Reference Manual

M DOUBLE-CLUTCH TRANSMISSION WITH DRIVELOGIC

Technical Training

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M Double-Clutch Transmission with Drivelogic

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M Double-Clutch Transmission with Drivelogic (M DCT Drivelogic)

Model: 4th Generation M3

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the operation of the M Double-Clutch Transmission with Drivelogic.
- Identify the Components of the M Double-Clutch Transmission with Drivelogic.
- Diagnose the operation of the M Double-Clutch Transmission with Drivelogic.

Introduction

BMW has introduced the new generation of sequential transmissions. The M Double-Clutch Transmission with Drivelogic (M DKG) GS7D36SG is available as an option on the entire E9x M3 series and is referred to as M DCT Drivelogic.

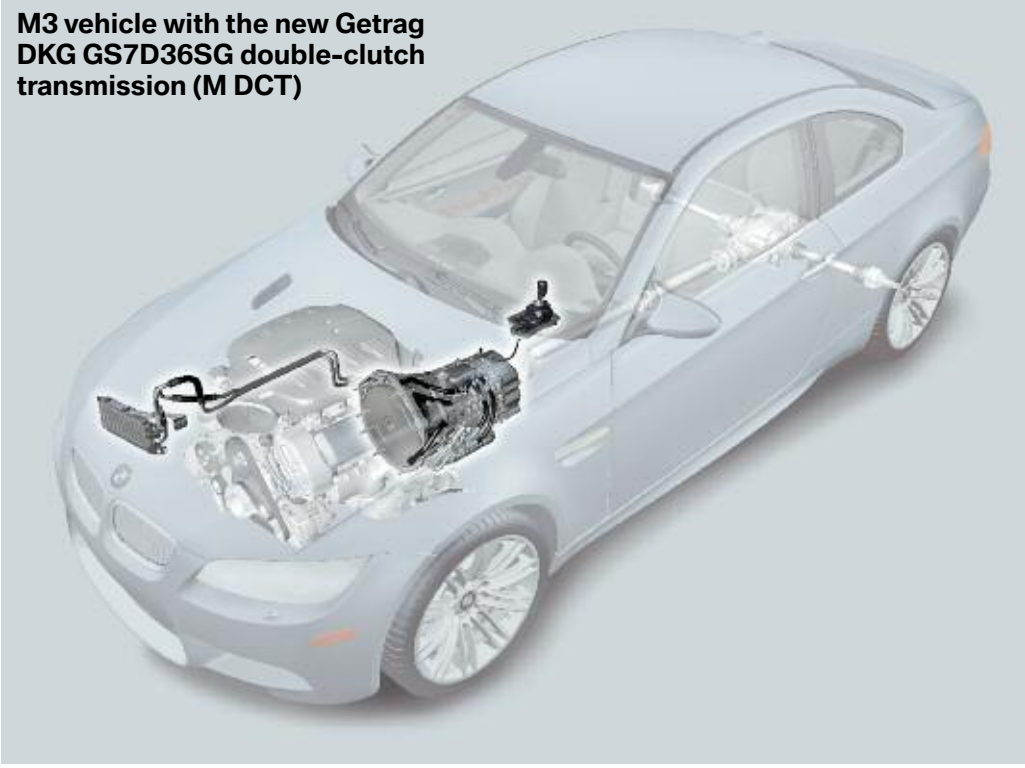
The M double-clutch transmission combines the benefits of a sequential M transmission with that of an automatic. Like the SMG, it can be used in automatic mode "Drive" and in manual mode "Sequential".

There are 5 Drivelogic programs in automatic “Drive” mode and 6 Drivelogic programs in “Sequential” mode. In sequential mode shifting can either be done with the new electronic sports shift lever, exclusive to the BMW M3, or with paddle shifters on the steering wheel. The main characteristic of this system is that there is no longer an interruption in driving force during the shifting operation.

Shifting is controlled by the M DCT electronics and executed by the M DCT hydraulic components. These are combined into one mechatronics module and integrated into the transmission. The M DCT has a dedicated system to directly lubricate all of the relevant transmission components. The transmission oil temperature is regulated by a special two stage cooling system.

An electric automatic parking lock has been integrated into the system. Selection of the driving programs and gears are controlled using the (M GWS) electric gear selector switch. Different driving modes and settings can be selected through the controller and the fifth settings menu of the CID (option dependent).

M3 vehicle with the new Getrag DKG GS7D36SG double-clutch transmission (M DCT)

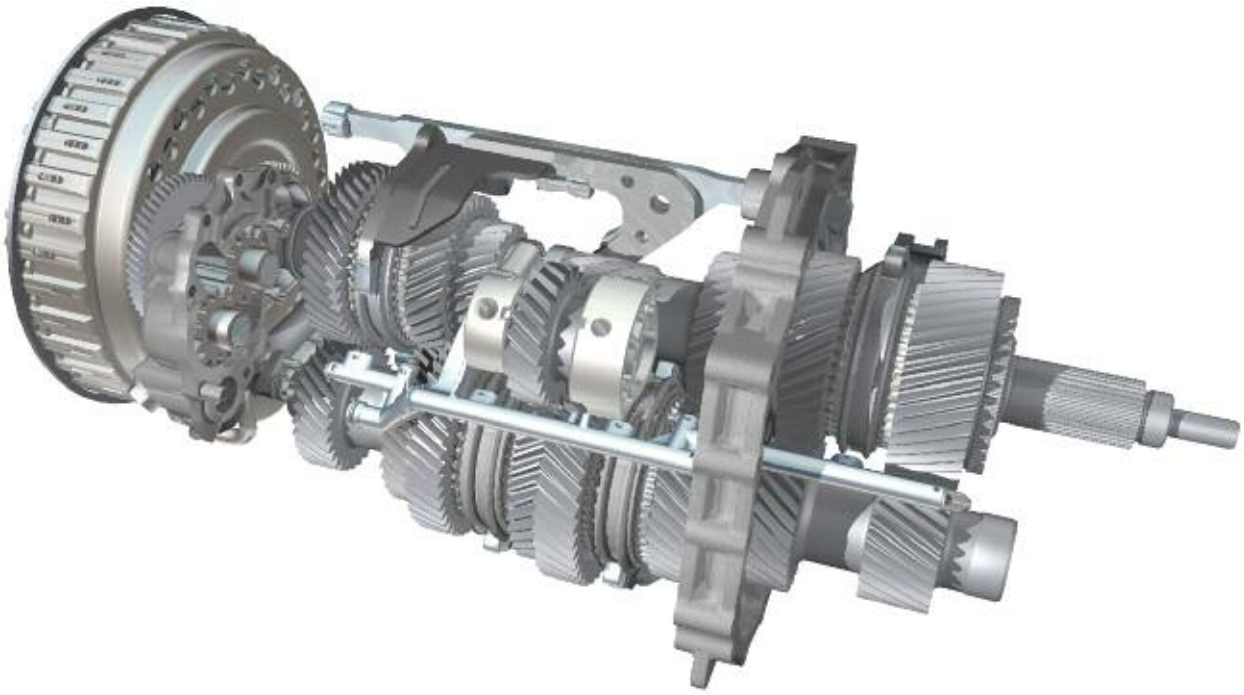


Special Features

GS7D36SG M double-clutch transmission features:

- Hydraulically operated double (wet) clutches
- Integrated mechatronics module, that consists of the M DCT electronics and the M DCT hydraulic components
- Internal direct lubrication of key transmission areas and components
- Special two-stage oil cooling system
- New M DCT electronic gear selector switch M GWS
- Automatic parking lock mechanism
- Drive shaft length has been adapted (shortened) to fit the M DCT transmission
- Fully variable M limited-slip differential with a modified gear ratio of 3.154 (without M DCT 3.846) and modified housing cover

M DCT Internal Structure



M DCT Applications

Transmission	Model	Engine/torque	Transmittable torque rating
GS7D36SG	E90 M3 E92 M3 E93 M3	S65B40O0 400 Nm	520 Nm

SMG/M DCT History

Series	Model	Engine	Predecessor manual transmission	Basic transmission	Introduced
E36	M3	S50B32	1st generation Sequential M transmission Not US	GS6S420BG	10/1996
E46	M3	S54B32O0	2nd generation Sequential M transmission	GS6S420BG	03/2001 06/2003
E85	Z4	M54B25/30	Sequential manual transmission	GS6S37BZ	04/2003
E6X	525i, 530i, 530i	M54B25/30 N52B30O0	Sequential manual transmission	GS6S37BZ	09/2003
E6X	545i, 645Ci 550i, 650i	N62B44O0 N62B48O1	Sequential manual transmission	GS6S53BZ	09/2003
E6X	M5/M6	S85B50O0	3rd generation Sequential M transmission	GS7S47BG	09/2005

Principle of Operation

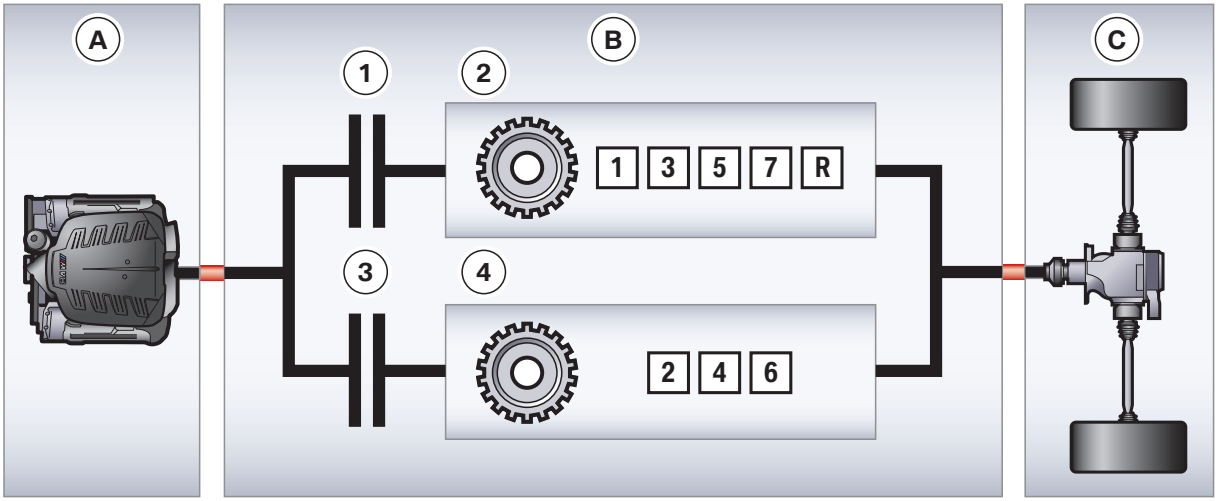
The M DCT consists of two sub-transmissions, each with its own clutch. Clutch 1 with sub-transmission 1 and clutch 2 with sub-transmission 2. Sub-transmission 1 consists of the gears 1, 3, 5, 7 and Reverse while sub-transmission 2 consists of gears 2, 4 and 6. This means that the your next gear is always pre-selected in the other sub-transmission, regardless of whether you are shifting up or down (with the exception of "R").

For example, while still in the acceleration phase of the currently selected gear, if on sub-transmission 1 the next logical gear on sub-transmission 2 is engaged in advance, in a process similar to the Shift Overlap function of an automatic transmission.

Precise control of the clutches when upshifting will allow the driving force to be transferred very quickly and smoothly from sub-transmission 1 to sub-transmission 2 without an interruption in driving power. This results in significant benefits not only for the available driving force but also in terms of shift comfort.

By combining the seamless driving force and comfort of the automatic with the direct connection to the engine as a manual, M DCT provides the benefits of both transmissions.

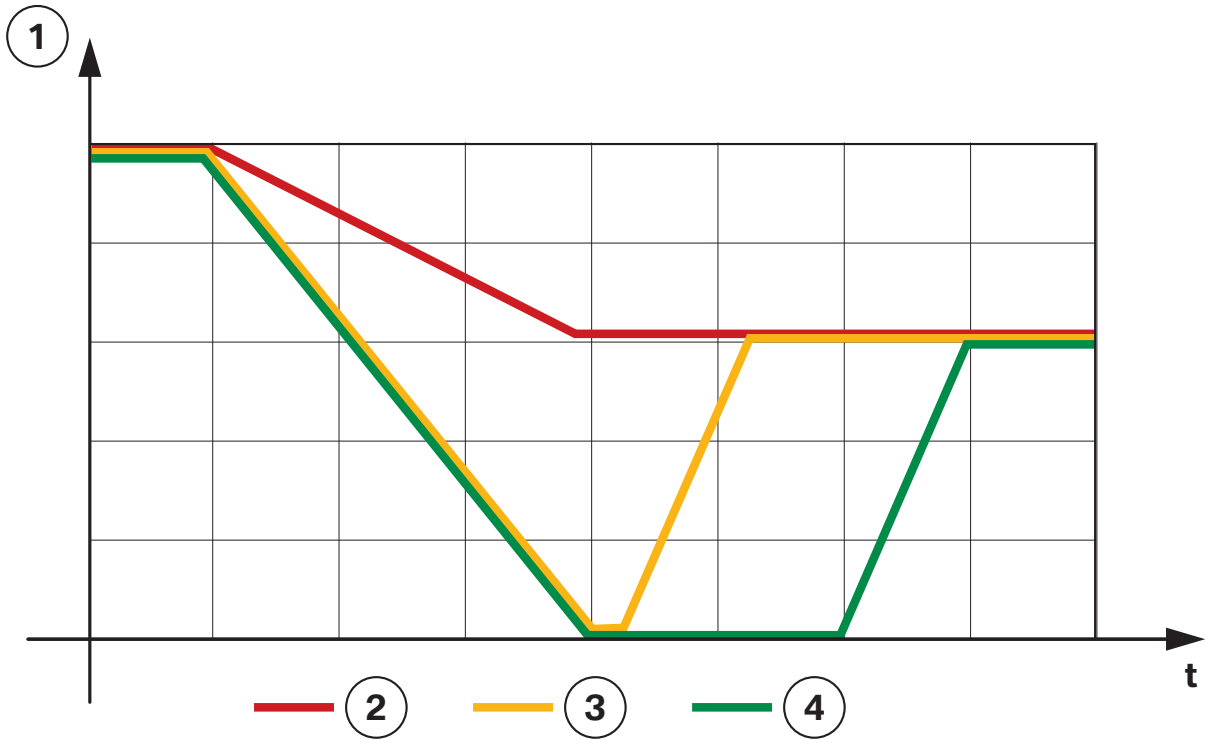
Simplified drawing of the M DCT functional principle



Index	Explanation	Index	Explanation
A	Engine S65	1	Clutch 1
B	Double-clutch transmission	2	Sub-transmission 1
C	Live axle	3	Clutch 2
		4	Sub-transmission 2

Comparison of the M DCT to the Manual and SMG

Diagram showing the driving force of one shift event of M DCT compared to SMG and manual transmissions



Index	Explanation	Index	Explanation
1	Driving force	4	Manual transmission
2	Double-clutch transmission (M DCT)	t	**Time** (one shift event)
3	Automated transmission (SMG)		

Note: Smooth gear changing without loss of driving force becomes clear when compared to the previous manual and SMG transmission.

