Introduction of the Inline Engine Generation 4-Cylinder OM654

Introduction into Service Manual

Mercedes-Benz

Mercedes-Benz Service

Introduction of the Inline Engine Generation 4-Cylinder OM654

Daimler AG · GSP/OR · D-70546 Stuttgart

Contents

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Dear Reader,
This Introduction into Service manual presents the new 4-cylinder diesel engine OM654 in model series 213. In terms of the contents, the emphasis in this Introduction into Service Manual is on presenting new and modified components and systems.

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

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

WIS is updated continuously. Therefore, the information available there reflects the latest technical status of our vehicles. This Introduction into Service manual presents initial information relating to the new engine generation and, as such, is not stored in WIS. The contents of this brochure are not updated. No provision is made for supplements.

We will publicize modifications and new features in the relevant WIS documents. The information presented in this Introduction into Service manual may therefore differ from the more up-to-date information found in WIS. All information relating to technical data is valid as of the copy deadline in September 2015 and may therefore differ from the current production configuration.

Daimler AG
Retail Operations (GSP/OR)

Note
This and other printed products can be ordered from the GLC by quoting the respective HLI number.

Note
The printed documents are now available in WIS via WIS Service Media.

Engine OM654 is a newly developed 4-cylinder diesel engine with common rail diesel injection system, multiway exhaust gas recirculation, single-stage turbocharging, exhaust after-treatment with the third generation SCR system and optimized thermal management. Engine OM654 will be introduced in the new E-Class.

The following goals are achieved with the new OM654:

- Uniform concept of a single engine family
- Suitable for different drive concepts
- Increased output
- Weight reduction
- Reduced consumption
- Compliance with future emissions limits
- Potential for development with regard to reductions in consumption and emissions
- Improved noise behavior

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OM654 D20 SCR

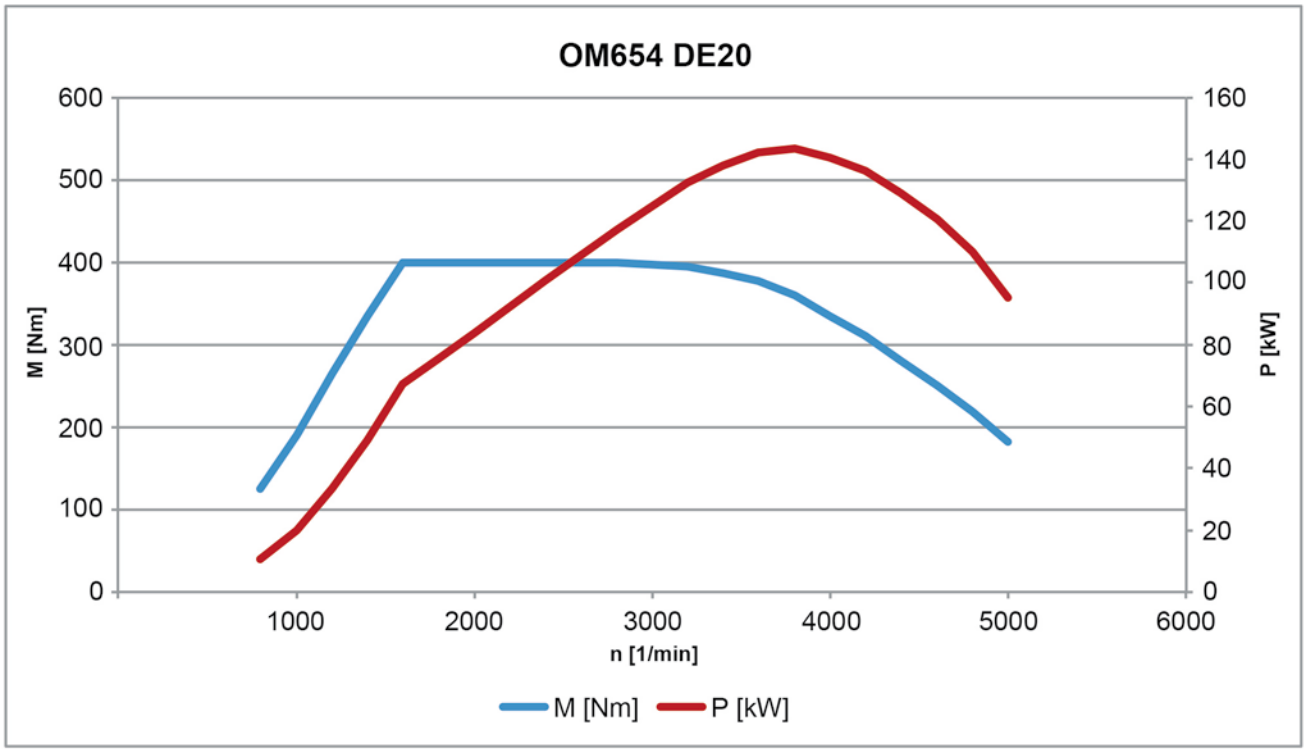
Brief description

The special features of engine OM654 in brief:

- Common rail diesel injection system with 2050 bar
- 8-hole piezo injectors
- Aluminum crankcase with Nanoslide cylinder wall coating
- Tandem oil pump integrated in the crankcase
- Timing chain on the flywheel side for driving the high-pressure pump, the oil pump and both camshafts
- Gearwheel drive for the balance shafts
- Oil spray nozzle shutoff valve for controlling the oil spray nozzles for piston crown cooling
- Aluminum cylinder head, four valves per cylinder, two overhead camshafts
- Multiway exhaust gas recirculation with cooled high-pressure and low-pressure exhaust gas recirculation
- Cylinder head with 2-piece water jacket
- Near-engine mounted combination of diesel oxidation catalytic converter, diesel particulate filter and SCR catalytic converter
- Exhaust aftertreatment with SCR
- Load-controlled preinjections and post injections
- Two balance shafts (Lanchester)
- Compliance with the Euro 6 emissions standard
- ECO start/stop function
- Quick-glow system with glow output stage
- 1-stage turbocharging, variable turbine geometry with water-cooled bearing housing and E-actuator

Model series 213	Unit	E 220 d Sedan
Engine model designation		OM654.920
Engine designation		OM654 D20 SCR
Emissions standard		Euro 6
Cylinder configuration/ number		Inline/4
Displacement	cm^3	1950
Bore	mm	82
Stroke	mm	92.3
Valves per cylinder		4
Cylinder spacing	mm	90
Compression ratio		15.5 : 1
Rated output at engine speed	kW rpm	143 3800
Rated torque at engine speed	Nm rpm	400 1600...2400
Fuel type		Diesel
Injection system		Common rail
Maximum injection pressure	bar	2050
Boost pressure	bar	1.8
Engine weight (dry)	kg	168

Performance graph



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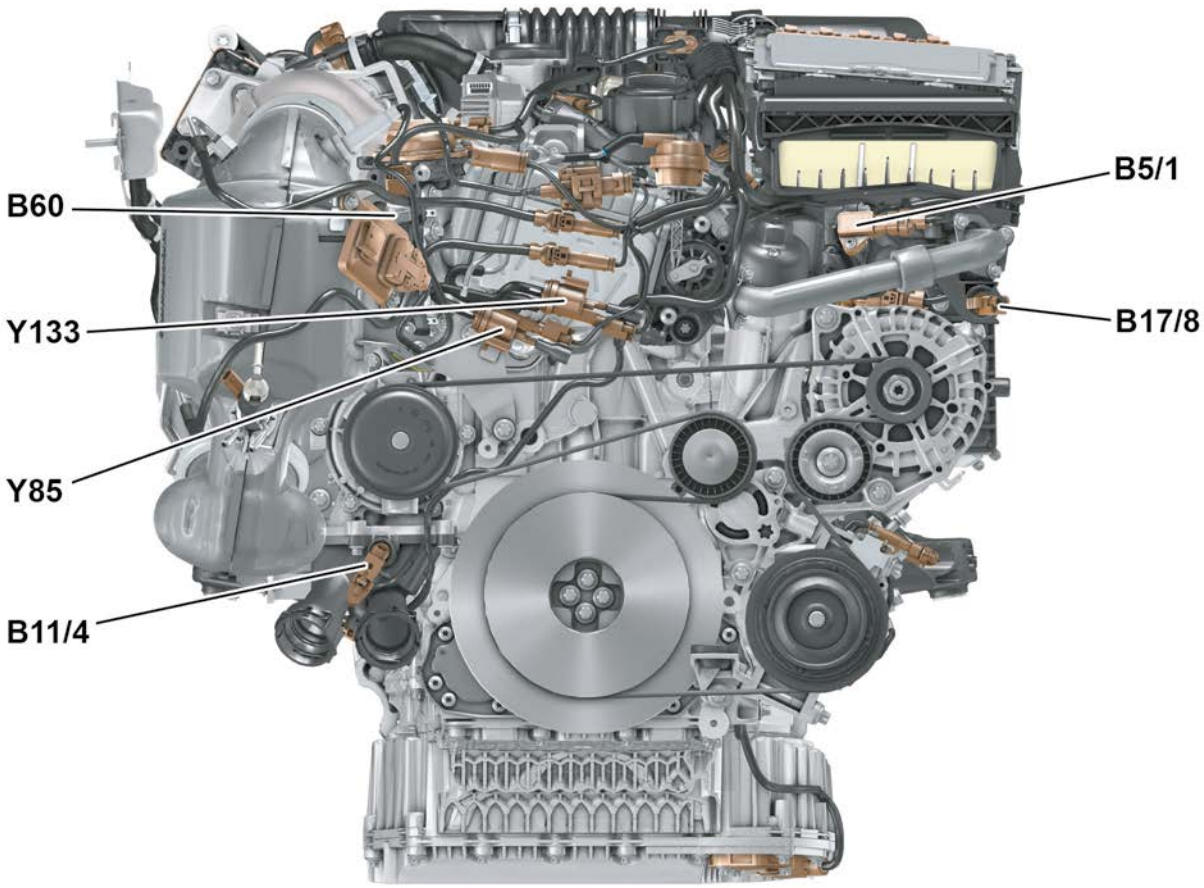

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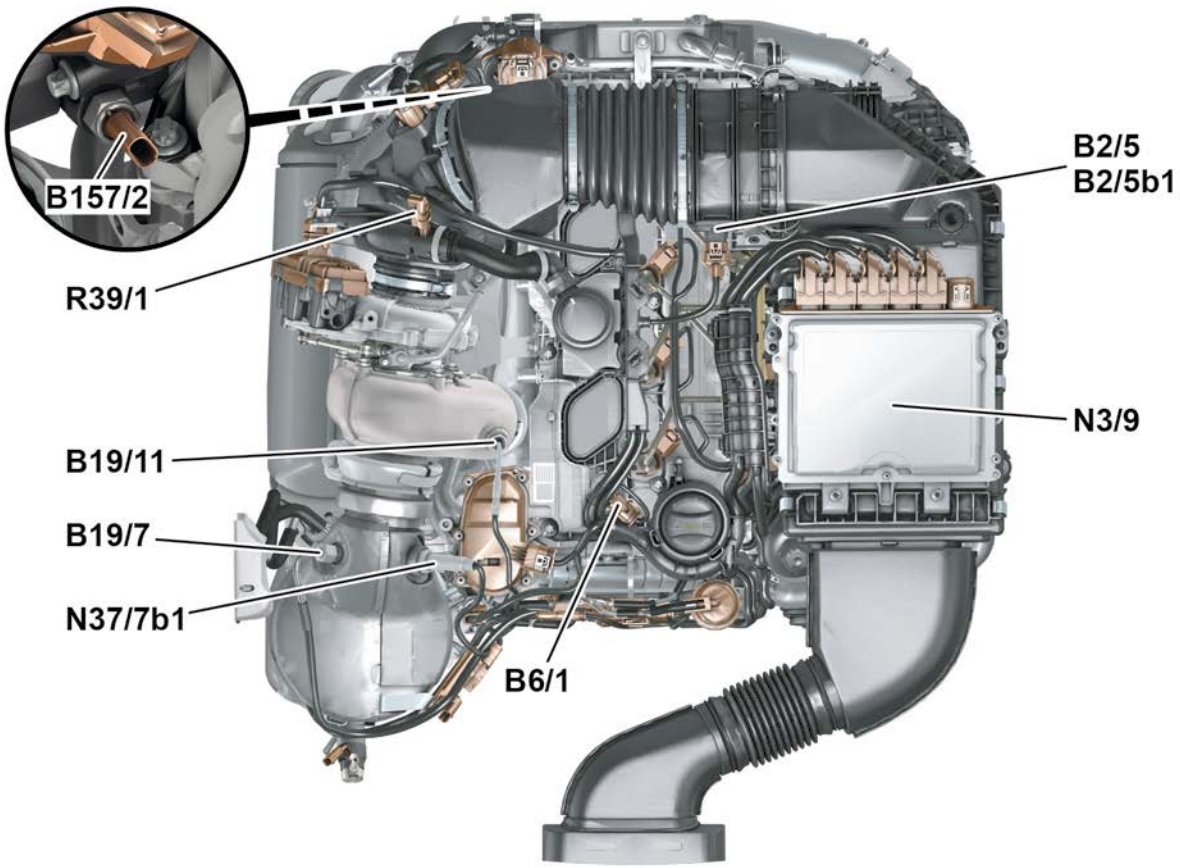
Front view of engine

B5/1	Boost pressure sensor	B60	Exhaust pressure sensor
B11/4	Coolant temperature sensor	Y85	EGR cooler bypass switchover valve
B17/8	Charge air temperature sensor	Y133	Coolant pump switchover valve

Engine views



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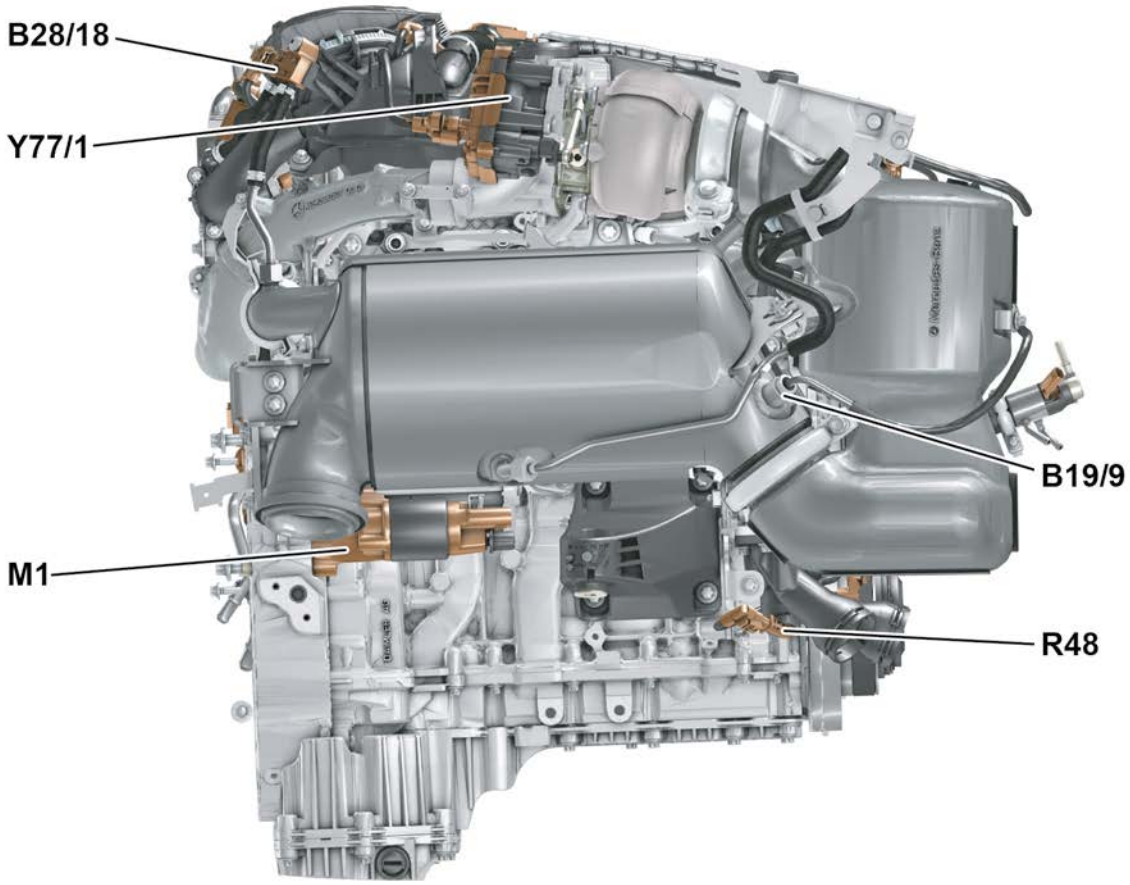
Top view of engine

B2/5	Hot film MAF sensor
B2/5b1	Intake air temperature sensor
B6/1	Camshaft Hall sensor
B19/7	Temperature sensor upstream of catalytic converter
B19/11	Temperature sensor upstream of turbocharger
B157/2	EGR temperature sensor, low pressure
N3/9	CDI control unit
N37/7b1	NOx sensor upstream of diesel oxidation catalytic converter
R39/1	Vent line heating element



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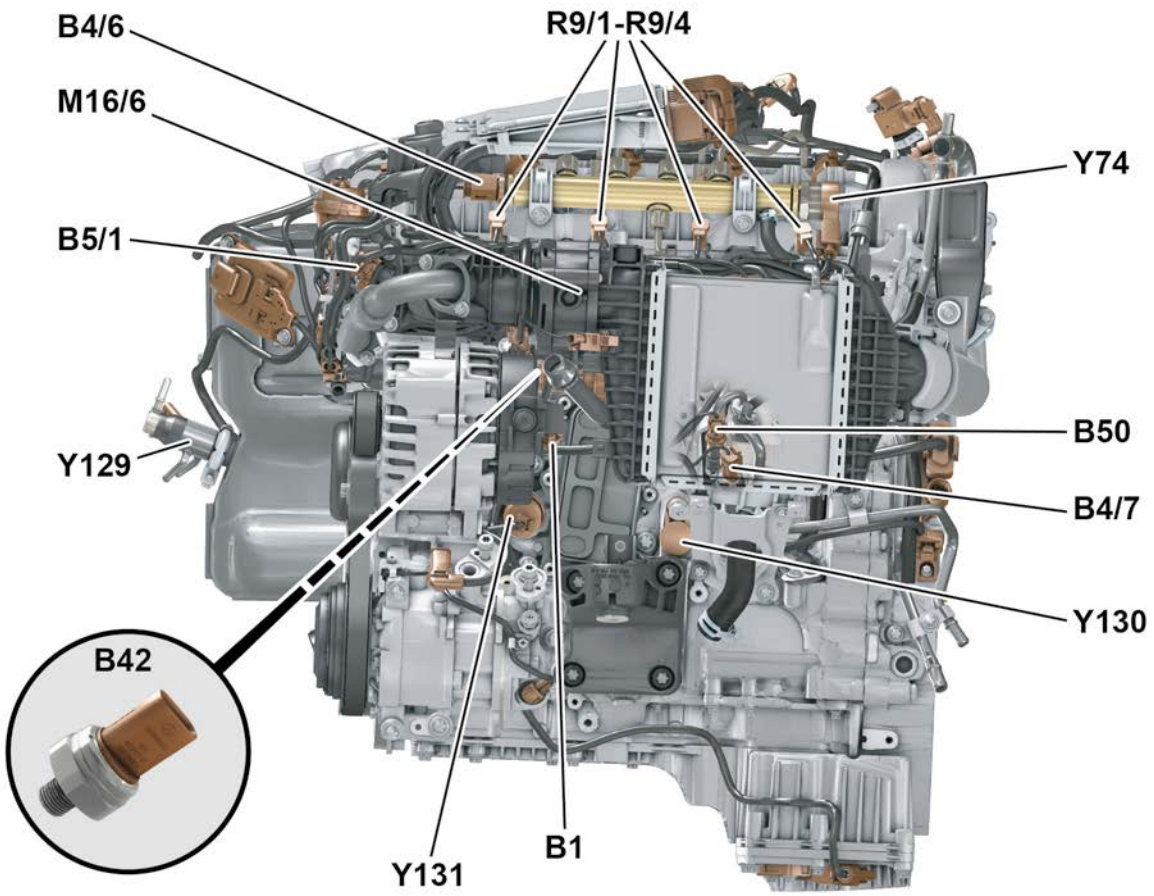
Right side view of engine

