



The 6.0 I W12 engine in the Audi A8 - Part 2

Self-study programme 268

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The self-study programme contains information on design features and functions.

The self-study programme is not intended as a Workshop Manual. Values given are only intended to help explain the subject matter and relate to the software version applicable at the time of SSP compilation.

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

New

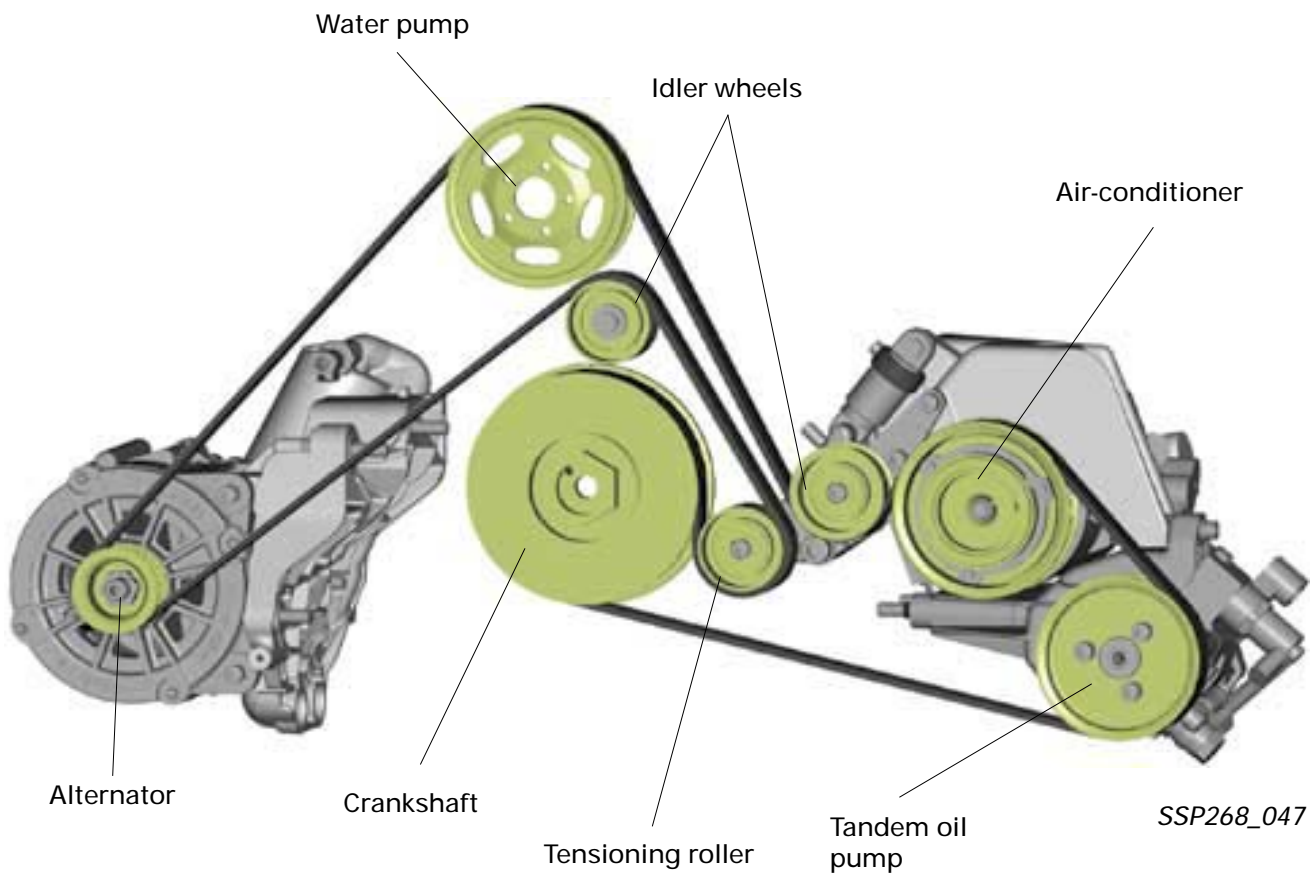


Attention
Note





Belt drive/ancillaries





Water-cooled alternator

To satisfy the power supply requirements of the Audi A8 W12, use is made of a water-cooled 190 A alternator with a power output of 2660 W.

Alternators generate a high level of current even at low speeds. High component temperatures occur in this operating range due to the low speeds in relation to power output.

With air-cooled alternators, the cooling output is a function of speed, which results in extreme heating of the components in the event of high power output in combination with low speed. High ambient temperatures aggravate this situation.

With water-cooled alternators, cooling is provided by a water jacket surrounding the stator winding and the surface of the mounting plate for rectifier diodes and regulator.

The water jacket of the alternator is incorporated into the engine cooling circuit (refer to SSP 267, Page 34 onwards). This serves to guarantee constantly efficient cooling in all operating ranges, which is of particular significance in the previously critical operating range, namely high power output at low speeds.

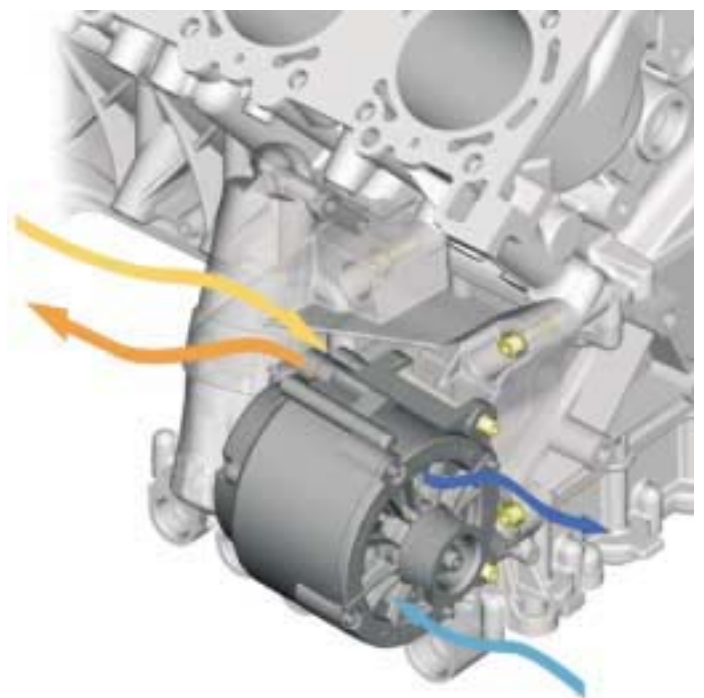
The "open" design with respect to the pulley provides an exchange of cooling air for the claw-pole rotor. The air vortex of the claw-pole rotor is sufficient to achieve this.

There is thus no need for a fan impeller.

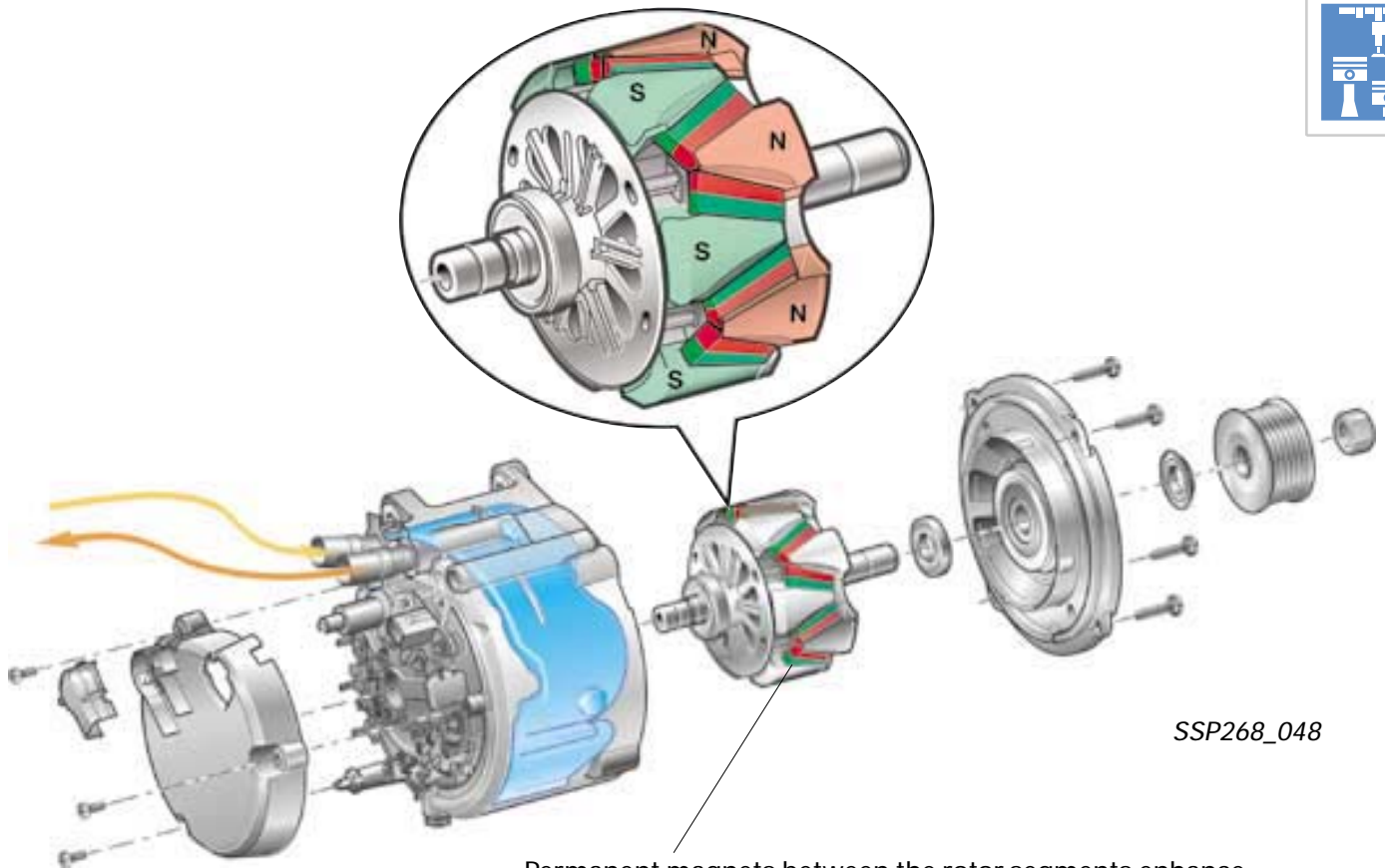
Permanent magnets between the rotor segments enhance the magnetic flux between claw-pole rotor and stator winding and serve to increase efficiency.

For this purpose, the poles of the permanent magnets have the same polarisation as the rotor segments.

The permanent magnets are relatively weak so as to minimise self-excitation and to permit regulation of the alternator voltage.



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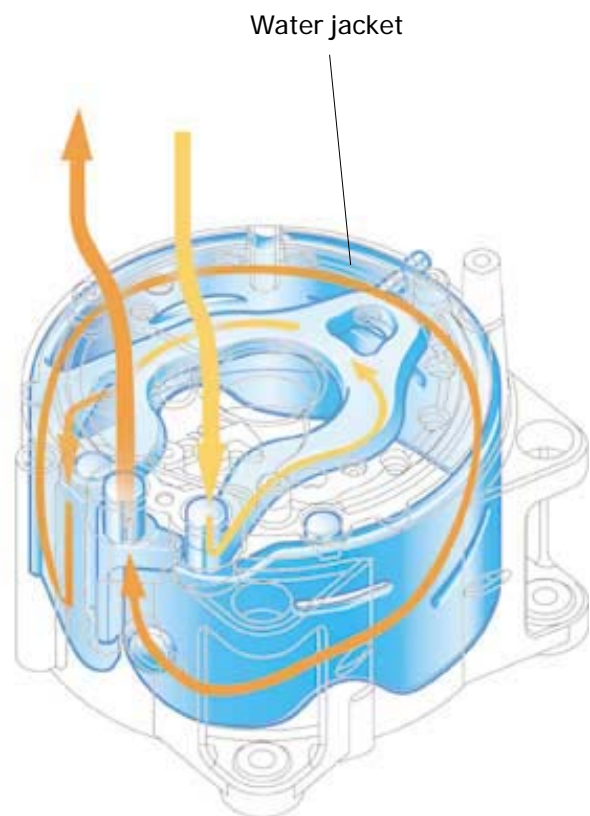


SSP268_048

Permanent magnets between the rotor segments enhance the magnetic flux (from the claws to the stator winding and vice versa), thus preventing stray flux between the individual poles.

Further advantages of water-cooled alternators:

- Quiet operation due to the absence of a fan impeller (no aerodynamic flow noise)
- Smooth running thanks to rigid, enclosed design of alternator housing
- Decrease in drive power required due to absence of fan impeller yields up to 5 % greater efficiency (as a function of speed)
- Recovery of heat lost to engine cooling circuit during warm-up phase
- High performance level thanks to constant cooling over entire speed range
- Insusceptibility to high ambient temperatures



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Engine, Mechanics



Hydraulic/electric fan control

Heat from the engine cooling system is dissipated by way of a hydraulic fan system in combination with a 300 W electric fan.

Advantages of hydraulic fan system:

- High overall system performance
- High efficiency even at low engine speeds
- No drain on vehicle electrical system
- Compact system allowing great flexibility of fitting location
- Infinite output control to suit requirements

The hydraulic fan system was adopted from the V8 TDI engine and adapted to match the specific features of the W12 engine (refer to SSP 226, Page 24 onwards).

A new addition is the temperature sensor for the radiator fan drive circuit -G382 (refer to Page 9).

Operation

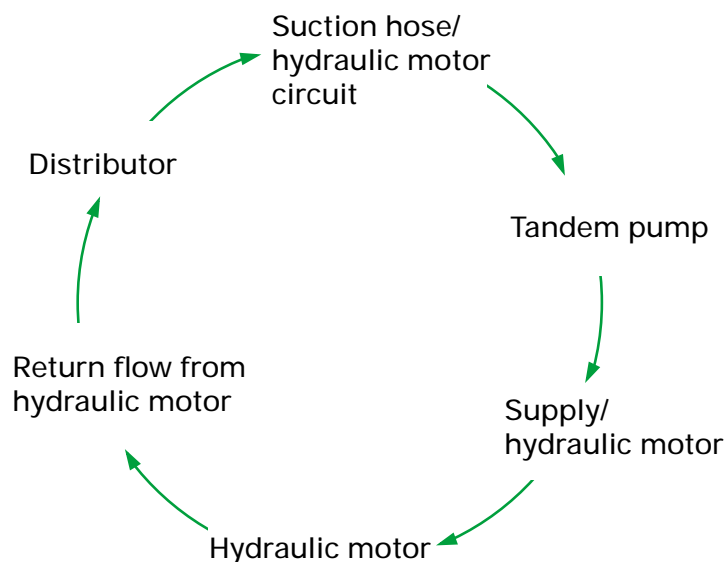
The hydraulic fan is controlled as a function of speed.

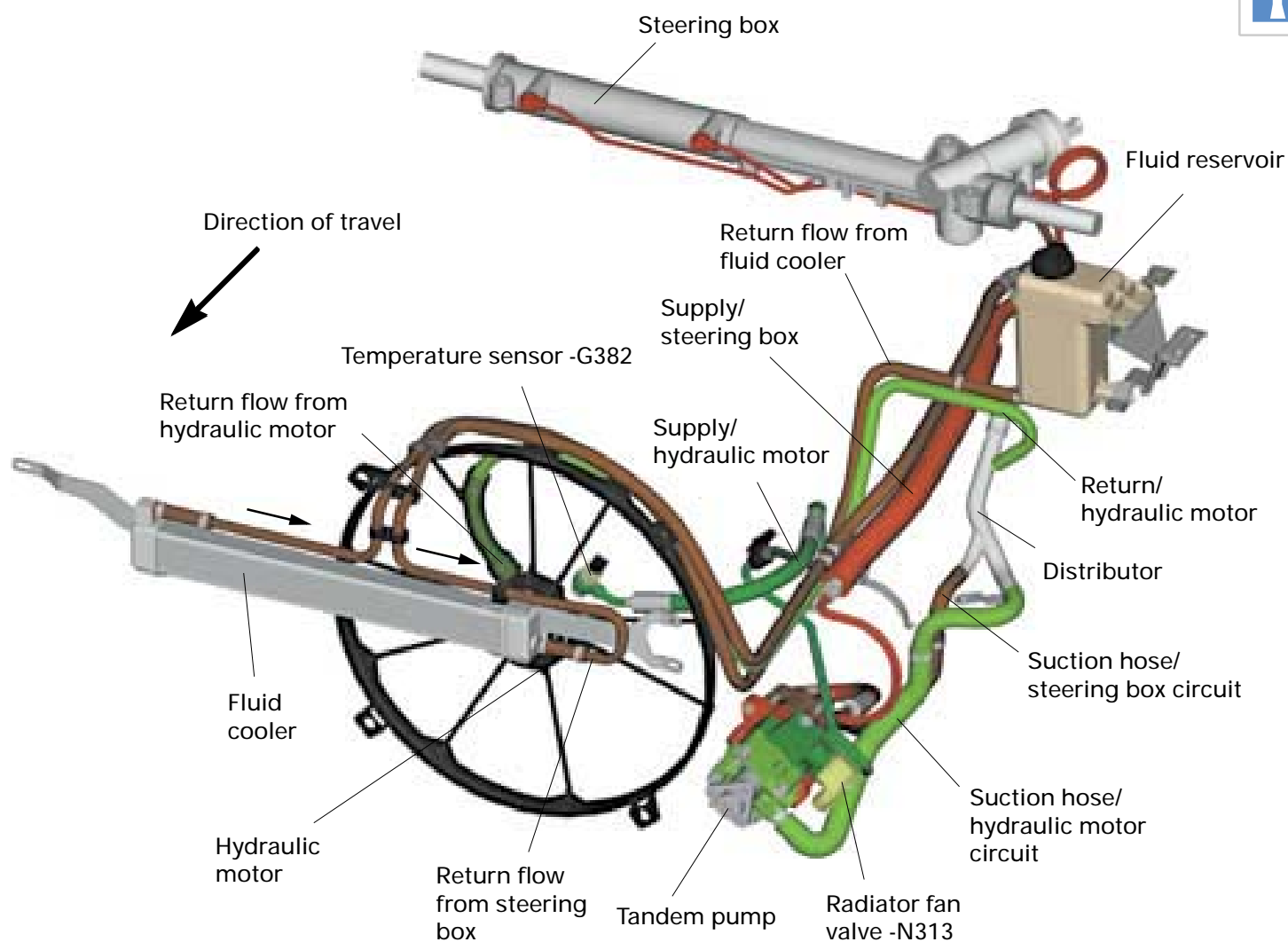
The speed of the hydraulic fan basically depends on the quantity of fluid flowing through the hydraulic motor.

In turn, the quantity of fluid is governed by the pump volume (pump speed) and the temperature of the hydraulic fluid.

The radiator fan valve -N313 (actuated by engine control unit 1 -J623) regulates the flow of fluid to the hydraulic motor and provides infinitely variable control of the fan speed.

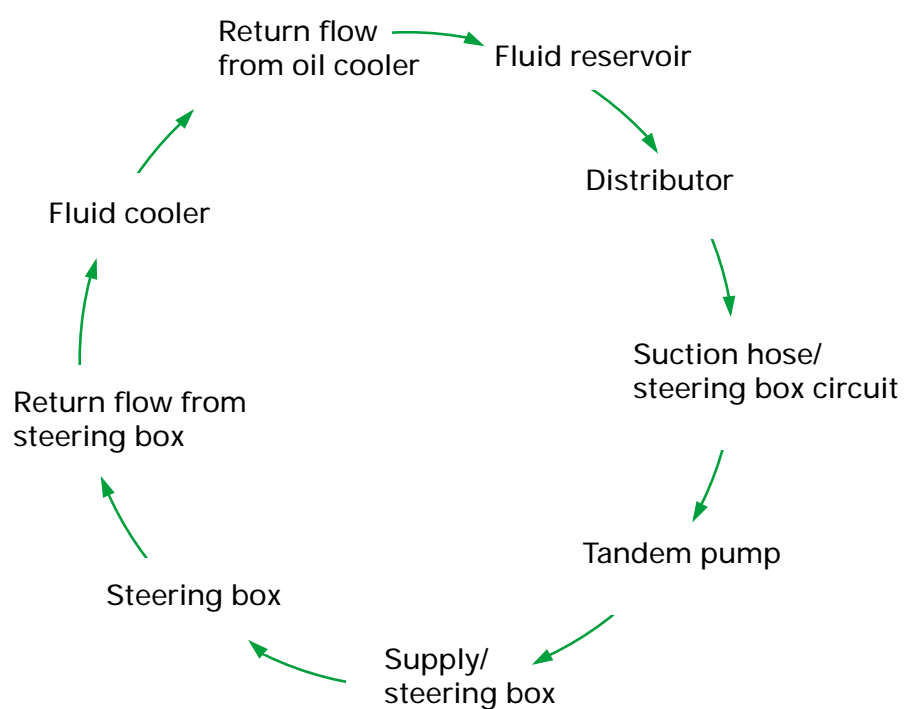
Hydraulic fan circuit:





SSP268_077

Power steering circuit:



Engine, Mechanics



Hydraulic fan control

On the basis of coolant temperature (-G62), ambient temperature (-G42) and vehicle speed, engine control unit 1 -J623 calculates a specified fan speed as a function of the specified coolant temperature.

