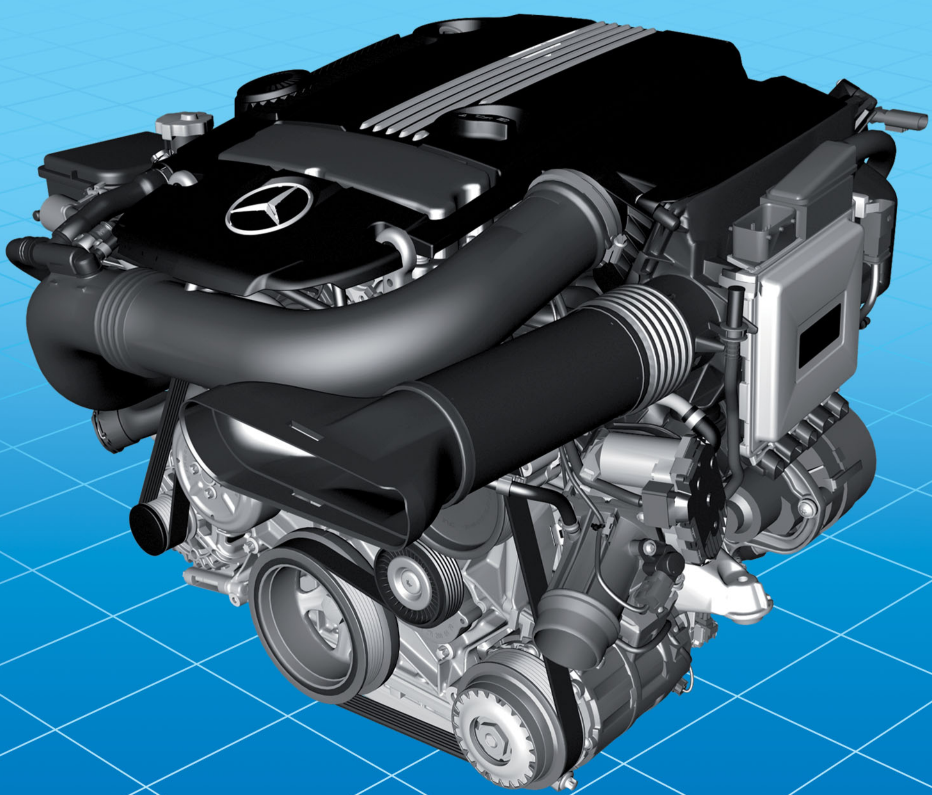
# New 4-Cylinder Gasoline Engine M 271 EVO

Introduction into Service Manual

Mercedes-Benz



# Introduction of the New 4-Cylinder Gasoline Engine M 271 EVO

Introduction into Service Manual

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

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## Contents

# Contents

# Preface

Dear reader,

This Introduction into Service Manual presents the changes and new features in the 4-cylinder gasoline engine M 271 EVO.

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

In terms of the contents, the emphasis in this Introduction into Service Manual is on presenting new and modified components, systems, system components and their functions.

This Introduction into Service Manual aims to provide an overview of the technical innovations and an insight into the complex systems.

However, this Introduction into Service Manual is not intended as a basis for repair work or technical diagnosis. For such needs, more extensive information is available in the Workshop Information System (WIS) and in the XENTRY Diagnostics system.

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

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 the information relating to specifications, equipment and options is valid as of the copy deadline in March 2009 and may therefore differ from the current production configuration.

Daimler AG

Technical Information
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# Brief description

## M 271 EVO

From September 2009 the M 271 EVO will be used in the BlueEFFICIENCY models of the C-Class and E-Class. There are three power variants: 115, 135 and 150 kW.

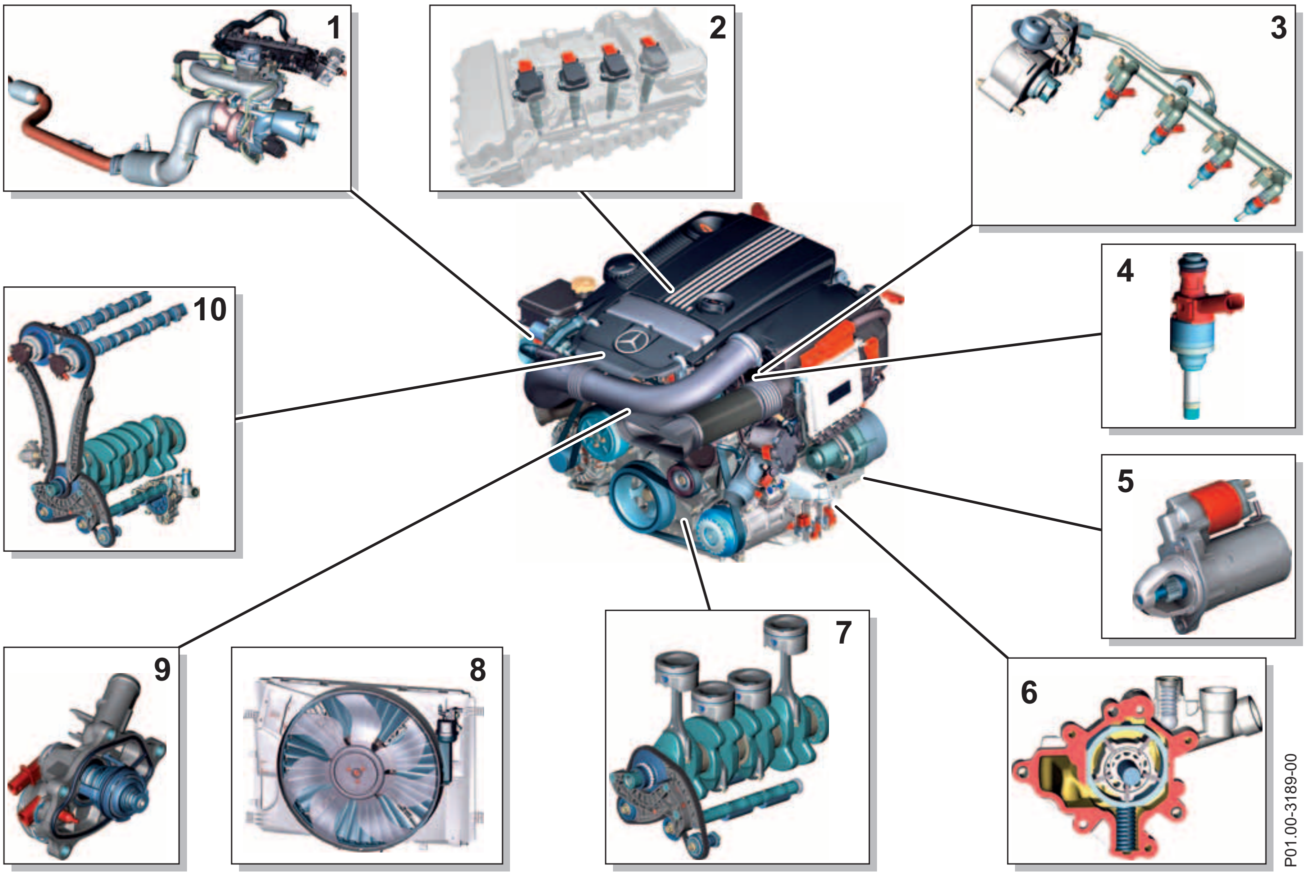
The development of the M 271 EVO combines the following objectives:

- Improved responsiveness due to increased power and higher torque
- Improved comfort thanks to smoother running
- Significantly lower fuel consumption and reduced $CO_2$ emissions
- Compliance with the Euro 5 standard

The M 271 EVO therefore combines the BlueEFFICIENCY requirements for economy and environmental compatibility with comfort and driving pleasure.

These objectives are realized by a variety of technical innovations and improvements:

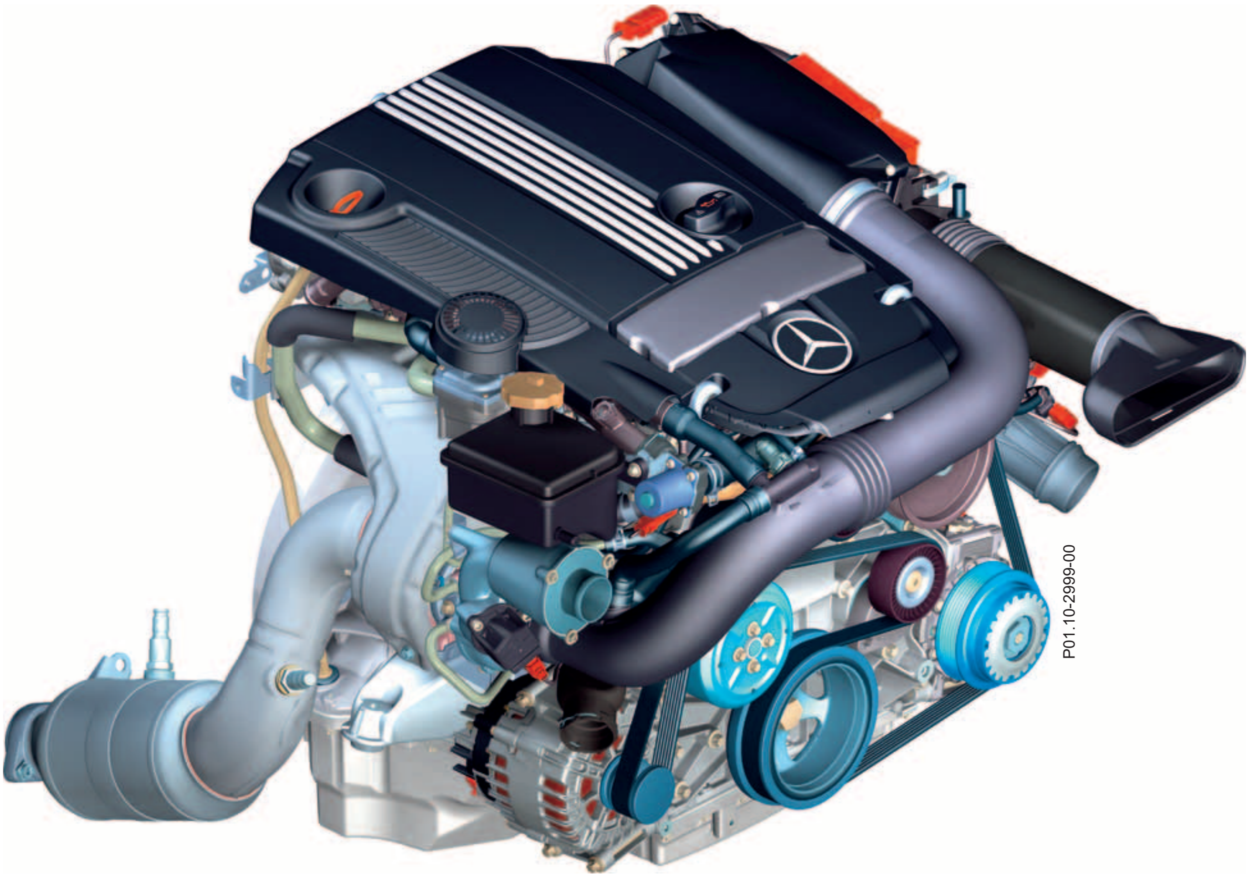
- Low-noise and low-maintenance chain drive
- Camshaft adjustment
- Lanchester balancer
- Homogeneous direct injection with 140 bar injection pressure
- Fuel injectors
- Quantity-controlled fuel pump
- Turbocharger
- Lambda control
- Secondary air injection for rapid heating of the catalytic converter
- Two-disk thermostat with three-disk functionality
- Radiator shutters
- Regulated oil pump with high efficiency
- Ignition system
- ECO start / stop system



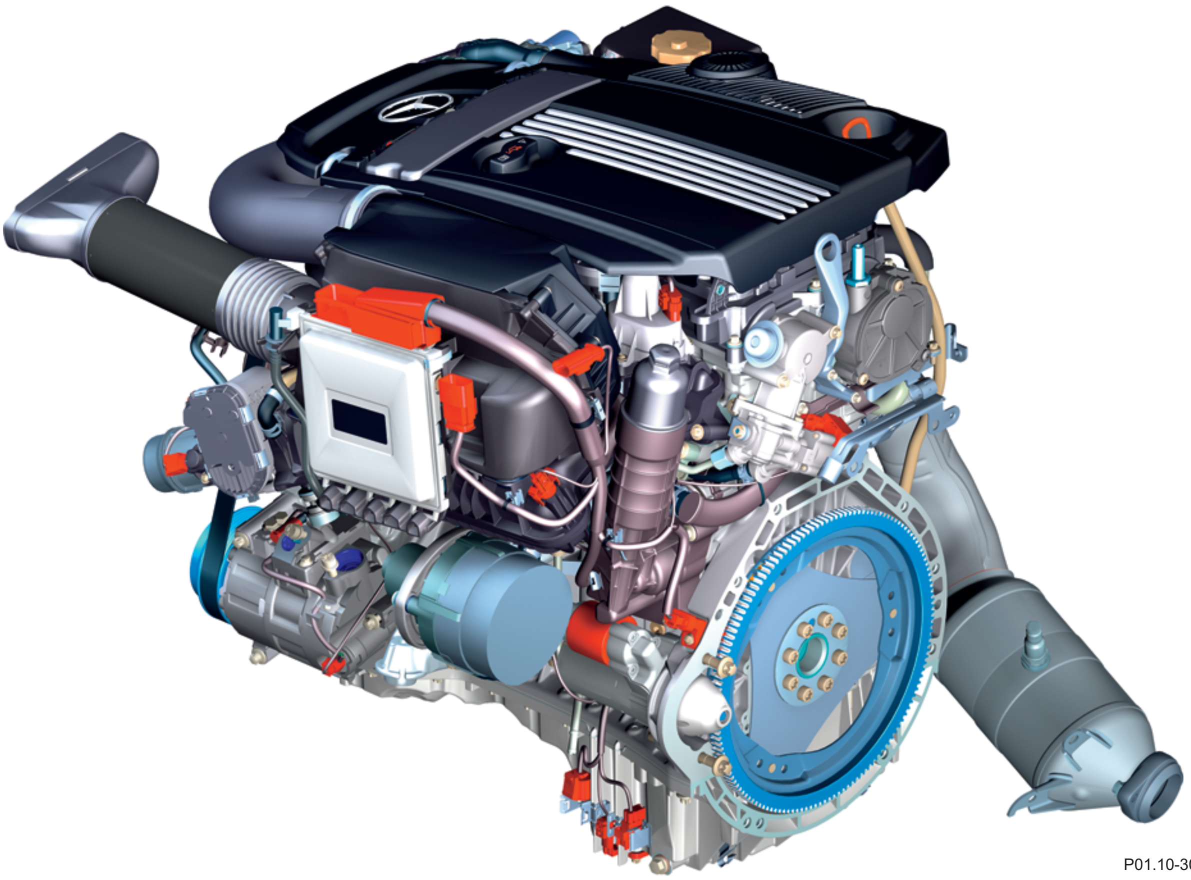

***Overview of new features and improvements***

*1 Exhaust system with turbocharger, optimized lambda control and secondary air injection*
*2 Ignition system*
*3 Homogeneous direct injection with quantity-controlled fuel pump*
*4 Fuel injectors*
*5 ECO start / stop system*
*6 Regulated oil pump*
*7 Lanchester balancer*
*8 Radiator shutters*
*9 Two-disk thermostat with three-disk functionality*
*10 Low-noise and low-maintenance chain drive with optimized camshaft adjustment*

# Engine views




*M 271 EVO control end*



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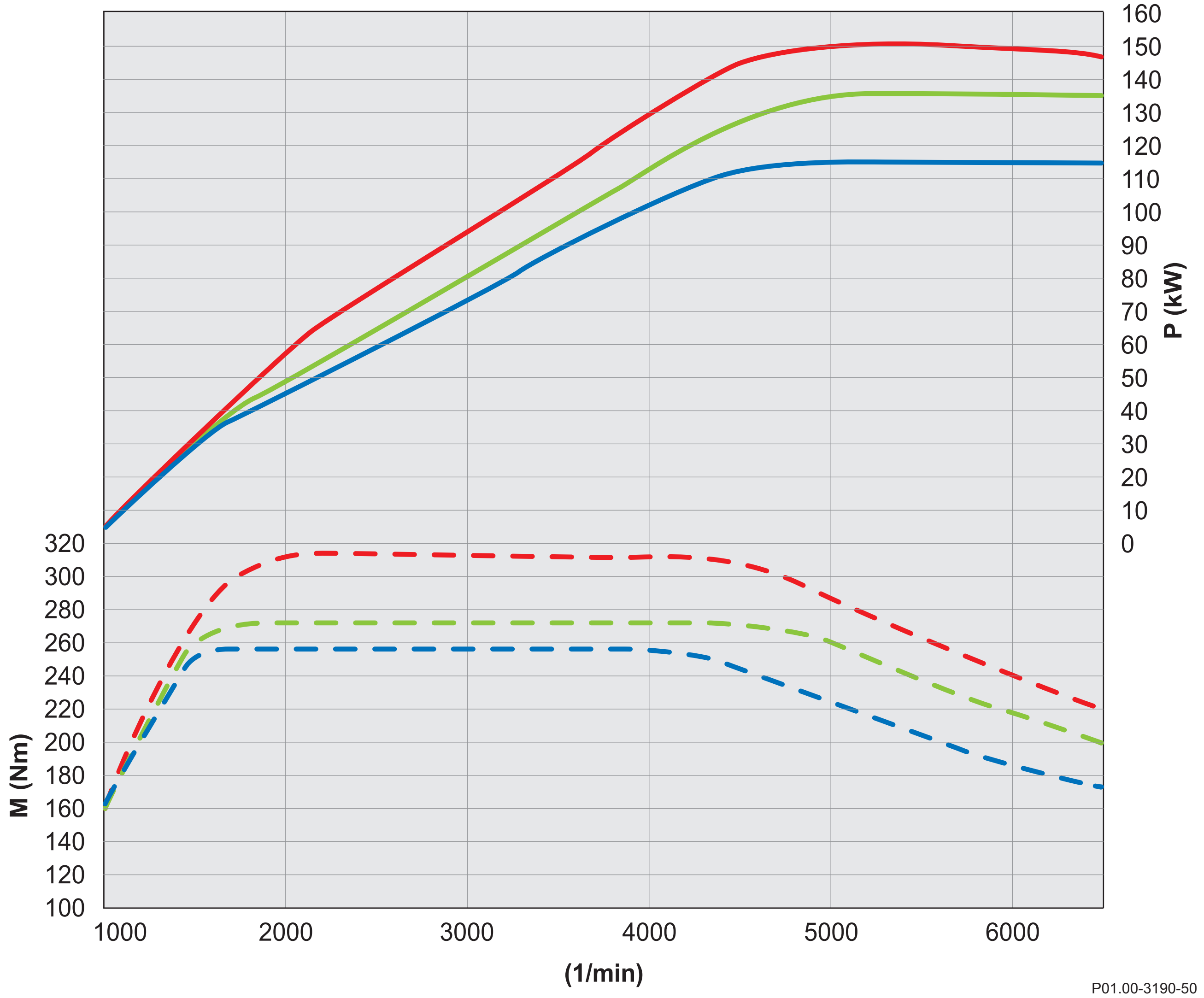
*M 271 EVO output end*

| M 271 EVO | | 271.820 | 271.860 | 271.860 |
|---|---|---|---|---|
| Displacement | $cm^3$ | 1,796 | 1,796 | 1,796 |
| Rated output | kW<br>at rpm | 115<br>5,000 | 135<br>5,250 | 150<br>5,500 |
| Rated torque | Nm<br>at rpm | 250<br>1,600...4,300 | 270<br>1,800...4,600 | 310<br>2,000...4,300 |
| Compression ratio | ε | 9.8 : 1 | 9.3 : 1 | 9.3 : 1 |



