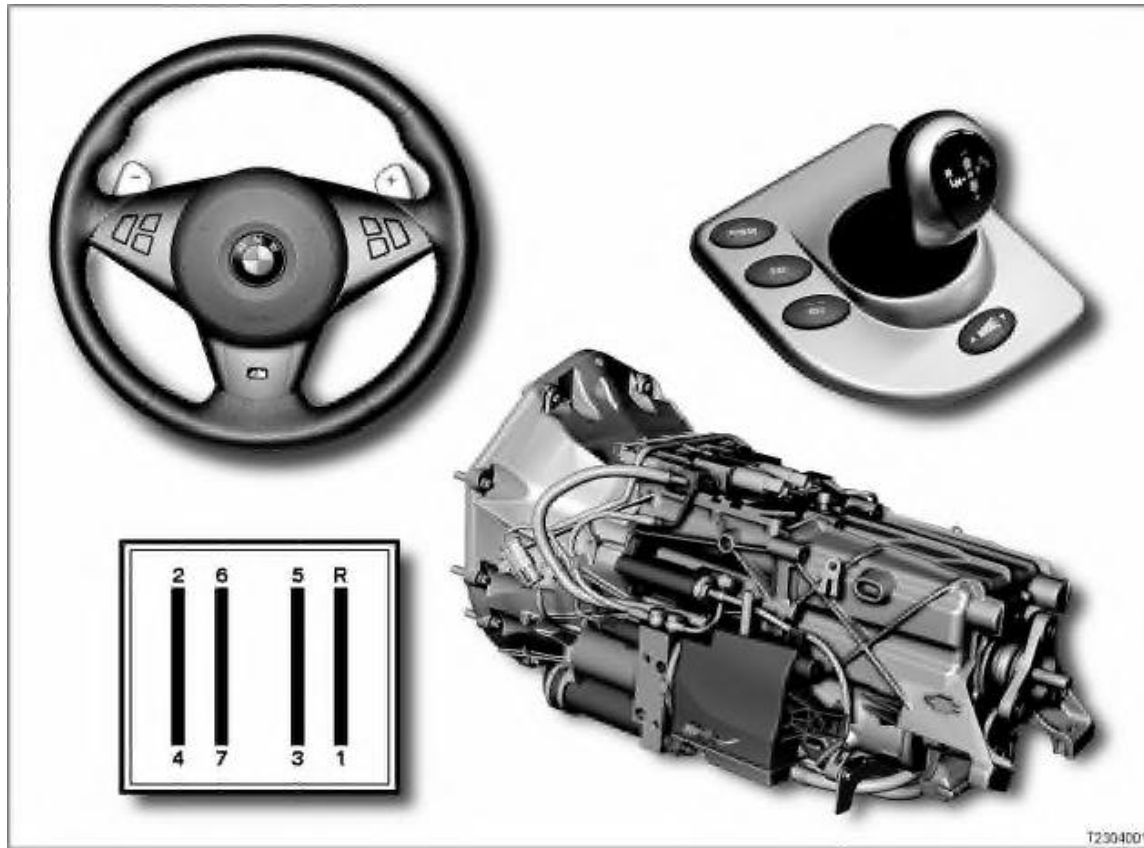


Sequential M transmission

E60 M5, E63 M6



Introduction

The new BMW M5 is the first car in the world to feature the sequential M transmission with **7** forward gears and **11** driving programs (5 driving programs in automatic mode and 6 driving programs in manual mode).

The sequential M transmission is derived from the world of motor racing. The sequential M transmission has now been adapted for series production.

The sequential M transmission automates clutch operation and gear changes. An electrohydraulic control system takes over the clutch operation and gearshifts.

The sequential M transmission can be driven as follows in manual mode or in automatic mode:

- Sequential (manual mode) "S":

Gears are shifted by briefly pressing "+" or "-", as follows:

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

Gears may be skipped by briefly pressing several times quickly.

The shift pulse is transmitted electrically to the SMG control unit ("shift-by-wire", i.e. gear shift by electronics). With "shift-by-wire" there is no mechanical link between the gear lever or gearshift paddles and the transmission.

- Automatic mode "D":

In automatic mode, the gear shift times are automatically actuated according to maps and in response to the driving situation.

The 3rd generation of the sequential M transmission is a fundamentally new development.

Gear changes with this sequential M transmission are approx. 20 percent faster than with the 2nd generation. (In the ideal case, a gear change takes only approximately 65 milliseconds.)

The fast gear change is made possible by the installation of 4 shift rods:

- Shift rod R/1 (for reverse gear and the 1st gear)
- Shift rod 5/3 (for 5th and 3rd gears)
- Shift rod 6/7 (for 6th and 7th gears)
- Shift rod 2/4 (for 2nd and 4th gears)

Each shift rod is hydraulically selected by a shift cylinder. The shift cylinders are actuated by the SMG control unit.
[System overview ...]

The sequential M transmission is designed for torque up to 550 Newton metres and engine speeds up to 8500 rpm.

The key benefits of the sequential M transmission compared to conventional manual transmissions:

- No clutch pedal as the clutch is operated automatically.
- 2 operating modes can be selected:
 - Sequential mode (manual mode) "S":
Sequential, manual gearshift via gear lever or gearshift paddles
 - Automatic mode "D" ("Drive"):
Fully automated gear change
- "Drivelogic" makes a total of 11 driving programs available, which are used to adapt the shift characteristics of the sequential M transmission to the desired driving style.
- Short and precise gearshifts, faults are not possible when changing gear
- 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:

09/2004.


Brief description of components

The "sequential M transmission" system consists of the following components:

- **Gear lever with gear lever cover**

The gear lever allow gears to be changed by briefly pressing.

The gear lever has 6 gear lever positions:

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

Gear indicator lighting is in the gear lever knob.

The following buttons are located in the gear lever cover: POWER, DSC, EDC and "Drivelogic".

[more ...]

- **Steering wheel with 2 gearshift paddles**

2 gearshift paddles are on the steering wheel.

Briefly pull the right gearshift paddle to shift up.

Briefly pull the left gearshift paddle to shift down.

[more ...]

- **SMG control unit**

The SMG control unit actuates the clutch operation and gear change. Furthermore, the SMG control unit sends messages to different control units, such as for adapting the engine speed.

[more ...]

- **Hydraulic control unit**

The hydraulic control unit performs the clutch operation and gear change electrohydraulically.

The hydraulic unit consists of the following components:

- **Pressure accumulator**

The pressure accumulator is fitted on the bottom left of the transmission. The pressure accumulator supplies enough hydraulic power for the gearshifts.

- **Hydraulic pressure sensor**

The hydraulic pressure sensor is fitted directly to the hydraulic block of the hydraulic control unit. The hydraulic pressure sensor reports the current hydraulic pressure to the SMG control unit. The hydraulic pump is switched on and off accordingly.

- **Clutch slave cylinder with PLCD sensor**

The clutch slave cylinder executes the clutch operations. The release travel is measured by the PLCD sensor (PLCD: Permanent magnetic Linear Contactless Displacement). The PLCD sensor is permanently linked to the clutch slave cylinder by a screwed connection.

The SMG control unit actuates the clutch slave cylinder via the solenoid valve for the clutch.

- **Monitoring of the clutch position**

During clutch action, the SMG control unit continuously measures and monitors the position of the clutch slave cylinder via the PLCD sensor. This also measures the clutch position.

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 to ensure that clutch operation is optimised. The clutch slipping point is updated in the SMG control unit to take into account changes due to installation tolerances and wear.

- **Solenoid valve for the clutch**

The solenoid valve for the clutch is used for actuating the clutch slave cylinder.

- **Hydraulic pump with electric motor**

The hydraulic pump with electric motor builds up to 90 bar system pressure for the gearshifts. The hydraulic pump with electric motor is actuated via the SMG control unit.

- **Hydraulic temperature sensor**

The hydraulic temperature sensor measures the temperature of the hydraulic fluid at the hydraulic pump. The signal is used for actuation of the transmission functions in the SMG control unit. The signal is transmitted by a direct wire from the hydraulic temperature sensor to the SMG control unit.

- **Pressure limiter valve**

The pressure limiter valve prevent the oil pressure in the hydraulic control unit from becoming too high.

- **Regulator block**

The regulator block is installed in the centre of the transmission housing close to the clutch housing.

The regulator block consists of the following components:

- 4 shift travel valves for actuating the hydraulic shift cylinders
- 2 pressure control valves for modulation of the shift force
- 4 hydraulic shift cylinders for moving the shift rod in the longitudinal axis
- 4 transmission position sensors for recording the selected gear

(The transmission position sensor for shift rod R/1 is designed as a double version.)

- **Expansion tank**

The expansion tank ensures that there is always sufficient hydraulic fluid available for the system.

- **Check valve**

The check valve at the outlet to the hydraulic pump prevents the hydraulic pressure from reducing when the hydraulic pump is inactive.

- **Filter**

A filter is installed at the inlet end of the hydraulic pump. The filter prevents impurities from entering the solenoid valve (functional failure). It is not necessary to clean the filter.

- **Sensor for transmission input speed**

The sensor (Hall sensor) measures the transmission input speed. The SMG control unit compares this speed with the engine speed. This is used to measure the clutch closing speed.

