



Audi 2.8l and 3.2l FSI engines with Audi valvelift system

Self-Study Programme 411

Audi has again extended its current vee engine series to include an additional power plant. The new 2.8l FSI engine fills the gap between the 2.4l MPI engine, which will be produced until mid-2008, and the 3.2l FSI engine. Moreover, this engine is a new technology platform.

Featured new technologies are:

- the Audi valvelift system,
- a flow-regulated oil pump with dual-stage pressure control and
- trioval sprockets.

The primary targets for development were to improve friction and fuel efficiency.

Internal engine friction was reduced through the following modifications:

- Reduction of pre-load on the 2nd and 3rd piston rings
- Use of the Audi valvelift system (small intake stroke at partial throttle)
- Reduction of the exhaust valve stroke (10 mm -> 9 mm)
- Replacement of the bucket tappets in the high-pressure pump drive with cylindrical tappets
- Adoption of roller chains for chain drives A to C
- Development of trioval sprockets with a friction-enhanced chain tensioner design
- Downsizing of the oil pump
- Integration of an oil pump flow regulator with dual-stage pressure control
- Downsizing of the coolant pump and increasing of the thermostat temperature

The new technologies will also be featured on forthcoming versions of the current engines. The 3.2l FSI engine will be the next in line. Due to the commonalities between the 2.8l and 3.2l FSI engines, both units are described in this Self-Study Programme.

2.8l FSI engine



411_001

3.2l FSI engine



411_123

Contents

Specifications 6

Engine mechanicals

Engine block8
Crank mechanism9
Crankcase ventilation system10
Crankcase air intake system11
Cylinder head12
Audi valvelift system14
Chain drive23
Actuation of ancillary units25

Oil circulation system

Lubrication system28
Design30
Oil pump31
Oil level indicator37

Cooling system

Engine cooling system40

Air circulation system

Overview45
Throttle valve control unit J33846
Variable intake manifold.....50
Vacuum hose assembly52

Fuel system

Low/high pressure system.....	53
-------------------------------	----

Exhaust system

Exhaust system.....	56
---------------------	----

Engine management

System overview for the 2.8l FSI engine	58
-----------------------------------------------	----

Service


Special tools	62
---------------------	----

The Self-Study Programme teaches the design and function of new vehicle models, automotive components or technologies.


The Self-Study Programme is not a Repair Manual.
All values given are intended for reference purposes only and refer to the software version valid at the time of preparation of the SSP.

For information about maintenance and repair work, always refer to the current technical literature.

Reference



Note



Specifications

2.8l FSI engine

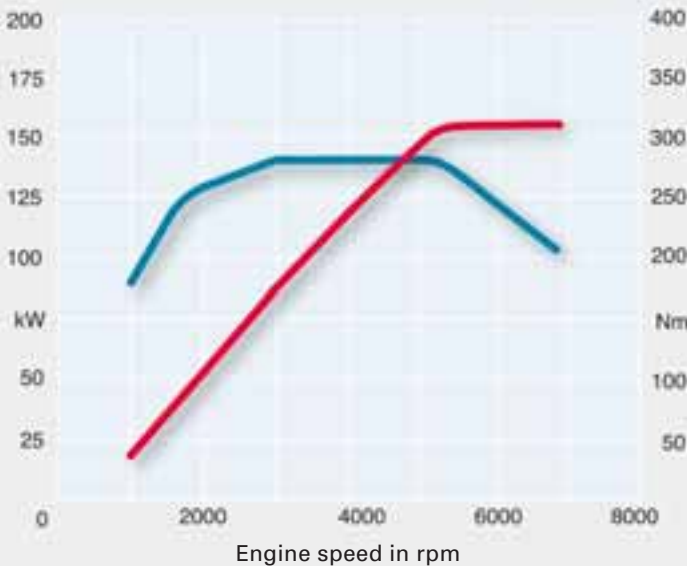
Specifications

Engine code	BDX
Type of engine	6-cylinder vee engine with 90° included angle
Displacement in cm ³	2773
Max. power in kW (bhp)	154 (210) at 5500 – 6800 rpm
Max. torque in Nm	280 at 3000 – 5000 rpm
No. of valves per cylinder	4
Bore in mm	84.5
Stroke in mm	82.4
Compression ratio	12 : 1
Firing order	1–4–3–6–2–5
Engine weight in kg	165
Engine management	Simos 8.1
Fuel grade	95 RON*) or higher
Exhaust emission standard	EU 4
Injection/ignition system	Simos 8.1
Exhaust gas recirculation	no
Charging	no
Knock control	yes
Variable valve timing	yes
Intake manifold changeover	yes
Secondary air system	no

* Unleaded fuel with 91 RON can also be used, but this can cause a slight loss of power

Torque/power curve

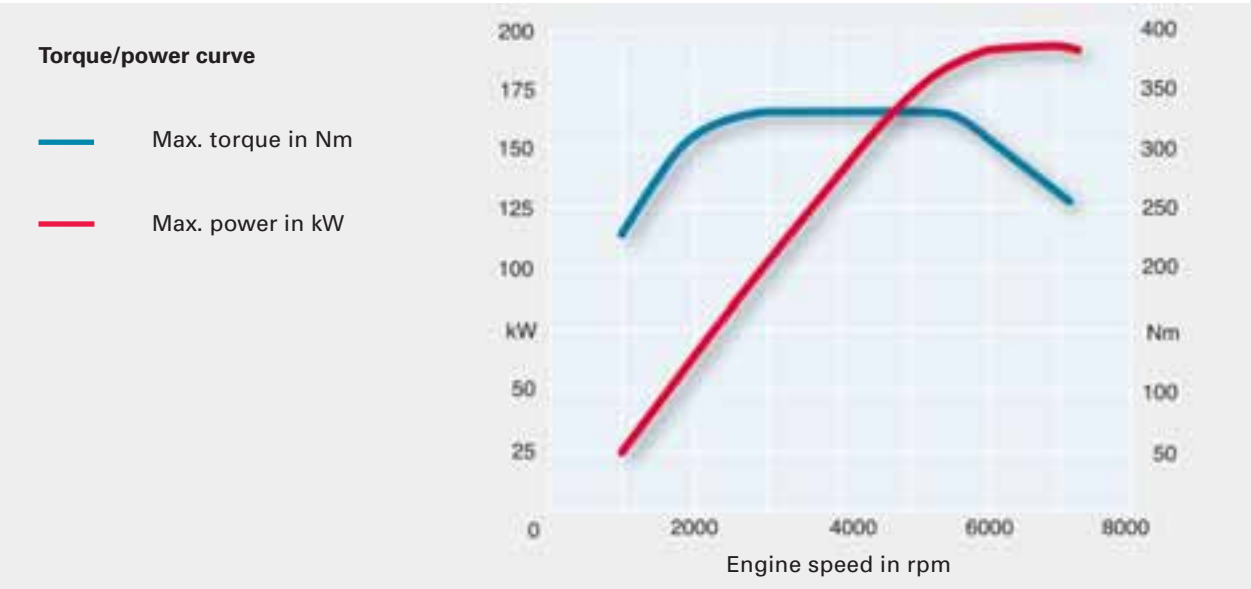
- Max. torque in Nm
- Max. power in kW



3.2I FSI engine

Specifications		
	Engine code	CALA
	Type of engine	6-cylinder vee engine with 90° included angle
	Displacement in cm ³	3197
	Max. power in kW (bhp)	195 (265) at 6500 rpm
	Max. torque in Nm	330 at 3000 – 5000 rpm
	No. of valves per cylinder	4
	Bore in mm	85.5
	Stroke in mm	92.8
	Compression ratio	12 : 1
	Firing order	1–4–3–6–2–5
	Engine weight in kg	171.7
	Engine management	Simos 8.1
	Fuel grade	at least 95 RON*
	Exhaust emission standard	EU 4
	Injection/ignition system	Simos 8.1
	Exhaust gas recirculation	no
	Charging	no
	Knock control	yes
	Variable valve timing	yes
	Intake manifold changeover	yes
	Secondary air system	no

* Unleaded fuel with 91 RON can also be used, but this can cause a slight loss of power



Engine block

- Homogeneous monoblock of supereutectic AlSi1717Cu4Mg alloy made by low-pressure chill casting
- The aluminium cylinder liner is finished in a three-stage honing and stripping process
- 90° V-cylinder crankcase
- Crankcase assembly: length 360 mm; width 430 mm
- Crankcase bottom section (bedplate) of gravity die-cast AlSi9Cu3 with integral GJS50 bearing bridges, control valve and oilways for dual-stage oil pump regulation
- Oil pan top section of AlSi12Cu with non-return valve
- A baffle and a plastic honeycomb insert are used for settling of the engine lube oil in the oil pan
- The oil drain screw and the oil level sensor are integrated in the sheet-steel oil pan bottom section.
- On the power transmission side, the crankcase is sealed by an aluminium sealing flange

Cylinder crankcase



Cylinder crankcase
bottom section (bedplate)



Oil pan top section

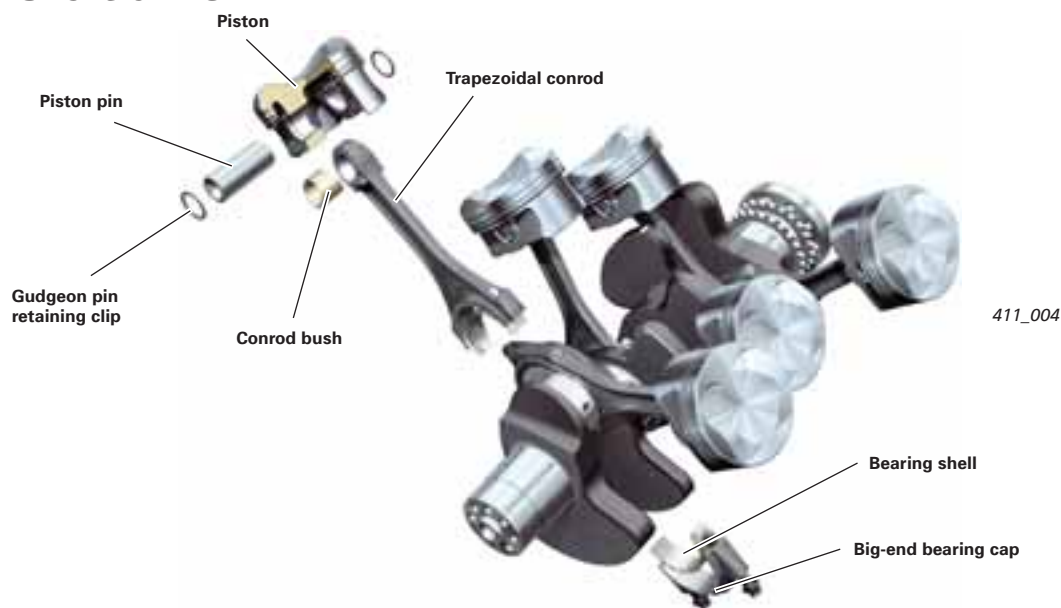


Oil pan bottom
section



411_003

Crankshaft drive



Crankshaft

The high-quality steel (C38) forged steel crankshaft is mounted on four bearings. The crank offset of the big-end bearing is 30°. This ensures a uniform firing interval of 120°. To compensate for the axial play, main bearing 3 acts as the thrust bearing. The vibration damper is attached by eight screws with internal serrations.

Piston

FSI specific pistons from the V-engine kit are used on both engines. The pistons have no upper piston ring supports. The piston skirts are Ferrostan coated. The gudgeon pin is retained by means of two snap rings.

Conrods

The conrods were adopted from the V8 engine for the 2.8l engine. New conrods were designed specially for the 3.2l engine. The conrods are made from cracked C70 steel. The small end is trapezoidal in shape and the big end bush is made of bronze.

	2.8l V6	3.2l V6
Length:	159 mm	154 mm
Big-end bearing width:	17 mm	17 mm
Small-end bush:	22 mm	22 mm
Trapezoid angle:	11°	11°

		2.8 litres	3.2 litres
	Main bearing \varnothing in mm	58	65
	Conrod journal \varnothing in mm	54	56
	Main bearing width in mm	18.5	18.5
	Big-end bearing width in mm	17	17
	Top main bearing shells	Two-component composite bearing	Three-component composite bearing
	Bottom main bearing shells	Two-component composite bearing	Three-component composite bearing
	Top big-end bearing shells	Two-component composite bearing	Two-component composite bearing
	Bottom big-end bearing shells	Two-component composite bearing	Two-component composite bearing

Crankcase ventilation system

The crankcase ventilation system was also revised and redesigned. This new design was first implemented in the 3.2l V6 FSI and 2.4l MPI engines in 2006.

The system in question is a head ventilation system where the blow-by gases are discharged to the valve covers.

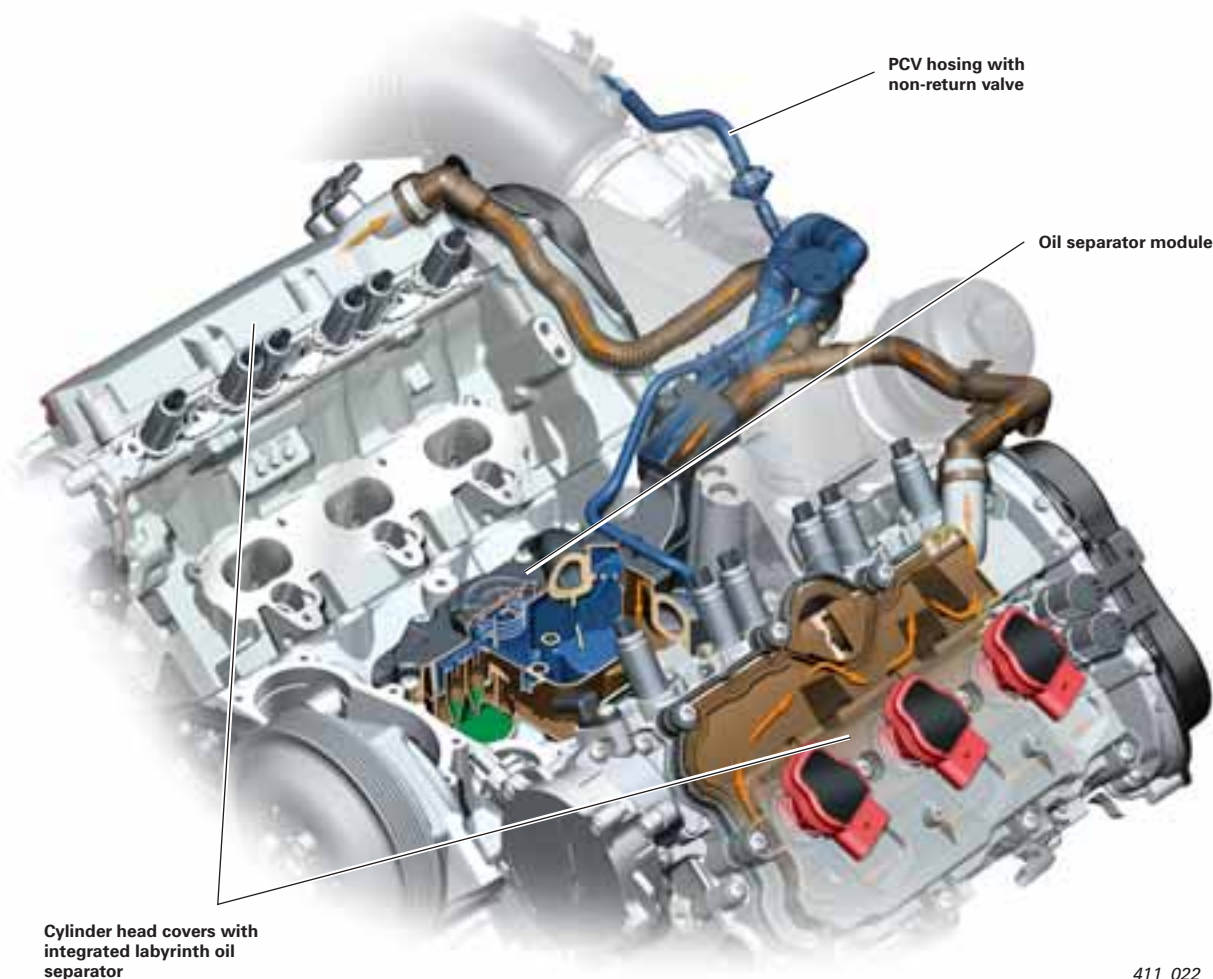
A labyrinth for coarse separation is integrated in the valve covers for coarse separation. The gas is routed along flexible plastic tubing to the vee space between the cylinder banks on the engine block, where the oil separator module is situated.

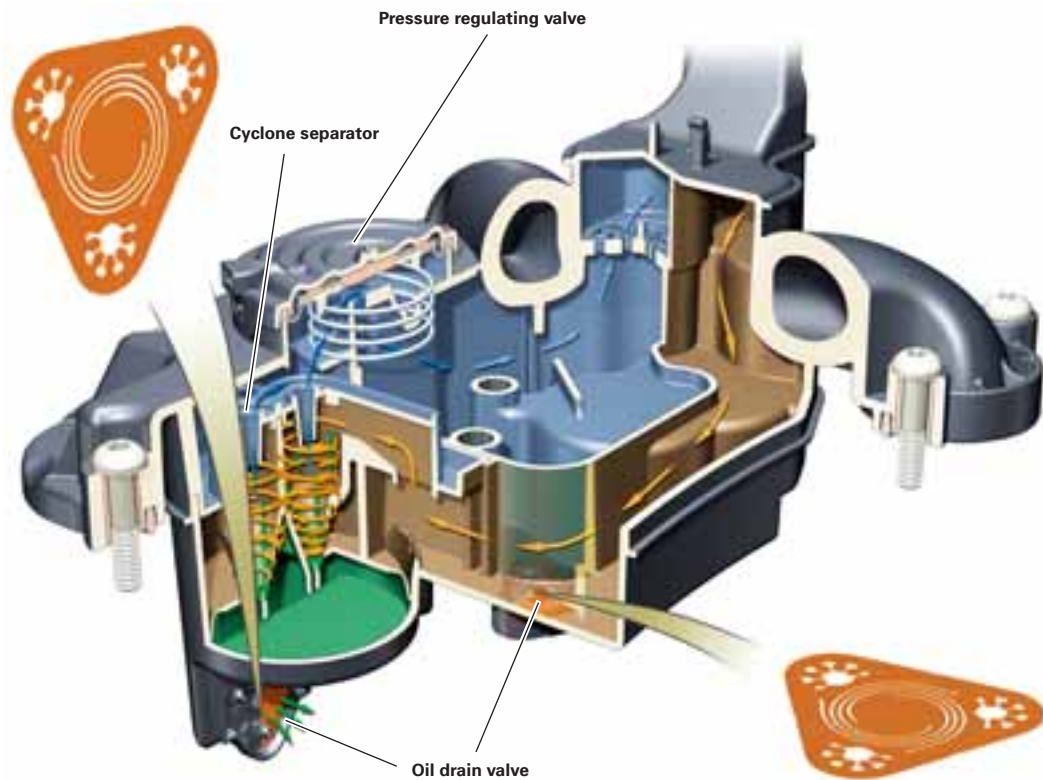
In the old V6 engine the oil separator module was a separate unit. The coolant ducts in the engine block were routed through a cast aluminium cover. This cover does not exist in the new engine. The coolant ducts are integrated in the oil separator module. The oil separator module therefore forms the end cover of the engine block. The oil separator basically has the same function as in the old V6 engine.

The gases are treated in two cyclones which operate in parallel. If the gas flow rate is too high, a bypass valve is opened in order to prevent an excessively high pressure from building inside the crankcase. After the gases have been treated, they are routed through the single-stage pressure regulating valve to the intake manifold. This pressure regulating valve is also integrated in the oil separator module. The oil collects inside a reservoir in the bottom section of the oil separator. The reservoir is sealed by an oil drain valve while the engine is running. The oil drain valve is pressed down onto the sealing face by the pressure acting upon it inside the crankcase.

The reservoir is large enough to absorb the oil which can collect over the running time of the engine on a full tank.

A further drain valve is located in the space below the pressure regulating valve. Condensed fuel vapours or water can drain off through this valve.





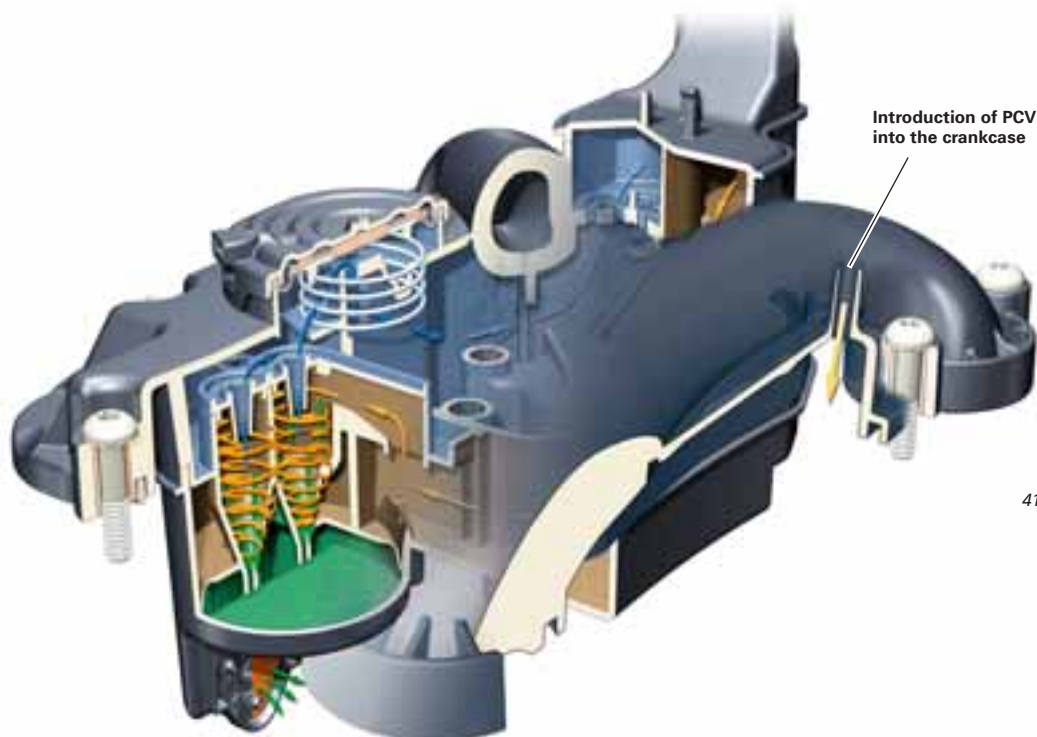
411_021

Crankcase air intake system

Fresh air is drawn from the intake hose and routed to the oil separator module via a line with a non-return valve.

Fresh air is introduced into the crankcase via a port. From here, it is channelled through the oil separator and directly into the crankcase.