B19/9	Temperature sensor upstream of diesel particulate filter
B28/18	EGR differential pressure sensor, low pressure
M1	Starter
R48	Coolant thermostat heating element
Y77/1	Boost pressure regulator

Engine views



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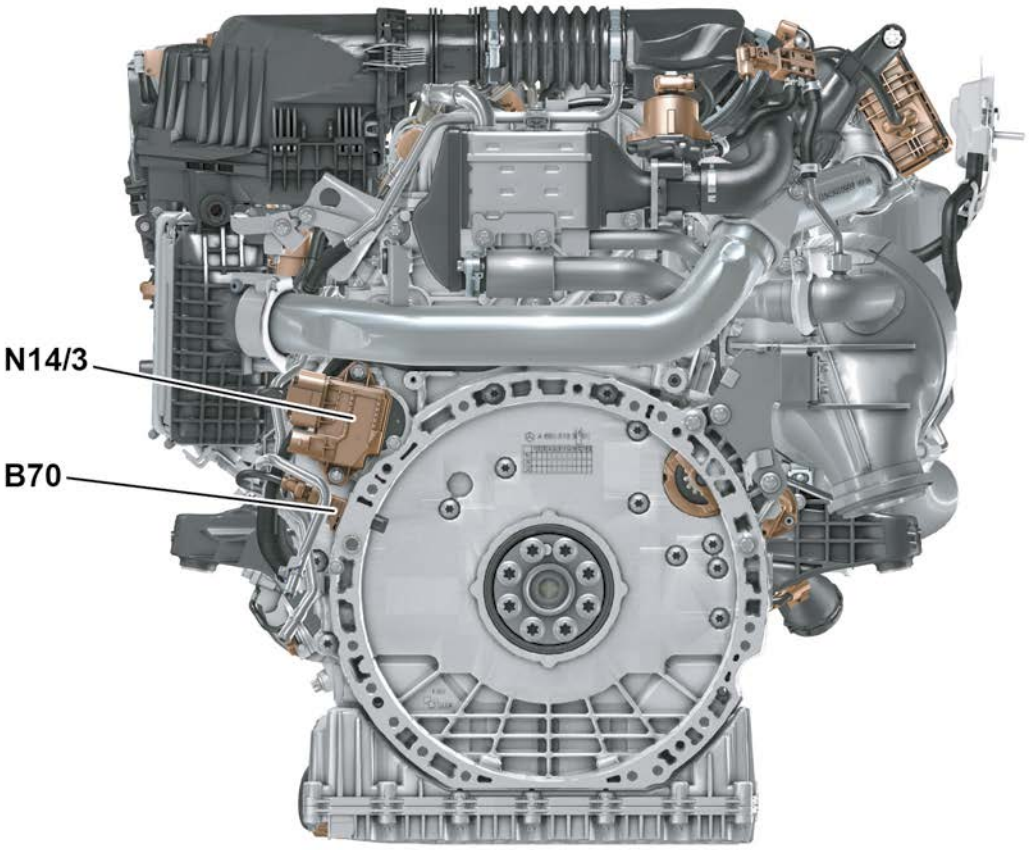
Left side view of engine

B1	Engine oil temperature sensor
B4/6	Fuel pressure sensor, high pressure
B4/7	Fuel pressure sensor
B5/1	Boost pressure sensor
B42	Engine oil pressure sensor
B50	Fuel temperature sensor
M16/6	Throttle valve actuator
R9/1	Cylinder 1 glow plug
R9/2	Cylinder 2 glow plug
R9/3	Cylinder 3 glow plug
R9/4	Cylinder 4 glow plug
Y74	Pressure regulating valve
Y129	AdBlue® metering valve
Y130	Engine oil pump valve
Y131	Oil spray nozzles shutoff valve



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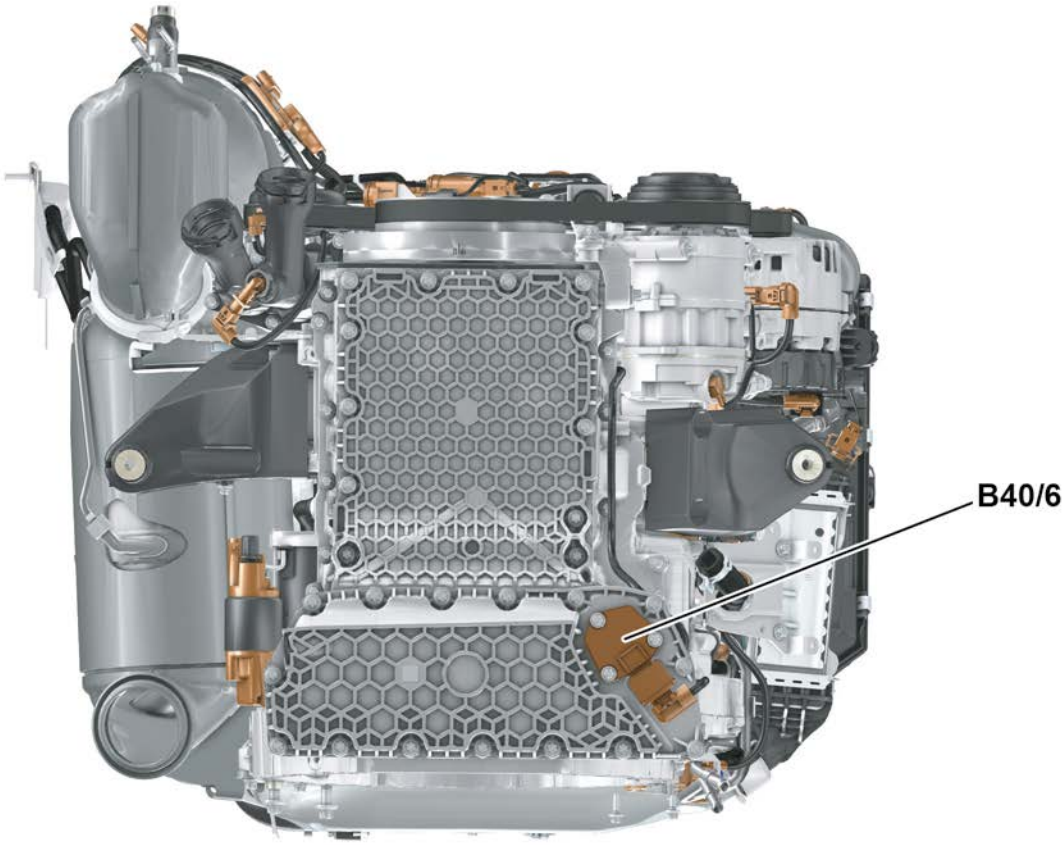
Rear view of engine

B70 Crankshaft Hall sensor

N14/3 Glow output stage

Engine views



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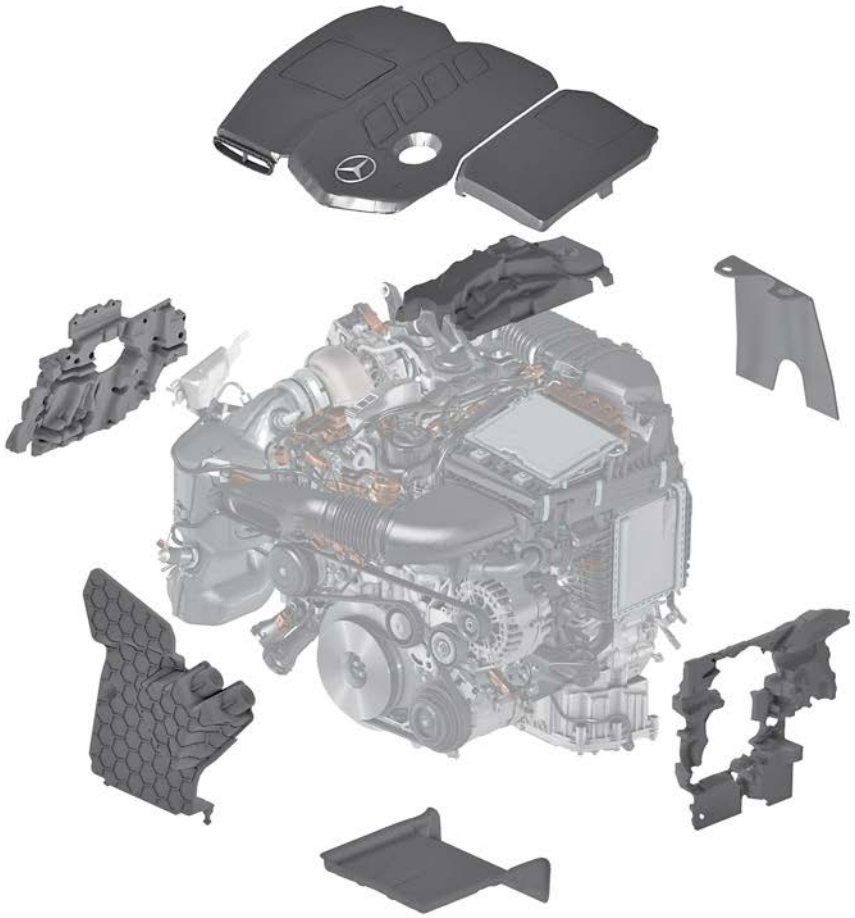
Bottom view of engine

B40/6 Engine oil fill level sensor



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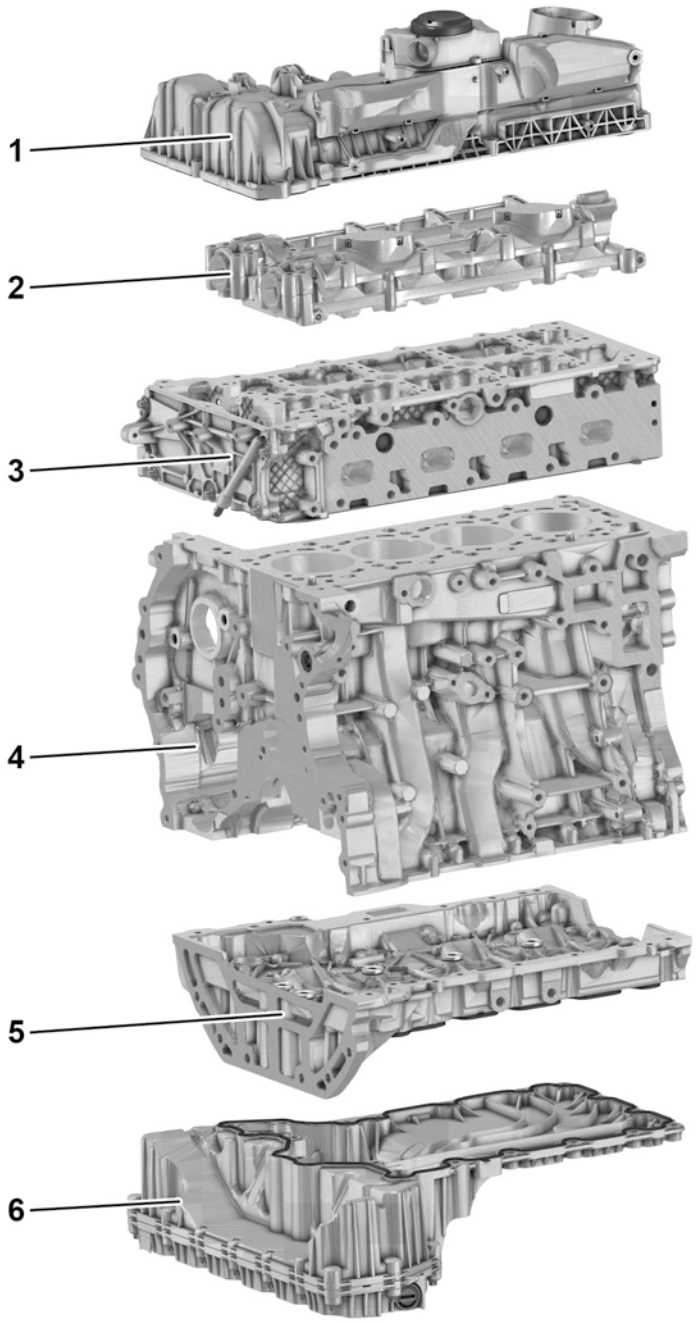
View of noise reduction kit

Basic engine

The crankcase used in engine OM654 is made of aluminum. The cylinder barrels are additionally lined with a Nanoslide® coating. The individual cylinders are arranged at intervals of 90 mm.

Additional benefits in terms of friction and installability arise from the deaxiated arrangement of the cylinder barrels towards the cold side of the engine. The cylinder head has a double water jacket to improve cooling of the areas exposed to thermal loads.



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Basic engine

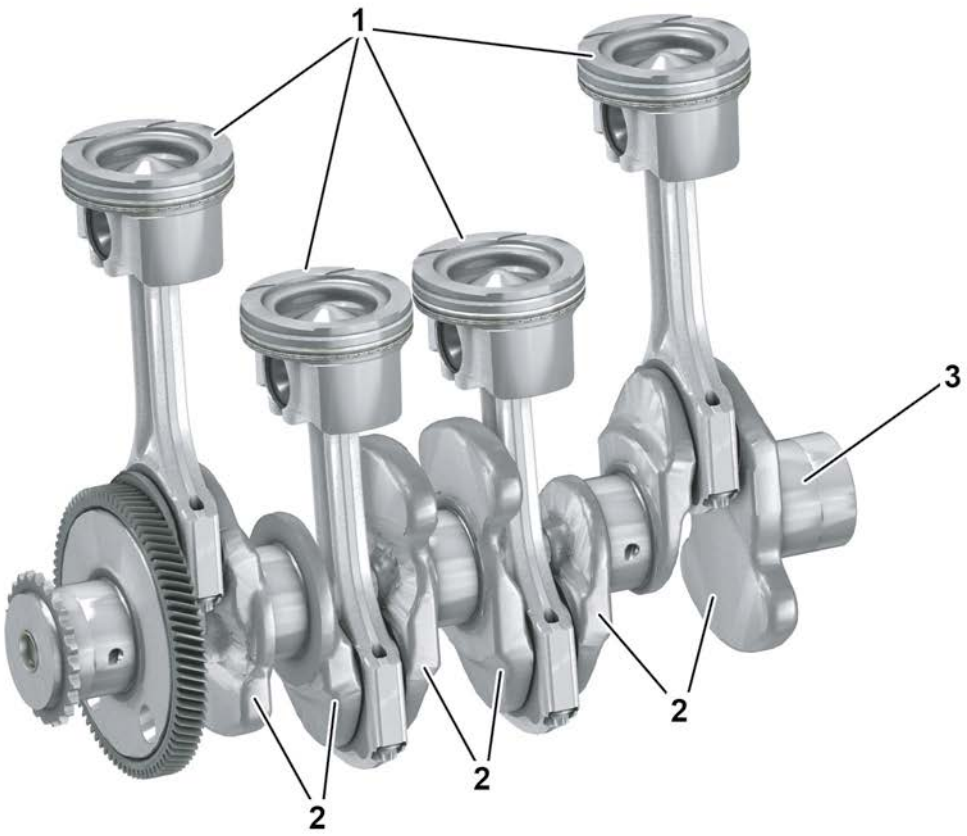
1 Cylinder head cover
2 Camshaft bearing housing
3 Cylinder head
4 Crankcase
5 Crankcase bottom section
6 Two-piece engine oil pan

Crank assembly, general

The crank assembly features a forged crankshaft carried on 5 bearings. The bore/stroke ratio is 82 mm to 92.3 mm. This ratio provides optimum filling of the combustion chamber and therefore highly efficient combustion. Smooth running is achieved by means of a Lanchester balancer.

Pistons

The pistons installed are made of steel with stepped combustion cavities. The narrow piston squish areas allow maximum air efficiency and thereby reduce soot levels.



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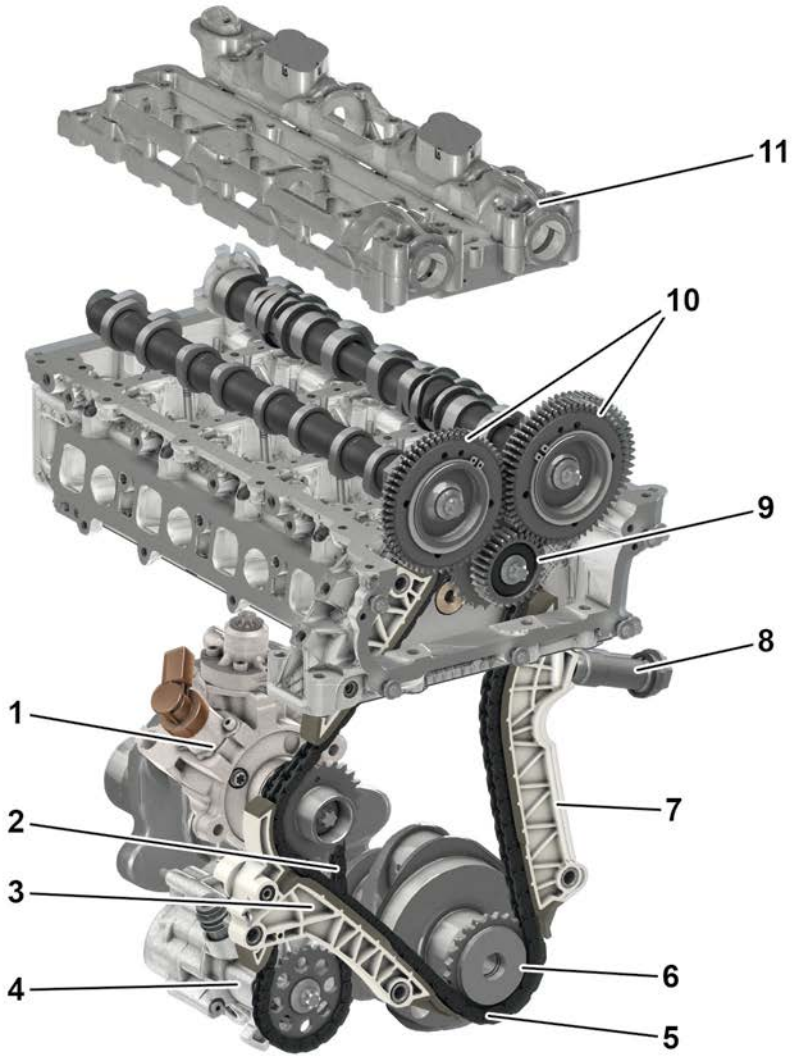
Crank assembly

1 Pistons
2 Counterweights
3 Crankshaft

Chain drive

The control drive is installed at the transmission end of the engine. It consists of a combination of chain drive and gear drive. The teeth of the sprocket (acting directly on the crankshaft) drive the fuel system high-pressure pump and an intermediate gear. The sprocket is bolted directly on the drive shaft of the fuel system high-pressure pump via a cone. A second chain track drives the tandem oil pump and the vacuum pump.

The camshaft drive gear drives the exhaust camshaft. The exhaust camshaft in turn drives the intake camshaft. The gears of the camshaft are braced against each other to reduce noise. Before the camshaft drive gears are removed, each camshaft drive gear must be secured to prevent it from turning. They are secured by means of a locking pin which is to be inserted into the hole provided.



