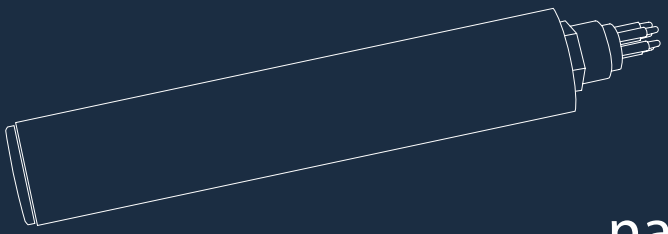
TriOS
Optical Sensors



nanoFlu

OPERATING INSTRUCTIONS

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1 General Information

1.1 Introduction

Welcome to TriOS.

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

nanoFlu fluorometers are online measuring instruments used to determine dyes and pigments (such as cyanobacteria, chlorophyll-A or CDOM) by measuring fluorescence emission. The parameters emit light at a certain wavelength when excited by a defined external light source.

Equipped with our innovative G2 interface with a web browser configuration, flexible protocols and data outputs, the nanoFlu possesses equipment attributes that are significantly greater than the devices currently available on the market.

In this manual, you will find all the information you will need to commission the nanoFlu. 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.

Read this manual thoroughly before using the device and retain it for future reference. 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.**

Software Updates

This manual refers to software version 1.0.x. Updates include bug fixes, new features and options. Devices with older software versions may not have all functions described here.

Copyright Notice

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 looked directly at the light source. The radiation emitted (UV light) can cause serious damage to the 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 material ordinance!

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, 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, chlorine-based connections.
- The material resistance should be checked after every use.
- The sensor has seals made from NBR (nitrile 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 cord. Make sure that no heavy objects are placed on the cord and that the cord is not folded. Make sure that the cord is not run 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 technician.
- Do not place unsuitable items in front of the measuring window 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 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.

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 Users and Operating Requirements

The nanoFlu fluorometer has been developed for use in industry and science. The target group for the operation of the nanoFlu fluorometer 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 nanoFlu is exclusively the implementation of fluorescence measurements as described in this manual. For this purpose, the fluorometer 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 fluorescence 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 nanoFlu 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 touching the measuring window, since it can become scratched or dirty. 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.

1.6 Disposal Instructions

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 before you send the device back to find out more details.

Address of the manufacturer:

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

nanoFlu fluorometers are low-priced, submersible miniaturized fluorometers for highly precise and selective measurement of CDOM (colored dissolved organic matter, yellow substances), chlorophyll A and phycocyanin in cyanobacteria. Long-term stability of measurements is ensured by the combination of low power consumption and innovative coating of the optical window, as an energy efficient and environmentally friendly antifouling solution.

The devices can be used in diverse applications for the monitoring of sea and river waters, as well as in drinking and wastewater treatment systems. Internal reference signals of the high performance LEDs used for fluorescence excitation compensate ageing effects and temperature influences.

2.1 Product Identification

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

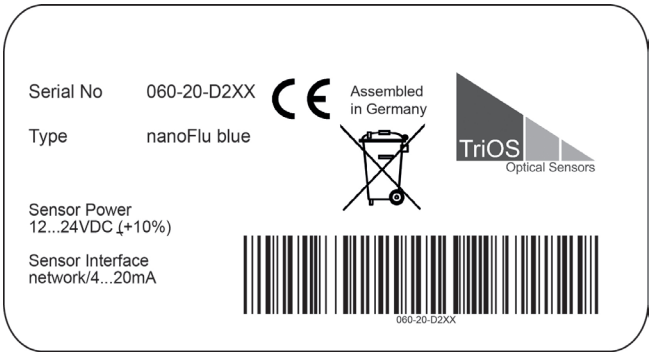
There is also a rating plate on the sensor with the following information that you can use to uniquely identify the product:

Serial number

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 deviate depending on the version of the product.

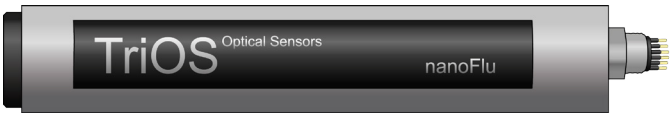
2.2 Scope of Delivery

The delivery contains the following components:

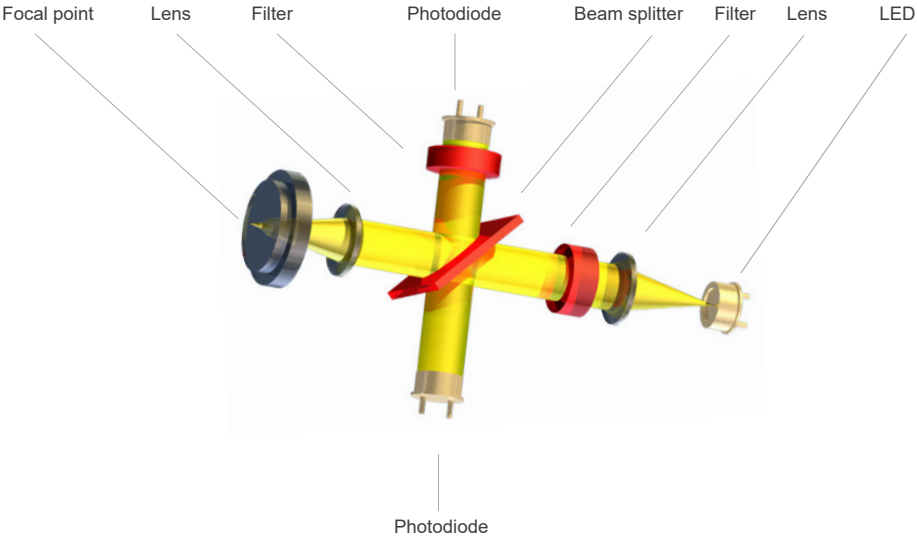
1. Sensor
2. Operating Instructions
3. Accessories (if applicable)

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

2.3 Measurement Principle and Design



For optimal use of the sensor, you must know and understand the idea and theory that the sensor is based on. The following is an overview of the measurement principle, the optical arrangement and the subsequent calculation.



