been activated approx. 15 minutes after the vehicle was unlocked, the gear lever position display will be switched off again.

Gearshift

If a gearshift is initiated in manual or automatic mode, the SMG control unit will actuate the corresponding solenoid valves in the valve block.

The pressurised hydraulic fluid flows into the clutch actuator and opens/closes the clutch.

At the same time, the SMG control unit sends information to the DME control unit that a gearshift has been initiated and that engine torque must be reduced.

In the next step, the gearshift and selector angle actuator is actuated. At the same time, the gearshift and selector angle actuator executes the forward/backward movement of the selector shaft, and if necessary turns the selector shaft.

During the gearshift, the engine speed may be raised as necessary to allow the clutch action to be completed more quickly and more smoothly.

When the gear is engaged, the clutch will automatically close.

The SMG control unit receives the precise clutch position from the clutch travel sensor.

After the gear change, the solenoid valves are actuated without the use of current.

The course of the entire gearshift depends on the pedal sensor position, road speed, engine speed and other factors (e.g. engine oil temperature).

Just before the vehicle reaches a standstill, the SMG will shift into 1st gear and open the clutch. The transmission of power between the engine and transmission is broken.

Gearshifts that would result in an excessively high or low engine speed are suppressed.

Driving in gear lever position "D" (automatic mode)

- Constant-speed travel

Continuous changes of the pedal sensor position (opening and closing the throttle) are registered in the SMG control unit. The SMG control unit then suppresses a pendulum shift between adjacent gears (up and down, e.g. on a motorway with constantly changing speed).

- Upshift suppression

The SMG control unit recognises from the pedal sensor position when the throttle is rapidly closed, e.g. before a brake application.

The SMG control unit suppresses the upshift. This ensures that the engine braking effect is retained and supports the braking action.

- **Driving uphill**

The SMG control unit recognises when the vehicle is driving uphill from the data from the wheel speed sensors and the accelerator pedal sensor position, and then prevents unnecessary upshifts and irritating pendulum shifts (e.g. at constantly high engine speed and foot taken from accelerator pedal).

- **Driving downhill**

Signals from the throttle-valve potentiometer (load signal), the wheel speed sensors (road speed) and the brake-light switch allow the SMG control unit to recognise when the vehicle is driving downhill. To maintain and increase the engine's braking effect, the SMG control unit will shift down a gear as road speed increases.

- **Braking deceleration and automatic downshift**

The SMG control unit recognises braking deceleration via the brake light switch, the wheel speed sensors and the accelerator pedal sensor position.

The SMG control unit shifts down according to road speed to maintain the engine's braking effect. As this happens, several gears may be skipped. The correct gear is automatically selected when the vehicle accelerates again.

- **Manual intervention in automatic mode**

When the gear lever or the gearshift paddles are operated in automatic mode, the system will automatically change to manual mode.

Automatic mode must be selected again.

Launch control (acceleration assist system)

Preconditions for launch control:

- High-grip road surface
- Dynamic Stability Control (DSC) deactivated (DSC button pressed for longer than 3 seconds)
- SPORT button pressed

Launch control allows the best possible vehicle acceleration from a standstill, on a par with racing cars. Normally, the clutch is engaged at approx. 1300 rpm. With launch control, the speed is increased to approx. 4000 rpm before the SMG system closes the clutch. For this to happen, the accelerator pedal only has to be quickly and fully depressed (kickdown).

When launch control is active, the system will automatically shift up through the gears, even in manual mode. This prevents the engine from reaching critical speeds.

Launch control is deactivated as follows: by releasing the accelerator pedal (cancelling the kickdown function), by executing a manual gear change, by deactivating Dynamic Driving Control (FDC) with the SPORT button, or by activating DSC

Important. Launch control can lead to increased wear of components.

During the running-in phase of a new vehicle, do not accelerate the vehicle using launch control. Excessively frequent use of launch control can cause increased wear of components.

Rocking free, e.g. from snow

To rock the vehicle free, e.g. from snow, the gear lever can be moved rapidly from 1st gear, via position

"N" to position "R" and vice versa. The gearshift must be completed within the space of 0.8 seconds as the gear lever lock (shift-lock) will otherwise be activated.

Vehicle standstill

If the SMG control unit recognises a vehicle standstill (from the accelerator pedal position sensor, the wheel speeds and the engine speed), the clutch will be opened and 1st gear engaged, regardless of the driving program (manual mode or automatic mode).

If the engine is running and the driver's door is opened, an acoustic signal will indicate that a drive position is still engaged and that the transmission is not in position "N" or "P". At the same time, the "N" symbol flashes nine times in the LCD display in the instrument cluster as a reminder.

If despite this, neither the pedals, the gearshift paddles nor the gear lever are moved, the gear will automatically be cancelled after approx. 2 seconds.

Gear lever position neutral and ignition off

If the gear lever is in "neutral" and the ignition is switched off, the "N" symbol in the LCD display in the instrument cluster will flash. In addition, the multi-audio system controller (M-ASK) will emit an acoustic warning.

Emergency program

In the emergency program, the vehicle remains operational, albeit with limitations.

Only the gear lever positions "R", "N" and 1st to 3rd gears are available. Depending on the type of transmission fault, the vehicle may no longer be operational after a vehicle standstill.

Notes for service staff

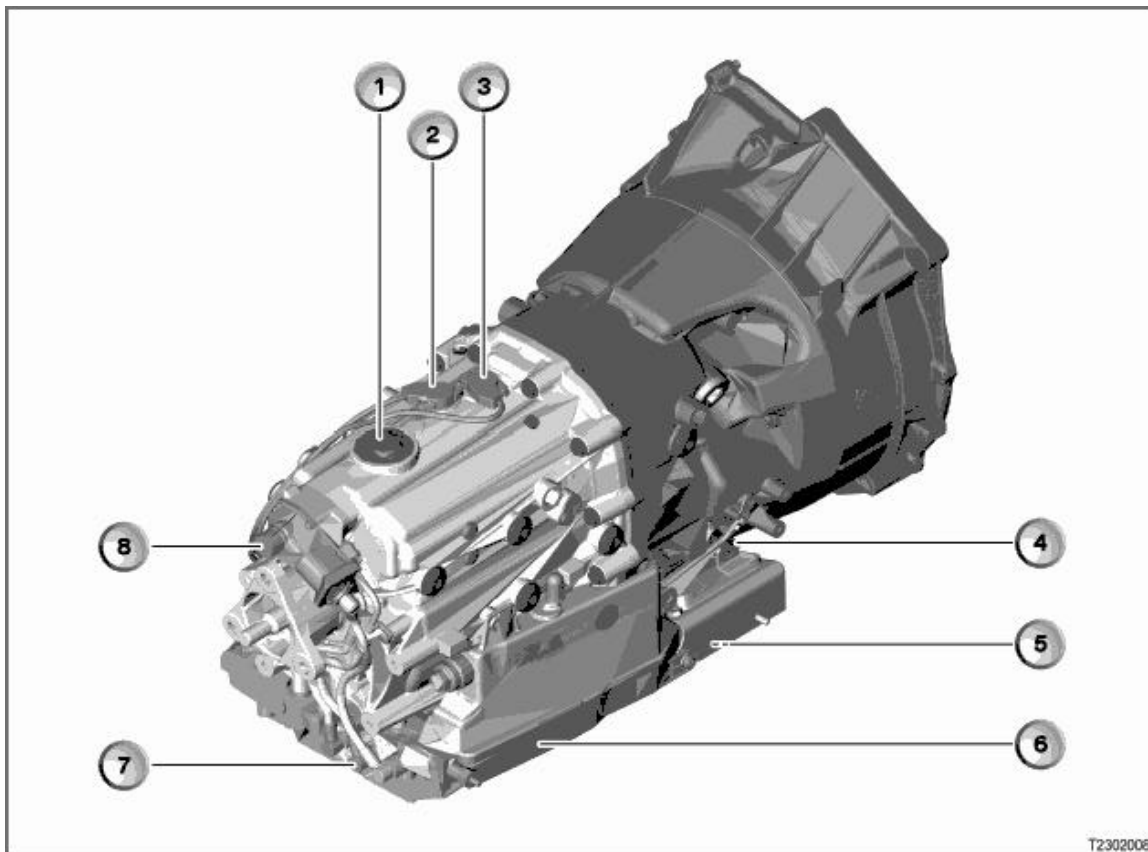
Service staff should note the following points:

- General information: [more ...]
- Diagnosis: ---
- Encoding/programming: ---
- Car and Key Memory: ---

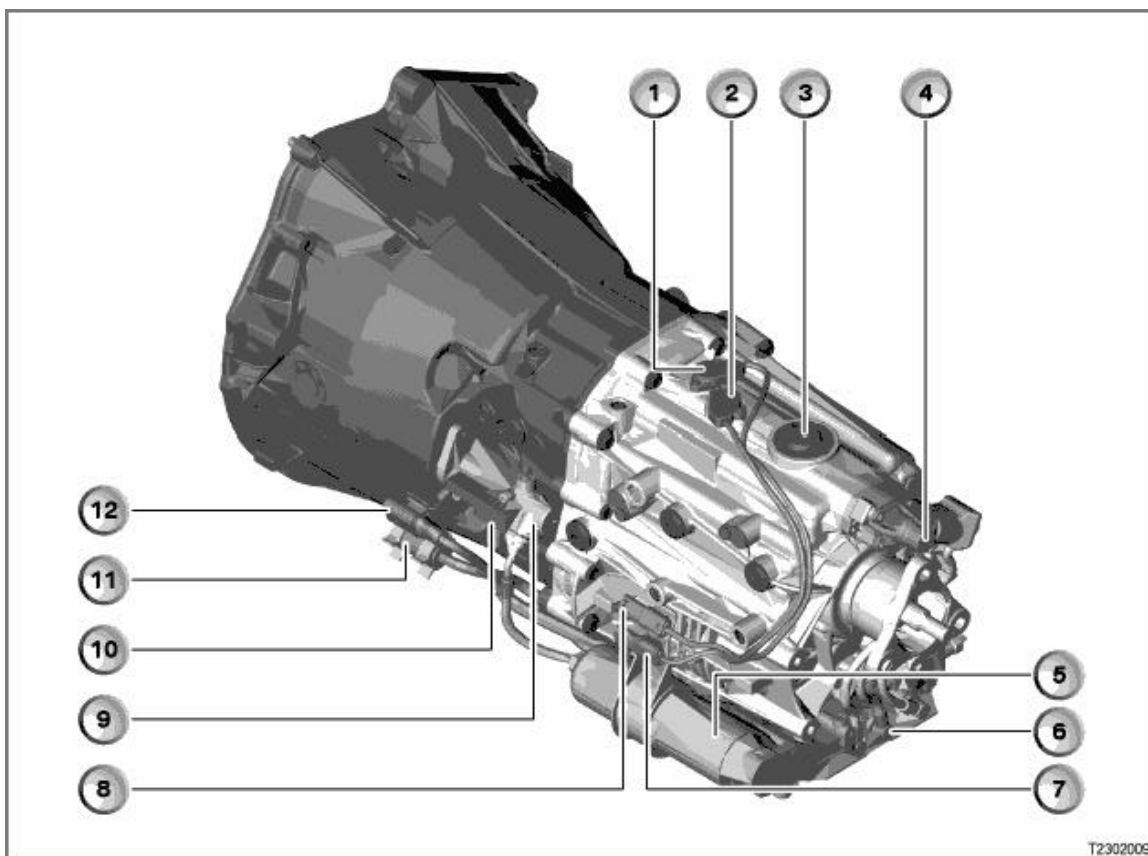
Subject to change.