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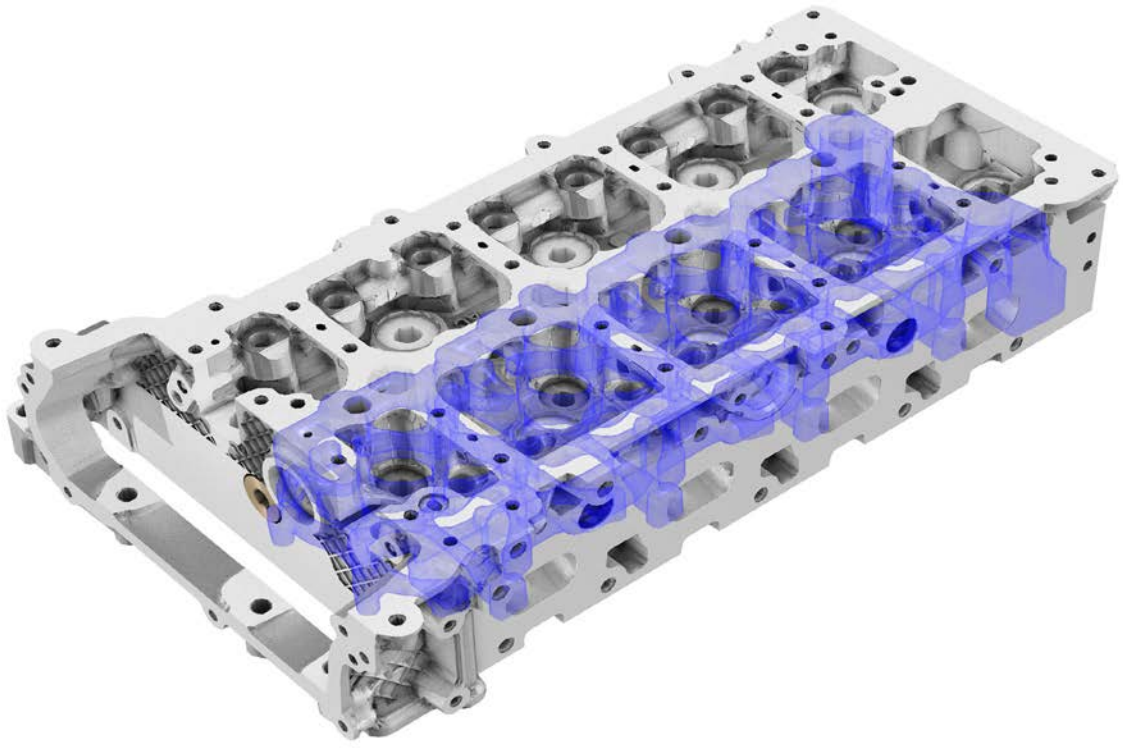
Chain drive (rear view of engine)

1 Fuel system high-pressure pump
2 Engine oil pump chain
3 Guide rail
4 Tandem oil pump
5 Camshaft timing chain
6 Crankshaft drive gear
7 Tensioning rail
8 Hydraulic chain tensioner
9 Camshaft drive gear
10 Camshaft gears
11 Camshaft bearing housing

The cylinder head is made of an aluminum-silicon alloy. A cylinder head with double water jacket is used. This improves cooling and simultaneously increases the rigidity of the component. The thermodynamic behavior and the efficiency of the engine are also improved. Adaptable flow openings in the cylinder head gasket between the upper and lower water jackets adjust the flow and distribution inside the cylinder head for the optimum temperatures.

The ducting concept incorporates ports with optimized swirl and flow on the intake side. Each cylinder has one tangential port and one spiral swirl port which can be switched via the intake port shutoff system.



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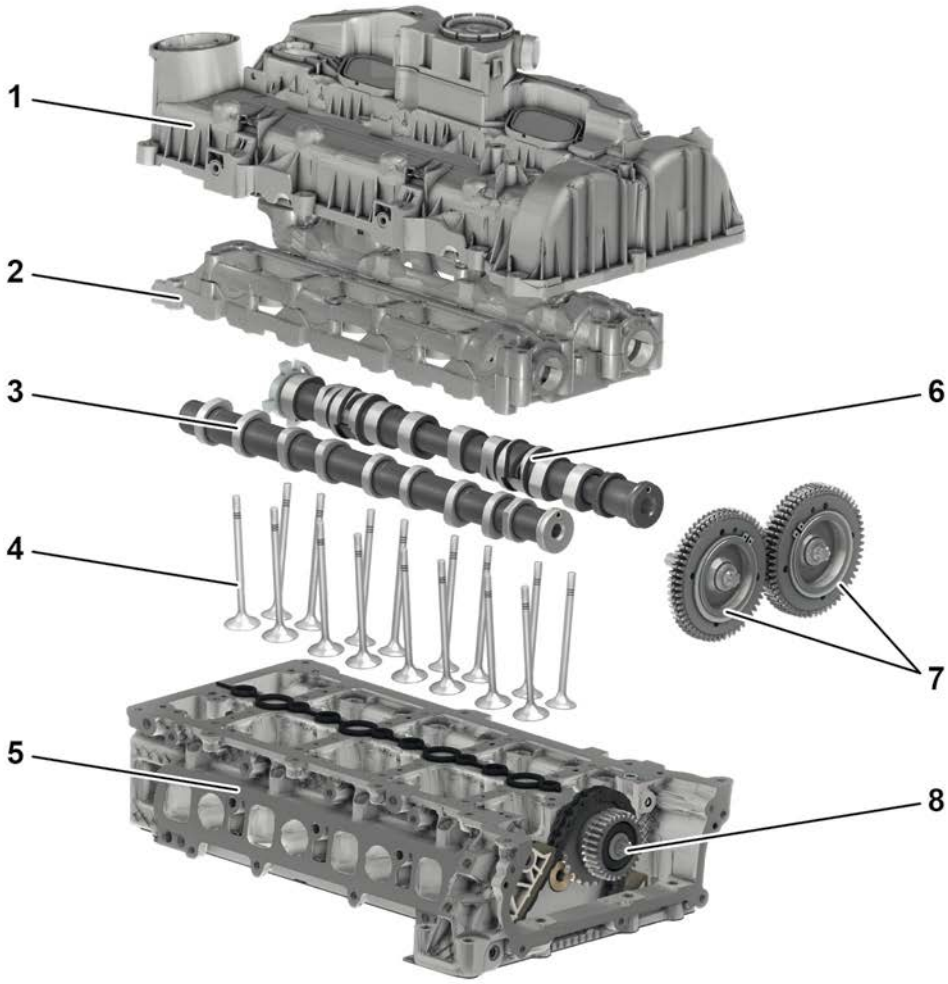
Cylinder head with water jacket

Cylinder head

Two overhead camshafts operate two intake valves and two exhaust valves per cylinder by means of roller cam followers. The camshafts are mounted in a separate camshaft bearing housing.

The valves are arranged in parallel so as to produce the optimum combination of cross section and strength of the combustion plate.



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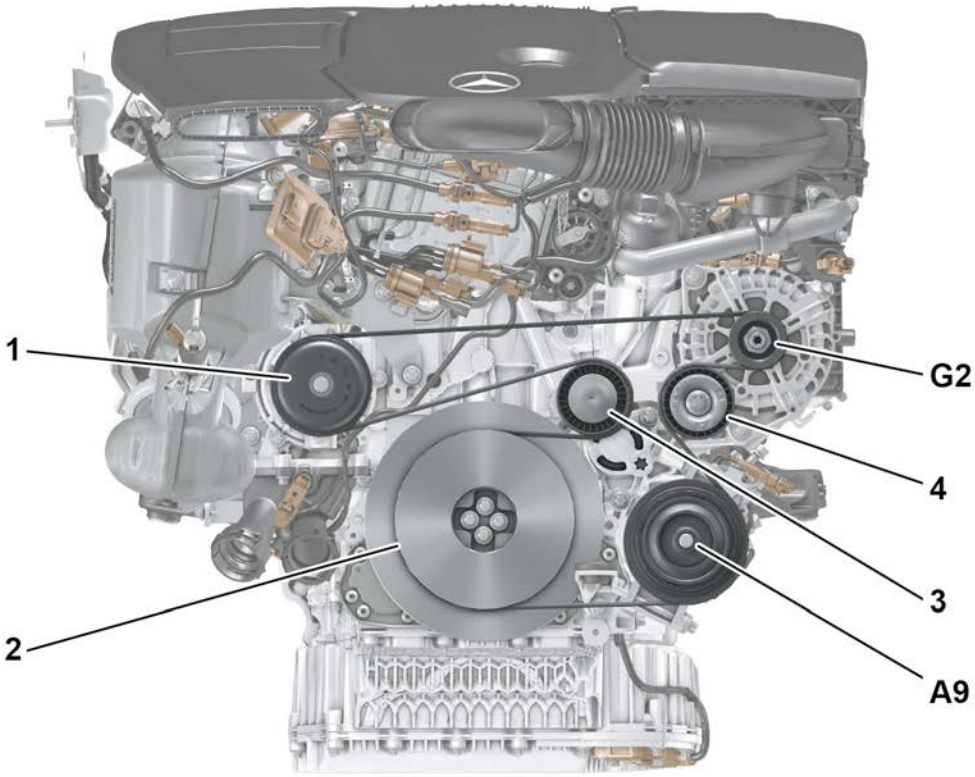
Cylinder head with valve timing

1 Cylinder head cover
2 Camshaft bearing housing
3 Intake camshaft
4 Valve
5 Cylinder head
6 Exhaust camshaft
7 Camshaft gears
8 Camshaft drive gear

The crankshaft belt pulley drives the coolant pump, the alternator and the refrigerant compressor via the belt drive system.

The drive system consists of a poly-V belt which is tensioned by a self-tensioning belt tensioner.



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Belt drive

1 Coolant pump
2 Crankshaft pulley
3 Belt tensioner
4 Idler pulley
A9 Refrigerant compressor
G2 Alternator

Preheating

Preglow system

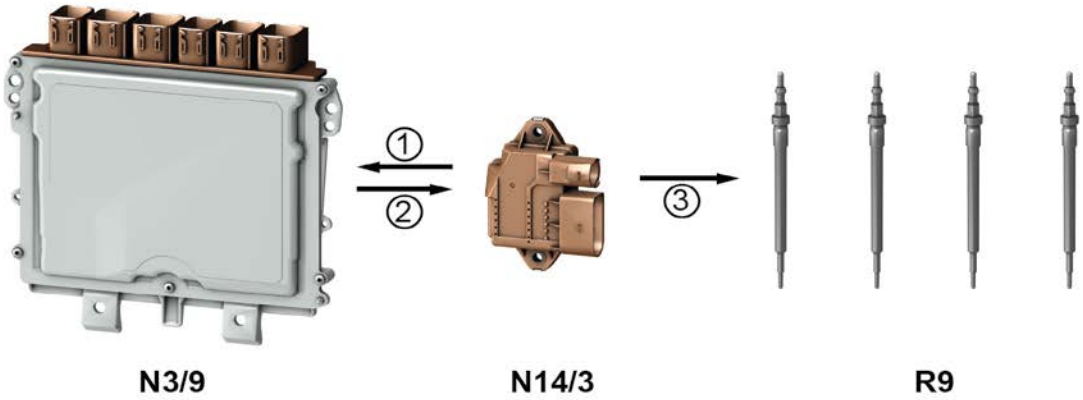
The radially arranged glow plugs are actuated by the CDI control unit via a glow output stage in relation to a pulse width modulated signal. This reduces the cold-starting time and stabilizes the cold running of the engine.

Glow output stage

The glow output stage communicates with the CDI control unit via the drive LIN. Over the drive LIN the diagnostic data are transmitted from the glow output stage to the CDI control unit and the necessary actuation of the glow plugs is communicated.

Glow plugs

The glow plugs are actuated directly by the glow output stage. Depending on the actuation, the glow plugs can reach temperatures of over 1000°C.



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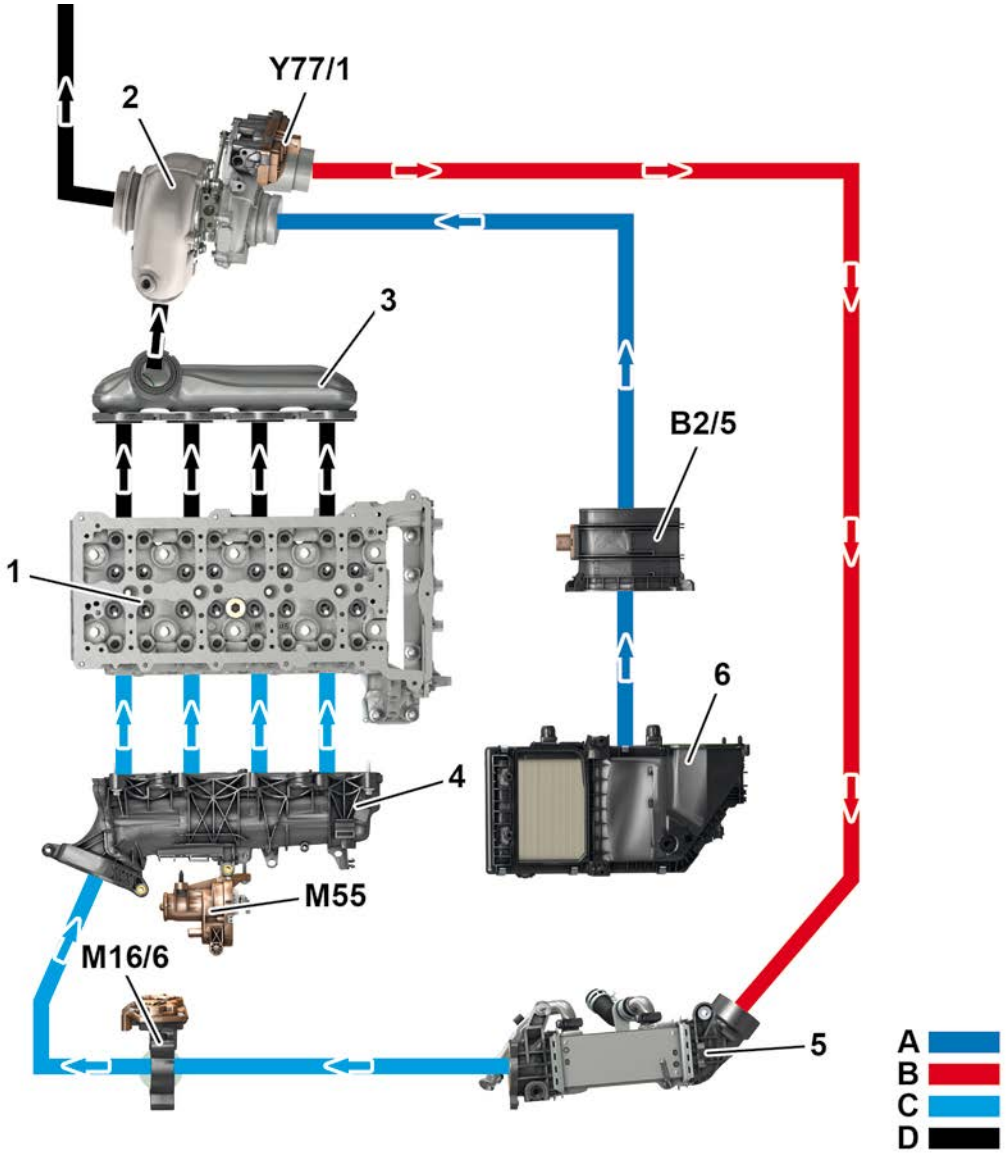
Schematic diagram of preglow system

1	Glow output stage, diagnosis	N3/9	CDI control unit
2	Glow output stage, actuation	N14/3	Glow output stage
3	Glow plugs, actuation	R9	Glow plugs

The intake air system supplies the engine with fresh, filtered air. The intake air mass is measured by the hot film mass air flow sensor and then compressed by the turbocharger. The charge air cooler cools the air which has been heated by compression and feeds it via the throttle valve actuator to the charge air manifold according to requirements.

The cooled compressed intake air travels via the charge air manifold into the individual combustion chambers of the engine. To improve mixture formation, the intake port shutoff actuator motor can open or close the air ducts integrated in the charge air manifold. The change in the flow rate and the improved swirl make for more efficient combustion.



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Schematic diagram of fresh air supply

1	OM654
2	Turbocharger
3	Exhaust manifold
4	Charge air manifold
5	Charge air cooler
6	Air filter
B2/5	Hot film MAF sensor
M16/6	Throttle valve actuator
M55	Intake port shutoff actuator motor
Y77/1	Boost pressure positioner
A	Intake air
B	Charge air (uncooled)
C	Charge air (cooled)
D	Exhaust gas

Forced induction

Forced induction, general

Turbocharging improves the cylinder charge, thus increasing the torque and power of the engine.

Boost pressure control

The boost pressure is regulated electronically via a boost pressure regulator. This actuator motor actuates the guide vanes of the turbocharger directly via a link rod. The guide vanes are adjusted steplessly by the map-dependent, pulse width modulated actuation. For this, the CDI control unit evaluates the following signals:

- Coolant temperature sensor
- Exhaust pressure sensor
- Hot film MAF sensor
- Crankshaft Hall sensor
- Atmospheric pressure sensor (integrated in CDI control unit)

The exhaust temperature and pressure are constantly monitored in order to protect the turbocharger. If there is any risk of thermal or mechanical overload, the CDI control unit reduces the boost pressure.

Turbocharger

The turbocharger used features variable turbine geometry (VTG). Its compact design results in low thermal and flow losses, providing a high degree of turbocharging.

The turbocharger consists of three main assemblies:

- Turbine
- Compressor
- Bearing housing

In the compressor the clean air is drawn in and accelerated by the rotation of the compressor impeller. Inside the scroll of the compressor housing the air speed is reduced, thus increasing the pressure. The compressor is driven via the turbocharger shaft, on which the compressor impeller and the turbine wheels are rigidly mounted. The turbine wheel is turned by the exhaust gases directed into the turbine housing. This reduces the exhaust gases from a high pressure level to a lower pressure.

The converted energy, i.e. the drive power of the turbine and thus the compressor output, can be regulated via the adjustable guide vanes. In order to increase the boost pressure the vanes are closed, i.e. the flow cross section between the vanes is reduced. This increases the pressure in front of the turbine wheel, increasing the amount of exhaust energy converted. When the guide vanes are closed, the flow cross section upstream of the turbine wheel is reduced, causing the exhaust stream to build up. This increases the pressure of the exhaust gas in front of the turbine wheel. This in turn increases the inlet speed of the exhaust gases into the turbine wheel, which produces a higher drive torque with greater compressor output. The boost pressure and the mass air flow into the engine are increased. When a decrease in the boost pressure is required, the guide vanes are opened wide, which reduces the build-up effect and thus the inlet speed. The drive torque of the turbine wheel drops and therefore so does the compressor output.

