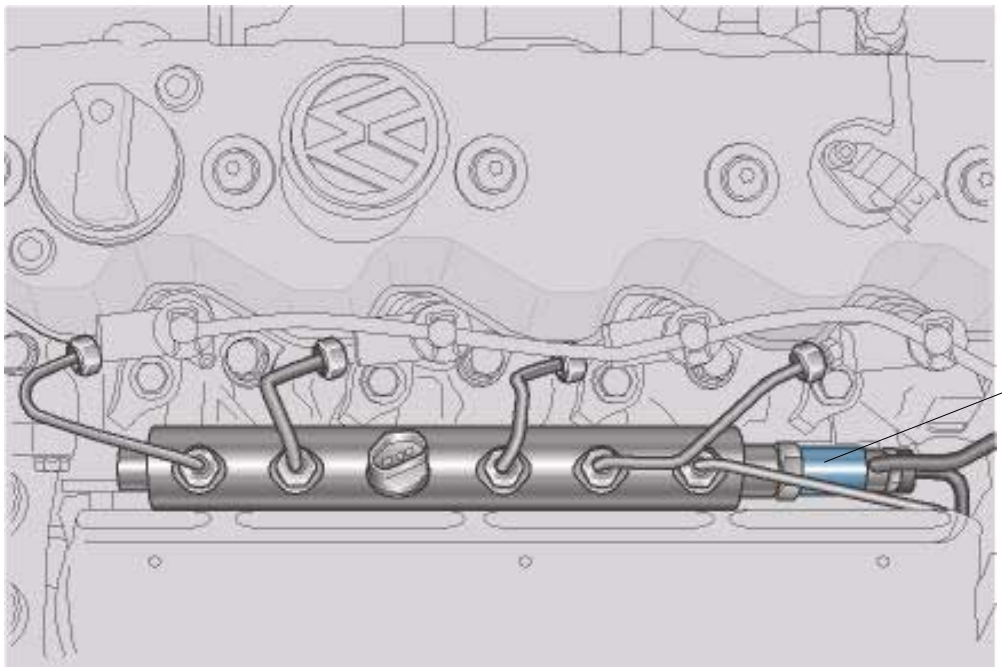
Pressure limiting valve

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.



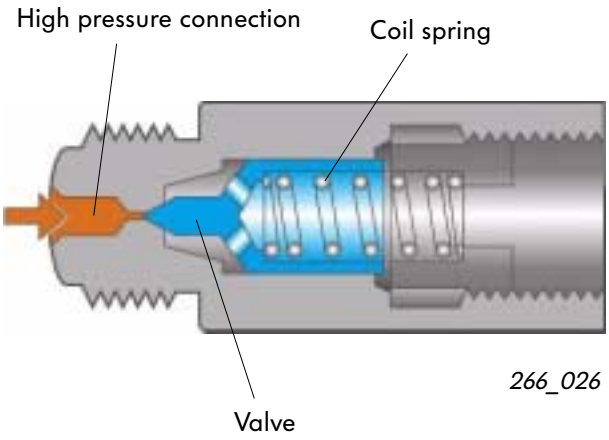
266_036a

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

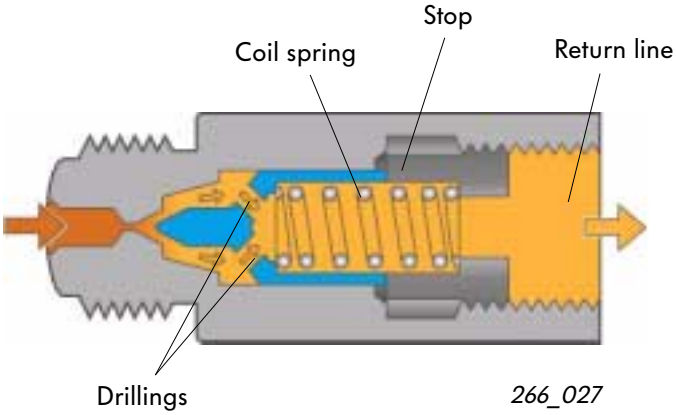


266_026

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.

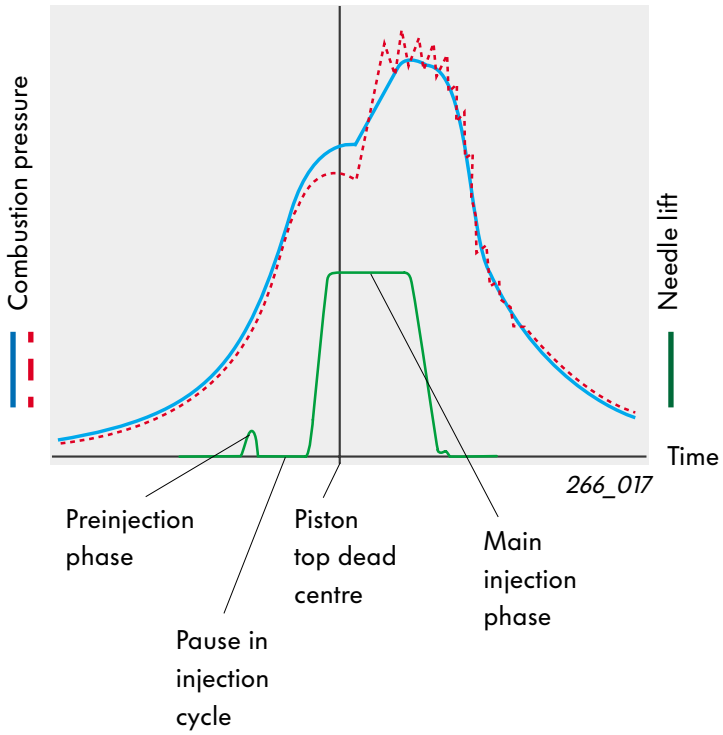
The advantages of the preinjection phase are:

- 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

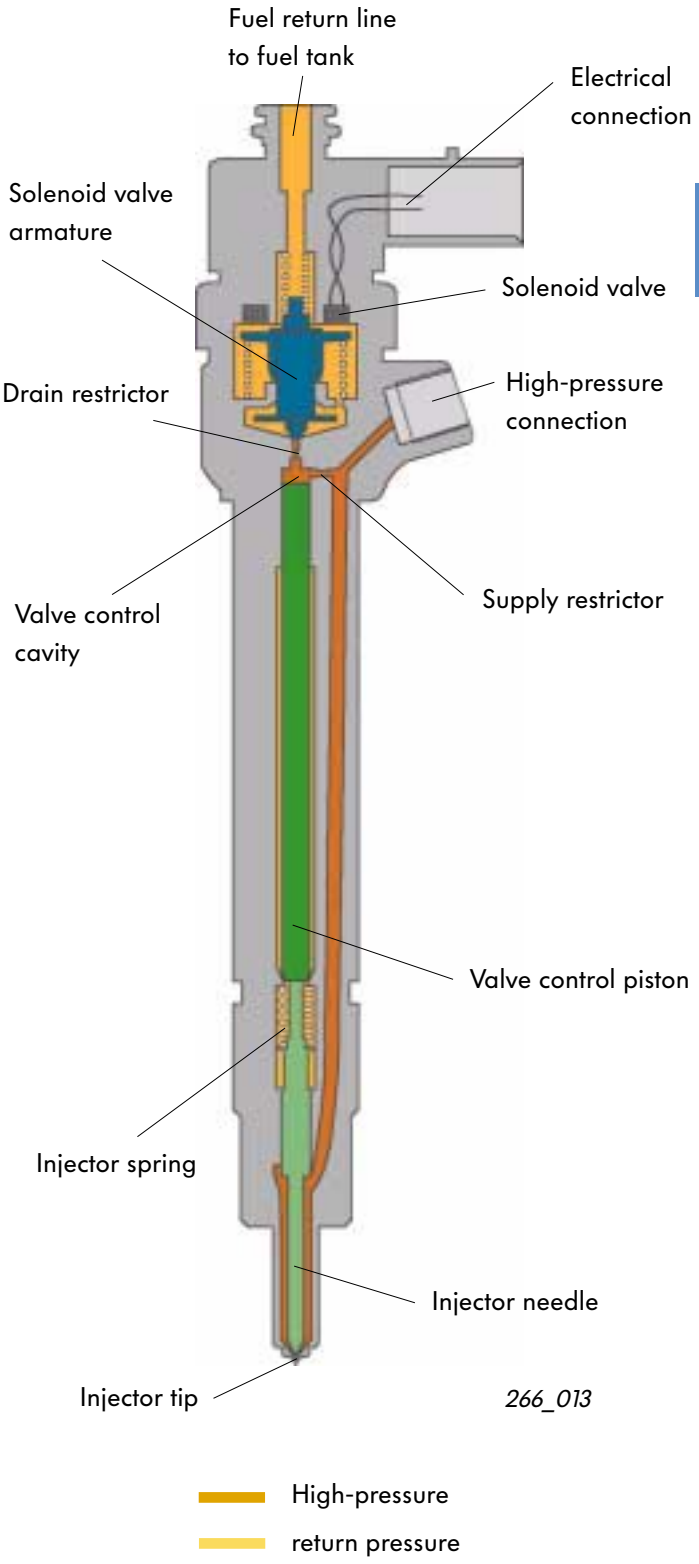
The injectors are fitted in the cylinder head.