E60 - System overview of sequential manual transmission (SMG)

- GS6S37BZ, viewed from right



Key	Explanation	Key	Explanation
1	Assembly opening for connecting the selector shaft to the gearshift and selector angle actuator	2	Shift travel sensor
3	Selector angle sensor	4	Inductive sensor for transmission input speed
5	Hydraulic pump	6	Expansion tank
7	Valve block	8	Gearshift and selector angle actuator

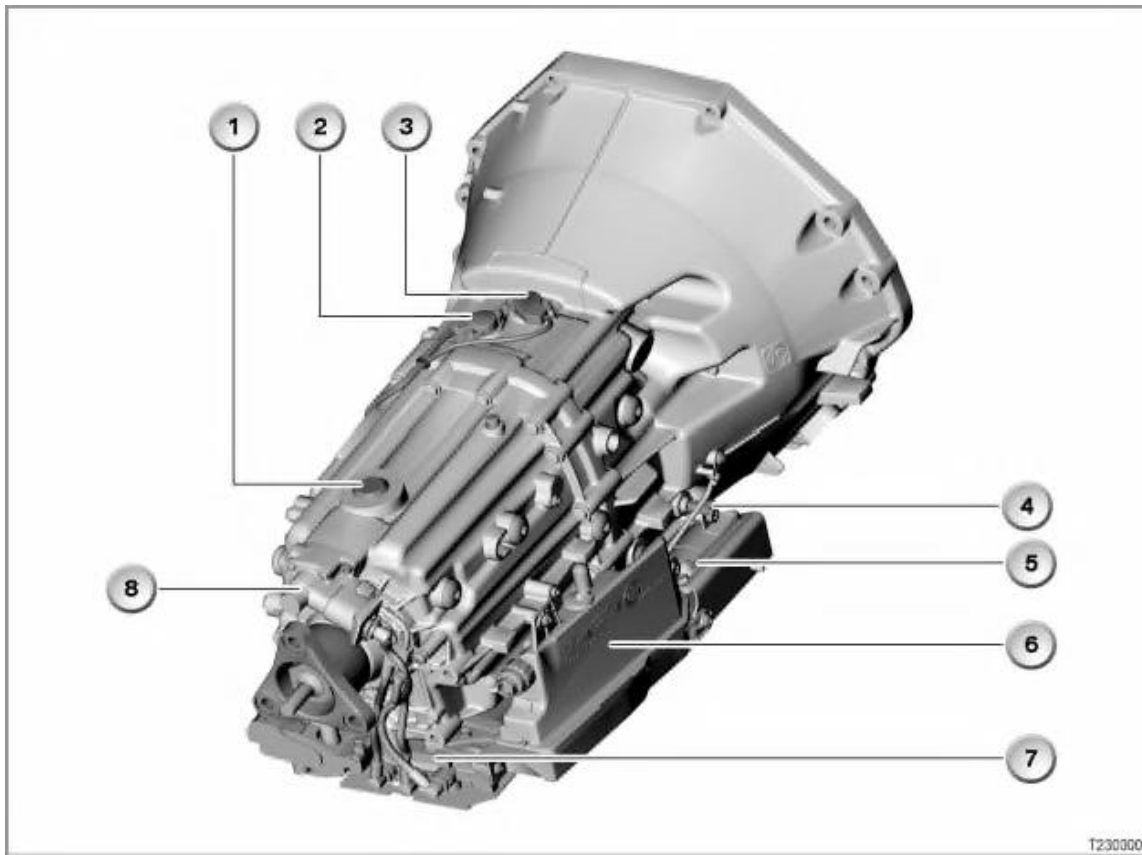


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Key	Explanation	Key	Explanation
1	Selector angle sensor	2	Shift travel sensor
3	Assembly opening for connecting the selector shaft to the gearshift and selector angle actuator	4	Gearshift and selector angle actuator
5	Pressure accumulator	6	Valve block
7	Connector for shift travel sensor	8	Connector for selector angle sensor
9	Clutch actuator	10	Clutch travel sensor

11	Connector for actuating components integrated in valve block (4 solenoid valves, hydraulic pressure sensor)	12	Connector for hydraulic pump power supply
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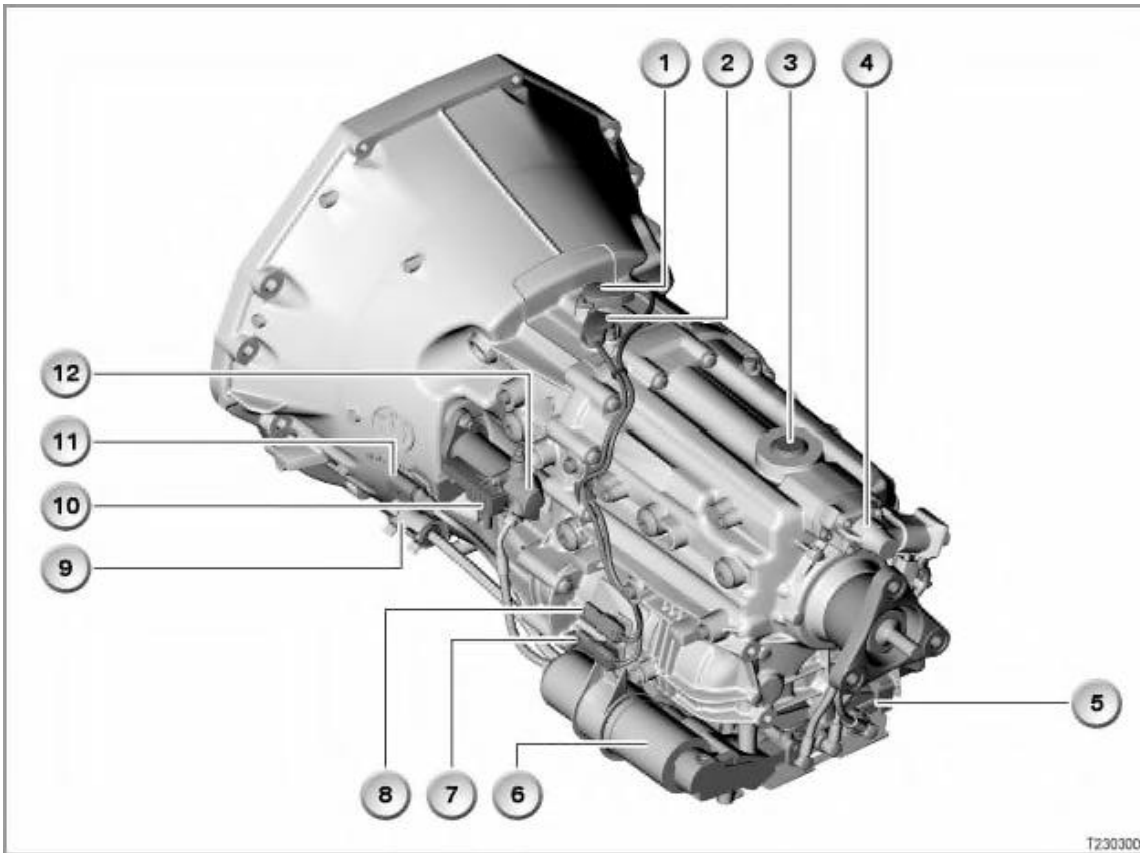
- GS6S53BZ, viewed from right



Key	Explanation	Key	Explanation
1	Assembly opening for connecting the selector shaft to the gearshift and selector angle actuator	2	Shift travel sensor
3	Selector angle sensor	4	Inductive sensor for transmission input speed
5	Hydraulic pump	6	Expansion tank

7	Valve block	8	Gearshift and selector angle actuator
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- GS6S53BZ, viewed from left

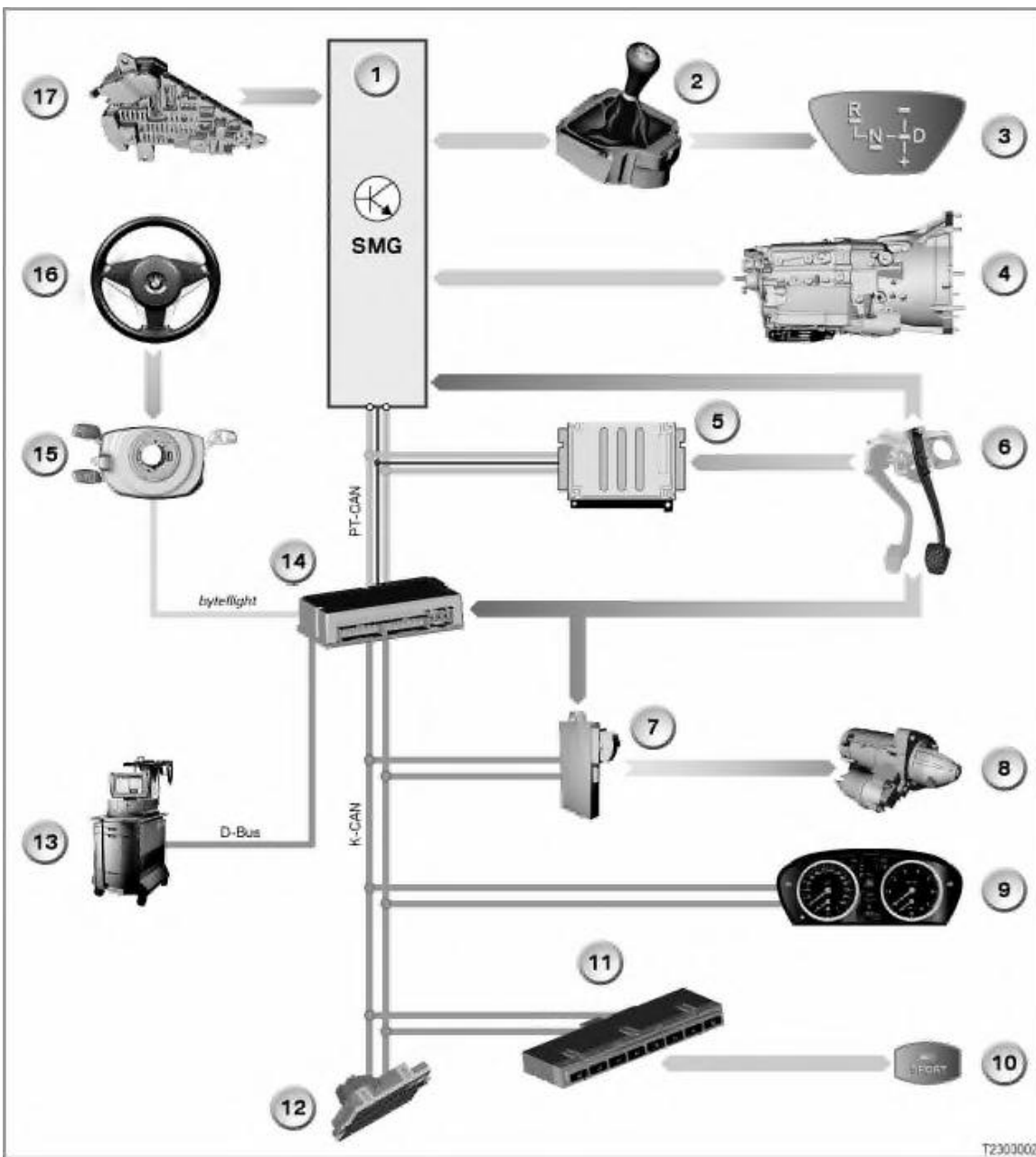


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Key	Explanation	Key	Explanation
1	Selector angle sensor	2	Shift travel sensor
3	Assembly opening for connecting the selector shaft to the gearshift and selector angle actuator	4	Gearshift and selector angle actuator
5	Valve block	6	Pressure accumulator
7	Connector for shift travel sensor	8	Connector for selector angle sensor

9	Connector for actuating components integrated in valve block (4 solenoid valves, hydraulic pressure sensor)	10	Clutch travel sensor
11	Connector for hydraulic pump power supply	12	Clutch actuator