Technical Data

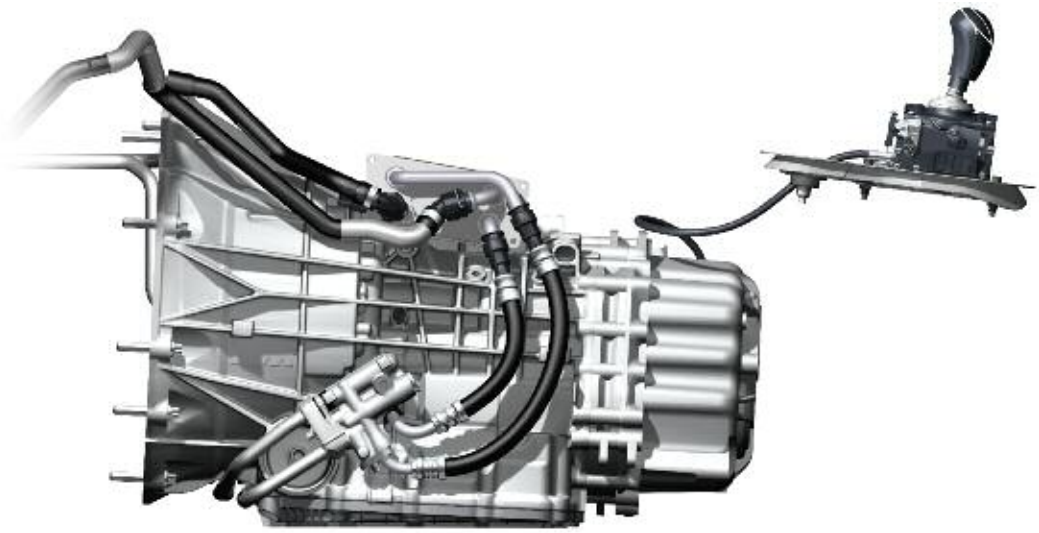
A 7 speed manual transmission with wet double-clutch, parking lock, integrated mechatronics module and sport gear ratio.

Description	Unit of Measurement
Specified torque [Nm]	520
Maximum engine speed [rpm]	9000
Dry weight without dual mass flywheel [kg]	77
Transmission ratio [:1]	Ratio
1st gear:	4.780
2nd gear:	3.056
3rd gear:	2.153
4th gear:	1.678
5th gear:	1.390
6th gear:	1.203
7th gear:	1.000
Reverse gear:	4.454
Shifting options	E9x M3: R-N-D/S with selectable Drivelogic program
Control	Electrohydraulic
Full oil capacity with transmission oil cooler (liter)	9
Oil grade: special new M DCT long-term oil	BMW designation DCTF-1

System Overview.

The components of the 2-stage transmission oil cooling system are built into the left side of the transmission.

External left side view of the M DCT transmission

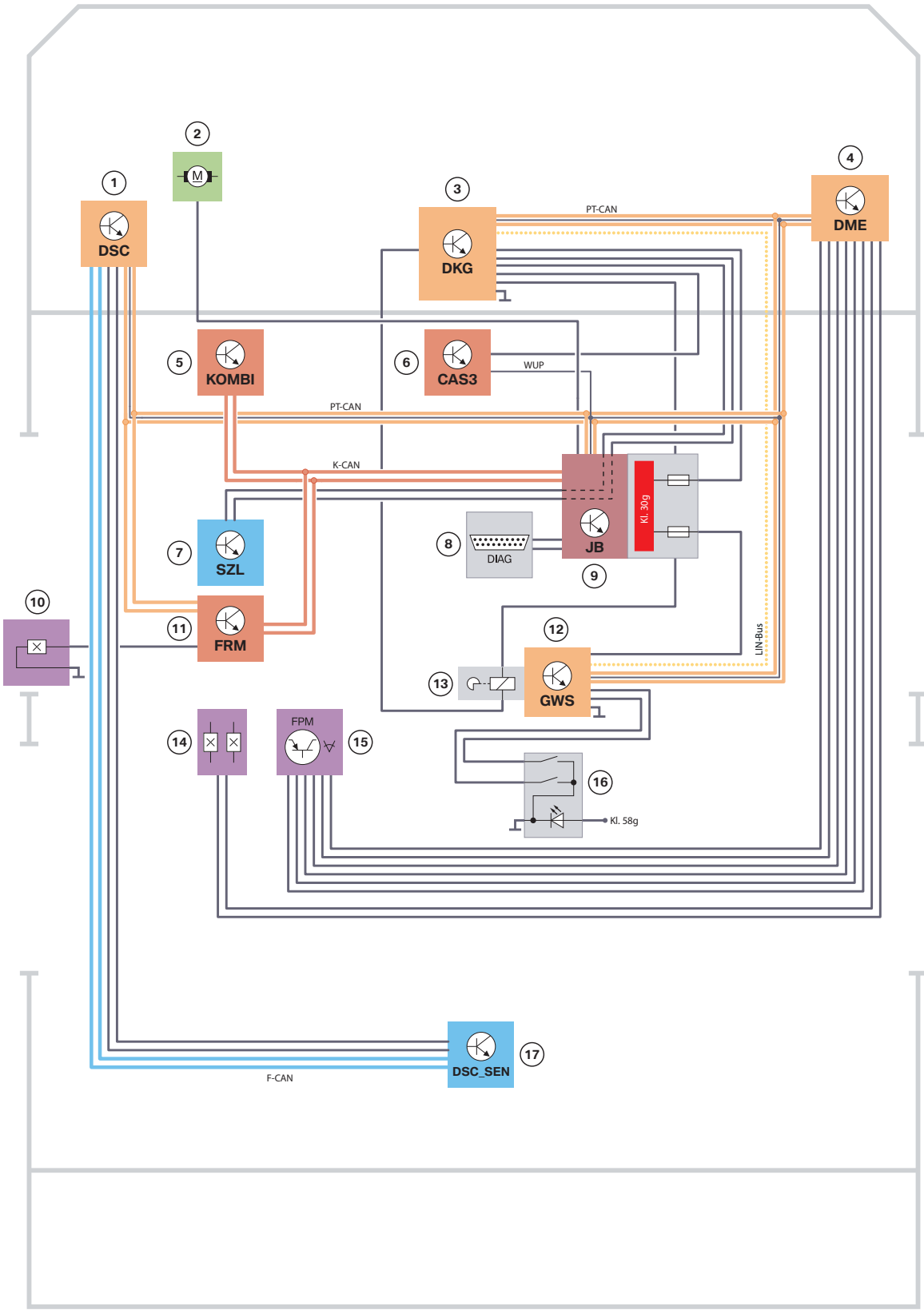


The mechatronics module is integrated into the transmission on the right side. The oil lines lead to the oil to air heat exchanger (coming from the left side of the transmission).

External right side view of the M DCT transmission

The electronic M DCT transmission control is networked with the M gear selector switch and the interfaces to the E9x M3 vehicle electrical system. The E9x-M3 vehicle electrical system has been expanded to include the M double clutch transmission.

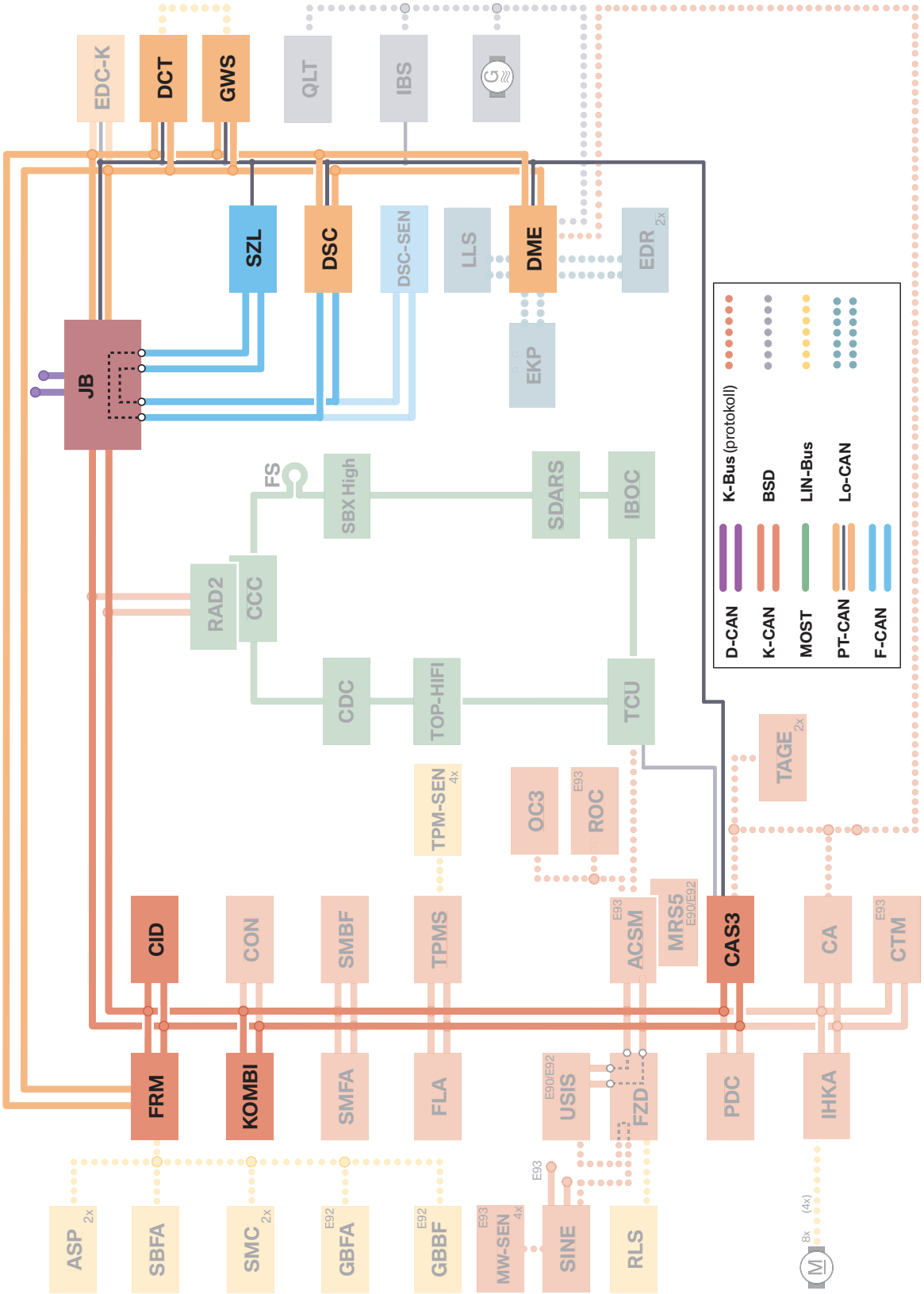
M DCT System Circuit Diagram



M DCT System Circuit Diagram Legend

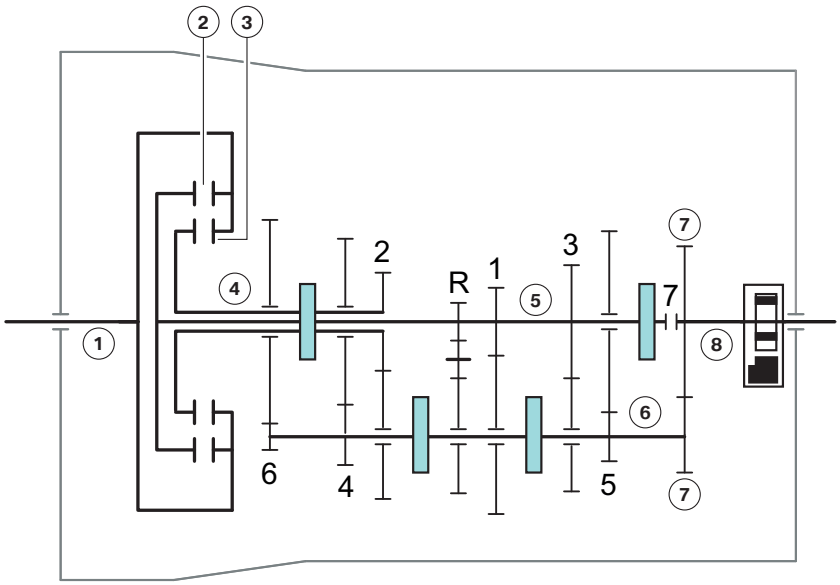
Index	Explanation	Index	Explanation
1	DSC control unit (Dynamic Stability Control)	10	Door contact switch
2	Auxiliary water pump	11	Footwell module
3	M DCT electronics (integrated into the Mechatronics module)	12	M gear selector switch (M GWS)
4	DME/ECM (Digital Engine Electronics)	13	Parking lock electromagnet
5	Instrument cluster	14	Brake light switch
6	CAS control unit (Car Access System)	15	Accelerator pedal module
7	Steering column switch cluster	16	Drivelogic program selector button
8	Diagnostics interface	17	DSC sensor unit
9	Junction box electronics		

E9x M3 M DCT System Circuit Bus Overview and Terminal Status



Index	Explanation	Index	Explanation
ACSM	Advanced Crash and Safety Management (E93 only)	JB	Junction box
ASP	Outside mirrors	KOMBI	Instrument cluster
CA	Comfort Access	LLS	Idle speed actuator
CAS3	Car Access System 3rd generation	LWS	Steering angle sensor
CCC	Car Communication Computer	MW-SEN	Microwave sensors (E93 only)
CDC	(Compact) CD changer	MRS5	Multiple restraint system, 5th generation (E90 and E92 only)
CID	Central information display	OC3	Seat occupancy detector mat (US only)
DCT	M DCT electronics (integrated into the transmission)	PDC	Park distance control
CON	Controller	QLT	Quality, level, temperature oil sensor
CTM	Convertible roof module (E93 only)	RAD	Radio2
DME	Digital motor electronics	RLS	Rain light sensor
DSC	Dynamic Stability Control	ROC	Rollover controller (E93 only)
DSC-SEN	DSC sensor	SBFA	Switch block, driver's door
EDC-K	Continuous Electronic Damping Control	SBX High	High-level interface box
EDR	Throttle valve actuator motor	SDARS	Satellite tuner (US only)
EKP-SG	Electric fuel pump control unit	SINE	Emergency power siren with integrated tilt alarm sensor
FLA	High beam assistant	SMBF	Passenger's seat module
FRM	Footwell module	SMC	Stepper motor controller
FS	MOST direct access	SMFA	Driver's seat module
FZD	Roof function center	SZL	Steering column switch cluster
GBBF	Seat belt extender controller, front passenger (E92 only)	TAGE	Outside door handle electronics
GBFA	Seat belt extender controller, driver (E92 only)	TCU	Telematics Control Unit
GWS	M gear selector switch	TOP-HiFi	Top-HiFi amplifier
IBS	Intelligent battery sensor	USIS	Ultrasonic passenger-compartment sensor (E90/E92 only)
IHKA	Integrated automatic heating/air conditioning system		

Operation and Power Flow



Schematic Structure of the M DCT

Index	Explanation	Index	Explanation
1	Central input shaft with clutch input	6	Countershaft
2	Clutch 1	7	Constant gears
3	Clutch 2	8	Output shaft
4	Inner input shaft 2	9	Sliding clutches
5	Inner input shaft 1	10	Parking lock

Operation

The driving force is guided into the transmission by a central input shaft (1) through wet clutches 1 and 2, which are integrated into the transmission.

