

NICO

OPERATING INSTRUCTIONS

Table of Contents

1 General Information	2	5.3 Measurement Properties	39
1.1 Introduction	2	5.3.1 Turbidity and Organics Compensation	39
1.2 Health and Safety Information	3	5.3.2 Nitrite	39
1.3 Warnings	4	5.3.3 Salinity	40
1.4 Users and Operating Requirements	4	5.3.4 Path Lengths and Limit Values	41
1.5 Intended Use	4	5.3.5 Unknown Substances	41
1.6 Disposal Information	5		
1.7 Certificates and Approvals	5		
2 Introduction	6	6 Malfunction and Maintenance	42
2.1 Product Identification	6	6.1 Cleaning and Upkeep	42
2.2 Scope of Delivery	6	6.1.1 Cleaning the Housing	42
2.3 Measurement Principle and Design	7	6.1.2 Cleaning the Measuring Window	43
2.3.1 Analysis	8	6.2 Maintenance and Inspection	43
2.3.2 Parameters	8	6.2.1 Checking the Zero Value	44
2.3.3 Compensation of Turbidity and Organics	9	6.3 Troubleshooting	46
2.3.4 Reference Values	9	6.3.1 Uploading Recovery Point	46
2.4 Browser	10	6.3.2 Uploading New Calibration	47
		6.4 Returns	47
3 Commissioning	20	7 Technical Data	48
3.1 Electrical Installation	20	7.1 Technical Specifications	48
3.1.1 SubConn 8-pin Connector	20	7.2 Measurement Ranges and Limits of Detection	50
3.1.2 Fixed Cable with M12 Industrial Plug	21	7.3 External Dimensions	51
3.2 Interfaces	22		
3.2.1 Serial Interfaces	22	8 Accessories	52
3.2.2 Network	24	8.1 VALtub	52
4 Use	28	8.2 Controller	52
4.1 Normal Operation	28	8.2.1 TriBox3	52
4.1.1 Immersion Operation	28	8.2.2 TriBox mini	52
4.1.2 Cleaning System	29		
4.1.3 Float	30	9 Warranty	53
4.2 Bypass	30		
4.3 Pipe Installation	33	10 Customer Service	54
5 Calibration	34	11 Contact	55
5.1 Manufacturer Calibration	34		
5.2 Customer Calibration	34	12 Keyword Index	56
5.2.1 Organic Compensation	34		
5.2.2 Scaling	35	Annex	58

1 General Information

1.1 Introduction

Welcome to TriOS.

We are glad that you have chosen to purchase our NICO immersion sensor.

NICO is an optical sensor for online measurement of nitrate. The measurement principle is based on the principle of photometry. By measuring the absorption at three wavelength points, a precise optical nitrate determination takes into account turbidity and organic substances. An internal temperature correction additionally increases the stability of the measured values.

The NICO features the new TriOS G2 interface, allowing fast and easy configuration of sensors by using a web browser. Integration into existing process control systems and external data loggers has never been easier. Wi-Fi connectivity allows laptops, tablets or smartphones to be easily used for control without any special application software or app installation.

In this manual, you will find all the information you will need to commission the NICO. Technical specifications as well as detection limits and the 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 on electronic instruments. The device meets the requirements of the international standards on electromagnetic compatibility. Please use only original TriOS accessories and cables to ensure smooth and professional use of the devices.

Please read this manual carefully before using the device and keep this manual on hand for future use. Before commissioning the sensor, please make sure that you have read and understood the following safety precautions. Always make sure that the sensor is correctly operated. The safety precautions described on the following pages should ensure the smooth and correct operation of the 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

All content in this manual, i.e. texts, photographs and graphics, are protected by copyright. Unless expressly stated otherwise, TriOS Mess- und Datentechnik GmbH is the owner of the copyright. Persons who violate the copyright shall be liable pursuant to § 106 et seq of the German Copyright Act, they will be warned at their own expense and must pay compensation.

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 strictly followed. A 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.

⚠ CAUTION Never look directly into the light source without suitable UV protection! UV light can irreversibly damage your eyes.

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 biologically dangerous. Therefore, you should always wear gloves when working with such materials. Please observe the currently valid biological agents regulation (German BioStoffV)!

Waste

When handling liquid waste, the regulations on water pollution, drainage and waste disposal must be observed.

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 and river 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, chlorine-based connections). The material resistance should be checked after every use.
- The sensor has seals made from NBR (acrylonitrile butadiene rubber). Sealing rings made from other materials may be used upon individual request. Before operation, please ensure that the measured medium does not damage the seals.
- Do not cut, damage or change the cable. Make sure that no heavy objects are placed on the cable and that the cable is not kinked. Make sure that the cable is not run near hot surfaces.
- If the sensor cable is damaged, it must be replaced with an original part by the customer service of TriOS Mess- und Datentechnik GmbH.
- Do not place unsuitable items in the optical path as long as the measurement process is running, as this can cause damage to the sensor or incorrect measurement results.
- Stop operation of the sensor in the event of excessive heat development (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 the 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 carried out 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 (which involve the replacement of the connecting cable) must be carried out by TriOS Mess- und Datentechnik GmbH or by a workshop authorized by TriOS. Faulty, improper repairs can result in accidents and injuries.

⚠ DANGER TriOS does not guarantee the plausibility of the measured values. The user is always responsible for the monitoring and interpretation of the measured values.

1.4 User and Operating Requirements

The NICO UV photometer was developed for use in industry and science. The target group for the operation of the NICO is technically skilled staff in plants, sewage treatment plants, water plants and institutes. The use of 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. The 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 purpose of the NICO is exclusively the implementation of photometric measurements as described in this manual. For this purpose, the photometer is an immersion sensor, which is used underwater or with flow cells. Please note the technical data of the accessory parts. Any other use is not considered to be in compliance with the intended use.

The sensor may only be used to measure the absorption and transmission of aqueous fluids, such as process wastewater, municipal wastewater, and the surface/groundwater. The use of other media can damage the sensor. For the use of the NICO in other media than those specified in this manual, please contact the customer service of TriOS Mess- und Datentechnik GmbH (support@trios.de).

NOTICE

Avoid any unnecessary contact with the glass parts in the optical path, as they can be scratched or soiled. This means 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.

NOTICE

Damage caused by improper use is excluded from the warranty.

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 must be proven with a certificate. Please contact us for more details before you send the device back.

Address of 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 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

NICO is an intelligent measuring instrument for nitrate measurement in water and aqueous solutions.


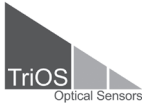

This sensor can be operated without additional hardware. In the following chapters, we shall explain the correct operation of the NICO sensor with all its functions and setting options.

NICO is an independent measuring instrument which can be operated with a power supply of 12 - 24 VDC ($\pm 10\%$). NICO is equipped with a serial RS-485 (EIA-485) interface that supports the Modbus RTU protocol (other protocol types can be set via the web interface). This makes NICO particularly suitable for complex applications, both for PLC-controlled industrial systems and for scientific long-term measurements.

2.1 Product Identification

All TriOS Mess- und Datentechnik GmbH products have a label, which clearly shows the product designation.

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

Serial number	Serial No 062-18-F07F		Assembled in Germany	
Product type	Type NICO			
Power supply	Sensor Power 12-24VDC ($\pm 10\%$)	 062-18-F07F		
Interface	Sensor Interface digital			

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 deviate depending on the version of the product.

2.2 Scope of Delivery

The delivery contains the following components:

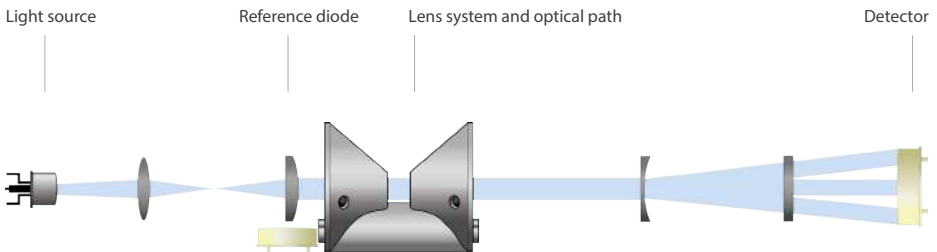
- Sensor
- Operating instructions
- Accessories (if applicable)

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

2.3 Measurement Principle and Design



The following is an overview of the measurement principle, the optical arrangement and the subsequent calculation.



Essentially, the NICO consists of four parts: a defined light source, a lens system, the optical path through the medium and a second lens system with three photodiodes as detectors. The arrangement of these parts is represented schematically in the above illustration.

A xenon flash lamp is used as a broadband light source. The light passes through the medium in the optical path and is partially absorbed by it. The photodiodes pick up the remaining light and determine its intensity I at defined wavelength points.

The weakening of the light when passing through the measurement medium is compared to the weakening caused by ultra-pure water. The measurement in ultra-pure water provides the so-called basic intensity I_0 . Using equation 1 and equation 2, the NICO determines the transmission T and the absorbance A for three defined wavelengths.

$$T = \frac{I}{I_0}$$

Equation 1: Calculation of transmission

$$A = -\log_{10} T = -\log_{10} \frac{I}{I_0}$$

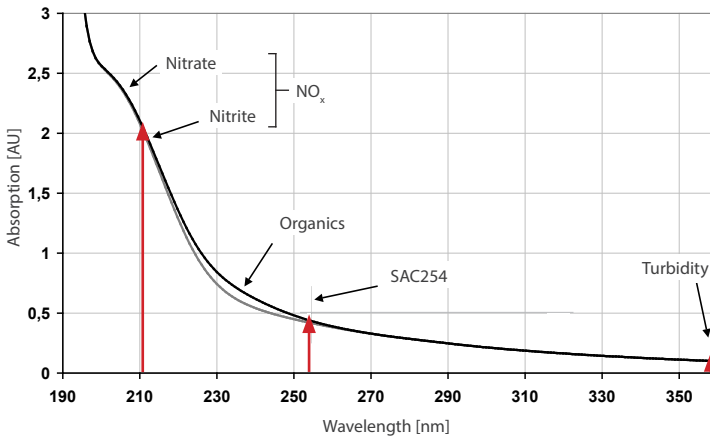
Equation 2: Calculation of absorbance

with

T	transmission in %
I	current light intensity
I_0	basic light intensity in ultra-pure water
A	absorption in AUs (AU = absorbance unit)

The integrated analysis software can calculate the corresponding concentrations from the absorption. The unit of the absorption value is the absorption unit [AU]. The manufacturer calibration is based on an allocation of the absorption units to a defined nitrate concentration based on standard nitrate solutions at a wavelength of 212 nm. An integrated compensation of turbidity and organics allows the measurement principle of the NICO sensor to be described as attenuation.

2.3.1 Analysis



Detection at wavelengths 212, 254 and 360 nm (red arrows).

2.3.2 Parameters

NICO measures absorption at 212 nm. The derived parameters NO₃-N, NO₃, NO_x-N and NO_x are output.