- Inputs/outputs

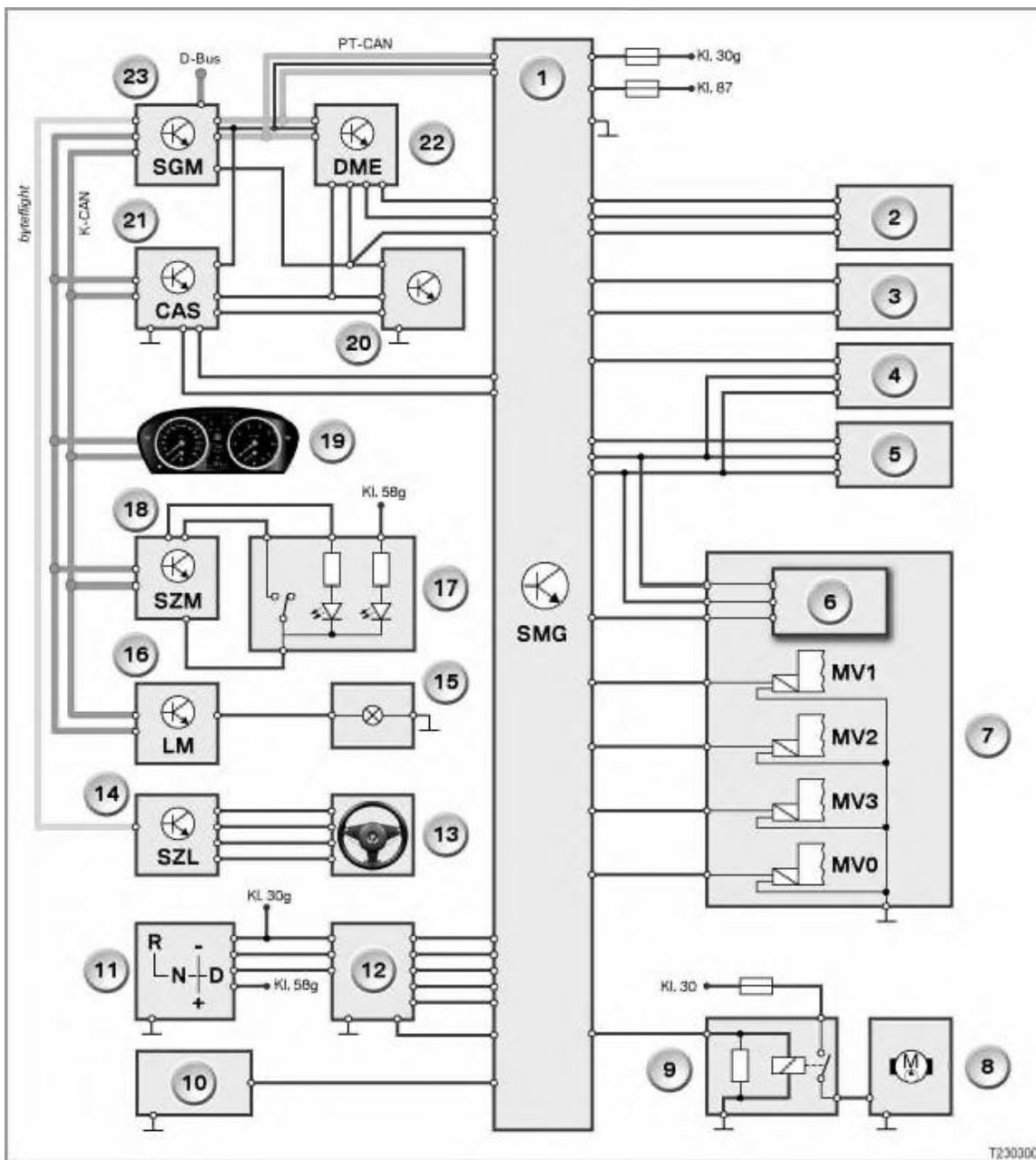


Key	Explanation	Key	Explanation
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1	SMG control unit		
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	(sequential manual gearbox)	2	Gear lever
3	Gear lever position display	4	Transmission with hydraulic unit and shift travel sensor, selector angle sensor, inductive sensor for transmission input speed, clutch travel sensor
5	DME control module (digital engine electronics)	6	Brake light switch
7	Car access system (CAS)	8	Starter motor
9	Instrument cluster	10	SPORT button for Dynamic Driving Control (FDC)
11	Centre-console switch cluster (SZM)	12	Light module (LM)
13	BMW diagnostic system	14	Safety and gateway module (SGM)
15	Steering column switch cluster (SZL)	16	Steering wheel with 2 gearshift paddles
17	Power distributor, rear		
byteflight	byteflight data bus	D-Bus	Diagnosis bus
K-CAN	Body CAN	PT-CAN	Powertrain CAN

- System circuit diagram

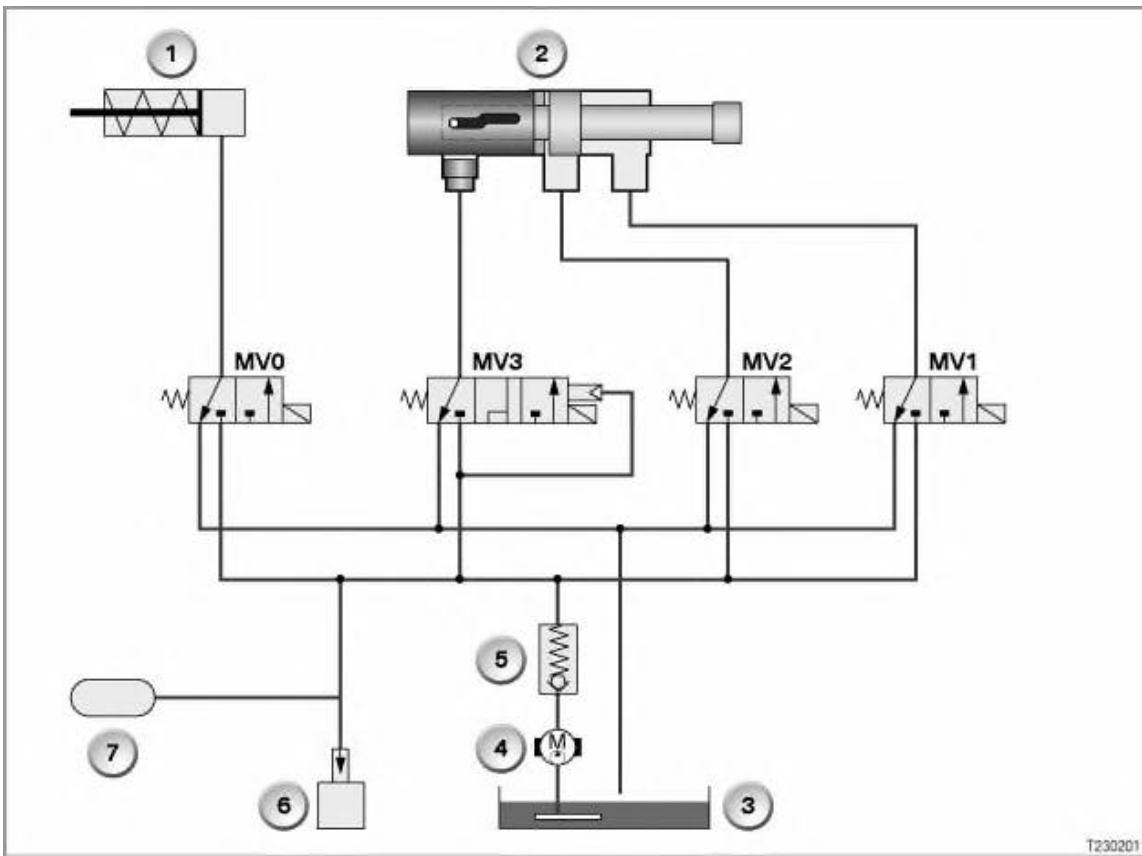


Key	Explanation	Key	Explanation
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1	SMG control unit
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	(sequential manual gearbox)	2	Clutch travel sensor
3	Inductive sensor for transmission input speed	4	Selector angle sensor
5	Shift travel sensor	6	Hydraulic pressure sensor
7	Valve block	8	Hydraulic pump
9	Relay for hydraulic pump	10	Gear lever lock (shift-lock)
11	Gear lever position display	12	Gear lever
13	Steering wheel with 2 gearshift paddles	14	Steering column switch cluster (SZL)
15	Reversing light	16	Light module (LM)
17	SPORT button for Dynamic Driving Control (FDC)	18	Centre-console switch cluster (SZM)
19	Instrument cluster	20	Brake light switch
21	Car access system (CAS)	22	Digital engine electronics (DME)
23	Safety and gateway module (SGM)	byteflight	byteflight data bus
D-Bus	Diagnosis bus	K-CAN	Body CAN
PT-CAN	Powertrain CAN	MV0	Solenoid valve for clutch actuator
MV1	Solenoid valve for shifting to 1st, 3rd, 5th gear and reverse gear	MV2	Solenoid valve for shifting to 2nd, 4th, 6th gear
MV3	Solenoid valve for selector angle brake and for pressure-relief valve	Kl. 30	Terminal 30 (power supply)
Kl. 30g	Terminal 30g (power supply, active)	Kl. 58g	Terminal 58g (locating light)
Kl. 87	Terminal 87 (power supply via relay)		

- Hydraulics diagram



Key	Explanation	Key	Explanation
1	Clutch actuator	2	Gearshift and selector angle actuator with selector angle brake
3	Expansion tank	4	Hydraulic pump with electric motor
5	Check valve	6	Hydraulic pressure sensor
7	Pressure accumulator	MV0	Solenoid valve for clutch actuator
MV1	Solenoid valve for shifting to 1st, 3rd, 5th gear and reverse gear	MV2	Solenoid valve for shifting to 2nd, 4th, 6th gear

MV3	Solenoid valve for selector angle brake and for pressure-relief valve		
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E60 - SMG, gear lever with mounting block and gear lever cover

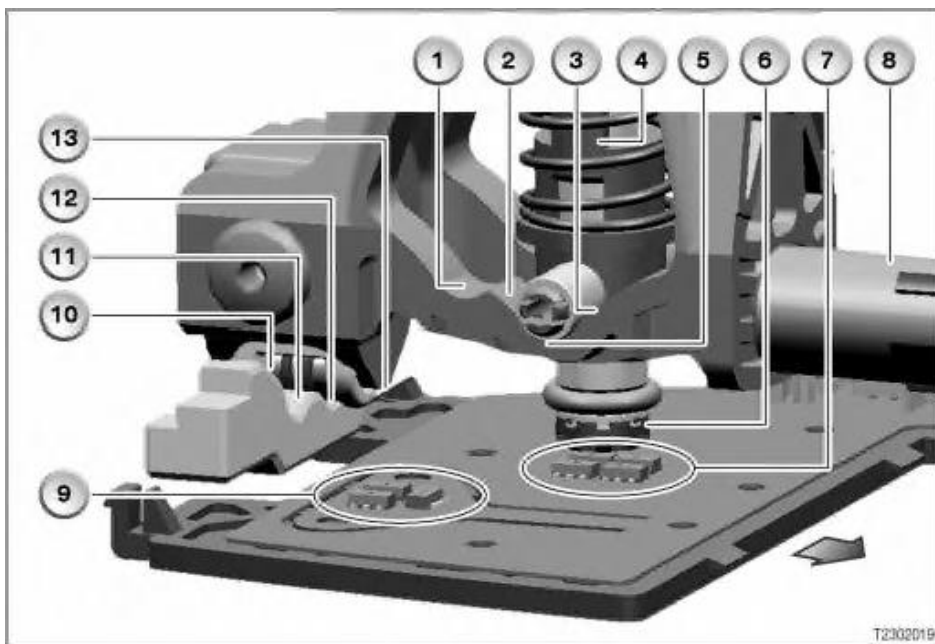
Installation location

The gear lever with mounting block and gear lever cover is installed in the centre console.



Key	Explanation	Key	Explanation
1	Gear lever	2	Gear lever cover
3	Gear lever position display	4	SPORT button for Dynamic Driving Control (FDC)

Construction



Key	Explanation	Key	Explanation
1	Gear lever position "R", longitudinal to direction of travel	2	Gear lever position "-" (downshift), longitudinal to direction of travel
3	Gear lever position "+" (upshift), longitudinal to direction of travel	4	Gear lever with spring for engaging
5	Gear lever position in manual mode, longitudinal to direction of travel	6	Permanent magnet (for recording the gear lever position via the Hall sensors)
7	4 Hall sensors for recognising gear change "+" or "-" and for recognising change between manual mode and automatic mode	8	Gear lever lock (shift-lock)
9	3 Hall sensors for identifying reverse gear position	10	Gear lever position "R" (perpendicular to direction of travel)

	Gear lever position "N" (perpendicular to direction of travel)	12	Gear lever position in manual mode (perpendicular to direction of travel)
13	Gear lever position "D" (perpendicular to direction of travel)		
The arrow shows the direction of travel			

The gear lever is mounted on the mounting block and has 6 mechanical positions:

- 3 engaging positions for neutral ("N"), reverse gear ("R") and manual mode (" -" symbol between "N" and "D").
- 3 one-touch positions for "+", "-", "D".

7 Hall sensors are installed in the mounting block to identify the position. These record the gear lever position without contact, and transmit this to the SMG control unit.

A spring-loaded catch holds the gear lever in the respective position "R", "N" and in manual mode ("- " symbol between "N" and "D"). The positions "+", "-" and "D" are selected by moving the gear lever briefly.

The gear lever is supplied with voltage via terminal 30g. The gear lever position is transmitted to the SMG control unit via 4 hard-wired cables and one digital cable.

The gear lever lock is also installed in the mounting block. The gear lever lock locks the gear lever in the "N" position to prevent unintentional gearshifts. The gear lever lock comprises an electromagnet, which switches a locking bolt. The locking bolt moves into a hole in the gear lever, locking it in position. The electromagnet is actuated by the SMG control unit. When the electromagnet is not subjected to current, the locking bolt locks the gear lever in the "N" position. It is then only possible to engage a gear by depressing the brake pedal.