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.

Design



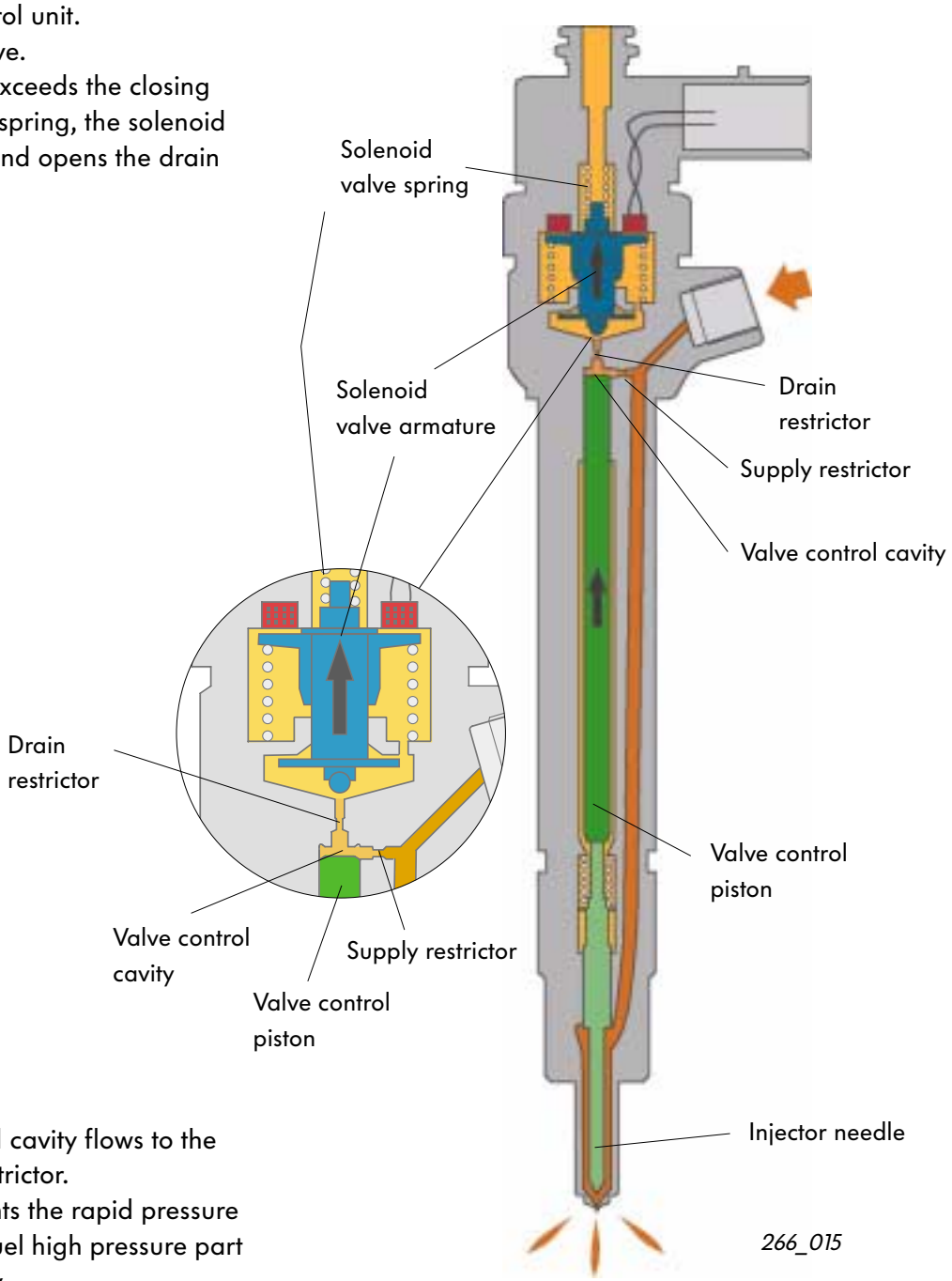
Any interruption in the electrical lead to an injector or in a solenoid valve will cause the engine to shut down.

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.

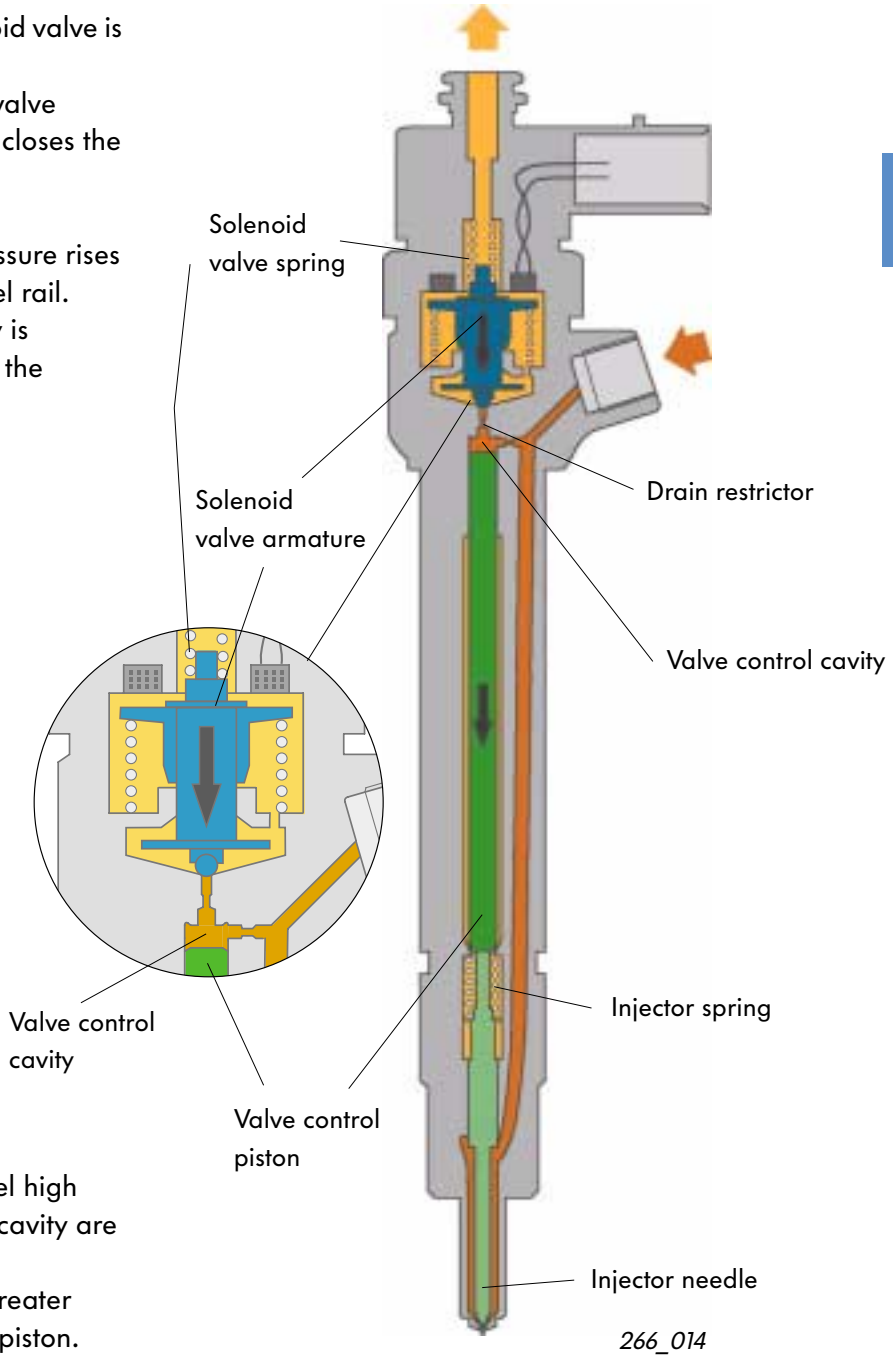


The fuel in the valve control cavity flows to the return line via the drain restrictor.
The supply restrictor prevents the rapid pressure equalisation between the fuel high pressure part and the valve control cavity.
The pressure acting on the valve control piston is lower at this moment than the fuel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

