TriOS

xylem

Dissolved Oxygen

OPERATING INSTRUCTIONS

Table of Contents

1 General Information 2
1.1 Introduction 2
1.2 Health and Safety Information 3
1.3 Warnings 4
1.4 Users and Operating Requirements 4
1.5 Intended Use 4
1.6 Disposal Information 5
1.7 Certificates and Approvals 5

2 Introduction 6
2.1 Product Identification 6
2.2 Scope of Delivery 7
2.3 Measurement Principle and Design 7

3 Commissioning 8
3.1 Electrical Installation 8
3.1.1 Fixed Cable with M12 Industrial Plug 8
3.2 Interfaces 8
3.2.1 Serial Interface 8

4 Use 9
4.1 Normal Operation 9
4.2 Bypass Installation 9
4.3 Support Tube Installation 10

5 Calibration 12
5.1 Two-Point Calibration 12
5.1.1 Offset Calibration 12
5.1.2 Slope Calibration 12
5.2 One-Point Calibration 13
5.3 Measurement Properties 13
5.3.1 Influences on the measurement 13
5.3.2 Temperature Compensation 13
5.3.3 Atmospheric pressure 13
5.3.4 Salinity 13

6 Malfunction and Maintenance 14
6.1 Cleaning and Upkeep 14
6.2 Maintenance and Inspection 14
6.2.1 Changing the Membrane Cap 15
6.3 Troubleshooting 15
6.3.1 Implausible Values 15
6.4 Returns 15

7 Technical Data 16
7.1 Technical Specifications 16
7.2 External Dimensions 17

8 Accessories 18
8.1 TriBox 3 18
8.2 TriBox Mini 18

9 Warranty 19

10 Customer Service 20

11 Contact 21

12 Keyword Index 22

Annex 24

1 General Information

1.1 Introduction

Welcome to TriOS.

We are glad that you have chosen to purchase the Dissolved Oxygen sensor.

The Dissolved Oxygen sensor is based on luminescent optical technology. With only low calibration requirements and thanks to an ultra low power technology, the sensor meets the demands of field works and short or long term campaigns. Without oxygen consumption, this technology allows you an accurate measure in all situations and especially in very low oxygen concentrations. The "smart" Oxygen sensor stores calibration and history data within the sensor. This allows you a "plug and play" system without re-calibration.

In this manual, you will find all of the information you will need to commission the Dissolved Oxygen sensor. Technical specifications, detection limits and dimensions can be found in chapter 7.

Please note that the user is responsible for complying with local and national regulations on the installation of electronic devices. Any damage caused by incorrect use or unprofessional installation will not be covered by the warranty. All sensors and accessories supplied by TriOS Mess- und Datentechnik GmbH must be installed and operated in accordance with the specifications provided by TriOS Mess- und Datentechnik GmbH. All parts were designed and tested in accordance with international standards for electronic instruments. The device meets the requirements of the international regulations on electromagnetic compatibility. Please use only original TriOS accessories and cables to ensure reliable and correct operation of the devices.

Before using the device, read the manual carefully, and keep this manual on hand so it can be used later. Before commissioning the sensor, please make sure that you have read and understood the following safety precautions. Always make sure that the sensor is operated correctly. The safety precautions described on the following pages should ensure the reliable and correct operation of this device and any additional associated devices and should prevent injuries to yourself or other persons and damage to other equipment.

NOTICE	**If the translation is at all different from the original German text, the German version is binding.**

Copyright Notice

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1.2 Health and Safety Information

This manual contains important information about health and safety rules. This information is labelled according to the international specifications of ANSI Z535.6 ("Product safety information in product manuals, instructions and other collateral materials") and must be followed strictly. The distinction is made between the following categories:

⚠ **DANGER**	**Danger warning / will lead to serious injury or death**
⚠ **WARNING**	**Warning / may lead to serious injury or death**
⚠ **CAUTION**	**Caution / may cause moderate injury**
NOTICE	**Can result in damage to property**

Tip / Useful Information

Electromagnetic Waves

Devices that radiate strong electromagnetic waves can influence the measurement data or result in a malfunction of the sensor. Avoid using the following devices in the same room as the TriOS sensor: mobile phones, cordless phones, transmitters/receivers and other electrical devices that produce electromagnetic waves.

Reagents

Follow the safety and operating instructions of the manufacturer when using reagents. Observe the valid Hazardous Materials Ordinance for reagents (German GefStoffV)!

Biological Safety

Liquid waste may be a biohazard. Therefore, you should always wear gloves when working with such materials. Please observe the current biological material ordinance (German BioStoffV)!

Waste

When handling liquid waste, observe the regulations on water pollution, drainage and waste disposal.

1.3 Warnings

- This sensor has been developed for use in industry and science. It should only be used for the measurement of aqueous solutions, e.g. process waste water, river water or sea water.

NOTICE **Stainless steel sensors are not intended for use in sea water or in high chloride concentrations (corrosion). Only sensors made of titanium can be used in these cases.**

- Sensors made from stainless steel must be cleaned immediately after coming into contact with salt water or other corrosive substances (e.g. acids, alkalis and chlorine-based connections.)
- The material resistance should be checked after every use.
- Do not cut, damage or change the cord. Make sure there are no heavy objects on the cord and that the cord is not folded. Make sure that the cord is not placed near hot surfaces.
- If the sensor cord is damaged, it must be replaced with an original part by the customer service of TriOS Mess- und Datentechnik GmbH or by an authorized TriOS workshop.
- Stop operation of the sensor if excessive heat develops (i.e. if it is hot to the touch). Switch off the sensor immediately and unplug the power cord from the power supply. Please contact your dealer or TriOS customer service.
- Never try to disassemble or modify a part of the sensor if such a procedure is not explicitly described in this manual. Inspections, modifications and repairs may only be done by the dealer or by qualified experts authorized by TriOS.