Essentially, the nanoFlu consists of four parts: a defined light source, a lens system, the optical path and a detector with ambient light suppression. The arrangement of these parts is represented schematically in the above illustration.

The light source consists of an LED with a defined wavelength depending on the version or parameter.

The excitation light beam is parallelized and a small part is reflected by a beam splitter (short pass) onto a reference diode to compensate fluctuations in the light source. A large part of the light is focused with a lens about 10 mm in front of the optical window. Fluorescent light is collected with the same lens and is reflected again by the beam splitter due to the higher wavelength. An interference filter in front of the photodiode for measuring fluorescence intensity prevents extraneous and scattered light from penetrating.

A special electronic circuit is used to eliminate ambient light.

2.3.1 Fluorescence

Fluorescence is the spontaneous emission of light directly after a material has been excited. The emitted light is generally lower in energy (larger wavelength) than the previously absorbed light (shorter wavelength).

Photons are absorbed and electrons of the molecule are lifted into an energetically higher orbital, i.e. excited. If they fall back to their original level, the released energy produces heat and photons (fluorescent light).

Double-bond electrons are excited more easily, because the p-electrons of the double bond are distributed over both atoms and are therefore not so strongly bound. Molecules with a conjugated double bond are particularly suitable for fluorescence; the electrons are distributed over several atoms and are therefore very easy to excite.

2.3.2 Parameters

Depending on the parameters, nanoFlu uses different LEDs for long-term stable measurements of fluorescence values. The following parameters (see table) can be measured or derived with nanoFlu.

Parameter	Excitation wavelength	Detection wavelength
Chl-a	470	682
blue	620	655
CDOM	360	460

2.4 Browser

nanoFlu is equipped with a web interface, which can be used to configure the sensor. 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://nanoFlu/ or

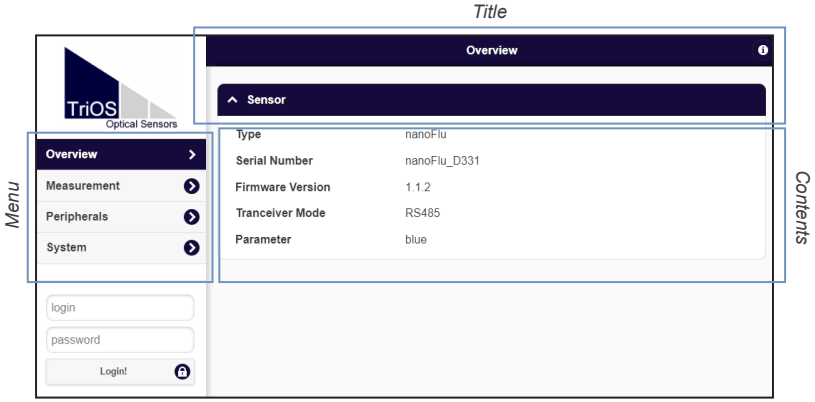
http:// nanoFlu _D2XX/ (D2XX is the serial number) or

http://192.168.77.1/

When connected to an Internet-capable device, automatic measurements will be stopped. As soon as the sensor is disconnected from your device, the measurements will continue at the set interval if the timer is activated for automatic measurements.

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

Title, menu and contents.



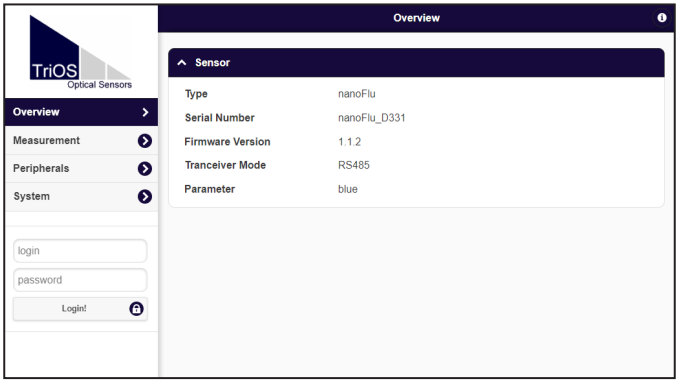
In the menu on the left, the subpoints are listed. There is a “Help” link on the right side that will take you to the TriOS Mess- und Datentechnik GmbH website. An active Internet connection is required to access the website.

The menu is used to navigate the web interface. Each line is a link to another page with different setting options. The link that refers to the page currently displayed is always highlighted in the menu. Special, selected contents and functions are exclusively reserved for the employees of TriOS Mess- und Datentechnik GmbH Customer Service. Authentication is needed for this content.

The “Contents” area displays the relevant information and setting options. Contents that require authentication are deactivated (“grayed out”).

