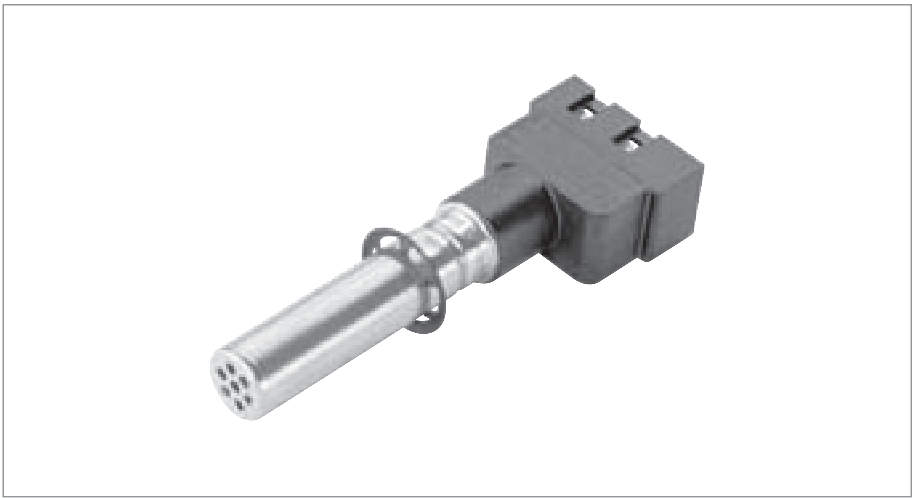
Lambda sensor LSU 1
Measurement of oxygen content

- It is suitable for industrial applications such as waste gas measurements in gas and oil burners.
- Module CJ125: 1267379259 can be used for evaluation.
- The dual-cell wideband sensor is a new type of zirconium dioxide Lambda sensor which can be used for a broad Lambda range from λ > 0.7 to infinity (air).



Application

Combustion processes
– Oil burner
– Gas burner

Design and operation

The Lambda sensor consists of two cells. It is made up of a Nernst type potentiometric oxygen concentration cell and an amperometric oxygen pump cell. Nernst cells have the property that oxygen ions diffuse through their ceramic at high temperatures, as soon as there are differences in the partial oxygen pressure at both ends of the ceramic. The transport of ions results in an electrical voltage between them, which is measured using electrodes.
In an oxygen pump cell, the application of an electrical voltage to a zirconium dioxide ceramic “pumps” oxygen ions from the cathode to the anode. If the continued flow of oxygen molecules out of the exhaust gas to the cathode is prevented by a diffusion barrier, the so-called limit current condition means that a current saturation is reached above a pump voltage threshold. The resulting limit current is proportional to the oxygen concentration in the exhaust gas.
In the oxygen sensor, the pump and Nernst cells are arranged in such a way that a diffusion gap of only around 10 – 50 µm exists between them. The gap is connected with the exhaust gas by a gas inlet hole and it acts as a diffusion barrier. This narrow diffusion duct also contains the porous platinum electrodes, one of the pump cells and one of the Nernst cells on the opposite side. The other electrode for the Nernst cell is located in a reference air duct and is exposed to the surrounding atmosphere by an aperture. Under normal conditions, the air here has an oxygen content of 20.9 percent by volume.

The components of the exhaust gas diffuse through the diffusion duct to the electrodes for the pump and Nernst cell, where they are brought to thermodynamic equilibrium. Control electronics record the Nernst voltage U_N in the concentration cell and supply the pump cell with a variable pump voltage U_P. If U_N takes on a value of less than 450 mV, the exhaust gas is lean and the pump cell is supplied with a current that causes oxygen to be pumped out of the duct. By contrast, if the exhaust gas is rich, U_N> 450 mV and the flow direction is reversed, causing the cell to pump oxygen into the duct.
An integrated module (CJ125) can be used for signal evaluation. As well as the controller for the pump flow and the controller that keeps the Nernst cell at 450 mV, this module includes an amplifier.
The sensor element is manufactured using thick-film techniques, which results in production distribution. This means that the characteristic curves for different sensors will vary. At an oxygen concentration of 0%, the output voltage is a uniform 0 V, as when using the evaluation circuit. However, at air the voltage scatters between approx. 6 and 8 V. This means that each sensor has to be individually calibrated so that a clear relationship between the measured oxygen concentration and the output voltage can be created. Calibration can be carried out on air in which the oxygen content is 20.9%. Calibration is recommended at each maintenance.

