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E85 Transmissions

Model: E85

Production: Start of Production MY 2003

Objectives:

After completion of this module you will be able to:

- Identify the four different transmissions available for the E85.
- Explain why is extremely important to properly torque the 6 speed manual transmission mounting bolts to the engine block.
- Describe the changes to the transmission input shaft.
- List the systems influenced by the "Sport" button.
- Explain where SMG system faults can be visually identified.
- Understand why "Teaching Gearbox" must be performed with the DISplus/GT1.

E85 Transmissions

There are 4 different transmissions offered for the E85:

2 manual transmissions:

- **GS5-20BG** 5-speed manual transmission (known from the E46 as S5D-250G). The brief designation is the B-gearbox.
- **GS6-37BZ** 6-speed manual transmission. The brief designation is the H-gearbox.

Automatic transmission:

- **GA5HP19Z** automatic transmission is available as an option (code 205). This transmission is known from the E46 as the A5S-325Z.

Sequential Manual Gearbox:

- The Sequential Manual Gearbox (SMG) is available as an option (code 206). The basis of the SMG is the H-gearbox (known as H-SMG).

The following table shows the engine/transmission combinations:

Engine	Manual	SMG (optional)	Automatic (optional)
M54B30	GS6-37BZ	H-SMG	GA5HP19Z (A5S-325Z)
M54B25	GS5-20BG (S5D-250G)	H-SMG	GA5HP19Z (A5S-325Z)

Dynamic Driving Control (if equipped)

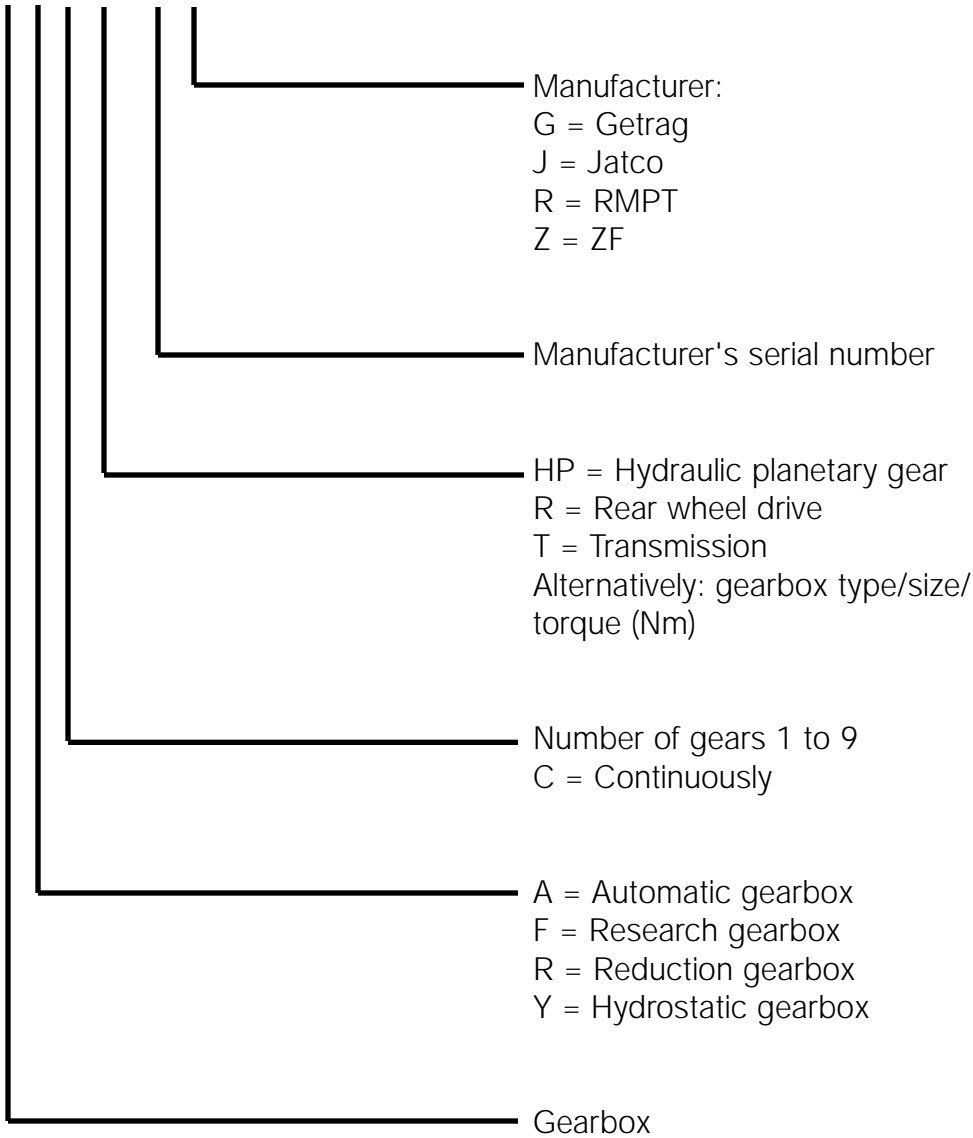
For “sporty” driving, the optional Dynamic Driving Control function is activated by pushing the “Sport” button on the center console next to the gearshift lever. When this function is activated, the following control modules are also influenced:

- H-SMG Control Module - shorter gearshift times
- EGS Control Module - Sport shift mode.

Note: Shifting the Automatic Transmission Gear Shift Lever to the left from “D” into the “MS” position activates the Steptronic Transmission Sport Program.

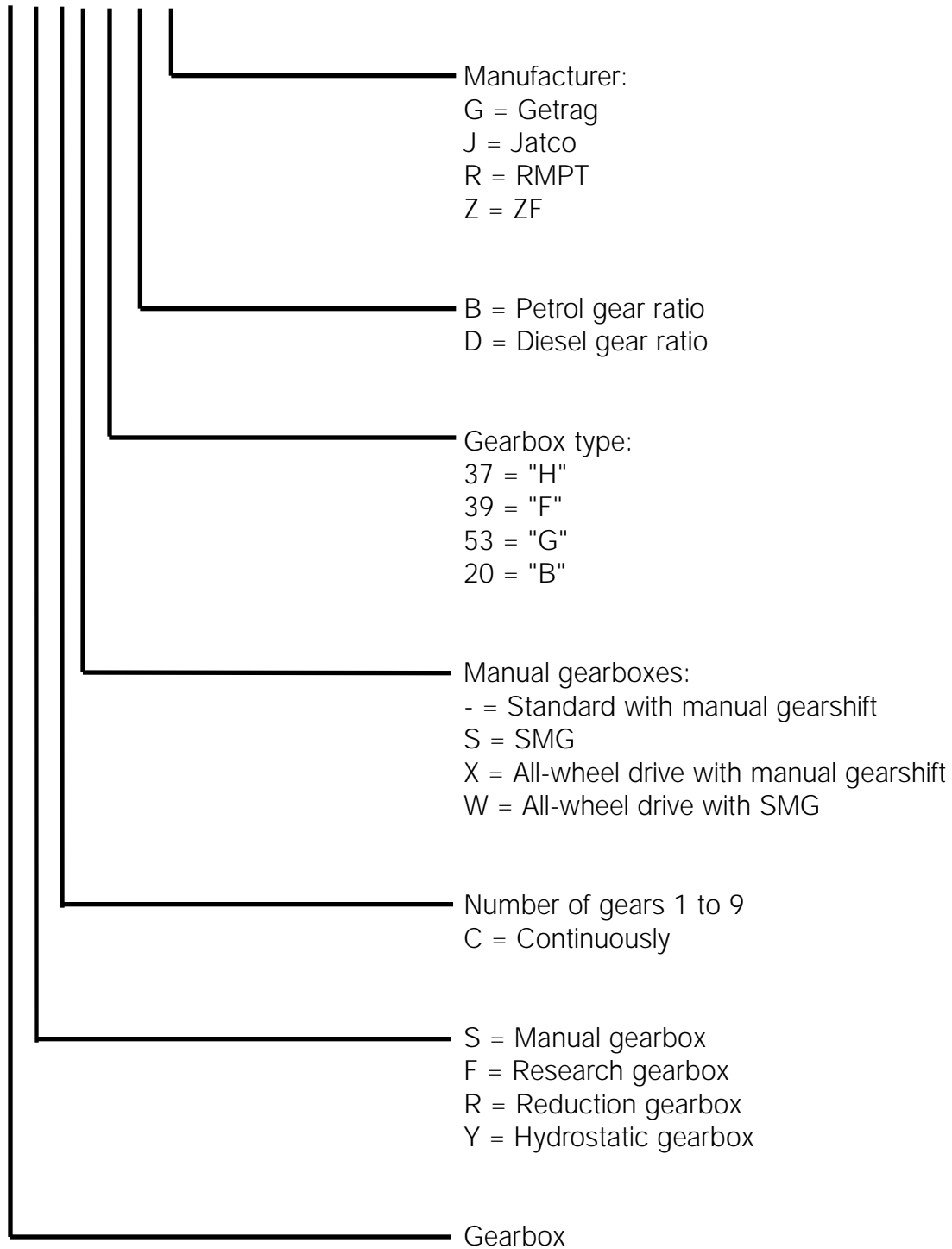
Example - automatic transmission:

G A 5 HP 19 Z



Example - manual transmission:

G S 6 - 37 B Z



E85 GS6-37BZ Manual Transmission (if equipped)

The GS6-37BZ 6-speed manual transmission (H-gearbox) is used in the E85 with the M54B30 engine. The gearbox is designed by Zahnradfabrik Friedrichshafen (ZF) and built and supplied by ZF and Getrag. This is why the gearbox designation bears the endings of both "Z" and "G." The changes to the GS6-37BZ compared with manual transmissions currently used in BMWs are:

- Flanged damping block
- Aluminium bolts (connecting to engine block)
- Aluminium bolt (connecting case halves)
- Input shaft mounting in dual-mass flywheel
- Involute input shaft teeth
- Shift gate for guiding the selector shaft
- External shift without play in neutral position
- New dual-mass flywheel



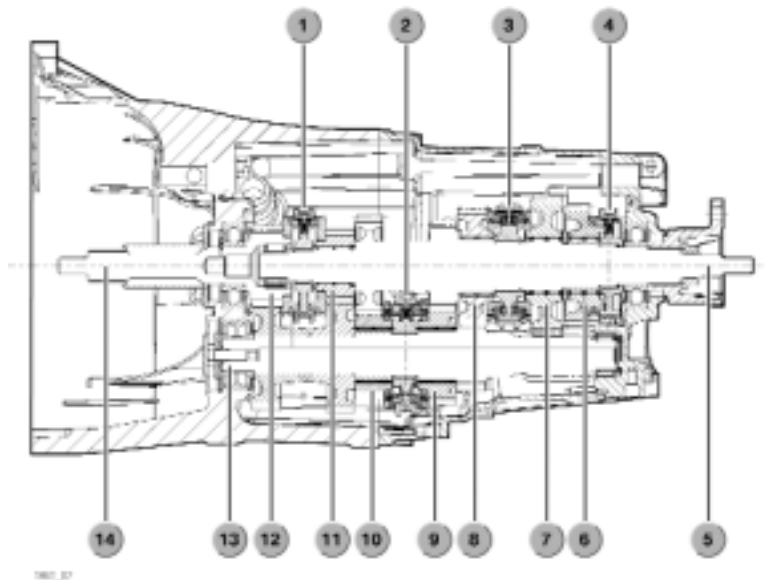
Components

The transmission consists of the following:

- Transmission case (front and rear half)
- Transmission shafts
- Gear sets
- Gear synchronizers
- Shift mechanism

and the engine-side components:

- Dual-mass flywheel (ZMS)
- Clutch

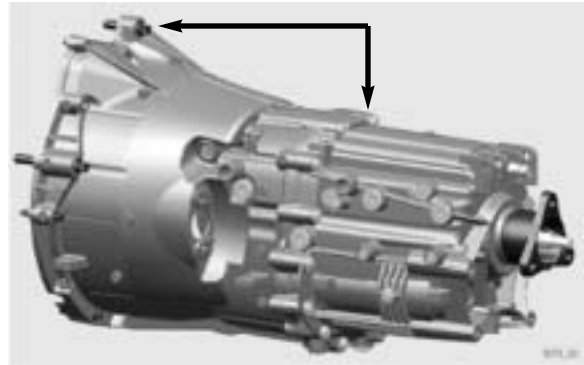


- | | | |
|----------------------------------|-----------------|---------------------------|
| 1. Selector sleeve, 5th/6th gear | 6. Reverse gear | 11. 6th gear |
| 2. Selector sleeve, 3rd/4th gear | 7. 1st gear | 12. 5th gear (direct 1:1) |
| 3. Selector sleeve, 1st/2nd gear | 8. 2nd gear | 13. Countershaft |
| 4. Selector sleeve, reverse gear | 9. 4th gear | 14. Input shaft |
| 5. Output shaft | 10. 3rd gear | |

Transmission Case

The casing is manufactured from diecast aluminium and flanged mounted with aluminium bolts to the engine block (arrows).

The front half of the casing is also bolted to the rear half with aluminium bolts. The casing is secured at the rear with 4 bolts to the damping block.



Note: Refer to TIS for correct tightening torque! For additional and updated information, refer to the Repair Instructions.

The bolted damping block (1) increases the transmission application for different vehicles. Modifying the acoustic damping to different vehicle types is achieved by changing the damping block.



Dual-mass Flywheel (ZMS)

A specially developed dual-mass flywheel is used with the H-gearbox. Because the 6-speed manual transmission has more gears, the flywheel is modified to compensate for vibration and noise.

In this flywheel, the 2 masses are connected via inner and outer dampers (rubber like damping material).

The masses are now supported by a plain bearing (no longer in a ball bearing). The plain bearing requires less space and enables an additional inner damper to be used.



The transmission input shaft is supported through the flywheel in a needle bushing with a roller pilot bearing. The flywheel is connected to the crankshaft flange with Torx socket bolts.

Clutch: 03/2003 will introduce new heavy metal-free friction linings which satisfy the requirements of used car regulations.

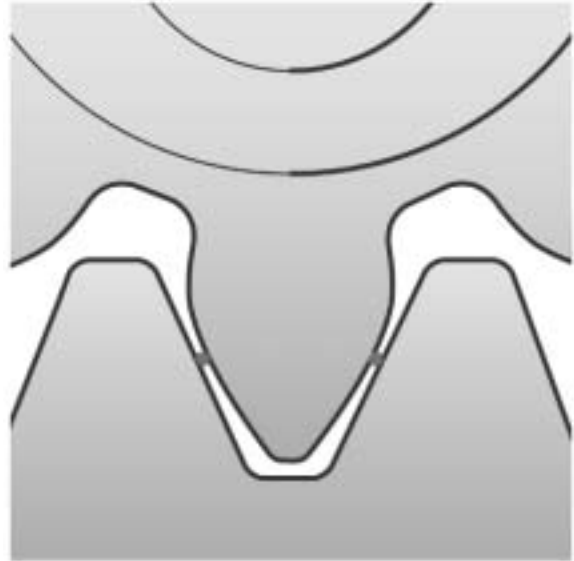


Input Shaft

The input shaft is approx. 25 mm shorter than that in the 5-speed. The input shaft longitudinal splines have an involute shape.