Clutch 1 (2) transmits the power to inner input shaft 1 (5).

Clutch 2 (3) transmits the power to inner input shaft 2 (4).

The torque is then transferred to the output shaft (8) via the countershaft (6).

The constant gears (7) are always engaged regardless of the gear selected. The countershaft and the output shaft are also always engaged.

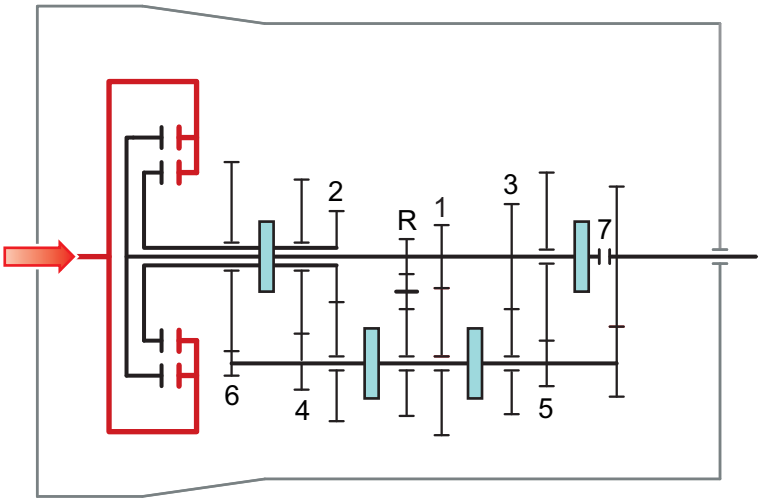
The respective gear pairs are selected via the sliding clutches (9).

The 7th gear is the direct gear, the sliding clutch connects inner input shaft 1 directly to the output shaft.

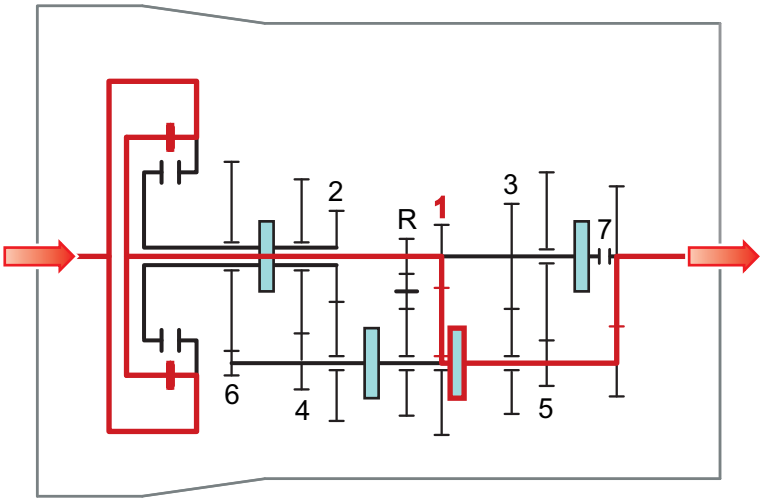
The parking lock (10) is located directly on the output shaft.

Power Flow

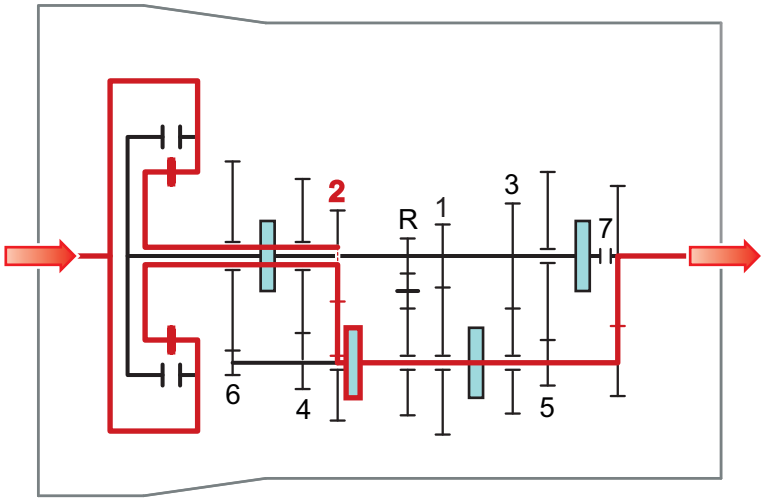
M DCT "Neutral"



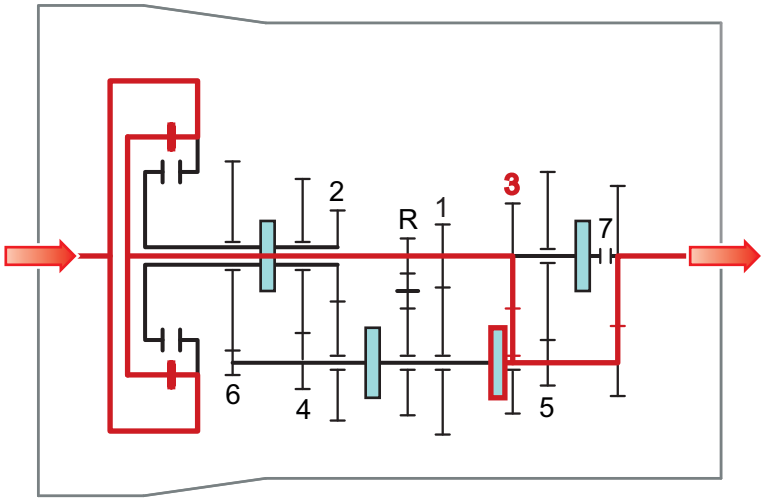
1st gear
power flow



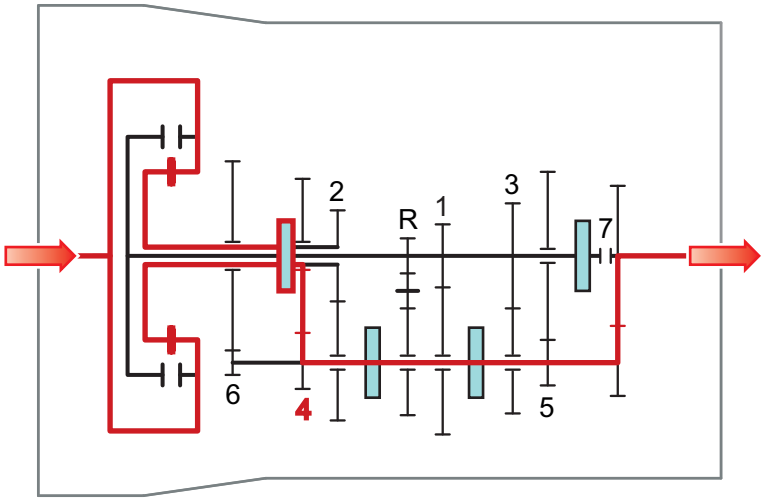
2nd gear
power flow



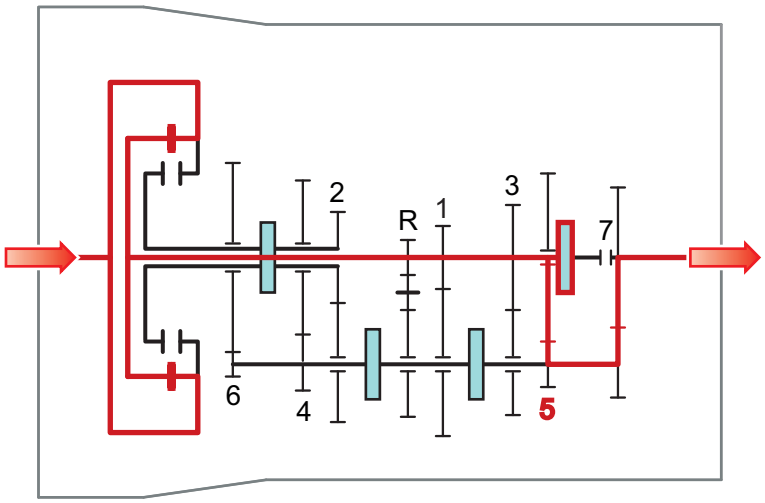
3rd gear
power flow



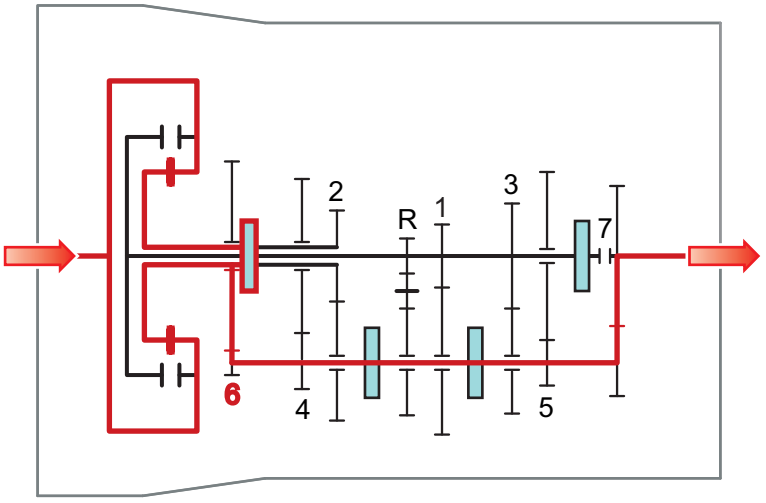
4th gear
power flow



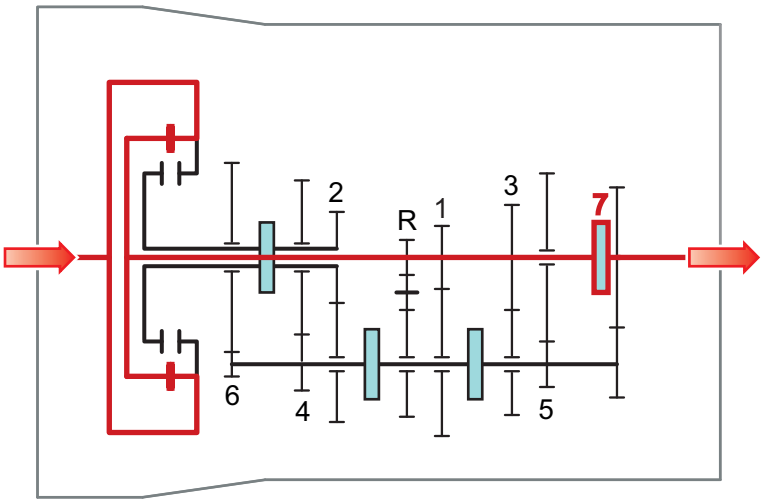
5th gear
power flow



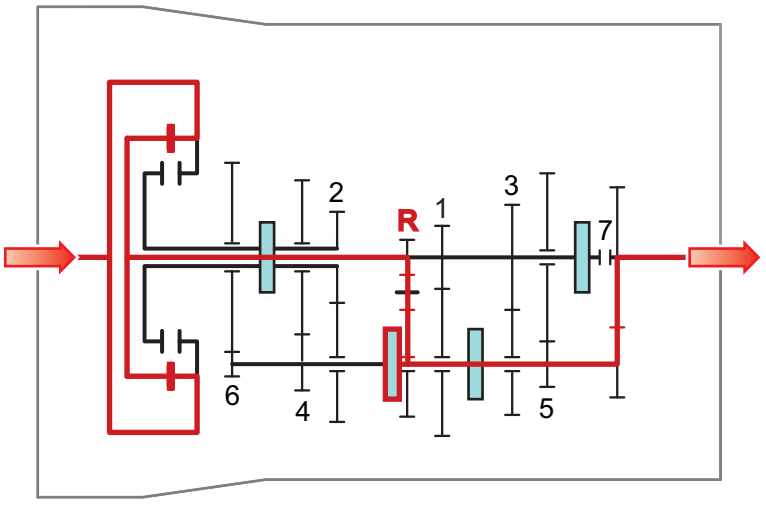
6th gear
power flow



7th gear
power flow



Reverse gear
power flow

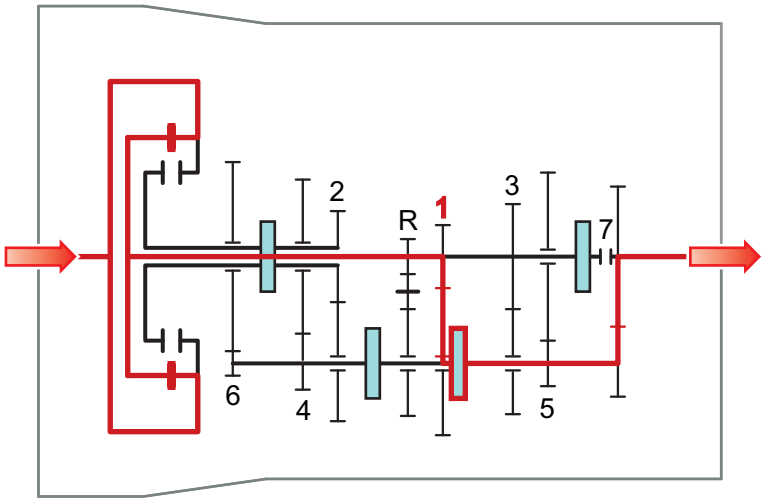


Shifting Operation From 1st to 2nd Gear

The following is a diagram demonstrating the shifting operation from 1st to 2nd gear with regulated transmission of the driving force between clutch 1 and clutch 2.