- **Longitudinal acceleration sensor**

Data from the longitudinal acceleration sensor has an effect upon the clutch function and the gearshift function (especially when pulling away on a slope). The longitudinal acceleration sensor is fitted to the floor panel under the front-passenger seat.

The following components and control units are involved in the function of the sequential M transmission:

- **M-ASK / CCC and CID: Multi-audio system controller / Car Communication Computer and Central Information Display**

- Multi-audio system controller / Car Communication Computer

The M-ASK / CCC is an interface for the instrument cluster to the Central Information Display (CID).

Additionally, the M-ASK / CCC emits acoustic warnings through the loudspeakers (depending on national version).

- Central Information Display

Amongst other things, the CID displays additional information about the Check-Control messages.

- **Instrument cluster**

The following displays are in the instrument cluster:

- Selected drive position:

- R (reverse)
- N (neutral)
- 1D...7D (automatic mode)
- 1...7 (manual mode)

- Selected driving program

- Check-Control symbol when there is a malfunction (on LCD display)

- Indicator lamp for "MDrive"

- **HUD: Head-up display**

The head-up display (option 610) shows the selected drive position.

- **DME: Digital engine electronics**

The DME sends messages about the current operating status of the engine to the SMG control unit (e.g. engine speed or torque).

The SMG control unit reports the current operating status of the transmission back to the DME.

- **CAS: Car Access System**

The CAS enables the starter only if a release signal is received from the SMG control unit (starter inhibitor).

The following conditions must be satisfied for the start to be enabled:

- The gear lever must be in position "N".
"N" must be on the instrument cluster LCD display. (This also keeps the transmission into "N").
- The SMG control unit enables the start when the brake pedal is depressed. The clutch is opened.

The CAS also provides input signals relating to terminal status (e.g. terminal 15 ON).

- **SGM or KGM: Safety and gateway module or body gateway module**

From 09/2005, the vehicle electrical system has been modified. The KGM supersedes the SGM.

> SGM up to 09/2005

The SGM is the gateway (= data interface) between:

- PT-CAN
- K-CAN
- **Byteflight**

The diagnosis wire is connected to the SGM.

> KGM from 09/2005

The KGM is the gateway (= data interface) between:

- PT-CAN
- K-CAN

The diagnosis wire is connected to the KGM.

- **LM: Light module**

The reversing light is switched on upon the basis of messages from the SMG control unit to the light module.

- **Brake light switch**

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
- For pulling away on a slope

Signal path: Brake light switch -> DME control unit -> PT-CAN -> SMG control unit

- **FPM: Accelerator pedal module**

The signal from the accelerator pedal module (driver's command) is needed to permanently monitor the vehicle's operating conditions (evaluation via DME).

- **Parking brake warning switch**

The SMG control unit uses the parking brake warning switch to detect whether the parking brake is applied or released. The signal is used for activating the clutch. The signal is transmitted by a direct wire from the parking brake warning switch to the SMG control unit.

- **RLS: Rain-light sensor**

The rain-light sensor is used for automatically adjusting the brightness of the gear indicator lighting in the gear lever knob to the background lighting.

- **Bonnet contact switch**

The 2 bonnet contact switches (Hall sensors) notify the SMG control unit of whether the bonnet is open or closed.

The gear is cancelled when the bonnet is open to prevent the vehicle from pulling away unintentionally in the workshop. (e.g. The engine is running at idle-speed. A drive position is selected. The accelerator pedal is in the idle position. The clutch is disengaged.

The accelerator pedal could be unintentionally pressed whilst work is being carried out in the engine compartment.)

The bonnet contact switches are permanently monitored whilst the vehicle is being driven. If a bonnet contact switch should fail, an "open bonnet" will be detected when the vehicle is stationary. The gear indicator on the LCD display flashes.

The bonnet contact switches are fitted in the two bonnet locks.

- **MDrive**

Some settings may be preconfigured in the "MDrive" submenu of the iDrive. All of these settings are enabled when the button with the "M" symbol in the steering wheel is pressed (indicator lamp in the instrument cluster lights up).

The following functions are configured in advance for the sequential M transmission:

- Menu item "Sequential M transmission"
 - Call up one of the 6 driving programs in manual mode
 - Call up one of the 5 driving programs in automatic mode

- **Local CAN**

The SMG control unit and the digital engine electronics (DME) are connected via the local CAN. Information such as that needed for actuating the clutch (e.g. engine speed, engine torque) is transmitted over the local CAN.

System functions

The sequential M transmission comprises the following functions:

- Engine start
- Gearshift
- Drivelogic
- Driving in gear lever position "D" (automatic mode)
- Launch control (acceleration assist system)
- Slip detection
- Pulling away on a slope
- Vehicle standstill
- Gear lever position "Neutral" and ignition OFF
- Gear lever lock (shift-lock)
- Rock free, e.g. from snow
- Protection of valves
- Self-diagnosis during a pressure loss
- Emergency program

Engine start

To start the engine, the gear lever and transmission must both be in "N" (neutral) and the brake must be applied. When the engine is started, sufficient system pressure must immediately be built up to open the clutch. This is why the SMG control unit is activated by 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.

Gearshift

- The clutch disengages:

When a gearshift is initiated in manual or automatic mode the SMG control unit actuates the corresponding solenoid valves. The hydraulic fluid under pressure flows into the clutch slave cylinder. The clutch opens

(disengages).

- The engine torque is reduced:

Simultaneously, the SMG control unit sends to the DME control unit the message that a gearshift is being initiated. The engine torque is reduced.

- Shifting:

The SMG control unit actuates the solenoid valves and the hydraulic shift cylinder. The shift cylinders execute the forwards and backwards movements of the corresponding shift rods. The desired gear is selected.

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

- Engagement:

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

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

The course of the entire gearshift depends on the accelerator pedal position, engine speed, road transmission speed and other controlled variables (e.g. engine oil temperature, selected driving program).

Gearshifts that would result in an excessively high or low engine speed are not executed.

Drivelogic

A total of 11 different driving programs are made available via "Drivelogic".

- In automatic mode there is a choice of **5 driving programs** (from "relaxed" to "sporty").

In driving program 1, for instance, the 2nd gear is selected for pulling away. The clutch operates with great sensitivity. This eases pulling away on wintry roads.

- In manual mode there is a choice of **6 driving programs** (from "adaptably dynamic" to "very sporty").

Driving program 6 is only available when DSC is deselected or with launch control.

The basic difference in the driving programs lies in their preselected shift times: The higher the driving program, the engine speed and the load, the shorter the shift time.

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

- Constant-speed travel

Continuous changes of the accelerator pedal 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 journey with constantly changing speed).

- Upshift suppression

Based on the accelerator pedal position, the SMG control unit recognises when the throttle is closed rapidly, e.g. before applying the brake.

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

- Manual intervention in automatic mode

If 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.

- Driving uphill

The SMG control unit uses signals from the following components to recognise when the vehicle is driving uphill:

- Longitudinal acceleration sensor
- Wheel-speed sensors
- Accelerator pedal position

The SMG control unit prevents unintentional upshifts and irritating pendulum shifts.

- Driving downhill

The SMG control unit uses signals from the following components to recognise when the vehicle is driving downhill:

- Throttle valve potentiometer (load signal)
- Wheel-speed sensors (road speed)
- Brake light switch

The SMG control unit shifts down a gear as the road speed increases. This ensures that the engine braking effect is retained and increased.

- Braking deceleration and automatic downshift

The SMG control unit uses signals from the following components to recognise braking deceleration:

- Brake light switch
- Wheel-speed sensors
- Accelerator pedal 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.

Launch control (acceleration assist system)

Launch control allows optimum vehicle acceleration from standstill, comparable to motor racing standards. For this to happen, the accelerator pedal only has to be quickly and fully depressed (kickdown).

When launch control is enabled, the system automatically shifts up through the gears, even in manual mode, for as long as the accelerator pedal is fully pressed down. This prevents the engine from reaching critical speeds.

Preconditions for enabling launch control:

- Vehicle standstill
- Dynamic Stability Control (DSC) deselected
- Driving program 6 selected at the for "Drivelogic" program switch
- Program "P 500" for engine control selected with the POWER button
- Sequential (manual) mode selected
- High-grip road surface

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

Do not accelerate using launch control during the running-in phase of a new car. Frequent use of launch control leads to increased component wear.

Slip detection

A disproportionate amount of wheel slip may occur when engaging the clutch or during a load change (e.g. on wet or icy road surfaces). The clutch is disengaged to stabilise the vehicle.

The procedure is executed as follows:

- The clutch is opened after wheel slip is detected between the wheels on the rear axle and front axle on the same side. This counteracts the vehicle swerving out.
- Afterwards, the clutch engages softly in response to further wheel slip.
- The clutch opens and closes as required until no more wheel slip is detected when the clutch is closed.

Pulling away on a slope

Special software is loaded into the sequential M transmission to ease pulling away on a slope (on an uphill slope, the vehicle could roll back when the brakes are released).

The brakes intervene automatically to ease pulling away on a slope. The function may be used in both manual and automatic modes (when driving forwards and reversing).