Further parameters for specified fan speed:

- Air conditioner/compressor "ON"
- Status of air-conditioner pressure switch -F129 (for further details, refer to Page 46)

The fan speed is directly proportional to the volume (speed) of the hydraulic pump, the temperature of the hydraulic fluid and the switching status of the radiator fan valve -N313.

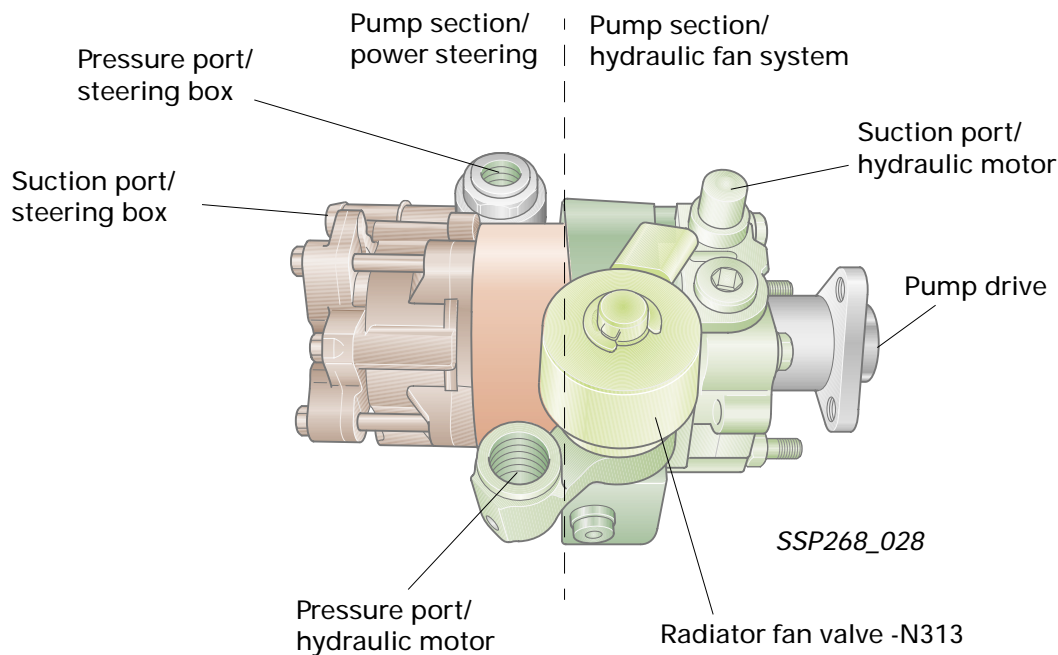
The current value for actuation of the radiator fan valve -N313 is calculated from the pump speed (derived from engine speed), the specified fan speed and the hydraulic fluid temperature (from -G382).

The radiator fan valve -N313 is actuated on a pulse-width modulated basis with a duty cycle (TVH) of between 0 and 100 %.

Valve -N313 is open when deenergised. In this status, the hydraulic fan attains its maximum speed of 2800 rpm.

The fluid flow is then restricted by the pressure control valve in the pump.

For technical reasons the hydraulic fan is never completely shut down. Even when no cooling is required, it is actuated at a minimum speed of approx. 400 rpm.



The hydraulic pump is of tandem design, supplying fluid pressure to the power steering and hydraulic fan.



Temperature sensor for radiator fan drive circuit -G382

The temperature sensor -G382 detects the temperature of the hydraulic fluid, which is of crucial importance to the viscosity of the fluid.

The viscosity influences the speed and thus the performance of the hydraulic fan.

For reasons of noise, the fan speed should not exceed approx. 2100 rpm. This speed limit is referred to in the following as "comfort speed".

If the coolant temperature exceeds roughly 115 °C, the hydraulic fan operates at maximum speed regardless of the associated noise level.

In view of pump losses, the following rules apply given a constant pump speed:

- High hydraulic fluid temperature
Lower fan speed
- Low hydraulic fluid temperature
Higher fan speed

The internal gear of the hydraulic motor simultaneously acts as fan drive gear and is driven by the regulated fluid flow.

Previous control method (V8 TDI engine without -G382)

The temperature of the hydraulic fluid is one of the fan speed parameters. With regard to the comfort speed, this was derived to date from the ambient temperature.

With allowance for production tolerances, this method of determining the temperature of the hydraulic fluid requires an appropriately large safety margin with respect to the acoustically acceptable comfort speed limit.

Optimum use can therefore not be made of the comfort speed range, with the fan having to run more frequently at maximum speed.

New control method (with -G382)



Sensing of the hydraulic fluid temperature (-G382) adds a further crucially important parameter which considerably improves hydraulic fan control, thus permitting more precise regulation and consequently better utilisation of the comfort speed range. More efficient use is made of the available potential up to the comfort speed limit.

As a result, the fan does not have to be operated as often at maximum speed with its associated high noise level.

Temperature sensor for radiator fan drive circuit -G382

Trochoid internal gear of
hydraulic motor



SSP268_027

Engine, Mechanics



Electric fan control

The 300 W electric fan (radiator fan -V7)


- Provides back-up for the hydraulic fan system when the engine is running (irrespective of engine speed)
- Ensures the necessary heat dissipation during continued coolant circulation

The twin series resistor permits three speed settings.

Fan run-on (fan speed 1) is activated by engine control unit 1 -J623 on the basis of the continued coolant circulation map and switched by the radiator fan run-on relay -J397.

Fan speed 2 is switched by the radiator fan thermoswitch -F18 or the air-conditioner operating and display unit -E87.

Fan speed 3 (max.) is switched either by the air-conditioner pressure switch -F129 or, as of a coolant temperature of approx. 115 °C, by the combi processor in the dash panel insert -J218. The input signal for this is supplied by the coolant temperature sender -G2.

 Vehicles for countries requiring an extremely high cooling output are fitted with radiator fan 2 -V177.

Continued coolant circulation

Continued coolant circulation is regulated by engine control unit 1 -J623 in line with a map.

Both the activation condition and the continued coolant circulation time are determined from the following parameters on the basis of an arithmetic model:

- Coolant temperature (from coolant temperature sender -G62)
- Engine oil temperature (from oil temperature sender -G8)
- Ambient temperature (from intake-air temperature sender -G42)

The activation condition and continued coolant circulation period are constantly calculated from the time of starting the engine.

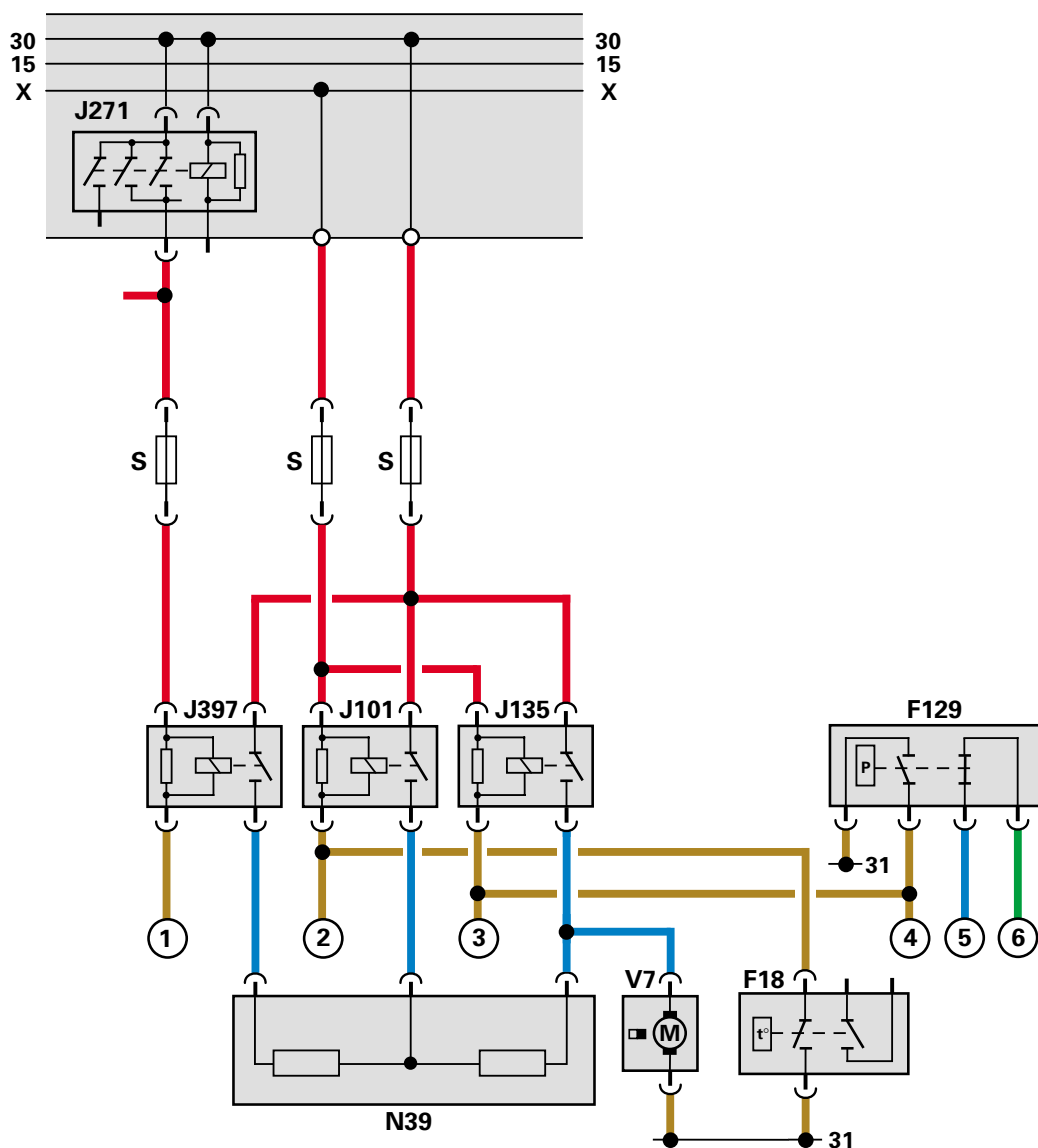
For continued coolant circulation, the pump -V51 and radiator fan -V7 are actuated in parallel.

The maximum continued coolant circulation time is limited to 10 minutes.

The map-controlled engine cooling thermostat -F265 is fully actuated during continued coolant circulation.

Examples of activation condition as a function of ambient and coolant temperature:

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



SSP268_116

F18 Radiator fan thermoswitch
 F129 Air-conditioner pressure switch
 J101 Radiator fan 2nd speed relay
 J135 Radiator fan 3rd speed relay
 J271 Motronic current supply relay
 J397 Radiator fan run-on relay
 N39 Radiator fan series resistor
 S Fuses
 V7 Radiator fan

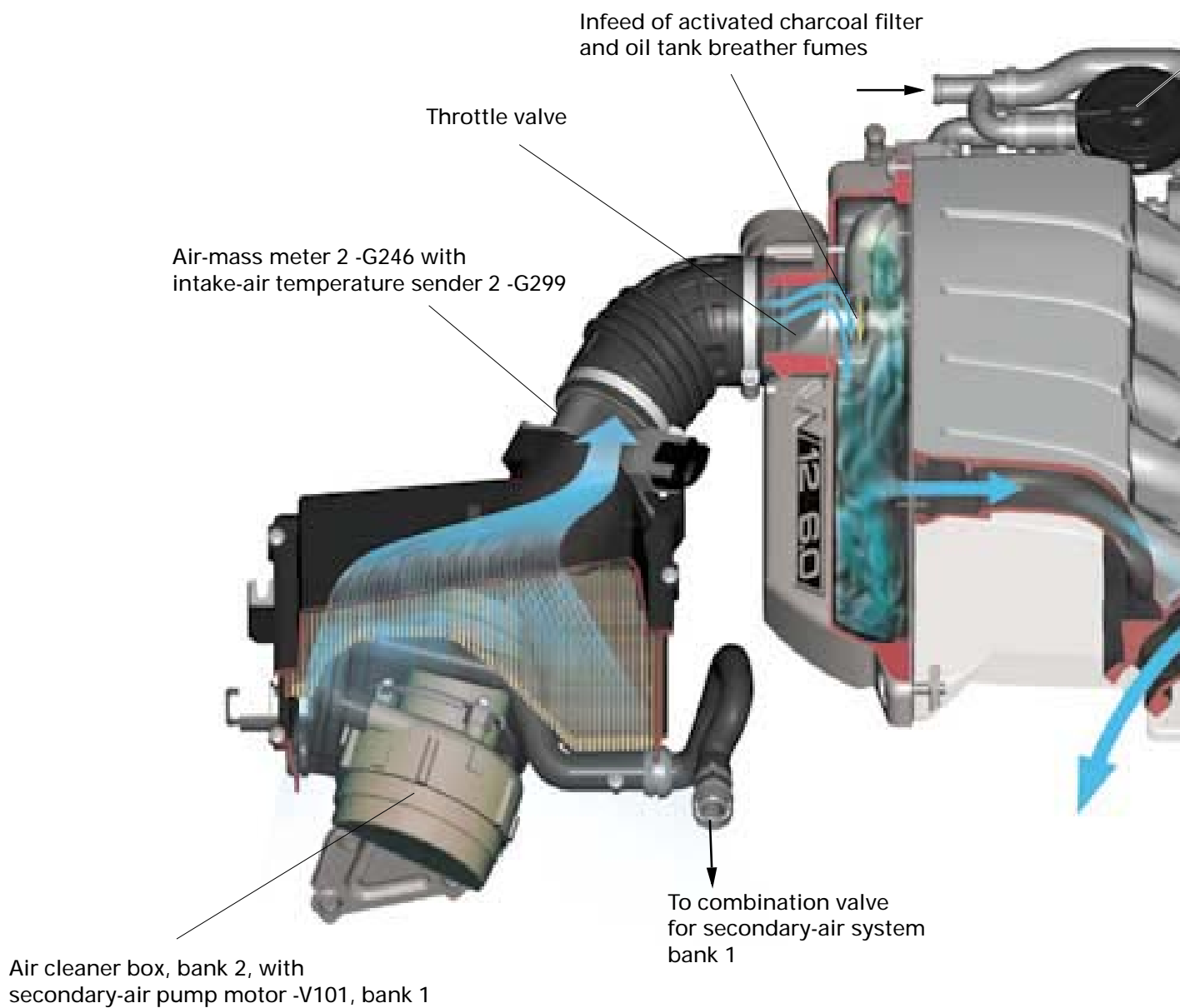
- ① From engine control unit 1 -J623
- ② From air-conditioner operating and display unit -E87
- ③ From combi processor in dash panel insert -J218
- ④ To engine control unit 1 -J623
- ⑤ To air-conditioner operating and display unit -E87
- ⑥ From air-conditioner operating and display unit -E87

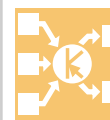
Engine sub-systems

Induction system

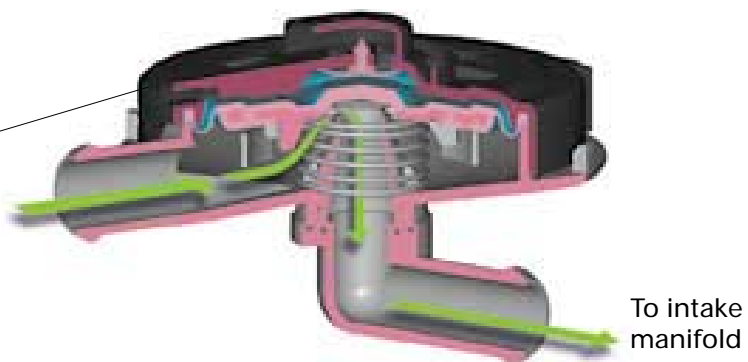


The induction system consists of a multi-piece intake manifold.





Pressure limiting valves



SSP268_123

Suction jet pump

Brake servo connection

Air-mass meter -G70 with intake-air temperature sender -G42

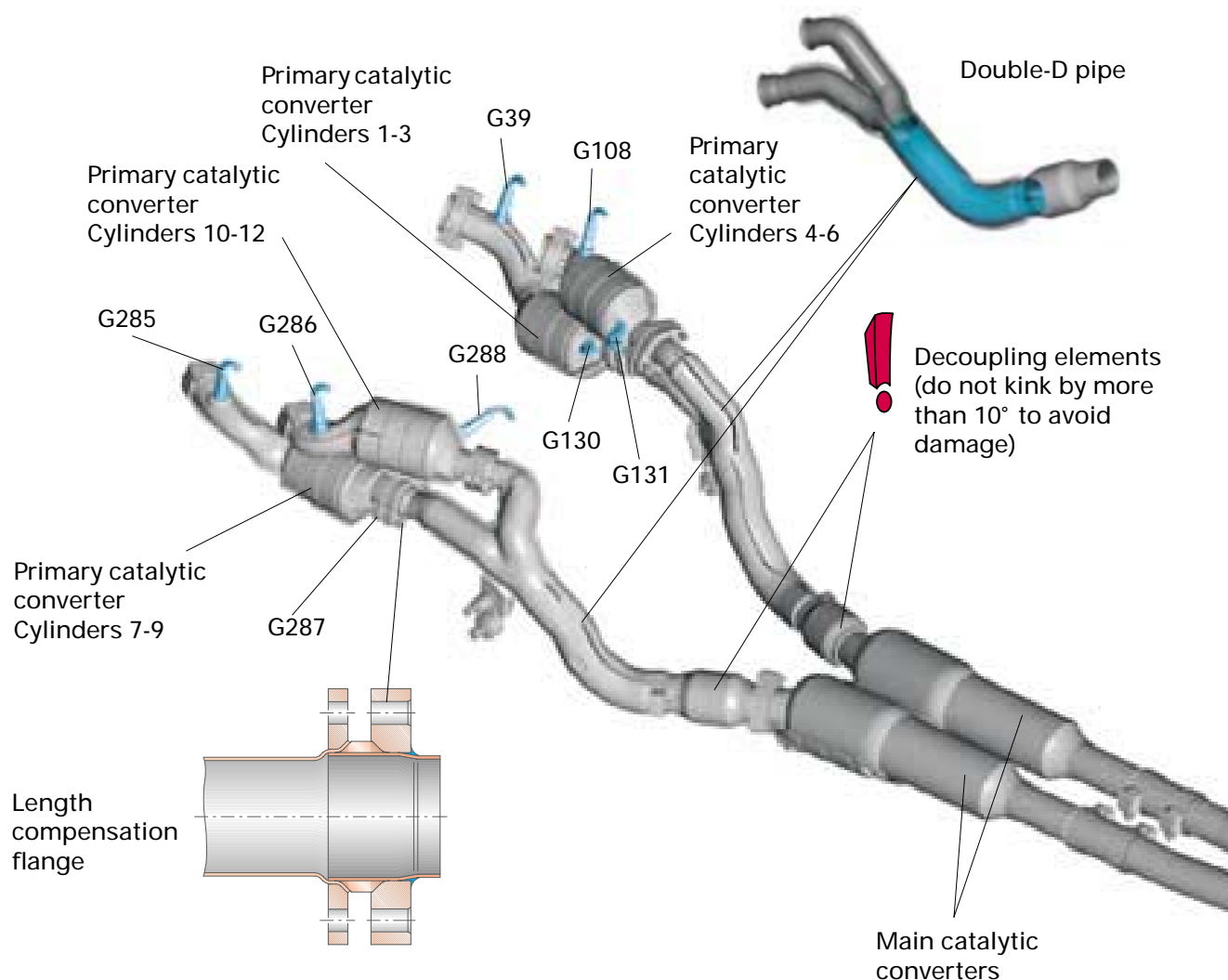
To combination valve for secondary-air system bank 2

SSP268_110

Air cleaner box, bank 1, with secondary-air pump motor 2 -V189, bank 2

Engine sub-systems

Exhaust system



To offset production tolerances, the flange connections between the two primary catalytic converters of exhaust banks 1 and 3 and the intermediate pipe are provided with a length compensation flange.

For manufacturing reasons, the clamp-type flange connection at the primary catalytic converter (exhaust bank 1/3) is additionally welded after assembly in series production.

The primary catalytic converters are thus paired with the intermediate pipe. Consequently, replacement of the primary catalytic converters (exhaust bank 2/4) or intermediate pipe also involves replacing the associated primary catalytic converter (exhaust bank 1/3).