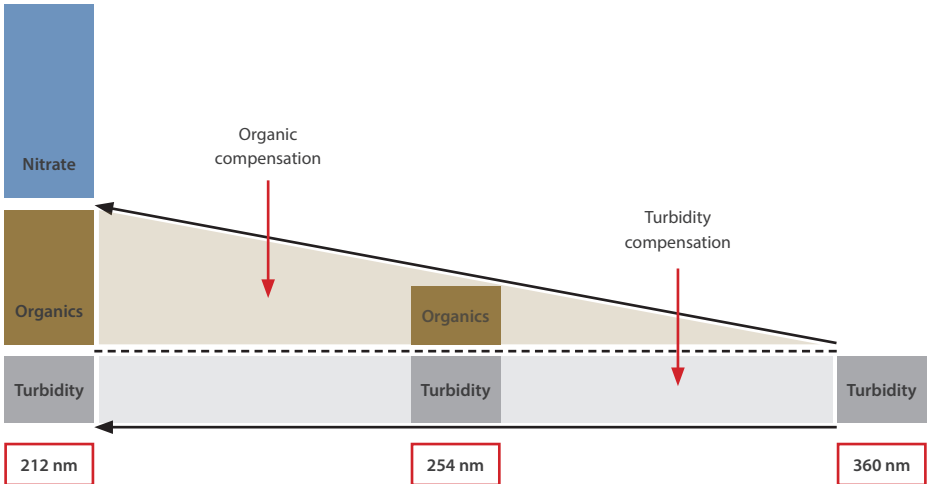
Taking the path length into account, the absorption values [AU] are calculated with the unit [1/m] at 212, 254 and 360 nm. The NICO sensor uses the absorption at 212 nm for the detection of NO₃-N. Absorption at 254 (SAC254) and 360 nm is used to correct organic compounds and turbidity. Optical path lengths of 0.3, 1, 2, 5 or 10 mm are available for NICO. A longer version of NICO allows longer path lengths of 20 and 50 mm.

It is possible to adapt the sensor with scaling factors to laboratory analyses and local conditions. Please note that the manufacturer's calibration is not affected by the customer-specific calibration.

All available parameters can be scaled. For details see chapter 5. Customer Calibration.

2.3.3 Compensation of Turbidity and Organics

Optical nitrate measurement can be influenced by the presence of particles (turbidity) and organic substances (organics). For this reason, the manufacturer's calibration contains a compensation for turbidity and organics, as shown schematically in the figure below.



In the case of organic compensation, it is possible to choose from three fixed compensations for different applications or a customer-specific compensation:

- Default: standard manufacturer calibration.
- High: manufacturer calibration with enhanced compensation for high concentrations of organic substances.
- Low: manufacturer calibration with reduced compensation for low concentrations of organic substances.
- Custom: individual compensation of the organics.

For details see chapter 5.2. Customer Calibration.

2.3.4 Reference Values

In addition to the derived parameters NO₃-N, NO₃, NO_x-N- and NO_x, the following reference values are output.

The SQI value is the sensor quality index that indicates the quality of the measurement.

RefA indicates the light intensity on the 212 nm channel.

RefB indicates the light intensity on the 254 nm channel.

RefC indicates the light intensity on the 360 nm channel.

RefD indicates the light intensity of the reference diode.

Details and limit values of the reference parameters can be found in chapter 5.3. Measurement Properties and chapter 6 Malfunction and Maintenance.

2.4 Browser

Every version of the NICO is equipped with a web interface, which can be used to configure and calibrate the sensor. For example, offsets and scaling factors can be assigned, interfaces configured and further settings entered. To access the web interface, you will need the G2 interface box and an Ethernet-capable device with a web browser, e.g. a notebook.

Open one of the following URLs (depending on the network structure) in your web browser:

`http://nico/`


`http://nico_FXXX/` (FXXX is the serial number)

`http://192.168.77.1/`

The web interface is divided into three areas (see figure):

Title, menu and contents.



In the title, the name of the current page is displayed. To the right of that is the Info button . This shows the contact data of the corresponding TriOS dealer as well as that of the TriOS Mess- und Datentechnik GmbH. In the menu on the left, the individual pages are listed. The name of the current page is highlighted in blue. In the menu, you will find the login form for certified TriOS service technicians to authenticate themselves. In most cases, problems can be solved on site using this option.

Please note that the service login can only be passed on to trained personnel. If you are interested in an internal training, please contact TriOS Mess- und Datentechnik GmbH personally.



Completed settings must be saved with the "Save" button. Otherwise, all settings are lost.

Overview

As shown in the following illustration, basic information about the sensor is summarized on the "Overview" page. This includes the device type and serial number of the sensor as well as the version number of the firmware which has been installed. The type of lamp module with the serial number is listed as well as the number of measurements, which have been carried out by this lamp module.

The screenshot shows the 'Overview' page of the TriOS interface. On the left is a navigation menu with options: Overview, Calibration, Data Logger, Measurement, Peripherals, and System. Below the menu are login fields for 'login' and 'password', and a 'Login!' button. The main content area is titled 'Overview' and contains two expandable sections:

- Sensor**
 - Type: NICO (Digital)
 - Serial Number: NICO_F075
 - Firmware Version: 1.1.5
 - Description:
- Lamp**
 - Type: EPA
 - Serial Number: 0244
 - Shot Counter: 74860

Calibration

Please note that the measurement of a new water base requires legitimation and only qualified personnel are entitled to do so. For further information please contact the TriOS Mess- und Datentechnik GmbH customer service. Further details are described in chapter 5. Calibration.

The screenshot shows the 'Calibration' page of the TriOS interface. The navigation menu on the left has 'Calibration' selected. The main content area is titled 'Calibration' and contains a table for 'Detector / Reference' data:

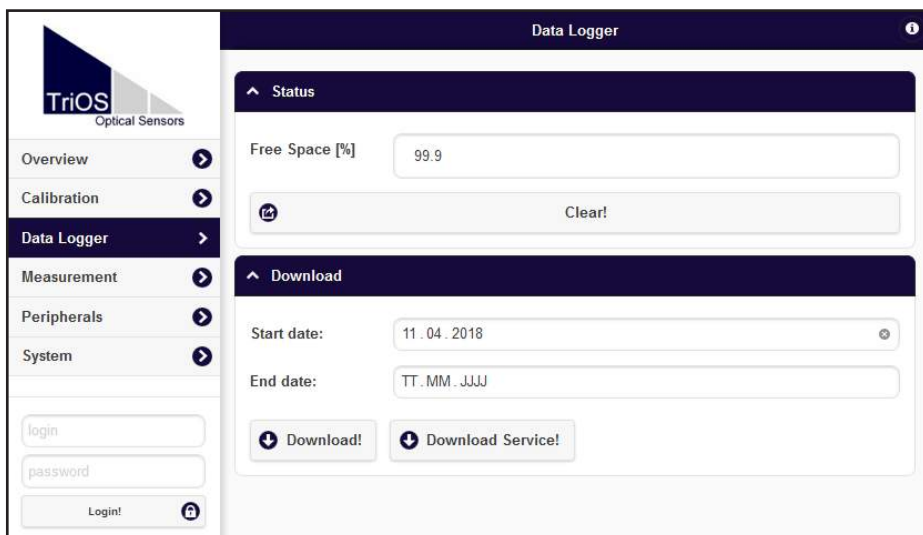
Detector / Reference				
Date / Time	2018-03-13 12:11:30			
Path Length [mm]	10			
	CH1	CH2	CH3	Reference
Wavelength [nm]	212	254	360	
Baseintensity [1]	21829	21729	24481	25931
<ul style="list-style-type: none"> ▼ Nitrate Calibration Set ▼ Nitrate Background 				

Data Logger

The NICO is equipped with a simple data logger function. This allows the NICO sensor an almost completely self-sufficient operation over a long period. A sufficient power supply must be provided.

The data logger function is controlled on the "Data Logger" page, which is shown in the following figure.

The factory-set measurement interval is set to 30 seconds. When the memory is full, only the most recently recorded measurement data is stored and the old data will be overwritten.



Status

The "Status" area displays what percentage of the memory is still available.

The memory can be formatted and all data deleted by clicking on the "Clear" button. For safety, users will be prompted for confirmation before deletion.



After confirming the security prompt, the NICO memory and thus all data is permanently deleted.

Download

The previously stored data can be retrieved by clicking on the "Download" button.

Because the memory may contain a lot of data, download can take a long time. Therefore, it is always advisable to specify a time range for the download and to download the data in several packages.


Measurement

The "Measurement" page shows the results of the last measurements performed and allows the interval to be set for automatic measurements. The new measurement can be triggered at any time. To do this, click on the "Measure now!" button. A new measurement will then be carried out with the saved settings.

The screenshot displays the 'Measurement' page of the NICO interface. On the left, a sidebar contains navigation links: Overview, Calibration, Data Logger, Measurement (highlighted), Peripherals, and System. Below these links are input fields for 'login' and 'password', and a 'Login!' button with a lock icon. The main content area is titled 'Measurement' and features a 'Parameter' section with a table of measurement results. The table has two columns: 'Parameter' and 'Processed Value'. The data rows are: N-NO3 [mg/l] with a value of 0.7294, NO3 [mg/l] with a value of 3.2311, N-NOx [mg/l] with a value of 0.7294, and NOx [mg/l] with a value of 3.2311. Below the table is a 'Settings' section. At the top of the main content area, there are buttons for 'Measure now!' and 'Settings', and a 'Columns...' button.

Parameter	Processed Value
N-NO3 [mg/l]	0.7294
NO3 [mg/l]	3.2311
N-NOx [mg/l]	0.7294
NOx [mg/l]	3.2311




Scaling factors for all parameters can be entered under the  button in the "Scaling" submenu. For details see chapter 5. Customer Calibration.

Scaling **Moving average**

The offset/scaling is calculated using the following formula:
 $y = (x - \text{Offset}) \times \text{Scaling}$

Parameter	Offset	Scaling
N-NO3 [mg/l]	<input type="text" value="0"/>	<input type="text" value="1"/>
NO3 [mg/l]	<input type="text" value="0"/>	<input type="text" value="1"/>
N-NOx [mg/l]	<input type="text" value="0"/>	<input type="text" value="1"/>
NOx [mg/l]	<input type="text" value="0"/>	<input type="text" value="1"/>

▼ more

 Edit


Under "Moving average" you can define an average correction for N (number) measured values.

Scaling **Moving average**

The moving average is calculated as mean of the last N data.

Parameter	N
N-NO3 [mg/l]	<input type="text" value="1"/>
NO3 [mg/l]	<input type="text" value="1"/>
N-NOx [mg/l]	<input type="text" value="1"/>
NOx [mg/l]	<input type="text" value="1"/>

▼ more

 Edit

Parameters

The results calculated at the last measurement are displayed in "Parameters".

The sample view shows the values of the parameters:

- NO₃-N calculated with spectral analysis in mg/L
- NO₃ calculated with spectral analysis in mg/L
- NO_X-N calculated with spectral analysis in mg/L
- NO_X calculated with spectral analysis in mg/L

If you press the "more" button, reference parameters will appear which will be explained below.

The screenshot shows the 'Measurement' screen of the NICO device. On the left is a navigation menu with options: Overview, Calibration, Data Logger, Measurement (selected), Peripherals, and System. Below the menu are login fields and a 'Login!' button. The main area displays a table of parameters and their processed values.

Parameter	Processed Value
N-NO ₃ [mg/l]	0.7294
NO ₃ [mg/l]	3.2311
N-NO _x [mg/l]	0.7294
NO _x [mg/l]	3.2311
SQI [1]	0.9593
RefA [1]	2020.4
RefB [1]	5218.3
RefC [1]	7654.7
RefD [1]	25882

The SQI value is the sensor quality index that indicates the quality of the measurement.

