The 2.7 Liter V6 Biturbo



Design and Function

Self-Study Program
Course Number 992903

Audi

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Always check Technical Bulletins and the Audi Worldwide Repair Information System for information that may supersede any information included in this booklet.

The 2.7 Liter V6 Biturbo

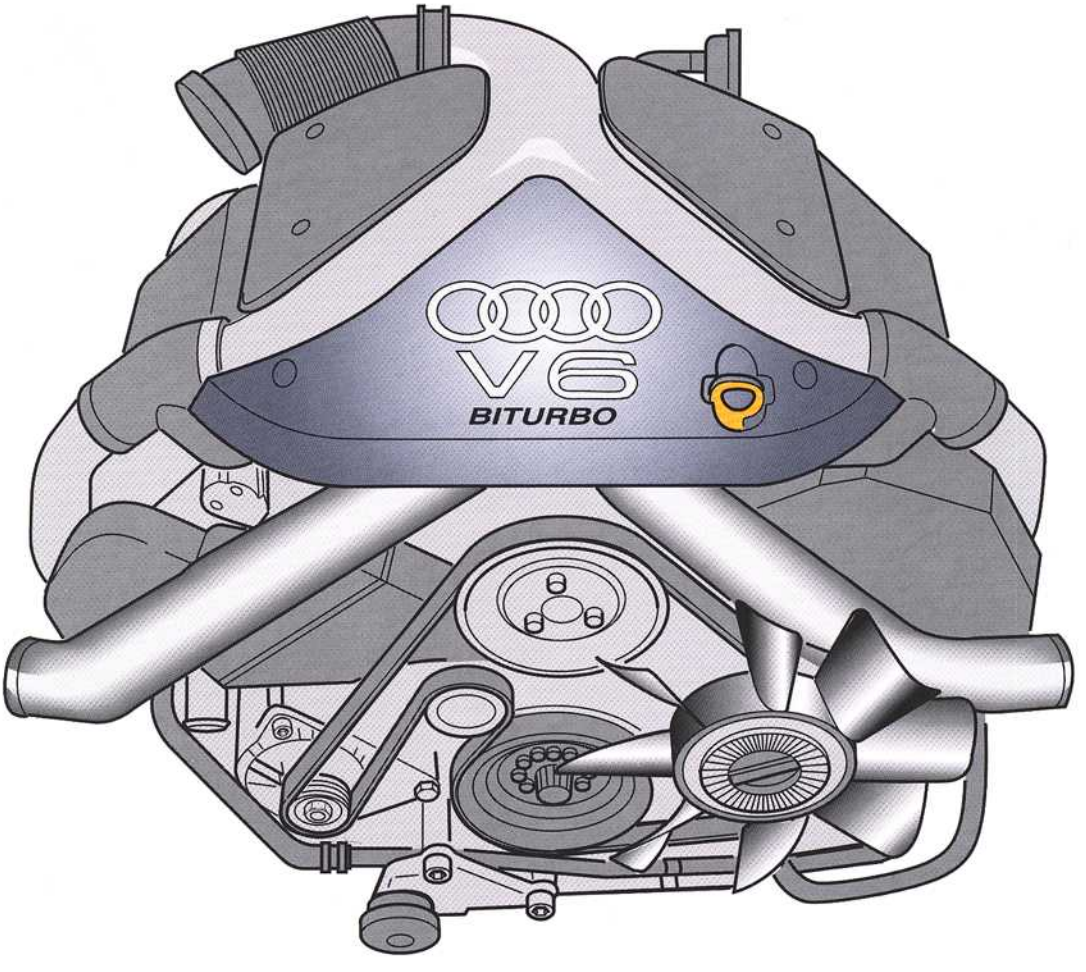
Turbocharged engines are already something of a tradition at AUDI. The task now facing AUDI's engineers was to develop a worthy successor to the 5-cylinder turbocharged engine.

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 realize a high "basic torque level" and a torque characteristic that rises to its peak in direct proportion to engine speed.

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).

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



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

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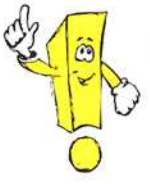
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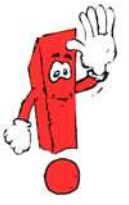
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New!



Important/Note!



This Self-Study Program provides you with information regarding design and function.

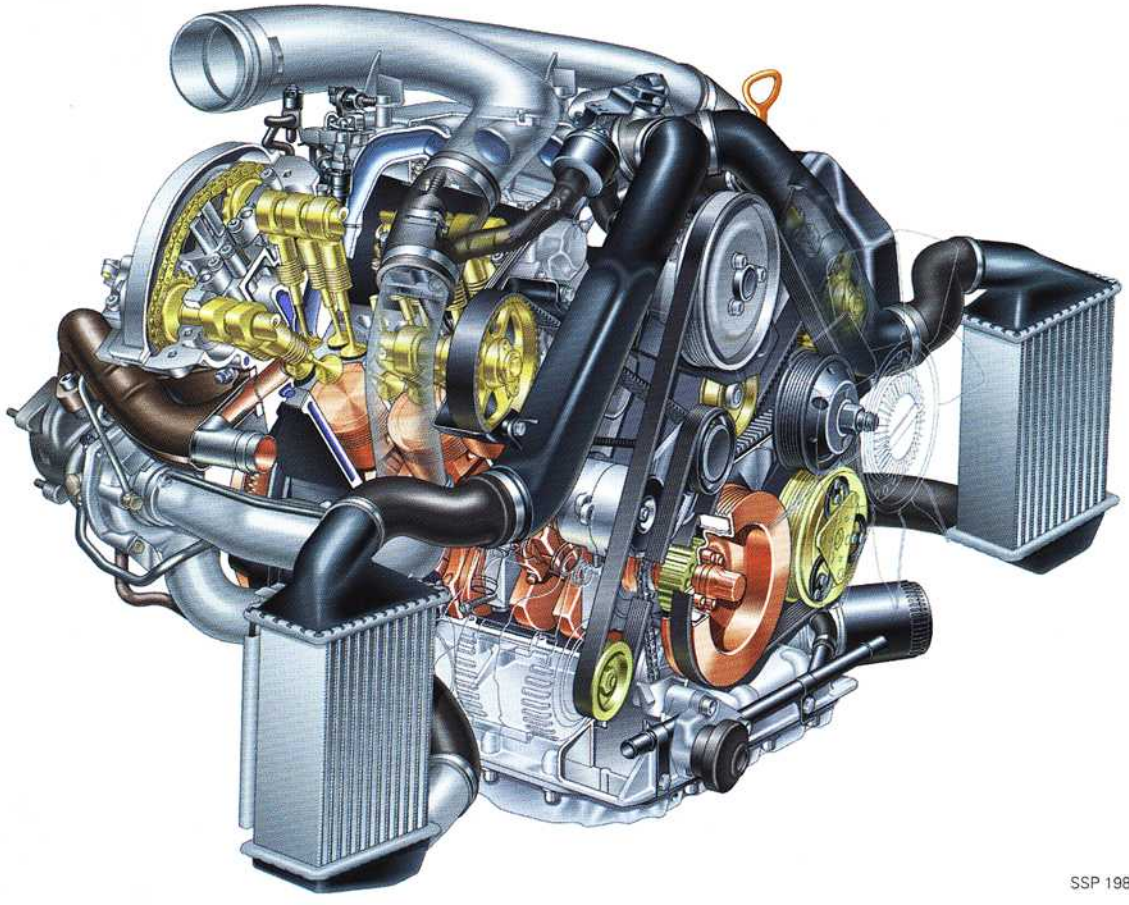
The Self-Study Program is not a Workshop Manual!

Please refer to the service literature for all the relevant maintenance and repair instructions.

The 2.7-liter V6 Biturbo

Using smaller turbochargers but fitting one to each bank of cylinders instead of a single larger unit has clear advantages with the V6 engine. The more rapid response of the smaller turbines leads to the desired high torque values even at low engine speeds. Thanks to their lower inertia, the engine responds more readily to rapid pressure on the accelerator. The short distances between the cylinder exhaust ports and the turbocharger inlets mean that the exhaust gas loses less momentum and charging efficiency is thus increased.

Each bank of cylinders has an intercooler which reduces the temperature of the intake air. Efficient cooling of the charge air is crucial to the forced aspiration principle: the cooler the air, the higher its density and the more oxygen is available for combustion. With cooled air, therefore, it is possible to achieve even higher engine efficiency.

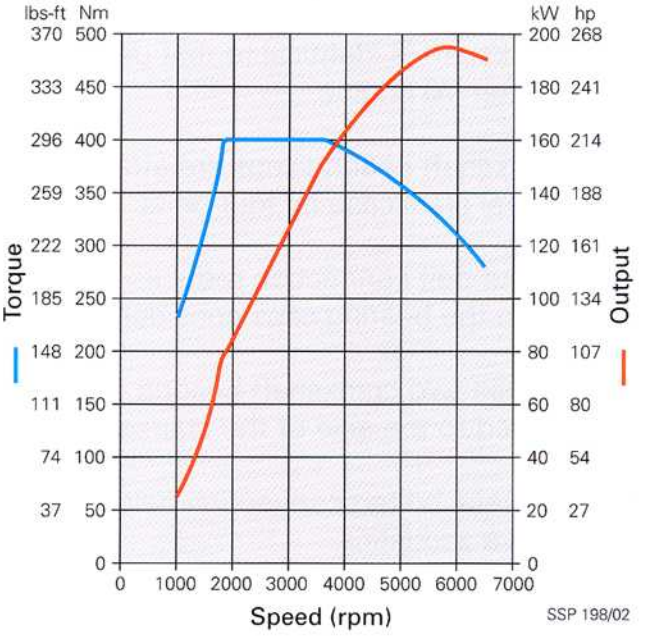


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The Technical Data

- **Configuration**
  V6 engine with 90° V-angle and twin turbochargers
- **Engine code**
  S4/A6: APB
- **Output**
  S4/A6: 250 hp (187 kW) at 5800 rpm
- **Torque**
  S4/A6: 258 lbs-ft (350 Nm) at 1850 rpm
- **Maximum speed**
  6800 rpm
- **Compression ratio**
  9.3 : 1
- **Displacement**
  163 cu in (2671 cm^3)
- **Bore**
  3.19 in (81 mm)
- **Stroke**
  3.40 in (86.4 mm)
- **Weight**
  approx. 440 lbs (200 kg)
- **Engine management**
  Motronic ME 7.1
- **Firing order**
  1-4-3-6-2-5
- **Fuel type recommended**
  S4/A6: 91 AKI

S4/A6



The Crankshaft

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

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

- The four-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.

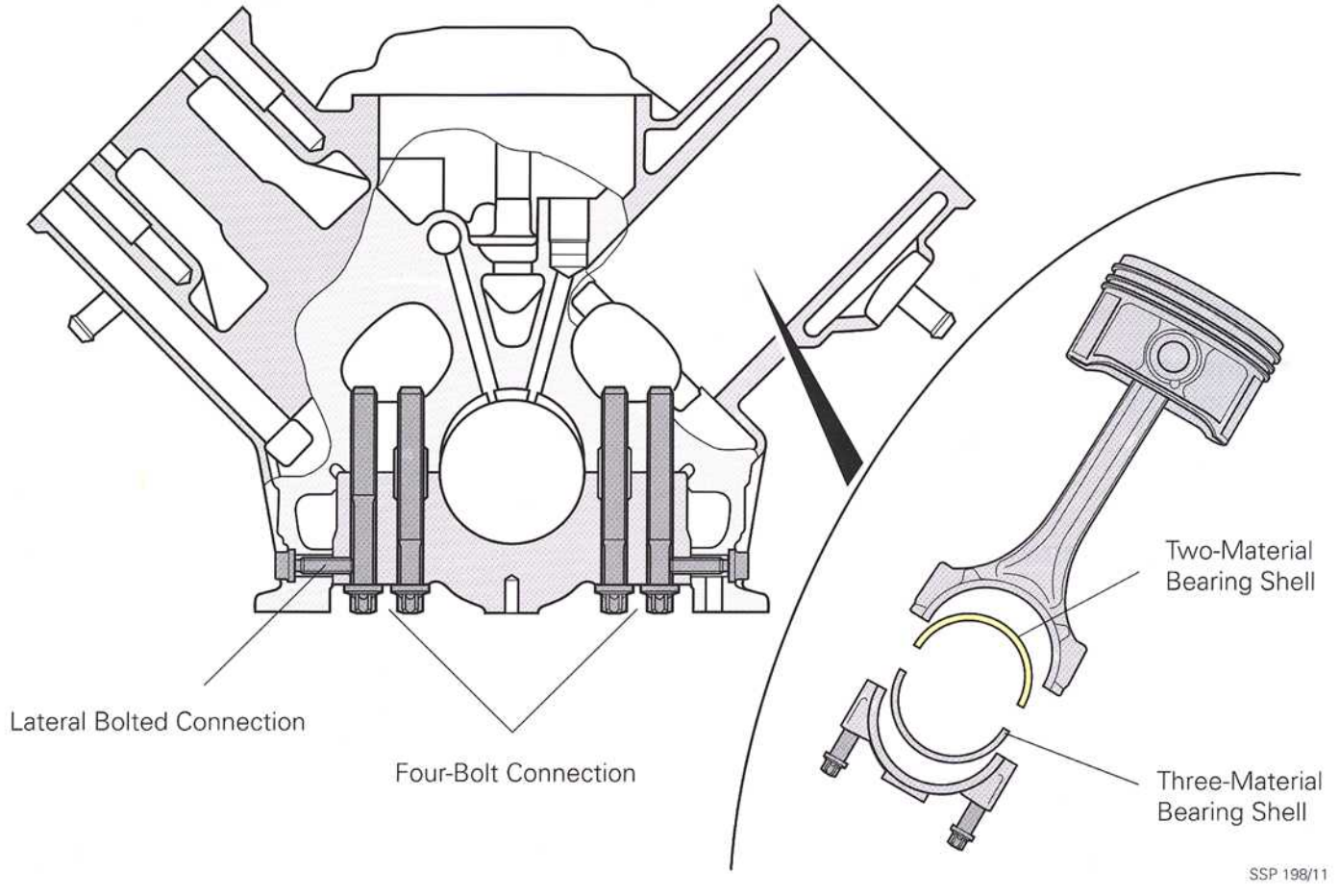
- The lateral bolted connection helps to improve acoustics.

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

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

Advantage

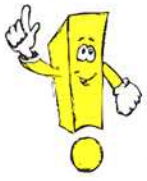
The bearing shell has a high load-bearing capacity.



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.

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



Tumble Duct

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

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

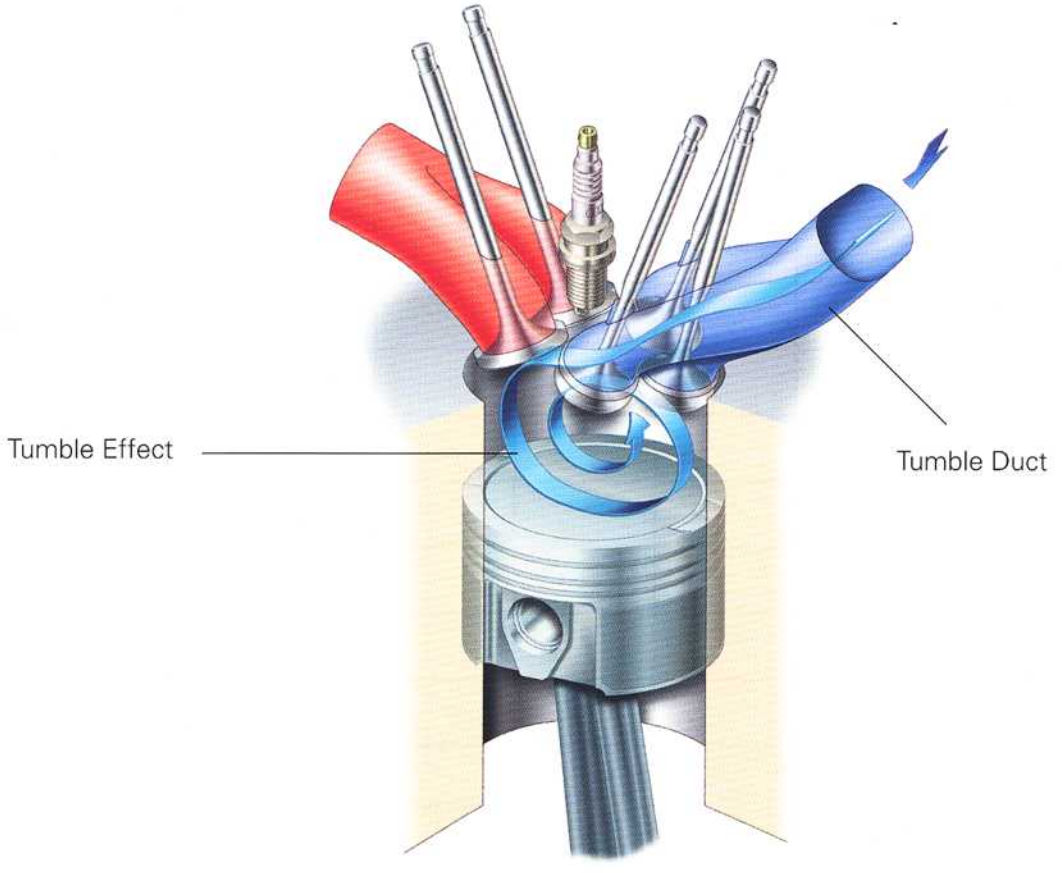
Advantages

- A good degree of swirl and improved ignition of the 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.



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The Variable Valve Timing

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

Variable valve timing with an adjustment angle of 22° is used here for the first time in turbocharged engines.

Advantages

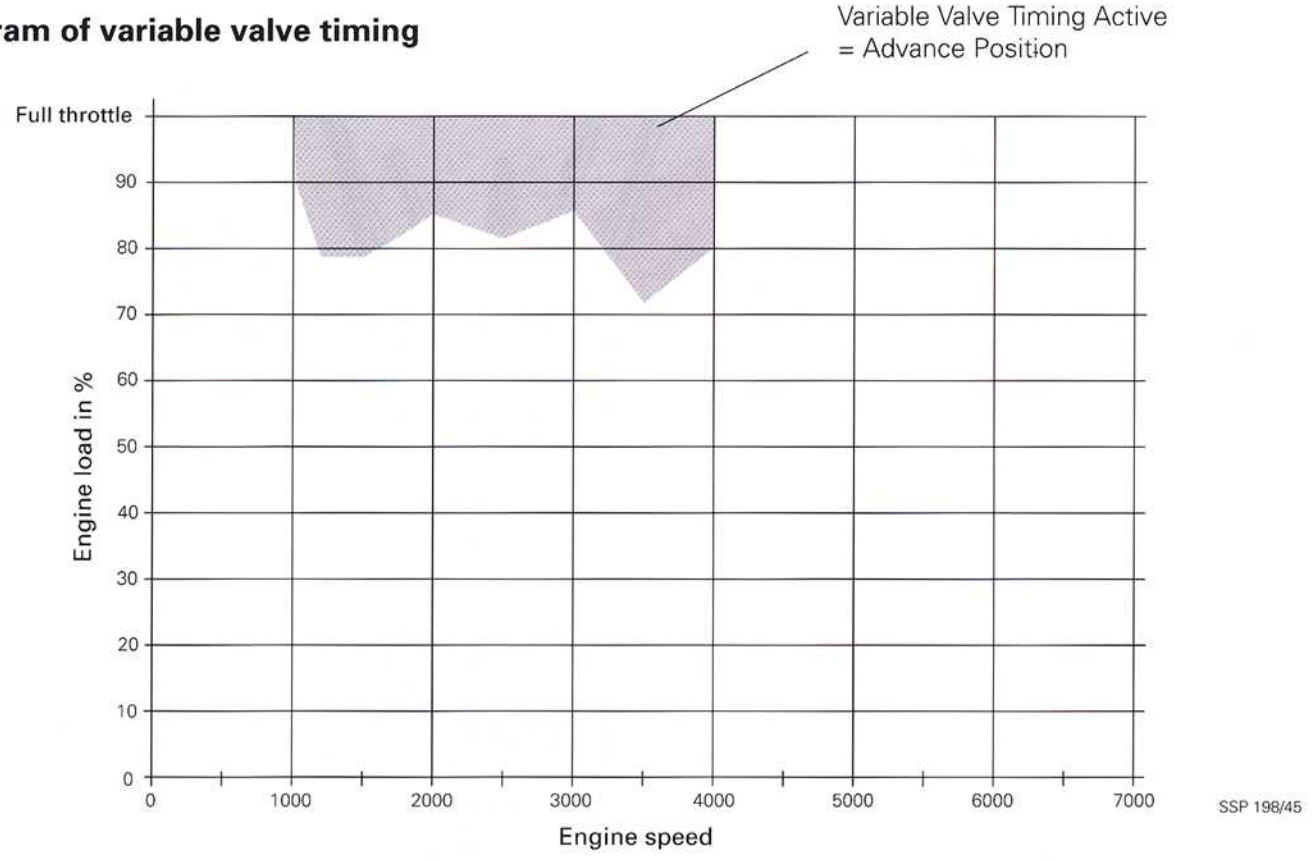
- A torque increase of approximately 10% is achieved at the bottom and top ends of the engine speed range.
- Better emission levels and fuel consumption figures.

The variable valve timing is activated by the Motronic System by means of the Valves for Camshaft Adjustment N205 and N208.

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

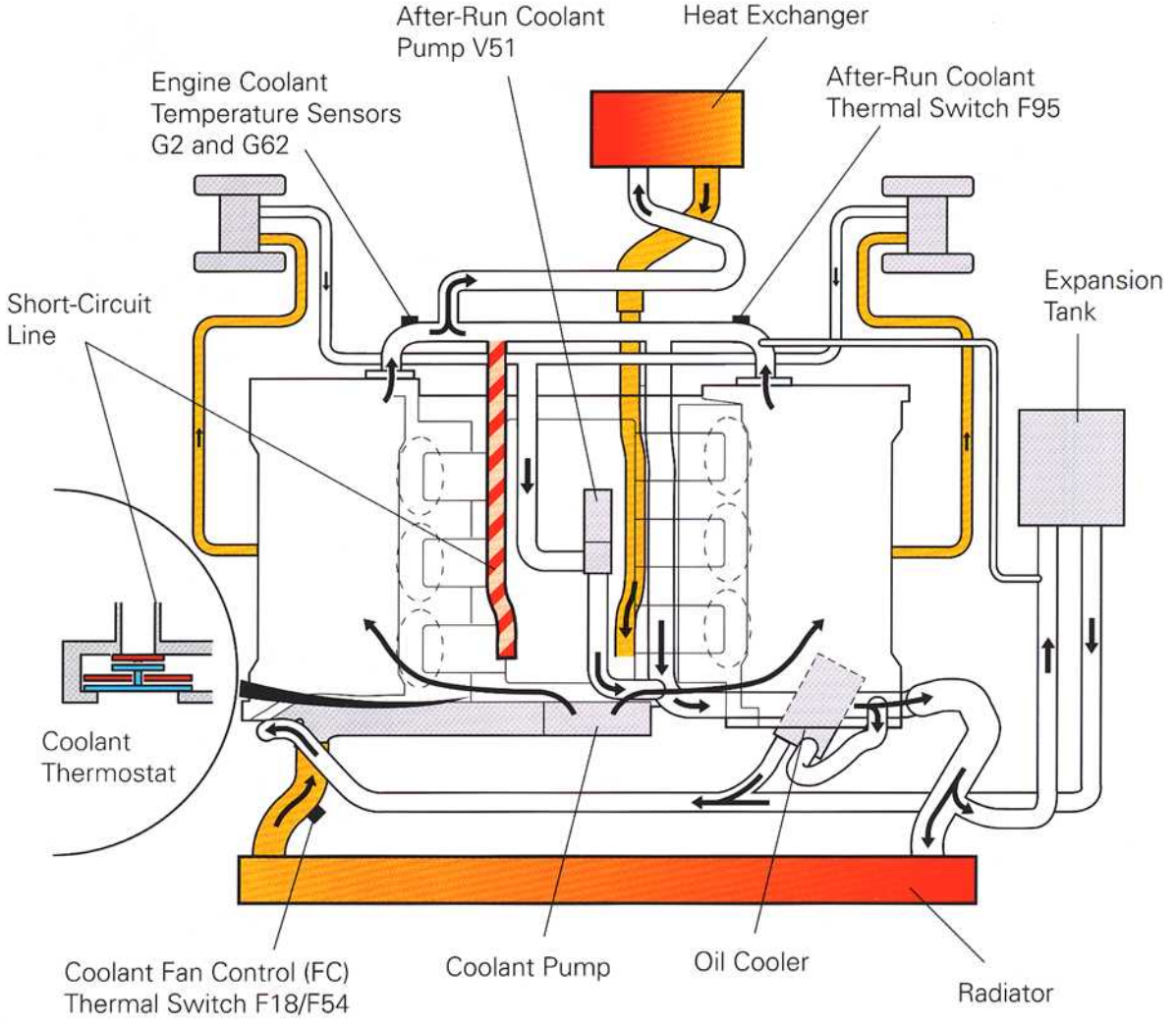


Cooling Circuit

Both exhaust gas turbochargers are liquid-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 keeps the coolant from overheating under high thermal load, such as when the hot engine is turned off.



After-Run Coolant Pump V51

The After-Run Coolant Pump V51 is located in the engine's V angle.

