nanoFlu

Manual

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1 General information

1.1 Introduction

Welcome to TriOS. We are delighted that you have chosen our nanoFlu immersion sensor.

nanoFlu fluorometers are online measuring devices for the precise and selective determination of dyes and pigments, such as CDOM (Colored Dissolved Organic Matter, yellow substance), chlorophyll a, phycocyanin in cyanobacteria, rhodamine or fluorescein. Detection is carried out by measuring the fluorescence emission. The parameters emit light at a specific wavelength when they are previously excited by a defined external light source.

nanoFlu is equipped with the TriOS G2 interface, which allows quick and easy sensor configuration using a web browser. Integration into existing process control systems and external data loggers is easy to implement. Mobile applications can also be realized with the battery pack available as accessories. Using WLAN, a laptop, tablet or smartphone can then simply be used for control without the need to install special application software or an app.

In this manual you will find all the information about nanoFlu that you need for commissioning. Technical specifications as well as detection limits and dimensions can be found in chapter 7.

Please note that the user is responsible for complying with regional and national regulations for the installation of electronic devices. Any damage caused by incorrect use or unprofessional installation is not covered by the warranty.

All sensors and accessories supplied by TriOS Mess- und Datentechnik GmbH must be installed and operated in accordance with TriOS Mess- und Datentechnik GmbH specifications. All parts have been designed and tested according to international standards for electronic instruments. The device complies with international standards for electromagnetic compatibility. Please use only original TriOS accessories and cables to ensure smooth and professional use of the devices.

Read this manual carefully before using the device and keep it for future reference. Before using the sensor, make sure that you have read and understood the safety precautions described below. Always ensure that the sensor is operated correctly. The safety precautions described on the following pages are intended to ensure problem-free and correct operation of the device and the associated accessories and to prevent you, other persons or devices from being harmed.

NOTICE

If translations differ from the original German text, the German version is binding.

Software updates

This manual refers to firmware version 1.1.3 and higher. Updates include troubleshooting and new functions and options. Devices with older firmware versions may not have all the functions described here.

Copyright notice

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1.2 Health and safety instructions

This manual contains important information on health and safety regulations. This information is marked in accordance with the international specifications of ANSI Z535.6 (“Product safety information in product man-

uals, instructions and other collateral materials”) and must be followed. The following categories are distinguished:

⚠ DANGER

Danger / Will cause serious injury or death

⚠ WARNING

Warnings / May cause serious injury or death

⚠ CAUTION

Caution / May cause moderate injury

NOTICE

May lead to material damage

Tip / Useful information

Electromagnetic waves

Devices that emit strong electromagnetic waves can influence the measurement data or cause the sensor to malfunction. Avoid operating the following devices in the same room as the TriOS sensor: cell phones, cordless phones, transceivers or other electrical devices that generate electromagnetic waves.

⚠ CAUTION

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

Reagents

Follow the manufacturer's safety and operating instructions when using reagents. Observe the applicable Ordinance on Hazardous Substances for Reagents (GefStoffV)!

Biological safety

Liquid waste may be biologically hazardous. You should therefore always wear gloves when handling such materials. Observe the currently valid Biological Substances Ordinance (BioStoffV)!

Waste

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

1.3 Warning notices

This sensor has been developed for use in industry and science. It should only be used to measure aqueous solutions such as drinking water, process waste water, river water or seawater.

NOTICE

Sensors made of stainless steel are not made for use in seawater or high chloride concentrations (corrosion). Only sensors made of titanium can be used here.

- Sensors made of stainless steel must be cleaned immediately after contact with salt water or other corrosion-causing substances (e.g. acids, alkalis, chlorine-based compounds). The material resistance should be tested for each application.
- The sensor has seals made of NBR (acrylonitrile butadiene rubber). Sealing rings made of other materials may be used on individual request. Before operation, ensure that the measuring medium does not damage the seals.
- Do not cut, damage or modify the cable. Make sure that there are no heavy objects on the cable and that the cable does not kink. Ensure that the cable does not run close to hot surfaces.
- If the sensor cable is damaged, it must be replaced with an original part by TriOS Mess- und Datentechnik GmbH customer support.
- Do not place any unsuitable objects in front of the optical window while the measurement process is running, as this may cause damage to the sensor or falsified measurement results.
- Plug the sensor if it becomes excessively hot (i.e. more than lukewarm). Switch off the sensor immediately and disconnect the cable from the power supply. Please contact your dealer or TriOS technical support.
- Never attempt to disassemble or modify any part of the sensor unless specifically described in this manual. Inspections, modifications and repairs may only be carried out by the device dealer or by TriOS authorized and qualified specialists.
- Devices from TriOS Mess- und Datentechnik GmbH comply with the highest safety standards. Repairs to the devices (which include the replacement of the connecting cable) must be carried out by TriOS Mess- und Datentechnik GmbH or an authorized TriOS workshop. Incorrect, improper repairs can lead to accidents and injuries.

NOTICE

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

1.4 User and operating requirements

The nanoFlu fluorometer was developed for use in industry and science. The target group for operating the nanoFlu is technically experienced specialist personnel in companies, sewage treatment plants, waterworks and institutes.

The application often requires the handling of hazardous substances. We assume that the operating personnel are familiar with the handling of hazardous substances due to their professional training and experience. In particular, the operating personnel must be able to correctly understand and implement the safety markings and safety instructions on the packaging and in the package inserts of the test kits.

1.5 Intended use

The intended use of the nanoFlu is exclusively to carry out fluorescence measurements as described in this manual. In this respect, the fluorometer is an immersion sensor that is used under water or with flow cells. Please observe the technical data of the accessories. Any other use is considered improper.

The sensor may only be used to measure the fluorescence of aqueous liquids such as process waste water, municipal waste water, surface water and groundwater. The use of other media can damage the sensor. To use the nanoFlu in media other than those specified here, please contact TriOS Mess- und Datentechnik GmbH technical support (support@trios.de).

NOTICE

Avoid any contact with the measurement window, as it can become scratched or dirty. As a result, the functionality of the device is no longer guaranteed.

According to current scientific knowledge, the device is safe to use if it is handled in accordance with the instructions in this manual.

NOTICE

Damage caused by improper use is excluded from the warranty.

1.6 Disposal instructions

At the end of its service life or useful life, the device and its accessories can be returned to the manufacturer (see address below) for disposal in an environmentally friendly manner. Proof of prior professional decontamination must be provided in the form of a certificate. Please contact us before returning the device for further details.

Address of the manufacturer:

TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
26180 Rastede
Rastede, Germany
Phone: +49 (0) 4402 69670 - 0
Fax: +49 (0) 4402 69670 - 20

1.7 Certificates and approvals

The product meets all requirements of the harmonized European standards. It therefore fulfills the legal requirements of the EU directives. TriOS Mess- und Datentechnik GmbH confirms the successful testing of the product by affixing the CE mark (see appendix).

2 Introduction

nanoFlu fluorometers are cost-effective, submersible miniature fluorometers for high-precision and selective measurement of CDOM (Colored Dissolved Organic Matter), chlorophyll A and phycocyanin in cyanobacteria, rhodamine or fluorescein. The combination of low power consumption and innovative coating of the optical windows as an energy and environmentally neutral antifouling solution ensures long-term stability of the measurements.

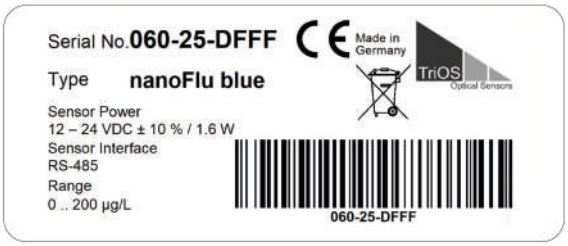
The devices can be used in a wide range of applications for monitoring seawater and river water as well as drinking water and wastewater. Internal reference measurements of the high-performance LEDs used for fluorescence excitation compensate for aging effects and temperature influences.

2.1 Product identification

All TriOS Mess- und Datentechnik GmbH products are provided with a product label that clearly shows the product designation.

There is also a type plate on the device with the following information, which you can use to clearly identify the product:

Serial number
Product type
Power supply
Interface
Measuring range



The nameplate also contains the product barcode, the TriOS Optical Sensors logo and the CE quality mark.