	OK	Caution!	See chapter 6
SQI	1...0.8	0.8...0.5	< 0.5

RefA indicates the light intensity on the 212 nm channel and should always be above 150, otherwise not enough light reaches the detector.

RefG indicates the light intensity on the 254 nm channel and should always be above 150, otherwise not enough light reaches the detector.

RefC indicates the light intensity on the 360 nm channel and should always be above 150, otherwise not enough light reaches the detector.

RefD indicates the light intensity of the reference diode and should always be above 13,000.

Further details on the evaluation of the reference values are described in chapter 5. Customer Calibration and chapter 6. Malfunction and Maintenance.

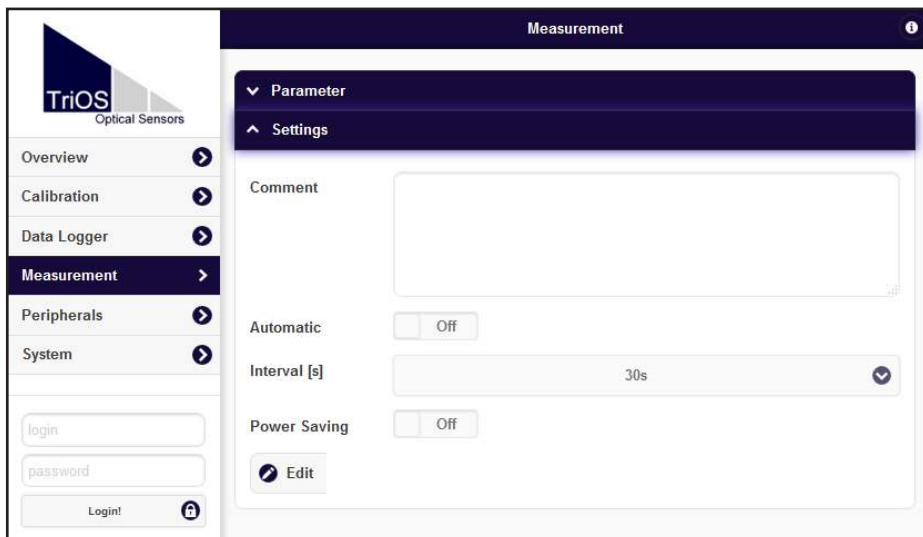


Please note that we are constantly striving to improve our products. The values given here are preliminary guidelines which can be adjusted in the course of development.

Settings

In "Settings" item, you can enter settings for automatic measurement by clicking on the "Edit" button.

- Comments can be entered in the "Comment" field, which are then linked to the measured values and spectra in order to simplify subsequent data assignment.
- Automatic measurements can be activated.
- An interval for the automatic measurements can be specified.



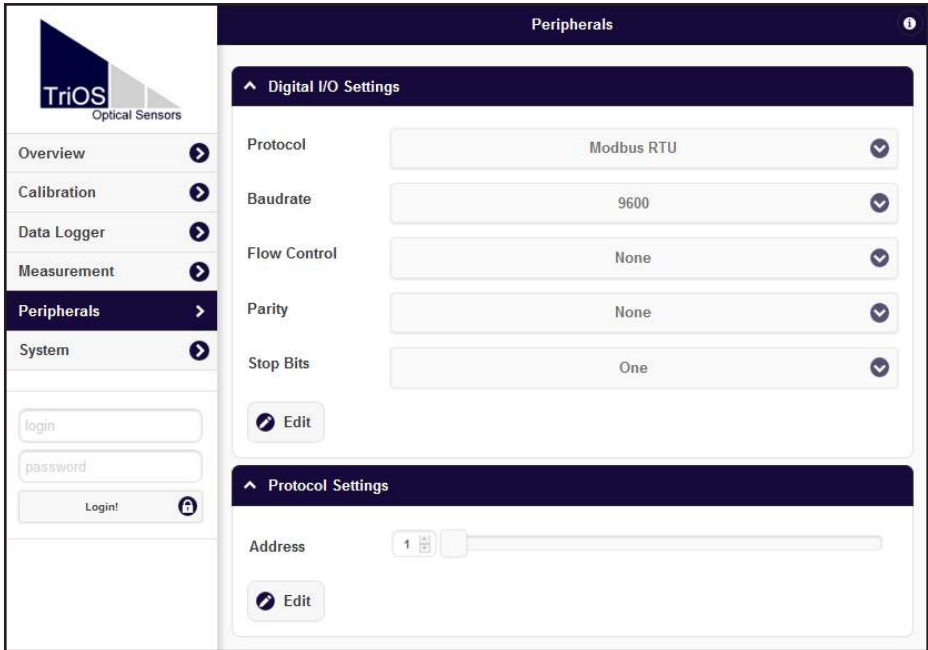
Please note that the factory setting for automatic measurement is set to "off".

NOTICE

To record data sets, please activate the automatic measurement only under a permanent power supply!

Peripherals

The "Peripherals" page is used to configure the interface, select a protocol, and change the Modbus address. To do so, just click on the "Edit" button at the page bottom.



The factory settings are:

Protocol: Modbus RTU

Baud rate: 9600

Flow control: None

Parity: None

Stop bits: 1

System

The "System" page is used to manage the sensor. On this page, the user can set times, download the current calibration as a recovery point and provide a LOG file.

The screenshot displays the 'System' management page for TriOS Optical Sensors. The interface is divided into a left sidebar and a main content area. The sidebar contains a navigation menu with options: Overview, Calibration, Data Logger, Measurement, Peripherals, and System (highlighted). Below the menu are login fields for 'login' and 'password', and a 'Login!' button. The main content area is titled 'System' and features several sections: 'Common Settings' with a 'Description' field and an 'Edit' button; 'Current Date and Time' with 'Date' (18.04.2018) and 'Time' (10:06:45) fields, a 'Synchronize & Save!' button, and an 'Edit' button; 'Recovery Point' with 'Backup' and 'Recover' options, each having a 'Download!' button, and an 'Upload!' button; and 'System Log' with a 'Download!' button. The footer of the page reads 'Copyright © TriOS Mess- und Datentechnik GmbH'.

Common Settings

After pressing the “Edit” button, a comment such as a name or the location of the sensor can be entered here.

Current Date and Time

You can set the date and time here or synchronize the data time with your computer.

Recovery Point

Click on the “Download” button to download the latest sensor calibration to a PC or other support. This calibration file (config.ini) must be stored and kept safe. Use the “Upload” function to restore a previously downloaded calibration file or to upload a calibration file generated by the customer support of TriOS Mess- und Datentechnik GmbH to the NICO.

Please note that this function requires authentication. See also chapter 5. Calibration.

System Log

This log is freely accessible and displays events such as measurements taken, changed settings and error messages. If service is required, the system information can be downloaded here. This information may be important in the event of troubleshooting by the customer service and must be included with the request.

Login

To use the Service function, you need a login and a password. You will receive this when you participate in a TriOS training session. For further information please contact the TriOS Mess- und Datentechnik GmbH customer service.

3 Commissioning

This chapter deals with the commissioning of the NICO 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 connections are connected correctly.

The sensor is ready for commissioning as soon as the installation of accessories is complete, it is connected to your control device and the configuration is complete.

Please never cut a cable to get an open end for e.g. the connection to SCADA or a distributed control system (DCS). We offer various cables with open ends. Please contact the TriOS Mess- und Datentechnik GmbH customer service for further information.

3.1 Electrical Installation

NICO is supplied either with a SUBCONN 8pin underwater connector or a fixed cable with M12/8pin industrial plug.

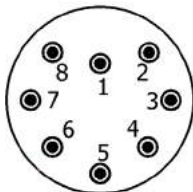
The NICO sensor is designed for a supply voltage range of 12 – 24 VDC (+/-10%). In combination with a G2 interface box, a standard power source with 24 VDC and a power of 8 W can be connected.

NOTICE The sensor can be operated with 12...24 VDC ($\pm 10\%$).

If no G2 interface box is used, please pay attention to the pin assignment. Connect the operating voltage to pin 8 in the middle of the cable and the reference voltage (ground potential) to pin 7.

NOTICE Ensure correct polarity of the supply voltage, because otherwise the sensor may be damaged.

3.1.1 SubConn 8-pin Connector

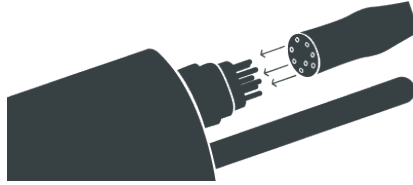


Face view (male)

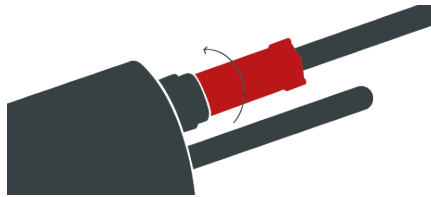
1. Ground (Power + Ser. Interface)
2. RS232 RX / RS-485 A (commands)
3. RS232 TX / RS-485 B (data)
4. Power (12...24 VDC)
5. ETH_RX-
6. ETH_TX-
7. ETH_RX+
8. ETH_TX+



Connect the male end of the connecting cable into the connector by making the pins align with the slots of the cable.



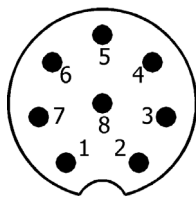
The next step is to hand-tighten the locking sleeve to secure the end of the connector into the bulkhead connection.



NOTICE

Do not twist or bend the connector when plugging or unplugging it. Insert the connector straight in and use the locking sleeve to attach the male contact pin.

3.1.2. Fixed Cable with M12 Industrial Plug



Face view (male)

1. RS-232 RX / RS-485 A (commands)
2. RS-232 TX / RS-485 B (data)
3. ETH_RX-
4. ETH_RX+
5. ETH_TX-
6. ETH_TX+
7. Ground (Power + Ser. Interface)
8. Power (12...24 VDC)



3.2 Interfaces

3.2.1 Serial Interface

The following options are available for operating the NICO sensor:

1. Operating the NICO sensor with a TriOS controller via the serial interface.
2. Operating the NICO sensor in a customer-specific installation via the RS-485 serial interface.
3. Configuring the NICO sensor and recording individual measurements via the web interface.
4. Operating the NICO sensor with an external power supply (e.g. G2 interface box, offered by TriOS Mess- und Datentechnik GmbH). The data is collected on an internal memory (up to 2 GB) and analysed after downloading.

The NICO provides two lines for digital, serial communication with a control device. They are equipped with a digital serial interface. The RS-485 (also EIA 485) standard is supported.

The RS-485 digital interface is a voltage interface. With RS-485, voltages from -5 V to +5 V to ground are possible.

RS-485 uses a differential signal, whereby the sign-negative potential of the A line is applied to the B line. The A-B difference is decisive, where the transmission is most resistant to interactive interference signals.

The screenshot displays the 'Peripherals' configuration page in the TriOS web interface. The left sidebar contains navigation links: Overview, Calibration, Data Logger, Measurement, Peripherals (highlighted), and System. Below the sidebar are login fields for 'login' and 'password' with a 'Login!' button. The main content area is titled 'Peripherals' and features two expandable sections: 'Digital I/O Settings' and 'Protocol Settings'. The 'Digital I/O Settings' section includes the following parameters:

Parameter	Value
Protocol	Modbus RTU
Baudrate	9600
Flow Control	None
Parity	None
Stop Bits	One

An 'Edit' button is located below these settings. The 'Protocol Settings' section includes:

Parameter	Value
Address	1

An 'Edit' button is located below the address field.

