TriOS
Optical Sensors

TW Turb

OPERATING INSTRUCTIONS

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1 General information

Welcome to TriOS.

We are delighted that you have chosen a device from our TW Master series, the TW Turb nephelometric turbidity sensor.

The TW Turb is based on the physical measurement method of 90° infrared scattering and measures turbidity in Formazine Nephelometric Units (FNU) or Nephelometric Turbidity Units (NTU), depending on the settings of the sensor. This sensor is used in drinking water applications or other low turbidity applications.

The sensor stores calibrations internally. This allows a “plug and play” system without recalibration if the location or transmitter is changed.

In this manual you will find all the information about TW Turb that you need for commissioning. Technical specifications, 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 software version 3.0.0. and higher. Updates include bug fixes and new functions and options. Devices with older software versions may not have all the functions described here.

Copyright notice

1.1 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.

Reagents

Follow the manufacturer's safety and operating instructions when using reagents. Observe the applicable Hazardous Substances Ordinance 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.

1.2 Warnings

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.

⚠ DANGER

This product is not suitable for use in potentially explosive atmospheres.

Further notes:

- The material resistance should be tested for each application.
- Do not cut, damage or modify the cables. Ensure that there are no heavy objects on the cables and that the cables do not kink. Ensure that the cables do not run close to hot surfaces.
- If a cable is damaged, it must be replaced with an original part by TriOS Mess- und Datentechnik GmbH customer support.
- Stop operation of the sensor if excessive heat is generated (i.e. more than lukewarm). Switch the sensor off immediately. 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.
- TriOS Mess- und Datentechnik GmbH devices 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.

1.3 User and operating requirements

The TW Turb was developed for use in industry and science. The target group for operating the TW Turb 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.

1.4 Intended use

The TW Turb sensor is intended exclusively for measuring turbidity in aqueous solutions with a pH range of 5-9, as described in these instructions. The TW Turb is operated in flow mode and can be used together with other devices from the TW Master series. 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 applications:

- Monitoring drinking water and groundwater
- Monitoring of surface water

Use in other media can damage the sensor. If the TW Turb sensor is to be used in media other than those specified in these instructions, please contact the technical support team at TriOS Mess- und Datentechnik GmbH (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.

1.5 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

1.6 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

The TW Turb is a sensor from the TW Master series. TW Turb is a turbidity sensor for nephelometric measurements in the infrared range. The sensor is available in various measuring ranges and as a white light version.

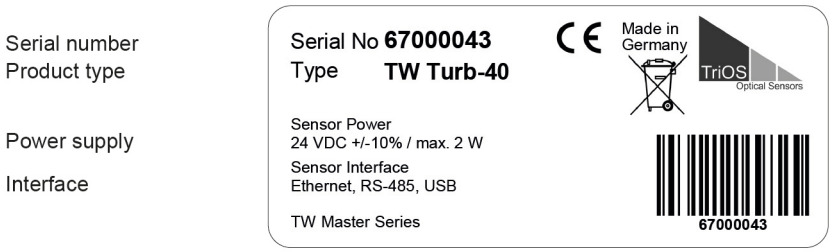
The modular design of the TW Master series makes it easy to expand the measuring system with sensors that exactly meet the requirements of your application. All devices in the TW Master series can be installed in a series (up to 3 devices) and analyze the desired parameters in just one bypass installation.

2.1 Product identification

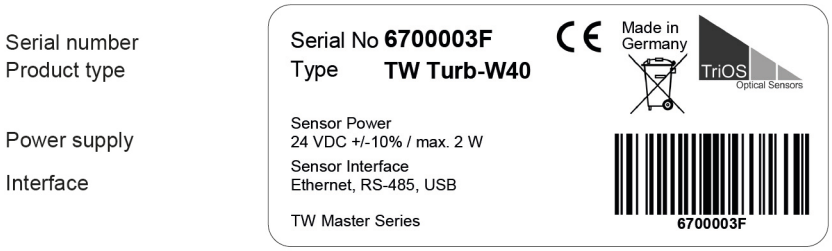
All TriOS Mess- und Datentechnik GmbH products are provided with a product label that clearly shows the product designation.

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

TW Turb-40



TW Turb-W40



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:

- Controller and display module
- Flow module
- Connection plate set
- PVC hose, 30 cm
- Connection hose, black, 10 m
- Accessories (if applicable)
- Allen key, 6 mm
- Operating instructions

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

2.3 Measuring principle and design

The TW Turb sensor is designed for measuring turbidity in aqueous solutions.

The unit has a removable display module with integrated sensor and flow cell with exchangeable windows (left in the picture) and a flow module (right in the picture).

The sensor measures according to the nephelometric principle of 90° infrared scattering. The scattering intensity measured by the detector, which is positioned at a 90° angle to the light source, can be used to precisely determine the turbidity of a liquid.

The measured value can be displayed in FNU or NTU. Formazine and AMCO CLEAR® are used internationally as standards for the calibration of turbidity sensors and make them comparable with each other.

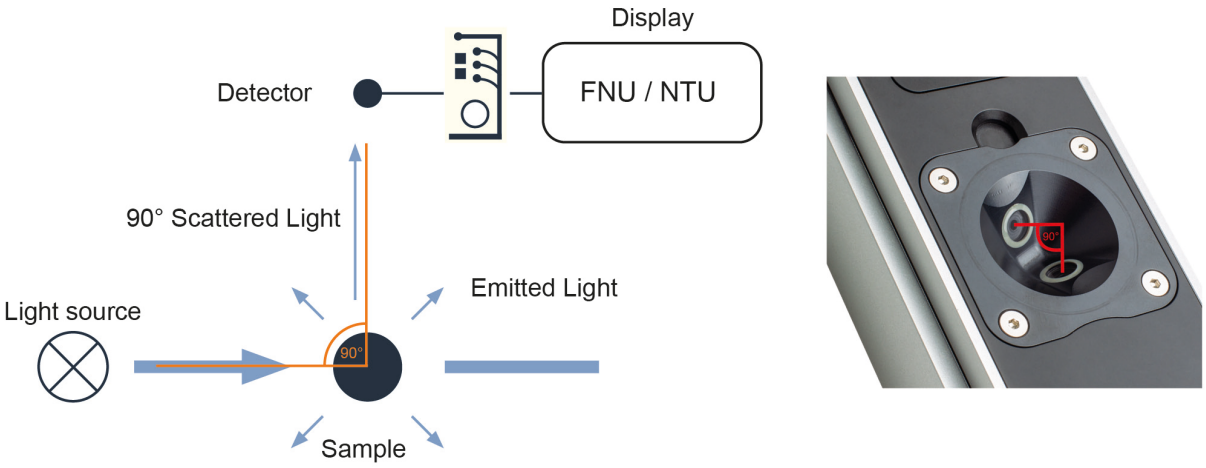
FNU = Formazine Nephelometric Units (nephelometric units of formazine). This unit is used in accordance with the ISO 7027 standard.

NTU = Nephelometric Turbidity Unit (nephelometric turbidity value). This unit is used in accordance with USEPA Method 180.1.

The TW Turb-40 is equipped with an infrared light source that emits light at a main wavelength of 860 nm. The detector has a high sensitivity at 860 nm.

The TW Turb-W40 uses a white light source and has a detector with a spectral peak sensitivity between 400 nm and 600 nm.

Principle of the 90° scattered light method



Measurement characteristics

Measurement parameters: Turbidity in FNU or NTU

Turbidity [FNU] or Turbidity [NTU]

- **Processed value**
- Takes into account offset, scaling and averaging of the post-processing

Turbidity RAW [FNU] or Turbidity RAW [NTU]

