AA/MKG2 1 987 717 494 / 200611 64.11.XX

Bosch tips
Correct assessment and handling of lambda sensors

BOSCH
Invented for life

The most effective exhaust treatment method for gasoline engines.

Lambda sensor

Design

Finger-type sensor
The principal feature of this type of sensor is a finger-shaped ceramic element. It is provided with a separate heater to achieve the minimum temperature of 350 °C required for control action. On the exhaust-gas end, the sensor housing is fitted with a protective tube to protect the sensor element against combustion residue in the exhaust gas (Fig. 1).

Planar sensor
The planar lambda sensor is a more advanced form of the finger-type sensor. The shape of the sensor element resembles an elongated plate. As both the measurement cell and the heater are integrated into this plate, the sensor is able to attain its operating state more quickly. The planar sensor has a double-walled protective tube (Fig. 2).

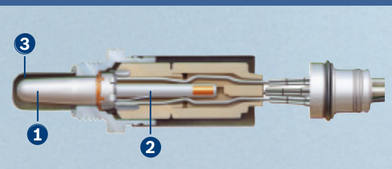


Fig. 1: Finger-type sensor
1 Ceramic sensor element
2 Heater
3 Protective tube

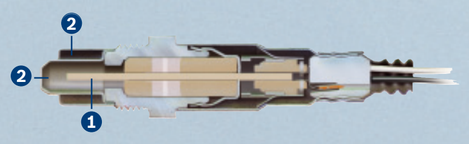


Fig. 2: Planar sensor
1 Planar sensor element with integrated heater
2 Double-walled protective tube

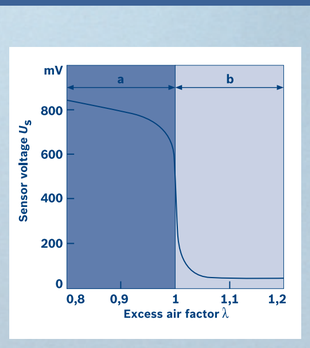


Fig. 3: Voltage step change at λ = 1

U_S Sensor voltage
a Rich mixture
b Lean mixture

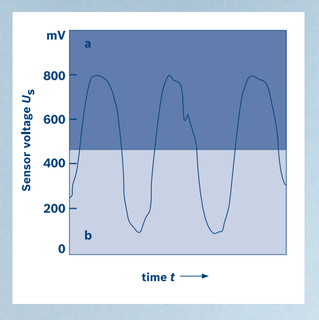


Fig. 4: Voltage characteristic in part-load operation
U_S Sensor voltage
a Rich mixture
b Lean mixture

Operation

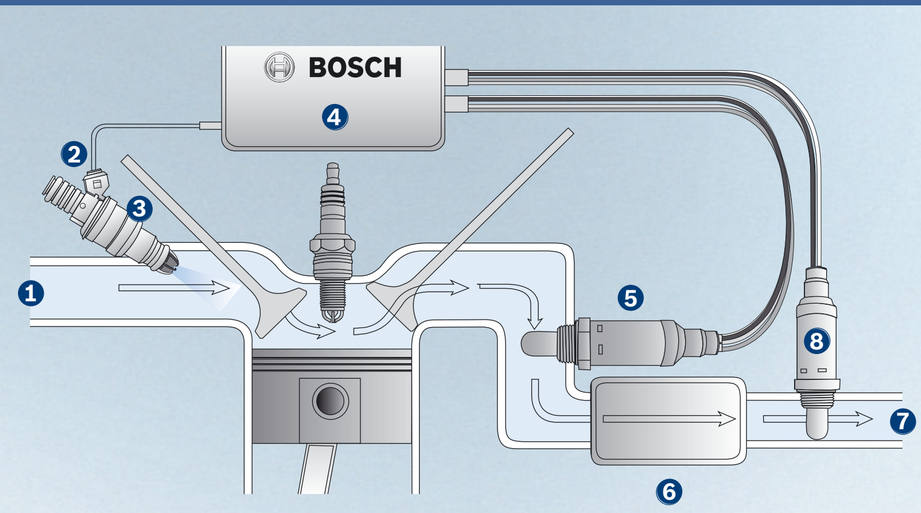
The lambda sensor
- measures the residual oxygen content of the exhaust gas
- at operating temperature (350 °C) generates a voltage of between approx. 25 and 900 mV corresponding to the oxygen content of the exhaust gas
- compares the residual oxygen content of the exhaust gas to the oxygen content of the surrounding air
- detects the transition from rich mixture (air deficiency λ < 1) to lean mixture (excess air λ > 1) and vice versa

Injection system

Layout

On more modern engines, lambda sensors are located in the exhaust system upstream and downstream of the catalytic converter. One side of the sensor element electrode is exposed to the exhaust gas, whereas the other is in contact with the surrounding air which is used as the reference air for measurement of the residual oxygen.

