Lambda sensor, LSU 4.9

Measurement of oxygen content

Input quantity: λ
Output quantity: U

- 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.
- 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.

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.

Explanation of characteristic quantities

λ Air ratio
U_N Nernst voltage
U_P Variable pump voltage

Installation instructions

- Installation in exhaust pipes at a location where the exhaust gas composition is representative whilst complying with the specified temperature limits.
- The sensor ceramic is rapidly heated when the sensor heating is switched on. After heating of the ceramic, any incidence of condensation water that could damage the hot sensor ceramic is to be ruled out.
- The selected angular installation position should be as close to vertically upwards as possible, but at least 10 from the horizontal. This prevents liquid from accumulating between the sensor housing and the sensor element. An inclination of 90 to the exhaust gas flow is ideal, but the maximum is 90 + 15 between the gas inlet hole and the exhaust gas flow) or 90 - 30. Other angular positions are to be evaluated separately where required.
- Tightening torque: 40 – 60 Nm, material properties and strength of the thread must be designed accordingly.

Robert Bosch GmbH
Automotive Aftermarket
Postfach 410960
76225 Karlsruhe
Germany

www.bosch-sensoren.de

Invented for life

BOSCH
Invented for life

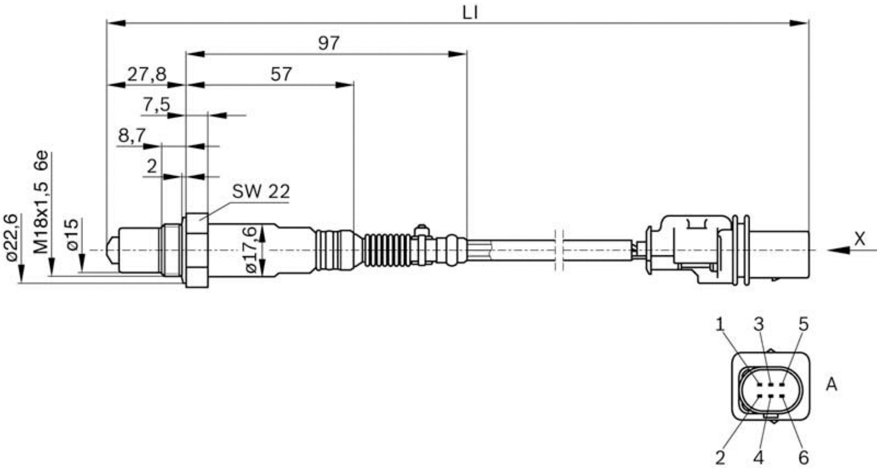
Part number 0 258 017 025

Technical data

Sensor element	
Nominal internal resistance of Nernst cell $R_{i,N}$ when new (operating point, adjustment value), (measurement with 1...4 kHz):	300 Ω
Max. current load of Nernst cell Sustained alternating current (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 heating power at 7.5 V heating voltage in steady-state condition to 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 condensation-water phase $U_{H,eff}$	≤ 2 V
Maximum permissible effective heater voltage $U_{H,eff}$ to reach short-term operating point ≤ 30 s (200 h cumulative)	≤ 13 V
Maximum permissible effective heater voltage $U_{H,eff}$ to reach stationary operating point	≤ 12 V
Maximum permissible electrical system voltage $U_{Batt,max}$	≤ 16,5 V
Minimum electrical system voltage	≥ 10,8 V
Operating temperatures	
Exhaust gas ($T_{Exhaustgas}$)	≤ 930 °C
Hexagon on sensor housing $T_{Hexagon}$	≤ 600 °C
Cable outlet (PTFE molded hose) - Sensor side (PTFE protective sleeve, $T_{Grommet}$)	≤ 250 °C
Cable outlet (PTFE molded hose) - Cable side (upper hose sleeve, $T_{Upperhose}$)	≤ 200 °C
Cable and protective hose	≤ 250 °C
Connector	≤ 120 °C
Maximum temperatures (max. 250 h cumulative over service life)	
Exhaust gas $T_{Exhaustgas}$	≤ 1030 °C
Hexagon on sensor housing $T_{Hexagon}$	≤ 680 °C
Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min)	
Cable outlet (PTFE molded hose) - Sensor side (PTFE protective sleeve, $T_{Grommet}$)	≤ 280 °C
Cable outlet (PTFE molded hose) - Cable side (upper hose sleeve, $T_{Upperhose}$)	≤ 230 °C
Cable and protective hose	≤ 280 °C
Exhaust-gas back pressure	
Continuous service	≤ 2,5 bar
Short-term maximum pressure, max. 250 h cumulative over service life	≤ 4 bar
Comment:	If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired.
Permissible vibration loading	
Stochastic vibrations (peak value/peak)	≤ 1000 m/s²
Sinusoidal vibrations	≤ 300 m/s²
Standby	
Approximate value for sensor switch-on time (“light off”)	≤ 10 s

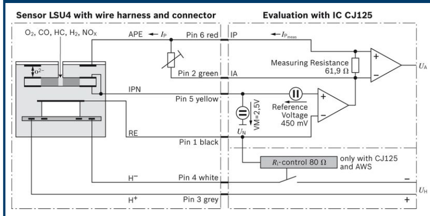
BOSCH
Invented for life

Dimensional drawing



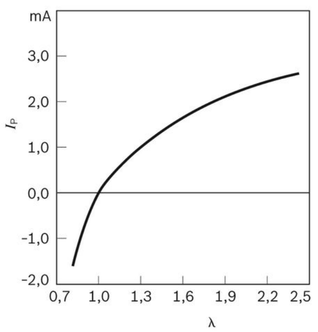
1 Pumping electricity (red)
2 Virtual ground (yellow)
3 Heater clock - (white)
4 Heater clock + U Batt (grey)
5 Trimming potentiometers (green)
6 Nernst voltage (black)

Block diagram



<!-- language missing -->

Characteristic curve



I_P = Pump current
λ = Air ratio

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