Dual clutch transmission
7G-DCT
System description
System Description
7G-DCT Dual Clutch Transmission
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Questions and Suggestions
If you have any questions or suggestions concerning this product, please write to us.
E-mail: customer.support@daimler.com
Fax: +49-(0)1805/0 10-79 78
or alternatively
Address: Daimler AG
GSP/OIS
HPC R822, W002
D-70546 Stuttgart

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Dear Reader,

This system description presents the new 7G-DCT dual clutch transmission.

The purpose of this brochure is to acquaint you with the technical highlights of this new transmission in advance of its market launch. This brochure is intended to provide information for people employed in service or maintenance/repair as well as for aftersales staff. It is assumed here that the reader is already familiar with the Mercedes-Benz transmissions currently on the market.

In terms of the contents, the emphasis in this system description is on presenting new and modified components and systems.

This system description is not intended as an aid for repairs or for the diagnosis of technical problems. For such needs, more extensive information is available in the Workshop Information System (WIS) and Xentry Diagnostics.

WIS is updated continuously. Therefore, the information available there reflects the latest technical status of our vehicles.

The system description provides initial information about the new 7G-DCT dual clutch transmission. The system description is not stored in this form in WIS. The contents of this brochure are not updated. No provision is made for supplements.

We will publicize modifications and new features in the relevant WIS documents. The information presented in this system description may therefore differ from the more up-to-date information found in the WIS.

All information relating to technical data, equipment and options is valid as of the copy deadline in September 2011 and may therefore differ from the current production configuration.

Daimler AG
Technical Information
and Workshop Equipment (GSP/OI)
Introduction

The newly developed 7G-DCT dual clutch transmission is being introduced together with the launch of the new B-Class (model 246).

The dual clutch transmission with model designation 724.0 supersedes the "AUTOTRONIC" CVT transmission (Continuously Variable Transmission) used on the current B-Class.

During development of the dual clutch transmission, attention was paid to ensuring a compact design and to integrating all transmission-relevant hydraulic, mechanical and electrical components. In particular, the electrohydraulically operated park pawl is a new feature on front-wheel drive vehicles with dual clutch transmission.

The dual clutch transmission has seven forward gears and one reverse gear. Both clutch operation and gear changes take place on a fully automatic basis, providing the driver with shifting comfort and vehicle dynamics of the highest level.

An overview of the main features of the dual clutch transmission:

- Compact transmission housing
- A cooling module with integrated pressure oil filter located on the dual clutch transmission
- Two sub-transmissions, each with multidisk clutch
- Internal and hollow shaft, two output shafts (for design reasons, a reversing gear was not used for the reverse gear)
- A pinion differential integrated in the transmission housing
- Multi-cone synchronization (3 cones) for transferring high frictional forces during acceleration or during braking of the idler gears during gear changes (1st–3rd gear), dual-cone synchronization (4th–7th gear), single-cone synchronization (reverse gear)
- A wet, hydraulically operated dual clutch (designed as a clutch module, consisting of two individual clutches)

- A shared transmission oil circuit (hydraulic control and lubrication of gear set) with one mechanical and one integrated electric auxiliary oil pump
- A fully integrated electric transmission control system with control and shift valves, sensors and actuators
- Electrohydraulically operated park pawl with an electrically actuated engagement device

Advantages of the dual clutch transmission:

- Short shift times
- Dynamic driving and gearshifting
- Compact design
- Integration of all transmission-relevant hydraulic, mechanical and electrical components
- Maximum comfort through smooth shift operations
- High level of efficiency
Introduction

Overall system

7G-DCT dual clutch transmission

Sectional views of dual clutch transmission

1 Pinion differential
2 Transmission oil heat exchanger
3 Dual clutch
4 Hollow shaft
5 Internal shaft
6 Clutch housing
7 Pressure oil filter, in cooling module (integrated transmission oil heat exchanger)

8 Output shaft 1
9 Output shaft 2
10 Transmission housing
11 VGS connector
12 Fully integrated transmission control (VGS)
13 Park pawl system
14 Transmission oil pan
Overall system

7G-DCT dual clutch transmission

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**7G-DCT dual clutch transmission**

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**Overall system**
Input and output signals

Overall system

7G-DCT dual clutch transmission

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Function diagram

1. Shift fork position sensor, signal
2. Rpm sensor, signal
3. Park pawl lift solenoid, actuation
4. Park pawl switchover valve, actuation
5. Park pawl position sensor, signal
6. Clutch control valve, actuation
7. System pressure control valve, actuation
8. Gear cylinder pressure control valve, actuation
9. Clutch pressure sensor, signal
10. Gear control control valve, actuation
11. Electric auxiliary oil pump, actuation
12. Transmission cooling coolant circulation pump, actuation
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14. Service brake, status
15. Electric parking brake control unit, status
16. Instrument cluster, message
17. Warning and indicator lamp, request
18. Steering wheel gearshift button, status
19. DIRECT SELECT lever, status
20. Door rotary tumbler switch, status
21. Transmission mode button, status
22. Transmission cooling, request
23. Transmission control diagnosis, communication
24. Circuit 15, status
25. DAS [FBS] start enable, status