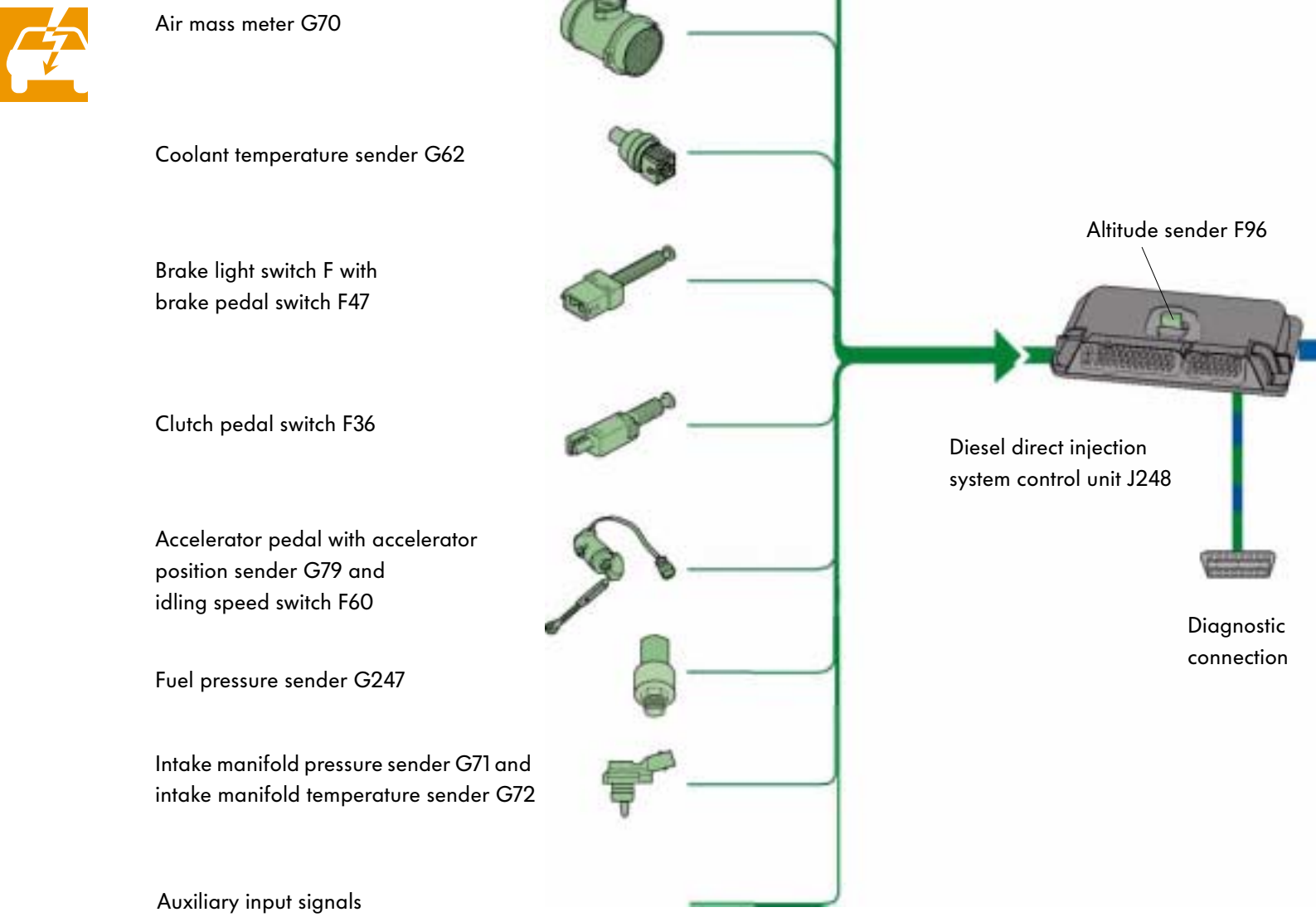


This means that the pressures in the fuel high pressure part and in the valve control cavity are again equal.
The injector needle closes due to the greater surface pressure acting on the control piston.
The injection cycle ends and the injector reverts back to its resting position.

