INSTALLATION, OPERATION AND MAINTENANCE MANUAL

CO2 Sensor High Range

"CO2-HR"

for aquaculture and other applications

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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 analyze 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.

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
The Junction Cable connecting the Sensor to the Junction Box and through which run power and communication, 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 version exist, for power supply 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
- 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

4.2 CONTENT OF THE MAINTENANCE KIT

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

3x	Screws M3x8Ti for the membrane flange
1x	2.5 Hexagon Key
1x	Membrane flange Seal Ring
1x	Membrane

4.3 OPTIONS FOR POWER CONNECTION

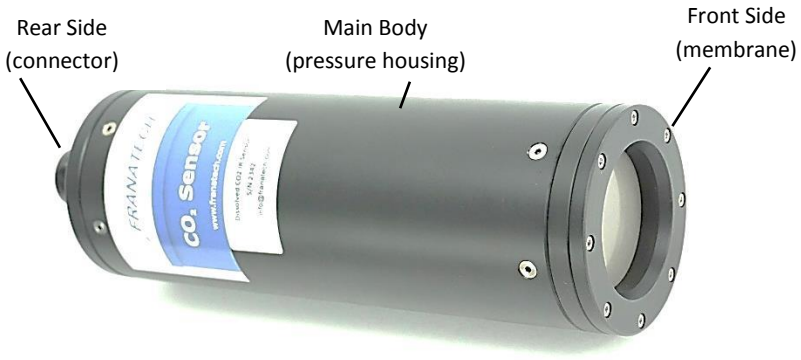
For the 24 VDC Version, a 4-pins mating connector is provided for splicing on a cable (see § 5.4.2 for details).
For the 110-240VAC version, a power cord is provided with the plug correspond to the country of delivery.

Mating connector for 24VDC

Power cord for 230VAC version
here with European plug

5 TECHNICAL DATA

5.1 SENSOR PRESENTATION

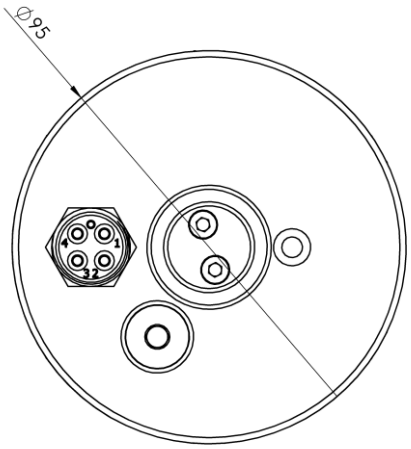


5.2 GENERAL DIMENSIONS

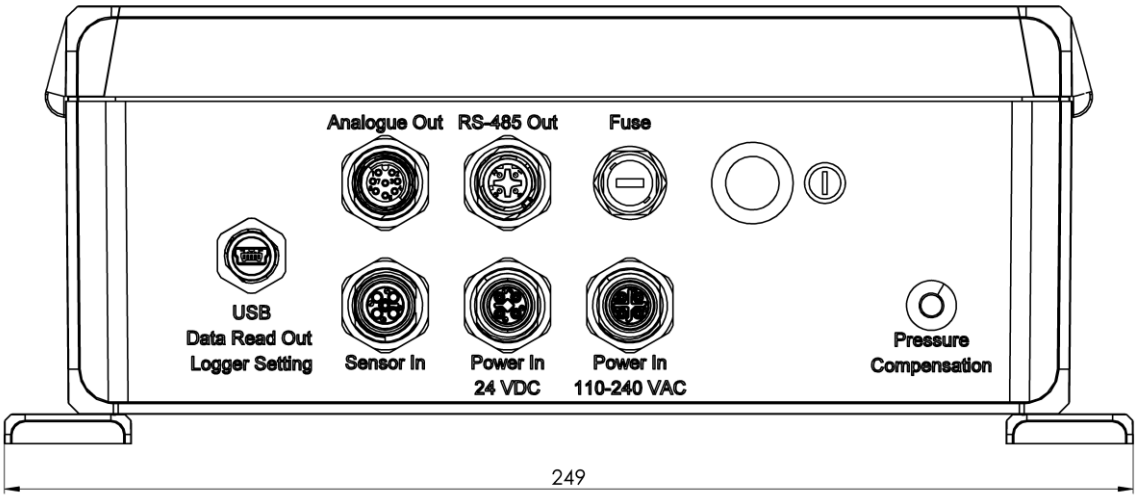
NOTE: Junction Cable length standard 10m.
Unit is mm for all dimensions on drawings.