Explanation of characteristic quantities

λ Air ratio
U_N Nernst voltage
U_P Variable pump voltage

Special accessory

Connectors (mating connectors) are available under order number: 3623 05 K31V167 from

Karl Lumberg GmbH & Co
Postfach 13 60
D-58569 Schalksmühle
Tel.: 02355/83-01
Fax: 02355/83-263

Installation instructions

We recommend that the sensor element is installed in the flue gas tube suspended, i.e. vertically downward with the connections pointing upwards. A further option is to select an angular installation position of at least 10 from the horizontal (connector outlet upwards). This prevents liquid from accumulating between the sensor housing and the sensor element.
The sensor element should be used in condensation protection mode (standby mode). It is heated to prevent condensation of the moist exhaust gas on the sensor surface. The sensor temperature must be > 75C so that it lies above the dew point temperature.
The sensor is resistant to aggressive exhaust gases such as carbon monoxide, carbon dioxide, nitrogen oxide and low tem-

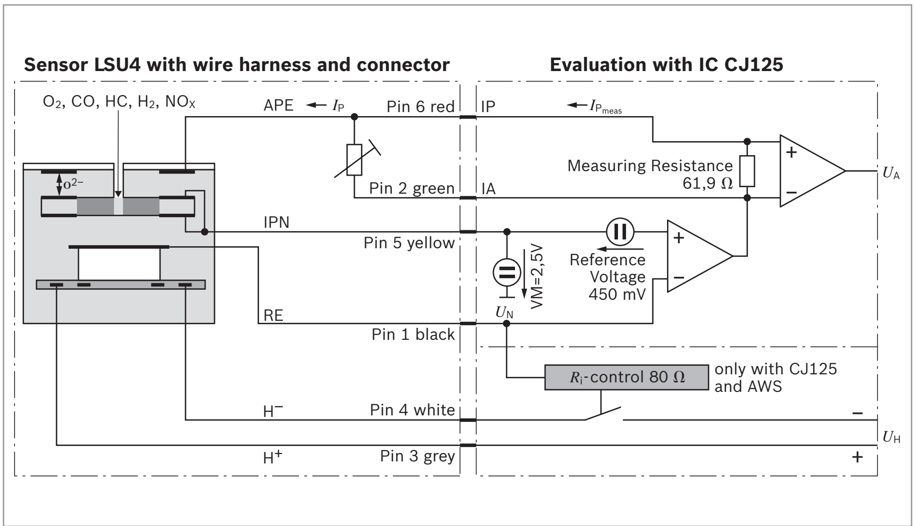
Lambda sensor LSU 1
Measurement of oxygen content

perature carbonization gas throughout its entire service life. However, if the sensor is exposed to lead, phosphorous, silicon, halogens or very high sulfur concentrations, this can reduce its service life.

Warranty claims

As set out in the general terms of delivery A 17, warranty claims can only be accepted if residue-free gaseous hydrocarbons and light fuel oil in accordance with DIN 51603 are used as permissible fuels.

Block diagram



Lambda sensor LSU 1
Measurement of oxygen content

Part number 0 258 004 010

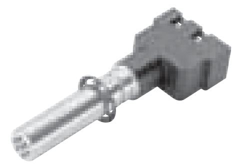
Technical data

Measuring range in λ	0,7 ... ∞
Measuring range for oxygen concentration	0 ... 21 %
Rated heating-voltage value U_H (DC or AC voltage)	9,5 V ± 0,5 V
Max. heating power	≤ 15 W
Typical heat output in operation	11 W
Max. switch-on current at -40 °C	≤ 5 A
Heater resistance at room temperature	3 Ω ± 0,5 Ω
Protection of heating circuit with slow-blow fuse	4 A
Sensor storage temperature	- 40 °C ... + 80 °C
Permissible exhaust-gas temperature at sensor	≤ 250 °C
Permissible ambient temperature at sensor housing (connector side)	≤ 80 °C
Temperature of heated sensor element in exhaust-gas area	≤ 800 °C
Reaction time τ with abrupt change of λ by 0.2?	≤ 5 sec.
Permissible vibration capacity during operation	≤ 50 m/s²
Permissible short-term impact capacity	≤ 300 m/s²
Service life in operation	≥ 12.000 hours
Service life in standby mode	≥ 50.000 hours

