



Bosch Lambda Sensors Ready to Install from the System Specialist



BOSCH

Invented for life

The System for Clean Air: Bosch Lambda Sensors

Systems and components from Bosch can be found nowadays in almost all vehicles

- ▶ With its concentrated expertise in the development of new technology, Bosch is also a competent partner for workshops when it comes to lambda sensors.
- ▶ The high quality of spare parts is known throughout the world: Original Bosch quality



The World's 1st Choice Concerning Lambda Sensors



Bosch has produced 500 million lambda sensors



Lambda sensors from Bosch are available all over the world

Clean Balance Sheet for Workshop and Environment

Modern vehicles with gasoline and diesel engines guarantee mobility. They will continue to dominate the roads for many years to come. At the same time, the aim is to increasingly reduce fuel consumption and emissions. Technical innovations from Bosch serve to protect the environment and lower exhaust-gas values. A central element of the exhaust measurement is the lambda sensor. Almost all lambda sensors installed in original equipment by Bosch are also available for the workshop.

Lambda Sensor: A Core System Component

Automobile technology already meets the toughest of requirements. All components must be in perfect harmony. Every lambda sensor is therefore manufactured as an element of the engine management system.

Advantage of Bosch: As all parts of the drivetrain are considered during development, the system know-how is correspondingly extensive. With lambda sensors, this also results in improvements in detail over and over again.

Bosch Lambda Sensors: A History of Innovations

- ▶ 1976: Start of series production of Bosch lambda sensors. This allowed the USA to limit the permissible emissions of vehicles. The 3-way catalytic converter had already been introduced 9 years earlier. However, it was only the lambda sensor that made the required air-fuel ratio control possible. The carbon monoxides, hydrocarbons and nitrogen oxides in exhaust gas are decomposed by up to 98%.
- ▶ 1993: Start of the pilot series of the planar lambda sensor, which is ready for operation a lot faster. Today's lambda sensors from Bosch are supplied as planar lambda sensors as standard.

Lambda Sensor Development: The Future

With a view to future emissions standards, Bosch continuously develops new sensor concepts: For faster operational readiness and the measurement of additional exhaust-gas components. Workshops do not even have to concern themselves with the details of these technical innovations in order to provide optimum service to their customer and to equip themselves for the future: Bosch offers a package geared to the workshop with spare parts and know-how.

Bosch: Workshop Partner

For the daily work with lambda sensors in the workshop, this means:

- ▶ Always the most modern lambda sensor technology
- ▶ Almost all lambda sensors ready for delivery at all times
- ▶ Program compiled specifically for workshop requirements
- ▶ Diagnostics devices, know-how and spare parts from a single source

Lambda Sensors for Gasoline Engines – Precise Measurements for Improved Air Quality

The first lambda sensor was installed in the exhaust gas system of a gasoline engine with manifold fuel injection. Since then we have used new technology concepts to develop an entire range of sensors with which engine manufacturers can precisely realize their criteria for lambda control. Our lambda sensors enable vehicles with manifold and direct gasoline injection to comply with all international emission regulations.

Developments for Clean Gasoline Engines Using Any Combustion Process

We develop the lambda sensor in parallel with the evolution of engine technology. The first lambda sensor was matched to the specific requirements of manifold fuel injection. Direct gasoline injection brought new requirements which we fulfill with new lambda sensor technology. Thanks to close co-operation with engine developers, we make the suitable specialized technology available already when a new generation of engines is being introduced.

Sensor Types: Switching-Type and Wide-Band Sensor

Basically there are two sensor types differing in their signal sequences: the switching-type sensor generates a stepped sensor signal at the transition from lean to rich mixtures: the stoichiometric point ($\lambda = 1$) at which the catalytic converter works best is precisely identified. The LSH thimble-type sensor, the first lambda sensor manufactured by us, was a switching-type sensor.

A new design, the planar sensor, was developed by us in our type LSF, our present switching-type sensor.

By contrast to the switching-type sensor, the LSU wide-band sensor measures the oxygen content in a range from $\lambda = 0.65$ to air. It thus permits more precise control concepts not only at the stoichiometric point, but also for lean or rich mixtures.

