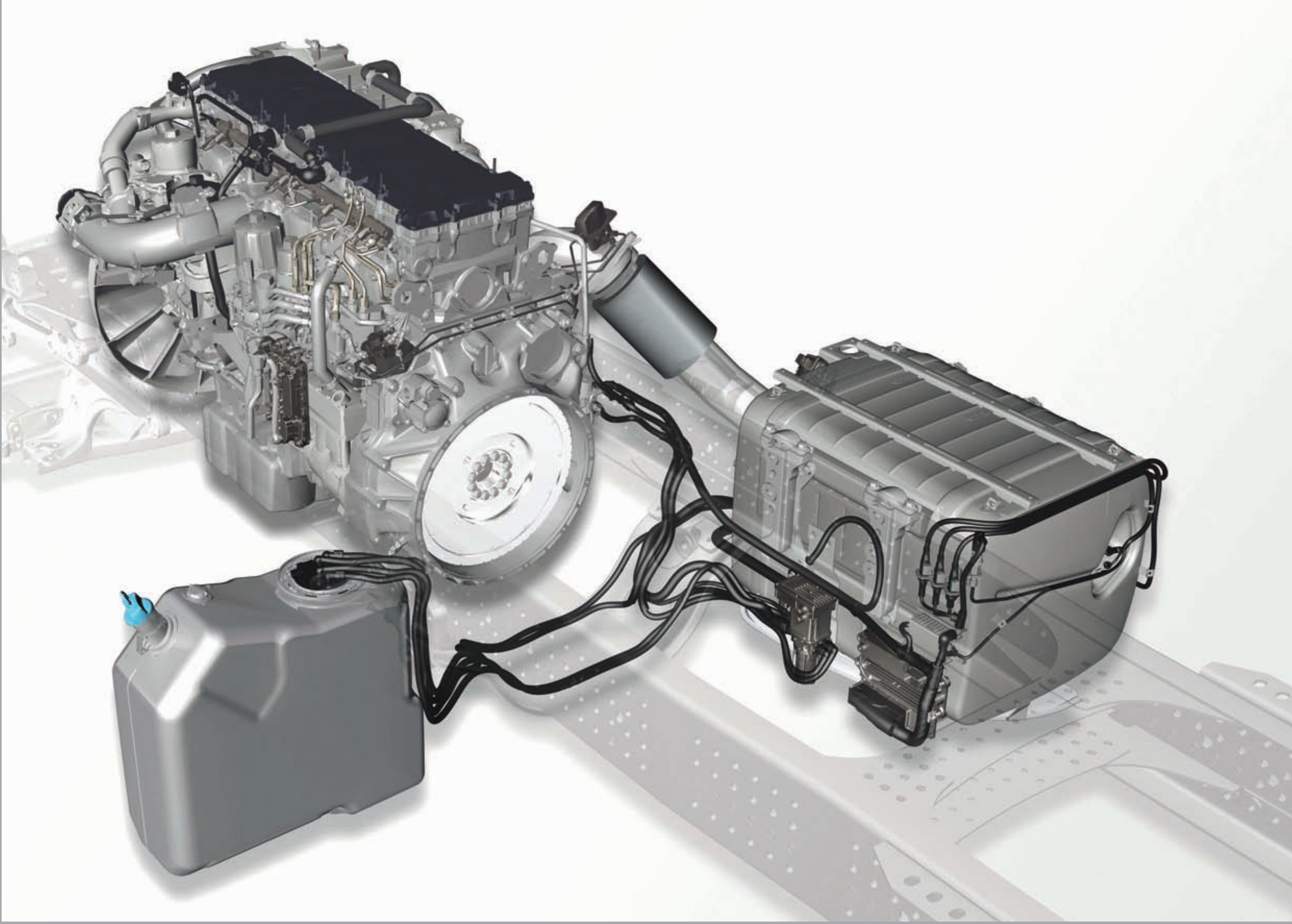

Introduction of engine OM 471 and exhaust aftertreatment

Introduction into Service Manual

Mercedes-Benz

Mercedes-Benz Service

Introduction of engine OM 471 and exhaust aftertreatment

Technical status 01.09.2011

Daimler AG · Technical Information and Workshop Equipment(GSP/OI)
D–70546 Stuttgart

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SN00.00-W-0001-01HD	Preface		

The intention behind this brochure is to introduce you to the new 6-cylinder inline diesel engine OM 471 along with the new exhaust aftertreatment system (EATS).
This brochure is intended for the technical personnel entrusted with the maintenance and repair of Mercedes-Benz trucks.

The content of this brochure is split up into:
- **as-built configuration descriptions**
- **function descriptions**
- **component descriptions**

All the data listed in this brochure correspond with the technical status as per September 2011.
Any changes or supplements hereto will be published in the Workshop Information System (WIS) only.

Additional documents for the OM 471 engine and the EATS, such as maintenance and repair instructions or wiring diagrams are also available in the Workshop Information System (WIS).

Mercedes-Benz
Wörth plant, GSP/TTM

September 2011

Contents

SN00.00-W-0110HA	**Overview of as-built configuration and function descriptions**	**2.8.11**

ENGINES 471.9

	Overview of new features		
	Engine OM 471		**Page 10**
	Technical data of diesel engine OM 471		**Page 11**
	As-built configuration descriptions		
	Cylinder head cover, as-built configuration		**Page 12**
	Cylinder head, as-built configuration		**Page 13**
	Cylinder head gasket, as-built configuration		**Page 18**
	Crankcase as-built configuration		**Page 19**
	Connecting rod, as-built configuration		**Page 21**
	Piston, as-built configuration		**Page 22**
	Crankshaft, as-built configuration		**Page 23**
	Valve control; as-built configuration		**Page 24**
	Gear drive, as-built configuration		**Page 29**
	Camshaft, as-built configuration		**Page 31**
	Belt drive, as-built configuration		**Page 32**
	Function descriptions		
	Crankcase ventilation system function		**Page 34**
	Charging, function		**Page 35**
	Engine management, function		**Page 37**
	Engine management, overall network		**Page 39**
	Engine management, behavior in the event of malfunctions		**Page 40**
	Start procedure, function		**Page 42**
	Idle speed control, function		**Page 44**
	Working speed control, function		**Page 46**
	Driving, function		**Page 48**
	Engine shutoff procedure, function		**Page 50**
	Determination of the engine speed and crankshaft angle, function		**Page 53**
	Determination of the compression stroke at cylinder 1, function		**Page 54**

	Determination of coolant temperature, function		**Page 55**
	Determination of air mass, function		**Page 56**
	Determination of the fuel temperature, function		**Page 57**
	Function of the specified engine torque calculation		**Page 58**
	Engine brake, function		**Page 60**
	Exhaust gas recirculation, function		**Page 66**
	Exhaust aftertreatment, function	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V Vehicles with code (M5Z) Engine version Euro VI	**Page 68** **Page 73**
	Exhaust aftertreatment, overall network		**Page 79**
	Engine oil circuit, function		**Page 80**
	Engine oil circuit, diagram		**Page 82**
	Coolant circuit, function		**Page 83**
	Coolant circuit, diagram		**Page 86**
	Engine cooling thermal management, function	i Only in vehicles with code (M7T) Coolant pump, controlled.	**Page 87**
	Engine cooling thermal management, overall network		**Page 90**
	Fuel supply, function		**Page 91**
	Fuel low pressure circuit function	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V Vehicles with code (M5Z) Engine version Euro VI	**Page 93** **Page 96**
	Fuel high pressure circuit function		**Page 100**
	Component descriptions		
	Central gateway control unit (CGW), component description	A2	**Page 101**

Contents

	Component description drive control (CPC) control unit	A3	**Page 102**
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Electronic Brake Control control unit (EBS), component description	A10b, A10c	**Page 105**
	Parameterizable special module (PSM) control unit component description	A22	**Page 106**
	Battery disconnect switch control unit, component description	A33 ℹ Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery disconnect switch • Code (E9E) ADR preinstallation, without chassis shielding	**Page 107**
	Radiator shutters, component description	A54, A55 ℹ Only in vehicles with code (M7K) Radiator shutters.	**Page 109**
	EATU output NOx sensor, component description	A57, A57 b1 Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 110**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 112**
	Pump module, component description	A58, M25	**Page 115**
	Exhaust aftertreatment (ACM) control unit, component description	A60 Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 117**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 119**
	AdBlue metering device, component description	A67	**Page 121**
	EATU input NOx sensor, component description	A70, A70 b1 Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 123**

		Vehicles with code (M5Z) Engine version Euro VI	**Page 125**
	Auxiliary heater heating unit, component description	A901 ℹ Only in vehicles with code (D6M) Auxiliary water heater, cab or code (D6N) Auxiliary water heater, cab and electric motor.	**Page 128**
	Auxiliary heater coolant circulation pump, component description	A901 M2 ℹ Only in vehicles with code (D6M) Auxiliary water heater, cab or code (D6N) Auxiliary water heater, cab and electric motor.	**Page 130**
	Travel and speed sensor, component description	B18	**Page 131**
	Exhaust pressure sensor upstream of diesel oxidation catalytic converter, component description	B37 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 132**
	Exhaust pressure sensor downstream of diesel particulate filter, component description	B38 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 133**
	Component description for accelerator pedal sensor	B44	**Page 134**
	Exhaust temperature sensor upstream of diesel oxidation catalytic converter, component description	B67 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 135**
	Exhaust temperature sensor downstream of diesel oxidation catalytic converter, top, component description	B68 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 136**
	Exhaust temperature sensor downstream of diesel oxidation catalytic converter, bottom, component description	B69 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 137**
	Exhaust temperature sensor downstream of diesel particulate filter, component description	B70 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 138**
	Exhaust temperature sensor upstream of SCR catalytic converter, component description	B72 ℹ Only in vehicles with code (M5R) Engine version EEV and in vehicles with code (M5Y) Engine version Euro V.	**Page 139**
	Exhaust temperature sensor downstream of SCR catalytic converter, component description	B73 Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 140**

Contents

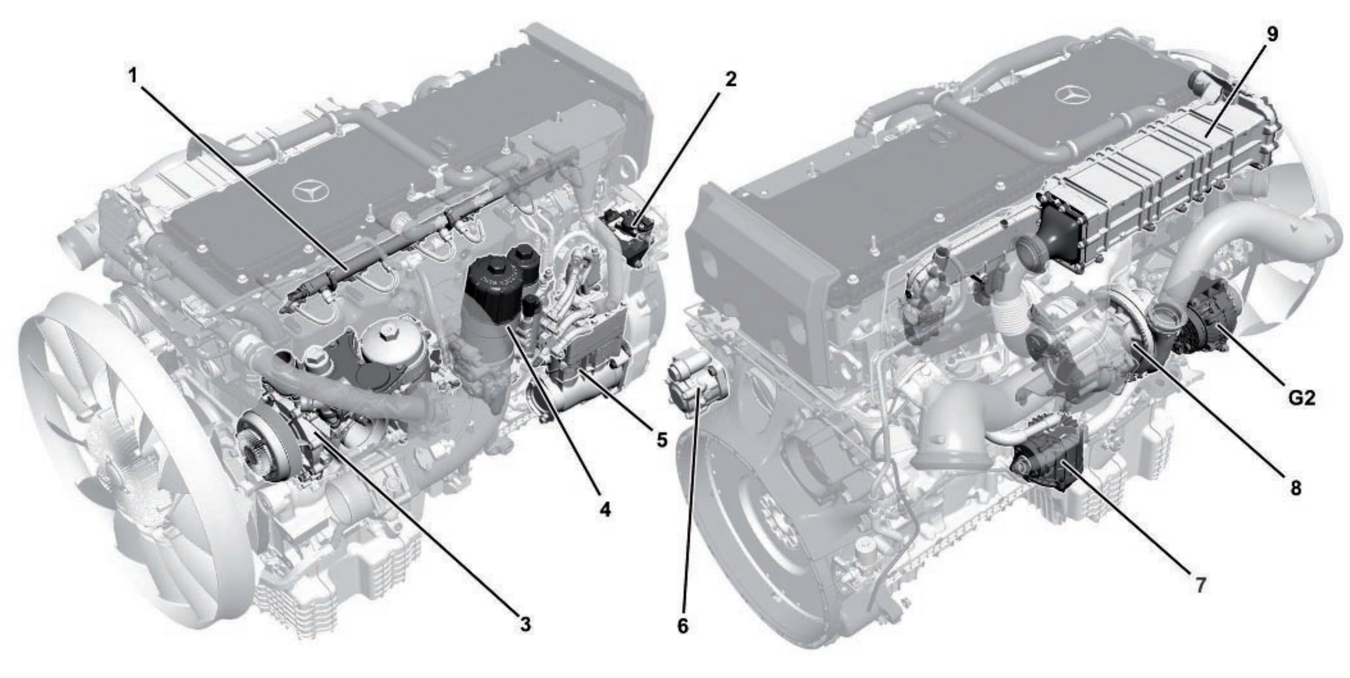
		Vehicles with code (M5Z) Engine version Euro VI	**Page 141**
	AdBlue fill level sensor/temperature sensor, component description	B74	**Page 142**
	Coolant pressure control sensor, component description	B87 ℹ Only in vehicles with code (B3H) Secondary water retarder.	**Page 144**
	Component description for crankshaft position sensor	B600	**Page 145**
	Component description for camshaft position sensor	B601	**Page 146**
	Component description for fuel temperature sensor	B602	**Page 147**
	Oil pressure sensor, description of components	B604	**Page 148**
	Component description for engine oil fill level sensor	B605	**Page 149**
	Component description for exhaust coolant temperature sensor	B606	**Page 150**
	Component description for intake coolant temperature sensor	B607	**Page 151**
	Charge air pressure and temperature sensor in charge air pipe, component description	B608	**Page 152**
	Turbine wheel rpm sensor, component description	B610 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 153**
	Component description for temperature sensor downstream of air filter	B611 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 154**
	Charge air temperature sensor in charge air housing, component description	B617	**Page 155**
	Exhaust gas recirculation differential pressure sensor, component description	B621	**Page 156**
	Component description for rail pressure sensor	B622	**Page 157**
	Diesel fuel metering device, component description	B625, B626, Y628, Y629 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 158**
	Fuel filter module pressure sensor, component description	B638	**Page 159**

	Component description for coolant pump	B640, Y631 [i] Only in vehicles with code (M7T) Coolant pump, controlled. No component description was created for vehicles with a rigid coolant pump.	**Page 160**
	Residual heat pump, component description	M20 [i] Only in vehicles with code (D6I) Residual heat utilization.	**Page 162**
	Tachograph (TCO) component description	P1	**Page 163**
	Electronic ignition lock (EIS), component description	S1	**Page 164**
	EMERGENCY OFF switch, component description	S30 [i] Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery disconnect switch • Code (E9E) ADR preinstallation, without chassis shielding	**Page 165**
	EMERGENCY OFF switch frame, component description	S31 [i] Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery disconnect switch • Code (E9E) ADR preinstallation, without chassis shielding	**Page 166**
	Engine start and engine stop button, component description	S600	**Page 167**
	Heating shutoff valve, component description	Y49	**Page 168**
	Coolant pressure control solenoid valve, component description	Y53 [i] Only in vehicles with code (B3H) Secondary water retarder.	**Page 169**

	Component description for fuel injectors	Y608. to Y613	**Page 170**
	Component description for the electromagnetic viscous coupling	Y616, Y616 b1	**Page 174**
	Component description for exhaust gas recirculation controller	Y621	**Page 176**
	Component description for engine brake solenoid valve	Y624, Y625	**Page 178**
	AdBlue® heater coolant solenoid valve, component description	Y627	**Page 180**
	Component description for boost pressure regulator	Y636	**Page 181**
	Component description for quantity control valve	Y642	**Page 182**
	Oil separator component description		**Page 183**
	Component description for fuel system high pressure pump		**Page 184**
	Pressure limiting valve, component description		**Page 185**
	Component description for turbocharger		**Page 186**
	Component description for exhaust gas recirculation cooler		**Page 187**
	Component description for AdBlue tank		**Page 188**
	Component description for oil pump		**Page 189**
	Oil/coolant module, component description		**Page 191**
	Oil thermostat, component description		**Page 193**
	Component description for oil/water heat exchanger		**Page 194**
	Component description for coolant thermostat		**Page 195**
	Retarder, component description	ℹ Only in vehicles with code (B3H) Secondary water retarder.	**Page 197**
	Component description for fuel pump		**Page 203**
	Component description for fuel cooler		**Page 204**
	Component description for fuel filter module		**Page 205**
	Diesel oxidation catalytic converter, component description	ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 208**
	Component description for SCR catalytic converter	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 209**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 211**
	Exhaust aftertreatment unit, component description	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 213**

		Vehicles with code (M5Z) Engine version Euro VI	**Page 215**
	Diesel particulate filter of exhaust aftertreatment unit, component description	i Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 218**
	Nozzle unit for DPF regeneration, component description	i Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 220**
	Heating system heat exchanger, component description		**Page 221**

SN00.00-W-0002-04H	Engine OM 471		



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1 *Amplified Pressure Common-Rail System (APCRS)*
2 *Diesel fuel-metering device (for regeneration of diesel particulate filter (DPF))*
3 *Oil/coolant module*
4 *Fuel filter module*
5 *Compressor*
6 *Power steering pump*
7 *Oil separator for crankcase ventilation system*
8 *Turbocharger*
9 *Cooled and regulated exhaust gas recirculation (AGR)*

G2 *Generator*

The engine OM 471 is the first 6-cylinder inline engine with two overhead camshafts to be used in a Mercedes-Benz commercial vehicle.
Both camshafts are driven by a gear drive which is located at the output side of the engine. The position of this drive gear makes a major contribution to reducing noise emission.

The extremely compact design of the engine is based on the optimized cylinder liner concept in which the overhead seat is located at the bottom in the crankcase - this design measure allows the gap between the cylinders to be reduced considerably.

The OM 471 engine is available in four output stages between 310 and 375 kW.
Advantages of new 6-cylinder inline engine:

- Lower fuel consumption in relation to high output
- Smooth running characteristics, whereby only four counterweights are required on the crankshaft
- Excellent application capability for the various emissions standards
- Implementation of particularly high combustion pressures of up to 230 bar

---

The positive properties of the new engine have been made possible by a variety of new technical developments:

- The new injection system, the amplified pressure common rail system (APCRS) (1), is the first common rail system to be used in Mercedes-Benz commercial vehicles that minimizes the quantity of fuel required for combustion. The advantage of this system lies in the fact that the rail and high-pressure lines have a relatively low pressure of 900 bar, and the fuel pressure required for injecting into the injector is generated, which has a particularly positive effect on material loads and therefore on component longevity.
- The completely redesigned engine brake system has an even higher braking power.
- The cooled and regulated exhaust gas recirculation (EGR) (9) and the diesel particulate filter (DPF) as well as the modified oil separator of the crankcase ventilation system (7) ensure that tomorrow's emissions regulations can also be met.
- The regulated coolant pump installed in the oil/coolant module (3), which has already been installed in Actros vehicles, also contributes to fuel economy.

---

i With each maintenance and repair work to the engine as well as to the ancillary assemblies and detachable parts comes the danger of property damage caused by soiling and foreign bodies. The high pressure diesel injection system, the intake system and the oil circuit, in particular, are at risk here.

To avoid any damage, when conducting repair work not only the specified special tools must be used along with observance of the WIS repair instructions, but in addition to this special care must be given to cleanliness at the workbay.
Additional information is available in the document AH00.00-N-5000-01H.

SN00.00-W-0002-05H	Technical data of diesel engine OM 471		

General information

	OM 471
Displacement (l)	12,8
No. of cylinders	6 (in line)
Valve control	DOHC
Valve number for each cylinder (intake/exhaust)	2/2
Idle speed (rpm)	560
Compression ratio (ε)	17,3
Stroke (mm)	156
Stroke: bore ratio	1,18
Weight (kg)	approx. 1200

Power categories

	OM 471 with code M3A	**OM 471 with code M3B**	**OM 471 with code M3C**	**OM 471 with code M3D**
Output (kW)	310	330	350	375
Output (horsepower)	421	449	476	510
Torque (Nm)	2100	2200	2300	2500

Piston

	OM 471
Diameter (mm)	132
Overall height (mm)	113
Compression height (mm)	75
Shank length	71,65

Piston pin

	OM 471
Inside diameter (mm)	23.5
Outside diameter (mm)	58
Length (mm)	88

Fuel system

	OM 471
Rail pressure, max. (bar)	900

Crankshaft bearing

	OM 471
Diameter (mm)	114
Width (mm)	36

Connecting rod

	OM 471
Length (mm)	268

Connecting rod bearing

	OM 471
Diameter (mm)	95
Width (mm)	36,4

Crankcase, cylinder liner (wet)

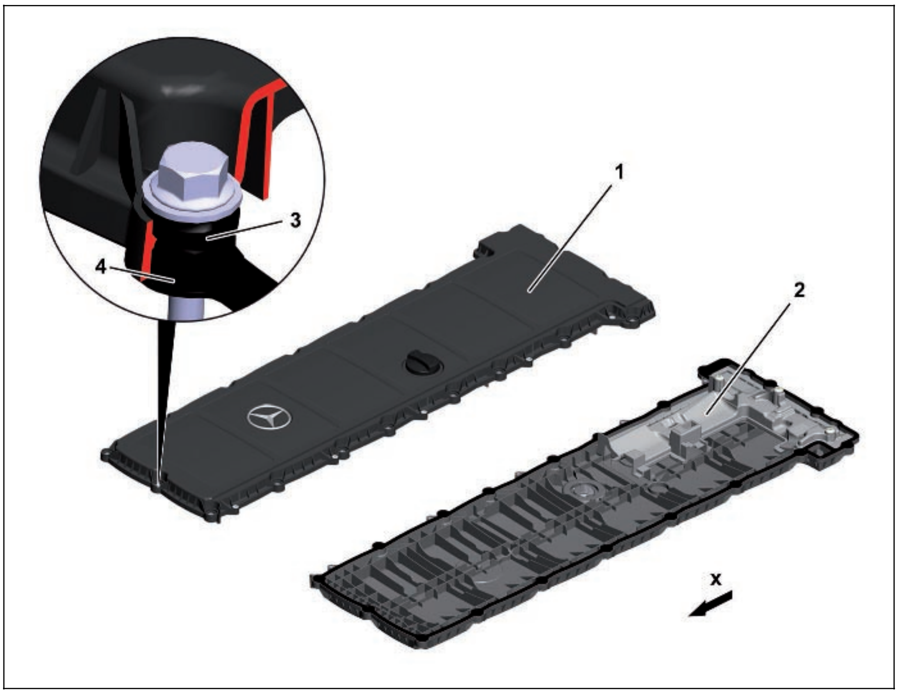
	OM 471
Cylinder diameter (mm)	132
Cylinder distance (mm)	165

GF01.20-W-0801H	Cylinder head cover, as-built configuration	1.7.11

ENGINES 471.9

1 Cylinder head cover
2 Prefilter
3 Elastomer element
4 Elastomer seal

x Direction of travel



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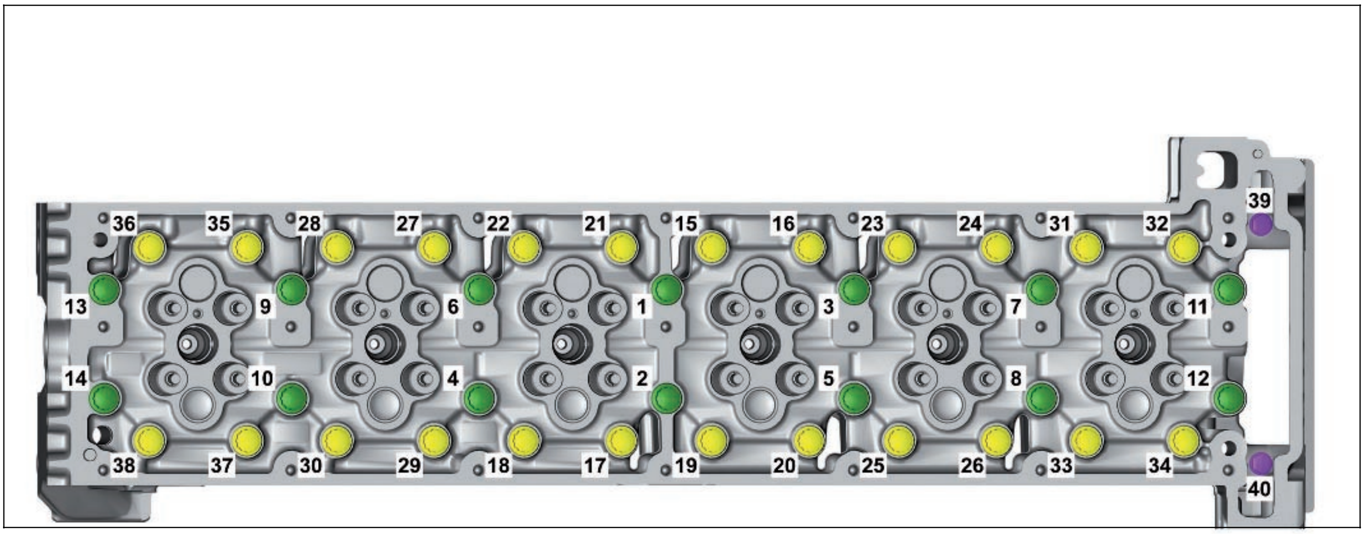
The cylinder head cover (1) consists of plastic and, on the one hand, prevents ingress of water and foreign objects into the valve assembly. On the other hand it seals the camshaft case to the outside using an elastomer seal (4) and prevents escape of the engine oil used to lubricate the valve assembly.
A prefilter (2) is integrated in the cylinder head cover (1). The prefilter (2) ensures that the engine oil which is swirled by the valve assembly and mixes with the blow-by gases is roughly separated before the blow-by gases are passed on to the oil separator for the crankcase ventilation system.

For acoustic decoupling of the cylinder head cover (1) an elastomer element (3) is inserted in all through holes which serve to attach the cylinder head cover (1) to the camshaft case. The elastomer elements (3) reduce noise emissions and possible damage which can occur due to vibrations.

GF01.30-W-0800H	Cylinder head, as-built configuration	1.7.11

ENGINES 471.9

The engine OM 471 has a one-piece cylinder head.
There are two intake valves and two exhaust valves for each cylinder in the cylinder head. The narrow engine design means that overall a symmetrical location of the valves can ensue. This symmetrical valve pattern is optimum for the combustion.



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Tightening procedure for cylinder head bolts

1 - 38 Cylinder head bolt (M15×2)
39 Bolt (M10)
40 Bolt (M10)

Cylinder head bolts

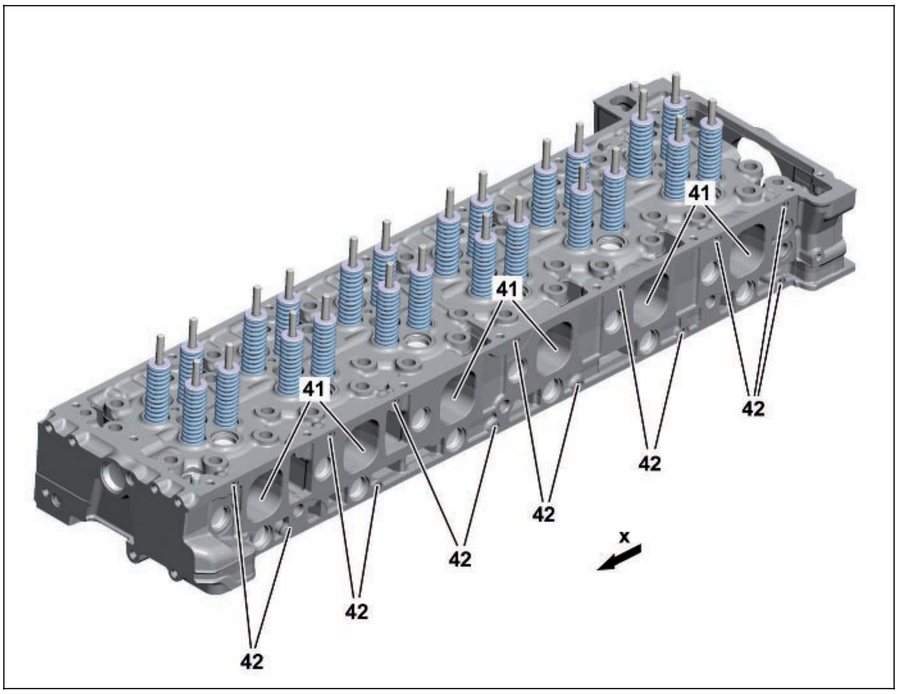
In order to ensure that the correct bolts are used when installing the cylinder head, on each bolt head there is an embossing which provides information on the thread strength of the respective cylinder head bolt.
The cylinder head bolts have the M15 2 thread and therefore have the embossing "15".
All the cylinder head bolts must be tightened in four stages as per a set tightening pattern. The tightening torques and the tightening angle can be obtained from the repair instructions.

As the cylinder head bolts elongate due to assembly, the shank length for each bolt which has already been used once must be measured before it is reassembled.
The relevant bolt must be replaced when the permissible shank length is exceeded.

[i] The cylinder head bolts are no longer assembled when the valve assembly is mounted. The valve assembly must be removed before dismantling the cylinder head.

41 *Intake ports*
42 *Threaded holes for the charge air manifold attachment*

x *Direction of travel*



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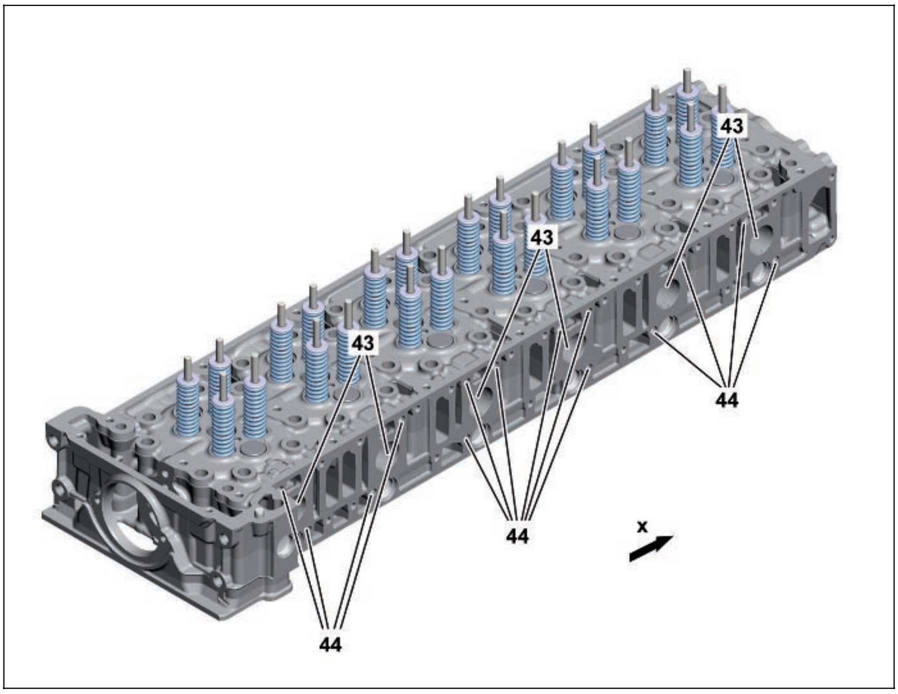
43 *Exhaust ducts*
44 *Threaded holes for the charge air manifold attachment*

x *Direction of travel*



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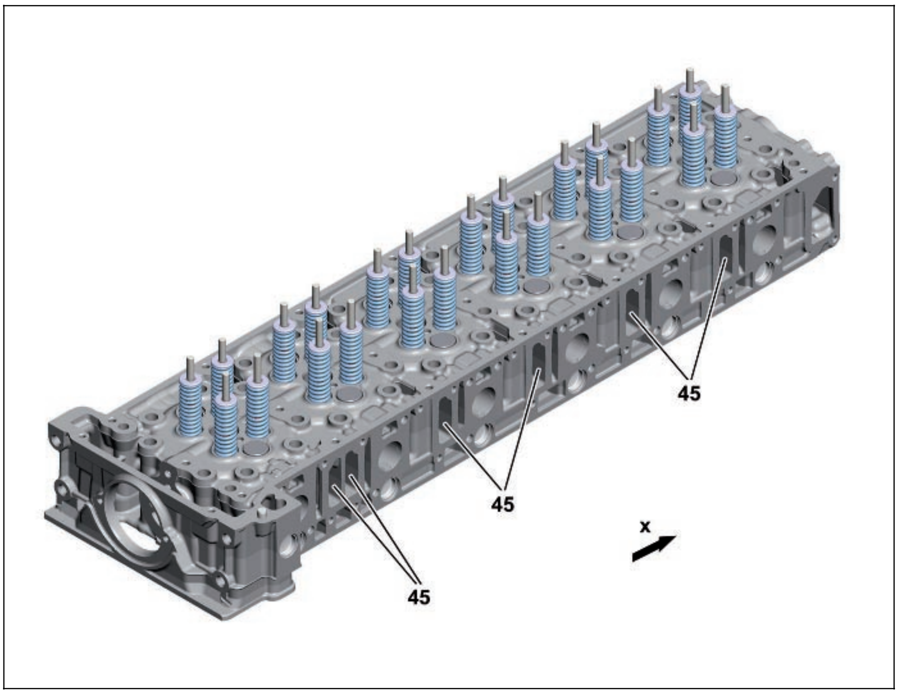
45 Connectors for coolant collector block

x Direction of travel



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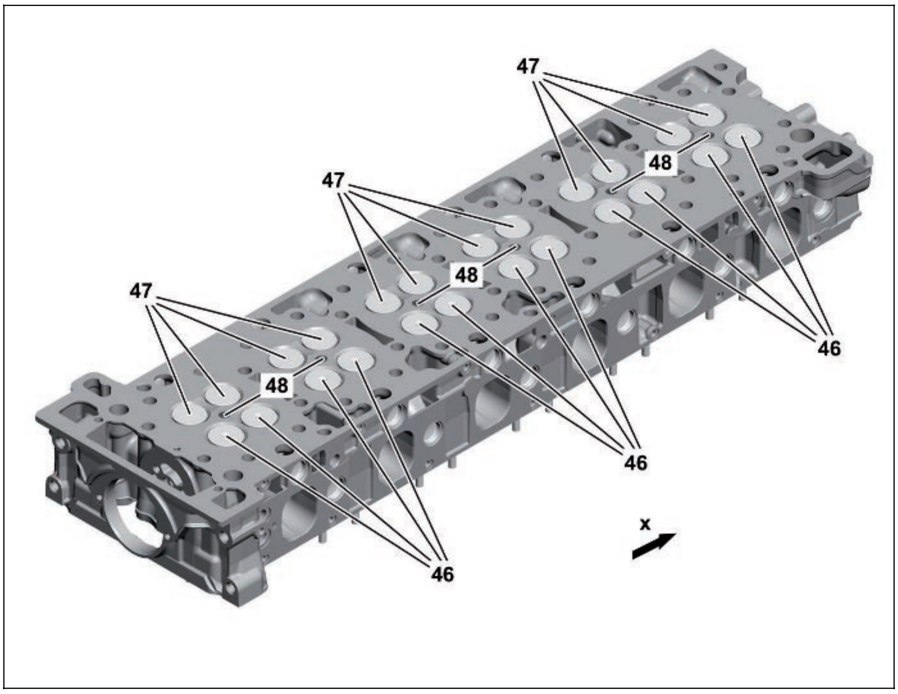
46 Inlet valves
47 Exhaust valves
48 Bores for the fuel injectors

x Direction of travel



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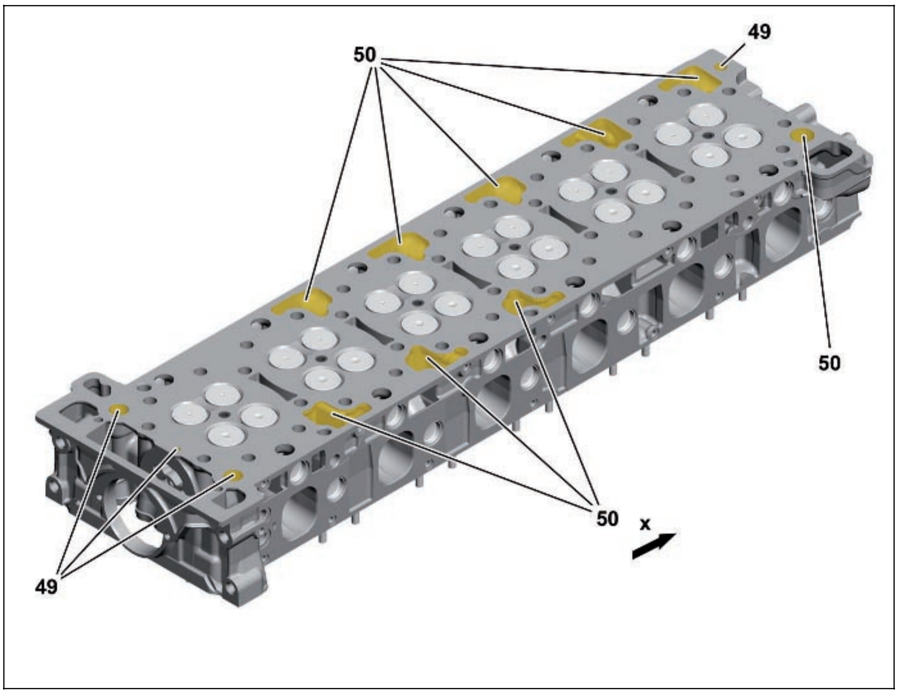
49 Oil overflow holes from cylinder crankcase to cylinder head
50 Oil return flow openings or oil return flow holes from cylinder head to cylinder crankcase

x Direction of travel



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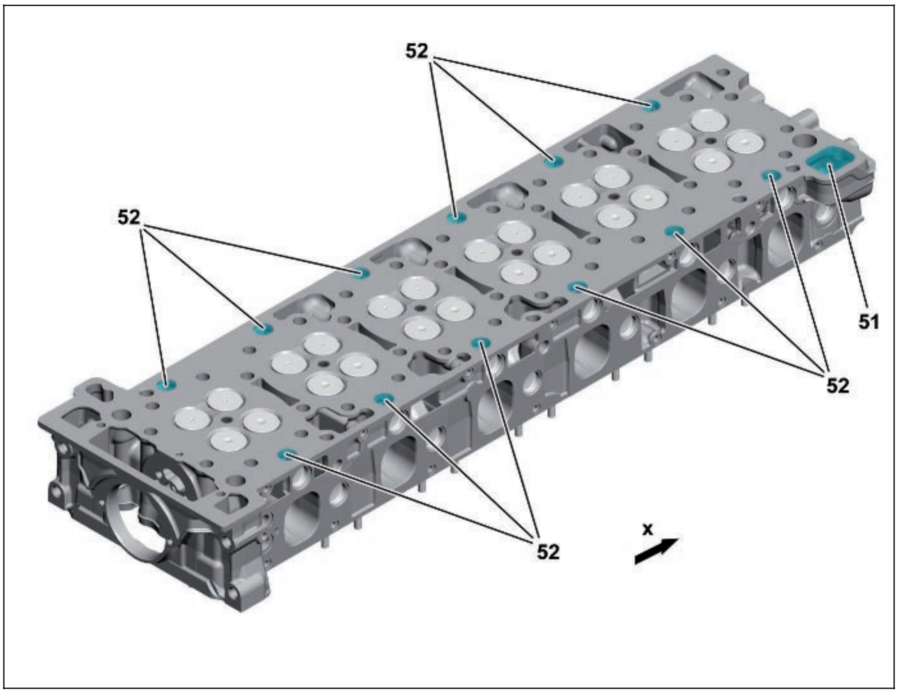
51 Coolant short-circuit channel from cylinder head to cylinder crankcase
52 Coolant overflow holes from cylinder crankcase to cylinder head

x Direction of travel



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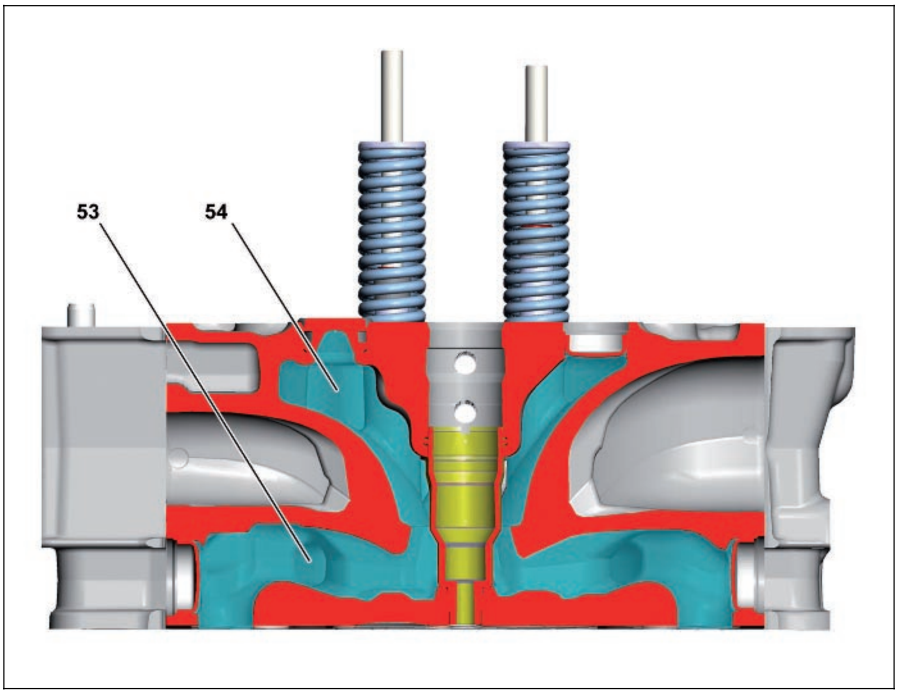
Cooling levers
53 Lower cooling level
54 Upper cooling level



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Cooling

The cylinder head has a divided coolant jacket. This means that the coolant, after it has flushed around the cylinders, flows into the cylinder head on the inlet side and on the exhaust side. The advantage is that the coolant first flushes around the fuel injectors and valve seat rings in the lower cooling level (53) of the cylinder head.

After this the coolant flows into the upper cooling level (54) of the cylinder head and cools the valve guides. The coolant is collected there and directed outwards.

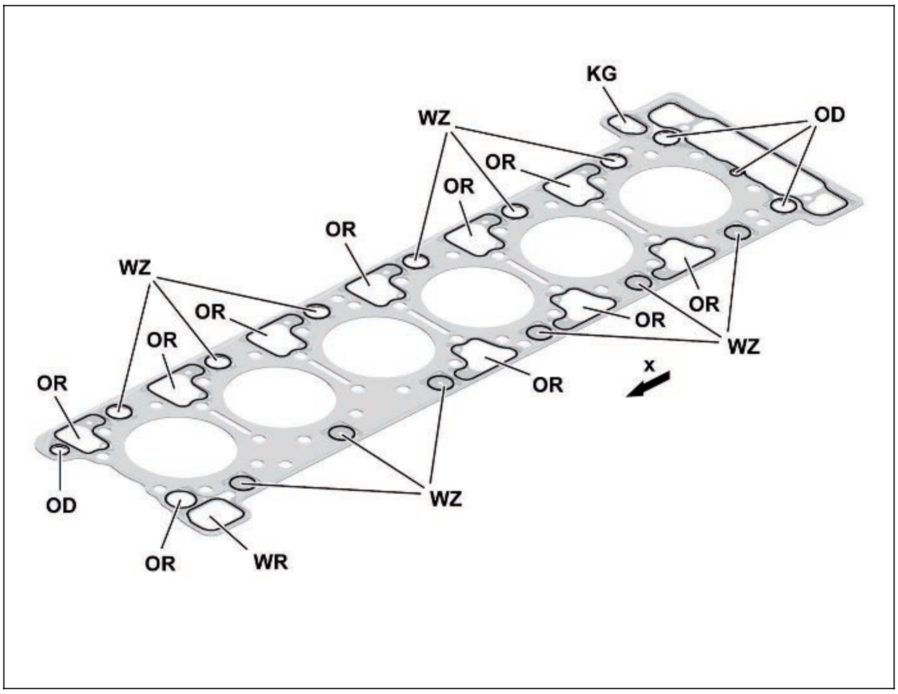
GF01.30-W-0801H	Cylinder head gasket, as-built configuration	1.7.11

ENGINES 471.9

Upper side of the cylinder head seal

OD Engine oil feed openings
OR Engine oil return opening
WR Coolant bypass duct opening
WZ Coolant feed opening
KG Opening for the blow-by duct to the crankcase ventilation system

x Direction of travel



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The cylinder head gasket consists of a number of layers of stainless steel.
The cylinder head gasket at the engine oil feed openings (OD) and at the coolant feed opening (WZ) is fitted with raised elastomer elements through which the seal between the cylinder head and the cylinder crankcase is improved.

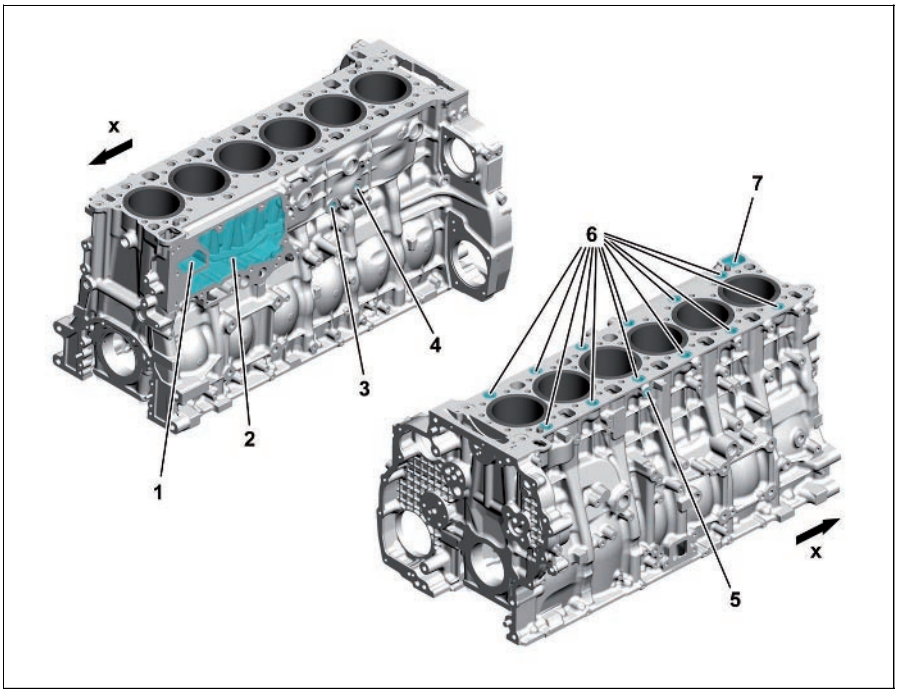
GF01.40-W-0802H	Crankcase as-built configuration	1.7.11

ENGINES 471.9

Crankcase from above, shown with coolant ducts

1 Coolant bypass duct
2 Recess for oil-water heat exchanger
3 Coolant connection for fuel cooler
4 Coolant connection for compressor
5 Coolant connection for exhaust gas recirculation positioner
6 Coolant overflow holes to the cylinder head
7 Coolant return from the cylinder head

x Direction of travel



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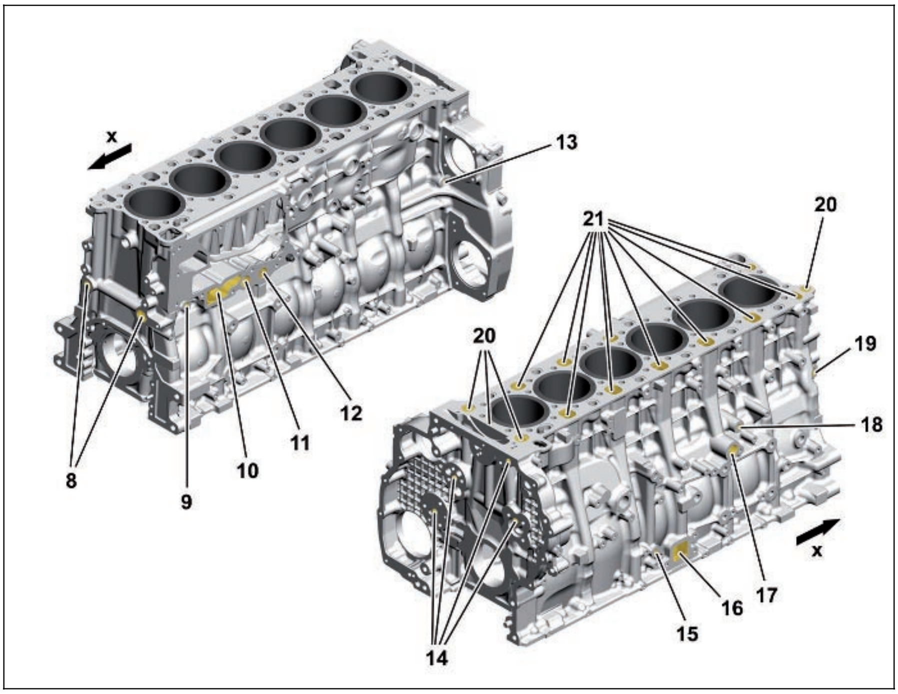
Crankcase from above, shown with oil ducts

8 Oil hole closed longitudinally
9 Connection for the oil pressure sensor
10 Oil return duct from oil filter (for changing the oil filter)
11 Oil feed from oil/coolant module (from oil filter) to crankcase
12 Oil feed from crankcase (from the oil pump) to oil/coolant module
13 Oil hole closed off laterally
14 Bores for oil supply to the gear drive



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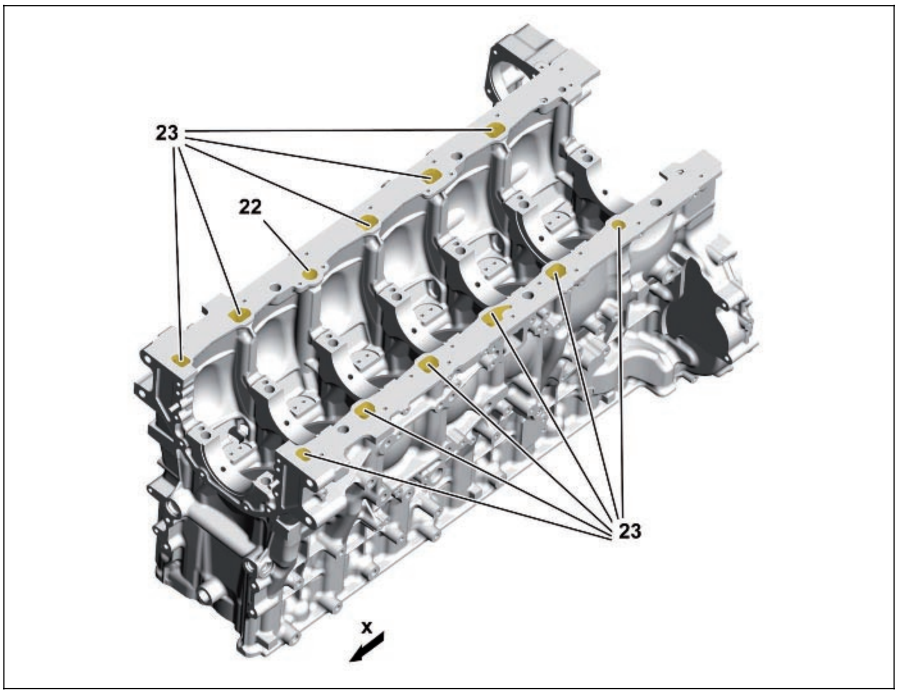
15 Connection for oil supply of the centrifuge on the oil separator to the crankcase ventilation system
16 Oil return duct from oil separator for crankcase ventilation system
17 Oil return duct from turbocharger
18 Connection for oil supply to the turbocharger
19 Oil hole closed off laterally
20 Oil overflow holes to the cylinder head
21 Oil return ducts from cylinder head

x Direction of travel

Crankcase from below, shown with oil ducts

22 Oil return duct to oil/coolant module
23 Oil return ducts to oil pan

x Direction of travel

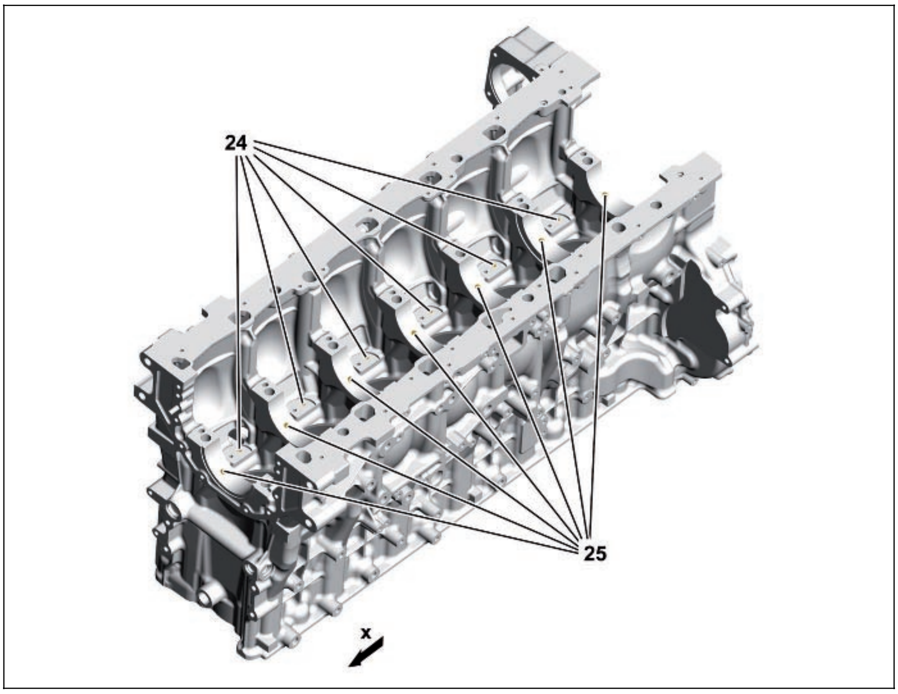


W01.40-1146-76

Crankcase from below, shown with oil ducts

24 Bores for oil supply to the oil spray nozzles
25 Bores for oil supply to the main bearing, crankshaft and connecting rod bearing

x Direction of travel



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The crankcase consists of cast iron and is characterized by the following features:

- a high rigidity and low noise emissions due to the vertical and horizontal reinforcements, as well as due to the design form of the oil return ducts
- a compact design due to the low distance from the cylinder

The crankcase also has 1.5 mm recesses at the sealing surface to the cylinder head for all coolant overflow holes to the cylinder head (6) and for all oil overflow holes to the cylinder head (20). These serve to receive the respective elastomer elements in the cylinder head gasket.

The following major assemblies and components are located on the crankcase:

Right-hand side

- Turbocharger
- Starter
- Oil separator for crankcase ventilation system

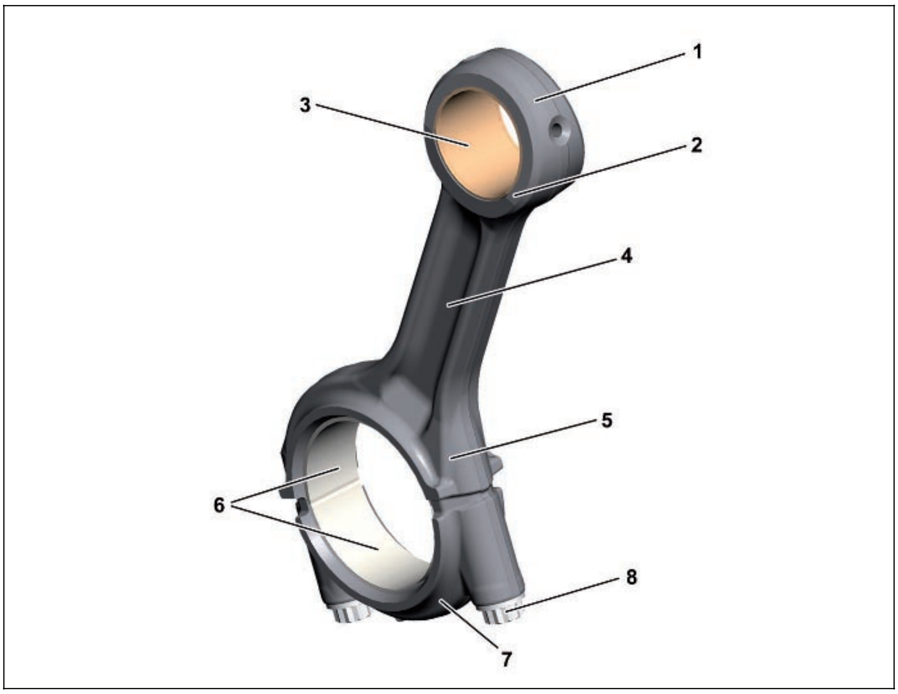
Left-hand side

- Oil/coolant module
- Engine management (MCM) control unit
- Fuel filter module
- Fuel high pressure pump
- Compressor, power steering pump

GF03.10-W-0800H	Connecting rod, as-built configuration	1.7.11

ENGINES 471.9

1 Connecting rod
2 Connecting rod small end (small)
3 Connecting rod bushing
4 Connecting-rod shank
5 Connecting rod big end
6 Connecting rod bearing shells
7 Connecting rod bearing cap
8 Stretch bolt



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The connecting rods are forged in steel and are characterized by their high strength.

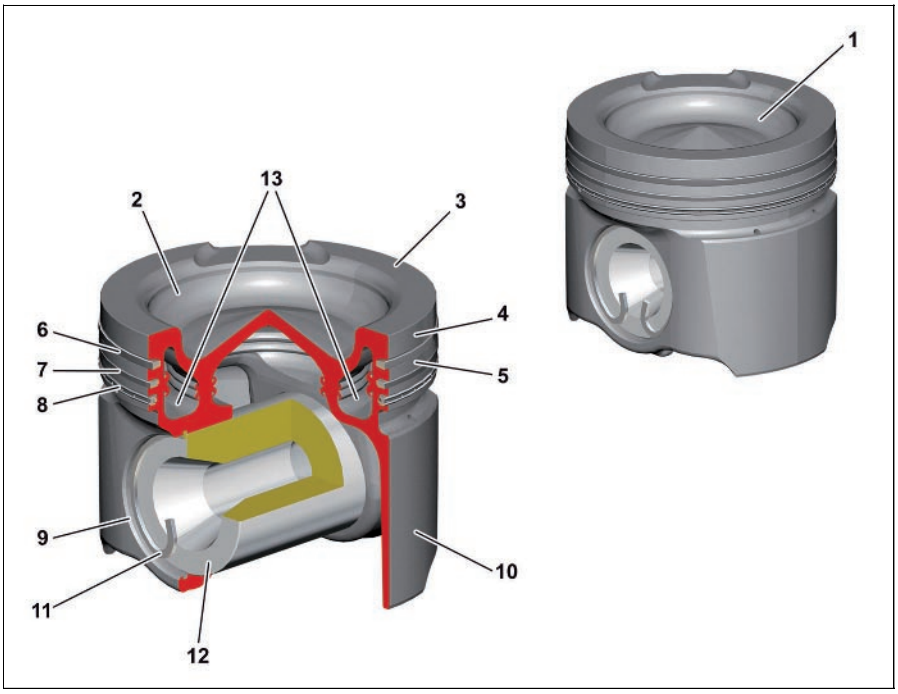
The connecting point between the connecting rod (1) and the connecting rod bearing cap (7) is cracked. This has the advantages, amongst other things, that one has no offset after screwing together both parts and the connecting rod bearing cap (7) cannot slip.

A connecting rod bushing (3) is pressed into a small connecting rod small end (2).

GF03.10-W-0801H	Piston, as-built configuration	2.8.11

ENGINE 471.9

1 *Piston*
2 *Combustion recess*
3 *Piston crown*
4 *Top land*
5 *Piston ring zone*
6 *1st piston ring*
7 *2nd piston ring*
8 *Oil scraper ring*
9 *Bolt eye*
10 *Piston skirt*
11 *Piston bolt circlip*
12 *Piston pin*
13 *Cooling duct*



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Feature

	OM 471
Version	Two piece
Material	Steel
Weight (with spring steel sheet)	3,339 KG
Piston diameter	132 mm
Bolt diameter	58 mm
Surface	friction optimized

Piston (1)
The piston (1) consists of a forged upper section and a forged lower section, which are connected to each other by means of a friction weld.

Piston crown (3)
The piston crown (3) is fitted with a combustion recess (2). Through the combustion recess (2) the clearance volume is partially transferred into the piston (1).

Top land (4)
The top land (4) protects the 1st piston ring (6) against excessively heating during the combustion process.

Piston ring zone (5)
The 1st piston ring (6), the 2nd piston ring (7) and the oil scraper ring (8) are located in the piston ring zone (5).
The 1st piston ring (6), the 2nd piston ring (7) take on the task of fine sealing to the crankcase.
The oil scraper ring (8) wipes off excess oil on the cylinder wall and leads the oil back into the oil pan.

Piston skirt (10)
The piston skirt (10) serves to guide the piston (1) into the cylinder liner. It transfers the lateral forces to the cylinder wall.
Located in the piston skirt (10) is the bolt eye (9) which supports the piston pin (12).

Cooling
The piston (1) is cooled via an oil spray nozzle for each cylinder located in the crankcase.
The oil spray nozzle continuously sprays engine oil into an injection opening in the cooling duct (13). Due to the coaxial spray direction of the oil spray nozzle the greatest possible throughput of engine oil is achieved in the cooling duct (13) and thus cooling of the piston is improved significantly.
One further opening which is located on the opposite side serves as a drain.

Additional bores in the cooling duct (13) serve to achieve better lubrication of the piston pin (12) and the connecting rod bearing bushing.

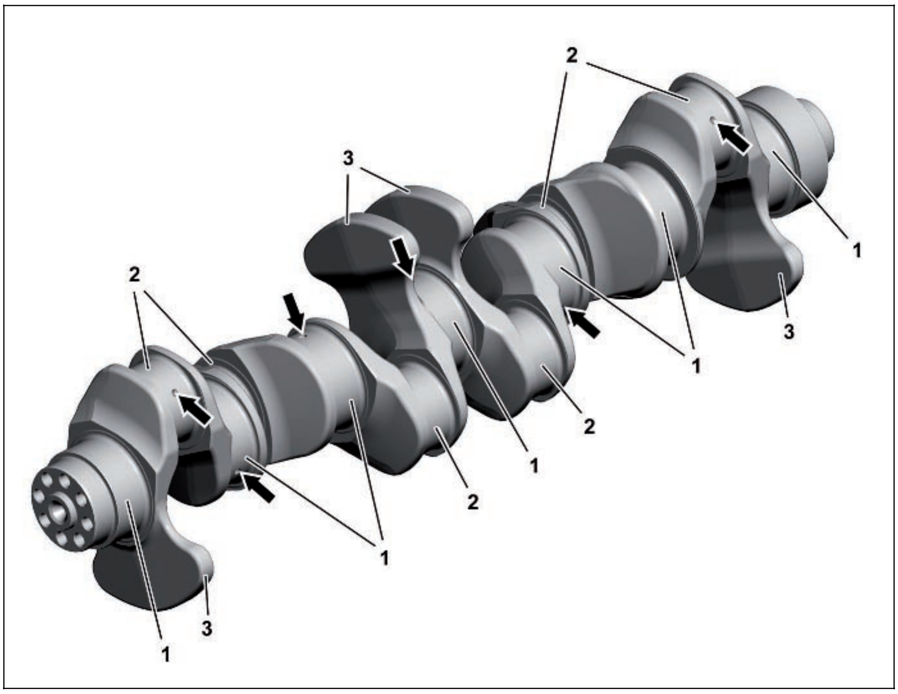
Protecting the contact surfaces
In order to protect the contact surfaces the friction, above all in the startup phase of the engine, is reduced by the applied protective coatings. This allows a longer working life and engine damage is avoided by the emergency running characteristics which result from the coating if the lubrication is faulty.

GF03.20-W-0800H	Crankshaft, as-built configuration	2.8.11

ENGINE 471.9

1 Crankshaft bearing journals
2 Connecting rod bearing journals
3 Counterweight

Arrows Oil holes



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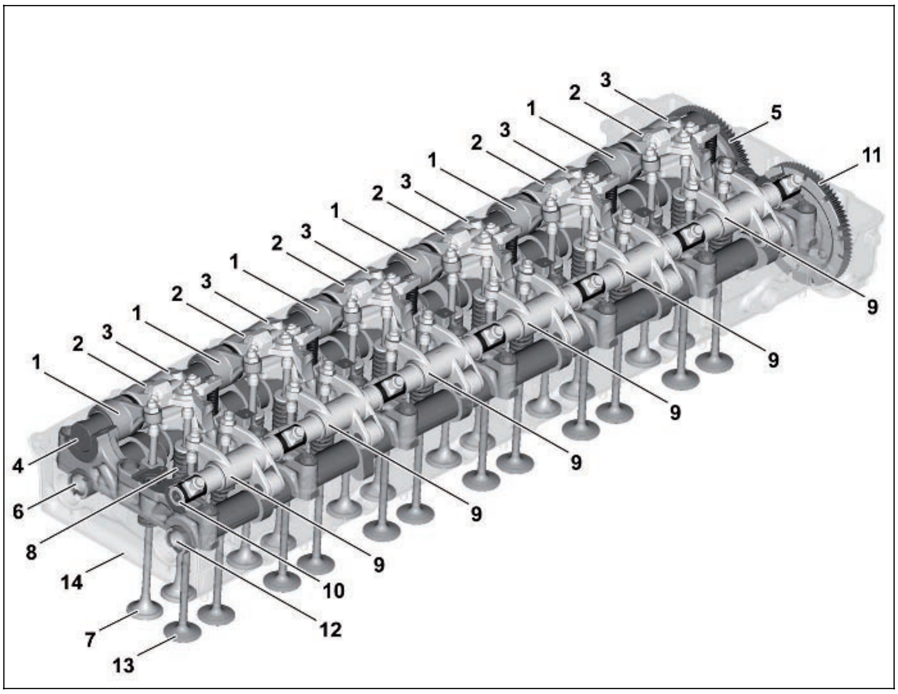
The crankshaft is mounted in the crankcase with 7 crankshaft bearing journals (1).
Counterweights (3) are forged onto the webs to avoid vibrations arising.
The crankshaft bearing journals (1) and the connecting rod journals (2) are inductively hardened and ground in the surface layer.

There are oil holes (arrows) on the crankshaft bearing journals (1) and on the connecting rod journal (2) over which the crankshaft bearing and connecting rod bearing are lubricated.

GF05.00-W-0800H	Valve control; as-built configuration	1.7.11

ENGINES 471.9

Valve control overall
1 Exhaust rocker arm
2 Exhaust rocker arm with hydroelement
3 Brake rocker arm
4 Exhaust rocker arm spindle
5 Drive gear for exhaust camshaft
6 Exhaust camshaft
7 Outlet valve
8 Valve spring
9 Intake rocker arm
10 Intake rocker arm spindle
11 Drive gear for intake camshaft
12 Intake camshaft
13 Inlet valve
14 Camshaft frame



W05.00-1033-06

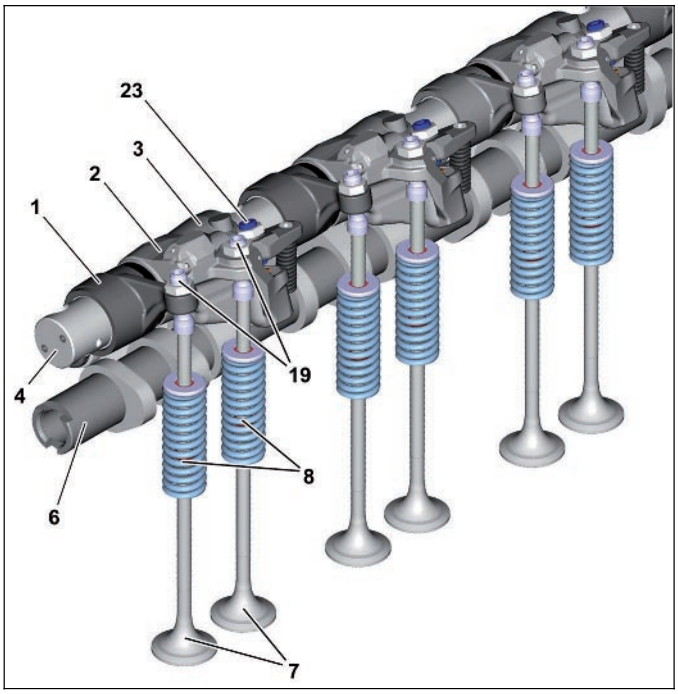
The gas exchange system in the combustion chambers is controlled via the valve control.

Components of the valve control include:

- Two upper recumbent camshafts - the intake camshaft (12) and the exhaust camshaft (6), which are driven by the gear drive via the pinion gear drive for the intake camshaft (11) or via the pinion gear drive for the exhaust camshaft (5)
- Two rocker arm spindles - the intake rocker arm spindle (10) and the exhaust rocker arm spindle (4) on which the intake rocker arm (9) or exhaust rocker arm (1), the exhaust rocker arm with hydroelement (2) as well as the brake rocker arm (3) are mounted
- Two exhaust valves (7) and two intake valves (13) per cylinder which are located symmetrically and pressed onto their seat via the valve springs (8) if they are not actuated by the corresponding rocker arm.

Valve control on the exhaust side

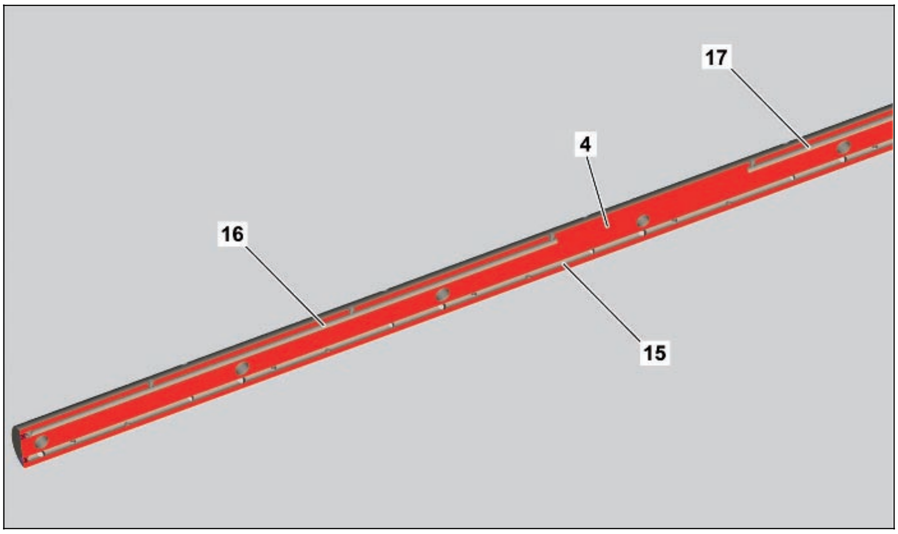
1 *Exhaust rocker arm*
2 *Exhaust rocker arm with hydroelement*
3 *Brake rocker arm*
4 *Exhaust rocker arm spindle*
6 *Exhaust camshaft*
7 *Exhaust valves*
8 *Valve springs*
19 *Adjusting elements for adjusting the valve clearance*
23 *Adjusting element for engine brake*



W05.00-1034-82

Design of the exhaust rocker arm spindle (4)

4 *Exhaust rocker arm spindle*
15 *Lubricating oil duct*
16 *Oil duct for cylinders 1 and 3*
17 *Oil duct for cylinders 4 and 6*



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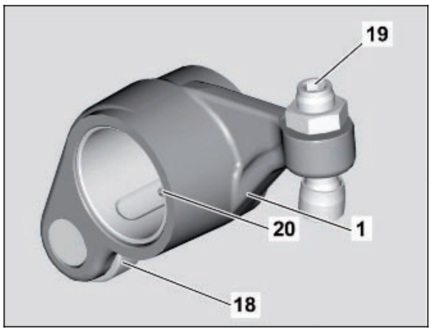

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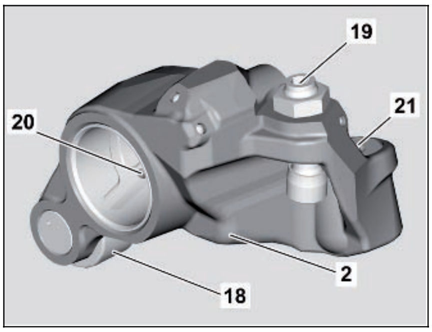

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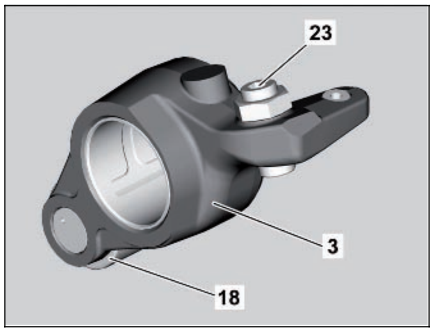


W05.00-1038-01

Design of the rocker arm

1 Exhaust rocker arm
18 Rocker arm roller
19 Adjusting element for adjusting the valve clearance
20 Oil inlet hole

2 Exhaust rocker arm with hydroelement
18 Rocker arm roller
19 Adjusting element for adjusting the valve clearance
20 Oil inlet hole
21 Piston

3 Brake rocker arm
18 Rocker arm roller
23 Adjusting element for engine brake

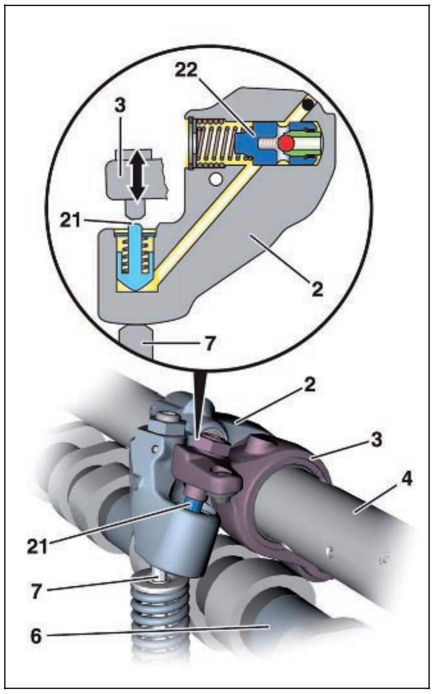
The valve control of the exhaust side is characterized by the fact that every cylinder has three rocker arms - one exhaust rocker arm (1), one exhaust rocker arm with hydroelement (2) and one brake rocker arm (3).
All rocker arms are fitted with a rocker arm roller (18). Use of rocker arm rollers (18) means that wear between the respective actuation cams of the exhaust camshaft (6) and the corresponding rocker arm is reduced. The noise emission of the valve assembly is also reduced.

The exhaust rocker arm (1) and exhaust rocker arm with hydroelement (2) are each equipped with an adjusting element for adjusting the valve clearance (19). The clearance between the brake rocker arm (3) and exhaust rocker arm with hydroelement (2) is set using the adjusting element for the engine brake (23).
The exhaust rocker arm (1), exhaust rocker arm with hydroelement (2) and brake rocker arm (3) are mounted rotatable on the exhaust rocker arm spindle (4).
The exhaust rocker arm spindle (4) is made out of solid material due to the higher loads in the engine brake system and is fitted with oil ducts - a lubricating oil duct (15) and two oil ducts for operation of the engine brake.

Exhaust valve control for a deactivated engine brake

2 Exhaust rocker arm with hydroelement
3 Brake rocker arm
4 Exhaust rocker arm spindle
6 Exhaust camshaft
7 Outlet valve
21 Piston
22 Check valve

Rotational movement of the camshaft is converted into linear travel by the exhaust cam on the exhaust camshaft (6) and transferred to the associated exhaust rocker arm on the exhaust rocker arm spindle (4). The exhaust rocker arms steer the linear travel in turn onto the respective exhaust valves (7) which are opened and then closed again by the valve springs.
Because the pistons (21) are pressed by a spring to their lower limit stop when the engine brake is deactivated, no contact takes place between the brake rocker arms (3) and the exhaust rocker arms with hydroelement (2) and the brake rocker arms (3) run in idle. This serves to prevent any unnecessary piston (21) motion and therefore any unnecessary wear.

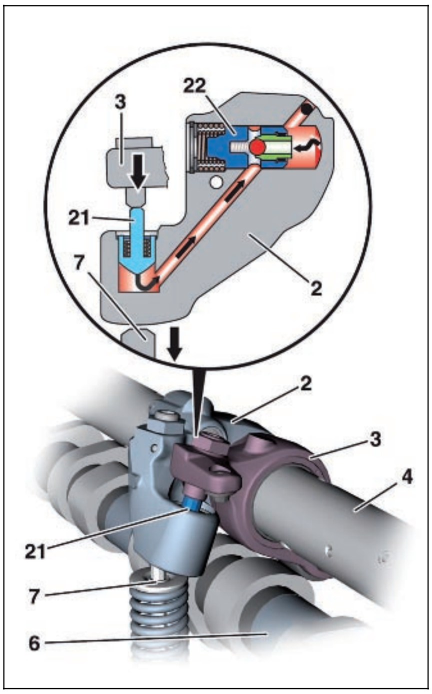


W05.00-1024-73

Exhaust valve control for an activated engine brake

2	*Exhaust rocker arm with hydroelement*
3	*Brake rocker arm*
4	*Exhaust rocker arm spindle*
6	*Exhaust camshaft*
7	*Outlet valve*
21	*Piston*
22	*Check valve*

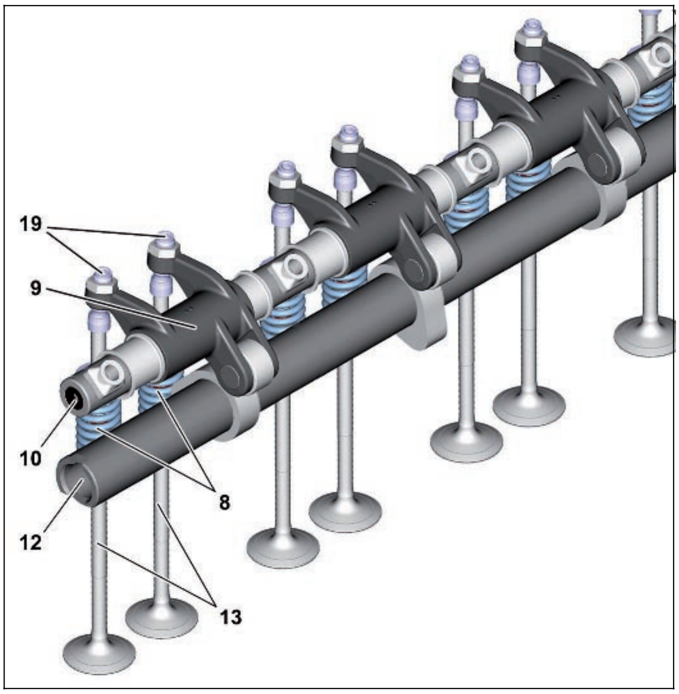
When in engine brake operation up to six exhaust valves (7), one per cylinder are opened as follows, according to the engine brake stage, by the brake cam of the exhaust camshaft (6): The corresponding exhaust rocker arms with hydroelement (2) have oil pressure applied to them in engine brake operation via the oil inlet hole (20). If the corresponding brake rocker arm (3) now presses on the piston (21), the check valve (22) is closed by the increased oil pressure. Depressurization is prevented and the downward movement of the respective brake rocker arm (3) is transmitted by the piston (21) onto the associated exhaust rocker arm with hydroelement (2) which opens the respective exhaust valve (7).



W05.00-1025-73

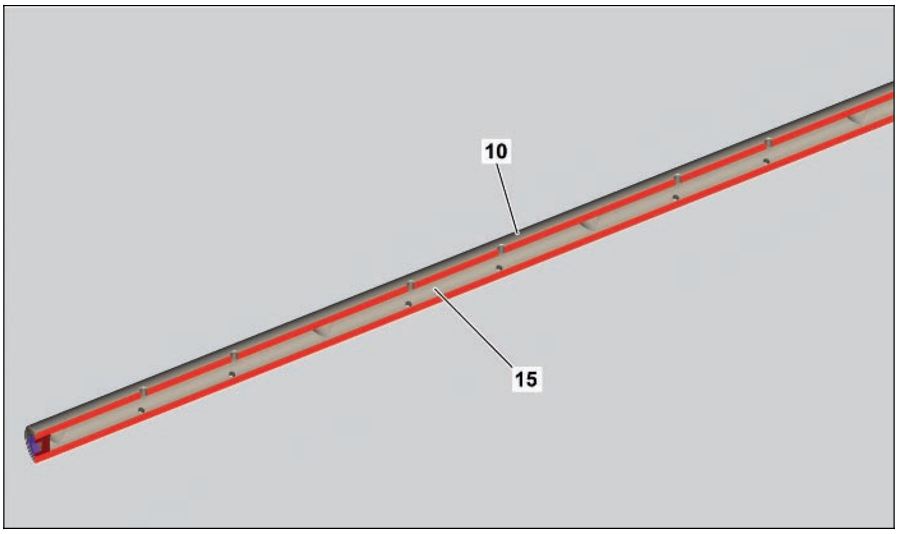
Valve control on the inlet side

8	*Valve springs*
9	*Intake rocker arm*
10	*Intake rocker arm spindle*
12	*Intake camshaft*
13	*Inlet valves*
19	*Adjusting elements for adjusting the valve clearance*



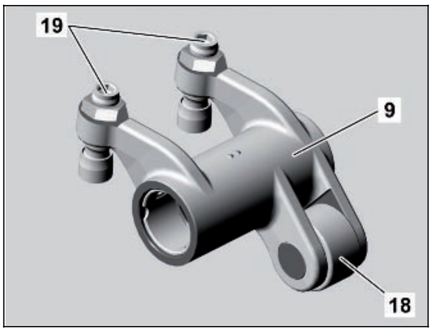
W05.00-1039-82

As-built configurations



W05.00-1040-75

Design of the intake rocker arm spindle (10)
10 Intake rocker arm spindle
15 Lubricating oil duct



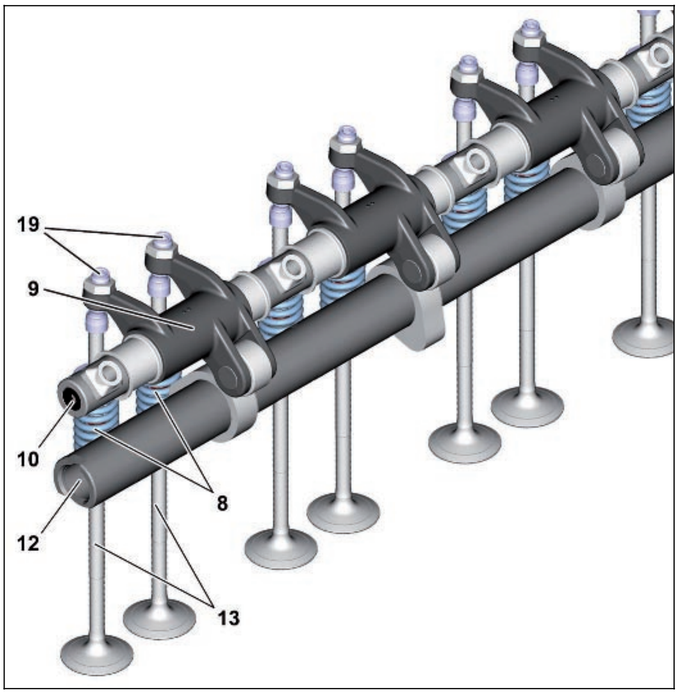
W05.00-1041-01

Design of the intake rocker arm (9)
9 Intake rocker arm
18 Rocker arm roller
19 Adjusting elements for adjusting the valve clearance

Every cylinder is assigned to an intake rocker arm (9) for valve timing for the inlet side over which the two intake valves (13) are actuated respectively.
All intake rocker arm (9) are fitted with a rocker arm roller (18). Use of rocker arm rollers (18) means that wear between the respective actuation cams of the intake camshaft (12) and the corresponding intake rocker arm (9) is reduced. The noise emission of the valve assembly is also reduced.
The intake rocker arms (9) are mounted rotatable on the intake rocker arm spindle (10).
The intake rocker arm spindle (10) is made out of pipe material for weight reduction and is fitted with a lubrication oil duct (15).
Each intake rocker arm (9) is fitted with two adjusters for adjusting the valve clearance (19).

Exhaust valve control
8 Valve springs
9 Intake rocker arm
10 Intake rocker arm spindle
12 Intake camshaft
13 Inlet valves
19 Adjusting elements for adjusting the valve clearance

Rotational movement of the camshaft is converted into linear travel over the cam on the intake camshaft (12) and on the associated exhaust rocker arm (9) on the exhaust rocker arm spindle (10). The intake rocker arms (9) in turn steer the linear travel onto the respective intake valves (13) which are opened and then closed again by the valve springs (8).



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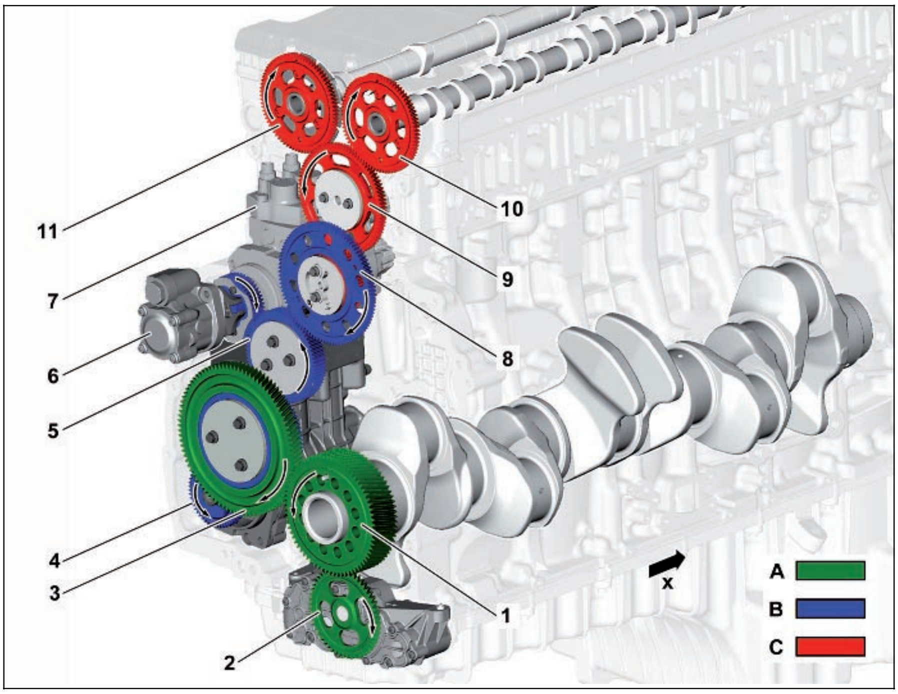
GF05.10-W-0801H	Gear drive, as-built configuration	1.7.11

ENGINES 471.9 in MODEL 963

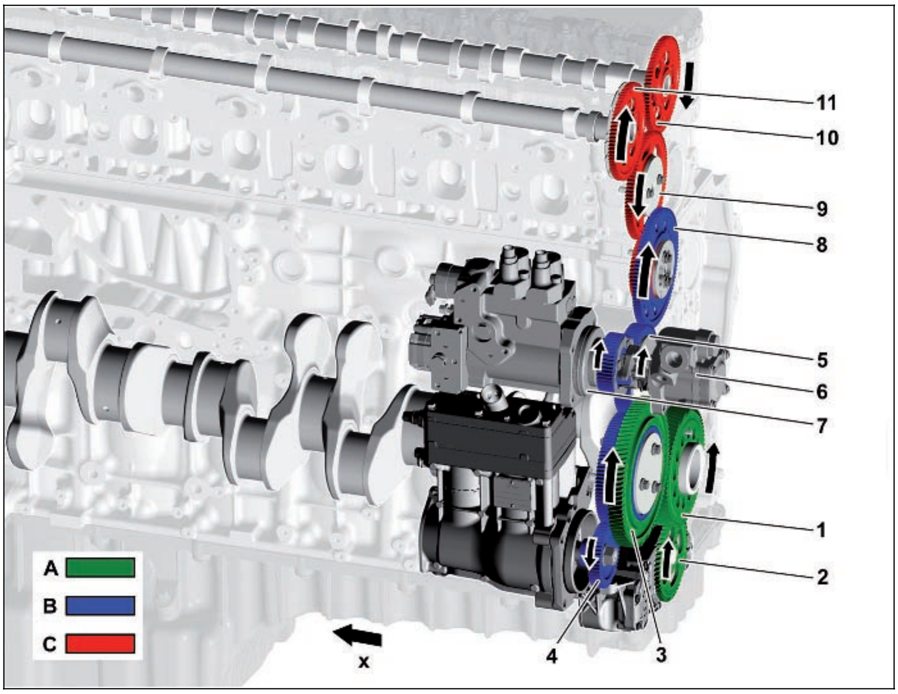


W01.40-1132-76

1 Crankshaft
2 Oil pump
3 Double intermediate wheel
4 Compressor
5 Intermediate gear
6 Power steering pump
7 Fuel high pressure pump
8 Double intermediate wheel
9 Intermediate gear
10 Exhaust camshaft
11 Intake camshaft

A Level 1
B Level 2
C Level 3

x Direction of travel



W01.40-1133-76

1 Crankshaft
2 Oil pump
3 Double intermediate wheel
4 Compressor
5 Intermediate gear
6 Power steering pump
7 Fuel high pressure pump
8 Double intermediate wheel
9 Intermediate gear
10 Exhaust camshaft
11 Intake camshaft

A Level 1
B Level 2
C Level 3

x Direction of travel

As-built configurations

General
The gear drive is located on the output side of the engine. This design allows the majority of major assemblies to be placed on the engine side.
The following components and major assemblies are driven by the crankshaft (1) via the gear drive:

- Oil pump (2)
- Double intermediate gear (3)
- Compressor (4)
- Intermediate gear (5)
- Power steering pump (6)
- Fuel high pressure pump (7)
- Double intermediate gear (8)
- Intermediate gear (9)
- Exhaust camshaft (10)
- Intake camshaft (11)

The driving power for the individual major assemblies and components is spatially transferred to the following levels:

- Level 1 (A)
- Level 2 (B)
- Level 3 (C)

Level 1 (A)
Level 1 (C) includes the drive gear for the crankshaft (1), the drive gear for the oil pump (2) and the double intermediate wheel (3).
The gears for level 1 (A) are helically geared.

Level 2 (B)
Level 2 (B) includes the intermediate gear (5), the double intermediate gear (8) as well as the drive gear for the fuel high-pressure pump (7) and the compressor (4).
The gears for level 2 (A) are straight geared.

Level 3 (C)
Level 3 (C) includes the intermediate gear (9), the drive gear for the exhaust camshaft (10) and the drive gear for the intake camshaft (11).
The gears for level 3 (A) are straight geared.

Torque curve
The drive for the gear drive takes place over the crankshaft (1):
The drive gear for the crankshaft (1) drives the gears of Level 1 (A), that is the drive gear for the oil pump (2) and the double intermediate wheel (3).
The gears for
Level 2 (B), that is the drive gear for the compressor (4) and the intermediate gear (5) are driven over the double intermediate gear (3), and the double intermediate gear (8) and the drive gear for the fuel high-pressure pump (7) are driven over the intermediate gear (5).

The double intermediate gear (8) drives the gears for level 3 (C), that is the intermediate gear (9), and via the intermediate gear (9), the drive gear of the exhaust camshaft (10) and the drive gear of the intake camshafts (11).

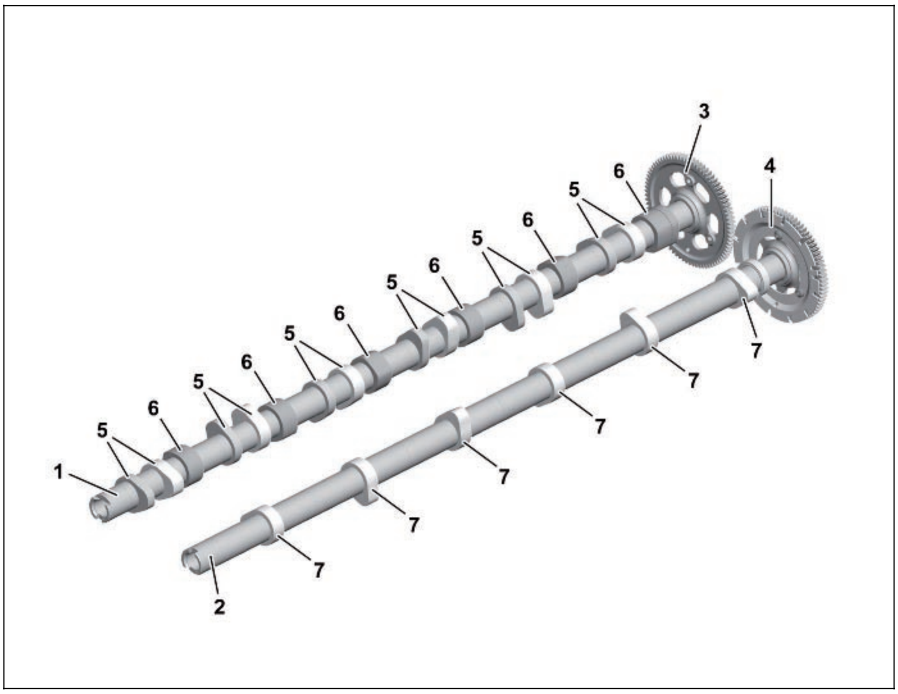
The power steering pump (6) is driven over a driver by the fuel high-pressure pump (7).

[i] The gear drive can be adjusted using a suitable special tool.

GF05.20-W-0800H	Camshaft, as-built configuration	1.7.11

ENGINES 471.9

1 *Exhaust camshaft*
2 *Intake camshaft*
3 *Drive gear for exhaust camshaft*
4 *Drive gear for intake camshaft*
5 *Exhaust cams*
6 *Brake cam*
7 *Intake cams*



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The engine OM 471 is the first 6-cylinder inline engine with two overhead camshafts to be used in a Mercedes-Benz commercial vehicle.
The exhaust camshaft (1) and the intake camshaft (2) are driven by the gear drive for the exhaust camshaft (3) and the gear drive for the intake camshaft (4) via the pinion gear drive.

There is an intake cam (7) on the intake camshaft (2) for each cylinder. The corresponding intake valves are opened via the intake cams (7) and the associated intake rocker arms on the intake rocker arm spindle.

There are two exhaust cams (5) and a brake cam (6) on the exhaust camshaft (1) per cylinder.
The corresponding exhaust valves are opened via the exhaust cams (5) and the associated exhaust rocker arms on the exhaust rocker arm spindle.
For an activated engine brake, an exhaust valve is opened per cylinder via the brake cam (6), shortly after beginning and before the end of the respective compression cycle.

