

# Wide-band Lambda sensor LSU 4

## Design and application

The LSU 4 wide-band Lambda sensor is a planar dual-cell limit-current sensor. In combination with the planar technology its modular design permits the integration of a number of functions.

The sensor element of the LSU 4 wide-band Lambda sensor is the combination of a Nernst concentration cell (sensor cell) with an oxygen-pump cell, which serves for ion transportation. The sensor is capable of precise measurement not only in the stoichiometric range at  $\lambda = 1$ , but also in the lean and rich ranges.

Together with its control electronics the sensor outputs a clear, continuous signal throughout a wide Lambda range ( $0.7 < \lambda < \text{air}$ ).

When a voltage is applied to the zirconium-dioxide ceramic element of the oxygen-pump cell, oxygen ions are "pumped" from the cathode to the anode. In the LSU 4 wide-band Lambda sensor, the oxygen pump and the Nernst concentration cell are arranged so that there is a diffusion gap of about 10...50  $\mu\text{m}$  between them. There are two porous platinum electrodes located in this gap, together with a pump electrode and a Nernst measuring electrode. The diffusion gap is connected with the exhaust gas through a gas-access passage whereby the porous diffusion barrier limits the flow of the oxygen molecules. Provided the pump voltage is high enough, this leads to a limit current which is proportional to the oxygen concentration.

The reference electrode of the Nernst concentration cell is exposed to the surrounding atmosphere via a reference-air passage and an opening.

The exhaust-gas components diffuse through the diffusion gap at the electrodes of the oxygen pump and Nernst concentration cell, where they are brought to thermodynamic balance.

An electronic circuit controls the pump current through the oxygen-pump cell so that the composition of the exhaust gas in the diffusion gap remains constant at  $\lambda = 1$ . This corresponds to a voltage at the Nernst concentration cell of  $U_N = 450 \text{ mV}$ .

Fig. 1: Wide-band Lambda sensor LSU 4 (View)



Fig. 2: Wide-band Lambda sensor LSU 4 (Section)

1 Sensor element (combination of Nernst concentration cell and oxygen-pump cell), 2 Double protective tube, 3 Seal ring, 4 Seal packing, 5 Sensor housing, 6 Protective sleeve, 7 Contact holder, 8 Contact clip, 9 PTFE sleeve, 10 PTFE shaped sleeve, 11 Five connecting leads, 12 Seal.

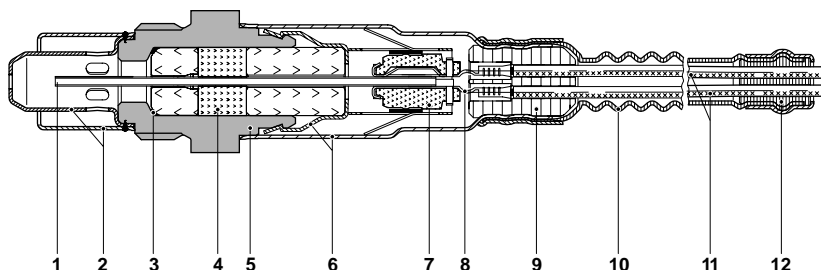


Fig. 3: Wide-band Lambda sensor LSU 4 (Design)

1 Nernst concentration cell, 2 Oxygen-pump cell, 3 Diffusion gap, 4 Reference-air passage, 5 Heater, 6 Heater circuit.

$I_P$  Pump current,  
 $U_H$  Heater voltage,  
 $U_{ref}$  Reference voltage.

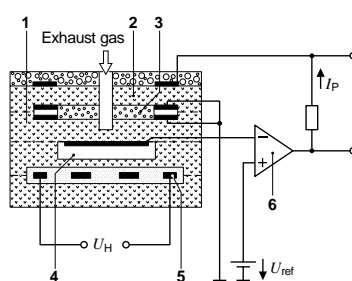
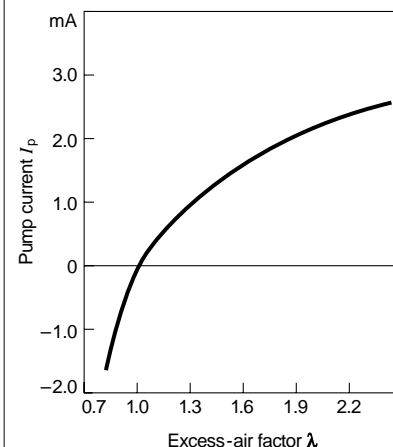


Fig. 4: Sensor signal (measuring current)



Here, in accordance with the laws of diffusion, the pump current is proportional to the oxygen concentration in the "lean" exhaust gas, and to the oxygen deficiency in "rich" exhaust gas. A heater is integrated in the sensor to ensure the required operating temperature of 700...800 °C.

The LSU 4 wide-band Lambda sensor opens up novel areas of application:

- Continuous Lambda control at  $\lambda = 1$ ,
- Control for  $\lambda > 1$  and for  $\lambda < 1$  is possible,
- Lean-burn concepts for SI engines,
- The control can be applied for the control of diesel engines, as well as for
- The control of gaseous-fuel engines and gas-fired heaters.

## Characteristics

- Continuous characteristic curve,
- Precise measurement within a wide range:  $\lambda = 0.7 \dots \text{air}$ ,
- Short response times  $< 100 \text{ ms}$ ,
- Rapid readiness for operation  $< 20 \text{ s}$ ,
- Good ageing resistance,
- Resistant to the effects of deposits and poisoning,
- Robust and compact,
- Highly temperature-resistant,
- Insensitive to stone-throw from road surface,
- Resistant to corrosion,
- Submersible,
- Double protective tube, and
- Operational life  $> 160\,000 \text{ km}$ .

## Specifications

Screw-in thread	M18x1.5 (assembly with special grease only)
Width across flats	A/F 22
Tightening torque	40...60 Nm
Protective tube	Dual protective tube
Sensor length (w.o. lead)	approx. 85 mm
Mass (weight)	approx. 150 g
Operating temperature –Ceramic probe tip (exhaust gas) –Hexagon –Lead outlet	...850°C ...570°C ...250°C
Maximum temperature (short time) –Ceramic probe tip (exhaust gas) –Hexagon –Lead outlet	...980°C ...630°C ...280°C
Operational life	> 160 000 km

Excess-air factor $\lambda$	Sensor signal (mA)
0.7	-2.0
1.0	0.0
1.3	0.5
1.6	0.9
1.9	1.1
2.2	1.3

1 Double protective tube, 2 Thread coated with special grease, 3 Designation lettering, 4 PTFE shaped sleeve, 5 Glass-fiber sleeve, 6 Plug.

