

Optical Sensors



TTurb

Operating instructions

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1 General information

1.1 General information

Welcome to TriOS.

We are pleased that you have chosen our nephelometric turbidity sensor TTurb.

TTurb is based on the physical measuring method of 90° infrared scattering and measures turbidity in a measuring range of up to 100, 400 or 1000 NTU, depending on the sensor type. The measured values can also be output in FNU, mg/L or TSSeq. Calibrations made are stored internally by this intelligent sensor. This enables a “plug-and-play” system without recalibration when changing the location or transmitter.

In this manual you will find all the information about the TTurb 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.

Firmware updates

This manual refers to firmware version 1.0.7. 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 manuals, 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 protection! Excessive 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

General notices:

- This sensor has been developed for use in industry and science. It should only be used to measure aqueous solutions such as process wastewater, river water or seawater.
- The material resistance should be tested for each application.

- Do not cut, damage or modify the cable. Ensure that there are no heavy objects on the cable and that the cable does not kink. Make sure 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.
- Never attempt to disassemble or modify any part of the device unless expressly described in this manual. Inspections, modifications and repairs may only be carried out by the device dealer or by qualified specialists authorized by TriOS.
- Devices from TriOS Mess- und Datentechnik GmbH comply with the highest safety standards. Repairs to the devices (which include the replacement of the connection 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 TTurb was developed for use in industry and science. The target group for operating the TTurb is technically experienced specialist personnel in companies, wastewater 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 TTurb is exclusively to measure turbidity in aqueous solutions as described in this manual. In this respect, the TTurb is an immersion sensor that is used under water or in conjunction with flow cells. Please observe the technical data of the accessories. Any other use is considered improper.

The compact and robust sensor is particularly suitable for the following areas of application:

- Industrial and municipal wastewater treatment plants
- Waste water management
- Monitoring of surface waters
- Aquaculture and fish farming
- Drinking water monitoring

Use in other media may damage the sensor. To use the TTurb in media other than those specified here, please contact TriOS Mess- und Datentechnik GmbH support (support@trios.de).

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

IMO regulations

TTurb is approved according to IMO regulations MEPC.340(77) for turbidity monitoring as described in the regulations. Observe the conditions of use of TTurb for this application (see chapter Application and the appendix).

2 Introduction

2.1 Introduction

The TriOS TTurb is a turbidity sensor that measures nephelometrically in the infrared range.

The sensor is available in different variants with different measuring ranges. The TTurb-1000 has an additional variant with the SubConn connection option (TTurb-1000 S).

A reference measurement of the light source ensures long-term stability of the measurement and reduces service costs due to infrequent calibration. An innovative multi-colored LED always shows the user the status of his measurement immediately. Green during a measurement, blue during calibration or configuration and red in the event of a malfunction.

Due to the integrated background light suppression, it is not necessary to protect the sensor from direct sunlight. It can therefore also be used close to the surface.

As an immersion sensor, the TTurb can be used directly in the measured medium, but is also available in the FlowCell-optimized variant directly with a flow cell for bypass applications. It is also possible to obtain the TTurb directly as a set with the TTurbCAL dry standard. This standard is always directly matched to each individual device and thus enables precise functional tests to be carried out directly on site, without any reagents.

2.2 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:

TTurb



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.

2.3 Scope of delivery

The delivery includes the following components:

- Sensor
- Operating instructions
- Accessories (if applicable)

Optional:

- Article 20M000002 TTurbCAL calibration unit (only for TTurb-1000)
- Article 10A800002 FlowCell TTurb

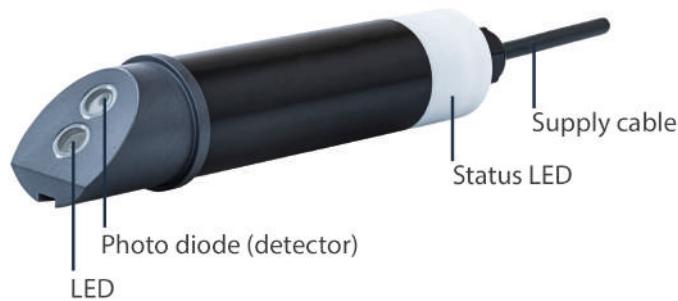
Keep the original packaging of the device for possible return shipment for maintenance or repair purposes.

2.4 Measuring principle and structure

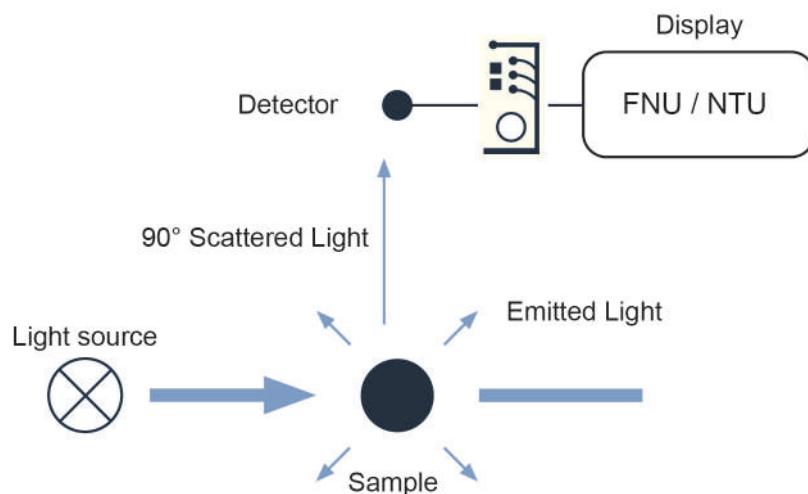
The sensor measures using the nephelometric principle of 90° infrared scattering. The turbidity of a liquid can be precisely determined based on the scattering intensity. The detector is positioned 90° to the light source for the measurement.

The measured value is given in FNU ("Formazine Nephelometric Units"), NTU, mg/L or TSSeq[mg/L]. Formazine is used internationally as a standard for the calibration of turbidity sensors, making them comparable with each other.

Measuring structure



Measuring principle of the 90° scattered light method



2.5 Browser

TTurb is equipped with a web interface that can be used to configure and calibrate the sensor. For example, offsets and scaling factors can be assigned, interfaces configured and other settings entered. To access the web interface, you need the G2 InterfaceBox and an Ethernet-capable device with a web browser, such as a notebook or smartphone (when using a G2 InterfaceBox with WLAN).

