BOSCH
Invented for life

# Lambda sensors

## Quick and easy testing and replacement

**Did you know?**

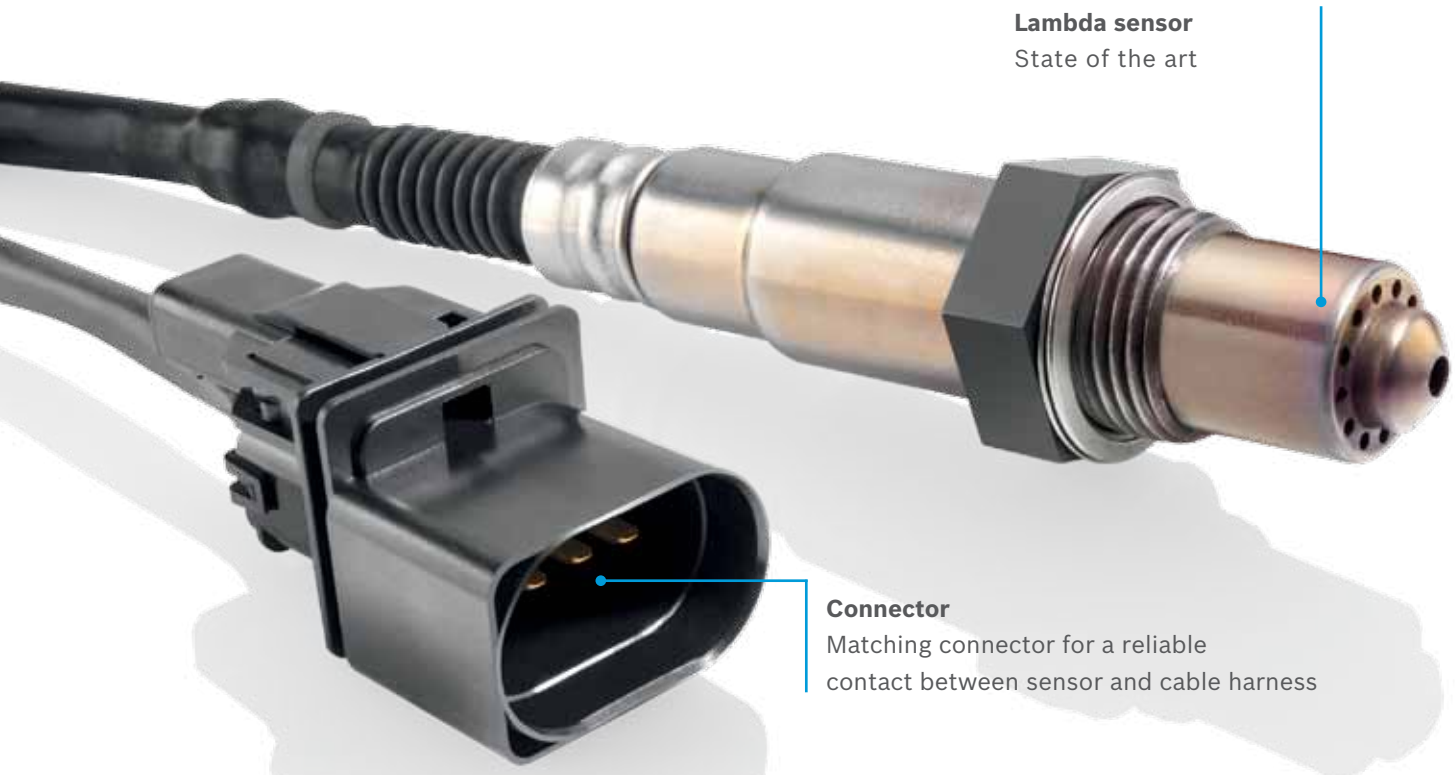
In 1976, Bosch invented the lambda sensor – by now a piece of vehicle equipment as self-evident as catalytic converters. Throughout the last 40 year, Bosch produced

# 1 bn

lambda sensors.

# Lambda sensors
## Overview

**A plus for the environment since 1976:** Invented by Bosch, Lambda sensors have made a significant contribution in order to fulfill current emission standards. To ensure their reliable operation, they are to be checked or replaced regularly.




### Market leader know-how

Since Bosch first invented lambda sensors, the company has promoted further development of these exhaust-gas sensors launching several innovations. The result: Every day, more than 50 million pieces leave the plants of the world's largest lambda-sensor producer and technological leader – Bosch.

But also workshops benefit from the Bosch know-how about the whole injection system and increasingly important exhaust-gas treatment.