A1. Instrument cluster
B. Interior CAN
C. Drivetrain CAN
D. Diagnostic CAN
E. Chassis CAN
F5kO. Transmission cooling coolant circulation pump relay
B15. Battery sensor LIN
M13/7. Transmission cooling coolant circulation pump
M42. Electric auxiliary oil pump
N3/9. CDI control unit (with diesel engine)
N3/10. ME-SFI control unit (with gasoline engine)
N10. SAM control unit
N30/4. Electronic Stability Program control unit
N69/1. Left front door control unit
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N73. Electronic ignition lock control unit
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Y3/14b1. K1 clutch pressure sensor
Y3/14b2. K2 clutch pressure sensor
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Y3/14b1. Park pawl lift solenoid
Y3/14n1. Dual clutch transmission internal shaft rpm sensor
Y3/14n2. Dual clutch transmission hollow shaft rpm sensor
Y3/14n3. Engine speed sensor
Y3/14n4. Dual clutch transmission fully integrated transmission control unit
Y3/14s1. Shift fork 1 position sensor
Y3/14s2. Shift fork 2 position sensor
Y3/14s3. Shift fork 3 position sensor
Y3/14s4. Shift fork 4 position sensor
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Y3/14y1. Gear control control valve, 1st/5th gear
Y3/14y2. Gear control control valve, 2nd/4th gear
Y3/14y3. Gear control control valve, 3rd/7th gear
Y3/14y4. Gear control control valve, 6th/R gear
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Driver information

The control and display concept is designed so that the driver has the best possible overview of the current operating condition of all relevant systems at all times and receives all driving information regarding the gear, gear range and transmission mode selections.

Instrument cluster

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- A1: Instrument cluster
- A1e10: Parking brake indicator lamp
- A1e11: Parking brake warning lamp
- A1e58: Engine diagnosis indicator lamp
- A1p12: Gear indicator
- A1p13: Multifunction display
- A1p16: Transmission mode display

- D: Gear range D (Drive)
- E: Economy
- M: Manual
- N: Gear range N (Neutral)
- P: Gear range P (Park)
- R: Gear range R (reverse gear)
- S: Sport

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Driver information

Gear indicator

The driver receives information about the gear range currently engaged (P, R, N, D) via the gear indicator.

When transmission mode "M" is selected, the gear ranges "P", "R", "N" as well as gears "1–7" are displayed (instead of gear range "D").

Transmission mode display

The transmission mode display shows the driver the currently selected transmission mode – Sport "S", Economy "E" or Manual "M". The transmission modes can be selected in the upper control panel via the automatic transmission transmission mode button.

Multifunction display

Depending on the operational status of the dual clutch transmission, system faults may also be displayed in addition to messages about required driver actions.

In this case, the message "Service Required – No Gear Change" appears on the multifunction display. At the same time as the display message, an acoustic signal sounds in the form of a gong.

Possible causes of this may be:

- An interruption of the signal flow e.g. at the gateway or due to an open circuit
- A mechanical or hydraulic defect in one or more transmission components and/or a fault in the transmission control system
- A voltage drop or overvoltage
- Sensor fault

Note

The message "Service Required – No Gear Change" does not allow any conclusion to be drawn about the exact fault.

Depending on the particular fault, it may be the case that the vehicle can no longer be driven further after engaging gear range "P" or it may longer be possible to shift out of position "P".

In this case, the nearest Mercedes-Benz workshop should be contacted.
Limp-home mode

If individual components of the electric transmission control system fail, the transmission control unit switches to a limp-home program stored in the characteristics map. The primary purpose of this is to protect the components and give the driver the opportunity to drive to the nearest Mercedes-Benz workshop despite the failure. Depending on the particular fault, measures can be implemented by the engine control system to prevent damage or excessive stress on the dual clutch transmission e.g. reduction of torque.

If a shift-relevant component can no longer be actuated or operated, an entire sub-transmission will no longer be available due to the defective component. The driver is informed of this visually by the multifunction display and acoustically by a gong. Furthermore, the driver will experience a reduction in shift comfort and, depending on the particular malfunction, may no longer be able to engage reverse gear.

In general, limp-home mode can be broken down as follows:

- Transmission limp-home mode due to malfunction of a sub-transmission
- Transmission limp-home mode due to interrupted power flow
- Transmission limp-home mode due to transmission overtemperature
- Transmission limp-home mode due to defective park pawl system

Transmission limp-home mode due to malfunction of a sub-transmission

If a sub-transmission fails, the following gears are no longer available:

- Sub-transmission 1: Gears "1-3-5-7" and reverse gear "R", because 1st gear also has to be engaged for power transmission in reverse gear
- Sub-transmission 2: Gears "R-2-4-6"

Transmission limp-home mode due to interrupted power flow

If the power flow of both clutches fails, e.g. due to a system pressure drop in the dual clutch transmission or due to a defective actuation system/clutch operation system, the vehicle coasts without power transmission and no longer has any traction.