Lambda probes	
Upstream of CAT	Downstream of CAT
G39	G130
G108	G131
G285	G287
G286	G288

The exhaust gas flow from three cylinders is collected in an exhaust manifold with air gap insulation, thus resulting in a total of four so-called exhaust banks (see illustration on Page 16).

Each exhaust bank is assigned an under-bonnet 3-way primary catalytic converter (metal-substrate catalytic converter). After passing through the primary catalytic converters, the exhaust gas flow of each exhaust bank is routed separately (in four channels) to the two decoupling elements.

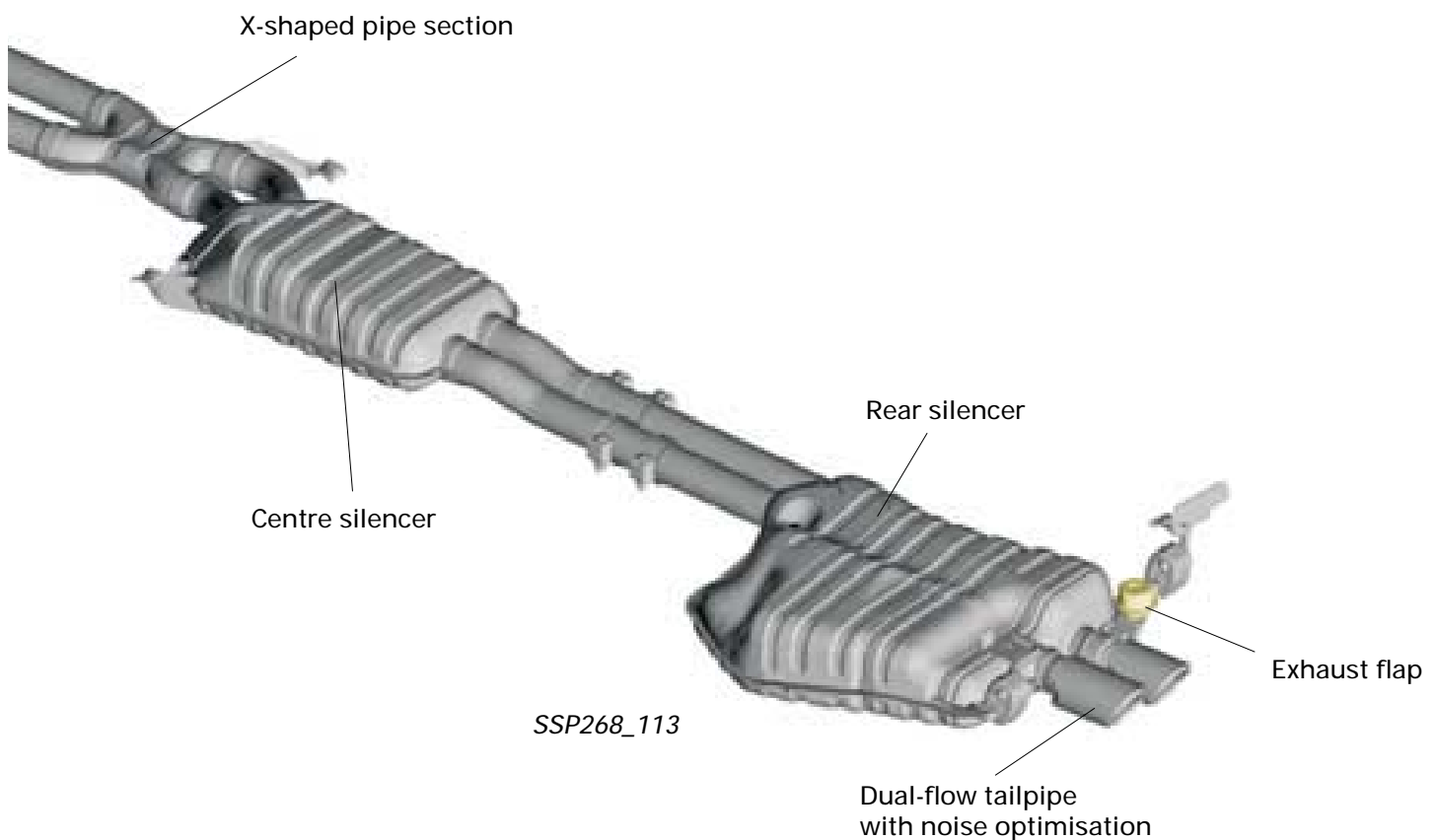
The four-channel design of the exhaust system until just upstream of the main catalytic converters (long separate exhaust flow routing) provides a vastly improved torque profile in the lower engine speed range.

This long exhaust gas flow separation is achieved by means of an intermediate pipe (fleece-insulated) with two D-section "inliners".

The further conversion of the exhaust gases takes place in the 3-way main catalytic converter (metal-substrate catalytic converter) assigned to each cylinder bank.

An X-shaped pipe section causes the two exhaust gas flows to merge before entering the centre silencer. The subsequent joint routing in the centre and rear silencers produces the typical 12-cylinder exhaust noise.

The right tailpipe is fitted with an electronically actuated exhaust flap.



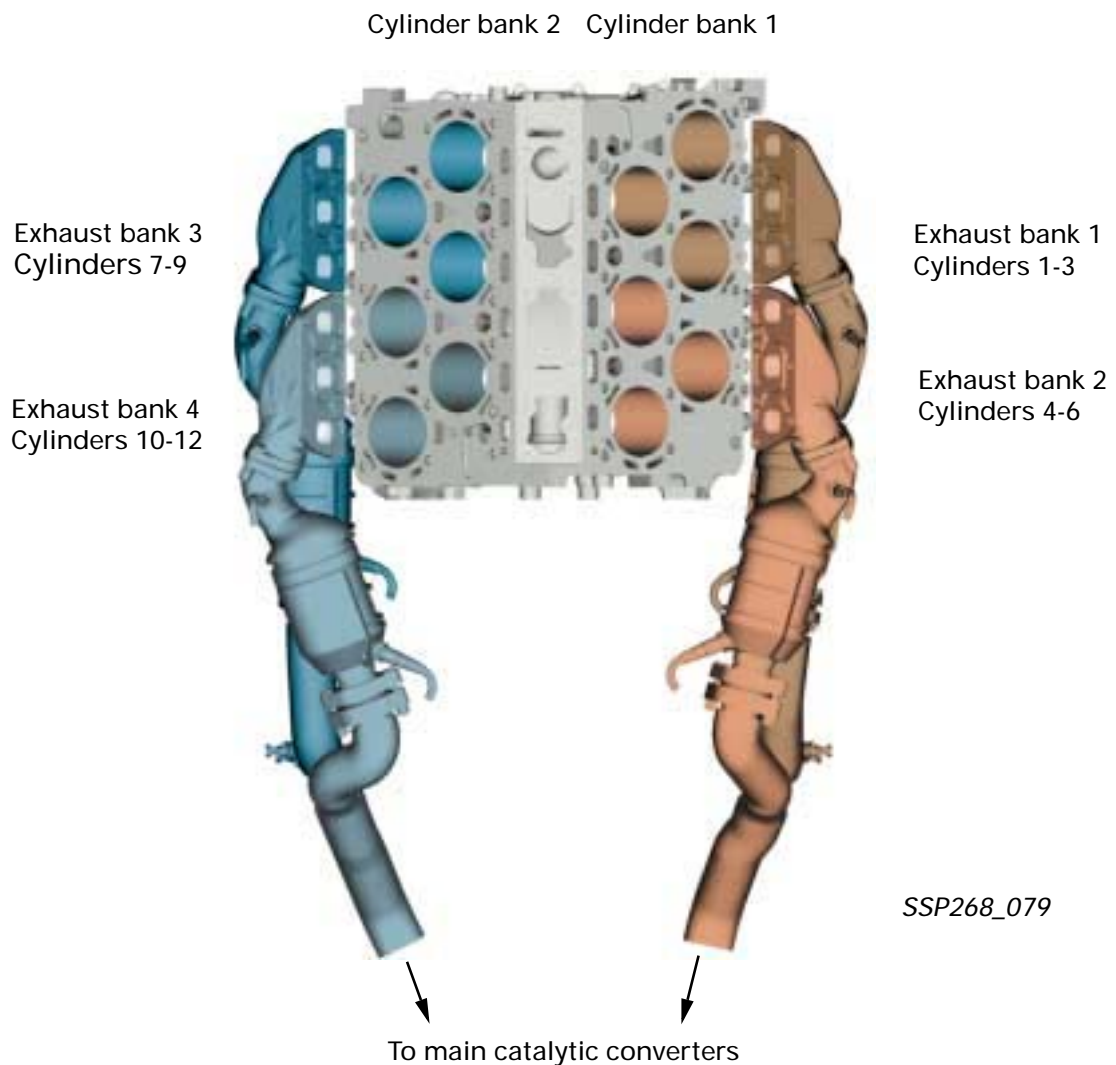
Engine sub-systems

Advantages of metal-substrate over ceramic-substrate catalytic converters:

- The lower flow resistance results in a lower exhaust back pressure (enhanced power yield).
- The catalytic converter response temperature is attained more quickly on account of the lower heat capacity of the metal substrate (reduced pollutant emissions).

Mixture composition and emission control are monitored by way of four independent control loops using eight heated Lambda probes.

Each primary catalytic converter is assigned a wide-band Lambda probe as upstream probe and a step-change probe as downstream probe. Operation of the wide-band Lambda probe is described in SSP 247 on Page 21 onwards.



Exhaust flap

The exhaust flap is switched by engine control unit 1 -J623 as a function of engine load, engine speed and vehicle speed.

The exhaust flap is closed at idle and in the lower part-throttle range, thus enhancing silencer efficiency.

When the above parameters exceed certain defined values, the exhaust flap is opened to reduce exhaust back pressure.

This enables the comfort level to be maintained in low load ranges without the detrimental effect of increasing exhaust back pressure in higher load ranges.

Operation/control of exhaust flap

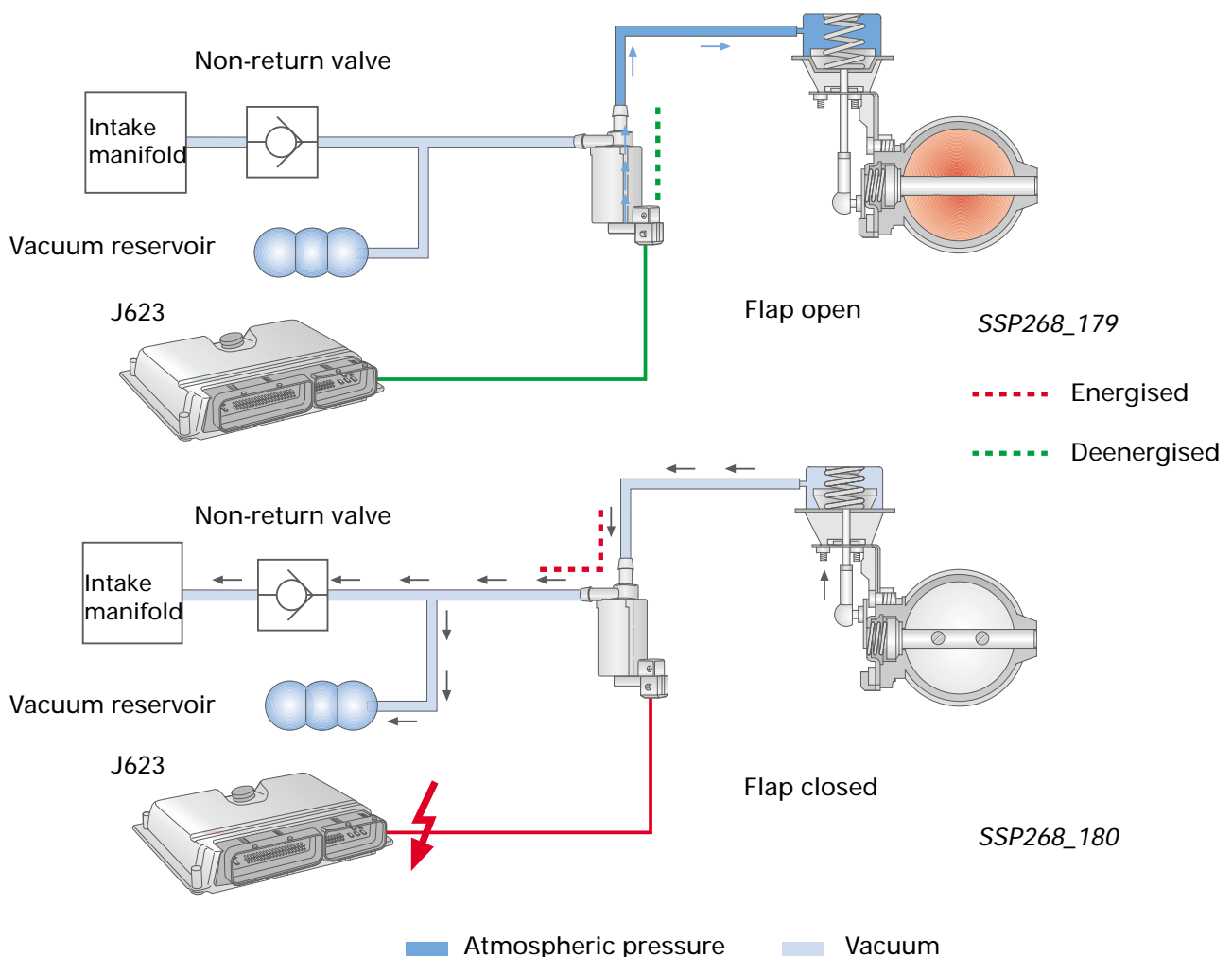
In deenergised and depressurised condition, the exhaust flap is kept open by way of spring force.

This ensures the unimpeded discharge of exhaust gases in the event of system faults and prevents a reduction of performance and/or component damage.

Actuation of the valve -N321 causes vacuum to be applied to the vacuum unit, thus closing the exhaust flap by overcoming the spring force.

Switching conditions for opening of exhaust flap:

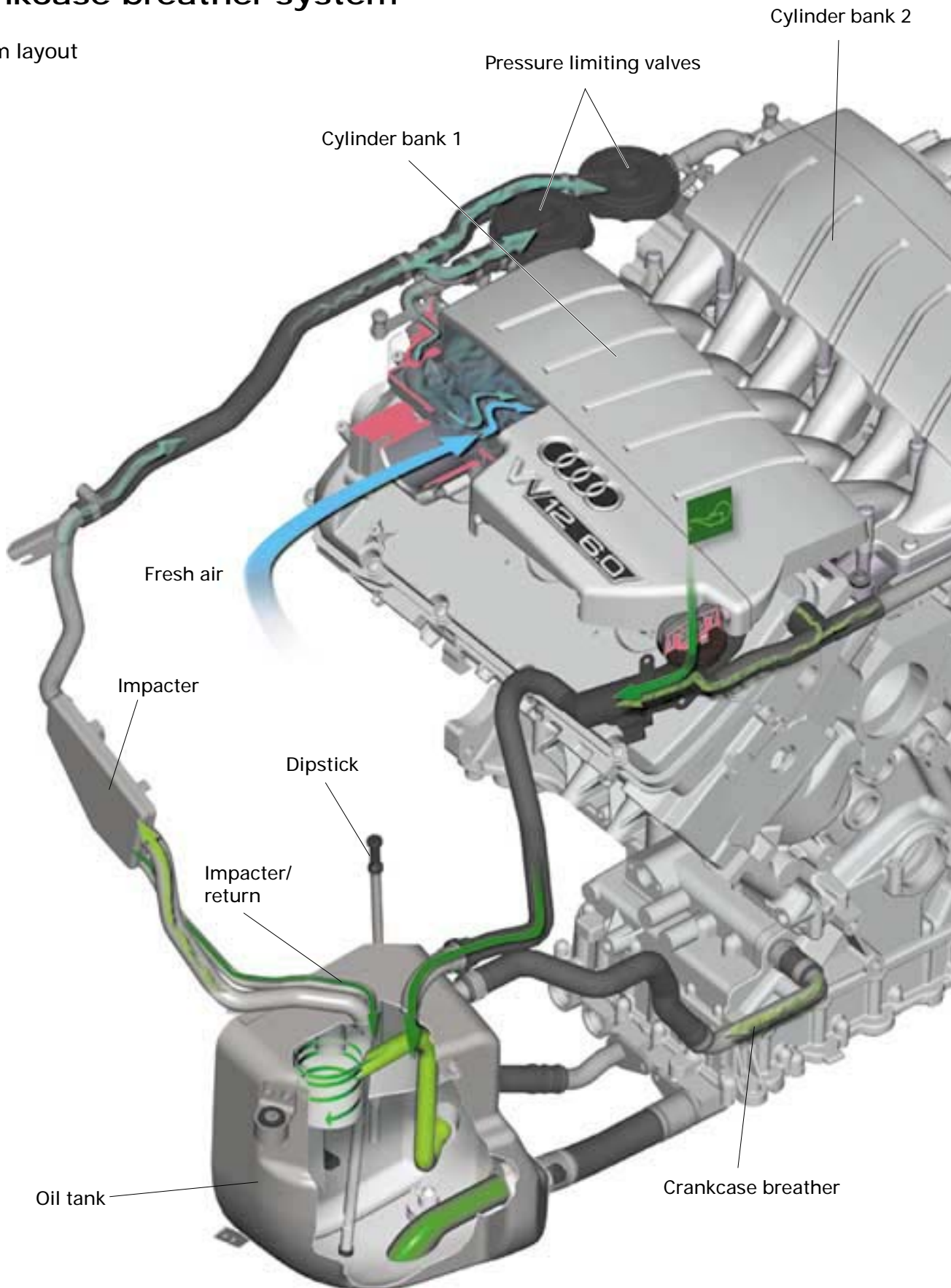
Vehicle speed	> 5 km/h
Engine load	> 50 %
Engine speed	> 2500 rpm



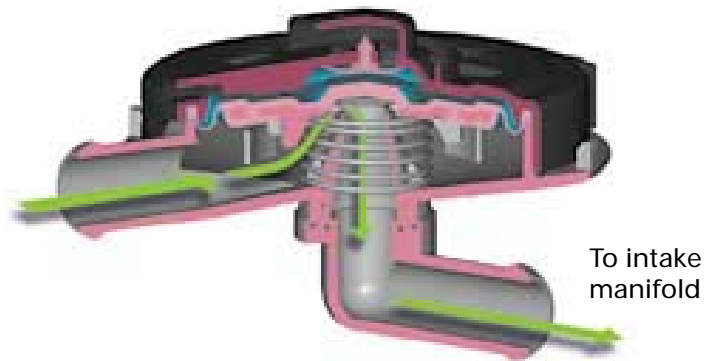
Engine sub-systems

Crankcase breather system

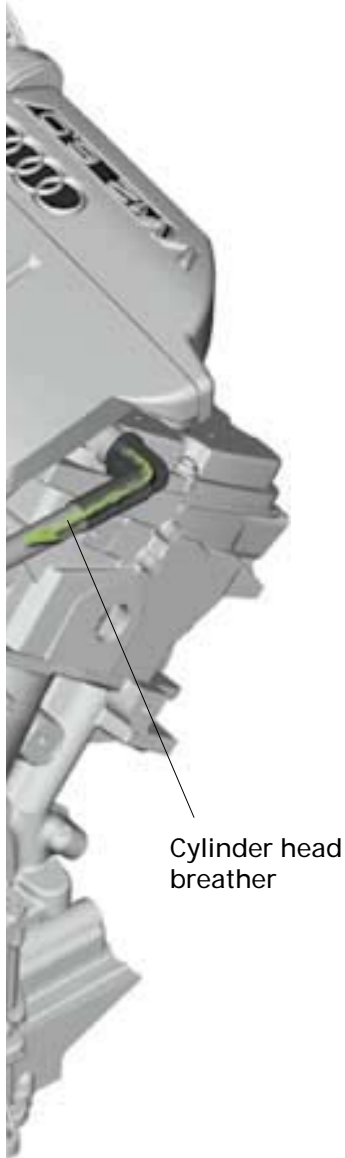
System layout



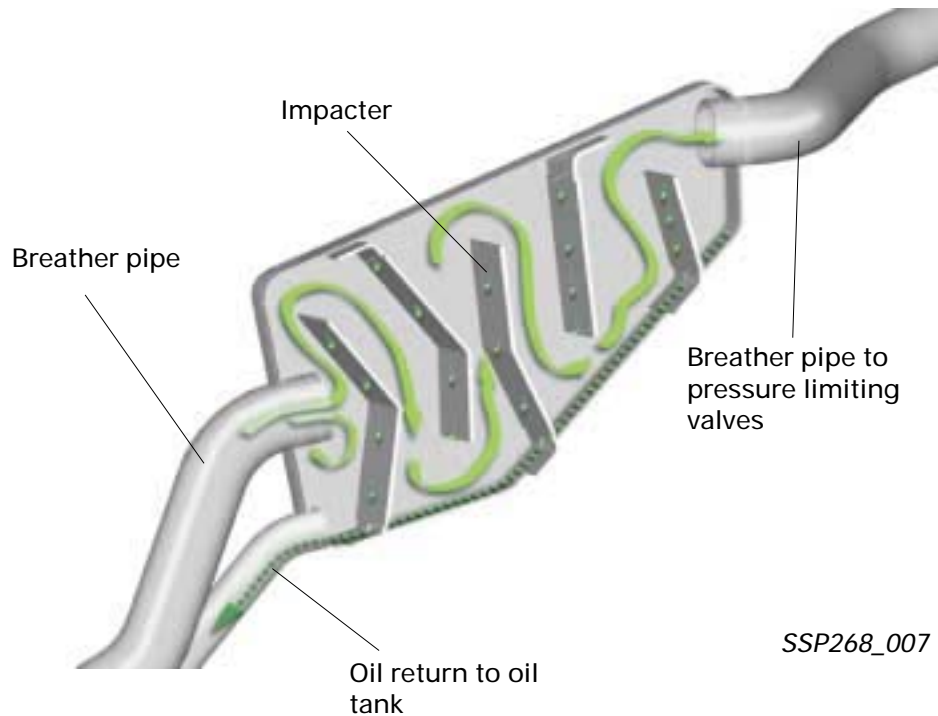
SSP268_064



SSP268_123



Cylinder head breather



SSP268_007

The breather fumes, consisting of blow-by gases and oil vapours, from the cylinder heads and central crankcase are collected in the oil tank, from where they are routed via pressure limiting valves into the intake manifold.

