# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

The 9G-TRONIC/725.011 automatic transmission is a completely new electronically controlled transmission using a multi-disc centrifugal pendulum torque converter. The transmission has one reverse gear and a 9.150 ratio spread through 9 forward gears. The ratios for gear changes are implemented by 3 multi-disc brake clutch assemblies, 3 multi-disc driving clutch assemblies and 4 planetary gear sets.

The 9G-Tronic 725.011 has a W9A 700 designation. It made its first appearance as the 722.011 in the E350 BlueTEC launched in September of 2013. Model designations 212.026 and 212.226 with an OM 642.852 Engine (6 cylinder, 24 valve diesel, DOHC with direct injection).

The transmission is fitted with both an off-axis hydraulic pump and an electronic pump. The electronic pump allows for start/stop technology as a fuel saving feature. The electric pump is also used to support working pressure, cooling, lubrication and the emergency engaging and release of the park pawl.

As with its predecessor (the 7G-Tronic Plus/722.9), the TCM is part of the valve body assembly. The fully integrated transmission control controller unit is connected to the CAN network receiving vehicle data it needs to control the transmission. Integrated into this controller unit is the electrical pump, three RPM sensors (Hall type), a Parking Pawl sensor, nine solenoids, temperature sensor, pressure and position sensor.

Following the trend seen with ZF transmissions, the 9G-Tronic has transmission filters incorporated into the pan. One filter is for the hydraulic pump while the other is for the electric pump. According to Mercedes, the oil change interval as per NAT2FE+ is every 125,000 km/5 years. The transmission fluid is yellow/gold in color and takes approximately 10 Liters to fill it up.

Transmission mode selection is done electronically through the "Direct Select" lever. Economy and Sport Modes are available by a push of the button. AMG sport packages provides a Manual mode "M" for manual tip up and tip down shift control via steering wheel buttons.

A cooler bypass valve is used and is typically located along side the cooler. When fluid temperature is below 70° C, the bypass valve will return the fluid back to the transmission without is passing through the cooler. As the temperature rises above 70° C, the valve begins to open. Once fluid temperature becomes greater than 90° C, the bypass valve forces all the fluid to pass through the cooler before returning to the transmission.

Limp-Home Mode and Emergency-P:

In order to guarantee a safe driving state and to prevent damage to the transmission, the fully integrated transmission control unit switches to limp-in mode if critical faults occur. With solenoid faults, the affected gear is blocked and no longer actuated.

Systems are also in place to get the transmission out of park when a malfunction takes place as well as keeping the transmission in the Park position when a malfunction occurs. The default action is determined by the malfunction at hand.

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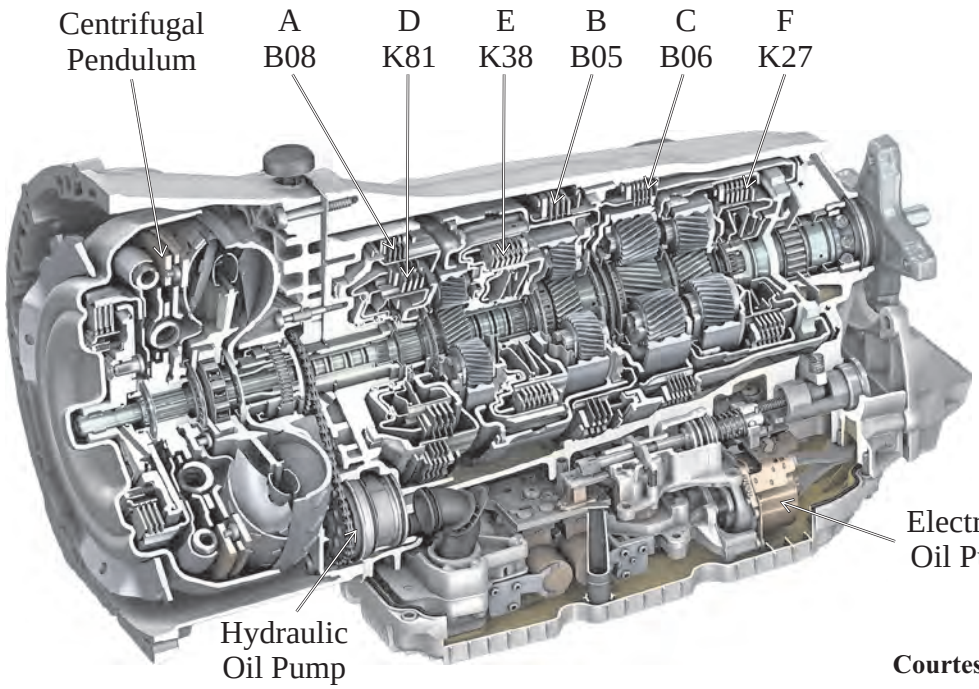


Courtesy of Daimler AG

| | A (B08) | B (B05) | C (B06) | D (K81) | E (K38) | F (K27) | RATIO |
|---|---|---|---|---|---|---|---|
| Neutral "N" | | • | • | | | | |
| Reverse Gear | • | • | • | | | | 4.932 |
| 1st Gear | | • | • | | • | | 5.503 |
| 2nd Gear | | | • | • | • | | 3.333 |
| 3rd Gear | | • | • | • | | | 2.315 |
| 4th Gear | | • | • | | | • | 1.661 |
| 5th Gear | | • | | • | | • | 1.211 |
| 6th Gear | | | | • | • | • | 1.000 |
| 7th Gear | | • | | | • | • | 0.865 |
| 8th Gear | • | | | | • | • | 0.717 |
| 9th Gear | • | • | | | | • | 0.601 |

Figure 1

The 725.011 transmission is able to skip gears. It is possible to shift from 9th gear directly into 4th gear. In this example only brake clutch A-B08 is switch off and brake C-B06 is turned on. In other words, the skip shift technology is confined to only one element being released and one being applied. As a result, faster and more direct shift operations are possible.

The torque converter clutch is engaged in all gears depending on the output speed, engine load and further parameters such as temperature and air pressure. To minimize torsional vibration caused by the combustion engine, additional damping elements and vibration-reducing measures are taken through the use of a torsional damper as well as a centrifugal pendulum inside the converter.

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Figure 2

**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.

**Gear indicator in instrument cluster in Economy transmission mode "E" and Sport transmission mode "S"**
This shows the driver the gear currently engaged automatically "D1" to "D9" or the other selector lever positions "R", "N", "P" (selector lever position "D" only if "R", "N" or "P" is engaged).

**Gear indicator in instrument cluster in Manual transmission mode "M"**
This shows the driver the gear engaged manually "1" to "9" or the other selector lever positions "R", "N", "P".

**Transmission mode display in instrument cluster**
This shows the driver the mode selected on the automatic transmission mode button:

- Economy "E"
- Manual "M"
- Sport "S"

The following selector lever positions are recorded via the DIRECT SELECT lever:

- "R", reverse gear
- "N", neutral and start position (no power transmission, vehicle can move freely)
- "D1 to D9", all 9 forward gears are available

In order to switch from one selector lever position to another, the DIRECT SELECT lever must be pressed over the actuation point (greater level of force required).

