

## The 2.7-litre V6 Biturbo

### Design and Function

### Self-study Programme 198

## The 2.7-litre V6 biturbo .....

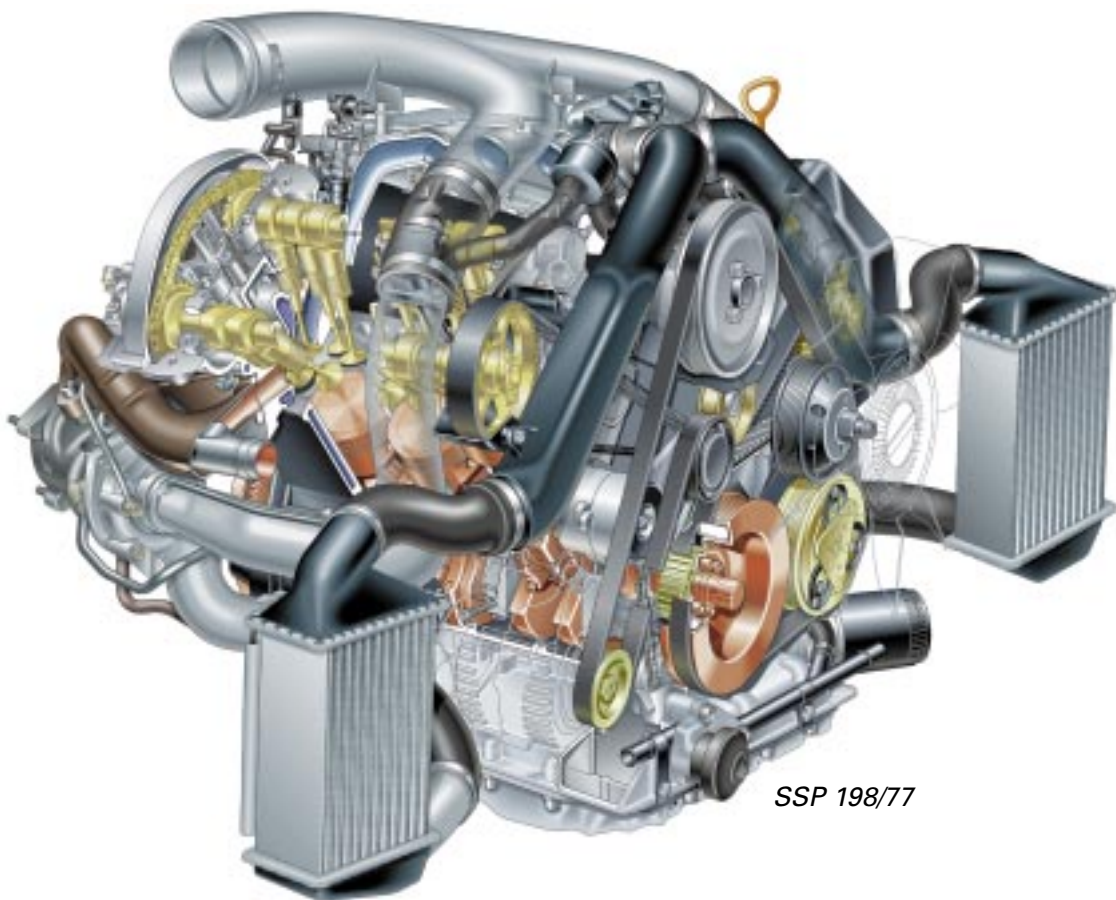
Turbocharged engines are already something of a tradition at AUDI. The task now facing AUDI's engineers was to develop a worthy successor to the 5-cylinder turbocharged engine.

One of the key development goals for the turbocharged engine was to achieve a good level of dynamic response, particularly at the bottom end of the rev band.

The goal of AUDI's engineers was to realise a high "basic torque level" and a torque characteristic that rises in direct proportion to engine speed to its peak.



The term "basic torque level" describes the torque which is immediately available when the throttle is opened (e.g. at part throttle or in overrun).



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**..... a further milestone in engine development by Audi!**

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This Self-study Programme provides you with information regarding design and function.

**The Self-study Programme is not a Workshop Manual!**

Please refer to the Service Literature for all the relevant maintenance and repair instructions.



**New!**



**Important!/Note!**

# Engine

## The 2.7-litre V6 biturbo

This engine will also be used in the Audi S4 and Audi A6.

The engine used in the A6 has a comfort-oriented setup, which means that it has different torque and power output.

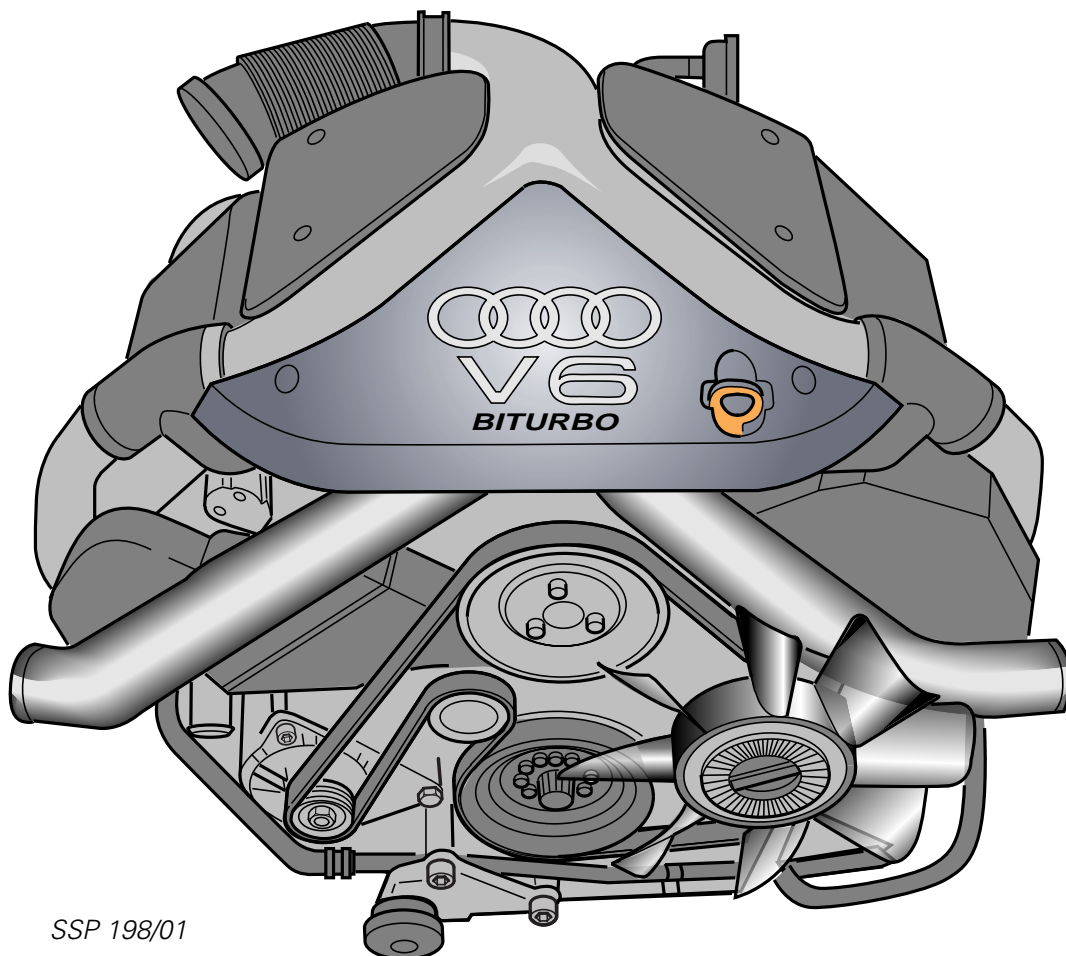
This effect was principally achieved by modifying the software configuration of the engine control unit.



A tuning protective device prevents the S4 engine control unit being installed in the A6!

**This prevents misuse, which can result in damage to the drivetrain!**

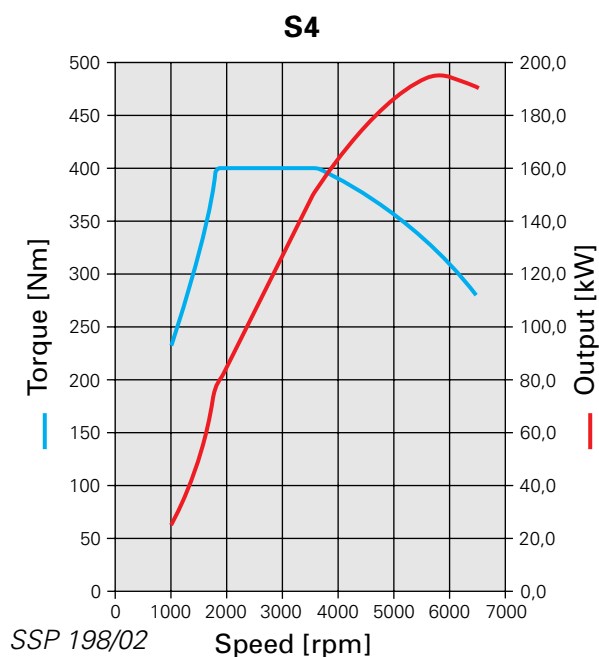
An auxiliary heater is not available as an option for the S4 and the A6, due to the constraints on space.



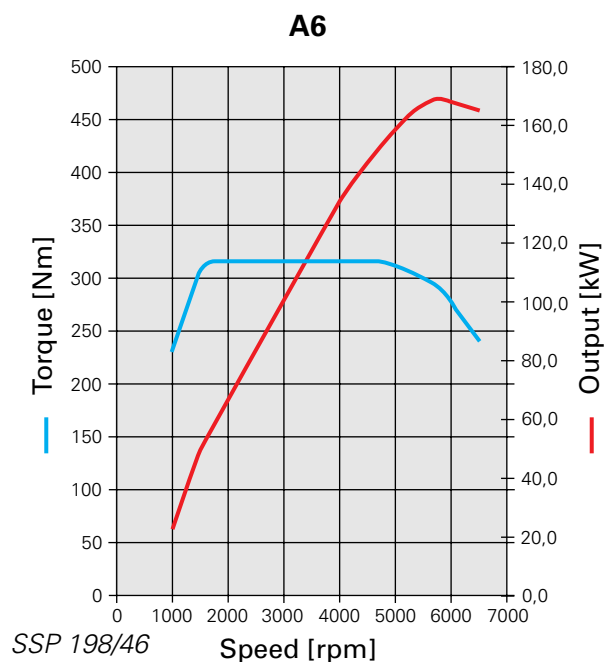
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## The technical data

- **Configuration:**  
V6 engine with 90° V-angle and twin turbochargers
- **Engine code:**  
S4: AGB  
A6: AJK
- **Output:**  
S4: 195 kW at 5800 rpm  
A6: 169 kW at 5800 rpm
- **Torque:**  
S4: 400 Nm at 1850 to 3600 rpm  
A6: 310 Nm at 1700 to 4600 rpm
- **Maximum speed:**  
6800 rpm
- **Compression ratio:**  
9.3 : 1
- **Displacement:**  
2671 cm<sup>3</sup>
- **Bore:**  
81 mm
- **Stroke:**  
86.4 mm
- **Weight:**  
approx. 200 kg
- **Engine management:**  
Motronic ME 7.1
- **Firing order:**  
1-4-3-6-2-5
- **Fuel type:**  
S4: 98/95/91 RON  
A6: 95/91 RON
- **Compliant with emission standard:**  
EU III-D



Figures obtained using 98 RON unleaded premium fuel to 89/491/EEC.



Figures obtained using 95 RON unleaded premium fuel to 89/491/EEC.



# Engine

## The crankshaft

The crankshaft is identical to that used in the 2.8-litre V6 engine.

The crankshaft bearing caps are attached to the central crankcase by 4 bolts.

- The 4-bolt connection reduces the load on the bearing caps considerably.

The middle two crankshaft bearing caps are also bolted to the side of the crankcase.

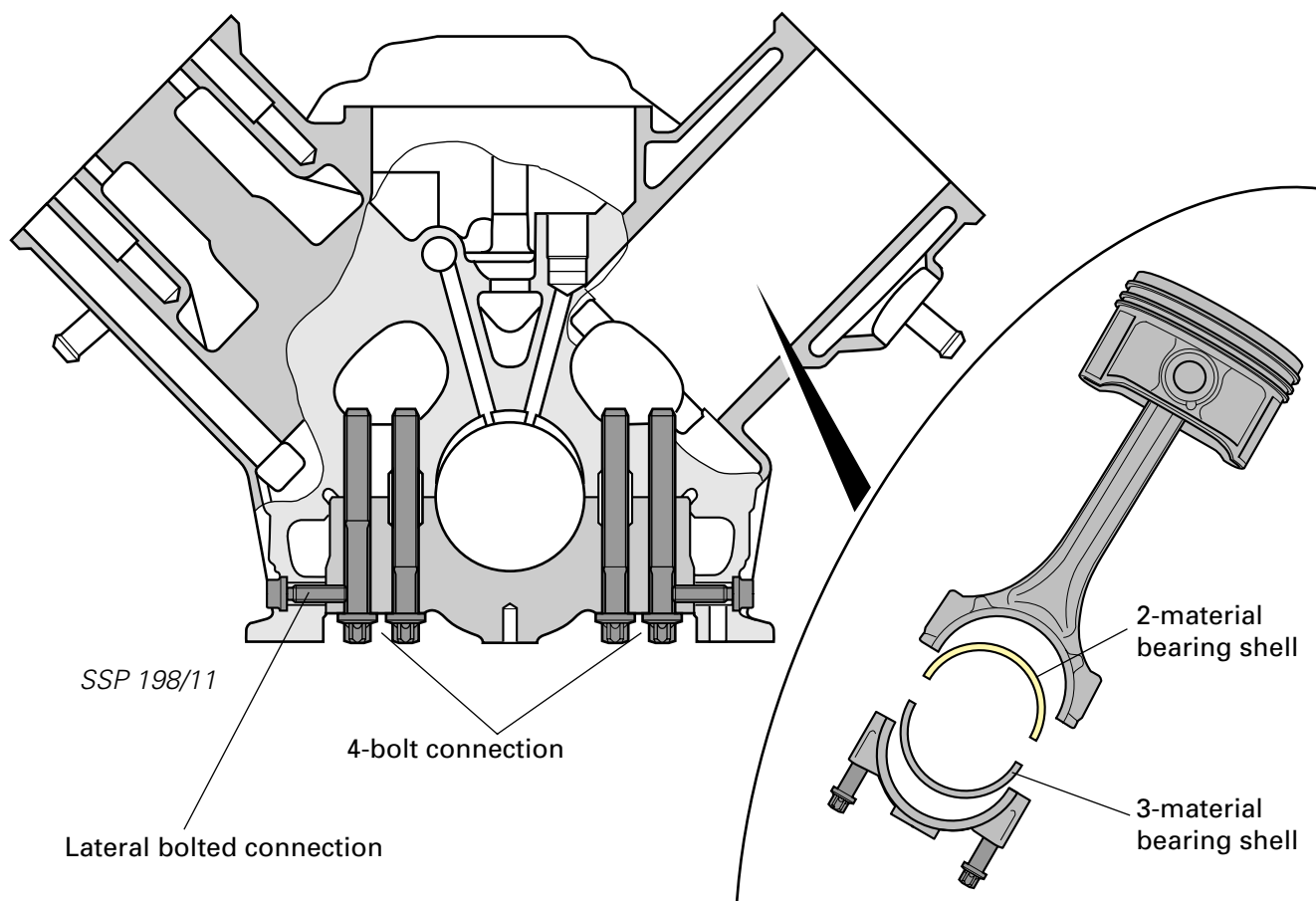
- The lateral bolted connection helps to improve acoustics.

The pistons are forged to enable them to withstand the high loads to which they are subjected.

Due to the high combustion pressures, a 2-material bearing shell is installed on the connecting rod side. The bearing cap has a 3-material bearing shell.

### **Advantage:**

The bearing shell has a high load-bearing capacity



## Cylinder head

The cylinder heads are largely identical to those used in the V6 naturally aspirated engine. Common parts are used for both banks of cylinders.

The mounting position of the right-hand cylinder head is rotated through an angle of 180° in relation to the left-hand cylinder head.

The timing of the inlet camshafts is engine-dependent.

To improve heat dissipation, the exhaust valves are sodium-filled.

The shape of the inlet duct causes the drawn-in air to tumble.

### Advantages:

- A good degree of swirl and high ignitability fuel-air mixture are achieved
- The tumble effect allows more efficient combustion

For a turbocharged engine, the compression ratio of 9.3 : 1 is high.

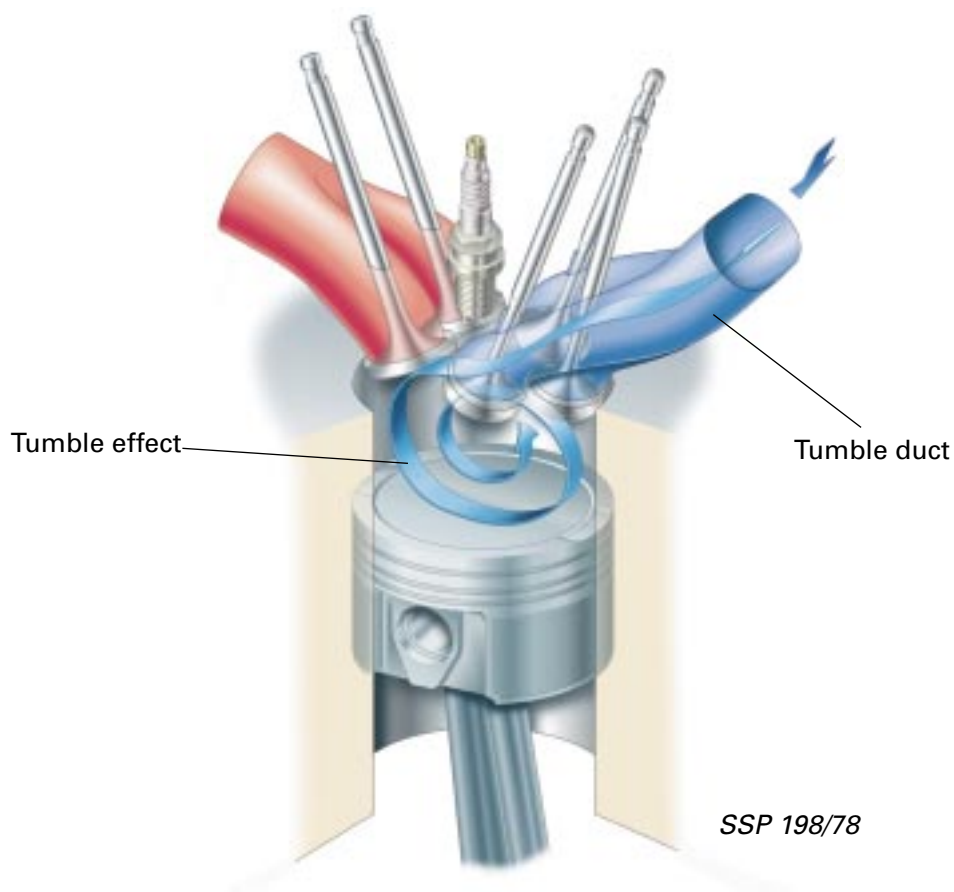
### Advantage:

- High "basic torque level" and fuel economy



### Tumble duct

In combination with five-valve-per-cylinder technology, the inlet duct is shaped as a so-called "tumble duct".



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# Engine

## The variable valve timing

The camshaft timing has been modified compared to the 2.8-litre V6 engine to meet the demands of turbocharging technology.

Variable valve timing with an adjustment angle of  $22^\circ$  is used here for the first time in **turbocharged engines**.

### Advantage:

- A torque increase of approx. 10% is achieved at the bottom and top ends of the engine speed range.
- Better emission levels and fuel consumption figures.

The variable valve timing is activated by the Motronic by means of camshaft adjustment valves N205 and N208.

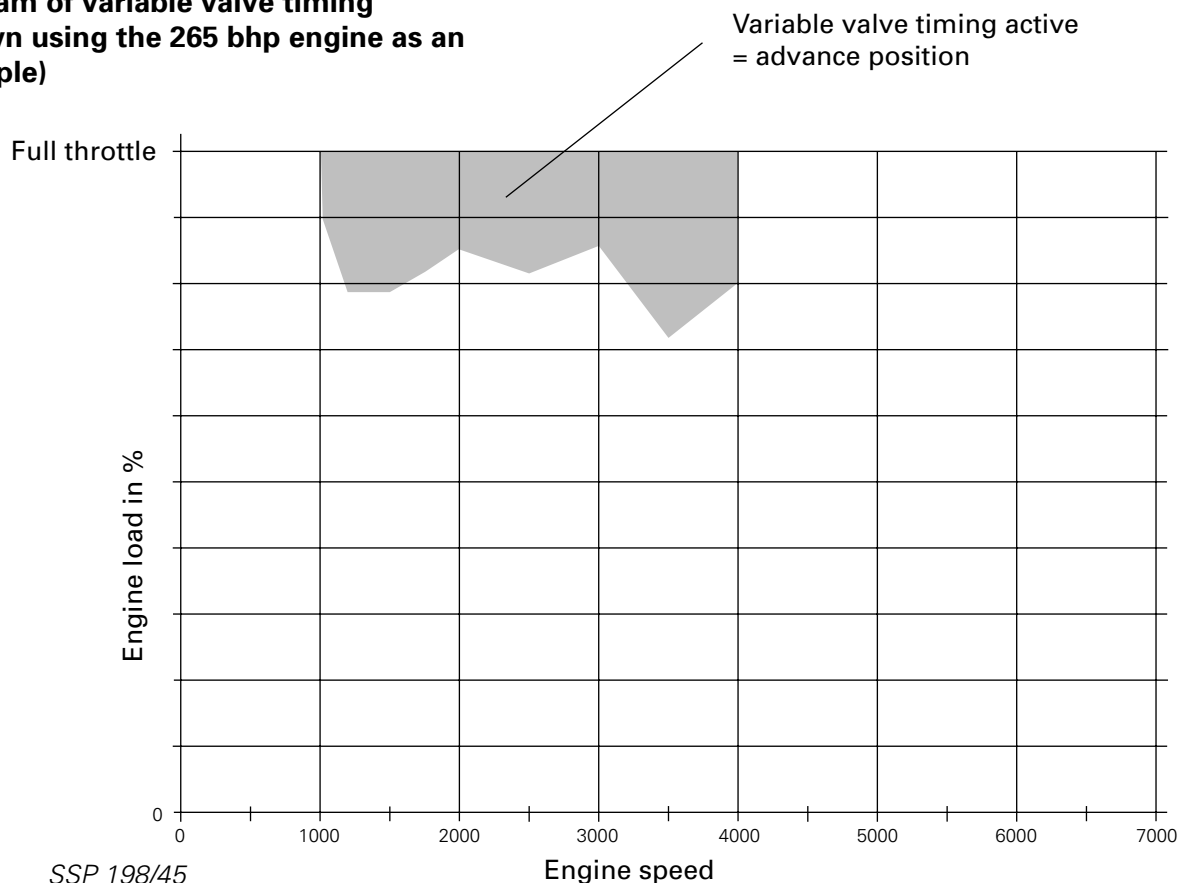


The design and function of the variable valve timing are already described in Self-study Programmes 182 and 192.

Activation of the variable valve timing is dependent on engine load and speed.

In the self-diagnosis, you can find out whether the variable valve timing is active or not by reading out the relevant measured value block (refer to Workshop Manual).

### Diagram of variable valve timing (shown using the 265 bhp engine as an example)





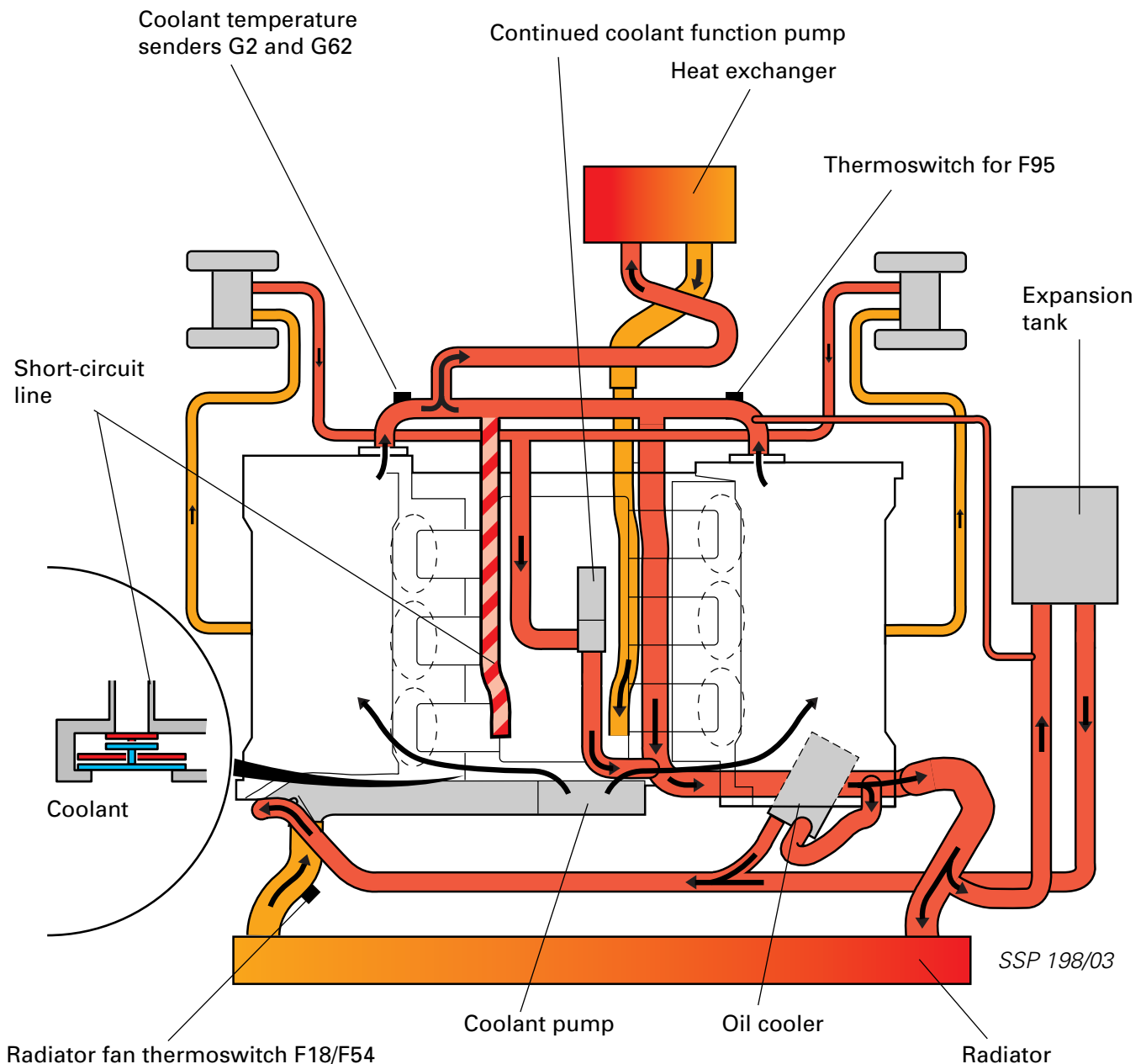
## Cooling circuit

Both exhaust gas turbochargers are water-cooled and integrated in the cooling circuit.

When the coolant thermostat is closed, the coolant flows back to the coolant pump along the short-circuit line as well as the heat exchanger.

When the coolant thermostat is open, the coolant flows back to the coolant thermostat through the radiator (primary flow) or through the oil cooler and expansion tank (secondary flow).

Located in the cooling circuit is an electrical coolant pump. This pump is required as a means of protection against overheating of the coolant under high thermal load, e.g. when the hot engine is turned off.



# Engine

## Electrical coolant circulation pump V51

Electrical coolant circulation pump V51 is located in the engine's V angle.

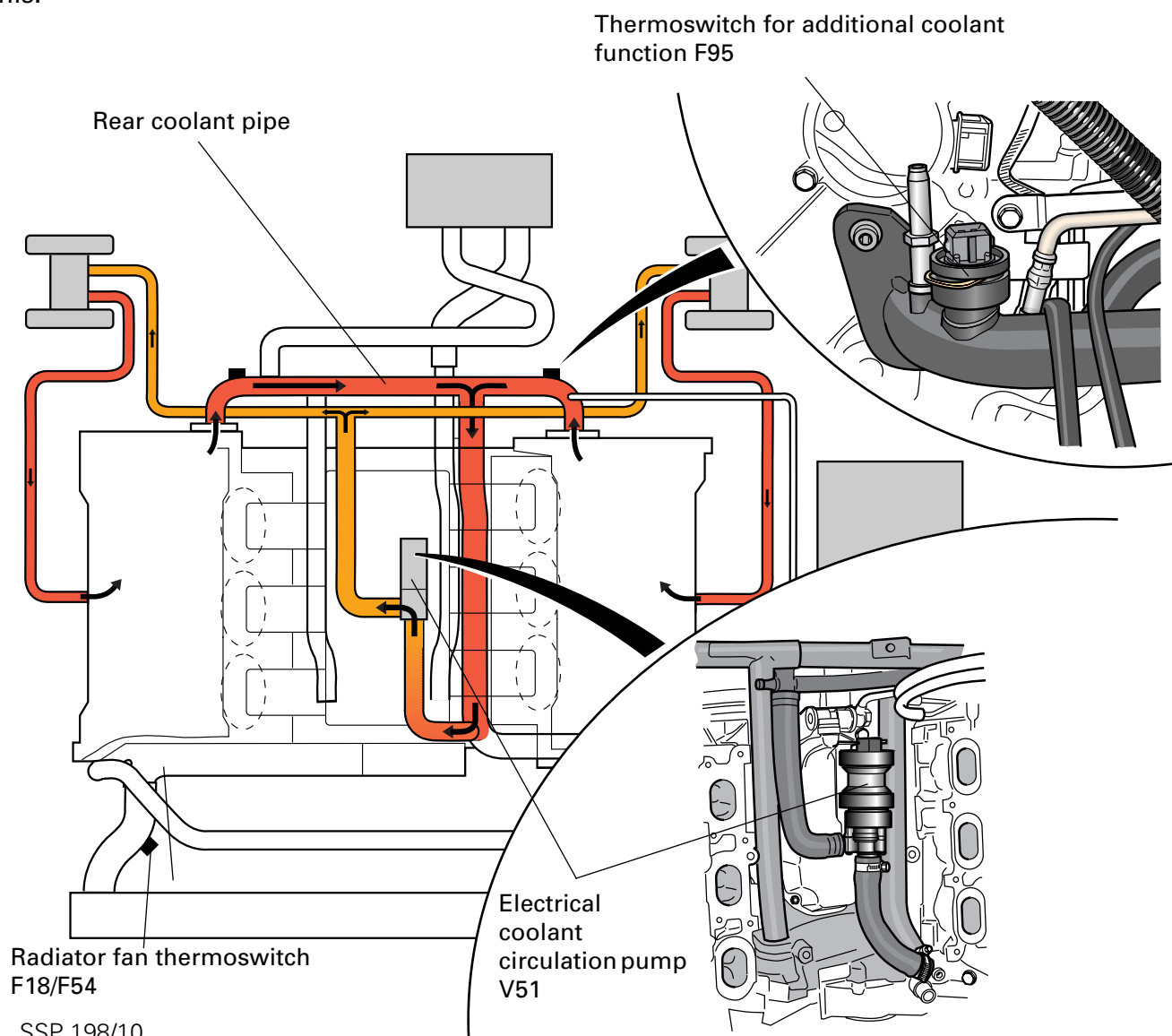
If the coolant temperature is too high, thermoswitch for coolant circulation run-on F95 activates the additional coolant function.