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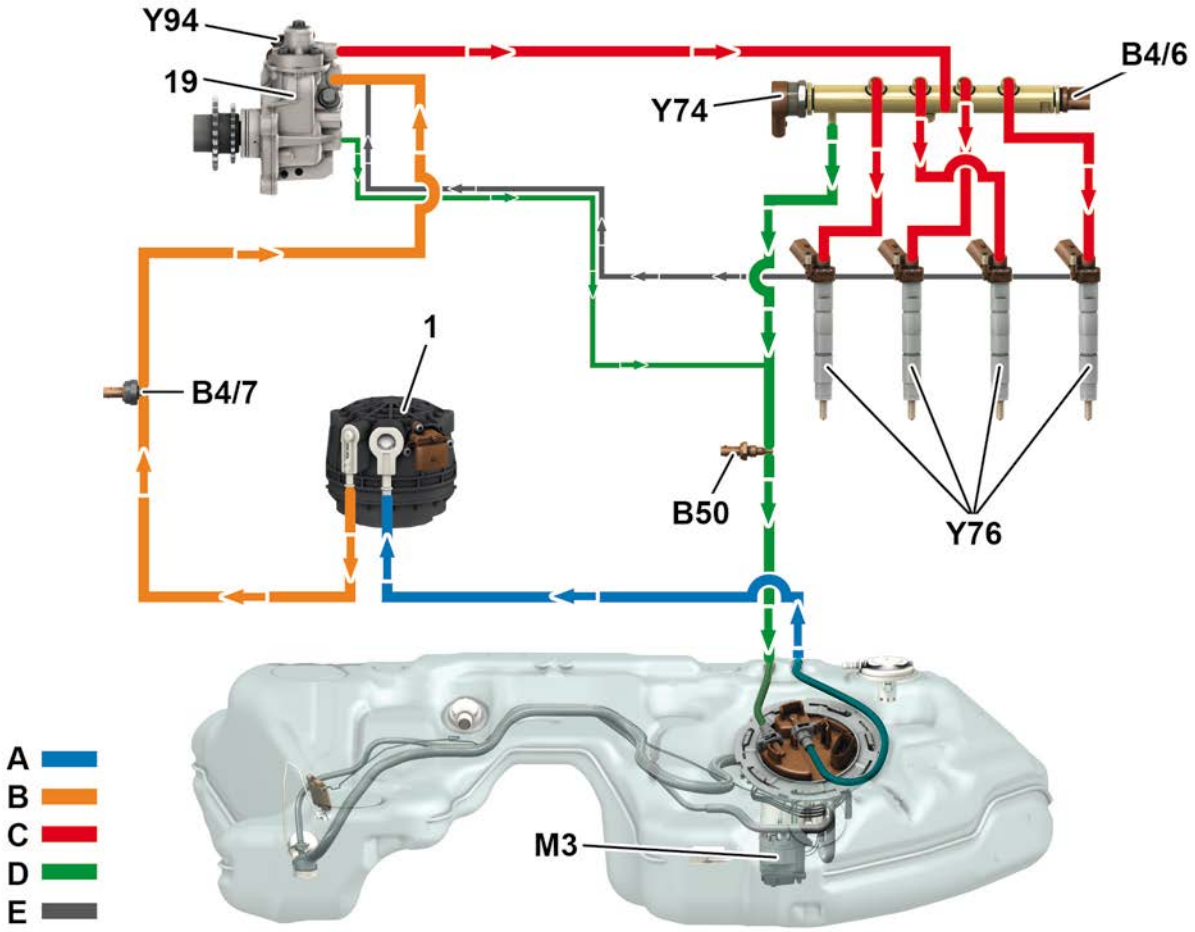
Turbocharger with variable turbine geometry (VTG)

Fuel supply



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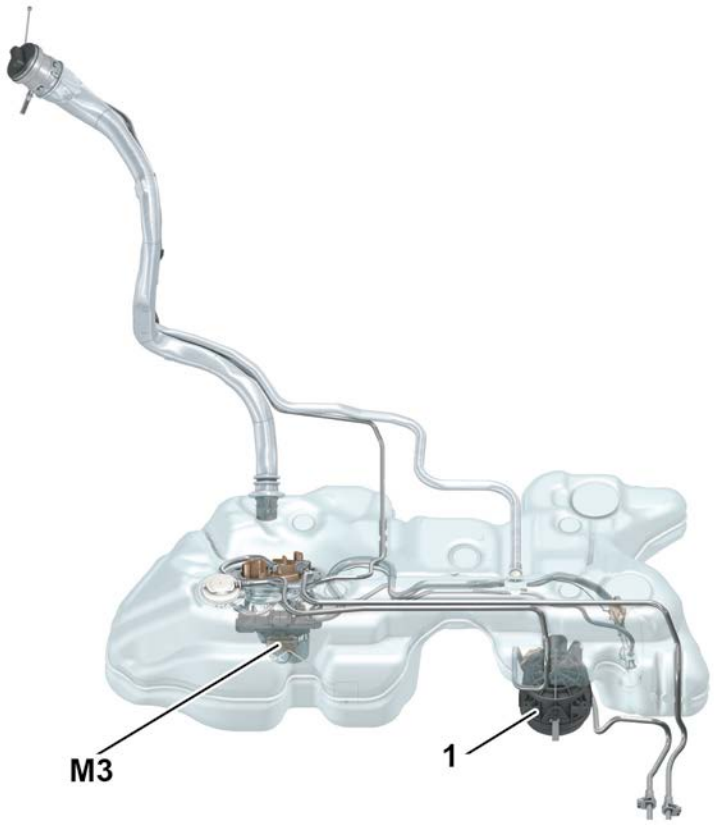
Schematic diagram of fuel circuit

1	Fuel filter module unit
19	Fuel system high-pressure pump
B4/6	Fuel pressure sensor, high pressure
B4/7	Fuel pressure sensor
B50	Fuel temperature sensor
M3	Fuel pump
Y74	Pressure regulating valve
Y76	Fuel injectors
Y94	Quantity control valve
A	Uncleaned fuel
B	Heated, cleaned fuel
C	Compressed fuel (high pressure)
D	Fuel return
E	Leak fuel line

Fuel supply, general

The fuel supply system provides filtered and, if necessary, heated fuel from the fuel tank under all operating conditions. The fuel quantity and pressure are continuously regulated according to a performance map by the fuel system control unit. This guarantees an optimum supply to the fuel system high-pressure pump in every operating state.



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Fuel tank

1 Fuel filter module unit

M3 Fuel pump

Fuel supply

Low-pressure fuel system

The low-pressure fuel system consists of the following components:

- Fuel tank
- Fuel pump
- Fuel lines
- Fuel filter with heating element and water separator
- Fuel temperature sensor
- Fuel pressure sensor

Low-pressure system fuel supply

A fuel pump is used in the low-pressure fuel system. The fuel pump ensures an optimum supply to the fuel system high-pressure pump with low energy requirements. The reduced volumetric flow rate reduces the filter load and therefore increases the service life of the fuel filter.

Fuel feed

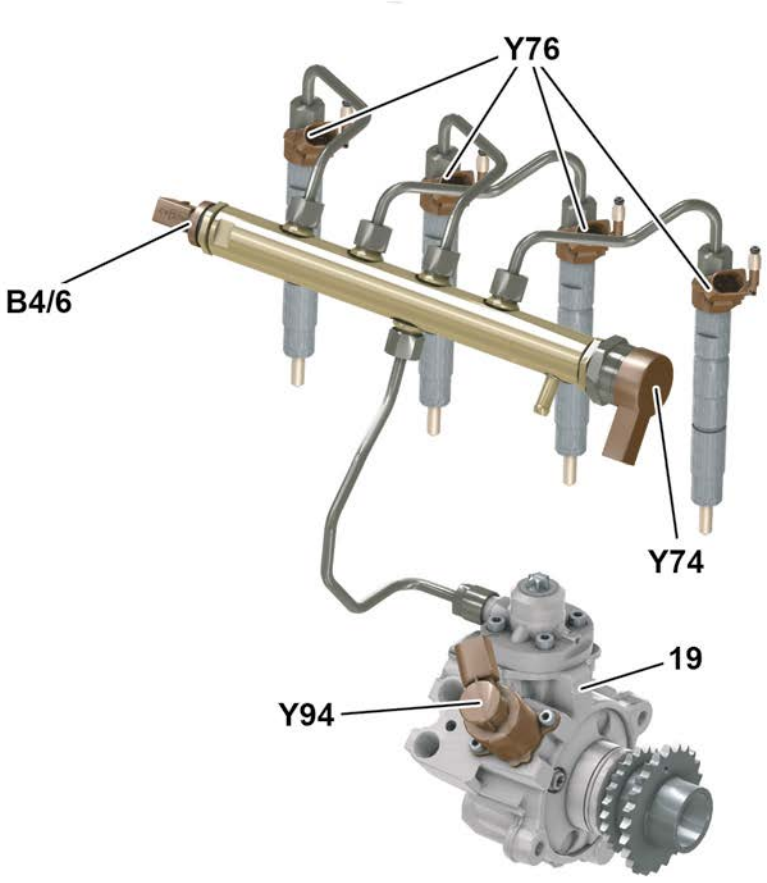
The fuel pump draws the fuel out of the swirl pot through a strainer and pumps it through the fuel filter to the fuel system high-pressure pump. The CDI control unit calculates the quantity currently required and reports this to the fuel system control unit. The fuel system control unit regulates the speed, and thus the delivery rate, of the fuel pump accordingly.

High-pressure fuel system, general

The high-pressure fuel system consists of the following components:

- Fuel system high-pressure pump
- Rail
- High-pressure lines
- Fuel pressure sensor, high pressure
- Fuel injectors
- Quantity control valve
- Pressure regulating valve

The fuel supplied by the fuel pump is compressed by the fuel system high-pressure pump. The fuel quantity is regulated according to requirements via the quantity control valve. The fuel is routed by way of the rail and the high-pressure lines to the individual fuel injectors. The fuel is finely atomized and injected into the combustion chamber. Based on a performance map, the CDI control unit calculates the cylinder-selective injection quantity for the respective operating condition. The injection quantity is dependent on the actuation period and the current fuel pressure in the rail. The pressure regulating valve regulates the fuel pressure in the rail to approx. 2050 bar based on the signal of the high-pressure fuel pressure sensor. The CDI control unit performs this regulation continuously.



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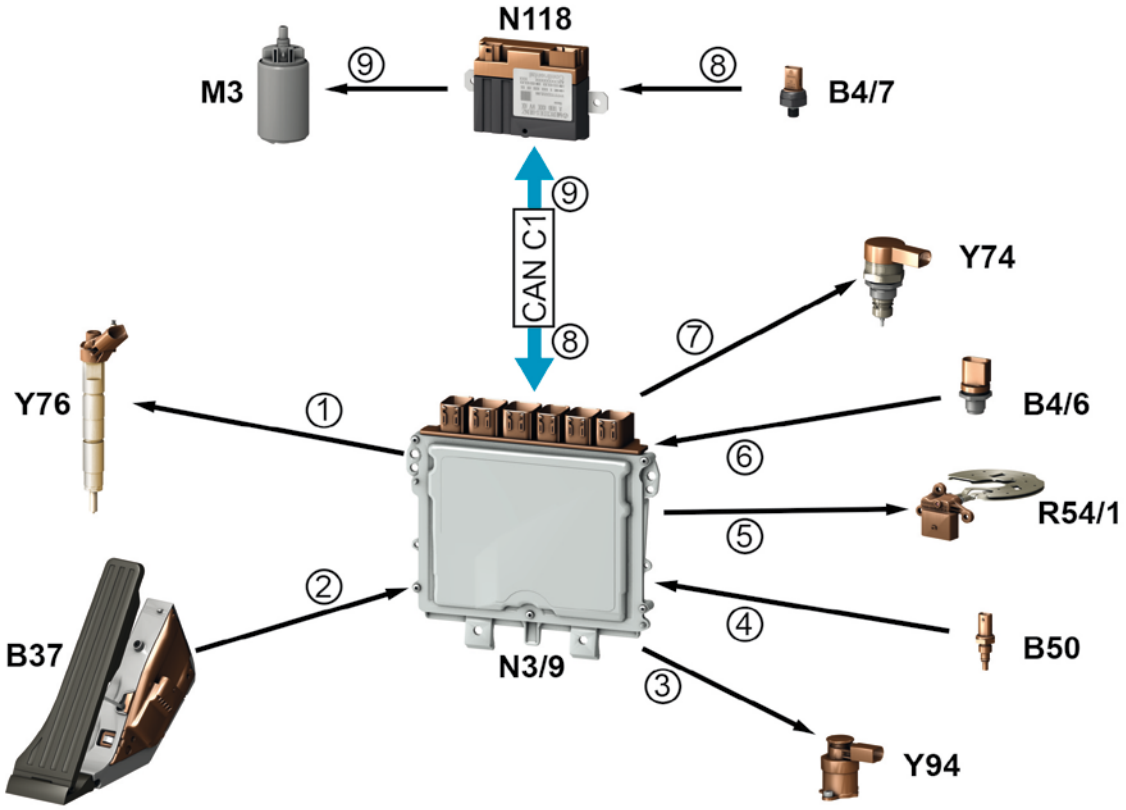
High-pressure fuel system

19	Fuel system high-pressure pump
B4/6	Fuel pressure sensor, high pressure
Y74	Pressure regulating valve
Y76	Fuel injectors
Y94	Quantity control valve

Fuel supply



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Function schematic of fuel supply

B4/6	Fuel pressure sensor, high pressure
B4/7	Fuel pressure sensor
B37	Accelerator pedal sensor
B50	Fuel temperature sensor
M3	Fuel pump
N3/9	CDI control unit
N118	Fuel pump control unit
R54/1	Fuel filter heating element
Y74	Pressure regulating valve
Y76	Fuel injectors
Y94	Quantity control valve

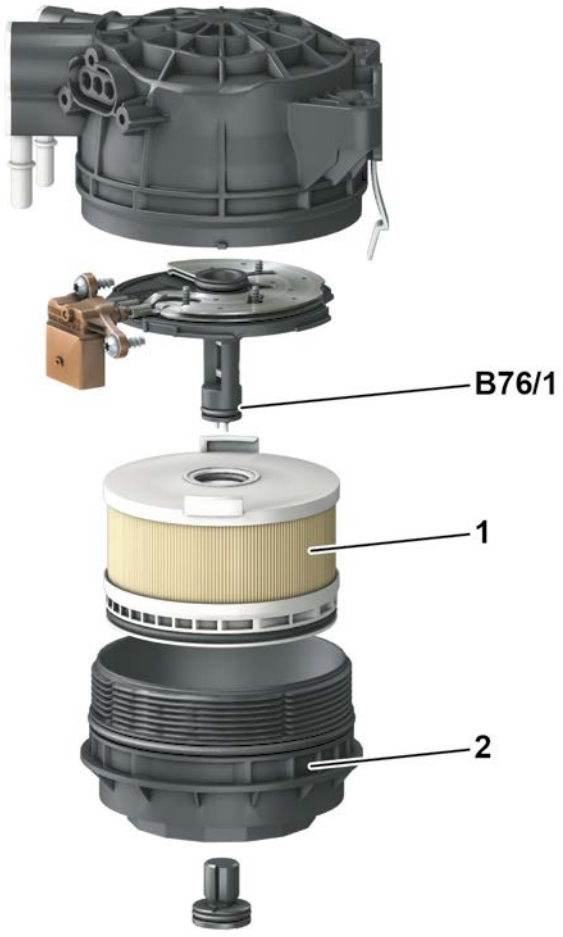
1	Fuel injectors, actuation
2	Accelerator pedal sensor, signal
3	Quantity control valve, actuation
4	Fuel temperature, signal
5	Fuel filter heating element, actuation
6	Fuel pressure, signal
7	Pressure regulating valve, actuation
8	Fuel pressure, signal
9	Fuel pump, specified pressure request

Fuel preheating, general

To ensure that the fuel remains fluid even at low outside temperatures, an electric heater is installed in the fuel filter. The heater is actuated by the glow output stage according to a performance map. The fuel filter also possesses a multistage water separator with condensation sensor. The fuel filter is located directly at the fuel tank.

Safety fuel shutoff

A safety fuel shutoff function guarantees road safety and the safety of the occupants. The safety fuel shutoff function is activated immediately when the engine speed signal is missing or when a crash signal occurs.



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Fuel filter unit

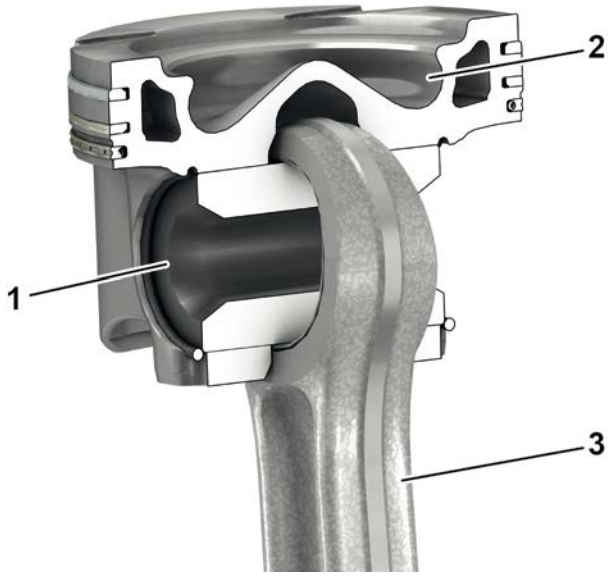
1 Fuel filter element
2 Cover

B76/1 Fuel filter condensation sensor with heating element

Combustion chamber

Combustion chamber shape, general

The combustion chamber is designed for minimum exhaust emissions and maximum air efficiency. Steel pistons with stepped combustion cavities are used for this. This cavity shape enables higher combustion rates and therefore greater efficiency of combustion. The resulting “fresh air curtain” in the cylinder barrels also reduces the dilution of the engine oil by the fuel coating on the cylinder wall.



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Sectional view of piston

1 Piston pin
2 Combustion cavity
3 Connecting rod

Injection control

The electronic engine management system MRD1 is used in engine OM654. The engine management system calculates the injection period and the fuel pressure on the basis of the following sensors and signals:

- Hot film MAF sensor
- Intake air temperature sensor
- Fuel pressure sensor, high pressure
- Engine oil temperature sensor
- Boost pressure sensor
- Camshaft Hall sensor
- Coolant temperature sensor
- Charge air temperature sensor
- Temperature sensor upstream of diesel particulate filter
- Temperature sensor upstream of turbocharger
- DPF differential pressure sensor
- Pressure sensor downstream of air filter
- Accelerator pedal sensor
- Fuel temperature sensor
- Crankshaft Hall sensor

The injection control has the following subfunctions:

Preinjection

The aim of preinjection is to reduce combustion noise and exhaust emissions. Fuel is injected up to 2 times prior to the actual main injection. This results in gentler combustion.

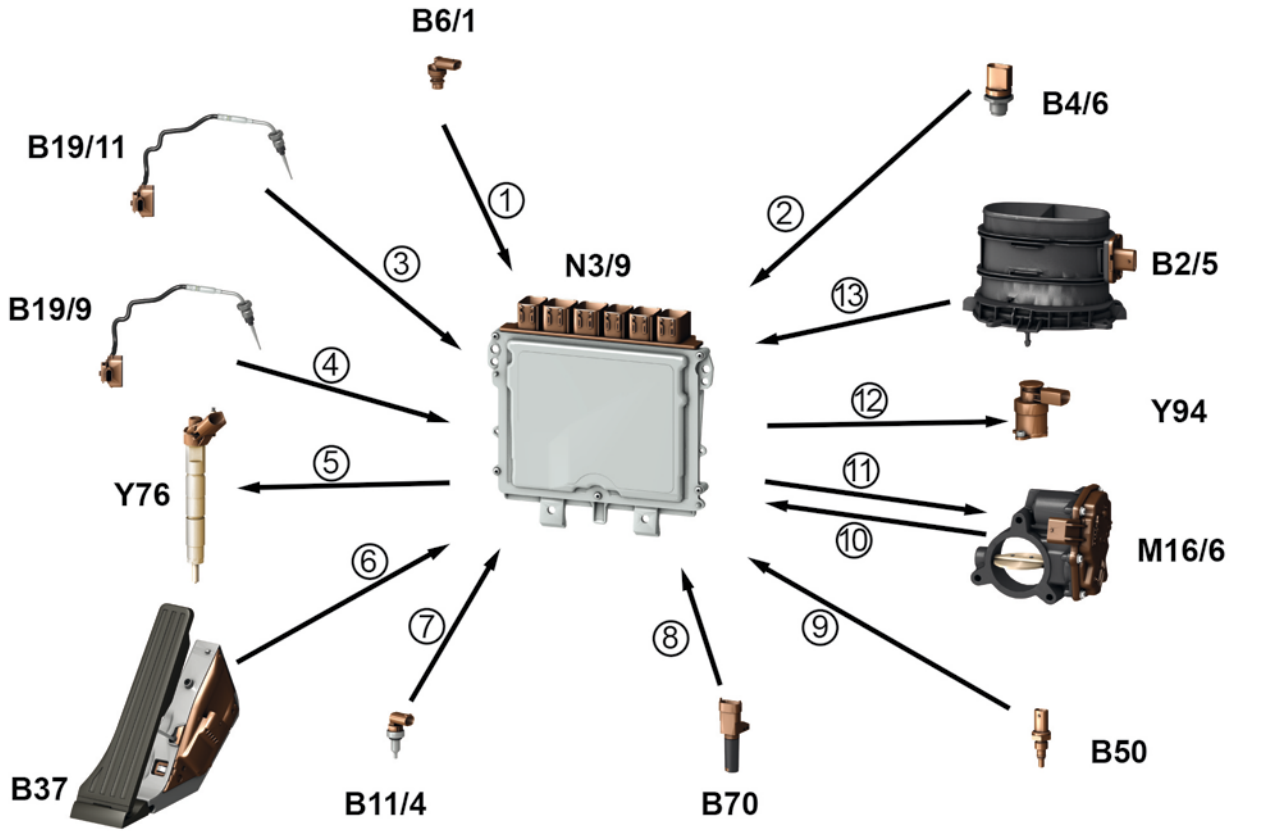
Main injection

The main injection generates the power and torque, and is controlled by the injection period and the injection timing point.