Crankcase ventilation system



411_009

Cylinder head

The cylinder heads were also sourced from the V-engine kit and modified accordingly.

Specifications:

- Aluminium cylinder head with twin assembled camshafts
- Intake camshafts featuring the Audi valvelift system
- Four-valve technology
- Valve actuation via roller cam followers with static hydraulic backlash compensation
- Intake valve: solid-stem valve, induction hardened valve seat
- Exhaust valve: chrome-plated solid-stem valve
- Steel spring retainer
- Single valve spring
- Variable intake camshaft timing based on the operating principle of the "hydraulic swivelling vane adjuster", adjustment range 42° crank angle, held in the retard position by a detent bolt when the engine stops running
- Variable exhaust camshaft timing, same function as intake cam adjuster, timing range 42° crank angle, locked in the advance position, spring assisted resetting
- Camshaft timing control valves are bolted into the cylinder head from above
- All camshaft sprockets are designed as "trioval sprockets"
- Four Hall sensors for camshaft position sensing
- Ladder frame acting as an upper bearing for the camshafts and as a mounting for camshaft timing adjustment actuators F366-F377
- Four-ply CrN spring steel cylinder head gasket (3.2l engine = three-ply)
- Decoupled plastic cylinder head cover with integral labyrinth oil separator
- High-pressure fuel pump driven by a triple cam and cylindrical tappets
- Rotary valve vacuum pump driven by intake camshaft bank 2
- Chain housing is sealed by a *Bondal*®* cover

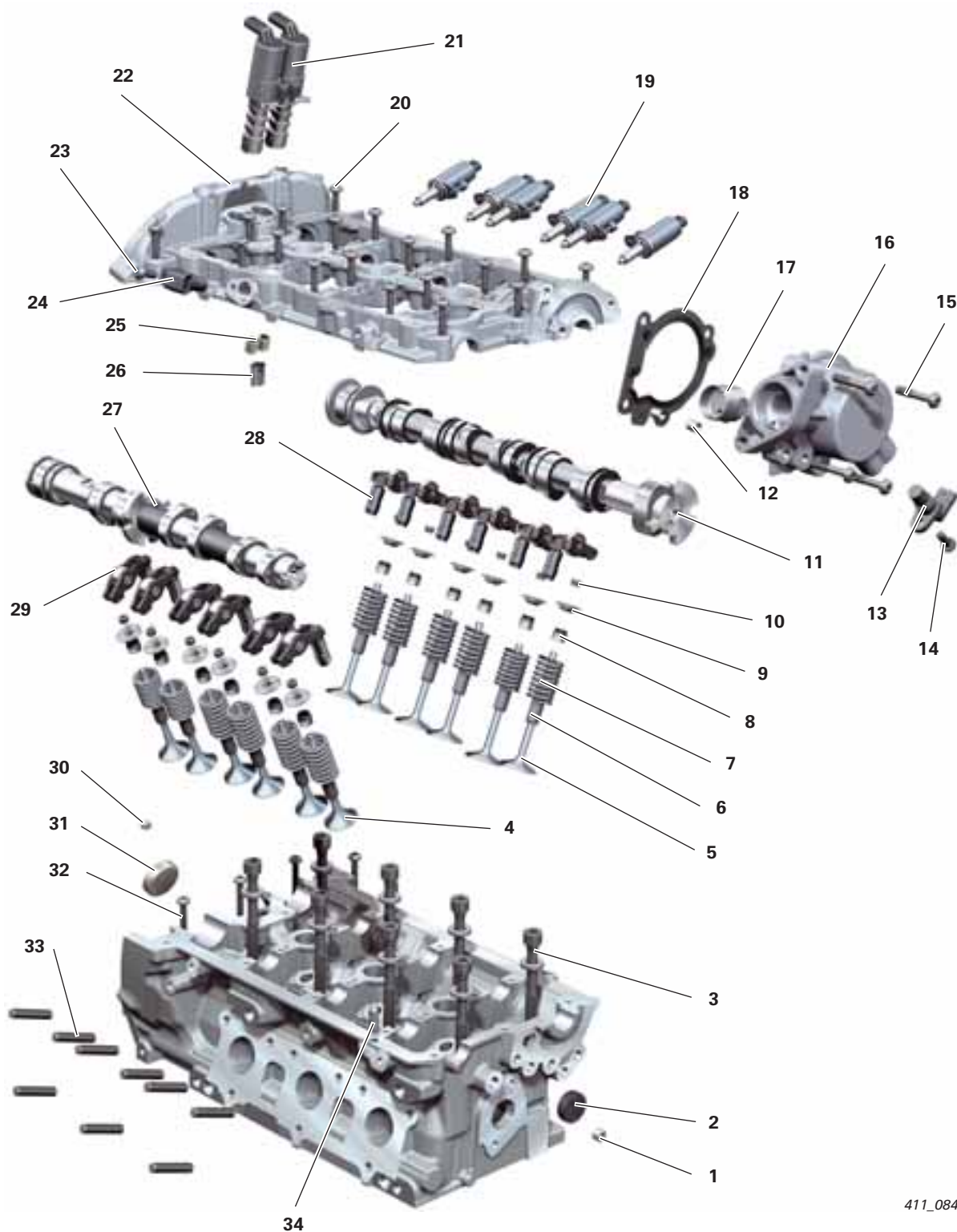
* *Bondal*® - vibration absorbent multilayer sandwich design.
A viscoelastic core between the layers of steel strip converts mechanical vibrations to heat. These components are manufactured to different specifications depending on ambient temperature and application.

Differences between the 2.8l and 3.2l engines

The camshaft timings are different in accordance with to the engine characteristics.

Legend

- | | | | |
|---|--------------------------------|----|-----------------------------------|
| 1 | Screw plug | 10 | Valve cone |
| 2 | Cover | 11 | Intake camshaft |
| 3 | Cylinder head bolt with washer | 12 | Fitting sleeve |
| 4 | Exhaust valve | 13 | Hall sender G40 |
| 5 | Intake valve | 14 | Screw |
| 6 | Valve guide | 15 | Screw |
| 7 | Valve spring | 16 | High-pressure pump module housing |
| 8 | Valve stem seal | 17 | Cylindrical tappet |
| 9 | Valve spring retainer | 18 | Seal |



411_084

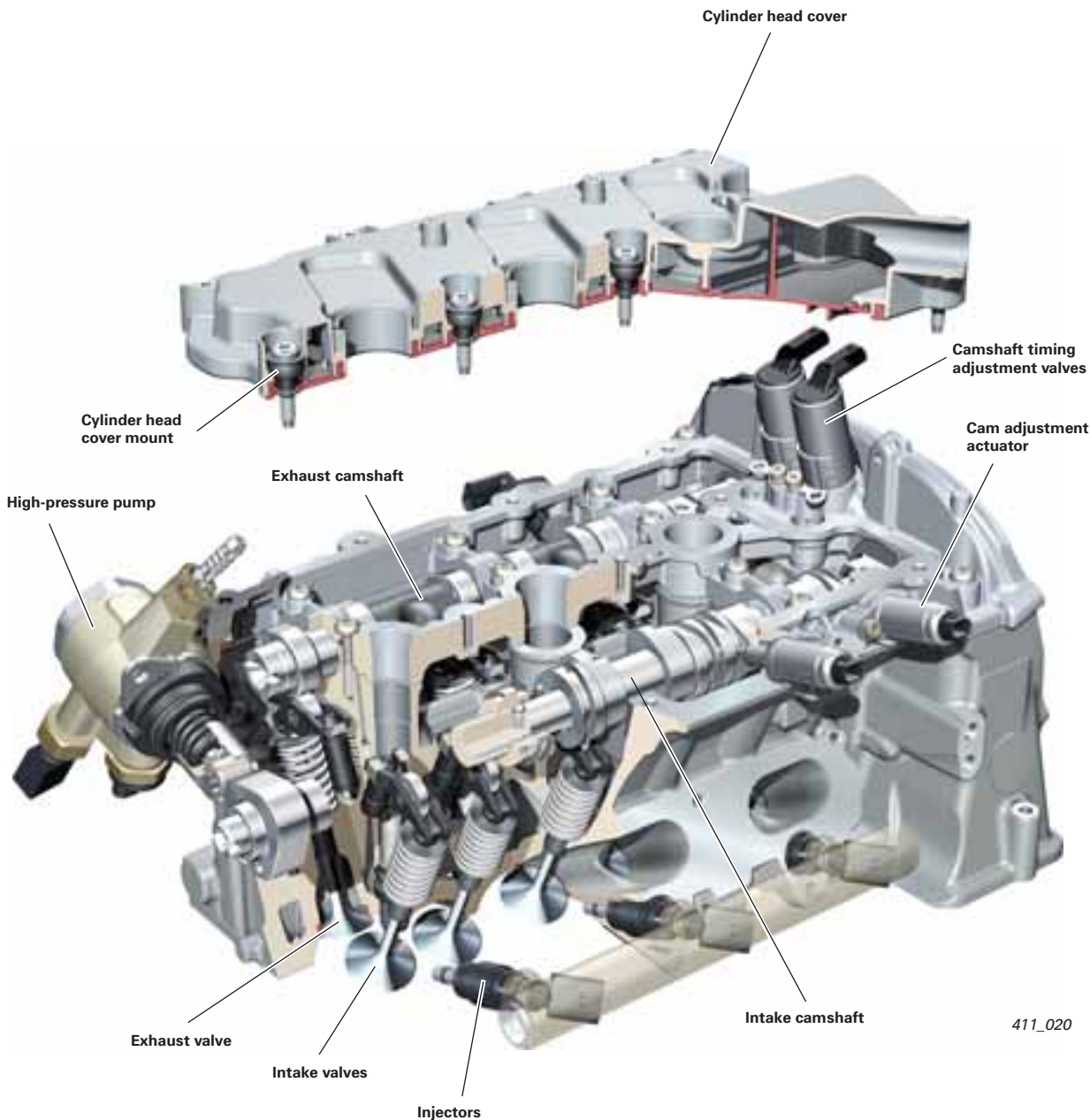
- 19 Displaceable cam element
- 20 Pan head screw
- 21 Camshaft timing adjustment valves
- 22 Ladder frame
- 23 Screw
- 24 Hall sender 3 G300
- 25 Non-return valves
- 26 Oil screen
- 27 Exhaust camshaft

- 28 Hydraulic valve clearance adjustment
- 29 Roller cam follower
- 30 Screw plug
- 31 Cover
- 32 Screw
- 33 Fitting stud bolt
- 34 Dowel pin

Audi valvelift system

The valvelift system is the result of recent technological development by Audi. Variable valve timing provides further enhanced driving comfort and better fuel economy. This technology is based on the dual-stage valve lift control system. The system is actuated directly on the camshaft - a major advantage when defining the valve lift curves.

The Audi valvelift system uses so-called cam elements which are seated on the intake camshafts and can be displaced axially. Two different cam profiles are arranged in juxtaposition for small and large valve lifts respectively. Due to the change in the position of the cam elements, the intake valves are controlled in dependence on load state.

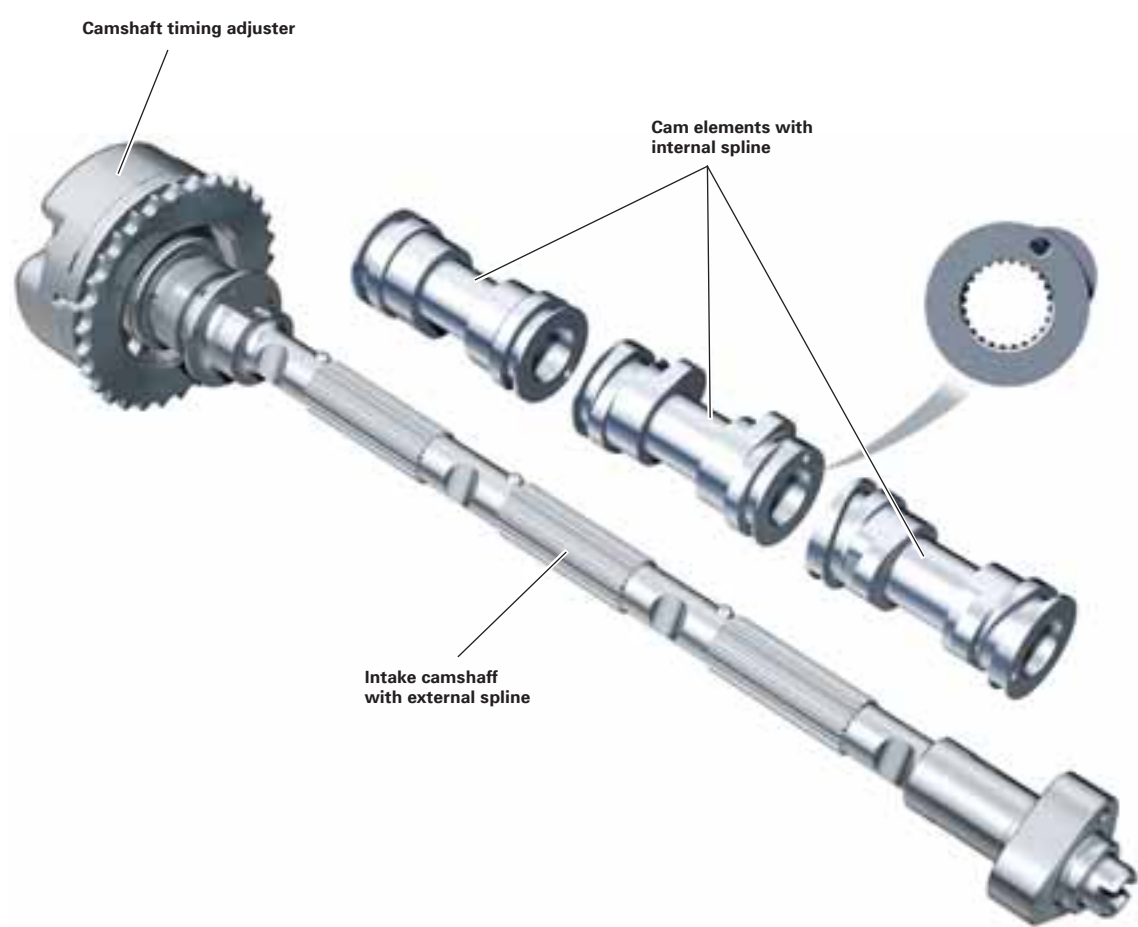


411_020

Camshaft design

The two basic intake shafts have splines upon which the cam elements are mounted. These cylindrical sleeves, which can be displaced axially by approx. 7 mm, have two cam lobe contours - one for small valve lifts and one for large valve lifts.

Intake camshaft bank 1

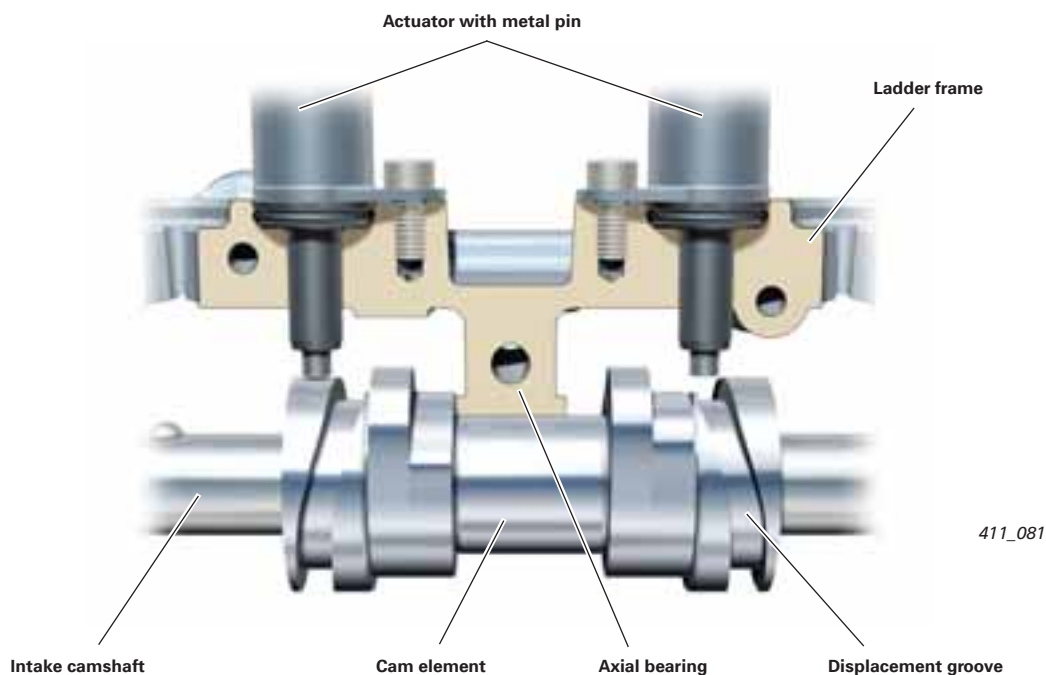


411_082

Camshaft bearing

Longitudinal displacement of the cam elements is provided by two metal pins, which are arranged perpendicular to the camshaft inside the cylinder head and can be extended by electromagnetic actuators. They lock into the grooves integrated in the cam elements. The lowered metal pin engages a displacement groove with a helical contour on the end of the cam elements. The helical groove pattern displaces the cam element in a longitudinal direction under rotation.

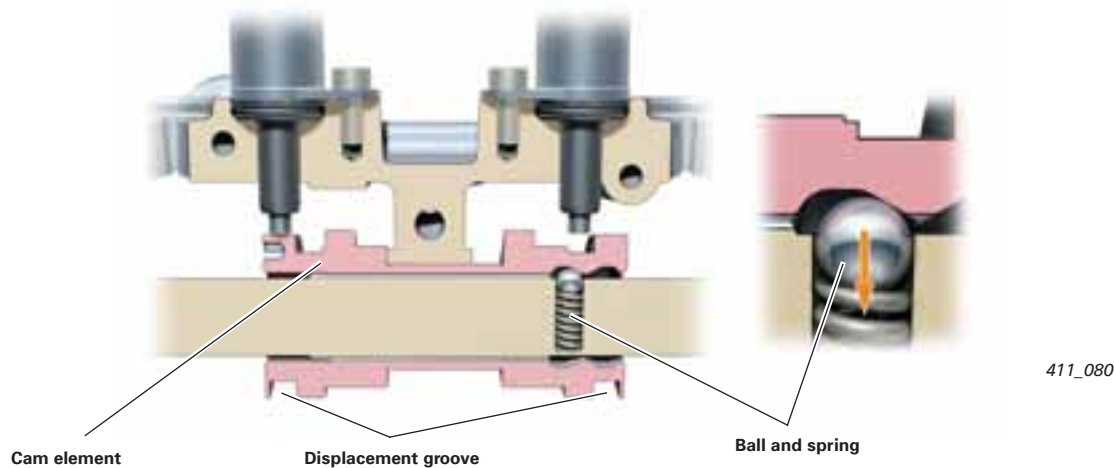
After the cam element has been displaced, the metal pin of the deenergised actuator is displaced back its initial position as a result of the special groove bed shape. The cam element is now positioned precisely in abutment with one side of the axial bearing. The cam element is returned to its original position by the second metal pin acting in conjunction with a displacement groove on the opposite side.



Camshaft detent

A spring-loaded ball integrated in the camshaft acts as a detent for the partial and full throttle positions of the cam element.

Locking of the cam elements



Cam lobe contour shape

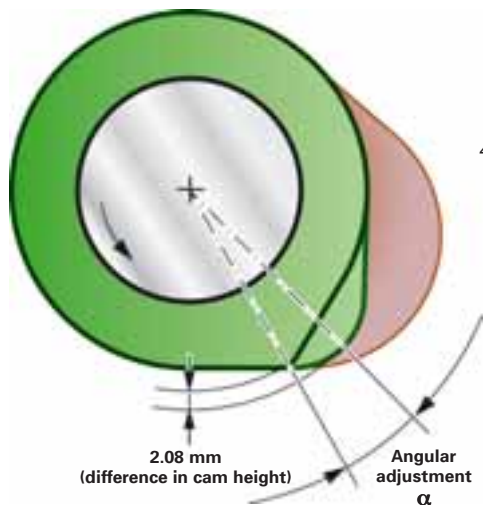
The individual cams are shaped and spaced differently in relation to one another.

Each cam element has two cam pairs, whereby each cam pair acts upon a single intake valve. The special shape of the cam lobe contours allows the engine characteristic to be controlled. The large cam lobe contours were designed to provide a sporty engine characteristic. The advantages of the Audi valvelift system are reflected in the design of the small cam shapes.

Valve opening is asymmetrical at partial throttle (small cam lobe contours). Firstly, the small cams are shaped in such a way that one intake valve opens further than the other one (2 mm and 5.7 mm respectively), and, secondly, the small cam lobe contours have different valve opening times. The cam lobe contours of the small valve lift are shaped in such a way that the intake valves open simultaneously. However, closing of the second valve is retarded. In combination with the special intake valve masking configuration in the cylinder head, this results in a higher flow rate and imparts a swirling motion to the fresh gases induced into the combustion chamber. Moreover, the FSI specific shape of the piston produces a tumbling motion in the fresh gases. This special combination results in optimum mixing of the injected fuel. For this reason, no intake manifold flaps are required.



