**SENSOR PROBES** 

# Oxygen Sensor Spots PSt3 / PSt6









# Oxygen Sensor Spots PSt3 / PSt6

Specification:

Chemical optical oxygen sensor spots for integration into transparent glass or plastic vessels

Document filename: IM\_SP-PSt3\_PSt6\_dv7

All rights reserved. No parts of this work may be reproduced in any form or by any means graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems - without the written permission of the publisher.

Products that are referred to in this document may be either trademarks and/or registered trademarks of the respective owners. The publisher and the author make no claim to these trademarks.

While every precaution has been taken in the preparation of this document, the publisher and the author assume no responsibility for errors or omissions, or for damages resulting from the use of information contained in this document or from the use of programs and source code that may accompany it. In no event shall the publisher and the author be liable for any loss of profit or any other commercial damage caused or alleged to have been caused directly or indirectly by this document.

Specifications may change without prior notice.

Manufacturer **PreSens** 

Precision Sensing GmbH

Am BioPark 11 93053 Regensburg, Germany Fax +49 941 94272111

Phone +49 941 94272100

info@PreSens.de www.PreSens.de

# **Table of Contents**

1	Preface	7
2	Safety Notes	
3	Description of the Oxygen Sensor Spots	9
3.1 3.2	Scope of Delivery  Measurement Set-up	
4	Operation	. 12
4.1	Unpacking the Oxygen Sensor Spots	. 12
4.2	Mounting the Sensor Spots in the Vessel	. 13
4.3	Calibration	. 15
4.3.1	Calibration of a PSt3 Sensor Spot – Preparation of Calibration Standards	. 15
	Calibration of a PSt6 Sensor Spot – Preparation of Calibration Standards	
5	Technical Data	. 18
6	Concluding Remarks	. 19

## 1 Preface

You have chosen a new, innovative technology for measuring oxygen.

Chemical optical sensors (also called optodes) have several important features:

- They are small.
- Their signal does not depend on the flow rate of the sample.
- They can be physically divided from the measuring system which allows a noninvasive measurement.
- They can be used in disposables.

Therefore, they are ideally suited for the examination of small sample volumes, for highly parallelized measurements in disposables, and for biotechnological applications. A set of different minisensors, flow-through cells and integrated sensor systems is available to make sure you have the sensor which matches your application.

Please feel free to contact our service team to find the best solution for your application.

Your PreSens Team

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE WORKING WITH THIS ITEM.

# 2 Safety Notes

It is the customer's responsibility to validate the sensor and transmitter under end-user conditions according to safety precautions of the application to ensure that the use of the sensor is safe and suitable for the intended purpose.

PreSens is explicitly not liable for direct or indirect losses caused by the application of these measurement systems. In particular it has to be considered that malfunctions can occur due to the naturally limited lifetime of the sensor depending on the respective application. The set-up of backup measurement stations is recommended when using the sensors in critical applications to avoid consequential losses. It is the customer's responsibility to install a suitable safety system in the event of sensor failure.

# 3 Description of the Oxygen Sensor Spots

The chemical optical oxygen sensor spots can be attached to the inner surface of any transparent glass or plastic vessel like e. g. shake and spinner flasks, tubes, Petri dishes or cultivation bags. Oxygen is measured non-invasively and non-destructively through the transparent vessel wall. The oxygen sensor spots do not consume oxygen. The YAU sensors can be autoclaved and stand steam sterilization, the NAU sensors cannot be autoclaved.



Fig. 1 Oxygen Sensor Spots PSt3 and PSt6

#### 3.1 Scope of Delivery

The PSt3 / PSt6 sensor spots are delivered in a light-tight package. Each unit contains 1 (autoclavable = YAU) or 10 (not autoclavable = NAU) sensor spots packed individually in a transparent plastic sachet.

#### Additionally required equipment (not supplied):

- Fiber optic oxygen transmitter, e. g. Fibox 4 (more oxygen transmitters can be found on www.presens.de/products)
- PC / Notebook
- Glue, e. g. SG1
- Vacuum tweezers (can be obtained from major lab suppliers like e.g. VWR or Fisher Scientific.)
- Tweezers
- Spatula
- Dispenser pipette

## 3.2 Measurement Set-up



Fig. 2 Set-up for measurement with a sensor spot PSt3 or PSt6

A polymer optical fiber (POF), which is connected to a fiber optic oxygen transmitter, e.g. Fibox 3, is placed on the outer surface of the vessel, right opposite the sensor spot. The transmitter is connected via a serial COM port to a PC.