Devices from TriOS Mess- und Datentechnik GmbH meet the highest safety standards. Repairs to the device that involve the replacement of the connecting cable must be done by TriOS Mess- und Datentechnik GmbH or a workshop authorized by TriOS. Faulty, improper repairs can result in accidents and injuries.

⚠ DANGER **TriOS does not guarantee the plausibility of measurement values. The user is responsible for monitoring and interpreting the values.**

1.4 Users and Operating Requirements

The Dissolved Oxygen sensor was developed for use in industry and science. The target group for the operation of the Dissolved Oxygen sensor is technically skilled staff in plants, sewage treatment plants, water plants and institutes. Operating this device often requires the handling of hazardous substances. We assume that the operating personnel are familiar with dealing with dangerous substances based on their professional training and experience. Operating personnel must be able to correctly understand and implement the safety labels and information on the packaging and in the package inserts of the test kits.

1.5 Intended Use

The Dissolved Oxygen sensor is designed exclusively to take oxygen measurements as described in this manual. For this purpose, the sensor is an immersion sensor, to be used underwater or with flow cells. Please note the technical data of the accessory parts. Other uses do not comply with the intended use.

The compact and robust stainless steel or titanium sensor is particularly well suited to the following typical areas of application:

• Industrial and municipal sewage treatment plants

• Wastewater management (nitrification and de-nitrification)*

• Surface water monitoring

• Fish farming, aquaculture

• Drinking water monitoring

The use of other media can damage the sensor. For the use of the Dissolved Oxygen sensor in media other than those specified this manual, please contact the customer service of TriOS Mess- und Datentechnik GmbH (support@trios.de).

NOTICE	**Avoid touching the membrane, because it can become scratched or dirty. If this happens, the functionality of the device can no longer be guaranteed.**

According to current scientific knowledge, the device is safe to use when it is handled according to the instructions in this user manual.

1.6 Disposal Information

At the end of the device's life or use, the device and its accessories can be returned to the manufacturer for environmentally friendly disposal for a fee. (See address below.) The preceding professional decontamination of the device must be proven with a certificate. Please contact us for more information before you send the device back.

Address of the manufacturer:

TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
D-26180 Rastede
Germany

Telephone: +49 (0) 4402 69670 - 0

Fax: +49 (0) 4402 69670 – 20

1.7 Certificates and Approvals

This product meets all of the requirements of the harmonized European standards. It therefore meets the legal requirements of the EU guidelines. TriOS Mess- und Datentechnik GmbH confirms the successful testing of the product by affixing the CE marking. (See Annex.)

2 Introduction

The Dissolved Oxygen sensor applies the luminescence-based optical measurement technology and measures reliably and accurately. With low consumables and maintenance required, the Dissolved Oxygen sensor gives an immediate return on the investment. The only intervention required is to replace the Membrane Cap every two years.

The sensor can even be used in applications with very weak flow of water.

The sensor offers the following advantages:

- Low operating costs due to reduced maintenance work (no electrolyte changes)
- Greater calibration intervals due to low drift behaviour
- No polarization voltage required
- High measuring accuracy, even for low concentrations
- Rapid response times
- No minimum inflow (no oxygen consumption)

The sensor features excellent interference immunity thanks to the integrated preamplifier and digital signal processing. The measured value for dissolved oxygen is automatically compensated with the temperature, air pressure, and salinity (salt content), and transferred without interference to the connected display unit and controller via a digital interface. The membrane cap is easy to replace, meaning the sensor is very easy to maintain. The current calibration data is saved directly in the sensor electronics. As a result, the Plug and Play function of the system is enabled without the need for recalibration. The sensor also includes a log book containing the last ten successful calibrations in the form of a ring buffer.

2.1 Product Identification

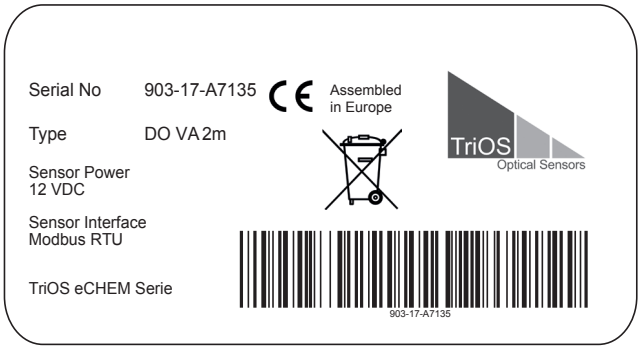
There is a rating plate on the sensor with the following information that you can use to uniquely identify the product:

Serial number

Product type

Power supply

Interface



In addition to the product bar code, the rating plate includes the TriOS Mess- und Datentechnik GmbH logo and the CE quality label.

Please note that the specifications given here are for illustration purposes only and may be different depending on the version of the product.