Sensor side view

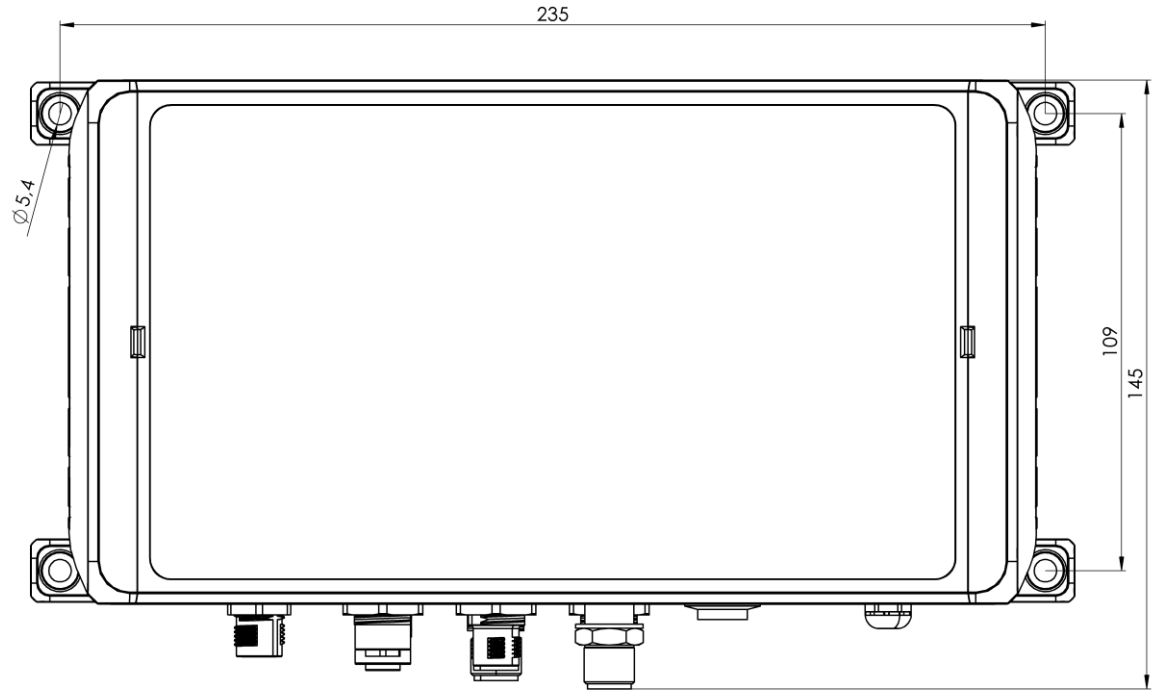
Sensor cross-section, rear view



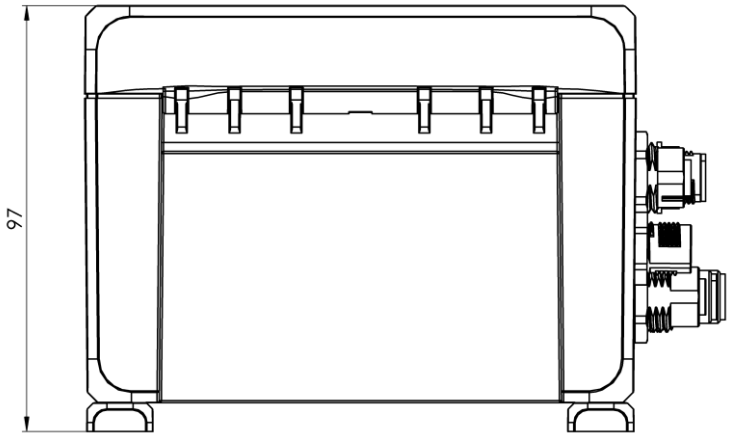
Junction Box Interface side



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 24VDC 1.1 kg
- Junction Box 110-240 VAC 1.2 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 64 (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

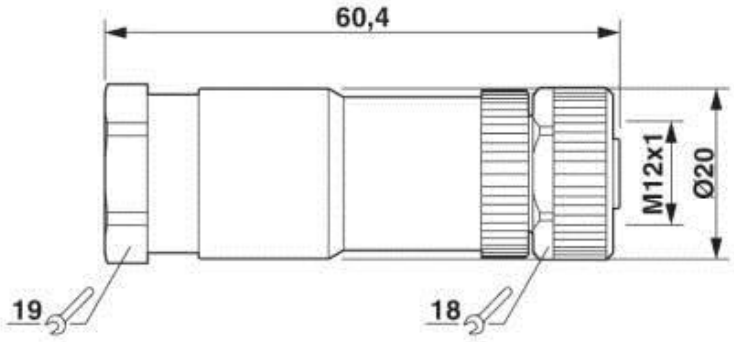
CAUTION: Open connectors must be covered with the corresponding screw cap

- Supply voltage 110-240 VAC or 24 VDC
- Protection Fuse 2.5 A, slow fuse
- Power consumption 6 W
- Output both digital (RS485) and analog (4..20mA) are available
- USB Port Logger setting and Data retrieval

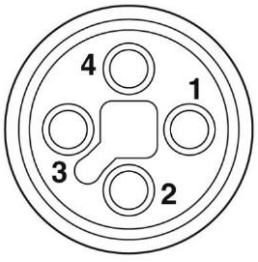
View of interface side of the Junction Box