The high temperatures which occur at the exhaust gas turbocharger produce vapour bubbles which prevent coolant being drawn in by pump V51.

When pump V51 starts up, the coolant flows through the exhaust gas turbocharger and the cylinder heads. The direction of flow in the turbocharger cooling circuit is reversed by this.

Due to this reversal of the direction of coolant flow, coolant is drawn in via the cylinder heads (large cross-sections), which means that any vapour bubbles which develop are expelled from the exhaust gas turbocharger lines.

The electrical coolant circulation pump again draws in coolant along the rear coolant pipe, thereby recirculating the coolant.



## Fan control

The control unit for radiator fan V293 regulates the output of the radiator fan and controls the continued coolant circulation. The induced-air fan V7 and the forced-air fan V177 are activated simultaneously.

Forced-air fan V177 is located upstream of the condenser, water cooler and visco fan. It assists the visco fan.

### The electronic power control

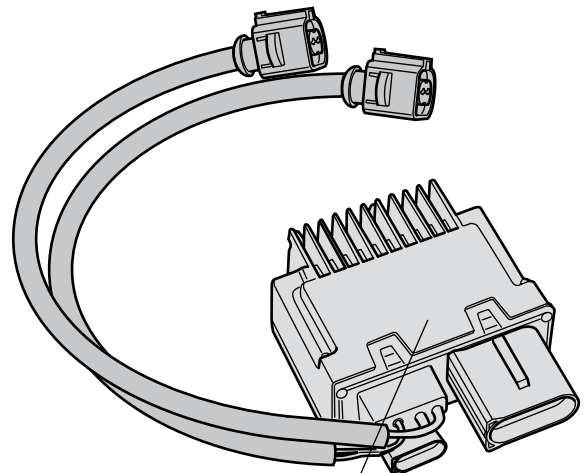
The various fan settings are executed by an electronic power control.

The fan motors are operated periodically, the length of the operating cycle depending on the fan setting selected. Fan output level is controlled via pulse-width-modulated outputs.

Should a fan fail, the radiator fan control unit increases the speed of the fan motor still available.

### Advantages of the power control:

- The series resistors previously used for power control are no longer required.
- Lower power consumption in lower fan settings.
- Safety functions.

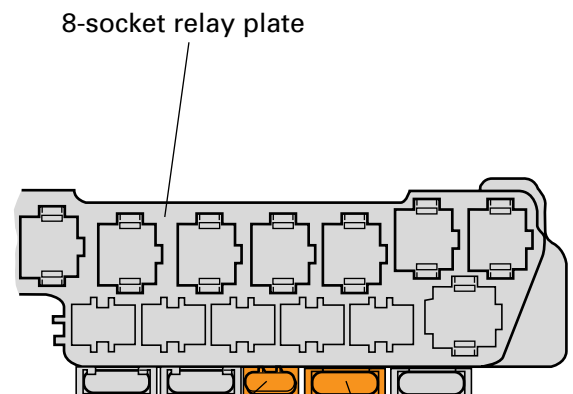


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Control unit for radiator fan  
attached to front right  
vehicle side member



The power supply is protected by a fuse on the 8-socket relay plate. For the correct fuse rating, please refer to wiring diagram. Vehicles equipped with an air conditioner require a higher fuse rating than vehicles without an air conditioner.



8-socket relay plate

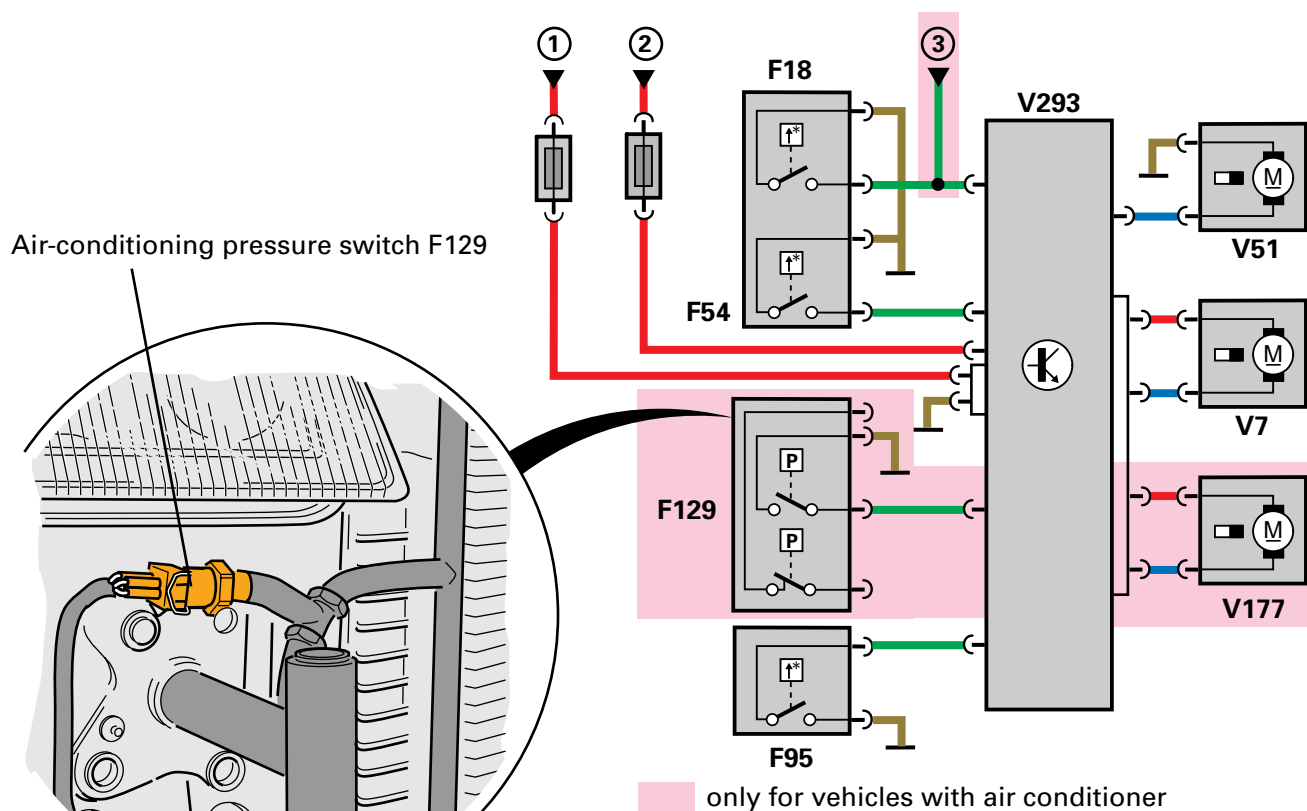
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Fuse, terminal 61

Fuse, terminal 30

# Engine

## Electric circuit of fan control:



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### for vehicles with air-conditioning system:

Integrated in the pressure switch for air conditioner F129 is the high-pressure switch for activating a higher fan setting.

The pressure switch is mounted below the right-hand headlight behind the bumper.

### Components:

- F18/F54 Radiator fan thermostats
- F95 Thermostat for continued coolant function
- F129 Pressure switch for air conditioner (only for vehicles with air conditioner)
- V293 Control unit for radiator fan
- V7 Radiator fan (induced-air fan)
- V51 Continued coolant circulation pump
- V177 Fan 2 for radiator (forced-air fan) (only for vehicles with air conditioner)
- 1 Terminal 30, positive supply via fuse on 8-socket relay plate
- 2 Terminal 61, D+ (alternator) via fuse on 8-way relay
- 3 Fan activation (only for vehicles with air conditioner)

## Function of fan circuit (for vehicles with air-conditioning system)

4 fan settings are possible:

### The electrical coolant function.....

is activated by coolant pump thermost switch F95.

The fan motors and continued coolant circulation pump V51 are activated.

The fan motors run at min. output (40%).



The continued coolant function is only activated if the "engine not running" signal is picked up at terminal 61. The continued coolant function period is limited to 10 minutes.

### Fan speed 1.....

is requested by radiator fan thermost switch F18 or by the air-conditioning control panel.

The fan motors run at 50% output.

### Fan speed 2.....

is activated by air-conditioning system pressure switch F129.

The fan motors run at 85 % output.

### Fan speed 3.....

is activated by radiator fan thermost switch F54.

The fan motors run at full output.



Fan speeds 1, 2 and 3 are only activated if the "engine running" signal is picked up at terminal 61.

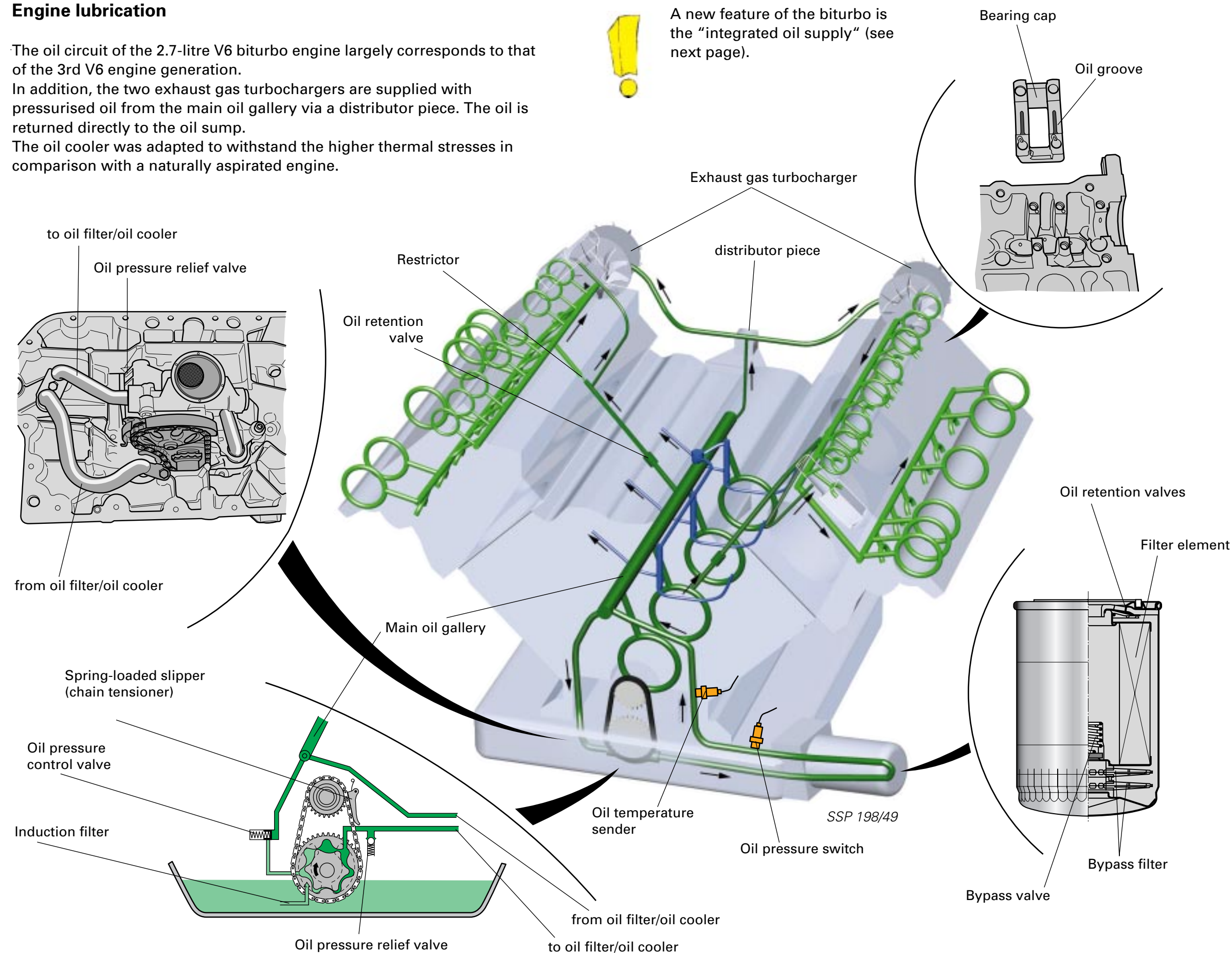


## Engine lubrication

The oil circuit of the 2.7-litre V6 biturbo engine largely corresponds to that of the 3rd V6 engine generation.

In addition, the two exhaust gas turbochargers are supplied with pressurised oil from the main oil gallery via a distributor piece. The oil is returned directly to the oil sump.

The oil cooler was adapted to withstand the higher thermal stresses in comparison with a naturally aspirated engine.



## The oil circuit

A duocentric oil pump draws in the oil through a coarse filter. Located in the pressure chamber of the pump is a pressure relief valve which protects downstream components against pressure peaks during cold starts.

The oil is fed to the oil filter via the oil cooler. After passing an oil retention valve, the oil flows through the filter element. A bypass filter is connected in parallel with the filter element.

The oil subsequently reaches the main oil gallery. A branch line is routed to the oil pressure control valve (clean oil side).

The following components are supplied with oil from the main oil gallery:

- the four crankshaft bearings
- the two exhaust gas turbochargers via an oil distributor line
- the three pairs of piston spray jets via a spray jet valve
- the cylinder head of cylinder bank 1 via an oil retention valve

The cylinder head of cylinder bank 2 is supplied through a separate bore from crankshaft bearing 2 via an oil retention valve also.

First of all, the camshaft adjustment valve is supplied with oil from the inlet drilling in the cylinder head. After the oil has passed by a restrictor, it is channeled via the cylinder head main gallery to the hydraulic valve tappets and the camshaft bearings.

# Engine

## The component parts of the oil circuit

### The oil pump .....

is an internal gear pump. It is attached to the crankcase as a separate component.

The oil pump is designed in such a way that it projects deep down into the oil sump and is immersed completely in the engine oil when the oil level is correct. This prevents the oil pump running dry.

The oil pump, in combination with the extremely short intake path, enables oil pressure to build up more quickly and safely, particularly during cold starts.

The oil pump is driven by the crankshaft by means of a single chain.

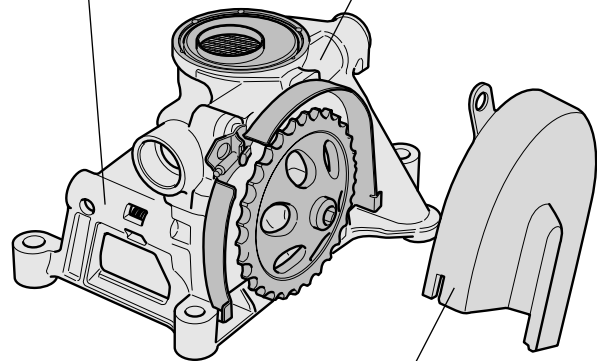
A spring-loaded flat plate produces the necessary tension.

A new feature of the oil pump is the chain guard made from sheet steel. It encapsulates both the chain wheel and the chain over a large area.

This reliably prevents oil frothing and the problems associated with this.

Oil pressure limiting valve

Oil pressure control valve



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Chain guard

### The oil filter .....

contains an oil retention valve, the filter element, a bypass filter and the filter bypass valve. The latter has the task of maintaining engine lubrication via the bypass filter if the filter element becomes clogged up or if the oil has a high viscosity.

### The oil cooler .....

is integrated in the primary flow. By increasing the capacity and optimising the flow resistance, the entire oil flow can be routed through the oil cooler. Unlike the V6 naturally aspirated engine, a bypass is not required.

### The spray jets valve .....

opens up the oil flow to the piston spray jets if the oil pressure is greater than 1.8 bar.

Reason: at low oil viscosity and low engine speeds, the oil pressure would otherwise drop below the minimum permissible level. That aside, piston cooling is not necessary at low engine speeds.



#### **The oil pressure control valve .....**

regulates the engine oil pressure. It is integrated in the oil pump housing. The oil quantity "regulated" by the oil pressure control valve is fed to the suction side of the oil pump.

This helps to optimise efficiency.

#### **The oil pressure limiting valve .....**

is a pressure relief valve. It is located inside the oil pump housing and opens when the oil pressure rises too high (cold start). If an excessively high oil pressure builds up, various component parts of the oil circuit (e.g. oil filter, oil cooler) may be damaged. Also, there is the possibility of the inlet and exhaust valves opening or no longer closing, due to "bulking" of the hydraulic tappets. The knock-on effect of this is that the engine can no longer be started or cuts out.

#### **The oil retention valves .....**

prevent the oil running out of the oil filter and the cylinder heads and back into the oil sump while the engine is stationary.

#### **The restrictors .....**

prevent "flooding" of the cylinder heads. At high engine speeds, an excessively large amount of oil enters the cylinder heads and has to be returned to the oil sump via the oil return drillings. The restrictors reduce the oil flow and thereby ensure that return flow takes place.

### **The "integrated oil supply" ...**

will also be adopted for all V6 5V naturally aspirated engines.

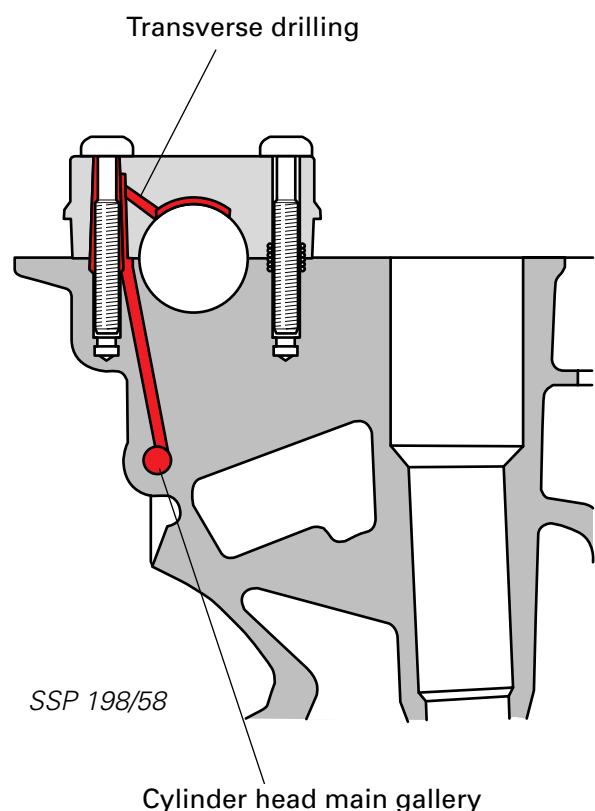
Each camshaft bearing is supplied via a drilling stemming from the cylinder head main gallery.

The oil is fed along a bolt shaft in the bearing cap to a transverse drilling.

A lubrication groove distributes the oil throughout the camshaft bearing. It is no longer necessary to run a pipe to the individual bearing caps.

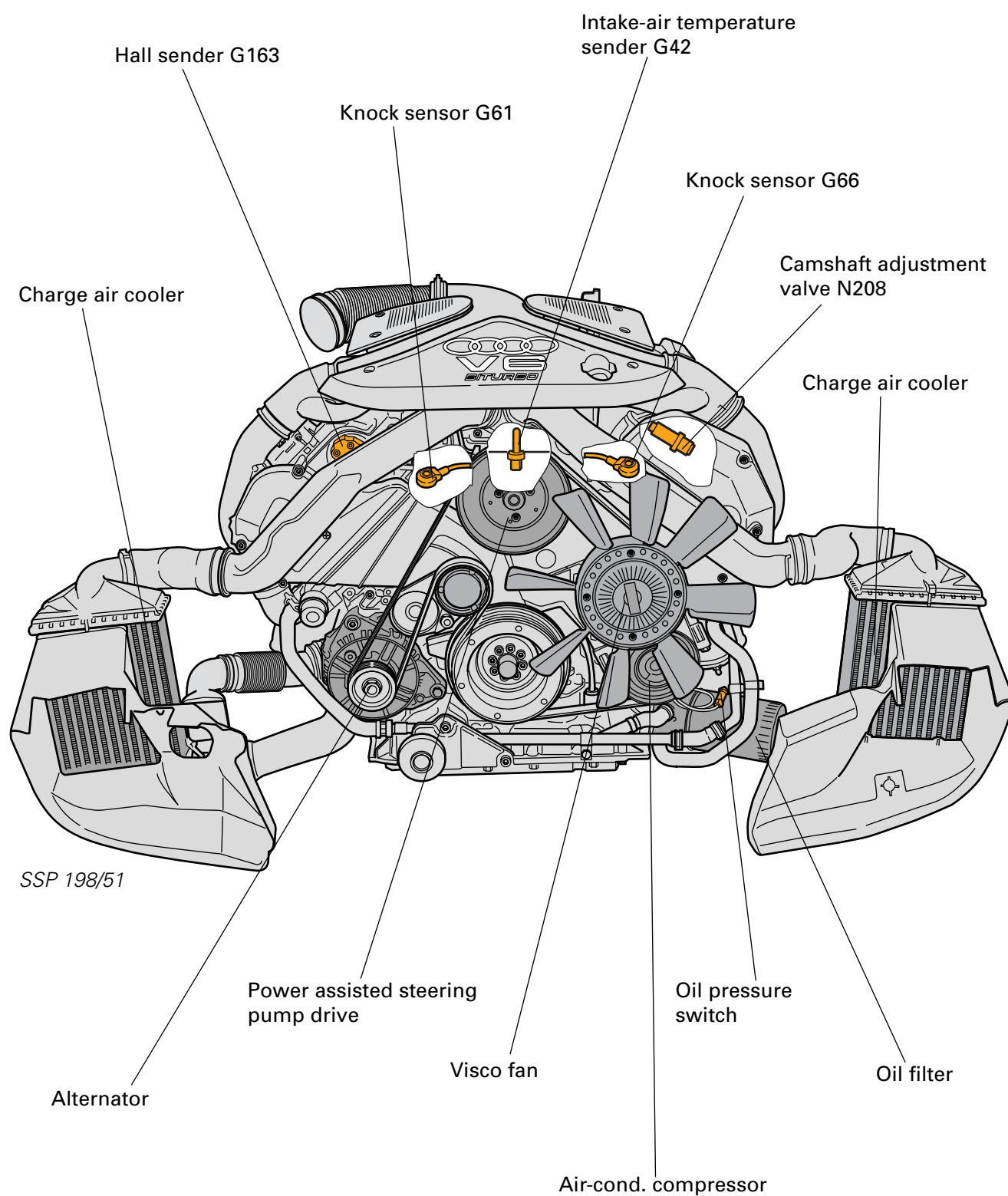
#### **Advantages:**

- Fewer components
- Quick and even oil supply
- No additional installation work necessary
- Lower cost

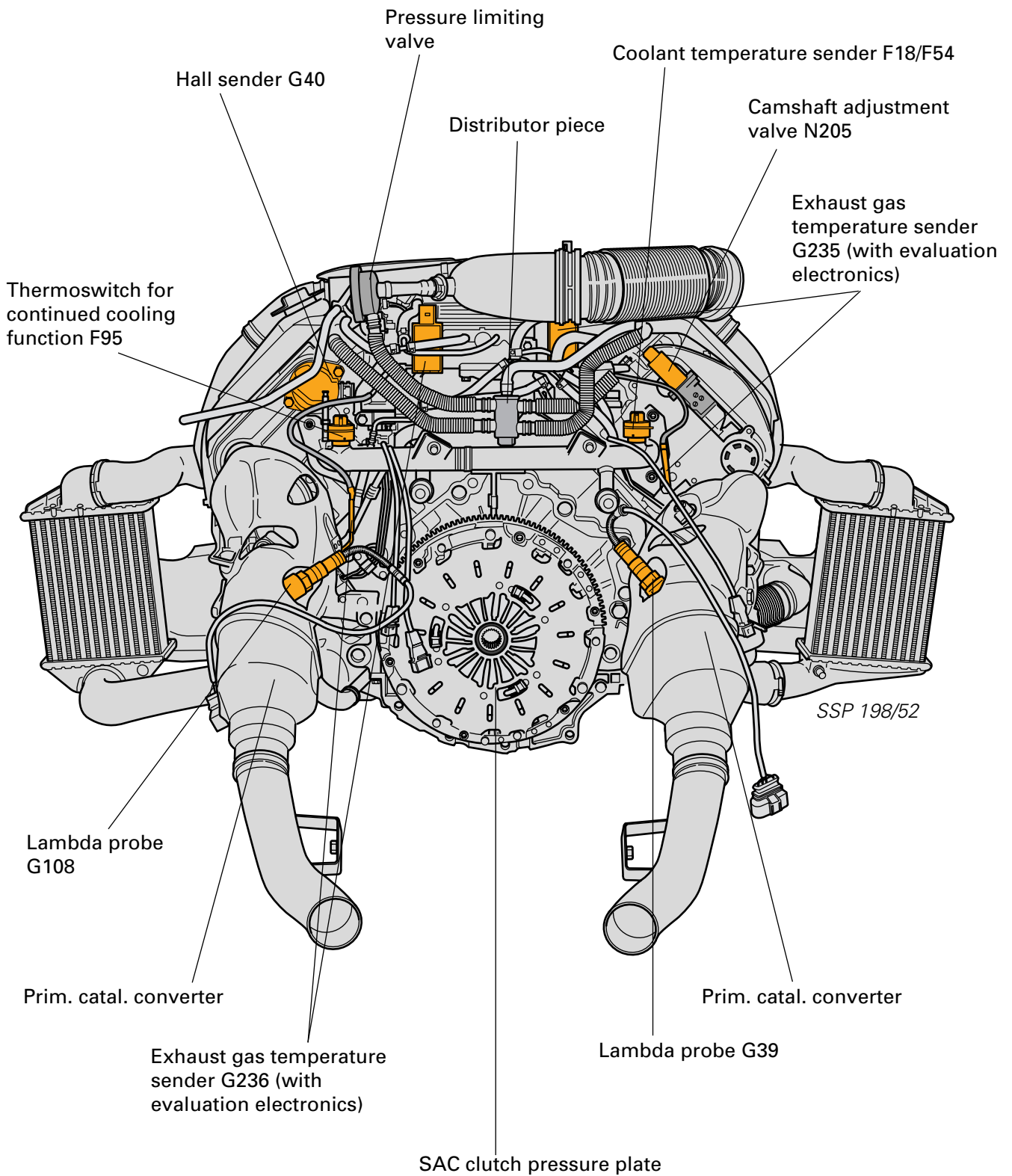


# Engine

## Front view of engine

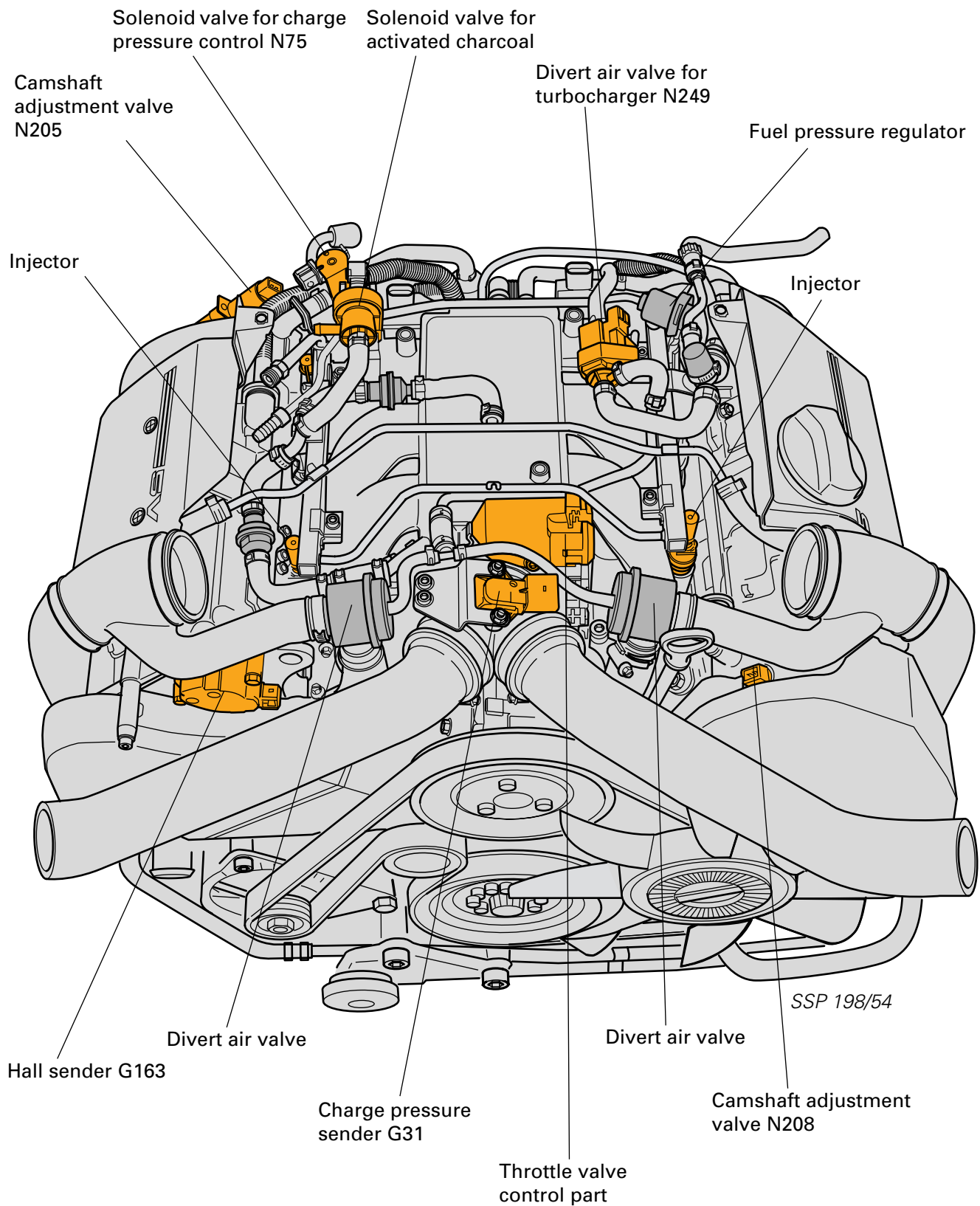


## Rear view of engine

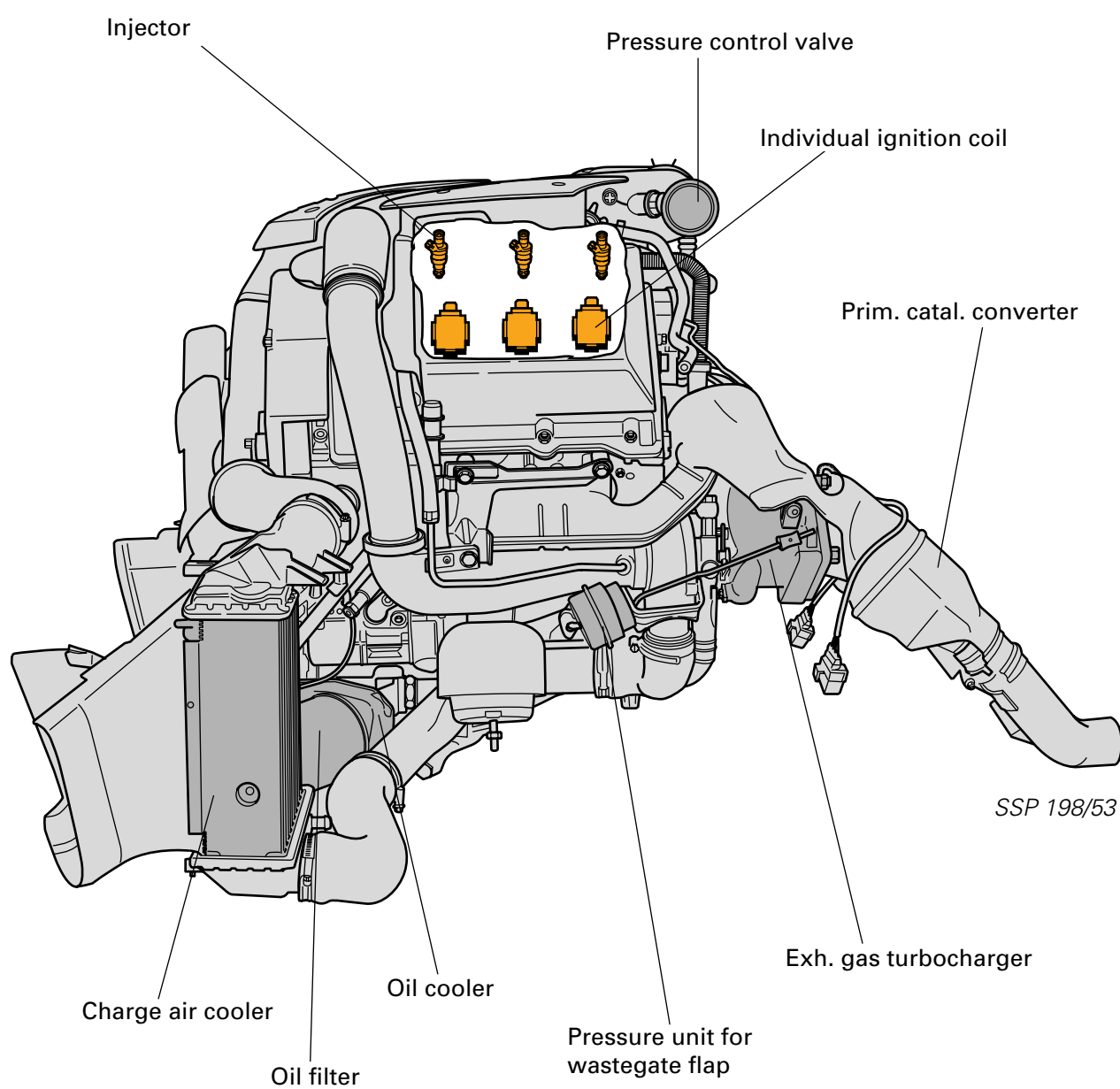


# Engine

## Top view of engine



## View of engine from left



# Engine

## Air ducting

Fresh air is induced by the combined air filter and air mass meter and distributed to the two exhaust gas turbochargers by the air distributor.