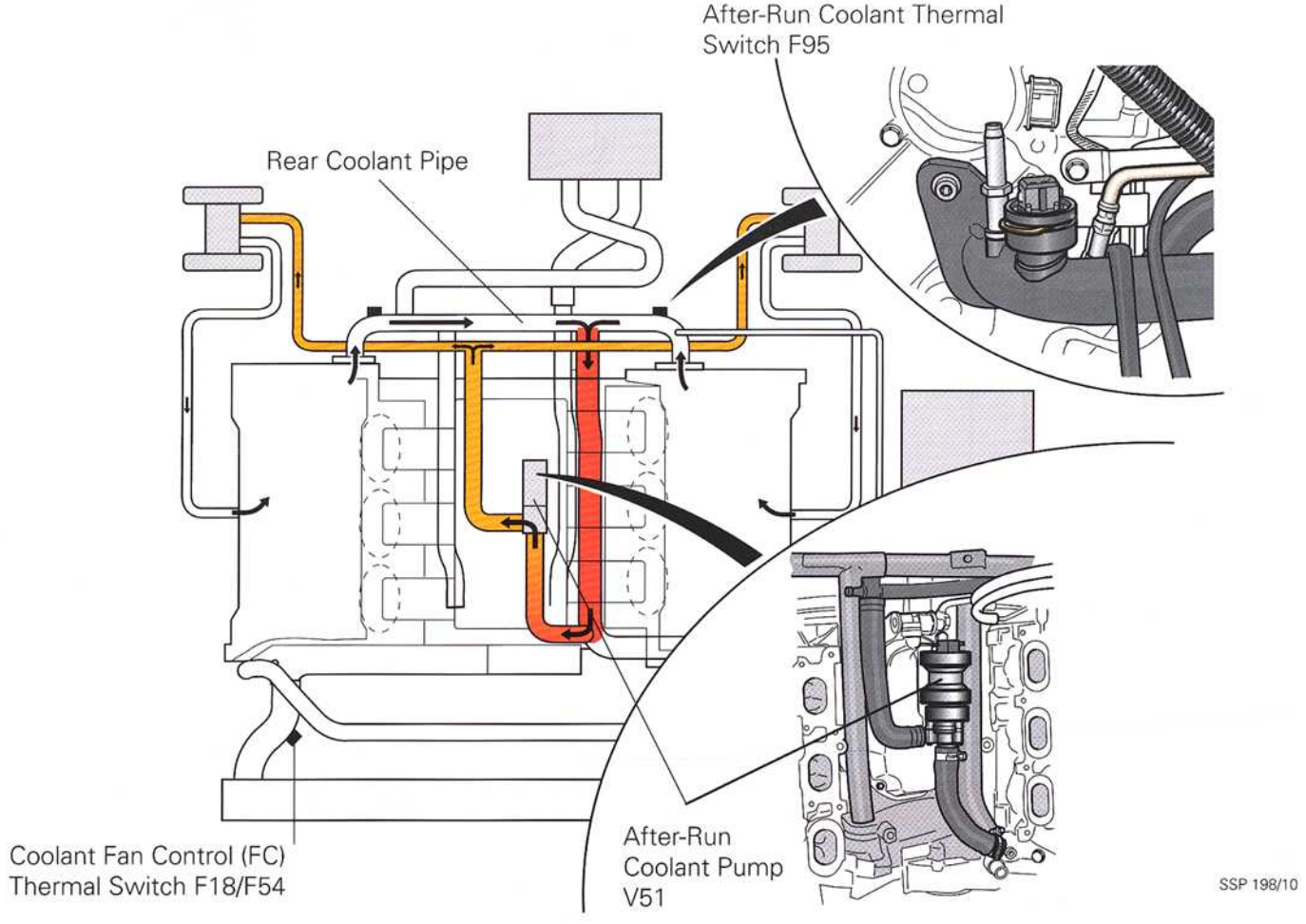
If the coolant temperature is too high, the After-Run Coolant Thermal Switch F95 activates the additional cooling function.

The high temperatures which occur at the exhaust gas turbocharger produce vapor bubbles which prevent coolant being drawn in by After-Run Coolant Pump V51. When After-Run Coolant 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 vapor 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.

The after-run cooling function is only activated if the "engine not running signal is picked up at terminal 61. The continued cooling function is limited to 10 minutes.



Fan Control

The control unit for Radiator Fan V293 regulates the output of the radiator fan and controls the continued coolant circulation. The Coolant Fan V7 and the Forced-Air Fan V177 are activated simultaneously. Forced-Air Fan V177 is located in front of the condenser, radiator and viscous-coupled fan. It assists the viscous-coupled fan.

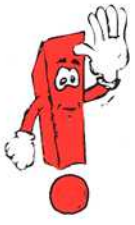
The Electronic Power Control

The various fan settings are executed by an electronic power control.
The fan motors are operated periodically. The length of the operating cycle depends on the fan setting selected. Fan output level is controlled via pulse-width-modulated outputs.

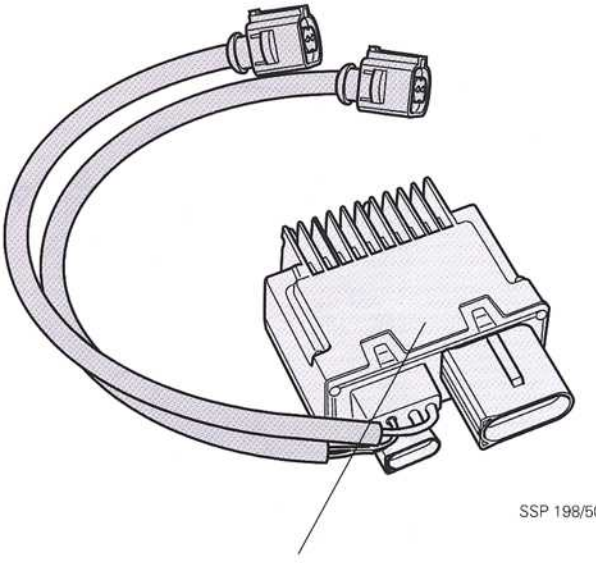
Should a fan fail, the radiator fan control module increases the speed of the fan motor still available.

Advantages of the Power Control

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

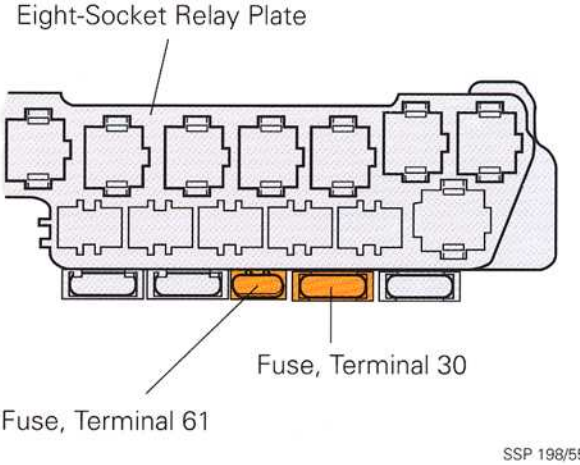


The power supply is protected by a fuse on the eight-socket relay plate. For the correct fuse rating, please refer to wiring diagram.



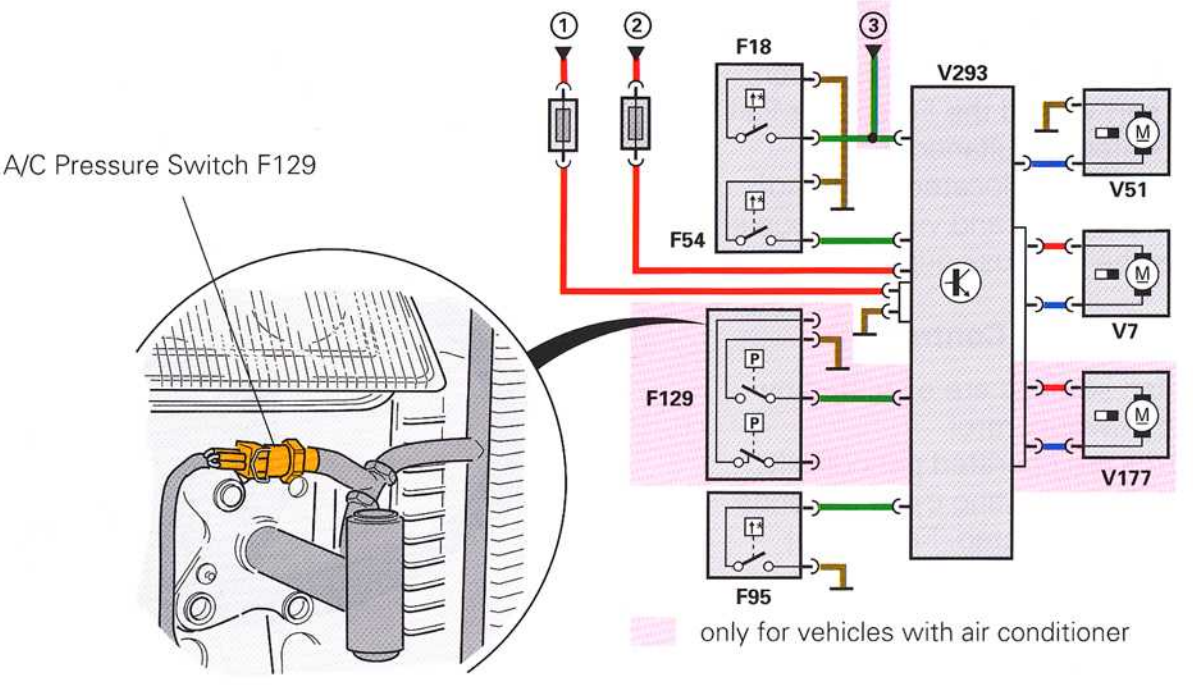
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Control Module for Radiator Fan Attached to Front Right Vehicle Side Member



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Electric Circuit of Fan Control



Integrated in the A/C Pressure Switch 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

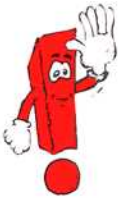
F18/F54	Coolant Fan Control (FC) Thermal Switch
F95	After-Run Coolant Thermal Switch
F129	A/C Pressure Switch
V293	Control Module for Radiator Fan
V7	Coolant Fan
V51	After-Run Coolant Pump
V177	Fan 2 for Radiator (Forced-Air Fan)
①	Terminal 30, positive supply via fuse on eight-socket relay plate
②	Terminal 61, D+ (generator) via fuse on eight-way relay
③	Fan activation

Function of Fan Circuit

Four fan settings are possible:

The electrical coolant function . . .

is activated by After-Run Coolant Thermal Switch F95.
The fan motors and After-Run Coolant Pump V51 are activated. The fan motors run at minimum output (40%).



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

Fan speed 1 . . .

is requested by Coolant Fan Control (FC) Thermal Switch F18 or by the air-conditioning control panel.
The fan motors run at 50% output.

Fan speed 2 . . .

is activated by A/C Pressure Switch F129.
The fan motors run at 85% output.

Fan speed 3 . . .

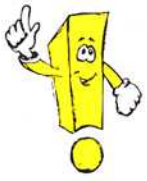
is activated by Coolant Fan Control (FC) Thermal Switch F54. The fan motors run at full output.



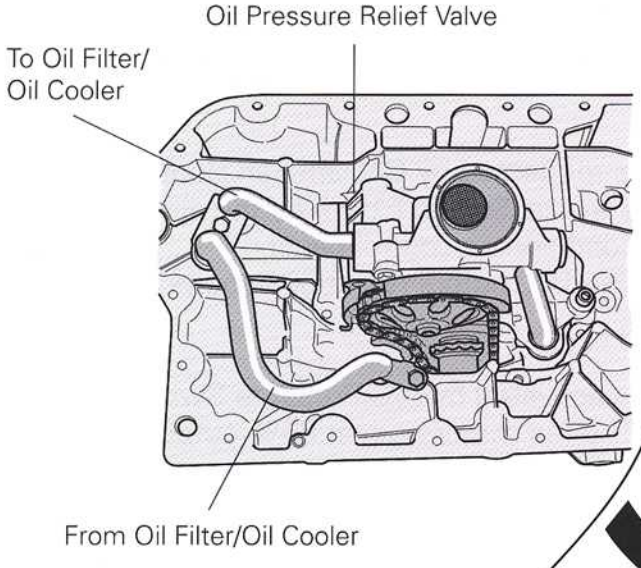
Fan speeds 1, 2 and 3 are only activated if the "engine running" signal is picked up at terminal 61.

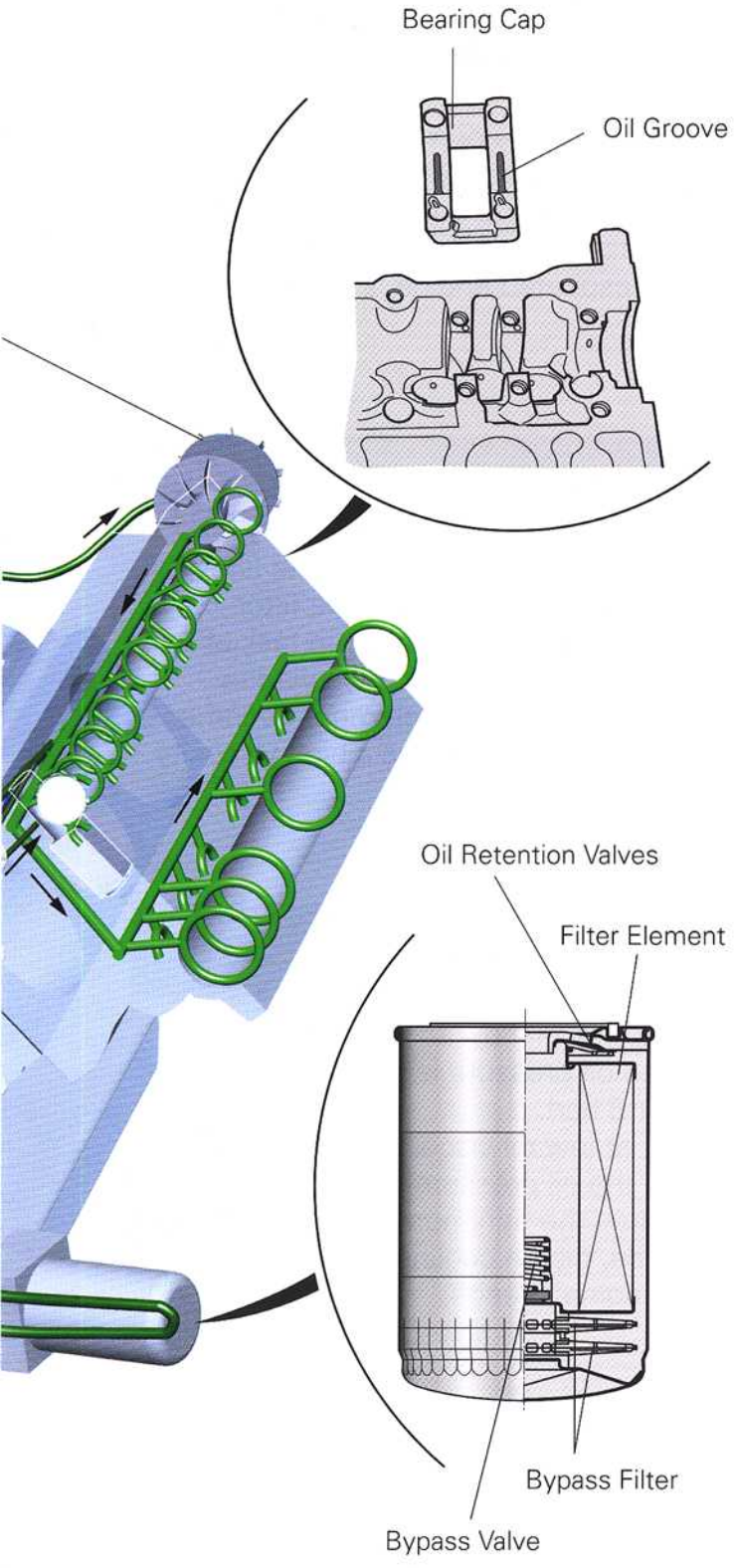
Engine Lubrication

The oil circuit of the 2.7-liter V6 biturbo engine largely corresponds to that of the 3rd V6 engine generation.
In addition, the two exhaust gas turbochargers are supplied with pressurized 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.



A new feature of the biturbo is the "integrated oil supply" (see page 15).





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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).

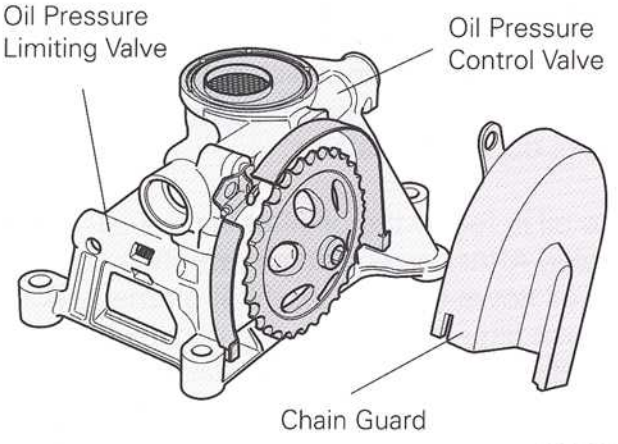
The following components are supplied with oil from the main oil gallery:

- 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 also supplied via an oil retention valve through a separate bore from crankshaft bearing 2.

In each cylinder head, the camshaft adjustment valve is supplied with oil from the inlet passages 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.

The Component Parts of the Oil Circuit



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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 from 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.

The oil cooler . . .

is integrated in the primary flow. By increasing the capacity and optimizing 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 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 spray jets valve . . .

opens up the oil flow to the piston spray jets if the oil pressure is greater than 26 psi (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 optimize 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 effect of this is that the engine cuts out or can no longer be started.

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 not running.

The restrictors . . .

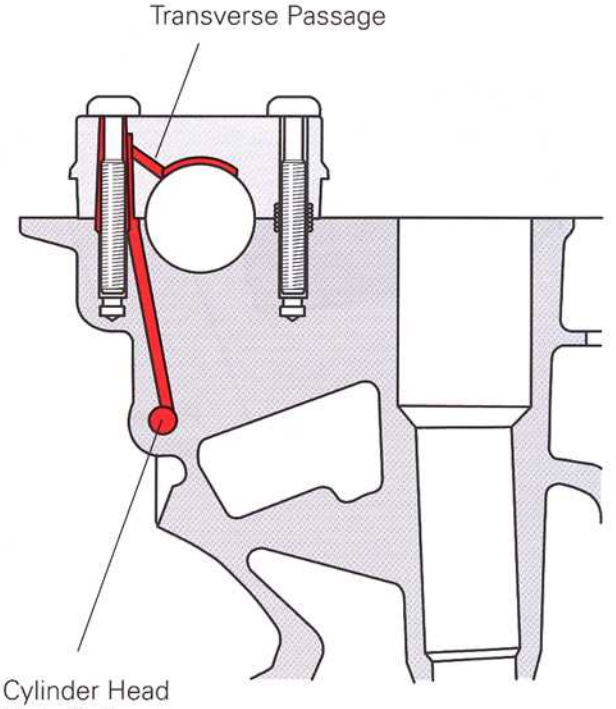
prevent "flooding" of the cylinder heads. At high engine speeds, an excessively large amount of oil enters the cylinder heads and has to be returned to the oil sump via the oil return passages. The restrictors reduce the oil flow and thereby ensure that return flow takes place.

The "Integrated Oil Supply" . . .

will also be adopted for all V6 5V naturally aspirated engines.
Each camshaft bearing is supplied via a passage stemming from the cylinder head main gallery.
The oil is fed along a bolt shaft in the bearing cap to a transverse passage.
A lubrication groove distributes the oil throughout the camshaft bearing. It is no longer necessary to run a pipe to the individual bearing caps.

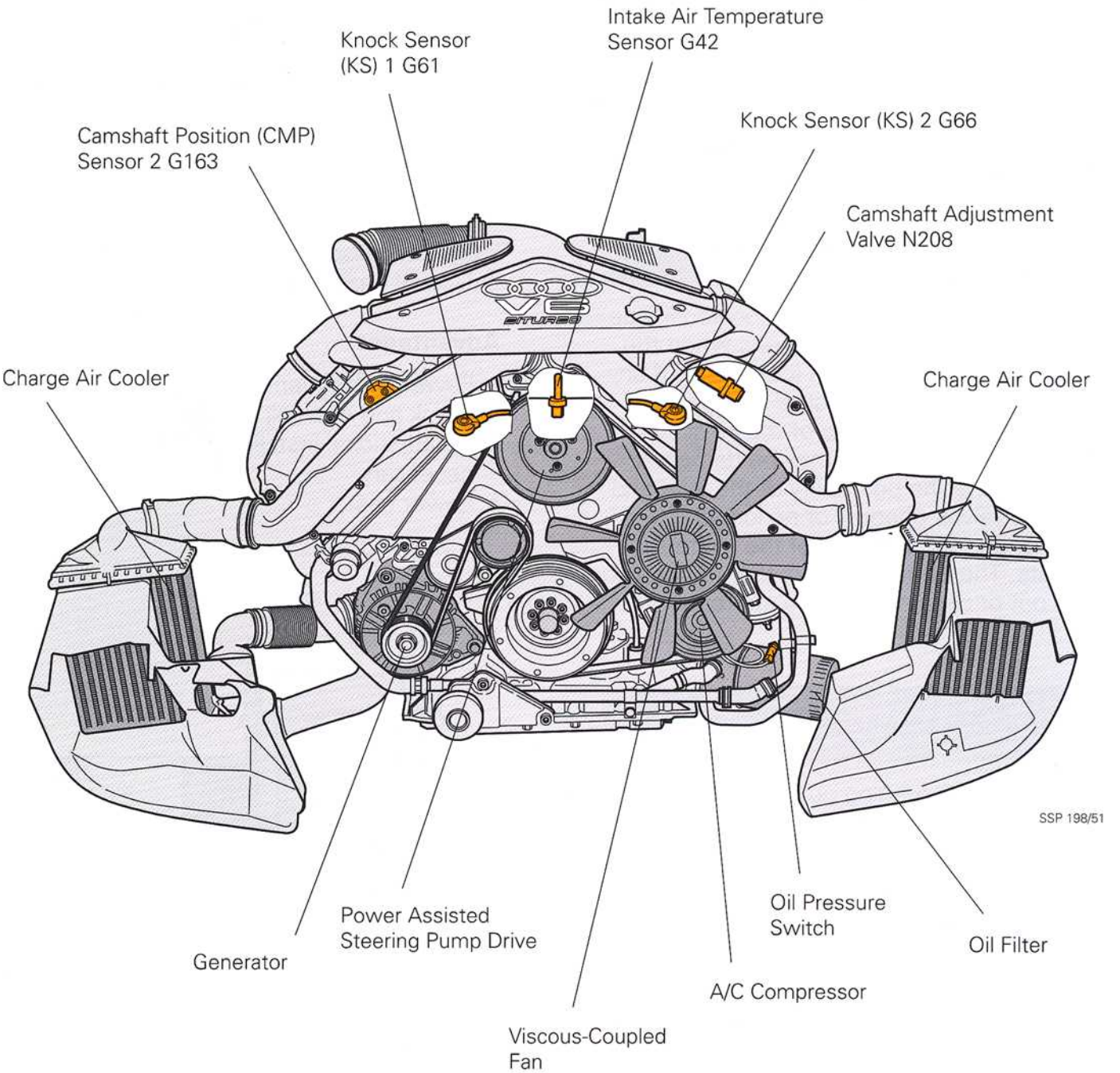
Advantages

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

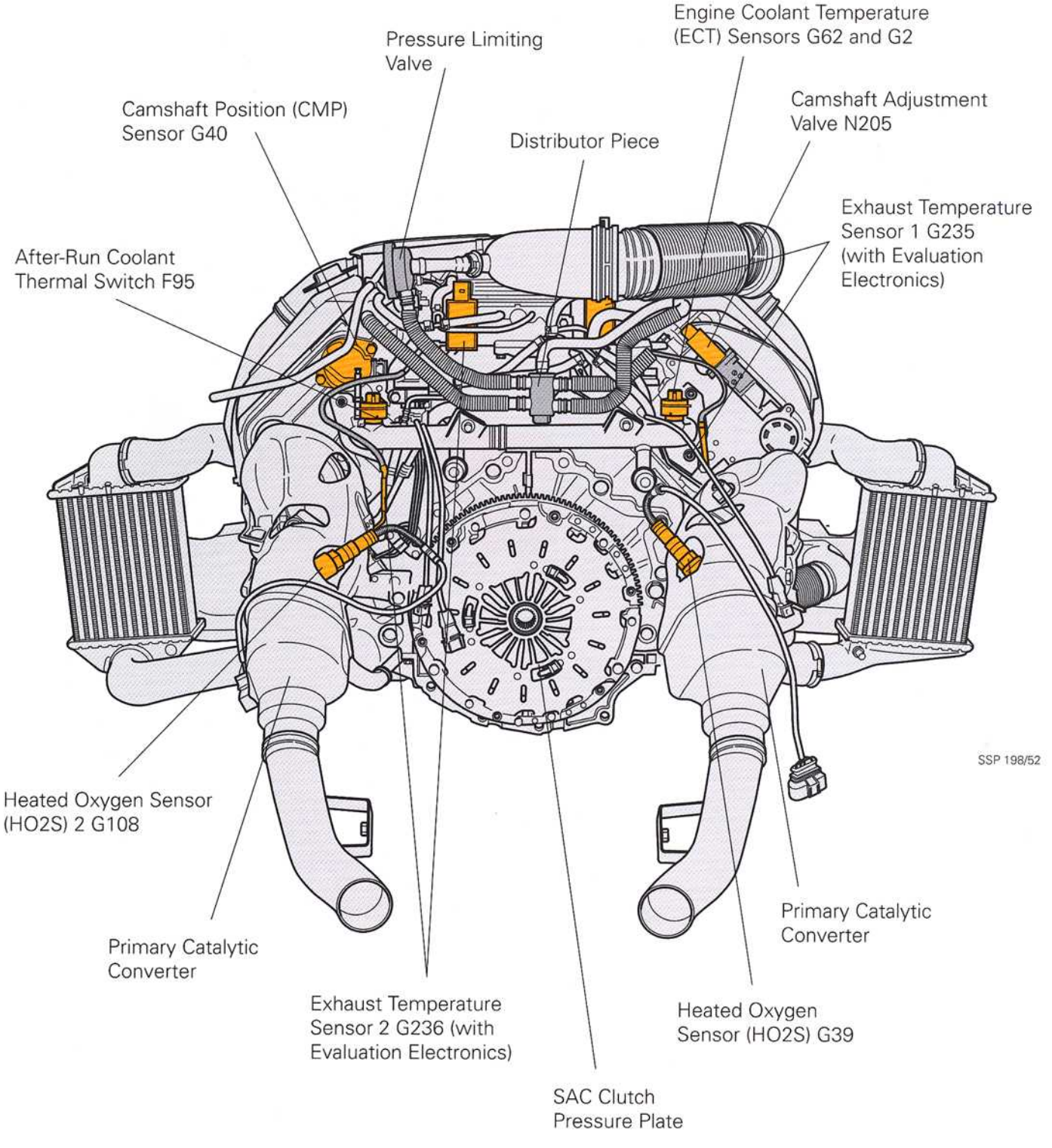


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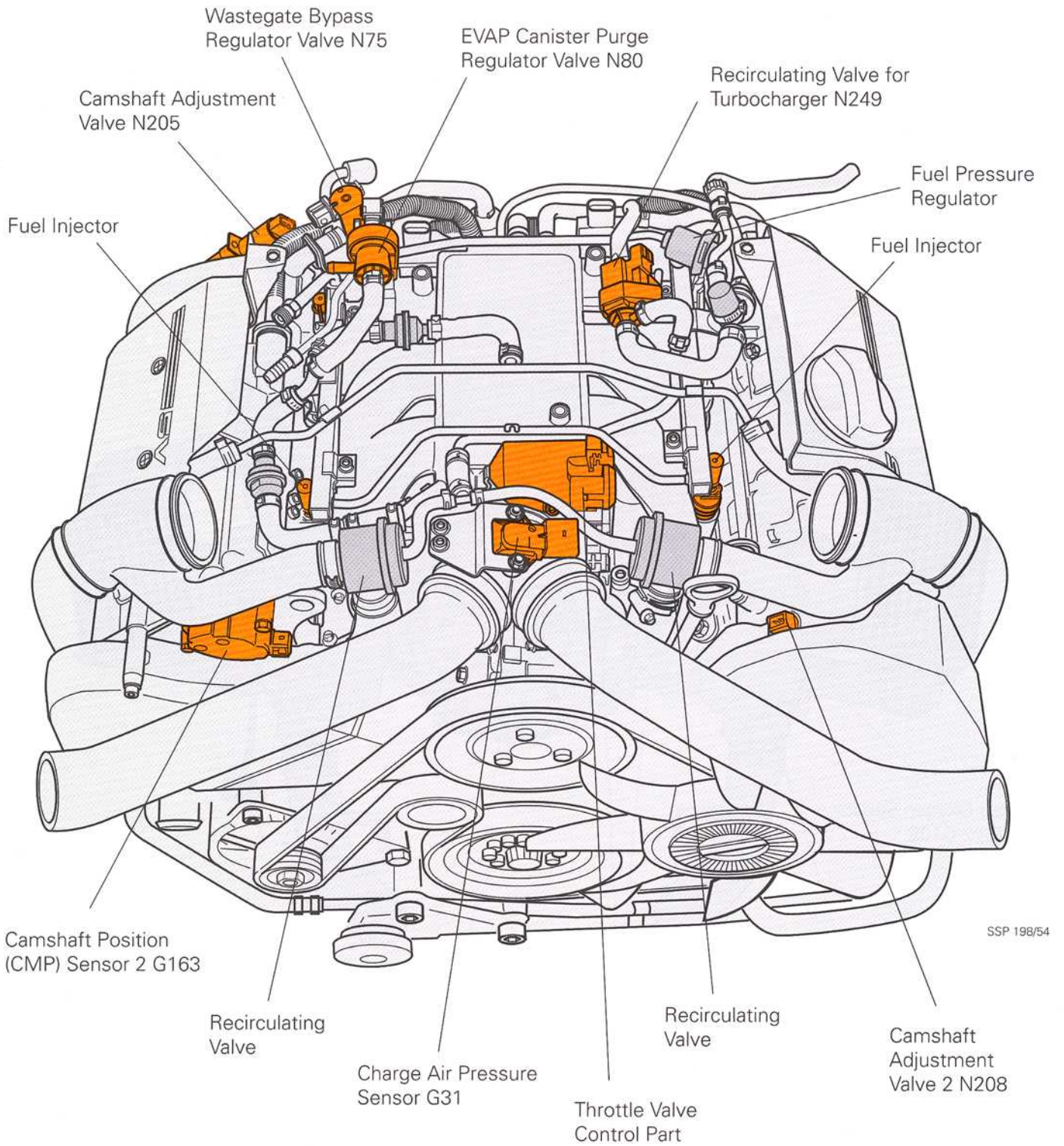
Front View of Engine