Involute Toothing: This denotes the special shape (mathematical curve) of the toothed segments of the input shaft splines (22 teeth total).

This creates linear contact (dots shown to the right) with the toothed segments to the clutch drive plate center splines. The reduced friction of the linear contact provides easier declutching operation.

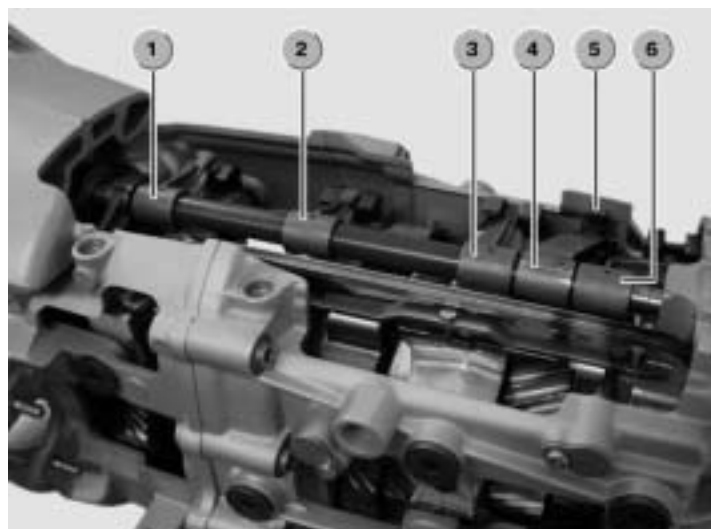


The splined clutch drive plate hub and guide sleeve form a seal to decrease contamination of the input shaft. The involute shaped splines make it easier to remove and install the transmission.

Transmission Shift Mechanism

The “short shift” travel of the E85 gearshift handle required a modification to the selector forces of the internal gearshift mechanism. This changed the internal shift gate and shift-gate finger. The shift gate finger is permanently attached to the selector shaft and engages the shift gate. The shift gate and finger precisely guide the selector shaft, conveying a precise gearshift sensation to the driver. This also provides a “passive lock” which prevents 2 gears from being simultaneously engaged.

1. Shift finger, 5/6 gear
2. Shift finger, 3/4 gear
3. Passive lock
4. Shift finger, 1/2 gear
5. Shift gate finger
6. Shift gate
7. Shift finger, reverse gear



The gears are shifted by selector forks. The design dictates that the selector fork for 1st and 2nd gears is transmitted as follows: When the selector shaft is pushed forwards (engagement of 1st gear), the selector fork forced is multiplied as it moves backwards to engage 1st gear.

The "chamfered" shift gate precisely guides diagonal gearshifts (2nd to 3rd, 4th to 5th and vice-versa).

1. Selector sleeve, 1/2 gear
2. Shift gate
3. Shift gate finger



A further function of the shift gate and the shift gate finger is to absorb "misuse forces" created by the driver at the gearshift lever (previously transmitted via the selector shaft to the selector forks). A reduction of selector forces is achieved by low pretension springs at the 5/6 gutter, reverse gear and 1/2 gutter (helical coiled spring).

1. Spring, 5/6 gutter
2. Helical coiled spring, 1/2 gutter
3. Shift finger, 5/6 gear
4. Spring, reverse gear



Note: A correctly operating selector force mechanism ensures that the gearshift lever is without play in neutral.

Notes:

Transmission Gear Sets

The GS6-37BZ is designed for 5th gear to be direct and 6th gear as an overdrive.

Gear Ratios						
1	2	3	4	5	6	R
4.350	2.496	1.665	1.234	1:1	0.851	3.926

Gear Synchronizers

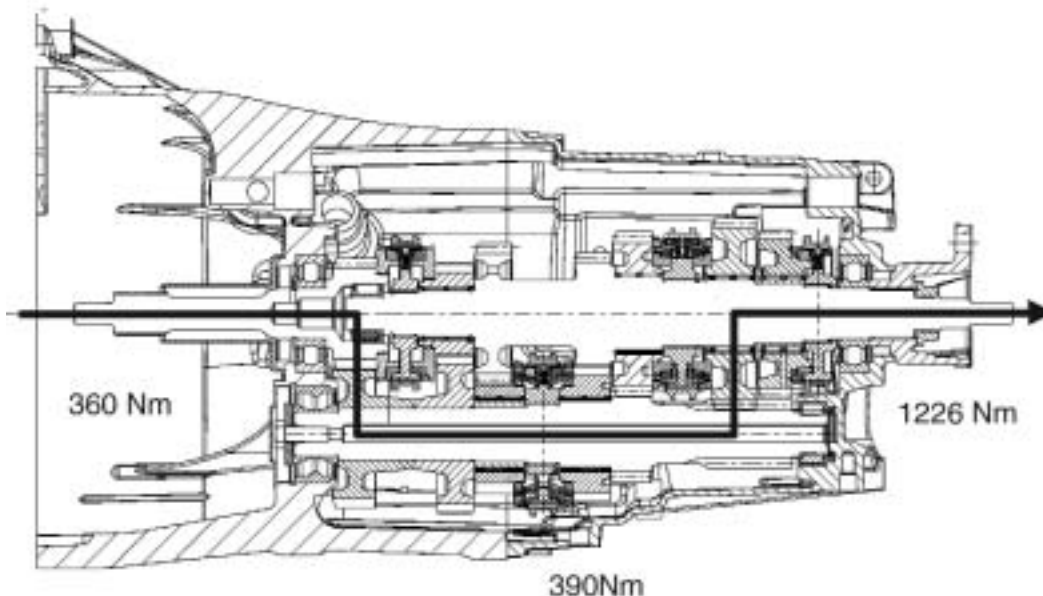
A triple-taper synchronizer is installed for 1st and 2nd gears. A double-taper synchronizer unit is installed for 3rd and 4th gears. A single-taper synchronizer unit is installed for 5th, 6th and reverse gear.

6-Speed Transmission Power Flow

The individual gear power flows for the M54B30 engine are illustrated in the next few pages. The power flows illustrated are applicable to an input torque of 300 Nm at a speed of 3500 rpm. The step-up ratio from the input shaft to the countershaft is 1.38. The input torque at the countershaft is 390 Nm.

