INSTALLATION, OPERATION AND MAINTENANCE MANUAL

CO2 Sensor High Range

"CO2-HR"

for aquaculture and other applications

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CONTENT

1 GENERAL

1.1 SENSOR PRINCIPLES

The CO2-HR is an in-situ sensor to be deployed underwater. It measures the Carbon Dioxide dissolved in fresh or salt water.
The concentration of dissolved CO2 in the water equilibrates with the concentration in the internal detector room of the sensor. Outside water and detector room are separated by a pressure resistant membrane inlet system, which is impermeable to water and ions, but let gases diffuse freely back and forth. The process is continuous and reversible, so that the changes of internal concentration are mirroring the changes in the outside water. The internal detector uses Infra-Red Absorptiometry to analyse the gas. This technology is tuned for CO2, thus minimizing cross-sensitivities.

1.2 ABBREVIATIONS

HSE	Health, Safety and Environment
PPE	Personal Protective Equipment

1.3 REFERENCES

EN388	European Standard for protective gloves
EN60529	European Standard for degrees of protection provided by enclosures

1.4 DEFINITIONS

Not Applicable for this version

2 REVISION HISTORY

Rev.	Date	Changes
A	25.09.2020	The first official version of this document.
B	17.09.2021	Adding technical details in §3.3, 5.1, 5.4.1
C	27.03.2025	Adding/ Updating technical details in § 4, 5, 7, 8, 9.6

3 HEALTH, SAFETY AND ENVIRONMENT

3.1 GENERAL

The following safety notes are used in this document:

NOTE: Shall be used to highlight items/steps of special importance.
CAUTION: Shall be used to highlight items/ steps that may result in damage to equipment.
WARNING: Shall be used to highlight items/ steps that may result in damage to equipment, or personnel injury.

Safety must always be addressed when performing operations, maintenance, and tests with the device.
The leader for the company that is using the equipment must ensure that all the personnel involved with manipulation of the equipment has read and is aware of the content of this document.

This document is to be considered in a complementary role to the existing HSE requirements stipulated by the company using the equipment.

Close attention must be paid when handling the equipment, as improper handling could lead to equipment damage and/ or personal injury.

NOTE: The CO2-HR does not contain any chemicals or compositions that could be hazardous upon exposure.

WARNING: Familiarize with equipment before operating.

3.2 PERSONAL PROTECTIVE EQUIPMENT

Recommended personal protective equipment in connection with all activities with this equipment:

- Steel capped shoes with anti-slip profile
- Safety glasses
- Protective clothing for working with equipment under harsh weather conditions
- Rubber gloves as per EN 388, category II
- Hard Hat for activities during which the equipment might be positioned or handled higher than the operating personnel
- All necessary protective clothing and equipment are to be used prior to beginning with any installation work.

3.3 HANDLING AND TRANSPORTATION

CAUTION: Due to the weight, special consideration needs to be made with regards to handling the equipment.

WARNING: Lift, Secure or Tow ropes or cables must be attached only to the eye on the rear lid of the device, designed for that purpose (see § 5.1)
The Junction Cable connecting the Sensor to the Junction Box and through which power and communication run, is not suited for lifting, securing, or towing the CO2-HR.
Plan lifting operation and ensure that the area is secured before proceeding with any lifts.
Pay attention during lifting operation and do not stand beneath the lifted item.

4 CONTENT OF DELIVERY

4.1 BASIC COMPONENTS

These are delivered for all versions.

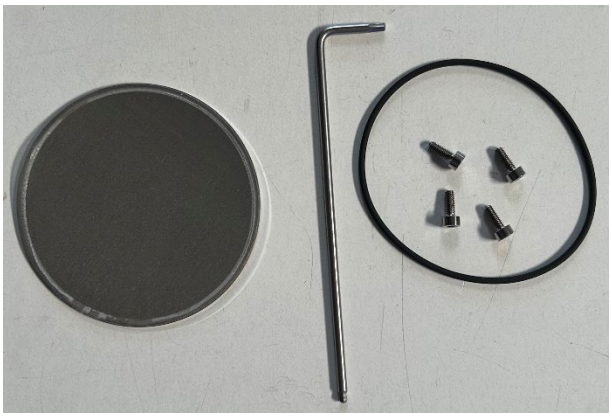
- Sensor
- Junction Box power and communication interface to client system. Features an internal data logger and a display. Two types of power supply are supported; 24 VDC or 110-240 VAC (see § 4.3)
- Junction Cable between Sensor and Junction Box
- USB Cable for connecting the Junction Box to a computer. Connectors USB-A and Mini-B, Standard USB 2.0
- Mating connectors for splicing cable connections for digital and analog outputs and 24VDC
- USB-Key contains software and manuals
- Maintenance Kit (see next section)

Sensor, Junction Cable, Junction Box

USB cable, mating connectors for digital and analog output and 24 VDC

4.2 CONTENT OF THE SERVICE KIT

This is needed for replacing the membrane (see § 9.5)



4x	Screws M3x8Ti for the membrane flange
1x	2.5 Hexagon Key
1x	Membrane flange Seal Ring
1x	Membrane with Sinter Disk

4.3 OPTIONS FOR POWER CONNECTION

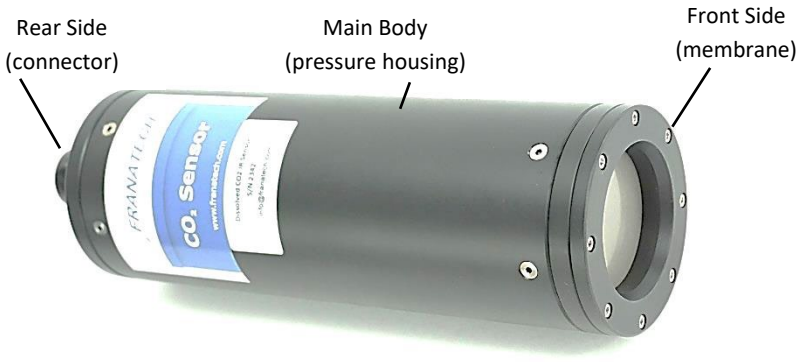
If using 24 VDC, a 4-pins mating connector is provided for splicing on a cable (see § 5.4.2 for details).

If using 110-240 VAC, a power cord is provided with four plug adapters.