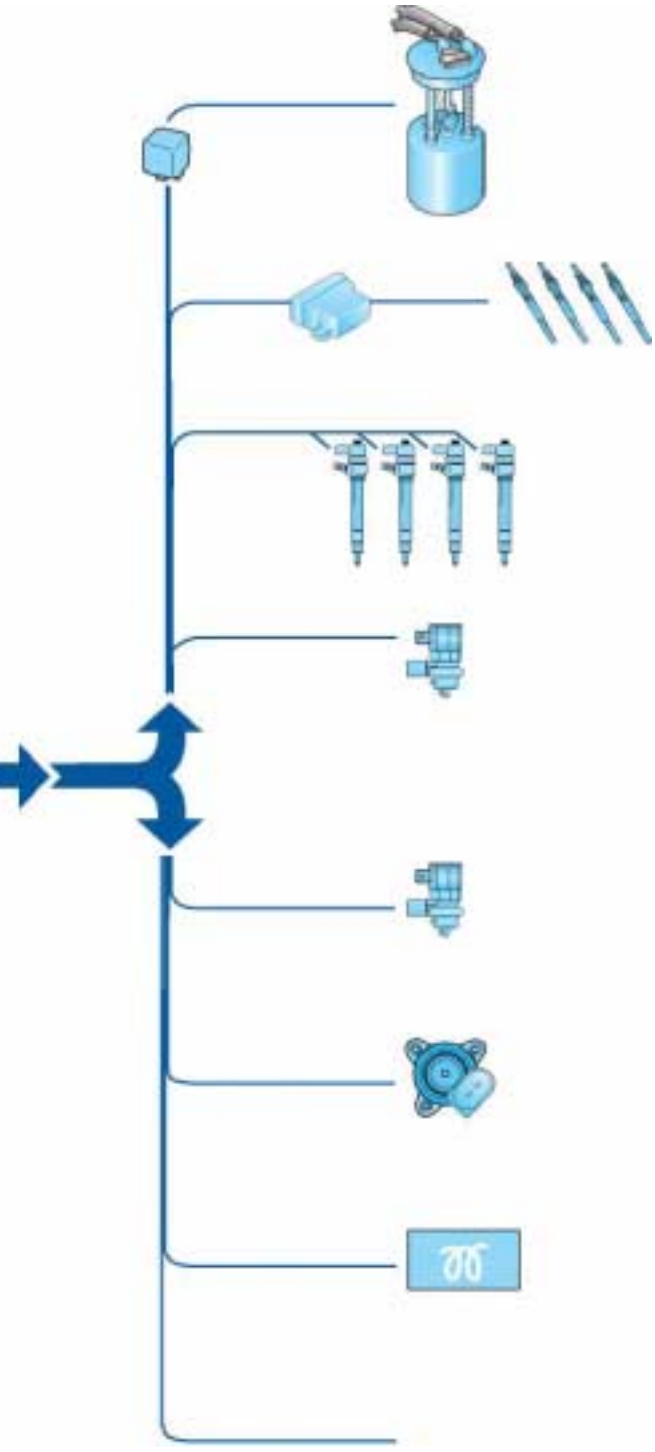
Engine management system

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

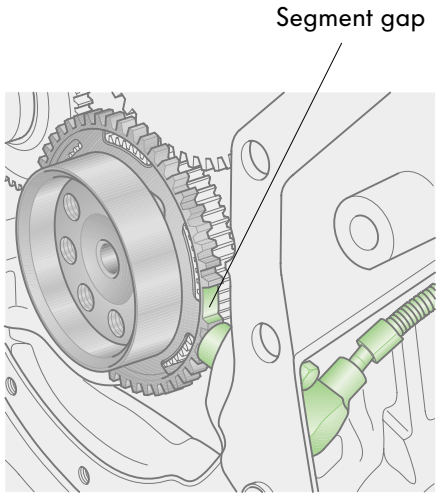
Glow period warning lamp K29

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

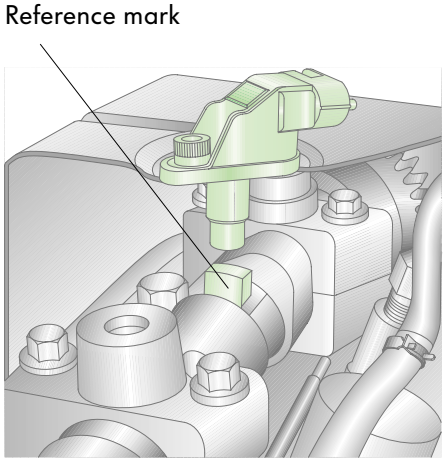
The signal detects the engine speed and the exact position of the crankshaft.
This information helps the diesel direct injection system control unit to calculate the injection point and injection quantity.

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

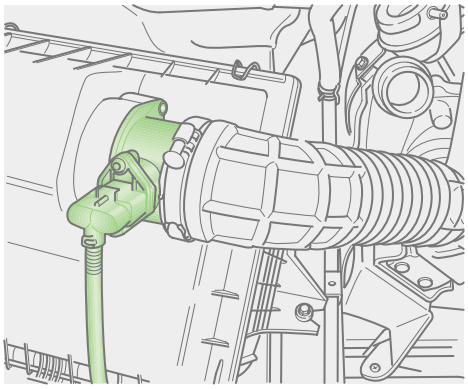
The signal is required by the diesel direct injection system control unit to detect the position of the first cylinder when the engine is started.

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

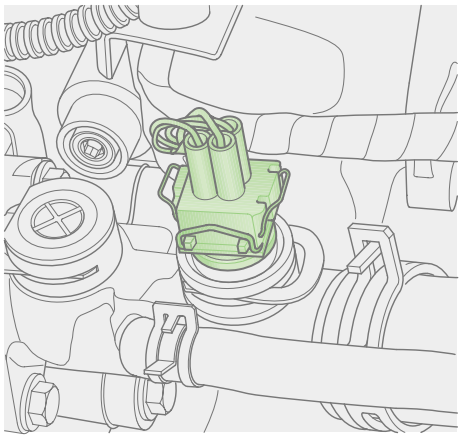
The signal values are used by the diesel direct injection system control unit to calculate the injection quantity.

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

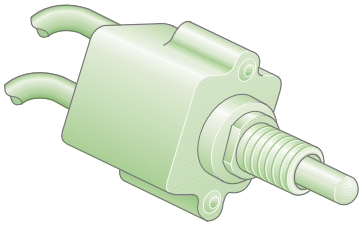
The two switches supply the diesel direct injection system control unit with the signal "brake actuated“. If the accelerator position sender is defective, the engine is throttled down for safety reasons when the brake is operated.

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

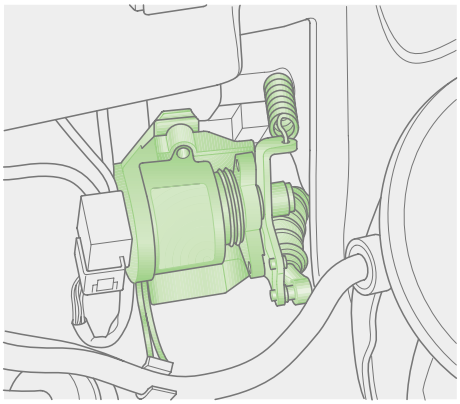
The signal helps the diesel direct injection system control unit to detect whether the clutch pedal is operated or not. When the clutch pedal is depressed, the injection quantity is reduced for a short period of time.
This prevents engine shudder during a gearshift operation.

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

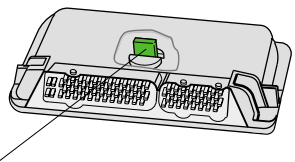
The accelerator pedal position acts as the main influencing factor to calculate the injection quantity.
The idling speed switch helps the diesel direct injection system control unit to recognise whether the accelerator pedal is being operated or not.

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.

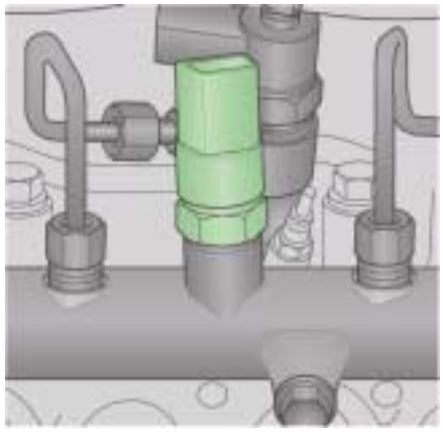
Effect of signal failure

Black smoke occurs at high altitudes.

Engine management system

Fuel pressure sender G247

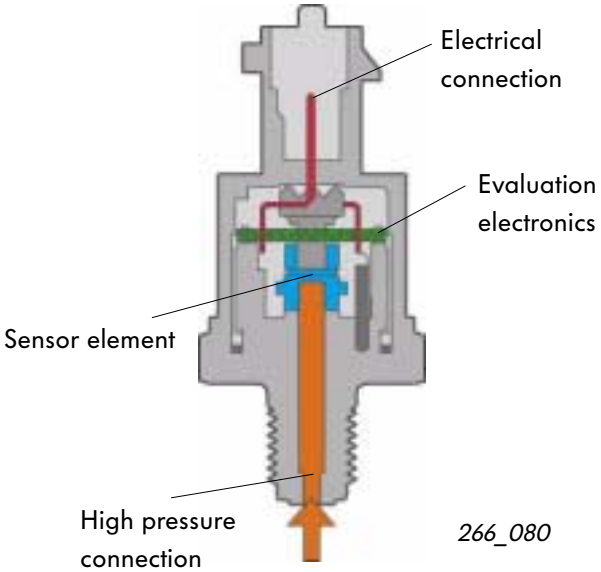
The fuel pressure sender is located on the high-pressure fuel rail and determines the current fuel pressure in the high-pressure section.



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.

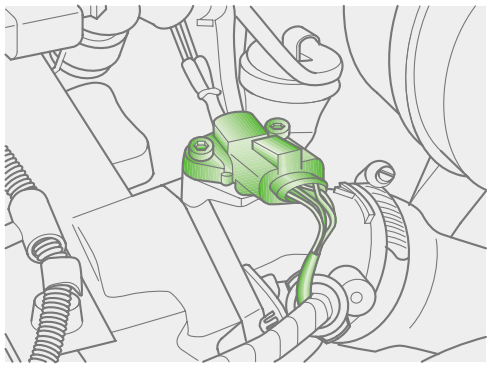
Effect of signal failure

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.

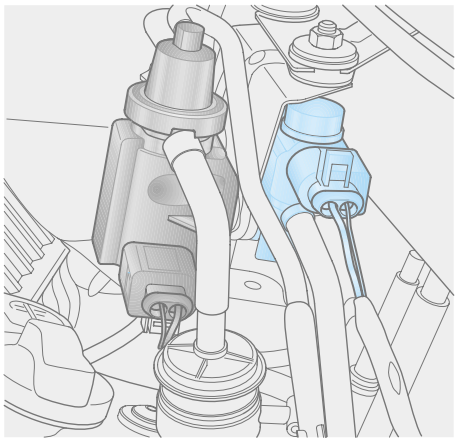
Air conditioner compressor

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.