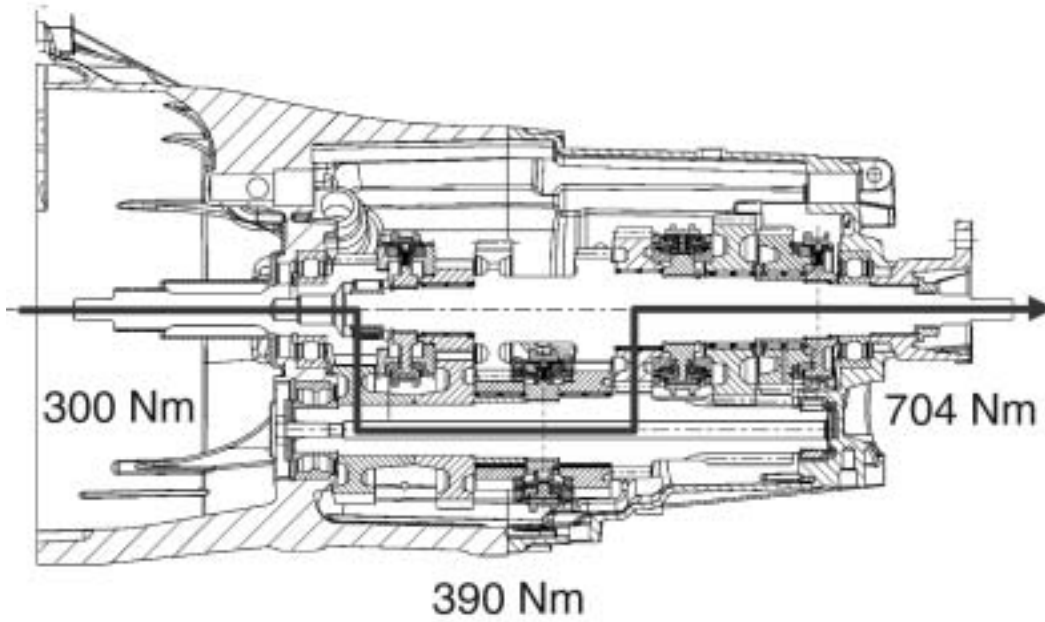
Power flow in 1st gear

An input torque of 300 Nm produces an output torque of 1226 Nm.



Power flow in 2nd gear

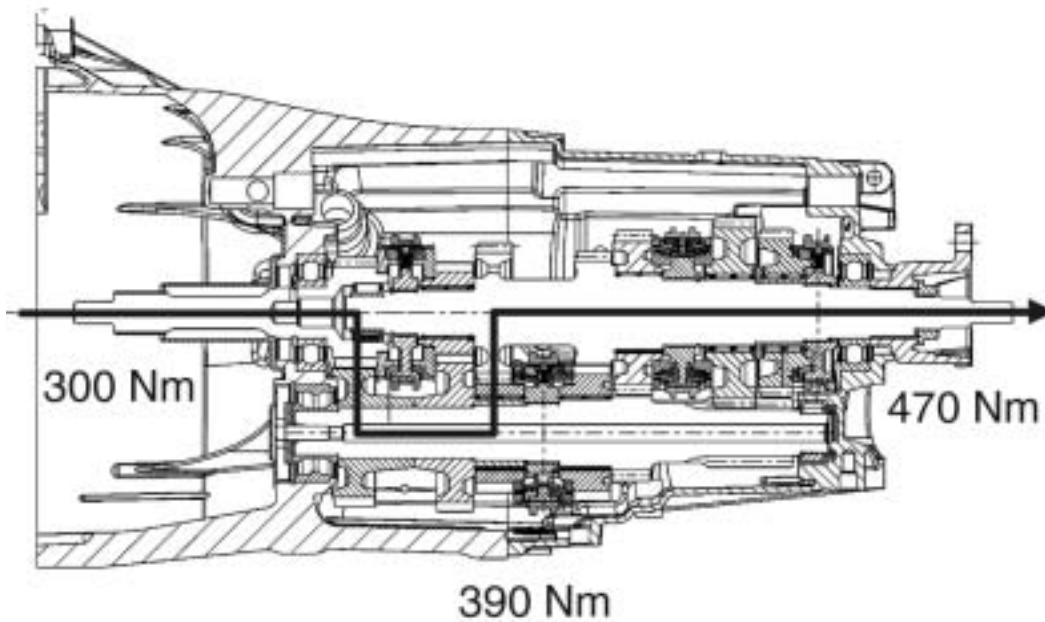
An input torque of 300 Nm produces an output torque of 704 Nm.



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Power flow in 3rd gear

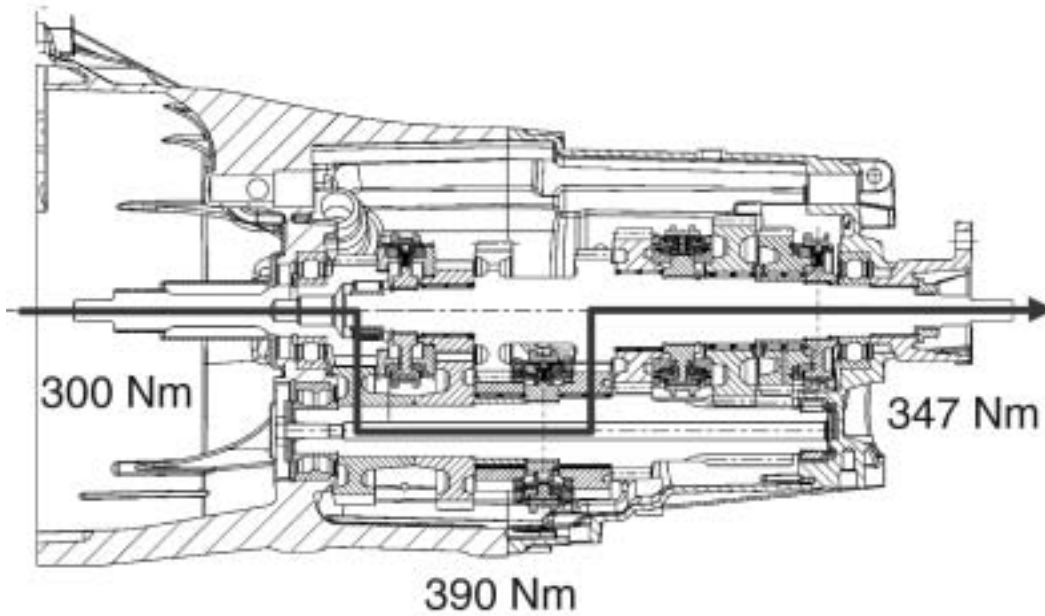
An input torque of 300 Nm produces an output torque of 470 Nm.



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Power flow in 4th gear

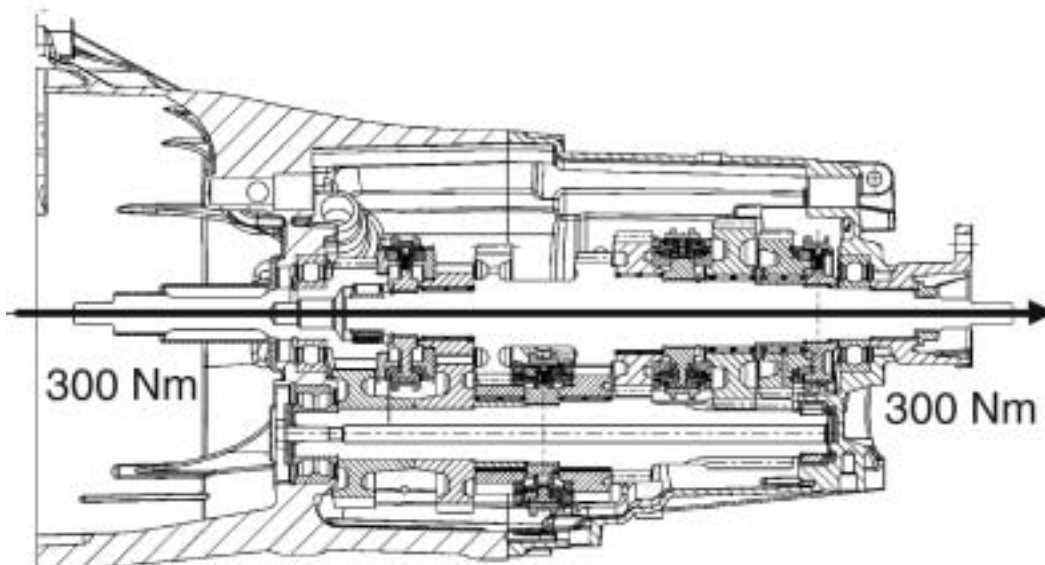
An input torque of 300 Nm produces an output torque of 347 Nm.