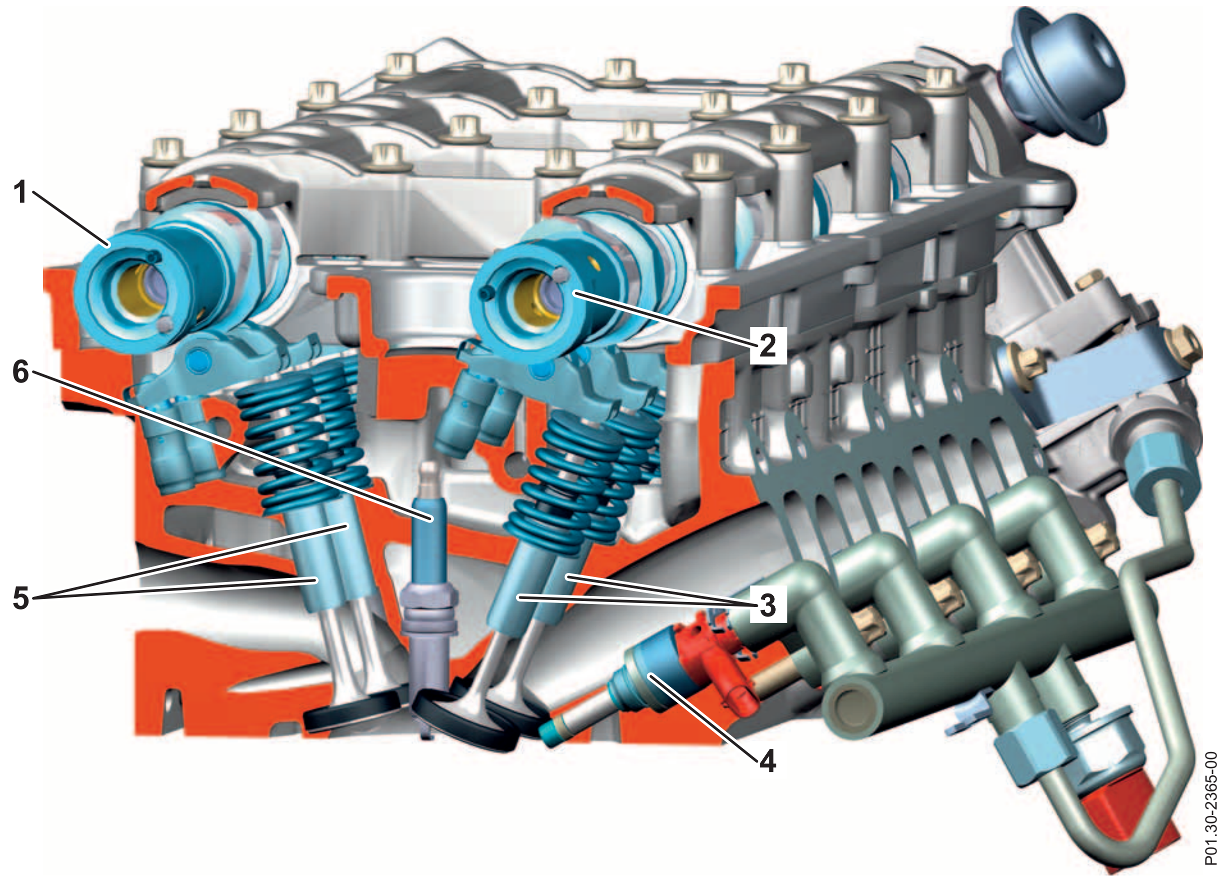

***Performance graph***

*M 271 EVO with 115 kW* *M 271 EVO with 135 kW* *M 271 EVO with 150 kW*

# Cylinder head

The cylinder head and the intake valves have been adapted to cope with the demands of homogeneous direct injection.

The M 271 EVO operates according to the four-valve concept with two camshafts, two camshaft adjusters and central spark plugs.




***Cylinder head***

*1 Exhaust camshaft*
*2 Intake camshaft*
*3 Intake valves*
*4 Fuel injector*
*5 Exhaust valves*
*6 Spark plug*

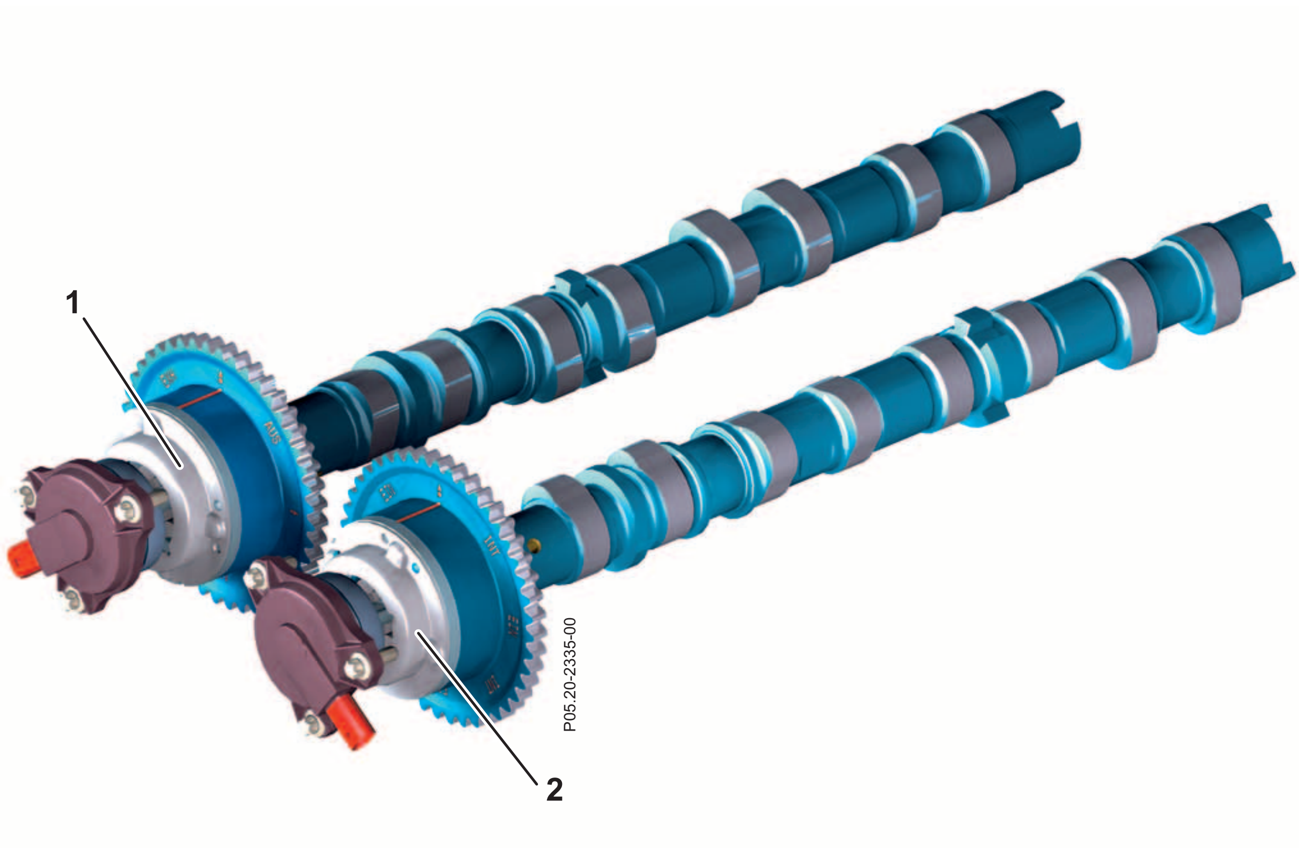
## Camshaft adjuster

The camshaft adjusters of the forged intake and exhaust camshafts are vane-cell adjusters and have been further improved. They allow the timing to be varied steplessly and more quickly than before.

The camshaft adjuster is a hydraulic swivel drive. The adjustment angle is 40° (crank angle) – corresponding to an angle of 20° performed at the adjuster (exhaust). The adjustment of the camshafts optimizes the engine torque curve and improves exhaust characteristics.

A spring-loaded pin locks the camshaft adjuster in the basic position when the engine is switched off in order to prevent uncontrolled movement of the adjuster during start-up.

The new camshaft adjuster is 34% lighter while the rate of adjustment is twice as fast.




***Camshaft adjuster***

*1 Exhaust camshaft adjuster*
*2 Intake camshaft adjuster*

# Crankcase

## Crankcase ventilation

The M 271 EVO features two crankcase ventilation systems:

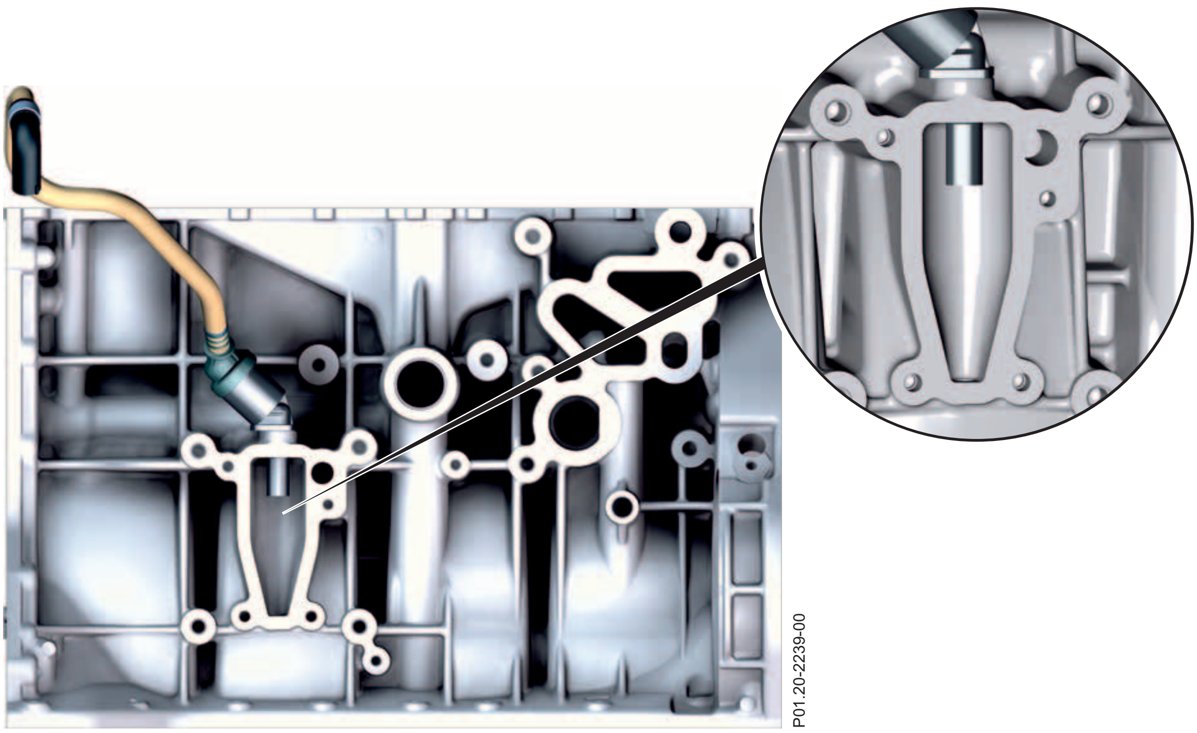
- Partial load ventilation with single cyclone oil separator
- Full load ventilation with double cyclone oil separator

## Partial load ventilation

The single cyclone oil separator is responsible for separating the oil at the partial load ventilation line. The partial load ventilation line runs from the left engine support flange into the charge air distribution line downstream of the throttle valve actuator.

Via an opening in the crankcase the blow-by gas (blow-by quantity) flows into the single cyclone separator which is located behind the left engine support. The oil separator is in the form of a cyclone: Incoming air is made to spiral and the resulting centrifugal forces separate the oil, which flows back into the housing.

The air cleaned in this way leaves the oil separator through a combination valve installed above the cyclone, which acts as a check valve in the event of overpressure in the charge air distribution line and as an air shutoff valve to protect the catalytic converter.

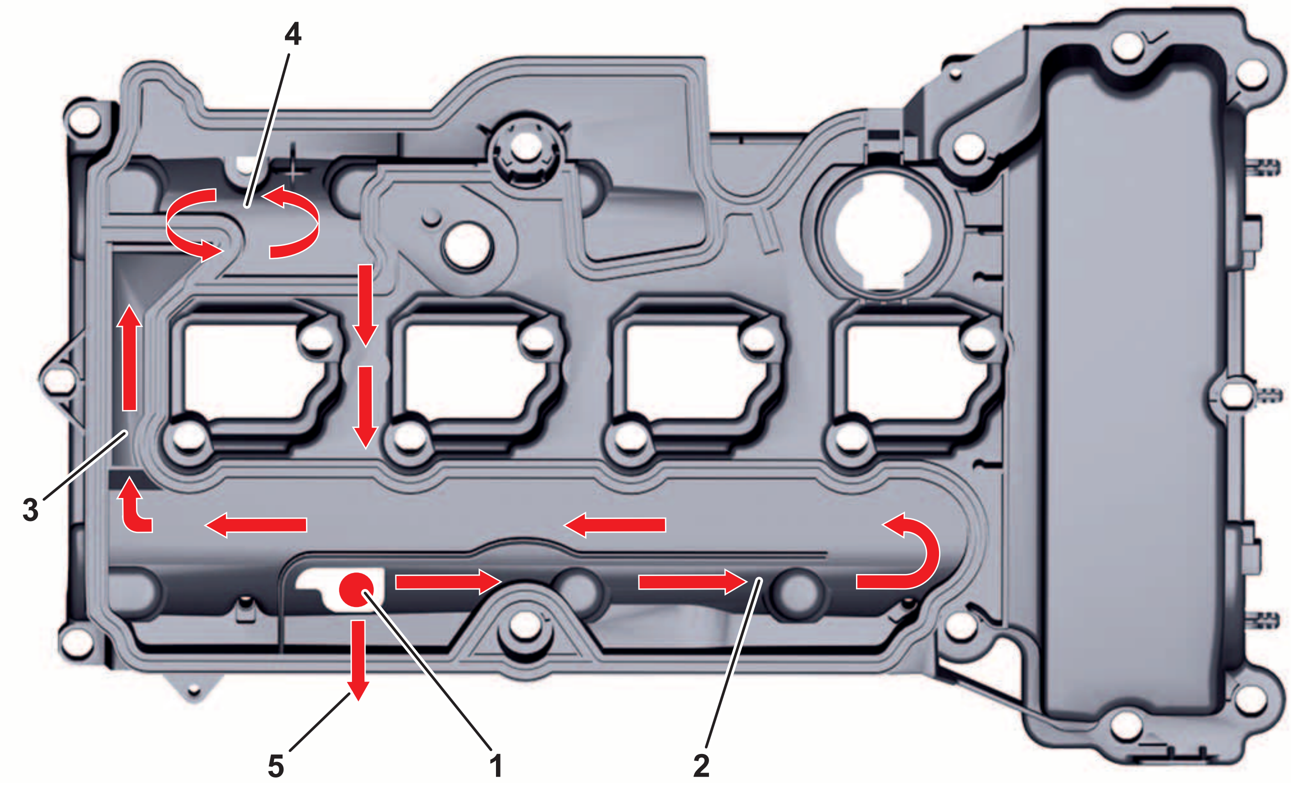



***Partial load ventilation with cyclone oil separator***

## Full load ventilation

The full load ventilation line runs from the oil separator into the charge air line upstream of the turbocharger. The oil separators are integrated in the cylinder head cover. The full load ventilation gases emerge on the exhaust side.

A parallel double cyclone oil separator provides highly efficient and precise oil separation.




***Blow-by gases in the cylinder head cover***

*1 Entry of blow-by gases*
*2 Volume separator*
*3 Ramp*
*4 Double cyclone oil separator*
*5 Exit of blow-by gases*

# Chain drive

## Low-noise chain drive

The camshafts are driven by a newly developed toothed bush chain.

The bearing for the leading slide rail and tensioning rail is arranged to have no contact with the timing case cover. This results in a considerable reduction in noise.

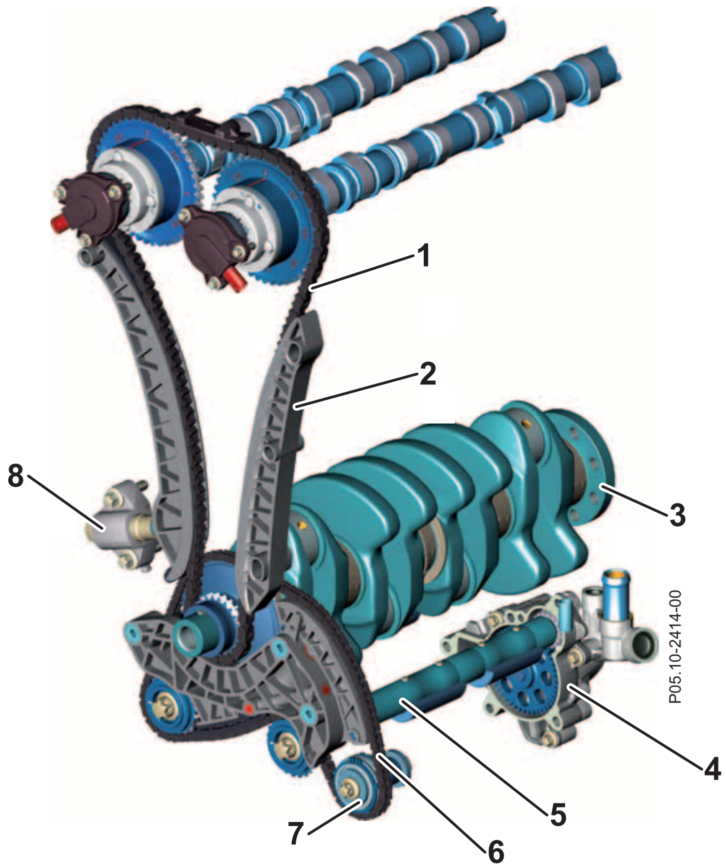
The lower position of the chain tensioner and resultant reduction in force in the chain drive contribute to this.