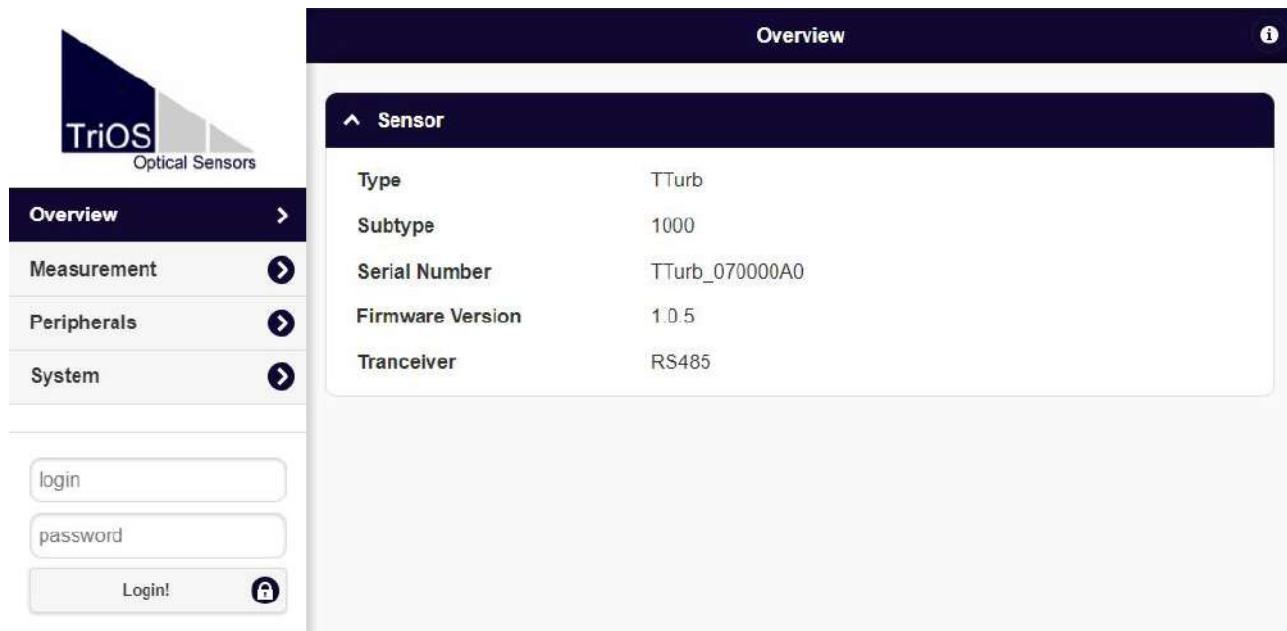
Open one of the following URLs in your web browser (depending on the structure of the network):

<http://tturb.trios.de/> http://TTurb_070XXXXX/ (070XXXXX is the serial number)

<http://192.168.77.1/>

The web interface is divided into three areas (see illustration): Title, Menu and Content

Web interface



The title shows the name of the current page. 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 a login form that certified TriOS service technicians can use to authenticate themselves. In most cases, problems can be solved on site.

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

NOTICE

Once settings have been made, they must be saved using the “Save” button. Otherwise the settings will be lost.

2.5.1 Overview page

The overview page, as shown in the following illustration, 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.

Overview page

Measurement

The “Measurement” page shows the results of the last measurement carried out. In addition, an interval for automatic measurements can be set via “Settings”. A new measurement can be triggered at any time with “Measure now!”. A new measurement is then carried out with the saved settings.

Measurements

Settings

The scaling factors for all parameters can be entered under the “Settings” button in the “Scaling” sub-item. Details can be found in chapter 5 Customer calibration.

Scaling **Moving average**

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

| Parameter | Offset | Scaling |
|------------------|--------|---------|
| Turbidity (FNU) | 0 | 1 |
| Turbidity (mg/l) | 0 | 1 |
| Turbidity (NTU) | 0 | 1 |
| TSSeq (mg/l) | 0 | 1 |

▼ more

Edit

Scaling factors

Mean value correction

An average correction for N (number) measured values can be defined in the “Moving average” sub-item.

Scaling **Moving average**

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

| Parameter | N |
|------------------|---|
| Turbidity (FNU) | 1 |
| Turbidity (mg/l) | 1 |
| Turbidity (NTU) | 1 |
| TSSeq (mg/l) | 1 |

▼ more

Edit

Mean value correction

Automatic measurements

In the “Settings” sub-item, settings for automatic measurement can also be made after pressing the “Edit” button.

- Automatic measurements can be activated.
- An interval for the automatic measurements can be defined.



Automatic measurements

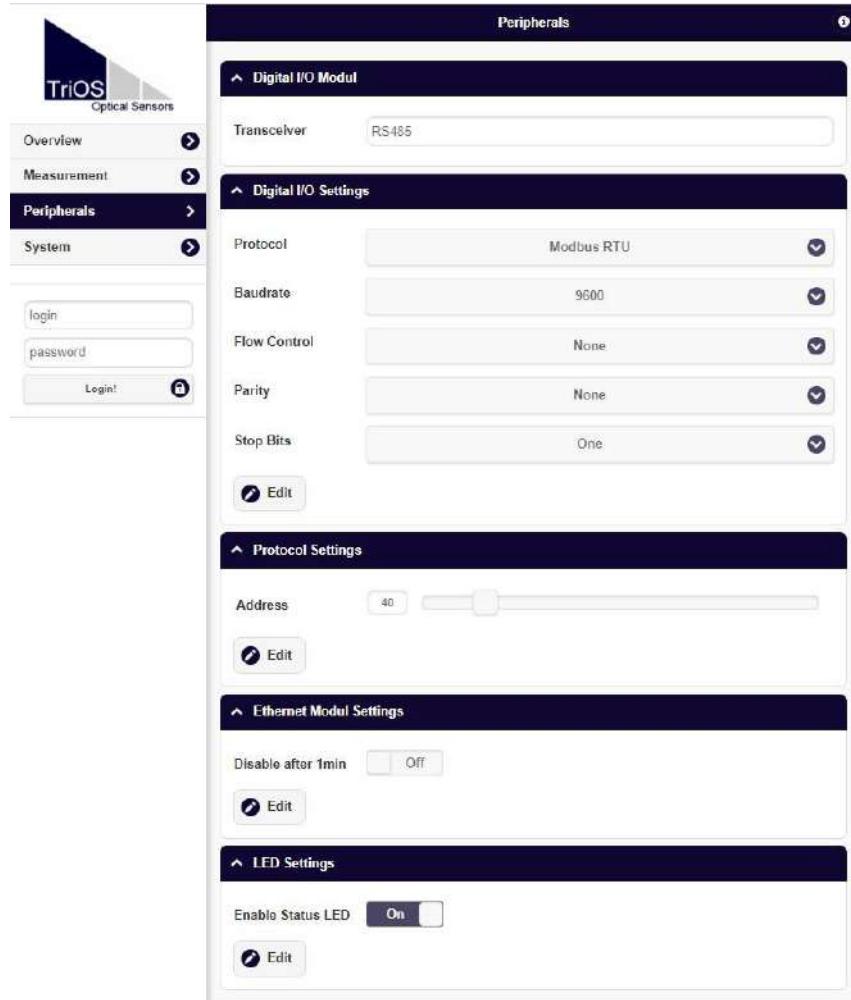
 Please note that the factory setting for automatic measurement is set to “Off”.

NOTICE

To record data sets, please only activate automatic measurement when the power supply is permanently on!

2.5.2 Peripherals

In the “Peripherals” submenu, you can configure the interface, select a protocol and change the Modbus address after pressing the “Edit” button.