The POF can be attached to the vessel and held in place by applying different accessories:

The stick-on adapter SOA can be attached to the outer surface of the vessel and holds the polymer optical fiber in place.



Fig. 3 Stick on adapter (SOA)

If you have applied a sensor spot to a round vessel the adapter for round containers can be used. The ARC can be adjusted to different vessel sizes and holds the polymer optical fiber in place.



Fig. 4 Adapter for round containers (ARC)

A coaster CFG connected to a fiber optic oxygen transmitter can also be used. Place the CFG under the vessel and make sure its optical module is right opposite the sensor spot.

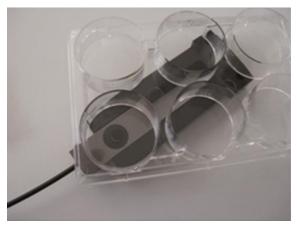


Fig. 5 Coaster CFG used to read the response of an oxygen sensor spot in a 6-well multidish

# 4 Operation

### 4.1 Unpacking the Oxygen Sensor Spots

The sensor spots are delivered in a light-tight package to ensure a long shelf life, so do not open this packaging immediately at delivery. It is recommended to unpack the sensor spots just before using them. Carefully remove the sensor spots from the protective external cover. Each packing unit includes 1 (autoclavable = YAU) or 10 (not autoclavable = NAU) sensor spots packed individually in transparent plastic sachets.

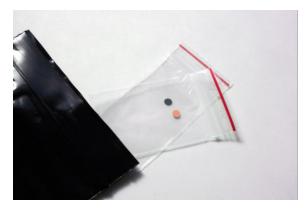


Fig. 6 Light tight package with individually packed sensor spots

An oxygen sensor spot has a red side (back) and a black side (front). The red side has to face the vessel wall when integrating it.

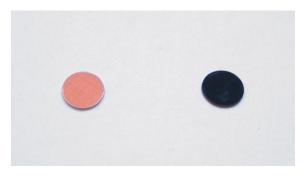


Fig. 7 Sensor spot back (red) and front (black)

#### 4.2 Mounting the Sensor Spots in the Vessel

You can also watch our videos about integrating an oxygen sensor spot into different vessels on http://www.presens.de/support-services/videos.html.

The wall of the test vessel should be transparent or semi-transparent and not too thick. The adhesion surface of the vessel should be plane or only slightly arched; moreover, the surface should be dry and clean, otherwise the sensor spot might partly detach from the vessel wall.

Place the sensor spot with its front side (black side) up on the desk; then pick it up by its front side with vacuum tweezers.

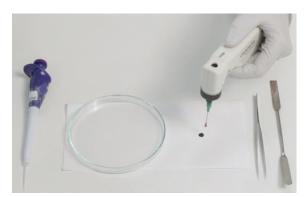


Fig. 8 Picking up an oxygen sensor spot with an aspirette by its front side

Holding the sensor spot with the vacuum tweezers apply approx. 2  $\mu$ L (± 0.5  $\mu$ L for adhesion on slightly arched surfaces; amount for standard spots with 5 mm diameter) of silicone glue on the red side of the sensor spot using a dispenser pipette.



Fig. 9 Applying silicone glue to the sensor spot

Now carefully place the sensor spot on the inside vessel wall. Slightly press it onto the surface so that a small ring of silicone glue emerges around its edge.



Fig. 10 Carefully place the oxygen sensor spot in the vessel

No air should be enclosed in the silicone glue between sensor spot and vessel wall.

The glue should be spread evenly over the sensor spot surface to avoid detachment.

Put the vessel in a dark place and let the silicone glue cure for at least 12 hours.

Then the vessel can be filled with your sample. Mount the respective accessory on the outer surface of the vessel right opposite the sensor spot and connect it via polymer optical fiber to the oxygen transmitter. Or, to do this manually, directly hold a polymer optical fiber to the outside vessel wall opposite the sensor spot.



Fig. 11 Polymer optical fiber held by hand opposite the sensor spot to read its response

#### 4.3 Calibration

Oxygen sensor spots have to be calibrated before use. A conventional two-point calibration in oxygen-free environment (nitrogen or sodium sulfite), and air saturated (PSt3) or 1 - 2% oxygen (PSt6) environment must be performed.

The oxygen sensor requires no re-calibration up to 100,000 measurement points.

Please see the respective transmitter instruction manual for more detailed information about software settings and calibration procedure.