The two Lanchester balance shafts are driven by a second chain, which is also located at the front of the engine. The oil pump is driven via the left Lanchester balance shaft.

A new simplex bush chain is used for this.

**Note**

Besides the lower mass, the impact forces of the bushes in the tooth roots are reduced by the chain links striking the shoulders on each side of the sprocket and absorbing a part of the impact pulses.




***Chain drive***

1 *Toothed bush chain: Drives the camshafts*
2 *Slide rail*
3 *Crankshaft*
4 *Oil pump*
5 *Balance shaft*
6 *Simplex bush chain: Drives the Lanchester balance shafts*
7 *Sprocket*
8 *Chain tensioner with tensioning rail*

# Crank assembly

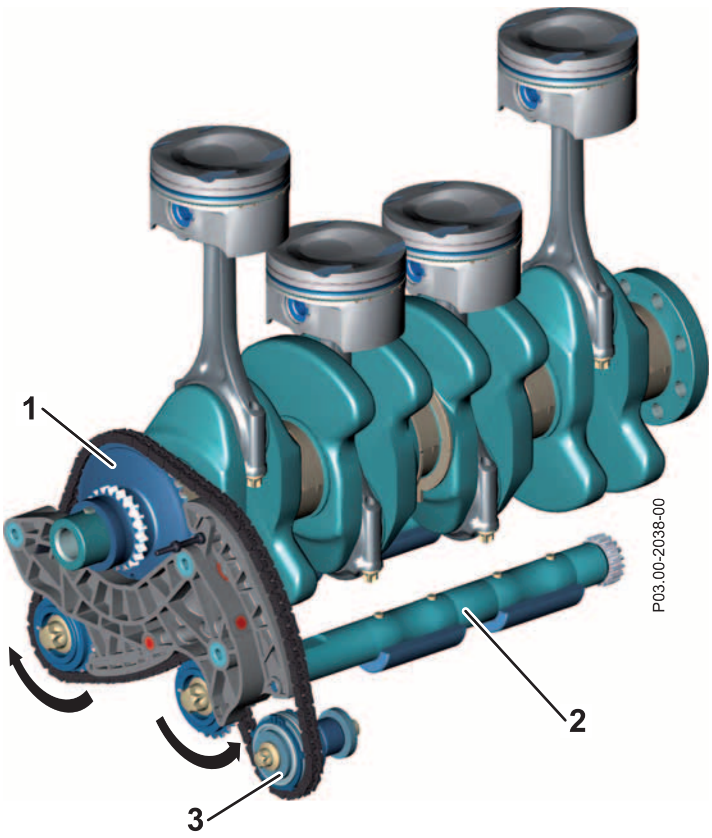
## Lanchester balancer

With the new Lanchester balancer it has been possible to achieve a considerable reduction in disturbing vibrations caused by piston movements, providing comfortable smooth running.
The Lanchester balancer operates with two contrarotating balance shafts, each mounted in three bearings in a one-piece die-cast aluminum housing.

These tubular steel shafts are inserted into the bearing channel of the housing and are then bolted to the imbalance mass segments. The faces of the imbalance mass segments also act as locators and axial bearings for the shafts in the housing.

**Note**

The housing in which the balance shafts are mounted is located inside the oil pan and is bolted to the crankcase from underneath. This housing also acts as a ladder-type frame which serves as a stiffening bridge for the bearing seats and thus improves the cross-bracing of the crankcase.




***Lanchester balancer***

*1 Crankshaft drive*
*2 Balance shaft*
*3 Sprocket*

## General

The major assemblies in the M 271 EVO have been relocated, due in part to the omission of the mechanical supercharger.

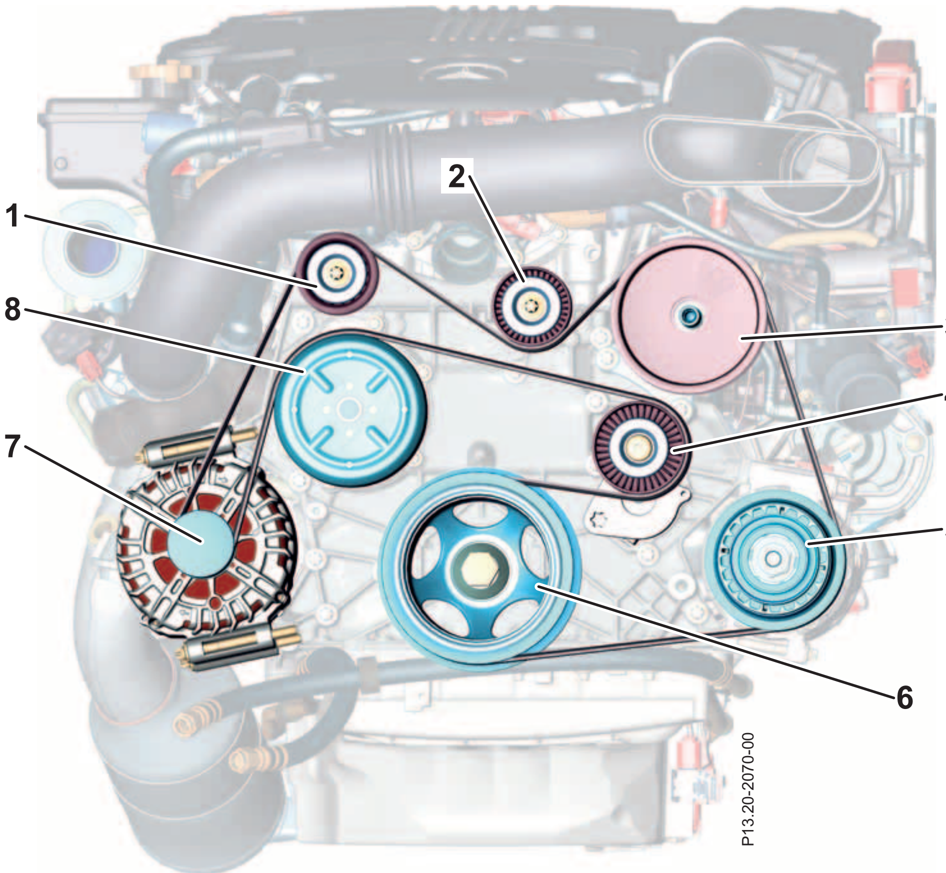
The belt pulley of the crankshaft drives the following major assemblies:

- Power steering pump
- Refrigerant compressor
- Alternator
- Coolant pump

They are driven by means of a one-piece, low-maintenance poly-V belt. The poly-V belt is tensioned by an automatic belt tensioner with tensioner pulley.

**Note**

When installing the poly-V belt, make sure the installation position is correct as described in the repair instructions.




***Belt drive***

*1 Guide pulley*
*2 Guide pulley*
*3 Power steering pump*
*4 Belt tensioner with tensioner pulley*
*5 Refrigerant compressor*
*6 Belt pulley*
*7 Alternator*
*8 Coolant pump*

# Homogeneous direct injection

## Injection technology

The M 271 EVO features homogeneous direct injection with spark ignition and turbocharging. These improve fuel economy and significantly reduce pollutant emissions.

## Operating principle of fuel injection control

The current fuel pressure in the rail is registered by the rail pressure sensor and forwarded to the quantity control valve. This valve causes the fuel high-pressure pump to build up a pressure of up to 140 bar in the rail.

The exact injection time is calculated by the ME-SFI control unit.

The ME-SFI control unit evaluates signals from the following components:

- Throttle valve actuator
- Camshaft sensor
- Crankshaft Hall sensor
- Rpm sensor
- Pressure sensors
- Temperature sensor

The timing of the intake and exhaust valves is variable.

This means that the mixture formation in the combustion chamber can be adapted to suit the current operating conditions.

The intake and exhaust valves are controlled by the adjustable camshafts. The exact position of the camshafts is detected by the camshaft sensors and forwarded to the ME-SFI control unit.

## Rail

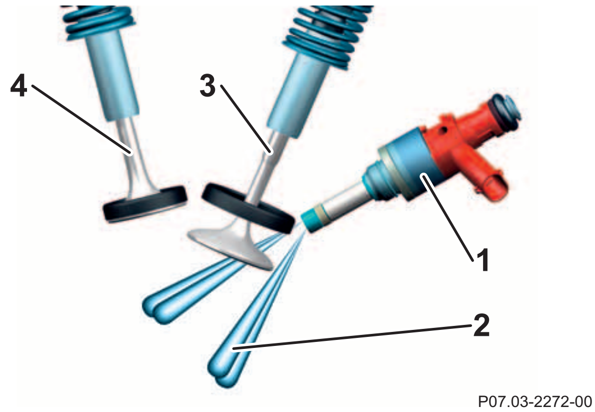
In a storage-type fuel injection system with fuel rail the pressure generation and injection functions are decoupled. The injection pressure is generated and regulated by the fuel high-pressure pump. The pressure is available in the rail during injection. The ME-SFI control unit actuates the quantity control valve and the fuel injectors spray the fuel into the combustion chamber with high precision.

## Fuel injectors

The fuel injectors are installed so that the fuel is injected at a certain angle. This angle is selected so as to prevent the fuel from being deposited on the wall of the combustion chamber or flooding the intake valves.

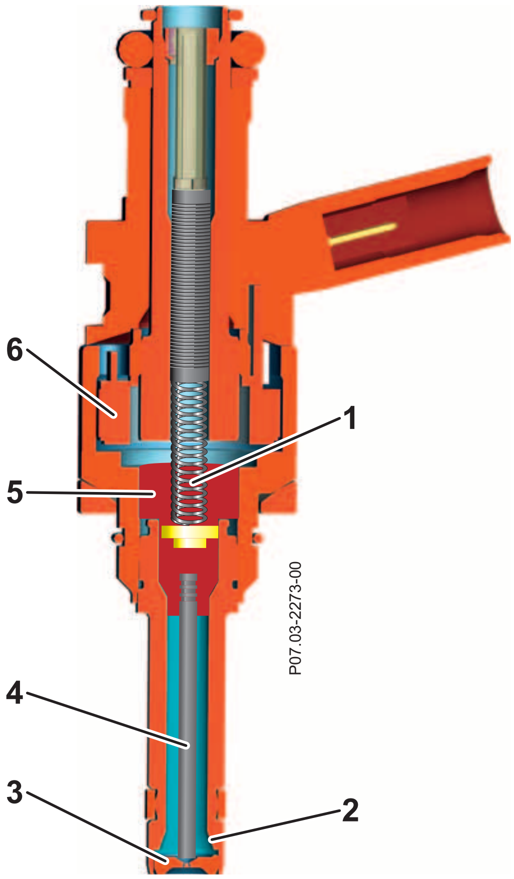
The multi-hole valves in the fuel injectors produce individual jets which are precisely adjusted according to the charge movement and the internal pressure in the cylinder.

This results in highly stable combustion, low emissions and low fuel consumption.




***Fuel injector with individual jets***

*1 Fuel injector*
*2 Individual jets*
*3 Intake valve*
*4 Exhaust valve*




***Cross section through the fuel injector***

*1 Coil spring*
*2 Valve seat*
*3 Multi-hole disk*
*4 Nozzle needle*
*5 Solenoid armature*
*6 Magnet coil*

# Homogeneous direct injection

## Fuel high-pressure pump

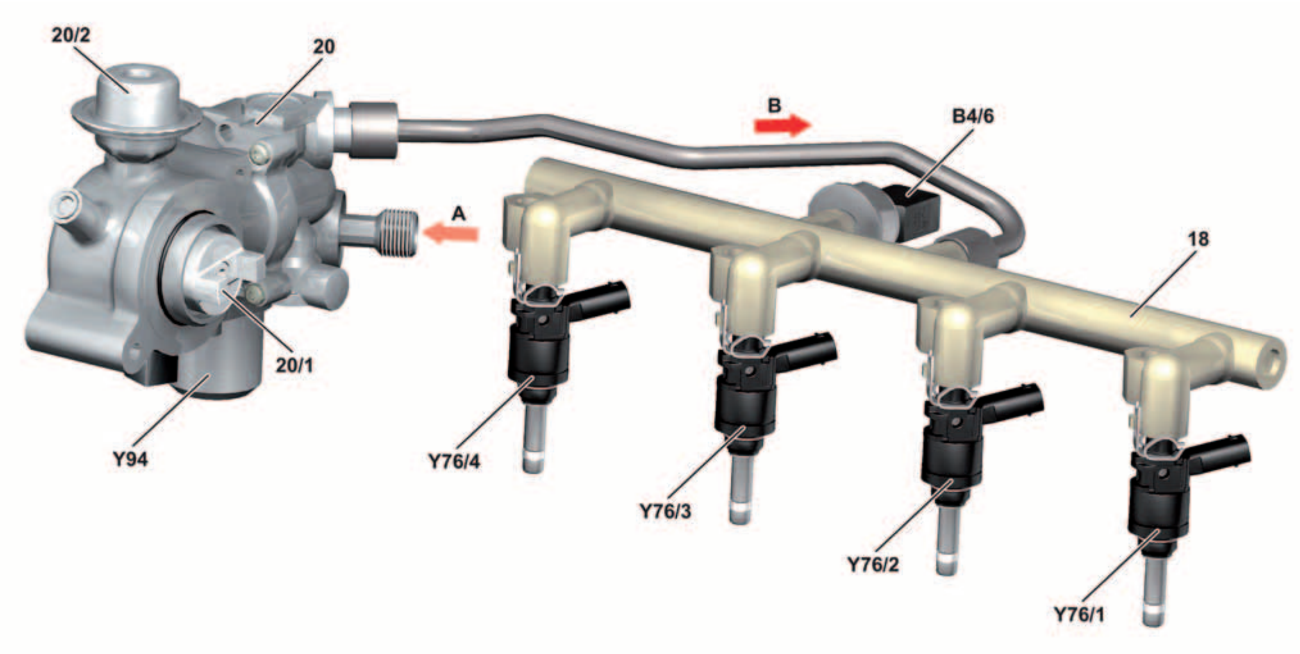
The fuel high-pressure pump is located at the rear of the cylinder head. It is driven via the intake camshaft. The fuel high-pressure pump is a single-plunger pump. Four cams enable four deliveries to be made for each rotation of the camshaft.

## Quantity control valve

The quantity control valve forms a unit with the fuel high-pressure pump. It functions as an intake throttle (proportional valve) and serves to regulate the fuel quantity (max. fuel pressure = 140 bar). For the regulation process, the current fuel pressure is registered by the rail pressure sensor in the rail.

## Rail pressure sensor

The rail pressure sensor measures the current fuel pressure in the rail and forwards a corresponding voltage signal to the ME-SFI control unit. When the engine is switched off, the quantity control valve interrupts the fuel supply, thus dissipating the high pressure.

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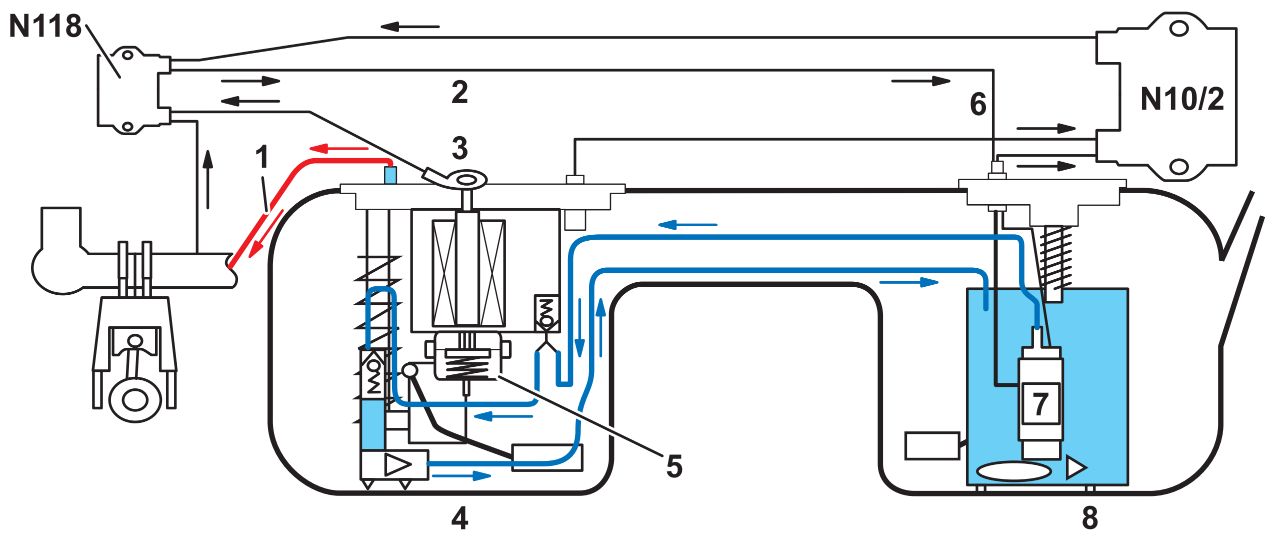
*High-pressure system*

| | |
|---|---|
| *18* | *Rail* |
| *20* | *Fuel high-pressure pump* |
| *20 / 1* | *Driver (drive system)* |
| *20 / 2* | *Fuel pressure damper* |
| *B4 / 6* | *Rail pressure sensor* |
| *Y76 / 1* | *Cylinder 1 fuel injector* |
| *Y76 / 2* | *Cylinder 2 fuel injector* |
| *Y76 / 3* | *Cylinder 3 fuel injector* |
| *Y76 / 4* | *Cylinder 4 fuel injector* |
| *Y94* | *Quantity control valve* |
| *A* | *Fuel feed from fuel tank (fuel low pressure)* |
| *B* | *Fuel feed to rail (fuel high pressure)* |

## Low-pressure system

The low-pressure system operates with a control unit for the fuel pump and a fuel pressure sensor in the fuel feed line.