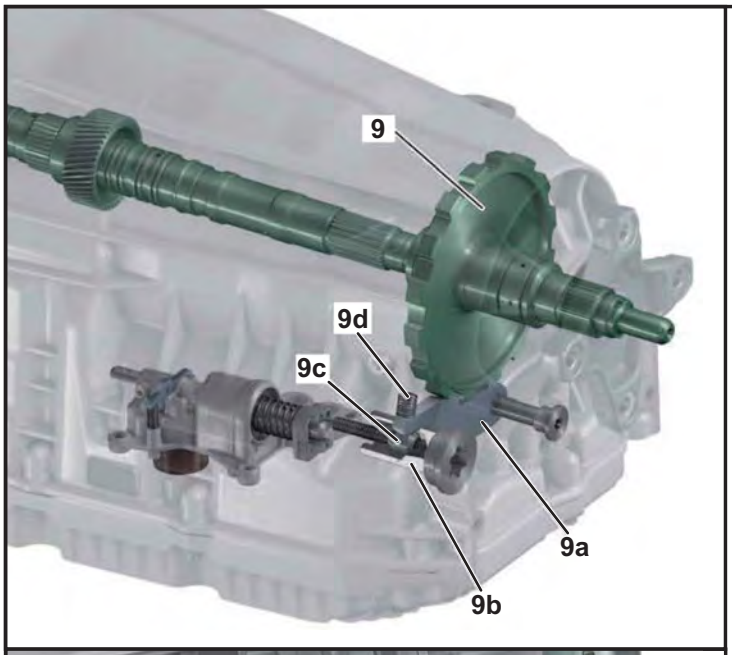
Actuating the park pawl on the DIRECT SELECT lever activates the park pawl at a vehicle speed of< 8 km/h.

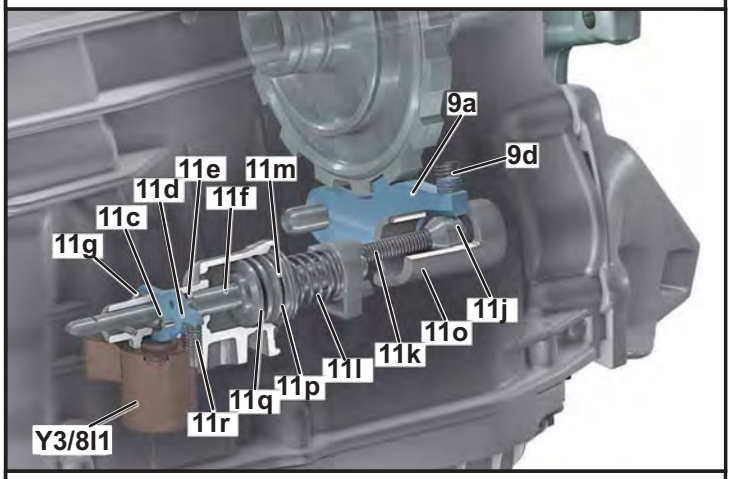
**Park pawl**
The park pawl gear, the electro-hydraulic components and park pawl mechanism are located in the rear part of the transmission housing. Their task is to secure the vehicle mechanically, in addition to the parking brake, in order to prevent it from rolling away.

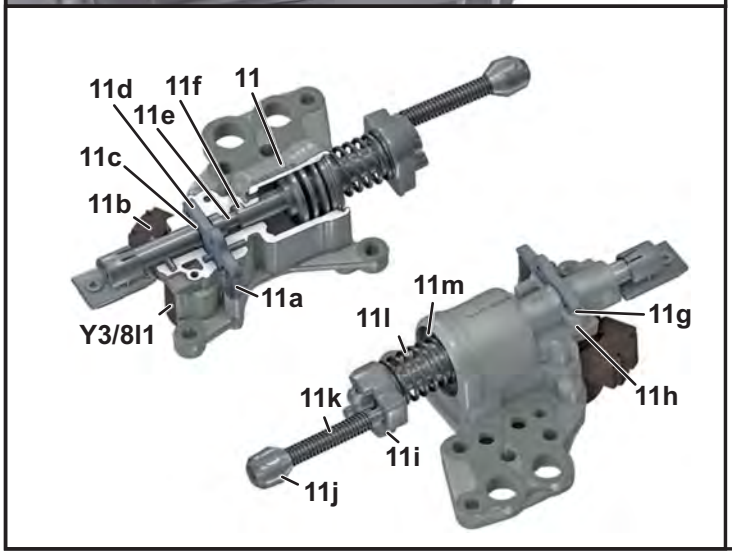
In selector lever position "P", the park pawl cone moves between the park detent and pilot bushing. As a result the park detent is pressed against the park pawl gear. If the tooth of the park detent does not engage in a tooth space when the vehicle is stationary, but rather touches a tooth of the park pawl gear, the park pawl cone is pre-tensioned by the spring behind the park pawl cone and positioned ready for operation.

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION




When the park pawl gear turns further, the park detent engages in the next tooth gap. To prevent damage due to incorrect operation, the intervals between the tooth gaps are such that the park detent can only engage when the vehicle is stationary or crawling at low speed. If the vehicle moves faster, the park detent is deflected by the oblique surfaces of the teeth and cannot engage. The part detent spring keeps the park detent away from the park pawl gear in gear ranges "R", "N", "D1 to D9".

**Park pawl control**

There is no mechanical connection whatsoever between the park pawl components of the transmission and the DIRECT SELECT lever (park-by-wire). The park pawl is engaged and disengaged purely by electro-hydraulic means, either through actuation of the DIRECT SELECT lever or depending on various factors such as opening of the driver door, the drivetrain entering an operational status or removal of the ignition key.

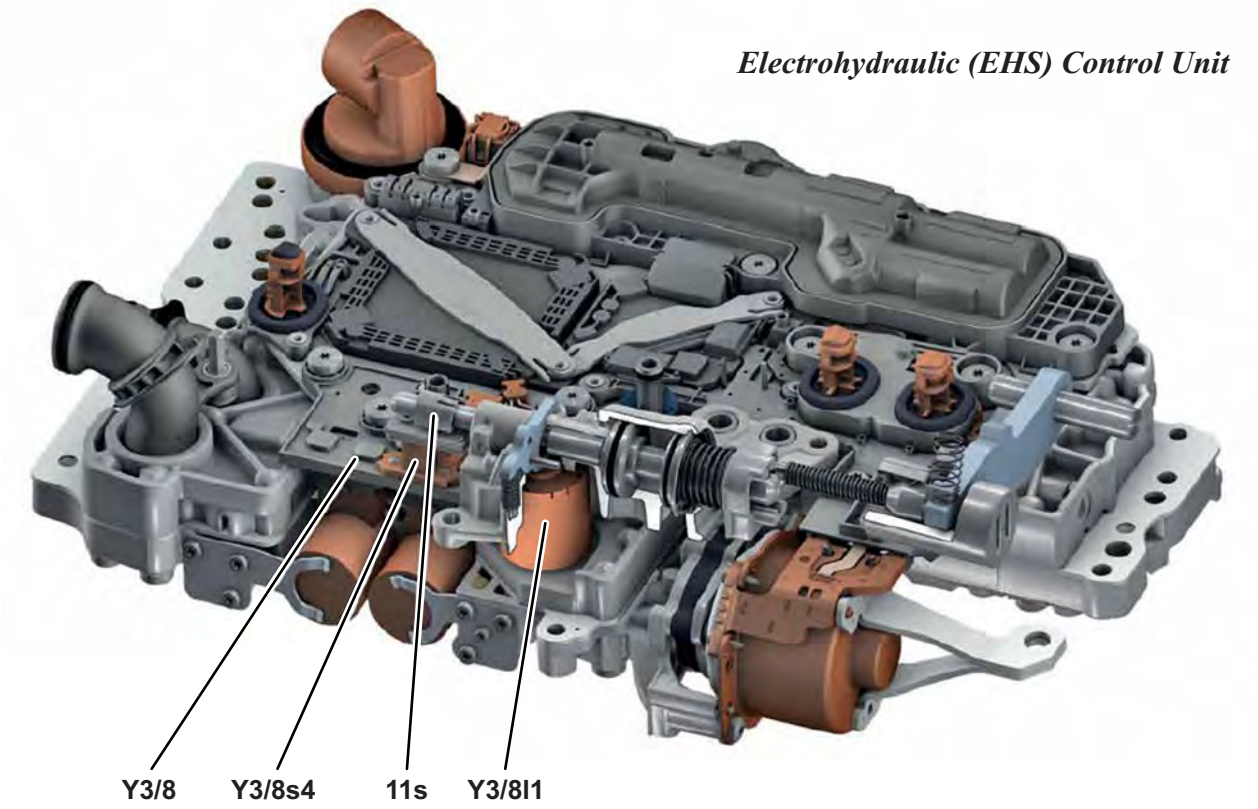
9.....Park pawl gear
9a.....Park detent
9b.....Pilot bushing
9c.....Park pawl cone
9d.....Park detent spring
11.....Piston housing
11a.....Catch spring
11b.....Park pawl lift solenoid connector
11c..... "P" locking contour
11d.....Notched lever
11e.....Locking contour "Not P"
11f.....Piston rod
11g.....Notched lever release pin
11h..... "P" pressure chamber
11i.....Spring retainer
11j.....Park pawl cone
11k.....Link rod
11l.....Pretension spring
11m.....Piston rod guide
11o.....Pilot bushing
11p.....Pressure chamber "Not P"
11q.....Piston
11r.....Catch spring
Y3/8l1.....Park pawl lift solenoid

