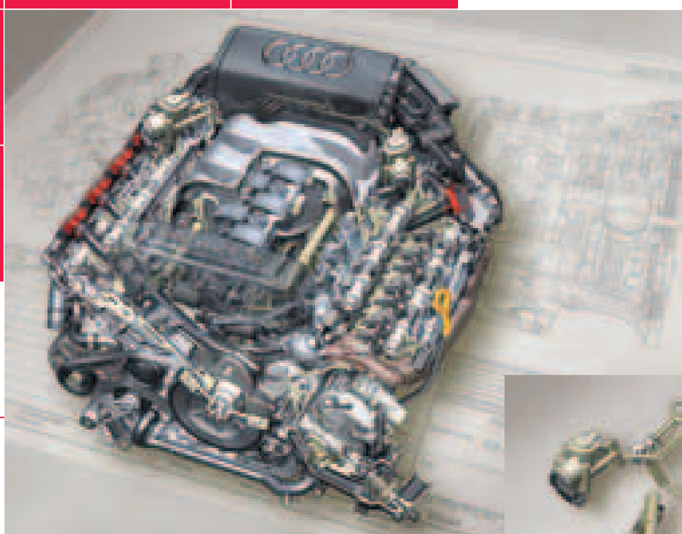
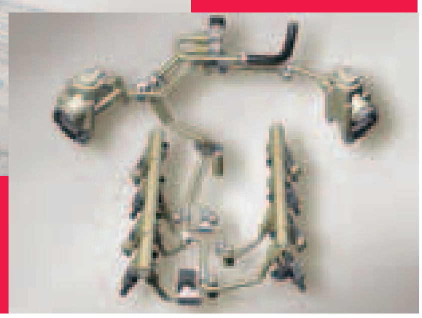
Service Training





Audi 4.2-litre V8 FSI engine

Self-Study Programme 377

Special features of the current Audi vee engine family are the 90-degree included angle between the cylinder banks and the spacing of 90 mm between the cylinders.
The first member of the family was the 3.2-litre V6 FSI engine. The 4.2-litre V8 FSI engine is also a member of this family.
It is available in two versions - a comfort-oriented basic version (used for the first time in the Audi Q7) and a sporty high-revving version for the new RS4. A V10 engine with 5.2 litres of displacement will also be available.

Like the RS4 engine, the V8 in the Q7 has FSI direct injection, which – following five victories in the Audi R8 Le Mans racing car – is now being introduced in a production eight-cylinder model.
The V8 was retuned for use in the Audi Q7. A fuller torque curve up to nominal speed and spontaneous response – these are the characteristics of this new engine.
The engine excels not only with its dominant power output and high maximum torque. The resultant driving performance is excellent, even in the face of tough competition.

RS4 high-revving engine

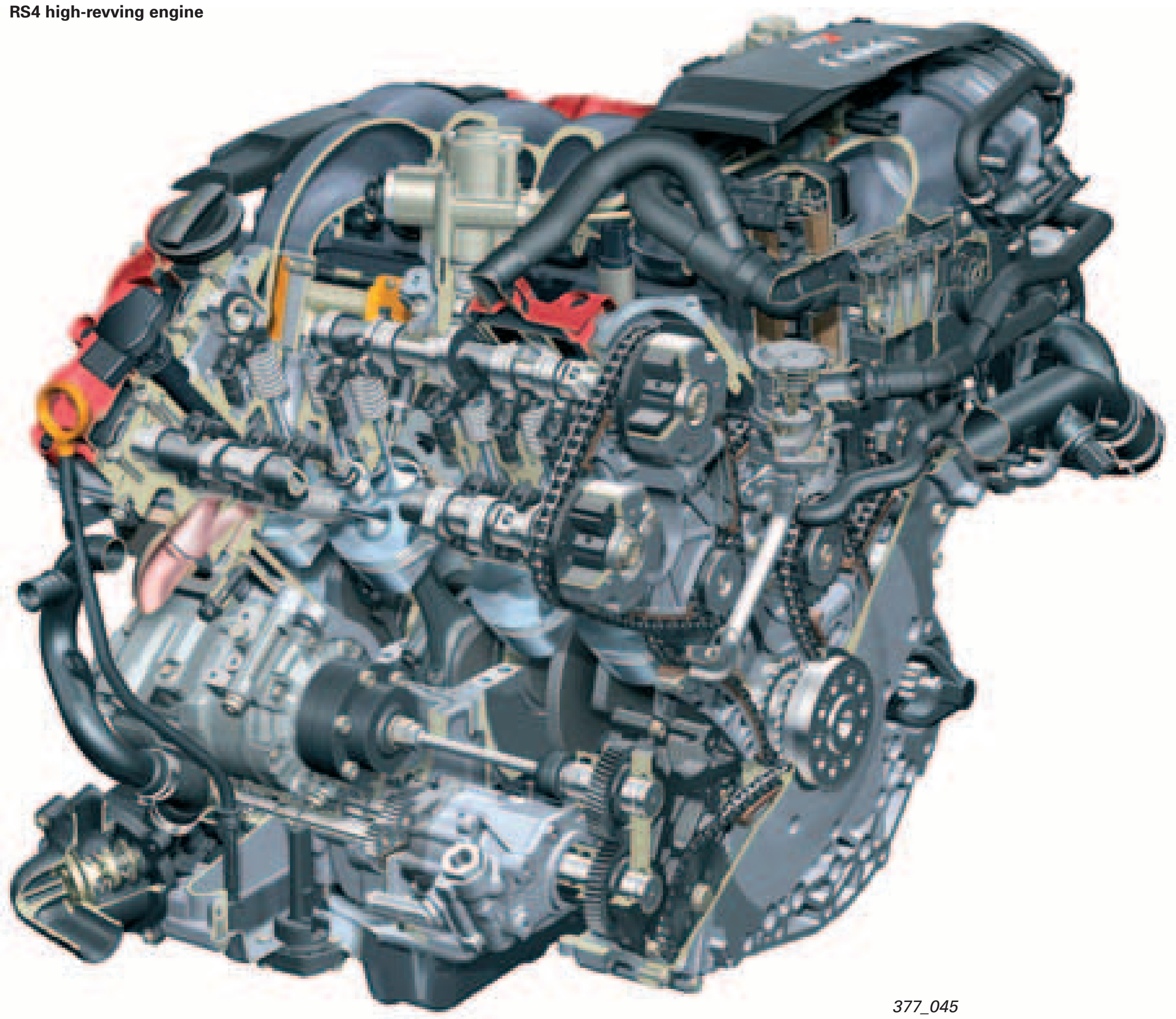


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Table of contents

Engine mechanicals

Oil circulation system

Cooling system

Air circulation system

Fuel system

Exhaust system

Engine management

Reference

Note

The 4.2-litre V8 FSI engine is supplied in the new Audi Q7, Audi A6, Audi A8 and in the RS4.

Note

The technical descriptions of this engine refer mainly to the V8 basic engine in the Audi Q7 and the high-revving engine in the Audi RS4.

The following main objectives were set for the development of the Q7 engine:

– High specific engine power:
  257 kW/350 bhp out of 4.2 litres (15 bhp more than MPI engines)
– High torque: 440 Nm out of 4.2 litres
– Reduction of fuel consumption by approx. 5 % (~360 g/kWh at 2000 rpm and 2 bar)
– Short and compact design
– Modular engine concept based on V6 FSI engine for V8 and V10 FSI (synergy)
– High idling quality
– High standard of comfort with regard to acoustics and running quality
– Low engine weight
– Off-road capability of Audi Q7 engine

Q7 engine

377_003

Technical features

- Petrol direct injection
- Homogeneous-charge mode
- Roller cam followers with hydraulic backlash compensation
- Flywheel-side chain drives for camshafts and ancillary units
- Variable camshaft adjustment for intake and exhaust camshafts
- Two-stage magnesium variable inlet manifold with integrated tumble flap (not fitted in RS4)
- Drive-by-wire throttle control
- for compliance with exhaust emission standards EU IV/LEV II

The main technical differences between the base engine and the high-revving engine lie in the following modules:

- Cranktrain
- Timing gear
- Cylinder head
- Oil supply
- Engine cooling
- Intake path
- Exhaust system
- Engine management

For an exact description of the differences, please refer to the relevant section.

RS4 engine

377_002

Torque/power curve

Max. torque in Nm

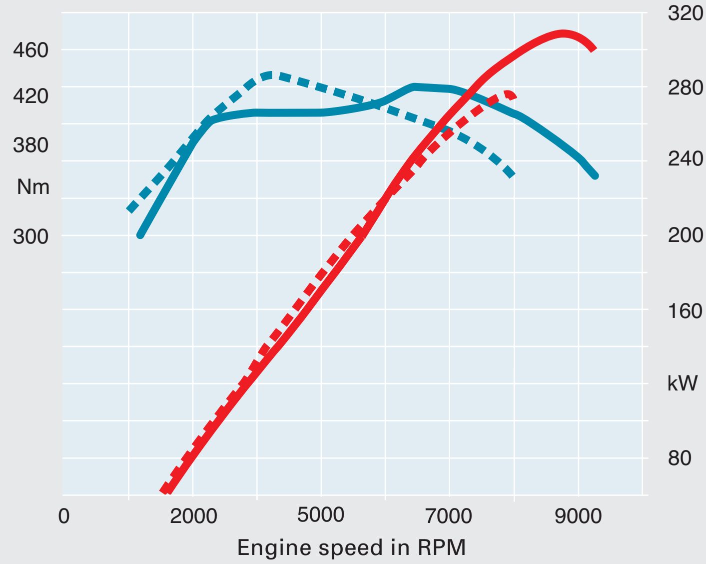
V8 FSI basic engine in Q7

V8 FSI high-revving engine in RS4

Max. power output in kW

V8 FSI basic engine in Q7

V8 FSI high-revving engine in RS4



Specifications

	Q7	RS4
Engine code	BAR	BNS
Type of engine	V8 90° vee angle 4V FSI	
Displacement in cm^3	4163	
Max. power output in kW (bhp)	257 (350) at 6800 rpm	309 (420) at 7800 rpm
Max. torque in Nm	440 at ~3500 rpm	430 at 5500 rpm
Number of valves per cylinder	4	
Bore in mm	84.5	
Stroke in mm	92.8	
Compression ratio	~12.5/-0.4 : 1	
Firing order	1–5–4–8–6–3–7–2	
Engine weight in kg	approx. 198*	approx. 212**
Engine management	Bosch MED 9.1.1	Bosch 2x MED 9.1
Fuel grade	98 / 95 RON	
Exhaust emission standard	EU IV/LEV II	

* with automatic transmission
** manual gearbox including clutch and dual-mass flywheel

Cranktrain

Cylinder block

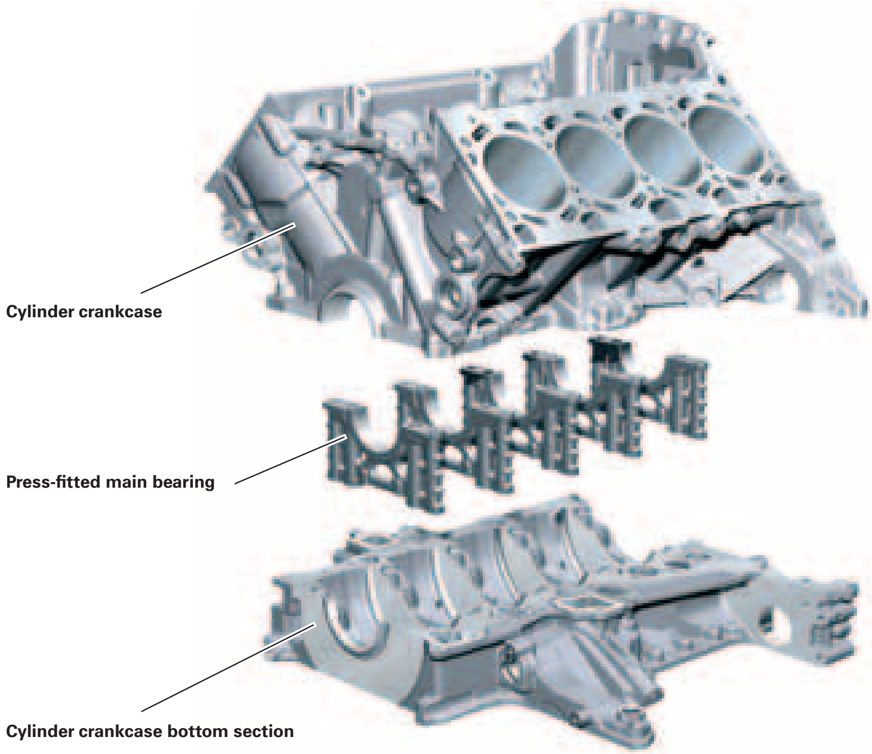
The cylinder crankcase has a closed-deck design. The closed-deck design is stronger than the open-deck design.
In an open-deck cylinder block, the water jacket for cooling the cylinders is open at the top.
The cylinder crankcase is made of a low-pressure gravity diecast aluminium-silicon alloy, is hypereutectic* and has a silicon content of 17 % (AlSi17Cu4Mg).
The cylinder crankcase underwent special heat treatment in order to increase its strength.
The cylinder liners are mechanically stripped.

The cylinder crankcase of the high-revving engine was machined to higher specifications due to the higher stresses in this component. To minimise warping of the cylinder manifolds, the crankcase is honed under stress. For this purpose, a honing template is attached to the crankcase before the honing process in order to simulate the warping of the bolted cylinder manifold.

*Aluminium alloys are classed as hypoeutectic or hypereutectic, depending on their silicon content. "Alusil" has a hypereutectic silicon content of 16 to 18 % so that primary silicon is precicipated on solidification of the molten metal.

A multistage honing process is applied. The silicon grains in the cylinderbores in the form of micro-scopically small, very hard particles are stripped to give the necessary wear resistance of the cylinder surfaces for the piston and piston rings.

- Cylinder spacing: 90 mm
- Cylinder bank offset: 18.5 mm
- Overall engine length: 464 mm
- Cylinder block height: 228 mm



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The **cylinder crankcase lower section** (bedplate bearing cross-member) is made of aluminium with press-fitted iron main bearing covers made of grade 50 nodular cast iron. It is centred using centring pins, sealed with liquid sealant and bolted to the cylinder crankcase.

The main bearing is symmetrically to the centre of the main bearing attached by four bolts.
The bedplate type design provides high stability. The bedplate has the same stabilising effect as a ladder frame.

Crankshaft

The crankshaft runs on five bearings and is made of high-alloy tempering steel (42CrMoS4). It is 90° cranked and has no conrod journal offset.

The vibration damper is a vulcanised single-mass damper with unbalance.

- Main bearing: Ø 65 mm
- Main bearing width: 18.5 mm
- Big-end bearing: Ø 54 mm
- Big-end bearing width: 15.25 mm

Modifications to high-revving engine

At the very high engine speeds, axial vibration occurs due to the unbalance in the single-mass damper. This can cause the crankshaft to break. To avoid this vibration, a dual-mass damper without unbalance is employed in the high-revving engine. To compensate for unwanted engine vibration, heavy metal inserts are integrated in the first and eighth crank webs by way of unbalance.

Cranktrain in the RS4

Con-rod

Cracked con-rods made of 36MnVS4 are used in the basic engine while the conventionally split con-rods in the RS4 engine are made of 34CrNiMo8 for strength.
In addition, the geometry of the con-rods was reduced for the high-revving engine and the tolerances were reduced.

- Bearing journals: Ø 54 mm
- Bearing bushings: 1.4 mm thick, 15.25 mm wide
- Length of bushing: Ø 20 mm rolled
- Con-rod length: 154 mm

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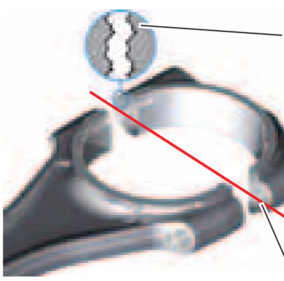
Cracking

During the cracking process, the con-rod is split at a predetermined breaking point using a special tool. The resultant unique breaking surface ensures the high joining precision of the two mating parts.



377_062

Piston

For strength reasons forged pistons with a slightly higher weight than conventional pistons is used. Both engines have the same piston geometry.

- Piston weight without rings: approx. 290 g
- Piston pin: Ø 20 mm x Ø 11.5 mm x 40 mm

377_057

Crankcase ventilation

The crankcase is ventilated through both cylinder heads.
The valve hoods incorporate a large settling space. This space acts as a gravity-type oil separator.
A fine oil separator is connected to the valve hoods by means of plastic hoses.

A control piston, a bypass valve, a two-stage pressure limiting valve and an oil drain valve are integrated in the oil separator housing.

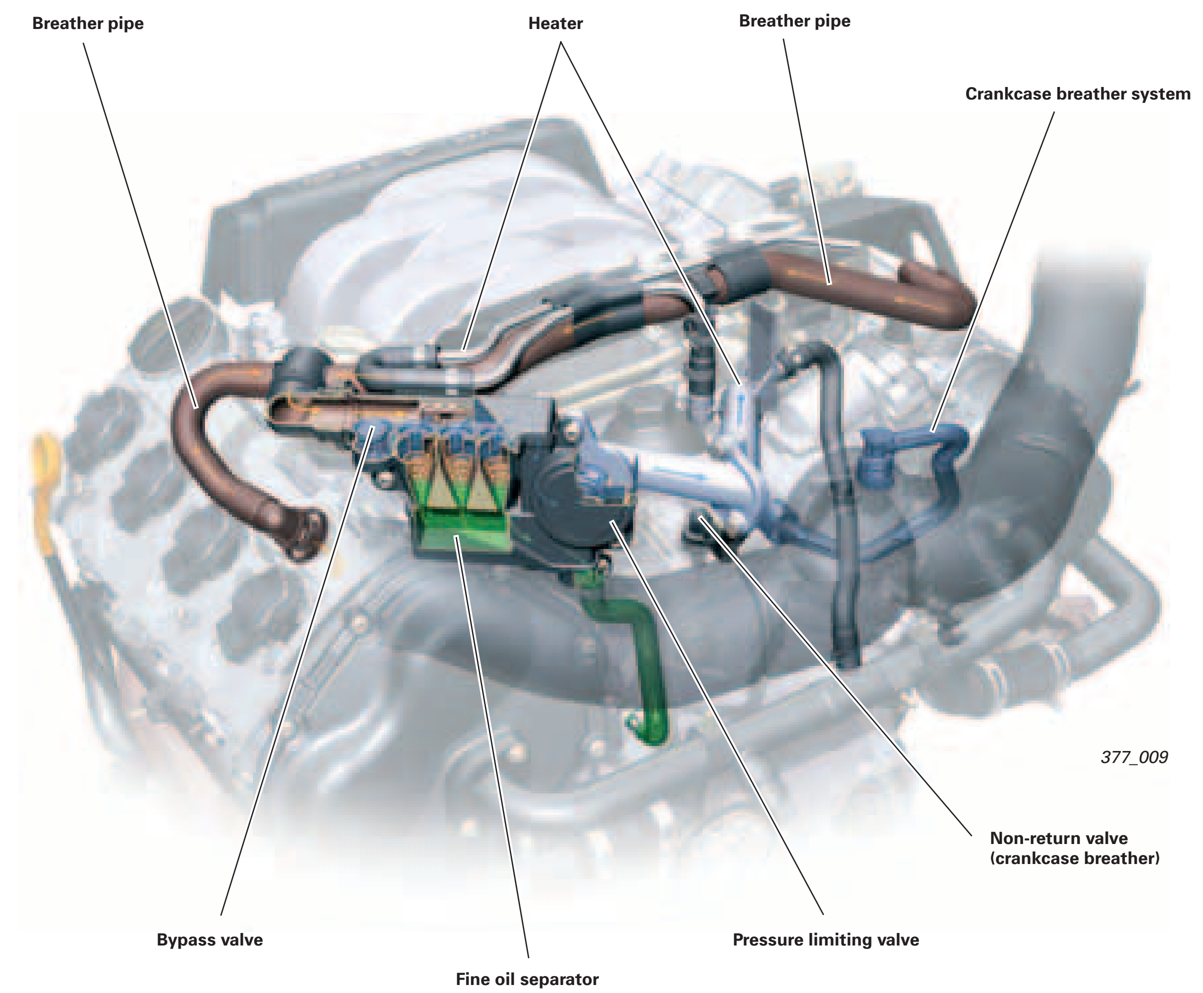
After the blow-by gas has passed through the fine oil separator, the gas flows into the intake manifold downstream of the throttle valve.
This inlet point is integrated in the coolant circulation system and heated. This prevents the crankcase breather from freezing up.