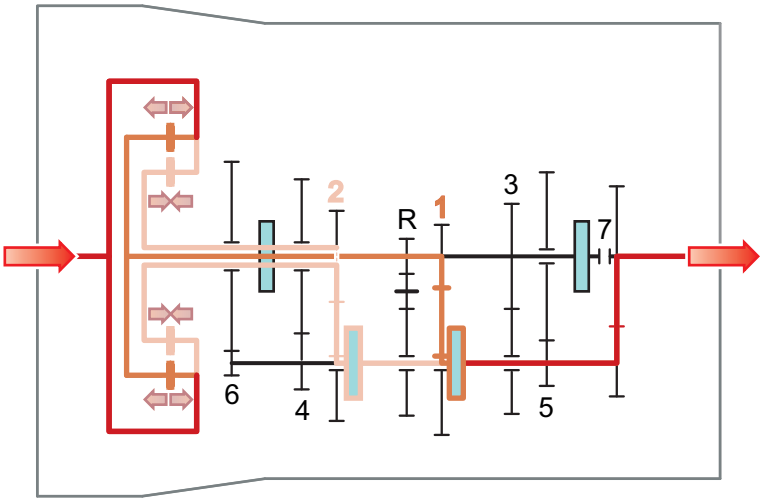
2nd gear is already pre-selected, while the driver accelerates in first gear (not shown). During the first phase, clutch 2 begins to engage as clutch 1 begins to disengage.

M DCT power flow route 1st gear



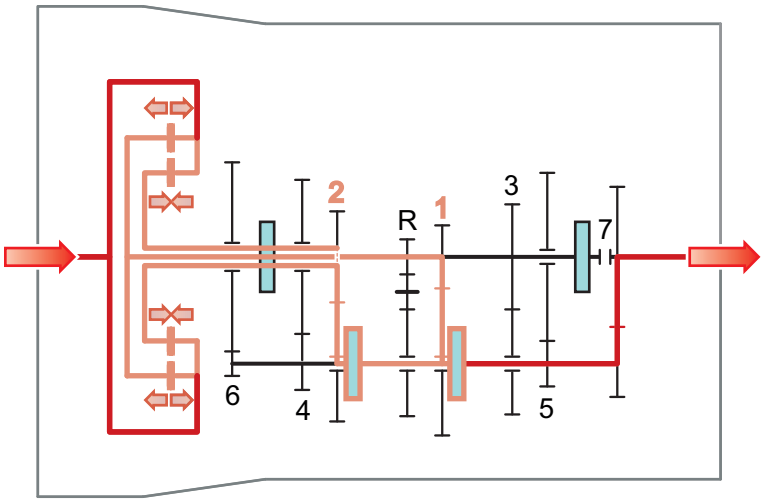
The greater portion of the driving force is still being transferred by clutch 1. The pressure on clutch 1 is still significantly higher than the increasing pressure on clutch 2.

M DCT gear shift from 1st to 2nd gear, first phase



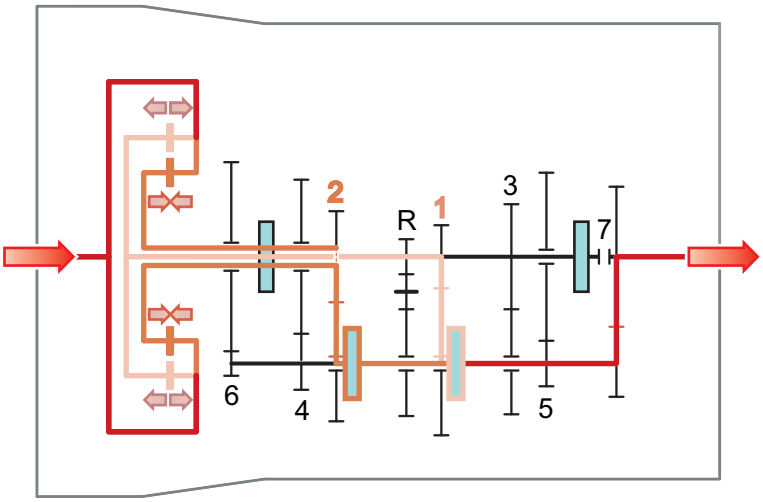
During the second phase, the driving force is distributed proportionally to clutch 2, which is engaging and clutch 1 which is disengaging. In this diagram both clutches have nearly the same pressure.

M DCT gear shift from 1st to 2nd gear, second phase



During the 3rd phase, clutch 2 carries the greater portion of the driving force, while clutch 1 disengages further. The pressure on clutch 2 is now significantly higher than the decreasing pressure on clutch 1.

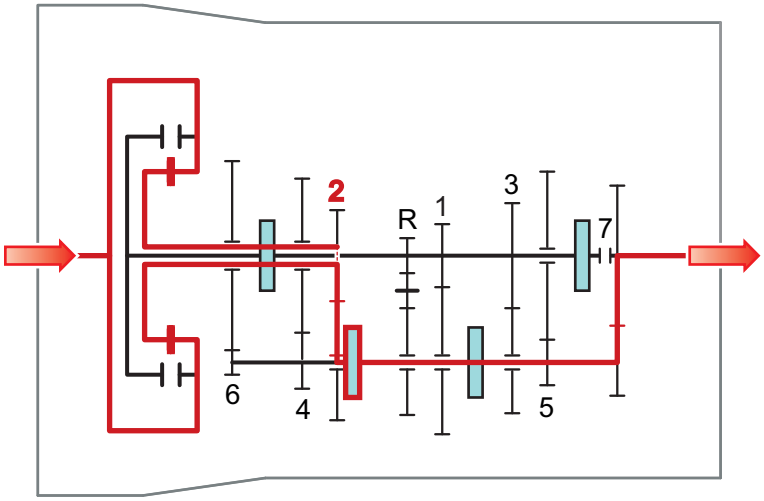
M DCT gear shift from 1st to 2nd gear, third phase



The gear shift from 1st to 2nd gear is complete, 3rd gear can now be pre-selected.

The same process applies for further gear shifts. The process runs in the reverse order when downshifting.

2nd gear power flow



System Components

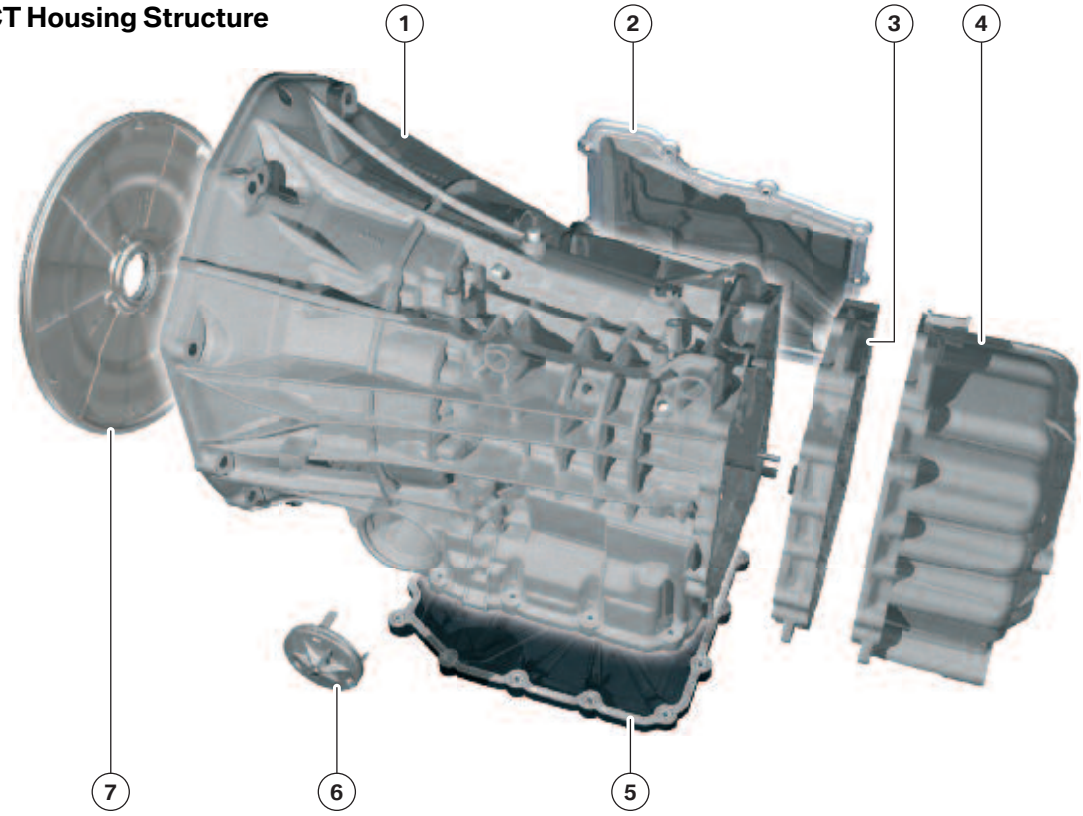
Housing Structure

The GS7D36SG transmission housing consists of three main components:

- The transmission housing
- The intermediate Case
- The rear housing cover

The main opening at the front is closed with the clutch cover. The case openings on the right side are closed with the mechatronics/hydraulic components cover. The lower openings are closed with the oil sump cover and on the left side with the oil filter cover.

M DCT Housing Structure

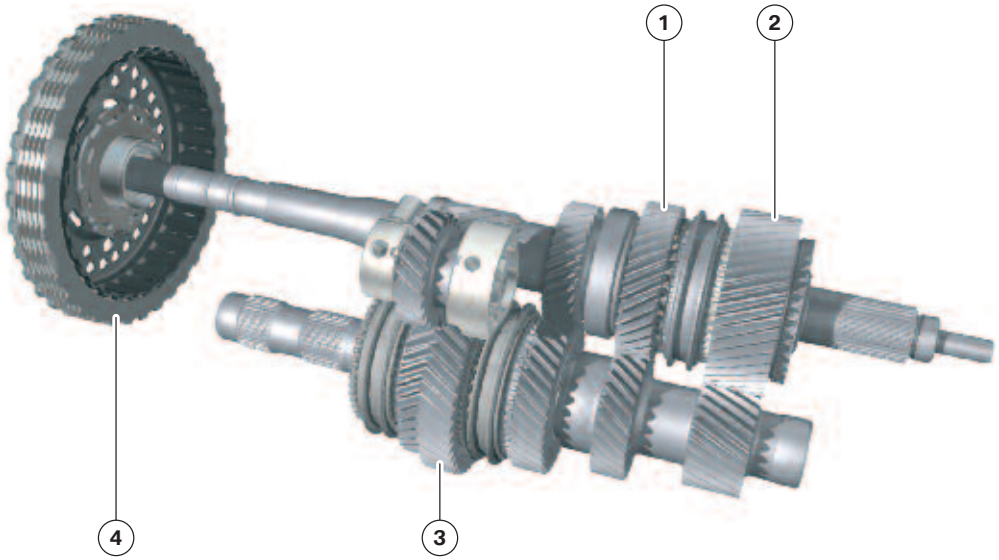


Index	Explanation	Index	Explanation
1	Transmission housing	5	Sump
2	Cover for the Mechatronics module or hydraulic components cover	6	Oil filter cover
3	Intermediate case	7	Clutch cover
4	Rear housing cover		

Internal Structure

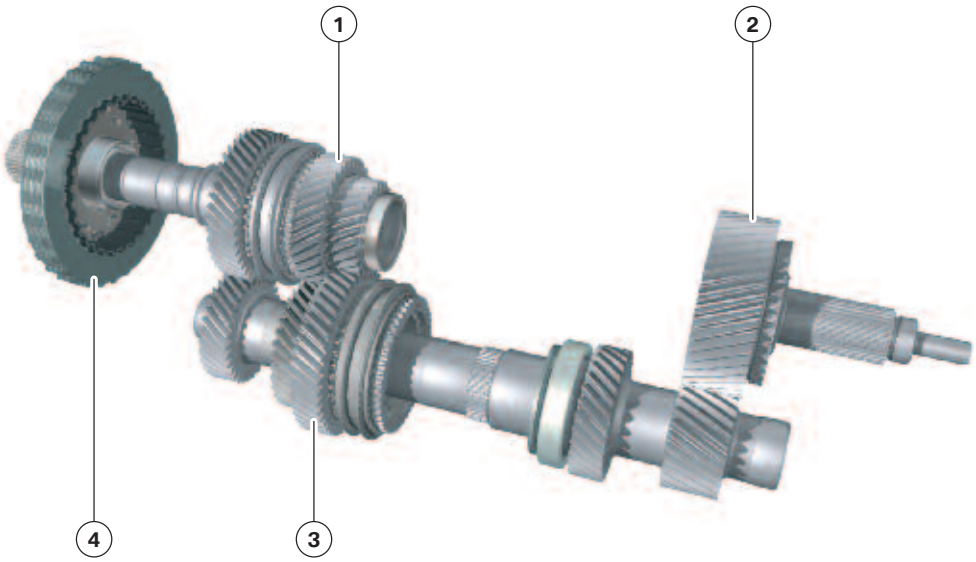
In the M DCT, driving force is transmitted in gears 1, 3, 5, 7 and R from clutch 1 to inner input shaft 1 and sub-transmission 1.

M DCT Sub-transmission 1



In gears 2, 4 and 6 the driving force is transmitted from clutch 2 to inner input shaft 2 and sub-transmission 2.

M DCT Sub-transmission 2

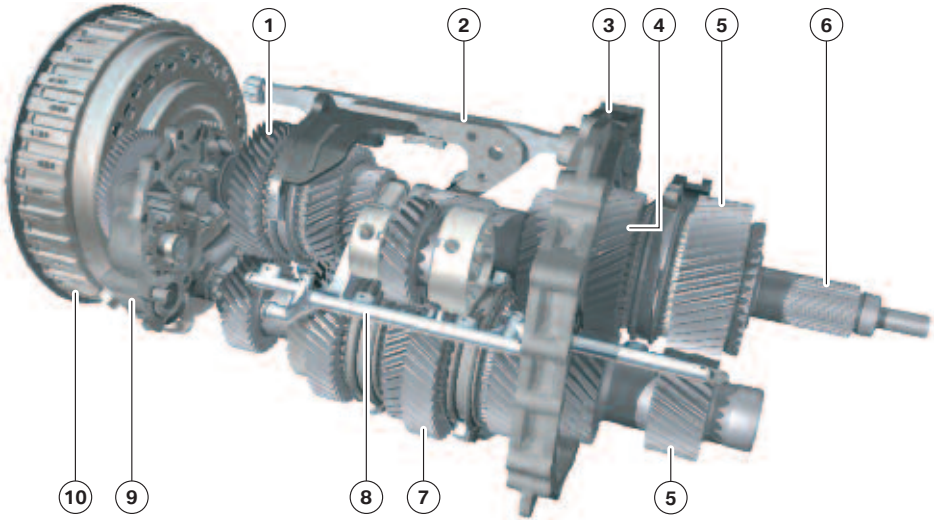


Index	Explanation	Index	Explanation
1	Inner input shaft 1 (top) Inner input shaft 2 (bottom)	3	Countershaft
2	Output shaft	4	Clutch 1 (top) Clutch 2 (bottom)

Clutch 1, clutch 2, input shaft 1, input shaft 2, the countershaft and the output shaft form the total gear set of the double-clutch transmission.