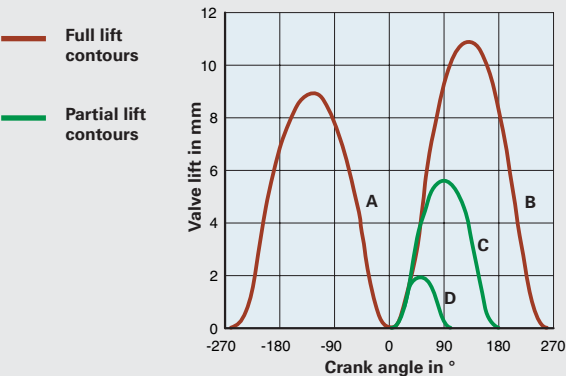
411_079



411_089

Legend - valve contours

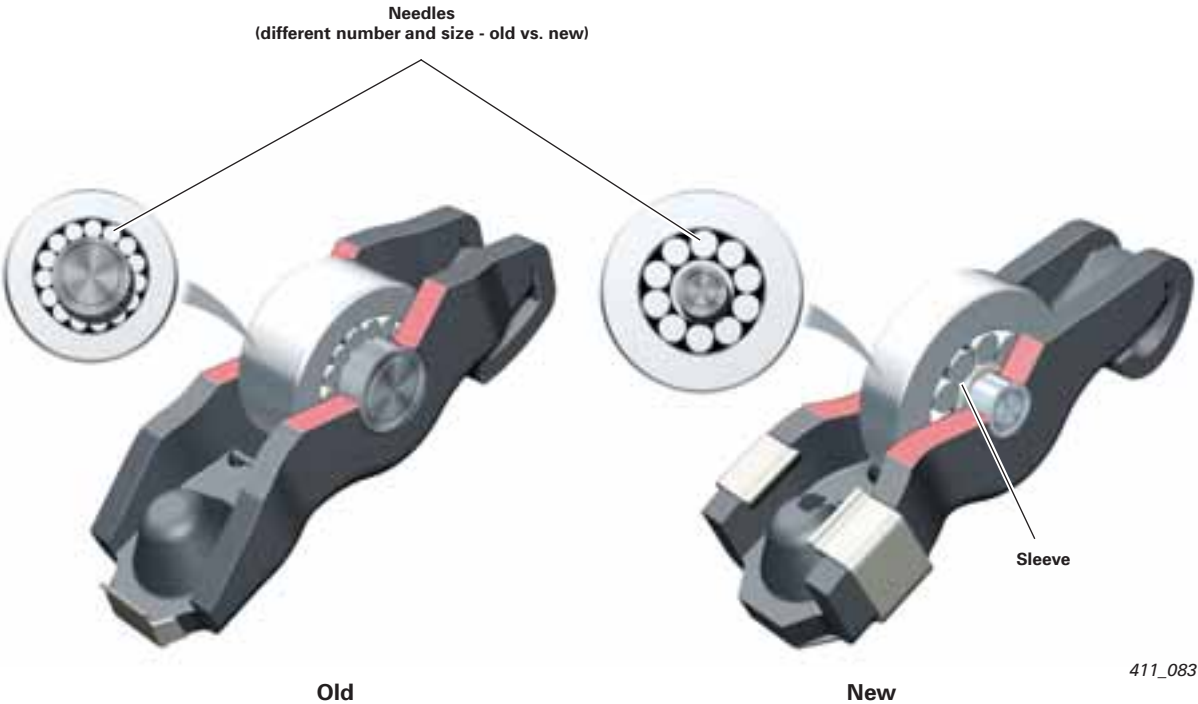
- A Exhaust valve, full lift 2x per cylinder (exhaust camshaft)
- B Intake valve, full lift 2x per cylinder
- C Intake valve, partial lift - large cam lobe contour
- D Intake valve, partial lift - small cam lobe contour



Modifications to the roller cam followers

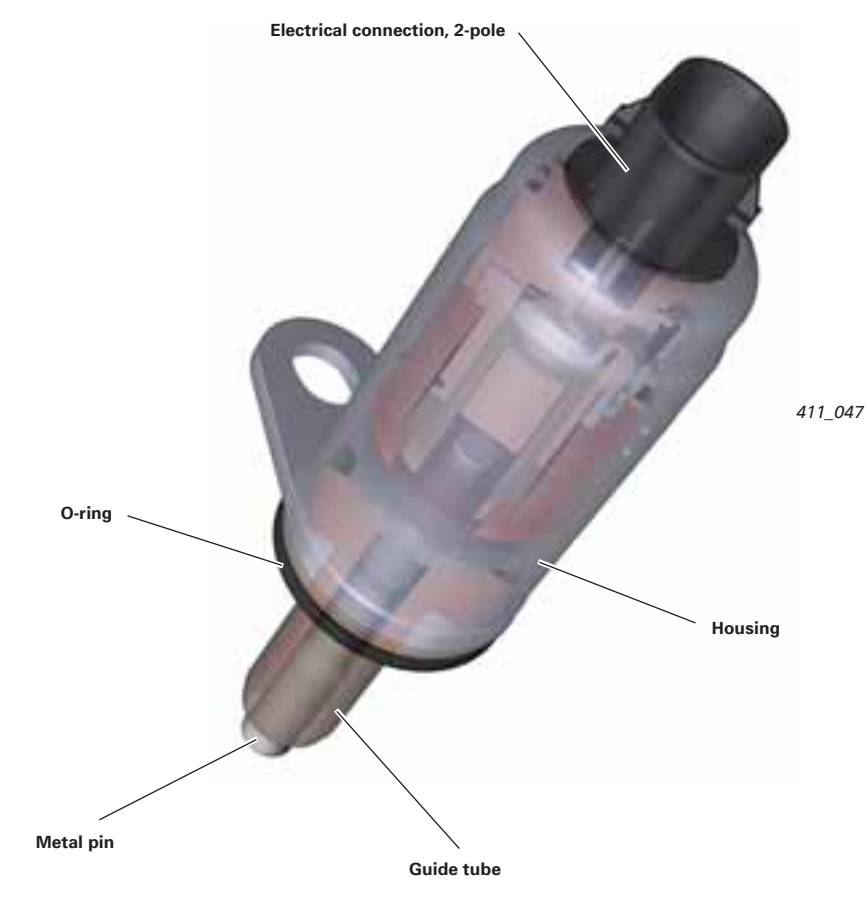
To realise both valve lift curves, it was necessary to modify the roller cam followers previously used. Since both cams run directly adjacent to one another, a certain amount of clearance must be provided. To this end, the roller diameter was enlarged and the pin diameter reduced.

The roller width was also reduced. To transmit the forces reliably with a reduced roller width, it was necessary to increase the diameter of the needle bearing. In addition, the inner bearing diameter was enlarged by integrating a sleeve into the pin.



Cam adjustment

Cam adjustment actuator F366 – F377



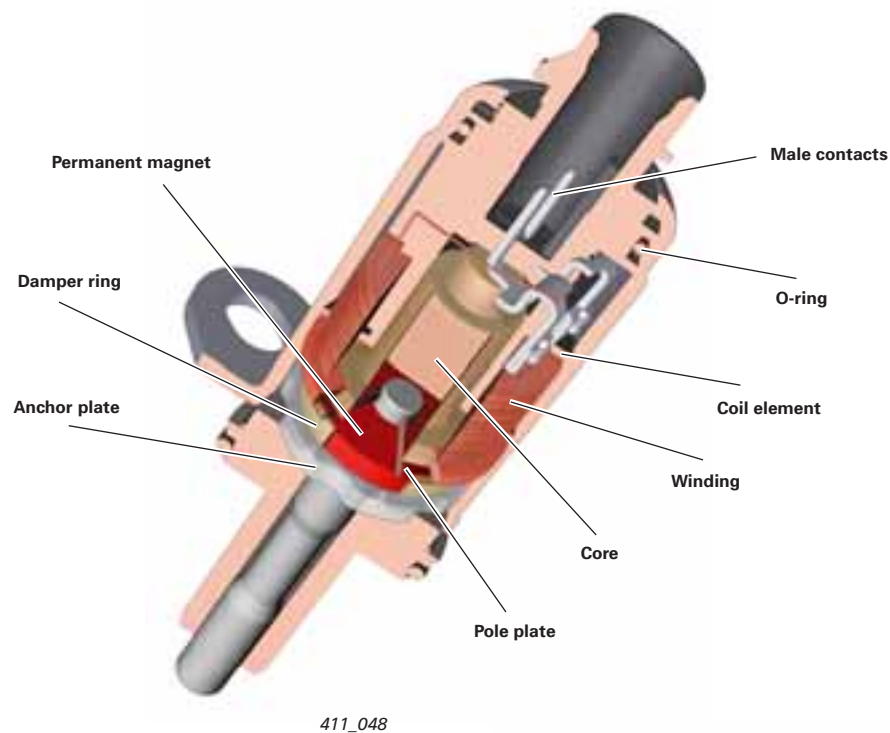
The cam adjustment actuator is a solenoid (electrical magnet). When it is activated by the engine control unit, a metal pin engages into the cam element's displacement groove and thereby triggers the adjustment to the other cam lobe contour.

Two actuators are used per cylinder. Only one actuator of a cylinder is activated for adaptation to a different cam lobe contour.

A permanent magnet attached securely to the metal pin ensures that the metal pin is held in the extended or retracted position.

The metal pin is extended electromagnetically. The pin retracts mechanically due to the contour of the displacement groove in the cam element.

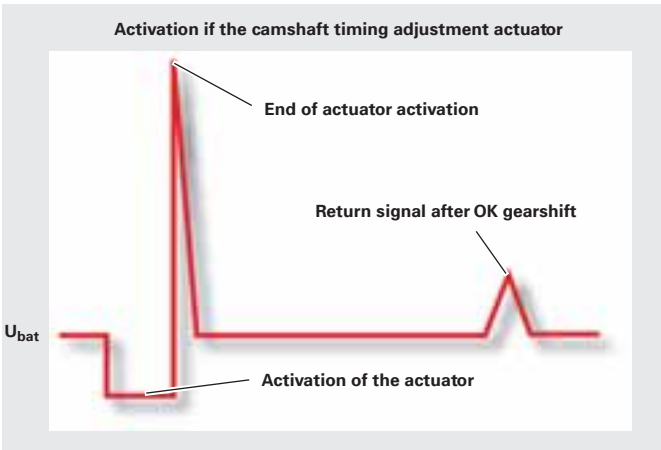
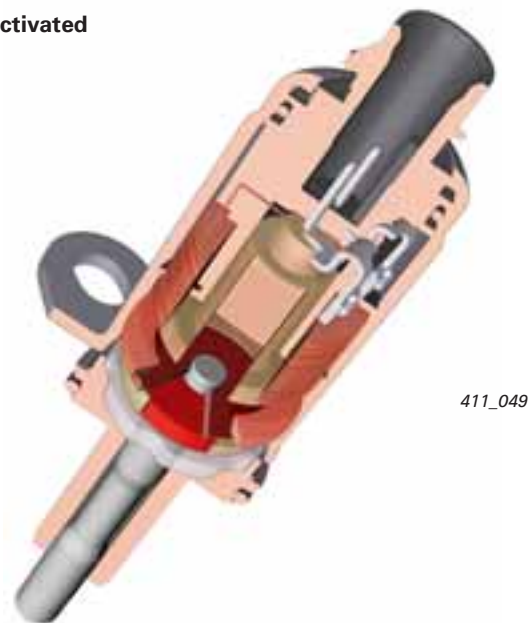
Not activated



When the solenoid is activated, the metal pin securely attached to the permanent magnet moves as far as the lower stop. The activation pulse is generated by the solenoid in order to extend only the metal pin. The metal pin is held in the extended position by the permanent magnet on the actuator housing.

After the cam element has been adjusted, the metal pin is forced back into its original position due to the shape of the groove bed on the camshaft cam element. At the same time, a voltage is induced by the permanent magnet in the solenoid coil. The engine control unit utilises this signal for recognition of a successfully performed gearshift.

Activated

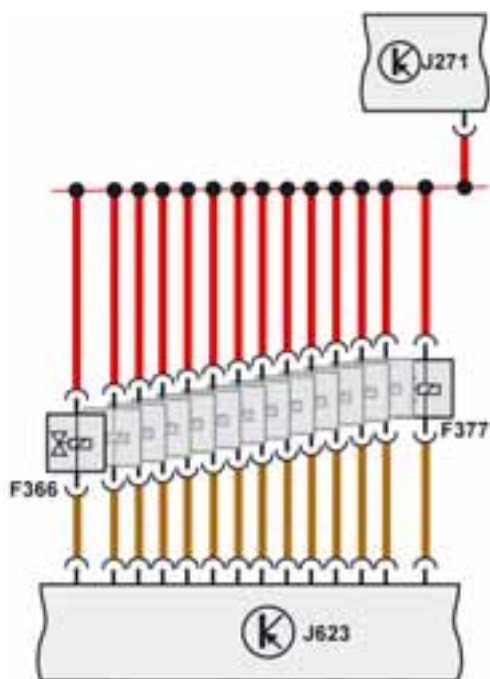


Activation of the camshaft timing adjustment actuators

The activation voltage (battery voltage) is generated by the Motronic current supply relay J271; earth is connected by the engine control unit J623.

Maximum power consumption per actuator is 3 A. All cylinders are activated successively in firing order.

- Extension time 18 - 22 ms
- Acceleration of the metal pins up to 100 G; an elastomer (damper ring) is installed in the area of the permanent magnet on account of this high rate of acceleration. Its purpose is to prevent oscillation and possible breakage of the permanent magnet.



411_059

Note

Do not interchange the connectors!



Changeover conditions

- **Position of small cam**
at engine start-up, idling - low torque demand and engine speed - 4000 rpm, overrun, engine off
- **Position of large cam**
as of 4000 rpm or a defined torque threshold (map controlled)
- U_{bat} : battery voltage is continuously applied to the actuator. The voltage peak at the end of the actuator activation process is caused by induction within the magnetic coil.
- After the actuator is activated, it is switched to earth by the engine control unit.
- Very short activation pulse; during this time the metal pin engages into the displacement groove in the cam element.
- After a single revolution of the camshaft, the metal pin is pushed back due to the displacement groove contour. At the same time, the permanent magnet moves towards the solenoid. A voltage is induced in the solenoid coil. The resulting voltage peak is detected by the engine control unit and diagnosed as a reset signal.
- If the metal pin cannot be extended upon activation, no reset signal is generated.

Engine mechanicals

Self-diagnostics

- Entry in fault memory: Yes
- Actuator diagnosis: not possible
- Basic setting: activate data block 155
- Codings: none
- Data block: see Basic setting
- If not all cylinders can be switched to large stroke, they all remain at small stroke. Engine speed is reduced to 4000 rpm. The EPC lamp in the dash panel insert is activated. The reduction in speed is also indicated to the driver on the display panel of the driver information system (DIS).
A fault message is entered into the fault memory.
- If not all cylinders can be switched to small stroke, they are all switched to large stroke.
A fault message is entered into the fault memory. The engine speed is not limited and the EPC lamp is not activated. The driver notices no loss of power. Idling may be slightly rougher.

Checking for valve lift changeover

- When data block 155 is activated, intake cam stroke changeover is switched from the small intake cam to the large intake cam and back in the firing order of the cylinders.
- The result of the change of stroke is checked as follows in data block 155:
 - Function 04 (Basic setting),
 - Data block 155,
 - Check by pressing -Activate- button (Test ON)
 - Depress accelerator and brake pedal,
 - Engine speed automatically increases to approx. 1000 rpm,
 - Wait until display in field 4 reads: "Syst. OK" (min. OK time: 5 s; max. OK time: 40 s).

Note

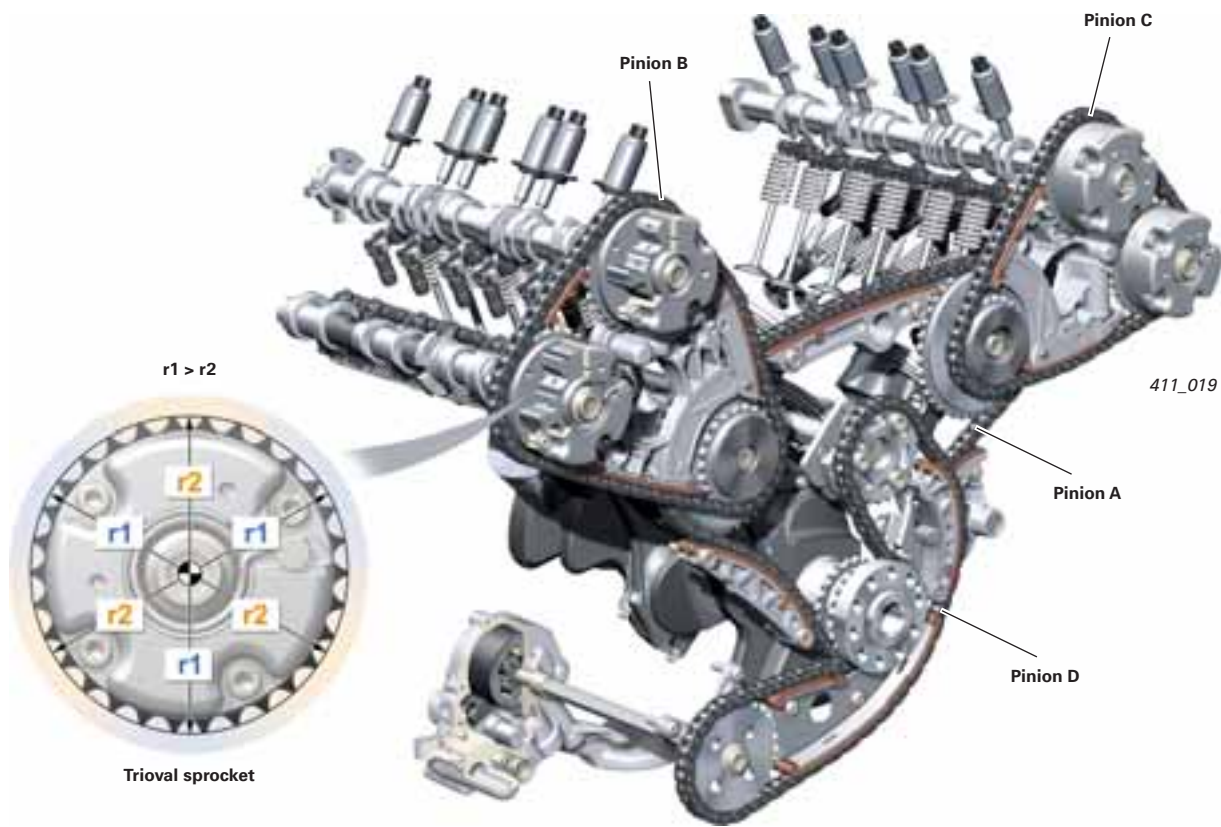


The valve changeover check is an integral part of the readiness code.

Data block 155	Oil temperature actual °C	Bit trace for large cam	Bit trace for small cam	Result "Text"
Display of nominal values	min. 80 °C	__11 1111	__11 1111	System OK

Chain drive

Valve train with trioval sprockets



	r1 - large	r2 - small
Crown circle diameter	46.86	45.71

The chain drive design derives from the chain drive used on the previous V6 petrol engines. The following modifications were made:

- Sprockets:
The number of teeth on the camshaft sprockets and the idler gears of pinion A were increased, thereby reducing the forces acting upon the chain.
- Trioval sprockets are used on all camshafts.
- Chains:
Newly developed roller chains (previously sleeve-type chains) for pinions A to C now have the same fatigue strength and wear resistance as sleeve-type chains. Furthermore, roller chains are superior to sleeve-type chains with respect to acoustics and friction.
- Chain tensioner:
Chain tensioner damping was also reduced by minimising the forces and vibrations acting upon the chain drive. This, in turn, reduces friction within the chain drive. The chains are partially supplied with lube oil through the ventilation orifices in the chain tensioner.
- Oil pump and balancer shaft drive:
The oil pump and the balancer shaft are driven by a roller chain and a mechanical tensioner.

The direction of rotation of the balancer shaft is reversed in the chain drive. All chain drives are maintenance free.

Engine mechanicals

Trioval sprockets

To open the valves of a cylinder, torque must be applied.
In a V6 engine, three valve opening operations are performed on each cylinder bank and camshaft per operating cycle.
This means that higher forces act upon the chain drive each time the valve opens. These forces produce vibration within the valve train, particularly at higher engine speeds.

Function:

The trioval sprockets are acircular in shape. They have three raised areas. The larger outer diameter at the raised areas increases the effective leverage acting upon the valves. The raised areas (larger leverage) act exactly when a cam is required to open the valve. Increasing the leverage reduces the forces acting upon the chain and counteracts unwanted vibration (see diagram).

This technology is also featured on the 2.0l TFSI engine with timing belt (CTC gear). However, the technology is better suited to this engine because, in the case of the 4-cylinder inline engine, the four valve opening operations per working cycle are divisible by the timing gear ratio. Here, therefore, the toothed belt sprocket on the crankshaft has two raised areas.

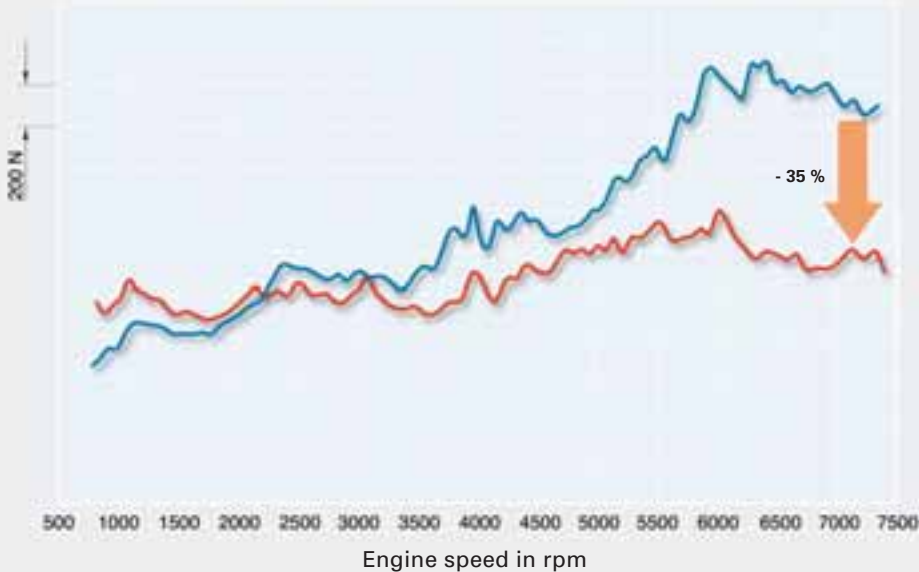
Advantages:

Since there is less force acting upon the chain, there is also less friction, so fuel economy is better. Furthermore, it is possible to use less expensive chains and chain tensioners having the same functional capabilities.

Another advantage is the reduced oscillation angle. The effect is smoother chain drive operation.

Reduction in the forces acting upon the chain through the use of trioval sprockets

- without trioval sprockets
- with trioval sprockets (standard)



Actuation of ancillary units

The crankshaft vibration damper drives the following ancillary units via the ribbed V-belt:

- Alternator
- Coolant pump
- Power steering pump
- Air conditioning compressor

An automatic tensioning pulley produces the correct tension.