This is initiated merely by pressing down the brake pedal when the vehicle is stationary. After the brake has been released, it is possible to drive off after approximately 0.8 seconds without rolling away out of control. During this time period, after the brake has been released the engine speed is increased to a level to match the slope. The clutch is moved to the clutch slipping point, which briefly prevents the vehicle from rolling back.

Vehicle standstill

The SMG control unit detects vehicle standstill from the accelerator pedal position, the wheel speeds and the engine speed. The clutch disengages. The 1st gear is selected (in manual and automatic modes).

If the driver's door or bonnet are opened when the engine is running, an acoustic signal draws attention to the position of the transmission. Reason: A drive position is still engaged and the transmission is not in position "N"). At the same time, the "N" symbol flashes in the LCD display in the instrument cluster.

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

When the gear lever is in "Neutral" position and the ignition is switched off, the "N" symbol flashes in the LCD display of the instrument cluster. In addition, the multi-audio system controller (M-ASK) will emit an acoustic warning. Reason: The vehicle may roll away.)

Gear lever lock (shift-lock)

The gear lever lock prevents an unintentional gearshift.

When the vehicle is stationary, it is only possible to select a drive position when the brake is still applied and approximately 1.5 seconds after the "Neutral" gear lever position has been selected (for safety reasons).

The gear lever is locked in the "Neutral" position by an electromagnet (electromagnet locks in a current-free state). The electromagnet is actuated by the SMG control unit. The gear lever lock is engaged when selector lever position "N" is detected and the ignition (terminal 15) is ON.

Rocking free, e.g. from snow

To rock the vehicle free, shift gear rapidly from 1st gear, via position "N" to position "R" and vice versa. Perform the gearshift within approximately 0.8 seconds, as otherwise the gear lever lock (shift-lock) will be activated.

Protection of valves

All valves in the transmission are activated periodically to protect the valves from becoming soiled. In this process, the valves are supplied with current so that they are moved and cleaned, but the shift cylinder is not moved.

Switch-on conditions:

- During wake-up of the SMG control unit
- Cyclically after expiry of a specified time

Self-diagnosis during a pressure loss

Defects (e.g. leakage) are detected because the hydraulic pump switches on more frequently than is normal. The SMG control unit limits the switch-on time.

If there is a fault, the Check-Control symbol in the LCD display of the instrument cluster lights up.

When the hydraulic pump is running, the pressure increase is monitored in response to the switch-on time. The gear is deselected if there is a defect in the hydraulic pump or a pressure value is undercut (e.g. sudden pressure loss).

The hydraulic control unit is deselected.

Emergency program

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

Depending on the type of transmission fault, the vehicle may no longer be operational after a vehicle standstill.

Operation

Activate launch control

(Note preconditions for activating launch control!)

The gear lever must be pushed forwards and the accelerator pedal must be pressed fully down. The engine is regulated to the optimum starting speed.

When the gear lever is released, the vehicle is accelerated with an ideally regulated slip for as long as the accelerator pedal is still pressed down.

The sequential M transmission with "Drivelogic" automatically changes gear from 1st to 7th until the top speed has been reached. Gearshifts are made shortly before the maximum engine number for the gear concerned is reached.

Deactivate launch control

- By the position of the accelerator pedal (releasing the kickdown position)
or
- By a manual gearshift
or
- By activating DSC

After a launch control operation, the vehicle must be driven over a certain distance before the next launch control operation is enabled.

Notes for service staff

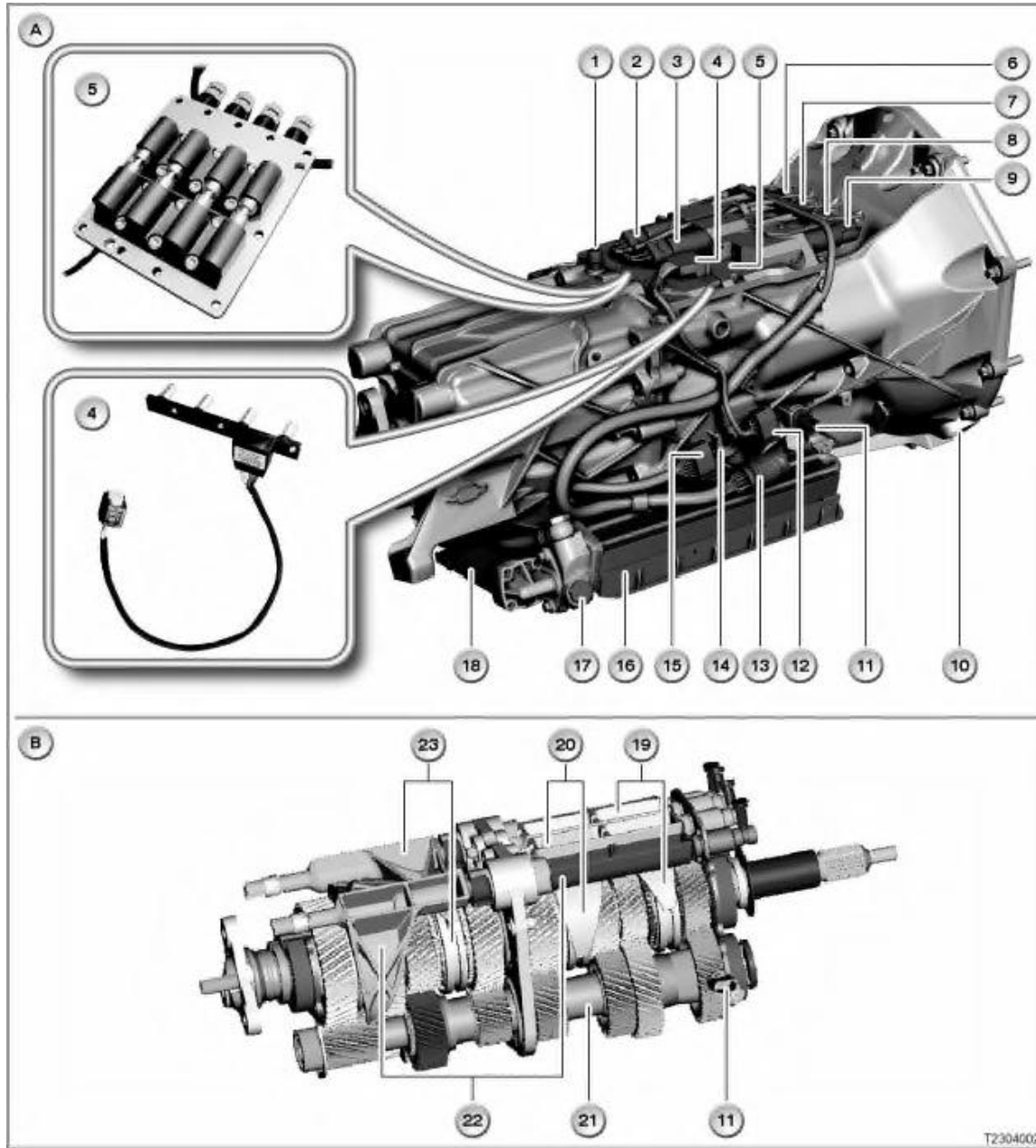
Service staff should note the following points:

- General information: [more ...]
- Diagnosis: ---
- Encoding/programming: ---

Subject to change.