M DCT sub-transmission 1 and sub-transmission 2 joined together with selector linkage

M DCT complete gear set



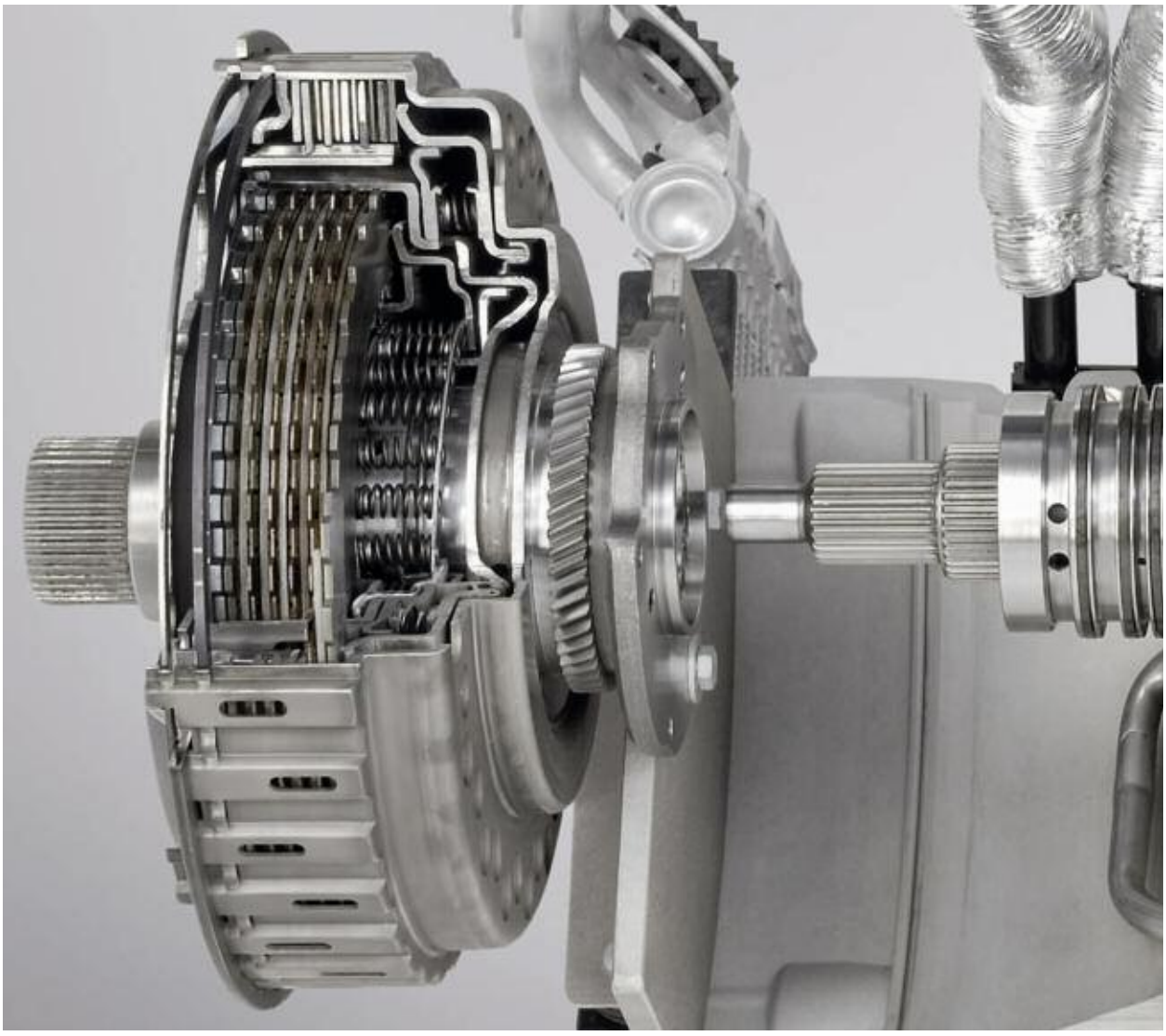
Index	Explanation	Index	Explanation
1	Inner input shaft 2	6	Output shaft
2	Selector linkage	7	Countershaft
3	Intermediate case	8	Lubricating pipe
4	Inner input shaft 1	9	Oil pump (sectional view)
5	Constant	10	External double-clutch housing (Driving force input)

The driving force is transmitted from the dual-mass flywheel over the central input shaft and the external double-clutch housing into the M DCT. The oil pump drive gear is connected at this point to the central input shaft.

There are four hydraulically operated selector rods and four sliding clutches, with one selector rod and one sliding clutch for each gear pair 4/6, 2/R, 1/3 and 5/7. Gears 1, 2, 3 and Reverse are equipped with double taper synchronization and gears 4, 5, 6 and 7 with single taper synchronization.

Carbon friction material is used for taper friction lining on all gears. The gear set assembly is mounted on three bearings that are evenly distributed along the length of the transmission shafts.

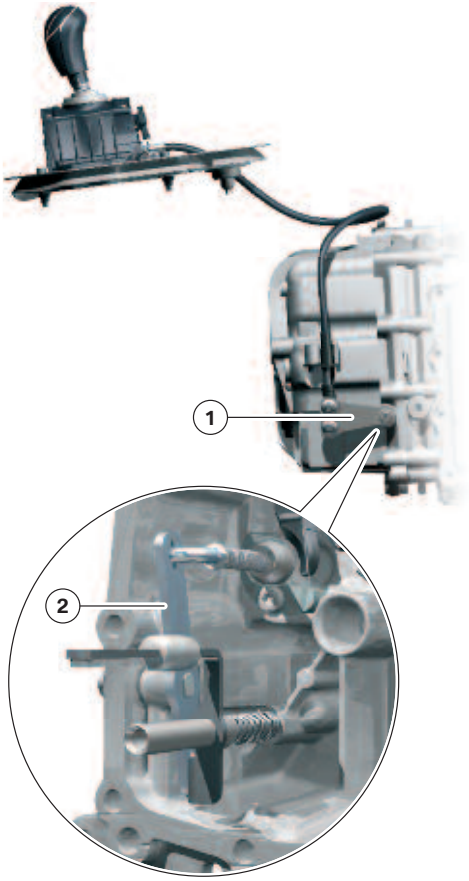
M DCT Double Wet Clutch Assembly
(Cut away view of clutch components)



Automatic Parking Lock

This is the first time that an integrated automatic parking lock has been used in an M vehicle. When the engine is turned off, there is no mechanical connection between engine and drive wheels (clutches are at zero pressure and disengaged).

M DCT parking lock lever, (view from rear right of transmission)

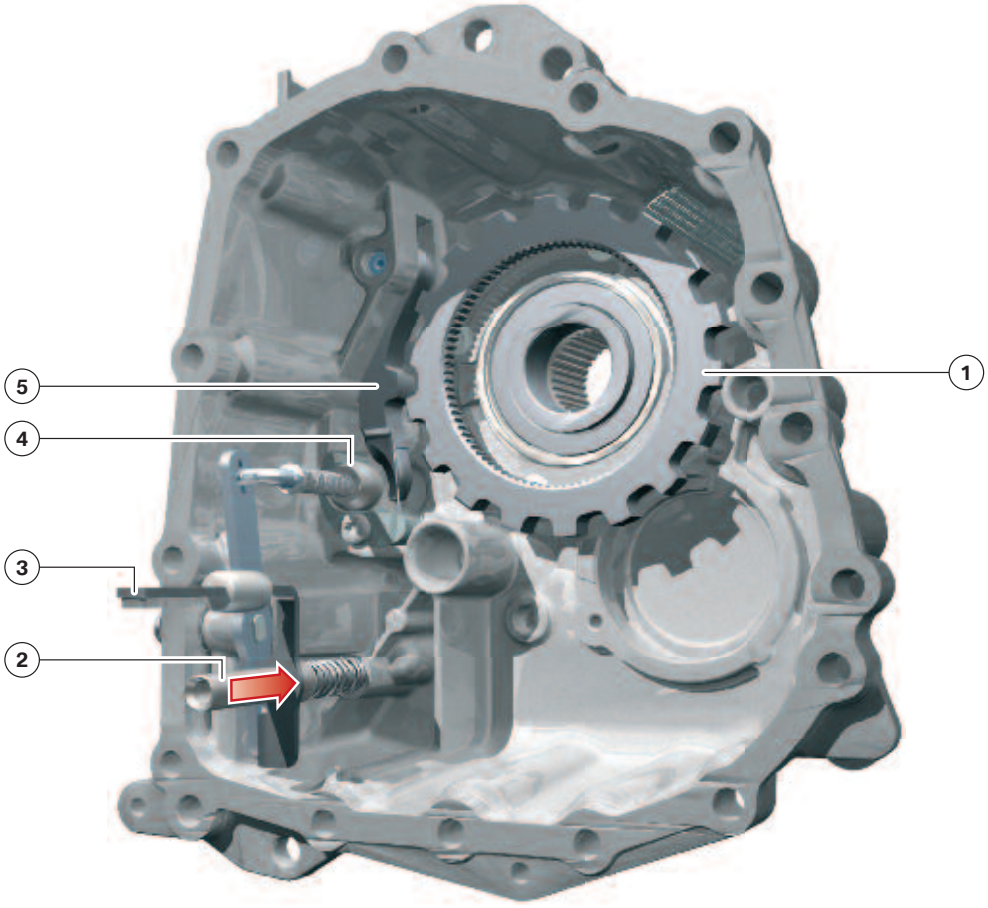


M DCT parking lock lever, (cut away view from rear right of transmission)

Index	Explanation	Index	Explanation
1	External parking lock lever	2	Inner parking lock lever

There is no parking lock button on the selector lever of the M GWS. The parking lock position is determined by the M DCT electronics. The parking lock is engaged with the use of a parking lock electromagnet. This electromagnet is built into the gear selector switch housing and is activated directly by the M DCT electronics. It transfers its movement (stroke) to a Bowden cable. The parking lock Bowden cable transfers the movement directly to the external parking lock lever on the transmission and then to the inner parking lock lever.

M DCT inner structure of the parking lock mechanism



Index	Explanation	Index	Explanation
1	Parking lock wheel	4	Pressure cone for operating the locking pawls
2	Parking lock hydraulic pistons and direction of pressure (red arrow)	5	Spring-loaded parking lock pawl
3	Magnet for parking lock sensors		

Note: The parking lock Bowden cable does not need to be adjusted.

The parking lock disengages hydraulically in the transmission. To engage the parking lock using the electromagnet, the parking lock hydraulic components must be at zero pressure.

The parking lock will always be automatically engaged once the engine has been turned off, except in "N".

When in "N" the parking lock is engaged:

- when vehicle remote control is not in the ignition lock (Comfort Access)
- when removing the remote control from the ignition lock
- 30 minutes after the engine has been turned off.

Note: At the car wash, before stopping the engine you must deliberately shift to "N" and leave the transmitter in the ignition lock. (With Comfort Access it must remain in the car or be inserted in the ignition lock).

Emergency Release of Parking Lock
In an emergency, the parking lock can be released by operating the emergency release mechanism. This is achieved releasing the mechanical connection between the GWS and M DCT. (See “Service Information”)

CAUTION!!! **If the parking lock is released the vehicle may roll.**

Note: The emergency release is described in detail in the Owner's Manual for the vehicle and in the Repair Instructions.

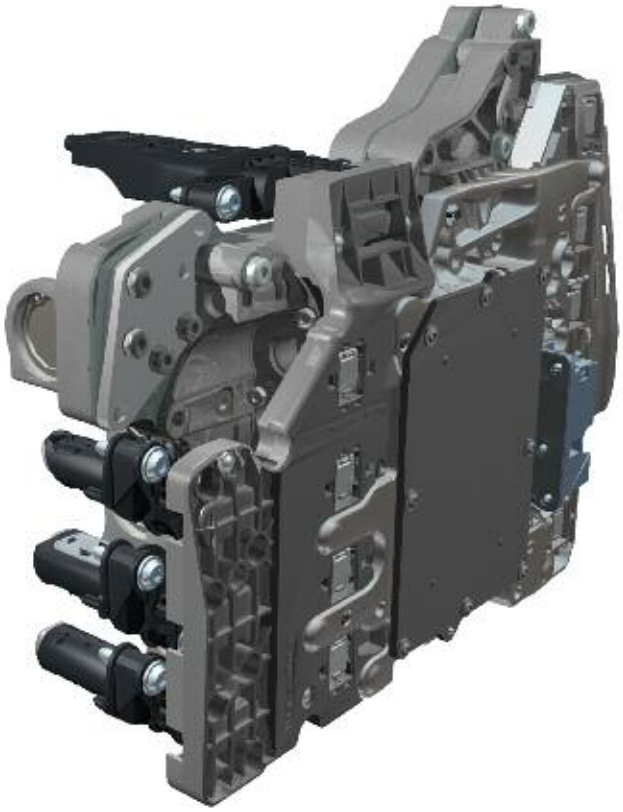
Mechatronics Module

The mechatronics module integrated into the M DCT transmission housing consists of the M DCT electronics and the M DCT hydraulic components.

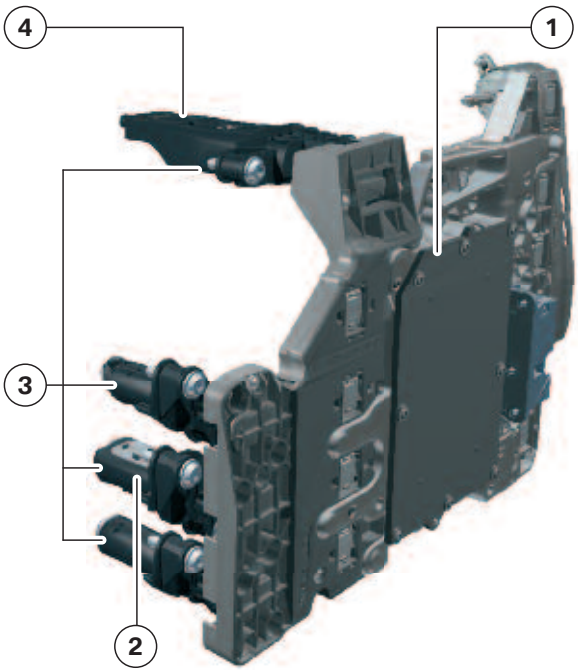
The selector rod position sensors are mounted directly on the M DCT electronics. The speed sensors for inner input shafts 1 and 2 are integrated in the upper position sensors.