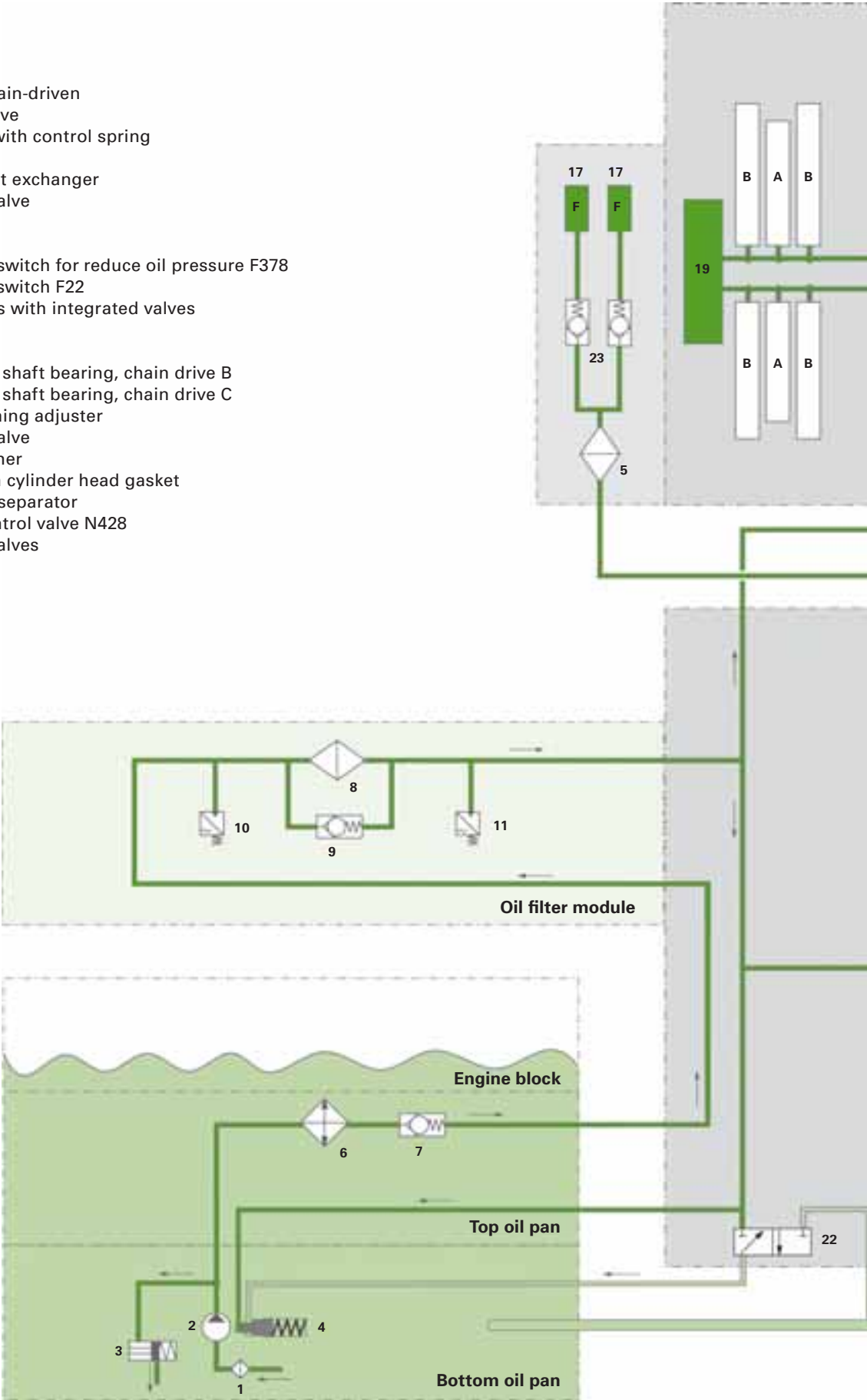


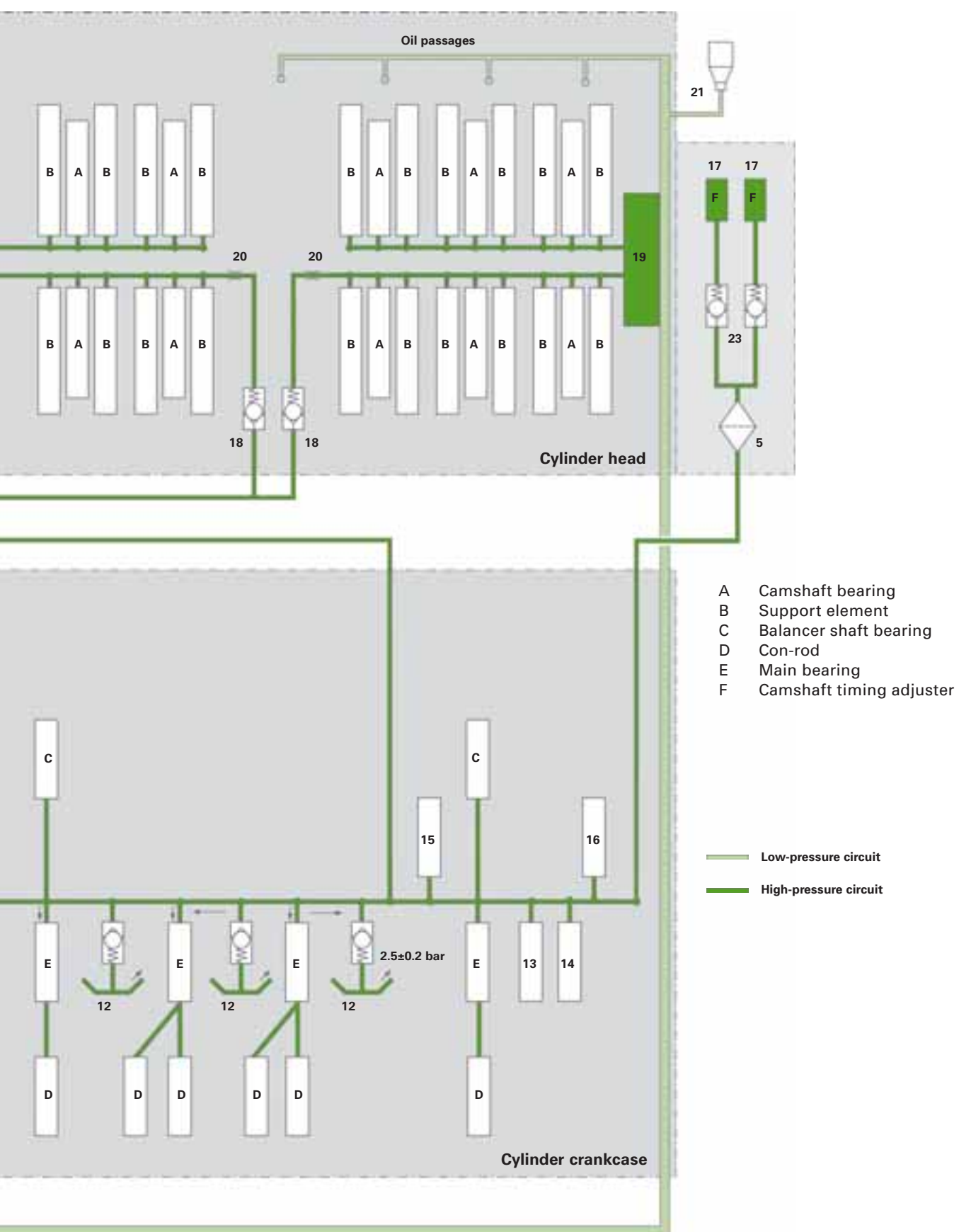
Oil circulation system

Lubrication system

Legend

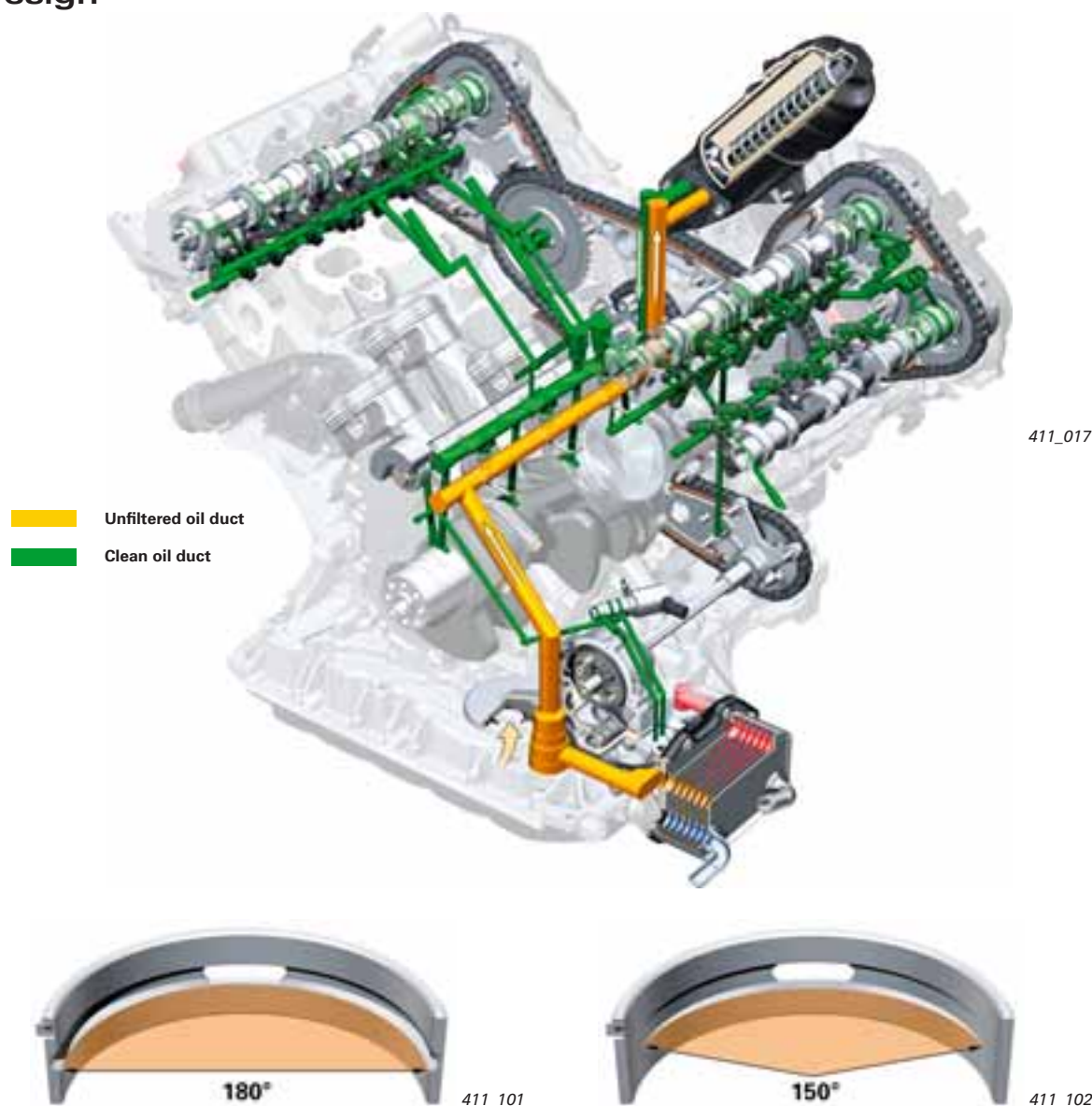
- 1 Screen
- 2 Oil pump, chain-driven
- 3 Cold start valve
- 4 Step piston with control spring
- 5 Oil screen
- 6 Water-oil heat exchanger
- 7 Non-return valve
- 8 Oil filter
- 9 Bypass valve
- 10 Oil pressure switch for reduce oil pressure F378
- 11 Oil pressure switch F22
- 12 Spray nozzles with integrated valves
- 13 Pinion D
- 14 Pinion A
- 15 Intermediate shaft bearing, chain drive B
- 16 Intermediate shaft bearing, chain drive C
- 17 Camshaft timing adjuster
- 18 Non-return valve
- 19 Chain tensioner
- 20 Restrictors in cylinder head gasket
- 21 Fine oil mist separator
- 22 Oil pump control valve N428
- 23 Non-return valves





Oil circulation system

Design



The key goal for the development of the lubrication system was to further reduce friction inside the engine. To this end, a string of modifications were made, e.g. in the chain drive. In addition, the oil flow rate was significantly reduced by optimising the oil circulation system.

Improvements:

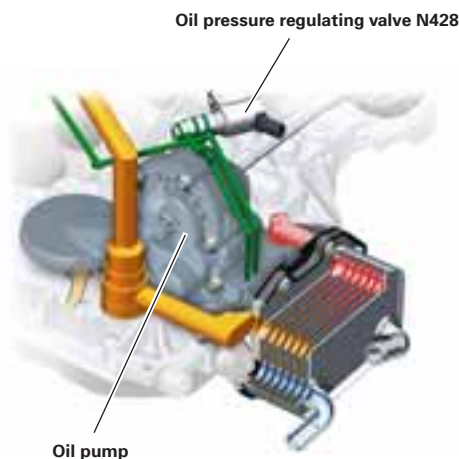
- Modification of crankshaft main bearing upper shell from a 180° crescent groove to a 150° crescent groove
- Transfer of the oil feed bore to the camshaft bearings
- Halving of the through-flow rate of the piston spray nozzles
- Reduction of camshaft timing adjuster leakage including camshaft timing adjustment valves
- The oil supply to the continuous camshaft timing adjuster was separated from the cylinder head oil supply (camshaft bearing and hydraulic components). This made it possible to restrict the oil pressure in the cylinder head while enhancing the connection between the camshaft timing adjustment valves and the oil supply.

Oil pump

Reciprocating slide valve regulating pump

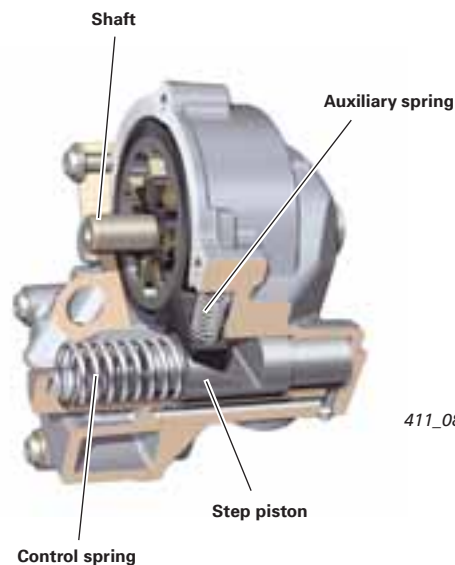
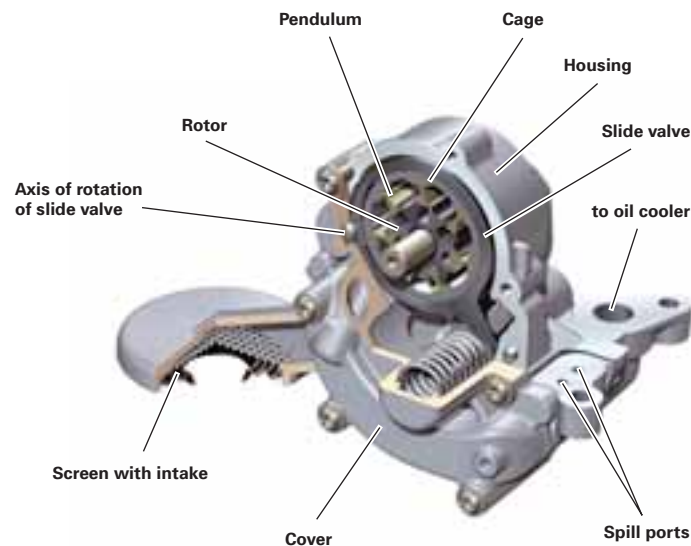
The flow rate reduction in the oil circulation system was the reason for the use of a new oil pump. The so-called reciprocating slide valve regulating pump requires much less driving power than pumps used previously.

With a delivery rate reduced by 30 %, the pump operates in a flow-regulated - and hence demand-driven - manner. The result is better fuel economy. An electrically activated valve (oil pressure regulating valve N428) is located in the cylinder block above the oil pump.



411_042

Design



411_085

The pump is driven by the chain drive via the shaft (see "Overview of chain drive"). The shaft is permanently coupled to the rotor. It is flushly connected to the cage by seven pendulums.

The pendulums are movably located within the radial slots in the pendulums. The rotor, pendulum and cage rotate jointly inside the slide valve, which acts serves as the cage liner.

The rotor is mounted eccentrically in relation to the slide valve and the cage. As a result, like in a rotary vane pump, spaces of different size form inside the individual cells.

The special feature is that the slide valve is mounted swivellably against the force of an auxiliary spring inside the pump housing.

The individual cells are formed between two pendulums, the cage, the rotor and the lateral pump covers.

The oil pressure inside the pump is produced by the following components:

- slide valve,
- cage,
- rotor and
- pendulum.

Oil circulation system

Oil feed

The suction range of the cells increases while the pump is rotating. This produces a vacuum and the oil is drawn into the pump through the screen. The rotational motion causes the oil to flow towards the pressure side. Here, the cells decrease in size and the oil is expelled from the pump under pressure. Oil is delivered according to demand.

To protect against excessively high pressure, a spring-loaded ball valve (cold start valve) is located at the pump outlet. It opens at approx. 11 bar and discharges the oil into the oil pan. The oil pressure produced by the pump flows directly into the crank-case's main oil gallery. At an engine speed of 4600 rpm, the oil pump switches from low pressure to high pressure. The piston bases spray nozzles are also activated in order to prevent the formation of temperature peaks. A separate water-oil cooler is installed directly adjacent to the pump.

Pump regulation

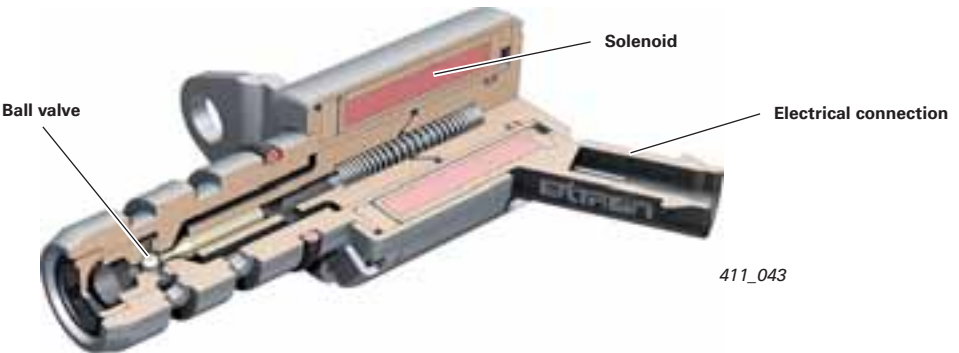
The pump is regulated by the oil pressure within the main oil gallery. To this end, a portion of the oil is branched off from the main oil gallery and flows through a control line and the oil pump control valve N428 to the oil pump. The oil pump control valve N428 is an electrically operated hydraulic 3/2-way valve. Firstly, it allows the extracted oil to flow directly to the oil pump and, secondly, it can be activated to open a second line to the oil pump.

This oil flow deriving from the oil pressure in the main oil gallery acts upon the control piston in the oil pump. The control piston (step piston) has two piston faces. Oil pressure is continuously applied to one piston face due to the oil flowing directly through the pump.

Additional oil pressure can be applied to the second piston face via the line connected by N428. The control spring counteracts the oil pressure acting upon the control piston.

If the N428 is not activated, both control lines are open. The oil pressure can therefore act upon both piston faces, thereby displacing the piston against the pressure of the control spring. When the piston is displaced, the slide valve follows the diagonally falling piston ramp and is swivelled. The swivelling action alters the eccentricity of the slide valve in relation to the rotor. This leads to a change in cell size and therefore the delivery rate of the pump.

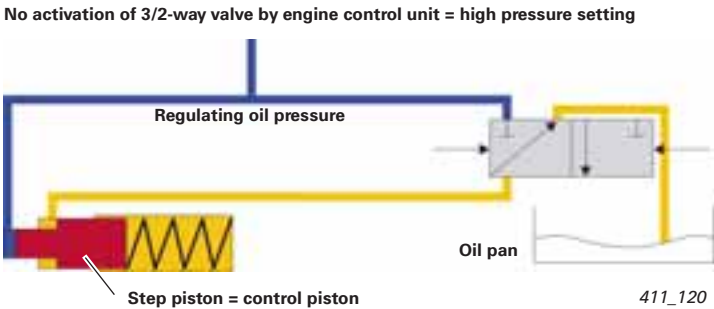
Oil pump control valve N428



Full delivery

The N428 is deenergised and earth is disconnected from engine control unit earth. The second control line is thereby closed off. Oil pressure is applied to one piston face only. The pressure exerted by the control spring displaces the control piston.

The slide valve is swivelled by the rising of the piston ramp. The swivelling action increases the rotor's eccentricity. The cells grow larger and the delivery rate of the pump increases.



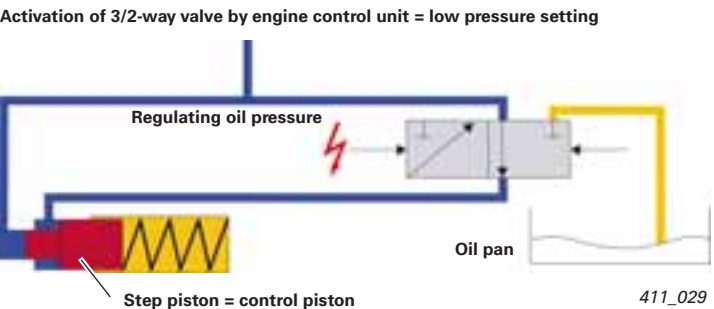
High pressure

The valve is not activated. The ball valve is opened. The full volumetric flow is pumped into the oil circulation system.

Partial feed

The N428 is energised by the engine control unit. The second control line is opened. Oil pressure is applied to both faces of the step piston. The effective force is greater than the force exerted by the control spring. The step piston moves, and the slide valve follows the falling ramp of the step piston (due to the force exerted by the auxiliary spring).

The eccentricity of the slide valve in relation to the rotor decreases, thereby reducing the size of the cells. The delivery rate decreases.

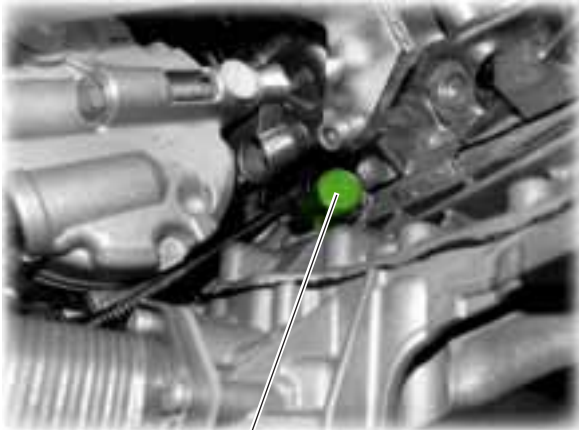


Oil circulation system

Oil pressure regulating valve N428

The oil pressure regulating valve N428 is a hydraulic 3/2-way valve. It is electrically activated by the engine control unit. The valve is located above the oil cooler in the engine block.

When the valve is activated, the second oilway to the oil pump control piston opens. The result is a reduction in the oil pressure and in the delivery rate of the oil pump. This allows fuel consumption to be reduced. In the event of failure of the valve, the engine runs at full oil pressure across the full engine speed range.



411_037

Oil pressure regulating valve N428

Oil pressure monitoring

Oil pressure is monitored by means of two oil pressure switches. Two monitoring switches are required for checking the changeover to high or low oil pressure. What is new is that the switches are not connected to the dash panel insert any more. The engine control unit evaluates the signals from the oil pressure switch.

If it is necessary to switch on the warning lamp in the dash panel insert, a message to this effect is sent to the CAN data bus.

Oil pressure switch for reduced oil pressure F378

The F378 closes at an oil pressure of 0.9 bar. If the oil pressure drops below this level, the switch opens and the engine control unit activates the warning lamp in the dash panel insert. The F378 is integrated in the main oil duct upstream of the oil filter module.