Transceiver:

- EIA-485 (also RS-485)

Protocol: Specifies the data protocol to be used. The following are supported:

- Modbus RTU
- ASCII Output

A detailed description of the Modbus RTU protocol for NICO can be found in the annex.

Baud rate: Specifies the transmission speed. The following options are available:

- 1200
- 2400
- 4800
- **9600 Standard setting for all TriOS controllers**
- 19200
- 38400
- 57600



Note: In the event of difficulties in the communication, try to reduce the baud rate.

Flow control: Activates flow control on the software level (XON/XOFF).



Note: If the Modbus RTU protocol is being used, "None" must be selected.

Parity: Activates the parity check for data transmission. Possible options are:

- None (deactivated)
- Even
- Odd

Stop bits: Specifies the number of stop bits. The following options are available:

- One
- Two



Note: In various Modbus devices, it may be necessary to set this to "Two" if a parity check does not need to take place.

In the "Protocol settings" section, you can input settings for the active protocol.

- In the Modbus RTU protocol, the following properties are also available:
 - **Address:** This is the slave address for the Modbus communication. It identifies the sensor in the bus system and must be unique.

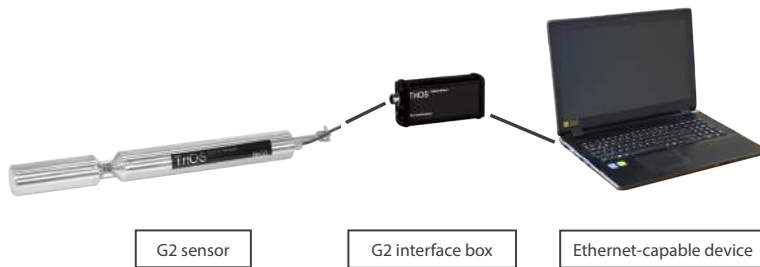
3.2.2 Network

For the new TriOS G2 sensors, the IEEE 802.3 10BASE-T-compliant Ethernet interface is used as a universal interface. This makes it possible to connect a single sensor or even to build a complex sensor network.

Network with a single G2 sensor

The easiest way to connect to the NICO is with the G2 interface box. It serves as both the connection and the power supply for the sensor and can be used with all TriOS G2 sensors.

The following figure shows a connection to a single sensor:



The TriOS G2 interface box translates the 8-pin M12 sensor plug to the conventional power supply connections (2.1 mm barrel connector) and to the network access (RJ45 socket).

G2 interface box



There are three connectors on the housing of the G2 interface box:

1. Power supply 12 or 24 VDC; 2.1 mm barrel connector
2. Sensor connector 8-pin M12
3. Ethernet connection RJ45 socket

Proceed as follows to connect the sensor to an Ethernet-capable device via the G2 interface box:

- Step 1) Make sure that the Ethernet adapter of your device is configured to automatically obtain the network settings (IP address and DNS server).
- Step 2) Plug the M12 plug on the cable end of the sensor into the M12 socket (2) of the G2 interface box and tighten the screw plug.
- Step 3) Connect the 12 or 24 VDC power supply to the G2 interface box to supply the sensor with power.
- Step 4) Wait at least 3 seconds before you connect the LAN cable with your Ethernet-capable device and the G2 interface box.

The web interface can now be called with any browser via one of the following URLs:

<http://nico/>

http://nico_FXXX/ (FXXX is the serial number)

<http://192.168.77.1/>



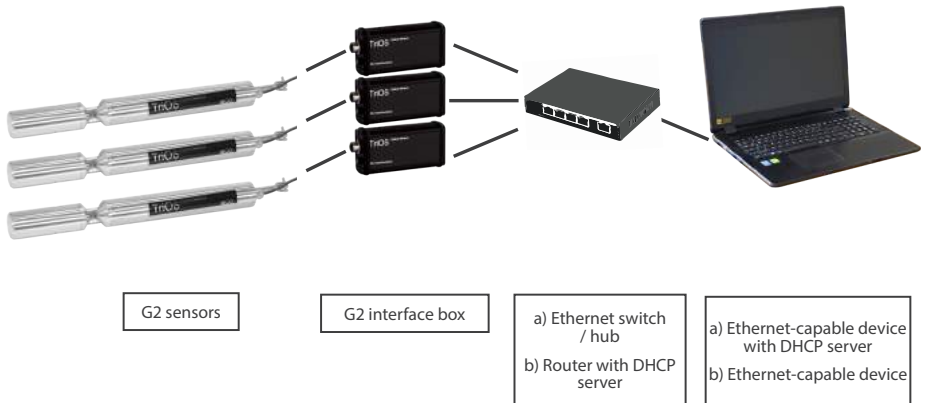
If the web interface cannot be accessed, make sure that the LAN cable was connected after the sensor was connected to the power supply and try all three URL options.

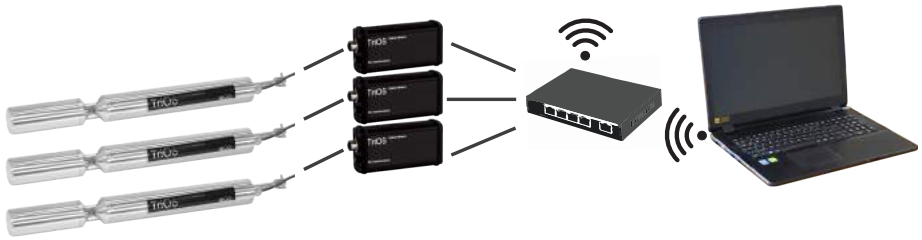
Network with multiple G2 sensors

By using an Ethernet switch / hub or a conventional router, it is possible to connect multiple sensors into a complex network and use them simultaneously. In the sensor network, each sensor must have its own G2 interface box for power supply.

Like any G2 sensor, the NICO delivers a simple DHCP server as well as a simple DNS server, which is configured exclusively for direct connection, as described in the previous section. For a complex sensor network, the servers must be supplied by the user. The NICO recognizes these automatically and then turns off the internal servers. Ask your network administrator for advice on how this can best be implemented in your case.

The following illustrations show examples of different ways to set up a sensor network.





G2 sensors

G2 interface box

a) Access point
b) Wireless router
with DHCP server

a) Wireless-capable device
with DHCP server
b) Wi-Fi-capable device



The NICO can only be used by one Ethernet-capable device at one time.



If multiple sensors are being used in a network, the web interface can be accessed via the host name http://nico_FXXX/ (FXXX is the serial number) or via the IP.

NOTICE

Damage caused by improper use is excluded from the warranty!

4 Use

The NICO can be operated with all TriOS controllers. Instructions for correct installation can be found in the relevant controller manual.

NOTICE Never transport the sensor while it is hanging on the cable.

4.1 Normal Operation

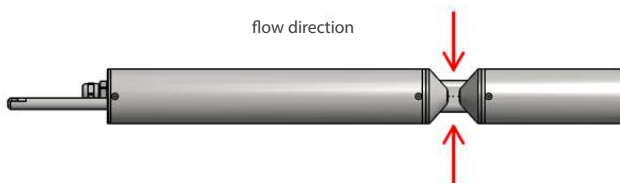
4.1.1 Immersion Operation

For immersion operation, the NICO can be completely or partially immersed in the water / measuring medium. To make a correct measurement, the measuring windows must be completely immersed and free of air bubbles. Use the mounting rod with a shackle and a stainless steel chain or a steel wire to hang the device in the medium. Do not put weight or pull on the sensor cable. The NICO can also be attached with suitable hydraulic clamps, as shown in the following illustration. Make sure to use suitable brackets with an inner diameter of 48 mm. To protect the housing pipe against excess punctual pressure, install the brackets close to the device covers. Fitting brackets can be obtained from TriOS.



The sensor should be installed perpendicular to the direction of flow. This minimizes deposits on the windows and optimally supports the nano-coating function.

The sensor must not touch the ground, as it may cause damage.



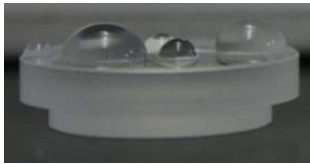
When immersing the sensor, make sure there are no air bubbles in front of the sensor discs. If there are air bubbles in front of the window, shake the sensor carefully until the bubbles have been removed.

4.1.2 Cleaning System

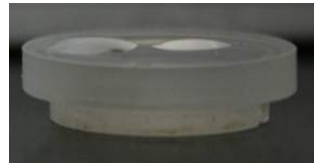
The NICO and all other sensors from TriOS Mess- und Datentechnik GmbH are equipped with innovative antifouling technology, to prevent pollution and dirt from attaching to the optical window: nano-coated window in combination with compressed-air cleaning.

Nano-coating

All optical windows from TriOS are treated with a nano-coating



Window with nano-coating



Window without nano-coating

Wetting of the surface on the coated glass is significantly lower. This effect creates a nano-coated surface on the glass, to which dirt cannot adhere. In combination with the compressed-air cleaning, the windows are kept clean for long periods of time and thus reduce the amount of cleaning necessary.

Compressed air cleaning

The NICO can be modified with the optional compressed-air cleaning head. The head is equipped with an air outlet directly on the window plate of the device and a hose fitting for the compressed-air connection. TriOS controllers have valves which allow fixed cleaning intervals to be set and controlled by software. For this, compressed air of between 3 and 6 bars must be provided.



NOTICE

The optimum pressure for compressed-air cleaning is between 3 and 6 bars. The total length of the hose should not exceed 25 meters. Suitable hoses are available from TriOS (polyurethane, 6 mm outer diameter, 4 mm inner diameter)

To connect the hose, push the hose into the matching connection port. To remove it, press the blue locking ring in the direction of the connection and pull the hose out. Secure the hose to the device and the cable with cable ties if necessary to avoid uncontrolled hits and movement of the compressed-air hose.

NOTICE

The pressure should not exceed 7 bars! This may damage the valve!



During compressed air flushing, measurements can be adversely affected. Therefore, flushing intervals should be meaningfully controlled.

4.1.3 Float

The float is the ideal solution for use with fluctuating water levels.



4.2 Bypass Installation

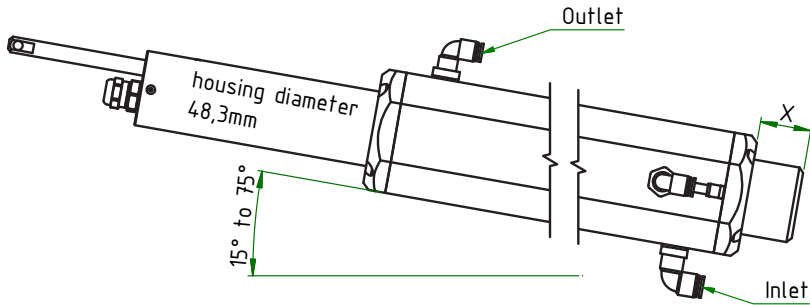
With the optional flow cell, the NICO can be installed as a bypass. Along with the flow cell, a panel is available on which the NICO and the flow cell can easily be mounted.