Note

Modifications after start of production

In both engines, the separated oil flows into the crankcase through the cover in the inner vee adjacent the crankcase breather (no longer through the chain housing).

In the Q7 engine the crankcase is vented through a single chamber, i.e. via bank 2 only. Better antiicing protection is achieved in this way.



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Function of fine oil separator

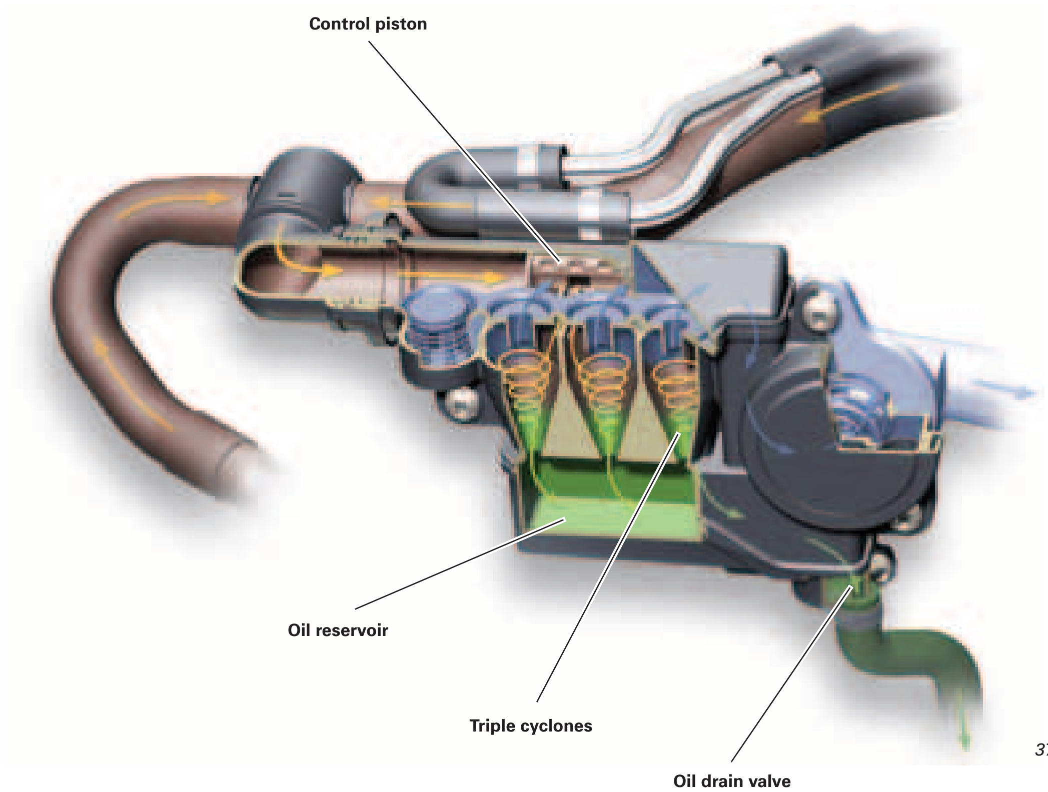
Blow-by gas volume is dependent on engine load and RPM. The fine oil ("oil spray") is separated by means of a cyclone separator. Cyclone separators only have a high separation efficiency over a small volumetric range. For this reason, one, two or three cyclones of the fine oil separator operate in parallel depending on the gas flow rate.

The cyclones are released by the control piston. The displacement of the control piston against its spring force is dependent on the gas flow rate. Piston ring flutter at very high engine RPM and low engine load can result in a very high gas flow rate.

The crankcase internal pressure is set by the two-stage pressure control valve.
The bypass valve together with the control piston ensures that the cyclones operate at the optimum operating point (if the volumetric flow rate is too high or too low, this will impair the functioning of the cyclones).
When the bypass valve opens, a fraction of the blow-by gas flows to the engine untreated, but the remainder is optimally treated by the cyclones.

The separated oil is collected in an oil reservoir beneath the cyclones. The oil cannot drain out of the reservoir until the oil drain valve is opened.
The oil drain valve is closed as long as the pressure in the crankcase, i.e. below the valves, is higher than in the oil separator. The valve opens automatically due to gravity only at very low engine RPM or when the engine is at a standstill, because the pressure conditions above and below the valve are in equilibrium.

The crankcase ventilation system also includes the crankcase breather. Air is extracted downstream of the air filter and flows through a non-return valve into the crankcase from above.
The non-return valve is located at the end of the vent line and is bolted between the two cylinder banks in the engine block.
A damping chamber is located below the non-return valve in the engine block. This prevents non-return valve flutter and eliminates noise.
A restrictor bore connects this chamber to the inner chamber of the crankcase. It has the task of supplying only a defined volume of fresh air to the crankcase.



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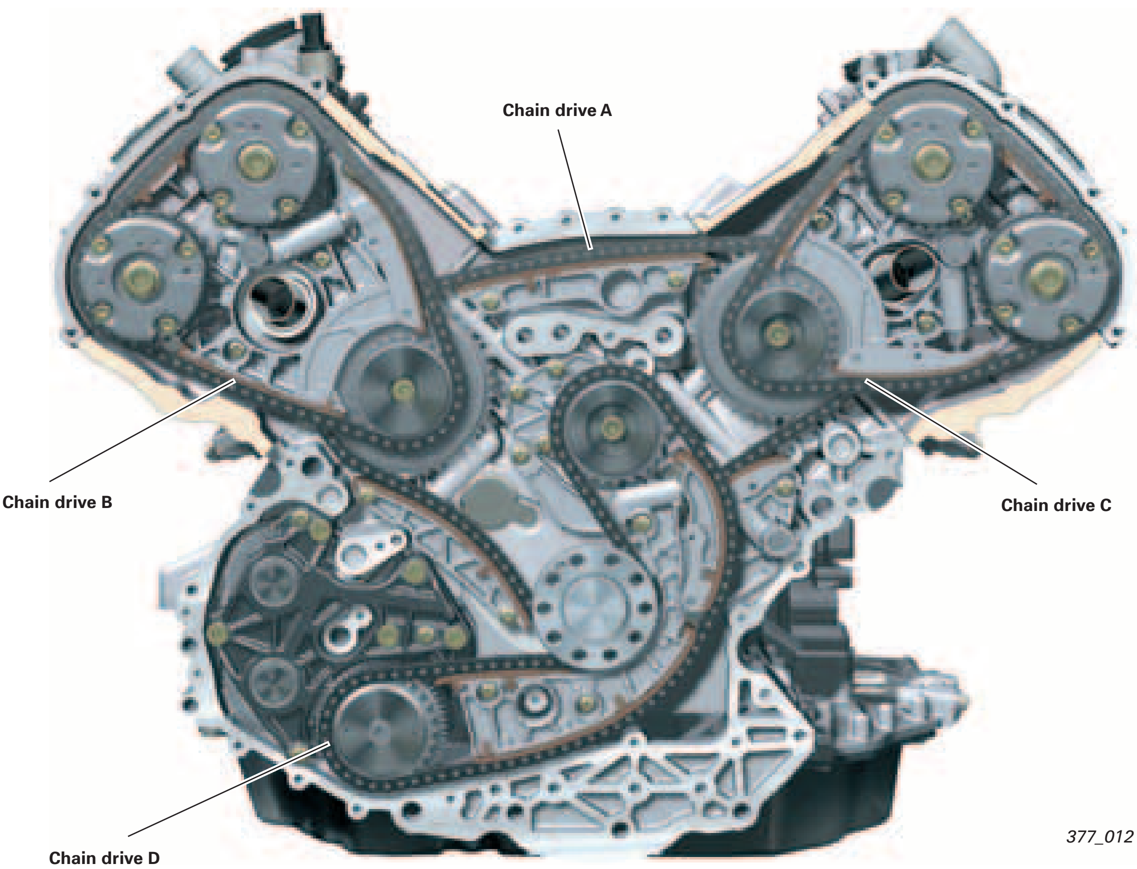
Chain drive

Illustration shows the Q7 engine



The timing gear concept is identical in all Audi vee-engine series.
The chain drive runs on two planes.

Plane 1
Basic drive A:
drives idler gears to camshafts from crankshaft

Plane 2
Top drive B and C: drives camshafts from idler gears
Chain drive D: drives ancillary units drive module from crankshaft

Correct chain tension is ensured by spring hydraulic tensioners. The chain drive is maintenance-free and designed for lifetime service.
The two engine types differ in terms of the type of chains used and the reduction ratios in drives A, B and C. The load on the roller chains was reduced in the basic engine version by selecting a higher number of teeth.

Q7

The camshafts in the basic engine are driven by 3/8“ simplex roller chains.
Due to their acoustic advantages, the chains were developed to meet the high comfort requirements.

In this case the idler gears have 40 and 24 teeth.
The camshaft sprockets have 30 teeth.

High-revving engine

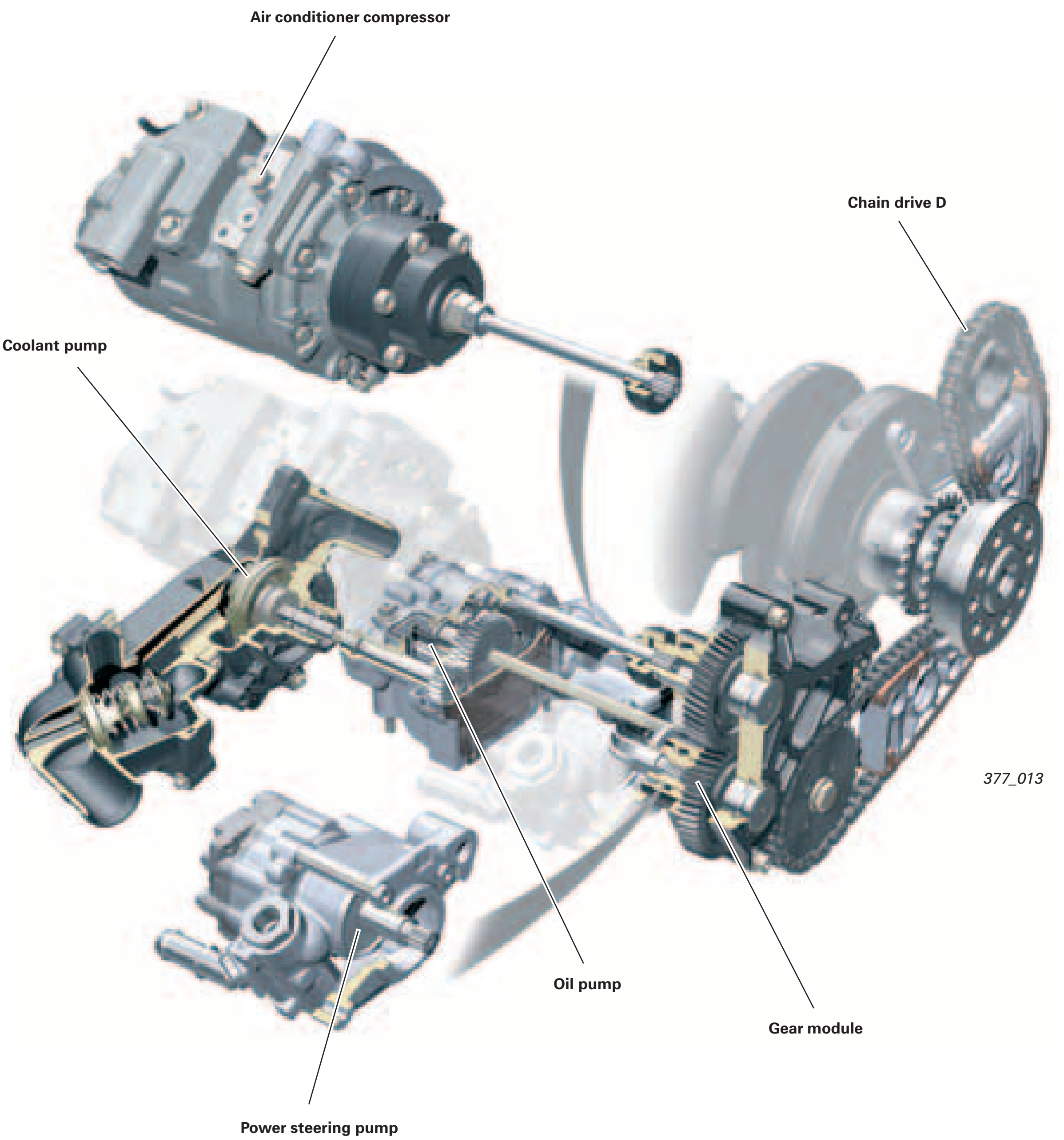
3/8“ simplex sleeve-type chains are used here.
Their advantage is their reduced wear and higher stress resistance at high engine speeds.

In this case the idler gears have 38 and 19 teeth.
The camshaft sprockets have 25 teeth.

Ancillary units drive

The oil pump, water pump, power steering pump and the compressor are driven by chain drive D.

The chain is driven directly by the crankshaft, deflected by an idler gear and drives the chain sprocket seated on the gear module.



Cylinder head

The cylinder heads are based technically on the well-known Audi four-valve FSI cylinder heads.

Specifications

– Aluminium cylinder head

– FSI intake ports with horizontal divisions to produce a tumble effect

– Four-valve technology with centralised layout of the spark plugs

– Inlet valve: chrome-plated solid stem valve

– Exhaust valve: chrome-plated sodium-filled hollow stem valve

– Valve lift 11 mm

– Lightweight, low-friction valve gear, valve actu tion via roller cam followers with hydraulic back-lash compensation, single valve spring

– Two assembled camshafts per cylinder head, driven by hydraulic swivel motors

– Intake valve opening angle 200 crank angle degrees

– Exhaust valve opening angle 210 crank angle degrees

– Adjustment range of the camshafts is 42 crank angle degrees

– The adjusters are locked by locking bolts when the engine is at a standstill; Intake in advance position, exhaust in retard position

– Return spring in exhaust adjuster

– Implementation of "internal exhaust gas recirculation" through the use of a correspond ing valve overlap

Different features of the high-revving engine

To match the higher engine power output and RPM, the following cylinder head components were modified:

– Intake ports are charge optimised (based on larger cross-sections)

– Intake valves are chrome-plated hollow stem valves (for weight reduction)

– Valve springs are made of a material with higher tensile strength and also have higher spring force

– To meet the higher fuel requirements the injectors are designed for higher flow rates.

– Roller cam followers are more robustly designed, with peened rollers for higher strength

– Camshafts have different timings and larger opening lengths

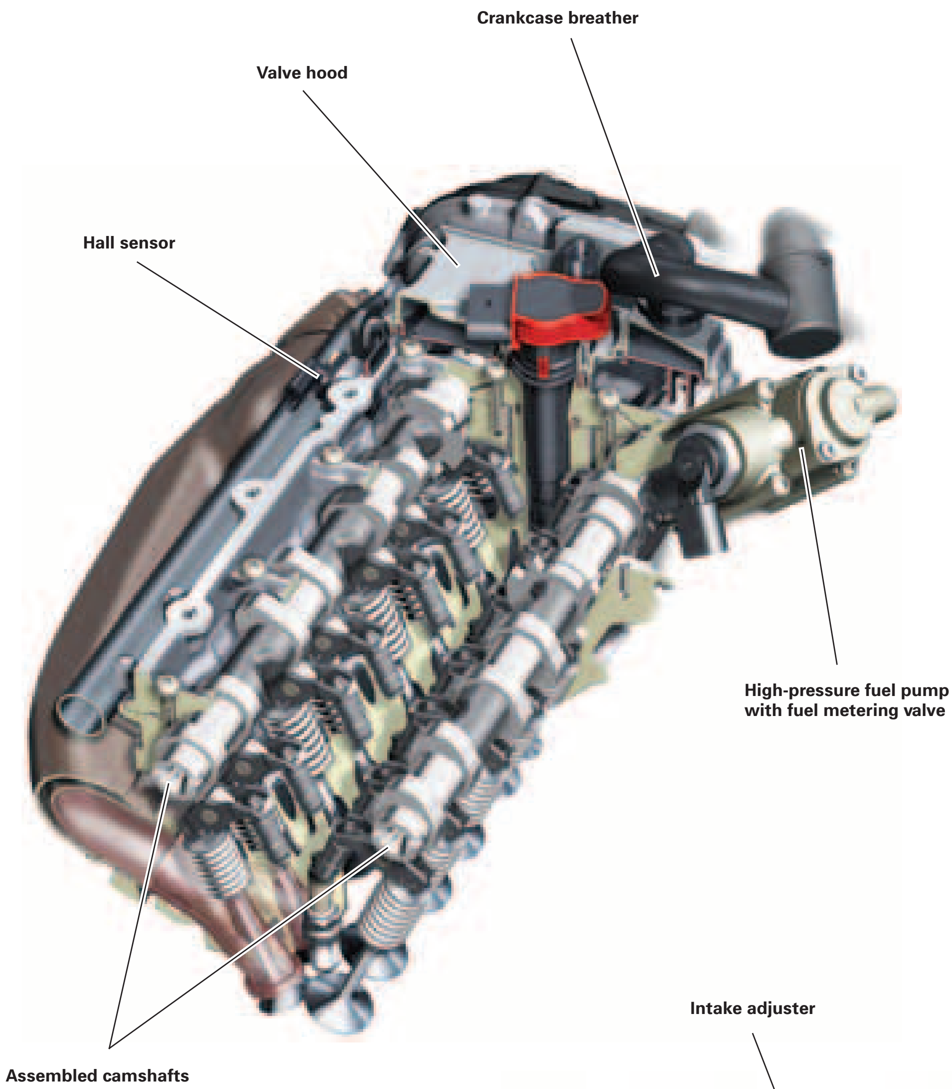
– Intake valve opening angle 230 crank angle degrees

– Exhaust valve opening angle 220 crank angle degrees

– The clearance compensation elements were adopted from the VR6 engine. They have a larger ball stroke which, in the course of testing, proved advantageous for the high-revving engine (with regard to the inflation of the hydraulic valve clearance compensation element).

– The cylinder head has a modified water jacket which circulates coolant to the area between the intake port and the injector and thereby reduces the temperatures in the cylinder head combustion chamber plate.

– Due to modified camshaft drive reduction ratio, the camshaft adjuster has 25 teeth for chain drive, as against 30 teeth in the basic engine.