- **Unprocessed value**
- Turbidity RAW

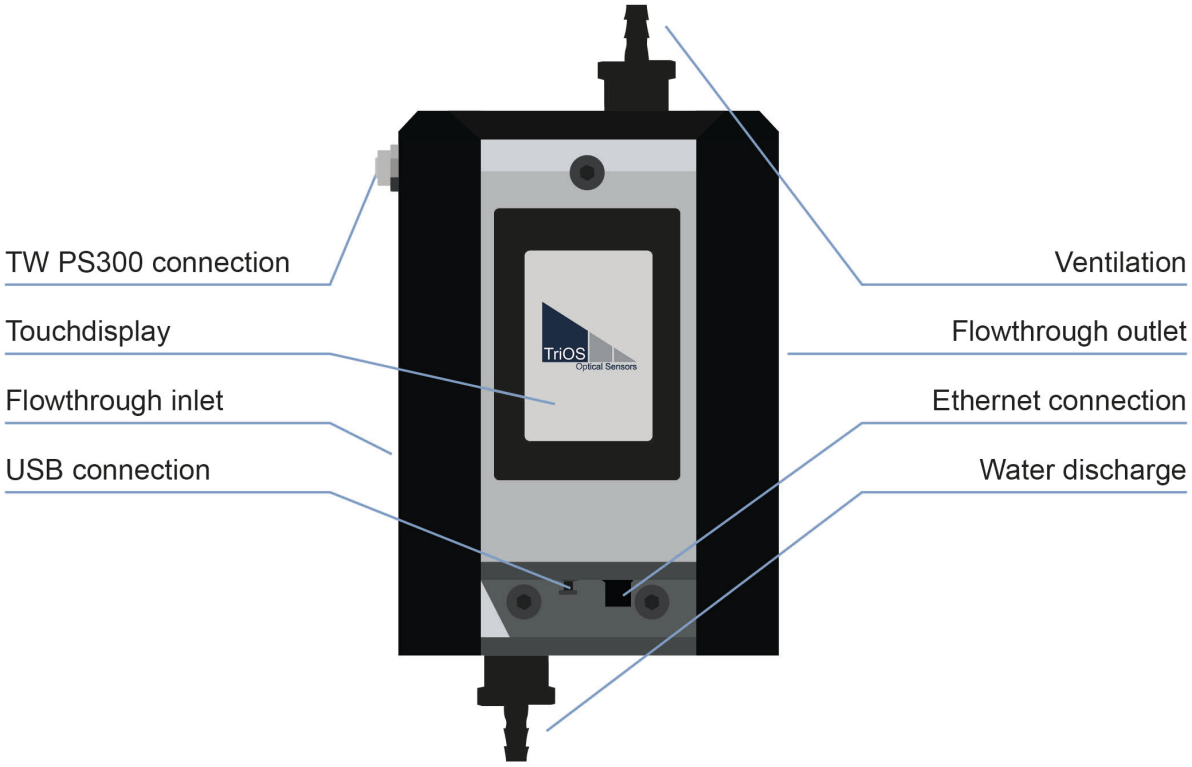
Measuring behavior

The TW Turb measures continuously. By selecting the storage interval (see chapter 3 Commissioning), the user can specify the frequency with which measurement data should be saved. The smallest storage interval is 5 s.

In addition, the user can set a further averaging over a defined time interval (see chapter 3 Commissioning) in order to smooth the measured values and eliminate measured value outliers caused by the brief occurrence of air bubbles.

2.4 Sensor operation

The capacitive touch display can be operated by touching or lightly tapping it with bare fingers or a special stylus.



NOTICE

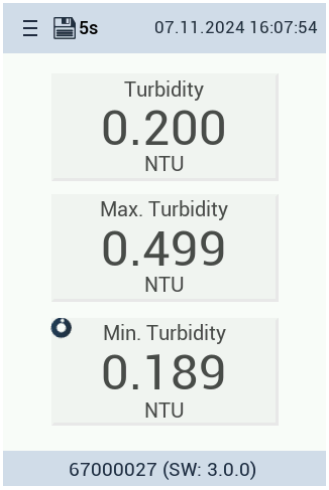
The use of sharp or pointed objects when operating the touch display can cause damage to the display.

2.4.1 Start screen

The TW Turb start screen shows the measured values of the respective parameter. The daily maximum, the daily minimum and the current value are displayed.

Menu

Values



Date and time

Firmware version of the sensor

Main menu

Click on the menu symbol (the triple menu bar) at the top left of the display to open the main menu of the TW Turb:

Main menu

2.4.2 Menu buttons / Functions

This button takes you to the sensor **calibration screen**. A detailed description of calibration can be found in chapter 5 of this manual.

This button leads to the settings of the **analog output screen** of the sensor. The measured value can be output via one of the six 4...20 mA outputs in the TW PS300 power supply unit. The configuration of the analog output is described in chapters 3 and 4 of this manual.

This button takes you to the sensor **cleaning screen**.
A detailed description can be found in chapter 4 of this manual.

This button takes you to the screen for **setting the storage interval**.
A detailed description can be found in chapter 4 of this manual.

This button takes you to the sensor **data export** screen.
Data exports are necessary if you have problems with the measurements.
A detailed description can be found in Chapter 6 of this manual.

This button takes you to the screen for **updating the** sensor's **firmware**. A firmware update is provided to improve measurements or to correct errors.

This button takes you to the sensor's **network settings** screen. If the sensor is to be integrated into a system, settings can be adjusted here. A detailed description can be found in chapter 6.

This button takes you to the sensor's **alarm and relay settings** screen. Threshold values for the alarm or the activation of relays can be set in the submenu. A detailed description can be found in Chapter 4 of this manual.

This button takes you to the sensor's **password settings** screen. You can set a password to restrict access to the sensor.
A detailed description can be found in chapter 6 of this manual.

This button takes you to the sensor's **display settings** screen.
A detailed description can be found in chapter 4 of this manual.

This button takes you to the sensor's **main settings screen**. Language and time can be set. English, French and German are currently available. A detailed description can be found in chapter 4 of this manual.

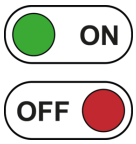
This button takes you to the sensor's **energy settings** screen. This button is used to access **maintenance mode**.
A detailed description can be found in chapter 4.

This button takes you to the sensor's **measurement interval screen**.
A detailed description can be found in Chapter 4 of this manual.

This button allows you to edit texts and numbers if required.

This button allows you to approve changes.

You can use this button to reject changes.



You can use this interactive button to switch functions on or off.

3 Commissioning

This chapter deals with commissioning 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 Hydraulic connection

The sensor (when sold as a single unit) is supplied with connection plates that have plug-in connections for hoses with an outer diameter of 10 mm.

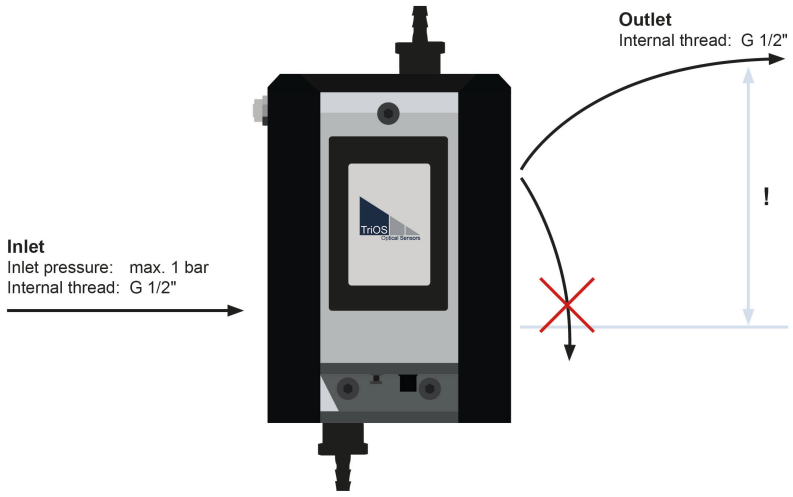
Hose to be used with these connectors must be suitable for this use (externally calibrated and tight enough)! TriOS offers these two solutions:

65A000022	TW Master connection hose black 5 m
02A110000	PUR hose 10-8 black 10 m
02A110001	PUR hose 10-8 black 25 m

NOTICE

Not every conventional hose with an outer diameter of 10 mm can be used!

Hydraulic connection diagram



Make sure that the drain hose is not installed hanging downwards, as this can create suction in the outflowing water, which causes negative pressure in the sensor. This favors the outgassing of the sample and significantly influences the measurement!

If the measured values indicate that there is still a negative pressure in the cell and the sample is outgassing too much, a baffle plate can be inserted into the outlet connection plate to reduce the line cross-section and thus reduce the pressure drop.

Alternatively, a tap or throttle can be fitted in the outlet to increase the pressure in the measuring cell. In this case, however, it is essential to ensure that the pressure in the cell does not exceed 1 bar, e.g. by installing a pressure reducer.

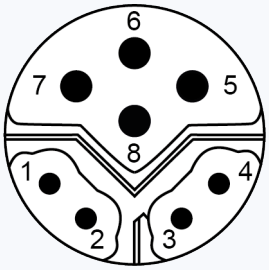
3.2 Electrical installation

The power supply is ensured by the M12 hybrid cable included in the scope of delivery.

> ***NOTICE***
>
> **Before connecting the TW Turb to the TW PS300, make sure that the power supply is switched off.**

Please use the contacts provided in the TW PS300 for the Modbus connection or analog outputs. Further information on the connection can be found in the TW PS300 operating instructions.

3.2.1 M12 hybrid industrial connector



pi	color	Function
1	White/ Orange	RS-485 A
2	Orange	RS-485 B
3	White/ Green	Do not connect
4	Green	Do not connect
5	Blue	Do not connect
6	White	Do not connect
7	Brown	+24 VDC
8	black	GND / Ground

The sensor is ready for commissioning as soon as the installation of the accessories has been completed (supply lines, down conductors), it is connected to the TW PS300 and the necessary configuration has been completed.

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

3.3 Interfaces

3.3.1 Serial interface

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

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

Please use the contacts provided in the TW PS300 for the Modbus connection. Further information on the connection can be found in the TW PS300 operating instructions.

