

Service.



The 2.0 I 110 kW engine with petrol direct injection (FSI)

Self Study Programme 279

Improved methods of injecting petrol into the intake port represent more or less the limit of what can be done to optimise economy with conventional techniques. The direct injection principle opens up new possible ways of creating more economical and environmentally sound petrol engines.

Thrifty diesel engines employ direct injection, in other words, the amount of fuel supplied corresponds exactly to the requirements at any given time.



The logical next step - at least in theory - would therefore be to apply the principle of direct injection to petrol engines as well.

FSI technology from Audi opens up a whole new dimension for the petrol engine.

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The Self Study Programme contains information on design features and functions.

**The Self Study Programme is not intended as a Workshop Manual. Values given are only intended to help explain the subject matter and relate to the software version applicable when the SSP was compiled.**

Use should always be made of the latest technical publications when performing maintenance and repair work.

**New**



**Attention Note**

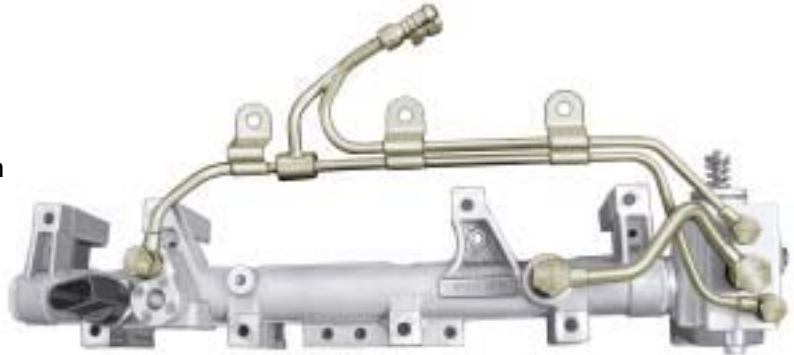


# Introduction



## Highlights of the FSI engine

High-pressure injection system with newly developed single-plunger high-pressure pump



279\_041



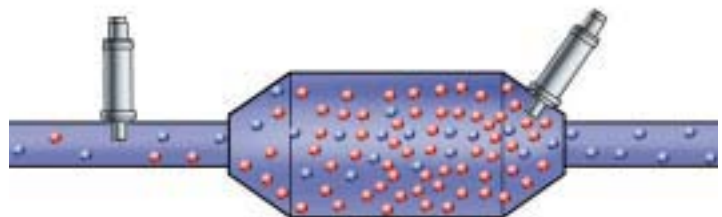
279\_025



279\_030

Air-controlled combustion process with map-controlled in-cylinder flow (stratified charge and homogeneous operation)

Enhanced exhaust gas treatment system with NO<sub>x</sub> storage catalytic converter and NO<sub>x</sub> sender

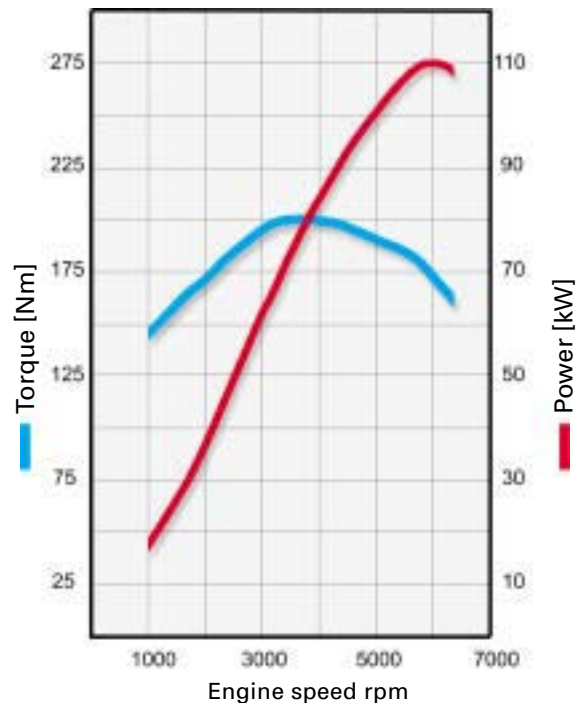


279\_007

## 2.0 I FSI engine



279\_001



279\_008

### Technical data:

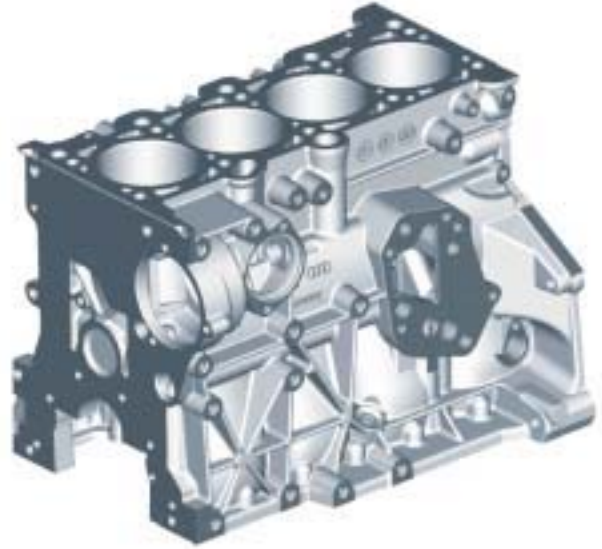
Engine code letters:	<b>AWA</b>		
Capacity:	1984 ccm	Valve timing:	Inlet opens 28° after TDC
Bore:	82.5 mm		Inlet closes 48° after BDC
Stroke:	92.8 mm		Exhaust opens 28° before BDC
Compression ratio:	11.5: 1		Exhaust closes 8° before TDC
Power:	110 kW (150 hp)	Inlet camshaft adjustment range:	42° crankshaft
Torque:	200 Nm/ 3250-4250 rpm	Emission class:	EU IV
Engine management system:	MED. 7.1.1	Capacities:	Engine oil incl. filter 4.8l
Valves:	4 per cylinder	Consumption: (5-speed manual gearbox)	Urban 9.9l/100 km
Valve timing:	Roller-type rocker fingers with hydraulic support elements		Non-urban 5.4l/100 km
			Average 7.1l/100 km

# Engine

## Engine block

The engine block is made of an aluminium alloy and is the most compact type in its class with a cylinder spacing of 88 mm and an overall length of only 460 mm.

The engine block is identical to that of the 2.0 l engine with manifold injection (crankshaft, conrods, balance shafts and oil pump).

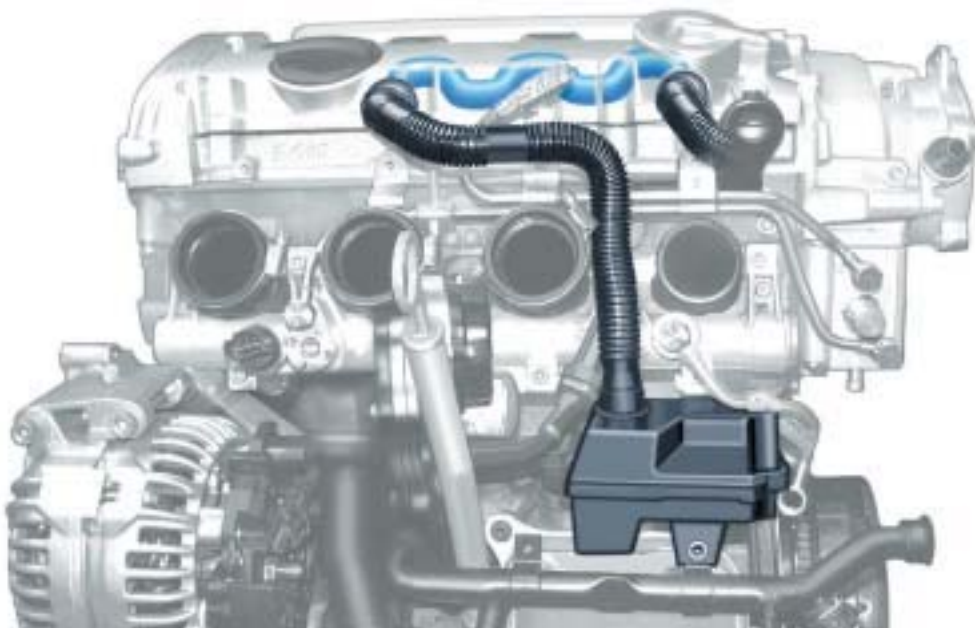


279\_009

## Crankcase breather

The blow-by gases are routed from the engine block directly into the first oil separator. The majority of the oil particles are removed from the gases in the oil separator labyrinth.

From there, the gases pass via the hose connection into the integrated labyrinth of the cylinder head cover and then as virtually oil-free blow-by gases into the intake manifold by way of the pressure control valve.



279\_046



## Pistons

Use is made of lightweight aluminium alloy solid-skirt pistons with closely spaced piston pin bosses.

Advantage: Reduced oscillating masses and lower coefficients of friction as only a part of the piston skirt periphery runs in the cylinder.

A bowl incorporated into the piston crown aims the air flow directly towards the spark plug in stratified charge operation. The geometric shape of the piston causes the air flow to "tumble".

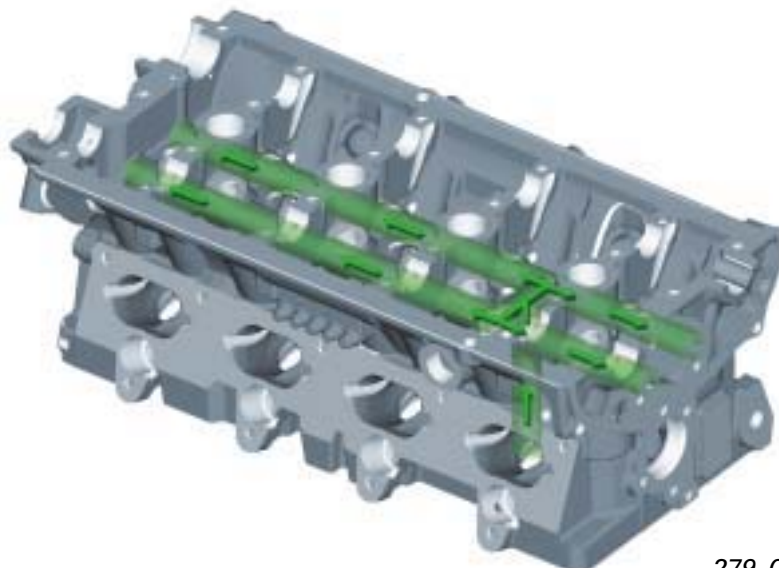


279\_010

## Oil circulation

The use of a 4-valve cylinder head with roller-type rocker fingers represents a major change in oil gallery design with respect to the 5-valve cylinder head with bucket tappets. Passing via the main oil gallery from the engine block, the oil enters the cylinder head between cylinders 3 and 4.

Oil pressure is applied to the hydraulic support elements and camshaft bearings by way of two oil ducts. The support elements are provided with a spray orifice for lubrication of the roller-type rocker fingers. Further along the oil ducts, oil pressure is applied to the rotary motor for camshaft adjustment.



279\_011



# Engine

## Cylinder head

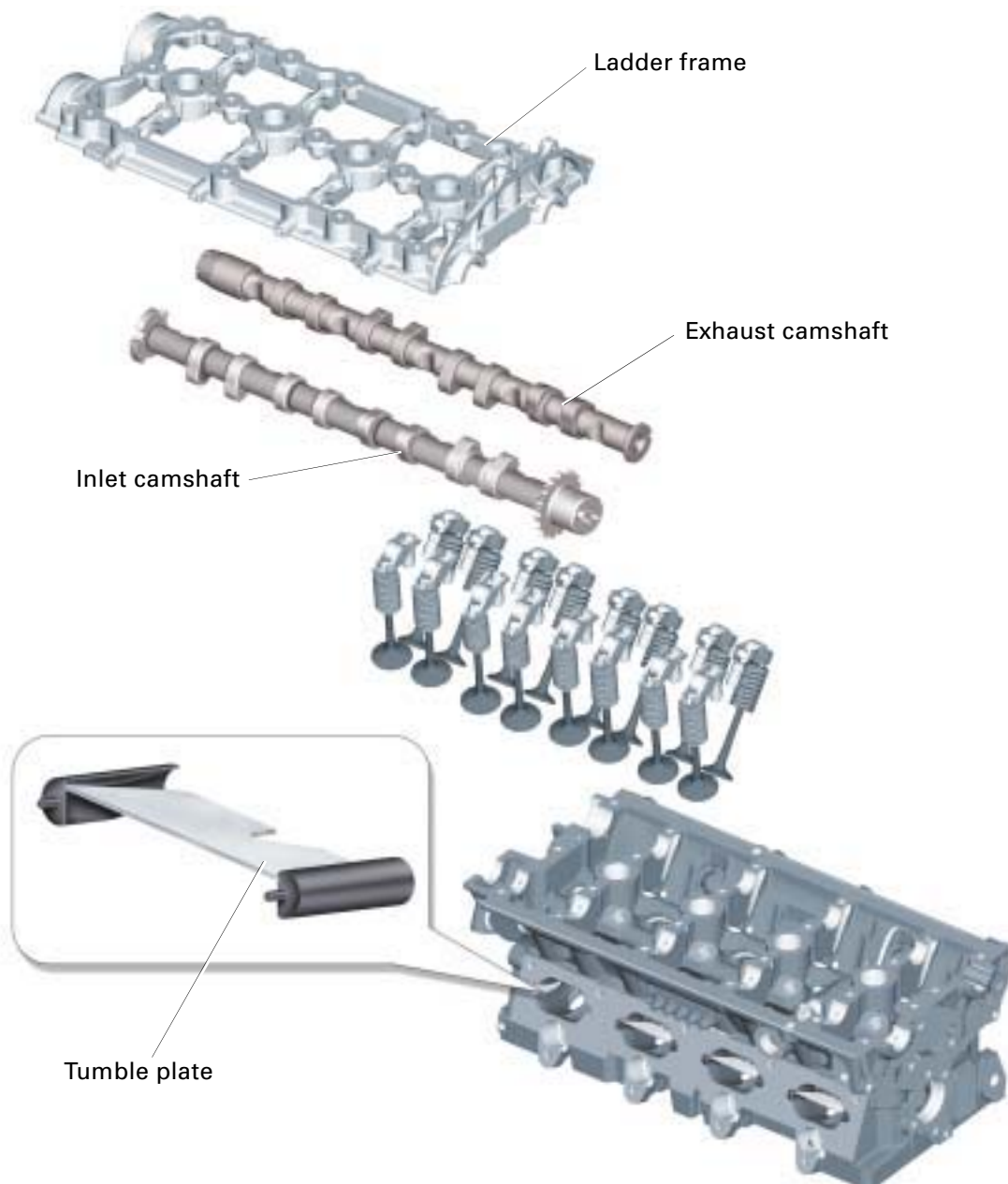
The 4-valve cylinder head with roller-type rocker fingers is designed to suit the direct injection process.