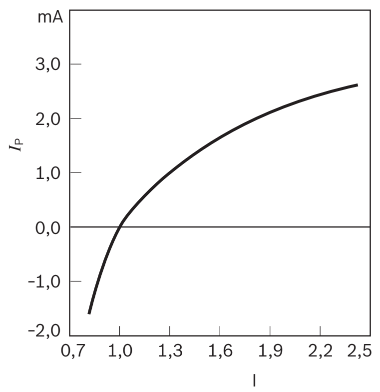
Output signals with CJ125

Output voltage at λ = 0.8 ... 1,2	U_A ≈ 0,5 ... 2 V
Output voltage at λ = 1; O_2 = 0.0 %	U_A = 1.5 V
Output voltage at λ → ∞; O_2 = 20,9 %	U_A ≈ 4.7 V

Figure

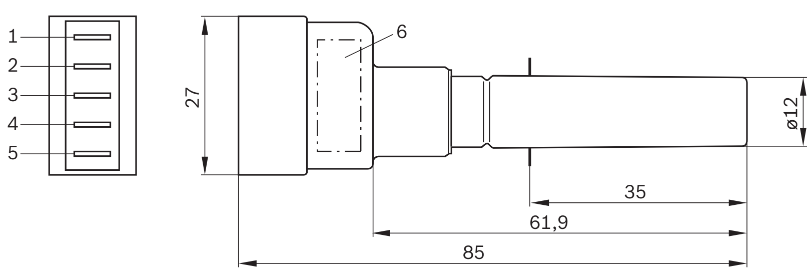


Characteristic curve



I_P* = Pump current
λ = Air ratio

Dimensional drawing



1 Pump outer electrode
2 Inner Pump-/Nernst electrode
3 Reference electrode
4 Sensor heater +
5 Sensor heater -

Notes

Lambda sensor LSU 4.9
Measurement of oxygen content

- ► The wideband Lambda sensor LSU is a planar ZrO_2 dual-cell limit current sensor with integrated heater.
- ► It is used for measuring the oxygen content and the λ value of exhaust gases in vehicle engines.
- ► Thanks to a steady characteristic curve in the range λ = 0.65 to air, it is universally applicable for λ = 1 and for other λ ranges.

Application

Engine management
– Gas engines
– Block-type thermal power stations
– Diesel engines
– Gasoline engines
– Lean combustion engines

Industrial processes
– Tempering furnaces
– Chemical industry
– Packaging equipment
– Process engineering
– Drying plants
– Metallurgy

Measurement and analysis processes
– Flue gas measurement
– Gas analysis
– Determination of Wobbe indexIncineration plants
– Wood
– Biomass

Design and operation

The LSU broadband Lambda sensor is a planar ZrO_2 two-cell limit current sensor with integral heater. It is suitable for measuring the oxygen content and the λ value of exhaust gases in vehicle engines (gasoline and diesel). A constant characteristic curve in the range from λ = 0.65 to air makes it suitable for universal use for λ =1 and for other λ ranges. The connector module includes a trimming resistor, which determines the characteristics of the sensor and is necessary for the sensor to function. To function, the LSU requires special operating electronics (e.g. AWS. LA4 or IC CJ125 evaluation circuit) and may only be operated in conjunction with these.
The Lambda sensor consists of two cells. It is made up of a Nernst type potentiometric oxygen concentration cell and an amperometric oxygen pump cell. Nernst cells have the property that oxygen ions diffuse through their ceramic at high temperatures, as soon as there are differences in the partial oxygen pressure at both ends of the ceramic. The transport of ions results in an electrical voltage between them, which is measured using electrodes.
The components of the exhaust gas diffuse through the diffusion duct to the electrodes for the pump and Nernst cell, where they are brought to thermodynamic equilibrium. Control electronics record the Nernst voltage U_N in the concentration cell and supply the pump cell with a variable pump voltage U_P. If U_N takes on a value of less than 450 mV, the exhaust gas is lean and the pump cell is supplied with a current that causes oxygen to be pumped out of the duct. By contrast, if the exhaust gas is rich, U_N> 450 mV and the flow direction is reversed, causing the cell to pump oxygen into the duct.
An integrated module (CJ125) can be used for signal evaluation. As well as the controller for the pump flow and the controller that keeps the Nernst cell at 450 mV, this module includes an amplifier.
The sensor element is manufactured using thick-film techniques, which results in production distribution. This means that the characteristic curves for different sensors will vary. At an oxygen concentration of 0%, the output voltage is a uniform 0 V, as when using the evaluation circuit. However, at air the voltage scatters between approx. 6 and 8 V. This means that each sensor has to be individually calibrated so that a clear relationship between the measured oxygen concentration and the output voltage can be created. Calibration can be carried out on air in which the oxygen content is 20.9%. Calibration is recommended at each maintenance.

