

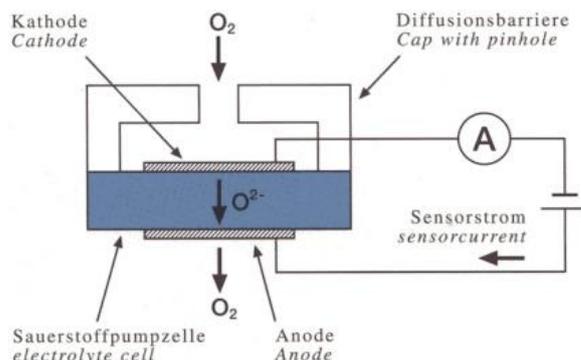
Principle of Operation:

When voltage is applied to a zirconia electrolyte cell, oxygen is pumped through the zirconia disc from the cathode side to the anode side because the carriers of the current flowing through the zirconia electrolyte are oxygen ions. By attaching a cap with a pinhole on the cathode side of the cell and by increasing the voltage over the cell the current shows saturation due to the rate limiting step in the transfer of oxygen to the cathode. This saturation current is called limiting current and is nearly proportional to the ambient oxygen concentration.



Below the advantages of the oxygen sensor:

- measuring range 10 ppm to 96% oxygen
- High accuracy
- For many types a more or less linear characteristic
- Small temperature dependence of the sensor signal
- Low interference with other gases
- Long service life
- In many cases “Single point calibration“ necessary only once



Schematic drawing of a sensor element



Several housing types

Applications:

Medical

- Oxygen Concentrators
- Incubators

Laboratory

- Inert gas processing cabinets (Glove boxes)
- Incubators (controlled bacterial growth)

Food industry

- Packaging
- Controlled food testing
- Monitoring fruit ripening processes (storage / transport)

Household/Gastronomy

- High-temperature humidity measurements (> 100 ° C) for baking / roast automation

Measuring technique

- Oxygen Meters (stationary / portable)
- Measurements under controlled O₂ content
- Air conditioning and ventilation

Security technology/Monitoring

- Fire protection (increased N₂ atmosphere e.g. Server rooms)
- Greenhouses, wine cellar
- Gas storage, refineries
- Diving
- Fermentation units

(Electrical-) industry

- Inert gas processing machines and cabinets
- Inert gas welding monitoring
- Storage with increased N₂ atmosphere (oxidation prevention)
- Drying units
- Nitrogen concentrators
- Exhaust gas measurement

Characteristic Data:

Measuring gas

Oxygen concentration

Measuring medium

Gaseous atmosphere

Measuring principle

Limiting current type sensor

Measuring ranges

Type SO-xx-001	10 ppm – 1000 ppm O ₂
Type SO-xx-010	0,01 – 1,0 vol.% O ₂
Type SO-xx-020	0,01 – 2,0 vol.% O ₂
Type SO-xx-050	0,05 – 5,0 vol.% O ₂
Type SO-xx-250	0,10 – 25,0 vol.% O ₂
Type SO-xx-960	1,00 – 96,0 vol.% O ₂

Details see paragraph: specifications

Output characteristic:

$$I_s(O_2) = -k \cdot \ln\left(1 - \frac{[O_2]}{100}\right)$$

$I_s(O_2)$	Sensor current in μA
$[O_2]$	Oxygen concentration in %
k	specific constant of sensor

Response time (t_{90})

2 to 25 sec. (Depends on: sensor type, gas flow, measuring chamber)

Sensor voltage / heating voltage / power consumption / heater cold resistance

Sensor voltage:	0,7 to 1,6 Volt
Heating voltage:	3.6 – 4.4 Volts
Power consumption:	1.3 to 1.8 Watts (depends on application and packaging)
Cold resistance:	$R_{(25^\circ C)} = 3.25 \Omega \pm 0.20 \Omega$

Warm up time

Min. 30 s

Maximum permissible operating temperature

350 °C (*)

**Depending on the cable and filter assembly (see paragraph: specification, Cable assembly)*

Permissible volumetric flow rate (Purging the sensor)