Peripherals settings

The factory settings are:

Protocol: Modbus RTU

Baud rate: 9600

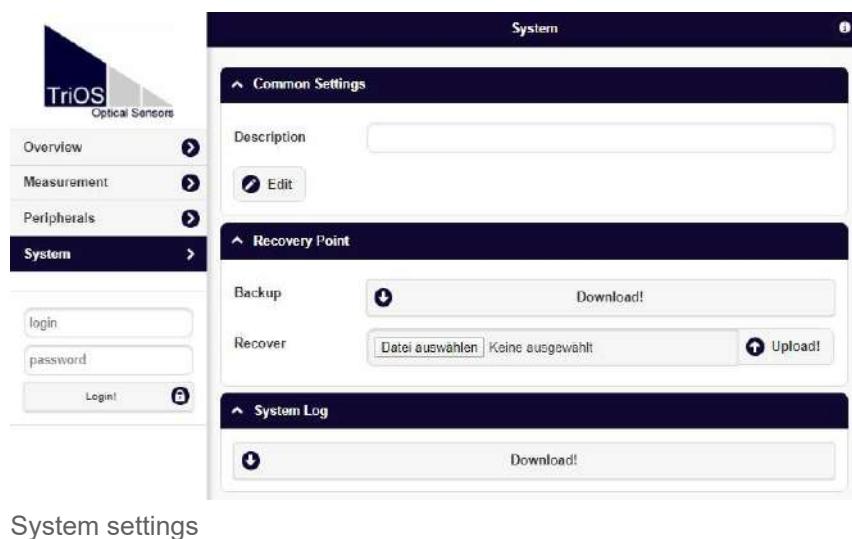
Flow control: None

Parity: None

Stop bits: 1

2.5.3 System

The "System" page is used to manage the sensor. Tasks on this page are time settings, downloading the current calibration as a restore point and providing a LOG file.



Common settings

Under "Common settings", a comment such as a name or the location of the sensor can be entered after pressing the "Edit" button.

Recovery point

To load the current calibration from the sensor and save it on a PC or other medium, press the "**Download**" button under "Recovery point". This calibration file (config.ini) must be saved and stored in a safe place. If a previously downloaded calibration or a calibration file created by TriOS Mess- und Datentechnik GmbH support is to be uploaded to the TTurb, this can be achieved using the "Upload" function.

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

System log

The "System log" is freely accessible and shows events such as measurements carried out, changed settings and error messages. System information can be downloaded here in the event of servicing. This information may be important in the event of troubleshooting by support and must be included with the request.

Service login

To use the service function, you need a login and a password. You will receive this when you attend a TriOS training course. For further information, please contact TriOS Mess- und Datentechnik GmbH support.

3 Commissioning

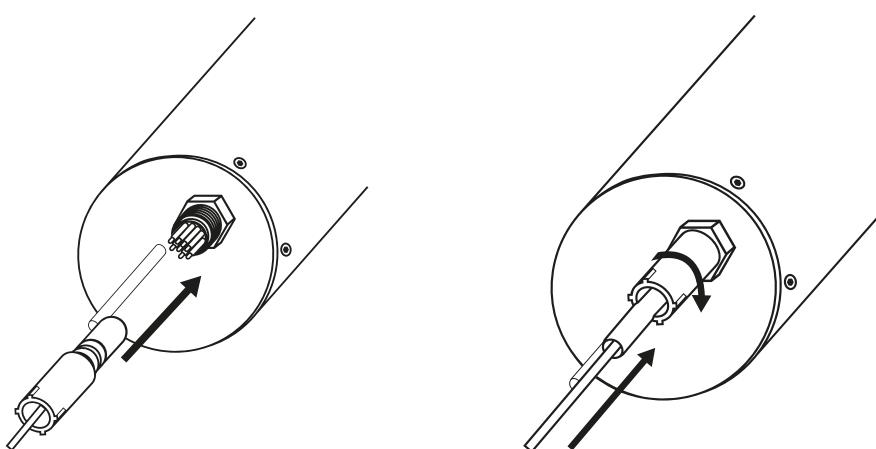
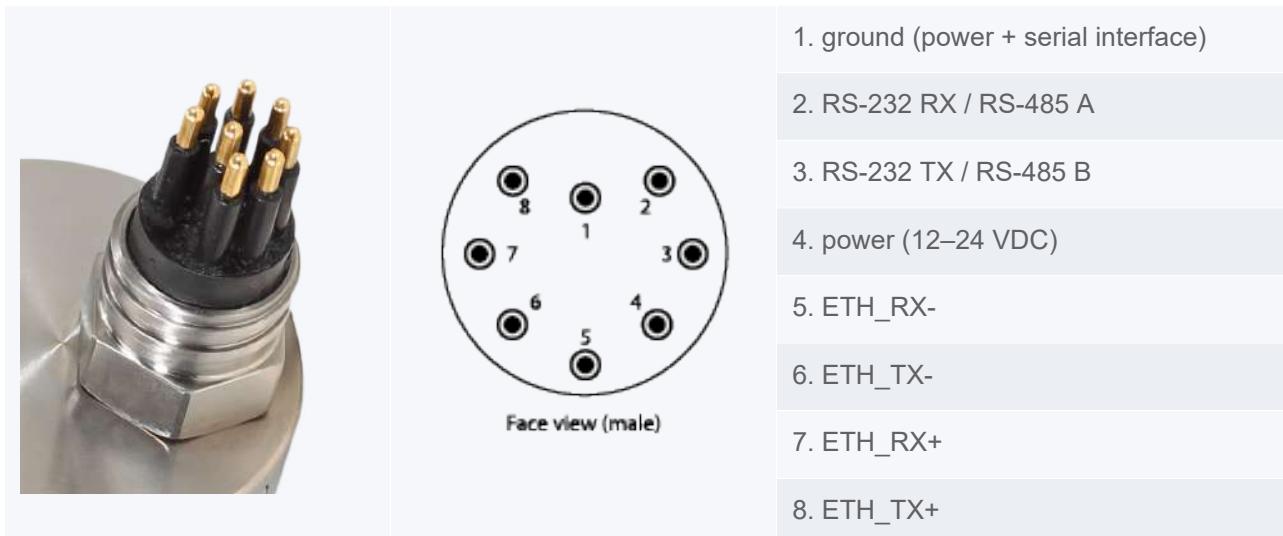
This chapter covers the commissioning of the sensor up to the first function test. Please pay particular attention to this section and follow the safety instructions to protect the product from damage and yourself from injury.

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

3.1 Electrical installation

3.1.1 SubConn 8pin connector

The TTurb-1000 can also be supplied with a SubConn 8pin connector.



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

In the next step, tighten the locking sleeve hand-tight to secure the connector end to the bulkhead connector.

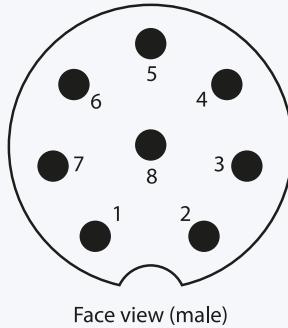
NOTICE

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

NOTICE

The sensor can be operated with 12–24 VDC.



| |
|--------------------------------------|
| 1. RS-485 A (commands) |
| 2. 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) |

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

NOTICE

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

3.2 Interfaces

3.2.1 Serial interface

The serial interface of the sensor is RS-485 (9600/8-N-1).

With RS-485, voltages from -5 V to +5 V to ground are possible. 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.

The protocol used is Modbus RTU. A detailed description of the Modbus RTU protocol for TTurb can be found in the appendix.

4 Application

TTurb can be operated with all TriOS controllers. You will find notices for correct installation in the respective controller manual. On all TriOS controllers, the sensor is automatically recognized during the sensor scan after the controller is switched on.

If the sensor is operated with the HS 100 DIN rail module or directly on a process control system or SCADA system, the customer is responsible for correct commissioning and programming. A detailed description of the Modbus registers and the calibration procedure can be found in the appendix.

4.1 Normal operation

The sensor can be used directly in open water such as a river, lake, pool or similar. Due to the integrated background light suppression, the measurement is not disturbed by sunlight.