The parking lock sensors are integrated in the second position sensor from the bottom.

M DCT Mechatronics Module

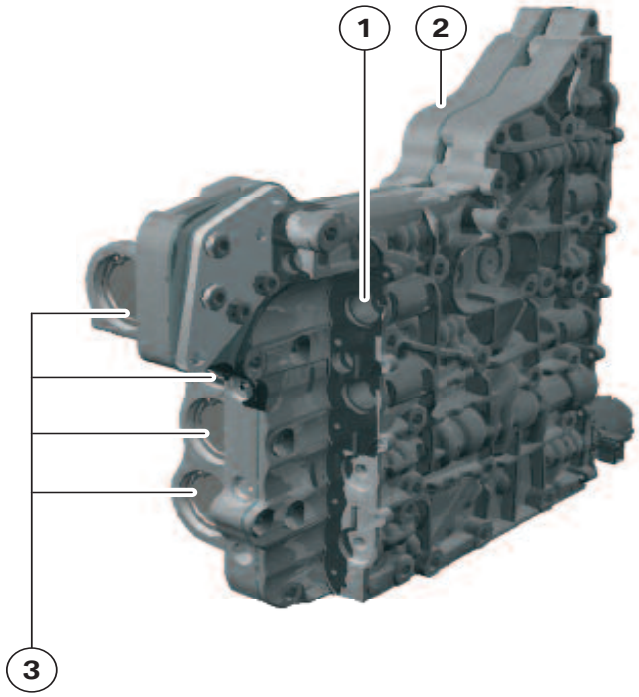


M DCT Electronic Components



Index	Explanation
1	M DCT electronics
2	Integrated parking lock sensors
3	Selector rod position sensors
4	Integrated shaft speed sensors

M DCT Hydraulic Components

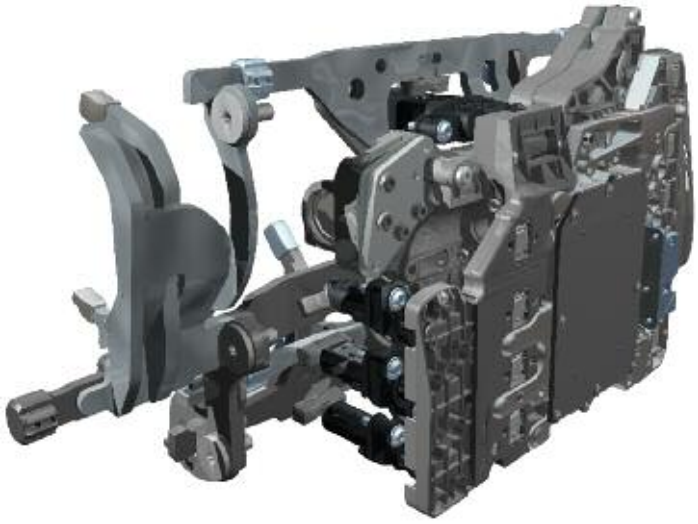


Index	Explanation
1	Take up shift valve
2	M DCT hydraulic components
3	Shift cylinders

The eight individual gears are engaged by four hydraulic cylinders and four individual selector rods. The selector rod positions are detected without the need for direct contact with the use of the selector rod position sensors.

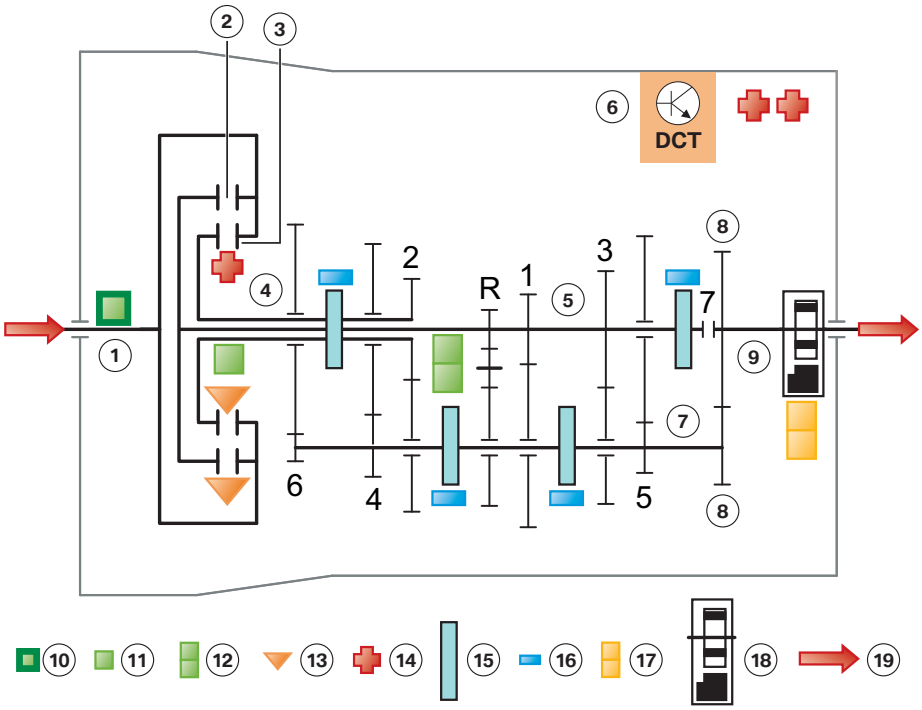
View of selector rod side of M DCT mechatronics module

M DCT mechatronics module with selector rods installed



Sensors and Communication

M DCT basic layout with clutches, shafts, M DCT electronics and sensors



Index	Explanation	Index	Explanation
1	Central input shaft	11	Gear rotation speed sensor for the inner input shaft 2 (Hall)
2	Clutch 1	12	Gear rotation speed sensor with rotation direction detection of inner input shaft 1 (Hall)
3	Clutch 2	13	Clutch oil pressure (Piezo) sensors
4	Inner input shaft 2	14	Oil temperature sensors (NTC)
5	Inner input shaft 1	15	Sliding clutches
6	M DCT electronics	16	Linear position (Hall) sensors
7	Countershaft	17	Parking lock (Hall) sensor (redundant)
8	Constant gear wheel	18	Parking lock
9	Output shaft	19	Power flow input, output and direction
10	Input engine speed (Hall) sensor		

Note: The engine speed signal is provided from the DME through the PT-CAN to the M DCT electronics.

M DCT Transmission Sensors

The following sensors are mounted in the transmission and their signals are sent directly to the M DCT electronics:

- Input shaft 1 speed (Hall) sensor monitors rotation and direction of transmission shaft 1.
- Input shaft 2 speed (Hall) sensor without rotation direction detection for the transmission shaft 2.
- Clutch oil pressure (Piezo) sensors for clutch 1 and 2.
- 3 temperature sensors (NTC), one for the ejected clutch oil and two redundant temperature sensors for the M DCT electronics.
- 4 linear (Hall) sensors monitor the selector rod position.
- 1 double (redundant) parking lock (Hall) sensor.

The oil sump temperature is measured using a complex temperature map and checked against the temperature of the clutch oil by the M DCT electronics.

Torque Intervention

The M DCT mechatronics module sends a torque requirement to the engine control module on the PT-CAN in order to achieve a torque intervention when shifting gear under load or when coasting. This is negative when upshifting so that the engine speed is reduced. When downshifting the torque intervention is positive, in order to increase the engine speed. Gear shifting is supported by the engine control module through this torque intervention strategy.

LIN-bus Module

There is a LIN-bus connection in the M DCT electronics for redundant communication with the gear selector switch (GWS).

M-Gear Selector Switch (M GWS)

The double clutch transmission in the E9x M3 has an M specific gear selector switch. It is operated in a similar way to the one in the E6x M5/M6 with the sequential M transmission (SMG).

M DCT M Gear Selector Switch (M GWS)

Index	Explanation	Index	Explanation
1	Selector lever	3	Drivelogic program selector button
2	Button to increase the Drivelogic program	4	Button to reduce the Drivelogic program

The M GWS consists of the selector lever with indicator, the housing with control module and the external but electrically connected Drivelogic program selector button.

Selector Lever Indicator and Function

The shift pattern, driving program, gear selection indicator on the selector lever are all similar to that of the E6x M5/M6 with SMG. The main difference is that the selector lever on the gear selector switch in the E9x M3 no longer snaps into the "N" and "R" positions, instead it only snaps into "R".

The M GWS selector lever is self centering as it returns back to its normal starting position on its own, after the driver selects the desired gear. Reverse gear is an exception; because once the shifter lever is moved left and into the "R" position the gear must be manually unselected by the driver.

The shift pattern, driving program, gear selection indicator on the selector lever are all displayed in red, depending on the position of the selector lever and driving program selected.

The indicator displays the currently selected driving program and the gear selection options. The indicator consists of the locating light that indicates the shift pattern and the function indicator lamp. These are two different red position LEDs that show the currently selected driving program and the gear selection options.

The function indicator lamp in the M GWS is controlled by the M DCT electronics. The function indicator lamp is monitored, read back and compared with the required indicator for plausibility.

In addition to the PT-CAN connection; there is a LIN-bus connection built in to the M GWS for redundant communication with the M DCT electronics.

Selector Lever in the Start Position

Except for when in the position "R", the selector lever always returns to the start position. When starting the engine the parking lock is always engaged and the clutches are both disengaged (zero oil pressure). The engine can be turned on regardless of the gear it was in when it was turned off.

The selector lever indicator is displayed in red when in the start position. Driving program "D" Drive (automatic gear mode) is selected by briefly pushing the selector lever to the right, causing the M DCT, when in automatic gear mode, to change gears automatically into first (second) gear. The selector lever indicator "D/S" option is also displayed in red to indicate the start position.

M GWS selector lever during and after starting the engine

The M GWS one-touch function is pushed to the right once to start automatic gear mode

Driving Program "S" (Sequential Mode)

By pressing the selector briefly to the right a second time the M DCT changes from automatic to sequential mode "S".

If, while driving in 2nd to 6th gear, the driving program "S" is selected, then in addition to the "D/S", the "+" and "-" will light up in red.

The driver can now change to the next higher gear by briefly moving the selector lever backwards a notch or downshift by moving it briefly forward a notch.

A desired gear shift may only be executed within the range of permissible engine speeds. There is no automatic up-shifting once the maximum speed has been reached.

In automatic “Drive” mode, as soon as the selector lever is moved towards the front, the back or a shift paddle on the steering wheel is activated, the M DCT switches to sequential mode.

The M GWS pushed to the right twice to start sequential mode.

In sequential mode there are two additional indicators, one for 1st gear and one for 7th gear.

Downshifting
In 1st gear the "-" is no longer lit up in red, because it is no longer possible to downshift.

M GWS in sequential mode, upshifting.

Upshifting
In 7th gear the "+" is no longer lit up in red, because it is not possible to shift higher.

M GWS in sequential mode, downshifting.

Gear Selection "N" Neutral

The driver can consciously shift into neutral by pressing the selector lever briefly to the left.

"N" will light up in red in the selector lever indicator. This is useful for example in a car wash.

The M GWS one-touch function is pushed to the left to shift into neutral.

Note: At the car wash, before stopping the engine you must deliberately shift to "N" and leave the transmitter in the ignition lock. (With Comfort Access it must remain in the car or be inserted in the ignition lock).

Gear Selection "R" Reverse Gear

When in this shift position, reverse gear is selected and the "R" will light up in red.

If the engine is turned on while the selector lever position is in "R", the start position of the selector lever will flash red at one second intervals. This signals the driver that the Reverse gear is selected and that he must first return the shift lever to the (self centering) start position, in order to select a new gear or driving program.

M GWS Reverse gear position

Drivelogic Program Selection

The controls and indicators in the vehicle are similar to the SMG II and SMG III vehicles.

The Drivelogic program switch gives you the option of choosing between six driving programs in sequential mode and five driving programs in drive mode.

The selected driving program is displayed as a bar chart in the instrument cluster.

In sequential mode the switching speed is affected which has a direct effect on the shifting firmness.

The sixth shift program can only be selected when the DSC function is de-activated.

In drive mode the shift points and the shifting speed are affected, as a higher shift program means a higher gear changeover speed and thus a higher shifting speed.

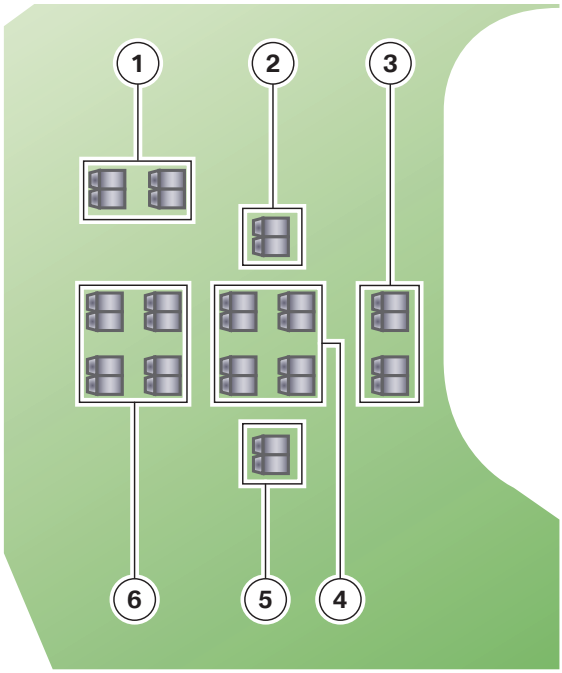
In addition to the Drivelogic program selection, the shift time is also dependent on the position of the accelerator pedal and how quickly it is operated.

M GWS Shifter Sensor System

The selector lever position is detected with the use of Hall sensors. These are available mostly in groups of 2 or 4. In total there are 14 Hall sensors. This ensures maximum fault handling and diagnostic capacity.

M GWS arrangement of Hall sensors for determining the selector lever position

Index	Explanation
1	Gear selection "R" reverse gear
2	"-" downshifting
3	Driving program "D/S" automatic or sequential mode
4	Selector lever start position
5	"+" upshifting
6	Gear selection "N" neutral



Interface to the M DCT

The selector lever position is transmitted through the PT-CAN and a LIN-bus. In the event of a failure of one of the two communication lines, a signal is still sent to the M DCT.

The M GWS wake up is done by a high signal on the PT-CAN wake-up line.

The M GWS itself has no active wake-up capabilities. The indicator on the selector lever is active as soon as bus communication is active on the PT-CAN or the LIN-bus.