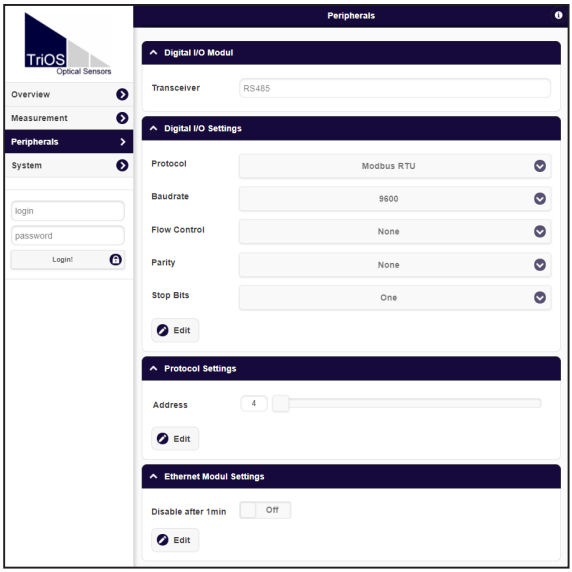
Overview

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 installed firmware, interface and parameters.



Peripherals

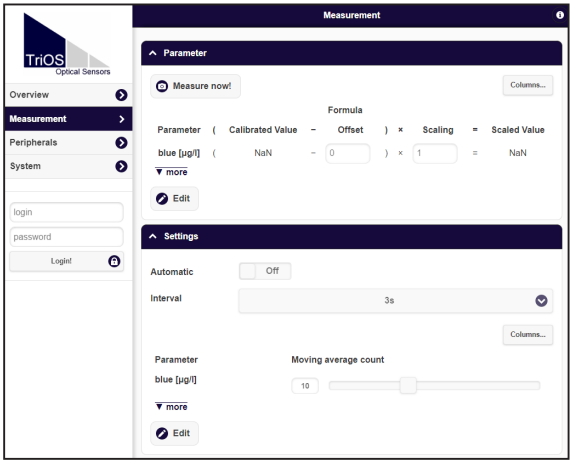
In the environment settings (“Peripherals”), various options are available depending on the version of the sensor.



Measurement

The "Measurement" page shows the results of the last measurement. In addition, the interval settings for the automatic measurements and the number of individual measurements to be averaged for the final measurement can be changed here. On this page, it is also possible to scale the measured value with the help of entries for “Offset” and “Scaling”.

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.



In order to make changes, the "Edit" button must first be pressed in the corresponding area.

The parameter can be calculated automatically with a scaling factor and an offset for specific parameters. The scaling factor always depends on the application and must be determined by the user, with the exception of the parameters predefined by the manufacturer. The values are entered in the corresponding “Scaling” and “Offset” fields. More information on the scalable parameters can be found in chapter 5.2 - Customer Calibration.

The time interval for automatic measurements is entered in the field for “Interval”. This interval should be understood as a minimum value. If the previous measurement has not yet been completed after the interval has elapsed (e.g. because the nanoFlu simply needs more time to calculate the average), this previous measurement will be waited out before the next one is started.

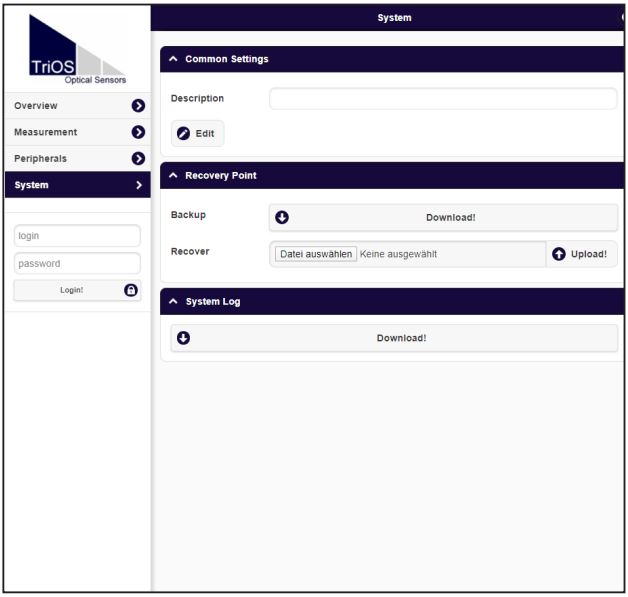
The factory-set measurement interval recommended by TriOS Mess- und Datentechnik GmbH is 3 seconds.

If several individual measurements are to be averaged for one measurement, the number of measurements can be set via the controller.

Important: Modified values must be saved by clicking on the “Save” button for them to be used for subsequent measurements.

System

The “System” page is used to manage the sensor. On this page you can add a comment under "Description". In addition, a restore point can be created or uploaded (see chapter 6.2.2) and the system log file can be exported. The sensor no longer has integrated RTC (real time clock) time buffering, which is why the date is reset to 01.01.1998 each time it is switched on.



Service

To use the Service function, you need a login and a password. You will receive this when you participate in a TriOS training session.

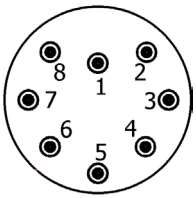
3 Commissioning

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 connections are connected correctly.