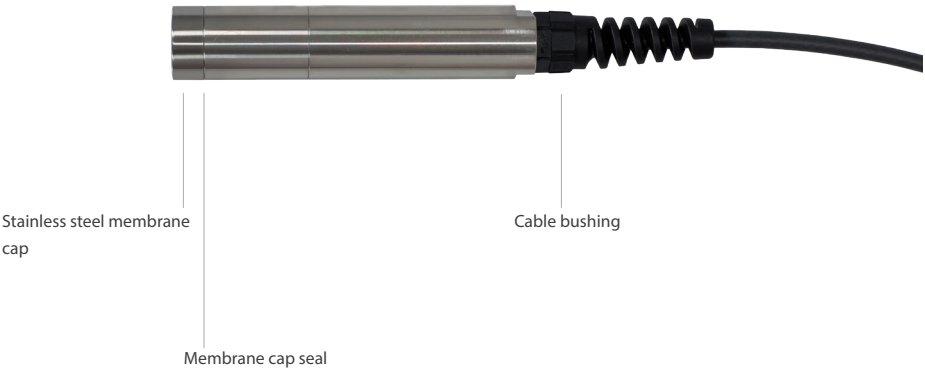
2.2 Scope of Delivery

The shipment contains the following components:

- Sensor
- Operating Instructions
- Accessories (if applicable)

Keep the original packaging in case the device needs to be returned for maintenance or repairs.

2.3 Measurement Principle and Design



3 Commissioning

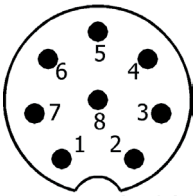
This chapter deals with the commissioning of the sensor. Please pay particular attention to this section and follow the safety precautions to protect the sensor from damage and yourself from injury.

Before the sensor is put into operation, it is important to ensure that it is securely attached and all of the connections are connected correctly.

3.1 Electrical Installation

NOTICE **The sensor must be operated with 12 VDC.**

3.1.1 Fixed Cable with M12 Industrial Plug



Face view (male)

1. RS-485 A
2. RS-485 B
6. Power 12 VDC
7. Ground (Power + Ser. Interface)

NOTICE **Ensure correct polarity of the operating voltage or otherwise the sensor may be damaged.**

The sensor is ready for initial startup once it is connected to your terminal, settled in its accessory of assembly and the parameterization has been carried out on the display unit.

3.2 Interfaces

3.2.1 Serial Interface

The sensors serial interface is RS-485.

For the RS-485, voltages of –5 V to +5 V with respect to the ground are possible. RS-485 uses a differential signal where the sign-negative potential of the A line is put on the B line. The A-B difference is decisive where the transmission is most resistant to interactive interference signals.

The used protocol is Modbus RTU. A detailed description of the Modbus protocol commands can be found in the Annex.

4 Use

The Dissolved Oxygen sensor can be operated with any of the TriOS controllers. Instructions for correct installation can be found in the controller manual.

4.1 Normal Operation

Once the sensor is connected to your Controller, the sensor is settled in its accessory of assembly and the parameterization has been carried out on the display unit, the sensor is ready for initial startup.

Remove the black cap of protection (by holding the sensor head downward and by unscrewing the hood towards the right). The sensor is delivered dry and the Membrane Cap must be rehydrated so that the measures are optimized. After dry storage, rehydrate the membrane for a 12 hours period (one night) in clear water.

Standard operation of the sensor is carried out by immersing it into the medium. The sensor can either hang freely or be mounted at 45°.

For measurement, you must eliminate bubbles trapped under the membrane. Presence of chlorine will distort the measure (overestimation of dissolved oxygen level).

During the introduction of the sensor to the measurement environment, wait for the sensor's temperature stabilization before starting a measurement. To optimize a sustainable functioning of your probe, we recommend you to respect a frequency of measurements above 10 seconds.

Optical oxygen sensors do not carry out any continuous measurements. To extend the operating life of the optical membrane, the measurement interval can be set to a value superior to 10 seconds.

NOTICE	**The membrane is vulnerable to chemicals (organic solvents, acids, peroxide) and mechanical treatments (impact, abrasion, tearing).**

4.2 Bypass Installation

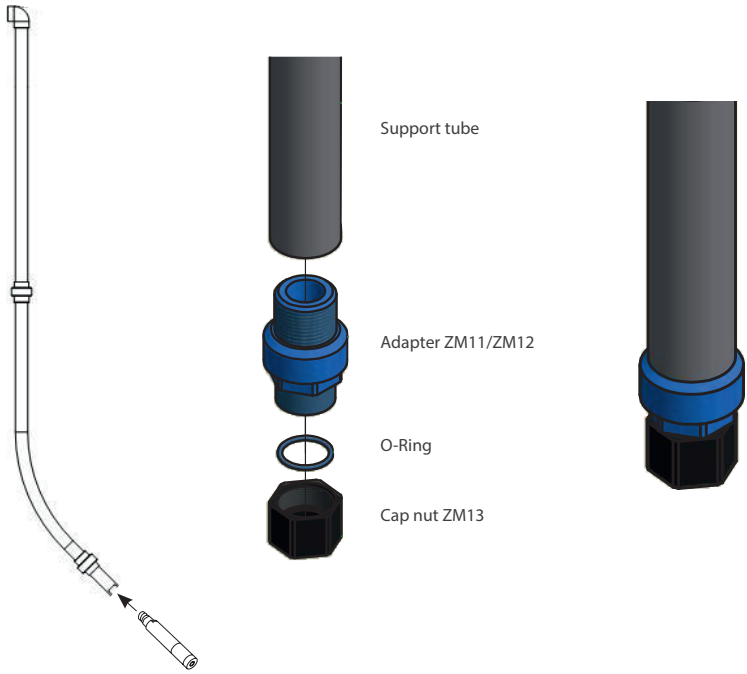
TriOS offers a compact modular FlowCell System to install the sensor into your application. This system allows flexible adaption to the application and the possibility to expand your range of sensors.