The gear lever cover holds the illuminated display for the gear lever position. The drive position engaged is shown in the gear lever position display by 3 LEDs (light-emitting diodes):

- "R" for reverse gear
- "N" for neutral
- "-" for manual mode (gear lever position between "N" and "D")

The gear lever position is displayed under the following conditions:

- When the driver's door is unlocked

- When the ignition is switched on

How it works

The following gearshifts are possible:

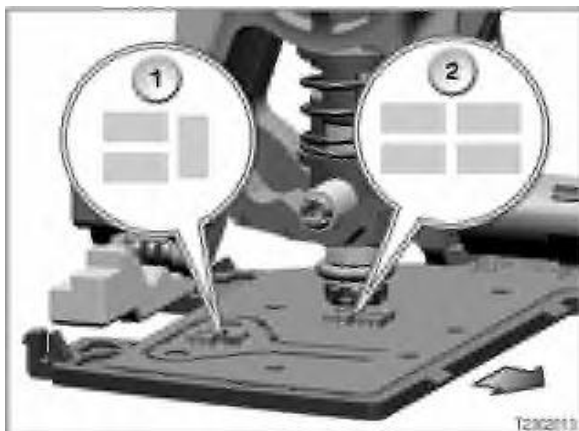
- From "N" to "R": Depress the brake, move the gear lever perpendicular to the direction of travel. The gear lever locks in gear lever position "R".
- From manual mode to automatic mode and vice versa: move gear lever perpendicular to the direction of travel to "-" or "D". The gear lever locks in the gear lever position selected.
- Upshifts/downshifts in manual mode: briefly move the gear lever longitudinal to the direction of travel to "+" or "-".

The gear lever **does not** lock.

The respective gear lever position is registered by Hall sensors.

The following illustrations show the Hall sensor signals in the respective gear lever positions. Only the Hall sensor marked (dark) transmits signals.

When reverse gear is engaged, this is registered by 3 Hall sensors. All other gear lever positions are registered by 4 Hall sensors.



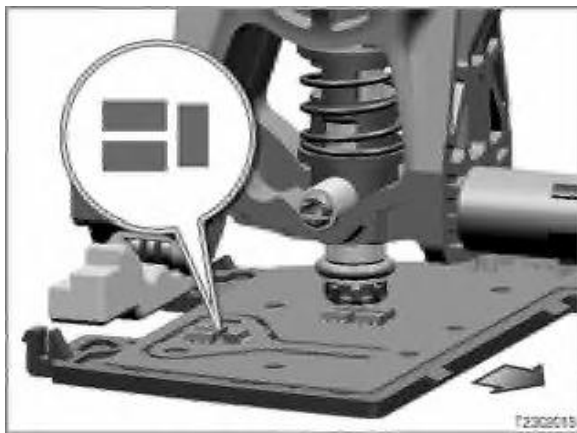
Gear lever position "N" (neutral)

- 1) 3 Hall sensors for reverse gear
- 2) 4 Hall sensors for all other gear lever positions

No signal from the Hall sensors.

The 3 Hall sensors for reverse gear and the 4 Hall sensors for the other gears cannot be activated at the same time.

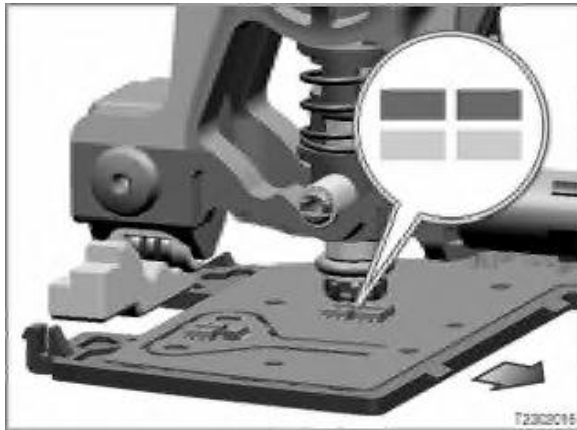
The arrow shows the direction of travel.



Gear lever position "R" (reverse gear)

The 3 rear Hall sensors transmit signals when the gear lever is engaged in position "R".

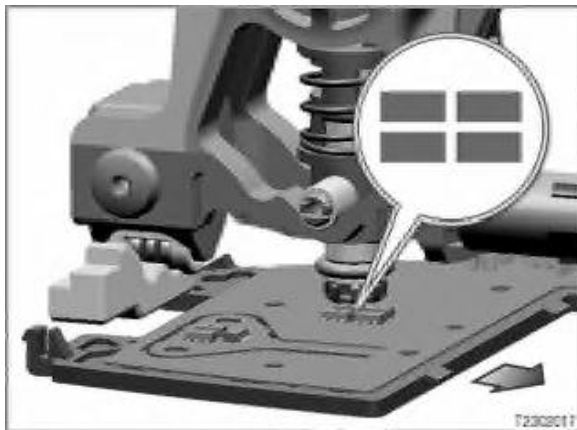
The arrow shows the direction of travel.



Gear lever position "D" (automatic mode)

The two Hall sensors on the left transmit signals when the gear lever is briefly moved to position "D".

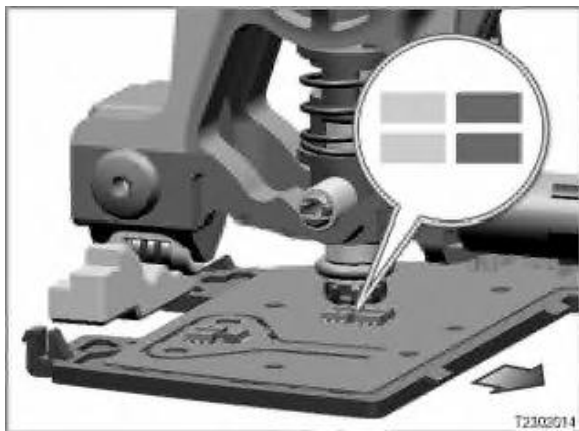
The arrow shows the direction of travel.



Gear lever position "-" (manual mode)

All Hall sensors transmit signals when the gear lever is in position "-" (symbol between "N" and "D").

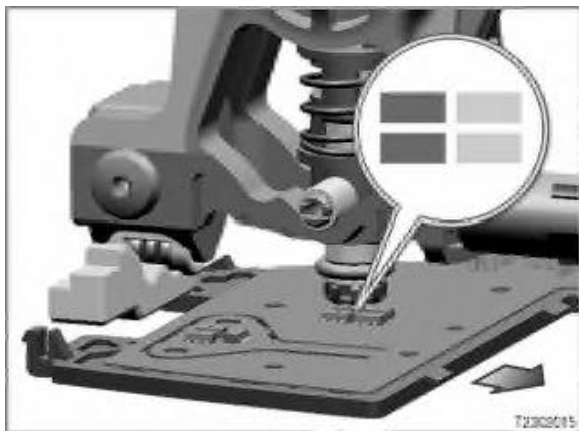
The arrow shows the direction of travel.



Gear lever position "+" (upshift)

The two foremost Hall sensors transmit signals when the gear lever is briefly moved to position "+".

The arrow shows the direction of travel.



Gear lever position "-" (downshift)

The two rearmost Hall sensors transmit signals when the gear lever is briefly moved to position "-".

The arrow shows the direction of travel.

E60 - SMG, steering wheel with 2 gearshift paddles

Installation location

In addition to conventional gear selection with the gear lever, gears can also be selected from the steering wheel (gearshift paddles).



Key	Explanation	Key	Explanation
1	Gearshift paddles		

Construction

The two gearshift paddles are identical in construction and are wired in parallel.

How it works

Power is supplied to the gearshift paddles from the steering column switch cluster (SZL). Pull one or both of the gearshift paddles to shift up a gear.

Press one or both of the gearshift paddles to shift down a gear.

E60 - SMG, SPORT button for Dynamic Driving Control (FDC)

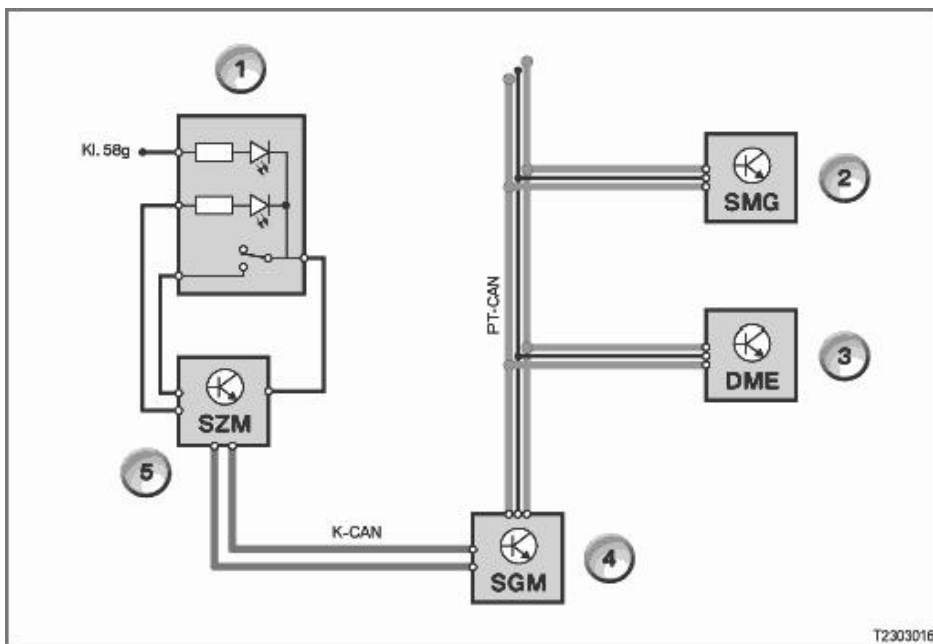
Installation location

The SPORT button for Dynamic Driving Control (FDC) is installed in the gear lever cover.



Key	Explanation	Key	Explanation
1	SPORT button for Dynamic Driving Control (FDC)	2	Gear lever cover

Construction



Key	Explanation	Key	Explanation
1	SPORT button for Dynamic Driving Control (FDC)	2	SMG control unit (sequential manual gearbox)
3	DME control module (digital engine electronics)	4	Safety and gateway module (SGM)
5	Centre-console switch cluster (SZM)		

How it works

The SPORT button is pressed.

Signal path: SPORT button --> hard-wired cables --> SZM --> K-CAN --> SGM --> PT-CAN --> DME control unit and SMG control unit.

The SZM switches earth to the SPORT button. The LED (light-emitting diode) for function indicator lamp in the SPORT button lights up.

When Dynamic Driving Control (FDC) is activated with the SPORT button, shift times for gear changes are reduced by the SMG control unit. In addition, in automatic mode the SMG only shifts into the next gear up at higher engine speeds.

The DME unit adjusts the accelerator-pedal values. The engine responds more spontaneously to changes in the accelerator pedal position.

The Servotronic is switched to a more sporty map via the safety and gateway module (SGM). Steering and holding forces on the steering wheel are given more sporty settings.

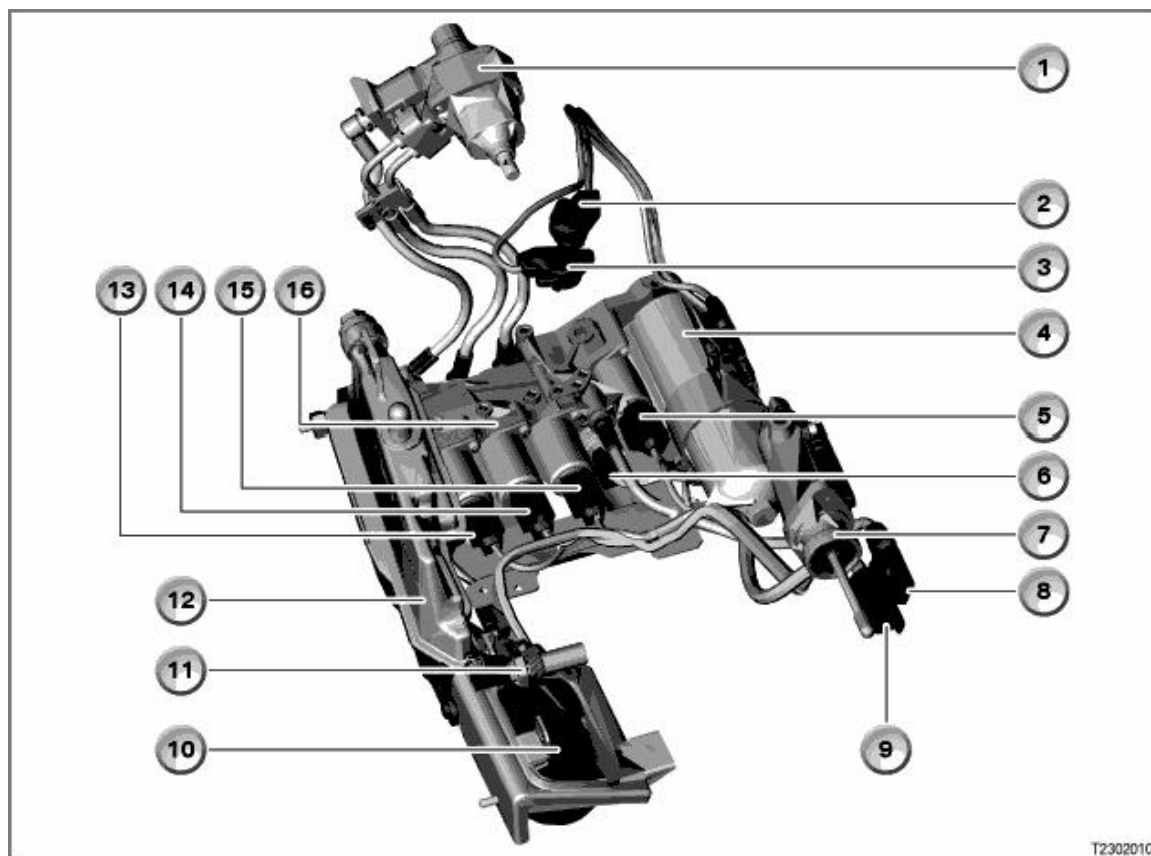
Dynamic Driving Control (FDC) can be selected with the SPORT button in either automatic mode or manual mode. FDC is always deactivated when the engine is started.