Sequential M transmission, system overview: E60 M5, E63 M6

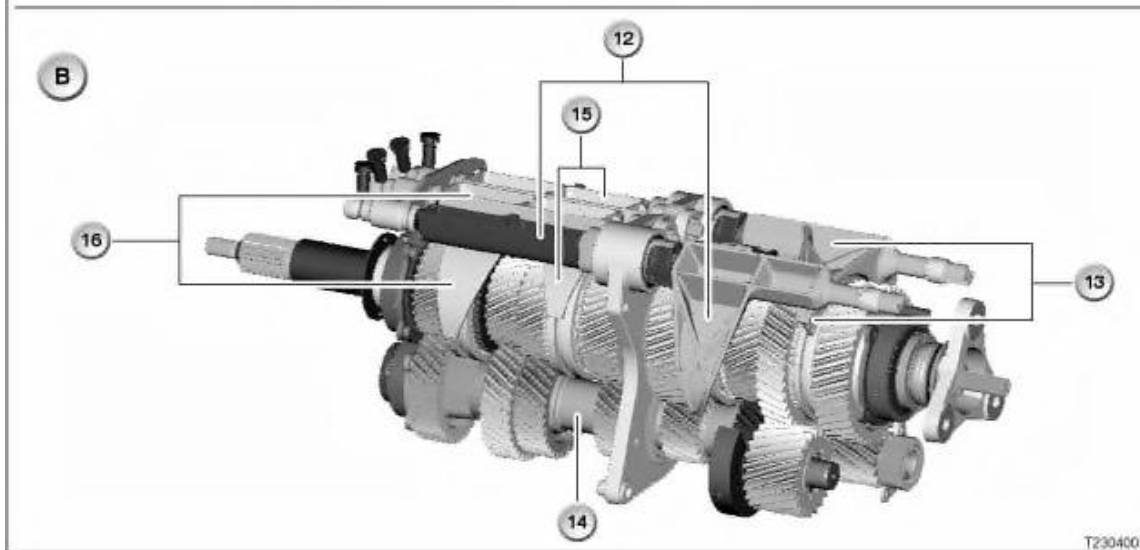
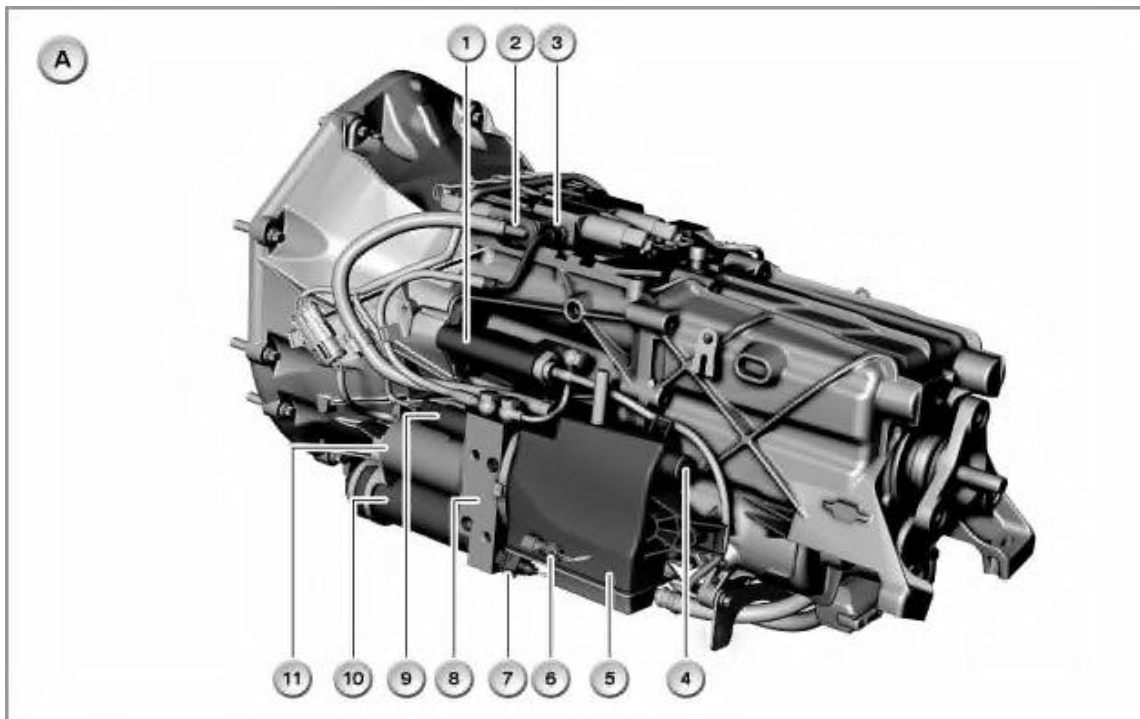
- Viewed from right



Item	Description	Item	Description
A	Sequential M transmission, viewed from right	B	Sequential M transmission, selector rods with selector fork
1	Transmission bleeding	2	Pressure control valve (for actuating the 2 shift travel valves for the gearshift mechanisms for 2nd/4th gear and 6th/7th gear)
3	Pressure control valve (for actuating the 2 shift travel valves for the gearshift mechanisms for reverse/1st gear and 5th/3rd gear)	4	Transmission position sensors

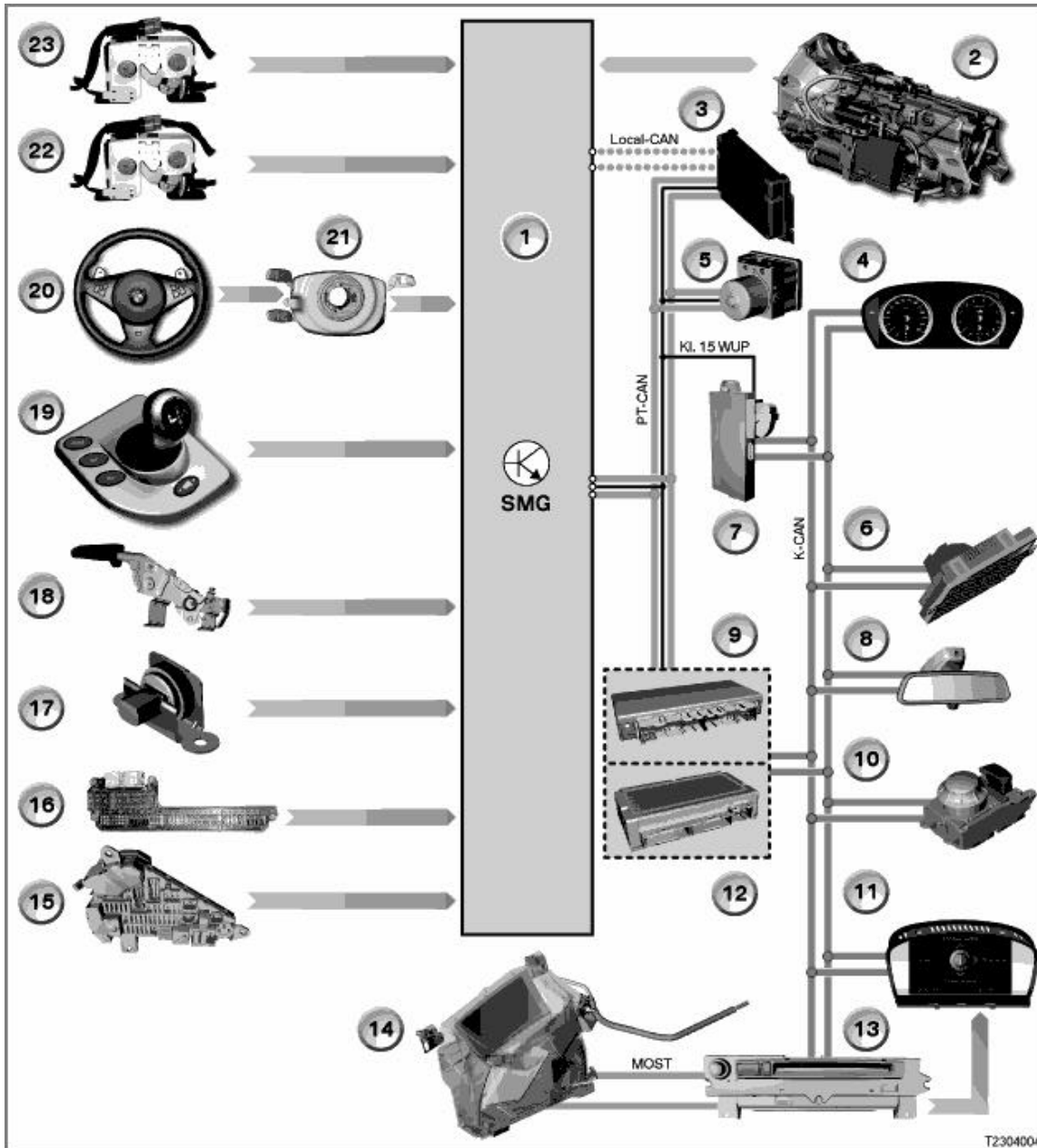
	Regulator block with 4 interior hydraulic shift cylinders	6	Shift travel valve (control of the shift cylinder for 2nd and 4th gears)
7	Shift travel valve (control of the shift cylinder for 6th and 7th gears)	8	Shift travel valve (control of the shift cylinder for 5th and 3rd gears)
9	Shift travel valve (control of the shift cylinder for gears R and 1)	10	Crankshaft sensor
11	Sensor for transmission input speed	12	Plug connector for transmission position sensors
13	Plug connector for valves and electric motor	14	Adjust oil level (for transmission oil)
15	Plug connector for clutch slave cylinder, hydraulic temperature sensor and hydraulic pressure sensor	16	Transmission oil cooler
17	Oil filter	18	Transmission oil pump
19	Shift rod 6/7 with shift fork	20	Shift rod 5/3 with shift fork
21	Countershaft	22	Shift rod R/1 with shift fork
23	Shift rod 2/4 with shift fork		

- Viewed from left



Item	Description	Item	Description
A	Sequential M transmission, viewed from left	B	Sequential M transmission, selector rods with selector fork
1	Clutch slave cylinder with PLCD sensor	2	Oil return
3	Oil pressure line	4	Oil filler opening for hydraulic oil
5	Expansion tank	6	Hydraulic pressure sensor
7	Hydraulic temperature sensor	8	Hydraulic block with hydraulic pump
9	Solenoid valve for clutch (for actuating the clutch slave cylinder)	10	Pressure accumulator
11	Electric motor for hydraulic pump	12	Shift rod 2/4 with shift fork
13	Shift rod R/1 with shift fork	14	Countershaft
15	Shift rod 5/3 with shift fork	16	Shift rod 6/7 with shift fork