Please note that the specifications given here are for illustrative purposes only and may vary depending on the product version.

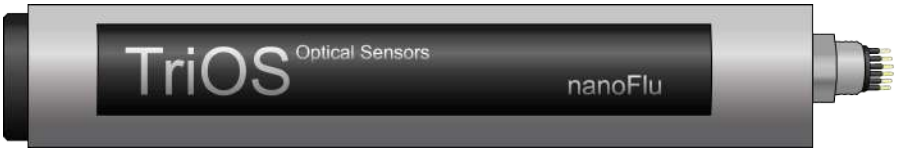
2.2 Scope of delivery

The delivery includes the following components:

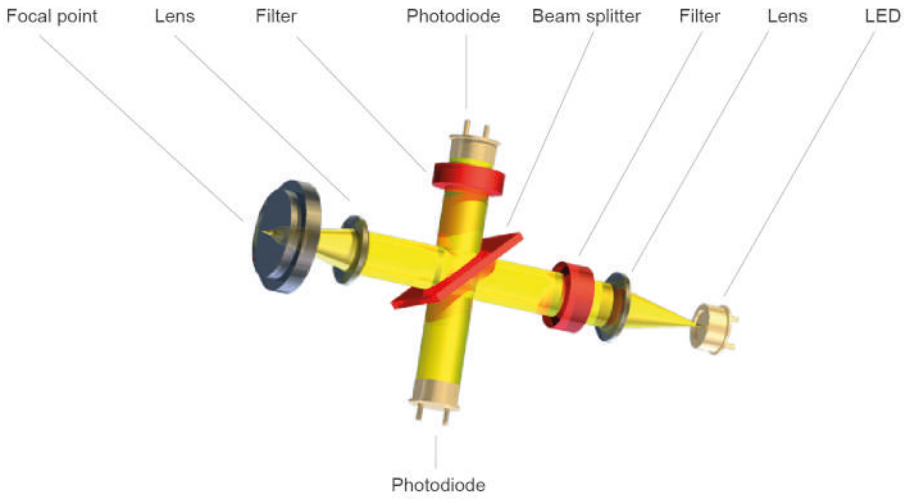
- Sensor
- Connection cable
- Manual/Short Instruction
- Accessories (if applicable)

Keep the original packaging of the device for possible return shipment for maintenance or repair purposes.

2.3 Measurement principle and structure



For optimal use of the sensor, it is inevitable to know and understand the idea and theory on which the sensor is based. The following is a thorough overview of the measuring 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 constant light suppression. The arrangement of these parts is shown schematically in the figure above.

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

The excitation light beam is parallelized and a smallest part is reflected by a beam splitter (short pass) onto a reference diode to compensate for fluctuations in the light source. The majority 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 reflected again by the beam splitter due to the higher wavelength. In front of the photodiode for measuring the fluorescence intensity, an interference filter prevents the penetration of extraneous and scattered light.

Ambient light is eliminated with a special electronic circuit.

2.3.1 Fluorescence

Fluorescence is the spontaneous emission of light directly after the excitation of a material. The emitted light is usually lower in energy (longer wavelength) than the previously absorbed light (shorter wavelength).

Photons are absorbed and electrons of the molecule are lifted into a higher-energy orbital, i.e. excited. If they fall back from there to their original level, the energy released is emitted as heat and photons (fluorescent light).

Electrons from double bonds are more easily excited because the p-electrons of the double bond are distributed over both atoms and are therefore not as strongly bound. Molecules with conjugated double bonds are particularly suitable for fluorescence; here the electrons are distributed over several atoms and are therefore very easy to excite.

2.3.2 Parameters

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

Sensor version	Parameters	Excitation wavelength	Detection wavelength
chl	chlorophyll a	470 nm	682 nm
blue	phycocyanin	620 nm	655 nm
cdom	CDOM	375 nm	460 nm
rho	rhodamine	470 nm	590 nm
fluo	fluorescein	470 nm	590 nm

2.4 Browser

nanoFlu is equipped with a web interface that can be used to configure the sensor. To access the web interface, you need the G2 InterfaceBox and an Ethernet-capable device with a web browser, such as a notebook.

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

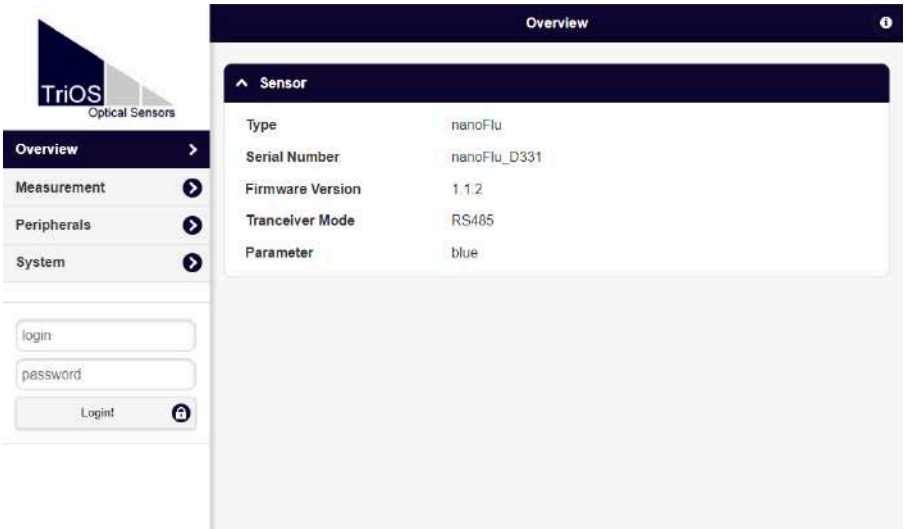
http://nanoFlu/ or

http://nanoFlu_D2XX/ (D2XX is the serial number) or

http://192.168.77.1/

With the Ethernet-capable device connected, suspend the automatic measurements. As soon as the sensor is disconnected from your device again, the measurements are resumed at the set interval if the timer for automatic measurements is activated.

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



Three areas: Top title, left menu and center content

The name of the current page is displayed in the title. To the right is the info button. This shows the contact details of the relevant TriOS authorized dealer and TriOS Mess- und Datentechnik GmbH.

The individual pages are listed in the menu on the left. The name of the current page is highlighted in blue.

Below the menu is the login area, which certified TriOS service technicians can use to authenticate themselves. In most cases, problems can be solved here on site.

The menu is used to navigate the web interface. Each line is a link to a different page with correspondingly different setting options. The link to the currently displayed page is always highlighted in the menu. Special, selected content and functions are reserved exclusively for TriOS Mess- und Datentechnik GmbH technical support staff. Authentication is required for this content, so it is not accessible to everyone.

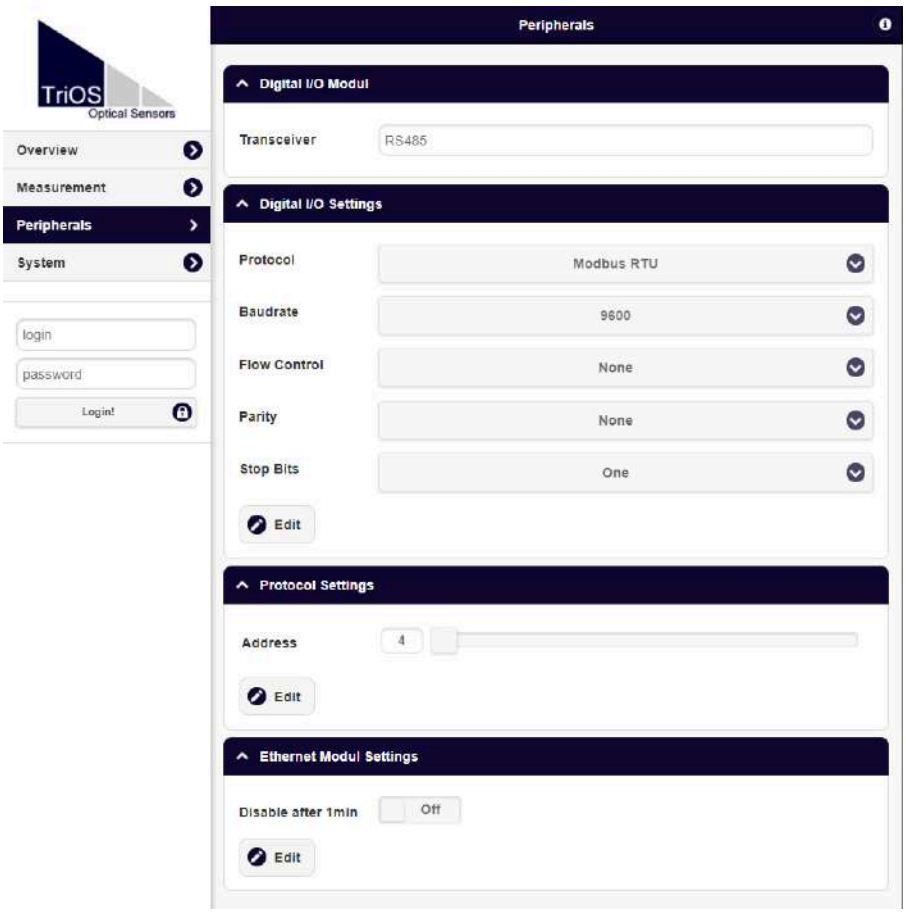
The “Content” area displays the relevant information and setting options. Content that requires authentication is deactivated (“grayed out”) if authentication fails or is not possible due to a lack of corresponding information.