411_035

Oil pressure switch for reduced oil pressure F378

Note



The 3.2l engine with Audi valvelift system is used in the A5. Here, the oil pressure switch F22 is connected to the onboard power supply control unit J519. In the case of the 2.8l engine powering the Audi A6, both oil pressure switches are connected to the engine control unit.

Oil pressure switch F22

The F22 operates within a pressure range above the changeover threshold of the oil pressure regulating valve N428. It closes at an oil pressure of 2.5 bar. By utilising the signal from the oil pressure switch, the engine control unit can detect when the oil pump is producing the required oil pressure. The F22 is integrated in the hydraulic oil port downstream of the oil filter in the oil filter module.



411_036

Oil pressure switch F22

Changeover points

The oil pressure level can be selected on the basis of three paths.

1. Engine speed path

The high pressure level is activated at a value defined in the map. The changeover is performed at an engine speed of approx. 4600 rpm.

2. Temperature path

To provide improved piston cooling, the high pressure setting is selected. The oil and coolant temperature are calculated in a map and the changeover point is set to the high pressure level. Increasing the oil pressure causes the valves to the spray nozzles to open.

3. Diagnostic path

Oil pressure can be increased by starting a short trip using the diagnostic tester. Data block 159 can be used to start the short trip in Basic setting mode. The following variables can be displayed on the four displays during the short trip:

Display 1:	Modelled oil temperature,
Display 2:	Activation of N428,
Display 3:	Status of oil pressure switches F22 and F378 and
Display 4:	Status of the short trip.

Note



For details of the exact procedure and the corresponding values, please refer to Guided Fault Finding.

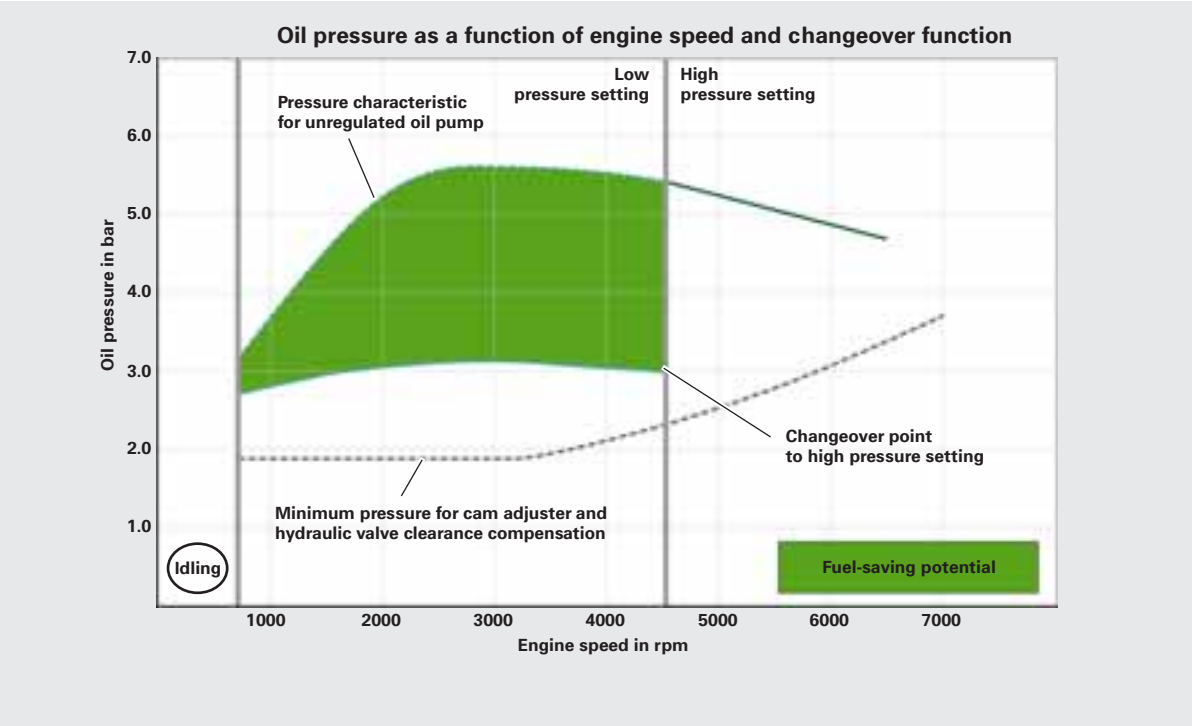
Oil circulation system

Advantages of the pump control system

By optimising the oil circulation system it was possible to utilise a volume-regulated oil pump with dual-stage oil pressure regulation. The diagram again highlights the advantage of this new technology.

In the green shaded area, you can see the potential for saving fuel in the low pressure setting up to the changeover point to the high pressure setting at an engine speed of 4600 rpm. The green broken line would be the pressure characteristic of the unregulated pump.

There is the additional advantage of volumetric flow control, because the pump no longer delivers at full capacity from engine speeds as low as approx. 2000 rpm and the flow rate is set according to demand. These modifications improve the fuel efficiency of these engines by 5 %.



Oil level indicator

With the launch of the new 2.8l and 3.2l V6 FSI engine with Audi valvelift system, Audi rolls out a new generation of the oil level sensor.

Old oil level sensor:

TOLS = Thermal Oil Level Sender
Operates on the hot-wire principle

The oil level is measured by means of a temperature-dependent meander conductor on a circuit board. The meander conductor is heated. The existing quantity of oil determines the degree of cooling. The resulting cooling time is a measure of the quantity of oil. A minimum oil level warning can be issued via the dash panel insert.

Reference

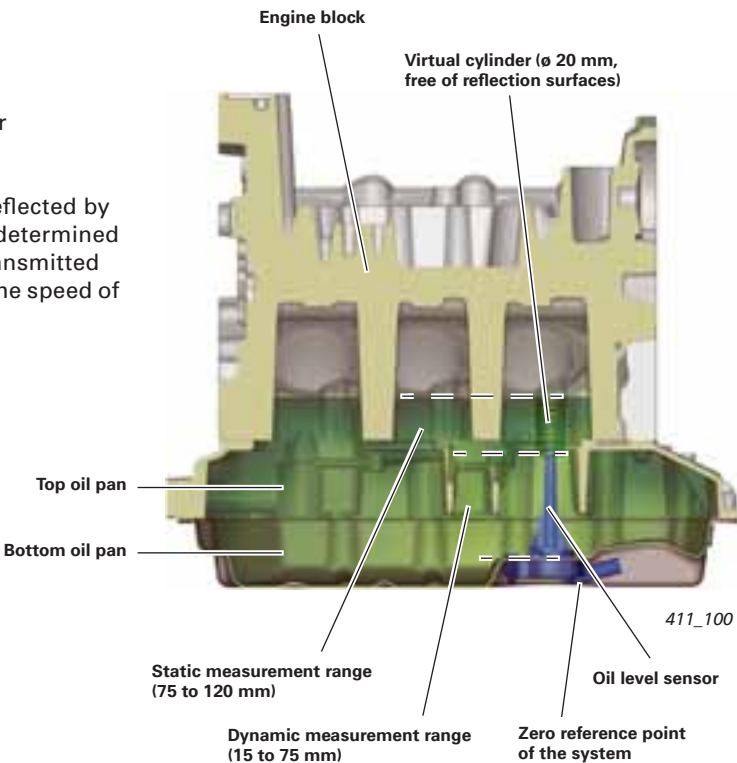


For a description of this sensor, please refer to SSP 207 Audi TT Coupé.

New oil level sensor:

PULS = Packaged Ultrasonic Level Sensor
Operates on the ultrasound principle

The transmitted ultrasound pulses are reflected by the oil-air boundary layer. The oil level is determined from the time difference between the transmitted and reflected pulses with allowance for the speed of sound.



Both sensors process their measured signals by means of sensor electronics integrated in the sensor housing. A PWM signal (PWM = pulse width modulation) is output.

Advantages of the ultrasonic sensor:

- Sensor signal is very quickly available (after approx. 100 ms)
- Low power consumption < 0.5 A (TOLS sensors require up to 5 A)

Oil circulation system

The signal from the old oil level sensor was previously evaluated in the control unit with display in dash panel insert (dash panel insert). The same control unit is used on the Audi A6 with 2.8l engine, although the new pulse sensor is fitted.

With the launch of the 3.2l engine, this function has been reassigned to the engine control unit on the new Audi A5. The values computed here are then transferred to the powertrain CAN bus.

The control unit with display in dash panel insert and the MMI then read in the signals, which are subsequently relayed to the relevant bus systems via the data bus diagnostic interface (gateway). The old system was able to issue a minimum oil level warning, as well as computing and indicating oil change intervals. The new sensor is fitted on the Audi A6, but there is no oil level indicator.

A realistically computed oil level indicator is used in conjunction with the Audi A5 and the 3.2l engine. The previously used dip stick is no longer used. The customer can only check the oil level via the gauge on the dash panel insert, or via the MMI.

The tube into which the dip stick was previously inserted still exists. Engine lubricating oil can be extracted through this tube in the service workshop. This tube is sealed by a sealing plug. A new special tool is available for checking the oil level, which is calculated and indicated. The oil gauge tester T40178 is inserted into the oil tube in the same way as a dipstick.

Oil gauge tester T40178



411_105

Reference



For details of the exact oil level inspection procedure, please refer to "Maintenance".

Calculating the oil level

The oil level is calculated by two measurement methods, namely dynamic and static measurement.

The dynamic measurement is performed while the vehicle is in operation.

Important measurement factors are:

- engine speed,
- longitudinal and transverse acceleration, from ESP control unit,
- bonnet contact (bonnet must be closed),
- engine temperature (engine should be at operating temperature),
- driving cycle after last bonnet contact > 50 km and
- a certain number of measured values must be generated within the driving cycle.

The **dynamic measurement** provides more accurate results, and therefore is mainly used. However, it cannot be used at all times.

The measurement process is interrupted at:

- rates of acceleration of over 3 m/s^2 ,
- oil temperature > 140°C and
- bonnet contact switch F266 was actuated.

To obtain data in these situations, the **static measurement** method is applied.

The static measurement is performed at:

- ignition "on" (to obtain a measurement result as quickly as possible, the measuring process is started when the driver's door is opened),
- engine oil temperature > 40°C ,
- engine speed < 100 rpm and
- engine at standstill > 60 sec.

Again, the acceleration data from the ESP is taken into account in order to allow for inclination of the vehicle.

The signal from the parking brake is also utilised. In the case of fluid levels that can lead to engine damage (measured value below min.), an underfill warning is issued. In the case of fluid levels which can lead to engine damage (measured value above max.), an overfill warning is issued.

Example of a static measurement

When refuelling at the filling station, the bonnet is opened in order to top up the windscreen washer fluid. The dynamic measurement cycle is interrupted by actuation of the bonnet contact switch F266. The signal from F266 is read in via CAN, and is supplied by the onboard power supply control unit (basic circuit diagram). As a result, the oil level would not be indicated again until after a driving cycle of 50 km. The customer would, therefore, no longer be able to check the oil level at a filling station. Even if the vehicle is in the workshop, the mechanic must be able to check the oil level via the gauge.

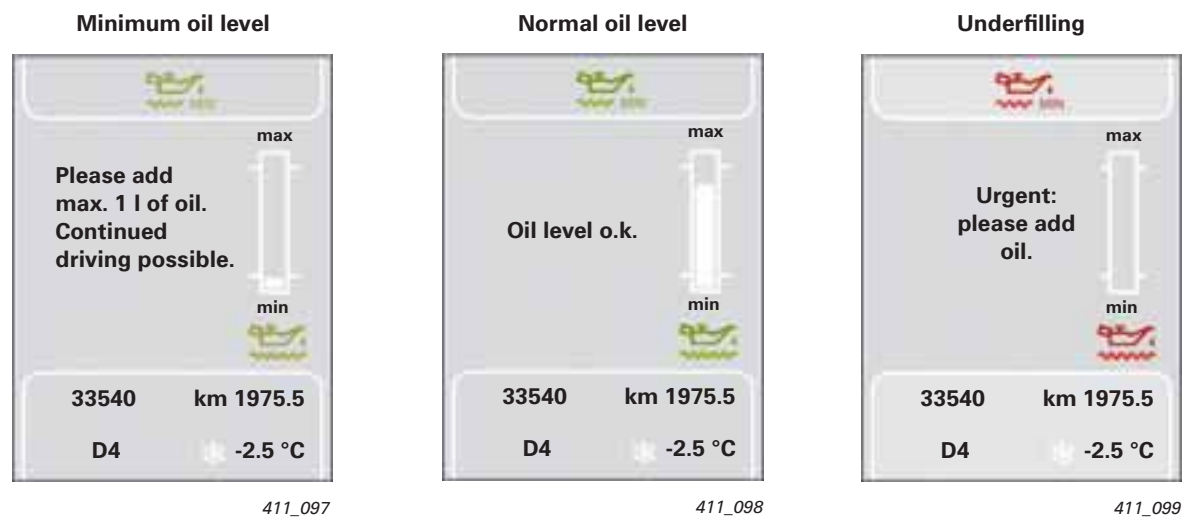
Example of display on MMI



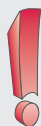
The following graphics show the display in the dash panel insert. Mode of display is engine-dependent:

- 1. Minimum display with prompt to add max. 1 litre of oil.
- 2. Display in red with indication of underfilling.
- 3. Overfilling.
- 4. Oil level o.k.
- 5. Display "Sensor faulty".

Examples of displays in the dash panel insert



Note

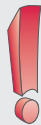


The displays may be monochrome and in colour depending on vehicle specification. Refer to the vehicle's Owner's Manual.

Cooling system

Engine cooling

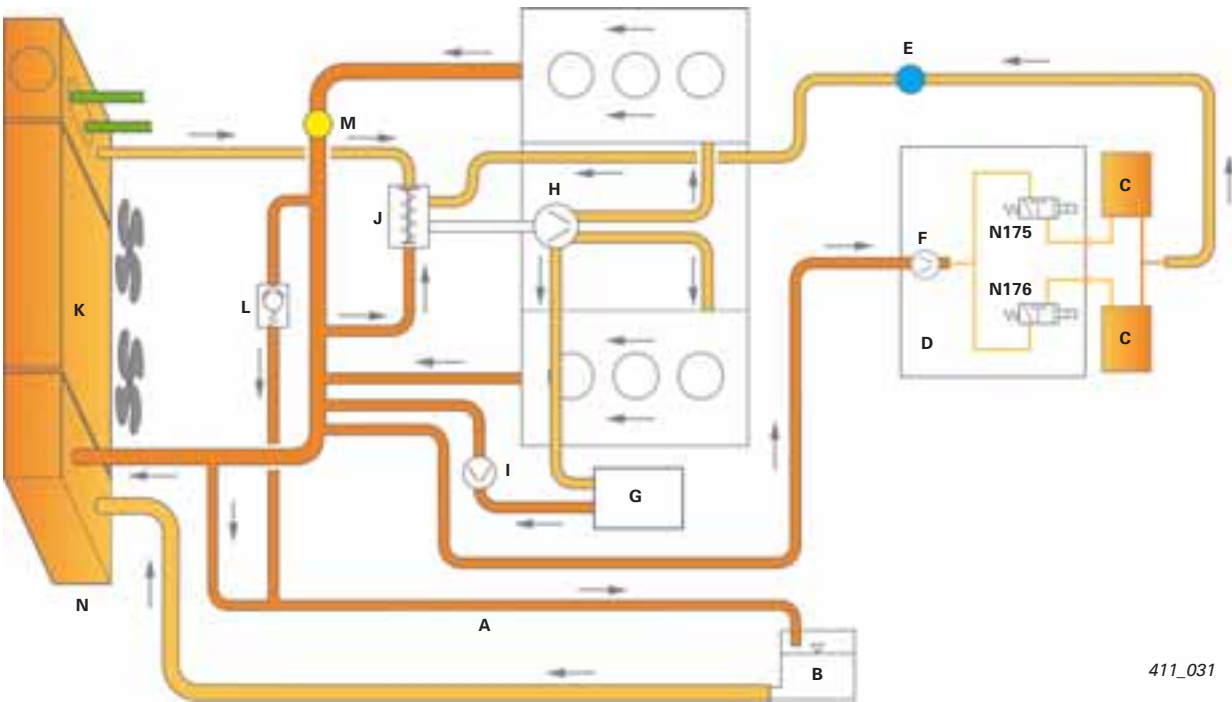
The diagrams show the coolant circuits of the Audi A6 with 2.8l engine. The current coolant circuits are shown in the Workshop Manual (Repair Group 19).



Note

In the case of the coolant circuit, a distinction is made between the variants with and without preheater. A coolant run-on pump is still fitted for so-called super-hot climates (PR. No. 8z9).

Coolant system without preheater

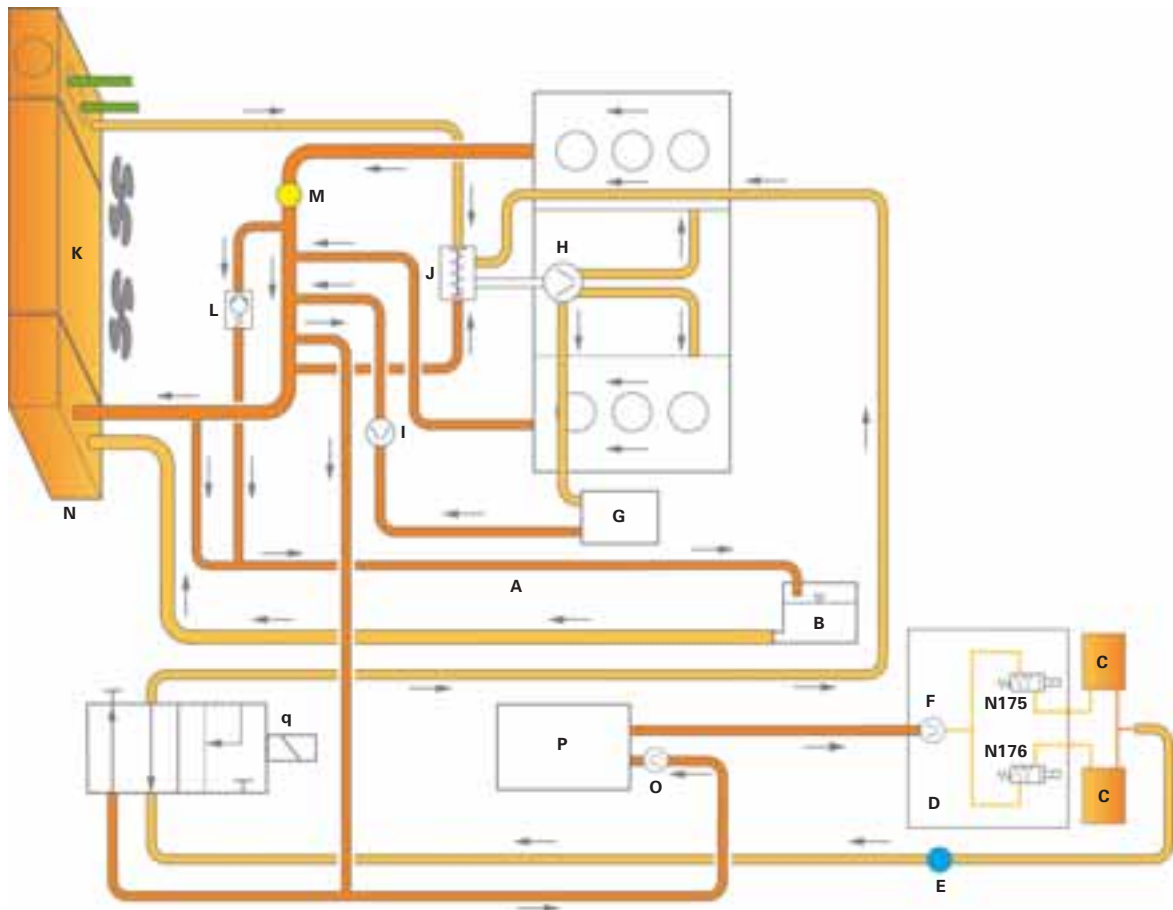


411_031

Legend

A	Breather pipe	G	Engine oil cooler
B	Expansion tank	H	Coolant pump
C	Heat exchanger	I	Additional coolant pump (hot climates only)
D	Heat regulation valve (N175/N176 and V50)	J	Coolant thermostat
E	Vent screw	K	Radiator
F	V50	L	Non-return valve

Coolant system with preheater



411_032

- M Coolant temperature sender G62
- N ATF cooler
- O Recirculation pump
- P Preheater
- Q Heater coolant shutoff valve N279



Note

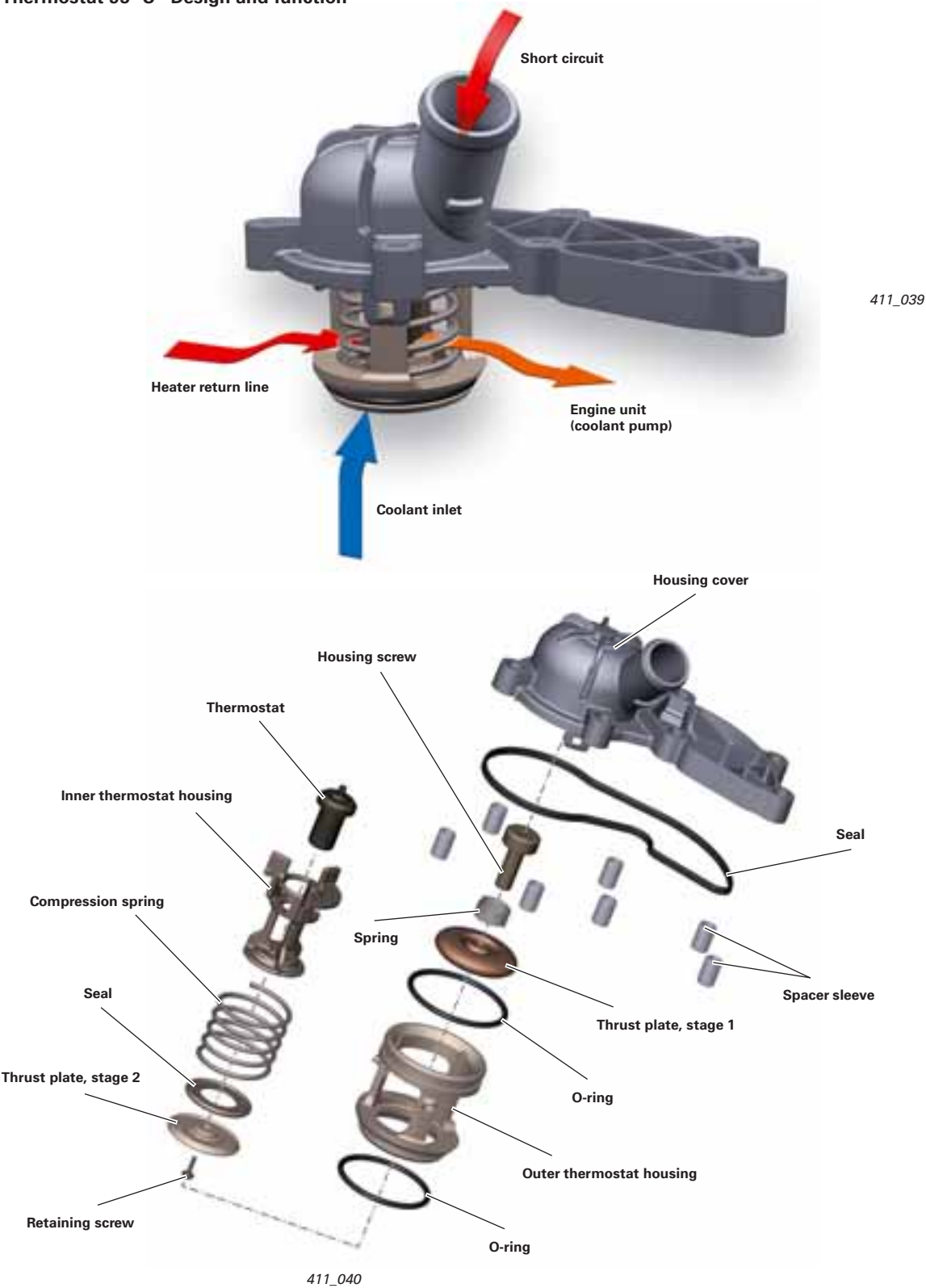
Left and right-hand drive models have different coolant circuit layouts. The illustrations show the configuration for left-hand drive models.