The control unit is integrated in the CAN network (CAN = Controller Area Network) of the engine.
It regulates the fuel pump according to the engine requirements. The fuel pressure is kept constant as a reference.

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*Low-pressure system*

| | |
|---|---|
| *1* | *Fuel feed line* |
| *2* | *Filter flange* |
| *3* | *Fuel pressure sensor* |
| *4* | *Suction jet pump 1* |
| *5* | *Pressure relief valve* |
| *6* | *Pump flange* |
| *7* | *Uncontrolled fuel pump* |
| *8* | *Suction jet pump 2* |
| *N10/2* | *Rear SAM control unit with fuse and relay module* |
| *N118* | *Fuel tank control unit* |

# System overview

The power output and torque of the M 271 EVO are increased by the use of a turbocharger with charge air cooling. Forced induction by means of a compressor is no longer implemented.

## Operating principle of forced induction

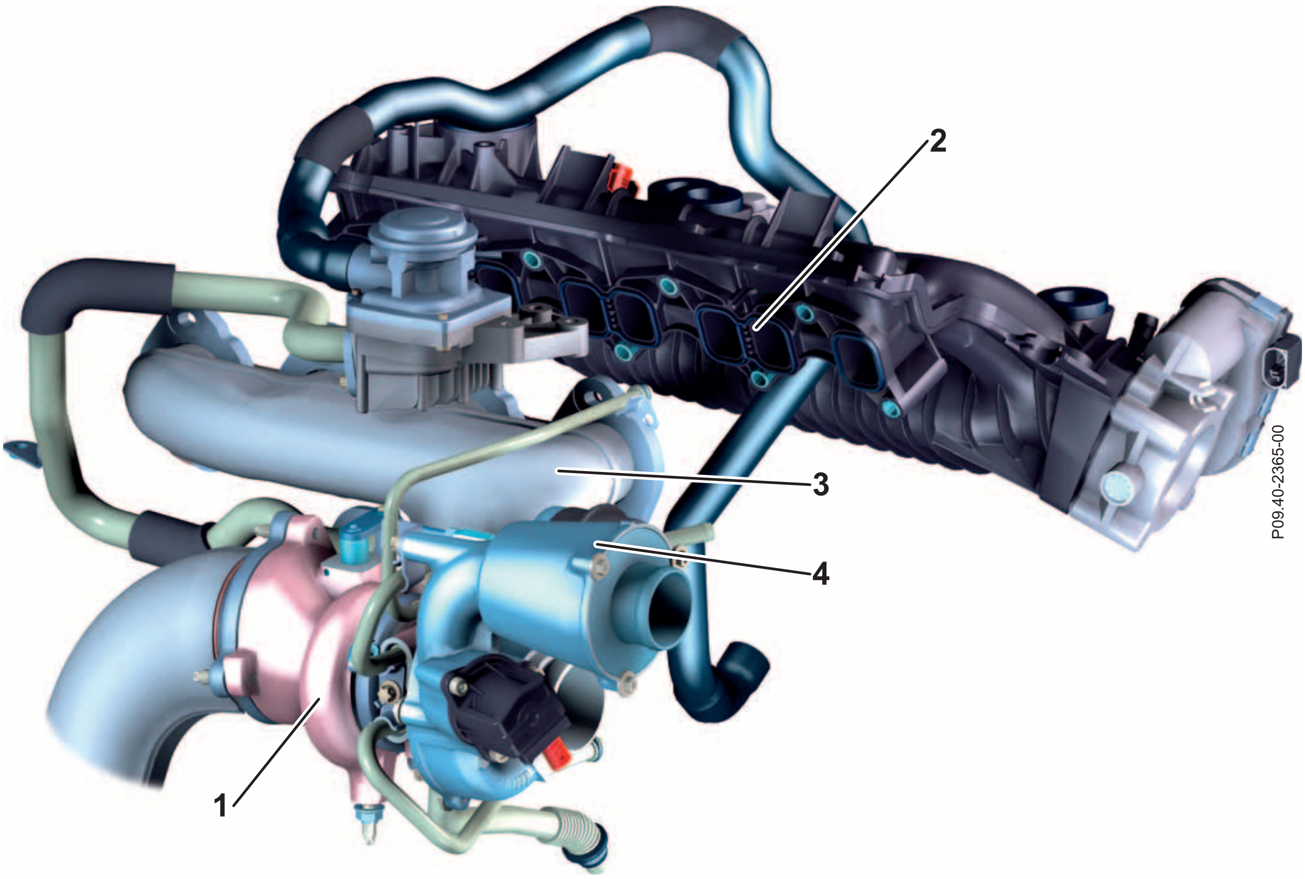
During forced induction, the flow energy of the exhaust gas is used to drive the turbocharger.

Fresh, clean air flows to the compressor inlet via the air filter. It is directed via the compressor outlet into the charge air line upstream of the charge air cooler.

The air in the charge air line is compressed as a result of the high rotational speed of the compressor turbine wheel that creates a high volumetric flow. The maximum boost pressure is 1.2 bar.

The noise damper at the compressor outlet dampens the boost pressure variations and the associated flow noises that occur during rapid rpm changes.

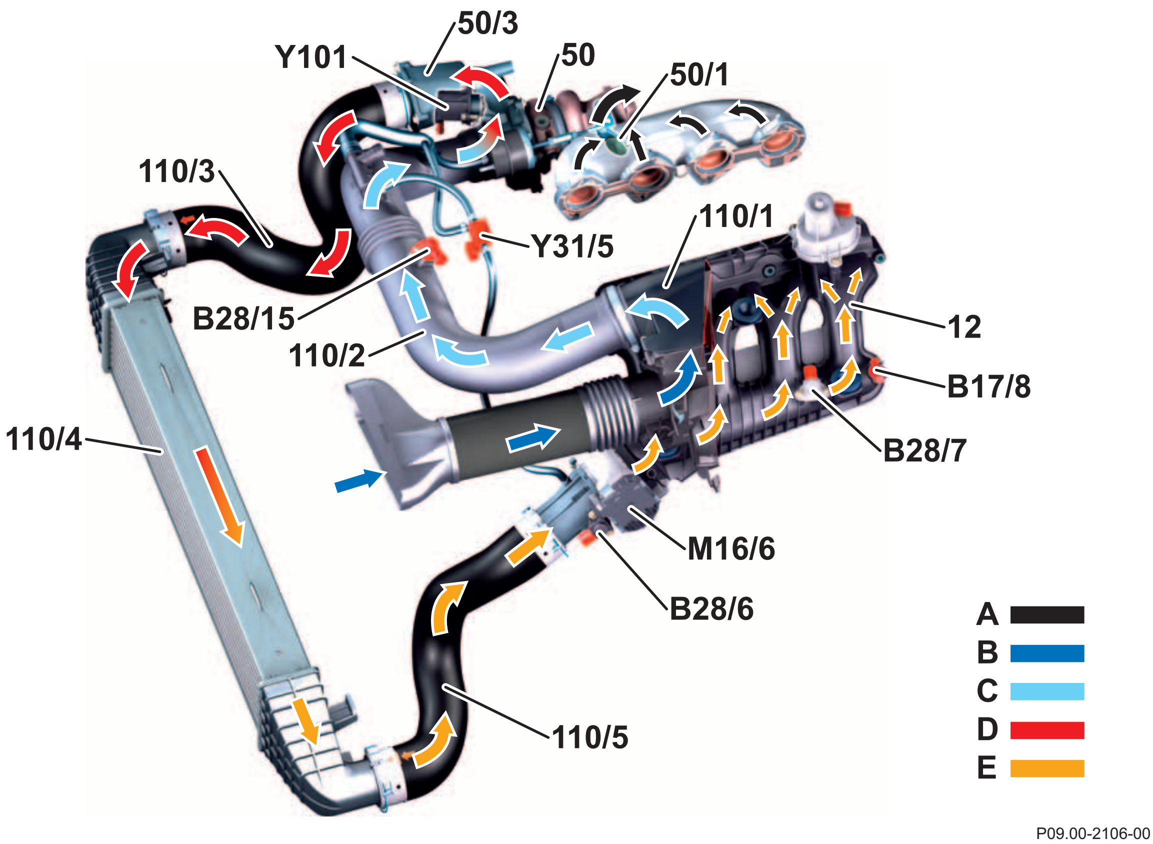
The compressed air flows via the charge air line to the charge air cooler. This cools the charge air, which has heated up due to compression, and directs it via the charge air line to the charge air distribution line.




***System overview***

*1 Turbocharger*
*2 Charge air distribution line*
*3 Exhaust manifold*
*4 Noise damper*

## System overview




***Function schematic of forced induction***

| | |
|---|---|
| *12* | *Charge air distribution line* |
| *50* | *Turbocharger* |
| *50/1* | *Boost pressure control flap (wastegate)* |
| *50/3* | *Noise damper* |
| *110/1* | *Air filter housing* |
| *110/2* | *Charge air line* |
| *110/3* | *Charge air line to charge air cooler* |
| *110/4* | *Charge air cooler* |
| *110/5* | *Charge air line to throttle valve actuator* |
| *B17/8* | *Charge air temperature sensor* |
| *B28/6* | *Pressure sensor upstream of throttle valve* |
| *B28/7* | *Pressure sensor downstream of throttle valve* |
| *B28/15* | *Pressure sensor upstream of compressor impeller* |
| *M16/6* | *Throttle valve actuator* |
| *Y31/5* | *Boost pressure control pressure transducer* |
| *Y101* | *Blow-off valve* |

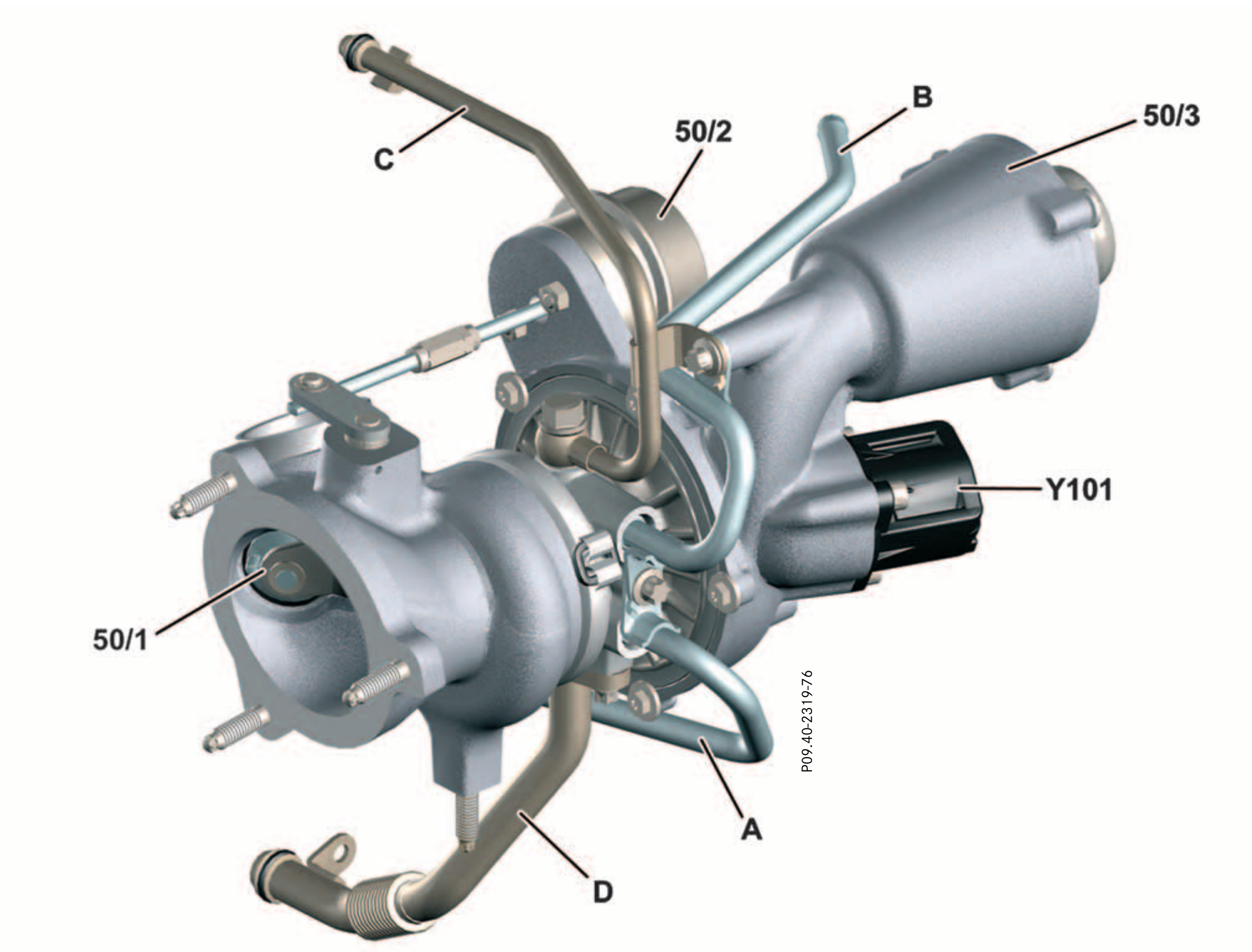
| | |
|---|---|
| *A* | *Exhaust gas* |
| *B* | *Intake air (unfiltered)* |
| *C* | *Intake air (filtered)* |
| *D* | *Charge air (uncooled)* |
| *E* | *Charge air (cooled)* |

### Operating principle of boost pressure control flap

The boost pressure is regulated by means of a boost pressure control flap (wastegate) installed at the turbine inlet.

The boost pressure control pressure transducer actuates the vacuum cell of the boost pressure control flap with boost pressure.

If the boost pressure is too high, the exhaust gases are directed around the turbine. This reduces the speed of the turbocharger and thus the boost pressure.




***Component overview***

| | | | |
|---|---|---|---|
| *50 / 1* | *Boost pressure control flap* | *A* | *Coolant feed line* |
| *50 / 2* | *Boost pressure control flap vacuum unit* | *B* | *Coolant return line* |
| *50 / 3* | *Noise damper* | *C* | *Engine oil feed line* |
| *Y101* | *Blow-off switchover valve* | *D* | *Engine oil return line* |

# Boost pressure control

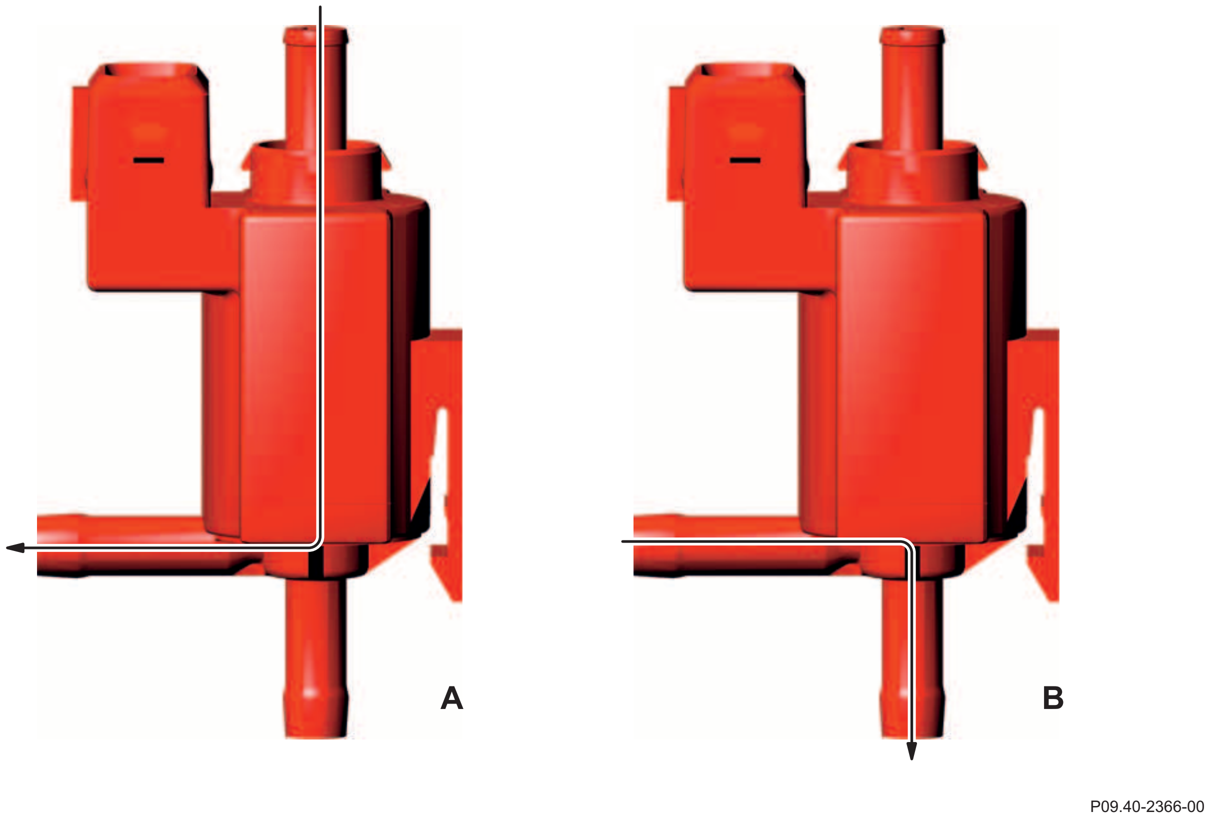
## Boost pressure control pressure transducer

The pressure transducer is actuated by the ME-SFI control unit according to a performance map and according to load.

To do this, the ME-SFI control unit evaluates the following sensors and functions:

- Charge air temperature sensor
- Pressure sensor upstream of throttle valve
- Pressure sensor upstream of compressor impeller
- Accelerator pedal sensor: Load request from driver
- Crankshaft Hall sensor: Engine speed
- Knock control
- Transmission overload protection
- Overheating protection

The pressure transducer actuates the vacuum cell of the wastegate with boost pressure from the charge air line. The vacuum cell then opens the wastegate, thus opening the bypass. The exhaust flow bypasses the turbine wheel via the bypass line, regulating the boost pressure and limiting the turbine speed.