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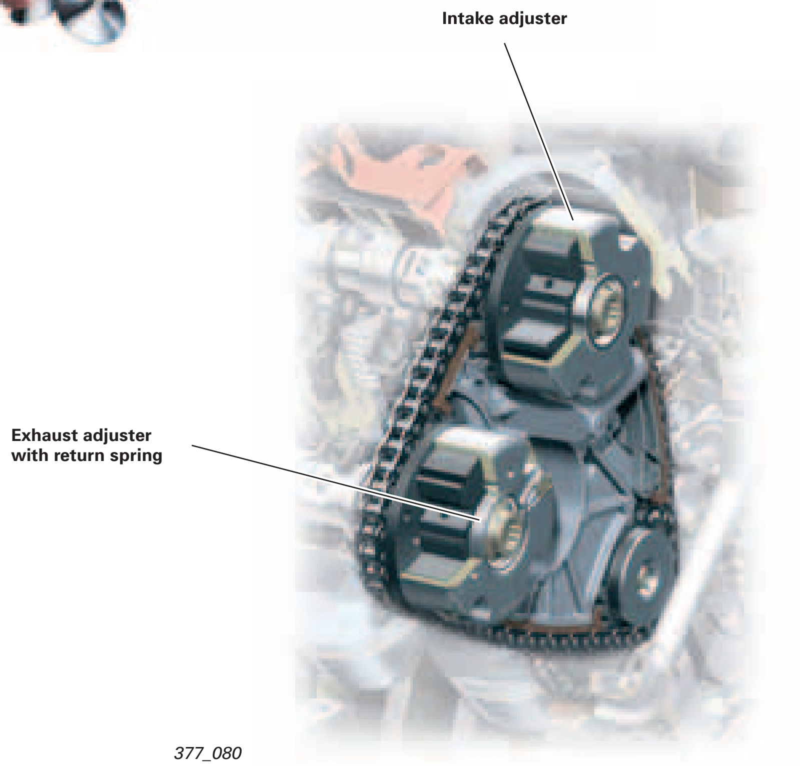

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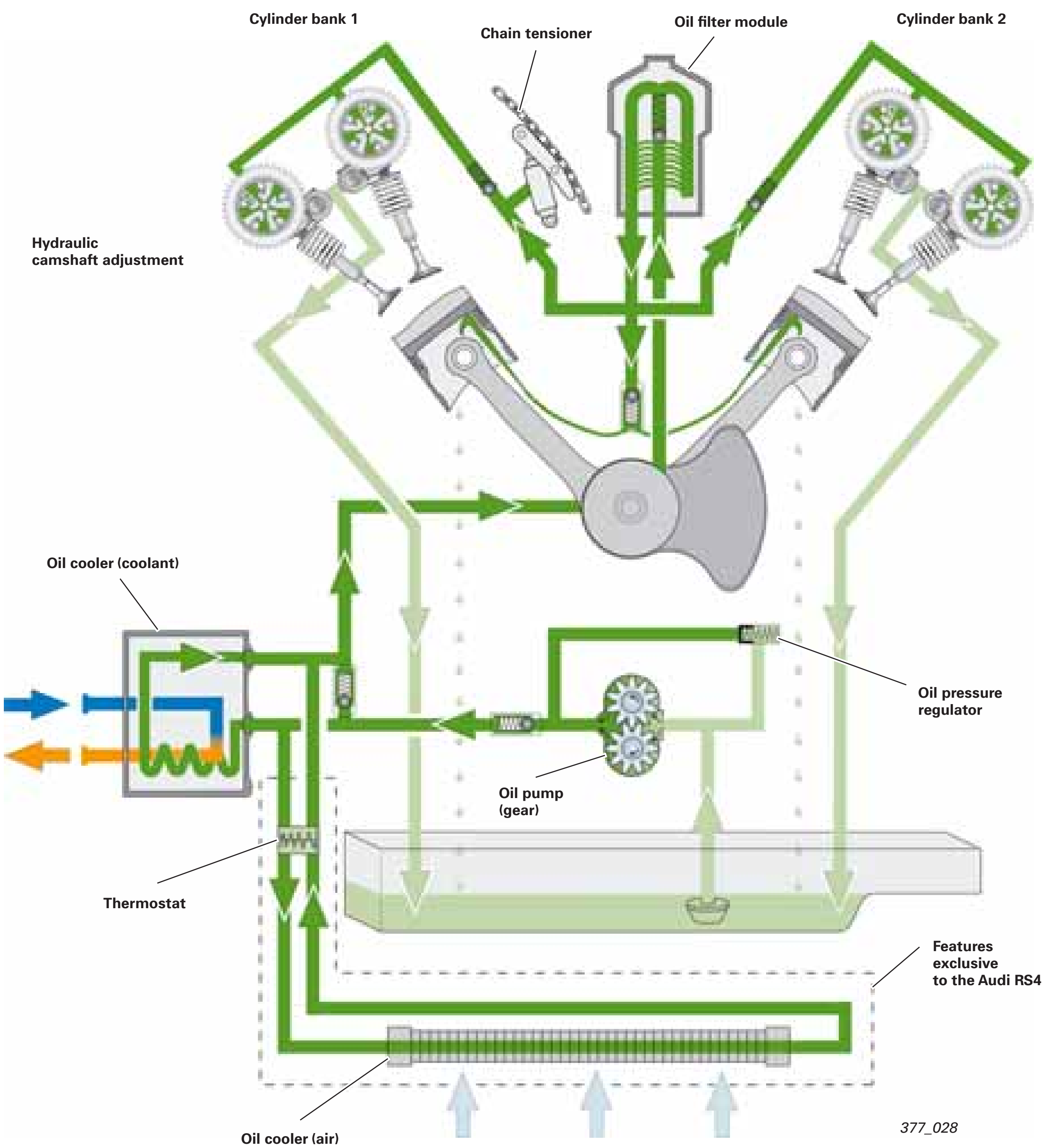
Design

The oil supply in the basic engine, and likewise in the high-revving engine, is based on a classic wet sump concept.
The focal point of development was on significant reduction of the oil flow rate. As a result, the oil remains in the sump for longer and is better able to deaerate.

The oil flow rate of 50 litres per minute (at 7000 rpm and 120 °C oil temperature) is very low for an eight-cylinder engine. This has helped to minimise oil pump drive power and thus improve fuel economy.

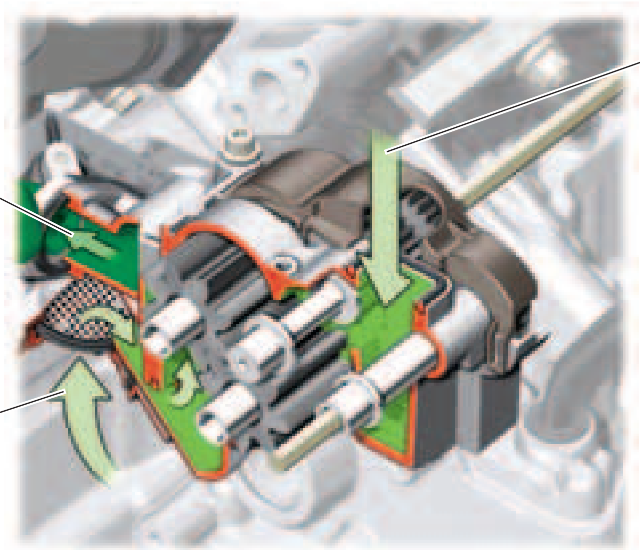
The baffle plate is designed such that it not only prevents the crankshaft churning the oil in the sump, but also strengthens the main bearing walls. In the basic engine the oil is cooled by an oil-water heat exchanger.

In the more highly stressed high-revving engine, an additional oil-air heat exchanger is used to minimise the oil temperature even at high engine load. This additional heat exchanger is operated in parallel with the heat exchanger via a thermostat.



Oil pump

The oil pump is situated above the oil pan. The oil is drawn in through the filter in the bottom of the sump and simultaneously through the engine return duct while driving. All engine lubrication points are swept from the pressurised oil side.



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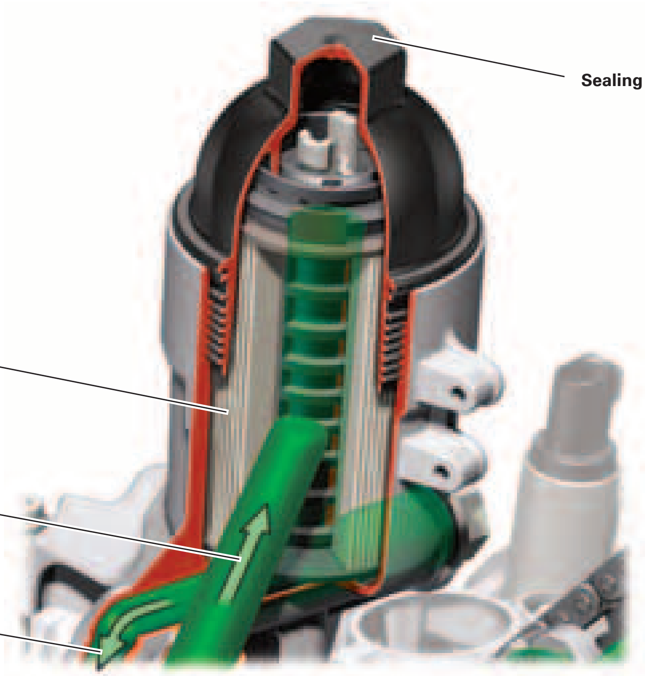
Oil filter module

The oil filter module is designed as a full-flow filter. For easy maintenance, it is accommodated in the inner vee of the engine. The filter element can be easily replaced without the need for special tooling. It is made of a polymer-based nonwoven material.



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Sump in the Audi RS4

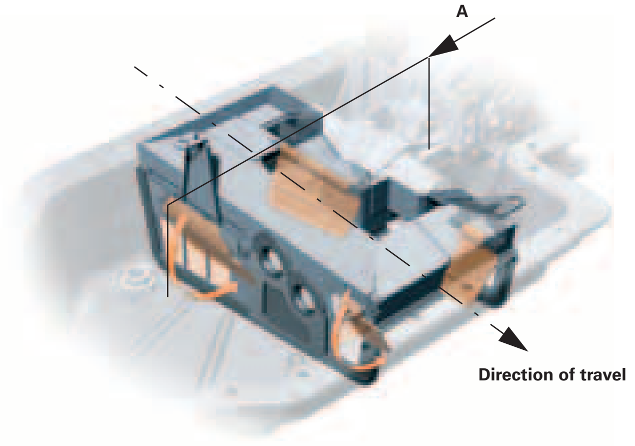
Especially in a sports car, a reliable supply of oil in all driving situations is vitally important. The oil supply system in the high-revving engine was designed for racing applications in which it is subjected to lateral acceleration of up to 1.4 g.
To ensure this, the sump in the RS4 has an additional system of flaps.

Design

Four flaps whose axis of rotation is parallel to the longitudinal axis of vehicle are arranged inside a housing. Each of the flaps opens towards the inside of the intake end of the oil pump.

Function

When the vehicle is cornering the oil flows inside the sump towards the outside of the corner. The two flaps facing the outside of the corner close and hold the oil in the sump intake.
At the same time, the two flaps facing the inside of the corner open to allow additional oil to flow into the intake. This ensures a sufficient supply of oil to the oil pump.



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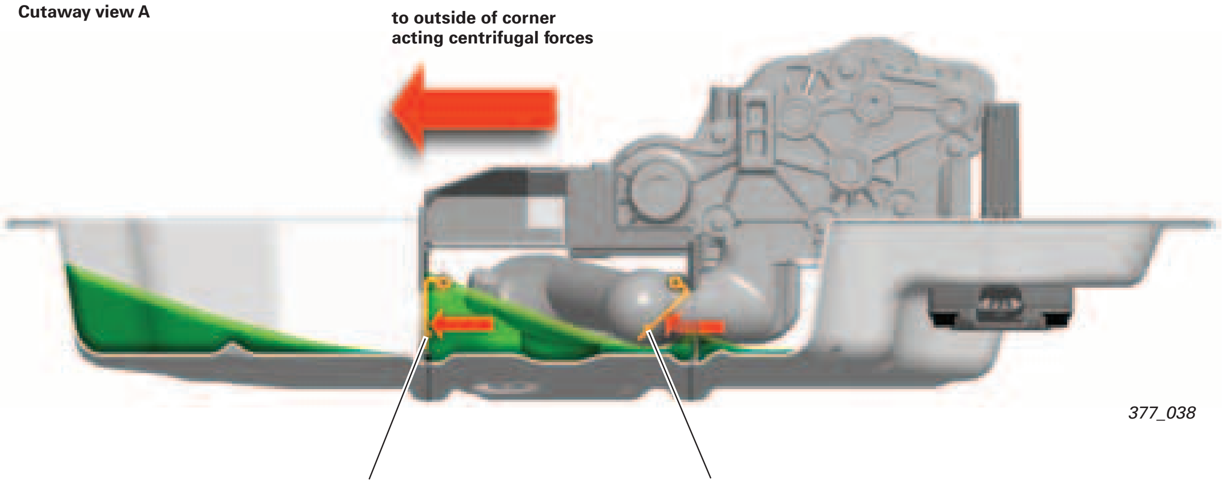
Cutaway view A



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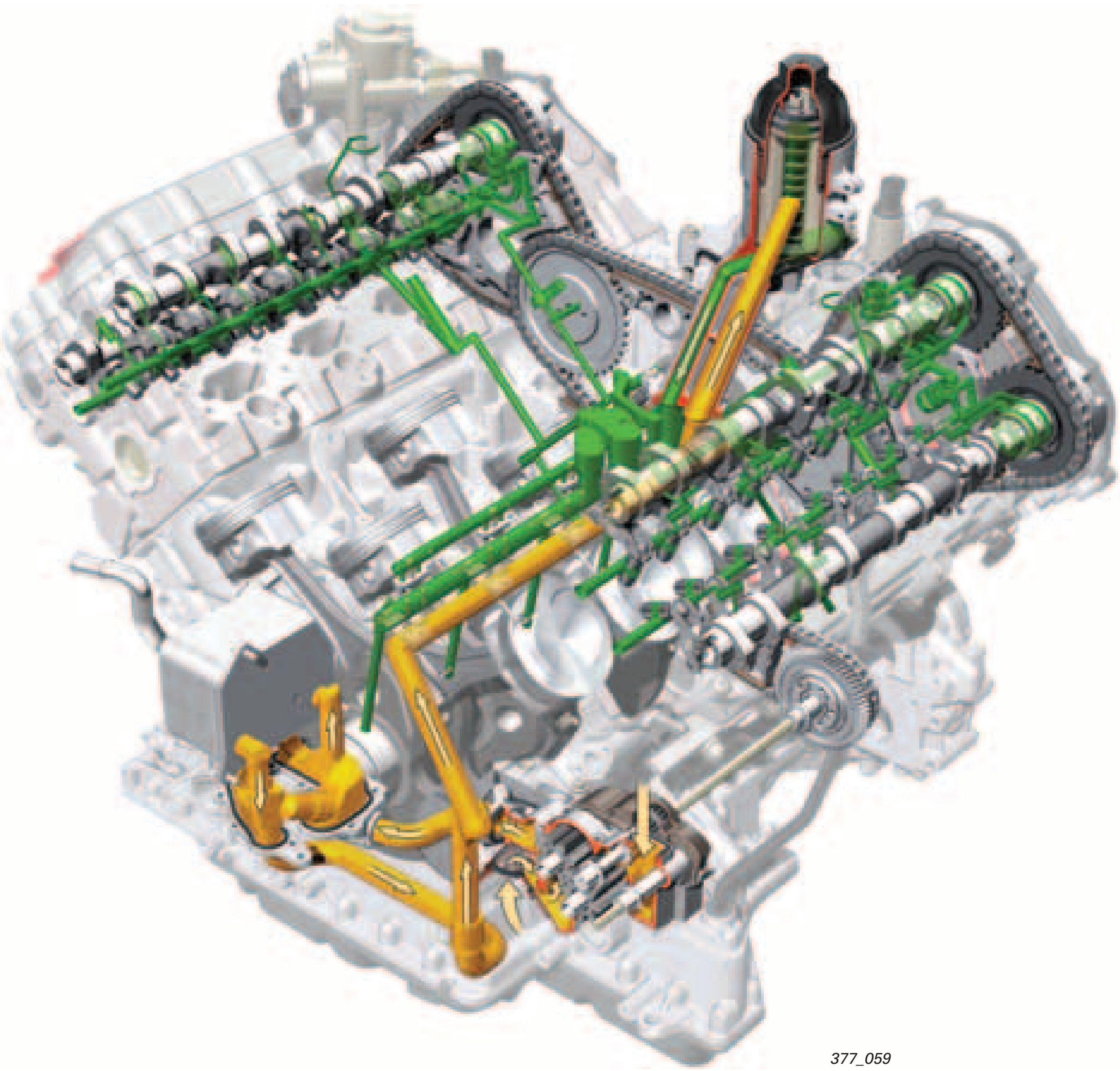
Oil circulation system



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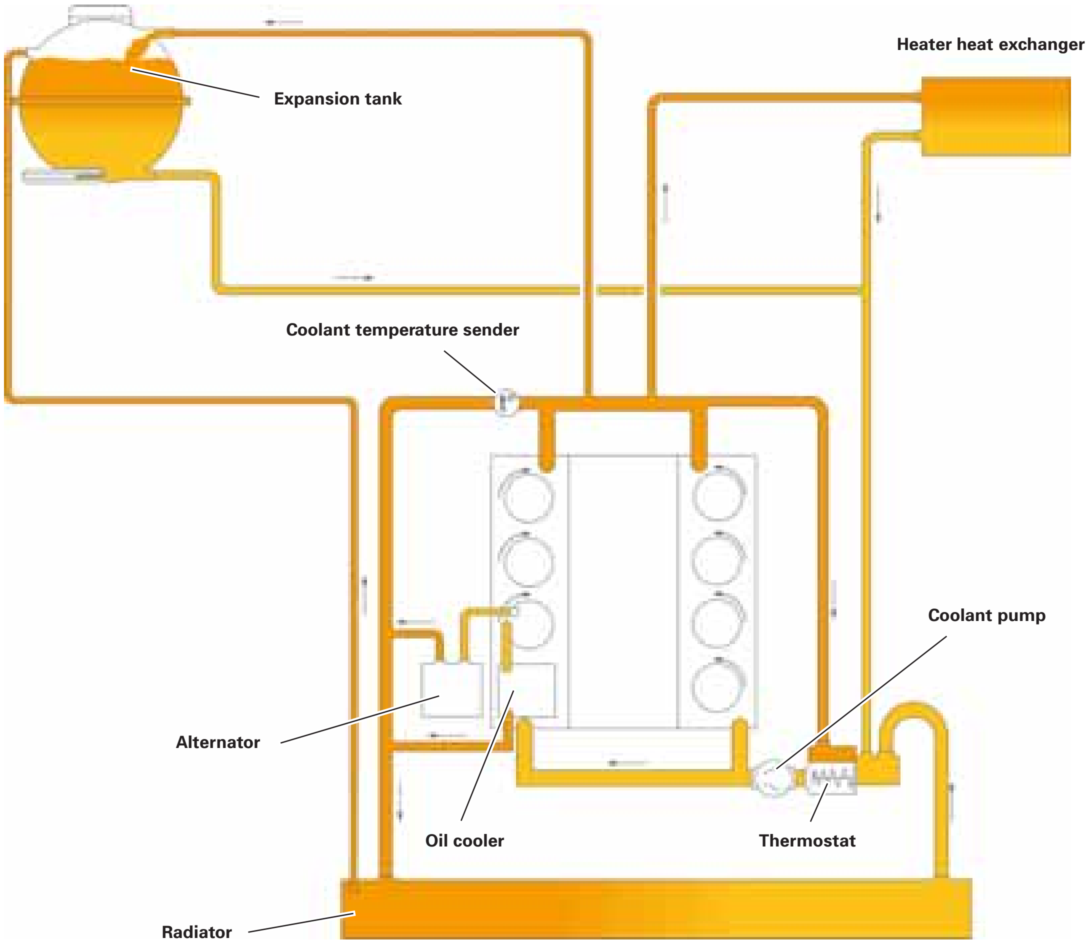
Pressurised oil downstream of filter

Pressurised oil upstream of filter

Cooling system in the Audi Q7



377_030

The cooling system in the new V8 engines was configured as a longitudinal-flow cooling system. The cooling water flows in on the outlet side and through the cylinder head gasket into the cylinder head, where it flows out longitudinally through the chain housing cover.
Cooling of the cylinder webs was improved by drilling coolant ducts with optimised cross-sectional area into the webs.
Forced flow through these bores is ensured by means of specially sealed water ducts.