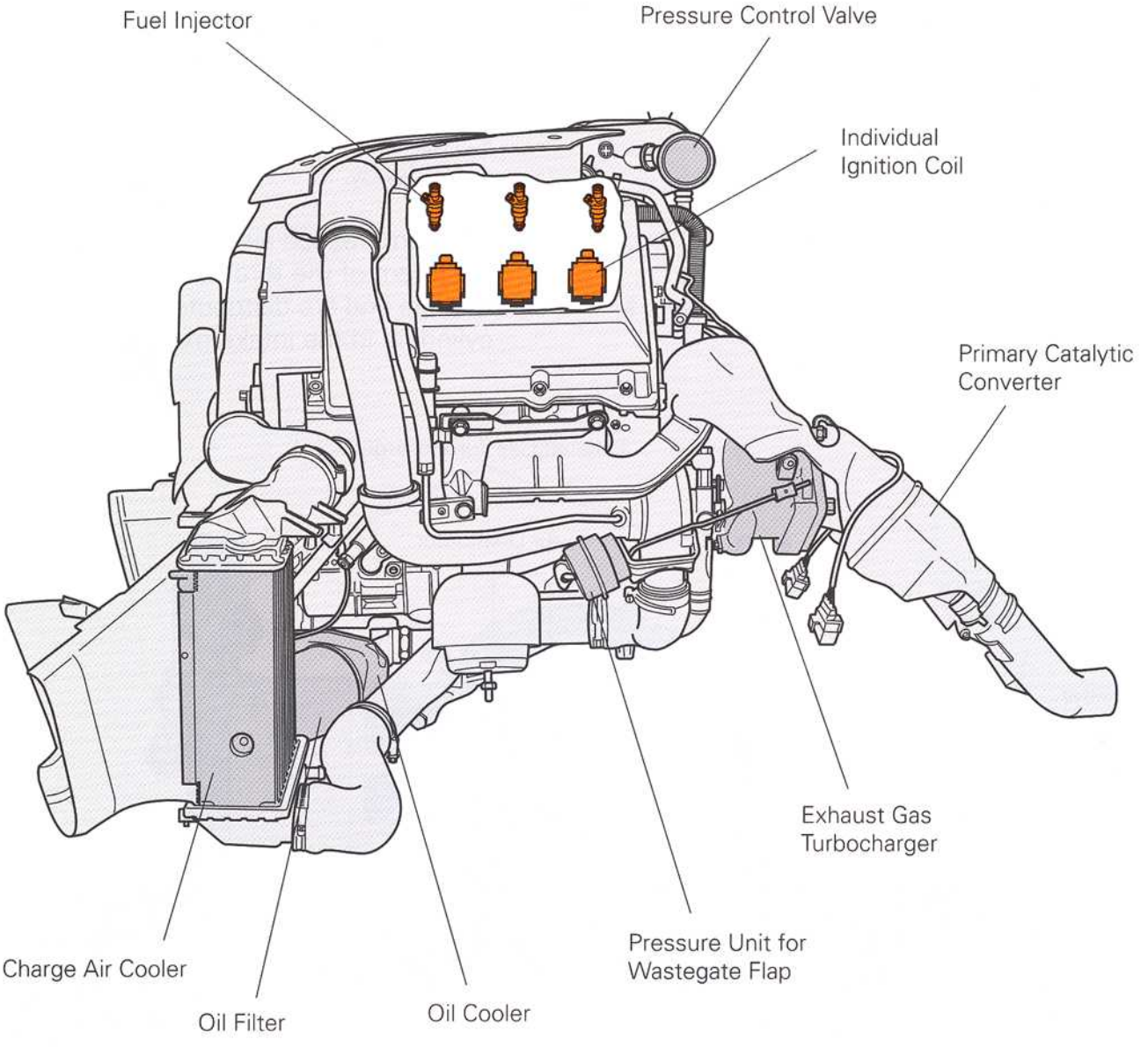
Rear View of Engine



Top View of Engine



View of Engine From Left



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Air Ducting

Fresh air is taken in by the combined air filter and mass air flow (MAF) sensor and distributed to the two exhaust gas turbochargers by the air distributor.

The air distributor is made of plastic.

Advantages

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

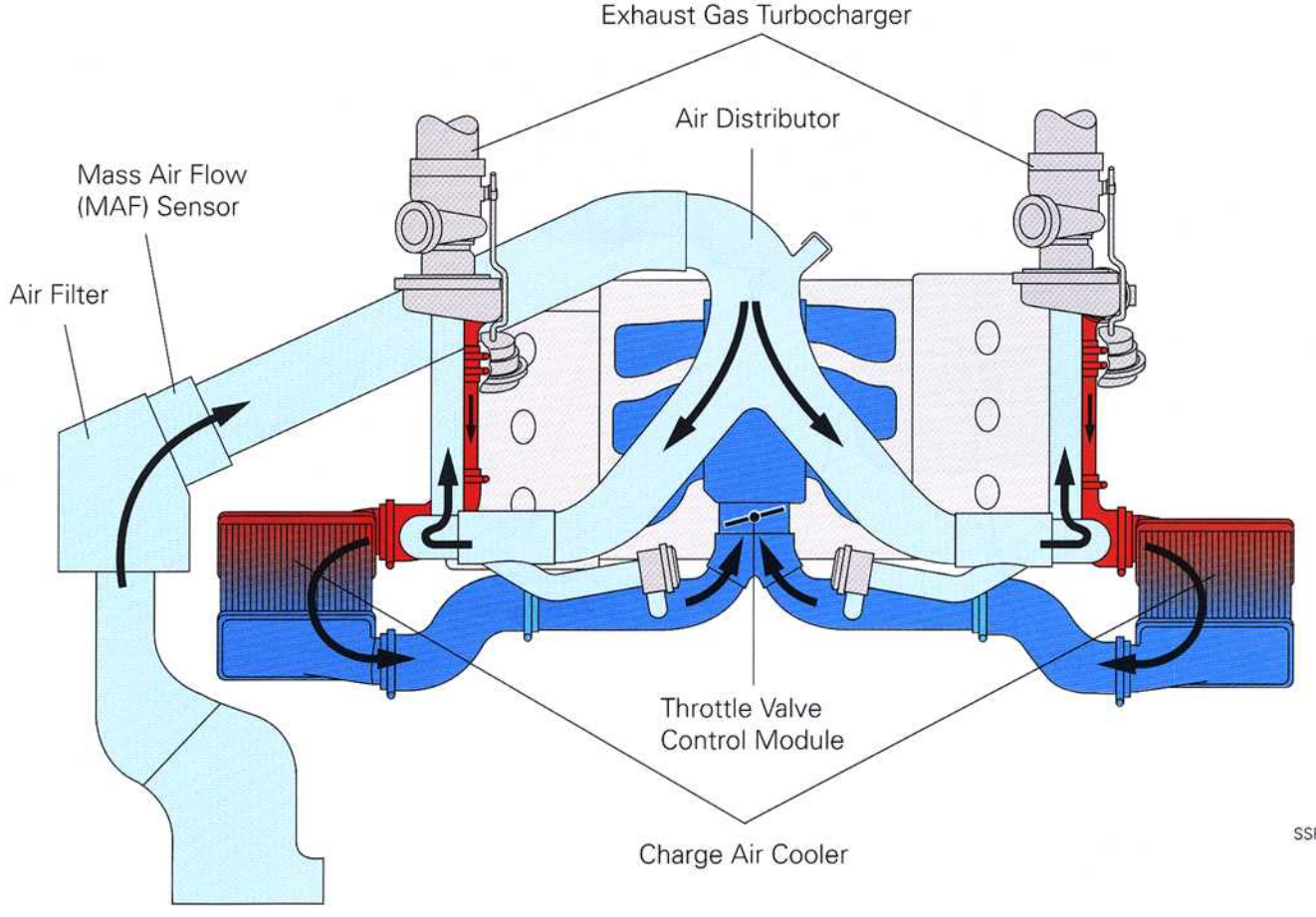
The air, which is compressed and thus heated by the exhaust gas turbocharger, is fed to the charge air coolers.

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.

Advantages of charge air cooling

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

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



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 Wastegate Bypass Regulator Valve N75.

Advantages of the biturbo technology

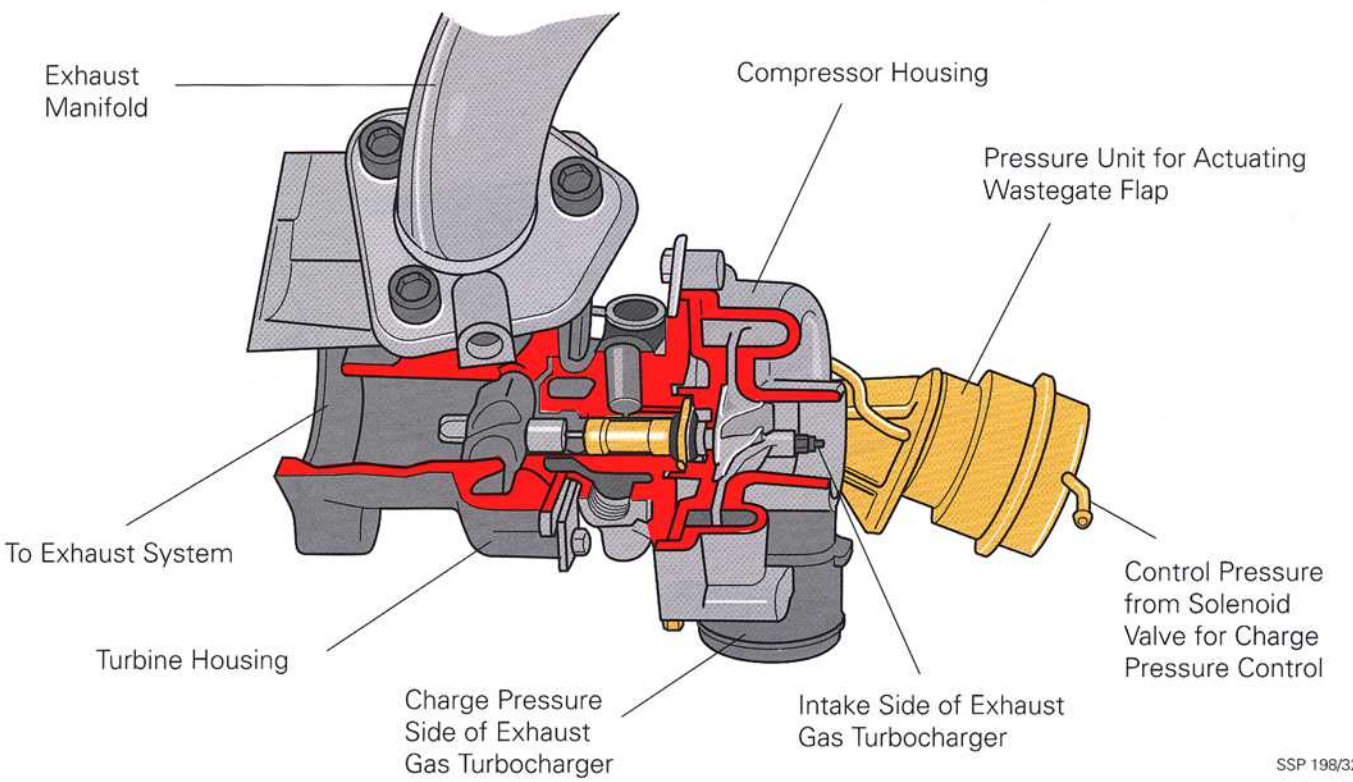
- Each exhaust gas turbocharger is smaller, which means better response due to its reduced mass.
- Higher charge pressure at low engine speeds.
- The exhaust gas turbochargers are located outside the V-angle due to the high temperatures they reach. The advantage of this arrangement is that the intake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



Exhaust System

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

Advantages

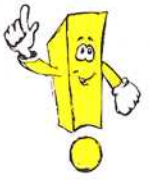
- Less heat loss of the exhaust gas and less heat radiation in the engine compartment
- Weight saving

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

Advantage

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

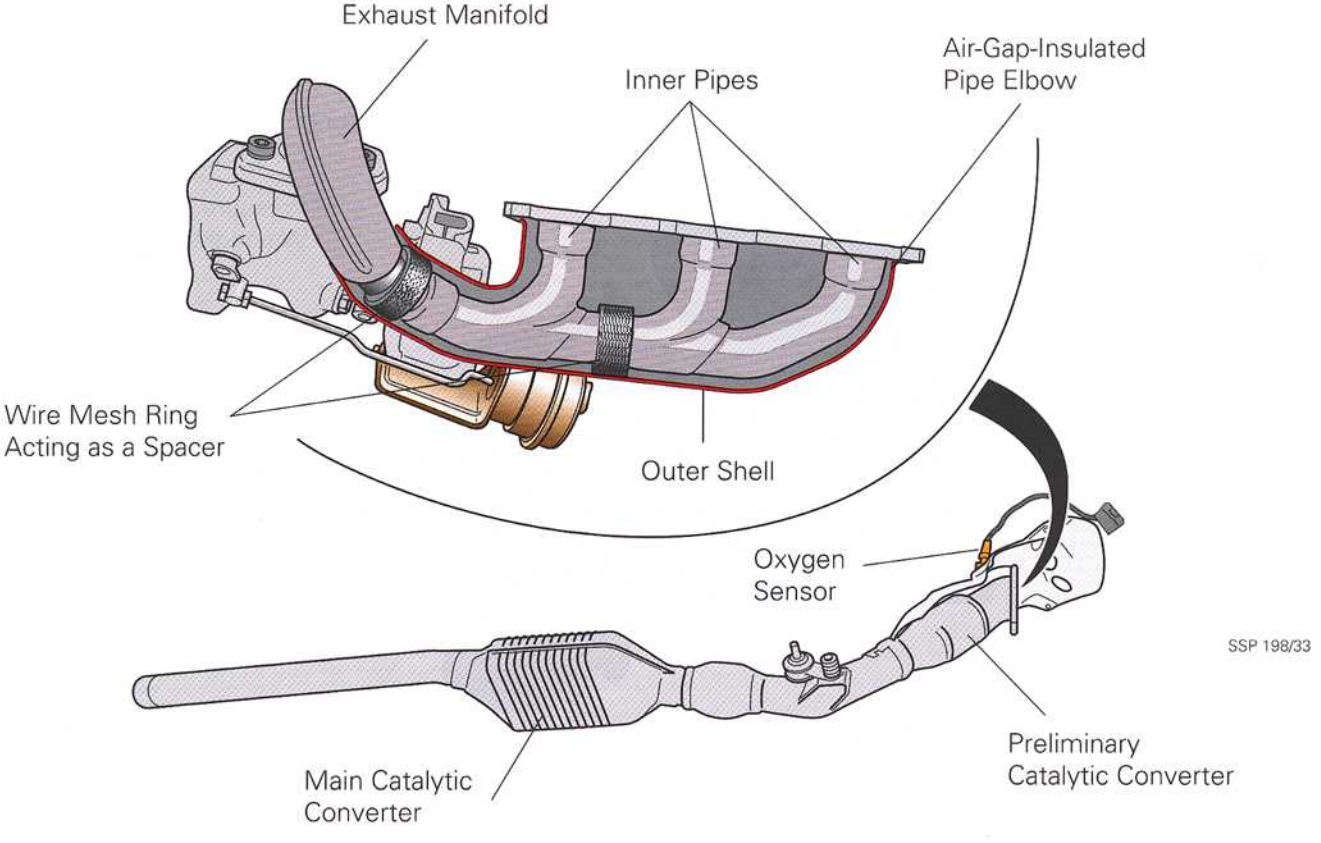
The large surface area main catalytic converters (ceramic substrate) are located under the vehicle floor.



A new generation of oxygen sensors is used in this engine. The "planar" oxygen sensor is an improvement on the finger-type oxygen sensor (refer to chapter on "Sensors").

Advantages

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



Pneumatically Controlled Systems

In the biturbo, four systems are pneumatically controlled:

- **Charge pressure control**

  The Motronic ME 7.1 activates the Wastegate Bypass Regulator Valve N75 and regulates the charge pressure via the wastegate.

- **Recirculating air control in overrun**

  The Motronic ME 7.1 activates the electric recirculating valve for the turbocharger and opens the pneumatic recirculating air valves using this vacuum.

- **EVAP system**

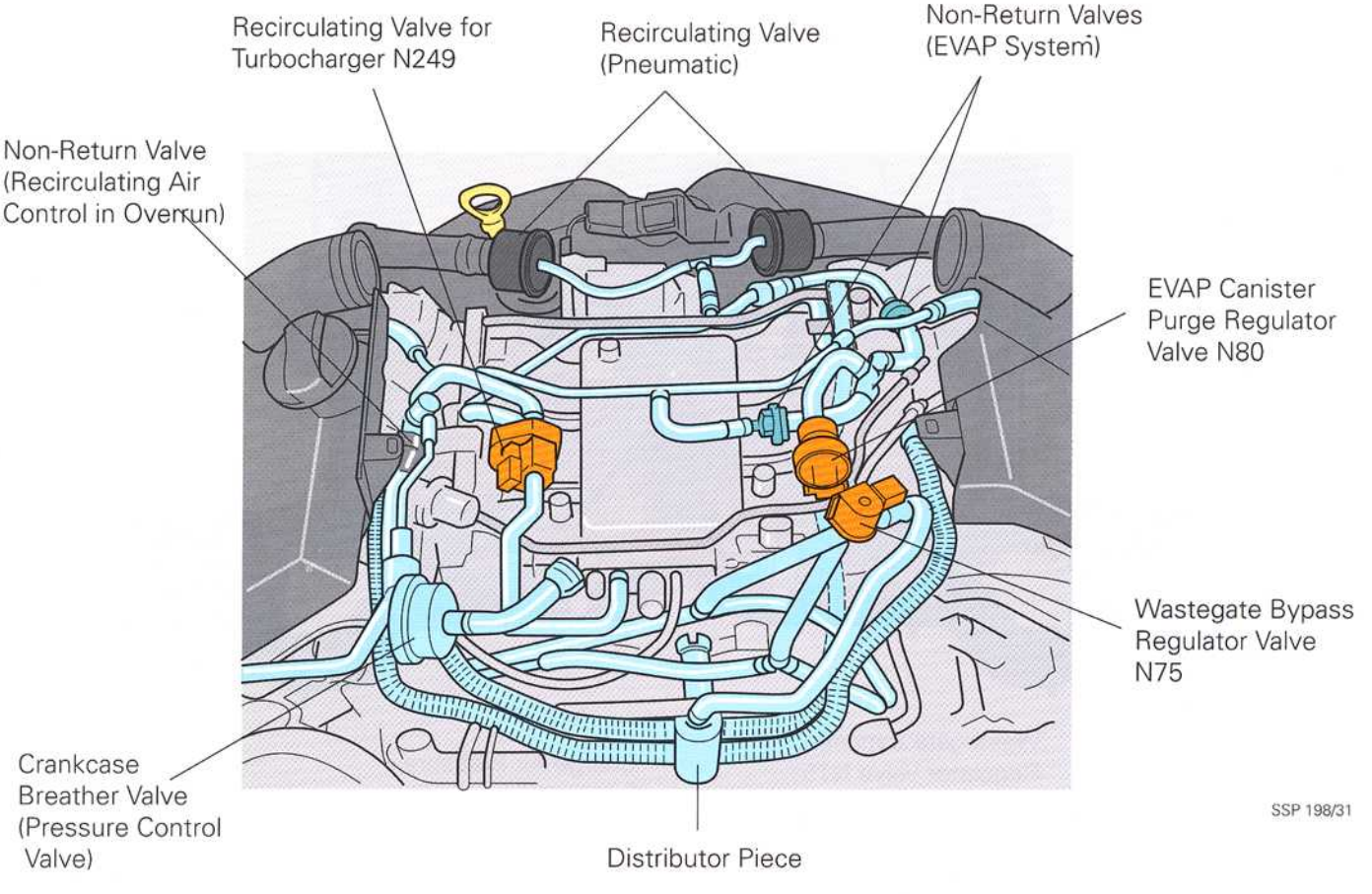
  The Motronic ME 7.1 activates the EVAP Canister Purge Regulator Valve N80 and regulates the fuel vapor feed rate to the engine via the vacuum.

- **Crankcase breather**

  The crankcase breather controls the return of oil vapors to the engine via two mechanical valves.



For the exact line routing, please refer to the workshop manual.



Charge Pressure Control

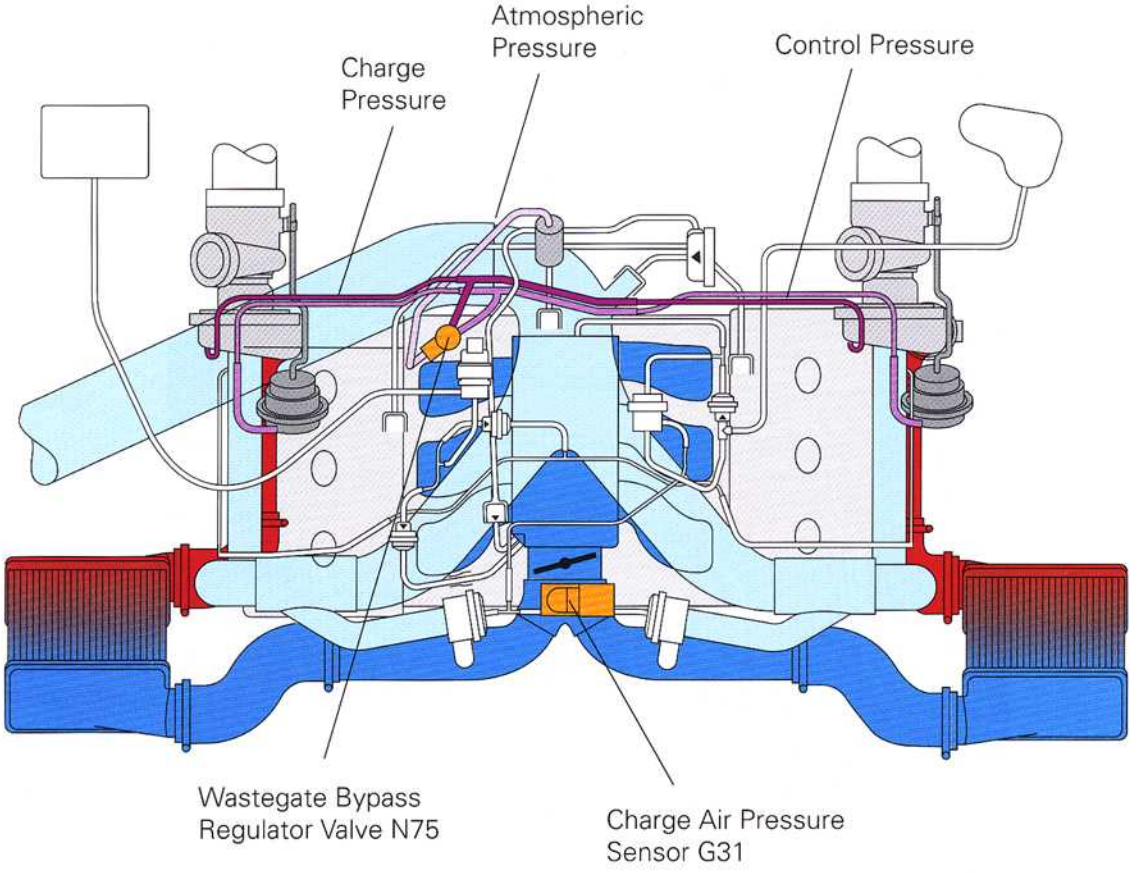
The air mass required to develop a specific level of torque is determined by means of an air mass calculation and produced by controlling the charge pressure as required.