Overview

The overview page (“Overview”, see illustration above) summarizes basic information about the sensor. 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

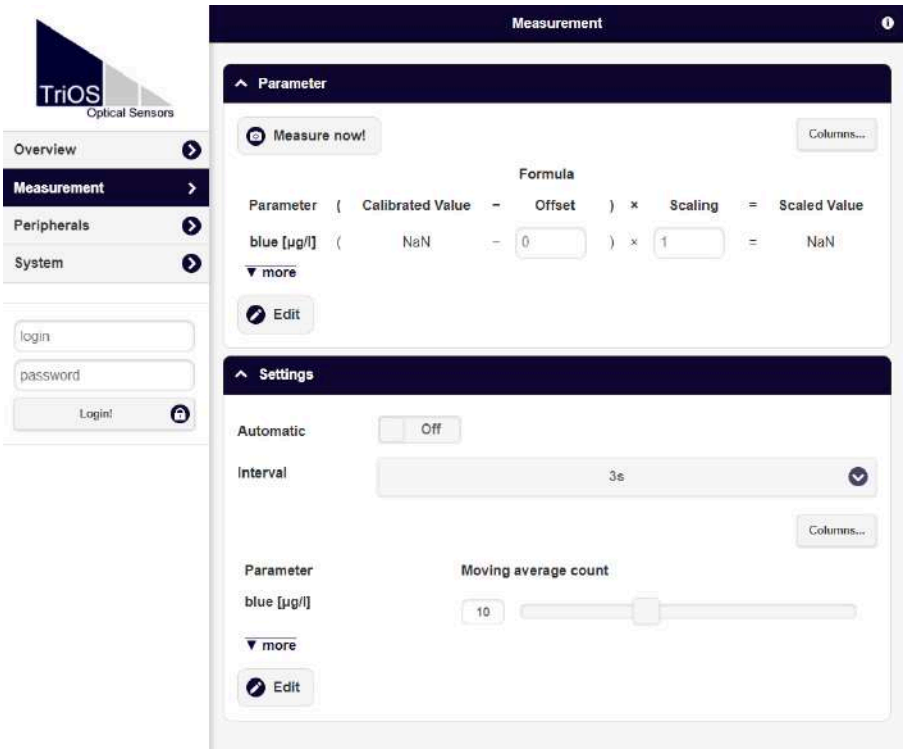
Different options are available in the environment settings (“Peripherals”) depending on the variant of the sensor.



Measurement

The “Measurement” page shows the results of the last measurement carried out. The settings for the interval for automatic measurements and the number of individual measurements to be averaged for the final measurement can also be changed here. It is also possible on this page to scale the measured value using entries for “Offset” and “Scaling”.

A new measurement can be triggered at any time. To do this, click on the “Measure Now!” button. A new measurement is then carried out with the saved settings.



To make changes, you must first press the “Edit” button in the corresponding area.

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

The time interval for automatic measurements is entered in the “Interval” field. This interval is to be understood as a minimum value. If the previous measurement has not yet been completed after the interval has expired (e.g. because the nanoFlu simply needs more time due to averaging), the system waits for this and only then starts the next measurement.

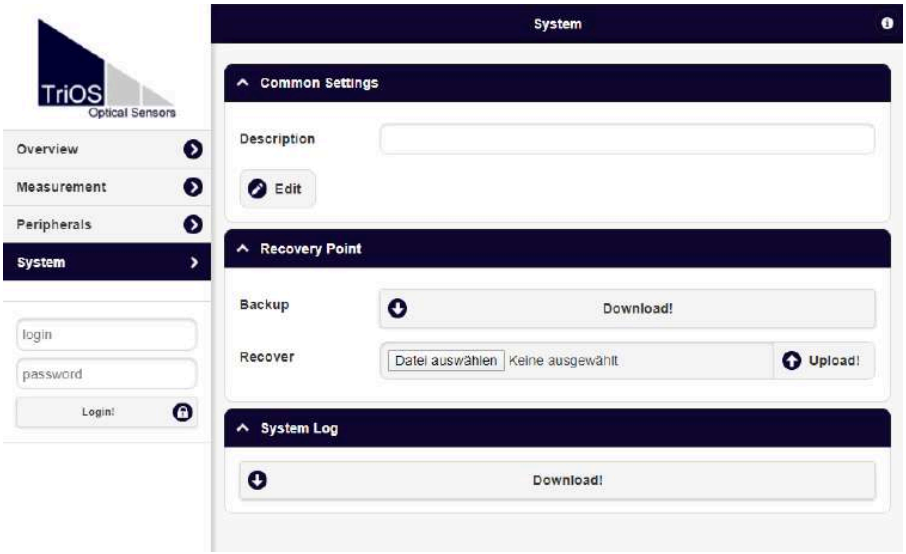
The measurement interval recommended by TriOS Mess- und Datentechnik GmbH and set at the factory is 3 s. If several individual measurements are to be averaged for a measurement, the number of measurements can be set via the controller.

Important: Changed values must be saved by clicking on the “Save” button so that they are adopted for the following measurements.

System

The “System” page is used to manage the sensor. On this page, the data can be provided with a comment under “Description”. In addition, a restore point can be created or uploaded (see chapter 6.2.2) and the sys-

tem log file can be exported. The sensor no longer has an integrated RTC (real time clock) time buffer, 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 attend a TriOS training course.

2.5 Login

To use the service function, you need a login and a password. You will receive this when you attend a TriOS training course.

3 Commissioning

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

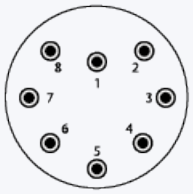
Before putting the sensor into operation, make sure that it is securely fastened and that all connections are made correctly.

3.1 Electrical installation

nanoFlu is supplied with either a fixed cable with M12 industrial plug or a SubConn connector 8pin underwater plug.

3.1.1 SubConn connector 8pin

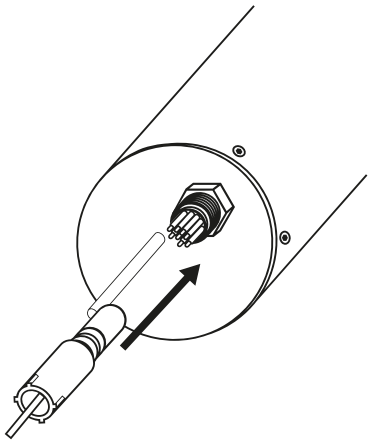
Pin assignment



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

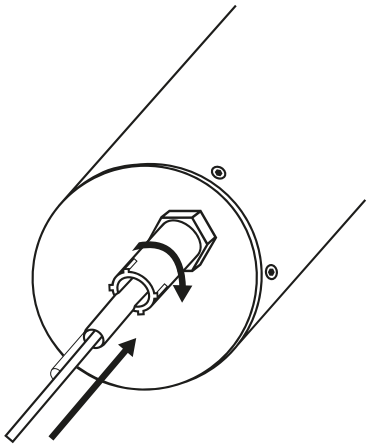
Connection

Step 1



Plug the connector end of the connection cable onto the connector plug by aligning the pins with the slots on the cable.