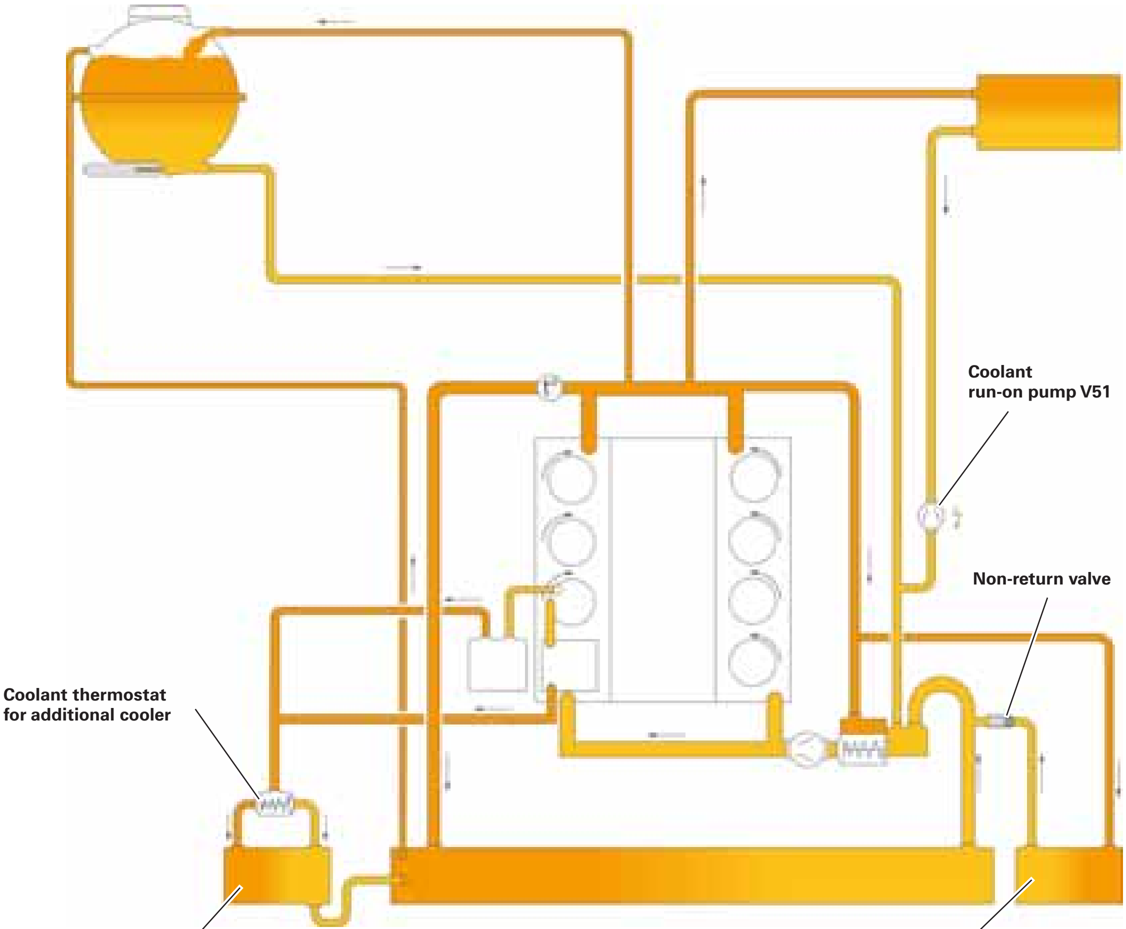
The high-revving engine also has two vee-shaped forced-flow bores between the inlet valves because they are subjected to higher stresses due to the high power density.

A map-controlled coolant thermostat is used in the basic engine.
When operating at full throttle the coolant temperature is reduced to 90 °C via an electrically heated thermostat to avoiding increasing the tendency of the engine to knock. When operating at part throttle - which is not critical with regard to knock - the coolant temperature is increased to 105 °C.
The thermodynamic advantages and the reduced friction result in a fuel saving of approx. 1.5 % when operating at low part throttle.

Radiator fan control

The engine control unit J623 activates radiator fan control unit J293 and radiator fan control unit 2 J672 by generating a separate PWM signal.
The radiator fan control units then energise the radiator fans based on the engine control unit signal by means of a PWM signal.
The radiator fan is activated by the engine control unit based on a characteristic map.

Cooling system in the Audi RS4



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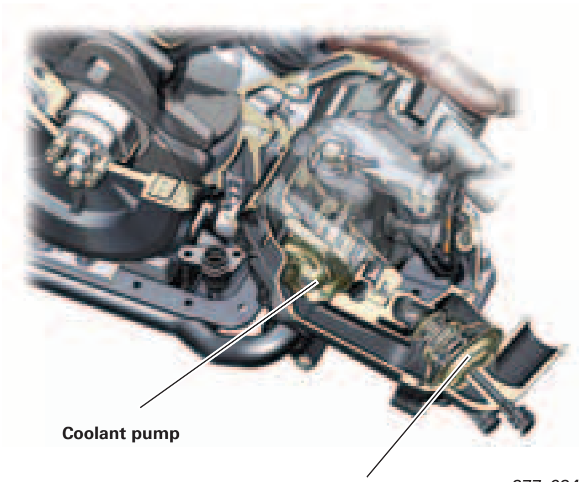
Coolant pump and thermostat

No map-controlled coolant thermostat is used in the high-revving engine.
To achieve more effective cooling, two additional coolers are used. Coolant flows continuously through one of the additional coolers.
The second additional cooler is opened via a coolant thermostat.

To avoid excessive heating-up after shutting off the hot engine, the coolant run-on pump is activated a preset period of time after the engine is shut off. The pump run-on time and the need for additional activation of both radiator fans are determined on the basis of characteristic maps. Various measured quantities are included in the calculation (engine temperature, ambient temperature, engine oil temperature and fuel consumption).



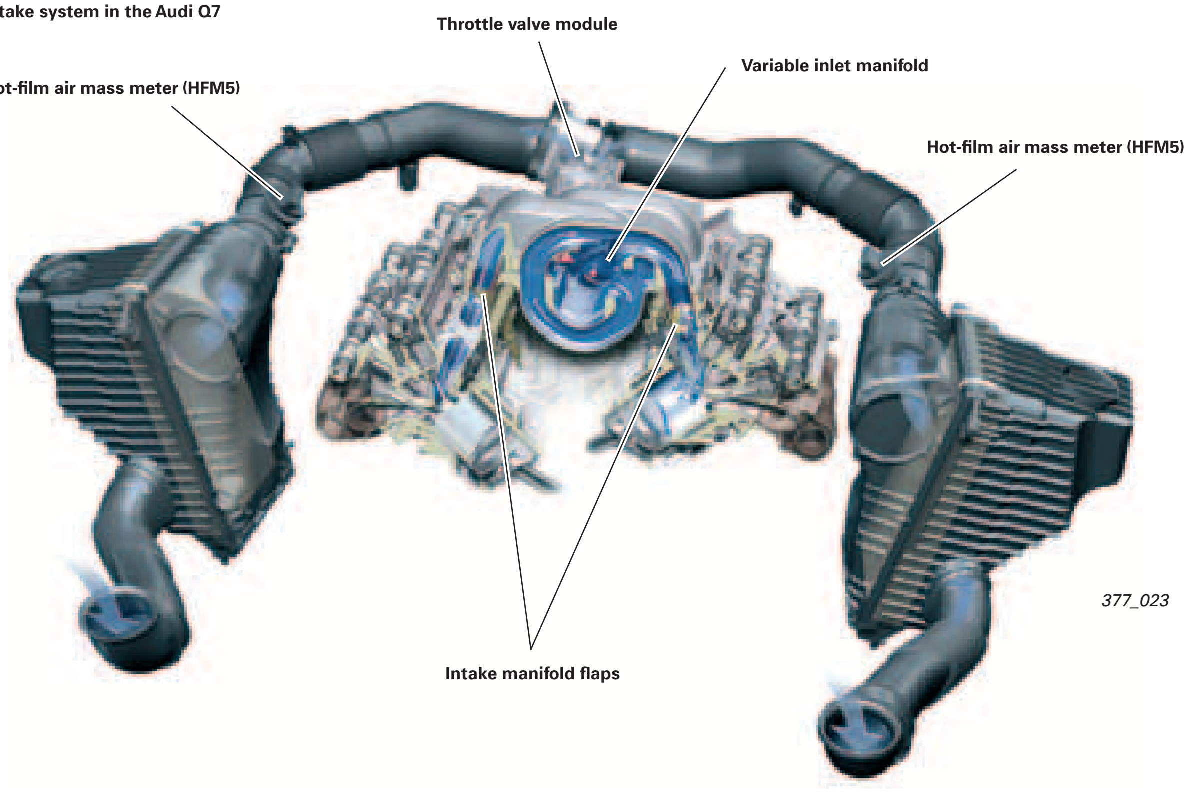
377_034

Air intake

The intake path of the Q7 is double-chambered and discharges into a variable inlet manifold made of gravity die cast aluminium. A Bosch throttle valve module with a diameter of 82 mm is located upstream of the variable inlet manifold.
The variable inlet manifold is of the two-stage type. In the lower RPM range, the long intake manifold path is activated in order to increase torque. In the upper RPM range, the short intake manifold path is activated. This positionproduces an increase in engine power output.

Intake manifold path change-over is map-controlled. The adjustment is made by the variable inlet manifold motor V183. No feedback is given on the position of the variable inlet manifold.
If the intake manifold shutoff is not functioning, exhaust gasquality is not impaired. In this case, the driver will notice a loss of power.

Intake system in the Audi Q7



377_023

Intake manifold flaps

As with the variable inlet manifold, the intake manifold flaps in both engine variants are controlled according to a characteristic map. In both engines the intake manifold flaps are activated in the lower engine load and RPM ranges.
They are brought into abutment with the port baffles in the cylinder head and thereby seal the lower part of the intake port. The aspirated air mass now flows through the upper section of the intake port and induces a tumbling charging motion inside the cylinder.
When not activated, the intake manifold flaps are open and sender and maximises the cross-sectional area of the port. All flaps in a cylinder bank are attached to a common shaft.

In the basic engine in the Q7 the intake manifold flaps are activated via an electrical actuator.
For each cylinder bank, the position of the intake manifold flaps is monitored by a Hall sensor.
In the high-revving engine, the intake manifold flaps are activated by a single vacuum actuator per cylinder bank. In this case, too, the flap position is indicated by means of Hall sensors.

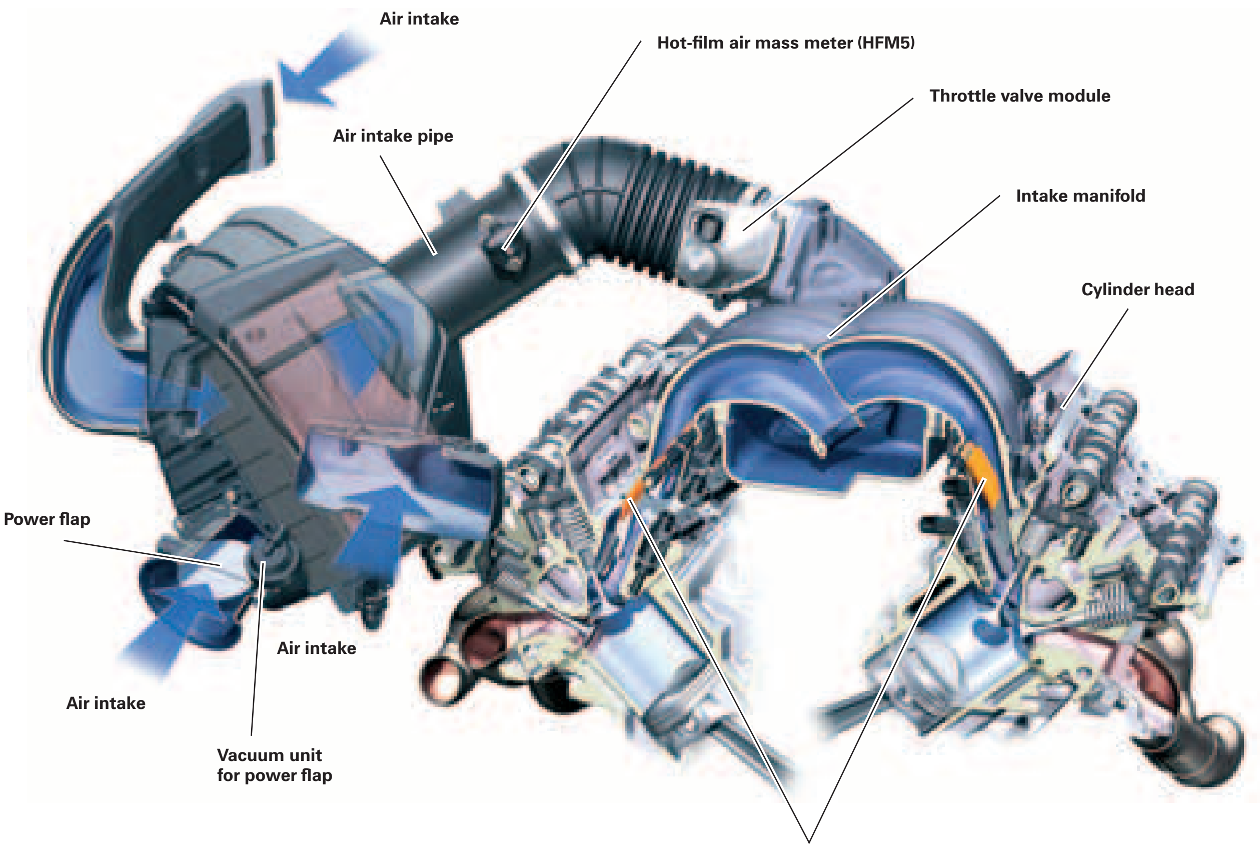
The intake system of the RS4 engine was designed with emphasis on maximum flow control. Pressure loss is minimised by a large cross-sectional areas in the hot-film air mass meter (HFM) and air intake pipe in combination with a 90 mm diameter throttle valve.

To ensure a sufficient supply of air to the engine at high RPM, the power flap in the air filter is opened at engine speeds higher than 5000 RPM and at road speeds higher than 200 kph.

The power flap is opened and closed by a vacuum actuator which is map-controlled by the engine control unit via the variable intake manifold change-over valve N335.

The sand cast aluminium intake manifold was designed specially to match the sporty characteristic of the engine. In contrast to the basic engine, maximum torque is produced at higher engine RPM. At this engine speed, the intake manifold change-over valve would be switched to the short path for higher power output.

Intake system in the Audi RS4



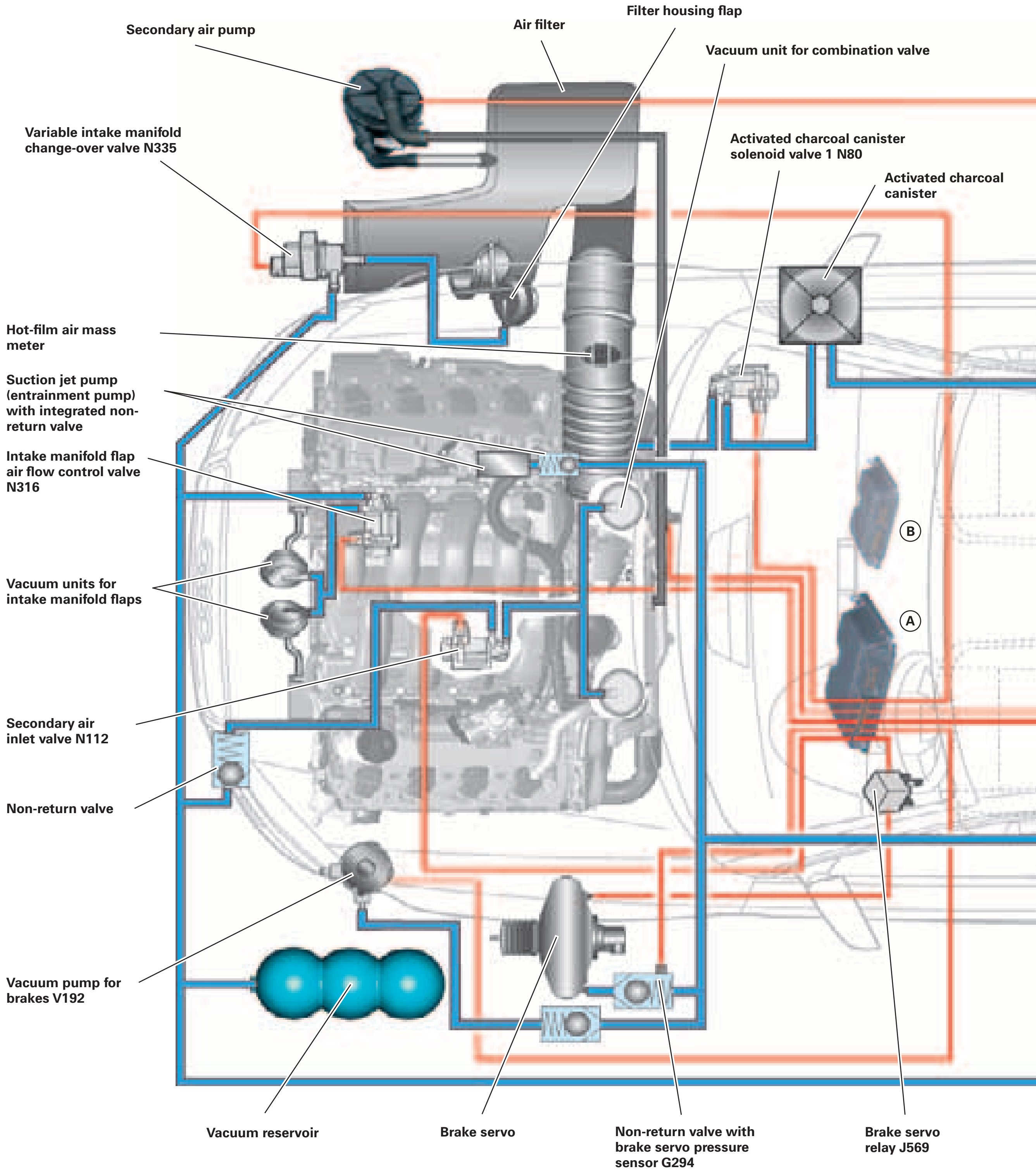
The RS4 engine does not have a variable inlet manifold.

377_022

Vacuum hoses in the Audi RS4

The conventional method of supplying vacuum to the brake servo and the engine components is problematic in the case of FSI engines.