Lambda control loop
1 Intake air
2 Fuel supply
3 Injector
4 ECU
5 Control sensor (upstream of catalytic converter)
6 Catalytic converter
7 Exhaust gas
8 Diagnostic sensor (downstream of catalytic converter)



Mode of operation

The ECU detects the mixture composition (lean or rich) from the lambda sensor voltage. It controls the injected fuel quantity such that an optimum mixture composition (λ = 1) is guaranteed, thus creating ideal conditions for exhaust gas treatment in the catalytic converter. Allowance is made for the engine load in this process. The quantity of fuel must be reduced if the mixture is too rich (λ < 1) and increased if it is too lean (λ > 1). If fitted, a second lambda sensor, the diagnostic sensor (downstream of the catalytic converter) detects whether the control sensor (upstream of the catalytic converter) is still functioning optimally. The ECU can then calculate the amount of compensation required to rectify any deviation.

Testing (for 3 and 4-wire lambda sensors)

Use suitable measuring instruments, such as a multimeter (A, V, O instrument) or an engine analyzer. With new systems, the most important values can be recorded with the Bosch testers KTS 520, 540, 550, 570, 650, FSA 740 employing the self-diagnosis function.

Notes on trouble-shooting

Take measurements and perform checks before removing the lambda sensor. The engine must be warm.

Fault lamp check (OBD: On-board diagnosis)	A defective lambda sensor may cause the OBD lamp to light.
Fault memory readout	Make use of a tester (for example KTS 520, 540, 550, 570, 650, FSA 740) or the flash code.
Visual inspection (in situ)	Applicable to connector, wiring and lambda sensor.
Exhaust and intake system leak test	Pay particular attention to the area between the engine and the lambda sensor. The ingress of additional air will bias the lambda sensor signals.
Wiring check	Check wiring for open circuit, short to positive or short to ground.
Test procedure	Connect up diagnostic tester, such as lambda control tester or engine analyzer.

Lambda sensor check

To be performed if the above trouble-shooting is not successful.

Test items:	Action in case of deviation:	Note the following:
Measurement of reference voltage Approximate values: 400...500 mV	Check ECU/electrics	Take measurement at ECU end of unplugged connector.
Measurement of lambda sensor signal frequency Approximate values at idle: > 0.5 Hz (cycle < 2 sec)	Replace lambda sensor	Plug in connectors. The frequency of the sensor signal voltage increases with increasing engine speed. A lambda control tester can also be used for this purpose.
Measurement of heating resistance If > 30 Ω	Replace lambda sensor	Take measurement at white wires on sensor end with connector unplugged.
Measurement of heating voltage Approximate values: 10 – 14.5 V	Check ECU/electrics	In modern systems, heating-voltage measurement is not possible if the lambda sensor heating has been deactivated on attaining the lambda sensor operating temperature.
Measurement of sensor voltage Approximate values with warm engine: Rich values > 0.6 V Lean values < 0.4 V	Replace lambda sensor	Take measurement at black and grey wires or at black wire and housing.

Handling

To be avoided at all costs:	Correct procedure:
I. Connectors Never apply contact spray or grease, as surrounding air is required for lambda sensor operation.	**I. Connectors** Always cover the sensor and connector before washing the engine or applying underseal.
II. Connecting cable There must not be any kinking or abrasion (caused by strain, compression or vibration).	**II. Connecting cable** Avoid hot resting and contact points on or at the exhaust system.
III. Sensor body Sensor is not to be subjected to impact or high-pressure cleaning.	**General precautions:** Treat the lambda sensor with care. It is never to be thrown or dropped. Protect against mechanical loading.
IV. Sensor tip Do not use leaded fuels. Do not apply thread grease to protective tube.	**IV. Sensor tip** Apply grease to thread on fitting.

Removal and installation

It is advisable to refer to the vehicle-specific trouble-shooting instructions when working with lambda sensors.

Assembly tool:	Use a 22 mm open box wrench or tool adapter.
Tightening torque:	40...60 Nm (use torque wrench).
Reinstalling the sensor:	Grease the thread with suitable assembly paste. **Attention:** Paste must not come into contact with protective tube.
Fitting new sensor:	Bosch lambda sensors are supplied with a ready-greased thread and a protective cap. Only remove the protective cap immediately prior to installation.
Fitting instructions:	• Take care not to twist the wiring harness on fitting/screwing in the sensor. Do not tug on the cable and connector. • Sensors are not to be used if the connector is dirty or damaged. • For the lambda sensor to function properly, it is important to keep the inside of the connector clean. It is therefore essential to protect the connector against all forms of contamination. • Use cable ties to take up any excess length of connecting cable into a loop.

Important

To protect the lambda sensor:

- Only use unleaded fuel without additives.
- Have the vehicle serviced at regular intervals.
- Only provide starting assistance using jumper cables, as unburnt fuel could enter the exhaust system if the vehicle were to be pushed.
- Do not fill the engine with oil beyond the max. mark on the dipstick.
- Observe checking and replacement intervals: Check the lambda sensor regularly (every 30 000 km) and replace at the intervals recommended by Bosch.