4.3 Support Tube Installation

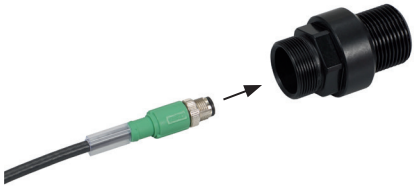
TriOS provides two adapter pieces for installing the TpH-D sensor in existing tube systems:

- NPT1 adapter ZM12 (incl. cap nut ZM13)
- G1 adapter ZM11 (incl. cap nut ZM13)

Assembly process



1. Guide the sensor cable from the side through the adapter, onto which the screw cap is later screwed (short thread).



2.Pull the complete cable through.

3. Fix the sensor with the mounting cap.

4. The sensor and adapter can now be installed in the support tube.

5 Calibration

The sensor is calibrated to specification at the factory. The manufacturer does not recommend calibration unless due to specific local regulations. If calibration is required, let the sensor come to equilibrium with the measurement process before calibration. Do not calibrate the sensor at setup.

After the membrane cap is replaced, calibration should always be carried out.

It is also advisable to regularly clean the sensor in a water-sulphite solution with a sulphite concentration of < 2 %, and to subsequently check the zero point (0 % saturation).

If the zero point is moved, a complete two-point calibration must be carried out.

5.1 Two-Point Calibration

With two-point calibration, the zero point (0% - offset) and slope (100 %)of the sensor are calibrated. This calibration method offers the greatest possible level of accuracy and is particularly recommended for measurements of small oxygen concentrations.

It is carried out as follows:

5.1.1 Offset calibration

The sensor must be cleaned before calibration (see chapter 6). Immerse the sensor in a water-sulphite solution (sulphite concentration < 2 %) in order to determine the zero point (0 % saturation). Mix the solution with the sensor so that the saturation in oxygen decreases more quickly (The oxygen fixed to the Membrane Cap must be consumed).

NOTICE	**The sensor can be damaged by chemicals. A damaged membrane can lead to incorrect measurement results. The sensor membrane must not be in contact with the sulphite solution for longer than 15 minutes.**

After calibration, clean the sensor with clear water and carefully dry it.

5.1.2 Slope calibration

Sensor slope is determined by positioning in oxygen-saturated environment (100 % saturation). The slope of the sensor is calibrated beyond the defined state of 100 % oxygen saturation. This state can in principle be achieved in two ways:

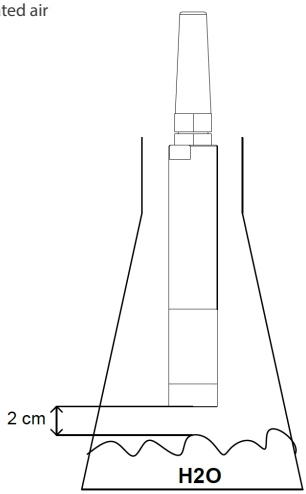
1. By positioning the sensor in water vapor-saturated air (for example, directly over a water surface, see picture on following page).

The sensor must be kept dry during the calibration process. Drops of water adhering to the sensor membrane could distort the measurement.

2. By positioning the sensor in air-saturated water (air is directed through water until the water is saturated with it).

The air pressure and temperature must remain constant during the calibration.

(1) Positioning in water vapor-saturated air



5.2 One-Point Calibration

The calibration in one point consists in propping up a 100% point : please consult chapter 5.1.2 (slope calibration).

5.3 Measurement Properties

5.3.1 Influences on the measurement

The oxygen measurement is dependent on the following parameters:

- The temperature of the measurement medium
- The air pressure (atmospheric pressure)
- The salinity of the measurement medium

The degree of solubility of oxygen in water is dependent on the temperature, the salinity, and the air pressure. This dependency is stored in the sensor's measurement electronics in the form of functions. The sensor can therefore determine the oxygen concentration of the measurement medium, in order to digitally transmit the influencing factors above, in compensated form, to the transmitter/controller.

5.3.2 Temperature compensation

The temperature compensation is automatically managed by the sensor via the integrated temperature sensor (NTC).

5.3.3 Atmospheric pressure

With the most frequently used calibration method – end value calibration of the sensor in water vapor-saturated air – the air pressure must be taken into account. For this purpose, the air pressure can, for example, be transmitted to the sensor by your controller, where it is saved.

The default value of the atmosphere used for the compensation is 1013 hPa.

5.3.4 Salinity

The value for the salinity of the measurement medium could be transmitted to the sensor by your terminal.

The default value of the salinity used for the compensation is 0 g/Kg.

6 Malfunction and Maintenance

The maintenance schedule shows minimum intervals for regular maintenance tasks. Perform maintenance tasks more frequently for applications that cause electrode fouling.

NOTICE **Do not disassemble the probe for maintenance or cleaning.**

- The sensor must always be kept clean, particularly in the area around the optical membrane. The presence of a biofilm on the membrane cap can lead to measuring errors.
- A dirty membrane should be cleaned with warm, soapy water. A soft sponge should be used for cleaning (not an abrasive scouring sponge).
- If the sensor is put out of operation, it should be rinsed prior to being stored, and the protective cap should be fitted with the protective case and a moist absorbent surface (like cotton).

6.1 Cleaning and Upkeep

Rinse meticulously the sensor and the membrane with clear water. If deposits like biofilm or mud persist, wipe the membrane gently with a sweet cloth or an absorbent paper.

NOTICE **For the Titanium version clean the body of the sensor by means of acetone (do not use methylated spirit, ethanol or methanol).**

6.2 Maintenance and Inspection

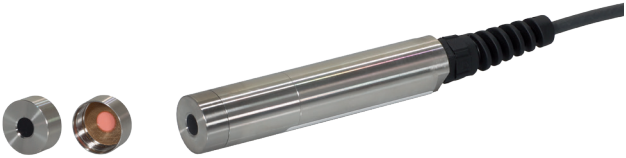
It is advisable to regularly clean the sensor in a water-sulphite solution with a sulphite concentration of < 2 %, and to subsequently check the zero point (0 % saturation).