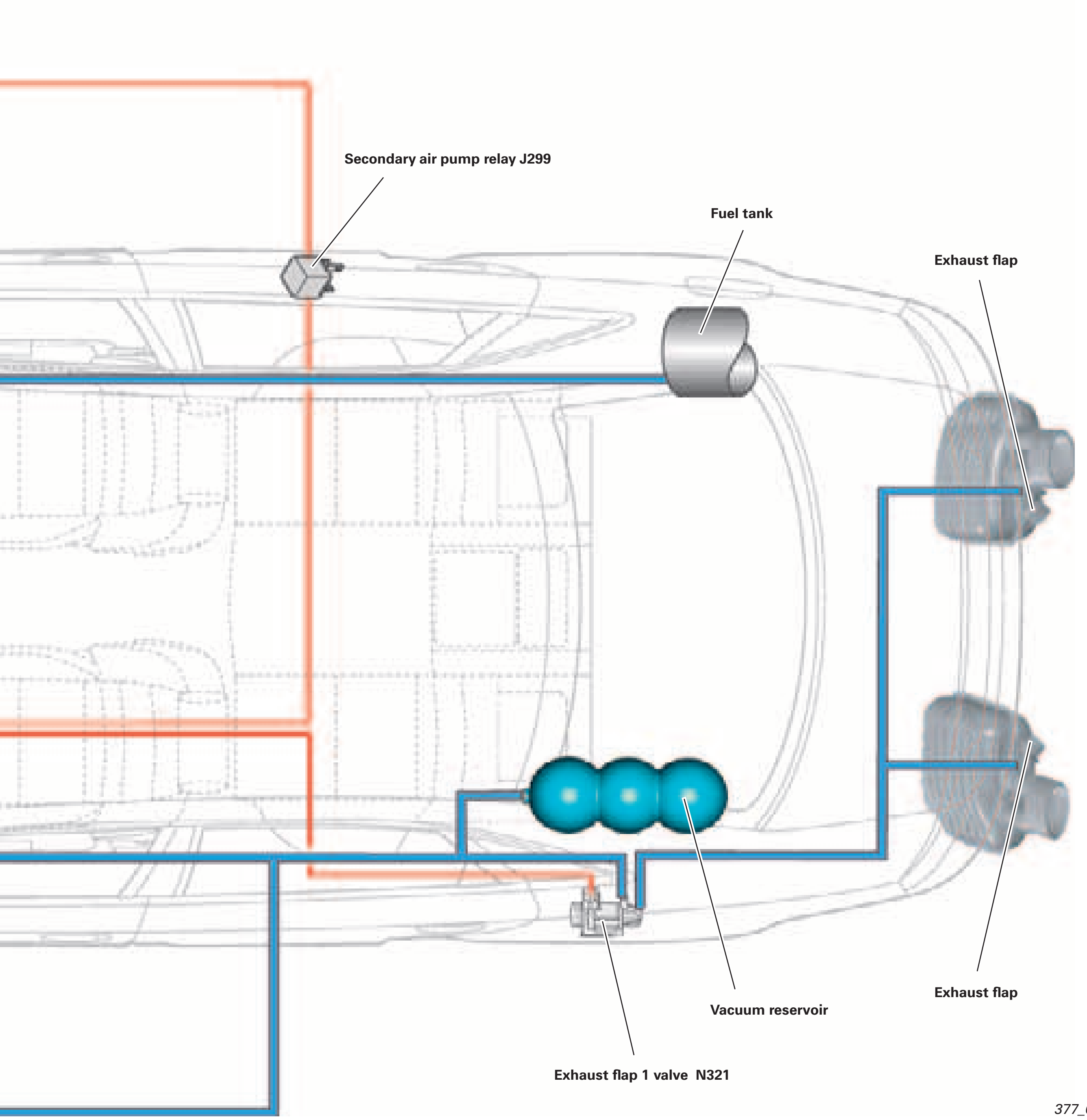
This means that connecting a vacuum line downstream of the throttle valve would offer little prospect of success because, in many engine operating situations, the wide open throttle valve would result in low mass flow rates and vacuum in the intake manifold being.



For this reason, in both engine versions, the requisite vacuum is produced by a suction jet pump and, if necessary, additionally by an electrical vacuum pump.

The suction jet pump is connected in parallel with the throttle valve part upstream and downstream of the throttle valve. The branched air flow drives the suction jet pump. An extreme case is that of cold starting. For example, when the catalytic converter is heating up, the throttle valve is wide open.

In this case, the vacuum produced by the suction jet pump is not enough to sufficiently evacuate the brake servo. The brake servo pressure sensor G294 is connected to the line to the brake servo and transmits its values to the engine control unit.
In the engine control unit (map controlled), the brake servo relay J569 and the vacuum pump for brakes V192 are activated until requisite vacuum is present.

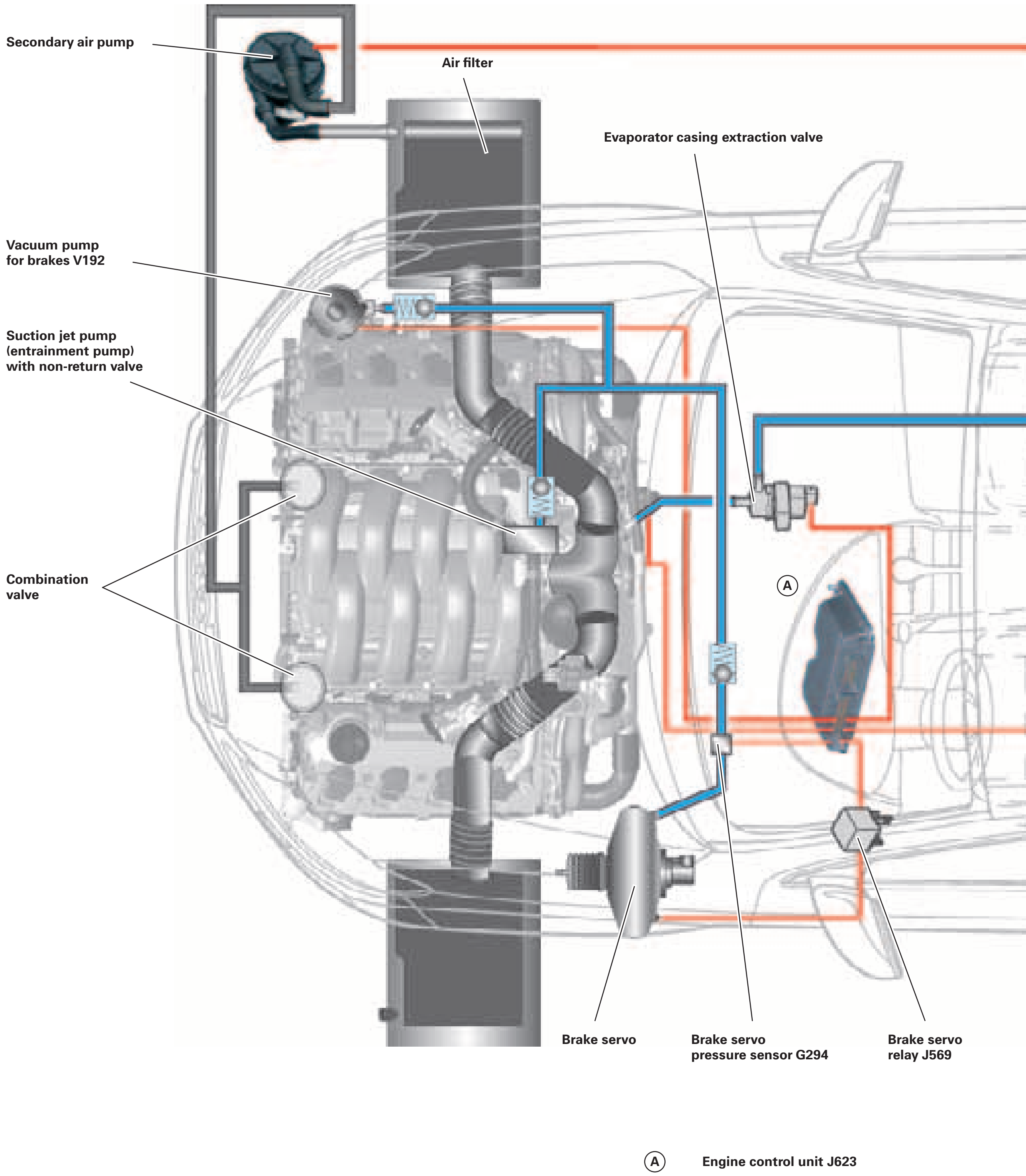


377_025

Ⓐ **Engine control unit (master) J623**

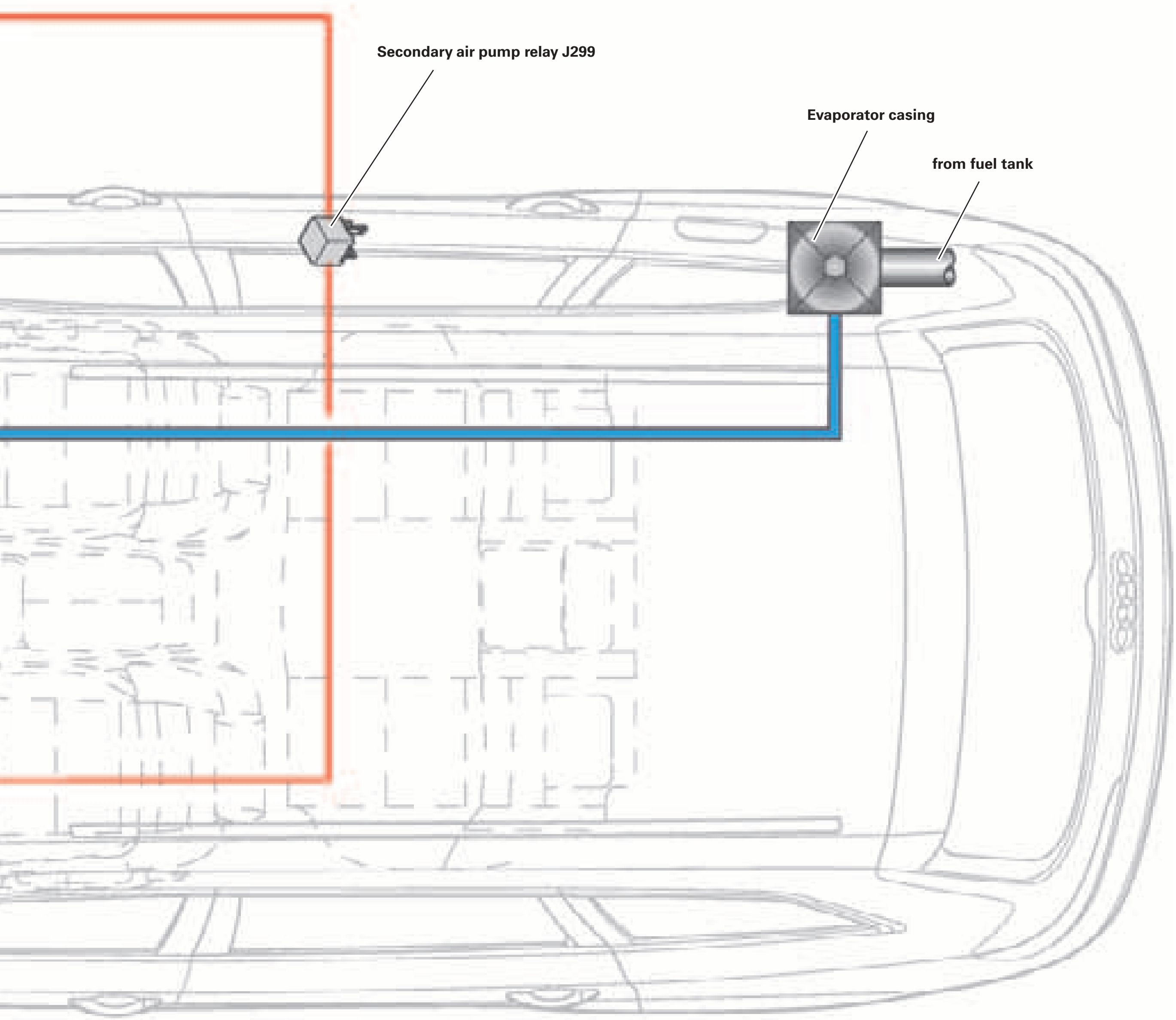
Ⓑ **Engine control unit 2 (slave) J624**

Vacuum hoses in the Audi Q7



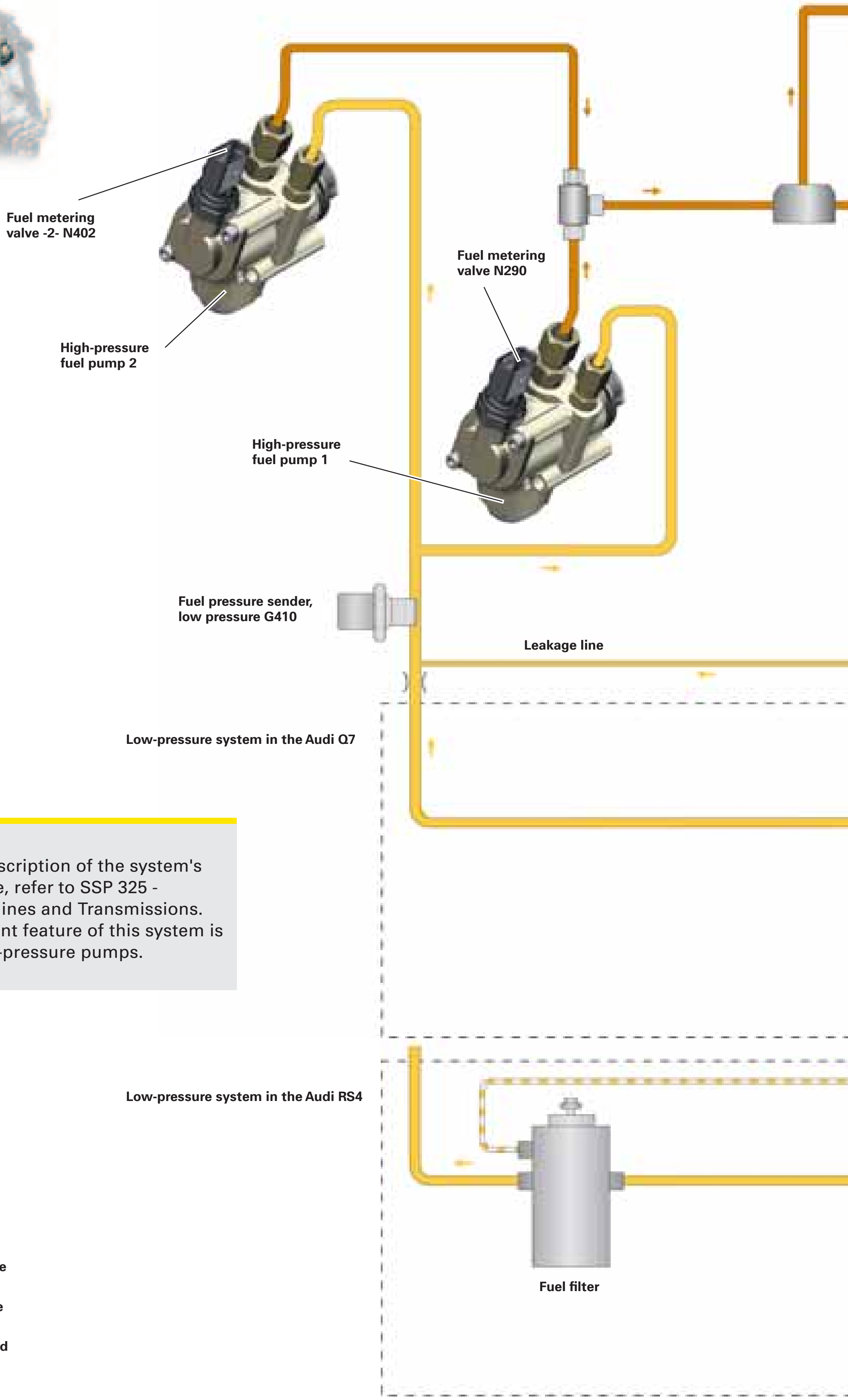
Note

The illustrations show the vacuum hoses. The fitting locations may deviate from those shown here.



377_068

Fuel system in the Audi Q7/RS4



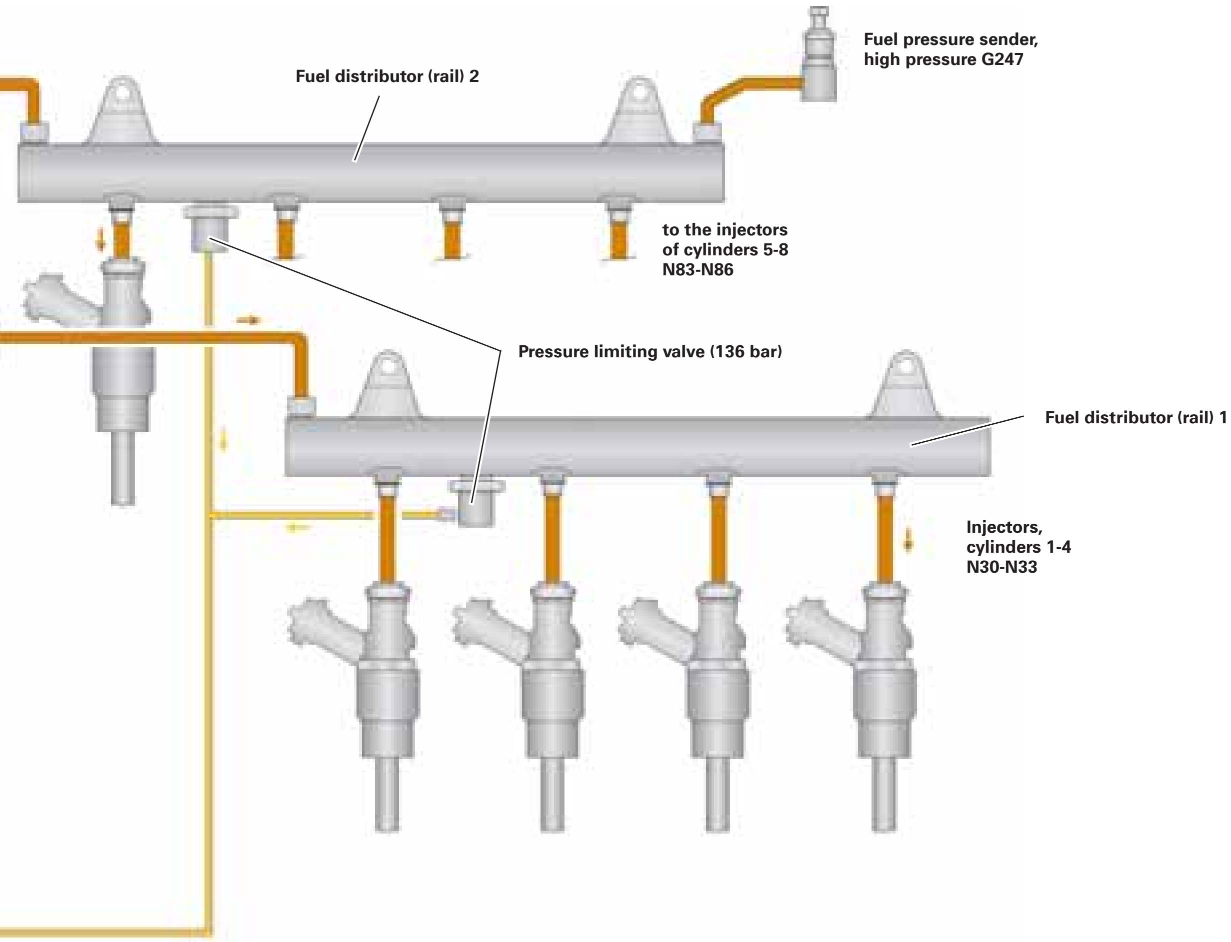
Reference

For an exact description of the system's operating mode, refer to SSP 325 - Audi A6 ‘05 Engines and Transmissions. The only different feature of this system is that it has high-pressure pumps.