If the fault in question is a sporadic fault, the vehicle can be driven on without any limitations after the next ignition sequence (the transmission control unit must "go to sleep" with the ignition off and the fault status stored in the fault memory must change from "ACTIVE" to "STORED"). If the fault is still present, the vehicle can no longer be driven and the nearest Mercedes-Benz workshop must be contacted.

If a gear control control valve fails, one of the sub-transmissions will no longer be available depending on the defective/inoperative control valve. The vehicle can still be driven to the nearest Mercedes-Benz workshop.
Limp-home mode

Transmission limp-home mode due to transmission overtemperature

During driving operation, high transmission oil temperatures occur due to friction on the clutch plates and gear sets as well as due to the waste heat from the transmission control system. In particular, high levels of waste heat are produced by the two clutches during operation and this is absorbed by the transmission oil.

If the transmission oil temperature exceeds a predefined threshold value, e.g. due to repeated starting off on uphill slopes at high outside temperatures, the engine control system reduces the engine power in accordance with the transmission oil temperature until it falls back below the threshold value. In addition, transmission mode selection "M" and manual intervention via the steering wheel gearshift buttons in transmission modes "E" and "S" (temporary transmission mode "M") is disabled for this period of time.

If the transmission cooling system fails, e.g. due to interruption of the coolant flow via the transmission oil heat exchanger, it is possible to continue driving to the nearest Mercedes-Benz workshop up to a defined threshold value. In this case, high loads should be avoided e.g. a dynamic driving style.

Transmission limp-home mode due to defective park pawl system

During normal operation, the park pawl prevents the vehicle from moving off by itself when the DIRECT LEVER is in position "P". If the park pawl cannot be engaged, e.g. due to missing/incorrect actuation of the park pawl switchover valve or park pawl lift solenoid, the driver has the option of securing the vehicle against rolling away activating the electric parking brake (EFB). If this is also faulty, the driver is informed of this by indicator/warning lamps on the instrument cluster and also by a message on the multifunction display. In this case, the driver must expect that the vehicle is not secured against rolling way.
Transfer of torque

The engine torque is transferred from the crankshaft of the combustion engine to the two-mass flywheel and on to the internal shaft or hollow shaft of the dual clutch transmission depending on whether clutch K1 or K2 is engaged. The dual clutch acts as an interface between the combustion engine and transmission and allows uninterrupted torque transfer during shift operations.

The odd gears 1, 3, 5 and 7 are engaged via clutch K1, the even gears 2, 4 and 6 as well as reverse gear are engaged via clutch K2. Transfer of the drive torques from the clutches to the internal or hollow shaft takes place via the positive connection of the toothed profiles. The drive forces are transferred depending on the requested gear to output shafts 1 and 2 and on to the pinion differential via gear connections which can be engaged via the hydraulically operated internal shift mechanism.

Note
All gears which are splined together with the respective shafts without the synchronizer engaged are designated fixed gears.
Power transmission/power flow

View of the gear set

1 Internal shaft
2 Hollow shaft
3 Output shaft 1
4 Output shaft 2
5 7th gear idler gear
6 3rd gear idler gear
7 Reverse gear idler gear
8 6th gear idler gear
9 Output shaft fixed gear 2
10 Internal shaft fixed gear (5th gear/7th gear)
11 Internal shaft fixed gear (3rd gear)
12 Internal shaft fixed gear (1st gear)
13 Hollow shaft fixed gear (2nd gear/reverse gear)
14 Hollow shaft fixed gear (4th gear/6th gear)
15 5th gear idler gear
16 1st gear idler gear
17 2nd gear idler gear
18 4th gear idler gear
19 Output shaft fixed gear 1
20 Spur gear (pinion differential)
22 Sliding sleeve (3rd gear/7th gear)
23 Sliding sleeve (reverse gear)
24 Sliding sleeve (1st gear/5th gear)

A Engine torque
The power flows of 1st gear and reverse gear are shown by way of example.

Power flow in 1st gear

1 Internal shaft
3 Output shaft 1
12 Internal shaft fixed gear (1st gear)
16 1st gear idler gear
19 Output shaft fixed gear 1
20 Spur gear (pinion differential)
21 Left and right drive shaft
24 Sliding sleeve (1st gear/5th gear)

A Engine torque

The following clutch/shift fork is engaged/actuated in order to provide power flow in 1st gear:

• K1 clutch (outer clutch)
• Shift fork (1st gear/5th gear)

Note

Output shaft fixed gears 1 and 2 are rigidly connected to the respective output shafts. The gears of gears 1–7 and reverse gear are idler gears which can be braked by synchronization devices and positively connected to the respective output shaft.

Note

The power flow via the individual components of the dual clutch transmission is symbolized by the red arrows. The list of the components is in numerical order and illustrates the position of the respective component on the gear set in combination with the picture "Views of gear seat" on page 18.
A reversing gear has not been used for the reverse gear. This reduces weight and friction as well as internal operating noises.