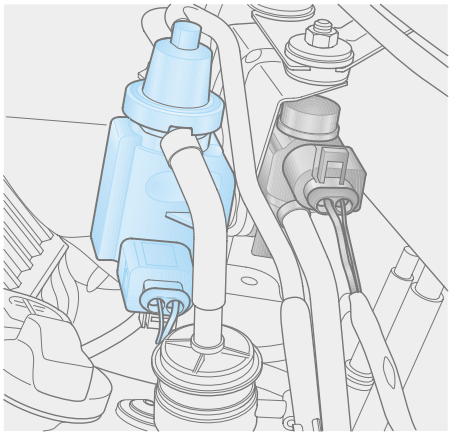
266_075

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

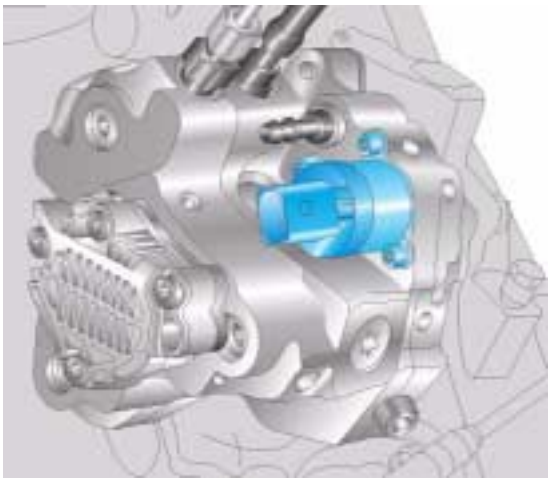
Fuel pressure regulating valve N276

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

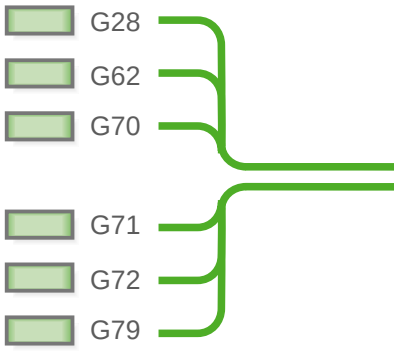
Control procedure

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.



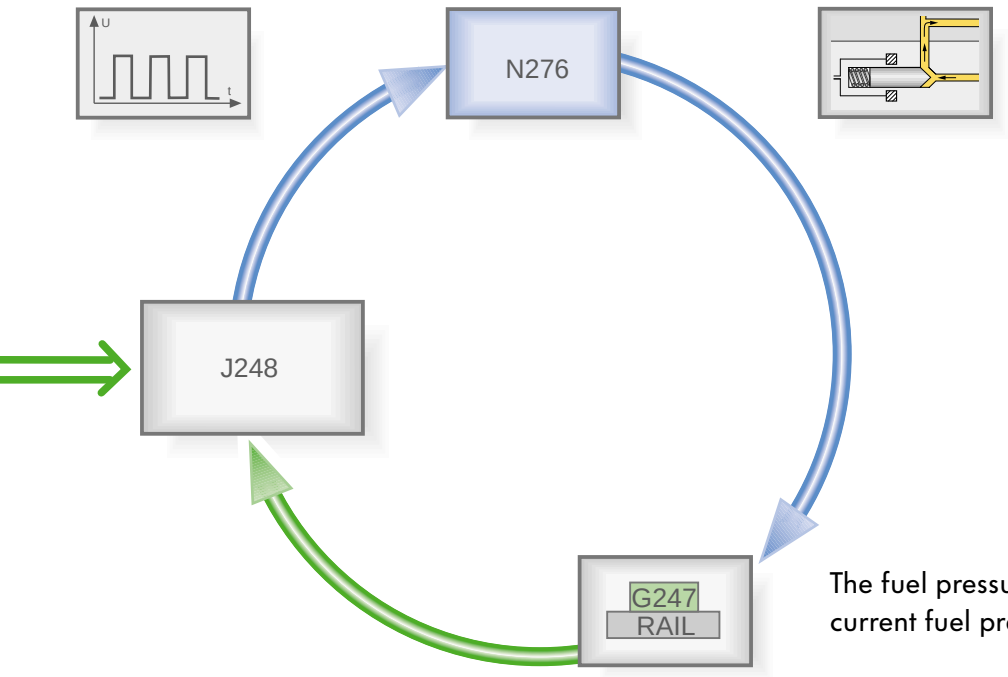
The diesel direct injection system control unit then activates the regulating valve N276 using a pulse-width modulated signal:

- 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.

