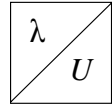


# “Lambda” oxygen sensors, Type LSM 11

For measuring the oxygen content



- Principle of the galvanic oxygen concentration cell with solid electrolyte permits measurement of oxygen concentration, for instance in exhaust gases.
- Sensors with output signal which is both stable and insensitive to interference, as well as being suitable for extreme operating conditions.



## Application

### Combustion processes

- Oil burners
- Gas burners
- Coal-fired systems
- Wood-fired systems
- Bio refuse and waste
- Industrial furnaces

### Engine-management systems

- Lean-burn engines
- Gas engines
- Block-type thermal power stations

### Industrial processes

- Packaging machinery and installations
- Process engineering
- Drying plants
- Hardening furnaces
- Metallurgy (steel melting)
- Chemical industry (glass melting)

### Measuring and analysis processes

- Smoke measurement
- Gas analysis
- Determining the Wobb index

## Range

### Sensor

Total length = 2500 mm	<b>0 258 104 002*</b>
Total length = 650 mm	<b>0 258 104 004</b>

\* Standard version

## Accessories

### Connector for heater element

Plug housing	<b>1 284 485 110</b>
Receptacles <sup>1)</sup>	<b>1 284 477 121</b>
Protective cap	<b>1 250 703 001</b>

### Connector for the sensor

Coupler plug	<b>1 224 485 018</b>
Blade terminal <sup>1)</sup>	<b>1 234 477 014</b>
Protective cap	<b>1 250 703 001</b>

### Special grease for the screw-in thread

Tin 120 g	<b>5 964 080 112</b>
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<sup>1)</sup> 5 per pack

2 needed in each case

## Special accessories

Please enquire regarding analysing unit LA2. This unit processes the output signals from the Lambda oxygen sensors listed here, and displays the Lambda values in digital form. At the same time, these values are also made available at an analog output, and via a multislave V24 interface.

## Installation instructions

The Lambda sensor should be installed at a point which permits the measurement of a representative exhaust-gas mixture, and which does not exceed the maximum permissible temperature. The sensor is screwed into a mating thread and tightened with 50...60 N · m.

- Install at a point where the gas is as hot as possible.
- Observe the maximum permissible temperatures.
- As far as possible install the sensor vertically, whereby the electrical connections should point upwards.
- The sensor is not to be fitted near to the exhaust outlet so that the influence of the outside air can be ruled out. The exhaust-gas passage opposite the sensor must be free of leaks in order to avoid the effects of leak-air.
- Protect the sensor against condensation water.
- The sensor body must be ventilated from the outside in order to avoid overheating.
- The sensor is not to be painted, nor is wax to be applied or any other forms of treatment. Only the recommended grease is to be used for lubricating the threads.
- The sensor receives the reference air through the connection cable. This means that the connector must be clean and dry. Contact spray, and anti-corrosion agents etc. are forbidden.
- The connection cable must not be soldered. It must only be crimped, clamped, or secured by screws.

## Technical data

### Application conditions

Temperature range, passive (storage-temperature range)	-40...+100 °C
Sustained exhaust-gas temperature with heating switched on	+150...+600 °C
Permissible max. exhaust-gas temperature with heating switched on (200 h cumulative)	+800 °C
Operating temperature	
of the sensor-housing hexagon	≤ +500 °C
At the cable gland	≤ +200 °C
At the connection cable	≤ +150 °C
At the connector	≤ +120 °C
Temperature gradient at the sensor-ceramic front end	≤ +100 K/s
Temperature gradient at the sensor-housing hexagon	≤ +150 K/s
Permissible oscillations at the hexagon	
Stochastic oscillations – acceleration, max.	≤ 800 m · s <sup>-2</sup>
Sinusoidal oscillations – amplitude	≤ 0.3 mm
Sinusoidal oscillations – acceleration	≤ 300 m · s <sup>-2</sup>
Load current, max.	±1 µA

### Heater element

Nominal supply voltage (preferably AC)	12 V <sub>eff</sub>
Operating voltage	12... 13 V
Nominal heating power for $v_{\text{Gas}} = 350$ °C and exhaust-gas flow speed of $\approx 0.7$ m · s <sup>-1</sup> at 12 V heater voltage in steady state	≈ 16 W
Heater current at 12 V steady state	≈ 1.25 A
Insulation resistance between heater and sensor connection	> 30 MΩ