Step 2



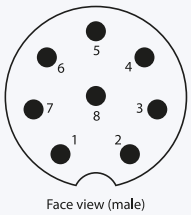
In the next step, turn the locking sleeve clockwise to secure the plug end to the bulkhead connector.

NOTICE

Do not bend the connection back and forth when inserting or removing it. Insert the connector straight and use the locking sleeve to tighten the pin contact.

3.1.2 Fixed cable with M12 industrial plug

Pin assignment



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 + serial interface)
8. Power (12 – 24 VDC)

NOTICE

Ensure that the polarity of the operating voltage is correct, otherwise the sensor may be damaged.

3.2 Interfaces

3.2.1 Serial interface

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 is not switchable and is already set on delivery.

The digital interfaces RS-232 and RS-485 are voltage interfaces. With RS-232, voltages from -15 V to +15 V are possible, with RS-485 from -5 V to +5 V, with respect to ground.

By default, nanoFlu is supplied as RS-485. On delivery, nanoFlu is configured for RS-485 with the following settings:

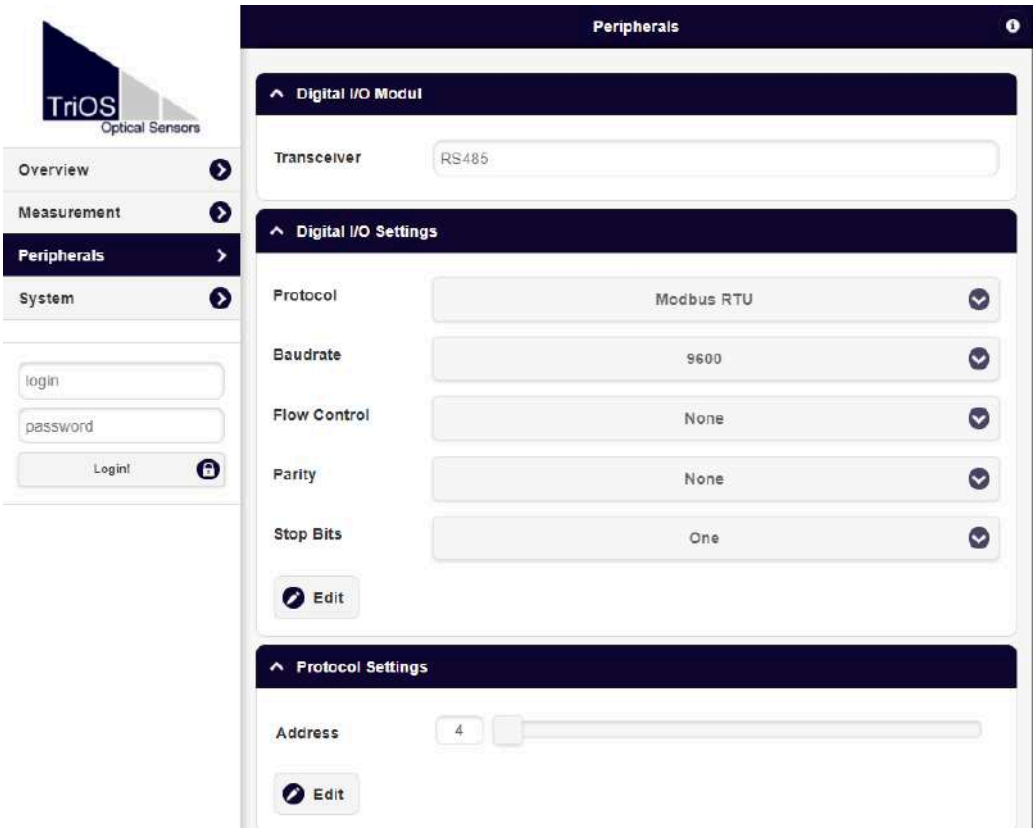
- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none

A detailed description of the Modbus RTU protocol for nanoFlu can be found in the appendix.

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

RS-485 uses a differential signal, whereby the sign-negated potential of the A line is applied to the B line. The decisive factor is the difference A-B, which makes the transmission as robust as possible against interference signals.

With nanoFlu, the digital interface can be configured in the web interface on the “Peripherals” page. The following setting options are available:



Protocol

Specifies the data protocol to be used:

- Modbus RTU (factory setting)
- ASCII Output

Baud rate

Specifies the transmission speed.

> **NOTICE**
>
> **If there are difficulties with communication, an attempt should be made to reduce the baud rate.**

Flow control

Activates flow control at software level (XON/XOFF).

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

Parity

Activates the parity check during data transmission. Possible options are:

- None (deactivated)
- Even
- Odd

Stop bits

Defines the number of stop bits.

> **NOTICE**
>
> **For various Modbus devices, it may be necessary to set “Two” here if no parity check is to take place.**

Settings for the active protocol can be made in the “Protocol Settings” section.

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

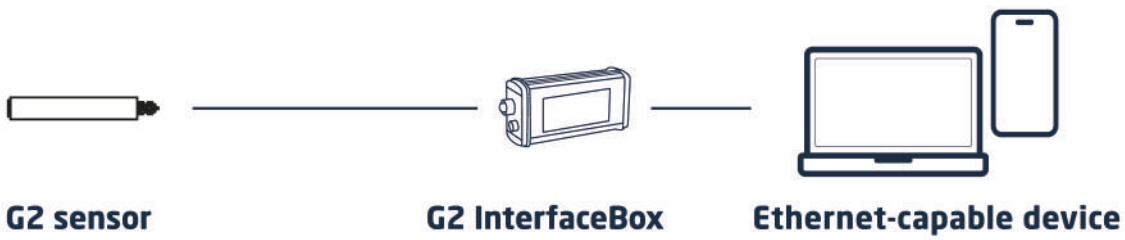
3.2.2 Network

The IEEE 802.3 10BASE-T compliant Ethernet interface is used as the universal interface for TriOS G2 sensors. This makes it possible to establish a connection to a single sensor or even to set up a complex sensor network.

Network with a single G2 sensor

The simplest way to establish a connection with the nanoFlu is with the G2 InterfaceBox. It is used both to establish the connection and to supply power to the sensor and can be used universally for all TriOS G2 sensors.

The following figure shows a connection setup to a single sensor:



The TriOS G2 InterfaceBox translates the 8pin M12 sensor plug to the commercially available connections for the power supply (2.1 mm hollow plug) and for network access (RJ-45 socket).

G2 InterfaceBox

There are three connections on the housing of the G2 InterfaceBox:

1. Power supply 12 or 24 VDC; 2.1 mm hollow plug
2. Sensor connection 8pin M12 plug
3. Ethernet connection RJ-45 socket

Proceed as follows to connect the sensor to an Ethernet-capable device using the G2 InterfaceBox:

1. Ensure that your device's Ethernet adapter is configured to automatically obtain the network settings (IP address and DNS server).
2. Insert the M12 plug at the cable end of the sensor into the M12 socket (2) of the G2 InterfaceBox and close the screw cap.
3. Connect the 12 or 24 VDC power supply unit to the G2 InterfaceBox to supply the sensor with power.
4. Wait at least 3 seconds before finally connecting the LAN cable to your Ethernet-capable device and the G2 InterfaceBox.

The web interface can now be accessed with any browser via the URL

http://nanoFlu/ or

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

http://192.168.77.1/.

If the web interface cannot be called up, make sure that the LAN cable is connected after the sensor has been supplied with power and try all three URL options.