### Advantages at a glance:

- Easy to fit thanks to vehicle-specific connector
- Quick and easy fitting, as all lambda sensors come with a pre-greased thread
- High reliability over a long service life due to functional and quality tests in accordance with the same standards as for original equipment parts

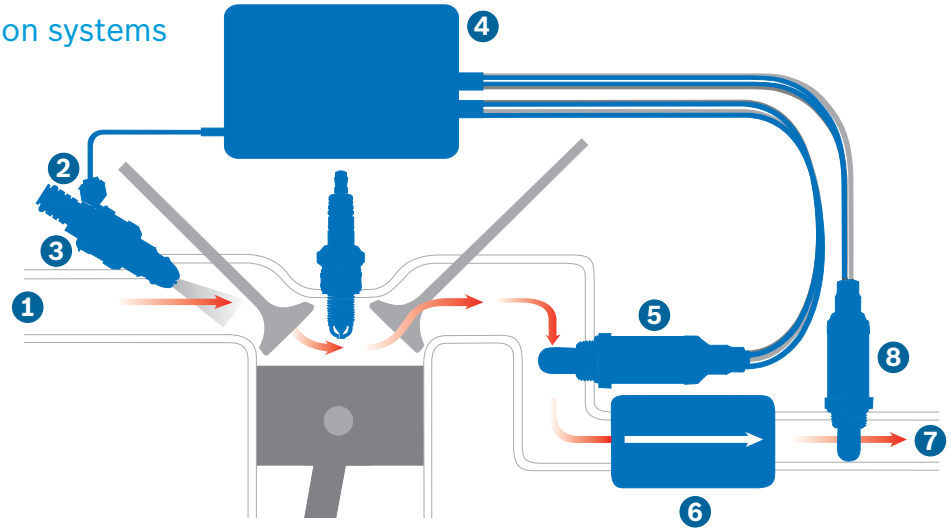
# Lambda sensors
## Technology

**Excellently geared to each other, they make exhaust-gas treatment more effective:** Modern exhaust-gas systems feature at least two lambda sensors: The air/fuel mixture is optimized by a control sensor upstream of the catalytic converter, its effectiveness by a diagnostic sensor downstream of it.

### The example of gasoline injection systems

Lambda control loop of gasoline injection systems

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



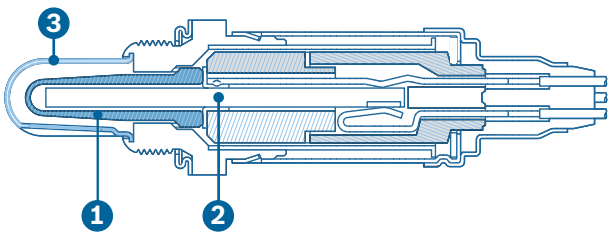

### Bosch lambda sensors – an important component of exhaust-gas treatment.

**Step-change sensors** detect the “stoichiometric mixture” (λ = 1) and compare the residual oxygen content of the exhaust gas with the oxygen content of the ambient air. They detect the transition from rich to lean air/fuel ratio and vice versa. Depending on the oxygen content of the exhaust gas, they generate a voltage of approx. 20 to 900 mV.

**Broad-band lambda sensors** can also measure lean (λ > 1) and rich mixtures (λ < 1) with high accuracy. This allows lambda sensors to be used for additional engine control functions (e.g. secondary air diagnosis). Broad-band sensors define the lambda value using the pump current featuring zero mA at λ = 1.

### The lambda-sensor voltage informs the control unit about the air/fuel mixture.

Considering the engine load, the fuel quantity injected is controlled in a manner ensuring an optimum air/fuel ratio – thus creating ideal conditions for exhaust-gas treatment at the catalytic converter. In case of rich mixtures, the amount of fuel is reduced. With lean mixtures, it is increased. The second lambda sensor downstream of the catalytic converter (the diagnostic sensor) checks if the control sensor works optimally. If there are any deviations, they can be compensated by the control unit.




**Finger-type sensor (fig.)**
The core element of finger-type sensors is their ceramic sensor element. For its operation as control sensor, a separate heater heats it up to a temperature exceeding 350 °C. A special protective tube protects the sensor against residues contained in exhaust gas. Most finger-type sensors are step-change sensors.

1. Sensor ceramics
2. Heating element
3. Protection tube

# Lambda sensors
## Technology

**Bosch leads in original equipment and on the aftermarket.** Most vehicles worldwide are equipped with Bosch lambda sensors as original equipment. But even the aftermarket lambda sensors feature the same high quality as OE ones.