1879_02

Power flow in 5th gear

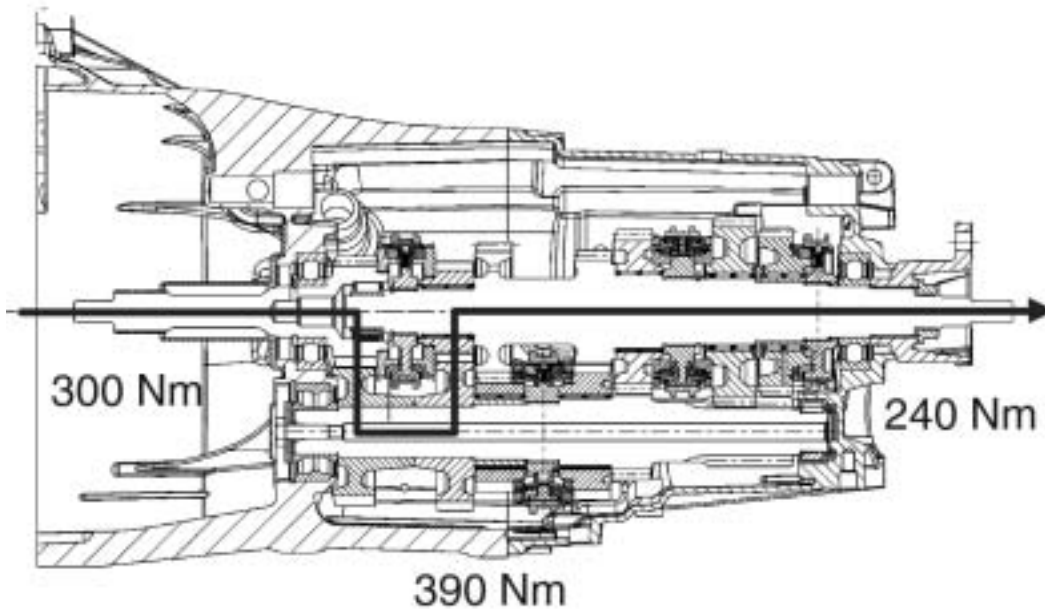
The transmission output torque is equal to the input torque (1:1 direct).



1879_02

Power flow in 6th gear

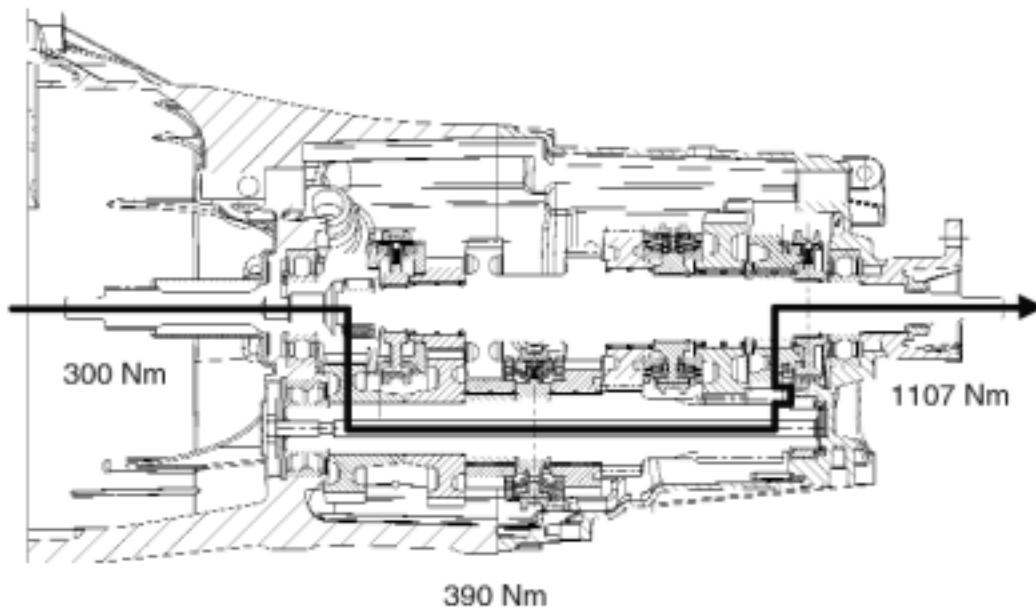
An input torque of 300 Nm produces an output torque of 240 Nm (overdrive).



1880_02

Power flow in reverse gear

An input torque of 300 Nm produces an output torque of 1107 Nm (reverse rotation).



1881_02

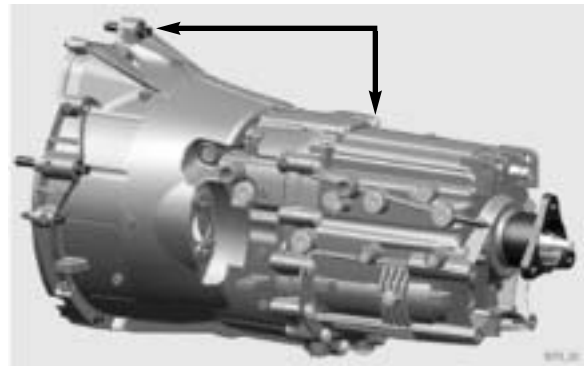
Workshop Hints

Removing Transmission

The case is flanged mounted with aluminium bolts to the engine block (arrows). The front half of the case is also bolted to the rear half with aluminium bolts. *These aluminium bolts may only be used 3 times.*

Note: Refer to TIS for correct tightening torque! For additional and updated information, refer to the Repair Instructions.

The shortened input shaft with the involute teeth make it easier to remove and install the transmission.



Installing Transmission

A special lubrication procedure is required for the involute teeth on the input shaft. Lubrication is carried out with two special tools:

- Carefully slide the grease scraper sleeve (P/N 21 2 220) over the input shaft up to the guide tube. This removes any previous lubrication and debris.
- Carefully slide the grease application sleeve (P/N 21 2 221) over the input shaft up to the guide tube.
- Using a brush, spread the grease evenly on the teeth and the profile base up to the grease application sleeve.
- Carefully pull back the grease application sleeve over the shaft. This provides an equal distribution over the entire spline contact surfaces.



E85 SMG 6-Speed Sequential Manual Gearbox (if equipped)