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

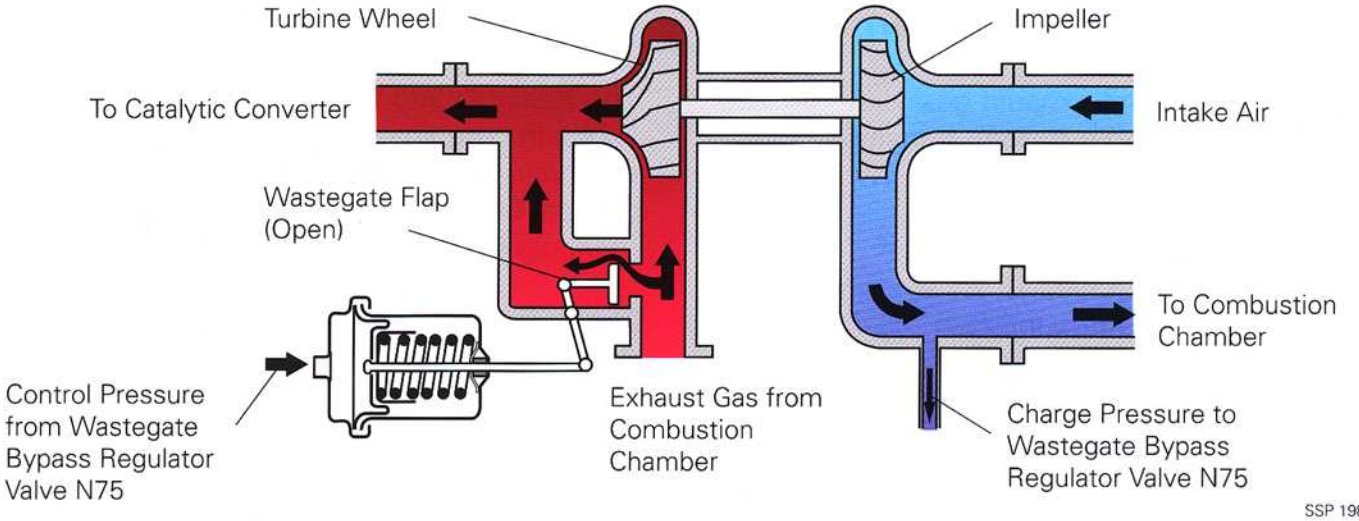
The charge pressure is measured by Charge Air Pressure Sensor G31.
The Motronic regulates the charge pressure of both turbochargers via Wastegate Bypass Regulator Valve N75.

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 from building up inside the intake system.



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The Wastegate Bypass Regulator Valve N75 changes the opening time to atmospheric pressure according to the signals it receives from the engine control module (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.

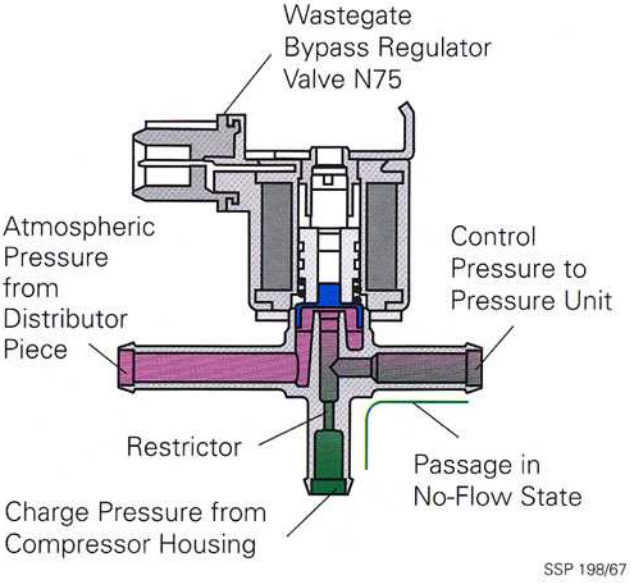
The wastegate is kept closed in a depressurized state by a spring inside the pressure unit . The entire exhaust gas flow is routed via the turbine, and a charge pressure is built up.

The control pressure counteracts the pressure unit 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 wastegate opens even if the charge pressure is low.

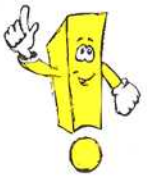
If the charge pressure control fails, the charge pressure is thus limited to a "basic charge pressure" in order to prevent the maximum permissible charge pressure being exceeded. This results in a loss of performance.

The "basic charge pressure" is the charge pressure (approx. 4.4-5.8 psi [300-400 mbar]) which is achieved without regulation (mechanical charge pressure).



Recirculating Control in Overrun

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



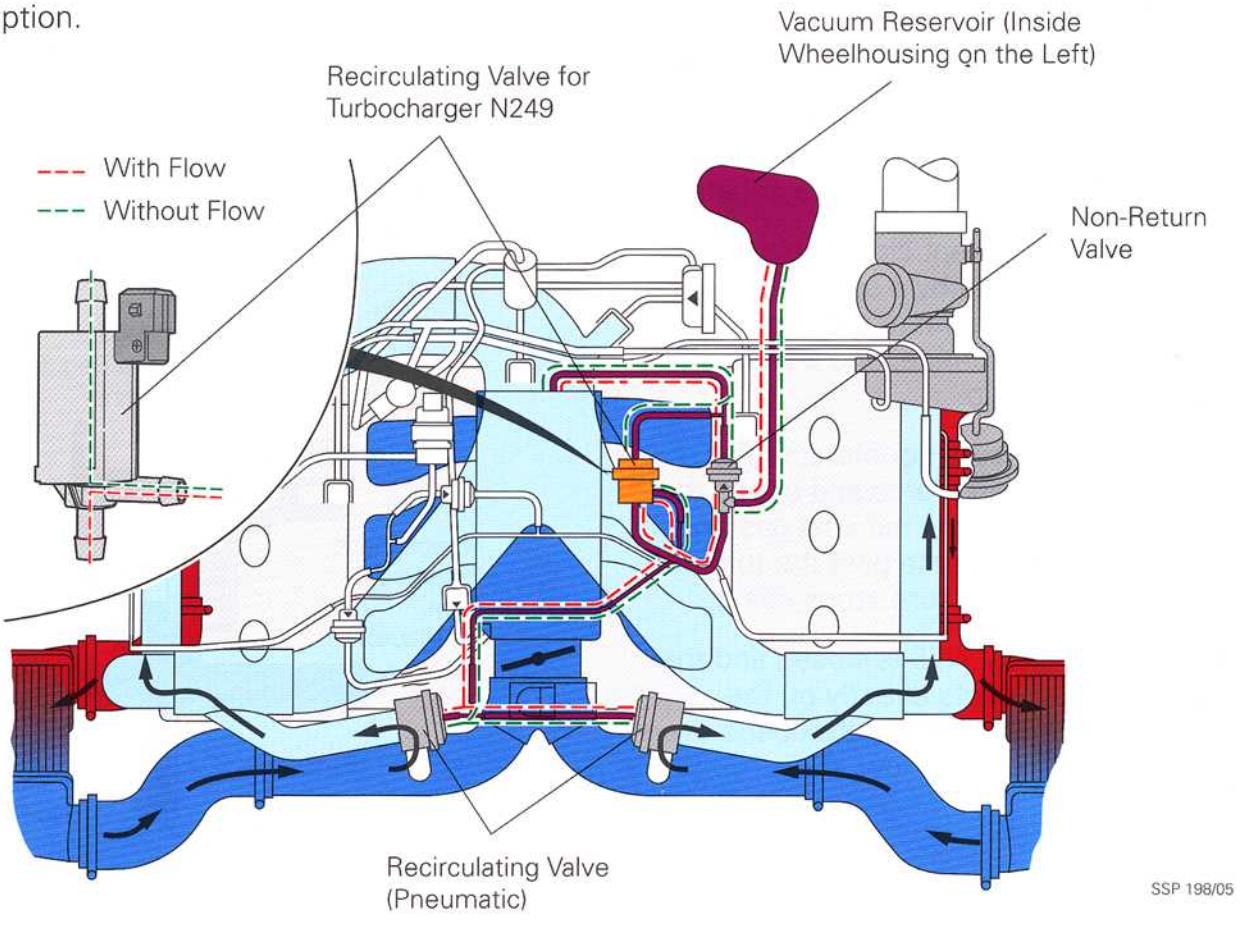
The Motronic ME 7.1 system also activates the two pneumatic recirculating valves by means of an electrical changeover valve, the Recirculating Valve for Turbocharger N249.

The Recirculating Valve for Turbocharger N249, in combination with the vacuum reservoir, enables the recirculating valves to operate independently of the intake manifold pressure.

The system is designed in such a way that the pneumatic recirculating valves continue to be opened by the intake manifold pressure if the Recirculating Valve for Turbocharger N249 fails.

Advantages

- Controlled opening of the recirculating valves reduces the noise level in the induction plenum and reduces fuel consumption.



EVAP System

Integrated in the lines of the evaporative emissions (EVAP) systems are the EVAP Canister Purge Regulator Valve N80 and two non-return valves.

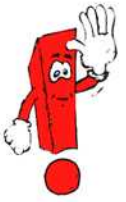
The engine control module, assisted by EVAP Canister Purge Regulator Valve N80, regulates the return rate of the fuel vapors from the EVAP canister.
The Motronic ME 7.1 system operates the purge valve cyclically using a pulse duty cycle.
The non-return valves control the return of fuel vapors, depending on operating state.

Vacuum in intake manifold

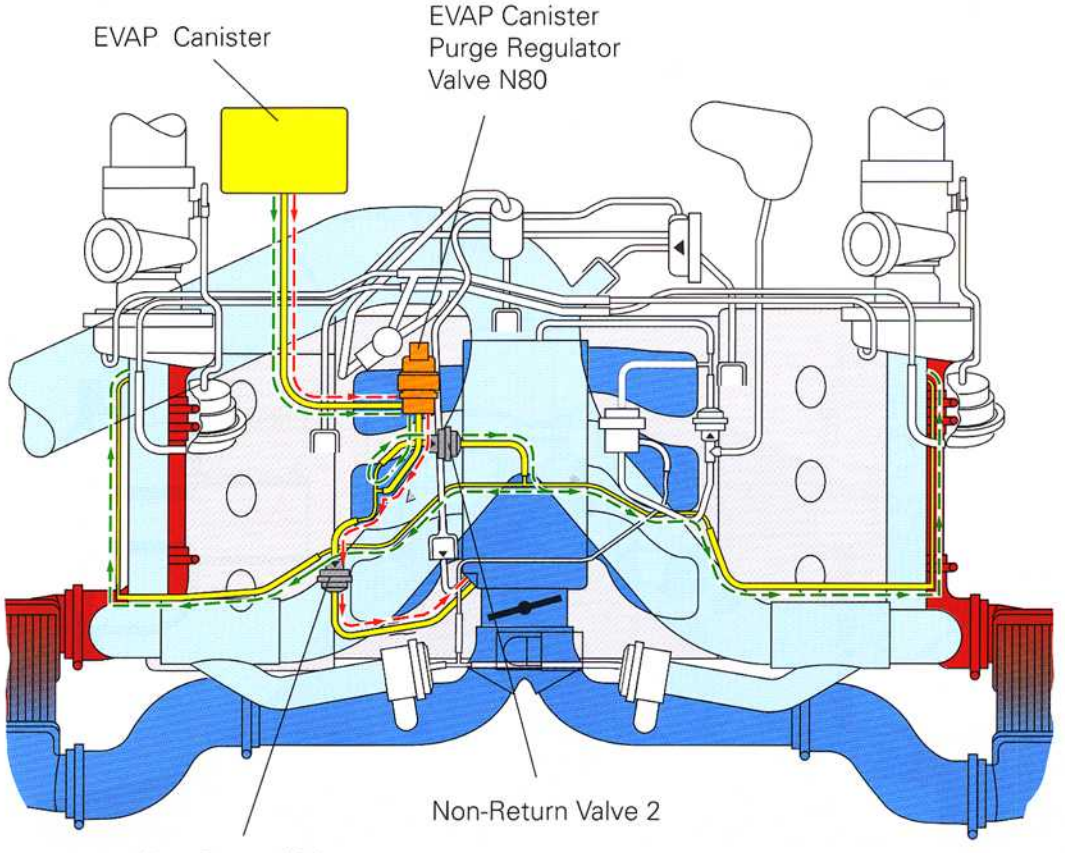
Non-return valve 1 open. Fuel vapors return to intake manifold.

Charge pressure in intake manifold

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



For the exact line routing, please refer to the workshop manual.



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The Crankcase Breather . . .

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

The oil vapors 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 vapors and gases to the engine, depending on the intake manifold pressure.

Vacuum in intake manifold

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

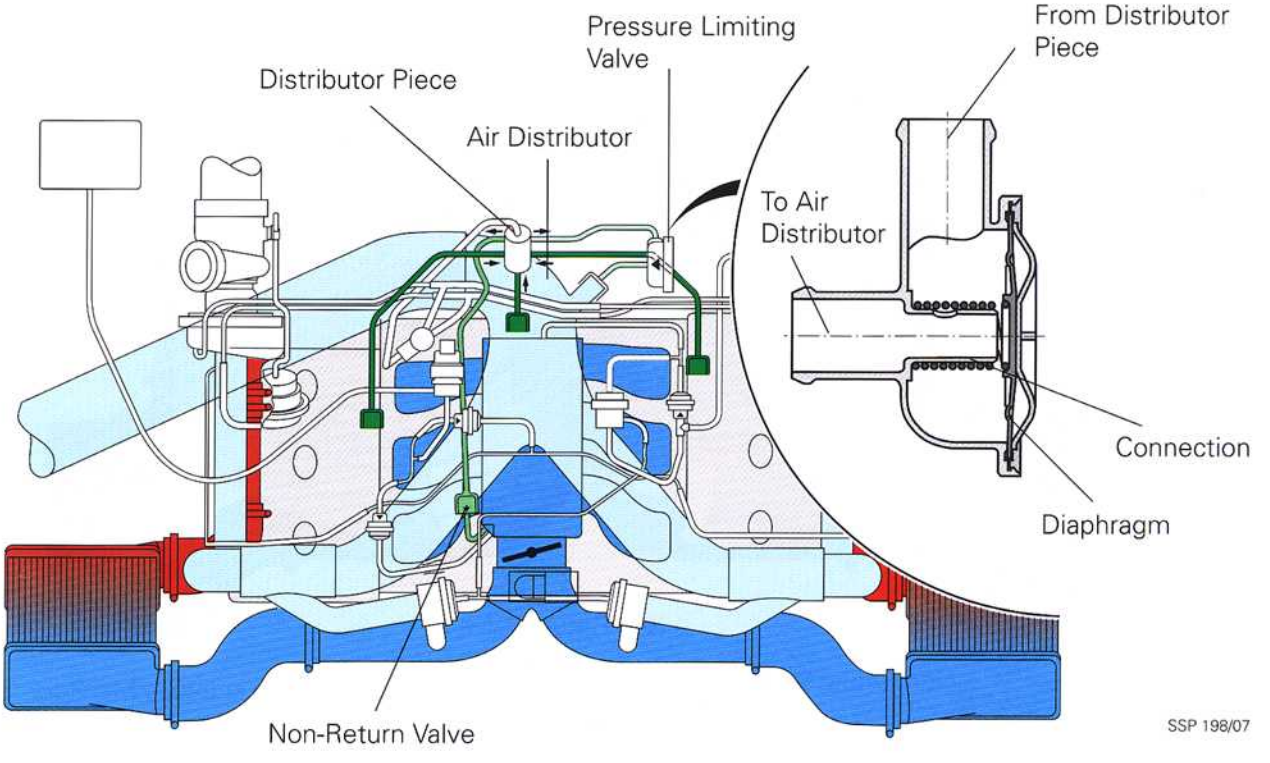
Charge pressure in intake manifold

The oil vapors 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.

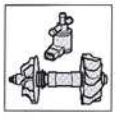


Subfunctions of the Motronic ME 7.1 System

The Motronic ME 7.1 System consists of existing and new subfunctions:



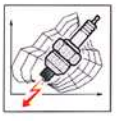
Sequential injection



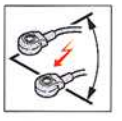
Charge pressure control
(see chapter on "Engine" pages 24 and 25)



Dual air-fuel ratio control



Mapped ignition



Cylinder-selective knock control



Static secondary distribution with six individual ignition coils



EVAP system



New



Torque-oriented engine management



New



Electrically actuated throttle valve (Electronic accelerator)



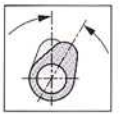
New



Cylinder bank-specific exhaust gas temperature control



New



Mapped variable valve timing (intake camshaft adjustment)
(see chapter on "Engine" page 6)

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Motronic ME 7.1

Sensors

Mass Air Flow (MAF) Sensor G70

Engine Speed (RPM) Sensor G28

Camshaft Position (CMP) Sensors (Bank 2) G40 and (Bank 1) G163

Heated Oxygen Sensors (HO2S) G39 and G108; G130 and G131

Throttle Valve Control Module J338 with Angle Sensor (1) G187 and (2) G188 for Throttle Drive (Power Accelerator Actuation) G186

Intake Air Temperature (IAT) Sensor G42

Engine Coolant Temperature (ECT) Sensors G2 and G62

Charge Air Pressure Sensor G31

Knock Sensors (KS) (Bank 1) G61 and (Bank 2) G66

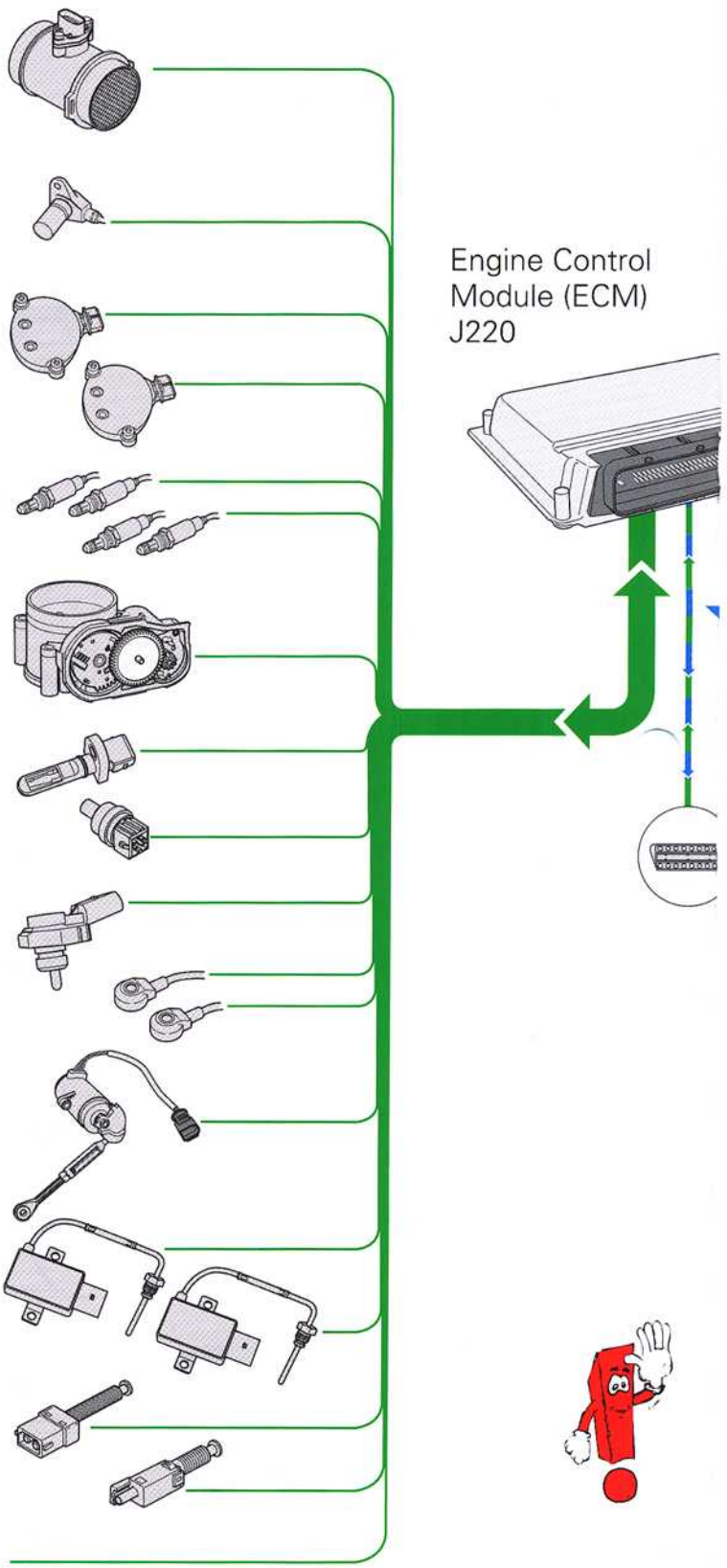
Throttle Position (TP) Sensor G79 and Sender -2- for Accelerator Pedal Position G185

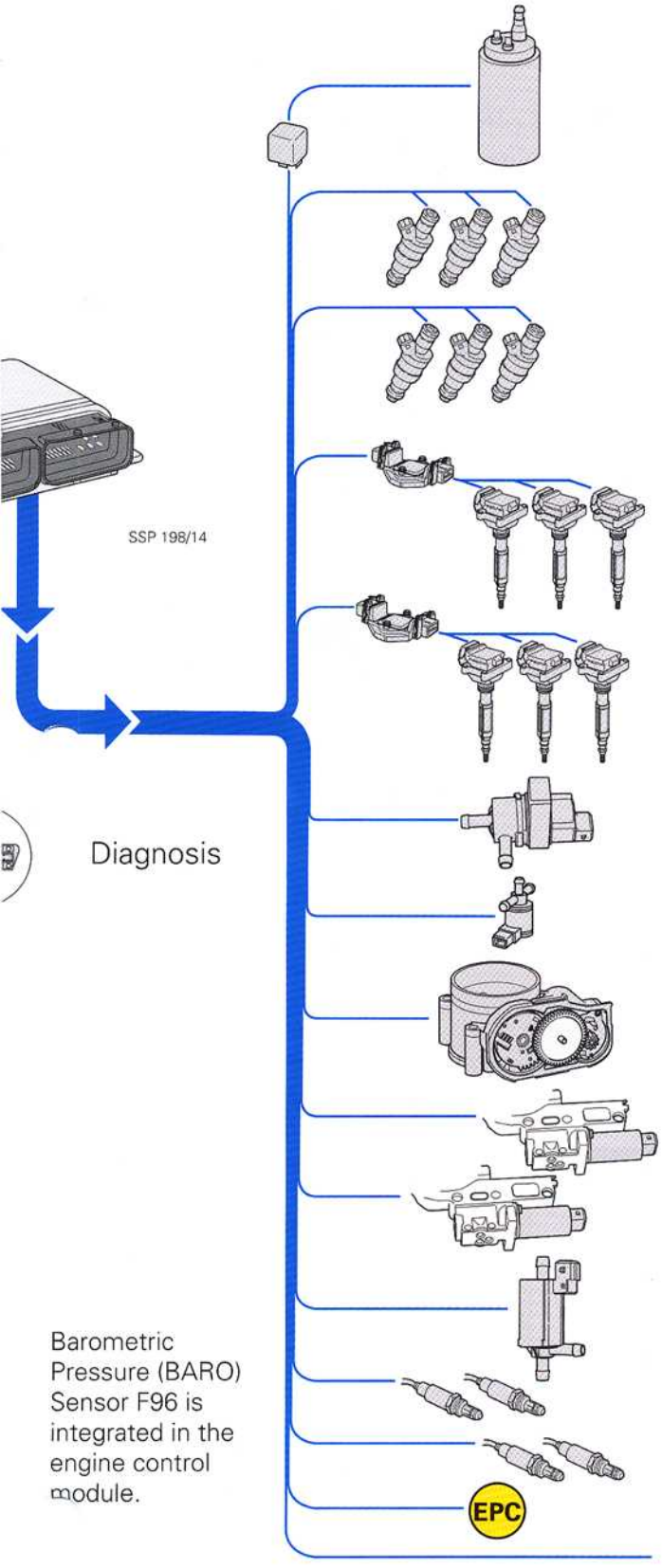
Sensors for Exhaust Temperature (Bank 1) G235 and (Bank 2) G236

Brake Light Switch F and Brake Pedal Switch F47

Clutch Vacuum Vent Valve Switch F36

Auxiliary Signals





Actuators

Fuel Pump (FP) Relay J17 and Fuel Pump (FP) G6

Fuel Injectors (Bank 1) N30, N31, N32

Fuel Injectors (Bank 2) N33, N83, N84

Power Output Stage (Bank 1) N122 and Ignition Coils N (Cyl. 1), N128 (Cyl. 2) and N158 (Cyl. 3)

Power Output Stage 2 (Bank 2) N192 and Ignition Coils N163 (Cyl. 4), N164 (Cyl. 5) and N189 (Cyl. 6)

EVAP Canister Purge Regulator Valve N80

Wastegate Bypass Regulator Valve N75

Throttle Valve Control Module J338 with Throttle Drive (Power Accelerator Actuation) G186

Valve for Camshaft Adjustment (Bank 1) N205 and (Bank 2) N208

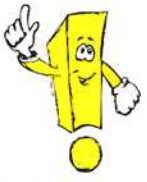
Recirculating Valve for Turbochargers N249

Oxygen Sensor (O2S) Heaters Z19 and Z28; Z29 and Z30

Fault Light for Power Accelerator Activation K132

Auxiliary signals

Torque-Oriented Engine Management



In previous engine management systems, demands for torque and efficiency were calculated by separate sub-systems such as ignition timing, injection time, boost control, etc.