Also Available with Protective Layer (Thermal Shock Protection – TSP)

For its current planar sensors Bosch offers the option of a porous Thermal Shock Protection layer on the sensor element. This layer permits earlier operational readiness after engine start-up and increased resistance to water impact.



LSF Xfour lambda sensor



LSF lambda sensor

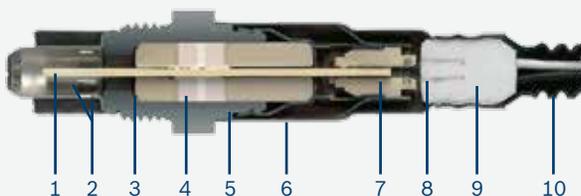
LSF Switching-Type Sensor

The two electrodes of the measuring cell are fitted to a multilayer ceramic element as a sensor element. An integrated heater very rapidly brings this flat sensor element to operating temperature. This fact, together with the high signal stability, contributes to minimal emissions and low fuel consumption.

The advantages of the LSF switching-type sensor:

- ▶ Low current requirements for the heater
- ▶ Operating temperature is rapidly reached
- ▶ High dynamic response
- ▶ Precise heater control
- ▶ Service life up to 240,000 km
- ▶ High signal stability, particularly in systems with central control
- ▶ Freely selectable installation position
- ▶ Reliable operation under all conditions (low voltage for the electrical system, cold exhaust)
- ▶ Low fuel consumption

Cross Section through the LSF Switching-Type Sensor



- 1 Sensor element
- 2 Double protection tube
- 3 Washer
- 4 Seal packing
- 5 Sensor housing
- 6 Protection sleeve
- 7 Contact bracket
- 8 Contact clip
- 9 PTFE (polytetrafluor ethylene – Teflon) grommet
- 10 PTFE formed hose

Switching-Type Sensor LSF Xfour

The LSF Xfour is available in the three versions Performance 60, Performance 50 and Value. All versions can be equipped with Thermal Shock Protection.

The advantages of the LSF Xfour switching-type sensor:

- ▶ High temperature resilience from hexagon to cable grommet
- ▶ Ultra Fast Light-Off sensor operational in less than 7 seconds
- ▶ Compact design approx. 50 mm and 60 mm length
- ▶ High accuracy over the entire temperature range

The Wide-Band Lambda Sensor for **Extended Application Possibilities** Using Constant Lambda Control

With the LSU wide-band lambda sensor, the oxygen content in the exhaust can be determined not only in the range $\lambda = 1$. The LSU supplies precise measuring results over a wide measuring range. It can thus also be used for lean-burn gasoline engines, diesel and gas engines. The high precision of the LSU and its broad measuring range help to reduce system costs while at the same time complying with the strictest exhaust gas regulations.

LSU Wide-Band Lambda Sensor

The LSU is the wide-band lambda sensor from Bosch. It is constructed as a planar sensor with measuring cell and heater in one sensor element. The sensor heating virtually eliminates influences exerted by the temperature of the exhaust gas on its special functions. In addition, it ensures that the LSU is ready for operation in the shortest possible time – depending on the type, heating-up time is between five and 20 seconds.

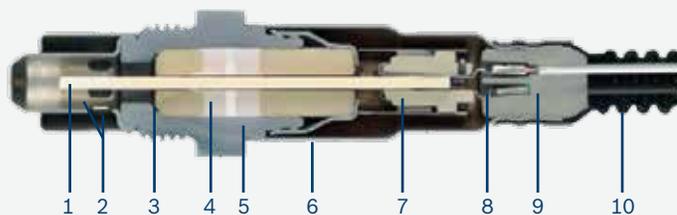
The resistance of the LSU to thermal and other loads is so high that it has a service life of 240,000 km.

Long-Term Low Emissions with the LSU

Legislation is imposing ever stricter limits on the emission of nitrogen oxides, hydrocarbons and NMOG (Non Methane Organic Gases). Our LSU offers the best preconditions for the reliable compliance with today's and future emission regulations.