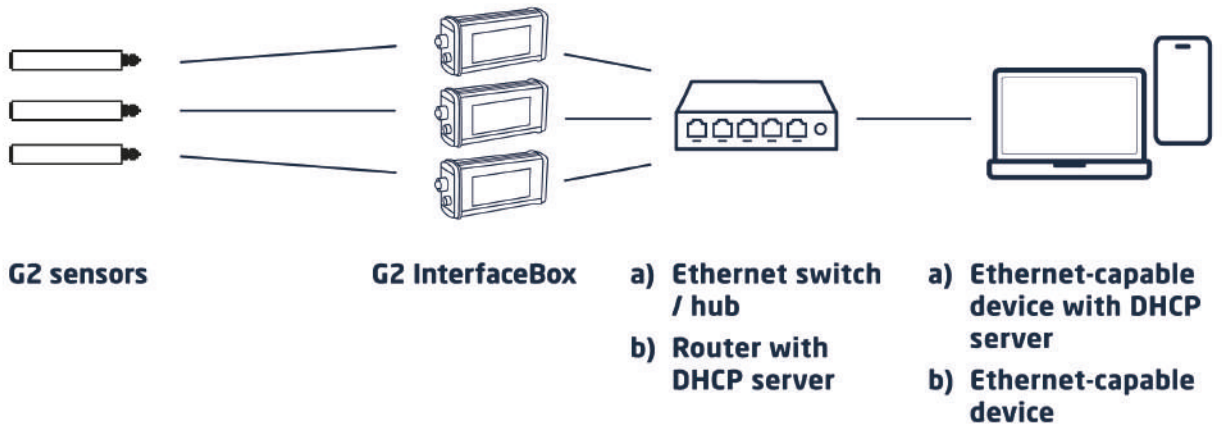
If an Ethernet-capable device is connected, the automatic measurements of the nanoFlu are suspended. As soon as the LAN connection between the sensor and the Ethernet-capable device is disconnected, the measurements are resumed at the set interval, provided the timer is activated.

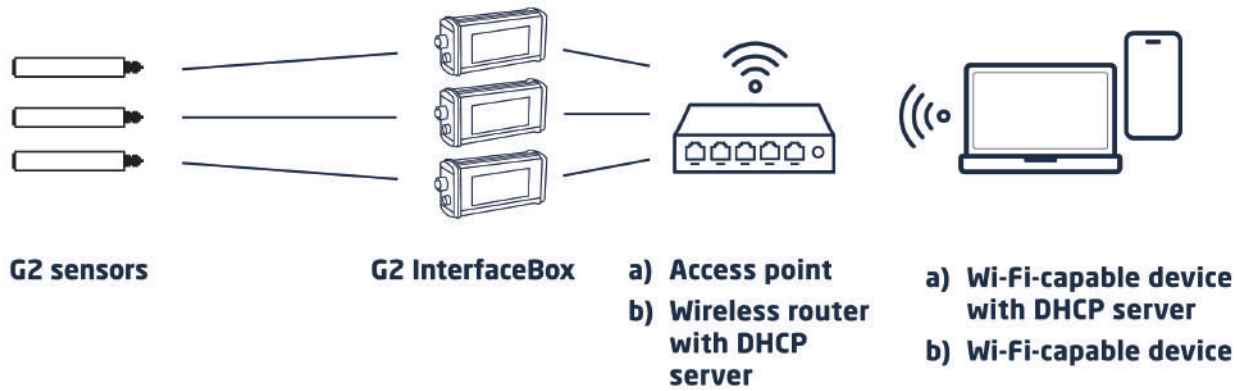
Network with several G2 sensors

Using an Ethernet switch or hub or commercially available router, it is possible to connect several sensors in a complex network and use them simultaneously. In the sensor network, each sensor requires its own G2 InterfaceBox for the power supply.

Like every G2 sensor, nanoFlu provides a simple DHCP server and a simple DNS server, which are configured exclusively for the direct individual connection - as described in the previous section. For a complex sensor network, it is necessary for these servers to be provided by the user. nanoFlu automatically detects these and then switches 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.





nanoFlu can only be used from one Ethernet-capable device at a time.

If several sensors are 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 improper use is excluded from the warranty!

4 Application

nanoFlu can be operated with all TriOS controllers. You will find notices for correct installation in the controller manual.

NOTICE

Never transport the sensor just hanging on the cable.

4.1 Normal operation

4.1.1 Diving operation

For diving operation, the nanoFlu can be completely or partially immersed in the water / measuring medium. For a correct measurement, the optical window must be completely submerged and free of air bubbles.

nanoFlu can also be attached using suitable hydraulic clamps. Make sure to use suitable brackets with an inner diameter of ~36 mm. To protect the housing tube from excessive punctual pressure, mount the clamps close to the device covers. Suitable brackets can be obtained from TriOS.

When immersing the sensor, make sure that there are no air bubbles in front of the sensor windows. If there are air bubbles in front of the window, shake the sensor cautiously until the bubbles are removed.

4.1.2 Float

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

4.1.3 Bypass installation

With the optional flow cell, nanoFlu can be installed as a bypass. To do this, you need the nanoFlu FlowCell (art. no.: 10A090000) and a nanoFlu with a special PET housing that has been specially designed for 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.

Installation of the sensor in the FlowCell

To install the nanoFlu in the flow cell, please proceed as follows:

1. Preparing the flow cell:
   - Mount the flow cell to the panel using the mounting set
   - Mount the fittings to the flow cell
   - Mount the drain
2. Remove the pressure ring from the FlowCell. It can easily be loosened by hand.
   Make sure that the 36 x 2.5 NBR o-ring is not lost. Then place the o-ring on the front of the nanoFlu.
3. Now place the pressure ring on the nanoFlu from the cable/connector side.
   Insert the nanoFlu into the flow cell.
   Make sure that the o-ring does not slip into the FlowCell.
4. Tighten the screw connection (without tools).
5. Start the flow.

NOTICE

Tubing with a diameter of 8 mm (6 mm inner diameter) is required.

4.1.4 Cleaning system

Nano-coating

nanoFlu and all other sensors from TriOS Mess- und Datentechnik GmbH are equipped with nano-coated optical windows (innovative antifouling technology).

Windows without nano coating

Windows with nano coating

The wettability of the surface on the coated glass is significantly lower. This effect is achieved by the nano-coated surface of the glass, to which no dirt adheres. This keeps the windows clean for longer and reduces the amount of cleaning required.

5 Calibration

5.1 Manufacturer calibration

All TriOS sensors are supplied calibrated. The calibration factors of the nanoFlu are stored in the sensor, i.e. all output values are calibrated values.

The conversion from the original measurement parameter to the scaled measurement parameter is carried out using the following equations.

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

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

- The offset is determined by a measurement in ultrapure water (free of humic and fulvic acids, with a conductivity of 18.2 MΩ-cm).

$$\mathbf{A = Raw - Offset}$$

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

$$\mathbf{B = A \cdot lin}$$

with:

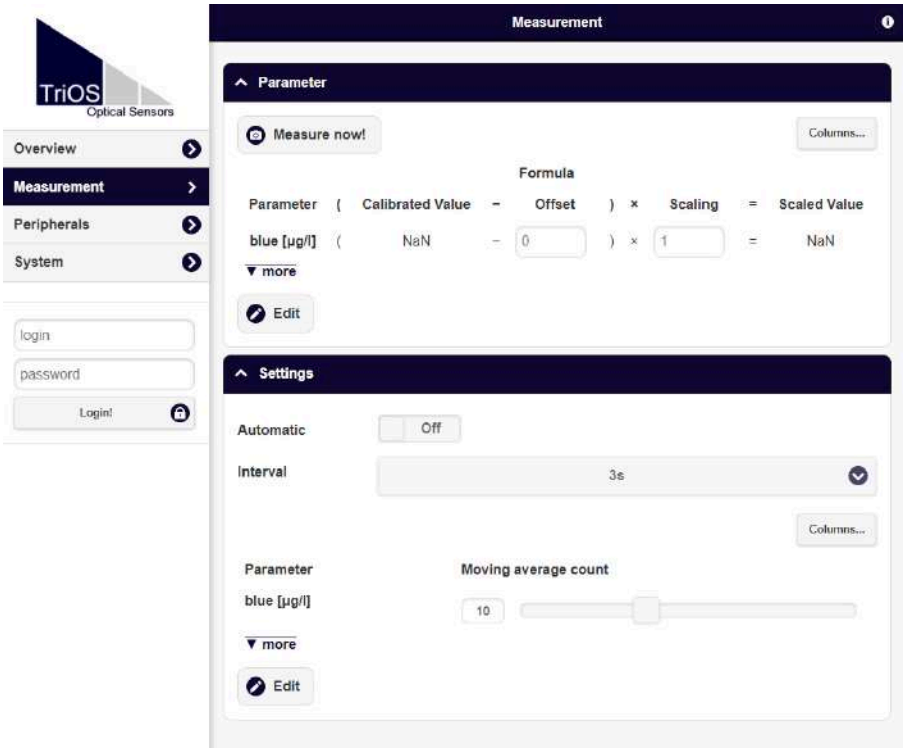
A	Offset corrected value
Raw	Raw data
offset	Offset value
B	Concentration of the substance in physical units
lin	Scaling factor

NOTICE

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 controller's scaling function or directly in the sensor's 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 serves as a fine adjustment of the sensor to special media and supplements the manufacturer calibration.