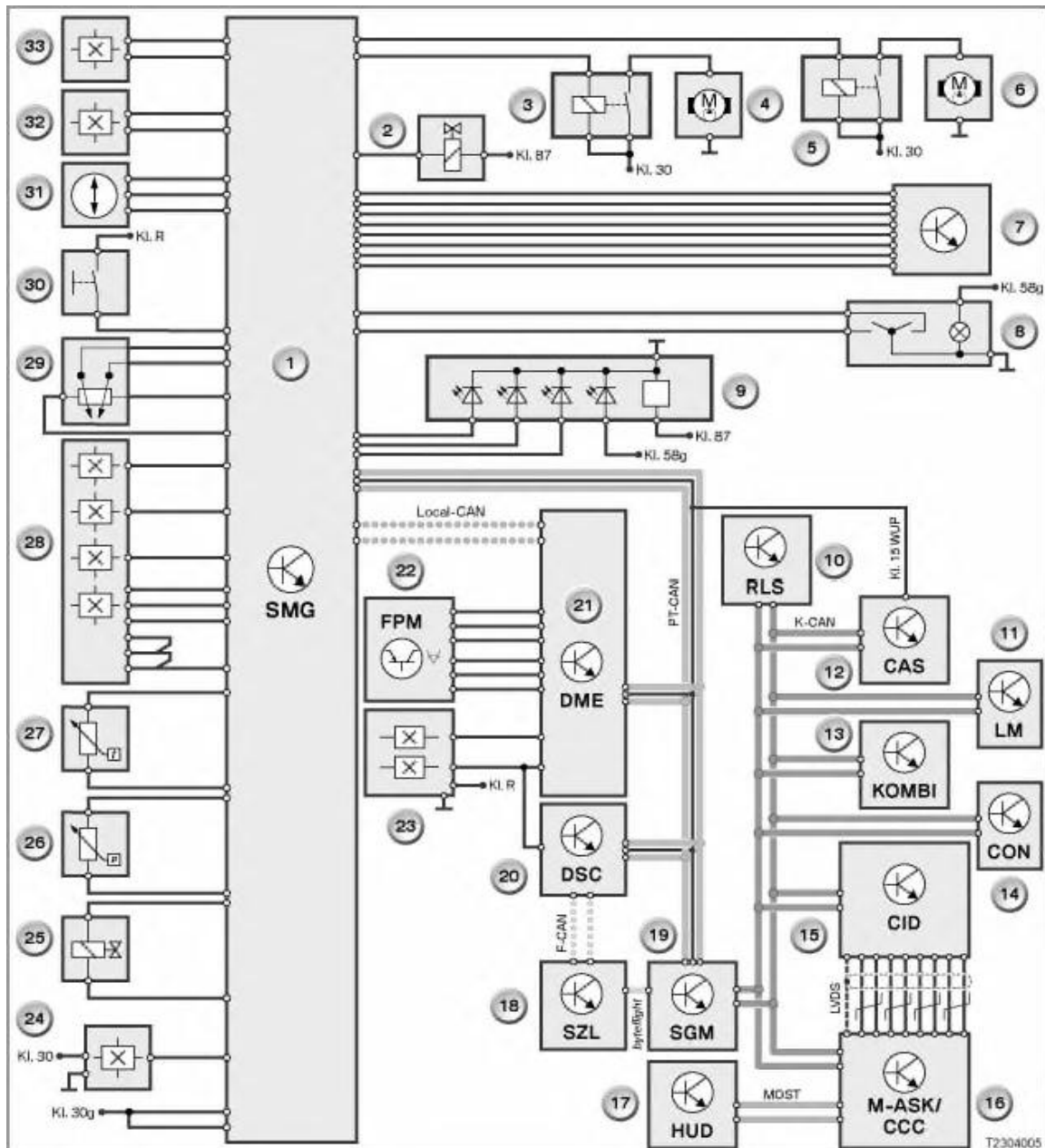
- Inputs/outputs



Item	Description	Item	Description
1	SMG control unit	2	Sequential M transmission
3	Digital engine electronics (DME)	4	Instrument cluster (KOMBI)
5	Dynamic Stability Control (DSC)	6	Light module (LM)
7	Car Access System (CAS)	8	Rain-light sensor (RLS)
9	Body gateway module (KGM) from 09/2005	10	Controller (CON)
11	Central Information Display (CID)	12	Safety and gateway module (SGM) before 09/2005
13	Multi-audio system controller (M-ASK) / Car Communication Computer (CCC)	14	Head-up display (HUD)

15	Power distributor, rear	16	Power distributor, front
17	Longitudinal acceleration sensor	18	Parking brake warning switch
19	Gear lever with gear lever cover	20	Steering wheel with gearshift paddles
21	Steering column switch cluster (SZL)	22	Bonnet contact switch, front right
23	Bonnet contact switch, front left		
K-CAN	Body CAN (body controller area network)	Local CAN	Local CAN (local controller area network)
MOST	MOST (media oriented system transport)	PT-CAN	Powertrain CAN (powertrain controller area network)
Kl. 30 WUP	Terminal 15 wake-up wire		

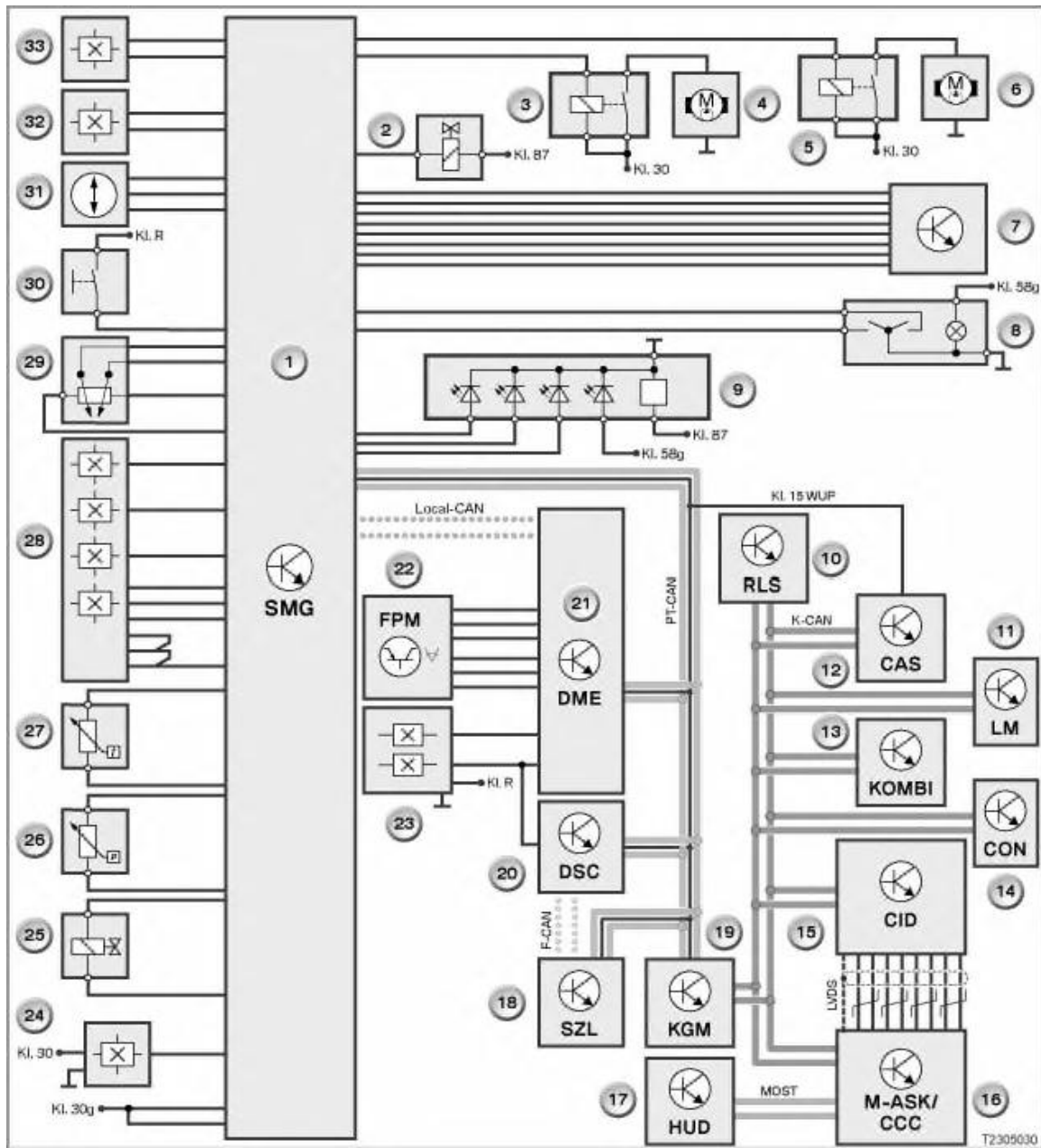
- System circuit diagram up to 09/2005



Item	Description	Item	Description
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1	SMG control unit	2	Gear lever lock (shift-lock)
3	Hydraulic pump relay	4	Hydraulic pump with electric motor
5	Relay for transmission oil pump	6	Transmission oil pump with electric motor
7	Gear lever	8	Program switch for "Drivelogic"
9	Gear indicator lighting in gear lever knob	10	Rain-light sensor (RLS)
11	Light module (LM)	12	Car Access System (CAS)
13	Instrument cluster (KOMBI)	14	Controller (CON)
15	Central Information Display (CID)	16	Multi-audio system controller (M-ASK) / Car Communication Computer (CCC)
17	Head-up display (HUD)	18	Steering column switch cluster (SZL)
19	Safety and gateway module (SGM)	20	Dynamic Stability Control (DSC)
21	Digital engine electronics (DME)	22	Accelerator pedal module (FPM)
23	Brake light switch	24	Sensor for transmission input speed
25	7 solenoid valves	26	Hydraulic pressure sensor
27	Hydraulic temperature sensor	28	Transmission position sensors
29	PLCD sensor	30	Parking brake warning switch
31	Longitudinal acceleration sensor	32	Bonnet contact switch, front left
33	Bonnet contact switch, front right		
byteflight	byteflight fibre optics	F-CAN	Chassis CAN (chassis controller area network)
K-CAN	Body CAN (body controller area network)	Local CAN	Local CAN (local controller area network)
MOST	MOST (media oriented system transport)	PT-CAN	Powertrain CAN (powertrain controller area network)
Kl. 15 WUP	Terminal 15 (wake-up wire) from CAS	Kl. 30	Terminal 30
Kl. 30g	Terminal 30g, active	Kl. 58g	Terminal 58g, locating light
Kl. 87	Terminal 87	Kl. R	Terminal R