GF13.21-W-0800H	Belt drive, as-built configuration	2.8.11

ENGINES 471.9 in MODEL 963, 964

General information

There are two different belt variants for belt drive of engine OM 471:

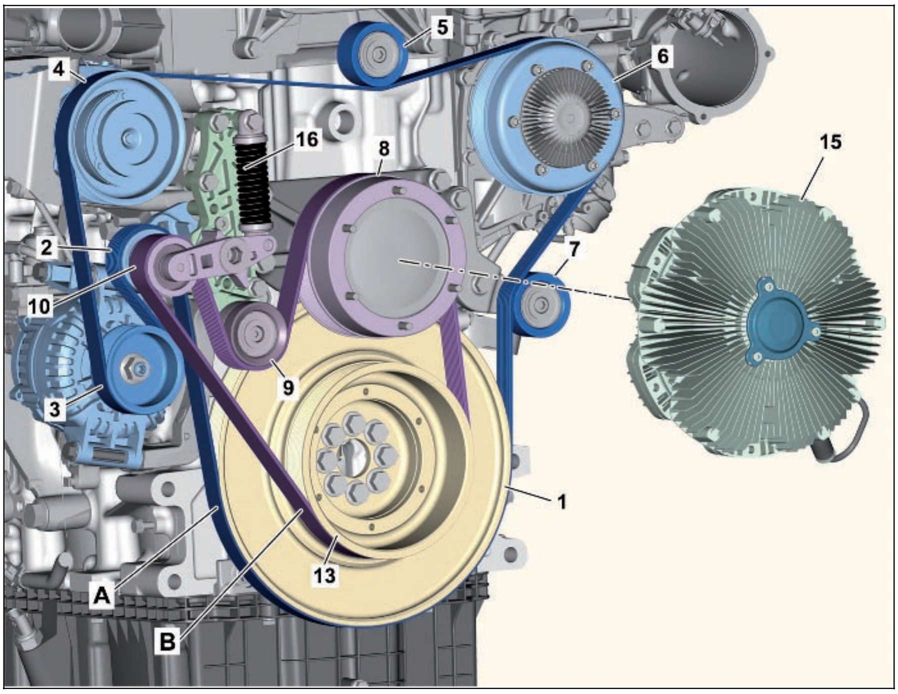
- Engine 471.9 with 2-belt drive (fan raised)
- Engine 471.9 with 3-belt drive (fan on the crankshaft)

The version as a 2 or 3 belt drive variant is dependent on a number of factors including the size of the radiator unit, the positioning height and the installed fan variants.

There is a double-clamping device for both variants, the so-called tandem clamping device, used over which the basic belt drive poly-V belt and the poly-V belt is tensioned by the fan drive.

2-belt drive (fan raised)

1 Belt pulley (on vibration damper)
2 Tensioner pulley for poly-V belt (A) (on the tandem clamping device)
3 Belt pulley (alternator)
*4 Belt pulley (A/C compressor)**
5 Pulley
6 Belt pulley (coolant pump)
7 Pulley
8 Pulley
9 Guide pulley (on the tandem clamping device)
10 Tensioner pulley for poly-V belt (B) (on the tandem clamping device)



W13.21-1015-76

13 Belt pulley (fan drive)
15 Fan clutch
16 Tandem clamping device

A Poly-V belt (basic belt drive)
B Poly-V belt (fan drive)

** if no A/C compressor is installed: backup belt pulley*

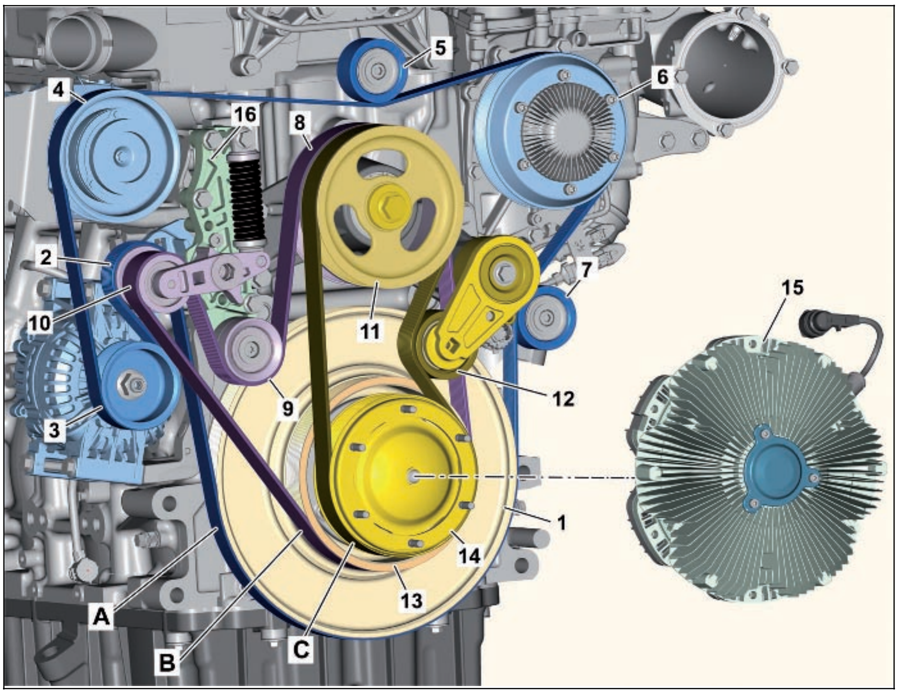
For a 2-belt drive the fan clutch is located on the guide pulley (8) which is in turn located on a bracket above the crankshaft axis. In this case one speaks about a raised fan.

The poly-V belt (A) drives the A/C compressor, the coolant pump and the alternator.

The poly-V belt (B) serves as the drive for the fan. For a rigid fan clutch the gear ratio of the crankcase speed and fan speed i = 1.2.

3-belt drive (fan on crankshaft)

1	*Belt pulley (on vibration damper)*
2	*Tensioner pulley for poly-V belt (A) (on the tandem clamping device)*
3	*Belt pulley (alternator)*
4	*Belt pulley (A/C compressor)**
5	*Pulley*
6	*Belt pulley (coolant pump)*
7	*Pulley*
8	*Pulley*
9	*Guide pulley (on the tandem clamping device)*
10	*Tensioner pulley for poly-V belt (B) (on the tandem clamping device)*
11	*Drive plate (fan drive)*
12	*Tensioning device for fan drive C (fan drive)*
13	*Belt pulley (fan drive)*



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14	*Drive plate (fan drive)*
15	*Fan clutch*
16	*Tandem clamping device*

A	*Poly-V belt (basic belt drive)*
B	*Poly-V belt (fan drive)*
C	*Poly-V belt (fan drive)*

** if no A/C compressor is installed: backup belt pulley*

For a 3-belt drive the fan clutch (15) is mounted on a drive plate (14) which is mounted rotatable on the belt pulley (1). The fan is therefore located on the crankshaft axis.

The poly-V belt (A) drives the A/C compressor, the coolant pump and the alternator.
The poly-V belt (B) and (C) together drive the fan.

The poly-V belt (B) drives the guide pulley (8) which sits on an axle with the drive plate (11). The poly-V belt (C) is driven over the drive plate (11) which in turn drives the drive plate (14) lying on the crankshaft axis.
For a rigid fan clutch the gear ratio of the crankcase speed and fan speed i, also here = 1.2.

GF01.20-W-0001H	Crankcase ventilation system function	1.7.11

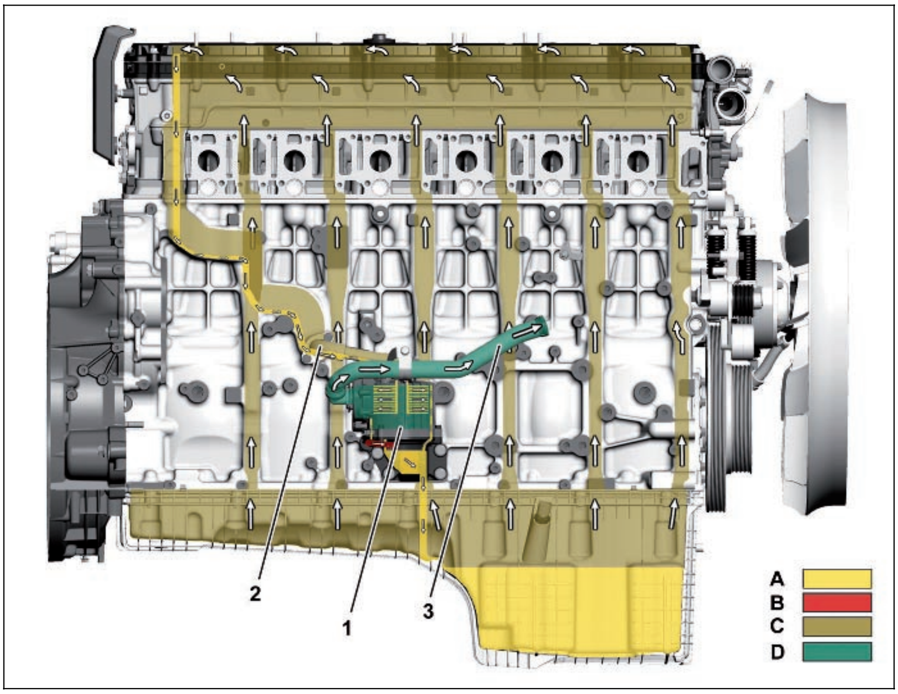
ENGINES 471.9 in MODEL 963

The crankcase ventilation system is responsible for relieving the pressure in the crankcase. To do this the gases are not led out of the crankcase (blow-by gases) but are led into the air intake pipe instead.
Since the blow-by gases contain engine oil it is led into an oil separator so that oil does not get into the air intake pipe.

Sequence of the blow-by gases and the engine oil

1 Oil separator (disk separator)
2 Vent line (from crankcase to oil separator)
3 Vent line (from oil separator to air intake pipe)

A Separated out engine oil
B Engine oil (to drive the centrifuge)
C Blow-by-gas (with engine oil)
D Blow-by-gas (clean)



W01.20-1047-76

The blow-by gas (C) generated by internal leakage at the piston rings, valve stem seals, turbocharger and compressor passes over the vent line (2) into the oil separator (1).
The engine oil separator (1). contained in the blow-by gas (C) is separated off with the aid of a centrifuge.
The separated engine oil (A) runs downward along the inner wall of the oil separator (1) and returns to the oil pan via the engine oil drain.

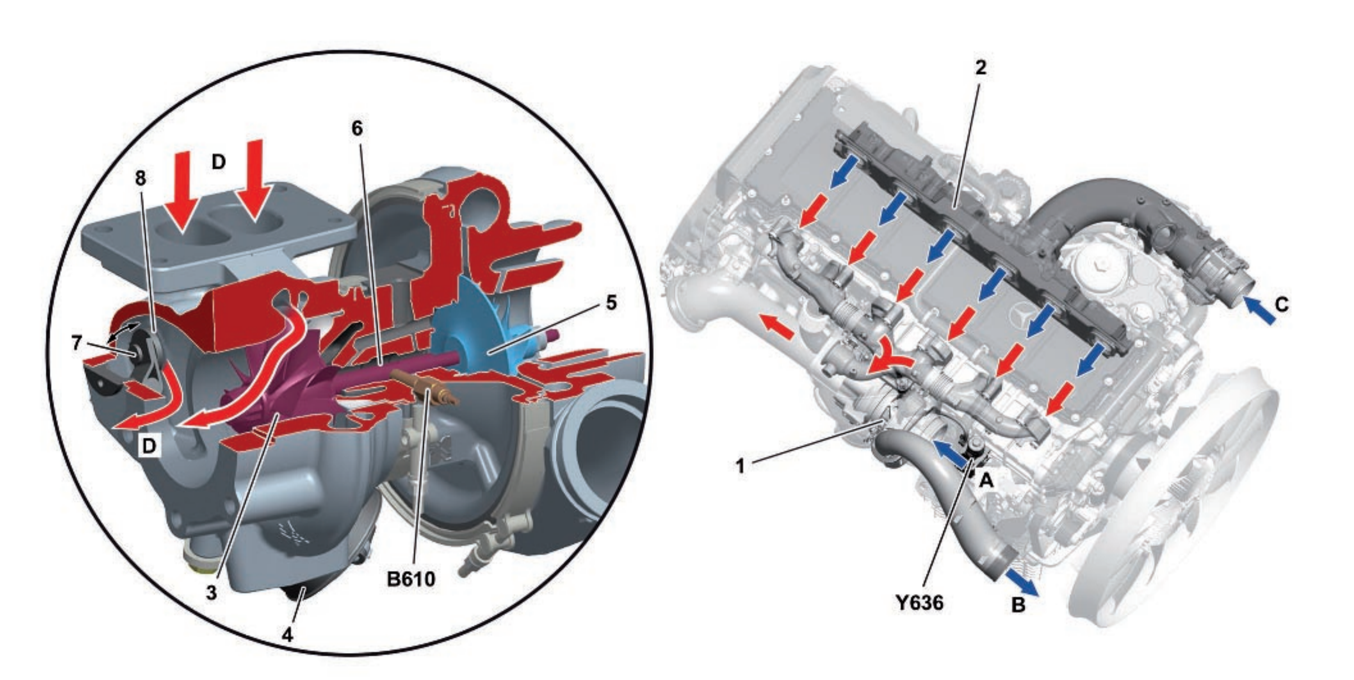
The cleaned blow-by-gas (D) flows over the vent line (3) into the air intake pipe.
A pressure regulating valve in the oil separator (1) regulates the pressure in the crankcase.

ℹ The crankcase ventilation system is maintenance free.

	Component description for oil separator		**Page 183**

GF09.00-W-2000H	Forced induction, function	20.7.11

ENGINES 471.9 in MODEL 963



W09.40-1213-79

Shown code (M5Z) Engine version Euro VI

1 Turbocharger
2 Charge air manifold
3 Turbine wheel
4 Vacuum cell
5 Compressor impeller
6 Shaft
7 Valve
8 Bypass opening
B610 Rpm sensor for turbine wheel (only for code (M5Z) Engine version Euro VI)
Y636 Charge pressure positioner
A Intake air from air filter
B Charge air to charge air cooler
C Charge air from charge air cooler
D Exhaust

General

Charging to the engines of model series OM 471 takes place through a turbocharger (1).
Through compression of the suctioned in air in the turbocharger (1) a larger air mass is brought into the combustion chamber.

The following advantages result through this:

- An increase in the engine power and the torque
- Reduction of fuel consumption in comparison to not supercharged diesel engines of the same power output
- Reduction of the pollutant emission

Function

The turbocharger (1) consists of a turbine and a compressor which are fitted to a joint shaft (6).

The exhaust (D) flows over the turbine wheel (3) and causes this to rotate. This rotational movement is transferred to the compressor impeller (5) over the shaft (6).
Through the compressor impeller (5) the intake air is compacted by the air filter (A) and passes over a charge air pipe to the charge air cooler.

In the charge air cooler the compacted air is cooled whereby the air density of the fresh gas filling and thus the output of the engine is increased.

The charge air then passes from the charge air cooler (C) via the charge air manifold (2) into the individual cylinders.

Boost pressure control and turbocharger protection function, shown code (M5Z) Engine version Euro VI

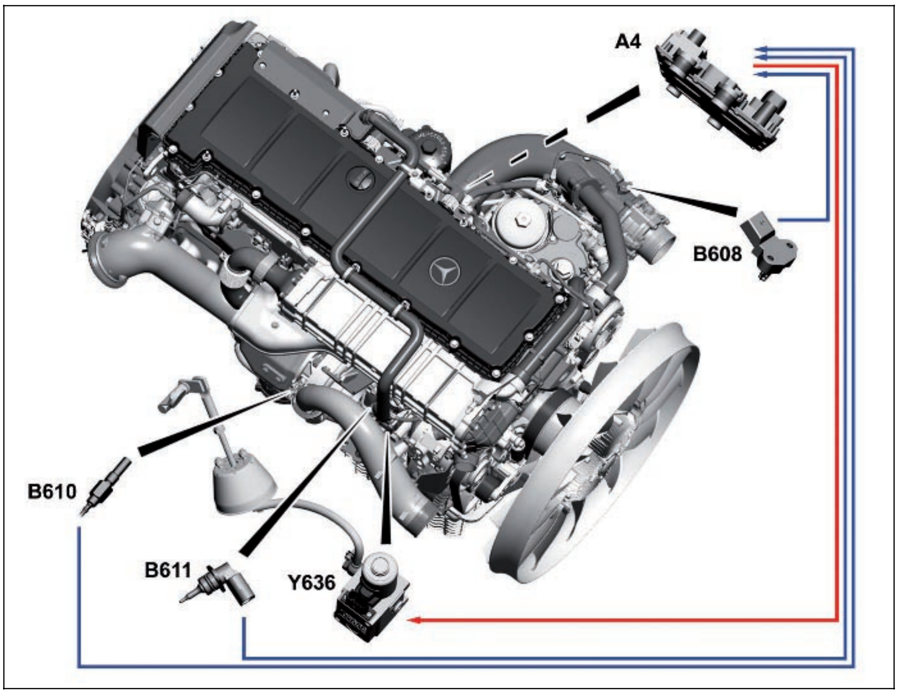
A4 Engine management control unit (MCM)

B608 Charge air pressure and temperature sensor in charge air pipe

B610 Rpm sensor for turbine wheel (only for code (M5Z) Engine version Euro VI)

B611 Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)

Y636 Charge pressure positioner



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Boost pressure control (via wastegate)

The engine management (MCM) control unit (A4) determines the current boost pressure via the charge air pressure and temperature sensor in the charge air pipe (B608).
If the engine management (MCM) control unit (A4) recognizes that the current boost pressure is too high, it limits the boost pressure in that it actuates the boost pressure regulator (Y636) with an appropriate pulse width modulated signal. The engine management (MCM) control unit (A4) can use the duty cycle of this signal to influence the pressure (up to 2.8 bar) which should be applied to the vacuum cell (4). The valve (7) is opened over a linkage according to this pressure, so that more or less exhaust (D) is passed over the bypass opening (8) on the turbine wheel (3) depending on how far it is opened.
Since only part of the exhaust (D) hits the turbine wheel (3) the acceleration is not so strong anymore and the boost pressure drops.

Turbocharger protection function

For vehicles with code (M5Z) Engine version Euro VI the rotor speed of the turbocharger (1) as well as the temperature of the intake air are monitored by the air filter (A) on the compressor inlet to protect the turbocharger.
This occurs with the aid of the turbine wheel rpm sensor (B610) and the temperature sensor downstream of air filter (B611).
Since these sensors for vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro VI are not installed, the engine management (MCM) control unit (A4) orients itself on the ambient temperature and on the altitude the vehicle is at. The latter is determined using the installed atmospheric pressure sensor.
Dependent on the determined values and values stored in the characteristics maps for the turbocharger protection function the engine management (MCM) control unit (A4) adapts the injection which leads to a lowering of the combustion temperature.
One indirect effect of actuation of the boost pressure regulator (Y636) can be reduction of the rotor speed of the turbocharger.

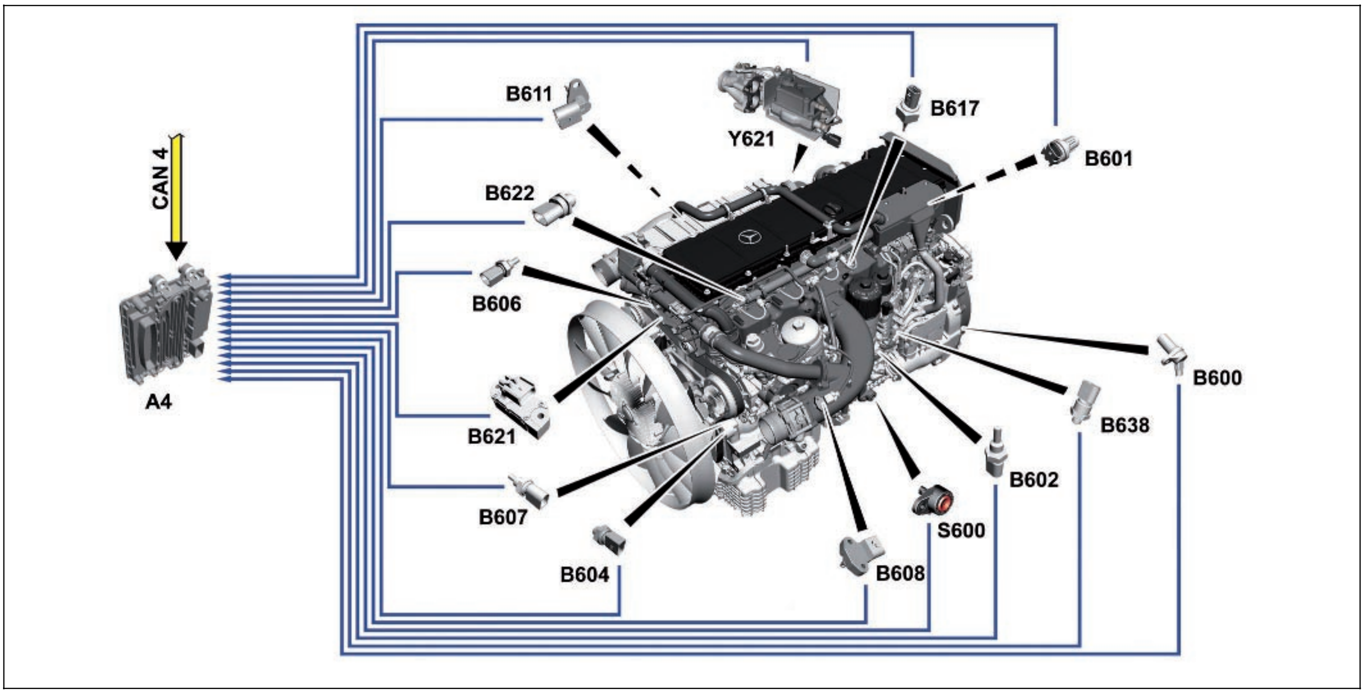
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Charge air pressure and temperature sensor in charge air pipe, component description	B608	**Page 152**
	Turbine wheel rpm sensor, component description	B610 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 153**
	Component description for temperature sensor downstream of air filter	B611 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 154**
	Component description for boost pressure regulator	Y636	**Page 181**
	Component description for turbocharger		**Page 186**

GF07.16-W-0003H	Engine management, function	2.8.11

ENGINE 471.9 in MODEL 963

The central control and regulator unit for engine management, which together with the EATS ensures that the engine runs under all operating conditions in as economical a manner as possible, with low pollutant and low-noise, is the engine management (MCM) control unit (A4).
It calculates the optimal beginning of injection as well as the injection quantity required for combustion according to the operating condition of the engine and the torque specification of the drive control (CPC) control unit (A3).

The engine management (MCM) control unit (A4) also ensures that the fuel is injected at exactly the right point in time and in the correct amount into the cylinders through exact, electrical actuation of fuel injectors for cylinder 1 to 6 (Y608 to Y613).



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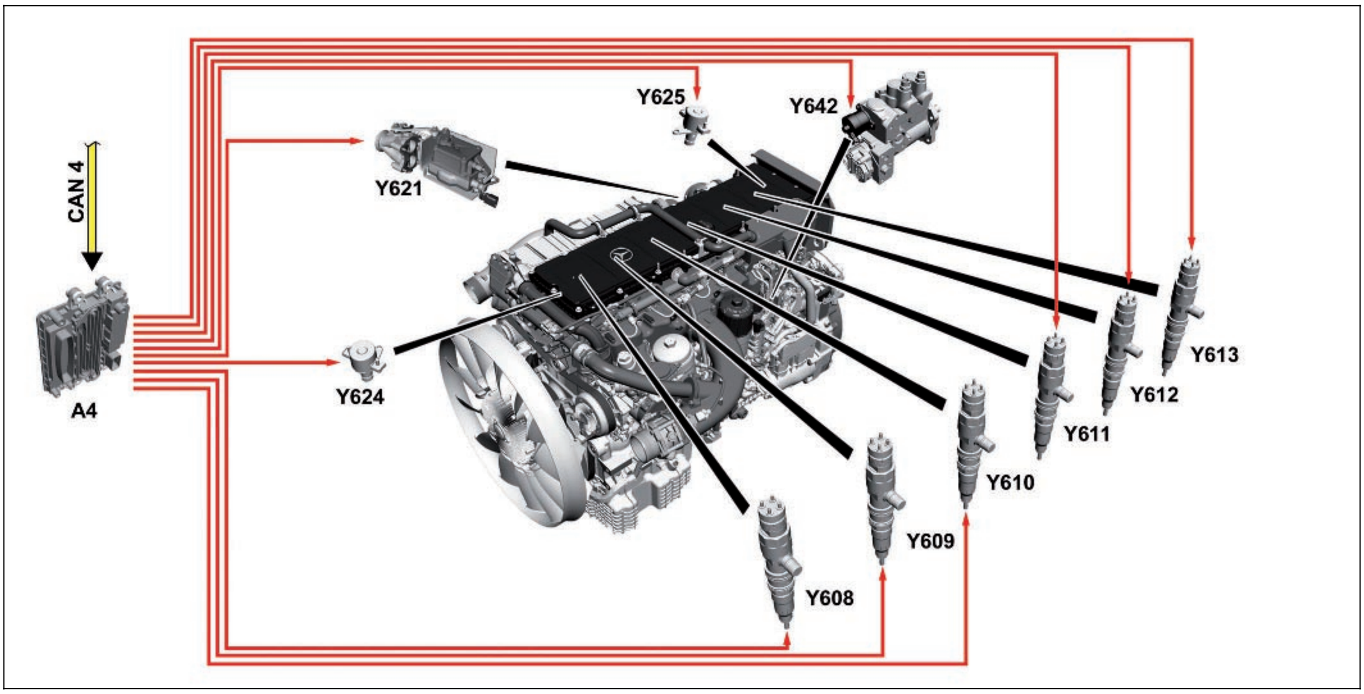
Input signals, shown with code (M5Z) Euro VI engine version

A4 Engine management control unit (MCM)
B600 Crankshaft position sensor
B601 Camshaft position sensor
B602 Fuel temperature sensor
B604 Oil pressure sensor
B606 Exhaust coolant temperature sensor
B607 Intake coolant temperature sensor
B608 Charge air pressure and temperature sensor in charge air pipe
B611 Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)
B617 Charge air temperature sensor in charge air housing
B621 Exhaust gas recirculation (AGR) differential pressure sensor
B622 Rail pressure sensor
B638 Fuel filter module pressure sensor
CAN 4 Drive train CAN
S600 Engine start and engine stop button
Y621 Exhaust gas recirculation positioner

The operating condition of the engine is determined based on input values from the following sensors:

- Crankshaft position sensor (B600)
- Camshaft position sensor (B601)
- Fuel temperature sensor (B602)
- Exhaust coolant temperature sensor (B606)
- Intake coolant temperature sensor (B607)
- Charge air pressure and temperature sensor in charge air pipe (B608)
- Temperature sensor downstream of air filter (B611) (only with code (M5Z) Euro VI engine version)
- Charge air temperature sensor in charge air housing (B617)
- Exhaust gas recirculation (AGR) differential pressure sensor (B621)
- Rail pressure sensor (B622)
- Fuel filter module pressure sensor (B638)

The specified torque, which is calculated by the drive control (CPC) control unit (A3) from (among other things) the position of the accelerator pedal, is routed over the drive train CAN (CAN 4) to the engine management (MCM) control unit (A4), which in turn sends the current engine torque and the maximum torque possible to the drive control (CPC) control unit (A3).
The drive train CAN (CAN 4) and the drive control (CPC) control unit (A3) can also be used to exchange information with other electronic systems or control units.



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Output signals, shown with code (M5Z)
Euro VI engine version

A4	*Engine management control unit (MCM)*
CAN 4	*Drive train CAN*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
Y621	*Exhaust gas recirculation positioner*
Y624	*Engine brake solenoid valve, stage 1*
Y625	*Engine brake solenoid valve, stage 2*
Y642	*Quantity control valve*

After evaluation of the input signals the engine management (MCM) control unit (A4) actuates the following actuators depending on the engine operating conditions and the torque specification from the drive control (CPC) control unit (A3):

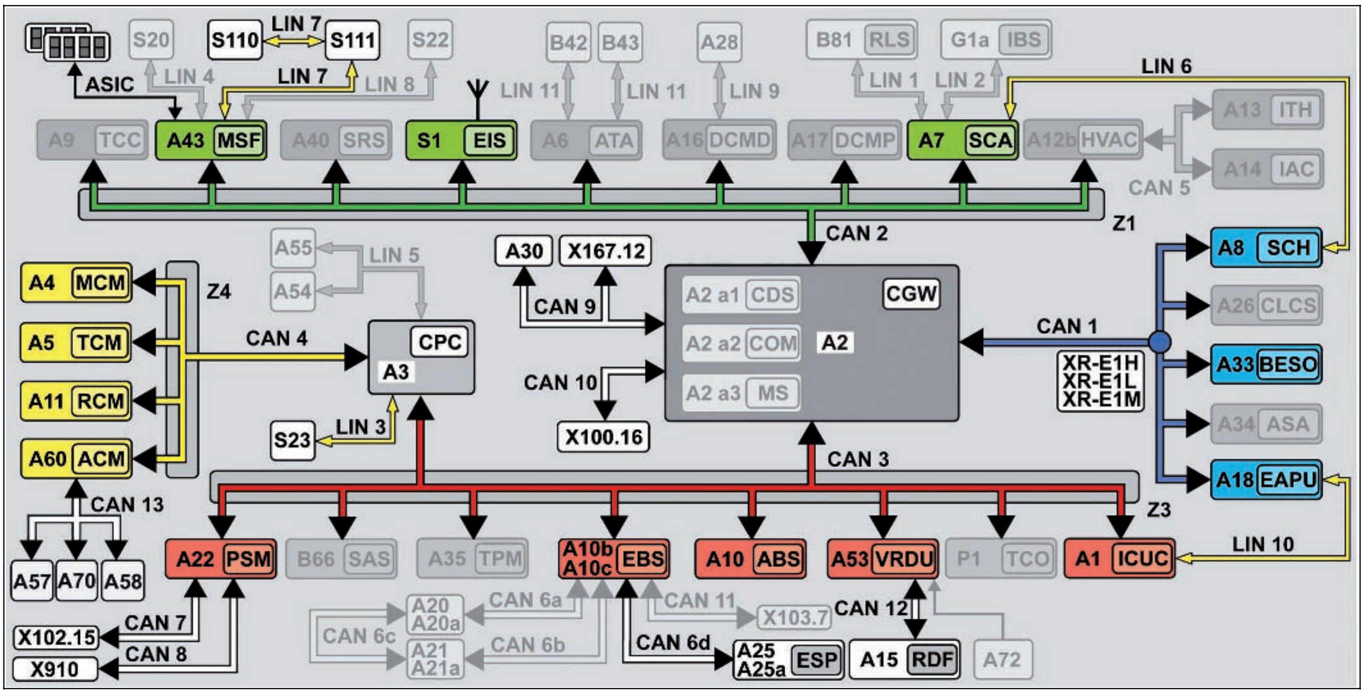
- Cylinder 1 fuel injector (Y608)
- Cylinder 2 fuel injector (Y609)
- Cylinder 3 fuel injector (Y610)
- Cylinder 4 fuel injector (Y611)
- Cylinder 5 fuel injector (Y612)
- Cylinder 6 fuel injector (Y613)
- Exhaust gas recirculation positioner (Y621)
- Quantity control valve (Y642)

If a fault occurs on the drive train CAN (CAN 4) or on a system component for the engine management, the engine management (MCM) control unit (A4) proceeds according to a clearly defined pattern depending on the severity of the fault. Thus it will fall back on replacement values for less severe faults such as the failure of a sensor while it will go into emergency mode for severe faults such as failure of the drive train CAN (CAN 4).
The driver is able to at least drive to the nearest workshop if there is a fault in the system.

i The engine management (MCM) control unit (A4) is part of the DAS, to which also the electronic ignition lock (EIS) (S1) and the transmission control unit (TCM) (A5) belong. If one of these control units or the electronic ignition lock (EIS) (S1) is replaced, then it must undergo teach-in using the Star Diagnosis in the DAS.

	Engine management, overall network		**Page 39**
	Engine management behavior for malfunctions		**Page 40**
	Start procedure, function		**Page 42**
	Idle speed control, function		**Page 44**
	Working speed control, function		**Page 46**
	Driving, function		**Page 48**
	Engine shutoff procedure, function		**Page 50**

GF07.16-W-0003-01H	Engine management, overall network		



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A1 *Instrument cluster (ICUC) control unit*
A2 *Central gateway control unit (CGW)*
A3 *Drive control (CPC) control unit*
A4 *Engine management control unit (MCM)*
A5 *Transmission control (TCM) control unit*
A7 *Cab signal acquisition and actuation module control unit (SCA)*
A8 *Frame signal acquisition and actuation module control unit (SCH)*
A10 *Antilock brake system (ABS) control unit, 4-channel*
A10b *Electronic Brake Control (EBS) control unit (Wabco)*
A10c *Electronic Brake Control (EBS) control unit (Knorr)*
A11 *Retarder control (RCM) control unit*
A15 *Front radar sensor (RDF) control unit*
A18 *Electronic Air Processing Unit (EAPU) control unit*
A22 *Parameterizable special module (PSM) control unit*
A25 *Electronic Stability Program (ESP®) control unit (Wabco)*
A25a *Electronic Stability Program (ESP®) control unit (Knorr)*
A30 *FleetBoard control unit*
A33 *Battery disconnect switch control unit (BESO)*
A43 *Modular switch panel (MSF) control unit*
A53 *Driver assistance system (VRDU) control unit*
A57 *EATU output NOx sensor control unit*
A58 *SCR control unit*
A60 *Exhaust aftertreatment (ACM) control unit*
A70 *EATU input NOx sensor control unit*
CAN 1 *Exterior-CAN*
CAN 2 *Interior CAN*
CAN 3 *Frame CAN*
CAN 4 *Drive train CAN*
CAN 6d *ESP® brakes CAN*
CAN 7 *Trailer CAN (PSM)*
CAN 8 *Body manufacturer CAN (PSM)*
CAN 9 *Telematics CAN*
CAN 10 *Diagnostic CAN*
CAN 12 *Radar CAN*
CAN 13 *NOx-CAN*
LIN 3 *Right multifunction control lever-LIN*
LIN 6 *LIN SCA/SCH redundancy*
LIN 7 *Button group LIN*
LIN 10 *EAPU-LIN*
S1 *Electronic ignition lock (EIS)*
S23 *Right multifunction control lever*
S110 *Left multifunction steering wheel button group*
S111 *Right multifunction steering wheel button group*
X100.16 *Diagnostic socket*
X102.15 *Trailer socket , 15-pin*
X167.12 *Electrical connector (telematics platform (TP))*
X910 *Electrical connector for body manufacturers*
XR-E1H *CAN-H exterior cable weld point 1*
XR-E1L *CAN-L exterior cable weld point 1*
XR-E1M *CAN-ground exterior cable weld point 1*
Z1 *Cab instrument panel CAN bus star point*
Z3 *Frame CAN bus star point*
Z4 *Drive CAN bus star point*

ASIC *ASIC data bus (Application System Integrated Circuit)*

GF07.16-W-0003-02H	Engine management behavior for malfunctions		

ℹ If the engine management (MCM) control unit (A4) detects a malfunction or a fault in the system or on a system component, it proceeds in accordance with a precisely specified method depending on the severity of the actual fault.

1 Response in the event of drive train CAN (CAN 4) malfunction

In order to achieve the greatest possible security against breakdowns, the signal line of the drive train CAN (CAN 4) is a double line. The individual lines are designated as CAN Low and CAN High and are fed with reverse poled signals. Thus faults which effect both lines simultaneously cancel each other out. Faults which only occur on one CAN line also do not create confusion for data transmission since the message can be reconstructed on the basis of the signal of the undisturbed line, i.e. the drive train CAN (CAN 4) is capable of operating over one wire.
The drive train CAN (CAN 4) only fails when both lines are interrupted or there is a short-circuit with the battery voltage or to ground.

A failure of the drive train CAN (CAN 4) is detected by the engine management (MCM) control unit (A4), and it switches to limp-home mode. If the engine speed at this stage is below the limp-home mode speed, the engine speed is then maintained. In all other cases, including after restarting the engine, the engine management (MCM) control unit (A4) adjusts the limp-home mode speed, irrespective of the load.
It is thus possible for the driver to at least bring the vehicle to the nearest workshop.

ℹ The limp-home mode is notified to the other systems and displayed in the instrument cluster control unit (ICUC) (A1). There is also entry of the condition in the fault memory.

---

2 Response when camshaft position sensor (B601) fails

If the camshaft position sensor (B601) fails when driving, then the engine continues to run. Nevertheless, the maximum torque of the engine will be limited to protect the engine from damage. The engine management (MCM) control unit (A4) can also regulate the limp-home speed.
If the camshaft position sensor (B601) fails to return any pulses during the startup phase, then in each case a portion of the double firing, with which the engine is started, is cutoff, until the dip in speed, which then occurs, when a piston is not in ignition TDC, enables ignition TDC to be recognized. Once ignition TDC is recognized, the engine continues to run in unchanged state. Nevertheless, the maximum torque of the engine will be limited to protect the engine from damage. The engine management (MCM) control unit (A4) can also regulate the limp-home speed.

---

3 Response when crankshaft position sensor (B600) fails

If the crankshaft position sensor (B600) fails, then the engine management (MCM) control unit (A4) still receives the rpm signals from the crankshaft position sensor (B601).
Its pulses do not come so closely together as those from the crankshaft position sensor (B600) but they are still adequate for calculating control time of the respective fuel injector. The time determination will be somewhat less exact so optimum fuel consumption or pollutant emission levels will not be achievable. Furthermore, for engine protection reasons, the maximum torque of the engine is limited to about a half. The engine management (MCM) control unit (A4) can also regulate the limp-home speed.

---

4 Response when a temperature sensor fails

If the values from a temperature sensor are implausible, or if a temperature sensor has an open circuit or a short circuit, the engine management (MCM) control unit (A4) continues to operate with substitute values.
Own replacement values are stored for each temperature sensor since the measurement values of the individual temperature sensors can deviate from each other. It is not feasible for these to be suitable for all operating conditions, however, which is why a mild reduction in the maximum possible torque available takes place.

---

5 Response when an exhaust gas recirculation (EGR) component fails

If the values of the charge air pressure and temperature sensor in the charge air pipe (B608), the charge air temperature sensor in the charge air housing (B617), the exhaust gas recirculation (EGR) differential pressure sensor (B621) or the exhaust gas recirculation positioner (Y621) are implausible, or if one of them suffers an open circuit or a short circuit, the engine management (MCM) control unit (A4) adjusts the limp-home mode speed and the engine's maximum torque is limited.

ℹ The fact that the limp-home strategy is alterable by the manufacturer means that it is possible that the engine speed remains unchanged and only the maximum torque of the engine is limited.

---

6 Response when atmospheric pressure sensor in engine management (MCM) control unit (A4) fails

If the atmospheric pressure sensor in the engine management (MCM) control unit (A4) has a malfunction or a fault, then - depending on the particular situation - it uses substitute values:

- If the pressure sensor in the charge air pressure and temperature sensor in the charge air pipe (B608) is intact, the engine management (MCM) control unit (A4) uses the air pressure in the charge air housing during the start procedure and the values stored in a substitute characteristic when the engine is running.
  The reason why the engine management (MCM) control unit (A4) falls back on values in a substitute characteristic while the engine is running is because the charge pressure in the charge air housing can differ according to the engine loading and cannot therefore be used as the atmospheric pressure.
- If the pressure sensor in the charge air pressure and temperature sensor in the charge air pipe (B608) is also defective, the engine management (MCM) control unit (A4) then uses the values of the previously-mentioned substitute characteristic for all operating conditions.

---

7 Response when engine management (MCM) control unit (A4) fails

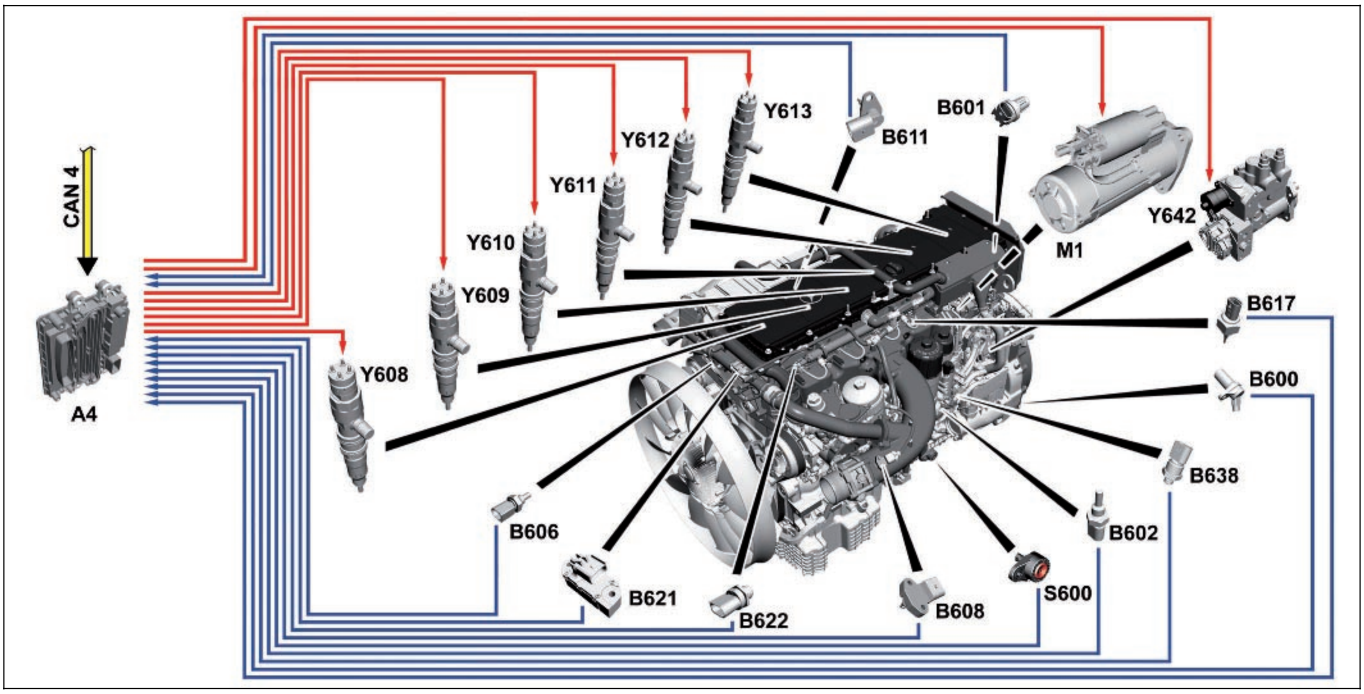
The engine management (MCM) control unit (A4) has only one host CPU, and no limp-home mode CPU.
If the host CPU fails the engine stops and cannot be started anymore.
The drive control (CPC) control unit (A3) however is capable of diagnosing the failure of the engine management (MCM) control unit (A4) by reading out the fault memory, so that diagnosis is still possible.

ℹ While the engine management (MCM) control unit (A4) switches to the limp-home mode when a severe fault occurs or if a less serious fault occurs it operates using substitute values, it saves every fault that occurs and notifies the driver of them by means of an appropriate display in the instrument cluster (ICUC) control unit (A1).

In addition to information about the type of fault and possibly also a measurement value, the engine control (MR) also stores information about whether the fault is current or just transient or occurs sporadically. The fault memory can also be automatically deleted again, of course, for less serious faults if the stored fault does not occur again within the next 50 hours. In order to avoid coming to wrong conclusions when troubleshooting, please observe that certain operating conditions can lead to limitation of the maximum torque of the engine.
e. example, a radiator contaminated with dirt and dust will have a reduced cooling output. The engine management (MCM) control unit (A4) determines an increase in coolant temperature and limits the engine's maximum torque so that the coolant temperature limit is not exceeded.

GF07.00-W-2001H	Start procedure, function	2.8.11

ENGINE 471.9 in MODEL 963



W07.16-1058-79

Shown code (M5Z) Engine version Euro VI

A4	*Engine management control unit (MCM)*
B600	*Crankshaft position sensor*
B601	*Camshaft position sensor*
B602	*Fuel temperature sensor*
B606	*Exhaust coolant temperature sensor*
B608	*Charge air pressure and temperature sensor in charge air pipe*
B611	*Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)*
B617	*Charge air temperature sensor in charge air housing*
B621	*Exhaust gas recirculation (EGR) differential pressure sensor*
B622	*Rail pressure sensor*
B638	*Fuel filter module pressure sensor*
CAN 4	*Drive train CAN*
M1	*Starter*
S600	*'Engine start and engine stop button*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
Y642	*Quantity control valve*

General information

The engine start procedure is initiated when a corresponding start request through the drive train CAN (CAN 4) is present, e.g. when starting the engine using the electronic ignition lock (EIS) (S1) or through the parameterizable special module (PSM) control unit (A22), or through corresponding operation of the engine start and engine stop button (S600).

Requirements

- Voltage supply (terminal 30 and terminal 15) on the engine management (MCM) control unit (A4) (ignition switched on)
- Electronic immobilizer deactivated by DAS and start enable issued by electronic ignition lock (EIS) (S1), i.e. the inserted transmitter key is authorized
- Starter lockout canceled, i.e.:
  - Transmission in neutral (only for start request using engine start and engine stop button (S600))
  - Power take-off, where present, switched off
  - Engine stopped or engine speed is <50 rpm

Function

If all requirements are met and if the engine start and engine stop button (S600) is pressed or a corresponding message with the start request is received over the drive train CAN (CAN 4), e.g. when the start-stop button on the electronic ignition lock (EIS) (S1) is pushed to the start position (Stage 2) and held there or the parameterizable special module (PSM) control unit (A22) sends a corresponding message with the start request, the engine management (MCM) control unit (A4) actuates the starter's starter solenoid (M1) through a series relay.
The starter (M1) sets the engine in motion and the engine management (MCM) control unit (A4) checks whether the starter (M1) is turning the engine at the specified minimum speed.
It also waits until it can recognize from crankshaft position sensor signals (B600) when cylinders 1 and 6 are at top dead center (TDC).

Only then can the actuation begin for the fuel injectors for cylinder 1 and 6 (Y608 and Y613), calculated while taking account of the current operating condition of the engine.
At the same time, the engine management (MCM) control unit (A4) calculates the required injection quantity for combustion and initiates the injection of this at the correct point in time into the combustion chambers of cylinders 1 and 6 through appropriate actuation of the quantity control valves (Y642) and fuel injectors for cylinder 1 and 6 (Y608 and Y613).
This so-called double ignition serves to accelerate the starting procedure. It is continued (afterwards follow cylinders 5 and 2, 3 and 4, then further with 1 and 6, etc.), until the ignition TDC of cylinder 1 is recognized with the aid of the camshaft position sensor (B601).

---

i If the camshaft position sensor (B601) fails to return any pulses, then in each case a portion of the double firing is cutoff, until the dip in speed, which then occurs, when a piston is not in ignition TDC, enables ignition TDC to be recognized. Once ignition TDC is recognized, the engine continues to run in unchanged state. Nevertheless, the maximum torque of the engine will be limited to protect the engine from damage. The engine management (MCM) control unit (A4) can also regulate the limp-home speed.

Determining the injection quantity:
Determination of the injection volume independently of the accelerator pedal position in order to achieve a secure engine start with the lowest possible emission of pollutants.

The injection quantity selected for the starting procedure is primarily geared to the coolant temperature, which is determined by the engine management (MCM) control unit (A4) via the exhaust coolant temperature sensor (B606).
Further influencing factors for the injection quantity during the starting procedure are the current engine speed as well as the geographical altitude at which the vehicle or engine is located.

i There is an atmospheric pressure sensor in the engine management (MCM) control unit (A4) over which the air pressure of the ambient air is determined for determination of the altitude and the current altitude of the vehicle or engine can be deduced.

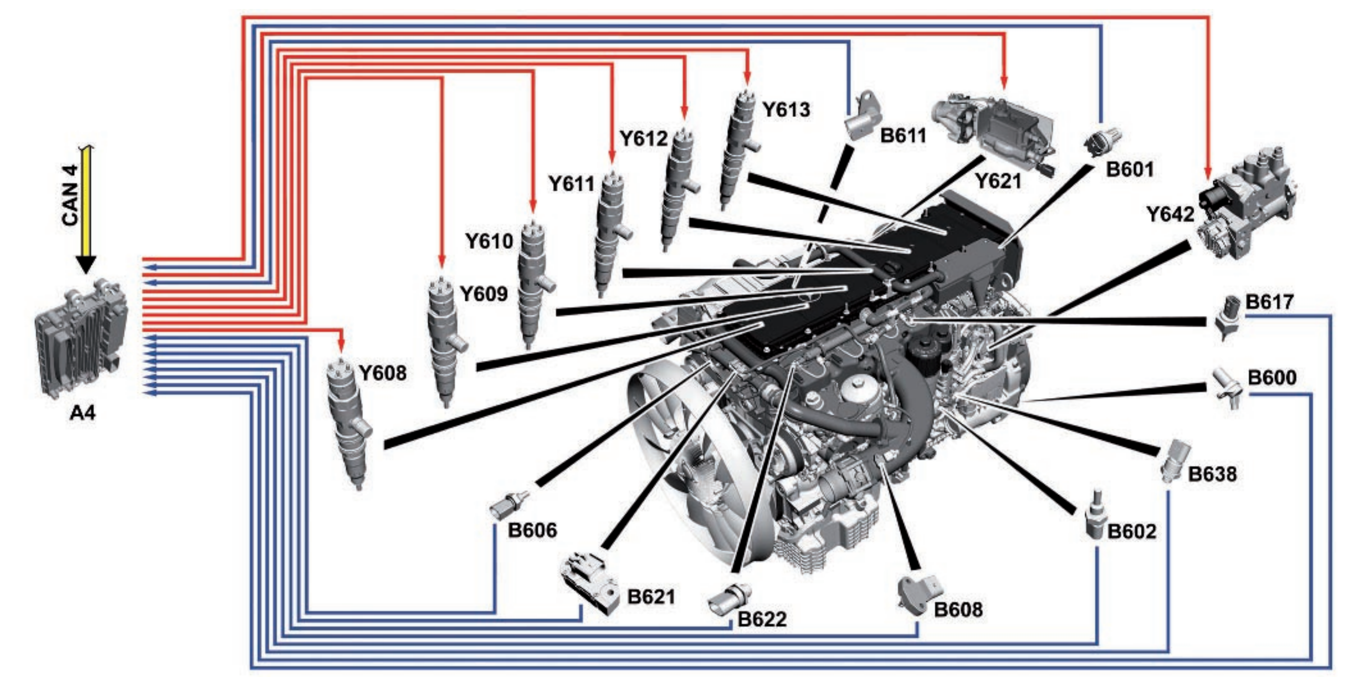
The engine starts with this initial, primarily temperature-dependent, start injection quantity.
If the engine does not start with the start injection amount, then the injection quantity will be continuously increased until the engine starts or the limit value for the max. start injection quantity is reached. This is then maintained until the starter (M1) actuation is interrupted either by itself or after a specific time by the engine management (MCM) control unit (A4), to protect the starter (M1) against mechanical or thermal overload (start time limit).
If the engine starts, while the start-stop button on the electronic ignition lock (EIS) (S1) or the engine start and engine stop button (S600) are still being pressed, and if it reaches a specific speed then the actuation of the starter (M1) is interrupted (starter dump speed).

The pinion is pulled back out of the ring gear on the flywheel, while start actuation of the injection quantity changes over to the idle speed control. This changeover is known as starter disengagement which exclusively results in a change of the calculation method. Because the cold start ability of diesel engines at low outside temperatures is restricted by the engine's increasing resistance to rotation, lower combustion chamber temperatures and unfavorable fuel atomization conditions, under certain conditions a pilot injection is conducted.
This contributes significantly to shorter starting times, to faster smooth engine operation, to improved throttle response, to lower white smoke emission, to less pollutant emissions and lower noise emissions.

	Determination of the engine speed and crankshaft angle, function		**Page 53**
	Determination of the compression stroke at cylinder 1, function		**Page 54**
	Determination of coolant temperature, function		**Page 55**
	Determination of air mass, function		**Page 56**
	Determination of the fuel temperature, function		**Page 57**
	Fuel supply, function		**Page 91**

GF07.16-W-2021H	Idle speed control, function	2.8.11

ENGINE 471.9 in MODEL 963



W07.16-1059-79

Shown code (M5Z) Engine version Euro VI

A4	*Engine management control unit (MCM)*
B600	*Crankshaft position sensor*
B601	*Camshaft position sensor*
B602	*Fuel temperature sensor*
B606	*Exhaust coolant temperature sensor*
B608	*Charge air pressure and temperature sensor in charge air pipe*
B611	*Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)*
B617	*Charge air temperature sensor in charge air housing*
B621	*Exhaust gas recirculation (AGR) differential pressure sensor*
B622	*Rail pressure sensor*
B638	*Fuel filter module pressure sensor*
CAN 4	*Drive train CAN*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
Y621	*Exhaust gas recirculation positioner*
Y642	*Quantity control valve*

[i] The idle speed is parameterized in the engine management (MCM) control unit (A4). The drive control (CPC) control unit (A3) can, however, send its own request via the drive train CAN (CAN 4), for example if the idle speed should be higher in order to operate ancillary assemblies at their working speed.
The higher rotational speed is basically always regulated. In other words, if the idle speed required by the drive control (CPC) control unit (A3) is higher than the idle speed parameterized in the engine management (MCM) control unit (A4), then the speed required by the drive control (CPC) control unit (A3) is regulated and vice versa.

The idle speed is regulated immediately after the starting procedure or if the drive control (CPC) control unit (A3) recognizes that the accelerator pedal is not being actuated.
While taking account of the idle speed specification from the drive control (CPC) control unit (A3) and the current operating condition of the engine, the engine management (MCM) control unit (A4) calculates the optimal start of actuation for the fuel injectors as well as the optimum actuation period (injection quantity) while also ensuring that the fuel is injected at the correct point in time, and in the correct quantities into the respective combustion chamber through appropriate actuation of the quantity control valve (Y642) and the fuel injectors for cylinder 1 to 6 (Y608 to Y613).

The injection quantity is constantly adjusted to the operating condition of the engine during the whole idling operation - e.g. if the load condition of the engine changes or a higher fuel requirement exists (due to a low outside temperature).
To calculate the injection quantity, the engine management (MCM) control unit (A4) mainly takes account of the following input factors:

- Engine speed
- Coolant temperature
- Fuel temperature
- Load request (specified torque)

Smoke limitation, smooth running control and altitude correction in the engine management (MCM) control unit (A4) can also influence the injection quantity (period of actuation) as well as the start of actuation for the fuel injectors.

Smoke limitation
The fuel quantity is limited via the smoke limitation characteristics so that virtually no output of smoke occurs.

Smooth running control
The smooth running control evens out injection amount differences of the individual fuel injectors.

Development of torque on the various cylinders can differ due to tolerances and wear on the individual fuel injectors. This leads to irregular running of the engine, that is the rotational speed of the crankshaft is slightly faster and slower. One particularly feels this when idling. The smooth running control can respond to rough running because it actuates every injection nozzle individually. It balances out the rotational speed fluctuations through slightly different injection quantities for the individual cylinder until all cylinders develop the same torque.

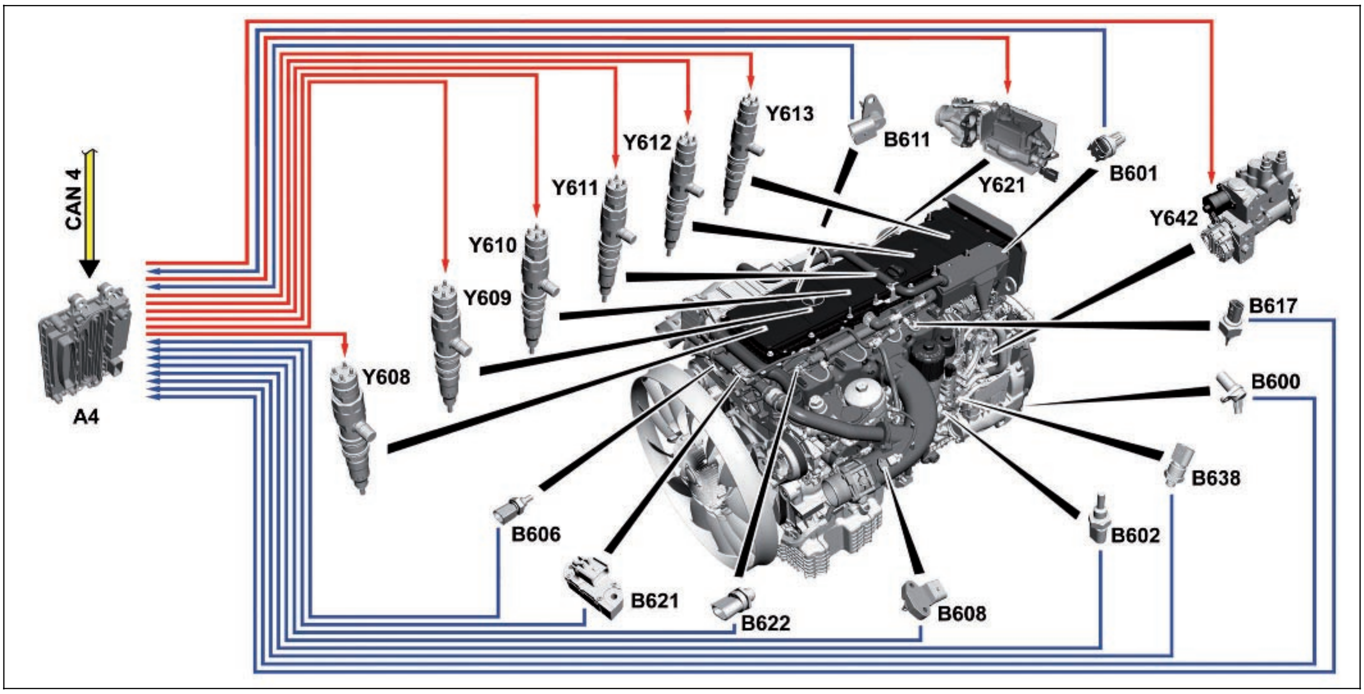
Altitude correction
Altitude correction is primarily designed in such a way that the rotor speed, the compressor outlet temperature and the turbine inlet temperature of the turbocharger, as well as the air/fuel ratio λ (lambda), does not exceed or drop below established limits. To do this, the exhaust gas recirculation rate (AGR rate), the actuation begin as well as the actuation period (injection quantity) for fuel injectors for cylinder 1 to 6 (Y608 to Y613) are adapted.
In order to reduce nitrous oxide emissions, the exhaust gas recirculation (AGR) is active for a certain period of time during idling mode (the AGR is switched off for longer periods in idling mode so that the exhaust gas recirculation cooler is not sooted up).

In the case of the exhaust gas recirculation (AGR), the suctioned out or supercharged fresh air is mixed with exhaust gas. This leads to the situation where the oxygen content of the suctioned out or supercharged air drops and its specific heat increases.
One can therefore achieve a lower combustion temperature and thus reduced output of nitrogen oxides (NO_x), whose proportion increases with increasing combustion temperatures. The amount of exhaust gases produced is also reduced.

	Determination of the engine speed and crankshaft angle, function		**Page 53**
	Determination of the compression stroke at cylinder 1, function		**Page 54**
	Determination of coolant temperature, function		**Page 55**
	Determination of air mass, function		**Page 56**
	Determination of the fuel temperature, function		**Page 57**
	Function of the specified engine torque calculation		**Page 58**
	Fuel supply, function		**Page 91**
	Exhaust gas recirculation, function		**Page 66**
	Exhaust aftertreatment, function	Vehicles with code (M5R) EEV engine version and vehicles with code (M5Y) Euro V engine version	**Page 68**
		Vehicles with code (M5Z) Euro VI engine version	**Page 73**

GF07.16-W-2022H	Working speed control, function	2.8.11

ENGINES 471.9 in MODEL 963



W07.16-1059-79

Shown code (M5Z) Engine version Euro VI

A4	*Engine management control unit (MCM)*
B600	*Crankshaft position sensor*
B601	*Camshaft position sensor*
B602	*Fuel temperature sensor*
B606	*Exhaust coolant temperature sensor*
B608	*Charge air pressure and temperature sensor in charge air pipe*
B611	*Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)*
B617	*Charge temperature sensor in charge air housing*
B621	*Exhaust gas recirculation (AGR) differential pressure sensor*
B622	*Rail pressure sensor*
B638	*Fuel filter module pressure sensor*
CAN 4	*Drive train CAN*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
Y621	*Exhaust gas recirculation positioner*
Y642	*Quantity control valve*

General information

The electronic working speed control takes place as soon as a power take-off is switched in. To do this up to three power take-offs can be parameterized differently according to the vehicle equipment. This means that for every power take-off difference control specifications can be established according to the area of use of the vehicle and according to how the parameters for the power take-off functions are set in the SCA (SCA) control unit (A7) or in the parameterizable special module (PSM) control unit (A22).
Along with a range of other parameters it is possible, for example, to set the entry requirements such as "parking brake tightened" or "transmission in neutral", or the engine speed range (min. engine speed, max. engine speed) as well as a torque limitation.
It is furthermore possible to set the working speed during operation of a power take-off over the accelerator pedal or the keys on the multifunction steering wheel individually to a rotational speed between 550 rpm and 750 rpm or to raise it over the idle speed switch (S900) to a parameterizable value.

Regulation of the working speed

Upon switching on of a power take-off its parameters for working speed control are transmitted by the SCA (SCA) control unit (A7) and the parameterizable special module (PSM) control unit (A22) via the CAN data bus system to the drive control (CPC) control unit (A3).
The drive control (CPC) control unit (A3) passes on the parameter via the drive train CAN (CAN 4) to the engine management (MCM) control unit (A4) whereby it initially takes account of the parameters set in the parameterizable special module (PSM) control unit (A22) since these are super-imposed over the parameters set in the SCA (SCA) control unit (A7).
This means: for vehicles with code (E3Y) PSM, body and trailer CAN ISO 11992 and for vehicles with code (E3Z) PSM, body CAN ISO 11898 instead of 11992 only the parameters in the parameterizable special module (PSM) control unit (A22) are taken into account, independently of which parameters are set in the SCA (SCA) control unit (A7).

Upon receipt of the appropriate information and while taking account of the current operating condition of the engine, the parameterizable special module (PSM) control unit (A4) computes the now required actuation begin of the fuel injectors as well as the necessary period of actuation (injection quantity) and ensures that the fuel is injected at the correct point in time and in the correct quantities into the respective combustion chamber through appropriate actuation of the quantity control valve (Y642) and the fuel injectors for cylinders 1 to 6 (Y608 to Y613).

ℹ The working speed is only regulated if the appropriate power take-off is fully engaged.

Changing the working speed

It is possible, dependent on the vehicle equipment and parameterization of the power take-off functions, to set the working speed during operation of a power take-off over the accelerator pedal or the keys on the multifunction steering wheel individually to a rotational speed between 550 rpm and 750 rpm or to raise it over the idle speed switch (S900) to a parameterizable value in as far as the max. working speed is not exceeded and the min. working speed is always reached.

● Changing the working speed with the accelerator pedal

If the accelerator pedal is actuated and thus the position of the accelerator pedal sensor (B44) alters then the drive control (CPC) control unit (A3) alters the control specification for the working speed and transmits this via the drive train CAN (CAN 4) to the engine management (MCM) control unit (A4). It takes account at the same time of the parameters prescribed by the SCA (SCA) control unit (A7) or by the parameterizable special module (PSM) control unit (A22), according to the vehicle equipment as well as the current actual rotational speed.
The engine management (MCM) control unit (A4) increases the working speed through appropriate actuation of the injection quantity to the desired value and holds this constant.

● Changing the working speed using the idle speed switch (S900)

One special task for regulation of the working speed is taken on by the idle speed switch (S900).
This allows one to switch in the constant engine speed facility which means that the engine management (MCM) control unit (A4) sets a single engine speed which has been parameterized and maintains this constant, quite independently of the loading conditions.

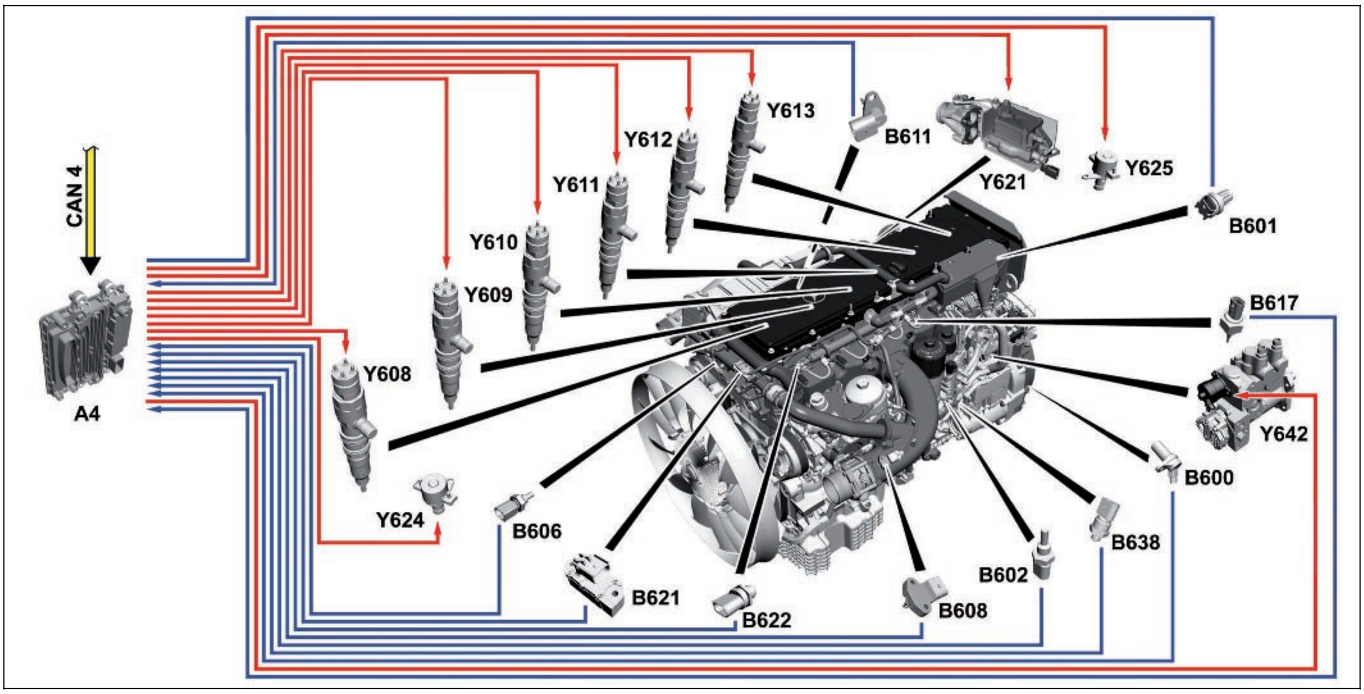
● Changing the working speed over the multifunction steering wheel

The working speed can be altered step by step in steps of 20 with the aid of keys on the multifunction steering wheel. The keys on the multifunction steering wheel are connected via a LIN data bus with the modular switch panel (MSF) control unit (A43) which transmits the entries via the interior CAN (CAN 2) to the central gateway (CGW) control unit (A2) which, in turn, passes this on via the frame-CAN (CAN 3) to the drive control (CPC) control unit (A3). The drive control (CPC) control unit (A3) compares the desired working speed with the current one, the max. permissible as well as the min. permissible working speed (if these were parameterized), adapts the control specification and transmits this to the engine management (MCM) control unit (A4).
The engine management (MCM) control unit (A4) alters the working speed through appropriate actuation of the injection quantity to the desired value and holds this constant.

	Determination of the engine speed and crankshaft angle, function		**Page 53**
	Determination of the compression stroke at cylinder 1, function		**Page 54**
	Determination of the coolant temperature, function		**Page 55**
	Determination of air mass, function		**Page 56**
	Determination of the fuel temperature, function		**Page 57**
	Fuel supply, function		**Page 91**
	Exhaust gas recirculation, function		**Page 66**
	Exhaust aftertreatment, function	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 68**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 73**

GF07.16-W-2023H	Driving, function	2.8.11

ENGINES 471.9 in MODEL 963



W07.16-1060-79

Shown code (M5Z) Engine version Euro VI

A4	*Engine management control unit (MCM)*
B600	*Crankshaft position sensor*
B601	*Camshaft position sensor*
B602	*Fuel temperature sensor*
B606	*Exhaust coolant temperature sensor*
B608	*Charge air pressure and temperature sensor in charge air pipe*
B611	*Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)*
B617	*Charge temperature sensor in charge air housing*
B621	*Exhaust gas recirculation (AGR) differential pressure sensor*
B622	*Rail pressure sensor*
B638	*Fuel filter module pressure sensor*
CAN 4	*Drive train CAN*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
Y621	*Exhaust gas recirculation positioner*
Y624	*Engine brake solenoid valve, stage 1*
Y625	*Engine brake solenoid valve, stage 2*
Y642	*Quantity control valve*

If the drive control (CPC) control unit (A3) does not demand any idle or working speed control then this is normal driving mode. In driving mode the injection quantity is primarily adjusted according to requests from the driver. This means that the torque specification of the engine is primarily dependent on the position of the accelerator pedal. It is only in certain situations that it can happen that the engine speed is adapted independently of the accelerator pedal position or of the specified torque request, for example for downshifting for rotational speed comparison between the main shaft and the countershaft.

In normal driving mode the engine management (MCM) control unit (A4) therefore first compares the engine specified torque coming in from the drive control (CPC) control unit (A3), which is derived from the position of the accelerator pedal and made available via the drive train CAN (CAN 4), with the current actual engine torque which represents the real operating conditions of the engine.

If the required engine torque is less than the current actual engine torque, the engine management (MCM) control unit (A4) reduces the injection quantity, and if the required engine torque is greater than the current actual engine torque then it increases the injection quantity.

[i] The engine management (MCM) control unit (A4) can limit the required engine torque sent by the drive control (CPC) control unit (A3) for engine protection reasons, e.g. if the coolant temperature exceeds a certain value or the engine has reached its final or maximum governed rpm, to observe the legally prescribed maximum speed or to limit it due to a control intervention function of the ABS (ABS) or the acceleration skid control (ASR).

Limitation of the required engine torque always leads to limitation of the injection quantity.

The injection quantity is also dependent on the following input parameters:

- Engine speed
- Air mass
- Coolant temperature
- Fuel temperature

The altitude correction and smoke emission limitation can also influence the injection quantity (actuation period) as well as the start of actuation of the fuel injectors.

Altitude correction
The altitude correction is primarily designed in such a way that the turbine speed, the compressor outlet temperature and the turbine inlet temperature of the turbocharger, as well as the air/fuel ratio λ (Lambda) does not exceed or drop below established limits. To do this, the exhaust gas recirculation rate (AGR rate), the actuation begin as well as the actuation period (injection quantity) for fuel injectors for cylinder 1 to 6 (Y608 to Y613) are adapted.

Smoke limitation
The fuel quantity is limited via the smoke limitation characteristics so that virtually no output of smoke occurs.

If the specified engine torque is negative, e.g. in deceleration mode, and if the motor speed lies above 950 rpm, the engine management (MCM) control unit (A4) interrupts actuation of the fuel injectors for cylinders 1 to 6 (Y608 to Y613) and lowers the fuel pressure in the rail via the rail quantity control valve (Y642). In this way the braking effect of the engine is used and the fuel consumption lowered.
The engine brake can be activated to reinforce the braking effect. The driver can select between 3 brake stages.

If the motor speed drops below 950 rpm, the engine management (MCM) control unit (A4) increases the fuel pressure in the rail over the rail quantity control valve (Y642) and actuates the fuel injectors for cylinders 1 to 6 (Y608 to Y613).

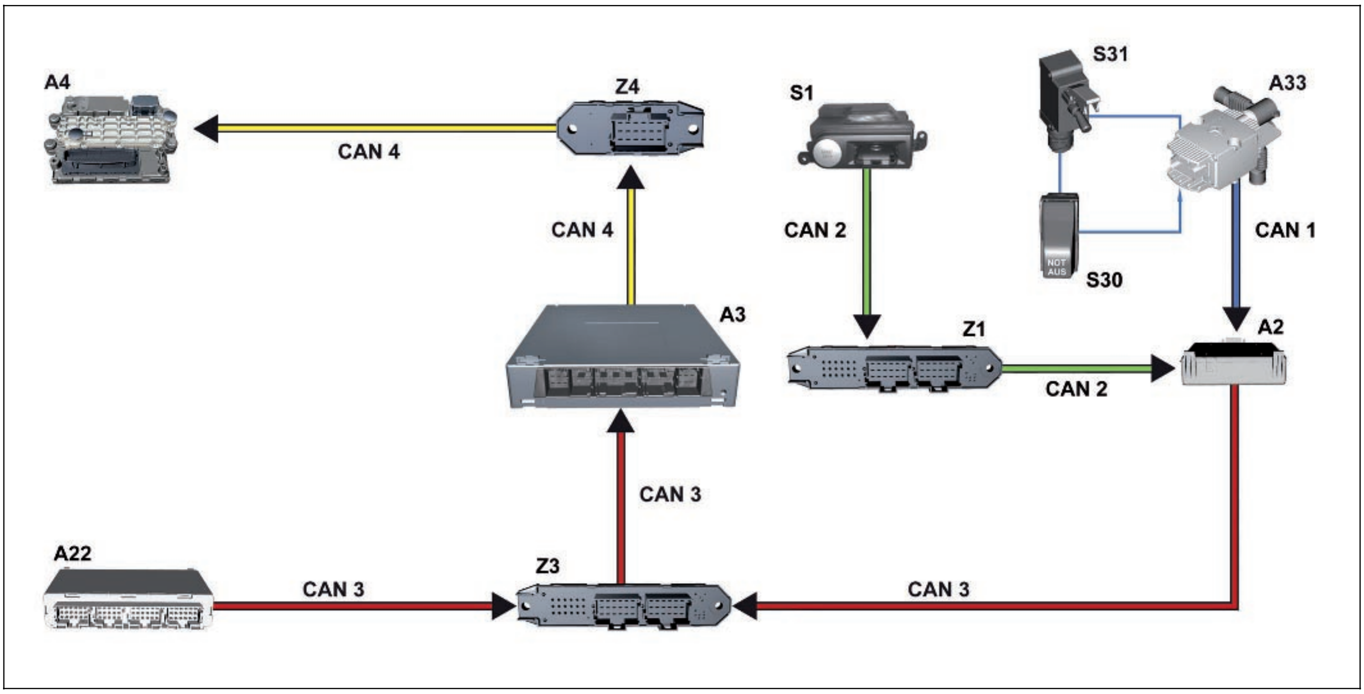
The exhaust gas recirculation (AGR) is active throughout the whole driving mode to reduce the nitrous oxide emissions.

In the case of the exhaust gas recirculation (AGR), the suctioned out or supercharged fresh air is mixed with exhaust gas. This leads to the situation where the oxygen content of the suctioned out or supercharged air drops and its specific heat increases.
One can therefore achieve a lower combustion temperature and thus reduced output of nitrogen oxides (NO_x), whose proportion increases with increasing combustion temperatures. The amount of exhaust gases produced is also reduced.

	Determination of the engine speed and crankshaft angle, function		**Page 53**
	Determination of the compression stroke at cylinder 1, function		**Page 54**
	Determination of the coolant temperature, function		**Page 55**
	Determination of air mass, function		**Page 56**
	Determination of the fuel temperature, function		**Page 57**
	Function of the specified engine torque calculation		**Page 58**
	Fuel supply, function		**Page 91**
	Exhaust gas recirculation, function		**Page 66**
	Forced induction, function		**Page 35**
	Engine brake, function		**Page 60**
	Exhaust aftertreatment, function	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 68**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 73**

GF07.00-W-2002H	Engine shutoff procedure, function	2.8.11

ENGINE 471.9 in MODEL 963

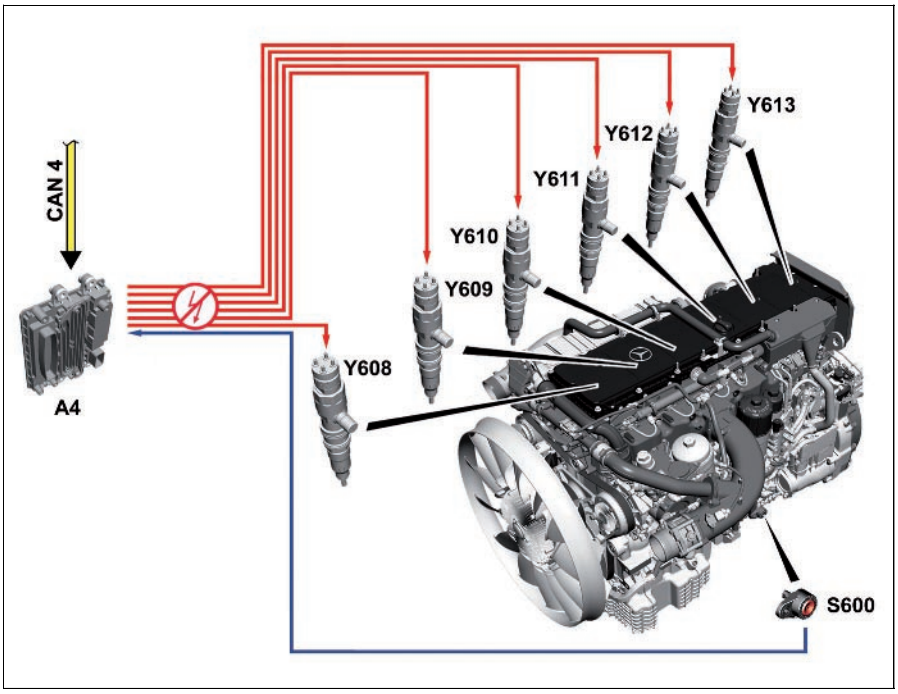


W07.16-1116-79

A2	Central gateway control unit (CGW)
A3	Drive control (CPC) control unit
A4	Engine management control unit (MCM)
A22	Parameterizable special module (PSM) control unit
A33	Battery disconnect switch control unit (BESO)*
CAN 1	Exterior-CAN
CAN 2	Interior CAN
CAN 3	Frame CAN
CAN 4	Drive train CAN
S30	EMERGENCY STOP switch*
S31	Chassis EMERGENCY OFF switch*
Z1	Cab instrument panel CAN bus star point
Z3	Frame CAN bus star point
Z4	Drive CAN bus star point
*	(Only for vehicles with code (E5T) ADR model class EX/II, including AT, code (E5U) ADR model class EX/III, including EX/II and AT, code (E5V) ADR model class FL, including EX/II, EX/III and AT, code (E5X) ADR model class AT, code (E5Z) accessories, ADR, code (E9D) preinstallation, bipolar battery circuit breaker, code (E9E) ADR preinstallation, without chassis cover)

Code (M5Z) Euro VI engine version shown

A4	*Engine management control unit (MCM)*
CAN 4	*Drive train CAN*
Y608	*Cylinder 1 fuel injector*
Y609	*Cylinder 2 fuel injector*
Y610	*Cylinder 3 fuel injector*
Y611	*Cylinder 4 fuel injector*
Y612	*Cylinder 5 fuel injector*
Y613	*Cylinder 6 fuel injector*
S600	*Engine start and engine stop button*



W07.16-1073-76

General

The engine's shutdown is initiated, when a corresponding shutdown message over the drive train CAN (CAN 4) is pending, e.g. when switching off the engine through the electronic ignition lock (EIS) (S1), through the battery disconnect switch (BESO) control unit (A33) or through the parameterizable special module (PSM) control unit (A22), or through a corresponding operation of the engine start and engine stop button (S600).

Function

As soon as the engine management (MCM) control unit (A4) receives a corresponding shutdown request over the drive train CAN (CAN 4) or if the engine start and engine stop button (S600) is operated with the engine running, it interrupts actuation of the fuel injectors for cylinder 1 to 6 (Y608 to Y613). The fact that no further injection occurs means that the engine comes to a standstill and stops.

At engine oil temperatures of less than 70 °C the engine brake is also activated to ensure that the engine can "coast down" when shutting down. At engine oil temperatures higher than 70 °C it can therefore happen that the engine "vibrates" when shutting down.

	Central gateway control unit (CGW), component description	A2	**Page 101**
	Component description drive control (CPC) control unit	A3	**Page 102**
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Parameterizable special module (PSM) control unit component description	A22	**Page 106**

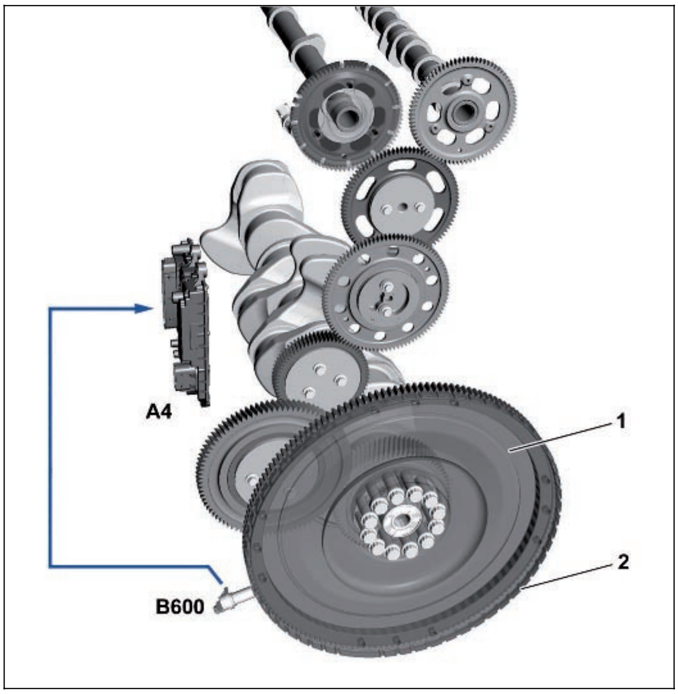
	Battery disconnect switch control unit, component description	A33 ℹ Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery circuit breaker • Code (E9E) ADR preinstallation, without chassis shielding	**Page 107**
	Electronic ignition lock (EIS), component description	S1	**Page 164**
	EMERGENCY OFF switch, component description	S30 ℹ Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery circuit breaker • Code (E9E) ADR preinstallation, without chassis shielding	**Page 165**
	Chassis EMERGENCY OFF switch, component description	S31 ℹ Only in vehicles with one of the following codes: • Code (E5T) ADR model class EX/II, including AT • Code (E5U) ADR model class EX/III, including EX/II and AT • Code (E5V) ADR model class FL, including EX/II, EX/III and AT • Code (E5X) ADR model class AT • Code (E5Z) Accessories, ADR • Code (E9D) Preinstallation, for bipolar battery circuit breaker • Code (E9E) ADR preinstallation, without chassis shielding	**Page 166**
	Engine start and engine stop button, component description	S600	**Page 167**
	Component description for fuel injectors	Y608. to Y613	**Page 170**

GF07.00-W-3001H	Determination of the engine speed and crankshaft angle, function	2.8.11

ENGINE 471.9 in MODEL 963

1 Flywheel
2 Groove

A4 Engine management control unit (MCM)
B600 Crankshaft position sensor



W07.16-1065-82

The engine speed and the crankshaft angle are taken at the flywheel (1). To do this there are 58 grooves (2) around the circumference of the flywheel (1) located 6° apart around the circumference, except for a gap of 18°.

ℹ With the aid of the 18° gap which is located between the groove 63° before top dead center (TDC) and the groove 45° before top dead center (TDC) for cylinders 1 and 6, the top dead center of cylinders 1 and 6 or the angular position of the crankshaft can be recognized.

Each groove (2) triggers an impulse in the crankshaft position sensor (B600). As soon as the engine management (MCM) control unit (A4) receives an impulse from the crankshaft position sensor (B600) its starts an internal counter (trigger). Calculations yield the crankshaft position and the engine speed.

Calculation of intermediate values makes it possible for the engine management (MCM) control unit (A4) to accurately determine the start of injection and the period of injection to within a fraction of a degree.

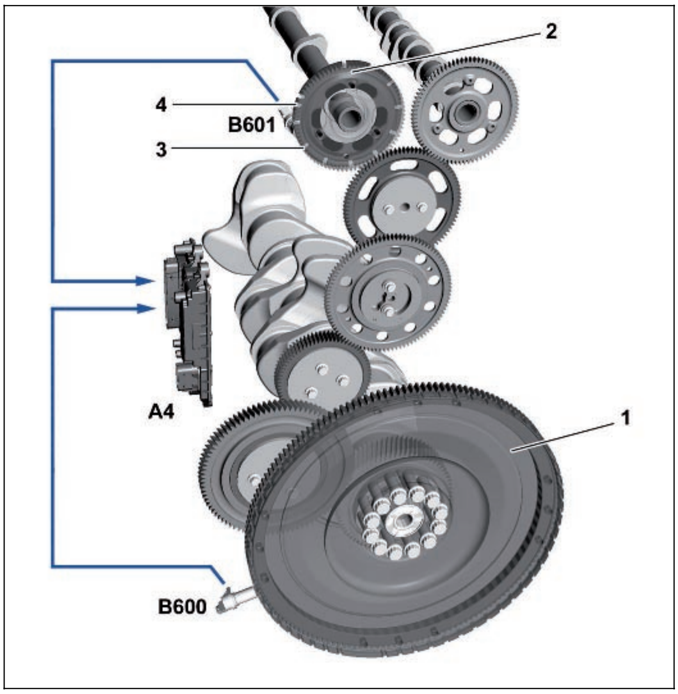
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for crankshaft position sensor	B600	**Page 145**

GF07.00-W-3002H	Determination of the compression stroke at cylinder 1, function	2.8.11

ENGINE 471.9 in MODEL 963

1 Flywheel
2 Camshaft sprocket
3 Groove (to detect the crankshaft angle for failure of the crankshaft position sensor)
4 Additional groove (for detecting the compression cycle at cylinder 1)

A4 Engine management control unit (MCM)
B600 Crankshaft position sensor
B601 Camshaft position sensor



W07.16-1064-82

General information
Detection of the compression cycle at cylinder 1 takes place as soon as the engine has started. Because the position of the crankshaft alone is not enough, the engine management (MCM) control unit (A4) also uses the signals from the camshaft position sensor (B601).
If the compression cycle at cylinder 1 is, however, just known the one time then all further compression cycles are just calculated based on signals from the crankshaft position sensor (B600).
Signals from the camshaft position sensor (B601) are exclusively used to determine the rotational speed or the compression cycle at cylinder 1 if the crankshaft position sensor (B600) fails.
The reason for this is that the crankshaft position sensor (B600) delivers more precise values about the position of the crankshaft than does the camshaft position sensor (B601); thus start of actuation of the fuel injectors can be determined that more exactly.

Function
The camshaft sprocket (2) on the intake camshaft has 12 grooves (3) which are respectively distributed at a distance of 30° from each other over the whole circumference of the camshaft sprocket (2), as well as an additional groove (4) before top dead center (TDC) of cylinder 1.
As soon as the intake camshaft turns, the grooves in the camshaft position sensor (B601) generate changes in the magnetic field which are converted by an electronic analysis system into switching signals and passed on to the engine management (MCM) control unit (A4).
If the engine is then started, the engine management (MR) control unit uses the additional groove (4) (A4) to check when cylinder 1 is in its compression cycle.
The fact that the engine management (MCM) control unit (A4) determines the position of the crankshaft at the same time via the crankshaft position sensor (B600) means that it can compare the position of the additional groove (4) to the position of the gap on the flywheel, so that signals from the crankshaft position sensor (B600) are sufficient to determine the compression cycle of cylinder 1 and thus actuation begin of the fuel injectors.

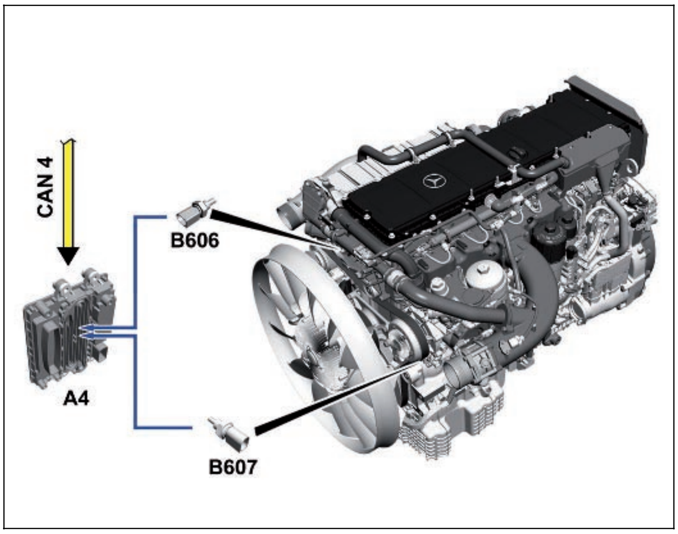
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for crankshaft position sensor	B600	**Page 145**
	Component description for camshaft position sensor	B601	**Page 146**

GF07.16-W-4012H	Determination of the coolant temperature, function	2.8.11

ENGINES 471.9 in MODEL 963

Shown code (M5Z) Engine version Euro VI

A4 Engine management control unit (MCM)
B606 Exhaust coolant temperature sensor
B607 Intake coolant temperature sensor
CAN 4 Drive train CAN



W07.16-1061-81

General

The coolant temperature which is required for a number of factors, including fan regulation or computation of the actuation begin of fuel injectors, is determined by the engine management (MCM) control unit (A4).

For fan regulation the engine management (MCM) control unit (A4) uses measurements made by the coolant intake temperature sensor (B607) and the coolant outlet temperature sensor (B606). In order to determine the actuation begin as well as the actuation period (=injection quantity) of the fuel injectors, the engine management (MCM) control unit (A4) exclusively uses measurements from the coolant outlet temperature sensor (B606).

Function

Both sensors, the intake coolant temperature sensor (B607) and the exhaust temperature sensor in the charge air temperature and boost pressure combination sensor (B606), are fitted with a temperature-dependent resistance with a negative temperature coefficient (NTC) - that is an electrical resistance which reduces as the temperature increases.
The voltage applied to the engine management (MCM) control unit changes (A4) according to the temperature of the coolant at the inlet coolant temperature sensor (B607) or outlet sensor (B606) the inlet or outlet coolant temperature can be determined based on its level.
If one of the sensors fails the engine management (MCM) control unit (A4) continues to operate with substitute values.
This allows the engine to be started even under unfavorable conditions and for the vehicle to continue to be driven.

i The engine management (MCM) control unit (A4) will limit the specified engine torque to protect the engine from overheating if the coolant temperature reaches an impermissibly high value.

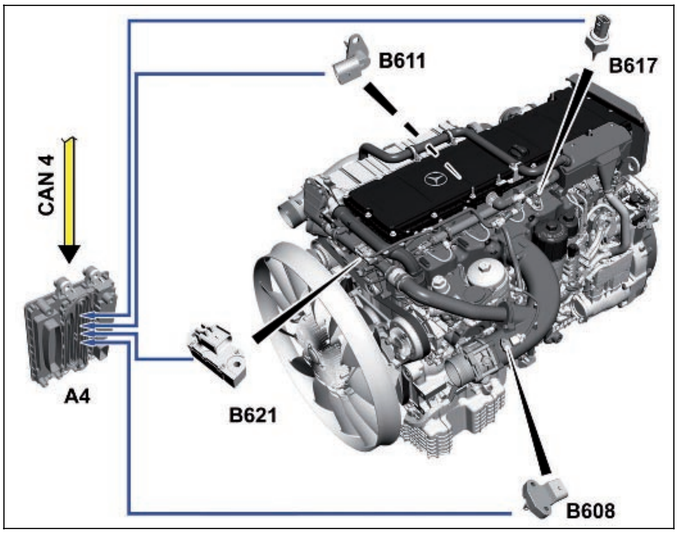
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for exhaust coolant temperature sensor	B606	**Page 150**
	Component description for intake coolant temperature sensor	B607	**Page 151**

GF07.07-W-3001H	Determination of air mass, function	2.8.11

ENGINE 471.9 in MODEL 963

Input signals,
shown with code (M5Z) Euro VI engine version

A4 *Engine management control unit (MCM)*
B608 *Charge air pressure and temperature sensor in charge air pipe*
B611 *Temperature sensor downstream of air filter (only for code (M5Z) Engine version Euro VI)*
B617 *Charge air temperature sensor in charge air housing*
B621 *Exhaust gas recirculation (AGR) differential pressure sensor*
CAN 4 *Drive train CAN*



W07.16-1062-81

General information

The air mass, along with the coolant temperature, engine speed or fuel temperature, is one of the most important factors required by the engine management to regulate the injection quantity. The injection quantity can only be exactly calculated with the aid of the air mass.

Function

Determination of the air mass occurs over the engine management (MCM) control unit (A4). This uses the following information, which is determined by the charge air pressure and temperature sensor in charge air pipe (B608), the temperature sensor downstream of the air filter (B611) - only with code (M5Z) Euro VI engine version, the exhaust gas recirculation (EGR) differential pressure sensor (B621) and the charge air temperature sensor in the charge air housing (B617):

- Mass of the actual suctioned in or supercharged fresh air
- Mass of the actual returned exhaust gases

The engine management (MCM) control unit (A4) can derive the air mass which is routed to the engine for combustion from these values.

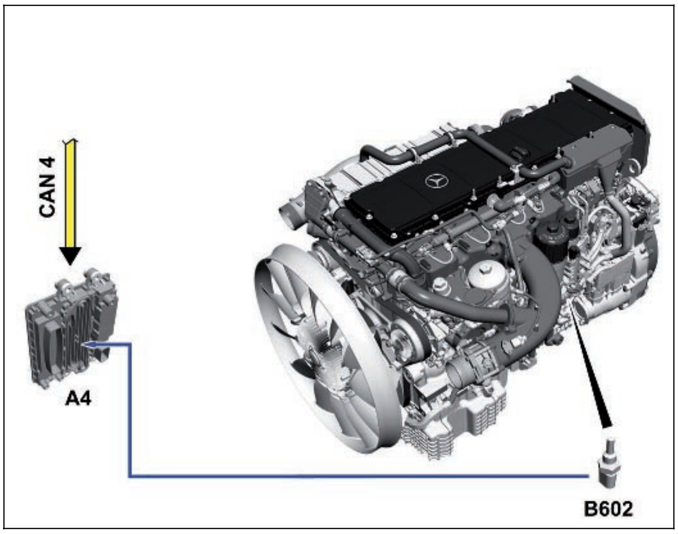
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Charge air pressure and temperature sensor in charge air pipe, component description	B608	**Page 152**
	Component description for temperature sensor downstream of air filter	B611 ℹ Only for vehicles with code (M5Z) Engine version Euro VI.	**Page 154**
	Charge air temperature sensor in charge air housing, component description	B617	**Page 155**
	EGR differential pressure sensor, component description	B621	**Page 156**

GF07.04-W-3001H	Determination of the fuel temperature, function	2.8.11

ENGINE 471.9 in MODEL 963

Shown code (M5Z) Engine version Euro VI

A4 Engine management control unit (MCM)
B602 Fuel temperature sensor
CAN 4 Drive train CAN



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General

The properties of the fuel (volume, viscosity) change significantly with increases or decreases in temperature so it is essential to determine the fuel temperature, particularly for calculating the injection period.