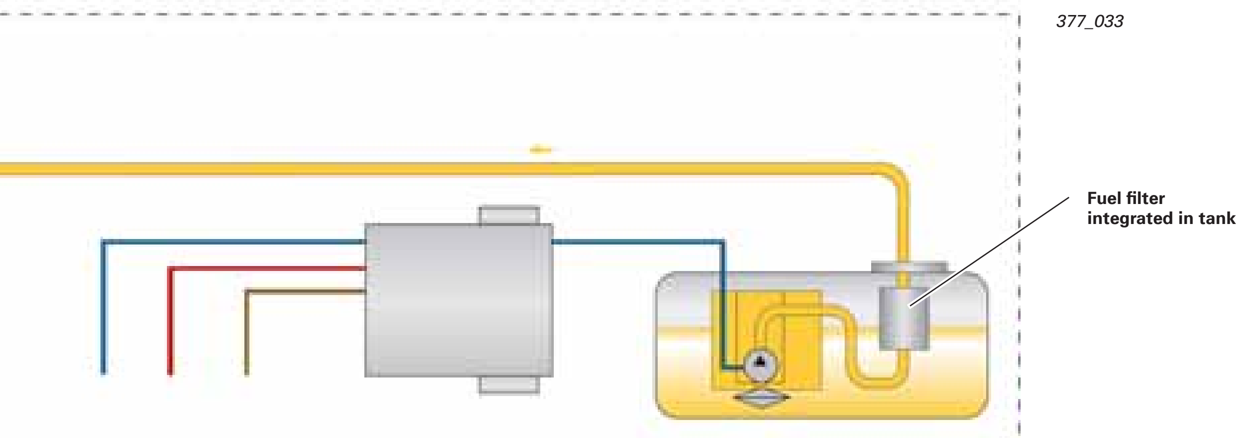
High-pressure

Low pressure

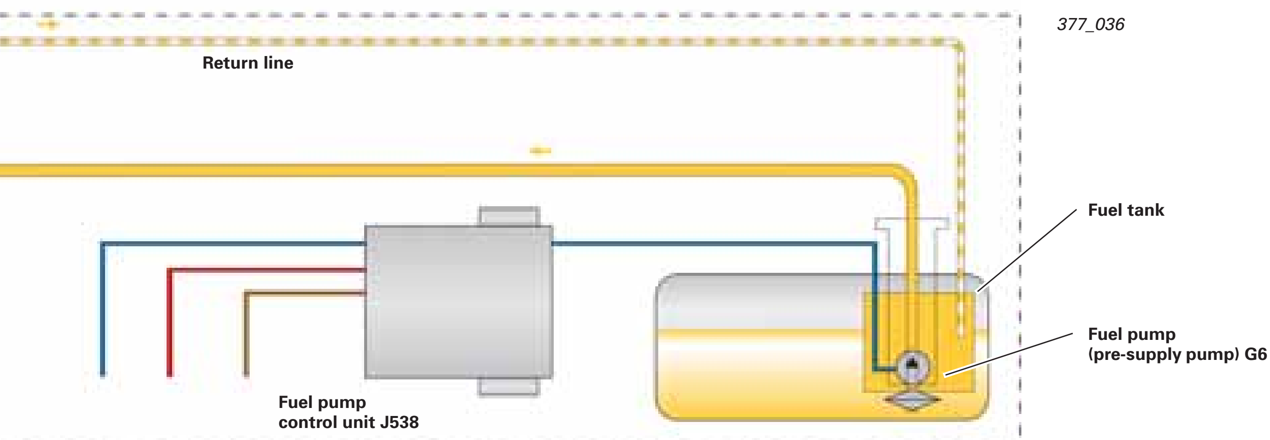
depressurised



377_033



377_036



Exhaust system

During the development of the exhaust system, special emphasis was placed on optimising flow resistance. The clamping flange system used in the 2.0-litre FSI engine has proved highly advantageous in this regard.

Audi Q7

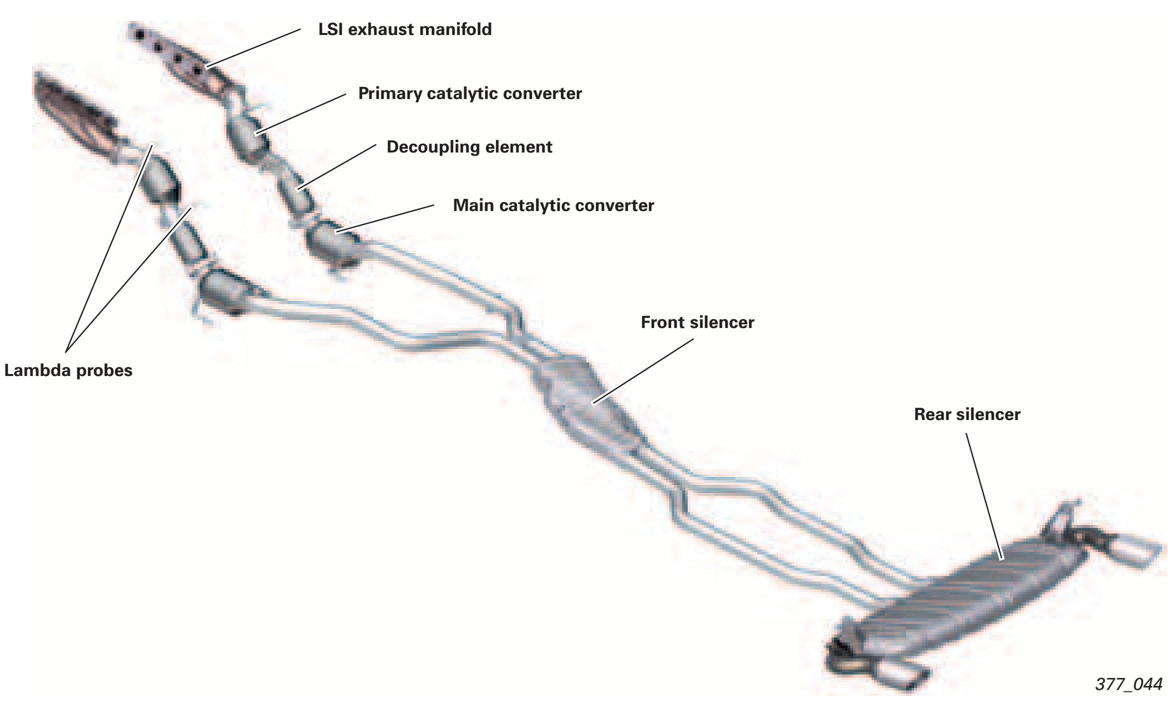
Each cylinder bank has its own exhaust pipe.
The air-gap insulated (LSI) exhaust manifolds are flanged onto the cylinder heads.
They offer the advantage of low heat loss in the exhaust gas. As a result of this, the primary catalytic converters are able to heat up quickly.
The primary catalytic converters are ceramic type catalytic converters. The lambda probes are connected to them. The lambda probe upstream of the catalytic converter is a broadband probe.
A nonlinear probe is located downstream of the catalytic converter. The main catalytic converters in the underbody area are also ceramic catalytic converters. The exhaust pipes of the individual cylinder banks discharge into a front silencer.
The front silencer is an absorption-type silencer.
A crossover function in the silencer ensures higher engine power output and torque.
The front silencer and the rear silencer are connected by separate pipes.
Again, the rear silencer is a common component of both exhaust pipes. On the inside of the rear silencer, however, the left and right exhaust pipes are clearly separated. Likewise, the rear silencer is an absorption-type silencer.

Audi RS4

To enhance the sporty character of the RS4 engine, a fan-type manifold is used in the RS4.
Good separation of the exhaust pulses is ensured by keeping the individual exhaust pipes apart until they merge into one. These fan-type manifolds are also attached by means of the clamping flange system.

The primary and main catalytic converters are metal type catalytic converters. Their advantage is that they have a lower flow resistance than ceramic catalytic converters. This is good for engine performance.
The front silencer for each of the exhaust pipes is housed in a common casing.
However, the exhaust pipes are kept separate.
The front and rear silencers are absorption-type silencers. They are notable for their low flow resistance.

Exhaust system in the Q7



Exhaust flap control Audi RS4

A further difference is the layout; one exhaust flap is located downstream of each of the rear silencers. The exhaust flaps are fitted to give the engine a sporty sound. The exhaust flaps are switched in such a way as to meet the statutory limits for vehicle exterior noise.

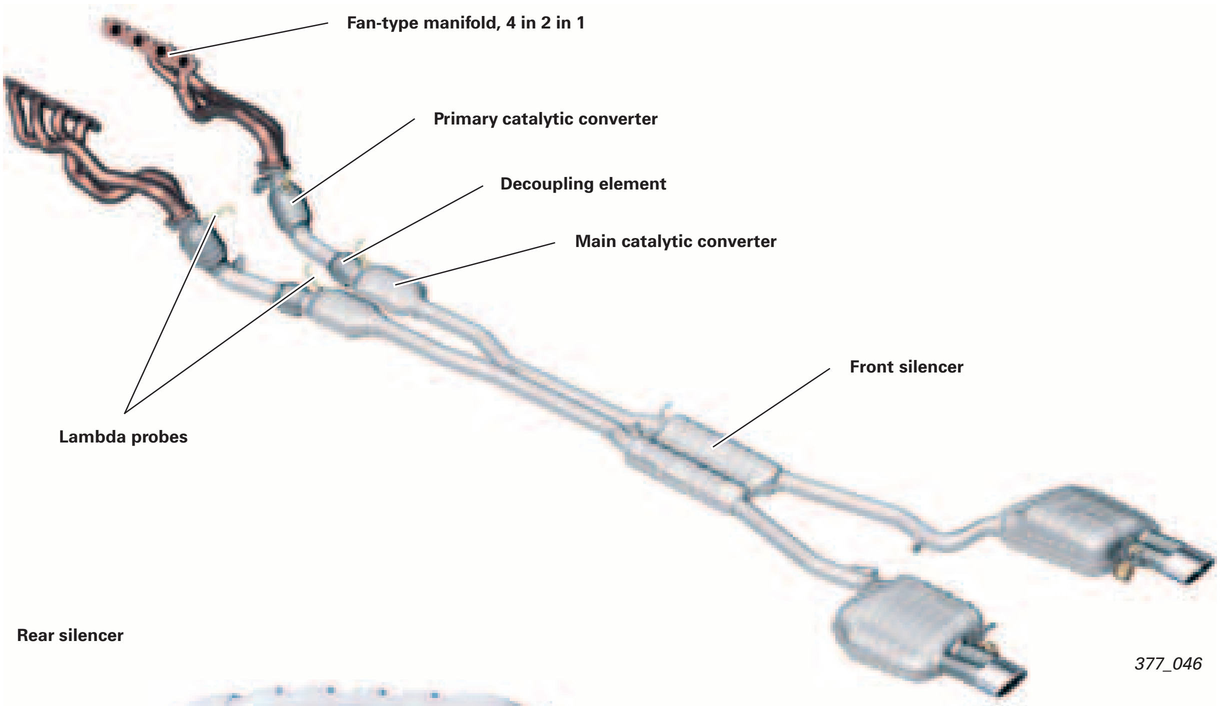
Low-frequency droning noise at low engine RPM is prevented. At high engine RPM and high exhaust-gas flow rates, flow noise and exhaust backpressure are reduced by opening the additional cross-section.
The exhaust gas flaps are closed at idle, low engine load and at low engine RPM.

Function

The exhaust flaps are switched by a vacuum actuator. Both vacuum units are switched by an electrically activated solenoid valve. The exhaust flaps are switched according to a characteristic map.

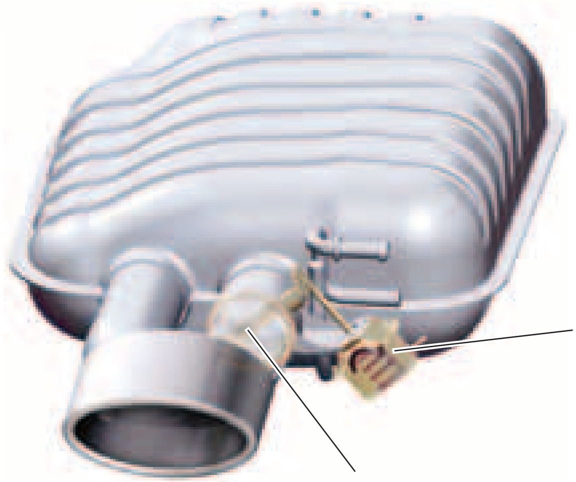
The factors of engine load, engine RPM, gear selected and the shift signal from the Sport button are used to plot the characteristic map.
For example, the exhaust flaps are opened at idle when the Sport button is pressed.

Exhaust system in the RS4



377_046

Rear silencer



377_060

Secondary air system

The secondary air system ensures that the catalytic converter heats up more quickly and is available sooner after a cold start.

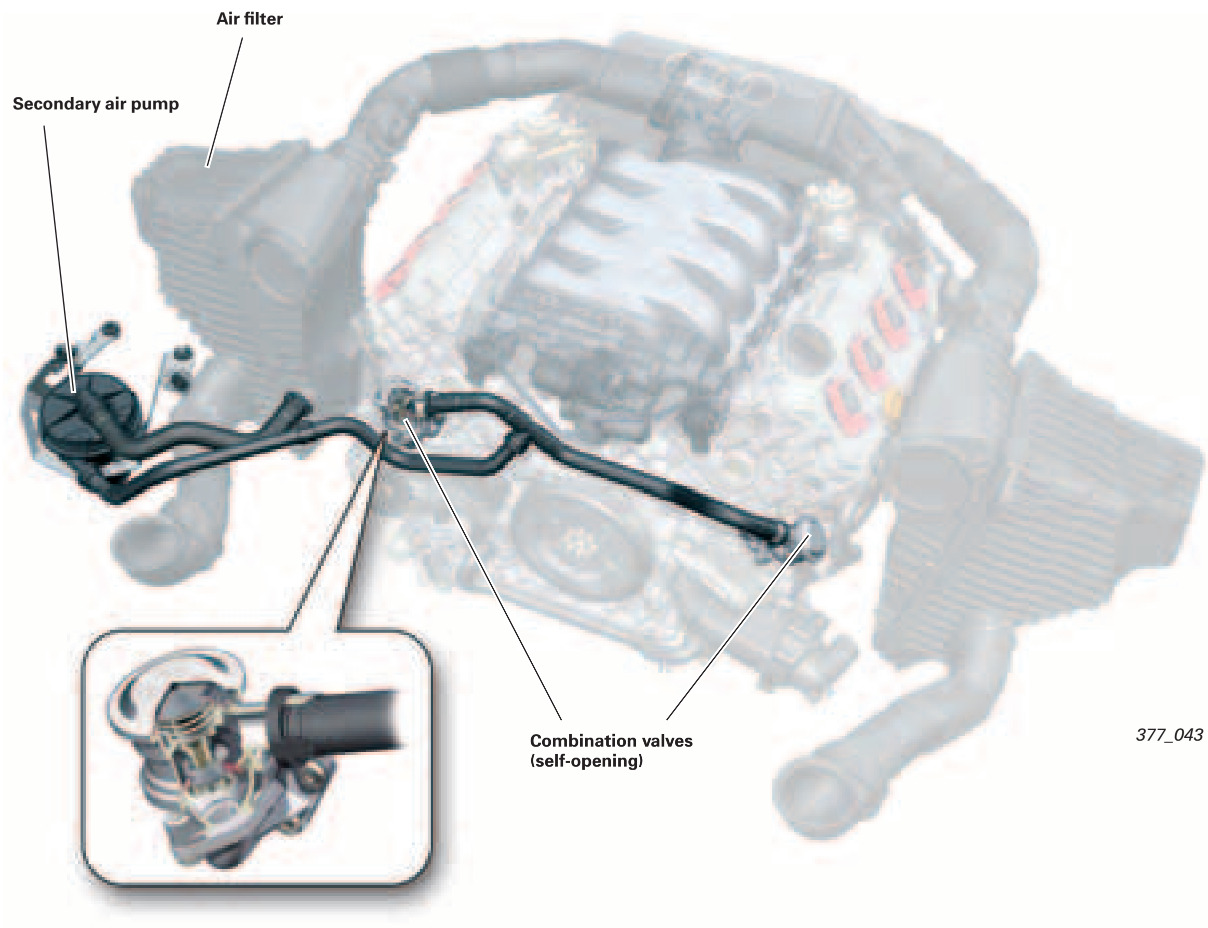
Principle

Due to the richer air-fuel mixture in the cold start and warm-up phases, a higher concentration of unburned hydrocarbons occurs in the exhaust gas. Post-oxidation in the manifold and headpipe is promoted by secondary-air injection.
The heat dissipated during this process heats the catalytic converter to operating temperature within approx. 30 seconds after engine start.

Operating mode in the Q7

During the warm-up phase, the engine control unit J623 activates secondary air pump V101 via the secondary air pump relay J299.
The air flow from the secondary air pump opens the combination valve for secondary air and admits air into the exhaust system upstream of the catalytic converter.

Secondary air system in the Q7



Operating mode in the RS4

The secondary air system operates in much the same way as that in the Q7 engine. The difference here lies in the way the combination valves open and close.

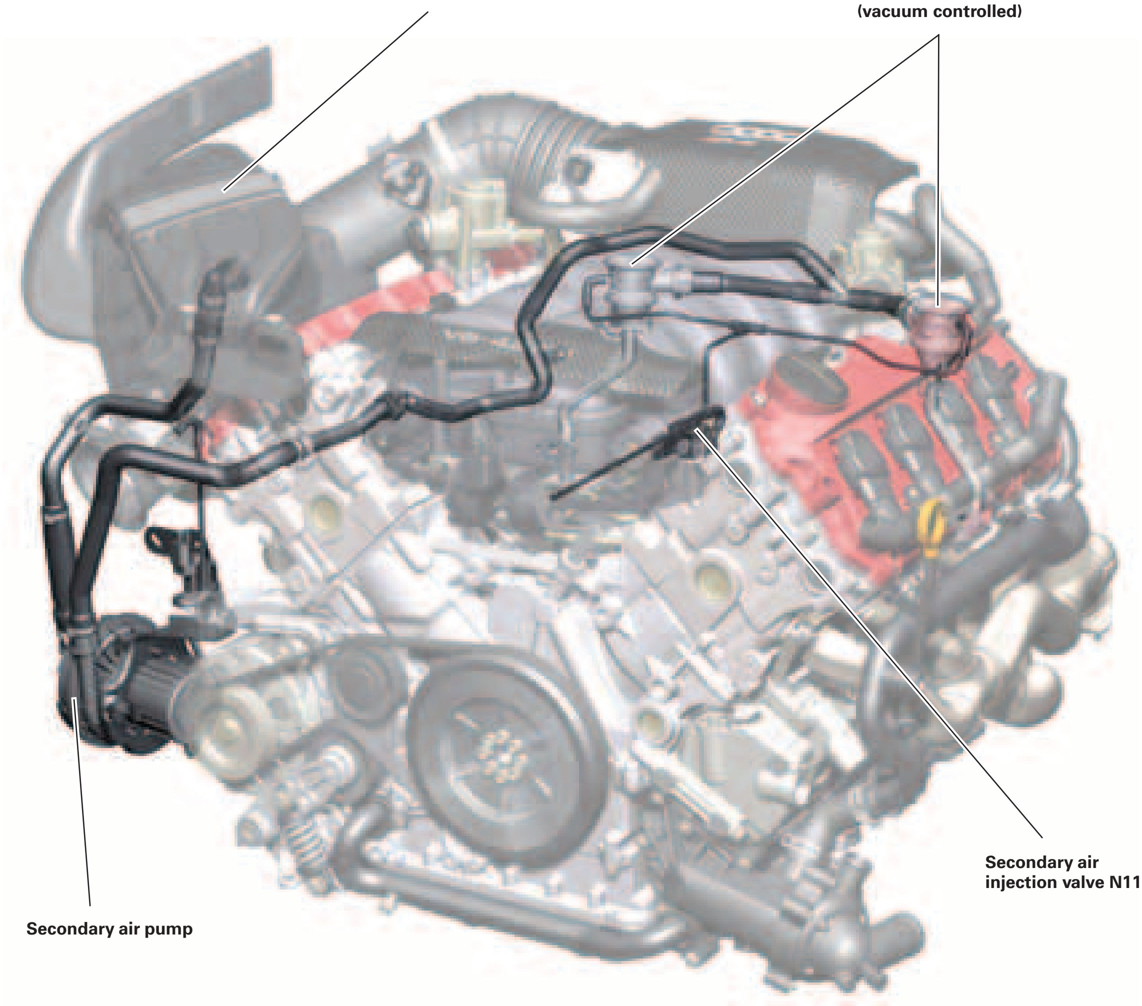
The air path from the secondary air pump to the secondary air duct in the cylinder head is opened by means of a vacuum unit on the combination valve. The vacuum unit is controlled by the secondary air inlet valve N112 via the engine control unit.