NOTICE

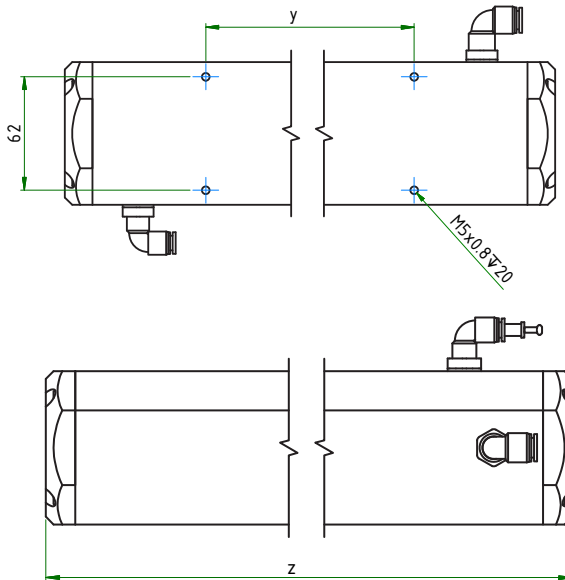
The maximum pressure in the flow cell must not exceed 1 bar. Make sure that the sensor is installed in the correct position to guarantee the free flow of water.

The NICO flow cell has three hose connections. The inlet has an 8 mm hose connection (lower connection on the figure). The outlet has a 6 mm hose connection (upper connection on the figure). Finally, there is a third hose connection on the top of the cell (middle connection in the figure) which can be used for cleaning with fluids. If this inlet is not being used, it should be sealed with a plug.



Because the NICO is available in different path lengths, the dimensions of the associated flow cells vary accordingly, as described in the following table:

Path length [mm]	x [mm]	y [mm]	z [mm]
up to 10	99.5	62	108
50	98.5	96	150



The hoses are installed by putting light pressure on the hose connectors. To remove the hoses, press on the locking ring on the hose connector and carefully pull the hose away.

NOTICE The flow cell cannot be combined with the compressed-air cleaning.

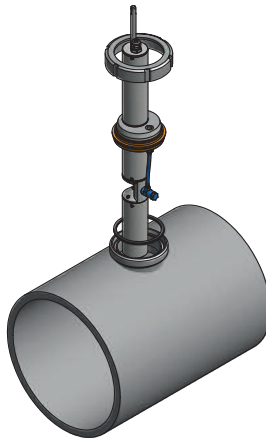
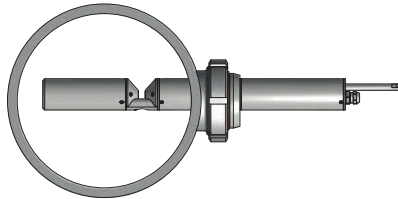
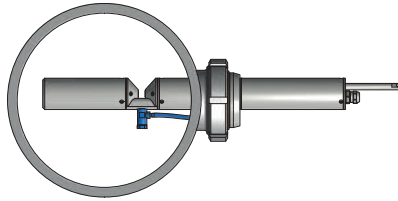


Follow the steps below to install the NICO in the flow cell.

1. Remove both end caps and both seals by loosening the eight screws.
2. Slide the NICO into the flow cell and secure it in the correct position. All openings must be clear so that the flowing fluid can flow directly through the optical path. The back of the NICO should point towards the flow cell bottom (the bottom of the flow cell is the side on which the cell is mounted). The screw heads at the tube ends should disappear completely into the flow cell cuvette, so that the NICO sits centrally in the flow cell cuvette.
3. Slide a seal over the NICO in the slots provided in the flow cell cuvette. Before final assembly, please check seals for damage and use new ones where necessary. Seals (48 x 5 mm NBR) are available as spare parts and can be purchased from TriOS Mess- und Datentechnik GmbH.
4. If the sensor position is correct, install both end caps and secure them with the eight screws. The flow cell and the NICO should be installed at an angle between 15° and 75° to the horizontal, so that neither bubbles nor sinking dirt particles affect the measurement. After installation, check for leaks and free flow of water.

4.3 Pipe Installation

The NICO can be mounted directly in the pipe (either with the special flanged version of the sensor or installation by the customer on-site). In the case of a grounded tube, no additional grounding of the sensor housing is required (as long as there is no insulation between the tube and the sensor). One of the flange solutions available from TriOS is shown in the figures below (possible with and without compressed air cleaning).



5 Calibration

5.1 Manufacturer Calibration

All TriOS sensors are delivered calibrated. The calibration of the NICO is stored in the sensor, meaning that all values that are output are calibrated values. See also chapter 2.1. Measurement Principle.

5.2 Customer Calibration

The sensor can be adapted to laboratory analyses and local conditions with other scaling factors. This is set in the controller or directly in the browser of the sensor. To do this, open the "Measurement" submenu in the browser. The customer calibration or local calibration works in addition to the manufacturer calibration, whose values are not changed by the customer calibration.

If you are logged in successfully, the NICO sensor can be calibrated and a new water base can be measured.

NOTICE Incorrect calibration can lead to undefined sensor behaviour!

Before calibration, it is essential to download the current water base and save it as a recovery point (see also Chapter 5. Customer Calibration and 6.3.1. Download Recovery Point).



Please save the current water base (zero line) before calibration!

5.2.1 Organic Compensation

Before you scale the values, the organic compensation should be checked and adjusted if necessary. In the case of organic compensation, it is possible to choose from three fixed compensations for different applications or an application-specific compensation:

- Default:** standard manufacturer calibration.
- High:** manufacturer calibration with enhanced compensation for high concentrations of organic substances.
- Low:** manufacturer calibration with reduced compensation for low concentrations of organic substances.
- Custom:** individual compensation of the organics.

If the measured nitrate value deviates from the laboratory value, the higher or lower fixed compensation should be tried out first.

Before performing application-specific organic compensation, it must be ensured that the prerequisites are met.

You can check this as follows. Time series of the reference values RefB and RefC can be plotted (at least 20 values). If the values of RefC exceed the values of RefB, an individual compensation of the organics can make sense.

If organic compensation does not improve your measurements, please contact customer service.

5.2.2 Scaling

In the "Parameters" subitem of the "Measurement" menu item, individual measurements can be triggered by pressing the "Measure now!" button and all available parameters can be scaled by pressing the "Edit" button. The formula used to calculate the scaled measured value with scaling factor and offset is as follows:

$$(\text{Raw Value} - \text{Offset}) \times \text{Scaling} = \text{Scaled Value}$$

$$(\text{Measured value} - \text{Axis Offset}) \times \text{Scaling factor} = \text{Scaled measured value}$$

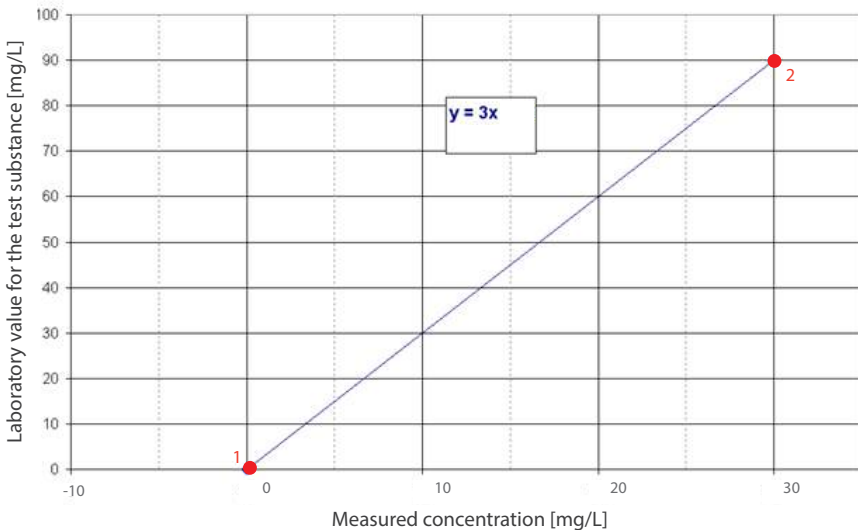
Local calibration is adjusted by means of a linear equation. Normally, only the scaling factor is needed to do this. Offset calibration is not always recommended.



A customer calibration with laboratory values should only be performed if the offset=0 and the scaling is between 0.8-1.2. Larger deviations should be checked. We do not recommend offset calibration. Please contact TriOS customer service if necessary.

For local calibration, at least one data point consisting of a laboratory value and a sensor value is required.

1. Offset = 0 is given
2. Make a diagram like the one shown below and connect the two data points with a straight line. The slope of the straight line is the scaling factor.



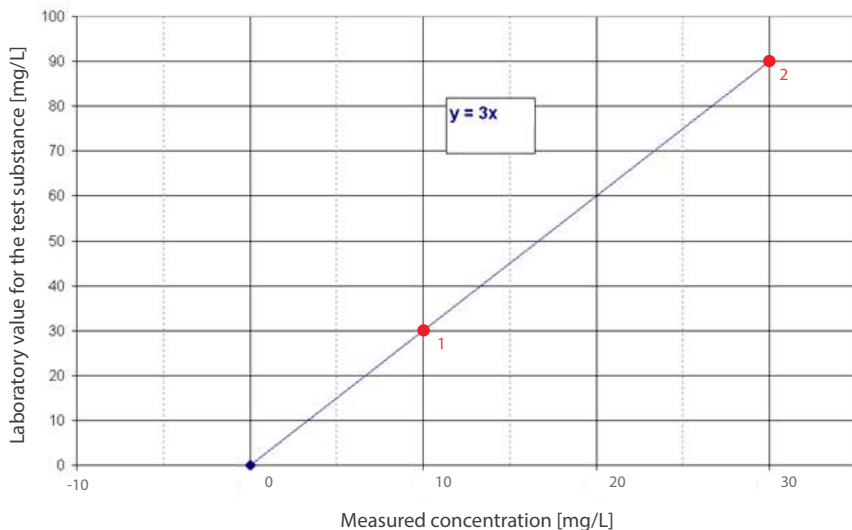
3. The scaling factor can be calculated using the following equation

$$\text{scaling factor} = \text{laboratory value} / \text{measured value}$$

For the previous example in the figure, this means:

$$\text{scaling factor} = 90 \text{ (mg/L)} / 30 \text{ (mg/L)} = 3$$

4. If there are several laboratory values available, all laboratory values should be entered in the graph. Offset = 0 should still be given. As shown in the diagram, the slope of the line is equal to the scaling factor.



The scaling factors must be set in the controller. All TriOS controllers have the ability to set scaling factors and offset values for the measurement parameters. Please refer to the appropriate manual. If you are not using a TriOS controller, it is possible to set the scaling factors in the web interface. Make sure not to carry out double scaling with the sensor.



Customer calibration can be used as a fine adjustment of the sensor for special media and is not intended to replace the manufacturer calibration.

NOTICE

Measurement ranges and detection limits of the scaled parameters are dependent on the scaling factor!

If you perform a calibration, please make sure that the sensor is calibrated in the environment in which measurements are to take place.

Both the set optical path in millimetres and the basic intensity at wavelengths 212, 254 and 360 nm and the reference diode are displayed on the “Calibration” page under the “Detector/Reference” menu item.