The air distributor is made of plastic.

### Advantage:

- Lower weight
- The intake air is heated to a lesser degree by the engine

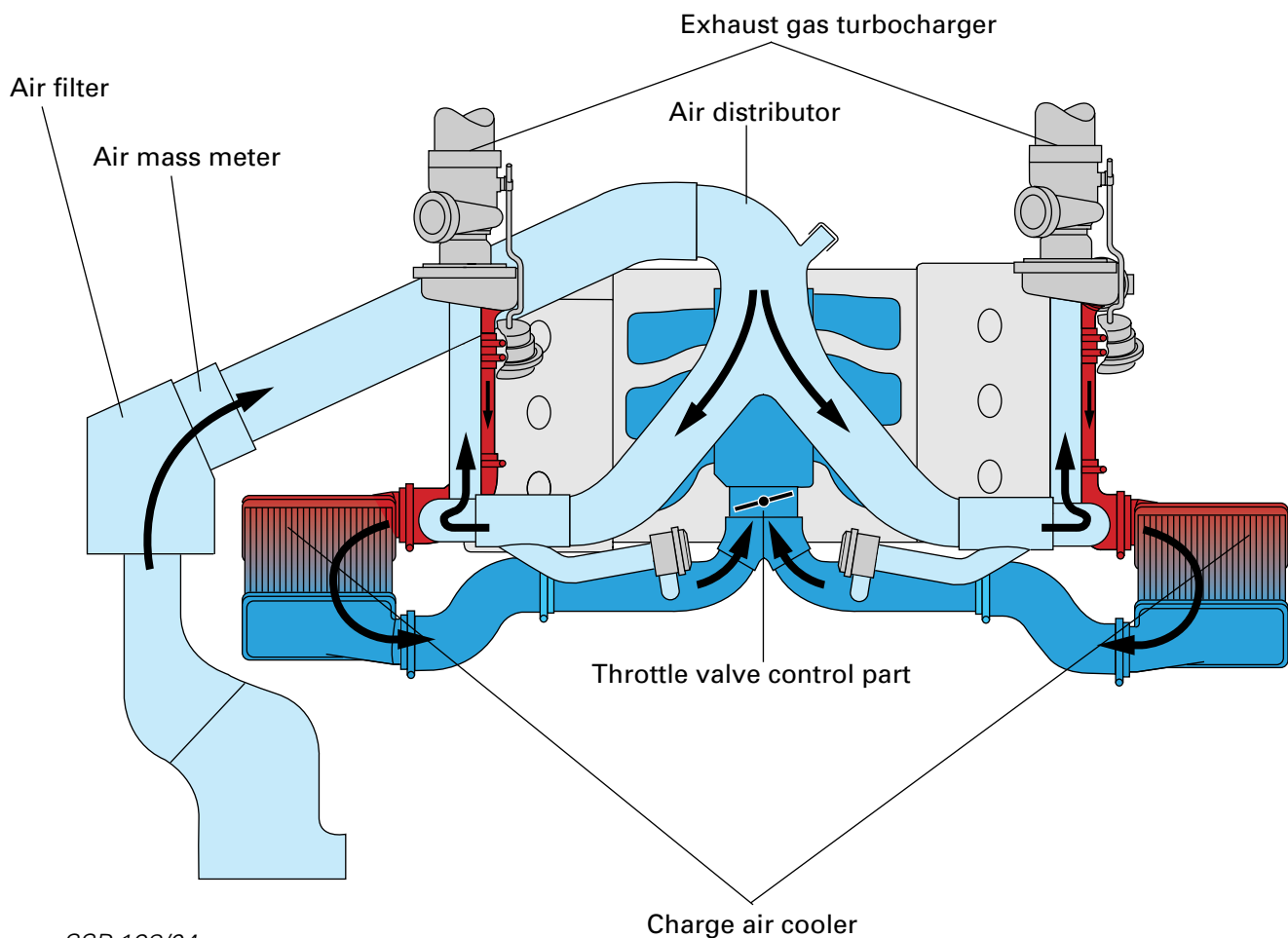
The air, which is compressed and thus heated by the exhaust gas turbocharger, is fed to the charge air coolers.

Cooling air intakes in the bumper and air vents in the wheel housing liners ensure that a sufficient amount of air flows through the charge air coolers.

### Advantage of charge air cooling:

- Cooled air has a higher density, and this means improved volumetric efficiency.
- The lower temperature reduces knock tendency also.

The compressed air streams then converge upstream of the throttle valve control part and distributed to the individual cylinders in the intake manifold.



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## Charging

**Two** water-cooled exhaust gas turbochargers with wastegate are used for charging. The charge pressure of both exhaust gas turbochargers is controlled via the common charge pressure control valve N75.

### Advantages of the biturbo technology:

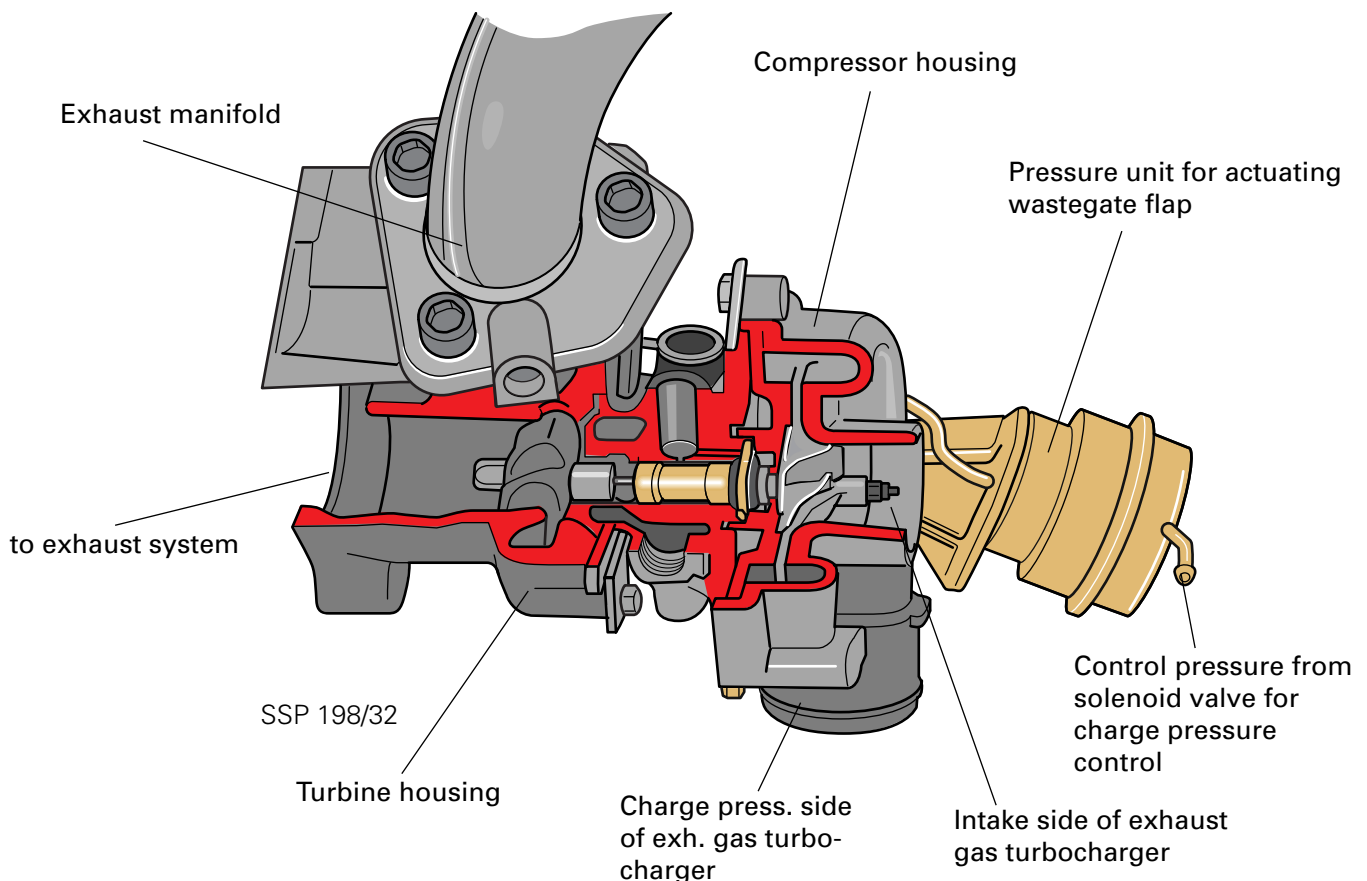
- The exhaust gas turbocharger is smaller, which means better response due its reduced mass.
- Higher charge pressure at low engine speeds.
- The exhaust gas turbochargers are located outside the V-angle due to the high temperatures they reach. This advantage of this arrangement is that the intake air is not heated up additionally and the sub-assemblies are not subjected to so much thermal stress.

- Since the turbochargers are flanged directly onto the exhaust manifold, the exhaust gases travel less distance and there is less temperature loss.
- As a result, the catalytic converters are able to heat up more quickly and the efficiency of the exhaust gas turbocharger is improved by the favourable air-flow.

### **The turbochargers must be replaced in pairs**

To maintain a synchronous air-flow through the two chargers, it is important to observe this instruction to account for manufacturing tolerances.

Service personnel are **not** permitted to adjust the linkage to the wastegate flap.





# Engine

## Exhaust system

The exhaust manifolds are designed as pipe elbows with insulated air gaps.

### Advantage:

- Less heat loss of the exhaust gas and less heat radiation in the engine compartment
- Weight saving

Located downstream of each exhaust gas turbocharger is a primary catalytic converter close to the engine (metal substrate) .

### Advantage

- The catalytic converters quickly reach a state of readiness for operation after a cold start

The large-surface area main catalytic converters (ceramic substrate) are located under the vehicle floor.

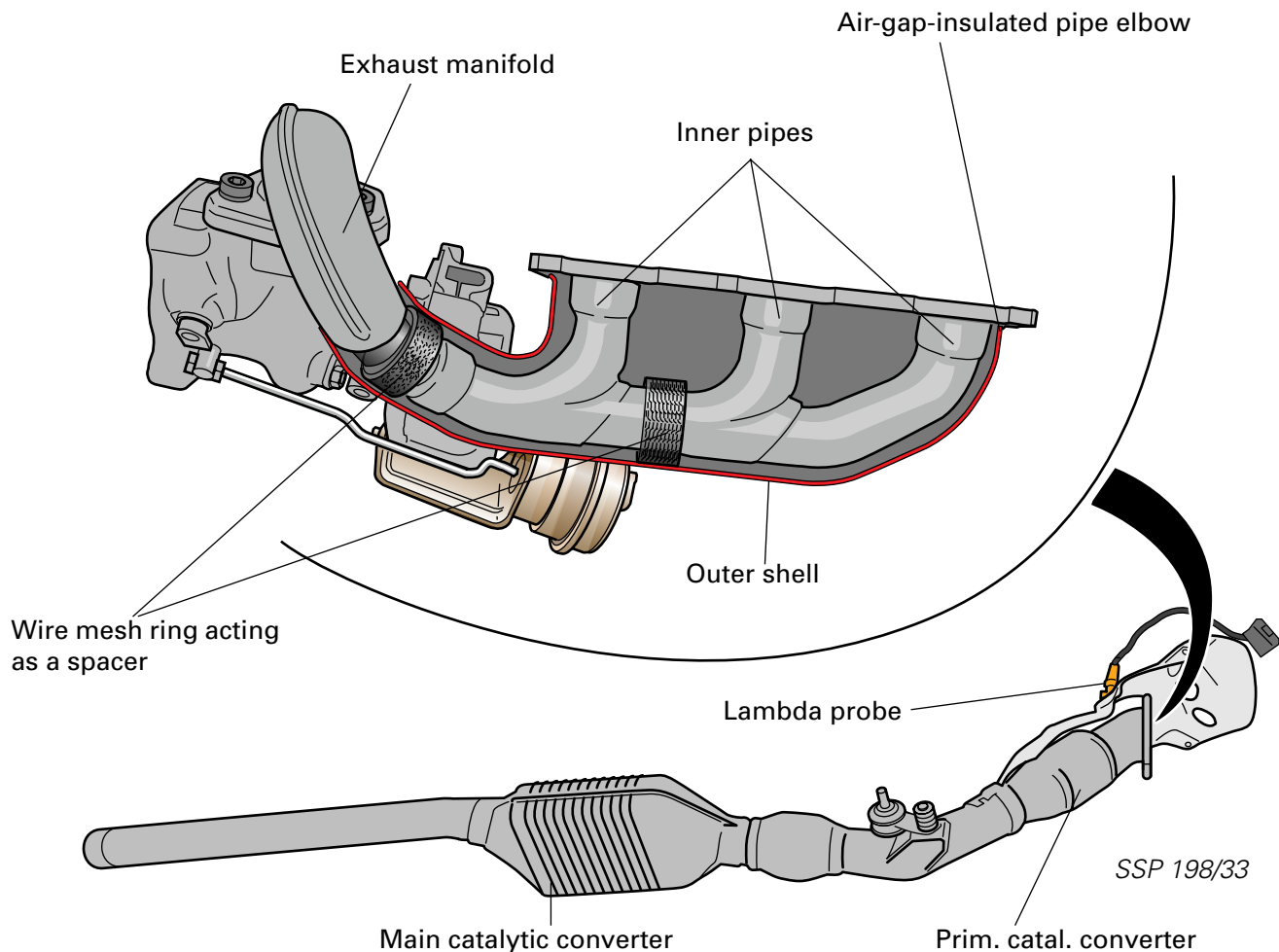


A new generation of probes is used in this engine.

The “planar lambda probe” is an improvement on the finger-type lambda probe (refer to chapter on “Sensors”).

### Advantage:

- Short warm-up time
- Less heating energy demand
- Long service life
- More stable control characteristic



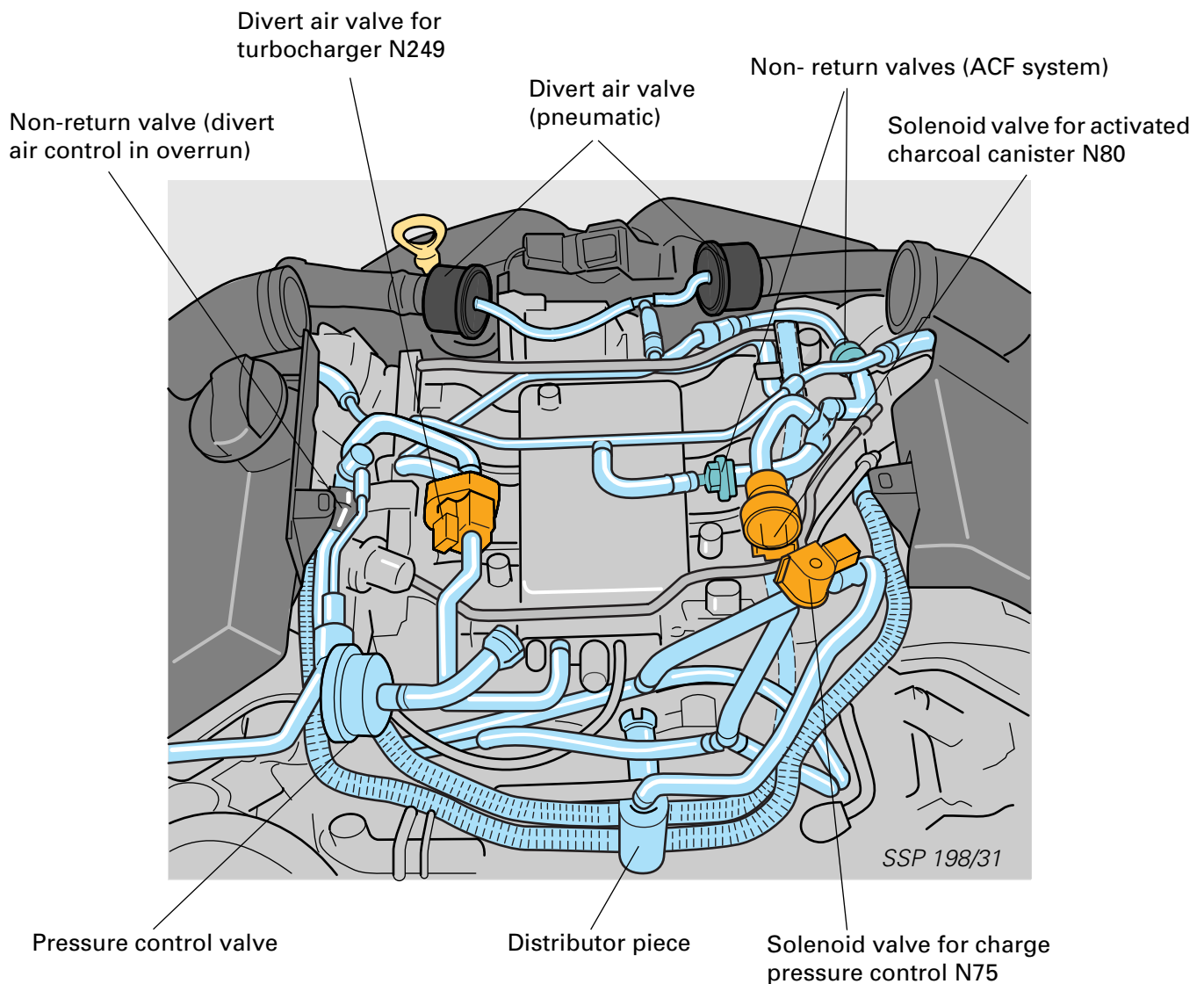
## Pneumatically controlled systems

In the Biturbo, 4 systems are pneumatically controlled:

- **Charge pressure control**  
The Motronic ME 7.1 activates the solenoid valve for charge pressure control N75 and regulates the charge pressure via the wastegate.
- **Divert air control in overrun**  
The Motronic ME 7.1 activates the electric divert air valve for the turbocharger and opens the pneumatic divert air valves using this vacuum.

- **ACF system**  
The Motronic ME 7.1 activates the solenoid valve for the activated charcoal canister and regulates the fuel vapour feed rate to the engine via the vacuum.
- **Crankcase breather**  
The crankcase breather controls the return of oil vapours to the engine via two mechanical valves.

For exact the line routing, please refer to the Workshop Manual.



# Engine

## Charge pressure control

The air mass required to develop a specific level of torque is determined by means of an air mass calculation and produced by controlling the charge pressure as required.

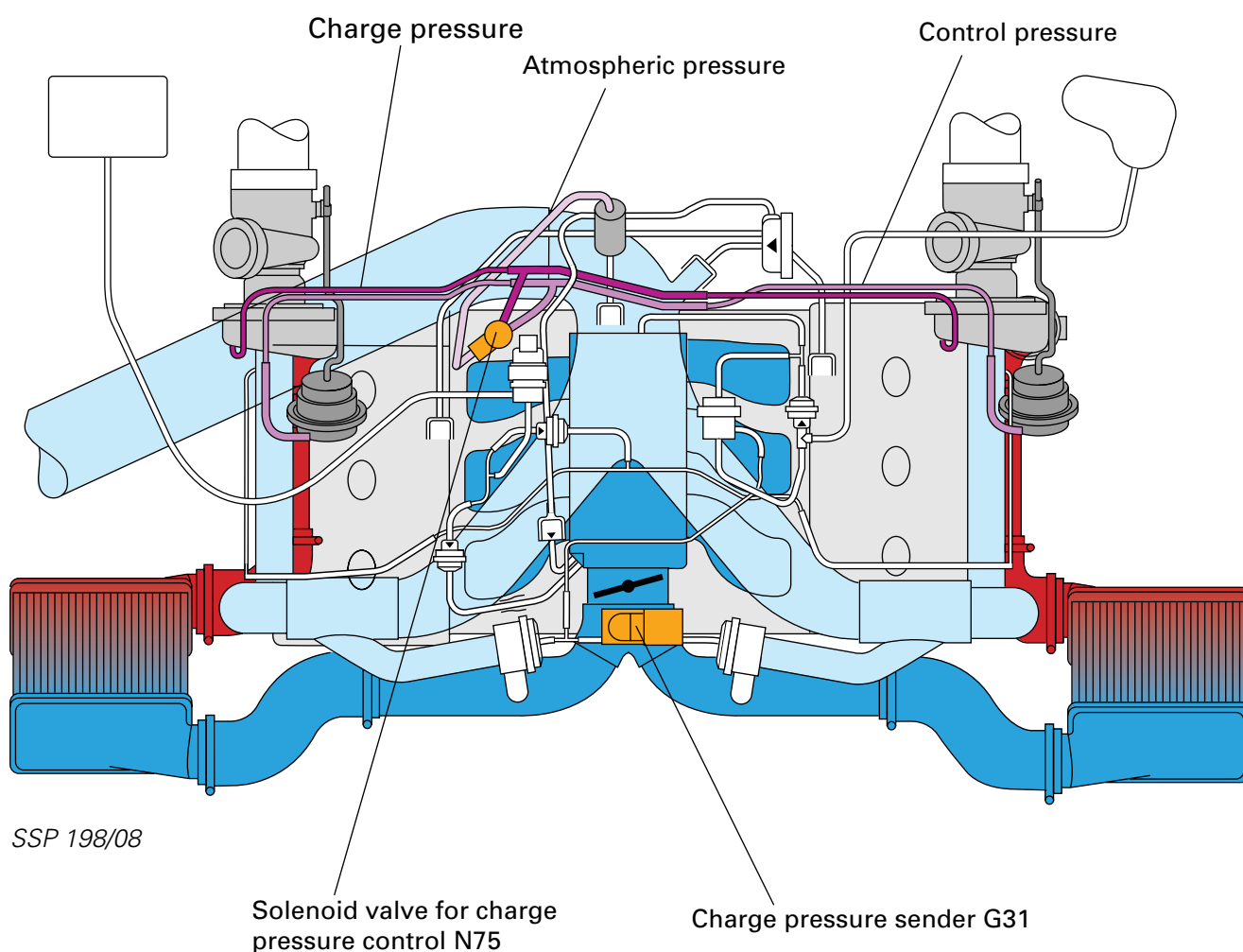
For safety reasons, the engine in the biturbo regulates the charge pressure, and not the air mass as is the case with the 1.8-litre 4-cylinder turbocharged engine.

The charge pressure is measured by charge pressure sender G31.

The Motronic regulates the charge pressure of both turbochargers via the solenoid valve for charge pressure control G31.

If a defect occurs in one of the cylinder banks (e.g. melting of the catalytic converter or blockage of the exhaust system), a purely air mass-oriented charging system would still try to provide the computed air mass. This would lead to an excessively high charge pressure.

In any case, the charge pressure control prevents an excessively high charge pressure building up inside the intake system.

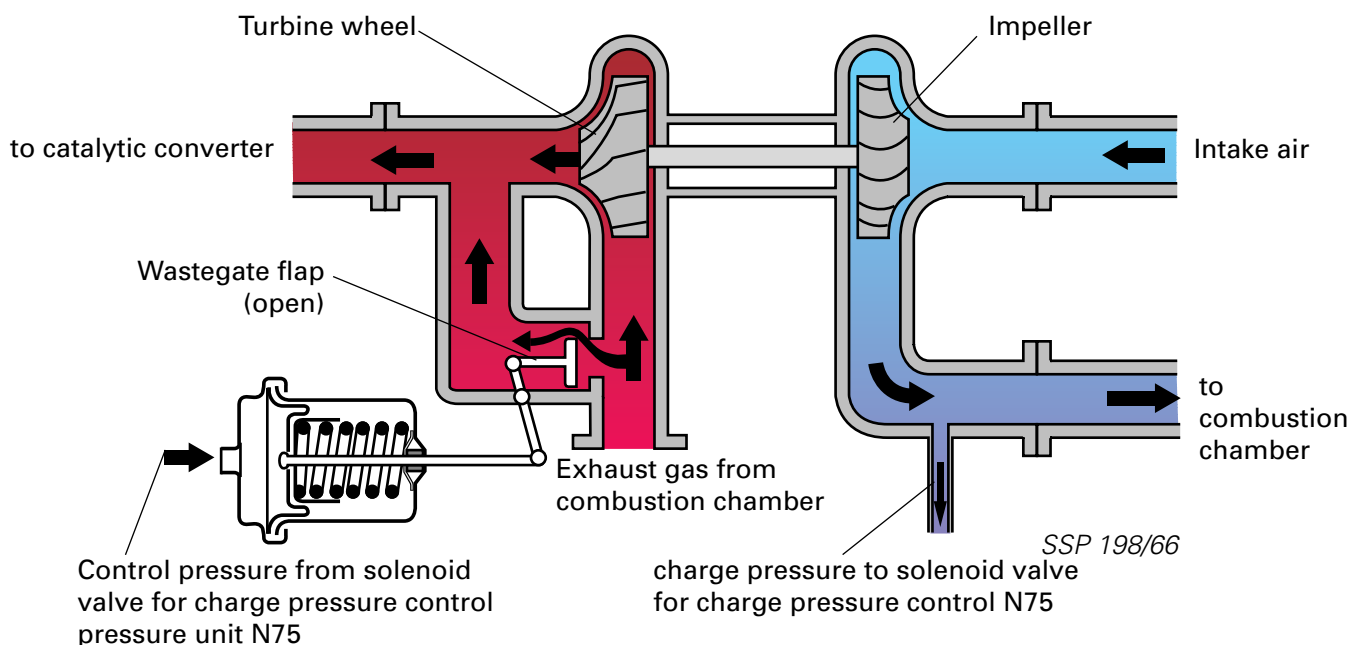


The solenoid valve for charge pressure control N75 changes the opening time to atmospheric pressure according to the signals it receives from the engine control unit (duty cycle).

Thus, a control pressure is produced by modulating the charge pressure and atmospheric pressure. This pressure acts on the pressure unit for the wastegate.

The wastegate is kept closed in a depressurised state by a spring inside the pressure unit. The entire exhaust gas flow is routed via the turbine, and a charge pressure is built up.