**Connector**
The connector fits just like the OE one.

**Sensor body**
Innovative Bosch technology, excellently geared to the respective type of engine.

**Sensor tip**
The integrated sensor is protected by the high-quality protection tube.

### Bosch right from the outset

Most vehicles are equipped with Bosch lambda sensors as part of their original equipment. Workshops easily identify the matching sensor. In addition, they can choose between the Bosch original and Bosch universal ranges.

### The Bosch original range

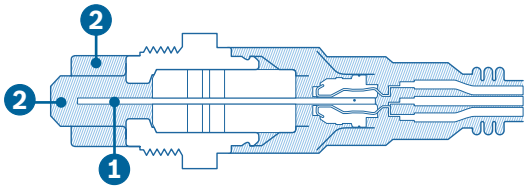
Original lambda sensors are always equipped with the genuine connector.

- They can be installed into the vehicle without any additional efforts
- High reliability over a long service life due to functional and quality tests in accordance with the same standards as for original equipment parts
- Bosch lambda sensors cover more than 85 % of all European vehicles

### The Bosch universal range

Only 10 universal sensors substitute some 1 000 original lambda sensors featuring different sensor elements and heating performances.

- Economical stock keeping, fast availability
- Short codes provide a quick and simple overview
- No special tools required for the installation
- The patented connector included in the scope of delivery ensures a reliable electric connection




**Planar sensor (fig.)**
The planar lambda sensor operates with a sensor shaped like a stretched plate. Housing both the measuring cell and the heating element, it features particularly fast operational readiness.

1 Planar sensor element with integrated heating element
2 Double-wall protection tube

# **Lambda sensors**
# Diagnoses

## Bosch lambda sensors – reliable functionality and a long service life

Being a wearing part, however, they are to be checked regularly and replaced if required. Bosch recommends checking lambda sensors every 30 000 km.

## Three steps to diagnose lambda sensors:

1. Read out the fault memory and check the actual values
2. Check the signal patterns (as specified by ESI[tronic] 2.0)
3. Check wires and connectors for secure connections

| | | Test step | Please note: |
|---|---|---|---|
| 1. |  | **Check warning lamp**<br>Important: The engine is to be warm. | A faulty lambda sensor will cause the OBD lamp (on-board diagnosis) to light up. |
| 2. |  | **Read out the fault memory** | Use a tester (e.g. Bosch KTS 570). |
| 3. |  | **Perform visual inspection**<br>(when fitted) | Connectors, wiring and the lambda sensor are affected. |
| 4. |  | **Perform a leak test on the intake and exhaust systems** | Check the area between engine and lambda sensor in particular. The ingress of additional air will cause incorrect lambda-sensor signals. |

## Defective lambda sensors can have different causes:

- Electrical faults
- Mechanical defects
- Poisoning / soiling / clogging
- Thermal overload

## Regular checks prevent expensive consequential damages

Car drivers need to know: Lambda sensors are wearing parts. Their regular inspection provides a series of advantages. Flawless lambda sensors

- cut the fuel costs by up to 15%
- contributes to fulfill current emission standards
- prevent expensive damage to the catalytic converter

**Lambda sensor condition:**
Green, grainy soiling

**Possible cause:**
Leakage of antifreeze agent into the combustion chamber

**Remedy:**
Replace the lambda sensor. Check the engine block, cylinder head, intake manifold and cylinder head gasket for wear and tear.

**Lambda sensor condition:**
Red or white soiling

**Possible cause:**
Fuel additives

**Remedy:**
Do not use fuel additives. Replace the lambda sensor.

**Lambda sensor condition:**
Black, with oily soiling

**Possible cause:**
Excessive oil consumption

**Remedy:**
Check the valve guides and seals as they may be worn. Replace the lambda sensor.

**Lambda sensor condition:**
Broken cable

**Possible cause:**
Tension on the cable was too high

**Remedy:**
Replace the lambda sensor. Do not tighten the new cable that much.

**Lambda sensor condition:**
Dark brown soiling

**Possible cause:**
Fuel/air mixture was too rich

**Remedy:**
Check the fuel pressure. Replace the lambda sensor.

**Lambda sensor condition:**
Damage on the molded cable tubing

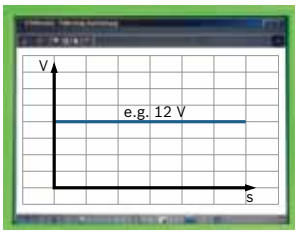
**Possible cause:**
Stone chips

**Remedy:**
Replace the lambda sensor.

# Lambda sensors
Diagnoses

## Test routine: lambda sensor heating

**1.**




**Check the power supply of the lambda sensor heater**

Check the actual values of the lambda sensor heater using a diagnostic tester. Testing via OBD is possible, too. Power is to be supplied. Please observe the switch-on conditions of the sensor heater.