**Courtesy of Daimler AG**

Figure 3

# MERCEDES 9G-TRONIC (725.011)
## FACTORY INFORMATION

*Electrohydraulic (EHS) Control Unit*




**Components of EHS with park pawl control**

11s..... Permanent magnet

Y3/8.....Fully integrated trans. controller unit

Y3/8l1.....Park pawl lift solenoid

Y3/8s4..... Park pawl position sensor

**Emergency engagement and emergency release of park pawl**
When the park pawl lift solenoid is intact, the electric trans- mission oil pump activates the park pawl (Not P) hydraulically with the combustion engine off. Engagement is carried out mechanically by means of a spring. If the park pawl lift solenoid is defective, the park pawl actuator is released hydraulically. In this case, a request is made to the electric transmission oil pump if the combustion engine off. Emergency release /emergency engagement is only possible towards "P" but not from "P" to "Not P".

The oil feed to the electric transmission oil pump takes place via a separate filter integrated in the oil pan. The transmis sion oil drawn in is fed by the electric transmission oil pump into the working pressure duct of the electrohydraulic control system.

**Courtesy of Daimler AG**

Figure 4

# MERCEDES 9G-TRONIC (725.011)
## FACTORY INFORMATION

**Park pawl position sensor**
The park pawl position sensor is used to monitor the position of the park pawl piston (position P and position Not P). The position of the park pawl piston is recorded by a linear Hall sensor. The sensor element for the sensor is a permanent magnet which is clipped onto the piston rod.

**Park pawl shift position "P"**
When the driver shifts the DIRECT SELECT lever to gear range "P", the pressure in pressure chamber "Not P" is released. At the same time, the fully integrated transmission control unit energizes the park pawl lift solenoid. This lifts the notched lever out of locking contour "Not P" against the spring force of the catch spring and thus prevents the "mechanical locking" of the piston rod. Due to the spring force of the pre-tensioning spring, the piston rod, which is coupled to the link rod, is pressed towards the park pawl gear and the park pawl cone is moved between the pilot bushing and park detent. The rising profile of the park pawl cone raises the park detent and presses it against the park pawl gear. If the tooth of the park detent does not engage in a tooth space when the vehicle 1s stationary, but rather touches a tooth of the park pawl gear, the park pawl cone is pre-tensioned by the spring of the link rod and positioned ready for operation.

When the park pawl gear turns further, the park detent engages in the next tooth gap. Once the park pawl is in position "P", the fully integrated transmission control unit terminates the energizing of the park pawl lift solenoid. When de-energized, the park pawl lift solenoid falls back into its initial position and no longer applies any pressure to the notched lever. This is pressed into locking contour "P" by the spring force of the catch spring and thus locks the piston rod.

**Park pawl shift position "Not P"**
If the driver shifts out of gear range "P" into "R", "N" or "D", the park pawl is moved against the spring force of the pre-tensioning spring towards shift position "Not P" through the application of pressure to the pressure chamber "Not P".

This takes place after the notched lever is raised against the force of the catch spring through the energization of the park pawl lift solenoid, thus opening the mechanical lock. If there is a sufficiently high working pressure, the park pawl is only held in position "Not P" by the hydraulic pressure. There is no contact between the piston rod and notched lever in the axial direction. The piston rod only moves against the catch due to the force of the pre-tensioning spring if the pressure reduces (pre-tensioning spring force > hydraulic pressure) or if there is a complete pressure drop. The condition "Not P" is then maintained by the "mechanical lock".

In shift position "Not P", the park pawl cone is positioned in front of the park detent and the park pawl gear can turn freely. The park pawl lift solenoid is actuated in pulses to minimize power loss in the fully integrated transmission control unit or electronic ignition lock control unit if the on-board electrical voltage is interrupted. The time period during which the fully integrated transmission control unit energizes the park pawl lift solenoid is generally measured to ensure that the piston rod reaches its new position before the energizing stops.

**Actuation of park pawl shift position "P" in the event of defective park pawl lift solenoid**
If the park pawl lift solenoid cannot be actuated or is defective, the mechanical lock of the notched lever is released by the notch lever release pin. The notched lever release pin is actuated hydraulically by the application of pressure to pressure chamber "p".

As a result, the notched lever is raised out of locking contour "Not P" of the piston rod and the park pawl is engaged by the spring force of the pre-tensioning spring.

**Emergency-P**
In the event of faults affecting the park pawl lift solenoid, which prevent the notched lever of the

**Courtesy of Daimler AG**

parking lock actuator from being released by the park pawl lift solenoid in position "Not P", the notched lever release pin can compensate for this by opening the notched lever hydraulically. The hydraulic pressure required for this is provided by the electric transmission pump with the combustion engine off.

When the Emergency-P function is activated, the locking of the piston rod by the notched lever is canceled (by the energized park pawl lift solenoid or hydraulically by the notched lever release pin in the hydraulic pressure is adequate), the lubricating pressure solenoid is in an energized state and the hydraulic cylinder is not pressurized towards the "Not P" position. The pre-tensioning spring is supported by the piston rod guide of the piston housing and thus moves the piston rod into shift position "P".

**Transfer of torque**

The engine torque is transferred from the crankshaft to the torque converter, then downstream through the automatic transmission to the drive wheels via the rear axle differential. Power is transferred in the torque converter via the driven impeller by diverting hydraulic fluid to the turbine wheel which is connected to the turbine shaft/input shaft. When the torque converter lockup clutch is engaged, power is transmitted via this mechanical connection. Via the gear wheels of the individual planetary gear sets, the torques coming from the converter, depending on the gear ratio and shift elements actuated, are passed on to the output shaft with the help of the multidisc clutches and multidisc brakes. A reduction of the output speed with high tractive forces and drive torques at the drive wheels.

**Powerflow illustrated based on 1st gear**

**Function sequence of power flow in 1st gear**

The following multidisc brakes and multidisc clutches are engaged:

- Multidisc brake B05
- Multidisc brake B06
- Multidisc clutch K38

In 1st gear, the power flows through the following gear sets:

- Planetary gear set P1
- Planetary gear set P2
- Planetary gear set P3

The sun gear of planetary gear set P1 is part of the drive shaft and is driven by it. The planet carrier of planetary gear set P1 is connected to the ring gear of planetary gear set P2 via multidisc clutch K38.

Multidisc brake B05 brakes the sun gear of planetary gear set P2. This increases the torque and reduces the rpm. The ring gear of planetary gear set P2 has a mechanical connection to the sun gear of planetary gear set P3.

The planetary gears roll within the ring gear of planetary gear set P3, which is braked to a standstill by multidisc brake B06, and transfer the resulting increased torque and resulting reduced rpm to the output shaft. The output shaft thus rotates with a reduced transmission input speed in the direction of rotation of the engine.