For all sensor types, the maximum flow rate depends on the way of purging the sensor (sensor in direct gas flow, gas beam shape, etc.) and the size of the measuring chamber. Exception: SO-E1-xxx (TO8 + hose connection for direct gassing). Permissible flow [ml/min]: 100 - 500 (optimal: 250)

Lifetime (MTTF)

~ 20.000 hours (*)

** Depending on measuring medium. Stated lifetime refers to a heated, operated sensor of type SO-xx-250 and SO-xx-960. A failure or reaching the lifetime typically means a slight deviation from the dispatch specifications.*

Vibration resistance

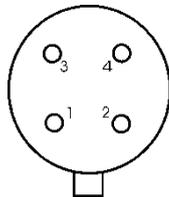
Sensors based on the TO8 socket as well as those built with a TO39 socket (SO-Bx-xxx, SO-Ex-xxx, SO-Ax-xxx) meet the European Norm EN60068-2-6 (Sinusoidal vibration tests).

Pin connection for different sensor types

Standard housing TO39 (Type SO-A0-xxx), TO8 (Type SO-Bx-xxx)

- 1 H+ (HS+)
- 2 H- (HS-)
- 3 Sen+
- 4 Sen-

(Pin-side view)



Sensors with connecting cable for 4-wire operation (SO-Bx-xxx-AxxxC, SO-Dx-xxx-AxxxC)

Sensors with connecting leads (teflon isolation with temperature stability up to 250 °C):

Cable colour	Pin Connection	Connected to pin No.
Violet 1 Violet 2	H+ HS+	1
White 1 White 2	H- HS	2
Red	Sen+	3
Black	Sen-	4



Schematic drawing of sensor connection cable with plug, view from backside of the plug

Specification:

Housing types

Type	Housing	Dimensions, remarks
SO-A0-xxx	TO39	Ø 9.2 mm; H= 6.4 mm; pin distance 3.59 mm
SO-B0-xxx SO-E2-xxx	TO8	Ø 15.3 mm; H= 13.7 mm; pin distance 7.18 mm
SO-B1-xxx	TO8 + mounting flange	Ø 15.3 mm; H= 13.7 mm; pin distance 7.18 mm; mounting holes (flange): Ø 3.4 mm, distance 36 mm
SO-D0-xxx-xxxxx	Screw mountable housing with sintered metal top	M 16 * 1.5 mm L tot.= 49 mm; with connection cable sintered metal top Ø 12 mm, L= 20 mm, SW22
SO-D1-xxx-xxxxx	Screw mountable housing with sintered metal top	M 10 * 1 mm L tot.= 43 mm; with connection cable sintered metal top Ø 12 mm, L= 20 mm SW10
SO-D2-xxx-xxxxx	Aluminium-screw-mountable housing with sintered metal filter	M 16 * 1.5 mm L tot.= 47.4 mm; with connection cable sintered metal filter Ø 12.5 mm, SW22
SO-E1-xxx	TO8 with hose connection	Ø 15,3 mm; H= 23,9 mm; pin distance 7,18 mm; hose connection 4,8 mm

Cable assembly

Type	Cable length [cm]	Operating temperature[°C]	Plug connector
SO-xx-xxx	none	350	none
Except: SO-E1-xxx	none	250 (*)	none
SO-xx-xxx-A100C	100	200 (*)	Rast 2,5
SO-xx-xxx-A300C	300	200 (*)	Rast 2,5

* Operating temperature of the sensor is limited by the temperature resistance of the cable assembly or by the use of an optional Teflon filter.