Interface	From	To	Message
PT-CAN	M GWS	M DCT	Operation of the selector lever
PT-CAN	M DCT	M GWS	Show gearbox data
LIN-bus	M GWS	M DCT	Operation of the selector lever
LIN-bus	M DCT	M GWS	Show gearbox data

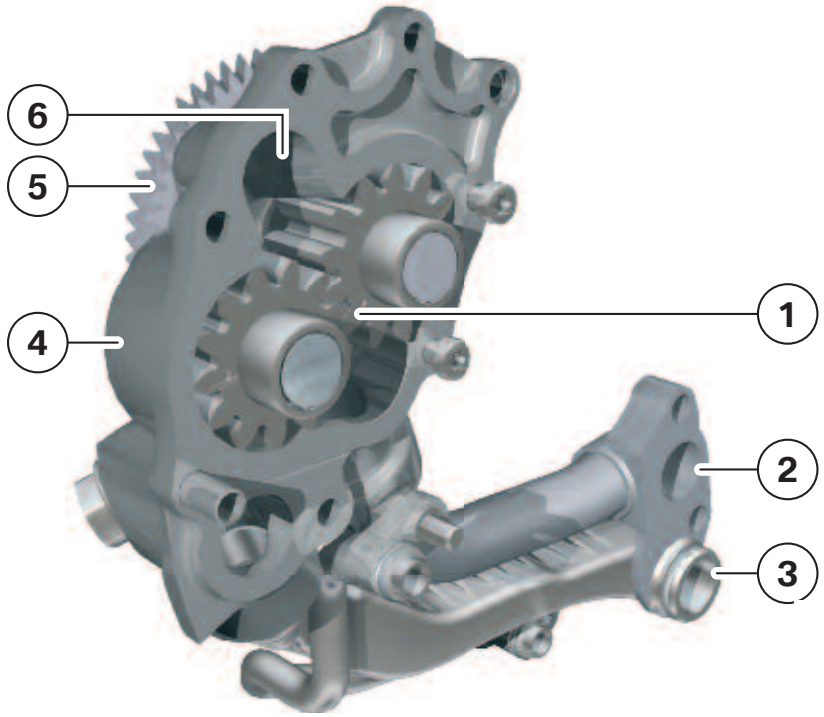
Transmission Oil System

Pressure and Flow Regulation

A gear driven pump is integrated into the M DCT transmission and is responsible for circulating the oil through the unit.

The transmission oil pump is driven by a gear on the drive input side which connects to the center input shaft of the M DCT. The engine must be running for the oil pressure to build up.

M DCT oil pump without sealing cover



Index	Explanation	Index	Explanation
1	Oil pump gears	4	M DCT gear oil pump housing
2	Oil pressure pipe to the hydraulic control unit	5	Drive gear
3	Oil return pipe	6	Oil intake side (oil supply)

Note: Because transmission oil pressure cannot be built up when the engine is not running, a M DCT vehicle should never be push-started.

The operating pressure is determined by a regulated control valve depending on the load and the function selected. The system is protected by a pressure relief valve in the pump.

The pressure is regulated according to the following priorities:

- Clutch engagement and disengagement
- Gear changes
- Cooling the clutch
- Lubrication cycle.

The transmission oil pressure should be high enough to:

- Be able to engage the clutches reliably.
- Allow the gear selector rod to reach the required control shift speed.

The normal operating pressure range is between 5 and 20 bar, although it can be increased up to 30 bar if necessary to maintain proper transmission operation.

At maximum shifting force, the pressure required to operate the selector rods can be the same as the operating pressure.

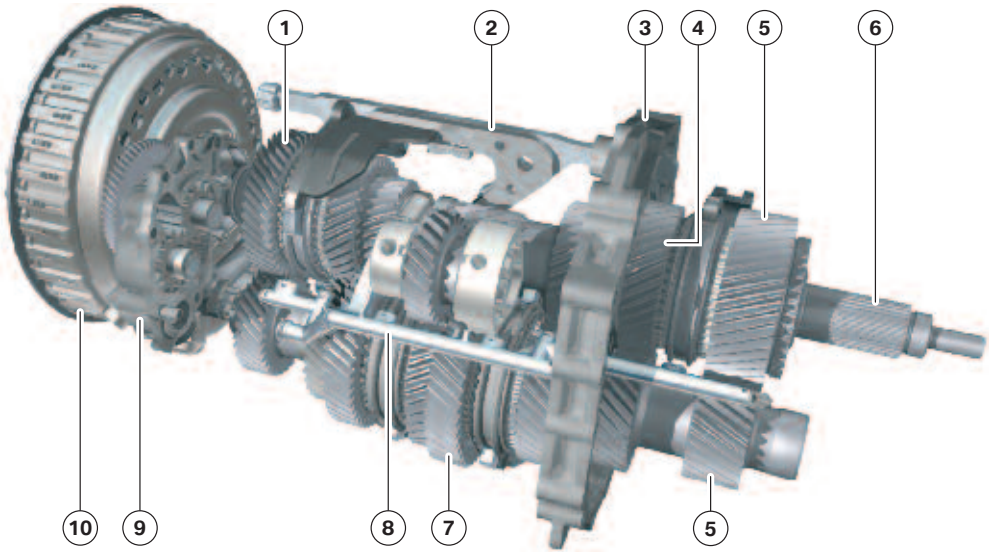
The pressure required for the clutches is limited to 18 bar. The clutch is regulated by an integrated proportioning valve.

Overpressure protection is ensured by a pressure relief valve.

Clutch cooling is map-controlled using a proportional valve.

Note: The M DCT Drivelogic transmission has a new long-term rated oil, DCTF-1, which requires no replacement unless specified for a repair.

M DCT gear set with lubricating pipe



Index	Explanation	Index	Explanation
1	Inner input shaft 2	6	Output shaft
2	Selector linkage	7	Countershaft
3	Intermediate case	8	Lubricating pipe
4	Inner input shaft 1	9	Oil pump (sectional view)
5	Constant	10	Dual clutch housing and oil pump drive gear

Oil-spray Lubrication

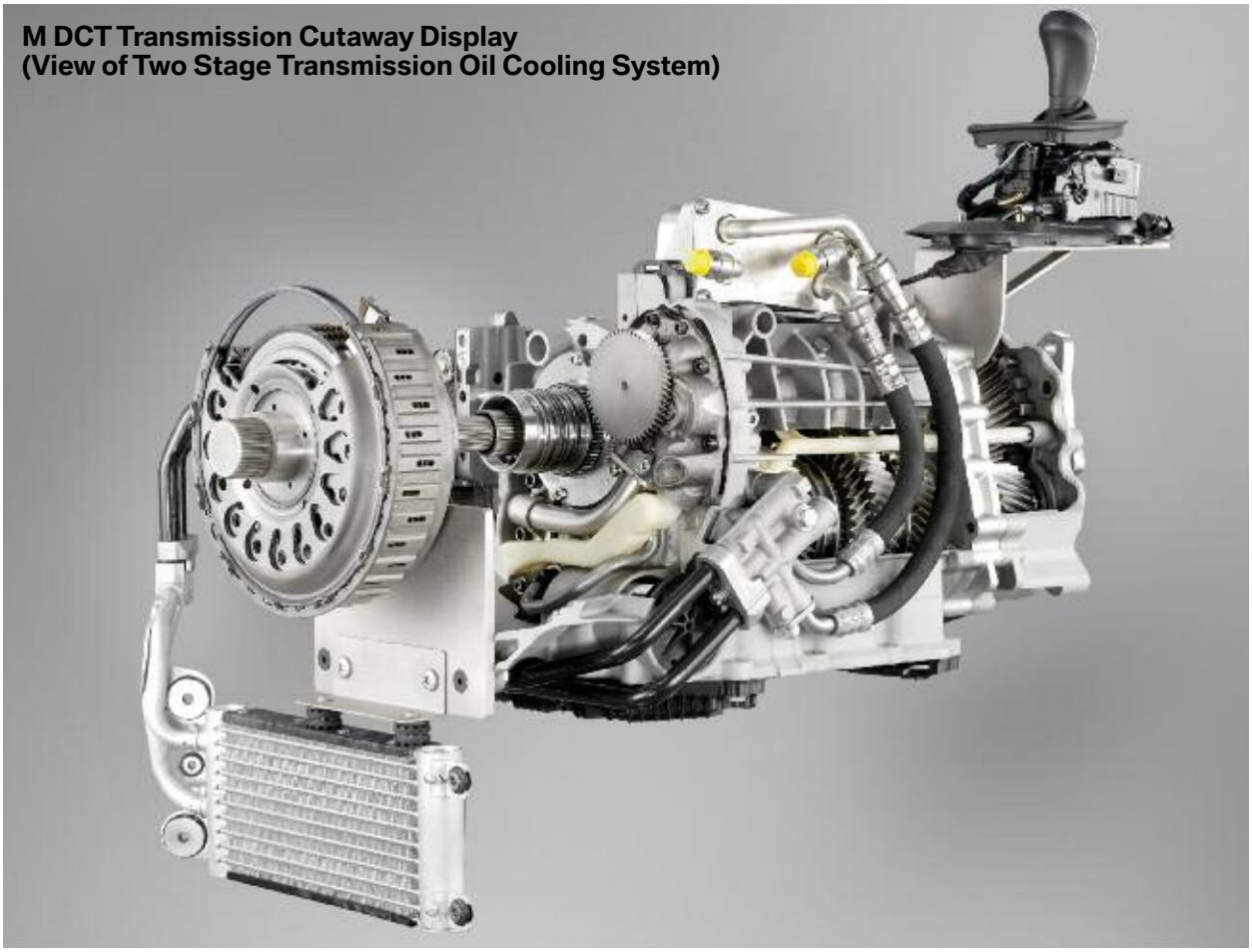
The M DCT transmission applies direct lubrication with the use of an internal lubricating pipe fitted with individual nozzles and aimed at pre-determined areas of the gear train.

M DCT gear set lubricating pipe

Hydraulic Emergency Operation

If there is a fault, the M DCT has a hydraulic emergency operation mode. For example, if the power supply fails, the active gear remains selected and the active clutch engaged. This makes it possible to drive to the next possible vehicle storage location or parking area. The clutch disengages only when the engine speed goes below the minimum rpm and then it remains disengaged.

Two-stage Transmission Oil Cooling



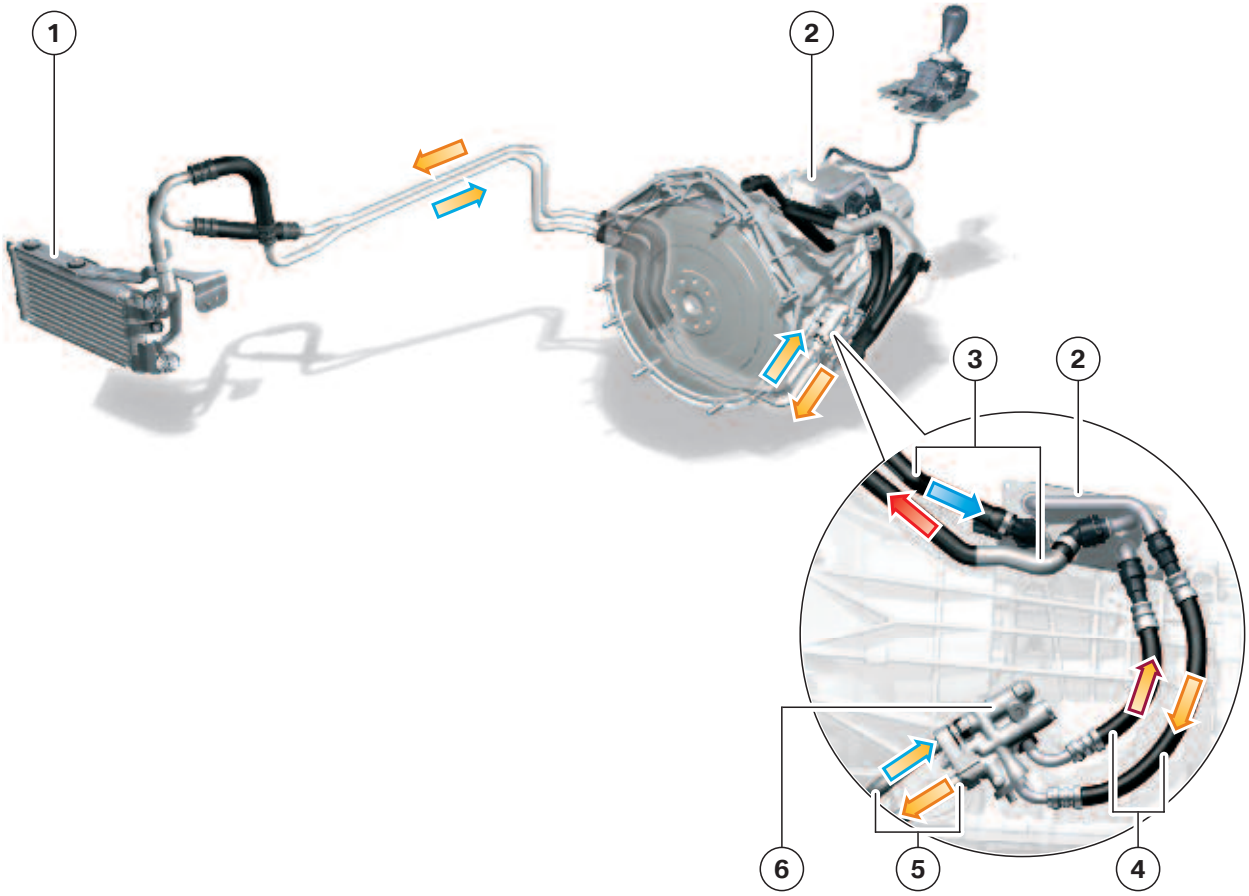
Oil to Coolant Cooling

The M DCT transmission oil cooling circuit consists of an oil to coolant heat exchanger, an oil to air heat exchanger, a transmission oil thermostat and the relevant cooler lines. The oil to coolant heat exchanger is part of the engine cooling system of the vehicle. Mounted on the transmission housing it allows the oil to flow directly from the M DCT into the oil to coolant heat exchanger.

Engine coolant directly from the cylinder head is pumped to the oil to coolant heat exchanger by the auxiliary coolant pump and then circulated back to the engine cooling system. The M DCT electronics can switch on the auxiliary coolant pump as needed. The auxiliary coolant pump, which is normally used to enhance the efficiency of the heating system, is used here to warm up the M DCT transmission. This design shortens the warm up time and maintains the transmission oil in the desired operating temperature range.

After the oil to coolant heat exchanger has brought the temperature of the transmission oil to above 95°C/203°F, an oil thermostat directs the transmission oil to the oil to air heat exchanger located at the front of the vehicle.