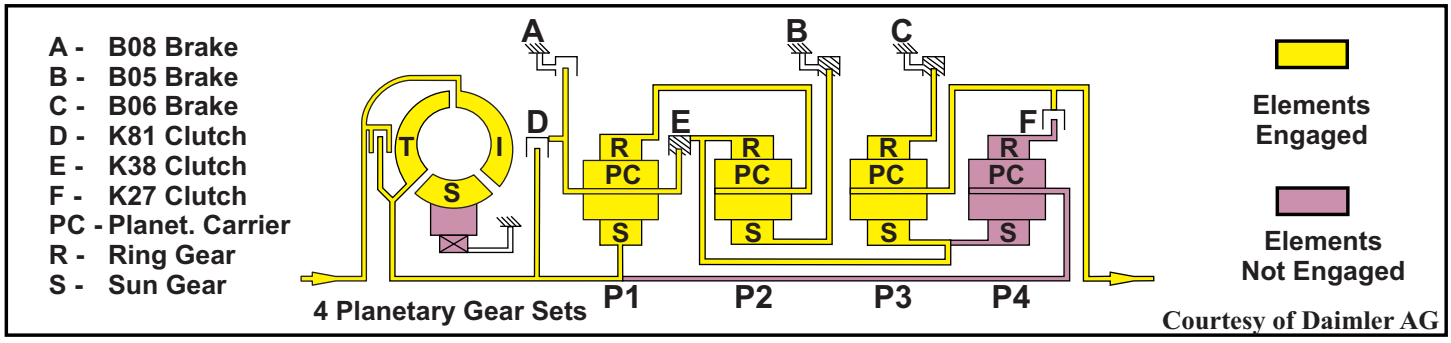
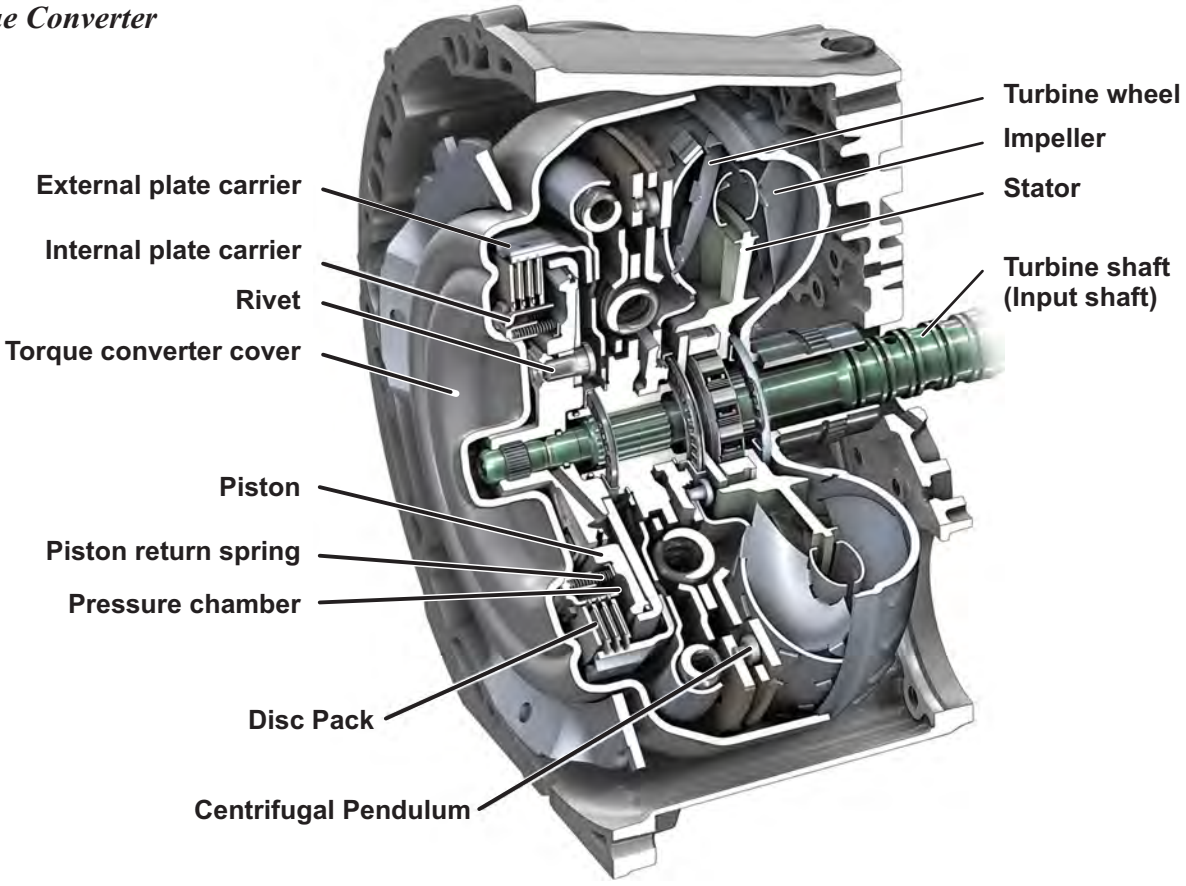



Figure 5

*Torque Converter*




**Torque converter lockup clutch (WÜK) with centrifugal pendulum**

The torque converter lockup clutch minimizes the power losses of the torque converter and ensures low-slip power flow from the crankshaft to the drive shaft of the automatic transmission depending on the engine load and vehicle speed. This allows the efficiency of the transmission to be improved. The torque converter lockup clutch is engaged in all gears depending on the output speed, the engine load and further parameters such as temperature and air pressure. In order to minimize the torsional vibrations caused by the combustion engine, additional damping elements and vibration-reducing measures are required:

- Torsional damper
- Centrifugal pendulum

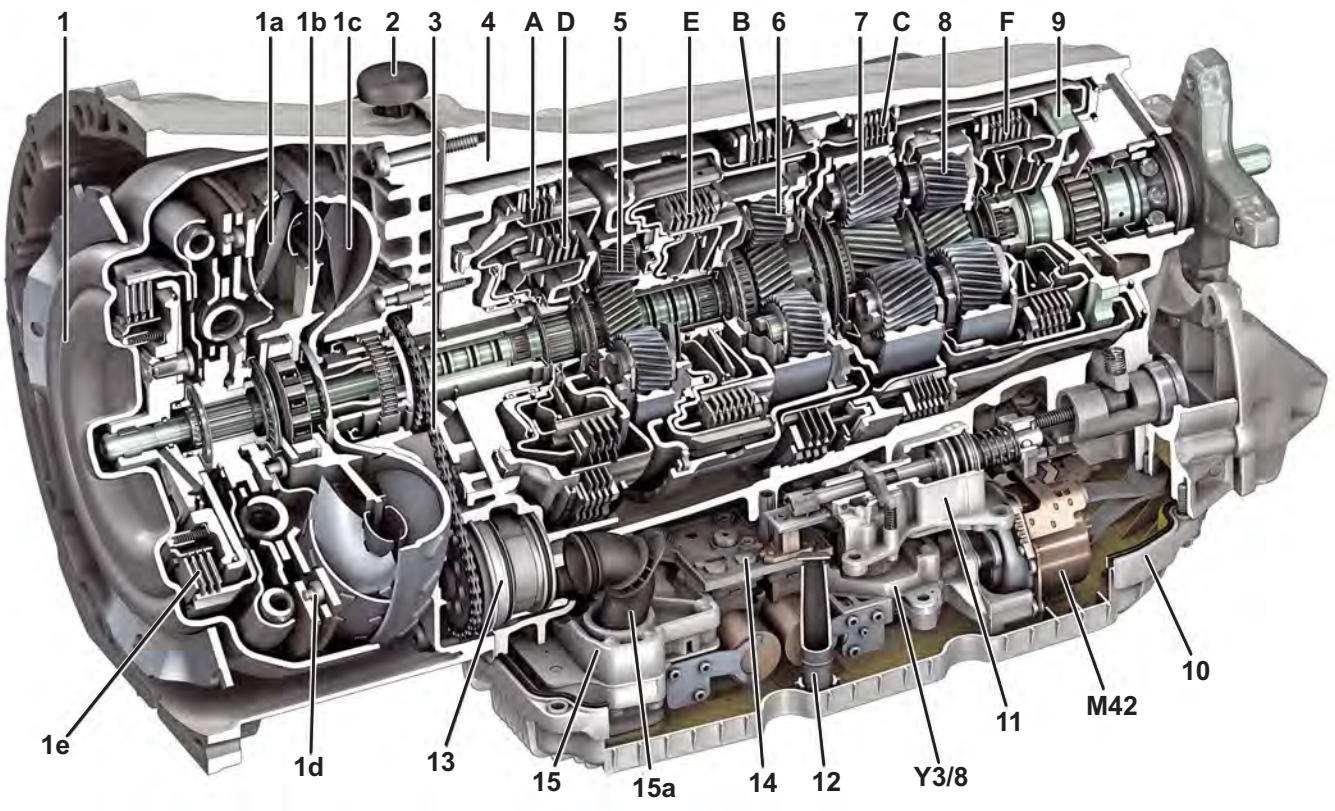
The torsional damper reduces the torsional vibrations caused by the combustion engine as result of combustion jolts. The pendulum masses of the centrifugal pendulum are mounted flexibly on rollers and produce a counter-moment due to their inertia, which minimizes the torsional vibrations from the engine over the entire rpm range. This measure improves comfort for the driver and saves wear and tear on the mechanical components of the transmission. A low-rpm shift program is possible, which helps to save fuel.

