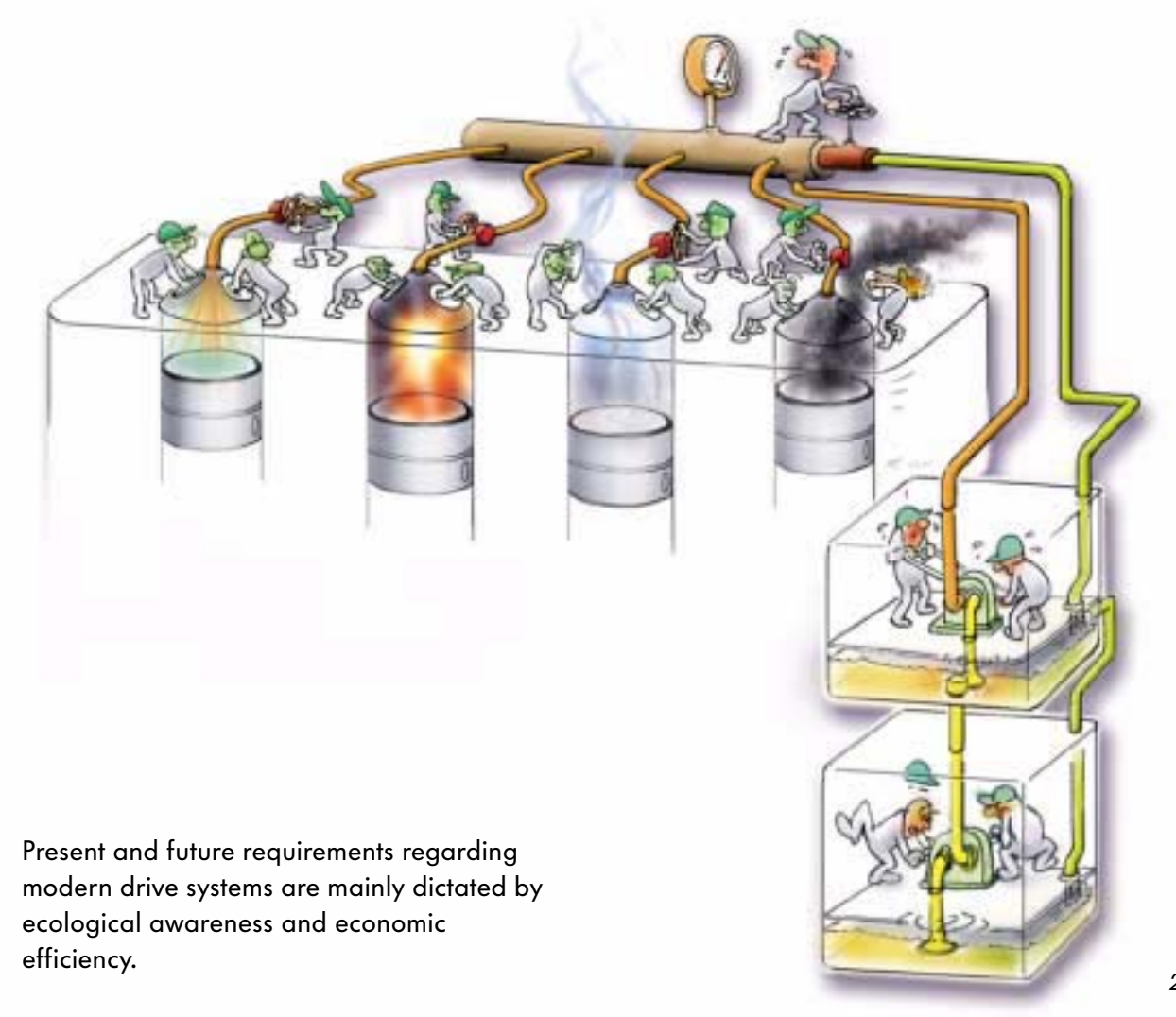
Service.

## Self-Study Programme 266

# 2.8 ltr. TDI Engine with Common Rail Injection

Design and Function

# Common Rail Injection System



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Present and future requirements regarding modern drive systems are mainly dictated by ecological awareness and economic efficiency.

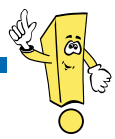
But these requirements are becoming more and more important due to the constantly growing number of diesel vehicles.

Mechanically regulated injection systems used in the past no longer meet the full requirements for low consumption, lower exhaust emissions and smooth engine running.
Now there are additional requirements such as very high injection pressures, exact injection cycles and high-precision dosing of the injected fuel.

These requirements are met by the common rail injection system which has now been fitted to the 2.8 ltr. TDI engine in the VW LT2.

This Self-Study Programme describes the system and the necessary changes to the basic engine.

**NEW**



**Important Note**

**This Self-Study Programme explains the design and function of new developments! The contents are not updated.**

Please always refer to the relevant Service Literature for all inspection, adjustment and repair instructions.

# Table of Contents

# Introduction

The 2.8 ltr. turbodiesel engine with distributor injection pump (engine codes AGK/ATA) has now been fitted with a modern common rail injection system. This has required several changes and modifications to the engine.
The engine is referred to by engine code AUH.

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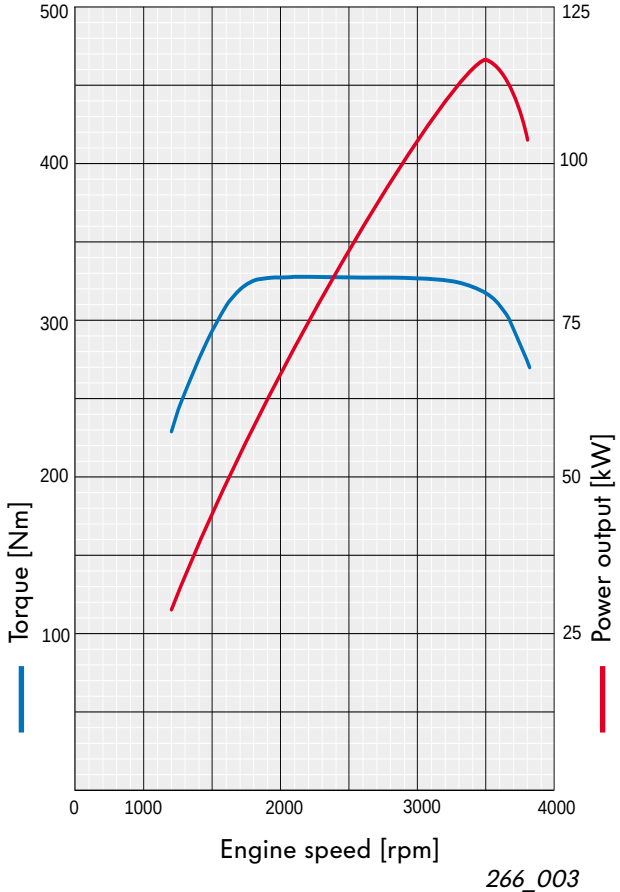
People wearing a pacemaker should not bend over the engine compartment when the engine is running since the injection valves are clocked at a rate of 100 Hz.

## Technical data

| | |
|---|---|
| Engine code | AUH |
| Type | Four-cylinder inline diesel engine with turbocharger |
| Displacement | 2798 cc |
| Maximum power output | 116 kW (158 bhp) at 3500 rpm |
| Bore | 93 mm |
| Stroke | 103 mm |
| Compression ratio | 18.5 : 1 |
| Maximum torque | 331 Nm at 1800 to 3000 rpm |
| Engine management system | Direct injection from common rail injection system with Bosch high-pressure pump CP 3.3 |
| Charge-air system | Variable turbine geometry with charge air cooling |
| Fuel | Diesel at least 49 CN or RME (Rape seed Methyl Ester = biodiesel) |
| Exhaust emission standard | EU 3 |

**Output and torque diagram**

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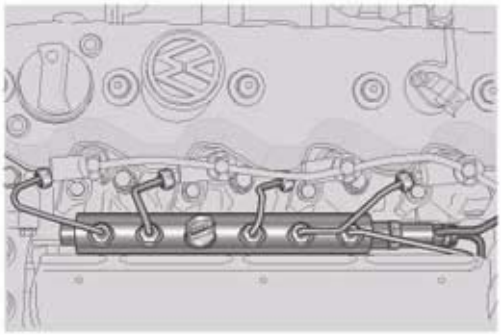
# Engine mechanicals

**Modifications compared with 2.8 ltr. TDI engine (AGK/ATA)**

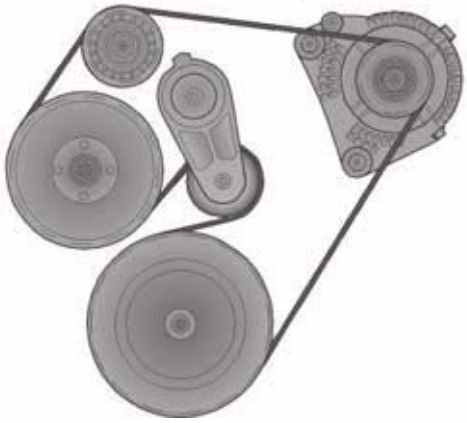
Fitting the engine with a common rail injection system has entailed the following modifications and adaptations to the previous engine.

Here is an overview of the main modifications:

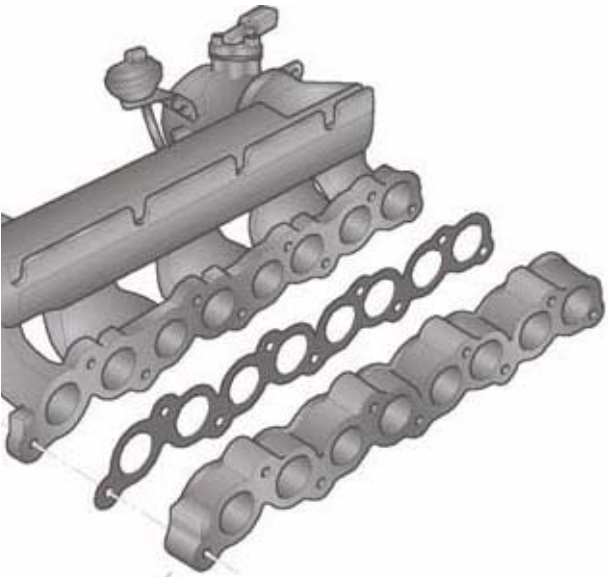


Fuel distribution via common rail

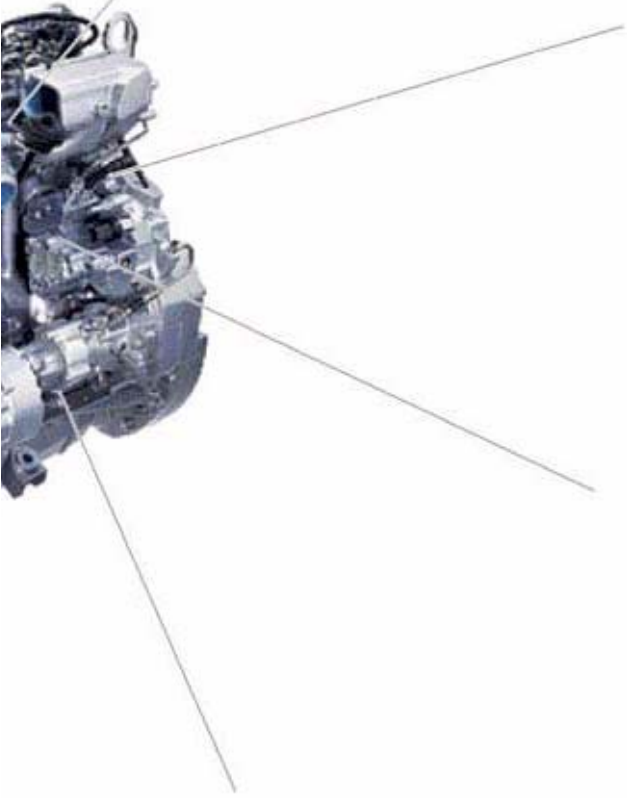
Variable turbine geometry

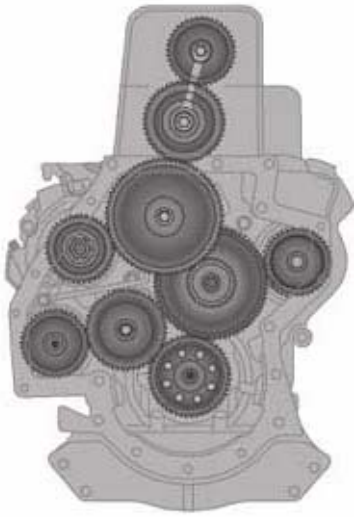


Optimised belt drive

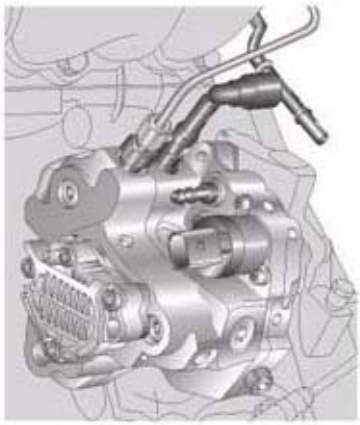


Intermediate flange between intake manifold and cylinder head

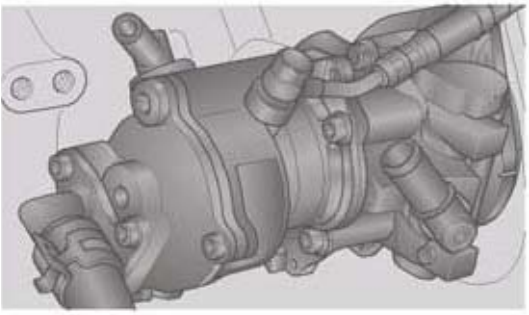




Adapted timing gear train with modified gears



High-pressure pump for the common rail injection system



Hydraulic pump and vacuum pump in common unit

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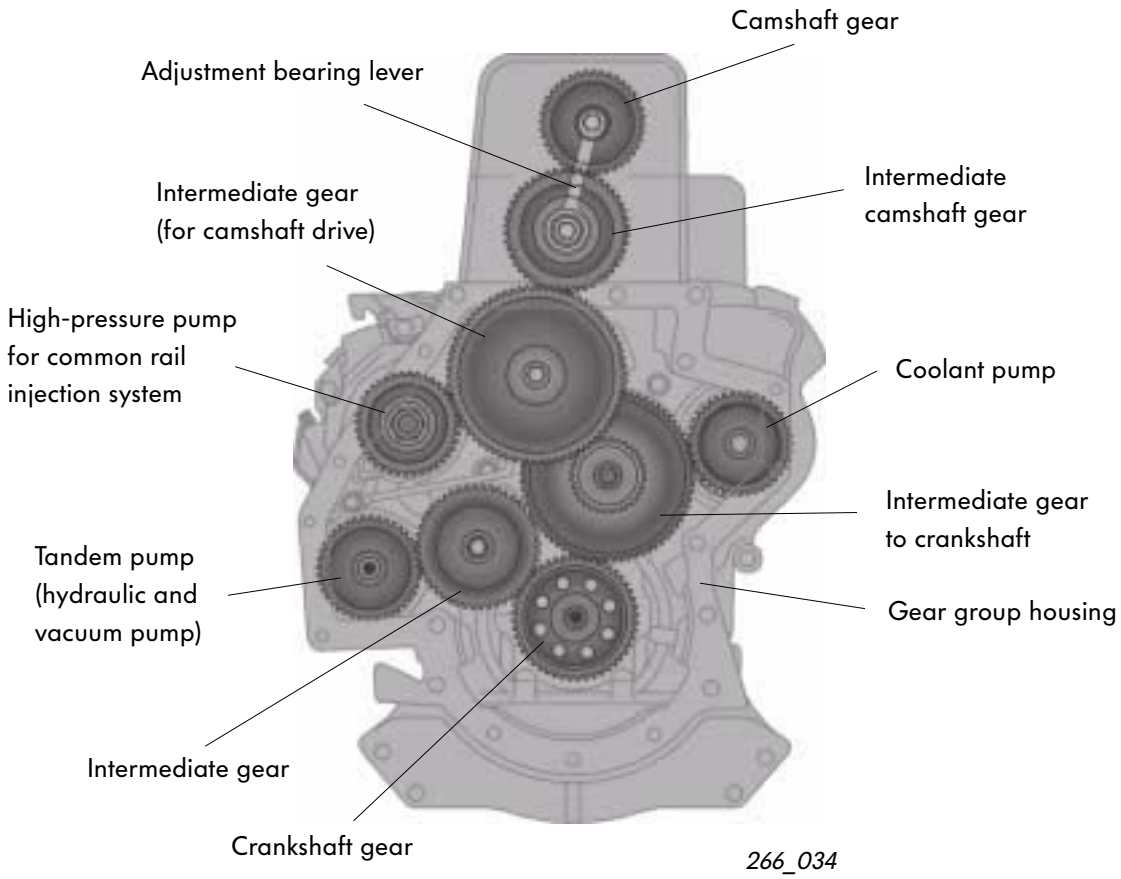
## Gear train drive

The camshaft is driven by the crankshaft via gear trains.

The coolant pump, common rail system high-pressure pump and tandem pump (hydraulic pump and vacuum pump) are also driven via gear trains.

All gear wheels are provided with 3° helical gearing.
This causes a definite reduction in axial forces compared with the preceding engine (15° helical gearing).

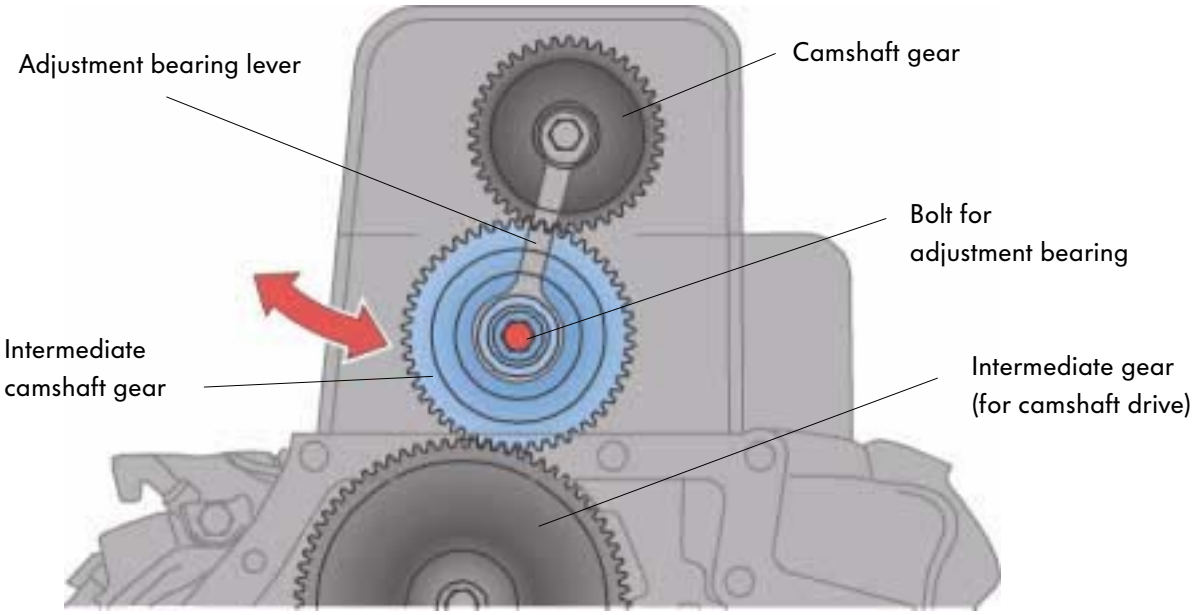



Cylinder 1 is located on the power output side as this is also the timing side of the engine.

## Gear backlash adjustment

Gear backlash in the camshaft intermediate gear is adjustable.

Backlash on all other gears can only be checked.