Valve timing is provided by way of two composite overhead camshafts rigidly mounted in a ladder frame.

The exhaust camshaft is driven by a toothed belt, which in turn drives the inlet camshaft by way of a simple chain.

Each intake port is split into a top and bottom half by a tumble plate, the shape of which is designed to prevent incorrect installation.

The mounts for the high-pressure injectors are integrated into the cylinder head, with the actual injectors projecting directly into the combustion chamber.

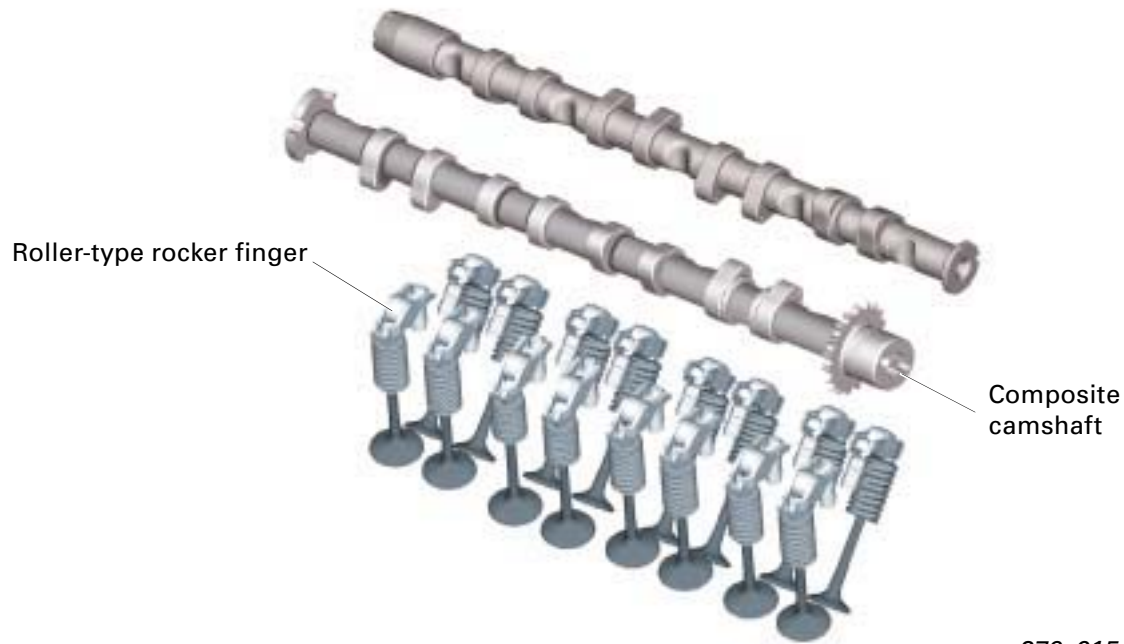


279\_013



The valve gear takes the form of a "light valve gear" (i.e. with one valve spring only).

The valves are actuated by two composite camshafts via roller-type rocker fingers which rest on hydraulic valve lifters.



The valve cover is made of plastic and features a permanently attached elastomer seal.

The valve cover contains the pressure control valve for the crankcase breather and the internal oil separator.



# Engine

## Camshaft timing control

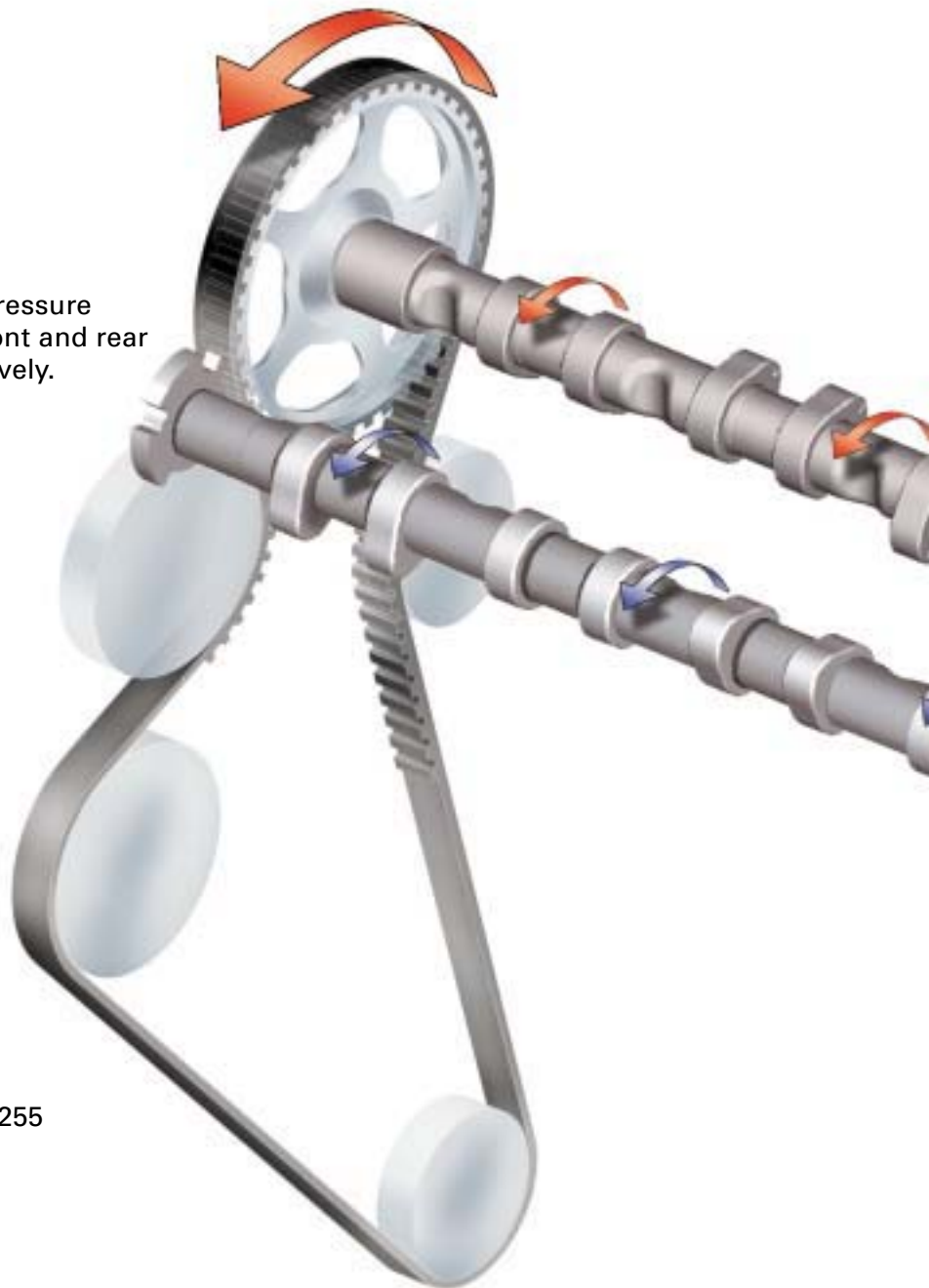
Continuous map-controlled hydraulic camshaft adjustment by up to 42° crank angle is achieved by way of a rotary motor.

The toothed belt drives the exhaust camshaft. The rotor of the motor is attached to the other end of the exhaust camshaft.

The stator is connected directly to the chain sprocket and drives the inlet camshaft via the chain.

The stator adjustment is transmitted by way of the chain to the inlet camshaft, thus varying the inlet valve timing.

The Hall sender wheel and high-pressure pump drive are attached to the front and rear end of the inlet camshaft respectively.

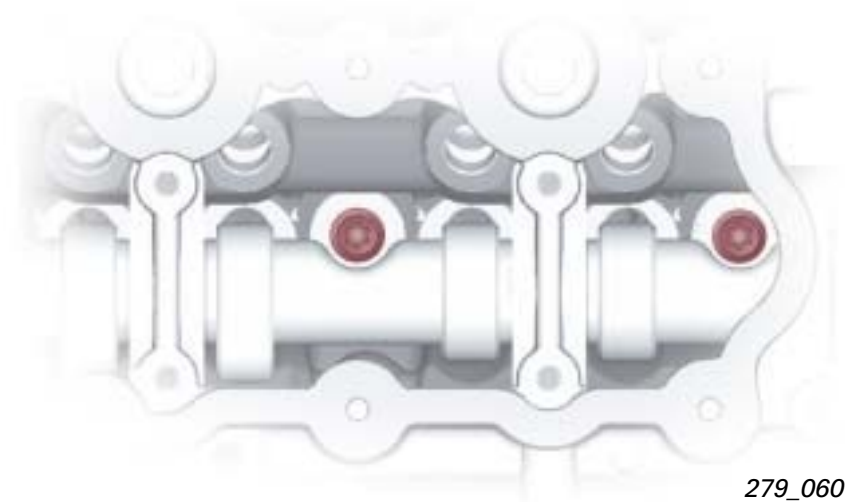
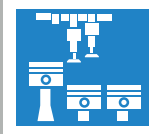


For details of camshaft timing control, refer to SSP 255

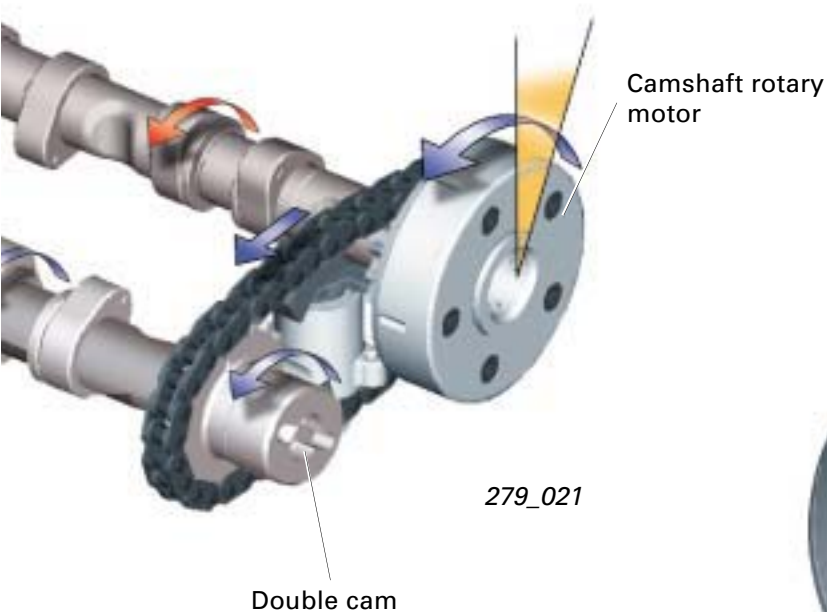
## Camshaft positioning

The inlet and exhaust camshafts must be turned such that the recesses are vertically opposed.

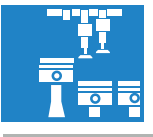
In this camshaft position the drive chain can be fitted without having to determine the number of rollers. This is also the only position in which the cylinder head bolts can be inserted and removed.



**!** The tightening torque for the cylinder head bolts is given in the latest Workshop Manual in ELSA (electronic service information system).



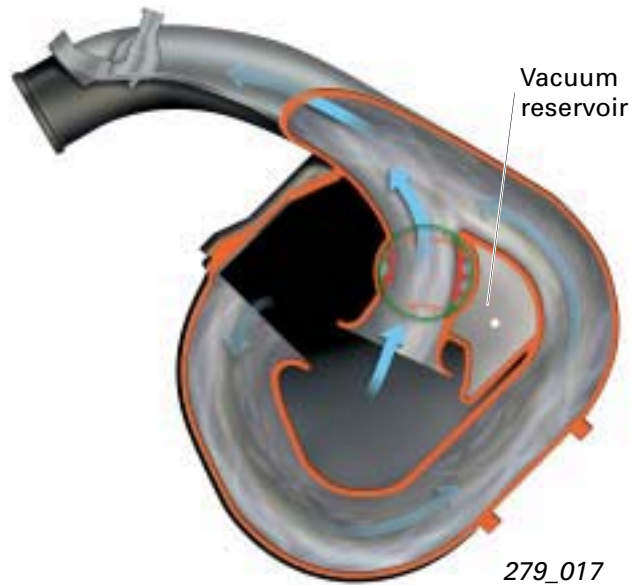
# Engine



## Intake manifold

The two-stage variable intake manifold promotes the desired power and torque characteristics. Pneumatic switching of the changeover barrel from torque to power position is map-controlled, with load, engine speed and temperature representing the relevant variables.

The vacuum reservoir is integrated into the intake manifold module.



279\_017

## Lower part of intake manifold

The lower part of the intake manifold contains four flaps which are driven by the intake-manifold flap motor -V157 via a joint shaft.

The potentiometer -G336 integrated into the motor provides the engine control unit -J220 with feedback on flap position.

The position of the intake-manifold flaps influences mixture formation and thus emission values. Intake-manifold flap control is classified as an emission-specific system and is monitored by the EOBD.

The lower part of the intake manifold is bolted to the fuel rail.



279\_018

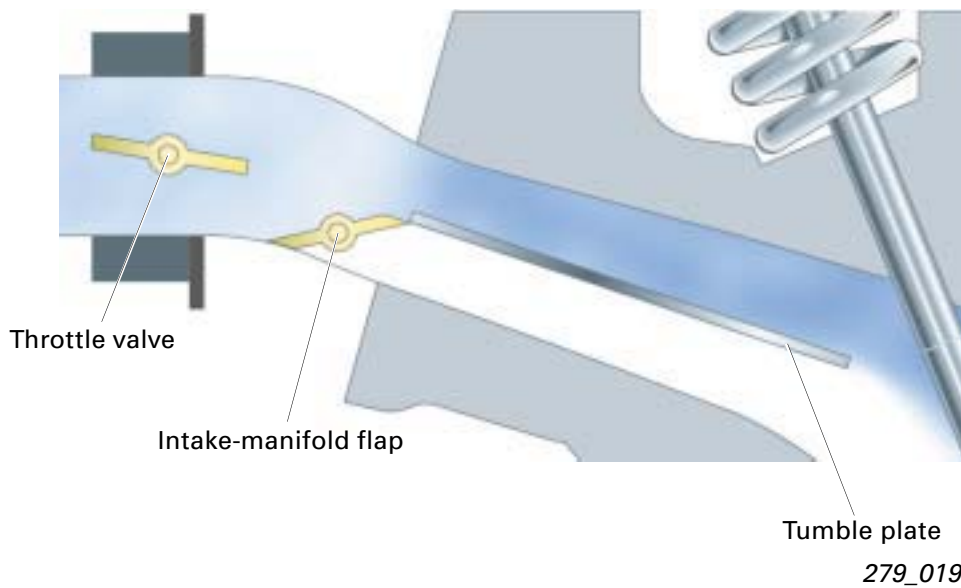
## Intake air routing

There are two alternatives for air routing with the FSI system.

