4.4
Secondary air system

For a certain cold start a mixture with excess fuel (rich mixture) is needed. Because the mixture is too rich in the cold start phase, there will be a greater amount of unburned hydrocarbons (HC) and carbon monoxide (CO) in the exhaust gas. Blowing oxygen-rich ambient air (secondary air) into the exhaust manifold will produce a post-oxidation (catalytic post-combustion) of pollutants. Although the secondary air system is switched on for only a maximum of 90 seconds after a cold start, this will reduce the HC and CO emissions considerably during the cold start phase. At the same time the warm-up time of the catalytic converter is shortened considerably by the heat that is released during the post-oxidation.

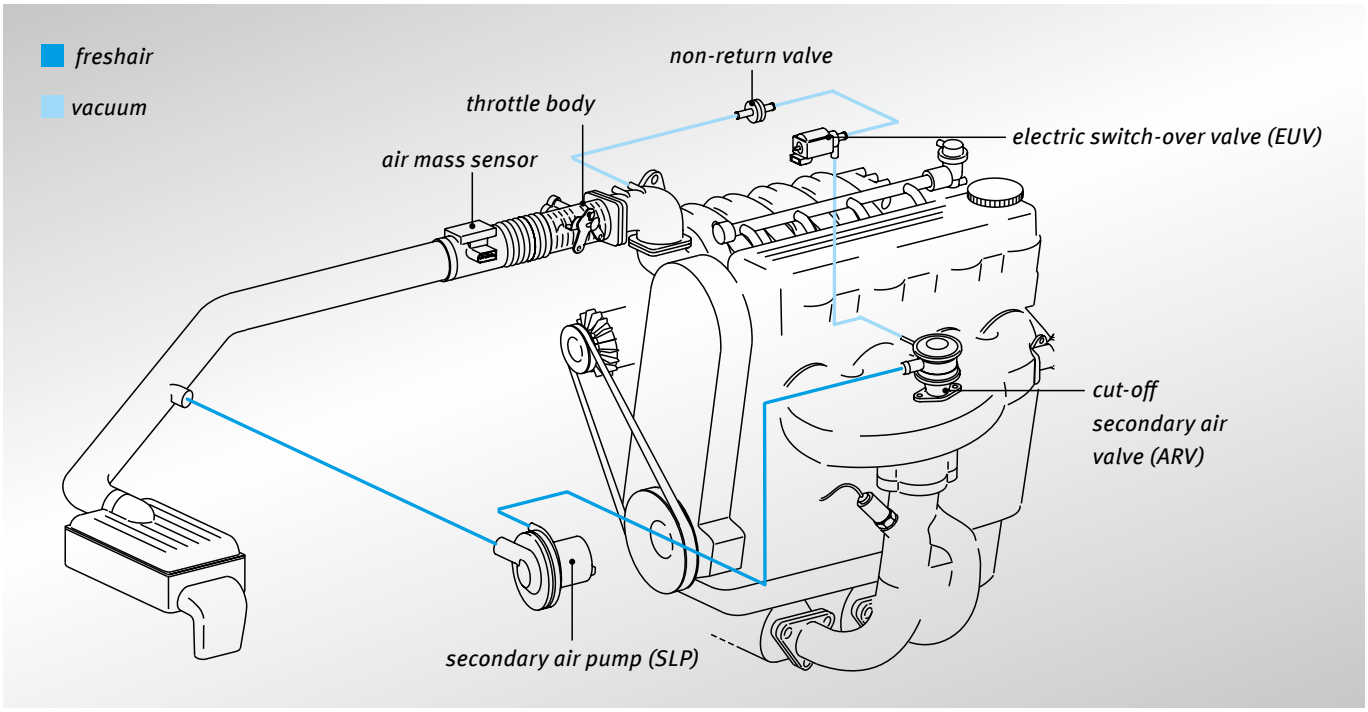

Fig. 20: secondary air system, schematic (newer version)

The additional air is provided by an electric secondary air pump (SLP) that blows the air into the exhaust manifold.
For this purpose appropriate tubing is required between the clean air side (downstream from the air filter) and the exhaust gas manifold.
The cut-off secondary air valve (ARV) is a pneumatically operated valve. An integrated non-return valve prevents exhaust gas or pressure peaks from reaching and damaging the secondary air system and the secondary air pump.
The ARV is controlled by an electric switch-over valve (EUV) based on the time after a cold start.