Post injection

Post injection is used to increase the exhaust temperature and thus to assist the regeneration process of the diesel particulate filter and the conversion process of the exhaust components in the oxidation catalytic converter.

Injection control



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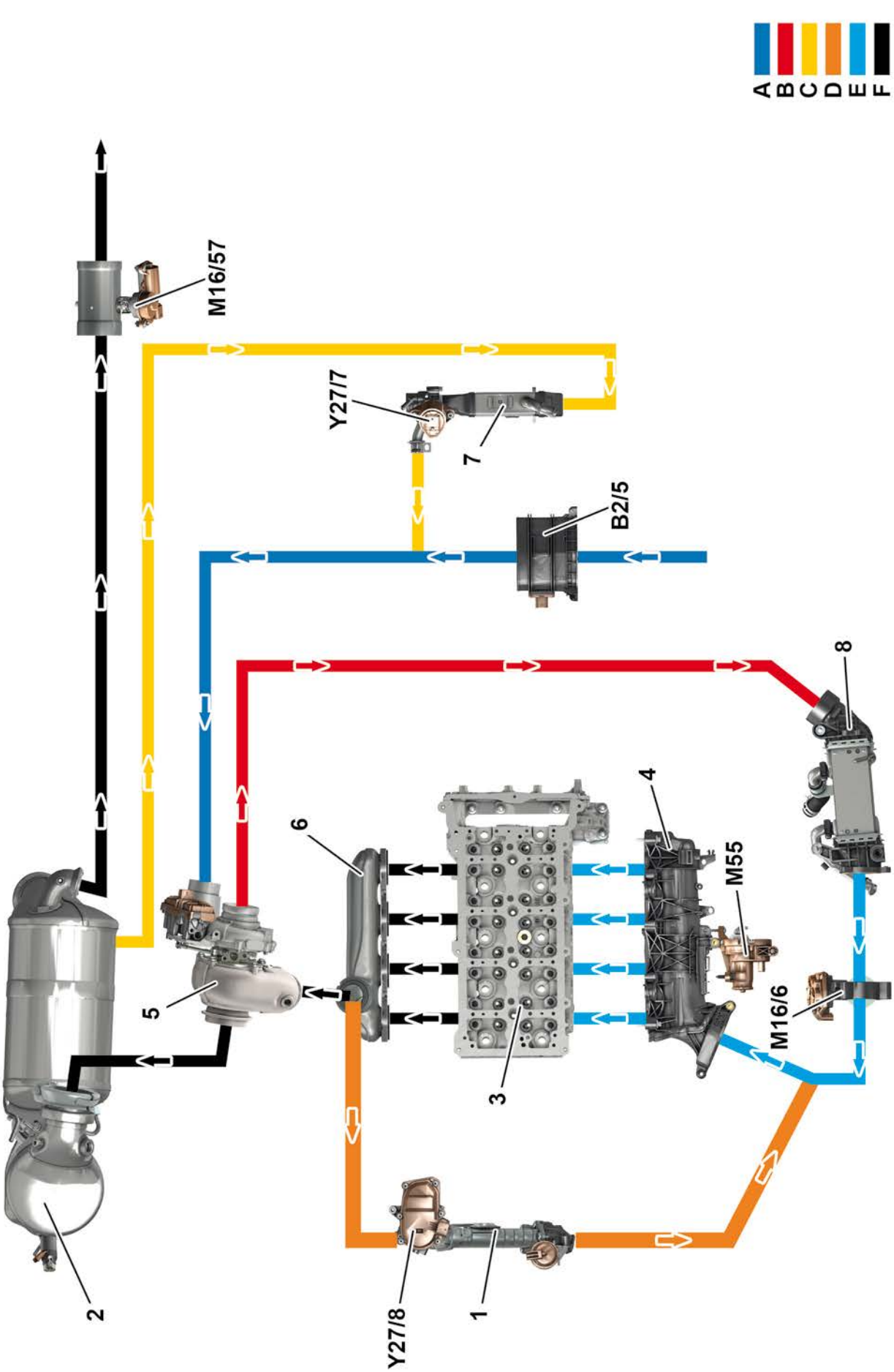
Function schematic of injection control

B2/5	Hot film MAF sensor
B4/6	Fuel pressure sensor, high pressure
B6/1	Camshaft Hall sensor
B11/4	Coolant temperature sensor
B19/9	Temperature sensor upstream of diesel particulate filter
B19/11	Temperature sensor upstream of turbocharger
B37	Accelerator pedal sensor
B50	Fuel temperature sensor
B70	Crankshaft Hall sensor
M16/6	Throttle valve actuator
N3/9	CDI control unit
Y76	Fuel injectors
Y94	Quantity control valve

1	Camshaft Hall sensor, signal
2	High-pressure fuel pressure sensor, signal
3	Temperature sensor upstream of turbocharger, signal
4	Temperature sensor upstream of diesel particulate filter, signal
5	Fuel injectors, actuation
6	Accelerator pedal sensor, signal
7	Coolant temperature sensor, signal
8	Crankshaft Hall sensor, signal
9	Fuel temperature sensor, signal
10	Throttle valve actuator, signal
11	Throttle valve actuator, actuation
12	Quantity control valve, actuation
13	Hot film MAF sensor, signal



Schematic diagram of exhaust gas recirculation

1	High-pressure EGR cooler
2	Diesel oxidation catalytic converter unit
3	OM654
4	Charge air manifold
5	Turbocharger
6	Exhaust manifold
7	Low-pressure EGR cooler
8	Charge air cooler
B2/5	Hot film MAF sensor
M16/6	Throttle valve actuator
M16/57	Exhaust flap controller
M55	Intake port shutoff actuator motor
Y27/7	Low-pressure EGR actuator
Y27/8	High-pressure EGR actuator
A	Intake air
B	Charge air (uncooled)
C	Low-pressure exhaust gas recirculation
D	High-pressure exhaust gas recirculation
E	Charge air (cooled)
F	Exhaust gas

Exhaust gas recirculation, general

A multistage exhaust gas recirculation system is used. This system is active in a very broad characteristic range, from idle up to the upper partial-load range. The interaction of the low-pressure exhaust gas recirculation actuator and the high-pressure exhaust gas recirculation actuator permits a high exhaust gas recirculation rate with no decrease in efficiency. In order to obtain a better cylinder charge, the exhaust gases are cooled and then fed into the intake air.

The recirculation rate depends on several different variables:

- Engine load and rpm
- Intake and charge air temperatures
- Exhaust temperatures
- Exhaust pressure

Exhaust gas recirculation lowers the nitrogen oxide (NOx) level in the exhaust by reducing the oxygen concentration in the combustion chamber. This process is assisted by reducing the combustion temperature by means of the higher heat capacity of the recirculated exhaust gases compared to the intake air.

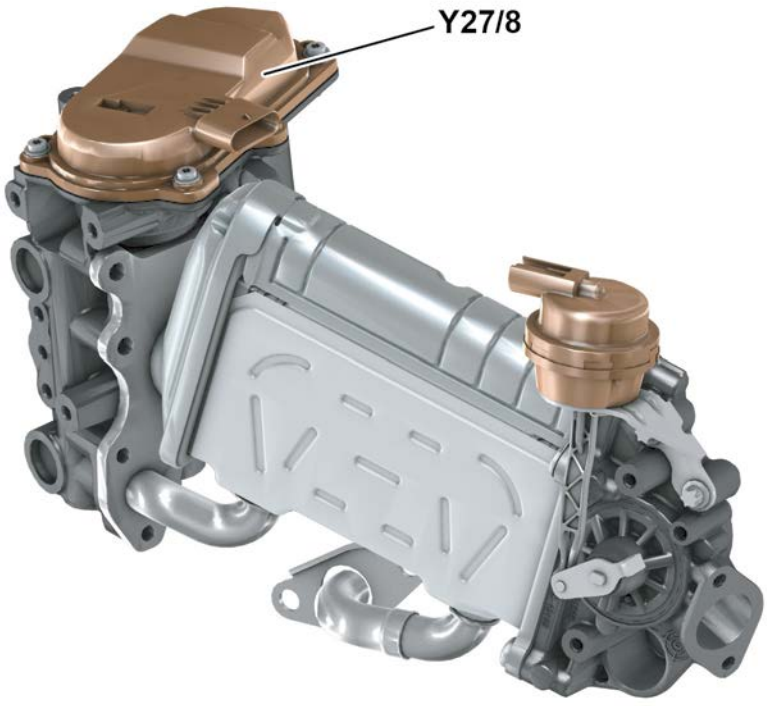
Exhaust gas recirculation

EGR high-pressure circuit

The exhaust gas is taken directly from the exhaust manifold, cooled and fed into the intake air. After evaluating the input signals, the CDI control unit actuates the high-pressure exhaust gas recirculation actuator according to a performance map. The recirculation rate is regulated by varying the actuation.

High-pressure exhaust gas recirculation actuator

The high-pressure exhaust gas recirculation actuator is a flap valve which can be opened on demand via an electric actuator motor. By means of a Hall sensor the position of the flap valve is detected and transmitted back to the CDI control unit as a SENT signal. The high-pressure exhaust gas recirculation actuator allows the exhaust gas to be recirculated directly from the exhaust manifold to the charge air manifold of the engine. On the way, the exhaust gases are cooled by a heat exchanger integrated in the coolant circuit.



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Partial view of high-pressure exhaust gas recirculation

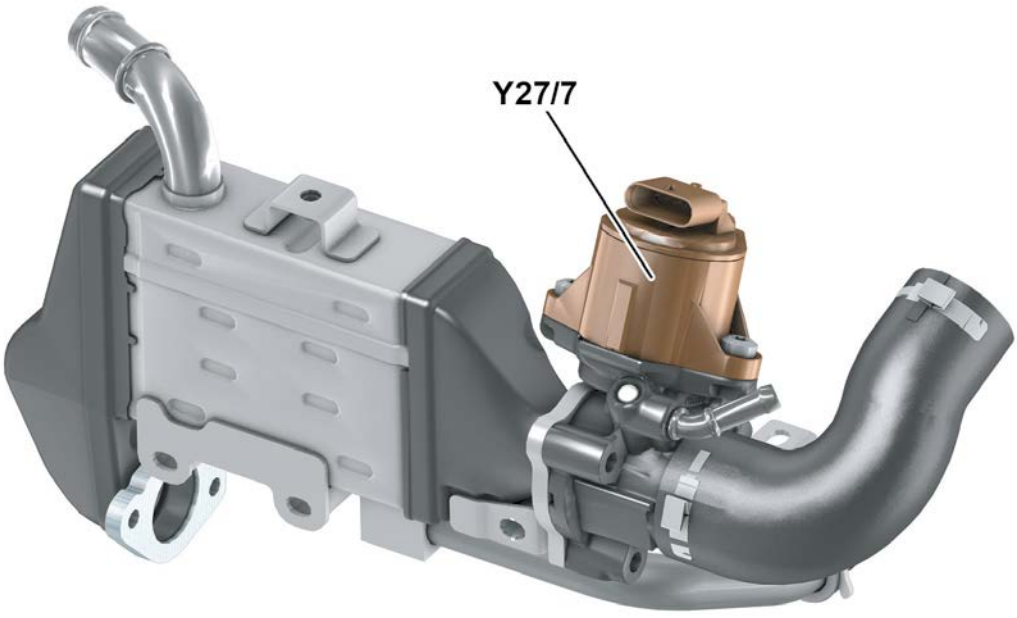
Y27/8 High-pressure EGR actuator

EGR low-pressure circuit

Low-pressure exhaust gas recirculation is only active at coolant temperatures above 60°C and in the idle to moderate partial-load ranges. After evaluating the input signals, the CDI control unit actuates the low-pressure exhaust gas recirculation actuator according to a performance map. At high exhaust gas recirculation rates with the valve fully open, the exhaust flap controller is also closed. The exhaust gases are extracted directly from the exhaust system downstream of the SCR catalytic converter, cooled by a heat exchanger integrated in the cooling system, and fed into the intake air system downstream of the hot film mass air flow sensor. Low-pressure exhaust gas recirculation can only function correctly in conjunction with the exhaust flap controller.

Low-pressure exhaust gas recirculation actuator

The low-pressure exhaust gas recirculation actuator is a flap valve which can be opened on demand via an electric actuator motor. By means of a Hall sensor the position of the flap valve is detected and transmitted back to the CDI control unit as a SENT signal. The low-pressure exhaust gas recirculation actuator allows the exhaust gas to be recirculated directly from the exhaust system after the SCR catalytic converter to the mixing tube upstream of the turbocharger of the engine.



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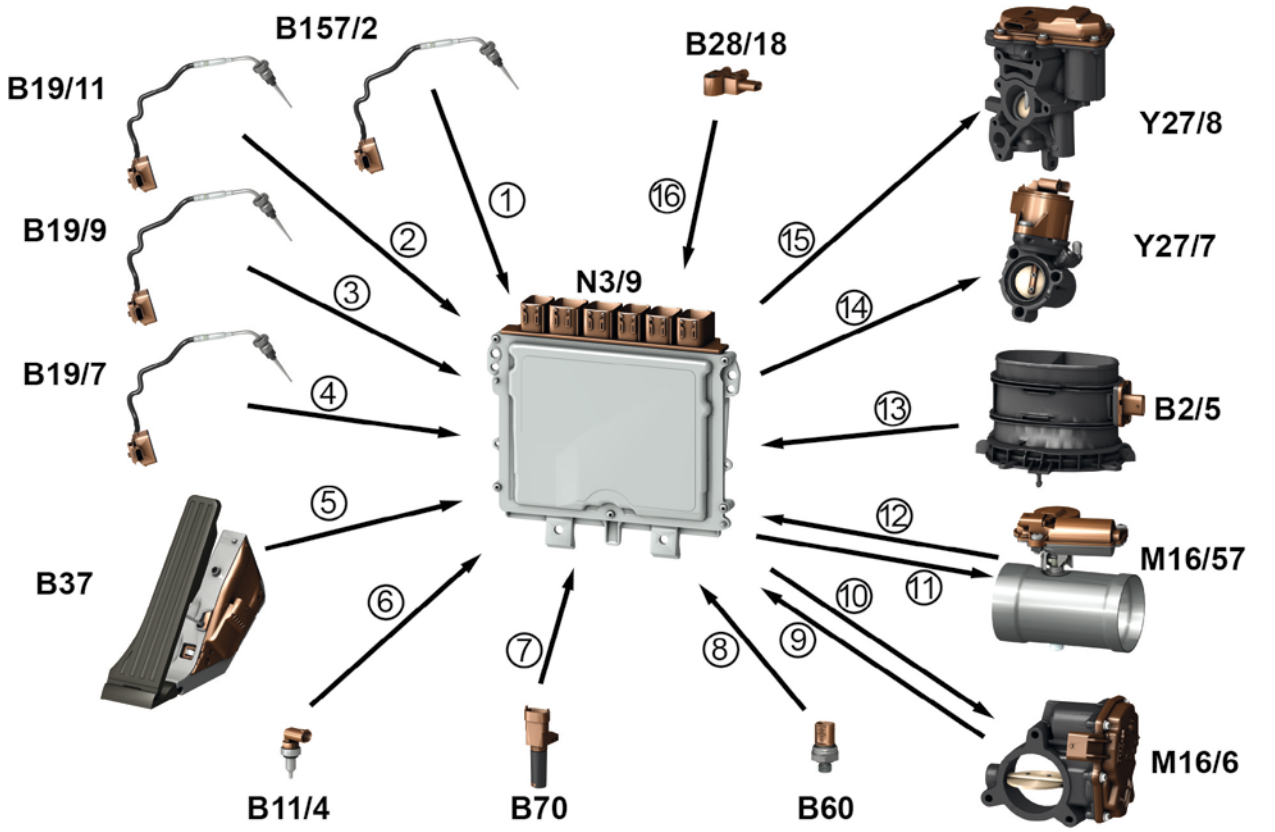
Partial view of low-pressure exhaust gas recirculation

Y27/7 Low-pressure EGR actuator

Exhaust gas recirculation



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Function schematic of exhaust gas recirculation

B2/5	Hot film MAF sensor
B11/4	Coolant temperature sensor
B19/7	Temperature sensor upstream of catalytic converter
B19/9	Temperature sensor upstream of diesel particulate filter
B19/11	Temperature sensor upstream of turbocharger
B28/18	EGR differential pressure sensor, low pressure
B37	Accelerator pedal sensor
B60	Exhaust pressure sensor
B70	Crankshaft Hall sensor
B157/2	EGR temperature sensor, low pressure
M16/6	Throttle valve actuator
M16/57	Exhaust flap controller
N3/9	CDI control unit
Y27/7	Low-pressure EGR actuator
Y27/8	High-pressure EGR actuator

1	High-pressure EGR temperature sensor, signal
2	Temperature sensor upstream of turbocharger, signal
3	Temperature sensor upstream of diesel particulate filter, signal
4	Temperature sensor upstream of catalytic converter, signal
5	Accelerator pedal sensor, signal
6	Temperature sensor upstream of catalytic converter, signal
7	Crankshaft Hall sensor, signal
8	Exhaust pressure sensor
9	Throttle valve actuator, signal
10	Throttle valve actuator, actuation
11	Exhaust flap controller, actuation
12	Exhaust flap controller, signal
13	Hot film MAF sensor, signal
14	Low-pressure EGR actuator, actuation
15	High-pressure EGR actuator, actuation
16	Low-pressure EGR differential pressure sensor, signal

SCR system (AdBlue®)

SCR stands for Selective Catalytic Reduction. The third generation of the emission control system/SCR system is used with engine OM654. In the SCR system, an aqueous urea solution is injected into the exhaust system immediately before the SCR catalytic converter. The chemical reactions it produces (thermolysis and hydrolysis) reduce the nitrogen oxides in the exhaust gas.