Power flow in reverse gear

1. Internal shaft
2. Hollow shaft
3. Output shaft 1
4. Output shaft 2
6. 3rd gear idler gear
7. Reverse gear idler gear
11. Internal shaft fixed gear (3rd gear)
12. Internal shaft fixed gear (1st gear)
13. Hollow shaft fixed gear (2nd gear/reverse gear)
16. 1st gear idler gear
17. 2nd gear idler gear
19. Output shaft fixed gear 1
20. Spur gear (pinion differential)
21. Left and right drive shaft
23. Sliding sleeve (reverse gear)
24. Sliding sleeve (1st gear/5th gear)

A  Engine torque

The following clutches/shift forks are engaged/actuated to provide power flow in reverse gear:

- K2 clutch (inner clutch)
- Shift fork (1st gear/5th gear)
- Dual shift fork (6th gear/reverse gear)

**Note**

More information about power flow in the individual gears can be found in the Workshop Information System (WIS).
Electrohydraulic control system

Task of transmission controller unit
The transmission controller unit is connected to the CAN network of the vehicle and evaluates the incoming signals and requests from other control units, actuating the internal actuators accordingly depending on this information. It also evaluates the signals of the sensor system and forwards them to the associated control units.

The transmission control unit actuates the following actuators and/or performs the following functions depending on the sensor and CAN input signals:
- Shift and control solenoid valves
- Electric auxiliary oil pump
- Hydraulic park pawl actuation
- Electric park pawl release
- Actuation of clutches

Special features of transmission controller unit
The dual clutch transmission was conceived as a compact transmission unit for transverse installation. Particular attention was paid to ensuring that all components which are involved in the gearshift, lubrication and control processes are integrated in the transmission.

The special features of the transmission controller unit are:
- The integrated electric auxiliary oil pump
- All shift and control solenoid valves are located on the transmission controller unit
- The entire sensor system (consisting of rpm, temperature, pressure and position sensors) is part of the controller unit
- The transmission control unit is integrated in the transmission controller unit
Electrohydraulic control system

Subsystems

Dual clutch transmission fully integrated transmission control controller unit

30a Supporting body

A Electrical connector

Y3/14 Dual clutch transmission fully integrated transmission controller unit

Y3/14n4 Dual clutch transmission fully integrated transmission control unit
Task of shift mechanism

The task of the shift mechanism on vehicles with dual clutch transmission is to engage the individual gears as quickly and comfortably as possible without the driver noticing an interruption of tractive power or other disturbances due to the shift operation.

In general, the shift operation function sequence can be divided into four areas:

• Shift actuation and transmission mode change by driver
• Electrohydraulic control
• Clutch operation
• Operation of internal shift mechanism

View of vehicle interior

S16/12  Automatic transmission transmission mode button
S16/13  DIRECT SELECT lever
S110/1  Steering wheel downshift button
S111/1  Steering wheel upshift button
Shift mechanism

Shift actuation and transmission mode change by driver

The driver can influence shift operations via the following controls:

- DIRECT SELECT lever (located on side of steering column tube module)
- Steering wheel gearshift buttons (located on left and right on rear of steering wheel)
- Automatic transmission transmission mode button

DIRECT SELECT lever

The DIRECT SELECT lever can be used to engage positions "P" (Park) and "N" (Neutral) as well as the travel directions "D" (Drive, forward travel) and "R" (reverse gear).

Steering wheel gearshift buttons

The steering wheel gearshift buttons located on the rear of the multifunction steering wheel allow a certain gear (1st–7th gear) to be manually selected in transmission mode "M". The driver is also able to manually intervene in the shift operations any time in transmission modes "E" and "S" (temporary transmission mode "M"). However, if no more buttons are pressed within a certain period of time, the transmission control system reverts to automatic mode (during downhill driving or when driving on twisty roads, this time period is extended according to the circumstances).

Automatic transmission transmission mode button

By pressing the automatic transmission transmission mode button on the upper control panel, the driver can choose whether shift operations take place automatically (transmission mode "E" and "S") or whether he/she wants to select the gears manually via the steering wheel gearshift buttons (transmission mode "M"). In transmission mode "E" or "S", the shift range is adjusted. Accordingly, transmission mode "E" produces a driving style oriented towards low rpms and fuel economy, while transmission mode "S" provides a more responsive and sporty driving style.

Note

During downshifting, the double-clutching function has the task of supporting the synchronization operations in the dual clutch and matching the engine speed to the target rpm of the next gear.

The double-clutching function provides quicker gear changes with less reaction torque.
Electrohydraulic control system

The task of the electrohydraulic control system (transmission controller unit with transmission control unit) is to receive and evaluate incoming electrical signals and actuate the control/switchover valves of the transmission controller unit accordingly. Via the control/switchover valves and the downstream control/shift valves (integrated in the shift valve body), the hydraulic flow to the respective gear actuator cylinders, the clutches and the park pawl system is enabled in order to initiate the gear (range) change.