Function

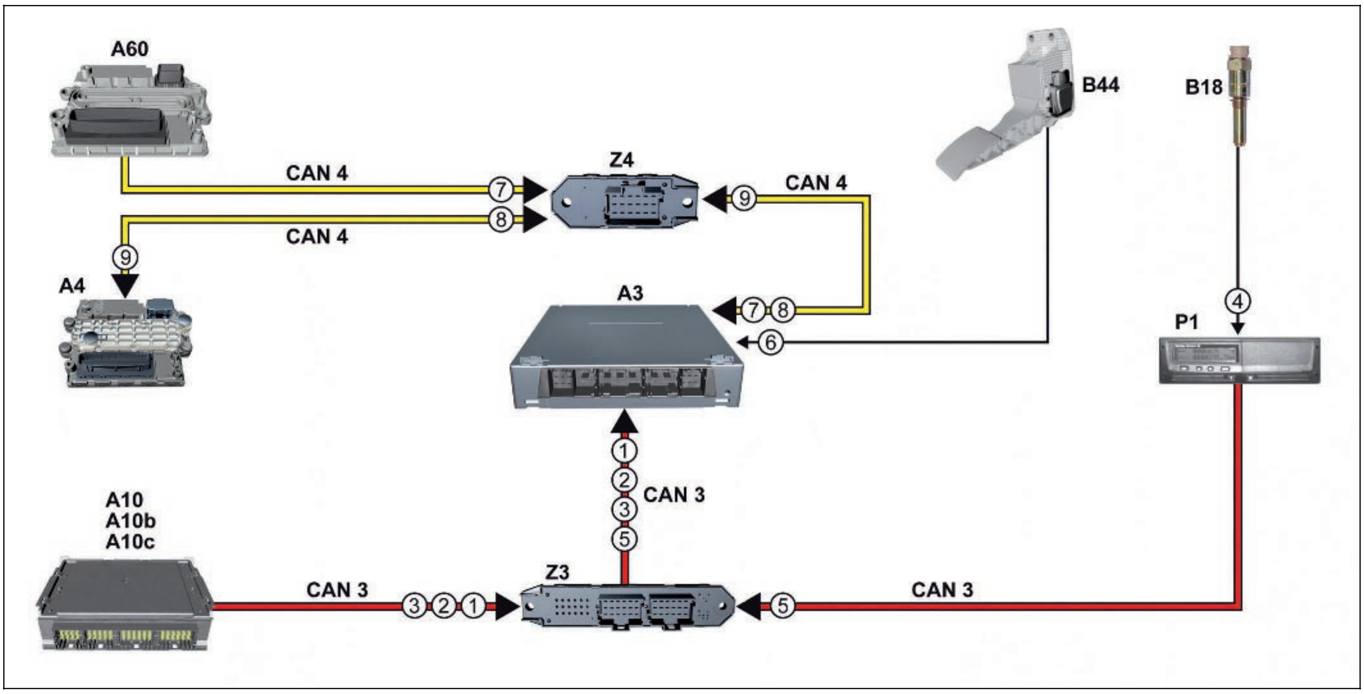
The fuel temperature is determined by the engine management (MCM) control unit (A4) using measurement values provided by the fuel temperature sensor (B602).
There is a temperature-dependent resistance with a negative temperature coefficient (NTC) in the fuel temperature sensor (B602), an electrical resistance which reduces as the temperature increases. The voltage applied to the engine management (MCM) control unit (A4) changes according to the temperature of the fuel; the level of this voltage is what determines the fuel temperature.

ℹ If the fuel temperature sensor (B602) malfunctions, the engine management continues to operate with substitute values.

	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for fuel temperature sensor	B602	**Page 147**

GF30.35-W-3002H	Function of the specified engine torque calculation	20.7.11

MODEL 963



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1	*Anti-lock braking system (ABS), status*
2	*Acceleration Skid Control (ASR), status*
3	*Electronic Stability Program (ESP®), status*
4	*Transmission output speed, signal*
5	*Vehicle speed, signal*
6	*Accelerator pedal sensor, signal*
7	*Exhaust aftertreatment, status*
8	*Maximum available engine torque, status*
9	*Engine target torque, request*
A3	*Drive control (CPC) control unit*
A4	*Engine management control unit (MCM)*
A10	*Antilock brake system (ABS) control unit, 4-channel*
A10b	*Electronic brake control control unit (EBS) (Wabco)*
A10c	*Electronic brake control control unit (EBS) (Knorr)*
A60	*Exhaust aftertreatment (ACM) control unit*
B18	*Travel and speed sensor*
B44	*Accelerator pedal sensor*
CAN 3	*Frame CAN*
CAN 4	*Drive train CAN*
P1	*Tachograph (TCO)*
Z3	*Frame CAN bus star point*
Z4	*Drive CAN bus star point*

General information

The target engine torque is a value that is calculated by the drive control control unit (CPC) (A3).
This value represents the driver request (e.g. accelerate) taking the current driving status into consideration.
The drive control control unit (CPC) (A3) provides the engine management control unit (MCM) (A4) with the current target engine torque for calculating the relevant variables for the engine timing.

Function

The drive control control unit (CPC) (A3) determines the current position of the accelerator pedal from the PWM (Pulse Width Modulated) signal of the accelerator pedal sensor (B44). As well as the accelerator pedal position, the drive control control unit (CPC) (A3) evaluates additional information, which can limit the target engine torque depending on the situation:

- Anti-lock braking system (ABS) (braking torque) status
- Acceleration skid control (ASR) (engine torque) status
- Electronic Stability Program (ESP®) (braking torque) status
- Vehicle speed
- Status of driver assist systems (e.g. Proximity Control Assist, with code (S1l) Proximity Control Assist)
- Exhaust aftertreatment status

The maximum available engine torque is evaluated in addition to this information. The information concerning the maximum available engine torque is provided by the engine management control unit (MCM) (A4).
The engine management control unit (MCM) (A4) evaluates the current coolant temperature, the fuel temperature and the engine rpm to do this.
The engine management control unit (MCM) (A4) then sends the maximum available engine torque to the drive control control unit (CPC) (A3).

The drive control control unit (CPC) (A3) uses the sum total of the listed information to calculate the relevant target engine torque.
The drive control control unit (CPC) (A3) transmits this request to the engine management control unit (MCM) (A4), which then calculates the variables for the injection quantity.

[i] The calculated target engine torque is output as a positive value. If the accelerator pedal is not operated, the target engine torque is specified as "0", and in deceleration mode the target engine torque is shown as a negative value.

	Drive control (CPC) control unit, component description	A3	**Page 102**
	Engine management control unit (MCM), component description	A4	**Page 103**
	Electronic Brake Control control unit (EBS), component description	A10b, A10c	**Page 105**
	Exhaust aftertreatment (ACM) control unit, component description	A60 Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 117**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 119**
	Travel and speed sensor, component description	B18	**Page 131**
	Accelerator pedal sensor, component description	B44	**Page 134**
	Tachograph (TCO) component description	P1	**Page 163**

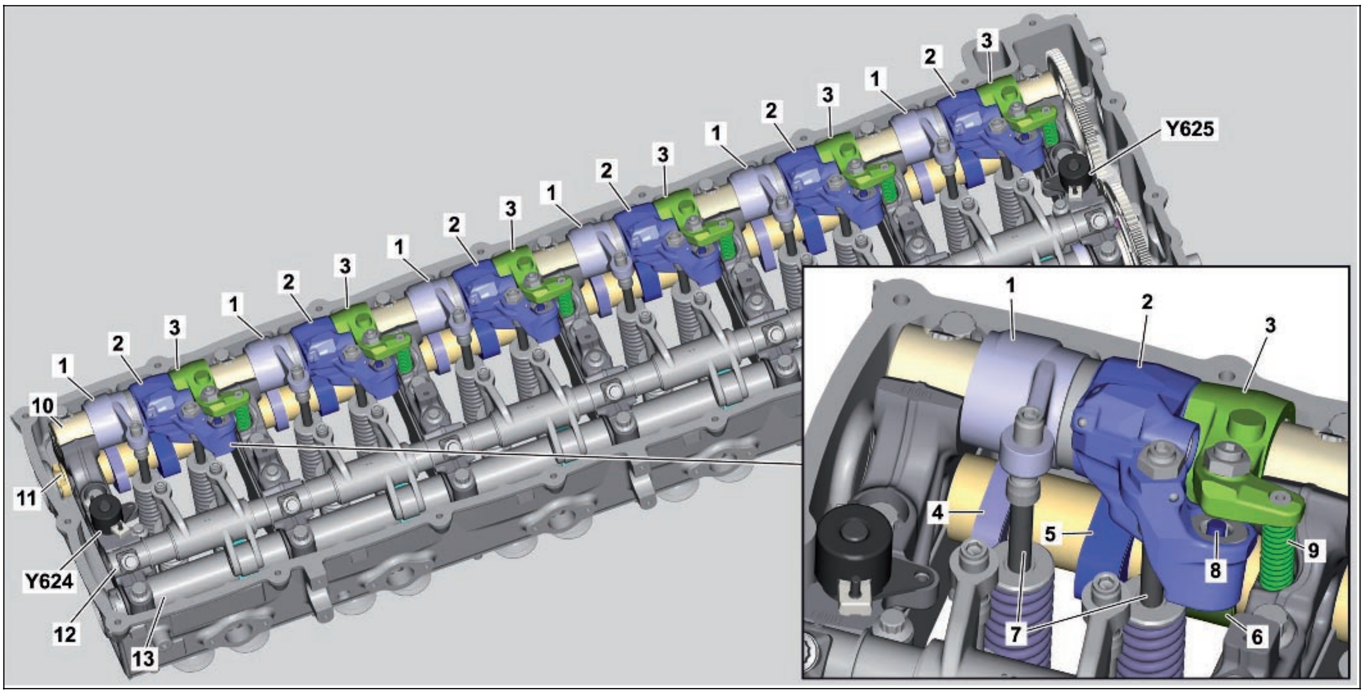
GF14.15-W-0002H	Engine brake, function	2.8.11

ENGINES 471.9 in MODEL 963, 964 with CODE () Engine brake, standard system
ENGINES 471.9 in MODEL 963, 964 with CODE () Engine brake, high performance system

General information
The engine brake system used is a so-called decompression brake system.
The braking effect is generated in the process according to the following principle:
Shortly after the beginning of the compression stroke, as the piston moves upwards in the direction of TDC, one of the two exhaust valves is opened for a short time on the respective cylinder. Therefore exhaust flows out of the exhaust manifold back into the cylinder due to the head pressure. The compression pressure is increased as a result and the upward moving piston in braked in its compression stroke.

The exhaust valve opens for a brief period shortly before the end of the compression stroke. Now part of the compression pressure is reduced. As a result the piston is less rapidly accelerated in the direction of the BDC in its next operating cycle.

Operating conditions
The engine braking system can be activated under the following conditions:
- Vehicle in deceleration mode, that is the driving and clutch pedal are not actuated
- Engine speed > 1000 rpm
- Antilock brake system (ABS) not in closed-loop operation.



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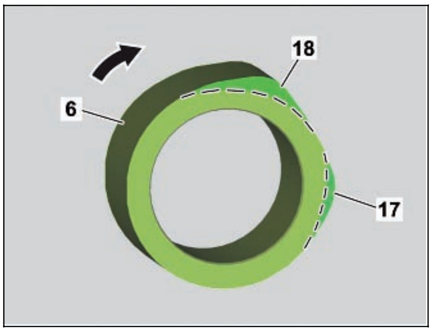
Overview of components of valve timing, shown on deactivated engine brake

1 Exhaust rocker arm
2 Exhaust rocker arm with hydroelement
3 Brake rocker arm
4 Exhaust cams
5 Exhaust cams
6 Brake cam
7 Outlet valve
8 Piston
9 Spring
10 Exhaust rocker shaft
11 Exhaust camshaft
12 Intake rocker arm spindle
13 Intake camshaft

Y624 Engine brake solenoid valve, stage 1
Y625 Engine brake solenoid valve, stage 2

Brake cam contour
6 Brake cam
17 1st peak
18 2nd peak



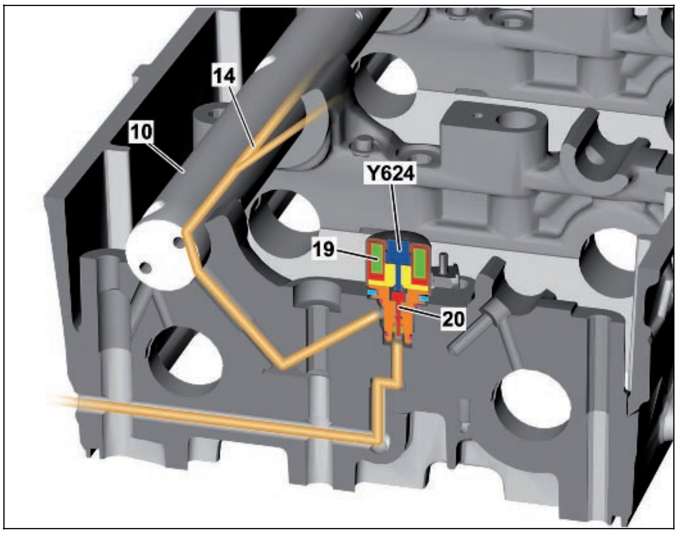
W14.15-1136-71

The brake cams (6) have two peaks with which the brake rocker arm (3) are actuated and by which the exhaust valves (7) can be opened.
- 1st peak (17) opens the exhaust valve (7) for a short time shortly before beginning the compression stroke.
- 2nd peak (18) opens the exhaust valve (7) for a short time shortly before ending the compression stroke.

Engine brake solenoid valve, shown on engine brake solenoid valve, stage 1

10 Exhaust rocker shaft
14 Cylinder 1...3 oil duct
19 Coil
20 Valve body

Y624 Engine brake solenoid valve, stage 1



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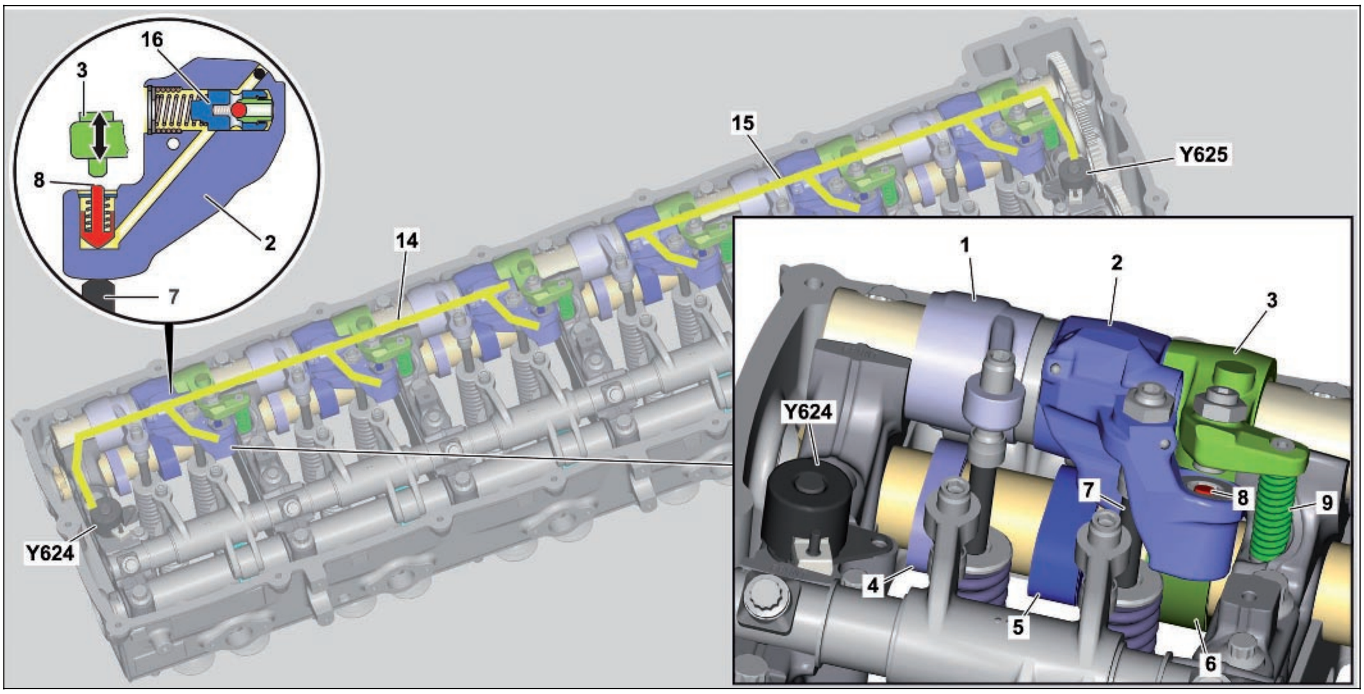


W14.15-1133-79

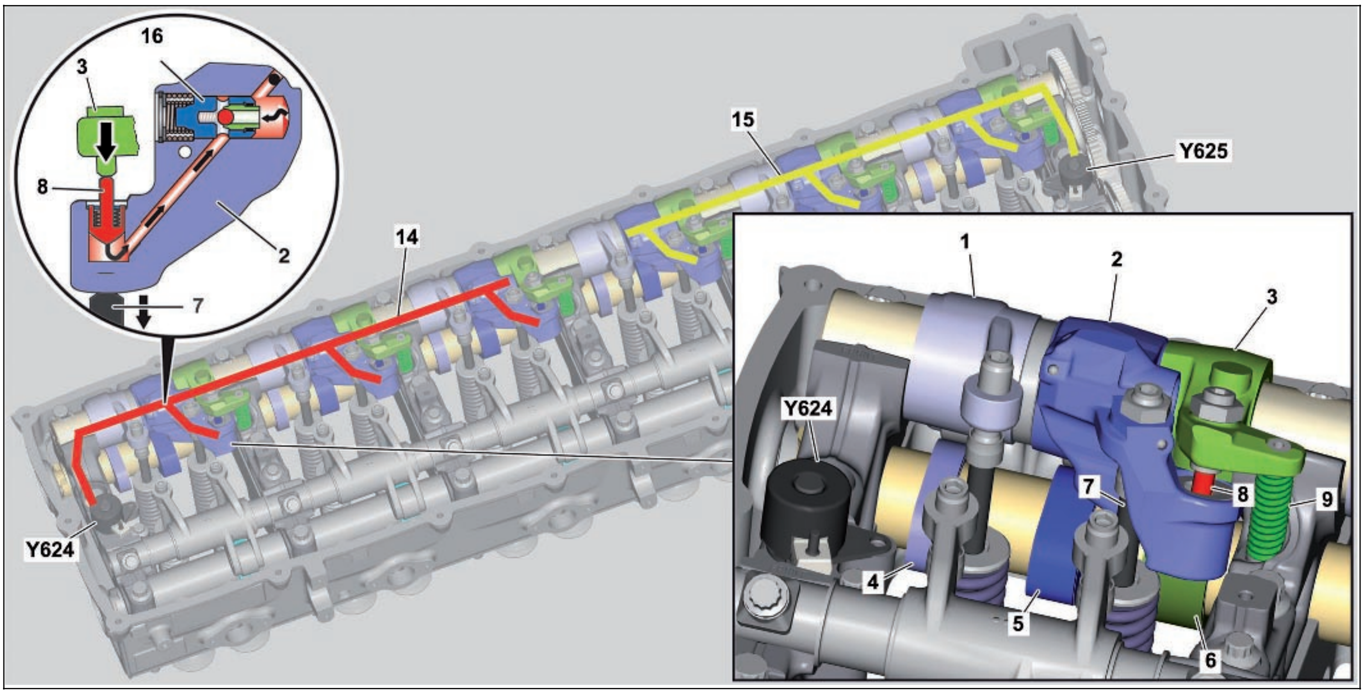
Engine brake deactivated

1 Exhaust rocker arm
2 Exhaust rocker arm with hydroelement
3 Brake rocker arm
4 Exhaust cams
5 Exhaust cams
6 Brake cam
7 Outlet valve
8 Piston
9 Spring
14 Cylinder 1...3 oil duct
15 Cylinder 4...6 oil duct
16 Check valve

Y624 Engine brake solenoid valve, stage 1
Y625 Engine brake solenoid valve, stage 2

In normal driving mode, if the engine brake is not activated, the engine brake solenoid valve, stage 1 (Y624) and the engine brake solenoid valve, stage 2 (Y625) are not actuated.
In this way no oil pressure can find its way out of the engine oil circuit over the oil ducts for the exhaust rocker shaft (10) to the exhaust rocker arms with hydroelement (2). The oil pressure present causes the piston (8) contained therein to be pressed by the spring (9) onto its downstop.

The respective brake rocker arm (3) does shift on the respective brake cams (6) but comes to nothing due to the missing frictional connection to piston (8).
Both exhaust valves (7) are therefore opened or closed as normal according to the cycles of the working cycle.



W14.15-1134-79

Brake stage I

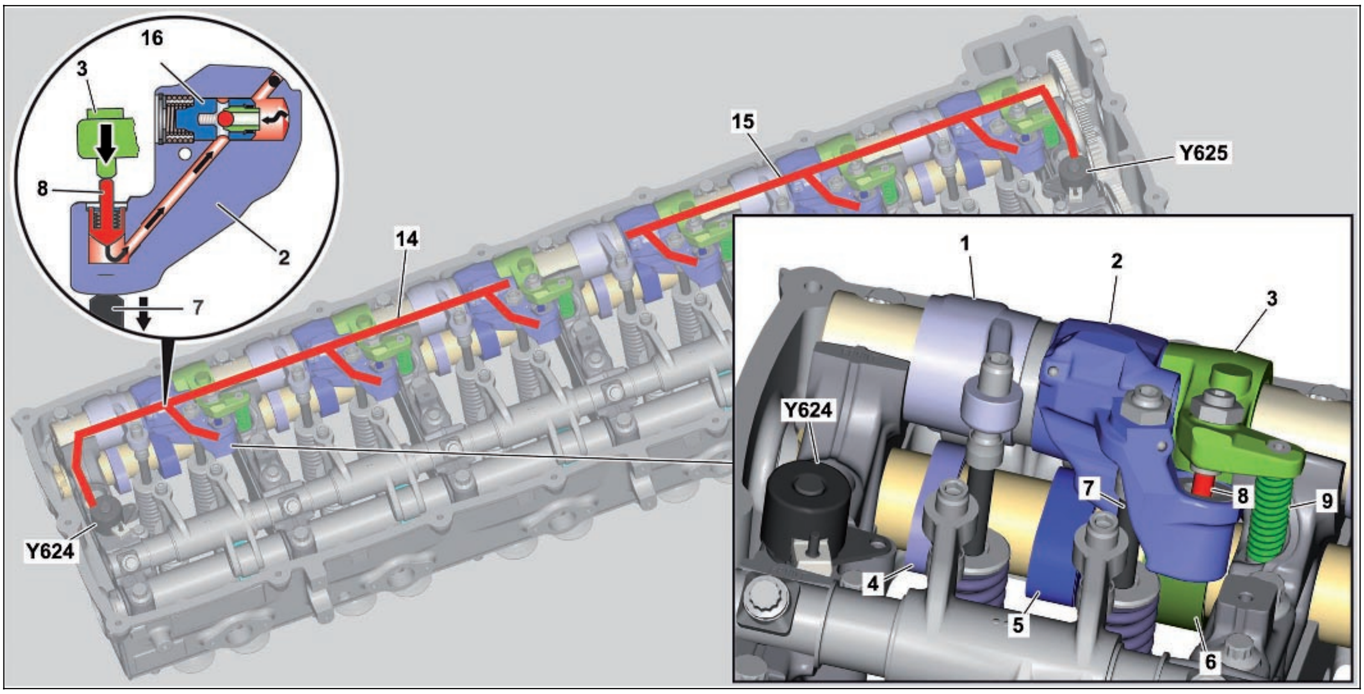
1	*Exhaust rocker arm*	*6*	*Brake cam*	*15*	*Cylinder 4...6 oil duct*
2	*Exhaust rocker arm with hydroelement*	*7*	*Outlet valve*	*16*	*Check valve*
		8	*Piston*		
3	*Brake rocker arm*	*9*	*Spring*	*Y624*	*Engine brake solenoid valve, stage 1*
4	*Exhaust cams*	*14*	*Cylinder 1...3 oil duct*	*Y625*	*Engine brake solenoid valve, stage 2*
5	*Exhaust cams*				

In brake stage I the brake power is achieved by cylinders 1...3. The engine management (MCM) control unit (A4) actuates the engine brake solenoid valve, stage 1 (Y624) just as soon as the driver activates brake stage 1 over the engine brake switch.
Oil is now pushed out of the engine oil circuit over the oil duct for cylinders 1...3 (14) of the exhaust rocker shaft (10) into the exhaust rocker arm with hydrolement (2) of cylinders 1...3.

In the exhaust rocker arms with hydroelement (2), oil first flows through the check valve (16) in flow direction and thus the space under the piston (8) is filled. If there is no gap anymore between the piston (8) and brake rocker arm (3) then the check valve (16) is closed by the now accumulating back pressure.

In this way a frictional connection is made between the brake rocker arm (3) and the piston (8). The respective exhaust valve (7) is now opened through the downward movement of the respective brake rocker arm (3).

If brake stage I is deactivated, the solenoid valve, stage 1 (Y624) is no longer actuated - the applied oil pressure in the exhaust rocker arms with hydrolement (2) and the exhaust rocker shaft (10) reduce.
The pistons (8) are pushed back to the downstop by spring force. The missing frictional connection between the brake rocker arm (3) and the exhaust rocker arm with hydroelement (2) means that the downward movement of the brake rocker arm (3) is no longer transferred to the exhaust valve (7).



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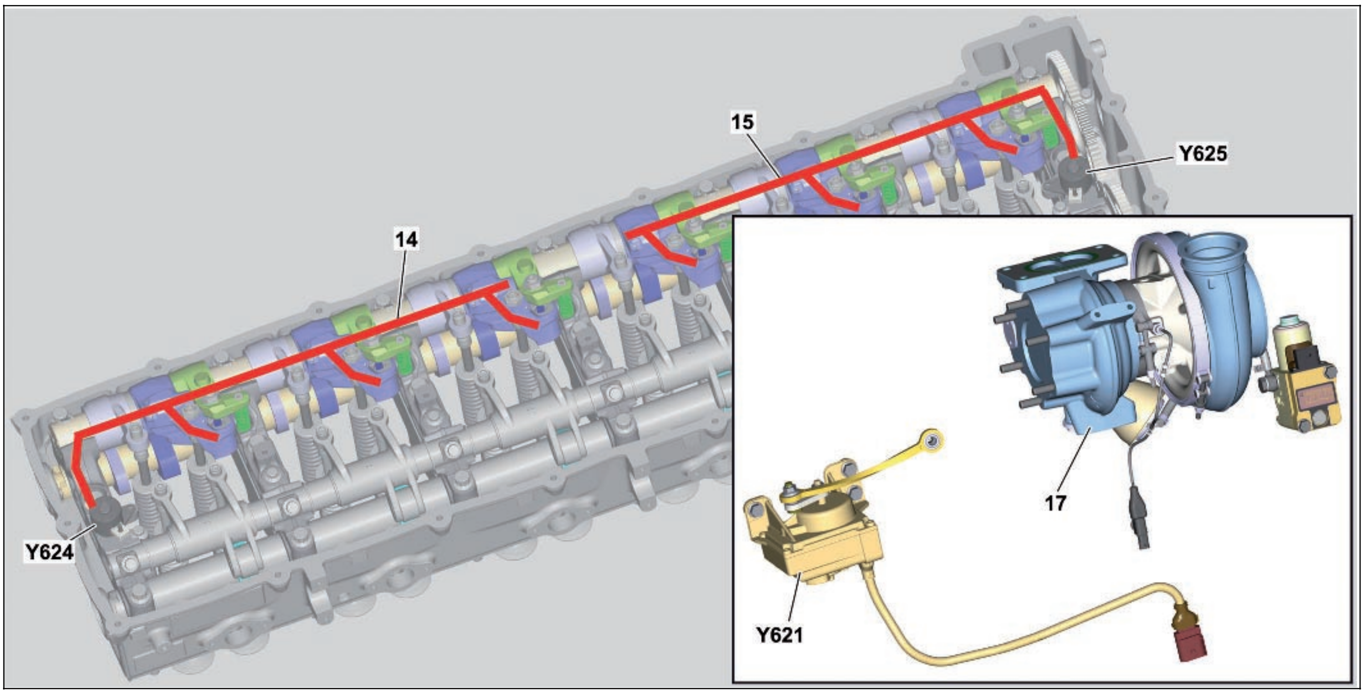
Brake stage II

1	*Exhaust rocker arm*	6	*Brake cam*	15	*Cylinder 4...6 oil duct*
2	*Exhaust rocker arm with hydroelement*	7	*Outlet valve*	16	*Check valve*
3	*Brake rocker arm*	8	*Piston*		
4	*Exhaust cams*	9	*Spring*	Y624	*Engine brake solenoid valve, stage 1*
5	*Exhaust cams*	14	*Cylinder 1...3 oil duct*	Y625	*Engine brake solenoid valve, stage 2*

In brake stage II the brake power is provided by all cylinders.
As soon as the driver activates brake stage 2 over the engine brake switch the engine management (MCM) control unit (A4) not only actuates the engine brake solenoid valve, stage 1 (Y624), but also the engine brake solenoid valve, stage 2 (Y625).
Oil is now pushed out of the engine oil circuit over the oil duct for cylinders 1...3 (14) and oil duct for cylinders 4...6 (15) of the exhaust rocker shaft (10) into all exhaust rocker arms with hydrolement (2).
In the exhaust rocker arms with hydroelement (2) oil first flows through the check valve (16) in flow direction and thus the space under the piston (8) is filled. If there is no gap anymore between the piston (8) and brake rocker arm (3) then the check valve (16) is closed by the now accumulating back pressure.
In this way a frictional connection is made between the brake rocker arm (3) and the piston (8). The respective exhaust valve is now opened through the downward movement of the respective brake rocker arm (3).
If the brake stage 2 is deactivated the engine brake solenoid valve, stage 1 (Y624) and the engine brake solenoid valve, stage 2 (Y625) are no longer actuated - the oil pressure applied in the exhaust rocker arms with hydrolement (2) and the exhaust rocker shaft (10) drops.
The pistons (8) are pushed back to the downstop by spring force. The missing frictional connection between the brake rocker arm (3) and the exhaust rocker arm with hydroelement (2) means that the downward movement of the brake rocker arm (3) is no longer transferred to the exhaust valve (7).



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Brake stage III

14	*Cylinder 1...3 oil duct*	*17*	*Turbocharger*	*Y624*	*Engine brake solenoid valve, stage 1*
15	*Cylinder 4...6 oil duct*	*Y621*	*Exhaust gas recirculation positioner*	*Y625*	*Engine brake solenoid valve, stage 2*

In brake stage III the brake power is reached by all cylinders and through an additional increase in the internal pressure of the cylinder.

As soon as the brake stage III is activated by the driver over the engine brake switch the initial reaction is for the same processes as for brake stage II to be triggered. In addition to the now fully switched-in decompression brake also the wastegate valve on the turbocharger (17) as well as the exhaust gas recirculation positioner (Y621) are actuated.

In this way a situation is achieved whereby the internal pressure of the cylinder is increased during the compression stroke - which results in a higher braking torque.
The engine management (MCM) control unit (A4) uses the boost pressure and the turborcharger speed as controlled variables.

Additional functions of the engine brake system

Providing support during shift operations
The engine brake is automatically activated for all normal shift operations without the driver having to do anything. Activation of the engine brake significantly lowers the rotational speed between the individual shift operations whereby more rapid synchronization is achieved, which in turn leads to a more rapid acceleration of the vehicle.

The engine management (MCM) control unit (A4) uses the following parameters as a controlled variable:

- Oil temperature
- Differential speed
- Boost pressure

The brake stages I...III are activated based on these.

Supporting stopping the engine
If the ignition is switched off and the injected fuel quantity = 0, the engine brake is automatically activated without any action on the part of the driver. The compression is strongly reduced through opening the exhaust valve so the engine can "slowly come to a halt" and not be shifted between two ignition TDCs by the compression.

This function is only effective for oil temperatures below about 70°C. In the case of a warm engine it is, therefore, possible that the engine tangibly "shakes" when stopping.

Performance feature of a standard and high performance system

The engine brake system is offered in two different power categories. The hardware of the two systems is identical.
The differences lie in the software - both systems are fitted with a different code-controlled data record.

Code (M5U) Engine brake, standard system

- 100 kW at 1300 rpm
- 300 kW at 2300 rpm

Code (M5V) Engine brake, high performance system

- 150 kW at 1300 rpm
- 400 kW at 2300 rpm

The high performance system functions according to the same mechanical/thermodynamic principle as the standard system. There are, however, parameters in the engine management (MCM) control unit (A4) which ensure that the internal pressure is increased in all cylinders in all engine brake stages over actuation of the wastegate on the turbocharger.

The exhaust gas recirculation positioner (Y621) is also actuated if necessary whereby the fill level of the cylinder is increased again. The result of this is: the piston must do more work to compress the air - the braking torque increases.

	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for engine brake solenoid valve	Y624, Y625	**Page 178**

GF14.20-W-3000H	Exhaust gas recirculation, function	2.8.11

ENGINES 471.9 in MODEL 963, 964

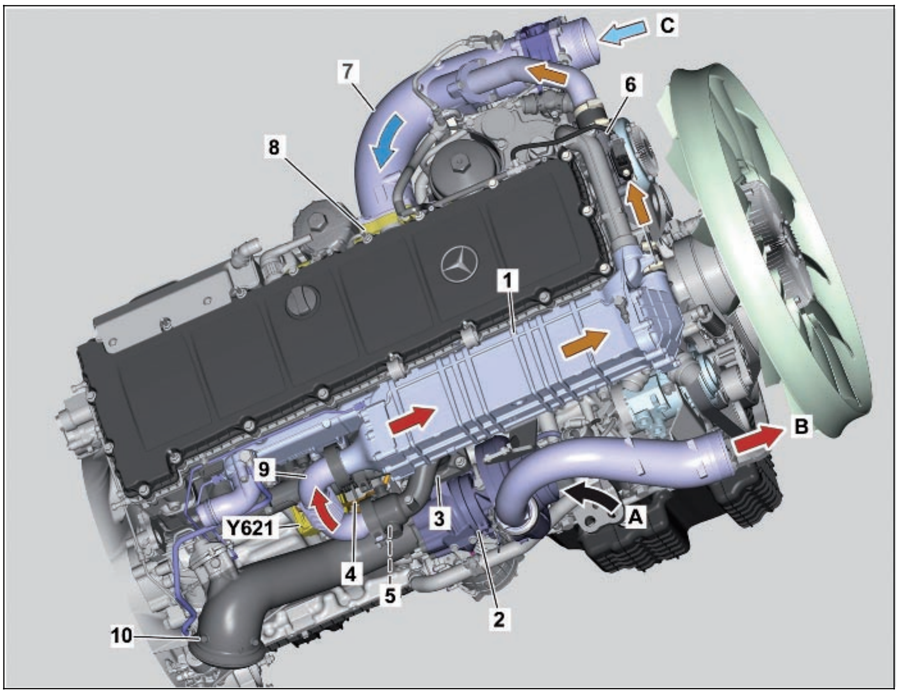
General information

The exhaust recycling (AGR) primarily serves to reduce the amount of nitrogen oxides to comply with the emission limits even before aftertreatment of the exhaust.
The suctioned in or supercharged fresh air is mixed with exhaust so that the concentration of oxygen in the combustion mixture reduces.
If the concentration of oxygen reduces the combustion temperature drops which leads to reduced output of nitrogen oxides (NOx).

The ratio of the recycled quantity of exhaust and suctioned in or supercharged fresh air must be exactly regulated at all points in time since the EGR (EGR) is active over the whole range of rotational speeds. For a combustion mixture with an excessively high proportion of exhaust deteriorates the combustion and the emission of soot particles, carbon monoxide (CO) and hydrocarbon (HC) increases. On the other hand the emission of nitrogen oxides (NOx) increases if the ratio of fresh or supercharged air is too high.

System components

1	*Exhaust gas recirculation cooler*
2	*Turbocharger*
3	*Exhaust manifold center part*
4	*Control lever*
5	*Throttle valve*
6	*EGR line (cold)*
7	*Charge air pipe (mixer housing)*
8	*Charge air housing*
9	*EGR line (hot)*
10	*Exhaust pipe*
Y621	*Exhaust gas recirculation positioner*
A	*Intake air from air filter*
B	*Charge air to charge air cooler (hot)*
C	*Charge air to charge air cooler (cold)*



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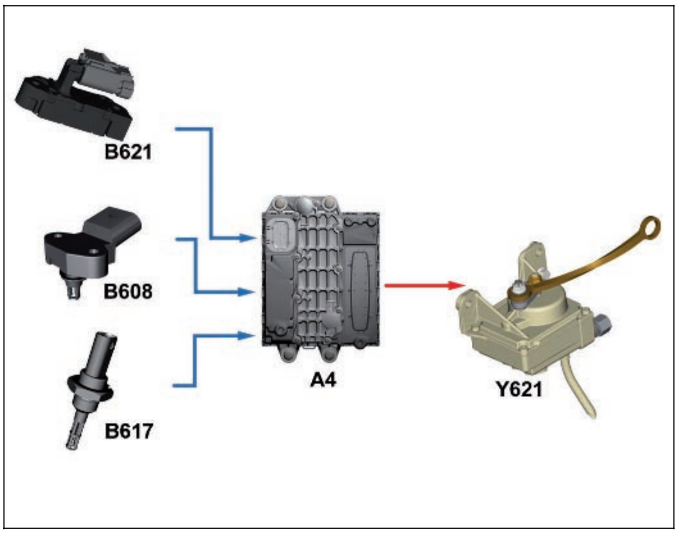
Networking of the electrical components

A4	*Engine management (MCM) control unit*
B608	*Charge air pressure and temperature sensor in charge air pipe*
B617	*Charge temperature sensor in charge air housing*
B621	*Exhaust gas recirculation (AGR) differential pressure sensor*
Y621	*Exhaust gas recirculation positioner*



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Function

The EGR rate describes the relationship of recycled quantity of exhaust to the quantity of fresh air. It is determined over the engine management (MCM) control unit (A4) that the mass of actually suctioned in or supercharged fresh air and the mass of actually recycled exhaust are correlated with one another.

Regulation of the EGR rate takes place over the exhaust gas recirculation positioner (Y621) which opens or closes the throttle valve (5) in the EGR line (6) over the adjustment lever (4) and therefore regulates which quantity of exhaust is added.

The branched off exhaust initially flows through the exhaust gas recirculation cooler (1) attached to the coolant circuit. Here cooling takes place from a temperature of about 650°C down to about 170°C.

The AGR rate can be increased by the cooling since the density and therefore the mass of the recycled exhaust is increased. Furthermore the added quantity of cooled exhaust causes a reduction in the NOx emissions by the lowering of the combustion temperature.

Once the exhaust has passed through the exhaust gas recirculation cooler (1), it passes through the EGR line (6) into the charge air pipe (7). It is mixed here with the fresh air coming out of the charge air cooler and then led to the individual cylinders for combustion.

	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for charge air pressure and temperature sensor in charge air pipe	B608	**Page 152**
	Component description for charge temperature sensor in charge air housing	B617	**Page 155**
	Component description for EGR differential pressure sensor	B621	**Page 156**
	Component description for exhaust gas recirculation controller	Y621	**Page 176**
	Component description for exhaust gas recirculation cooler		**Page 187**

GF14.40-W-0002HA	Exhaust aftertreatment, function	2.8.11

ENGINES 471.9 in MODEL 963 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963 with CODE (M5R) Engine version EEV

General information
The EATS to comply with the emissions standards Euro V or EEV based on new engine technology in combination with a range of measures to reduce the emissions in exhaust.

The emissions standard Euro V, EEV
Emissions standard are legal guidelines which serve to subdivide vehicles into certain emissions classes. These emissions classes are assigned to certain emission-code-numbers
which serve, amongst other things, to compute the vehicle tax and classification in emission groups for environmental zones.

The emissions standards Euro V and EEV for commercial vehicles establish very strict limits for output of carbon monoxide (CO), nitrogen oxide (NOx), hydrocarbons (HC) and particles (PM).

As a vehicle manufacturer Mercedes-Benz must guarantee compliance with these limits for an established time period and mileage. Therefore the EATS is a component of engine/vehicle homologation subject to compulsory certification.

EATS for Euro V, EEV

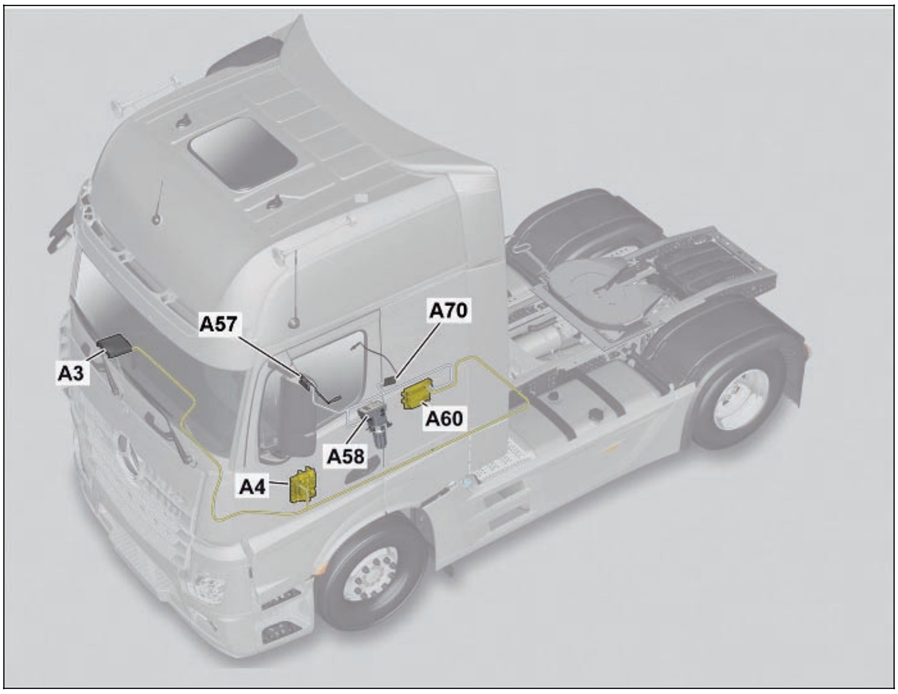
New diesel engine generation
The new engine generation is fitted with a common rail diesel injection system, EGR and boost pressure control. The engines themselves are set to maximum efficiency and low particulate emissions.

Exhaust aftertreatment by means of:

- Selective Catalytic Reduction (SCR) with an ammonia locking CAT

Networking of control units

A3	*Drive control (CPC) control unit*
A4	*Engine management control unit (MCM)*
A57	*NOx sensor control unit outlet of EATU*
A58	*SCR control unit (in pump module)*
A60	*Exhaust aftertreatment (ACM) control unit*
A70	*NOx sensor control unit inlet of EATU*



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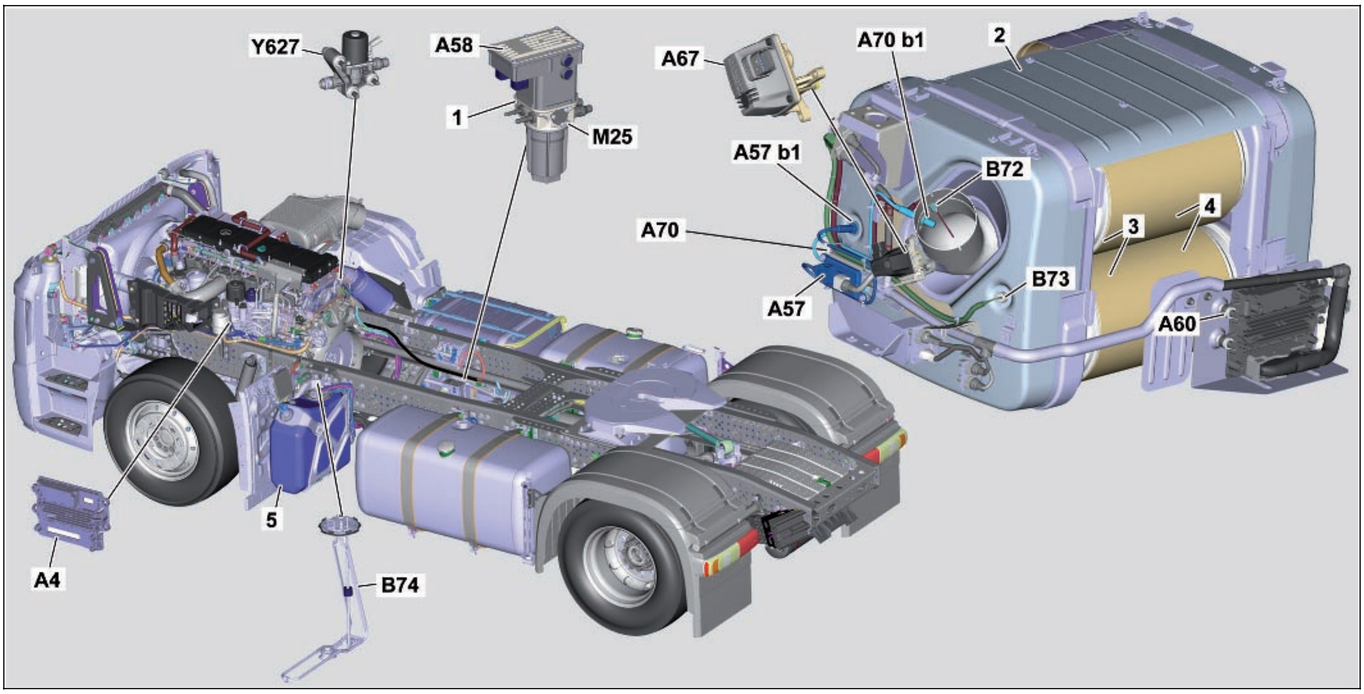

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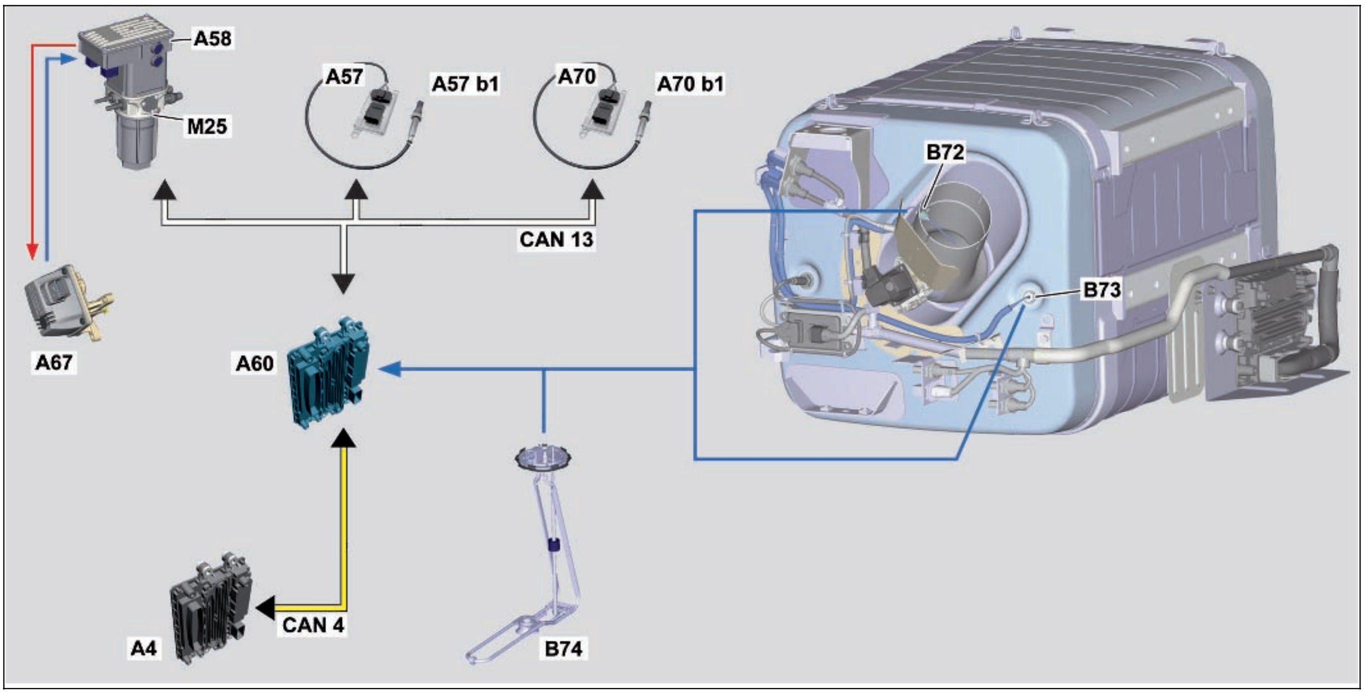
1	*Pump module*
2	*Exhaust aftertreatment unit*
3	*Ammonia locking CAT*
4	*SCR catalytic converter*
5	*AdBlue® tank*
A4	*Engine management control unit (MCM)*
A57	*NOx sensor control unit outlet of EATU*
A57 b1	*NOx sensor outlet of EATU*
A58	*SCR control unit*
A60	*Exhaust aftertreatment (ACM) control unit*
A67	*AdBlue® metering device*
A70	*NOx sensor control unit inlet of EATU*
A70 b1	*NOx sensor inlet of EATU*
B72	*Exhaust temperature sensor upstream of SCR catalytic converter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*
B74	*AdBlue® fill level sensor/temperature sensor*
M25	*SCR delivery pump*
Y627	*AdBlue® heater coolant solenoid valve*



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A4 *Engine management control unit (MCM)*
A57 *NOx sensor control unit outlet of EATU*
A57 b1 *NOx sensor outlet of EATU*
A58 *SCR control unit*
A60 *Exhaust aftertreatment (ACM) control unit*
A67 *AdBlue® metering device*
A70 b1 *NOx sensor control unit inlet of EATU*
A70 *NOx sensor inlet of EATU*
B72 *Exhaust temperature sensor upstream of SCR catalytic converter*
B73 *Exhaust temperature sensor downstream of SCR catalytic converter*
B74 *AdBlue® fill level sensor/temperature sensor*
CAN 4 *Drive train CAN*
CAN 13 *NOx-CAN*
M25 *SCR delivery pump*

Function of the EATS (overall system)

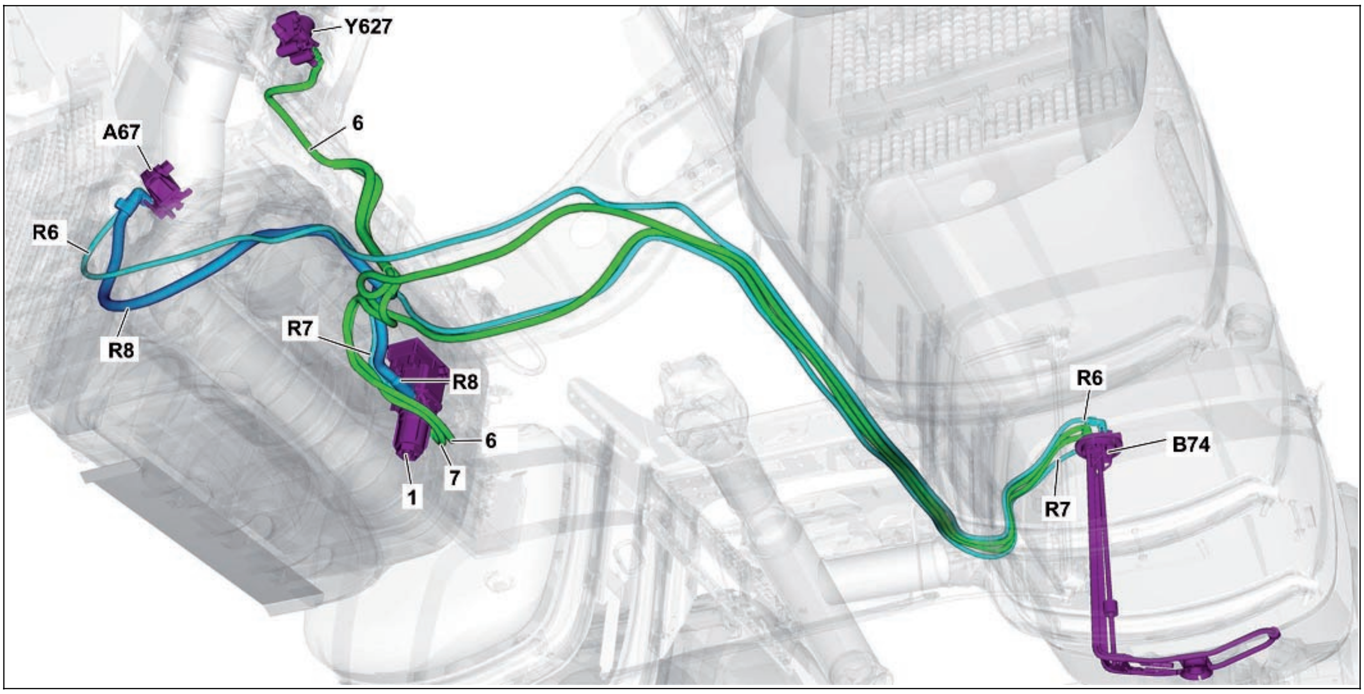
The basic functionalities of the whole EATS are monitored and regulated over the engine management (MCM) control unit (A4) and the exhaust aftertreatment (ACM) control unit (A60).
After an engine start the engine management (MCM) control unit (A4) starts an automatic test routine automatically in the background which checks the operational readiness of the EATS. The SCR control unit (A58) integrated in the pump module (1) is actuated after successful release of the system. This switches on the SCR delivery pump (M25) contained in the pump module (1) which now suctions up AdBlue® out of the AdBlue® container (5) and delivers it over the AdBlue® feed line to the AdBlue® metering device (A67).

Since the AdBlue® injection does take place continuously in the exhaust flow the AdBlue® flows back again over the AdBlue® return line into the AdBlue® container. This circulation continuously takes place independently of whether AdBlue® is injected or not. So recirculation cooling is achieved which protects the AdBlue® metering device (A67) directly attached to the EATU (2) against damage due to overheating.

Reduction of NOx in the SCR catalytic converter

The AdBlue® injection into the exhaust flow is calculated by the engine management (MCM) control unit (A4). If AdBlue® should be injected this first of all sends a signal to the exhaust aftertreatment (ACM) control unit (A60) which processes the data and afterwards actuates the SCR control unit (A58) integrated on the pump module.
The injection timing point and the injection quantity are now calculated there and the AdBlue® metering device (A67) is appropriately actuated.
The following occurs if AdBlue® is injected:
the AdBlue® metering device (A67) injects AdBlue® into the so-called hydrolysis segment in the EATU (2) directly into the exhaust flow.

The AdBlue® mixes here with the already precleaned exhaust and breaks down in a first process step into ammonia (NH_3). Along with the nitrogen oxide molecules (NOx) generated during combustion the ammonia (NH_3) so created flows on in the exhaust flow to the SCR catalytic converter (4). Its honeycomb structure has a special coating which allows conversion of NH_3 and NOx into harmless nitrogen (N_2) and water vapor (H_2O).



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AdBlue®/coolant line system

1	*Pump module*	*A67*	*AdBlue® metering device*	*R7*	*AdBlue® intake duct heating element*
6	*Coolant feed line*	*B74*	*AdBlue® fill level sensor/temperature sensor*	*R8*	*AdBlue® pressure line heating element*
7	*Coolant return line*	*R6*	*AdBlue® return line heating element*	*Y627*	*AdBlue® heater coolant solenoid valve*

AdBlue® line system

The AdBlue® line system lies between the AdBlue® container (5), pump module (1) and AdBlue® metering device (A67).
The fact that the AdBlue® metering device (A67) is directly attached to the EATU and is therefore subjected to high temperatures, AdBlue® is circulated continuously from engine start and in a certain run-on time after engine stop for recirculation cooling.

AdBlue® heater

AdBlue® freezes below a temperature of about -13°C. The AdBlue® heater ensures that any AdBlue® that has frozen during periods of non-operation is heated and reliquified and prevents AdBlue from freezing while driving in cold outside temperatures.
The AdBlue® lines from the AdBlue® container (5) to the pump module (1) are bundled with the coolant lines and routed insulated.
The AdBlue® lines between the pump module (1) and the AdBlue® metering device (A67) are not heated by coolant but instead over in electrically heated heating elements integrated in the line sections.

Function of AdBlue® heating by coolant

The AdBlue® heater consists of the AdBlue® coolant solenoid valve heater (Y627) which is located on the rear side of the engine and a coolant line system. The AdBlue® coolant solenoid valve heater (Y627) is actuated by the engine management (MCM) control unit (A4). Over the AdBlue® fill level sensor/temperature sensor (B74) integrated in the AdBlue® container (5), it detects when the temperature of the tank contents is approaching the defined limit value of approx. 8°C. If this is the case and if the coolant temperature has already reached a temperature of 65°C, the AdBlue® heater coolant solenoid valve (Y627) is opened so the coolant flows through the line system.

Function of AdBlue® heating by an electrical heater

The heating coil of the heating elements integrated in the AdBlue® lines is switched on and off by the exhaust aftertreatment (ACM) control unit (A60). Very pertinent here are also the values which are delivered by the AdBlue® fill level sensor/temperature sensor (B74).

	Overall network for exhaust aftertreatment		**Page 79**
	Component description for engine management (MCM) control unit	A4	**Page 103**
	Component description for NOx sensor outlet of EATU	A57, A57 b1	**Page 110**
	Component description for pump module	A58, M25	**Page 115**
	Component description for exhaust aftertreatment (ACM) control unit	A60	**Page 117**
	Component description for AdBlue metering device	A67	**Page 121**
	Component description for NOx sensor control unit inlet of EATU	A70, A70 b1	**Page 123**
	Component description for exhaust temperature sensor upstream of SCR catalytic converter	B72	**Page 139**
	Component description for exhaust temperature sensor downstream of SCR catalytic converter	B73	**Page 140**
	Component description for AdBlue® fill level sensor/temperature sensor	B74	**Page 142**
	Component description for AdBlue® heater coolant solenoid valve	Y627	**Page 180**
	Component description for AdBlue tank		**Page 188**
	Component description for SCR catalytic converter		**Page 209**
	Component description for EATU		**Page 213**

GF14.40-W-0002H	Exhaust aftertreatment, function	20.7.11

ENGINE 471.9 in MODEL 963 with CODE (M5Z) Engine version Euro VI

General information
The EATS for fulfilling the Euro VI emissions standard is based on new engine technology in combination with a series of measures aimed at reducing exhaust emissions.

Euro VI emissions standard
Emissions standards are statutory directives used to classify vehicles in specific pollutant classes. These pollutant classes are assigned specific emission code numbers,
that are also used to calculate the automobile tax and the categorization into pollutant classes for environmental zones.

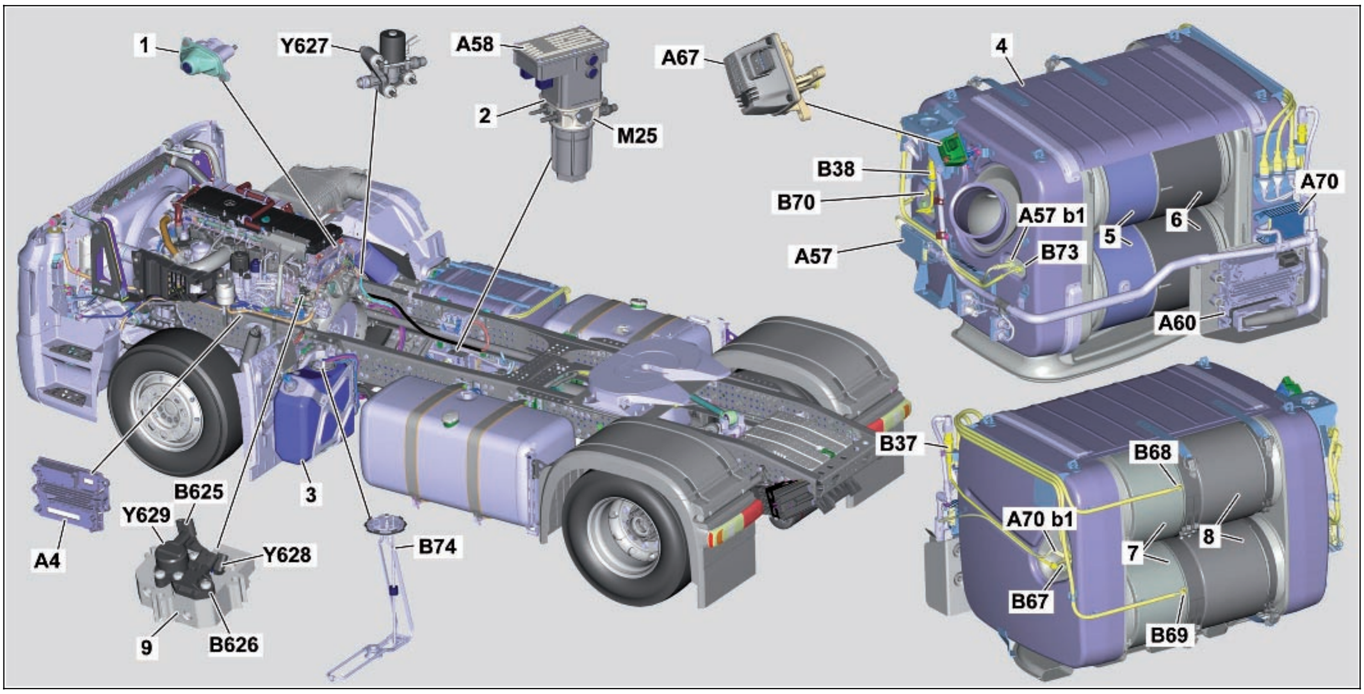
The Euro VI emissions standard for commercial vehicles defines strict limits for the emission of carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC) and particles (PM).

As the vehicle manufacturer Mercedes-Benz must guarantee compliance with these limits for a determined period of time and mileage. For this reason, the exhaust aftertreatment system (EATS) is a part of the engine/vehicle homologation process that requires certification.

Brief information on EATS for Euro VI

New diesel engine generation
The new engine generation is equipped with a common rail diesel injection system, EGR and boost pressure control. The engines are configured for maximum efficiency and low particulate emissions.

Exhaust aftertreatment through:
- Selective catalytic reduction (SCR) with ammonia blocking CAT
- Diesel oxidation catalytic converter (DOC)
- Diesel particulate filter (DPF)



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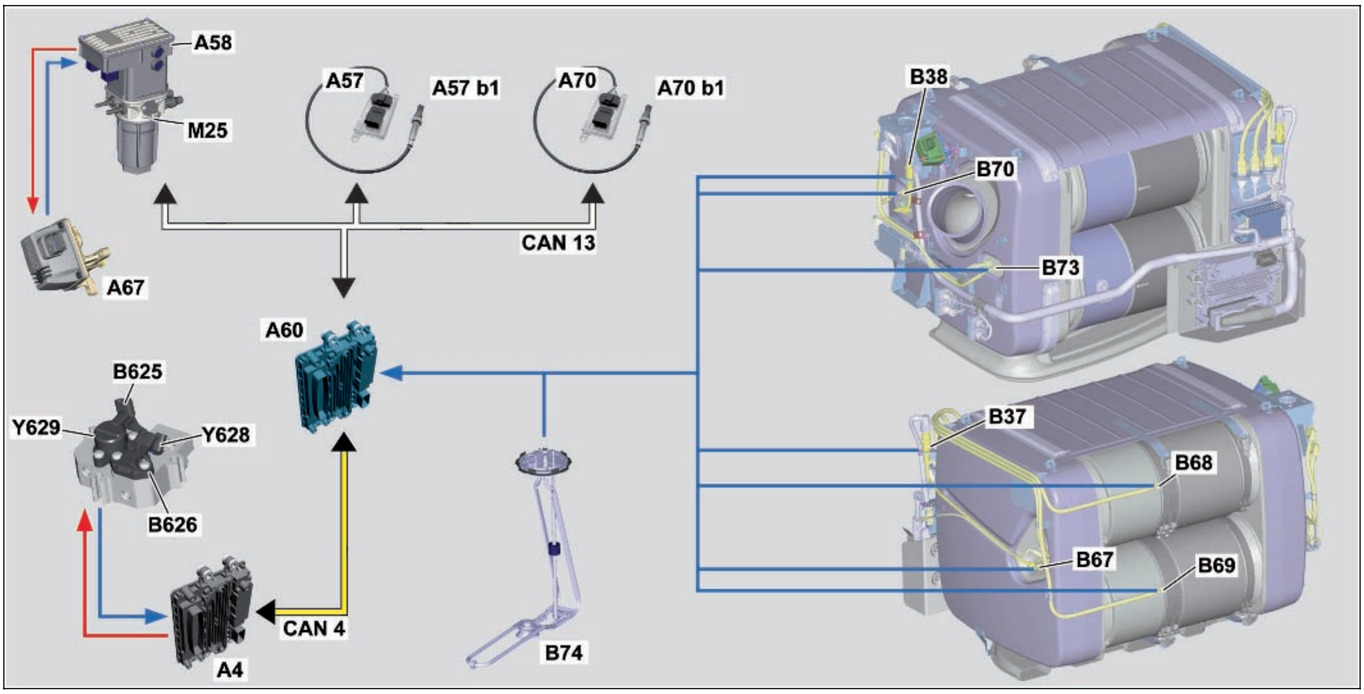
System overview

1	*Nozzle unit for DPF regeneration*
2	*Pump module*
3	*AdBlue® tank*
4	*Exhaust aftertreatment unit*
5	*Ammonia blocking CAT*
6	*SCR catalytic converter*
7	*Diesel oxidation catalytic converter (DOC)*
8	*Diesel particulate filter (DPF)*
9	*Diesel fuel metering device (for DPF regeneration)*
A4	*Engine management control unit (MCM)*
A57	*NOx sensor control unit output for exhaust aftertreatment unit*
A57 b1	*NOx sensor output for exhaust aftertreatment unit*
A58	*SCR control unit*
A60	*Exhaust aftertreatment (ACM) control unit*
A67	*AdBlue® metering device*
A70	*NOx sensor control unit input for exhaust aftertreatment unit*
A70 b1	*NOx sensor input for exhaust aftertreatment unit*
B37	*Exhaust pressure sensor upstream of diesel oxidation catalytic converter*
B38	*Exhaust pressure sensor downstream of diesel particulate filter*
B67	*Exhaust temperature sensor upstream of diesel oxidation catalytic converter*
B68	*Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter*
B69	*Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*
B70	*Exhaust temperature sensor downstream of diesel particulate filter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*
B74	*AdBlue® fill level sensor/temperature sensor*
B625	*Fuel pressure sensor (inlet)*
B626	*Fuel pressure sensor (outlet)*
M25	*SCR delivery pump*
Y627	*AdBlue® heater coolant solenoid valve*
Y628	*Fuel metering valve*
Y629	*Fuel shutoff valve*



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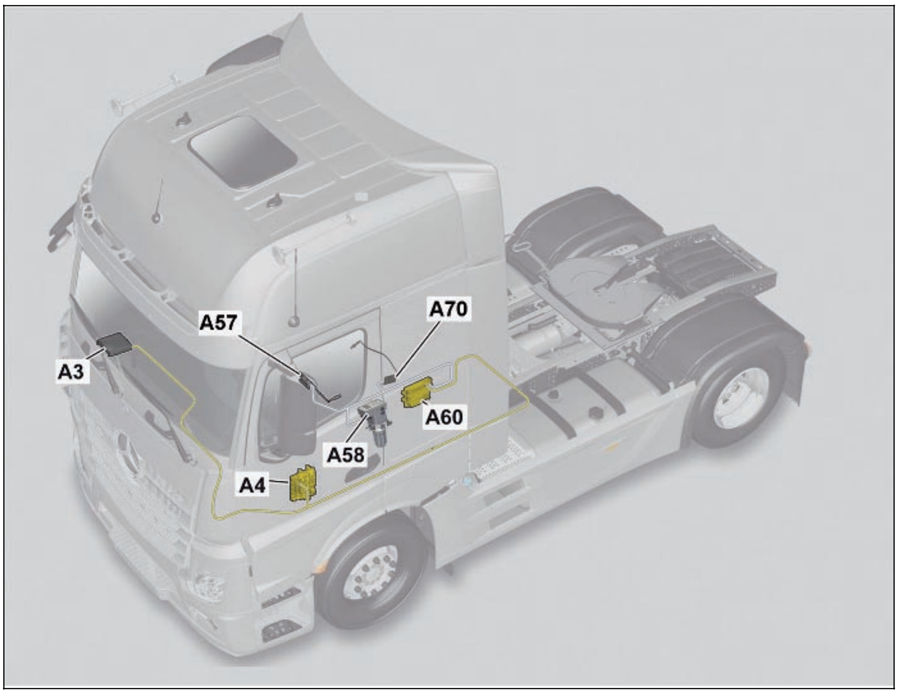
Electronic networking

A4	*Engine management control unit (MCM)*
A57	*NOx sensor control unit output for exhaust aftertreatment unit*
A57 b1	*NOx sensor output for exhaust aftertreatment unit*
A58	*SCR control unit*
A60	*Exhaust aftertreatment (ACM) control unit*
A67	*AdBlue® metering device*
A70	*NOx sensor control unit input for exhaust aftertreatment unit*
A70 b1	*NOx sensor input for exhaust aftertreatment unit*
B37	*Exhaust pressure sensor upstream of diesel oxidation catalytic converter*
B38	*Exhaust pressure sensor downstream of diesel particulate filter*
B67	*Exhaust temperature sensor upstream of diesel oxidation catalytic converter*
B68	*Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter*
B69	*Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*
B70	*Exhaust temperature sensor downstream of diesel particulate filter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*
B74	*AdBlue® fill level sensor/ temperature sensor*
CAN 4	*Drive train CAN*
CAN 13	*NOx-CAN*
B625	*Fuel pressure sensor (inlet)*
B626	*Fuel pressure sensor (outlet)*
M25	*SCR delivery pump*
Y628	*Fuel metering valve*
Y629	*Fuel shutoff valve*

Networking of control units

A3 Drive control (CPC) control unit
A4 Engine management control unit (MCM)
A57 NOx sensor control unit output for exhaust aftertreatment unit
A58 SCR control unit (in pump module)
A60 Exhaust aftertreatment (ACM) control unit
A70 NOx sensor control unit input for exhaust aftertreatment unit



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Function of exhaust aftertreatment system (overall system)
The basic functionalities of the overall EATS are monitored and controlled by the engine management (MCM) control unit (A4) and the exhaust aftertreatment (ACM) control unit (A60).
After the engine is started, the engine management (MCM) control unit (A4) automatically starts an automatic test routine in the background, which checks the operational readiness of the EATS. Once the system has been enabled, the SCR control unit (A58) integrated into the pump module (2) is actuated. This switches on the SCR delivery pump (M25) in the pump module (2), which then sucks in AdBlue® from the AdBlue® container (3) and pumps it over the AdBlue® feed line to the AdBlue® metering device (A67).

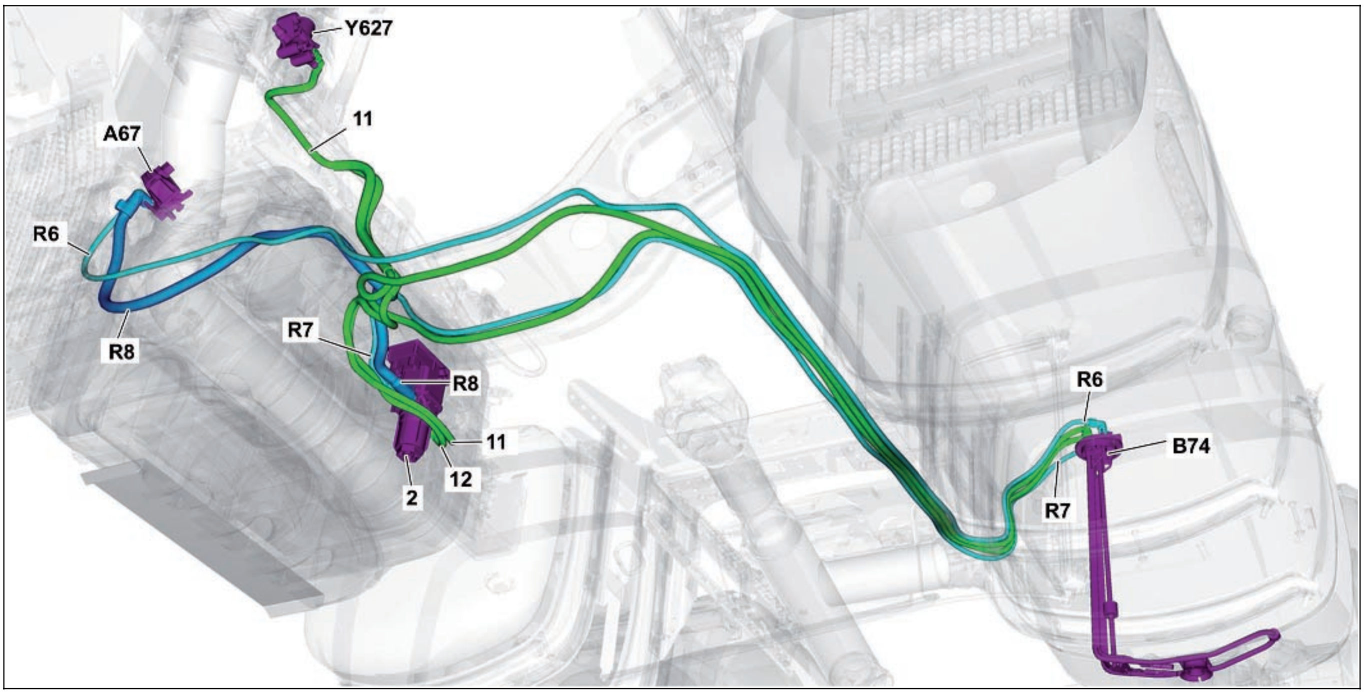
Because the AdBlue® injection into the exhaust flow is not continuous, the AdBlue® flows over the AdBlue® return line back into the AdBlue® container (3). This circulation is continuous, and irrespective of whether AdBlue® is injected or not. This enables recirculation cooling to be achieved, which prevents the AdBlue® metering device (A67), which is installed on the EATU (4) itself against damage due to overheating.

Phase 1: Conversion of CO and HC in the diesel oxidation catalytic converter
The exhaust gas coming from the exhaust manifold initially flows through the EATU (4) into the diesel oxidation catalytic converter (7). In it, the given hydrocarbons (HC) and the carbon monoxide (CO) are converted to carbon dioxide (CO_2) and water (H_2O). Apart from this, a part of the nitric oxide (NO) is oxidized to form nitrogen dioxide (NO_2).

Phase 2: Reduction of particulate mass in the diesel particulate filter
The diesel particulate filter (8) is connected in series after the diesel oxidation catalytic converter (7). In its porous filter structure the particles are separated through adhesion and then collected.

Phase 3: Reduction of NOx in SCR catalytic converter
The AdBlue® injection into the exhaust flow is calculated by the engine management (MCM) control unit (A4). If AdBlue® is to be injected, then this initially sends a signal to the exhaust aftertreatment (ACM) control unit (A60), which processes the data and then actuates the SCR control unit (A58) integrated into the pump module.

The injection timing point and the injection quantity are now calculated here and the AdBlue® metering device (A67) actuated accordingly.
If AdBlue® is injected, the following happens:
The AdBlue® metering device (A67) located in the exhaust path downstream of the diesel oxidation catalytic converter (7) and diesel particulate filter (8) injects AdBlue® straight into the exhaust flow.
The AdBlue® is mixed here with the previously precleaned exhaust and decomposes in an initial process step to form ammonia (NH_3). Along with the nitrogen oxide molecules generated during combustion (NOx), the resulting ammonia (NH_3) flows through the exhaust flow towards the SCR catalytic converter (6). Its honeycomb core has a special coating, which enables a conversion of NH_3 and NOx into harmless nitrogen (N_2) and water vapor (H_2O).



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AdBlue®/coolant line system

2	*Pump module*	*A67*	*AdBlue® metering device*	*R7*	*AdBlue® intake duct heating element*
11	*Coolant feed line*	*B74*	*AdBlue® fill level sensor/temperature sensor*	*R8*	*AdBlue® pressure line heating element*
12	*Coolant return line*	*R6*	*AdBlue® return line heating element*	*Y627*	*AdBlue® heater coolant solenoid valve*

AdBlue® line system
The AdBlue® line system extends from the AdBlue® container (3), the pump module (2) and the AdBlue® metering device (A67). Because the AdBlue® metering device (A67) is installed onto the EATU itself, and therefore exposed to high temperatures, AdBlue® is constantly circulated when the engine starts and in a specific run-on time after the engine is stopped for recirculation cooling.

AdBlue® heater
AdBlue® freezes from a temperature of approx. -13 °C. The AdBlue ® heater ensures that any AdBlue® that has frozen during periods of non-operation is heated and reliquified and prevents it from freezing while driving in cold outside temperatures.
The AdBlue® lines from the AdBlue® container (3) to the pump module (2) are routed and insulated together with coolant lines. The AdBlue® lines between the pump module (2) and AdBlue® metering device (A67) are not electrically heated by the coolant, but by the heating elements integrated into the line sections.

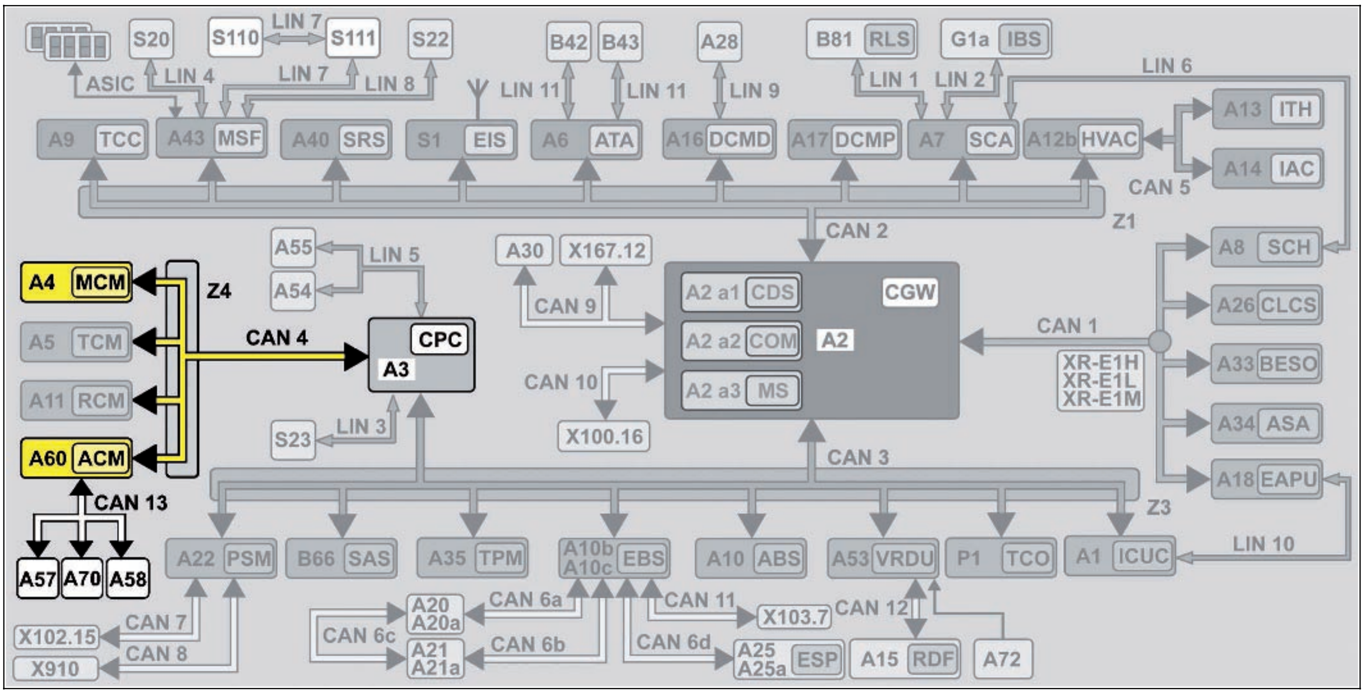
Function of AdBlue® heating through coolant
The AdBlue® heater consists of the AdBlue® heater coolant solenoid valve (Y627), which is located on the rear end of the engine and a coolant line system. The AdBlue® heater coolant solenoid valve (Y627) is actuated by the engine management (MCM) control unit (A4). The AdBlue® fill level sensor/temperature sensor (B74) integrated in the AdBlue® container (3) enables it to detect when the temperature of the container's contents is approaching the limit of approx. 8 °C. If this is the case and if the coolant temperature has already reached +65 °C, the AdBlue® heater coolant solenoid valve (Y627) is opened is that the coolant can flow through the line system.

Function of AdBlue® heating through electrical heater
The heating coils of the heater elements integrated into the AdBlue® lines are switched on and off by the exhaust aftertreatment (ACM) control unit (A60). Decisive here are the values supplied by the AdBlue® fill level sensor/temperature sensor (B74).

	Exhaust aftertreatment overall network		**Page 79**
	NOx sensor output for exhaust aftertreatment unit, component description	A57, A57 b1	**Page 112**
	Pump module, component description	A58, M25	**Page 115**
	Exhaust aftertreatment (ACM) control unit, component description	A60	**Page 119**

	AdBlue metering device, component description	A67	**Page 121**
	NOx sensor input for exhaust aftertreatment unit, component description	A70, A70 b1	**Page 125**
	Exhaust pressure sensor upstream of diesel oxidation catalytic converter, component description	B37	**Page 132**
	Exhaust pressure sensor downstream of diesel particulate filter, component description	B38	**Page 133**
	Exhaust temperature sensor upstream of diesel oxidation catalytic converter, component description	B67	**Page 135**
	Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter, component description	B68	**Page 136**
	Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter, component description	B69	**Page 137**
	Exhaust temperature sensor downstream of diesel particulate filter, component description	B70	**Page 138**
	Exhaust temperature sensor downstream of SCR catalytic converter, component description	B73	**Page 141**
	AdBlue® fill level sensor/temperature sensor, component description	B74	**Page 142**
	Diesel fuel metering device, component description	B625, B626, Y628, Y629	**Page 158**
	AdBlue® heater coolant solenoid valve, component description	Y627	**Page 180**
	Component description for AdBlue tank		**Page 188**
	Diesel oxidation catalytic converter, component description		**Page 208**
	Component description for SCR catalytic converter		**Page 211**
	EATU, component description		**Page 215**
	Diesel particulate filter of EATU, component description		**Page 218**
	Nozzle unit for DPF regeneration, component description		**Page 220**

GF14.40-W-0003-03H	Exhaust aftertreatment overall network		



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A3 — *Drive control (CPC) control unit*

A4 — *Engine management control unit (MCM)*

A57 — *NOx sensor control unit output for exhaust aftertreatment unit*

A58 — *SCR control unit*

A60 — *Exhaust aftertreatment (ACM) control unit*

A70 — *NOx sensor control unit input for exhaust aftertreatment unit*

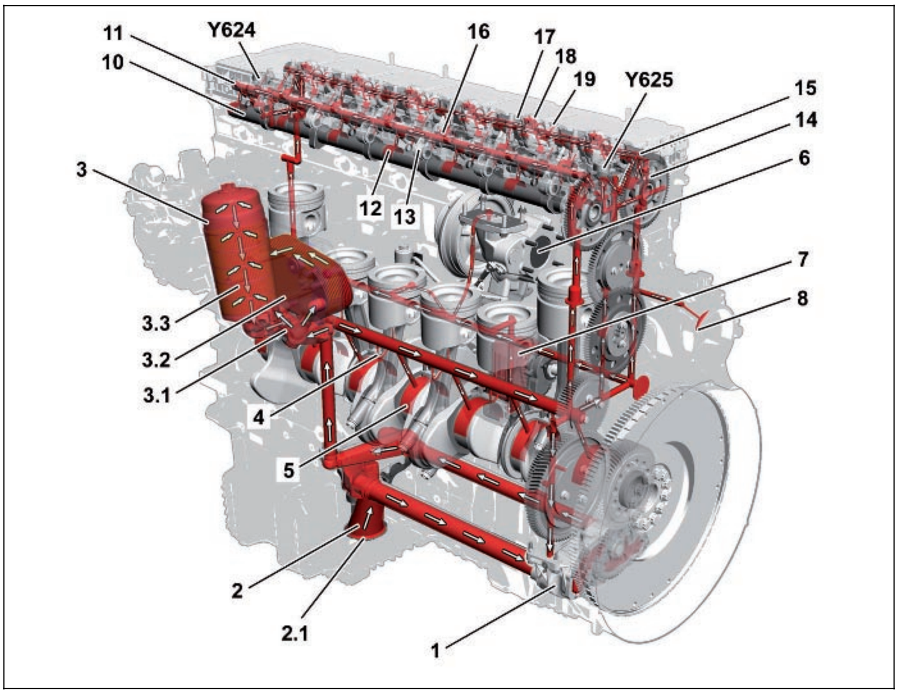
CAN 4 — *Drive train CAN*

CAN 13 — *NOx-CAN*

Z4 — *Drive CAN bus star point*

GF18.00-W-0001H	Engine oil circuit, function	20.7.11

ENGINE 471.9 in MODEL 963



W18.00-1064-76

1 Oil pump
2 Oil intake manifold
2.1 Oil strainer
3 Oil/coolant module
3.1 Oil thermostat
3.2 Oil/water heat exchanger
3.3 Oil filter
4 Oil spray nozzle
5 Crankshaft bearing lubrication point
6 Turbocharger
7 Crankcase ventilation system oil separator
8 Power take-off lubrication point
10 Intake camshaft
11 Intake rocker arm spindle
12 Intake camshaft bearing lubrication point
13 Intake rocker arm
14 Exhaust camshaft
15 Exhaust rocker arm spindle
16 Exhaust camshaft bearing lubrication point
17 Exhaust rocker arm
18 Exhaust rocker arm with hydroelement
19 Brake rocker arm
Y624 Engine brake solenoid valve, stage 1
Y625 Engine brake solenoid valve, stage 2

All moving components on the engine, which are lubricated or cooled by engine oil, are supplied with engine oil via the engine oil circuit.
The lubrication reduces friction and mechanical wear on moving components. Impacts are also absorbed by the oil buffer in the bearings.

The engine oil circuit is supplied with engine oil via the oil pump (1). The oil pump (1) is designed as a gear pump and is driven by the pinion gear drive.
If the engine is started, the oil pump (1) sucks in engine oil in the oil pan through the oil intake manifold (2) and the oil strainer (2.1) fastened to it and pumps it to the oil/coolant module (3).

At an engine temperature of less than 115 °C the engine oil is routed through the open oil thermostat (3.1) over a bypass straight into the oil filter (3.3). At 115 °C the oil thermostat (3.1) closes the bypass and the engine oil flows first to the oil-water heat exchanger (3.2) before reaching the oil filter (3.3).

The oil-water heat exchanger (3.2) is used to cool the engine oil after the engine's warm-up phase.

In the oil filter (3.3) the engine oil flows from the outside inwards through the oil filter element, where it is cleaned.
Finally the engine oil enters the main oil ducts as well as the front and rear oil cross ducts in the crankcase.

The main oil ducts mainly lubricate the crankshaft bearings, the connecting rod bearings and the oil spray nozzles (4) with engine oil.
The following oil ducts or oil pressure lines branch off from the main oil ducts:

- The oil duct to the pressure regulating valve in the oil pump (1)
- The oil ducts to the cylinder head
- The oil ducts to the gearwheel drive
- The oil pressure line to the turbocharger (6)

The oil spray nozzles (4) spray engine oil continuously below the piston crowns to ensure that they are cooled.

The lubricating oil duct for the exhaust rocker arm spindle (15), lubricating oil duct for the intake rocker arm spindle (11) and oil ducts for operation of the engine brake all branch off from the oil ducts to the cylinder head.

Engine oil is supplied through the lubricating oil duct for the exhaust rocker arm spindle (15) to the exhaust rocker arm's rocker arm bearings (17), the exhaust rocker arm with hydro element (18) and the brake rocker arm (19) as well as the bearings and cams of the exhaust camshaft (14). The rocker arm bearings for the intake rocker arms (13) and the bearings and cams on the intake camshaft (10) are supplied with engine oil via the lubricating oil duct for the intake rocker arm spindle (11).

The oil ducts for operation of the engine brake are used solely to supply engine oil to the exhaust rocker arm with hydro element (18). Both oil ducts are separated by two solenoid valves from oil ducts to the cylinder head and are only filled with oil under pressure for an activated engine brake.

The oil ducts to the gearwheel drive supply engine oil to the individual bearings of the gearwheels on the gearwheel drive as well as the engine-mounted power take-off, insofar as one is installed.
The turbocharger (6) is supplied with engine oil through the external oil pressure line.

The engine oil is returned by way of return ducts and return holes in the camshaft housing, cylinder head and in the crankcase.

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i The engine oil fill level sensor (B605) is used for monitoring the engine oil level and engine oil temperature in the oil pan.
The engine oil pressure is recorded through the oil pressure sensor (B604).

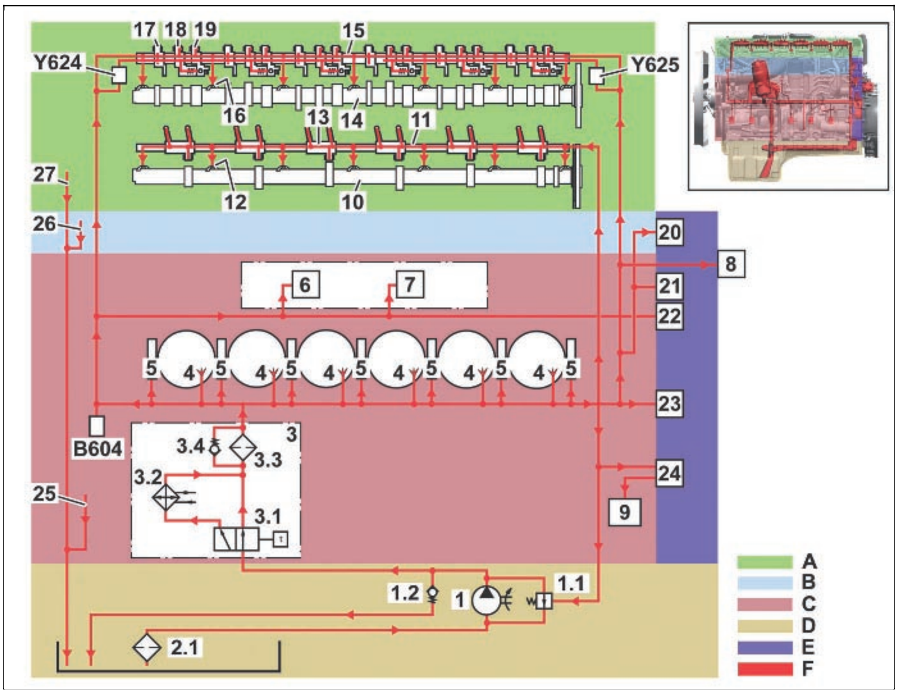
The engine oil fill level sensor (B605) and the oil pressure sensor (B604) are connected to the engine management (MCM) control unit (A4).

Where there is insufficient engine oil pressure, the oil level is too low or the engine oil temperature too high, a corresponding warning is shown in the instrument cluster control unit (A1).
If the engine oil pressure is too low the engine power is reduced.

	Engine management control unit (MCM), component description	A4	**Page 103**
	Oil pressure sensor, description of components	B604	**Page 148**
	Component description for engine oil fill level sensor	B605	**Page 149**
	Oil separator component description		**Page 183**
	Component description for turbocharger		**Page 186**
	Engine oil circuit schematic		**Page 82**
	Component description for oil pump		**Page 189**
	Oil/coolant module, component description		**Page 191**
	Oil thermostat, component description		**Page 193**
	Component description for oil/water heat exchanger		**Page 194**

Functions

GF18.00-W-0001-01H	Engine oil circuit schematic		



W18.00-1066-76

1 *Oil pump*
1.1 *Pressure control valve*
1.2 *Safety valve*
2.1 *Oil strainer*
3 *Oil/coolant module*
3.1 *Oil thermostat*
3.2 *Oil/water heat exchanger*
3.3 *Oil filter*
3.4 *Check valve*
4 *Oil spray nozzle*
5 *Crankshaft bearing lubrication point*
6 *Turbocharger*
7 *Crankcase ventilation system oil separator*
8 *Power take-off lubrication point*
9 *Compressor lubrication point*
10 *Intake camshaft*
11 *Intake rocker arm spindle*
12 *Intake camshaft bearing lubrication point*
13 *Intake rocker arm*
14 *Exhaust camshaft*
15 *Exhaust rocker arm spindle*
16 *Exhaust camshaft bearing lubrication point*
17 *Exhaust rocker arm*
18 *Exhaust rocker arm with hydroelement*
19 *Brake rocker arm*
20 *Intermediate gear lubrication point (to camshafts)*
21 *Double idler gear lubrication point (to next gear level)*
22 *Intermediate gear lubrication point (for power take-off)*
23 *Intermediate gear lubrication point (for fuel system high pressure pump)*
24 *Double idler gear lubrication point (for compressor and next gear level)*
25 *Crankcase return*
26 *Cylinder head return*
27 *Camshaft housing return*
B604 *Oil pressure sensor*
Y624 *Engine brake solenoid valve, stage 1*
Y625 *Engine brake solenoid valve, stage 2*

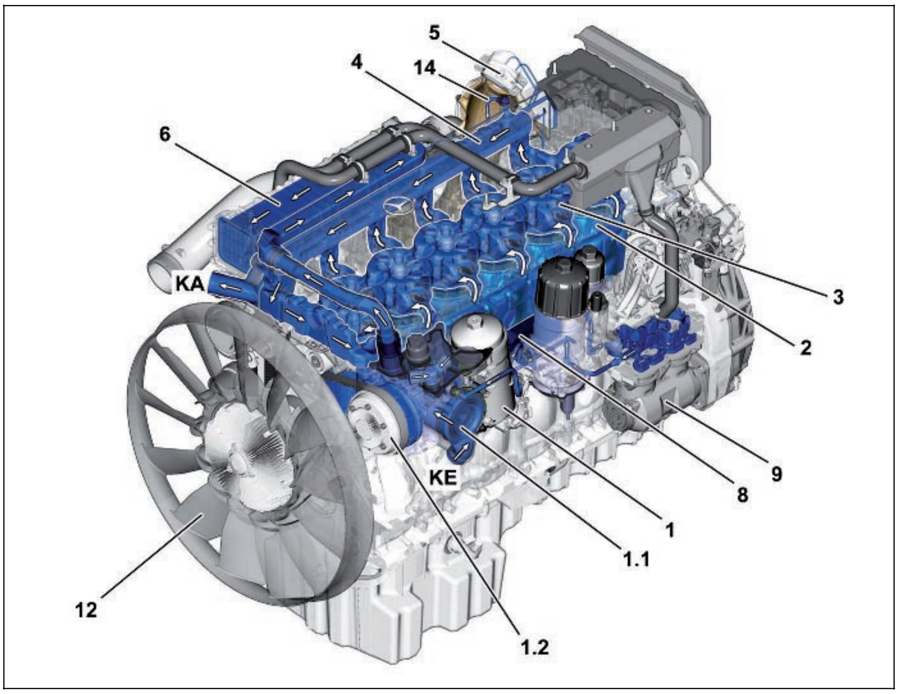
A *Camshaft housing*
B *Cylinder head*
C *Crankcase*
D *Oil pan*
E *Gearwheel drive*
F *Engine oil*

GF20.00-W-0001H	Coolant circuit, function	20.7.11

ENGINE 471.9 in MODEL 963

Shown with code (M5Z) Euro VI engine version

1 Oil/coolant module
1.1 Coolant thermostat
1.2 Coolant pump
2 Cylinder liner
3 Cylinder head
4 Coolant manifold
5 Injection nozzle for regeneration of diesel particulate filter (only with code (M5Z) Euro VI engine version)
6 Exhaust gas recirculation cooler
8 Fuel cooler
9 Compressor
12 Fan
14 Coolant feed to AdBlue® heater



W20.00-1073-76

KA Coolant outlet to cooler

KE Coolant inlet from cooler

General

The engines in model series OM 471 have a closed cooling system (pressurized system). This means that coolant in the cooling system, which is circulated by the coolant pump (1.2), absorbs the heat from the hot engine components and - once the engine has reached its operating temperature - it dissipates this through a cooler to the outside air.

Engine cooling circuit

The coolant pump (1.2) is belt driven. If the engine is running, and if it has not yet reached its operating temperature, then the coolant pump (1.2) circulates the coolant inside the engine. In vehicles with code (M7T) Coolant pump, control of the speed of the coolant pump (1.2) is permanently monitored by the engine management (MCM) control unit (A4) with the aid of the coolant pump rpm sensor (B640), and adapted as needed through activation of the coolant pump solenoid valve (Y631).

Because the coolant thermostat (1.1) is closed when the engine is cold, the coolant flows over the coolant bypass duct into the oil/coolant module (1) and is routed there past the closed coolant thermostat (1.1) through the coolant pump (1.2) to the oil-water heat exchanger.