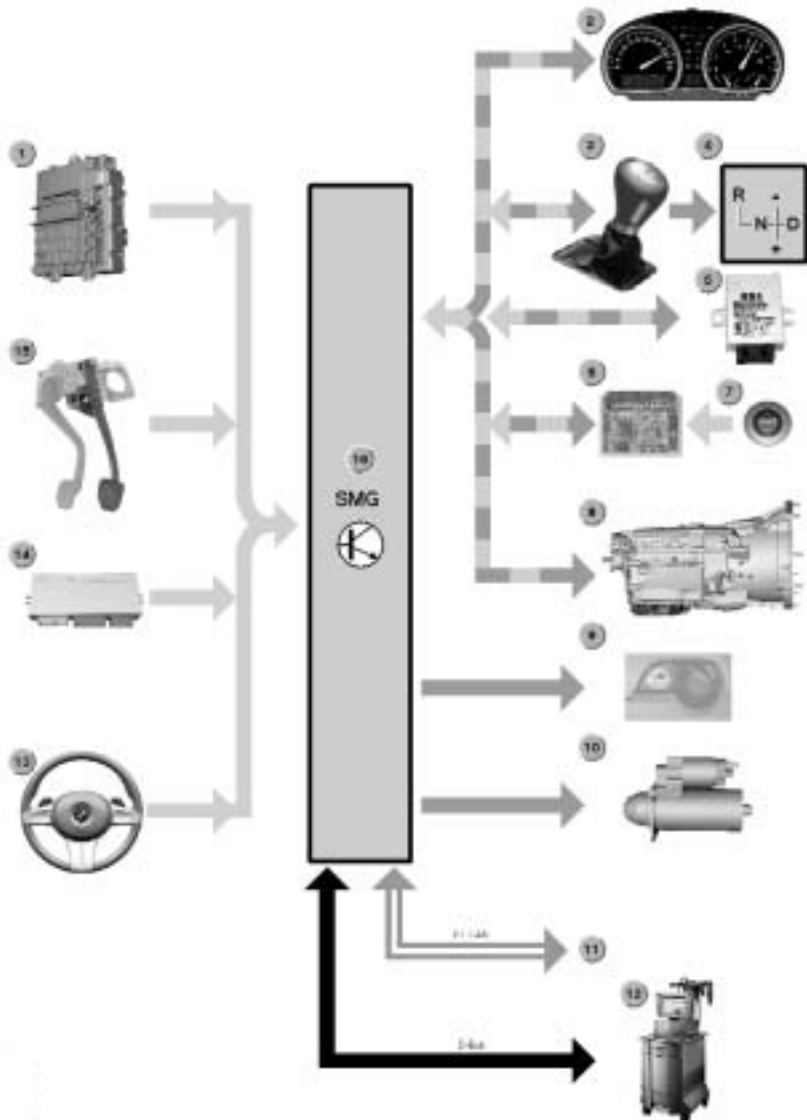
The optional Sequential Manual Gearbox (H-SMG) is a further development of the E85 GS6-37BZ 6-speed manual (H-gearbox). Compared to previous SMG technology, changes include:

- Completely new transmission
- Mounting positions of the hydraulic components and the sensors on the transmission housing.

In combination with the SMG option, the customer also obtains the Dynamic Driving Control function. This function provides a "Sport" effect on driving by influencing the Engine Management, Transmission (SMG and EGS) and Electronic Power Steering (EPS) control systems. This function is activated with the "Sport" button.

System Overview - Inputs/Outputs

1. Power distribution box
2. Instrument cluster
3. Gearshift lever
4. Illuminated shift gate
5. EWS III
6. MS45 ECM
7. Dynamic Driving Control "Sport" button
8. SMG assembly on transmission
 - Hydraulic unit
 - Shift travel sensor
 - Selection angle sensor
 - Input speed sensor
 - Clutch control travel sensor
9. Reverse light relay
10. Starter motor
11. PT-CAN
12. Diagnosis Bus- DISplus/GT1
13. SMG steering wheel with shift paddles
14. General Module - GM5
15. Brake light switch
16. SMG Control Module



System Components

The H-SMG system is made up of the following components:

- SMG gearshift lever
- SMG steering wheel with shift paddles
- “Sport” button (Dynamic Driving Control)
- SMG hydraulic system
- SMG Control Module
- Reverse light relay
- Transmission
- Displays/indications in Instrument Cluster

SMG Gearshift Lever

The design of the lever and the shift gate is similar to the previously used SMG shift lever. The shift gate depicted on the gearshift knob features the “D” symbol instead of the “C” symbol for cruise mode. The lever is connected to the transmission by electric leads only and the gearshift lever positions are monitored by 7 Hall sensors.

Operation

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

The gearshift lever position display (indicated with LEDs) is integrated in the gearshift lever center console trim, behind the gearshift lever.

SMG Steering Wheel with Shift Paddles

A gear change can also be performed using the shift paddles on the steering wheel.

Operation

- An upshift is performed when either shift paddle is pulled backward
- A downshift is performed when either shift paddle is pressed forward.



Sport Button

Pressing the "Sport" button (1) activates the Dynamic Driving Control function and selects sportier transmission performance (shorter gearshift times). This function can also be selected in cruise mode.

The request signal is monitored by the MS45 ECM which transmits the signal to the SMG and EPS Control Modules.

If there are no faults in the Control Modules, the EPS Control Module illuminates the function light in the Sport button.



SMG Hydraulic System

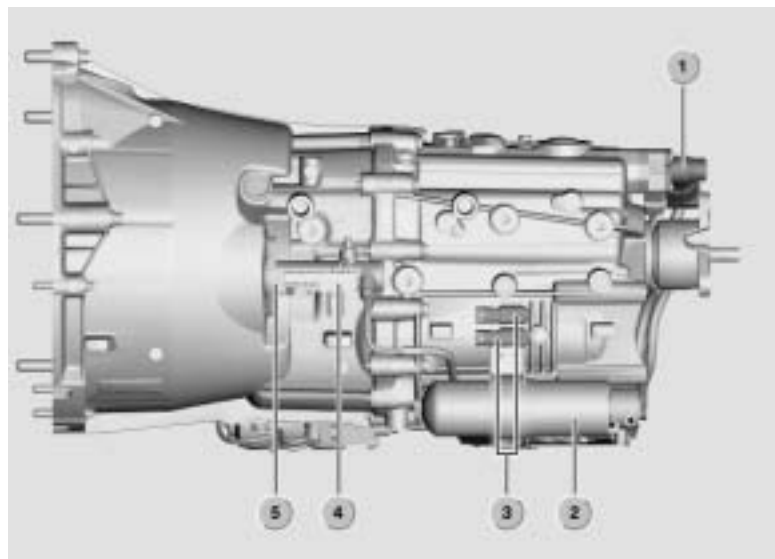
The clutching operation and the gear shift is performed automatically by the SMG hydraulic system. The H-SMG hydraulic system has similar components and functions as the previous SMG hydraulic system.

Installation location

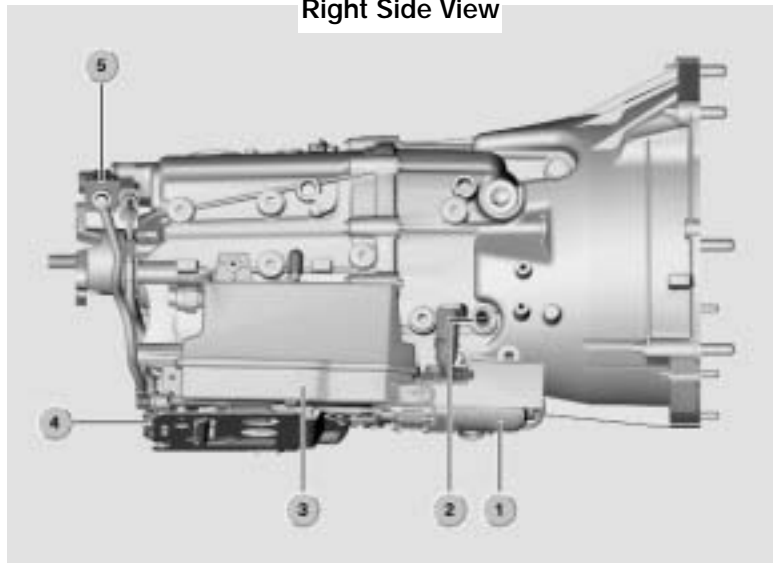
In comparison with the previous SMG, the mounting positions of the hydraulic system components in the H-SMG have undergone significant changes, as can be seen in the following 5 illustrations:

Left Side View

1. Shift/selector actuator
2. Pressure accumulator
3. Connections for:
 - Shift travel sensor
 - Selection angle sensor
4. Clutch control travel sensor
5. Clutch actuator