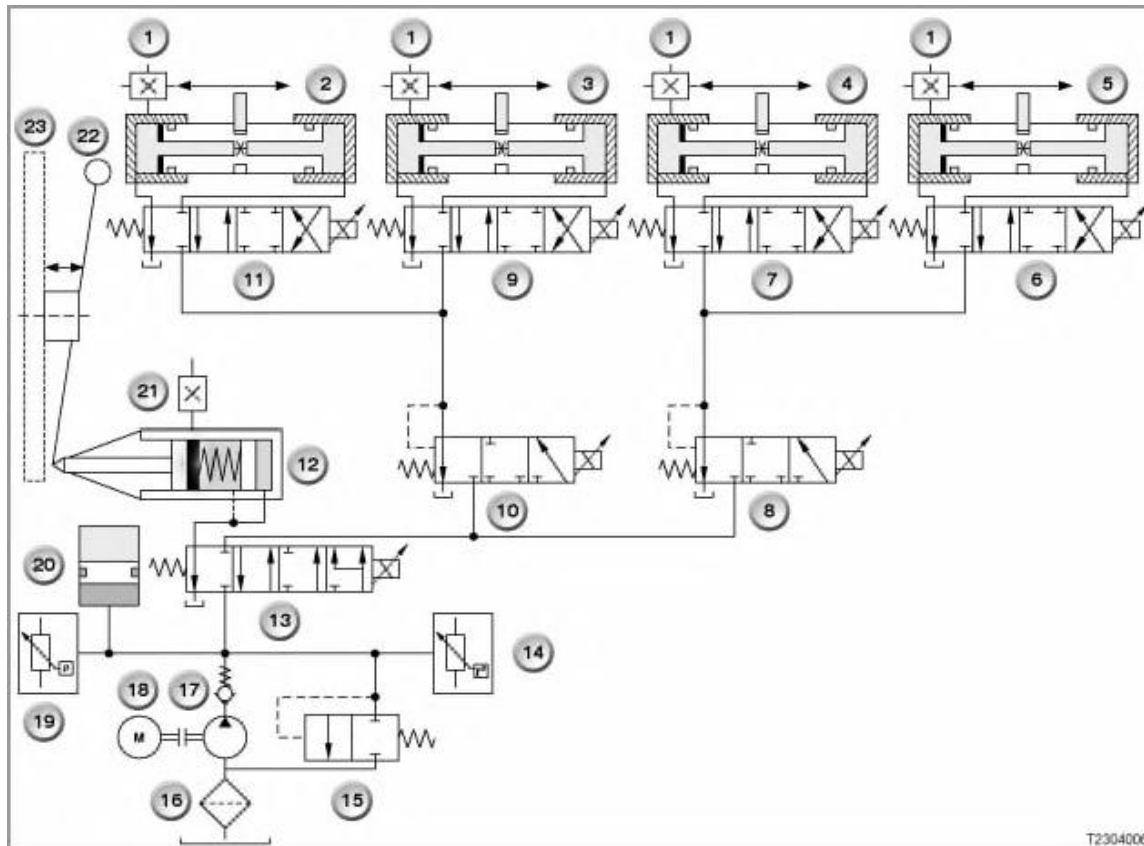
- System circuit diagram from 09/2005



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33	Bonnet contact switch, front right		
F-CAN	Chassis CAN (chassis controller area network)	K-CAN	Body CAN (body controller area network)
Local CAN	Local CAN (local controller area network)	MOST	MOST (media oriented system transport)
PT-CAN	Powertrain CAN (powertrain controller area network)		
Kl. 15 WUP	Terminal 15 (wake-up wire) from CAS	Kl. 30	Terminal 30
Kl. 30g	Terminal 30g, active	Kl. 58g	Terminal 58g, locating light
Kl. 87	Terminal 87	Kl. R	Terminal R

- Hydraulics diagram



Item	Description	Item	Description
1	4 transmission position sensors	2	Dual-action hydraulic shift cylinder for the gearshift mechanisms for 2nd and 4th gears

3	Dual-action hydraulic shift cylinder for the gearshift mechanisms for 6th and 7th gears	4	Dual-action hydraulic shift cylinder for the gearshift mechanisms for 5th and 3rd gears
5	Dual-action hydraulic shift cylinder for the gearshift mechanisms for reverse and 1st gears	6	Shift travel valve (control of the shift cylinder for gears R and 1)
7	Shift travel valve (control of the shift cylinder for 5th and 3rd gears)	8	Pressure control valve (for actuating the 2 shift travel valves for the gearshift mechanisms for reverse/1st gear and 5th/3rd gear)
9	Shift travel valve (control of the shift cylinder for 6th and 7th gears)	10	Pressure control valve (for actuating the 2 shift travel valves for the gearshift mechanisms for 6th/7th gear and 2nd/4th gear)
11	Shift travel valve (control of the shift cylinder for 2nd and 4th gears)	12	Clutch slave cylinder
13	Solenoid valve for the clutch	14	Hydraulic temperature sensor
15	Pressure limiter valve	16	Filter
17	Check valve	18	Hydraulic pump with electric motor
19	Hydraulic pressure sensor	20	Pressure accumulator
21	PLCD sensor	22	Clutch release lever
23	Clutch with release bearing		

Gear lever with gear lever cover: E60 M5, E63 M6

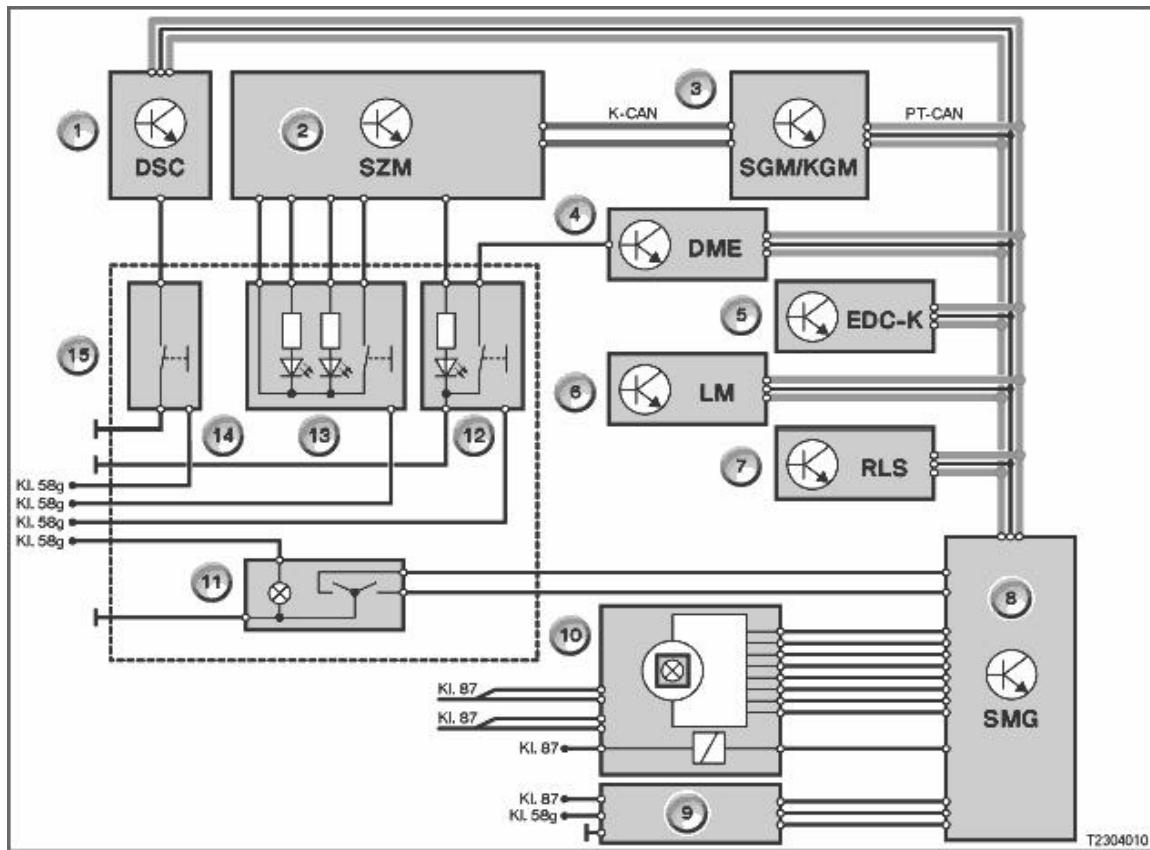
Installation location

The gear lever and gear lever cover are installed in the centre console.