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

The local calibration is adjusted using a linear equation. Two constants are required for this: Scaling factor (scaling) and offset, which are used according to the following equation:

$$A = \text{parameter} - \text{offset}$$
$$B = A \cdot \text{Scaling}$$

With A as the parameter output by nanoFlu.

A	Offset corrected value
Offset	Offset value
B	Customer calibrated parameters

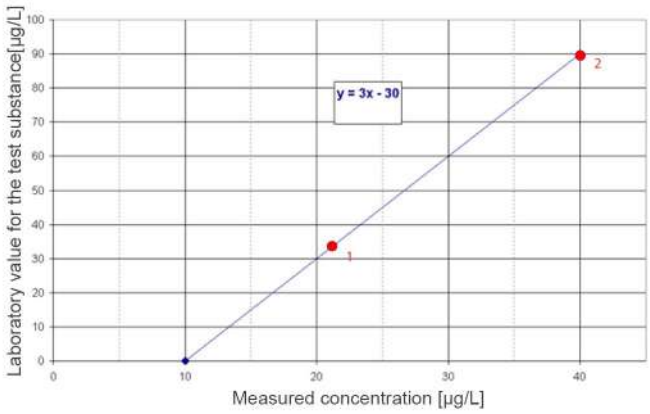
At least two data points, consisting of the laboratory and sensor values, are required for local calibration. The simplest method to achieve this is to use a non-contaminated and a contaminated sample.

Procedure with uncontaminated sample

1. The uncontaminated sample is used to determine the offset. To do this, immerse the fluorometer in the uncontaminated liquid. In this special case, the signal directly indicates the value of the offset for the local calibration.

$$\text{Offset} = \text{measured value1}$$

2. Now immerse the sensor in the contaminated medium, note the measured value2 output by the fluorometer and carry out a laboratory analysis of the sample.
3. Create a diagram as shown below and connect the two data points with a straight line. The slope of this straight line corresponds to the scaling factor.



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

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

Using laboratory for the laboratory values and measured value for the values output by the sensor. This means for the example in the picture above:

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

Procedure without uncontaminated sample

5. If no uncontaminated sample is available, at least two samples with as different contamination as possible are required. In this case, the scaling factor is calculated first.

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

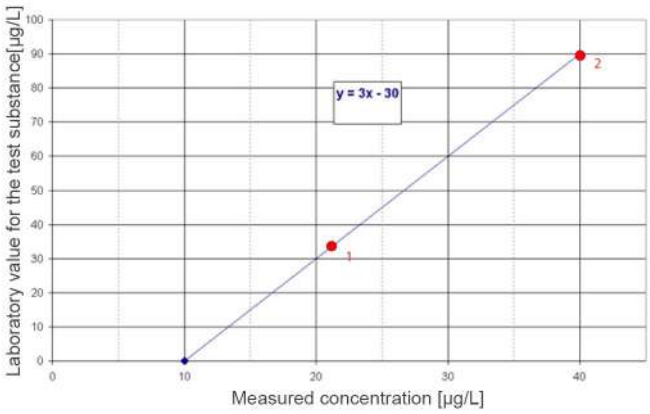
Calculation of the offset without zero point measurement (1.):

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

Measured value2 should be significantly larger than measured value1. The offset is also determined by the abscissa of the straight line (X-axis intersection). This means for the example given:

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

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



All TriOS controllers have the option of setting scaling factors and offset values for measurement parameters.

Please refer to the relevant manual.

Make absolutely sure that you do not perform double scaling for the sensor: On the one hand directly in the G2 sensor menu and on the other via the TriOS controller!

NOTICE

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

6 Malfunction and maintenance

To ensure error-free and reliable measurement, the device should be checked and maintained at regular intervals. To do this, the sensor must first be cleaned.

6.1 Cleaning and care

Deposits (fouling) and dirt depend on the medium and the duration of exposure to the medium. Therefore, the degree of soiling depends on the application. For this reason, it is not possible to give a general answer as to how often cleaning of the sensor is necessary.

Normally the system is kept clean by the nano-coated window. If the soiling is too severe, the following instructions should be followed.

NOTICE

Damage caused by improper cleaning is not covered by the warranty!

6.1.1 Housing cleaning

⚠ CAUTION

Please use protective goggles and gloves when cleaning the sensor, CAUTION especially if acids or similar are used for cleaning.

To loosen solid dirt, we recommend soaking the sensor in a rinsing solution for a few hours. Exposed plug connections should be avoided during any cleaning so that they do not come into contact with water. When cleaning, please always ensure that the locking cap of the connector is firmly closed. Please inform yourself thoroughly about the risks and safety of the cleaning solution used.

If the sensor is very dirty, additional cleaning with a float may be necessary. You should exercise extreme caution to avoid scratching the glass of the optical path.

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

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

NOTICE

Under no circumstances should the sensor be cleaned with hydrochloric acid. Even very low concentrations can damage stainless steel components. In addition, TriOS Messund Datentechnik GmbH warns against the use of other strong acids, even if the sensor has 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!

To make cleaning the optical windows easier, TriOS Mess- und Datentechnik GmbH offers a cleaning set with acetone and special optical cleaning paper.

NOTICE

Do not use harsh cleaning solutions, spatulas, sandpaper or cleaning agents containing abrasive substances to remove stubborn dirt.

6.1.3 Preparation for function test and zero value determination

Clean the sensor as described in chapters 6.1.1 and 6.2.2 and rinse it carefully with deionized water at the end of the cleaning process. Dry the sensor with a paper towel and to remove any grease residue, apply a little acetone to a kitchen towel and wipe it again.

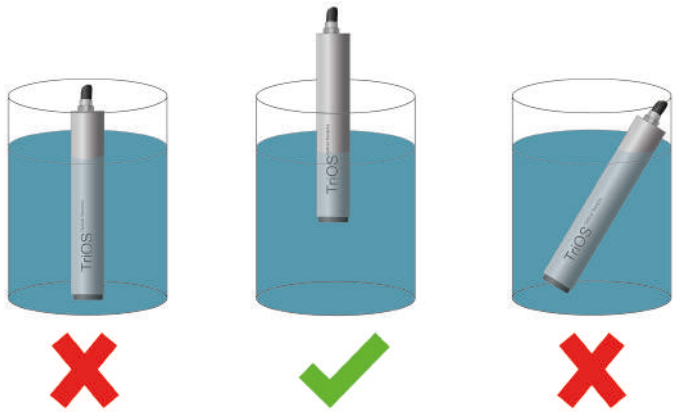
⚠ CAUTION

Always wear suitable gloves and safety goggles to protect yourself!

Clean the window of the sensor with special optical paper or a soft, lint-free cloth and some acetone according to the instructions for cleaning the measurement window.

Important: Then polish the window with a dry, soft cloth or special optical paper to remove any thin film that may appear during cleaning of the window.

Provide a suitable measuring vessel filled with ultrapure water. The measuring vessel should be carefully cleaned with detergent solution before use and then rinsed with ultrapure water. Immerse the sensor in the vessel sufficiently filled with ultrapure water so that the optical window is completely immersed in the water. Never place the sensor on the optical window. The optical window should be at least 10 cm from the bottom.



Wait 10 - 15 minutes. During this time, hidden soiling can be removed from the sensor.

Remove the sensor from the water and rinse it with ultrapure water. Fill the container with fresh ultrapure water and immerse the sensor again. Lift the sensor and move it slightly in the water to remove any air bubbles and air pockets. Carry out the function test or calibration of the sensor.