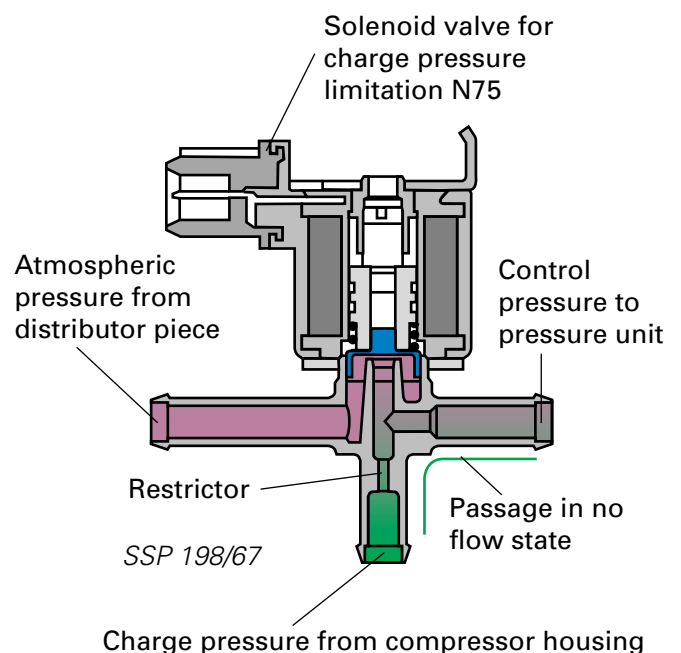
The control pressure counteracts this spring force and opens the wastegate. Part of the exhaust gas flow is fed from the wastegate past the turbine, and the charge pressure stops rising.



If there is no flow, N75 is closed and the charge pressure acts directly on the pressure unit. The waste gate opens even if the charge pressure is low.

If the charge pressure control fails, the charge pressure is thus limited to a "basic charge pressure" in order to prevent the maximum permissible charge pressure being exceeded. This results in a loss of performance.

The "basic charge pressure" is the charge pressure (approx. 300 - 400 mbar) which is achieved without regulation (mechanical charge pressure).



# Engine

## Divert air control in overrun

To avoid pumping the exhaust gas turbochargers when a sudden transition from high load to overrun is made, two divert air valves are used.

The divert air valve N249, in combination with the vacuum reservoir, enables the divert air valves to operate independently of the intake manifold pressure.

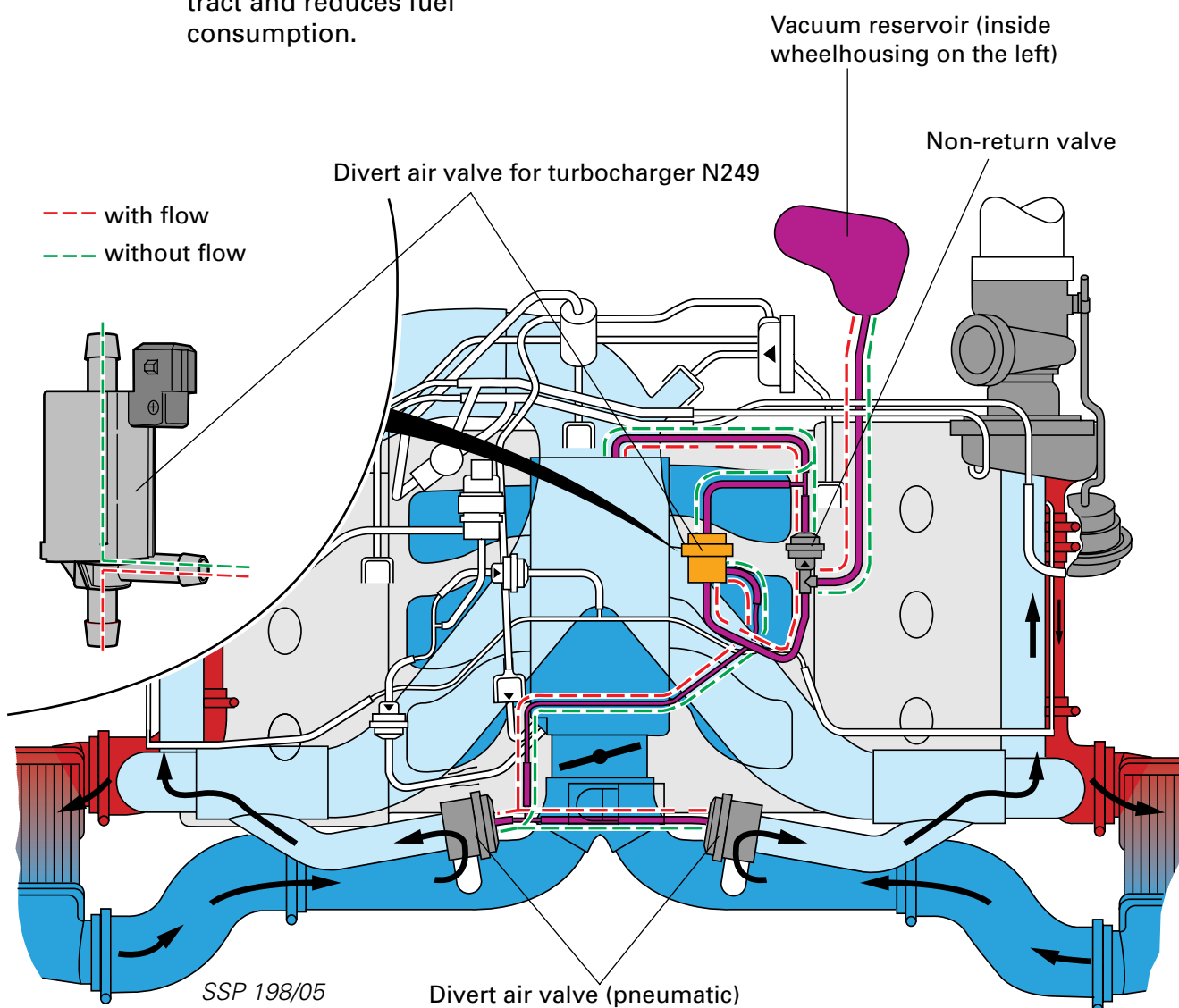
The system is designed in such a way that the pneumatic divert air valves continue to be opened by the intake manifold pressure if the electrically actuated divert air valve N249 fails.



The Motronic also activates the two pneumatic divert air valves by means of an electrical changeover valve, the divert air valve for turbocharger N249.

### Advantage:

- Controlled opening of the divert air valves reduces the noise level in the induction tract and reduces fuel consumption.



## ACF system

Integrated in the lines of the ACF systems are the solenoid valve for activated charcoal canister N80 and two non-return valves.

The engine control unit, assisted by solenoid valve N80, regulates the return rate of the fuel vapours from the ACF canister.

The Motronic operates the solenoid valve cyclically using a pulse duty cycle.

The non-return valves control the return of fuel vapours, depending on operating state.

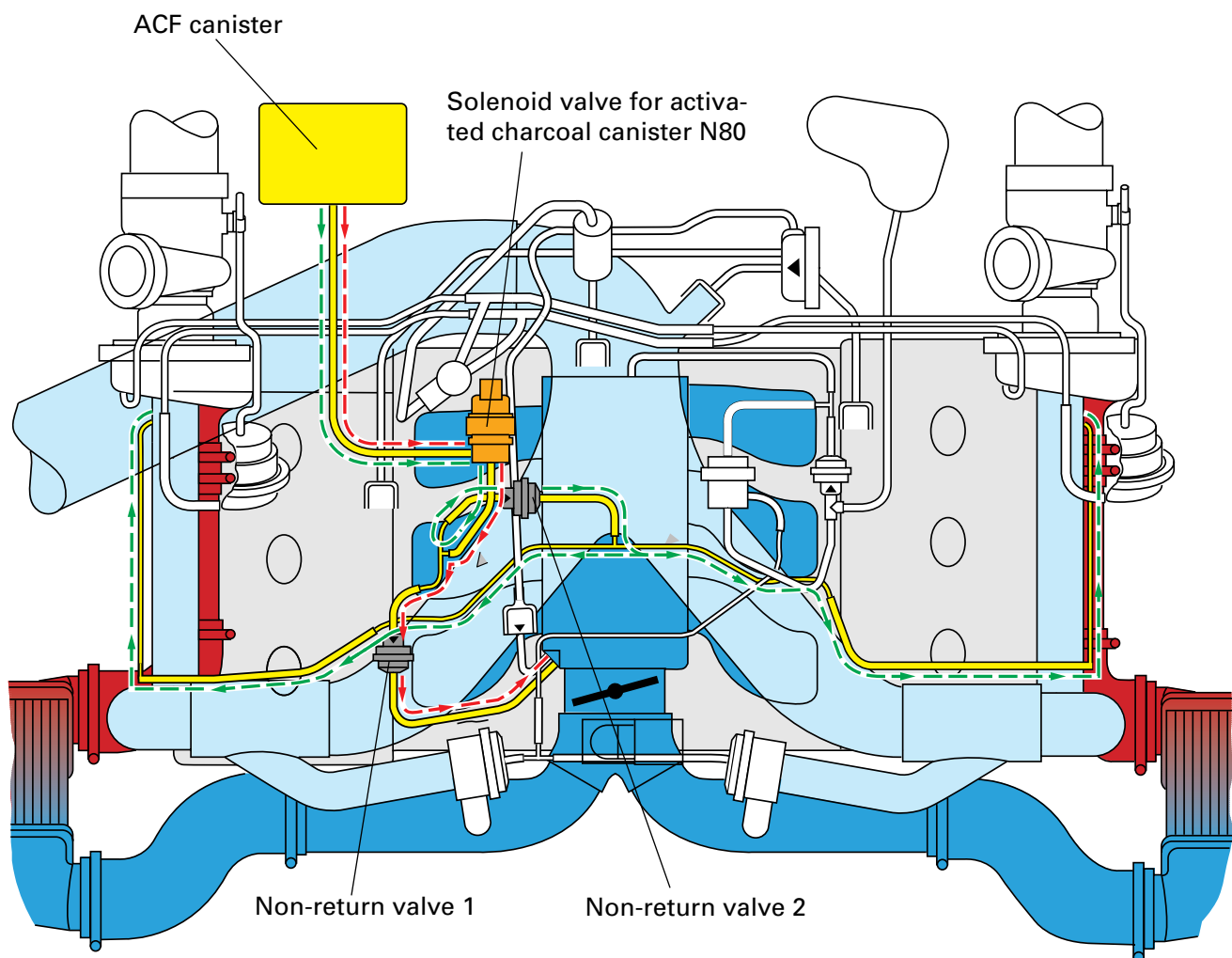
### **Vacuum in intake manifold:**

Non-return valve 1 open. Fuel vapours return to intake manifold.

### **charge pressure in intake manifold:**

Non-return valve 2 open. Fuel vapours return upstream of exhaust gas turbocharger.

For the exact line routing, please refer to the Workshop Manual.



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→ Vacuum in intake manifold

→ Charge pressure in intake manifold

# Engine

## The crankcase breather ...

...comprises a distributor piece, a pressure limiting valve, a non-return valve and the associated hoses.

The oil vapours and "blow-by" gases from the cylinder heads and the crankcase converge in the distributor piece.

The pressure limiting valve and the non-return valve control the return of these vapours and gases to the engine, depending on the intake manifold pressure.

### Vacuum in intake manifold:

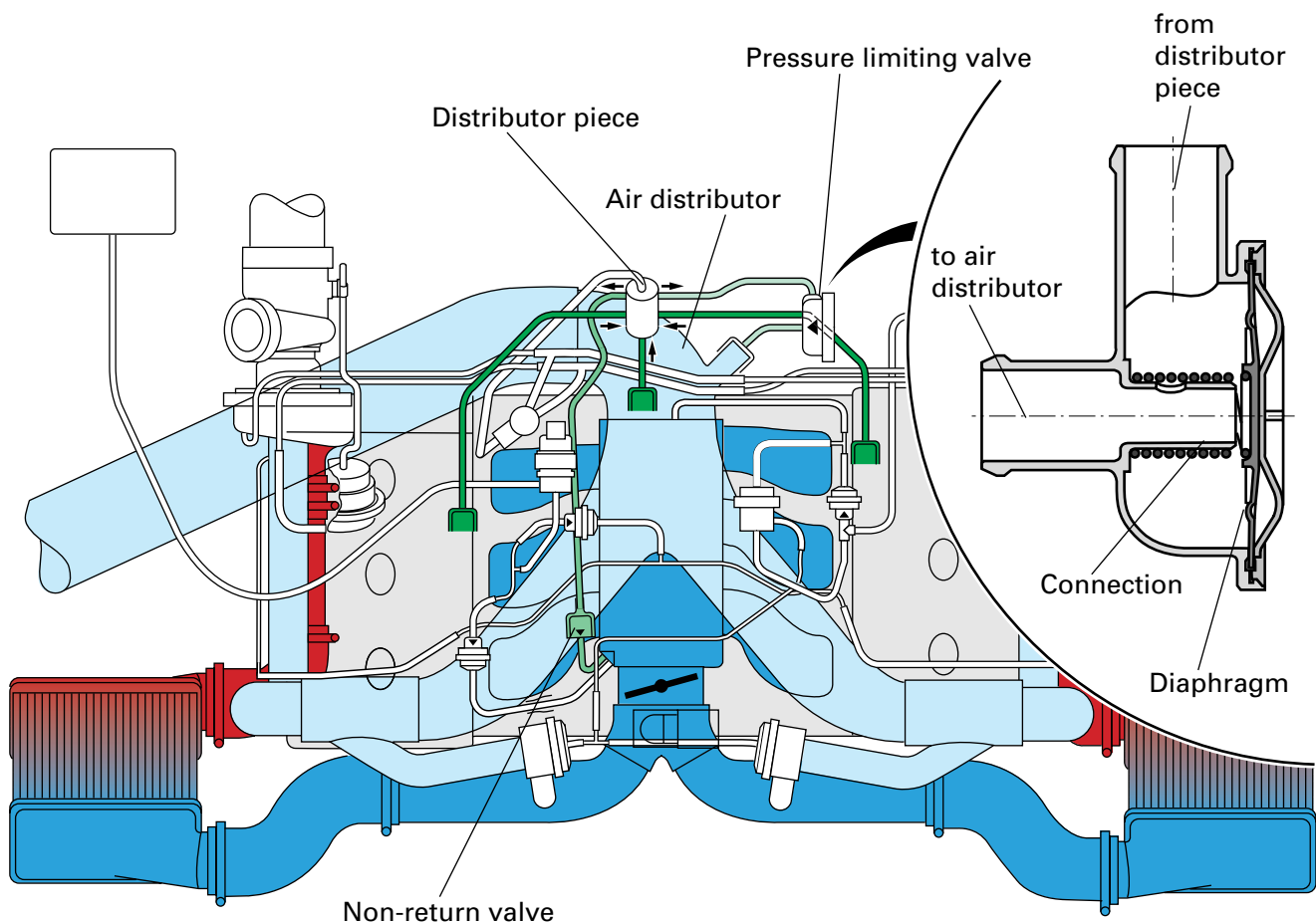
The oil vapours and "blow-by" gases return via the non-return valve in the intake manifold.

### charge pressure in intake manifold:

The oil vapours and "blow-by" gases return via the pressure limiting valve in the air distributor.

The **pressure limiting valve** limits the vacuum in the crankcase. If the vacuum in the crankcase exceeds a defined value, the diaphragm is drawn over the connection against the force of the spring and closes the connection. The valve is designed in such a way that it allows a small quantity to pass through when closed. This prevents the engine oil being drawn into the intake tract and has no adverse effects on engine breathing.

The term "blow-by" gases refers to the gases which escape from the combustion chamber past the piston rings.

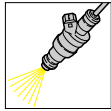


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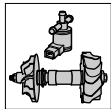


## Subfunctions of the Motronic

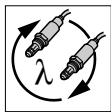
The Motronic consists of known and new subfunctions:



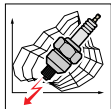
**Sequential injection**



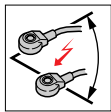
**Charge pressure control**  
(see chapter on "Engine" pp. 26 and 27)



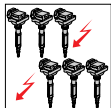
**Stereo lambda control**



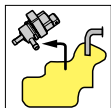
**Mapped ignition**



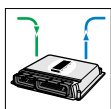
**Cylinder-selective knock control**



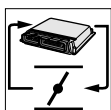
**Static high-tension distribution with 6 individual ignition coils**



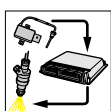
**ACF system**



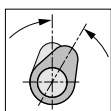
**Torque-oriented engine management**



**Electrically actuated throttle valve (Electronic accelerator)**



**Cylinder bank-specific exhaust gas temperature control**



**Mapped variable valve timing (intake camshaft adjustment)**  
(see chapter on "Engine" p. 8)



**New**



**New**



**New**



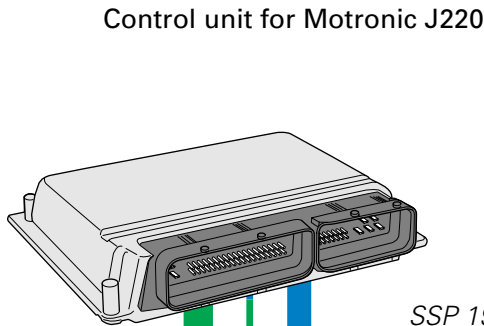
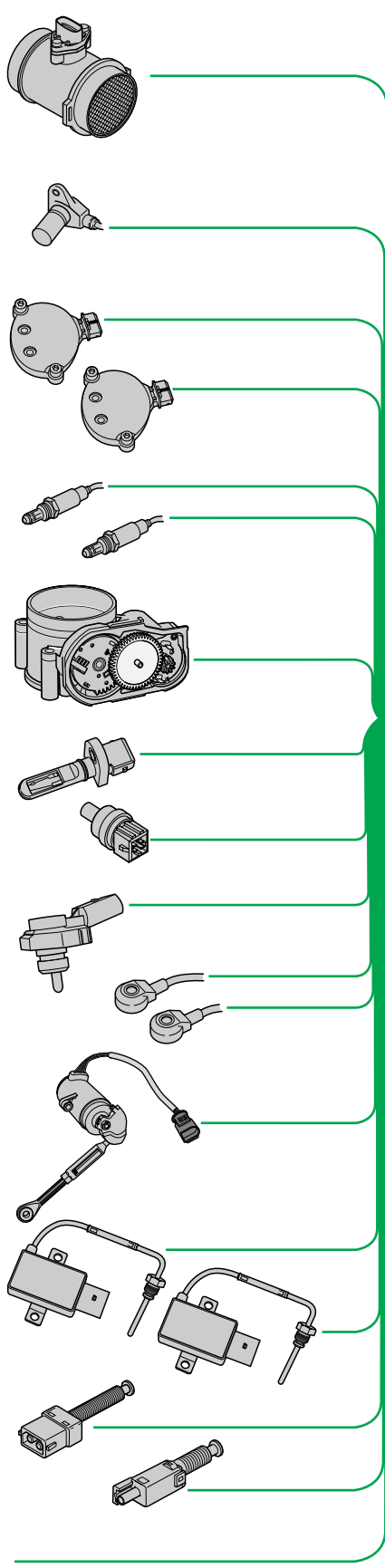
**New**

SSP 198/44

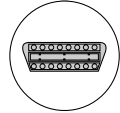
# Motronic ME 7.1

## Sensors

- Hot-film air mass meter G70
- Engine speed sender G28
- Hall senders (bank 2) G40 and (bank 1) G163
- Lambda probes (bank 1) G39 and (bank 2) G108
- Throttle valve control part J338 with angle sender (1) G187 and (2) G188 for throttle valve drive G186
- Intake air temperature sender G42
- Coolant temperature senders G2 and G62
- Charge pressure sender G31
- Knock sensors (bank 1) G61 and (bank 2) G66
- Accelerator position sender G79 and 2 G185
- Exhaust gas temperature senders (bank 1) G235 and (bank 2) G236
- Brake light switch F and brake pedal switch F 47
- Clutch pedal switch F36
- Auxiliary signals

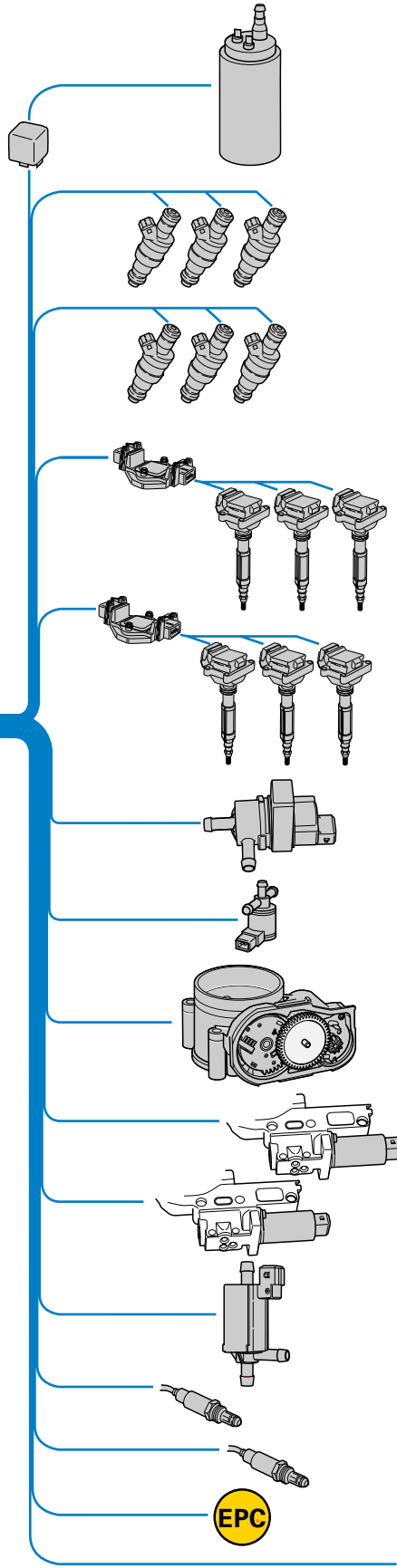


Altitude sender F96 is integrated in the engine control unit.



## Actuators

- Fuel pump relay J17 and fuel pump G6
- Injectors (bank 1) N30, N31, N32
- Injectors (bank 2) N33, N83, N84
- Output stage (bank 1) N122 and ignition coils N (cyl. 1), N128 (cyl. 2) and N158 (cyl. 3)
- Output stage 2 (bank 2) N192 and ignition coils N163 (cyl. 4), N164 (cyl. 5) and N189 (cyl. 6)
- Solenoid valve for activated charcoal canister N80
- Solenoid valve for charge pressure control N75
- Throttle valve control part J338 with throttle valve drive G186
- Camshaft adjustment valve (bank 1) N205 and (bank 2) N208
- Divert air valve for turbochargers
- Heater for lambda probe (bank 1) Z19 and (bank 2) Z28
- Fault lamp for electric throttle control K132
- Auxiliary signals



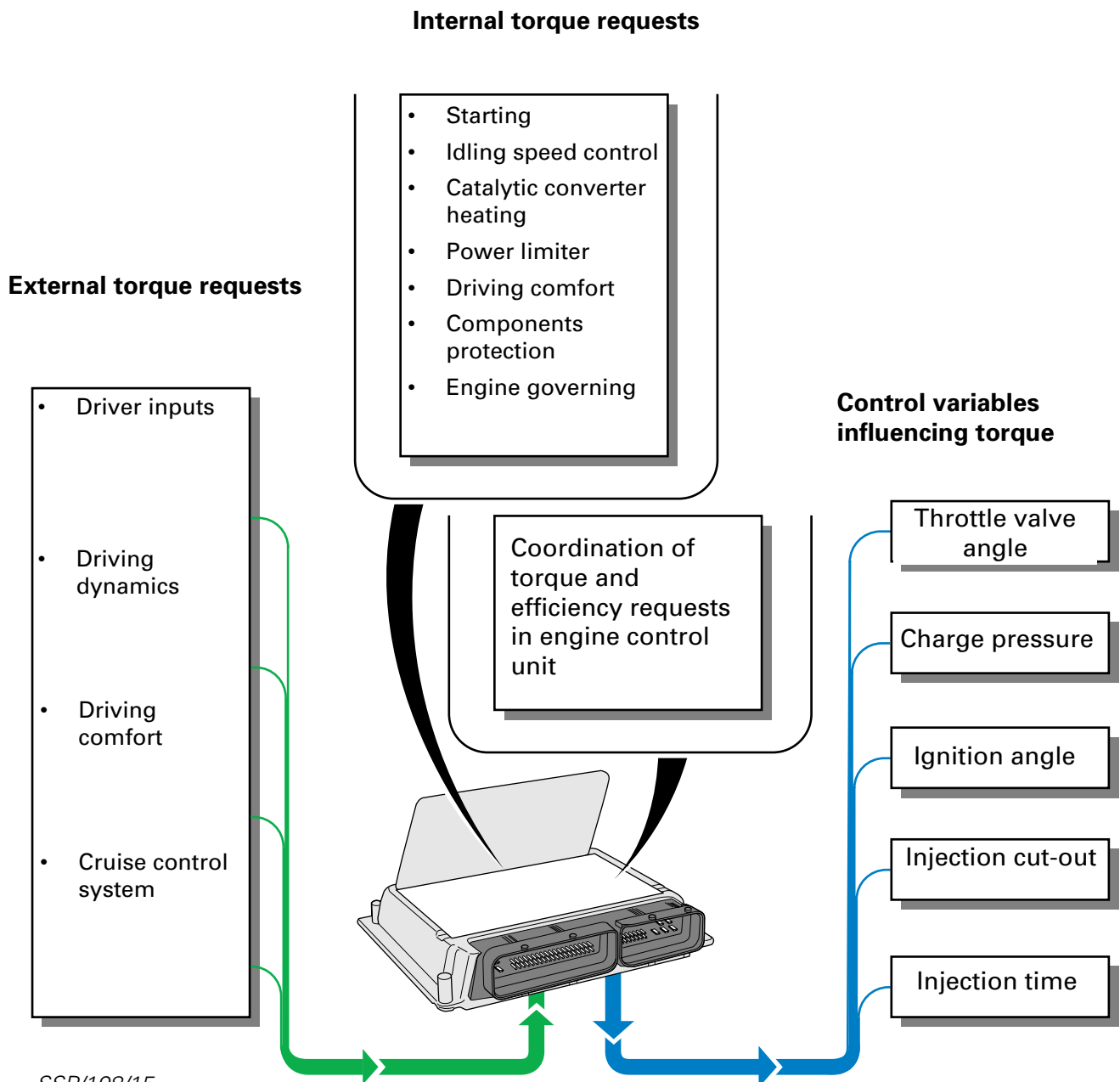
# Subsystems of the Motronic

## Torque-oriented engine management



The Motronic ME 7.1 has a torque-oriented functional structure. This is made possible by the new electronic accelerator function.

Making allowance for efficiency and the emissions standards, the engine control unit coordinates the external and internal requests and meets them by adjusting the available control variables accordingly.



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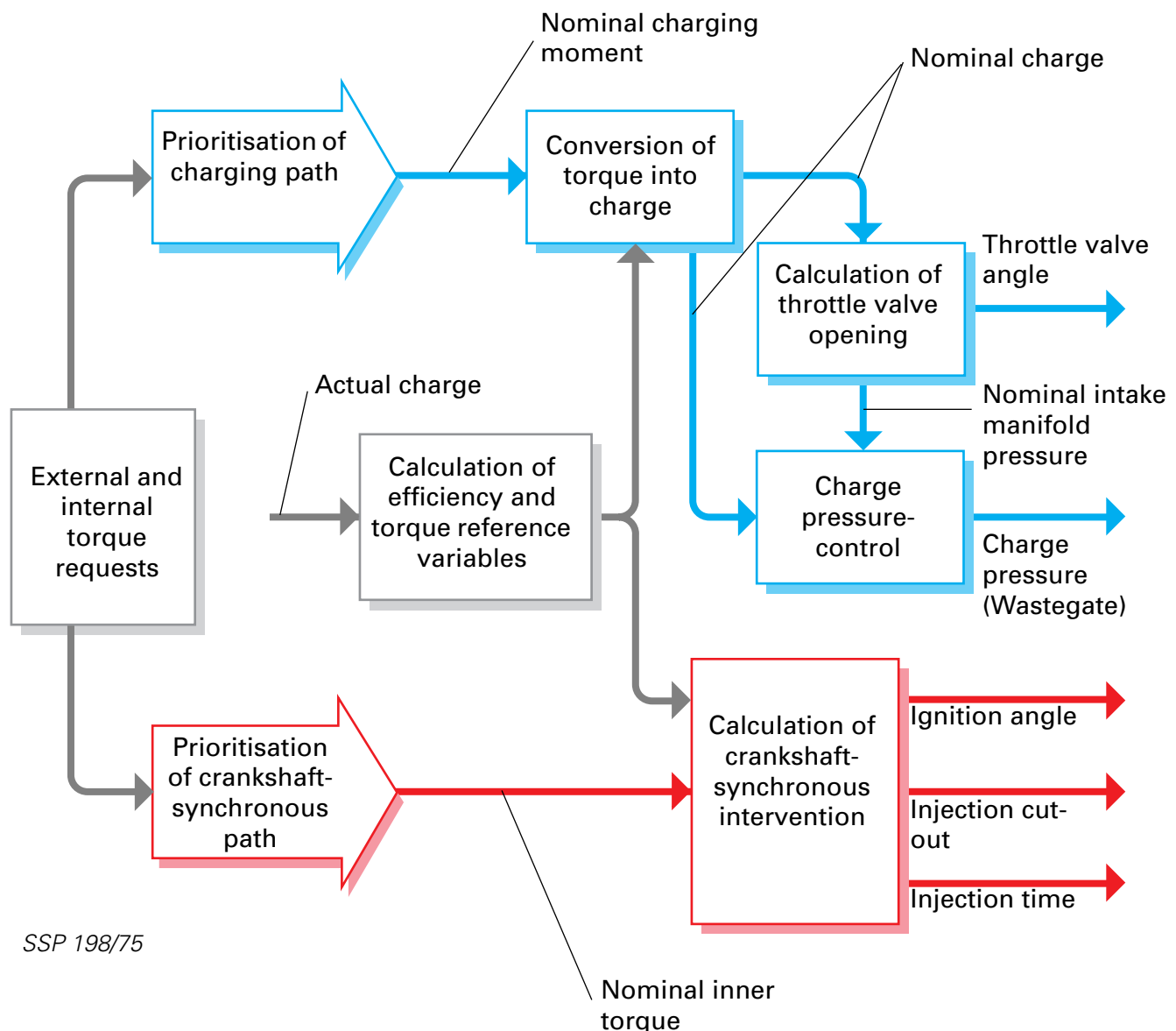
# Subsystems of the Motronic

## Torque-oriented functional structure

In comparison with previously known systems, the ME 7.1 is not confined to the output of torque variables to the networked control units (ABS, automatic gearbox), it also uses these physical variables to calculate control variables.