Lambda sensor LSU 4.9
Measurement of oxygen content

Installation instructions

– Installation in exhaust gas pipes at a location exhibiting a representative exhaust gas composition given compliance with the specified temperature limits.
– The ceramic sensor element warms up rapidly after switching on the sensor heating. Once the ceramic element has warmed up, the occurrence of condensate, which could damage the hot ceramic sensor element, must be avoided.
– If possible, the installation position should be vertically upwards, however at least at an angle of 10 ° with respect to the horizontal. This prevents the accumulation of liquid between the sensor housing and sensor element. An angle of 90 ° is desirable, however no greater than 90 ° + 15 ° gas inlet hole with respect to the exhaust gas flow or 90 ° - 30 °. Other angular positions are to be assessed separately if applicable.
– Tightening torque: 40 - 60 Nm, the material properties and strength of the thread must be designed accordingly.

Explanation of characteristic quantities

λ Air ratio
U_N Nernst voltage
U_P Variable pump voltage

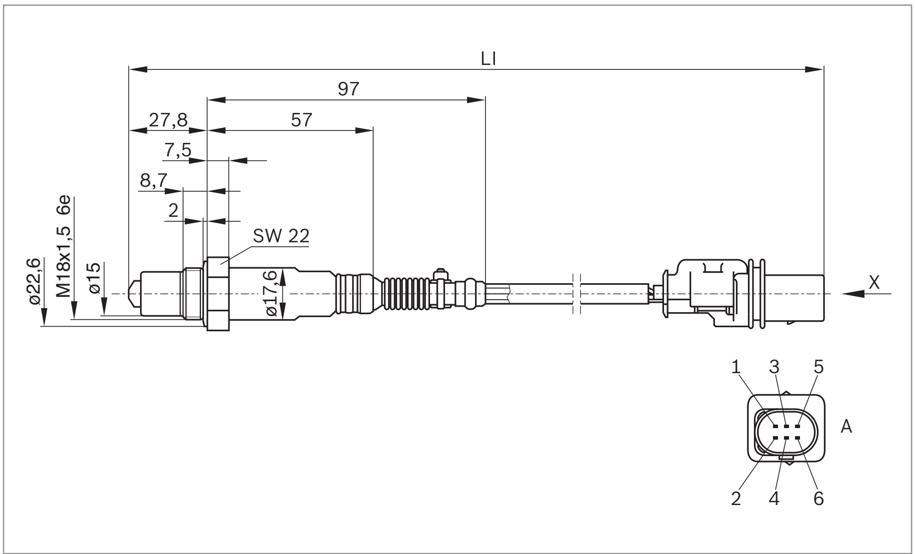
Lambda sensor LSU 4.9
Measurement of oxygen content