***Boost pressure control pressure transducer***

*A Bypass closed*
*B Bypass open*

## Pressure sensor upstream of throttle valve

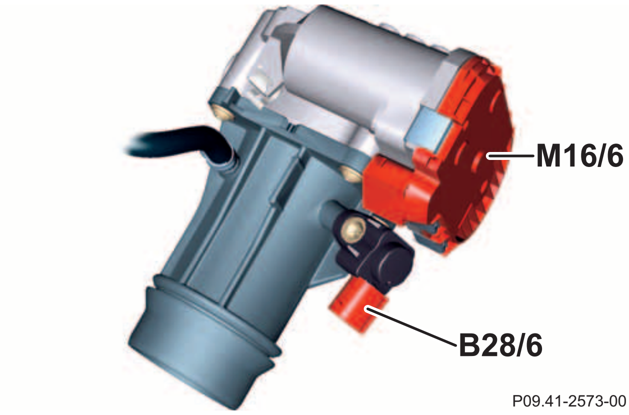
The pressure sensor upstream of the throttle valve measures the charge air pressure in the charge air line.

### Operating principle

The charge air pressure deforms the membrane, which acts on the potentiometer. This causes the resistance of the potentiometer to change, thus influencing the voltage signal that the pressure sensor forwards to the ME-SFI control unit.

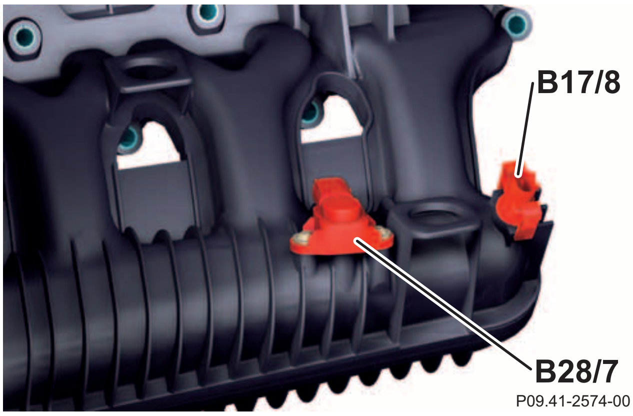
## Pressure sensor downstream of throttle valve

The pressure sensor downstream of the throttle valve measures the charge air pressure in the charge air distribution line and forwards this value to the ME-SFI control unit.




***Pressure sensor upstream of throttle valve***

*M16/6 Throttle valve actuator*
*B28/6 Pressure sensor upstream of throttle valve*




***Pressure sensor downstream of throttle valve***

*B17/8 Charge air temperature sensor*
*B28/7 Pressure sensor downstream of throttle valve*

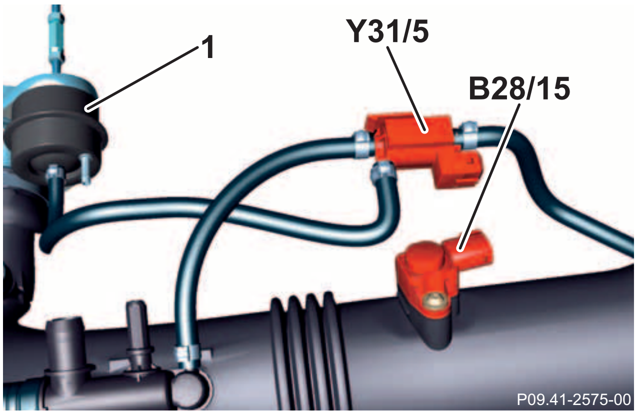
# Boost pressure control

## Pressure sensor upstream of compressor impeller

The pressure sensor upstream of the compressor impeller registers the pressure on the clean air side for the ME-SFI control unit.
This enables it to detect any sudden pressure drop, e.g. due to clogging of the air filter cartridge. The pressure sensor upstream of the compressor impeller is located in the charge air line upstream of the turbocharger.

**Note**

All the pressure sensors operate according to the same principle – they are controlled by positive pressure.




***Pressure sensor upstream of compressor impeller***

| | |
|---|---|
| *1* | *Vacuum unit* |
| *Y31 / 5* | *Boost pressure control pressure transducer* |
| *B28 / 15* | *Pressure sensor upstream of compressor impeller* |

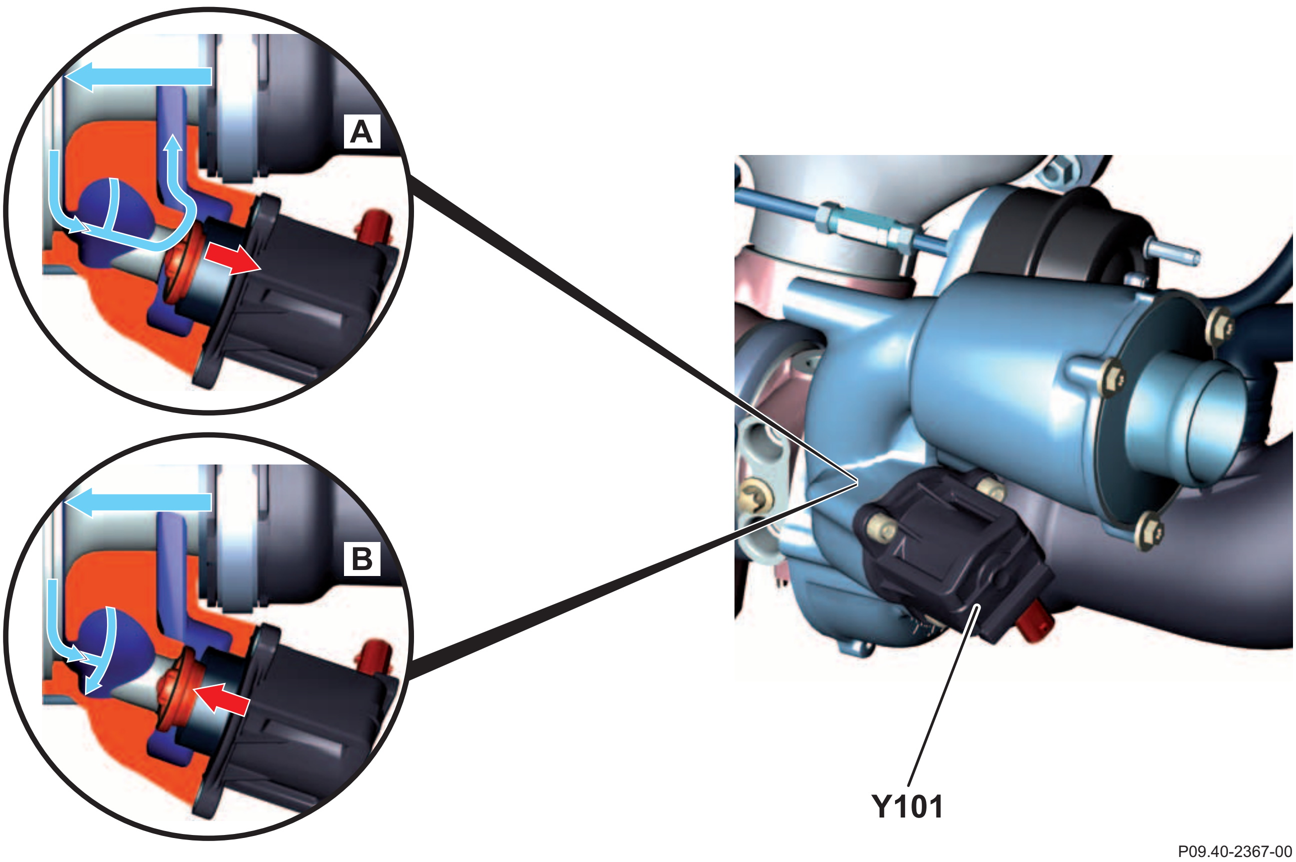
## Electric blow-off valve

Due to the inertia of the shaft, the compressor impeller and the turbine wheel, the turbocharger always spins on slightly after the vehicle starts to decelerate. Because of this, a boost pressure surge runs back to the compressor when the throttle valve actuator is closed quickly.

This boost pressure surge causes a situation at the compressor impeller where there is a low delivery volume and high pressures, which leads to so-called "turbocharger whistling" (brief howling and mechanical stress).

In order to prevent this boost pressure surge, the blow-off valve opens and quickly releases the pressure in the intake line.

When the ME-SFI control unit detects the transition from load mode to deceleration mode, it actuates the blow-off valve. The blow-off valve opens the bypass at the compressor impeller and the boost pressure is reduced. In load mode the blow-off valve is closed by an integral spring.




***Operating principle of blow-off valve***

*Y101 Blow-off valve*
*A Blow-off valve open*
*B Blow-off valve closed*

# Swirl flap control

## General

The swirl flap control changes the air ducting in the intake ports. Each cylinder has two intake ports. One of these can be closed by a swirl flap.

The swirl flap actuator motor adjusts the swirl flaps via a linkage. Four of the eight intake ports are continually closed for the purpose of "swirl generation".

For the swirl flap control the ME-SFI control unit scans the following sensors:

- Pressure sensor downstream of throttle valve
- Crankshaft Hall sensor
- Swirl flap Hall sensor

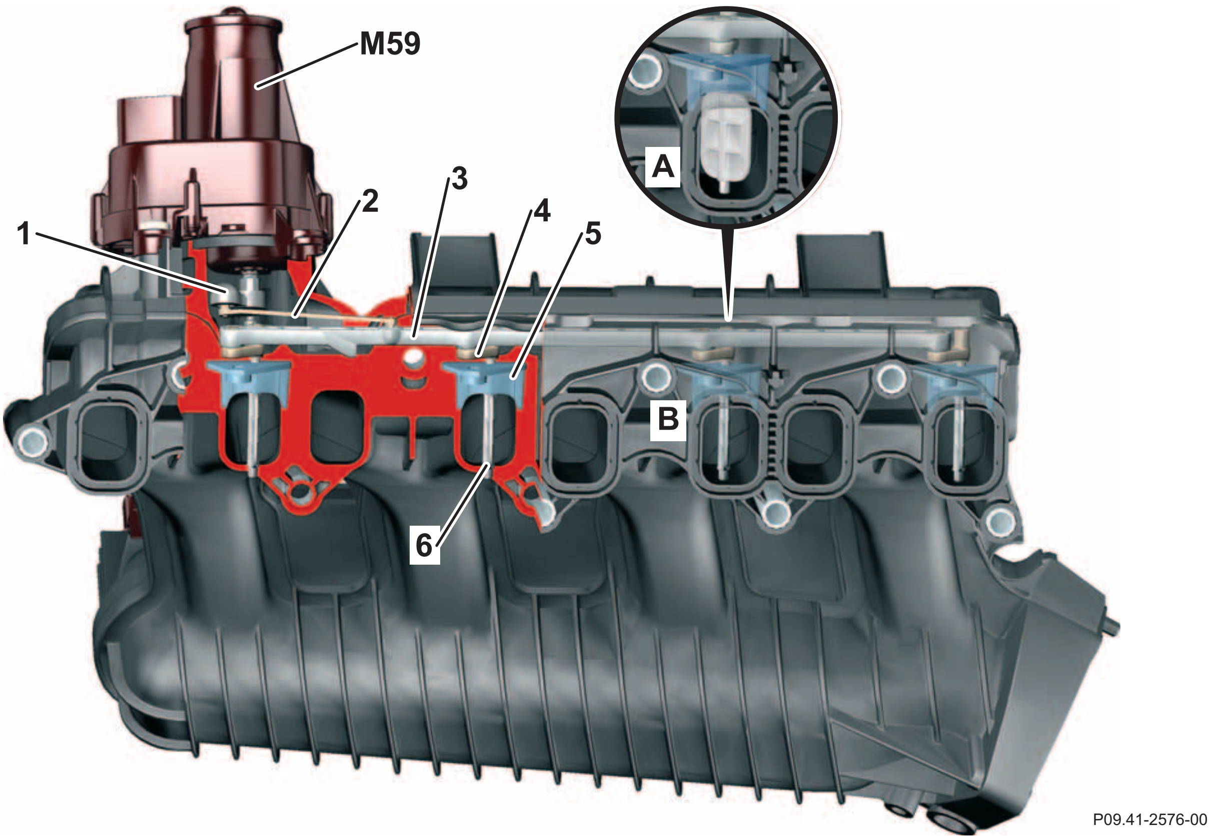
The ME-SFI control unit actuates the swirl flap actuator motor with a pulse width modulated signal according to a performance map.

The swirl flaps are adjusted particularly in the warm-up phase in order to achieve better mixture formation. At idle and at low engine speeds the swirl flaps are closed. This produces a strong swirl effect, which has a positive influence on mixture formation.

The swirl flaps are adjusted according to load and engine speed in order to produce the optimum movement of air at all times. At high engine loads the swirl flaps are fully open.

The swirl flaps are open when de-energized. This is ensured by a return spring integrated in the actuator motor.

## Swirl flap control




***Sectional view of charge air manifold***

| | |
|---|---|
| *1* | *Adjusting lever of actuator motor* |
| *2* | *Linkage of actuator motor* |
| *3* | *Adjustment shaft* |
| *4* | *Adjusting lever of swirl flap* |
| *5* | *Upper guide of swirl flap* |
| *6* | *Swirl flap* |
| *M59* | *Swirl flap actuator motor* |
| | |
| *A* | *Swirl flap closed* |
| *B* | *Swirl flap open* |

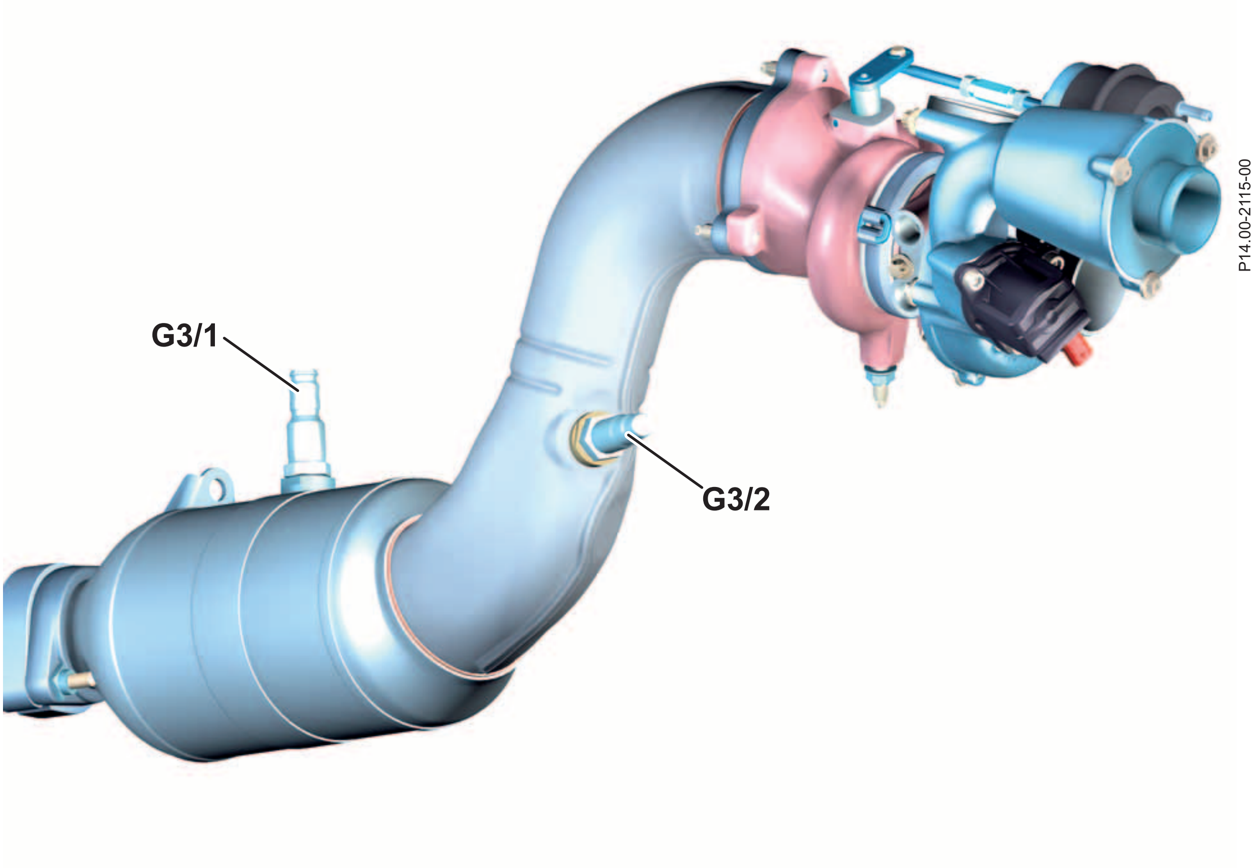
# Lambda control

## Operating principle of lambda control

The M 271 EVO operates with two lambda (oxygen) sensors. The oxygen sensor upstream of the catalytic converter measures oxygen variations in the exhaust flow. The oxygen sensor downstream of the catalytic converter measures the residual oxygen in the exhaust gas after exhaust treatment in the catalytic converter.

In order to achieve a higher exhaust conversion rate in the catalytic converters, the mixture composition is regulated within tight limits in the range of $\lambda = 1$.

The residual oxygen is an important indicator of the mixture composition. A low residual oxygen content means a lack of air; in other words a "rich" mixture. A high residual oxygen content means a surplus of air, or a "lean" mixture. If the oxygen sensor detects that the mixture is too rich, the ME-SFI control unit shortens the injection period until the mixture becomes leaner. If the mixture is too lean, the process operates in reverse.




***Lambda control***

*G3 / 1 Oxygen sensor downstream of catalytic converter*

*G3 / 2 Oxygen sensor upstream of catalytic converter*

## Oxygen sensor upstream of catalytic converter

The oxygen sensor upstream of the catalytic converter is a wideband oxygen sensor with two voltage-jump sensors.