Cooling system

The cooling system originating from the 3.2l FSI engine was revised. Temperature peaks in the cylinder crankcase were reduced by modifying the cylinder water jacket. This made it possible to reduce the delivery rate and to downsize the coolant pump.

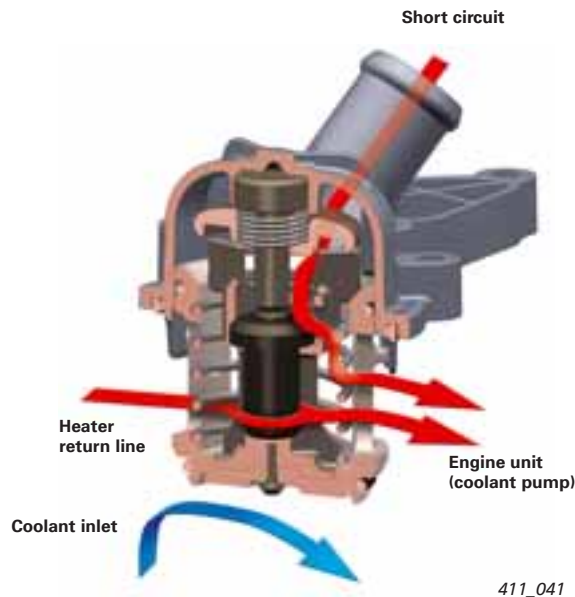
As a further measure for reducing engine friction, the opening temperature of the coolant thermostat in the 2.8l FSI engine was increased by 8 °C to 95 °C. The solid-plastic thermostat in the 2.8l FSI engine opens at a temperature of higher than 95 °C.

Thermostat 95 °C - Design and function



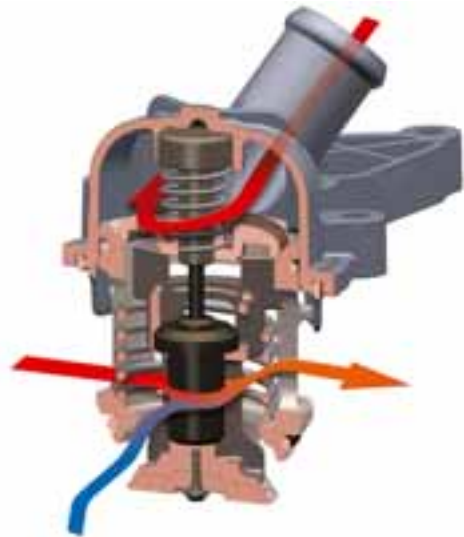
Thermostat closed

The thermostat remains closed up to a coolant temperature of 95 °C.



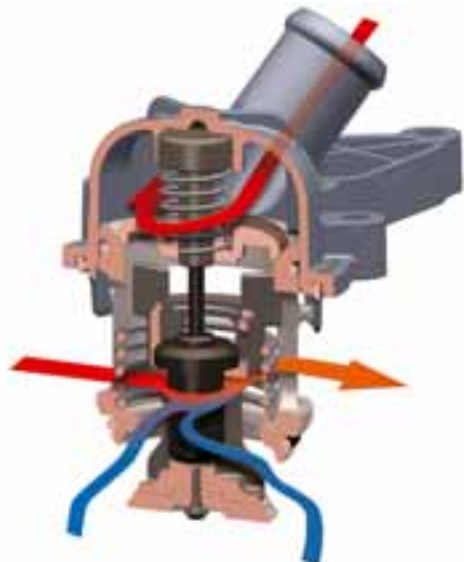
Thermostat partially open

The thermostat opens slowly at a coolant temperature of higher than 95 °C. At a coolant temperature of 108 °C, the port cross section is approx. 12 mm (working stroke).



Thermostat open

The maximum port cross section of 16 mm (overstroke) is reached at a coolant temperature of 135 °C.



Cooling system

Cooling run-on

Cooling run-on is controlled by the engine control unit J623 on the basis of a map.

Both the "on" condition and the cooling run-on time are determined by means of a mathematical model based on the following parameters:

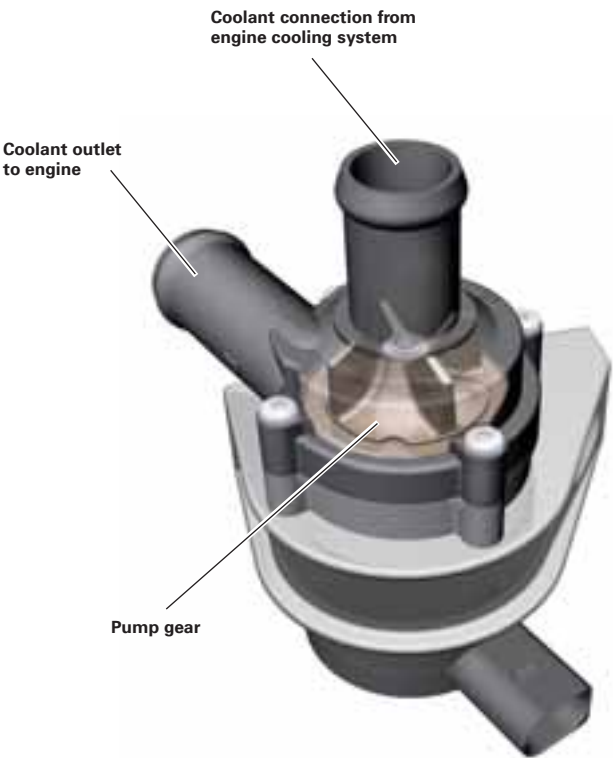
- Coolant temperature (coolant temperature sender G62),
- Engine oil temperature (oil temperature sender G8) and
- ambient temperature (intake air temperature sensor G42).

The "on" condition and the cooling run-on time are computed continuously from engine start onwards. During the cooling run-on cycle, the coolant run-on pump V51 and the radiator fan V7 are activated in parallel.

The maximum run-on time is limited to 10 minutes.

Examples of the "on" condition in dependence on ambient temperature and coolant temperature:

- | | |
|-----------------------|--------|
| - Ambient temperature | 10 °C |
| - Coolant temperature | 110 °C |
| - Ambient temperature | -10 °C |
| - Coolant temperature | 115 °C |
| - Ambient temperature | 40 °C |
| - Coolant temperature | 102 °C |



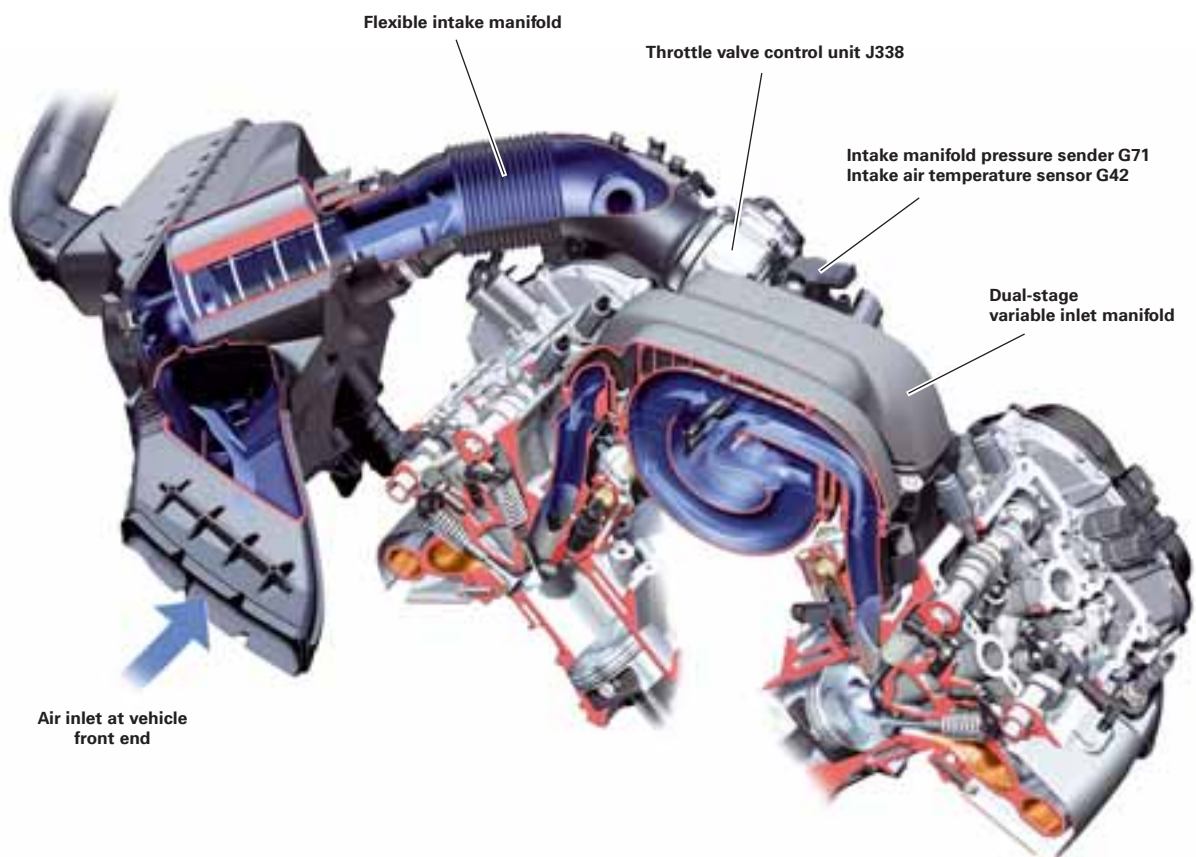
411_062

Overview

The air duct running from the air inlet to the throttle valve control unit J338 was adopted from the previously installed 3.2l FSI engine (engine code AUK).

Other features are:

- cylindrical air filter cartridge,
- dual-stage variable intake manifold and
- plastic throttle valve.



411_024

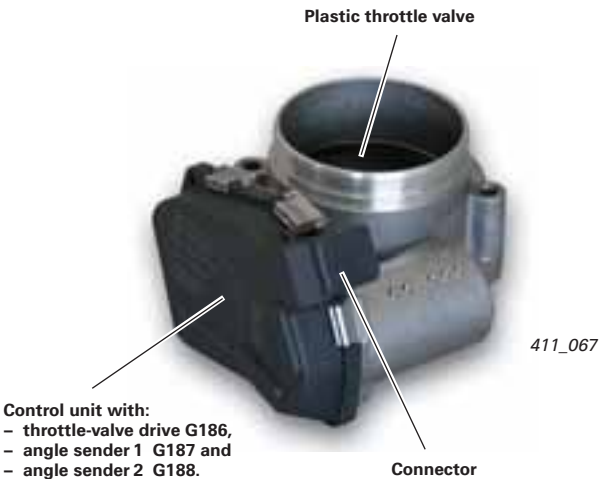
Installation of intake manifold flaps was not necessary due to the use of the Audi valvelift system.

Throttle valve control unit J338

Control unit with angle senders G187 and G188

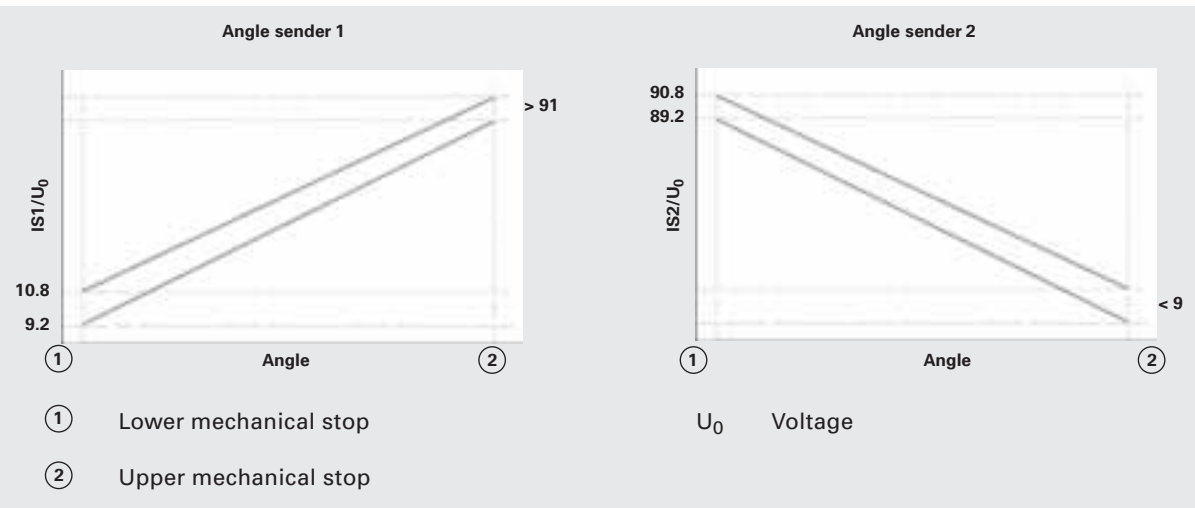
Throttle valve control unit J338 is comprised of:

- throttle valve drive (electric power control) G186,
- throttle valve drive angle sender -1- for electric power control G187 and
- throttle valve drive angle sender -2- for electric power control G188.



Signals of the angle senders

Two magnetoresistive sensors are used as angle senders. Throttle valve positions are output to the engine control unit in the form of analogue voltage signals (see diagram). The characteristic curves of both sensors are counter-opposed.



Design and function of magnetoresistive sensors

Magnetoresistive sensors operate contactlessly. They are used to measure the angle of rotation, e.g. the adjustment angle of the throttle valve. Due to the special internal design of these sensors, angles of rotation from 0° to 180° are measurable.

Other advantages are:

- Resistance to temperature-related variation in magnetic field strength,
- Resistance to ageing of the reference magnet and
- Resistance to mechanical tolerances.

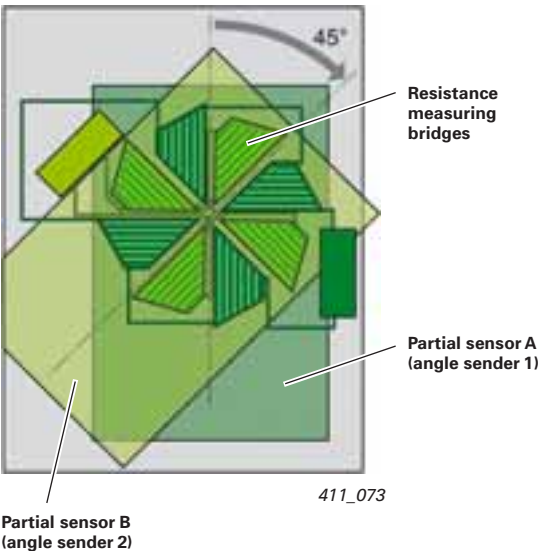
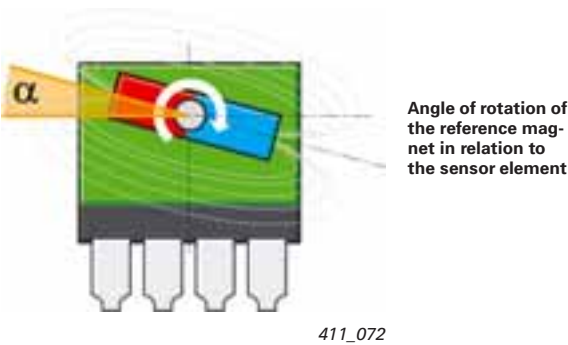
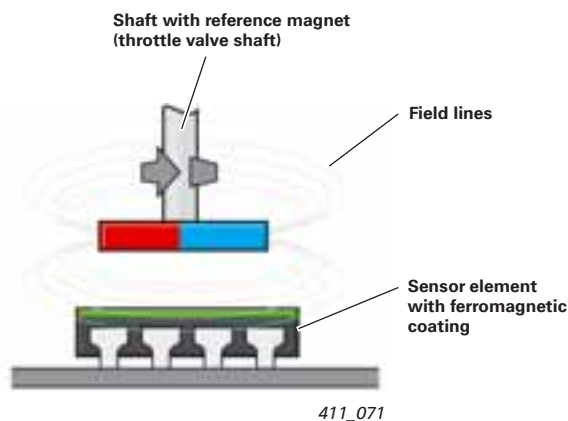
Design

A magnetoresistive sensor consists of an electronic sensor element, which is coated with a ferromagnetic material, and a magnetic acting as a reference magnet.

The magnet is connected to the shaft whose angle of rotation is to be measured. When the shaft with the bar magnet rotates, the position of the magnet field lines changes in relation to the sensor element. The resistance of the sensor element changes as a result. The sensor electronics use this value to compute the absolute angle of rotation of the shaft in relation to the sensor.

The sensor element consists of two partial sensors A (1) and B (2) counter-rotated at an angle of 45°. Each partial sensor, in turn, consists of four resistance measuring bridge rotated through 90° about a common centre.

- (1) Angle sender 1 G187
- (2) Angle sender 2 G188

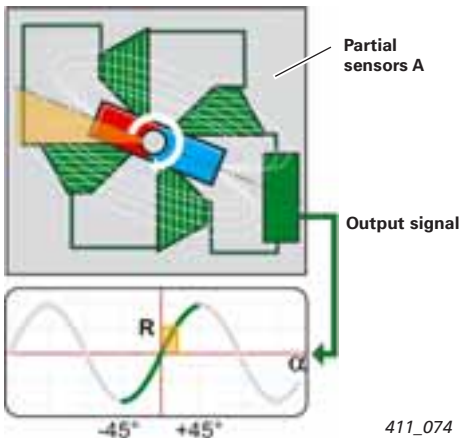


Air circulation system

Function

The rotation of the shaft counter to a partial sensor produces a sinusoidal change of resistance (R) in this partial sensor. Due to the shape of a sine-wave curve, only angles within the range from -45° to $+45^\circ$ can be clearly defined by the partial sensor.

Example:
resistance R is equivalent to an angle of rotation of $\alpha = 22.5^\circ$.

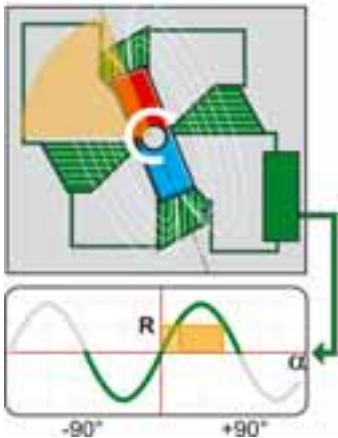


A resistance value provides an angle of rotation.

411_074

In the range between -90° and $+90^\circ$, there are two possible angles for each resistance value. A partial sensor alone therefore cannot provide a clear signal within this measurement range.

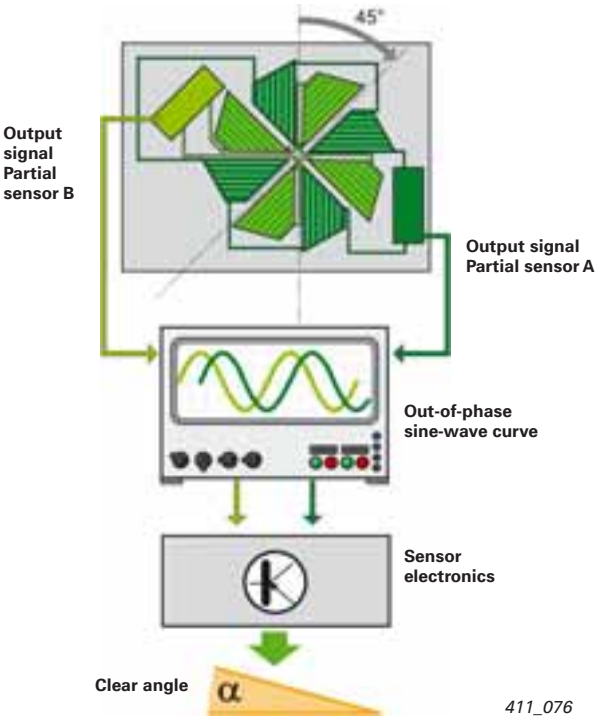
Example:
resistance R is equivalent to an angle of rotation of $\alpha = 22.5^\circ$ and 67.5° .



A resistance value produces two possible angles of rotation.

411_075

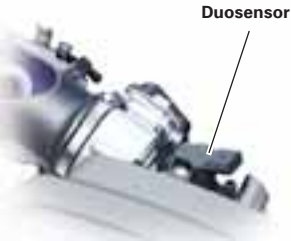
Two partial sensors counter-rotated at an angle of 45° are used to generate in a measurement signal in the form of two sine-wave curves 45° out of phase. By applying a computational function, the sensor electronics can now compute from both curves a clearly defined angle between 0° and 180° and output this information to the assigned control unit.



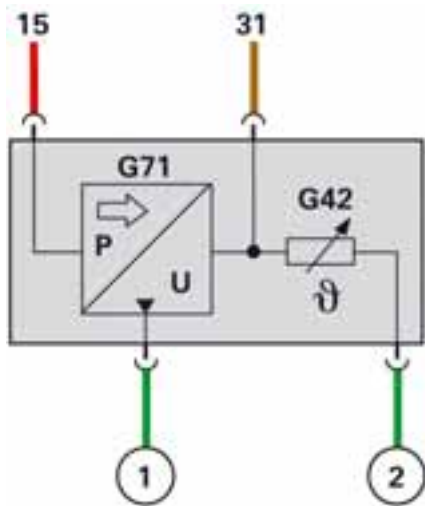
411_076

Duosensor (pressure/temperature)

A sensor unit consisting of intake air temperature sensor G42 and intake manifold pressure sender G71 is integrated in the intake fitting. Air mass is primarily calculated using intake manifold pressure sender G71. The integrated intake air temperature sensor G42 (NTC) simultaneously measures the temperature of the induced air. The engine control unit computes from both values the air mass induced by the engine.