### Version 1:

The intake-manifold flap is closed and the intake air mass thus routed over the tumble plate into the combustion chamber.

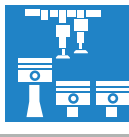
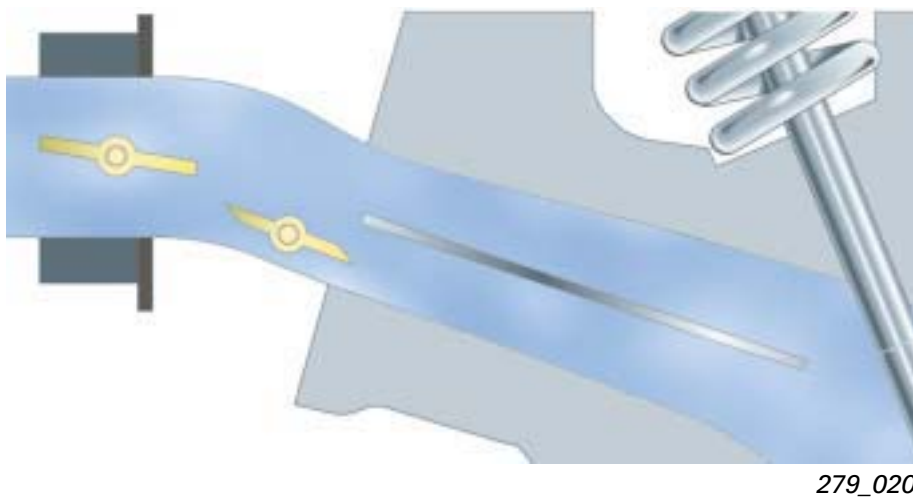
This method of air routing is used for stratified charge operation.



### Version 2:

The intake-manifold flap is opened and the intake air mass thus routed over and under the tumble plate into the combustion chamber. This method of air routing permits homogeneous operation.

Such a method is referred to as air-controlled combustion with map-controlled in-cylinder flow.





# Engine management

## System components

Air-mass meter -G70

Intake-manifold pressure sender -G71  
Intake-air temperature sender -G42

Engine speed sender -G28

Hall sender -G40

Throttle valve control part-J338  
Angle senders 1 + 2 -G187,  
-G188

Accelerator position sender -G79  
Accelerator pedal position sender 2  
-G185

Brake light switch -F  
CCS brake pedal switch -F47

Fuel pressure sender -G247

Intake-manifold flap potentiometer  
-G336

Knock sensors -G61, -G66

Coolant temperature sender -G62

Coolant temperature sender -  
radiator outlet -G83

Operating and display  
unit for AC -E87

EGR potentiometer -G212

Lambda probe -G39  
Lambda probe after catalyst -G130

Exhaust-gas temperature sender  
-G235

NO<sub>x</sub> sender -G295,  
control unit for NO<sub>x</sub> sender -J583

Additional input signal

Motronic control  
unit -J220

Steering angle  
sender -G85

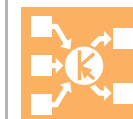
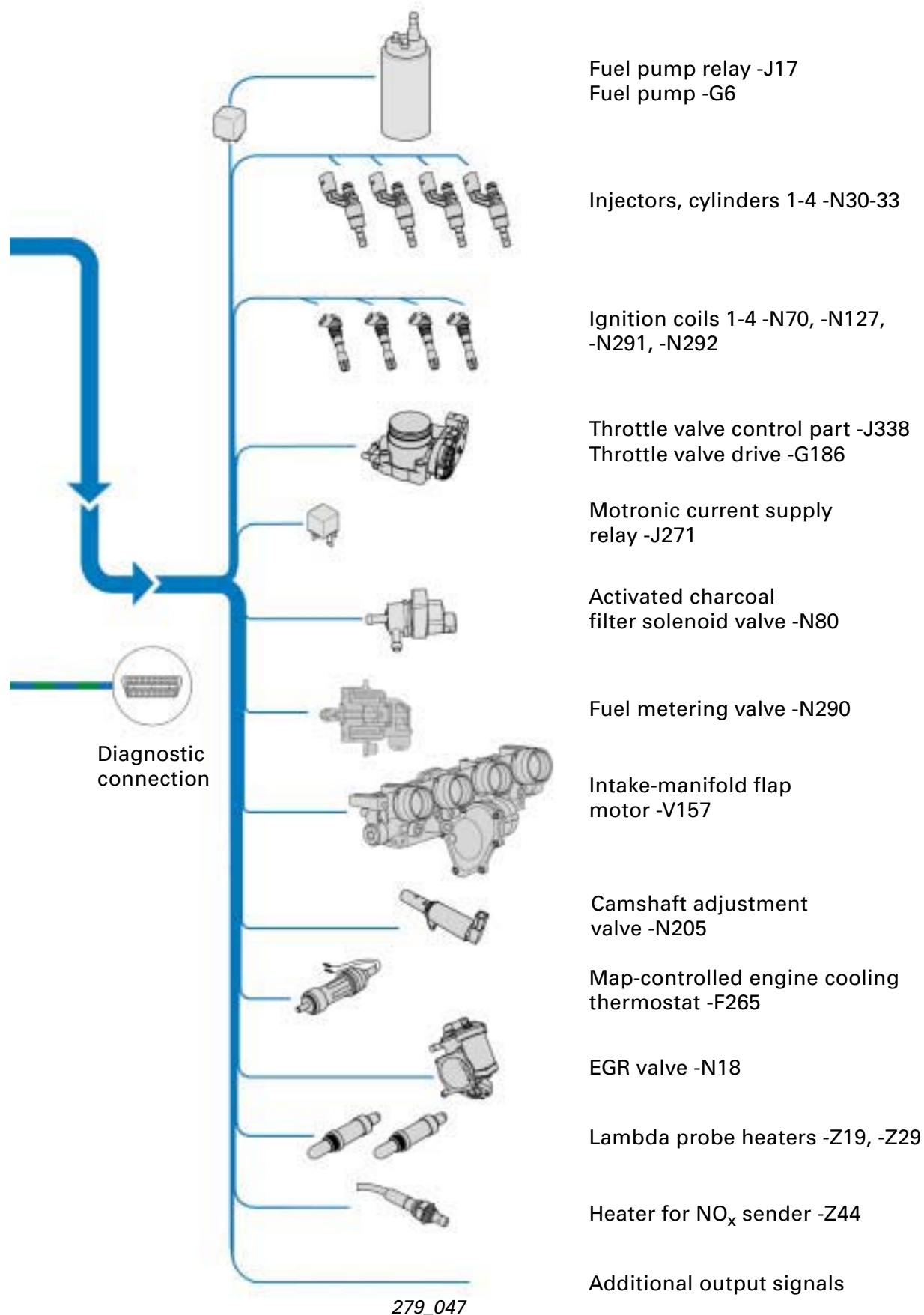
ABS control unit  
-J104

Automatic gearbox  
control unit

Airbag  
control unit -J234

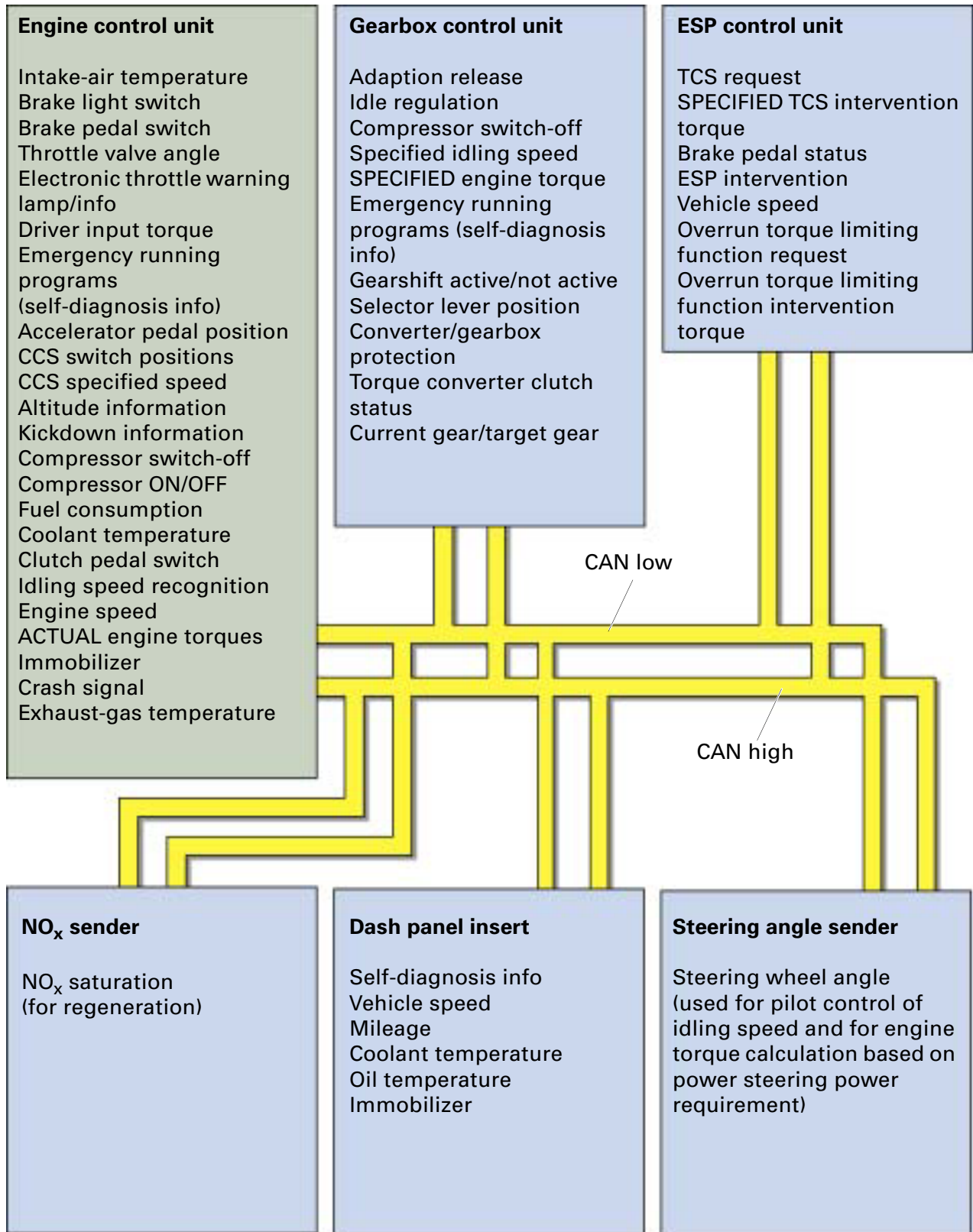
Control unit with display  
in dash panel  
insert -J285

Operating and display  
unit for AC -E87



# Engine management

## CAN bus interfaces



279\_067

## Engine control unit

Use is made for engine management of the Motronic control unit MED 7.1.1.

**The designation MED 7.1.1 stands for:**

M = Motronic  
E = Electronic throttle  
**D = Direct injection**  
7. = Version  
1.1 = Development status

The Bosch Motronic MED 7.1.1 incorporates petrol direct injection. With this system the fuel is injected directly into the cylinder and not into the intake manifold.



279\_048



## Modes of operation

Whereas conventional petrol engines are reliant on a homogeneous air/fuel mixture, lean petrol direct injection engines can be operated with a high level of excess air in the part-throttle range by means of specific charge stratification.

There are two main modes of operation with the FSI system: Stratified charge operation in the part-throttle range and homogeneous operation in the full-throttle range.



Four more modes of operation are available to round off the FSI concept. These modes of operation are contained in the reading measured value block function.

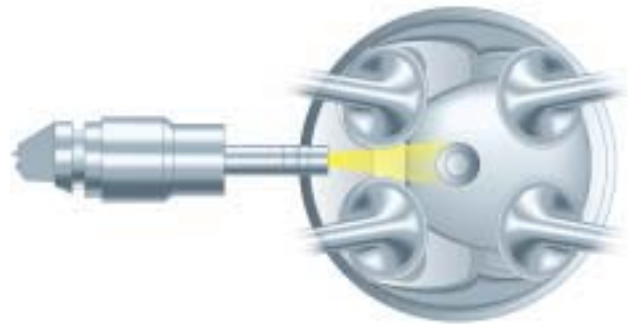
# Engine management

## Stratified charge operation

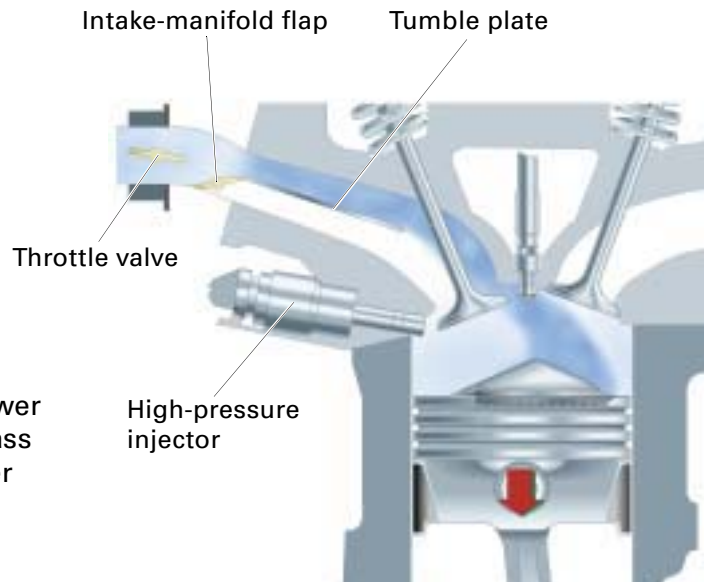
To achieve a stratified charge, injection, combustion chamber geometry and in-cylinder flow must be optimally matched in addition to satisfying certain prerequisites.