# 4.3.1 Calibration of a PSt3 Sensor Spot – Preparation of Calibration Standards

1st Calibration Point:

#### Oxygen-free water

To prepare oxygen-free water dissolve 1 g of sodium sulfite (Na<sub>2</sub>SO<sub>3</sub>) and 50  $\mu$ L cobalt nitrate (Co(NO<sub>3</sub>)<sub>2</sub>) standard solution ( $\rho$ (Co) = 1000 mg/L; in nitric acid 0.5 mol/L) in 100 mL water. Use a suitable vessel with a tightly fitting screw top and label it **cal 0**. Make sure there is only little headspace in your vessel. Due to a chemical reaction of oxygen with the Na<sub>2</sub>SO<sub>3</sub> the water becomes oxygen-free. Additional oxygen, diffusing from air into the water, is removed by surplus Na<sub>2</sub>SO<sub>3</sub>. Close the vessel with the screw top and shake it for approximately one minute to dissolve Na<sub>2</sub>SO<sub>3</sub> and to ensure that the water is oxygen-free. To prepare oxygen-free water you also can use sodium dithionite (Na<sub>2</sub>S<sub>2</sub>O<sub>4</sub>).

Fill the calibration solution **cal 0** in the vessel you have mounted the sensor spot in. Make sure the sensor spot surface is covered completely with the liquid. To minimize the response time, slightly stir the solution. Then follow the instructions in the respective transmitter manual for calibration. After recording the first calibration point remove the calibration solution **cal 0**, fill the vessel with distilled water and stir it for 1 minute. Repeat this procedure at least 5 times to clean the sensor spot from sodium sulfite.

For storing the calibration solution **cal 0** keep the vessel closed after calibration with a screw top to minimize oxygen contamination. The shelf life of **cal 0** is about 24 hours provided that the vessel has been closed with the screw top.

# Nitrogen-saturated atmosphere As an alternative you can use nitrogen-saturated atmosphere as calibration standard cal 0. Use a commercially available test gas N<sub>2</sub> (5.0) (suppliers are e. g. Air Liquide,

Linde, Westfalen AG).

Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

#### 2nd Calibration Point:

#### Air-saturated water

Add 100 mL water to a suitable vessel and label it **cal 100**. To obtain air-saturated water, blow air into the water using an air-pump with a glass-frit (air stone), creating a multitude of small air bubbles, while stirring the solution. After 20 minutes, switch of the air-pump and stir the solution for another 10 minutes to ensure that the water is not supersaturated.

Fill the calibration solution **cal 100** in the vessel you have mounted the sensor spot in. Make sure the sensor spot surface is covered completely with the liquid. To minimize the response time, slightly stir the solution. Then follow the instructions in the respective transmitter manual for calibration.

#### Water vapor-saturated air

As an alternative you can use water-vapor saturated air as calibration standard **cal 100**. Place wet cotton wool in the vessel you have mounted the sensor spot in. Close the vessel with a fitting screw top or lid. (For inserting the temperature sensor into the vessel you might have to drill a hole in the lid.) Wait about 2 minutes to ensure that the air is water vapor-saturated.

Then follow the instructions in the respective transmitter manual for calibration.



Fig. 12 Calibration set-up: Two-point calibration of a PSt3 sensor spot with liquid calibration standards

# 4.3.2 Calibration of a PSt6 Sensor Spot – Preparation of Calibration Standards

Calibration of PSt6 sensor spots is performed with certified gases (suppliers are e. g. Air Liquide, Linde, Westfalen AG).

#### 1st Calibration Point:

Nitrogen-saturated atmosphere
 Use nitrogen (N<sub>2</sub> 5.0) as a first calibration standard cal 0.

Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

#### 2nd Calibration Point:

 $01 - 2\% O_2$ 

The second calibration value **cal 2nd** for a PSt6 sensor is ideally in the range between 5 and 10 % air sat. (ca. 1-2 %  $O_2 \rightarrow$  % air sat. = %  $O_2$  x 100/20.95). Use a commercially available test gas of 1-2 % O2 as a second calibration standard **cal 2nd**.

Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

If it is not possible to use gases or to build a suitable calibration chamber, a manual calibration can be performed, using calibration values obtained from the final inspection protocol delivered with the sensor spots. You can find more information about manual calibration in the instruction manual of the respective transmitter.