There must be a constant power supply of 10.5 to 13.5 V.

**It the power supply OK?**

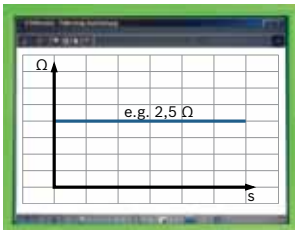
**No**

**Possible causes:**
- Use the diagnostic tester to check if the lambda sensor heating is activated. Note: In case the lambda sensor (diagnostic sensor) is installed afar from the engine, the control unit will only activate the heater after driving a certain distance.
- Relay does not switch to „continuous positive“
- Open circuit, short circuit to ground or positive. Check cable harness and connector for possible defects or corrosion.

**Determine the cause and remedy. For additional detailed tests: ESI[tronic] 2.0**

**Yes**

**2.**




**Check heater resistor at ambient temperature**

**Note:** The higher the temperature of the lambda sensor, the higher the heating resistance and vice versa.

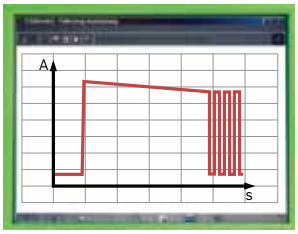
**Test value:** < 30 ohms (component temp.: 20 °C)

See ESI[tronic] 2.0 for a description of this test.
**Are the test values OK?**

**No** Defective lambda sensor

**Yes**

**3.**




**Measure the heating current**

To ensure quick operational readiness of the lambda sensor, the current supplied is higher at first and then decreased turning on and off the ground supply.

**Note:** Shortly after starting the engine and until exceeding the exhaust-gas dew point, no current is applied to the heater.

**Is the heating current decreasing as the temperature rises?**

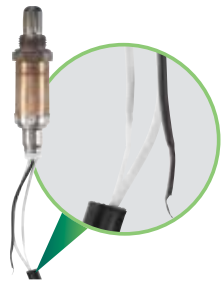
**No**

Use the **diagnostic tester to check if the lambda sensor heater is activated.**

**Note:** In case the lambda sensor is installed afar from the engine, the control unit will only activate the heater once the vehicle drove a certain distance.

**Yes**

**4.**



**Check vehicle cable harness for:**
- Damage
- Corrosion
- Contact faults at the connectors
- Open circuit, short to ground, short to positive and transfer resistances

**Is the cable harness between lambda sensor and control unit OK?**

**No** Defective cable harness

**Yes**

**5.**

Yes

**Check control unit:**
- Check multi-point connector for damage, corrosion or faulty contacts.

**Is the control unit OK?**

No → Faulty control unit

Yes

**Lambda sensor heating is okay.**

▶ Delete fault memory ▶ Perform a test drive ▶ Check the fault memory

### If the error remains, please continue with the following steps:

- Delete the fault memory
- Perform a test drive
- Check the fault memory

**Other possible error causes:**

- Interrupted cables or short circuits (short to positive or to ground)
- Occasionally poor connection or non-conductive connectors (loose contact caused by vibrations or temperature variations).
- Insufficient power supplied to the engine control unit (ECU)

**A detailed description of the test can be found at ESI[tronic] 2.0!**

## Proper handling of lambda sensors

**Connectors**
Always cover both the sensor and the connector before washing the engine or applying the protective undercoating.

**Connection cable**
Pay attention to kinking and chafing points caused by tension, pressure or vibration.

**Sensor body**
Always handle lambda sensors carefully, do not throw nor drop them! Protect them against mechanical strains!

**Sensor tip**
Install with pre-greased thread.

### Simple, but highly effective precautions

Do not apply contact spray nor grease as ambient air is required for the operation of lambda sensors.

Avoid hot resting points and contact surfaces on or at the exhaust system.

Protect the sensor against impacts and do not clean using high-pressure cleaners.

Do not use leaded fuels. Do not apply thread grease to the protective tube. Keep the engine mechanically flawless as residues – e.g. combustion residues – may cause deposits on the lambda sensor.

# Lambda sensors
## Diagnoses

### Simple test steps for reliable troubleshooting:

- Important: For a reliable diagnosis, the engine mechanical system and the ignition system are to be okay.
- You will find detailed test steps and test values at ESI[tronic] 2.0.