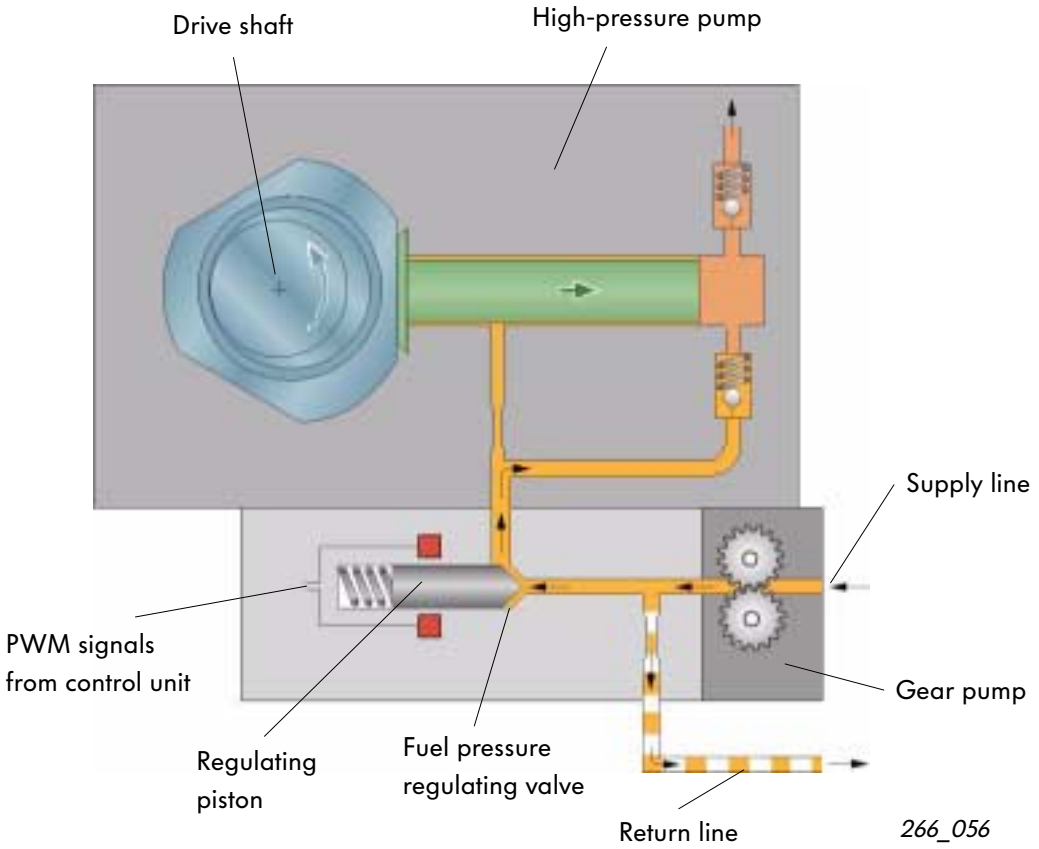
266_094a

Function

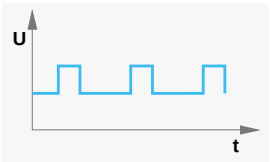
Low fuel pressure

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



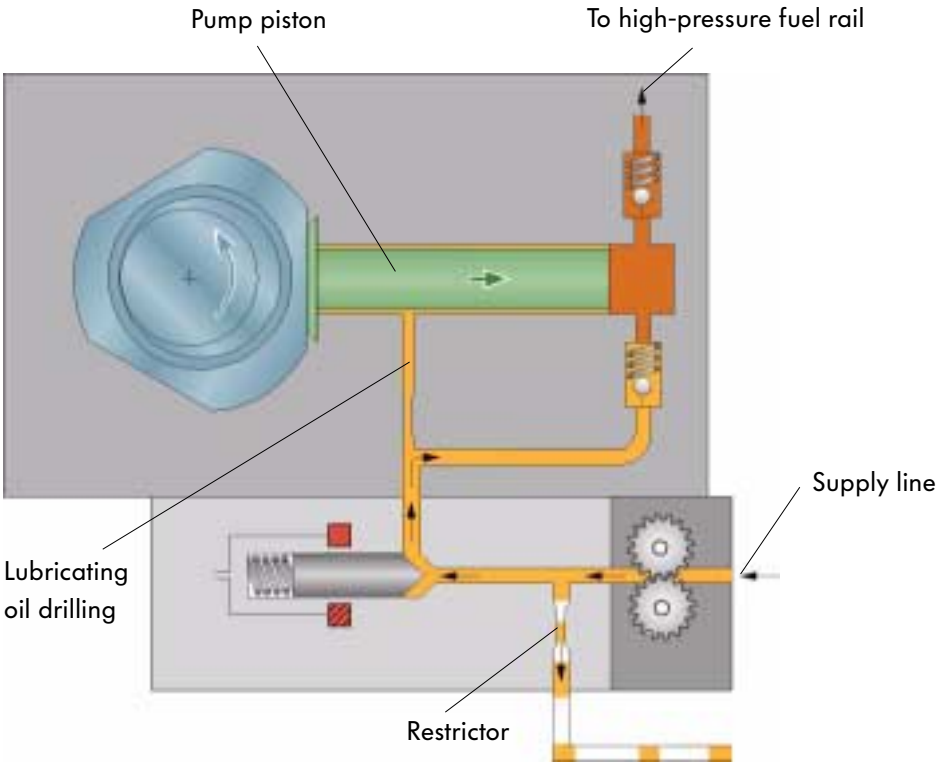
PWM signal with short pulse width

266_106

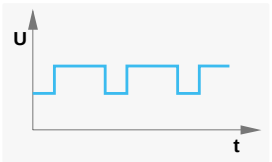
High fuel pressure

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

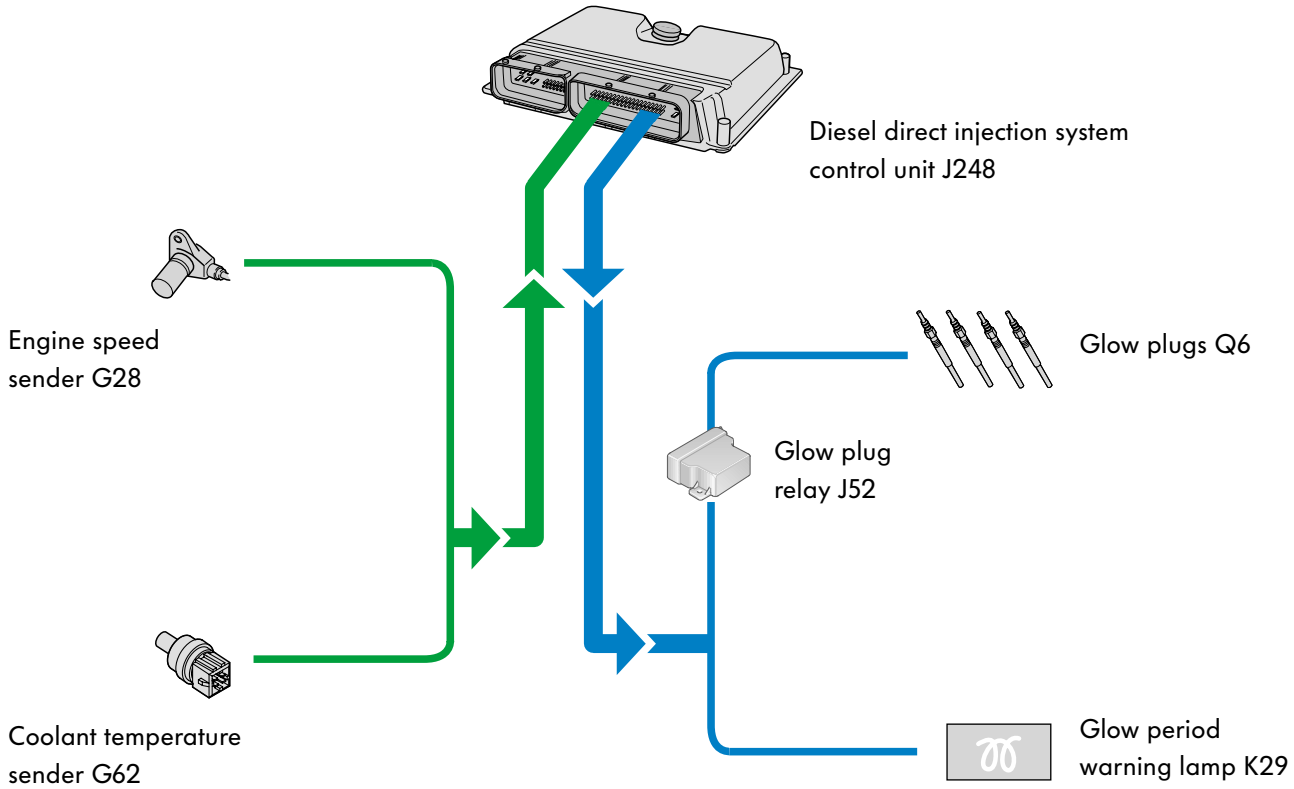
Engine management system

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

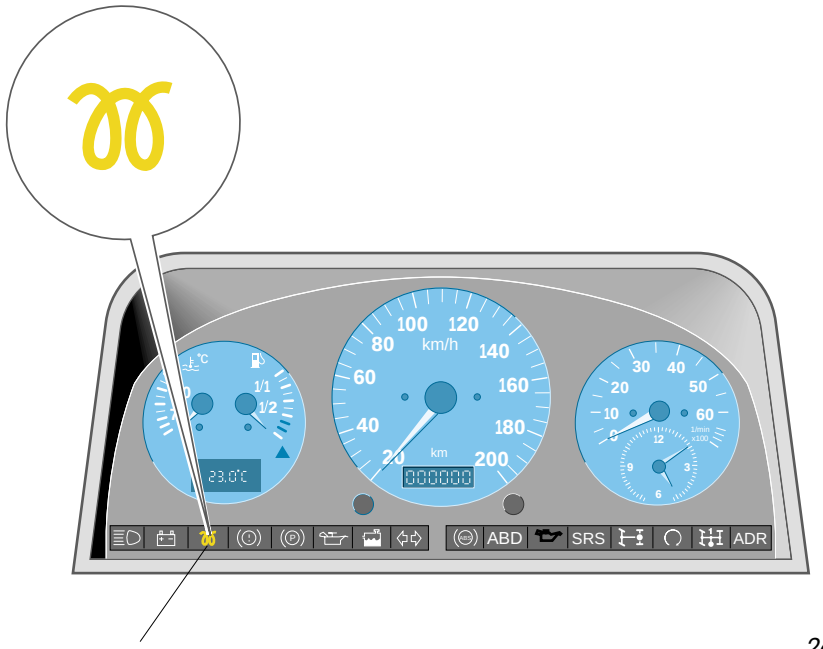
The glow period makes a distinction between two phases:

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.