USB-C Power Delivery 100V-240VAC Input + plug adapters

5 TECHNICAL DATA

5.1 SENSOR PRESENTATION



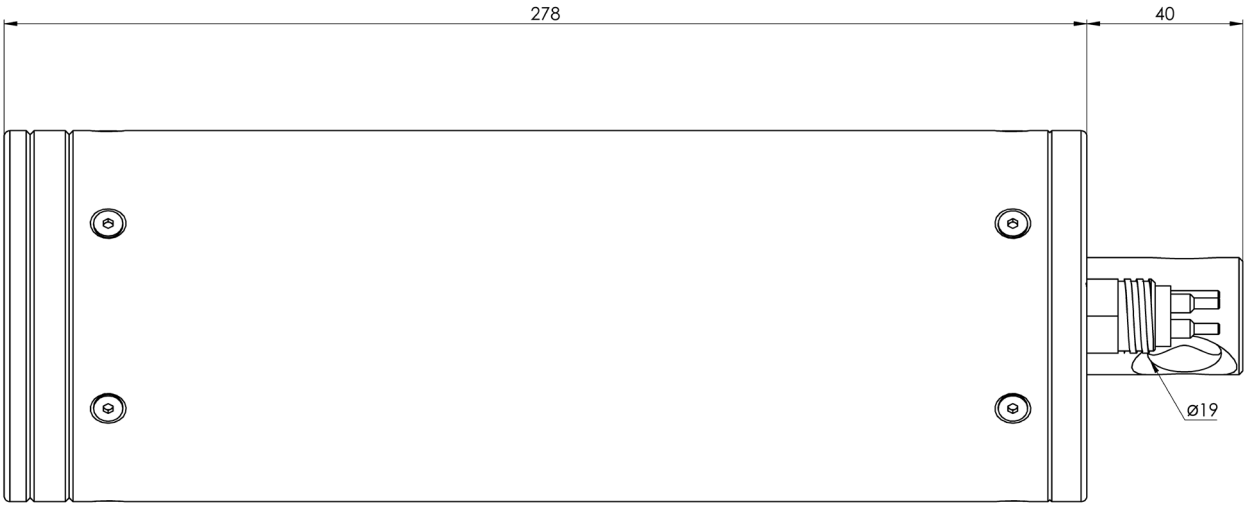
Sensor overview

Detail of rear lid

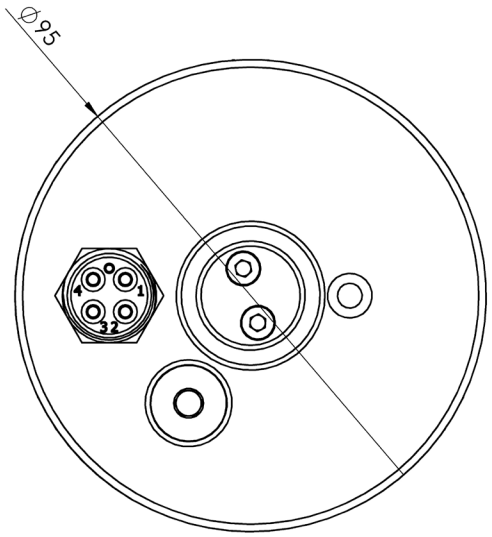
NOTE: the temperature sensor measures the outside temperature (ambient or in water). The value is displayed on the junction box.

5.2 GENERAL DIMENSIONS

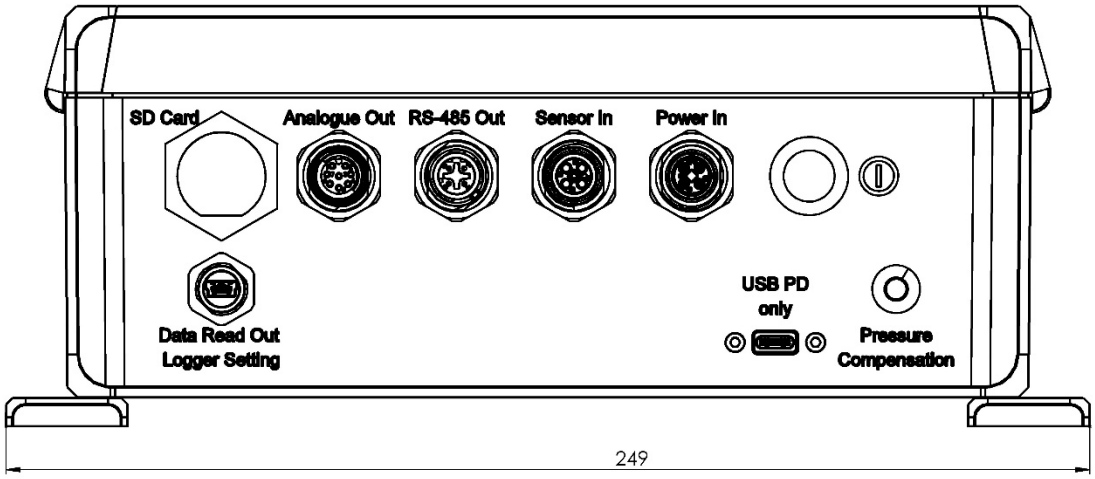
NOTE: Junction Cable length standard 10m.
Unit is mm for all dimensions on drawings.



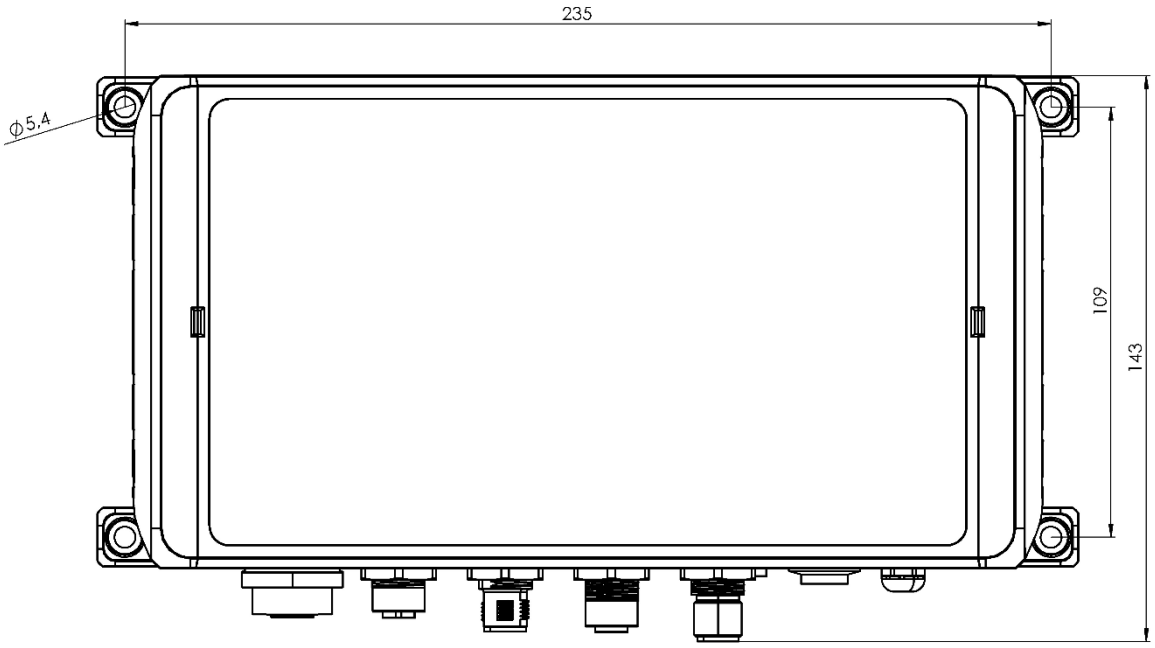
Sensor side view



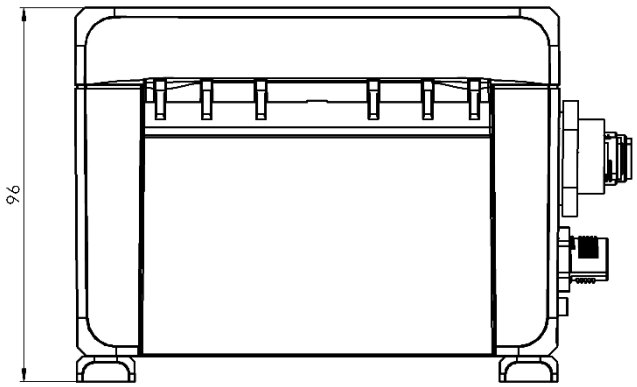
Sensor cross-section, rear view



Junction Box Interface side



Top view



Side view

5.3 MECHANICAL SPECIFICATION

Material in contact to water:

- Sensor Housing POM (DELRIN)
- Membrane Rubber Silicone suitable for uses under the Recommendation "XV. Silicones" of the German Bundesinstitut für Risikobewertung, and FDA 21 CFR §177.2600 "Rubber articles intended for repeated use"
- Connector: Titanium Gr.2, Chloroprene Rubber
- Junction Cable: Mantle Chloroprene Rubber, Locking sleeve ABS

Weight:

- Sensor 2.6 kg
- Junction Box 1.0 kg
- Junction cable (standard 10m) 2.6 kg

Environment:

- Operation temperature -2°C - +40°C
- Storage temperature -18°C - +50°C
- Salinity 0.5 – 40 ‰
- Depth rating sensor 300m
- Depth rating Junction Cable 300m exception of connector to Junction Box
- IP rating Junction Box IP 66 (EN60529)

5.4 ELECTRICAL SPECIFICATION

5.4.1 Operational features

CAUTION: Connectors generally have a keyway to prevent mating in an incorrect orientation. Forcing during mating can damage the contacts. Open connectors must be covered with the corresponding screw cap

- Supply voltage 110-240 VAC or 24 VDC (tolerance: min 18 VDC, max 27 VDC)
- Protection Fuse internal SLOW FUSE 500mA
- Power Consumption 6 W (VAC PD Adapter)
- USB-C VAC Consumption 20V…0,2A; 5V…0,7A; 12V-0,3A
- VDC 9-36V (Optimal 24V)
- Output both digital (RS485) and analog (4...20mA) are available
- USB Port Logger setting and Data retrieval
- MicroSD Card FAT32 Format

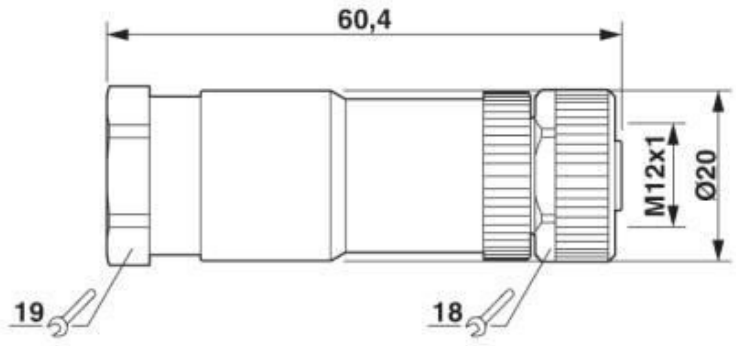
CAUTION: If both USB-C Power Adapter and the 24 VDC Power Cord are connected then only the USB-C Power Adapter is used. Damages caused by usage of any Power Adapter/ Cord not included on delivery is not covered by warranty.

View of interface side of the Junction Box

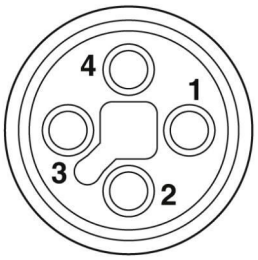
NOTE: a pressure compensation mechanism prevents inside overpressure in case of high temperature

5.4.2 Power interface 24VDC

Mating connector for mounting on connection cable:
Type SACC-M12FST-3PECON-PG11-M, manufacturer Phoenix Contact



Face view



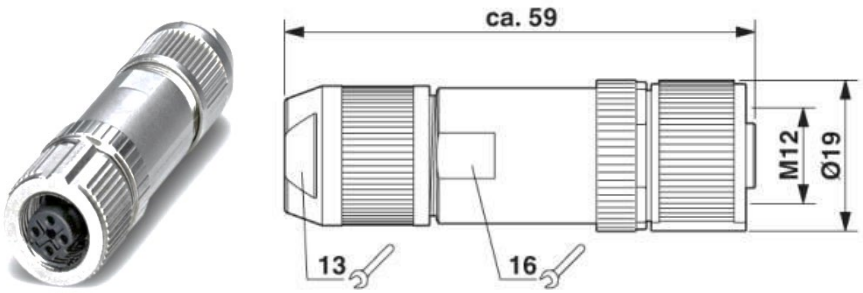
1	Power IN 24VDC
2	GND
3	Not connected (reserve)
4	Not connected (reserve)

5.4.3 Output interface digital RS485

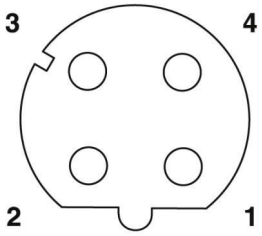
To calculate the maximum cable length the following parameters must be considered:

- Diameter of cable, as limited by the size of the provided connector
- Conductor diameter
- Combined resistance of cable and port termination on client system to which the cable is connected
- Check the corresponding norms for more details

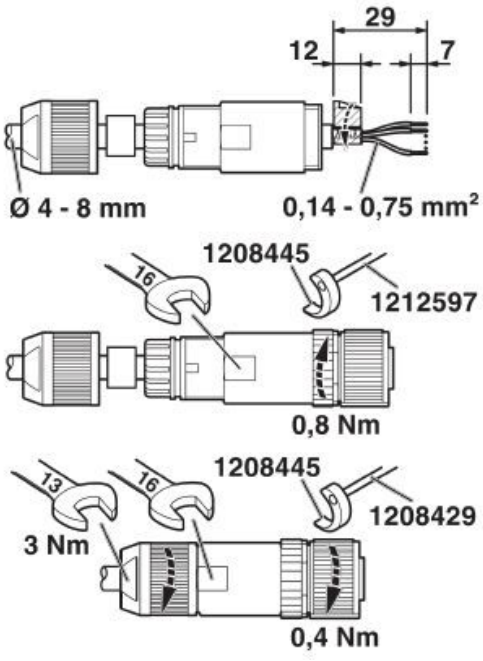
Mating connector for mounting on cable connection:
Type SACC-M12FSD-4PL SH PN, manufacturer Phoenix Contact