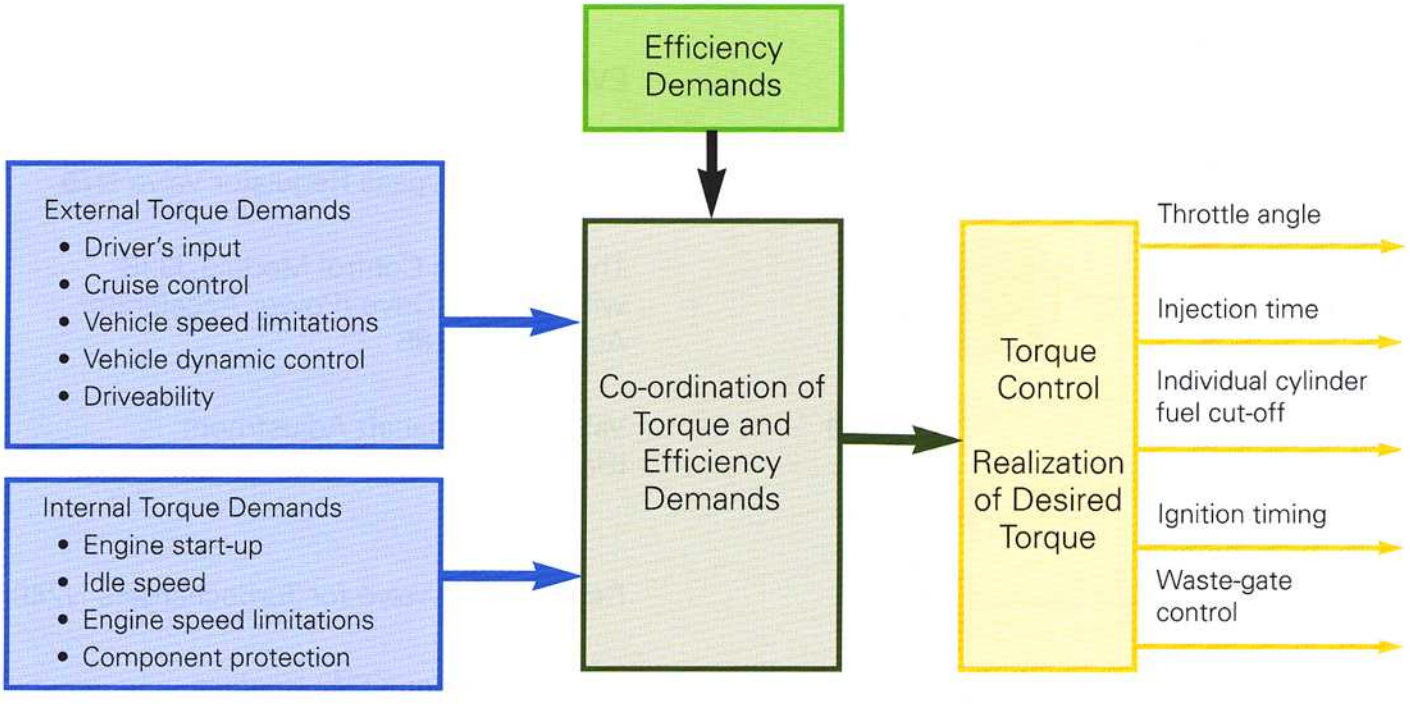
The interaction between these sub-systems has become increasingly complicated as new demands such as traction and vehicle dynamic control are added to the system.

The new Motronic ME 7.1 system is called a torque-based engine management system.

All torque and efficiency demands on the system are defined as variables that are controlled in a central module.

The resulting torque demand is converted into injection timing, ignition timing, boost control, and individual injector cut-off for traction and vehicle dynamic control.

The addition of electronic throttle position control allows further modification of the cylinder charging for improved torque control. This simplified architecture allows better coordination of additional demands.



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Torque-Oriented Functional Structure

In order to meet the torque demands as quickly as possible, demands for torque are co-ordinated via two paths:

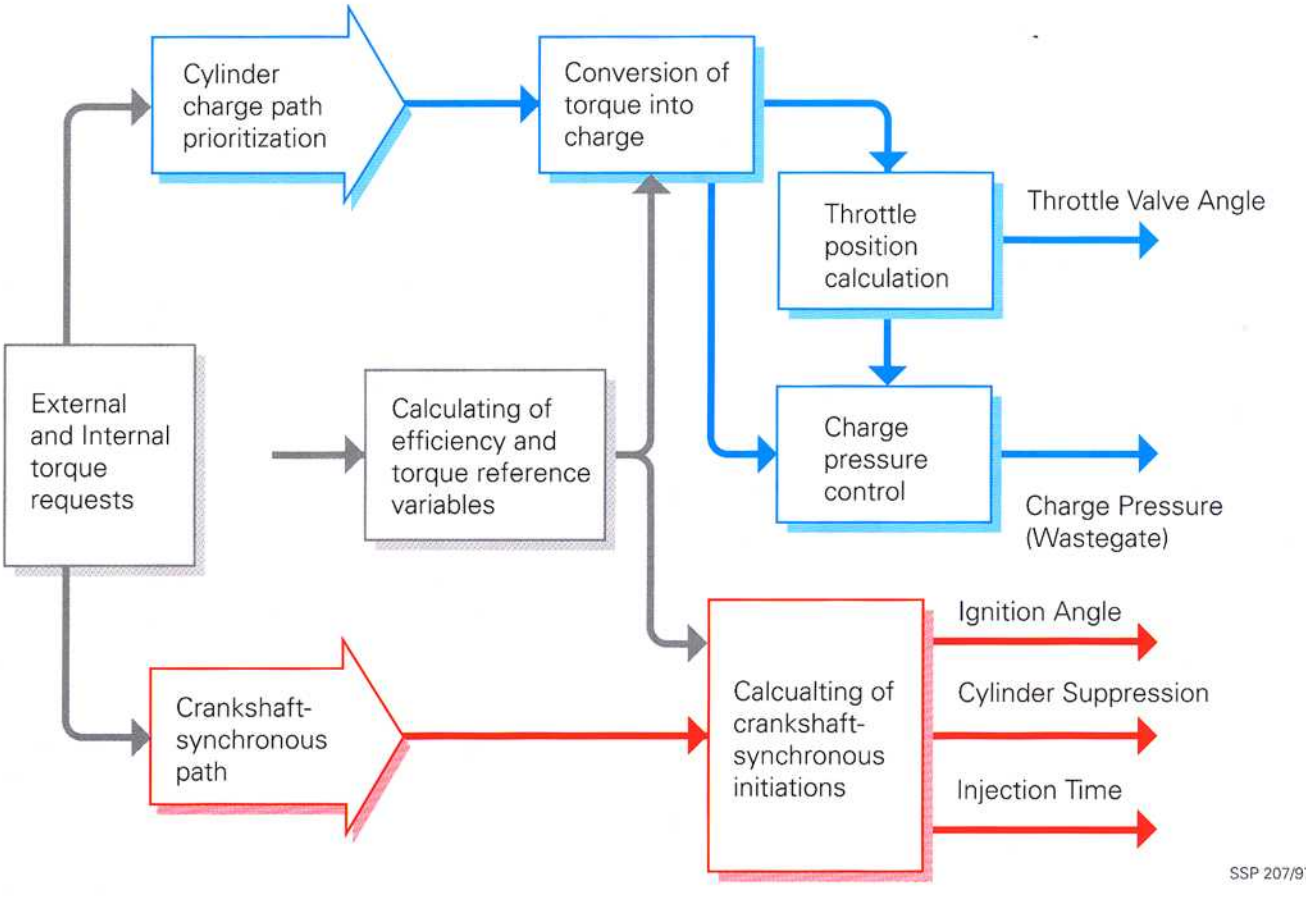
- The cylinder charge path controls all charge influencing actuators, such as throttle valve angle and wastegate.
- The crankshaft-synchronous path controls all interactions that occur simultaneously with the operating cycle of the engine, such as ignition and injection timing.

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

For the most part, long-term torque requests are fulfilled along the cylinder charge path.

The crankshaft-synchronous path is used to set the injection quantity or cylinder cut-out necessary under the given circumstances and the optimal ignition angle.

This path is particularly well suited to meeting short term torque requests, which usually have a torque-reducing effect.



Electronic Throttle Control Function

With Motronic ME 7.1, there is no longer a throttle control cable between the accelerator pedal and the throttle valve, This has been replaced by an electronic control system.

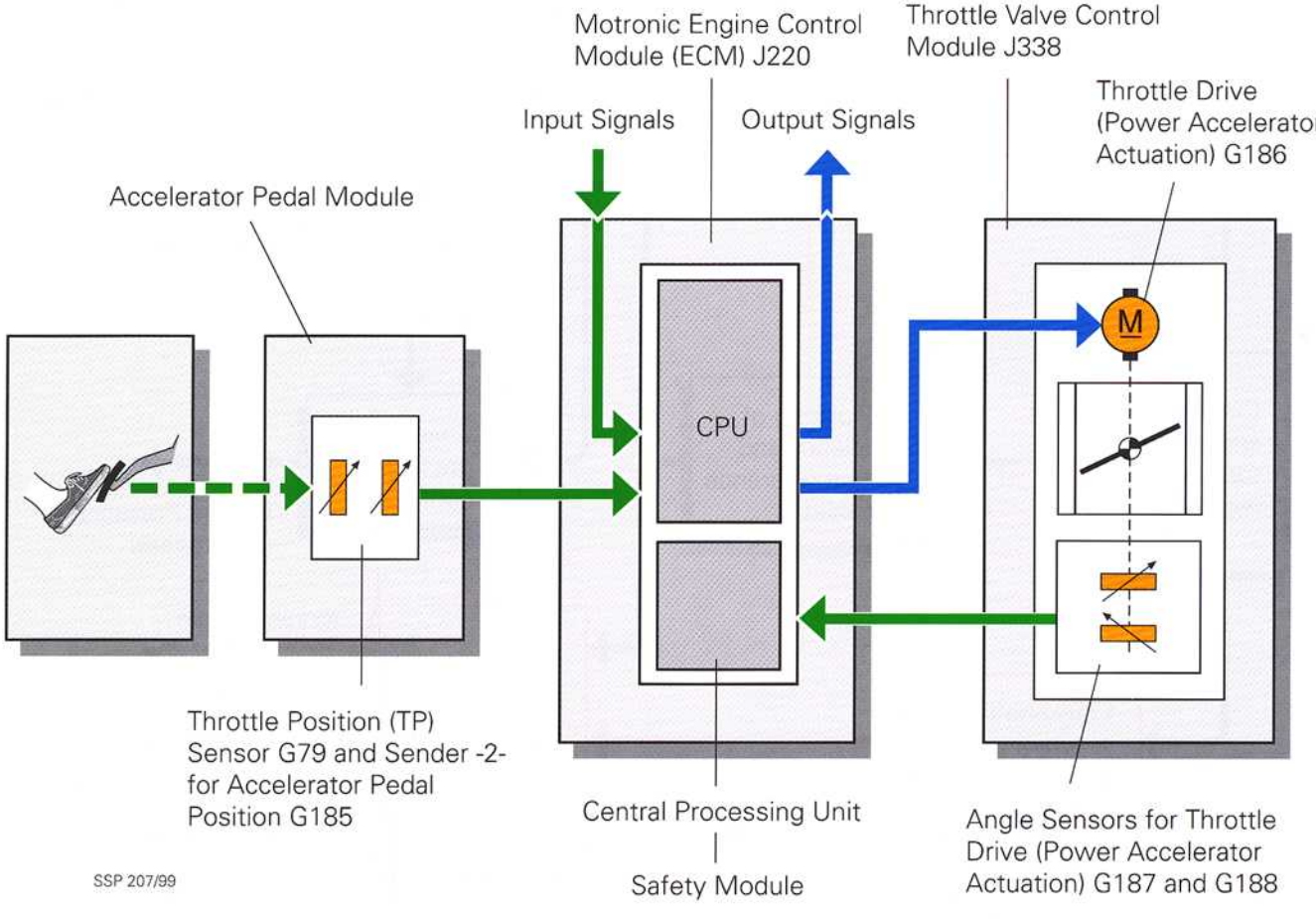
The system has the following components:

- The Accelerator Pedal Module
- The Motronic Engine Control Module (ECM) J220
- The Throttle Valve Control Module J338

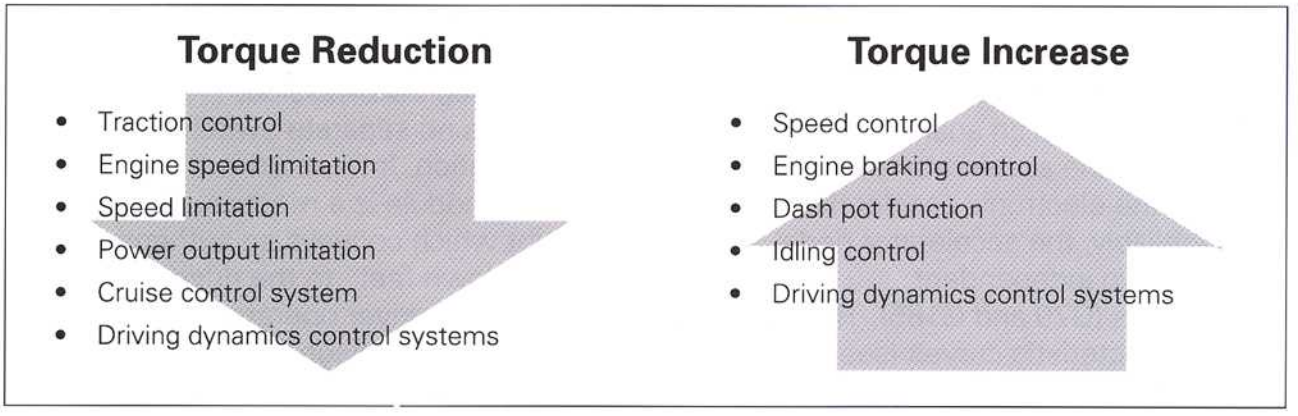
The driver input at the accelerator pedal is registered by the Sender -2- for Accelerator Pedal Position G185 and transmitted to the Motronic Engine Control Module (ECM) J220.

The Motronic Engine Control Module (ECM) J220 positions the throttle valve via an electric motor. The Motronic Engine Control Module is provided with continuous feedback on the throttle valve position.

Extensive safety measures have been implemented in the hardware and software. For example, dual sensors, a safety module and a self-monitoring processor structure are integrated in the electronic throttle control function.



Electronic Throttle Control



The throttle valve control system is used to reduce and increase torque without adversely affecting the exhaust emissions.

The ideal combination of throttle opening and charge pressure can be controlled for greatest efficiency.

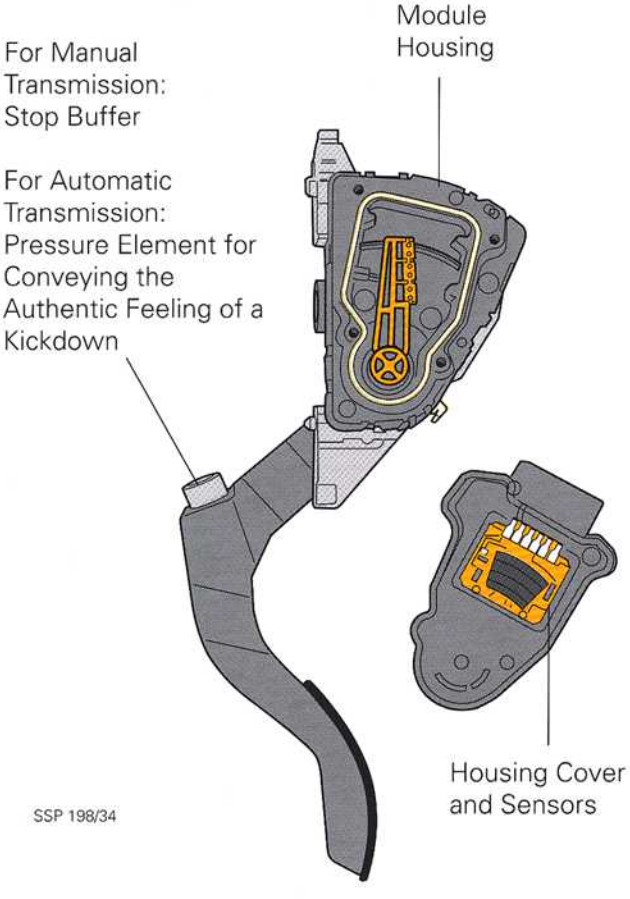
Under acceleration, throttle movement is programmed to best increase intake charge velocity.

On deceleration, the throttle valve can be held open to reduce emissions.

The part throttle operation can easily be modulated for slower opening speeds, a function previously accomplished through the use of a cam or progressive throttle body.

Accelerator Pedal Module

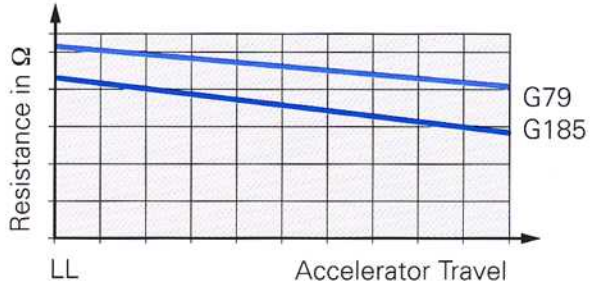
The accelerator pedal module combines the accelerator pedal and the accelerator position sensors into a single unit.
The accelerator pedal module transfers to the Motronic system an analog signal that corresponds to the accelerator position. To ensure that the electronic accelerator functions reliably, the accelerator pedal module has two independent potentiometers (G79 and G185). They have different characteristic curves (see diagram).
The engine control module monitors the two sensors G79 and G185 for proper functioning and plausibility. If a sensor fails, the other sensor serves as a substitute.



The accelerator pedal module transfers the driver's input to the Motronic system and provides kickdown information to the automatic transmission.
There is no separate switch for kickdown information. Integrated in the accelerator pedal module 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 sensor is exceeded. If a voltage defined in the engine control module is attained in the process, this is interpreted as a kickdown and is transferred to the automatic transmission (via the CAN data bus).
The accelerator position sensors for the manual and automatic transmissions are identical. Kickdown is enabled or disabled via the accelerator limit stop.

Advantages of the accelerator pedal module

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



Self-Diagnosis/Emergency Running

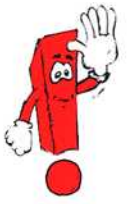
If a fault occurs in the accelerator pedal module or the wiring, two emergency running programs can be run depending on fault type.

Emergency running program 1 – If an accelerator position sensor 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. However, the idling speed position must be learned once by the good sensor.
- The signal supplied by the brake light switch for Brake Pedal Switch F47 indicates the idling speed.
- Comfort functions (CCS) are prohibited.
- The Fault Light for Power Accelerator for Activation K132 comes on.

Emergency running program 2 – If both accelerator position sensors fail, driver input recognition is not possible

- The engine only runs at idling speed.
- The Fault Light for Power Accelerator Activation K132 comes on.



At idling speed, the Throttle Position (TP) Sensor G79 and the Sender -2- for Accelerator Pedal Position G185 are not diagnosed. If the accelerator pedal module becomes disconnected, no fault is stored in the engine control module.
The Fault Light for Power Accelerator Activation 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 to a defined 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.

Throttle Valve Control Module J338

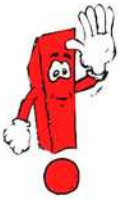
The Throttle Valve Control Module J388 comprises . . .

. . . throttle valve housing with throttle valve
. . . Throttle Drive (Power Accelerator Actuation) G186 with reduction gear
. . . Angle Sensors for Throttle Drive (Power Accelerator Actuation) G187 and G188

Activated by the Motronic Engine Control Module (ECM) J220, 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.

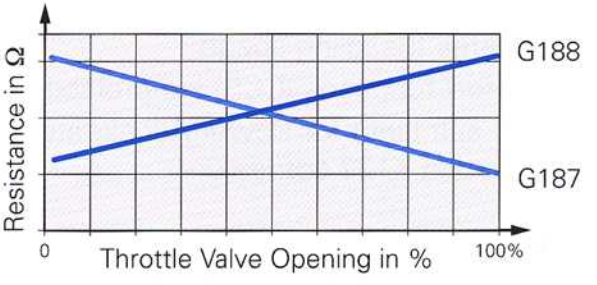
For safety reasons, two angle sensors (redundancy) are used. They have opposite resistance characteristics (see diagram).

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

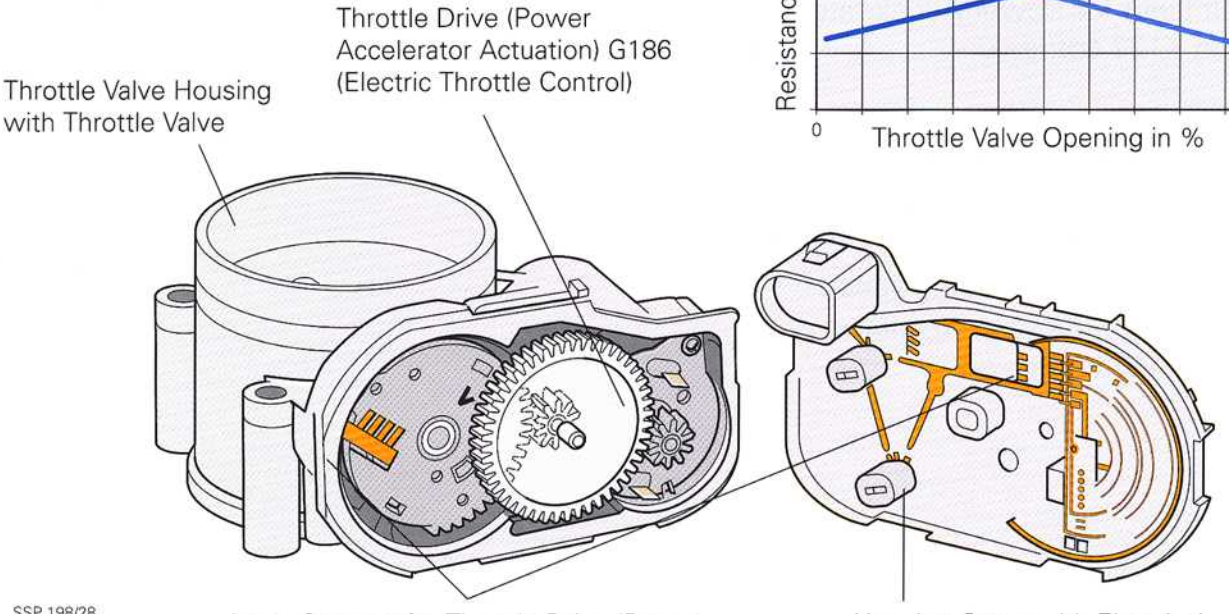


Angle Sensors for Throttle Drive (Power Accelerator Actuation) G187 and G188 cannot be replaced separately. The throttle valve control module may not be opened.

Redundancy means: superfluous, non-essential. It is not essential to have two sensors, but each provides backup for the other.



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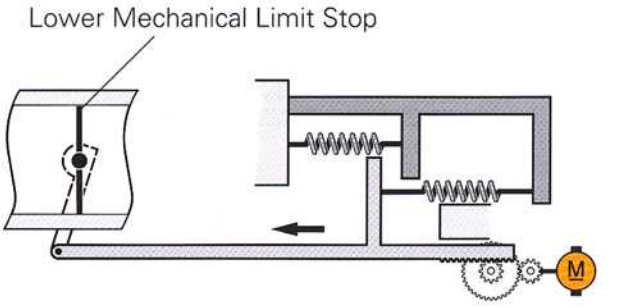


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Functional Positions of Throttle Valve Control Module J338

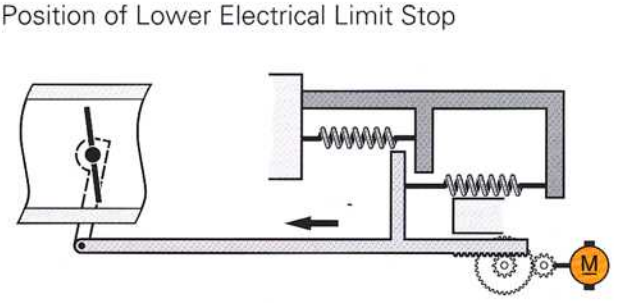
The Motronic Engine Control Module (ECM) J220 recognizes four key functional positions of the Throttle Valve Control Module J338.

- **The lower mechanical limit stop**
  The throttle valve is closed. This position is required to adapt the angle sensor.



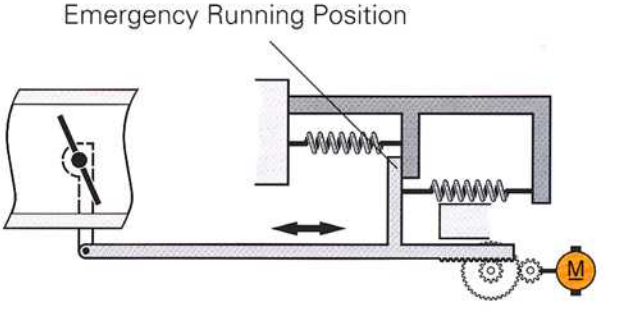
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- **The lower electrical limit stop**
  is defined by the Motronic Engine Control Module (ECM) J220 and is located just below the lower mechanical limit stop. During operation, the throttle valve closes no further than the lower electrical limit stop. This prevents the throttle valve from working its way into the throttle valve housing.



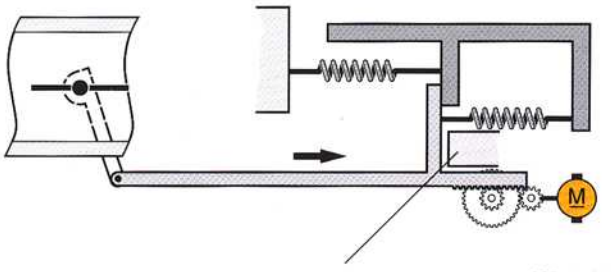
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- **The emergency running position**
  is the position of the throttle valve in the de-energized state and ensures that air flow is sufficient if any of the relevant electronic accelerator functions fails. Idling speed is higher (approx. 1000 rpm) and uneven.
  Very limited vehicle operation is possible.



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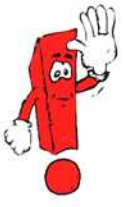
Position at Upper Electrical Limit Stop



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Upper Mechanical Limit Stop

- **The upper electrical limit stop** is defined in the Motronic Engine Control Module (ECM) J220 and does not need to be learned.



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

To enable the exact angular position of the throttle valve to be identified, Angle Sensors for Throttle Drive (Power Accelerator Actuation) G187 and G188 must be learned .

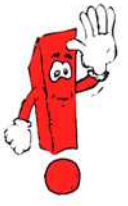
By moving the throttle valve into predefined positions, the values of the angle sensors are stored in the Motronic Engine Control Module (ECM) J220 (calibrated) and checked for plausibility.The state of the mechanics (terminals, weak springs) in the Throttle Valve Control Module J338 is determined by evaluating the throttle valve's reaction speed.

Basic Adjustment (Adaptation) . . .

. . . involves not only learning the throttle valve position, but also a complete check of the Throttle Valve Control Module J338

. . . 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 adaptation is acknowledged.
- **specifically** - by initiating basic setting 04 in measured value block 60 (refer to workshop manual)



Adaptation conditions

For basic setting (adaptation), 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 Module J338 or in the wiring, three emergency running programs can be run, depending on fault type.

Emergency running program 1 – If an angle sensor for throttle drive fails or an implausible signal is received:

- Torque-increasing requests on engine, e.g. CCS, EBC (engine braking control) are suppressed.
- The Fault Light for Power Accelerator Activation K132 comes on.