3.3.2 Analog output

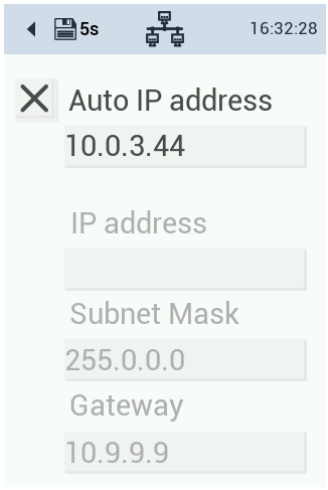
The TW Turb can be used to control the analog 4...20 mA outputs of the TW PS300. To set it up, please connect your system to a TW PS300 with integrated analog outputs.

Configuration is carried out via the corresponding display. The desired output number (1 to 6) can be selected and the measured value can be scaled.

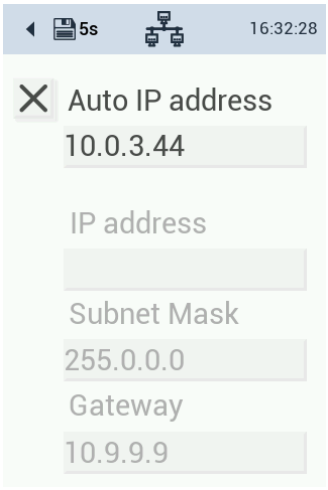
See chapter 4.2 Setup and configuration.

3.3.3 Ethernet interface

It is possible to read and control the TW Turb directly via Modbus TCP. You can make the network settings yourself. To do this, tap on the relevant line and enter the corresponding numbers. If the “Auto IP address” box is checked, a connected DHCP server (e.g. router) assigns the IP address:



IP address is configured manually



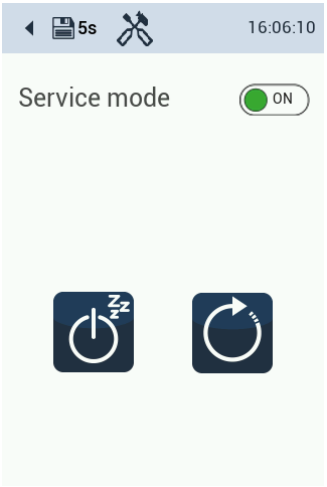
IP address is assigned by the DHCP server

4 Application

4.1 Setup and configuration

Maintenance mode

Maintenance mode should always be activated if configuration changes are required. To activate it, click on the power switch and switch on maintenance mode.
The tool symbol at the top of the display indicates that maintenance mode is activated.



Language, date and time

The date and time must be set in order to adapt to the local time zones.
To change the language, drag the country flags to the left or right. To set the date and time, click and drag the window and swipe up or down.

Setting the display

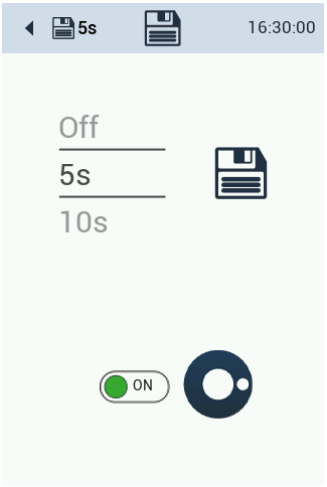
The brightness of the display can be adjusted to the local conditions.
To do this, swipe the cursor back and forth between the two settings (dark - light).

The display can also be switched off after 60 minutes to save power (auto sleep). It switches on again automatically as soon as you touch the screen.

Saving

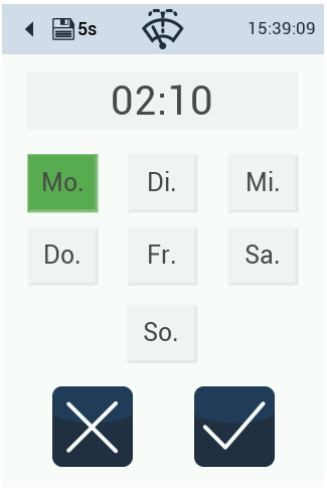
Saving the measurement data can be switched off by tapping “Off”.

Measurement can be switched off by pressing the “ON / OFF” button. Corresponding warning symbols appear on the main screen. The last value is saved.

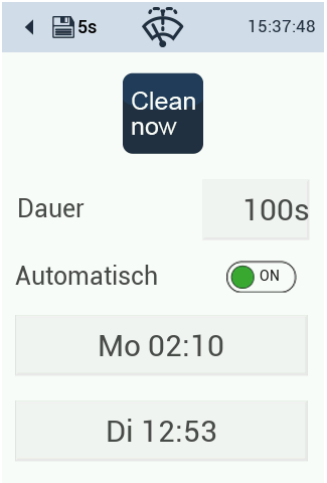


Cleaning interval

Two cleaning times can be configured, which are repeated on an adjustable number of days per week.

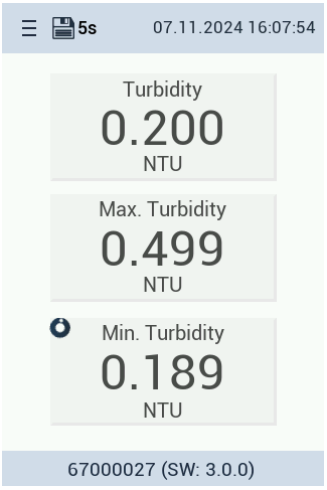


When activated by the interactive switch, the field turns green and shows “ON”.

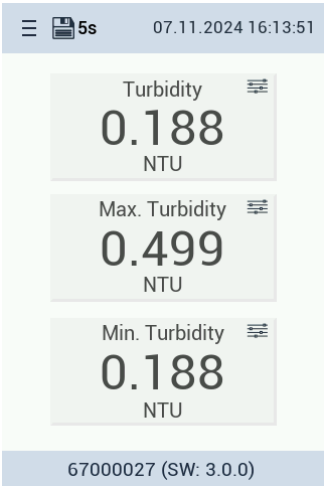


Display and configuration of the measured values

The measured value display is configured by clicking on the upper measured value field and the unit (FNU / NTU) can be changed. This change is also applied to the alarm settings.

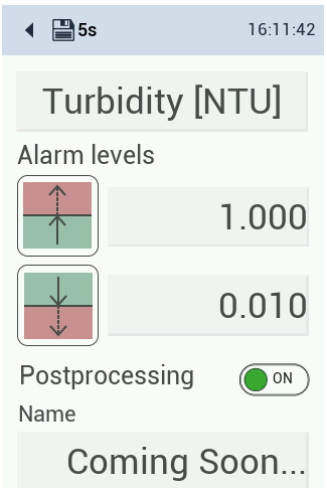


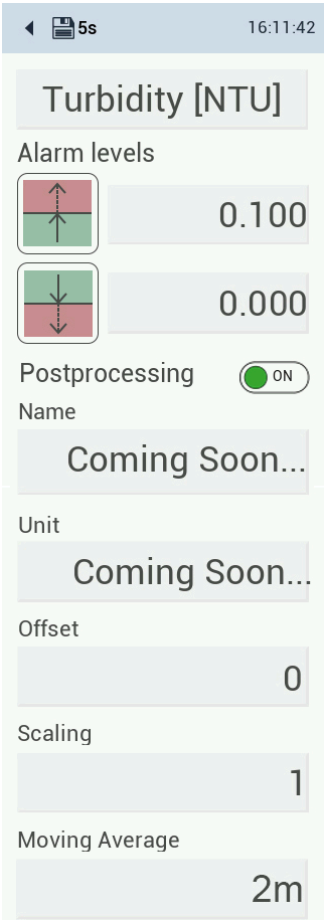
The display shows the serial number and the current software version at the bottom of the display. If post-processing is activated, the symbol appears at the top right of the measurement field.



Post-processing

It may be necessary to adapt the measurement results to the local conditions. To check whether this is necessary, analyze a water sample in the laboratory. The difference between the laboratory result and the measurement result of the TW Turb can be calculated. The scaling can be edited in the submenu of the main display.
Activate or deactivate the box for post-processing. This does not change the factory or customer calibration.
The post-processed measurement result is shown on the display. If you want to read out this value via Modbus, query register 1500.
The post-processed value is used for the analog output.
The name and unit of the post-processing cannot be edited at the moment. (Software version 3.0.0)





The unit can be changed between FNU and NTU in the upper button.

Alarm levels can be defined for the measured value. If the value is higher than the maximum or lower than the minimum threshold value, the background of the value turns red. If the set threshold values are met, the colored marking of the value disappears.

Interactive switch to green = post-processing on

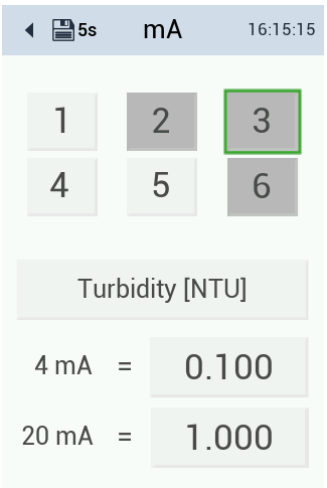
The “Offset” field can be edited by tapping it.