## CALIBRATION SET-UP for Calibration with Certified Gases

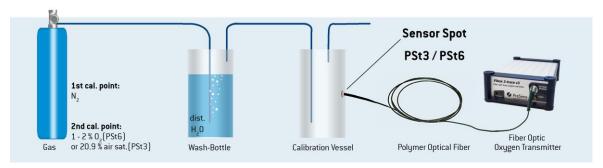


Fig. 13 Calibration set-up: Two-point calibration of PSt3 and PSt6 sensor spots with gases

# **5 Technical Data**

Measurement range		Sensor Typ	e PSt3	Sensor Type I	PSt6	
0 - 1000 hPa   0 - 1400 μmol/L   0 - 41.4 hPa   0 - 56.9 μmol/L	Specifications	Gaseous & Dissolved O <sub>2</sub>	Dissolved O <sub>2</sub>	Gaseous & Dissolved O <sub>2</sub>	Dissolved O <sub>2</sub>	
Limit of detection 0.03 % oxygen 15 ppb 0.002 % oxygen 1 ppb  Resolution	Measurement range	0 – 100 % O <sub>2</sub>	0 – 45 mg/L	0 – 4.2 % O <sub>2</sub>	0 – 1.8 mg/L	
Resolution		0 – 1000 hPa	0 – 1400 µmol/L	0 – 41.4 hPa	0 – 56.9 μmol/L	
# 0.1 % O <sub>2</sub> at 20.9 % O <sub>2</sub> 2.83 µmol/L # 0.0015 % O <sub>2</sub> at 0.2 % O <sub>2</sub> 0.03 µmol/L # 0.01 hPa at 2 hPa # 1.4 µmol/L at 283.1 # 0.007 hPa at 0.023 hPa # 0.020 µmol/L at 1 hPa at 207 hPa # 0.015 hPa at 2.0 hPa 2.8 µmol/L # 0.015 hPa at 2.0 hPa 2.8 µmol/L # 0.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.9 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub> # 20.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub> # 20.05 % O <sub>2</sub>	Limit of detection	0.03 % oxygen	15 ppb	0.002 % oxygen	1 ppb	
# 0.1 hPa at 2 hPa # 1.4 µmol/L at 283.1 # 0.007 hPa at 0.023 hPa # 0.020 µmol/L a # 1 hPa at 207 hPa part 20	Resolution	± 0.01 % O <sub>2</sub> at 0.21 % O <sub>2</sub>	± 0.14 µmol/L at	± 0.0007 % O <sub>2</sub> at 0.002 % O <sub>2</sub>	± 0.010 µmol/L at	
# 1 hPa at 207 hPa			-		•	
Accuracy* ± 0.4 % O₂ at 20.9 % O₂ ± 1ppb or ± 3 % of the respective concentration; whichever is higher  Drift at 0 % oxygen		± 0.1 hPa at 2 hPa	±1.4 µmol/L at 283.1	± 0.007 hPa at 0.023 hPa	± 0.020 µmol/L at	
# 0.05 % O₂ at 0.2 % O₂    respective concentration; whichever is higher		***************************************	µmol/L		2.8 µmol/L	
Drift at 0 % oxygen	Accuracy*	=		• •		
Drift at 0 % oxygen		± 0.05 % O <sub>2</sub> at 0.2 % O <sub>2</sub>		•		
Measurement temperature range Response time (t <sub>90</sub> ) < 6 sec. < 40 sec. < 6 sec. < 40 sec.  Properties  Compatibility  Aqueous solutions, ethanol, methanol  No cross-sensitivity with  CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> lonic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, +80 °C, +176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment in the oxygen free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen				whichever is higher		
temperature range  Response time (t <sub>90</sub> ) < 6 sec. < 40 sec. < 6 sec. < 40 sec.  Properties  Compatibility Aqueous solutions, ethanol, methanol  No cross-sensitivity pH 1 – 14 CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> Ionic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization**  procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air- environment (nitrogen, sodium sulfite) and air- saturated environment    O - 50 °C     O -	Drift at 0 % oxygen	•	(sampling interval of 1	< 2 ppb within 30 days (sampling interval of 1 min.)		
Response time (t <sub>90</sub> ) < 6 sec. < 40 sec. < 6 sec. < 40 sec.  Properties  Compatibility Aqueous solutions, ethanol, methanol  No cross-sensitivity pH 1 – 14  with CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> lonic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride  Chlorine gas  Sterilization Steam sterilization**  procedure Ethylene oxide (EtO)  Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)  3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air-  environment (nitrogen, sodium sulfite) and air-  saturated environment  sec. < 40 sec.   Two-point calibration in oxygen-free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen	Measurement	0 – 50 °	rC.	0 50 °C		
Compatibility Aqueous solutions, ethanol, methanol  No cross-sensitivity with CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> lonic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air- saturated environment environment    Naqueous solutions, ethanol, methanol   PH 1 – 14   CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub>   Ionic species   Organic solvents, such as acetone, toluene, chloroform or methylene chloride   Chlorine gas   Sterilization   Steam sterilization**   Ethylene oxide (EtO)   Gamma irradiation   Cleaning procedures   Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)   3 % H <sub>2</sub> O <sub>2</sub>   Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration   Two-point calibration in oxygen-free environment   environment (nitrogen, sodium sulfite) and air-   (nitrogen) and a second calibration value optimally   between 1 and 2 % oxygen	temperature range	0 – 30		0-30 6		