Prerequisite

An intact angle sensor and plausible air mass flow. The air mass flow is indicated by the Mass Air Flow (MAF) Sensor G70 and the Charge Air Pressure Sensor G31.

Emergency running program 2 – If the throttle valve drive fails or malfunctions:

- The throttle 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 Light for Power Accelerator Activation K132 comes on.

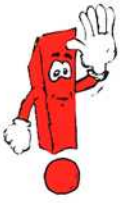


Prerequisite

Emergency running program 2 is only run if both angle sensors for throttle drive recognize the emergency running position.

Emergency running program 3 – If the throttle valve position is not clearly recognizable and/or if the throttle valve is not definitely known to be in the emergency running position:

- The throttle 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 fuel injection.
- The Fault Light for Power Accelerator Activation K132 comes on.



Repair work may not be performed on the Throttle Valve Control Module J338! If G186, G187 or G188 becomes faulty, unit J338 must be replaced completely and a **basic setting performed.**

Fault Light for Power Accelerator Activation K132



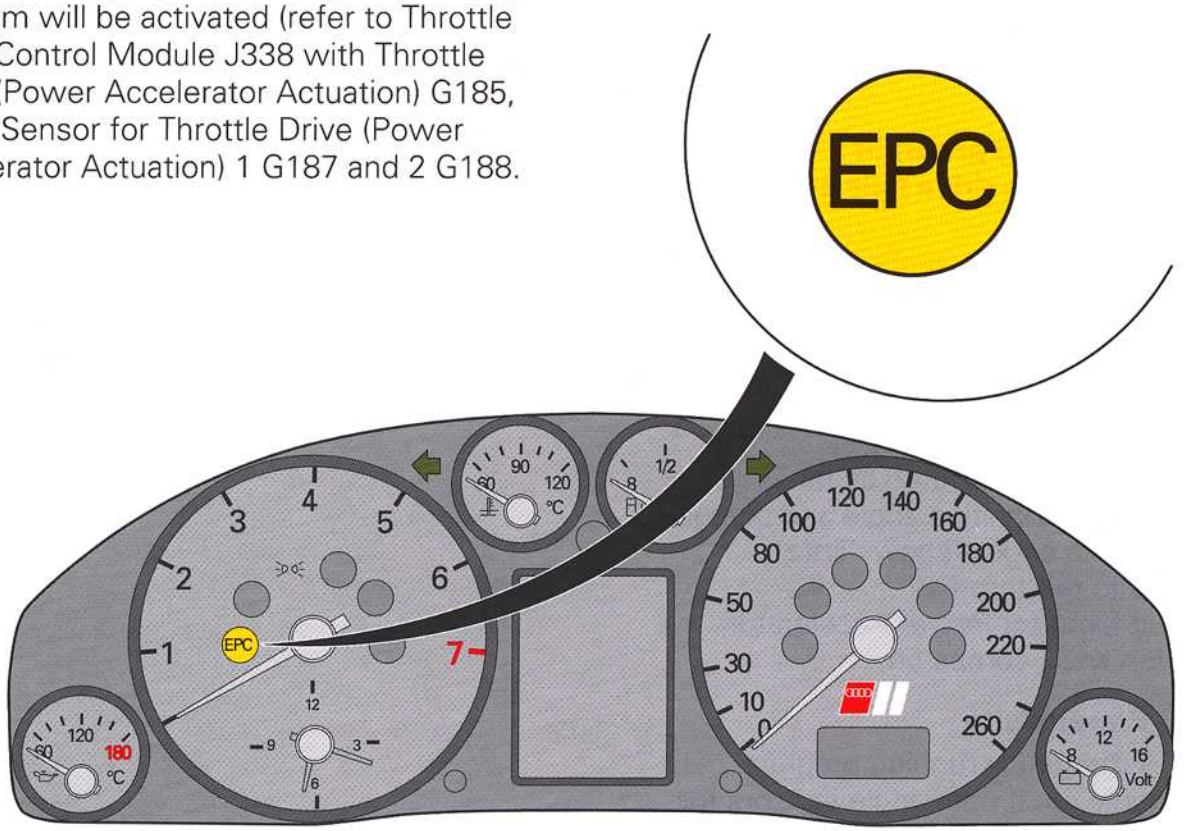
EPC stands for **E**lectronic **P**ower **C**ontrol.

Faults in the electronic accelerator system are detected by the self-diagnosis and indicated via the separate EPC fault light. At the same time, an entry is made in the fault memory.

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

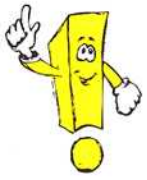
The Fault Light for Power Accelerator Activation K132 is activated by being electronically switched to ground through the engine control module.

If a fault occurs in the electronic accelerator system, an appropriate emergency running program will be activated (refer to Throttle Valve Control Module J338 with Throttle Drive (Power Accelerator Actuation) G185, Angle Sensor for Throttle Drive (Power Accelerator Actuation) 1 G187 and 2 G188.



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Exhaust Temperature Control



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

For turbocharged engines, the maximum permissible exhaust temperature is a key design criterion.
To protect the exhaust gas turbocharger and the exhaust manifold, the exhaust temperature should not exceed 1832°F (1000°C) for a lengthy period of time.

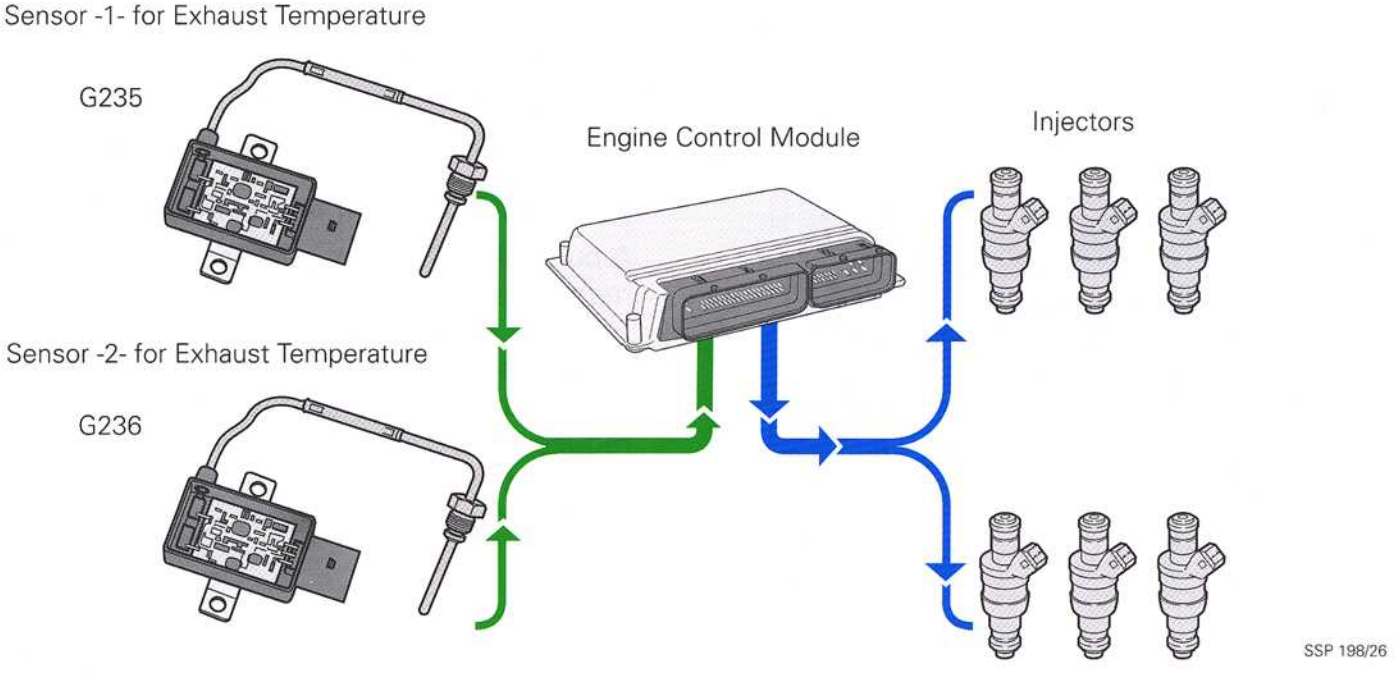
Since many of the components which influence the exhaust temperature have tolerances, thermodynamic adaptation previously took place at 1742°F (950°C) for safety's sake.
This was achieved by enriching the air/fuel mixture.

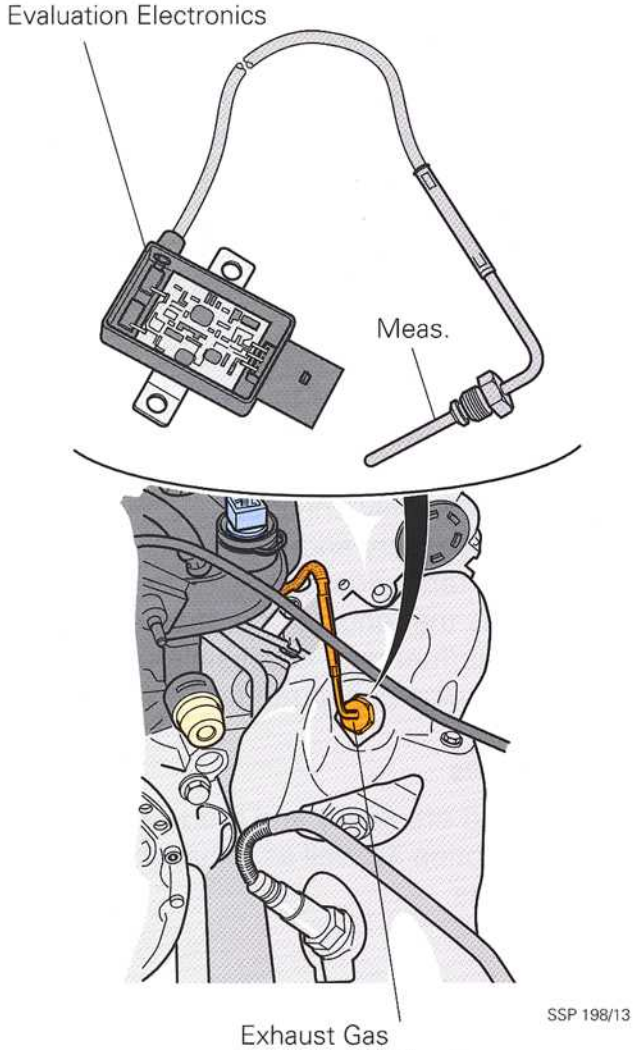
The exhaust temperature is recorded in a cylinder-bank-specific manner by the two Sensors for Exhaust Temperature G235 and G236.
The Motronic system controls the exhaust temperature to 1796°F (980°C) by enriching the air/fuel mixture.

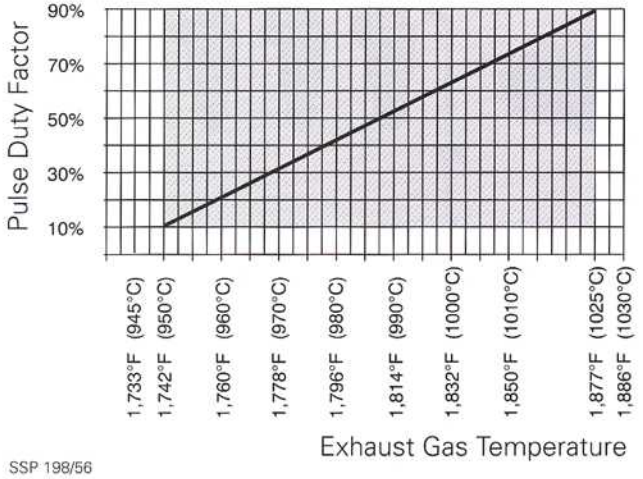
It is therefore possible to largely dispense with the preventive enrichment process that has been standard practice until now.
The mixture is only enriched...
... when necessary and
... to the extent necessary.
This means that engine operation at optimum air/fuel ratio is possible up to high load and engine speed ranges.

Advantages

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







Sensors for Exhaust Temperature 1 G235 and 2 G236

To facilitate exhaust temperature control, the exhaust temperature must be recorded to a high degree of accuracy.
An accuracy of ± 9°F (5°C) is achieved in the measurement range from 1742°F to 1877°F (950°C to 1025°C).

The sensor for exhaust temperature 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 ≥10% to ≤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 recognized as a fault.
A fault is detected as of a certain enrichment quantity.
If a sensor fails, the charge pressure is reduced to a safe level and an emergency enrichment characteristic (engine speed-dependent) is used.

Charge Air Pressure Sensor G31

The Charge Air Pressure Sensor G31 is located **upstream** of the Throttle Valve Control Module J338.

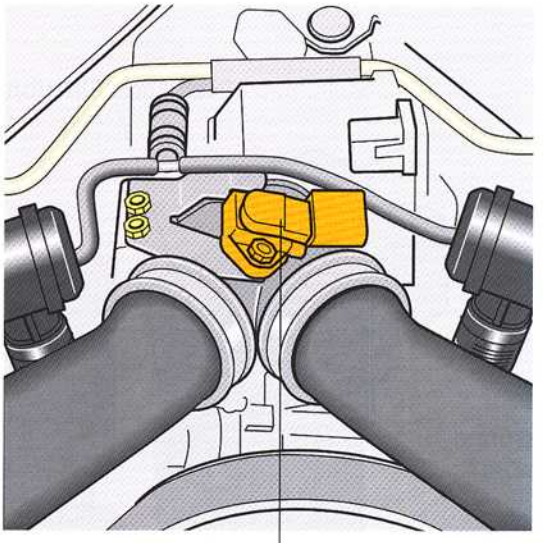
The Motronic system supplies the sensor with a voltage of 5 volts and ground. The signal which the sensor generates is a pressure-proportional voltage ranging from 0 to 5 volts.

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

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

Substitute function and self-diagnosis

If Charge Air Pressure Sensor G31 fails, the charge pressure is controlled via the characteristic curve (engine speed-dependent). This will result in a deficiency of engine power.



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Charge Air Pressure Sensor G31

The Barometer Pressure (BARO) Sensor F96 . . .

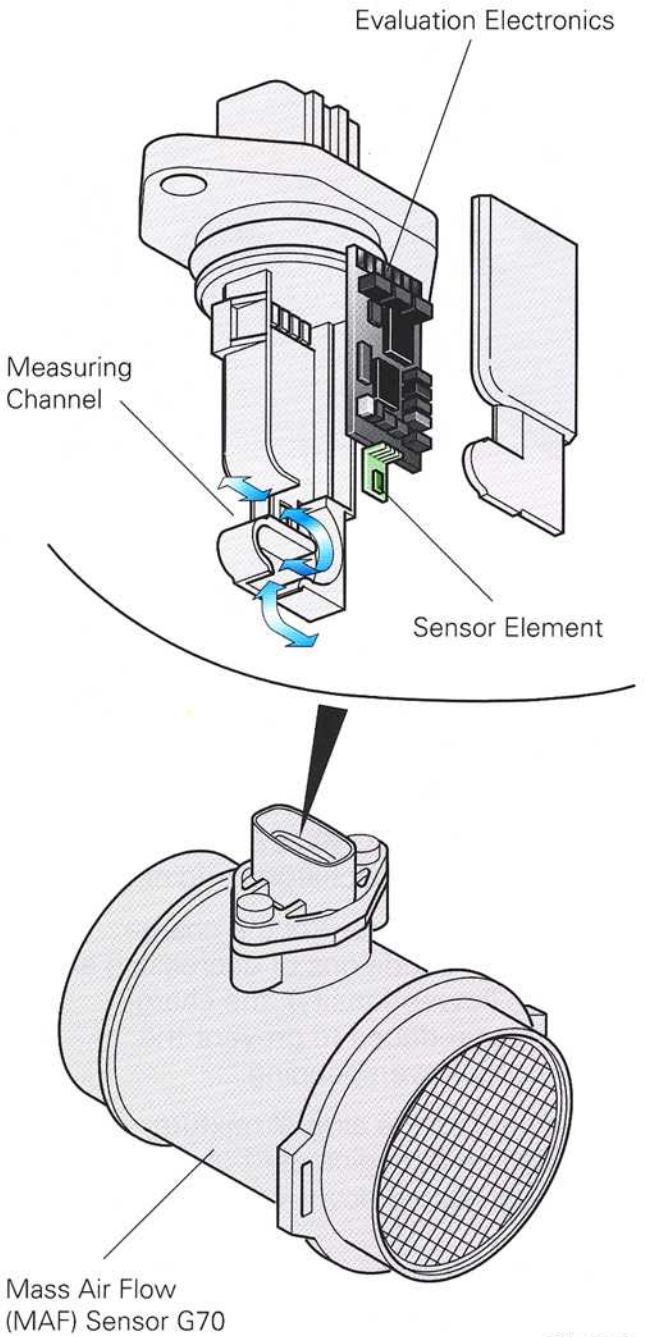
. . . is integrated in the Motronic Engine Control Module (ECM) J220, as is normally the case with turbocharged engines.

. . . 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.

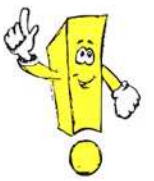
. . . influences the air/fuel mixture composition at engine start-up. The starting mixture is leaned down with rising altitude.

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.
Adaptation of the injection quantity at start-up no longer takes place.
The fault message "Control unit defective" is displayed in the self-diagnosis.



Mass Air Flow (MAF) Sensor G70



The Mass Air Flow (MAF) Sensor G70 operates on the same principle as before. In certain engine operating states, pulsations occur in the intake manifold, reversing the air flow - and this gives rise to measurement errors.

The MAF sensor is designed in such a way that it is able to recognize 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 MAF sensor is a thermal flowmeter. A partial airflow from the measuring pipe is fed past the sensor element through a measuring channel in the MAF sensor housing.
The ascertained temperature values are evaluated in the evaluation electronics. The Motronic system applies a voltage proportional to the air mass to the MAF sensor. This voltage is needed to calculate the injection period and actual engine torque.

Substitute function and self-diagnosis

The MAF sensor detects air masses above or below predefined limits. If the MAF sensor 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.

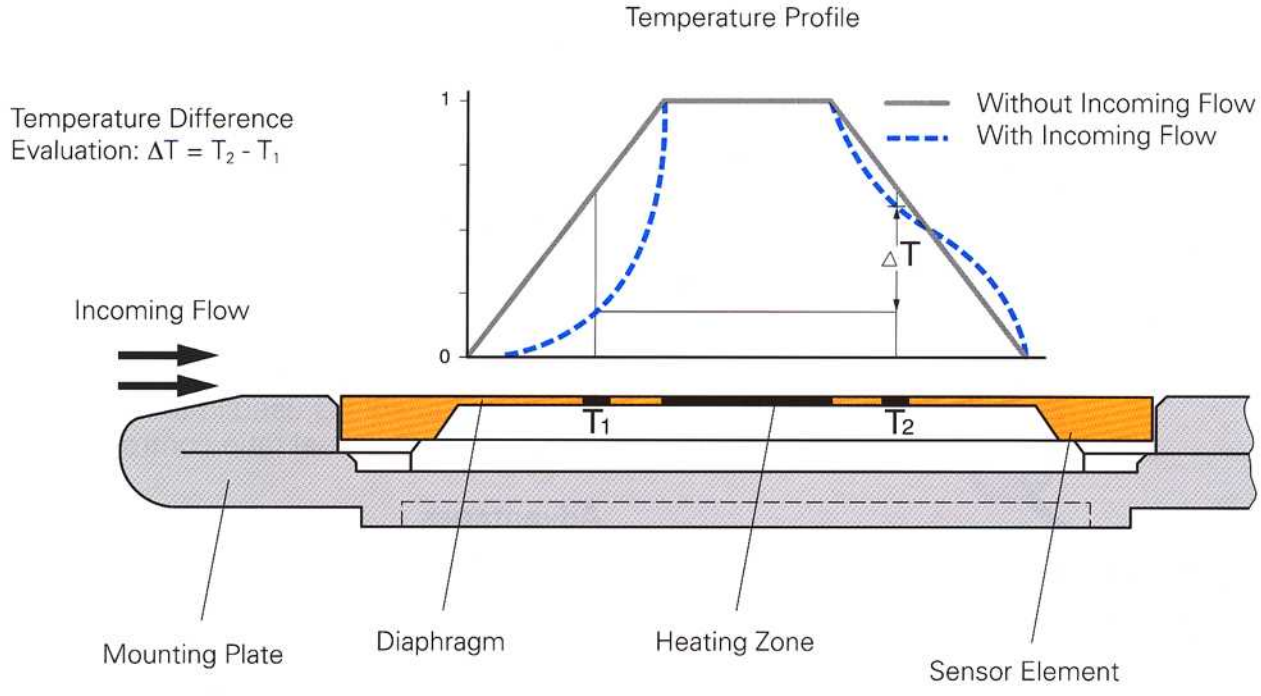
The heating zone is set to an overtemperature by means of a heating resistor and temperature sensor T_2.

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 ΔT.
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

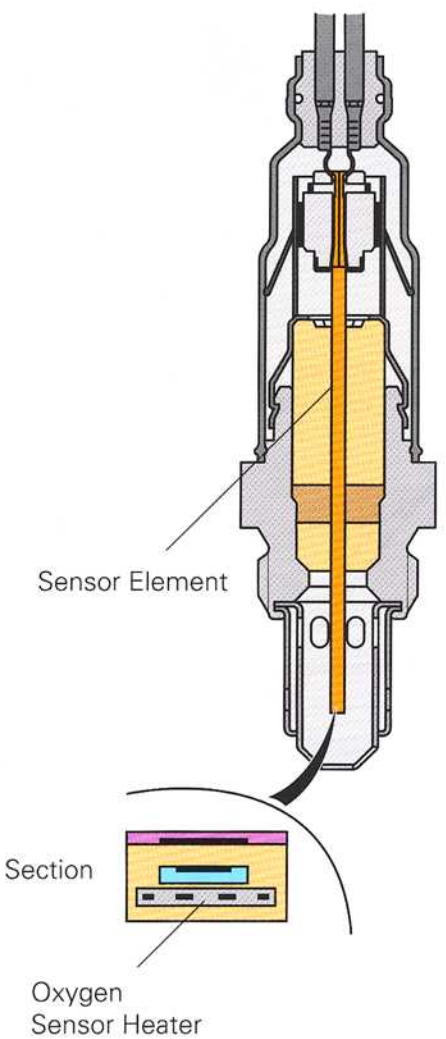
- The differential signal permits a direction-dependent characteristic which enables the Motronic system to detect a return air flow.



Heated Oxygen Sensors (HO2S)

The planar heated oxygen sensor (HO2S) is a further development of the finger-type oxygen sensor and has a transient response at the stoichiometric air/fuel ratio. There is a single oxygen sensor 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 oxygen sensor react quickly. The oxygen sensor should therefore reach its operating temperature within as short a space of time as possible. Its planar (= flat, elongated) design makes this possible.
The sensor heater is integrated in the sensor element. It quickly reaches its operating temperature despite its lower heating capacity.



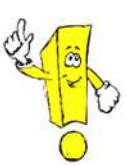
Note

At an exhaust gas temperature as low as 300°F (150°C), the sensor heater generates the necessary minimum temperature of 660°F (350°C).
The oxygen sensor is ready to operate approximately 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).

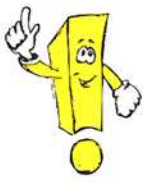


A new generation of oxygen sensors is used in the biturbo for dual air/fuel ratio control.

Advantages

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

Camshaft Position (CMF) Sensors G40 and G163



On V-engines with variable valve timing, a Hall-effect sensor acting as a camshaft position (CMP) 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.

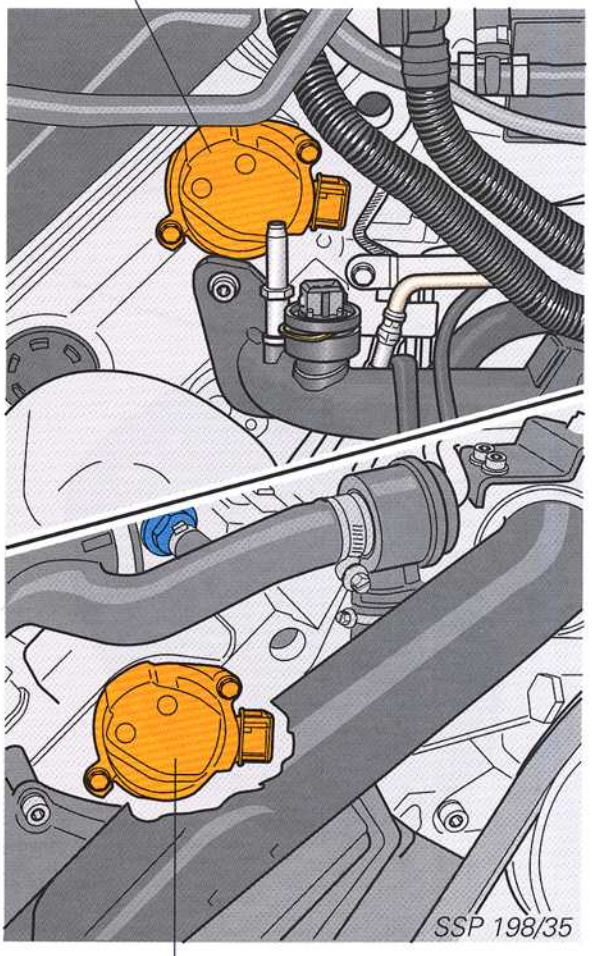
The signal which Camshaft Position (CMP) Sensor G40 supplies together with the signal which Engine Speed (RPM) Sensor G28 generates (incremental sender for engine speed and reference mark) enable ignition TDC of cylinder 1 to be identified (synchronization of cylinder 1).
After the simultaneous input of both signals, initial injection and ignition are enabled.

By using Camshaft Position (CMP) Sensor G163 and G40 as camshaft sensors, the adjustment of both camshafts can be monitored closely and evaluated by the self-diagnosis.