Face view



1	Not connected
2	Not connected
3	RS485 TX+
4	RS485 TX-

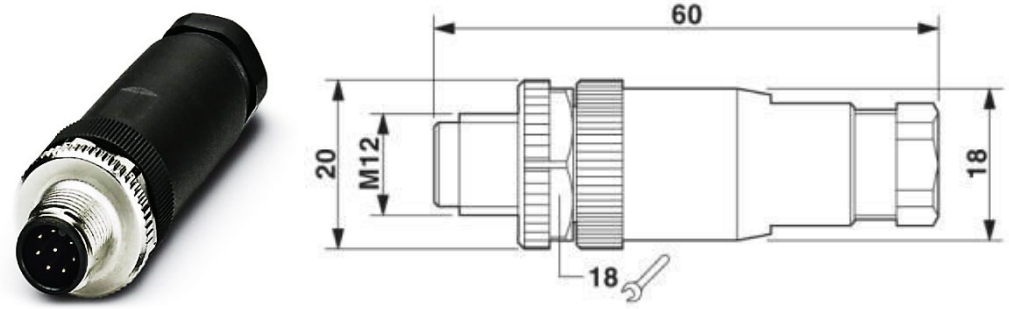


5.4.4 Output interface analog 4...20mA

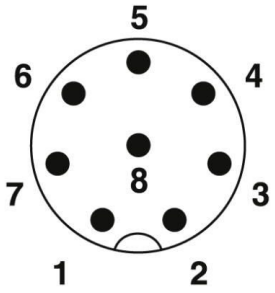
To calculate the maximum cable length the following parameters must be considered:

- Diameter of cable, as limited by the size of the provided connector
- Conductor diameter
- Combined resistance of cable and port termination on client system to which the cable is connected
- Check the corresponding norms for more details

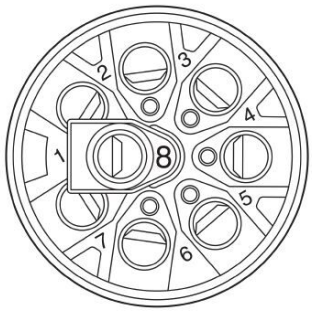
Mating connector for mounting on cable connection:
Type SACC-M12MS-8CON-PG9-M, manufacturer Phoenix Contact



Face view



Rear view showing wire slots



1	4-20mA	(CO_2 ppmv)
2	GND	
3	4-20mA	(CO_2 mg/L)
4	GND	
5	4-20mA	(Temperature °C)
6	GND	
7	not connected	
8	not connected	

5.5 OUTPUT FORMAT

5.5.1 Analog range conversion

4..20mA CO2 ppmv	0 - 50000 ppmv
4..20mA CO2 mg/L	0 - 50 mg/L
4..20mA Temperature	0°C – 40°C

5.5.2 Protocol RS485

Baud rate: 9600 baud
Stop bits: 1
Data bits: 8
Parity: none
Flow control: none

Command	Response	Examples of Output
*M1\r	aM1m.m\r	aM11.2\r => 1.2mg/l
*M2\r	aM2n.n\r	aM2100.5\r => 100.5ppmv
*A2\r	aA2t.t\r	aA220.5\r => 20.5°C
*S1\r	aS1s\r	aS12230 => S/N 2230

\r = carriage return (ASCII Character 13)
t.t = temperature °C
m.m = CO2 mg/l
n.n = CO2 ppmv
s = S/N of connected sensor (S/N of the box and the sensor are not the same)

During start-up or in case of sensor errors all sensor readings show values equal to “-1.0”

6 HANDLING AND TRANSPORTATION

6.1 GENERAL PRECAUTIONS

The sensor is supplied with mechanical protection caps for the sensor head (yellow cap) and the bulkhead connector (red or black screwcap) depending on production batch).
They are made for the purpose of avoiding damage during storage, transport, packing and unpacking the unit.

The device shall not be exposed to shock from free fall. In case of such an occurrence, contact the supplier. It might be necessary to return the unit to the supplier for full check and refurbishment.

6.2 HANDLING AND LIFTING

CAUTION: Avoid holding or hanging the sensor by the Junction Cable, as it is not a traction cable. Use the eye on the rear lid beside the bulkhead connector, as marked below by the red arrow.

Prior to any operation, it shall be confirmed that all lifting or securing devices, sling sets, shackles, soft slings are certified for the purpose.
Ensure no work is performed beneath the equipment during lifting operations.

6.3 TRANSPORTATION AND STORAGE

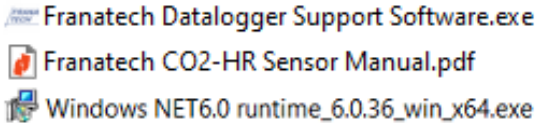
The equipment shall always be transported in such a way that unwanted movements (e.g. rolling, if transported lying horizontally) are prevented.

During temporary storage in storeroom or on working deck, safety measures are required to prevent uncontrolled movements of the sensor, or of other objects in the vicinity which could cause damage to the sensor, in particular to the membrane and the connector.

Storage temperature -18°C - +50°C

7 INSTALLATION

7.1 CONTENT OF USB stick



“Windows NET 6.0 runtime_6.0.36_win_x64.exe” is required for communicating with the Junction Box over a USB connection and for supporting the actual software named “Franatech Datalogger Support Software”.

The software allows:

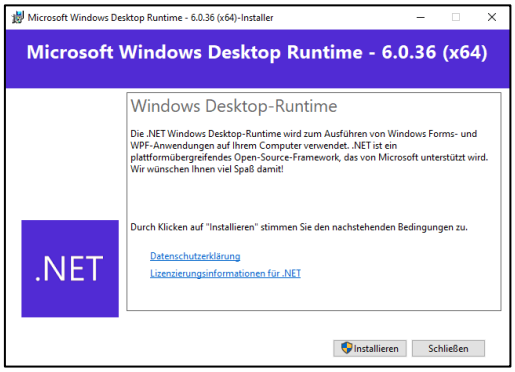
- setting the logger date and time
- setting the data storage rate
- delete data files

7.2 DESKTOP SOFTWARE INSTALLATION

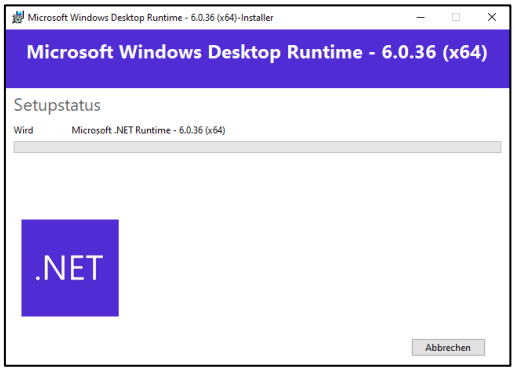
NOTE: Only the Runtime needs to be installed.
The software can be operated directly without installation.
Simply copy it to a destination of your choice and operate from there.
Operating system required: Windows 7 and upwards

If Windows NET 6.0 runtime 6.0.36 was not installed, running the Franatech Datalogger Support Software will prompt a download-link for Windows NET 6.0. If it has not been installed or the installation has failed, the Franatech Datalogger Support Software will not start.

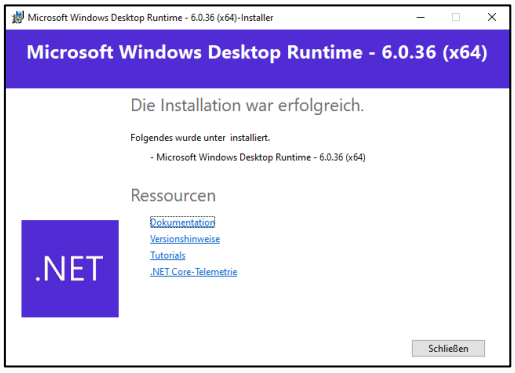
To install the runtime, insert the USB stick in your PC and launch “Windows NET 6.0 runtime_6.0.36_win_x64.exe.” Alternatively use the download-link as described earlier. You will need administrator rights to install “Windows NET 6.0 runtime_6.0.36_win_x64.exe.”