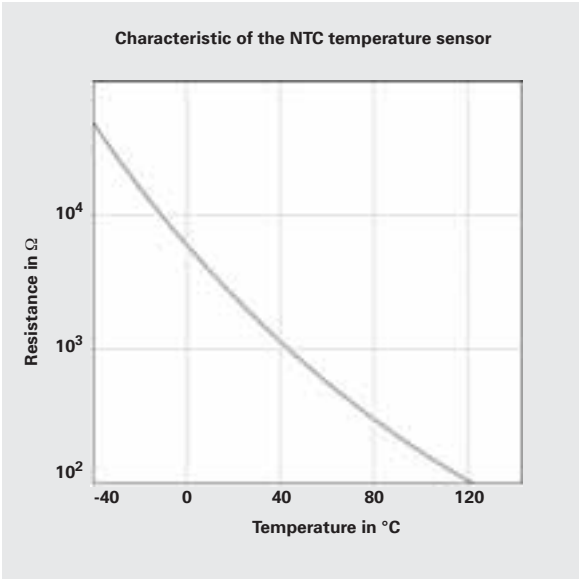
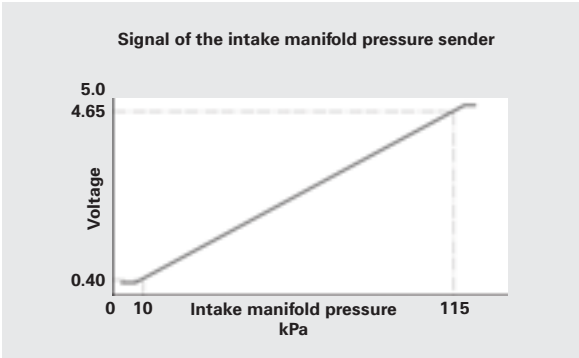


411_053



411_060

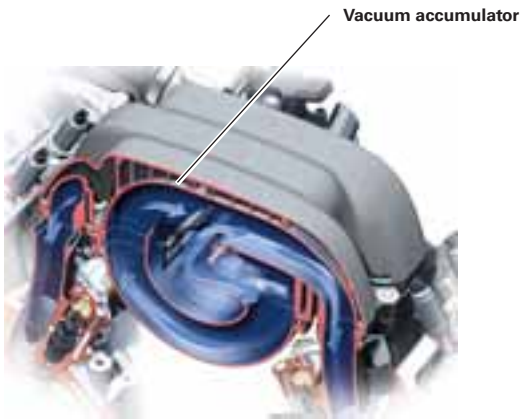
- G42 Intake air temperature sensor
- G71 Intake manifold pressure sender
- 15 Terminal 15
- 31 Terminal 31
- ① Voltage signal, intake manifold pressure
- ② Resistance signal, intake air temperature



Air circulation system

Variable intake manifold

To improve power output and torque, a dual-stage variable intake manifold is used. The changeover is performed by means of variable intake manifold changeover valve N156, which, upon activation, releases the vacuum. Position feedback is provided by the variable intake manifold position sender G513. The vacuum accumulator is integrated in the variable intake manifold housing.



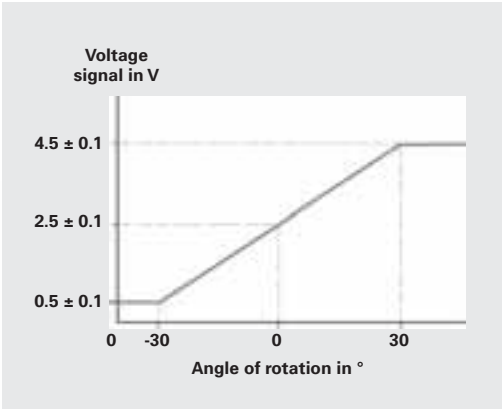
411_052

Variable intake manifold position sender G513

The variable intake manifold position sender transmits the position of the intake manifold flaps directly to the engine control unit. The sender operates on the Hall sender principle.

A Hall sender is an electronic control switch. It consists of a rotor with magnets (on the intake manifold flap shaft) and a semiconductor circuit integrated in the sensor, the Hall IC.

In the Hall IC, a supply current flows through a semiconductor layer. The rotor rotates within an air gap. Due to the high number of magnets in the rotor, an exact determination of the variable intake manifold position is possible.



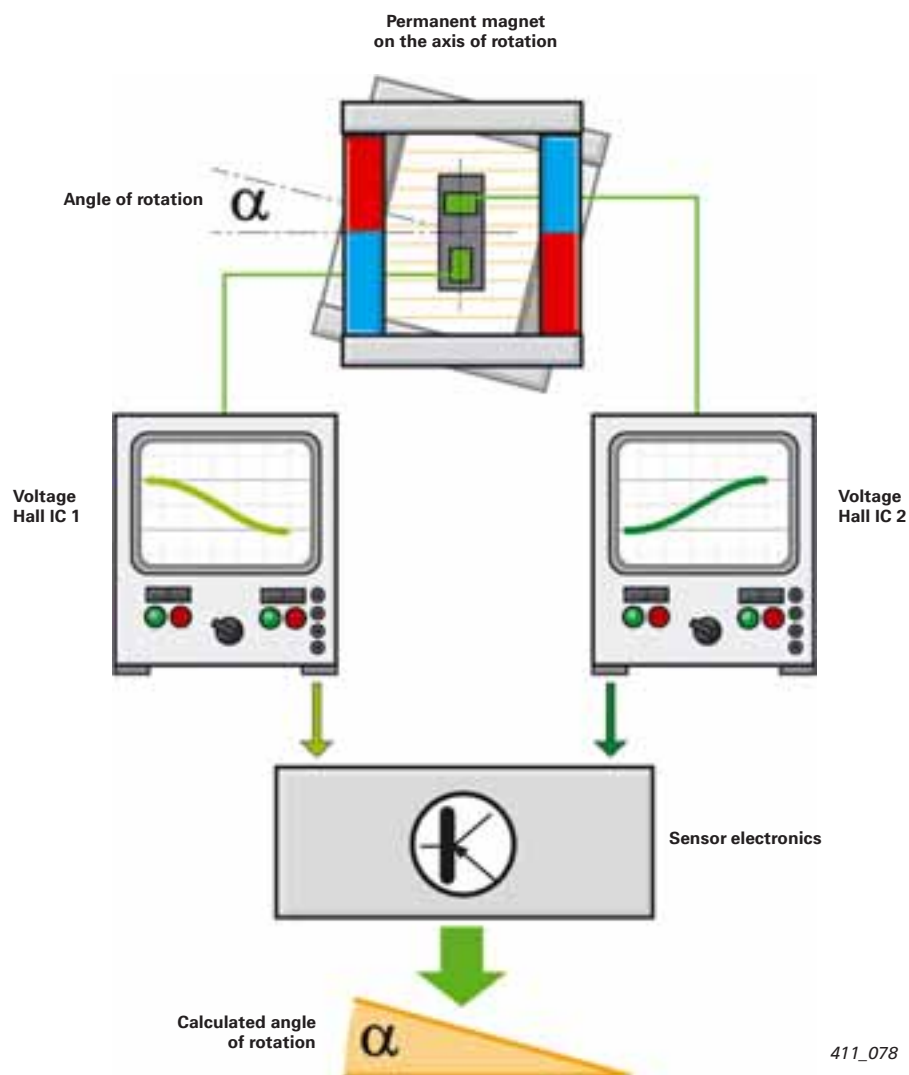
411_061

Design and functional principle of Hall sensors

Hall sensors are used for rotation speed measurement and position recognition.
Both linear distances and angles of rotation can also be determined by position recognition.

The variable intake manifold position sender therefore measures the angle of rotation, i.e. the position of the intake manifold flaps.

Depending on the design of the Hall sensor and the permanent magnet, angles of rotation can also be registered and measured based on the Hall principle.
To this end, two Hall ICs are arranged perpendicular to one another inside the sensor.
In this configuration both Hall ICs generate opposing Hall voltages.
The sensor electronics use these two voltages to compute the adjustment angle of the axis of rotation.



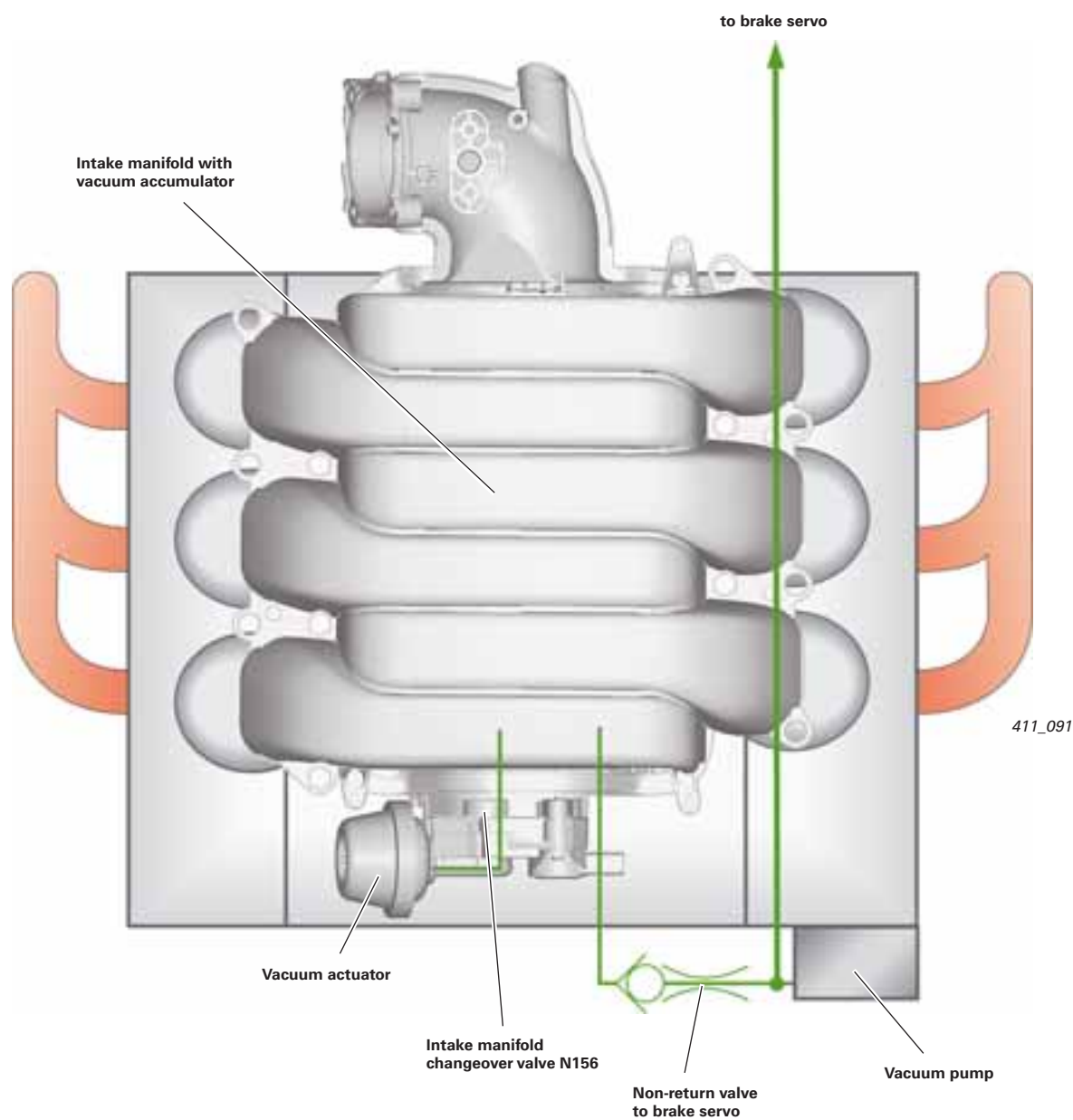
411_078

Air circulation system

Vacuum hose assembly

The vacuum supply for the two motors is relatively simple. Only two systems have to be supplied with vacuum. Vacuum is used, firstly, for evacuating the brake servo and, secondly, for changing over the intake manifold.

A mechanical swivelling vane pump is driven by the intake camshaft of cylinder bank 2. The pump continuously produces the required vacuum while the engine is running. A cavity in the intake manifold serves as a vacuum accumulator (see Fig. 411_052).



Low-pressure system

The demand-driven system previously featured on the 3.2l V6 FSI engine is also used here.

Reference



For a description of this system, refer to SSP 325 Audi A6 '05 Engines and Transmissions.

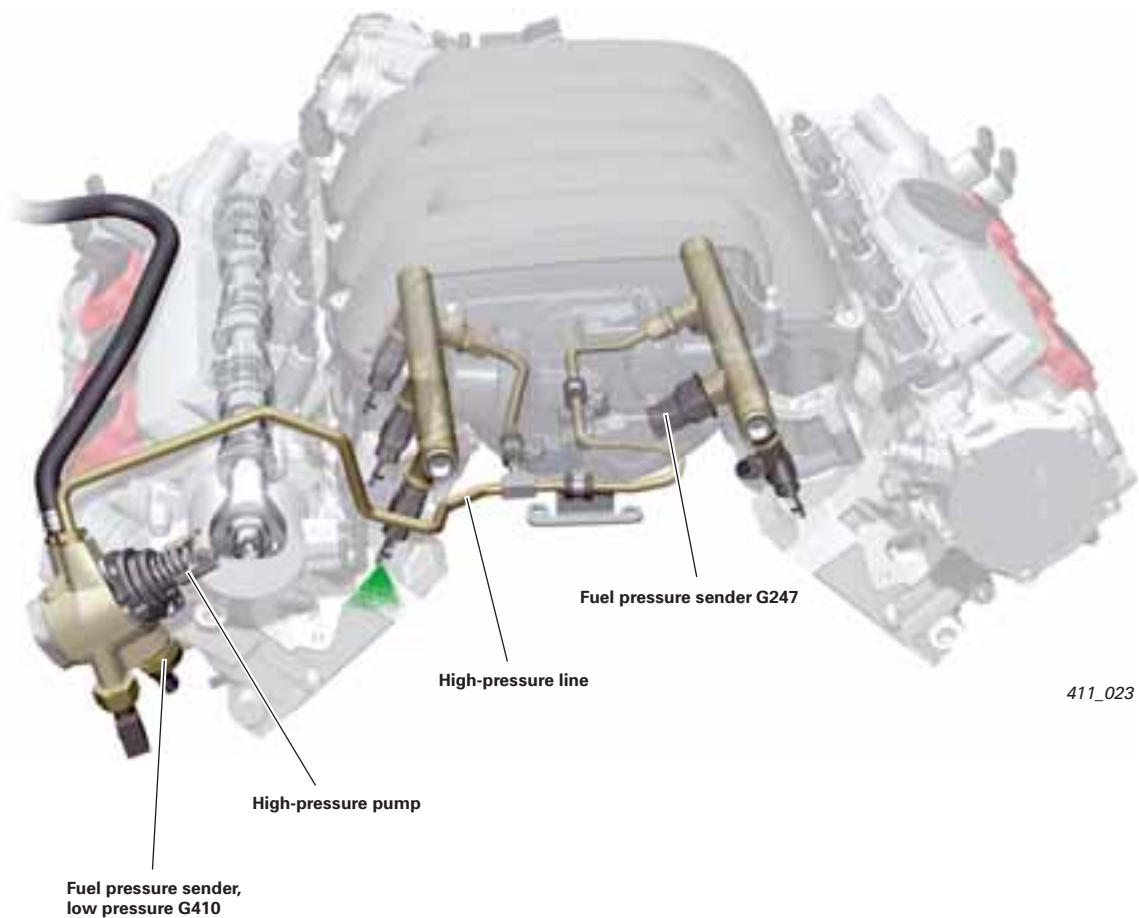
High pressure system

The previously used fuel system was revised and improved for the new engine generation with Audi valvelift system.

The targets for improvement were:

- Reduction of driving power
- Simplification of the system by eliminating the pressure limiting valve in the fuel rail, thereby also eliminating the low-pressure return line from the fuel rail to the high-pressure pump supply line

Due to the improvements made to the high-pressure pump, additional space is required. For this reason, the positions of the vacuum pump and the fuel high-pressure pump were reversed compared to the 3.2l FSI engine.



411_023

Fuel system

Comparison of the 1st and 3rd generation high-pressure pumps

1st generation high-pressure pump



An improved version of the high-pressure fuel pump previously featured on the 3.2l FSI engine is used on the 2.8l and 3.2l FSI engines with Audi valvelift system. The high-pressure fuel pump is manufactured by HITACHI.

The demand-controlled single-piston high-pressure pump is driven by a triple cam via a cylindrical tappet. The use of a cylindrical tappet has allowed driving power to be reduced. The triple cam is located at the end of the intake camshaft of cylinder bank 1. Due to the very high maximum delivery rate, it is possible to use a standardised fuel system for both engines.

3rd generation high-pressure pump (standard pump for V6 engine)

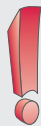


The pressure limiting valve previously built into the fuel rail is now integrated in the pump. This eliminates the need for an additional low-pressure return line.

The following are also integrated in the pump:

- the fuel pressure sender, low pressure G410,
- the fuel metering valve N290 and
- a pressure reducer, which reduces pulsation in the supply line.

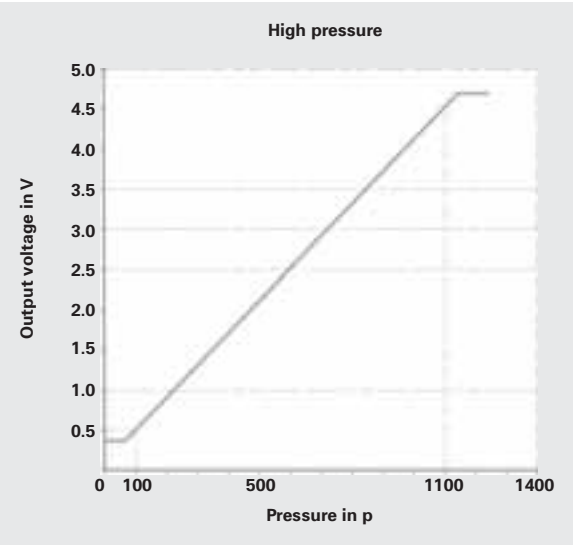
Note



The control concept of the high-pressure fuel feed system derives from the 3.2l FSI engine (see SSP 325 Audi A6 '05 Engines and Transmissions). Unlike the 3.2l FSI engine, the high-pressure pump delivers maximum feed when the fuel metering valve N290 is inactive, e.g. when the connector is disconnected from N290. The pressure rises to the discharge pressure of the pressure limiting valve, with the result that the discharge noise is audible.

Fuel pressure sender, low pressure G410

The fuel pressure sender, low pressure G410 is integrated in the high-pressure fuel pump on the supply side. It is a thin-film pressure sensor with integrated electronic evaluation circuit. An analogue voltage signal is output to the engine control unit (see diagram).



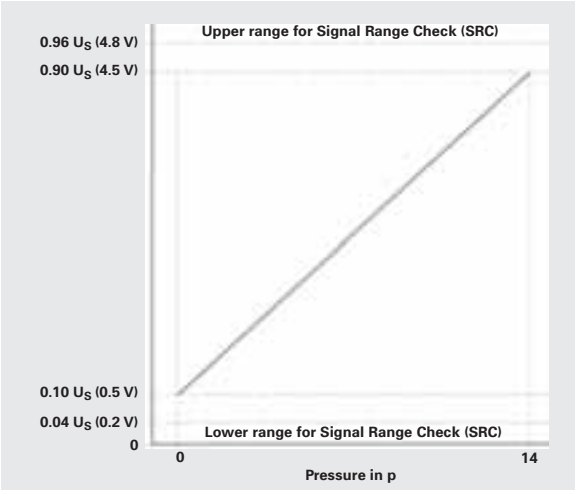
411_064

Injectors

The high-pressure injectors also derive from the injectors used on the previous 3.2l FSI engine. They are designed as single-hole nozzles and have been revised and improved with regard to the delivery of minimal injection quantities. Again, the activation voltage is 65 V. The injectors of the new 3.2l engine have a slightly higher flow rate.

Fuel pressure sender G247

The fuel pressure sender G247 is integrated in the fuel rail of cylinder bank 2. It operates in a measurement range from 0-140 bar (see Fig. 411_023 page 51). The functional principle of this sender is similar to that of the G410. The sole difference is that it is rated for a different pressure range.

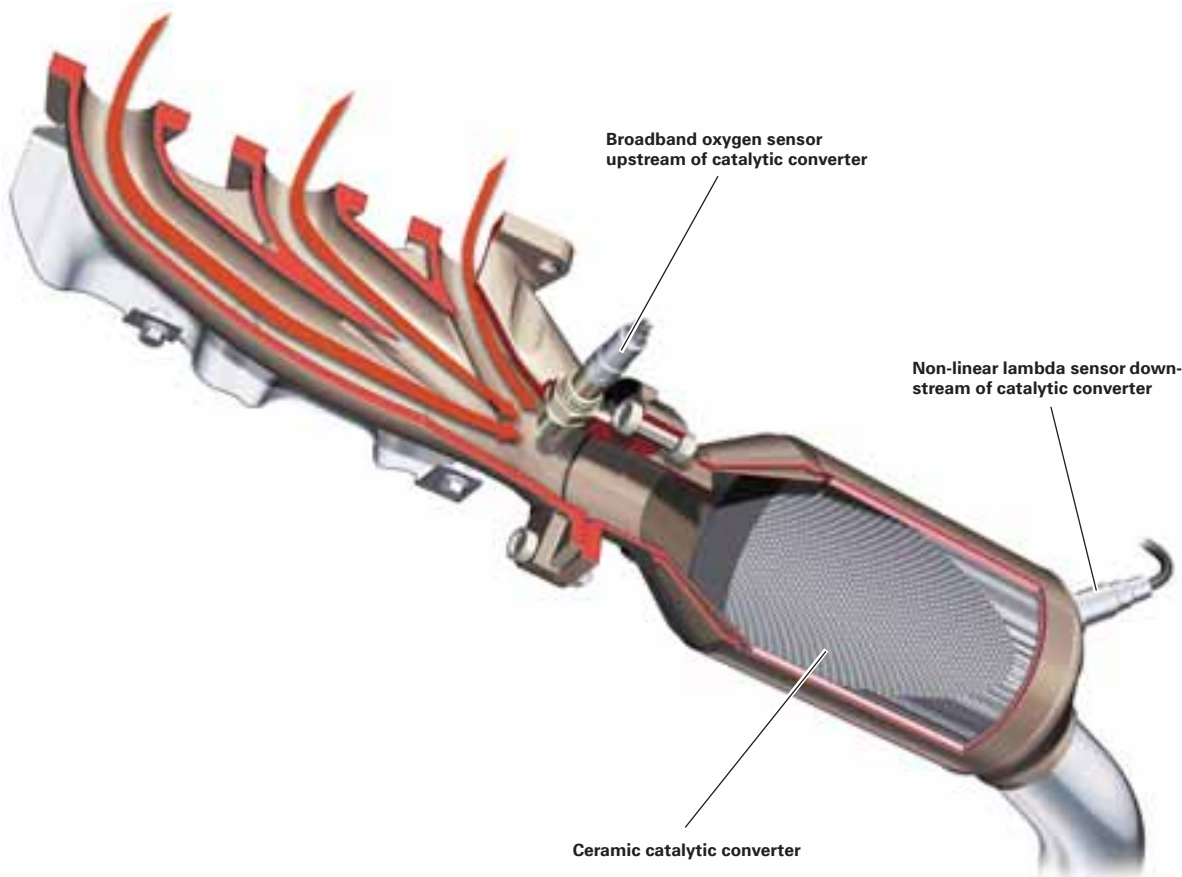


Exhaust system

Essentially, the components of the 3.2l FSI engine were used in the development of the 2.8l and 3.2l FSI engine with Audi valvelift system.