Namely:

- Engine in corresponding load and engine-speed range
- No system faults of relevance to emissions
- Coolant temperature above 50 °C
- Temperature of NO<sub>x</sub> storage catalytic converter between 250 °C and 500 °C
- Intake-manifold flap closed

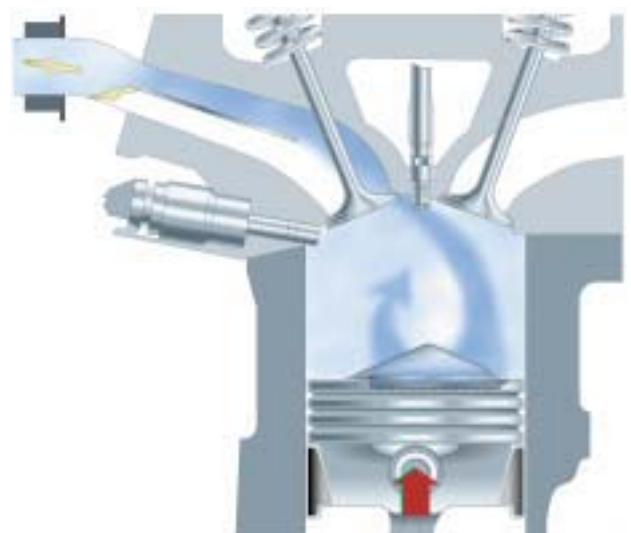


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279\_024

In stratified charge operation, the intake-manifold flap completely closes off the lower intake port, thus causing the intake air mass to be accelerated and tumble via the upper intake port into the cylinder.

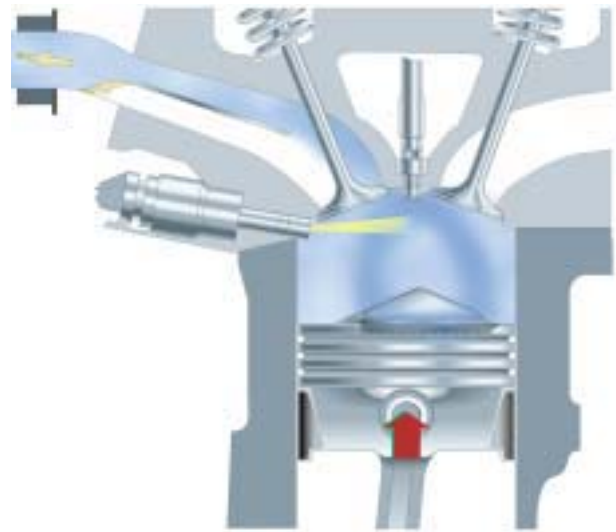


279\_025

The tumble effect is further enhanced by the bowl in the piston. At the same time, the throttle valve is opened wide to minimise throttle losses.

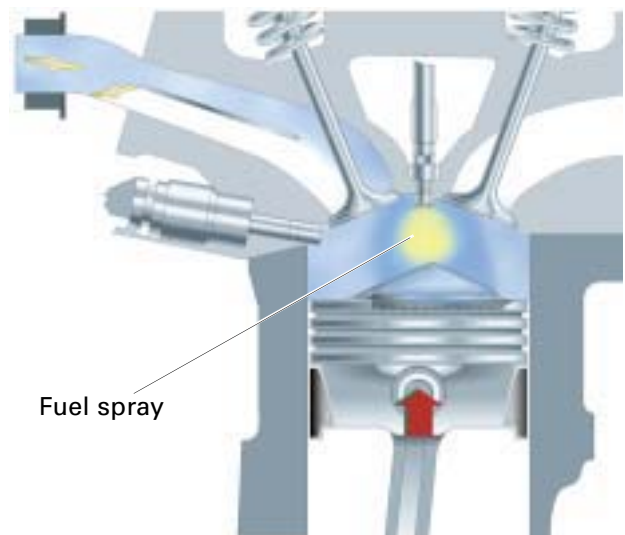


In the compression stroke, fuel is injected under high pressure (50-100 bar) into the area around the spark plugs just before the ignition point.



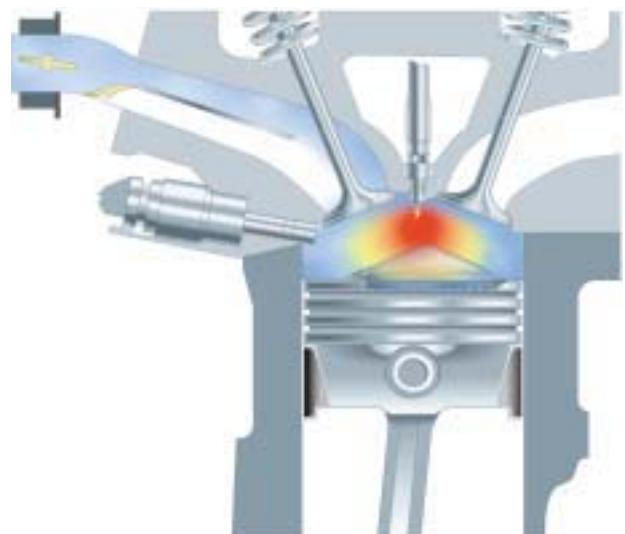
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In view of the relatively shallow injection angle, the fuel spray scarcely comes into contact with the piston crown (so-called "air-controlled" method).

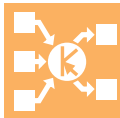


279\_027

A mixture with good ignition properties forms around the spark plugs and is ignited in the compression phase. In addition, a layer of air forms between the ignited mixture and the cylinder wall after combustion, thus providing insulation and reducing heat dissipation via the engine block.



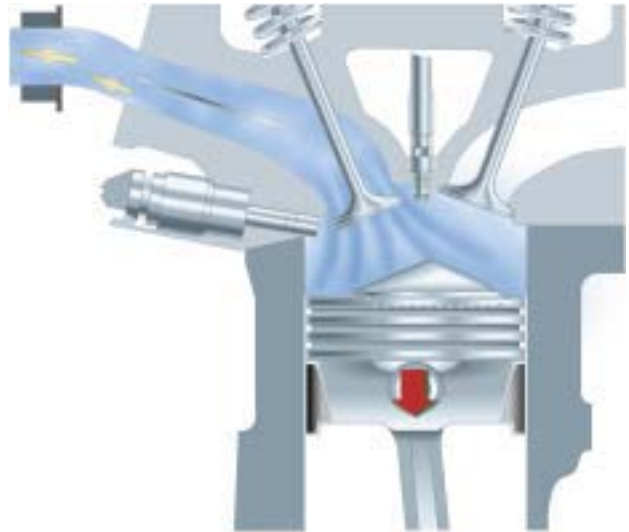
279\_028



# Engine management

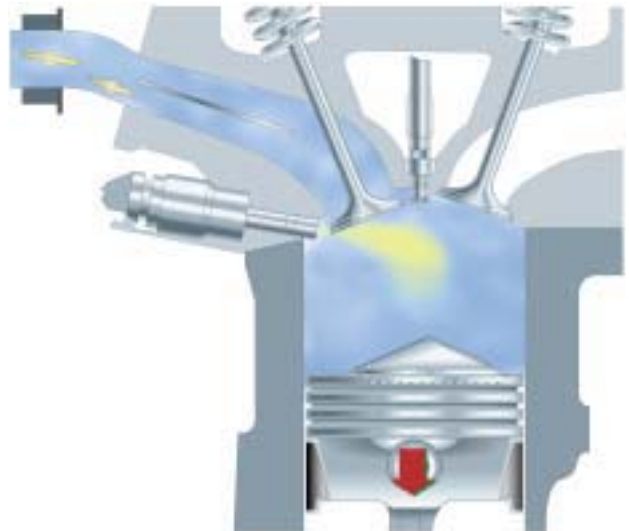
## Homogeneous operation

In the upper load and engine-speed range, the intake-manifold flap is opened to enable the intake air mass to flow into the cylinder via the upper and lower intake port.



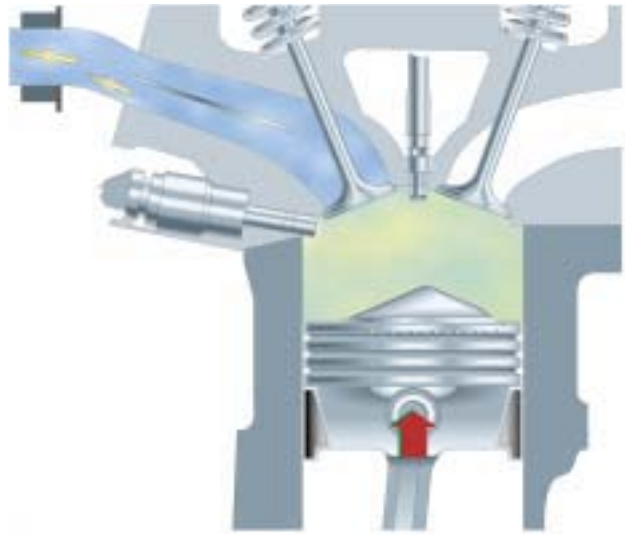
279\_030

In contrast to stratified charge operation, fuel is not injected in the compression phase, but rather in the induction phase, producing a homogeneous charge (14.7:1) in the cylinder.



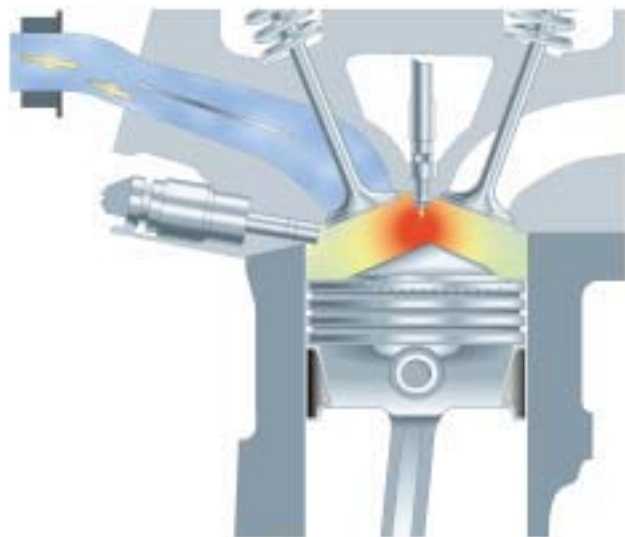
279\_031

Injection in the induction stroke allows far more time to obtain an optimum air/fuel mixture.



279\_032

Combustion takes place in the entire combustion chamber without any insulating air and EGR masses.



279\_033

The advantages of homogeneous operation are the result of direct injection in the induction stroke, in the course of which fuel vaporisation causes some of the heat to be extracted from the intake air mass. Such internal cooling reduces the knock tendency, which means the engine compression ratio can be increased and efficiency enhanced.

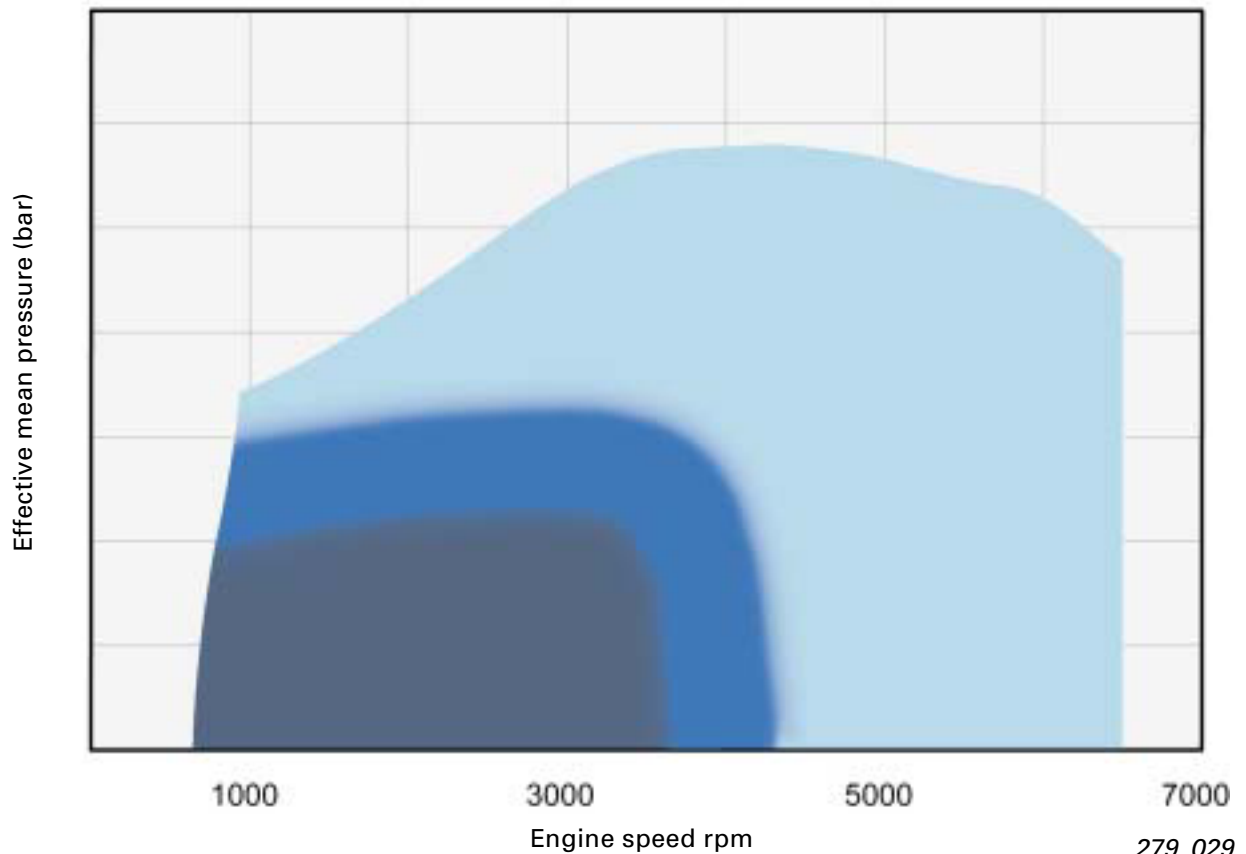
# Engine management

Stratified charge operation is not possible over the entire map range.

The range is restricted due to the fact that greater loads require a richer mixture and the fuel consumption advantage becomes progressively less.

Combustion stability also deteriorates with Lambda values less than 1.4, as the mixture preparation time is no longer adequate with increasing engine speeds and the greater air-flow turbulence has a negative effect.

- Homogeneous operation  $\lambda = 1$  or  $\lambda > 1$  with 3-way catalytic converter
- Homogeneous lean operation with  $\lambda = 1.5$
- Charge stratification with adapted in-cylinder flow and optimised EGR strategy



Maximum fuel economy is achieved in stratified charge operation.