E60 - SMG, hydraulic unit with sensors

Installation location

The hydraulic unit is precharged and tested and is attached to the manual transmission together with the actuators (gearshift and selector angle actuator and clutch actuator with clutch travel sensor).

Construction



T2302010

Key	Explanation	Key	Explanation
1	Gearshift and selector angle actuator	2	Shift travel sensor

3	Selector angle sensor	4	Pressure accumulator
5	Solenoid valve MV3 for selector angle brake and for pressure-relief valve	6	Hydraulic pressure sensor
7	Clutch actuator with clutch travel sensor	8	Power supply for hydraulic pump (electric motor)
9	Connector for valve block component actuation (4 solenoid valves, hydraulic pressure sensor)	10	Hydraulic pump
11	Inductive sensor for transmission input speed	12	Expansion tank
13	Solenoid valve MV0 for clutch actuator	14	Solenoid valve MV1 for shifting to 1st, 3rd, 5th gear and reverse gear
15	Solenoid valve MV2 for shifting to 2nd, 4th, 6th gear	16	Valve block

The connector for valve block component actuation (4 solenoid valves, hydraulic pressure sensor) is on the left-hand side of the transmission.

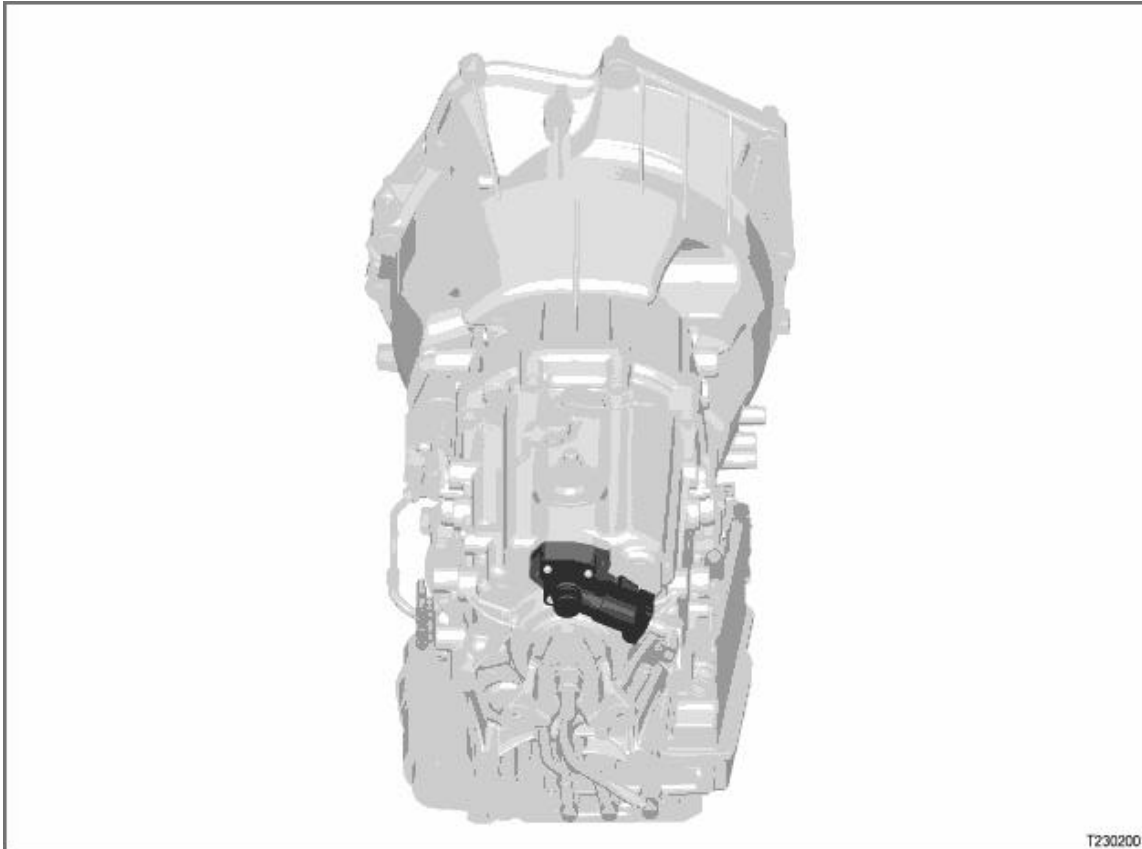
Above this central connector, there is the power supply connector for the hydraulic pump (electric motor).

The hydraulic pump is wired to earth via the transmission housing.

E60 - SMG, gearshift and selector angle actuator

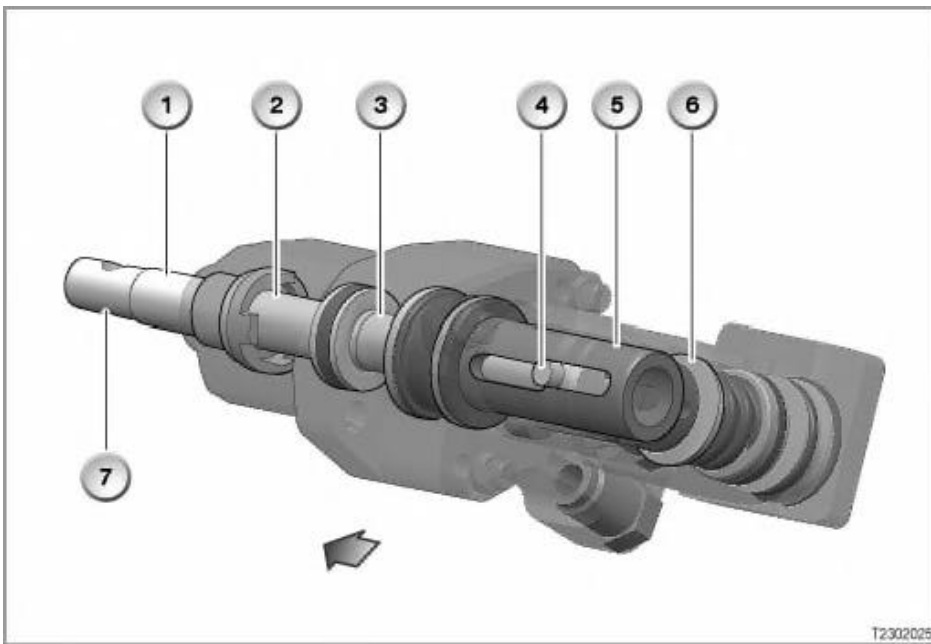
Installation location

The gearshift and selector angle actuator is secured to the top rear of the transmission housing.



Construction

The following illustrations show the construction of the gearshift and selector angle actuator .



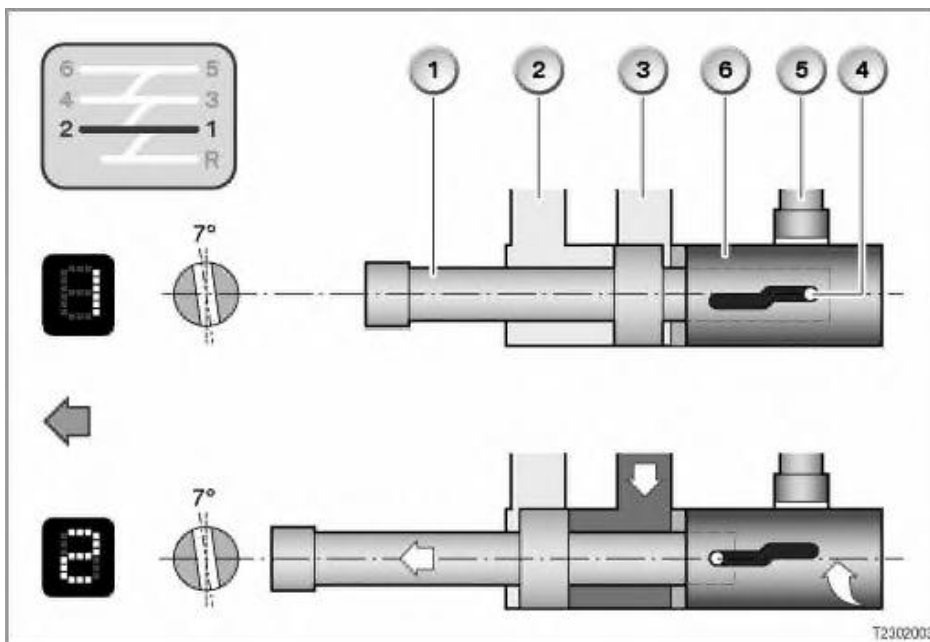
T2302025

Key	Explanation	Key	Explanation
1	Piston rod with connection to selector shaft	2	Oil channel, controlled by solenoid valve MV1
3	Oil channel, controlled by solenoid valve MV2	4	Piston rod cylinder pin in S-contour (cylinder pin guide)
5	Selector angle brake bush with S-contour for cylinder pin guide	6	Selector angle brake piston (oil channel actuated by solenoid valve MV3)
7	Connection of piston rod with selector shaft		

The arrow shows the direction of travel.

How it works

- Example: gearshift from 1st gear to 2nd gear



Key	Explanation	Key	Explanation
1	Piston rod with connection to selector shaft	2	Oil channel, controlled by solenoid valve MV1
3	Oil channel, controlled by solenoid valve MV2	4	Piston rod cylinder pin in S-contour (cylinder pin guide)
5	Selector angle brake piston (oil channel actuated by solenoid valve MV3)	6	Selector angle brake bush

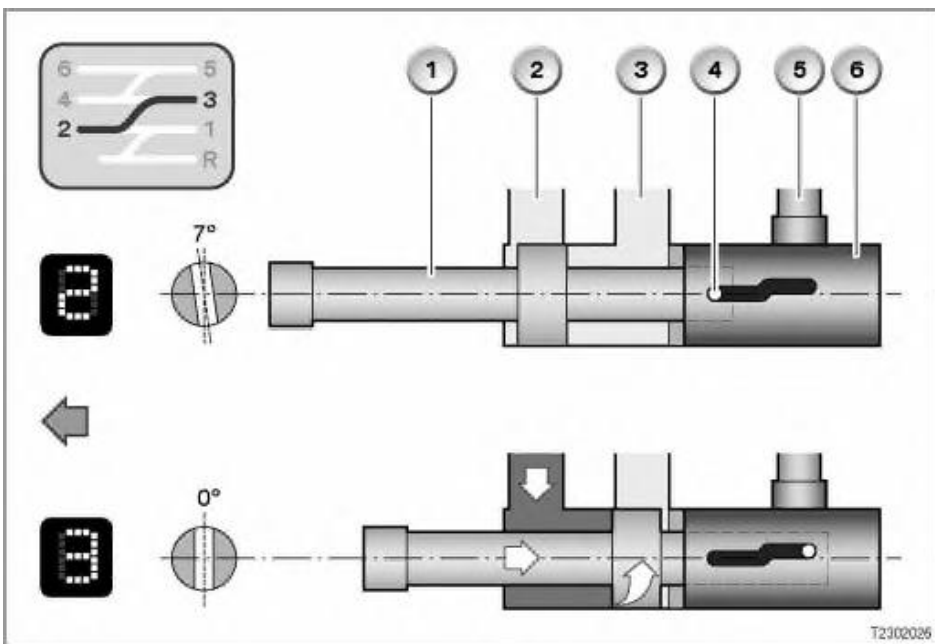
The arrow shows the direction of travel.

The selector angle brake piston is not operated.

Solenoid valve MV2 opens. Pressure is then built up in the oil channel. The oil pressure moves the piston rod forwards (in direction of travel).