The screenshot shows the 'Calibration' page in the TriOS interface. The left sidebar contains navigation options: Overview, Calibration (selected), Data Logger, Measurement, Peripherals, and System. Below these are login fields for 'login' and 'password', and a 'Login!' button. The main content area is titled 'Calibration' and features a 'Detector / Reference' section with the following data:

	CH1	CH2	CH3	Reference
Date / Time	2018-03-13 12:11:30			
Path Length [mm]	10			
Wavelength [nm]	212	254	360	
Baseintensity [1]	21829	21729	24481	25931

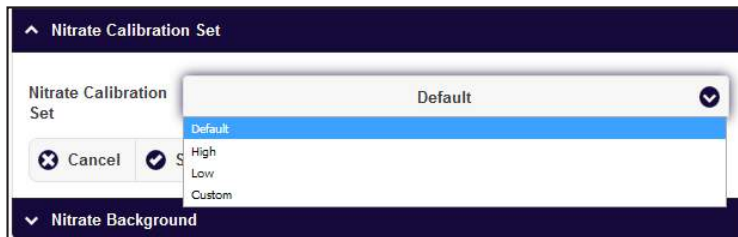
Below the table, there are two expandable sections: 'Nitrate Calibration Set' and 'Nitrate Background'.

The path length of the sensor can be entered in the “Path length [mm]” field. Possible path lengths are 0,3, 1, 2, 5 and 10 mm.

Please note that the entry of the path length must be saved by clicking on the “Save” button so that it is set correctly for the next measurements.

Your calibration can be further specified under the “Nitrate Calibration Set” menu item.

This screenshot shows the 'Calibration' page with the 'Nitrate Calibration Set' section expanded. The 'Nitrate Calibration Set' is currently set to 'Default'. An 'Edit' button is visible below the dropdown menu. The 'Detector / Reference' and 'Nitrate Background' sections are collapsed.



Default: standard manufacturer calibration.

High: manufacturer calibration with enhanced compensation for high concentrations of organic substances.

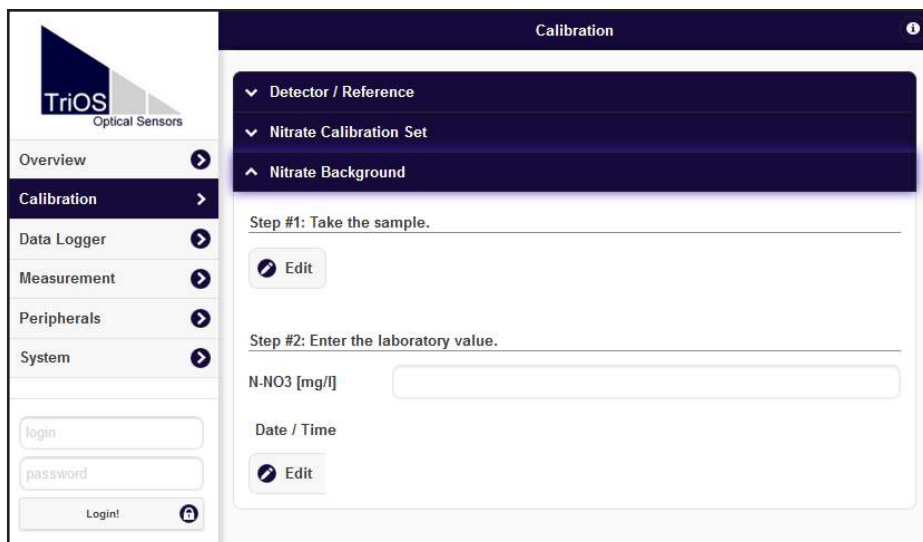
Low: manufacturer calibration with reduced compensation for low concentrations of organic substances.

Custom: individual compensation of the organics. Under certain conditions, the compensation of high concentrations of organic substances generated in the customer calibration is taken into account.

You can check the organic compensation as follows. Time series of the reference values RefB and RefC can be plotted (at least 20 values). If the values of RefC exceed the values of RefB, an individual compensation of the organics can make sense.

It may be necessary to calibrate the NICO sensor specifically for organic substances. In this case, it is necessary to enter a NO₃-N [mg/L] reference value (laboratory analysis) under step #2 to match the sample from step #1.

This is done under the "Nitrate Background" menu item.



Customer calibration can be used as a fine adjustment of the sensor for special media and is not intended to replace the manufacturer calibration.

5.3 Measurement Properties



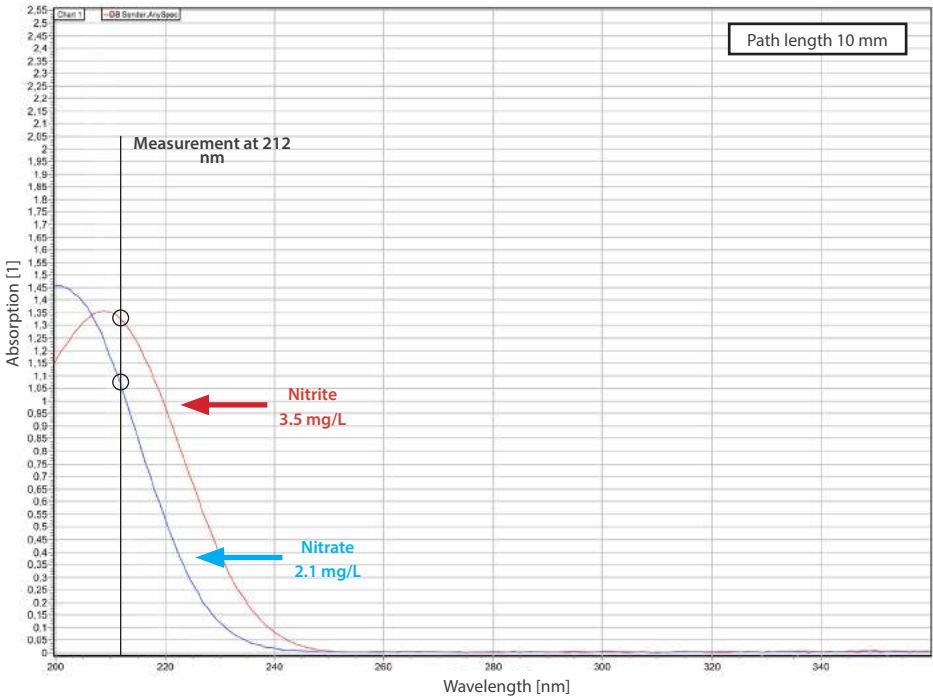
The path length must be chosen according to the absorption level of the medium.

5.3.1 Turbidity and Organics Compensation

There is a correlation between turbidity/organics and absorption, however these depend greatly on the size and type of particles and the concentration of organic substances. Normally the organic matter is sufficiently compensated for the existing calibration settings (Default, High, Low). If in doubt about the accuracy of the data provided, please contact TriOS customer service.

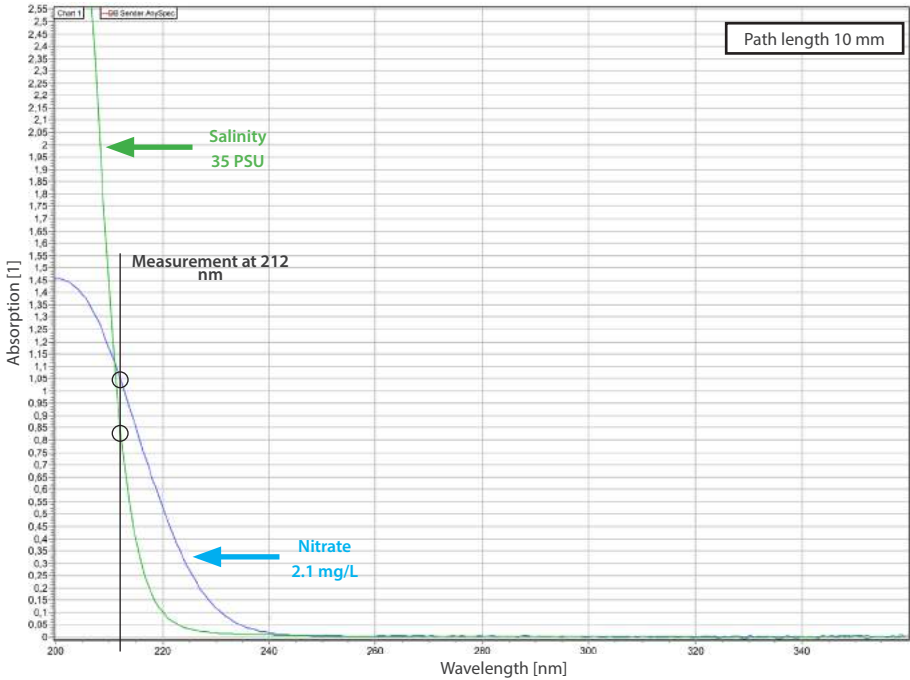
5.3.2 Nitrite

Increased concentrations of nitrite can severely interfere with the optical determination of nitrate, as nitrite and nitrate absorb in the same wavelength range. The figure below shows the absorption curves of nitrate (2.1 mg/L) and nitrite (3.5 mg/L). Please note that specific spectral analysis at 212 nm may result in an overlap of nitrate and nitrite. Since the sensor has been calibrated for nitrate, the measured value applies only to nitrate. If nitrite is present, it is no longer possible to determine how high the respective concentration actually is and an incorrect determination is made. A differentiated detection of nitrite and nitrate can be carried out with the OPUS sensor.



5.3.3 Salinity

Please note that the optical determination of nitrate in connection with high salt concentrations (≥ 1 PSU) can lead to interference. The salinity absorbs light of the same wavelength range. The figure below shows the absorption curves of nitrate (2.1 mg/L) and salinity of seawater (35 PSU). Specific spectral analysis at 212 nm may result in an overlap of the absorption of nitrate and salinity. A differentiated detection of salinity and nitrate can be carried out with the OPUS sensor.



5.3.4 Path Lengths and Limit Values

The reference values RefA, RefB, RefC and SQI should first be checked in the application.

The following table lists the limit values of the reference values RefA, RefB, RefC and SQI for checking the sensor in the application.

Reference value	Explanation	Lower limit value	Recommendation
RefA	Light intensity on the 212 nm channel	150	Check the sensor and, if necessary, shorten the path length
RefB	Light intensity on the 254 nm channel	150	Check the sensor and, if necessary, shorten the path length
RefC	Light intensity on the 360 nm channel	150	Check the sensor and, if necessary, shorten the path length
SQI	Spectral quality index	0.5	Check the sensor and, if necessary, shorten the path length



If the limit values RefA, RefB, RefC and SQI fall below the limit values listed in the table above, it should be ensured that the NICO sensor functions properly before the path length is changed! Further details can be found in chapter 6. Malfunction and Maintenance.

5.3.5 Unknown Substances

Substances that absorb UV light but are not taken into account in the calibration can severely interfere with the measurement result. Under certain circumstances, measured values can no longer be calculated (NAN or permanently zero).

If this is the case, please contact TriOS customer service (see also chapter 11).

6 Malfunction and Maintenance

To ensure an error-free and reliable measurement, the device should be periodically checked and maintained. For this, the sensor must be cleaned first.

6.1 Cleaning and Upkeep

Deposits (vegetation) and dirt depend on the medium and the duration of exposure of the medium. Therefore, the degree of pollution depends on the use. For this reason, it is not possible to give a general answer to how often the sensor should be cleaned.

Normally, the system is kept clean by the nano-coated window and also by the air cleaning system. If the contamination is too bad, the following instructions should be followed.

NOTICE Damage arising from improper cleaning is not covered by the warranty!

6.1.1 Cleaning the Housing

CAUTION Please use protective goggles and gloves when cleaning the sensor, especially when using acids, etc.