Important note:
Newer versions of cut-off secondary air valves are opened by the pressure of the secondary air. In this case the EUV is no longer applicable.

Cut-off secondary air valves are opened only while secondary air is being blown in immediately after cold start.

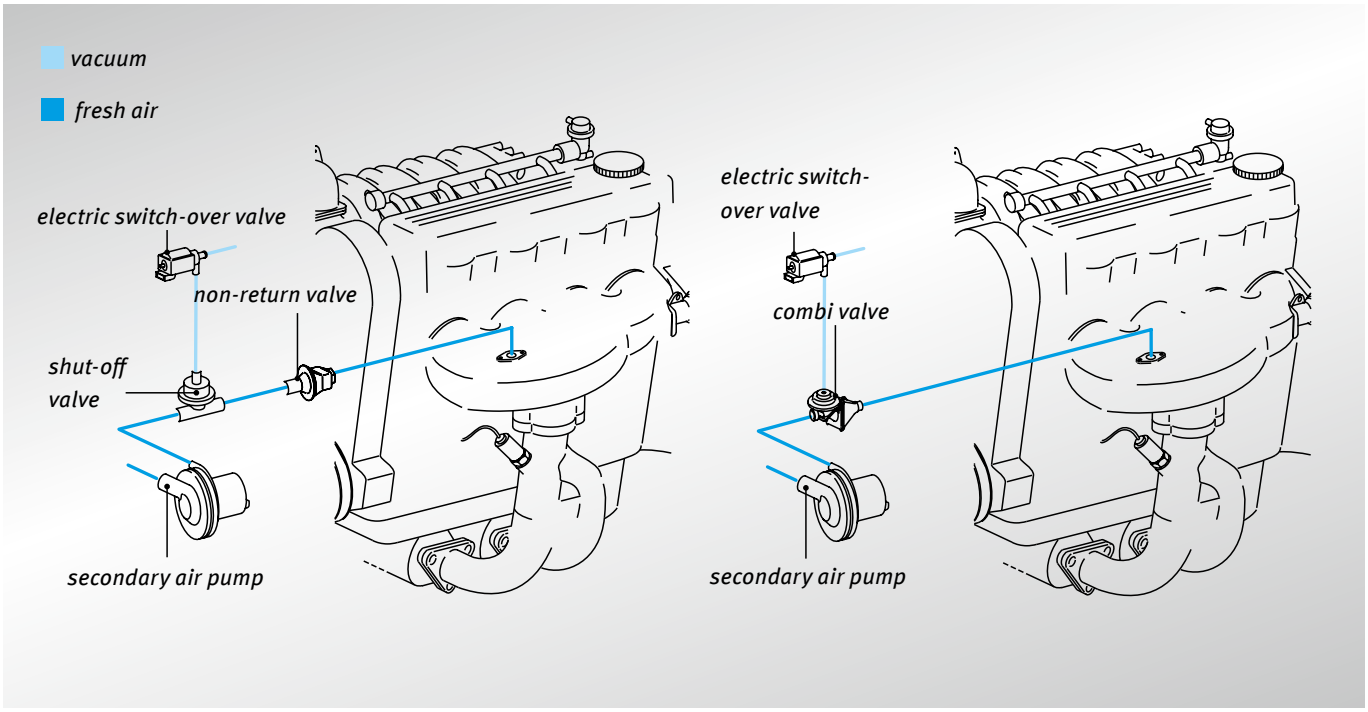

Fig. 22: secondary air system, schematic (older variants)

Fig. 23: combi valve

Fig. 24: shut-off valve, older version

Fig. 22 shows two older variants frequently used with

- separate shut-off and non-return valves
- adjacent shut-off and non-return valves together as a combi valve

Combi valves consist of a shut-off valve with a built-in non-return valve.

Shut-off valves are vacuum operated diaphragm valves. They are installed between the SLP and the non-return valve to the exhaust gas manifold. They seal off the secondary air system to the exhaust gas manifold. They are opened for secondary air mode only immediately after cold start. They are actuated by the electric switch valve.

4.4.1 Monitoring

The functioning and electric equipment of the secondary air system are monitored in OBD.

- The functioning is monitored with the help of the lambda probe by monitoring the flow rate of the secondary air at certain operating points. When certain limits are exceeded, an error will be detected.
- The electrical equipment is monitored for short circuit to earth, short circuit in the supply voltage and interruption.

In EOBD the secondary air system is chekked only with respect to the electric connections of the secondary air pump, but not with respect to its functioning.