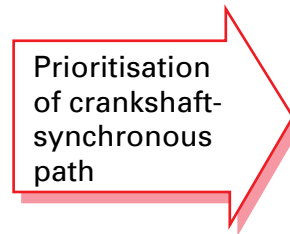
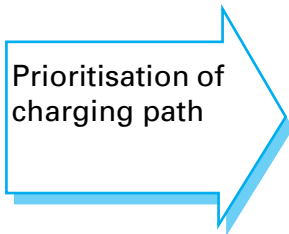
All - internal and external - torque demands are combined, and a nominal torque is derived from this.

To translate the nominal torque into actions, the control variables are co-ordinated with regard to consumption and emissions so as to optimise torque control.



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**The control variable calculation is subdivided into two paths**



### **Path 1**

The charging path regulates the control variables which influence charging:

- Throttle valve angle
- Charge pressure

The air mass necessary to develop a specific torque is determined by means of a "calculation model" and is made available along path 1.

Path 2 is used to set the injection quantity or cylinder cut-out necessary under the given circumstances and the optimal ignition angle.

### **Path 2**

All control actions which influence torque regardless of charging are combined in the crankshaft-synchronous path:

- Ignition angle
- Injection cut-out
- Injection time

By and large, long-term torque requests are fulfilled along path 1.

**Path 2** is particularly well suited to meeting short-term torque requests, which usually have a torque-reducing effect.

# Subsystems of the Motronic

## Electrically actuated throttle valve (electronic accelerator)



With the Motronic ME 7.1, Audi is using an electrically actuated throttle valve for the first time.

There is no longer any need for a mechanical accelerator cable between the accelerator and throttle valve. This has been replaced by an electronic control system (drive-by-wire).

The accelerator position sender records the accelerator pedal angle and transfers it to the engine control unit.

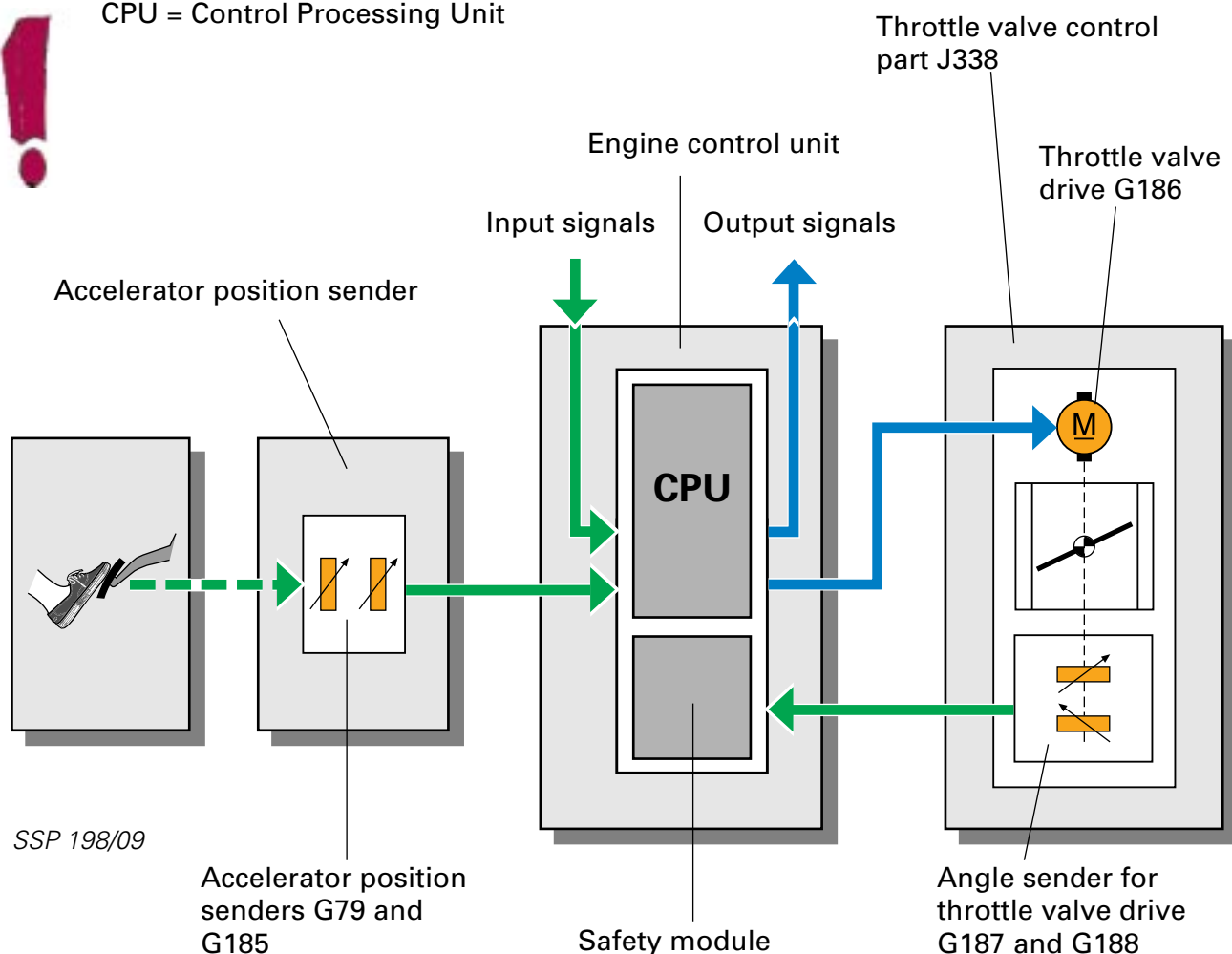
The engine control unit adjusts the throttle valve by means of an electric motor. A continuous stream of feedback signals on the position of the throttle valve is sent to the engine control unit.

Extensive security measures in hardware and software format - such as twin senders, safety module and self-monitoring computer architecture - are integrated in the electronic accelerator .

The system comprises the following components:

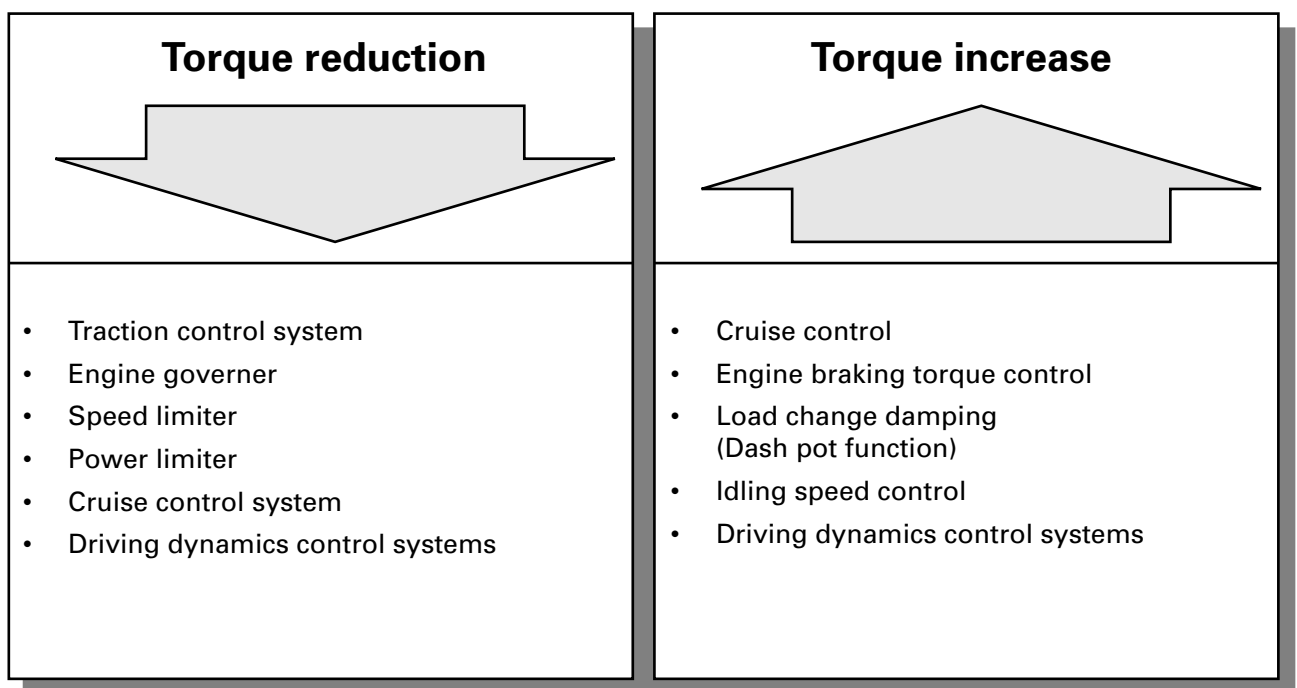
- Accelerator position sender
- Engine control unit
- throttle valve control part

CPU = Control Processing Unit



The electronic accelerator controls the engine output electronically and, over and above intake-air control, offers the advantage that functions such as idling speed control, cruise control or engine governing can be executed easily and comfortably.

The electronic accelerator is used for reducing and increasing torque and does not adversely affect exhaust emissions.



The throttle valve can be opened regardless of the accelerator position, and this serves to reduce throttle losses.

The ideal combination of throttle valve cross-section and charge pressure produce the necessary torque.

In this way, the throttle valve can be opened fully while the accelerator pedal has not been fully depressed.

With electronic accelerator, much improved emissions and higher fuel economy are achieved in specific load states.

Over and above this, any accelerator characteristic can be programmed, e.g. gradual acceleration when driving at low speed.



# Subsystems of the Motronic

## Accelerator position senders G79 and G185

The accelerator position sender transfers an analog signal corresponding to the accelerator position to the Motronic. To ensure that the electronic accelerator functions reliably, the accelerator position sender has two independent potentiometers (G79 and G185). They have different characteristic curves (see diagram).

The control unit monitors the two senders G79 and G185 for proper functioning and plausibility.

If a sender fails, the other sender serves as a substitute.

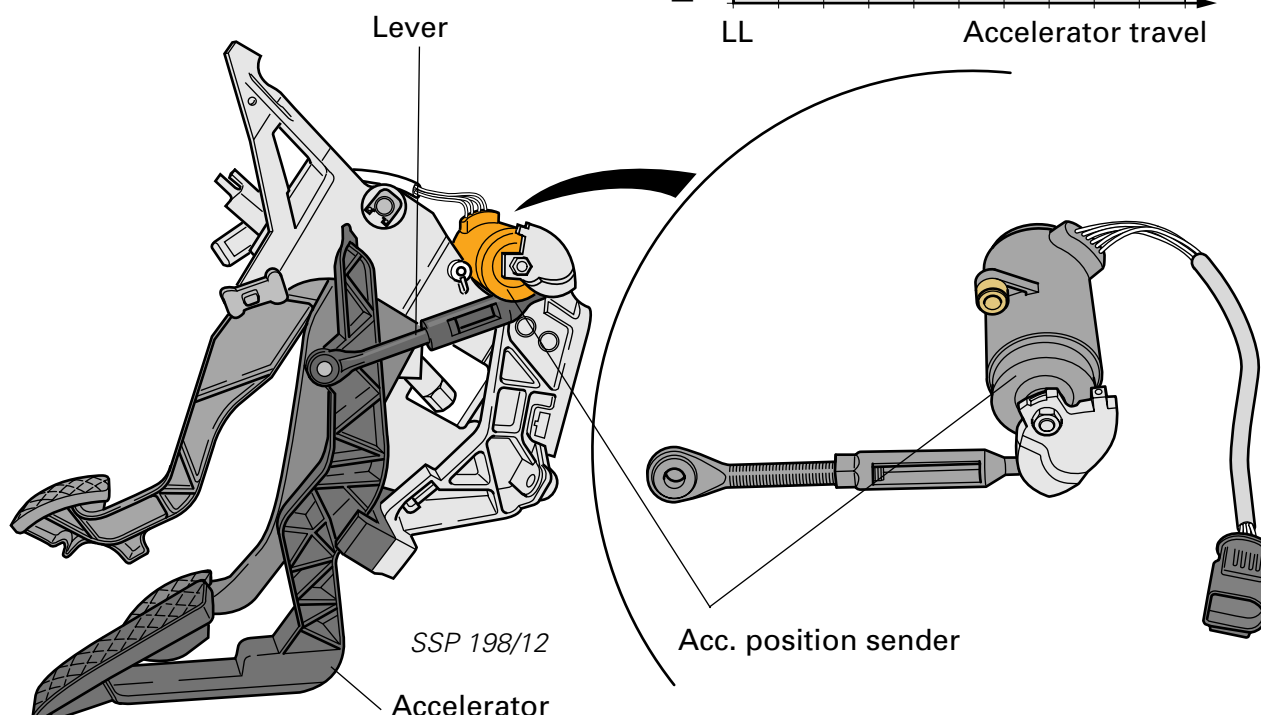
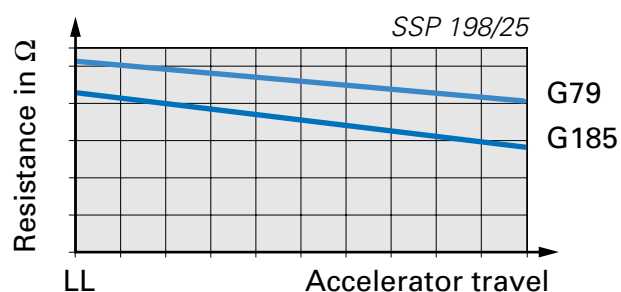
The accelerator position sender transfers the driver's inputs to the Motronic and provides kickdown information to the automatic gearbox.



There is no separate switch for kickdown information. Integrated in the accelerator position sender is a "mechanical pressure point" which conveys an authentic "kickdown feel" to the driver.

When the driver operates the kickdown, the full-load voltage of the accelerator position sender is exceeded. If a voltage defined in the engine control unit is attained in the process, this is interpreted as a kickdown and transferred to the automatic gearbox (via CAN-Bus).

The accelerator position senders for the manual gearboxes and automatic gearboxes are identical. Kickdown is enabled or disabled via the accelerator limit stop (refer to chapter on "TDI engines").



## Self-diagnosis/emergency running

If a fault occurs in the accelerator position sender or the wiring, two emergency running programs can be run depending on fault type.

### Emergency running program 1 If an accelerator position sender fails:

- Accelerator position limited to a defined value.
- If a full load is predefined, the power output is increased slowly.
- In the case of implausible signals between G79 and G185, the lower value is used.  
**Prerequisite:**  
The idling speed position must be learnt once by the intact sender.
- The signal supplied by brake light switch for brake pedal switch F47 indicates the idling speed.
- Comfort functions (CCS) are prohibited.
- The fault lamp for electric throttle control K132 comes on.

### Emergency running program 2 If both accelerator position senders fail, driver input recognition is not possible:

- The engine only runs at idling speed.
- The fault lamp for electric throttle control K132 comes on.



At idling speed, the accelerator position senders G79 and G185 are not diagnosed.

If the plug of the accelerator position sender drops off, no fault is stored in the control unit.

The fault lamp for electric throttle control K132 does not come on.

The engine runs at idling speed and does not respond to the accelerator pedal.



#### **Safety function:**

For safety reasons, the throttle valve is closed as far as a defined angular position when both the accelerator pedal and the brake pedal are depressed.

If the brake is pressed first followed by the accelerator pedal, the driver input (torque request) is executed.

# Subsystems of the Motronic

## throttle valve control part J338 with throttle valve drive G186, angle senders 1 G187 and 2 G188 for throttle valve drive

The throttle valve control part comprises...

- ... throttle valve housing with throttle valve
- ... throttle valve drive G186 with reduction gear
- ... angle senders for throttle valve drive G187 and G188

Activated by the engine control unit, the throttle valve drive controls the air-flow rate necessary to develop the required torque. Feedback on momentary throttle valve position is provided by two potentiometers G187 and G188.

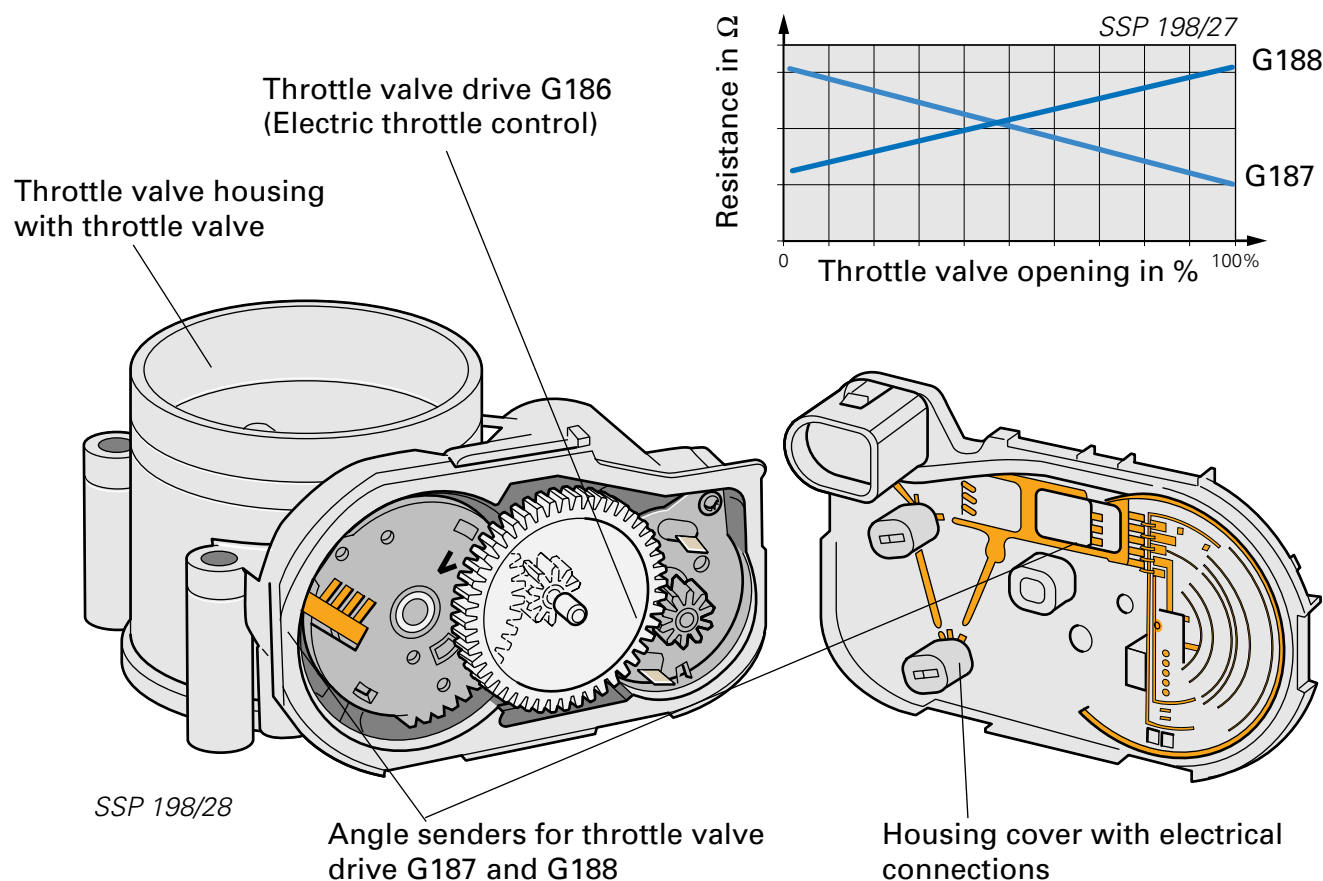
For safety reasons, two angle senders (redundancy) are used. They have opposite impedance characteristics (see diagram).

If an angle sender fails, the second sender maintains the electronic accelerator function via an emergency running program.



Angle senders G187 and G188 cannot be replaced separately. The throttle valve control part may not be opened.

Redundancy means: superfluous, non-essential.



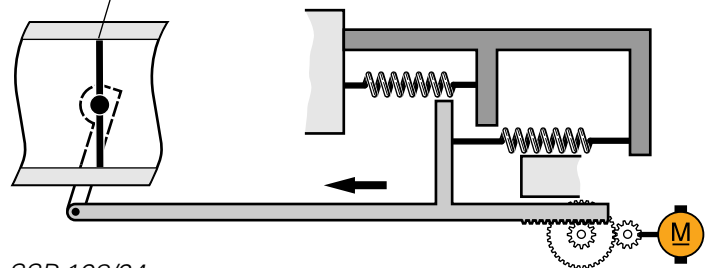
## Functional positions of throttle valve control part (linear representation)

The engine control unit recognises four key functional positions of the throttle valve control part.

- **The lower mechanical limit stop**

The throttle valve is closed. This position is required to adapt the angle sender.

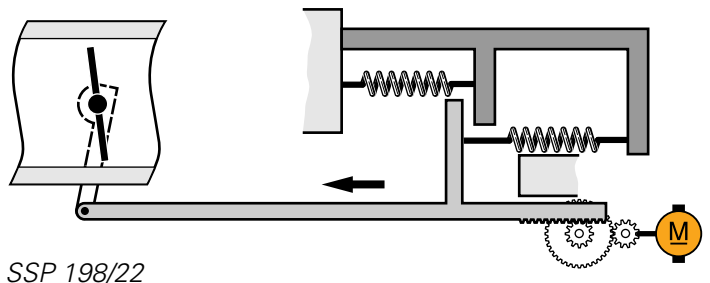
Lower mechanical limit stop



- **The lower electrical limit stop**

is defined by the control unit and is located just below the lower mechanical limit stop. During operation, the throttle valve closes no further than the lower electrical limit stop. This prevents the throttle valve working its way into the throttle valve housing.

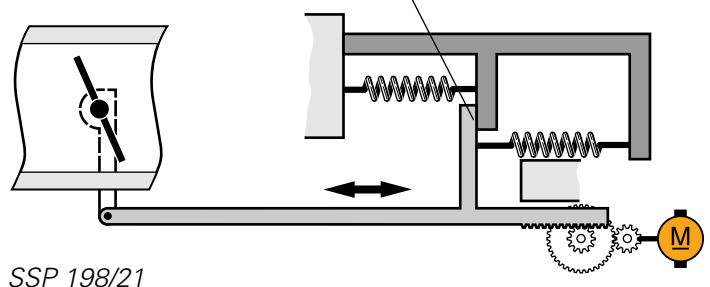
Position of lower electrical limit stop



- **The emergency running position**

is the position of the throttle valve in the deenergised state and ensures that air flow is sufficient if any of the relevant electronic accelerator functions fails. Idling speed is higher - approx. 1000 rpm - and uneven. Very limited vehicle operation is possible.

Emergency running position



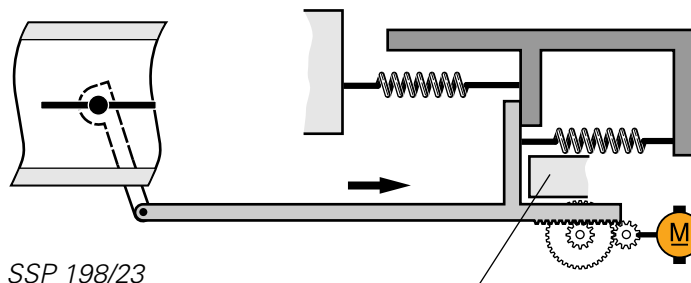
# Subsystems of the Motronic

- **The upper electrical limit stop** is defined in the control unit does not need to be learned.

Position at upper electrical limit stop



As in the **fully open position**, the shaft diameter is greater than the thickness of the throttle butterfly.



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Upper mechanical limit stop

To enable the exact angular position of the throttle valve to be identified, angle senders for throttle valve drive G187 and G188 must be learnt .

By moving the throttle valve into predefined positions, the values of the angle senders are stored in the control unit (calibrated) and checked for plausibility. The state of the mechanics (terminals, weak springs) in the throttle valve control part is determined by evaluating the throttle valve's reaction speed.

## Basic adjustment (adaption) ...

... involves not only learning the throttle valve position, but also a complete check of the throttle valve control part

... can be performed using the following three methods:

- **manually** - provided the ignition has been switched on for at least 24 minutes without operating the starter or accelerator.
- **automatically** - provided the need for adaption is acknowledged.
- **specifically** - by initiating basic setting 04 in measured value block 60 (refer to Workshop Manual)



### Adaption conditions

For basic setting (adaption), the test conditions described in the Workshop Manual must be met.

The basic setting routine will be cancelled if the test conditions are not fulfilled **while** it is in progress.

## Self-diagnosis/emergency running mode

If a fault occurs in the throttle valve control part or in the wiring, three emergency running programs can be run, depending on fault type.

### Emergency running program 1

**If an angle sender for throttle valve drive fails or an implausible signal is received:**

- Torque-increasing requests on engine, e.g. CCS, EBC (engine braking control) are suppressed.
- The fault lamp for electrical throttle control K132 comes on.



#### **Prerequisite:**

An intact angle sender and plausible air mass flow. The air mass flow is indicated by the air mass meter and the charge pressure sender G31.

### Emergency running program 2

**If the throttle valve drive fails or malfunctions:**

- The throttle valve drive is switched off and the throttle valve goes into the emergency running position. This results in considerable loss of power, increased idling speed and possibly also rough idling.
- Driver inputs are executed as far as possible via the ignition angle and charge pressure. The engine shows little response to the throttle.
- The fault lamp for electrical throttle control K132 comes on.



#### **Prerequisite:**

Emergency running program 2 is only run if both angle senders for throttle valve drive recognise the emergency running position.

### Emergency running program 3

**If the throttle valve position is not clearly recognisable and/or if the throttle valve is not definitely known to be in the emergency running position:**

- The throttle valve drive is switched off and the throttle valve goes into the emergency running position. This results in considerable loss of power, increased idling speed and possibly also rough idling.
- The engine speed is limited to approx. 1200 rpm by restricting the injection.
- The fault lamp for electric throttle control K132 comes on.



Repair work may not be performed on the throttle valve control part J338! If G186, G187 or G188 becomes faulty, unit J338 must be replaced completely and a **basic setting performed**.



# Subsystems of the Motronic

## Fault lamp for electric throttle control K132

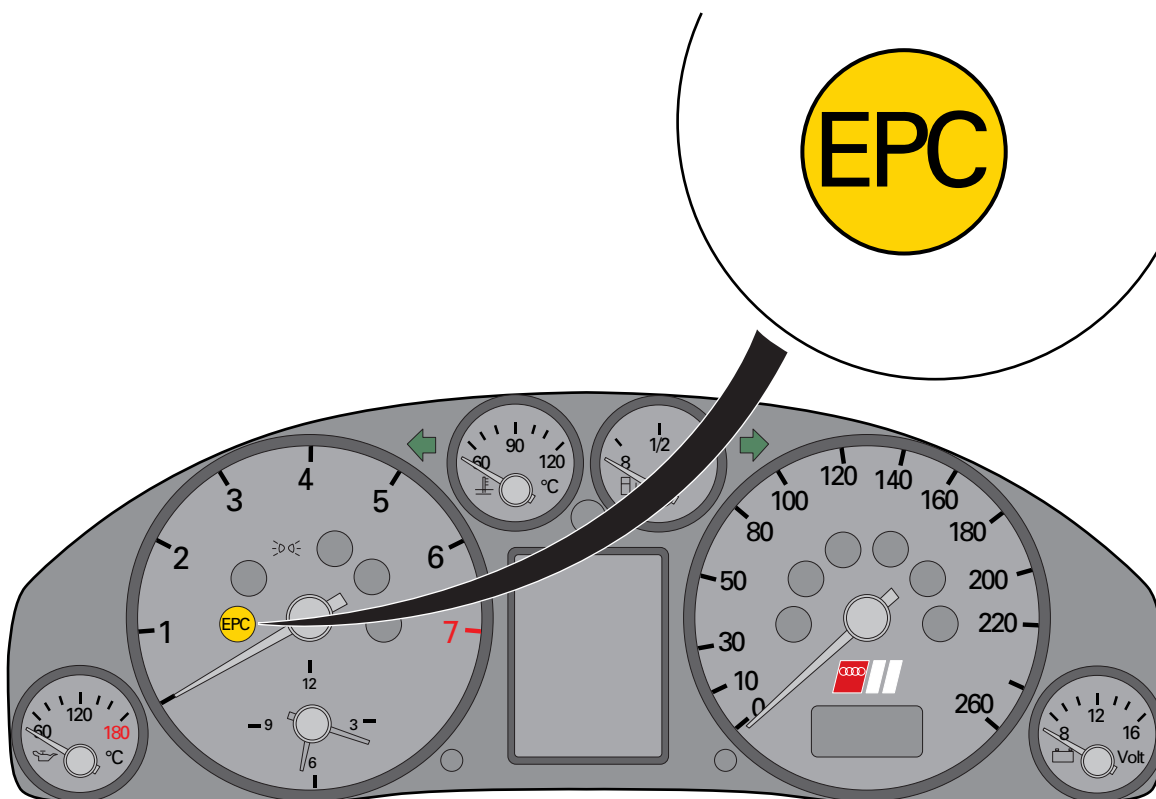
Faults in the Electronic Accelerator System are detected by the self-diagnosis and indicated via the separate EPC fault lamp. At the same time, an entry is made in the fault memory.

When the ignition is turned on, the fault lamp comes on and must go out again after 3 seconds if a fault state does not exist.

Fault lamp K132 is activated directly by the engine control unit via an earth potential.

If a fault occurs in the Electronic Accelerator System, an appropriate emergency running program will be activated (refer to Accelerator position sender and throttle valve control part).

**EPC** stands for **E**lectronic **P**ower **C**ontrol.



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In keeping with our policy of continuous product improvement, the accelerator position sender has been replaced by the **accelerator pedal module**.

The accelerator pedal module has already been used in other vehicle models within the Group.

The accelerator pedal module combines the accelerator pedal and the accelerator position sender as a unit.