Exploded view of dual clutch transmission fully integrated transmission controller unit

- 30a Supporting body
- 30b Valve housing
- 30c Intermediate panel
- 30d Shift valve body
- M42 Electric auxiliary oil pump
- Y3/14y1 Shift rod control valve A
- Y3/14y2 Shift rod control valve B
- Y3/14y3 Shift rod control valve C
- Y3/14y4 Shift rod control valve D
- Y3/14y5 Park pawl switchover valve
- Y3/14y6 System pressure control valve
- Y3/14y7 K1 clutch control valve
- Y3/14y8 K2 clutch control valve
- Y3/14y9 Gear cylinder pressure control valve
Shift mechanism

Clutch operation

Operation of the dual clutch is not performed by a mechanical or hydraulic release device (central clutch release bearing, clutch release fork) as on "conventional" manual transmissions, but takes place on an entirely electrohydraulic basis.

In order to transfer the drive torque of the combustion engine to the internal or hollow shaft and then on to the respective sub-transmission, one of the clutch packs first has to be frictionally connected via the application of hydraulic pressure.

The hydraulic pressure is controlled by the transmission control unit via two control valves:

- Clutch K1 control valve
- Clutch K2 control valve

Depending on the gear being engaged, the hydraulic flow passes via a shift valve connected in series and on to the clutch hub and then to the corresponding pressure chambers of the clutch packs via a rotary connection.

Furthermore, part of the pump flow is used to reduce the contact pressure of the clutch plates (dynamic pressure buildup, due to centrifugal forces at high rpms) and for clutch cooling.

Operation of internal shift mechanism

The internal shift mechanism includes all components within the transmission housing which are involved in the actual shift operation or ensure a splined connection of the idler gears with the respective output shaft.

This includes:

- The gear actuator cylinders
- The shift forks
- The synchronization devices

In order to engage a gear, pressure is built up or released in the respective gear actuator cylinder so that the sliding sleeve of the synchronization device is moved by the shift fork. The shift fork is guided onto the shift rod and engages in the sliding sleeve. It moves the sliding sleeve in an axial direction and thus balances the rpm between the idler gear and output shaft so that the gear is engaged.

Permanent magnets are attached to the shift forks via U-shaped brackets. The brackets transfer the axial movements of the shift forks during shift operations.

Based on the position of the permanent magnets, the transmission control unit can indirectly determine the position of the corresponding shift fork.
Sectional view of internal shift operation

1  Permanent magnet  
2  Gear actuator cylinder  
3  Shift fork  
4  Sliding sleeve of synchronization device  
5  Oil pipe  
6  Shift rod  
7  Output shaft 2  

Y3/14s3  Shift fork 3 position sensor
Oil supply/oil cooling system

Oil supply

Oil supply, lubrication and cooling of the dual clutch transmission are carried out by two independently operating transmission oil pumps as well as by splash oil lubrication via the oil bath which the gears rotate in.

The following components of the dual clutch transmission depend on a constant oil supply during driving operation:

- Electrohydraulic transmission control system including all actuators and sensors
- Gear sets and shafts as well as all moving components of the dual clutch transmission
- Dual clutch
- Shift operation system

Generally, a distinction can be made between the following types of oil supply:

- Oil supply by splash oil lubrication
- Oil supply by the primary pump (vane-type pump)
- Oil supply by the electric auxiliary oil pump

Splash oil lubrication

The gear sets of the dual clutch transmission rotate in an oil bath and the transmission oil is splashed up from here and passed onto the engaged fixed or idler gears. The transmission oil which splashes up performs the majority of the gear set and bearing lubrication.

Primary pump (vane-type pump)

With the combustion engine running, the primary pump delivers oil to the electrohydraulically actuated dual clutch transmission. The primary pump is driven by a gear pair, whereby the driving gear is permanently connected to the dual clutch. The driven gear is bolted to the primary pump, which is located in the transmission housing behind the dual clutch.

Note

The pump pressure regulated by the primary pump ranges from 3.5 bar to 22 bar and depends on the actuation by the transmission control unit.
Electric auxiliary oil pump

The electric auxiliary oil pump is located centrally on the transmission controller unit and is connected to the transmission control unit via an electrical connection.

The main task of the electric auxiliary oil pump is to support the primary pump in the following operating conditions:
- At low rpms
- During start/stop operation
- At high transmission oil temperatures (support for clutch cooling)

The transmission control unit actuates the electric auxiliary oil pump at low combustion engine speeds (coast down shifting and upshifting, clutch operation). This is carried out in order to compensate for the resulting low delivery rate of the primary pump and to ensure a constant oil pressure as well as optimal cooling and lubrication of the transmission components.