It is essential to ensure sufficient distance between the sensor and other probes, pool edges, banks or similar. The measurement result could be falsified by scattering from surfaces.

4.2 Bypass installation

The sensor can be used in an optional flow cell. If a flow cell that was not purchased from TriOS is used, calibration is mandatory.

The TriOS TTurb flow cell has several advantages over commercially available products:

The sensor is always fixed in the same position by a guide device with an end stop. This guarantees stable measured values after cleaning or servicing in conjunction with removal of the device.

The flow cell can be dismantled and / or opened in just a few seconds thanks to its simple assembly and innovative locking technology. It can be extended to the right with additional cells for other parameters such as pH.

There is a drain plug at the bottom of the flow cell to remove deposited dirt with very little effort.



NOTICE

Negative pressure can damage the sensor.

Installation in the FlowCell

Follow the steps in the following instructions to install the TTurb turbidity sensor in the TriOS FlowCell.

1. Remove the pressure ring from the FlowCell. It can easily be opened by hand.
2. First slide the o-ring (attached to the FlowCell in a bag) onto the TTurb. Then insert the TTurb into the FlowCell.
3. When the TTurb is positioned along the groove, guide the pressure ring along the cable above the sensor to fix it on the FlowCell.
4. When the TTurb has been positioned correctly, tighten the pressure ring hand-tight.

NOTICE

The TTurb may only be mounted in the FlowCell as shown in the pictures. There is a positioning groove in the FlowCell for correct alignment.



(1) Pressure ring
(2) TTurb
(3) O-ring



4.3 Operation with approval according to IMO regulations

Approval according to IMO regulations

TTurb is approved in accordance with IMO regulations MEPC.340(77) for monitoring turbidity in the wash water of exhaust gas cleaning systems. The turbidity can be output in FNU or NTU.

Specifications according to MEPC.340(77)

The approval assumes an operating temperature of 5 °C to 55 °C.

Installation

TTurb can be installed as a bypass in a FlowCell (FlowCell eCHEM) (see chapter 4.2. Bypass installation).

Electrical installation

Applications with ship approval, as mentioned above, must be equipped with a TTurb sensor with a fixed cable of maximum 5 m length. The shielded cable has an M12 industrial plug as connection.

The sensor must be connected to an external control unit for the power supply (12 VDC or 24 VDC) and the recording of measurement data. The shielding of the M12 industrial plug must also be earthed (see chapter 3.1.1 M12 industrial plug).

5 Calibration

5.1 Manufacturer calibration

TTurb outputs the measured value in the units FNU (“Formazine Nephelometric Units”), NTU, mg/L and TSSeq [mg/L].

5.1.1 Standard manufacturer calibration

For the standard manufacturer calibration, the sensor is calibrated in a large vessel with a formazin turbidity standard.

5.1.2 Calibration for use in a FlowCell

For use in a FlowCell, the sensor is calibrated directly in a FlowCell. Manufacturer calibration is carried out using a formazin turbidity standard or a polymer traceable to formazin.

5.2 Customer calibration

Customer calibration can always be carried out with a formazine turbidity standard or with the TTurbCAL solid standard (TTurb-1000 only).

5.2.1 Calibration with formazin turbidity standard

⚠ CAUTION

Formazin is carcinogenic, may cause allergic reactions and is harmful to aquatic organisms. Use formazin standard solutions with great care.

The sensor can be recalibrated in use with a one-point calibration by externally determining the scaling factor (slope). The manufacturer calibration remains unaffected by this calibration. The recalibrated measured values can be read out via the Modbus registers from 1500. The raw values can still be read out via the registers from 1000.

The scaling factor can then be set manually in the controllers, via the G2 InterfaceBox in the sensor or in the DCS / SCADA.

The customer calibration of the sensor is not automatically taken over by the controllers, i.e. after calibration and successful calculation, the value for the slope must be entered in the controller.

 **For the calibration of the slope, a standard concentration should be selected that lies within the upper measurement range of the sensor. If the sensor has a range up to 100 FNU, the calibration should be carried out with a measuring solution that is between 50 - 100 FNU.**

 **We recommend using a large black bucket or a large black vessel for calibration, which provides sufficient space between the optical window and the vessel wall. Light refraction at the edge of the vessel could influence the measurement and falsify the calibration, therefore we recommend not to calibrate in a beaker.**

Leave the setup untouched during calibration and avoid disturbing factors such as contact or environmental influences.

Calibration steps

1. Set the measurement interval of the TTurb to 10 seconds and allow the sensor to warm up for at least 10 minutes before calibration.
2. Follow the cleaning instructions for the TTurb as described in chapter 6.
3. Once the TTurb has warmed up and is free of dirt, you can start checking the TTurb.
4. Immerse the TTurb in the formazin turbidity standard. Make sure that the assembly is standing on a flat surface.
5. Take 16 measurements and calculate the average value. Note the measured concentration.
6. Read the concentration of the standard and calculate the slope.

$$\text{Gradient} = \frac{\text{Concentration of the formazin turbidity standard}}{\text{Mean value from 16 Measurements}}$$

The slope should be between 0.5 - 2.

If the slope is *outside* this range, repeat the measurement to rule out an application error. If the slope is outside the specified range even after repeating the measurement several times, you should send the TTurb in for inspection and calibration.

If the slope is within the above-mentioned range, continue with the following point:

7. After successful calculation, enter the value for the slope into the controller, web interface or process control system (PCS). To do this, follow the instructions in the respective manual for the controller or sensor. You can then continue with your measurements.

5.2.2 Calibration with solid standard TTurbCAL

TTurbCAL (see chapter 8 “Accessories”) is used for both calibration and validation of the sensor. The TTurbCAL can only be used together with the TriOS TTurb-1000 sensor with which it was supplied. Both products have been matched to each other in the manufacturer's laboratory.



TTurbCAL open

Measurement principle

The TTurbCAL solids standard is used to check the assigned TTurb-1000 sensor. The light emitted by the sensor is scattered by the material in the standard and detected by the sensor at a 90° angle. The penetration of ambient light or external light is prevented by placing the standard on the sensor head.

Parameters

TTurbCAL was developed for the calibration of TriOS TTurb-1000. The sensor measures turbidity in a measurement range of 0 - 1000 FNU. Each TTurbCAL generates a specific turbidity signal that corresponds to a turbidity concentration in FNU.

The exact concentration of the TTurbCAL is noted on the type plate. The serial number (TTurb SN) of the corresponding TTurb-1000 is also noted. The picture below shows an example of such a type plate.



NOTICE

- The product has been developed for use in industry and science. It should only be used for calibration of the associated TTurb-1000.
- Only use TTurbCAL in air. Use in other media may damage the product.
- Protect TTurbCAL from environmental influences such as precipitation.
- Store TTurbCAL in a dry place. After use, the cover of the TTurbCAL should be screwed back on to prevent dust or liquids from entering.
- Never attempt to disassemble or modify any part of the TTurbCAL. Inspections, modifications and repairs may only be carried out by the device dealer or by TriOS authorized and qualified specialists.