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If backlash needs to be checked, first check the backlash between the intermediate gear (for camshaft drive) and the intermediate camshaft gear.

Then check the backlash between the intermediate camshaft gear and the camshaft sprocket.

To adjust, first slacken the bolt on the adjustment bearing (do not remove!).

Then adjust the backlash by moving the adjustment bearing lever (see arrow) to the side.

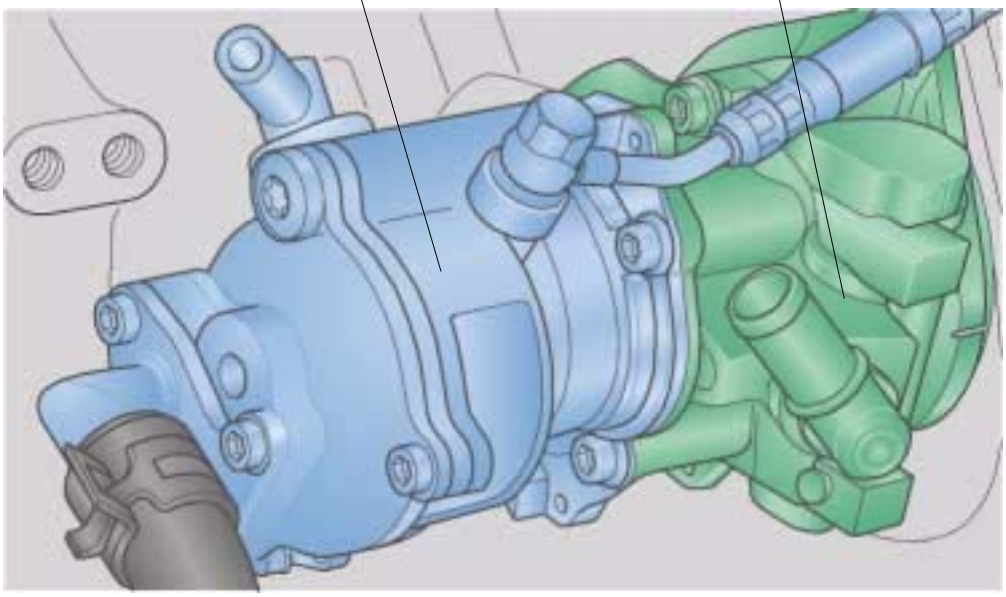
After adjustment, tighten the bolt of the adjustment bearing again.

The precise work sequence and the values for checking and adjusting the backlash are in the Workshop Manual.

## Tandem pump

The toothed belt and timing gear trains are becoming ever more complex due to the continuous increase in the number of engine auxiliary components.

This is why the vacuum pump and the power steering hydraulic pump were integrated in a single unit on the 2.8 ltr. engine with common rail injection system.



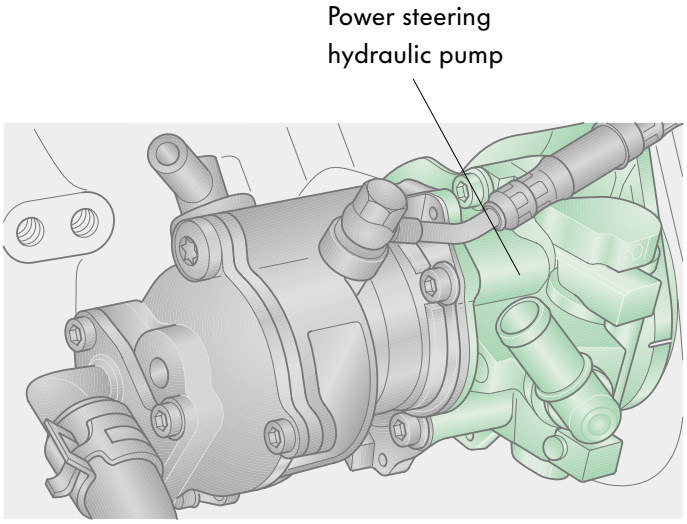

266_041

The vacuum pump and the power steering hydraulic pump are housed in a common housing.
This unit bolted to an intermediate gear of the gear train is referred to as the tandem pump.

The two pumps are driven by a common drive shaft which is driven by the engine toothed belt.

## Power steering hydraulic pump

The hydraulic pump for supplying oil under pressure to the power steering lies in the front of the tandem pump (directly after the drive gear).

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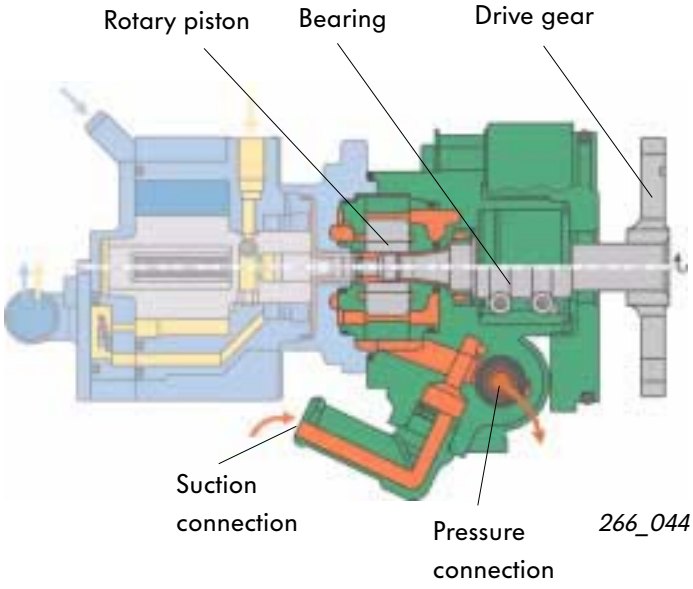
## Design

The pump consists of a rotary piston with ten moving slides.
The rotary piston is attached to the pump drive shaft.
It rotates together with the slides in a pressure chamber.
In the front part of the pump casing are supply and discharge holes which are joined to the corresponding connections by galleries.




266_044

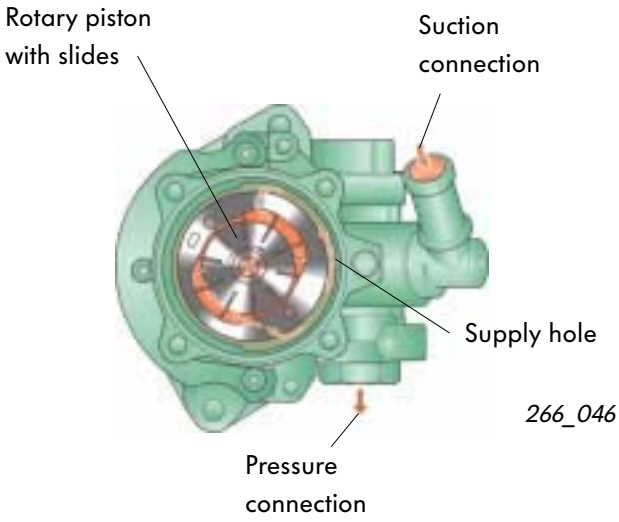
## Function

Oil flows through a supply hole to the pump interior and reaches the rotary piston via galleries.

As a result of their movement, the slides form externally pressure-tight chambers. These chambers change their size as they rotate.

As the volume of a chamber increases, a vacuum forms in the chamber and oil is drawn in. The oil then flows to the pressure side.

There the chamber volume decreases due to the shape of the pump. This builds up pressure inside the chamber. After reaching the discharge holes the oil under pressure exits the chamber and flows in the direction of the pressure connection.

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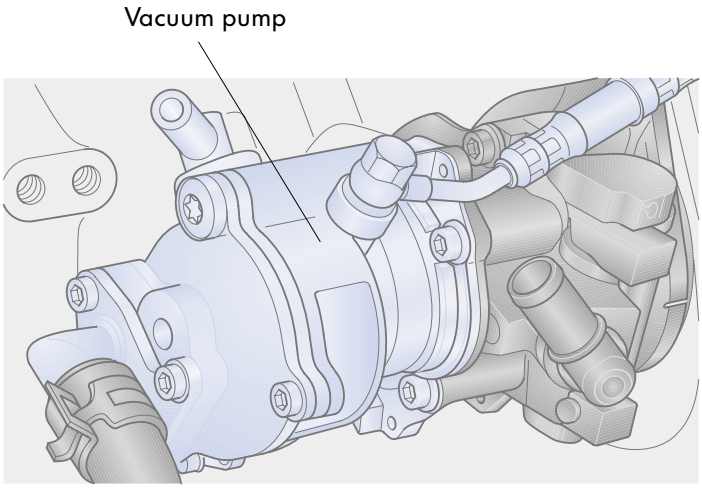
### Vacuum pump

The rear part of the tandem pump is the vacuum pump.
It generates the vacuum for the brake servo and engine control.

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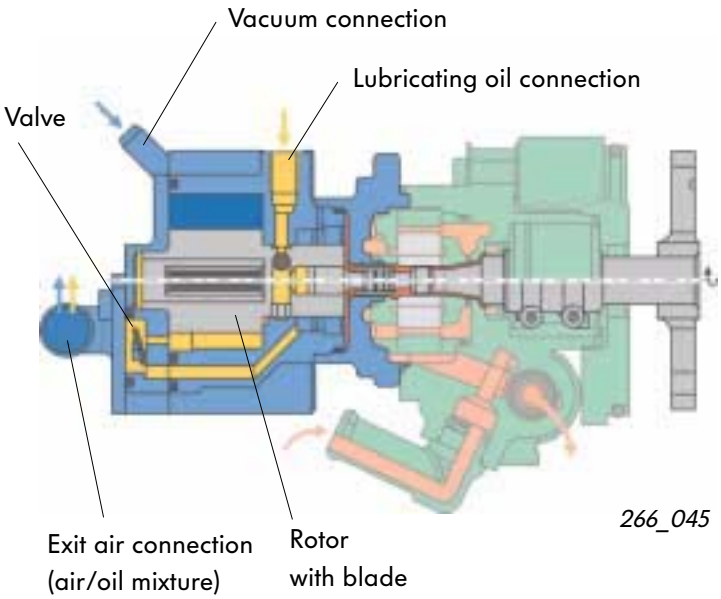
### Design

The vacuum pump comprises an offset rotor and a blade. The blade is made of plastic and is mounted in a movable bearing.
The pump shaft is lubricated by the engine oil circuit via a pressure oil connection.



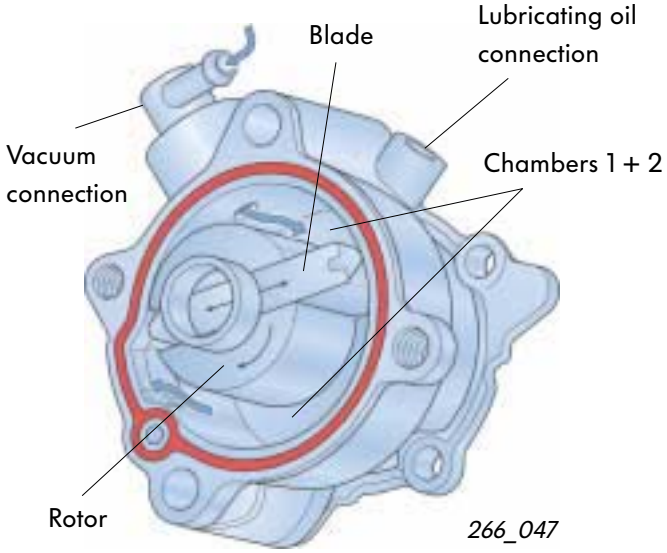

266_045

### Function

The turning motion of the rotor and the pushing movement of the blade create two chambers of different volume.
When one chamber increases in size, its volume becomes larger - the space is filled with air.

As the rotor continues to move, the chamber is closed off by the blade and the space becomes smaller again. The intake air is compressed in this way.
The air is expelled through a valve into the crankcase. At the same time, a new chamber is formed around the vacuum connection.

Lubricating oil that is no longer required is blown out together with the air into the crankcase.



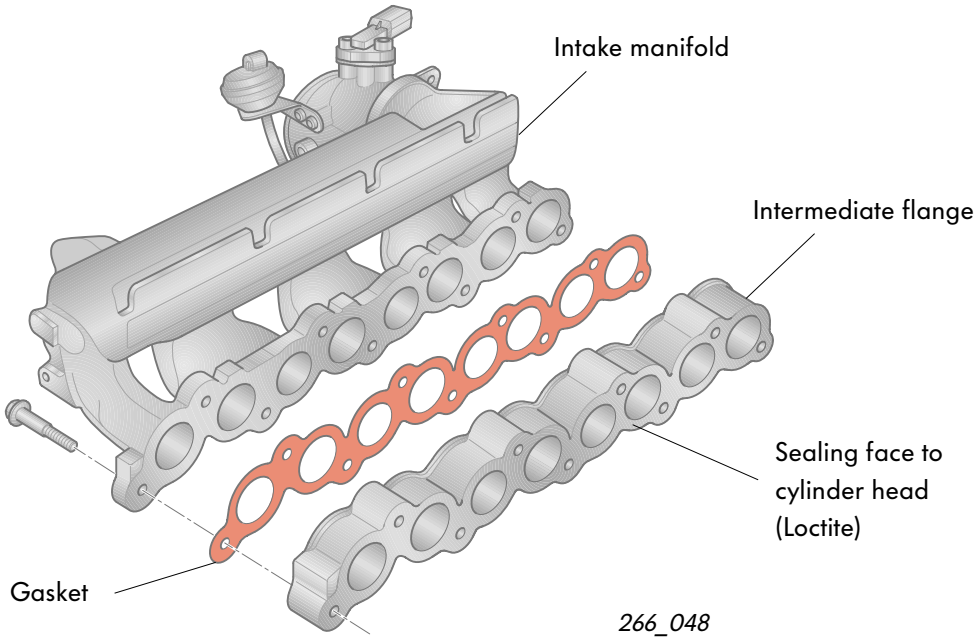

266_047

## Intermediate flange

To create the necessary construction space for the high-pressure fuel rail of the common rail injection system, an intermediate flange must be mounted between the cylinder head and the intake manifold.

The intermediate flange and the intake manifold are joined to the cylinder head by common bolts.

On the engine side, the intermediate flange is sealed by locking fluid (Loctite 5182); on the intake manifold side it is sealed by a gasket.

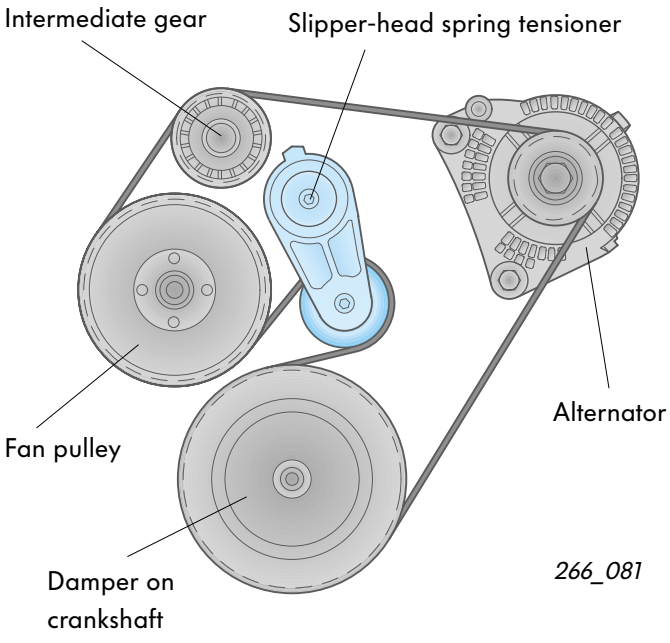



## Belt drive

Another further development is used on the engine's belt drive.

The large number of auxiliary components requires a reliable belt drive.
For this reason the previous hydraulic belt tensioner has been replaced by a new slipper-head spring tensioner.

This system achieves an optimisation of the belt drive regarding reliability and service life.



## Variable turbocharger

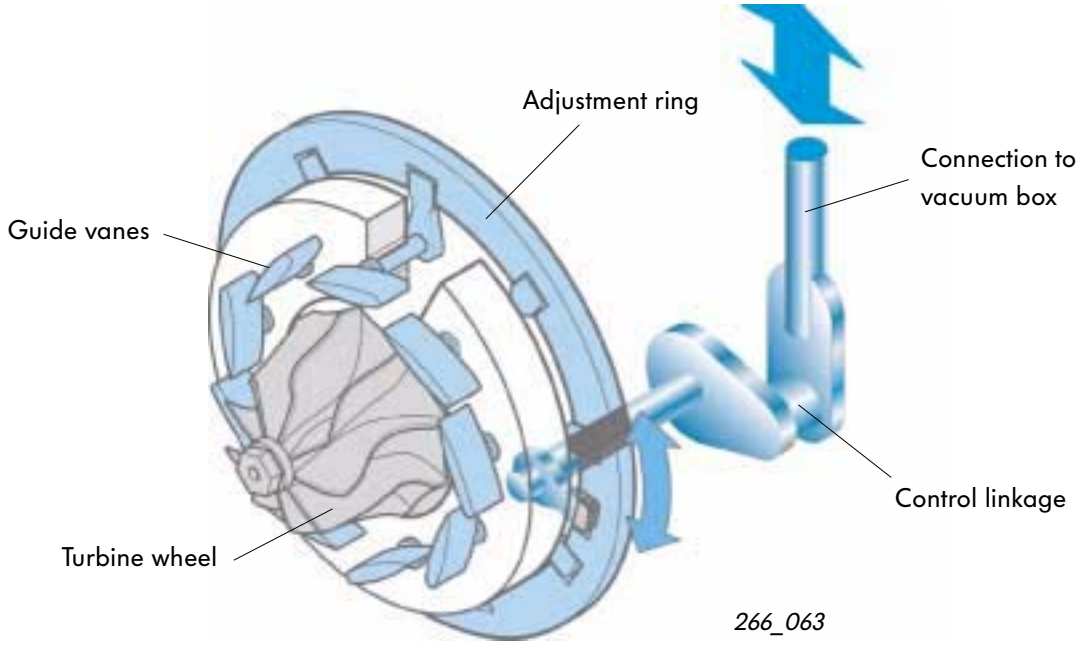
Another innovation on the 2.8 ltr. TDI engine with common rail injection system is the new exhaust gas turbocharger with variable turbine geometry.

The advantage of an exhaust gas turbocharger with variable turbine geometry is mainly that it generates an optimum charge pressure across the entire rev range and achieves therefore better combustion. In addition the exhaust gas pressure in the upper rev range is lower and better power is achievable in the lower rev range.
Due to these advantages the engine produces lower exhaust gas and fuel consumption figures than its predecessor.

266_060

The variable guide vanes arranged in a ring around the turbine wheel constantly guide the full exhaust gas flow across the turbine wheel. The adjustable guide vanes can change the direction and velocity of the gas flow. The guide vanes are adjusted by a vacuum box with a control linkage.
The vacuum box is controlled by charge pressure control solenoid valve N75.

SSP 190 "The variable turbocharger“ explains the design and function.




266_063

# Common rail injection system

## General

The common rail injection system is a high-pressure injection system for diesel engines. It is normally referred to as a common rail injection system.