By clicking install the program will install the runtime automatically



Please wait until the installation is completed

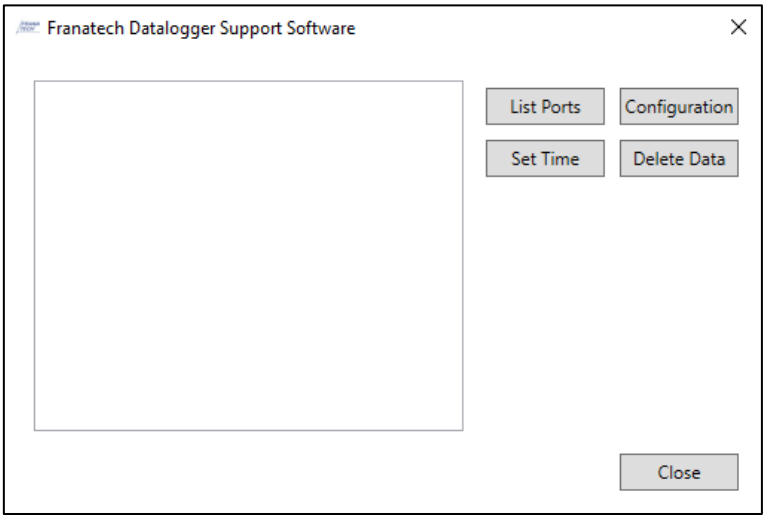


Close to complete the installation.

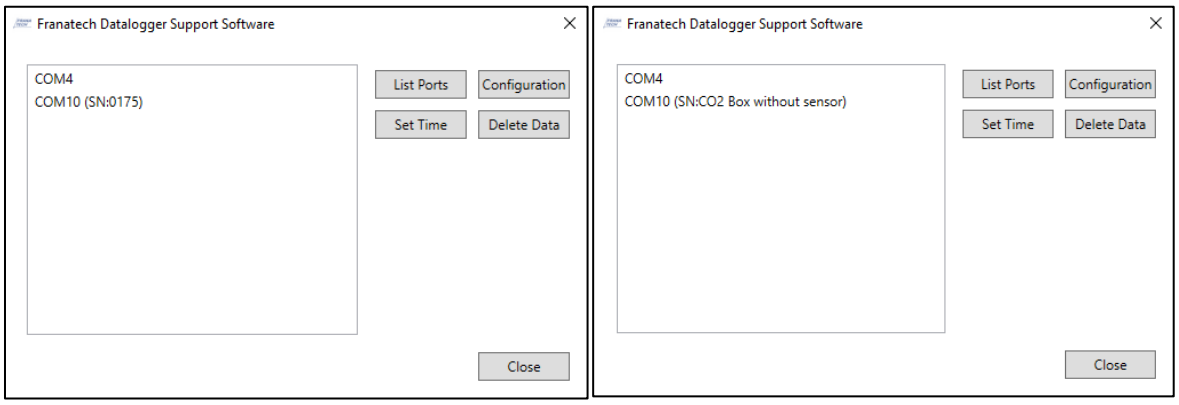
7.3 SETTING THE LOGGER: STORAGE RATE, DATE AND TIME

Connect the Junction Box with the PC on which the software has been copied.
The sensor does not need to be connected to the Junction Box.
Switch the Junction Box on.

Launch the Franatech Datalogger Support Software. The software main window appears as below:

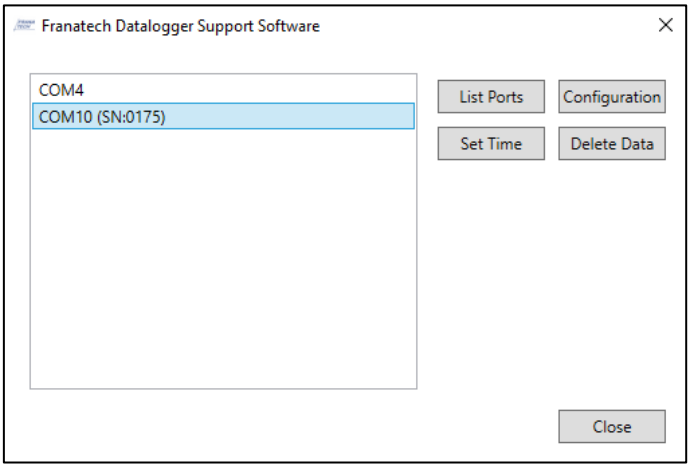


Left-click on the “List Ports” button in order to list all available ports connected to the computer.

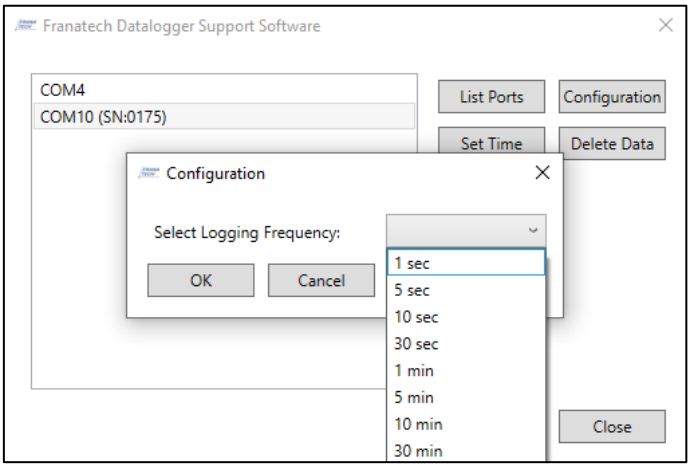


If a sensor is connected to the Junction Box, the Franatech Datalogger Support Software will display its Serial Number. If no sensor is connected to the Junction Box, then “CO2 Box without sensor” will be displayed. Logging frequency and time/date can be set without a connected sensor.

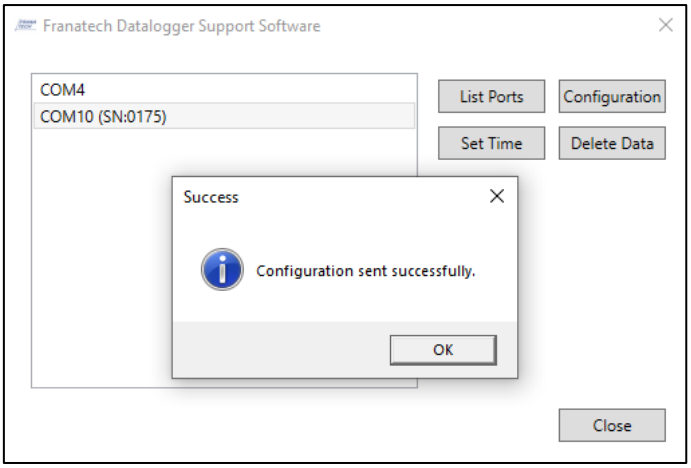
Highlight the Junction Box by left-clicking its COM Port on the list.