The scaling factor can be edited by tapping it.

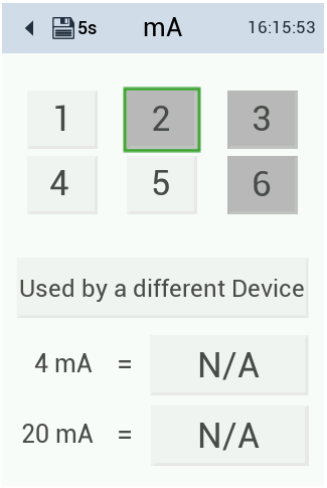
To prevent turbidity fluctuations from immediately activating an alarm, the measured value can be displayed as a moving average. Various times from 30 s to one hour (1h) can be selected for this.
(2m = 2 minutes)

Configuration of the analog outputs

There are 6 analog outputs available. Each output can be configured separately. Switch between the analog outputs and set the values for 4 mA and 20 mA. Check the box to activate the analog output.



The analog output being configured is outlined in green. Outputs that are occupied are highlighted in gray. Outputs assigned by another device must first be enabled before they can be assigned again.

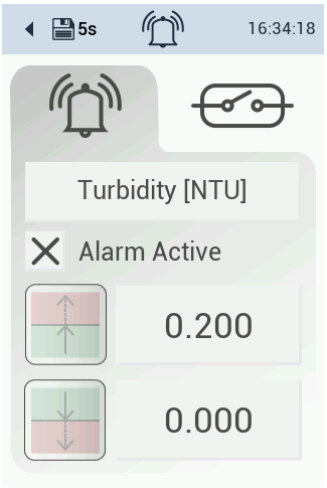


Alarm and relay functions

The TW Turb offers an alarm and relay output via the TW PS300. For setup, please connect your system to the relay and buzzer output interface of the TW PS300 (chapter 2.3 of the TW PS300 manual).

The buzzer and relay output is configured via the TW Turb display. The alarm values can be set by clicking on the measured value fields.

The alarm triggers a buzzer in the TW PS300 when it is activated. The alarm sounds if the measured value is above the upper limit value 5 times in succession and is deactivated if the measured value is within the range 5 times in succession.



The relay can be set in the same way. To change the values, click on the values. To activate the functions, click on the checkbox.

4.2 Bypass installation

TW Turb can only be used as a bypass installation. The 10 mm hose is supplied with the system.

When the power cable is connected, the sensor is powered up. This can take up to one minute. The screen will remain black in the meantime.

4.3 Connecting plate with RGB LED

An RGB LED is connected to 3 GPIO connections (General Purpose Input/Output), which is used to signal the status of the loop. Here (R, G, B) = (PB10, PB11, PA12).

LED	LED Description
Green permanent	Normal operation, loop closed and confirmed
Red flashing	Loop is open
Flashing blue	Loop closed and waiting for confirmation
Flashing green	Loop released and waiting for voltage stabilization

In the bootloader, the LED flashes red and blue alternately and at the end of a firmware update it flashes red or green for a short period, depending on whether the update process was successful or not.

4.4 Notes on installation

When using several TW master devices in a bypass installation, care must be taken to ensure that all devices have the same software package version.

The current software package can be installed on the devices using a USB stick (see chapter 6).

5 Calibration

5.1 Manufacturer calibration

Calibration of the scaling

The scaling is determined with a 32 FNU formazine or polymer solution based on styrene-divinylbenzene.

An offset calibration adapted to the measuring window is carried out with filtered ultrapure water in accordance with DVGW 213-6.

5.2 Customer calibration

The sensor can be recalibrated during operation with a one-point calibration for scaling. The factory calibration remains untouched. The calibrated value is calculated internally.

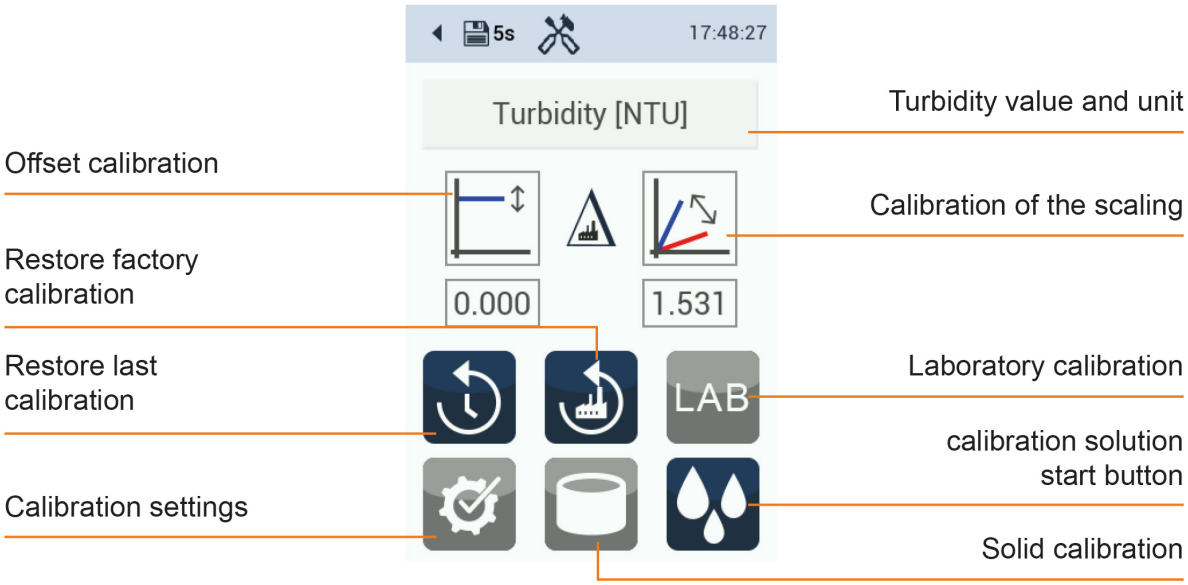
NOTICE

The values used are random and do not represent real data.

NOTICE

Only a customer calibration of the scaling is possible for TW Turb (no offset).

After calibration, it is recommended to compare the measured value with a known concentration to check the success of the calibration. Incorrect calibration always leads to incorrect measured values. The scaling should be between 0.5 and 2.



The grayed-out function buttons are not yet available in this software version 3.0.0.

5.2.1 TW Turb calibration set

Compatible with

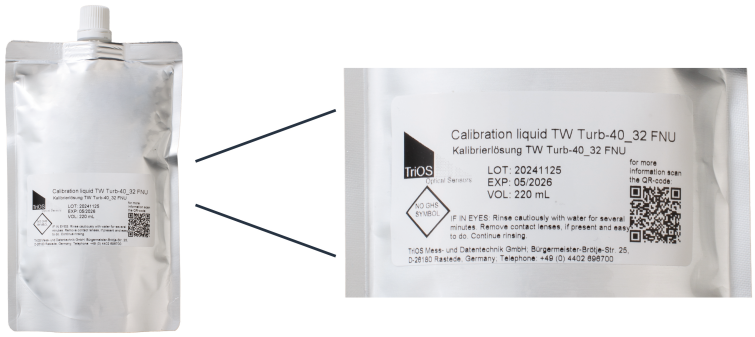
- TW Turb 40

Contents (sufficient for 3 applications - one bag for rinsing and one bag for measurement)

- 6 bags filled with 220 ml calibration solution based on styrene-divinylbenzene copolymer
- Turbidity values: for TW Turb-40: 32 FNU
- Tube
- Hose clamp
- Adapter for flow cell connection

Additional material required:

- Cleaning kit from TriOS with optical paper and isopropanol bottle. The bottle must be filled with isopropanol by the user.
- Alternatively: soft cloth and lint-free paper (possibly kitchen paper), spirit or isopropanol
- Collecting container for used calibration solution
- Cleaning brush



The first filling of the measuring cell with calibration solution is used for rinsing, the calibration is carried out with the second filling.

5.2.2 Preparing the calibration

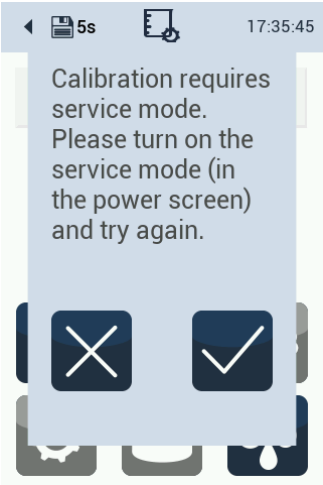
- Set the system to maintenance mode *
- Close the inlet (important: when using the cleaning panel, be sure to close the main inlet)
- Close the drain
- Position the collection vessel under the drain and open the drain valve
- Open the ventilation
- Drain the water from the measuring cell
- If another measuring cell is connected to the TW Turb, drain this cell as well
- Remove the hose from the inlet adapter
- Dismantle the TW Turb sensor module

Dismantling the sensor module

Loosen the Allen screws (quarter turn)

Remove the sensor module

- Clean the window with optical paper and isopropanol or spirit
- Polish the window with a dry cloth
- Wipe out / wipe dry the cell
- Clean dirty flow cells with clear water (using a brush if necessary) and wipe dry
- Refit the TW Turb sensor module. The sensor starts again



*If the maintenance mode has not been activated after you have clicked on the calibration button, the adjacent message appears.
Confirm this information and activate the mode as described in the section “Setup and configuration”.