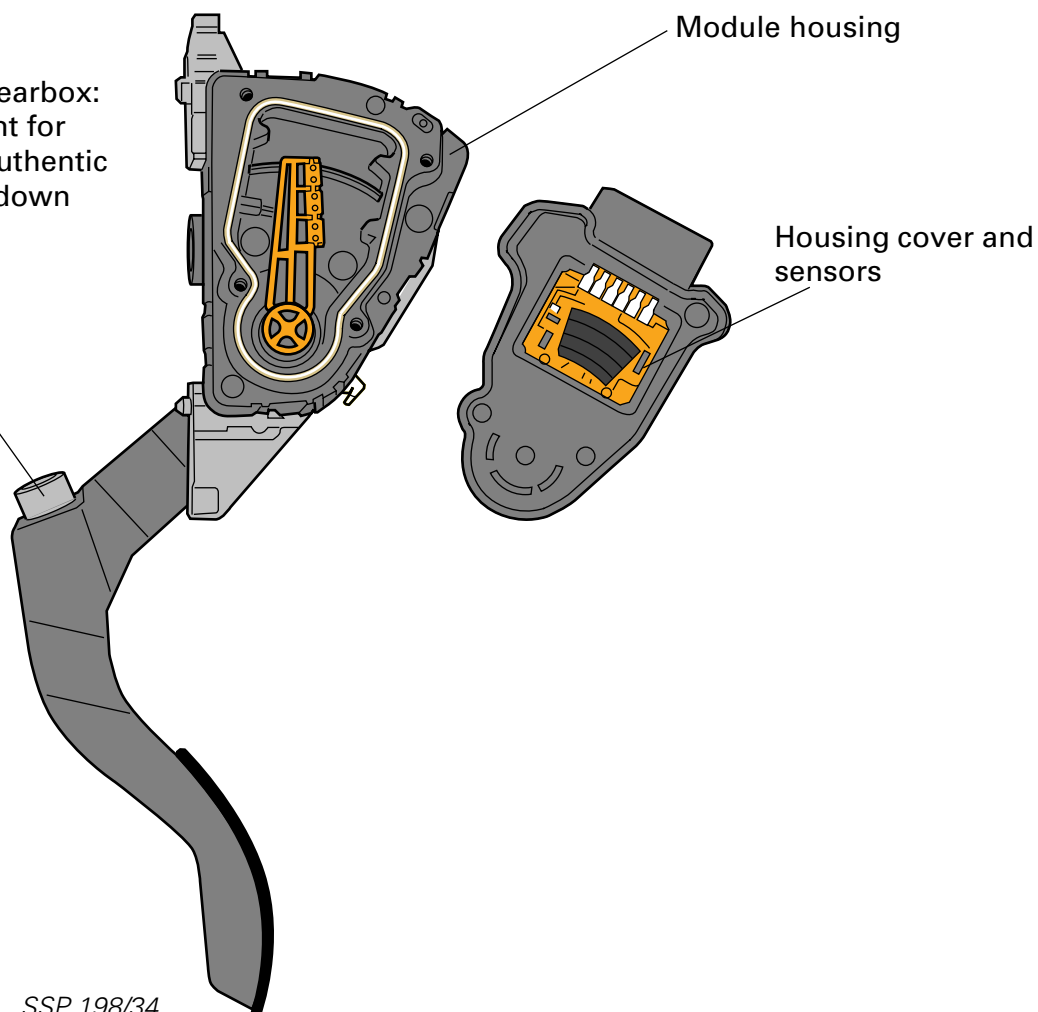
The mechanics of the accelerator pedal module are located inside the module housing. Sensors G79 and G185 are located in the housing cover.

#### **Advantages of the accelerator pedal module:**

- Compact, lightweight, easy to assemble
- Modular technology
- Inexpensive to manufacture

For manual gearbox:  
Stop buffer

For automatic gearbox:  
Pressure element for  
conveying the authentic  
feeling of a kickdown



# Subsystems of the Motronic

## Exhaust gas temperature control



A new feature of Audi automobiles is a function which monitors exhaust gas temperature over the entire engine speed range.

For turbocharged engines, the maximum permissible exhaust gas temperature is a key design criterion.

To protect the exhaust gas turbocharger and the exhaust manifold, the exhaust gas temperature should not exceed 1000 °C for a lengthy period of time.

Since many of the components which influence the exhaust gas temperature have tolerances, thermodynamic adaptation previously took place at 950 °C for safety's sake.

This was achieved by enriching the air/fuel mixture.

The exhaust gas temperature is recorded in a cylinder-bank-specific manner by the two exhaust gas temperature senders G235 and G236.

The Motronic controls the exhaust gas temperature to 980 °C by enriching the air/fuel mixture .

It is therefore possible to largely dispense with the prophylactic enrichment process that has been standard practice until now.

The mixture is only enriched...

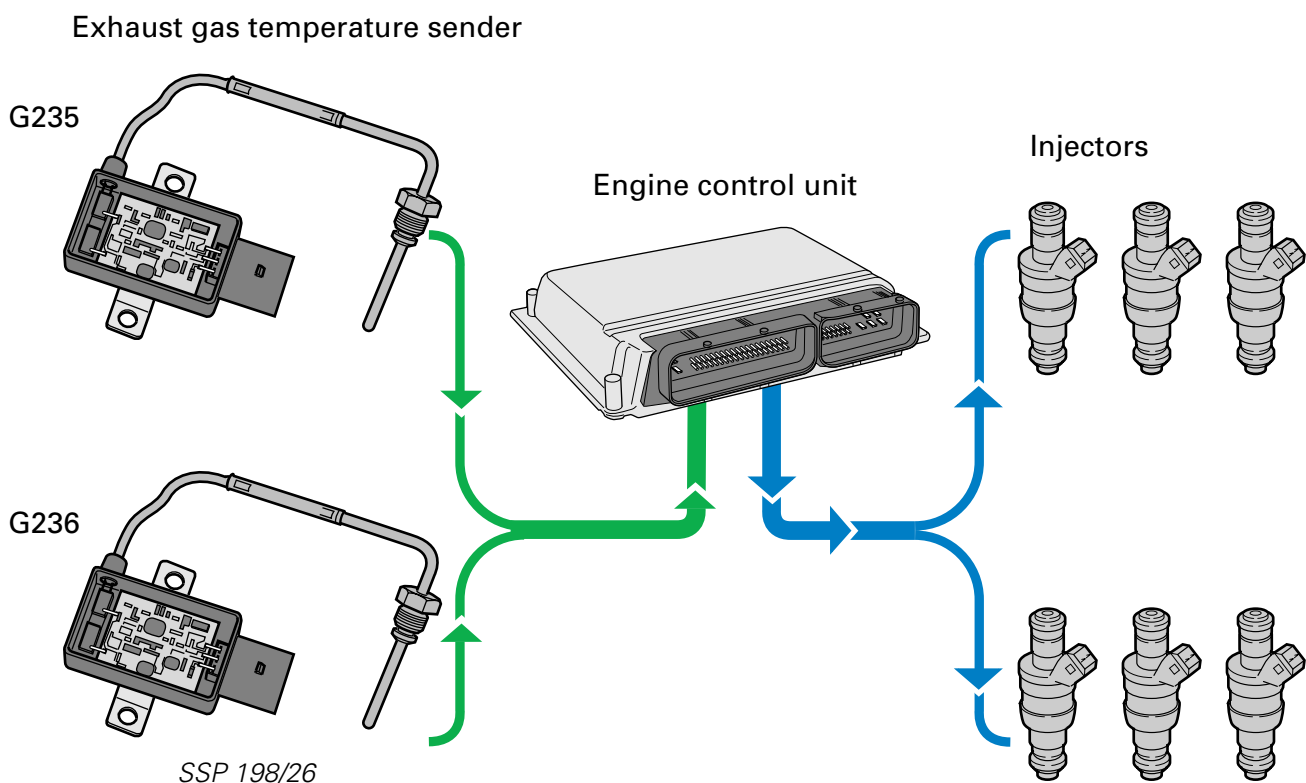
... when necessary and

... to the extent necessary.

This means that engine operation with  $\lambda = 1$  is possible up to high load and engine speed ranges.

### Advantage:

- Improved efficiency and reduction of fuel consumption as well as exhaust emissions.



## Exhaust gas temperature sender G235 and G236

To facilitate exhaust gas temperature control, the exhaust gas temperature must be recorded to a high degree of accuracy.

An accuracy of  $\pm 5\text{ }^{\circ}\text{C}$  is achieved in the measurement range from  $950\text{ }^{\circ}\text{C}$  to  $1025\text{ }^{\circ}\text{C}$ .

The exhaust gas temperature sender is located inside the exhaust manifold upstream of the exhaust gas turbocharger.

It comprises a measuring sensor and evaluation electronics.

The measuring sensor and the control unit are permanently connected by means of a shielded, heat-resistant wire.

The evaluation electronics convert the signal which the measuring sensor generates into a pulse-width-modulated signal (PWM signal).

This is a square-wave signal with a fixed frequency and a variable pulse duty factor.

The pulse duty factor is expressed as a percentage. The measurement range extends from  $\geq 10\%$  to  $\leq 90\%$ .

A specific pulse duty factor is assigned to each temperature (refer to diagram).

### Substitute function and self-diagnosis:

A pulse duty factor of  $<1\%$  or  $>99\%$  is recognised as a fault.

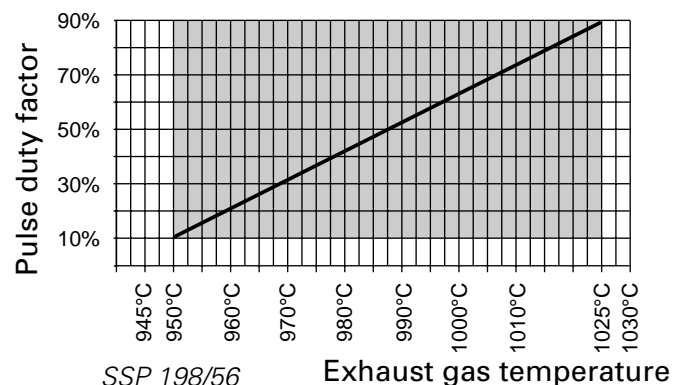
A fault is detected as of a certain enrichment quantity.

If a sender fails, the charge pressure is reduced to a safe level and an emergency enrichment characteristic (engine speed-dependent) is used.

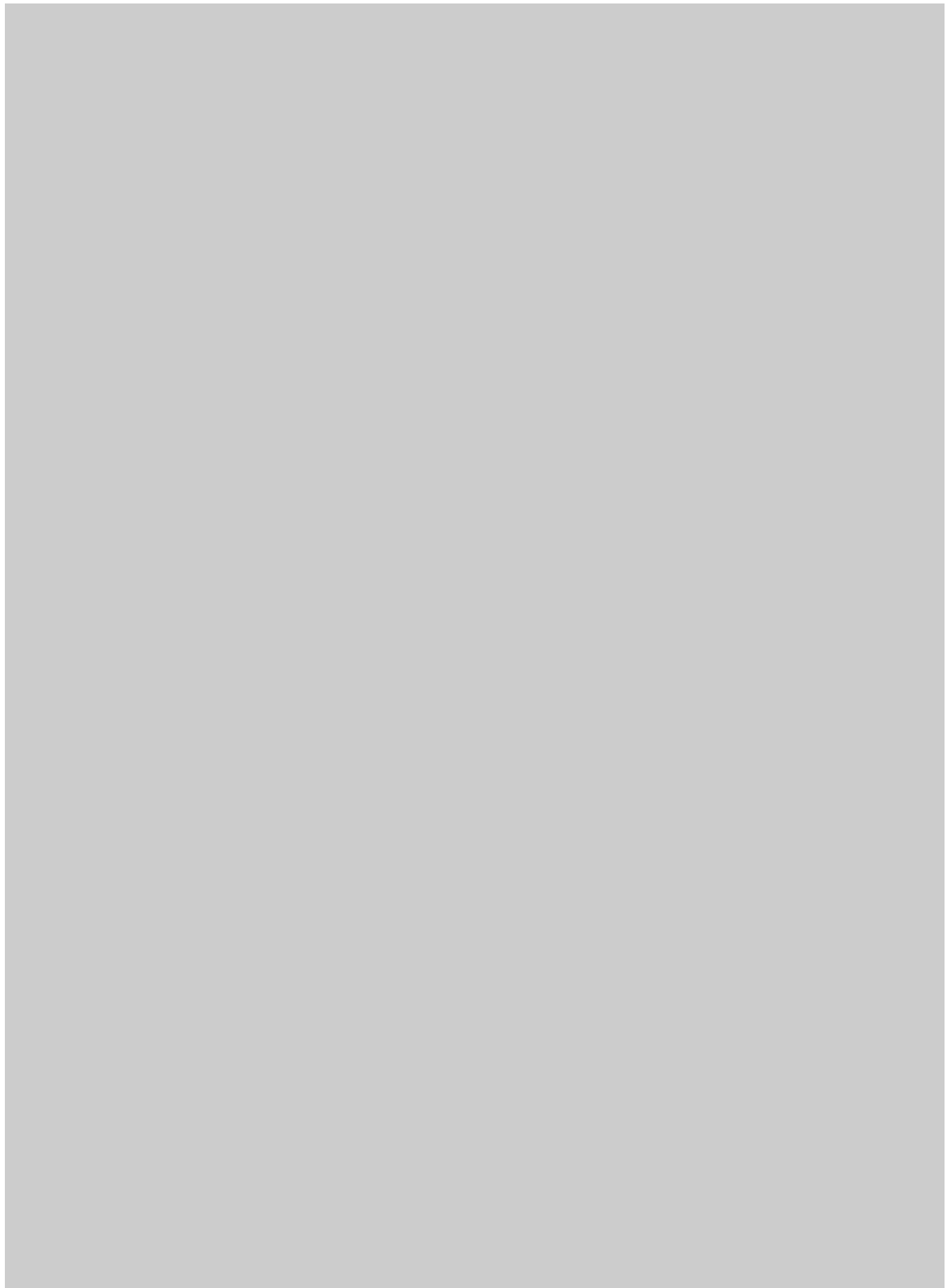
evaluation electronics

Meas.

Exhaust gas temperature sender



# Notes



The following chapter presents the new features of the sensors, provided that they have not already been described in the chapter on Subsystems of Motronic.

## Charge pressure sender G31

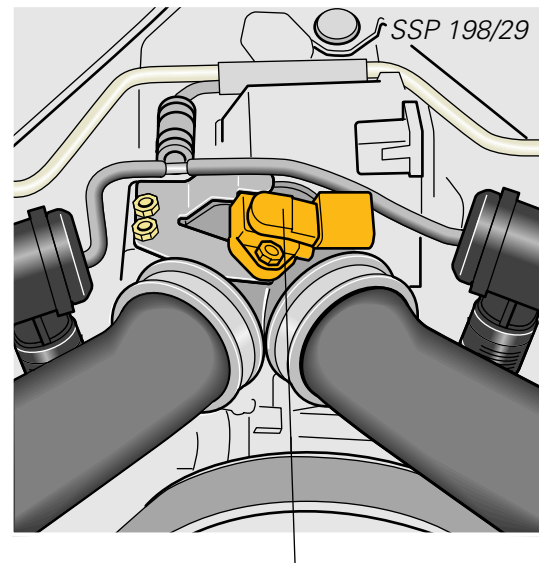
The charge pressure sender is located **upstream** of the throttle valve control part.

The Motronic supplies the sender with a voltage of 5 volts and earth.  
The signal which the sender generates is a pressure- proportional voltage ranging from 0 to 5 volts.

At atmospheric pressure (at sea-level), the voltage is approx. 2.5 volts.  
The signal is used for charge pressure control.

The Motronic also needs information on charge pressure so that it can take counter-measures if the maximum permissible pressure is exceeded.

**Substitute function and self-diagnosis:**  
If sender G31 fails, the charge pressure is controlled via the characteristic curve (engine speed-dependent). This will result in a deficiency of engine power.



Charge pressure sender G31

## The altitude sender F96 ....

... is integrated in the engine control unit, as is normally the case with turbocharged engines.

... is required to control the charge pressure. In conditions of decreasing air pressure (lower density), the charge pressure is reduced to prevent the turbocharger overspeeding.

... influences the air/fuel mixture composition at engine start-up. The starting mixture is leaned down with rising altitude.

### Substitute function and self-diagnosis

If a signal fails, the charge pressure is reduced to a safe level, which results in a deficiency of engine power.

Adaption of the injection quantity at start-up no longer takes place.

The fault message "Control unit defective" is displayed in the self-diagnosis.

## Hot-film air mass meter G70



The hot-film air mass meter operates on the same principle as before.  
In certain engine operating states, pulsations occur in the intake tract, reversing the air flow - and this gives rise to measurement errors.

The hot-film air mass meter is designed in such a way that it is able to recognise this returning air flow (pulsation fault).

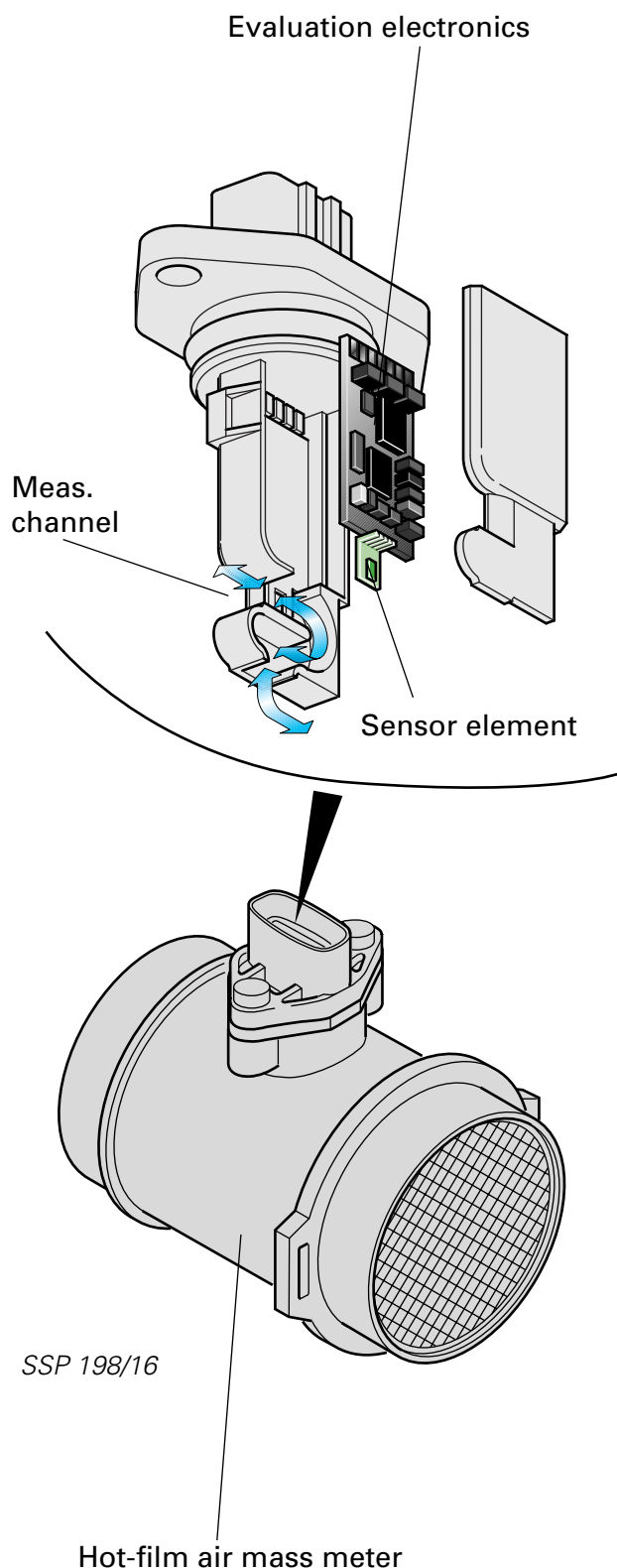
This more exact method of intake air measurement in all operating states improves engine management and reduces exhaust emissions.

The hot-film air mass meter is a thermal flowmeter. A partial airflow from the measuring pipe is fed past the sensor element through a measuring channel in the air mass meter housing.

The ascertained temperature values are evaluated in the evaluation electronics. The Motronic applies a voltage proportional to the air mass to the air mass meter. This voltage is needed to calculate the injection period and of actual engine torque.

### **Substitute function and self-diagnosis:**

The air mass meter detects air masses above or below predefined limits. If the air mass meter fails, the air mass is calculated on the basis of a characteristic curve (throttle valve angle and engine speed).





## The measuring principle of the return flow recognition

The sensor element is embedded in the mounting plate.

The sensor element comprises a diaphragm with a heating zone and two symmetrically arranged temperature sensors  $T_1$  and  $T_2$ .

The heating zone is set to an overtemperature by means of a heating resistor and temperature sensor  $T_2$ .

If there is an incoming flow, the upstream part of the diaphragm cools down along with the temperature sensor  $T_1$ .

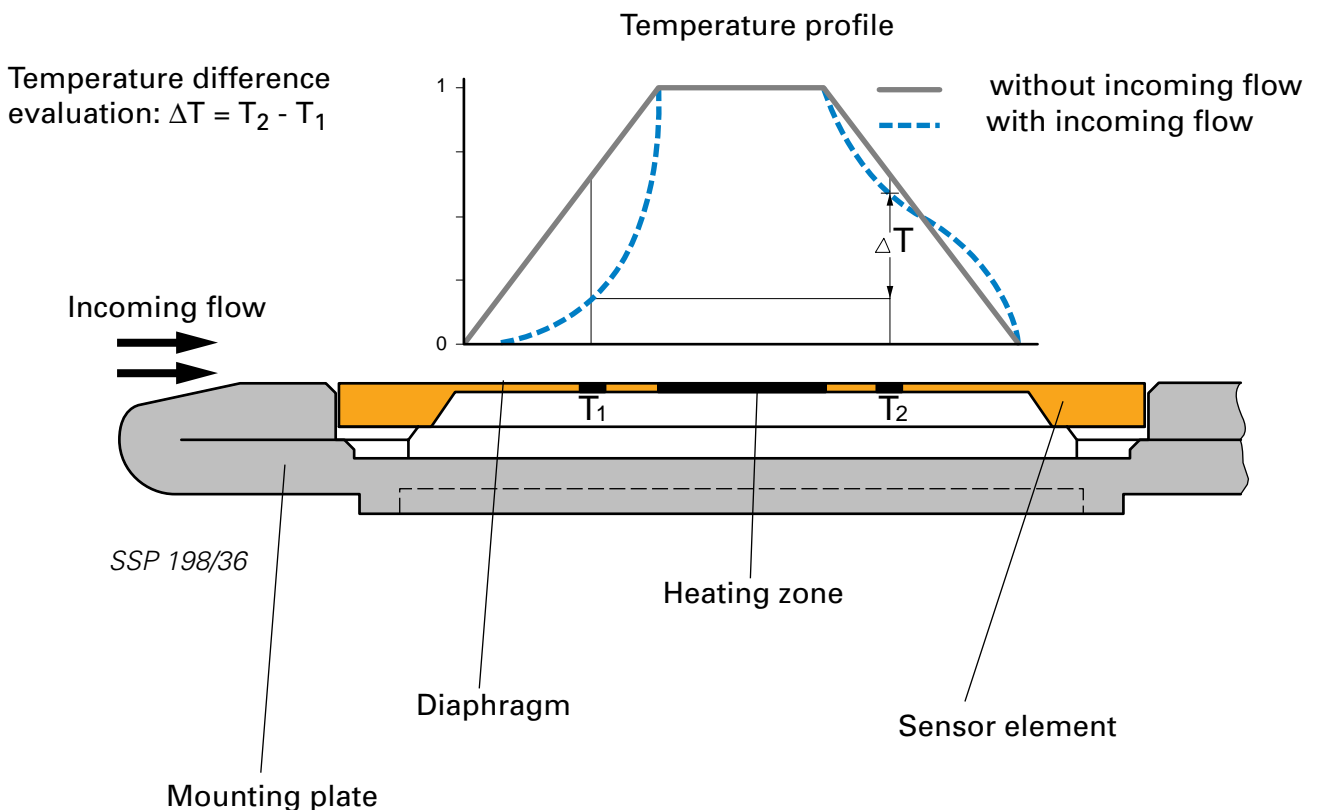
The temperature of the upstream temperature sensor  $T_2$  is maintained due to the heated air in the heating zone.

Temperature sensors  $T_1$  and  $T_2$  indicate a temperature difference of  $\Delta T$ .

In the case of a return air flow, the temperature difference occurs at temperature sensor  $T_1$ .

The amount and direction of this difference are therefore dependent on the incoming flow.

- Advantage: the differential signal permits a direction-dependent characteristic which enables the Motronic to detect a return air flow.



## Lambda probes G39 and G108

The planar lambda probe is a further development of the finger-type lambda probe and has a transient response at  $\lambda = 1$ . There is a single lambda probe in the exhaust pipe running to each of the primary catalytic converters.

To ensure that the exhaust gases are treated efficiently, it is important that the lambda probe should react quickly. The lambda probe should therefore reach its operating temperature within as short a space of time as possible. Its planar (= flat, elongated) design makes this possible.

The probe heater is integrated in the sensor element. It quickly reaches its operating temperature despite its lower heating capacity.

### Note:

At an exhaust gas temperature as low as 150 °C, the probe heater generates the necessary minimum temperature of 350 °C. The lambda control is ready to operate approx. 10 seconds after engine start-up.

A porous, ceramic protective layer is sintered onto the sensor element.

This layer prevents the sensor element being damaged by residues in the exhaust gas. It ensures that the sensor element will have a long service life and meet the tough functional demands.

### Substitute function:

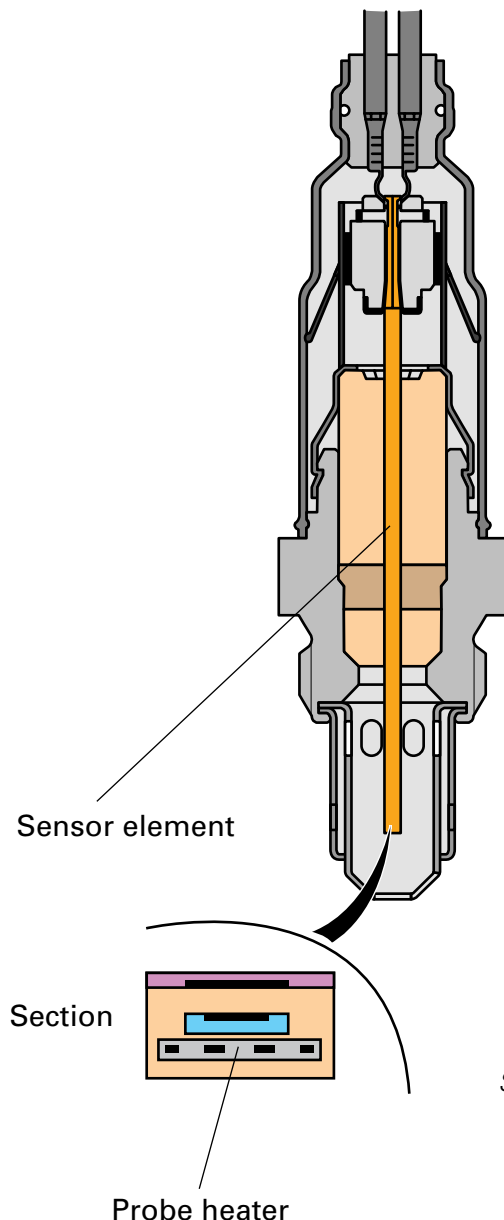
Controlled operation based on a characteristic curve (cylinder bank-specific).



A new generation of probes used in the biturbo for stereo lambda control.

### Advantages:

- The warm-up period is short, which means lower emissions during the warm-up phase
- Low heating power consumption
- More stable control characteristic



SSP 198/37

## Hall senders G40 and G163



On V-engines with variable valve timing, a Hall sender acting as a camshaft sensor is attached to the left- and right-hand cylinder banks.

To permit cylinder-selective knock control and sequential injection, cylinder 1 must be defined precisely.

The signal which Hall sender G40 supplies together with the signal which engine speed sender G28 generates (incremental sender for engine speed and reference mark) enable ignition TDC of cylinder 1 to be identified (synchronization of cylinder 1).

After the simultaneous input of both signals, initial injection and ignition are enabled.

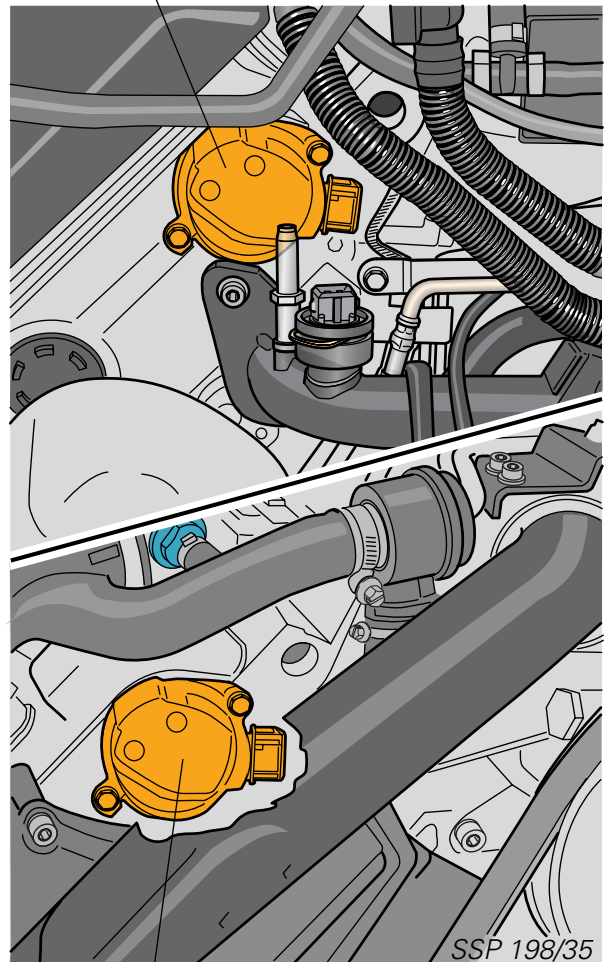
By using Hall senders G163 and G40 as camshaft sensors, the adjustment of both camshafts can be monitored closely and evaluated by the self-diagnosis.

### **Substitute function and self-diagnosis:**

If Hall sender G40 fails, Hall sender G163 takes on the task of synchronising first cylinder.

If both Hall senders fail, it is possible to start the engine and the engine runs with substitute functions.

Hall sender G40



Hall sender G163

## Engine speed sender G28

The engine speed sender is an inductive sender which records the engine speed and the exact angular position of the crankshaft (single-sender system).

Attached to the flywheel is a separate sender wheel for the G28.

The sender wheel is designed as a segmented wheel and is subdivided into 60 segments. If the sender wheel moves past G28, this produces an alternating voltage whose frequency changes as a factor of engine speed. The frequency is the magnitude of the engine speed.

To enable it to recognise the crankshaft position, there is a gap of two segments in the sender wheel.

The G28 recognises the engine speed. Together with Hall sender G40, the G28 recognises the exact position of the engine mechanics, i.e. ignition TDC of cylinder 1. The injection and ignition timing are determined using this information.