The forwards movement of the piston rod turns the selector angle brake bush via the S-contour (cylinder pin guide) (through the cylinder pin on the piston rod). As only the selector angle brake bush is turned, not the piston rod and thus the selector shaft, the shift gate is not changed.

- Example: gearshift from 2nd gear to 3rd gear



Key	Explanation	Key	Explanation
1	Piston rod with connection to selector shaft	2	Oil channel, controlled by solenoid valve MV1
3	Oil channel, controlled by solenoid valve MV2	4	Piston rod cylinder pin in S-contour (cylinder pin guide)
5	Selector angle brake piston (oil channel actuated by solenoid valve MV3)	6	Selector angle brake bush
The arrow shows the direction of travel.			

The rotational movement of the selector shaft is realised with the selector angle brake.

The selector angle brake piston is operated and holds the selector angle brake bush fast.

Oil pressure is applied to the oil channel actuated by solenoid valve MV1. This pushes the piston rod to the rear (against the direction of travel).

During the rearward movement of the piston rod, the cylinder pin rigidly affixed to the piston rod follows the S-contour (guide) in the fixed S-cam bush.

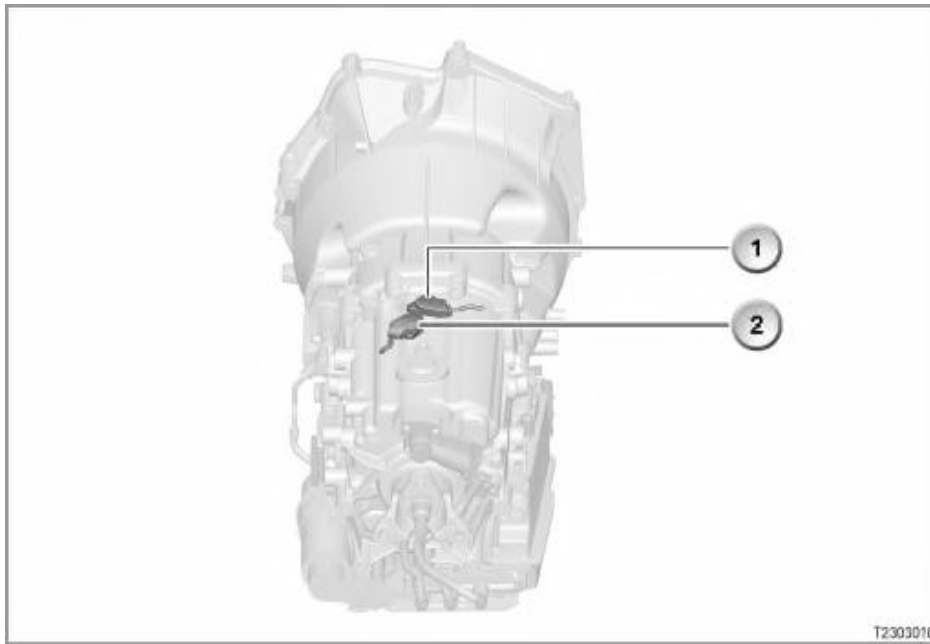
The cylinder pin and with it the piston rod are thus turned. The piston rod and the selector shaft change into shift gate for the 3rd and 4th gears.

E60 - SMG, shift travel sensor and selector angle sensor

Installation location

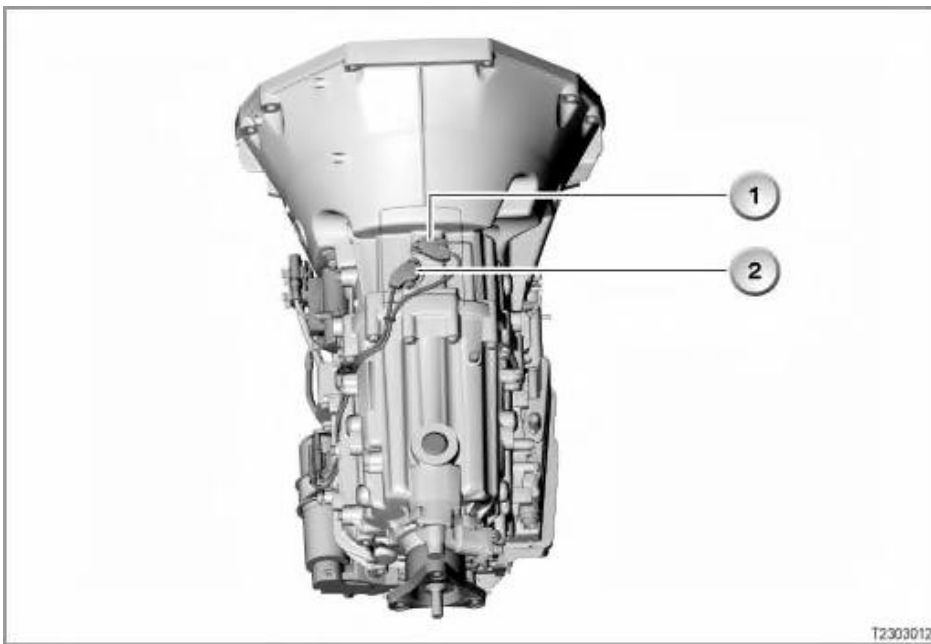
The shift travel sensor and the selector angle sensor are installed differently in the two transmissions:

- GS6S37BZ: on the top of the transmission **behind** the flange connection



Key	Explanation	Key	Explanation
1	Selector angle sensor	2	Shift travel sensor

- GS6S53BZ: on the top of the transmission **in front of** the flange connection



T2303012

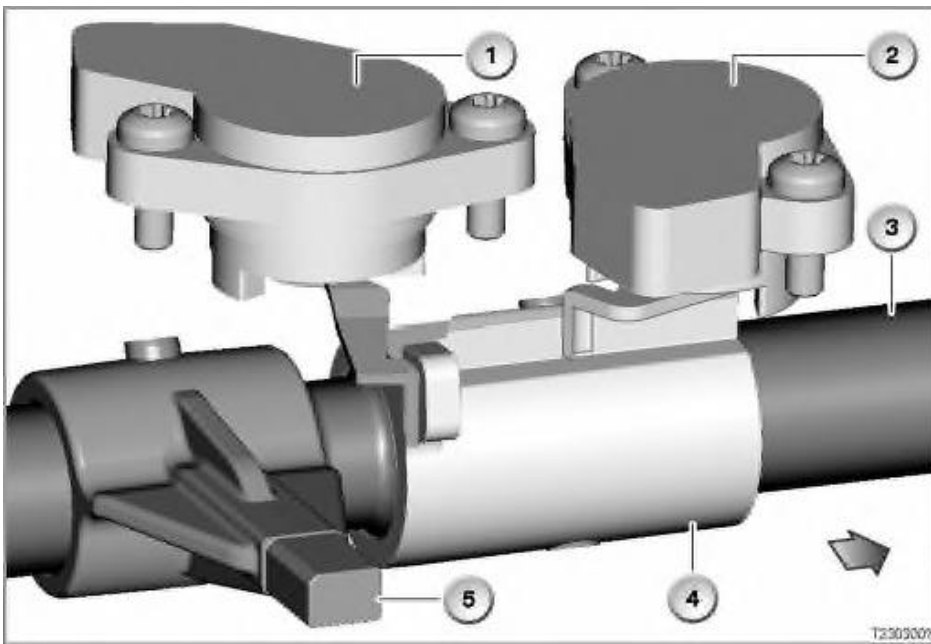
Key	Explanation	Key	Explanation
1	Selector angle sensor	2	Shift travel sensor

Construction

Both sensors are Hall sensors.

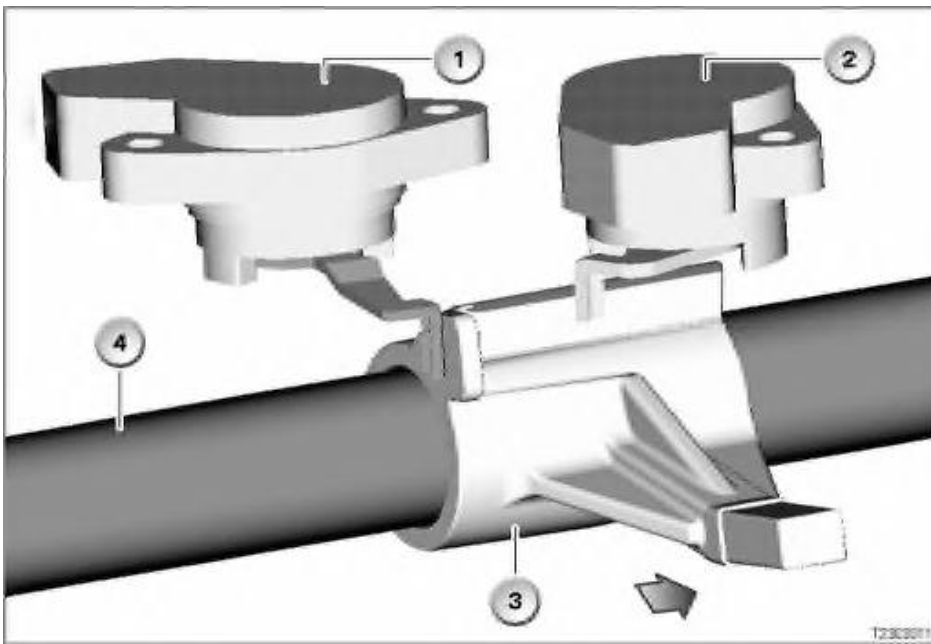
How it works

The following illustration shows the shift travel sensor and the selector angle sensor in the GS6S37BZ.



Key	Explanation	Key	Explanation
1	Shift travel sensor	2	Selector angle sensor
3	Selector shaft	4	Driver
5	Selector arm, 1st/2nd gear		
The arrow shows the direction of travel.			

The following illustration shows the shift travel sensor and the selector angle sensor in the GS6S53BZ.



Key	Explanation	Key	Explanation
1	Shift travel sensor	2	Selector angle sensor
3	Selector arm, 5th/6th gear	4	Selector shaft

The arrow shows the direction of travel.

The gear engaged is recognised from the shift travel sensor and the selector angle sensor:

The shift travel sensor detects the forwards and backwards movements of the selector shaft in the respective shift gate. 4 shift gates are available:

- Reverse gear shift gate
- Shift gate for 1st and 2nd gear
- Shift gate for 3rd and 4th gear
- Shift gate for 5th and 6th gear

The selector angle sensor detects how far the selector shaft turns, and so recognises a change of shift gate.

A change of shift gate is made for the following shift actions:

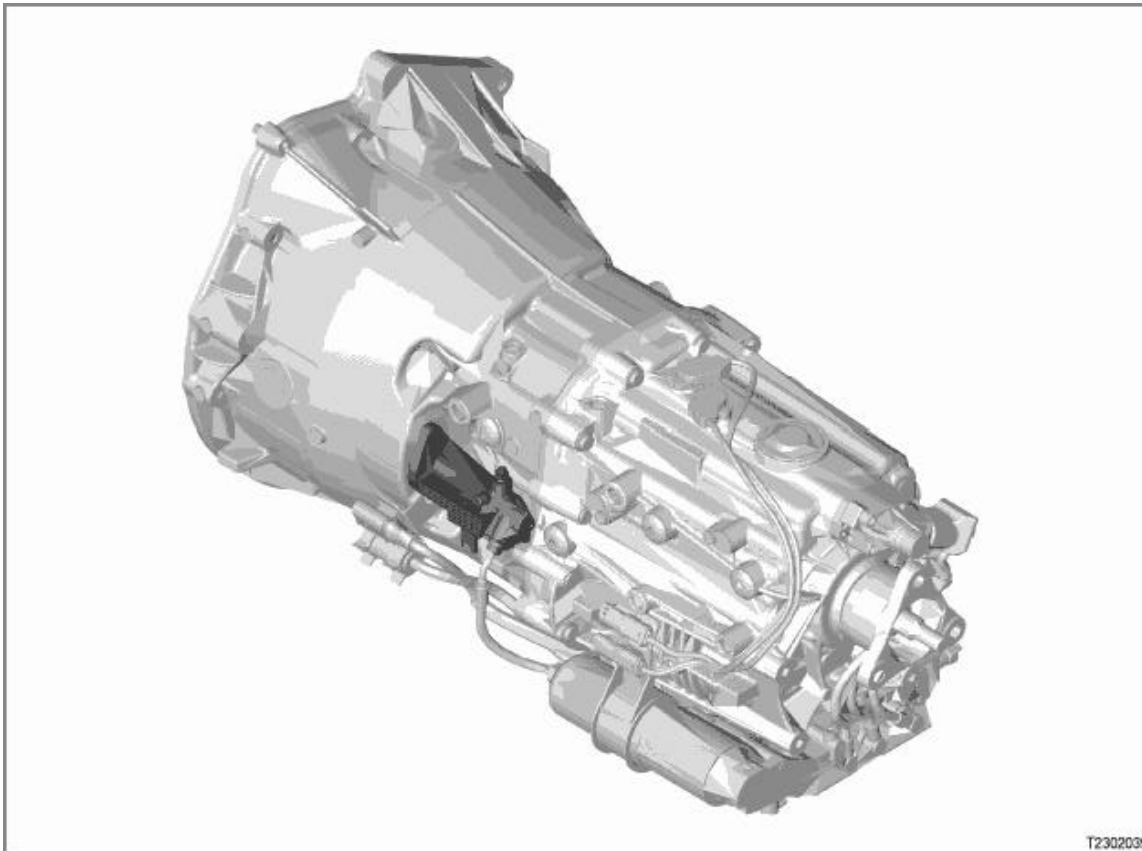
- Reverse gear to 1st gear and vice versa
- 2nd gear to 3rd gear and vice versa
- 4th gear to 5th gear and vice versa

Power is supplied to the shift travel sensor and the selector angle sensor via the SMG control unit (5 volts).