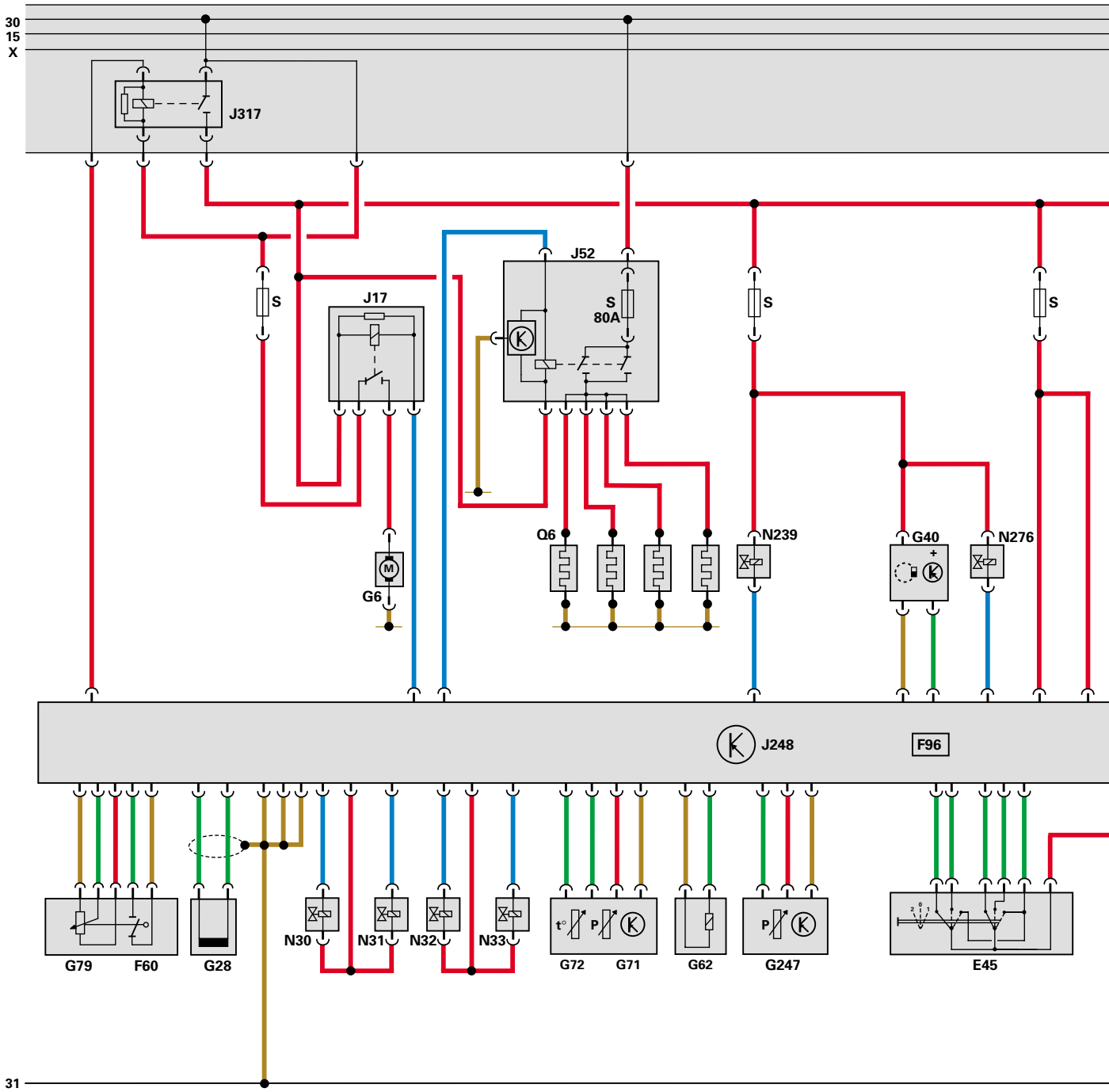
266_105c

Glow period
warning lamp K29

Engine management system

Function diagram

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



Colour codes

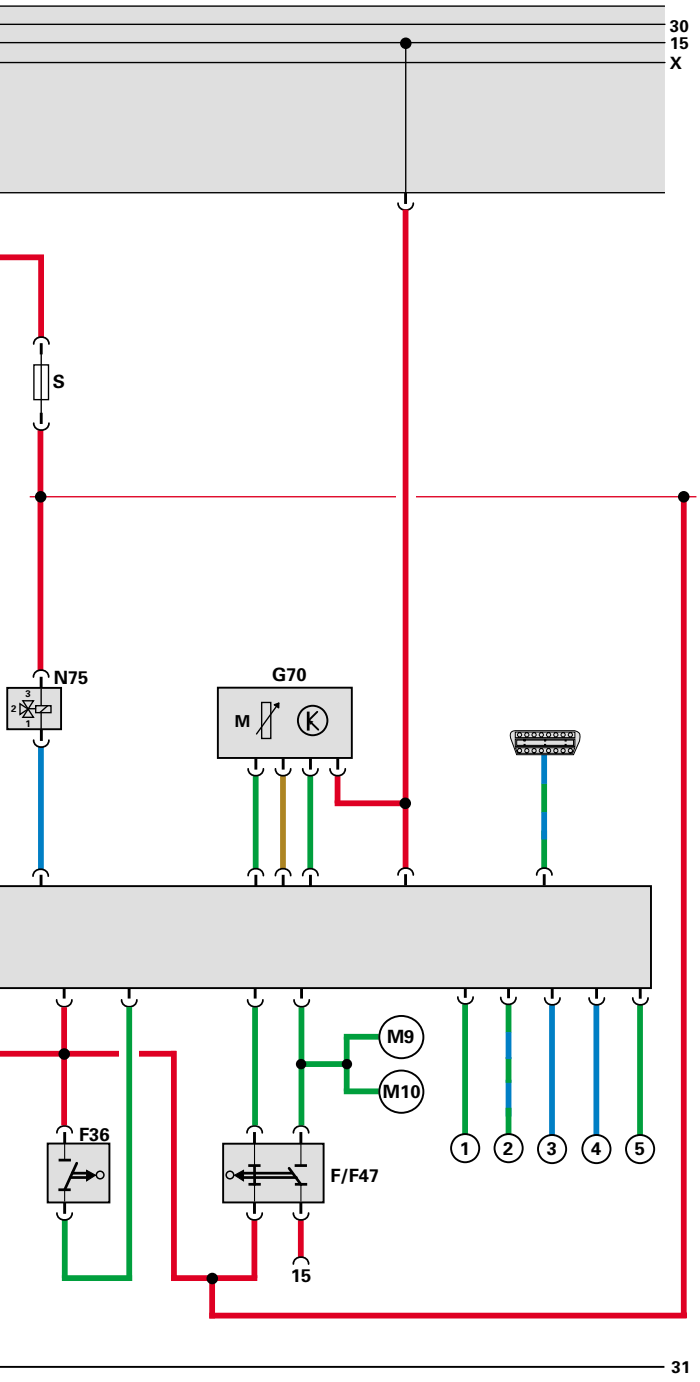
= input signal

= output signal

= positive

= GND

= bidirectional



266_001

Auxiliary signals

(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

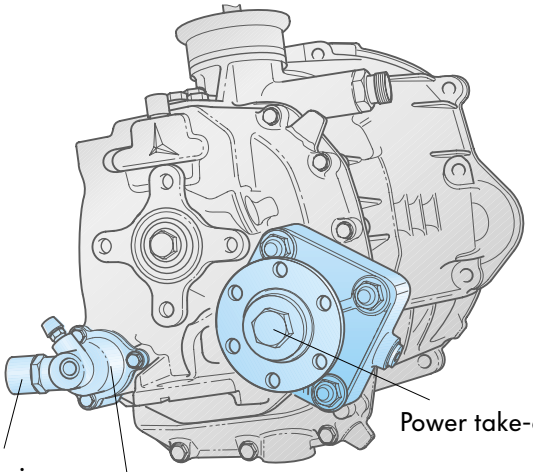
S - Fuse

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.