### Self Study Programme Questionnaire

What is your position within the Dealership?

Please quote name, telephone number and fax number for reply and queries.

.....

Are the descriptions and explanations readily comprehensible?

YES ☐ NO ☐ → Page/Section

.....

Are the illustrations clear and adequate?

YES ☐ NO ☐ → Page/Fig. No.

.....

Is enough detail given on the subject matter relevant to your work?

YES ☐ NO ☐ → Page

.....

Do you consider anything to have been overlooked?

NO ☐ YES ☐ → Page/What?

.....

Should further items be added to this questionnaire?

NO ☐ YES ☐ → Which question(s)?

.....

Remarks/miscellaneous:

.....

Please submit your questionnaire to the following fax number:

**++49/841 89 36 36 7**

A note to  
all users:

This Self Study Programme is intended to familiarise readers with the  
2.0 l 110 kW engine with petrol direct injection (FSI).

Your opinion matters to us.

That is why we would like you to give us your thoughts on and any  
suggestions for future Self Study Programmes.  
The following questionnaire is designed to help you do so.

Please make use of fax number 0049/841 89 36 36 7 for your suggestions.

Thank you for your assistance.

**Your Service Technology Training  
Team**



	<b>Notes</b>	

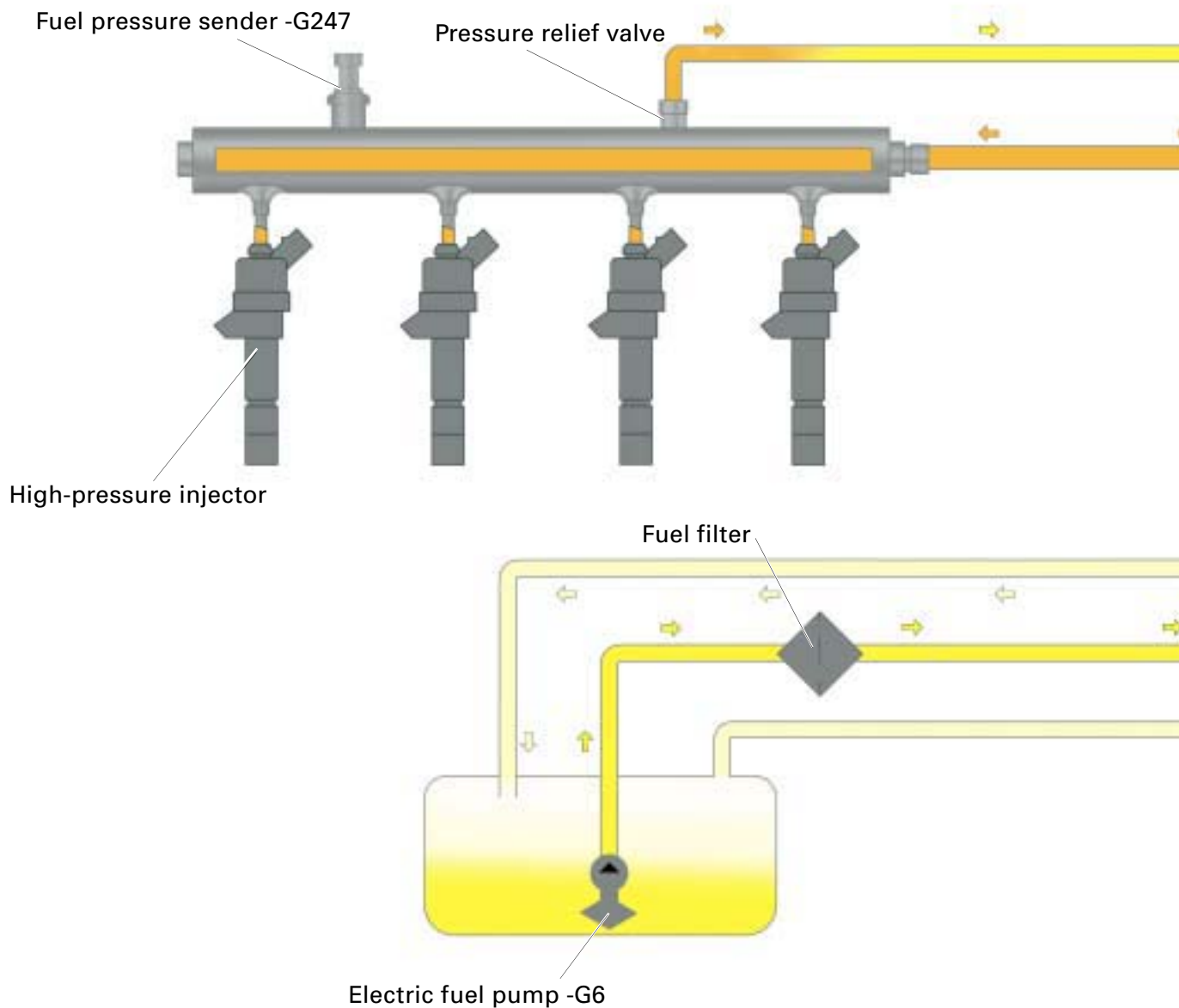
# Engine sub-systems

## Fuel system

The fuel system consists of a low and high-pressure section.

**In the low-pressure system,** the fuel is conveyed by an electric fuel pump at approx. 6 bar via the filter to the high-pressure pump.

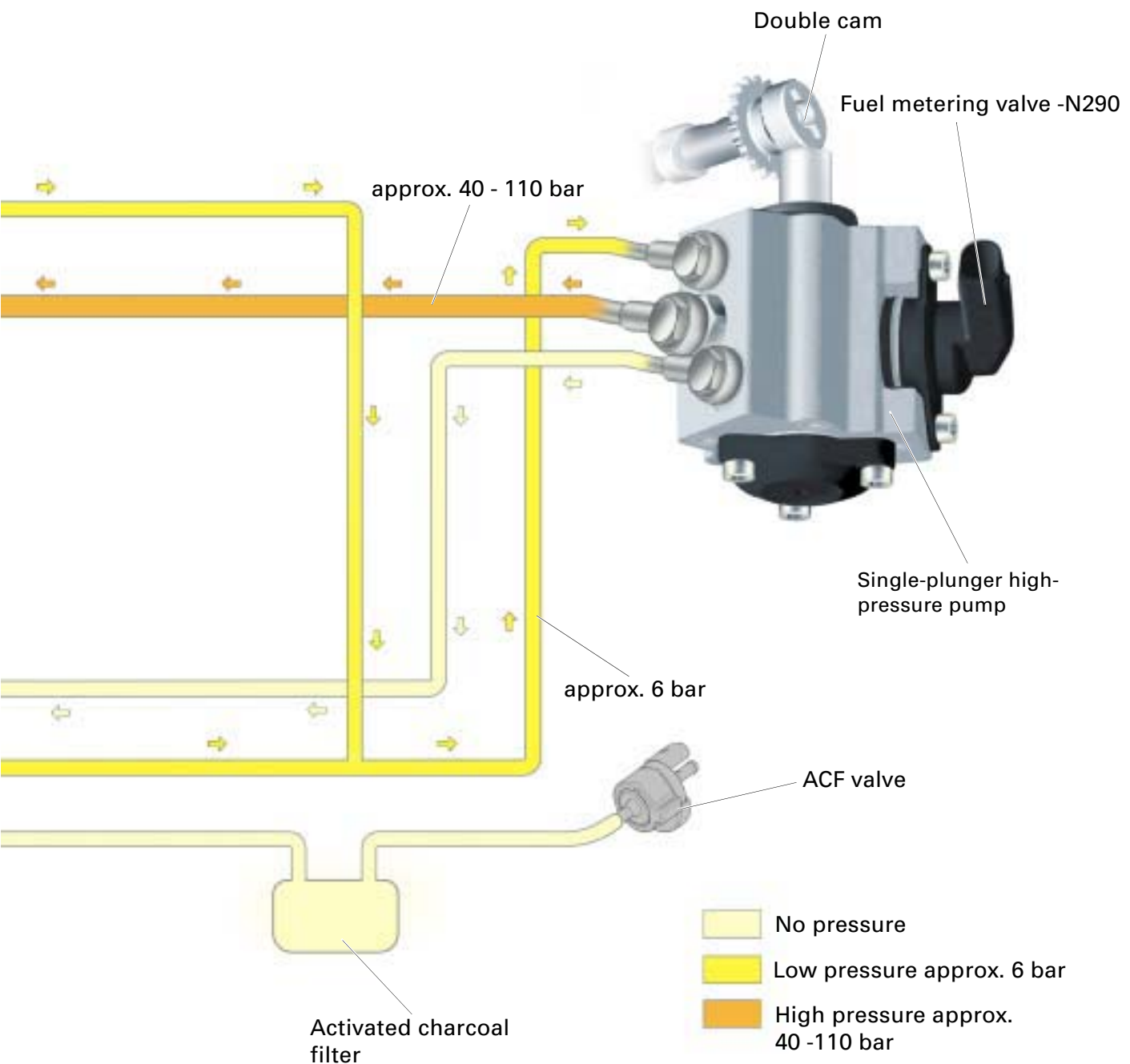
The return flow from the high-pressure pump passes directly back to the tank.



**In the high-pressure system,** the fuel flows at approx. 40 – 110 bar (depending on load and engine speed) out of the single-plunger high-pressure pump into the fuel rail, from where it is distributed to the four high-pressure injectors.

The pressure relief valve is designed to protect the components subjected to high pressure and opens as of a pressure of > 120 bar.

When the pressure relief valve opens, the fuel flows into the supply pipe to the high-pressure pump.



# Engine sub-systems

## Single-plunger high-pressure pump

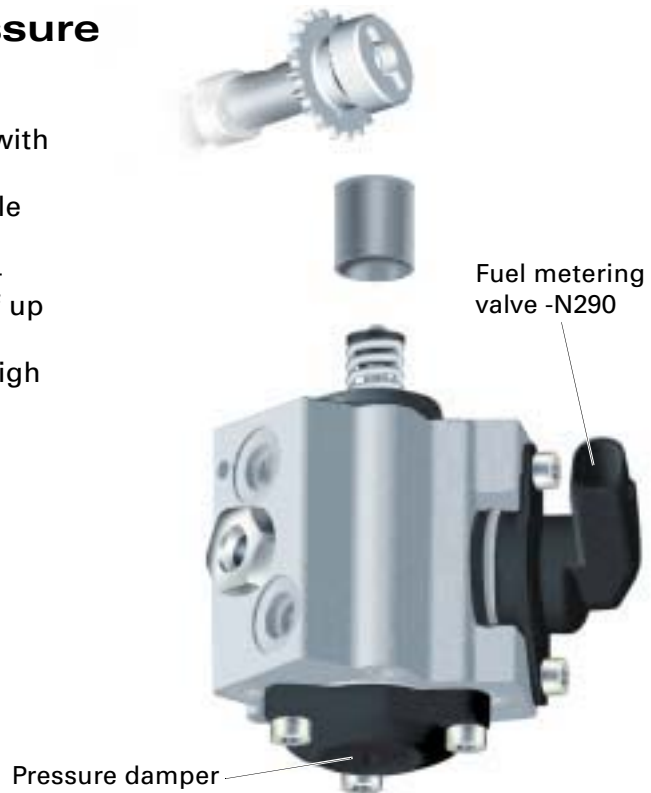
The single-plunger high-pressure pump with adjustable delivery rate is driven mechanically by the camshaft via a double cam.

The electric fuel pump provides the high-pressure pump with a supply pressure of up to 6 bar.

The high-pressure pump generates the high pressure required in the rail.

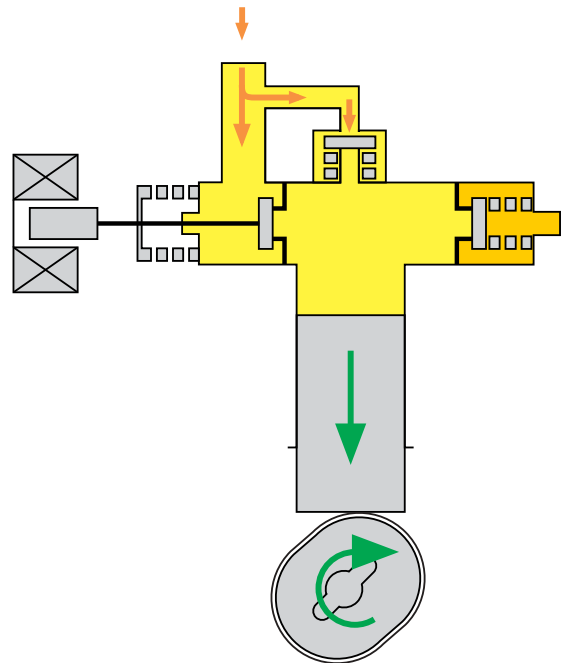


The pressure damper reduces fuel pressure pulsation in the system.



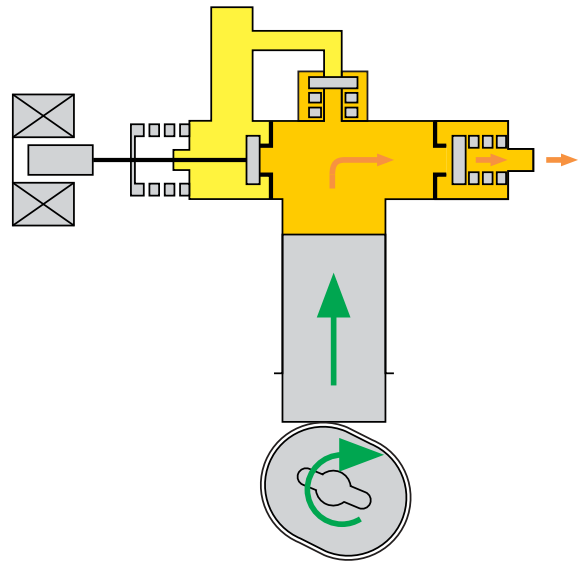
279\_035

As the piston moves down, fuel flows at a supply pressure of approx. 6 bar from the in-tank pump via the inlet valve into the pump chamber.