**Courtesy of Daimler AG**

Figure 6

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

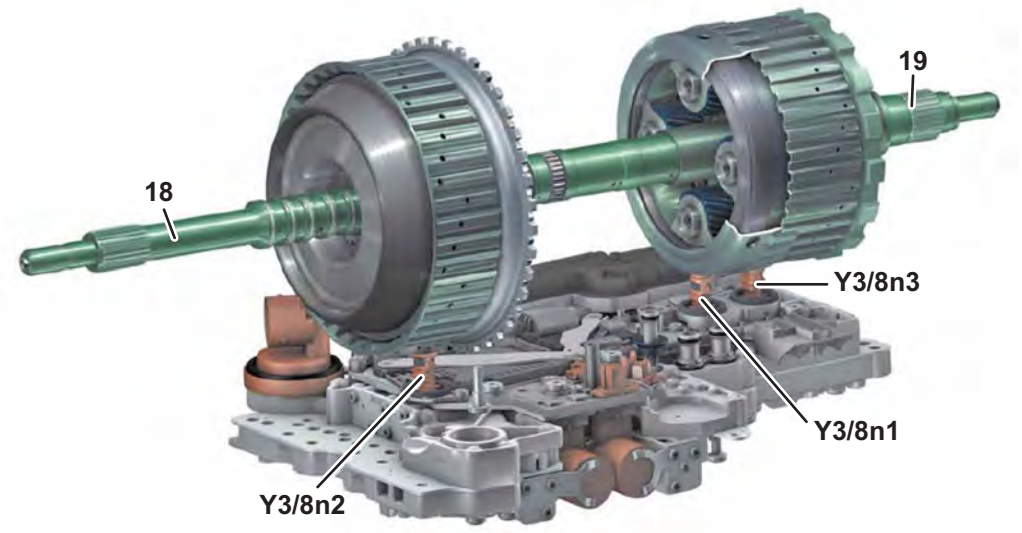



1.....Torque Converter
1a.....Turbine wheel
1b.....Stator
1c.....Impeller
1d.....Centrifugal pendulum
1e.....Torque converter lockup clutch
2.....Transmission housing ventilation
3.....Oil pump drive chain
4.....Transmission housing
5.....Planetary gear set 1
6.....Planetary gear set 2
7.....Planetary gear set 3
8.....Planetary gear set 4
9.....Park pawl gear
10.....Oil pan
11.....Piston housing of electro-hydraulic park pawl actuator
12.....Guide tube
13.....Oil pump
14.....Supporting body for VGS
15.....Cover/shift valve body
15a.....Pressure pipes and intake manifolds
A.....B08 multi-disc brake
B.....B05 multi-disc brake
C.....B06 multi-disc brake
D.....K81 multi-disc clutch
E.....K38 multi-disc clutch
F.....K27 multi-disc clutch
M42....Electric transmission oil pump
Y3/8....Fully integrated transmission control controller unit

**Courtesy of Daimler AG**

Figure 7

*RPM Sensor System*




**Components of the RPM sensor system**

18.....Turbine/Input shaft

19.....Output shaft

Y3/8n1.....Turbine wheel rpm sensor

Y3/8n2.....Internal transmission rpm sensor

Y3/8n3.....Output shaft rpm sensor

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**Internal transmission speed rpm sensor**
The internal transmission rpm is recorded by an active sensor (differential Hall sensor with integrated magnet). External plate carrier K81 is used as a passive sensor element for the internal rpm.

**Turbine wheel rpm sensor**
The turbine wheel speed is recorded by passive sensor (differential Hall sensor). A pole wheel is used as an active sensor element for the turbine speed. It is pressed onto the planet carrier of planetary gear set P4.

**Output shaft rpm sensor**
The output speed is recorded by an active sensor with rotation direction detection (differential Hall sensor with integrated magnet). External plate carrier K27 is used as a passive sensor element for the output speed. It is welded to the output shaft and is part of multidisc clutch F assembly.