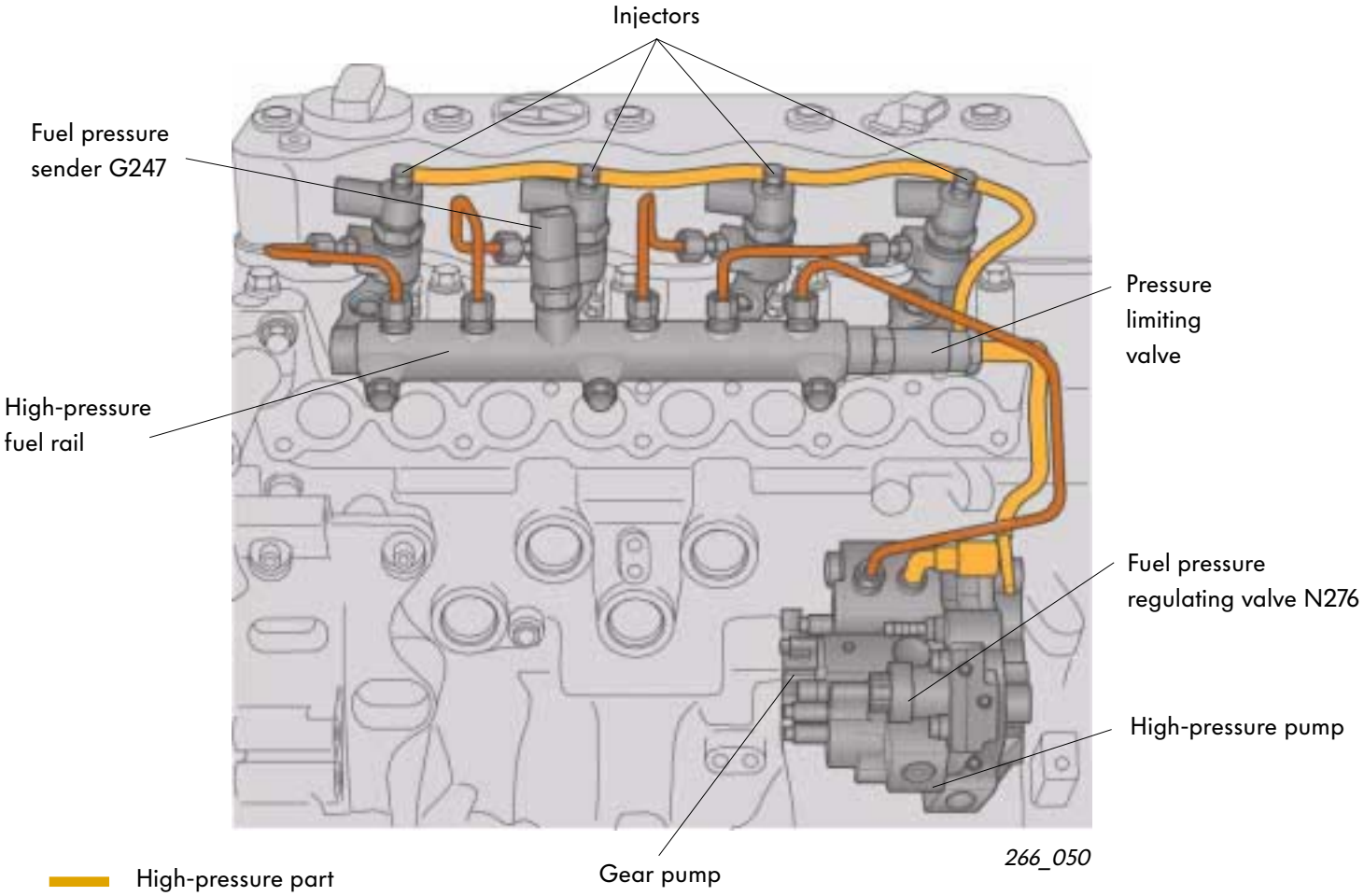
The term "Common Rail" means a common high-pressure fuel rail for all injectors.

Pressure generation and fuel injection are separate in the common rail injection system.

A separate high-pressure pump generates the high pressure required for injection.
The pressure is stored in an accumulator and is delivered to the injectors via short injection lines.

The advantages of the common rail injection system are:

- the injection pressure is almost freely selectable from the map
- the high injection pressure range at low engine speeds and in part-throttle range
- the flexible start of fuel injection with pre- and main injection cycles

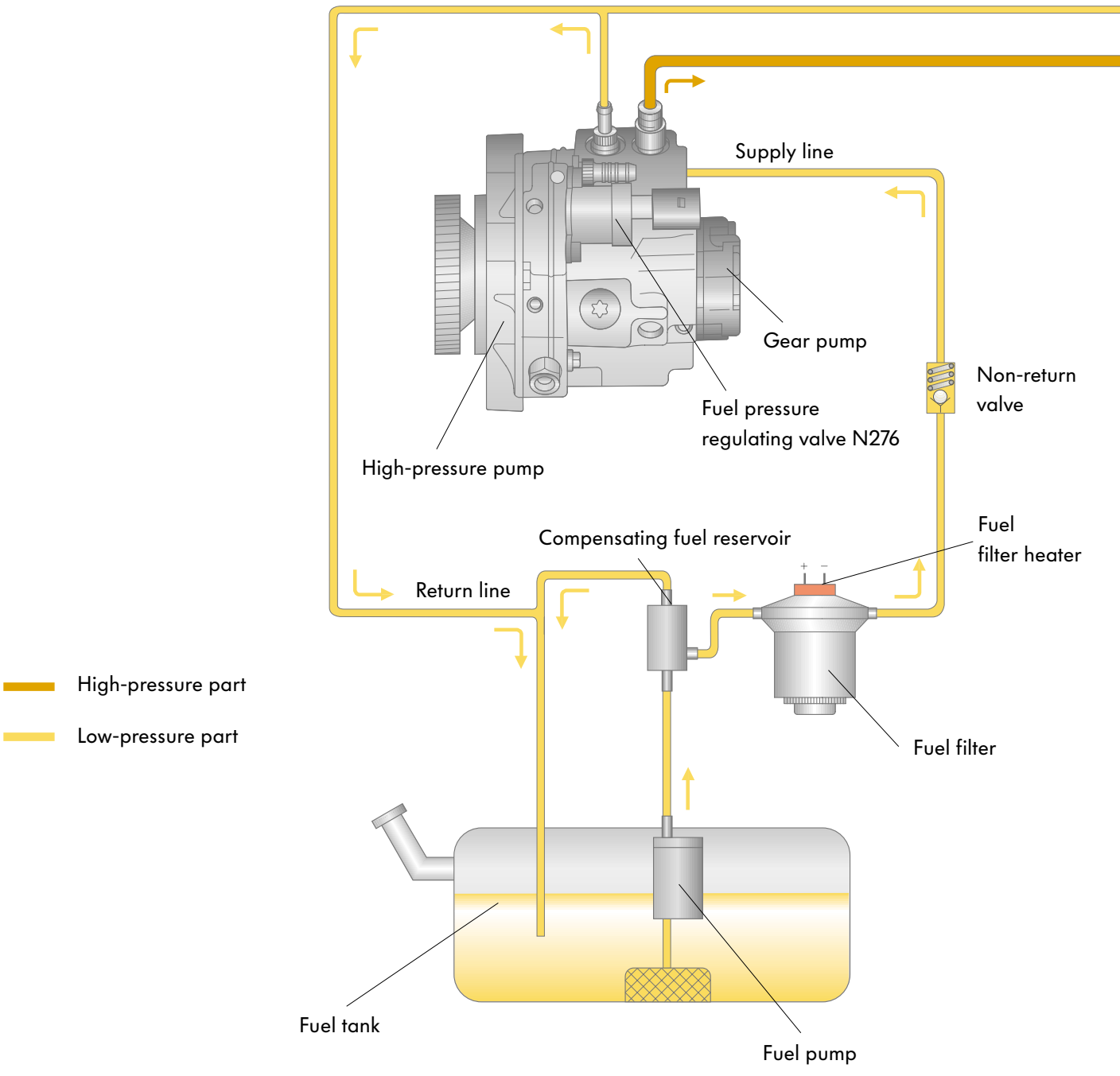


# Common rail injection system

## Fuel system

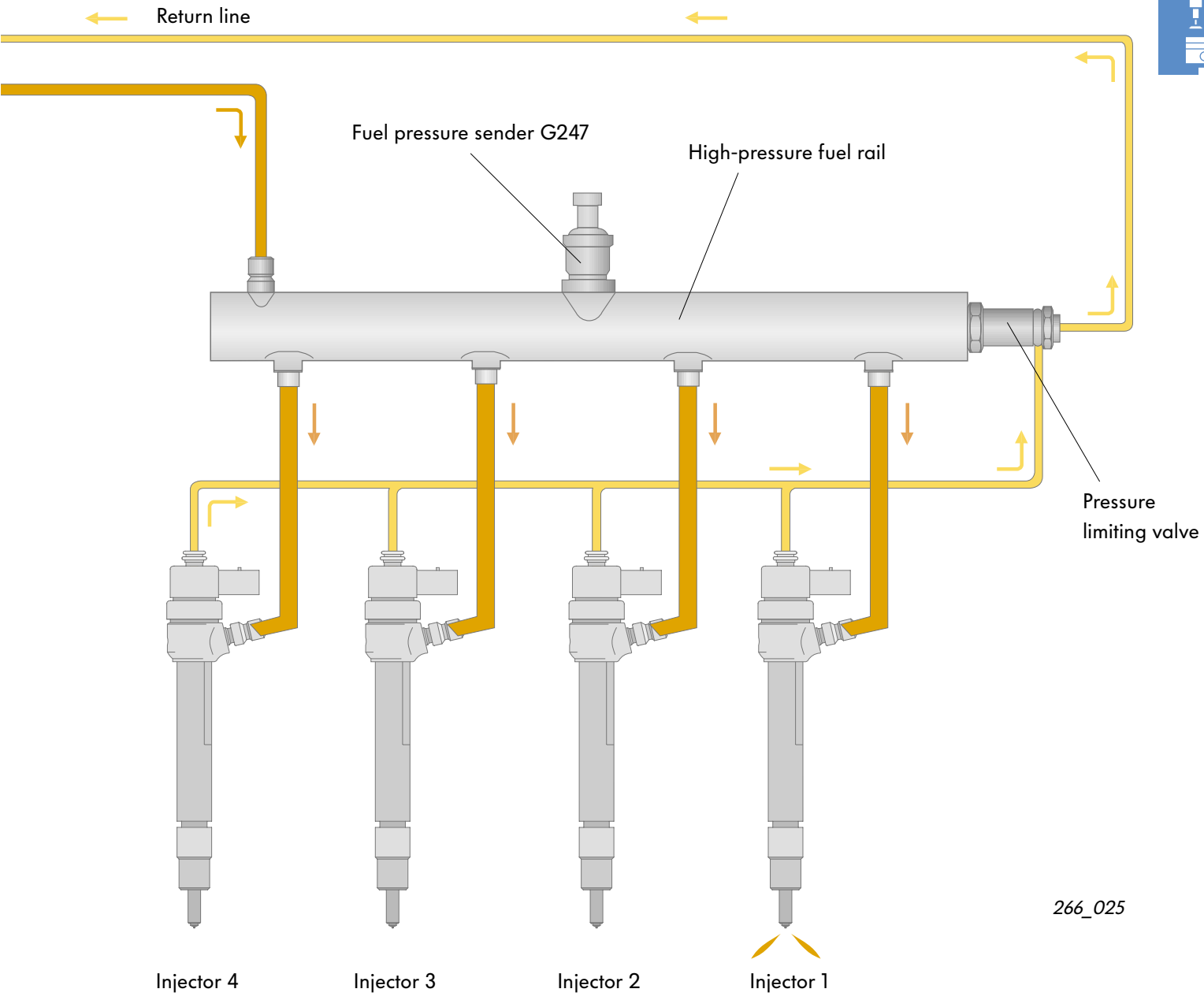
The fuel delivery system is divided into two parts:

- the low-pressure part
  comprising the fuel pump in the fuel tank, the compensating fuel reservoir, the fuel filter and the gear pump and ...
- the high-pressure part
  comprising the high-pressure pump, the high-pressure fuel rail, the injectors and the pressure limiting valve.



In the low-pressure part, fuel is conveyed by the fuel pump and the gear pump from the fuel tank via the compensating fuel reservoir to the high-pressure pump.

This is where the high pressure is generated for the fuel injection process and stored in the high-pressure fuel rail.
The fuel flows from the high-pressure fuel rail to the injectors which then inject the fuel into the combustion chambers.

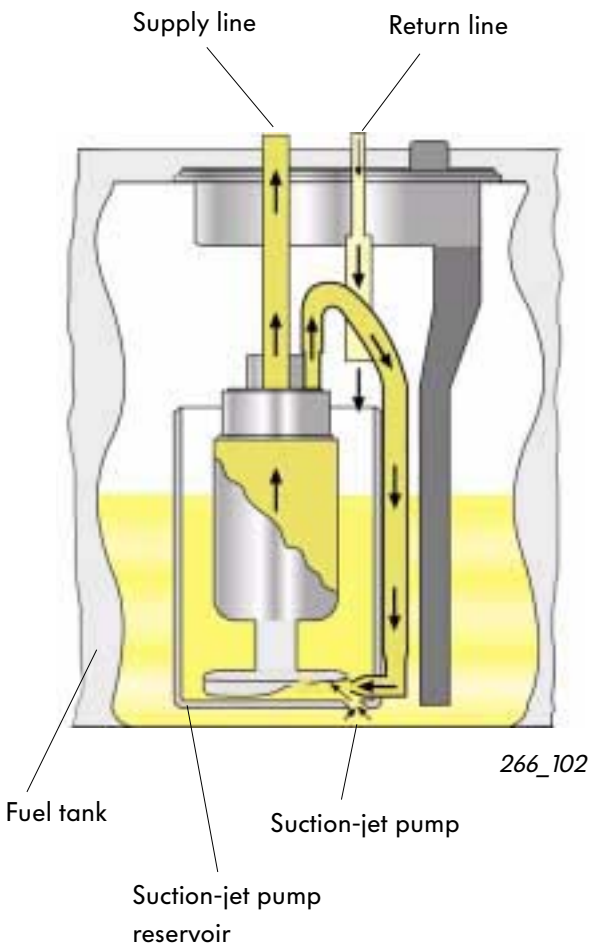


# Common rail injection system

## Fuel delivery system

### Fuel pump G6

The fuel pump is located in the fuel tank.
It operates as a pre-supply pump and supplies sufficient fuel in all operating conditions to the gear pump integrated in the high-pressure pump.




### Function

When the ignition is switched on, the fuel pump is activated by the diesel direct injection system control unit via the fuel pump relay.
The pump runs for about 3 seconds and builds up a preliminary pressure.
As soon as the engine is running, the pump continuously supplies fuel to the low-pressure part.

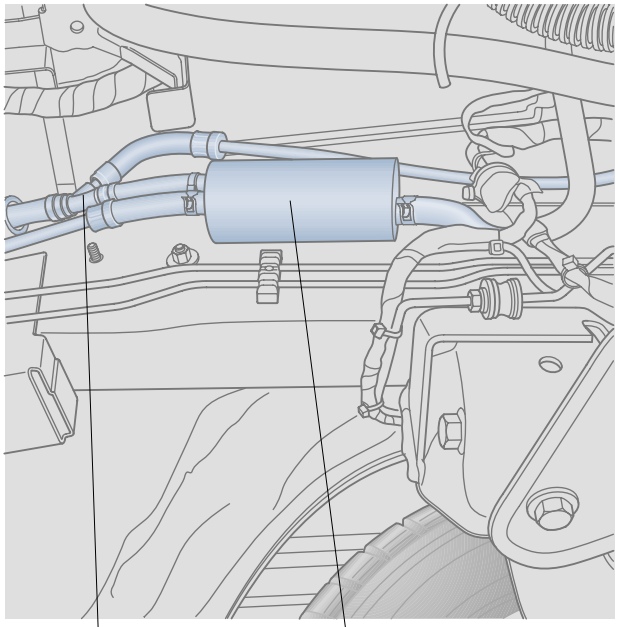
The fuel pump draws in fuel from the fuel tank via a filter.
The conveyed fuel is divided in the pump lid.

Part of the fuel runs in the supply line to the gear pump, the other part goes to drive the suction-jet pump.
The suction-jet pump extracts the fuel from the fuel tank and conveys it to the fuel pump reservoir.

## Compensating fuel reservoir

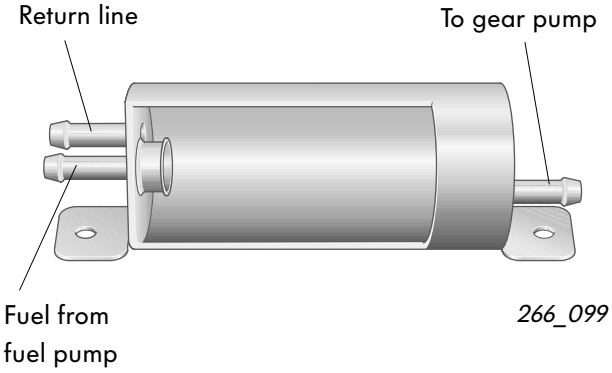
The fuel conveyed by the fuel pump is pumped to the compensating fuel reservoir.
From there it runs to the gear pump.

The compensating fuel reservoir ensures that the fuel pressure upstream of the gear pump remains almost constant in any operating condition.




## Function

The fuel conveyed by the fuel pump is pumped to the compensating fuel reservoir.
From there it runs to the gear pump.
In order to compensate for pressure fluctuations, the compensating fuel reservoir receives excess fuel from the fuel return line via a T-piece.
In the T-piece, fuel flowing back from the engine mixes with fuel from the return line of the compensating fuel reservoir.
This cools the fuel flowing back to the fuel tank.



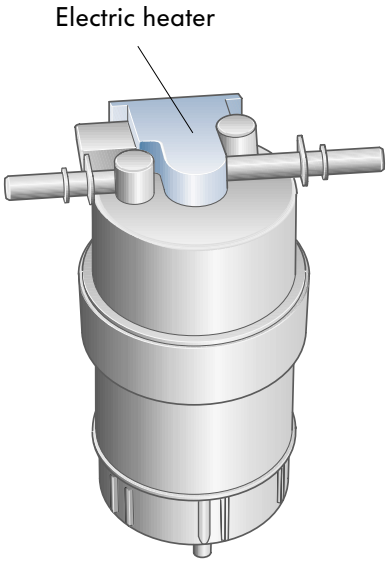
# Common rail injection system

**Fuel filter with electric heater**

The fuel filter is equipped with an electric heater.

The heater is switched on by the fuel filter heater relay.
It heats up the fuel in the supply line.

This prevents the fuel filter from becoming clogged by crystallising paraffin crystals at low ambient temperatures.

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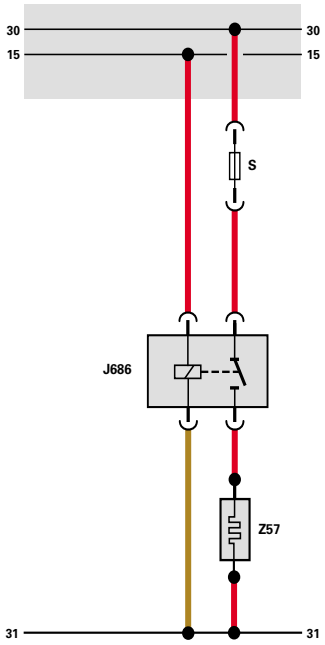
**Electrical circuit**

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**Legend:**

J686 - Fuel filter heater relay
Z57 - Fuel filter heater

## Gear pump

The gear pump is a purely mechanical pre-supply pump.
It increases the fuel pressure provided by the fuel pump G6 to ensure supply of the high-pressure pump with fuel in all operating conditions.
The gear pump is located directly on the high-pressure pump.
Both pumps are driven by a common shaft.

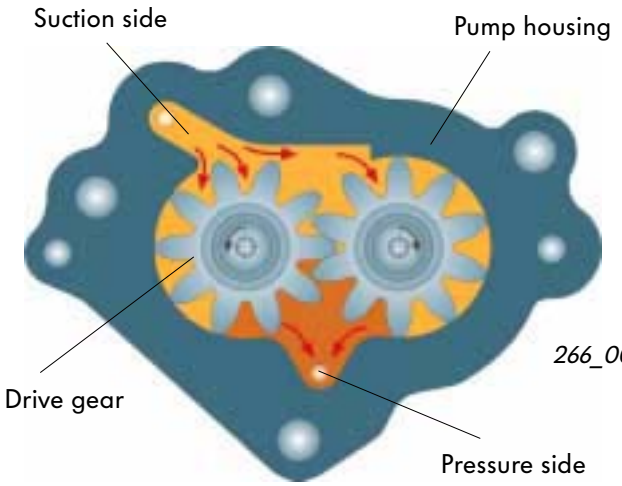

266_057

## Design

Two gears rotating in opposite directions are located in the gear pump housing.
One gear is driven by the input shaft.