The standard log frequency is 60 seconds. To change it click “Configuration.” In the following window use the dropdown menu and select the preferred Logging Frequency:

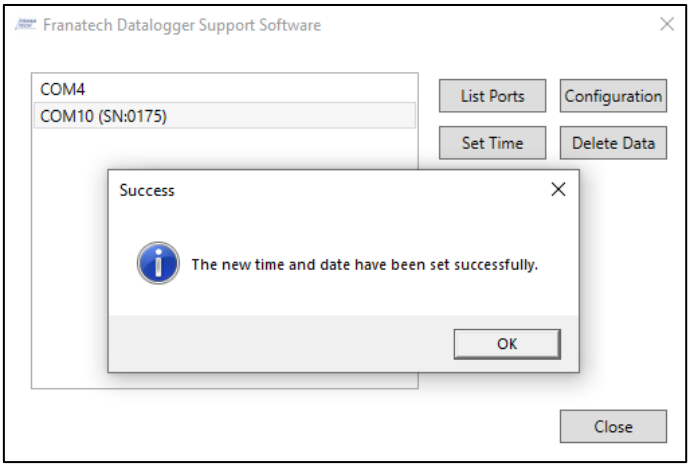


After confirming by clicking on the “OK” button please wait for the confirmation window prompt to be displayed.



After closing the confirmation window, the Junction Box will perform a restart automatically.

To change the time and date of the Junction Box select the Box as described in the above steps and click the “Set Time” button. The Franatech Datalogger Support Software then imports time and date directly from the connected PC. Please wait for up to 5 seconds for the process to complete. Upon completion a confirmation prompt is displayed.



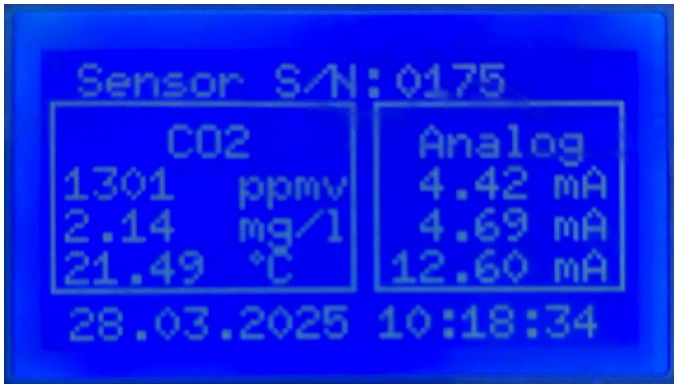
Upon closing the confirmation prompt the Junction Box will perform a restart automatically.

NOTE: To change the Time Zone on the Box, the Time Zone must be changed on the connected PC before starting the Franatech Datalogger Support Software

7.4 DESCRIPTION OF DISPLAY ON JUNCTION BOX

Switch the Junction Box on.

The sensor serial number is factory preset. Date and time can be updated or synchronized as described in previous section.



The left column “CO2” displays the actual measured values.
The right column “Analog” displays their equivalent transmitted over the analogue output
The temperature is measured with the sensor on the rear lid, see § 5.1

The display helps to identify two possible errors:

Sensor Error corresponds to failed or missing connection, for instance if the sensor is not connected.

Potential causes corresponding to the image could be:
That can come from:

- damaged cable
- cable too long for the selected connection (see § 5.4.3 and 5.4.4)
- unshielded cable
- wrong sensor type

As supplementary confirmation all values are set to 2 mA.

8 OPERATION INSTRUCTIONS

8.1 PUTTING THE SENSOR TO WATER

In case prior disinfection is required, use exclusively substances explicitly and officially authorized for cleaning of plants, transport and equipment in the aquaculture industry.

- Remove yellow cap
- Unscrew and remove connector protection cap (red or black depending on production charge).
- Connect the sensor to the Junction Box.
- Connect the Junction Box to power.
- Switch the Junction Box on (button on the interface side)

- Check on the display that the sensor is working and there are no error messages (see previous section).
- Put the sensor to water.

Note: The membrane is in a recess of the head, which might trap bubbles when the sensor is immersed vertically.
The sensor should therefore be slanted during immersion.
Slosh it around will also help to flush the bubbles.

The sensor works equally effectively whether installed in a horizontal or vertical orientation.

After being put to water the sensor gives reliable values within +/-20% after approximately 15 min. Full accuracy of 0.5 mg/l is reached after 30 min.

8.2 DRY OUT BEFORE TURNING OFF POWER

If the sensor must be taken off power for a short time, for instance to move to another tank, remove first the sensor out of the water, keep it under power for 10 min for drying. Then disconnect it from power. Before putting it again to water, power it again in the air for 10 min.

Before long-term storage, or before packaging or shipping, it is recommended to wipe carefully the housing and membrane dry and clean, eventually disinfect. Extend the dry-out period to 30 min. Afterwards, disconnect from power, put protection caps on sensor head and connector.

Storage conditions and general precautions should be according to Chapter 6, § 6.3

8.3 USE OF THE SENSOR IN AIR

The sensor can also be used in air.

This means that, for example, during emptying of the tank it is not necessary to remove the sensor or switching off the power.

8.4 INTERNAL DATA LOGGING

The internal data logging starts as soon as the assembly sensor and junction box are powered.
A single continuous file (log.txt) contains the logged data. The logging frequency is set to log every 60 seconds. This setting can be changed via the Configuration menu on the Franatech Datalogger Support Software.

Internal data format:	*.txt
Exported data format:	*.txt
Separator:	tab

8.5 DOWNLOAD DATA FROM THE DATALOGGER

The Junction Box does not need to be connected to the PC over the USB cable and it does not need to be powered.

The download can be done without the sensor being connected to the Junction Box. In that case the display on the box will display the following error screen:

If a sensor is reconnected to the Junction Box, the measurement will resume after 5 seconds but no new data will be logged unless a MicroSD Card is inserted into the MicroSD Card reader.

CAUTION: Anytime the MicroSD Card is inserted into the MicroSD Card Port while the Junction Box is powered, a restart is required to ensure that data is logged.

Extract the MicroSD Card from the MicroSD Card Port on the front panel of the Junction Box. Connect the MicroSD Card to a PC/ terminal device and open it via Windows Explorer to Copy– Paste or Drag-and-Drop the ‘log.txt’ file containing the logged data to any folder path. In case of name conflicts, a warning message will appear. Change names at storage location or deselect the file.

After copying or moving the ‘log.txt’ file, reinsert the MicroSD Card into the MicroSD Card Port on the front panel of the Junction Box and restart the Junction Box.

CAUTION: After completion, cover the MicroSD Card Port with its protection screw-cap.

8.6 DELETE DATA FROM THE DATALOGGER

There are two methods for data deletion:

Method A does not require the Junction Box to be connected to the PC or to be powered up. Proceed as described in 8.5 and extract the MicroSD Card from the MicroSD Card Port on the front panel off the Junction Box. Open the MicroSD Card on the PC with Windows Explorer. Right-click on 'log.txt' and select Delete.

CAUTION: Ensure that the data on log.txt has either been downloaded or can be deleted without being saved. Deleted files cannot be restored.