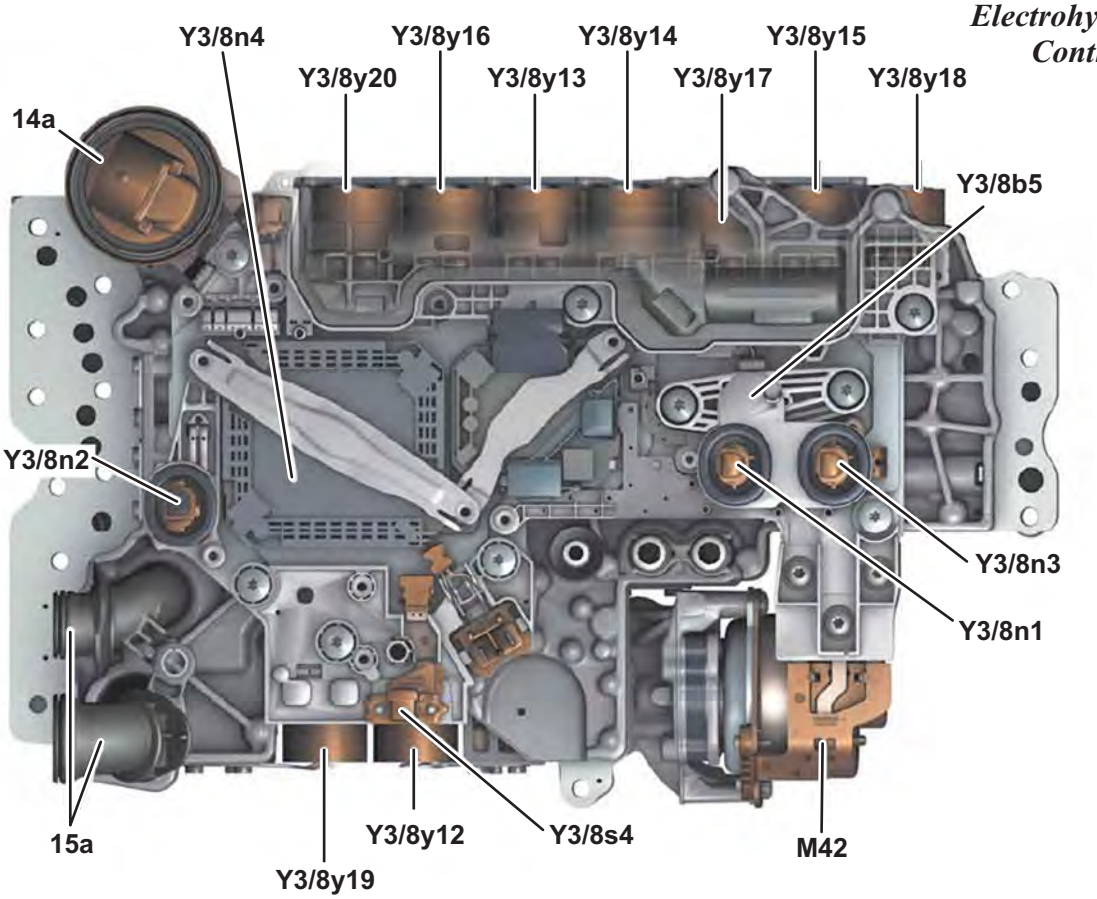
**Courtesy of Daimler AG**

Figure 8

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

*Electrohydraulic Control*




**Components of EHS**

14a.....Transmission connector

15a.....Pressure and intake pipes

M43.....Electric transmission oil pump

Y3/8b5.....Pressure sensor

Y3/8n1.....Turbine wheel rpm sensor

Y3/8n2.....Internal transmission rpm sensor

Y3/8n3.....Output shaft rpm sensor

Y3/8n4.....Fully integrated trans. control unit

Y3/8s4..... Park pawl position sensor

Y3/8y12.....Lubrication pressure solenoid

Y3/8y13.....Clutch control solenoid K81

Y3/8y14.....Clutch control solenoid K38

Y3/8y15.....Clutch control solenoid K27

Y3/8y16.....Multidisc brake control solenoid B08

Y3/8y17.....Multidisc brake control solenoid B05

Y3/8y18.....Multidisc brake control solenoid B06

Y3/8y19.....Working pressure solenoid

Y3/8y20.....Torque converter lockup clutch solenoid

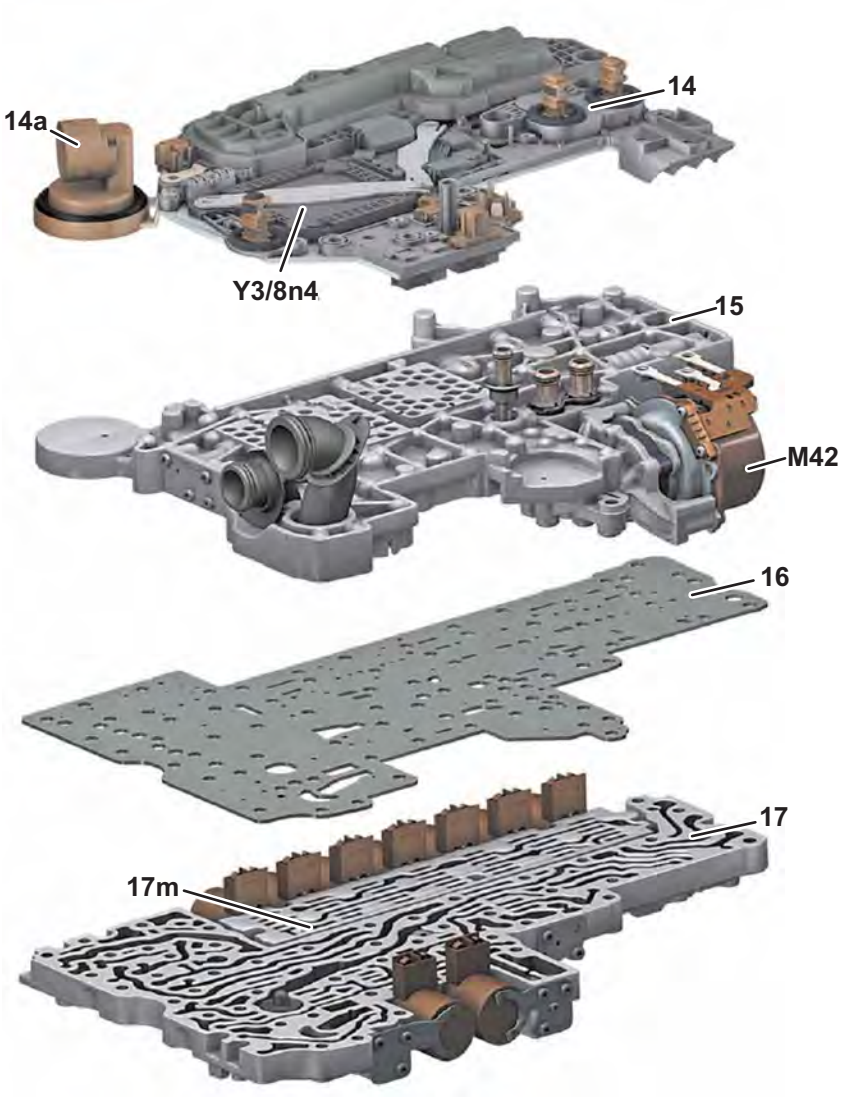
**Courtesy of Daimler AG**

Figure 9

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

*Electrohydraulic Control*




**Exploded view of the EHS**

14.....Supporting body of VGS

14a.....Transmission connector

15.....Cover/shift valve housing

16.....Intermediate plate

17.....Shift valve housing

17m.....Valve block

M42..... Electric trans. oil pump

Y3/8n4.....Fully integrated trans. control unit

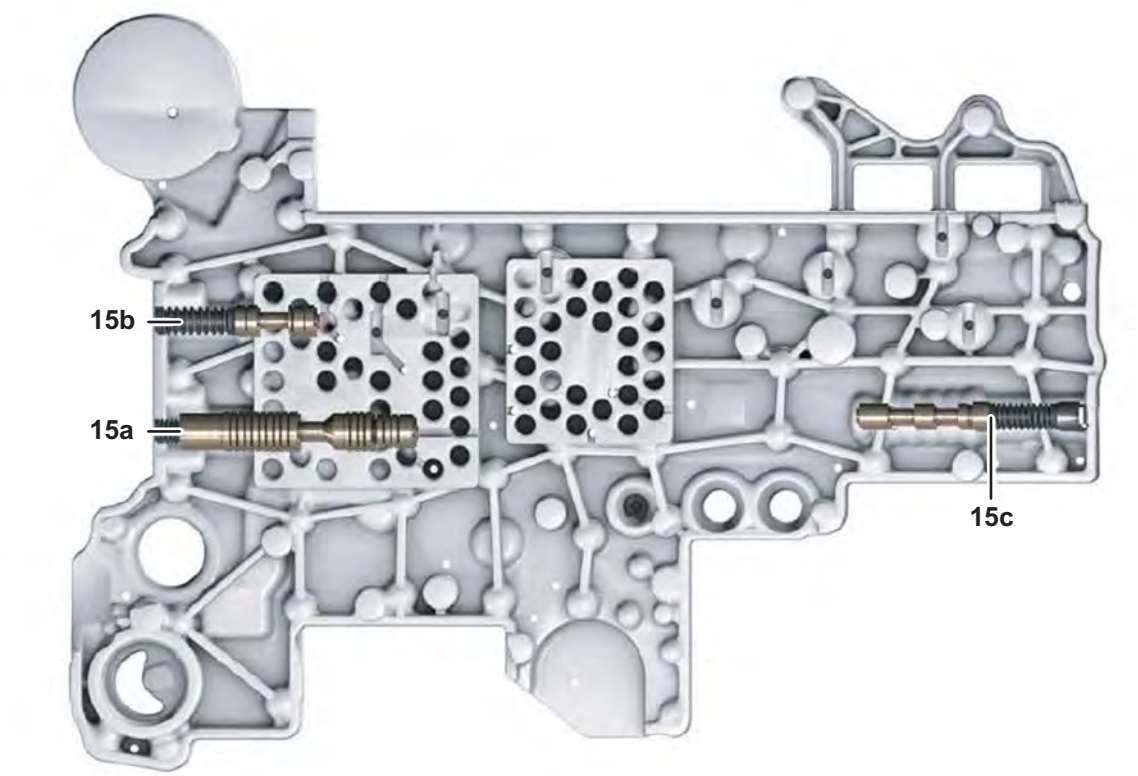
**Courtesy of Daimler AG**

Figure 10

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

***Cover / shift valve housing***




**Cover shift valve housing valve identification**

15a..... Working pressure regulating valve

15b..... Boost shift valve (supports centrifugal oil cover filling)