To check the TTurb-1000 with the TTurbCAL solids standard, hold the sensor in your hand pointing vertically upwards and follow these steps:

Calibration steps

1. Set the measurement interval of the TTurb-1000 to 10 seconds and allow the sensor to warm up for at least 10 minutes before calibration.
2. Follow the cleaning instructions for TTurb and TTurbCAL as described in chapter 6.
3. Once the TTurb has warmed up and both the sensor and the TTurbCAL are free of dirt, you can start checking the TTurb-1000.
4. Place the TTurbCAL on the TTurb. The shape of the standard is designed to fit the TTurb perfectly. The correct position on the sensor head is quickly set by applying light pressure to the TTurbCAL. Repeat the positioning process a total of three times to find the optimum position. The highest measured value indicates the best position.
5. Take 16 measurements and calculate the average value. Note the measured concentration.
6. Read the concentration of the TTurbCAL from the type plate of the standard and calculate the slope.

$$\text{Gradient} = \frac{\text{Concentration of the TTurbCAL}}{\text{Mean value from 16 Measurements}}$$

The slope should be between 0.5 - 2.

If the slope is *outside* this range, repeat the measurement to rule out an application error. If the slope is outside the specified range even after repeating the measurement several times, you should send the TTurb-1000 together with the TTurbCAL in for inspection and calibration.

If the slope is within the above-mentioned range, continue with the following point:

7. After successful calculation, enter the value for the slope into the controller, web interface or process control system (PCS). To do this, follow the instructions in the respective manual for the controller or sensor. You can then continue with your measurements.

5.2.3 Calibration via controller wizard

Both the TriBox3 and the TriBox mini have a wizard that can be used to perform a guided calibration.

5.2.3.1 Calibration wizard of the TriBox3

The TriBox3 calibration wizard offers guided calibration via scaling, offset or factory calibration.

We recommend using the calibration wizard to determine the scaling factor. After successful execution using the wizard, the new scaling factor is automatically saved in the sensor and activated.

NOTICE

When calibrating via the TriBox3, it is possible to restore the factory calibration (by selecting the factory calibration, see also the TriBox3 manual).

Procedure with the TriBox3

To perform a calibration with the wizard, please proceed as follows:

1. Switch to maintenance mode (menu “Options” ► “Service mode”).
As soon as maintenance mode is activated, five blue LEDs flash.
2. Select the sensor to be calibrated in the sensor menu by tapping the blue sensor area.
3. Select “Calibrate” in the menu of the selected sensor.
4. The calibration options appear on the display, of which “Scaling” is selected in this case. The calibration wizard starts directly with the measurement, so the respective calibration standard should be ready (TTurbCAL or a standard solution).
5. Follow the instructions of the calibration wizard on your TriBox3 to adjust the scaling of the sensor.
6. The instructions of the wizard must be followed exactly, otherwise the accuracy of the measurements cannot be guaranteed after the wizard has been completed.
7. After calibration, you can exit maintenance mode and continue with the measurement.

5.2.3.2 Calibration wizard of the TriBox mini

The TriBox mini calibration wizard offers guided calibration via scaling or offset.

NOTICE

When calibrating via the TriBox mini, there is no way to restore the factory calibration!

For this reason, we recommend calibration via external determination and input of the scaling factor (see chapter 5.2.1).

If you follow the calibration wizard, the new scaling factor is automatically saved and activated in the sensor and cannot be undone.

If calibration via the wizard is still desired, proceed as follows for the TriBox mini:

1. Switch to service mode (menu “Options (Settings)” ► “Service mode”).
As soon as service mode is activated, five blue LEDs flash.
2. Select the sensor to be calibrated in the sensor menu by tapping the corresponding sensor area.
3. Select the “Calibrate” button in the menu of the selected sensor and follow the instructions of the calibration wizard.
4. The calibration methods “Offset” and “Scaling” appear on the display, of which “Scaling” is selected in this case. The calibration wizard starts directly with the measurement, so the respective calibration standard should be ready (TTurbCAL or a standard solution).
5. Continue to follow the instructions of the calibration wizard on your TriBox mini to adjust the scaling of the sensor.
6. The instructions of the wizard must be followed exactly, otherwise the accuracy of the measurements cannot be guaranteed after the wizard has been completed.
7. After calibration, you can exit service mode and continue with the measurement.

5.2.4 Calibration in the EGC Water Analyzer

The calibration of the TTurb-1000 in a TriOS EGC Water Analyzer is described in detail in the EGC Water Analyzer manual.

6 Malfunction and maintenance

6.1 Cleaning and care

The sensor should be cleaned manually at intervals depending on the application. To do this, the sensor must be removed from the measuring basin or flow cell.

NOTICE

Always switch to maintenance mode before starting the service if you are using TriOS controllers so that incorrect measurements caused by cleaning do not trigger malfunctions.

The optical windows of the sensor should be free of dirt and fingerprints. Use a soft, lint-free cloth for cleaning and take care not to scratch the windows. Dirt on the optical windows affects the accuracy of the measurement. For heavier soiling, isopropanol can be used to clean the sensor head.

If precipitates are visible (such as carbonates or iron oxides), a handkerchief or similar moistened with citric acid can be placed on the windows for a few minutes.

NOTICE

The optical windows and the cable must be checked at every service.

6.2 Maintenance and testing

The sensor does not require any special maintenance, except for cleaning and checking the cable and optical windows as described in 6.1.

To check the measured values, you can either use a standard solution or carry out a reference measurement. The standard solution should be within the expected measurement range of the measured medium.

For a quick function check, hold the sensor vertically on a white sheet of paper. The measured value should be a full scale (e.g. 1000 FNU). Continue measuring as you move the sensor further and further away from the sheet of paper. The measured value should become smallest with increasing distance.

6.3 Return shipment

Please note the procedure for your return.

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! Returns without an RMA number cannot be accepted and processed!

TTurb // Malfunction and maintenance

Please note that the sensor or the device must be cleaned and disinfected before shipping.

Use the original packaging to ensure that the goods are sent undamaged. 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 receiving the return shipment.