Technical data	
Sensor element	
Nominal internal resistance of Nernst cell $R_{i,N}$ As new (operating point, calibration value), (measurement with 1...4 kHz):	300 Ω
Max. current load of Nernst cell Continuous AC ?(f = 1...4 kHz) for $R_{i,N}$ measurement	≤ 250 µA
Recommended reference pump current (sustained)	= 20 µA
Max. pump current to pump cell for rich-gas signal (λ≥ 0.65)	≥ - 9 mA
Max. pump current to pump cell for lean-gas signal (air)	≤ 6 mA
Heater supply	
Nominal voltage	7,5 V
Nominal heat output at 7.5 V Heating voltage in steady-state condition with air	approx. 7,5 W
Typical cold resistance of heater at room temperature, including cable and connector	3,2 Ω
Minimum cold resistance of heater at -40C	1,8 Ω
When switching on the heater, the heating power is to be limited as follows:	
Heater voltage in condensate phase $U_{H,eff}$	≤ 2 V
Maximum permissible effective heater voltage $U_{H,eff}$ for attainment of operating point briefly ≤ 30 s (200 h cumulated)	≤ 13 V
Maximum permissible effective heater voltage $U_{H,eff}$ for attainment of operating point steady-state	≤ 12 V
Maximum permissible vehicle electrical system voltage $U_{Batt,max}$	≤ 16,5 V
Minimum vehicle electrical system voltage	≥ 10,8 V
Operating temperatures	
Exhaust gas ($T_{Exhaustgas}$)	≤ 930 °C
Hexagon at sensor housing ($T_{Hexagon}$)	≤ 600 °C
Cable outlet (PTFE sheath) - sensor side (PTFE socket, $T_{Grommet}$)	≤ 250 °C
Cable outlet (PTFE sheath) - cable side (upper sleeve, $T_{Upperhose}$)	≤ 200 °C
Cable and protective sheathing	≤ 250 °C
Connector	≤ 120 °C
Maximum temperatures (max. 250 h cumulative over service life)	
Exhaust gas ($T_{Exhaustgas}$)	≤ 1030 °C
Hexagon at sensor housing ($T_{Hexagon}$)	≤ 680 °C
Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min)	
Cable outlet (PTFE sheath) - sensor side (PTFE socket, $T_{Grommet}$)	≤ 280 °C
Cable outlet (PTFE sheath) - cable side (upper sleeve, $T_{Upperhose}$)	≤ 230 °C
Cable and protective sheathing	≤ 280 °C
Exhaust gas back pressure	
Continuous operation	≤ 2,5 bar
Brief maximum pressure, max. 250 h accumulated over service life	≤ 4 bar
Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired.	
Permissible oscillating load	
Stochastic oscillations (peak value)	≤ 1000 m/s²
Sinusoidal oscillations	≤ 300 m/s²
Readiness for operation	
Approximate value for sensor ON time („Light-off“)	≤ 10 s

Lambda sensor LSU 4.9
Measurement of oxygen content

Part number 0 258 017 025

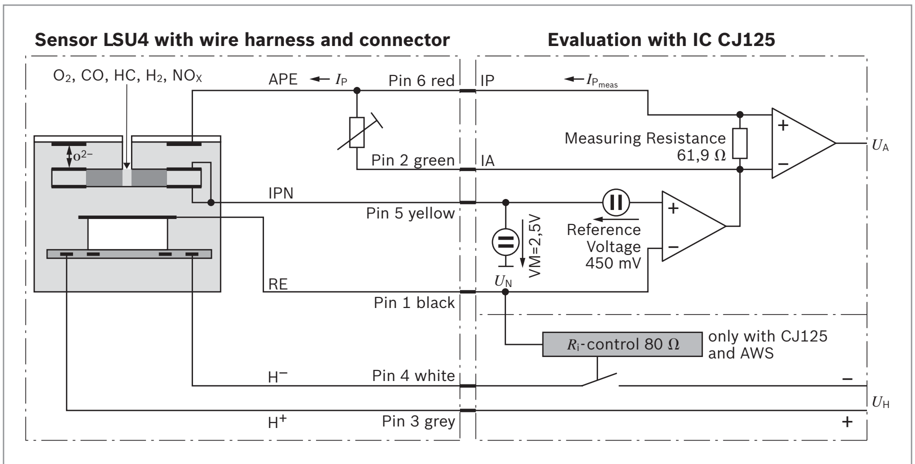
Dimensional drawing



1 Pumping electricity (red)
2 Virtual ground (yellow)
3 Heater clock - (white)
4 Heater clock + U Batt (grey)
5 Trimming potentiometers (green)
6 Nernst voltage (black)

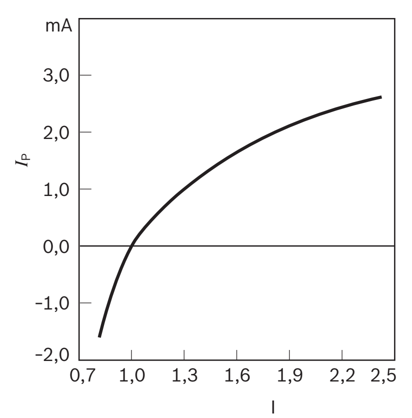
Figure

Block diagram



The evaluation module CJ 125 is required for operation of the LSU 4.9. Further details on request.

Characteristic curve



I_P = Pump current
λ = Air ratio

Accessories		Order number
Mating connector parts set	Connector housing, contacts, grommet	1 986 280 016

List of part numbers

Notes