The oil-water heat exchanger cools the engine oil if its temperature is more than 115 °C (opening temperature of oil thermostat), so that a temperature of 120 °C is not exceeded. The oil-water heat exchanger is fastened to the oil/coolant module (1), and it protrudes into the crankcase.

The coolant is routed in this way into the crankcase and therefore to the cylinder liners (2). At the same time a portion of the coolant is routed to the fuel cooler (8) and the compressor (9), as well as over separate feed lines to the exhaust gas recirculation cooler (6) and the exhaust gas recirculation positioner (Y621).

The coolant then flows from the fuel cooler (8) and the compressor (9) straight back to the coolant pump (1.2).
The coolant pumped to the cylinder liners (2) then flows back to the cylinder head (3).
The cylinder head (3) contains a partitioned coolant jacket. This means that once the coolant has flushed the cylinders, both on the inlet and the outlet sides, it then flows to the cylinder head (3). In the cylinder head (3) the coolant flows first to the lower cooling level where it flushes the fuel injectors and the valve seat rings.
Finally, the coolant flows to the upper cooling level and cools the valve guides located there.
After this the coolant is routed outwards into the coolant manifold (4), into which the coolant from the exhaust gas recirculation cooler (6) and the coolant from the exhaust gas recirculation positioner (Y621) is routed.
The coolant flows from the coolant manifold (4) back over the coolant bypass duct and the still closed coolant thermostat (1.1) into the oil/coolant module (1) and to the coolant pump (1.2), until the engine's operating temperature is reached.

When the engine operating temperature is reached, the cooler circuit is activated when the coolant thermostat (1.1) is opened. Depending on the position of the coolant thermostat (1.1), more or less coolant flows through the vehicle cooler or directly over the coolant bypass line to the coolant pump (1.2). The temperature of the coolant in the coolant circuit is regulated in this way.
The fan (12) is used to increase the vehicle cooler's cooling output.
The coolant temperature is continuously monitored by the coolant outlet temperature sensor (B606) and coolant inlet temperature sensor (B607), both of which are connected to the engine management (MCM) control unit (A4).
The various pressures in the cooling system, which are created by the temperature fluctuations, are compensated for through the coolant expansion reservoir, which - depending on the vehicle equipment - is located either at the front behind the maintenance flap or at the rear on the cab mounting crossmember.

Heating circuit
The coolant for the heater circuit is taken from the coolant manifold (4).
A shutoff valve is installed in front of the heater heat exchanger, through which the coolant flow through the heater circuit or the heater heat exchanger can be regulated.
In vehicles with code (D6I) Residual heat utilization, the additional residual heat pump (M20) upstream of the heater shutoff valve (Y49) ensures that the coolant is circulated in the heater circuit when the engine is switched off. This in turn means that the engine's residual heat can be used for up to two hours.

The auxiliary heater installed in vehicles with code (D6M) Cab auxiliary water heater or with code (D6N) Cab and engine auxiliary water heater, is integrated with an additional bypass line into the heater circuit in such a way that the coolant is circulated through the auxiliary circulation pump in the heater circuit only and therefore does not have to be routed through the entire engine.

Connection of secondary water retarder - in vehicles with code (B3H) Secondary water retarder
The coolant for the secondary water retarder is also taken from the coolant manifold (4). Due to the fact that when the secondary water retarder is activated, a large volume of coolant is taken from the coolant circuit thereby causing the pressure in the cooling system to be greatly reduced, this is regulated by targeted injection of compressed air from the consumer circuit.
To do so, the drive control (CPC) control unit (A3) uses the coolant pressure control sensor (B87) to permanently monitor the pressure in the coolant expansion reservoir. Under a certain pressure and depending on the coolant temperature, it actuates the coolant pressure solenoid valve control (Y53), which accordingly allows compressed air to pass through the consumer circuit in the coolant expansion reservoir.

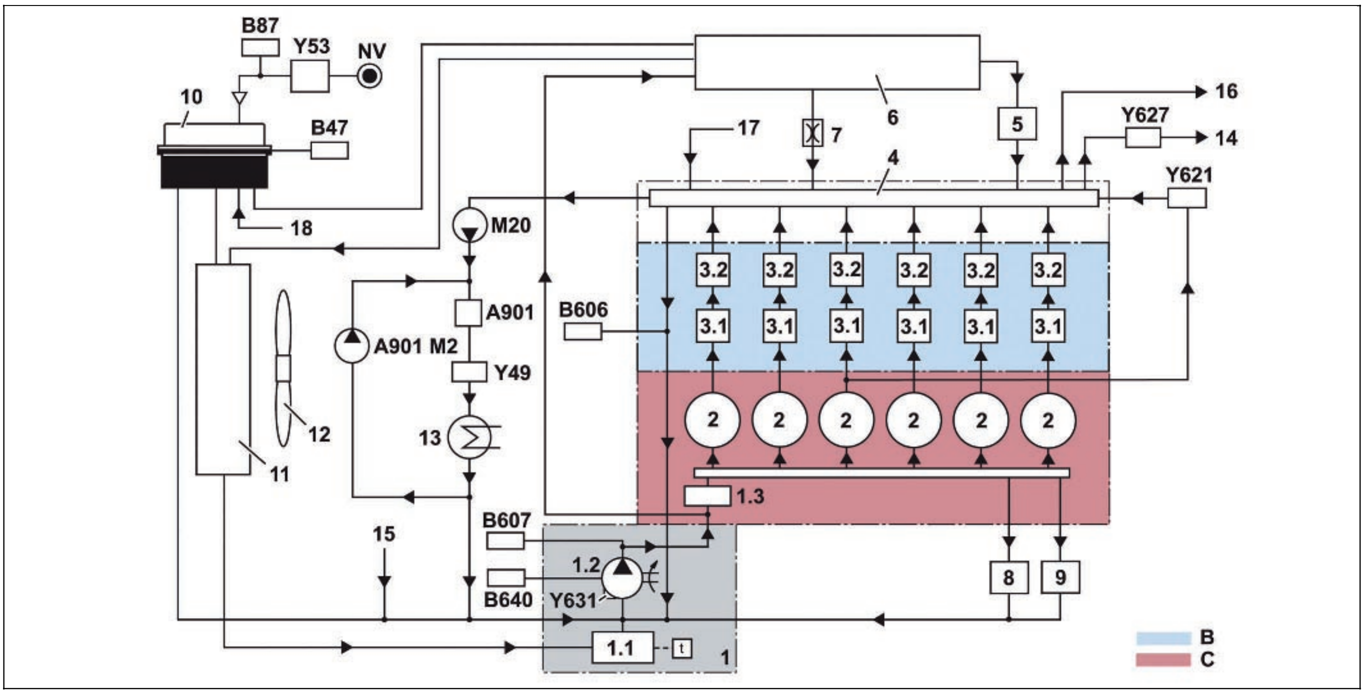
Cooling of injection nozzle for regeneration of diesel particulate filter (DPF) - for vehicles with code (M5Z) Euro VI engine version
The coolant used for cooling the injection nozzle is taken from the exhaust gas recirculation cooler (6), routed through the nozzle unit for diesel particulate filter regeneration, in which the injection nozzle is located, and routed back to the coolant manifold (4).

AdBlue® heater
The coolant for the AdBlue® heater is also taken from the coolant manifold (4). When the AdBlue® heater coolant solenoid valve (Y627) is actuated, the coolant is routed through the hose package to the AdBlue® container and from there back to the oil/coolant module (1).

	Coolant circuit schematic		**Page 86**
	Engine management control unit (MCM), component description	A4	**Page 103**
	Auxiliary heating heater, component description	A901 ℹ Only in vehicles with code (D6M) Cab auxiliary water heater or code (D6N) Cab and engine auxiliary water heater.	**Page 128**

	Auxiliary heater coolant circulation pump, component description	A901 M2 i Only in vehicles with code (D6M) Cab auxiliary water heater or code (D6N) Cab and engine auxiliary water heater.	**Page 130**
	Coolant pressure control sensor, component description	B87 i Only in vehicles with code (B3H) Secondary water retarder.	**Page 144**
	Component description for exhaust coolant temperature sensor	B606	**Page 150**
	Component description for intake coolant temperature sensor	B607	**Page 151**
	Residual heat pump, component description	M20 i Only in vehicles with code (D6I) Residual heat utilization .	**Page 162**
	Heating shutoff valve, component description	Y49	**Page 168**
	Coolant pressure control solenoid valve, component description	Y53 i Only in vehicles with code (B3H) Secondary water retarder.	**Page 169**
	Component description for exhaust gas recirculation controller	Y621	**Page 176**
	AdBlue® heater coolant solenoid valve, component description	Y627	**Page 180**
	Component description for exhaust gas recirculation cooler		**Page 187**
	Oil/coolant module, component description		**Page 191**
	Component description for coolant pump	i Only in vehicles with code (M7T) Coolant pump, controlled. A component description was not created for vehicles with a rigid coolant pump.	**Page 160**
	Component description for oil/water heat exchanger		**Page 194**
	Component description for coolant thermostat		**Page 195**
	Retarder, component description	i Only in vehicles with code (B3H) Secondary water retarder.	**Page 197**
	Nozzle unit for DPF regeneration, component description	i Only in vehicles with code (M5Z) Euro VI engine version.	**Page 220**
	Heating system heat exchanger, component description		**Page 221**

GF20.00-W-0001-01H	Coolant circuit schematic		



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1 — *Oil/coolant module*
1.1 — *Coolant thermostat*
1.2 — *Coolant pump*
1.3 — *Oil/water heat exchanger*
2 — *Cylinder liners*
3.1 — *Lower coolant level*
3.2 — *Upper coolant level*
4 — *Coolant manifold*
5 — *Nozzle unit for regeneration of diesel particulate filter (only with code (M5Z) Euro VI engine version)*
6 — *Exhaust gas recirculation cooler*
7 — *Throttle*
8 — *Fuel cooler*
9 — *Compressor*
10 — *Coolant expansion reservoir*
11 — *Radiator*
12 — *Fan*
13 — *Heating system heat exchanger*
14 — *Coolant feed to AdBlue® heater*
15 — *Coolant return from AdBlue® heater*
16 — *Coolant feed to retarder (only with code (B3H) Secondary-water retarder)*
17 — *Coolant return from retarder (only with code (B3H) Secondary-water retarder)*
18 — *Coolant return to retarder ventilation (only with code (B3H) Secondary-water retarder)*

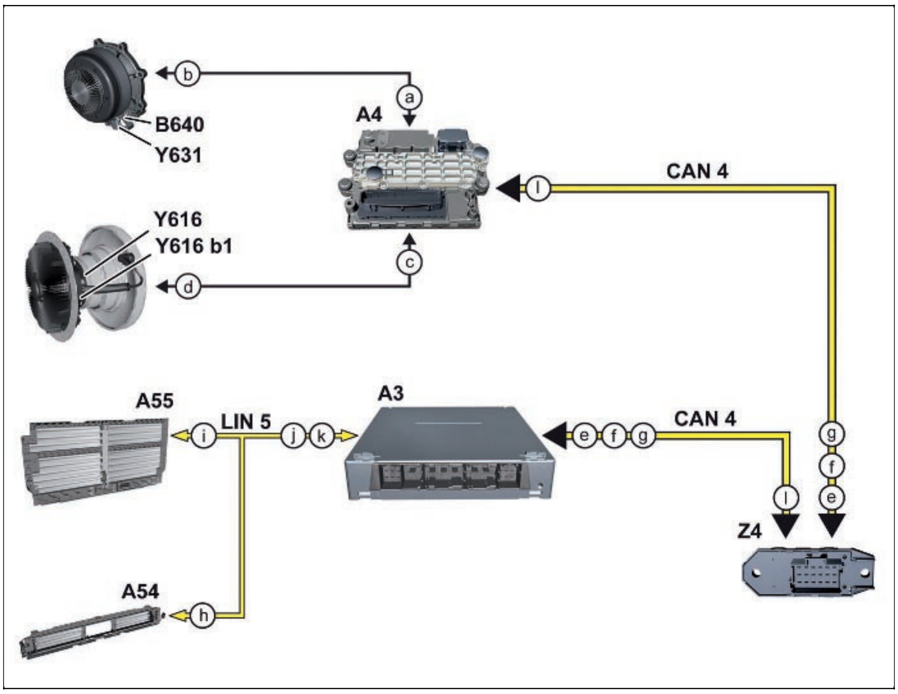
A901 — *Heater for auxiliary water heater (only with code (D6M) Cab auxiliary water heater or code (D6N) Cab and engine auxiliary water heater)*
A901 M2 — *Circulation pump (only with code (D6M) Cab auxiliary water heater or code (D6N) Cab and engine auxiliary water heater)*
B47 — *Coolant level switch*
B87 — *Sensor for coolant pressure regulation (only with code (B3H) Secondary water retarder)*
B606 — *Exhaust coolant temperature sensor*
B607 — *Intake coolant temperature sensor*
B640 — *Coolant pump rpm sensor (only with code (M7T) Coolant pump, controlled)*
M20 — *Residual heat pump (only with code (D6I) Residual-heat utilization)*
Y49 — *Heater shutoff valve*
Y53 — *Solenoid valve for coolant pressure regulation (only with code (B3H) Secondary water retarder)*
Y621 — *Exhaust gas recirculation positioner*
Y627 — *AdBlue® heater coolant solenoid valve*
Y631 — *Solenoid valve for coolant pump (only with code (M7T) Coolant pump, controlled)*

B — *Cylinder head*
C — *Crankcase*
NV — *Compressed air supply electrical accessory*

GF20.00-W-0003H	Engine cooling thermal management, function	20.7.11

MODEL 963 with CODE (M7T) Coolant pump, controlled

A3	*Drive control (CPC) control unit*
A4	*Engine management control unit (MCM)*
A54	*Lower radiator shutters controller unit*
A55	*Upper radiator shutters controller unit*
B640	*Coolant pump rpm sensor*
CAN 4	*Drive train CAN*
LIN 5	*Radiator shutters LIN*
Y616	*Fan clutch solenoid valve*
Y616b1	*Fan rpm sensor*
Y631	*Coolant pump solenoid valve*
Z4	*Drive CAN bus star point*



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a	*Coolant pump rpm, signal*
b	*Coolant pump, actuation*
c	*Fan clutch rpm, signal*
d	*Fan clutch, actuation*
e	*Coolant temperature, signal*
f	*Charge air temperature, signal*
g	*Engine speed, signal*
h	*Lower radiator shutters controller unit (A54), actuation **
i	*Upper radiator shutters controller unit (A55), actuation **
j	*Lower radiator shutters controller unit (A54), status **
k	*Upper radiator shutters controller unit (A55), status **
l	*Secondary water retarder, status*
***	*With code (M7K) Radiator shutters*

General information
The engine cooling thermal management optimizes the engine's efficiency while also reducing fuel consumption. This is achieved by the targeted and demand-controlled actuation of the following components:

- Circulation pump
- Fan clutch

Regulation of the coolant pump enables the coolant flow rate through the engine to be reduced to the amount required for each operating condition. The engine radiator's cooling air flow rate is also regulated by the fan clutch as a function of the operating condition. Apart from this, the engine cooling thermal management in vehicles with code (M7K) Radiator shutters has a cooling air control, which governs the vehicle's aerodynamics depending on the coolant temperature.
The cooling air control is implemented by actuating the following components:

- Lower radiator shutters controller unit (A54)
- Upper radiator shutters controller unit (A55)

Electromagnetic coolant pump control
The electromagnetic coolant pump delivery rate can be continuously varied through the integrated electromagnetic viscous coupling. The electromagnetic viscous coupling is actuated by the engine management (MCM) control unit (A4) through a pulse width modulated signal (PWM signal). The engine management (MCM) control unit (A4) evaluates the following information for this:

- Coolant temperature
- Engine speed
- Engine load status
- Compressor operating condition (active/idle)
- Secondary water retarder operating condition (with code (B3H) Secondary water retarder)

Depending on the listed information, the engine management (MCM) control unit (A4) calculates the corresponding set value for actuation of the viscous coupling.

Functions

In vehicles with code (B3H) Secondary water retarder, during the secondary water retarder's braking operation, the coolant pump is actuated at full power to achieve a maximum braking effect of the secondary water retarder.

Electromagnetic fan clutch control, function
The electromagnetic fan clutch delivery rate can be continuously varied through the integrated electromagnetic viscous coupling. The electromagnetic fan clutch is actuated by the engine management (MCM) control unit (A4) using a PWM signal.

The engine management (MCM) control unit (A4) evaluates the following information for this:

- Coolant temperature
- Engine oil temperature
- Boost air temperature
- Engine speed
- Fan speed
- Secondary water retarder operating condition (with code (B3H) Secondary water retarder)

Depending on the listed information, the engine management (MCM) control unit (A4) calculates the set value for actuation of the electromagnetic fan clutch.

Cooling air control, function (with code (M7K) Radiator shutters)
The lower radiator shutters control unit (A54) and the upper radiator shutters control unit (A55) is actuated steplessly by the drive control (CPC) control unit (A3) over the radiator shutters LIN (LIN 5). The radiator shutters are opened and closed as a function of the following factors:

- Secondary water retarder operating condition (with code (B3H) Secondary water retarder)
- Engine brake operating condition
- A/C operating condition
- Heat output requirement
- Vehicle speed
- Outside air temperature
- Coolant temperature
- Boost air temperature
- Engine speed

Depending on the listed information, the drive control (CPC) control unit (A3) uses a characteristics map to calculate the set values for actuation of the radiator shutters.

To prevent any repeated radiator shutter switching, there is a hysteresis between the opening and closing points.
This means that the opening time of the radiator shutters is 30 s, even when the vehicle's operating condition would result in the corresponding radiator shutters being closed.

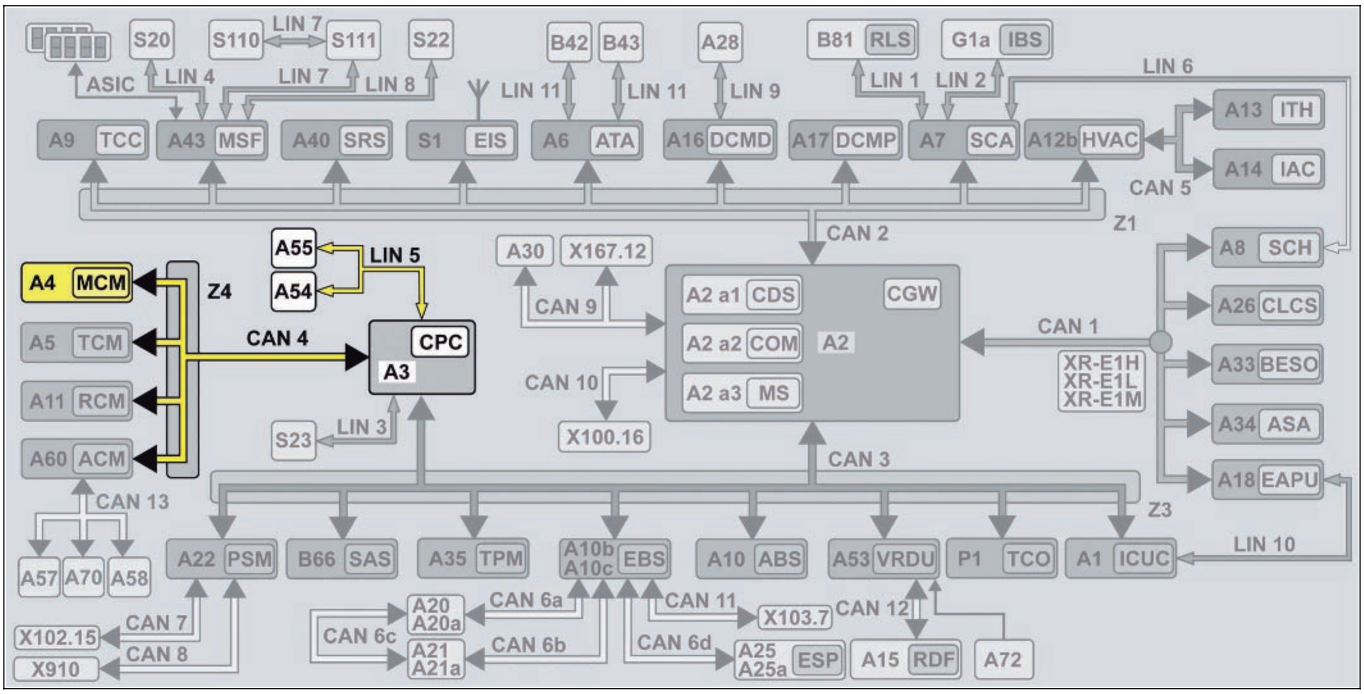
The lower radiator shutters control unit (A54) and the upper radiator shutters control unit (A55) closes or opens the slats as described in the following table:

Vehicle operating condition	Upper radiator shutters	Lower radiator shutters
Ignition OFF, Parking brake closed	Open	Closed (step protection)
Engine running, Parking brake open	Open	Open
Vehicle accelerates, Vehicle speed 55 km/h	Open	Open
Speed 55 km/h, No cooling request pending	Closed	Closed
Speed drops below 55 km/h, Cooling request pending	Is opened and remains open	Is opened and remains open
Vehicle speed 20 km/h	Open	Open
Air conditioning switched on	Open	Open
Secondary water retarder in braking operation (With code (B3H) Secondary water retarder); Coolant temperature $<$ 94 °C and brake power $<$ 150 kW	Opens 5 s after braking of secondary water retarder starts	Opens 5 s after braking of secondary water retarder starts
Secondary water retarder in braking operation (With code (B3H) Secondary water retarder); Coolant temperature $<$ 94 °C and brake power $>$ 150 kW	Opens immediately	Opens immediately

Vehicle operating condition	Upper radiator shutters	Lower radiator shutters
Coolant temperature > 97°C	OPENS	Opens immediately
Coolant temperature > 98°C	Open	Open
Charge air temperature > 8 °C over ambient temperature	OPENS	OPENS
Charge air temperature > 10 °C over ambient temperature	Open	Open

	Engine cooling thermal management overall network		**Page 90**
	Drive control (CPC) control unit, component description	A3	**Page 102**
	Engine management control unit (MCM), component description	A4	**Page 103**
	Radiator shutters, component description	A54, A55 i Only in vehicles with code (M7K) Radiator shutters.	**Page 109**
	Component description for coolant pump	B640, Y631	**Page 160**
	Component description for the electromagnetic viscous coupling	Y616, Y616 b1	**Page 174**

GF20.00-W-0003-01H	Engine cooling thermal management overall network		



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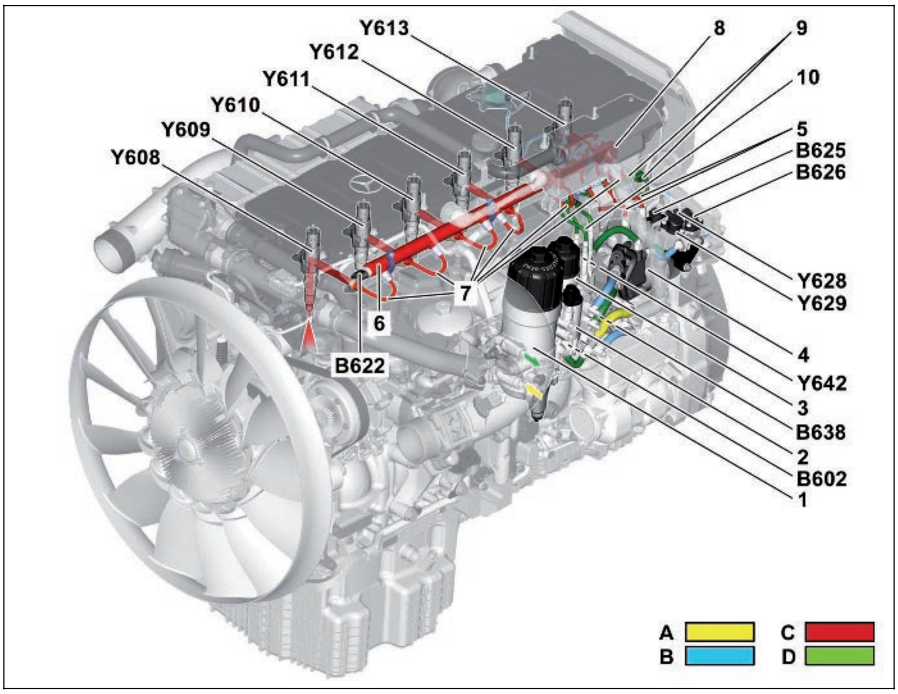
A3 *Drive control (CPC) control unit*
A4 *Engine management control unit (MCM)*
A54 *Lower radiator shutters controller unit*
A55 *Upper radiator shutters controller unit*
CAN 4 *Drive train CAN*
LIN 5 *Radiator shutters LIN*
Z4 *Drive CAN bus star point*

GF47.00-W-0002H	Fuel supply, function	20.7.11

ENGINES 471.9 in MODEL 963

Code (M5Z) Engine version Euro VI shown

1 Water separator
2 Fuel prefilter
3 Fuel filter
4 Fuel system high pressure pump
5 Fuel high-pressure lines from fuel system high pressure pump to rail
6 Rail
7 Fuel high-pressure line from rail to respective fuel injector
8 Pressure limiting valve
9 Fuel return lines of fuel injectors
10 Fuel return line from pressure limiting valve



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B602 Fuel temperature sensor
B622 Rail pressure sensor
B625 Fuel pressure sensor (input) (only with code (M5Z) Engine version Euro VI)
B626 Fuel pressure sensor (output) (only with code (M5Z) Engine version Euro VI)
B638 Fuel filter module pressure sensor
Y608 Cylinder 1 fuel injector
Y609 Cylinder 2 fuel injector
Y610 Cylinder 3 fuel injector
Y611 Cylinder 4 fuel injector
Y612 Cylinder 5 fuel injector
Y613 Cylinder 6 fuel injector
Y628 Fuel metering valve (only with code (M5Z) Engine version Euro VI)
Y629 Fuel shutoff valve (only with code (M5Z) Engine version Euro VI)
Y642 Quantity control valve

A Fuel feed lines, intake side
B Fuel feed lines, thrust side
C Fuel high-pressure lines
D Fuel return lines

General information

The emission regulations, which are becoming increasingly strict, and increasing customer demand with regard to fuel consumption, overall profitability, and also environmental protection, require a completely new injection system.
The "Amplified Pressure Common Rail System (APCRS)", is the first common rail system to be used in a Mercedes-Benz commercial vehicle that minimizes the quantity of fuel required for combustion.

On the one hand, this is taken care of by a fuel low-pressure circuit, which ensures that the fuel is cleaned and available to the fuel high-pressure circuit of the APCRS in sufficient quantities, and on the other hand the fuel high-pressure circuit, via which the fuel supplied by the fuel low-pressure circuit is injected into the cylinder at the right time, with the required pressure and in sufficient quantities.

Functions

Fuel low pressure circuit
The fuel low-pressure circuit essentially consists of the following components:

- Fuel tank
- Fuel filter module with water separator (1), fuel prefilter (2) and fuel filter (3), in which the fuel is cleaned in several stages
- Fuel pump which is located at the fuel high pressure pump (4)
- Fuel feed lines, intake side (A)
- Fuel feed lines, thrust side (B)
- Fuel return lines (D), via which the diverted quantity of the solenoid valves at the nozzle needles and the diverted quantity of the solenoid valves at the pressure boosters is returned to the fuel low-pressure circuit
- Fuel temperature sensor (B602)
- Fuel filter module pressure sensor (B638)

With code (M5Z) Engine version Euro VI, the following components are also present:

- Fuel pressure sensor (inlet) (B625)
- Fuel pressure sensor (outlet) (B626)
- Fuel metering valve (Y628)
- Fuel shutoff valve (Y629)

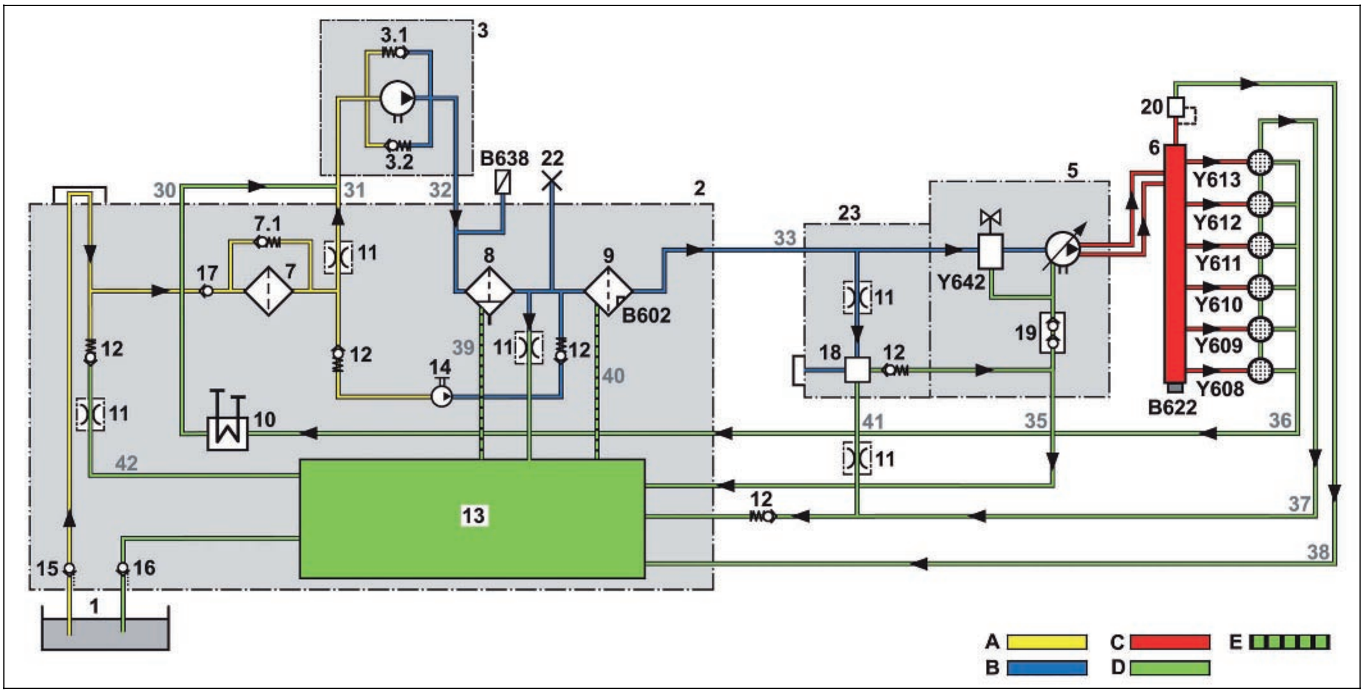
Fuel high-pressure circuit
The fuel high-pressure circuit of the APCRS consists of the following components:

- Fuel system high pressure pump (4), which delivers the fuel into the rail (6) and compresses it to about 900 bar
- Rail (6)
- Pressure limiting valve (8), which is closed during normal operation and only opens if the maximum rail pressure of 1100 bar is exceeded (limp home mode)
- Rail pressure sensor (B622)
- Cylinder 1 fuel injector (Y608)
- Cylinder 2 fuel injector (Y609)
- Cylinder 3 fuel injector (Y610)
- Cylinder 4 fuel injector (Y611)
- Cylinder 5 fuel injector (Y612)
- Cylinder 6 fuel injector (Y613)
- Quantity control valve (Y642)
- Fuel high-pressure lines (C)

	Fuel low pressure circuit function	Vehicles with code (M5R) Engine version EEV and vehicles with code (M5Y) Engine version Euro V	**Page 93**
		Vehicles with code (M5Z) Engine version Euro VI	**Page 96**
	Fuel high pressure circuit function		**Page 100**

GF47.00-W-3011HA	Fuel low pressure circuit function	20.7.11

ENGINES 471.9 in MODEL 963 with CODE (M5R) Engine version EEV
ENGINES 471.9 in MODEL 963 with CODE (M5Y) Engine version Euro V



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1 Fuel tank
2 Fuel filter module
3 Fuel pump
3.1 Pressure limiting valve
3.2 Bypass valve
5 Fuel system high pressure pump
6 Rail
7 Fuel prefilter
7.1 Wastegate
8 Water separator
9 Fuel filter
10 Fuel cooler
11 Throttle
12 Check valve
13 Fuel accumulator
14 Hand-operated delivery pump
15 Shutoff valve in the fuel feed (locked in open position)
16 Shutoff valve in the fuel return (locked in open position)
17 Shutoff valve (in the form of an elastomer ball, which prevents draining of the intake duct for standstill of the engine)
18 Evaporation volume of the diesel fuel metering device (for regeneration of the diesel particulate filter (DPF) - for engine version Euro VI)
19 2-stage valve
20 Pressure limiting valve
22 Filling valve
23 Pressure preparation flange for the fuel supply of the diesel fuel metering device (for engine version Euro VI)
30 Fuel return line from fuel cooler to fuel filter module
31 Fuel feed line from fuel filter module to fuel pump
32 Fuel feed line from fuel pump to fuel filter module
33 Fuel feed line from fuel filter module to fuel system high pressure pump
35 Fuel return line from 2-stage valve
36 Fuel return line of pressure booster
37 Fuel return line of nozzle needle valves
38 Fuel return line from pressure limiting valve
39 Vent line (from water separator)
40 Vent line (from fuel filter)
41 Fuel return line from pressure preparation flange for fuel supply of diesel fuel metering device (with engine version Euro VI)
42 Fuel return bypass

B602 Fuel temperature sensor
B622 Rail pressure sensor
B638 Fuel filter module pressure sensor
Y608 Cylinder 1 fuel injector
Y609 Cylinder 2 fuel injector
Y610 Cylinder 3 fuel injector
Y611 Cylinder 4 fuel injector
Y612 Cylinder 5 fuel injector
Y613 Cylinder 6 fuel injector
Y642 Quantity control valve

A Fuel feed/suction side
B Fuel feed (thrust side)
C Fuel high pressure
D Fuel return
E Bleeding

Functions

The fuel pump (3), which has been designed as a gear pump, supplies fuel to the fuel low pressure circuit.
When the engine is started, the fuel pump (3) draws in the fuel in the fuel tank (1) and delivers it into the fuel filter module (2) via the shutoff valve in the fuel feed (15).
The shutoff valve in the fuel feed (15) prevents fuel from escaping when the fuel line between the fuel tank (1) and the fuel filter module (2) is disconnected.
The fuel in the fuel filter module (2) first passes into the fuel prefilter (7), in which large dirt particles (> 100 µm) are filtered out of the fuel that is flowing through it.
A shutoff valve (17) which is located at the fuel inlet of the fuel prefilter (7) prevents the suction line in the fuel tank (1) from emptying during long vehicle stop times.

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i If the fuel prefilter (7) is contaminated and the flow of fuel is therefore inhibited, the fuel is drawn in via the bypass valve (7.1). The fuel which has been cleaned by the fuel prefilter (7) is led out of the fuel filter module (2) and enters the fuel pump (3) which delivers it back into the fuel filter module (2) and into the water separator (8) that it contains.

i The system pressure in the fuel feed thrust side (B) which can already be achieved at idle speed is determined by the opening pressure of the pressure limiting valve (3.1).
The bypass valve (3.2) is installed for the case of external filling of the fuel system.

The water inside the fuel is separated out in the water separator (8) and led to the water accumulator. Small dirt particles are also filtered out due to the construction.

The water from the water collector can be drained by means of a mechanical drain valve.
After leaving the water separator (8), the fuel flows through the fuel filter (9).
Extremely small contamination (> 2 µm) is filtered out in the fuel filter (9), similarly to the water separator (8).
If air has gathered in the water separator (8) housing or the fuel filter (9) due to replacement of a filter insert, for example, this is led into the fuel collection chamber (13) via one ventilation bore each with vent lines (39, 40). The air is then dissipated from there into the fuel tank (1).
The fuel system must be bled occasionally after changing an air filter element with the aid of the hand-operated delivery pump (14). In the case of extensive repair work one can also use the filling valve (22).
Once the contamination has been filtered out by the fuel filter (9), the fuel is pumped out of the fuel filter module (2) to the fuel system high pressure pump (5).

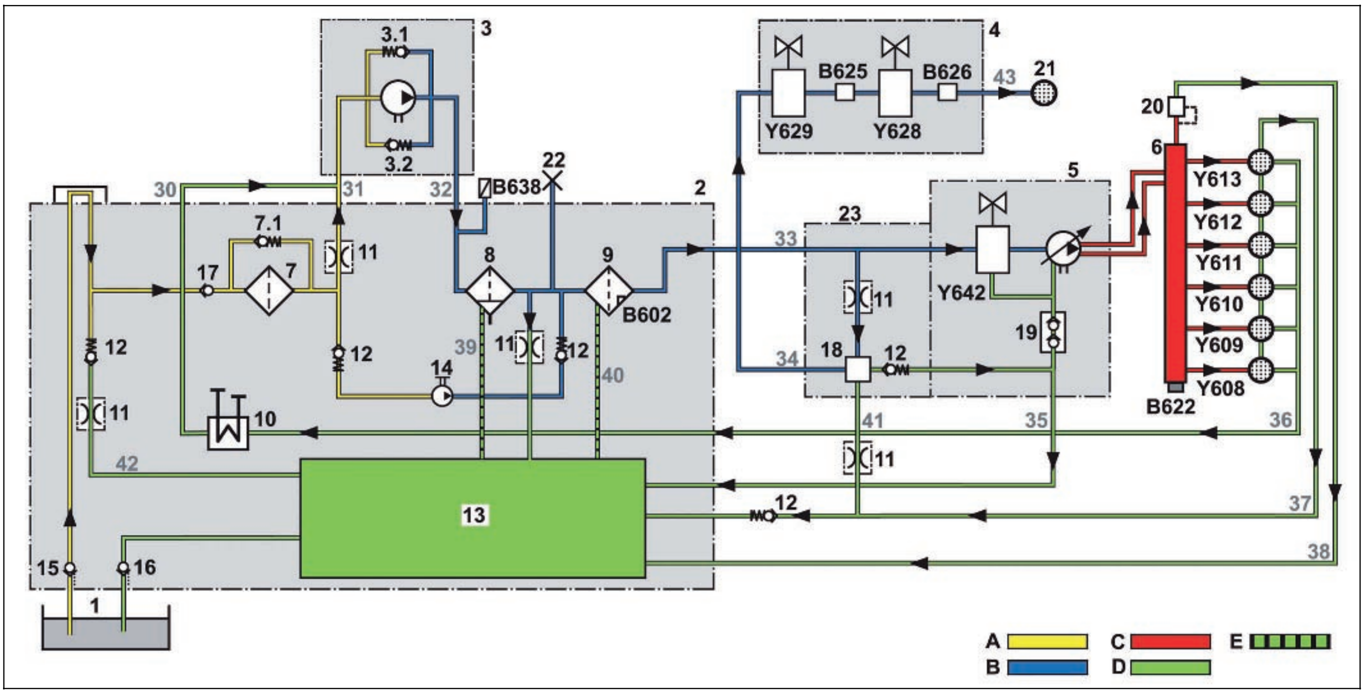
The fuel is compressed in the fuel system high pressure pump (5) and then led to the rail (6).
When this occurs, the quantity control valve (Y642) restricts the amount of fuel to be delivered by the fuel system high pressure pump (5) to exactly the right quantity.
The remaining fuel is led away via the 2-stage valve (19). The first stage of the 2-stage valve (19) opens at around 2 bar and provides the lubrication of the camshaft plain bearings in the fuel system high pressure pump (5).
The second stage opens at around 4.5 bar and regulates the system pressure in the thrust side fuel feed (B) to a range between 4.5 and 6.5 bar by leading excess fuel from the 2-stage valve (35) to the fuel collection chamber (13) via the fuel return line.
If the maximum rail pressure is exceeded, the pressure limiting valve (20) opens and the excess fuel is led from the pressure limiting valve (38) to the fuel collection chamber (13) via the fuel return line.

The fuel that is required for hydraulic pressure boosting is collected in a bore in the cylinder head and led to the fuel cooler (10) via the fuel return line of the pressure booster (36), from where it is led back to the fuel pump (3).
The fuel cooler (10) serves to cool down the fuel, which is at a temperature of about
120 °C.
The excess fuel from the injector needle valves is also collected in a bore in the cylinder head and led into the fuel collection chamber (13) via the fuel return of the nozzle needle valves (37) and the check valve (12).
The check valve (12) in the fuel return of the nozzle needle valves (37) has the task of achieving the required back pressure of about 2 bar while the engine is running, therefore ensuring that the fuel injectors work perfectly.
Part of the returned fuel is taken from the fuel collection chamber (13) and returned to the fuel low pressure circuit via the fuel return bypass (42), just upstream of the fuel prefilter (7).
The fuel quantity is determined by the throttle (11) and the check valve (12) in the fuel return bypass (42), which reduces the fuel pump (3) suction load.
The remaining fuel from the fuel collection chamber (13) is led back to the fuel tank (1).
The shutoff valve in the fuel return line (16) prevents fuel leaking out when the fuel line between the fuel tank (1) and the fuel filter module (2) is disconnected.

	Component description for fuel temperature sensor	B602	**Page 147**
	Fuel filter module pressure sensor, component description	B638	**Page 159**
	Component description for quantity control valve	Y642	**Page 182**
	Pressure limiting valve, component description		**Page 185**
	Component description for fuel pump		**Page 203**
	Component description for fuel cooler		**Page 204**
	Component description for fuel filter module		**Page 205**

GF47.00-W-3011HB	**Fuel low pressure circuit function**	**20.7.11**

ENGINES 471.9 in MODEL 963 with CODE (M5Z) Engine version Euro VI



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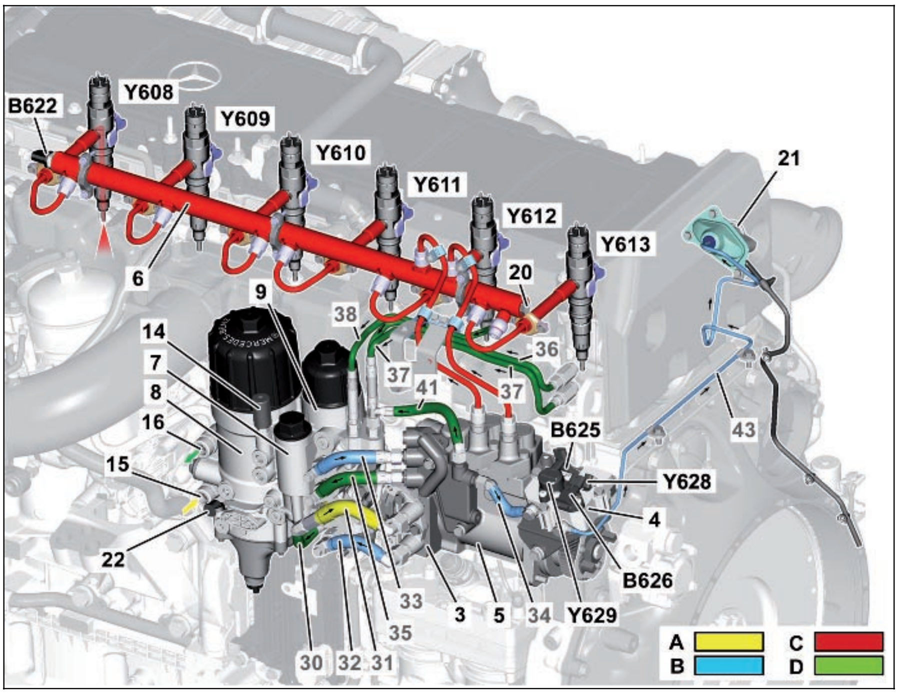
1 *Fuel tank*
2 *Fuel filter module*
3 *Fuel pump*
3.1 *Pressure limiting valve*
3.2 *Bypass valve*
4 *Diesel fuel metering device (for regeneration of diesel particulate filter (DPF))*
5 *Fuel system high pressure pump*
6 *Rail*
7 *Fuel prefilter*
7.1 *Wastegate*
8 *Water separator*
9 *Fuel filter*
10 *Fuel cooler*
11 *Throttle*
12 *Check valve*
13 *Fuel accumulator*
14 *Hand-operated delivery pump*
15 *Shutoff valve in the fuel feed (locked in open position)*
16 *Shutoff valve in the fuel return (locked in open position)*
17 *Shutoff valve (in the form of an elastomer ball, which prevents draining of the intake duct for standstill of the engine)*
18 *Evaporation volume of diesel fuel metering device (for regeneration of the diesel particulate filter (DPF))*
19 *2-stage valve*
20 *Pressure limiting valve*
21 *Injection nozzle (for regeneration of the diesel particulate filter (DPF))*
22 *Filling valve*
23 *Pressure preparation flange for the fuel supply of the diesel fuel metering device*
30 *Fuel return line from fuel cooler to fuel filter module*
31 *Fuel feed line from fuel filter module to fuel pump*
32 *Fuel feed line from fuel pump to fuel filter module*
33 *Fuel feed line from fuel filter module to fuel system high pressure pump*
34 *Fuel feed line from fuel system high pressure pump to diesel fuel metering device*
35 *Fuel return line from 2-stage valve*
36 *Fuel return line of pressure booster*
37 *Fuel return line of nozzle needle valves*
38 *Fuel return line from pressure limiting valve*
39 *Vent line (from water separator)*
40 *Vent line (from fuel filter)*
41 *Fuel return line from pressure preparation flange for the fuel supply of the diesel fuel metering device*
42 *Fuel return bypass*
43 *Fuel feed line from diesel fuel metering device to injection nozzle in the nozzle unit for DPF regeneration*

B602 *Fuel temperature sensor*
B622 *Rail pressure sensor*
B625 *Fuel pressure sensor (inlet)*
B626 *Fuel pressure sensor (outlet)*
B638 *Fuel filter module pressure sensor*
Y608 *Cylinder 1 fuel injector*
Y609 *Cylinder 2 fuel injector*
Y610 *Cylinder 3 fuel injector*
Y611 *Cylinder 4 fuel injector*
Y612 *Cylinder 5 fuel injector*
Y613 *Cylinder 6 fuel injector*
Y628 *Fuel metering valve*
Y629 *Fuel shutoff valve*
Y642 *Quantity control valve*

A *Fuel feed/suction side*
B *Fuel feed (thrust side)*
C *Fuel high pressure*
D *Fuel return*
E *Bleeding*



W47.00-1039-76

3 *Fuel pump*
4 *Diesel fuel metering device (for regeneration of diesel particulate filter (DPF))*
5 *Fuel system high pressure pump*
6 *Rail*
7 *Fuel prefilter*
8 *Water separator*
9 *Fuel filter*
14 *Hand-operated delivery pump*
15 *Shutoff valve in the fuel feed (locked in open position)*
16 *Shutoff valve in the fuel return (locked in open position)*
20 *Pressure limiting valve*
21 *Injection nozzle (for regeneration of the diesel particulate filter (DPF))*
22 *Filling valve*
30 *Fuel return line from fuel cooler to fuel filter module*
31 *Fuel feed line from fuel filter module to fuel pump*
32 *Fuel feed line from fuel pump to fuel filter module*
33 *Fuel feed line from fuel filter module to fuel system high pressure pump*
34 *Fuel feed line from fuel system high pressure pump to diesel fuel metering device*
35 *Fuel return line from 2-stage valve*
36 *Fuel return line of pressure booster*
37 *Fuel return line of nozzle needle*
38 *Fuel return line from pressure limiting valve*
41 *Fuel return line from pressure preparation flange for the fuel supply of the diesel fuel metering device*
43 *Fuel feed line from diesel fuel metering device to injection nozzle in the nozzle unit for DPF regeneration*

B622 Rail pressure sensor
B625 Fuel pressure sensor (inlet)
B626 Fuel pressure sensor (outlet)
Y608 Cylinder 1 fuel injector
Y609 Cylinder 2 fuel injector
Y610 Cylinder 3 fuel injector
Y611 Cylinder 4 fuel injector
Y612 Cylinder 5 fuel injector
Y613 Cylinder 6 fuel injector
Y628 Fuel metering valve
Y629 Fuel shutoff valve

A Fuel feed/suction side
B Fuel feed (thrust side)
C Fuel high pressure
D Fuel return

The fuel pump (3), which has been designed as a gear pump, supplies fuel to the fuel low pressure circuit.
When the engine is started, the fuel pump (3) draws in the fuel in the fuel tank (1) and delivers it into the fuel filter module (2) via the shutoff valve in the fuel feed (15).
The shutoff valve in the fuel feed (15) prevents fuel escaping when the fuel line between the fuel tank (1) and the fuel filter module (2) is disconnected.
The fuel in the fuel filter module (2) first passes into the fuel prefilter (7), in which large dirt particles (> 100 µm) are filtered out of the fuel flowing through it.
A shutoff valve (17) which is located at the fuel inlet of the fuel prefilter (7) prevents the suction line in the fuel tank (1) from being emptied during long vehicle stop times.

If the fuel prefilter (7) is contaminated and the fuel flow rate is therefore being inhibited, the fuel is drawn in via the bypass valve (7.1).

The fuel which has been cleaned by the fuel prefilter (7) is led out of the fuel filter module (2) and enters the fuel pump (3), which delivers it back into the fuel filter module (2) and into the water separator (8) that it contains.

The system pressure in the fuel feed thrust side (B) which can already be achieved at idle speed is determined by the opening pressure of the pressure limiting valve (3.1).
The bypass valve (3.2) is installed for the case of external filling of the fuel system.

The water inside the fuel is separated out in the water separator (8) and led to the water accumulator. Small dirt particles are also filtered out due to the construction.

The water from the water collector can be drained by means of a mechanical drain valve.
After leaving the water separator (8) the fuel flows through the fuel filter (9).
Extremely fine contamination (> 2 µm) is filtered out in the fuel filter (9), as it is in the water separator (8).
If air has gathered in the water separator (8) housing or the fuel filter (9) due to replacement of a filter insert, for example, this is led into the fuel collection chamber (13) via one ventilation bore each with vent lines (39, 40). The air is then dissipated from there into the fuel tank (1).
The fuel system must be bled occasionally after changing an air filter element with the aid of the hand-operated delivery pump (14). In the case of extensive repair work one can also use the filling valve (22).
Once the contamination has been filtered out by the fuel filter (9) the fuel is pumped out of the fuel filter module (2) to the fuel system high pressure pump (5).

Part of the fuel is compressed in the fuel system high pressure pump (5) and then led to the rail (6).
When this occurs, the quantity control valve (Y642) restricts the amount of fuel to be delivered by the fuel system high pressure pump (5) to exactly the right quantity.
Part of the fuel is prepared for supplying the diesel fuel metering device (23) with fuel upstream of the quantity control valve (Y642) in the pressure preparation flange, and then led out of the fuel system high pressure pump (5) to the diesel fuel metering device (4).
The diesel fuel metering device (4) ensures that the metered quantity of fuel is led via a line to the injection nozzle (21) in the nozzle unit for DPF regeneration, which is at the exhaust pipe upstream of the diesel particulate filter (DPF).
The fuel is then injected in a targeted manner into the hot exhaust flow from the injection nozzle (21), whereby the exhaust temperature increases and the diesel particulate filter (DPF) is regenerated.

The remaining fuel is led away via the 2-stage valve (19). The first stage of the 2-stage valve (19) opens at around 2 bar and provides the lubrication of the camshaft plain bearings in the fuel system high pressure pump (5).
The second stage opens at around 4.5 bar and regulates the system pressure in the thrust side fuel feed (B) to a range between 4.5 and 6.5 bar by leading excess fuel from the 2-stage valve (35) to the fuel collection chamber (13) via the fuel return line.
If the maximum rail pressure is exceeded, the pressure limiting valve (20) opens and the excess fuel is led from the pressure limiting valve (38) to the fuel collection chamber (13) via the fuel return line.
The fuel that is required for hydraulic pressure boosting is collected in a bore in the cylinder head and led to the fuel cooler (10) via the fuel return line of the pressure booster (36), from where it is delivered to the fuel pump (3).
The fuel cooler (10) serves to cool down the fuel, which is at a temperature of about
120 °C.

The excess fuel from the nozzle needle valves is also gathered in a bore in the cylinder head and led into the fuel collection chamber (13) via the fuel return for the nozzle needle valves (37) and the check valve (12).
The check valve (12) in the fuel return of the nozzle needle valves (37) has the task of achieving the required back pressure of about 2 bar while the engine is running and therefore ensuring that the fuel injectors work perfectly.
Part of the returned fuel is taken from the fuel collection chamber (13) and led back into the fuel low pressure circuit via the fuel return bypass (42) just upstream of the fuel prefilter (7).
The fuel quantity is determined by the throttle (11) and the check valve (12) in the fuel return bypass (42), which reduces the suction load on the fuel pump (3). The remaining fuel from the fuel collection chamber (13) is led back to the fuel tank (1).
The shutoff valve in the fuel return line (16) prevents fuel from escaping when the fuel line between the fuel tank (1) and the fuel filter module (2) is disconnected.

	Component description for fuel temperature sensor	B602	**Page 147**
	Diesel fuel metering device, component description	B625, B626, Y628, Y629	**Page 158**
	Fuel filter module pressure sensor, component description	B638	**Page 159**
	Component description for quantity control valve	Y642	**Page 182**
	Pressure limiting valve, component description		**Page 185**
	Component description for fuel pump		**Page 203**
	Component description for fuel cooler		**Page 204**
	Component description for fuel filter module		**Page 205**
	Nozzle unit for DPF regeneration, component description		**Page 220**

GF47.00-W-3013H	Fuel high pressure circuit function	20.7.11

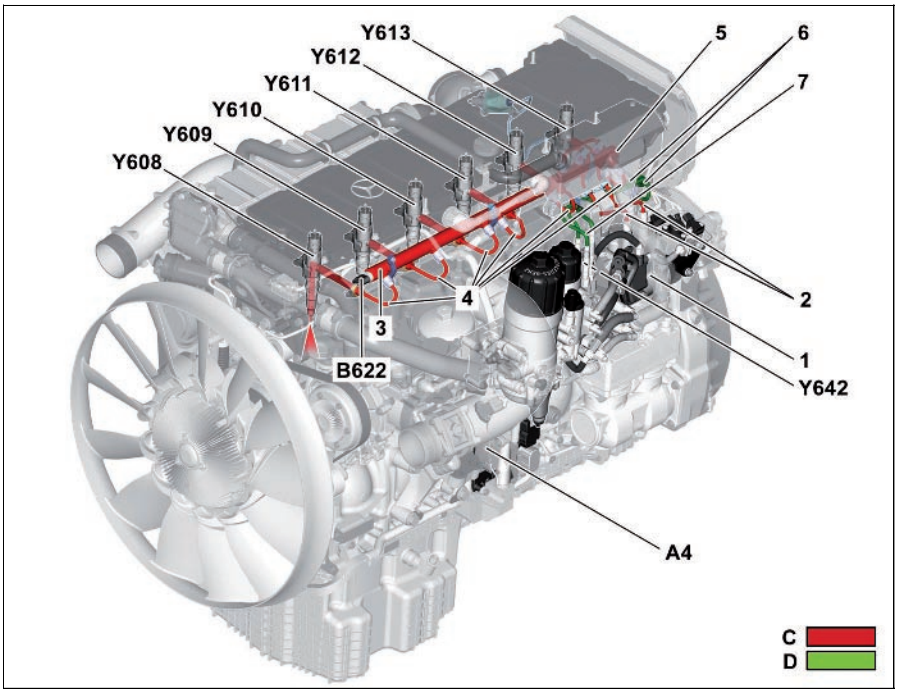
ENGINES 471.9 in MODEL 963

Code (M5Z) Engine version Euro VI shown

1 Fuel system high pressure pump
2 Fuel high-pressure lines (from fuel system high pressure pump to rail)
3 Rail
4 Fuel high-pressure lines (from rail to respective fuel injector)
5 Pressure limiting valve
6 Fuel return lines of fuel injectors
7 Fuel return line from pressure limiting valve

A4 Engine management control unit (MCM)
B622 Rail pressure sensor
Y608 Cylinder 1 fuel injector
Y609 Cylinder 2 fuel injector
Y610 Cylinder 3 fuel injector
Y611 Cylinder 4 fuel injector
Y612 Cylinder 5 fuel injector
Y613 Cylinder 6 fuel injector
Y642 Quantity control valve

C Fuel high pressure lines
D Fuel return lines



W07.16-1067-76

The fuel delivered by the fuel pump and cleaned by the fuel filter module flows via the quantity control valve (Y642) to the fuel high pressure pump (1).
Depending on the operating status of the engine, the engine management control unit (MCM) (A4) uses the quantity control valve (Y642) to determine the amount of fuel that is led into the fuel system high pressure pump (1).
The fuel is compressed by the fuel high pressure pump (1) and delivered to the rail via the two fuel high pressure lines (2). The fuel pressure of about 900 bar that is generated in this way is detected via the rail pressure sensor (B622) and passed on to the engine management (MCM) control unit (A4).
If the maximum permissible rail pressure has been exceeded, the mechanical pressure limiting valve (5) opens and the excess fuel flows back from the pressure limiting valve (7) to the fuel filter module in the low-pressure fuel circuit via the fuel return line.

The highly compressed fuel passes from the rail (3) to the fuel injectors for cylinder 1 to 6 (Y608 to Y613) via the fuel high pressure lines (4).
From fuel injectors for cylinders 1 to 6 (Y608 to Y613) the fuel is injected, according to the injection variant, with or without additional pressure amplification into the respective cylinder. The injection pressure can be up to 2100 bar.
The injection quantity, the injection timing point and the relevant injection variants are determined by the engine management (MCM) control unit (A4) depending on the operating condition of the engine.
The diverted quantity of the solenoid valves at the nozzle needles and the diverted quantity of the solenoid valves at the pressure boosters pass via the two fuel return lines of the fuel injectors (6) back to the fuel filter module and therefore back into the low-pressure fuel circuit.

	Engine management control unit (MCM), component description	A4	**Page 103**
	Component description for rail pressure sensor	B622	**Page 157**
	Component description for fuel injectors	Y608. to Y613	**Page 170**
	Component description for quantity control valve	Y642	**Page 182**
	Component description for fuel system high pressure pump		**Page 184**
	Pressure limiting valve, component description		**Page 185**

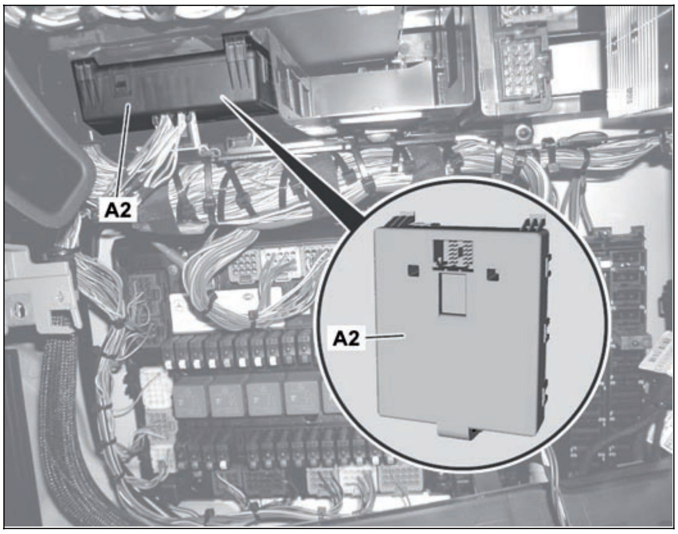
GF54.21-W-0009H	Central gateway control unit (CGW), component description	29.6.11

MODEL 963, 964

Location

A2 Central gateway control unit (CGW)

The central gateway control unit (CGW) (A2) is located in the electronics compartment on the passenger side.



W54.21-1422-11

Task

The central gateway control unit (CGW) (A2) forms the central interface of the vehicle networking and is directly connected to the following 5 high-speed bus systems:

- Vehicle CAN (CAN 1)
- Interior CAN (CAN 2)
- Frame CAN (CAN 3)
- Telematics CAN (CAN 9)
- Diagnostic CAN (CAN 10)

Routing data
The main task of the central gateway control unit (CGW) (A2) is to route individual CAN messages between the connected CAN data bus systems. In other words, e.g. it issues messages from the interior CAN (CAN 2) to the frame CAN (CAN 3).

The central gateway control unit (CGW) (A2) only knows which messages are being routed to which CAN system, and not which control unit must receive the individual messages.

Control unit monitoring
The central gateway control unit (CGW) (A2) monitors all control units for failure except itself and the components of the Electronic Brake Control control unit (EBS).
In the process, it checks whether a control unit actively participates in the bus traffic. If a control unit does not send a message after a long period, it assumes failure and issues a corresponding fault code. In addition, the failure is displayed on the instrument cluster control unit (ICUC) (A1).

Network management
The central gateway control unit (CGW) (A2) is responsible for selectively waking up and putting asleep the connected control units. All control units are awakened if a message is sent to a bus system.
Sleep is initiated only when all control units have signaled sleep readiness. As a result, synchronization occurs at sleep time.

Bus termination resistors
Bus termination resistors are used to avoid reflections that would lead to the falsification of actual information. The characteristic impedance of the electrical line is important for the bus termination resistor.
Bus termination resistors are installed for the following data bus systems in the central gateway control unit (CGW) (A2):

- Frame CAN (CAN 3)
- Telematics CAN (CAN 9)
- Diagnostic CAN (CAN 10)

Virtual control units
Virtual control units are not equipped with their own housing. They are integrated into the hardware and software of other control units. However, they do appear as individual control units in the Star Diagnosis.

The following control units are realized as virtual control units in the central gateway control unit (CGW) (A2):

- The central data memory (CDS) (A2 a1)
- The communications interface control unit (COM) (A2 a2)
- The maintenance system control unit (MS) (A2 a3)

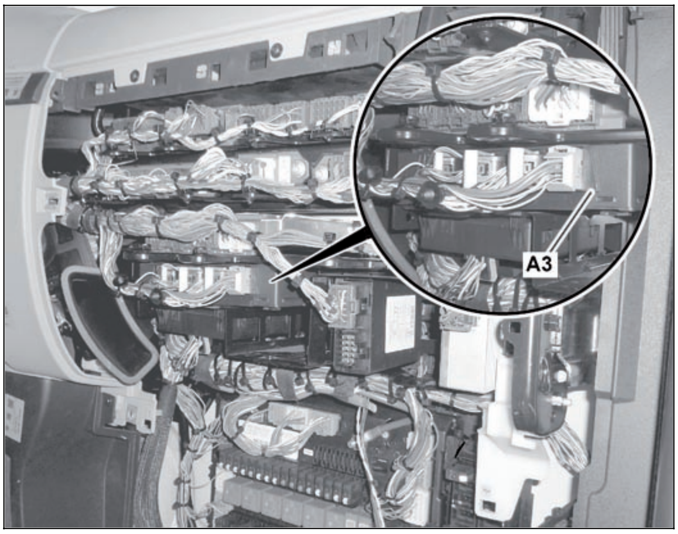
GF30.35-W-4105H	Component description drive control (CPC) control unit	1.7.11

MODEL 963, 964

Location

A3 Drive control (CPC) control unit

The drive control (CPC) control unit (A3) is located on the passenger-side in the electronics compartment.



W30.35-1237-11

Task

The drive control (CPC) control unit (A3) calculates various control factors relevant for the driving cycle for the following functions dependent on the current transmission mode:

- Cruise control
- Limiter
- Proximity Control Assist
  (for code (S1I) Proximity Control Assist)
- Engine brake (computation of braking torque)
- Coolant temperature management
- Automatic gear detection
- Monitoring of the coolant level
- Monitoring of the charging current
- Monitoring of the air filter
- Legal vehicle speed limit
- Diesel particulate filter (DPF) regeneration
- Computation/correction of the engine specified torque
- Retarder control
  (for code (B3H) Secondary water retarder)

According to the tasks performed the drive control (CPC) control unit (A3) is positioned in the Control Area Network (CAN) as the central interface (Gateway) between the frame CAN (CAN 3) and the drive train CAN (CAN 4).

The drive control (CPC) control unit communicates via CAN with the following control units:

- IC control unit (ICUC) (A1)
- Central gateway (CGW) control unit (A2)
- Engine management (MCM) control unit (A4)
- Transmission (TCM) control unit (A5)
- Cab signal acquisition and actuation module (SCA) control unit (A7)
- Antilock brake system (ABS) control unit, 4-channel (A10)
- Electronic Brake Control (EBS) control unit (A10b)
  (Wabco)
- Electronic Brake Control (EBS) control unit (A10c)
  (Knorr)
- Retarder control (RCM) control unit (A11)
- Parameterizable special module (PSM) control unit (A22)
- Exhaust aftertreatment (ACM) control unit (A60)
- Tachograph (P1)

Function

To record and evaluate electric sensor signals and switch signals

- Accelerator pedal sensor (B44)
- Coolant level switch (B47)
- Air filter sensor (B48)
- Coolant pressure regulation sensor (B87)
  (for code (B3H) Secondary water retarder)
- Alternator (G2)
  (determination of status of circuit 50 and charge current monitoring)
- Right multifunction control lever (S23)

Electrical actuation of components

- Coolant pressure regulation solenoid (Y53)
  (for code (B3H) Secondary water retarder)
- Controller unit for lower radiator shutters (A54)
  (for code (M7K) Radiator shutters)
- Controller unit for upper radiator shutters (A55)
  (for code (M7K) Radiator shutters)

Records, evaluates and transmits CAN messages

CAN messages are made available via frame CAN (CAN 3) and drive train CAN (CAN 4) which are relevant for the respective functions from other control unit and are also vise versa sent to these.

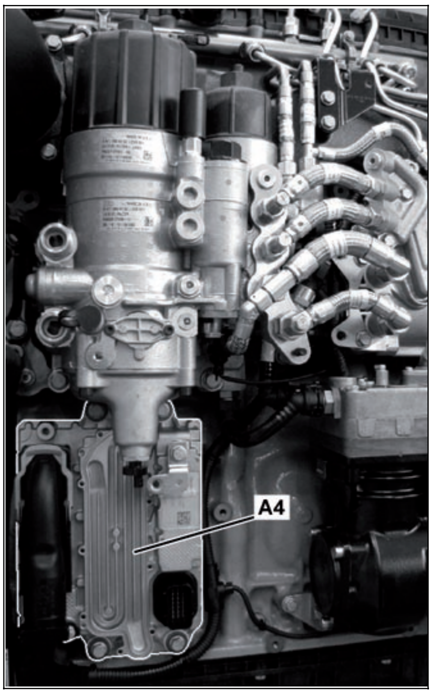
GF07.08-W-4110H	Component description for engine management (MCM) control unit	2.8.11

ENGINE 471.9 in MODEL 963

Location

A4 Engine management control unit (MCM)

The engine management (MCM) control unit (A4) is located on the left side of crankcase.



W07.08-1006-03

Task

The engine management (MCM) control unit (A4) services primarily as an interface between the electrical or electronic components located on the engine side and drive control (CPC) control unit (A3) on the vehicle side.
Both control units are networked together via the drive train CAN (CAN 4) and the CAN bus drive neutral point (Z4).
The engine management (MCM) control unit (A4) takes on a number of tasks.

On the one hand it takes on the controlling and regulating processes, e.g. for systems such as the engine management or the exhaust gas recirculation (AGR) while, on the other hand, it serves in turn just to pass on information such as the oil level in the engine.

The following is an overview of the tasks of the engine management (MCM) control unit (A4):

Engine management for the Amplified Pressure Common Rail System (APCRS)
The main task of the engine management (MCM) control unit (A4) is to regulate injection of the Amplified Pressure Common Rail System (APCRS).
All required data such as the output, diverse performance maps or data which serves to protect the engine is stored in the engine management (MCM) control unit (A4).
In order to regulate the injection which takes place through appropriate actuation of the fuel injectors for cylinder 1 to 6 (Y608 to Y613) and the quantity control valve (Y642), the engine management (MCM) control unit (A4) reads in signals from virtually all sensors connected to it. This means: all information except that from the engine oil fill level sensor (B605) is used in the computations.

Exhaust gas recirculation (EGR)
The fact that exhaust gas recirculation is active over the whole rotational speed range means that the ratio between recycled exhaust gas masses and suctioned in or supercharged fresh air mass must be matched exactly and thus exactly regulated.
This relationship, the so-called exhaust gas recirculation rate, is regulated by the engine management (MCM) control unit (A4) through appropriate actuation of the exhaust gas recirculation positioner (Y621).
The EGR rate value here is determined by the information from the charge air pressure and temperature sensor in the charge air pipe (B608), by the exhaust gas recirculation (EGR) differential pressure sensor (B621) and by the charge air temperature sensor in the charge air housing (B617), taking the data stored in a corresponding characteristics map into account.

Diesel particulate filter (DPF) - only for code (M5Z) Engine version Euro VI
During the regeneration phase of the diesel particulate filter (DPF) the engine management (MCM) control unit (A4) actuates the fuel shutoff valve (Y629) and (in intervals) the fuel metering valve (Y628).
The fuel shutoff valve (Y629) and the fuel metering valve (Y628) are located together with the fuel pressure sensor (inlet) (B625) and the fuel pressure sensor (outlet) (B626), in one metering device. This ensures that diesel fuel is metered over a line to the injection nozzle in the nozzle unit for DPF regeneration which is located on the exhaust pipe upstream of the diesel particulate filter (DPF).
The injection nozzle injects specific fuel amounts into the hot exhaust flow. During the resulting reaction in the exhaust aftertreatment unit, a great deal of heat is generated, in which the soot deposited in the diesel particulate filter (DPF) is burnt to form ash.

IC control unit (ICUC) (A1)
To display this in the instrument cluster control unit (ICUC) (A1) the engine management (MCM) control unit (A4) records the engine oil level, the engine oil temperature, the engine oil pressure, the coolant temperature and the engine rpm.

It also uses values from the following sensors:

- Engine oil fill level sensor (B605)
- Oil pressure sensor (B604)
- Intake coolant temperature sensor (B607) or exhaust (B606)
- Crankshaft position sensor (B600)

Fan control
For fan regulation purposes the engine management (MCM) control unit (A4) uses information from the coolant inlet temperature sensor (B607) and the coolant outlet temperature sensor (B606).

Engine brake
According to a request from the drive control (CPC) control unit (A3), the engine management (MCM) control unit (A4) actuates the engine brake solenoid valve, stage 1 (Y624), the engine brake solenoid valve, stage 2 (Y625) or both solenoid valves together.
Actuation of solenoid valves causes the engine oil to be fed to the respective rocker arms with hydroelement. This means that the respective brake rocker arms operate via the respective rocker arm with hydroelement on an exhaust valve, whereby the engine brake is active.

Tasks covering a number of systems
These tasks include engine or system diagnosis, since almost all electrical or electronic components which are attached to the engine management (MCM) control unit (A4) can be diagnosed.

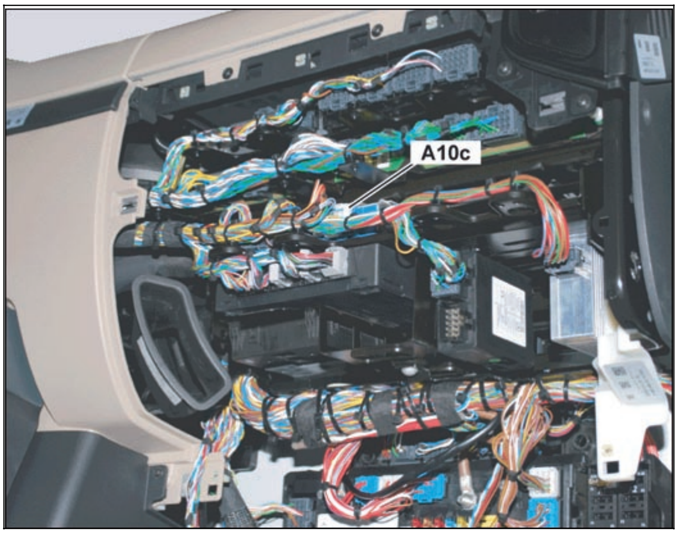
GF42.25-W-3135H	Electronic Brake Control control unit (EBS), component description	20.7.11

MODEL 963

Location

Shown on model 963.4, Knorr version
A10c Electronic brake system (EBS) control unit

The Electronic Brake Control control unit (EBS) (A10c) is installed in the electronics compartment on the front passenger side.



W42.25-1270-81

Task

The Electronic Brake Control control unit (EBS) (A10b or A10c) is the central component of the electronic brake system (EBS) and has the following tasks:

- Record the driver's brake command via the electrical signals of the brake value sensor (B17 or B17a).
- Calculate the specified brake pressures of the individual axles or the semi-trailer/trailer depending on the sensor data and taking into account the brake force distribution and wear harmonization.
- Actuation of the front axle axle modulator (A20 or A20a), the rear axle axle modulator (A21 or A21a), the ABS solenoid valves (Y1, Y2) and the trailer control valve (Y6 or Y6a) with the corresponding electrical signals to apply the specified brake pressures.
- Evaluate the feedback from the brake components during the entire brake application and readjust the brake pressure if necessary.
- Control the ABS or ASR interventions.
- Communication with other systems/control units in the vehicle via the frame CAN (CAN 3).
- Actuation of electronically braked trailers via the ISO 11992 interface (X103.7).
- Actuation of the air admission 3/2-way valve (Y5) or the ASR solenoid valve 2 (Y5a) for ASR suppression on the leading axle/trailing axle on vehicles with 3 axles.
- Control the function of the hill holder.
- Performing system diagnosis.
- Storage of system errors for diagnosis.
- Report major faults via the display field in the instrument cluster control unit (ICUC) (A1).

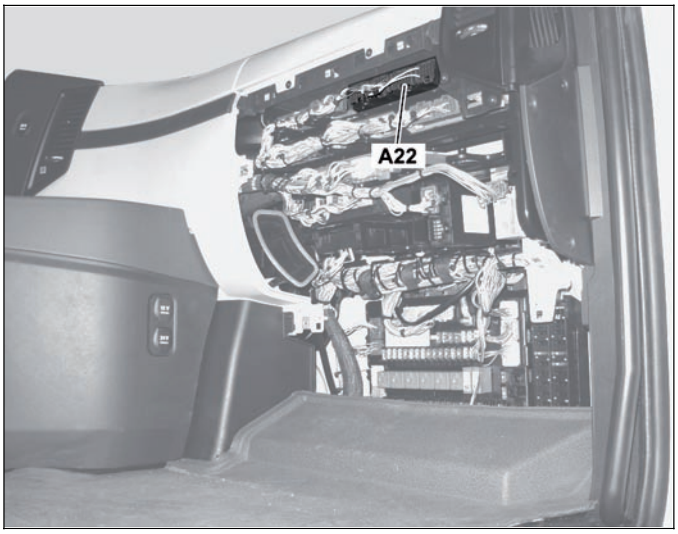
GF54.21-W-5005H	Parameterizable special module (PSM) control unit, component description	29.6.11

MODEL 963, 964

Location

A22 Parameterizable special module (PSM) control unit

The parameterizable special module (PSM) (A22) control unit is located on the passenger side in the electronics compartment.



W54.21-1432-11

Task

The parameterizable special module control unit (PSM) (A22) is integrated in the overall network on the vehicle side via the frame CAN (CAN 3). The trailer CAN (PSM) (CAN 7) and the body CAN (PSM) (CAN 8) serve as external interfaces.
The parameterizable special module control unit (PSM) (A22) allows for the implementation of complex controls and functions.

Full access to data from the entire vehicle CAN enables multiple applications to be carried out with a minimum of additional hardware components. Several functions are performed entirely without additional parts. They only need to be parameterized. 42 equations are available at the factory as preinstalled applications. These can be individually adapted (parameterization) to their respective use in the vehicle.

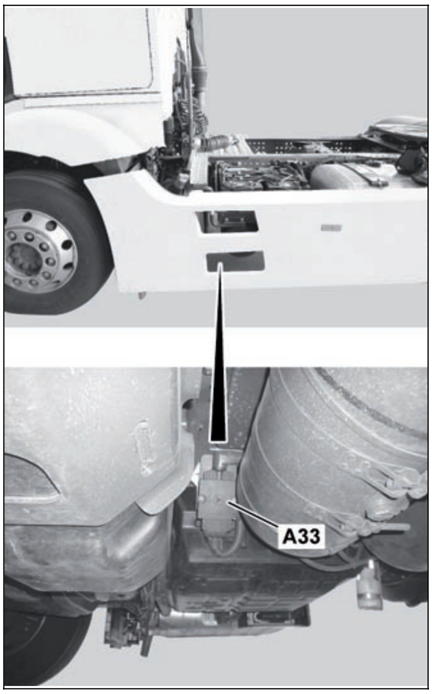
GF54.25-W-6000H	Battery disconnect switch control unit, component description	2.8.11

MODEL 963 with CODE (E5T) ADR model class EX/II, including AT
MODEL 963 with CODE (E5U) ADR model class EX/III, including EX/II and AT
MODEL 963 with CODE (E5V) ADR model class FL including EX/II, EX/III and AT
MODEL 963 with CODE (E5X) ADR model class AT
MODEL 963 with CODE (E5Z) Accessories, ADR
MODEL 963 with CODE (E9D) Preinstallation, double-pole battery disconnect switch
MODEL 963 with CODE (E9E)

Location

In vehicles without code (C7T) Integral rear end
A33 Battery disconnect switch control unit (BESO)

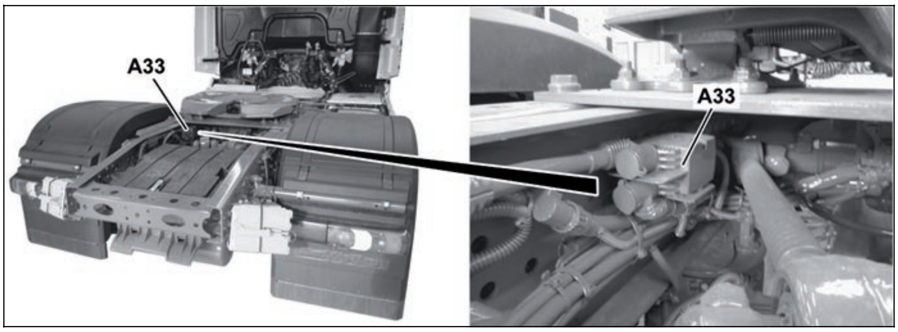
In vehicles with standard rear end, the battery disconnect switch (BESO) control unit (A33) is installed below the vehicle battery in the direction of travel in front of the compressed air reservoirs of the brake system.



W54.21-1431-03

In vehicles with code (C7T) Integral rear end
A33 Battery disconnect switch control unit (BESO)

In vehicles with integral rear end, the battery disconnect switch (BESO) control unit (A33) is installed on the inside of the left longitudinal frame member above the rear axle.



W54.21-1430-04

Tasks

- Evaluating the positions of the EMERGENCY OFF switch (S30) and the frame EMERGENCY OFF frame (S31)
- Disconnecting the on-board electrical system from the battery, when the EMERGENCY OFF switch (S30) or the frame EMERGENCY OFF switch (S31) is pressed

Design

- Control electronics
- Bistable relay for disconnecting the on-board electrical system from the battery

Function

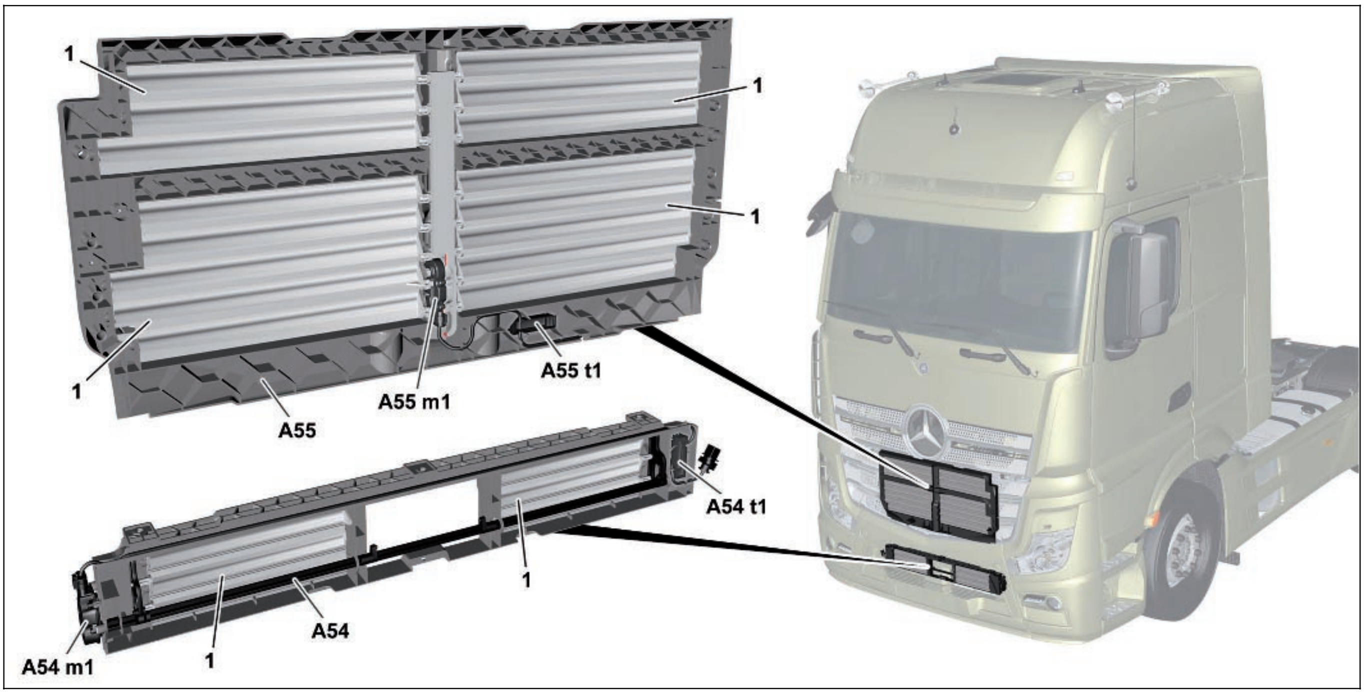
The battery disconnect switch (BESO) control unit (A33) evaluates the positions of the EMERGENCY OFF switch (S30) and the frame EMERGENCY OFF switch (S31) via the input signal.

ℹ As a redundant message on the exterior CAN (CAN 1), the battery disconnect switch (BESO) control unit (A33) also transmits a pulse width modulated signal (PWM signal) via a direct line to the sensor and actuator module, cab (SCA) control unit (A7). If the battery disconnect switch (BESO) control unit (A33) recognizes that the EMERGENCY OFF switch (S30) or the frame EMERGENCY OFF switch (S31) was pressed, it changes the duty cycle of the PWM signal from 50% to 75%, whereupon the sensor and actuator module, cab (SCA) control unit (A7) recognizes that the on-board electrical system starts being disconnected.

When the EMERGENCY OFF switch (S30) or the frame EMERGENCY OFF switch (S31) are pressed, the battery disconnect switch (BESO) control unit (A33) disconnects the on-board electrical system from the battery. Even before the on-board electrical system is disconnected from the battery, it sends a message to the exterior CAN (CAN 1) for further processing, announcing that the on-board electrical system will be disconnected from the battery. Among other things, the engine management (MCM) control unit (A4) initiates the switching-off of the engine due to this message. The on-board electrical system is disconnected by a bistable relay integrated into the battery disconnect switch (BESO) control unit (A33). The bistable relay is actuated 800 ms after the battery disconnect switch (BESO) control unit (A33) has recognized that the EMERGENCY OFF switch (S30) or the frame EMERGENCY OFF switch (S31) was pressed. The tachograph (TCO) (P1) continues to be supplied with voltage by the battery disconnect switch (BESO) control unit (A33) via a separate pin.

GF20.40-W-5010H	Radiator shutters, component description	20.7.11

MODEL 963, 964 with CODE (M7K) Radiator shutters



W20.00-1062-79

Shown on model 963 with code (S1l) Proximity Control Assist

1 Slats

A54 Lower radiator shutters controller unit

A54 m1 Lower radiator shutters actuator motor

A54 t1 Voltage converter 24 V/14 V

A55 Upper radiator shutters controller unit

A55 m1 Upper radiator shutters actuator motor

A55 t1 Voltage converter 24 V/14 V

Location

The radiator shutters, consisting of the lower radiator shutters controller unit (A54) and the upper radiator shutters controller unit (A55) are located behind the respective radiator grille.

Task

The lower radiator shutters controller unit (A54) and the upper radiator shutters controller unit (A55) control the throughflow of air in the engine compartment via the position of the slats (1). The drag coefficient of the vehicle is optimized by controlled slat (1) opening and closing, since the air flow is led around the vehicle. The warm-up phase of the engine can also be influenced via the position of the slats (1).

Design

The lower radiator shutters controller unit (A54) consists of the following components:

- Lower radiator shutters actuator motor (A54 m1)
- Voltage converter 24 V/ 14 V (A54 t1)

The upper radiator shutters controller unit (A55) consists of the following components:

- Upper radiator shutters controller unit (A55 m1)
- Voltage converter 24 V/ 14 V (A55 t1)

Function

The lower radiator shutters controller unit (A54) and the upper radiator shutters controller unit (A55) are actuated by the drive control control unit (CPC) (A3) using digital switching signals via the radiator shutters LIN (LIN 5). The digital switching signals are forwarded by the voltage converter 24 V/ 14 V (A54 t1) and the voltage converter 24 V/ 14 V (A55 t1) in the form of direction of rotation commands (voltage reversal) to the lower radiator shutters actuator motor (A54 m1) and the upper radiator shutters actuator motor (A55 m1). The slats (1) of the lower radiator shutters controller unit (A54) and the slats (1) of the upper radiator shutters controller unit (A55) are opened or closed in accordance with the request from the drive control control unit (CPC) (A3).

[i] The operating voltage of the lower radiator shutters actuator motor (A54 m1) and the upper radiator shutters actuator motor (A55 m1) is designed to be U = 12 V. The on-board electrical system voltage (U = 24 V) is reduced accordingly by the voltage converter 24 V/ 14 V (A54 t1) and the voltage converter 24 V/ 14 V (A55 t1).

Variants

The design of the lower radiator shutters controller unit (A54) and the upper radiator shutters controller unit (A55) varies according to the model and the equipment:

- Vehicles with ground clearance of 600
- Vehicles with ground clearance of 765
- Vehicles with Proximity Control Assist (with code (S1l) Proximity Control Assist)

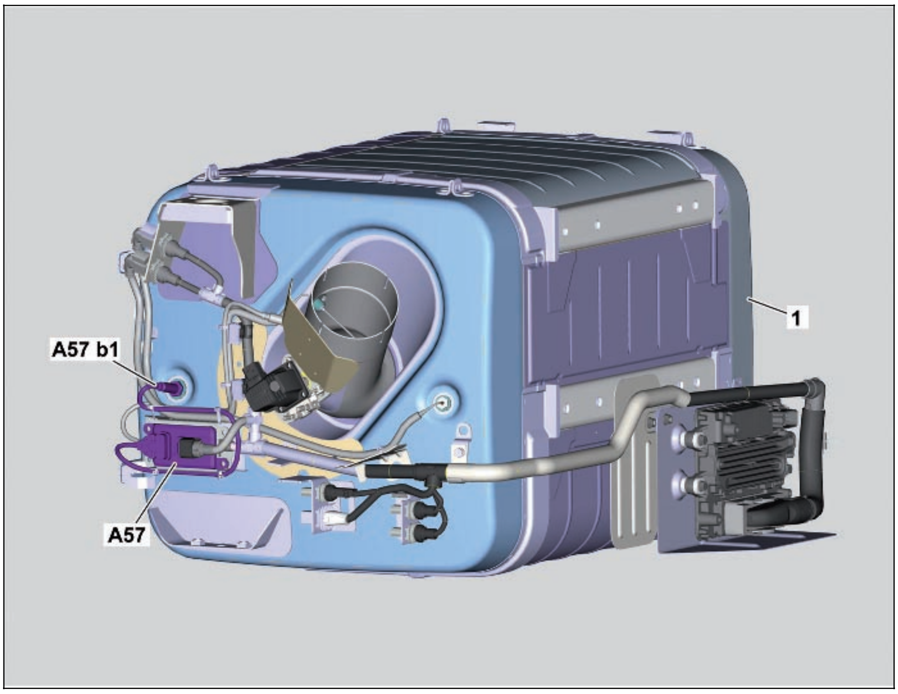
GF49.20-W-3009HA	EATU output NOx sensor, component description	2.8.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

1 Exhaust aftertreatment unit

A57 EATU output NOx sensor control unit
A57 b1 EATU output NOx sensor



W14.40-1595-76

The EATU output NOx sensor (A57 b1) is screwed into the inlet tube of the exhaust aftertreatment unit (1) from the outside and forms one unit together with the EATU output NOx sensor control unit (A57).

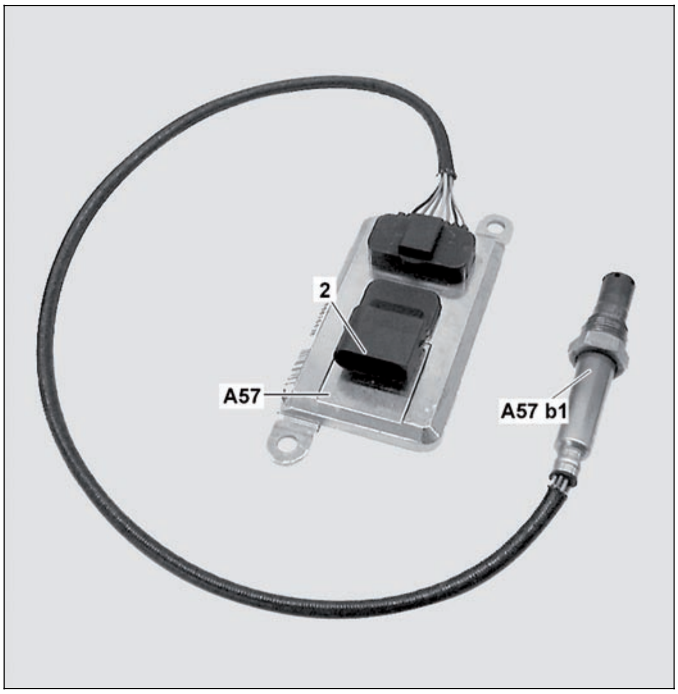
Task

The EATU output NOx sensor (A57 b1) represents the actual measurement sensor, whereas the EATU output NOx sensor electronic control unit (A57) is used to compute the NOx raw concentration in the exhaust before exhaust aftertreatment by the SCR catalytic converter and ammonia slip catalytic converter.

Design

2 Electrical connection

A57 EATU output NOx sensor control unit
A57 b1 EATU output NOx sensor



W14.40-1586-12

The EATU output NOx sensor control unit (A57) and the EATU output NOx sensor (A57 b1) are connected to each other via a non-separable electrical line and form one unit.

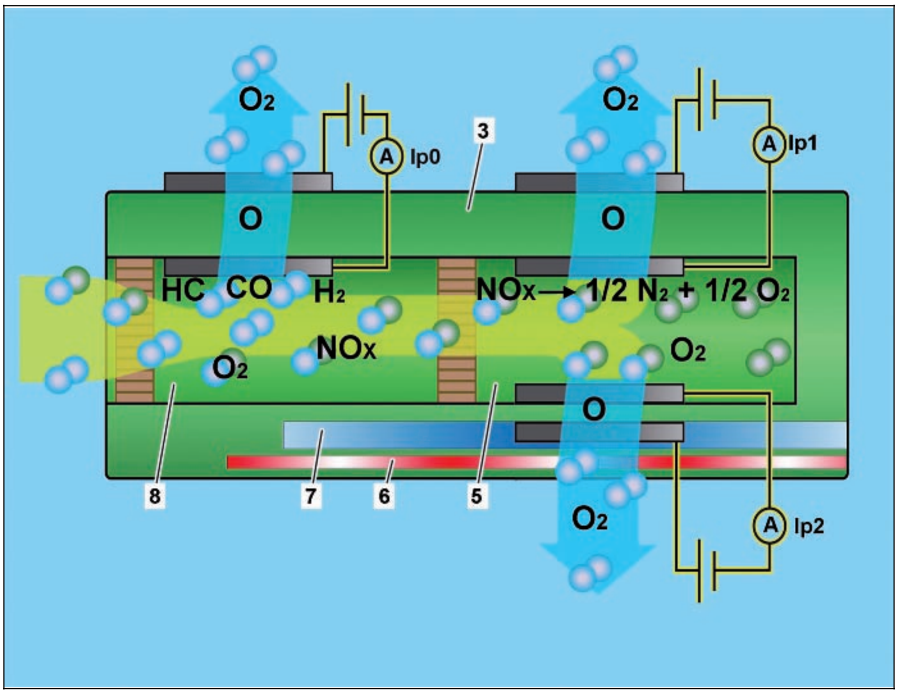
The EATU output NOx sensor (A57 b1) is similar in design to a wide-band oxygen sensor. It is fitted with its basic elements such as the so-called Nernst cell and the oxygen pump cell.
Its front part in the measuring probe which projects out into the exhaust consists of a metal housing with openings and a gas-permeable ceramic body inside made out of zirconium dioxide.

The surfaces of the ceramic body are fitted on both sides with electrodes made out of a thin platinum layer. The measuring probe is in contact with outside air via a reference air duct.
The metal housing protects the ceramic body inside against mechanical stress and sudden increases in temperature.

The EATU output NOx sensor (A57 b1) is fitted with an integral heating element which serves to rapidly achieve the required operating temperature of about 800 °C for the chemical processes taking place therein.

The electrical line between the EATU output NOx sensor (A57 b1) and the EATU output NOx sensor control unit (A57) has a defined length of approx. 60 mm.

Function



3 Measuring probe (ceramic body)
5 Chamber
6 Heating element
7 Reference air duct
8 Chamber

Ip0 Pump current (main pump electrode)
Ip1 Pump current (auxiliary pump electrode)
Ip2 Pump current (measuring electrode)

W14.40-1350-76

The EATU output NOx sensor (A57 b1) functions according to the principle of the so-called oxygen ions line according to which the wide-band oxygen sensor also functions.
Part of the exhaust flowing past the measuring probe (3) passes through a diffusion barrier into the first chamber (8).
In this case, the O_2 concentration is regulated at a defined value by means of the so-called pump voltage applied to an electrode until the oxygen content differs on either side of the ceramic body.
The special properties of the ceramic body create the signal voltage (Nernst voltage) at its friction planes. This is the measure for the residual oxygen content in the exhaust.
The traces of HC, CO and H_2 in the exhaust oxygenate at the electrode made out of platinum. The gas then passes over a further diffusion barrier and arrives in the second chamber (5) where it is broken down with the aid of a second NOx electrode into NO and O_2.

The O_2 concentration is also regulated to close to zero at the same time with the aid of a further electrode. The nitrous oxide concentration is deduced from the size of the pump current (Ip2) required.
The EATU output NOx sensor control unit (A57) is used to compute the required pump voltages, to regulate the complex system and to compute the NOx raw values. It receives the analog signals from the EATU output NOx sensor (A57 b1) and digitizes them. It then forwards them as digital CAN messages to the exhaust aftertreatment (ACM) control unit (A60) at a defined transfer rate, which then evaluates them.