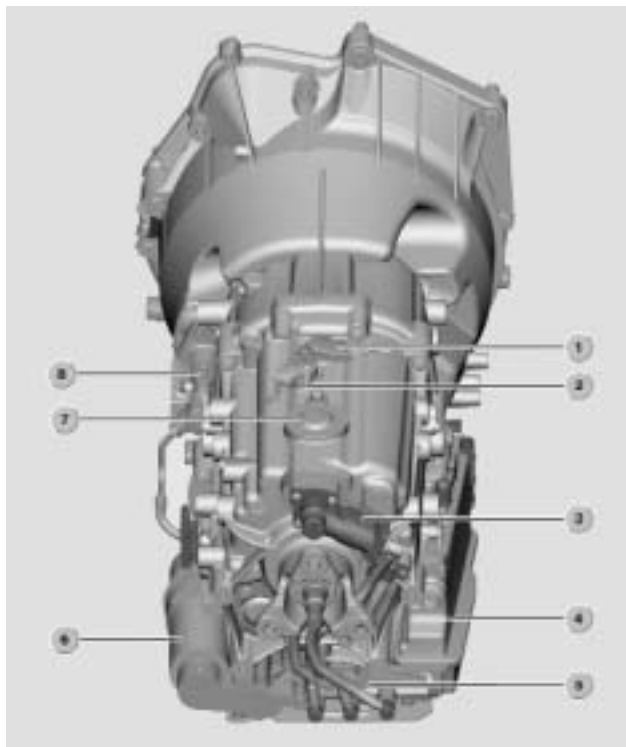


Right Side View



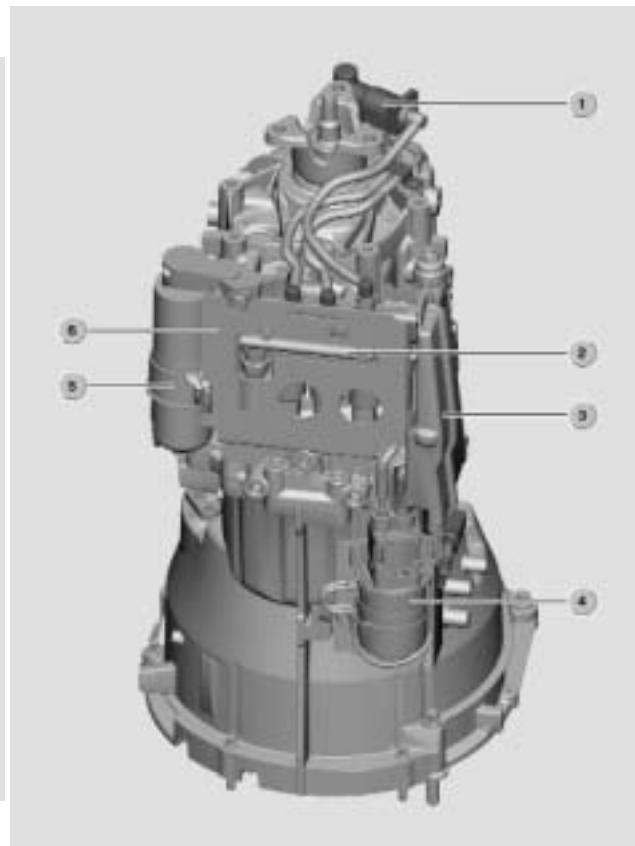
- 1. Hydraulic pump
- 2. Transmission input speed sensor
- 3. Expansion tank
- 4. Valve block
- 5. Shift/selection actuator

Top Rear View



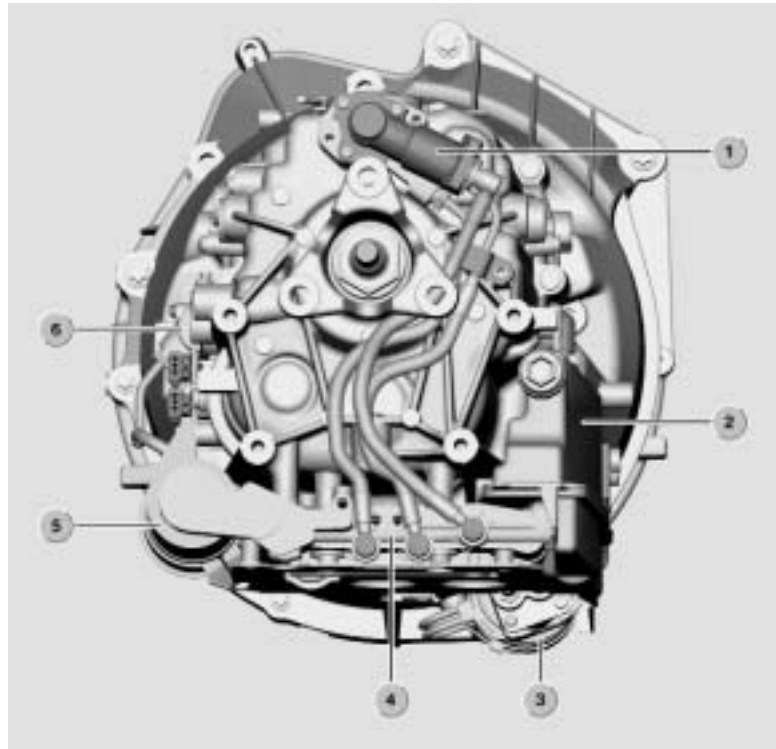
- 1. Selection angle sensor
- 2. Shift travel sensor
- 3. Shift/selection actuator
- 4. Expansion tank
- 5. Valve block
- 6. Pressure accumulator
- 7. Selector shaft connection mounting hole
- 8. Clutch actuator with control travel sensor

Bottom Rear View



- 1. Shift/selection actuator
- 2. Valve block
- 3. Expansion tank
- 4. Hydraulic pump
- 5. Pressure accumulator
- 6. Valve block guard

Rear View

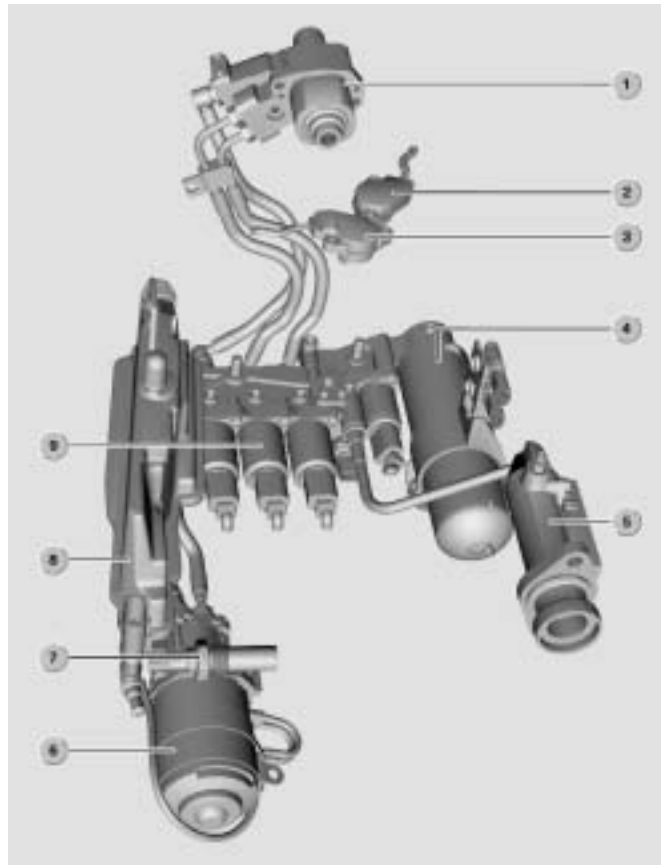


1. Shift/selection actuator
2. Expansion tank
3. Valve block
4. Hydraulic pump
5. Pressure accumulator
6. Clutch actuator with clutch control travel sensor

Compared with the previous SMG hydraulic system, the H-SMG hydraulic system is slightly modified in the following areas:

- The electromechanical reverse light switch has been omitted.
- The valve block is located underneath the transmission.
- The expansion tank is located on the right side of the transmission with new min/max fill level markings.
- The electrohydraulic pump is located on the right side of the transmission.
- On the left side of the transmission, below the clutch actuator, is a central connector for the valve block (solenoid valves EV0 to EV3, pressure sensor, voltage and ground supply to the valves).
- Flexible high pressure hydraulic lines with quick-connect couplings are used.