15c..... Park/Not Park shift valve

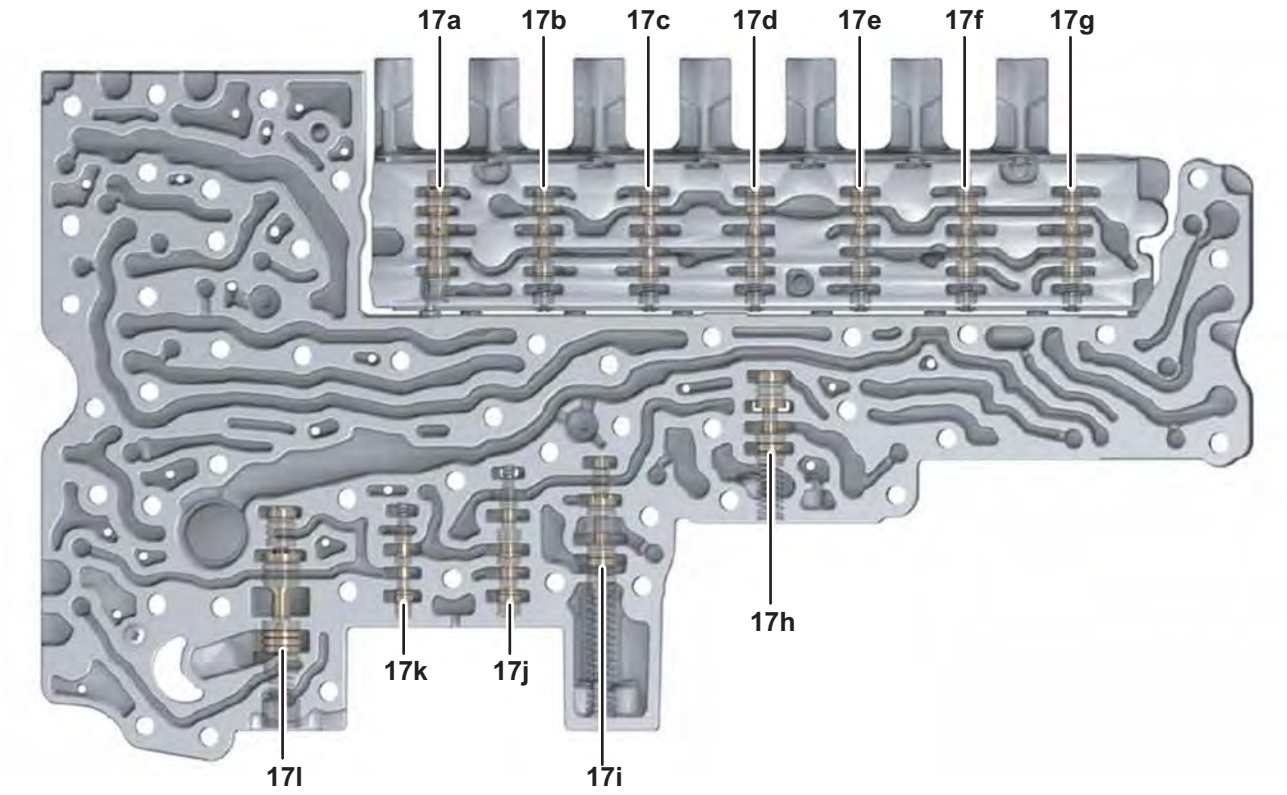
**Courtesy of Daimler AG**

Figure 11

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION

***Shift valve housing and valve block***




**Shift valve housing and valve block valve identification**

17a.....WÜK (TCC) regulating valve

17b.....Brake regulating valve B08

17c.....Clutch regulating valve K81

17d.....Clutch regulating valve K38

17e.....Brake regulating valve B05

17f..... Clutch regulating valve K27

17g.....Brake regulating valve B06

17h.....No Park shift valve

17i..... Lubrication pressure shift valve

17j..... Lubricating press. sol. reg. valve

17k.....Working pressure reg. valve

17l..... Lubrication pressure reg. valve

**Courtesy of Daimler AG**

Figure 12

**Shift pressure, lubricating pressure and working pressure**
The oil pressures are separated into:
- Working pressure
- Lubrication pressure
- Shift pressure

**Working pressure**
The oil pressure produced by the primary pump is converted into working pressure by the working pressure regulating valve.

The level of working pressure depends on the position of the regulating valve and therefore on its geometry.

The position of the working pressure regulating valve is influenced by the working pressure solenoid to match the load and gear. All other oil pressures required for transmission control are derived from the working pressures.

**Lubrication pressure**
At the working pressure regulating valve excess oil is diverted to the lubrication pressure regulating valve and from there used in a regulated manner for lubrication and cooling of mechanical transmission parts and the torque converter. In addition, the oil pressure in the torque converter is limited via regulation of the lubrication pressure.

**Shift pressure**
The shift pressure (oil pressure in the multidisc clutch or multidisc brake) is derived from the working pressure.

The respective solenoid influences the position of the associated regulating valve. In turn, the position influences the oil pressure prevailing in the multidisc brake or multidisc clutch. The shift pressure thus depends on the geometry of the respective regulating valve.

**Electric transmission oil pump**
The electric transmission oil pump provides the hydraulic system's oil supply when the internal combustion engine is switched off. It is actuated through the fully integrated transmission control unit.

The electric transmission oil pump has the following tasks:
- Support the working pressure supply (boosting)
- Support cooling and lubrication
- Provide start/stop capability
- Emergency engagement and emergency release of park pawl

**Support the working pressure supply (boosting)**
When there are increased flow rate requirements (e.g. during shift operations), the electric transmission oil pump supports the mechanically driven primary pump according to demand. The additional flow rate provided by the electric transmission oil pump counteracts working pressure dips as a result of under-supply in these situations

**Support cooling and lubrication**
The electric transmission oil pump is actuated according to demand in the event of high cooling and lubrication requirements in order to provide additional flow rate. Due to the possibility of providing additional flow rate according to is demand, it was possible to make the primary oil pump significantly smaller and thus reduce C02 emissions.

**Provide start/stop capability**
When the combustion engine is switched off during the stop phase, the electric transmission oil pump provides the basic pressure level and thus keeps the hydraulic ducts of the electrohydraulic control system and the piston chambers of the shift elements filled with oil. The electric transmission oil pump is operated on a current-controlled basis to supply the exact quantity required to compensate for the leakage of the electrohydraulic actuator. This form of operation allows the power consumption of the electric transmission oil pump to be reduced to the bare minimum during start/stop operation.