279\_037

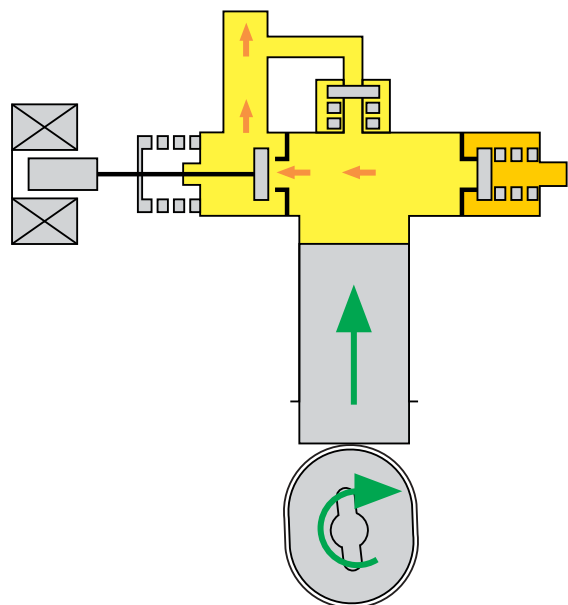
As the piston moves up, the fuel is compressed and conveyed into the fuel rail on exceeding the prevailing rail pressure. Located between pump chamber and fuel inlet is the switchable fuel metering valve.



279\_038

If the fuel metering valve opens prior to completion of the delivery stroke, the pressure in the pump chamber is dissipated and the fuel flows back into the fuel inlet. A non-return valve between pump chamber and fuel rail stops the rail pressure decreasing when the fuel metering valve opens.

To regulate the delivery rate, the fuel metering valve is closed as of pump cam BDC position until a certain stroke is reached. Once the necessary rail pressure has been attained, the fuel metering valve opens to prevent any further increase in pressure in the rail.



279\_039

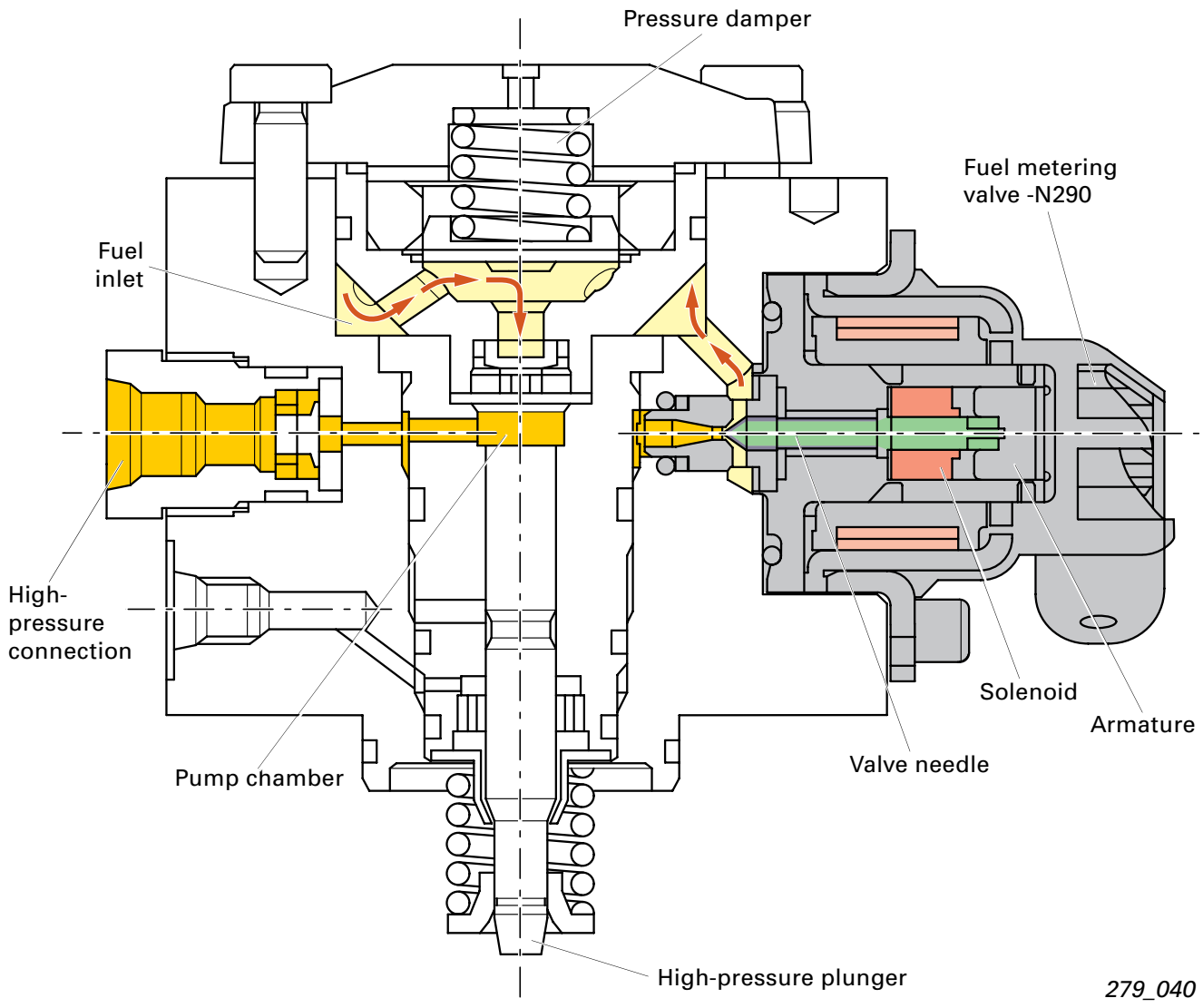


# Engine sub-systems

## Fuel metering valve -N290

For safety reasons, the fuel metering valve is designed as a solenoid valve which is open when deenergised. Consequently, the entire delivery volume of the high-pressure pump is pumped back into the low-pressure circuit by way of the open valve seat.

Energisation of the solenoid builds up a magnetic field which presses the valve needle connected to the armature into the valve seat. On attaining the rail pressure the fuel metering valve is no longer energised and the magnetic field collapses. The high pressure forces the needle out of the pump chamber and the fuel from the pump delivery chamber which is no longer required can flow back into the low-pressure circuit.

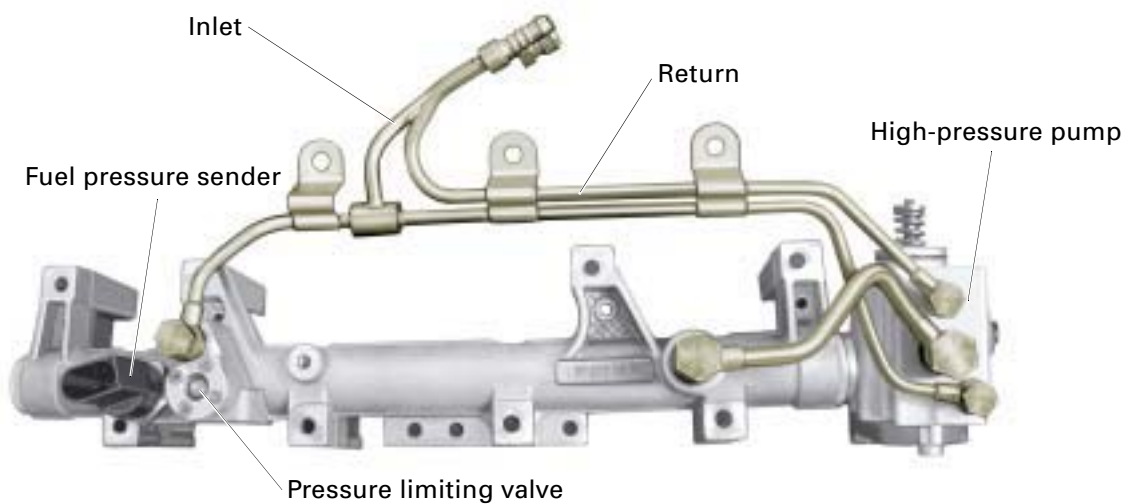


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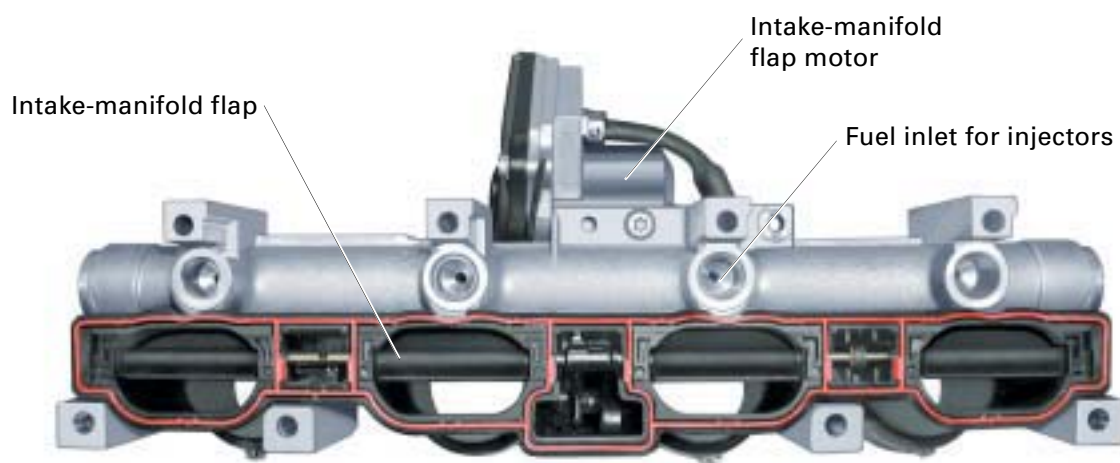
## Fuel rail

The rail is designed to distribute a defined fuel pressure to the high-pressure injectors and to provide an adequate volume for pressure pulsation compensation.

It functions as a high-pressure accumulator and acts as a mount for injectors, fuel pressure sender, pressure limiting valve and high/low-pressure connections.



279\_041



279\_064

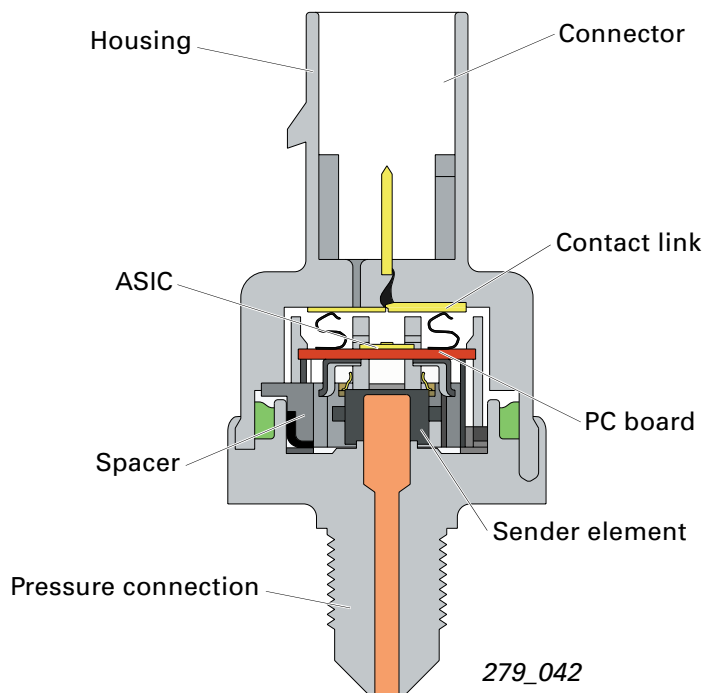
# Engine sub-systems

## Fuel pressure sender -G247

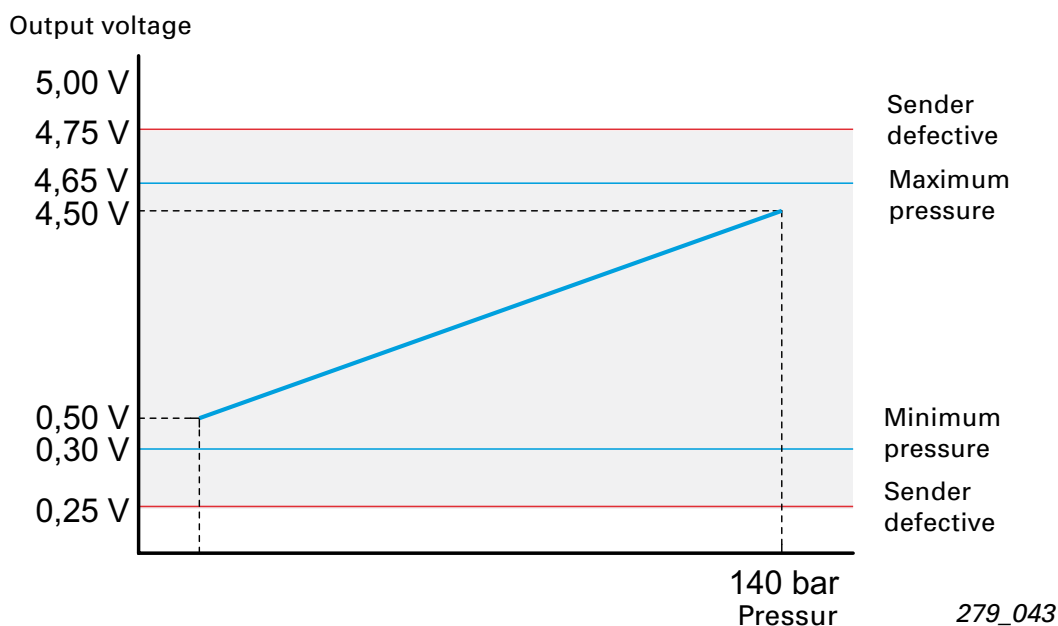
Within the overall system, the function of the fuel pressure sender is to measure the fuel pressure in the rail. The pressure applied is relayed to the engine control unit as a voltage quantity and used for fuel pressure control.

The evaluation electronics integrated into the sender are supplied with 5 V.

With increasing pressure, the resistance drops and signal voltage rises.



The pressure sender characteristic curve illustrated shows signal output voltage [V] as a function of pressure [MPa].