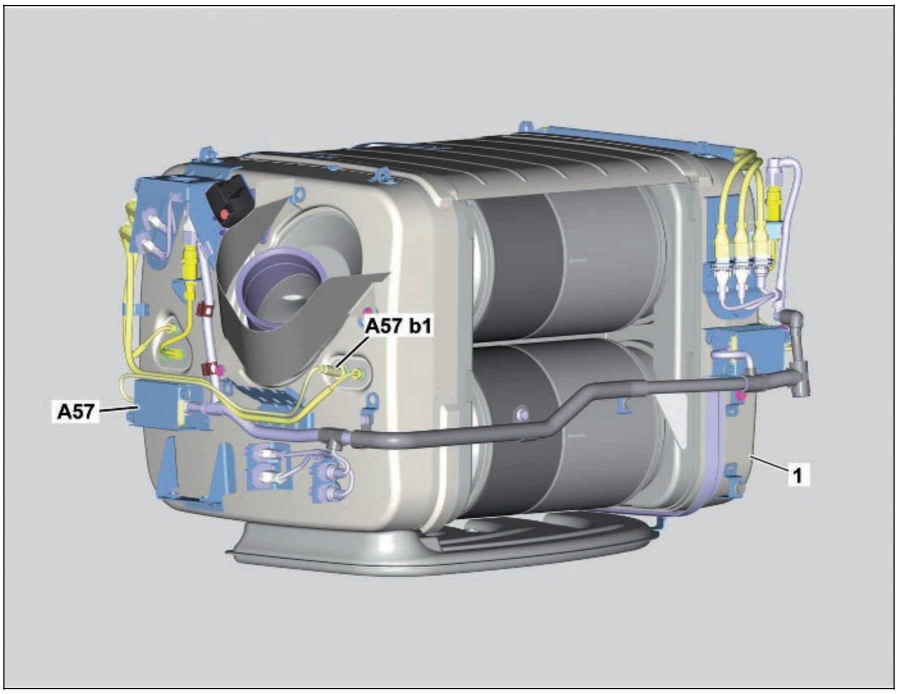
GF49.20-W-3009H	Exhaust aftertreatment unit outlet NOx sensor, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

1 Exhaust aftertreatment unit:

A57 Exhaust aftertreatment unit outlet NOx sensor control unit
A57 b1 Exhaust aftertreatment unit outlet NOx sensor



W14.40-1585-76

The exhaust aftertreatment unit outlet NOx sensor (A57 b1) is screwed in from the outside in the deflection chamber upstream of the diesel oxidation catalytic converter (DOC).
The exhaust aftertreatment unit outlet NOx sensor (A57) is attached to a bracket at the exhaust aftertreatment unit (1). Both components form a single unit.

Task

The exhaust aftertreatment unit outlet NOx sensor (A57 b1) represents the actual measuring probe, whereas the exhaust aftertreatment unit outlet NOx sensor electronic control unit (A57) is used to calculate the raw NOx concentration in the exhaust upstream of the exhaust aftertreatment by the diesel oxidation catalytic converter (DOC), the diesel particulate filter (DPF) and the SCR catalytic converter.

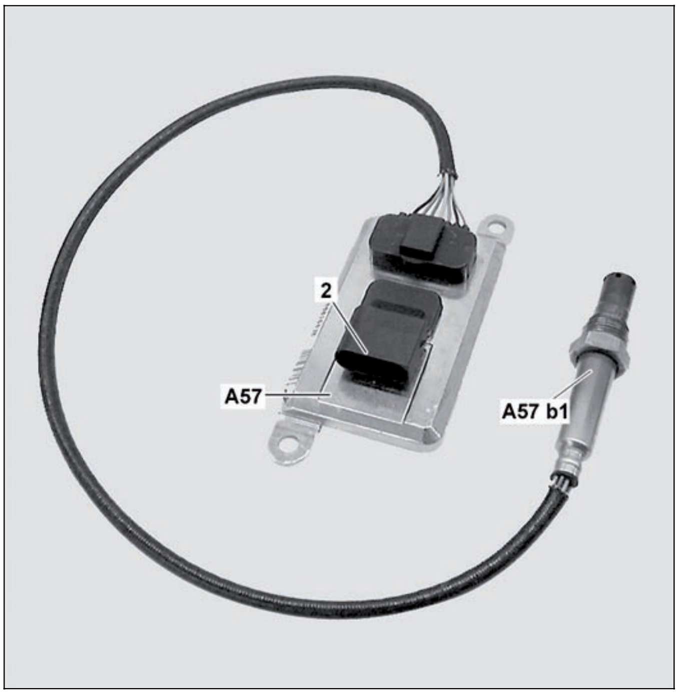
Design

2 *Electrical connection*

A57 *Exhaust aftertreatment unit outlet NOx sensor control unit*
A57 b1 *Exhaust aftertreatment unit outlet NOx sensor*

The exhaust aftertreatment unit outlet NOx sensor control unit (A57) and the exhaust aftertreatment unit outlet NOx sensor (A57 b1) are interconnected via an electrical line that cannot be disconnected, and form a single unit.

The exhaust aftertreatment unit outlet NOx sensor (A57 b1) has a similar design to a wide-band oxygen sensor. It is fitted with its basic elements such as the so-called Nernst cell and the oxygen pump cell.
Its front part in the measuring probe which projects out into the exhaust consists of a metal housing with openings and a gas-permeable ceramic body inside made out of zirconium dioxide.

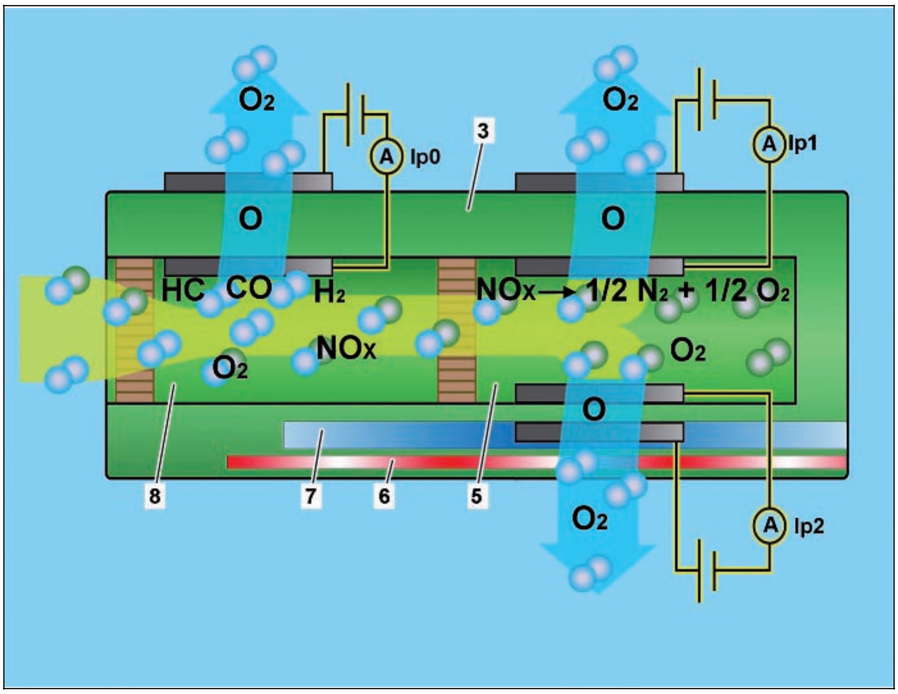


W14.40-1586-12

The surfaces of the ceramic body are fitted on both sides with electrodes made out of a thin platinum layer. The measuring probe is in contact with outside air via a reference air duct.
The metal housing protects the ceramic body inside against mechanical stress and sudden increases in temperature.

The exhaust aftertreatment unit outlet NOx sensor (A57 b1) is fitted with an integral heating element which serves to rapidly achieve the operating temperature of about 800 °C that is required for the chemical processes taking place therein.
The electrical line between the exhaust aftertreatment unit outlet NOx sensor (A57 b1) and the exhaust aftertreatment unit outlet NOx sensor control unit (A57) has a defined length of approx. 60 mm.

Function



W14.40-1350-76

3 Measuring probe (ceramic body)
5 Chamber
6 Heating element
7 Reference air duct
8 Chamber

Ip0 Pump current (main pump electrode)
Ip1 Pump current (auxiliary pump electrode)
Ip2 Pump current (measuring electrode)

The exhaust aftertreatment unit outlet NOx sensor (A57 b1) functions according to the principle of the so-called oxygen ions line, according to which the wideband oxygen sensor also functions.
Part of the exhaust flowing past the measuring probe (3) passes through a diffusion barrier into the first chamber (8).
In this case the O_2 concentration is regulated at a defined value by means of the so-called pump voltage applied to an electrode until the oxygen content differs at both sides of the ceramic body.
The special properties of the ceramic body create the signal voltage (Nernst voltage) at its boundary surfaces. This is the measure for the residual oxygen content in the exhaust.
The traces of HC, CO and H_2 in the exhaust oxygenate at the electrode made out of platinum.
The gas then passes over a further diffusion barrier and arrives in the second chamber (5) where it is broken down with the aid of a second NOx electrode into NO and O_2. The O_2 concentration is also regulated to close to zero at the same time with the aid of a further electrode. The nitrous oxide concentration is deduced from the size of the pump current (Ip2) required.
The exhaust aftertreatment unit outlet NOx sensor (A57) serves to compute the required pump voltages, to regulate the complex system and to compute the NOx raw values.It receives the analog signal from the exhaust aftertreatment unit outlet NOx sensor (A57 b1) and digitalizes it. It forwards these as digital CAN signals at a defined transfer rate to the exhaust aftertreatment control unit (ACM) (A60), which then evaluates them.

GF14.40-W-3003H	Pump module, component description	20.7.11

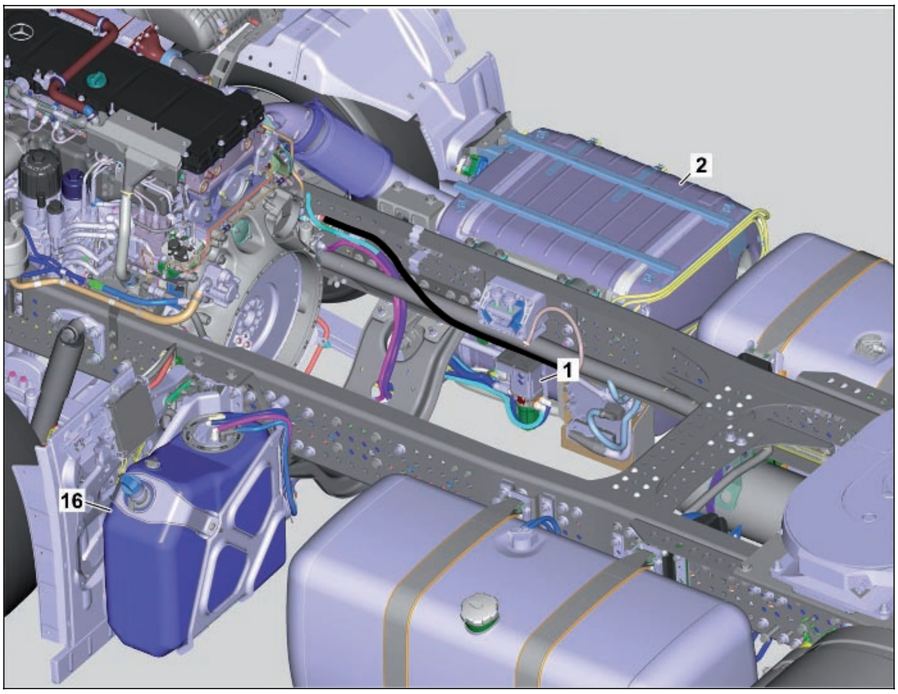
ENGINE 471.9 in MODEL 963, 964

Location

Shown on model 963 with code (M5Z)
Engine version Euro VI

1 Pump module
2 EATU
16 AdBlue® tank

The pump module (1) which contains the SCR control unit (A58) and SCR delivery pump (M25) is fastened to a bracket on the inside of the right longitudinal frame member behind the EATU (2).



W14.40-1562-76

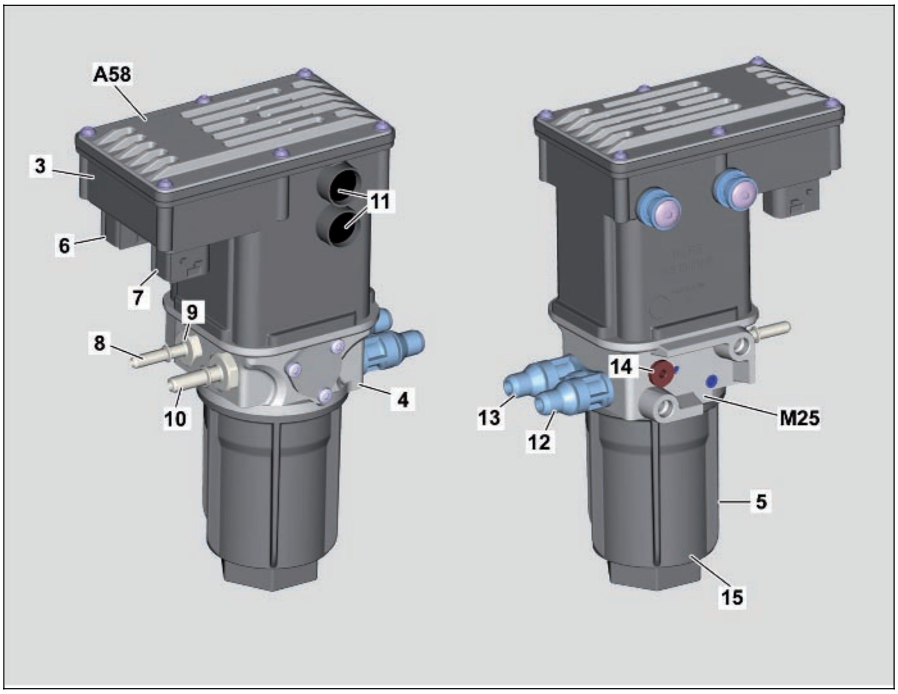
Task

The pump module (1) sucks in AdBlue® from the AdBlue® container (16), filters it and pumps it to the AdBlue® metering device (A67). The SCR control unit (A58) calculates the injection period and the injection quantity.

Design

3 Electronics housing
4 Connecting body
5 Filter housing
6 Electrical connection (communication to AdBlue® metering device)
7 Electrical connection (communication to exhaust aftertreatment (ACM) control unit)
8 AdBlue® inlet
9 Intake filter (mesh size 190 µm)
10 AdBlue outlet
11 Vent valves
12 Coolant inlet
13 Coolant outlet
14 Pressure limiting valve
15 Main filter (mesh size 20 to 30 µm)

A58 SCR control unit
M25 SCR delivery pump

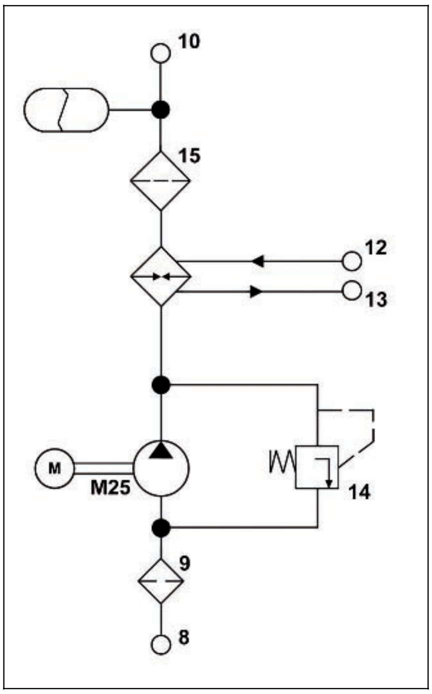


W14.40-1570-76

Function

8 AdBlue® inlet
9 Intake filter
10 AdBlue® outlet
12 Coolant inlet
13 Coolant outlet
14 Pressure limiting valve
15 Main filter

M25 SCR delivery pump



W14.40-1560-03

After the engine starts, the exhaust aftertreatment (ACM) control unit (A60) actuates the pump module (1) or more accurately, the SCR control unit (A58) integrated into it. This switches the SCR delivery pump (M25), so that AdBlue® is sucked in from the AdBlue® container and pumped at an operating pressure of approx. 10 bar towards the AdBlue® metering device (A67).

Because the AdBlue® metering device (A67) is cooled be circulation through circulating AdBlue®, AdBlue® is pumped continuously, irrespective of whether injection is necessary or not. The AdBlue® that is not required or not injected flows back through the return line to the AdBlue® container.

Heating
A duct inside the connecting body (4) enables the pump module (1) to have engine coolant flow through it for heating or defrosting. The coolant inflow is regulated by an engine mounted solenoid valve as a function of the temperature by the engine management (MCM) control unit (A60).

Delayed-off running
To avoid any damage through overheating on the AdBlue® metering device (A67), the pump module (1) continues to pump AdBlue® for some time after the engine stops so that the cooling can be maintained for a longer period.

GF14.40-W-3020HA	Exhaust aftertreatment (ACM) control unit, component description	20.7.11

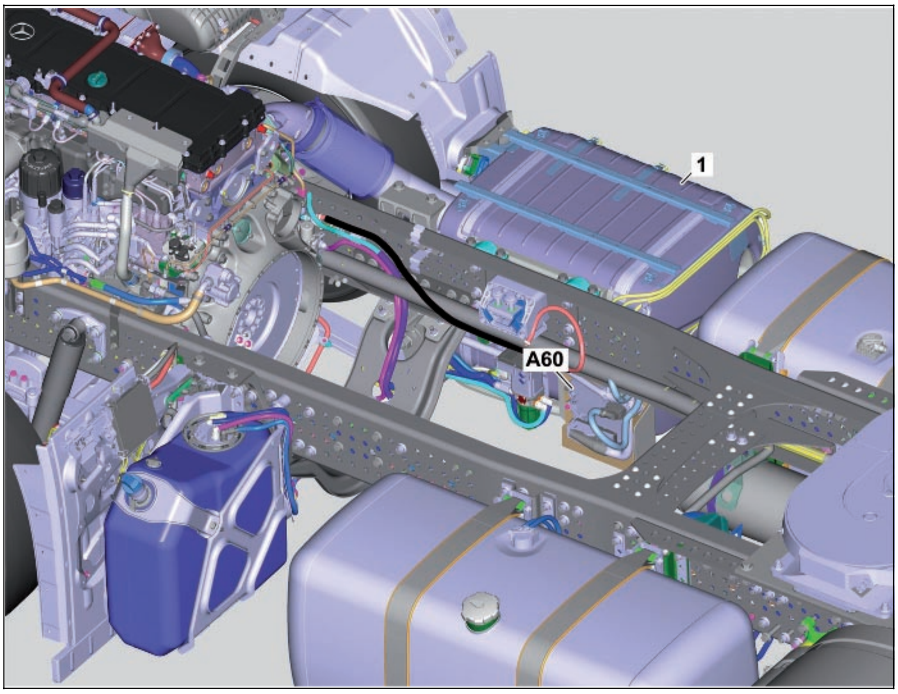
ENGINE 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINE 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

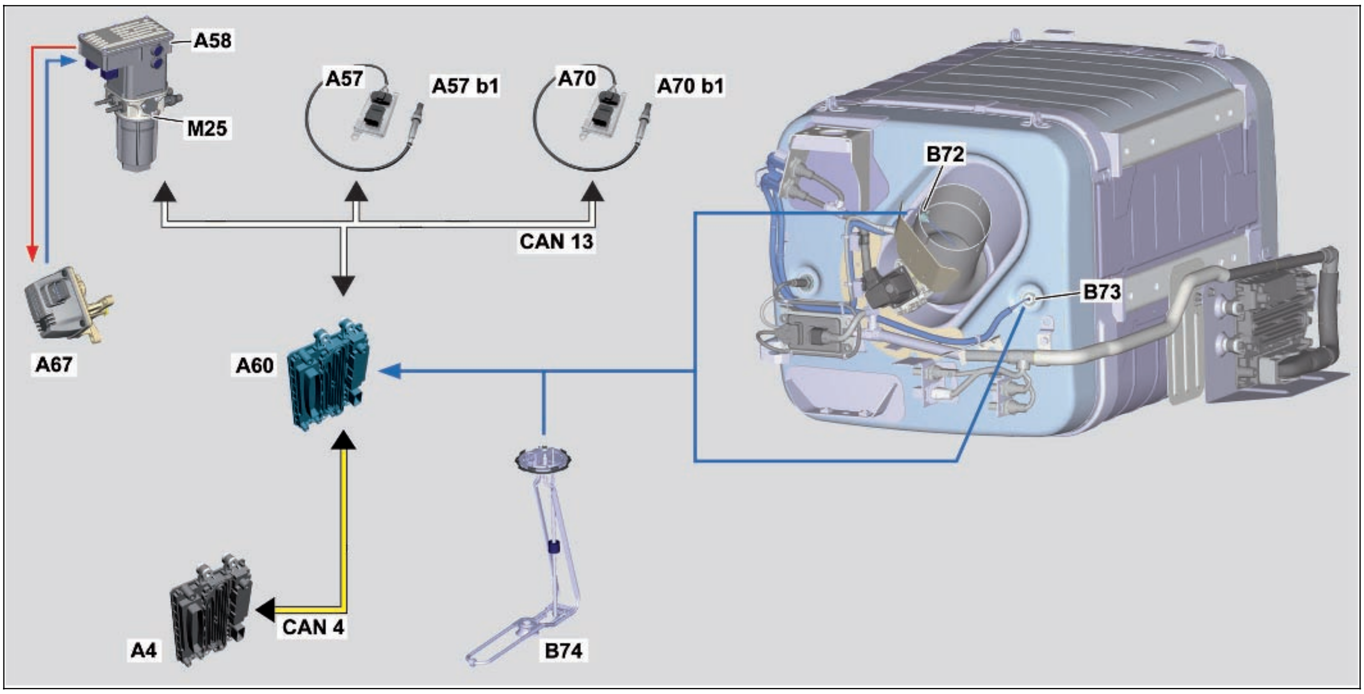
1 *Exhaust aftertreatment unit*

A60 *Exhaust aftertreatment (ACM) control unit*

The exhaust aftertreatment (ACM) control unit (A60) is fastened to a bracket on the inside of the EATU (1).



W14.40-1568-76



W14.40-1598-79

A4 *Engine management control unit (MCM)*
A57 *NOx sensor control unit output for exhaust aftertreatment unit*
A57 b1 *NOx sensor output for exhaust aftertreatment unit*
A58 *SCR control unit (in pump module)*
A60 *Exhaust aftertreatment (ACM) control unit*
A67 *AdBlue® metering device*
A70 *NOx sensor control unit input for exhaust aftertreatment unit*
A70 b1 *NOx sensor input for exhaust aftertreatment unit*
B72 *Exhaust temperature sensor upstream of SCR catalytic converter*
B73 *Exhaust temperature sensor downstream of SCR catalytic converter*
B74 *AdBlue® fill level sensor/ temperature sensor*
CAN 4 *Drive train CAN*
CAN 13 *NOx-CAN*
M25 *SCR delivery pump (in pump module)*

Task

The exhaust aftertreatment (ACM) control unit (A60) regulates and controls practically all the exhaust aftertreatment system functions.
The exhaust aftertreatment (ACM) control unit (A60) receives the analog signals from the directly connected sensors. It receives the NOx sensor signals over CAN connections and communicates with the SCR control unit (A58) and the engine management (MCM) control unit (A4).

AdBlue® injection
It uses the data supplied by the SCR control unit (A58) and the engine management (MCM) control unit (A4) to calculate the required AdBlue® quantity, which is then sent over the SCR control unit (A58) to the AdBlue® metering device (A67).

GF14.40-W-3020H	Exhaust aftertreatment (ACM) control unit, component description	20.7.11

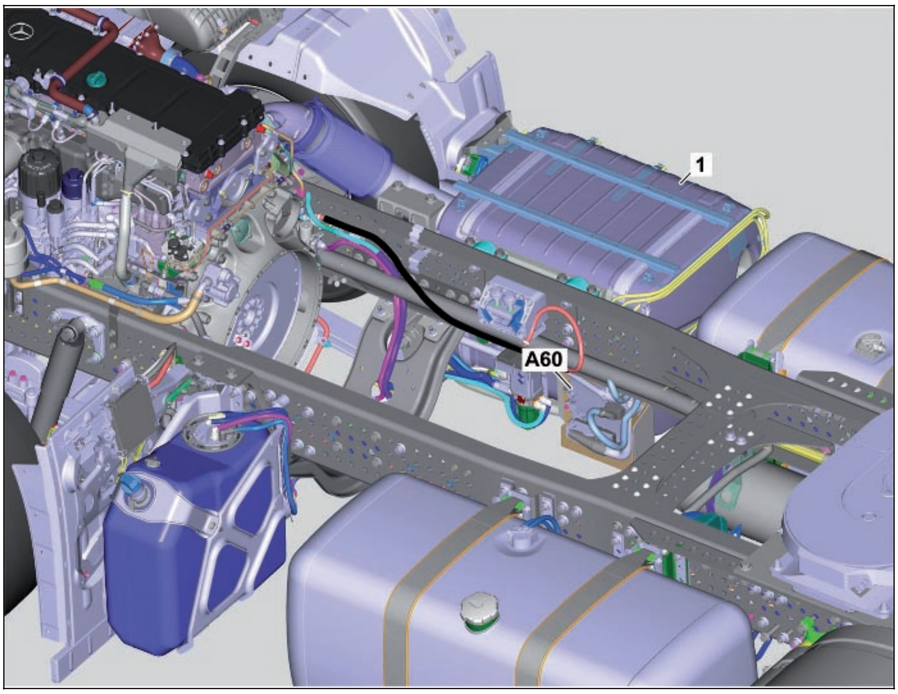
ENGINE 471.9 in MODEL 963 with CODE (M5Z) Engine version Euro VI

Location

1 *Exhaust aftertreatment unit*

A60 *Exhaust aftertreatment (ACM) control unit*

The exhaust aftertreatment (ACM) control unit (A60) is fastened to a bracket on the inside of the EATU (1).

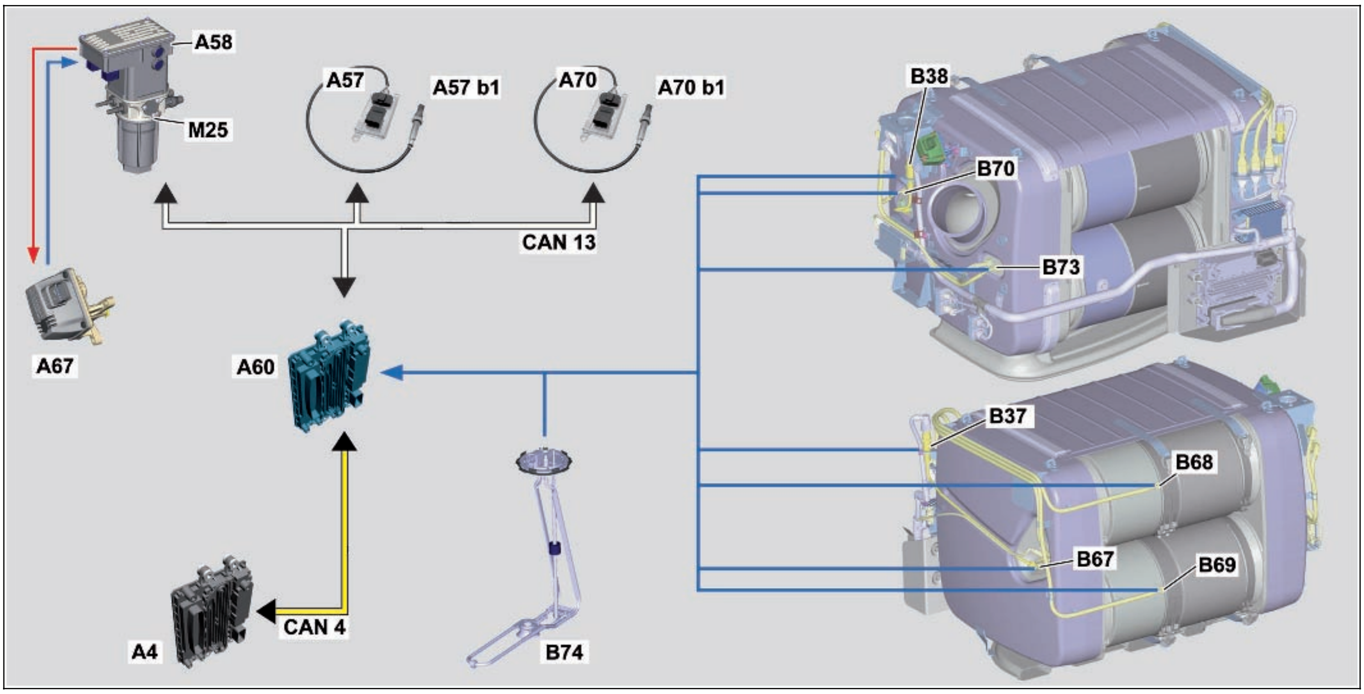


W14.40-1568-76

Task

The exhaust aftertreatment (ACM) control unit (A60) regulates and controls practically all the exhaust aftertreatment system functions.

It also processes the incoming digital and analog signals of the connected sensor system and communicates over CAN connections with the connected control units.



W14.40-1597-79

A4	*Engine management control unit (MCM)*
A57	*NOx sensor control unit output for exhaust aftertreatment unit*
A57 b1	*NOx sensor output for exhaust aftertreatment unit*
A58	*SCR control unit*
A60	*Exhaust aftertreatment unit (ACM) control unit*
A67	*AdBlue® metering device*
A70	*NOx sensor control unit input for exhaust aftertreatment unit*
A70 b1	*NOx sensor input for exhaust aftertreatment unit*
B37	*Exhaust pressure sensor upstream of diesel oxidation catalytic converter*
B38	*Exhaust pressure sensor downstream of diesel particulate filter*
B67	*Exhaust temperature sensor upstream of diesel oxidation catalytic converter*
B68	*Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter*
B69	*Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*
B70	*Exhaust temperature sensor downstream of diesel particulate filter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*
B74	*AdBlue® fill level sensor/temperature sensor*
CAN 4	*Drive train CAN*
CAN 13	*NOx-CAN*
M25	*SCR delivery pump*

The exhaust aftertreatment (ACM) control unit (A60) receives the analog signals from the directly connected sensors. It receives the NOx sensor signals over CAN connections and communicates with the SCR control unit (A58) and the engine management (MCM) control unit (A4).

AdBlue® injection

It uses the data supplied by the SCR control unit (A58) and the engine management (MCM) control unit (A4) to calculate the required AdBlue® quantity, which is then forwarded over the SCR control unit (A58) to the AdBlue® metering device (A67).

Diesel particulate filter regeneration

The diesel particulate filter load status is monitored by the temperature and pressure sensors. If active regeneration is required, it is requested by the engine management (MCM) control unit (A4).

GF14.40-W-3013H	AdBlue metering device, component description	20.7.11

ENGINE 471.9 in MODEL 963, 964

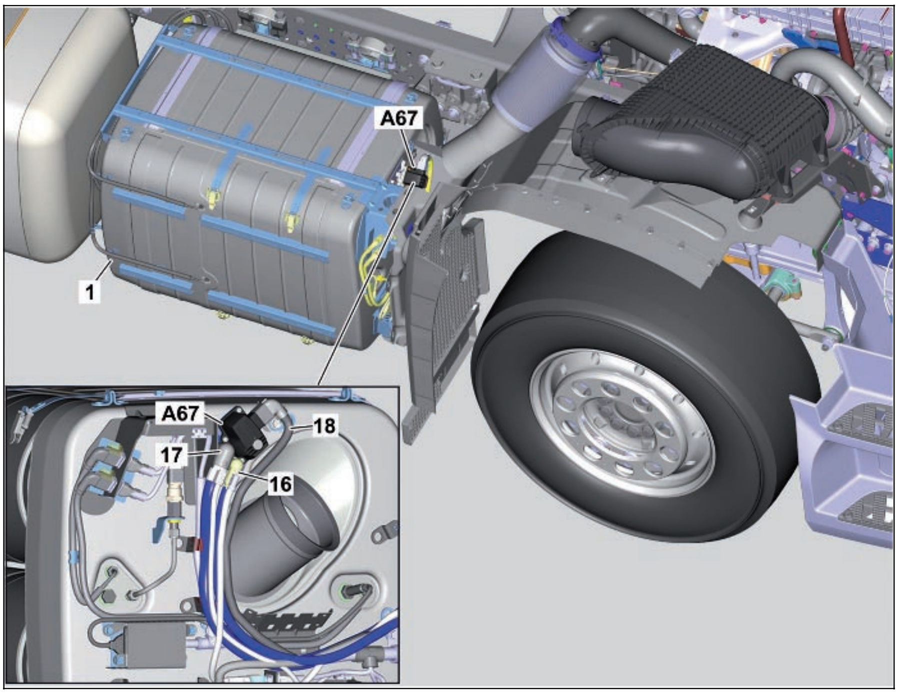
Location

Shown on model 963 with code (M5Z)
Engine version Euro VI

1 Exhaust aftertreatment unit
16 AdBlue® return line
17 AdBlue® pressure line
18 Electrical line

A67 AdBlue® metering device

The AdBlue® metering device (A67) is directly screwed onto the EATU at the right front in the direction of travel. The injection nozzle of the AdBlue® metering device (A67) protrudes here into the hydrolysis segment of the EATU (1).



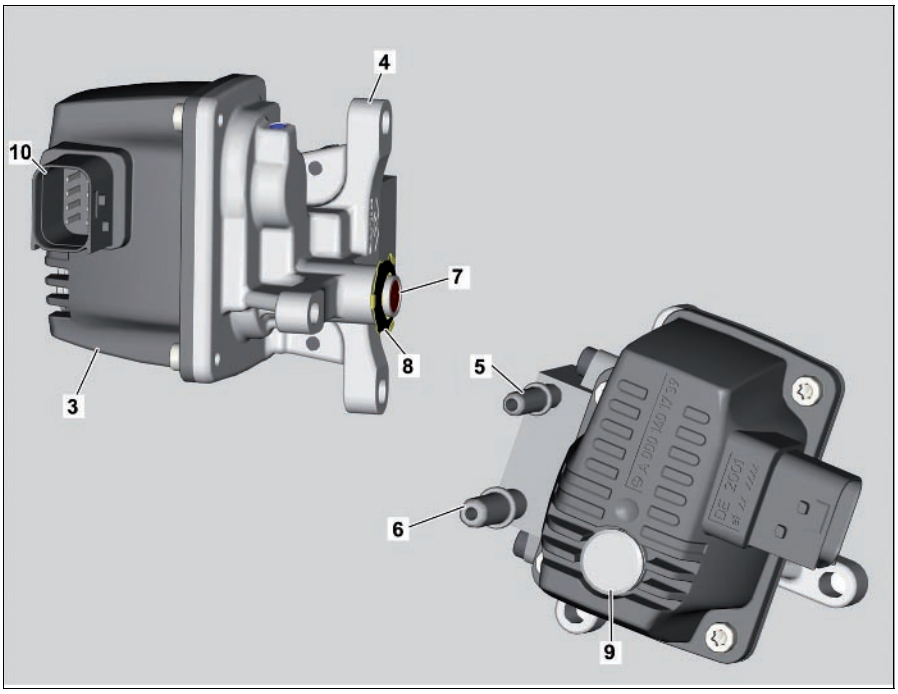
W14.40-1565-76

Task

The AdBlue® metering device (A67) injects the AdBlue® quantity, as calculated by the control units, for the corresponding period into the exhaust flow.

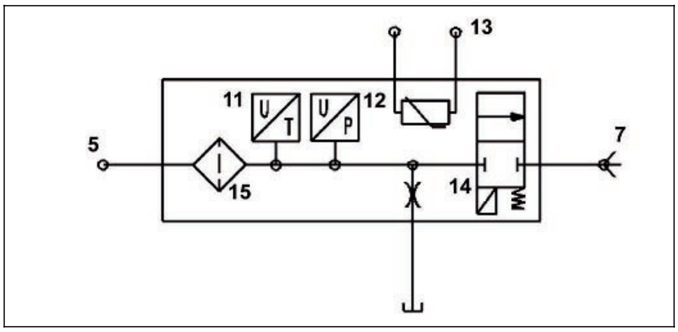
Design

3 Housing (plastic)
4 Basic body (stainless steel)
5 AdBlue® inlet
6 AdBlue® outlet (return)
7 Injection nozzle
8 Gasket
9 Vent valve
10 Electrical connection



W14.40-1566-76

Function



W14.40-1567-10

5 AdBlue® inlet
7 Injection nozzle
11 Temperature sensor
12 Pressure sensor
13 Heating element
14 Injector
15 Filter

When the engine is started and at an operating pressure of approx. 10 bar, the AdBlue® metering device (A67) has AdBlue® pumped constantly through it by the pump module.
This happens irrespective of whether AdBlue® is injected or not, because the AdBlue® metering device (A67) is protected against overheating at the installation location on the EATU (1) and the prevailing high temperatures by this recirculation cooling.

The AdBlue® that is not required or not injected flows back through the return line to the AdBlue® container. This cooling is absolutely necessary, and it continues for a specific period in a run-on phase, even when the engine is switched off.

Injection

The AdBlue® metering device (A67) receives the signals from the SCR control unit (A58) for the currently delivered AdBlue® quantity. The pressure sensor (12) and temperature sensor (11) integrated into the AdBlue® metering device (A67) supply the values for the basis on which the opening duration and opening period of the injection valve (14) are calculated.
The AdBlue® metering device (A67) is actuated by the SCR control unit (A58) - the computation however takes place in the exhaust aftertreatment (ACM) control unit (A60).

The injection valve (14) opens in pulsed intervals and injects - due to the atomized effect produced by the injection nozzle (7) - AdBlue® as a superfine spray straight into the exhaust flow, or put more accurately into the hydrolysis path of the EATU (1)

Heating

At low ambient temperatures the AdBlue® metering device (A67) is heated by the integrated heating element (13).

GF49.20-W-3008HA	EATU input NOx sensor, component description	2.8.11

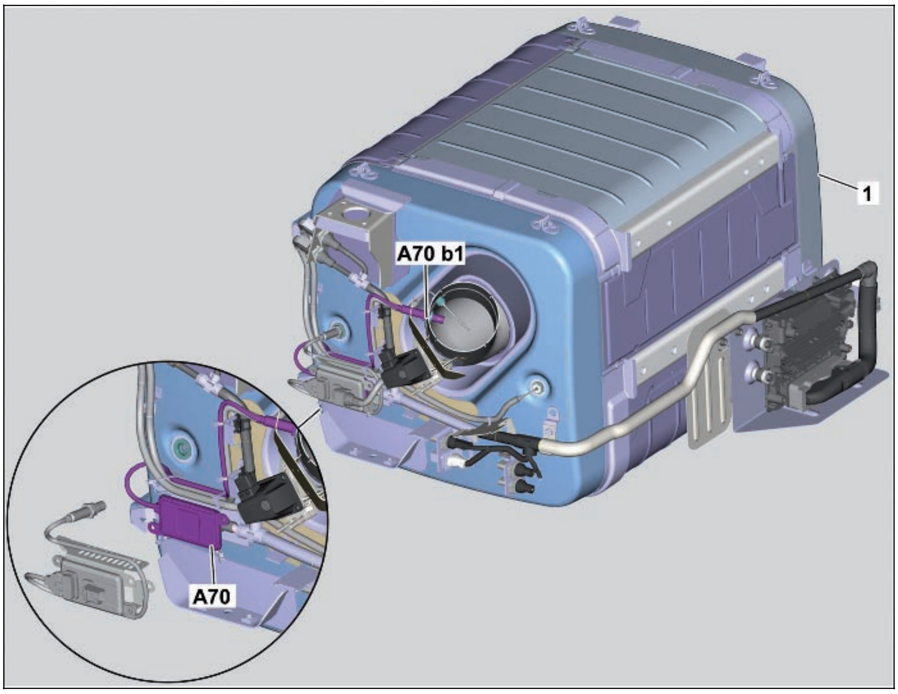
ENGINES 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

1 Exhaust aftertreatment unit

A70 EATU input NOx sensor control unit
A70 b1 EATU input NOx sensor

The EATU input NOx sensor (A70 b1) is screwed into the chamber downstream of the SCR catalytic converter and ammonia slip catalytic converter from the outside and forms one unit together with the EATU input NOx sensor control unit (A70).



W14.40-1596-76

Task

The EATU input NOx sensor (A70 b1) represents the actual measurement sensor, whereas the EATU input NOx sensor electronic control unit (A70) is used to compute the NOx concentration in the exhaust after exhaust aftertreatment by the SCR catalytic converter and ammonia slip catalytic converter.

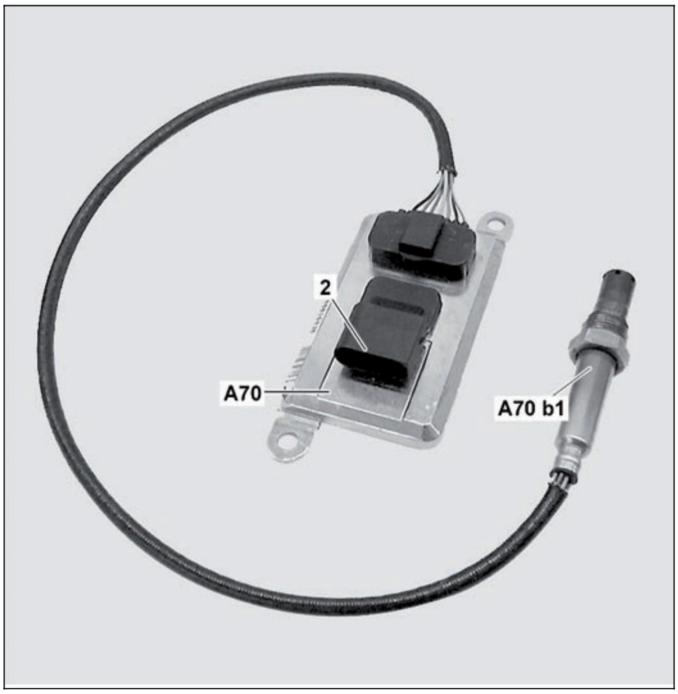
Design

2 Electrical connection

A70 EATU input NOx sensor control unit
A70 b1 EATU input NOx sensor

The EATU input NOx sensor control unit (A70) and the EATU input NOx sensor (A70 b1) are connected to each other via a non-separable electrical line and form one unit.

The EATU input NOx sensor (A70 b1) is similar in design to a wide-band oxygen sensor. It is fitted with its basic elements such as the so-called Nernst cell and the oxygen pump cell.
Its front part in the measuring probe which projects out into the exhaust consists of a metal housing with openings and a gas-permeable ceramic body inside made out of zirconium dioxide.



W14.40-1587-12

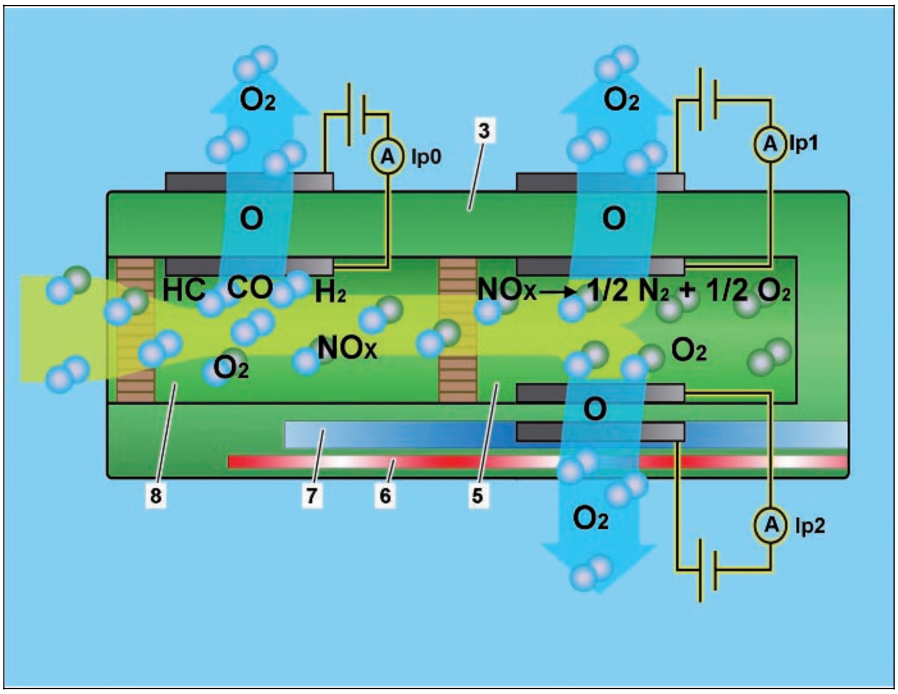
The surfaces of the ceramic body are fitted on both sides with electrodes made out of a thin platinum layer. The measuring probe is in contact with outside air via a reference air duct.
The metal housing protects the ceramic body inside against mechanical stress and sudden increases in temperature.

The EATU input NOx sensor (A70 b1) is fitted with an integral heating element which serves to rapidly achieve the required operating temperature of about 800 °C for the chemical processes taking place therein.
The electrical line between the EATU input NOx sensor (A70 b1) and the EATU input NOx sensor control unit (A70) has a defined length of approx. 60 mm.

Function

3 Measuring probe (ceramic body)
5 Chamber
6 Heating element
7 Reference air duct
8 Chamber

Ip0 Pump current (main pump electrode)
Ip1 Pump current (auxiliary pump electrode)
Ip2 Pump current (measuring electrode)



W14.40-1350-76

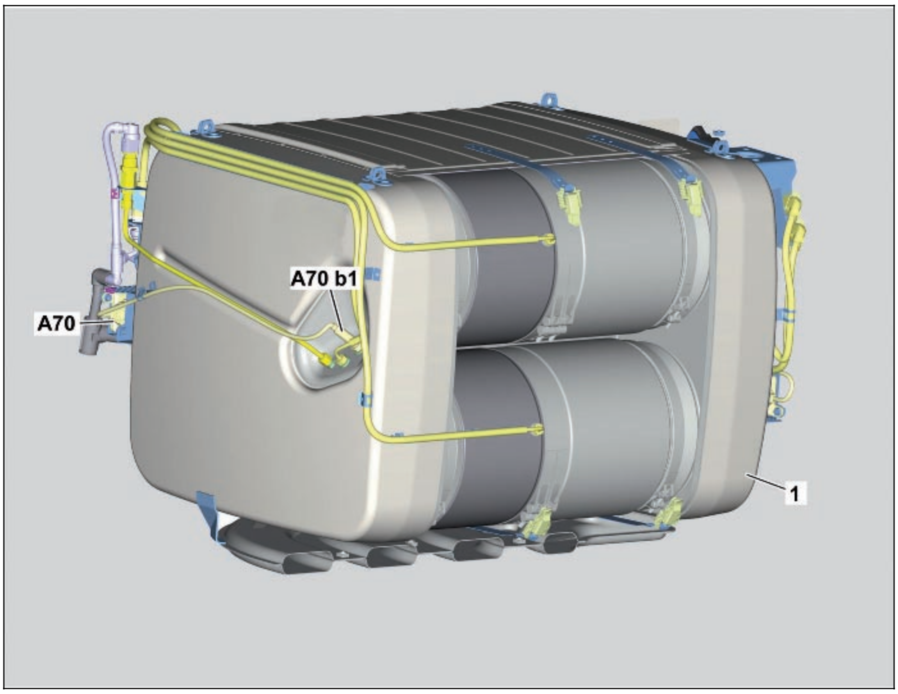
The EATU input NOx sensor (A70 b1) functions according to the principle of the so-called oxygen ions line according to which the wide-band oxygen sensor also functions.
Part of the exhaust flowing past the measuring probe (3) passes through a diffusion barrier into the first chamber (8).
In this case, the O_2 concentration is regulated at a defined value by means of the so-called pump voltage applied to an electrode until the oxygen content differs on either side of the ceramic body.
The special properties of the ceramic body create the signal voltage (Nernst voltage) at its friction planes. This is the measure for the residual oxygen content in the exhaust.
The traces of HC, CO and H_2 in the exhaust oxygenate at the electrode made out of platinum.

The gas then passes over a further diffusion barrier and arrives in the second chamber (5) where it is broken down with the aid of a second NOx electrode into NO and O_2. The O_2 concentration is also regulated to close to zero at the same time with the aid of a further electrode. The nitrous oxide concentration is deduced from the size of the pump current (Ip2) required. The EATU input NOx sensor control unit (A70) is used to compute the required pump voltages, to regulate the complex system and to compute the NOx raw values. It receives the analog signals from the EATU input NOx sensor (A70 b1) and digitizes them. It then forwards them as digital CAN signals to the exhaust aftertreatment (ACM) control unit (A60) at a defined transfer rate, which then evaluates them.

GF49.20-W-3008H	Exhaust aftertreatment unit inlet NOx sensor, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location



W14.40-1582-76

1 Exhaust aftertreatment unit:

A70 Exhaust aftertreatment unit inlet NOx sensor control unit
A70 b1 Exhaust aftertreatment unit inlet NOx sensor

The exhaust aftertreatment unit inlet NOx sensor (A70 b1) is screwed in from the outside in the chamber downstream of the SCR catalytic converter and the ammonia blocking catalytic converter.
The exhaust aftertreatment unit inlet NOx sensor (A70) is attached to a bracket at the exhaust aftertreatment unit (1). Both components form a single unit.

Task

The exhaust aftertreatment unit inlet NOx sensor (A70 b1) represents the actual measuring probe, whereas the exhaust aftertreatment unit inlet NOx sensor control unit (A70) is used to calculate the NOx concentration in the exhaust downstream of the exhaust aftertreatment by the diesel oxidation catalytic converter (DOC), the diesel particulate filter (DPF) and the SCR catalytic converter.

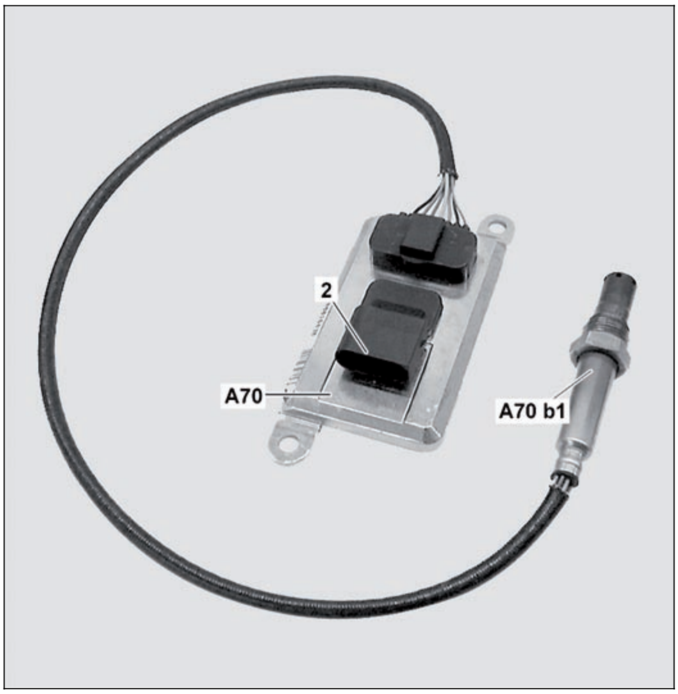
Design

2 *Electrical connection*

A70 *Exhaust aftertreatment unit inlet NOx sensor control unit*
A70 b1 *Exhaust aftertreatment unit inlet NOx sensor*

The exhaust aftertreatment unit inlet NOx sensor control unit (A70) and the exhaust aftertreatment unit inlet NOx sensor (A70 b1) are interconnected via an electrical line that cannot be disconnected, and form a single unit.

The exhaust aftertreatment unit inlet NOx sensor (A70 b1) has a similar design to a wide-band oxygen sensor. It is fitted with its basic elements such as the so-called Nernst cell and the oxygen pump cell.



W14.40-1587-12

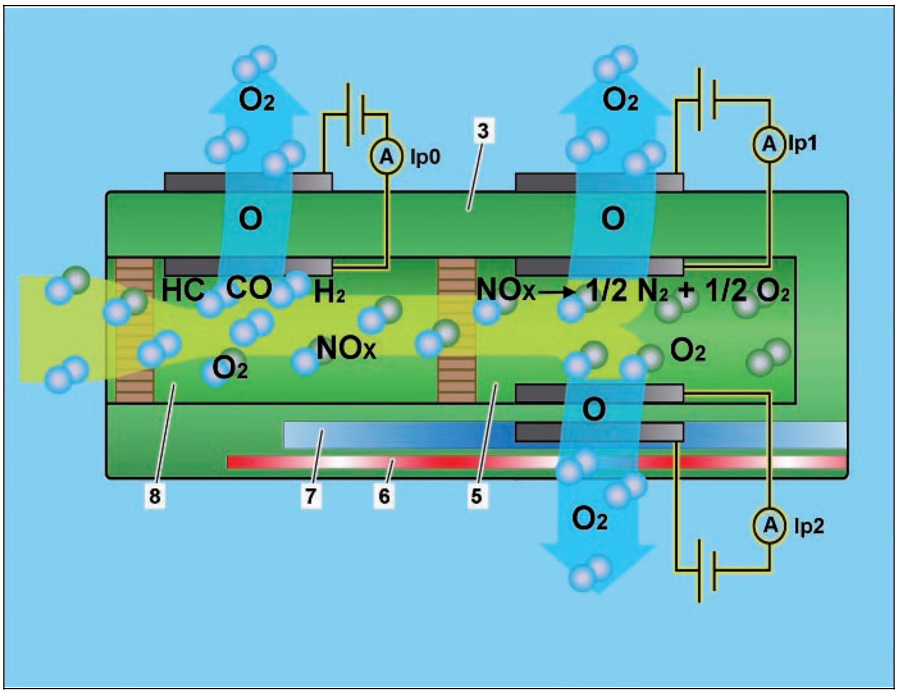
Its front part in the measuring probe which projects out into the exhaust consists of a metal housing with openings and a gas-permeable ceramic body inside made out of zirconium dioxide. The surfaces of the ceramic body are fitted on both sides with electrodes made out of a thin platinum layer. The measuring probe is in contact with outside air via a reference air duct. The metal housing protects the ceramic body inside against mechanical stress and sudden increases in temperature.

The exhaust aftertreatment unit inlet NOx sensor (A70 b1) is fitted with an integral heating element which serves to rapidly achieve the operating temperature of about 800 °C that is required for the chemical processes taking place therein.
The electrical line between the exhaust aftertreatment unit inlet NOx sensor (A70 b1) and the exhaust aftertreatment unit inlet NOx sensor control unit (A70) has a defined length of approx. 60 mm.

Function

3 Measuring probe (ceramic body)
5 Chamber
6 Heating element
7 Reference air duct
8 Chamber

Ip0 Pump current (main pump electrode)
Ip1 Pump current (auxiliary pump electrode)
Ip2 Pump current (measuring electrode)



W14.40-1350-76

The exhaust aftertreatment unit inlet NOx sensor (A70 b1) functions according to the principle of the so-called oxygen ions line according to which the wideband oxygen sensor also functions.
Part of the exhaust flowing past the measuring probe (3) passes through a diffusion barrier into the first chamber (8).
In this case the O_2 concentration is regulated at a defined value by means of the so-called pump voltage applied to an electrode until the oxygen content differs at both sides of the ceramic body.
The special properties of the ceramic body create the signal voltage (Nernst voltage) at its boundary surfaces. This is the measure for the residual oxygen content in the exhaust.
The traces of HC, CO and H_2 in the exhaust oxygenate at the electrode made out of platinum.

The gas then passes over a further diffusion barrier and arrives in the second chamber (5) where it is broken down with the aid of a second NOx electrode into NO and O_2. The O_2 concentration is also regulated to close to zero at the same time with the aid of a further electrode. The nitrous oxide concentration is deduced from the size of the pump current (Ip2) required.
The exhaust aftertreatment unit inlet NOx sensor control unit (A70) serves to compute the required pump voltages, to regulate the complex system and to compute the NOx raw values.It receives the analogue sensor signals and digitizes them. It forwards these as digital CAN signals at a defined transfer rate to the exhaust aftertreatment control unit (ACM) (A60), which then evaluates them.

GF83.70-W-4039H	Auxiliary heater unit, component description	20.7.11

MODEL 963, 964 with CODE (D6M) Cab hot water auxiliary heater
MODEL 963, 964 with CODE (D6N) Cab and engine hot water auxiliary heater

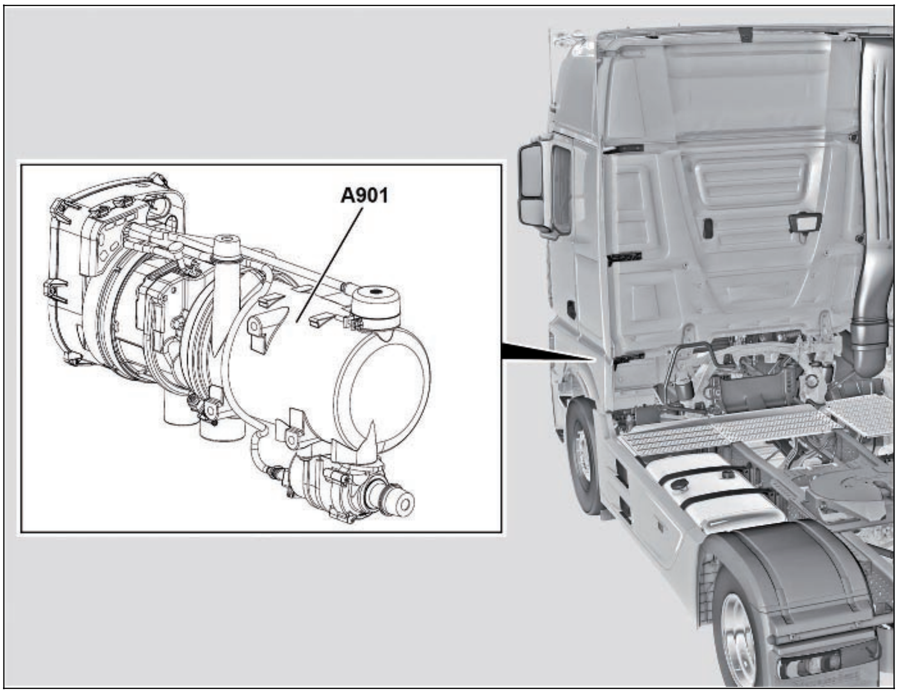
Location

Shown on auxiliary heater, code (D6N) Cab and engine hot water auxiliary heater
A901 Auxiliary water heater unit

The heater (A901) is bolted on behind the left entrance on the cab floor.

Task

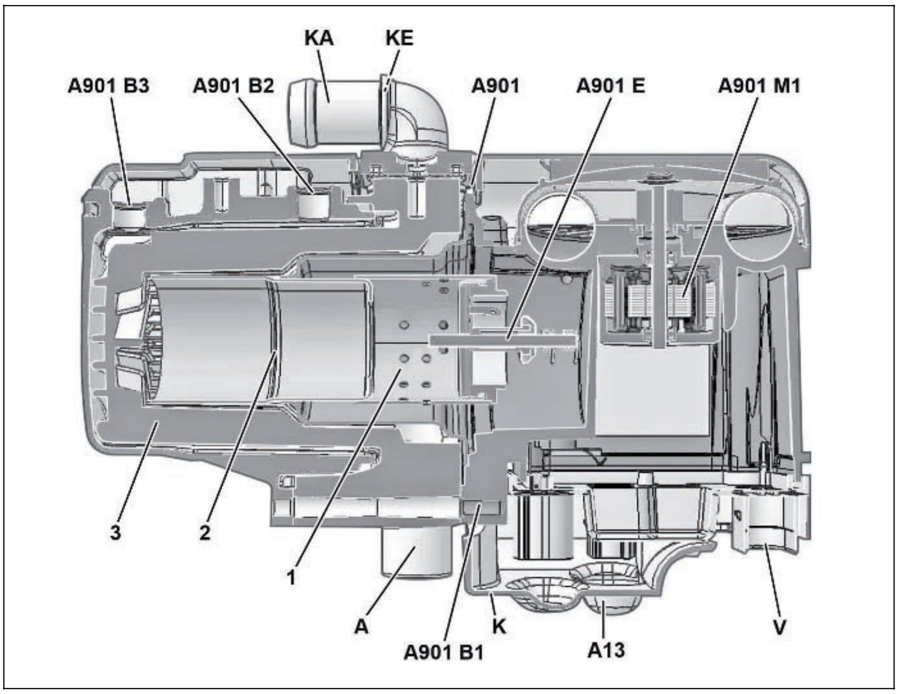
The auxiliary water heater unit (A901) is used for
- preheating,
- continuous heating,
- stationary heating and
- heat boosting.



W83.70-1434-06

Auxiliary heater, code (D6M) Cab hot water auxiliary heater

1	*Burner insert*
2	*Burner tube*
3	*Heat exchanger*
A13	*Truck auxiliary heater (ITH) control unit*
A901	*Auxiliary water heater unit*
A901 B1	*Auxiliary heater exhaust temperature sensor*
A901 B2	*Temperature sensor*
A901 B3	*Overheating protection*
A901 E	*Glow plug*
A901 M1	*Combustion air blower*
A	*Exhaust outlet*
K	*Fuel inlet*
KA	*Coolant outlet*
KE	*Coolant inlet*
V	*Combustion air inlet*

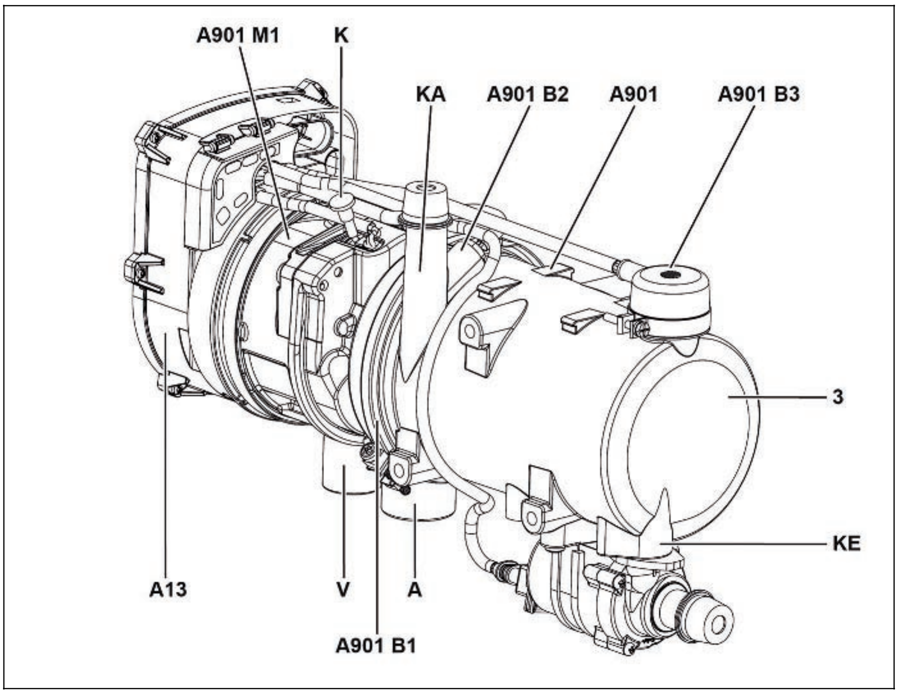


W83.70-1457-06

Auxiliary heater, code (D6N) Cab and engine hot water auxiliary heater

3	*Heat exchanger*
A13	*Truck auxiliary heater (ITH) control unit*
A901	*Auxiliary water heater unit*
A901 B1	*Auxiliary heater exhaust temperature sensor*
A901 B2	*Temperature sensor*
A901 B3	*Overheating protection*
A901 M1	*Combustion air blower*

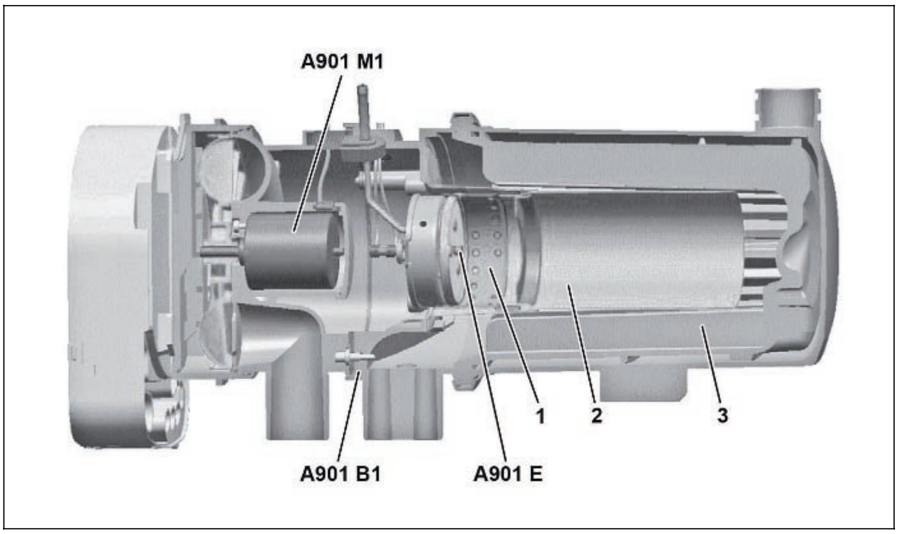
A	*Exhaust outlet*
K	*Fuel inlet*
KA	*Coolant outlet*
KE	*Coolant inlet*
V	*Combustion air inlet*



W83.70-1458-06

Auxiliary heater, code (D6N) Cab and engine hot water auxiliary heater

1	*Burner insert*
2	*Burner tube*
3	*Heat exchanger*
A901 B1	*Auxiliary heater exhaust temperature sensor*
A901 M1	*Combustion air blower*
A901 E	*Glow plug*



W83.70-1459-05

GF83.70-W-4032H	Auxiliary heater coolant circulation pump, component description	20.7.11

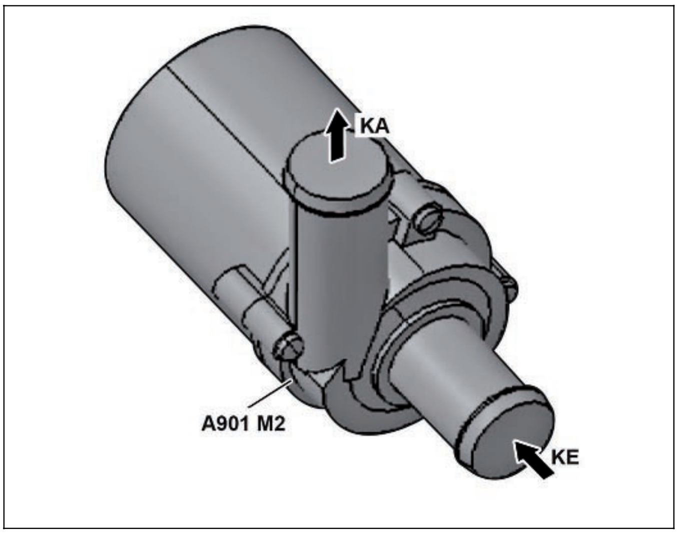
MODEL 963, 964 with CODE (D6M) Cab hot water auxiliary heater
MODEL 963, 964 with CODE (D6N) Cab and engine hot water auxiliary heater

Location

A901 M2 Circulation pump

KA Coolant outlet
KE Coolant inlet

The circulation pump (A901 M2) is connected on the outside to the heater.



W83.70-1436-11

Task

The circulation pump (A901 M2) pumps coolant out of the engine's cooling circuit, through the heater unit's heat exchanger to the heater heat exchanger.

Design

Located in the circulation pump (A901 M2) is a DC motor, which drives an impeller in an external housing. Located on the front side of the circulation pump (A901 M2) is the coolant inlet (KE).

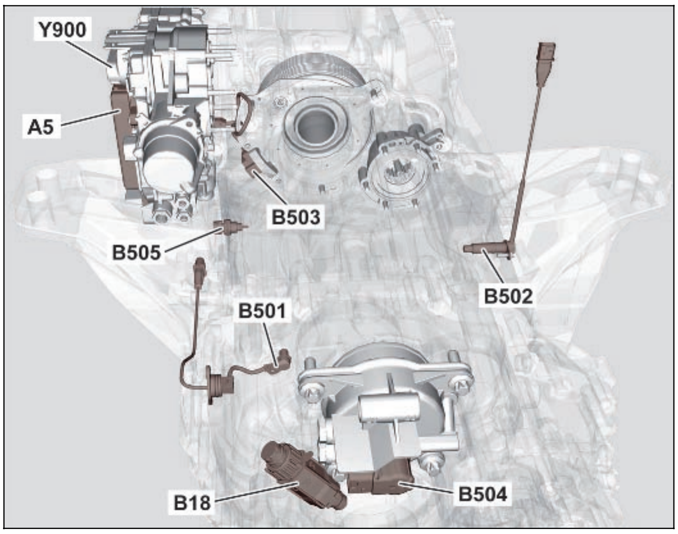
GF26.19-W-3002H	Travel and speed sensor, component description	20.7.11

TRANSMISSION 715 in MODEL 963 with CODE (G5G) Mercedes PowerShift 3
TRANSMISSION 715 in MODEL 964 with CODE (G5G) Mercedes PowerShift 3

Location

B18 Travel and speed sensor

The travel and speed sensor (B18) is screwed into the upper area of the rear transmission cover.



W26.19-1127-81

Task at initialization

- Saves the serial number and the master code.

  [i] When first put into service, the travel and speed sensor (B18) and the tachograph (TCO) (P1) are harmonized, i.e. a common working code is defined.

Tasks while driving

- Registers the rotational speed of the transmission output shaft as an analog voltage signal.
- Transforms the analog voltage signal into a digital realtime signal.
- Checks the realtime signal for irregularities.
- Transfers real-time signal to tachograph (TCO) (P1).
- Receives data and command signals from the tachograph (TCO) (P1) and provides an "I/O" data signal containing cumulated encrypted information.

GF49.20-W-3001H	Exhaust pressure sensor upstream of diesel oxidation catalytic converter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

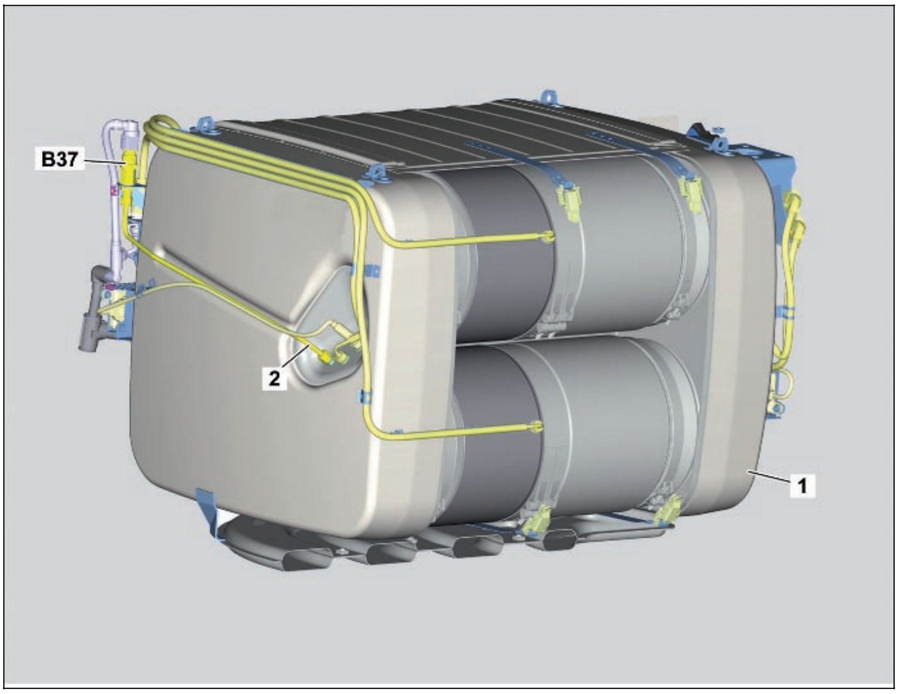
1 Exhaust aftertreatment unit:
2 Pressure line

B37 Exhaust pressure sensor, upstream of diesel oxidation catalytic converter

The exhaust pressure sensor upstream of the diesel oxidation catalytic converter (B37) is screwed into the deflection chamber from the outside, upstream of the diesel oxidation catalytic converter (DOC).

Task

The exhaust pressure sensor upstream of the diesel oxidation catalytic converter (B37) records the pressure at the defined measuring point in the deflection chamber.



W14.40-1577-76

Design

Inside the stainless steel sensor housing there is a basic unit to which two electrodes are attached.
The inner electrode is the measuring electrode, and the outer electrode is the reference electrode. Above this, exposed to the exhaust pressure, there is a pressure-sensitive ceramic membrane - the shared counter-electrode.
Together, this configuration constitutes a plate capacitor. Since the measuring principle is based on the capacity change, which is extremely small, the sensor has processing electronics that are extremely sensitive.

Function

The exhaust flowing past the probe deforms the membrane because of its pressure. The deformation changes the distance between the capacitor plates and therefore the capacity of the capacitor. The integrated circuit converts the capacity change signal into a defined voltage, from which the exhaust aftertreatment control unit (ACM) (A60) calculates the exhaust pressure level.

GF49.20-W-3002H	Exhaust pressure sensor downstream of diesel particulate filter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

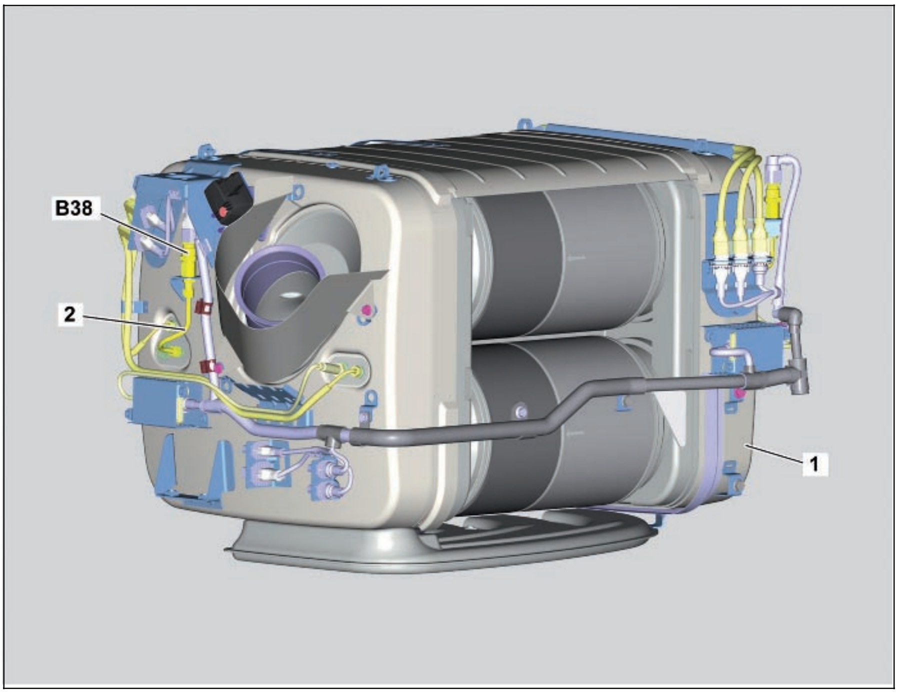
1 Exhaust aftertreatment unit:
2 Pressure line

B38 Exhaust pressure sensor downstream of diesel particulate filter

The exhaust pressure sensor downstream of the diesel particulate filter (B38) is screwed into the deflection chamber from the outside, downstream of the diesel particulate filter (DPF).

Task

The exhaust aftertreatment control unit (ACM) (A60) records the pressure at the defined measuring point in the deflection chamber via the exhaust pressure sensor downstream of the diesel particulate filter (B38).



W14.40-1578-76

Design

Inside the stainless steel sensor housing there is a basic unit to which two electrodes are attached.
The inner electrode is the measuring electrode, and the outer electrode is the reference electrode. Above this, exposed to the exhaust pressure, there is a pressure-sensitive ceramic membrane, the shared counter-electrode.
Together, this configuration constitutes a plate capacitor. Since the measuring principle is based on the capacity change, which is extremely small, the sensor has processing electronics that are extremely sensitive.

Function

The exhaust flowing past the probe deforms the membrane because of its pressure. The deformation changes the distance between the capacitor plates and therefore the capacity of the capacitor. The integrated circuit converts the capacity change signal into a defined voltage, from which the exhaust aftertreatment control unit (ACM) (A60) calculates the exhaust pressure level.

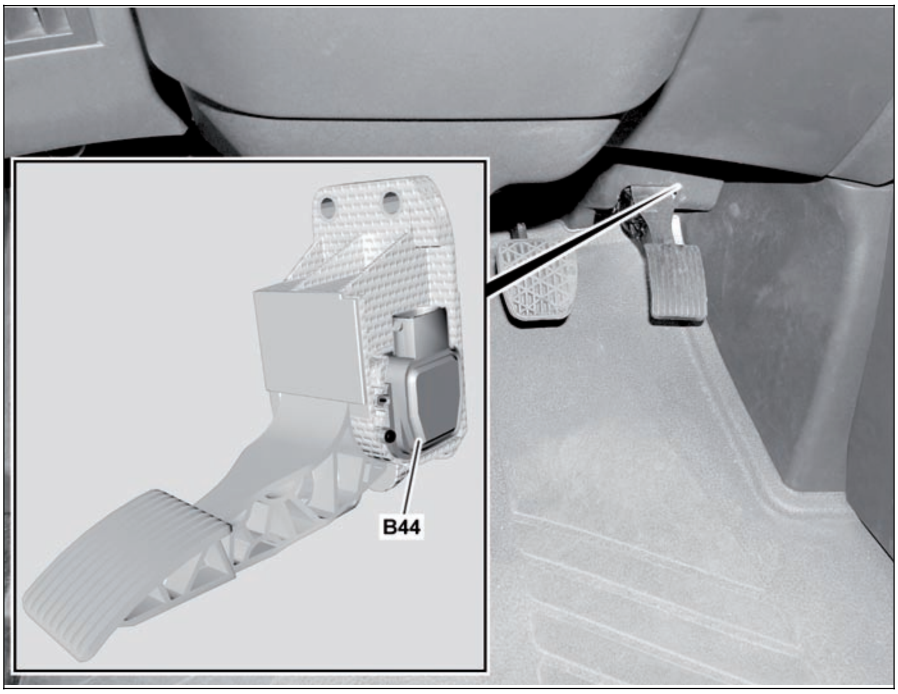
GF30.20-W-2012H	Component description for accelerator pedal sensor	1.7.11

MODEL 963, 964

Location

B44 Accelerator pedal sensor

The accelerator pedal sensor (B44) is located on the accelerator pedal in the driver footwell at the front right.



W30.20-1005-06

Task

The accelerator pedal sensor (B44) detects the accelerator pedal position.

Design

The accelerator pedal sensor (B44) consists of two Hall sensors.

Function

The Hall sensors integrated in the accelerator pedal sensor (B44) transmit a respectively anticyclical signal. In this way perfect position recognition of the accelerator pedal is achieved at any time. This information is read in and appropriately processed by the drive control (CPC) control unit (A3) by means of direct lines as a pulse width modulation signal.

GF49.20-W-3003H	Exhaust temperature sensor upstream of diesel oxidation catalytic converter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

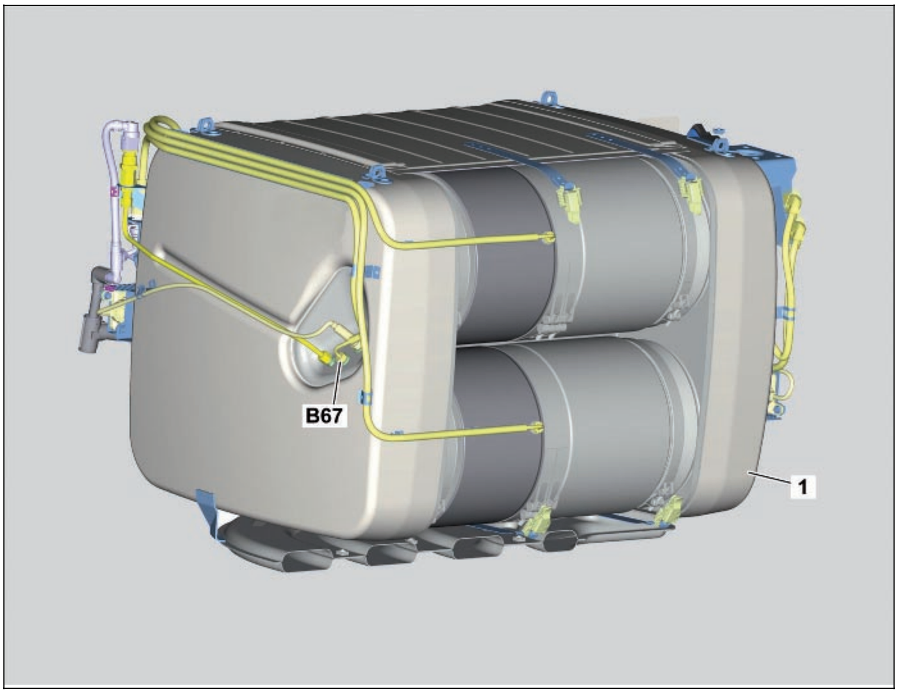
Location

1 Exhaust aftertreatment unit:

B67 Exhaust temperature sensor upstream of diesel oxidation catalytic converter

Task

Via the exhaust temperature sensor upstream of the diesel oxidation catalytic converter (B67), the exhaust aftertreatment control unit (ACM) (A60) records the temperature of the exhaust flow in the deflection chamber upstream of the diesel oxidation catalytic converter (DOC).



W14.40-1579-76

Design

The sensor consists of a stainless steel housing. The housing contains a measuring element, a PTC resistor.PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

Depending on its temperature, the gas flowing past the probe influences the measuring element inside, and makes its electrical resistance change.
Since the sensor has a constant measuring current flowing through it, the resistance change causes a voltage drop, via which the exhaust aftertreatment control unit (ACM) (A60) can work out the associated temperature value.

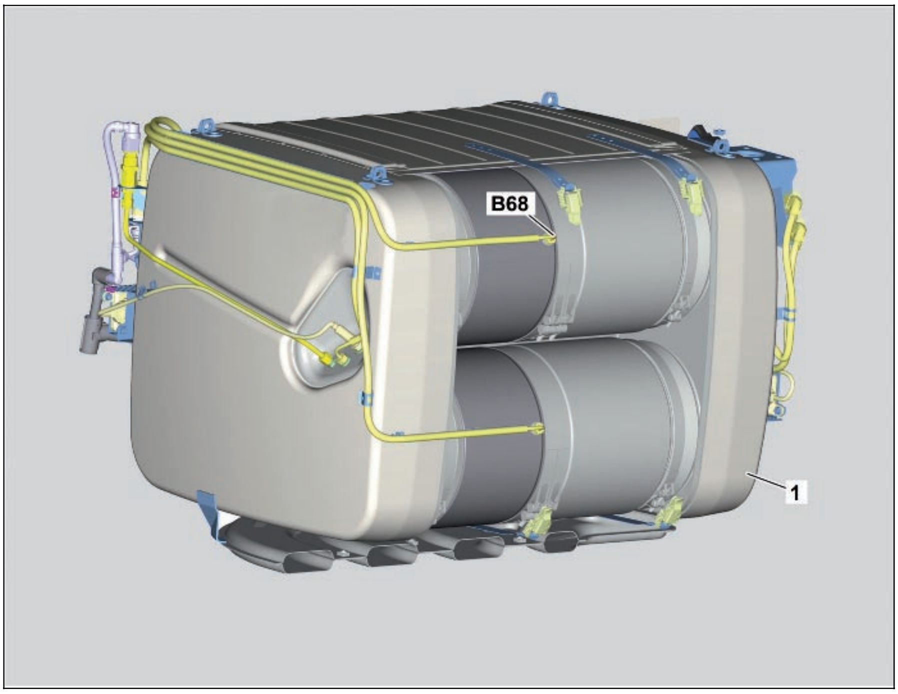
GF49.20-W-3004H	**Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter, component description**	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

1 Exhaust aftertreatment unit:

B68 Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter



W14.40-1580-76

Task

The exhaust aftertreatment control unit (ACM) (A60) records the temperature of the exhaust flow downstream of the upper diesel oxidation catalytic converter (DOC) via the exhaust temperature sensor upstream of the upper diesel oxidation catalytic converter (B68).

Design

The sensor consists of a stainless steel housing. The housing contains a measuring element, a PTC resistor.PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

Depending on its temperature, the gas flowing past the probe influences the measuring element inside, and makes its electrical resistance change.
Since the sensor has a constant measuring current flowing through it, the resistance change causes a voltage drop, via which the exhaust aftertreatment control unit (ACM) (A60) can work out the associated temperature value.

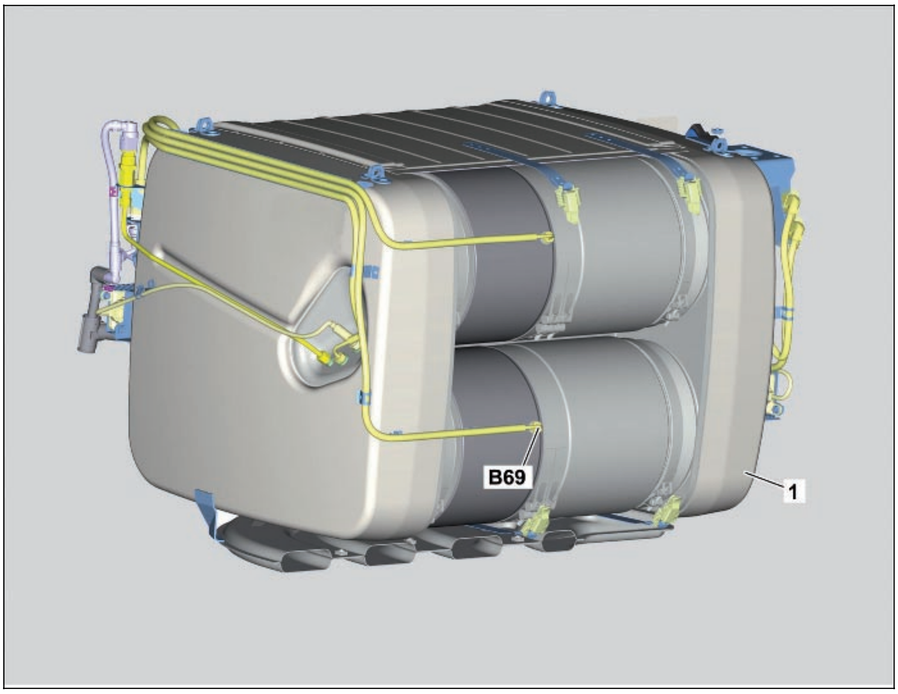
GF49.20-W-3005H	Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964

Location

1 *Exhaust aftertreatment unit:*

B69 *Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*



W14.40-1581-76

Task

The exhaust aftertreatment control unit (ACM) (A60) records the temperature of the exhaust flow downstream of the lower diesel oxidation catalytic converter (DOC) via the exhaust temperature sensor upstream of the lower diesel oxidation catalytic converter (B69).

Design

The sensor consists of a stainless steel housing. The housing contains a measuring element, a PTC resistor.PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

Depending on its temperature, the gas flowing past the probe influences the measuring element inside, and makes its electrical resistance change.
Since the sensor has a constant measuring current flowing through it, the resistance change causes a voltage drop, via which the exhaust aftertreatment control unit (ACM) (A60) can work out the associated temperature value.

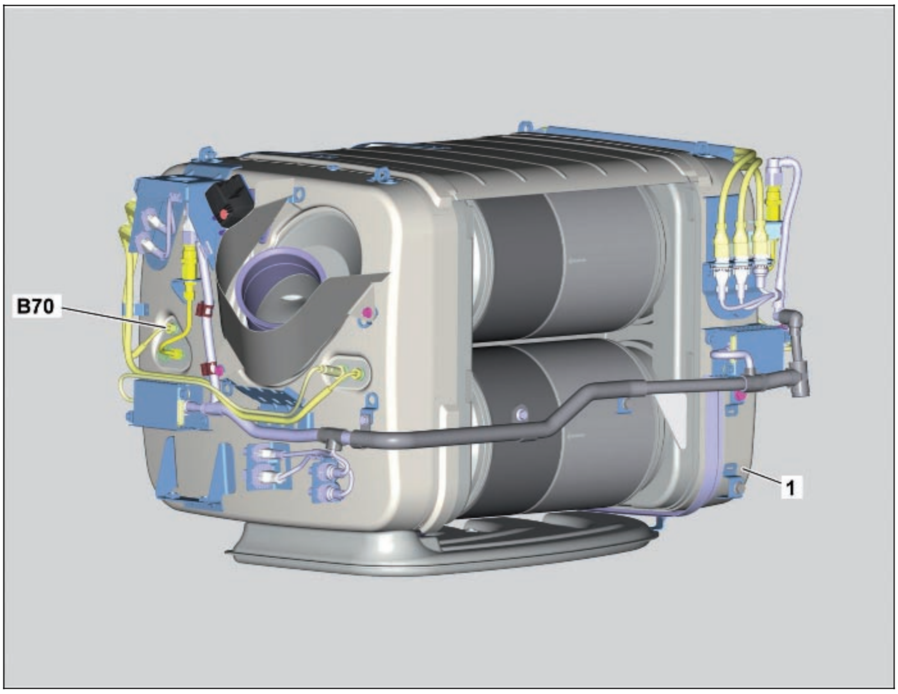
GF49.20-W-3006H	Exhaust temperature sensor downstream of diesel particulate filter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

1 *Exhaust aftertreatment unit:*

B70 *Exhaust temperature sensor downstream of diesel particulate filter*



W14.40-1583-76

Task

The exhaust aftertreatment control unit (ACM) (A60) records the temperature of the exhaust flow downstream in the deflection chamber downstream of the diesel particulate filter (DPF) via the exhaust temperature sensor downstream of the diesel particulate filter (B70).

Design

The sensor consists of a stainless steel housing. The housing contains a measuring element, a PTC resistor.PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

Depending on its temperature, the gas flowing past the probe influences the measuring element inside, and makes its electrical resistance change.
Since the sensor has a constant measuring current flowing through it, the resistance change causes a voltage drop, via which the exhaust aftertreatment control unit (ACM) (A60) can work out the associated temperature value.

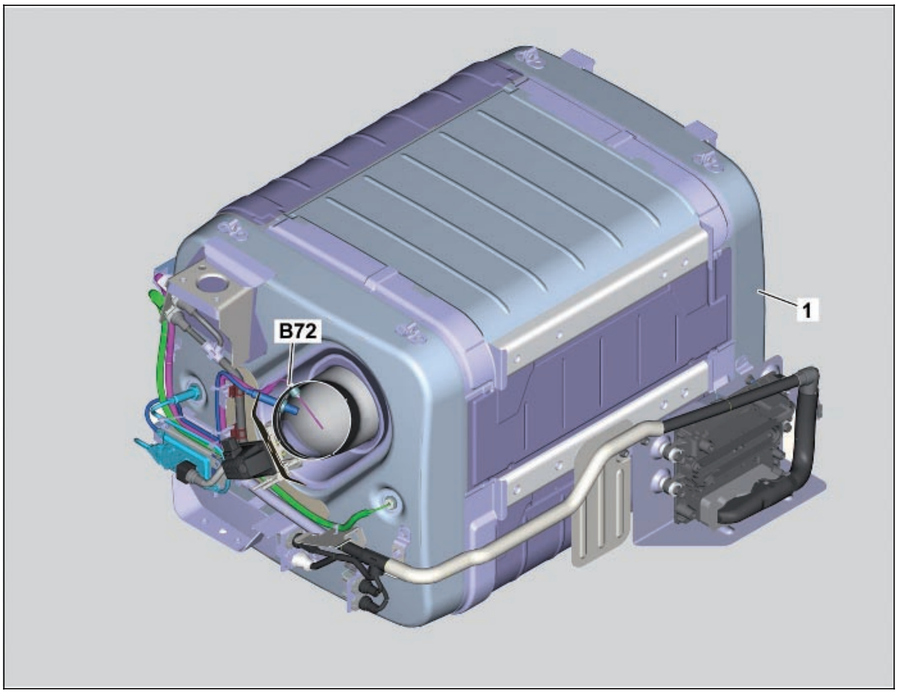
GF49.20-W-3013HA	Exhaust temperature sensor upstream of SCR catalytic converter, component description	2.8.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

1 Exhaust aftertreatment unit

B72 Exhaust temperature sensor upstream of SCR catalytic converter



W14.40-1593-76

Task

The exhaust aftertreatment (ACM) control unit (A60) registers the temperature of the exhaust flow in the inlet tube of the exhaust aftertreatment unit (1) via the temperature sensor exhaust upstream of the SCR catalytic converter (B72).

Design

The exhaust temperature sensor upstream of SCR catalytic converter (B72) consists of a stainless steel housing. The inside contains a measuring element, a PTC resistor. PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

The exhaust blowing by the sensor influences the measuring element on the inside depending on its temperature and leads to a change in its electric resistance.
Since a constant measurement current flows through the exhaust temperature sensor upstream of SCR catalytic converter (B72), there is a voltage drop due to the change in resistance, which the exhaust aftertreatment (ACM) control unit (A60) can use to derive the associated temperature value.

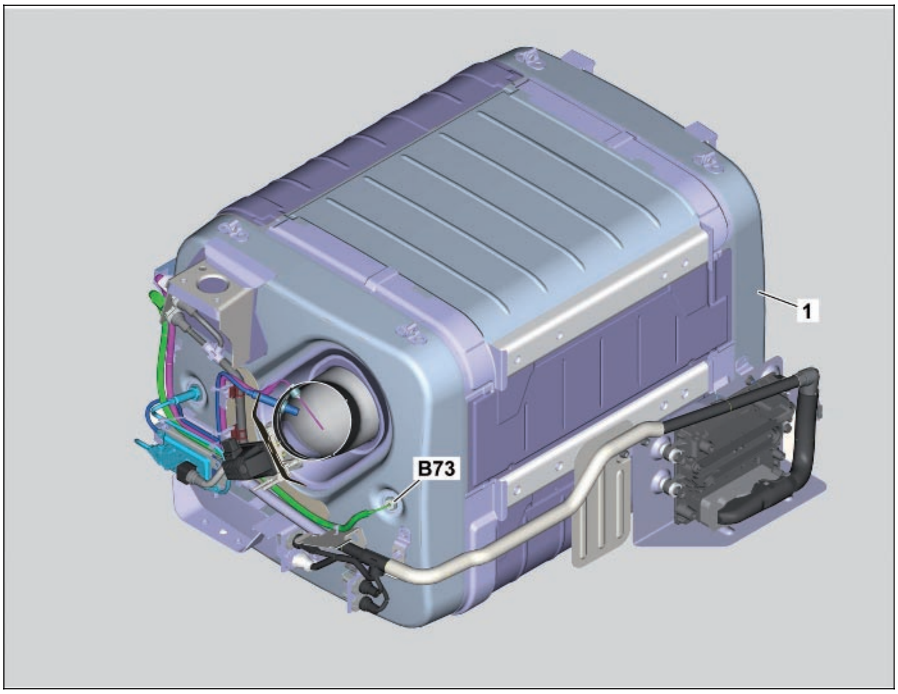
GF49.20-W-3007HA	**Exhaust temperature sensor downstream of SCR catalytic converter, component description**	**2.8.11**

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

1 *Exhaust aftertreatment unit*

B73 *Exhaust temperature sensor downstream of SCR catalytic converter*



W14.40-1594-76

Task

The exhaust aftertreatment (ACM) control unit (A60) registers the temperature of the exhaust flow in the chamber downstream of the SCR catalytic converter via the exhaust temperature sensor downstream of SCR catalytic converter (B73).

Design

The exhaust temperature sensor downstream of SCR catalytic converter (B73) consists of a stainless steel housing. The inside contains a measuring element, a PTC resistor. PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

The exhaust blowing by the sensor influences the measuring element on the inside depending on its temperature and leads to a change in its electric resistance.
Since a constant measurement current flows through the exhaust temperature sensor downstream of SCR catalytic converter (B73), there is a voltage drop due to the change in resistance, which the exhaust aftertreatment (ACM) control unit (A60) can use to derive the associated temperature value.