## Function

When the gears rotate, fuel is entrained between the gear trains and is conveyed along the pump inner walls to the pressure side.
From there, the fuel continues to the high-pressure pump housing.
The engaging teeth of the two gears prevent fuel from flowing back.




266_007

## High-pressure part

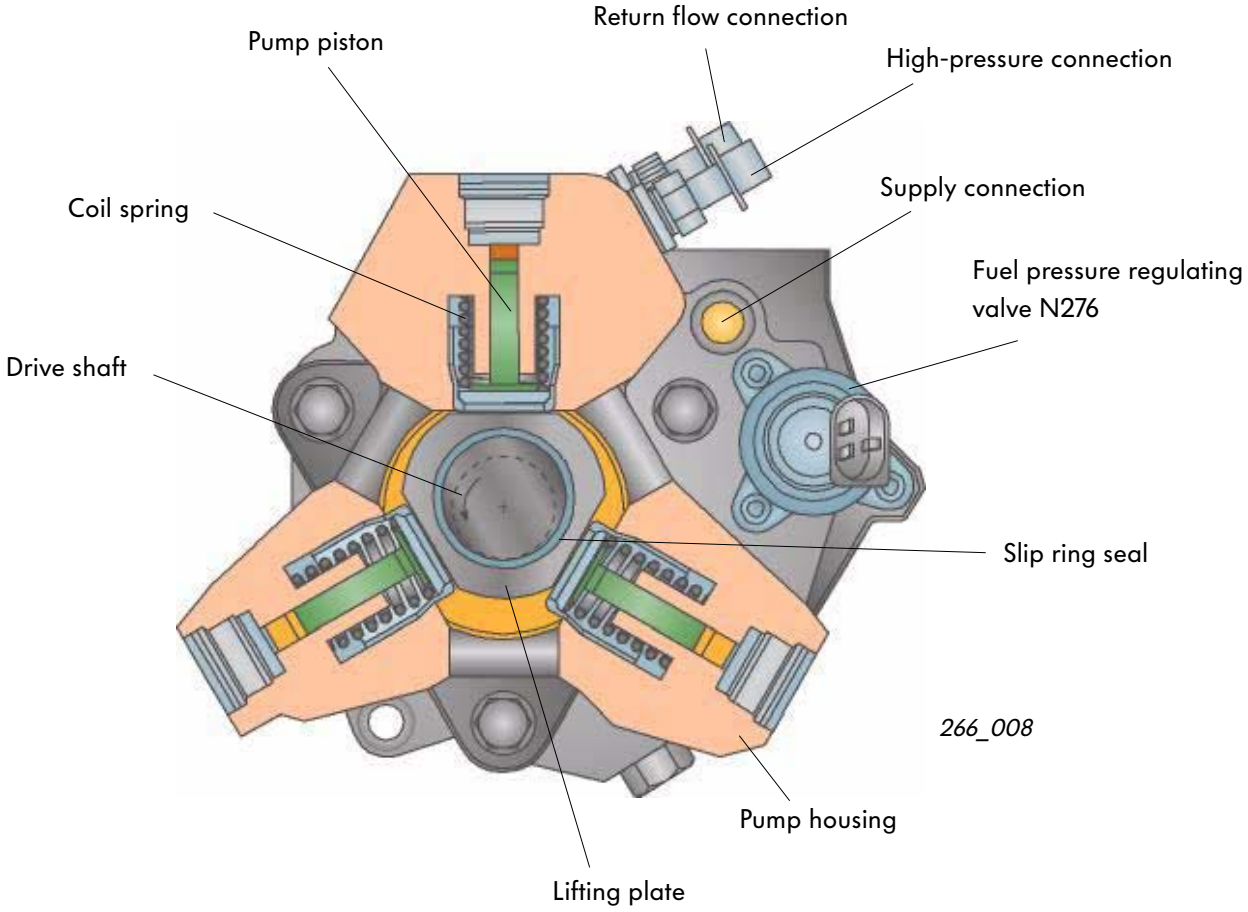
### High-pressure pump

Its function is to generate the fuel pressure required for injection at high pressure.
The high pressure is produced by three pump pistons arranged in a star at an angle of 120°.

The high-pressure pump is bolted to the gear train intermediate flange and is driven by the crankshaft via intermediate gears.

The gear pump and the fuel pressure regulating valve are also located on the high-pressure pump.


266_051

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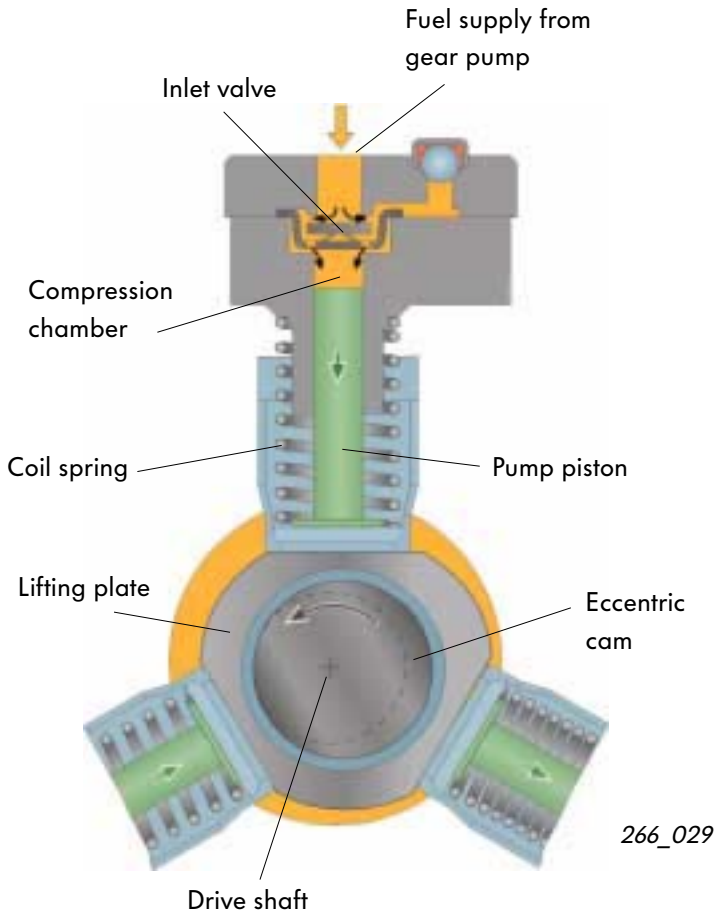
**Function**

The high-pressure pump input shaft has an eccentric cam.
It is driven by the input shaft and moves the pump piston of the three pump elements up and down via the lifting plate.



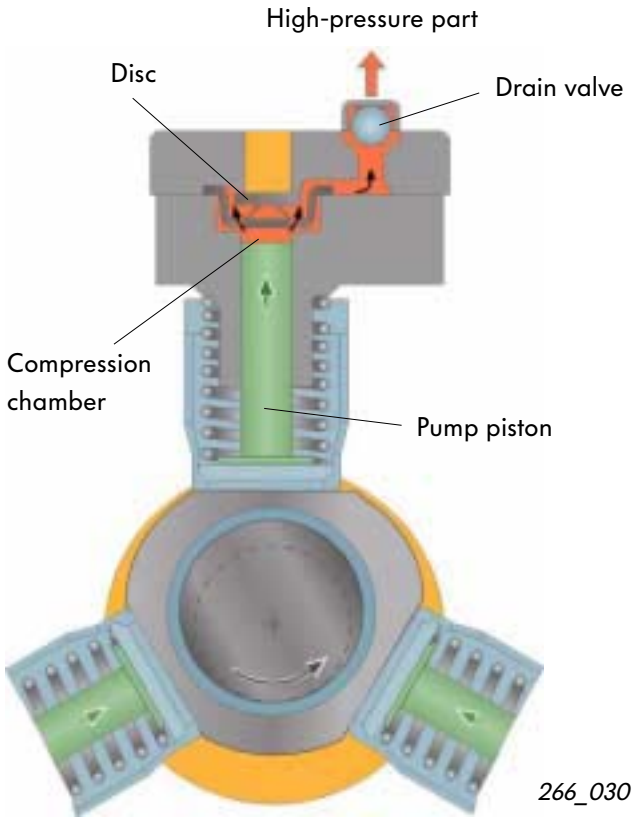

266_029

**Suction stroke**

The downwards movement of the pump piston causes the compression chamber to increase in volume. This lowers the fuel pressure inside the compression chamber.
Pressure from the gear pump can then convey fuel into the compression chamber via the inlet valve.

**Delivery stroke**

When the pump piston starts its upwards movement, pressure rises in the compression chamber. This pushes the disc in the inlet valve down and closes the compression chamber.
The piston moving upwards continues to build up pressure.
When the fuel pressure in the compression chamber exceeds the pressure in the high-pressure part, the outlet valve opens and the fuel flows to the high-pressure part.




266_030

# Common rail injection system

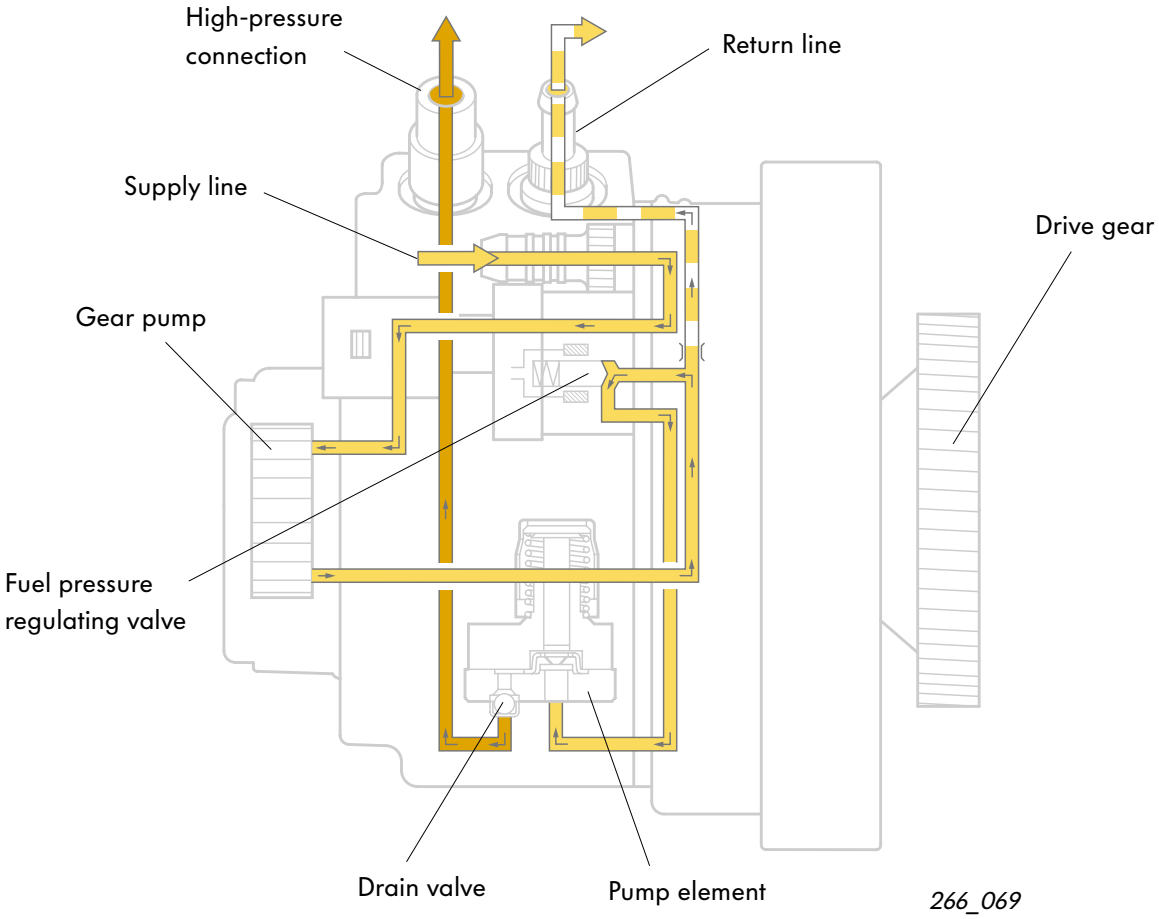
**Fuel flow in the high-pressure pump**

Fuel first arrives over the supply line to the pump interior.
There it is guided by galleries to the gear pump.

From the pressure side of the gear pump, fuel is conveyed to the fuel pressure regulating valve.

Depending on the electrical actuation of the solenoid (duty cycle), part of the fuel is sent to the pump elements.
The other part is lead off to the return line.

The fuel pressure for high-pressure injection is generated in the pump element.
The pump element outlet valve opens and the fuel escapes in the direction of the high-pressure connection.
Fuel runs from the high-pressure connection to the high-pressure rail via a pressure line.



## High-pressure fuel rail

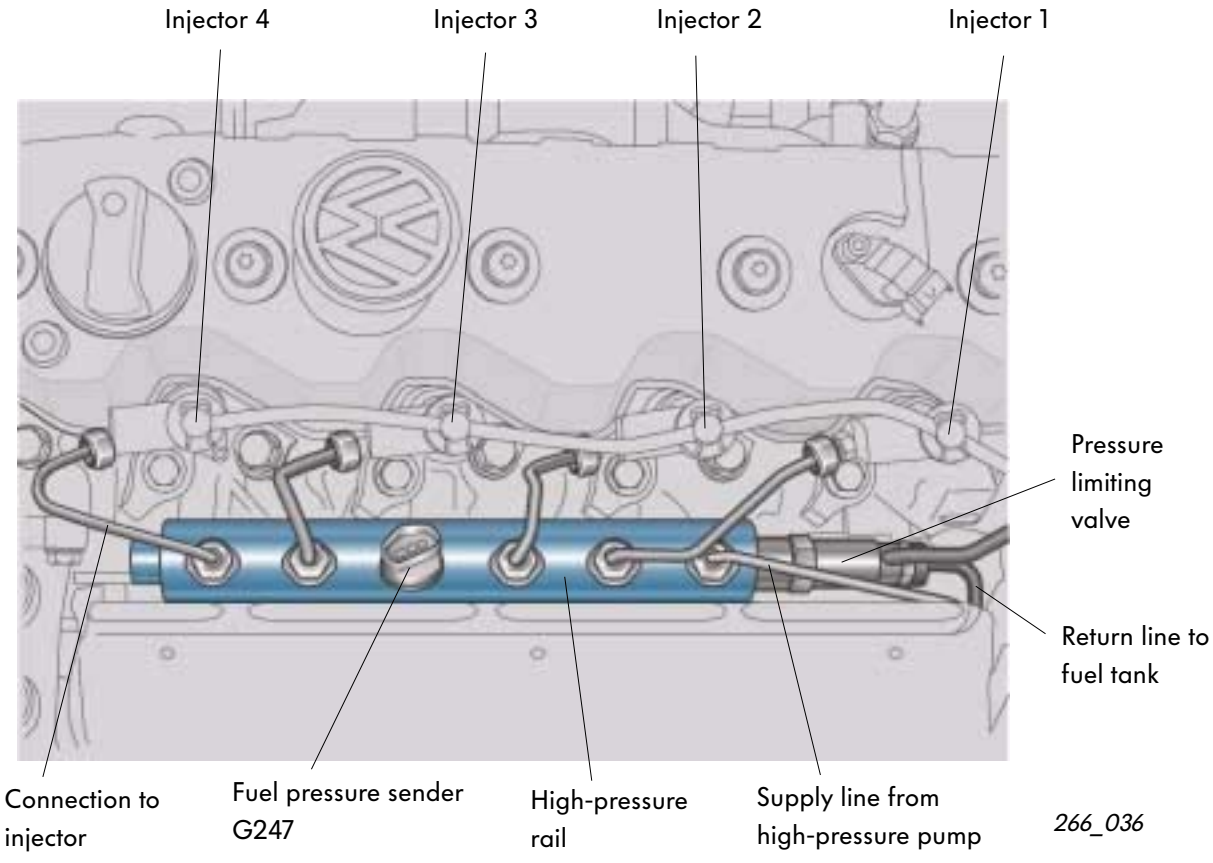
The high-pressure fuel rail is a pipe made of forged steel.
Its function is to store the fuel under high pressure before it is injected into the cylinders. Due to its large volume, it also compensates for pressure fluctuations which occur as a result of pumping action by the high-pressure pump and injection processes.

## Design

The high-pressure fuel rail includes the connection for the fuel supply of the high-pressure pump, the connections to the injectors, the return line to the fuel tank, the pressure limiting valve and the fuel pressure sender.

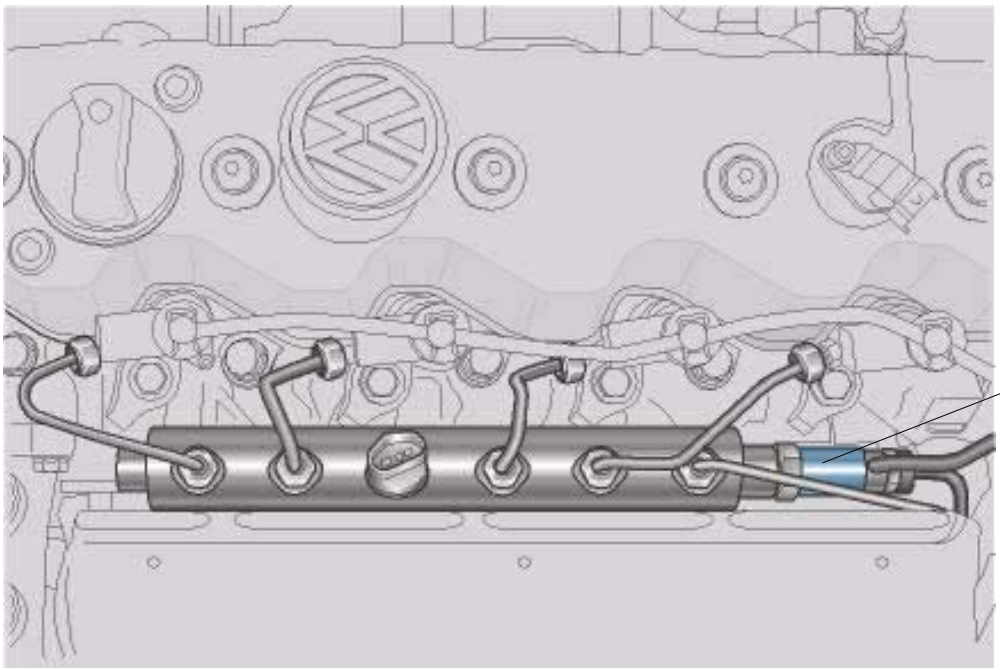
## Function

The fuel in the high-pressure fuel rail is subjected to a constant high pressure.
If fuel is taken from the high-pressure fuel rail for injection, the pressure in the high-pressure fuel rail remains almost constant due to its large storage volume.
It also compensates for pressure fluctuations which occur as a result of the pulsating supply by the high-pressure pump to the high-pressure fuel rail.



**Pressure limiting valve**

The pressure limiting valve is located directly on the high-pressure fuel rail.
Its function is to limit maximum pressure in the high-pressure fuel rail and protect the high-pressure fuel rail from overload.