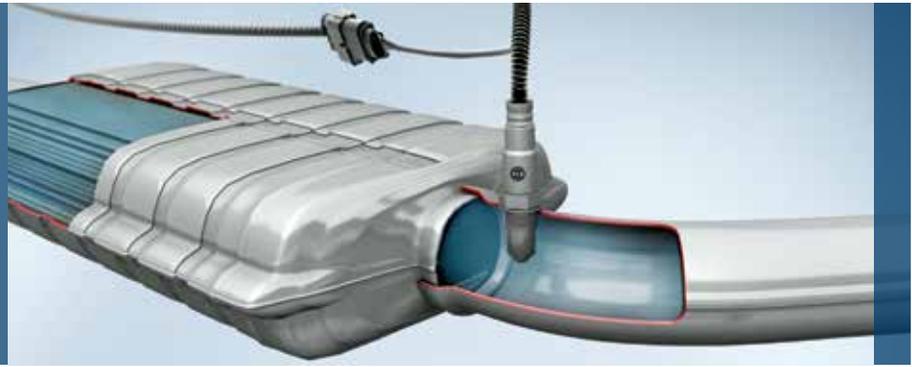
The LSU rapidly and precisely identifies even the slightest deviations in mixture formation so that correction takes place before the disruption can

Cross-Section through the LSU Wide-Band Lambda Sensor



- 1 Sensor element
- 2 Double protection tube
- 3 Washer
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- 5 Sensor housing
- 6 Protection sleeve
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The lambda sensor LSU enables emission limits to be met reliably and at favorable system costs



negatively influence the performance of the catalytic converter. This guarantees compliance with the emission limits on a long-term basis.

High Controller Dynamics with the LSU

The LSU evaluates deviations from the lambda setpoint which can thus be re-established faster than with switching-type sensors. This high controller dynamics permits:

- ▶ Balance control for optimized oxygen storage in the catalytic converter, leading to enhanced conversion
- ▶ Greater precision in determining the average lambda value
- ▶ Free selection of lambda modulation

Consumption Benefits with the LSU

With lambda setpoints in the lean range, the LSU permits functions for:

- ▶ Component protection
- ▶ Catalyst purge after overrun: the mixture is only enriched for a short time. This saves fuel by comparison with today's lean-burn strategies where the mixture is permanently enriched

With lambda setpoints in the rich range, the mixture can be selectively enriched with the help of the LSU. This brings advantages for:

- ▶ Driveability
- ▶ Catalyst heat-up
- ▶ Component protection

Further Development: LSU ADV

The LSU ADV (Advanced) stands out due to its reduced response times and faster readiness for operation (Ultra Fast Light Off (UFLO) $\leq 5s$). This enables even lower emission values during the heat-up phase.

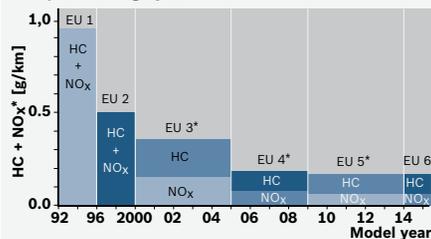
Further benefits of the LSU ADV are:

- ▶ High temperature resilience
- ▶ High accuracy over life-time
- ▶ Customer's choice of connector possible
- ▶ Reduced complexity of vehicle wire-harness
- ▶ Simplified diagnosis

Bosch is continuously developing the lambda sensor to enable compliance with future emissions threshold values

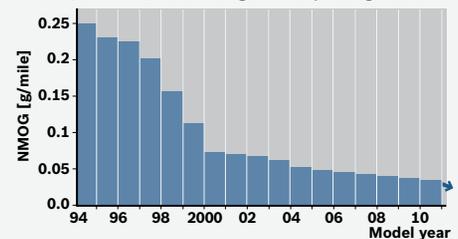
Emission Legislation in Europe and in California

European Driving Cycle



* Separation of HC and NO_x from EU3 onwards, values in accordance with EC directive 98/69

USA (California): fleet average NMOG passenger cars



NMOG: Non Methane Organic Gases (taking into account the ozone forming potential of hydrocarbons in the exhaust gas)

Wide-Band Lambda Sensor for **Reduced System Costs** of the Exhaust-Gas Aftertreatment

With the LSU, systems fulfilling present and future emission and diagnosis regulations can be realized at considerably lower cost. For functions such as secondary-air diagnosis, the LSU requires no additional components. It is, in addition, possible to employ a catalytic converter with thinner coatings of noble metals. These advantages are the result of the high dynamics and the precise measurement of the lambda value over a wide measuring range.