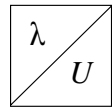
### Data for heater applications

Lambda control range $\lambda$	1.00...2.00
Sensor output voltage for $\lambda = 1.025$ ...2.00 at $v_{\text{Gas}} = 220$ °C and a flow rate of $0.4$ ... $0.9$ m · s <sup>-1</sup>	68...3.5 mV <sup>2)</sup>
Sensor internal resistance $R_{\text{I}}$ in air at 20 °C and at 12 V heater voltage	≤ 250 Ω
Sensor voltage in air at 20 °C in as-new state and at 13 V heater voltage	-9...-15 mV <sup>3)</sup>
Manufacturing tolerance $\Delta \lambda$ in as-new state (standard deviation 1 s) at $v_{\text{Gas}} = 220$ °C and a flow rate of approx. $0.7$ m · s <sup>-1</sup>	
at $\lambda = 1.30$	≤ ±0.013
at $\lambda = 1.80$	≤ ±0.050
Relative sensitivity $\Delta U_{\text{S}}/\Delta \lambda$ at $\lambda = 1.30$	0.65 mV/0.01
Influence of the exhaust-gas temperature on sensor signal for a temperature increase from 130 °C to 230 °C, at a flow rate ≤ $0.7$ m · s <sup>-1</sup>	
at $\lambda = 1.30$ ; $\Delta \lambda$	≤ ±0.01
Influence of heater-voltage change ±10 % of 12 V at $v_{\text{Gas}} = 220$ °C	
at $\lambda = 1.30$ ; $\Delta \lambda$	≤ ±0.009
at $\lambda = 1.80$ ; $\Delta \lambda$	≤ ±0.035
Response time at $v_{\text{Gas}} = 220$ °C and approx. $0.7$ m · s <sup>-1</sup> flow rate As-new values for the 66% switching point; $\lambda$ jump = $1.10 \leftrightarrow 1.30$	
for jump in the "lean" direction	2.0 s
for jump in the "rich" direction	1.5 s
Guideline value for sensor's "readiness for control" point to be reached after switching on oil burner and sensor heater; $v_{\text{Gas}} \approx 220$ °C; flow rate approx. $1.8$ m · s <sup>-1</sup> ; $\lambda = 1.45$ ; sensor in exhaust pipe dia. 170 mm	70 s
Sensor ageing $\Delta \lambda$ in heating-oil exhaust gas after 1,000 h continuous burner operation with EL heating oil; measured at $v_{\text{Gas}} = 220$ °C	
at $\lambda = 1.30$	≤ ±0.012
at $\lambda = 1.80$	≤ ±0.052
Useful life for $v_{\text{Ga}} < 300$ °C	In individual cases to be checked by customer; guideline value > 10,000 h

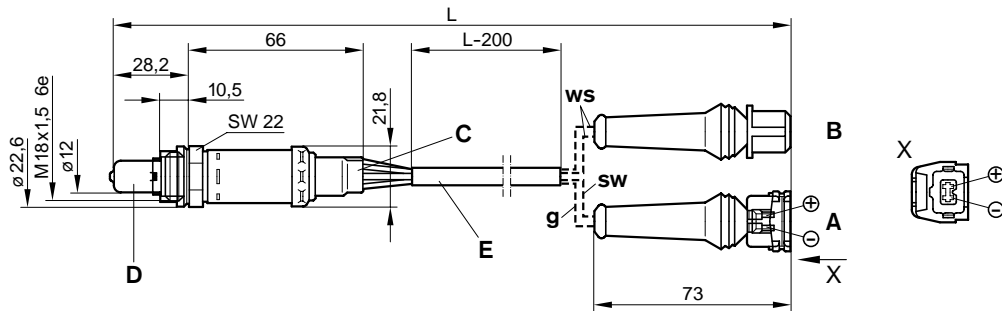
<sup>2)</sup> See characteristic curves.   <sup>3)</sup> Upon request -8.5...-12 mV.