Item	Description	Item	Description
1	Gear lever with gear indicator lighting	2	Gear lever cover
3	Program switch for "Drivelogic"	4	EDC button for Dynamic Driving Control (FDC)
5	DSC button	6	POWER button

Construction



Item	Description	Item	Description
1	Dynamic Stability Control (DSC)	2	Centre-console switch cluster (SZM)
3	Safety and gateway module (SGM) before 09/2005 Body gateway module (KGM) from 09/2005	4	Digital engine electronics (DME)
5	Continuous electronic damper control (EDC-K)	6	Light module (LM)
7	Rain-light sensor (RLS)	8	SMG control unit
9	Gear indicator lighting	10	Gear lever with gear lever lock
11	Program switch for "Drivelogic"	12	POWER button
13	EDC button for Dynamic Driving Control (FDC)	14	DSC button
15	Gear lever cover		
Kl. 58g	Terminal 58g	Kl. 87	Terminal 87

Gear lever

The gear lever is mounted on the mounting block. Eight Hall sensors are installed in the mounting block. These record the gear lever position without contact, and transmit this to the SMG control unit.

The gear lever is supplied with voltage via terminal 87g. The gear lever position is transmitted to the SMG control unit via hard-wired cables.

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. This locks the gear lever.

The SMG control unit actuates the electromagnet. 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 indicator lighting is mounted in the gear lever. The drive position engaged is shown in the gear indicator by 3 LEDs (light-emitting diodes) from terminal 15 ON as follows:

- "R" for reverse gear
- "N" for neutral
- "o" with "+" and "-" and "D/S"

The rain-light sensor is used for automatically adjusting the gear indicator lighting to the background lighting.

Program switch for "Drivelogic"

"Drivelogic" makes different driving programs available, which are used to adapt the shift characteristics of the sequential M transmission individually to the desired driving style.

- 5 driving programs in automatic mode
- 6 driving programs in manual mode
(driving program 6 only available when DSC is deselected or with launch control.)

The program switch for "Drivelogic" is connected directly to the SMG control unit.

The following buttons are further installed in the gear lever cover:

- POWER button
- DSC button
- EDC button

POWER button

The following engine control programs can be selected at the POWER control:

- "P 400" (display: LED does not light up)
- "P 500" (display: LED lights up)

The centre console switch cluster (SZM) actuates the LED.

The "P 400" program is always activated after terminal 15 ON.

The engine performance is reduced slightly in the "P 400" program. The program is provided for when the full engine output is not required, such as in city traffic.

The full engine output is available in the "P 500" program.

The POWER button is connected directly to the DME control unit (DME - digital engine electronics).

DSC button

The DSC button is connected directly to the DSC control unit.

EDC button for Dynamic Driving Control (FDC)

The following programs can be selected with the EDC button (EDC = electronic damper control):

- Comfort (display: LEDs do not light up)
- Normal (display: 1 LED lights up)
- Sport (display: 2 LEDs light up)

The "Comfort" program is always activated after terminal 15 ON.

The centre console switch cluster (SZM) actuates the LEDs. The SZM sends the selected program to the appropriate control units by means of a CAN message.

"MDrive" is switched on by pressing on the button with the "M" symbol in the steering wheel. The last program selected for the EDC in the "MDrive" submenu is activated automatically. It is possible to change the program at any time by pressing the EDC button.

"MDrive" switches off when the "M" button is pressed again. The active EDC program remains switched on.

Steering wheel with 2 gearshift paddles E60 M5, E63 M6

Installation location

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

The button for activating/deactivating "MDrive" is also on the steering wheel.



Item	Description	Item	Description
1	Left gearshift paddle: Briefly pull to shift down.	2	Right gearshift paddle: Briefly pull to shift up.
3	Button for activating/deactivating "MDrive"		

How it works

Pull the right gearshift paddle to shift up.

Pull the left gearshift paddle to shift down.

"MDrive" activation/deactivation

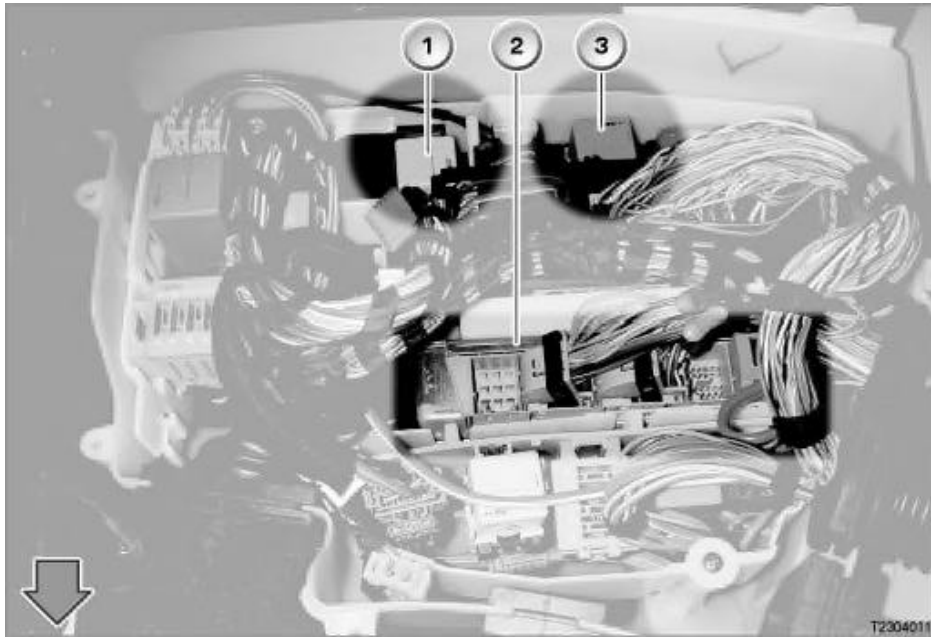
Press the button with the "M" symbol on the steering wheel. The indicator lamp for "MDrive" in the instrument cluster lights up. "MDrive" is activated.

Pressing the "M" button again deactivates "MDrive".

SMG control unit: E60 M5, E63 M6

Installation location

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

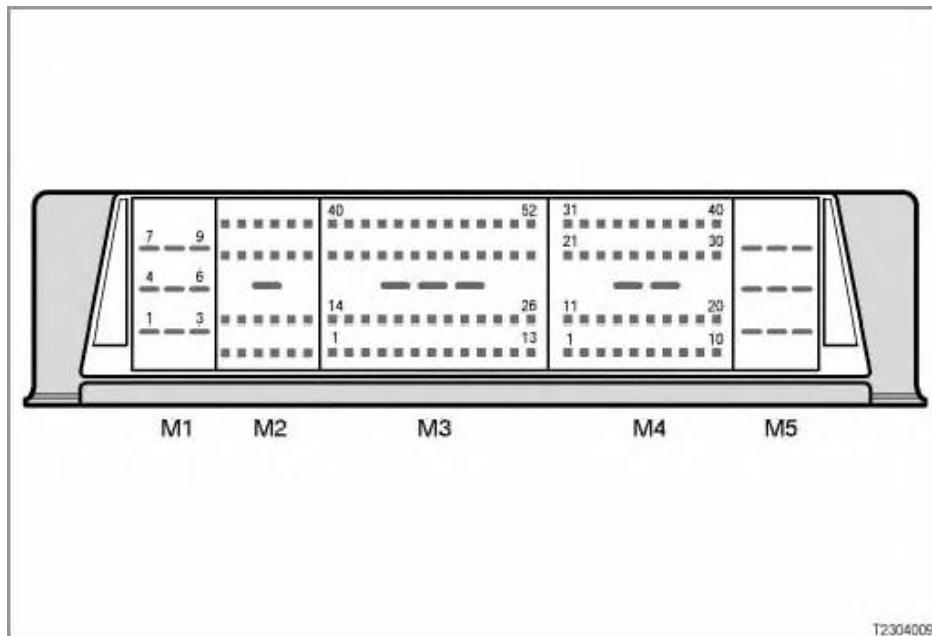


Item	Description	Item	Description
1	Relay for transmission oil pump	2	SMG control unit
3	Hydraulic pump relay		
The arrow shows the direction of travel.			