NOTICE

During the calibration process, the sensor displays measured values with factory calibration (in the calibration menu).

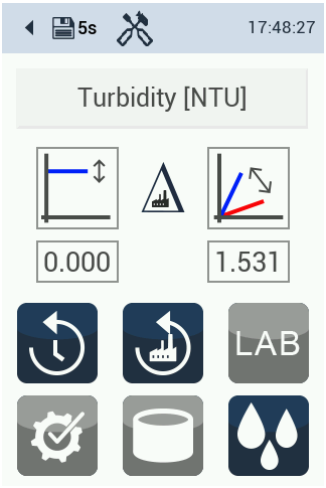
Rinsing with calibration solution

- Activate maintenance mode again
- Unscrew the lid from the calibration bag
- Screw on the hose
- Place the hose clamp on the end of the adapter for the flow cell
- Press the calibration solution up to the end of the hose and close the hose clamp
- Hang the calibration bag in the device (alternatively hold it in your hand), see illustration below
- Insert the hose adapter into the inlet of the flow cell
- Attention: The ventilation on the TW Turb must be open
- Open the hose clamp
- The calibration solution now flows into the measuring cell
- As soon as calibration solution emerges from the aeration, close the valve and close the hose clamp
- If another cell is connected to the TW Turb module, excess calibration solution flows into the neighboring cell as overflow. The drain should then be opened so that the excess solution can drain into a waste container.
- Alternatively, the calibration bag can be held below the inlet and the calibration solution slowly pressed into the measuring cell by rolling up the bag. This can be advantageous for very low turbidity values.
- After a reaction time of approx. 5 minutes, drain the calibration solution via the TW Turb outlet into a collection container and dispose of it in accordance with official regulations (see safety data sheet).

Calibration bag suspended in device

5.2.3 Carrying out the calibration

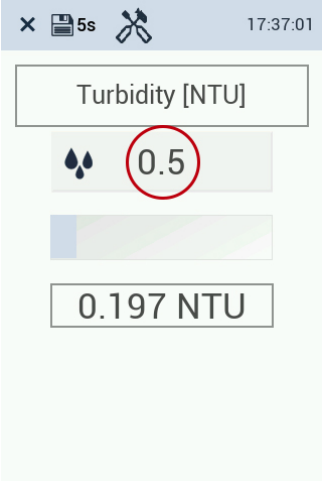
Start



After setting the maintenance mode, the process is started by pressing the highlighted button (calibration).

Calibration procedure

- Refill the cell with calibration solution as described in "Rinsing with calibration solution" (2nd calibration bag)
- The calibration solution must stabilize in the measuring cell for 5 to 10 minutes, only then can the calibration be started
- Perform the calibration after a minimum of 5 minutes and a maximum of 10 minutes waiting time



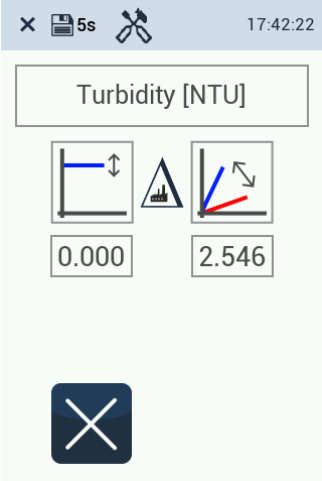
The stabilization phase starts.
The displayed turbidity values are calculated with the factory calibration (not with the last customer calibration). Post-processing is not taken into account at this point.

The turbidity value of the calibration solution (e.g. formazine solution) is entered in the marked field (see label on the calibration kit bag).

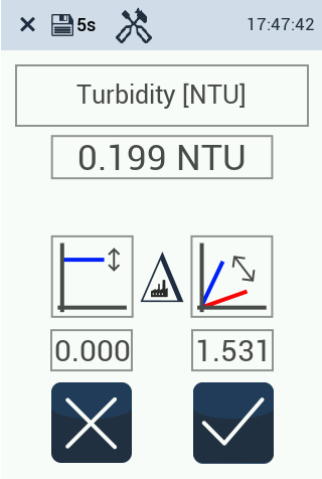
The sensor now begins to stabilize the value. When the sensor is ready, click on the “Play” button. The sensor starts the calibration process.

Check calibration

When the calibration is complete, the arrow at the bottom right of the display is activated. Click on this button to check the calibration.



If the calibration was not successful because the deviation is too high, the “Approve” button does not appear.
Press the cross and carry out the calibration again if necessary.



If the calibration was successful, it can be accepted, completed and saved in the sensor by pressing the tick.
The new scaling factor may deviate from the factory calibration within a range of 0.5 to 2.

Resetting the calibration

If necessary, you can reset to the last (successful) calibration.

This button resets to the factory calibration. The reset must be confirmed with a tick.

End calibration

- At the end of the calibration process, drain the calibration solution into a collection container and dispose of it in accordance with official regulations (see safety data sheet)
- Close the ventilation and drain valves
- Remove the hose of the calibration bag from the inlet adapter
- Refit the inlet hose of the system in the inlet adapter
- Open the inlet and outlet
- End maintenance mode
- Put the system back into operation

6 Malfunction and maintenance

Interference parameters

Possible interference of the measurement signal due to finely distributed air bubbles: If the measurement signal does not meet expectations, air bubbles may be the cause.

This can usually be remedied by increasing the pressure in the measuring cell to 0.2 to 1 bar.

Pressure can be generated by a tap at the outlet. It is essential to ensure that the pressure in the cell does not exceed 1 bar! A pressure reducer in the inlet is highly recommended.

If necessary, increasing the flow rate can also generate sufficient overpressure in the cell so that no tap is required at the outlet.

NOTICE

Under no circumstances should the outlet of the measuring medium generate a negative pressure in the measuring cell! This is often the case if the drain hose is routed downwards into a sink and the flow rate is not sufficient to generate an overpressure in the cell.

Influence of real color with TW Turb white light

With TW Turb-W40, coloration of the measuring solution can influence the measuring signal. The presence of true color, i.e. the color of the water, which is due to dissolved, light-absorbing substances, can lead to reduced turbidity values. However, this effect is generally not significant in treated water.

The light from a white light source is partially absorbed by colored solutions, which leads to a reduction in the available light, but also to a reduction in the scattered light.

Coarse sediments

The presence of coarse sediments, which settle quickly, reduces the measurement signal.

6.1 Maintenance and inspection

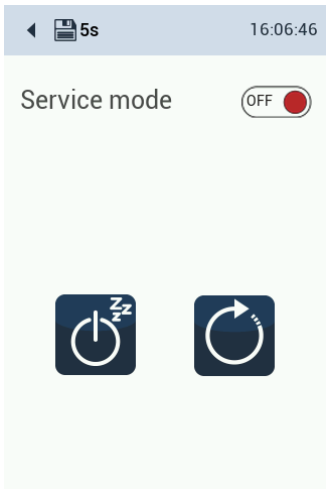
6.1.1 Maintenance mode / Screen off / Reboot

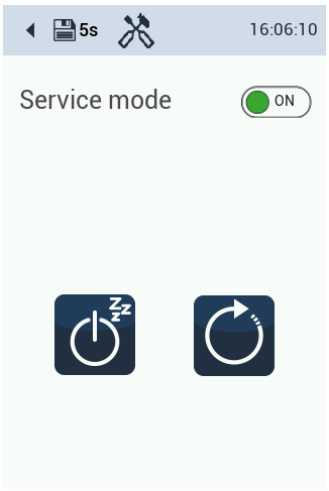
If maintenance mode is activated on the TW Turb, the light on the TW PS300 lights up white. This light appears blue through two small round windows in the housing cover of the TW PS300.

There is no alarm in maintenance mode!

The values are frozen in maintenance mode. The analog output permanently displays the last current value in maintenance mode.

The measured values appear in the main measurement window as usual. They are also saved in the data logger, but with the comment “Service”. Maintenance mode is automatically deactivated after 2 hours.





Screen off

Switches the screen off.
Touching the display switches the screen on again.

A restart is carried out by pressing the reboot button.

6.1.2 Functionality test

To check the measured values, a standard solution (e.g. formazin) can be used or a reference measurement can be carried out. The standard solution should be within the expected measuring range of the measuring medium.

Table 1: Maintenance and calibration intervals for TW Turb

sensor	Maintenance	Inspection
TW Turb	Weekly	Monthly

6.1.3 Data download

The data from the TW Turb can be downloaded via USB stick and processed in other applications.

