4.6
Air supply

Fresh air is required for mixture formation and combustion. It is fed into the engine through the inlet port.
The components involved are the air mass sensor, throttle body, intake manifold and inlet port shut-off (“tumbles flaps”).

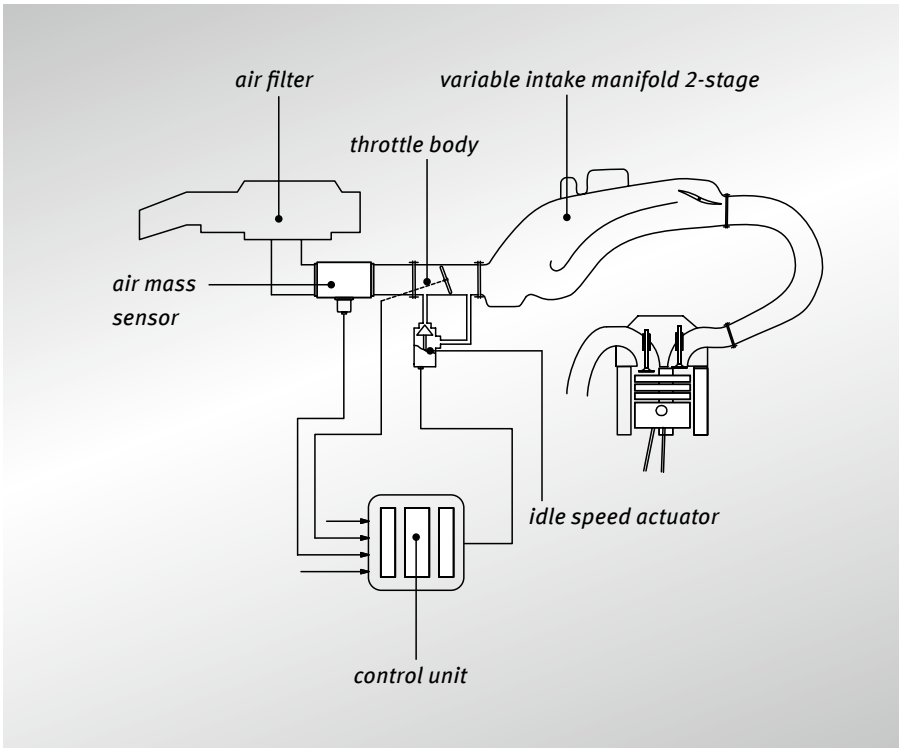

Fig. 39: air supply (schematic)

Air mass sensors (LMS)
Air mass sensors (LMS) continuously measure the air mass supplied to the engine. The LMS signal is used to calculate the injection quantity, and for diesel engines, to control the exhaust gas recirculation as well.

Further details can be found in our Service Informations.