If possible, the sensor should be in an inclined position in the measuring vessel to avoid an accumulation of very fine, barely visible air bubbles at the upper optical window. When using a stationary measuring cylinder in which the sensor is positioned vertically, particular attention should be paid to air bubbles in front of the optical window.

Ensure sufficient stability!

6.2 Maintenance and inspection

NOTICE

Avoid any contact with the glass parts in the optical path, as these can become scratched or dirty. As a result, the functionality of the device is no longer guaranteed.

6.2.1 Checking the zero value

Prepare the sensor for the zero value check as described in the previous chapter.

We recommend using glass vessels for checking and determining the zero value, as these do not contain or emit any fluorescent substances that would interfere with a zero value measurement.

Alternatively, another vessel suitable for immersion can be used. The optical window must always be completely immersed in the water during the measurement.

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

If possible, carry out the zero value determination at an ambient temperature of 20 °C. The temperature of the ultrapure water should also be 20 °C.

General notices:

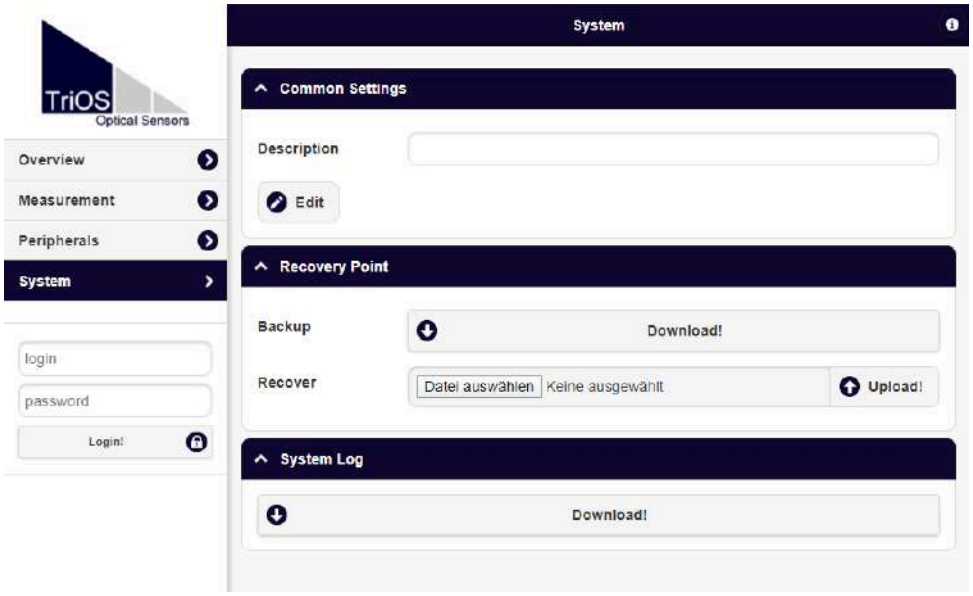
- Do not touch the part of the sensor that is immersed in the ultrapure water with your hands unless you are wearing gloves during the sensor test.
- Be sure to use ultrapure water (ultra pure, resistance of 18.2 MΩcm) or distilled water.
- If impurities appear in the water during the test, it must be replaced!
- Make sure that there are no air bubbles in front of the optical windows. Even fine air bubbles in front of the optical windows can cause a transmission of 97% or less.

It is recommended to carry out at least 5 individual measurements before the test under “Measurement” in order to bring the sensor up to operating temperature.

NOTICE

Damage caused by improper cleaning is not covered by the warranty!

6.2.2 Recovery point



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

To upload a previously saved recovery point, enter the save path to the corresponding calibration file in the “Recover” field using the file dialog located behind the “Browse...” button. Then click on the “Upload” button to start the transfer. If the process is completed successfully, this is confirmed by a green box with the inscription “Success”. If the process fails, a red box with an error message is displayed.

The following error messages and warnings are possible:

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

6.3 Return shipment

Please note the procedure for your return shipment.

If you are returning a sensor or device, please use the URL **trios.de/rma** to go to our **online form**, which you can use to register your return shipment to TriOS **technical support**.

To ensure a smooth return shipment process, please fill out the online form completely. Please note the mandatory fields, otherwise the form cannot be sent. The system **automatically assigns an RMA number**.

After submitting your entries, you will immediately receive an e-mail with the data you have entered, a link to **free DHL shipping** and a label with the **RMA number of your case**.

Please make sure you stick this label **clearly visible on the** outside of **your return package** so that the package can be assigned more quickly.

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

Please note that sensors or devices may need to be cleaned and disinfected before shipping.

In order to ship the goods undamaged, use the original packaging. If this is not available, ensure that safe transportation is guaranteed and that the sensors are secured with sufficient packing material.

We will contact you as soon as possible after receipt of the return shipment.

7 Technical data

7.1 Technical specifications

Measurement technology	**Light source**	LED
	Detector	Photodiode
Measurement principle		Fluorescence

Parameters	CDOM [µg/L] with 0...200 µg/L or chlorophyll a [µg/L] with 0...200 µg/L or 0...500 µg/L or phycocyanin [µg/L] with 0...200 µg/L or 0...500 µg/L or rhodamine [µg/L] with 0...200 µg/L or fluorescein [µg/L] with 0...200 µg/L
Measurement range	0...200 µg/L or 0...500 µg/L
Measurement accuracy	± 5 %

Temperature compensation	No
Turbidity compensation	No
Data logger	No
Response time (T100)	6 s (default)
Measurement interval	3 s (default)

Interface	**digital**	Ethernet (TCP/IP)
		RS-232 or RS-485 (Modbus RTU)

Power consumption	**typical**	< 1 W
	with net-work	< 1,6 W
Power supply		12 - 24 VDC (± 10 %)

Housing material		Stainless steel (1.4571/1.4404) or Titanium (3.7035) or POM	
Dimensions (L x Ø)		~171 mm x 36 mm	~ 6.7" x 1.4"
Weight	**VA**	~ 500 g	~ 1.1 lbs
	Ti	~ 400 g	~ 0.9 lbs
	POM	~ 270 g	~ 0.6 lbs

System compatibility		Modbus RTU	
Max. Pressure	**with Subconn**	30 bar	~ 435 psi
	with fixed cable	3 bar	~ 43.5 psi
	in FlowCell	1 bar, 2...4 L/min	~ 14.5 psi, 0.5 to 1 gpm
Degree of protection		IP68	
Sample temperature		+2...+40 °C in situ +2...+40 °C FlowCell	~ +36 to +104 °F in situ ~ +36 to +104 °F FlowCell
Ambient temperature		+2...+40 °C	~ +36 to +104 °F
Storage temperature		-20...+80 °C	~ -4 to +176 °F
Relative humidity		0...95 %, non-condensing	
Transportation conditions		see storage temperature	
Inflow velocity		0.1...10 m/s	~ 0.33 to 33 fps
Maintenance effort		≤ 0.5 h/month typical	
Calibration/ maintenance interval		24 months	
Warranty		1 year (EU & USA 2 years)	

7.2 Measurement ranges and detection limits

The following table provides an overview of the measurement ranges of the various parameters and their detection limits (under laboratory conditions):

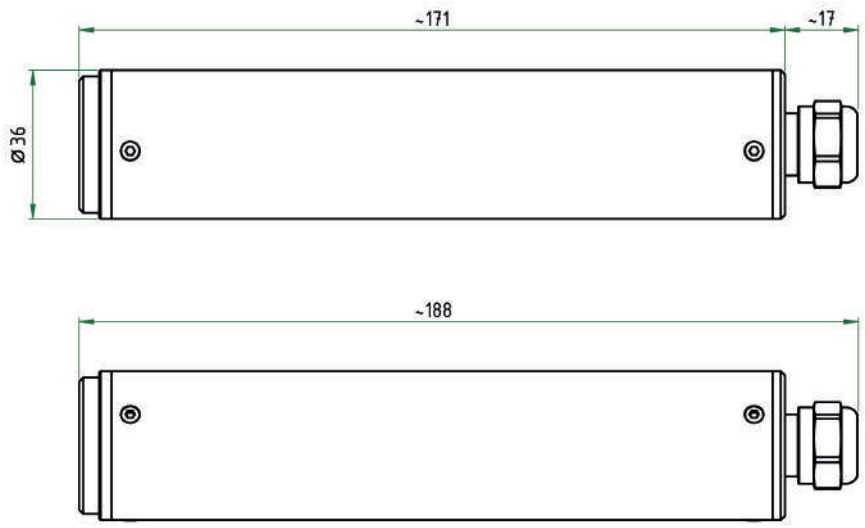
Parameters	Unit	Measurement range	Detection limit
chlorophyll a	µg/L	0...200 µg/L 0...500 µg/L	0.2 µg/L 1 µg/L
phycocyanin	µg/L	0...200 µg/L 0...500 µg/L	0.3 µg/L 3 µg/L
CDOM	µg/L	0...200 µg/L	0.3 µg/L
rhodamine	µg/L	0...200 µg/L	0.5 µg/L
fluorescein	µg/L	0...200 µg/L	0.1 µg/L