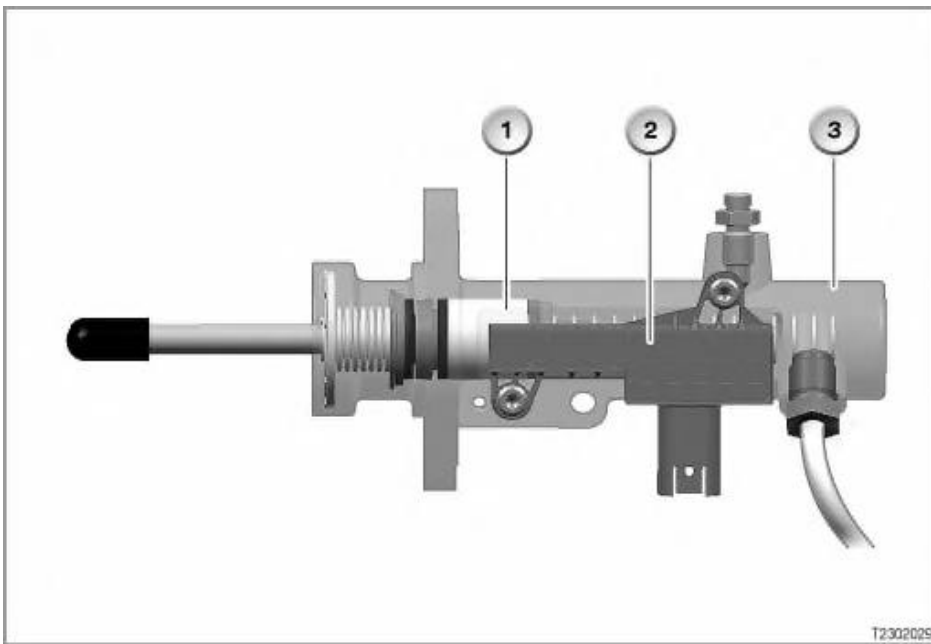
E60 - SMG clutch actuator with clutch travel sensor

Installation location

The clutch actuator with clutch travel sensor is attached to the left-hand side of the transmission.



Construction



Key	Explanation	Key	Explanation
1	Permanent magnet	2	Clutch travel sensor
3	Clutch slave cylinder		

The clutch actuator comprises the following components:

- Clutch travel sensor on clutch slave cylinder housing
- Clutch slave cylinder

The clutch slave cylinder comprises:

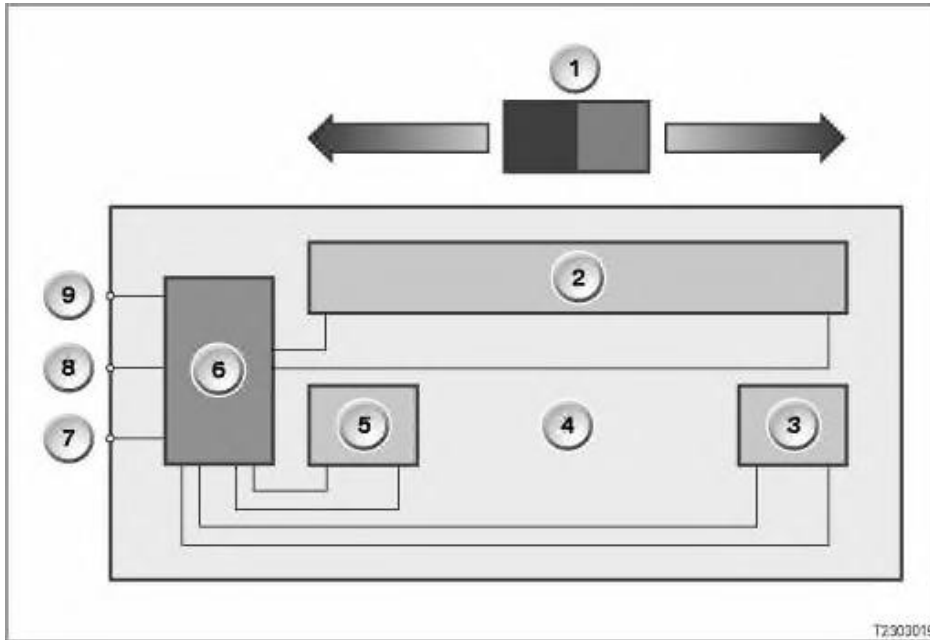
- Piston and
- Permanent magnet

The permanent magnet is affixed to the piston.

The clutch travel sensor detects the release travel of the piston (equal to release travel of clutch) via the release travel of the permanent magnet.

How it works

The following illustration shows how the clutch travel sensor works.



Key	Explanation	Key	Explanation
1	Permanent magnet on piston of clutch slave cylinder	2	Primary coil
3	Secondary coil 1	4	Clutch travel sensor
5	Secondary coil 2	6	Evaluation electronics
7	Analogue signal output	8	Earth via SMG control unit
9	Power supply (5 volts) from SMG control unit		

Calculation of release travel

The permanent magnet indicates the release travel of the piston as follows:

- Depending on the position of the permanent magnet, a voltage is generated in the primary coil.
- Depending on the position of the permanent magnet, a variable voltage is thus induced on the secondary coils.
- The electronic evaluation unit calculates the position of the permanent magnet and thus the release travel of the clutch from the different induced voltages of secondary coil 1 and secondary coil 2.
- The release travel is transmitted to the SMG control unit via the analogue signal output.

Actuation of release force and release travel

The SMG control unit controls the clutch slave cylinder via the specified pressure for solenoid valve MV0. The necessary pressure on the clutch slave cylinder is generated via the solenoid valve. The release force is thus apportioned. The necessary release travel is generated with a lever on the release bearing of the clutch.

Monitoring of clutch position and clutch slipping point

- The clutch position is continuously monitored:

During clutch operation, the SMG control unit continuously measures and monitors the position of the clutch slave cylinder, and with it the position of the clutch, via the clutch travel sensor. In addition, the precise clutch slipping point is calculated from the different speeds of the engine and transmission.

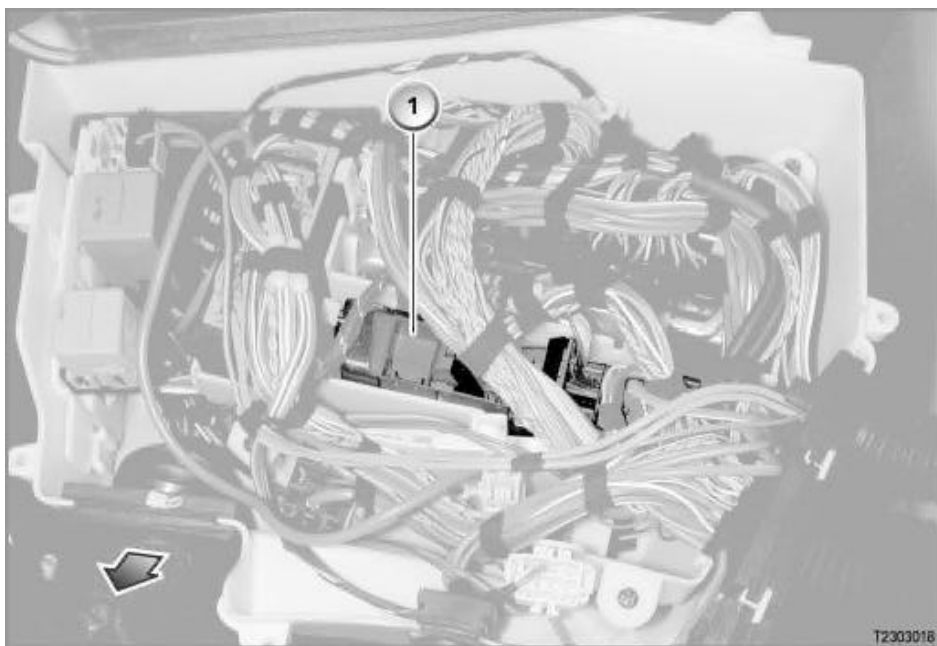
- Clutch slipping point:

The clutch slipping point is stored in the SMG control unit for optimal clutch operation and is updated according to changes due to installation tolerances and wear.

E60 - SMG control unit (sequential manual transmission)

Installation location

The SMG control unit is installed in the electronics box in the engine compartment (on the right in the direction of travel).



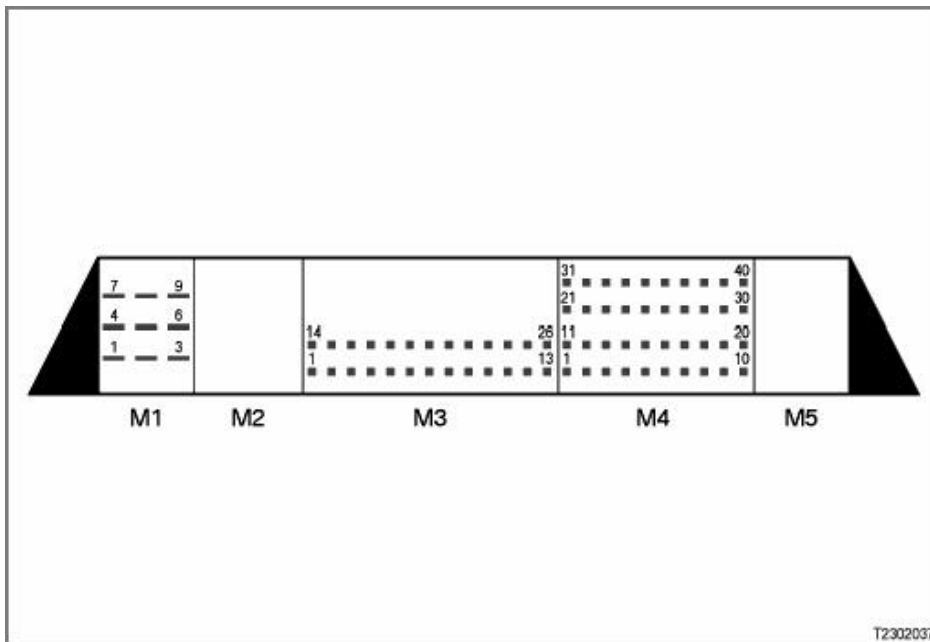
Key	Explanation	Key	Explanation
1	SMG control unit (sequential manual gearbox)		

The arrow shows the direction of travel.

Construction

The SMG control unit is a single-board control unit with modular connector system. Of the 5 chambers, only 3 chambers are assigned.

The following illustration shows the 5 chambers (M1-M5).