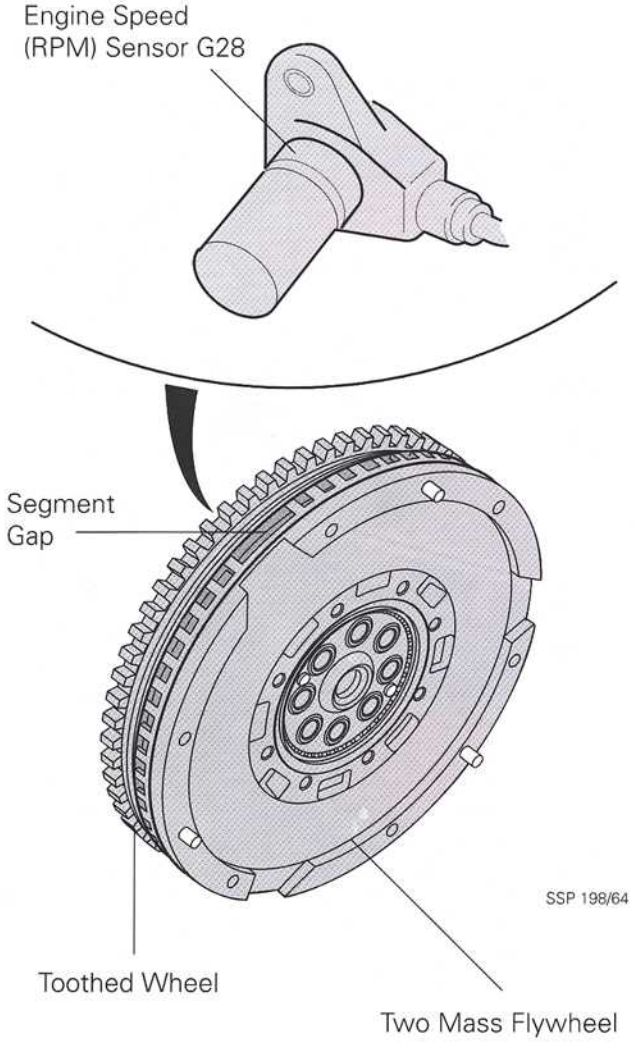
Substitute function and self-diagnosis

If Camshaft Position (CMP) Sensor G40 fails, Camshaft Position (CMP) Sensor G163 takes on the task of synchronizing the first cylinder.
If both CMP sensors fail, it is possible to start the engine and the engine runs with substitute functions.

Camshaft Position (CMP) Sensor G40



Camshaft Position (CMP) Sensor G163



Engine Speed (RPM) Sensor G28

The Engine Speed (RPM) Sensor G28 is an inductive sensor which records the engine speed and the exact angular position of the crankshaft (single-sensor system).

Attached to the flywheel is a separate toothed wheel for the G28.
The toothed wheel is subdivided into 60 segments.
If the toothed wheel moves past G28, this produces an alternating voltage whose frequency changes as a factor of engine speed.
To enable it to recognize the crankshaft position, there is a gap of two segments in the toothed wheel.

The G28 recognizes the engine speed. Together with Camshaft Position (CMP) Sensor G40, the G28 recognizes 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

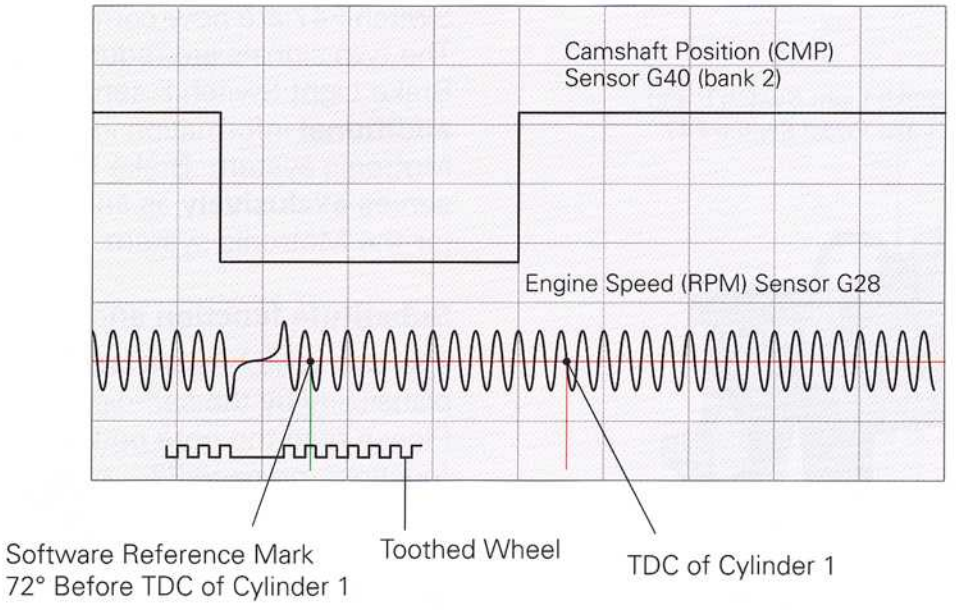
The signal which G28 generates is checked together with the signal supplied by the G40 for plausibility.
If the Motronic Engine Control Module (ECM) J220 does not detect any segment gaps during eight "phases" of the G40, an entry is made in the fault memory.

If the Engine Speed (RPM) Sensor G28 fails, it is not possible to start or run the engine.



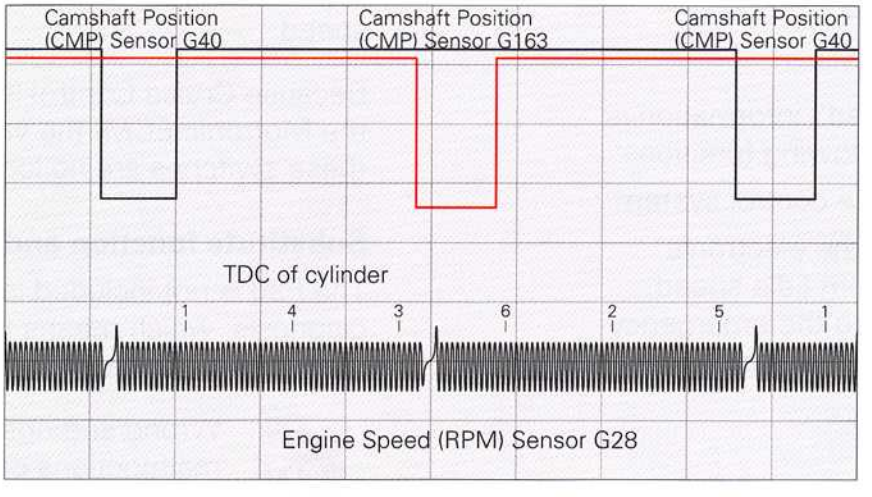
Since the G28 is an inductive sensor, the self-diagnostics are unable to perform electrical tests (short circuit to positive or negative or open circuit).

Diagram of signal of engine speed sensor and camshaft position sensor using the oscilloscope function of VAS 5051



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Diagram of signal of engine speed sensor and the two camshaft position sensors

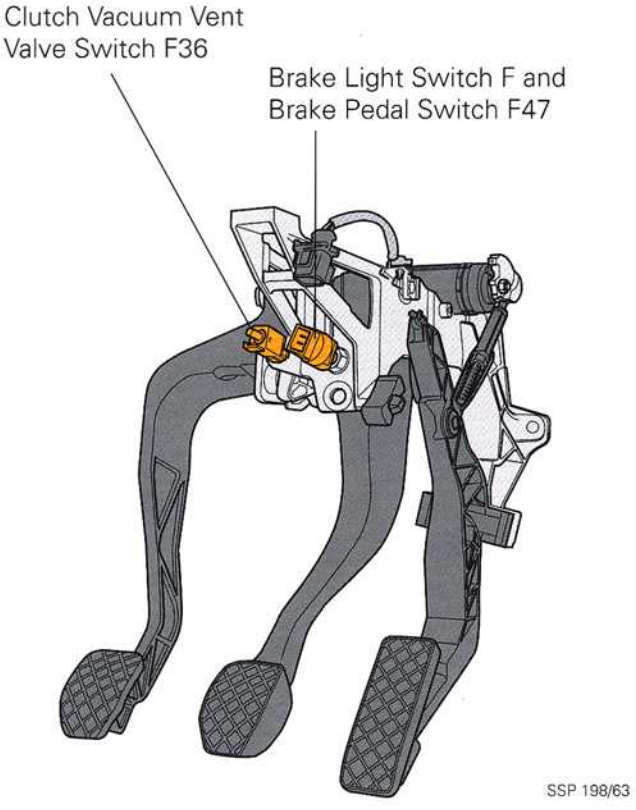


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Here, the signals which G40, G163, and G28 generate are shown combined for added clarity.
A two-channel oscilloscope does not allow all three signals to be represented.
The TDC mark of the belt pulley reflects the TDC of cylinder 3.

Brake Light Switch F and Brake Pedal Switch F47



"Brake pedal applied" information is required for the following functions:

- Function of cruise control system
- Safety check of the electronic accelerator system (idle speed recognition during the emergency running mode of the accelerator position sensor)

Brake Light Switch F and Brake Pedal Switch F47 are now combined as a unit. The two signals are redundant for safety. Brake Light Switch F serves as an **additional** information input for the Motronic system. Brake Pedal Switch F47 serves **exclusively** as an information input for the Motronic system.

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 37.

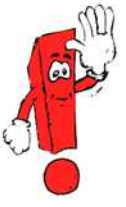
Clutch Vacuum Vent Valve Switch F36 . . .

. . . 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.

Because Cruise Control is now a function of the Motronic ECM, the vacuum portion of these switches are no longer needed.

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 mis-operation (driver keeps foot on clutch pedal) may result in load change jolts or engine speed overshoots.

Additional Signals/Interfaces to Motronic ME 7.1 System

The Motronic system receives a large number of additional signals.
The following overview shows the signal direction and meaning referred to the Motronic Engine Control Module (ECM) J220.



The term "interfaces" is used to describe the control module connections and wiring connections of the various control modules.

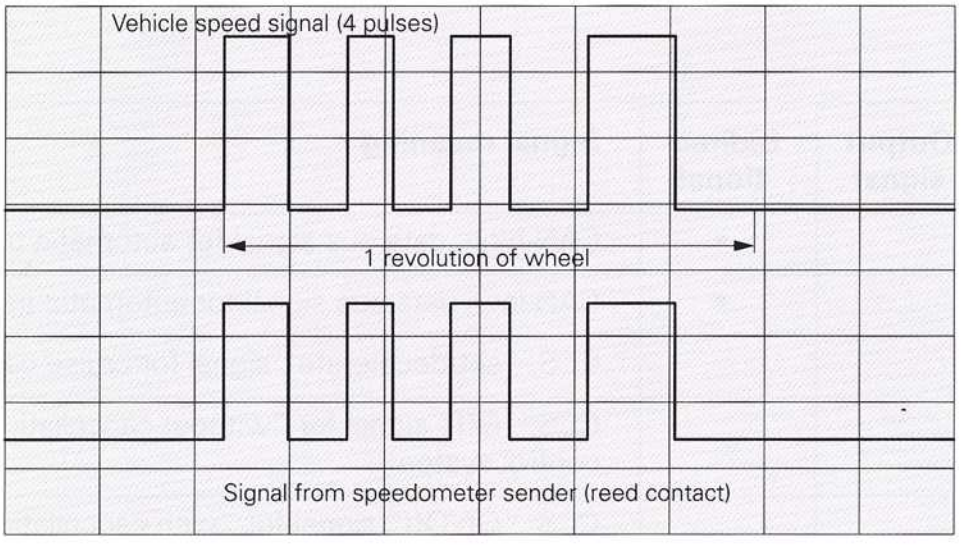
Input signal	Output signal	Bidirectional	Signal meaning
		•	CAN-high, data bus signal for automatic transmission
		•	CAN-low, data bus signal for automatic transmission
•			CCS, "set/decelerate" signal for cruise control system
•			CCS, "Off" signal for "without cancellation" cruise control system
•			CCS, "On/Off" signal for "with cancellation" cruise control system (master switch)
•			CCS, "Resume/accelerate" signal for cruise control system
•			Vehicle speed signal
		•	Immobilizer/diagnosis signal (running production change)
		•	Air conditioner compressor "On/Off" signal
•			Engine coolant temperature signal
	•		Engine speed signal
	•		Fuel consumption signal

Additional Signals/Interfaces

The Vehicle Speed Signal . . .

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

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



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Engine Coolant Temperature Signal

The Motronic Engine Control Module (ECM) J220 receives from the instrument cluster a coolant temperature signal calculated from the signal which the Engine Coolant Temperature (ECT) Sensor G2 generates and a related temperature characteristic.
The signal is a "data message" and is switched to ground when a temperature of approximately 250°F (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".

At a temperature of 241°F (116°C), the charge pressure is reduced in order to counteract a further rise in temperature.
If the temperature drops below a value of approximately 241°F (116°C), a data message is again transferred and all actions previously performed are reversed.

The "Compressor On/Off" Interface . . .

. . . serves to provide the Motronic Engine Control Module (ECM) J220 with information on the circuit state of the compressor.

. . . enables the engine control module 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 module then increases the idling speed to compensate for the higher engine load.

The interface as a signal output

If the engine control module switches the interface to ground, the compressor is switched off for a defined period of time as required.

The engine control module 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

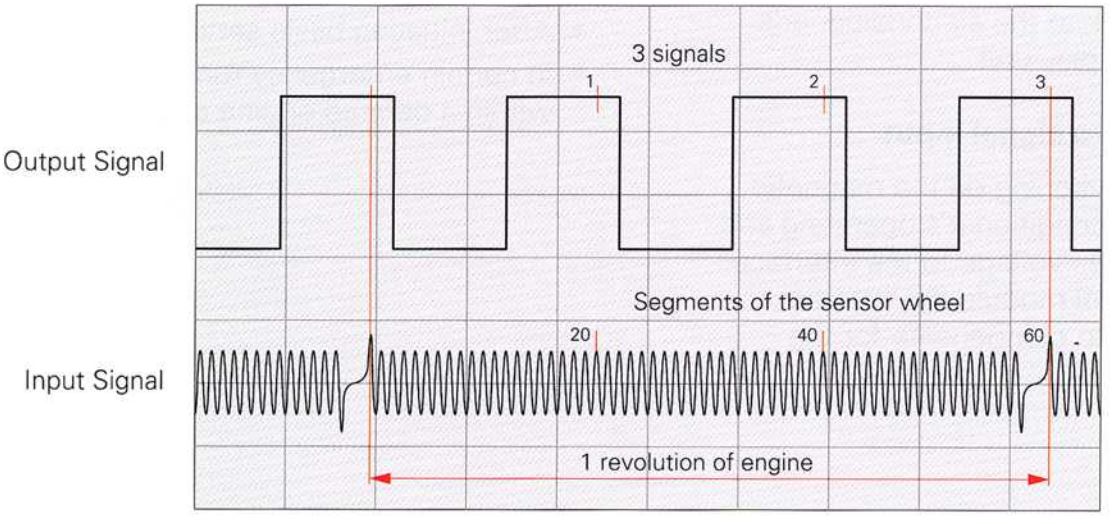
Additional Signals/Interfaces

The Engine Speed (RPM) Signal . . .

. . . is a square-wave signal which is conditioned by the Motronic Engine Control Module (ECM) J220 and whose frequency is synchronous with engine speed.
The duty factor is approximately 50%.
Three signals are transferred per revolution of the engine.

. . . is required by the following system components:

- Instrument cluster
- Automatic transmission
- Air conditioner



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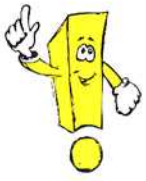
The CAN-High/CAN-Low Interfaces . . .

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

The CAN data bus (Controller Area Network) is a serial data transfer system.

The Interfaces of the Cruise Control System (CCS) . . .

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



Cruise control is executed by the Motronic Engine Control Module (ECM) J220 by means of the electronic accelerator function.

Vehicle speed can be kept constant at speeds greater than approximately 15 mph (25 km/h).

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

When the control unit is enabled, a "G" appears in the control unit identification screen of the Scan Tool.

Functional Diagram

Components

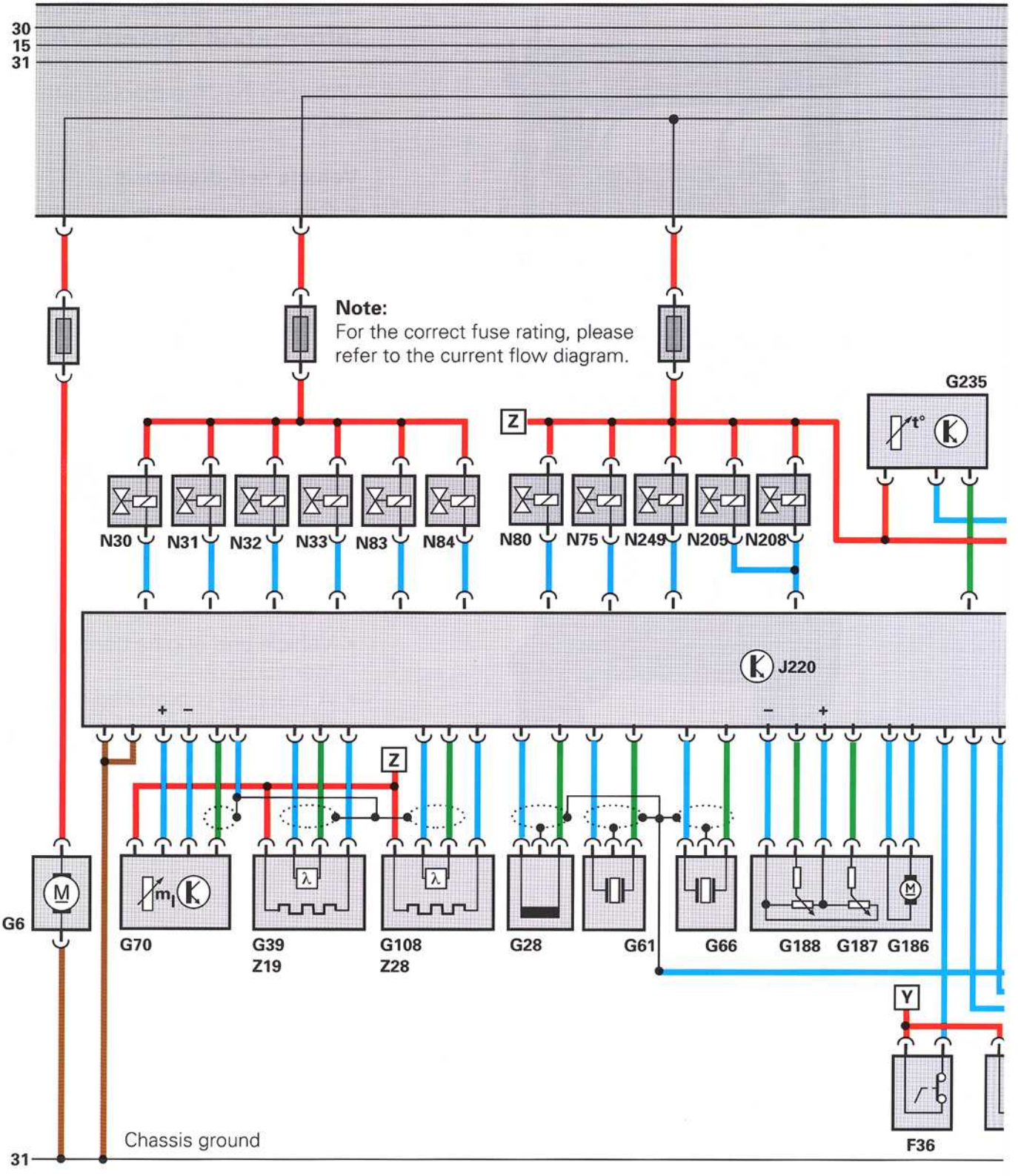
F	Brake Light Switch
F36	Clutch Vacuum Vent Valve Switch
F47	Brake Pedal Switch
F96	Barometric Pressure (BARO) Sensor
G2	Engine Coolant Temperature (ECT) Sensor
G6	Fuel Pump (FP)
G28	Engine Speed (RPM) Sensor
G31	Charge Air Pressure Sensor
G39	Heated Oxygen Sensor (HO2S)
G40	Camshaft Position (CMP) Sensor
G42	Intake Air Temperature (IAT) Sensor
G 61	Knock Sensor (KS) 1
G62	Engine Coolant Temperature (ECT) Sensor
G66	Knock Sensor (KS) 2
G70	Mass Air Flow (MAF) Sensor
G79	Throttle Position (TP) Sensor
G108	Heated Oxygen Sensor (HO2S) 2
G130	Oxygen Sensor, behind three way catalytic converter
G131	Oxygen Sensor, behind three way catalytic converter
G163	Camshaft Position (CMP) Sensor 2
G185	Sender -2- for Accelerator Pedal Position
G186	Throttle Drive (Power Accelerator Actuation)
G187	Angle Sensor -1- for Throttle Drive (Power Accelerator Actuation)
G188	Angle Sensor -2- for Throttle Drive (Power Accelerator Actuation)
G235	Sender -1- for Exhaust Temperature
G236	Sender -2- for Exhaust Temperature
J17	Fuel Pump (FP) Relay
J220	Motronic Engine Control Module (ECM)
J338	Throttle Valve Control Module
K132	Fault Light for Accelerator Activation
N	Ignition Coil
N30	Cylinder 1 Fuel Injector
N31	Cylinder 2 Fuel Injector
N32	Cylinder 3 Fuel Injector
N33	Cylinder 4 Fuel Injector
N75	Wastegate Bypass Regulator Valve
N80	Evaporative Emissions (EVAP) Canister Purge Regulator Valve
N83	Cylinder 5 Fuel Injector
N84	Cylinder 6 Fuel Injector
N122	Power Output Stage
N128	Ignition Coil 2
N158	Ignition Coil 3
N163	Ignition Coil 4
N164	Ignition Coil 5
N189	Ignition Coil
N192	Power Output Stage 2
N205	Valve -1- for Camshaft Adjustment
N208	Valve -2- for Camshaft Adjustment
N249	Recirculating Valve for Turbocharger
Z19	Oxygen Sensor (O2S) Heater
Z28	Oxygen Sensor (O2S) 2 Heater
Z29	Oxygen Sensor (O2S) Heater
Z30	Oxygen Sensor (O2S) 2 Heater
I	To instrument cluster
II	To instrument cluster (warning lamp)

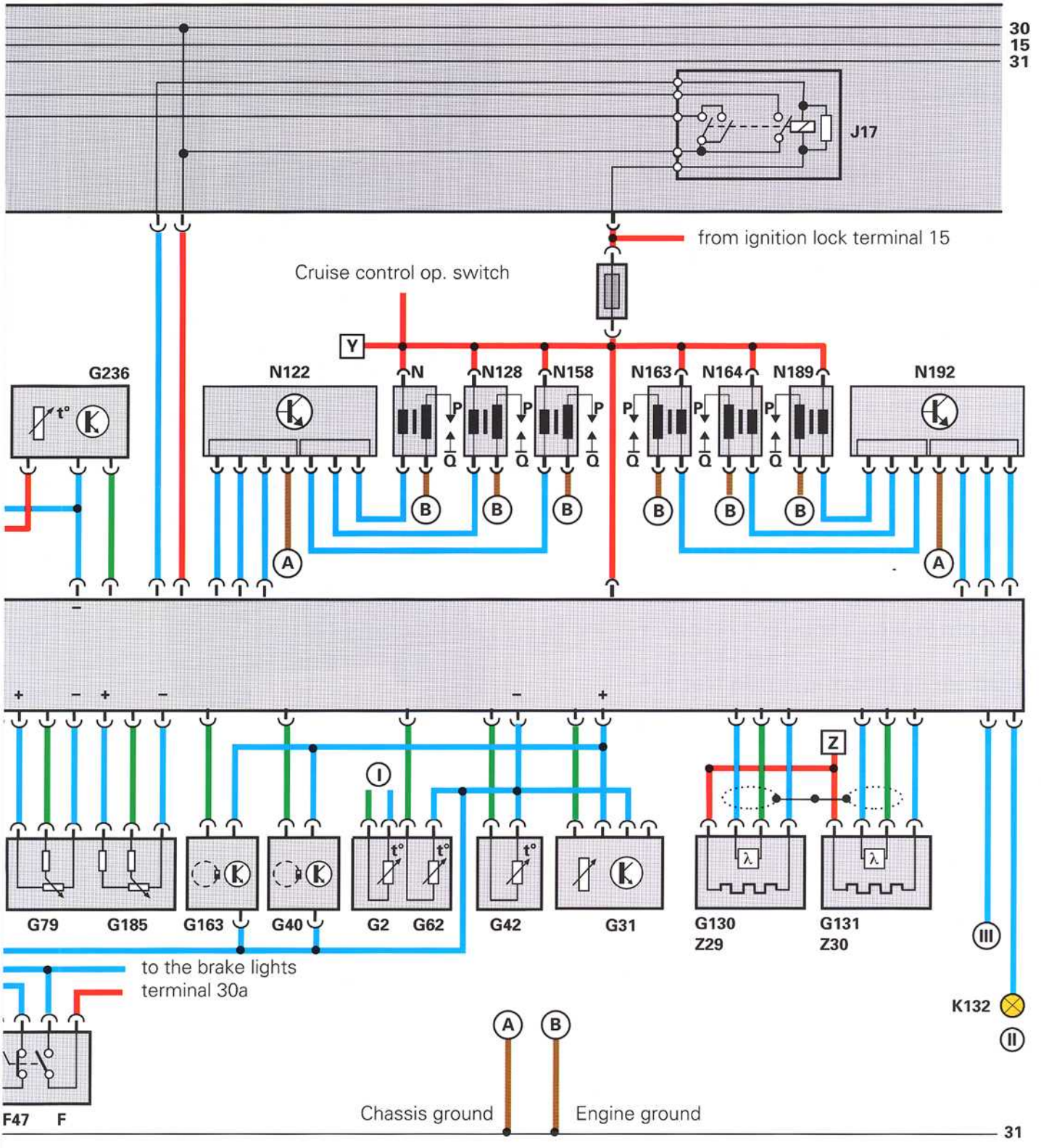
III Additional Signals

1	CAN-high (automatic transmission)
2	CAN-low (automatic transmission)
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	Vehicle speed signal
8	Immobilizer/diagnosis signal
9	Air conditioner compressor "On/Off" signal
10	Engine coolant temperature signal
11	Engine speed (rpm) signal
12	Fuel consumption signal

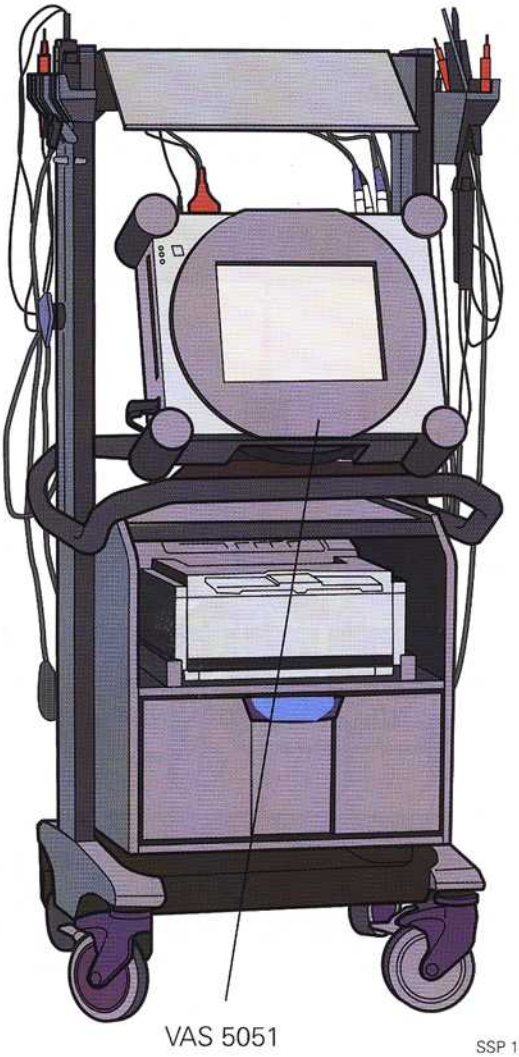
Color Codes

- Input signal
- Output signal
- Positive
- Ground
- Bidirectional


30
15
31
Note:
For the correct fuse rating, please refer to the current flow diagram.
G235
Z
N30
N31
N32
N33
N83
N84
N80
N75
N249
N205
N208
J220
+
–
Z
G6
G70
G39
Z19
G108
Z28
G28
G61
G66
G188
G187
G186
Y
F36
Chassis ground
31


30
15
31
J17
from ignition lock terminal 15
Cruise control op. switch
Y
G236
N122
N
N128
N158
N163
N164
N189
N192
P
Q
B
A
+
–
I
Z
G79
G185
G163
G40
G2
G62
G42
G31
G130
Z29
G131
Z30
III
K132
II
to the brake lights
terminal 30a
F47
F
Chassis ground
Engine ground
31

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VAS 5051

SSP 198/39

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 engine control module 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.