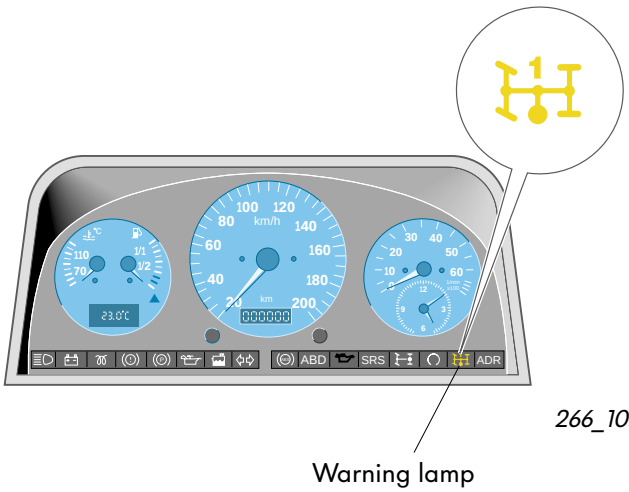


266_083

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

266_103

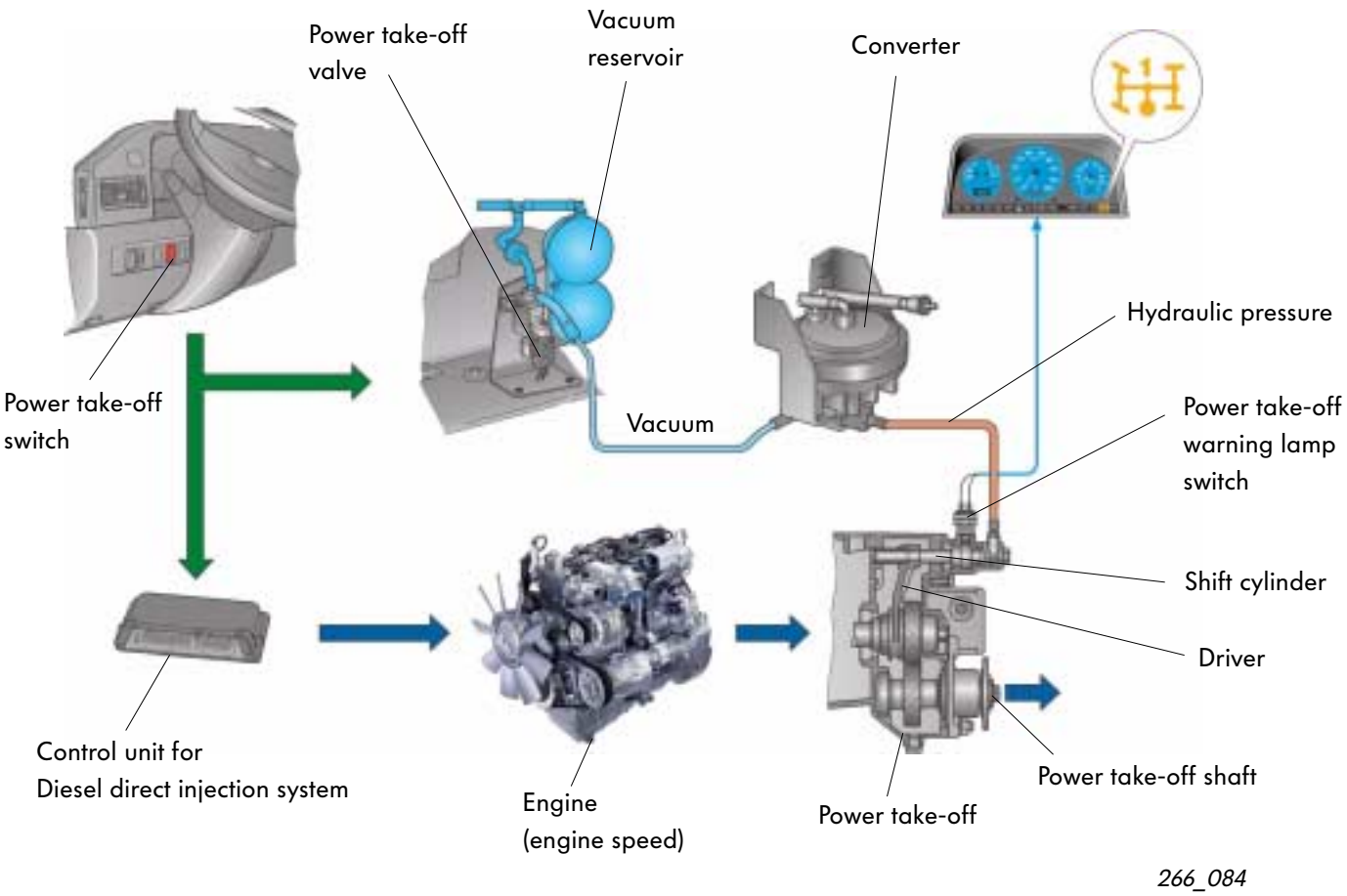
When the power take-off is activated, the warning lamp in the dash panel insert lights up.



266_105b

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.

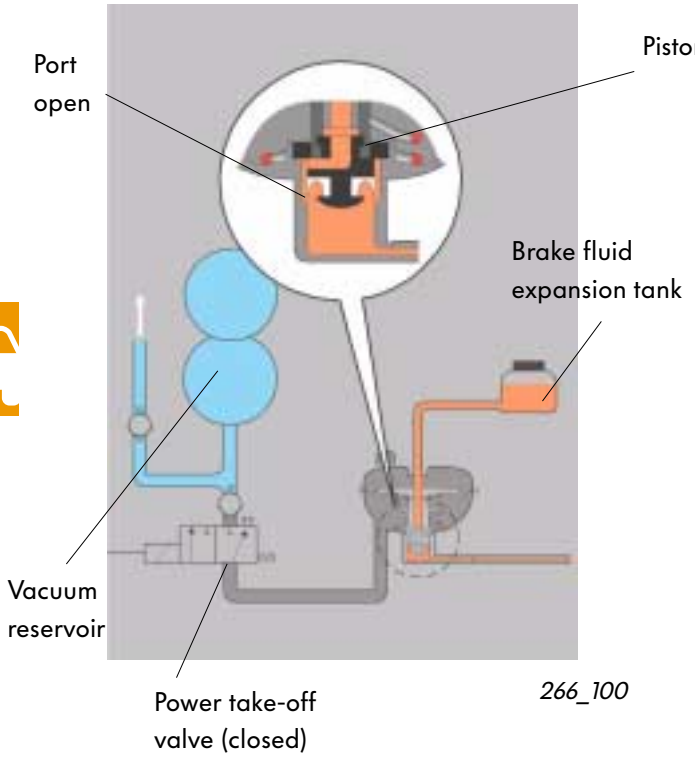
The warning lamp switch on the shift cylinder switches the warning lamp for the power take-off in the dash panel insert.
The warning lamp remains lit as long as the power take-off is on.

Auxiliary functions

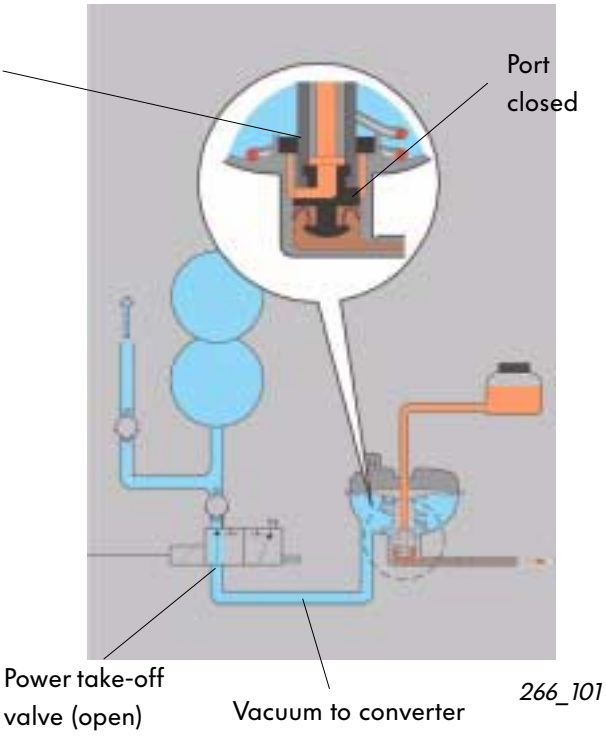
Converter

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

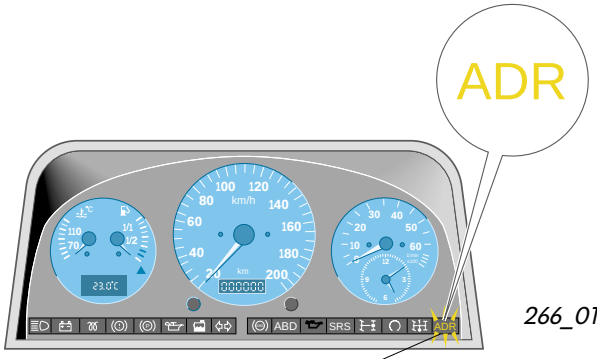
The working speed of the power take-off is controlled using the engine speed by the diesel direct injection system control unit.

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.

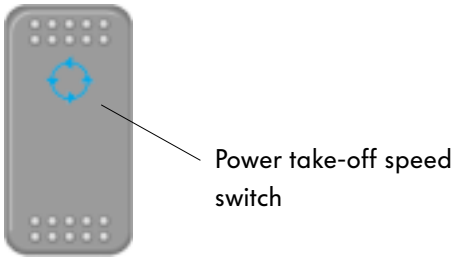
Depending on the type of power take-off, a
- variable working speed control or a
- fixed working speed control
can be used.



266_0105a

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.



266_093

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.

266

240.2810.85.20 Technical status 03/02