Two different processes are used to check the functioning.

Immediately after a cold start
The secondary air pump will be switched on for approximately 90 seconds.
The secondary air blown in will not be regulated.
If the lambda probe is ready for operation, and if useful probe signals are emitted, they will be compared with the set-point values.

At operating temperature
This monitoring occurs during an idling phase when the engine is at an operating temperature.
To run the test, the SLP is switched on. This causes the lamba probe to register a lean mixture. The probe signal is compared with the set-point values in the control unit.

Possible fault codes (with diagnostic instructions)

Errors in the secondary air system are indicated by fault codes P0410 – P0419.

Fault code	Possible causes/errors	Possible solutions/actions
P0410 Secondary air system-malfunction		
no detection of secondary air by lambda probe (no lean signal)	The secondary air pump is not working.	• If fault codes P0418/0419 are recorded, energise the secondary air pump externally to run the test. If the SLP is now working, check all relays, lines and plug-in connections. If the SLP is not working, it will have to be replaced. • If there is a secondary air pump failure due to condensates (detectable by soiling in the pump output), check the cut-off secondary air valve on the secondary air side for leaks and the electric switch-over valve for functioning. • If there is soiling on the secondary air side input of the cut-off secondary air valve, the valve must be replaced. • Check whether the secondary air pump has malfunctioned due to water (detectable by water residue in the pump). Check the suction pipe for leaks.

Fault code	Possible causes/errors	Possible solutions/actions
Secondary air system – insufficient quantity		
set-points not reached	The secondary air rate detected is too low (insufficient lean signal). The secondary air pump is running, but the air does not reach the exhaust gas manifold.	• Check cut-off secondary air valve for functioning with vacuum hand pump. If the ARV does not open when there is a vacuum, replace it. • If the ARV does open when there is a vacuum, check the electric switch-over valve and the vacuum line. • Check the power supply to the EUV. If the EUV does not switch when current is being supplied, replace it. • Check the EUV for free flow and replace if necessary. Check the non-return valve and the secondary air lines for free flow. To do this, disconnect the line from the exhaust manifold, let the secondary air pump run, and check the air output ortake out the non-return valve and check the free flow by blowing the air through; here no essential air resistance should be detectable.
P0412 Secondary Air Injection System Switching Valve "A" Circuit (EUV-SL)		
P0415 Secondary Air Injection System Switching Valve "B" Circuit (EUV-SL)		
activation not OK	The electric switch-over valve (EUV) does not activate. • power is not being supplied to the EUV • electrical error	• lines, plug-in connections and EUV check
P0413 Secondary Air Injection System Switching Valve "A" Circuit (EUV-SL) Open		
P0416 Secondary Air Injection System Switching Valve "B' Circuit (EUV-SL) Open		
the electric switch-over valve (EUV) do not activate	• power is not being supplied to the EUV • activation not OK • electrical error	• lines, plug-in connections and EUV check
P0414 Secondary Air Injection System Switching Valve "A" Circuit (EUV-SL) Shorted		
P0417 Secondary Air Injection System Switching Valve "B" Circuit (EUV-SL) Shorted		
the electric switch-over valve (EUV) does not activate	The electric switch-over valve (EUV) does not activate. • power is not being supplied to the EUV • activation not OK • electrical error • ahort circuit	• lines, plug-in connections and EUV check
P0418 Secondary Air Injection System Relay "A" Circuit Malfunction		
P0419 Secondary Air Injection System Relay "B" Circuit Malfunction		
secondary air pump is not working	Secondary air pump relay A or B does not activate. • activation not OK • electrical error • short circuit	• check relays, lines, plug-in connections and secondary air pump

Further fault codes that are of significance in connection with the secondary air system

P0100	mass or volume air flow circuit	malfunction
P0101	mass or volume air flow circuit	range/performance problem
P0102	mass or volume air flow circuit	low input
P0103	mass or volume air flow circuit	high input
P0104	mass or volume air flow circuit	intermittent
P0105	manifold absolute pressure/ barometric pressure circuit	malfunction
P0106	manifold absolute pressure/ barometric pressure circuit	range/performance problem
P0107	manifold absolute pressure/ barometric pressure circuit	low input
P0108	manifold absolute pressure/ barometric pressure circuit	high input
P0109	manifold absolute pressure/ barometric pressure circuit	intermittent
P0110	intake air temperature circuit	malfunction
P0111	intake air temperature circuit	range/performance problem
P0112	intake air temperature circuit	low input
P0113	intake air temperature circuit	high input
P0114	intake air temperature circuit	intermittent

Non-return valves are installed between the shut-off valve and the exhaust gas manifold to prevent pressure peaks from causing damage to the secondary air system. They are opened by the pressure of the secondary air flow.