### **Substitute function and self-diagnosis:**

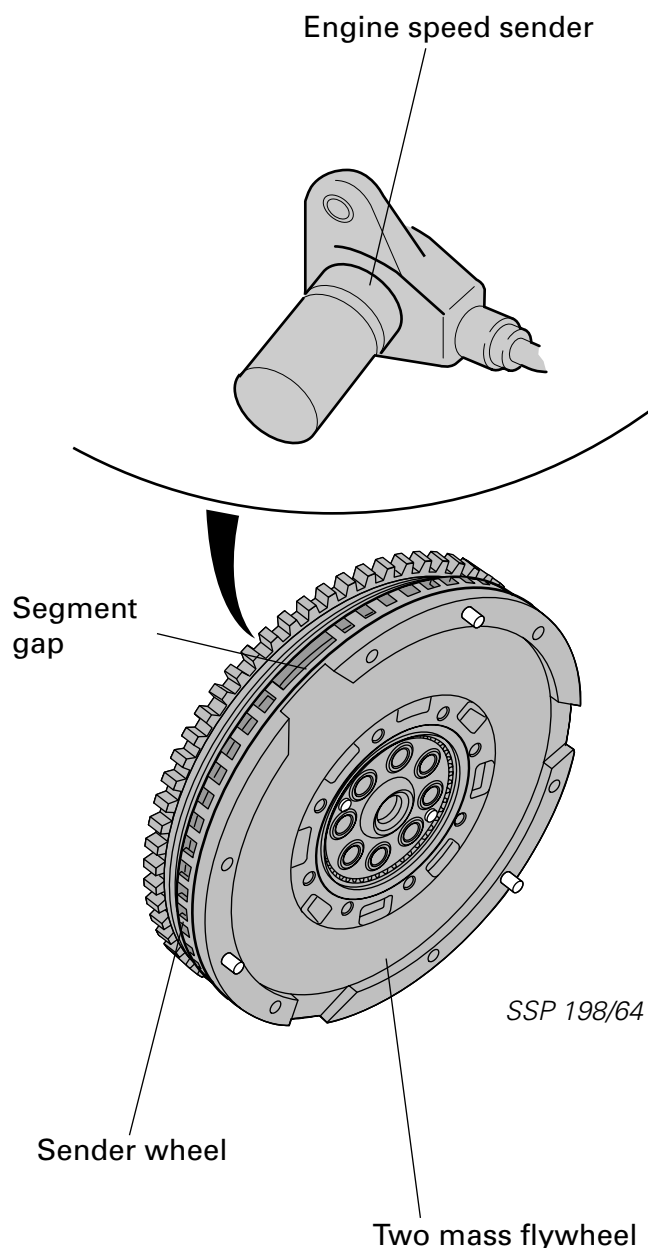
The signal which G28 generates is checked together with the signal supplied by the G40 for plausibility.

If the Motronic control unit does not detect any segment gaps during 8 "phases" of the G40, an entry is made in the fault memory.

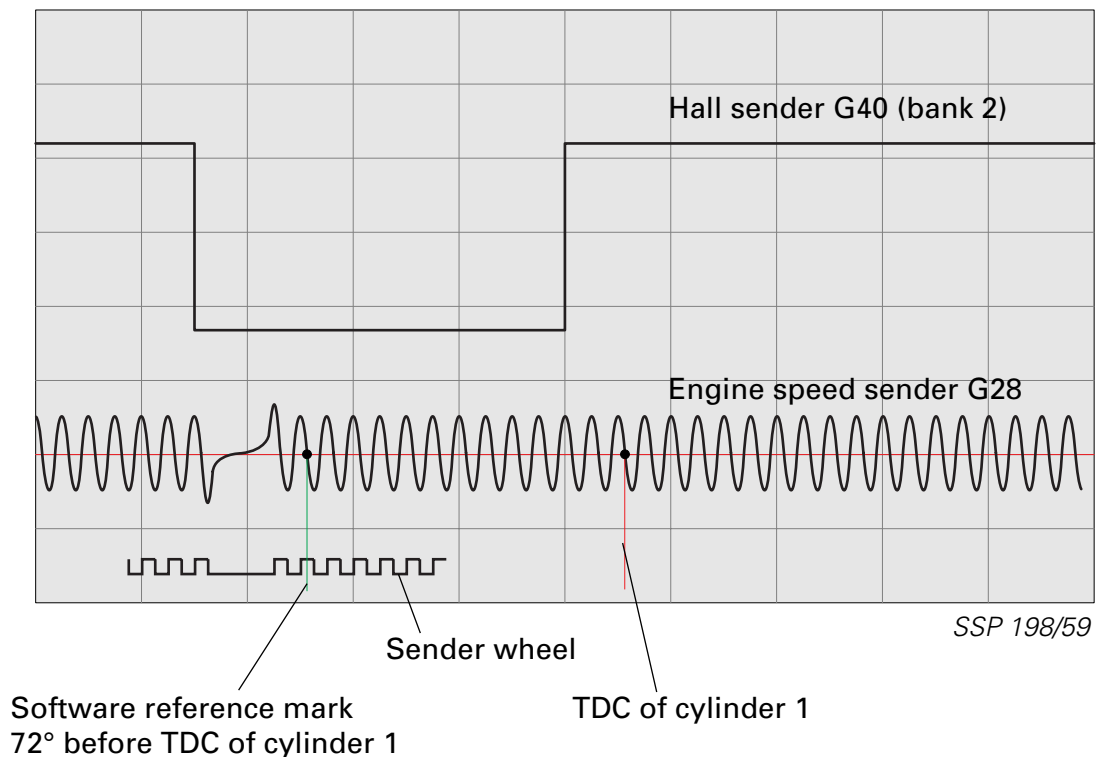
If the engine speed sender fails, it is not possible to start or run the engine.



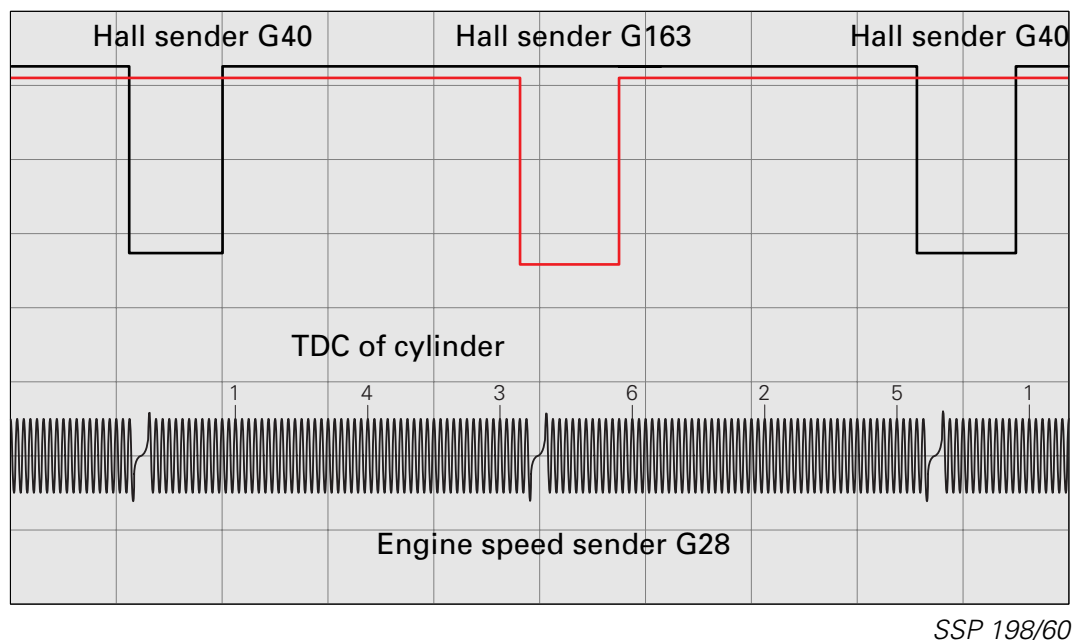
Since the G28 is an inductive sender, the self-diagnostics are unable to perform electrical tests (short circuit to positive or negative or open circuit).



**Diagram of signal of engine speed sender and Hall sender using the oscilloscope function of VAS 5051**



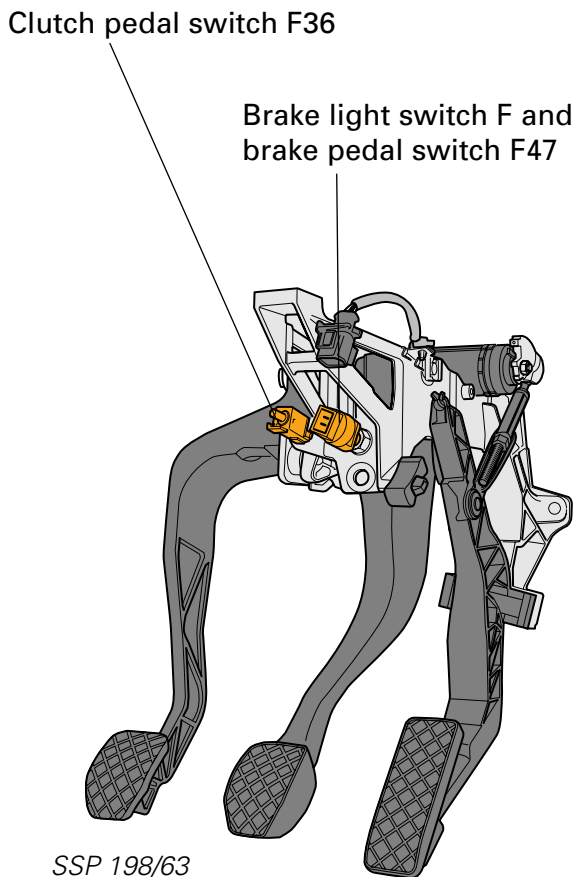
**Diagram of signal of engine speed sender and the two Hall senders**



Here, the signals which G40, G163 and G28 generate are shown combined for added clarity. A two-channel oscilloscope does not allow all three signals to be represented. The TDC mark of the belt pulley reflects the TDC of cylinder 3.



## Brake light switch F and brake pedal switch F47



The information “brake operated” is required for the following functions:

- Function of cruise control system
- Safety interrogation of electronic accelerator function (idling speed recognition during emergency running mode of accelerator position sender)

Brake light switch F and brake pedal switch F47 are combined as a unit. Both serve as information senders for “brake operated”, which means they are redundant (for safety reasons).

Brake light switch F is open in the “off” position and is supplied with voltage from terminal 30. It serves as an **additional** information input for the Motronic.

Brake pedal switch F47 is closed in the “off” position closed and is supplied with voltage from terminal 15. It serves **exclusively** as an information input for the Motronic.

### **Substitute function and self-diagnosis:**

The two switches are cross-checked for plausibility by the self-diagnosis.

Please read the note on the “Safety function” on page 39.

## Clutch pedal switch F36 ...

... switches the cruise control system off.

... deactivates the load change functions during the gearshift operation. The load change function is controlled via ignition angle intervention and throttle valve closing speed.

The clutch pedal switch is closed in the “off” position and is supplied with voltage from terminal 15.

### **Substitute function and self-diagnosis:**

The F36 is not included in the self-diagnosis, which means that no substitute functions are initiated.



Wrong settings, electrical malfunctions or maloperation (driver keeps foot on clutch pedal) may result in load change jolts or engine speed overshoots.

# Additional signals/interfaces

## Additional signals/interfaces to Motronic ME 7.1

The Motronic receives a large number of additional signals.  
The following overview shows the signal direction and meaning referred to the Motronic control unit



The term “interfaces” is used to describe the control unit connections and wiring connections of the various control units.

Input signal	Output signal	Bidirectional	Signal meaning
		●	CAN-high, data bus signal for automatic gearbox
		●	CAN-low, data bus signal for automatic gearbox
●			CCS, “set/decelerate” signal for cruise control system
●			CCS, “Off” signal for without cancellation cruise control system
●			CCS, “On/Off” signal for with cancellation cruise control system (master switch)
●			CCS, “Resume/accelerate” signal for cruise control system
●			Road speed signal
		●	Immobiliser/diagnosis signal
		●	Air conditioner compressor “On/Off” signal
●			Coolant temperature signal
	●		Engine speed signal
	●		Fuel consumption signal

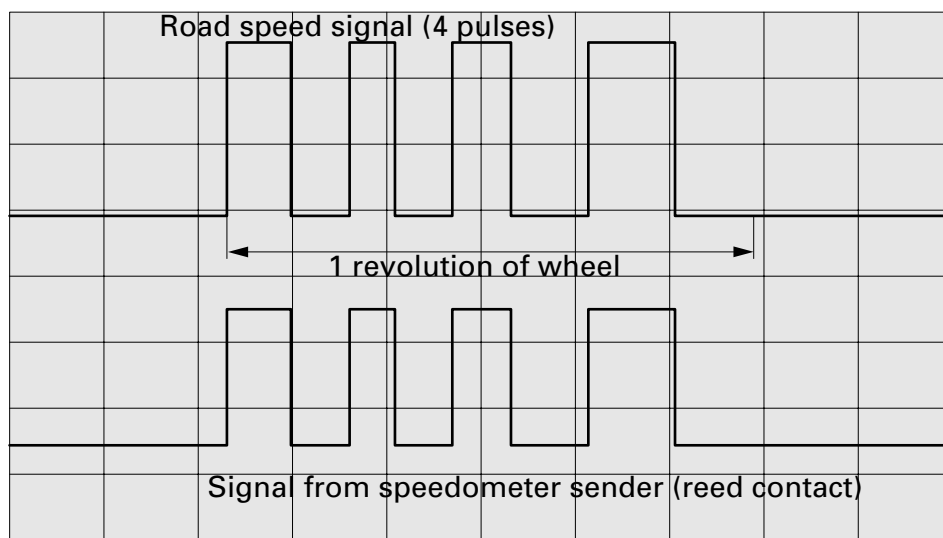


# Additional signals/interfaces

## The road speed signal ...

... is required for operation of the cruise control system, speed limiter, load change measures, idling speed stabilisation and internal safety checks of the control unit (e.g. adaption conditions).

... is a square-wave signal which is conditioned by the dash panel insert. The frequency of this signal changes as a factor of road speed. The dash panel insert transfers 4 pulses per revolution of the wheel.



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## Coolant temperature signal

The engine control unit receives from the dash panel insert a coolant temperature signal calculated from the signal which coolant temperature sender G2 generates and a related temperature characteristic. The signal is a "data message" and is connected to the earth potential when a temperature of approx. 120 °C is exceeded. In this case, the air conditioner's operating and display unit switches the compressor off along the bidirectional wire designated "Air-conditioner compressor On/Off".

As of a temperature of 116 °C, the charge pressure is reduced in order to counteract a further rise in temperature. If the temperature drops below a value of approx. 116 °C, a data message is again transferred and all actions previously performed are reversed.

## The “Compressor On/Off” interface ...

... serves to provide the engine control unit with information on the circuit state of the compressor.

... enables the engine control unit to switch off the compressor or inhibit start-up.

... provides a link to the air conditioner's operating and display unit.

### **The interface as a signal input:**

Shortly before switching on the magnetic coupling, the air conditioner's operating and display unit applies voltage to the interface. The engine control unit then increases the idling speed to compensate for the higher engine load.

### **The interface as a signal output:**

If the engine control unit applies an earth potential to the interface, the compressor is switched off for a defined period of time as required.

### The engine control unit switches the compressor off in the following situations:

- After initiating basic setting (function 04)
- In certain emergency running programs within a defined engine speed range

## The immobiliser/diagnosis interface ...

... is the communication link between the engine control unit and the immobiliser in the dash panel insert.

... also serves as the diagnosis wire (K-wire) for the diagnosis tester. Dialogue takes place via: diagnosis plug ⇔ dash panel insert interface ⇔ immobiliser/diagnosis interface ⇔ engine control unit

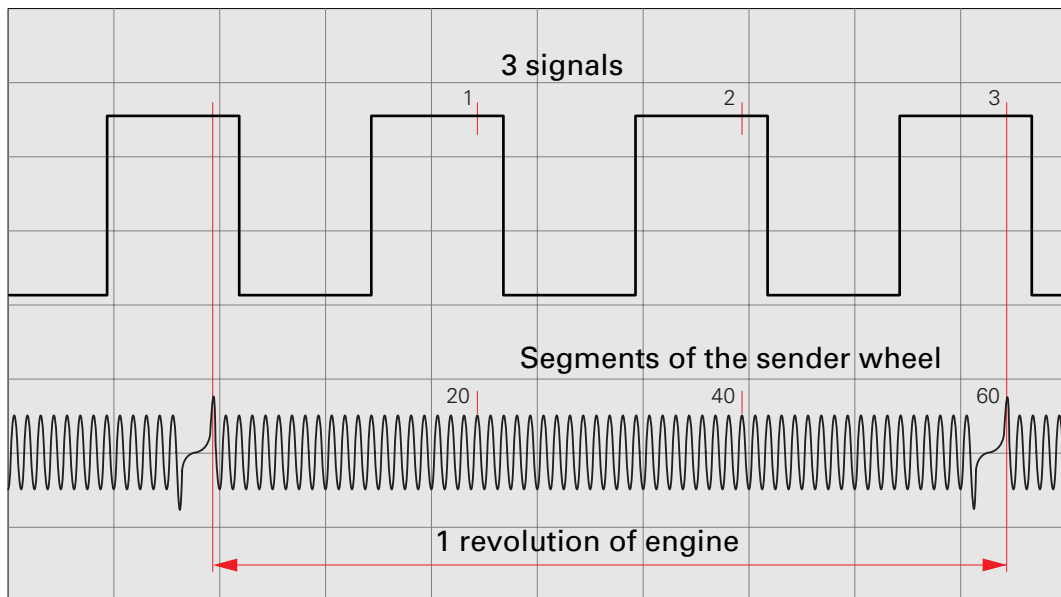
# Additional signals/interface

## The engine speed signal...

... is a square-wave signal which is conditioned by the engine control unit and whose frequency is synchronous with engine speed. The duty factor is approx. 50%. Three signals are transferred per revolution of the engine.

... is required by the following system components:

- Dash panel insert
- Automatic gearbox
- Air conditioner



SSP 198/61

## The CAN-high/CAN-low interfaces ...

... serve to transfer data between the control units.

The CAN data bus (**C**ontroller **A**rea **N**etwork) is a serial data transfer system.

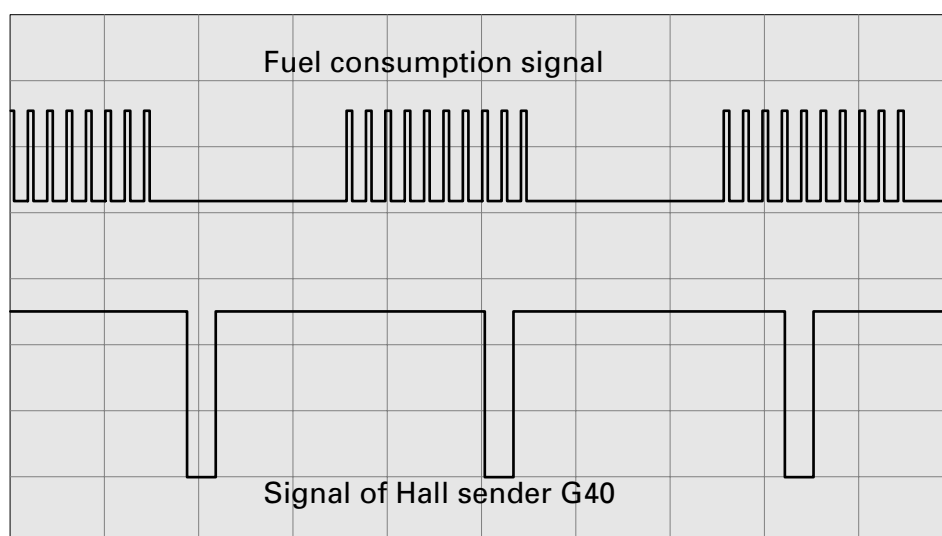


You can find detailed information regarding the CAN databus in SSP 186.

## The fuel consumption signal...

... is a data message which is conditioned by the engine control unit. The sum total of the high levels during a defined period of time corresponds to the injected fuel quantity.

... is required by the dash panel insert to calculate fuel consumption and range.



SSP 198/68



Signal at idling speed in a time grid of 50 ms/div.

## The interfaces of the cruise control system (CCS) ...

... are linked to the controls on the steering column switch.

The CCS must be enabled or disabled using the "login procedure" function (as with TDI engines).



Cruise control is executed by the engine control unit by means of the electronic accelerator function.

When the control unit is enabled, a "G" appears in the control unit identification (refer to Workshop Manual).

Road speed can be kept constant as of approx. 25 kph.

# Functional diagram

## Components:






F	Brake light switch
F36	Clutch pedal switch
F47	Brake pedal switch
F96	Altitude sender (integrated in engine control unit)
G2	Coolant temperature sender
G6	Fuel pump
G28	Engine speed sender
G31	Charge pressure sender
G39	Lambda probe (cylinder bank 1)
G40	Hall sender (cylinder bank 2)
G42	Intake air temperature sender
G 61	Knock sensor (cylinder bank 1)
G62	Coolant temperature sender
G66	Knock sensor (cylinder bank 2)
G70	Air mass meter
G79	Accelerator position sender 1
G108	Lambda probe (cylinder bank 2)
G163	Hall sender (cylinder bank 1)
G185	Accelerator position sender 2
G186	Throttle valve drive (electric throttle control)
G187	Angle sender 1 for throttle valve drive
G188	Angle sender 2 for throttle valve drive
G235	Sender 1 for exhaust gas temperature
G236	Sender 2 for exhaust gas temperature
J17	Fuel pump relay
J220	Motronic control unit
J338	throttle valve control part
K132	Warning lamp for electric throttle control
N	Ignition coil, cylinder 1
N30	Injector, cylinder 1
N31	Injector, cylinder 2
N32	Injector, cylinder 3
N33	Injector, cylinder 4
N75	Solenoid valve for charge pressure control
N80	Solenoid valve for activated charcoal canister
N83	Injector, cylinder 5
N84	Injector, cylinder 6
N122	Output stage (cylinder bank 1)
N128	Ignition coil, cylinder 2
N158	Ignition coil, cylinder 3
N163	Ignition coil, cylinder 4
N164	Ignition coil, cylinder 5

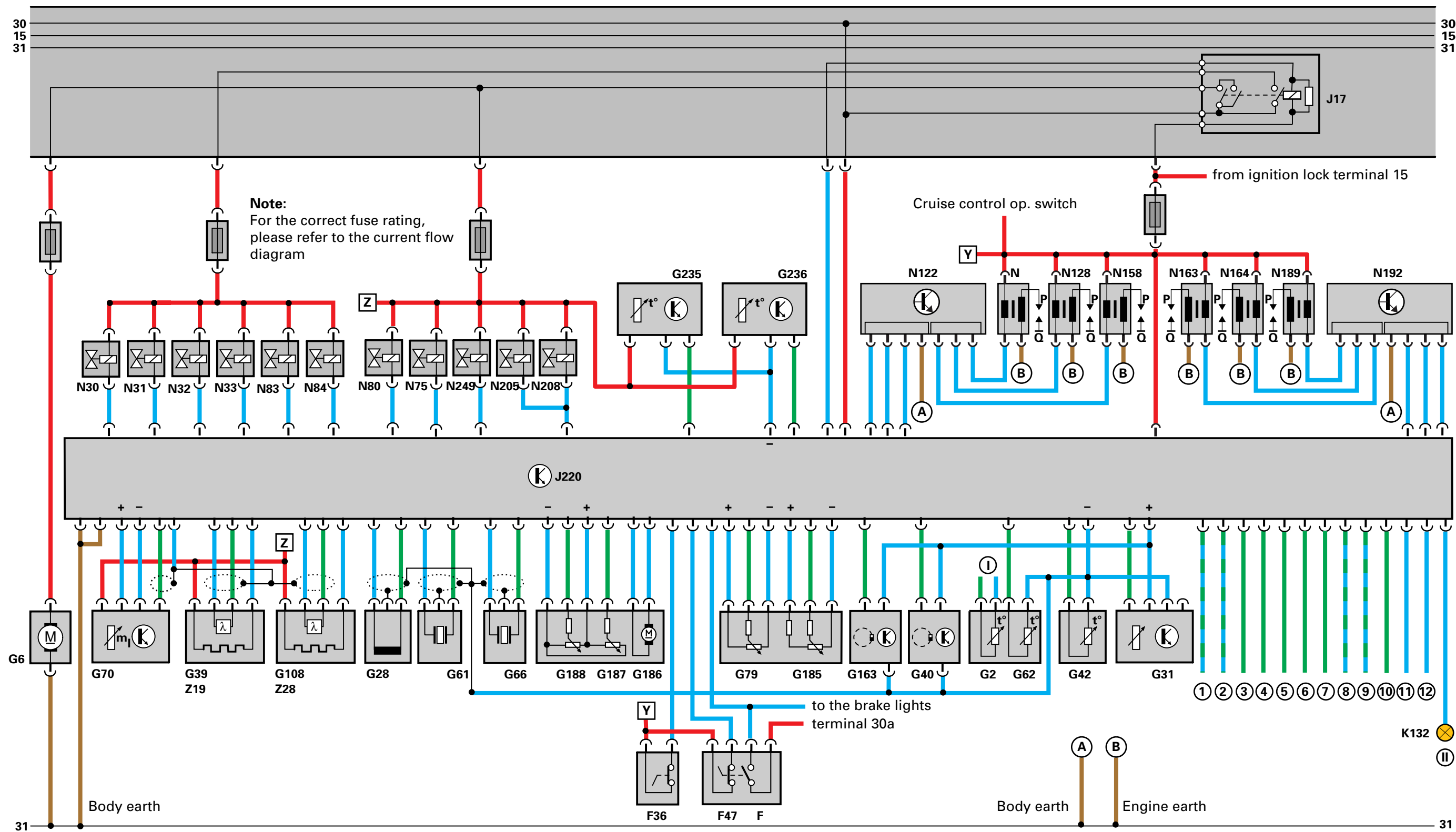
N189	Ignition coil, cylinder 6
N192	Output stage (cylinder bank 2)
N205	Camshaft adjustment valve 1 (cylinder bank 1)
N208	Camshaft adjustment valve 2 (cylinder bank 2)
N249	Divert air valve for turbocharger
Z19	Heater for lambda probe
Z28	Heater for lambda probe 2
I	To dash panel insert
II	To dash panel insert (warning lamp)

## Additional signals

1	CAN-high (automatic gearbox)
2	CAN-low (automatic gearbox)
3	„Set/decelerate“ signal for cruise control system
4	“Off” signal without cancellation for cruise control system
5	“On/Off” signal with cancellation for cruise control system
6	Resume/accelerate” signal for cruise control system
7	Road speed signal
8	Immobiliser/diagnosis signal
9	Air conditioner compressor “On/Off” signal
10	Coolant temperature signal
11	Engine speed signal
12	Fuel consumption signal

## Colour codes:

	Input signal
	Output signal
	Positive
	Earth
	Bidirectional



# Self-diagnosis

## Vehicle diagnosis, test and information system VAS 5051

VAS 5051 has the following three operating modes:

### Vehicle self-diagnosis

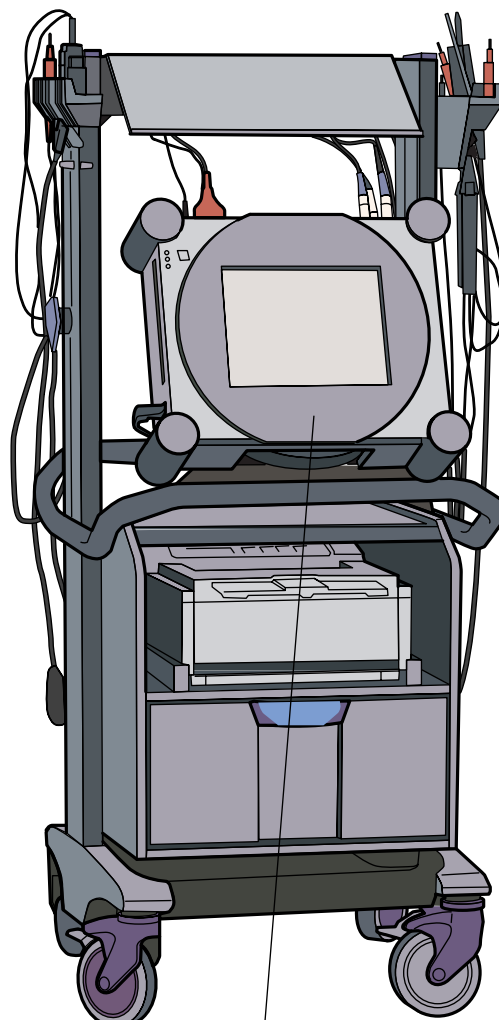
- Communication via the vehicle's diagnosis interface
- Offers the functional capability of currently available diagnosis testers V.A.G 1551 and V. A. G 1552

### Test instruments

- Measurement of the vehicle's electrical parameters (voltage, current, resistance) and testing of diodes
- DMO (Digital Memory Oscilloscope) for representing the voltage curves of the various individual sensors and actuators

### Guided fault finding

- Vehicle and control unit identification
- A test plan is prepared on the basis of the fault messages issued by the the self-diagnosis, the fault description of customer complaints or assumptions regarding the cause of the trouble.



SSP 198/39

VAS 5051



You will find introductory notes and technical information on this system in Self-Study Programme 202.

For self-diagnosis, please use the Workshop Manual in which the procedure for the various individual functions is described.