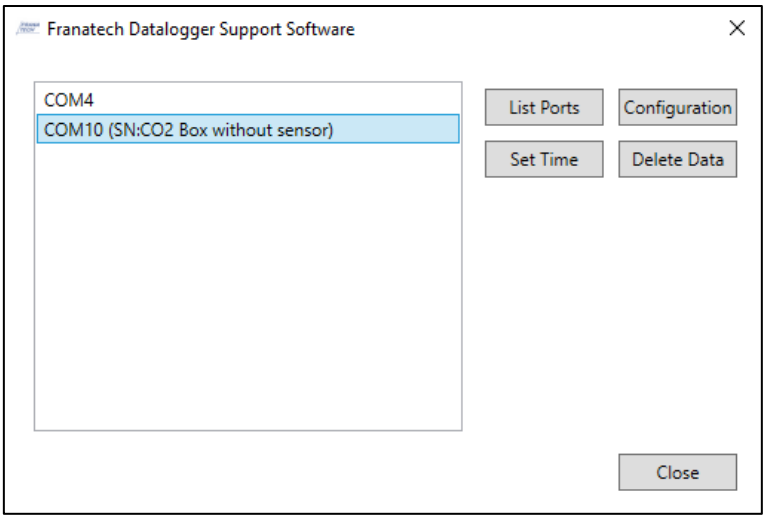
Confirm deletion of the selected file and wait for the process to finish. Once the process is complete, the MicroSD Card can be ejected from the PC and reinserted into the MicroSD Card Port of the Junction Box. Restart the Junction Box.

Method B requires the Junction Box to be connected to the PC over the USB cable and powered.

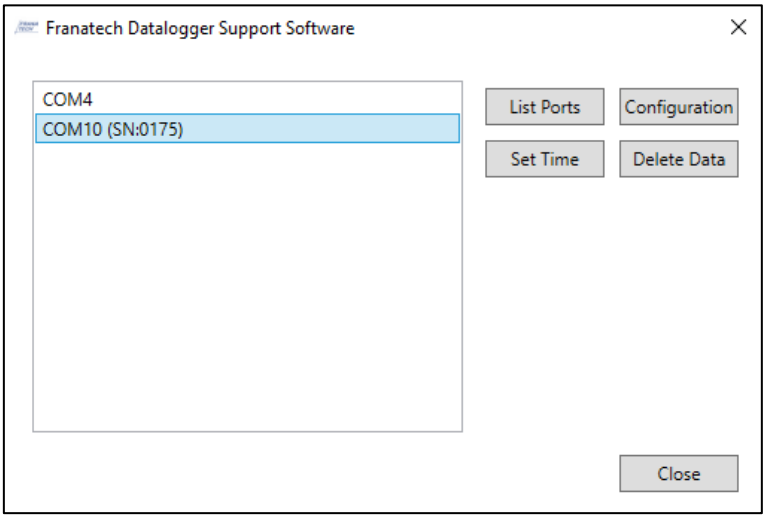
Data deletion can be done without the sensor being connected to the Junction Box. In that case the display on the box will display the following error screen:

If the sensor is connected to the Junction Box, the measurement will continue in the background.

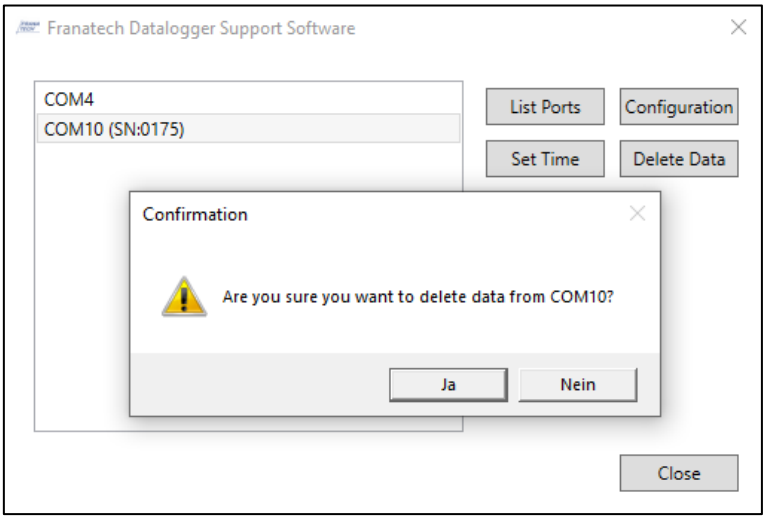
Open the Franatech Datalogger Support Software while the Junction Box is powered up and the MicroSD Card is inserted in the MicroSD Card Port. Then click the "List Ports"-Button. If no sensor is connected to the Junction Box it will be noted in the List next to the corresponding COM Port:



If a sensor is connected to the Junction Box, then its Serial Number will be displayed next to the corresponding COM Port in the List:

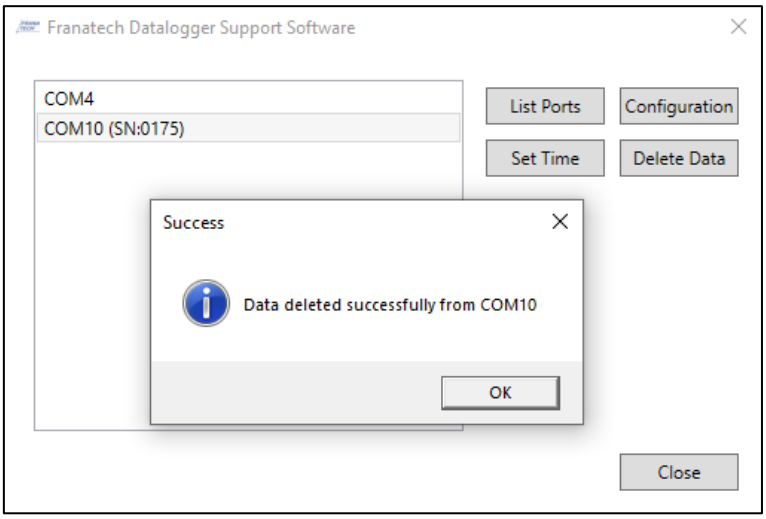


Highlight the COM Port of the box by left-clicking it then select the “Delete Data” Button.



CAUTION: Ensure that the data on log.txt has either been downloaded or can be deleted without being saved. Deleted files cannot be restored.

Confirm the deletion of the data. And wait until data deletion has been confirmed:



After confirming the Junction Box will perform a restart. If a sensor is (re)connected the measurement will resume. Eventually close the window to quit the software.

CAUTION: after completion, disconnect the USB cable, and cover the port with its protection screw-cap.

8.7 MANUAL SHUT DOWN

- Ensure any download is completed
- Quit the software if it is open
- Ensure that the USB cable is disconnected and the screw-cap mounted on the USB port
- Turn the power off using the same button as for powering.

8.8 EXTERNAL POWER UNSCHEDULED INTERRUPTION

Power interruption during measurement:

- The current file will be automatically closed without damage.
- After the power comes back, the data logger will resume on the same log file without overwriting previous data.

- Data-logger settings are untouched, as they are written in a specific file

Power interruption with junction box connected to PC:

- If the interruption occurs during deletion, configuration or setting of time/date, verify how far the process was and repeat the process if needed.