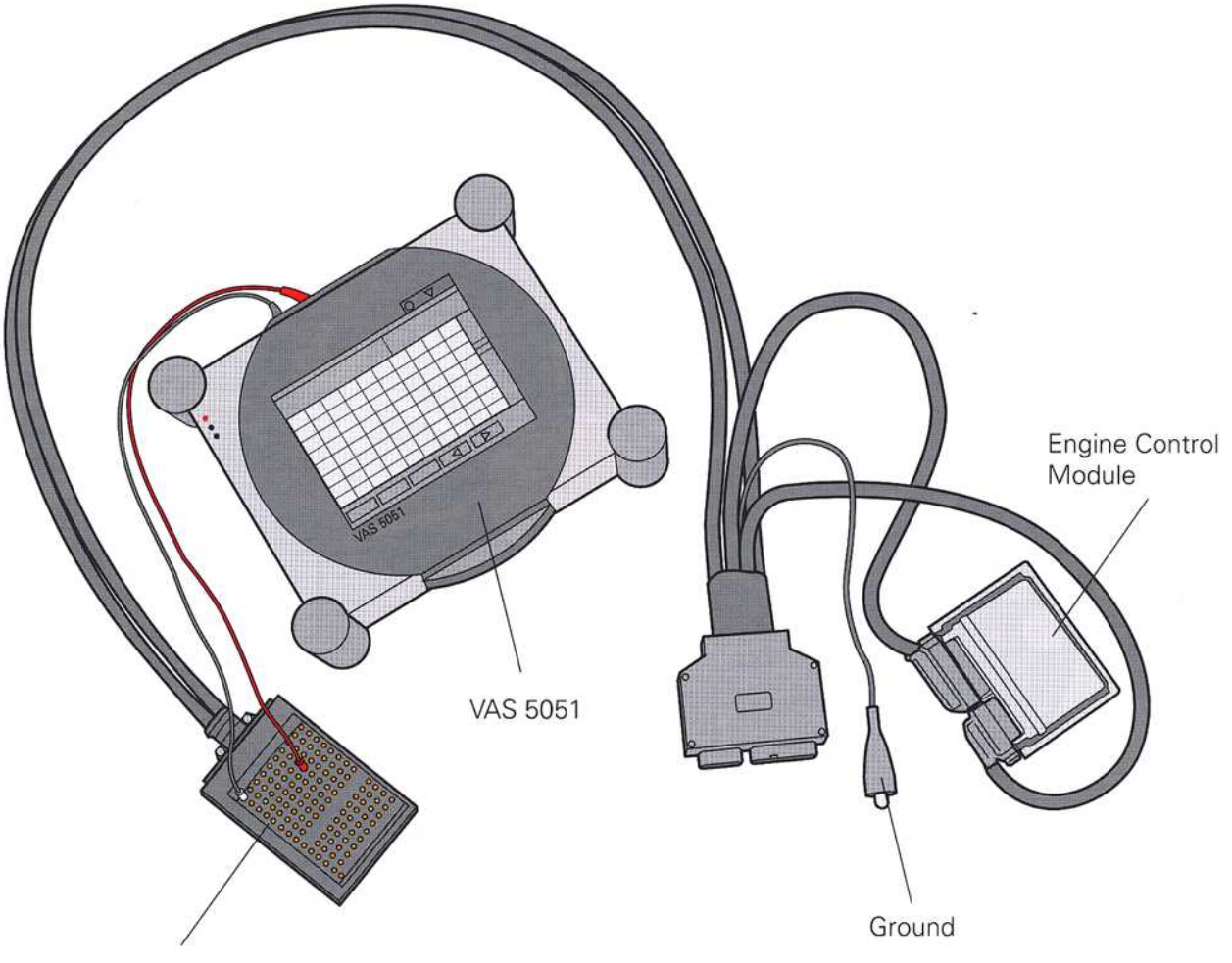
Test Box V.A.G. 1598/31

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

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

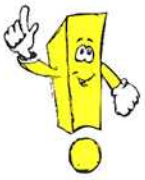


The test leads are additionally shielded, give greater flexibility and protection against electromagnetic interference.



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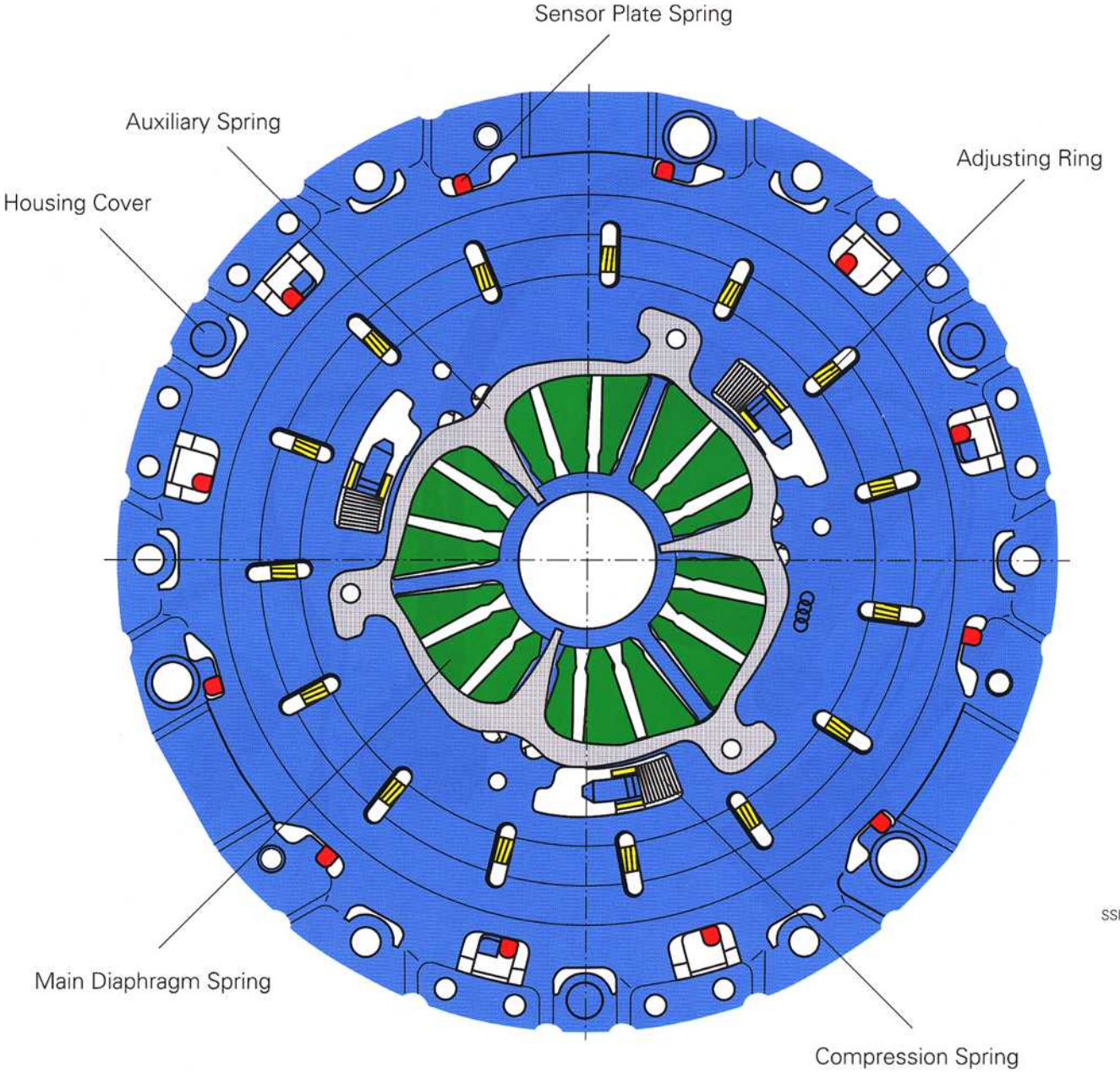
Self-Adjusting Clutch (SAC)



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

Advantages

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



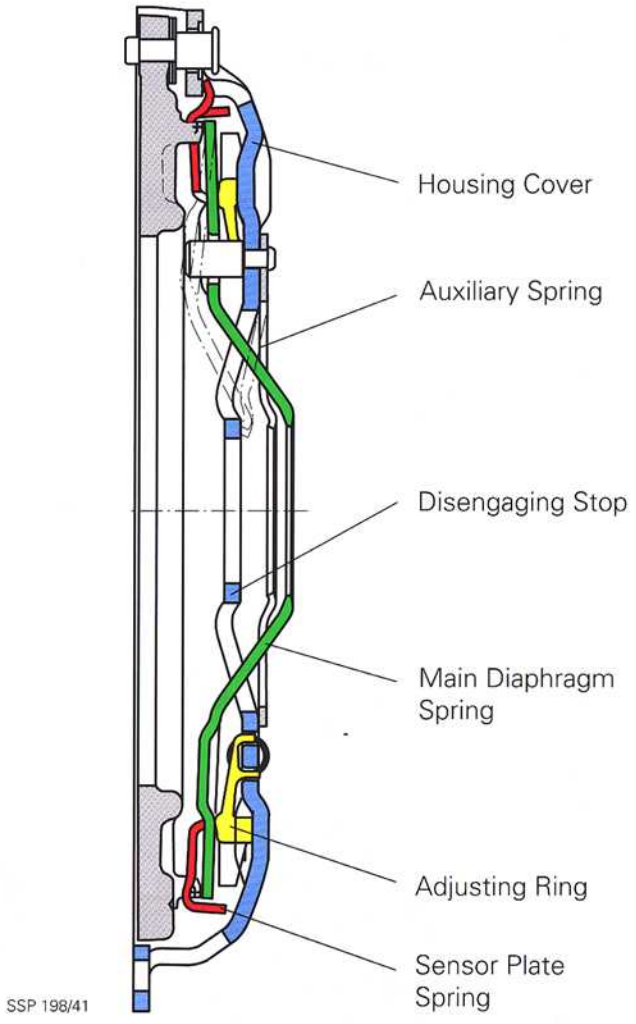
Problem

As the clutch disc 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 approximately 1.5 - 2 mm, the characteristic of the main diaphragm spring is such that the forces initially increase as a factor of distance traveled.
This has the 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).



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.

Function of SAC Clutch

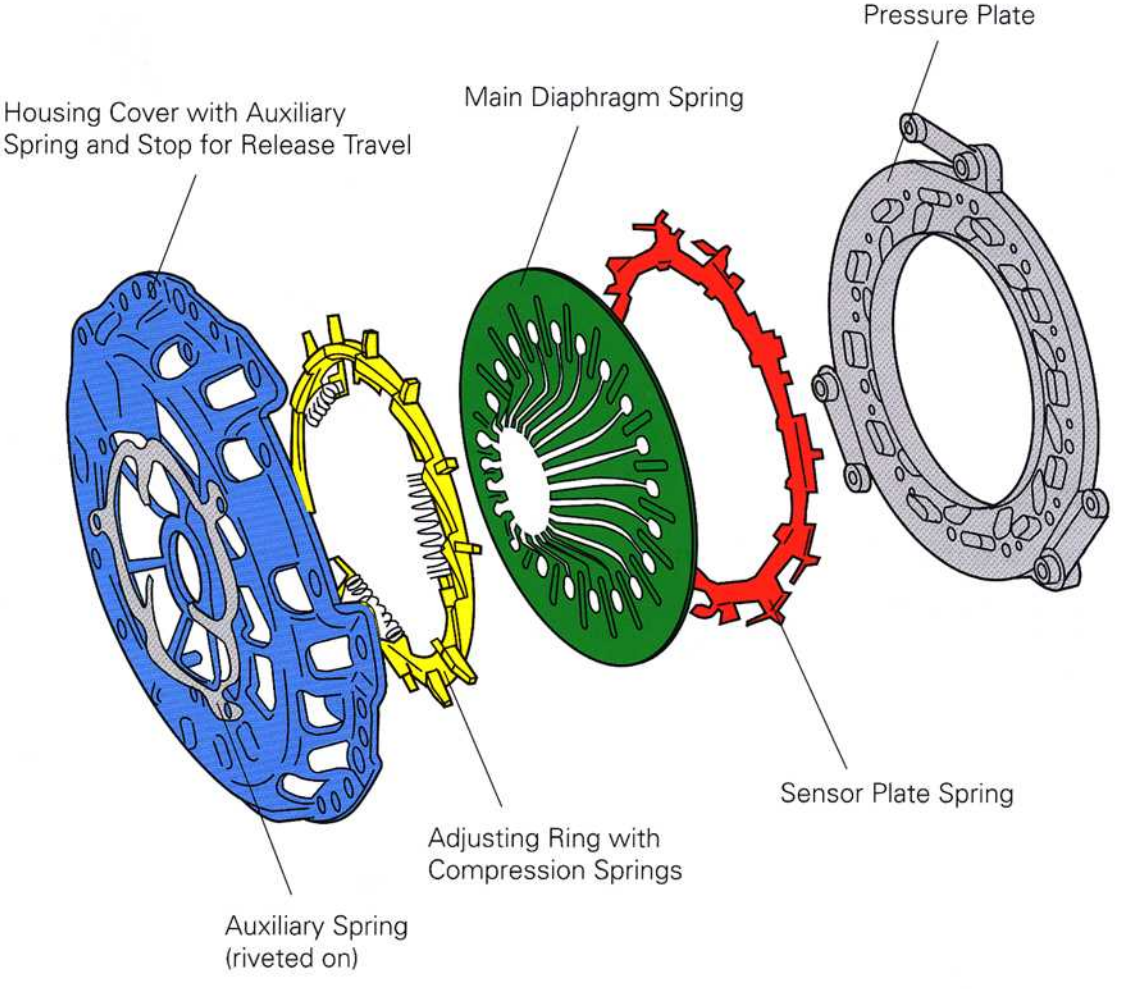
Compared to a conventional clutch, the following parts are new or modified:

- 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.

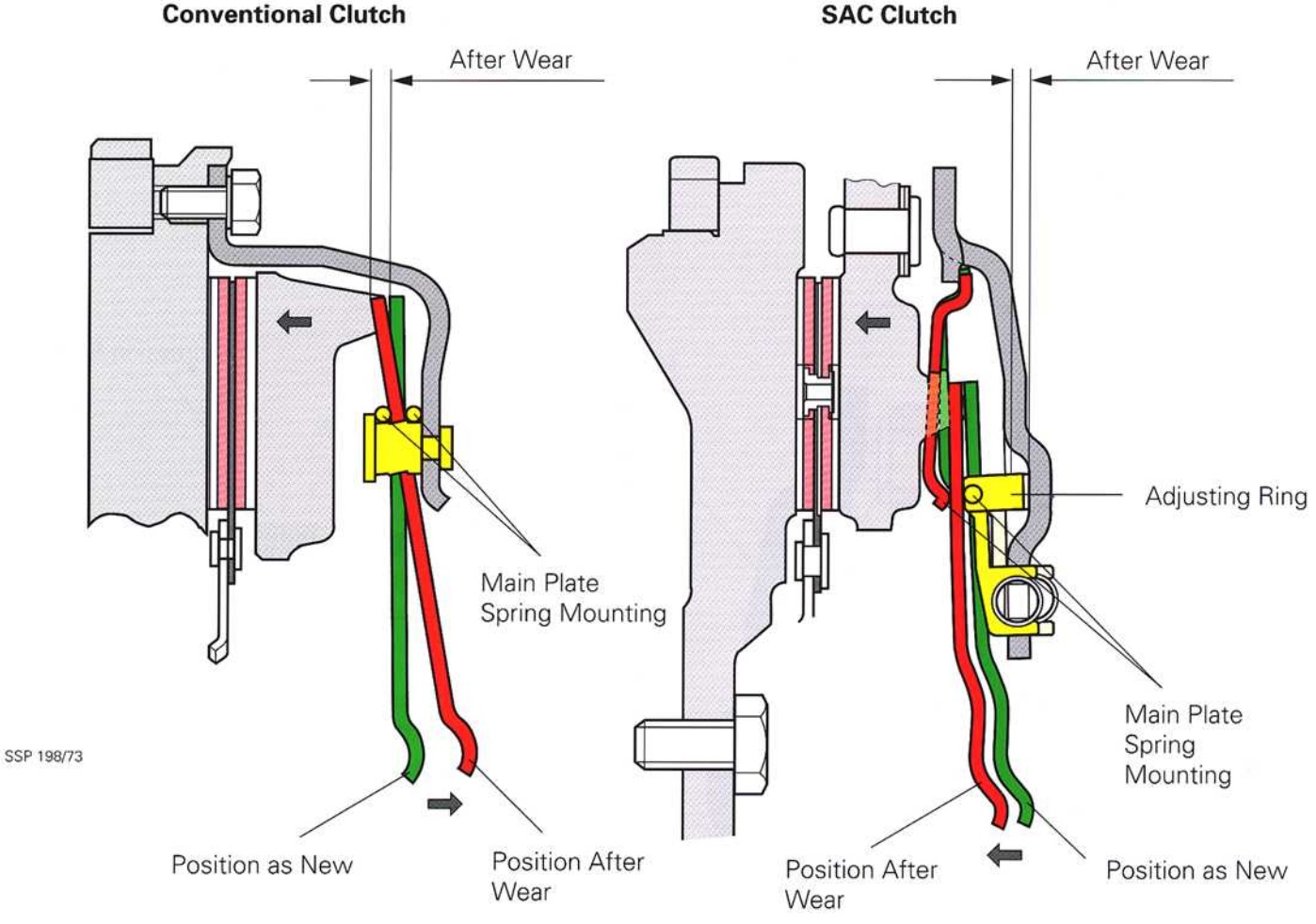
The **auxiliary spring** counteracts the main plate spring as of a defined travel distance and ensures an even force curve during clutch engagement and disengagement.

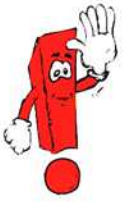


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Unlike conventional pressure plates, the main diaphragm spring mounting of the SAC clutch is non-rigid.

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





If the clutch disc is renewed without replacing the pressure plate, the adjusting ring must be reset. (Refer to Workshop Manual).

The adjusting ring on new SAC clutch pressure plates is already set to the proper position.

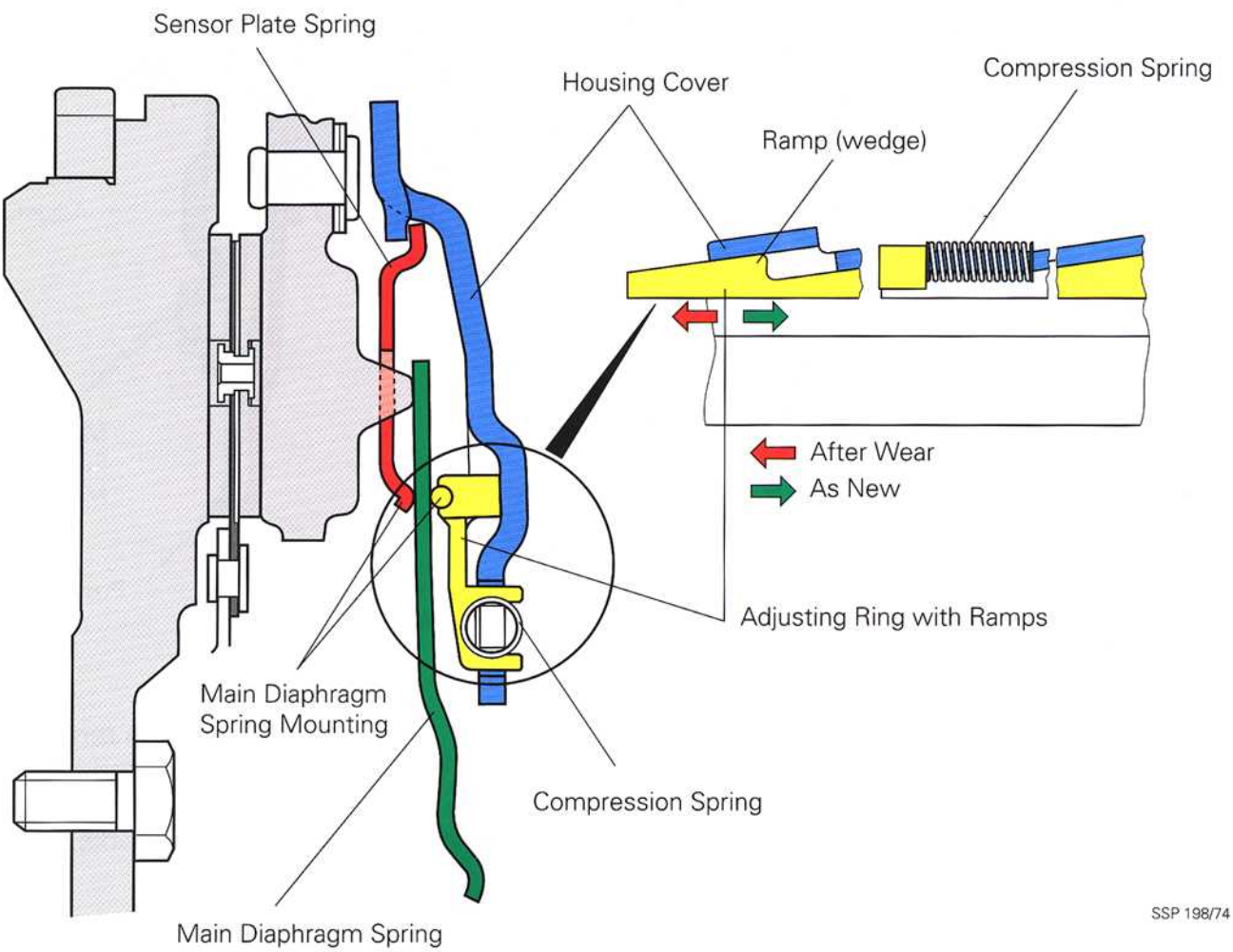
Clutch Disengagement Process

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 for and the forces are again equalized.



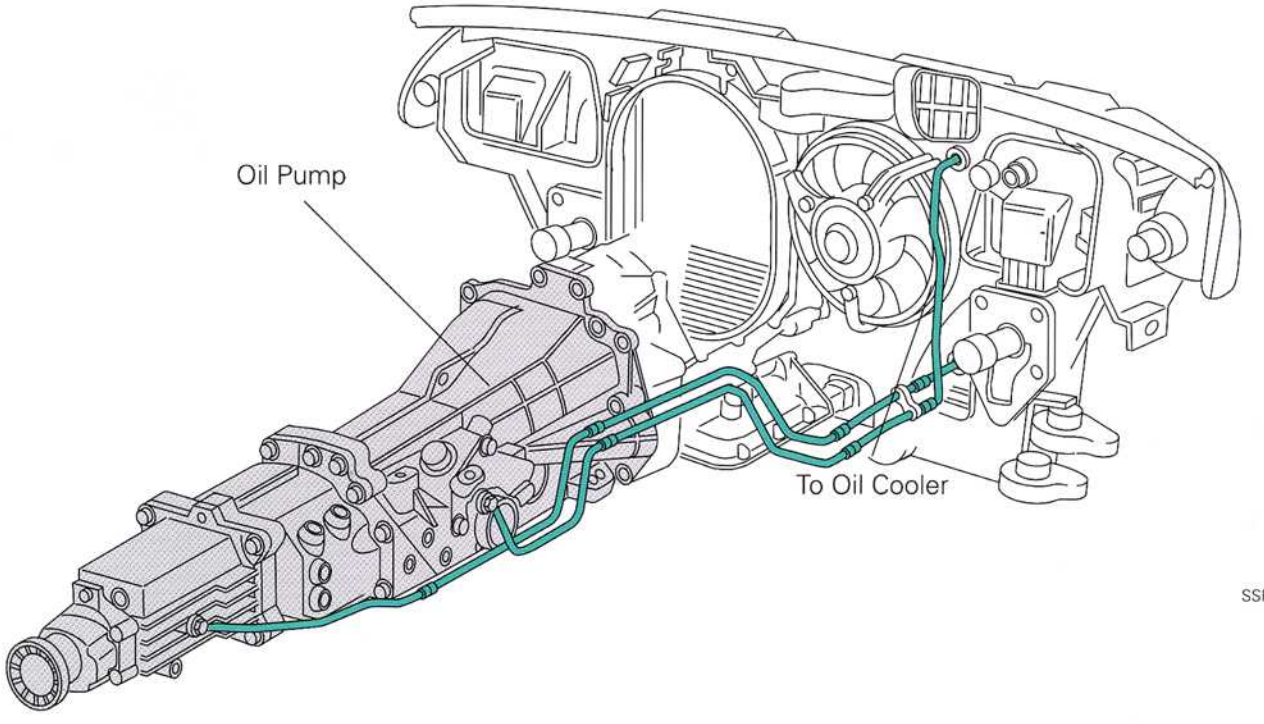
Manual Transmission

The six speed Quattro Manual Transmission (0IE) is similar to versions used in earlier Audi high performance models.

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



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



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Notes

Notes

Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this SSP.

The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at:

www.accessaudi.com

From the accessaudi.com homepage:

- Click on the “ACADEMY” Tab
- Click on the “Academy Site” Link
- Click on the ”CRC Certification” Link

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