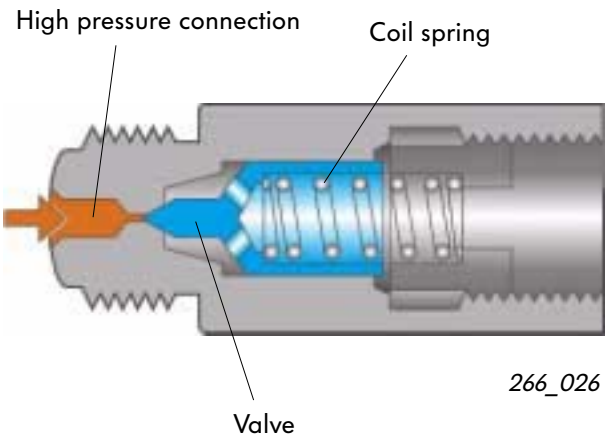

*266_036a*

If the pressure inside the high-pressure fuel rail exceeds the maximum pressure of 1450 bar, the pressure limiting valve opens and the excess fuel flows to the return line.
Comparison: 1450 bar is the rough equivalent of the weight of a mid-range car pressing on a surface area of one square centimetre.

**Design**

The pressure limiting valve is a purely mechanical component.
The connection to the high-pressure fuel rail is a threaded fitting.
Inside is a valve with drillings. The valve is retained in its seat by a compression spring.

**Valve closed**

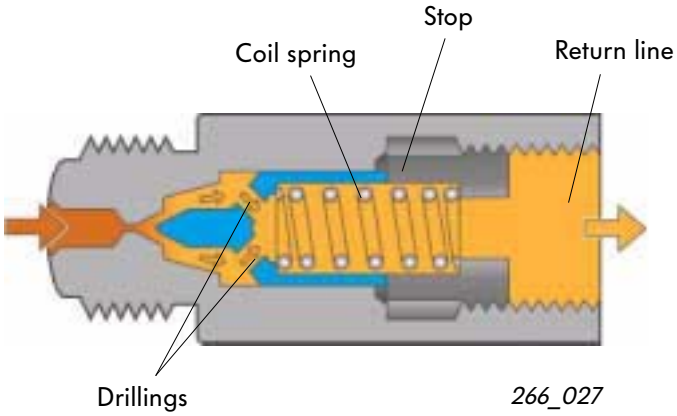



*266_026*

**Function**

If the fuel in the high-pressure fuel rail exceeds 1450 bar, the valve opens.
Fuel can now escape from the high-pressure fuel rail and run into the return line via the drillings.
Pressure in the high-pressure fuel rail drops.

**Valve open**




*266_027*

# Common rail injection system

## Injection

The fuel is injected in the combustion chambers by electromagnetically controlled injectors.
To achieve the most efficient combustion possible, injection is divided into a preinjection phase and a main injection phase.

The injectors are actuated once for preinjection phase and once for the main injection phase by the diesel direct injection system control unit.

### Preinjection phase

Before the pistons reach top dead centre (TDC), a small amount of fuel is first injected into the combustion chamber. This causes a rise in temperature and pressure in the combustion chamber.
The purpose of this is to shorten the firing delay of the main injection phase and therefore reduce pressure rise and pressure peaks.

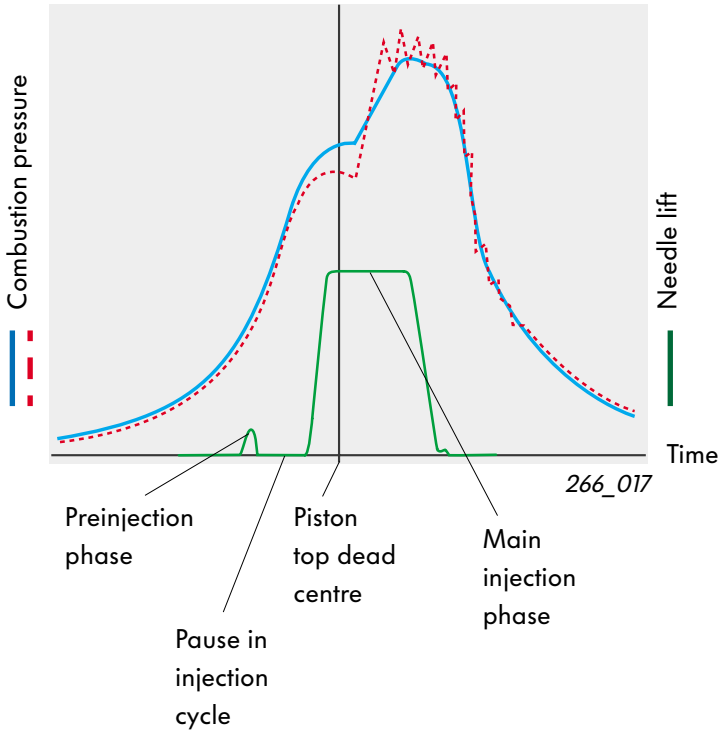
The advantages of the preinjection phase are:

- low combustion noise
- low exhaust emissions

### Main injection phase

After precombustion and after a short pause in the injection cycle, the main injection quantity is injected into the combustion chamber.
The level of the injection pressure remains almost identical during the entire injection cycle.

**Difference in pressure curve of combustion with and without preinjection phase**




Pressure curve with preinjection phase

Pressure curve without preinjection phase

Needle lift with preinjection phase

## Injectors

The injectors are fitted in the cylinder head.

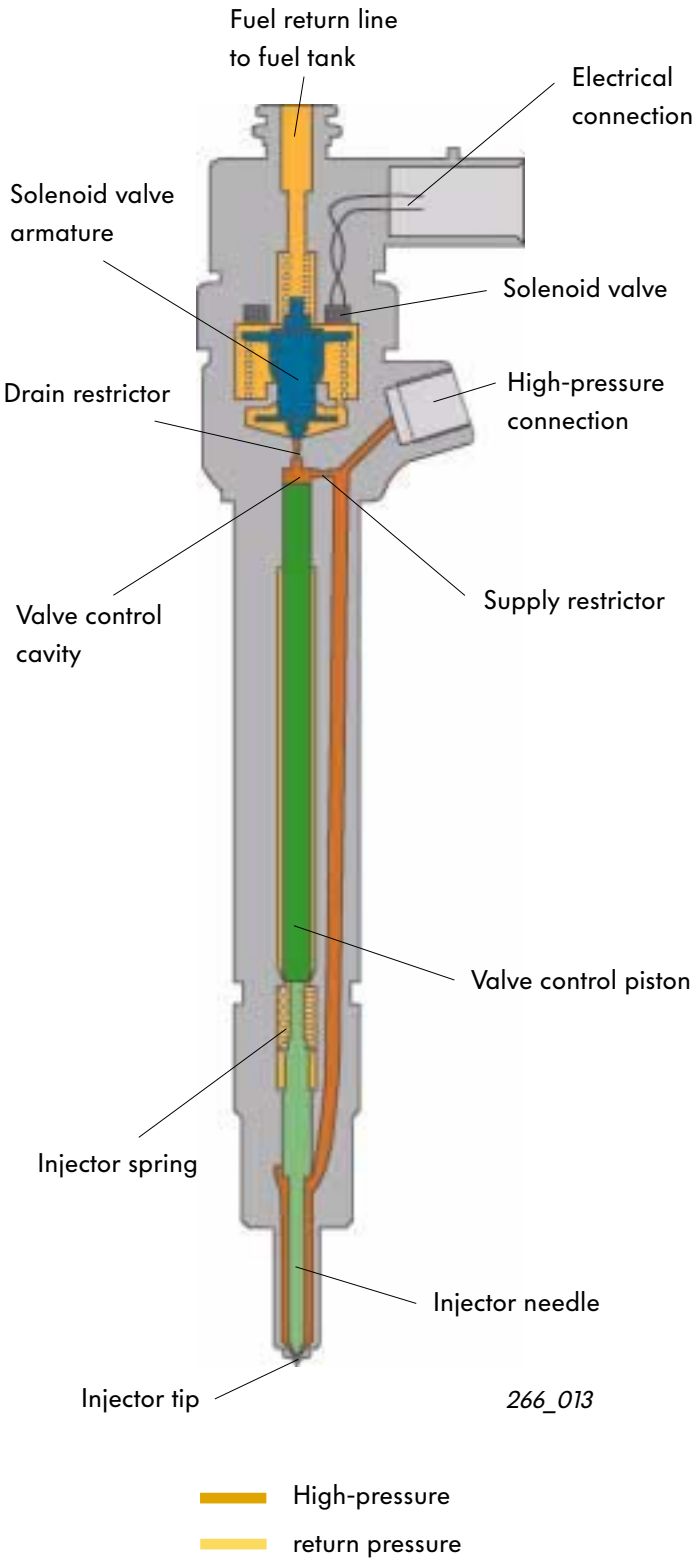
Their function is to inject the right amount of fuel at the right time into the combustion chambers. They are therefore actuated by the diesel direct injection system control unit.

### Resting position

In its resting position, the injector is closed.
The solenoid valve is not actuated.
The solenoid valve armature is pressed into its seat by the force of the solenoid valve spring.
The injector needle is closed by the high pressure of the fuel due to the high ratio of the control piston surface area in relation to the injector needle.

Any interruption in the electrical lead to an injector or in a solenoid valve will cause the engine to shut down.

### Design

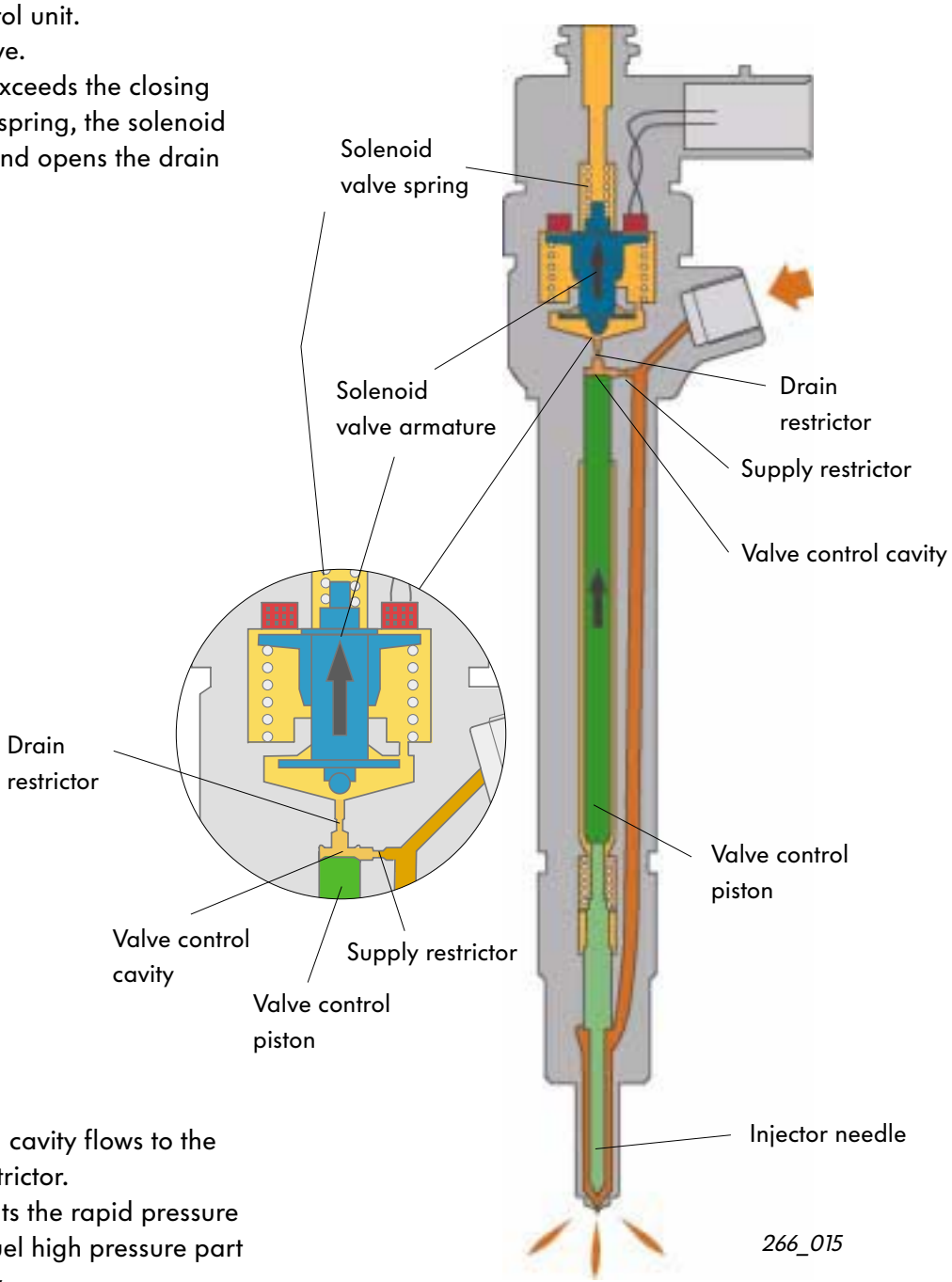


# Common rail injection system

**Function**

**Start of fuel injection**

The start of fuel injection is initiated by the diesel direct injection system control unit.
It actuates the solenoid valve.
When the magnetic force exceeds the closing force of the solenoid valve spring, the solenoid valve armature moves up and opens the drain restrictor.

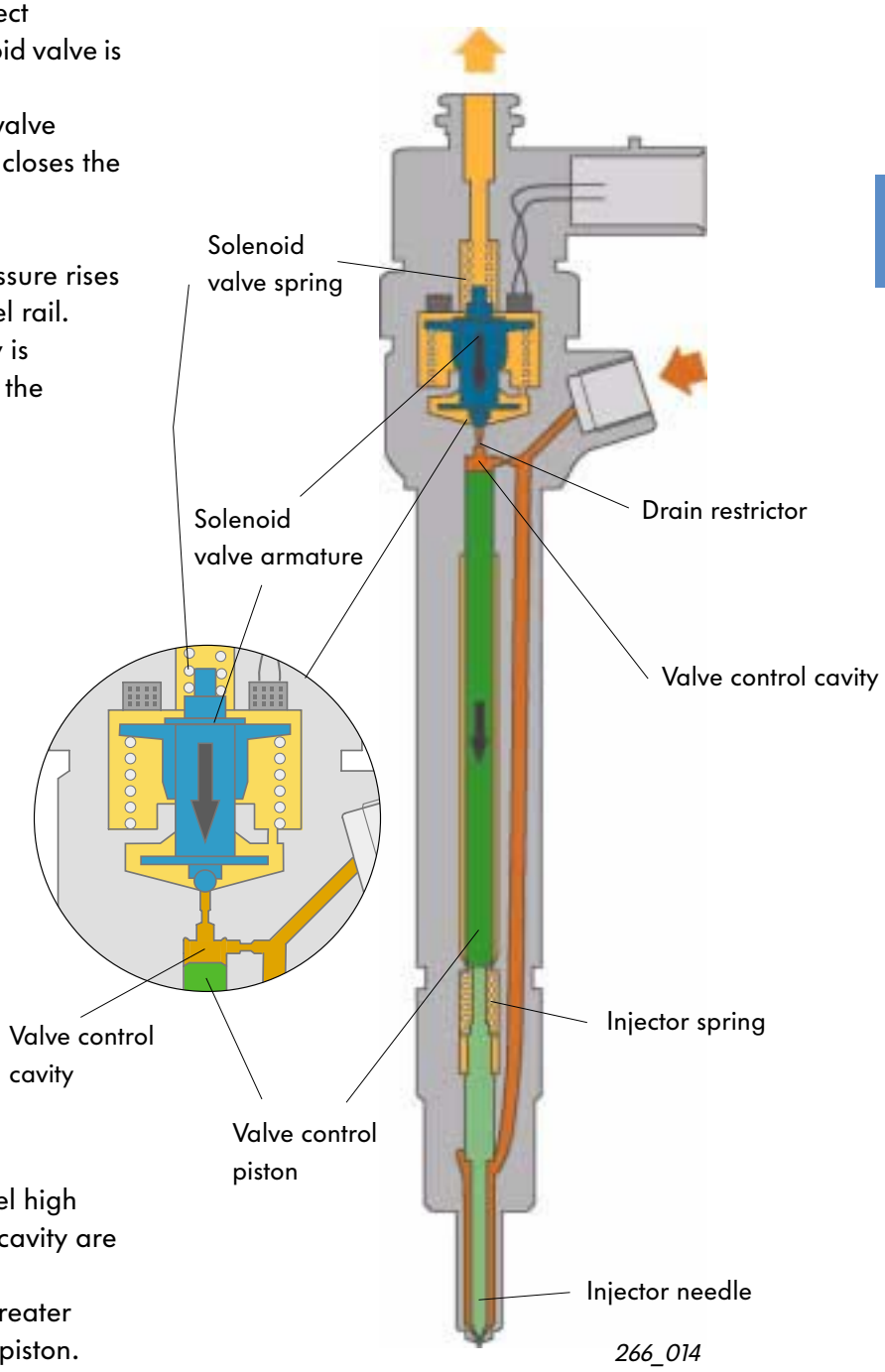



The fuel in the valve control cavity flows to the return line via the drain restrictor.
The supply restrictor prevents the rapid pressure equalisation between the fuel high pressure part and the valve control cavity.
The pressure acting on the valve control piston is lower at this moment than the fuel high pressure that is acting on the injector needle.
This raises the injector needle and injection begins.

**End of injection**

The injection cycle ends when the solenoid valve is no longer actuated by the diesel direct injection system control unit. The solenoid valve is deenergised.
The valve spring presses the solenoid valve armature back into the valve seat and closes the drain restrictor.

In the valve control cavity, the fuel pressure rises to the pressure in the high-pressure fuel rail.
The pressure in the valve control cavity is therefore exactly the same again as in the injector needle.

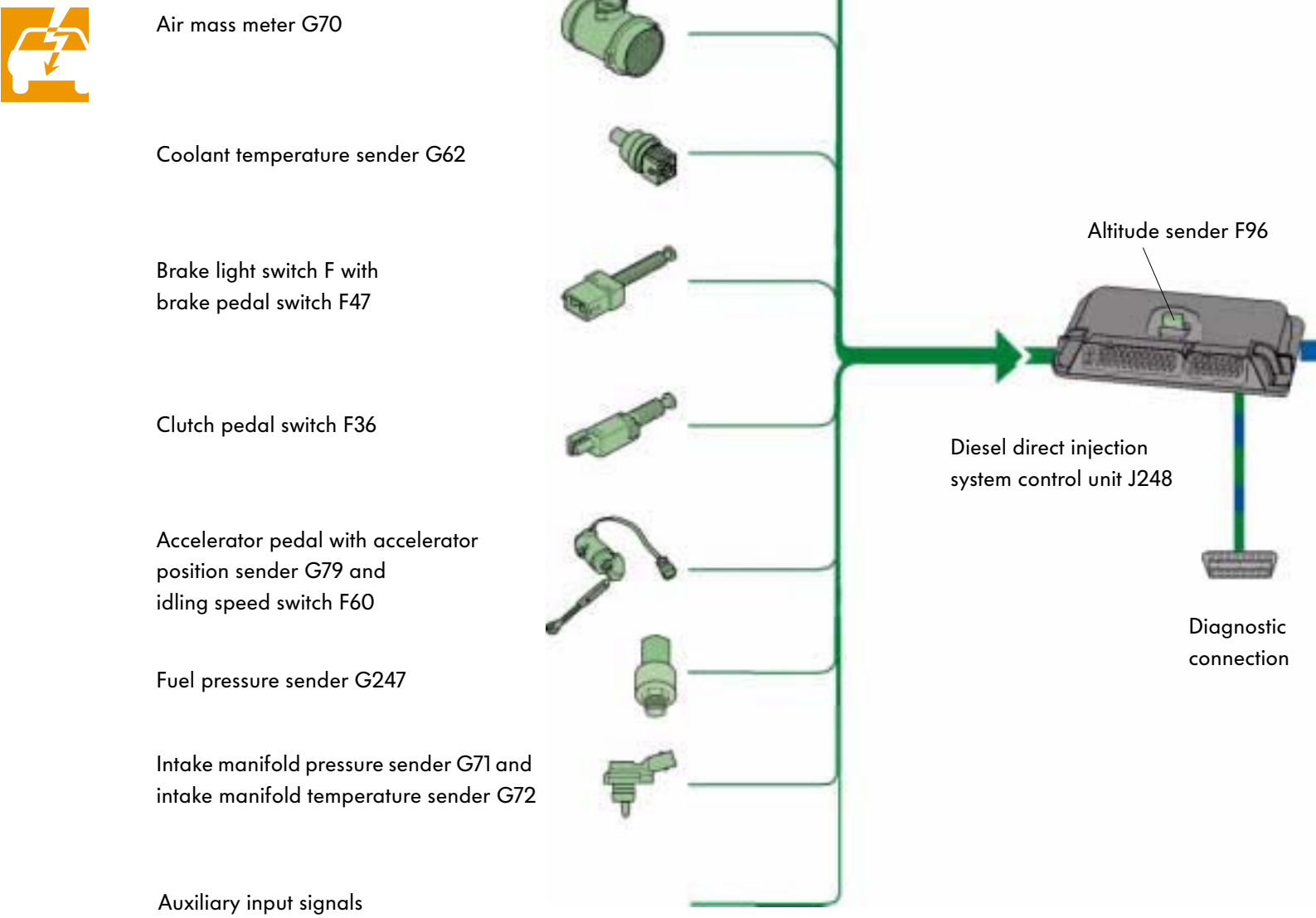



This means that the pressures in the fuel high pressure part and in the valve control cavity are again equal.
The injector needle closes due to the greater surface pressure acting on the control piston.
The injection cycle ends and the injector reverts back to its resting position.

