Exhaust emission system

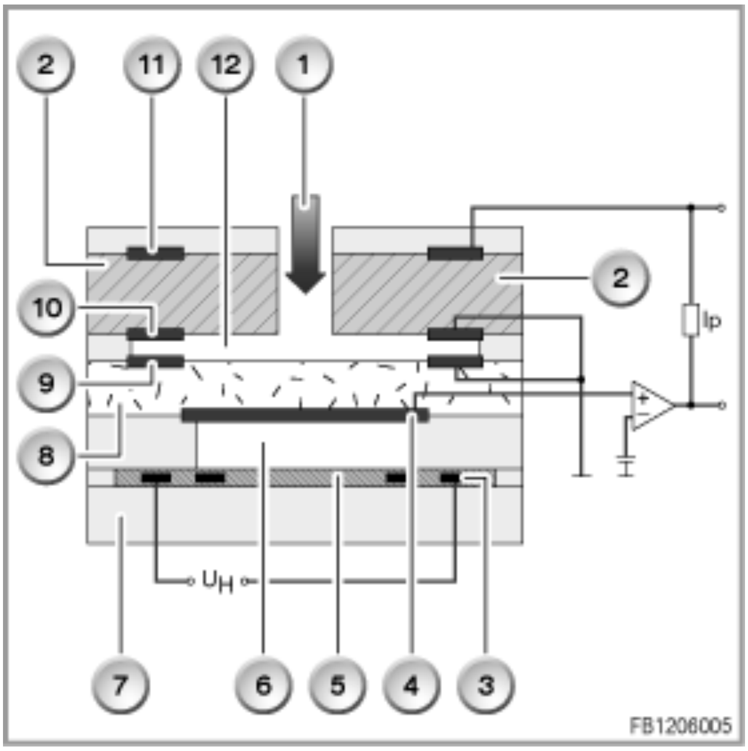
The N12 4-cylinder petrol engine satisfies the EURO 4 exhaust emission standards, or LEVII in the US version (LEV = Low Emission Vehicle). The engine has a catalytic converter close to the engine. On the US version there is an additional catalytic converter on the underbody. Two oxygen sensors are used for oxygen level control. A broadband oxygen sensor (Bosch: 4.9 universal oxygen sensor) acts as the control sensor upstream of the catalytic converter close to the engine. A bistable sensor (NTK: FLO type) serves as the monitoring sensor downstream of the catalytic converter.

Brief component description

This section describes the following exhaust-system components:

Broadband oxygen sensor

The sensor system of the broadband oxygen sensor consists of ceramic layers of zirconium dioxide (laminate). The heating element inserted in the laminate rapidly ensures the required operating temperature of at least 750 °C. The broadband oxygen sensor has 2 cells, a so-called measurement cell and a reference cell. The two cells are coated with electrode made of platinum.