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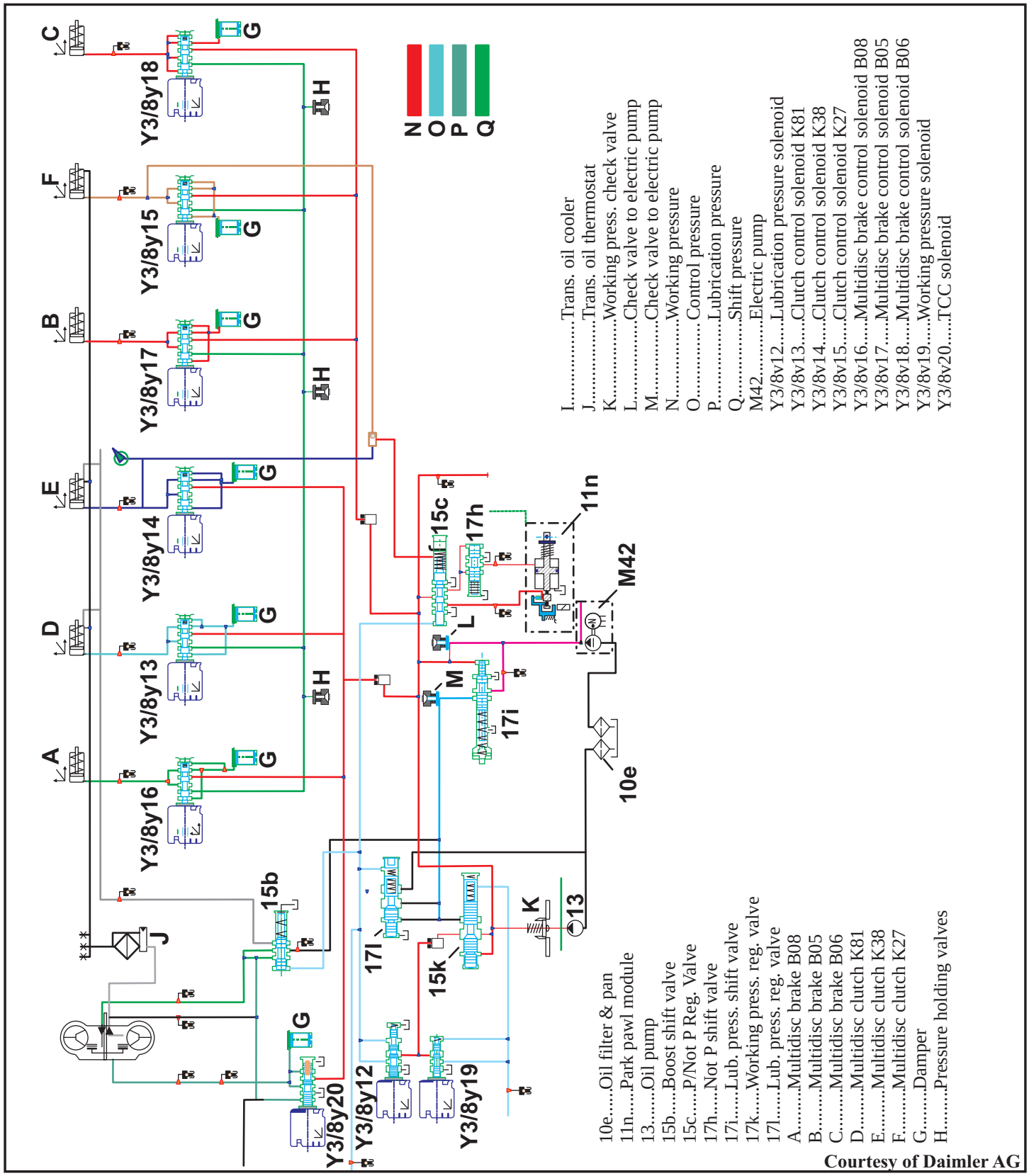
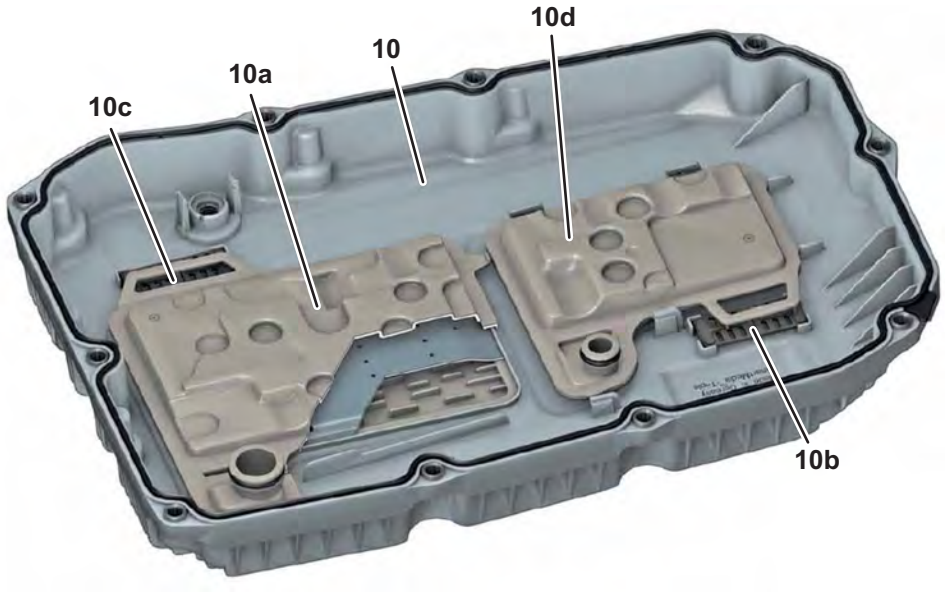

I.....Trans. oil cooler
J.....Trans. oil thermostat
K.....Working press. check valve
L.....Check valve to electric pump
M.....Check valve to electric pump
N.....Working pressure
O.....Control pressure
P.....Lubrication pressure
Q.....Shift pressure
M42.....Electric pump
Y3/8v12....Lubrication pressure solenoid
Y3/8v13....Clutch control solenoid K81
Y3/8v14....Clutch control solenoid K38
Y3/8v15....Clutch control solenoid K27
Y3/8v16....Multidisc brake control solenoid B08
Y3/8v17....Multidisc brake control solenoid B05
Y3/8v18....Multidisc brake control solenoid B06
Y3/8v19....Working pressure solenoid
Y3/8v20....TCC solenoid
10e....Oil filter & pan
11n....Park pawl module
13.....Oil pump
15b....Boost shift valve
15c....P/Not P Reg. Valve
17h....Not P shift valve
17i....Lub. press. shift valve
17k....Working press. reg. valve
17l....Lub. press. reg. valve
A.....Multidisc brake B08
B.....Multidisc brake B05
C.....Multidisc brake B06
D.....Multidisc clutch K81
E.....Multidisc clutch K38
F.....Multidisc clutch K27
G.....Damper
H.....Pressure holding valves
Courtesy of Daimler AG

Figure 13

# MERCEDES 9G-TRONIC (725.011)

## FACTORY INFORMATION




10..... Oil pan
10a..... Primary pump oil filter
10b..... Magnet for metallic wear debris
10c..... Magnet for metallic wear debris
10d..... Electronic transmission oil pump oil filter

**Oil level check**

The oil level is checked using an overflow method. If an oil level check is performed, a routine must be started via Xentry (Scan tool). It can then be performed in a temperature window between 35 °C and 45 °C.

In addition, the new special tool "adapter" (W725 589 00 90 00) for the oil filling unit is required to f ill the oil.

**Maintenance information**

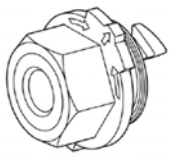
Oil change interval as per NAT2FE+ every 125,000 km/5 years.

Exchange of both oil filters in the oil pan, the oil pan must be replaced for this as the filters are permanently integrated into the oil pan every 125,000 km/5 years.

Exchange of the pressure oil filter on the front integral carrier based on service sheet specification.

Use of the new automatic transmission fluid Shell ATF 097 (Mercedes-Benz Specifications for operating Fluids 236.16).

The new automatic transmission fluid has the following part number: A001 989 92 03.



*Adapter for filling oil into the transmission part number: W725 589 00 90 00*

**Courtesy of Daimler AG**

Figure 14