## Oxygen sensor downstream of catalytic converter

The oxygen sensor measures the residual oxygen content in the exhaust gas for the following purposes:

- Two-sensor control
- Monitoring of catalytic converter efficiency

## Exhaust system

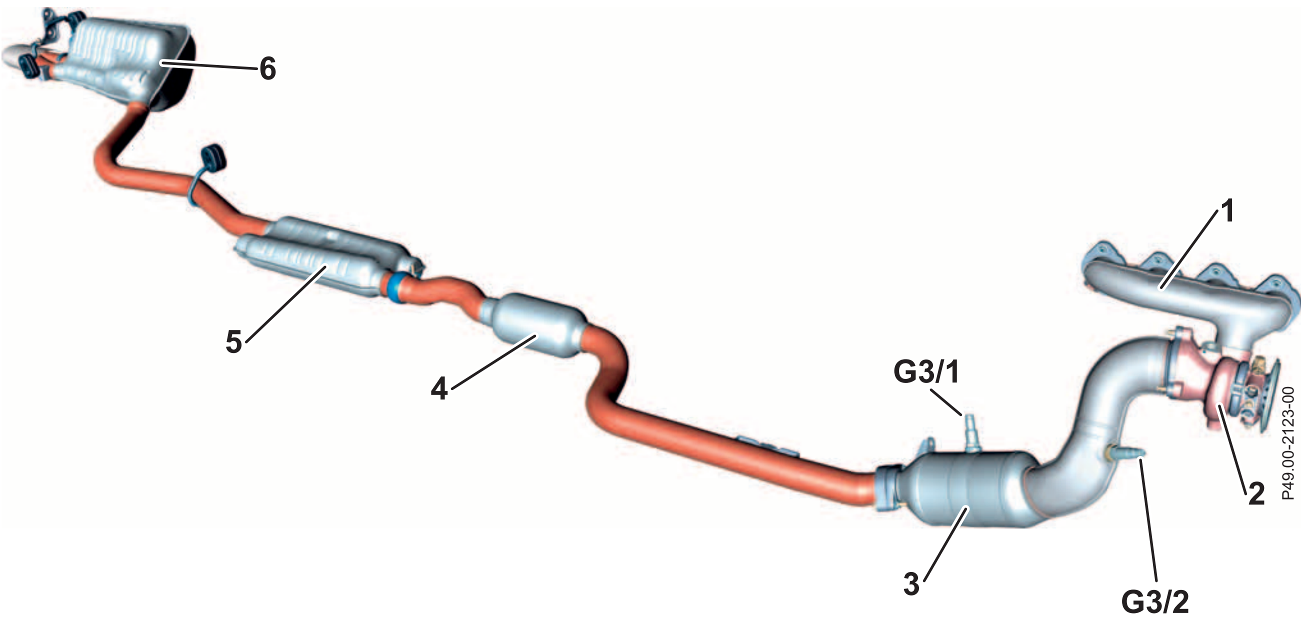
The exhaust system consists of a single-pipe system with near-engine mounted catalytic converter, underfloor catalytic converter and front and rear mufflers.

**Note**

The following Technology Guide provides an overview of the exhaust aftertreatment systems and the relevant limits imposed by the emission regulations:

Exhaust aftertreatment for current passenger car model series

Order No. 6516 1337 02




*Exhaust system*

| | |
|---|---|
| 1 | *Exhaust manifold* |
| 2 | *Turbocharger* |
| 3 | *Catalytic converter* |
| 4 | *Underfloor catalytic converter* |
| 5 | *Front muffler* |
| 6 | *Rear muffler* |
| G3 / 1 | *Oxygen sensor downstream of catalytic converter* |
| G3 / 2 | *Oxygen sensor upstream of catalytic converter* |

# Secondary air injection

## Electric secondary air injection pump

The electric secondary air injection pump adds fresh air to the exhaust in order to heat the catalytic converter to its operating temperature more quickly.

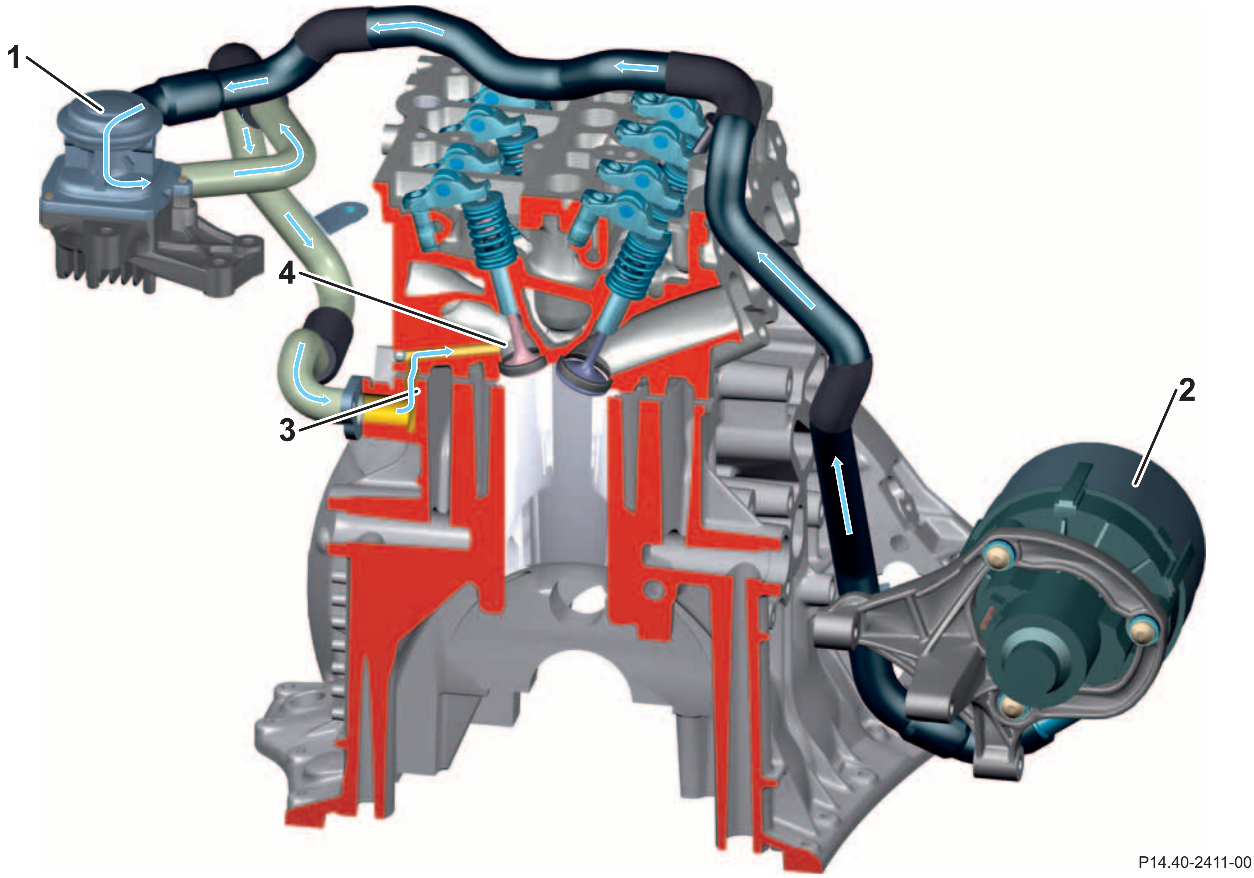
Due to air injection the hot exhaust gas is burned with the fresh air in the exhaust ports. The hydrocarbons (HC) and carbon monoxide (CO) in the exhaust react with the oxygen ($O_2$) in the fresh air to produce water ($H_2O$) and carbon dioxide ($CO_2$).

This afterburning increases the temperature of the exhaust gas and enables the catalytic converter to warm up more quickly. This improves the exhaust emission values in the engine warm-up phase.

After actuation, air injection remains disabled until the coolant reaches a temperature of over 60 °C and then drops back down below 40 °C. This allows the electric secondary air injection pump to cool down in turn.

**Note**

The secondary air injection in the M 271 EVO can be actuated via Xentry Diagnostics.




***Secondary air system***

*1 Air shutoff valve of secondary air injection pump*
*2 Secondary air injection pump*
*3 Air ducting to exhaust valve*
*4 Exhaust valve*

## Air pump switchover valve

The switchover valve actuates the air shutoff valve with vacuum from the vacuum pump to start air injection. The air line to the vacuum pump contains a check valve. This guarantees that the vacuum generated in the switchover valve is built up and maintained.

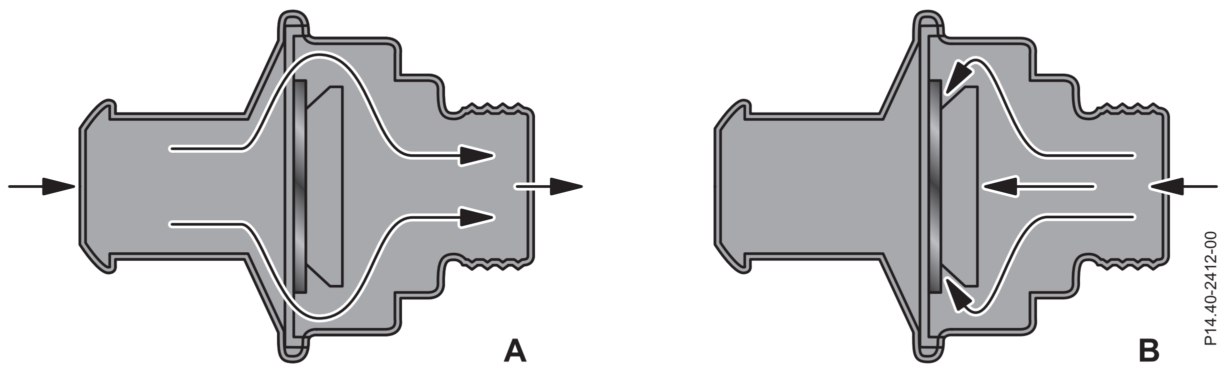
The switchover valve is actuated by a ground signal direct from the ME-SFI control unit.

## Air shutoff valve of secondary air injection pump

When actuated, the air shutoff valve enables air injection. When air injection is shut off, it prevents air from being sucked into the exhaust ports due to the exhaust flow.

The air shutoff valve is actuated with vacuum via the air pump switchover valve. The vacuum causes the diaphragm to open and the injected air from the electric secondary air injection pump can enter the exhaust ports of the cylinder head via the air shutoff valve.

The diaphragm prevents air from entering when there is no vacuum opposite the switchover valve.




***Air shutoff valve***

*A Diaphragm open*
*B Diaphragm closed*

# Engine cooling

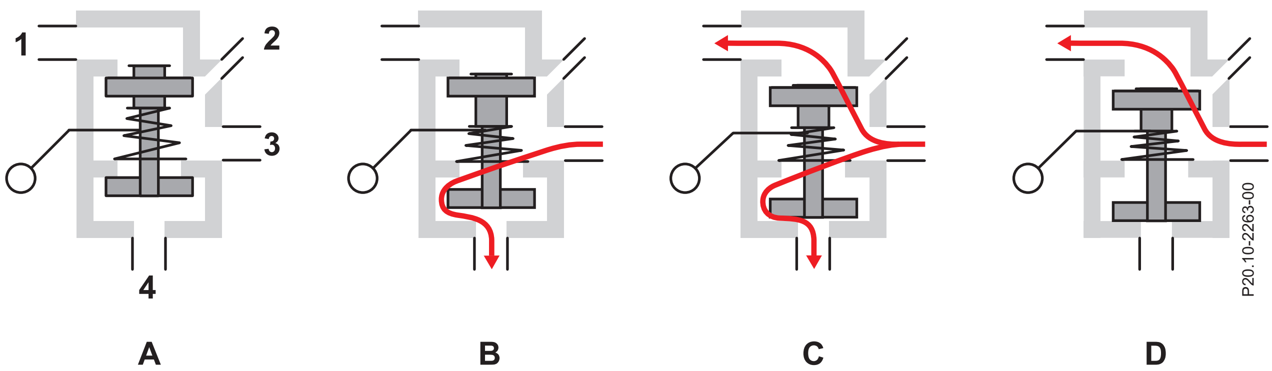
## Operating principle

In the M 271 EVO an electronically controlled two-disk thermostat with three-disk functionality ensures that the coolant temperature is controlled by a performance map.
The coolant temperature is regulated for each operating point according to requirements.

The advantages of this are as follows:

- The friction power of the engine is lower as the oil and engine temperatures are increased in parallel at partial load.
- The engine temperature is significantly reduced in the high-load range, allowing the engine to achieve greater efficiency at these operating points.

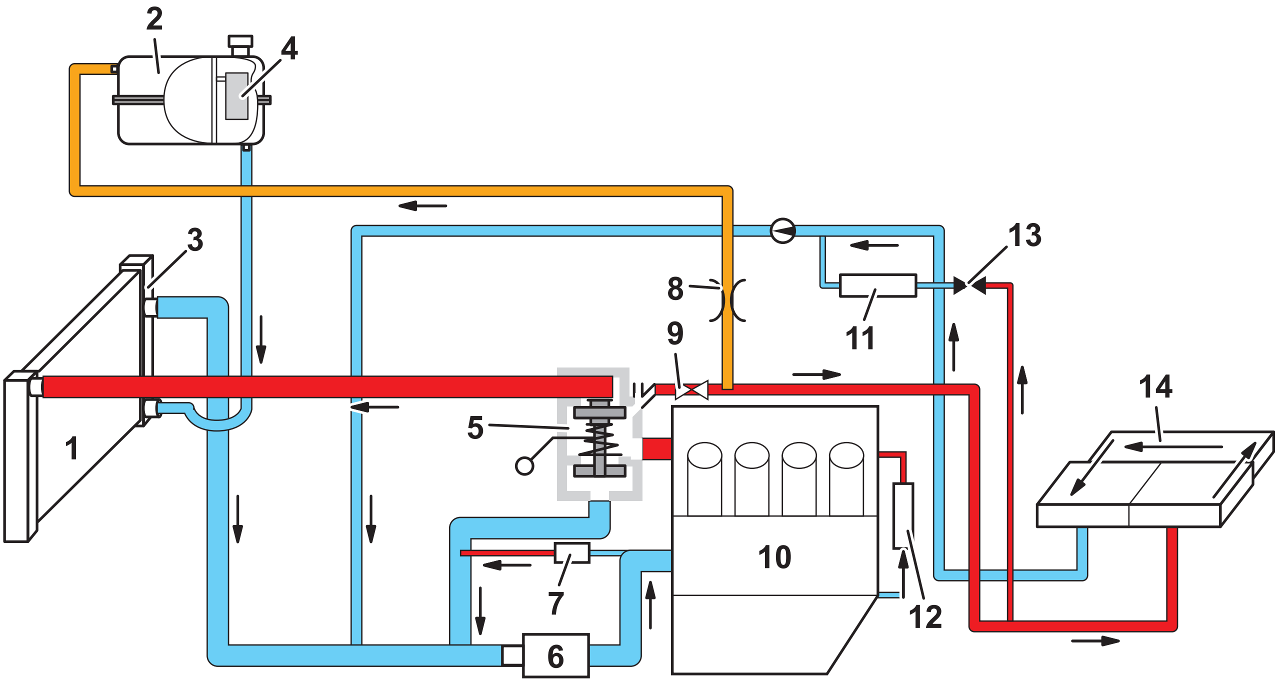
When starting from cold, there is no flow through the coolant circuit. No coolant flows through the cylinder head. This enables the combustion chambers and cylinder barrels to heat up quickly in the warm-up phase. When the coolant reaches 80 °C, the thermostat opens the bypass circuit. Only at 103 °C is the target coolant temperature reached under partial load, and the coolant is regulated to this temperature as the cooling circuit starts to open.




***Thermostat settings of the two-disk thermostat with three-disk functionality***

*1 Radiator*
*2 Heater*
*3 Engine*
*4 Bypass*

*A Full throttling: Both disks are closed when the engine is cold.*
*B Bypass mode: The bypass disk opens at a pressure differential of > 0.7 bar.*
*C Mixed mode: The main disk opens above 103 °C (deenergized) or 80 °C (energized).*
*D Cooling mode: The main disk is fully open; the bypass is closed.*

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***Overview of coolant circuit***

1 *Radiator*
2 *Expansion reservoir*
3 *Transmission cooler*
4 *Silica gel container*
5 *Two-disk thermostat with three-disk functionality*
6 *Coolant pump*
7 *Turbocharger*
8 *Throttle*
9 *Shutoff valve*
10 *Crankcase*
11 *Windshield washer fluid heater*
12 *Engine oil cooler*
13 *Duo-valve*
14 *Heater heat exchanger*

*Coolant return*
*Coolant feed*
*Breather*

# Engine cooling

## Radiator shutters

The radiator shutters control the flow of cooling air through the radiator and the engine compartment. With the reduced input of cooling air, aerodynamic drag decreases and fuel economy improves.

Controlled closing of the radiator shutters via the ME-SFI control unit reduces the amount of cooling of the engine compartment.

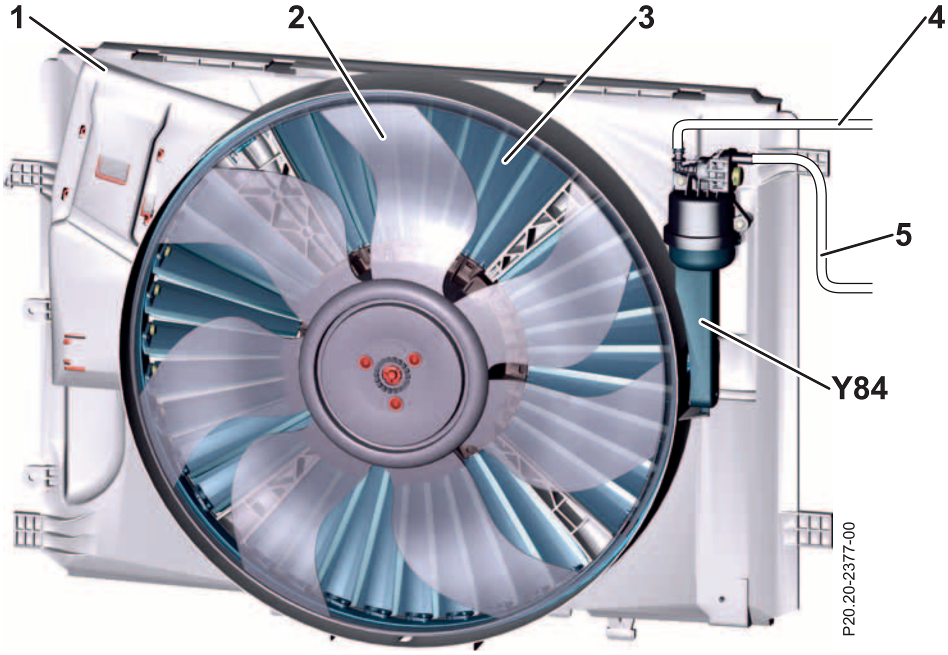
At the same time, closing the radiator shutters considerably reduces the external noise of the engine.

## Operating principle

Adjustment of the radiator shutters is activated via a vacuum unit / adjusting element on the radiator housing. An actuator controlled by the ME-SFI control unit is actuated by a ground signal from the ME-SFI control unit after engine start. The vacuum coming from the brake booster builds up in the vacuum unit / adjusting element and the radiator shutters are closed via a linkage.

**Note**

When the coolant temperature reaches 106 °C, the radiator shutters are opened via a return spring. At 98 °C they are closed again via the adjusting element.