M DCT Two Stage Transmission Oil Cooling (view of system components)



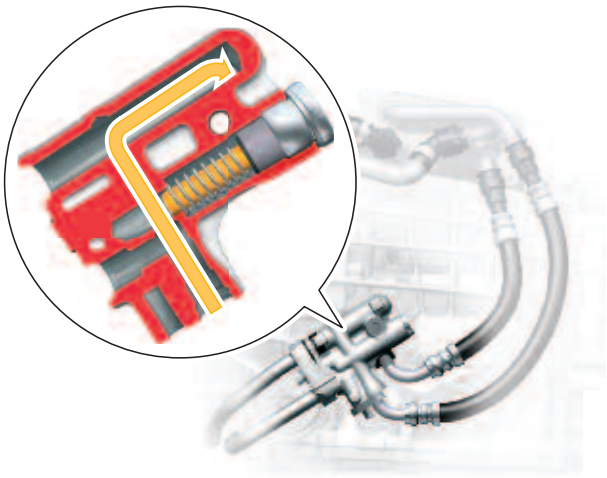
Index	Explanation	Index	Explanation
1	Oil to air heat exchanger	4	Transmission oil supply and return flow to the oil to coolant heat exchanger
2	Oil to coolant heat exchanger	5	Transmission oil supply and return flow to the oil to air heat exchanger
3	Coolant supply and return flow to the oil to coolant heat exchanger	6	Oil thermostat for oil to air cooling

Oil to Air Cooling

An oil thermostat is used to direct the oil flow through the oil to air heat exchanger. There is a by-pass passage in bore of the oil thermostat which is located between the supply and the return flow from the oil to air heat exchanger.

Oil "Warm-up"

When the oil temperature is below 95°C (203°F), the oil by-pass passage in the thermostat is open. Oil flows out of the oil to coolant heat exchanger directly through the oil thermostat and back into the M DCT. This by-passes the oil to air heat exchanger completely and allows the system to reach operating temperature.

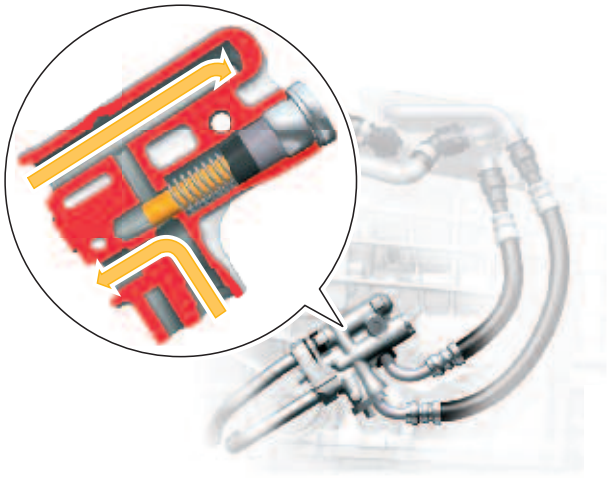


M DCT oil thermostat at an oil temperature below 95 °C

Oil "Cooling"

When the oil temperature is above 95°C (203°F), the oil by-pass passage is closed by a thermal control valve in the oil thermostat. The hot oil is now directed to the oil to air heat exchanger for cooling before it flows back into the M DCT.

This design enhances the overall thermal efficiency of the oil to air heat exchanger while maintaining the proper transmission oil operating temperature.



M DCT oil thermostat at an oil temperature above 95 °C

Note: In the event that the transmission oil temperature increases above the allowable limit, the engine torque is reduced and the maximum rpm is limited as a safety measure.

Service Information

Parking Lock

The parking lock Bowden cable does not need to be adjusted.

Parking Lock Emergency Release

To manually release the electrical parking lock:

- Removed the shifter boot is to gain access to the release mechanism.
- Using the screw driver from the vehicle tool kit or (similar tool), unclip the release mechanism cover.
- Insert the screw driver/tool in the release mechanism to the left of the shifter.
- Move the release toward the rear of the vehicle and observe the shifter indicator light illuminate the “N” position.

CAUTION!!! **The vehicle will roll with the emergency parking lock released.**

The emergency release is described in detail in the vehicle’s Owner's Manual and in the Repair Instructions.

Note: Releasing the parking lock using the emergency release can cause a fault code entry in the M DCT electronics.

Car Wash

At the car wash, before stopping the engine, you must actively switch to "N". Vehicles with “Comfort Access” must leave the transmitter in the vehicle or in the ignition lock.

Transmission Oil

M DCT Oil Type

"BMW DCTF-1" is a long-term oil that was especially designed for the M DCT transmission.

Oil Change Interval

The M DCT Drivelogic transmission has a new long-term rated oil, DCTF-1, which requires no replacement unless specified for a repair. (See SI B 00 01 07)

Transmission Oil Cooling

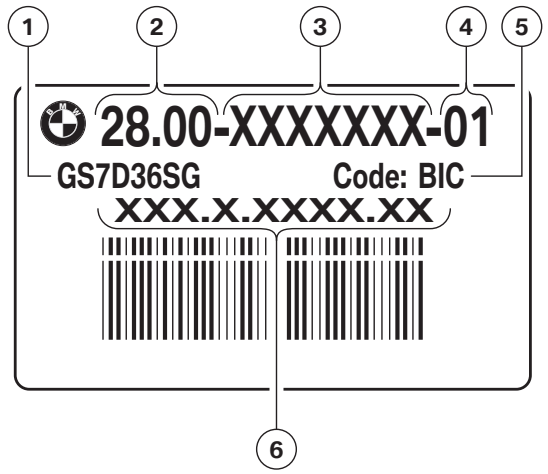
In the event that the transmission oil temperature increases above the allowable limit, the engine torque is reduced and the maximum rpm is limited as a safety measure.

CAUTION!!! **Because system oil pressure cannot be built up when the engine is not running, push starting a M DCT vehicle is not recommended.**

Identifying the Transmission

This double-clutch transmission has an "S" as the seventh character of its transmission designation, which stands for Sport gear ratio (e.g. GS7D36"S"G).

Transmission Type Plate



Index	Explanation
1	Transmission designation in accordance with BMW GS 90007
2	Subassembly
3	BMW item number
4	Revision index
5	Transmission code
6	GETRAG item number

Service Functions

The following Service Functions are currently available on the BMW diagnostic equipment (GT1 Tester) for the M DCT transmission:

- Clutch adaptation
- Transmission adaptation
- Oil calibration
- Parking lock hook test

Note: Depending on the version of diagnostic software used, some Service Functions may not be available.

Clutch Adaptation

The Clutch adaptation teaches the clutch engagement points for each clutch and saves the data in the M DCT control module.
Clutch Adaptation should always be performed after the following service procedures :

- Clutch replacement
- Mechatronic module replacement
- Replacing the speed sensor or oil temperature sensor
- Replacing the oil pump
- If any work was done to the internal transmission components

Transmission Adaptation

The transmission adaptation service function ensures that the neutral positions and mechanical end stops will be learned and saved in the M DCT transmission control module.

Transmission adaptation should always be performed after the following service procedures :

- After replacement of the mechatronic module

Oil Calibration

This service function relates to the control and monitoring of the M DCT transmission oil temperature, which governs the function of specific components and relevant transmission controls.

The Oil Calibration should always be performed after the following service procedures:

- Clutch replacement
- Mechatronic module replacement
- Replacing the speed sensor or oil temperature sensor
- Replacing the oil pump
- If any work was done to the internal transmission components
- After a change or repair of the parking lock linkage
- If any work was done to the Gear Selector

CAUTION!!! **Always exercise caution and follow proper safety procedures. Transmission oil can exceed the temperature 40°C /104°F.**

Parking Lock Hook Test

This service function tests and operates the parking lock hook with the Gear Selector. The parking lock will be selected hydraulically and must be held in place with the parking lock hook.

The Parking Lock Hook Test should always be performed after the following service procedures:

- Clutch replacement
- Mechatronic module replacement
- Replacing the speed sensor or oil temperature sensor
- Replacing the oil pump
- If any work was done to the internal transmission components
- After a change or repair of the parking lock linkage
- If any work was done to the Gear Selector
- Replacing the complete transmission

Possible Fault Messages

The following is an overview of possible fault indicators and the associated Check Control Messages.

High Transmission Oil Temperature

There are two transmission oil temperature messages which generate appropriate responses:

1. When the transmission oil temperature has overheated (oil sump or clutch) and in the case of certain valve faults.

Check Control Message 104	Information in the CID
Transmission Temperature. Drive carefully! 	Transmission Temperature Risk of transmission overheating. Shift program with restricted vehicle operation active. Avoid high engine loads.
Reaction: The engine torque is reduced. The shift program is adjusted to lower the temperature.	
Action: Check driving profile and environmental conditions. Look for a possible fault in the transmission oil cooling system. It may be necessary to check the M DCT using BMW Diagnostic Equipment.	

2. When the transmission oil temperature has overheated (oil sump or clutch).

Check Control Message 105	Information in the CID
Transmission Temperature Drive carefully! 	Transmission has Overheated Stop and shift the transmission position into “P” after it has cooled down, drive on carefully. If overheating re-occurs, visit your nearest BMW Service Center to check this.
Reaction: The engine torque is greatly reduced. The current gear remains engaged until you reach a standstill. After reaching a standstill, the parking lock is engaged.	
Action: Look for a fault in the transmission oil cooling system. Check the M DCT transmission using BMW Diagnostic Equipment.	

Internal Transmission Faults (Implausible sensor, valve readings and limit value infringements)

Check Control Message 368 may be displayed:

- If Implausible temperature values or a temporary pressure limit reading of negative pressure or overpressure.
- In the event of an electrical defect with the temperature sensors (wire open circuit or short circuit).
- When Implausible input from (engine) speed or sub-transmission speed.

Check Control Message 368	Information in the CID
Transmission fault. 	Transmission Fault The journey can be continued. Visit your nearest BMW Service Center to check this.
Reaction: None.	
Action: Check the M DCT using BMW Diagnostic Equipment.	

Check Control Message 365 may display:

- In the event that the temperature sensors and pressure sensors do not detect cooling oil flow, for example, because a valve has jammed while other valve problems or sensor failure are being experienced.
- With persistent pressure limit infringements.
- In the event of mechanical selector rod problems or sensor faults (position sensors for the selector rods).
- Because the temperature measured in the M DCT electronics does not match the value range of the other temperature sensors.

Check Control Message 365	Information in the CID
Faulty transmission. Drive carefully 	Transmission Fault Emergency program activated. Visit your nearest BMW Service Center to check this.
Reaction: A clutch may be blocked. Clutch 1 (the gears R, 1, 3, 5 and 7 can no longer be selected) or clutch 2 (the gears 2, 4 and 6 can no longer be selected). Individual or gear pairs are blocked.	
Action: Check the M DCT using BMW Diagnostic Equipment.	

Check Control Message 254 may display:

- In the event of a failure of certain control valves.

Check Control Message 254	Information in the CID
Faulty transmission. Drive carefully 	Transmission Fault Reduced acceleration may occur. Visit your nearest BMW Service Center to check this.
Reaction: The journey can be continued with limited engine performance.	
Action: Check the M DCT using BMW Diagnostics Equipment.	

Check Control Message 307 may display:

- If the transmission oil temperature increases or overheats and the ratio of the oil sump temperature to clutch temperature is implausible.
- In the event of PT-CAN failure or a communication fault.
- When there is accelerator pedal fault message or implausible reading.

Check Control Message 307	Information in the CID
Faulty transmission. Drive carefully 	Transmission Fault Some functions may be faulty. Gear can be engaged without braking. Drive carefully! Visit your nearest BMW Service to check this.
Reaction: Only 2nd and R gears are available.	
Action: Check the M DCT using BMW Diagnostic Equipment.	

Faults Related to Implausible Readings (with the brakes, parking lock or gear selector switch [GWS])

Check Control Message 250 may display:

- When there is a fault with the brake light switch or implausible reading.
- In the event of unrealistic driving conditions, such as excessive deceleration without brake operation.
- lengthy simultaneous accelerator pedal and brake pedal operation, for more than 1 min.

Check Control Message 250	Information in the CID
Gear can be engaged without braking. 	Important! It is still necessary to step on the brakes before shifting into gear. The journey can be continued. Turn off the engine before leaving the vehicle. Have it checked by your BMW Service Center as soon as possible.
Reaction: If the brake light switch is defective, starting the engine may not be possible.	
Action: Check driving profile, vehicle may need to be checked using BMW Diagnostic Equipment.	

Check Control Message 302 may display:

- If the parking lock cannot be engaged electromechanically.

Check Control Message 302	Information in the CID
Transmission position “P” is not selected. 	Transmission Position Position “P” is not selected. Caution! The vehicle may roll in this condition.
Reaction: Inoperative parking lock function, the vehicle must be secured with the hand brake/parking brake when switching off the engine.	
Action: Check for proper functioning parking lock electromagnet in the M GWS. Check the routing path of the Bowden cable between the parking lock electromagnet in the M GWS and the parking lock lever on the M DCT. Check for proper functioning parking lock lever on the M DCT. Check M DCT using BMW Diagnostic Equipment.	

Check Control Message 175 may display:

- In the event of a parking lock sensor fault.

Check Control Message 175	Information in the CID
Transmission position “P” is faulty. 	Faulty Transmission Transmission position “P” may not be possible. When at a standstill activate the parking brake. Visit your nearest BMW Service Center to check this.
Reaction: Parking lock may not be selected.	
Action: Check if the parking lock is selected. Check the M DCT using BMW Diagnostic Equipment.	

Check Control Message 541 may display:

- In the event that the parking lock cannot be disengaged hydraulically.

Check Control Message 541	Information in the CID
Transmission position “P” is faulty. 	Faulty Transmission To pull away, unlock the parking lock manually, see Vehicle Owner's Manual. Visit your nearest BMW Service Center to check this.
Reaction: Parking lock must be disengaged via the emergency release.	
Action: After emergency release, check the M DCT using BMW Diagnostic Equipment.	

Check Control Message 394 may display:

- In the event of a M GWS malfunction.

Check Control Message 394	Information in the CID
Selector lever may be faulty. 	Selector Lever is Faulty The journey can be continued. If necessary repeat gearshift request.
Reaction: One or more M GWS functions may be faulty.	
Action: Repeat driving program selection on the M GWS or use the gearshift paddles on the steering wheel. Check the M GWS using BMW Diagnostic Equipment.	

Invalid Bus Message

Check Control Message 419 may display:

- PT-CAN message, invalid engine torque.

Check Control Message 419	Information in the CID
Faulty drive 	Faulty Drive The journey can be continued. Reduced acceleration. Visit your nearest BMW Service Canter to check this.
Reaction: Clutch is not operating smoothly. Shifting between gears is not smooth.	
Action: Check vehicle by using BMW Diagnostic Equipment.	