**Measurement setup for most of the test steps**

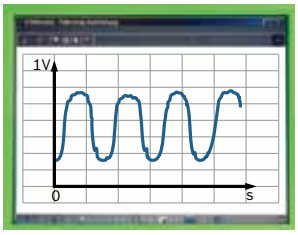
### Test routine: lambda sensor signal

**1.**

**Test requirements:**

- Fuel injection system, ignition and engine mechanical system are OK
- No leaks into the intake and exhaust-gas systems
- Engine warm and idling

**2.**

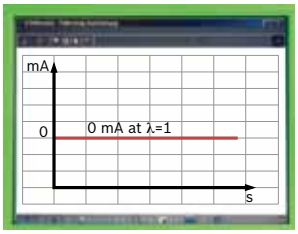



**Check signal profile – step-change sensor:**

- Control sensor signal oscillates between approx. 0.1 and 0.9 V
- The larger the control-sensor voltage boost, the better the signal
- The lower the voltage boost of the diagnostic sensor, the better the condition of the catalytic converter
- Frequency between 0.3 and 3 Hz
- Voltage < 0.4 V ➔ lean mixture
- Voltage > 0.5 V ➔ rich mixture

**or**

**3.**




**Check signal profile – broad-band sensor:**

- At lambda = 1 ➔ pump current 0 mA
- Pump current < 0 mA ➔ rich mixture
- Pump current > 0 mA ➔ lean mixture

When analyzing the lambda sensor, please note the type of engine, the purpose of application (control or diagnostic sensor) and the operating conditions. Excess of air at the mixture formation can be a normal operating condition (diesel, fuel stratified direct injection, lean-combustion engines, ...)

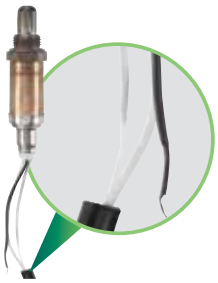
**Is the signal profile OK?**

**Yes**

**No** Defective lambda sensor

When analyzing the lambda sensor, please note the type of engine, the purpose of application (control or diagnostic sensor) and the operating conditions. Excess of air at the mixture formation can be a normal operating condition (diesel, fuel stratified direct injection, lean-combustion engines, ...)

## 4.



Yes

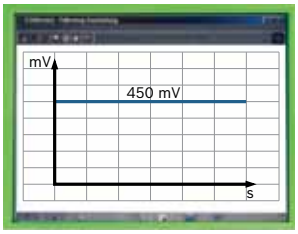
**Check vehicle cable harness for:**

- Damage
- Corrosion
- Contact faults at the connectors
- Open circuit, short to ground, short to positive and transfer resistances

**Is the cable harness between lambda sensor and control unit OK?**

No → Defective cable harness

## 5.




Yes

**Check control unit:**

- Is the reference voltage 450 mV?
- Check multi-point connector for damage, corrosion and faulty contacts.

**Is the control unit OK?**

No → Faulty control unit

Yes

**Lambda sensor signal is okay.**

▶ Delete fault memory ▶ Perform a test drive ▶ Check the fault memory

**In case the error remains, please continue with the following steps:**

- Delete the fault memory
- Perform a test drive
- Check the fault memory

**Other possible error causes:**

- Interrupted cables or short circuits (short to positive or to ground)
- Occasionally poor connection or non-conductive connectors (loose contact caused by vibrations or temperature variations).
- Leakage at the intake, exhaust-gas or fuel-evaporator systems
- Leaking/defective fuel injector
- Load detection sensors are misaligned (e.g. HFM signal drift)
- Insufficient power supplied to the engine control unit (ECU)
- Poisoned lambda sensor
- Overaged lambda sensor
- Defective catalytic converter
- Soiled throttle valve control unit

**Please observe the detailed test description at ESI[tronic]!**

# Driven by efficiency

Technology from Bosch is used in practically every vehicle in the world. For us, the focus is on people and helping them to stay mobile.

We have been dedicated to people for more than 125 years with our pioneering spirit, research, production and expertise.

For them, we are constantly improving our combination of spare parts, diagnostic and workshop equipment as well as services:

- Solutions for efficient vehicle repairs
- Innovative workshop equipment and software
- One of the world's most comprehensive ranges of spare parts – including both new and replacement parts
- Extensive dealer network for quick and reliable parts supply
- Expert customer care via our hotline
- Comprehensive range of trainings
- Specific sales and marketing support

For additional information, please visit:

**bosch-automotive-aftermarket.com**

**What drives you, drives us**

AA-MBC2 2018/10 Subject to technical and program changes.

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