## High-pressure injectors -N30, -N31, -N32, -N33

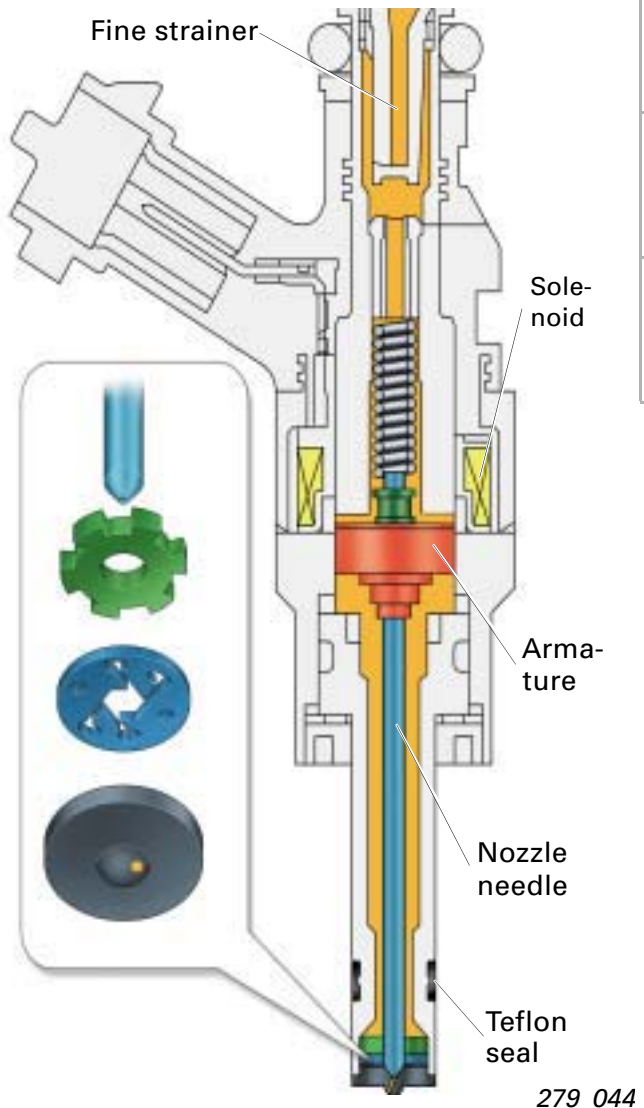
The high-pressure injector acts as an interface between the rail and the combustion chamber.

The function of the high-pressure injector is to meter the fuel and, by way of atomisation, to create a specific fuel/air mixture in a defined combustion chamber area (stratified charge or homogeneous operation).

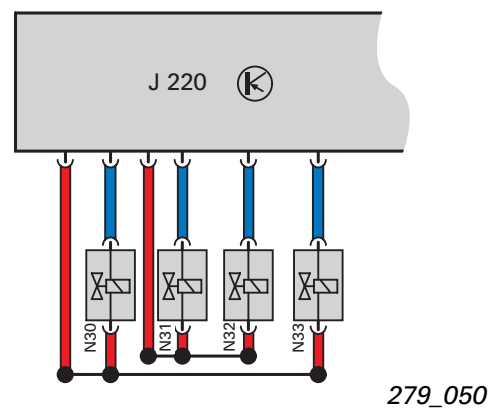
On account of the difference between rail and combustion chamber pressure, injector actuation causes the fuel to be forced directly into the combustion chamber.



The Teflon seal always has to be replaced after removing the injector (refer to Workshop Manual).



Two booster capacitors integrated into the engine control unit generate the necessary actuation voltage of 50 - 90 V required to ensure a much shorter injection period than with intake-manifold injection.



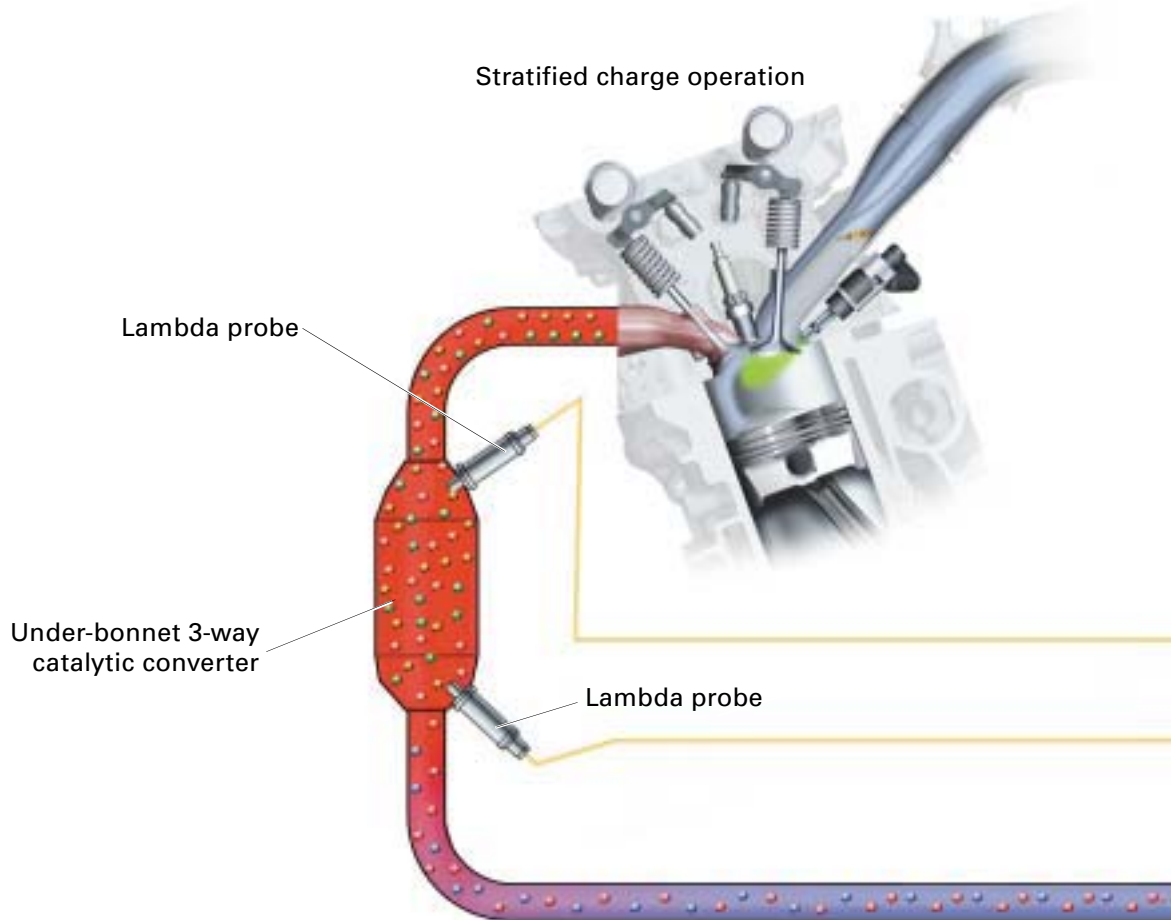
# Engine sub-systems

## Exhaust system

The ever increasing demands on exhaust systems as a result of reduced emission limits require an innovative concept specifically adapted to the FSI process.

## 2.0 l FSI engine

This engine features an under-bonnet three-way primary catalytic converter with an upstream and downstream probe for catalytic converter monitoring.



## Exhaust-gas temperature sender -G235

The sender is located directly upstream of the NO<sub>x</sub> storage catalytic converter.

It transmits the exhaust-gas temperature to the engine control unit for calculation of the temperature in the NO<sub>x</sub> storage catalytic converter.

The engine-management system requires this information

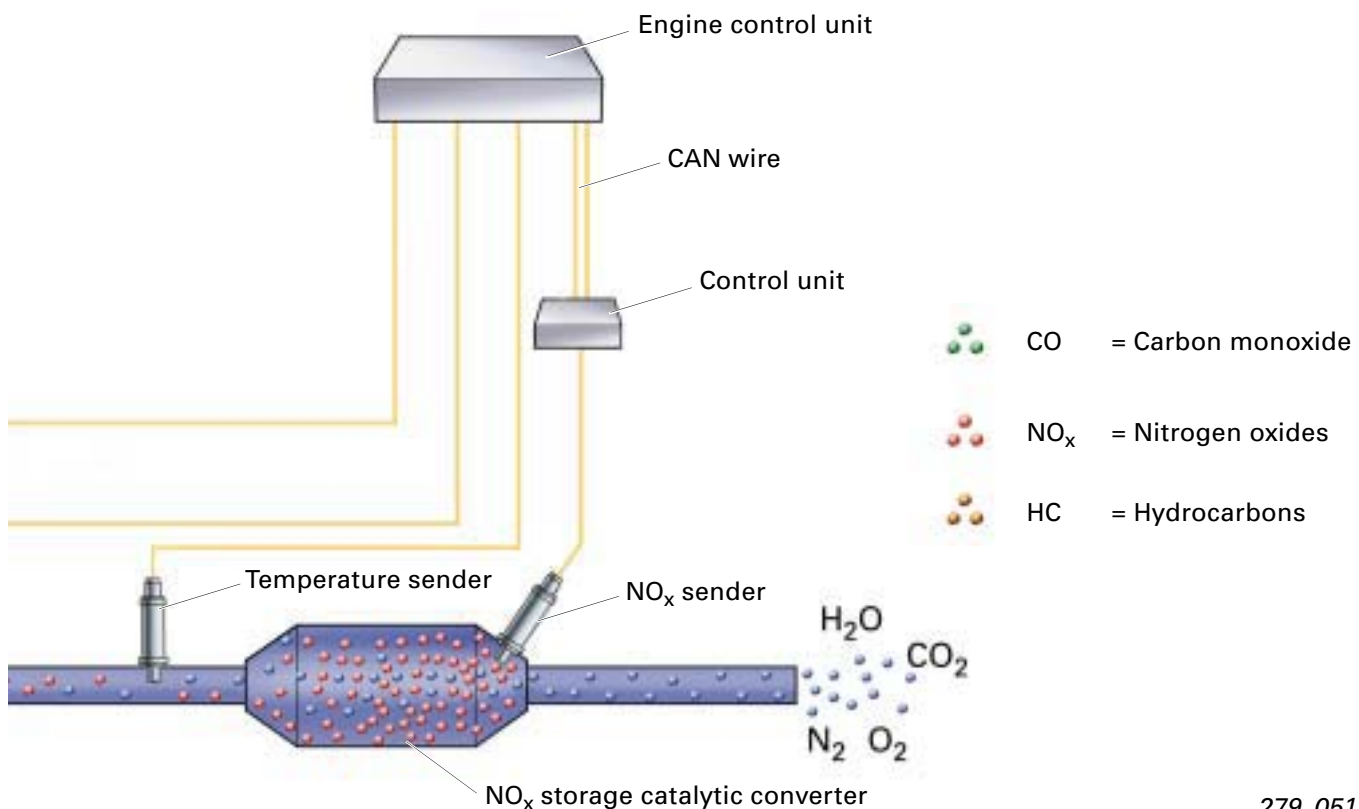
- For switching to stratified charge operation, as nitrogen oxides can only be stored in the NO<sub>x</sub> catalytic converter at temperatures between 250 and 500 °C
- To remove sulphur deposits from the NO<sub>x</sub> storage catalytic converter.

This is only possible at catalytic converter temperatures above 650 °C with a rich mixture and is achieved by way of switching to homogeneous operation and ignition retard.

## Exhaust gas treatment system

With a lean mixture composition, the conventional three-way catalytic converter exhibits a high conversion rate for CO and HC on account of the high residual oxygen content of the exhaust gas. The NO<sub>x</sub> conversion rate drops however if CO and HC concentrations are too low.

Use is made of the NO<sub>x</sub> storage catalytic converter to reduce the increased NO<sub>x</sub> component in lean operation (stratified charge operation).



279\_051

## NO<sub>x</sub> storage catalytic converter

The design of this converter corresponds to that of the three-way catalytic converter. The wash coat is however additionally provided with barium oxide to permit buffer storage of nitrogen oxides at temperatures between 250 and 500 °C through nitrate formation.

In addition to the desired nitrate formation, the sulphur contained in the fuel is always stored as well.

The storage capacity is however limited. The engine control unit is informed of saturation by the NO<sub>x</sub> sender and the engine-management system then takes appropriate action to regenerate the NO<sub>x</sub> storage catalytic converter.

# Engine sub-systems

## Regeneration phases

These are regulated by the engine control unit and are designed to extract the nitrogen oxides and sulphur. In this process, nitrogen oxides are converted into non-toxic nitrogen and sulphur into sulphur dioxide.

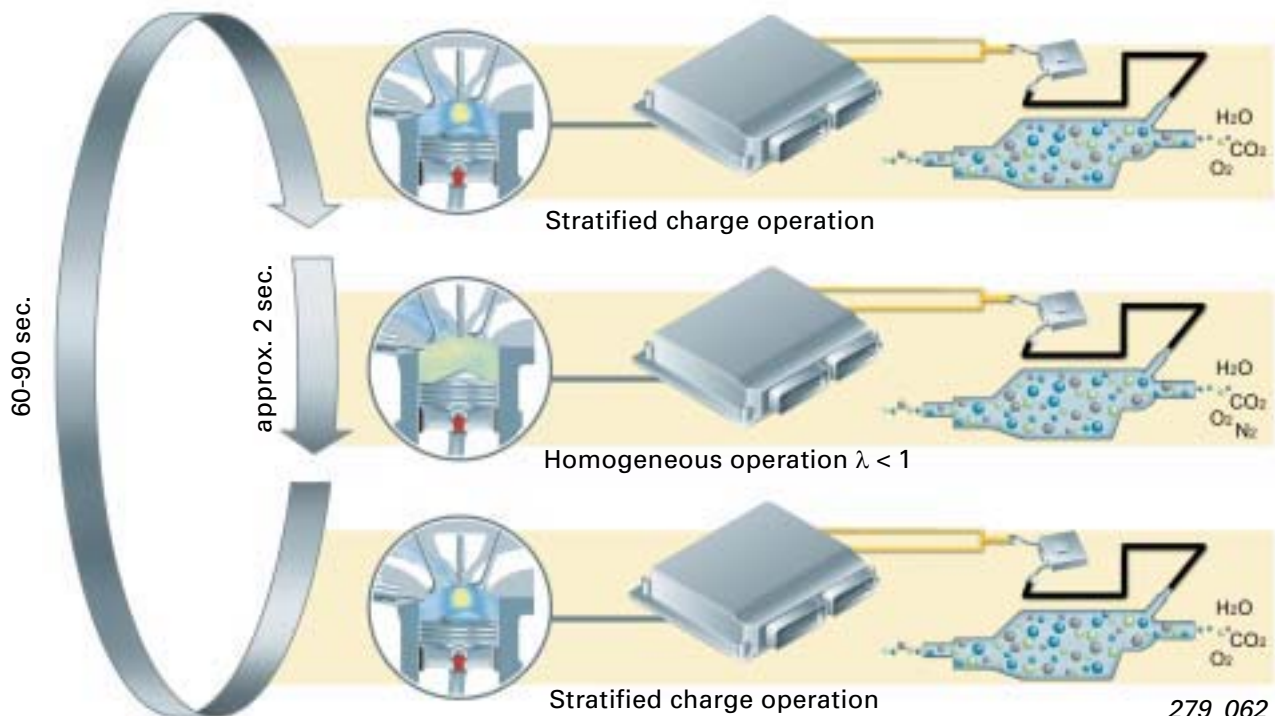
## Nitrogen oxide regeneration

This takes place as soon as the concentration in the  $\text{NO}_x$  storage catalytic converter exceeds the level specified in the engine control unit.