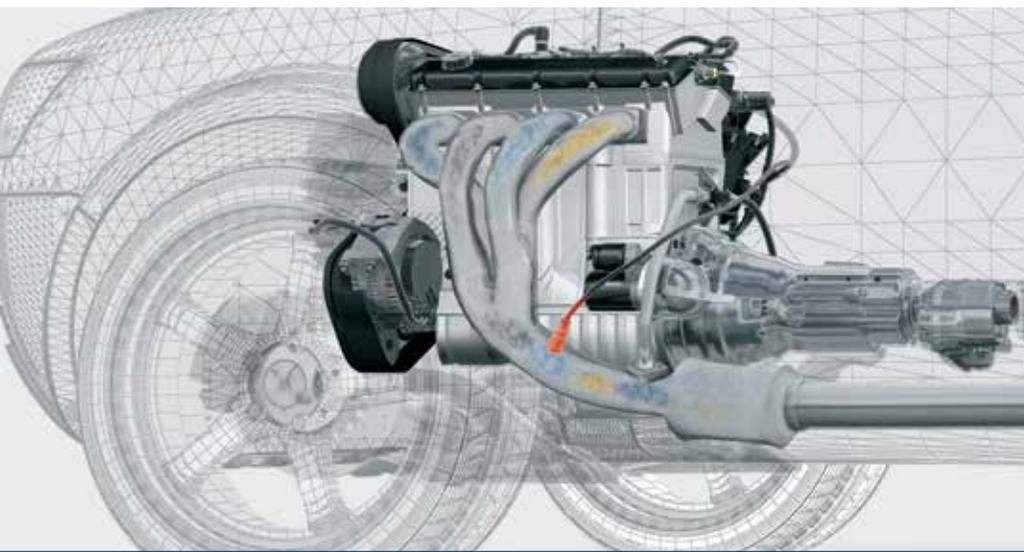
Reduced System Costs for Exhaust-Gas Aftertreatment with the LSU

In comparison to a system comprising two switching-type sensors, an exhaust gas aftertreatment system made up of one wide-band and one switching-type sensor permits cost savings of around one fifth.

Save with the LSU: Constant Lambda Control

The high precision and dynamics of the LSU permit a much better utilization of the exhaust gas system's capacities than before. This allows a reduction in the system reserves previously required:

- ▶ Reduced noble-metal coating thickness in the catalytic converter
- ▶ Improved utilization of the catalytic converter's capacity to store oxygen thanks to balance control
- ▶ Adaptation of lambda modulation to the state of the catalytic converter



Cylinder individual lambda control: the LSU measures deviations from the lambda setpoint in each individual cylinder

Extremely economical: the LSU offers many opportunities to reduce system costs



Save with the LSU: Individual-Cylinder Lambda Control

The LSU continuously measures and evaluates the lambda value of the exhaust gas flowing past it. In this way it can determine the composition of the mixture from the cylinder concerned for each individual combustion. This is illustrated on page 8. The composition of the mixture varies in accordance with differing cylinder charges and fuel dispersal from the injection valves.

The advantages with the LSU:

- ▶ Cylinder co-ordination is easier to achieve
- ▶ The catalytic converter has a higher conversion rate
- ▶ Thinner noble-metal coatings are required

Save with the LSU: Secondary-Air Diagnosis

Diagnosis regulations are demanding new functions such as secondary-air diagnosis. The LSU enables this function to be realized without additional sensors for monitoring the secondary-air flow.

The advantages of the LSU:

- ▶ This function can be realized without additional components
- ▶ Stricter requirements for on-board diagnosis can be complied with

Save with the LSU: Diagnosis Functions

The measured values of the LSU permit even better exploitation of the diagnosis limits than previously.