Measuring ranges

Sensor type	Measuring range	Output current	at gas composition	Sensor voltage	Code
SO-xx-001	10 ppm O ₂ – 1000 ppm O ₂	70 µA – 140 µA	400 ppm O ₂ , remainder N ₂	0.70 volt	A
SO-xx-010	0.01 % O ₂ – 1.0 % O ₂	150 µA – 250 µA	1.0 % O ₂ , remainder N ₂	0.75 volt	H
SO-xx-020	0.01 % O ₂ – 2.0 % O ₂	150 µA – 250 µA	2.0 % O ₂ , remainder N ₂	0.75 volt	B
SO-xx-050	0.05 % O ₂ – 5.0 % O ₂	150 µA – 250 µA	5.0 % O ₂ , remainder N ₂	0.80 volt	C
SO-xx-250	0.10 % O ₂ – 25.0 % O ₂	100 µA – 200 µA	20.9 % O ₂ , remainder N ₂ (air)	0.85 volt	D
SO-xx-960	1.00 % O ₂ – 96.0 % O ₂	15 µA – 30 µA	20.9 % O ₂ , remainder N ₂ (air)	1.60 volt	E

* Operation outside the specified measuring range can cause a permanent damage of the electrode.

Accuracy, reproducibility and response time

Sensor type	Accuracy	Reproducibility
SO-xx-001 (*)	± 20 ppm O ₂	< 10 ppm O ₂
SO-xx-010	± 100 ppm O ₂	< 100 ppm O ₂
SO-xx-020	± 200 ppm O ₂	< 100 ppm O ₂
SO-xx-050	± 500 ppm O ₂	< 250 ppm O ₂
SO-xx-250	± 0.25 % O ₂	< 0.1 % O ₂
SO-xx-960	± 1.00 % O ₂	< 0.2 % O ₂

* Currently SO-D2-001 not available

Temperature of the housing during operation

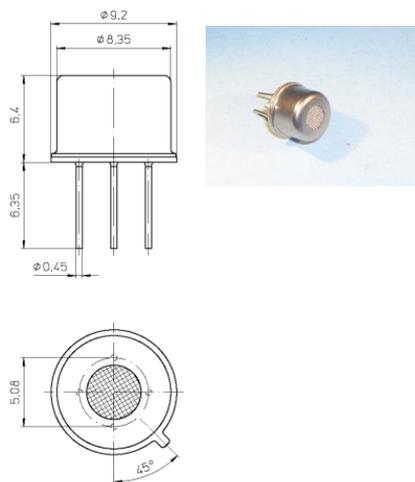
Type	Housing	Max. temperature
SO-Ax-xxx	TO39	250 °C
SO-Bx-xxx	TO8	70 °C
SO-Dx-xxx-xxxxx	Screw mounted housing	70 °C

(Measured at ambient temperature of 25°C)

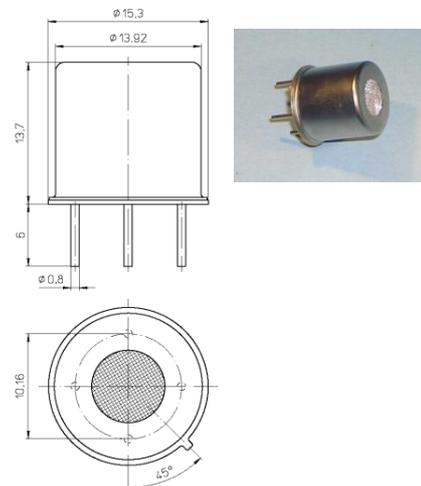
Appendix: Housing types

Standard housings:

TO39 (SO-A0-xxx)

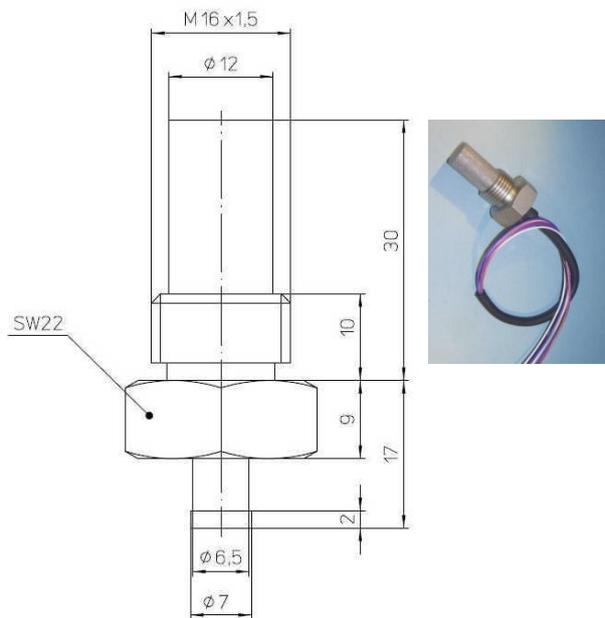


TO8 (SO-B0-xxx)