Compatibility  Aqueous solutions, ethanol, methanol  No cross-sensitivity with  CO2, H2S, SO2 lonic species  Cross-sensitivity to  Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization**  procedure  Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures  Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H2O2 Acidic agents (HCI, H2SO4), max. 4 – 5 %  Calibration  Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air- saturated environment between 1 and 2 % oxygen	Response time (t <sub>90</sub> )	< 6 sec.	< 40 sec.	< 6 sec.	< 40 sec.	
No cross-sensitivity with CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> lonic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen	Properties					
with CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub> lonic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen	Compatibility	Aqueous solutions, ethanol,	methanol			
Ionic species  Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen	No cross-sensitivity	pH 1 – 14				
Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas  Sterilization Steam sterilization** procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free Two-point calibration in oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen	with	CO <sub>2</sub> , H <sub>2</sub> S, SO <sub>2</sub>				
Chlorine gas  Sterilization Steam sterilization**  procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment    Cleaning procedures   Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)   Two-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment (nitrogen, sodium sulfite) between 1 and 2 % oxygen		Ionic species				
Sterilization Steam sterilization**  procedure Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air- saturated environment environment environment environment saturated environment  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCl, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Two-point calibration in oxygen-free environment environment (nitrogen, sodium sulfite) and air- saturated environment between 1 and 2 % oxygen	Cross-sensitivity to	_	cetone, toluene, chloro	form or methylene chloride		
Ethylene oxide (EtO) Gamma irradiation  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F) 3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment environment environment environment  Cleaning procedures Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)  3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Two-point calibration in oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen						
Gamma irradiation  Cleaning procedures  Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)  3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration  Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment  saturated environment  Gamma irradiation  Tuo-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment  between 1 and 2 % oxygen						
Cleaning procedures  Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)  3 % H <sub>2</sub> O <sub>2</sub> Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration  Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment  saturated environment  Cleaning in place (CIP, 2 % NaOH, + 80 °C, + 176 °F)  Two-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment  between 1 and 2 % oxygen	procedure	Ethylene oxide (EtO)				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
Acidic agents (HCI, H <sub>2</sub> SO <sub>4</sub> ), max. 4 – 5 %  Calibration Two-point calibration with oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen	Cleaning procedures					
Calibration Two-point calibration with oxygen-free Two-point calibration in oxygen-free environment environment (nitrogen, sodium sulfite) and air-saturated environment between 1 and 2 % oxygen						
environment (nitrogen, sodium sulfite) and air- saturated environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen						
saturated environment between 1 and 2 % oxygen	Calibration					
			um sulfite) and air-	` ' ' '	ion value optimally	
Storage Stability 60 months provided the sensor material is stored in the dark***						
·	Storage Stability	60 months provided the sen	sor material is stored ir	the dark***		

<sup>\*</sup>after two-point calibration as described in this manual

<sup>\*\*</sup>for –YAU sensor types only!

<sup>\*\*\*</sup>storage stability was tested @ +20 °C

# **6 Concluding Remarks**

Dear Customer,

With this manual, we hope to provide you with an introduction to work with the oxygen sensor spots type PSt3 and PSt6.

This manual does not claim to be complete. We are endeavored to improve and supplement this version.

We are looking forward to your critical review and to any suggestions you may have.

You can find the latest version at www.PreSens.de.

With best regards,

Your PreSens Team



#### Manufacturer

PreSens
Precision Sensing GmbH

Am BioPark 11 93053 Regensburg Germany

Phone +49 941 94272100 Fax +49 941 94272111

info@PreSens.de www.PreSens.de