The advantages of the LSU:

- ▶ Improved diagnosis of the catalytic converter via active storage measurement for catalyst diagnosis instead of lambda modeling
- ▶ Enhanced robustness of the system

Save with the LSU: Reduced Fuel Consumption

The LSU permits extremely precise control of mixture formation under all operating conditions. It thus makes a contribution towards reduced fuel consumption.

Efficient for a clean environment:
lambda control with the LSU from
Bosch



Exhaust-Gas Sensors for Use in Diesel Engines and Small Engines

In developing lambda sensors for gasoline and diesel engines Bosch has two teams of competent specialists with comprehensive know-how. Both groups are in close contact with each other and thus constantly extend their knowledge via mutual exchange of experience.

In the field of small engines a specialized team matches the development and application of lambda sensors individually to the specific requirements of this market.

Joint Development for Clean Diesel Engines

Convincing features of modern diesel engines are high torque, tractive power and minimized emissions. At the Bosch Diesel Systems division we enhance customer benefits with worldwide development, product planning and platform management for diesel control units and sensors.

Thanks to close co-operation in the development of exhaust gas sensors for diesel and gasoline systems, we combine the know-how from both sectors to further develop our lambda sensors.

LSU Lambda Sensor for Diesel Engines

The LSU wide-band lambda sensor permits constant control in the range of $\lambda = 0.65$ to air. It thus offers the right preconditions for use in diesel engines operated with excess air.

In diesel vehicles, the LSU guarantees reliable compliance with the strictest exhaust gas and on-board diagnosis regulations: with its integrated heater, it reaches its operating temperature in five to 20 seconds, depending on type, exhibiting convincingly rapid response.

Lambda control with the LSU in diesel systems brings a number of advantages:

- ▶ Reduction in emission distribution of around 50% in Euro 4 applications
- ▶ Avoidance of smoke clouds when accelerating
- ▶ Improved engine protection (full-load protection)
- ▶ Implementation of the regeneration strategy of the NO_x catalytic converter

The LSU ADV version has been specially optimized for use in diesel engines. The first diesel-specific sensor LS Diesel is under development at present.

Lambda sensors from Bosch prove their worth in diesel systems and in motor racing



Lambda Sensors for Small Engines

Small engines are also increasingly subject to compliance with emission regulations. Examples of their use are two-wheeled vehicles or off-road applications, from snowmobiles or outboard motors right down to lawn mowers. Thanks to our experience with engines of all kinds, we can also offer the right sensors for this field of application. Small-engine manufacturers will find specialized contacts within the Bosch lambda sensors team.

Exhaust-Gas Sensors for All Engines

Every combustion engine, irrespective of its size and the fuel it burns, can be operated even more cleanly with lambda control. With our individually-matched sensors we make a contribution towards ever better air purity: Focus on Clean Air.

With its wide measuring range, the LSU wide-band lambda sensor helps to make diesel engines cleaner than ever before



Bosch: Your Partner for the Workshop of the Future

For over 120 years, innovations from Bosch have kept vehicles in motion to ensure that people get from A to B safely and comfortably.

Bosch Automotive Aftermarket offers the trade and workshops a worldwide unique combination of:

- ▶ Efficient diagnostics
- ▶ Modern workshop equipment
- ▶ Quick and reliable delivery service
- ▶ The most extensive range of replacement parts in the market
- ▶ Workshop concepts for all requirements
- ▶ Comprehensive range of training courses
- ▶ Targeted sales and marketing promotion
- ▶ Skilled hotline
- ▶ Workshop portal available 24 hours every day
- ▶ Favorable leasing offers for workshop equipment and software
- ▶ And many other services to guarantee your success

When this is all combined, not only the parts fit into place but also the time schedule, organization, and the result.

Bosch Lambda Sensors in Premium Quality

Superior technology and high dependability: From the original equipment through motor racing to the spare parts market.

Diagnostics and parts: You only find both at Bosch

Where to find Original Bosch Quality:

More information at:
www.werkstattportal.bosch.de
www.werkstattportal.bosch.at
www.werkstattportal.bosch.ch



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