If the zero point is moved, a complete two-point calibration must be carried out.

NOTICE **Avoid touching the membrane, because it can become scratched or dirty. If this happens, the functionality of the device can no longer be guaranteed.**

6.2.1 Changing the Membrane Cap

The average life time of the Membrane Cap is of 2 years. In case of deterioration of the cap or of difficulty on the processes of calibration, the membrane cap will be to change (see chapter 5).



1. Unscrew the Membrane Cap from the sensor body. When doing so, ensure that the front part of the sensor is not touched.
2. Remove the replacement Membrane Cap from the opaque protective bag and screw slowly onto the sensor body. When screwing on, ensure that the membrane of the sensor is not touched.
3. Rehydrate the membrane for a 12 hours period and recalibrate the sensor in 2 points (chapter 5.1).

NOTICE **Do only unscrew the Cap for changing it.**

After the membrane cap is replaced, calibration should be carried out.

6.3 Troubleshooting

6.3.1 Implausible Values

After every reboot, the sensor will show „9998,0“ as a placeholder value for every measurement, as long as no actual measurement values are avaible.

6.4 Returns

Please observe the following procedure for your returns.

If returning a sensor, please contact customer service first. To ensure a smooth return and to avoid incorrect deliveries, each return package must first be reported to the customer service. You will then receive a numbered RMA form, which you need to fill out completely, check and send back to us. Please attach the form with the number so it is clearly visible on the outside of the return package or write it in large numbers on the packaging. This is the only way your return package can be correctly allocated and accepted.

Caution! Return shipments without an RMA number cannot be accepted and processed!

Please make sure that the sensor is cleaned and disinfected before shipping. In order to ship the goods undamaged, use the original packaging. If this is not on hand, make sure that safe transport is guaranteed and the sensor is safely packed using enough packing material.

7 Technical Data

7.1 Technical Specifications

Measurement principle		Luminescence	
Parameter		Dissolved Oxygen	
Measurement range		0...20 mg/L 0...20 ppm 0...200 %	
Measurement accuracy		± 0.1 mg/L ± 0.1 ppm ± 1 %	
Resolution		0.01	
Response time		90 % of the value in less than 60 seconds	
Measurement interval		> 5 s	
Inflow Velocity		no movement necessary	
Temperature Compensation		Via NTC (compensation active for temperature lower than 0 °C)	
Measurement range (temperature)		0...+50 °C	
Resolution (temperature)		0.01 °C	
Accuracy (temperature)		0.5 °C	
Membrane Cap		No cross-sensitivity with : pH 1 – 14 ; CO2, H2S, SO2 Cross-sensitivity to Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas	
Material		Standard Version in passivated Stainless steel 316L body, strainer and screw, For Seawater application Version in Titanium body, strainer and screw, Cable : polyurethane jacket Steam gland : Polyamide Patch with active material (black) – Membrane : Optical isolation silicon	
Dimensions (L x Ø)		146 mm x 25 mm	~ 5.7″ x 1″
Weight	stainless steel	~ 450 g	~ 1 lbs
	titanium	~ 300 g	~ 0.7 lbs
Interface		RS-485 (Modbus RTU)	
Power consumption		1 W	
Power supply		12 V (± 10 %)	
Sensor cable		2 m and 10 m	

Calibration/maintenance interval	2 years	
Warranty	1 year (EU& US: 2 years) on electronics; All wearing parts are not included in the warranty	

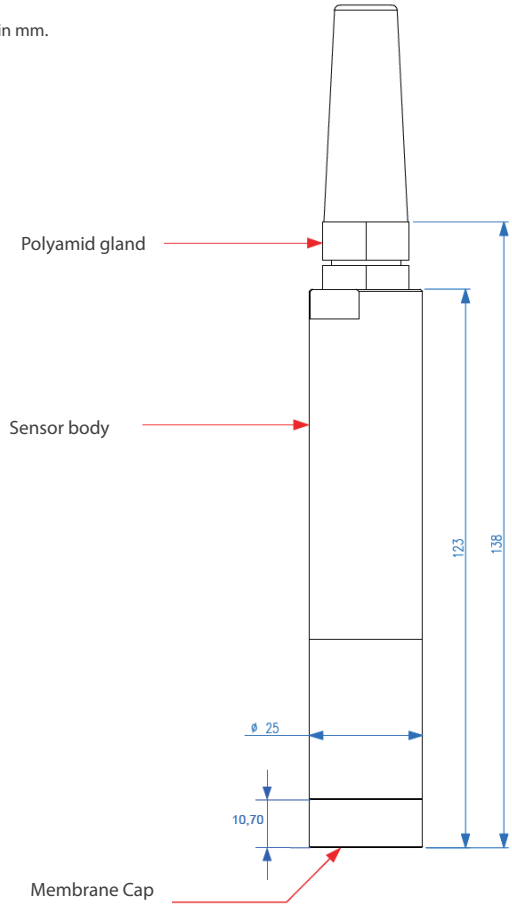
INSTALLATION

Max. pressure	5 bar	~ 72.5 psig
Protection type	IP68	NEMA 6P

Sample temperature	0...+50 °C	~ +32 °F... +122 °F
Ambient temperature	0...+50 °C	~ +32 °F... +122 °F
Storage temperature	-10...+60 °C	~ +14 °F... +140 °F

7.2 External Dimensions

All dimensions are indicated in mm.