The basic engine in Q7 and the high-revving engine in RS4 have different fitting locations for the secondary air system. In the Q7 the secondary air system is fitted at the engine front end on the input side of the ribbed vee belt, while in the RS4 it is fitted at the output end of the engine.

Reference

For an exact description of the operating mode this system, please refer to SSP 217 - The V8 5V Engine.

Secondary air system RS4



377_074

System overview - Audi Q7 (Bosch MED 9.1.1)

Sensors

Air mass meter G70
Air mass meter 2 G246
Intake air temperature sensor G42

Accelerator pedal position sender G79
Accelerator pedal position sender 2 G185

Engine speed sender G28

Knock sensors 1–4
G61, G66, G198, G199

Fuel pressure sender G247

Intake manifold flap potentiometer G336
Intake manifold flap potentiometer 2 G512

Hall sender G40
Hall senders 2+3 G163, G300
Hall sender 4 G301

Fuel pressure sender, low pressure G410

Coolant temperature sender G62

Throttle valve module J338
Throttle valve drive angle senders -1- and -2-
(electric power control) G187, G188

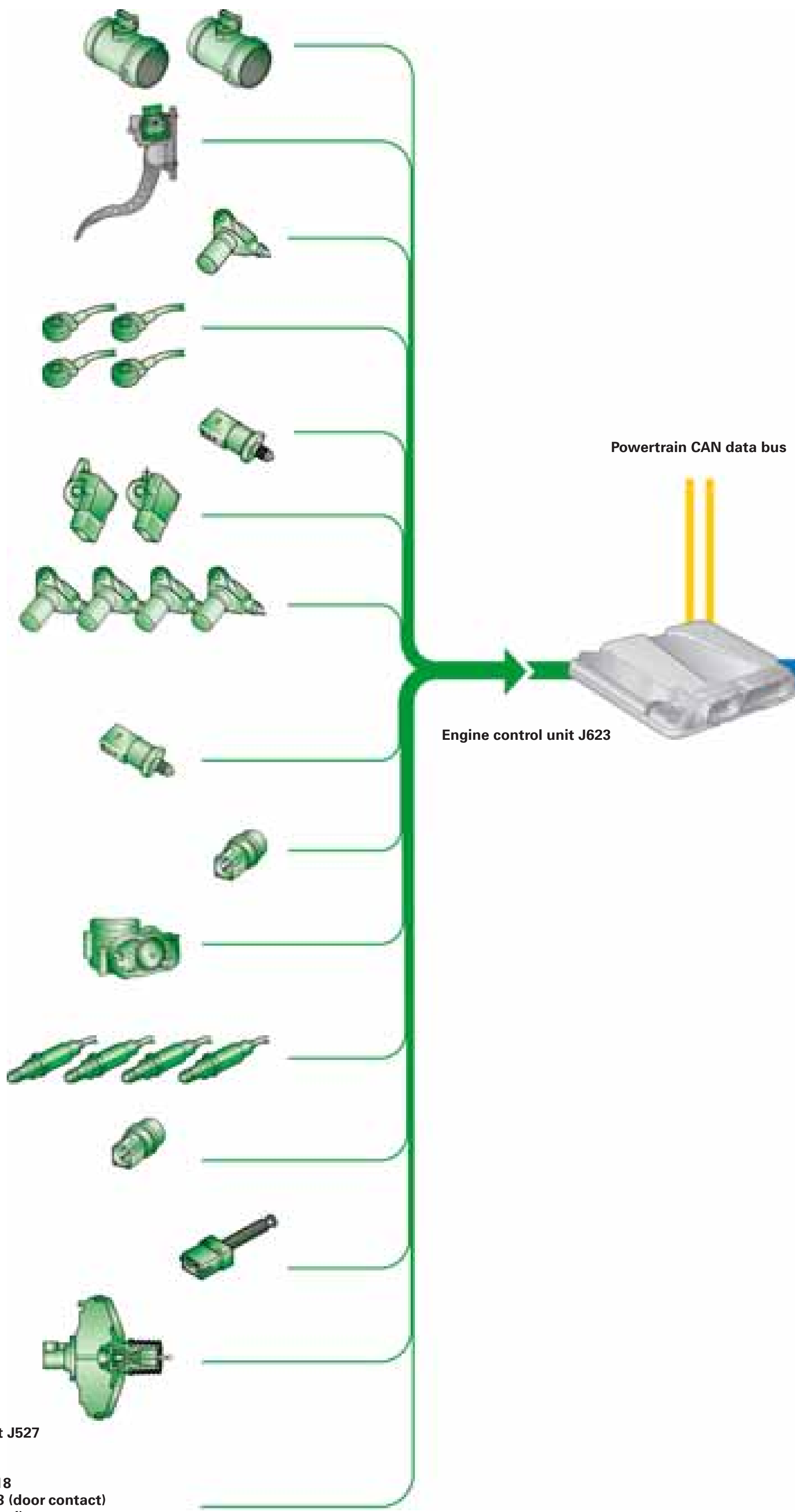
Lambda probe G39
Lambda probe 2 G108
Lambda probe after catalytic converter G130
Lambda probe after catalytic converter 2 G131

Coolant temperature sender -
radiator outlet G83

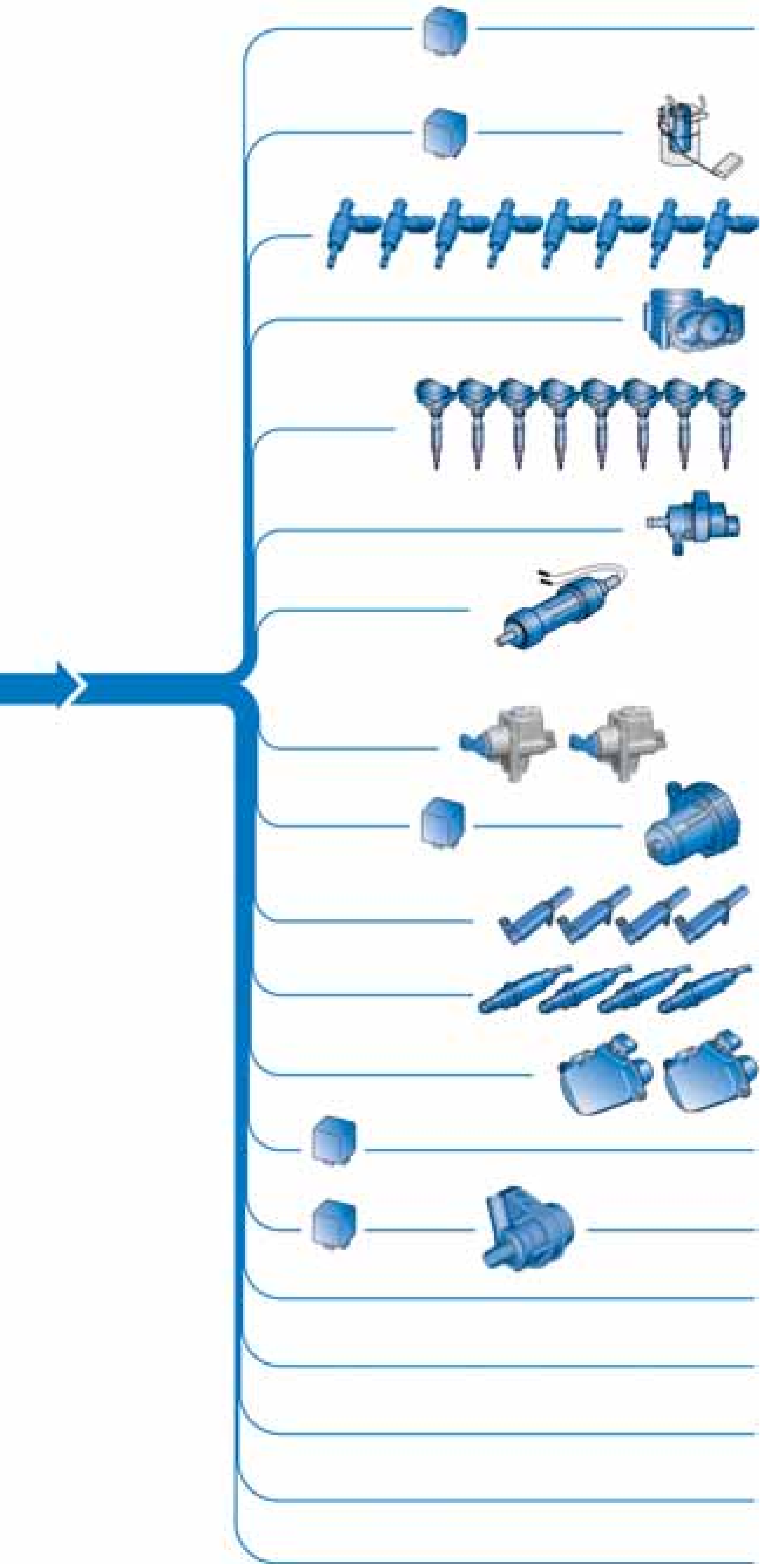
Brake light switch F
Brake pedal switch F47

Brake servo pressure sensor G294

Additional signals:
Cruise control system on/off
from steering column electronics control unit J527
Terminal 50/50 R
Brake servo
Entry and start authorisation control unit J518
Convenience system central control unit J393 (door contact)
Multi-function switch F125 (interlock /PN signal)
Auxiliary heater wake-up via Climatronic control unit J255



Actuators



Starter motor relay J53, starter motor relay -2- J695
Motronic current supply relay J271
Engine component current supply relay J757

Fuel pump control unit J538
Fuel pump (pre-supply pump) G6

Injectors, cylinders 1-8
N30-N33, N83-N86

Throttle valve module J338
Throttle valve drive (electric power control) G186

Ignition coils N70, N127, N291, N292, N323-N326
Cylinders 1-8

Activated charcoal filter solenoid valve 1 N80

Map-controlled engine cooling thermostat F265

Fuel metering valve N290
Fuel metering valve -2- N402

Secondary air pump relay J299
Secondary air pump motor V101

Inlet camshaft timing adjustment valves 1+2 N205, N208
Exhaust camshaft timing adjustment valves 1+2 N318, N319

Lambda probe heater Z19
Lambda probe 2 heater Z28
Lambda probe 1 heating, after catalytic converter Z29
Lambda probe 2 heating, after catalytic converter Z30

Variable inlet manifold motor V183
Intake manifold flap motor V157

Brake light suppression relay J508

Continued coolant circulation relay J151
Coolant run-on pump V51

Fuel system diagnostic pump (USA) V144

Brake servo relay J569
Vacuum pump for brakes V192

Radiator fan control unit J293 PWM
Radiator fan V7

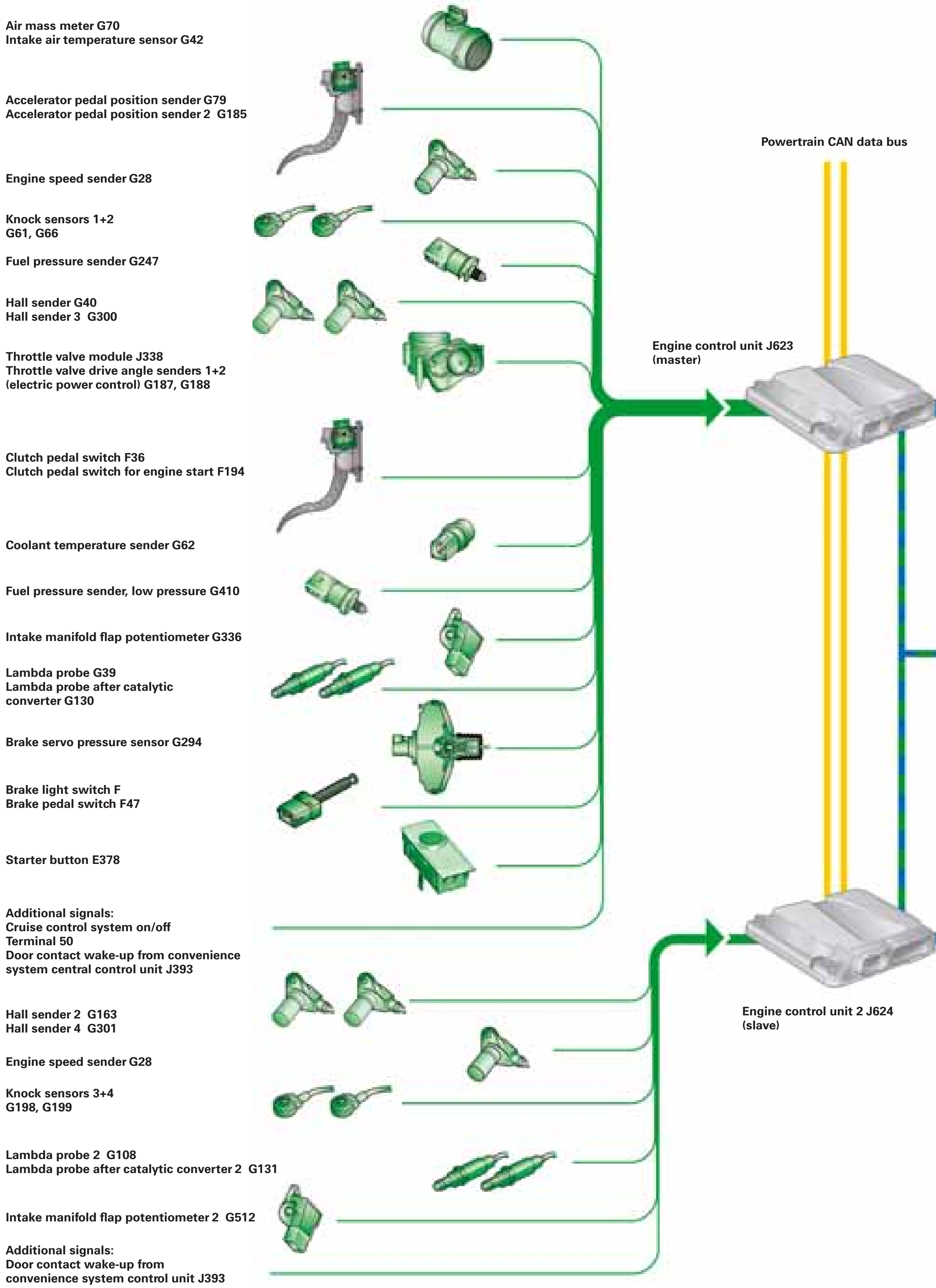
Radiator fan control unit -2- J671
Radiator fan 2 V177

Additional signals:
Engine speed
Climatronic control unit J255

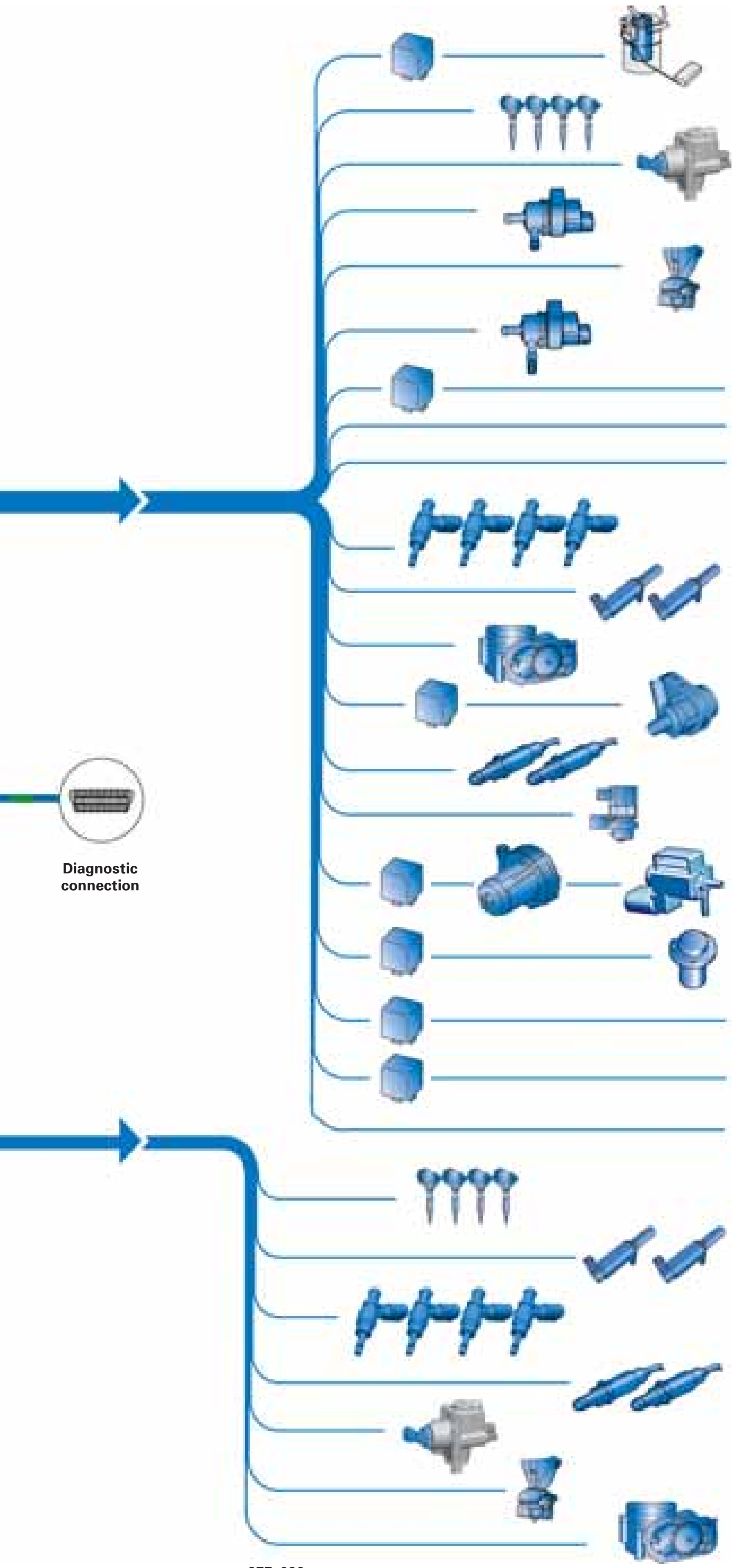
377_029

System overview - Audi RS4 (Bosch MED 9.1)

Sensors



Actuators



Fuel pump control unit J538
Fuel pump (pre-supply pump) G6

Ignition coils N70, N127, N291, N292
Cylinders 1–4

Fuel metering valve N290

Activated charcoal filter solenoid valve 1 N80

Electro/hydraulic engine mounting solenoid valve, right N145

Intake manifold flap air flow control valve N316

Starter motor relay J53, starter motor relay -2- J695

Exhaust flap 1 valve N321

Fuel system diagnostic pump (USA) V144

Injectors, cylinders 1–4
N30–N33

Inlet camshaft timing adjustment valve -1- N205
Exhaust camshaft timing adjustment valve -1- N318

Throttle valve module J338
Throttle valve drive (electric power control) G186

Continued coolant circulation relay J151
Coolant run-on pump V51

Lambda probe 1 heater Z19
Lambda probe 1 heating, after catalytic converter Z29

Variable intake manifold change-over valve N335

Secondary air pump relay J299
Secondary air pump motor V101
Secondary air inlet valve N112

Brake servo relay J569
Vacuum pump for brakes V192

Engine component current supply relay J757

Motronic current supply relay J271

Additional signals:
Engine speed
Radiator fan control unit J293 and J671

Ignition coils N323-N326
Cylinders 5-8

Inlet camshaft timing adjustment valve -2- N208
Exhaust camshaft timing adjustment valve -2- N319

Injectors, cylinders 5-8
N83-N86

Lambda probe 2 heater Z28
Lambda probe 2 heating, after catalytic converter Z30

Fuel metering valve -2- N402

Electro/hydraulic engine mounting solenoid valve, left N144

Throttle valve module J338

377_032

Engine management in the new V8 FSI is by two versions of the Bosch MED 9.1.1.
A single control unit is used in the Q7 engine. There are two control units for the RS4 engine.
A master-slave concept is required here due to the requisite processing power at engine speeds up to 8250 RPM.