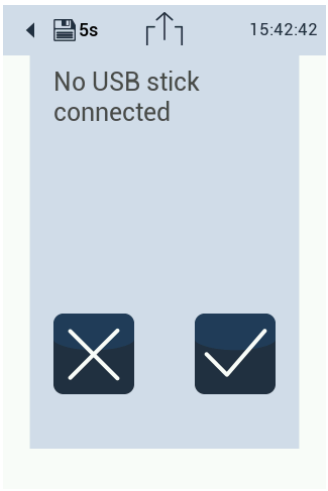
To download measurement data, connect a USB device.

Click on the “Export data” button and set a start and end time. The download is started.

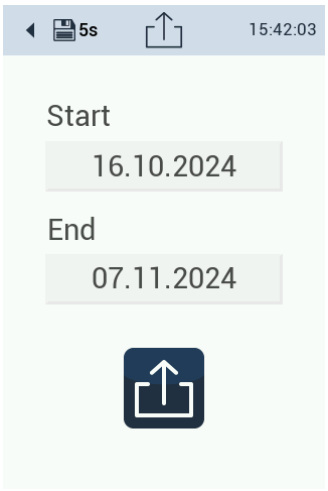
If the USB stick for the download is missing, an error message appears.

The start and end date can be set. The start date is retained even after a restart and does not need to be reset. The end date for the data download is updated to the current date when the page for the data download is selected.

Data download menu button



Error no USB



Set start and end

Start the download

Press the data download button. There is no button to cancel the download.

Measurement data and log files are downloaded from the sensor:

TWTurb-40_67000075_export_2024_11_07.zip
TWTurb-40_67000075_logs_2024_11_07.zip

The data must be unzipped using a zip program. The measurement data is then stored in daily folders. The log file is intended for the service and can only be unzipped with a password.

A csv file of the measurement data contains the following parameters:

DateTime [YYYY-MM-DD hh:mm:ss]	Turbidity [FNU]	Turbidity RAW [FNU]	Comment [Text]

The following information can be found in the log file (messages):

Factory calibration of parameter 0 = (0.000000, 0.000161, 0.000000) [2023-02-02 13:54:27]

Active calibration of parameter 0 = (0.00000000, 0.000161, 0.000000) [2023-06-06 13:56:55]

Last calibration of parameter 0 = (0.00000000, 0.000284, 0.000000) [2023-06-06 13:56:24]

Service parameters are output as additional information:

2023-06-04 01:14:33:852 [Info] [CSVFileStorer] Turbidity = 0.22828 FNU; TurbRaw = 0.22899 FNU; TurbMovMed = 0.22828 FNU; CalSig = 1402.9 ; RawSigLight = 1240.9 ; RawSigDark = -162.02400 ; TemperatureLED = 31.062 Celsius

The service parameters are stored in the log file every 5 minutes with a storage interval of 5 s to 5 min. If the storage interval is longer, the interval for storing the service parameters increases accordingly.

The saving of raw data in the measurement.csv file can be activated via a USB stick on which a special file is saved. The USB stick must be inserted when the sensor is restarted. The header line in the csv file is only updated once a day when the sensor is restarted or at 0:00. Therefore, the header is not updated when switching from “Save raw data” to “Normal memory”. This must be taken into account when evaluating the measurement data!

If raw data saving is activated, raw data is no longer saved in the log file.

Parameters of the csv file

DateTime [yyyy-mm-dd hh:mm:ss]	07/11/2024 17:39:45	Timestamp
Turbidity [FNU]	0.37607	Value shown on the display. Can be post-processed by the user
Turbidity RAW [FNU]	0.37607	Unprocessed value
TurbRaw [FNU]	0.37607	unprocessed raw value

Firmware update

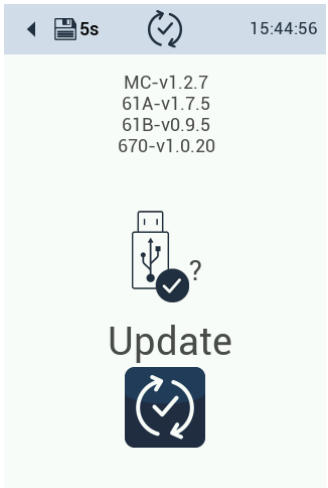
The software package version is listed on the main screen next to the serial number of the sensor.

Each software package version contains specific firmware versions of sensors and modules from the TW Master series. These firmware versions are listed under the Firmware update menu item. After a firmware update, at least one firmware version should have changed.

The individual firmware versions of the sensors are also listed in the Firmware update menu.

6.1.4 Firmware update

A firmware update may be required. To upload a new firmware version, the firmware must be on a USB stick. Insert the USB stick into the sensor and open the submenu.
Start the upload by clicking on the confirmation button.



6.2 Cleaning

6.2.1 Manual 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 the sensor needs to be cleaned.

Manual cleaning of the measuring windows and flow cells should be carried out as follows:

- Set the system to maintenance mode
- Close the water inlet (important: when using the cleaning panel, be sure to close the main inlet)
- Close the drain
- Position the collection vessel under the drain and open the drain valve
- Open the ventilation
- Drain the water from the measuring cell
- If another measuring cell is connected to the TW Turb, drain this cell as well
- Dismantle the TW Turb sensor module (see section 5.2.2)
- Remove coarse soiling with a soft, damp paper towel
- Wipe the measuring windows with another soft, damp paper towel, using a little washing-up liquid in water if necessary
- Dry the measuring windows with a clean, soft cloth
- Clean the measuring windows with a soft tissue or kitchen paper or cotton swab (lint-free) moistened with isopropanol or spirit
- Polish the measuring windows with a soft, lint-free cloth or a dry cotton swab

The flow module can be cleaned with clear water and, if necessary, a soft cloth.

If the flow module is very dirty, it can be cleaned using a silicone brush and, if necessary, a cleaning agent, e.g. a hand dishwashing detergent, citric acid (10%) or oxalic acid (5%).

Take care not to remove the O-ring. If the O-ring shows signs of porosity, replace it.

To reduce the manual cleaning effort, an automatic and configurable cleaning system (TW Cleaning) can be purchased. See the following pages.

Maintenance and inspection

Scratched and permanently soiled windows can be replaced with a new pair of windows.

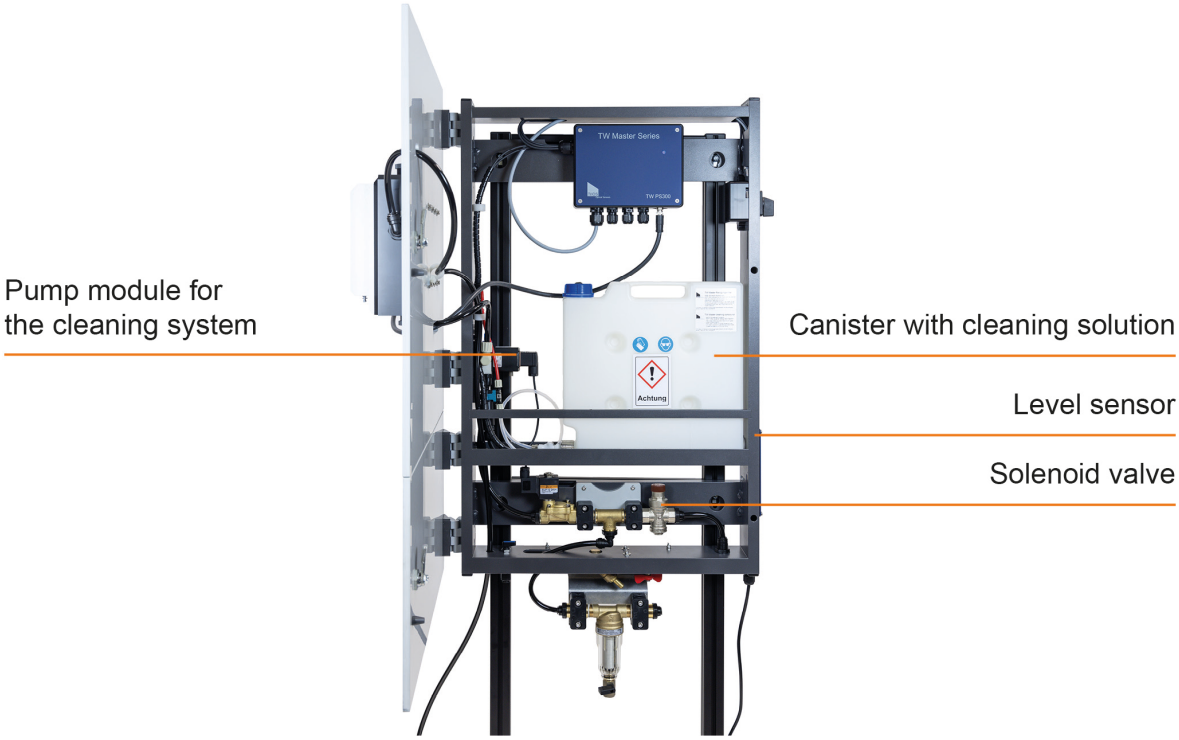
6.2.2 Cleaning with the TriOS TW cleaning panel

TW cleaning panel

The TriOS TW cleaning panel is available as an accessory. The TriOS TW cleaning panel enables automatic chemical cleaning and is therefore particularly recommended for measuring heavily soiled media.