3.1 Electrical Installation

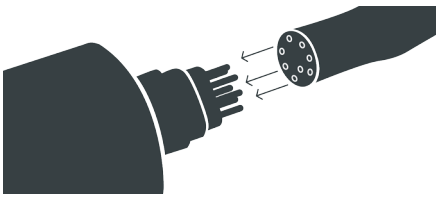
3.1.1 SubConn 8-pin Connector



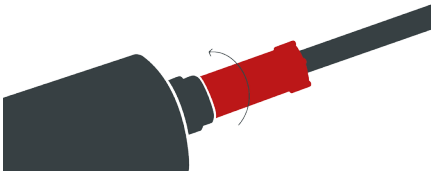
Face view (male)

1. Ground (Power + Ser. Interface)
2. RS232 RX / RS485 A (commands)
3. RS232 TX / RS485 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.

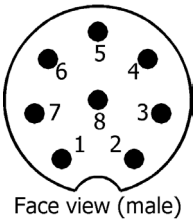


The next step is to hand-tighten the locking sleeve to secure the end of the connector into the bulkhead connection.



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. RS232 RX / RS485 A (commands)
2. RS232 TX / RS485 B (data)
3. ETH_RX-
4. ETH_RX+
5. ETH_TX-
6. ETH_TX+
7. Ground (Power + Ser. Interface)
8. Power (12...24 VDC)

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

3.2 Interfaces

3.2.1 Serial Interface

The nanoFlu provides two lines for digital, serial communication with a control device. It is equipped with a configurable digital serial interface as RS-232 (also EIA 232) or RS-485 (also EIA 485). The interface cannot be switched and is already defined when delivered.

For the RS-232, voltages of –15 V to +15 V with respect to the ground are possible. For the RS-485, voltages of –5 V to +5 V with respect to the ground are possible.

nanoFlu is delivered as RS-485 in the standard version. Upon delivery, the nanoFlu is configured for RS-485 with the following settings:

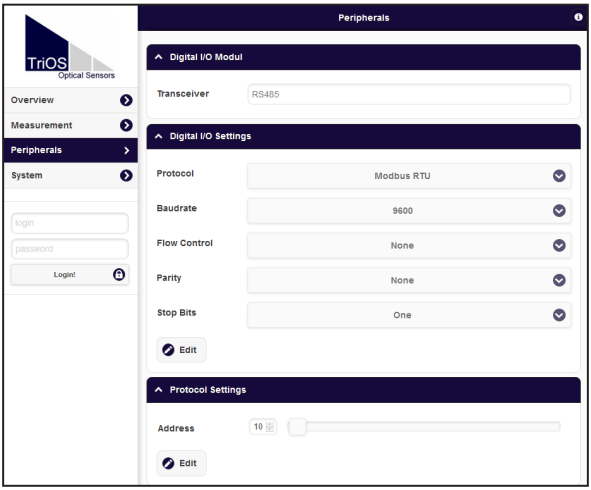
- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none

Detailed description of the Modbus protocol commands can be found in the annex.

For the RS-232, data transmission takes place on one line per direction, with the RX cable being used for the communication from the control device to the sensor and the TX cable being used from the sensor to the control device.

RS-485 uses a differential signal with 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.

For the nanoFlu, the “Peripherals” page of the web interface allows configuration of the digital interface. The following setting options are available:



- Protocol: Specifies the data protocol to be used. Supported:
  - Modbus RTU
  - ASCII Output

- Baud rate: Specifies the transmission speed.

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).

This is only supported with the internal TriOS data protocol and must be deactivated when using the Modbus RTU.

- Parity: Activates the parity check for data transmission. Possible options are:
    - None (deactivated)
    - Even
    - Odd
- Stop bits: Specifies the number of stop bits.

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 nanoFlu 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 your Ethernet LAN cable with your Ethernet-capable device and the G2 interface box.

The web interface can now be accessed with any browser using the following URLs:

http://nanoFlu/ or

http://nanoflu_DXXX/ (DXXX is the serial number) or

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.

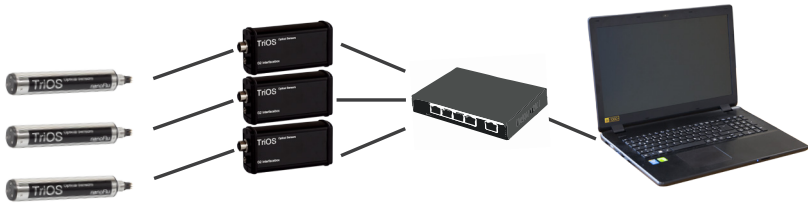
Automatic measurement by the nanoFlu is stopped when an Ethernet-capable device is connected. As soon as the LAN connection between the sensor and the Internet capable device is disconnected, the measurements will be continued at the set interval if the timer is activated.

Network with multiple G2 sensors

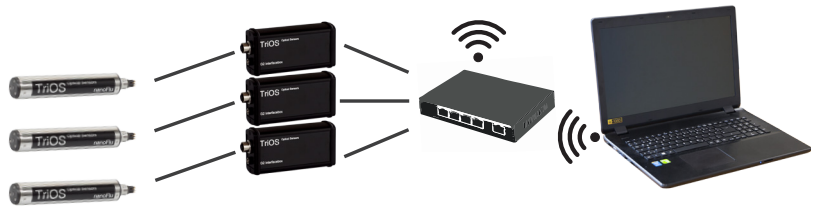
By using an Ethernet switch / hub or a conventional router, it is possible to connect multiple sensors into a complex network and use them simultaneously. In the sensor network, each sensor must have its own G2 interface box for power supply.