The processor operates at a clock frequency of 56 MHz. The internal memory has a storage capacity of 512 Kbytes. Each of the two external memories has a storage capacity of two Mbytes.
The connection to the vehicle network is made by means of a CAN data bus.
In the case of the master-slave concept, data is additionally exchanged across a private bus.

Further differences between the Q7 and RS4 engines in respect of engine management are as follows:

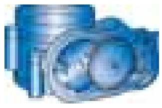
Engine speed sender G28

An inductive sender is used in the Q7 engine.
A Hall sensor is used in the RS4 engine with master-slave concept.
The signal from the Hall sender, can unlike the signal from the inductive sender, be split with the result that it can be utilised by both engine control units.
Applying the signal directly to both engine control units ensures that the control units are absolutely in sync.

377_067

Throttle valve module

The Bosch throttle valve module used in the Q7 is the largest in the range with a diameter of 82 mm. The Pierburg system was selected because the air intake system in the RS4 has a diameter of 90 mm. However, both systems work in exactly the same way.

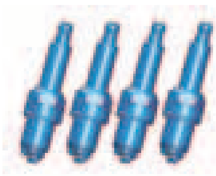


377_065

Spark plugs

In contrast to the Q7, spark plugs with a higher heat rating (colder plugs)* are used because the RS4 engine is subjected to higher thermal stresses.

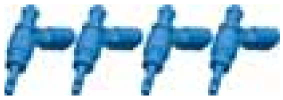
* applies to NGK spark plugs



377_071

Injectors

Due to the higher fuel demand and the shorter time window available for injection at very high engine speeds, the RS4 engine is fitted with larger injectors than the Q7 engine.



377_066

Diagnosis

The RS4 engine is diagnosed via the K-wire.
The Q7 is diagnosed via the powertrain CAN bus.

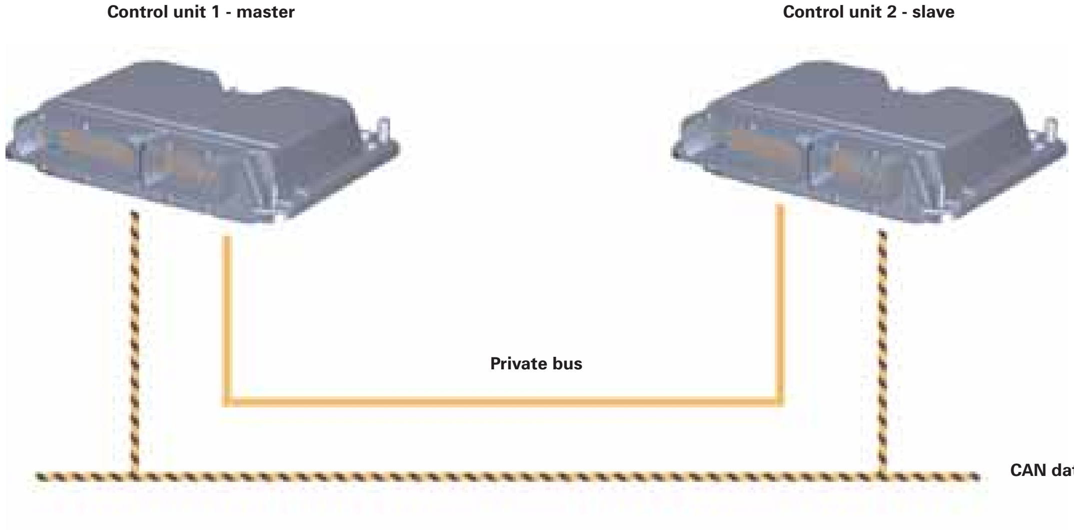
Communications between control units in the RS4

The engine control unit (master) J623 computes and controls the signals from the actuators for cylinder bank 1.
Most sensors are connected to the engine control unit (refer to System overview, pages 38/39).
Both control units are connected to the CAN data bus; the slave control unit is used as a receiver only.

The load signals required to compute and control the signals for the actuators of cylinder bank 2 are transmitted via private bus.
The slave control unit acts as the misfire detector for each of the eight cylinders. It also processes the signal from the engine speed sender G28.

Master and slave control units are identical in design and have the same part number.
A voltage code in the control unit determines whether the control unit in the master or the slave.

If battery positive is applied to the encoding pin, the control unit is the master.



377_064

Operating modes

Start - high-pressure stratified charge start

Injection of the metered fuel mass begins during the compression stroke phase and ends shortly before the firing point.

In comparison to the low-pressure start system, homogenisation is greatly improved by utilising the heat of compression for carburetion, and HC emissions are reduced.

After start - HOSP = homogeneous split

Application:
- Heating the primary catalytic converters to 300 °C in approx. 12 sec.; lambda value 1.05
- Intake manifold flap position: closed
- Throttle valve position: wide open

Injection:
- First injection approx. 300° before ignition TDC
- Second injection of small amount of fuel approx. 60° before ignition TDC, retarded ignition timing

- Mixture combusts very late
- Exhaust valve already open

As a result, the cat reaches its operating temperature very quickly.

Normal operation homogeneous carburetion

(lambda 1) with open or closed intake manifold flap (map based)

CAN data bus interfaces (powertrain CAN data bus) in the Audi Q7

The messages listed here are transmitted from the control units to the powertrain CAN data bus. However, only a few of the important messages are listed. In reality, there are many more. Of course, these messages are subject to change due to software updates.

Engine control unit (master) J623
Transmits:
Idle information (EBC)
Kick-down information
Engine speed
Engine torque
Accelerator pedal angle
Mechanical engine torque loss
Gearbox code
Engine configuration
Coolant temperature
Brake light switch information
Brake pedal switch
CCS switch positions
CCS set speed
SET/ACTUAL idle speed
Throttle-valve angle
Intake air temperature
Drive-by-wire throttle lamp
OBD2 lamp
"Hot" warning lamp
Power reduction or
air conditioner compressor load
shedding
Fuel consumption
Radiator fan activation
Oil temperature
Fault memory entry
Activation of electrical
brake servo pump

Automatic gearbox control unit J217
Transmits:
Selector active/inactive
Air conditioner compressor "OFF"
Torque converter lock-up clutch
status
Target gear
Selector lever position
NOMINAL engine torque
Motion resistance index
Limp-home programs
Cooling request
OBD status (MIL lamp activation)
Idle input torque
Rev-up flag
Nominal idling speed
Creep adaptation mode request
Hazard warning light system "on"
Gear shift active

Data bus diagnostic interface J533
Trailer operation
Rear light
Brake light
Trailer brake light
Auxiliary heater active
All relevant ACC messages
from J428
All relevant CCS messages
from J523
Alternator load torque
Climatronic J255:
- Request
- RPM increase
- Torque increase

Dash panel insert J285:
- Fuel tank information
- Ambient temperature
- Standing time
- Mileage
- Information from oil level/
  oil temperature sender G266

CAN High

CAN Low

ABS control unit 104
TCS request
EBC request
ABS request
EDL intervention
ESP intervention
ESP brake light switch
Active brake servo
Road speed signal
TCS intervention torque
EBC intervention torque
Lateral acceleration
Wheel speed
Brake pressure status

Ride height control J197
V-limit
in case of falsely set code 80 kph

Steering angle sender G85
Steering wheel angle (utilised for idling pre-control and engine torque calculation based on the power demand of the power steering system)
Torque request at full steering lock

CAN data bus interfaces (powertrain CAN data bus) in the Audi RS4

Engine control unit (master) J623
Idle information
Accelerator pedal angle
Clutch switch
Engine torque
Engine speed
Coolant temperature
Brake light switch information
CCS status
Throttle-valve angle
Intake air temperature
OBD2 lamp
"Hot" warning lamp
Air conditioner compressor "OFF" or power reduction
Starter control (automatic start)
Oil temperature

ABS control unit J104
TCS request
EBC request
ABS request
EDL intervention
ESP intervention
ESP brake light switch
Rough road suppression
ABS in diagnostics
Active brake servo
Road speed signal
TCS intervention torque
EBC intervention torque
TCS lamp activation
Lateral acceleration
Wheel speed

Control unit with display in dash panel insert J285
Rear light
Steering column electronics control unit J527:
All relevant CCS messages
Sport switch
Climatronic J255:
All signals which require load adaptation due to a load request.
Dash panel insert J285:
- Fuel tank information
- Oil temperature
- Ambient temperature
- Standing time
- Mileage
- Information from oil level/ oil temperature sender G266

CAN High

CAN Low

CAN 2 Low

CAN 2 High

Engine control unit 2 (slave) J624
Utilises the signals from CAN 1 (powertrain CAN bus) and CAN 2 (private CAN) to calculate the activation of the actuators of cylinder bank 2 (left bank) (refer to System overview).

Airbag control unit J234
Crash intensity
Fuel shut-off

Steering angle sender G85
Steering wheel angle and steering wheel angle speed (utilised for idle pre-control and engine torque calculation based on the power demand of the power steering system)

Start mode of the Audi RS4

Start button
(starter button E378)

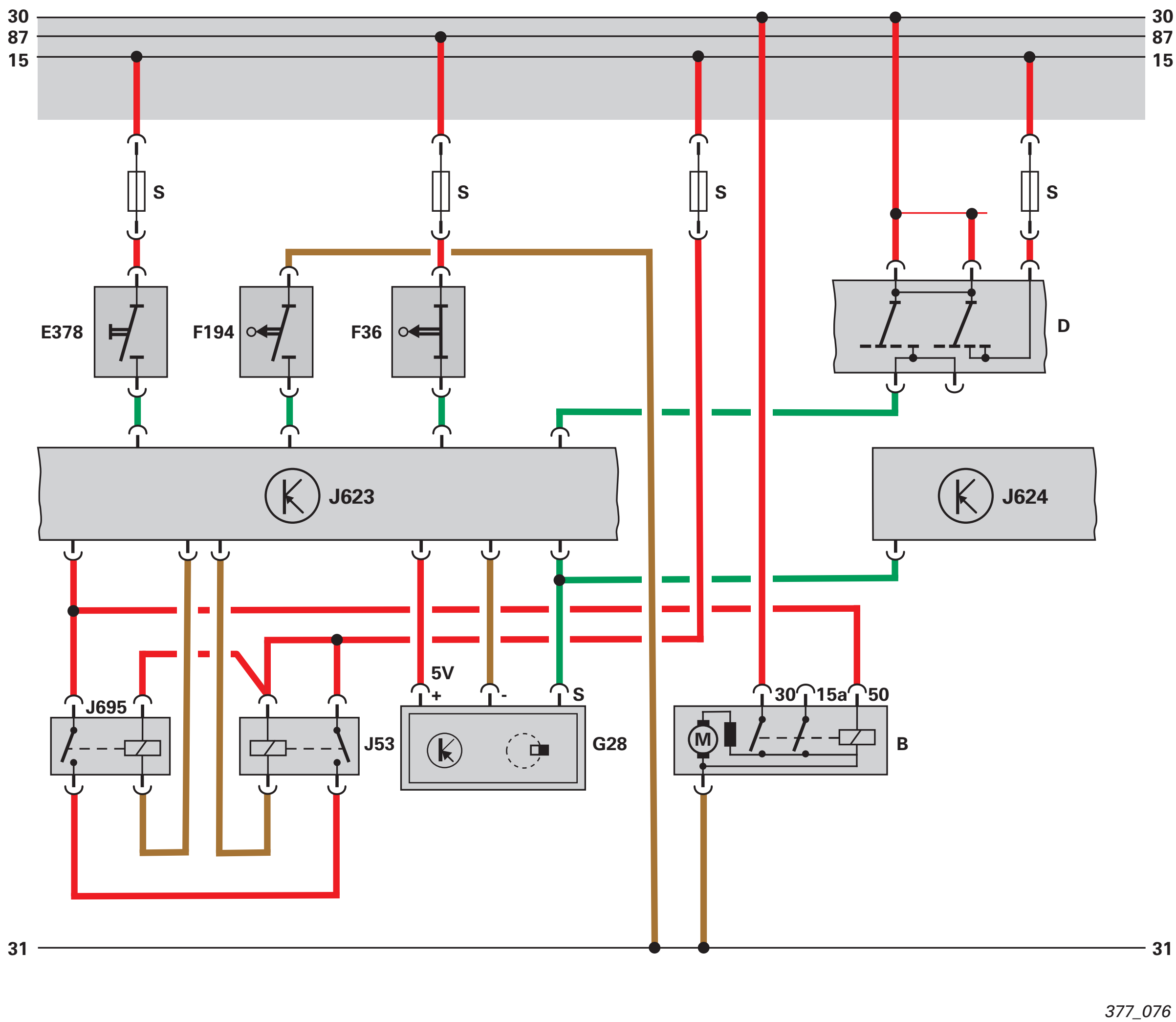
The RS4 is equipped with a Start button (except models for USA, Canada and Korea).
It is located in the centre console adjacent the handbrake lever. The engine is started by briefly pressing the switch when the ignition is "on".
The Start button is a simple NO contact and switches the terminal 15 signal through to the engine control unit J623 when terminal 15 is actuated.

Apart from the fact that the start contact has been moved to the Start button, the functions of the ignition lock are the same as in the A4. The ignition lock is disabled in the starting position.
To start the engine, the signals from the clutch pedal switch F36 and the clutch pedal switch for engine starting F194 must also be present.
When the clutch is depressed, the F36 recognises that the clutch pedal has left its rest position and opens.
The F194 is actuated, i.e. closed, when the clutch is fully depressed.
Because one switch opens and the other closes, the engine control unit can verify the redundancy of both switches.
The cruise control system also utilises the signal from the F36.

When a repeat attempt is made to start the (e. g. stalled) engine, the ignition key does not have to be turned back. The vehicle can be restarted straight away.
Operating the Start button when the engine is running has no effect as the Start button is disabled by the engine control unit when engine RPM is detected.

By alternately switching off the starter relay after engine start, the engine control unit can determine whether either of the two relays is "sticking".
Function testing both relays ensures that the starter is always switched off after engine start and therefore de-meshes.
If a relay does fails to open due to "sticking", current flow is nevertheless interrupted by the opening of the second relay. In this case a fault is entered in the engine control unit memory.

377_070



Legend of function diagram

B Starter

D Ignition switch

E378 Starter button

F36 Clutch pedal switch
F194 Clutch pedal switch for engine start

G28 Engine speed sender

J53 Starter motor relay
J623 Engine control unit (master)
J624 Engine control unit 2 (slave)
J695 Starter motor relay -2-

Sport mode of the Audi RS4

To accentuate the sporty character of the RS4, the driver can switch Sport mode "on" of "off" using a special switch.

377_077

When the Sport program button is pressed the following in-vehicle functions are activated:

– more direct accelerator pedal response
– improved lateral support function of the driver's seat
– more sporty exhaust system set-up

Depending on steering wheel type, the sport program button is fitted in different locations.

In vehicles equipped with the RS sport steering wheel, the Sport program button is located in the left steering wheel spoke; in models equipped with a multifunction steering wheel, it is located in the centre console.

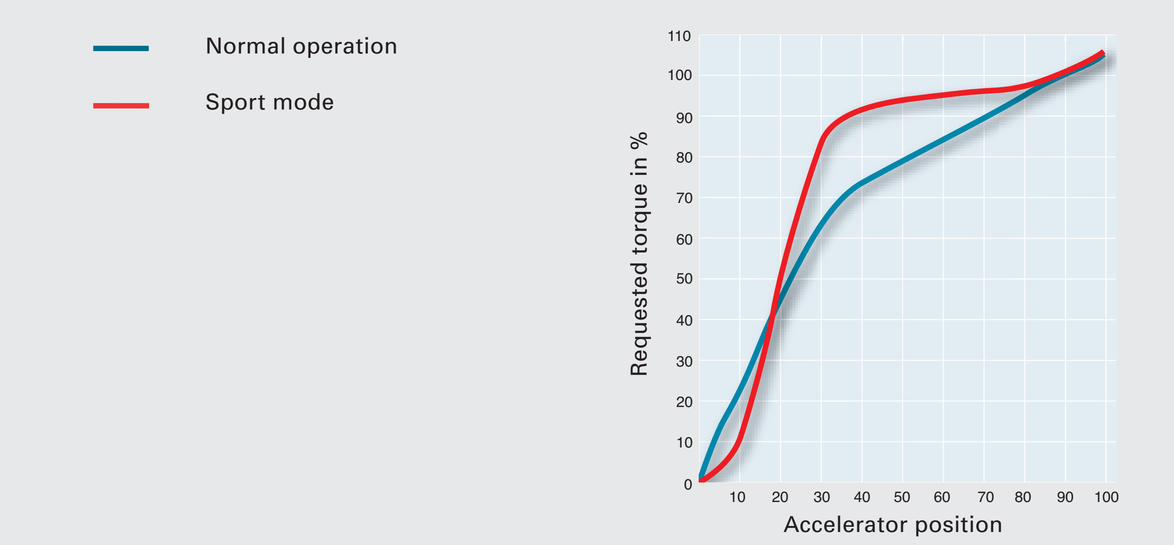
When Sport mode is activated, an indicator lamp comes on in the dash panel insert.
Sport mode is deactivated when the ignition is turned off.

377_078

Accelerator pedal function (throttle progression)

When Sport mode is activated, the engine becomes more responsive. At the same time, the characteristic curve of the accelerator pedal is modified in the engine control unit. This means that, in Sport mode, the requested engine torque is higher than in normal operation in the same accelerator pedal position.

In addition the comfort-oriented "soft" engine torque curve is suppressed. As a result, the engine responds immediately to pressure on the accelerator pedal.



Seat function

The improved lateral support function of the front seats is only available in combination with RS bucket seats.

The backrest and side seat bolsters are inflated. The seat bolster inflation function can be set manually using the buttons on the seat.
When the Sport button is pressed, only the driver's seat side bolster are inflated. If a certain limit has been preset manually, then the bolsters will be inflated up to this value.

When Sport mode is turned off, the bolsters are deflated (approx. two sec.). The sport seat function can be deactivated by the driver as necessary.
The procedure is described in the vehicle's Owner's Manual.

Note

The sport seat function is deactivated automatically after the vehicle battery terminals are disconnected. The sport seat function must be reactivated if this has been set by the customer.

Function of the sport program button

Multi-function steering wheel control unit

When the sport program button E541 in the centre console is pressed, a terminal 15 signal is transmitted to the steering column electronics control unit J527 across a discrete line.

RS sport steering wheel

The signal from the sport program button is transmitted from the multi-function steering wheel control unit J453 across the LIN bus to the steering column electronics control unit.

Reference

Foe details of the bus topology, please refer to SSP 343 - The new Audi A4 '05.

Exhaust flap control

After the Sport mode is activated, unlike in normal operation, the exhaust flaps in the rear silencer are opened when the engine is idling. This emphasises the sporty sound of the RS4 engine.

After the engine speed is increased, however, the exhaust flaps are closed again. This ensures that the vehicle meets the statutory noise emission limits. Reopening of the exhaust flaps while driving is speed and load dependent, and is regulated on the basis of a characteristic map.

377_079

The steering column electronics control unit converts the signal and sends this message to the convenience CAN bus.
The message is transmitted via the gateway in the dash panel insert and is evaluated by the control unit with display in dash panel insert J285.
A check is made to determine whether the sport seat function has been activated.
If the function is active, a message to this effect is transmitted across the convenience CAN bus to the seat and steering column adjustment control unit with memory J136, and the driver's seat backrest and side bolsters are inflated or deflated for two seconds.

The gateway also transmits the message "Sport button pressed" to the powertrain CAN bus.
The engine control unit adapts the throttle progression and exhaust flap control based on this information.

Vorsprung durch Technik **www.audi.co.uk**

377

AUDI AG
D-85045 Ingolstadt
Technical status: 03/06

Printed in Germany
A06.5S00.23.20