The associated acidic cleaning agent is particularly effective against iron, manganese and limescale deposits. The supplied canister with a nominal volume of 5 liters enables easy handling and time-saving cleaning.

The canister must be refilled depending on the set pumping time, the sensors used and the cleaning frequency. As the pumping capacity is 230 mL/min and the TW Turb module has a filling volume of approx. 150 mL, the pumping time for the TW Turb module must be at least 40 seconds (additional modules must be added and increase the pumping time).



TriOS TW cleaning panel with open door

Ensure that the canister always contains sufficient cleaning solution. The contents of the canister are checked via a level sensor on the side of the TW cleaning panel.

If the level sensor detects an insufficient level of cleaning solution, cleaning is not carried out. An empty canister appears on the display.

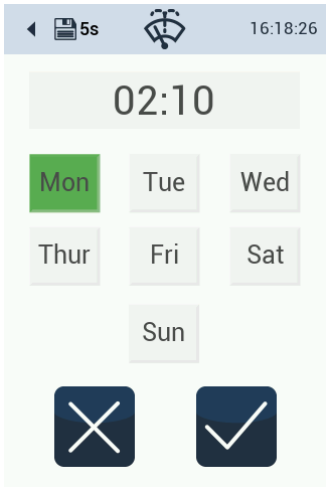
Preparing the cleaning solution

The TriOS cleaning solution consists of two components. To prepare the cleaning solution, first add approx. 4 liters of distilled water to the canister.

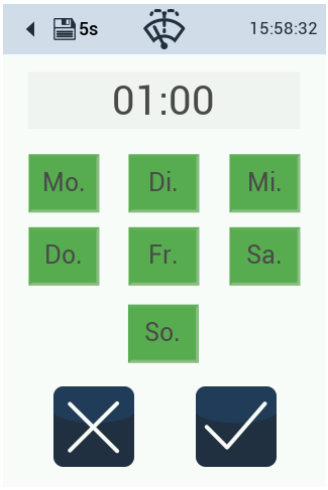
Then add both bags (component A and component B) to the canister one after the other (caution: the solution may bubble up slightly; follow the safety instructions) and fill with water up to the 5 liter mark. The canister can then be closed, placed back in the panel and connected.

Setting the cleaning times

The days of the week and the time can be set flexibly for automatic cleaning (see examples below). The configuration should be based on the degree of soiling.
Refill packs for preparing the cleaning solution can be purchased from TriOS. See chapter 8 Accessories.



Cleaning always on Mondays



Cleaning daily

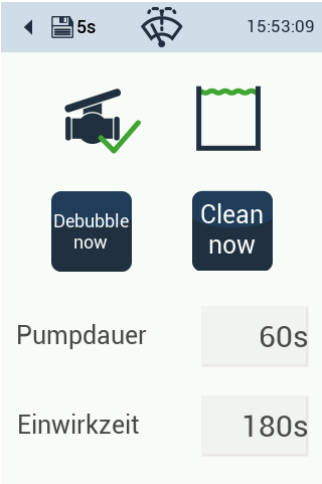
Automatic cleaning procedure

During automatic cleaning, the inlet valve is first closed after a degassing process (“debubble”) and then the cleaning solution is pumped in. After a set reaction time, the inlet valve is opened again and the cleaning solution is rinsed out. The pumping duration and exposure time can be set for the cleaning process.

Rinsing then takes place, whereby the rinsing time is currently 3 minutes and cannot be changed. Once the process is complete, the measurement screen is displayed again.

Automatic cleaning can be canceled manually at any time. A corresponding message then appears on the display.

In addition to automatic cleaning, chemical cleaning can also be carried out manually. The “Clean now” button can be used for this.



Start cleaning manually

7 Technical data

7.1 Technical specifications

TW-Turb-40 / TW Turb-W40

	TW Turb-40	TW Turb-W40
Application	Drinking water, groundwater and surface water	
Measurement technology - light source	LED 860 nm, FWHM* 30 nm	White light LED (color temperature between 2200-3000 °K)
Measurement technology - detector	IR photodiode with a spectral peak response at 860 nm	Photodiode with a spectral peak response in the range between 400 and 600 nm
Measuring principle	Nephelometry	
Parameters	Turbidity in FNU or NTU	Turbidity in NTU
Applied standard	DIN EN ISO 7027-1:2016-11	EPA Method 180.1 (August 1993)

* Full Width at Half Maximum (= half value width)

	TW Turb-40	TW Turb-W40
Measuring range	0-40 FNU	0-40 NTU
Measuring accuracy	± (5 % + 0.01) FNU	± (5 % + 0.05) NTU
Resolution	0.002 FNU	0.002 NTU
Sensitivity	0.005 FNU	0.005 NTU
Repeatability	± (0.5 % + detection limit)	tbd
Detection limit	0.01 FNU	0.01 NTU

	TW Turb-40	TW Turb-W40
Linearity / coefficient of variation	≤ 0,53 %	tbd
Measurement deviation	≤ (2 % of the measured value + detection limit)	tbd
Reproducibility	≤ (1 % of the measured value + detection limit)	tbd
Response time (T90) - sensor	20 s (only for the sensor)	
Response time (T90) - entire system	90 s at a flow rate of 10 L/h	

	TW Turb-40	TW Turb-W40
Warm-up time	60 s	

	TW Turb-40	TW Turb-W40
Data logger	Internal 8 GB memory, smallest storage interval 5 s	
Response time	20 s	
Smallest measurement interval	3,1 s	
Cross sensitivities	Finely dispersed air bubbles	Colored solutions, finely dispersed air bubbles

Display	3.5 inch capacitive color touch display, 320x480 pixels
Interface - digital	RS-485 (Modbus RTU), Ethernet (Modbus TCP)
Interface - analog	-
Power supply	12-24 VDC (± 10 %)
Power consumption	typically 2 W; standby: 1.5 W
Connection	M12 hybrid industrial connector, 8-pin

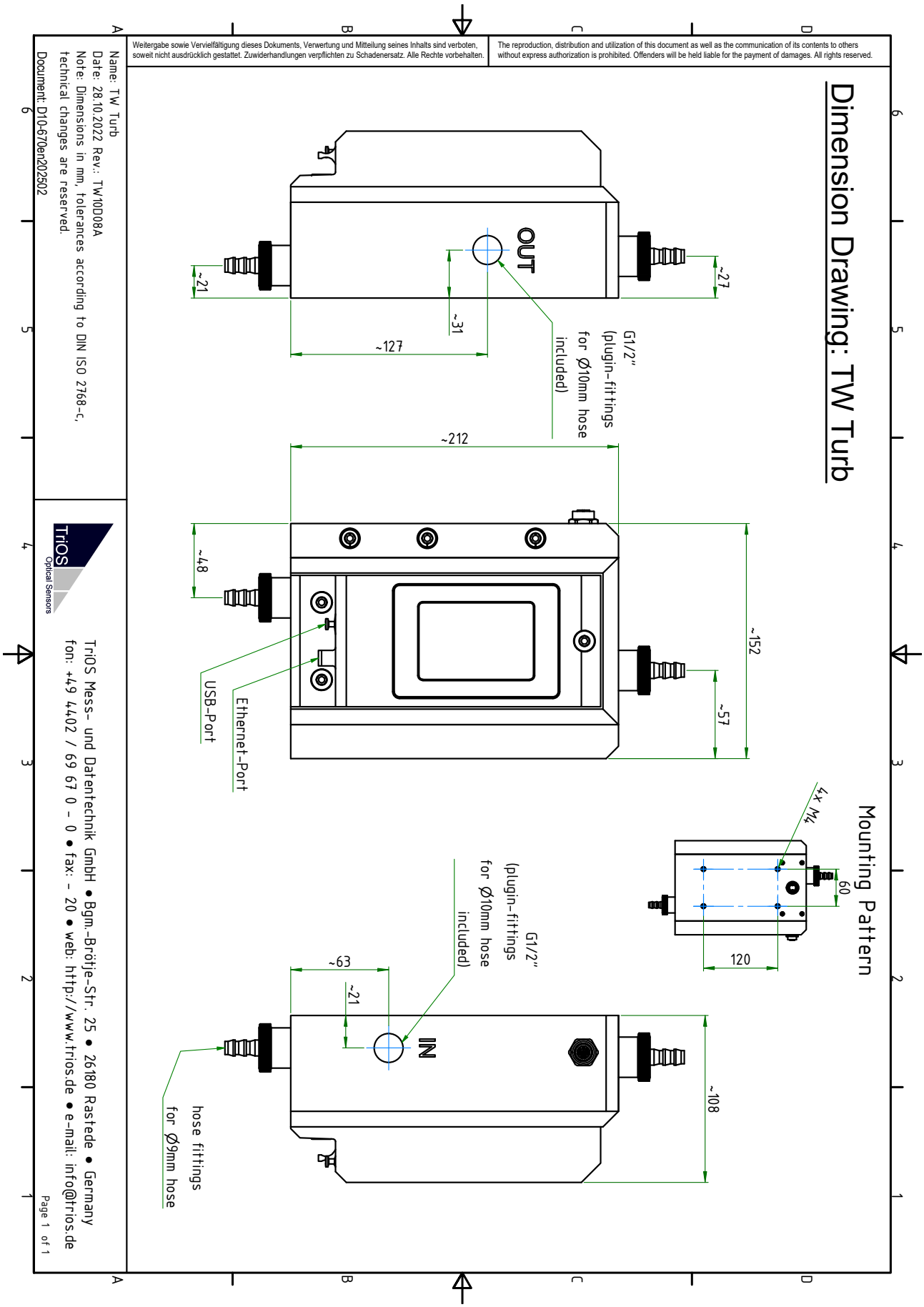
Housing material - flow cell	POM / NBR
Housing material - sensor	Aluminum / POM / PET / quartz glass
Dimensions (W/H/D)	160 / 280 / 108 mm
weight	approx. 3.8 kg