The engine control unit effects switching from stratified charge to homogeneous operation.

This causes the temperature of the  $\text{NO}_x$  storage catalytic converter to increase. The nitrates formed thus become unstable and decompose under reducing ambient conditions.

The nitrogen oxides are converted into harmless nitrogen. The storage catalytic converter is thus emptied and the cycle recommences.



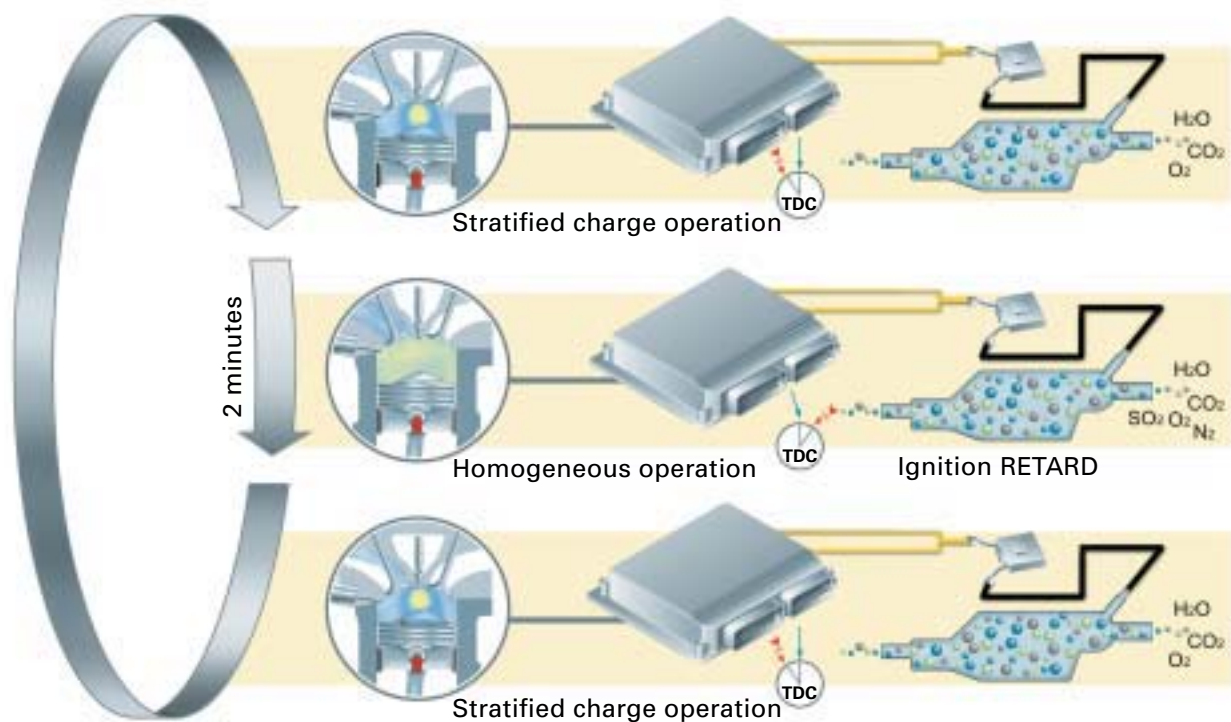


## Sulphur regeneration

This takes place in separate phases, as the sulphates formed are more chemically stable and therefore do not decompose in the course of nitrogen oxide regeneration. The sulphur also occupies storage space, with the result that the storage catalytic converter becomes saturated at ever shorter intervals. As soon as the specified value is exceeded, the engine-management system reacts by implementing the following action:

- Switching from stratified charge to homogeneous operation for approx. two minutes and
- Ignition retard

This increases the catalytic converter operating temperature to above 650 °C, which causes the sulphur stored to react to form sulphur dioxide  $\text{SO}_2$ .



279\_063

With low-sulphur fuels, the desulphurisation interval is correspondingly longer, whereas high-sulphur fuels necessitate more frequent regeneration phases.

Driving at high engine speed under heavy load automatically leads to desulphurisation.

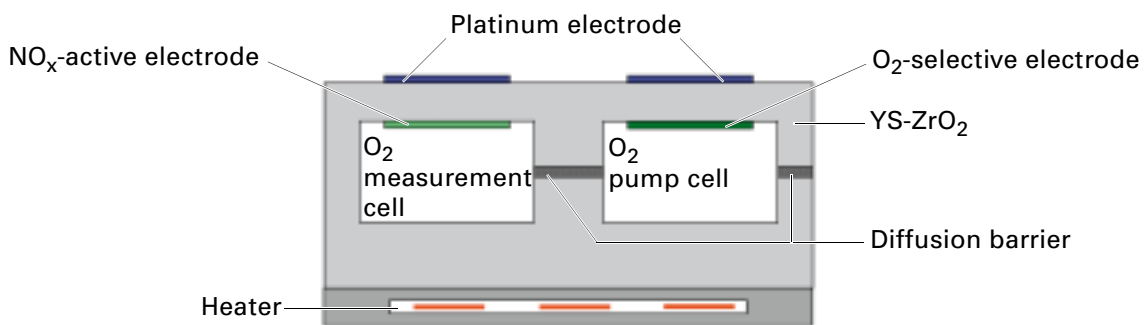
# Engine sub-systems

## NO<sub>x</sub> sender -G295

The sender is located directly downstream of the NO<sub>x</sub> storage catalytic converter. The NO<sub>x</sub> sender operates in a manner similar to the wide-band Lambda probe.

In the first pump cell, the oxygen content is adapted to a constant, roughly stoichiometric value (14.7 kg of air : 1 kg of fuel) and the Lambda value picked off via the pump flow.

The gas flow is then routed via a diffusion barrier into the O<sub>2</sub> measurement cell, where reducing electrodes separate the nitrogen oxides into oxygen (O<sub>2</sub>) and nitrogen (N<sub>2</sub>). The NO<sub>x</sub> concentration is determined by way of the pump oxygen flow.



279\_065

## Control unit for NO<sub>x</sub> sender -J583

This is located on the underside of the vehicle next to the NO<sub>x</sub> sender. It conditions the sender signals and transmits the information to the engine control unit by way of the drive CAN bus.

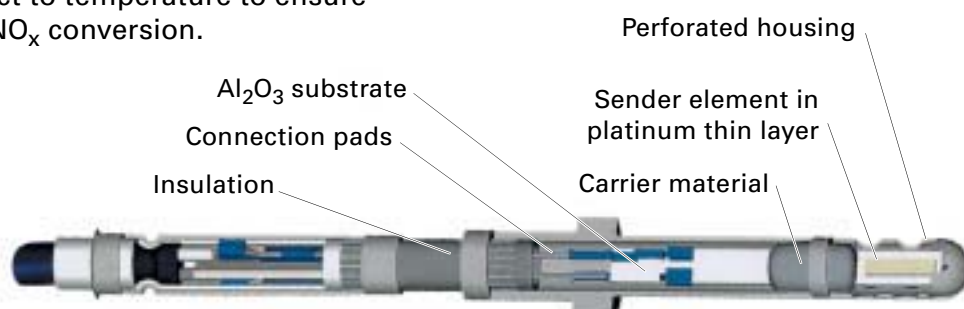
The rapid data transfer enables the engine control unit to establish nitrogen-oxide saturation more effectively and to initiate regeneration of the storage catalytic converter.

## Exhaust-gas temperature sender -G235

This is located directly upstream of the NO<sub>x</sub> storage catalytic converter.

The exhaust-gas temperature sender permits monitoring and control of the operating range of the NO<sub>x</sub> storage catalytic converter with respect to temperature to ensure optimum NO<sub>x</sub> conversion.

In addition, the exhaust-gas temperature sender is used for thermal diagnosis of the primary catalytic converter, to support the exhaust-gas temperature model and to protect components in the exhaust system.

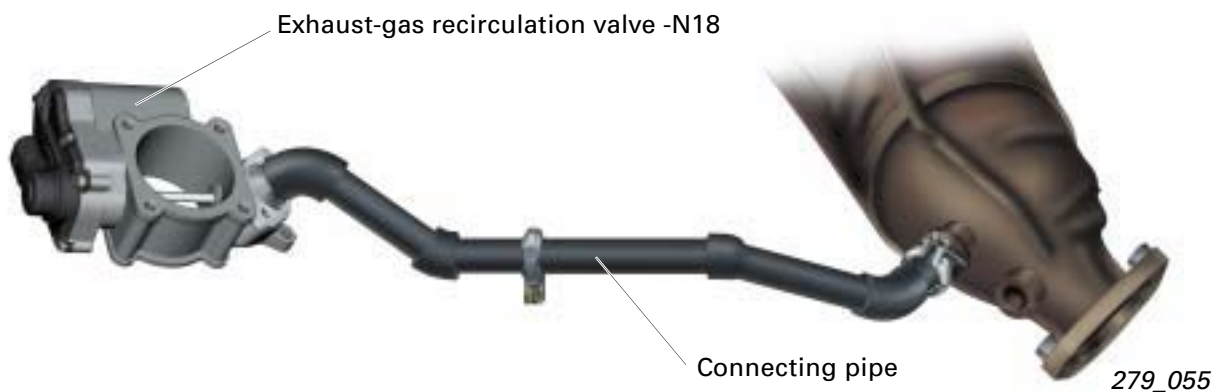


279\_066

## Exhaust-gas recirculation

The engine features external exhaust-gas recirculation. The exhaust gas is extracted by way of a connecting pipe at the primary catalytic converter. The volume of exhaust gas calculated precisely by the engine control unit is fed in via the exhaust throttle valve, which is driven by an electric motor.

The position of the exhaust throttle valve is monitored by a potentiometer. It permits calculation of the exhaust gas volume and is used for self-diagnosis. The exhaust gas returned to the combustion chamber is used to lower the peak combustion temperature and thus reduce nitrogen oxide formation.



The exhaust-gas recirculation valve -N18 takes the form of a module and comprises the following components:

- Throttle valve
- Electric motor with exhaust-gas recirculation potentiometer -G212

Exhaust-gas recirculation takes place in stratified charge/homogeneous operation at up to approx. 4000 rpm with medium load. There is no EGR at idle.



Adaption by way of "basic setting" function must always be performed after replacing exhaust-gas recirculation valve and/or engine control unit.

# Engine

## Block diagram



### Motronic ME7.1.1

- F36 Clutch pedal switch  
F47 Brake light switch  
F265 Map-controlled engine cooling thermostat  
G2 Coolant temperature sender  
G6 Fuel pump relay  
G28 Engine speed sender  
G39 Lambda probe  
G40 Hall sensor  
G42 Intake-air temperature sender  
G61 Knock sensor 1  
G62 Coolant temperature sender  
G66 Knock sensor 2  
G70 Air-mass meter  
G71 Intake-manifold pressure sender  
G79 Accelerator position sender  
G83 Coolant temperature sender - radiator outlet  
G130 Lambda probe after catalyst  
G185 Accelerator pedal position sender 2  
G186 Throttle valve drive  
G187 Throttle valve drive angle sender 1  
G188 Throttle valve drive angle sender 2  
G212 Exhaust-gas recirculation potentiometer  
G235 Exhaust-gas temperature sender  
G242 Fuel pressure sender  
G292 NO<sub>x</sub> sender  
G338 Intake-manifold flap potentiometer

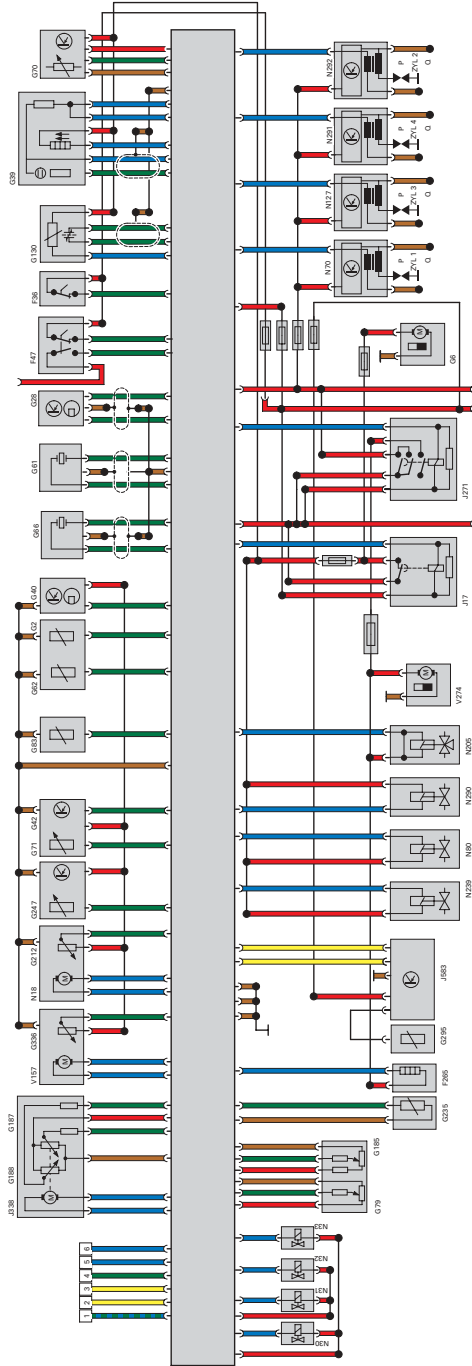
- J17 Fuel pump relay  
J271 Motronic current supply relay  
J338 Throttle valve control part  
J583 Control unit for NO<sub>x</sub> sender  
N18 Exhaust-gas recirculation valve  
N30 Injector, cylinder 1  
N31 Injector, cylinder 2  
N32 Injector, cylinder 3  
N33 Injector, cylinder 4  
N70 Ignition coil 1 with output stage  
N80 Activated charcoal filter solenoid valve

### Colour code

- = Input signal
- = Output signal
- = Positive supply
- = Earth
- = CAN bus
- = Bidirectional

### Additional signals

- ① K-wire
- ② CAN High/drive
- ③ CAN Low/drive
- ④ Alternator test signal
- ⑤ Radiator fan PWM
- ⑥ TD signal (Multitronic only)





## Special tools

**T 10133/1**



279\_072

**T 10133/2**



279\_057

**T 10133/3**



279\_073

**T 10133/9**



279\_058

**T 10133/5**



279\_070

**T 10133/6**



279\_068

**T 10133/7**



279\_069

**T 10133/8**



279\_059

**T 10133/4**



279\_071



	<b>Notes</b>		