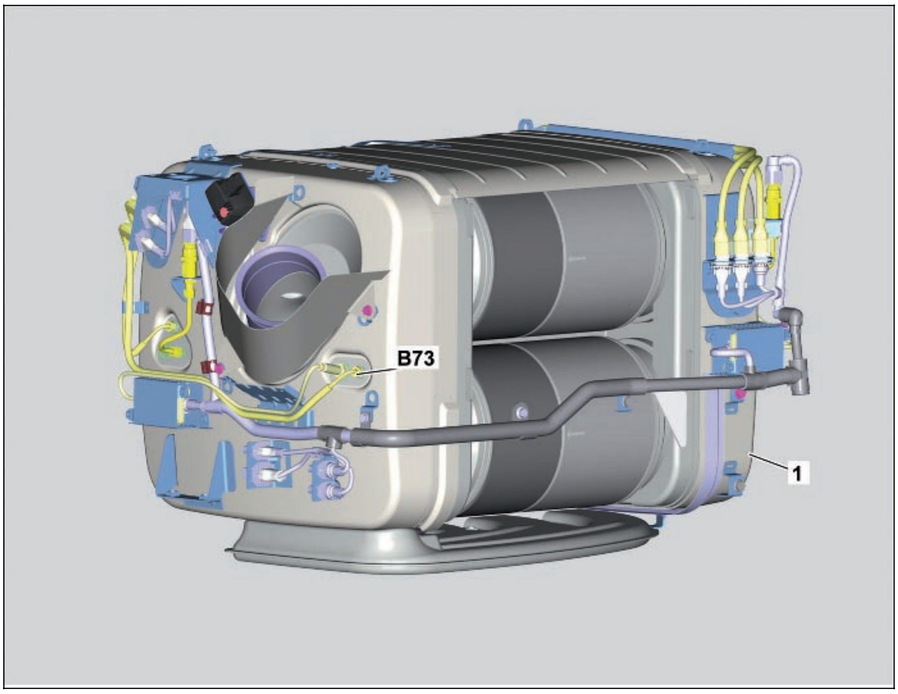
GF49.20-W-3007H	Exhaust temperature sensor downstream of SCR catalytic converter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

1 *Exhaust aftertreatment unit:*

B73 *Exhaust temperature sensor downstream of SCR catalytic converter*



W14.40-1584-76

Task

The exhaust aftertreatment control unit (ACM) (A60) records the temperature of the exhaust flow in the chamber downstream of the SCR catalytic converter via the exhaust temperature sensor downstream of the SCR catalytic converter (B73).

Design

The sensor consists of a stainless steel housing. The housing contains a measuring element, a PTC resistor.PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as the temperature increases.

Function

Depending on its temperature, the gas flowing past the probe influences the measuring element inside, and makes its electrical resistance change.
Since the sensor has a constant measuring current flowing through it, the resistance change causes a voltage drop, via which the exhaust aftertreatment control unit (ACM) (A60) can work out the associated temperature value.

GF14.40-W-3026H	AdBlue® fill level sensor/temperature sensor, component description	20.7.11

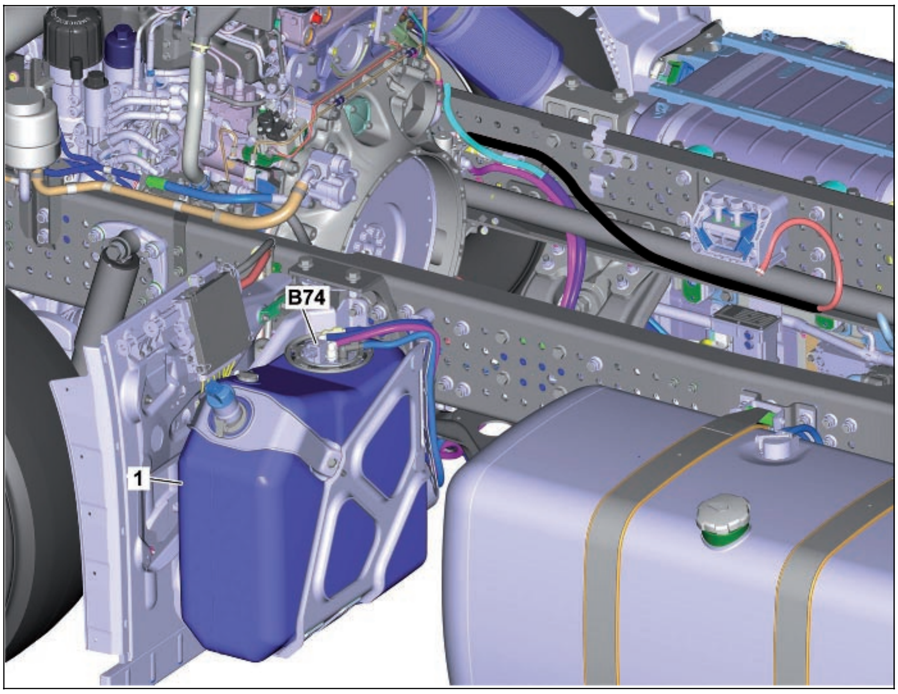
ENGINE 471.9 in MODEL 963, 964

Location

Shown on model 963 with code (M5Z)
Engine version Euro VI

1 AdBlue® tank

B74 AdBlue® fill level sensor/temperature sensor



W14.40-1563-76

The AdBlue® fill level sensor/temperature sensor (B74) is screwed in from the outside into the AdBlue® container (1). This is generally located on the left longitudinal frame member.

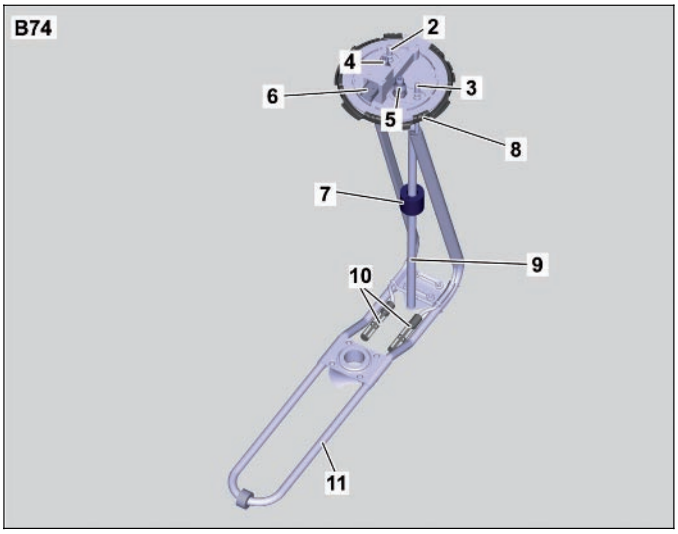
Task

The AdBlue® fill level sensor/temperature sensor (B74) records the fluid level and the temperature of the AdBlue® supply in the AdBlue® container (1).

Design

2 AdBlue® inlet (return from AdBlue® metering device)
3 AdBlue® outlet (feed line to pump module)
4 Coolant outlet (to pump module)
5 Coolant inlet (from engine)
6 Electrical connection
7 Float
8 Bayonet ring
9 Immersion tube
10 AdBlue® filter
11 Coolant duct

B74 AdBlue® fill level sensor/temperature sensor



W14.40-1571-81

The AdBlue® fill level sensor/temperature sensor (B74) contains separate components for determining the fill level and the temperature.

Fill level sensor
The fill level is determined with the aid of the immersion tube (9) with integrated resistance measuring chain made of so-called reed contacts and a float (7), which contains permanent magnets.

Temperature sensor
For the temperature measurement a measuring element based on the NTC resistance (Negative Temperature Coefficient) is located at the lower end of the immersion tube (9).

Function

Determination of the fill level
The sensor to determine the fill level functions according to the float principle with magnetic transfer. A ring magnet fitted in the float (7) actuates tiny reed contacts via its magnetic field through the wall of the immersion tube (9). These reed contacts pick up an uninterrupted measured voltage at a resistor data channel (voltage divider principle), which is proportional to the height of the fill level.
The values of the electrical resistance that changes along with the position of the float (7) are transmitted in defined intervals as an analog signal over the exhaust aftertreatment (ACM) control unit (A60) to the engine management (MCM) control unit (A4). Using the resistance value, this calculates the associated fill level.

Determination of temperature
The AdBlue surrounding the AdBlue® fill level sensor/temperature sensor (B74) influences the inside of the measuring element according to its temperature and therefore the size of the electrical resistance.
The values of the electrical resistance that changes are transmitted in defined intervals as an analog signal over the exhaust aftertreatment (ACM) control unit (A60) to the engine management (MCM) control unit (A4). Based on the resistance value, the MR control unit calculates the associated temperature.

GF20.30-W-1002H	Coolant pressure control sensor, component description	20.7.11

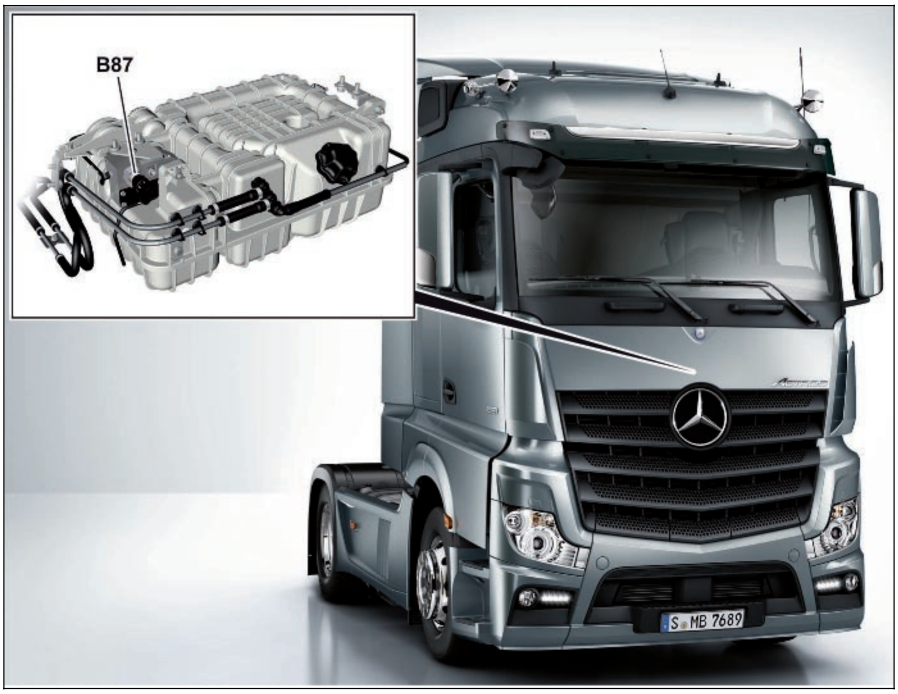
MODEL 963, 964 with CODE (B3H) Secondary water retarder

Location

Shown on model 963, front coolant expansion reservoir

B87 Coolant pressure control sensor

The coolant pressure control sensor (B87) is located on the coolant expansion reservoir.



W20.30-1027-76

Task

The coolant pressure control sensor (B87) monitors the pressure in the coolant circuit. The signals from the coolant pressure control sensor (B87) are read in directly by the drive control (CPC) control unit (A3). The drive control (CPC) control unit (A3) uses them to calculate the set values for the coolant pressure control solenoid valve (Y57).

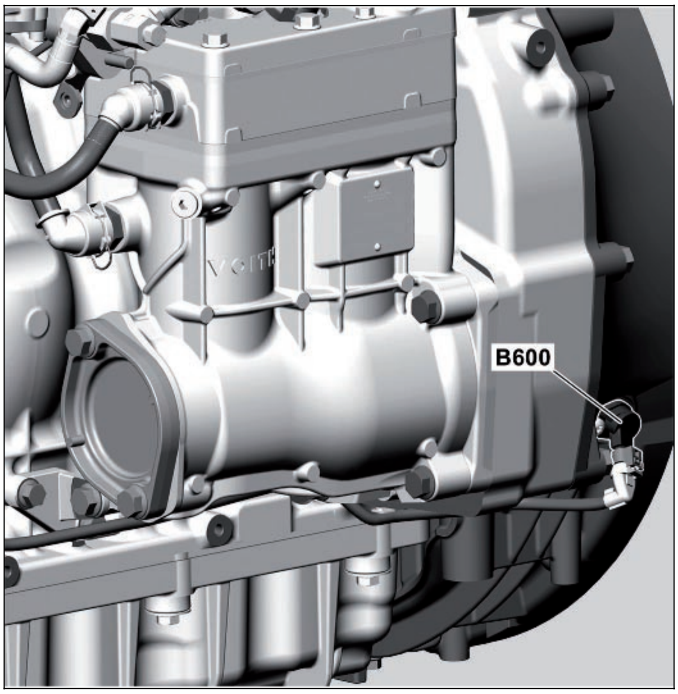
GF03.20-W-4100H	Component description for crankshaft position sensor	20.7.11

ENGINES 471.9 in MODEL 963

Location

B600 Crankshaft position sensor

The crankshaft position sensor (B600) is located on the left on the timing case.



W07.04-1073-12

Task

The crankshaft position sensor (B600) makes electrical voltage signals available to the engine management (MCM) control unit (A4) for a rotating engine from which the rotational speed as well as the position of the crankshaft can be determined.

Design

The crankshaft position sensor (B600) is an inductive sensor and is fitted with a sensor coil as well as a permanent magnet.

Function

The permanent magnet on the camshaft position sensor (B600) generates a magnetic field. Once the flywheel is rotated, magnetic field fluctuations occur due to grooves in the flywheel which are located, up to a gap of 18°, 6° apart around the flywheel circumference. Inductive voltage signals are generated in this way in the crankshaft position sensor coil (B600) with the aid of which the engine management (MCM) control unit (A4) can determine the engine speed and, by using the gap of 18°, the angular position of the crankshaft.

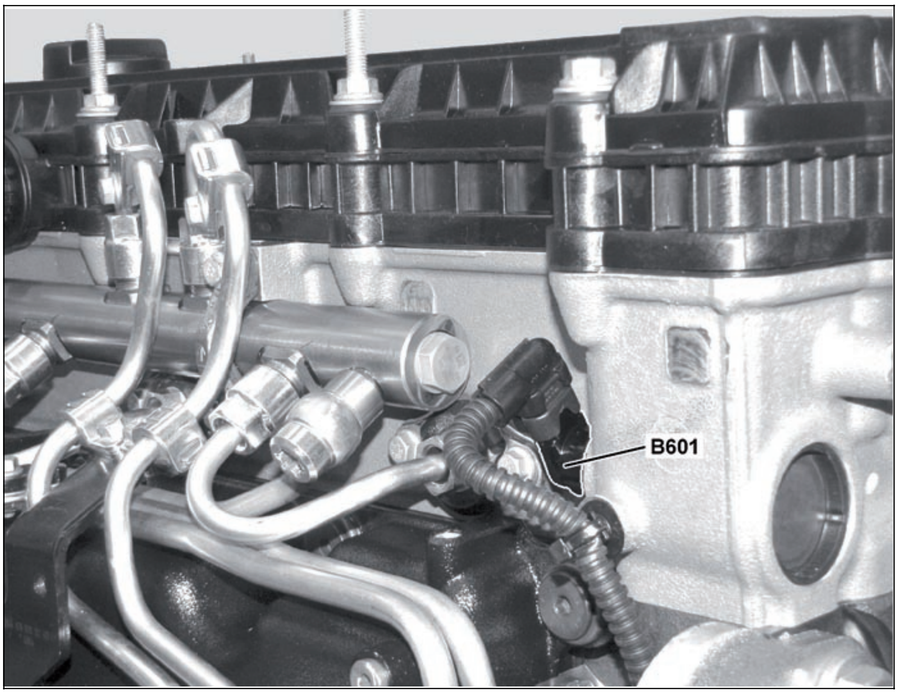
GF05.20-W-4105H	Component description for camshaft position sensor	20.7.11

ENGINES 471.9 in MODEL 963

Location

B601 Camshaft position sensor

The camshaft position sensor (B601) is located on the camshaft frame at the height of cylinder 6 next to the rail.



W05.20-1035-06

Task

The camshaft position sensor (B601) makes a switching signal available to the engine management (MCM) control unit (A4) for rotating engine from which the compression cycle of cylinder 1 and, as required (in limp-home mode, in case of failure of the crankshaft position sensor), the engine speed or crankshaft position can be determined.

Design

The camshaft position sensor (B601) is a Hall sensor and is fitted with a permanent magnet as well as an electronic analysis system.

Function

The permanent magnet on the camshaft position sensor (B601) generates a magnetic field. When the camshaft rotates, fluctuations in the magnetic field occur due to the grooves in the camshaft sprocket. These changes in the magnetic field are converted by the electronic analysis system in the camshaft position sensor (B601) into shift signals and passed on to the engine management (MCM) control unit (A4).

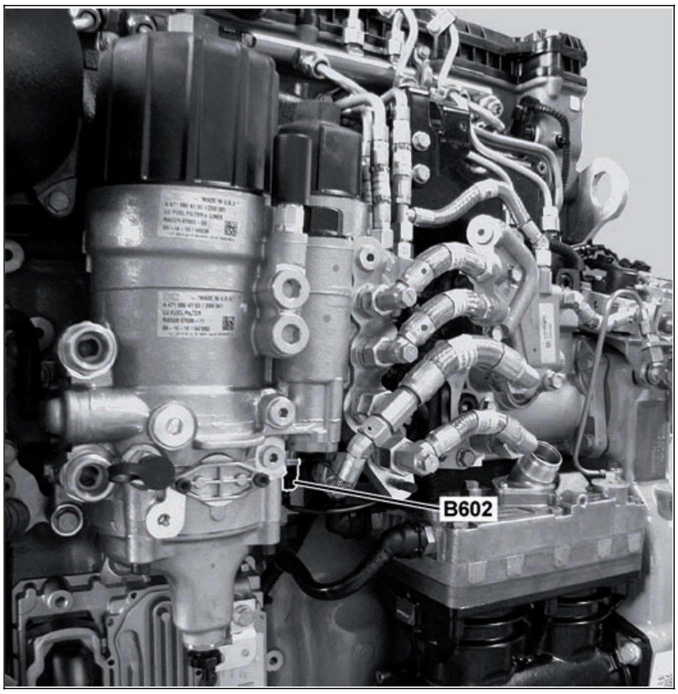
GF47.50-W-4100H	Component description for fuel temperature sensor	20.7.11

ENGINES 471.9 in MODEL 963

Location

B602 Fuel temperature sensor

The fuel temperature sensor (B602) is on the left-hand side of the crankcase, next to the fuel filter module.



W47.50-1010-12

Task

The engine management control unit (MCM) (A4) records the fuel temperature via the fuel temperature sensor (B602).

Design

There is an NTC resistor inside the fuel temperature sensor (B602). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

The fuel at the fuel temperature sensor (B602) influences the temperature measuring element inside the sensor depending on its temperature and thus the size of the electrical resistance. The engine management control unit (MCM) (A4) derives the associated temperature from the electrical resistance.

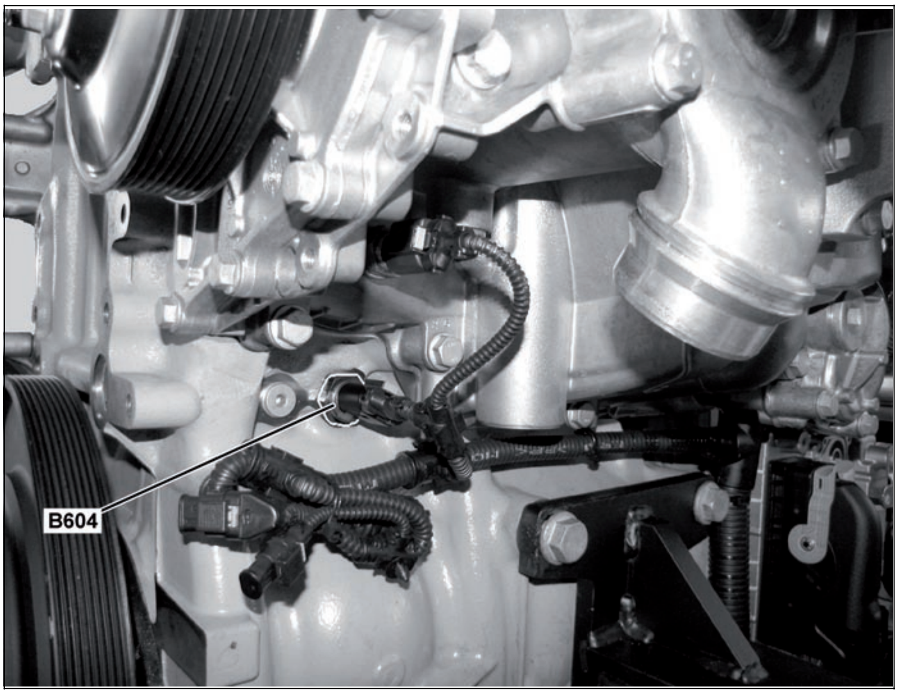
GF18.40-W-2010H	Oil pressure sensor, description of components	20.7.11

ENGINE 471.9 in MODEL 963

Location

B604 Oil pressure sensor

The oil pressure sensor (B604) is screwed on below the coolant pump into the crankcase.



W18.40-1034-06

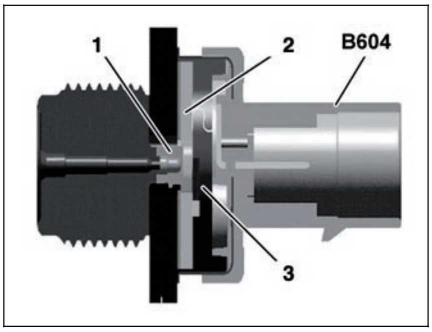
Task

The oil pressure sensor (B604) enables the engine management (MCM) control unit (A4) to determine the current engine oil pressure.

Design

1 Sensor element
2 Sensor membrane
3 Hybrid element

B604 Oil pressure sensor



W18.40-1029-01

Function

The engine oil pressure operates on the sensor element (1) of the hybrid element (3) and distorts the sensor membrane (2).
There are four pressure-dependent resistances (strain measuring resistors) on the sensor membrane (2). Its bridge circuit is supplied with voltage by an electronic analysis system which also serves for signal amplification and signal correction. The electronic analysis system is powered by the engine management (MCM) control unit (A4) with 5 V direct voltage.
The resistors in the sensor membrane (2) are arranged in such a way that on deforming the sensor membrane (2) two resistors are clinched and two resistors elongated.
Contraction and elongation changes the electrical resistance of the resistors which in turn has effects upon the measurement voltage, which is being applied to the electronic analysis system. The electronic analysis system amplifies the measurement voltage, compensating for possible temperature fluctuations or balancing out possible manufacturing tolerances on the resistances and passes on the cleared out measurement voltage to the engine management (MCM) control unit (A4) which uses it to derive the current engine oil pressure.

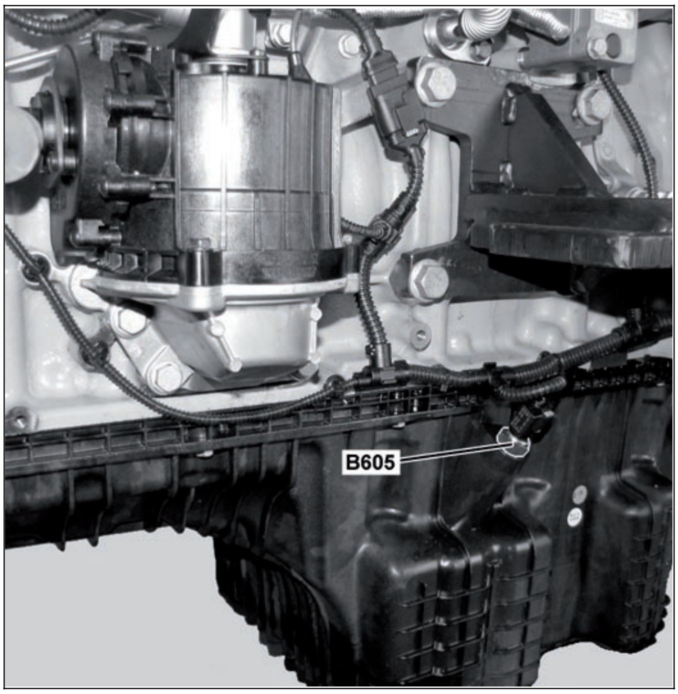
GF18.40-W-4117H	Component description for engine oil fill level sensor	20.7.11

ENGINE 471.9 in MODEL 963

Location

B605 Engine oil fill level sensor

The engine oil fill level sensor (B605) is located onto the right side of the engine and screwed into the oil pan from above.



W18.40-1033-12

Task

The engine oil fill level sensor (B605) enables the engine management (MCM) control unit (A4) to determine the instantaneous fill level as well as the engine oil temperature in the oil pan.

Design

Located inside the engine oil fill level sensor (B605) is a series resistor and resistance wire, which are connected in parallel to each other, as well as an NTC resistor, which is connected before them in series. NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

The resistance wire is located in the measuring probe.
The engine oil fill level sensor (B605) is installed in such a way that the measuring probe dips fully into the engine oil when the engine oil level is correct.
The NTC resistor is located at the tip of the sensor.

Function

Determine engine oil level
Engine oil passes via a feed hole into the measuring probe of the engine oil fill level sensor (B605) and thus directly to the resistance wire.
Depending on how far the resistance wire dips into the engine oil the overall resistance at the engine oil fill level sensor (B605) changes and drops with a reducing engine oil level.

After switching on of the ignition, the engine management (MCM) control unit (A4) applies a measurement voltage every 6 s to the engine oil fill level sensor (B605). It checks the electrical overall resistance of the engine oil fill level sensor (B605) and uses it to deduce the current engine oil level in the oil pan.

Measurement of engine oil temperature
The engine oil at the engine oil fill level sensor (B605) influences the temperature measuring element inside the sensor depending on its temperature and therefore the electrical resistance value. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

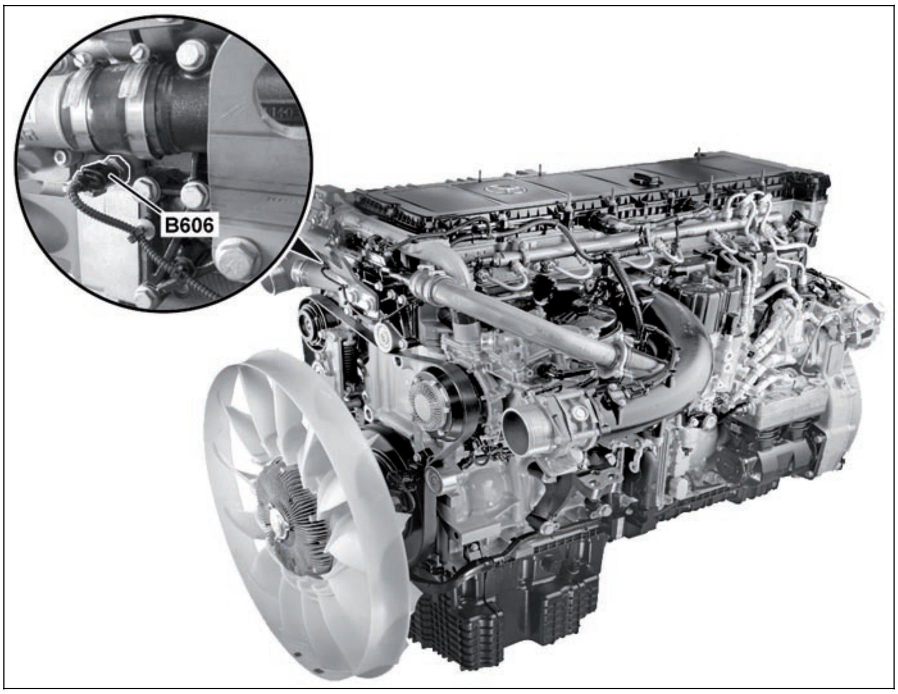
GF20.00-W-4100H	Component description for exhaust coolant temperature sensor	20.7.11

ENGINE 471.9 in MODEL 963

Location

B606 *Exhaust coolant temperature sensor*

The exhaust coolant temperature sensor (B606) is located on the front side of the coolant manifold which is on the right side of engine between the cylinder head and the exhaust gas recirculation cooler.



W07.04-1078-06

Task

The coolant outlet temperature sensor (B606) enables the engine management (MCM) control unit (A4) to determine the current coolant temperature at the engine outlet.

Design

There is an NTC resistor inside the exhaust coolant temperature sensor (B606). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

The coolant at the exhaust coolant temperature sensor (B606) influences the temperature measuring element inside the sensor depending on its temperature and thus the size of the electrical resistance. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

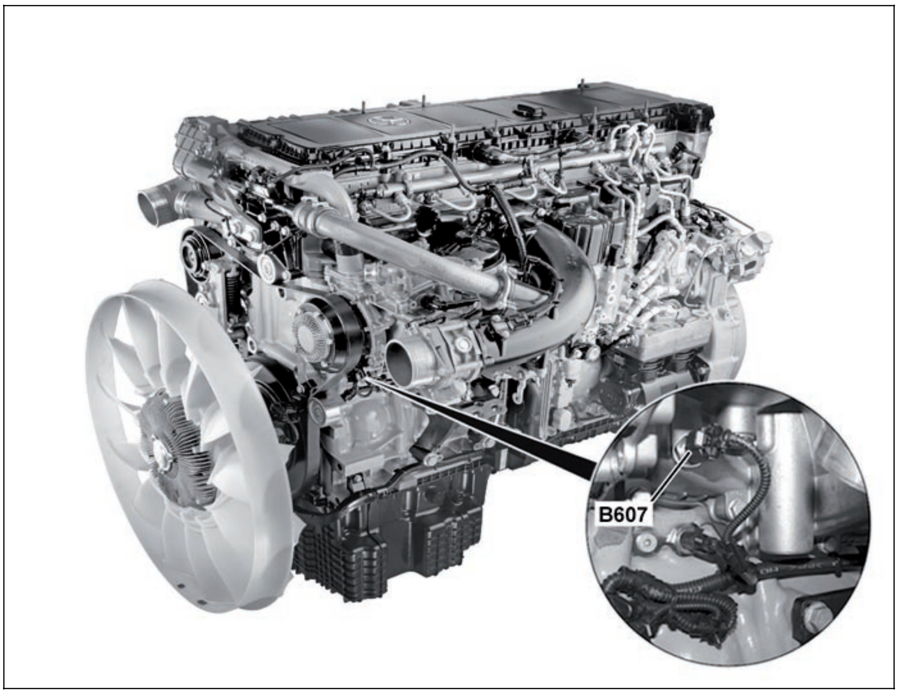
GF20.00-W-4110H	Component description for intake coolant temperature sensor	20.7.11

ENGINE 471.9 in MODEL 963

Location

Shown with code (M5Z) Euro VI engine version
B607 Intake coolant temperature sensor

The intake coolant temperature sensor (B607) is located under the coolant pump on the oil/coolant module.



W20.00-1052-06

Task

The coolant inlet temperature sensor (B607) enables the engine management (MCM) control unit (A4) to determine the current coolant temperature downstream of the coolant pump.

Design

There is an NTC resistor inside the intake coolant temperature sensor (B607). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

The coolant at the intake coolant temperature sensor (B607) influences the temperature measuring element inside the sensor depending on its temperature and thus the size of the electrical resistance. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

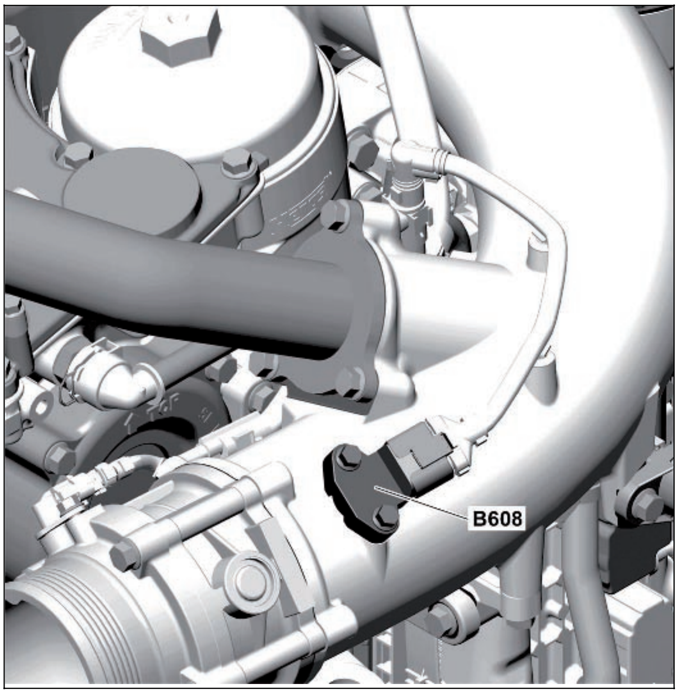
GF09.41-W-4130H	Charge air pressure and temperature sensor in charge air pipe, component description	20.7.11

ENGINE 471.9 in MODEL 963

Location

B608 Charge air pressure and temperature sensor in charge air pipe

The charge air pressure and temperature sensor in the charge air pipe (B608) is located on the charge air pipe on the left side of the engine.



W07.04-1072-12

Task

The charge air pressure and temperature sensor in the charge air pipe (B608) enables the engine management (MCM) control unit (A4) to determine the air pressure and the air temperature of the aspirated or supercharged combustion air.
These two values and the values of the differential pressure sensor exhaust gas recirculation (EGR) (B621), the charge air temperature sensor in the charge air housing (B617), as well as the values of the temperature sensor downstream of the air filter (B611) with code (M5Z) Euro VI engine version, are used to deduce the air mass that is routed to the engine for combustion.

Design

The charge air pressure and temperature sensor (B608) consists of two electrically separate components for measuring the boost pressure and the charge air temperature.

Pressure sensor for determining the charge air temperature
The pressure sensor is a so-called semiconductor pressure sensor which detects the air pressure in the charge air pipe by means of the piezoelectric principle. This consists of four pressure-dependent resistors (strain measuring resistors) which are arranged in a silicon membrane as well as an electronic analysis system which is supplied with a 5 V DC voltage via the engine management (MCM) control unit (A4).

Temperature sensor for measurement of the charge air temperature
There is an NTC resistor at the cone point of the charge air pressure and temperature sensor in the charge air pipe (B608). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

Determining the boost pressure
The intake air or supercharged combustion air in the charge air housing passes over a bore in the silicon diaphragm with the four pressure-dependent resistors and distorts it.
The resistors in the silicon membrane are arranged in such a way that, on deformation of the membrane, the transverse stress of the resistance bridge is altered.
The electronic analysis system amplifies this transverse stress and compensates in this way for possible temperature fluctuations or compensates for any manufacturing tolerances of the resistors. It subsequently routes the filtered measurement voltage to the engine management (MCM) control unit (A4) which then deduces the air pressure in the charge air housing.

Measuring the charge air temperature
Depending on its temperature, the air flowing by influences the temperature of the measuring element on the tip of the sensor and therefore the electrical resistance value. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

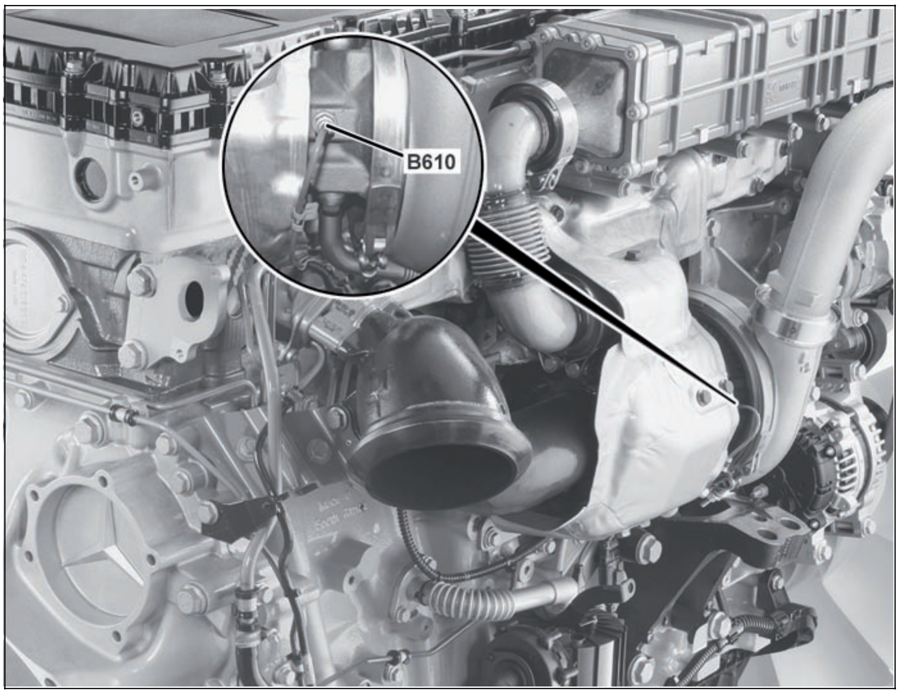
GF09.40-W-4050H	Component description for turbine wheel rpm sensor	1.7.11

ENGINES 471.9 in MODEL 963 with CODE (M5Z) Engine version Euro VI

Location

B610 Turbine wheel rpm sensor

The turbine wheel rpm sensor (B610) is located in the center of the turbocharger.



W09.40-1229-06

Task

The engine management (MCM) control unit (A4) detects the rotor speed of the turbocharger over the turbine wheel rpm sensor (B610).
The rotor speed is used to protect the turbocharger from running at excessively high rotational speeds.

Design

The turbine wheel rpm sensor (B610) is an inductive sensor and possesses a permanent magnet as well as a sensor coil.

Function

The permanent magnet on the turbine wheel rpm sensor (B610) generates a magnetic field. Magnetic field changes occur due to a groove in the turbocharger shaft when the shaft turns. A voltage is induced in the coil of the turbine wheel rpm sensor (B610) or inductive voltage signals are generated. With the aid of these signals the engine management (MCM) control unit (A4) can determine the rotor speed.

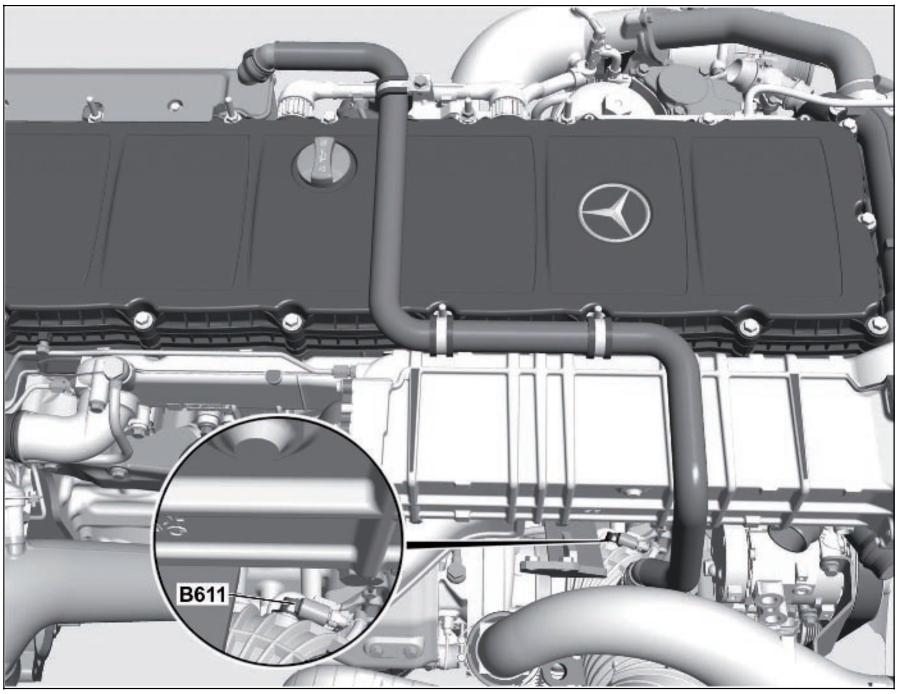
GF09.20-W-4010H	Component description for temperature sensor downstream of air filter	1.7.11

ENGINES 471.9 in MODEL 963 with CODE (M5Z) Engine version Euro VI

Location

B611 Temperature sensor downstream of air filter

The temperature sensor downstream of air filter (B611) is located in the intake air hose between the air filter and turbocharger.



W09.20-1004-06

Task

The engine management (MCM) control unit (A4) detects the temperature of the intake air at the compressor inlet of the turbocharger over the temperature sensor downstream of air filter (B611).
In combination with the current rotor speed and the load condition of the engine the engine management (MCM) control unit (A4) recognizes amongst other things whether the boost pressure regulator (Y636) is actuated and whether the injection must be adapted in order to protect the turbocharger against an excessively high thermal load.

Design

There is an NTC resistor inside the temperature sensor downstream of air filter (B611). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

The intake air blowing by at the temperature sensor downstream of air filter (B611) influences the temperature of the measuring elements inside the sensor according to their temperature and therefore the magnitude of the electrical resistance. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

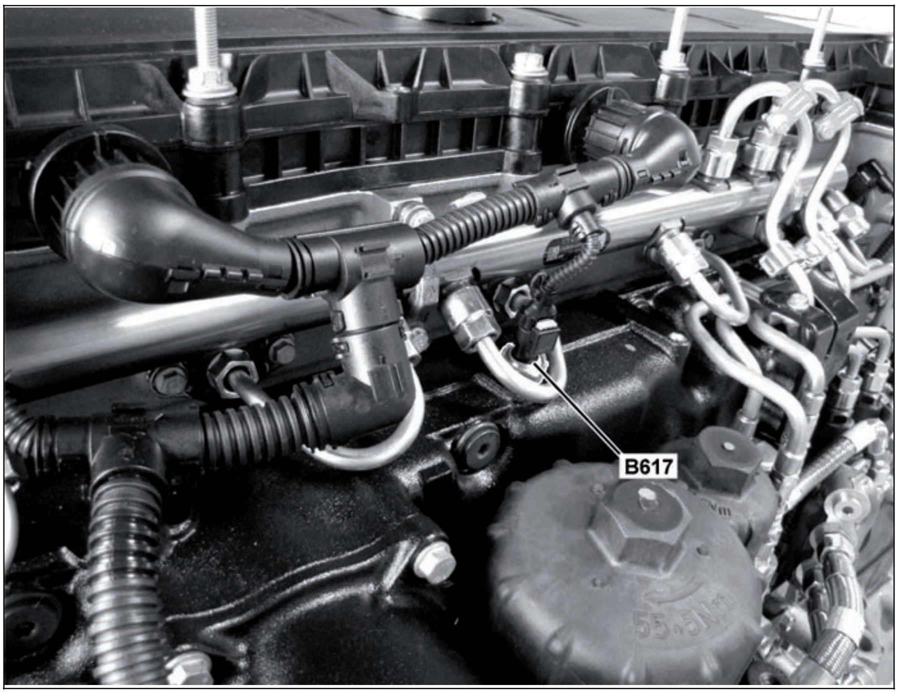
GF09.41-W-4125H	Component description for charge temperature sensor in charge air housing	2.8.11

ENGINES 471.9 in MODEL 963

Location

B617 Charge temperature sensor in charge air housing

The charge air temperature sensor in the charge air housing (B617) is located on the charge air housing.



W09.41-1059-06

Task

Over the charge air temperature sensor downstream in the charge air housing (B617), the engine management (MCM) control unit (A4) detects the temperature of the charge air shortly before it enters the combustion chamber.
The engine management (MCM) control unit (A4) determines the effective recycled exhaust mass using the charge air temperature and values from the exhaust recirculation (AGR) differential pressure sensor (B621) which plays a significant role in calculating the exhaust recirculation rate.

Design

There is an NTC resistor located inside the charge air temperature sensor in the charge air housing (B617). NTC stands for "Negative Temperature Coefficient", which means that electrical resistance falls as temperature rises.

Function

The charge air prevailing at the charge air temperature sensor in the charge air housing (B617), depending on its temperature, influences the temperature of the measuring element inside the sensor and thus the magnitude of the electrical resistance. The engine management (MCM) control unit (A4) deduces the associated temperature from the electrical resistance.

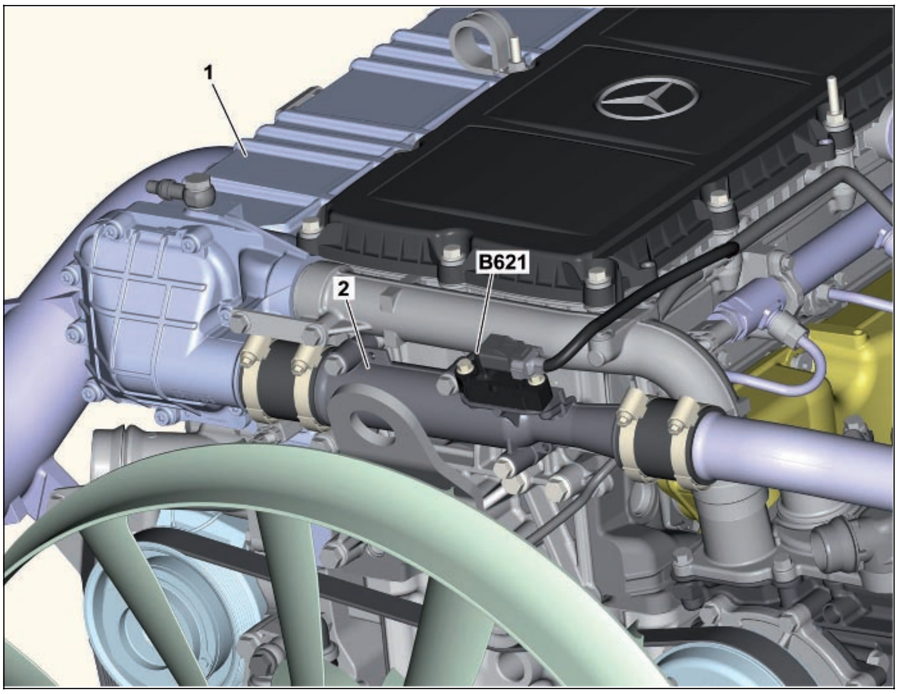
GF14.20-W-1004H	Component description for EGR differential pressure sensor	2.8.11

ENGINES 471.9 in MODEL 963, 964

Location

1 Exhaust gas recirculation cooler
2 Exhaust gas recirculation pipe

B621 Exhaust gas recirculation (AGR) differential pressure sensor



W14.20-1023-76

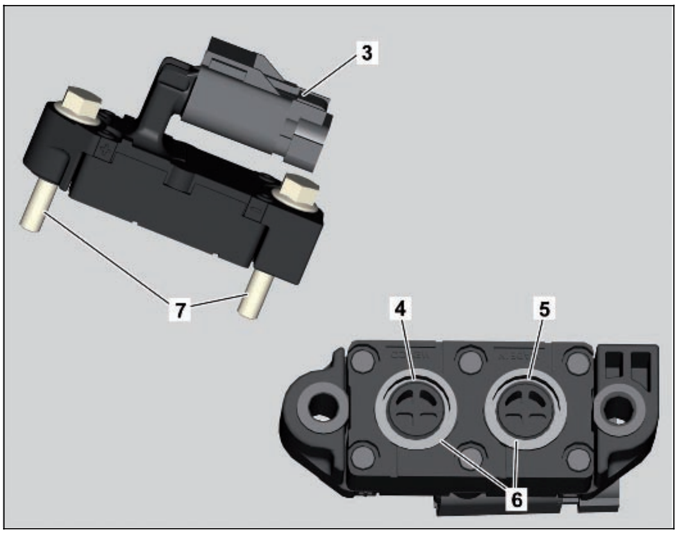
The EGR (AGR) differential pressure sensor (B621) is located on the front side of the engine, where it is screwed in from the outside into the exhaust gas recirculation pipe (2).

Task

The EGR (AGR) differential pressure sensor (B621) supplies the engine management (MCM) control unit (A4) with information in order to calculate the EGR volumetric flow rate.

Design

3 Electrical connection
4 High pressure connection
5 Low-pressure connection
6 Seals
7 Bolts



W14.20-1024-81

The EGR (AGR) differential pressure sensor (B621) consists of a plastic housing which it fitted inside with two chambers which is separated from a thin membrane which functions as a mechanical intermediate stage. Four strain gauge resistances (DMS) are located on the membrane in the bridge circuit.

The membrane is exposed on one side to the exhaust and thus the pressure.
The EGR (AGR) differential pressure sensor (B621) is fitted with an electronic analysis system and for signal transmission to the engine management (MCM) control unit (A4) and a power supply due to the bridge circuit it contains

Function

If the exhaust recycling pipe (2) has exhaust flowing through it there is a respective pressure applied at the part of the membrane in the EGR (AGR) differential pressure sensor (B621) exposed to the exhaust. This is therefore distorted and the strain gauge resistances (DMS) are elongated or squashed. The strain gauge resistances (DMS) reacts to the change in length with a change in its ohmic resistance. These values are prepared by the electronic analysis system and transmitted as analog signals to the engine management (MCM) control unit (A4).

Since the EGR (AGR) differential pressure sensor (B621) has a constant measuring current flowing through it there is a voltage drop due to the change in resistance over which the engine management (MCM) control unit (A4) can deduce the associated pressure value.

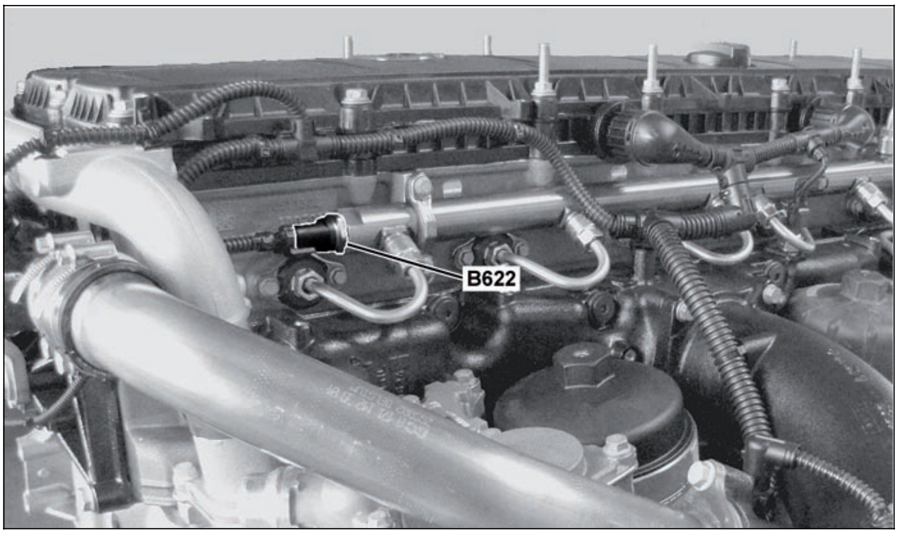
GF07.04-W-6253H	Component description for rail pressure sensor	20.7.11

ENGINES 471.9 in MODEL 963

Location

B622 Rail pressure sensor

The rail pressure sensor (B622) is located at the front on the rail.



W07.04-1080-05

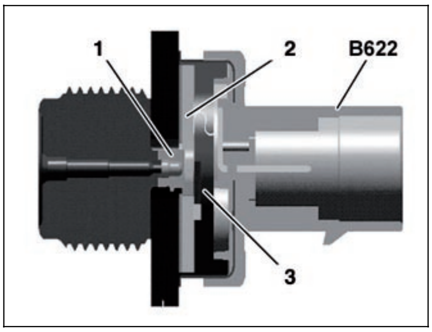
Task

The engine management (MCM) control unit (A4) determines the current rail pressure via the rail pressure sensor (B622).

Design

1 Sensor element
2 Sensor membrane
3 Hybrid element

B622 Rail pressure sensor



W07.04-1071-01

Function

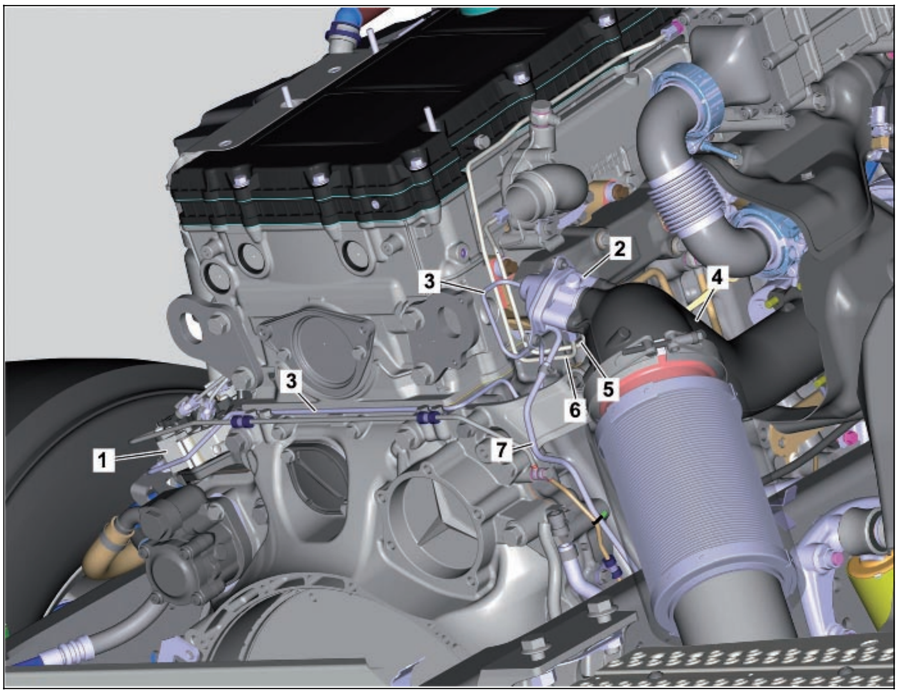
The rail pressure operates on the sensor element (1) of the hybrid element (3) and distorts the sensor membrane (2).
There are four pressure-dependent resistances (strain measuring resistors) on the sensor membrane (2). Its bridge circuit is supplied with voltage by an electronic analysis system which also serves for signal amplification and signal correction. The electronics analysis system itself is provided with a 5 V DC voltage by the engine management (MCM) control unit (A4).
The resistors in the sensor membrane (2) are arranged in such a way that on deforming the sensor membrane (2) two resistors are clinched and two resistors elongated.
Contraction and elongation changes the electrical resistance of the resistors which in turn has effects upon the measurement voltage, which is being applied to the electronic analysis system. The electronic analysis system amplifies the measurement voltage, compensating for possible temperature fluctuations or balancing out possible manufacturing tolerances on the resistances and passes on the cleared out measurement voltage to the engine management (MCM) control unit (A4) which uses it to derive the current rail pressure.

GF49.20-W-3011H	Diesel fuel metering device, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

1 *Diesel fuel metering device*
2 *Nozzle unit for DPF regeneration*
3 *Fuel line*
4 *Exhaust pipe*
5 *Coolant line*
6 *Coolant line*
7 *Leakage line*



W49.20-1017-76

The diesel fuel metering device (1) is on the left-hand side of the engine behind the fuel system high pressure pump.

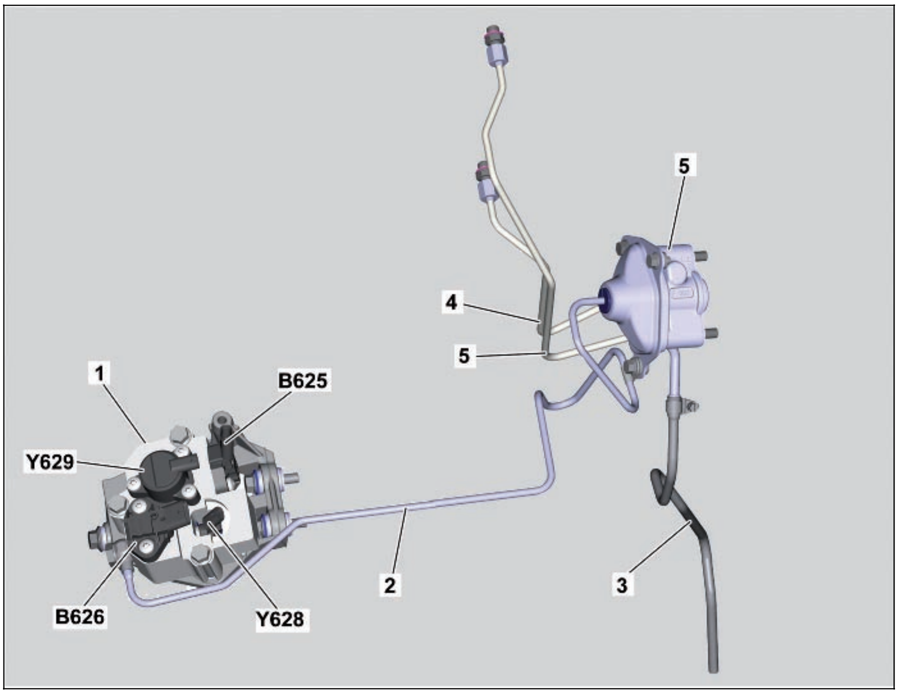
Task

The diesel fuel metering device (1) is used to provide the required quantity of diesel fuel for injecting into the exhaust pipe (4) during active diesel particulate filter (DPF) regeneration.

Design

1 *Diesel fuel metering device*
2 *Nozzle unit for DPF regeneration*
3 *Fuel line*
4 *Exhaust pipe*
5 *Coolant line*

B625 Fuel pressure sensor (inlet)
B626 Fuel pressure sensor (outlet)
Y628 Fuel metering valve
Y629 Fuel shutoff valve



W49.20-1018-76

The diesel fuel metering device (1) is a component that is permeated with fuel channels and has an aluminum body. The sensors that are placed on it have their measuring probes inserted into the fuel channels.
It is connected to the nozzle unit (2) via the fuel line (3).

Function

When the exhaust aftertreatment control unit (ACM) (A60) decides that active regeneration of the diesel particulate filter (DPF) is required on the basis of the values provided by the sensor system, it sends a request to the engine management control unit (MCM) (A4). This actuates the fuel shutoff valve (Y629), so that diesel fuel from the low-pressure circuit enters the component.

The fuel metering valve (Y628) is also opened at defined intervals. The calculated quantity of diesel fuel therefore flows into the feed line to the nozzle unit for DPF regeneration (2).
The two pressure sensors deliver values that are used in the valve opening time calculation.

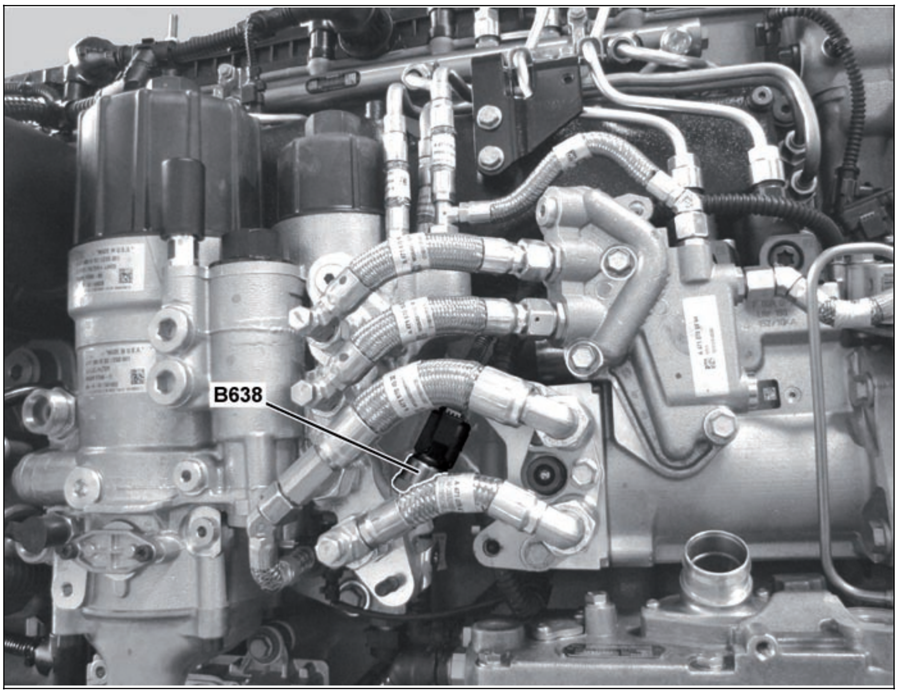
GF47.50-W-4110H	Fuel filter module pressure sensor, component description	20.7.11

ENGINES 471.9 in MODEL 963

Location

B638 Fuel filter module pressure sensor

The fuel filter module pressure sensor (B638) is on the left-hand side of the crankcase at the fuel filter module.



W47.50-1009-06

Task

With the aid of the fuel filter module pressure sensor (B638) the engine management control unit (MCM) (A4) can detect whether the fuel filter element needs to be changed. The fuel filter module pressure sensor (B638) is also used for diagnostic purposes.

Design

The fuel filter module pressure sensor (B638) is a so-called semiconductor pressure sensor which detects the fuel pressure in the fuel filter module using the piezo-electric principle. This consists of 4 pressure-dependent resistors (strain measuring resistors) which are arranged in a silicon membrane, and an electronic analysis system which is supplied with a 5 V DC voltage via the engine management control unit (MCM).

Function

The fuel pressure acts upon the silicon membrane with the four pressure-dependent resistors and deforms it. The resistors in the silicon membrane are arranged in such a way that 2 resistors are contracted and 2 resistors are elongated when the sensor membrane is deformed.
Contraction and elongation changes the electrical resistance of the resistors which in turn has effects upon the measurement voltage, which is being applied to the electronic analysis system. The electronic analysis system amplifies the measuring voltage, compensating for possible temperature fluctuations and manufacturing tolerances in the resistors. The measuring voltage which has been "cleaned" in this way is forwarded to the engine management control unit (MCM) (A4), which uses it to derive the current fuel pressure in the fuel filter module and the load condition of the fuel filter element.

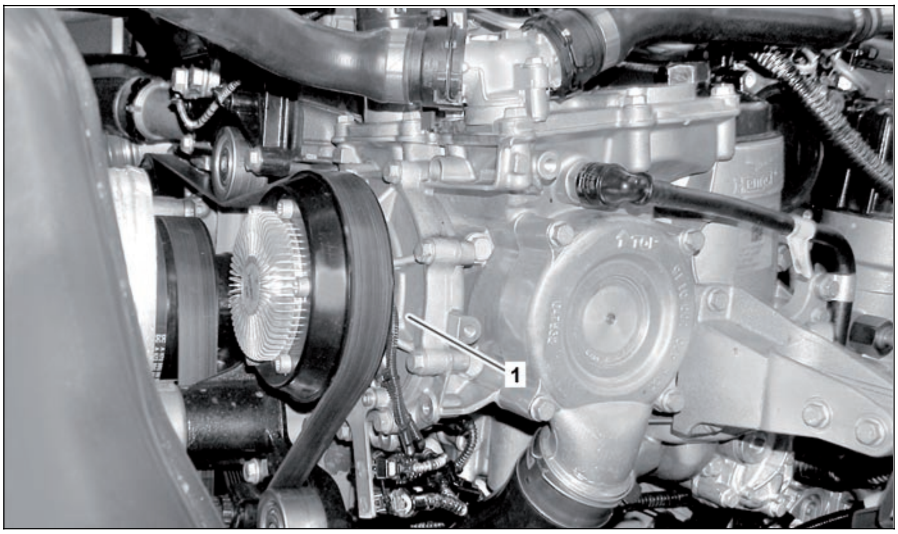
GF20.00-W-4000H	Component description for coolant pump	20.7.11

MODEL 963, 964 with CODE (M7T) Coolant pump, controlled

Location

1 Coolant pump

The coolant pump (1) is located at the left front on the engine.



W20.10-1071-05

Task

The coolant pump (1) is used to recirculate the coolant in the engine's cooling circuit. The coolant is recirculated in a demand-oriented manner as a function of the operating condition. In other words, the engine management (MCM) control unit (A4) continuously regulates the coolant pump's (1) delivery rate through an electromagnetic viscous coupling.

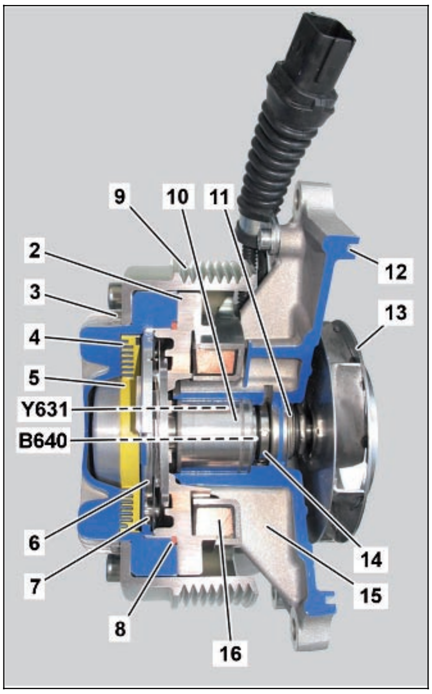
This means that the delivery rate is reduced, in particular, in the partial load range. The reduced delivery rate cuts the required drive energy, whereupon the fuel consumption is reduced accordingly.

Design

Sectional view

2 Base body
3 Cover
4 Working chamber (filled with silicone oil)
5 Viscous disk
6 Intermediate disk
7 Armature (with valve lever)
8 O-ring (sealing ring)
9 Belt pulley
10 Two-collar bearing (with drive shaft)
11 Slide ring seal
12 Seal (to engine)
13 Pump impeller
14 Signal ring for coolant pump rpm sensor (B640)
15 Pump housing
16 Solenoid

B640 Coolant pump rpm sensor
Y631 Coolant pump solenoid valve



W20.10-1072-73

Function

The frictional connection between the belt pulley (9) and the drive shaft is made by an electromagnetic viscous coupling, which is actuated by the engine management (MCM) control unit (A4).

ℹ The power is transmitted between the belt pulley (9) and the drive shaft through the silicone oil shearing in the working chamber (4). Shearing is understood to mean the displacement of silicone oil between the basic body's (2) drive slats and the drive slats of the viscous coupling (5).

The engine management (MCM) control unit (A4) requires the speed of the coupling drive (rotational speed of pump impeller (13)) and the drive speed of the belt pulley (9) to regulate the electromagnetic viscous coupling.
The belt pulley (9) drive speed is determined using the engine rpm and the diameter of the belt pulley (9).
The step-up ratio through the poly-V belt is also taken into consideration.
This information is filed in the engine management (MCM) control unit (A4).
The speed of the coupling output shaft is recorded by the coolant pump rpm sensor (B640) and evaluated by the engine management (MCM) control unit (A4).
This information is used by the engine management (MCM) control unit (A4) to determine the current speed and therefore the coolant pump's delivery rate (1).
For design reasons the coolant pump (1) always supplies the full delivery rate when it is not actuated. In other words, the belt pulley (9) and the pump impeller (13) are 95% nonpositive. If the coolant pump (1) delivery rate is to be reduced, the engine management (MCM) control unit (A4) actuates the coolant pump solenoid valve (Y631) through a pulse width modulated signal (PWM signal).

The armature (7) is closed through actuating the coolant pump solenoid valve (Y631). The silicone oil is then pumped by the centrifugal force out of the working chamber (4) between the lid (3) and viscous disk (5), thereby reducing the pump impeller's (13) mechanical power.
The constant balancing between drive and output speed enables the engine management (MCM) control unit (A4) to detect the current delivery rate at any given time. The engine management (MCM) control unit (A4) raises or lowers the delivery rate of the coolant pump (1) depending on the respective cooling requirement.

ℹ The coolant pump (1) is configured as a fail-safe component. This means that the working chamber (4) of the electromagnetic viscous coupling is filled with silicone oil when in an idle condition. If the electronic actuation of the electromagnetic viscous coupling is missing because of a defect, then 100 % of the cooling output available is always used. This means however, that the working principle of the viscous coupling may be extremely restricted at very low temperatures or when the engine is cold started. The extremely sluggish and cold silicone oil (particularly at low speeds) cannot be pumped out of the working chamber (4) and therefore it results in full activation of the coolant pump (1).

The coolant pump (1) is equipped with the following emergency running characteristics:

- In the event of electrical faults (e.g. cable breakage, sensor system malfunction) the coolant pump (1) automatically supplies the maximum delivery rate for design reasons.
- Mechanical defects (e.g. rpm drop because of an oil loss at the viscous coupling or a cracked poly-V belt) are detected by the coolant pump rpm sensor (B640) and they result in engine output limitation.
- A mechanical defect in the coolant pump (1) with simultaneous failure of the coolant pump rpm sensor (B640) can be detected through the coolant temperature trend, and it also results in an engine output limitation.

ℹ In the event of a fault, the driver is notified by means of a corresponding warning message shown on the multifunction display (A1 p1).

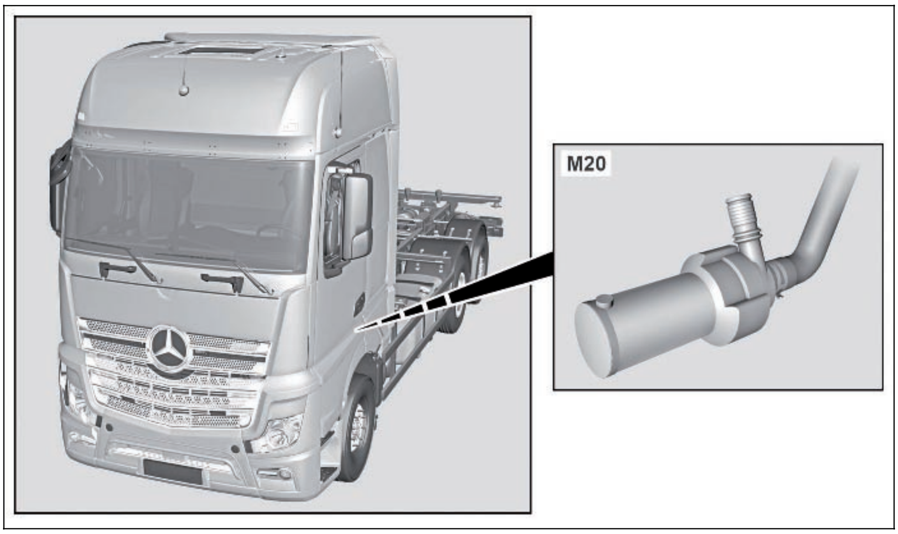
GF83.75-W-0002H	Residual heat pump, component description	6.7.11

MODEL 963, 964 with CODE (D6I) Residual heat utilization

Location

M20 Residual heat pump

The residual heat pump (M20) is located at the left under the cab.



W83.20-1102-05

Task

The residual heat pump (M20) ensures coolant circulation with the engine switched off. The heater core is thus constantly supplied with coolant still warm from the operation of the engine.

GF54.61-W-4105H	Tachograph (TCO) component description	1.7.11

MODEL 963, 964

Location

P1 Tachograph (TCO)

The tachograph (TCO) (P1) is installed in the headliner.

W54.61-1089-06

Task

The tachograph (TCO) (P1):

- Records the real-time signal of the travel and speed sensor (B18).
- Sends data and command signals to the travel and speed sensor (B18).
- Calculates the vehicle speed, route and trip mileage covered.
- Transmits the calculated data over the frame-CAN (CAN 3) to the instrument cluster control unit (ICUC) (A1).
- Serves for registration, storage, display, printout and output of driver and vehicle-specific data. Storage on the digital tachograph is in the device memory, as well as on the inserted tachograph cards or - for the modular tachograph - on the tachograph disk.

GF80.57-W-6004H	Electronic ignition lock (EIS), component description	1.7.11

MODEL 963, 964

Location

S1 Electronic ignition lock (EIS)

The electronic ignition lock (EIS) (S1) is located at the right next to the steering column in the instrument panel.

W80.57-1020-11

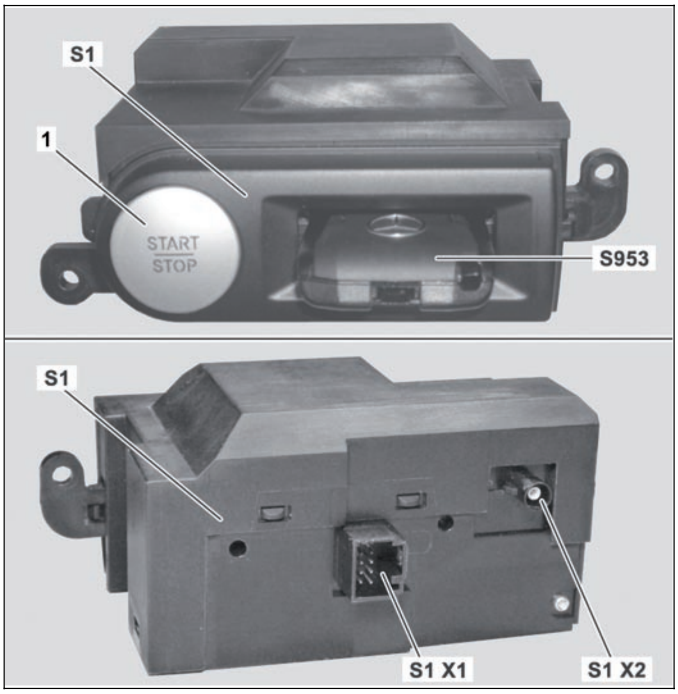
General information

The electronic ignition lock (EIS) (S1) in combination with the transmitter key (S953) is the central controller unit for the DAS. The electronic ignition lock (EIS) (S1) - when the transmitter key (S953) is not inserted - also serves as a communications interface between the transmitter key (S953) and the vehicle network.

Design

1 Start-stop button

S1 Electronic ignition lock (EIS)
S1 X1 Connector
S1 X2 Connector
S953 Transmitter key



W80.57-1009-12

Task

The electronic ignition lock (EIS) (S1) is responsible for the following tasks:

● **Reading in input factors**
Input factors are red in over the interior CAN (CAN 2).

● **Output of signals**
Signal output is over the interior CAN (CAN 2) and over a direct line to the sensor and actuator module, cab (SCA) control unit (A7).

● **Transmitter key voltage supply (S953)**
When the transmitter key (S953) is inserted into the electronic ignition lock (EIS) (S1) this activates the inductive power transmission for the transmitter key (S953) power supply.

Function

Sending and receiving infrared signals with the transmitter key *(S953) inserted*
Data exchange between the electronic ignition lock (EIS) (S1) and the transmitter key (S953) with regard to the DAS over an infrared interface.

Sending and receiving high-frequency signals when the transmitter key (S953) is not inserted
Depending on the transmitter key (S953) version, the electronic ignition lock (EIS) (S1) reads in the high frequency signals of the transmitter key (S953) or it sends them to it.

GF54.25-W-4130H	EMERGENCY OFF switch, component description	2.8.11

MODEL 963 with CODE (E5T) ADR model class EX/II, including AT
MODEL 963 with CODE (E5U) ADR model class EX/III, including EX/II and AT
MODEL 963 with CODE (E5V) ADR model class FL including EX/II, EX/III and AT
MODEL 963 with CODE (E5X) ADR model class AT
MODEL 963 with CODE (E5Z) Accessories, ADR
MODEL 963 with CODE (E9D) Preinstallation, double-pole battery disconnect switch
MODEL 963 with CODE (E9E)

Location

Shown on left-hand drive vehicle
S30 EMERGENCY STOP switch

The EMERGENCY OFF switch (S30) is located in the instrument panel to the right next to the steering wheel in instrument panel switch module 3 (A46).

W54.25-1190-11

Task

The switching positions of the EMERGENCY OFF switch (S30) are evaluated by the battery disconnect switch (BESO) control unit (A33). When the EMERGENCY OFF switch (S30) is pressed, the battery disconnect switch (BESO) control unit (A33) ensures that the engine is switched off and all electrical consumers are disconnected from the on-board electrical system.

Design

Double-throw contact switch with protective cap designed as a flap in order to rule out inadvertent actuation.

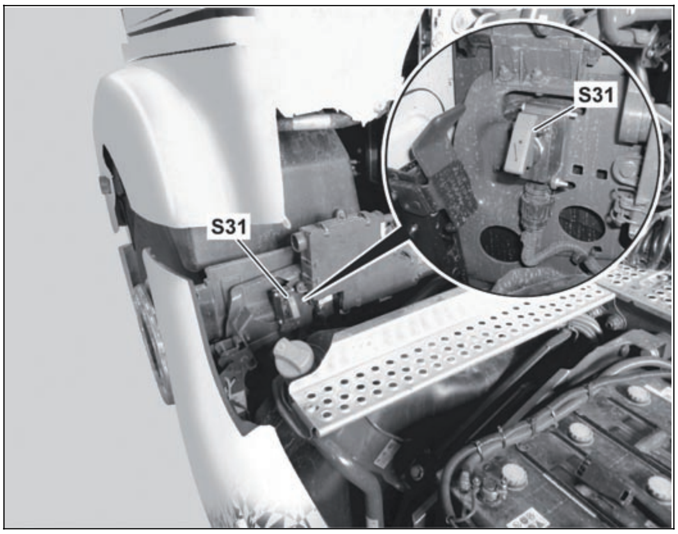
GF54.25-W-4131H	Frame EMERGENCY OFF switch, component description	2.8.11

MODEL 963 with CODE (E5T) ADR model class EX/II, including AT
MODEL 963 with CODE (E5U) ADR model class EX/III, including EX/II and AT
MODEL 963 with CODE (E5V) ADR model class FL including EX/II, EX/III and AT
MODEL 963 with CODE (E5X) ADR model class AT
MODEL 963 with CODE (E5Z) Accessories, ADR
MODEL 963 with CODE (E9D) Preinstallation, double-pole battery disconnect switch
MODEL 963 with CODE (E9E)

Location

Shown on left-hand drive vehicle
S31 Frame EMERGENCY OFF switch

The frame EMERGENCY OFF switch (S31) is located on the driver side behind the cab at the level of the wheel arch.



W54.25-1189-11

Task

The switching positions of the frame EMERGENCY OFF switch (S31) are evaluated by the battery disconnect switch (BESO) control unit (A33). When the frame EMERGENCY OFF switch (S31) is pressed, the battery disconnect switch (BESO) control unit (A33) ensures that the engine is switched off and all electrical consumers are disconnected from the on-board electrical system.

Design

Double-throw contact switch with protective cap designed as a flap in order to rule out inadvertent actuation.

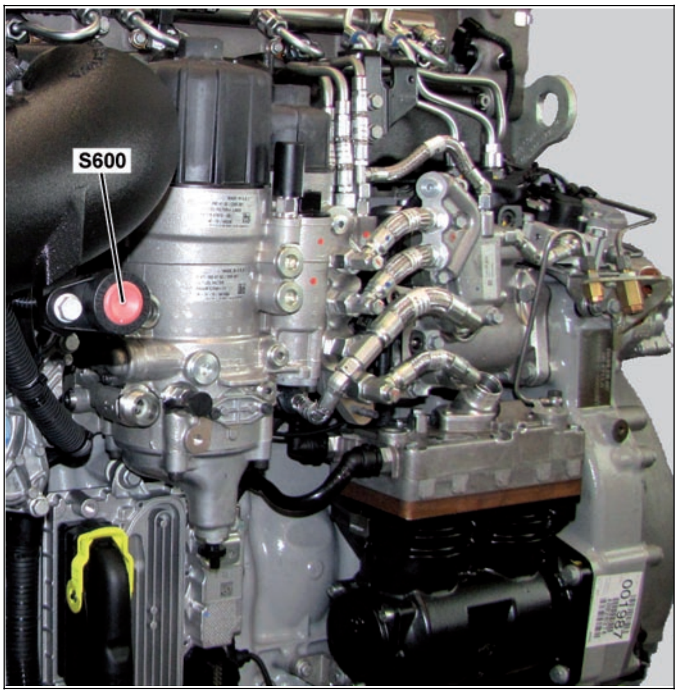
GF07.00-W-4010H	Engine start and engine stop button, component description	2.8.11

ENGINE 471.9 in MODEL 963

Location

Code (M5Z) Euro VI engine version shown
S600 Engine start and engine stop button

The engine start and engine stop button (S600) is located in the left direction of travel position, next to the fuel filter on the charge air housing.



W07.16-1070-82

Task

The engine start and engine stop button (S600) has different tasks, depending on whether the engine is at a standstill or running, and if the actuation of the fuel injectors via Star Diagnosis was switched off or not:

- If the engine is at a standstill and actuation of the fuel injectors is not switched off, a brief press of the engine start and engine stop button (S600) can start the engine again. The engine continues to run at idle speed after releasing the button.
- If the engine start and engine stop button (S600) is pressed and held with the engine at a standstill, the engine rpm starts increasing after 3 s until the engine reaches the maximum governed rpm or until the engine start and engine stop button (S600) is released again. After releasing the engine start and engine stop button (S600) the engine will continue to run at the rpm it had reached before the button was released.
- If the engine has stopped and actuation of the fuel injectors has been switched off, then pressing the engine start and engine stop button (S600) rotates the engine until the button is released again.
- If the engine start and engine stop button (S600) is pressed with the engine running, the engine management (MCM) control unit (A4) interrupts actuation of the fuel injectors and the engine is switched off.

i A safety function in the software for the engine management (MCM) control unit (A4) and the drive control (CPC) control unit (A3) prevents the engine from starting when a gear is engaged (starter lockout), or it prevents starter actuation when the engine is already running (start-quantity locking device).

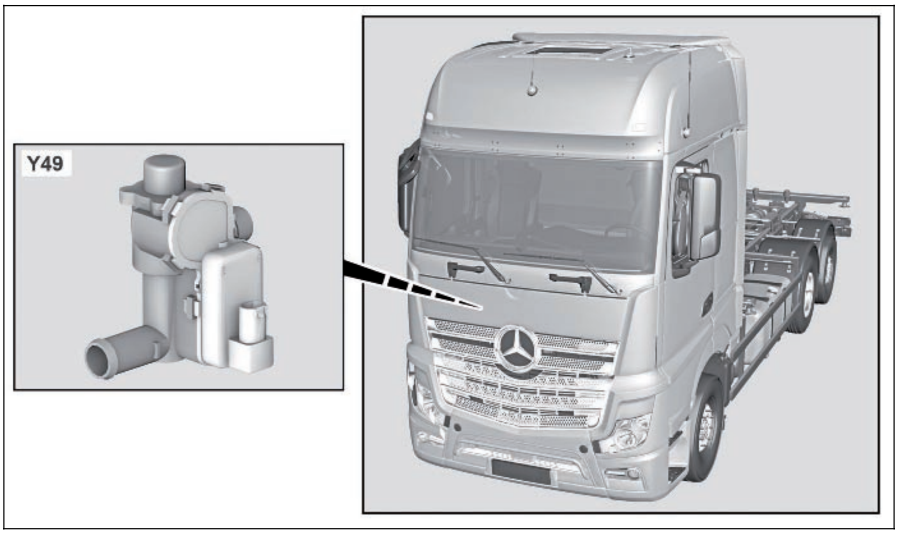
GF83.20-W-3126H	Heating shutoff valve, component description	20.7.11

MODEL 963, 964

Location

Y49 Heater shutoff valve

The heater shutoff valve (Y49) is located on the left next to the fresh air intake on the heater blower unit.



W83.20-1104-05

Task

The heater shutoff valve (Y49) blocks the coolant supply to the heater heat exchanger if heat output is not required (temperature control flaps set to cold).

Function in vehicles with code (D6M) Hot water auxiliary heater, cab or code (D6N) Hot water auxiliary heater, cab and engine

The auxiliary heater only heats the coolant in the cooling circuit of the heater heat exchanger when the heating shutoff valve is closed (Y49). To avoid frequent switching on and off of the auxiliary heater, the heater shutoff valve (Y49) is intermittently opened so that coolant continues to flow from the engine cooling circuit.

GF20.30-W-1001H	Coolant pressure control solenoid valve, component description	20.7.11

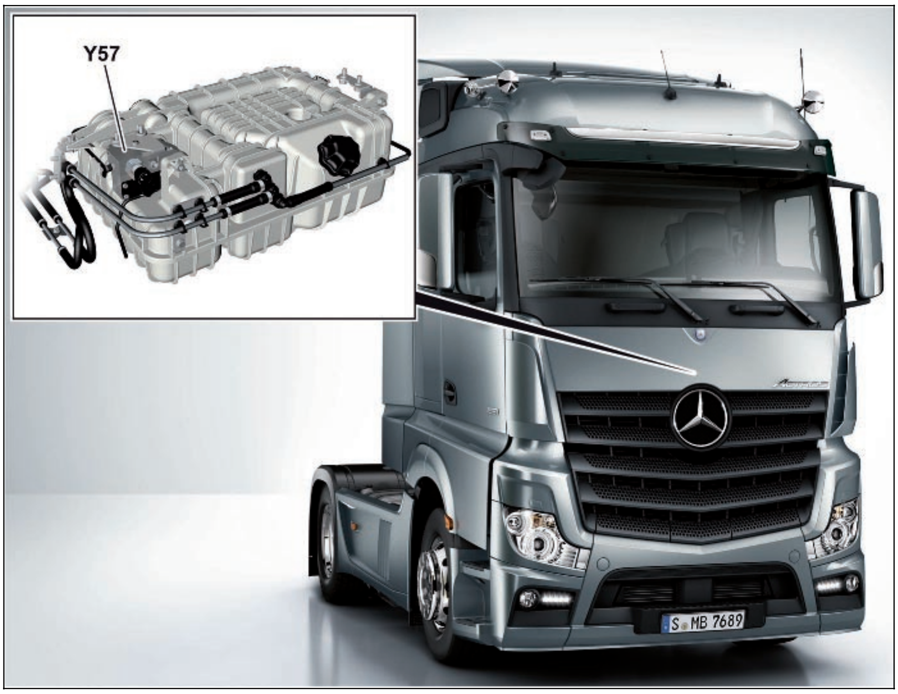
MODEL 963, 964 with CODE (B3H) Secondary water retarder

Location

Shown on model 963, front coolant expansion reservoir

Y57 Coolant pressure control solenoid valve

The coolant pressure control solenoid valve (Y57) is located on the coolant expansion reservoir.



W20.30-1026-76

Task

The coolant pressure control solenoid valve (Y57) enables the pressure in the cooling system to be raised or lowered.

Design

The coolant pressure control solenoid valve (Y57) consists of the following components:

- Intake valve (reservoir pressure)
- Exhaust valve (atmosphere)

Function

The coolant pressure control solenoid valve (Y57) is actuated by the drive control (CPC) control unit (A3). The pressure level is taken from a characteristic filed in the drive control (CPC) control unit (A3). The characteristic, and therefore the pressure level, increases along with the coolant temperature. If the pressure drops below the stored value, the compressed air is routed out of the consumer circuit into the expansion reservoir until the required pressure level is reached. If the pressure increases beyond the stored value, the pressure is released from the expansion reservoir. When in an operating temperature condition, a pressure of between p = 480 mbar and max. 1480 mbar is regulated, depending on the coolant temperature level.

This regulation is necessary to ensure that a high pressure level is achieved at all operating conditions. A higher pressure level is required, in particular, when activating the secondary water retarder.

i Coolant is taken from the cooling circuit when the secondary water retarder is activated. This in turn results in a drop in pressure in the cooling system.

The increased pressure serves to prevent pressure dropping below a critical threshold. This helps to avoid any cavitation damage in the cooling circuit, while also preventing the coolant in the exhaust gas recirculation cooler from boiling.

i Cavitation damage is caused by blistering (hollow spaces) in the cooling circuit. If, for example, a turbine wheel moves in such a hollow space and impacts then with the coolant flow, extremely high mechanical forces will be generated on the surface of the turbine wheel. In the long term these will destroy the turbine wheel.

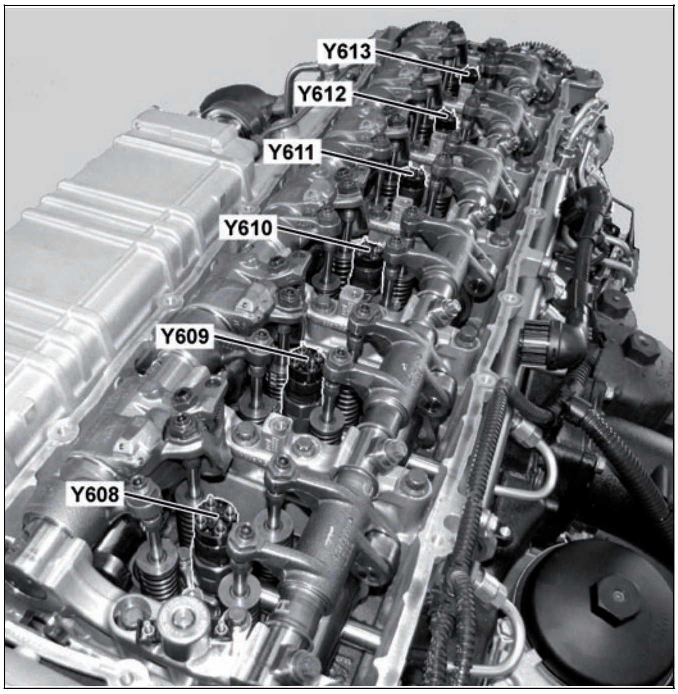
GF07.03-W-6120H	Component description for fuel injectors	3.8.11

ENGINES 471.9 in MODEL 963

Location

Y608 Cylinder 1 fuel injector
Y609 Cylinder 2 fuel injector
Y610 Cylinder 3 fuel injector
Y611 Cylinder 4 fuel injector
Y612 Cylinder 5 fuel injector
Y613 Cylinder 6 fuel injector

The fuel injectors for cylinder 1 to 6 (Y608 to Y613) are fastened by means of clamping pieces at the cylinder head and positioned centrally between the valves of the respective cylinder.



W07.03-1056-12

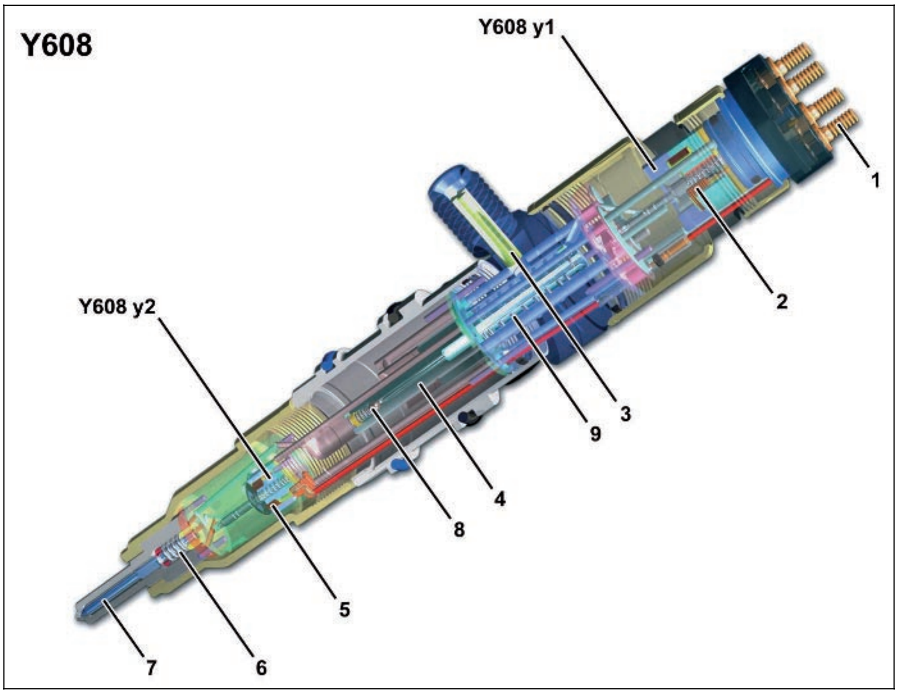
Task

The purpose of the fuel injectors is to inject fuel at high pressure into the respective cylinders.
The injection timing point, injection period and the injection variants (e.g. with or without pressure boosting) are established by the engine management (MCM) control unit (A4).

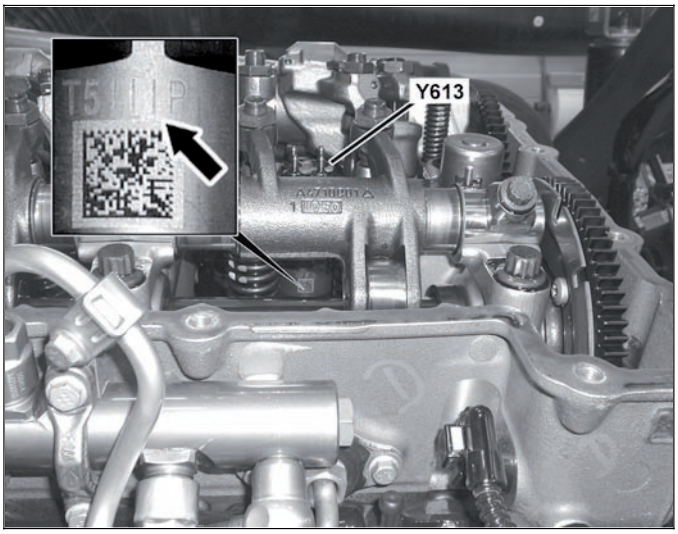
Design

Shown on cylinder 1 fuel injector (Y608)
1 Electrical connection
2 Coil
3 High pressure feed
4 Pressure booster
5 Coil
6 Spring
7 Nozzle needle
8 Check valve
9 Return spring

Y608 Cylinder 1 fuel injector
Y608 y1 Cylinder 1 pressure booster solenoid valve
Y608 y2 Cylinder 1 nozzle needle solenoid valve



W07.03-1057-76



W07.03-1062-11

Location of the injector quantity compensation code, shown on injection nozzle for cylinder 6 (Y613)
Y613 Cylinder 6 fuel injector

Arrow Injector quantity compensation code

All fuel injectors have a 6-digit code, the so-called injector quantity compensation code (arrow) which is applied above the high pressure feed point.
The code describes the quantity characteristics of the respective fuel injector. If a fuel injector is replaced this must be reported to the engine management (MCM) control unit (A4) over Star Diagnosis.

Function

The fuel injectors are fitted with a pressure booster (4). This gives rise to 2 injection variants:

- Injection without a pressure booster (4)
- Injection with a pressure booster (4)

In the case of injection without pressure booster (4) the injection pressure is determined by the rail pressure (about 900 bar).
In the case of injection with pressure booster (4) the injection pressure of up to 2100 bar is generated in the fuel injector.

Use of the pressure booster (4) offers the following advantages:

- The leak oil losses in the high pressure area are reduced.
- The pressure load of the high pressure pump, the rail, the high pressure lines as well as components in the fuel injectors are countersunk since only few components have the highest pressure applied to them.

Therefore each injection nozzle is fitted with a second solenoid valve. Taking the example of the cylinder 1 fuel injector (Y608), this would be the solenoid valve for the pressure booster for cylinder 1 (Y608 y1), over that for the pressure booster (4), depending on the operating condition of the engine, which can be actuated by the engine management (MCM) control unit (A4), independently of actuation of the cylinder 1 nozzle needle solenoid valve (Y608 y2).

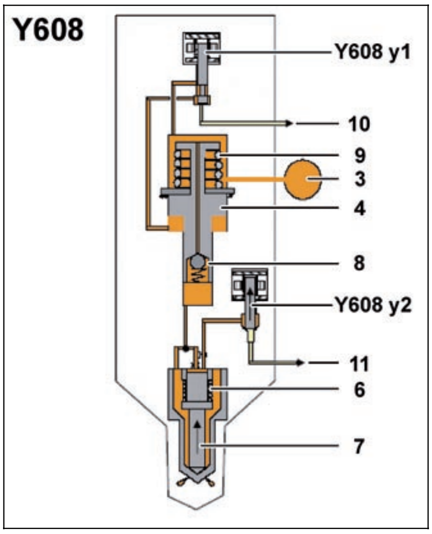
Injection without a pressure booster (4)

ℹ The following description of the function of injection without a pressure booster (4) is described using the cylinder 1 fuel injector (Y608) as an example and can be applied to all other fuel injectors.

Schematic diagram of injection without a pressure booster (4), shown on cylinder 1 fuel injector (Y608)

3 High pressure feed
4 Pressure booster
6 Spring
7 Nozzle needle
8 Check valve
9 Return spring
10 Fuel return for pressure booster
11 Fuel return for nozzle needle

Y608 Cylinder 1 fuel injector
Y608 y1 Cylinder 1 pressure booster solenoid valve
Y608 y2 Cylinder 1 nozzle needle solenoid valve



W07.03-1058-72

The cylinder 1 pressure booster solenoid valve (Y608 y1) is not actuated.
The fuel lies at rail pressure above and below the pressure booster (4). The compressed fuel passes out of the rail to the nozzle needle (7) via the check valve (8) in the pressure booster (4).