To loosen caked-on dirt, we recommend softening the sensor for several hours in a rinsing solution. During any cleaning, exposed connectors should be avoided so that these do not come in contact with water. To ensure this, make sure that the locking cap of the connector is properly locked. Please inform yourself thoroughly about the risks and safety of the cleaning solution used.

If the sensor is very dirty, additional cleaning with a sponge may be necessary. You should exercise extreme caution to avoid scratches on the windows of the optical path.

In the case of calcification, a 10% citric acid or acetic acid solution can be used for cleaning.

Brownish dirt or spots can be contamination due to iron manganese oxides. In this case, a 5% oxalic acid solution or a 10% ascorbic acid solution can be used to clean the sensor. Please note that the sensor should only briefly come in contact with the acid, and then it should be thoroughly rinsed.

NOTICE Under no circumstances should the sensor be cleaned with hydrochloric acid. Even very low concentrations can damage components made of stainless steel. In addition, TriOS Mess- und Datentechnik GmbH cautions against using any other strong acids.

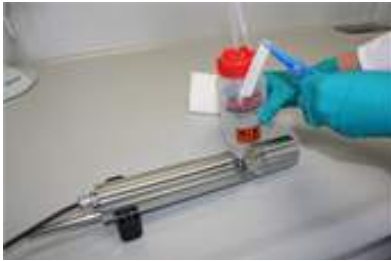


6.1.2 Cleaning the Measuring Window

You can clean the window with a lint-free cloth, a clean paper towel or a special optical paper from TriOS Mess- und Datentechnik GmbH with a few drops of acetone. Make sure that you do not touch the window surface with your fingers!

TriOS Mess- und Datentechnik GmbH offers a cleaning set with a bottle of acetone and special optical cleaning paper to simplify cleaning the optical window.

NOTICE Do not use any aggressive cleaning solutions, putty, sandpaper or cleaning solutions that contain abrasive substances to remove caked-on dirt.



NOTICE Avoid any additional contact with the glass parts in the optical path, as they can be scratched or soiled. This means the functionality of the device can no longer be guaranteed.

If, despite all care, the windows are scratched or damaged, they can be replaced.

6.2 Maintenance and Inspection

To evaluate the reference values and to avoid unnecessary maintenance and a failure of the measurement operation, please carry out the following steps:

1. The reference value RefD indicates the light intensity of the xenon flash lamp. If this value is below 13,000, the sensor must be sent in for inspection. The lamp is probably used up.

Please note that consumable parts of the sensor, such as the lamp and the reference diodes, are subject to normal ageing processes and must be replaced depending on the frequency of use. Please contact the TriOS GmbH customer service.
2. If the reference value RefD exceeds 13,000 but the values of RefA, RefB and RefC are below 150, remove the sensor from the medium and perform a measurement in air.

If the values of RefA, RefB and RefC do not increase, please thoroughly clean the sensor and especially the measuring windows (as described in detail in chapter 6.2.1.) and repeat the air measurement.
3. If cleaning does not cause the reference values RefA, RefB and RefC to increase when measuring in air, we recommend checking the zero value in ultra-pure water as described in detail in chapter 6.2.1. Checking the Zero Value.
4. The reference values RefA, RefB and RefC should reach the order of magnitude of the reference value RefD: RefA, RefB and RefC \approx RefD \pm 5000 is acceptable.

5. If the reference values RefA, RefB and RefC do not reach the order of magnitude of the RefD even after careful cleaning and measurement in ultra-pure water, the sensor must be sent in. Please contact the TriOS customer service.
6. If reference values RefA, RefB and RefC reach the order of magnitude of RefD but are still below 150 in the medium, the optical path should be shortened.

6.2.1 Checking the Zero Value

Limit values to decide whether a new zero line must be drawn (in ultra-pure water with clean measuring windows):

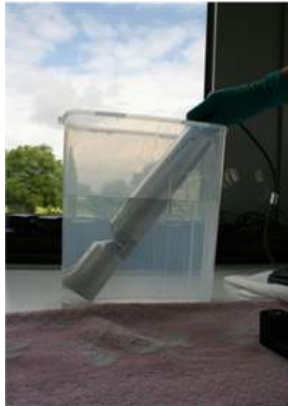
- 4 mg/L N-NO₃ with 1 mm path
- 0.4 mg/L N-NO₃ with 10 mm path

No new zero line needs to be drawn below these values.

Prepare the sensor for the zero-value check as described in the previous chapter and clean the sensor thoroughly as described above. We recommend using the TriOS VALtub to check the zero value, because this seals the optical path optimally and allows for a fast zero-value check. Make sure that the O-rings of the VALtub are positioned exactly over the seals of the sensor.



Alternatively, another container suitable for immersion can be used. When taking a measurement, the optical path must always be completely immersed in the water.



The zero value of the NICO is checked via the web interface. To access the web interface, you will need the G2 interface box and an Ethernet-capable device with a web browser, such as a notebook.

Before the zero-value check, prepare the sensor as described below:

Clean the probe as described in chapter 6.1.1 Cleaning the Housing. At the end of the cleaning process, rinse the probe carefully with deionized water. Dry the sensor with a paper towel. Wipe the sensor off with a little acetone on a kitchen towel to remove any greasy residues.

▲ CAUTION For your own safety, you must wear appropriate gloves and protective goggles!

Clean the sensor windows with special optical paper or a soft, lint-free cloth and a few drops of acetone according to the previous instructions on cleaning the measuring window.

Important: Polish the window next with a soft dry cloth or special optical paper to remove the thin film that may have appeared while cleaning the window.

Have a suitable measurement container filled with ultra-pure water ready nearby. Before this step, the measurement container should already have been cleaned carefully with a detergent solution and rinsed with ultra-pure water.

Immerse the sensor in the container, which has been sufficiently filled with ultra-pure water so that the measuring windows are completely covered by water. Wait 10 – 15 minutes. During this time, hidden dirt can come loose from the sensor.

Remove the probe from the water and rinse it with ultra-pure water. Fill the container once more with fresh ultra-pure water and immerse the sensor again. Lift the probe and move it around in the water to remove any air bubbles that may have formed. You can now check the zero value using the web interface.

The sensors should be positioned diagonally in the measurement container or vertically in the VALtub, if at all possible, to prevent very small, almost invisible air bubbles collecting at the top of the measuring window. When using an upright measuring cylinder which requires the sensor to be positioned vertically, make sure to watch out for air bubbles in the optical path.

Make sure it is sufficiently stable!

Carry out the zero-value check at an ambient temperature of 20°C, if at all possible. The temperature of the ultra-pure water should also be 20°C.

General Information:

- Do not touch the part of the sensor which has been submerged in the ultra-pure water with your hands during the sensor check unless you are wearing gloves.
- Be sure to use highly pure water (ultra pure, resistance of 18.2 MΩcm) or distilled water.
- If impurities in the water show up during the check, the process must be started over!
- Make sure there are no air bubbles in front of the measuring windows.

We recommend carrying out at least five individual measurements in "Measurement" prior to the check to bring the sensor up to operating temperature.

NOTICE Damage arising from improper cleaning is not covered by the warranty!

6.3 Troubleshooting

6.3.1 Uploading Recovery Point

The screenshot displays the 'System' settings page of the TriOS Optical Sensors web interface. The page is divided into several sections:

- Common Settings:** Includes a 'Description' field with an 'Edit' button.
- Current Date and Time:** Shows 'Date' as 18.04.2018 and 'Time' as 10:06:45. It includes a 'Synchronize & Save!' button and an 'Edit' button.
- Recovery Point:** Contains a 'Backup' section with a 'Download!' button, and a 'Recover' section with a search button ('Durchsuchen...') and an 'Upload!' button. The text 'Keine Datei ausgewählt.' is displayed next to the search button.
- System Log:** Includes a 'Download!' button.

The left sidebar contains navigation options: Overview, Calibration, Data Logger, Measurement, Peripherals, System (selected), login, password, Login!, Customer Service, Contact, Keyword Index, and FAQ.

A previously downloaded recovery point can be uploaded under the “System” menu item, “Recovery Point” subitem, which can be accessed via the “Upload” function.

Select the path to your calibration file by clicking the “Browse” button and upload the file by clicking the “Upload” button. If the file upload was successful, a green “Success” box appears, otherwise an error message is displayed. The following error messages are possible:

- **“File not OK”**: The calibration file could not be read correctly. Please check the path to your calibration file, and if the error cannot be corrected, contact the TriOS Mess- und Datentechnik GmbH customer service.
- **“Device type or serial number does not match”**: The calibration file does not match the connected sensor.

6.3.2 Uploading New Calibration

If servicing is required, the file of the “Download Service” (see chapter 2.5.3 Data Logger) should first be sent to TriOS customer service (see also chapter 2.5.3 Data Logger and chapter 5 Calibration). If a calibration file created by the service of TriOS Mess- und Datentechnik GmbH is then to be uploaded to the NICO, this can be done via the “Upload” function.

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-technology	light source	Xenon flash lamp	
	detector	4 photo diodes + filter	
Measurement principle		Attenuation	
Optical path		0.3 mm, 1 mm, 2 mm, 5 mm, 10 mm, 50 mm	
Parameters		NO ₃ -N, NO ₃ , NO _x -N, NO _x (calibrated with NO ₃ standard solution)	
Measurement range	1 mm path	0.5...60 mg/L NO ₃ -N	
	10 mm path	0.05...6 mg/L NO ₃ -N	
Measurement accuracy		± (5 % + 0.1 mg/L NO ₃ -N) with 10 mm path ± (5 % + 1 mg/L NO ₃ -N) with 1 mm path	
Turbidity compensation		Yes	
Data Logger		~ 2 GB	
Reaction time T100		20 s	
Measurement interval		≥ 10 s	
Housing material		Stainless steel (1.4571/1.4404) or titanium (3.7035)	
Dimensions (L x Ø)		~ 470 mm x 48 mm (10 mm path)	~ 18.5" x 1.9" (with 10 mm path)
Weight	stainless steel	~ 3 kg	~ 6.6 lbs
	titanium	~ 2 kg	~ 4.4 lbs
Interface	digital	Ethernet (TCP/IP)	
		RS-485 (Modbus RTU)	
Power consumption		≤ 7 W	
Power supply		12...24 VDC (± 10 %)	

Required supervision	Typically ≤ 0.5 h/month	
Calibration/maintenance interval	24 months	
System compatibility	Modbus RTU	
Warranty	1 year (EU: 2 years)	US: 2 years

INSTALLATION

Max. pressure	with Subconn	30 bar	~ 435 psig
	with fixed cable	3 bar	~ 43.5 psig
	in flow unit	1 bar, 2...4 L/min	~ 14.5 psig at 0.5 to 1.0 gpm
Protection type		IP68	NEMA 6P
Sample temperature		+2...+40 °C	~ +36 °F to +104 °F
Ambient temperature		+2...+40 °C	~ +36 °F to +104 °F
Storage temperature		-20...+80 °C	~ -4 °F to +176 °F
Inflow velocity		0.1...10 m/s	~ 0.33 to 33 fps