The SCR system contains the following system components:

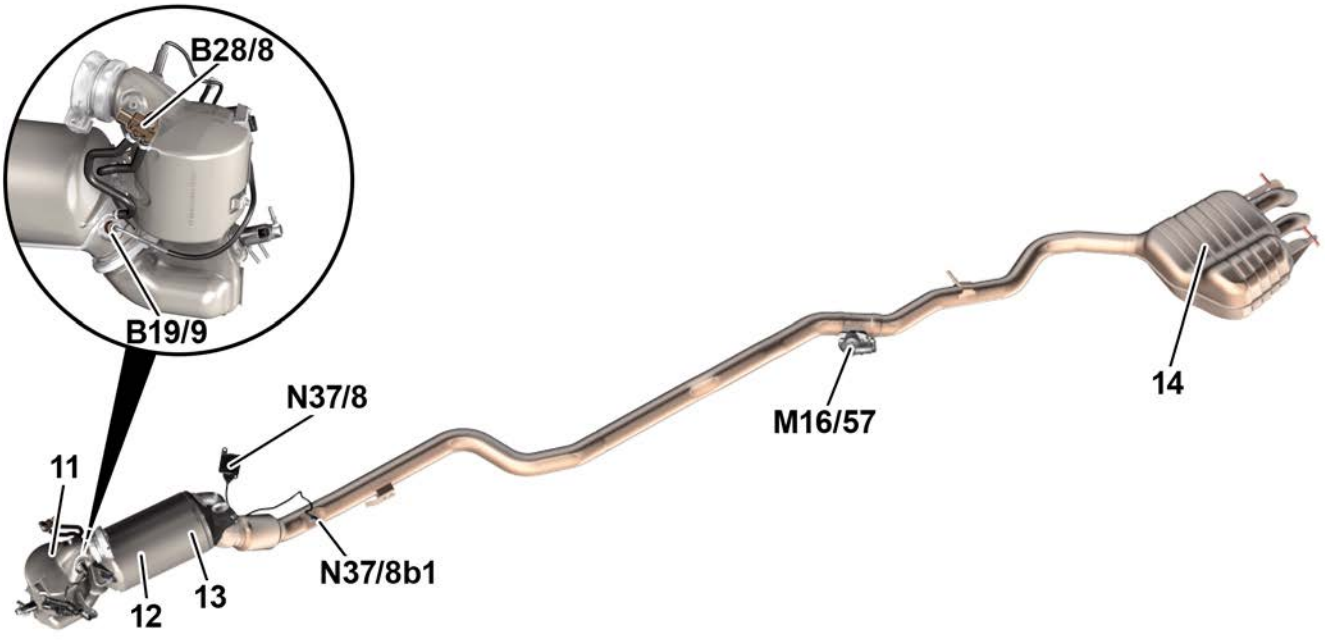
- AdBlue® metering valve
- AdBlue® control unit
- AdBlue® pressure line heating element
- AdBlue® delivery module
- AdBlue® tank module
- AdBlue® tank
- AdBlue® filler neck
- AdBlue® tank temperature sensor
- AdBlue® fill level and quality sensor
- AdBlue® tank heating element
- AdBlue® delivery pump
- Control unit of NOx sensor upstream of diesel oxidation catalytic converter
- NOx sensor upstream of diesel oxidation catalytic converter
- Control unit of NOx sensor downstream of SCR catalytic converter
- NOx sensor downstream of SCR catalytic converter
- Temperature sensor upstream of SCR catalytic converter
- SCR catalytic converter

Exhaust treatment

Exhaust system

Vehicles with engine OM654 are fitted with a newly developed exhaust system. This consists of the following components:

- Diesel oxidation catalytic converter
- Diesel particulate filter and SCR catalytic converter unit
- Rear muffler
- Exhaust flap controller
- NOx sensors
- Temperature sensors
- SCR components



P14.00-2165-00

View of exhaust system

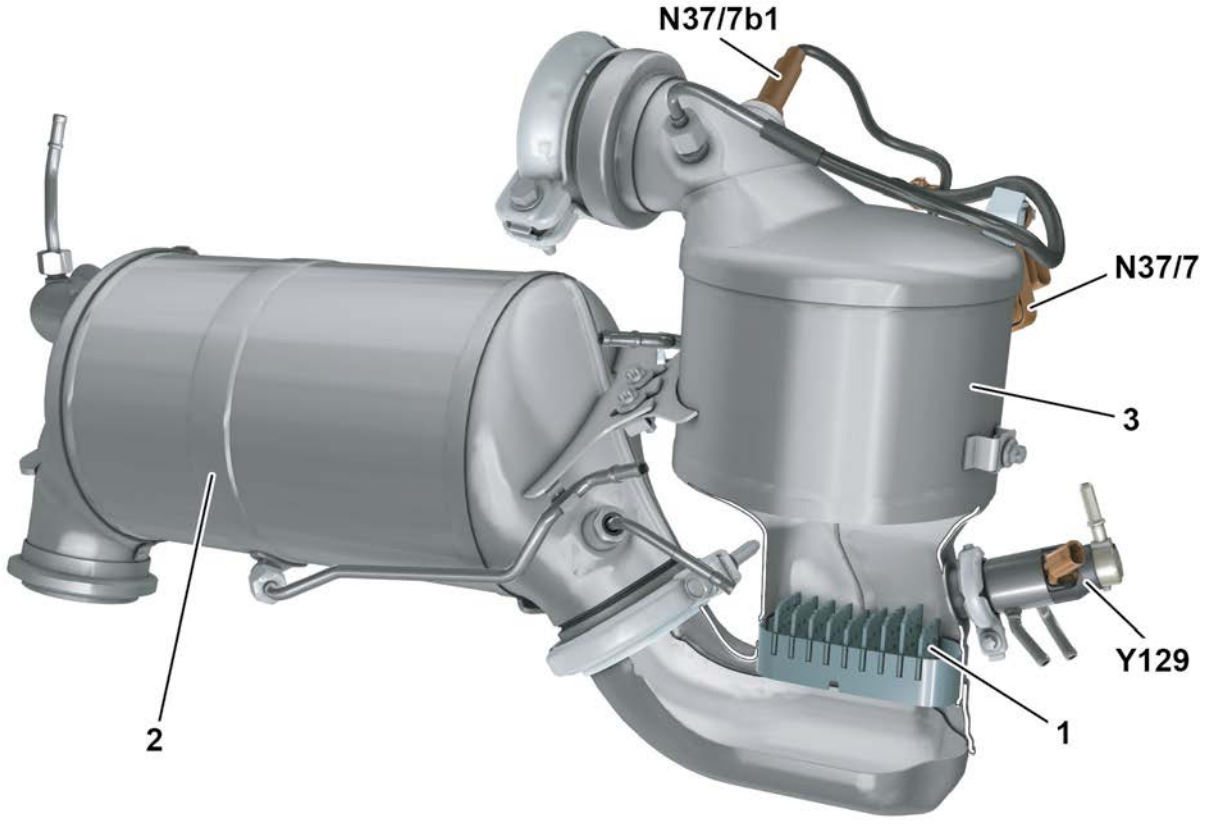
11	Diesel oxidation catalytic converter
12	Diesel particulate filter
13	SCR catalytic converter
14	Rear muffler
B19/9	Temperature sensor upstream of diesel particulate filter
B28/8	DPF differential pressure sensor
M16/57	Exhaust flap controller
N37/8	Control unit of NOx sensor downstream of SCR catalytic converter
N37/8b1	NOx sensor downstream of SCR catalytic converter

Diesel oxidation catalytic converter

The diesel oxidation catalytic converter features advanced catalyst coatings which provide CO_2 savings in short-range operations. Its location close to the engine means that it heats up quickly and operates efficiently even in the lower engine temperature ranges.

Diesel particulate filter and SCR catalytic converter unit

A compact unit consisting of diesel particulate filter and SCR catalytic converter is being used for the first time. This composition provides quicker heating, resulting in advantages in terms of temperature management and emissions reduction. The diesel particulate filter has been revised and the individual honeycombs have been given an SCR coating. This helps to reduce NOx emissions at low outside temperatures. This innovation also satisfies the conditions for an SCR reaction shortly after engine start and in low-load operation. Injection by the AdBlue® metering valve can occur.



P14.00-2165-00

Sectional view of exhaust system

1 Vaporizer plates
2 Diesel particulate filter/ SCR catalytic converter
3 Diesel oxidation catalytic converter

N37/7 Control unit of NOx sensor upstream of diesel oxidation catalytic converter
N37/7b1 NOx sensor upstream of diesel oxidation catalytic converter
Y129 AdBlue® metering valve

Exhaust treatment

AdBlue® control unit

The AdBlue® control unit controls the following functions according to performance maps:

- AdBlue® delivery
- Injection of the reduction agent (injection quantity and injection period)
- Antifreeze protection and recirculation of the reduction agent
- Communications with the CDI control unit over the drivetrain sensor CAN

AdBlue® delivery module

The AdBlue® delivery module performs the following subtasks:

- Pressure generation
- Pressure measurement
- Flow reversal

Several components are integrated in the delivery module:

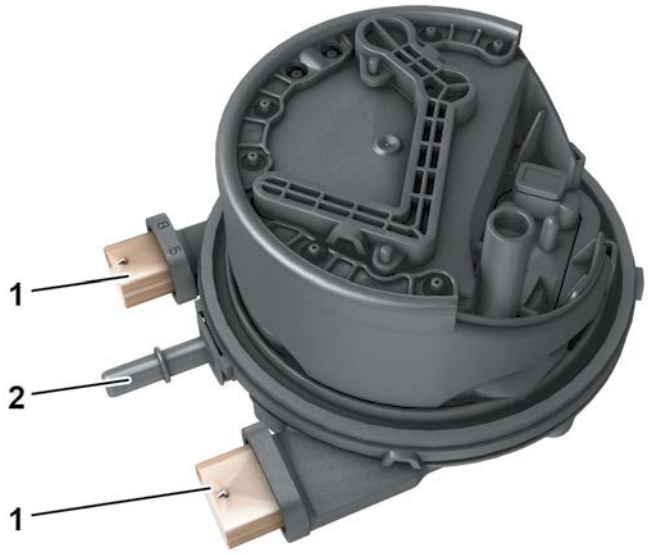
- AdBlue® delivery pump
- AdBlue® heating element
- AdBlue® fill level and quality sensor

To generate pressure, the AdBlue® control unit actuates the AdBlue® delivery pump integrated in the AdBlue® delivery module with a pulse width modulated signal according to a performance map.

The AdBlue® control unit registers the system pressure generated by the AdBlue® delivery pump via the current curve of the pulse width modulated signal.

At “circuit 15 OFF” the AdBlue® control unit initiates the power-down sequence. During the control unit power-down sequence, the remaining AdBlue® reduction agent is extracted by the AdBlue® delivery pump. For this, the AdBlue® delivery pump is actuated by the AdBlue® control unit. This reversal of the actuation causes the reduction agent to be extracted from the pressure line and the AdBlue® metering valve. At the same time, the AdBlue® metering valve is opened to prevent a vacuum from forming. This return process lasts for between 8 and 10 seconds, depending on the vehicle application.

The AdBlue® tank heating element ensures that liquid reduction agent is drawn from the AdBlue® tank even at low temperatures. In addition, the AdBlue® pressure line is heated according to a performance map. This return feed of the remaining reduction agent prevents the AdBlue® pressure line and the AdBlue® delivery module from freezing at approx. -10°C and being damaged.



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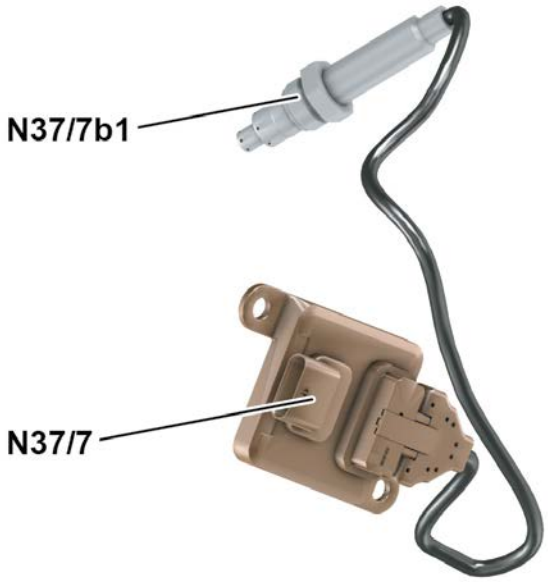
AdBlue® delivery module

1 Electrical connection

2 AdBlue® line connection

NOx sensors control unit

The NOx sensors register the NOx and O_2 concentrations in the exhaust gas upstream of the diesel oxidation catalytic converter and downstream of the DPF/SCR catalytic converter unit. This information is forwarded to the control units in the form of voltage signals. Communication between the NOx control units and the CDI control unit takes place over the drivetrain sensor CAN.



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NOx sensor control unit

N37/7 Control unit of NOx sensor upstream of diesel oxidation catalytic converter

N37/7b1 NOx sensor upstream of diesel oxidation catalytic converter

AdBlue® metering valve

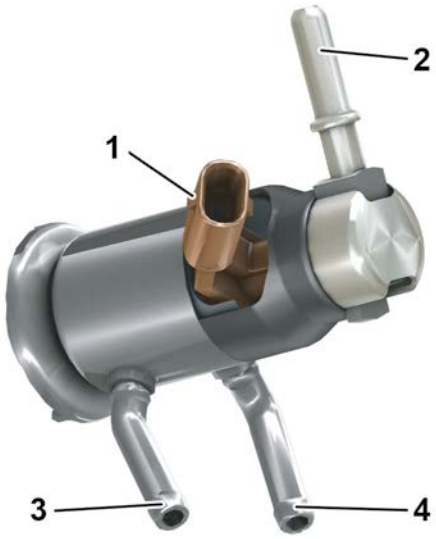
The AdBlue® metering valve sprays the reduction agent into the exhaust tract in front of the SCR catalytic converter. As the AdBlue® metering valve is not ice pressure-proof, the reduction agent must be extracted from the AdBlue® metering valve when the engine is switched off.

In sub-zero outside temperatures with a cold exhaust tract, the AdBlue® metering valve is electrically heated in order to prevent the valve from freezing. This is done by energizing the coil in the AdBlue® metering valve, upon which the float needle is not opened. Additionally, the AdBlue® metering valve is integrated in the coolant circuit in order to avoid thermal damage.

AdBlue® mixing and conditioning concept

Due to the new requirements for the reduction of exhaust emissions, an innovative vaporization and mixing concept has been developed. Vaporizer plates are arranged downstream of the diesel oxidation catalytic converter and upstream of the AdBlue® mixing tube. Together with the AdBlue® metering valve, these vaporizer plates ensure that the exhaust gases are thoroughly mixed with the reduction agent.

This substantially improves the efficiency of the exhaust treatment.



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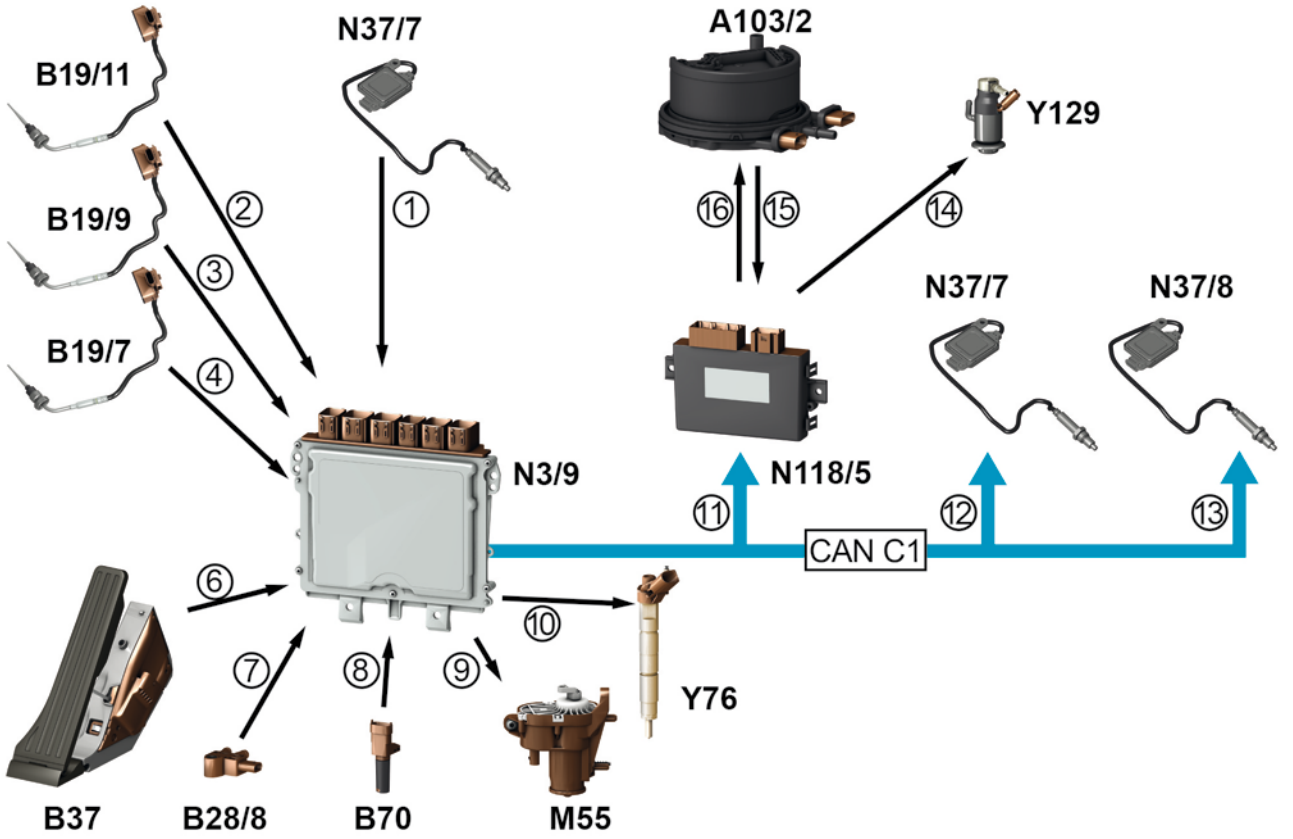
AdBlue® metering valve

1 Electrical connection
2 AdBlue® line connection
3 Coolant feed
4 Coolant return

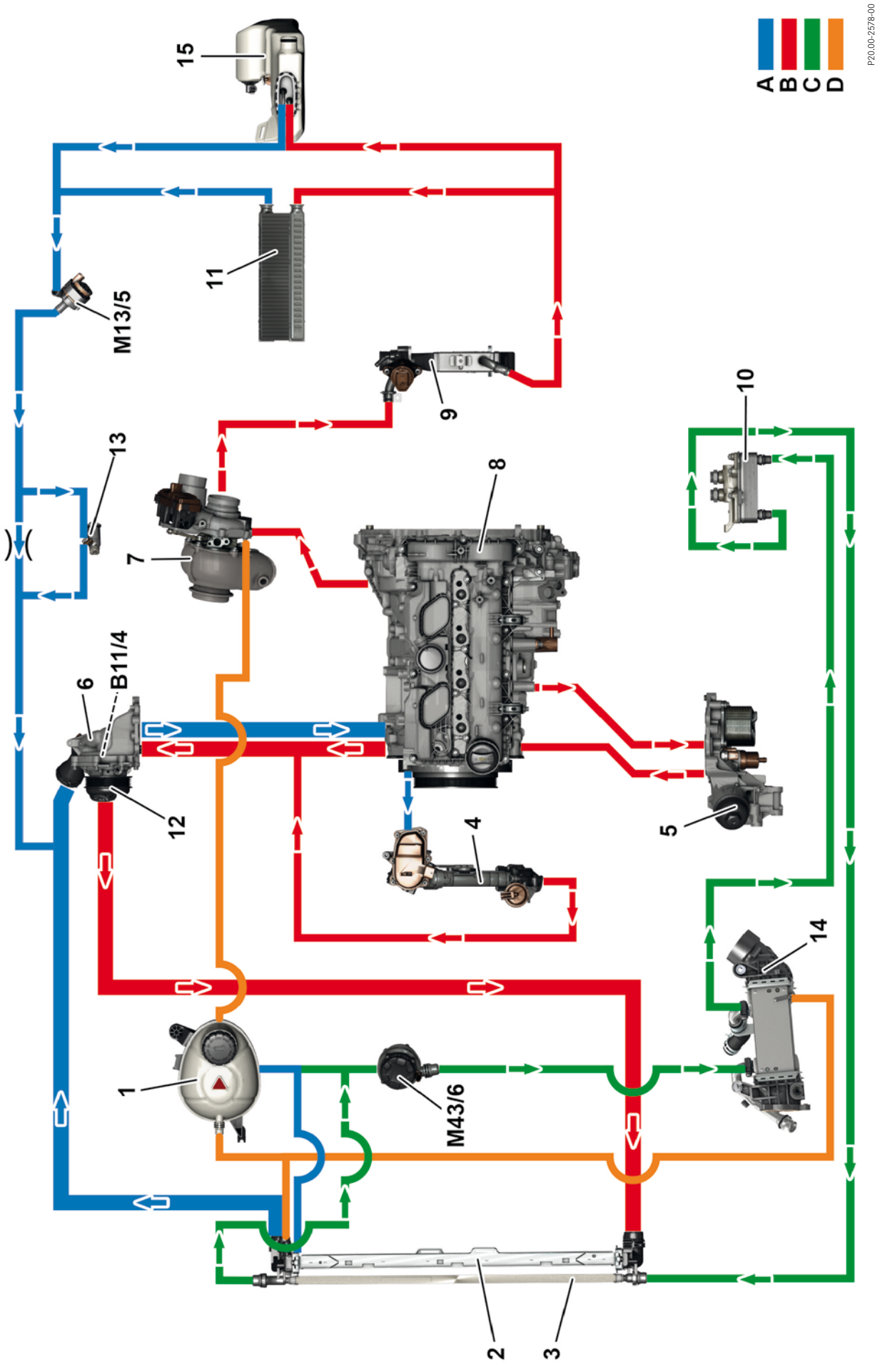
Exhaust treatment



Function schematic of exhaust treatment

A103/2	AdBlue® delivery module
B19/7	Temperature sensor upstream of catalytic converter
B19/9	Temperature sensor upstream of diesel particulate filter
B19/11	Temperature sensor upstream of turbocharger
B28/8	DPF differential pressure sensor
B37	Accelerator pedal sensor
B70	Crankshaft Hall sensor
M55	Intake port shutoff actuator motor
N3/9	CDI control unit
N37/7	Control unit of NOx sensor upstream of diesel oxidation catalytic converter
N37/8	Control unit of NOx sensor downstream of SCR catalytic converter
N118/5	AdBlue® control unit
Y76	Fuel injectors
Y129	AdBlue® metering valve
CAN C1	Drive CAN