If the engine management (MCM) control unit (A4) actuates the cylinder 1 nozzle needle solenoid valve (Y608 y2) then the fuel pressure in the control space is built up above the nozzle needle (7) via the fuel return nozzle needle (11).

The nozzle needle (7) is lifted with the aid of the adjacent rail pressure. The fuel is injected at the specified rail pressure into cylinder 1.

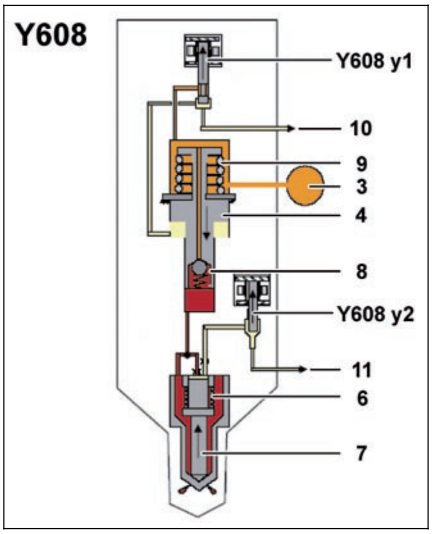
If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 nozzle needle solenoid valve (Y608 y1) the pressure in the control space above the nozzle needle (7) builds up again. The nozzle needle (7) is pressed onto its seat again with the aid of the spring (6) and the injection process stops.

Injection with a pressure booster (4)

ℹ The following descriptions of the variants for injection with a pressure booster (4) is described using the cylinder 1 fuel injector (Y608) as an example and can be applied to all other fuel injectors.

Schematic diagram of injection with a pressure booster (4), shown on cylinder 1 fuel injector (Y608)

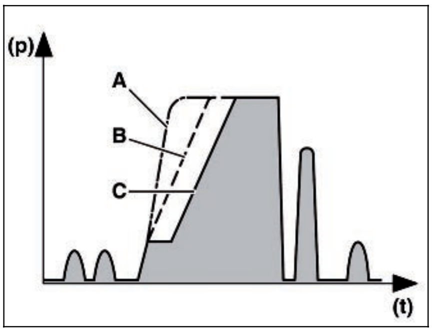
3	*High pressure feed*
4	*Pressure booster*
6	*Spring*
7	*Nozzle needle*
8	*Check valve*
9	*Return spring*
10	*Fuel return for pressure booster*
11	*Fuel return for nozzle needle*
Y608	*Cylinder 1 fuel injector*
Y608 y1	*Cylinder 1 pressure booster solenoid valve*
Y608 y2	*Cylinder 1 nozzle needle solenoid valve*



W07.03-1059-72

Graphic presentation of the injection process

A	*Actuation of the solenoid valve for the pressure booster before actuation of the nozzle needle solenoid valve*
B	*Actuation of the solenoid valve for the pressure booster parallel to actuation of the nozzle needle solenoid valve*
C	*Actuation of the solenoid valve for the pressure booster after actuation of the nozzle needle solenoid valve*
p	*Injection pressure*
t	*Time*



W07.16-1009-01

During injection with a pressure booster (4), the injection process is determined by temporally offset or simultaneous actuation of the nozzle needle solenoid valve and the solenoid valve for the pressure booster for the injection process. The following options for the injection process are possible:

- Actuation of the solenoid valve for the pressure booster before actuation of the nozzle needle solenoid valve (A)
- Actuation of the solenoid valve for the pressure booster parallel to actuation of the nozzle needle solenoid valve (B)
- Actuation of the solenoid valve for the pressure booster after actuation of the nozzle needle solenoid valve (C)

Actuation of the solenoid valve for the pressure booster before actuation of the nozzle needle solenoid valve (A)
The cylinder 1 pressure intensifier solenoid valve (Y608 y1) is actuated before the cylinder 1 nozzle needle solenoid valve (Y608 y2) by the engine management (MCM) control unit (A4). The rail pressure applied below the pressure booster (4) is reduced via the fuel return pressure booster (10).
The pre-compressed fuel from the rail which is also pressing against the nozzle needle (7) is compressed by the pressure booster (4) up to a high fuel pressure level (red).
If the engine management (MCM) control unit (A4) actuates the cylinder 1 nozzle needle solenoid valve (Y608 y2) then the fuel pressure in the control space is built up above the nozzle needle (7) via the fuel return nozzle needle (11). The nozzle needle (7) is lifted with the aid of the fuel pressure.
The fuel is injected with a fuel pressure increased by the pressure booster (4) into cylinder 1.

The level of the fuel pressure is dependent on the point in time of the initial actuation of the cylinder 1 pressure booster solenoid valve (Y608 y1).
If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 pressure booster solenoid valve (Y608 y1), the pressure below the pressure booster (4) builds up again. The pressure booster (4) goes back into its starting position.

If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 nozzle needle solenoid valve (Y608 y2) the pressure in the control space above the nozzle needle (7) builds up again. The nozzle needle (7) is pressed onto its seat again with the aid of the spring (6) and the injection process stops.

Actuation of the solenoid valve for the pressure booster parallel to actuation of the nozzle needle solenoid valve (B)
The cylinder 1 pressure intensifier solenoid valve (Y608 y1) and the cylinder 1 nozzle needle solenoid valve (Y608 y2) are actuated simultaneously by the engine management (MCM) control unit (A4).
The rail pressure applied below the pressure booster (4) is reduced via the fuel return pressure booster (10).
The fuel pressure in the control space above the injector needle (7) is reduced via the fuel return injector needle (11).
The nozzle needle (7) is lifted at first with the aid of the adjacent rail pressure.
During injection the pre-compressed fuel from the rail is compressed by the pressure booster (4) to a high fuel pressure level (red).
The fuel pressure increases during injection.

If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 pressure booster solenoid valve (Y608 y1), the pressure below the pressure booster (4) builds up again. The pressure booster (4) goes back into its starting position.

If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 nozzle needle solenoid valve (Y608 y1) the pressure in the control space above the nozzle needle (7) builds up again. The nozzle needle (7) is pressed onto its seat again with the aid of the spring (6) and the injection process stops.

Actuation of the solenoid valve for the pressure booster after actuation of the nozzle needle solenoid valve (C)
The fuel pressure in the control compartment above the nozzle needle (7) is initially reduced. This occurs in that the engine management (MCM) control unit (A4) actuates the cylinder 1 nozzle needle solenoid valve (Y608 y2). The nozzle needle (7) is lifted with the aid of the adjacent rail pressure. The fuel is injected at the prescribed rail pressure.
After beginning the injection the cylinder 1 pressure booster solenoid valve (Y608 y1) is actuated and the rail pressure applied under the pressure booster (4) reduces over the fuel return pressure booster (10).
On then is the pre-compressed fuel from the rail compressed by the pressure booster (4) to a high fuel pressure level (red).
This means that the fuel pressure only increases some time after beginning injection.

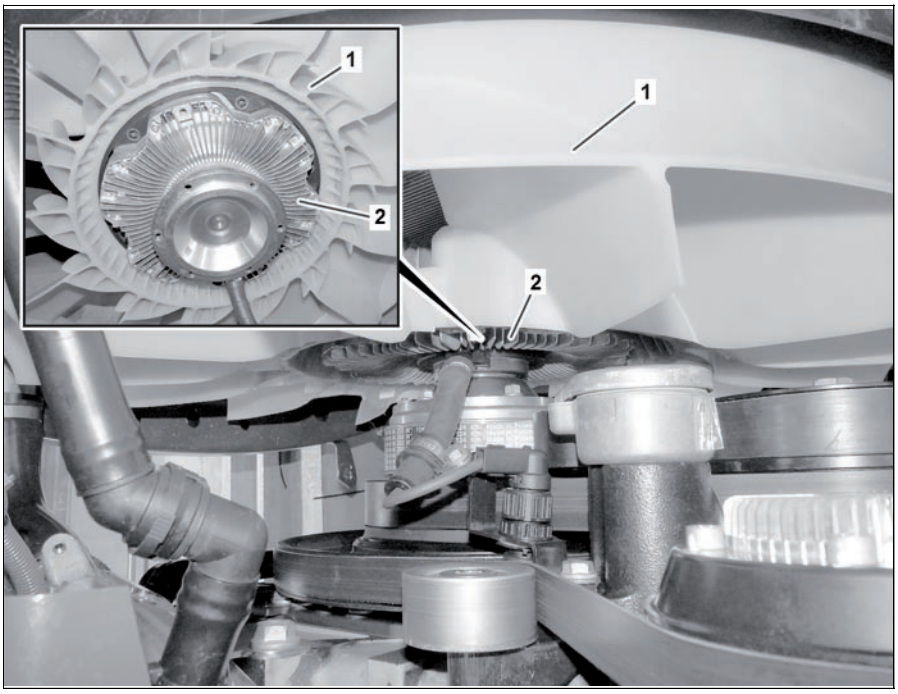
If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 pressure booster solenoid valve (Y608 y1), the pressure below the pressure booster (4) builds up again. The pressure booster (4) goes back into its starting position.

If the engine management (MCM) control unit (A4) interrupts actuation of the cylinder 1 nozzle needle solenoid valve (Y608 y1) the pressure in the control space above the nozzle needle (7) builds up again. The nozzle needle (7) is pressed onto its seat again with the aid of the spring (6) and the injection process stops.

GF20.40-W-2002H	Component description for the electromagnetic viscous coupling	20.7.11

MODEL 963, 964

Location



W20.40-1154-06

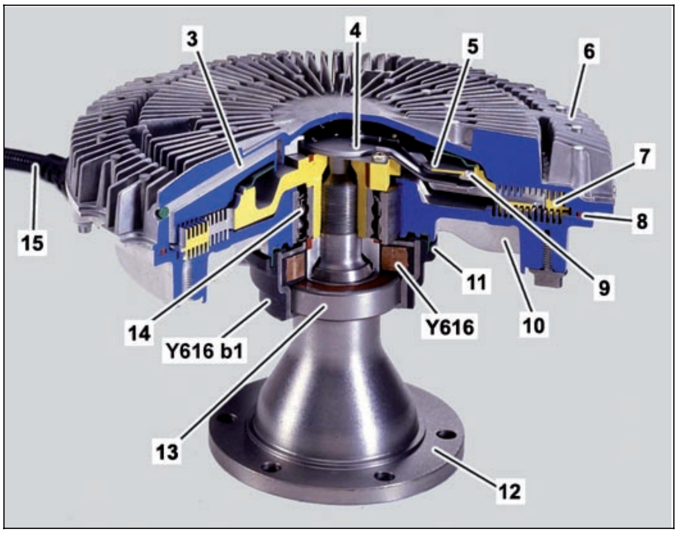
1 Fan wheel
2 Electromagnetic viscous coupling

The electromagnetic viscous coupling (2) is located between the fan wheel (1) and the engine.

Task

The electromagnetic viscous coupling (2) regulates the fan wheel (1) speed on a need basis when requested to do so by the engine management (MCM) control unit (A4). The actuation that is dependent on the engine operating condition, as well as external factors such as, e.g. the charge air temperature, reduces fuel consumption.

Design



W20.40-1155-81

Sectional view

3	*Return hole*
4	*Valve lever*
5	*Storage room*
6	*Cover*
7	*Clutch plate*
8	*Gasket*
9	*Oil feed bore*
10	*Housing*
11	*Sensor ring*
12	*Flange shaft*
13	*Bearing*
14	*Main bearing*
15	*Electrical line (with hose as a torque support)*
Y616	*Fan clutch solenoid valve*
Y616b1	*Fan rpm sensor*

ⓘ The fan clutch solenoid valve (Y616) is swivel mounted along with the fan rpm sensor (Y616 b1) on the stub shaft (12). The hose fitted to the electrical line (15) is used as a torque support. This prevents the assembly from also turning.

Function

Power is transmitted between the primary side (clutch plate (7)) and the secondary side, consisting of the lid (6) and the housing (10), through silicone oil shearing in the working chamber.

ⓘ Shearing is understood to refer to the displacement of silicone oil between the drive slats of the clutch plate (7) and the power take-off slats of the housing (10) and the lid (6).

The rotational speed of the primary side on vehicles without a high-speed fan drive matches the current engine speed.

If the fan clutch solenoid valve (Y616) is not actuated, the oil feed bore (9) is open and the clutch plate (7) is flushed with the maximum possible volume of silicone oil.
In other words, the fan wheel (1) rotates at the current engine speed or the rotational speed that matches the belt drive's step-up ratio.
The engine management (MCM) control unit (A4) energizes the fan clutch solenoid valve (Y616) using a pulse width modulated signal (PWM signal) corresponding to the current cooling requirement. A magnetic field is generated at the valve lever (4) which then closes the valve lever (4).
The silicone oil then flows partly or completely through the return hole (3) back into the working chamber, which then results in the fan speed being reduced. If the rotational speed of the fan wheel (1) is to be increased, the PWM signal for actuating the fan clutch solenoid valve (Y616) is changed accordingly. The magnetic field is then reduced and the valve lever (4) opens the inflow into the working chamber.

On vehicles equipped with a high-speed fan drive, the rotational speed of the primary side is higher by the respective step-up ratio.

ⓘ Information on the respective step-up ratio for the belt drive is stored in the engine management (MCM) control unit (A4).

The secondary side is connected to the fan wheel (1). The main bearing (14) separates it from the primary side.
The rotational speed of the secondary side is sensed by the engine management (MCM) control unit (A4) through the fan rpm sensor (Y616 b1).
The rotation of the primary side generates a centrifugal pressure. The centrifugal force induces the silicone oil to flow from the reservoir chamber (5) through the oil feed bore (9) and into the working chamber. The inflow of silicone oil is regulated by the valve lever (4). It opens and closes the oil feed bore (9).
The valve lever (4) is actuated by the engine management (MCM) control unit (A4) through the fan clutch solenoid valve (Y616).

This then increases the volume of silicone oil that flows in. The fan rotational speed and the cooling output are increased. Due to this operating principle, the electromagnetic viscous coupling (2) operates in fail-safe mode. In other words, in the event of an electronic defect, e.g. line break, the electromagnetic viscous coupling (2) is activated at full output (max. cooling output).

Thermal protection function
To prevent any thermal overloading of the silicone oil in the electromagnetic viscous coupling (2), from an engine speed of n = approx. 2200 rpm (vehicles without high-speed fan drive) or n = 1850 rpm (vehicles with high-speed fan drive), a limited activation of the viscous coupling is then necessary. Depending on the engine's operating condition, the electromagnetic viscous coupling (2) is either fully activated or not at all. This is necessary to prevent any critical temperature in the electromagnetic viscous coupling (2). Cooling output remains available.

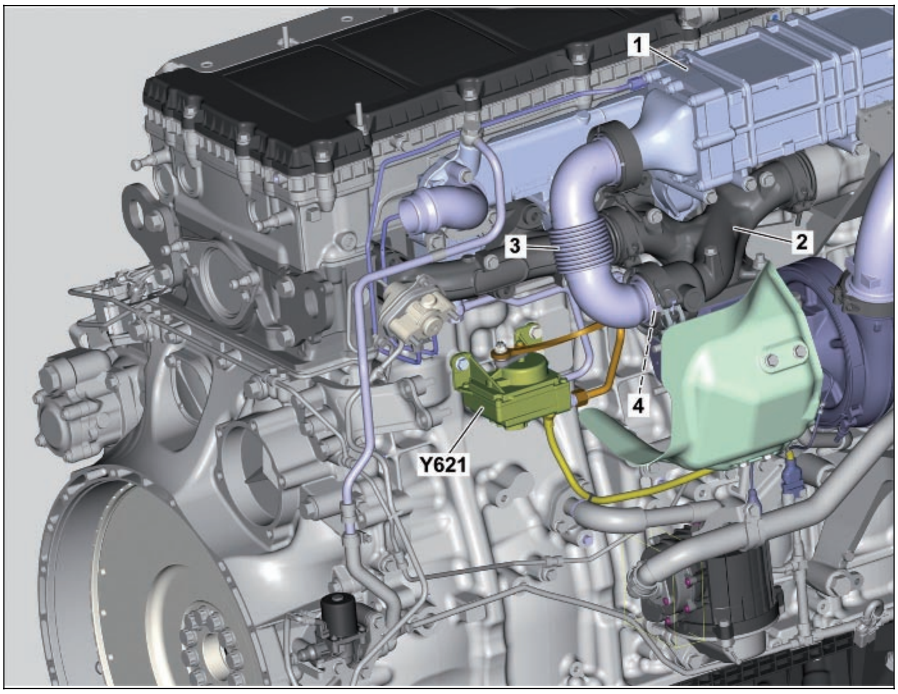
GF14.20-W-4007H	Component description for exhaust gas recirculation controller	20.7.11

ENGINE 471.9 in MODEL 963, 964

Location

1 Exhaust gas recirculation cooler
2 Exhaust manifold center section
3 Exhaust gas recirculation pipe
4 Throttle valve

Y621 Exhaust gas recirculation positioner



W14.20-1025-76

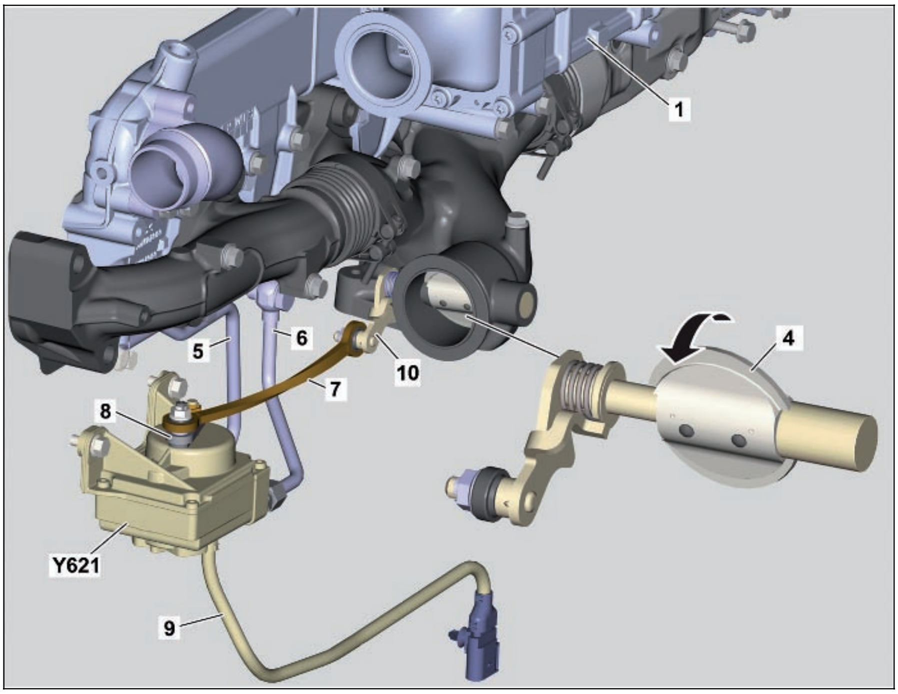
Task

The exhaust gas recirculation positioner (Y621) regulates the volume of recirculated exhaust gas through deflection of the throttle valve (4).

Design

1 Exhaust gas recirculation cooler
4 Throttle valve
5 Coolant line
6 Coolant line
7 Actuator rod
8 Lever
9 Electrical line
10 Control lever

Y621 Exhaust gas recirculation positioner



W14.20-1026-76

The exhaust gas recirculation positioner (Y621) consists of a housing, which has a coil inside and a mechanism for moving the adjusting lever (10) for the throttle valve (4).
The component is supplied with coolant from the engine's coolant circuit through a duct.

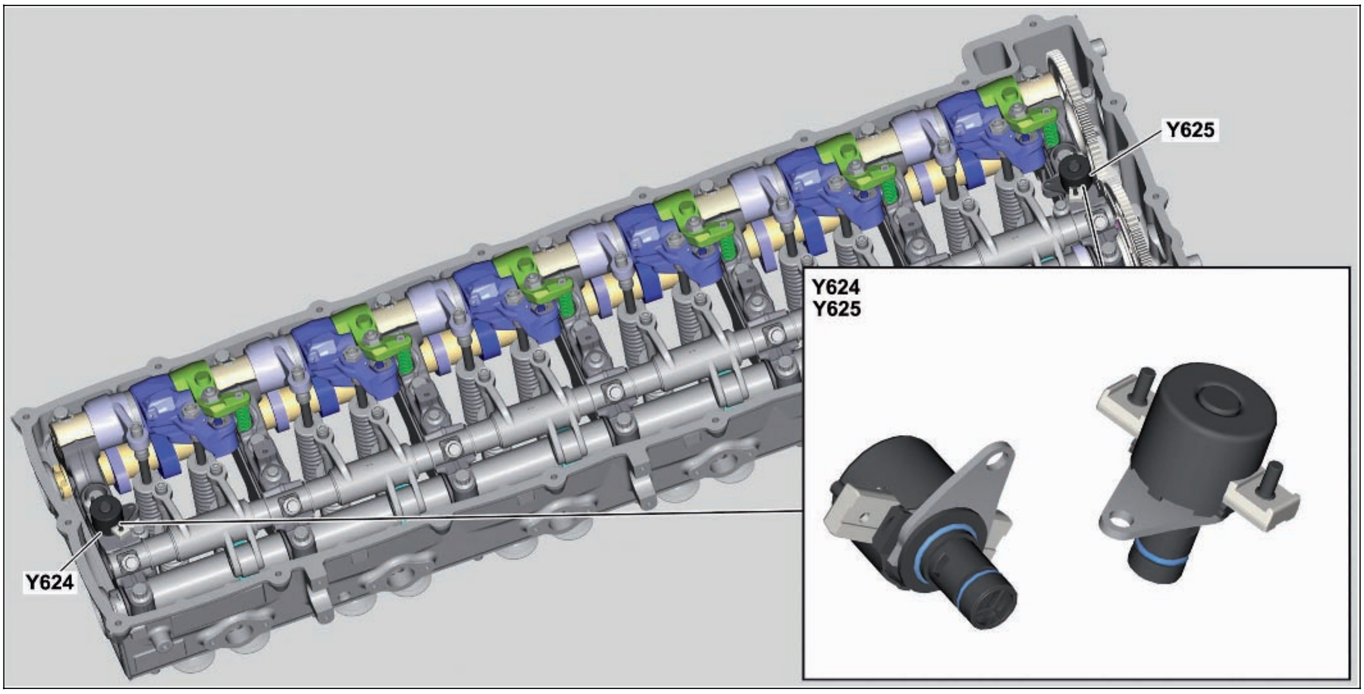
Function

Exhaust gas recirculation rate control
The exhaust gas recirculation positioner (Y621) is actuated by a PWM signal from the engine management (MCM) control unit (A4).
During actuation a magnetic field is generated inside the coil through which the mechanism is then actuated to deflect the adjusting lever (10).
The adjusting lever (10) is connected to the throttle valve (4) in the exhaust gas recirculation pipe (3) and it gradually rotates this depending on the control signal from the engine management (MCM) control unit (A4) so that more or less exhaust is branched off towards the exhaust gas recirculation cooler.

Influence on the engine braking system
The exhaust gas recirculation positioner (Y621) is actuated in certain circumstances by the engine management (MCM) control unit (A4) to support the engine braking system. In interplay with the waste gate valve of the turbocharger, this should help to achieve an increase in the cylinder's internal pressure, which in turn means that the upstroke piston is braked more powerfully, and therefore the braking torque is increased.

GF14.15-W-3000H	Component description for engine brake solenoid valve	2.8.11

ENGINES 471.9 in MODEL 963, 964 with CODE () Engine brake, standard system
ENGINES 471.9 in MODEL 963, 964 with CODE () Engine brake, high performance system



W14.15-1138-79

Location

Y624 Engine brake solenoid valve, stage 1
Y625 Engine brake solenoid valve, stage 2

The engine brake solenoid valve, stage 1 (Y624) is installed in the front rocker arm bracket, the Engine brake solenoid valve, stage 2 (Y625) in the rear rocker arm bracket in the camshaft case.

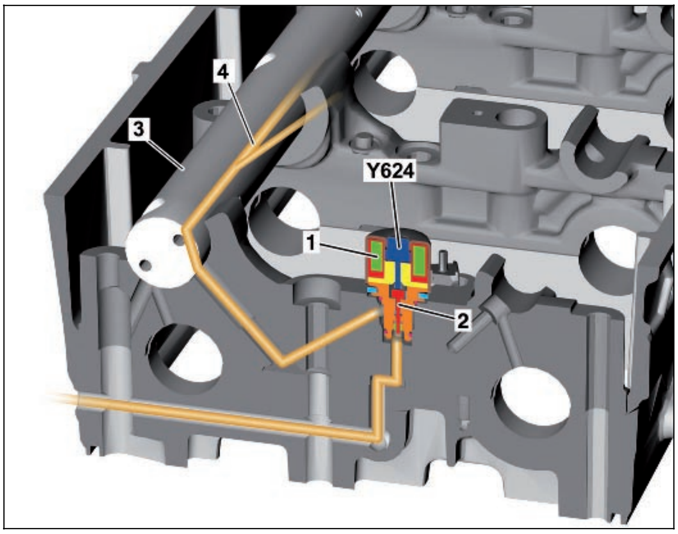
Task

The task of the engine brake solenoid valve, stage 1 (Y624) is to supply oil pressure to the hydroelements in the exhaust rocker arms of cylinders 1 and 3.
The engine brake solenoid valve, stage 2 (Y625) on the other hand applies oil pressure to cylinders 4...6 for actuation.

Design

Shown on engine brake valve, stage 1 (Y624)

1	*Coil*
2	*Valve body*
3	*Outlet rocker shaft*
4	*Oil ducts for cylinders 1...3*
Y624	*Engine brake solenoid valve, stage 1*



W14.15-1139-81

Function

For a stopped engine the valve body (2) lies under the force of gravity on its downstop. The control oil passage to the exhaust rocker arm spindle (3) is open. Since there is no oil pressure applied at this point in time, no control oil flows in the direction of the outlet rocker shaft (3).

If the engine is started oil pressure is applied to the valve body (2) and pushes this against the upper stop. In this way the control oil passage to the exhaust rocker arm spindle (3) is closed off.

Activation of the engine brake
The engine management (MCM) control unit (A4) actuates the engine brake solenoid valve, stage 1 (Y624) just as soon as the driver activates the engine brake over the engine brake switch. The energization of the coil (1) the valve body (2) is presses into the downstop.
The pressure oil now flows through the again opened pressure oil passage over the oil duct for cylinders 1...3 (4) contained in the outlet rocker shaft (3) to the exhaust rocker arms with hydroelement. The engine brake is activated in this way.

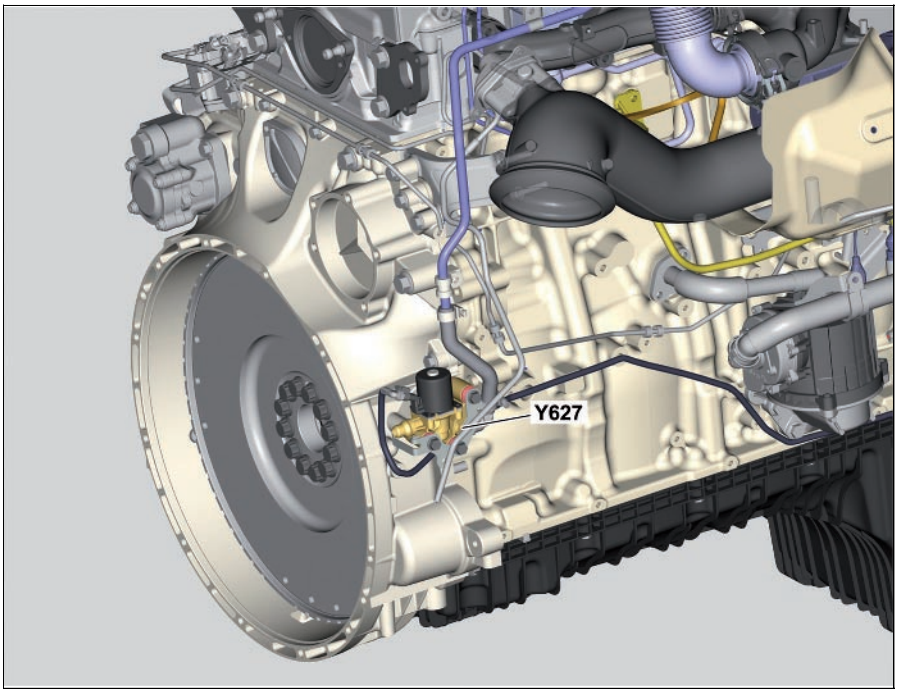
Deactivation of the engine brake
If the driver sets the engine brake switch back into position 0 or the engine brake is deactivated, the coil (1) is no longer energized - the valve body (2) is pushed upwards. No more oil flows over the control oil passage in the outlet rocker shaft (3). The oil remaining in the outlet rocker shaft (3) escapes in the ventilation.

i For brake stages 2 and 3 engine brake valve, stage 2 is actuated.

GF14.40-W-3025H	AdBlue® heater coolant solenoid valve, component description	20.7.11

ENGINE 471.9 in MODEL 963, 964

Location



W14.40-1600-76

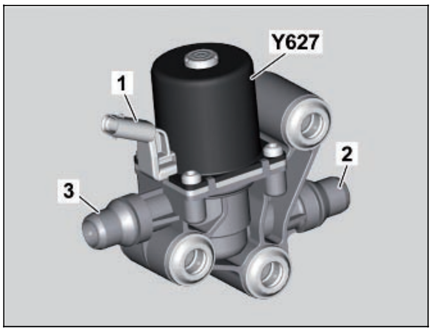
Shown on engine 471.9 with code (M5Z)
Engine version Euro VI
Y627 AdBlue® heater coolant solenoid valve

The AdBlue® heater coolant solenoid valve (Y627*)* is located at the right rear on the engine's crankcase.

Task

The AdBlue® heater coolant solenoid valve (Y627*)* branches off coolant from the engine's coolant circuit to heat the AdBlue® line circuit, the AdBlue® container and the pump module.

Design



W14.40-1573-71

1 Electrical connector
2 Coolant inlet
3 Coolant outlet

Y627 AdBlue® heater coolant solenoid valve

The AdBlue® heater coolant solenoid valve (Y627*)* is A 2/2 directional control valve.
Inside the valve, the valve body is designed as a solenoid armature.

Function

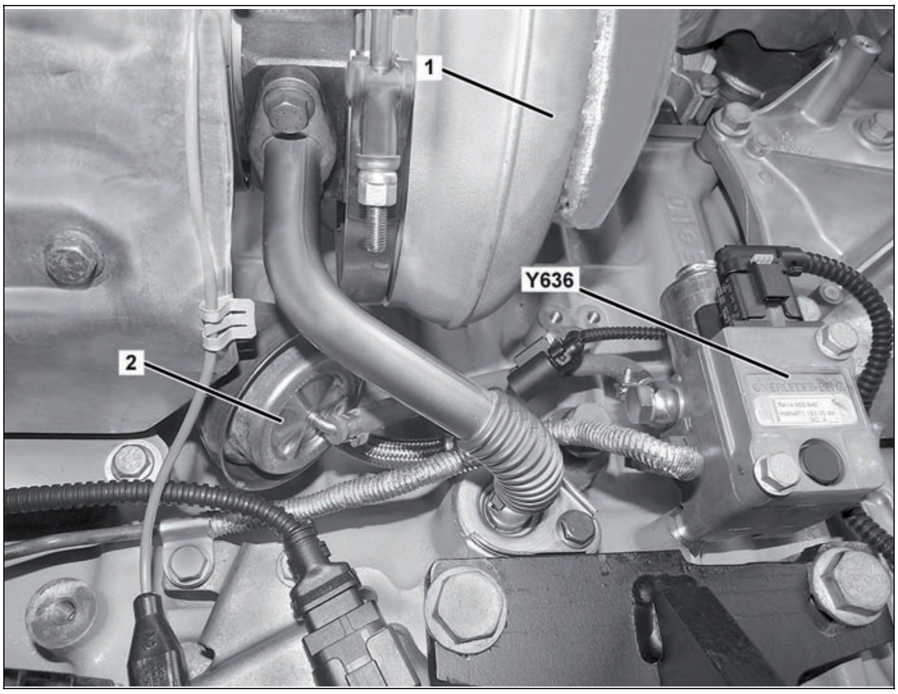
The AdBlue® heater coolant solenoid valve (Y627*)*) is actuated by the engine management (MCM) control unit (A4). The AdBlue® fill level sensor/temperature sensor (B74) enables the engine management (MCM) control unit (A4) to recognize whether the temperature of the AdBlue® is approaching the limit of 8 °C.
If the coolant has reached a temperature of ≥ 65 °C, and the temperature of the AdBlue has reached the limit value, then the AdBlue® heater solenoid valve (Y627*)* is actuated by the engine management (MCM) control unit (A4). The valve then opens and coolant is branched off from the engine's coolant circuit.
If the AdBlue® heater coolant solenoid valve (Y627) is open, the coolant is available at the closed valve body inside the component.

This valve body keeps the passage between the coolant supply line and the coolant working line closed via the force of a push spring.
When current is applied the valve body slides and opens the passage so that coolant can flow through.
When the current is interrupted, the spring pushes it back into its starting position. Thus means that the passage is blocked off again.

GF09.40-W-4020H	Component description for boost pressure regulator	1.7.11

ENGINES 471.9 in MODEL 963

Location



W09.40-1212-06

Shown code (M5Z) Engine version Euro VI

1 Turbocharger
2 Vacuum cell

Y636 Charge pressure positioner

The boost pressure regulator (Y636) is located on the right side of the engine next to the turbocharger (1).

Task

The vacuum cell (2) on the turbocharger (1) has compressed air applied to it over the boost pressure regulator (Y636).
If the engine management (MCM) control unit (A4) recognizes that the current boost pressure or the rotor speed is too high it limits the boost pressure or the rotor speed in that it actuates the boost pressure regulator (Y636) with an appropriate pulse width modulated signal. The engine management (MCM) control unit (A4) can use the duty cycle of this signal to influence the pressure (up to 2.8 bar) which should be applied to the vacuum cell (2).

A valve is opened on the bypass opening over a linkage according to this pressure which allows more or less exhaust to be led past the turbine wheel dependent on how wide it is opened.
Since only part of the exhaust (D) hits the turbine wheel the acceleration is not so strong anymore and the boost pressure or the rotor speed drop.

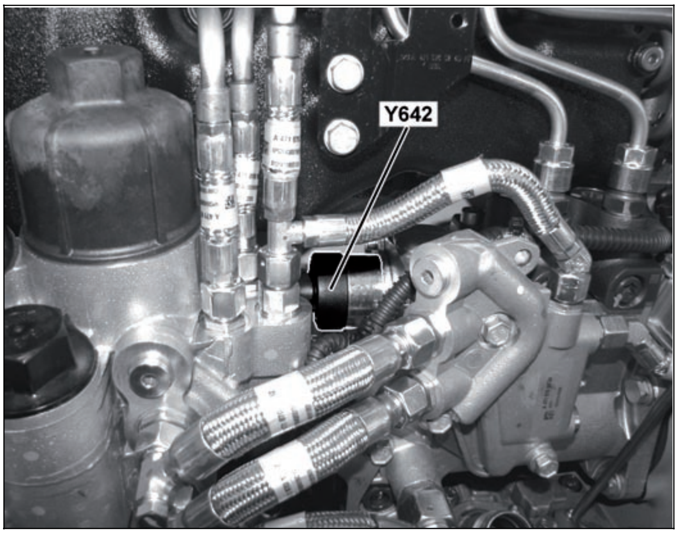
GF07.05-W-6010H	Component description for quantity control valve	20.7.11

ENGINES 471.9 in MODEL 963

Location

Y642 Quantity control valve

The quantity control valve (Y642) is located on the fuel high pressure pump.



W07.16-1068-11

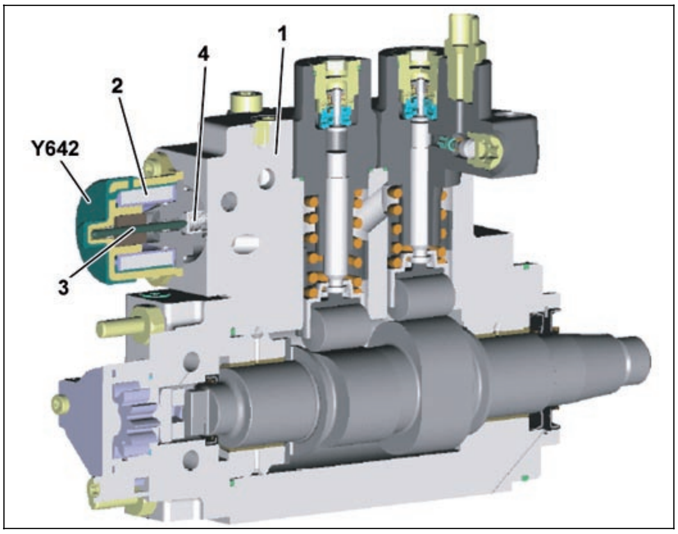
Task

The quantity control valve (Y642) has the following tasks to fulfill:
- Regulation of the fuel feed to the pump elements of the high-pressure pump
- Regulation of the rail pressure
- Discontinuity of fuel supply to pump elements of the fuel high pressure pump for "Engine stop"

Design

1 Fuel high pressure pump housing
2 Coil
3 Float needle
4 Valve spring

Y642 Quantity control valve



W07.05-1003-81

Function

The engine management (MCM) control unit (A4) actuates the coil (2) of the quantity control valve (Y642) using a pulse width modulated signal. The magnetic field of the coil (2) produced in this way influences the position of the float needle (3) and thus the flow cross-section in the quantity control valve (Y642) and flow rate of the fuel.
At "Engine stop" the float needle (3) is pushed back by the valve spring (4) and the fuel flow is interrupted.

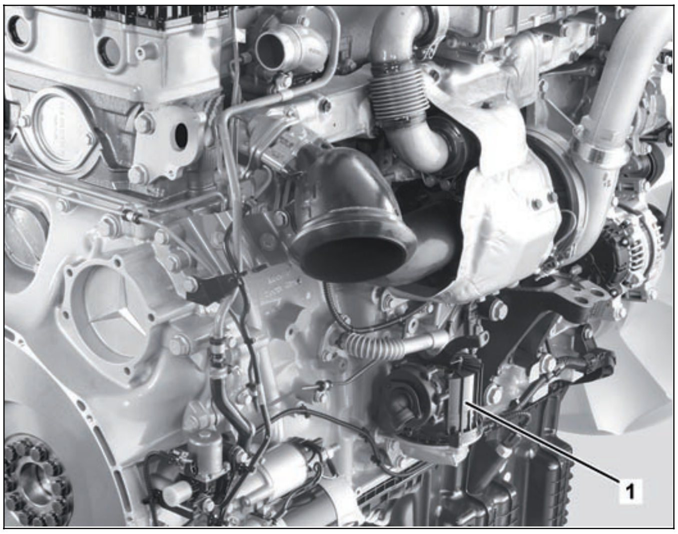
GF01.20-W-2010H	Component description for oil separator	1.7.11

ENGINES 471.9 in MODEL 963

Location

1 Oil separator

The oil separator (1) is located on the right side of the engine below the turbocharger.



W01.20-1048-11

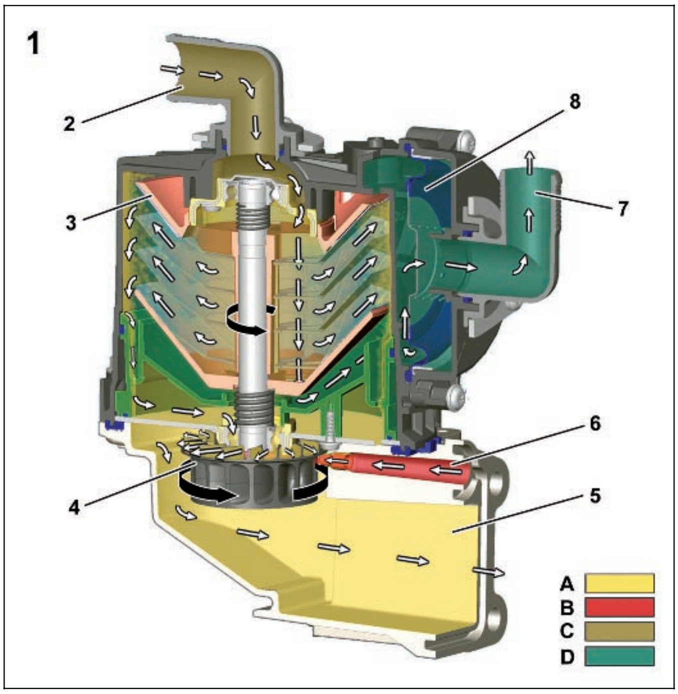
Task

The engine oil separator (1).contained in the blow-by gas (C) is separated off with the aid of a centrifuge and passed back into the oil pan.

Design

1 Oil separator
2 Input fitting (blow-by gas with engine oil)
3 Centrifuge
4 Centrifuge drive wheel
5 Engine oil drain
6 Oil pressure duct
7 Outlet fitting (blow-by gas, cleaned)
8 Pressure control valve

A Separated out engine oil
B Engine oil (to drive the centrifuge)
C Blow-by-gas (with engine oil)
D Blow-by-gas (clean)



W01.20-1050-82

Function

The blow-by gas (C) generated by internal leakage at the piston rings, valve stem seals, turbocharger and compressor passes over the input fitting (2) into the oil separator (1).
In the oil separator (1) the blow-by gas (C) is led to the centrifuge (3). The centrifuge (3) is caused to turn driven by the centrifuge drive wheel (4) which is driven by the engine oil (B) delivered over the oil pressure duct (6), whereby the rotational speeds can reach up to 8000 rpm.
The centrifugal force so generated throws the engine oil droplets contained in the
blow-by gas (C) onto the disc walls where the gather into larger drops and thrown onto the inner wall of the oil separator (1).

The engine oil (A) separated in this way runs downward along the inner wall and returns to the oil pan via the engine oil drain (5).

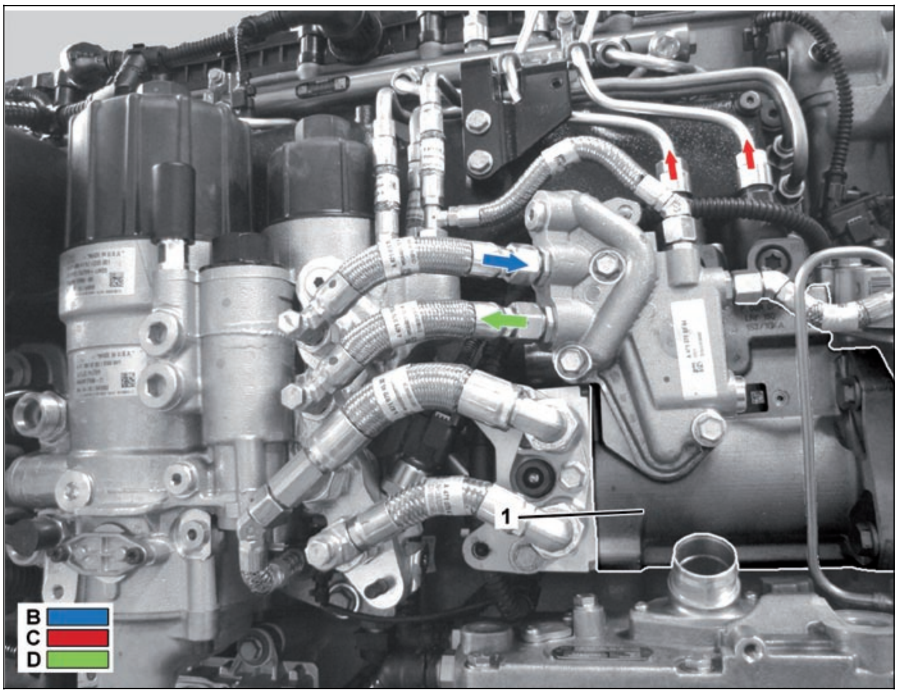
The cleaned blow-by gas (D) is taken out of the oil separator (1) over the outlet fitting (7) and subsequently over a hose into the air intake pipe upstream of the turbocharger.
The pressure regulating valve (8) regulates the pressure in the crankcase.

i The oil separator (1) is maintenance free.

GF07.02-W-3012H	Component description for fuel system high pressure pump	20.7.11

ENGINES 471.9 in MODEL 963

Location



W47.20-1084-76

1 Fuel system high pressure pump

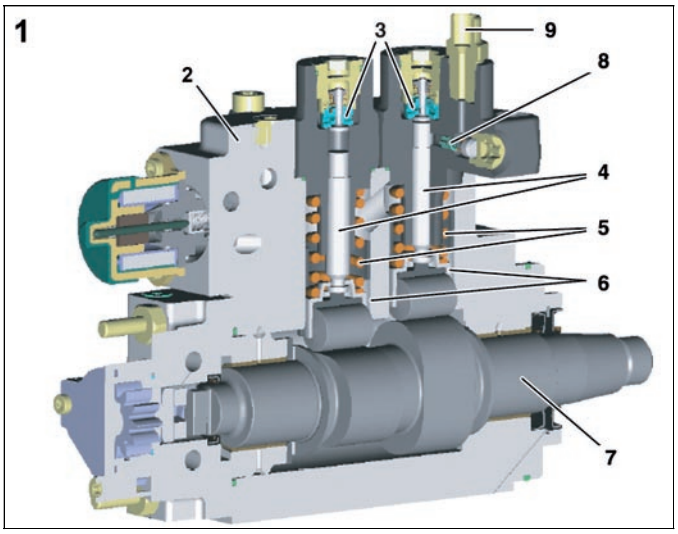
B Fuel feed (thrust side)
C Fuel high pressure
D Fuel return

The fuel high pressure pump (1) is located at the rear on the left side of the crankcase and is driven via the pinion gear drive.

Task

The fuel high-pressure pump (1) supplies the fuel high-pressure circuit with fuel and ensures that the fuel required for combustion is available in sufficient quantity and at the required pressure at the fuel injectors, under all operating conditions.

Design



W07.20-1000-81

1 Fuel system high pressure pump
2 Fuel high pressure pump housing
3 Suction valves
4 High pressure piston
5 Compression springs
6 Roller tappet
7 Camshaft
8 High pressure valve
9 High pressure connection

Function

The camshaft (7) for the fuel high pressure pump (1) is driven by the pinion gear drive.
The fuel is compressed by two high-pressure pistons (4) and led via the respective high-pressure connection (9) and corresponding high-pressure lines to the rail.
Both roller tappets (6) on the double cams of the camshaft (7) are pressed together by the two push springs (5) which are offset by 90°. Thus two power strokes occur for one camshaft revolution per high-pressure piston (4).
If the high pressure piston (4) is in a downward movement, the fuel can flow over the corresponding intake valve (3) into the clearance volume via the high pressure piston (4).

If the high pressure piston (4) now changes to an upward movement, the corresponding intake valve (3) is closed by the compression pressure arising and the fuel in compressed until the high pressure valve (8) opens a transfer duct between the high pressure compartment and the corresponding high pressure connection (9). The highly compressed fuel can now flow into the rail.
If the high pressure piston (4) again changes to a downward movement, the transfer duct is closed by the spring-loaded high pressure valve (8) and new fuel can flow through the now opened intake valve (3) into the clearance volume.

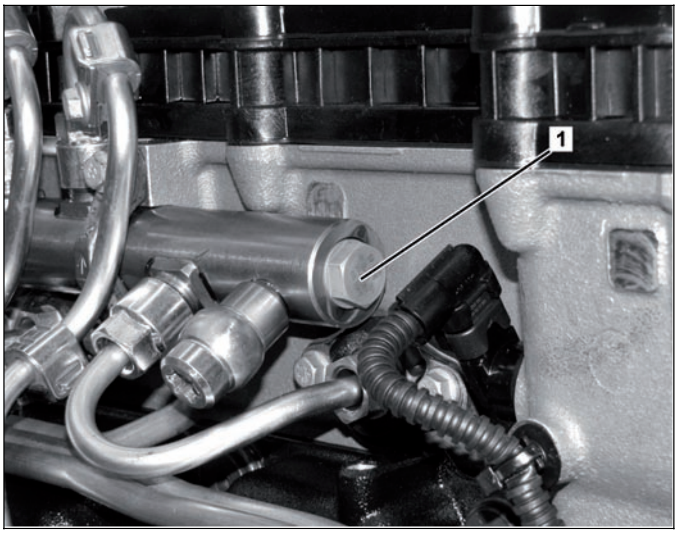
GF07.05-W-6011H	Component description for pressure limiting valve	20.7.11

ENGINES 471.9 in MODEL 963

Location

1 Pressure limiting valve

The pressure limiting valve (1) is located at the rear end of the rail.



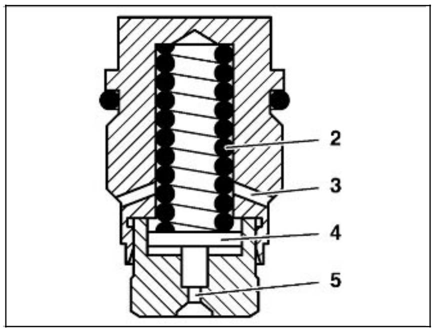
W07.16-1069-11

Task

The pressure limiting valve (1) is a safety element which limits the maximum rail pressure in the injection system to about 1100 bar. If the engine management (MCM) control unit (A4) recognizes that the pressure limiting valve (1) is open it activates the limp-home mode.

Design

2 Compression spring
3 Cutoff bore
4 Pressure plate
5 Cutoff throttle



W07.04-1052-01

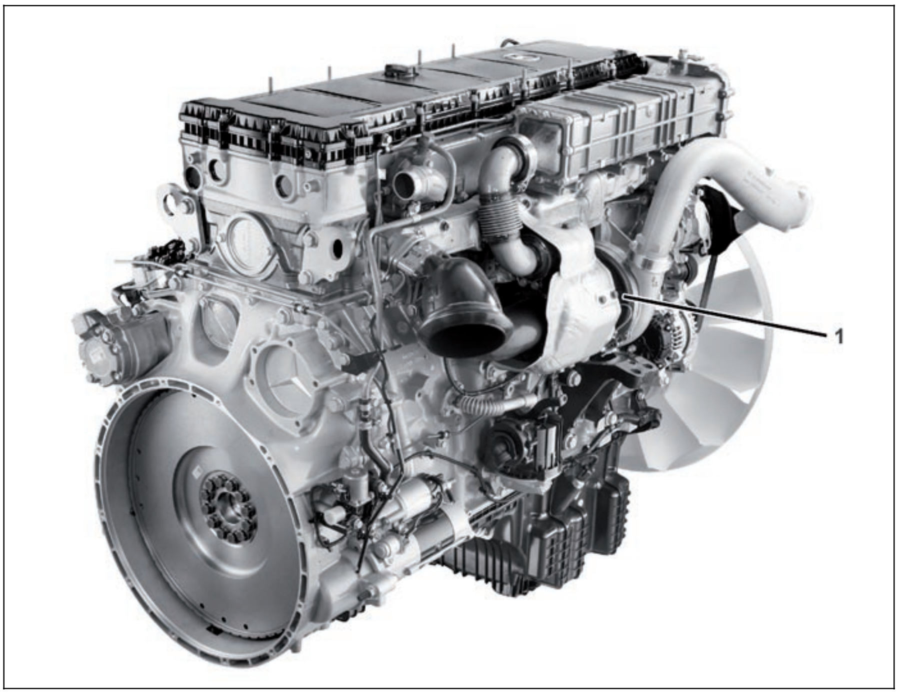
Function

If the current rail pressure exceeds the maximum rail pressure of about 1100 bar, the push spring (2) is pressed together by the pressure plate (4). A connection is opened at the same time to the cutoff bore (3) and the excess fuel flows into the return.

GF09.40-W-4010H	Component description for turbocharger	20.7.11

ENGINES 471.9 in MODEL 963

Location



W09.40-1214-06

Shown code (M5Z) Engine version Euro VI

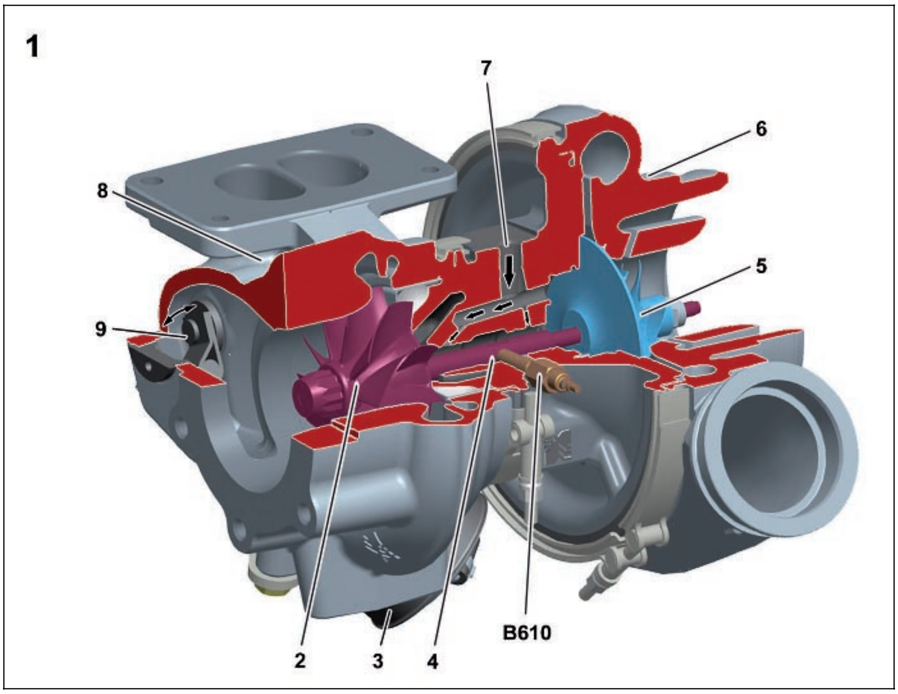
1 Turbocharger

The turbocharger (1) is located on the right side of the engine below the exhaust gas recirculation cooler.

Task

The turbocharger (1) converts the thermal energy of the exhaust flow into mechanical energy and compacts the suctioned air.

Body



W09.40-1230-76

Shown code (M5Z) Engine version Euro VI

1 Turbocharger
2 Turbine wheel
3 Vacuum cell
4 Shaft
5 Compressor impeller
6 Compressor housing
7 Oil supply connection
8 Turbine housing
9 Valve

B610 Rpm sensor for turbine wheel (only for code (M5Z) Engine version Euro VI)

ℹ Engine oil passes to the bearings on the shaft (4) via the oil supply connection (7) which is lubricated and cooled in this way. Via a return line, the engine oil flows back again into the crankcase and from there into the oil pan.

GF14.20-W-2020H	Component description for exhaust gas recirculation cooler	20.7.11

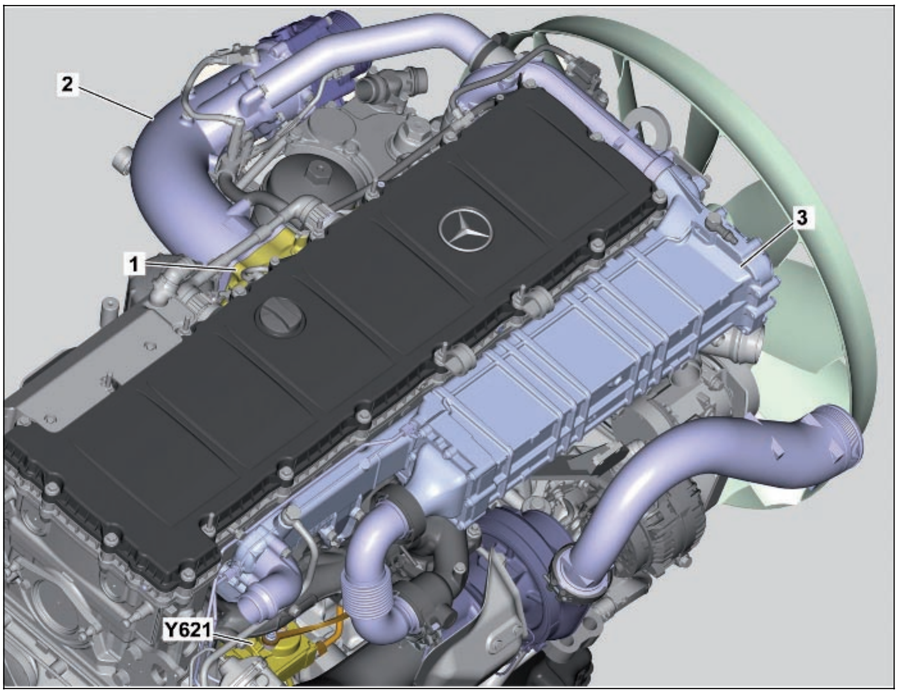
ENGINE 471.9 in MODEL 963, 964

Location

1 Charge air housing
2 Charge air pipe (mixer housing)
3 Exhaust gas recirculation cooler

Y621 Exhaust gas recirculation positioner

The exhaust gas recirculation cooler (3) is located on the right side of the engine over the exhaust manifold and the turbocharger.



W14.20-1021-76

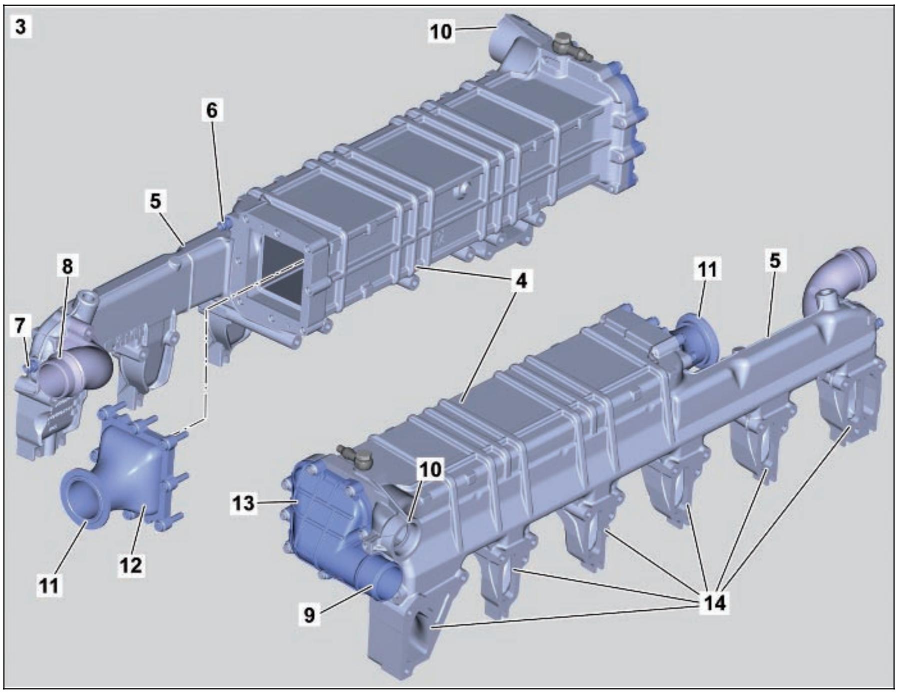
Task

The exhaust gas recirculation cooler (3) cools the branched off exhaust from a temperature of approx. 650 °C to a temperature of approx. 170 °C.

Design

3 Exhaust gas recirculation cooler
4 Exhaust chamber
5 Coolant strip
6 Coolant output (feed line to nozzle unit for diesel particulate filter regeneration)
7 Coolant line (return line from nozzle unit for diesel particulate filter regeneration)
8 Coolant outlet
9 Exhaust outlet (to charge air pipe)
10 Coolant output (to coolant pump)
11 Exhaust inlet (from exhaust manifold)
12 Front end cover
13 Rear end cover
14 Coolant outlet

The exhaust gas recirculation cooler (3) consists of an oblong box-shaped housing, with two disconnected chambers - the exhaust chamber (4) and the coolant strip (5).



W14.20-1022-76

Function

The branched off exhaust flows through the exhaust inlet (11) into the exhaust chamber (4) and flows through it and on to the exhaust outlet (9) towards the charge air pipe (2), where it is then fed together with the fresh air or the charged air to the combustion process.

Coolant from the engine's coolant circuit permanently flows through the coolant strip (5) of the exhaust gas recirculation cooler.
The exhaust gas that flows in the exhaust chamber (4) is cooled by the heat transfer.

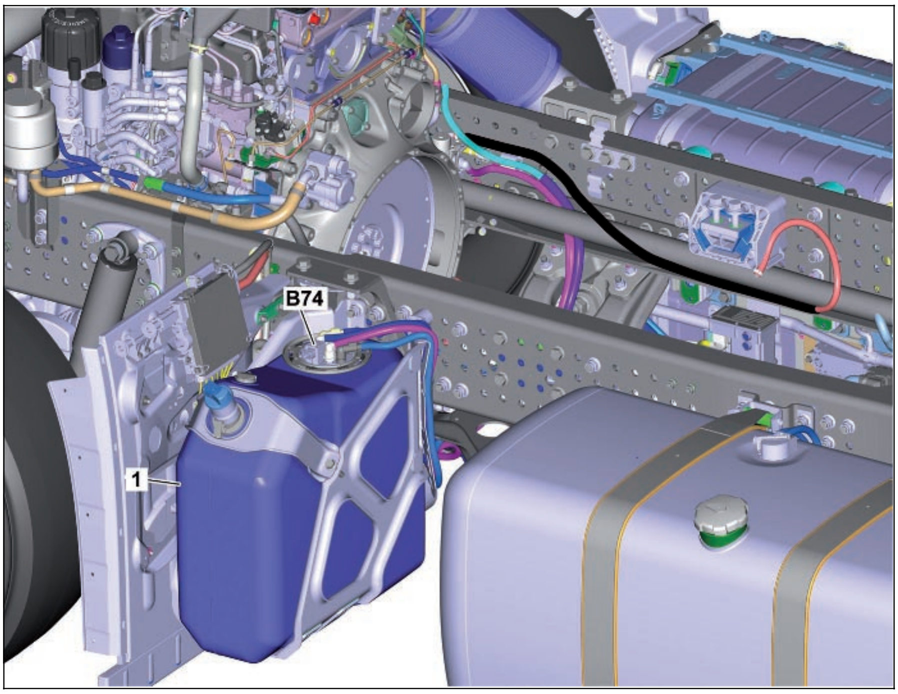
GF14.40-W-3001H	Component description for AdBlue tank	20.7.11

ENGINE 471.9 in MODEL 963, 964

Location

1 AdBlue® tank

B74 AdBlue® fill level sensor/temperature sensor

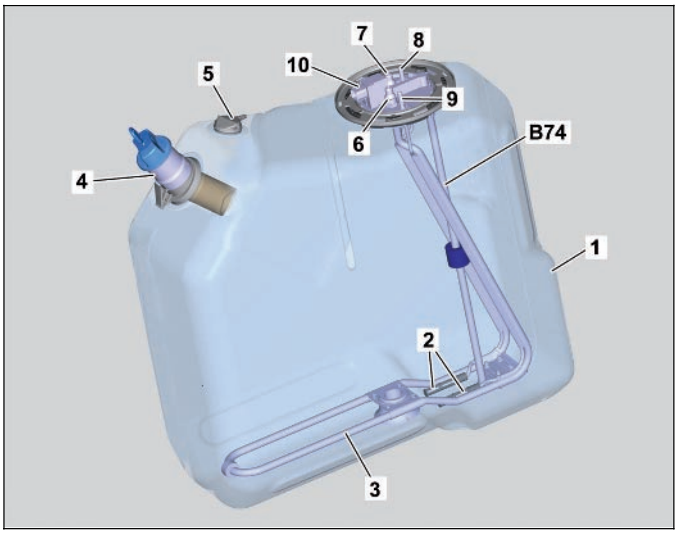


W14.40-1563-76

Design

1 AdBlue® tank
2 AdBlue® filter
3 Coolant duct
4 Filler neck
5 Bleeding
6 Coolant inlet (from engine)
7 Coolant outlet (to pump module)
8 AdBlue® inlet (return from AdBlue® metering device)
9 AdBlue® outlet (feed line to pump module)
10 Electrical connection

B74 AdBlue® fill level sensor/temperature sensor



W14.40-1564-81

Function

AdBlue® refueling
The filler neck (4) with its special diameter and integrated magnetic adapter should prevent incorrect fueling, e.g. with diesel fuel.

During refueling, the magnetic field of the magnetic adapter actuates a solenoid switch located in the outlet pipe of the nozzle, thereby enabling the tank to be refueled.

This system also prevents incorrect fueling of the diesel fuel tank with AdBlue®, as its filler neck is not fitted with a magnetic adapter and the solenoid switch in the nozzle only permits refueling when a defined magnetic field is present.

AdBlue® heating
The coolant coming from the engine or the AdBlue® heater coolant solenoid valve flows through the coolant inlet (6) into the coolant duct (3), flows through this and then through the coolant outlet (7) and on to the pump module.
The heat transfer of the coolant duct (3) means that any frozen AdBlue® is defrosted and it also prevents liquid AdBlue® from freezing at low temperatures.

GF18.10-W-4000H	Component description for oil pump	20.7.11

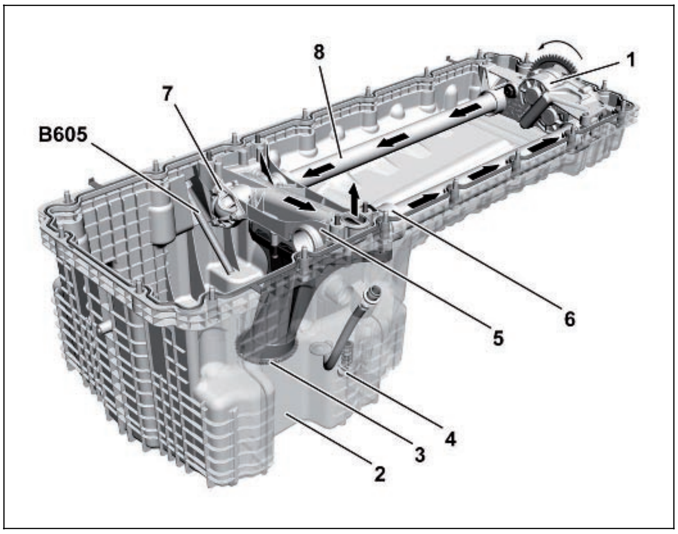
ENGINE 471.9 in MODEL 963

Location

1 Oil pump
2 Oil pan
3 Oil strainer
4 Oil drain screw
5 Oil intake manifold
6 Suction pipe
7 Return flow check valve
8 Pressure line

B605 Engine oil fill level sensor

The oil pump (1) is located in the oil pan (2) at the output side of the engine.



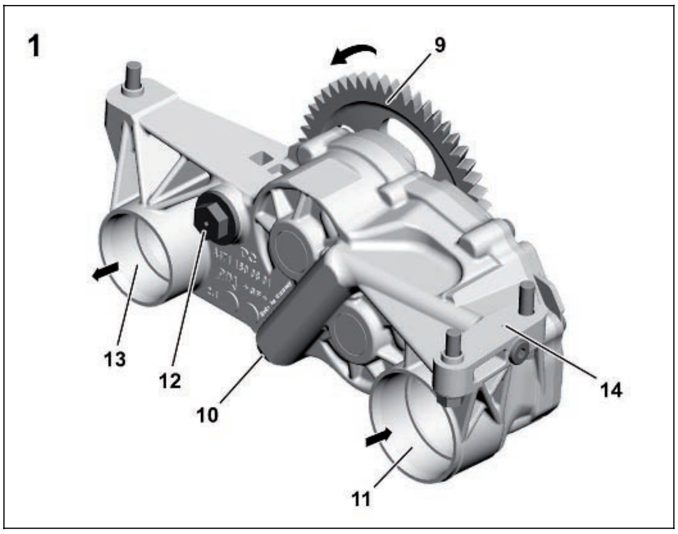
W18.10-1044-11

Task

The oil pump (1) supplies the oil circuit of the engine with engine oil. It ensures that engine oil is available under all operating conditions in adequate quantities and at the required pressure at the respective locations.

Body

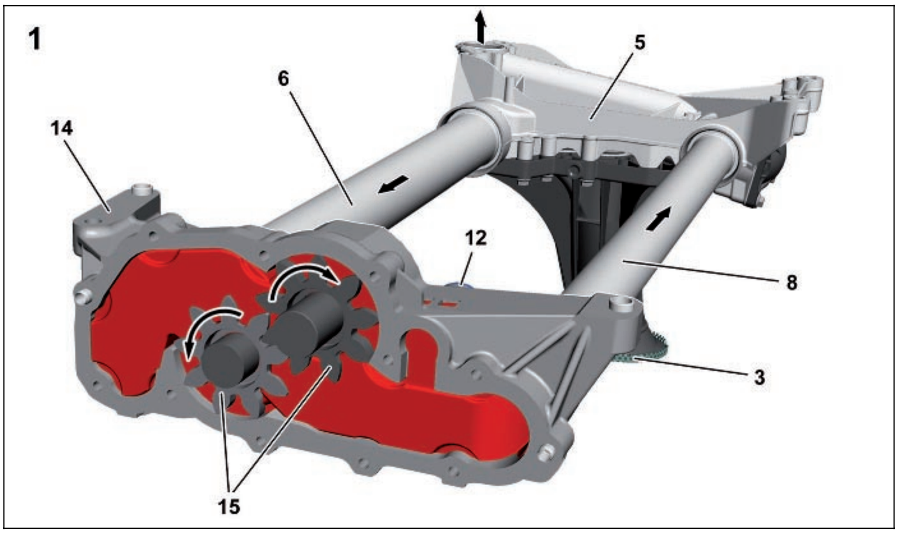
Rear
1 Oil pump
9 Drive gear
10 Pressure control valve
11 Oil inlet
12 Safety valve
13 Oil outlet
14 Oil duct - to pressure regulator valve (10)



W18.10-1045-11

Front side, without drive gear (9)

- *1 Oil pump*
- *3 Oil strainer*
- *5 Oil intake manifold*
- *6 Suction pipe*
- *8 Pressure line*
- *12 Safety valve*
- *14 Oil duct (to pressure regulator valve (10))*
- *15 Impeller*



W18.10-1046-75

Function

The drive gear (9) for the oil pump (1) which is driven by the crankshaft gear drives the two impellers (15).
The rotational movement of the impellers (15) and the design of the pump chamber cause the engine oil to be suctioned up and delivered to the oil outlet (13) along the inner wall of the pump. When sucked in, the engine oil in the oil pan (2) flows first to the oil strainer (3) and the suction line (6), before passing through the oil inlet (11) into the oil pump (1).

The engine oil flows first through the oil outlet (13) into the pressure line (8) before then flowing through the return flow check valve (7) and the main oil duct's feed line into the engine oil circuit.

Regulation of the engine oil pressure takes place via the pressure regulator valve (10).
The pressure regulator valve (10) has the oil pressure applied to it via the engine oil in the oil duct (14) which is connected with the main oil duct. A certain amount of engine oil is fed via the pressure regulator valve (10) on the suction line according to the oil pressure in the oil duct (14). This regulates the engine oil pressure on the one hand and reduces the operating energy input of the oil pump (1) on the other.

Impermissibly high pressures in the oil circuit are avoided via the safety valve (12) which can occur in the cold start phase of the engine if the engine oil is not yet viscous.
The safety valve (12) opens at a pressure $>$10 bar and routes some of the engine oil back into oil pan (2).

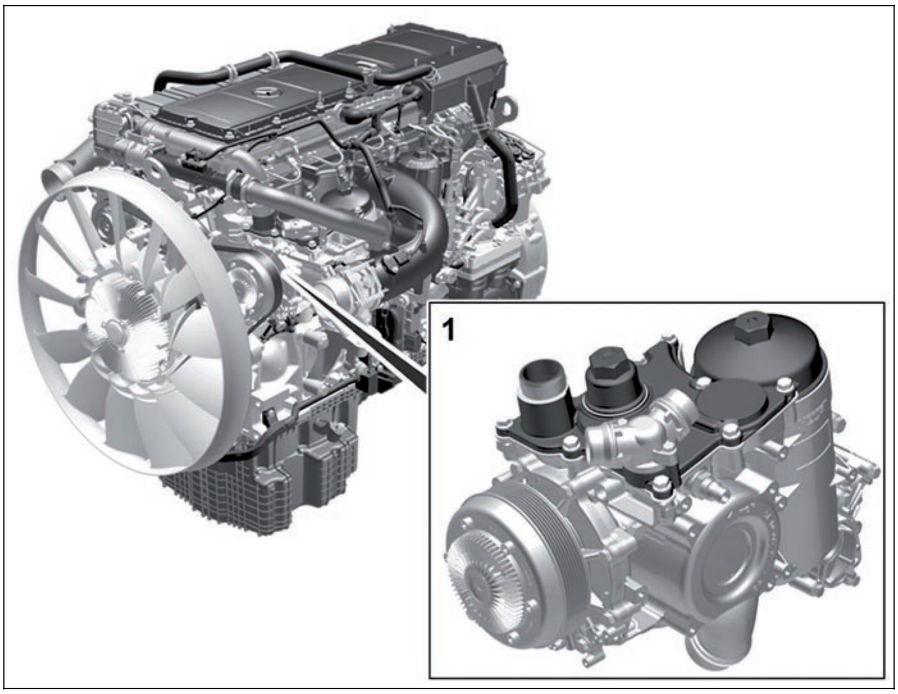
GF18.20-W-4100H	Oil/coolant module, component description	20.7.11

ENGINE 471.9 in MODEL 963

Location

1 Oil/coolant module

The oil/coolant module (1) is located on the left side of the engine.



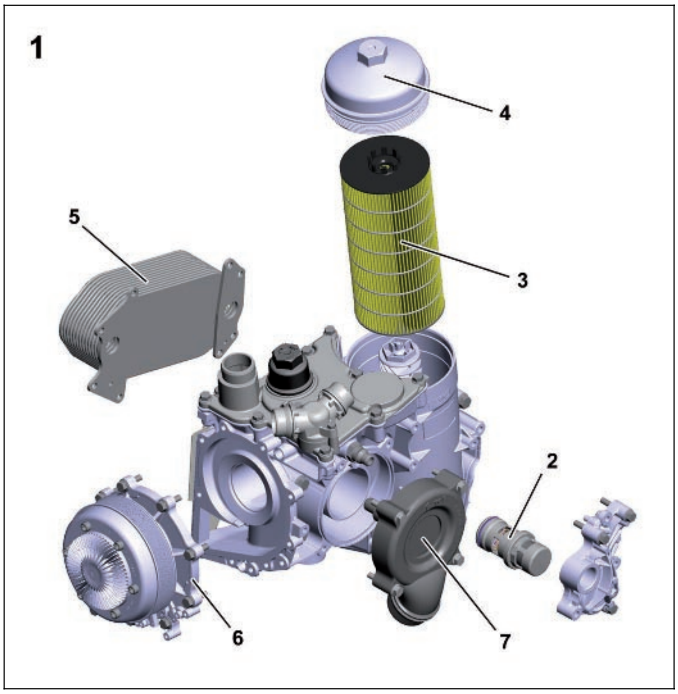
W18.20-1032-06

Task

The oil/coolant module (1) is used to:
- Filter the engine oil
- Regulate the engine oil temperature
- Regulate the coolant temperature
- Support the coolant pump

Body

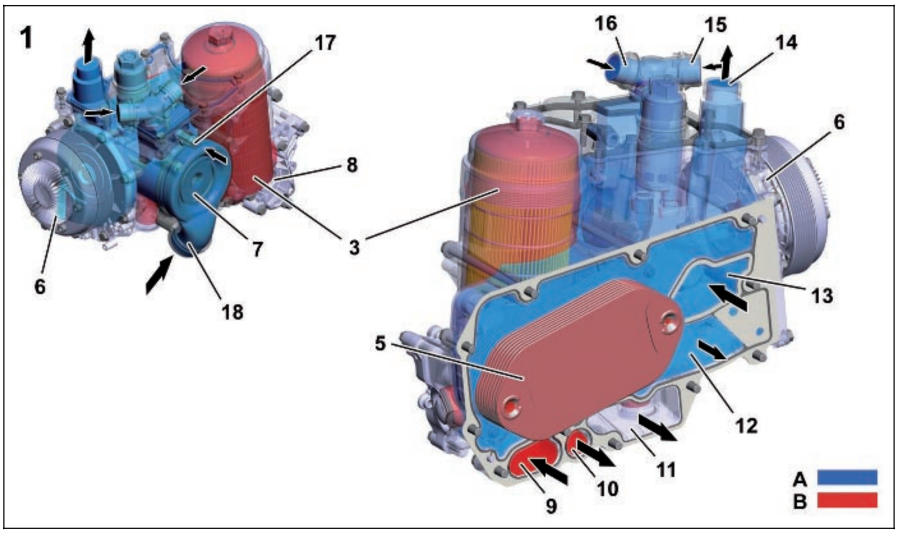
1 Oil/coolant module
2 Oil thermostat
3 Oil filter
4 Oil filter cover
5 Oil/water heat exchanger
6 Coolant pump
7 Coolant thermostat



W18.20-1037-82

Function

1 Oil/coolant module
3 Oil filter
5 Oil/water heat exchanger
6 Coolant pump
7 Coolant thermostat
8 Initial filling valve
9 Engine oil inlet (from oil pump)
10 Engine oil outlet (to main oil ducts in crankcase)
11 Engine oil drain from oil filter (for oil filter change)
12 Coolant outlet (to crankcase)
13 Coolant inlet (from coolant bypass duct)
14 Coolant outlet (to exhaust gas recirculation cooler)



W18.20-1038-75

15 Coolant inlet (from coolant expansion reservoir, when the coolant expansion reservoir is at the front or the heater return, when the coolant expansion reservoir is at the rear)
16 Coolant inlet (from coolant expansion reservoir, when the coolant expansion reservoir is at the rear or the heater return, when the coolant expansion reservoir is at the front)
17 Coolant inlet (return from compressor and fuel cooler)
18 Coolant inlet (from cooler)

A Coolant
B Engine oil

Filter the engine oil
The engine oil flows, depending on the position of the oil thermostat (2), either straight into the oil filter housing (3) or after it has passed through the oil-water heat exchanger (5).

In the oil filter housing the engine oil flows from the outside inwards through the oil filter (3) and on to the support dome, where it is filtered The worm-shaped characteristic of the support dome routes the filtered engine oil upwards to the tip of the support dome, where it flows in through several holes in the support dome. Within the support dome the engine oil is initially routed downwards and then to the rear of the oil/coolant module (1), where the engine oil outlet (10) is located. The filtered engine oil then flows through the engine oil outlet (10) into the crankcase and the main oil ducts located there, and therefore back into the oil circuit.

Regulate the engine oil temperature
To regulate the engine oil temperature an oil thermostat (2) is located immediately downstream of the engine oil inlet.
At an engine temperature of less than 115 °C the engine oil is routed through the open oil thermostat (2) over a bypass straight into the oil filter (3). At 115 °C the oil thermostat (2) closes the bypass and the engine oil flows first to the oil-water heat exchanger (5) before reaching the oil filter (3).

Regulating the coolant temperature
The coolant temperature is regulated through the coolant thermostat (7). When the engine is cold, the coolant pump (6) makes the coolant circulate inside the engine. The coolant from the coolant short-circuit duct flows over the coolant inlet (13) into the oil/coolant module (1) where it is routed at the closed coolant thermostat (7) past the coolant pump (6) to the coolant outlet (12). When the engine operating temperature is reached, the cooler circuit is activated when the coolant thermostat (7) is opened.

The coolant from the cooler flows over the coolant inlet (18) and the open coolant thermostat (7) into the oil/coolant module (1). Depending on the position of the coolant thermostat (7), more or less coolant flows through the cooler or directly over the coolant bypass line to the coolant pump (6). The temperature of the coolant in the coolant circuit is regulated in this way.

GF18.30-W-2020H	Oil thermostat, component description	20.7.11

ENGINE 471.9 in MODEL 963

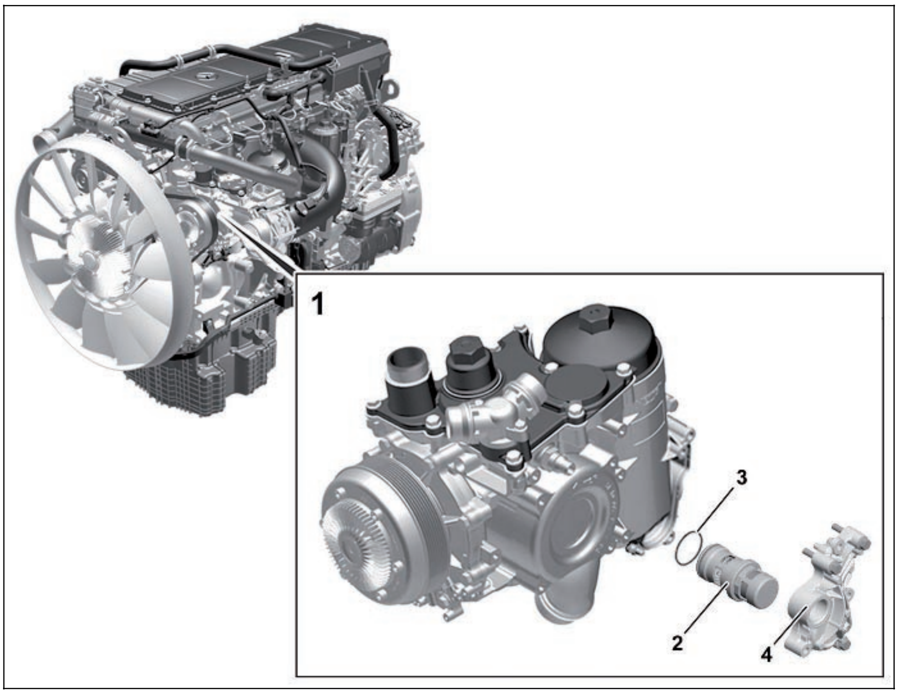
Location

1 Oil/coolant module
2 Oil thermostat
3 O-ring
4 Cover

The oil thermostat (2) is built into the oil/coolant module (1), which is located on the left side of the engine.

Task

The oil thermostat (2) is used to regulate the engine oil temperature.

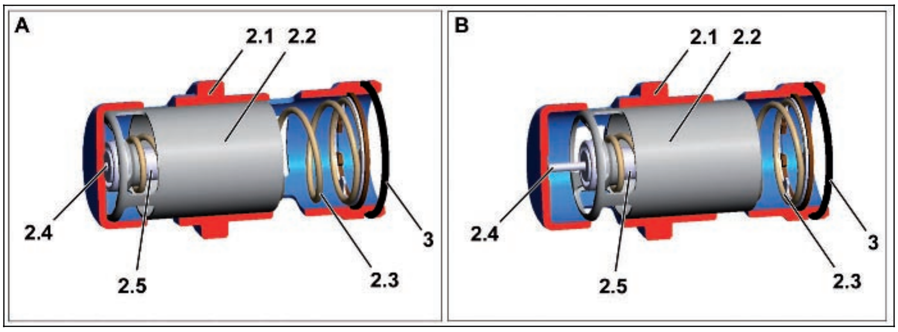


W18.30-1015-06

Design

2.1 Housing
2.2 Sliding ring valve
2.3 Spring
2.4 Operating piston
2.5 Expansion element
3 O-ring

A Oil thermostat open
B Oil thermostat closed

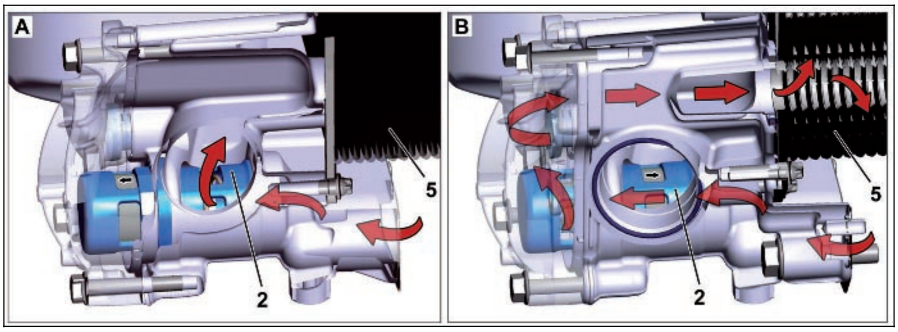


W18.30-1016-74

Function

2 Oil thermostat
5 Oil/water heat exchanger

A Oil thermostat open
B Oil thermostat closed



W18.30-1017-74

At an engine temperature of less than 115 °C the engine oil is routed through the open oil thermostat (2) over a bypass straight into the oil filter. At 115 °C the oil thermostat (2) closes the bypass and the engine oil flows first to the oil-water heat exchanger (5) before reaching the oil filter.

GF20.00-W-4003H	Component description for oil/water heat exchanger	20.7.11

ENGINE 471.9 in MODEL 963

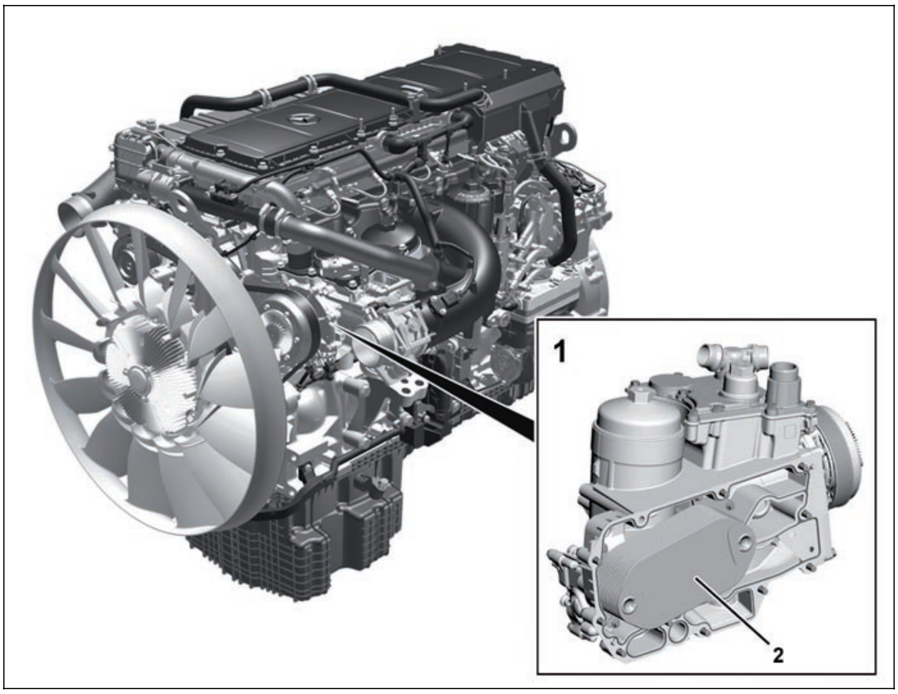
Location

1 Oil/coolant module
2 Oil/water heat exchanger

The oil-water heat exchanger (2) is located on the left side of the engine in the oil/coolant module (1).

Task

The oil-water heat exchanger (2) is used to cool the engine oil.



W20.00-1044-06

Design

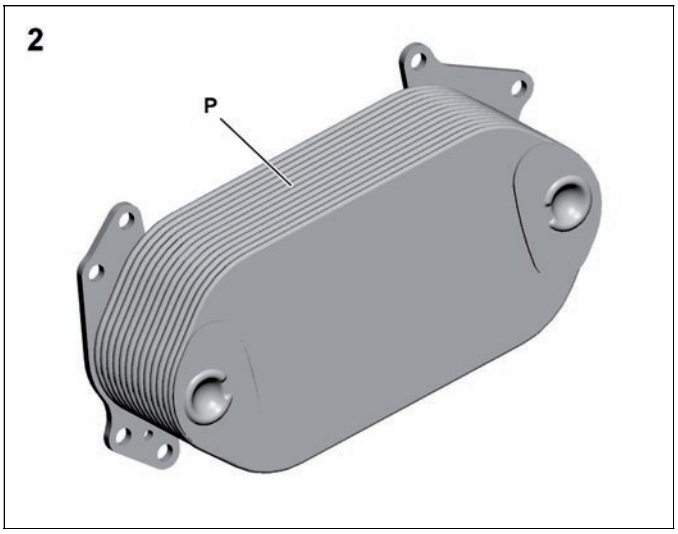
2 Oil/water heat exchanger

P Plates

The oil/water heat exchanger (2) consists of a number of plates (P) in which engine oil circulates.

Function

From an engine oil temperature of 115 °C, when the oil thermostat closes the bypass to the oil filter, the engine oil is routed through the oil-water heat exchanger (2). The oil-water heat exchanger (2) has coolant flowing around it and as a consequence it cools the engine oil.



W20.00-1045-11

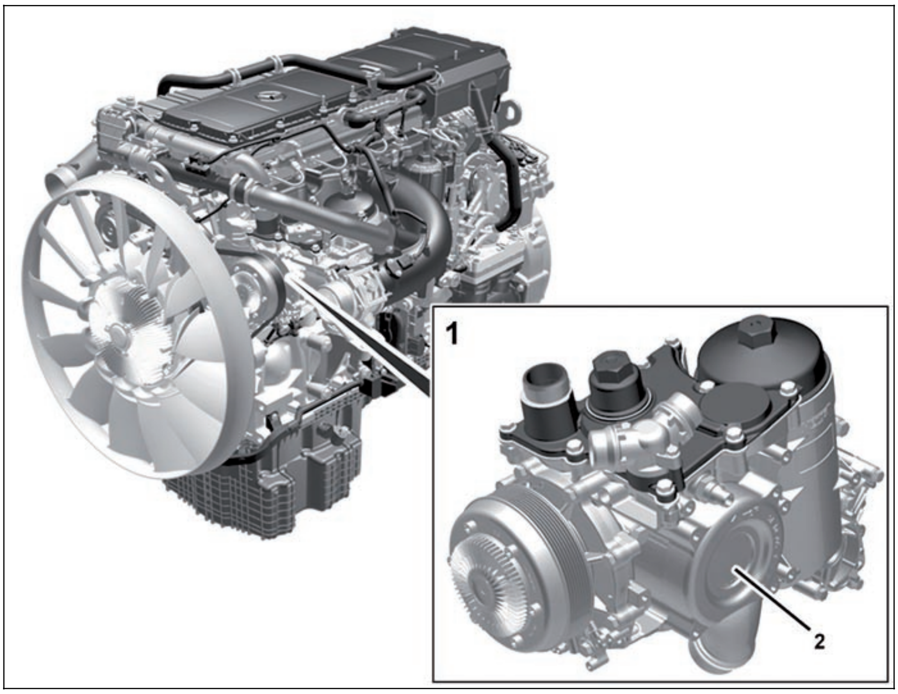
GF20.10-W-3162H	Component description for coolant thermostat	20.7.11

ENGINE 471.9 in MODEL 963

Location

1 Oil/coolant module
2 Coolant thermostat

The coolant thermostat (2) is located on the left side of the engine on the oil/coolant module (1).



W20.10-1066-06

Task

The coolant thermostat (2) regulates the coolant inlet temperature in the engine in a range between roughly 87 °C to 95 °C.

Design

The coolant thermostat (2) consists of a housing with integral sliding ring valve thermostat.

Function

The coolant thermostat (2) regulates the flow of coolant through the engine radiator and thereby the temperature of the coolant in the coolant circuit.
The following benefits result from regulating the coolant inlet temperature in the engine:

- Operating temperature is reached faster
- Emissions reduced

The 3 following different operating conditions can arise depending on the coolant inlet temperature:

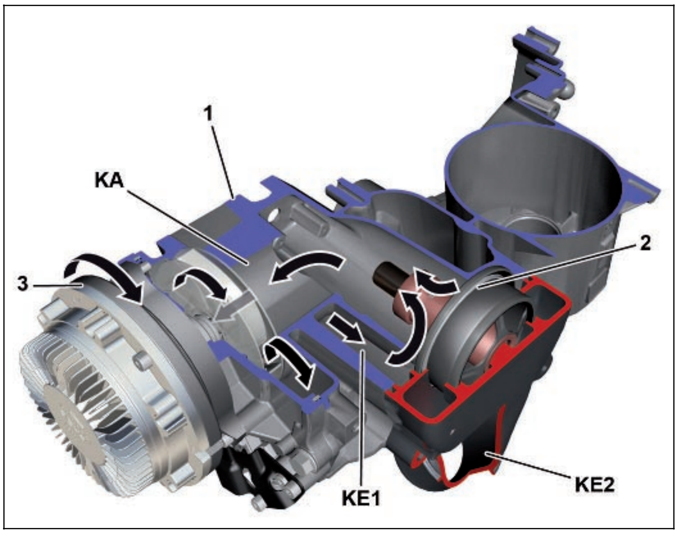
- Bypass mode
- Mixed mode
- Cooler mode

Bypass mode

1 Oil/coolant module
2 Coolant thermostat
3 Coolant pump

KA Coolant outlet (to engine)
KE1 Coolant inlet (from bypass line)
KE2 Coolant inlet (from cooler)

The coolant thermostat (2) is closed for a coolant inlet temperature < 87°C. The coolant only circulates in the engine. The vehicle heating heat exchanger can, however, be flowed through.



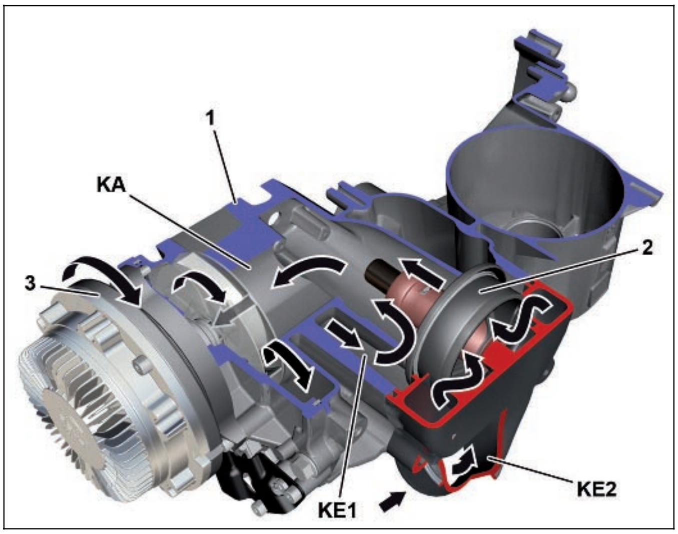
W20.10-1073-81

Mixed mode

1 Oil/coolant module
2 Coolant thermostat
3 Coolant pump

KA Coolant outlet (to engine)
KE1 Coolant inlet (from bypass line)
KE2 Coolant inlet (from cooler)

For a coolant inlet temperature > 87°C and < 95°C the coolant thermostat (2) opens partially and the coolant flows at the same time through the engine radiator and the short circuit line to the coolant thermostat (2).



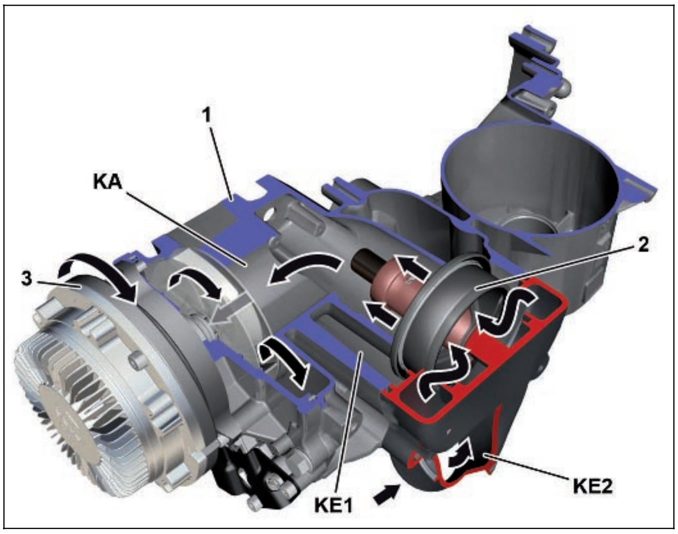
W20.10-1074-81

Cooler mode

1 Oil/coolant module
2 Coolant thermostat
3 Coolant pump

KA Coolant outlet (to engine)
KE1 Coolant inlet (from bypass line)
KE2 Coolant inlet (from cooler)

The coolant thermostat (2) is completely open for a coolant inlet temperature > 95°C. The coolant is fully fed to the engine radiator.