8 Accessories

8.1 TriBox3

Digital, 4-channel display and control unit with integrated solenoid valve for compressed-air control

TriBox3 is a measurement and control system for all TriOS sensors. The device has 4 sensor channels with selectable RS-232 or RS-485 function. In addition to the Modbus RTU, various other protocols are available. A built-in valve allows the use of compressed-air cleaning for the sensors. The TriBox3 also has various interfaces, including an IEEE 802.3 Ethernet interface, an IEEE 802.11 b/g/n interface, a USB connection and 6 analog outputs (4...20 mA). An integrated relay can trigger alarms or control external devices. Features such as low power consumption, a robust aluminium housing and a range of interfaces make it suitable for all applications associated with environmental monitoring, drinking water, wastewater treatment plants and many other areas.

8.2 TriBox mini

Digital 2-channel controller

Mini controller with two digital sensor inputs and two 4...20mA outputs. All of the measured values and diagnostics data that are saved can be selected using an integrated web browser.

9 Warranty

The warranty period of our devices within the EU and the United States is 2 years from the date of invoice. Outside of the EU, the warranty period is one year. All normal consumables, such as light sources, are not included in the warranty.

The warranty is subject to the following conditions:

- The device and all accessories must be installed as described in the corresponding manual and must be operated according to the specifications.
- Damage due to contact with corrosive and damaging substances, liquids or gases and damage during transport are not covered by the warranty.
- Damage due to improper handling and use of the device is not covered by the warranty.
- Damage resulting from modification or unprofessional attachment of accessories by the customer is not covered by the warranty.

NOTICE	**Opening the sensor voids the warranty!**

10 Customer Service

If you are having a problem with the sensor, please contact TriOS customer service.

To send back the sensor, please request an RMA number from customer service.

Technical support contacts:

support@trios.de

Telephone: +49 (0) 4402 69670 - 0

Fax: +49 (0) 4402 69670 – 20

To help us provide you faster service, please send us the sensor ID number by email (the last four digits of the serial number consisting of letters and numbers, e.g. 28B2)

11 Contact

We are constantly working to improve our devices. Visit our website for news and information.

If you have found an error or bug in one of the devices or programs, please let us know:

Customer service:	support@trios.de
General questions/sales:	sales@trios.de
Website:	www.trios.de

TriOS Mess- und Datentechnik GmbH

Bürgermeister-Brötje-Str. 25

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Fax	+49 (0) 4402 69670 - 20

12 Keyword Index

A

Accessories 18
Atmospheric pressure 13

B

Biological safety 3
Bypass installation 9

C

Calibration 12
CE certification 24
Certificates & approvals 5
Cleaning 14
Contact 21
Copyright 2
Customer service 20

D

Disposal 5

E

Electrical installation 8
Electromagnetic waves 3

F

FlowCell 9

G

H

Health and safety information 3

I

Intended use 4

J

K

L

M

M12 industrial plug 8
Maintenance 14
Measurement properties 13
Membrane Cap 15

N

Normal operation 9

O

Offset Calibration 12
One-Point Calibration 13
Operating requirements 4

P

Product Identification 6

Q

R

Rating plate 6

Reagents 3

Returns 15

RMA number 15

S

Safety instructions 3

Salinity 13

Scope of delivery 7

Slope Calibration 12

Specifications 16

Structure of the sensor 7

Support Tube Installation 12

T

Technical Specifications 16

Temperature Compensation 13

Two-Point Calibration 12

U

User requirements 4

V

W

Warnings 4

Warranty 19

Waste 3

X

Y

Z

Annex

CE Declaration of Conformity

Hersteller/Manufacturer/Fabricant: TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
D- 26180 Rastede

Konformitätserklärung
Declaration of Conformity
Déclaration de Conformité

Die TriOS GmbH bescheinigt die Konformität für das Produkt
The TriOS GmbH herewith declares conformity of the product
TriOS GmbH déclare la conformité du produit

Bezeichnung Product name Designation	**eCHEM Sauerstoff** **eCHEM Oxygen**
Typ / Type / Type:	**Art. Nr. 90S531100, 90S531130** **Art. Nr. 90S534100, 90S534130**
Mit den folgenden Bestimmungen With applicable regulations Avec les directives suivantes	2014/30/EU EMV-Richtlinie 2011/65/EU RoHS-Richtlinie
Angewendete harmonisierte Normen Harmonized standards applied Normes harmonisées utilisées	EN 61326-1:2013 EN 61010-1:2010 EN 50581:2012

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Modbus RTU

Parameters

Number	Parameter	Unit
1	Temperature	°C
2	Oxygen saturation	%
3	Oxygen concentration	mg/l
4	Oxygen concentration	ppm

Data types

Name	Register Count	Format
Uint16	1	Unsigned 16 bit integer. Value range: 0x0000 - 0xFFFF
Bits16	1	Register contains a bitmask, where every bit has a special meaning. This is most often used for parameter selection, where Bit 1 corresponds to the temperature and the following bits to parameter 1, 2, 3 and 4
Bits32	2	A bit vector using 32 bits, same as Bits16 but spanning two registers
Uint32	2	Unsigned 32 bit integer. Value range: 0x00000000 - 0xFFFFFFFF
Float	2	IEEE 754 32 bit floating point value
ASCII	1+	A sequence of ascii characters with two 8 bit characters stored in each 16 bit register
Date	8	A date in the form mmhhddMMYYYY, where mm is the minute, hh the hour, dd the day, MM the month and YYYY the year

All multi-register datatypes are stored in big-endian word order. That is the word with the most significant bits is stored at the lesser register address.