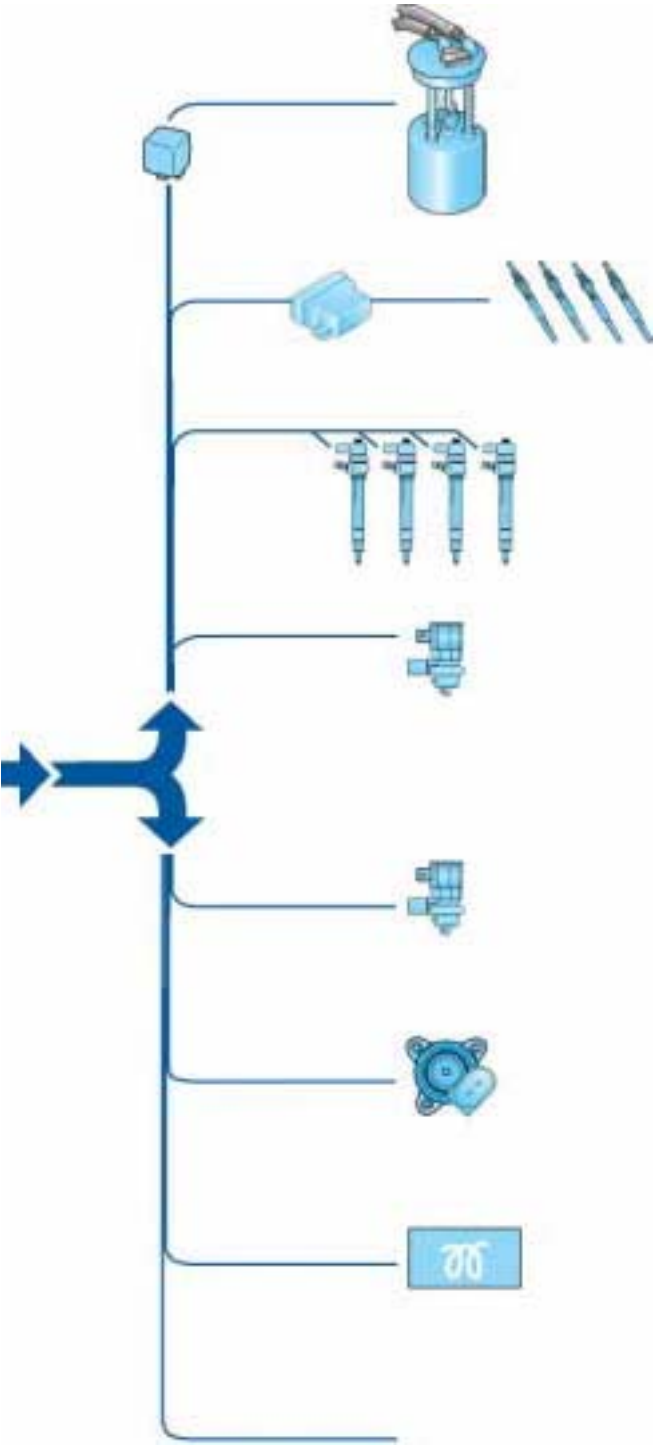
# Engine management system

## System overview

### Sensors



**Actuators**



*266_002*

Fuel pump relay J17 and
fuel pump G6

Glow plug relay J52 and
glow plugs 1 - 4 Q6

Injector solenoid valve 1 - 4
N30, N31, N32, N33

Solenoid valve for charge pressure control N75

Intake manifold flap change-over valve N239

Fuel pressure regulating valve N276

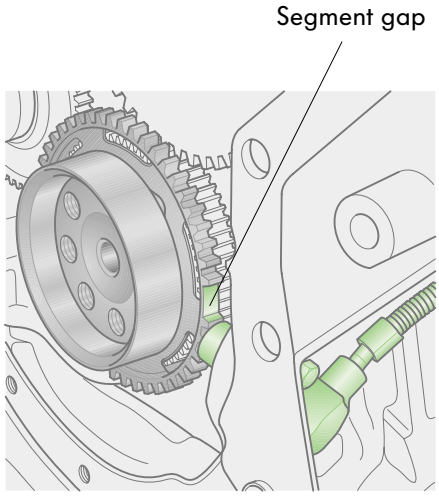
Glow period warning lamp K29

Auxiliary input signals

## Sensors

### Engine speed sender G28

The engine speed sender is an inductive sender. It is attached to the timing gear housing.
The sender wheel is located on the crankshaft between the flywheel and the timing gear.
A segment gap on the sender wheel acts as the reference mark for the sender.




266_019

### Signal utilisation

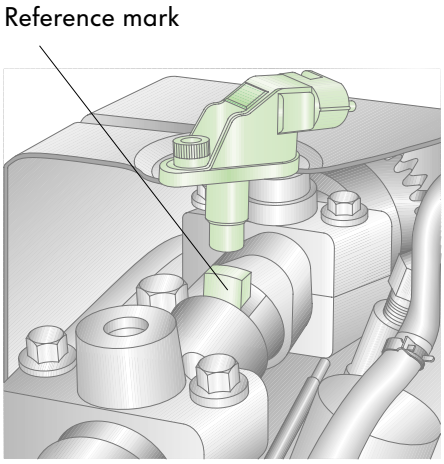
The signal detects the engine speed and the exact position of the crankshaft.
This information helps the diesel direct injection system control unit to calculate the injection point and injection quantity.

### Effect of signal failure

The engine cannot run.

### Hall sender G40

The Hall sender is mounted in the cylinder head cover. A tooth segment on the camshaft acts as a reference mark.
The sender helps to detect the position of the camshaft.




266_018

### Signal utilisation

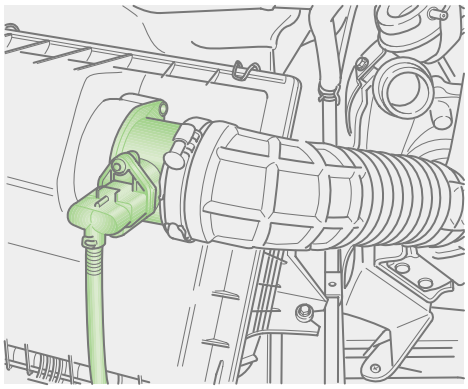
The signal is required by the diesel direct injection system control unit to detect the position of the first cylinder when the engine is started.

### Effect of signal failure

The engine continues to run.
The diesel direct injection system control unit uses the signal from the engine speed sender G28 for this.
However, the engine cannot be restarted.

### Air mass meter G70

The air mass meter with reverse flow recognition is located in the intake pipe and determines the intake air mass.
Opening and closing the valves cause return flows of the air mass drawn into the intake pipe. The hot-film air mass meter with reverse flow recognition recognises the backflowing air mass and includes this in its signal to the diesel direct injection system control unit.



266_073

### Signal utilisation

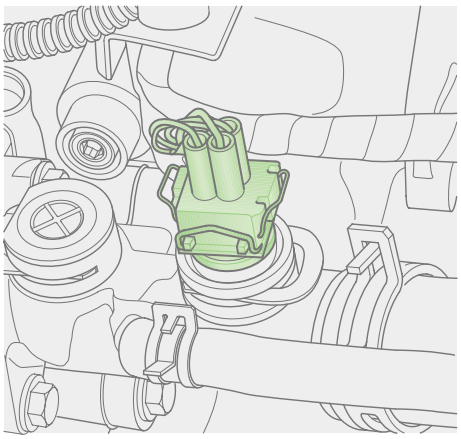
The signal values are used by the diesel direct injection system control unit to calculate the injection quantity.

### Effect of signal failure

If the signal from the air mass meter fails, the diesel direct injection system control unit calculates with a fixed substitute value.

### Coolant temperature sender G62

The coolant temperature sender is located in the coolant connection of the cylinder head.
The sender informs the diesel direct injection system control unit about the current coolant temperature.



266_074

### Signal utilisation

The coolant temperature is used by the diesel direct injection system control unit as a correction value to calculate the injection quantity.

### Effect of signal failure

If the signal fails, the diesel direct injection system control unit calculates with a fixed substitute value.

# Engine management system

### Brake light switch F and brake pedal switch F47

The brake light switch and the brake pedal switch are located together in a single component on the foot controls. The switches help the diesel direct injection system control unit to recognise whether the brake pedal is being operated.

266_078

### Signal utilisation

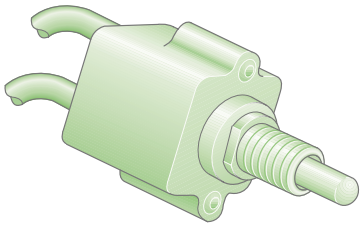
The two switches supply the diesel direct injection system control unit with the signal "brake actuated“. If the accelerator position sender is defective, the engine is throttled down for safety reasons when the brake is operated.

### Effect of signal failure

If one of the two switches fails, the diesel direct injection system control unit reduces the fuel quantity.
The engine has less power.

### Clutch pedal switch F36

The clutch pedal switch is located on the foot controls and is operated by the clutch pedal. It detects when the clutch pedal is depressed.



266_076

### Signal utilisation

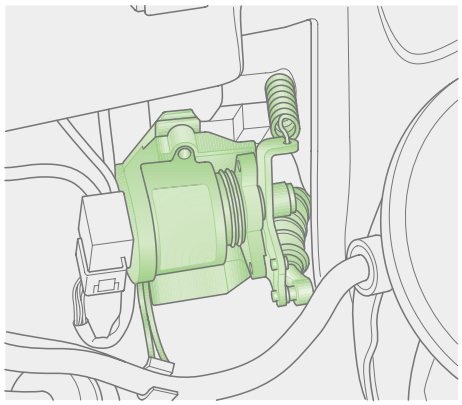
The signal helps the diesel direct injection system control unit to detect whether the clutch pedal is operated or not. When the clutch pedal is depressed, the injection quantity is reduced for a short period of time.
This prevents engine shudder during a gearshift operation.

### Effect of signal failure

If the clutch pedal switch signal fails, load impacts may occur during gearshift operations.

### Accelerator position sender G79 with idling speed switch F60

The accelerator position sender is located in the engine compartment and is linked to the accelerator pedal by a rod linkage.
The control unit recognises the position of the accelerator pedal from the signal sent by the accelerator position sender.
The sender also includes an idling speed switch.



266_071

#### Signal utilisation

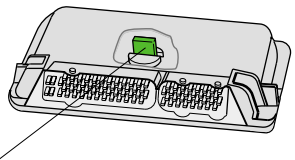
The accelerator pedal position acts as the main influencing factor to calculate the injection quantity.
The idling speed switch helps the diesel direct injection system control unit to recognise whether the accelerator pedal is being operated or not.

#### Effect of signal failure

Without this signal the diesel direct injection system control unit cannot recognise the accelerator pedal position. The engine will continue to run at higher idling speed.
The driver can reach the nearest workshop.

### Altitude sender F96

The altitude sender is located in the diesel direct injection system control unit.



Altitude sender

266_077

#### Signal utilisation

The altitude sender reports the current ambient air pressure to the diesel direct injection system control unit. The signal is dependent on the geographical altitude. The signal provides an altitude correction for charge pressure control.

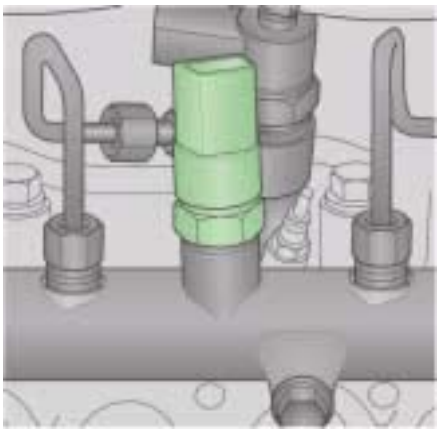
#### Effect of signal failure

Black smoke occurs at high altitudes.

# Engine management system

### Fuel pressure sender G247

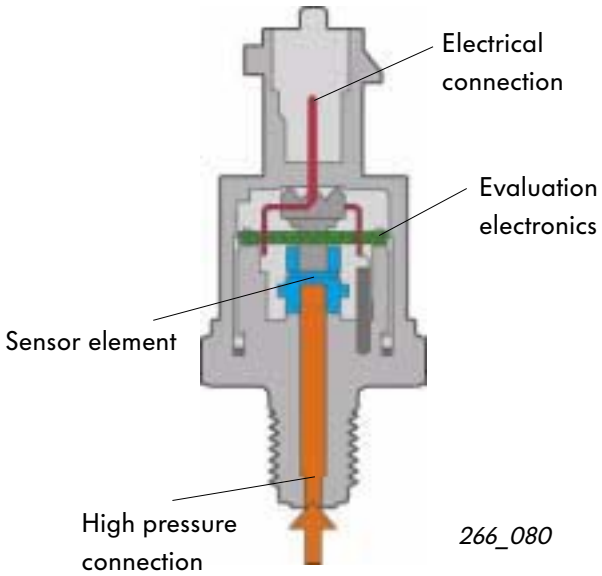
The fuel pressure sender is located on the high-pressure fuel rail and determines the current fuel pressure in the high-pressure section.



*266_058*

### Function

Fuel pressure reaches the sensor element via the high-pressure connection.
The sensor is a steel diaphragm with vapour-deposit strain gauges.
When there is a change in pressure, the diaphragm shape changes as well as the resistance of the strain gauges.
The evaluation electronics amplify the resistance signal and transfer it in the form of a voltage signal to the diesel direct injection system control unit.
Using a characteristic curve stored there, the control unit calculates the current fuel pressure.




*266_080*

### Signal utilisation

The voltage signal is an influencing parameter for the diesel direct injection system control unit to control the fuel pressure in the fuel high-pressure part.

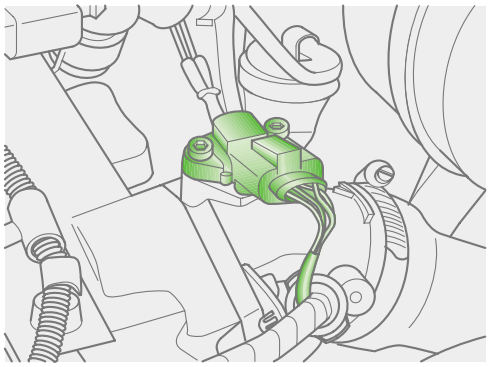
### Effect of signal failure

The engine cannot run.

If the fuel pressure sender detects a strong pressure drop or pressure rise in the high-pressure part, the engine is shut down for safety reasons.

## Intake manifold pressure sender G71 and intake manifold temperature sender G72

The two senders are integrated in a single components located in the intake pipe.



266_023

### Intake manifold pressure sender G71

The intake manifold pressure sender detects the current pressure in the intake manifold.

### Signal utilisation

The sender signal is required by the diesel direct injection system control unit to control the charge pressure.

### Effect of signal failure

If it fails, there is no substitute function.
The charge pressure control is shut down and the engine power is reduced.

### Intake manifold temperature sender G72

The intake manifold temperature sender detects the current air temperature of the intake air.

### Signal utilisation

The signal acts as a correction value for the diesel direct injection system control unit to calculate the charge pressure.
This takes into account the effect of temperature on the density of the charge air.

### Effect of signal failure

If the signal fails, the diesel direct injection system control unit calculates with a fixed value.
This leads to reduced engine performance.

# Engine management system

## Auxiliary input signals

### Road speed signal

This signal is sent to the diesel direct injection system control unit by the road speed sender. It has the following functions:

- limits the top speed
- dampens engine shudder when shifting gear and
- checks the function of the cruise control system.

### Cruise control system

The signal from the cruise control system switch is detected by the diesel direct injection system control unit and indicates that the cruise control system is active.

### Air conditioner compressor standby

The diesel direct injection system control unit receives the signal from the air conditioner switch that the air conditioner compressor was switched on.
It raises the engine idling speed to prevent a sharp drop in engine speed when the compressor starts.

### Working speed control

The working speed control switch sends the signal for raising the engine speed to the diesel direct injection system control unit.

## Auxiliary output signals

### Engine speed

This signal is intended as engine speed information for the rev counter in the dash panel insert.

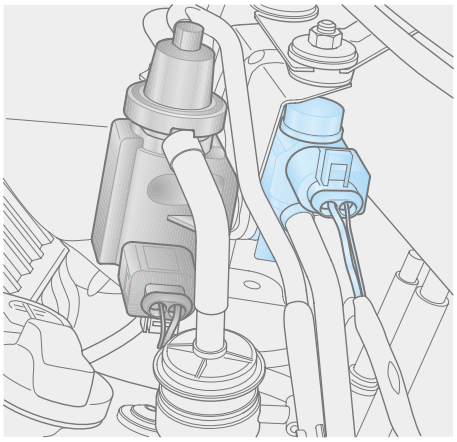
### Air conditioner compressor

The signal switches off the air conditioner compressor to limit engine load under certain conditions.

## Actuators

### Charge pressure control solenoid valve N75

The charge pressure control solenoid valve is an electro-pneumatic valve and is mounted on the engine bulkhead together with the intake manifold flap change-over valve N239 in the engine compartment.
The solenoid valve is clocked by the diesel direct injection system control unit and switches the control pressure to operate the vacuum box to adjust the turbocharger vanes.
The charge pressure is controlled by a map stored in the diesel direct injection system control unit.



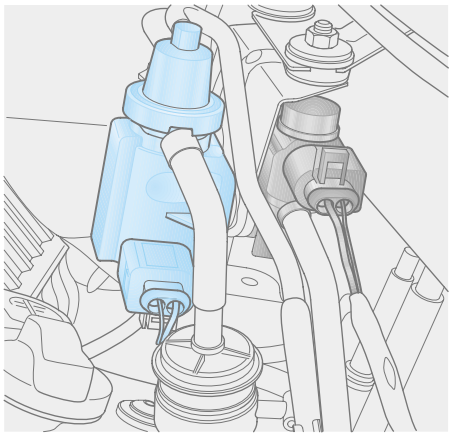
266_075

### Effects of failure

If the charge pressure control solenoid valve fails, engine performance drops.