Like any G2 sensor, the nanoFlu 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. nanoFlu 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) Ethernet switch / hub b) Router with DHCP server	a) Ethernet-capable device with DHCP server b) Ethernet-capable device



G2 sensors	G2 interface box	a) Access point b) Wireless router with DHCP server	a) Wireless-capable device with DHCP server b) Wireless-capable device

The nanoFlu 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://nanoflu_DXXX/ (DXXX is the serial number) or via the IP. Ask your network administrator for advice.

NOTICE **Damage caused by misuse is not covered by the warranty!**

4 Use

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

4.1 Normal Operation

4.1.1 Immersion Operation

For immersion operation, the nanoFlu can be completely or partially immersed in the water / measuring medium. To make a correct measurement, the measuring window must be completely immersed and free of air bubbles. nanoFlu can also be attached with suitable hydraulic clamps. Make sure to use suitable brackets with an inner diameter of ~36 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.

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 Float

nanoFlu can also be used in a float, which is particularly useful in case of fluctuating water levels.

4.1.3 FlowCell / Bypass

With the optional flow cell, the nanoFlu can be installed as a bypass. For this purpose you need the nanoFlu FlowCell (Art.No.: 10A090000) and a nanoFlu with a special housing, which was especially designed for the operation in the FlowCell (Art.No.: 32SX03X10). Together with the flow cell a panel is available on which the nanoFlu and the flow cell can be easily mounted.

1. Follow the instructions below to install the nanoFlu in the flow cell:
2. Preparation of the flow cell:
    - Mount the flow cell to the panel using the mounting kit
    - Mount fittings on the flow cell
    - Install drain
3. Remove the pressure ring from the FlowCell. It can be easily removed by hand. Make sure that the 36x2.5 NBR O-ring is not lost. Then put it onto the front of the nanoFlu.
4. Now bring the pressure ring onto the nanoFlu from the cable/plug side.
5. Insert the nanoFlu into the flow cell, making sure that the O-ring does not slip into the FlowCell.
6. Tighten the screw connection (without tools).
7. Start flow.

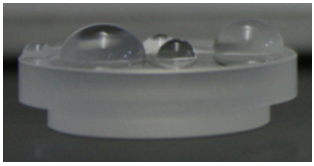
NOTICE **Hoses with a diameter of 8 mm (6 mm inner diameter) are required.**

4.1.4 Cleaning System

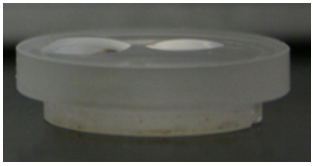
The nanoFlu is equipped with innovative antifouling technology to prevent pollution and dirt from attaching to the optical window: nano-coated window in combination with compressed-air cleaning.

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. The nanocoating greatly helps reduce the contamination of the optical windows. 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.

5 Calibration

5.1 Manufacturer Calibration

All TriOS sensors are delivered calibrated. The calibration factors of the nanoFlu are stored in the sensor, meaning that all values that are output are calibrated values.

The conversion from the original measurement parameter to the scaled measurement parameter is carried out by means of the following equations.

The offset and scaling factor are stored in a sensor for the measurement parameter.

The manufacturer calibration of the sensor is carried out as follows:

- The offset is determined by measuring in ultra-pure water (free of humic and fulvic acid, 18.2 MΩcm water)

$$A = Raw - Offset$$

- The scaling factor for each measurement range is determined by using the respective calibration standard.

$$B = A \cdot lin$$

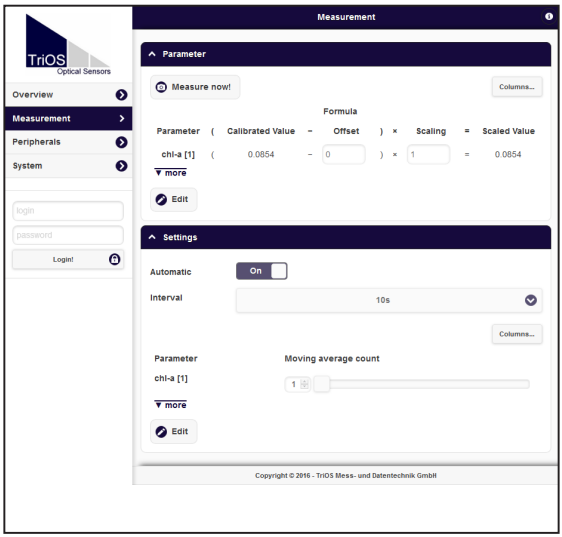
with

A	offset corrected value
Raw	raw data
Offset	offset value
B	concentration of the substance in physical units
lin	scaling factor

The manufacturer calibration should not be changed!

5.2 Customer Calibration

The sensor can be adapted to laboratory analyses and local conditions with other calibration factors. This is set using the scaling function of 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.



The customer calibration can be used as a fine adjustment of the sensor for special media and supplements the manufacturer calibration.

Before recording measurement values, check the zero value of the sensor with their reference solutions. If necessary, determine a new zero value (see chapters 6.2.1 and 6.3.1).

Local calibration is adjusted by means of a linear equation. Two constants are required for this: the scaling factor and offset, which are used according to the following equation:

$$A = parameter - offset$$

$$B = A \cdot scaling$$

With *A* being the parameter output, which is output by the nanoFlu.

A offset corrected value

Offset offset value

B customer-calibrated parameters

For local calibration, at least two data points, i.e. a laboratory value and a sensor value, are required. The easiest way to do this is to use a non-contaminated sample and a contaminated sample.