***Radiator shutters***

1 *Radiator*
2 *Cooling fan*
3 *Radiator shutters*
4 *Vacuum line from brake booster*
5 *Signal line from ME-SFI control unit*

Y84 *Vacuum unit / adjuster element for radiator shutters (diagnosable)*

# Engine lubrication

## Regulated oil pump

The oil circuit is supplied by a regulated oil pump. It offers high displacement in a small installation space and high efficiency.

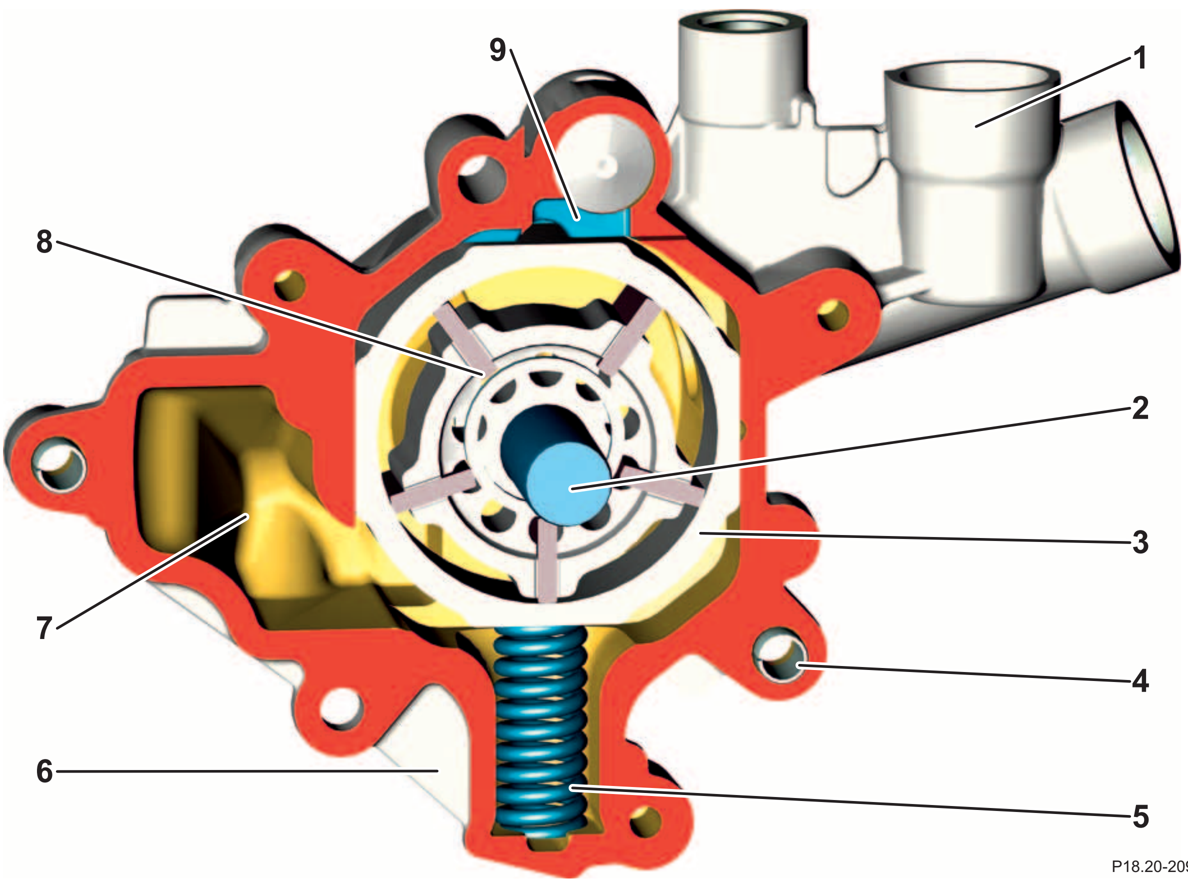
The regulated oil pump is designed as a vane-type pump. With its infinitely variable delivery rate it is able to regulate the oil pressure.

### Operating principle

The regulated oil pump is flange-mounted on the end face of the rear bearing seat of the Lanchester balancer housing and is driven by the intake-side balance shaft via a pair of gear wheels.

The oil pump is regulated on the clean-oil side. The oil is taken from the main oil duct and directed into the regulating chamber. In this regulating chamber the oil pushes against the spring-loaded set collar of the vane-type pump.

When the target pressure is reached in the main oil duct, the set collar is pushed against the spring force so that the eccentricity of the vane cell is reduced. This reduces the effective size of the oil pump and the delivery rate decreases so that the oil pressure cannot rise further.




*Regulated oil pump*

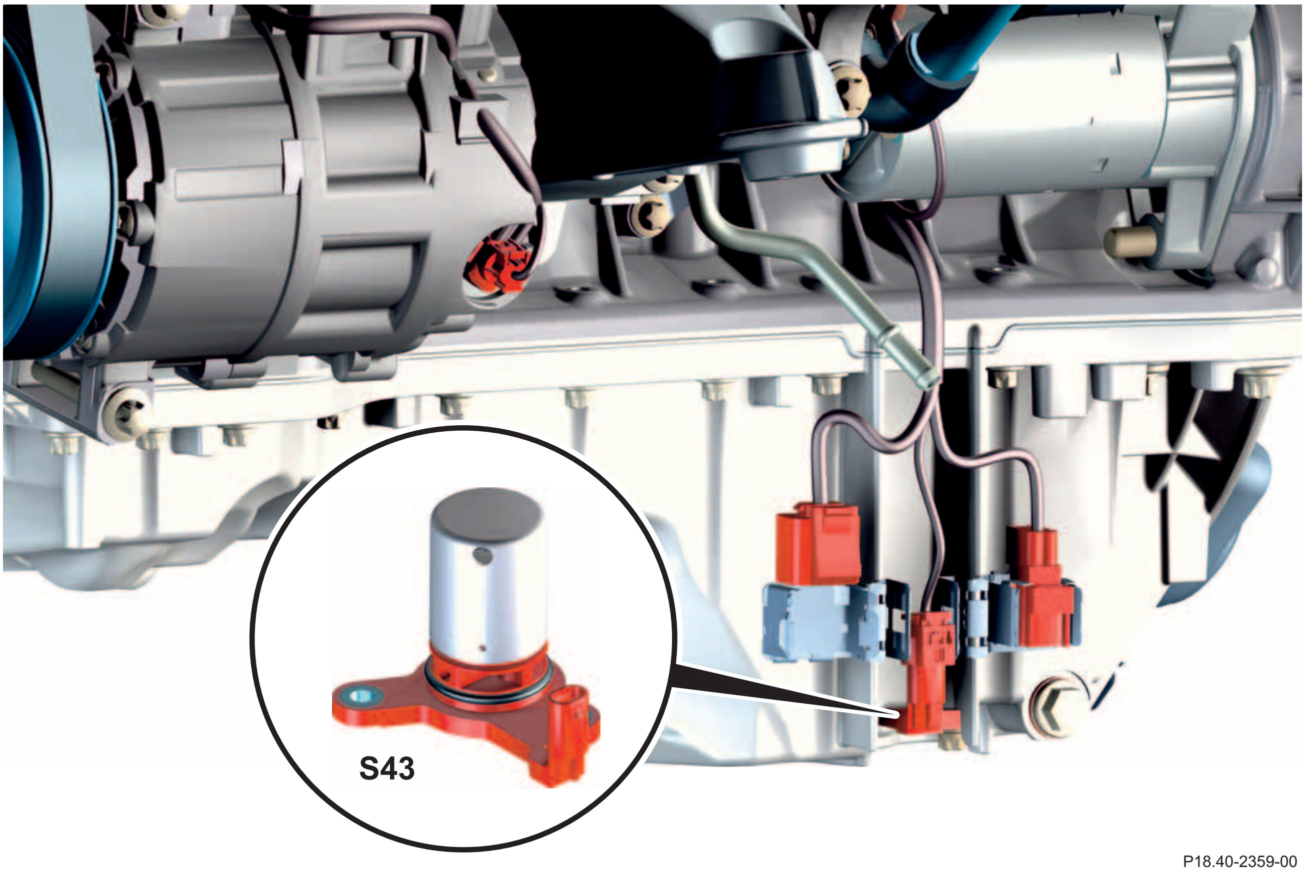
*1 Pressure-side transfer point to crankcase*
*2 Drive*
*3 Set collar*
*4 Fitting sleeve*
*5 Set collar spring*
*6 Housing*
*7 Intake duct*
*8 Vane cell*
*9 Regulating oil*

## Oil level check switch

The oil level is registered by an oil level check switch, which transmits a signal to the ME-SFI control unit when the minimum oil level is reached. This information is forwarded to the instrument cluster via CAN (Controller Area Network) so that the customer is advised to check the oil level in good time before the lubrication becomes inadequate.

**Note**

The oil level check switch is located in the bottom left-hand side of the engine oil pan at the transmission end.




***Oil level check switch***

*S43 Oil level check switch*

## Motor electronics control unit

The M 271 EVO features an advanced version of the electronic engine control SIM4KE20 of the M 271.

The expanded signals take into account the conversion to the turbocharger and the modification of the injection system for direct injection.

The control unit is integrated in the air filter on the M 271 EVO, which guarantees optimum cooling conditions.

For the change to the modified fuel injectors the hardware has been converted to high-voltage, quick-switching output stages which allow a dual injection strategy to be realized. This aids compliance with the Euro 5 standard.

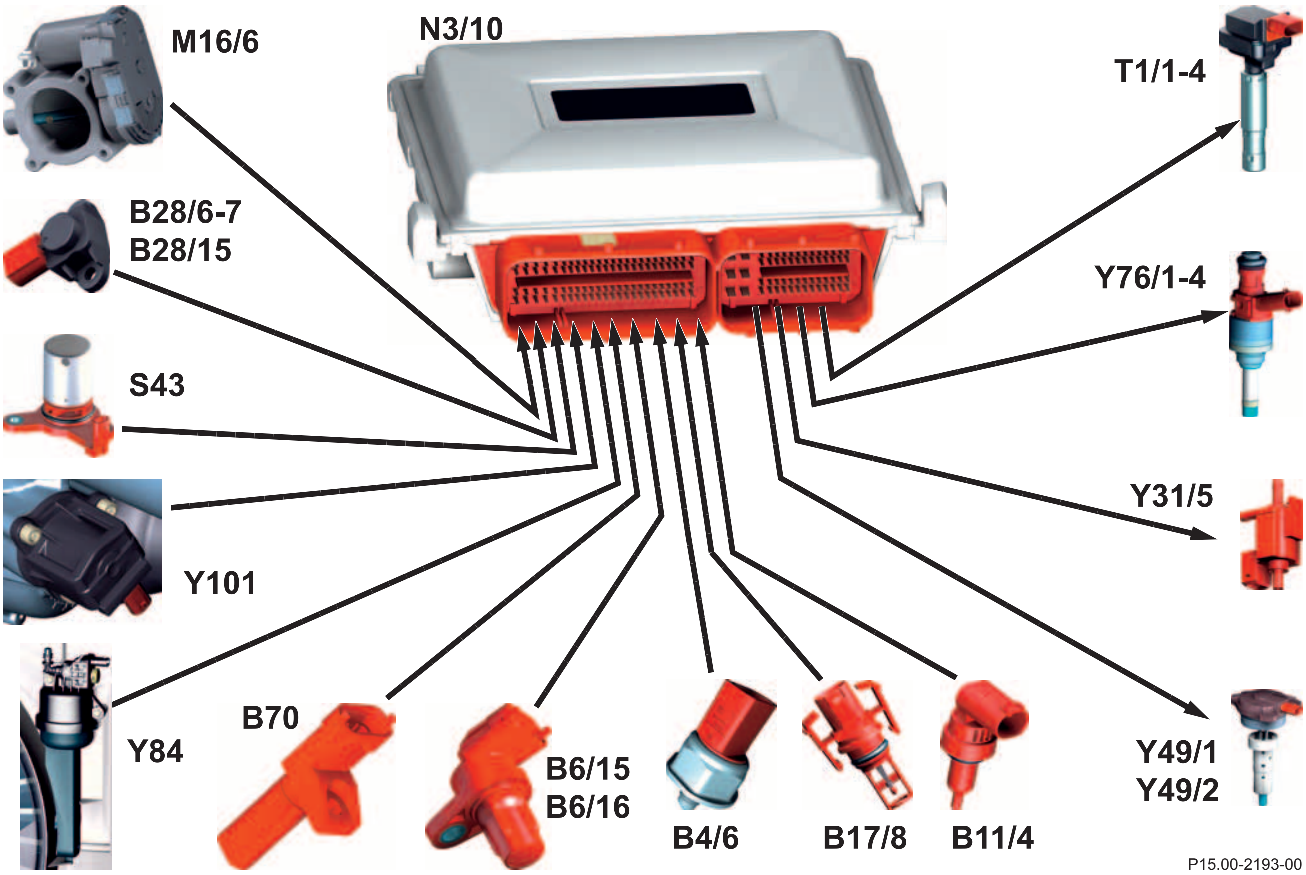
The engine control of the M 271 EVO was planned as a modular platform for a wide variety of service conditions in various different model series, countries and power variants. For this reason the engine control was designed from the very beginning as a factory-flashable control unit.

**Note**

The universal hardware is programmed with software that has been specially tailored for the customer's vehicle with the appropriate data version in a flash station on the production line itself.

**Note**

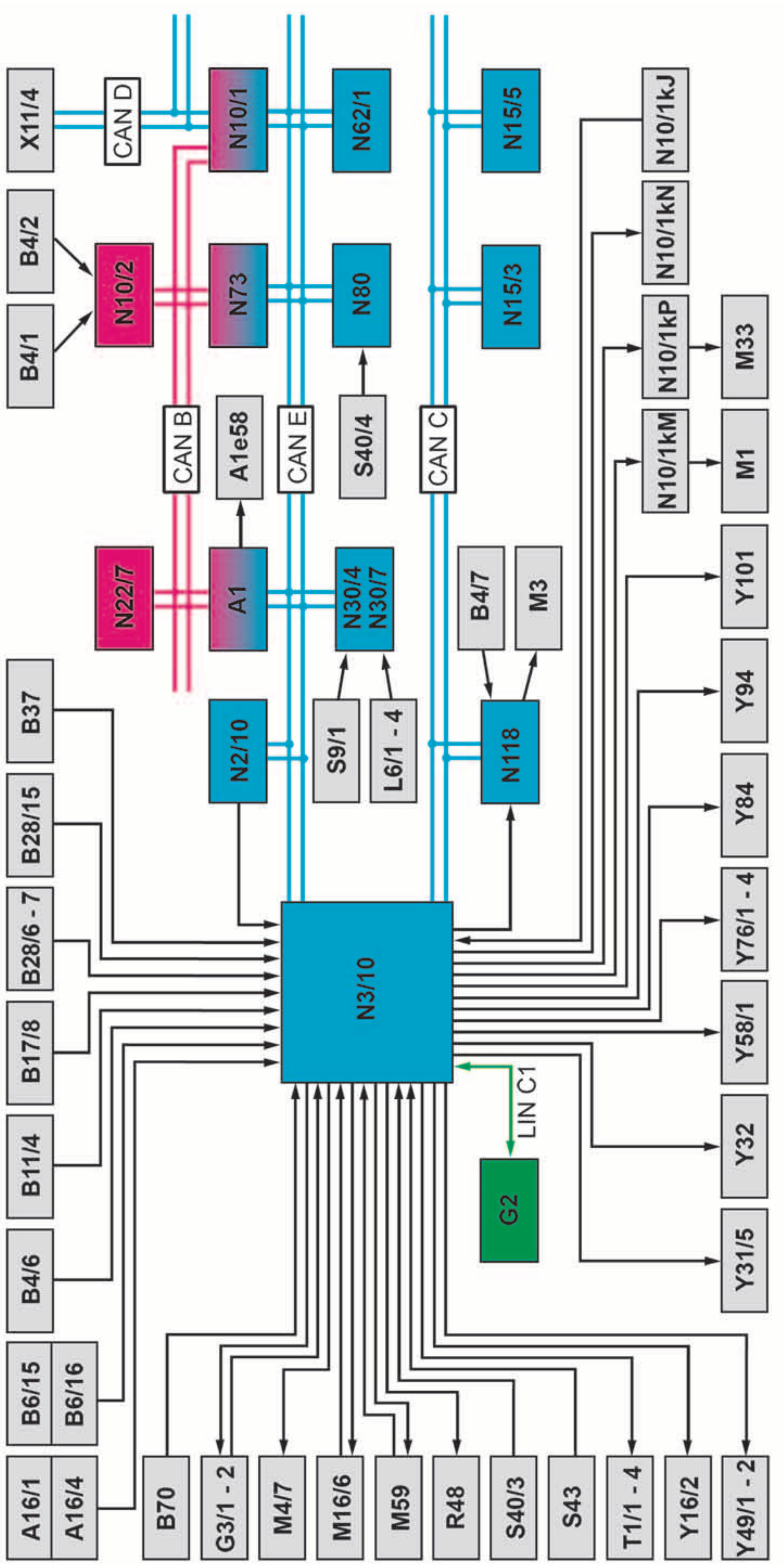
The following page provides an overview of the electronic components which are described in detail in this Introduction into Service Manual.