### Intake manifold flap change-over valve N239

The intake manifold flap change-over valve switches the vacuum to operate the intake manifold flap in the intake pipe.
The intake manifold flap prevents shudder when the engine is shut down.
It interrupts the air supply when the engine is turned off.
Less air is compressed and the engine turns off softly.



266_079

### Effects of failure

If the intake manifold flap change-over valve fails, the intake manifold flap opens.

# Engine management system

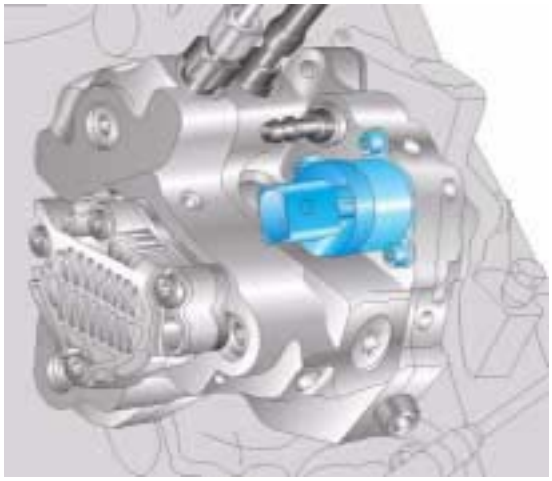
### Fuel pressure regulating valve N276

The fuel pressure regulating valve N276 is located on the high-pressure pump.

Its function is to regulate the fuel pressure in the high-pressure part. It is therefore activated by the diesel direct injection system control unit.

The fuel pressure is regulated on the suction side in the low-pressure part. This has the advantage that the high-pressure pump only needs to generate the pressure required by the momentary operating situation.

This reduces the power consumption of the high-pressure pump and avoids heating the fuel unnecessarily.



266_054

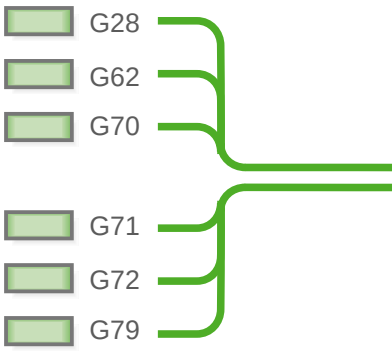
### Control procedure

The regulating valve N276 is activated by the control unit to control fuel pressure.

Control unit J248 uses the information from the

- engine speed sender G28,
- coolant temperature sender G62,
- air mass meter G70,
- intake manifold pressure sender G71,
- intake manifold temperature sender G72,
- accelerator position sender G79 and
- fuel pressure sender G247

to calculate the fuel pressure required for injection.



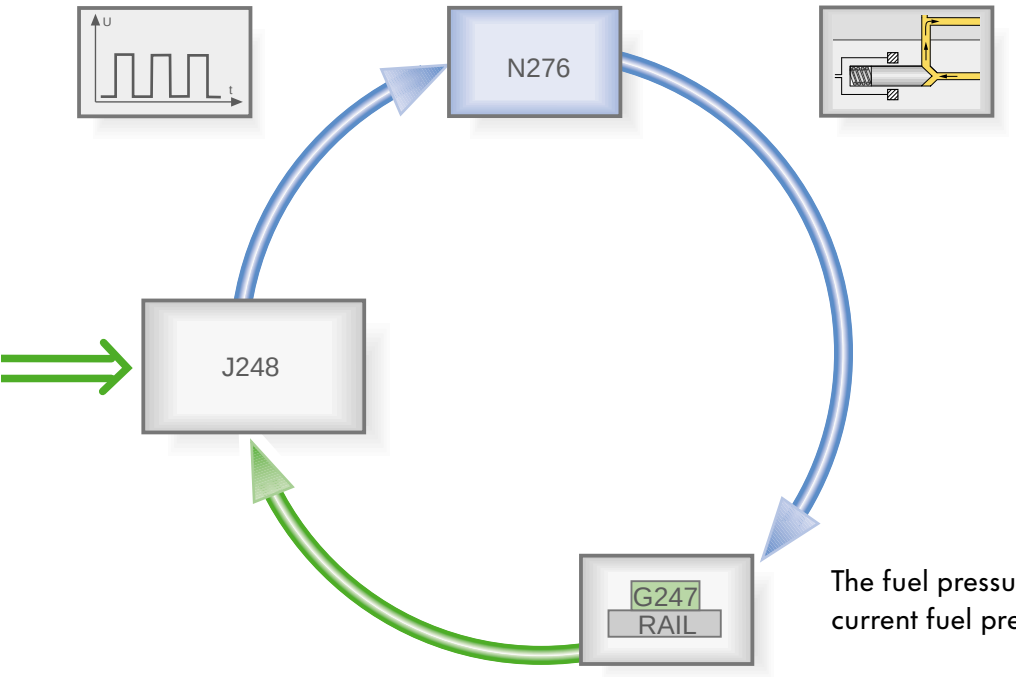
The diesel direct injection system control unit then activates the regulating valve N276 using a pulse-width modulated signal:

- large pulse width = high pressure
- short pulse width = low pressure.

Depending on the necessary engine load, the control unit changes the pulse width which is used to activate the regulating valve.
This regulates the flow rate of the fuel to the high-pressure pump.

PWM signal

Regulating valve




The fuel pressure sender G247 reports the current fuel pressure to the control unit J248.

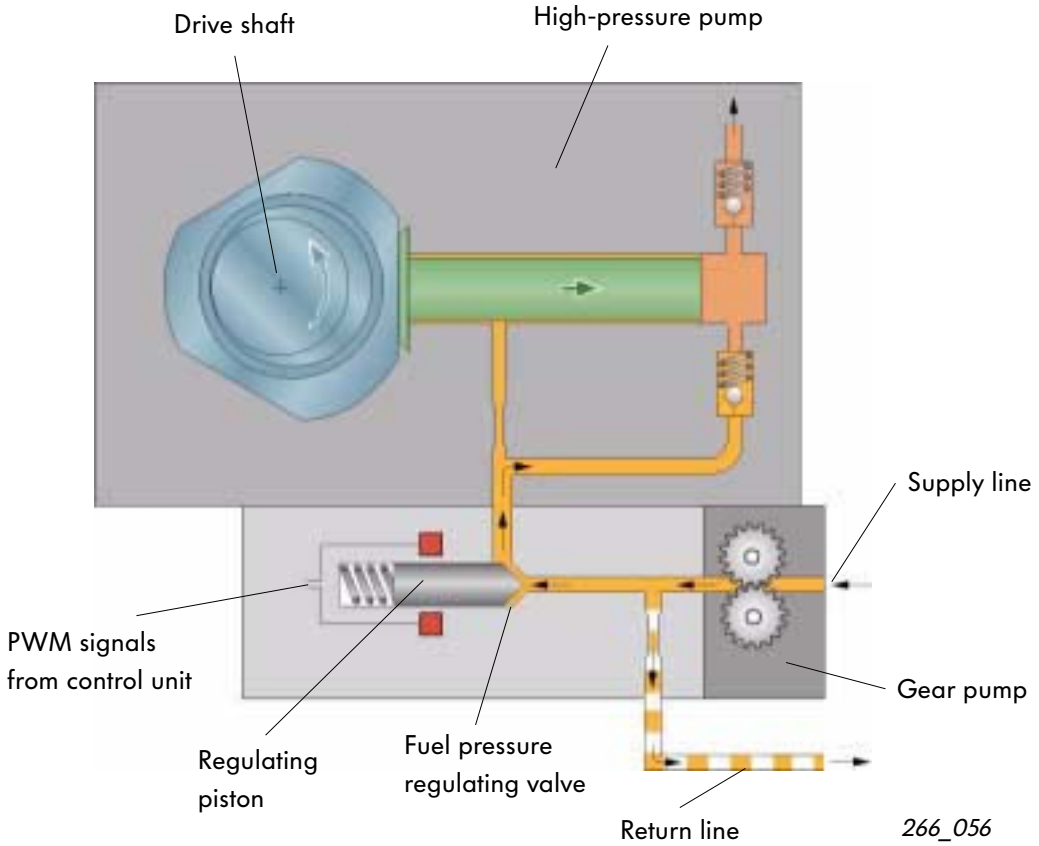
*266_094a*

**Function**

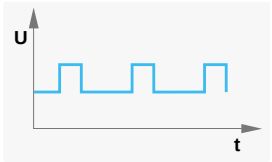
**Low fuel pressure**

If less fuel pressure is required, the signal pulse width is short.
The regulating piston reduces the fuel supply to the high-pressure pump.
So only a small quantity of fuel reaches the high-pressure pump and generates a lower fuel pressure.

Excess fuel conveyed by the gear pump is returned to the fuel tank via the return line.




266_056



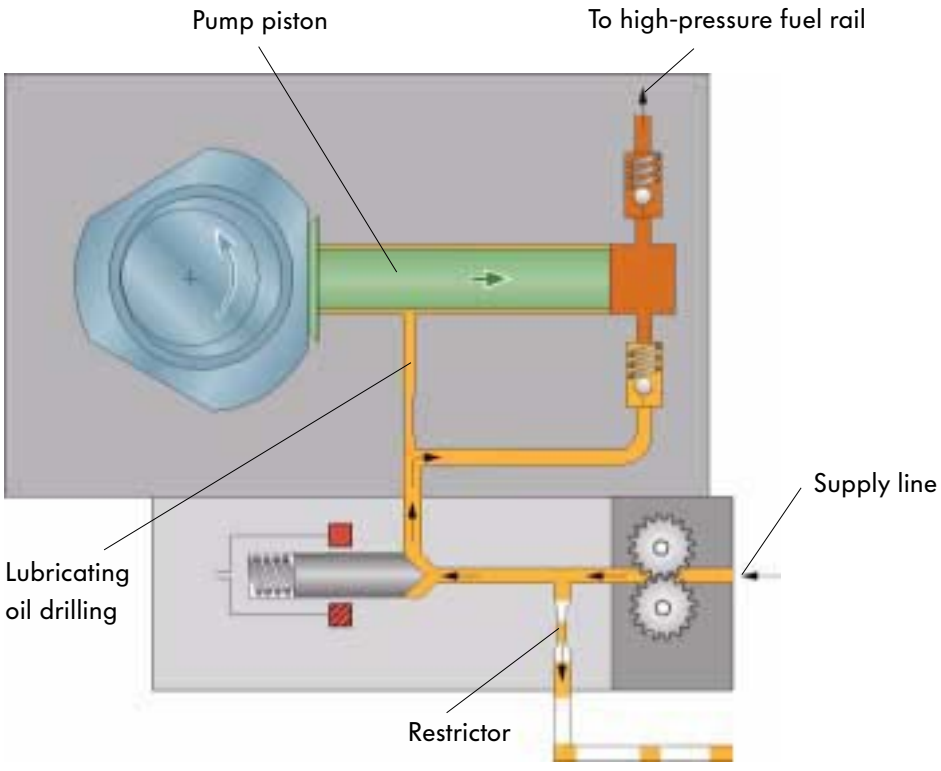

PWM signal with short pulse width

266_106

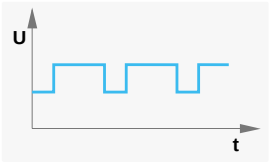
## High fuel pressure

To generate high fuel pressure, the fuel pressure regulating valve is activated by a long pulse width signal.
The regulating piston releases a large cross-section from the gear pump to the high-pressure pump.

So a large quantity of fuel reaches the high-pressure pump and generates a lower fuel pressure.




*266_055*




PWM signal with long pulse width

*266_107*

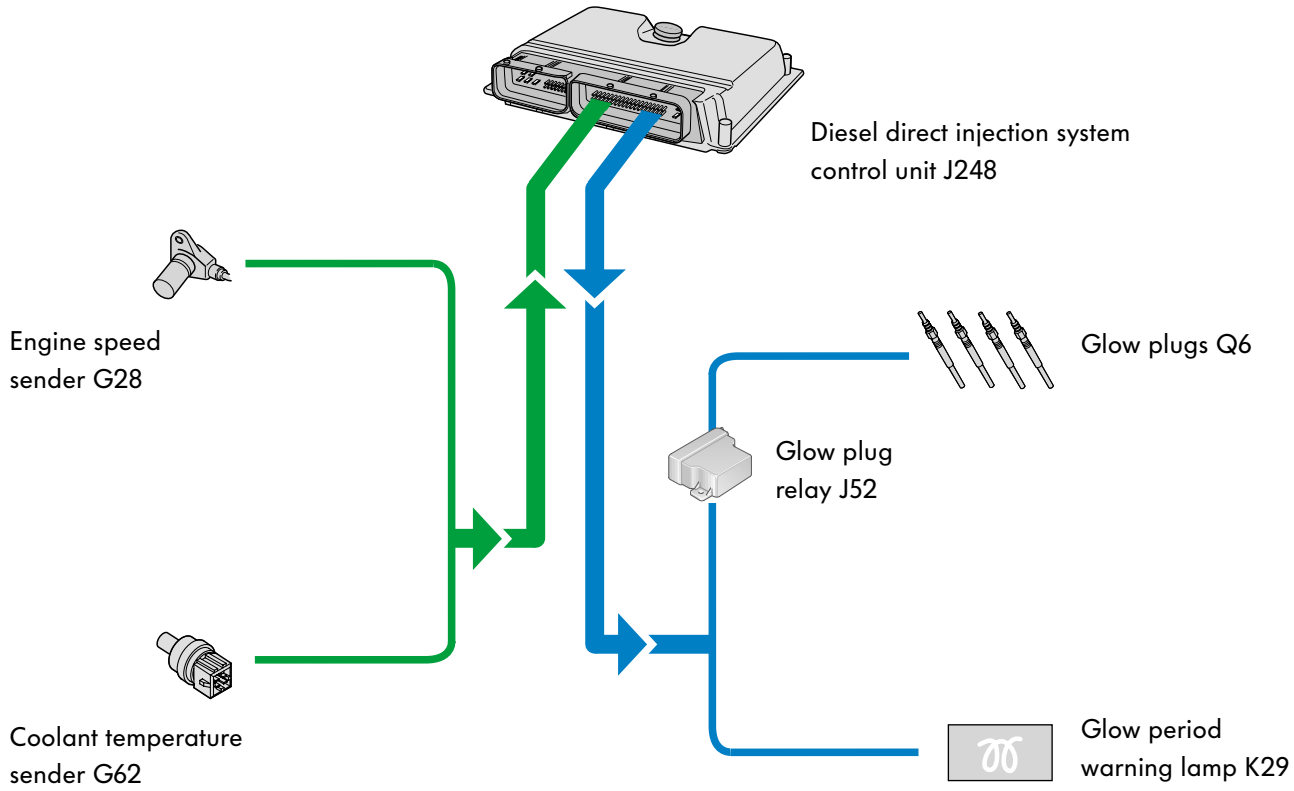
# Engine management system

## Glow plug system

The glow plug system makes for easier starting at low temperatures. It is switched on by the diesel direct injection system control unit at a coolant temperature of under +9 °C.
The glow plug relay is activated by the diesel direct injection system control unit.
It then switches on the working current for the glow plugs.

The system overview of the glow plug system shows you what sensors use which signals for the glow plug system and what actuators are activated.

**System overview of glow plug system**




*266_064*

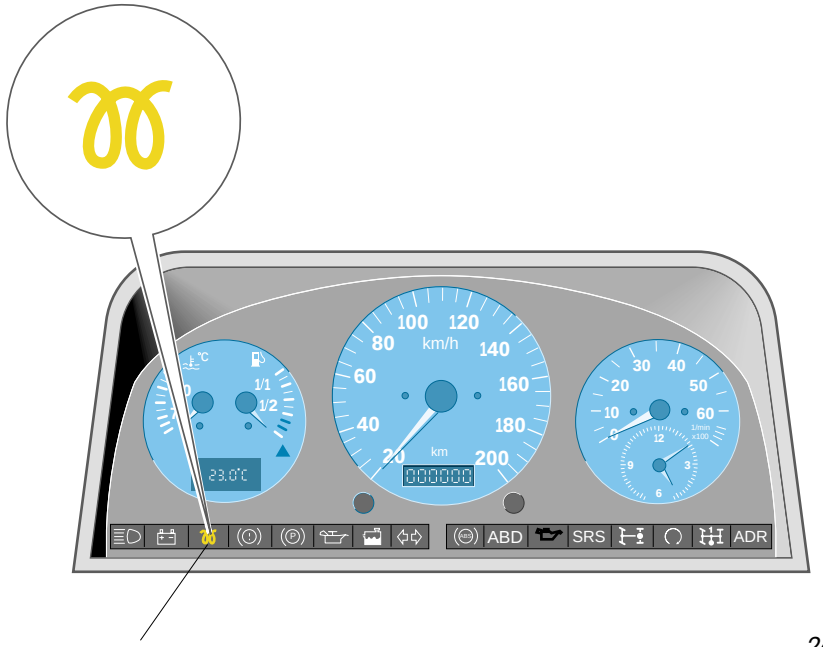
The glow period makes a distinction between two phases:

**Glow phase**

When the ignition is switched on, the glow plugs are switched on at a temperature of under +9 °C.
The warning lamp lights up in the dash panel insert for glow period.
When the glow phase ends, the warning lamp goes out and the engine can start.

**Afterglow phase**

Every time the engine is started, there is an afterglow phase, irrespective of whether a glow phase took place.
This lowers combustion noise, improves idling quality and reduces hydrocarbon emissions.