An oil separator extracts the oil particles from the fumes so as to ensure that the gases entering the intake system contain as little oil as possible even at high air flow rates.

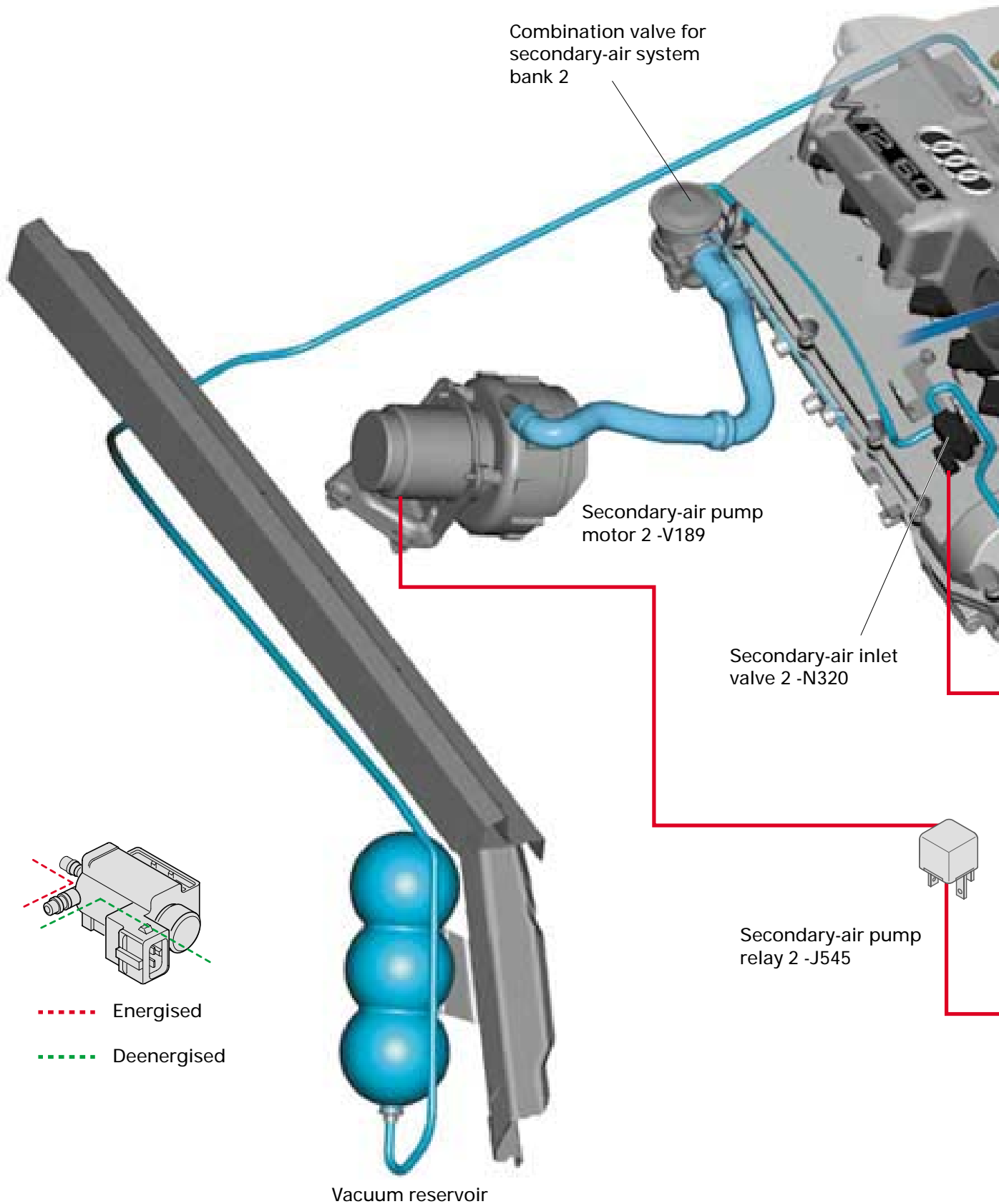
The pressure limiting valves restrict the vacuum in the engine. If the vacuum in the engine exceeds a certain value, the diaphragm is pulled (overcoming the spring force) onto the connection to seal it.

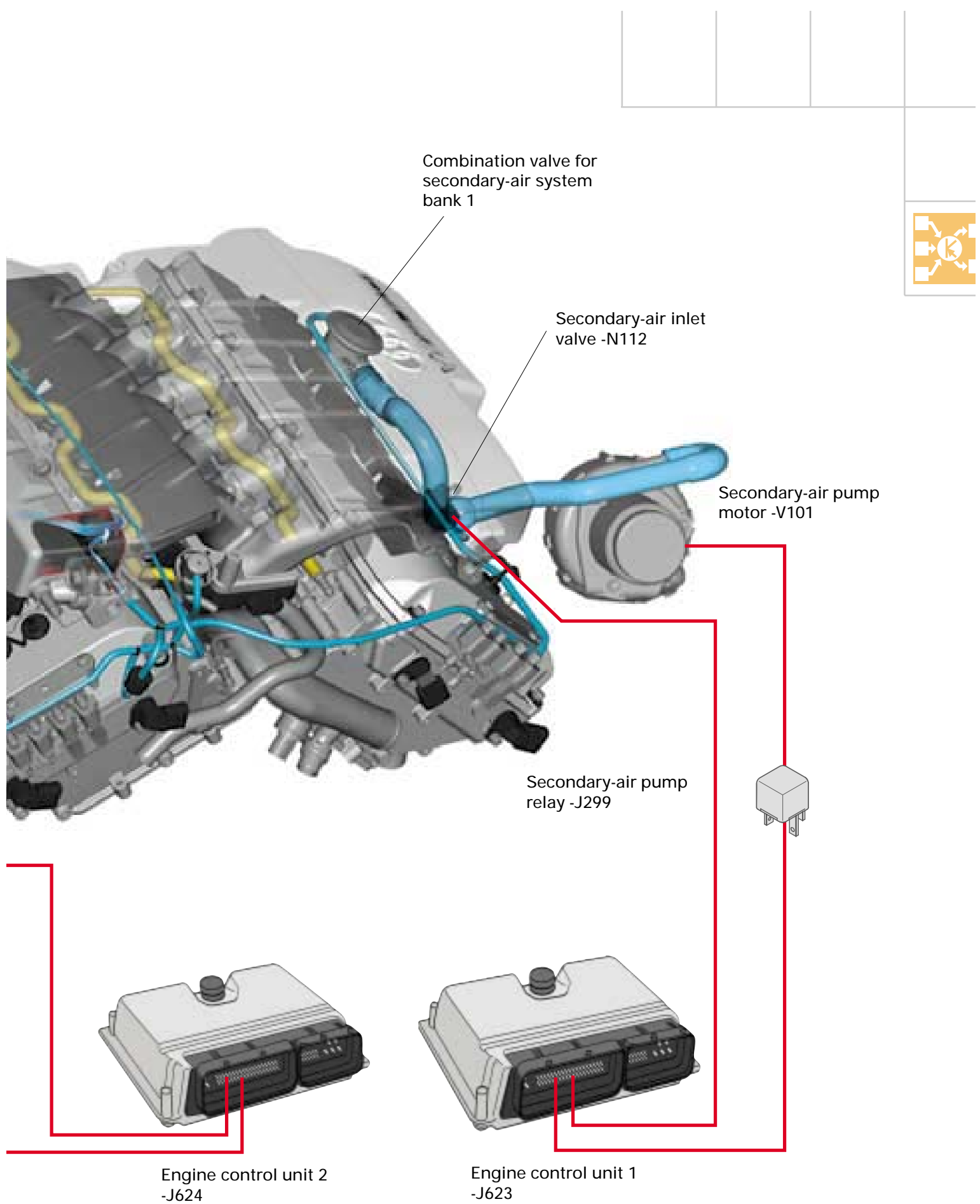
This prevents excessive vacuum damaging the axial oil seals.

Engine sub-systems

Secondary-air system

System layout

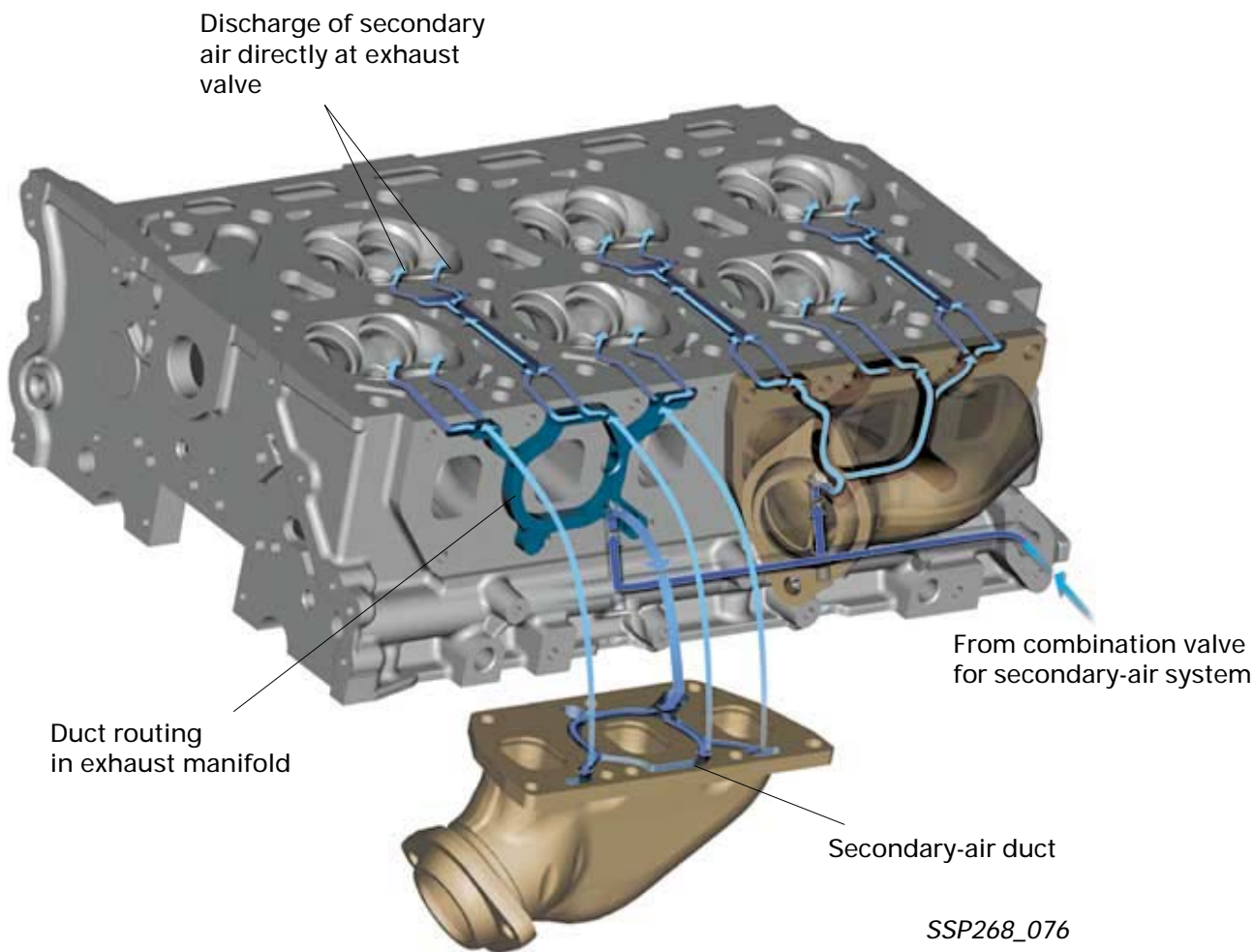




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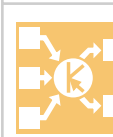
Engine sub-systems

Operation of the secondary-air system and the individual components is described in detail in SSP 217 on Page 32 onwards.



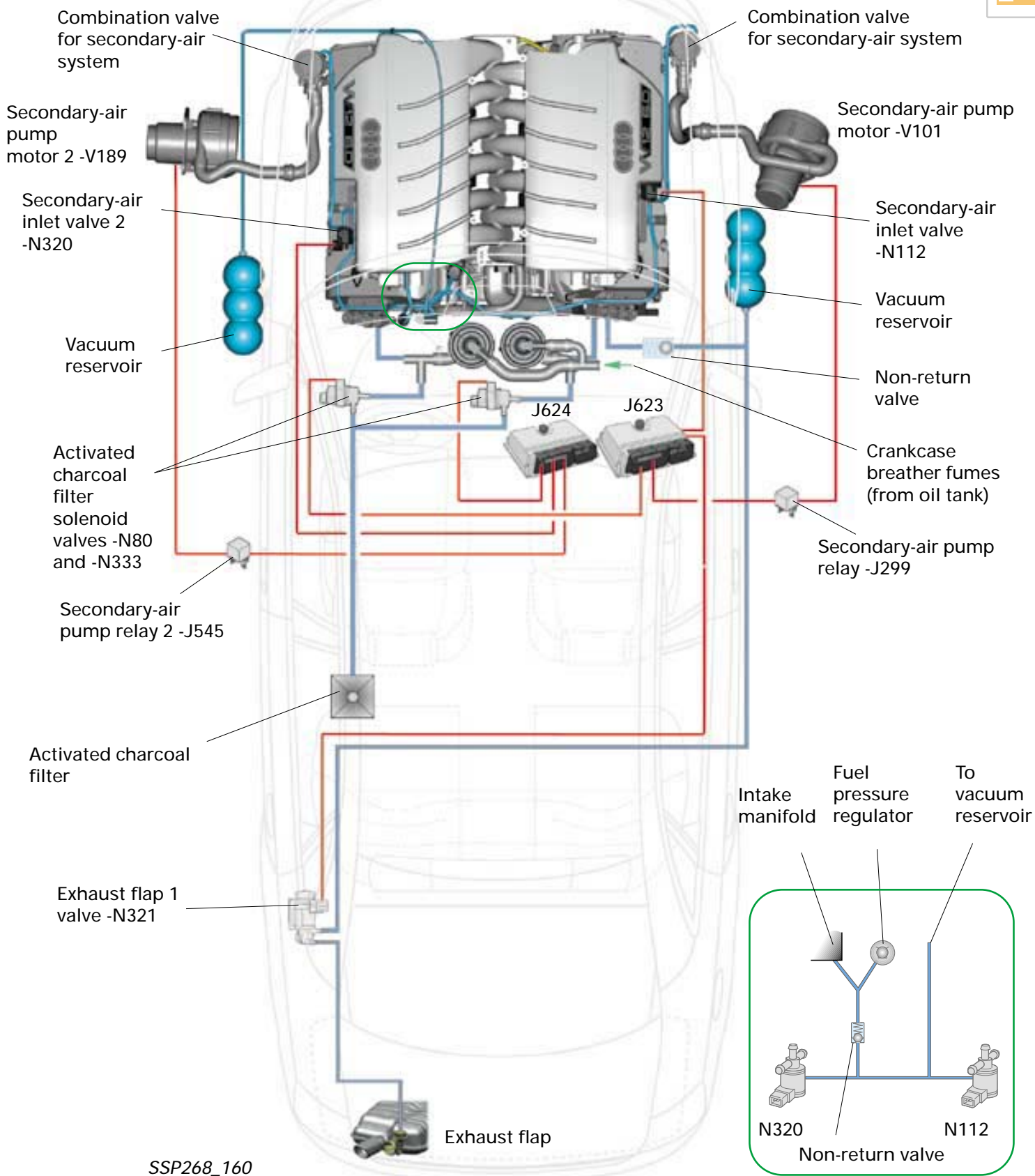
A special feature of the secondary-air system is that the secondary air is routed by way of ducts in the exhaust manifolds back to the secondary-air ducts in the cylinder head.

The secondary-air ducts in the cylinder head route the secondary air directly behind the exhaust valves.



Vacuum system

System layout



SSP268_160

Engine sub-systems

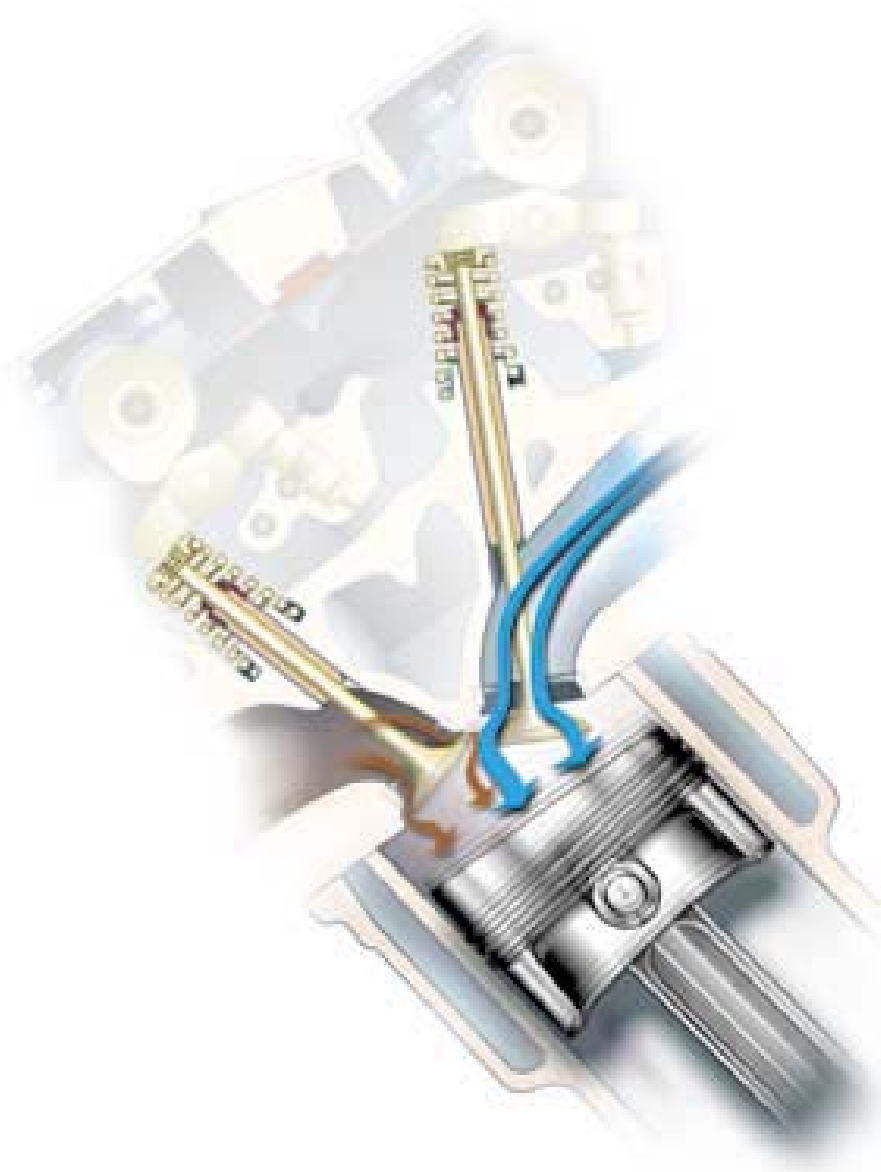
Exhaust-gas recirculation



As exhaust-gas recirculation is implemented by way of the valve overlap (internal EGR), it is dealt with in the Section on Camshaft timing control in SSP 267.