7 Technical data

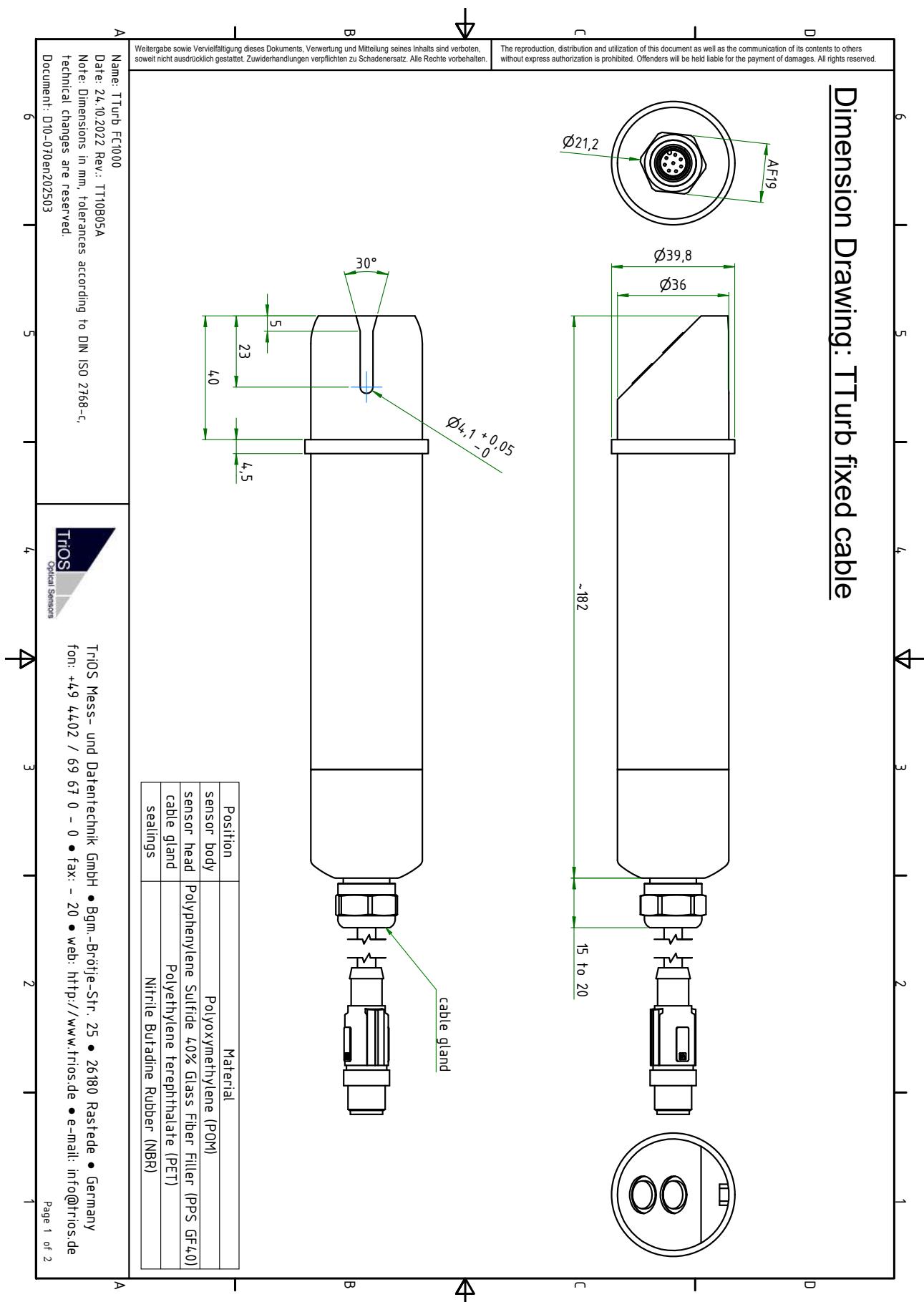
7.1 Technical specifications

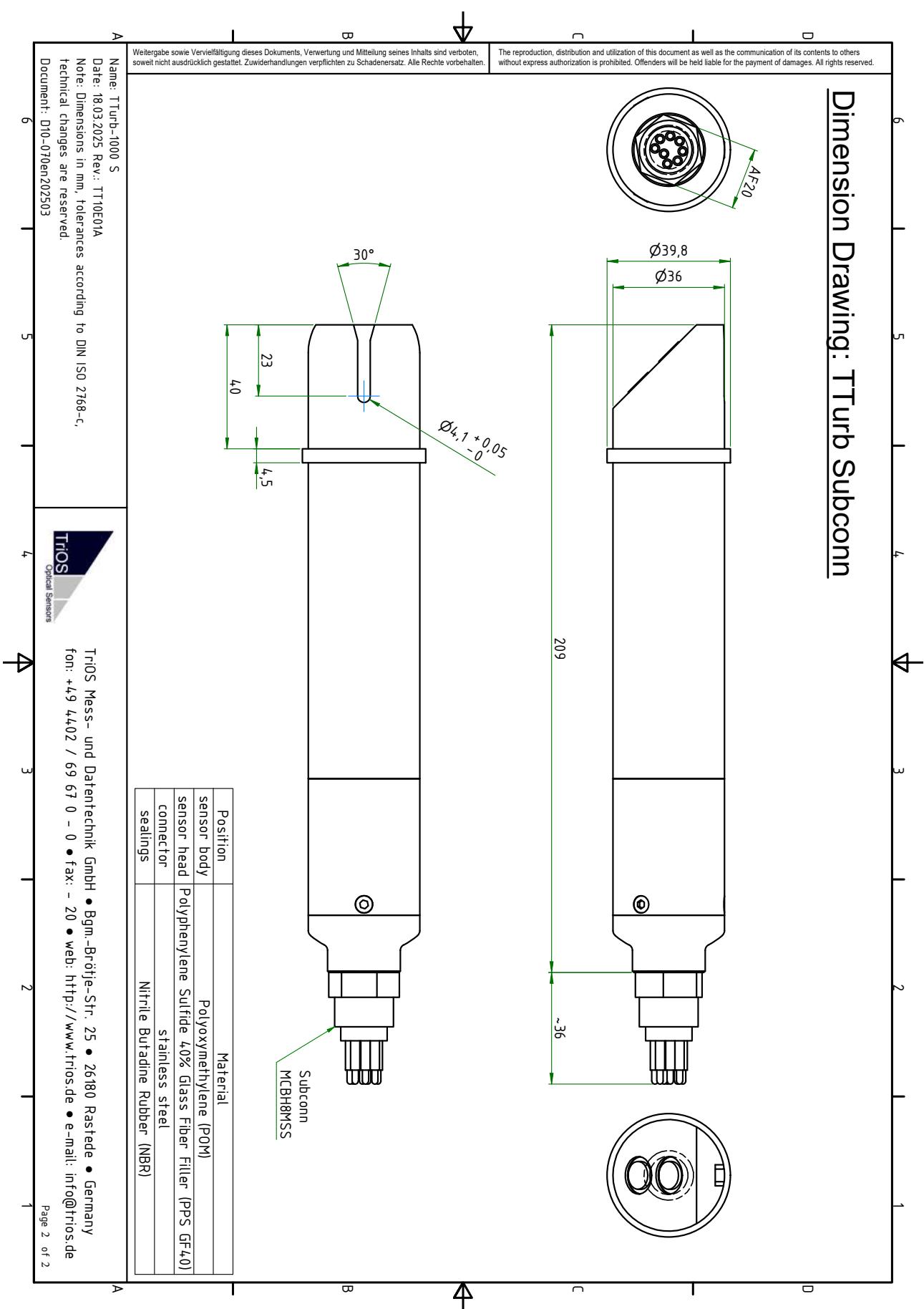
| | | |
|-------------------------------|---------------------|--|
| Measurement technology | Light source | LED |
| | Detector | photodiode |
| Measuring principle | | Nephelometry (90° scattered light method) |
| Parameters | | Turbidity in FNU; mg/L; NTU; TSSeq |
| Standard applied | | DIN EN ISO 7027-1:2016-11 |
| Measuring range | | 0 – 100, 0 – 400, 0 – 1000 FNU |
| Measuring accuracy | | ± (5 % + 0.5); max. ± 2 FNU |
| Detection limit | | 0.5 FNU for TTurb-100 2 FNU for TTurb-400 2 FNU for TTurb-1000 |
| Measuring wavelength | | 860 nm, FWHM 30 nm |
| Response time T100 | | 6 s |
| Measuring interval | | ≥ 3 s |

| | | |
|--|-------------------------------|---|
| Housing material | PET / POM / NBR | |
| Dimensions (L x Ø) | with fixed cable | 182 x 36 mm ~ 7.2" x 1.4" |
| | with SubConn connector | 209 x 36 mm ~ 8.2" x 1.4" |
| Weight | approx. 0.3 kg | ~ 0.7 lbs |
| Interface | | Ethernet (TCP/IP) RS-485 (Modbus RTU) |
| Power consumption | | typically < 0.9 W with network < 1.5 W |
| Power supply | | 12 – 24 VDC ±10 % |
| Connection | | 8pin M12 plug |
| Maintenance effort | | ≤ 0.5 h/month typical |
| Calibration/ maintenance interval | | 24 months, when using a TTurbCAL 4 years |

| | | | |
|-----------------------------|-------------------------|---|---------------------|
| System compatibility | | Modbus RTU | |
| Warranty | | 1 year (EU&US: 2 years) on electronics; wearing parts are excluded from the warranty | |
| Max. Pressure | with fixed cable | 3 bar | 43.5 psi |
| | in flow cell | 1 bar, 2-4 L/min | 14.5 psi, 2-4 L/min |
| Degree of protection | | IP68 | |
| Sample temperature | | 0...+40 °C | +32...104 °F |
| Ambient temperature | | 0...+40 °C | +32...104 °F |
| Storage temperature | | 0...+80 °C | +32...176 °F |
| Inflow velocity | | max. 0.1 m/s | |

7.2 Outer dimensions





8 Accessories

8.1 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, an IEEE 802.11 b/g/n 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.