W20.10-1075-81

GF43.30-W-3300H	Retarder, component description	20.7.11

MODEL 963, 964 with CODE (B3H) Secondary water retarder

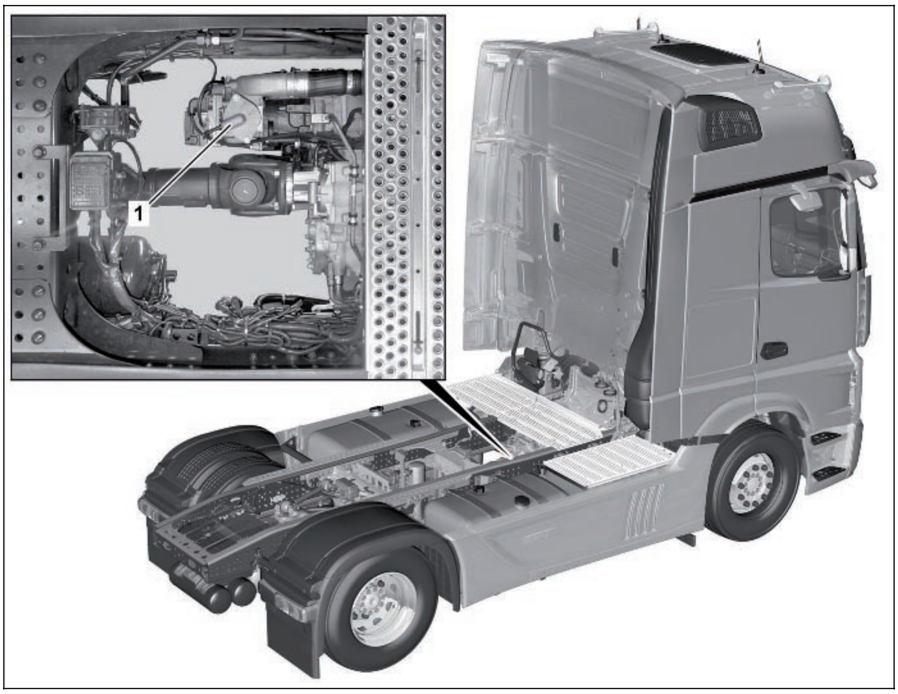
Location

Illustrated on model 963
1 Secondary water retarder

The secondary water retarder (1) is located on the left in the direction of travel next to the transmission output flange.

Task

The task of the secondary water retarder (1) is to convert the flow energy of the engine coolant into mechanical braking energy when requested by the driver or a driving assistance system.



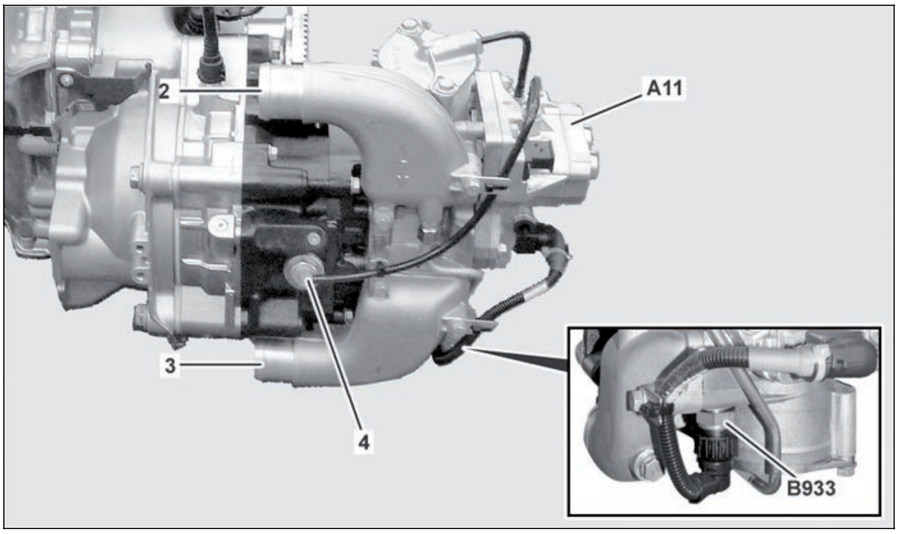
W43.30-1320-06

Design

The secondary water retarder (1) is designed on the principle of hydrodynamic torque conversion.

External view of secondary water retarder
2 Coolant manifold, feed
3 Coolant manifold, return
4 Relief valve

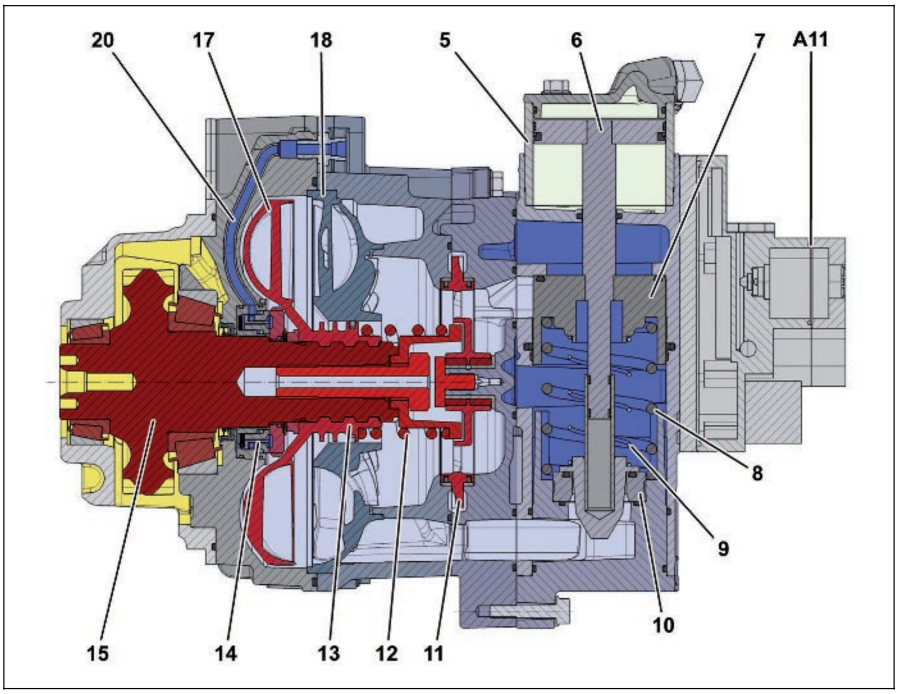
A11 Retarder control (RCM) control unit
B933 Coolant temperature sensor



W43.30-1298-05

Sectional view of secondary water retarder in idle mode

5	*Valve block*
6	*Actuator*
7	*Switching valve*
8	*Switching valve compression spring*
9	*Control valve compression spring*
10	*Control valve*
11	*Side channel pump*
12	*Compression spring for sliding rotor*
13	*Twisted teeth*
14	*Slide ring seal*
15	*Retarder shaft*
17	*Rotor*
18	*Stator*
20	*Shutoff pressure line, return*
A11	*Retarder control (RCM) control unit*



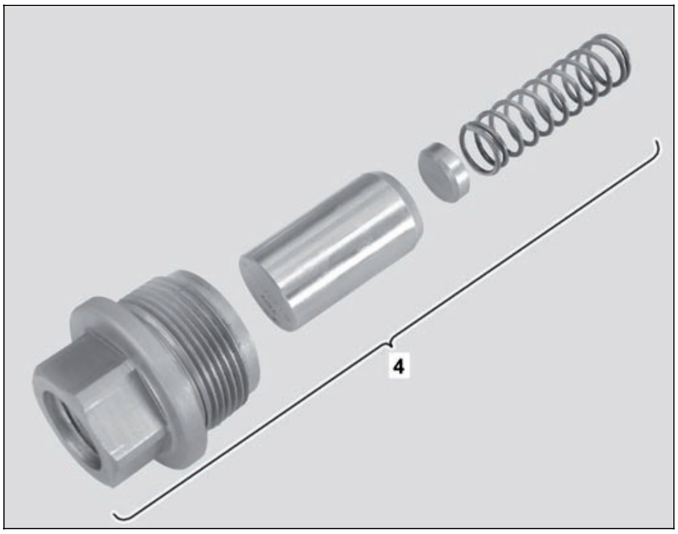
W43.30-1296-76

Function

ℹ The individual components shown under Design perform the functions described below.

Relief valve (4)

The relief valve (4) actuates the side channel pump (11) when requested by the retarder control unit (RCM) (A11).

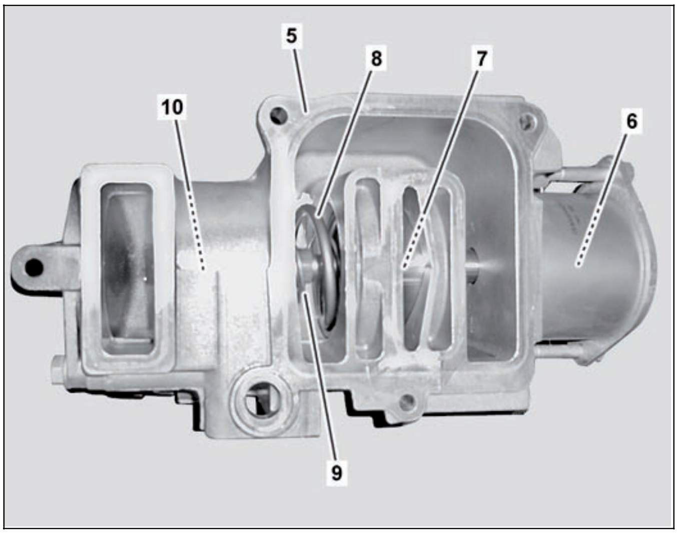


W43.30-1322-11

Valve block (5)

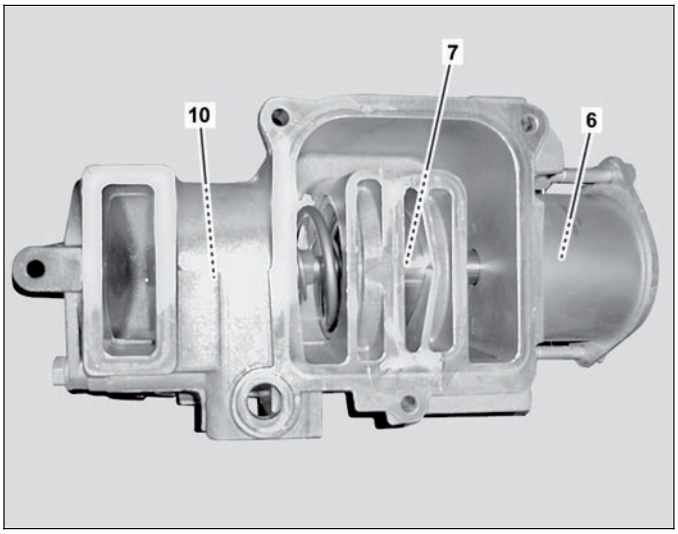
The valve block (5) consists of an actuator (6), a switching valve (7), a control valve (10), the switching valve compression spring (8) and the control valve compression spring (9).

If a braking torque is requested, the switching valve (7) directs the engine coolant into the working chamber. If no braking torque is requested, the switching valve (7) separates the working chamber from the coolant circuit. Depending on the pneumatic pressure applied, the control valve (10) controls the coolant feed into the working chamber and thus the intensity of the braking effect. In idle mode, the control valve (10) acts as a check valve and seals the bypass to the working chamber.



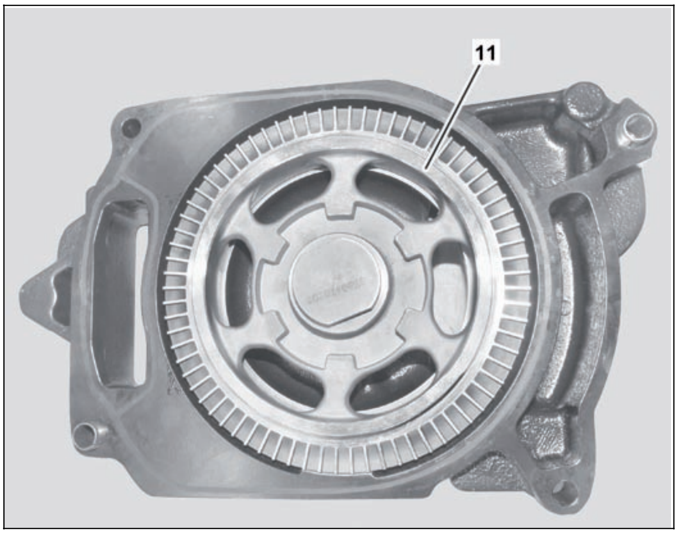
W43.30-1324-11

Actuator (6)
The actuator (6) controls the switching valve (7) and the control valve (10) via a piston rod. For this purpose, the actuator (6) is pneumatically actuated by the retarder control unit (RCM) (A11) and the actuator (6) converts the pneumatic pressure into mechanical movement.



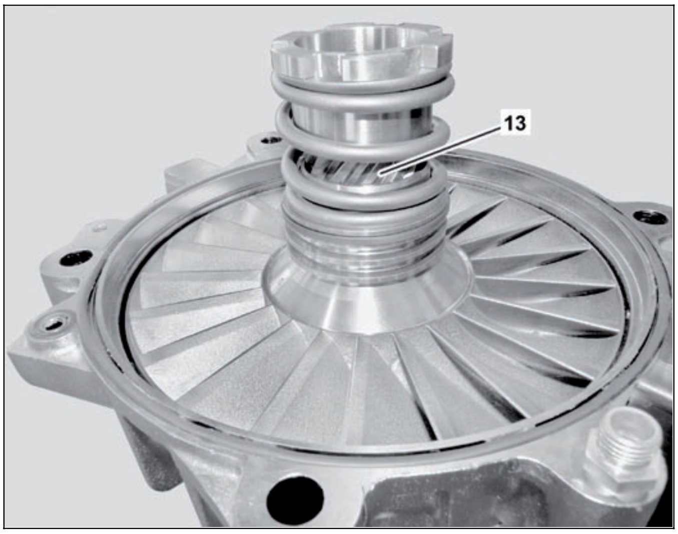
W43.30-1323-11

Side channel pump (11)
When the retarder function is shut off, the side channel pump (11) pumps the engine coolant in the working chamber back into the coolant circuit. The side channel pump (11) is connected directly to the retarder shaft (15) and is actuated via the relief valve (4).



W43.30-1325-11

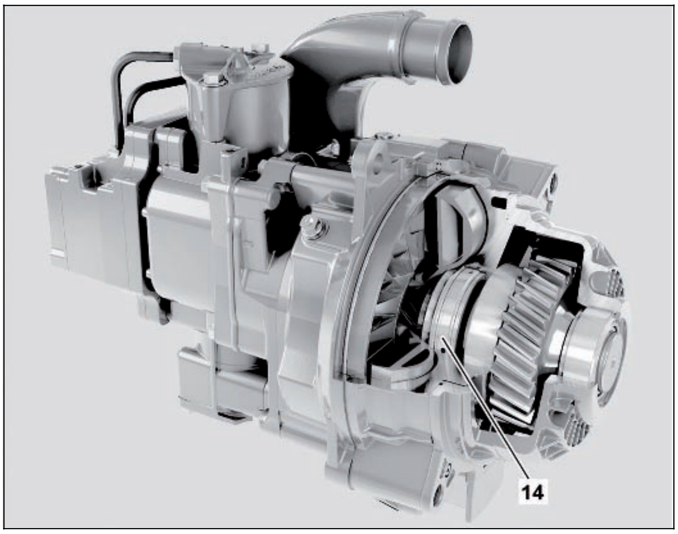
Twisted teeth (13)
The twisted teeth (13), in combination with the compression spring for rotor sliding (12), allows the rotor to be moved, thus regulating the distance between rotor (17) and stator (18).



W43.30-1326-11

Slide ring seal (14)

The slide ring seal (14) seals the working chamber at the transmission end. The slide ring seal (14) consists of two sealing surfaces which engine coolant flows through. The flowing engine coolant causes pressure compensation between the seal and the working chamber and thus a blocking effect. At the same time, the engine coolant reduces the frictional heat produced between the sealing surfaces.

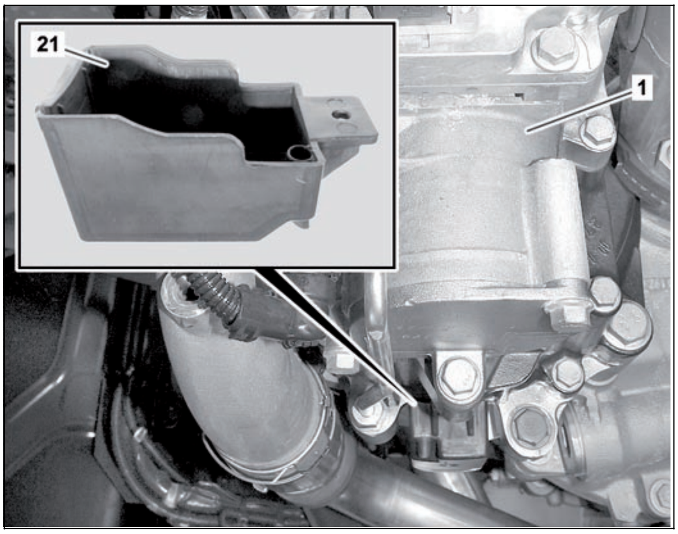


W43.30-1332-11

Evaporation tray (21)

[i] The slide ring seal (14) must be continuously coated with engine coolant on its sealing surfaces in order to minimize the frictional heat. Accordingly, the possibility of small quantities of engine coolant escaping to the outside via the sealing surfaces cannot be ruled out.

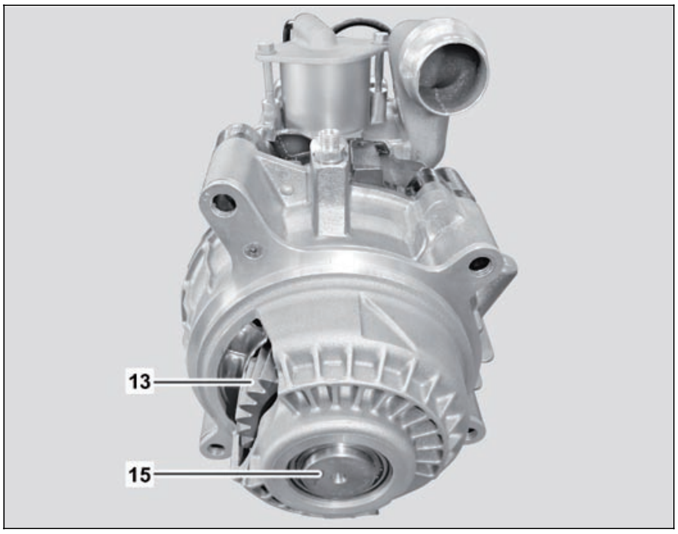
The evaporation tray (21) attached to the housing of the secondary water retarder (1) collects the small quantities of engine coolant which escape and allows them to evaporate.



W43.30-1333-11

Retarder shaft (15)

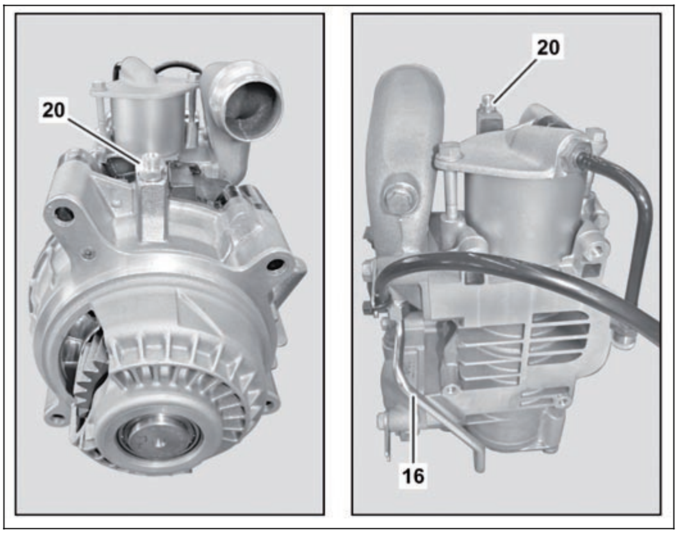
The retarder shaft (15) mechanically connects the rotor (17) to the transmission of the vehicle via the twisted teeth (13). The retarder shaft (15) is driven by the transmission output shaft of the vehicle transmission via a gear pair.



W43.30-1327-11

Shutoff pressure line, feed (16)

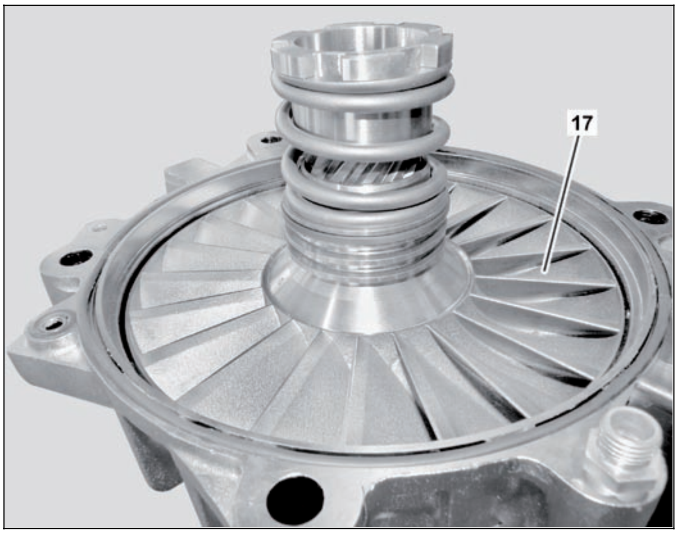
The shutoff pressure line, feed (16) continuously supplies the slide ring seal (14) with engine coolant. The engine coolant is fed back to the cooling circuit of the engine via the connection to the shutoff pressure line, return (20).



W43.30-1331-11

Rotor (17)

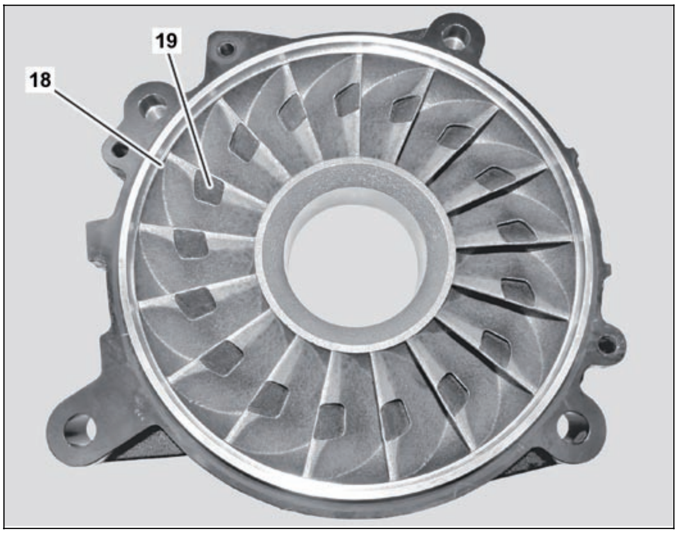
The rotor (17) is driven by the retarder shaft (15) via the twisted teeth (13) and feeds the engine coolant to the stator (18) through the rotational movement of its blades.



W43.30-1328-11

Stator (18)

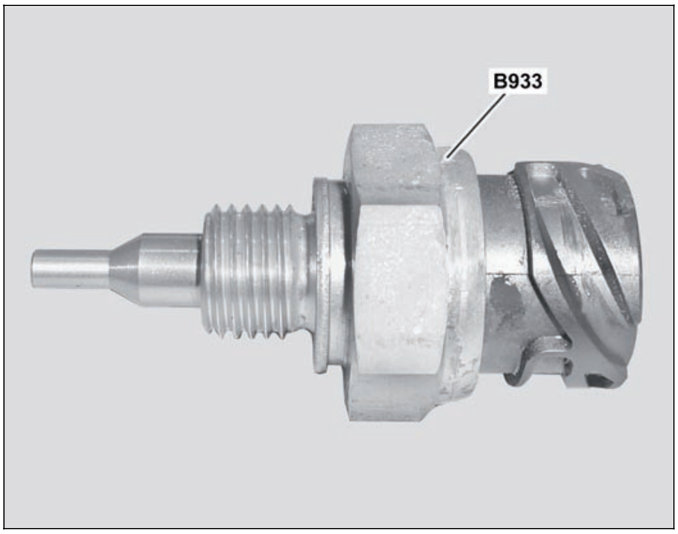
The stator (18), which is fixed to the retarder housing, takes in the rotating engine coolant with its blades through the filling slot (19) and directs it back to the rotor (17). The resulting frictional forces brake the rotor (17).



W43.30-1329-11

Coolant temperature sensor (B933)

The coolant temperature sensor (B933) records the coolant temperature of the coolant which is fed back to the cooling circuit of the engine. The signals from the coolant temperature sensor (B933) are read in directly by the retarder control unit (RCM) (A11).

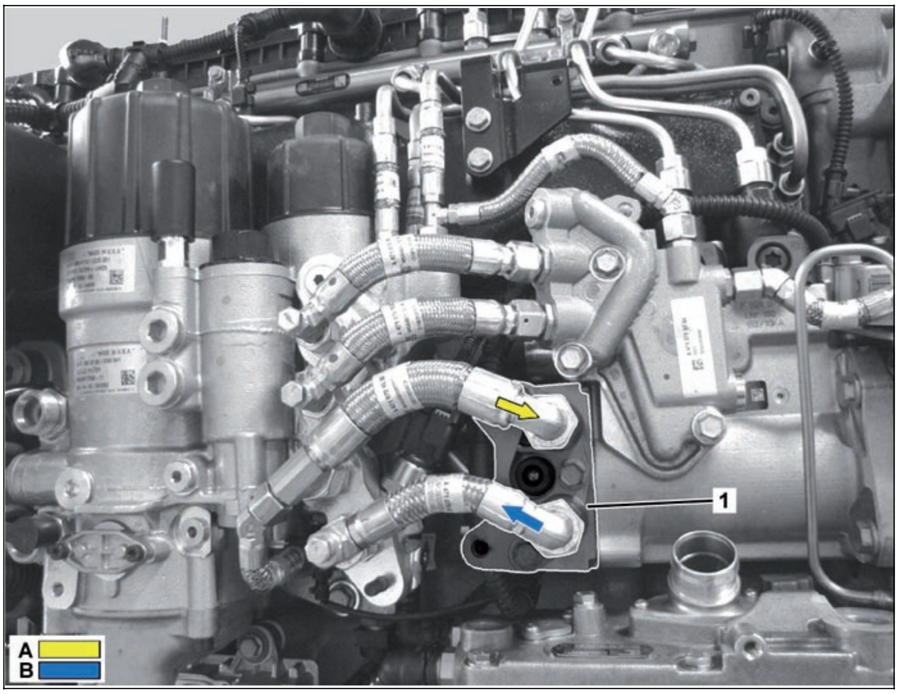


W43.30-1330-11

GF47.20-W-2000H	Component description for fuel pump	20.7.11

ENGINES 471.9 in MODEL 963

Location



W47.20-1083-76

1 Fuel pump

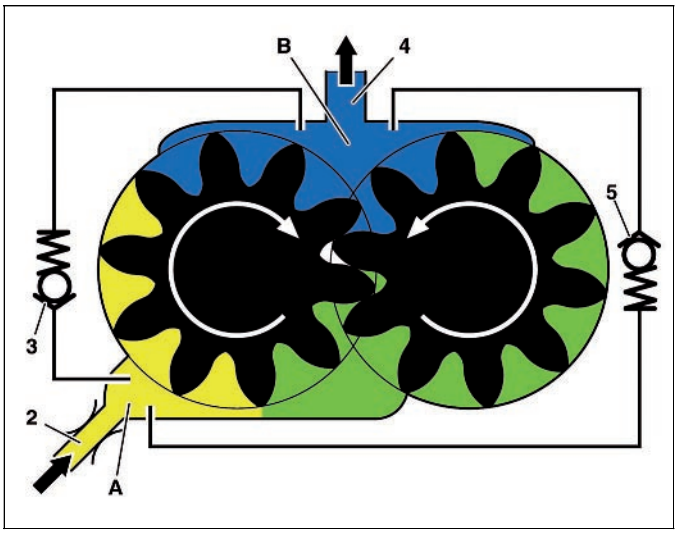
A Fuel feed/suction side
B Fuel feed (thrust side)

The fuel pump (1) is located at the fuel high pressure pump.

Task

The fuel pump (1) draws the fuel out of the fuel tank via the fuel filter module, and supplies the fuel system high pressure pump with the required quantity in all engine operating conditions.

Design



W47.20-1061-81

2 Fuel inlet
3 Bypass valve
4 Fuel outlet
5 Pressure limiting valve

A Fuel feed/suction side
B Fuel feed (thrust side)

Function

The fuel pump (1) is designed as a gear pump and is driven via the fuel high pressure pump. As soon as the engine starts and runs, the right gearwheel in the fuel pump (1) is driven via a drive plate on the camshaft of the fuel high pressure pump. Since the teeth on the right gearwheel engages in the teeth on the left gearwheel, it turns simultaneously in the opposite direction. The rotating movement of both gearwheels and the design of the pump chamber cause the fuel to be drawn in via the fuel inlet (2) and delivered to the fuel outlet (4) along the inner wall of the pump. During this operation fuel is compressed until the fuel pressure or system pressure required is reached.

The max. permissible system pressure that can already be reached at idle speed is determined by the opening pressure of the pressure limiting valve (5).
If the system and/or the opening pressure is reached and therefore the pressure limiting valve (5), that is designed as an overflow valve, is opened, thrust side fuel feed (B) is connected to the suction side fuel feed (A) via a duct to prevent a further build-up of pressure.
If the fuel system is being filled externally, the bypass valve (3) is installed through which fuel can flow past the stationary gearwheels to the thrust side fuel feed (B).

GF47.20-W-2103H	Component description for fuel cooler	20.7.11

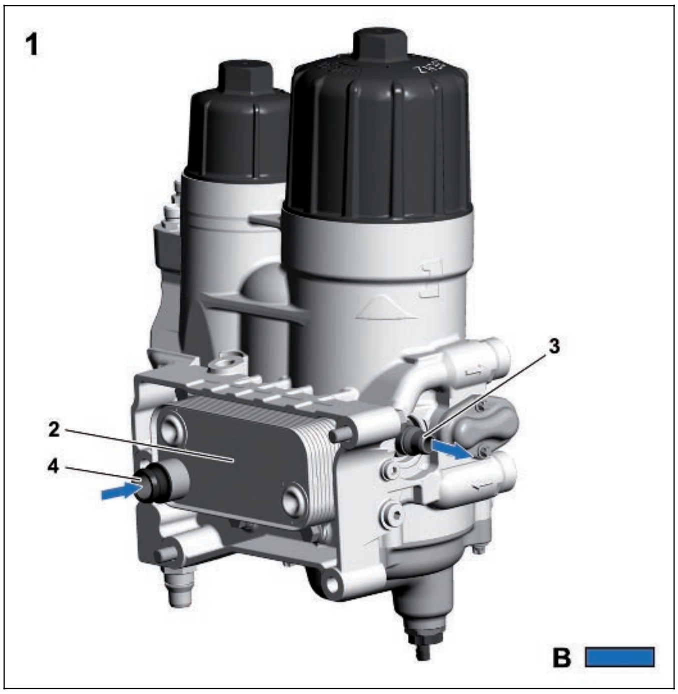
ENGINES 471.9 in MODEL 963

Location

1 Fuel filter module
2 Fuel cooler
3 Coolant outlet for fuel filter module
4 Coolant inlet

B Coolant

The fuel cooler (2) is located behind the fuel filter module (1).



W47.00-1037-82

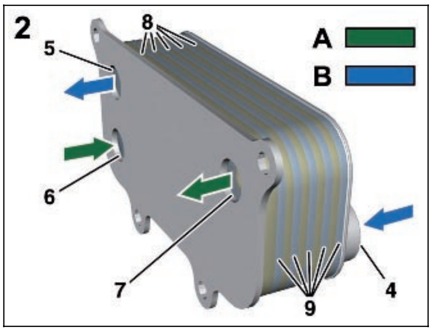
Task

The fuel cooler (2) cools the warmed fuel which is led from the fuel injector pressure boosters into the fuel filter module (1) via a return line.

Body

2 Fuel cooler
4 Coolant inlet
5 Coolant outlet
6 Fuel inlet
7 Fuel outlet
8 Fuel cooling ducts
9 Coolant duct

A Fuel
B Coolant



W47.00-1027-71

The fuel cooler (2) is designed as a shell cooler.

Function

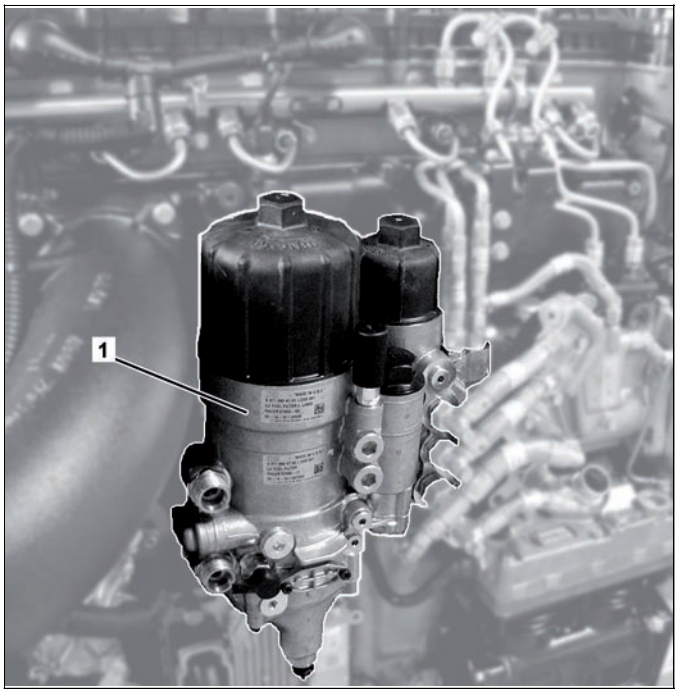
The warmed fuel from the fuel injector pressure boosters flows through the fuel cooling ducts (8) to the fuel outlet (7) via the fuel inlet (6). From there, the cooled fuel then runs through the fuel feed line of the fuel filter module to the fuel pump via a line.

The fuel cooler (2) is supplied with coolant from the crankcase via the coolant inlet (4).The coolant flowing through the coolant duct (9) cools the fuel, it passes via the coolant outlet (5) to the fuel filter module (1) and flows via the fuel filter module coolant outlet (3) directly to the coolant pump.

GF47.20-W-4200H	Component description for fuel filter module	20.7.11

ENGINES 471.9 in MODEL 963

Location



W47.20-1082-12

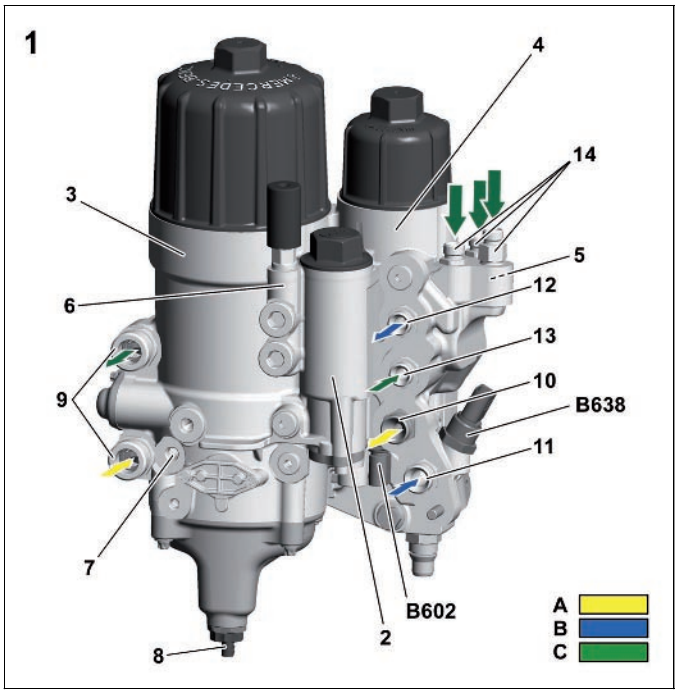
1 Fuel filter module

The fuel filter module (1) is located on the left side of the crankcase.

Task

The water in the fuel is separated in the fuel filter module (1), and dirt particles are filtered out in two stages.

Design



W47.20-1085-82

1 Fuel filter module
2 Fuel prefilter
3 Water separator
4 Fuel filter
5 Fuel accumulator
6 Hand-operated delivery pump
7 Filling valve
8 Mechanical drain valve
9 Shutoff valves
10 Fuel connection to fuel pump
11 Fuel connection from fuel pump
12 Fuel connection to the fuel system high pressure pump
13 Return connection from the fuel system high pressure pump
14 Connections for pressure limiting valve return and fuel injectors

B602 Fuel temperature sensor
B638 Fuel filter module pressure sensor

A Fuel feed/suction side
B Fuel feed (thrust side)
C Fuel return

System components

The fuel filter module (1) consists of the following components:

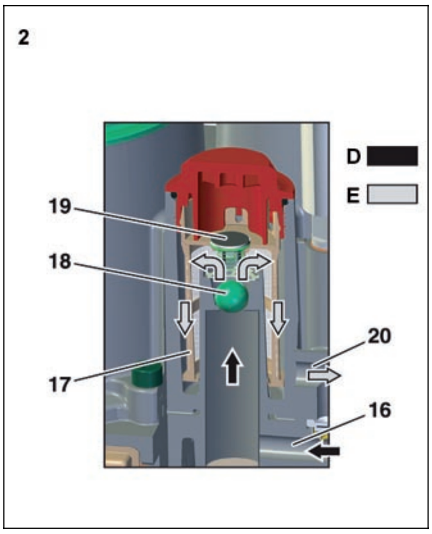
- Fuel prefilter (2) through which large dirt particles are removed from the fuel.
- Water separator (3) with water collector through which the water in the fuel is separated.
- Fuel filter (4) through which small dirt particles are removed from the fuel.
- The fuel collection chamber (5) via which the fuel is collected from all fuel return lines and led into either the fuel prefilter (2) via a bypass or directly into the fuel tank.
- The hand-operated delivery pump (6) with the aid of which the fuel system can be vented, for example after replacing a fuel filter insert.
- The filling valve (7) with the aid of which the fuel system can also be vented, for example after replacing a fuel filter insert.
- Shutoff valves (9) which prevent fuel escaping when disassembling the fuel lines between the fuel tank and the fuel filter module (1).

Function

Fuel prefilter

2 Fuel prefilter
16 Fuel inlet
17 Filter element
18 Elastomer ball
19 Wastegate
20 Fuel outlet

D Not cleaned fuel
E Precleaned fuel



W47.20-1078-72

Not cleaned fuel (D) passes over the fuel inlet (16) into the fuel prefilter (2).
The suctioned up fuel presses the elastomer ball (18) off its seat and flows through the filter insert (17) from inside to out. The larger dirt particles remain in the filter insert (17) and the precleaned fuel (E) flows via the fuel outlet (20) to the fuel pump.

The elastomer ball (18) has the task of preventing the intake duct from running dry with the fuel prefilter (2) open.

If the fuel prefilter (2) is fouled and the fuel flow rate is blocked in the process then the fuel is suctioned over the wastegate (19).

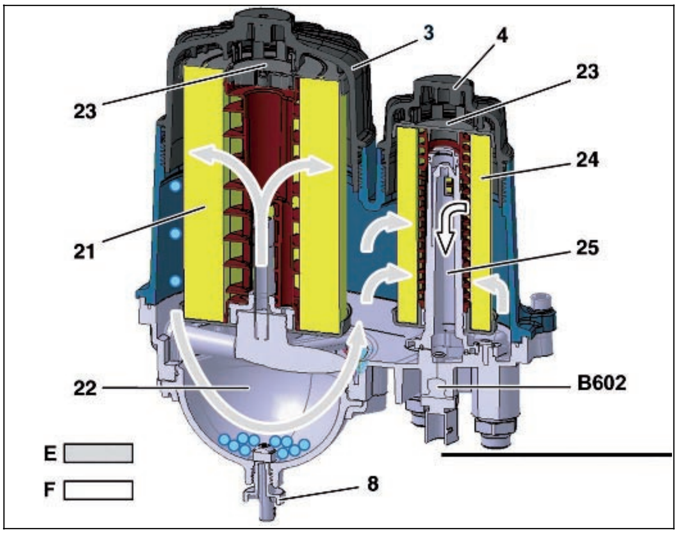
When removing the filter insert clipped on the cover (17) a drain bore to the fuel collector (5) is released so the fuel can flow out of the fuel prefilter housing.

Water separator and fuel filter

3 Water separator
4 Fuel filter
8 Mechanical drain valve
21 Water separator insert
22 Water collector
23 Ventilation bore
24 Fine filter insert
25 Inner dome

B602 Fuel temperature sensor

E Precleaned fuel
F Cleaned fuel



W47.20-1081-81

Water separator (3)
The water separator insert (21) in the water separator (3) consists of many layers and has the task of separating out the water contained in the fuel.
The water separator insert (21) has fuel flowing from inside outwards. The special construction ensures that small water droplets either remain in the water separator insert (21) or bind themselves to already retained water droplets. Small dirt particles are also filtered out due to the construction.
In order to ensure that the water droplets can sink downwards into the water collector (22), it is essential that the flow rate of the fuel is reduced.
This is achieved using the special forming of the housing.
The flow rate of the fuel is increased again by the shape of the housing and the fuel passes into the fine filter insert (24).

The ventilation bore (23) above the water separator insert (21) diverts the air that is trapped in the water separator (3) when the water separator insert (21) is changed, for example, into the fuel collection chamber (5), from where it can be returned to the fuel tank via the fuel return line.
The ventilation bore (23) also guarantees full use of area in the water separator insert (21).

When removing the water separator insert (21) clipped on the cover a drain bore to the fuel collector (5) is released so that fuel can flow out of the water separator housing.

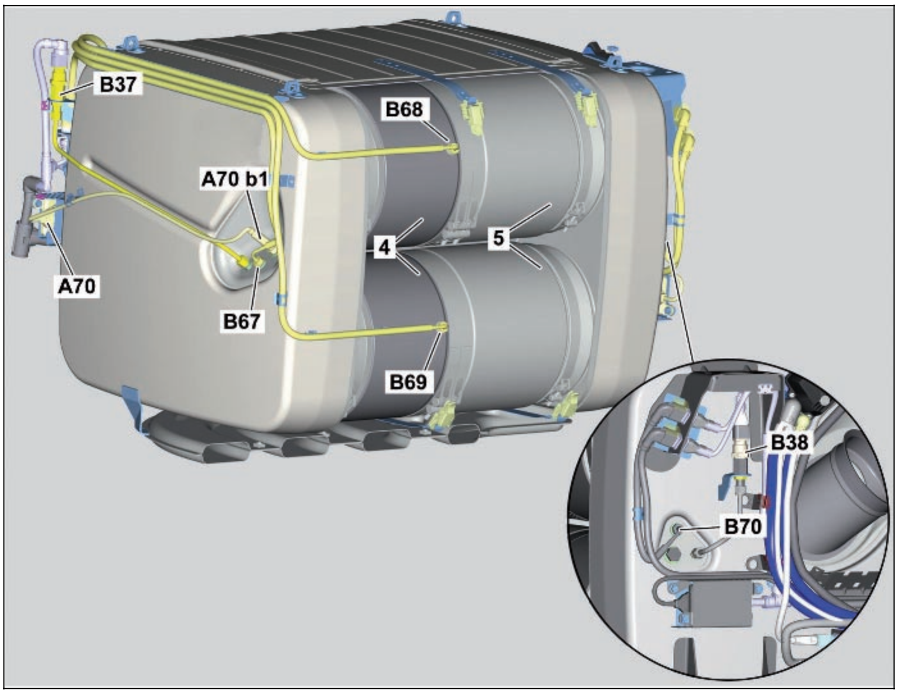
Fuel filter (4)
The fine filter insert (24) of the fuel filter (4) also consists of many layers but has fuel flowing from outside inwards.
The smallest dirt particles are filtered out at a very high separation rate by the fine filter insert (24).
Also the fuel filter (4) has a ventilation bore (23). Just as for the water separator insert (21), full use of area in the water separator insert (24) is achieved and venting of the fuel filter housing guaranteed.
When removing the fine filter insert clipped on the cover (24) a drain bore to the fuel collector (5) is released so the fuel can flow out of the fuel filter housing.

The cleaned fuel (F) is led to the fuel high pressure pump through an overflow bore in the inner dome (25).
The high position of the overflow bore in the inner dome (25) ensures that no uncleaned fuel can reach the fuel high pressure pump, even if the fuel does not run out of the fuel filter housing.
The engine management control unit (MCM) (A4) determines the current fuel temperature via the fuel temperature sensor (B602).With the aid of the fuel filter module pressure sensor (B638) the engine management control unit (MCM) (A4) can detect whether the fuel filter element needs to be changed. The fuel filter module pressure sensor (B638) is also used for diagnostic purposes.

GF49.10-W-3006H	Diesel oxidation catalytic converter, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location



W14.40-1576-76

4 *Diesel oxidation catalytic converter (DOC)*
5 *Diesel particulate filter (DPF)*

A70 *Exhaust aftertreatment unit inlet NOx sensor control unit*
A70 b1 *Exhaust aftertreatment unit inlet NOx sensor*
B37 *Exhaust pressure sensor upstream of diesel oxidation catalytic converter*
B38 *Exhaust pressure sensor downstream of diesel particulate filter*
B67 *Exhaust temperature sensor upstream of diesel oxidation catalytic converter*
B68 *Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter*
B69 *Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*
B70 *Exhaust temperature sensor downstream of diesel particulate filter*

The diesel oxidation catalytic converter (DOC) (4) is integrated in the exhaust aftertreatment unit. It is the first location upstream of the diesel particulate filter (DPF) (5) to be reached by the exhaust downstream of the engine.

Task

The diesel oxidation catalytic converter (DOC) (4) is used to convert the carbon monoxide (CO) and hydrocarbon (HC) in the exhaust into less harmful carbon dioxide (CO_2) and water (H_2O).

Design

The diesel oxidation catalytic converter (DOC) (4) consists of two cylindrical inserts with a metal sleeve. Inside this is the actual catalytic converter element, which consists of a porous monolithic block made from a special ceramic material.
In order to make it possible for the required chemical reactions to take place and assist with passive regeneration of the diesel particulate filter (DPF) (5), the catalytic converter element is covered with a series of rare metals - the so-called oxidization layer (wash coat).

Function

The exhaust coming from the engine flows through the diesel oxidation catalytic converter (DOC) (4). Part of the nitrous oxides (NOx) that is present is reduced by the chemical reaction with the rare metals in the coating, meaning that oxygen is released. The released oxygen then allows the CH and CO parts of the exhaust to oxidize, resulting in CO_2 and water.

Since a significant amount of pollutant conversion only occurs from a temperature of about 250 °C, the exhaust aftertreatment unit with the diesel oxidation catalytic converter (DOC) (4) is located as close to the engine as possible on the right-hand side of the vehicle.

GF49.10-W-3008HA	Component description for SCR catalytic converter	2.8.11

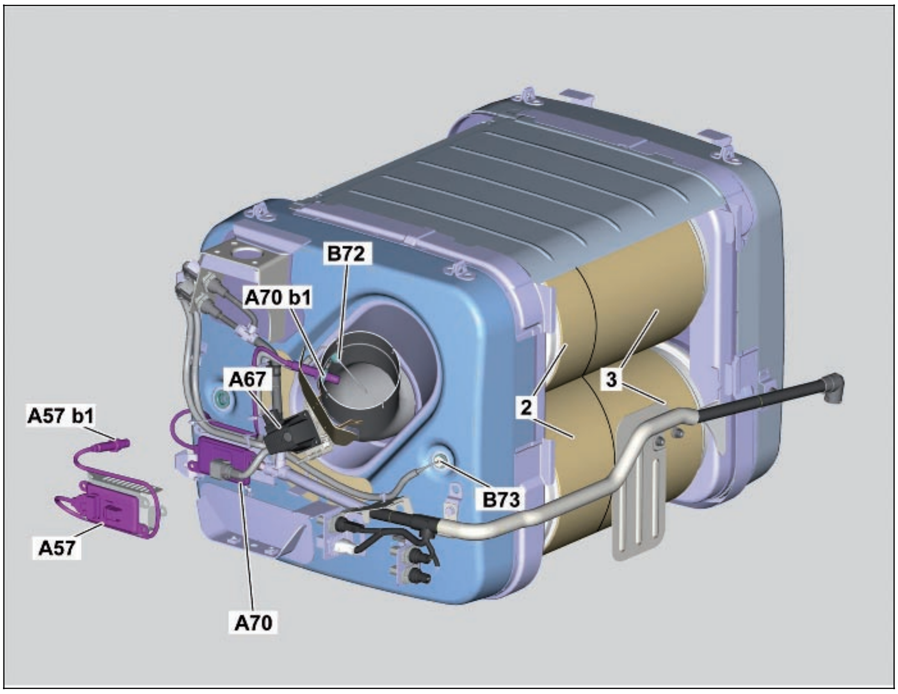
ENGINES 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

Location

2 *Ammonia slip catalytic converter*
3 *SCR catalytic converter*

A57 *EATU output NOx sensor control unit*
A57 b1 *EATU output NOx sensor*
A67 *AdBlue® metering device*
A70 *EATU input NOx sensor control unit*
A70 b1 *EATU input NOx sensor*
B72 *Exhaust temperature sensor upstream of SCR catalytic converter*
B73 *Exhaust temperature sensor downstream of SCR catalytic converter*

The SCR catalytic converter (3) is located in the exhaust aftertreatment unit and forms one unit together with the ammonia slip catalytic converter (2).



W14.40-1602-76

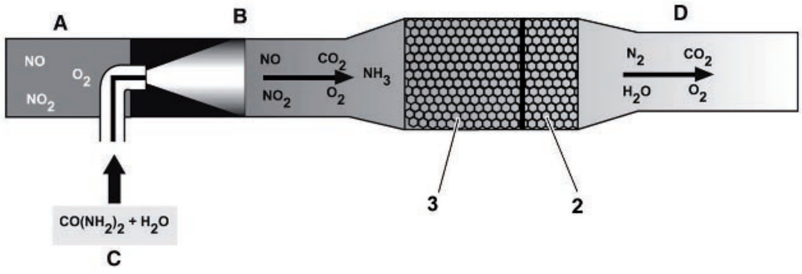
Task

The poisonous nitrogen oxides (NOx) generated during combustion are reduced into non-toxic nitrogen (N_2) and water (H_2O) in the SCR catalytic converter (3). The ammonia slip catalytic converter (2) is primarily used to the convert ammonia particles (NH_3) that have not reacted, which would otherwise be easy to detect in the vehicle environment due to the low odor threshold of ammonia.

Design

The SCR catalytic converter (3) and the ammonia slip catalytic converter (2) consist of two cylindrical catalytic converter elements connected in series in a sheet metal envelope. To permit the chemical reaction, this ceramics block is fitted with a special coating made from a series of rare metals such as titanium, tungsten, platinum and vanadium.

Function



W14.40-1588-05

2 Ammonia slip catalytic converter
3 SCR catalytic converter

A Exhaust (from electric motor)
B Hydrolysis segment
C AdBlue®
D Exhaust gas (end product)

The exhaust (A) flows through the inlet tube of the exhaust aftertreatment unit into the mixing tube, the so-called hydrolysis segment (B).
Here, the amount of AdBlue® computed by the exhaust aftertreatment (ACM) control unit (A60) based on the sensor information is injected.

The AdBlue® is converted here in a first process step into ammonia (NH_3) and then continues to flow in the direction of the SCR catalytic converter (3).
In the honeycomb bodies contained in it, the second stage of the reduction process takes place: The nitrogen oxide molecules meet the ammonia molecules (NH_3) - energy in the form of heat is released. Only nitrogen (N_2) and water vapor (H_2O) are left over as products of this chemical reaction, which are not harmful to the environment
For this procedure, which is known as selective catalytic reduction, a certain operating temperature is necessary for the SCR catalytic converter (3). This is 250 °C for this purpose.

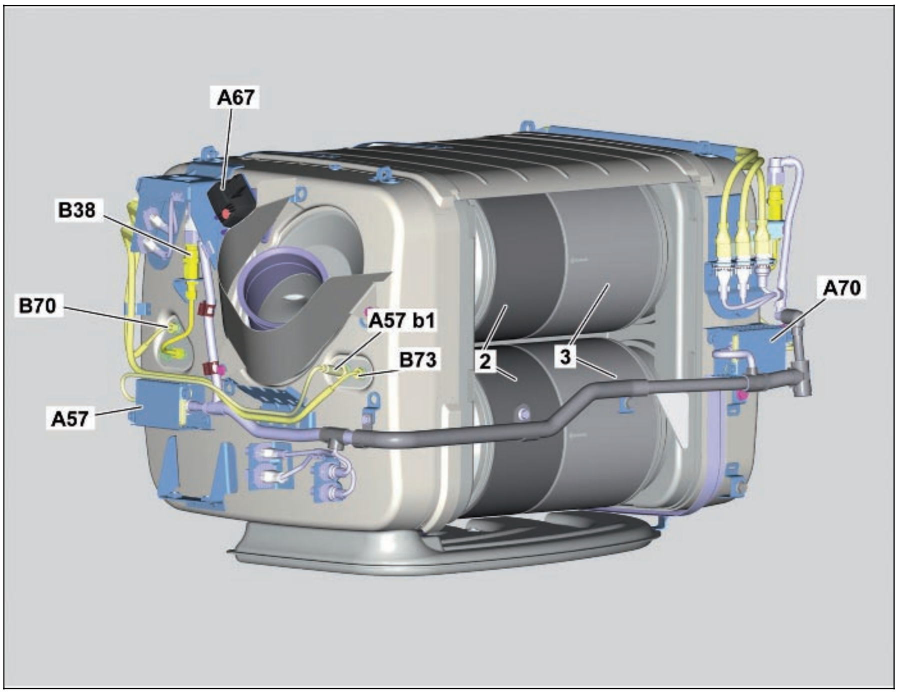
The exhaust that has already been cleaned from NOx by the SCR catalytic converter (3) for the most part also flows through the ammonia slip catalytic converter (2) before it is emitted into the environment.
Here, the NH_3 molecules that have not been used up are oxidized by the platinum on the surface of the ammonia slip catalytic converter (2) together with the O_2 molecules.
Some of the few NOx molecules that haven not been reduced during the previous processing step are also reduced to NO and H_2O.

GF49.10-W-3008H	Component description for SCR catalytic converter	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

2	*Ammonia blocking catalytic converter*
3	*SCR catalytic converter*
A57	*Exhaust aftertreatment unit outlet NOx sensor control unit*
A57 b1	*Exhaust aftertreatment unit outlet NOx sensor*
A67	*AdBlue® metering device*
A70	*Exhaust aftertreatment unit inlet NOx sensor control unit*
B38	*Exhaust pressure sensor downstream of diesel particulate filter*
B70	*Exhaust temperature sensor downstream of diesel particulate filter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*



W14.40-1575-76

The SCR catalytic converter (3) is in the exhaust aftertreatment unit, and forms a single unit together with the ammonia blocking catalytic converter (2).

Task

The SCR catalytic converter (6) reduces the toxic nitrous oxides (NOx) generated by fuel combustion into non-toxic nitrogen (N_2) and water (H_2O).The ammonia blocking catalytic converter (2) is primarily used to convert non-reactive ammonia particles (NH_3), which would otherwise be easily perceptible in the vehicle environment because of the low odor threshold of ammonia.

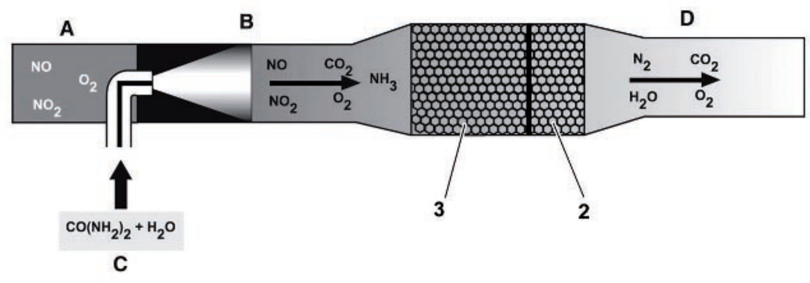
Design

The SCR catalytic converter (3) and the ammonia blocking catalytic converter (2) consist of two cylindrical catalytic converter elements in a metal sleeve that are connected in series. In order to make the chemical reactions take place, this ceramic block has a special coating made from a series of rare metals such as titanium, tungsten, platinum and vanadium.

Function

2 *Ammonia blocking catalytic converter*
3 *SCR catalytic converter*

A *Exhaust (from DPF)*
B *Hydrolysis segment*
C *AdBlue®*
D *Exhaust gas (end product)*



W14.40-1588-05

The exhaust (A), which has been pre-cleaned by the diesel oxidation catalytic converter (DOC) and the diesel particulate filter (DPF), continues flowing through the mixing tube, the so-called hydrolysis segment (B). This is where the quantity of AdBlue® that has been calculated by the exhaust aftertreatment control unit (ACM) (A60) on the basis of the sensor information is injected in.
The AdBlue® first converts itself into ammonia (NH_3) here, and then continues flowing in the direction of the SCR catalytic converter (3).
The second stage of the reduction process takes place in the honeycomb structure that it contains. The nitrous oxide molecules collide with the ammonia molecules (NH_3), and energy is released in the form of heat. Only nitrogen (N_2) and water vapor (H_2O) are left over as products of this chemical reaction, which are not harmful to the environment

The SCR catalytic converter (3) must be at a certain operating temperature for this process to take place (known as selective catalytic reduction). This is 250 °C for this purpose.

The exhaust, which has had most of the NOx removed by the SCR catalytic converter (3) passes the ammonia blocking catalytic converter (2) before it enters the atmosphere.
Here, the platinum on the surface of the ammonia blocking catalytic converter makes the unused NH_3 molecules oxidize with the O_2 molecules.
Some of the few NOx molecules that were not reduced in the previous stage of the process are also reduced to NO and H_2O.

GF49.10-W-3010HA	Exhaust aftertreatment unit, component description	2.8.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Y) Engine version Euro V
ENGINES 471.9 in MODEL 963, 964 with CODE (M5R) Engine version EEV

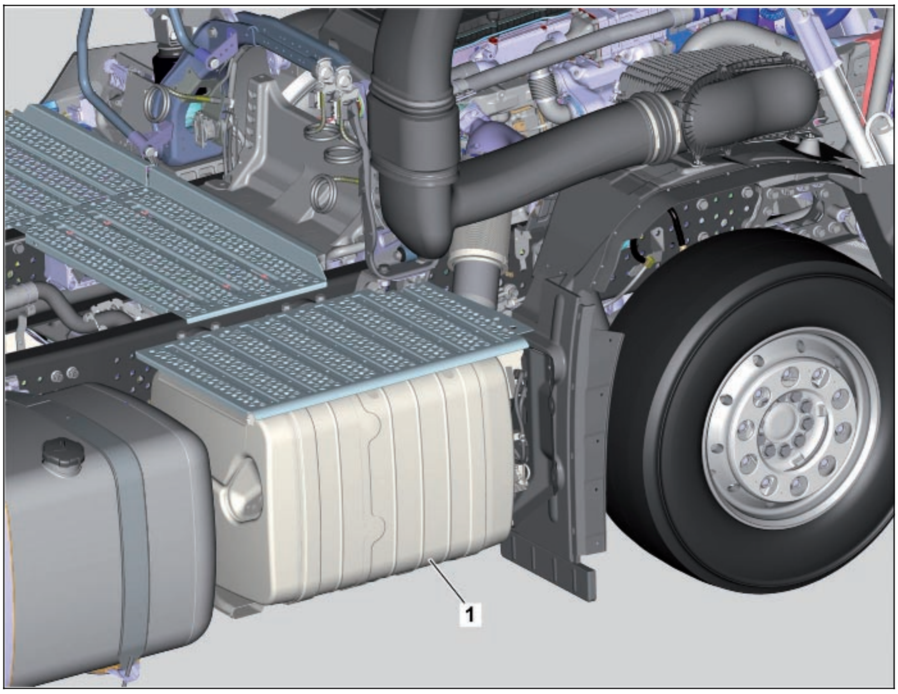
Location

1 Exhaust aftertreatment unit

The exhaust aftertreatment unit (1) is mounted on the side on the frame.

Task

The exhaust aftertreatment unit (1) is the major component in the vehicle for limiting emissions. Furthermore, it also keeps noise emission as low as possible in its function as a muffler.

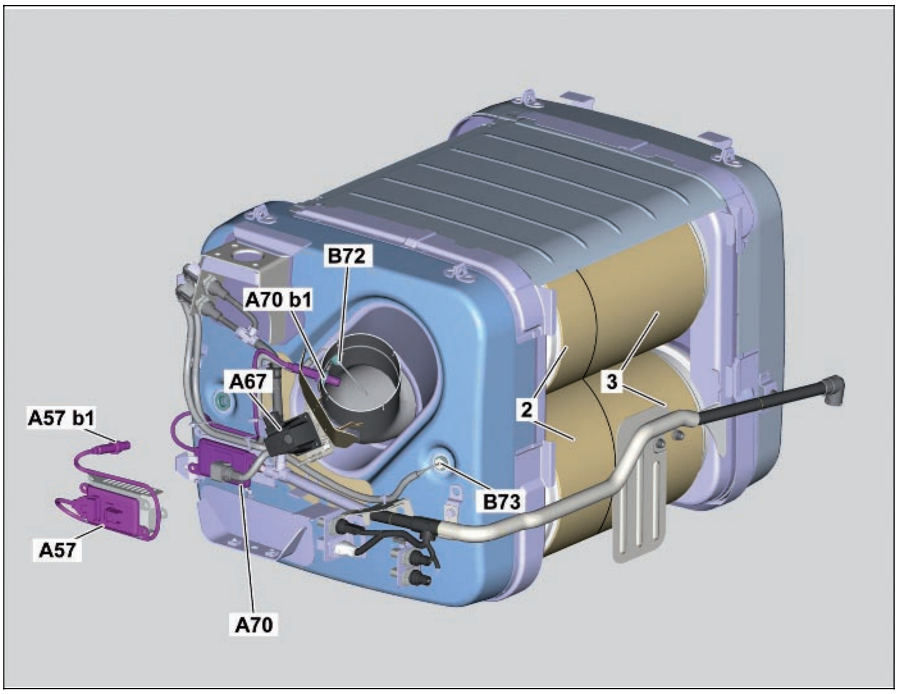


W49.20-1027-76

Design

2 Ammonia slip catalytic converter
3 SCR catalytic converter

A57 EATU output NOx sensor control unit
A57 b1 EATU output NOx sensor
A67 AdBlue® metering device
A70 EATU input NOx sensor control unit
A70 b1 EATU input NOx sensor
B72 Exhaust temperature sensor upstream of SCR catalytic converter
B73 Exhaust temperature sensor downstream of SCR catalytic converter

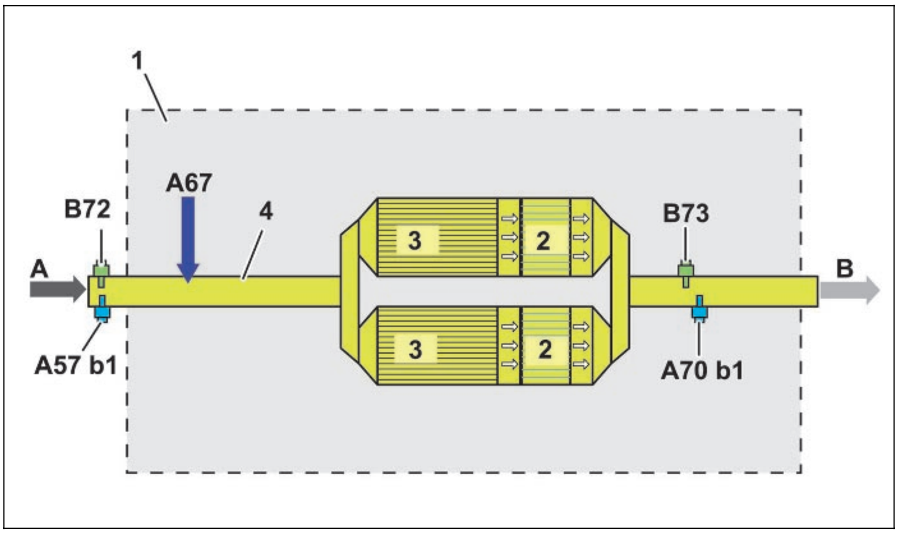


W14.40-1602-76

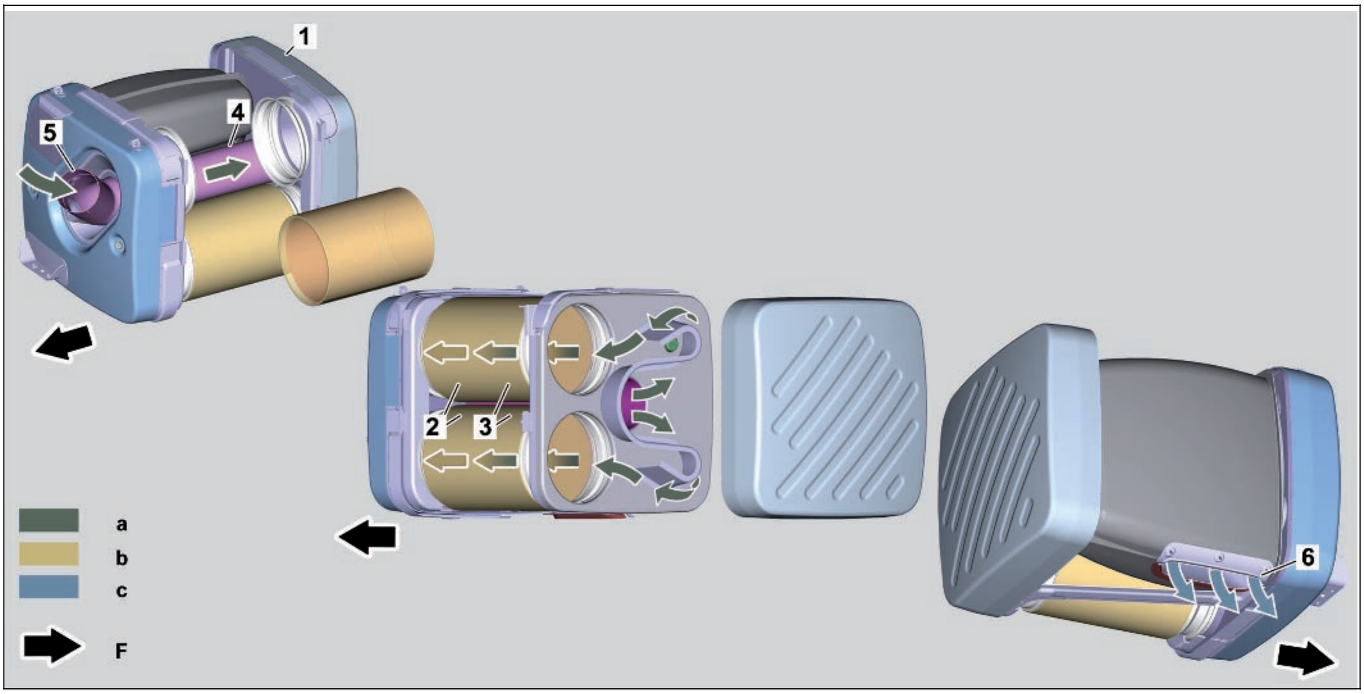
System components

Location of sensors

1	*Exhaust aftertreatment unit*
2	*Ammonia slip catalytic converter*
3	*SCR catalytic converter*
4	*Mixing tube (hydrolysis segment)*
A57 b1	*EATU output NOx sensor*
A67	*AdBlue® metering device*
A70 b1	*EATU input NOx sensor*
B72	*Exhaust temperature sensor upstream of SCR catalytic converter*
B73	*Exhaust temperature sensor downstream of SCR catalytic converter*
A	*Exhaust from the engine*
B	*Exhaust cleaned (to atmosphere)*



W49.20-1023-75



W49.20-1024-79

Function

1	*Exhaust aftertreatment unit*	*5*	*Inlet pipe*	*b*	*Exhaust in SCR catalytic converter and ammonia slip catalytic converter*
2	*Ammonia slip catalytic converter*	*6*	*Outlet pipe*	*c*	*Exhaust cleaned (to atmosphere)*
3	*SCR catalytic converter*				
4	*Mixing tube (hydrolysis segment)*	*a*	*Exhaust from the engine*	*F*	*Direction of travel*

The exhaust from the engine (a) flows through the inlet tube (5) into the mixing tube (4). In the mixing tube (4), the so-called hydrolysis segment, AdBlue® is injected via the AdBlue® metering device (A67). The exhaust is redirected in the rear section of the exhaust aftertreatment unit (1), so that it flows through the SCR catalytic converter (3) and the ammonia slip catalytic converter (2) from the rear.

The exhaust is redirected again at the front side of the exhaust aftertreatment unit (1) and passes the muffler housing. The cleaned exhaust is finally emitted into the environment via the outlet tube (6).

GF49.10-W-3010H	Exhaust aftertreatment unit, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964

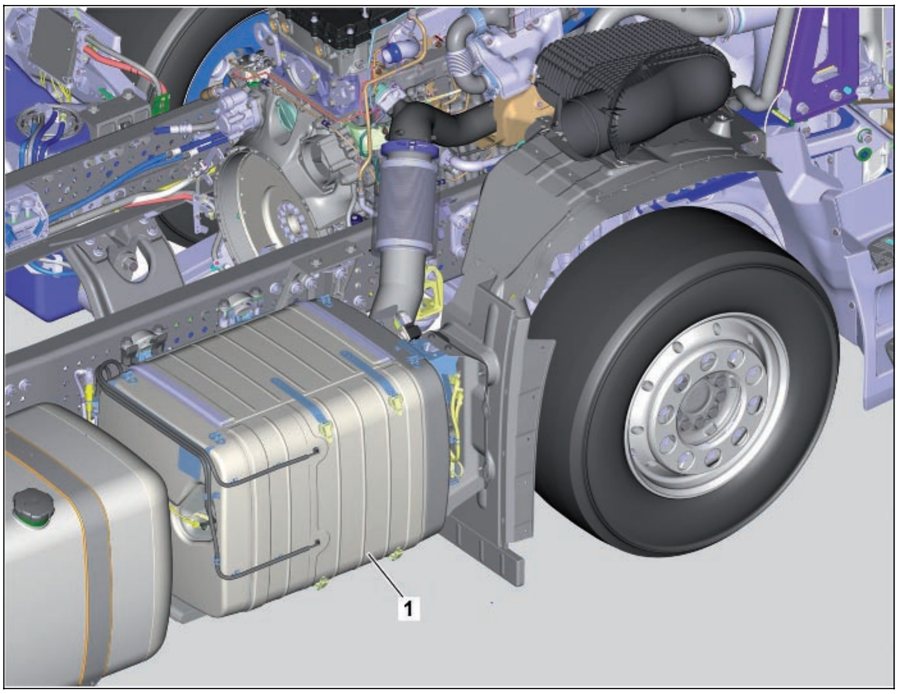
Location

1 Exhaust aftertreatment unit:

The exhaust aftertreatment unit (1) is attached to the frame on the right-hand side.

Task

The exhaust aftertreatment unit (1) is the main component that restricts emissions in the vehicle. It also keeps noise emissions to a minimum because of its function as a muffler.

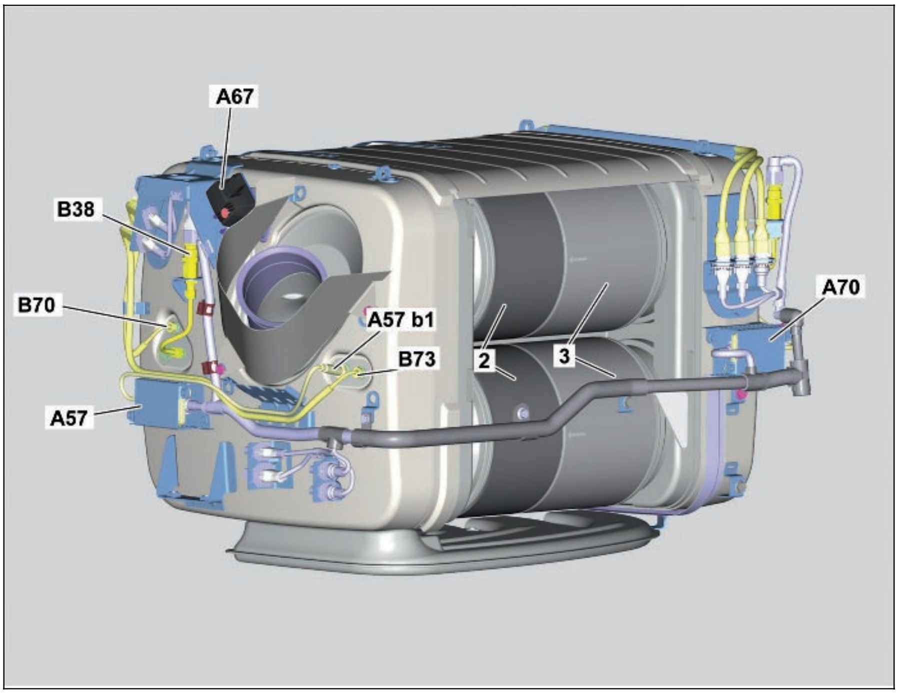


W14.40-1574-76

Design

2 Ammonia blocking catalytic converter
3 SCR catalytic converter

A57 Exhaust aftertreatment unit outlet NOx sensor control unit
A57 b1 Exhaust aftertreatment unit outlet NOx sensor
A67 AdBlue® metering device
A70 Exhaust aftertreatment unit inlet NOx sensor control unit
B38 Exhaust pressure sensor downstream of diesel particulate filter
B70 Exhaust temperature sensor downstream of diesel particulate filter
B73 Temperature sensor downstream of SCR catalytic converter

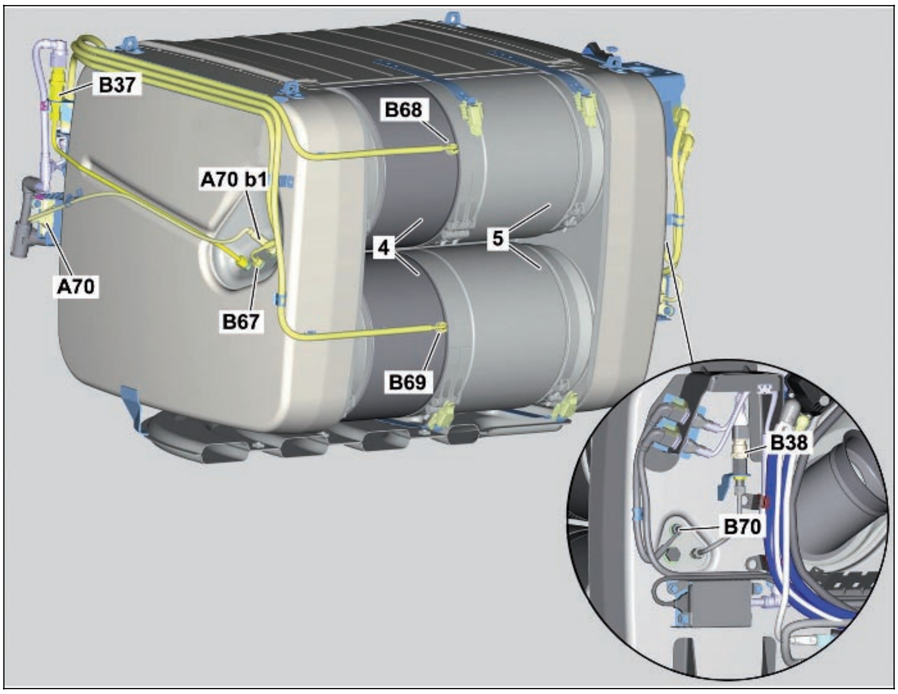


W14.40-1575-76

System components

4 Diesel oxidation catalytic converter (DOC)
5 Diesel particulate filter (DPF)

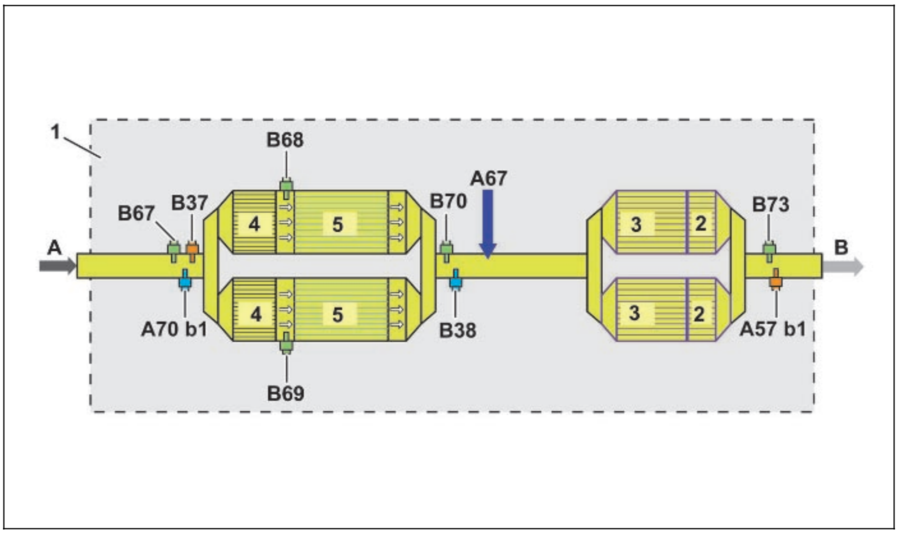
A70 Exhaust aftertreatment unit inlet NOx sensor control unit
A70 b1 Exhaust aftertreatment unit inlet NOx sensor
B37 Exhaust pressure sensor downstream of diesel oxidation catalytic converter
B38 Exhaust pressure sensor downstream of diesel particulate filter
B67 Exhaust temperature sensor upstream of diesel oxidation catalytic converter
B68 Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter
B69 Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter
B70 Exhaust temperature sensor downstream of diesel particulate filter



W14.40-1576-76

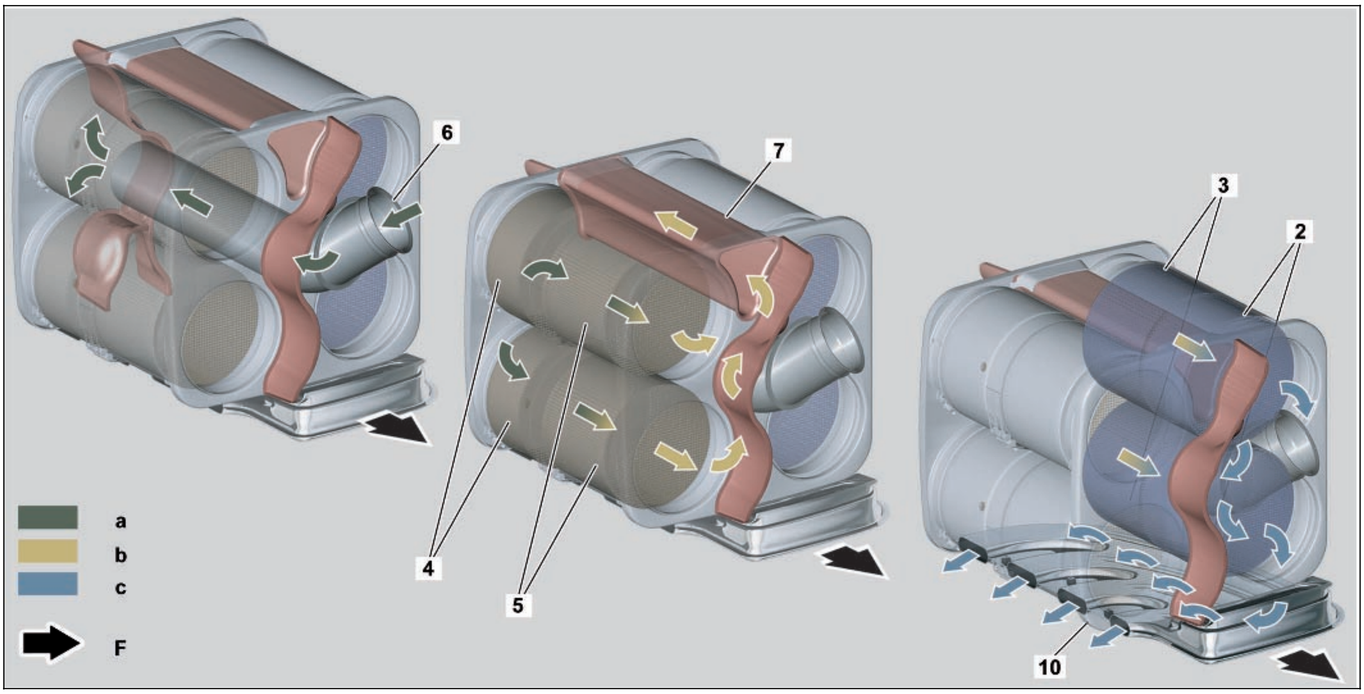
Location of sensors
1 Exhaust aftertreatment unit:
2 Ammonia blocking catalytic converter
3 SCR catalytic converter
4 Diesel oxidation catalytic converter (DOC)
5 Diesel particulate filter (DPF)

A57 b1 Exhaust aftertreatment unit outlet NOx sensor
A67 AdBlue® metering device
A70 b1 Exhaust aftertreatment unit inlet NOx sensor control unit
B37 Exhaust pressure sensor downstream of diesel oxidation catalytic converter



W49.20-1022-75

B38 Exhaust pressure sensor downstream of diesel particulate filter
B67 Exhaust temperature sensor upstream of diesel oxidation catalytic converter
B68 Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter
B69 Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter
B70 Exhaust temperature sensor downstream of diesel particulate filter
B73 Temperature sensor downstream of SCR catalytic converter



W49.20-1021-79

Function

2	*Ammonia blocking catalytic converter*	10	*Outlet pipe*	c	*Exhaust downstream of diesel oxidation catalytic converter, diesel particulate filter, SCR catalytic converter and ammonia blocking catalytic converter*
3	*SCR catalytic converter*				
4	*Diesel oxidation catalytic converter*	a	*Exhaust from engine*		
5	*Diesel particulate filter*	b	*Exhaust downstream of diesel oxidation catalytic converter and diesel particulate filter*		
6	*Inlet pipe*				
7	*Mixing tube (hydrolysis segment)*			F	*Direction of travel*

The exhaust from the engine (a) first flows through the exhaust aftertreatment unit (1) via a pipe. Then it is deflected and flows through the diesel oxidation catalytic converter (4) from the rear, and then flows through the diesel particulate filter (5).
At the front of the exhaust aftertreatment unit (1) the exhaust is then deflected again and flows back to the rear part of the exhaust aftertreatment unit (1) via the mixing tube (7).

In the mixing tube (7), the so-called hydrolysis segment, AdBlue® is injected by the AdBlue® metering device (A67). In the rear part of the exhaust aftertreatment unit (1) the exhaust is deflected so that it flows through the SCR catalytic converter (3) and the ammonia blocking catalytic converter (2) from the rear. The cleaned exhaust is given off into the atmosphere via the outlet pipe (10).

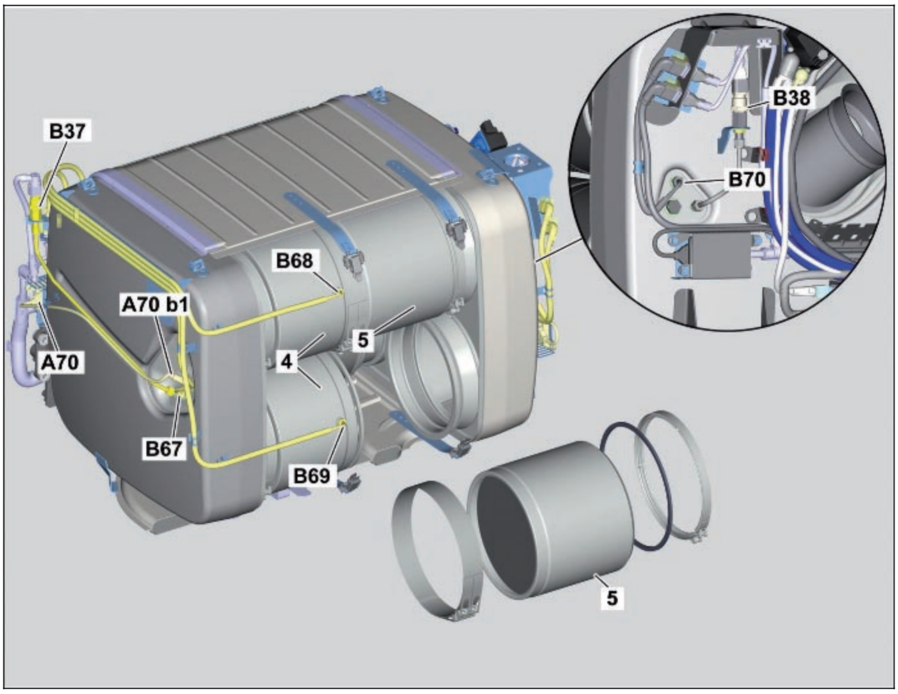
GF49.20-W-3010H	Diesel particulate filter of the exhaust aftertreatment unit, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location

4 *Diesel oxidation catalytic converter (DOC)*
5 *Diesel particulate filter (DPF)*

B37 *Pressure sensor, exhaust upstream of oxidation catalytic converter*
B38 *Exhaust pressure sensor downstream of diesel particulate filter*
B67 *Exhaust temperature sensor upstream of diesel oxidation catalytic converter*
B68 *Exhaust temperature sensor downstream of upper diesel oxidation catalytic converter*
B69 *Exhaust temperature sensor downstream of lower diesel oxidation catalytic converter*
B70 *Exhaust temperature sensor downstream of diesel particulate filter*



W14.40-1601-76

The diesel particulate filter (DPF) (5) is integrated in the exhaust aftertreatment unit. It is the second location downstream of the diesel oxidation catalytic converter (DOC) (4) to be reached by the exhaust downstream of the engine.

Task

The diesel particulate filter (DPF) (5) is used for filtering and storing the soot particles in the exhaust, which occur during the combustion process in the engine.

Design

The diesel particulate filter (DPF) (4) consists of two cylindrical inserts with a metal sleeve. Inside the filter is the actual filter element, which consists of a porous monolithic block made from silicon carbide (SiC).
In order to assist with passive regeneration and counteract rapid filter clogging, the filter element is covered with a series of rare metals - the so-called oxidization layer (wash coat).

Function

The exhaust, which has been pre-cleaned by the diesel oxidation catalytic converter (DOC) (4), flows through the filter element in the diesel particulate filter (DPF) (5). The soot particles are retained in its porous honeycomb structure.
The effectiveness of the diesel particulate filter (DPF) (5) is so high that about 90 % of the particulate mass and approx. 95 % of the number of particles can be retained.
The exhaust aftertreatment control unit (ACM) (A60) can calculate the current load condition of the diesel particulate filter (DPF) (5) via the signal evaluations of the pressure and temperature sensors attached to the inlet and the outlet of the exhaust aftertreatment unit, and initiate regeneration measures via the engine management control unit (MCM (A4).
In spite of passive and active regeneration, the diesel particulate filter (DPF) (5) does not have an unlimited service life and therefore requires regular maintenance.

Regeneration
The diesel particulate filter (DPF) (5) regenerates itself more or less independently. This is achieved using a passive self-cleaning mechanism. This passive regeneration is based on CRT technology (Continuously Regenerating Trap).
If a certain condition is reached in which passive regeneration is not longer sufficient, active regeneration is initiated.

Passive regeneration
Passive regeneration takes place imperceptibly to the driver while the vehicle is being driven. Because of the diesel oxidation catalytic converter (DOC) (4) upstream of the diesel particulate filter (DPF) (5) the exhaust contains carbon dioxide (CO_2) instead of carbon monoxide (CO). This reacts with the soot particles on the oxidization layer of the filter element. This exothermic reaction releases heat, meaning that some of the deposited soot particles combust when a temperature of approx. 250 °C is reached.

Active regeneration
For active regeneration, diesel fuel is added to the exhaust flow via the diesel fuel metering device. Extremely high temperatures occur in the exhaust aftertreatment unit during the ensuing reaction.The deposited soot is burned and turns into ash.
Whereas passive regeneration takes place unnoticed in the background, when active regeneration occurs an indication is given, and in some cases the driver is requested to initiate active regeneration at the next opportunity. Regeneration can be interrupted, but this must be avoided if possible.

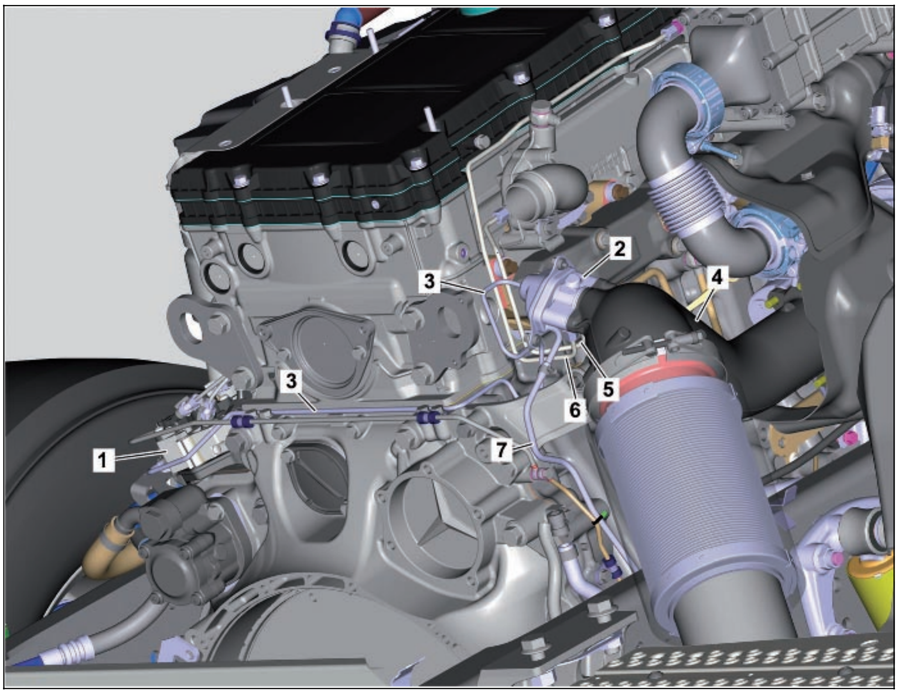
Basically, the regeneration duration is variable and is calculated on the basis of sensor signals, recorded values, the distance driven since the previous regeneration and the different operating ranges of the engine.

When the diesel particulate filter (DPF) (5) has reached its filling limit and active regeneration is no longer possible, it must be cleaned or replaced by a specialist workshop.

GF49.20-W-3012H	Nozzle unit for DPF regeneration, component description	20.7.11

ENGINES 471.9 in MODEL 963, 964 with CODE (M5Z) Engine version Euro VI

Location



W49.20-1017-76

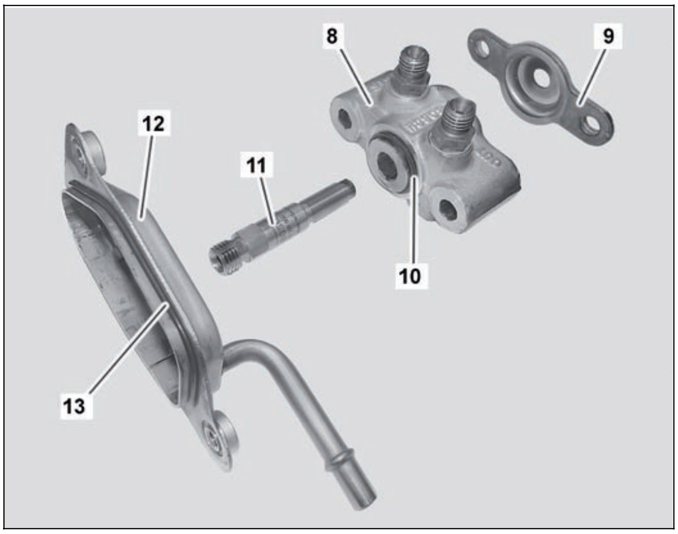
1 Metering device for DPF regeneration
2 Nozzle unit for DPF regeneration
3 Fuel line
4 Exhaust pipe
5 Coolant line
6 Coolant line
7 Leakage line

The nozzle unit for DPF regeneration (2) is on the right-hand side of the engine next to the exhaust pipe (4) downstream of the turbocharger.

Task

The nozzle unit for DPF regeneration (2) is used for injecting the correct quantity of diesel fuel provided by the metering device for DPF regeneration (1) into the exhaust flow during active diesel particulate filter (DPF) regeneration.

Design



W49.20-1019-11

8 Cooling adapter
9 Housing lower section
10 Sealing ring
11 Injection nozzle
12 Shielding pot
13 Gasket

Function

The nozzle unit for DPF regeneration (2) injects the diesel fuel that is present at the injection nozzle into the exhaust flow in a fine spray (atomized). Backflow is prevented by the integrated check valve.
Because of the temperature present at the exhaust pipe, it is cooled using the coolant from the engine's coolant circuit.

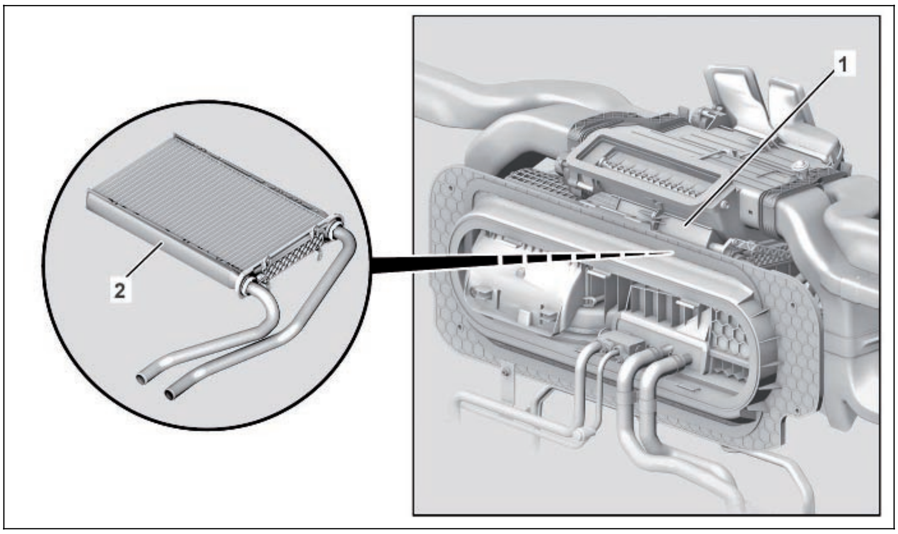
GF83.20-W-3123H	Heating system heat exchanger, component description	20.7.11

MODEL 963, 964

Location

1 Heater blower unit
2 Heating system heat exchanger

The heater heat exchanger (2) is in the heater blower unit (1).



W83.20-1103-05

Task

The heater heat exchanger (2) gives off the heat of the coolant into the air that flows through it.
The temperature of the vehicle interior is therefore controlled

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