In start/stop mode with the combustion engine off, all actuators return to their basic state under no load which means that no gear changes can be made and the dual clutch can no longer be actuated. In order to minimize the resulting delay between a start-off request and the start-off time, the electric auxiliary oil pump provides the required oil pressure before the actual start-off process. In certain driving conditions (e.g. frequent start-off on uphill slopes or when driving with a trailer), the clutch needs to be cooled by an increased oil flow. The transmission control unit determines whether this is necessary based on the transmission oil temperature at the clutch plates. The increase in flow is also achieved by activating the electric auxiliary oil pump.

Note

The delivery pressure of the electric auxiliary oil pump ranges from 0 bar to 8 bar and depends on the actuation by the transmission control unit.
Oil supply/oil cooling system

Oil cooling

The task of the transmission cooling system is to maintain the transmission oil temperature at an optimal level and protect both the mechanical and electrical components of the dual clutch transmission from damage due to overheating.

A major component of the transmission cooling system is the transmission oil heat exchanger. This makes up the cooling module together with the pressure oil filter. The transmission oil heat exchanger is designed as a stacked plate cooler and is located on the top of the transmission housing. It acts as an interface between the coolant and transmission oil circuit. A regulated flow of coolant is pumped from the cooler through the transmission oil heat exchanger by the transmission cooling coolant circulation pump depending on the transmission oil temperature. This coolant flow absorbs the waste heat of the heated transmission oil and passes it on to the coolant circuit.

Transmission oil heat exchanger

4 Transmission oil heat exchanger
A Coolant feed from transmission cooling coolant circulation pump
B Return flow to coolant circuit

Note

Further information about the oil cooling system can be found in the GF documentation in the Workshop Information System (WIS).
Oil supply/oil cooling system

System components

Coolant circuit, schematically illustrated on engine 270

1 Radiator
2 Coolant expansion reservoir
3 Transmission oil heat exchanger
4 Turbocharger
5 Coolant pump
6 Engine 270
7 Engine oil/coolant heat exchanger
8 Thermostat
9 Heater heat exchanger

M13/5 Coolant circulation pump (with code (581)
M13/7 Transmission cooling coolant circulation pump
A Low-temperature cooling circuit coolant return
B Coolant return to engine
C Coolant feed
D Coolant circuit ventilation

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Dual clutch

**Principle of the dual clutch**

Instead of a conventional clutch with mechanical or hydraulic release mechanism like those usually installed on vehicles with manual transmissions, a dual clutch transmission uses a clutch module with two combined multidisk clutches which are electrohydraulically actuated on alternating basis. Each multidisk clutch is coupled to a sub-transmission. Sub-transmission 1 (K1 clutch engaged) contains the odd forward gears 1, 3, 5 and 7. Sub-transmission 2 (K2 clutch engaged) contains the even forward gears 2, 4, 6 and reverse gear.

During driving operation and with the exception of reverse gear, only one gear of a sub-transmission is ever engaged, while the next expected gear is pre-engaged by the transmission control system (associated clutch still open, no power transmission takes place).

Due to the high thermal load which arises when starting off in gear range "D" because of the frictional energy at the clutch plates, K1 clutch is located above K2 clutch. Due to this design measure, the friction surface of K1 clutch is correspondingly higher than that of K2 clutch, which reduces the specific thermal load.

Starting off in gear range "R" is carried out via K2 clutch. This also results in high friction values and thus high temperatures at the clutch plates, but the effect of this is limited by the fact that the vehicle starts off less frequently in reverse gear.

The main advantages achieved through these design features and functional characteristics include improved vehicle dynamics, greater comfort through jolt-free shifting, high efficiency and almost uninterrupted power transmission.
Dual clutch

1 Internal shaft
2 Hollow shaft
3 K1 clutch external plates
4 K1 clutch internal plates
5 K2 clutch external plates
6 K2 clutch internal plates
7 K1 clutch external plate carrier
8 K1 clutch internal plate carrier
9 K2 clutch external plate carrier
10 K2 clutch internal plate carrier
Park pawl

On the dual clutch transmission, the park pawl is no longer engaged by the driver via a mechanical cable connection/linkage but is instead actuated electrohydraulically by the transmission control unit.

The park pawl system (park-by-wire) consists of the following components:

- The DIRECT SELECT lever
- The transmission controller unit with integrated transmission control unit and electrohydraulic park pawl switchover valve
- The park pawl lift solenoid
- The park pawl position sensor
- The parking lock mechanism

---

Park pawl

24 Park pawl gear
81 Park detent
82 Piston
83 Piston spring
84 Pressure cone spring
85 Pressure cone
86 Pull rod
87 Permanent magnet
88 Coil spring

Y3/14 Dual clutch transmission fully integrated transmission controller unit
Y3/14s5 Park pawl position sensor
Y3/14i1 Park pawl lift solenoid
The park pawl is engaged or released either through actuation of the P button on the DIRECT SELECT lever or depending on various factors such as opening of the driver door with the engine running (fully automatic engagement of park pawl). All components of the park pawl system, except the DIRECT SELECT lever, are integrated in the dual clutch transmission. In general, a distinction is made between the operating conditions

- Park pawl position "P" and
- Park pawl position "Not P"

**Park pawl position "P"**

In park pawl position "P", the vehicle is secured against the possibility of rolling away by the park pawl.