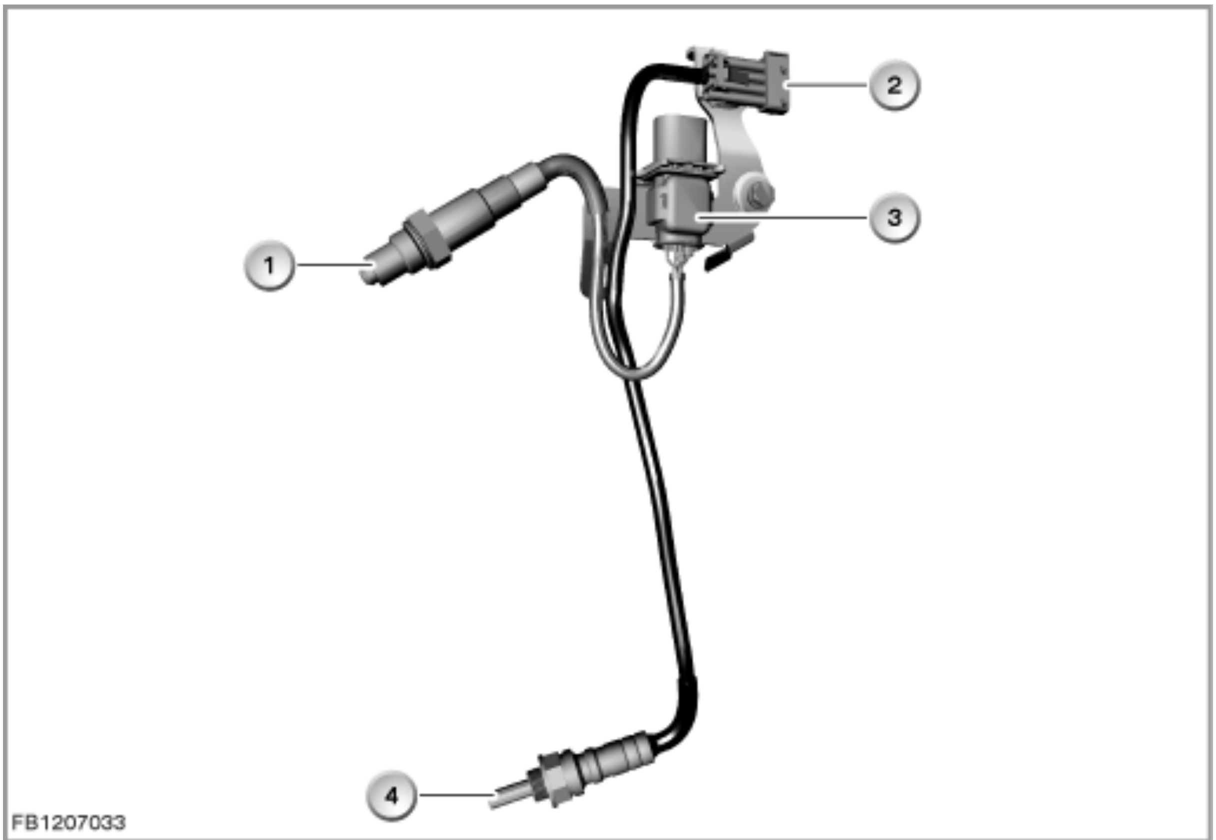
Item	Explanation	Item	Explanation
1	Exhaust gas	2	Measuring cell
3	Electrode for heating	4	Electrode of the measuring cell
5	Heating element	6	Gap with ambient air
7	Ceramic layer	8	Reference cell
9	Electrode of the reference cell	10	Electrode of the measuring cell
11	Electrode of the measuring cell	12	Measuring gap

The broadband oxygen sensor can be used to measure an air/fuel ratio steplessly between 0.6 and 2.5 (constant characteristic curve). The broadband oxygen sensor works with a lower heater output than a conventional oxygen sensor. The broadband oxygen sensor is also operational more quickly. Current is applied at the measuring cell. This means that oxygen ions are pumped into the reference cell until a voltage of 450 mV settles between the electrode of the reference cell. The applied current at the measuring cell is the measured variable for the fuel-air ratio. This enables the oxygen sensor emissions control to set any desired air/fuel ratio in the combustion chamber.

Catalytic-converter mounted close to the engine

The catalytic converter reduces the pollutant emissions:

- With the aid of oxygen (O_2) carbon monoxide (CO) is converted into carbon dioxide (CO_2).
- Hydrocarbons (HC) react with oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O).
- Nitrous oxides (NO_x) break down into nitrogen (N) and oxygen (O_2).



Item	Explanation	Item	Explanation
1	Oxygen sensor before catalytic converter	2	4-pin plug connection
3	6-pin plug connection	4	Oxygen sensor after catalytic converter

At all times, the Digital Engine Electronics (DME) regulate the fuel-air mixture with regard to the following criteria:

- Exhaust emissions
- Consumption
- Power development
- Catalytic converter protection

Here, the DME picks up the residual oxygen content in the exhaust gas via the oxygen sensors and corrects the fuel injection rate on the basis of this data.

A model for the exhaust-gas temperature integrated in the DME meets (among others) the following specifications:

- The catalytic converter heater ensures that the catalytic converter quickly reaches operating temperature and conversion capability following engine start.
- The effect of the catalytic converter protection is that the exhaust-gas temperatures, in particular at full load, are regulated in such a way that a thermal overload of the catalytic converter is prevented.