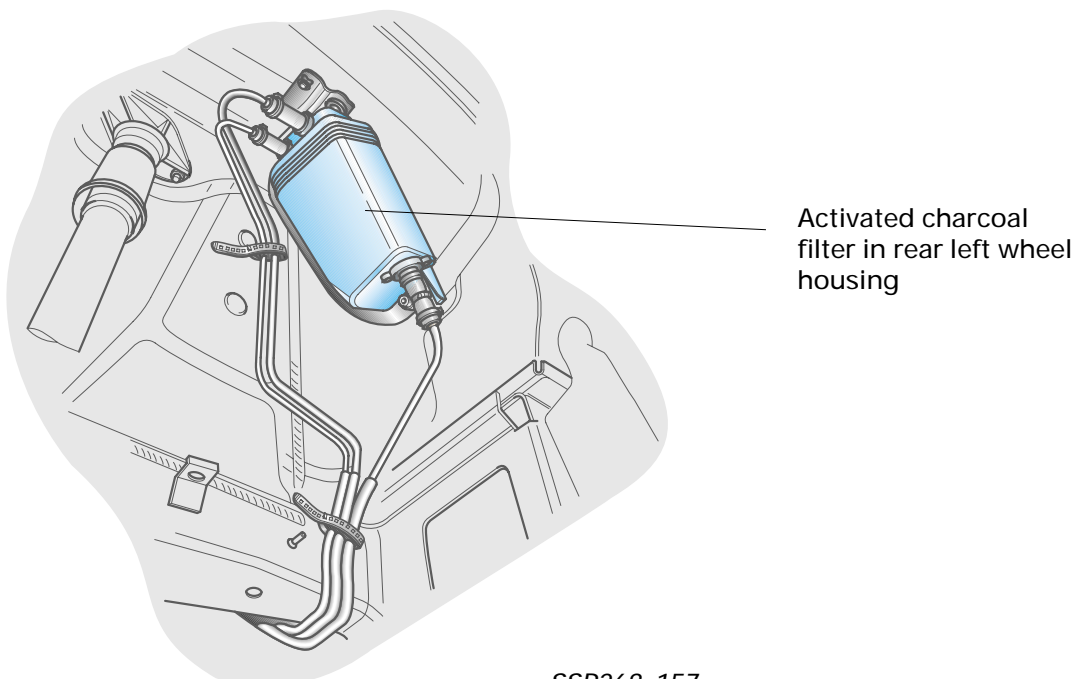
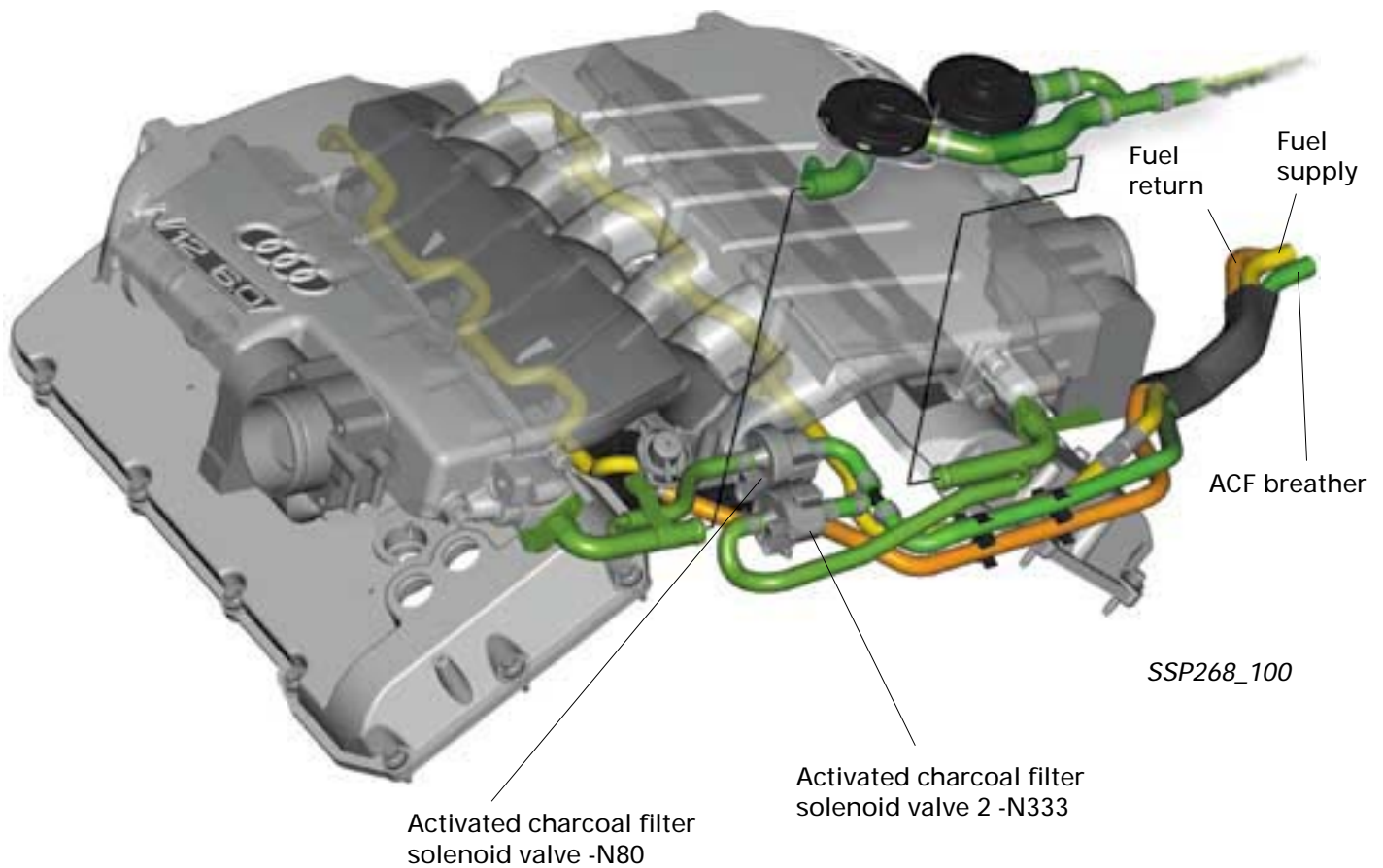


The appropriate description can be found in SSP 267 on Page 54 onwards.



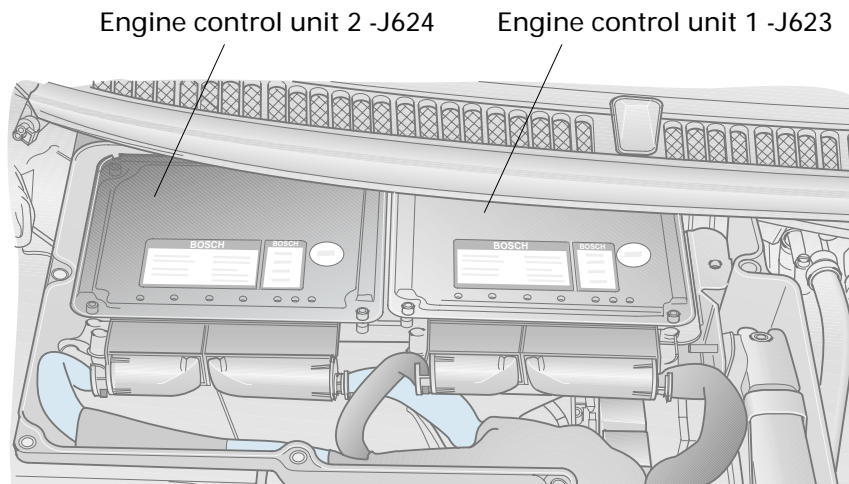
SSP267_117

Fuel tank breather system - activated charcoal filter (ACF)



Engine management

Engine management concept



SSP268_129

The engine management system for the W12 engine - Motronic ME7.1.1 - takes the form of a so-called twin control unit concept.

The two control units are fully identical and each is assigned to one cylinder bank. This means that the two cylinder banks are to be viewed as separate engines.

Certain sub-functions are however common to both control units:

- Engine control unit 1 -J623 for cylinder bank 1
- Engine control unit 2 -J624 for cylinder bank 2

The Motronic ME7.1.1 engine management system is a more advanced version of the Motronic ME7.1, which was described in SSPs 198 and 217.

Relevant information can be found as follows:

- Torque-oriented engine management (SSP 198, Page 33 onwards)
- Electrically operated throttle valve (electronic throttle function - SSP 198, Page 36 onwards; SSP 217, Page 42)
- Sensors (SSP 198, Page 49 onwards)
- Rapid starting functions (SSP 217, Page 40 onwards)
- Engine run-out detection (SSP 217, Page 41)

Control unit/cylinder bank assignment identification is provided by way of so-called pin encoding in the wiring harness. To provide a clear distinction, the wiring harness to each control unit is wound with differently coloured tape.

Pin encoding means that the interface pin 49 of engine control unit 1 -J623 is connected to terminal 15 and pin 49 of engine control unit 2 -J624 is connected to terminal 31.

On account of the twin control unit concept attention must be paid to the following:

Both control units must ...

- ... have the same software version
- ... be matched to the cruise control system (CCS)
- ... be matched to the immobilizer
- ... be viewed as separate entities for self-diagnosis
- ... have the same encoding

The following functions are implemented solely by engine control unit 1 -J623:

- Determination of specified speed values for idling speed control
- Coolant temperature regulation, continued coolant circulation, actuation of continued coolant circulation pump -V51 and hydraulic fan
- Provision of CAN data for drive system CAN
- Actuation of fuel pump relay -J17 and Motronic current supply relay -J271
- Control of exhaust flap

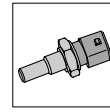
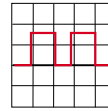
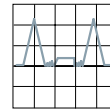
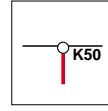
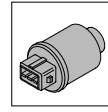
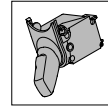
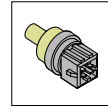
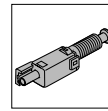
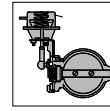
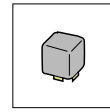
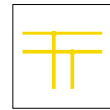
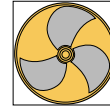
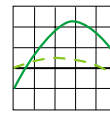
Processing of the following interfaces:

- Brake light/pedal switches -F/-F47 (refer to SSP 198, Page 56)
- Coolant temperature sender -G62 (refer to Page 32)
- Cruise control system switch -E45
- AC high-pressure signal from air-conditioner pressure switch -F129
- Terminal 50 signal
- Engine speed signal

For further details, refer to "Additional signals/ interfaces", Page 43 onwards.

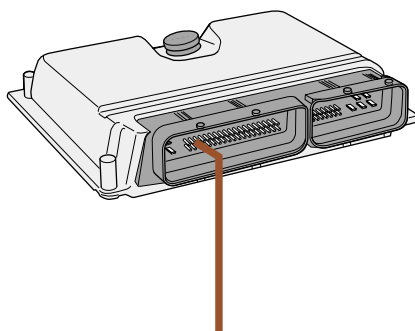
The following functions are implemented solely by engine control unit 2 -J624:

- Detection of combustion missing
- Processing of oil temperature sender -G8 signal (refer to Page 42)



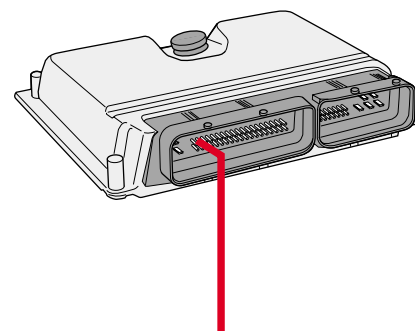
SSP268_148

Engine control unit 2 -J624



Terminal 31

Engine control unit 1 -J623

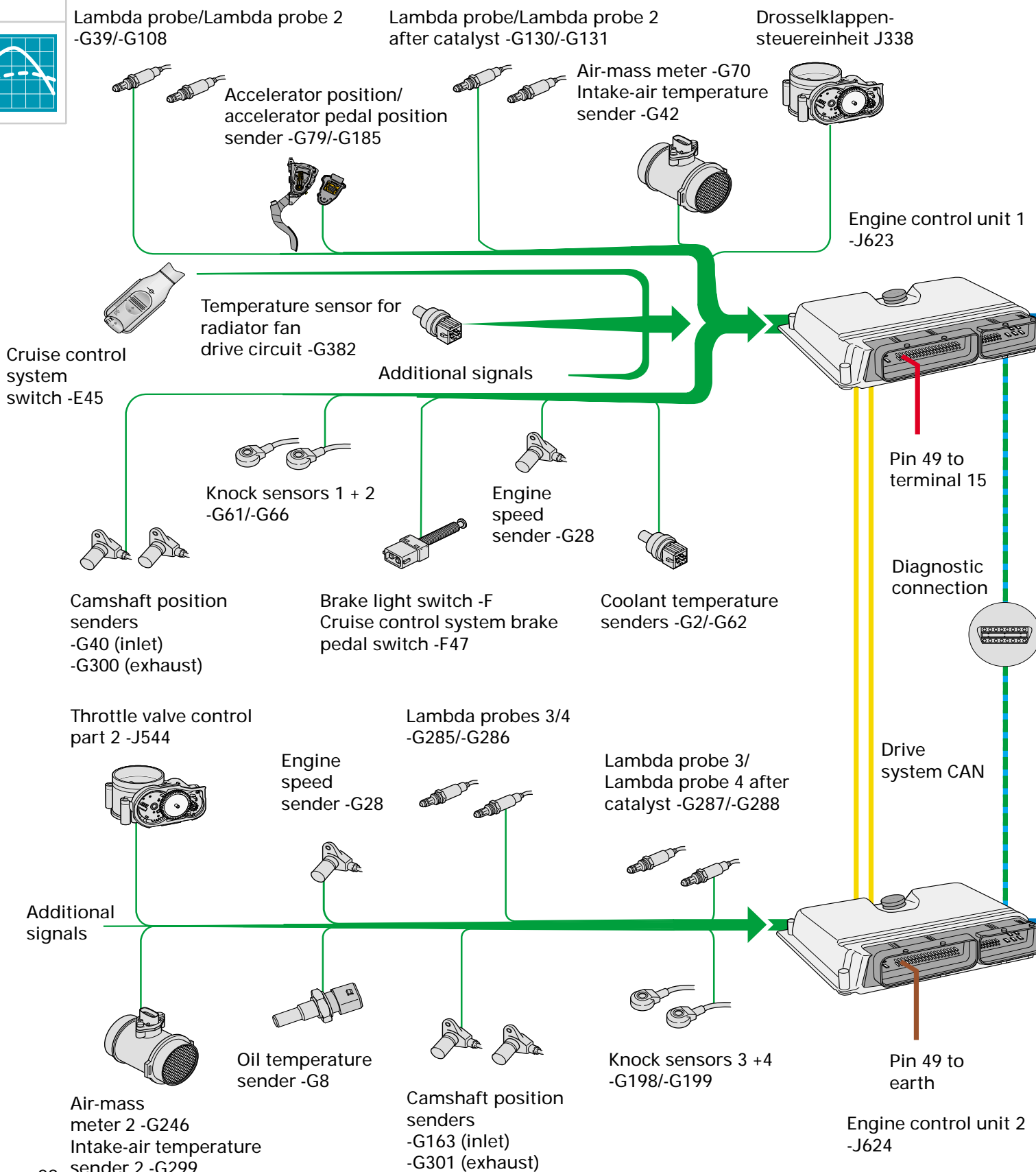


Terminal 15

Engine management

System layout

Motronic ME7.1.1
Sensors/actuators



Throttle valve
control part -J338

Ignition coils with output
stage -N70, 127, 291, 292,
323, 324

Injectors
-N30, 31, 32, 33, 83, 84

Motronic
current supply
relay -J271



Secondary-air inlet
valve -N112

Activated charcoal filter
solenoid valve -N80

Map-controlled engine
cooling thermostat -F265

Additional
signals

Exhaust flap 1
valve -N321

Camshaft
adjustment
valves
-N205 (inlet)
-N318 (exhaust)

Additional coolant
pump relay -J496
with continued
coolant circulation
pump -V51

Secondary-air pump relay
-J299 with secondary-air
pump motor -V101

Radiator fan
valve -N313

Fuel pump
relay -J17 with
fuel pump -G6

Radiator fan
run-on relay
-J397

Electrohydraulic engine
mounting solenoid valve,
right -N145

Throttle valve
control part 2 -J544

Ignition coils with
output stages -N325, -N326,
-N327, -N328, -N329, -N330

Injectors -N85, 86, 299,
300, 301, 302

Secondary-air inlet
valve 2 -N320

Additional
signals

SSP268_119

Activated charcoal filter
solenoid valve 2 -N333

Camshaft
adjustment valves
-N208 (inlet)
-N319 (exhaust)

Electrohydraulic engine
mounting solenoid valve,
left -N144

Secondary-air pump relay 2
-J545 with secondary-air
pump motor 2 -V189

Engine management

Block diagram

Motronic ME7.1.1



A	Battery
E45	Cruise control system switch
F	Brake light switch
F47	Cruise control system brake pedal switch
F265	Map-controlled engine cooling thermostat
G2	Coolant temperature sender
G6	Fuel pump
G8	Oil temperature sender
G28	Engine speed sender
G39	Lambda probe
G40	Inlet camshaft position sender/cylinder bank 1
G42	Intake-air temperature sender
G61	Knock sensor 1
G62	Coolant temperature sender
G66	Knock sensor 2
G70	Air-mass meter
G79	Accelerator position sender
G108	Lambda probe 2 after catalyst
G130	Lambda probe 3 after catalyst
G131	Inlet camshaft position sender/cylinder bank 2
G163	Accelerator pedal position sender 2
G185	Throttle valve drive (electric throttle operation)
G186	Throttle valve drive angle sender 1 (electric throttle operation)
G187	Throttle valve drive angle sender 2 (electric throttle operation)
G188	Throttle valve drive angle sender 2 (electric throttle operation)
G198	Knock sensor 3
G199	Knock sensor 4
G246	Air-mass meter 2
G285	Lambda probe 3
G286	Lambda probe 4
G287	Lambda probe 3 after catalyst
G288	Lambda probe 4 after catalyst
G296	Throttle valve drive 2
G297	Angle sender 1 for throttle valve drive 2
G298	Angle sender 2 for throttle valve drive 2
G299	Intake-air temperature sender 2

G300	Exhaust camshaft position sender/cylinder bank 1
G301	Exhaust camshaft position sender/cylinder bank 2
G382	Temperature sensor for radiator fan drive circuit
J17	Fuel pump relay
J299	Motronic current supply relay
J338	Throttle valve control part
J397	Radiator fan run-on relay
J496	Additional coolant pump relay
J544	Throttle valve control part 2
J545	Secondary-air pump relay 2
J623	Engine control unit 1
J624	Engine control unit 2
M9	Brake light bulb, left
M10	Brake light bulb, right
N30	Injector, cylinder 1
N31	Injector, cylinder 2
N32	Injector, cylinder 3
N33	Injector, cylinder 4
N70	Ignition coil 1 with output stage
N80	Activated charcoal filter
N83	Solenoid valve
N84	Injector, cylinder 5
N85	Injector, cylinder 6
N86	Injector, cylinder 7
N112	Secondary-air inlet valve
N127	Ignition coil 2 with output stage
N144	Electrohydraulic engine mounting solenoid valve, left
N145	Electrohydraulic engine mounting solenoid valve, right
N205	Camshaft adjustment valve 1
N208	Camshaft adjustment valve 2
N291	Ignition coil 3 with output stage
N292	Ignition coil 4 with output stage
N299	Injector, cylinder 9
N300	Injector, cylinder 10
N301	Injector, cylinder 11
N302	Injector, cylinder 12
N313	Radiator fan valve

N318	Exhaust camshaft control valve 1
N319	Exhaust camshaft control valve 2
N320	Secondary-air inlet valve
N323	Ignition coil 5 with final output stage
N324	Ignition coil 6 with final output stage
N325	Ignition coil 7 with final output stage
N326	Ignition coil 8 with final output stage
N327	Ignition coil 9 with final output stage
N328	Ignition coil 10 with final output stage
N329	Ignition coil 11 with final output stage
N330	Ignition coil 12 with final output stage
N333	Activated charcoal filter solenoid valve 2
S	Fuses
V51	Continued coolant circulation pump
V101	Secondary-air pump motor
V189	Secondary-air pump motor 2