In this state, the park detent blocks the park pawl gear. The park detent is held in the teeth of the park pawl gear by the exterior contour of the spring-loaded pressure cone.

A locking pin locks the piston in place, which provides the preload on the pressure cone via the pressure cone spring. The locking pin system also safeguards park pawl position "P" even if there is no hydraulic actuation pressure.

**Park pawl position "Not P"**

In park pawl position "Not P", the pressure cone and the park detent are in the basic position and the park pawl gear can rotate freely. The piston is pushed against the spring force of the piston spring and is locked in place by the locking pin, which is actuated by the park pawl lift solenoid.

**Note**

The park pawl positions "P" and "Not P" are recorded by the park pawl position sensor by the permanent magnet attached to the piston and this information is transferred to the transmission control unit.
Park pawl

Condition change between "P" and "Not P"

In order to change the park pawl position, the transmission control unit actuates the lift solenoid which presses the locking pin out of the catch of the piston.

The piston is then pressurized on one side with hydraulic pressure in accordance with the required actuation direction, "P" or "Not P". The transmission control unit energizes the park pawl switchover valve and thus enables the hydraulic flow to the corresponding pressure chamber for piston actuation.

Note:

If the power supply or hydraulic pressure control system fails, the park pawl lift solenoid can be energized via an external power supply to release the park pawl piston in order to engage the park pawl via the piston spring. It is not possible to release the park pawl without hydraulic pressure.
Gear set
Due to the location of the shafts and the compact gear set, it was possible to keep the dimensions of the transmission housing small, both in terms of height and width. Despite the small installation space, seven forward gears and one reverse gear are provided.
The following components form part of the gear set:

- Internal shaft with three fixed gears and one sensor rotor
- Hollow shaft mounted on a needle roller bearing with two fixed gears and one sensor rotor
- Two output shafts with idler gears and synchronizers, each with a fixed gear, one park pawl gear (output shaft 1 only)
- Pinion differential with spur gear

Torque transfer takes place on alternating basis via K1 clutch (outer multidisk clutch) and K2 clutch (inner multidisk clutch).

A "sub-transmission" is assigned to each clutch.

On sub-transmission 1 (gears 1, 3, 5 and 7) power flow takes place via the corresponding fixed gear of the internal shaft to the associated output shaft idler gears, and on sub-transmission 2 (gears 2, 4, 6 and reverse gear) via the fixed gear of the hollow shaft to the associated output shaft idler gears.

During driving operation, only one "sub-transmission" is ever transmitting power.

---

**Note**

All gears which are splined together with the respective shafts without the synchronizer engaged are designated fixed gears.

The gears of gears 1–7 and reverse gear are idler gears which can be braked by synchronization devices and positively connected to the respective output shaft.
Synchronization

Synchronization refers to the equalization of rotational speed and positive connection between the output shaft and respective idler gear.

Frequent shift operations with short shift times in combination with reduced shift force require an effective synchronization system.

Sectional view of output shaft 1

15 5th gear idler gear
16 1st gear idler gear
17 2nd gear idler gear
18 4th gear idler gear
19 Output shaft fixed gear 1
22 Sliding sleeve
24 Park pawl gear
70 Cone ring (1st gear)
71 Synchronizer ring (1st gear)
72 Synchronizer body with thrust piece (1st gear/5th gear)
73 Friction ring with friction lining (1st gear)
74 Needle roller bearing
75 Cone ring (4th gear)
76 Friction ring (4th gear)
77 Synchronizer ring (4th gear)
78 Synchronizer body with thrust piece (2nd gear/4th gear)
A Tapered roller bearing
Synchronization

Generally, a distinction is made between the following synchronization types:

- Multiple-cone synchronization (1st to 3rd gear)
- Dual-cone synchronization (4th to 7th gear)
- Single-cone synchronization (reverse gear)

Multiple-cone synchronization (3 cones, 1st to 3rd gear)

A multiple-cone synchronizer is used to synchronize the 1st, 2nd and 3rd gear. The most important components of this are an additional cone ring between the friction ring and synchronizer ring and a friction lining on the friction ring. The three friction surfaces of the cone and friction ring are added together and allow the gears to be braked or accelerated more quickly and with less force on a multiple-cone synchronizer.

Dual-cone synchronization (4th to 7th gear)

A dual-cone synchronizer is used to synchronize the 4th, 5th, 6th and 7th gear.

Single-cone synchronization (reverse gear)

A single-cone synchronizer is used to synchronize reverse gear.
Deployment of 7-speed automatic dual clutch transmission

With the end of the AUTOTRONIC transmission (CVT) and introduction of the 7-speed automatic dual clutch transmission, the oil and filter change intervals change from once at 60,000 km (previously) to every 100,000 km/5 years (new).

Replacement of the pressure oil and intake oil filter is included in the scope of the change.