7.2 Measurement Ranges and Limits of Detection

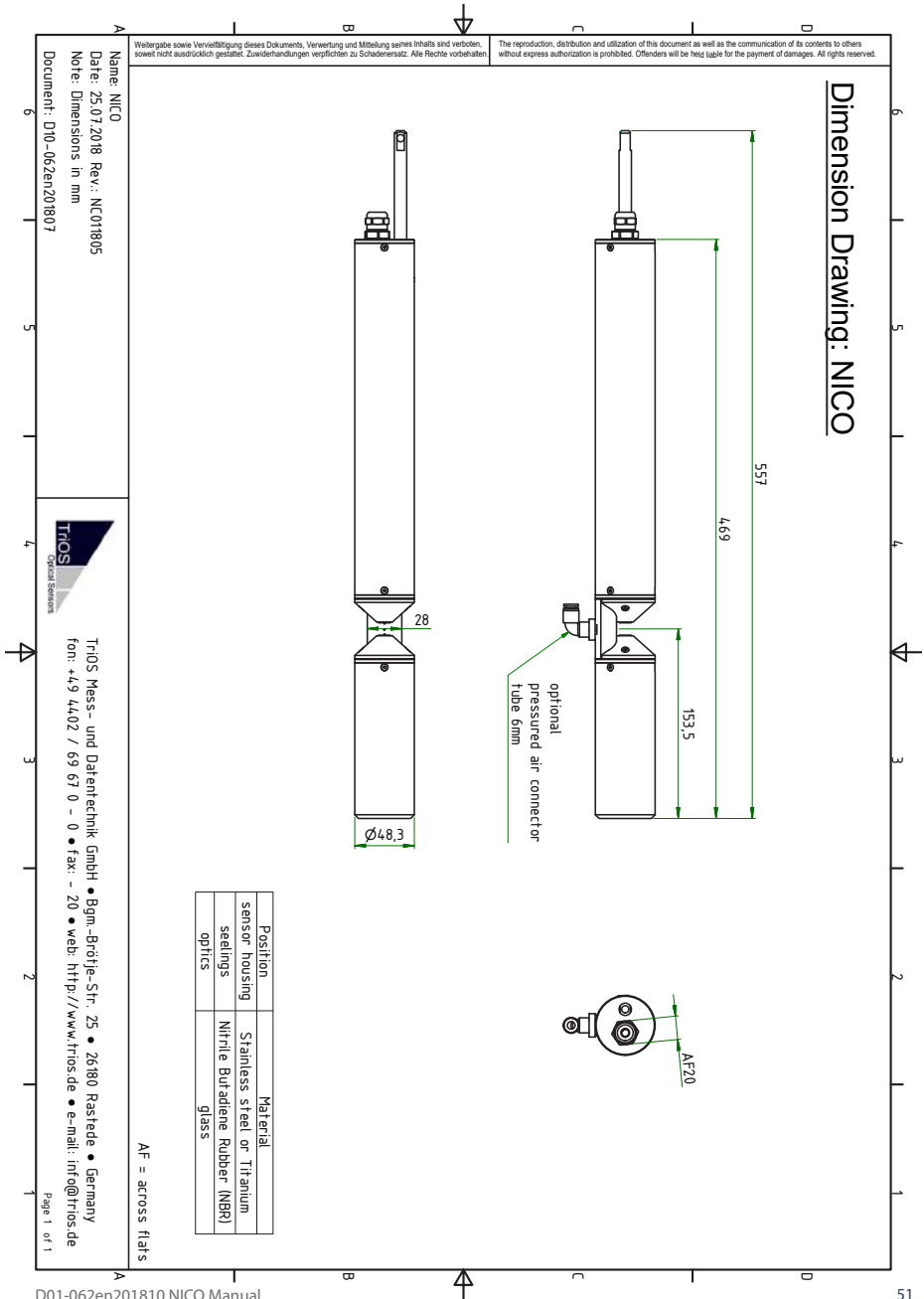
The following table lists the measurement ranges and detection limits depending on the path length:

Path length [mm]	Parameters	Measurement range*	Detection limit*	Determination limit*	Precision*	Accuracy**
0.3	Nitrate NO ₃ -N	0...200	1.65	4.95	0.495	± (5% + 3.3)
	Nitrate NO ₃	0...886	7.26	21.78	2.178	± (5% + 14.5)
1	Nitrate NO ₃ -N	0...60	0.5	1.5	0.15	± (5% + 1)
	Nitrate NO ₃	0...266	2.2	6.6	0.66	± (5% + 4.4)
2	Nitrate NO ₃ -N	0...30	0.25	0.75	0.075	± (5% + 0.5)
	Nitrate NO ₃	0...133	1.1	3.3	0.33	± (5% + 2.2)
5	Nitrate NO ₃ -N	0...12	0.1	0.3	0.03	± (5% + 0.2)
	Nitrate NO ₃	0...53	0.44	1.32	0.132	± (5% + 0.88)
10	Nitrate NO ₃ -N	0...6	0.05	0.15	0.015	± (5% + 0.1)
	Nitrate NO ₃	0...26.6	0.22	0.66	0.066	± (5% + 0.44)
20	Nitrate NO ₃ -N	0...3	0.025	0.075	0.0075	± (5% + 0.05)
	Nitrate NO ₃	0...13	0.11	0.33	0.033	± (5% + 0.22)
50	Nitrate NO ₃ -N	0...1.2	0.01	0.03	0.003	± (5% + 0.02)
	Nitrate NO ₃	0...5	0.044	0.132	0.0132	± (5% + 0.09)

*The unit used for all measured values is [mg/L].

** Based on a standard calibration solution; Note: 1 mg/L NO₃-N corresponds to 4.43 mg/L NO₃.

7.3 External Dimensions



8 Accessories

8.1 VALtub

The VALtub is used to test and recalculate the zero values. Because of the adapted shape, only small amounts of water are required to take a measurement.



8.2 Controller

8.2.1 TriBox3

Digital 4-channel display and control unit with integrated solenoid valve for pneumatic control

TriBox3 is a measurement and control system for all TriOS sensors. The device provides 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 offers various interfaces, including an IEEE 802.3 Ethernet interface, an IEEE 802.11 b/g/n interface, a USB connection and 6 analogue outputs (4...20 mA). An integrated relay can be used to trigger alarms or to control external devices. Features such as low power consumption, a robust aluminium housing and a range of interfaces make it suitable for all applications that have to do with environmental monitoring, drinking water, wastewater treatment plants and many other areas.



8.2.2 TriBox Mini

Digital 2-channel controller

Mini controller with two digital sensor inputs and two 4...20mA outputs. All stored measured values and diagnostic data can be read out via 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.

We recommend sending the sensor in for maintenance and calibration every 2 years. To do this, please request an RMA number from customer service.

Technical support contact:

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)

- General Information
- Introduction
- Commissioning
- Use
- Calibration
- Malfunction and Maintenance
- Technical Data
- Accessories
- Warranty
- Customer Service
- Contact
- Keyword Index
- FAQ

11 Contact

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

If you have found an error or bug in one of our 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

D-26180 Rastede

Germany

Telephone +49 (0) 4402 69670 - 0

Fax: +49 (0) 4402 69670 - 20

12 Keyword Index

A

Absorbance	7
Accessories	52

B

Biological safety	3
Browser overview	10
Bypass installation	30

C

CE certification	58
Certificates & approvals	5
Cleaning	42
Cleaning systems	29
Cleaning the housing	42
Cleaning the measuring window	43
Compressed air cleaning	29
Contact	55
Copyright	2
Customer calibration	34
Customer Service	54

D

Declaration of Conformity	58
Detection limit	50
Dimensions	51
Disposal	5

E

Electrical installation	20
Electromagnetic waves	3

F

Flow cell	30
-----------	----

G

G2 interface box	24
------------------	----

H

Health and safety information	3
Hydraulic clamps	28

I

Immersion operation	28
Intended use	4
Interfaces	22

J

K

L

M

M12 industrial plug	21
Maintenance	43
Manufacturer calibration	34
Measurement principle	7
Measurement properties	39

N

Nano-coating	29
Normal operation	28

O

Operating requirements	4
------------------------	---

P

Panel installation	30
Peripherals	17
Pipe installation	33
Product identification	6

Q

R

Rating plate	6
Reagents	3
Returns	47
RMA number	47

S

Safety instructions	3
Scope of delivery	6
Structure of the sensor	7
SubConn 8-pin connector	20

T

Technical specifications	48
Transmission	7
Troubleshooting	46

U

User requirements	4
-------------------	---

V

W

Warnings	4
Warranty	52
Waste	3

X

Y

Z

Zero-value check	44
------------------	----

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 **NICO**
Product name
Designation

Typ / Type / Type: -

Mit den folgenden Bestimmungen 2014/30/EU EMV-Richtlinie
With applicable regulations 2011/65/EU RoHS-Richtlinie
Avec les directives suivantes

Angewendete harmonisierte Normen EN 61326-1:2013
Harmonized standards applied EN 55011:2009 + A1:2010
Normes harmonisées utilisées EN 61010-1:2010
EN 50581:2012

Datum / Date / Date Unterschrift / Signature / Signatur

12.10.2017

R. Heuermann

D05-062yy201710

Modbus RTU

Serial Interface

The serial port configuration for the RS-485 interface is (9600,8N1):

- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none

Data types

Name	Register	Format
Bool	1	false: 0x0000, true: 0xFF00
Uint8	1	8-bit positive integer. Values: 0x0000 - 0x00FF
Uint16	1	16-bit positive integer. Values: 0x0000 - 0xFFFF
Uint32	2	32-bit positive integer. Values: 0x00000000 - 0xFFFFFFFF
Float	2	IEEE 754 32-bit floating-point number
Char[n]	$\left[\frac{n}{2} \right]$	Null-terminated ASCII character string

Functions

The NICO supports the following Modbus functions:

Name	Code	Description / Use
Read multiple registers	0x03	Read the serial number, configuration, calibration and measurement data
Write single register	0x06	Triggering of (calibration) measurements
Report slave ID	0x11	Read the serial number

Standard Modbus server address

Upon delivery, the NICO sensor is set to address 1 (0x01).

Read / Write multiple registers (0x03 / 0x10)

The following values are in the registers:

Designation	R/W	Address	Data type	Description
Modbus slave address	RW	0	Uuint16	Modbus server address of the sensor. Valid IDs: 1...247
Device serial number	R	10	Char[10]	Serial number of the sensor
Firmware version	R	15	Char[10]	Version number of the installed firmware
N-NO3 / scaled	R	1000 / 1500	Float	
NO3 / scaled	R	1002 / 1502	Float	
SQI / scaled	R	1004 / 1504	Float	
RefA / scaled	R	1006 / 1506	Float	
RefB / scaled	R	1008 / 1508	Float	
RefC / scaled	R	1010 / 1510	Float	
RefD / scaled	R	1012 / 1512	Float	

Write single register (0x06)

With the “write single register” function, specific actions are written in the register rather than values. The following section describes how this mechanism works.

Designation	Address	Description
Trigger measurement	1	<p>A single measurement is taken. The type of measurement depends on the written value:</p> <p>0x0101: Absorption spectrum + substance analysis</p> <p>All other values are reserved for future expansions and can cause uncertain behaviour of the sensor.</p> <p>Note: Up to and including firmware version 1.2.4, it is possible that Modbus requests will not be answered during the measurement.</p>

Report slave ID (0x11)

Provides the sensor designation followed by the serial number followed by the firmware version each as a null-terminated ASCII character string.

Example:

N	I	C	O	0x00	F	0	2	0	0X00	1	.	1	0x00
---	---	---	---	------	---	---	---	---	------	---	---	---	------