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 assignments

Pin assignments of connector X53001, chamber M1, 9-pin		
Pin	Type	Description
1	---	---
2	---	---
3	---	---
4	A	Terminal 31 (earth sensor)
5	M	Terminal 31 (earth)
6	M	Terminal 31 (earth)
7	V	Terminal 30 (power supply via rear power distributor)
8	V	Terminal 30 (power supply via rear power distributor)
9	---	---
	A = Output M = Earth V = Supply For current specifications regarding pin assignments, please refer to BMW diagnosis system	

Pin assignments of connector X53003, chamber M3, 52-pin		
Pin	Type	Description
1	E	Signal wire from parking brake warning switch
2	---	---
3	E	Signal input from Hall sensor to gear lever position recognition
4	E	Signal input from Hall sensor to gear lever position recognition
5	---	---
6	E	Signal input from Hall sensor to gear lever position recognition

7	E	Signal input from Hall sensor to gear lever position recognition
8	E	Signal input from Hall sensor to gear lever position recognition
9	E	Signal input from Hall sensor to gear lever position recognition
10	E	Signal input from Hall sensor to gear lever position recognition
11	---	---
12	E	Signal wire from program switch for "Drivelogic"
13	A	Power supply (5V) for sensor system
14	E	Wake-up wire (terminal 15 WUP)
15	---	---
16	E	Signal wire from program switch for "Drivelogic"
17	---	---
18	E	Signal wire from longitudinal acceleration sensor
19	E	Signal input from Hall sensor to gear lever position recognition
20	E	Earth connection for sensor system
21	---	---
22	---	---
23	---	---
24	---	---
25	---	---
26	E	Negative wire from gear lever lock (shift-lock)
27	E	Signal wire for gear indicator (gear lever position "D/S")
28	E	Signal wire for gear indicator (gear lever position "R")
29	E	Signal wire for gear indicator (gear lever position "N")
30	---	---
31	---	---
32	---	---
33	---	---
34	---	---
35	---	---
36	---	---
37	---	---
38	---	---
39	---	---
40	E	Signal wire from gearshift paddle (upshift)
41	E	Signal wire from gearshift paddle (downshift)
42	A	Signal wire to bonnet contact switch (left)

43	A	Signal wire to bonnet contact switch (right)
44	E	Signal wire from bonnet contact switch (left)
45	E	Signal wire from bonnet contact switch (right)
46	---	---
47	---	---
48	A	Signal wire for starter enable
49	E	Signal wire for engine speed
50	---	---
51	E/A	PT-CAN High (powertrain controller area network)
52	E/A	PT-CAN Low (powertrain controller area network)
	A = Output E = Input E/A = Input and output For current specifications regarding pin assignments, please refer to BMW diagnosis system	

Pin assignments of connector X70014, chamber M4, 40-pin

Pin	Type	Description
1	---	---
2	A	Power supply (5V) for hydraulic pressure sensor, PLCD sensor and transmission position sensors
3	E	Signal wire from transmission position sensor for gears R and 1 (redundant)
4	E	Earth connection for sensors
5	E	Signal wire from transmission position sensor for 6th and 7th gears
6	E	Negative wire from pressure control valve 1 (pressure control valve for actuating the 2 shift travel valves for the gearshift mechanisms for reverse/1st gear and 5th/3rd gear)
7	E	Negative wire from pressure control valve 2 (pressure control valve for actuating the 2 shift travel valves for the gearshift mechanisms for 2nd/4th gear and 6th/7th gear)
8	E	Signal wire from PLCD sensor
9	E	Signal wire from PLCD sensor
10	A	Negative wire from shift travel valve (control of the shift cylinder for reverse and 1st gears)
11	E	Signal wire from sensor for transmission input speed
12	E	Signal wire from hydraulic pressure sensor
13	E	Signal wire from transmission position sensor for reverse and 1st gears
14	E	Signal wire from transmission position sensor for 3rd and 5th gears
15	E	Signal wire from transmission position sensor for 2nd and 4th gears
16	E	Negative wire from hydraulic pump relay
17	---	---

18	E	Negative wire from shift travel valve (control of the shift cylinder for 6th and 7th gears)
19	E	Negative wire from relay for transmission oil pump
20	E	Negative wire from shift travel valve (control of the shift cylinder for 2nd and 4th gears)
21	A	Power supply for hydraulic temperature sensor
22	---	---
23	E	Negative wire from shift travel valve (control of the shift cylinder for 3rd and 5th gears)
24	A	Positive wire from pressure control valve 1 (pressure control valve for actuating the 2 shift travel valves for the gearshift mechanisms for reverse/1st gear and 5th/3rd gear)
25	A	Positive wire from pressure control valve 2 (pressure control valve for actuating the 2 shift travel valves for the gearshift mechanisms for 2nd/4th gear and 6th/7th gear)
26	---	---
27	---	---
28	E	Negative wire from solenoid valve for the clutch
29	A	Positive wire from shift travel valve (control of the shift cylinder for 3rd and 5th gears)
30	A	Positive wire from solenoid valve for the clutch
31	E	Earth connection for transmission position sensors
32	---	---
33	---	---
34	A	Power supply (5V) for transmission position sensors
35	---	---
36	E/A	Local CAN High (local controller area network)
37	E/A	Local CAN Low (local controller area network)
38	A	Positive wire from shift travel valve (control of the shift cylinder for reverse and 1st gears)
39	A	Positive wire from shift travel valve (control of the shift cylinder for 6th and 7th gears)
40	A	Positive wire from shift travel valve (control of the shift cylinder for 2nd and 4th gears)
	A = Output E = Input E/A = Input and output For current specifications regarding pin assignments, please refer to BMW diagnosis system	

General information for service staff on sequential M transmission:E60 M5, E63 M6

The following general information is provided for service staff:

- Work sequence of service functions
- Start the vehicle by towing

Important: Pull out the hydraulic pump relay when work is carried out on the hydraulic system.

The hydraulic pump relay must have been pulled out before work is carried out on the hydraulic system in order to prevent the hydraulic pump from starting unintentionally.

The hydraulic pump is not to run dry under any conditions!

The hydraulic pump relay is not to be reinserted for the whole time that repair work is carried out.

In the "bleed hydraulic system" service function a prompt is shown to reinsert the hydraulic pump relay. (The hydraulic pump relay is located in the electronics box.)

Note: EDC button is the FDC button.

For reasons associated with the system, the designation "FDC button" is used in diagnosis for the EDC button.

Work sequence of service functions

Service function	Work sequence
When the SMG control unit is replaced	<ol style="list-style-type: none"> 1. Teach-in clutch valve characteristic values 2. Adapt complete sequential M transmission 3. Teach-in clutch slipping point 4. Teach-in match of the longitudinal acceleration sensors
Prior to performing work on the hydraulic system, if the system is open or filled with hydraulic fluid	<ol style="list-style-type: none"> 1. Reduce hydraulic pressure
After completion of work on the hydraulic system, if the system was open	<ol style="list-style-type: none"> 1. Bleed regulator block 2. Bleed clutch slave cylinder and hydraulic lines
After removal and installation of parts (no parts replacement): <ul style="list-style-type: none"> - Engine - Sequential M transmission - Clutch 	<ol style="list-style-type: none"> 1. Teach-in clutch valve characteristic values 2. Adapt complete sequential M transmission 3. Teach-in clutch slipping point
When the following is replaced <ul style="list-style-type: none"> - Sequential M transmission - Hydraulic control unit and regulator block - Engine 	<p><i>Note: Only carry out points 1 and 2 if the hydraulic system has been opened!</i></p> <ol style="list-style-type: none"> 1. Bleed regulator block 2. Bleed clutch slave cylinder and hydraulic lines 3. Teach-in clutch valve characteristic values 4. Adapt complete sequential M transmission 5. Teach-in clutch slipping point

When the clutch is replaced

Note: Only carry out point 1 if the hydraulic system has been opened!

	<ol style="list-style-type: none"> 1. Bleed clutch slave cylinder and hydraulic lines 2. Teach-in clutch valve characteristic values 3. Teach-in clutch slipping point 4. Reset characteristic curves for clutch (automatically performed by BMW diagnosis system after completion of teach-in of points 2 and 3)
<p>When clutch component parts are replaced:</p> <ul style="list-style-type: none"> - Clutch release lever - Ball pin - Release bearing - ... 	<ol style="list-style-type: none"> 1. Teach-in clutch valve characteristic values 2. Teach-in clutch slipping point 3. Reset characteristic curves for clutch (automatically performed by BMW diagnosis system after completion of teach-in of points 1 and 2)
<p>When the clutch slave cylinder with PLCD sensor is replaced</p>	<ol style="list-style-type: none"> 1. Bleed regulator block 2. Bleed clutch slave cylinder and hydraulic lines 3. Teach-in clutch valve characteristic values 4. Teach-in clutch slipping point 5. Reset characteristic curves for clutch (automatically performed by BMW diagnosis system after completion of teach-in of points 3 and 4)
<p>When the longitudinal acceleration sensor is replaced</p>	<ol style="list-style-type: none"> 1. Teach-in match of the longitudinal acceleration sensors

Start the vehicle by towing

It is only possible to tow the vehicle to start the engine as follows:

- On-board supply voltage must be adequate
- Terminal 15 ON
- Gear lever in position "N" and pull vehicle
- When the towing speed exceeds 5 km/h, select manual mode with the gear lever (gear lever position "S").
- Afterwards and within approximately 2 seconds, pull the gear lever to S+ and hold it in the this position.
The correct gear is automatically selected and engaged.