***Overview***

*N3/10* *ME-SFI [ME] control unit*
*M16/6* *Throttle valve actuator*
*B28/6* *Pressure sensor upstream of throttle valve*
*B28/7* *Pressure sensor downstream of throttle valve*
*B28/15* *Pressure sensor upstream of compressor impeller*
*S43* *Oil level check switch*
*Y101* *Blow-off valve*
*Y84* *Vacuum unit/adjuster element for radiator shutters (diagnosable)*
*B70* *Crankshaft Hall sensor*
*B6/15* *Intake camshaft Hall sensor*
*B6/16* *Exhaust camshaft Hall sensor*
*B4/6* *Rail pressure sensor*
*B17/8* *Charge air temperature sensor*
*B11/4* *Coolant temperature sensor*
*Y49/1* *Intake camshaft solenoid*
*Y49/2* *Exhaust camshaft solenoid*
*Y31/5* *Boost pressure control pressure transducer*
*Y76/1-4* *Fuel injector, cylinders 1-4*
*T1/1-4* *Ignition coil, cylinders 1-4*

## Motor electronics control unit




*Block diagram*

| | |
|---|---|
| A1 | Instrument cluster |
| A1e58 | Engine diagnosis indicator lamp |
| A16 / 1 | Rear knock sensor |
| A16 / 4 | Front knock sensor |
| B4 / 1 | Fuel level indicator sensor, left |
| B4 / 2 | Fuel level indicator sensor, right |
| B4 / 6 | Rail pressure sensor |
| B4 / 7 | Fuel pressure sensor |
| B6 / 15 | Intake camshaft Hall sensor |
| B6 / 16 | Exhaust camshaft Hall sensor |
| B11 / 4 | Coolant temperature sensor |
| B17 / 8 | Charge air temperature sensor |
| B28 / 6 | Pressure sensor upstream of throttle valve |
| B28 / 7 | Pressure sensor downstream of throttle valve |
| B28 / 15 | Pressure sensor upstream of compressor impeller |
| B37 | Accelerator pedal sensor |
| B70 | Crankshaft Hall sensor |
| CAN B | Interior CAN |
| CAN C | Drivetrain CAN |
| CAN D | Diagnostic CAN |
| CAN E | Chassis CAN |
| G2 | Alternator |
| G3 / 1 | Oxygen sensor downstream of catalytic converter |
| G3 / 2 | Oxygen sensor upstream of catalytic converter |
| L6 / 1 | Left front axle rpm sensor |
| L6 / 2 | Right front axle rpm sensor |
| L6 / 3 | Left rear axle rpm sensor |
| L6 / 4 | Right rear axle rpm sensor |
| LIN C1 | Drivetrain LIN |
| M1 | Starter |
| M3 | Fuel pump |
| M4 / 7 | Engine and air conditioning fan motor with integrated control |
| M16 / 6 | Throttle valve actuator |
| M33 | Electric air pump |
| M59 | Intake manifold swirl flap actuator motor |
| N2 / 10 | Supplemental restraint system control unit |
| N3 / 10 | ME-SFI [ME] control unit |
| N10 / 1 | Front SAM control unit with fuse and relay module |
| N10 / 1kJ | Circuit 15 relay |
| N10 / 1kM | Circuit 50 relay, starter |
| N10 / 1kN | Circuit 87 relay, engine |
| N10 / 1kP | Secondary air injection relay |
| N10 / 2 | Rear SAM control unit with fuse and relay module |
| N15 / 3 | Electronic transmission control control unit (with code (423) 5-speed automatic transmission (NAT)) |
| N15 / 5 | Electronic selector lever module control unit (with code (423) 5-speed automatic transmission (NAT)) |
| N22 / 7 | Automatic air conditioning control and operating unit |
| N30 / 4 | Electronic Stability Program control unit (except code (233) DISTRONIC PLUS) |
| N30 / 7 | Electronic Stability Program Premium control unit (with code (233) DISTRONIC PLUS) |
| N62 / 1 | Radar sensors control unit (with code (233) DISTRONIC PLUS) |
| N73 | Electronic ignition lock control unit |
| N80 | Steering column tube module control unit |
| N118 | Fuel pump control unit |
| R48 | Coolant thermostat heating element |
| S9 / 1 | Brake light switch |
| S40 / 3 | Clutch pedal switch (with manual transmission) |
| S40 / 4 | Cruise control lever |
| S43 | Oil level check switch |
| T1 / 1-4 | Ignition coil, cylinders 1-4 |
| X11 / 4 | Diagnostic connector |
| Y16 / 2 | Heating system shutoff valve |
| Y31 / 5 | Boost pressure control pressure transducer |
| Y32 | Air pump switchover valve |
| Y49 / 1 | Intake camshaft solenoid |
| Y49 / 2 | Exhaust camshaft solenoid |
| Y58 / 1 | Purge control valve |
| Y76 / 1-4 | Fuel injector, cylinders 1-4 |
| Y84 | Vacuum unit / adjuster element for radiator shutters (diagnosable) |
| Y94 | Quantity control valve |
| Y101 | Blow-off switchover valve |

# Ignition system

## Ignition coils

Single-spark ignition coils are used in the M 271 EVO.

Each cylinder has its own ignition coil, actuated and controlled by the ME-SFI control unit.

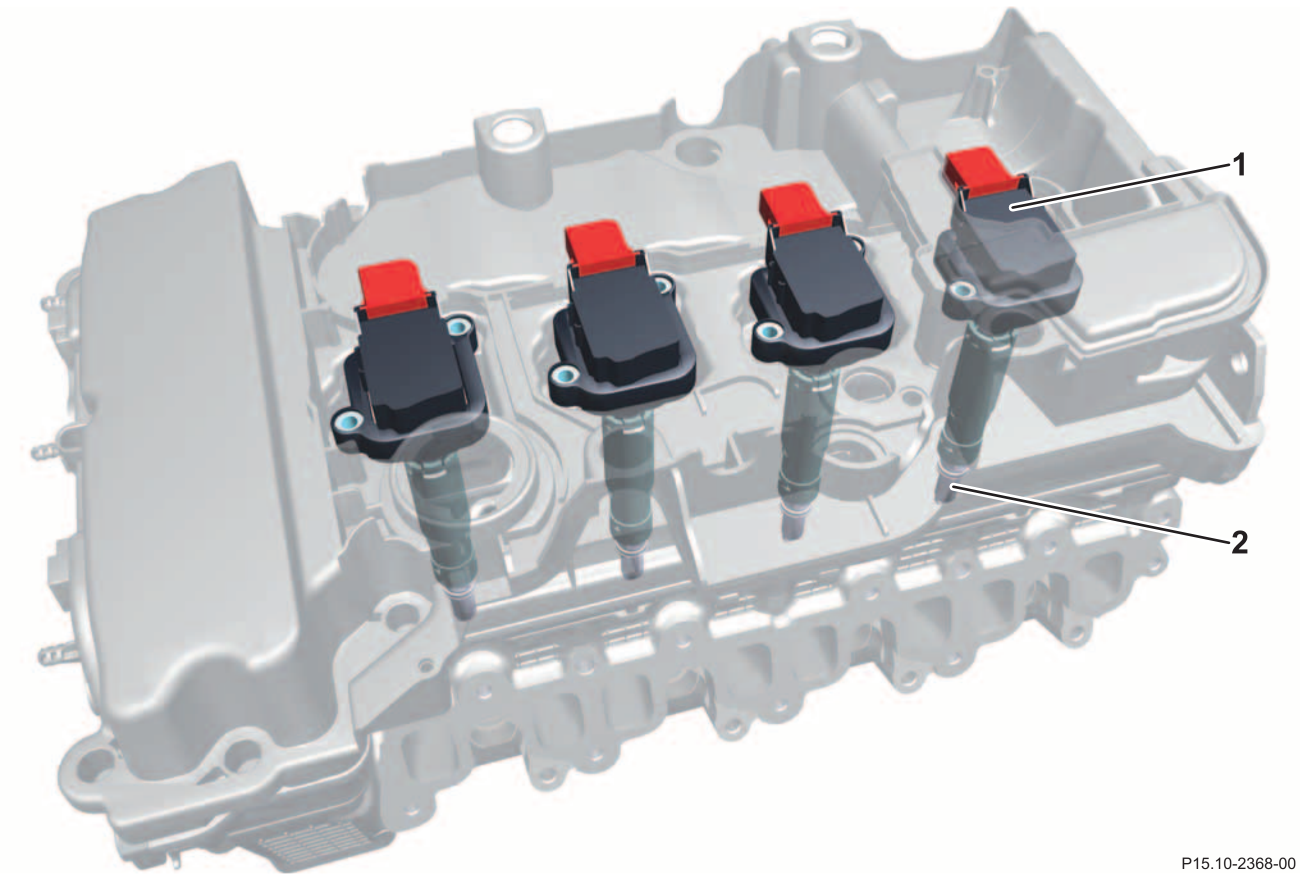
In all operating states (start-up, wide open throttle, partial load, deceleration mode) corrections can be made to the ignition angle whenever external variables (e.g. engine temperature, intake air temperature, battery voltage) make this necessary.

The ignition map is generally adjusted according to the following criteria:

- Reduction in fuel consumption
- Pollutant reduction
- Increase in torque at low rpm
- Power increase
- Improvement in engine smooth running characteristics

Additional functions integrated in the ME-SFI control unit are:

- Idle speed control
- Rpm limitation (variable)
- Knock control
- Limp-home mode
- Sensor monitoring
- Self-diagnosis




***Location of ignition coils***

*1 Ignition coil*
*2 Spark plug*

On its market launch in September 2009, the M 271 EVO will be equipped with an ECO start / stop system, initially only in combination with the manual transmission.

## Operating principle

The ECO start / stop system allows the engine to be shut off at very low speeds and while stationary provided that certain vehicle-dependent and driver-related conditions are met (autostop function).

In this way, fuel consumption is further reduced.

The starter can perform an automatic restart (autostart function) as soon as necessary. The ECO start / stop system employs a crankshaft Hall sensor with direction detection and a modified starter.

The ME-SFI control unit uses the modified crankshaft Hall sensor to detect the position of the crankshaft. This means that, when the engine is restarted, a reduced fuel quantity can be injected directly in the first cylinder in order to guarantee a rapid starting procedure, e.g. at traffic lights.

## Function requirements

In order to perform an autostop with the aid of the ECO start / stop system, the following requirements must be satisfied:

1 The engine has achieved the necessary operating parameters (e.g. the minimum required coolant temperature).
2 The following driver-related conditions are met:
- The transmission is in neutral.
- The clutch and accelerator pedal are not operated.
- The service brake is applied.
- The vehicle speed is below a limit speed.

3 The ECO start / stop system has not been switched off with the ECO button (the default after initial start-up is the ON state).
4 After a key start or e.g. maneuvering, appropriate limit speeds have been exceeded.
5 The vehicle-dependent conditions of the following systems are met:
- Air conditioning
- On-board electrical system
- Brake system
- Suspension
- Other sensor systems, such as the door locks, seat belt buckles and engine hood contacts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*ECO button with indicator lamp*

# ECO start/stop system

## Primary functions

The ECO start / stop system consists of the following primary functions:

- Engine stop function
- Engine start function
- Forced engine start

## Engine stop function

The engine is switched off by the ME-SFI control unit when the following function conditions are satisfied:

- The transmission is in neutral.
- The clutch and accelerator pedal are not operated.
- The service brake is applied.
- The vehicle speed is below a limit speed.

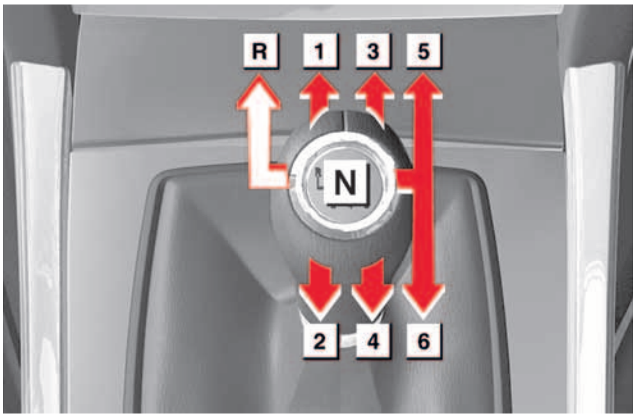
## Engine start function

An automatic engine start occurs when the engine is at autostop, i.e. the engine was switched off via the engine stop function and the circuit 15 voltage (ignition ON) is still present.

For this, one of the following function conditions must be satisfied:

- Accelerator pedal is operated.
- The clutch is operated.
- The ECO start / stop system is switched off via the ECO button.
- The vehicle speed is above a limit speed.
- A function that requires the engine to be running, such as a vehicle level increase, is activated by the driver.

To restart the engine, the ME-SFI control unit requests a restart (autostart).

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***Shift pattern in vehicles with ECO start / stop system***

### Forced engine start

Another form of automatic engine start is available as a protection function, namely the forced engine start. This requires that the drive train is open.

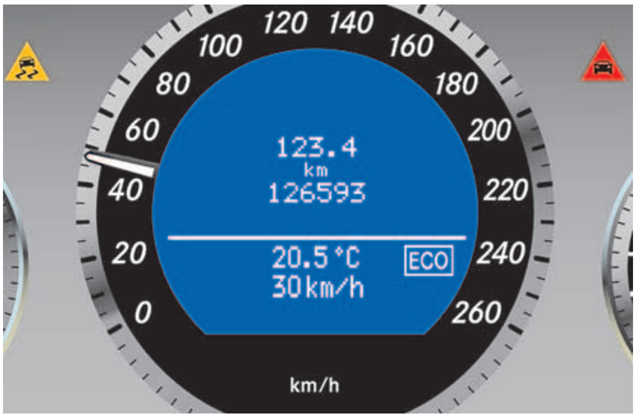
The engine is started automatically by the ME-SFI control unit without intervention from the driver when one of the following function conditions is met:

1 The driver unfastens the seat belt or opens the driver door.
2 A vehicle-related condition in one of the following systems is no longer satisfied:

- Air conditioning
- On-board electrical system
- Brake system
- Suspension
- Other sensor systems

### Instrument cluster displays

In vehicles with ECO start / stop system, additional messages are stored in the multifunction display of the instrument cluster. The ECO symbol announces the availability of the autostop function to the driver.

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*ECO symbol in multifunction display*

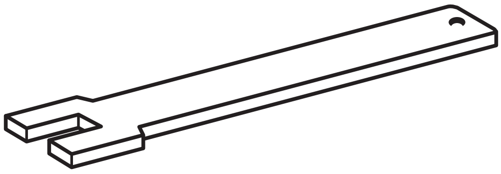
**Note**

Further details on these and other electrical systems (e.g. function descriptions and the locations of electrical components) are available in the Workshop Information System (WIS) under "Basic knowledge / functions" (GF).

# Engine

## Open end wrench

| | |
|---|---|
| **Use** | The open end wrench enables the Lanchester balancer shafts to be positioned so that the mounting bolts can be loosened and tightened. |
| **Part number** | W271 589 01 01 00 |
| **FG** | 01 |
| **Set** | C |



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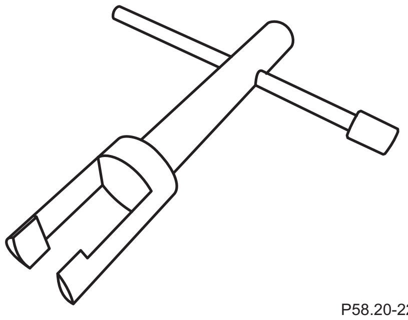
## Extractor

| | |
|---|---|
| **Use** | The extractor is used to extract seized fuel injectors. |
| **Part number** | W271 589 02 33 00 |
| **FG** | 07 |
| **Set** | B |
| **Note** | Only in combination with:<br>Impact extractor W602 589 00 33 00 |



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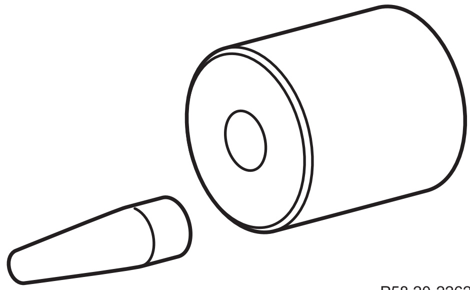
## Assembly tool

| | |
|---|---|
| **Use** | The assembly tool is used to install and calibrate the teflon ring on the fuel injector. |
| **Part number** | W271 589 01 43 00 |
| **FG** | 07 |
| **Set** | B |



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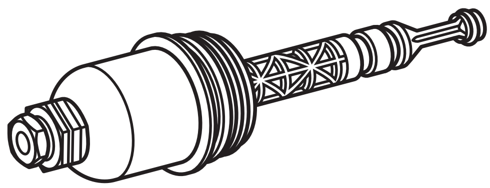
## Tester cap

| | |
|---|---|
| **Use** | The oil pressure is used to check the oil pressure at the oil filter housing insert. |
| **Part number** | W271 589 04 63 00 |
| **FG** | 18 |
| **Set** | B |
| **Note** | Only in combination with:<br>Tester W103 589 00 21 00 |

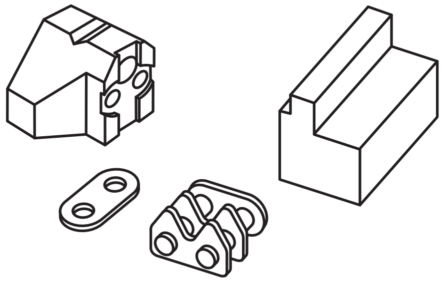


P58.20-2263-00

# Engine

## Assembly attachments

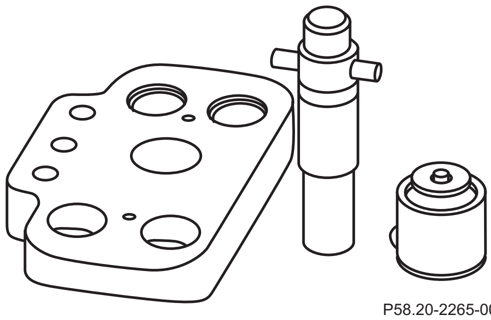
| | |
|---|---|
| **Use** | The assembly attachments are used to press on the outer tabs and to rivet the bush chain. |
| **Part number** | W271 589 05 63 00 |
| **FG** | 05 |
| **Set** | C |
| **Note** | Consisting of chain guide F13 and D16 and centering fork (2 ea.).<br>Only in combination with:<br>Riveting and assembly tool<br>W642 589 00 33 00 |



P58.20-2264-00

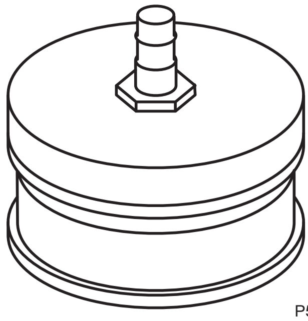
## Guide plate

| | |
|---|---|
| **Use** | The guide plate is used as a guide when pressing down the valve springs. |
| **Part number** | W271 589 06 63 00 |
| **FG** | 05 |
| **Set** | B |
| **Note** | Only in combination with:<br>Valve assembly tool kit<br>W111 589 25 61 00 |



P58.20-2265-00

| Connection adapter | |
|---|---|
| **Use** | The connection adapter is used for leak testing of the charge air system. |
| **Part number** | W271 589 01 91 00 |
| **FG** | 09 |
| **Set** | B |
| **Note** | Only in combination with:<br>Leak tester W611 589 02 21 00 |



P58.20-2266-00

# Abbreviations

**CAN**

Controller Area Network

**CO**

Carbon monoxide

**$CO_2$**

Carbon dioxide

**HC**

Hydrocarbons

**$H_2O$**

Water

**LIN**

Local interconnect network

**ME**

Motor electronics (ME-SFI)

**$O_2$**

Oxygen

**SAM**

Signal acquisition and actuation module

**WIS**

Workshop Information System