### Warranty claims

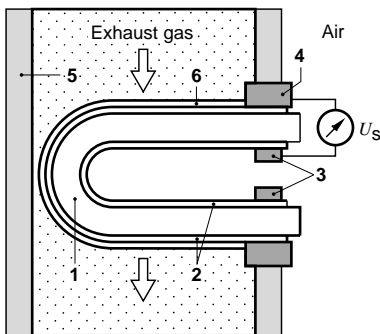
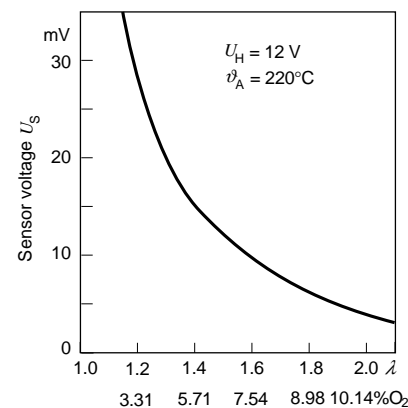
In accordance with the general Terms of Delivery A17, warranty claims can only be accepted under the conditions that permissible fuels were used. That is, residue-free, gaseous hydrocarbons and light heating oil in accordance with DIN 51 603.

**Dimension drawing.**

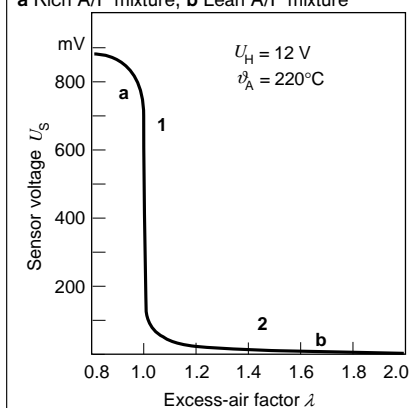
**A** Signal voltage, **B** Heater voltage, **C** Cable sleeve and seals,  
**D** Protective tube, **E** Protective sleeve, **L** Overall length. **ws** White,  
**sw** Black, **g** Grey.

**Lambda sensor in exhaust pipe (principle).**

**1** Sensor ceramic, **2** Electrodes, **3** Contact,  
**4** Housing contact, **5** Exhaust pipe, **6** Ceramic  
 protective coating (porous).

**Characteristic curve: Propane gas (lean range).****Characteristic curve: Complete range.**

**1** Closed-loop control  $\lambda = 1$ ; **2** Lean control  
**a** Rich A/F mixture, **b** Lean A/F mixture

**Design and function**

The ceramic part of the Lambda sensor (solid electrolyte) is in the form of a tube closed at one end. The inside and outside surfaces of the sensor ceramic have a microporous platinum layer (electrode) which, on the one hand, has a decisive influence on the sensor characteristic, and on the other, is used for contacting purposes. The platinum layer on that part of the sensor ceramic which is in contact with the exhaust gas is covered with a firmly bond-ed, highly porous protective ceramic layer which prevents the residues in the exhaust gas from eroding the catalytic platinum layer. The sensor thus features good long-term stability.

The sensor protrudes into the flow of exhaust gas and is designed such that the exhaust gas flows around one electrode, whilst the other electrode is in contact with the outside air (atmosphere).

Measurements are taken of the residual oxygen content in the exhaust gas.

The catalytic effect of the electrode surface at the sensor's exhaust-gas end produces a step-type sensor-voltage profile in the area around  $\lambda = 1$ .<sup>1)</sup>

The active sensor ceramic ( $ZrO_2$ ) is heated from inside by means of a ceramic Wolfram heater so that the temperature of the sensor ceramic remains above the  $350\text{ }^\circ\text{C}$  function limit irrespective of the exhaust-gas temperature. The ceramic heater features a PTC characteristic, which results in rapid warm-up and restricts the power requirements when the exhaust gas is hot. The heater-element connections are completely decoupled from the sensor signal voltage ( $R \geq 30\text{ M}\Omega$ ). Additional design measures serve to stabilize the lean characteristic-curve profile of the Type LSM11 Lambda sensor at  $\lambda > 1.0 \dots 1.5$  (for special applications up to  $\lambda = 2.0$ ):

- Use of powerful heater (16 W)
- Special design of the protective tube
- Modified electrode/protective-layer system.

The special design permits:

- Reliable control even with low exhaust-gas temperatures (e.g. with engine at idle),
- Flexible installation unaffected by external heating,
- Function parameters practically independent of exhaust-gas temperature,
- Low exhaust-gas values due to the sensor's rapid dynamic response,
- Little danger of contamination and thus long service life,
- Waterproof sensor housing.

**Explanation of symbols**

$U_S$  Sensor voltage  
 $U_H$  Heater voltage  
 $t_A$  Exhaust-gas temperature  
 $\lambda$  Excess-air factor<sup>1)</sup>  
 $O_2$  Oxygen concentration in %

<sup>1)</sup> The excess-air factor ( $\lambda$ ) is the ratio between the actual and the ideal air/fuel ratio.