7-speed automatic dual clutch transmission

A Pressure oil filter
B Intake oil filter
## Special tools

### Assembly sleeve

<table>
<thead>
<tr>
<th>Use</th>
<th>Assembly sleeve for installing clutch cover.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB number</td>
<td>W724 589 00 14 00</td>
</tr>
<tr>
<td>FG</td>
<td>27</td>
</tr>
<tr>
<td>Set</td>
<td>C</td>
</tr>
<tr>
<td>Category</td>
<td>Mercedes-Benz Passenger Car Special Operations</td>
</tr>
</tbody>
</table>

### Assembly tool

<table>
<thead>
<tr>
<th>Use</th>
<th>Assembly tool for assembling/disassembling dual clutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB number</td>
<td>W724 589 00 31 00</td>
</tr>
<tr>
<td>FG</td>
<td>27</td>
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<tr>
<td>Set</td>
<td>B</td>
</tr>
<tr>
<td>Category</td>
<td>Mercedes-Benz Passenger Car Special Operations</td>
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</tbody>
</table>

Note

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### Assembly device

<table>
<thead>
<tr>
<th><strong>Use</strong></th>
<th>Assembly device for holding, disassembling and assembling transmission.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MB number</strong></td>
<td>W724 589 00 40 00</td>
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<td><strong>FG</strong></td>
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<td><strong>Set</strong></td>
<td>C</td>
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<td><strong>Category</strong></td>
<td>Mercedes-Benz Passenger Car Special Operations</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>In combination with passenger car engine assembly stand (see GOTIS chapter A, design group 01, topic 15.0).</td>
</tr>
</tbody>
</table>

### Support

<table>
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<th><strong>Use</strong></th>
<th>Support for measuring play between clutch cover and needle roller bearing on dual clutch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MB number</strong></td>
<td>W724 589 01 31 00</td>
</tr>
<tr>
<td><strong>FG</strong></td>
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<td><strong>Set</strong></td>
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<td>Mercedes-Benz Passenger Car Special Operations</td>
</tr>
<tr>
<td><strong>Note</strong></td>
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</tbody>
</table>

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Questions about the dual clutch transmission

What are the main advantages of a dual clutch transmission compared to a conventional automatic transmission/manual transmission?

- The main advantages perceived by the driver include the smooth power transmission and the resulting increase in comfort. Furthermore, the short shift times and lack of any interruption in power transmission provide a sporty and dynamic driving feel.

In terms of its technology, the new dual clutch transmission impresses through its compact design, high efficiency, large gear ratio spread and through the integration of the electrohydraulic control system in the transmission.

How is the park pawl engaged?

- The park pawl is completely integrated in the transmission housing and is actuated purely by electrohydraulic/electrical means via the transmission control unit.

How is a sufficient oil supply for lubricating and cooling the mechanical and electrical transmission components provided?

- Generally, a distinction is made between three different types of oil supply:
  1. Oil supply by splash oil lubrication
  2. Oil supply by the primary pump
  3. Oil supply by the electric auxiliary oil pump

The splash oil lubrication serves primarily to lubricate the gear sets. The primary pump and electric auxiliary oil pump provide the hydraulic oil pressure for controlling the actuators, the park pawl and the dual clutch. The electric auxiliary oil pump allows the start/stop function to be used and additionally supports the primary pump e.g. at low engine speeds.
Questions about the dual clutch transmission

What happens, for example, if system components of the transmission control system fail or in the event of defects in the shift actuators, park pawl system or dual clutch?

- Depending on the fault in question, then transmission control unit switches to a limp-home mode. Depending on the circumstances, it may be possible to continue driving to the nearest Mercedes-Benz workshop.

Is there a mechanical connection between the steering wheel gearshift buttons or DIRECT SELECT lever to the transmission?

- No, gear (range) selection takes place on a solely electric basis without a mechanical connection.

What are the most important design-related differences between a dual clutch transmission and a continuously variable automatic transmission?

- A dual clutch transmission consists, in principle, of two fully synchronized sub-transmissions. A clutch is assigned to each sub-transmission, which transfers the torque of the combustion engine to the internal or hollow shaft depending on the gear engaged. On a continuously variable automatic transmission, in contrast to a dual clutch transmission, a torque converter or a wet clutch (on AMG vehicles) is installed. Another major distinguishing feature is the shift operation. On a dual clutch transmission, the individual gears are engaged using synchronization devices. These make a splined connection between the idler gear and output shaft or between two idler gears (3rd gear idler gear/reverse gear idler gear). Gear selection on a continuously variable automatic transmission does not take place by engaging idler gears, but by driving or braking/coupling individual planetary gear set components.
Abbreviations

CAN
Controller Area Network

CVT
Continuously Variable Transmission

D
Gear range D

E
Economy transmission mode

EFB
Electronic parking brake

LIN
Local Interconnect Network

M
Manual transmission mode

N
Neutral gear range

P
Park gear range

R
Reverse gear range

S
Sport transmission mode

VGS
Fully integrated transmission control

WIS
Workshop Information System
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Dual clutch transmission
7G-DCT
System description