1	NOx sensor, signal
2	Temperature sensor upstream of turbocharger, signal
3	Temperature sensor upstream of diesel particulate filter, signal
4	Temperature sensor upstream of catalytic converter, signal
5	Low-pressure EGR differential pressure sensor, signal
6	Accelerator pedal sensor, signal
7	DPF differential pressure sensor, signal
8	Crankshaft Hall sensor, signal
9	Intake port shutoff actuator motor, actuation
10	Fuel injectors, actuation
11	AdBlue® injection, request
12	NOx sensor heater, actuation
13	NOx sensor heater, actuation
14	AdBlue® metering valve, actuation
15	AdBlue® fill level, message
16	AdBlue® injection, request



Coolant circuit schematic

Schematic diagram of coolant circuit

1 Coolant expansion reservoir
2 Engine radiator
3 Low-temperature cooler
4 High-pressure EGR cooler
5 Engine oil heat exchanger
6 Coolant thermostat
7 Turbocharger
8 OM654
9 Low-pressure EGR cooler
10 Transmission oil heat exchanger
11 Heater heat exchanger
12 Coolant pump
13 AdBlue® metering valve
14 Charge air cooler
15 Washer fluid reservoir
B11/4 Coolant temperature sensor
M13/5 Coolant circulation pump
M43/6 Low-temperature circuit circulation pump 1
A Cold coolant
B Hot coolant
C Low-temperature circuit
D Coolant circuit ventilation

Engine cooling system, general

The engine cooling system in the OM654 consists of the following components:

- Coolant pump
- Engine radiator
- Coolant expansion reservoir
- Heater heat exchanger
- Engine oil heat exchanger
- Coolant thermostat
- Exhaust gas recirculation cooler
- Low-temperature circuit circulation pump 1
- AdBlue® metering valve
- Turbocharger
- Charge air cooler
- Transmission oil heat exchanger
- Coolant circulation pump

Coolant circuit

One special feature of engine OM654 is a cylinder head with double water jacket and an additional coolant pump for the low-temperature circuit. These properties ensure adequate cooling for components subject to high thermal loads and thereby protect them against overload.

The coolant expansion reservoir is used by both coolant circuits, which otherwise circulate independently of each other. When servicing, it is therefore necessary to bleed the entire coolant circuit. Complete filling/ bleeding of the circuit can only be guaranteed when it is filled with a vacuum in the system.

Coolant thermostat

The coolant thermostat is an expansion-element thermostat. This expansion element expands at a coolant temperature of approx. 94°C to open the coolant circuit. “Full opening” of the thermostat occurs at 106°C and the entire volume can flow through the engine radiator.

Active afterrun cooling

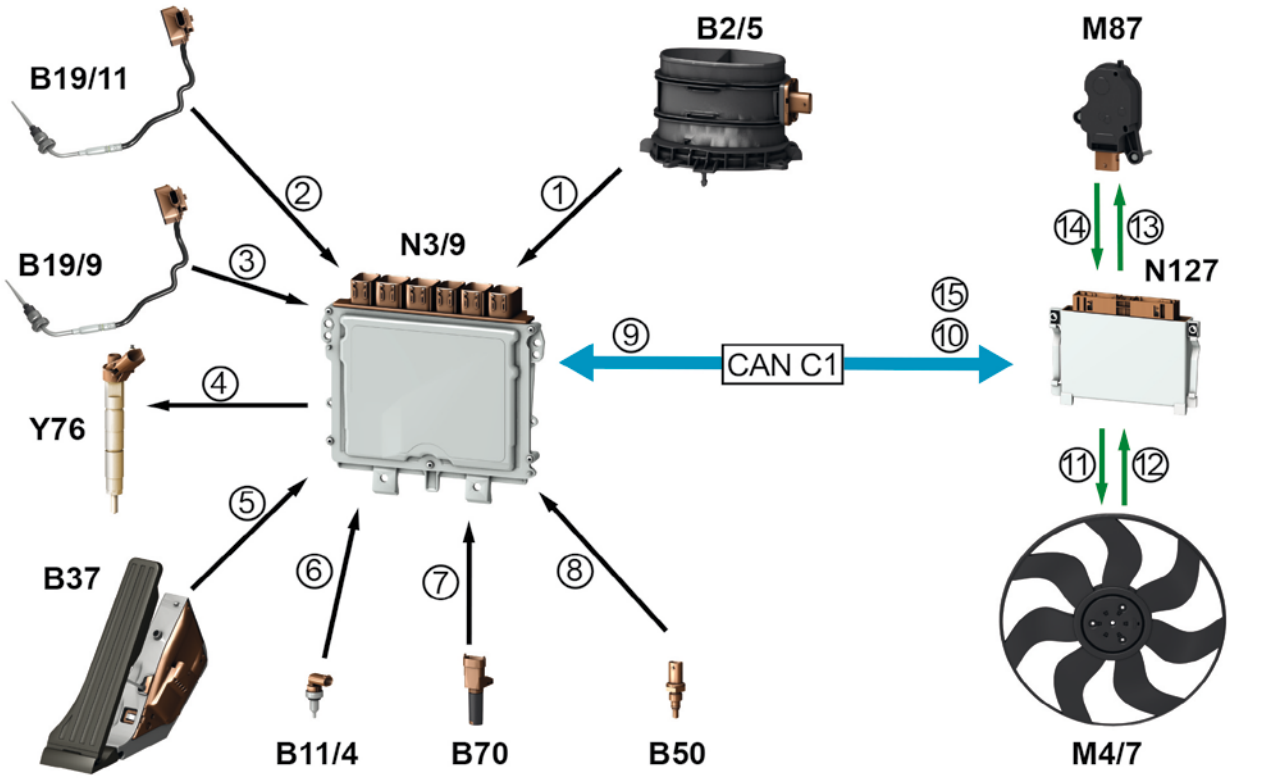
The active afterrun cooling function is provided with the aid of the coolant circulation pump. It is actuated according to demand in order to cool the following components after the engine is switched off and thus protect them against overload.

- Turbocharger
- AdBlue® metering valve

Thermal management

The CDI control unit detects increased load demands on the engine (e.g. driving with a trailer, etc.). As soon as the evaluated signals enter critical thermal ranges, the opening behavior of the thermostat is changed. In these situations the thermostat opens at only 80°C.

Thermal management



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Function schematic of thermal management

B2/5	Hot film MAF sensor
B11/4	Coolant temperature sensor
B19/9	Temperature sensor upstream of diesel particulate filter
B19/11	Temperature sensor upstream of turbocharger
B37	Accelerator pedal sensor
B50	Fuel temperature sensor
B70	Crankshaft Hall sensor
M4/7	Fan motor
M87	Radiator shutters actuator motor
N3/9	CDI control unit
N127	Drivetrain control unit
Y76	Fuel injectors
CAN C1	Drive CAN

1	Intake air temperature sensor, signal
2	Temperature sensor upstream of turbocharger, signal
3	Temperature sensor upstream of diesel particulate filter, signal
4	Fuel injectors, actuation
5	Accelerator pedal sensor, signal
6	Coolant temperature sensor, signal
7	Crankshaft Hall sensor, signal
8	Fuel temperature sensor, signal
9	Wheel speed, signal
10	Coolant temperature, signal
11	Fan motor, specified rpm request (LIN)
12	Fan motor, status (LIN)
13	Radiator shutters actuator motor, request
14	Radiator shutters actuator motor, status
15	Engine load, signal

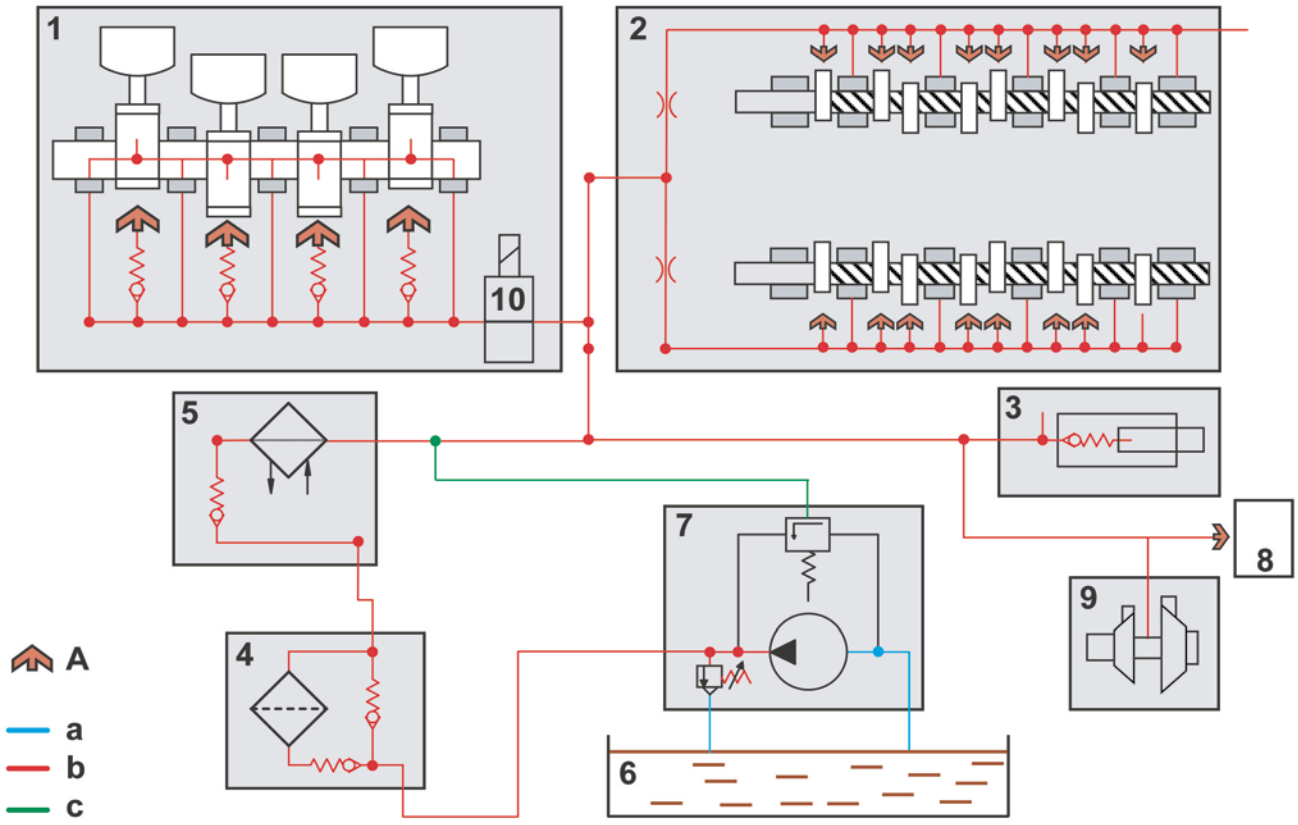
Charge air cooling, general

The charge air cooler cools the charge air previously compressed, and therefore heated, by the turbocharger. Cooled charge air lowers the combustion temperature and thus reduces emissions. The lower charge air temperature also produced a better cylinder charge and the boost pressure can be increased.

P09.41-2853-00

Charge air cooler

Engine lubrication



P18.00-2426-00

OM654 oil circuit diagram

1 Crankcase
2 Cylinder head
3 Chain tensioner with oil spray nozzle
4 Engine oil filter module
5 Engine oil heat exchanger
6 Engine oil pan
7 Tandem oil pump
8 Chain sprayer
9 Turbocharger
10 Piston spray switching valve
a Return line
b Pressure line
c Control pressure for engine oil pump
A Oil spray nozzle

CDI control unit

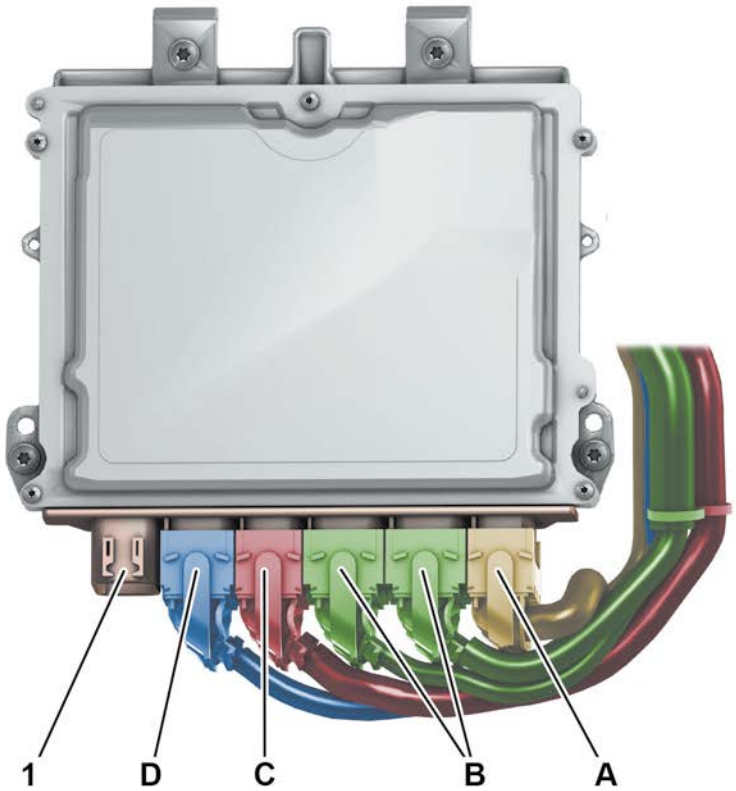
Engine OM654 features a multicore engine control unit. The microcontroller technology employed here is capable of satisfying the extremely high demands and requirements of the engine. Functionality and performance have been improved while simultaneously reducing the power requirements.

The most important functions of the engine control unit are:

- Control of fuel injection
- Control of exhaust gas recirculation
- Torque control
- Monitoring of the entire engine management

The following systems and functions are controlled and coordinated by the CDI control unit according to the input signals:

- Fuel supply
- Fuel injection
- Engine speed control
- Torque coordination
- ECO start/stop function
- Charging
- On-board diagnosis
- Engine limp-home mode
- Exhaust gas recirculation
- Exhaust treatment
- Thermal management
- Preglowing



P07.16-4196-00

View of engine wiring harnesses

1 Vehicle plug connection
A Crankcase wiring harness
B Cylinder head and intake tract wiring harnesses
C Exhaust system waring harness
D Injection wiring harness

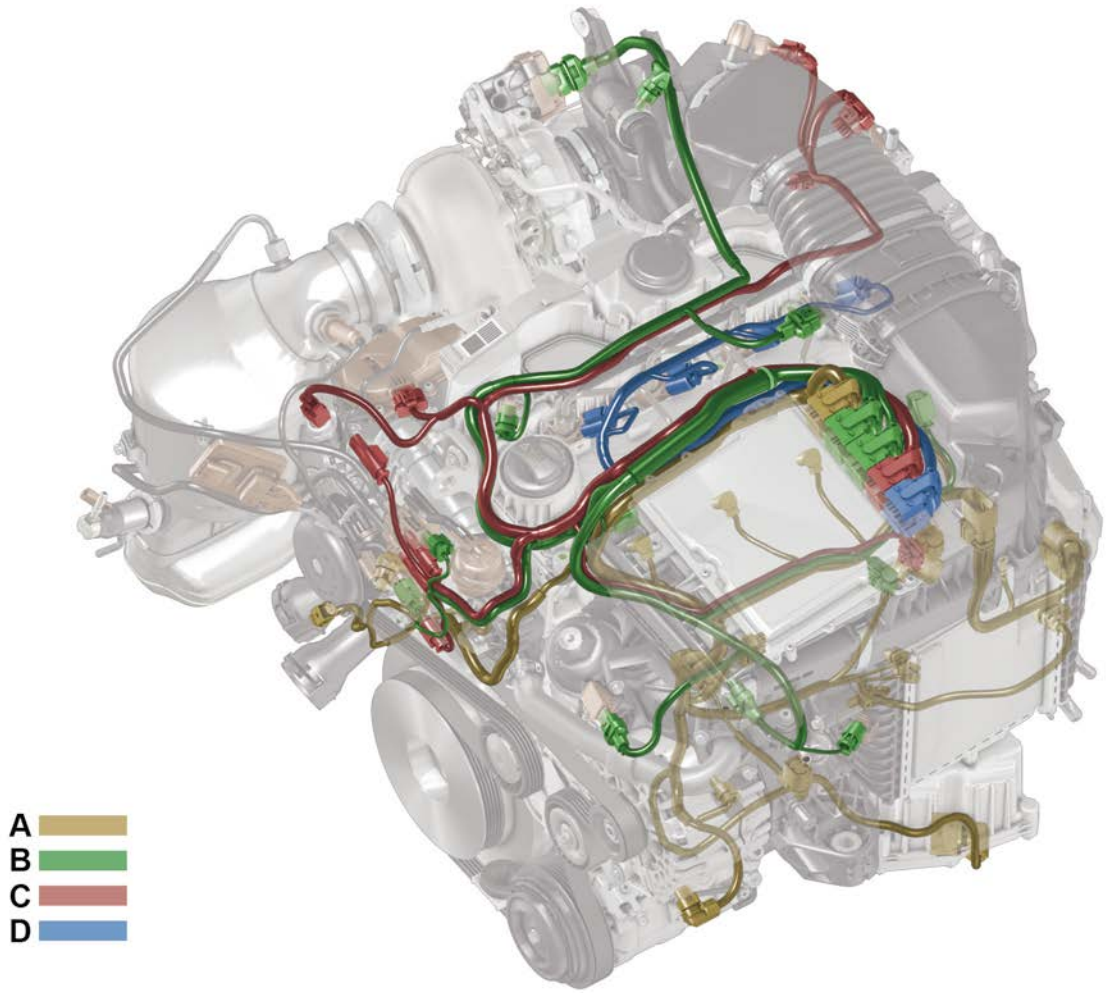
Engine management

Engine wiring harness

The engine wiring harness in engine OM654 is split into separate wiring modules. Each module can be replaced individually and independently of the others. This improves the ease of repair and diagnosis.