8.2 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.



8.3 Flow cell

Flow cell for eCHEM sensors

The flow cells specially developed for the eCHEM series are used for bypass installations of the eCHEM sensors manufactured by TriOS. The measuring medium is fed through the cell via an inflow, thus enabling reagent-free measurement outside the process.

The flow cells are based on a modular system that can be expanded with additional modules.



8.4 TTurbCAL

Calibration standard

The TTurbCAL is a solid matter standard that provides an FNU value for reagent-free calibration of TriOS TTurb sensors. The standard is very easy to use and makes on-site device calibration considerably easier.



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. To do this, please request an RMA number from technical support.

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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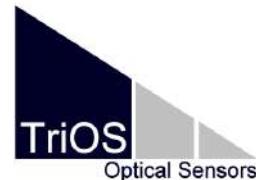
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13 Appendix

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
Désignation

TTurb

Typ / Type / Type

100, 400, 1000

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

23.05.2024

R. Heuermann

D05-070yy202405

Seite 1 von 1

13.2 Type Approval



TYPE APPROVAL CERTIFICATE

Certificate No:
TAA00002X2
Revision No:
1

This is to certify:

That the Miscellaneous Transmitter

with type designation(s)
TTurb

Issued to
TriOS Mess- und Datentechnik GmbH
Rastede, Germany

is found to comply with
DNV rules for classification – Ships, offshore units, and high speed and light craft

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV.

| | |
|-------------|----------|
| Temperature | A |
| Humidity | B |
| Vibration | A |
| EMC | B |
| Enclosure | B (IP68) |

Issued at **Hamburg** on **2022-07-06**

This Certificate is valid until **2025-12-16**.

DNV local station: **Hamburg – CMC North/East**

for DNV

Approval Engineer: **Jens Dietrich**

.....
Joannis Papanuskas
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.



Form code: TA 251

Revision: 2021-03

www.dnv.com

Page 1 of 3



Job Id: 262.1-030658-2
 Certificate No: TAA00002X2
 Revision No: 1

Product description

Turbidity Sensors TTurb 100, TTurb 400 and TTurb 1000

| | |
|-------------------------|---|
| Measurement technology: | LED light source Photodiode detector |
| Measurement principle | Nephelometry |
| Parameters | Turbidity as FNU; mg/L; NTU; TSSeq |
| Measuring range | 0...100, 0...400, 0...1000 FNU |
| Measurement accuracy | ± (5 % + 0.5); max. ±2 FNU |
| Detection limit | 0.5 FNU for TTurb 100 2 FNU for TTurb 400 and TTurb 1000 |
| Measurement wavelength | 860 nm, FWHM 30 nm |
| Reaction time T100 | 6 s |
| Measurement interval | ≥ 3 s |
| Interface | Ethernet (TCP/IP) RS-485 (Modbus RTU) |
| Power Supply | 12...24 VDC (± 10 %) |
| Connection | 8-pin M12 plug |

Application/Limitation

The Type Approval covers hardware listed under Product description. When the hardware is used in applications to be classed by DNV, documentation for the actual application is to be submitted for approval by the manufacturer of the application system in each case. Reference is made to DNV rules for classification of ships Pt.4 Ch.9 Control and monitoring systems.

The "TTurb" is found to be in compliance with the requirements of Resolution MEPC.259(68) – "2015 Guidelines for exhaust gas cleaning systems", Chapter 10.2 "Washwater monitoring" as well as Resolution MEPC.340(77) – "2021 Guidelines for exhaust gas cleaning systems", Chapter 10.2 "Discharge water monitoring"

The Trios turbidity sensor TTurb meets the following requirements:

- Permission deviation of the Turbidity monitoring equipment (MEPC.340(77), 10.2.2)
- Principle of detection for Turbidity MEPC.259(68), 10.2.5 and MEPC.340(77), 10.2.6)

Product certificate

If specified in the Rules, ref. Pt.4 Ch.9 Sec.1, the control and monitoring system in which the above listed hardware is used shall be delivered with a product certificate. For each such delivery the certification test is to be performed at the manufacturer of the application system before the system is shipped to the yard. The test shall be done according to an approved test program.

Tests carried out

Applicable Tests according to DNV CG-0339, August 2021

Marking of product

Maker, type designation, serial number.

Periodical assessment

The scope of the periodical assessment is to verify that the conditions stipulated for the type are complied with, and that no alterations are made to the product design or choice of systems, software versions, components and/or materials.

The main elements of the assessment are:

- Ensure that type approved documentation is available
- Inspection of factory samples, selected at random from the production line (where practicable)
- Review of production and inspection routines, including test records from product sample tests and control routines
- Ensuring that systems, software versions, components and/or materials used comply with type approved documents and/or referenced system, software, component and material specifications
- Review of possible changes in design of systems, software versions, components, materials and/or performance, and make sure that such changes do not affect the type approval given
- Ensuring traceability between manufacturer's product type marking and the type approval certificate



Job Id: **262.1-030658-2**
Certificate No: **TAA00002X2**
Revision No: **1**

Periodical assessment is to be performed after 2 years and after 3.5 years. A renewal assessment will be performed at renewal of the certificate.

END OF CERTIFICATE

13.3 Modbus RTU

Software version

This Modbus protocol refers to software version 1.0.7 and higher.

Serial interface

On delivery, the RS485 serial interface is configured with the following settings (9600, 8N1):

- 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 - 0xFFFFFFFF |
| Float | 2 | IEEE 754 32-bit floating point number |
| Char[n] | $\lceil \frac{n}{2} \rceil$ | 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

The sensor supports the following Modbus functions:

| Name | Code | Description / Use |
|--------------------------|------|---|
| Read multiple registers | 0x03 | Read write configuration and calibration, configuration, calibration and measurement data |
| Write multiple registers | 0x10 | Write configuration and calibration |
| Write single register | 0x06 | Write configuration and calibration |
| Report slave ID | 0x11 | Read serial number and write configuration and calibration |

Standard Modbus server address

On delivery, the sensor is set to address 40 (0x28).