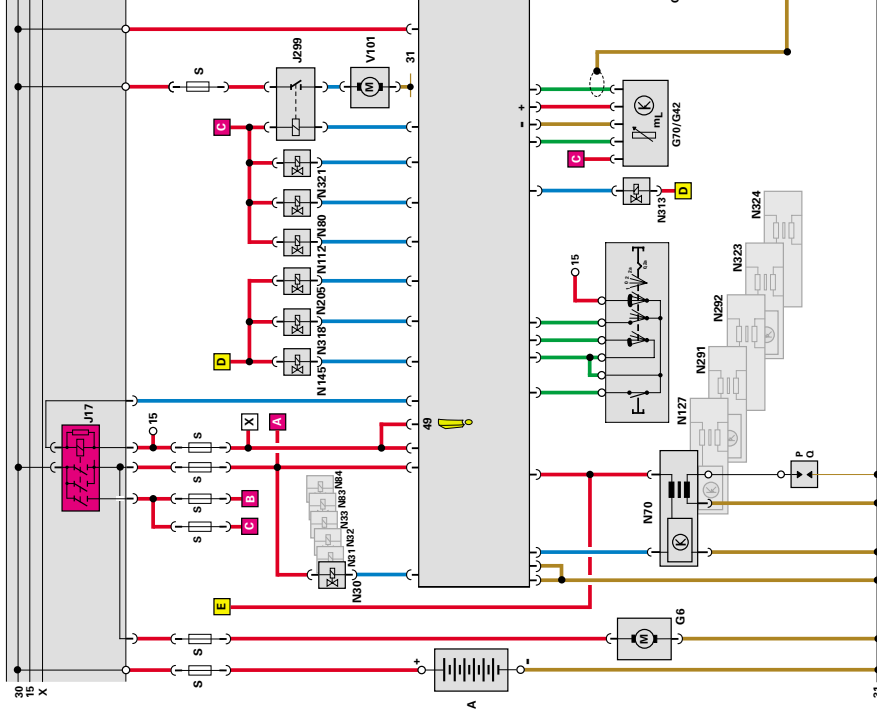
Additional signals

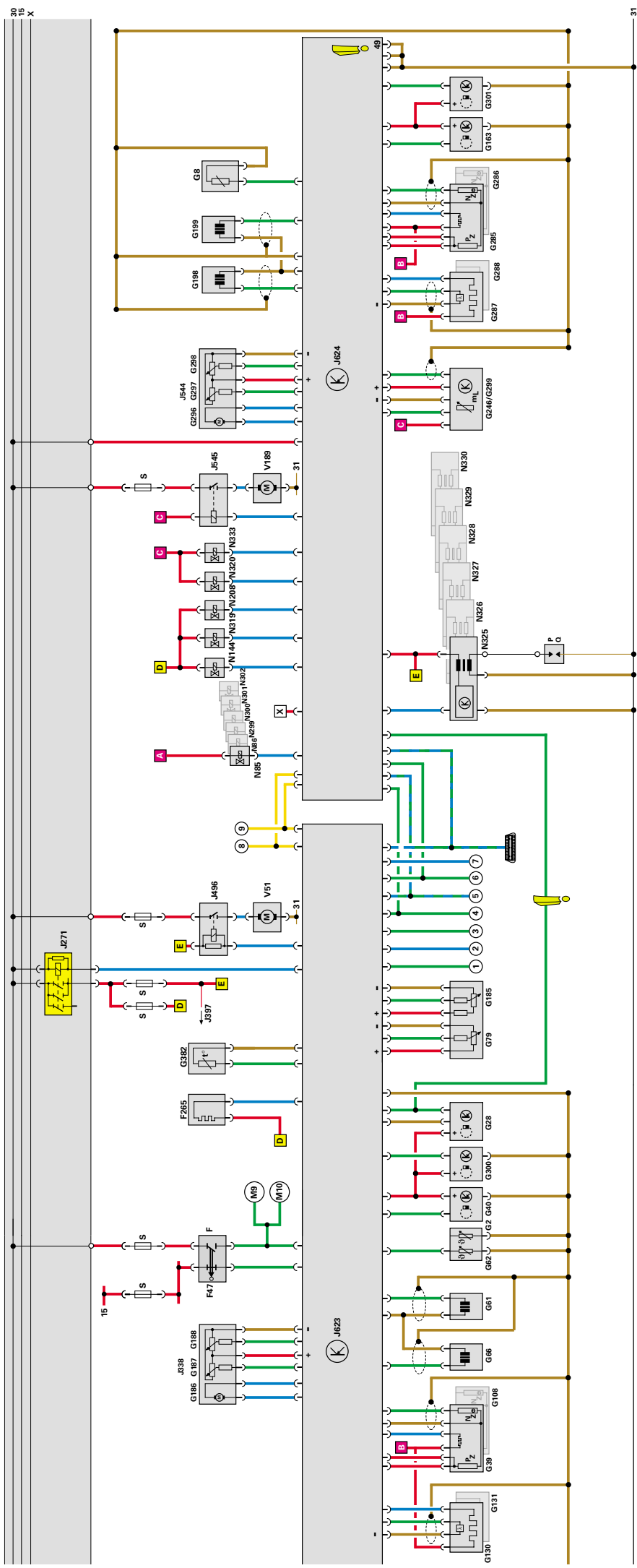
- Terminal 50
- To radiator fan run-on relay -J397
- AC high-pressure signal from air-conditioner pressure switch -F129 (high-pressure switch)
- AC requirement signal (from air-conditioner control unit -E87)
- Compressor "ON/OFF" signal
- Crash signal
- Engine speed signal
- CAN Low/drive
- CAN High/drive

Colour code

- = Input signal
- = Output signal
- = Positive supply
- = Earth
- = CAN BUS

- A } Power supply from Fuel pump relay -J17
- B } Power supply from Motronic current supply relay -J271
- C } Connections within block diagram
- D }
- E }
- X }





Engine management

Special features of Motronic ME7.1.1

The Motronic ME7.1.1 is a more advanced version of the Motronic ME7.1.

Important new features:

- Greater computer capacity on account of new computer-bound sub-functions
- Extension of control unit activities after switching off ignition with the aid of main relay concept
- Infinitely variable adjustment of inlet and exhaust camshafts (refer to SSP 267, Page 59 onwards)
- Designed to suit new wide-band Lambda probes upstream of catalytic converter (refer to Page 14)
- Designed for coolant temperature regulation
- Enhanced evaluation of signals from coolant temperature sender -G62
- Management of additional and new CAN messages (refer to Page 44)

-G62 evaluation

Precise determination of the coolant temperature in the lower operating temperature range is required for cold starting and subsequent warm-up.

Coolant temperature regulation demands exact recognition of the coolant temperature in the upper operating temperature range.

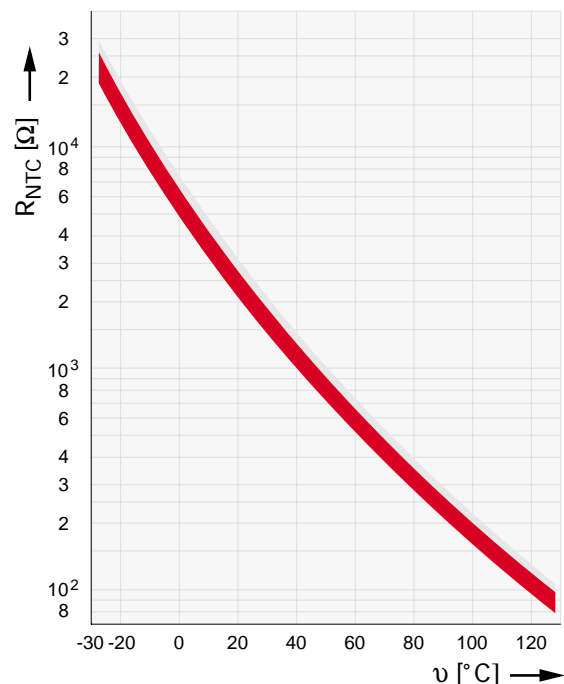
Precision sensing of the coolant temperature over a broad temperature range must therefore be of a very high standard.

For physical reasons, the characteristic curve of -G62 (NTC sender) is highly degressive over the temperature range to be recorded (approx. -30 °C to + 120 °C). At the same time the coefficient of resistance ranges from approx. 25 000 ohms to approx. 115 ohms.

The change in resistance per °K thus varies considerably at low and high temperatures.

To achieve the required level of accuracy for both temperature ranges, the ME7.1.1 has a separate evaluation circuit for each one.

Switching to the evaluation circuit for the upper temperature range takes place as of a coolant temperature of approx. 50 °C.



SSP268_190

Main relay concept

To date, the power supply for the sensors and actuators was provided largely via the fuel pump relay -J17.

A new addition is the Motronic current supply relay -J271 (main relay).

As with the fuel pump relay -J17, the Motronic current supply relay -J271 is actuated by engine control unit 1. Thanks to the Motronic current supply relay -J271, the engine control units can still implement certain functions after the engine has been switched off (ignition OFF).

The following sensors/actuators are supplied with power by the Motronic current supply relay -J271:

- Engine control unit 1
- Engine control unit 2
- Ignition coils of cylinder bank 1
- Ignition coils of cylinder bank 2
- Camshaft adjustment valves
- Engine mounting solenoid valves
- Radiator fan valve -N313
- Additional coolant pump relay -J496 (continued coolant circulation pump -V51)
- Radiator fan run-on relay -J397 (radiator fan -V7)
- Map-controlled engine cooling thermostat -F265

After switching off the ignition, the ignition coils continue to be actuated until the engine stops in order to ensure ignition of the fuel already injected. This means that no unburned fuel/air mixture reaches the exhaust system, thus reducing the level of exhaust emissions.

The camshaft adjustment valves also remain actuated until the engine stops following ignition switch-off to ensure that the camshafts are kept in the appropriate position until the engine has stopped.

The engine mounting solenoid valves are actuated to provide smooth, vibration-free engine shutoff.

The solenoid valve for the hydraulic fan is actuated to prevent brief fan speed increase.

As engine control unit 1 is responsible for control of the entire continued coolant circulation process, it must be possible to actuate the control elements (relay -J496, relay -J397 and thermostat -F265).



Refer to block diagram on Page 30.

Engine management

Engine speed sender -G28

The engine speed sender supplies the most important engine management input signal.

The engine will not run in the event of -G28 failure.

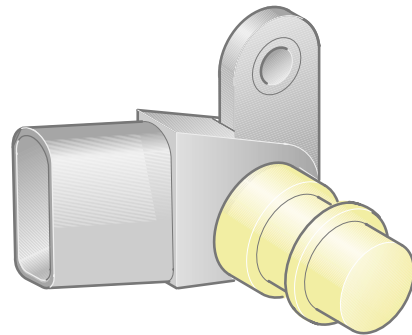
The absence of a signal from -G28 is recognised by the self-diagnosis function.

In view of the twin control unit concept and the high dynamic requirements (real time) for the engine speed signal, the engine speed sender -G28 is connected directly to both engine control units.

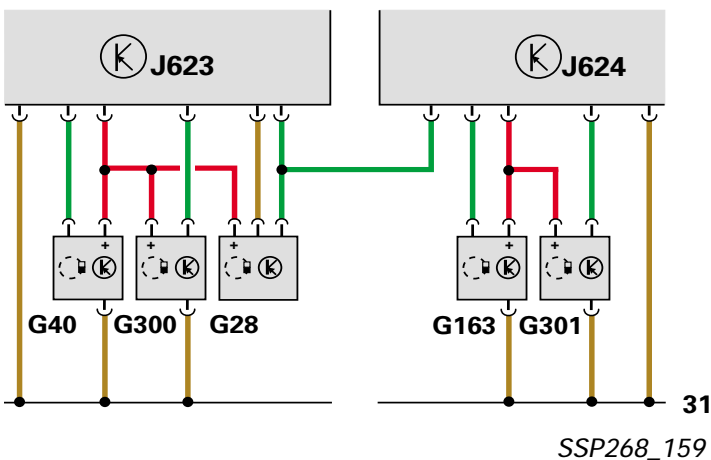
The sensor used is a so-called "differential Hall sensor" with integrated permanent magnet which is suitable for scanning ferromagnetic sender wheels.



Previous knowledge of the way in which Hall sensors work is required for understanding of this Section. Further details can be found in pertinent motor vehicle engineering reference works.

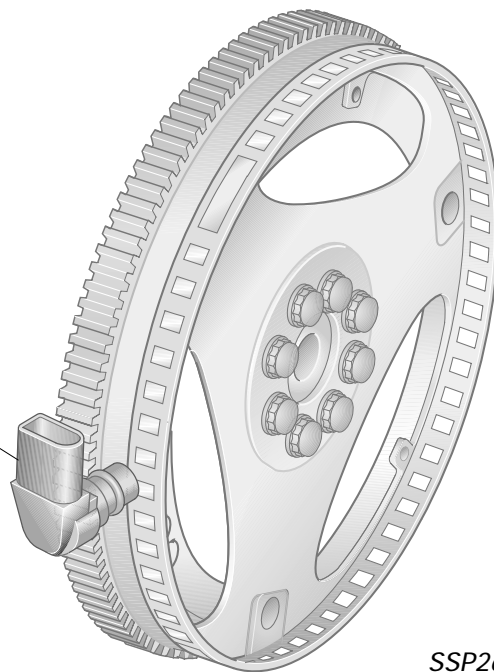


SSP268_164



- G28 Engine speed sender
- G40 Inlet camshaft position sender/cylinder bank 1
- G163 Inlet camshaft position sender/cylinder bank 2
- G300 Exhaust camshaft position sender/cylinder bank 1
- G301 Exhaust camshaft position sender/cylinder bank 2

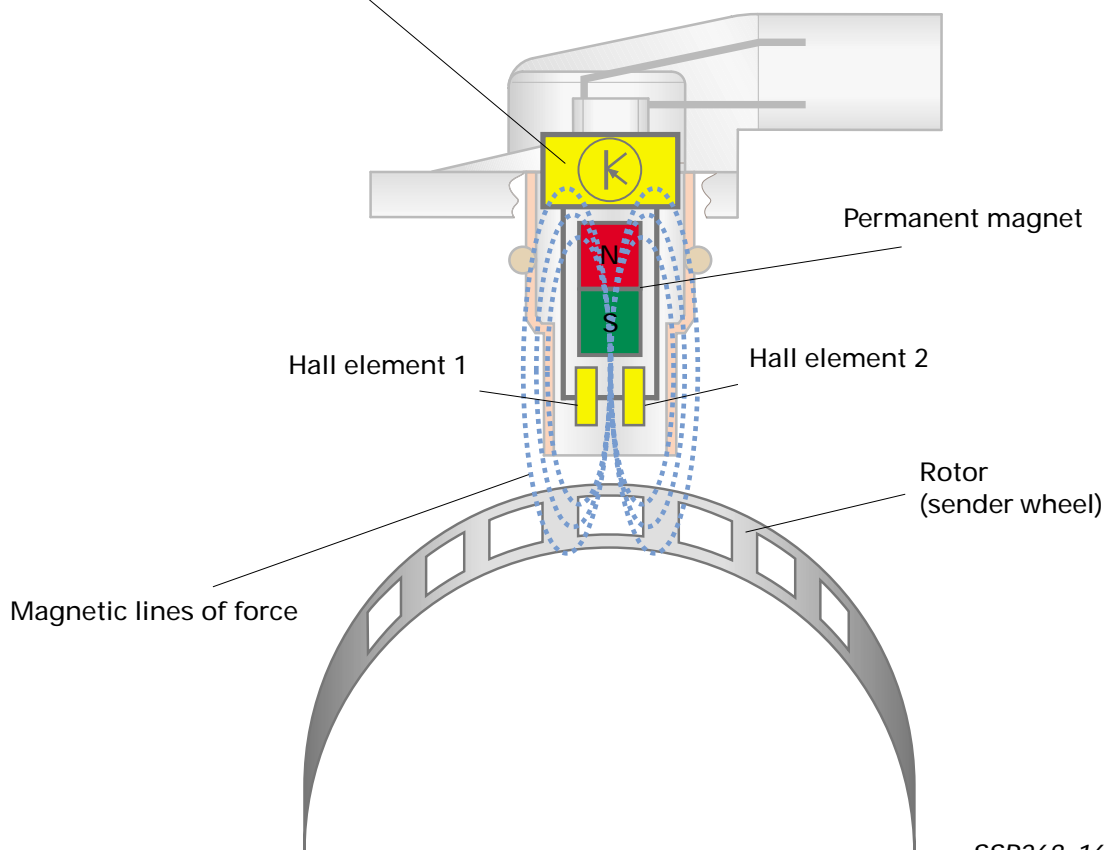
Engine speed sender -G28



SSP268_167



Evaluation electronics



SSP268_168

Engine management

Sensor design

Signals are generated by two Hall elements arranged behind one another with respect to the sender wheel.

Located above the two Hall elements and integrated into the sensor is a permanent magnet, the field of which acts on the Hall elements. The integrated evaluation electronics - also referred to as Hall IC - evaluate the Hall voltages of the two Hall elements and generate the sensor output signal.

Hall elements react to changes in the magnetic field. The sender wheel takes the form of a rotor and influences both the field strength of the permanent magnet and the Hall voltages of the two Hall elements.

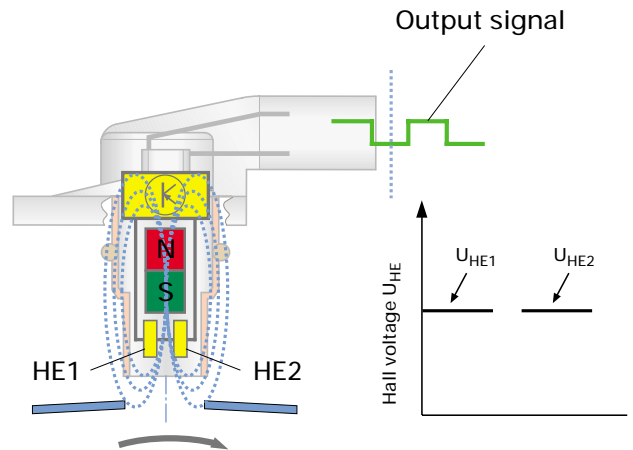
If the rotor (ferrous metal) is located directly beneath the Hall elements, the ferrous metal will intensify the magnetic field in the area of the Hall elements. The Hall voltage of the two Hall elements increases with increasing magnetic field strength.

The fact that the two Hall elements are arranged behind one another leads to differing Hall voltage levels at the Hall elements at the transition from rotor to gap (or vice versa).

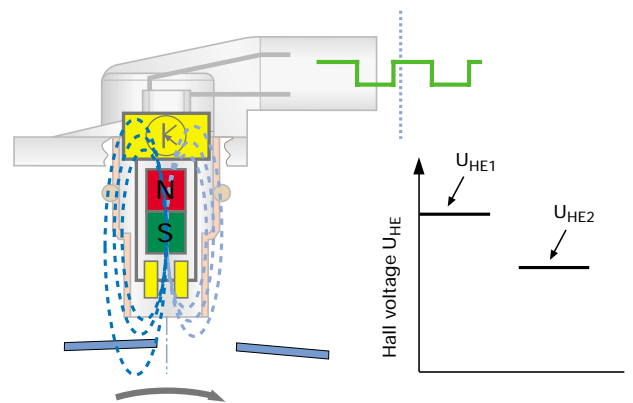
The resultant difference between and the magnitude of the Hall voltages are used for evaluation and generation of the output signal.



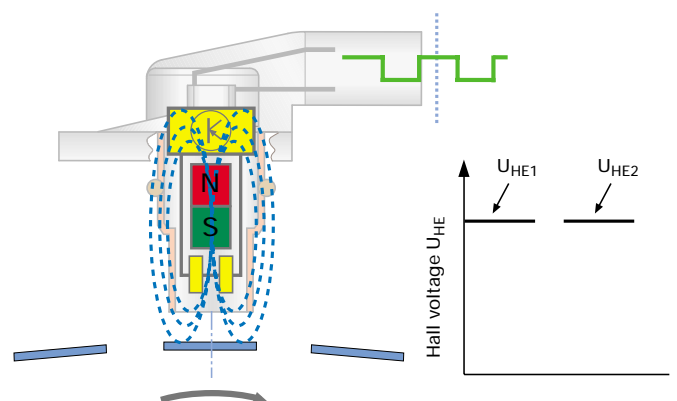
IC stands for "integrated circuit" and refers to an integrated semi-conductor circuit.



SSP268_194



SSP268_195



SSP268_196

Camshaft position senders

In addition to the main purpose of defining the camshaft position with respect to the position of the crankshaft, one camshaft position sender each is required for inlet and exhaust camshaft adjustment.

Sender signals are required for the following functions:

- -G28 and -G40

Synchronisation of bank 1 (with cylinder 1/ cylinder 6) for knock control and sequential injection

-G300 is responsible for synchronisation in the event of failure of -G40.

- -G28 and -G163

Synchronisation of bank 2 (with cylinder 12/cylinder 7) for knock control and sequential injection

-G301 is responsible for synchronisation in the event of failure of -G163.

Bank 2 synchronisation is offset by 60° with respect to bank 1. The pin encoding ensures that allowance is made for this in the software.