The individual modules are assigned as follows:

- Module A = Crankcase
- Module B = Cylinder head/ intake tract
- Module C = Exhaust system
- Module D = Injection



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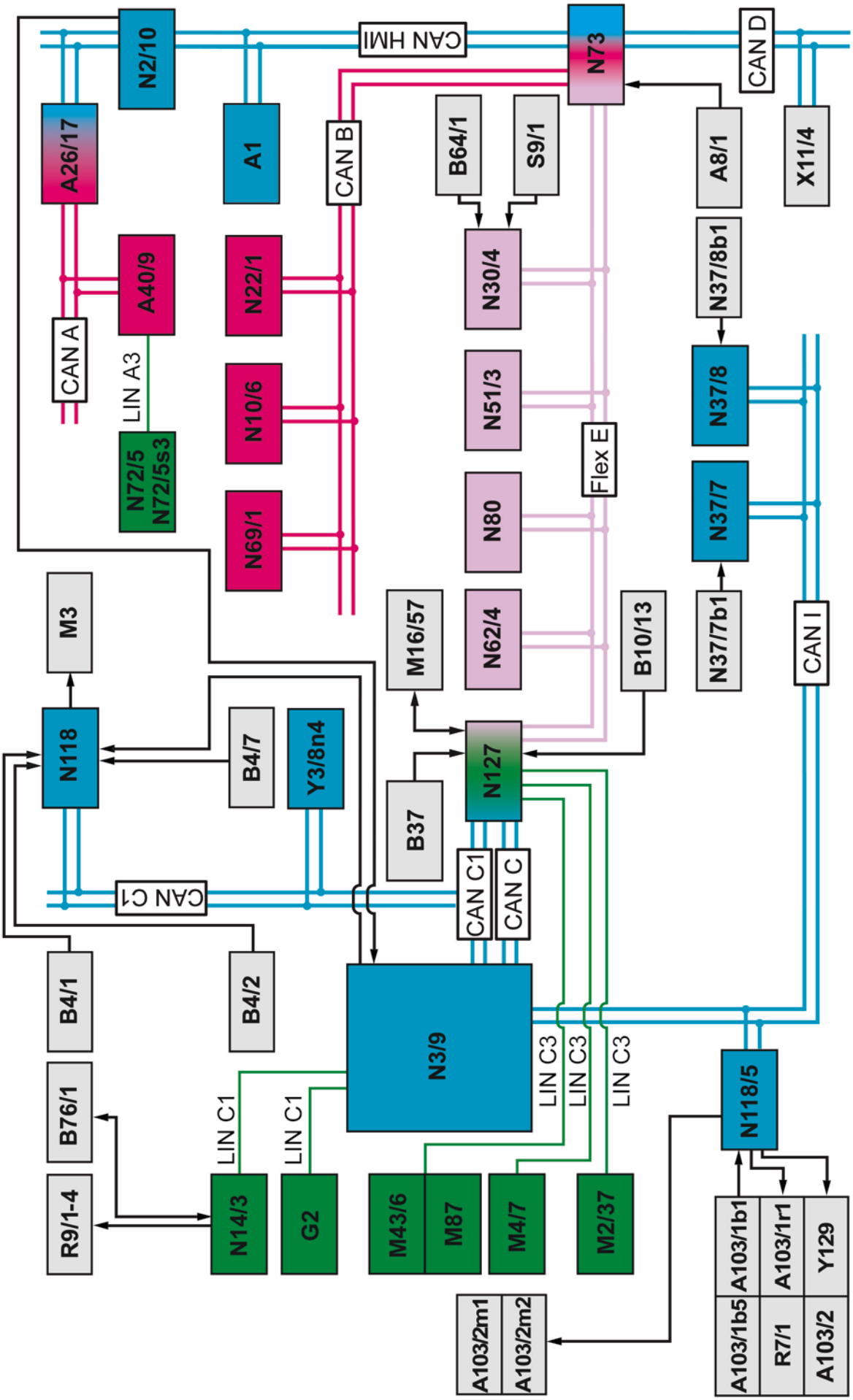
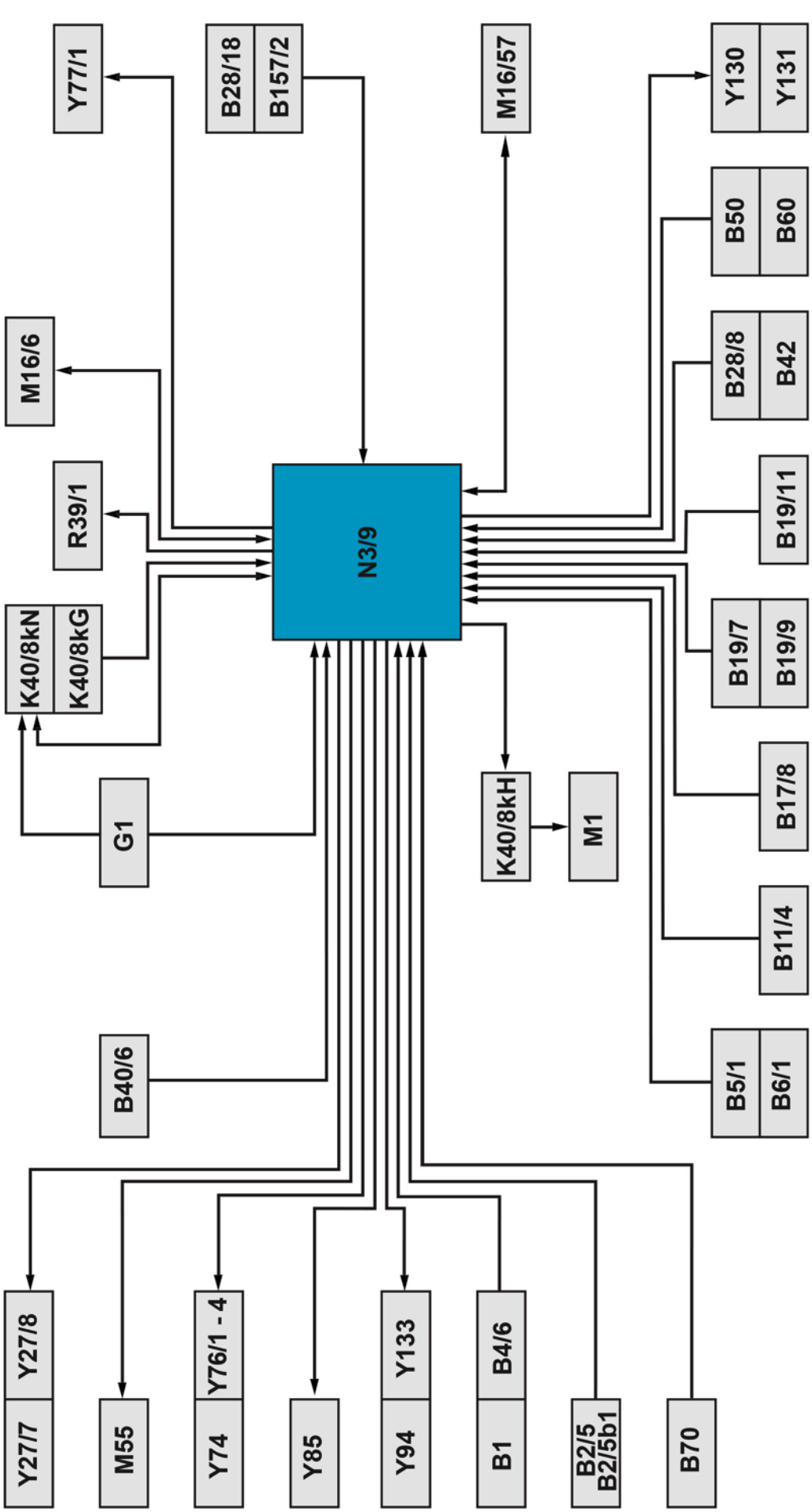
View of engine wiring harnesses

A Crankcase wiring harness
B Cylinder head and intake tract wiring harnesses
C Exhaust system waring harness
D Injection wiring harness



Block diagram of CAN network

A1	Instrument cluster
A8/1	Transmitter key
A26/17	Head unit
A40/9	Audio/COMAND operating unit
A103/1b1	AdBlue® tank temperature sensor
A103/1b5	AdBlue® fill level sensor
A103/1r1	AdBlue® tank heating element
A103/2	AdBlue® delivery module
A103/2m1	AdBlue® delivery pump
A103/2m2	AdBlue® extraction pump
B4/1	Fuel level indicator fuel tank fill level sensor, left
B4/2	Fuel level indicator fuel tank fill level sensor, right
B4/7	Fuel pressure sensor
B10/13	Low-temperature circuit temperature sensor
B37	Accelerator pedal sensor
B64/1	Brake vacuum sensor
B76/1	Fuel filter condensation sensor with heating element
G2	Alternator
M2/37	Radiator trim flap actuator motor
M3	Fuel pump
M4/7	Fan motor
M16/57	Exhaust flap controller
M43/6	Low-temperature circuit circulation pump 1
M87	Radiator shutters actuator motor
N2/10	Supplemental restraint system control unit
N3/9	CDI control unit
N10/6	Front SAM control unit
N14/3	Glow output stage
N22/1	Climate control system control unit
N30/4	Electronic Stability Program control unit
N37/7	Control unit of NOx sensor upstream of diesel oxidation catalytic converter
N37/7b1	NOx sensor upstream of diesel oxidation catalytic converter
N37/8	Control unit of NOx sensor downstream of SCR catalytic converter
N37/8b1	NOx sensor downstream of SCR catalytic converter
N51/3	AIR BODY CONTROL control unit
N62/4	Intelligent Drive control unit
N69/1	Left front door control unit
N72/5	Right lower control panel
N72/5s3	ECO start/stop function button
N73	Electronic ignition lock control unit
N80	Steering column tube module control unit
N118	Fuel pump control unit
N118/5	AdBlue® control unit
N127	Drivetrain control unit
R7/1	AdBlue® pressure line heating element
R9/1	Cylinder 1 glow plug
R9/2	Cylinder 2 glow plug
R9/3	Cylinder 3 glow plug
R9/4	Cylinder 4 glow plug
S9/1	Brake light switch
X11/4	Diagnostic connector
Y3/8n4	Fully integrated transmission control unit
Y129	AdBlue® metering valve
CAN A	Telematics CAN
CAN B	Interior CAN
CAN C	Engine CAN
CAN C1	Drive CAN
CAN D	Diagnostics CAN
CAN HMI	User interface CAN
CAN I	Drivetrain sensor CAN
Flex E	Suspension FlexRay
LIN A3	LCP LIN
LIN C1	Drive LIN
LIN C3	Drivetrain LIN



Block diagram of direct network

B1	Engine oil temperature sensor
B2/5	Hot film MAF sensor
B2/5b1	Intake air temperature sensor
B4/6	Fuel pressure sensor, high pressure
B5/1	Boost pressure sensor
B6/1	Camshaft Hall sensor
B11/4	Coolant temperature sensor
B17/8	Charge air temperature sensor
B19/7	Temperature sensor upstream of catalytic converter
B19/9	Temperature sensor upstream of diesel particulate filter
B19/11	Temperature sensor upstream of turbocharger
B28/8	DPF differential pressure sensor
B28/18	EGR differential pressure sensor, low pressure
B40/6	Engine oil fill level sensor
B42	Engine oil pressure sensor
B50	Fuel temperature sensor
B60	Exhaust pressure sensor
B70	Crankshaft Hall sensor
B157/2	EGR temperature sensor, low pressure
G1	On-board electrical system battery
K40/8kG	Engine compartment circuit 15 relay
K40/8kH	Starter circuit 50 relay
K40/8kN	Circuit 87M relay
M1	Starter
M16/6	Throttle valve actuator
M16/57	Exhaust flap controller
M55	Intake port shutoff actuator motor
N3/9	CDI control unit
R39/1	Vent line heating element
Y27/7	Low-pressure EGR actuator
Y27/8	High-pressure EGR actuator
Y74	Pressure regulating valve
Y76/1	Cylinder 1 fuel injector
Y76/2	Cylinder 2 fuel injector
Y76/3	Cylinder 3 fuel injector
Y76/4	Cylinder 4 fuel injector
Y77/1	Boost pressure regulator
Y85	EGR cooler bypass switchover valve
Y94	Quantity control valve
Y130	Engine oil pump valve
Y131	Oil spray nozzles shutoff valve
Y133	Coolant pump switchover valve

Socket wrench	
Use	For removing and installing the hydraulic directional control valve, size 38.5
MB number	W654 589 00 09 00
FG	18
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	–

P58.20-2528-00

Counterholder	
Use	For removing and installing the decoupler on the belt drive and for turning the crankshaft
MB number	W654 589 00 40 00
FG	03
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	–

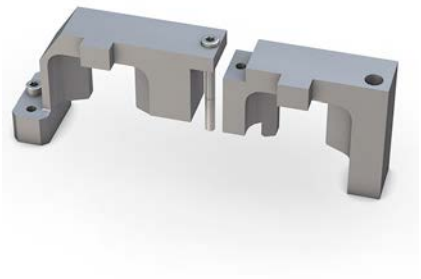
P58.20-2524-00

Special tools

Sleeve	
Use	For holding the sprocket when removing and installing the fuel high-pressure pump
MB number	W654 589 00 14 00
FG	03
Set	B
Category	Mercedes-Benz Cars/Special Operation
Note	–

P58.20-2527-00

Hold-down tool	
Use	For holding the camshaft in place when slackening or tightening the mounting bolt on the camshaft sprocket
MB number	W654 589 01 40 00
FG	03
Set	C
Category	Mercedes-Benz Cars/Special Operation
Note	–



P58.20-2521-00

Adjustment tool	
Use	For determining the top dead center position (TDC). The adjustment tool fixes the top dead center (TDC) on the crankshaft and checks the top dead center on the exhaust camshaft.
MB number	W654 589 00 21 00
FG	05
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	–

P58.20-2520-00

Adapter cable, 284-pin	
Use	For testing the wiring harness on the engine control unit
MB number	W654 589 02 63 00
FG	07
Set	B, C
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	In combination with test box/W000 589 00 21 00

P58.20-2530-00

Special tools

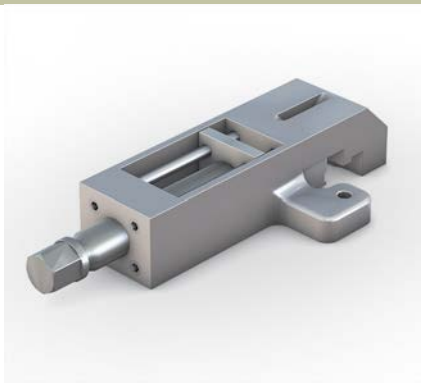
Adapter	
Use	For leak testing the charge air system
MB number	W654 589 00 91 00
FG	09
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	In combination with leak tester/W611 589 02 21 00

P58.20-2519-00

Insertion tool	
Use	For installing the rear crankshaft radial shaft sealing ring
MB number	W654 589 01 43 00
FG	01, 03
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	In combination with insertion tool/W651 589 01 61 00

P58.20-2525-00

Basic tool	
Use	Chain breaker tool and riveting/press-on tool with thrust and guide pieces for replacing the timing chain
MB number	W654 589 00 33 00
FG	05
Set	C
Category	Mercedes-Benz Cars/Special Operation
Note	–



P58.20-2526-00

Plate	
Use	Acts as a guard when riveting the timing chain, to prevent the timing chain from skipping onto the drive gear.
MB number	W654 00 589 32 00
FG	05
Set	B
Category	Mercedes-Benz Cars/Special Operation
Note	–

P58.20-2532-00

Special tools

Adapter cable, 39-pin	
Use	For testing the wiring harness on the exhaust control unit (UDCM)
MB number	W654 589 03 63 00
FG	14
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	In combination with test box/W000 589 00 21 00

P58.20-2529-00

Assembly plate	
Use	During assembly and disassembly the tensioning wheel must be turned and secured with the lock pin.
MB number	W654 589 00 31 00
FG	05
Set	C
Category	Mercedes-Benz Cars/Special Operation
Note	–

P58.20-2522-00

Box wrench set	
Use	For slackening/tightening the engine mount threaded connections on the new inline engine generation
MB number	W001 589 01 16 10
FG	22
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	Supplement to engine mount wrench set/W001 589 01 16 00

P58.20-2531-00

Insertion tool	
Use	For installing the front crankshaft radial shaft sealing ring
MB number	W654 589 00 43 00
FG	03
Set	B
Category	Mercedes-Benz Cars Basic Operation - Mandatory/No exemptions
Note	–

P58.20-2533-00

Abbreviations

CAN
Controller Area Network

CDI
Common rail direct injection

CO_2
Carbon dioxide

DPF
Diesel particulate filter

EKAS
Intake port shutoff

Euro 6
Euro 6 emissions standard

HP EGR
High-pressure exhaust gas recirculation

LIN
Local interconnect network

LP EGR
Low-pressure exhaust gas recirculation

NOx
Nitrogen oxides

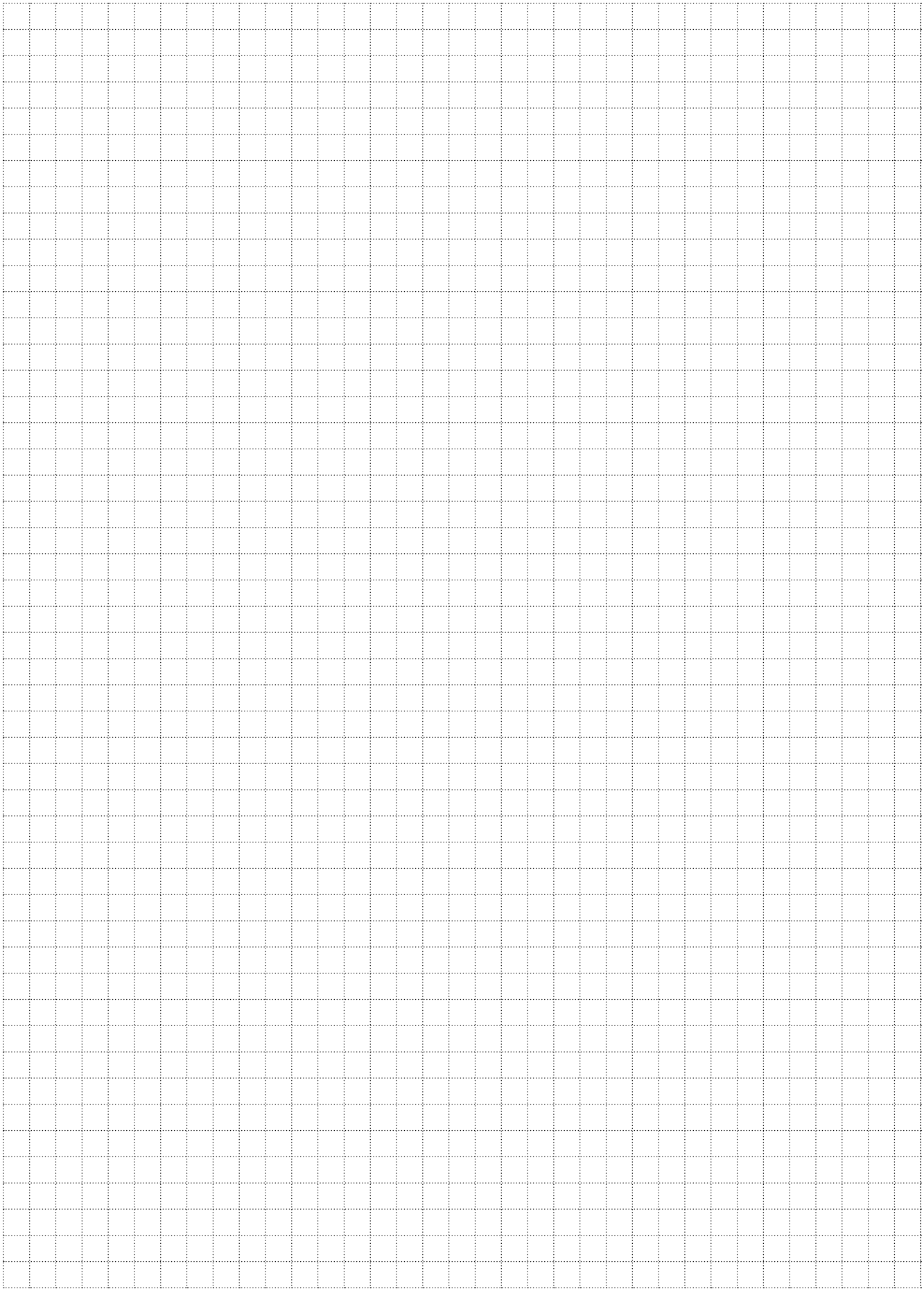
PWM
Pulse width modulation

SCR
Selective Catalytic Reduction

VTG
Variable turbine geometry

Notes

Space for your notes



Notes

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