Supported Modbus functions

These Modbus function codes are supported by the sensor:

Name	Code	Description / Use
Read multiple registers	0x03	Read the serial number, firmware version and of course measurement data
Write single register	0x06	Write a value in one register
Write multiple registers	0x10	Write data into a sequence of registers
Report slave ID	0x11	Get the sensor identification

Default Slave Address

The factory default setting of the slave address is 10 (0x0A).

Register description

The following table describes the Modbus register mapping:

Designation	R/W	Register	Data type	Description
Start measurement	W	1	Bits16	Start a measurement for a set of parameters. Value 31(0x1F)
Restore default calibration	W	2	Bits16	Restore the default calibration coefficients. Value 31(0x1F)
Reset standard of temporary calibration	W	76	Int16	Write 1 into this register to perform the reset
Temperature	R	83	Float	Current temperature measurement in °C
Oxygen saturation	R	85	Float	Measured oxygen saturation in %
Dissolved oxygen	R	87	Float	The concentration of dissolved oxygen in mg/l
Dissolved oxygen	R	89	Float	The concentration of dissolved oxygen in ppm
Modbus slave address	RW	163	Int16	Modbus slave address from 1 to 247
Measurement duration	R	164	Int16	Approximate time to obtain all measurements in ms
Averaging	RW	170	Int16	Averaging for all values except temperature. Values from 1 to 50 are allowed
Parity and Stop Bits	RW	188	Int16	0: Default: 2 stop bits (no parity) 1: Even parity and 1 stop bit 2: Odd parity and 1 stop bit
Temporary coefficients	W	332	Bits32	Each calibration coefficient (Offset, Scaling) has a corresponding bit in this two registers. Bit 1: Offset of temperature sensor Bit 2: Scaling of temperature sensor Bit 3: Offset of oxygen sensor Bit 4: Factory value Bit 5: Factory value Bit 6: Scaling of oxygen sensor
Temperature Offset	RW	512	Float	Write the temperature offset into this register during calibration
Temperature Scaling	RW	514	Float	Write the temperature scaling into this register during calibration
Oxygen Offset	RW	516	Float	Write the oxygen offset into this register during calibration
Oxygen Scaling	RW	522	Float	Write the oxygen scaling into this register during calibration
Operator Name of Temperature	W	638	ASCII[8]	Name of the operator who calibrated the temperature sensor (8 registers for 16 ascii characters)
Date of Temperature Calibration	W	646	Date	Write the current date at the end of the temperature calibration into this registers (see "Data types" section)
Operator of Oxygen Calibration	W	654	ASCII[8]	Name of the operator who calibrated the oxygen sensor (8 registers for 16 ascii characters)
Date of Oxygen Calibration	W	662	Date	Write the current date at the end of the oxygen calibration into this registers (see "Data types" section)
Sensor identifier	R	3344	ASCII[16]	Sensor identifier with serial number (16 registers with 32 characters) Example: SN-PODOA-7466

External compensation of temperature, salinity and atmospheric pressure

The adjustments for each parameter can be activated separately. The value 1 hereby activates the external correction, whereas 0 deactivates it. The temperature is an exception. 0 is used for the internal temperature correction.

Unit	Register
%	166
mg/L	167
ppm	168

00 00 00 00 0_ _ _ 00 00

- Salinity (0=inactive oder 1=active)
- Pressure (0=inactive oder 1=active)
- Temperature (0=internal oder 1=external)

NOTICE **These setting are only saved temporarily and are lost after a restart.**

To use an external temperature measurement, it has to be written into the registers 93/94 as a float (unit °C) and activated in the registers 166,167 or 168 with 00 00 00 00 0**0 01** 00 00.

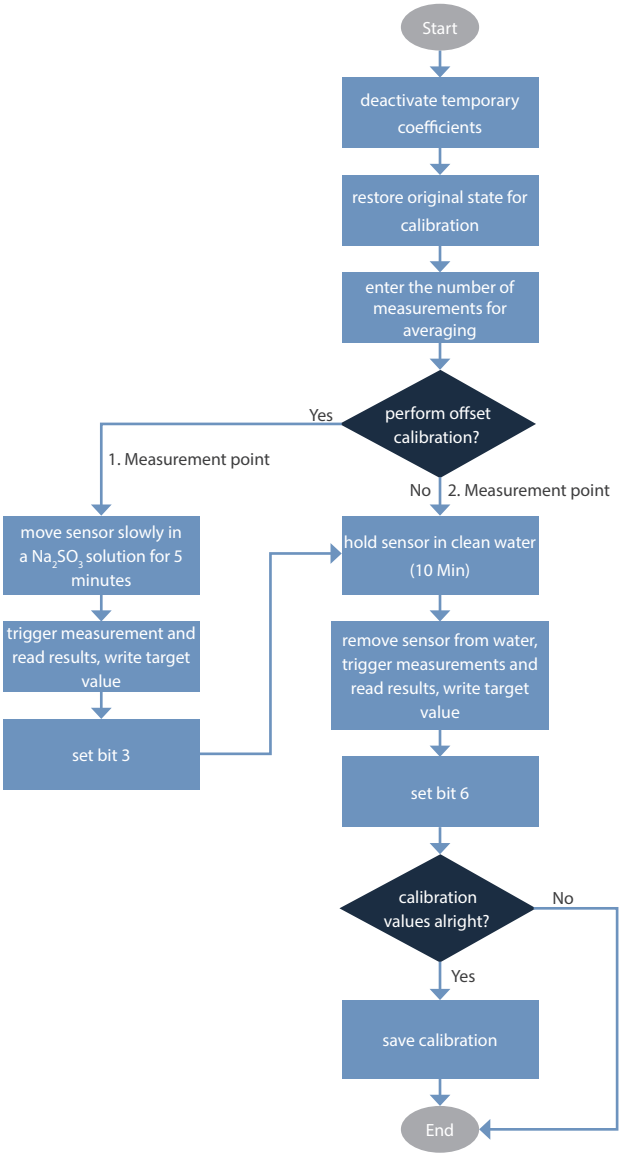
To use a correction for the atmospheric pressure, it has to be written into the registers 95/96 as a float (unit hPa) and activated in the registers 166,167 or 168 with 00 00 00 00 0**0 10** 00 00.