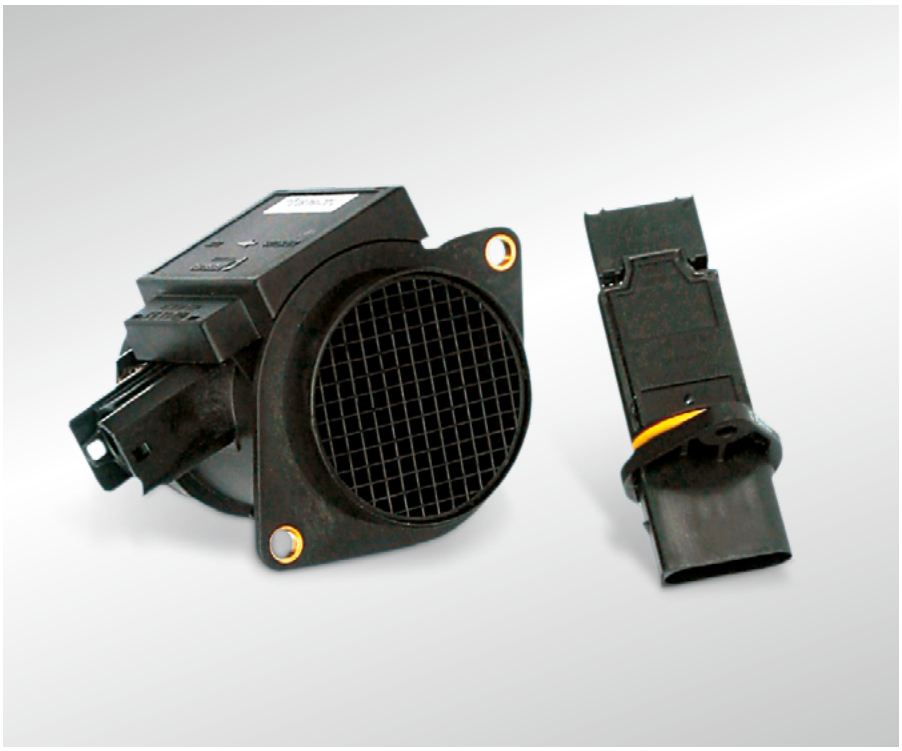

Fig. 40: different air mass sensors

Throttle bodies

The air flow drawn in by the engine is controlled by throttle valves. The cylinder is filled based on the throttling of the intake air. In the past throttle bodies were used mainly for petrol engines. Now they are being used more and more in diesel engines as well in connection with emissions control.

In the newer diesel engines the pressure difference between the exhaust gas side and the intake side alone is not sufficient to obtain greater exhaust gas recirculation rates (up to 60%). For this reason "regulating throttles"[5] are used in the intake manifold to increase the vacuum in order to enhance the exact regulation of the exhaust gas recirculation rates. This regulating throttle is mostly integrated in the EGR emulsion housing.

Whereas until about 1995 the idle speed was controlled by separate actuators (in the intake manifold, for example), more recent mechanical throttle bodies have an integrated idle speed actuator (LLFR) as an attachment[6].

Depending on the operating state, the LLFR regulates the air quantity that is necessary for warm-up and to maintain the idle speed through an air duct as a bypass to the throttle valve. The actuation is handled directly by the control unit.

In more recent applications idle control and start-up enrichment are achieved by adjusting the throttle valve. Here the throttle valve is adjusted by an electric motor. This process is faster, it allows small air flows for idling and an adjustment of the throttle valve without a mechanical link to the accelerator pedal (e-gas, electronic accelerator pedal; "drive by wire").

In order for the fuel/air mixture to burn as quickly as possible, the air is given a swirl by two separate inlet ports for each piston. Each of these inlet ports is also equipped with an adjustable "tumble flap" that is operated by the EAM-i (electric drive module with integrated "intelligence") by means of a leverage system.

Fig. 41: intake manifold with tumble flaps and EAM-i

Fig. 42: different throttle bodies

Fig. 43: inlet manifolds, different versions

[5] In practice, different names are used for throttle valves in diesel engines, such as regulating throttles, diesel valves, diesel front valves.

[6] Please refer also to Service Information SI 0060 and SI 0061. In practice, different names are used such as idle controller, idle setting valve, valve for idle stabilisation, idling actuator etc.

Variable intake manifolds
In petrol engines, intake manifolds are generally used complete with throttle bodies.
Instead of intake manifolds with a fixed length, “variable intake manifolds” are also being used in petrol engines more and more.
With variable intake manifolds the actual length of the air intake channels can be changed. This produces clear improvements in the torque and in fuel consumption.
To change (“to vary”) the length, pneumatic actuators (vacuum units) or electromotive actuators (“electric drive modules – EAMs”) are used.
The pneumatic actuators are operated by pneumatic valves (e.g. EUV). The electric drive modules (EAMs) are actuated by the engine control unit directly.
Furthermore, direct injection engines are often equipped with additional valves between the actual intake manifold and the inlet ports in the cylinder head (“intake manifold and inlet port shut-off”, “tumble flaps”). The valves can be adjusted to change the air supply (flow speed, direction).

Electropneumatic pressure transducer (EPW) for actuating a turbocharger (VTG)
The engine torque that can be achieved in a vehicle is based on the fresh gas content of the cylinder filling. Exhaust gas turbochargers use the energy of the exhaust gas in a turbine to raise the cylinder filling via a connected compressor. VTG turbochargers vary the required boost pressure by adjusting the blades in the turbine. This adjustment has to be very precise. The EPW is actuated by the engine control unit via the corresponding map. Depending on the duty cycle of the signal the control pressure by which the turbine blades are adjusted via a vacuum unit is set.