Access restrictions

The R/W column describes the access restrictions for the registers. "R" can be read (0x03), "W" can be written (0x10).

| Letter | Letter Description |
|--------|-----------------------|
| R | Read access only |
| R/W | Read and write access |

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

The registers contain the following values:

| Designation | R/W | Address | Data type | Data type Description |
|--------------------------------------|-----|---------|-----------|---|
| Modbus slave ID | R/W | 0 | Uint16 | The Modbus server address of the sensor. |
| Measurement time-out | R | 1 | Uint16 | The time in [10-1 s] that the currently active measurement process will continue |
| Device serial number | R | 10 | Char[10] | The serial number of the TTurb sensor |
| Firmware version | R | 15 | Char[10] | The version number of the installed firmware |
| Subtype | R | 20 | Char[10] | Maximum measured value range (100; 400; 1000) |
| Self-trigger activated | R/W | 100 | Bool | Indicates whether the sensor is switched to automatic mode. |
| Self-trigger interval | R/W | 101 | Uint32 | The measuring interval in [s] for automatic mode. Adjustable range: 1s - 86400s. |
| Moving average | R | 103 | Uint16 | Number of measured values for calculation of the concentration Value range: 1 - 300. |
| 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" |
| Allow negative values | R/W | 139 | Bool | Activates or deactivates the clipping of negative measured values to zero. |
| Parameter Index for offset / scaling | R/W | 400 | Uint16 | By setting the parameter index, an offset or scaling factor can be set for the selected parameter. The parameter list is shown in this document and starts at address 1000 (e.g. 0x0000 for turbidity (FNU), 0x0001 for turbidity (mg/L)). |
| Activate offset / scaling | R/W | 401 | Bool | Activates or deactivates post-processing. For the selected parameter, starting at Modbus address 400. |

| Designation | R/W | Address | Data type | Data type Description |
|---|-----|-------------|-----------|---|
| Offset | R/W | 402 | Float | Parameter offset. Formula: scaled = (raw - off-set) * scaling |
| scaling | R/W | 404 | Float | Scaling factor. Formula: scaled = (raw - offset) * scaling |
| Moving Average | R/W | Uint32 | | Number of individual measurements to be averaged for a measurement. Adjustable range: 1 - 25. |
| Turbidity (FNU) concentration / scaled concentration | R | 1000 / 1500 | Float | Concentration of turbidity in FNU / post-processed concentration |
| Turbidity (mg/l) concentration / scaled concentration | R | 1002 / 1502 | Float | Turbidity concentration in mg/L / post-processed concentration |
| Turbidity NTU concentration / scaled concentration | R | 1004 / 1504 | Float | Turbidity concentration in NTU / post-processed concentration |
| TSS _{eq} mg/L concentration / scaled concentration | R | 1014 / 1514 | Float | Concentration of TSSeq in mg/L / post-processed concentration |
| Temperature LED | R | 1412 | Float | Temperature of the LED PCB board |
| FSM Control | R/W | 5000 | Uint16 | Finite-state machine control register. |
| FSM parameters | R/W | 5001 | Uint16 | The parameter to be used in the FSM. |
| FSM status | R | 5002 | Uint16 | Status of the FSM |
| Permanent errors | R | 5003 | Uint16 | Number of permanent errors. The error messages are explained in the "ErrorBits" table at the end. |
| Temporary errors | R | 5004 | Uint16 | Number of temporary errors. The temporary errors are explained in the "ErrorBits" table at the end. |
| Permanent warnings | R | 5005 | Uint16 | Number of permanent warnings. The warnings are explained in the "ErrorBits" table at the end. |
| Temporary warnings | R | 5006 | Uint16 | Number of temporary warnings. The temporary warnings are explained in the "ErrorBits" table at the end. |
| Calibration Control | R | 6000 | Uint16 | Reset all parameters: 0x0001: Manufacturer calibration 0x0002: Last calibration |
| Factory calibration parameters | R | 6001 | Uint16 | Reserved (set to 0x0000) |

| Designation | R/W | Address | Data type | Data type Description |
|---------------------------------|-----|---------|-----------|--|
| Factory calibration - offset | R | 6002 | Float | Offset of the factory calibration |
| Factory calibration - Scaling | R | 6004 | Float | Slope of the factory calibration |
| Factory calibration - Square | R | 6006 | Float | Square factor of the factory calibration |
| Factory calibration - Timestamp | R | 6008 | Uint32 | Time of the factory calibration |
| Active calibration - Parameter | R | 6010 | Uint16 | Reserved (set to 0x0000) |
| Active calibration - Offset | R | 6011 | Float | Offset of the active calibration. |
| Active calibration - Scaling | R | 6013 | Float | Slope of the active calibration. |
| Active calibration - Square | R | 6015 | Float | Square factor of the active calibration. |
| Active calibration - Timestamp | R | 6017 | Uint32 | Time of the active calibration. |
| Last calibration - parameter | R | 6019 | Uint16 | Reserved (set to 0x0000) |
| Last calibration - offset | R | 6020 | Float | Offset of the last calibration. |
| Last calibration - Scaling | R | 6022 | Float | Slope of the last calibration. |
| Last calibration - Square | R | 6024 | Float | Square factor of the last calibration. |
| Last calibration - Timestamp | R | 6026 | Uint32 | Time of the last calibration. |

Write single register (0x06)

Writing a value other than false (0x0000) to a coil / register of the following address triggers the action listed below.

| Designation | Address | Address Description |
|---------------------|---------|-----------------------------------|
| Trigger measurement | 1 | A single measurement is recorded. |

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:

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|------|---|---|---|---|---|------|---|---|---|---|---|---|---|---|------|---|---|---|---|---|------|
| T | r | i | O | S | 0x00 | T | T | u | r | b | 0x00 | 0 | 7 | 0 | 0 | 0 | 0 | 2 | 0 | 0x00 | 1 | . | 0 | . | 7 | 0x00 |
|---|---|---|---|---|------|---|---|---|---|---|------|---|---|---|---|---|---|---|---|------|---|---|---|---|---|------|

NOTICE

The configuration registers should be written to as infrequently as possible and in particular not in every measurement cycle, as otherwise the flash memory may be damaged.

ErrorBits

| | Bit Nr. | Gerätetreiber-beschreibung | Beschreibung |
|-------------------|---------|----------------------------|--|
| Permanent Error | 0 | REF_OVERFLOW | Reference Overflow Error during Reference Light measurement I.e, this bit is set (and never cleared) if during a regular measurement RawRefLight is greater than 32500. |
| | 1 | REF_UNDERFLOW | Not implemented |
| Temporary Error | 4 | FSM_STATE | FSM State General Error (set when the state machine – which should not be possible – enters an unknown invalid state) |
| | 5 | FSM_TRANSITION | FSM Transition Error (invalid transition step) |
| | 6 | FSM_AUTHENTICATION | FSM Authentication Error (no authentication for secured actions (e.g. writing a manufacturer calibration)) |
| | 8 | FSM1_PARAMETER_METHOD | FSM1 Parameter Method Error (unsupported calibration method) |
| | 9 | FSM1_CALCULATE | FSM1 Calculate Error (calibration parameter could not be calculated) (Not enough measurement points were taken for a calibration, e.g only 2 points for a square calibration). |
| Permanent Warning | 0 | CAL_OVERFLOW | With current calibration coefficients, the measuring range of the sensor can no longer be fully covered. This bit is only set or cleared during a calibration process using the internal state machine |
| Temporary Warning | 0 | SIG_OVERFLOW | Signal Overflow Warning during Signal Light measurement. I.e, this bit is set if during a regular measurement, if RawSigLight is greater than 32500, and cleared if its smaller or equal. |

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