7.3 Outer dimensions

Version with SubConn connector 8pin

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

Version with M12 industrial plug



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

PET housing for installation in FlowCell

Position	Material
body and end cap	Polyethylene terephthalate (PET)
front cap	Polyoxymethylene (POM)
screws	Stainless steel
sealing	Nitrile Butadiene Rubber (NBR)

8 Accessories

8.1 Controller

8.1.1 TriBox3

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

TriBox3 is a measuring and control system for all TriOS sensors. The device offers 4 sensor channels with selectable RS-232 or RS-485 function. In addition to 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, a USB port and 6 analog outputs (4 .. 20 mA).
An integrated relay can be used to trigger alarms or control external devices. Low power consumption, a robust aluminum housing and a range of interfaces makes it suitable for all applications in environmental monitoring, drinking water, wastewater treatment plants and many other areas.

8.1.2 TriBox mini

Digital 2-channel controller

Die TriBox mini is an controller with two digital sensor inputs and two 4 .. 20 mA outputs and represent a cost-effective alternative to analog measuring points.
The TriBox mini is compatible with all TriOS sensors.
All stored measured values and diagnostic data can be read out via an integrated web browser.

9 Warranty

The warranty period for our devices within the EU and the USA is 2 years from the date of invoice. Outside the EU it is 1 year. Excluded from the warranty are all normal consumables
(depending on the product, e.g. light sources or windows).

The warranty is subject to the following conditions:

- The device and all accessories must be installed as described in the relevant manual and operated in accordance with the specifications.
- Damage caused by contact with aggressive and material-damaging substances, liquids or gases, as well as transport damage, are not covered by the warranty.
- Damage caused by improper handling and use of the device is not covered by the warranty.
- Damage caused by modification or unprofessional attachment of accessories by the customer is not covered by the warranty.

NOTICE

Opening the device will void the warranty!

10 Technical support

If you have a problem with a TriOS sensor / a TriOS device, please contact TriOS technical support.

We recommend sending in sensors every 2 years for maintenance and calibration. When returning devices, please be sure to follow the procedure described in Chapter 6.

Contact technical support:

E-mail: support@trios.de
Phone: +49 (0) 4402 69670 - 0
Fax: +49 (0) 4402 69670 - 20

To enable us to help you quickly, please send us the sensor ID number (serial number with 8 digits, consisting of letters and numbers, e.g. 6700003F) by e-mail.

11 Contact us

We are constantly working on improving our devices. Please visit our website for the latest news.

If you have found a fault in one of our devices or programs or would like additional functions, please contact us:

Technical Support:	support@trios.de
General questions/sales:	sales@trios.de
Website:	www.trios.de

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

Telephone	+49 (0) 4402 69670 - 0
Fax	+49 (0) 4402 69670 - 20

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13 Appendix

13.1 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, blue, cdom, rho, fluo, red, TRP**
Mit den folgenden Bestimmungen With applicable regulations Avec les directives suivantes	2014/30/EU EMV-Richtlinie 2011/65/EU RoHS-Richtlinie + (EU) 2015/863 + (EU) 2017/2102
Angewendete harmonisierte Normen Harmonized standards applied Normes harmonisées utilisées	EN IEC 61326-1:2021 EN 61010-1:2010 +A1:2019 +A1:2019/AC:2019 EN IEC 63000:2018
Datum / Date / Date	Unterschrift / Signature / Signature
22.05.2024	R. Heuermann

D05-060yy202405

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13.2 Modbus RTU

Firmware version

This Modbus protocol refers to firmware version 1.1.3 and higher

Serial interface

The serial interface configuration for the RS-232 or RS-485 interface of the nanoFlu is as delivered:

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

Data types

Data type 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 - 0xFFFFFFFFFF
Float	2	IEEE 754 32-bit floating point number
Char[n]	$[\frac{n}{2}]$	Zero 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 serial number, firmware version, configuration, calibration and measurement data
Write multiple registers	0x10	Write configuration
Write single register	0x06	Trigger measurement or self-calibration process
Report slave ID	0x11	Read serial number and firmware version

Standard Modbus server address

On delivery, the nanoFlu is set to the following addresses:

Address	Parameter
3 (0x03)	chl
4 (0x04)	blue, TRP, PTSA
5 (0x05)	CDOM, rho, fluo

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

Device Busy Exceptions

Note that neither read nor write accesses are available during a measurement; an attempt to read or write them will result in a *device busy exception* instead.

Access authorizations

The “R/W” column describes the access restrictions for registers. An “R” means that it can be read (0x03), a “W” means that it can be written to (0x10).

The following table describes the Modbus register assignment *:

Designation	R/W	Address	Data type	Data type Description
Modbus Server Address	R/W	0	Uint16	The Modbus server address of the sensor. Permitted addresses: 1...247
Measurement timeout	R	1	Uint16	The time in [10-1 s] that the currently active measurement process will continue
Device serial number	R	10	Char[20]	The device name, followed by the serial number of the sensor, separated by an underscore, e.g. “nanoFlu_D200”
Firmware version	R	20	Char[10]	The version number of the installed firmware
Self-trigger activated	R/W	100	Bool	Activate or deactivate automatic mode. For an external trigger: Deactivate automatic mode.
Self-trigger interval	R/W	101	Uint32	The interval in [s] for self-triggered measurements. Value range: 13 s - 86400 s
Moving average	R/W	103	Uint16	The number of samples for the calculation of an average concentration. Value range: 1 - 25
System date and time	R/W	104	Uint32	Date and time in seconds since 01.01.1970
Device description	R/W	106	Char[64]	A free description of the sensor, e.g: “southern supply line”
Parameter index for offset / scaling	R/W	400	Uint16	The index of the parameter for the subsequent offset and scaling settings. Index = log2(substance); e.g. for nanoFlu blue: index = log2(2) = 1

Designation	R/W	Address	Data type	Data type Description
				For possible substance values, see register #500
Activate offset / scaling	R/W	401	Bool	Activates or deactivates the scaling and offset calculation for the parameter selected in #400. Notice: This has no effect on the calculation of the moving average.
Offset	R/W	402	Float	Parameter Offset Formula: scaled = (raw-offset) * scaling
Scaling	R/W	404	Float	Parameter Scaling Formula: scaled = (raw-offset) * scaling
Available substances	R	500	Uint16	Sub-types of the nanoFlu, possible substances: 1: chl-a 2: blue 4: CDOM 8: red 16: rho 128: TRP 256: fluo 512: PTSA
Parameter name	R	603	Char[32]	Name of the device parameter
Temperature	R	998	Float	Sensor temperature in [°C]
Concentration / scaled concentration	R	1000 / 1500	Float	

* **Notice:** The configuration registers should be written to as rarely as possible, especially not in every measurement cycle, as otherwise the flash memory may be damaged.

Write single register (0x06)

Writing a value not equal to 0x0000 to the following coils/registers executes the associated action.

Designation	Address	Address Description
Trigger measurement	1	A single measurement is triggered, but only if no measurement is currently running.

Report slave ID (0x11)

Returns the sensor designation, followed by the serial number, followed by the firmware version, each as a zero-terminated ASCII character string.

Example

n	a	n	o	F	l	u	0x00	D	2	0	0	0x00	1	.	1	.	3	0x00

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