4.6.1 Monitoring

The electric components are monitored for continuity, short circuit and short circuit to earth. The position of actuators (final position open/closed) is registered. The position is registered by potentiometers or non-contact measured-value readings. In part the adjustment time is also monitored (e.g. tumble flaps).

Possible fault codes

Errors in air supply components are indicated by the following fault codes..

Air mass sensor

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
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

Intake manifold

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

Throttle bodies

P0120	throttle/pedal position sensor/switch a circuit	malfunction
P0121	throttle/pedal position sensor/switch a circuit	range/performance problem
P0122	throttle/pedal position sensor/switch a circuit	low input
P0123	throttle/pedal position sensor/switch a circuit	high input
P0124	throttle/pedal position sensor/switch a circuit	intermittent
P0220	throttle/pedal position sensor/switch b circuit	malfunction
⋮		
P0229	throttle/pedal position sensor/switch c circuit	intermittent
P0510	closed throttle position switch	closed
P0638	throttle actuator control range/performance (bank 1)	performance problem
P0639	throttle actuator control range/performance (bank 2)	performance problem

Idle speed actuator:

P0505	idle control system	malfunction
P0506	idle control system	RPM lower than expected
P0507	idle control system	RPM higher than expected
P0508	idle control system	circuit low
P0509	idle control system	circuit high

Electropneumatic transducer:

P0033	turbo charger bypass valve control circuit	malfunction in electrical circuit
P0034	turbo charger bypass valve control circuit	signal too low
P0035	turbo charger bypass valve control circuit	signal too high
P0234	turbo/super charger overboost condition	limit value exceeded
P0235	turbo/super charger boost sensor a circuit	limit value not reached
P0243	turbo/super charger wastegate solenoid A	malfunction in electrical circuit
P0244	turbo/super charger wastegate solenoid A	range/performance
P0245	turbo/super charger wastegate solenoid A	signal too low
P0246	turbo/super charger wastegate solenoid A	signal too high
P0247	turbo/super charger wastegate solenoid B	malfunction in electrical circuit
⋮		
P0250	turbo/super charger wastegate solenoid B	signal too high

4.6.3 Diagnostic instructions

If malfunctions are produced, they are almost always caused by deposits and, sticking.
Wear can usually be detected only when large distances are driven.

Air mass sensors (LMS)
he most frequent causes of malfunctions in air mass sensors is soiling. This applies especially to the newer LMSs with back-flow detection. This way oily intake air can leave a film on the sensor. The result will be faulty signals. The result can be “pinging” and lack of power.

- When there are leaks in the inlet port, dirt particles can enter with the intake air, hitting the air mass sensor at a high speed and destroying it.
- Also errors made during servicing such as uncleanness when the filter is being changed, or the use of wrong filters can be the cause of soiling and damage to the air mass sensor.

Especially in the case of turbochargers the pressure on the air mass sensor is great because both the air flow and the air speed are very high.

Further details can be found in our Service Informations.

Throttle bodies
Frequent malfunctions in throttle bodies:

- Dirt deposits in the throttle valve can build up so heavily that idle control is no longer possible.
- Soiling in the idle speed actuator can produce sticking or decrease the cross-section to the extent that the engine “dies”.

Important note:
These errors are often caused by very oily intake or charge air.
Examples of causes of very oily intake or charge air can be:

- Malfunctions in the crankcase ventilation (e.g. oil separator, engine exhaust valve).
- Increased blow-by gas emission due to increased wear on the pistons and cylinders.
- Malfunctions in the turbocharger (e.g. worn bearing, plugged oil return line).
- Exceeding of the maintenance intervals (failure to change oil and oil filter).
- Use of engine oil quality not suited for the application.
- Frequent short trips (especially during colder months, formation of oil/water emulsion that gets into the engine exhaust).
- Engine oil level too high.
- Worn valve stem seals or guides causing increased oil transfer into the inlet port.