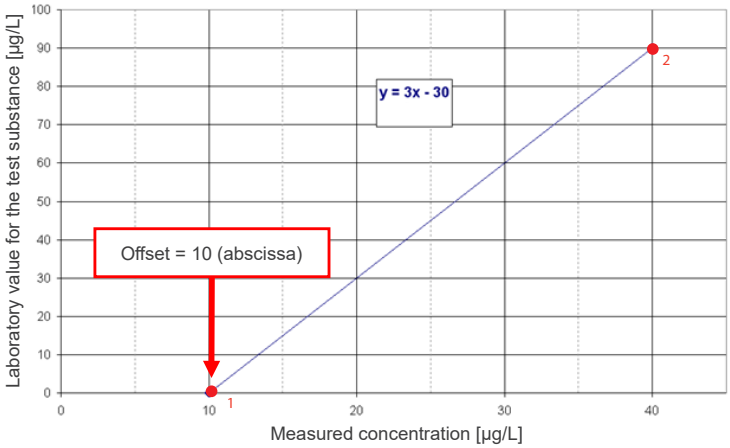
1. The non-contaminated sample is used to determine the offset. To do this, immerse the fluorometer in the fluid that is not contaminated. In this specific case, the signal gives the value of the offset directly for local calibration.

   $$offset = measuredvalue1$$

   If a non-contaminated sample is not available, the equation in point 5 below offers another option.

2. Now immerse the sensor in the contaminated medium and note down measuredvalue2, which is output by the fluorometer, and do a laboratory analysis of the sample.

3. 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.



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

$$scaling\ factor = \frac{lab}{measuredvalue2 - offset}$$

With *lab* for the laboratory values and *measuredvalue* for the values output by the sensor.

For the previous example in the figure, this means:

$$scaling\ factor = \frac{90\ \text{mg/L}}{(40 - 10)\ \text{mg/L}} = 3$$

5. If a non-contaminated sample is not available, at least two samples with very different levels of contamination are needed. In this case, you will first calculate the scaling factor.

$$scaling\ factor = \frac{(lab2 - lab1)}{(measuredvalue2 - measuredvalue1)}$$

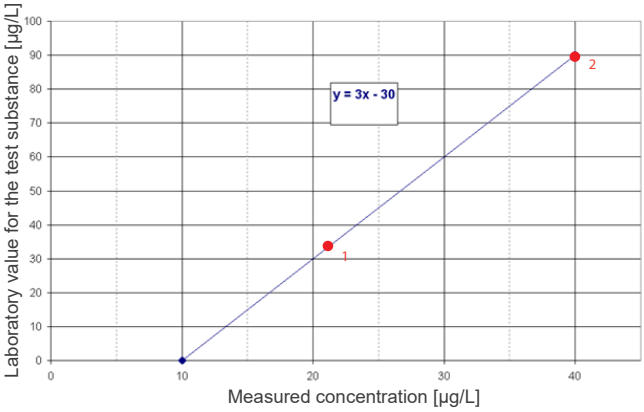
Calculation of the offset without zero-point measurement (1.):

$$offset = measuredvalue2 - \frac{lab2}{Scaling\ factor}$$

measuredvalue2 should be significantly larger than *measuredvalue1*. The offset can also be found using the abscissa of the straight line (intersection with X axis). For the above example, this means:

$$scaling\ factor = \frac{90 - 30}{40 - 20} = 3$$

$$offset = 40 - \frac{90}{3} = 40 - 30 = 10$$



All TriOS controllers have the ability to set scaling factors and offset values for the measurement parameters. Please refer to the appropriate manual. Make sure not to carry out double scaling with the sensor: once in the G2 sensor menu directly and once more with the TriOS controller!

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!**

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.

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 scratching the glass of the optical path.

In the case of calcification, a 10 % citric acid solution or acetic acid 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 of hydrochloric acid can damage components made of stainless steel. In addition, TriOS Mess- und Datentechnik GmbH cautions against using strong acids, even if the sensor should have a titanium housing.**

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.**

6.1.3 Preparing the Sensor for the Function Test and Zero Value Determination

Clean the probe as described in chapter 6.1.1 and 6.2.2. 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.

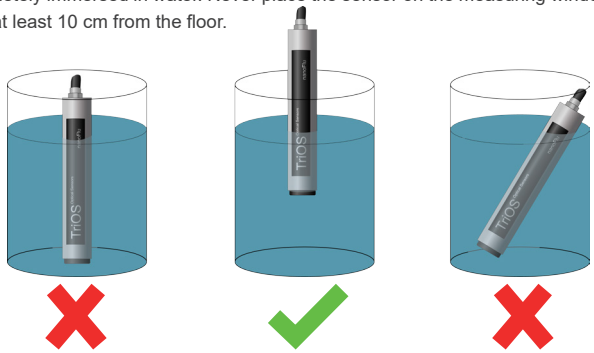
⚠ CAUTION **For your own safety, you must wear the appropriate gloves and protective goggles!**

Clean the sensor window 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 window is completely immersed in water. Never place the sensor on the measuring window. The measuring window should be at least 10 cm from the floor.



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. Carry out the function test or the calibration of the sensor.

The sensors should be positioned diagonally in the measurement container, 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 the measurement container is sufficiently stable!