Operating conditions	
Operating temperature	Sample (insitu) 0...30 C°
Ambient temperature	0...40 C°
min. Internal pressure	0.2 bar
max. internal pressure	1 bar
Flow rate	min. 6 L/h (0.1 L/min)
	recommended 30 L/h (0.5 L/min)
	max. 1200 L/h (20 L/min)
Internal volume	approx. 150 mL
Transport conditions	0...80°C

Storage conditions	0...80°C
Protection class	IP30

Maintenance effort	Depending on the water quality, typically < 0.5 h / month
Calibration/maintenance interval	Depending on water quality (typically every 12 months), regular cleaning depending on water quality
System compatibility	TW Master, Modbus RTU, Modbus TCP
Warranty period	1 year (EU & USA: 2 years)

7.2 Outer dimensions



8 Accessories

Available are

Article number	Designation
65P000001	Flow cell
65P000000	Replacement measuring window
65A000019	Calibration set for TW Turb-40
65A000002	Cleaning set
See chapter 3.1 "Hydraulic connection"	Hose material (PUR hose black) without drinking water approval
65A000023	Cleaning agent

Planned are:

Article number	Designation
65P000003	Throttle or tap for the drain
xxx	Pressure reducer for the inlet (if no TriOS cleaning panel is available)

8.1 TW Panel

Item number	Designation
65A000001	TW Master Panel with automatic cleaning
65A000000	TW Master Panel without cleaning

8.2 Cleaning set

The cleaning set (article no. 65A000002) for the TW Master series contains a silicone brush, a bottle for isopropanol, optical paper and pliers for holding the optical paper. This set can be used to clean the optical windows of the TW Turb sensor.

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 guarantee is subject to the following conditions:

- The appliance 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 guarantee.
- Damage caused by improper handling and use of the appliance 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

12 Index

T

W

13 Appendix

13.1 CE Declaration of Conformity

Hersteller/Manufacturer/Fabricant: TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
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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	**TW Turb**
Typ / Type / Type	**4, 40, W40**
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 23.05.2024	Unterschrift / Signature / Signature R. Heuermann

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13.2 Modbus RTU - TW Master

Modbus server in TW Master Series

TW Master Software Package V3.0.0

Serial interface

On delivery, the TW sensors are configured to RS-485 with the following settings:

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

Ethernet interface (Modbus TCP)

The port number is 502. The corresponding IP address can be found in the network settings.

Data types

Data type name	Register	Format
Bool	1	false= 0x0000, true ≠ 0x0000
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 - 0xFFFFFFFFF
Uint64	4	64-bit positive integer. Values: 0x00000000 - 0xFFFFFFFFFFFFFFFF (2^{64} - 1)
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

These Modbus function codes are supported:

Name	Code	Description / Use
Read multiple registers	0x03	Read serial no., 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 device type, serial number and firmware version.

Default slave address

The factory default setting for the slave address is

Sensor	Sensor address
TW Turb 40	2 (0x02)
TW pH / EC	5 (0x05)
TW Turb W40	7 (0x07)

Reading / writing multiple registers (0x03 / 0x10)

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

Name	R/W	Address	Data type	Data type Description
Modbus slave address	R/W	0	Uint8	Identifier used for the Modbus protocol. Valid IDs: 1...247
Measurement	W	1	Uint16	0x0000 Sends a trigger 0x0001 Read parameters only
Device serial Number	R	10	Char[10]	The serial number of the sensor
Firmware version	R	15	Char[10]	The version of the installed firmware
Trigger enabled	R/W	100	Bool	false= 0x0000, true ≠ 0x0000
Storage interval	R/W	101	Uint16	Storage interval in seconds; 0x0000 = OFF
Service mode	R/W	102	Bool	false= 0x0000, true ≠ 0x0000
System Time	R/W	120	Uint64	64-bit Unix time (in seconds since 01/01/1970)
Description	R/W	124	Char[64]	Description for the sensor
IP address	R	156	Uint32	Current IP address of the sensor
Postprocessing	R/W	200ff	Bool	see below (Scaling and offset table)
Free memory	R	840	Uint32	Free memory of the data logger in KB
Cleaning state (if applicable)	R	843	Uint16	0x0000 unkown 0x0001 not active 0x0002 error 0x0003 stopped due to error 0x0004 valve closed 0x0005 pumps activated 0x0006 exposure time 0x0007 flushing 0x0008 finished 0x0009 door open

Name	R/W	Address	Data type	Data type Description	
				0x000A 0x000B 0x0020 0x0021	door closed busy (lead time) debubble valve closed debubble valve open
Flags PS300	R	844	UInt16	see table “TW PS300 flags” below	
Parameter / scaled parameter	R	1000ff / 1500ff	Float	TW Turb	1000/1500: Turbidity in FNU/NTU
				TW pH / EC	1000/1500: pH 1004/1504: Temperature in °C 1014/1514: Conductivity in µS/cm

Scaling and offset (post-processing)

Name	R/W	Address	Data type	Description
Postprocessing of parameter #1	R/W	200	Bool	OFF = 0x0000, ON ≠ 0x0000
Offset	R/W	201	Float	Offset (to be subtracted from measurement value)
Scaling factor	R/W	203	Float	Scaling of the measurement value
Averaging	R/W	205	Bool	OFF = 0x0000, ON ≠ 0x0000
Averaging in s	R/W	206	UInt16	Number of seconds for averaging
Postprocessing of parameter #2	R/W	240	Bool	OFF = 0x0000, ON ≠ 0x0000
Offset	R/W	241	Float	Offset (to be subtracted from measurement value)
Scaling factor	R/W	243	Float	Scaling of the measurement value
Averaging	R/W	245	Bool	OFF = 0x0000, ON ≠ 0x0000
Averaging in s	R/W	246	UInt16	Number of seconds for averaging
Postprocessing of parameter #3	R/W	280	Bool	OFF = 0x0000, ON ≠ 0x0000
		...		
Postprocessing of parameter #4	R/W	320	Bool	OFF = 0x0000, ON ≠ 0x0000
		...		
Postprocessing of parameter #5	R/W	360	Bool	OFF = 0x0000, ON ≠ 0x0000
		...		

Global measurement table

This makes it possible to offer all available measured values of all sensors in a coherent register area for each individual sensor.

A register area from register 1200 to register 1399 is reserved for this purpose, in which 100 measured values can be stored as 32-bit floating point numbers.

Designation	R/W	Address	Data type	Data type Description
Turbidity value	R	1200	Float	[FNU/NTU]
Temperature	R	1202	Float	[°C]
pH	R	1204	Float	[pH]
Conductivity	R	1206	Float	[µS/cm]

TW PS300 flags

Bit	Flag
0	Is set when the TW PS300 has reported for the first time.
1	Set when the control panel is present
2	Set if the cleaning system is present
3	Set when the TW PS300 is in service mode
4	Set when the TW PS300 alarm is activated
5	Set when the relay of the TW PS300 is switched
6	Set when the valve of the TW PS300 is closed
7	Set when the door is present and open
8	Set when the cleaning pump is pumping
9	Set when the fill level in the cleaning container is too low

Example

Response: 0x0041 -> 0000 0000 0100 0001

Bit#	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1

Setting the flags for this example: 0 and 6

Report slave ID (0x11)

The sensor name, the serial number and the firmware version are each displayed as a zero-terminated ASCII character string.

Example (n for hexadecimal numbers, x for decimal numbers):

TRIOS	0x00	Sensor type	0x00	Serial number	0x00	Software version	0x00
TRIOS	0x00	TWTurb-40	0x00	670nnnnn	0x00	x.x.x	0x00
TRIOS	0x00	TWTurb-W40	0x00	670nnnnn	0x00	x.x.x	0x00
TRIOS	0x00	TWpHEC	0x00	668nnnnn	0x00	x.x.x	0x00

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