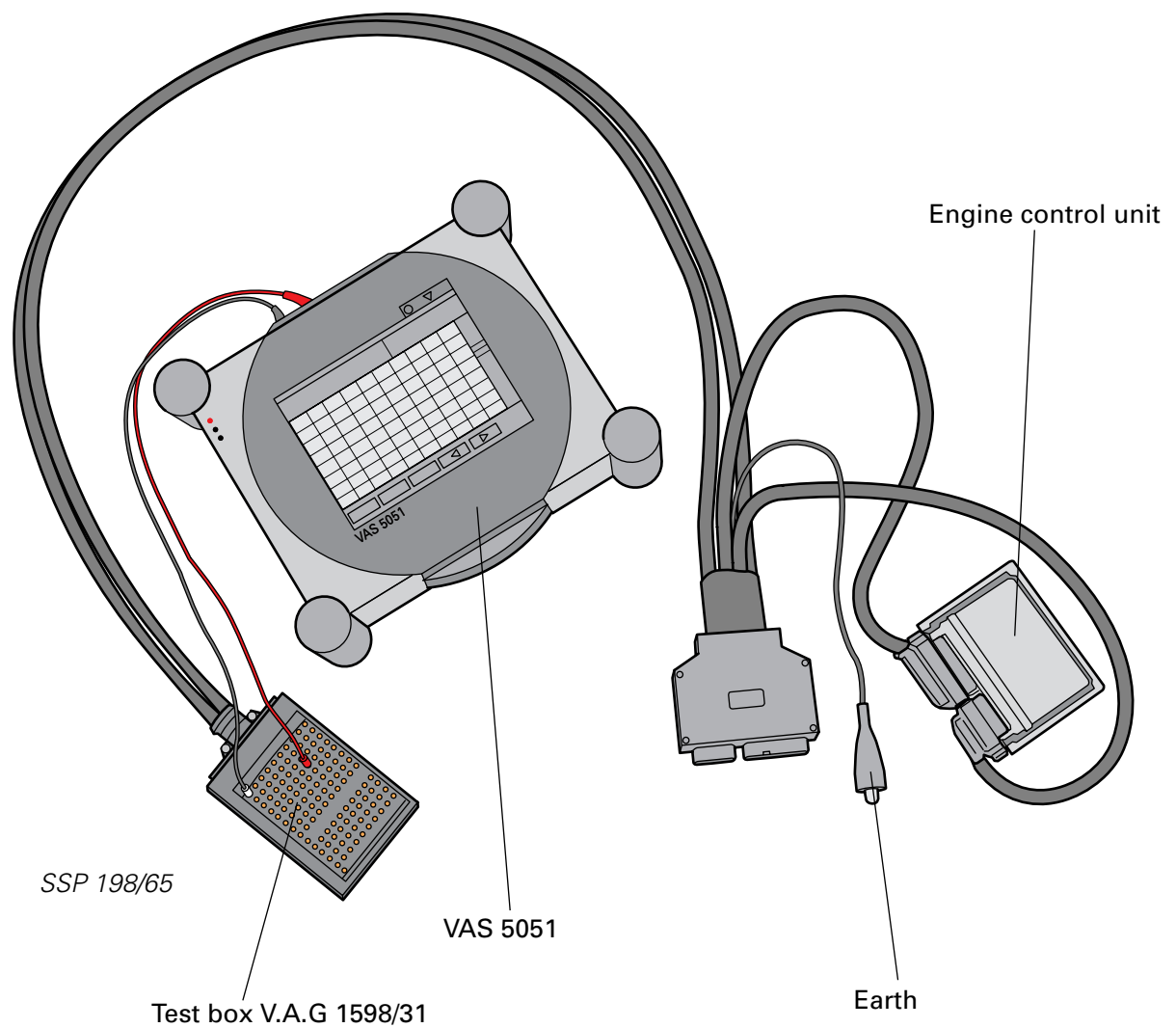
## Test box V.A.G 1598/31

The new test box V.A.G 1598/31 is used to carry out tests on the Motronic ME 7.1.

It also allows tests to be performed while the engine is running.



The test leads V.A.G 1598/31-1 (1 metre long) and V.A.G 1598/31-2 (2.5 metres long), which are additionally screened, give greater flexibility and protection against electromagnetic interference.



# Power Transmission

## Self-adjusting clutch

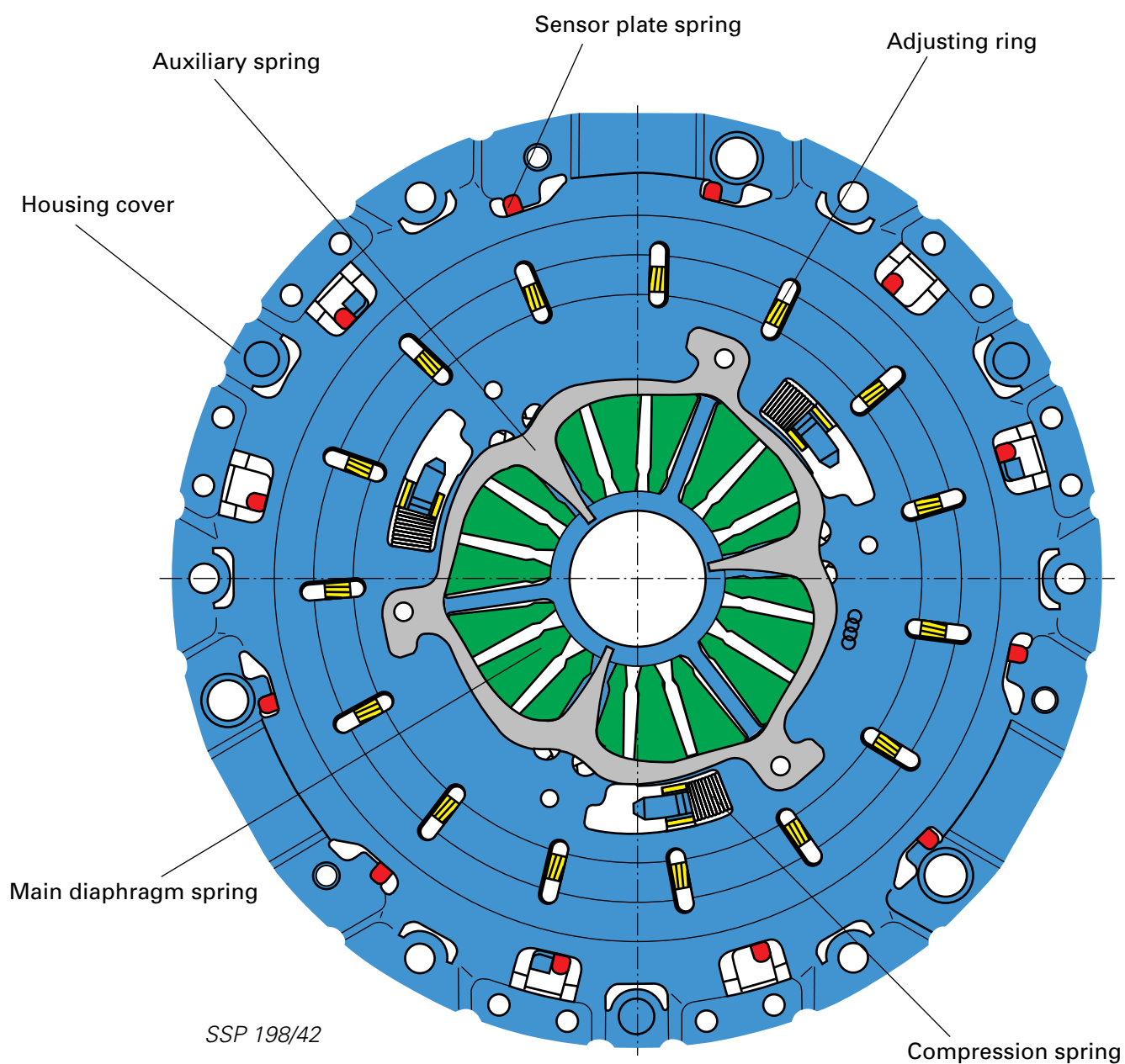


For the biturbo engines, Audi is using an SAC clutch pressure plate with a wear compensation feature for the first time.

„SAC“ stands for **Self-Adjusting Clutch**.

### Advantages:

- Constant clutch releasing loads throughout the service life of the clutch plate.
- Greater wear reserve of the clutch plate.



### Problem:

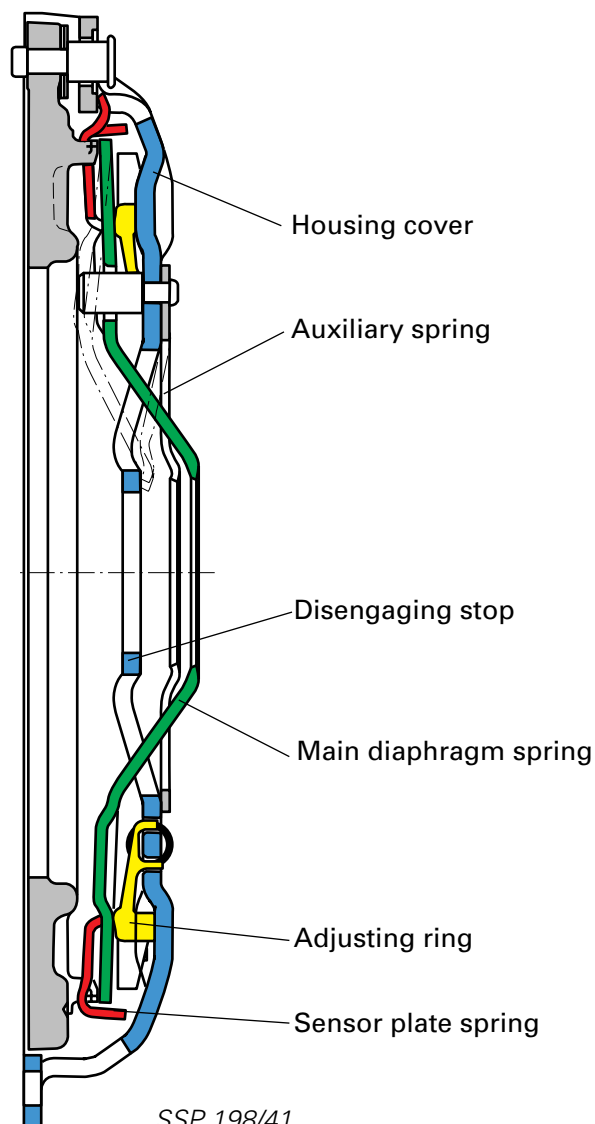
As the clutch plate wears, the position of the main diaphragm spring changes, as do the characteristics for contact pressure and releasing load.

The main diaphragm spring has a digressive characteristic. To prevent the contact pressure of the pressure plate dropping too low over a wear range of approx. 1.5 - 2 mm, the characteristic of the main diaphragm spring is such that the forces initially increase as a factor of distance travelled.

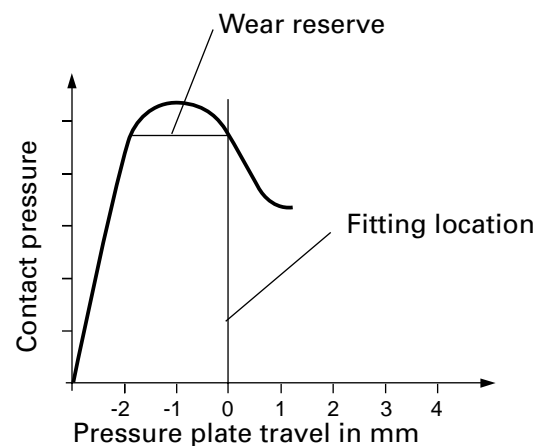
This has the knock-on effect of producing uncomfortably high pedal forces.

The clutch in the biturbo engine is required to transmit high levels of torque.

Higher contact pressures have to be applied to compensate for the limitations on the surface area of the clutch lining for design reasons. This in turn results in higher releasing loads (particularly as wear progresses).



### Contact pressure characteristic (conventional clutch)



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### Solution to problem:

If the position of the main diaphragm spring remains constant over the entire wear range, the associated forces will also remain unchanged.

This effect is achieved using the new SAC clutch pressure plate.

# Power Transmission

## Function of SAC clutch

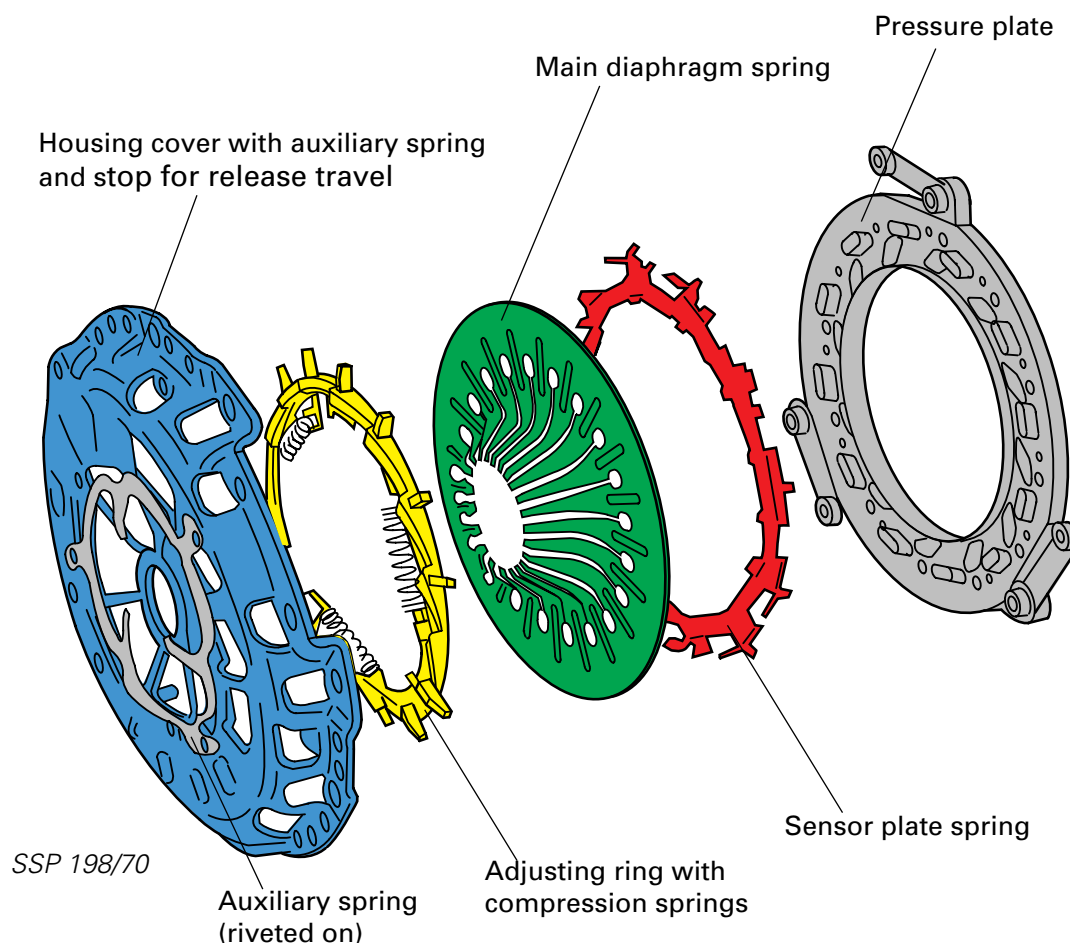
Compared to a conventional clutch, the following parts are new or modified:

- Sensor plate spring
- Adjusting ring with ramps (wedges) and compression springs
- Housing cover with ramp indentations and guides for the compression springs
- Stop for release travel (integrated in the housing cover)
- Auxiliary spring (riveted to the housing cover)



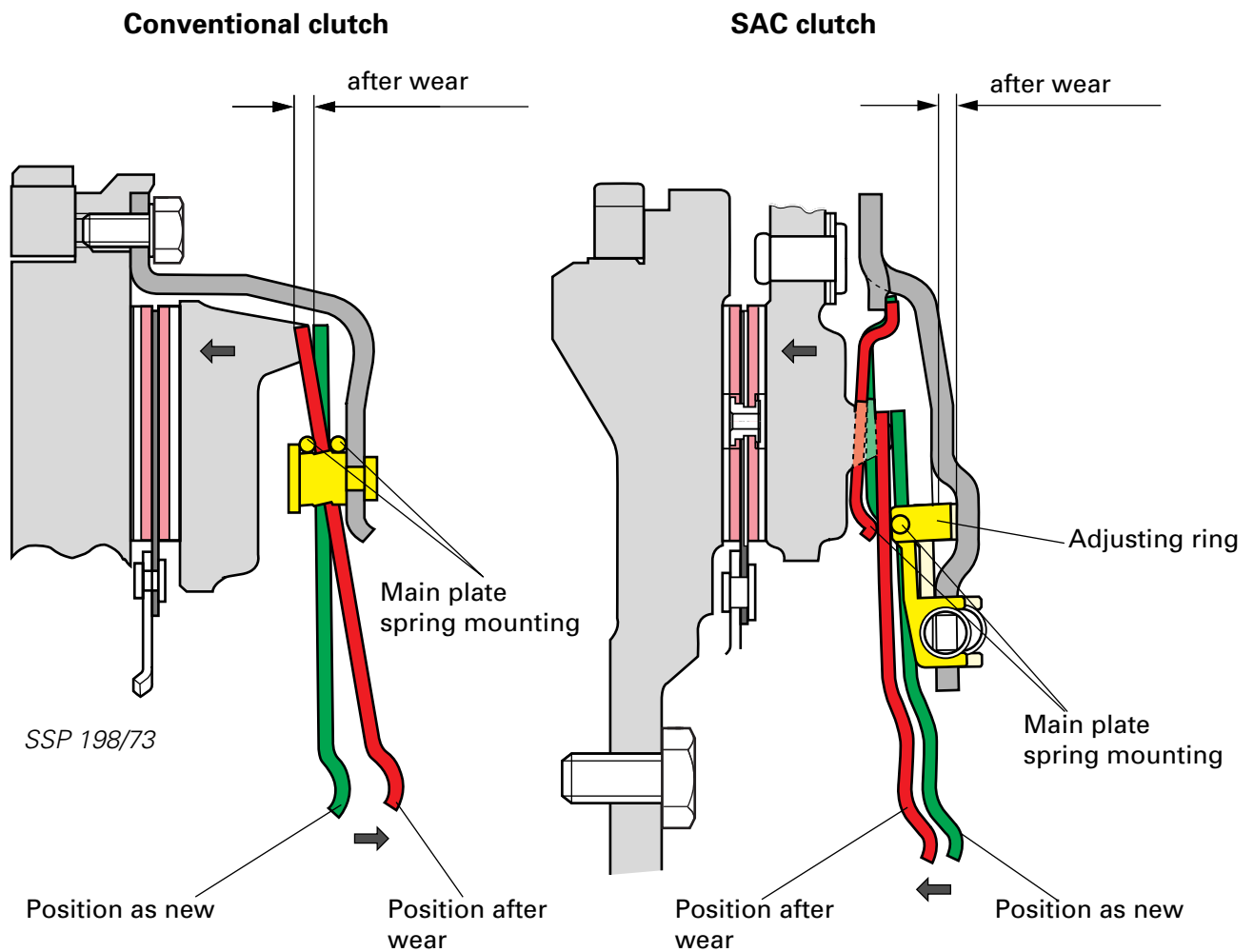
The **stop for release travel** limits the travel of the release bearing and prevents unintentional adjustment of the adjusting ring.

The **auxiliary spring** counteracts the main plate spring as of a defined travel distance and ensures an even force curve during clutch engagement and disengagement.



Unlike conventional pressure plates, the main diaphragm spring mounting of the SAC clutch is non-rigid.

The sensor plate spring and the adjusting ring locate (mounting) the main diaphragm spring.



When the clutch plate is renewed, the adjusting ring must be turned back (refer to Workshop Manual).

The adjusting ring on new SAC clutch pressure plates is already reset.

# Power transmission

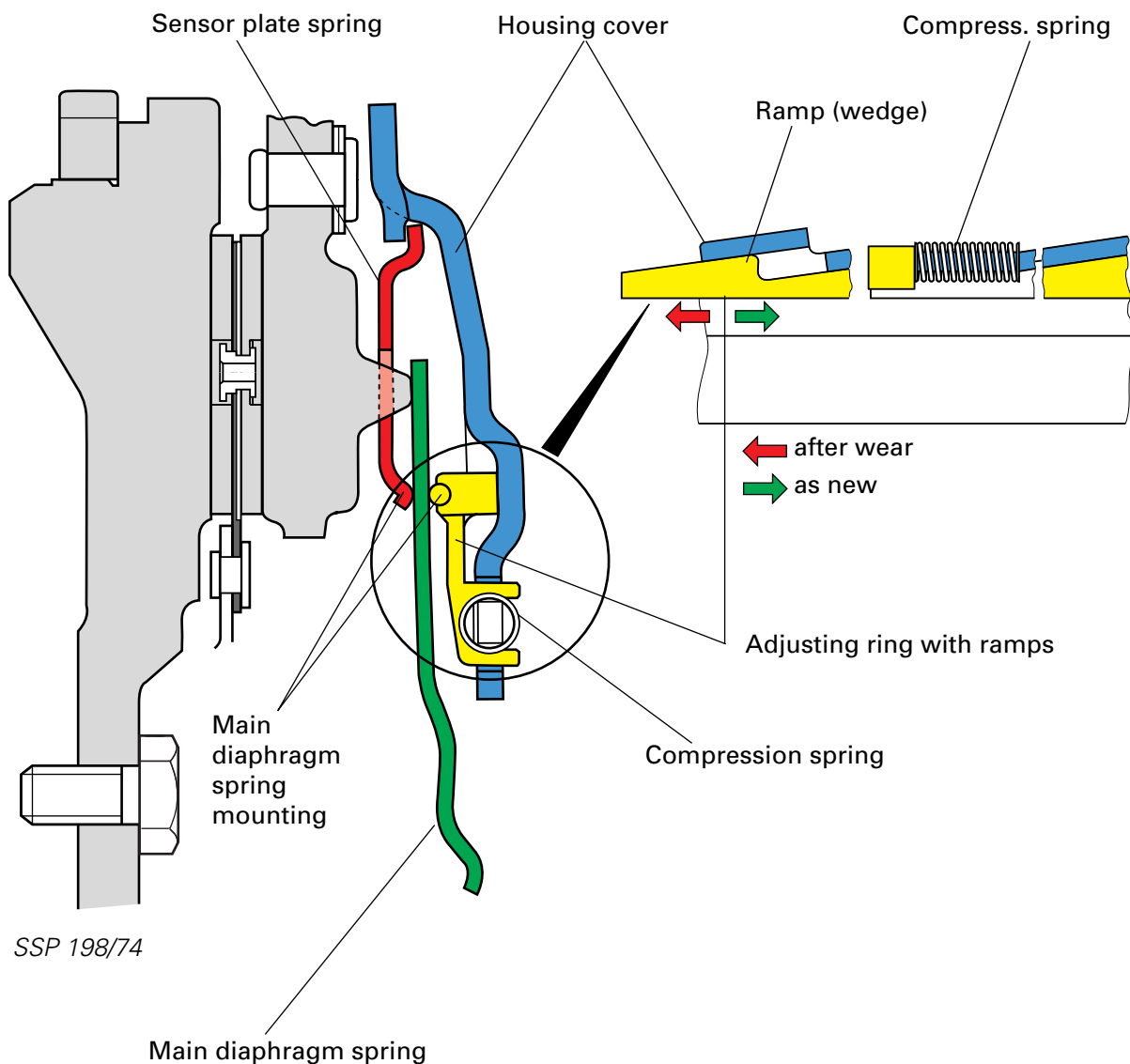
## Clutch disengagement process

The force of the sensor plate spring counteracts that of the main diaphragm spring and is rated such that the main diaphragm spring is pressed against the adjusting ring under normal releasing load.

If the force of the main diaphragm spring (also refer to load diagram) is greater than that of the sensor plate spring, the main plate spring will not come into contact with the adjusting ring.

The compression springs rotate the adjusting ring along the ramps in the housing cover.

In this way, lining wear is compensated and the forces are again equalised.



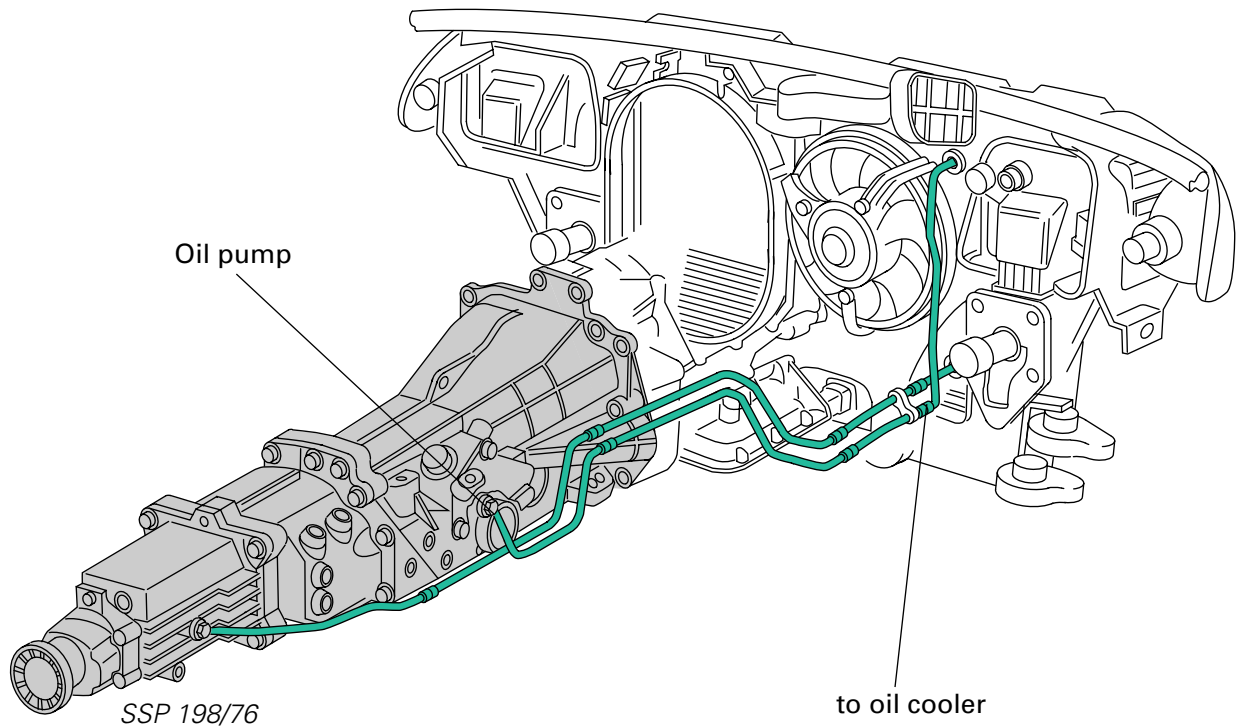
# Gearbox

In the S4, power is transmitted through the already familiar 6-speed Quattro manual gearbox of type 01E (C90 gearbox).

As is normal with Audi's high-performance models, the gearbox oil is cooled by an oil pump and an oil cooler.



Due to the two mass flywheel in combination with the SAC clutch, a new 11 mm-thick spacer ring is used for the manual gearboxes in between the engine and gearbox.

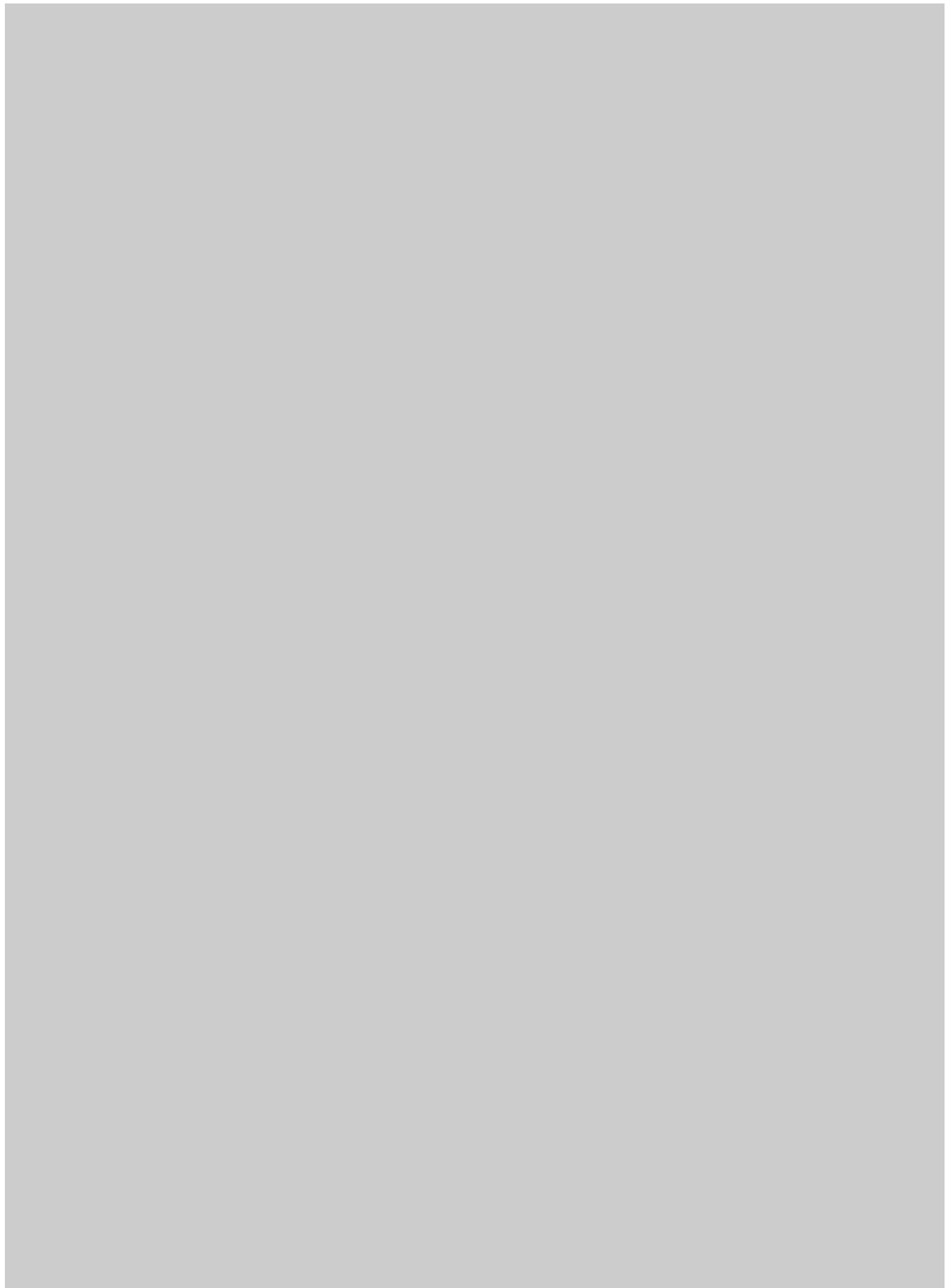


The **Audi A6** with biturbo engine can be combined with the following gearbox versions at the customer's option:

Front-wheel drive	Manual gearbox	01E (without oil cooling)
Quattro drive	Manual gearbox	01E (without oil cooling)
Front-wheel drive	Automatic gearbox	01V
Quattro drive	Automatic gearbox	01V



# Notes



**Dear reader,**

With its innovative development of the new biturbo engine, AUDI has achieved a further milestone in the field of engineering.

With this Self-study Programme you were able to familiarise yourself with the technology of the biturbo.

In the course of work on our corporate identity (CI), the Self-study Programme now has a new format. For example, the SSP number is printed on the back page of the booklet so that you no longer need to take the booklet out of the folder when searching for it.

Please fax us your suggestions for improving the Self-study Programmes on +49 841-89-6367.

**With the kind regards of your Technical Service Training Team**