1. Shift/selection actuator
2. Shift travel sensor
3. Selection angle sensor
4. Pressure accumulator
5. Clutch actuator with clutch control travel sensor
6. Hydraulic pump
7. Transmission input speed sensor
8. Expansion tank
9. Valve block



SMG Control Module

The SMG Control Module is located in the electronics box at the front left in the engine compartment. It is positioned next to the ECM, in place of the EGS Control Module.

1. Engine Control Module (ECM)
2. SMG Control Module
3. ECM (main) relay
4. Fuel injector relay
5. SMG hydraulic pump relay



Displays/Indications

The selected drive positions are displayed in 2 segments in the instrument cluster. The selected gear position (1-6) is displayed in the right segment (2).



The drive mode is displayed in the left segment (1), "D" for automatic mode. No symbol appears in the left segment when the manual drive program is selected. Only the selected gears are displayed in the right segment.

A fault can also be displayed in the left segment with "F." A serious gearbox fault is indicated by an indicator light in the instrument cluster.



Workshop Hints

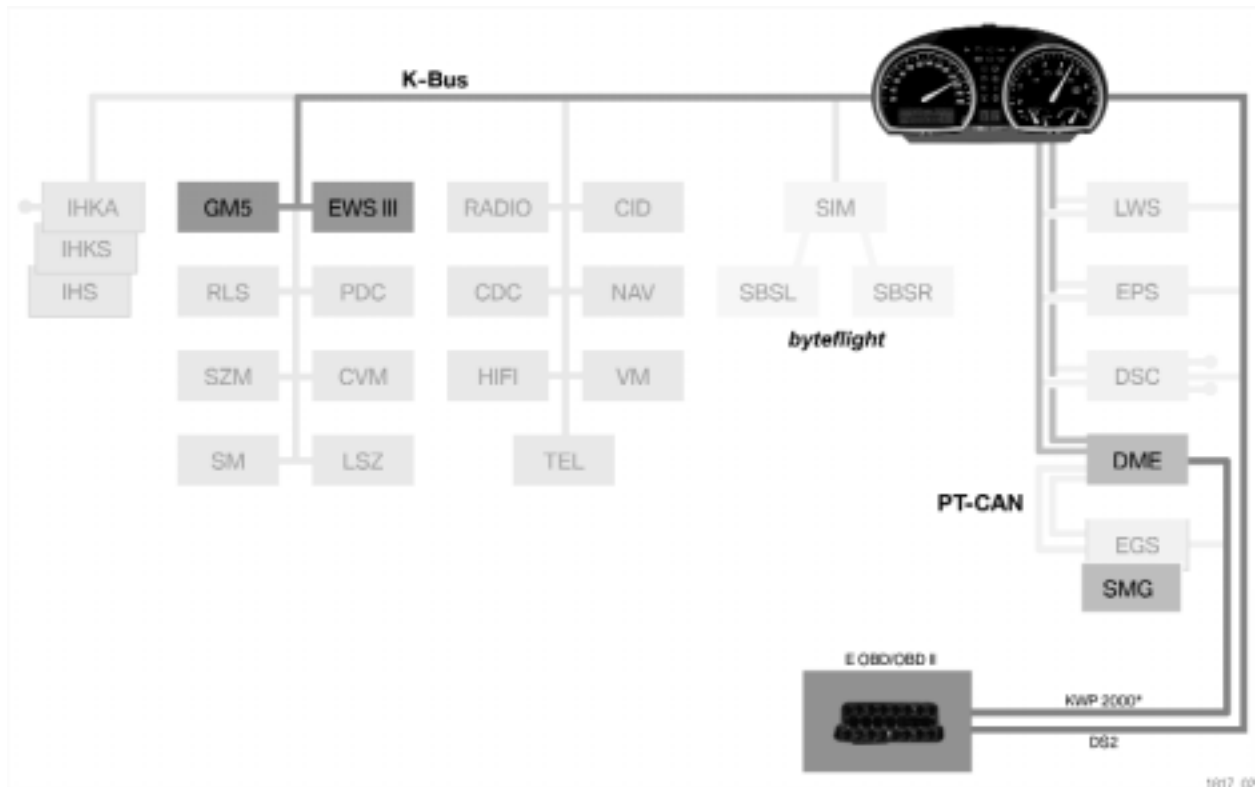
Central Connector

To simplify access, a small central connector is located on the left side of the gearbox below the clutch sensor. The central connector incorporates the circuit connections for the following hydraulic unit components:

- Wiring for hydraulic valves
- Signal line for pressure sensor
- Voltage and ground supply for pressure sensor
- Ground connection for hydraulic valves

The gearshift lever accommodates a Micro-Quadlock system with a 12 pin pin tray. Two pins are additionally assigned in the US version. They are the outputs for the illuminated gearshift lever position indicator, which is located on the driver's side next to the gearshift lever on the center console.

SMG Bus System Overview



Diagnosis

Diagnosis corresponds to E46 diagnostics and contains the following:

- Read identification
- Read fault memory
- Delete fault memory
- Diagnosis request

Programming

The SMG Control Module is programmable. Programming must be performed whenever the SMG Control Module has been replaced.

Notes: _____

Working on Hydraulic System

Note: Prior to any work on the hydraulic system, the system pressure must be reduced with the service function "Before working on hydraulic system" in the DISplus/GT1.

- The hydraulic pump relay must be removed to prevent the hydraulic pump from activating. The relay must not be reconnected for the entire duration of the repair work.
- The service function "After working on hydraulic system" must be implemented with the DISplus/GT1 (to vent the hydraulic system).
- The service function "Teach gearbox" must be implemented with the DISplus/GT1. The hydraulic pump must not run when dry!
- After work is completed on the hydraulic system, the hydraulic fluid level must be checked and topped up if necessary. The hydraulic pump relay can be reinstalled. The hydraulic fluid level must be checked again.

Teaching Gearbox

The service function "Teaching gearbox" must be implemented with the DISplus/GT1 when the following components are replaced:

- SMG Control Module
- SMG Transmission
- Clutch
- Clutch sensor

Note: The SMG control system learns the clutching characteristic during the drive off operation. There may be impaired comfort during the initial gearshift operations.

Review Questions

1. List the four different transmissions available for the E85.

2. Why is extremely important to properly torque the 6 speed manual transmission mounting bolts to the engine block? _____

3. What does the term "Involute Toothing" refer to? _____

4. The "Sport" button can influence what three systems in an E85?

5. Where can SMG system faults be visually identified by the driver?

6. What procedure must be performed after replacing any of the following components: SMG Control Module, SMG transmission, clutch, clutch sensor?