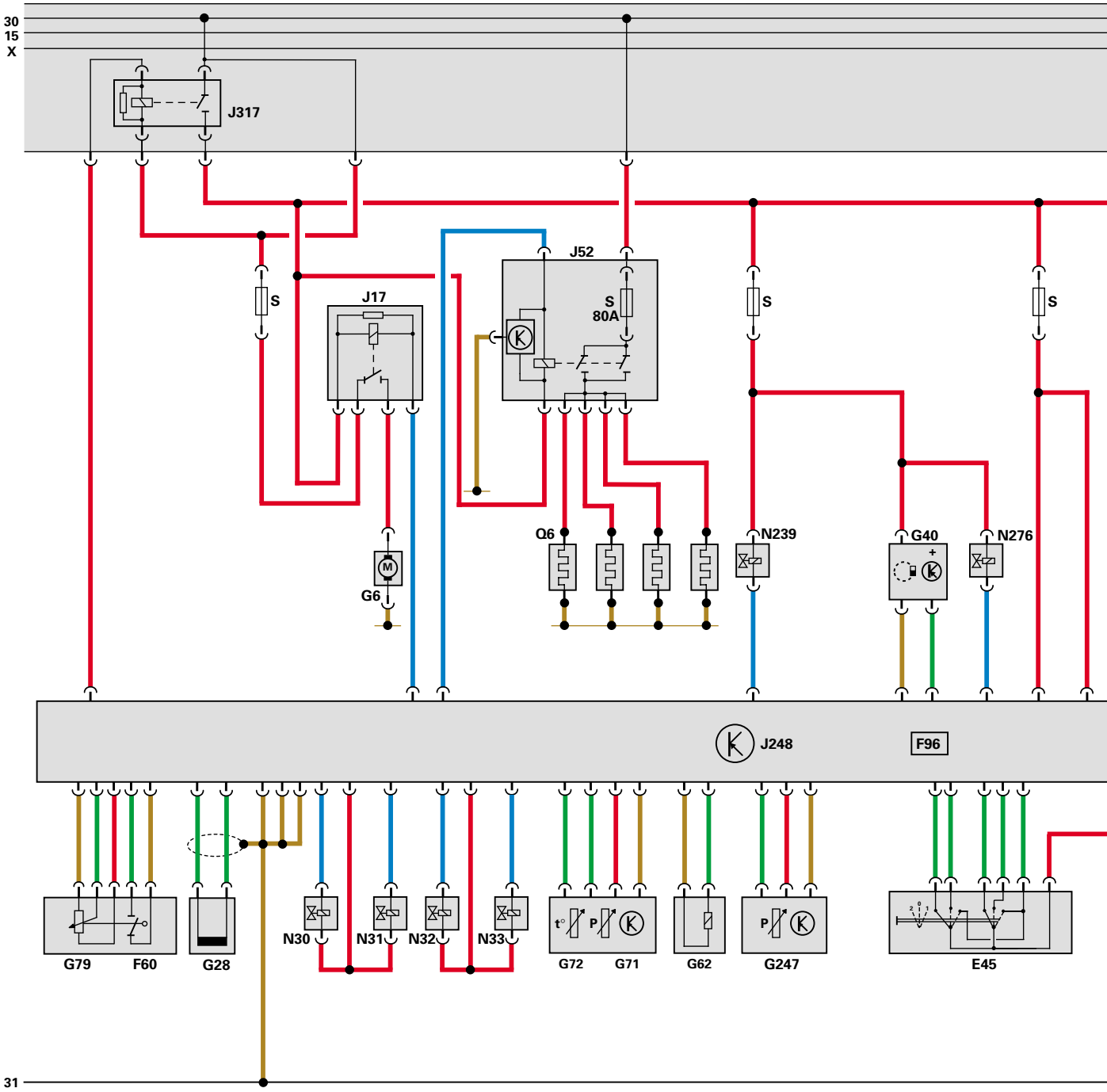

*266_105c*

Glow period
warning lamp K29

# Engine management system

## Function diagram

**(2.8 ltr. TDI engine with common rail - AUH)**




**Colour codes**

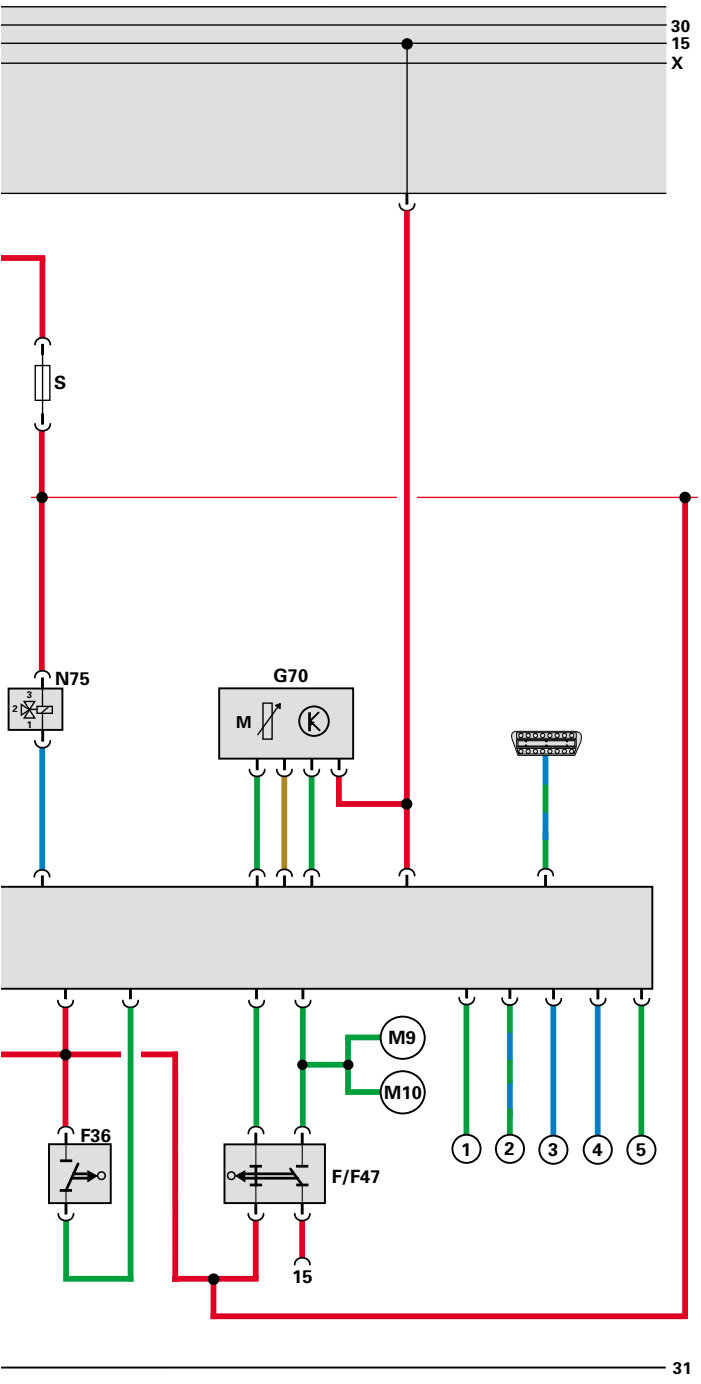
= input signal

= output signal

= positive

= GND

= bidirectional




**Auxiliary signals** *266_001*

(1) Road speed signal
(2) Air conditioner compressor signal
(3) To glow period warning lamp K29
(4) Engine speed signal
(5) Working speed control

**Parts**

E45 - Cruise control system switch
F - Brake light switch
F36 - Clutch pedal switch
F47 - Brake pedal switch for cruise control system/diesel direct injection system
F60 - Idling speed switch
F96 - Altitude sender

G6 - Fuel pump
G28 - Engine speed sender
G40 - Hall sender
G62 - Coolant temperature sender
G70 - Air mass meter
G71 - Intake manifold pressure sender
G72 - Intake manifold temperature sender
G79 - Accelerator position sender
G247 - Fuel pressure sender

J17 - Fuel pump relay
J52 - Glow plug relay
J248 - Diesel direct injection system control unit
J317 - Voltage supply relay - Terminal 30

M9 - Brake light bulb, left
M10 - Brake light bulb, right

N30 - Solenoid valve for injector, cylinder 1
N31 - Solenoid valve for injector, cylinder 2
N32 - Solenoid valve for injector, cylinder 3
N33 - Solenoid valve for injector, cylinder 4
N75 - Charge pressure control solenoid valve
N239 - Intake manifold flap change-over valve
N276 - Fuel pressure regulating valve

Q6 - Glow plugs

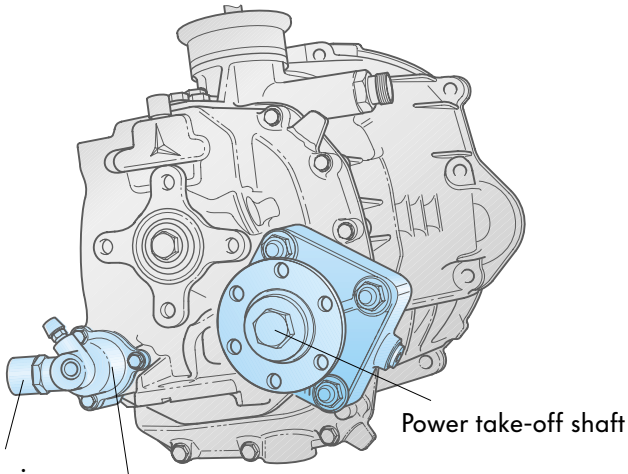
S - Fuse

# Auxiliary functions

## Power take-off

Optionally, the LT can be equipped with a power take-off to drive additional devices.

The power take-off permits the operation of auxiliary devices such as a tipping body or a loading platform.
The power take-off is driven by the manual gearbox.

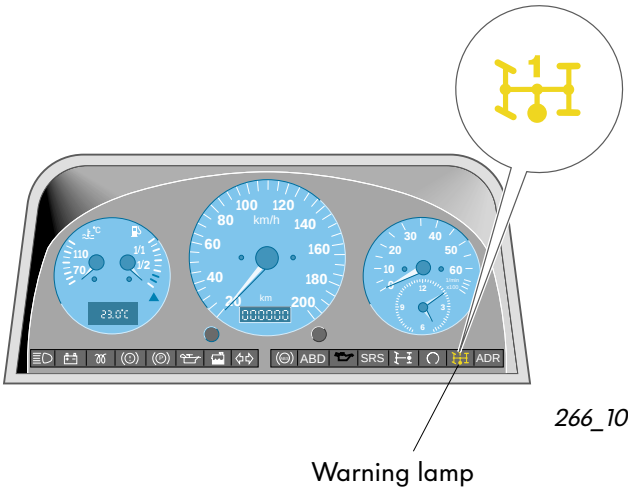



266_083

The power take-off is switched on by the power take-off switch in the dash panel.

266_103

When the power take-off is activated, the warning lamp in the dash panel insert lights up.

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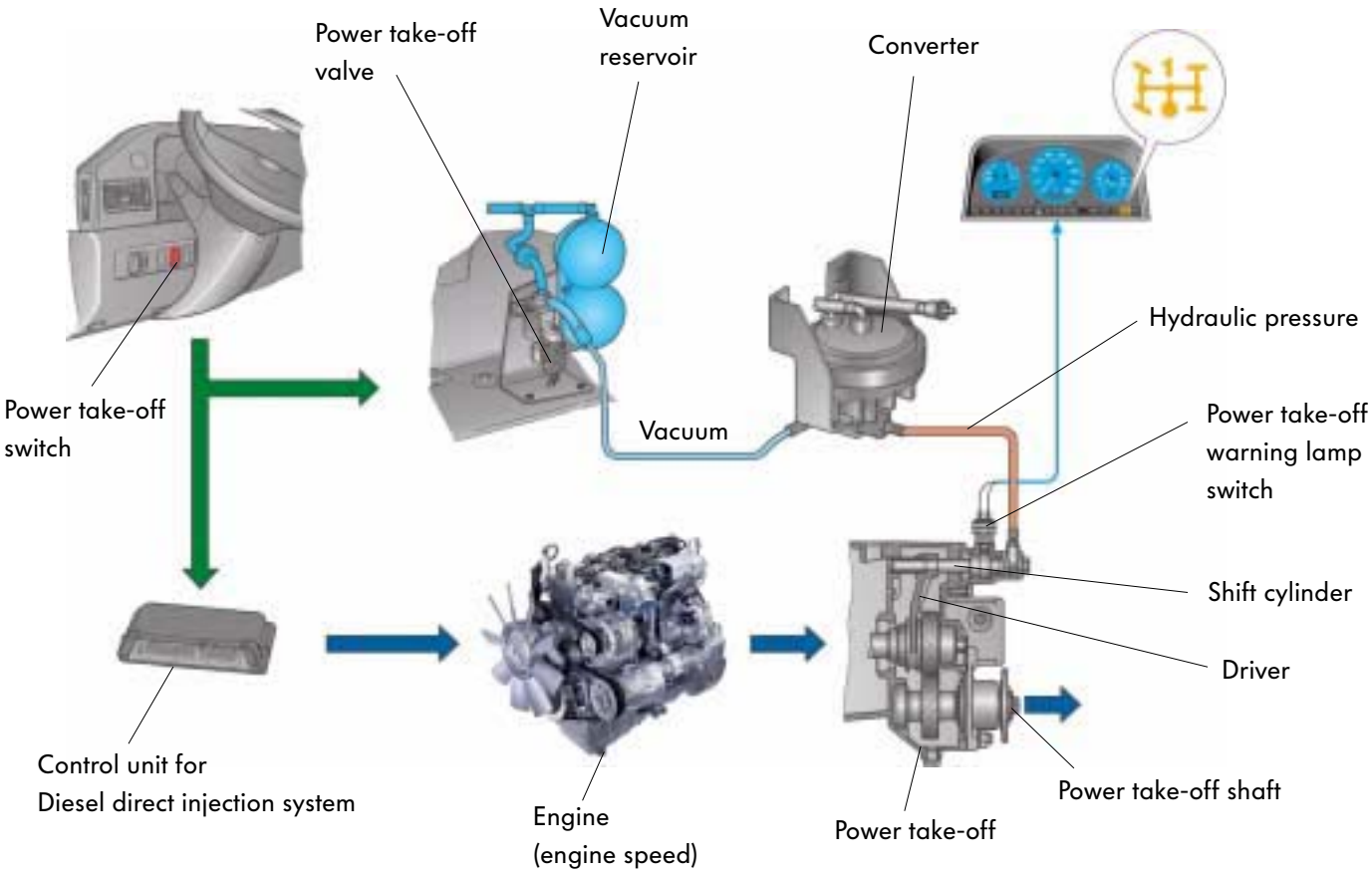
When operating the auxiliary device, make sure the manufacturer's operating instructions are adhered to.

## System overview of power take-off




### Function

The power take-off is activated by the rocker switch in the dash panel.
The power take-off valve then opens and applies a vacuum to the converter.
The converter builds up a hydraulic pressure which switches the power take-off reduction gear via a shift cylinder and the driver.

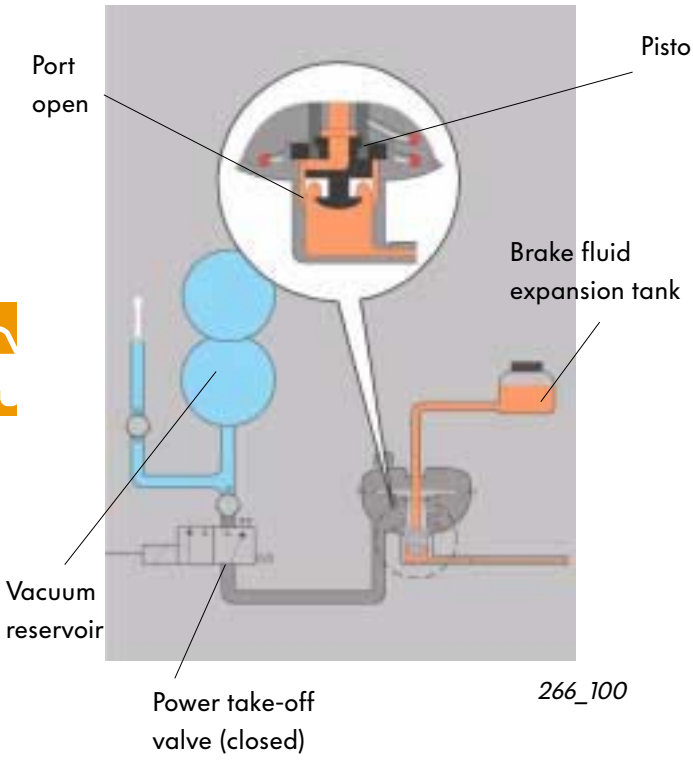
The warning lamp switch on the shift cylinder switches the warning lamp for the power take-off in the dash panel insert.
The warning lamp remains lit as long as the power take-off is on.

# Auxiliary functions

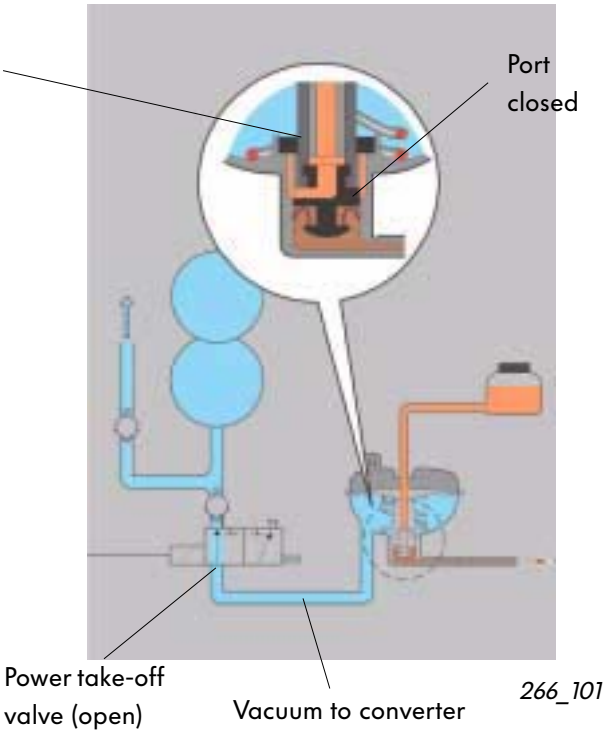
**Converter**

The converter converts the vacuum into a hydraulic pressure.
The oil pressure operates the shift cylinder.

**Power take-off not on**




**Power take-off on**




As long as the power take-off valve is closed, pressure equalisation exists between the brake fluid expansion tank and the power take-off shift cylinder.

When the power take-off is switched on, the power take-off valve opens.
This applies a vacuum to the converter.
The piston moved down.

The piston moving down closes the opening between the expansion tank and the shift cylinder.
A hydraulic pressure is built up between the converter and the shift cylinder.
This pressure causes the shift cylinder to switch the power take-off on.
The power take-off shaft starts to turn.

## Working speed control

The working speed of the power take-off is controlled using the engine speed by the diesel direct injection system control unit.

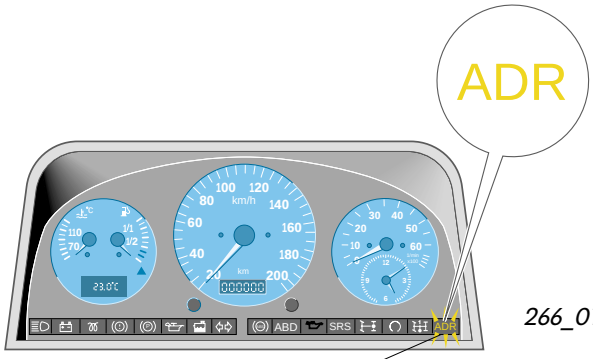
A warning lamp for the automatic engine speed control (ASC) is located in the dash panel insert. If there is a fault in the automatic engine speed control, the ASC warning lamp flashes.

## Automatic engine speed control

To prevent a drop in engine speed when the power take-off is switched on, an automatic engine speed control is activated.
It is controlled by the diesel direct injection system control unit.

Depending on the type of power take-off, a
- variable working speed control or a
- fixed working speed control

can be used.

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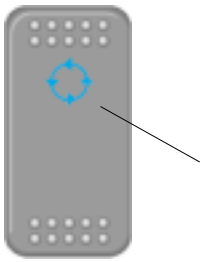
## Variable working speed control

In this type of control, the working speed is changed by pressing the power take-off switch up or down.
The maximum engine speed is adjustable within a range of 1000 rpm to 3000 rpm using the VAS 5051 Vehicle Diagnostic, Testing and Information System.

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## Fixed working speed control

In this type of control the working speed does not change when the power take-off is active.
The fixed speed is adjustable within a range of 1000 rpm to 3000 rpm using the VAS 5051 Vehicle Diagnostic, Testing and Information System.

You will find instructions for adapting the variable or fixed working speed control in the Workshop Manual.

# Test your knowledge

**What are the correct answers?**

One or more, or even all, answers may be correct.

**1. Using what gear of the toothed belt drive can the backlash be adjusted?**

☐ a) Camshaft gear wheel.

☐ b) Intermediate camshaft gear.

☐ c) Adjustment is possible using all gears.

**2. What is the maximum possible pressure in the high-pressure fuel rail?**

The maximum possible pressure is ..... bar.

**3. What components are responsible for controlling the fuel pressure in the high-pressure circuit of the common rail injection system?**

☐ a) The pressure limiting valve.

☐ b) The fuel pressure sender G247.

☐ c) The injectors.

**4. What component of the high-pressure pump is responsible for moving the three pump pistons up and down?**

The up and down movements of the three pump pistons is performed by the ..... on the ..... .

**5. Why is phased injection performed in the common rail injection system (pre- and post-injection)?**

☐ a) To inject the greatest possible fuel quantity into the combustion chamber.

☐ b) To shorten the firing delay of the main injection phase.

☐ c) To avoid combustion noise.

**6. What is the injection quantity of the injectors dependent on?**

☐ a) The control duration of the solenoid valve on the Injector.

☐ b) Pressure in the rail.

☐ c) The pressure limiting valve.

**Answers:**

1. b; 2. 1450 bar; 3. b; 4. Eccentric cams, input shaft; 5. b, c; 6. a. b;

Service.

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240.2810.85.20 Technical status 03/02