System functions

The following system function for the exhaust emission system is described:

Oxygen sensor emissions control

For complete and perfect combustion, a air/fuel ratio of 1 kilogram of fuel and approx. 14.7 kilograms of air is necessary. The air mass corresponds to around 11 cubic metres. The ratio between the air quantity that is actually being supplied and that required for a stoichiometric ratio is designated as lambda. During normal operation of the vehicle, the Lambda value fluctuates. The engine has its best performance with a lack of air (Lambda approx. 0.9 = rich mixture). The engine has its lowest consumption with excess air (Lambda approx. 1.1 = lean mixture). The catalytic converter can most effectively reduce pollutant emissions if the fuel-air mixture is in the region of Lambda = 1. The conversion rate, i.e. the proportion of converted pollutants, is 98 % to virtually 100 % in the case of modern catalytic converters. The Digital Engine Electronics (DME) control the optimised composition of the fuel-air mixture. The oxygen sensors deliver essential information on the composition of the exhaust gas.

The front oxygen sensor measures residual oxygen in the exhaust gas. The fluctuation values of the residual oxygen are forwarded to the DME control unit as a voltage signal. The DME corrects the mixture composition by means of fuel injection. A second oxygen sensor (monitoring sensor) is built in behind the catalytic converter. The catalytic converter has a high oxygen storage capacity. This means there is only a little oxygen behind the catalytic converter. The monitoring sensor supplies a virtually constant (attenuated) voltage. With increasing age, the oxygen storage capacity of the catalytic converter declines. The monitoring sensor then reacts increasingly to oxygen sensor deviation with voltage fluctuations. These characteristics are used by a special diagnostic function for catalytic converter monitoring. A malfunction of the catalytic converter is indicated by the emissions warning light.

Notes for Service department

General notes

Important! Protect the plug connection of the broadband oxygen sensor against soiling.

The broadband oxygen sensor requires ambient air inside the sensor. The ambient air enters the interior via the plug connection through the cable. This is why the plug connection must be protected against soiling, e.g. by wax or sealant. In the event of faults in the lambda control, the plug connection on the broadband oxygen sensor must be checked for soiling. If necessary, the plug connection must be cleaned.

Diagnosis instructions

The following monitoring functions test the condition of the exhaust system:

CO adjustment

On vehicles without oxygen sensor emissions control, the carbon monoxide emissions at idle are adjusted using the diagnosis system. The adjustment values are preset in this case.

Oxygen sensor adaptation

The purpose of oxygen sensor adaptation (mixture adaptation) is to compensate for component tolerances and ageing effects affecting the fuel-air mixture. Factors such as excess air and fuel pressure also have an impact on the oxygen sensor adaptation (partial compensation) For those reasons, no precise regulation limits for a fault can be given. Oxygen sensor adaptation makes the following distinctions:

- additive fuel mixture adaptation
- multiplicative mixture adaptation

Additive fuel mixture adaptation takes effect at or around idle speed. This effect steadily decreases as the engine speed increases. Multiplicative mixture adaptation is effective throughout the entire characteristic map. An important factor is, for example, the fuel pressure.

The delivery status of the adaptation values and equipment specifications can be reset using the "Reset adaptation values" service function. Then the adaptation values must be relearned by the system. In order to initialise the system and allow it to "learn" the mixture-adaptation data it is necessary to operate the vehicle for an extended period between idle and part-load.

Catalytic converter diagnosis

The catalytic converter diagnosis uses continuous oxygen sensors upstream and bistable sensors downstream of the catalytic converter. The diagnosis tests the oxygen storage capacity of the catalytic converter. The oxygen storage capacity provides an indication of the catalytic converter's conversion capability. A rich fuel-air mixture is specified during the initial phase of the catalytic converter diagnosis (approx. 3 seconds) until the oxygen sensor voltage reaches a defined value. Because rich exhaust is low in oxygen, there is a corresponding reduction in the amount of oxygen stored in the catalytic converter. In the 2nd phase a lean mixture with oxygen-rich exhaust gas is supplied. The longer it takes to reach the maximum oxygen storage capacity, the higher the conversion capability of the catalytic converter will be.