

# ZR400 MINI-ZIRCONIA OXIDE SENSOR

TECHNICAL BULLETIN 006

Trace oxygen measurement, 0 to 1000 ppm  
For high purity applications

## Introduction

The Neutronics ZR400 mini-zirconia sensor is a ceramic, solid-state device that features accurate measurement and a fast response to oxygen. This zirconia solid electrolyte cell includes a low-power on-board heater and two electrodes. Unlike many solid-state oxygen sensors, the ZR400 does not require a reference gas for normal operation. For the most accurate readings, a simple flexible two-point calibration is recommended. During the normal service life of the sensor, no additional calibration is required.

## Description

When voltage is applied to the sensor, oxygen ions are pumped through the zirconia disk from the cathode side to the anode side. The oxygen ions are the carriers of the current flowing through the zirconia electrolyte. A diffusion hole on the cathode side of the cell limits the flow of oxygen into the cathode area where it is converted to oxygen ions and pumped. 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 referred to as the limiting current and is proportional to the ambient oxygen concentration.

The sensor (figure 1) is mounted directly onto a printed circuit board that supplies heater bias and voltage to the sensor element. Since the sensor is a heated device, the sensor body is positioned a few millimeters above the surface of the PCB to promote gas circulation.

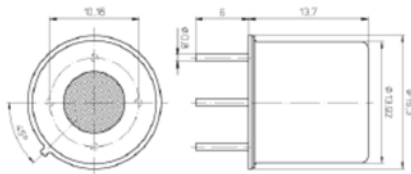


Fig. 1

## Applications

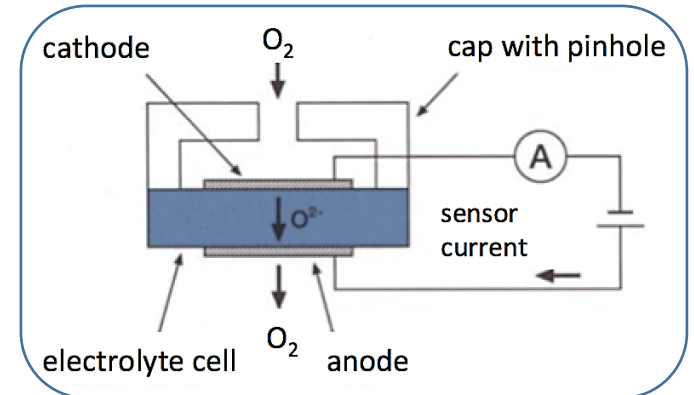
Air separation

Biochemical processing/fermentation

Contact lens manufacturing

Cryogenic gas generation

Food and beverage packaging



## Features

- Rapid response time – reads ppm oxygen from air in < 10 seconds
- Long service life – expected sensor service life is 3 to 4 years
- Low interference with other gases
- Small temperature dependence of the sensor signal
- High accuracy --  $\pm 3$  ppm in the range of 1 to 50ppm

Glass and fiber optics manufacturing

Inert gas purity/nitrogen purity systems

Semiconductor manufacturing

Welding

Glove box systems

# ZR400 MINI-ZIRCONIA OXYGEN SENSOR

When the ambient temperature fluctuations are small, constant voltage with current limitation is supplied to the heater and sensor pins. In this heater mode, the output signal changes by 0.034%/°C ambient temperature. Since the heater is built into the sensor assembly, no external temperature sensor is required to control the heater temperature.

## Cross sensitivity

The sensor selects 100% oxygen. If other gases exist, preliminary reactions may occur where additional oxygen may result or oxygen may be consumed. Gases containing halogens – fluorine, chlorine, and bromine – will cause damage to the sensor. SO<sub>x</sub> and H<sub>2</sub>S in concentrations of 50 ppm will induce a loss of electrode activity and shorten the sensor service life. VOCs, silicones, and adhesive compounds have a similar influence (figure 2).

Exposure to these gases can lessen the catalytic effect of the

platinum electrode. This may cause a reduction in response time or sensor failure. Depending on the type of corrosive gas, chemical reactions may occur on the electrode, causing inaccurate readings.

At small concentrations or short residence time of exposure, sensor damage is reversible. The sensor will regenerate if it is operated at normal conditions (operation in ambient air, 20.9% oxygen content).

## Sensor storage

The sensor is unaffected by temperature changes in its unheated state. Storage temperatures may range from -10°C to 85°C (14°F to 185°F). Non-condensed humidity has no effect on the unheated sensor.

Fig. 2

| Gas                         | Max. concentration of the checked gas | Cross sensitivities ( $\Delta\%O_2$ )/(% gas) | At O <sub>2</sub> concentration |
|-----------------------------|---------------------------------------|---|---------------------------------|
| CO <sub>2</sub>             | 40%                                   | -0.027  | 20% O <sub>2</sub>              |
| CO <sub>2</sub>             | 40%                                   | -0.01   | 5% O <sub>2</sub>               |
| CO                          | 1000 ppm                              | -0.73   | 20% O <sub>2</sub>              |
| CO                          | 1000 ppm                              | -0.83   | 5% O <sub>2</sub>               |
| NO <sub>2</sub>             | 1000 ppm                              | 1.06  |                                 |
| SO <sub>2</sub>             | 1000 ppm                              | -0.24   |                                 |
| CH <sub>4</sub>             | 1000 ppm                              | -1.77   | 5% O <sub>2</sub>               |
| H <sub>2</sub> S            | 400 ppm                               | ~0.0  |                                 |
| H <sub>2</sub> O (humidity) | 90% abs.                              | ~0.0  |                                 |

## Technical specifications

|                                  |   |
|----------------------------------|---|
| Measurement technology           | Mini-zirconia oxide, limiting current type  |
| Measure gas                      | Oxygen  |
| Measurement range                | 0 to 1,000 ppm  |
| Accuracy                         | ±3 ppm in the range of 0 to 50 ppm; ±4 ppm in the range of 51 to 100 ppm; ±5 ppm in the range of 101 to 500 ppm; ±10 ppm in the range of 501 to 1,000 |
| Response time (T <sub>90</sub> ) | < 10 seconds  |
| Sample flow                      | 0.5 to 1.5 slm (1 slm nominal)  |
| Warm up time                     | 60 seconds  |
| Operating temperature            | 0°C to 50°C (32°F to 122°F)   |
| Relative humidity                | 0 to 90%, non-condensing  |
| Storage temperature              | -10°C to 85°C (14°F to 185°F)   |
| Vibration resistance             | Meets EN 60068-2-6 (Sinusoidal vibration tests)   |
| Service life                     | 3 to 4 years  |
| Warranty                         | 12 months from date of shipment   |



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