Pin assignment X70011, chamber M1, 9-pin

Pin	Type	Description
1	E	Terminal 15 (wake-up wire)
2	---	---
3	---	---
4	M	Terminal 31 (earth for electronic circuitry)
5	M	Terminal 31 (earth)
6	M	Terminal 31 (earth)
7	V	Terminal 30g (power supply, active)
8	E	Terminal 87 (power supply via relay)
9	E	Terminal 87 (power supply via relay)

	E = Input M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system	

Pin assignment X70003, chamber M3, 26-pin

Pin	Type	Description
1	---	---
2	---	---
3	A	Starter enable, release signal to car access system (CAS)
4	---	---
5	---	---
6	E	Analogue signal from Hall sensors for gear lever position recognition
7	E	Analogue signal from Hall sensors for gear lever position recognition
8	E	Analogue signal from Hall sensors for gear lever position recognition
9	E	Engine speed
10	---	---
11	---	---
12	E	Terminal 50 (starter motor)
13	A	Gear lever lock (shift-lock)
14	A	Earth for gear lever
15	E	Brake light switch

16	---	---
17	---	---
18	---	---
19	---	---
20	---	---
21	---	---
22	---	---
23	E	Analogue signal from Hall sensors for gear lever position recognition
24	E	Digital signal from Hall sensors for gear lever position recognition
25	---	---
26	---	---
	A = Output E = Input For current specifications regarding pin assignment, please refer to BMW diagnosis system	

Pin assignment X70014, chamber M4, 40-pin

Pin	Type	Description
1	---	---
2	A	Power supply (5 volt) for clutch travel sensor
3	E	Selector angle sensor
4	E	Clutch travel sensor
5	---	---

6	---	---
7	---	---
8	---	---
9	---	---
10	A	Solenoid valve MV3 for selector angle brake
11	A	Power supply (5 volts) for selector angle sensor, shift travel sensor and hydraulic pressure sensor
12	E	Shift travel sensor
13	E	Hydraulic pressure sensor
14	---	---
15	A	Earth for clutch travel sensor
16	A	Earth for selector angle sensor, shift travel sensor and hydraulic pressure sensor
17	M	Earth for SMG control unit
18	---	---
19	---	---
20	A	Solenoid valve MV2 for shifting to 2nd, 4th, 6th gear
21	E	Terminal 87
22	---	---
23	E	Inductive sensor for transmission input speed (inductive +)
24	E	Inductive sensor for transmission input speed, inductive -
25	---	---

26	---	---
27	---	---
28	---	---
29	---	---
30	A	Relay for hydraulic pump
31	---	---
32	E/A	Diagnosis bus
33	--	---
34	---	---
35	---	---
36	E/A	PT-CAN High (powertrain controller area network)
37	E/A	PT-CAN Low (powertrain controller area network)
38	---	---
39	A	Solenoid valve MV1 for shifting to 1st, 3rd, 5th gear
40	A	Solenoid valve MV0 for clutch actuator
	A = Output E = Input E/A = Input and output M = Earth For current specifications regarding pin assignment, please refer to BMW diagnosis system	

E60 - SMG, display in instrument cluster

Installation location

The LCD display (liquid crystal) is located between the speedometer and the rev counter.



Key	Explanation	Key	Explanation
1	Time	2	Outside temperature
3	Warning triangle indicates Check-Control message present	4	Trip meter
5	Distance recorder	6	Engaged drive position display
7	SPORT button for activated Dynamic Driving Control (FDC)	8	Engaged gear display

Construction

The LCD display is divided into 2 sections.

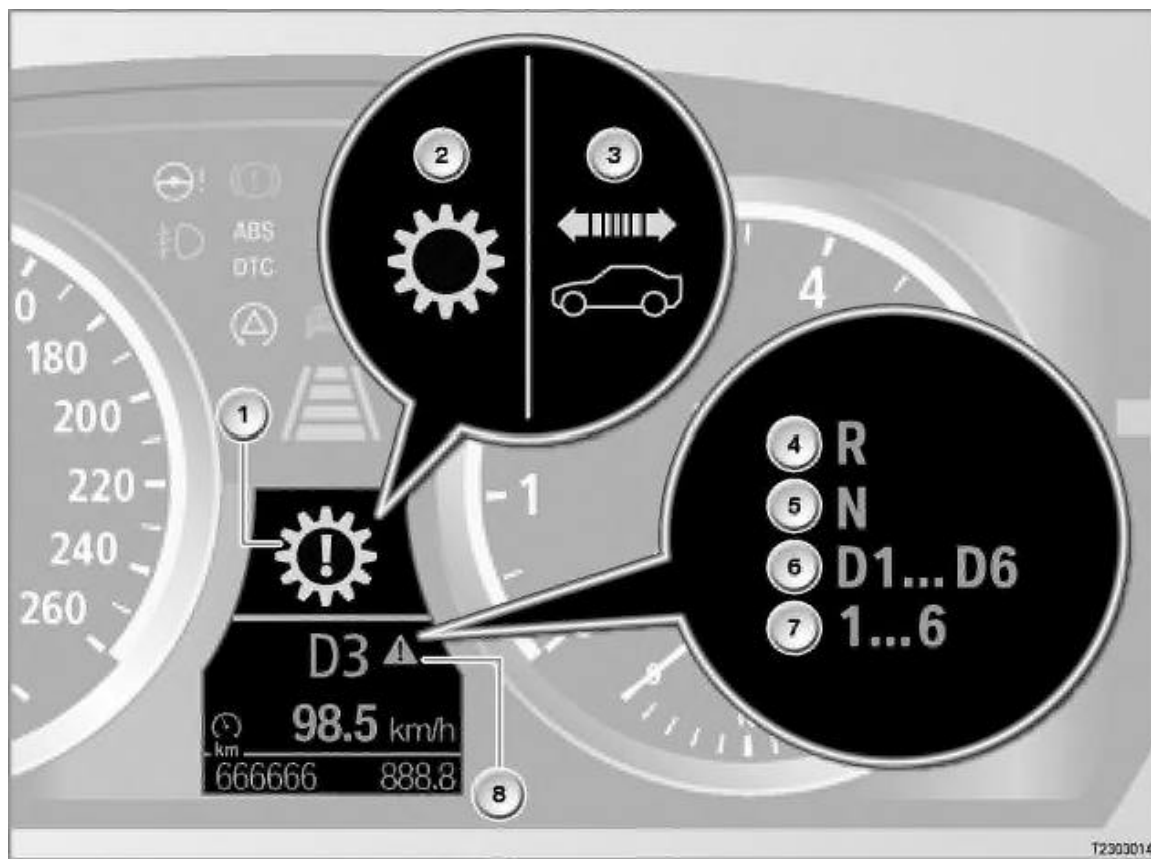
- Upper field:

Shows the time and the outside temperature. In addition, this field also contains the variable indicator lamp for Check-Control messages and the service display for Condition Based Service (CBS).

- Lower field:

Shows, for example, the drive position selected and the gear engaged.

The following illustration shows the variable indicator lamp for Check-Control messages and the possible selector lever position and gear engaged displays.



Key	Explanation	Key	Explanation
1	Emergency program activated and/or transmission malfunction (yellow or red indicator lamp)	2	Clutch overheated, or select position "N" and depress the brake to start the engine, or select gear again (yellow indicator lamp)
3	Transmission in position "N", i.e. vehicle could roll away (yellow indicator lamp)	4	Reverse gear
5	Neutral (= idle)	6	Automatic mode (D = Drive), display "D1" to "D6"
7	Manual mode (= Steptronic), display 1st gear to 6th gear	8	The warning triangle indicates Check-Control message present

How it works

The LCD display is activated when terminal R is switched ON and has orange backlighting.

The SMG control unit feeds CAN messages about the gear engaged or the drive position selected and fault messages to the instrument cluster (signal path: SMG control unit --> PT-CAN --> K-CAN --> Instrument cluster).

When Check-Control messages are faded in, the upper field of the LCD display (time and outside temperature) is overwritten.

A Check-Control message is displayed as a symbol in the LCD display via the variable indicator lamps (red and yellow). The instrument cluster assigns priorities, i.e. determines which message is most important.

Check-Control messages with priority 1 are displayed permanently, messages with priority 2 only for a few seconds.

The presence of Check-Control messages is indicated by a warning triangle in the LCD display. These Check-Control messages can be displayed in sequence in the LCD display by pressing the Check-Control button in the turn-signal/main-beam switch. The Check-Control button is read in via the K-CAN.

After a few seconds without the button being pressed, either the time/ambient temperature or a Check-Control message with priority 1 is displayed.

In addition to the visual display, the Check Control also alerts the driver with acoustic signals. The instrument cluster assumes control over these warnings via the K-CAN. The acoustic warnings are emitted by the multi-audio system controller (M-ASK) through the loudspeakers.

Most Check-Control messages are supplemented by explanatory notes and instructions in the central information display (CID).

The notes supplementing the Check-Control message are selected as follows:

- Select the "Settings" menu with the controller and press the controller.
- Select "BMW Service" and press the controller.
- Select "Check-Control message" and press the controller.

If a Check-Control message appears in the instrument cluster, a short form of the Check-Control message also appears in the status line of the central information display (CID).

E60 - SMG, display in instrument cluster

Installation location

The LCD display (liquid crystal) is located between the speedometer and the rev counter.



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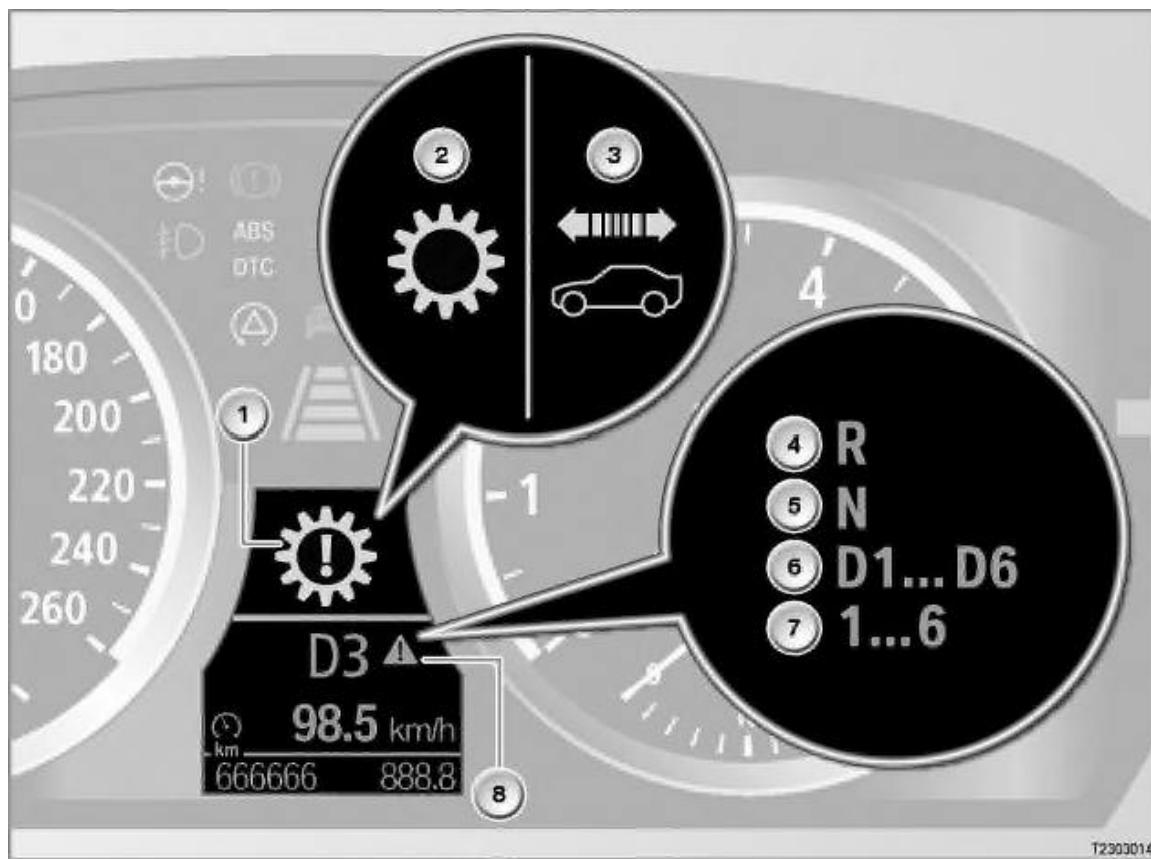
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If a Check-Control message appears in the instrument cluster, a short form of the Check-Control message also appears in the status line of the central information display (CID).

E60 - General information for service staff on sequential manual transmission (SMG)

The following general information is provided for service staff:

- Performing repairs on the sequential manual transmission (SMG)
- Oil loss in hydraulic system without visible leakage
- Control unit failure, hydraulics defect

Performing repairs on the sequential manual transmission (SMG)

Important: Only exchange complete SMG until such time as all genuine spare parts are available.

Until all genuine spare parts are available, a provisional procedure has been agreed for performing repairs on the sequential manual transmission (SMG): Only replace the complete transmission.

For up-to-date details on the availability of genuine BMW spare parts, please refer to the Electronic Parts Catalogue (EPC).

Oil loss in hydraulic system without visible leakage

Oil loss in hydraulic system expansion tank without visible leakage in the hydraulic system could indicate an internal leak in the gearshift and selector angle actuator. Check transmission fluid level.

SGM control unit failure, hydraulics defect

Warning! Do not attempt to push or tow the vehicle with a gear engaged and the clutch closed.

In the event of a failure of the SMG control unit or of a defect in the hydraulics when a gear is engaged and the clutch closed, the vehicle must be neither pushed nor towed away. Moving the vehicle in this condition will result in transmission damage.