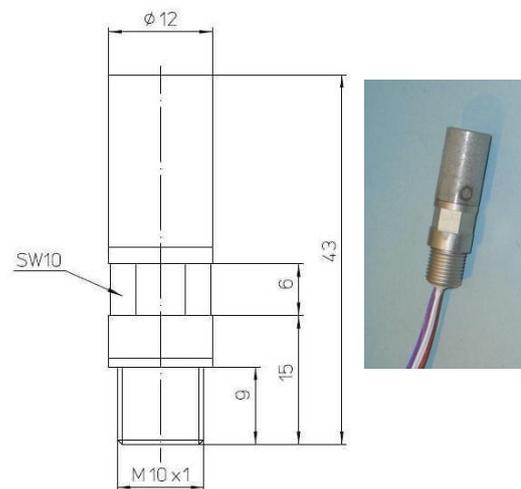


Screw mountable housings with sintered metal cap

SO-D0-xxx- xxxxx

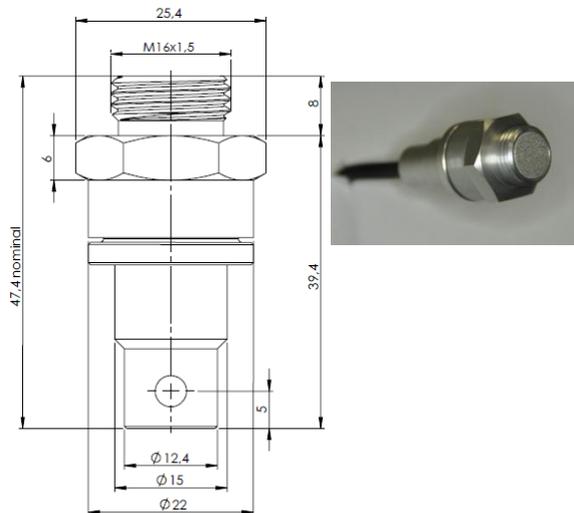


SO-D1-xxx- xxxxx



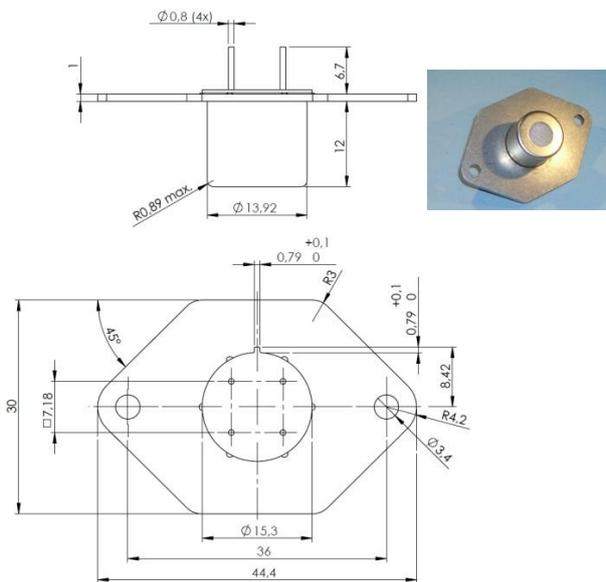
Aluminium Screw mountable housings with sintered metal filter

SO-D2-xxx-xxxxx (SW22)



TO8 housing with mounting flange

SO-B1-xxx-xxxxx



TO8 housing with hose connection (direct exposure to gas)

SO-E1-xxx