Further causes of malfunction, especially in the case of greater distances driven, are:

- Wear of or deposits on the potentiometer (sporadic malfunctions).
- Wear on the throttle valve.
- Failure of the throttle valve actuator motors (engine “saws” during idling).
- Defective micro switch in the throttle body (attachments).

Further details can be found in our Service Informations.

Important note:
If there are wear and damage on the potentiometer or micro switches, the throttle bodies should be replaced.
Due to the inability to make adjustments, it is impossible to include a repair in the service.
After a new throttle body has been installed, it may be necessary to “teach” the control unit.

Modern engine control units have adaptive “storage modules”, i.e. some of the map data required for operation must be “learned”.
The map data will first be recorded during driving and stored in the memory. This may take a few minutes!
For this reason a test drive should be taken and only then should the function be checked again.

Intake manifolds
Errors in intake manifolds are:

- Intake manifold is broken or cracked.
  Damage to intake manifolds is mostly due to severe damage resulting from improper work on the engine or heavy impact (misfires).
- Actuator does not work or is giving an incorrect signal.
  For pneumatic actuators:
  Check whether there is a vacuum, whether the electric switch-over valve is being actuated electrically and is functional.
  For electric actuators:
  Check electric supply and potentiometer signals.
  In both cases also check whether the intake manifold is stuck due to deposits.
- Intake manifold makes noises.
  In this case the intake manifold will have to be dismounted for a more exact diagnosis.
  Possible causes can be foreign objects such as loose parts in the intake manifold, slipped gaskets (under certain circumstances not detected) and missing or damaged connecting hoses.

Attention:
Be careful when dismounting the intake manifold so that loose parts do not get into the engine and cause damage, for example!
Modern (bonded) intake manifolds can no longer be taken apart.

Tumble flaps
n the case of tumble flaps/inlet port shut-off, sticking due to deposits is the most common cause of failure, especially in diesel applications.
The adjustment time is monitored in the diagnosis. If the valves are stuck, they will not be adjusted, or the set time will be exceeded. In the diagnosis, the actuator, usually an EAM-i, can be detected as faulty. This error cannot be corrected by replacing the actuator.

Further details on tumble flaps and EAM-i can be found in our Service Informations.

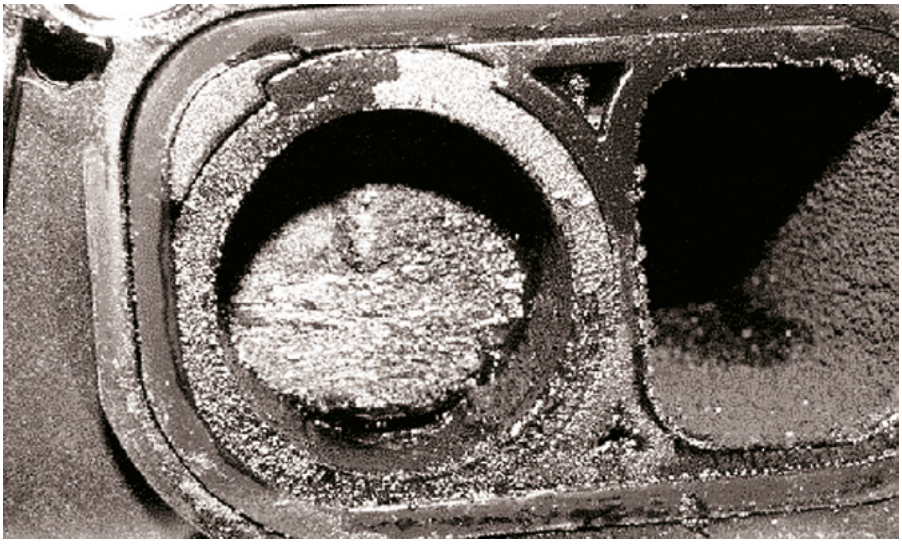

Fig. 44: thumble flaps, malfunction due to heavy deposits

Electropneumatic pressure transducer (EPW)
The most frequent causes of malfunctions are:
- water or soiling or
- leaky hose connections.

These errors are not always detected by the component diagnosis.
High ambient temperatures can cause sporadic malfunctions.
Malfunctions are seldom caused by incorrectly attached connecting hoses.

Further details can be found in our Service Informations.