- -G28 and -G40/300

Control and monitoring of camshaft adjustment for cylinder bank 1

- -G28 and -G163/301

Control and monitoring of camshaft adjustment for cylinder bank 2

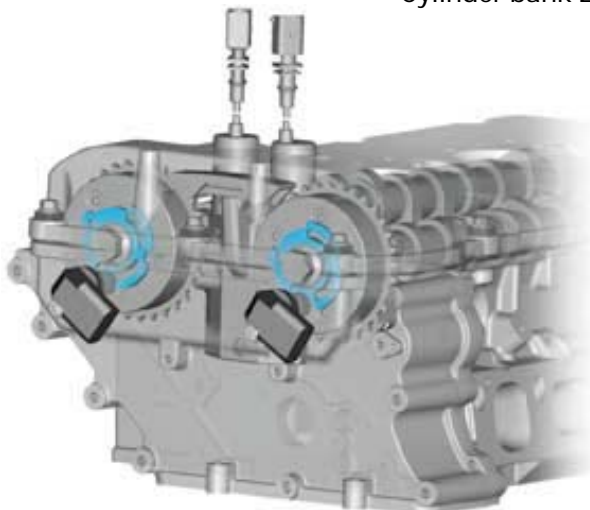
There is no camshaft timing control function if one of the camshaft position senders is defective.

In the event of failure of both the camshaft position senders of one bank, engine starting is enabled by the engine run-out detection function.

Adaption of sender signals -G40/-G300/-G163 and -G301 provides more accurate determination of the camshaft basic positions (for more information, refer to SSP 267 - Part 1, Section on "Camshaft timing control", Page 54).



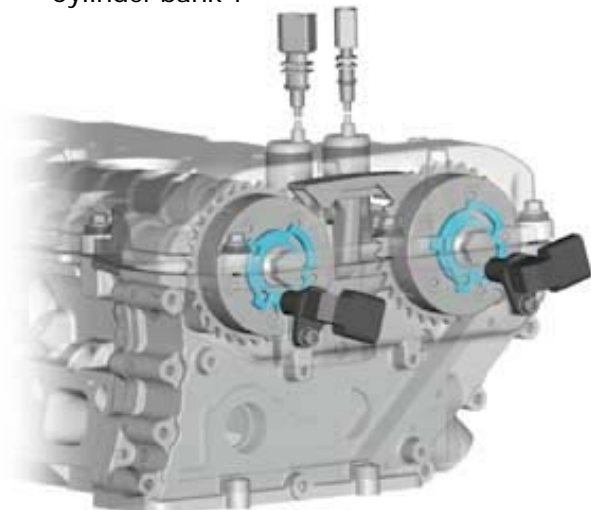
Cylinder bank 2



Hall sender 4
-G301

Hall sender 2
-G163

Cylinder bank 1



Hall sender
-G40

Hall sender 3
-G300

SSP268_147

Engine management

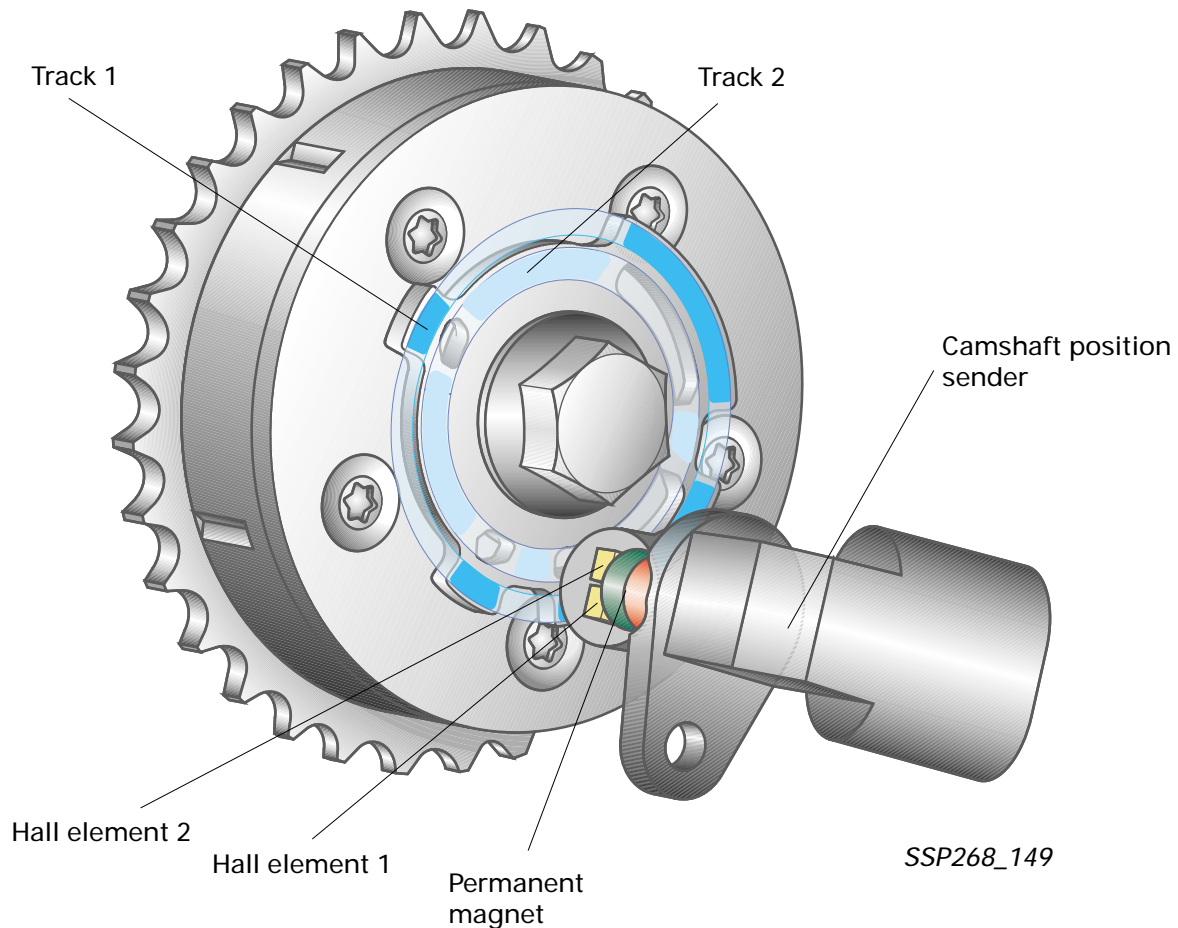
Sensor design

As already described for the engine speed sender -G28, the camshaft position sender is also a so-called "differential Hall sensor".

The camshaft position senders employ a two-track rapid start sender wheel made of ferrous metal.

The sender wheel has two broad and two narrow rotors/gaps.

This design, featuring different rotor widths, enables the signal profile of -G40/-G163 together with that of sender -G28 to be used for more rapid determination of camshaft adjustment with respect to the crankshaft.



A further feature of the sender wheel design is that two "tracks" are in adjacent, mutually inverted arrangement.

The "two-track system" ensures more precise generation of the sensor signal.

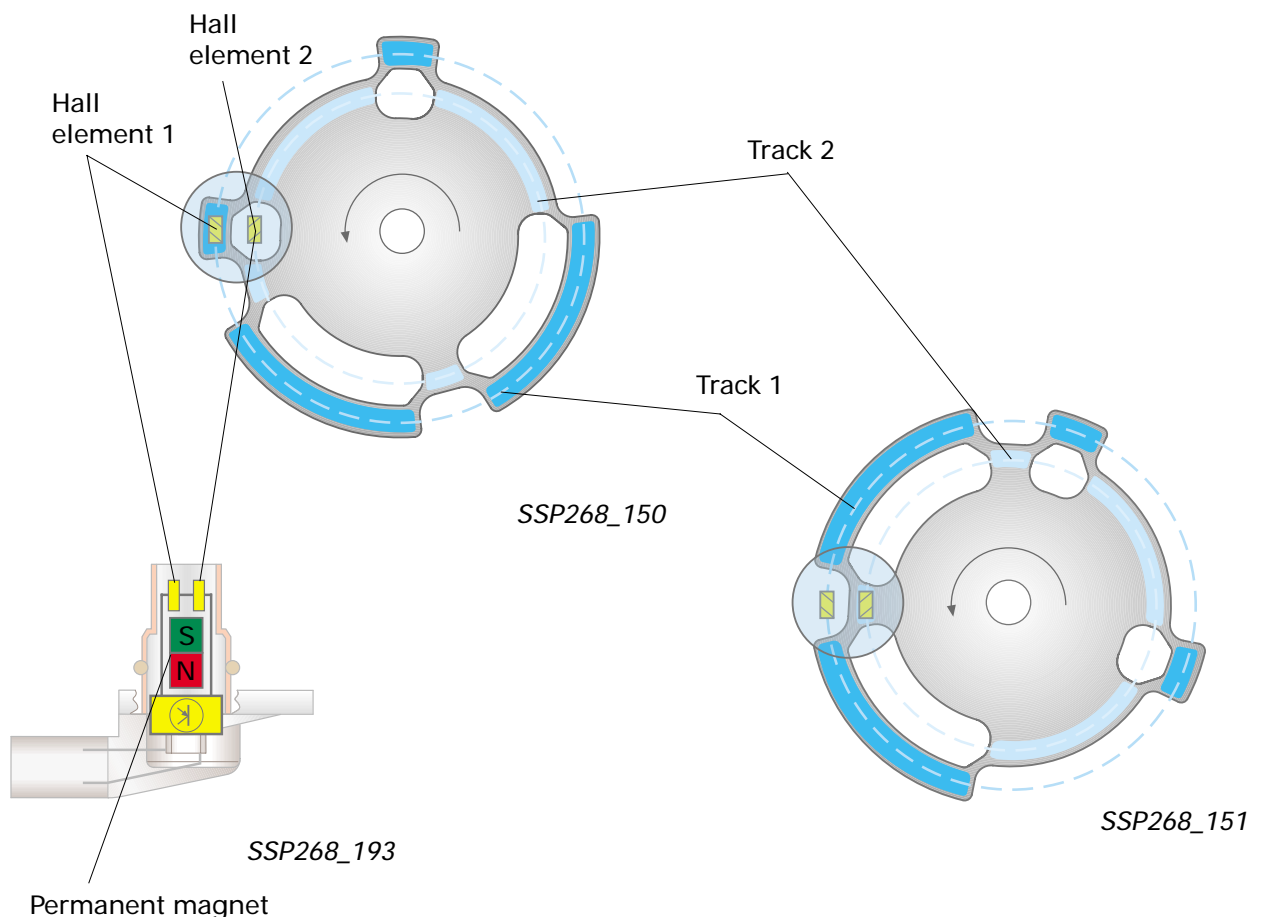
The signals are generated by two Hall elements HE1 and HE2 arranged next to one another with respect to the sender wheel. One track is assigned to each of the Hall elements.

Located above the two Hall elements and integrated into the sensor is a permanent magnet, the field of which acts on the Hall elements. The integrated evaluation electronics - also referred to as Hall IC - evaluate the Hall voltages of the two Hall elements and generate the sensor output signal.

Hall elements react to changes in the magnetic field. The sender wheel is of two-track design and influences the strength of the permanent magnet.

When the rotor (ferrous metal) of track 1 is located directly beneath HE1, there is a gap under HE2. The ferrous metal intensifies the magnetic field in the area of HE1 and the Hall voltage of HE1 increases with respect to HE2.

The difference between HE1 and HE2 and the magnitude of the two Hall voltages are used for evaluation and generation of the output signal.



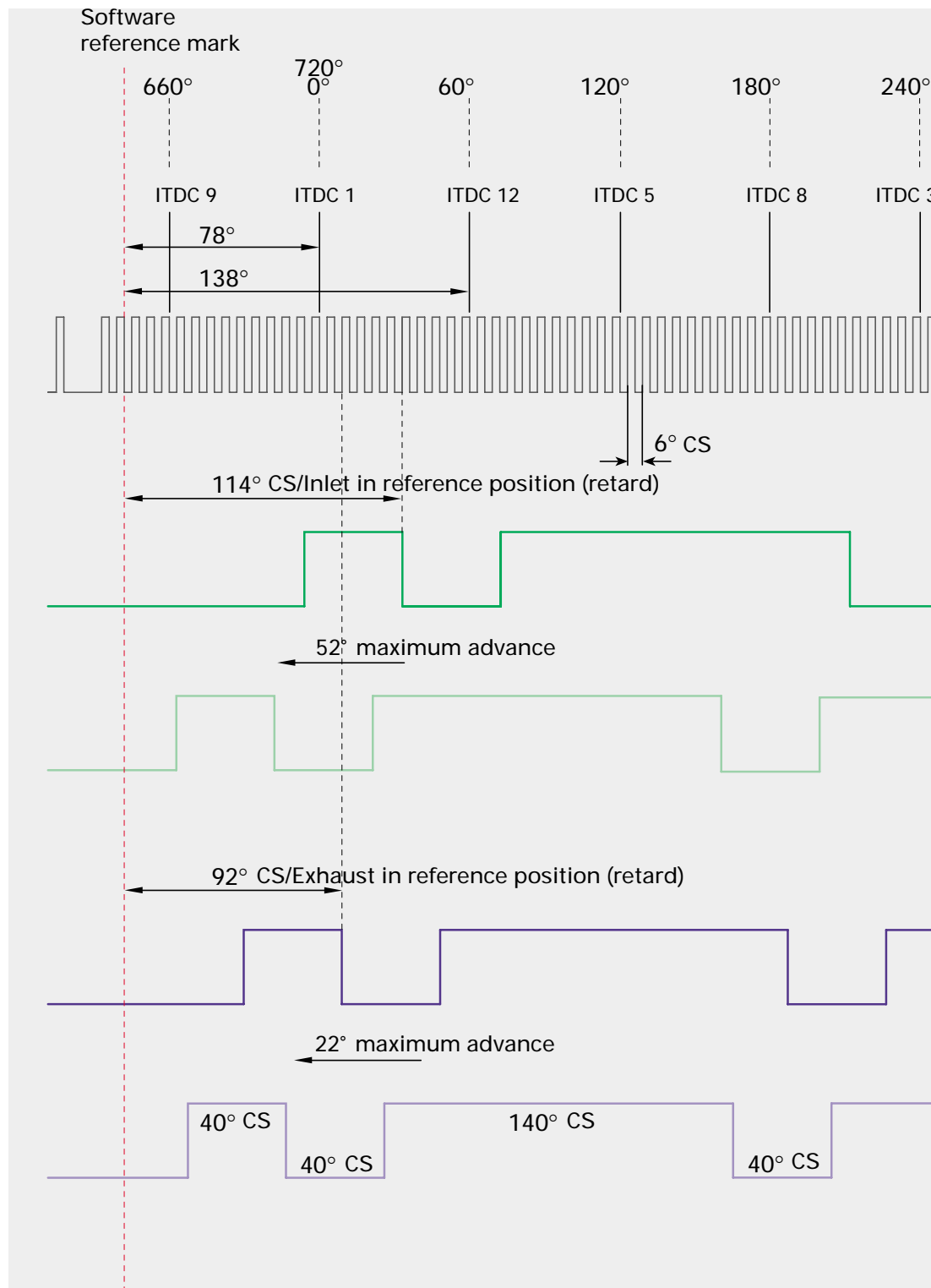
Engine management



Engine speed sender
-G28

Inlet camshaft
-G40/-G163

Exhaust camshaft
-G300/-G301

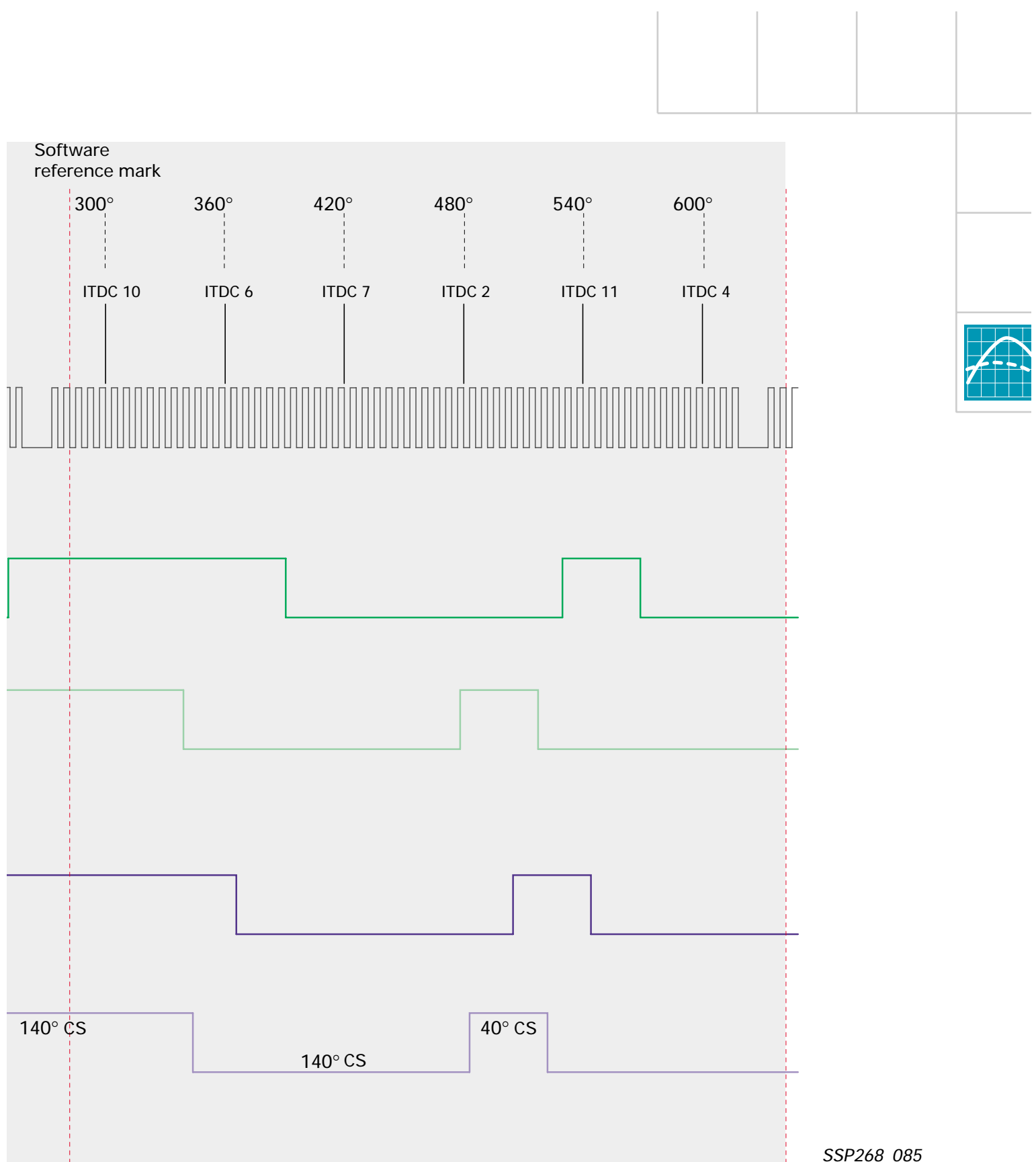


The signal profiles of the camshaft position senders are identical for both inlet and exhaust camshafts of cylinder banks 1 and 2 (same distance from software reference mark).

Basic synchronisation of the first ignition TDC (ITDC) of cylinder bank 1 (cylinder 1) takes place 78° after the software reference mark.

On account of the special features of the engine mechanical and management systems, basic synchronisation of the first ignition TDC (ITDC) of cylinder bank 2 (cylinder 12) takes place 138° after the software reference mark.

Allowance is made for this in the control unit and it is specified by the pin encoding.



SSP268_085



Use is made as engine speed sender of a Hall sensor. The software reference mark is the 2nd trailing edge after the gap (60-2 system).

The camshafts are in "retard" position if the camshaft adjustment valves are deenergised when the engine is running. If there is no or only insufficient oil pressure, the camshafts are also set to retard position on account of the chain pull.

Engine management

Oil temperature sender -G8

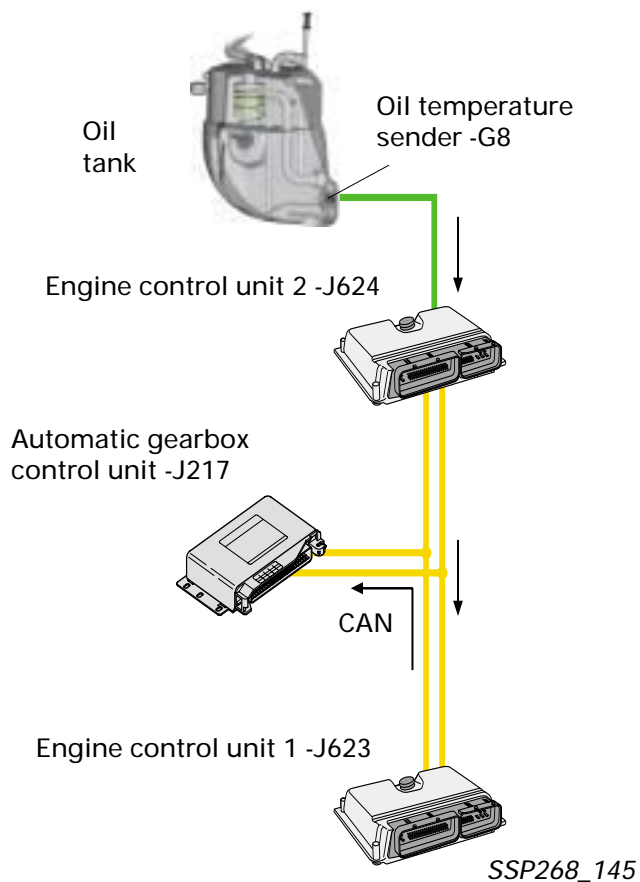
The signal of the oil temperature sender -G8 is evaluated by engine control unit 2 -J624 and transmitted by way of CAN data transfer to engine control unit 1 -J623.