8.9 COMMUNICATION INTERRUPTION

If the USB cable is broken or pulled off: the impact on file deletion, configuration or setting of time/date and the remediation procedures are the same as for Power Interruption (previous section)

If the software screen freezes, unplug the USB cable, restart the software, and restart the interrupted action.

9 MAINTENANCE

9.1 DESINFECTION

Use exclusively substances explicitly and officially authorized in the aquaculture industry for cleaning of plants, transport and equipment

9.2 SENSOR CALIBRATION CHECK

To verify if the sensor requires a re-calibration, pull it out of water and let it run dry in reasonably clean fresh air, outside air or a good, ventilated area. Wait at least one hour, or until it stabilizes around a level. It should then show a value of between 300 and 800 ppmv, or max 2 mg/L.

9.3 LUBRICATION OF CONNECTOR

The male bulkhead connector on the sensor and the female mating connector on the junction cable should be greased at interval, at least if they are disconnected regularly. The lubrication should be checked each time the cable is disconnected.
According to connector manufacturer's recommendations: ensure the connectors are lubricated. The recommended lubricant is Molykote 44 Medium. Use sparingly. Half a match-head dose per contact is adequate.

9.4 MEMBRANE CLEANING

Normally the membrane requires cleaning first when a bio-fouling cover (slime) has built up.

NOTE: Discolouration due to algae or particles does not impact the functionality.

Users' practical experience for cleaning intervals reaches from once a week (typically in a bio-filter) to once every 4 months (low biomass tank).

A regular rinsing with water jet at low pressure might be enough. Otherwise use a soft sponge or a soft tissue to wipe carefully the membrane.

Do not use soapy water, the membrane can lose its hydrophobic property.

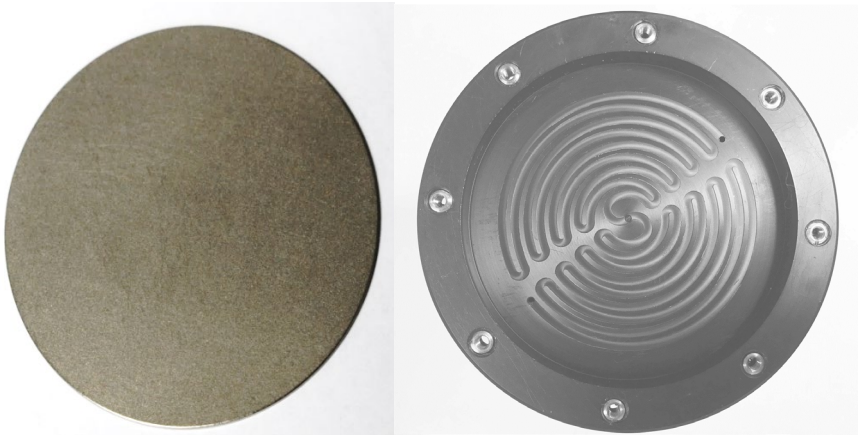
WARNING: avoid contact with sharp edges, fingernails, do not scrape or scratch.

9.5 REPLACE THE MEMBRANE

WARNING: replace the membrane only in case of a visible damage like deep scratches, puncture, large folds.

Unscrew the membrane flange, remove the flange to access the membrane. Remove the membrane with its support sintered disc

CAUTION: Check that there is NO trace of water behind the disc. Check the seat for damages or trace of water



WARNING: if there are traces of water, contact Franatech for further instructions.

If no damage and no water are visible, put the sintered disc in place, pay attention to insert it with the correct face to the inside.

Before positioning the membrane flange, ensure that the front side seal ring is in the right position (red arrow). To hold it in place, place a minute drop of silicone grease in the gouge before inserting the seal ring.

WARNING:

- do not grease the front side seal ring itself, this would damage the membrane
- the side ring, sealing to the main body, can be greased

Once the ring is inserted, press the flange straight onto the membrane, slowly to avoid any bulging or folding of the membrane.

Tighten the screws crosswise in order to avoid slanting of the flange, for instance according to the following plan:

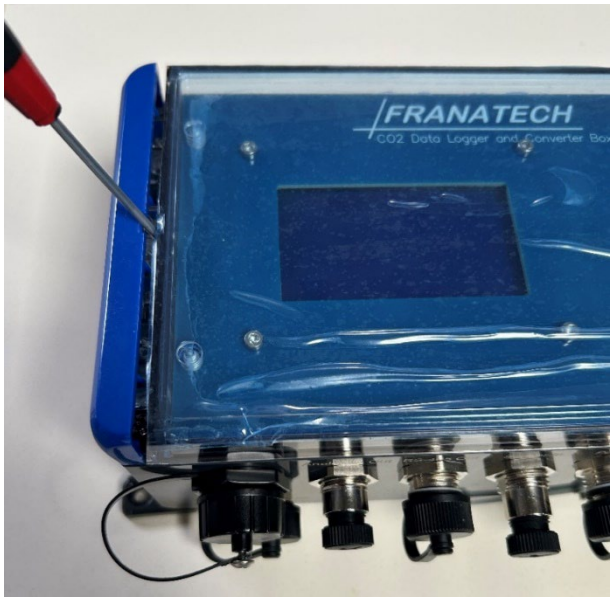
9.6 REPLACE INTERNAL BATTERIES

The Junction Box features an internal clock powered by 2 AAA VARTA Longlife Alkaline Batteries. It is recommended to exchange the batteries every 3 years to prevent damage to the Junction Box via batterie leakage.

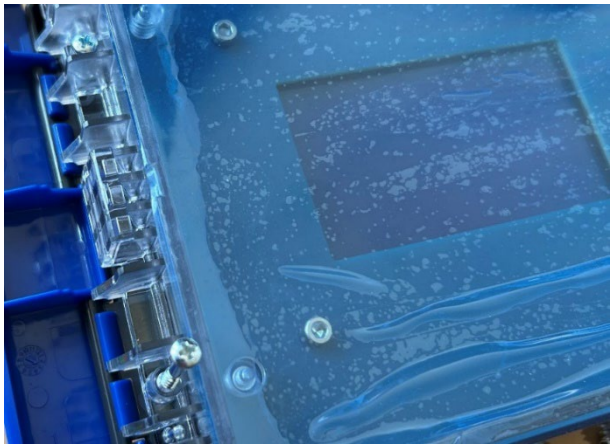
WARNING:

- do not open the Junction Box while it remains connected to any power source
- to ensure that the Junction Box works as intended, do not disconnect cables and do not damage elements of the PCB board

Position the Junction Box with the Front Panel facing towards the operator. Apply pressure to the depression to the left and right blue cap on the lid of the Junction Box with a flathead screwdriver, to disengage it.



Then using a Phillips screwdriver, unscrew the 4 screws connecting the lid to the box.



Finally, open the lid of the Junction Box.

Remove the black closure tab and change the batteries. Then reengage the closure tab to secure the new batteries in place. Close the lid of the Junction Box and screw in the 4 original screws into position. Finally reengage the blue cap on the lid.

CAUTION:

- ensure that the Junction Box is closed properly to prevent humidity from entering