6.2 Maintenance and Inspection

NOTICE **Avoid touching the measuring window, since it can become scratched or dirty. This means the functionality of the device can no longer be guaranteed.**

6.2.1 Checking the Zero Value

Prepare the sensor for the zero-value check as described in chapter 6.1 Cleaning and Upkeep.

To check and determine the zero value, we recommend to use glass vessels because they do not contain or emit any fluorescent substances that would interfere with a zero value measurement.

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

The zero value of the nanoFlu 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 / laptop.

Carry out the zero-value determination 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:

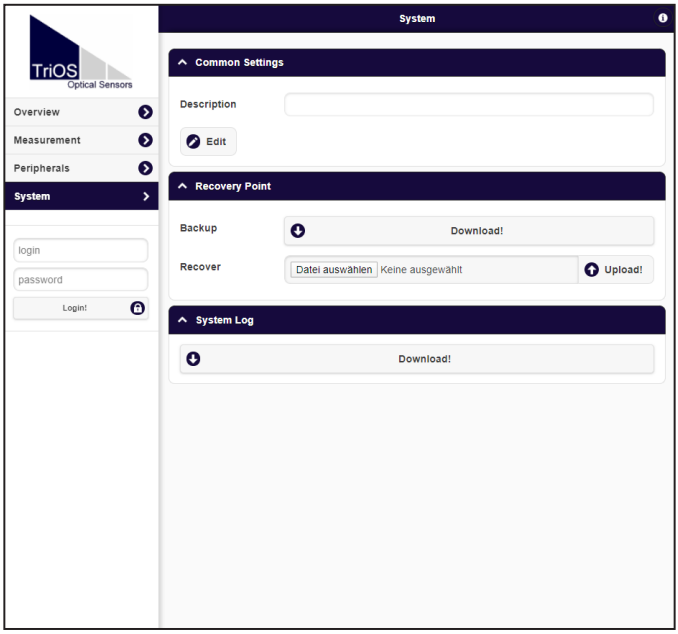
- Do not touch the part of the sensor which has been submerged in the ultra-pure water with your hands during the sensor check unless you are wearing gloves.
- Be sure to use highly pure water (ultra pure, resistance of 18.2 MΩcm) or distilled water.
- If impurities in the water show up during the check, the process must be started over!
- Make sure there are no air bubbles in front of the measuring windows. Even very small air bubbles in front of the measuring windows can cause a transmission of 97 % or less.

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 caused by improper cleaning is not covered by the guarantee!**

NOTICE **After replacing the measuring windows, carry out a new zero-value measurement.**

6.2.2 Restore Point



On the “System” page, a previously downloaded calibration can be restored or a calibration file created by the service of TriOS Mess- und Datentechnik GmbH can be installed on the sensor.

To upload a previously saved restore point, use the file dialog located behind the "Browse..." button to enter the save path to the corresponding calibration file in the "Recover" field. Next, click on the “Upload” button to begin the transfer. When the process has been successfully completed, this will be indicated by a green “Success” box. If the process is not successful, a red box will be displayed with an error message.

The following error messages and warnings are possible:

- **File not OK**. The calibration file could not be read correctly. Make sure that you have selected the correct file and repeat the process. If the error persists, please contact TriOS customer support at support@trios.de.
- **Device type or serial number does not match**. The calibration file is not suitable for the sensor currently connected. Make sure that the correct calibration file has been selected.

6.4 Returns

Please observe the following instructions when returning items.

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 an RMA form, which you need to fill out completely, check and send back to us. Customer service will check your form and then give you an RMA number. Please attach the document 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 can not 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	LED
	Detector	Photodiode
Measurement principle		Fluorescence
Parameters		see parameter list, chapter 7.2
Measurement range		0...200 µg/L or 0...500 µg/L
Measurement accuracy		± 5 %
Turbidity compensation		no
Data logger		no
Reaction time T100		6 s
Measurement interval		3 s
Housing material		Stainless steel (1.4571/1.4404) or titanium (3.7035)
Dimensions (L x Ø)		171 mm x 36 mm
Weight	stainless steel	0,5 kg
	titanium	0,4 kg
Interface	digital	Ethernet (TCP/IP)
		RS-232 or RS-485 (Modbus RTU)
Power consumption	typical	< 1 W
	with network	< 1.6 W
Power supply		12...24 VDC (± 10 %)
Required supervision		typically ≤ 0,5 hours per month
Calibration/maintenance interval		24 months
System compatibility		Modbus RTU
Warranty		1 year (EU: 2 years)

INSTALLATION

Max. pressure	with Subconn	30 bars
	with fixed cable	3 bars
	in flow cell	1 bar, 2...4 L/min
Protection type		IP68
Sample temperature		+2...+40 °C
Ambient temperature		+2...+40 °C
Storage temperature		-20...+80 °C
Inflow velocity		0.1...10 m/s

7.2 Measurement Ranges and Limits of Detection*

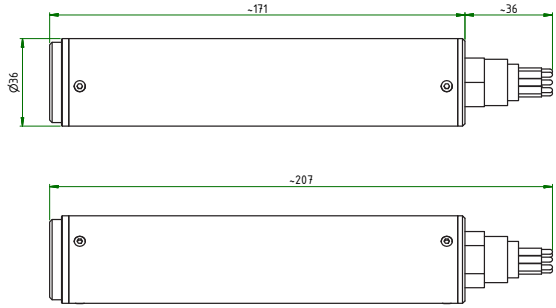
The following table provides an overview of the measurement ranges of various parameters and their limits of detection:

Parameters	Unit	Measurement range	Detection limit
Chl_a	µg/L	0...200 µg/L 0...500 µg/L	0,2 µg/L 1 µg/L
blue	µg/L	0...200 µg/L 0...500 µg/L	0,3 µg/L 3 µg/L
CDOM	µg/L	0...200 µg/L	0,3 µg/L

*under laboratory conditions

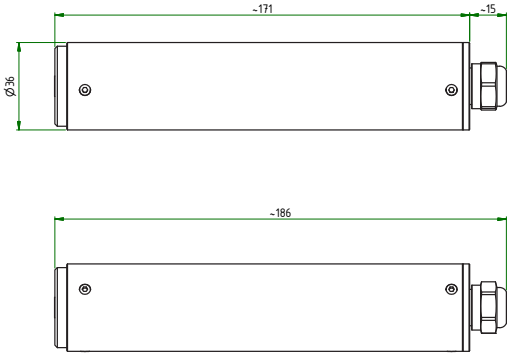
7.3 External Dimensions

Version with SubConn see chapter 3.1.1



Position	Material
body	stainless steel or titanium
end caps	Polyoxymethylene (POM)
optic	optical glass
screws	stainless steel
sealings	nitrile butadine rubber (NBR)

Version with fixed cable see chapter 3.1.2



Position	Material
body	stainless steel or titanium
end caps	polyoxymethylene (POM)
optic	optical glass
screws	stainless steel
sealing	nitrile butadine rubber (NBR)

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 offers 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 analog 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 TriBox Mini

Digital 2-channel controller

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

9 Warranty

The warranty period of our devices within the EU is 2 years from the date of the 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 the 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 contacts:

support@trios.de

Tel.: +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.

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

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Germany

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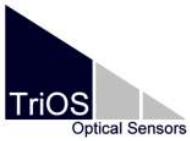
12 Keyword Index

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	**nanoFlu**
Typ / Type / Type:	**chl-a, blue, cdom**
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 55011:2009 + A1:2010 EN 61010-1:2010 EN 50581:2012
Datum / Date / Date 12.10.2017	Unterschrift / Signature / Signatur R. Heuermann

D05-060yy201710

Modbus RTU

Serial Interface

When delivered, the nanoFlu has the following settings for the serial interface (RS232 or RS485):

- 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 floating-point number, big endian
Char[n]	$\left[\frac{n}{2}\right]$	Null-terminated ASCII character string.
Uint16[n]	n	Field of n 16-bit integers (cf. Uint16).
Float[n]	2n	Field of n floating-point numbers (cf. float).

Functions

nanoFlu supports the following Modbus functions:

Name	Code	Description / Use
Read multiple registers	0x03	Read the serial number, configuration, calibration and measurement data
Write multiple registers	0x10	Write the configuration and calibration
Write single register	0x06	Triggering of (calibration) measurements
Report slave ID	0x11	Read the serial number

Standard Modbus server address

When delivered, nanoFlu is set to the following address depending on the parameter:

Address	Parameter
3 (0x03)	Chl-a
4 (0x04)	Blue
5 (0x05)	CDOM

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

Before the registers can be read above address 1000, a measurement must be triggered.

The following values are in the registers:

Designation	R/W	Address	Data type	Description
Modbus slave ID	RW	0	Uint16	Modbus server address of the nanoFlu. Allowed addresses: 1…247
Measurement timeout	R	1	Uint16	The time in [10-1 s] that the currently running measurement process will still require (see also “Trigger measurement”)
Device serial number	R	10	Char[20]	Serial number of the nanoFlu sensor.
Firmware version	R	20	Char[10]	Version number of the installed firmware.
Self-trigger activated	RW	100	Bool	Indicates whether the sensor is in automatic mode (only necessary for first installation).
Self-trigger interval	RW	101	Uint32	The measurement interval in [s] for the automatic mode. Adjustable range: 1s – 86400s.
Moving average	RW	103	Uint16	Number of individual measurements which are averaged for a measurement. Adjustable range: 1 – 25.
System date and time	RW	104	Uint32	Date and time as seconds since 1 January 1998. Starts again after each power-up!
Device description	RW	106	Char[64]	An unrestricted description of the sensor e.g.: “south supply line”.
Parameter Index for offset / scaling	RW	400	Uint16	When setting the parameter index, an offset or scaling factor can be set for the selected parameter. Parameter index of nanoFlu for each parameter: 0x0000.
Activate Offset/Scaling	RW	401	bool	Specifies whether offset and scaling are used.
Offset	RW	402	Float	Parameter offset. Formula: scaled = (calibrated – offset) * scaling
Scaling	RW	404	Float	Scaling factor. Formula: scaled = (calibrated – offset) * scaling
Available substances	R	500	Uint16	Available parameters: 1 := chl-a 4 := CDOM 2 := blue

Parametername	RW	603	Char[32]	Name of the parameter
Temperature	R	998	Float	Sensor temperature in [°C] during the last measurement.
Concentration / scaled concentration	R	1000/1500	Float	

NOTICE	**Writing to the configuration registers should be done as seldom as possible and especially not in every measuring cycle, otherwise the flash memory may be damaged.**

Write single register (0x06)

With the “write single register” function, instead of changing the configuration values, a single measurement trigger is sent, in which a value ≠0 is written.

Designation	Address	Description
Trigger measurement	1	A single measurement is taken.

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	a	n	o	F	l	u	0x00	D	2	0	0	0x00	1	.	0	.	0	0x00