It is used for calculating the specified coolant temperature and the continued coolant circulation time.

To prevent overheating of the engine, mandatory change-up from 4th to 5th gear is implemented on exceeding an engine oil temperature of approx. 135 °C.

The decrease in engine speed counteracts a further increase in engine oil temperature.

The mandatory change-up described above also takes place on exceeding a coolant temperature of approx. 120 °C.



Detection of combustion missing

Please refer to the notes given in the "Service" Section on Page 48.

	<h1>Notes</h1>	

Engine management

CAN data exchange

The twin control unit concept has resulted in the addition of new CAN messages, via which the two engine control units exchange data. Engine control unit 1 transmits information to engine control unit 2 by way of so-called "master-slave messages".

So-called "slave-master messages" provide engine control unit 1 with data from engine control unit 2.

Although these messages are transmitted by means of the general drive system CAN, they are only used for the exchange of data between the two engine control units.

Engine control unit 2 can only transmit by way of slave-master messages. Although engine control unit 2 can transmit data to engine control unit 1 and the dash panel insert (immobilizer), it is otherwise only designed to receive data.

Data transmitted by the engine control units

Data received and evaluated by the engine control units

¹ These data are additionally transmitted by way of master-slave messages

² These data are only transmitted by way of master-slave messages

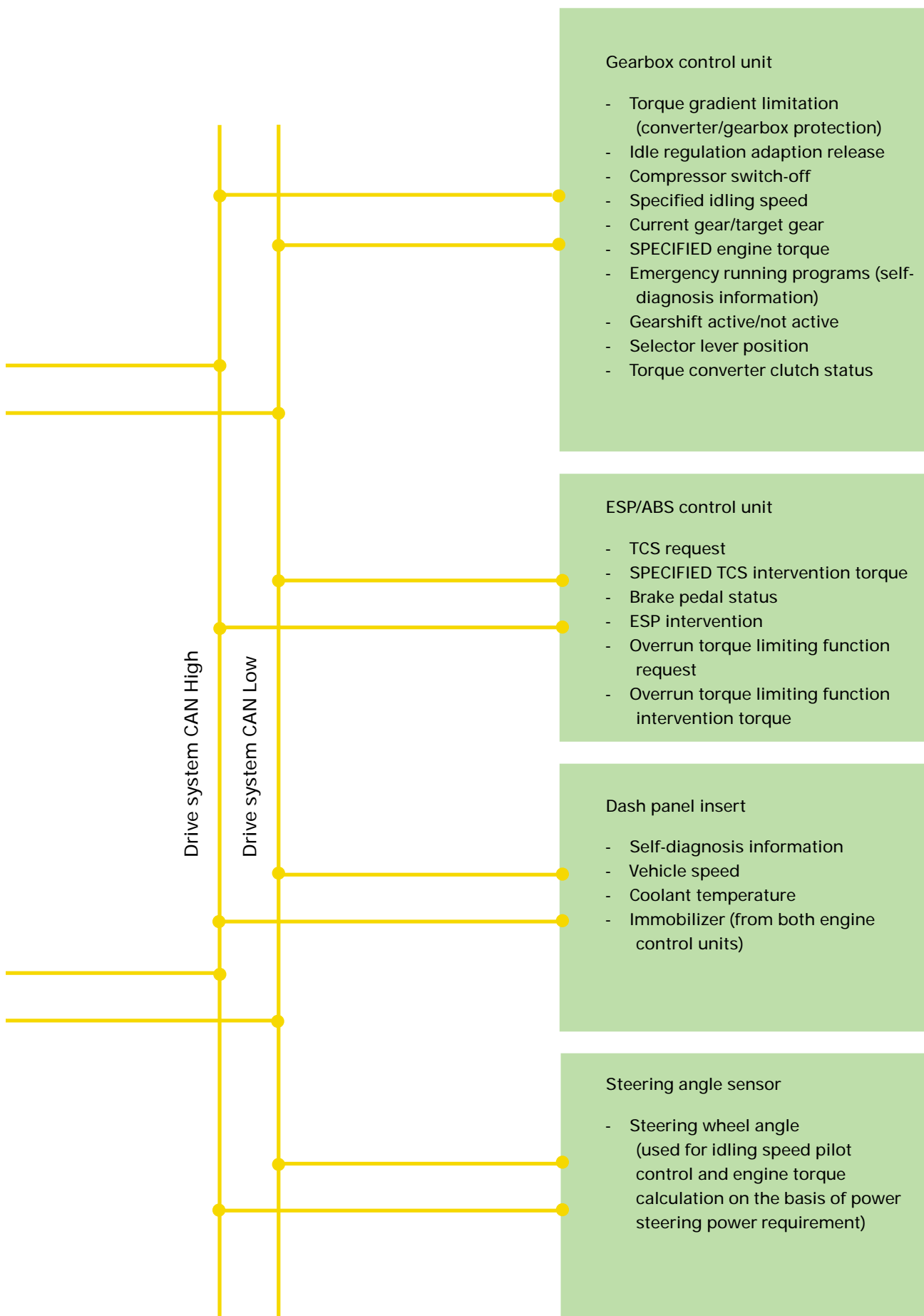
³ These data are only transmitted by way of slave-master messages

Engine control unit 1 (master control unit)

- Intake-air temperature
- Brake light switch¹
- Brake pedal switch
- Throttle valve angle
- Electronic throttle warning lamp/info
- Driver input torque
- Fault status¹
- Accelerator pedal position¹
- CCS switch positions
- CCS specified speed
- Altitude information
- Compressor switch-off
- Compressor ON/OFF (feedback from bidirectional interface)
- Fuel consumption
- Coolant temperature¹
- Idling speed recognition
- Engine shutoff position²
- Engine speed
- ACTUAL engine torques
- Emergency running programs (self-diagnosis information)
- -G8 oil temperature warning
- V_{\max} limit active²
- Immobilizer
- Crash signal²

Engine control unit 2 (slave control unit)

- EPC fault lamp request³
- OBD fault lamp request³
- Misfiring detection³
- Fault status³
- Oil temperature (from -G8)³
- Immobilizer³



Engine management

Additional signals/interfaces

In addition to CAN BUS data exchange, the following signals are relayed via separate interfaces.



Pin 42	Terminal 50	ECU* 1 only
Pin 67	Crash signal	ECU 1 and ECU 2
Pin 41	AC compressor signal ON/OFF	ECU 1 and ECU 2
Pin 40	AC requirement signal	ECU 1 and ECU 2
Pin 54	Air-conditioner high-pressure switch signal	ECU 1 only
Pin 37	Engine speed signal	ECU 1 only
Pin 49	Pin encoding of control units + to pin 49 = engine control unit 1 - to pin 49 = engine control unit 2	
Pin 43	K-wire/diagnosis	ECU 1 and ECU 2
Pin XX	Interfaces - cruise control system, refer to Page 47	ECU 1 only

* ECU = Engine control unit

Terminal 50 signal

The engine run-out detection function (refer to SSP 217, Page 41) can recognise "reversing" in the course of the engine shutoff process. As reversing of the engine can be ruled out on starting, the terminal 50 information (starter operated) is used for checking the plausibility of and evaluating the reversing detection function.

Air-conditioner compressor ON/OFF signal

For a detailed description, refer to SSP 198, Page 59.

The compressor ON signal is also used as a source of information for calculating the speed of the hydraulic fan.

Air-conditioner high-pressure switch signal

The signal from the air-conditioner pressure switch -F129 (high pressure) provides information for actuating the hydraulic fan (refer to Page 8 onwards). When the high-pressure switch is closed (approx. 16 bar), both maximum electric fan speed and maximum hydraulic fan actuation are set.

Crash signal

For a detailed description, refer to SSP 217, Page 47.

Although ECU 1 switches the fuel pump, the crash signal is also transmitted to ECU 2.

In addition to powering the fuel pump, the fuel pump relay is also responsible for supplying voltage to other actuators of both ECUs (refer to block diagram).

The crash signal in ECU 2 suppresses unwanted entries in the fault memory such as would be caused by deactivation of the fuel pump.

As of software version 0004, the crash signal is transmitted by means of a master-slave message. The pin 67 interface is no longer evaluated. To avoid unnecessary expense, no modifications have been made to the wiring harness (wiring to pin 67 interface still exists).

Air-conditioner requirement signal

For a detailed description, refer to SSP 217, Page 48.

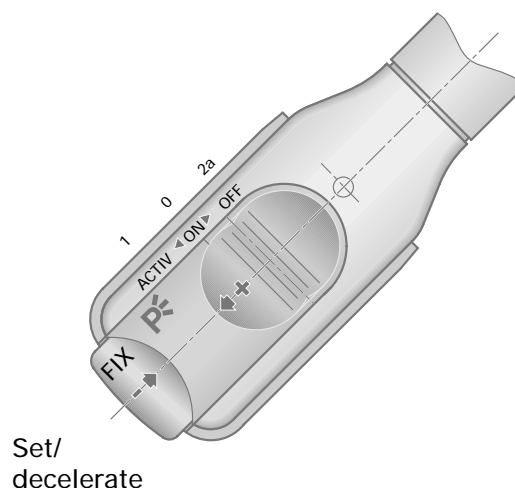
Engine speed signal

For a detailed description, refer to SSP 198, Page 60.

Numerous control units require engine speed information for calculation purposes. In the majority of cases, the engine speed transmitted by way of the CAN message suffices.

The engine speed is one of the most important information parameters for gearbox control, with a high standard of resolution and transmission speed being required.

The output signal (square-wave signal) generated by engine control unit 1 satisfies these requirements.



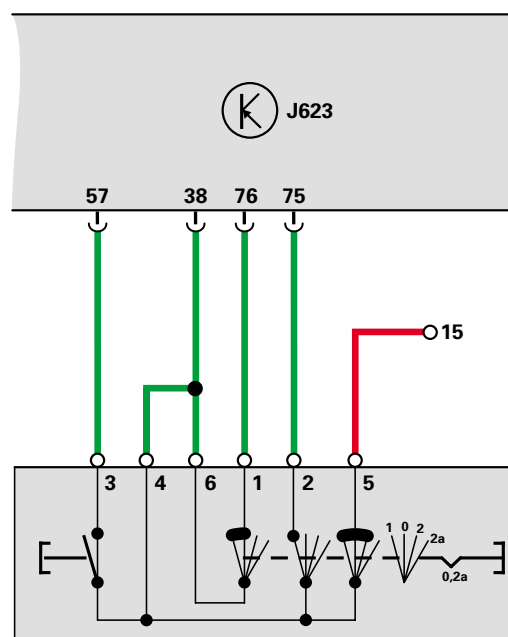
SSP268_189

Cruise control system (CCS) interfaces

For a detailed description, refer to SSP 198, Page 61.

- Pin 38 ON/OFF with erasing of memory (master switch)
- Pin 57 Set/decelerate
- Pin 75 Reactivate/accelerate
- Pin 76 OFF without erasing of memory

Switch position	Function
0	ON
1	Reactivation Accelerate/set
2	OFF - without erasing of memory
2a	OFF - with erasing of memory



SSP268_191

Notes on maintenance

A few special points have to be noted as regards handling of diagnostic testers and the self-diagnosis function on account of the twin control unit concept.

As regards self-diagnosis, the two control units are basically to be viewed as separate entities (does not apply to combustion missing detection).



The self-diagnosis functions are implemented in the control unit to which the components are connected (with the exception of combustion missing detection).

The readiness code must be set, read out and reset separately for each control unit (e.g. by starting "short trip" test sequence with diagnostic tester).

Erasing the fault memory sets the readiness code automatically in the appropriate control unit.

The combustion missing detection function is only activated in engine control unit 2 -J624, which is thus responsible for both cylinder banks.

Combustion missing affecting cylinder bank 1 can only be read out in engine control unit 2.

Separate address words are required for entry into self-diagnosis function:

- | | |
|-----------------|---|
| Address word 01 | Engine control unit 1 -J623
Cylinder bank 1
(exhaust banks 1 and 2) |
| Address word 11 | Engine control unit 2 -J624
Cylinder bank 2
(exhaust banks 3 and 4) |



Further information on the twin control unit concept can be found on Page 26 onwards.

If a fault has been stored in engine control unit 2, the fault "Please read out fault memory of engine control unit 2" will be stored in engine control unit 1. This fault message can only be erased when there is no fault entry stored in engine control unit 2.



For more details of Euro On-Board Diagnosis (EOBD) and readiness code, refer to SSP 231.

Both control units must ...

- ... have the same software version
- ... be matched to the cruise control system (CCS)
- ... be matched to the immobilizer
- ... be viewed as separate entities for self-diagnosis
- ... have the same encoding



For defined fault-finding, the Lambda control can be deactivated under "Basic setting" on selecting display group 99/ reactivated under "Reading measured value block".

Engine oil change

In view of the dry sump lubrication, it is always necessary to open both oil drain plugs (sump and oil tank) to drain off the engine oil.

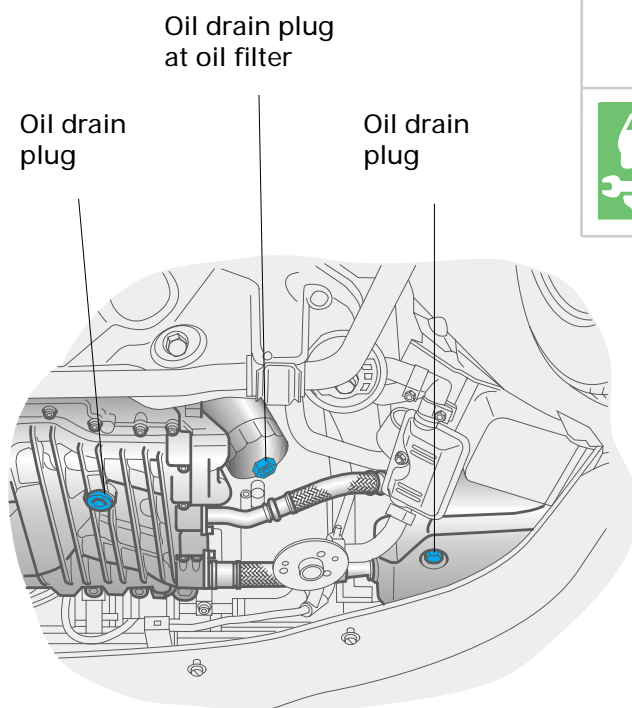
The use of an oil extractor is not possible with the W12 engine.

The W12 engine is only to be filled with LongLife engine oil as per VW Standard 50301.

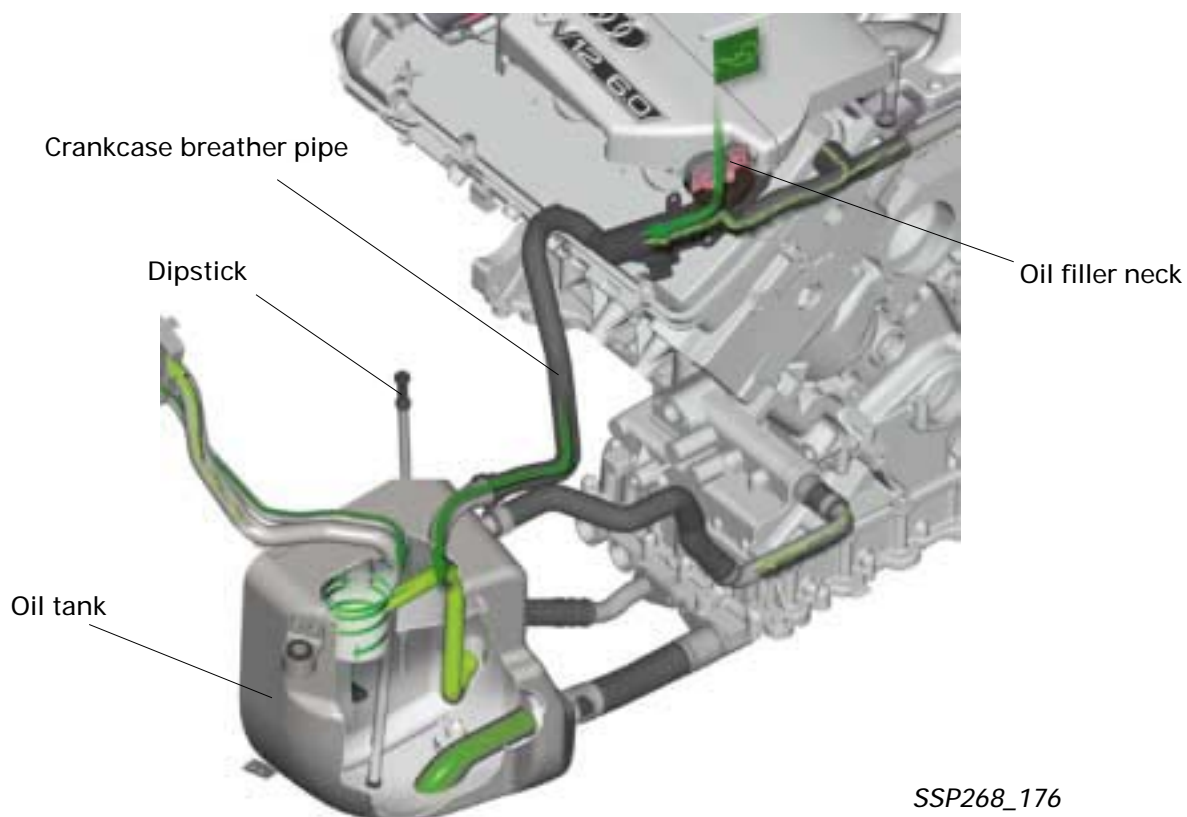
The oil filler neck leads into the crankcase breather pipe from the cylinder heads to the oil tank.

The procedure for checking the oil level is described in SSP 267 - Part 1, Page 30 onwards.

Please also heed the relevant additional information given in the Maintenance manual.



SSP268_165



SSP268_176

Workshop equipment/ special tools

Listed in the following are the new items of workshop equipment and special tools designed for the W12 engine.

VAS 6100 Workshop crane

With a loadbearing capacity of 1200 kg, the workshop crane VAS 6100 is designed to handle the new large-volume engines (e.g. V8 TDI, W12) as well as future developments.

Extension VAS 6101 (load bearing capacity 300 kg) is available as an option.

VAS 6095 Engine and gearbox assembly mount

In addition to the generously designed loadbearing capacity of 600 kg, VAS 6095 offers two major new features.

Unit mounting with the aid of universally adjustable clamps in combination with the locating pins provides ease of access to the back of the engine (e.g. when working on timing mechanism).

Work is facilitated by being able to hydraulically adjust the height of the unit by approx. 200 mm.

The tilt mechanism enables the unit to be easily moved into any angular position required. The mechanism is self-locking so that there is no need for separate fixing.

The integrated storage facilities and sliding drip tray for collecting fluids round off the practical design of this item.

VAS 6095 is compatible with existing engine and gearbox supports.



SSP268_186



SSP268_184



Locating pin

SSP268_182

Unit assembly trolley

Still at the development stage is a unit assembly trolley for simple and reliable performance of all engine and gearbox pre-assembly work.

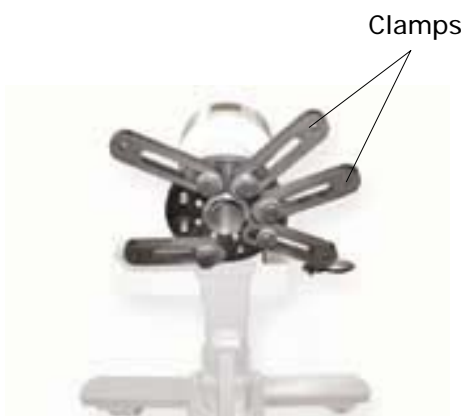
The work table is in two sections to facilitate separation and joining of engine and gearbox.

The unit assembly trolley will be universally applicable and is expected to be available in the 1st quarter of 2002.



SSP268_185

V.A.G 1342/15 Oil pressure test adapter with
V.A.G 1342/16 Oil pressure test pipe section



SSP268_187



SSP268_181