To use a correction value for the salinity, it has to be written into the registers 97/98 as a float (unit ppt) and activated in the registers 166,167 or 168 with 00 00 00 00 0**1 00** 00 00.

To activate more than one correction, it is possible to set all Bits to 1 (active).

Example: Sample for register 166, 0167 and 168.

HEX	DEC	BIN	
0x0070	112	00 00 00 00 0**1 11** 00 00	All three corrections are activated
0x0060	96	00 00 00 00 0**1 10** 00 00	Salinity and pressure activated, temperature internal
0x0040	64	00 00 00 00 0**1 00** 00 00	Salinity activated, pressure deactivated and temperature internal


Start
deactivate temporary coefficients
restore original state for calibration
enter the number of measurements for averaging
perform offset calibration?
Yes
1. Measurement point
No
2. Measurement point
move sensor slowly in a Na_2SO_3 solution for 5 minutes
trigger measurement and read results, write target value
set bit 3
hold sensor in clean water (10 Min)
remove sensor from water, trigger measurements and read results, write target value
set bit 6
calibration values alright?
No
Yes
save calibration
End

Calibration of DO sensor via Modbus

To calibrate the sensor via Modbus, measurements have to be triggered and results have to be read continuously. The frames are specified for the factory default slave address 10 (**0A**). This can be changed if necessary. The CRC is also calculated with the modbus address 10 and has to be recalculated when changed.

Actions before calibration

1. Deactivate the use of temporary coefficients

   Write a 0 in register 332 and 333

   Frame: **0A** 10 01 4C 00 02 04 00 00 00 00 **DF 7E**

2. Restore original state for calibration

   Write a 1 in register 76

   Frame: **0A** 10 00 4C 00 01 02 00 01 **1A AC**

3. Enter the number of measurements for averaging

   Set the number in register 170 to 25 (respectively your chosen number of measurements)

   Frame: **0A** 10 00 AA 00 01 02 00 19 **0C A0**

1. Measurement point (if required)

4. Prepare a sodium sulphite solution (Na2SO3) (a tip of a teaspoon dissolved in water) and move the sensor around in the solution. Leave the sensor in the solution until the measurement values have stabilized.

5. Measurements have to be triggered and results have to be read continuously, by writing the value 31 into Register 1 and then waiting for 2 seconds until reading the measurements.

   Trigger frame measurement: **0A** 06 00 01 00 1F **98 89**

   Read frame result: **0A** 03 00 53 00 08 **B5 66** (all measurement values up from 83 are output).

   Write the target value 0 as a float into the registers 516/517

   Frame: **0A** 10 01 4C 00 02 04 00 00 00 00 **DE BD**

6. Put bit 3 into register 333 (lower half of the long-value into registers 332 and 333), for the offset, that was just calculated, to be used.

2. Measurement point

7. Take the sensor out of the solution and put it in clean water for 10 minutes.

8. Then take the sensor out, hold it in air and continuously perform measurements by writing the value 31 into register 1and waiting for about 2 seconds until reading the measurements.

   Trigger frame measurement: **0A** 06 00 01 00 1F **98 89**

   Read frame result: **0A** 03 00 53 00 08 **B5 66**

In Air, the measurement value of Oxygen should be 100%. Write the target value 100 as a float into register 522/523.

Frame: **0A** 10 02 0A 00 02 04 42 C8 00 00 **DA 12**

Meanwhile please trigger continuous measurements and read the values.

Trigger frame measurement: **0A** 06 00 01 00 1F **98 89**

Read frame result: **0A** 03 00 55 00 08 **B5 66** (Oxygen in % in register 85)

9. To use this calculated measurement value, write bit 6 (lower half of the long-value in registers 332 and 333) into register 333.

Checking measurement values

Check the new calibration by continuously triggering measurements and reading the measurement values. This can be done as described in 2. Measurement Point by putting the sensor in clean water for 10 minutes, taking the sensor out, holding it in air and continuously perform measurements in air and reading the results.

Saving the calibration

10. To apply the calibration, a name with the length of 16 (Length 8 byte, to be seen in the example from *) as well as the time and date (Length 8 byte, Minute Hour Day Month Year, to be seen in the example from **) has to be entered as ASCII signs. Otherwise the calibration will not be saved.

    Frame Example:

    0A 10 02 8E 00 10 20 *46 72 61 6E 63 6F 69 73 20 20 20 20 20 20 20 20 **30 37 31 30 30 34 30 33 32 30 31 39 20 20 20 20 **93 BA**

End / Exit / Discard calibration

11. To leave or discard the calibration, write the value 1 into register 76.

    Frame: **0A** 10 00 4C 00 01 02 00 01 **1A AC**

12. Finally you have to switch back to the saved coefficients. To do so, write the value 0 into register 332 and 333.

    Frame: **0A** 10 01 4C 00 02 04 00 00 00 00 **DF 7E**