Secondary air pumps are high-speed one or two-stage fans.
If the air is not extracted from the inlet port but directly from the engine compartment, an air filter is integrated.

Electric switch-over valves (EUV) are 2/3 way valves. They are used for vacuum control valves, EGR valves, secondary air valves and for many other purposes.
You will find further information on EUVs in the Service Information SI 0050, SI 0051 and SI 052.

Fig. 25: non-return valve (older version)

Fig. 26: secondary air pump

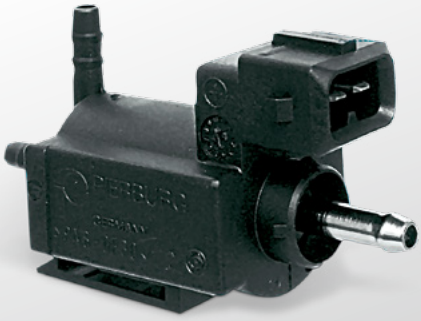

Fig. 27: electric switch-over valve (EUV)

Diagnostic instructions

A malfunction of a component in the secondary air system will often cause damage to several components.
A frequently occurring error is a malfunctioning secondary air pump. Almost always damage is caused by exhaust gas condensates in the pump.
During the repair the actual cause of the damage is often not detected and the secondary air pump is just replaced. The cause of the damage remains in the vehicle and can cause the secondary air pump to malfunction again.
For this reason, when there is damage, all associated components must be checked. For example, stuck non-return valves are classified by OBD as malfunctions of the secondary air pump even if they are working properly.
Moreover, damage to the secondary air system can cause errors that are attributed to other components by the error detection.

Fig. 28: condensate in the secondary air pump

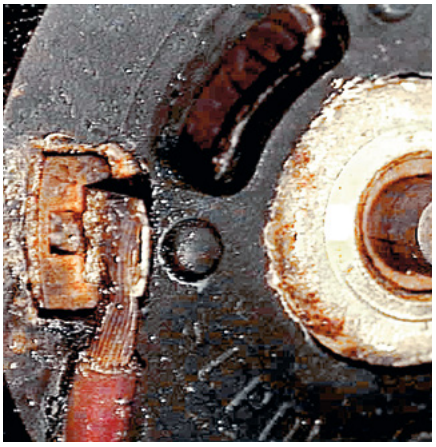

Fig. 29: secondary air pump – corroded electric connections

Fig. 30: cut-off secondary air valve – damage to the diaphragm and valve plate due to condensates

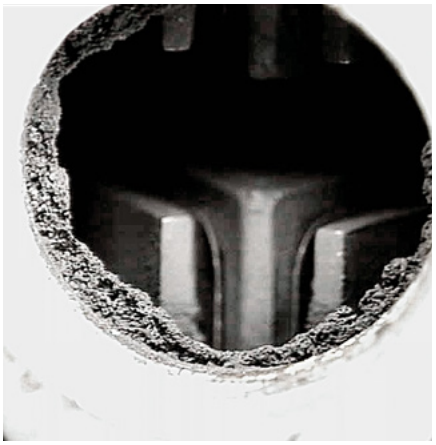

Fig. 31: deposits in the non-return valve

Malfunction	Possible causes/errors	Possible solutions/actions
loud whistle (“howling”) after cold start. SLP generates noises. SLP fails repeatedly.	• Bearing corroded with condensates. • Lines and insulation destroyed by condensates. • EUV incorrectly connected (to wrong cables).	If the SLP causes noises, replace it and determine the cause of the damage as described under fault codes P0410 and P0411. Check the ARV and the EUV. If there are several EUVs in the vehicle, ensure that the connections are not mixed up.
exhaust pipe noises or smell of exhaust gas in the engine compartment.	Leaks in the exhaust gas tract or in the secondary air system, between the exhaust gas manifold and the cut-off secondary air valve or non-return valve.	Let the secondary air pump run still installed (externally powered). Determine the leaky places (e.g. using leak detection spray). Replace faulty line or gasket. Attention: When the line between the SLP and the exhaust manifold is scorched, proceed as for fault codes P0410 and P0411.