The exhaust manifold is designed in such a way that the exhaust gas discharged from each cylinder impinges directly on the broadband oxygen sensor upstream of the catalytic converter. The exhaust gas is not mixed with exhaust gas from the other cylinders.

In addition to the aforementioned intake manifold, the exhaust manifold and the exhaust system have been adopted unchanged. Cylinder-selective lambda control has again been implemented here.



411_086

Engine control unit J623



411_103

Differences between the 2.8l and 3.2l engines

The system overview overleaf refers to the 2.8l engine on the Audi A6. The following table shows the main differences between the 2.8l engine on the A6 and the 3.2l engine on the A5.

		2.8 litre A6	3.2 litre A5
	G28	Inductive sender	Hall sensor
	F36 Clutch pedal switch	No	Yes
	F194 Clutch pedal switch for engine starting	Yes	Yes
	G476 Clutch position sender	No	Yes
	Oil level and temperature sender port	Dash panel insert	to ECU

Engine management

System overview for 2.8l FSI engine

Sensors

Intake manifold pressure sender G71
Intake air temperature sensor G42

Oil level/oil temperature sender G266

Engine speed sender G28

Hall senders G40, G163, G300 and G301

Throttle valve control unit J338
Angle sender G188, G187

Accelerator pedal position sender G79
Accelerator pedal position sender 2 G185
Clutch pedal switch for engine starting F194
Clutch position sender G476

Brake light switch F
Brake pedal switch F47

Fuel pressure sender G247
Fuel pressure sender, low pressure G410

Fuel gauge sender G
Fuel gauge sender -2- G169

Knock sensor G61, G66

Oil pressure switch F22 (3.2l engine: oil pressure switch on onboard computer module 1, 2.8l engine: oil pressure switch on engine control unit)

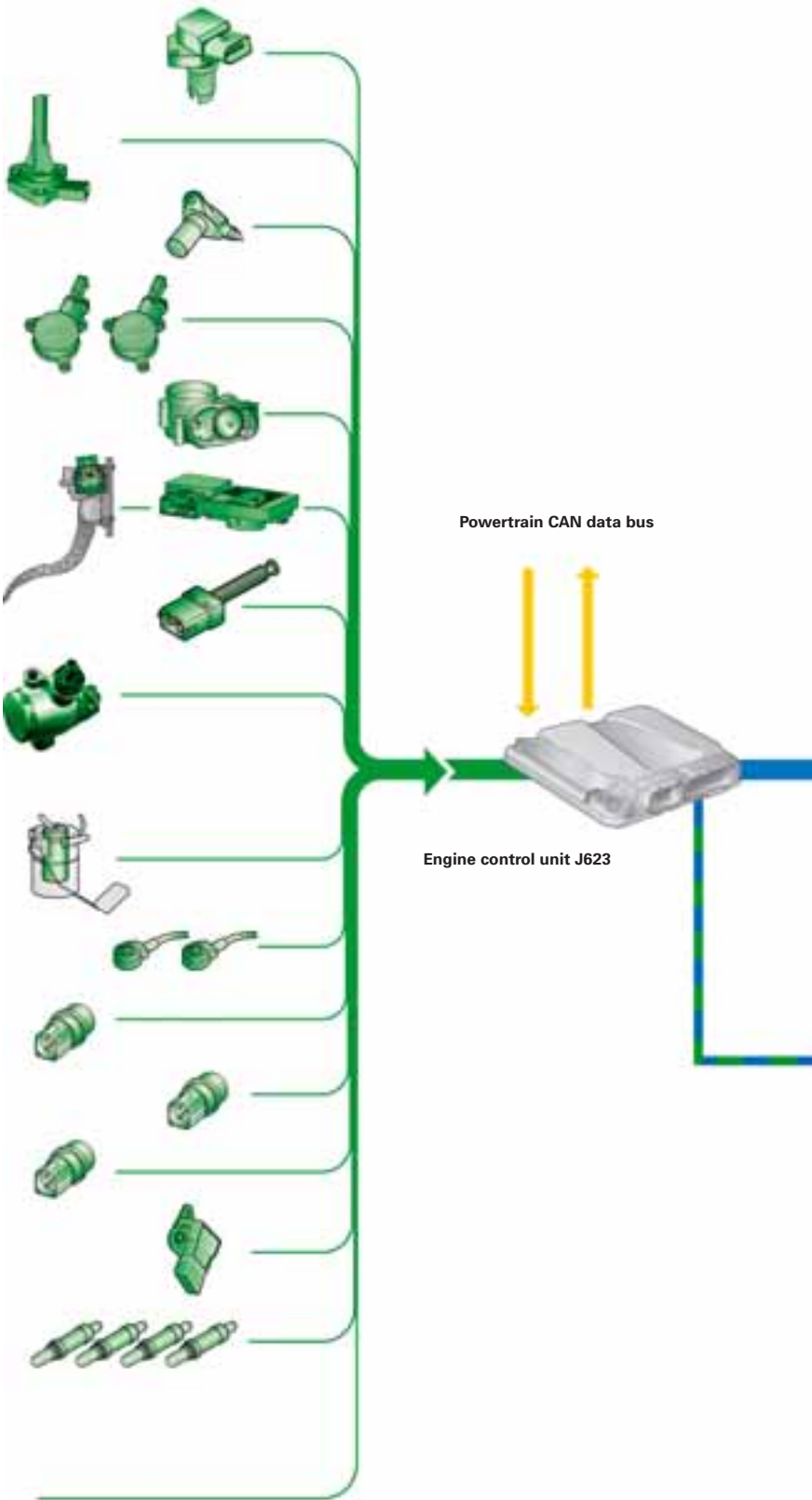
Oil pressure switch for reduced oil pressure F378 (2.8l engine: oil pressure switch on engine control unit)

Coolant temperature sender G62

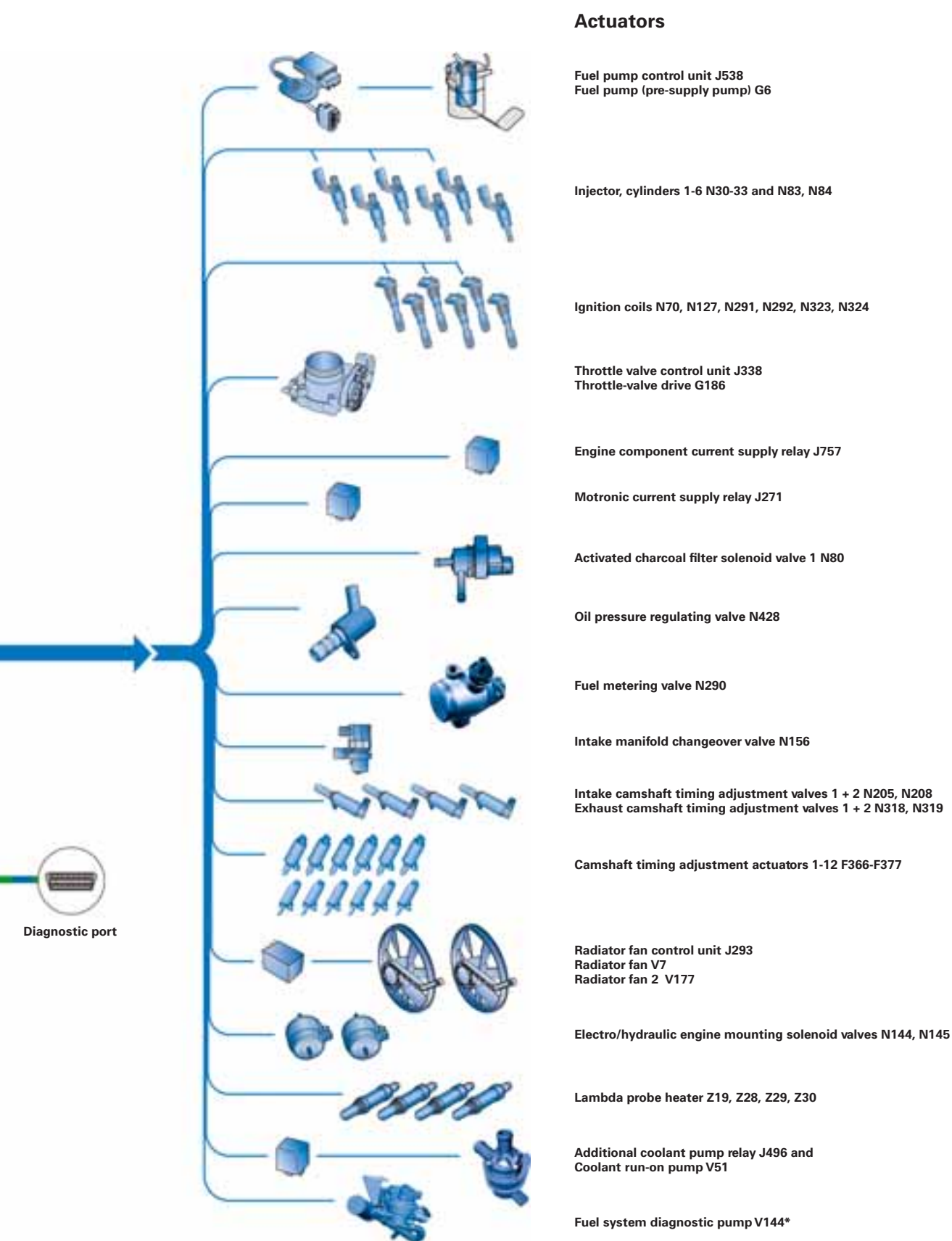
Variable intake manifold position sender G513

Oxygen sensor upstream of cat G108, G39
Oxygen sensor downstream of cat G130, G131

Auxiliary signals:
J393 (door contact signal),
J518 (start request),
J695 (output start relay term. 50 stage 2),
J53 (output start relay term. 50 stage 1),
J518 (term. 50 at starter),
J364 (preheater),
E45 (cruise control system)
J587 (selector lever position)



The system overview of the 3.2l FSI engine deviates from this description. Refer to the relevant current flow diagram.



Output signal: engine speed to automatic gearbox control unit J217 for vehicles with automatic gearbox 01J

411_046

* for vehicles with fuel system diagnostic pump

Engine management

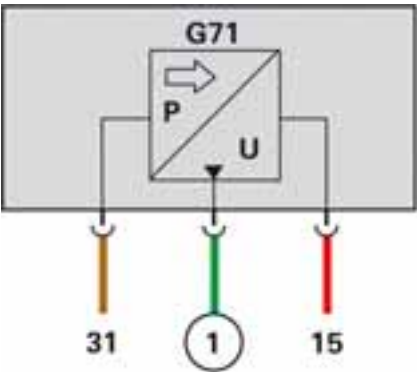
The SIMOS 8.1 engine management system is used on both new engines.
The main new developments compared to the SIMOS 6D2 on the 3.2l V6 FSI engine are:

- Audi valvelift system,
- De-restricted engine operating concept in part-throttle mode,
- Revision of the pressure-speed load sensing configuration (p/n control),
- Load change control and
- elimination of intake manifold flaps.

De-restricted engine operating concept

The engine is fully de-restricted across a large section of the load map up to the valve lift changeover. Herein a constant intake manifold pressure is maintained.

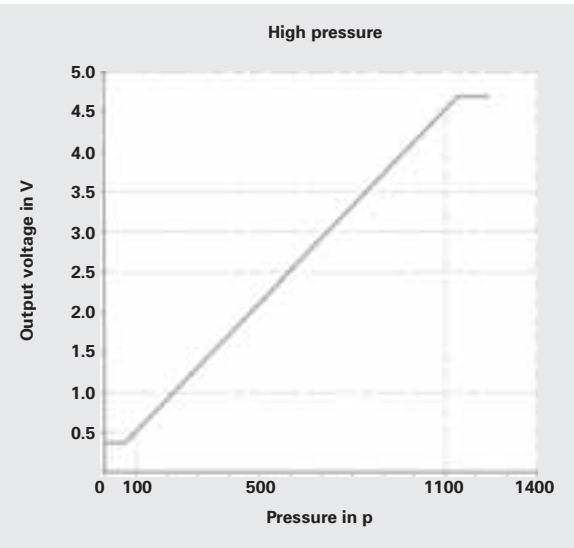
The throttle valve is almost completely opened. However, a residual pressure of 50 mbar is set by slightly adjusting the throttle valve so that the fuel tank and crankcase vents are functional.



411_057

- G71 Intake manifold pressure sender
- 15 Terminal 15
- 31 Terminal 31
- ① Voltage signal for intake manifold pressure

Intake manifold pressure sender G71



p/n control

Engine load is controlled within the de-restricted load range by adjusting the intake camshaft, by reducing the residual gas content and by retarded opening of the intake valves.

The position of the intake camshaft serves as a reference input variable for engine load control. In de-restricted operation, engine load is sensitive to changes in valve timing. For this reason, the measurement accuracy of the Hall sender has been improved for position sensing of the camshafts. After changing over to full valve lift, engine load is again controlled via the throttle valve. The intake manifold pressure now serves as the reference input variable again. This is, therefore, not a straight p/n control system, but a pressure, intake camshaft position and rpm based control system.

Elimination of intake manifold flaps

Due to the charge motion produced by partial lift, it was possible to dispense with the intake manifold flaps. This advantage can also be utilised in the cold starting phase and in the heating phase of the catalytic converters. As with previous Audi FSI and TFSI engines, the Homogeneous Split (HOSP) double injection strategy with extreme ignition advance angle retard adjustment while retaining sufficient running smoothness. This minimises the time it takes the catalytic converters to reach their activation temperature, which, in turn, leads to a reduction in exhaust emissions.

Operating modes

1. HOSP (Homogeneous Split) for the cold starting phase for heating the catalytic converters

The duration of this operating mode is always dependent on the ambient conditions. To this end, the values of the temperature sensors are computed in a characteristic map. The maximum operating time in HOSP mode is 50 sec.

2. Homogeneous

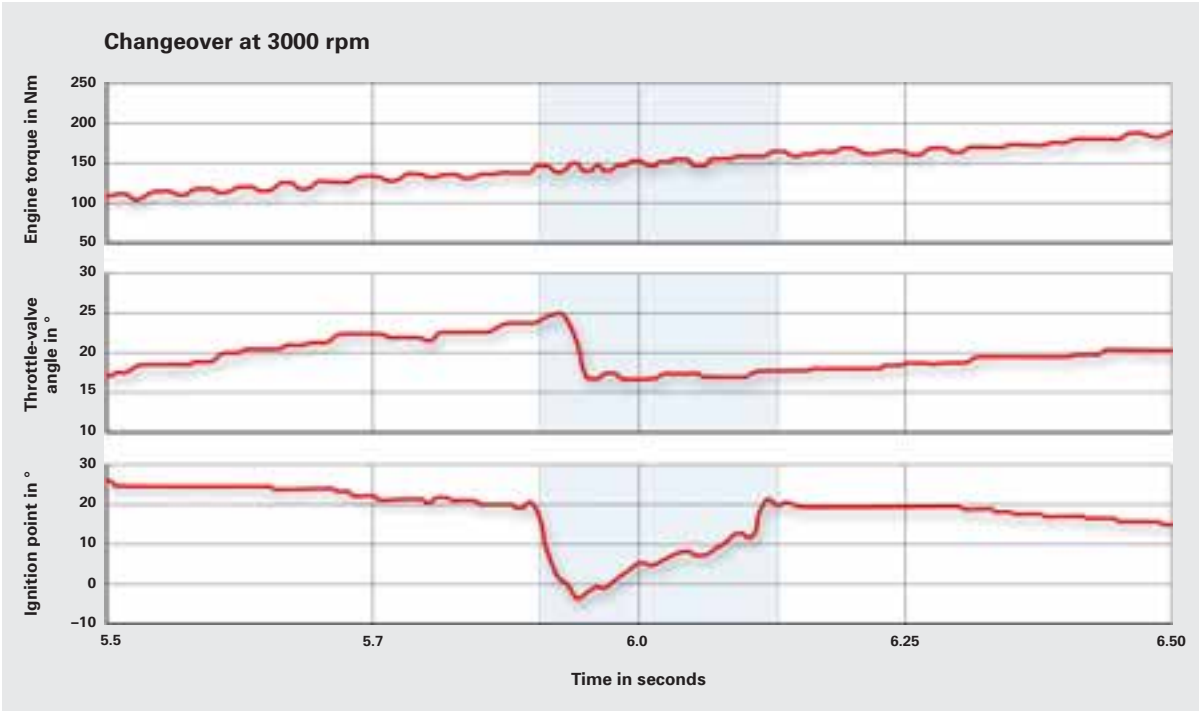
This operating mode is implemented in each engine power and speed range, except during the cold starting phase.

Fuel injection is synchronous with the intake cycle, i.e. while the intake valves are open.

Load change control

A further task of the engine control unit is torque neutral changeover from partial lift to full lift. In the engine speed range from 3000-4000 rpm, a straight valve lift changeover without countermeasures would suddenly result in approx. 120 Nm of additional torque. This would cause an unacceptable load shock.

The potential torque differential during changeovers must consequently be reduced to a level no longer perceptible to the driver (<10 Nm) through appropriate engine control measures.



The changeover, which can be performed at engine speeds between 3000 and 4000 rpm, takes approximately 300 ms.

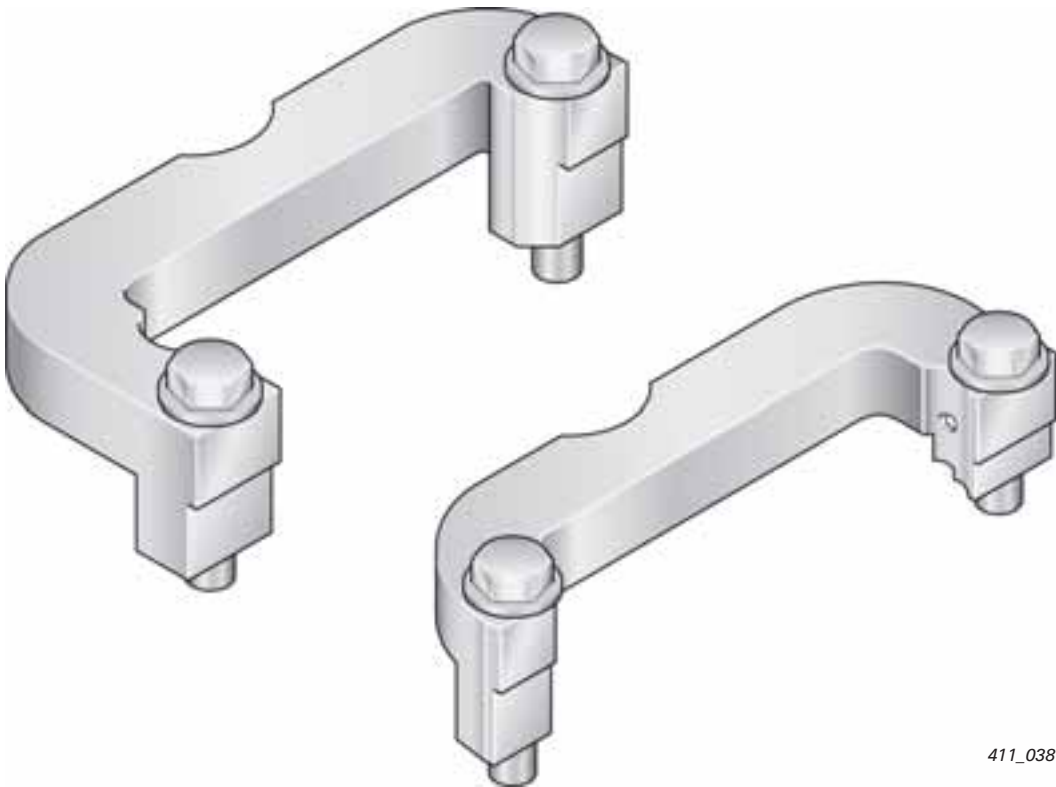
The following measures are taken:

- Ignition is retarded by approx. 20°,
- Throttle valve is closed with a slight delay,
- Intake and exhaust camshafts are adjusted to the new target positions at the maximum adjustment rate, and
- the ignition advance angle is adjusted to the new setpoint according to the adjustment rate of the camshafts and the change of intake manifold pressure.

Special tools



Here you are shown the new special tools for the 2.8l and 3.2l FSI engines with Audi valvelift system.



T40133/1/2 Camshaft locating fixture

411_038



T40178 Oil gauge tester

411_105

Maintenance work		
	Engine lube oil replacement interval with LongLife oil with engine lube oil specifications	up to 30,000 km/24 months after SID* (oil change interval is dependent on driving style) Engine lubricating oil according to VW 504 00
	Engine lube oil replacement interval without LongLife oil with engine lube oil specifications	Fixed interval of 15,000 km/12 months Engine lubricating oil according to VW 504 00 or VW 502 00
	Engine oil filter replacement interval	during every oil change
	Engine lube oil change quantity (service)	6.2 litres (including filter)
	Extraction/drainage of engine lube oil	both are possible
	Air cleaner replacement interval	90000 km
	Fuel filter replacement interval	Lifetime
	Spark plug replacement interval	90,000 km/6 years
Timing and ancillary unit drive		
	Ribbed V-belt replacement interval	Lifetime
	Ribbed V-belt tensioning system	Lifetime
	Timing gear chain replacement interval	Lifetime
	Timing gear chain tensioning system	Lifetime

* Service Interval Display

All rights reserved. Technical specifications subject to change without notice.

Copyright
AUDI AG
I/VK-35
Service.training@audi.de
Fax +49-841/89-36367

AUDI AG
D-85045 Ingolstadt
Technical status: 09/07

Printed in Germany
A07.5S00.42.20