5.4.2 Power interface 24VDC

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



Face view



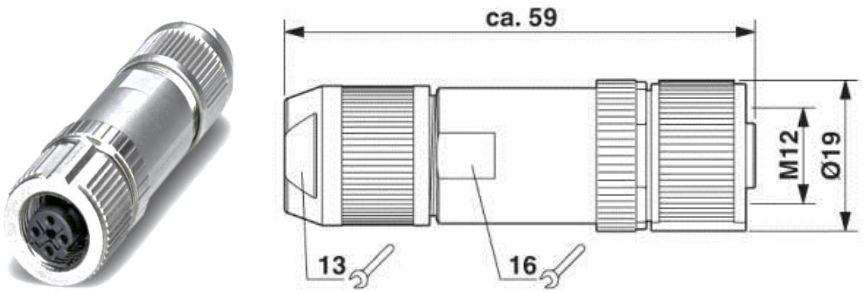
1	Power IN 24VDC
2	GND
3	Not connected (reserve)
4	Not connected (reserve

5.4.3 Output interface digital RS485

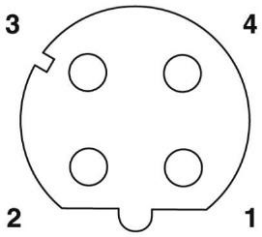
To calculate the maximum cable length the following parameters must be considered:

- 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

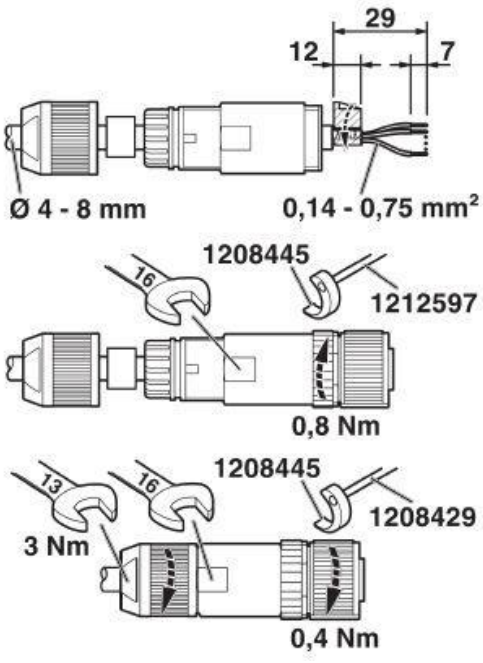
Mating connector for mounting on cable connection:
Type SACC-M12FSD-4PL SH PN, manufacturer Phoenix Contact



Face view



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

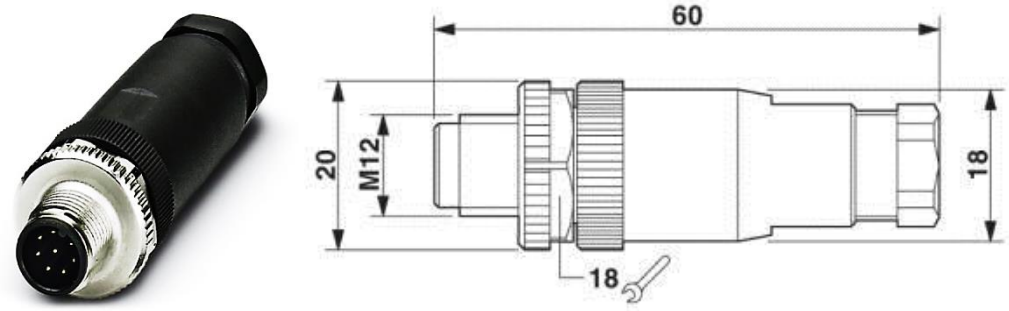


5.4.4 Output interface analog 4..20mA

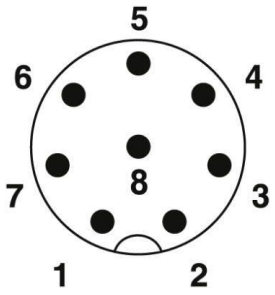
To calculate the maximum cable length the following parameters must be considered:

- 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

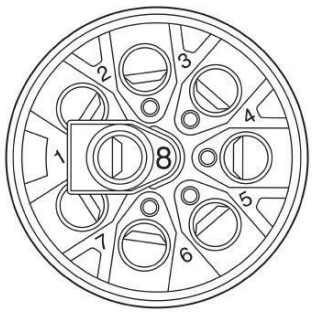
Mating connector for mounting on cable connection:
Type SACC-M12MS-8CON-PG9-M, manufacturer Phoenix Contact



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 screw-cap) 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

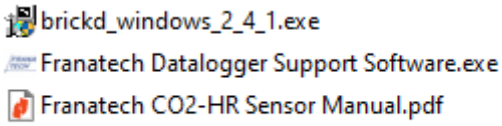
The equipment shall always be transported in such a way that unwanted movements (e.g. rolling, if transported lying horizontally) are prevented.

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



“brickd_windows_2_4_1.exe” serves to install the drivers required for communicating with the Junction Box over a USB connection and for supporting the actual software named “Franatech Datalogger Support Software”.

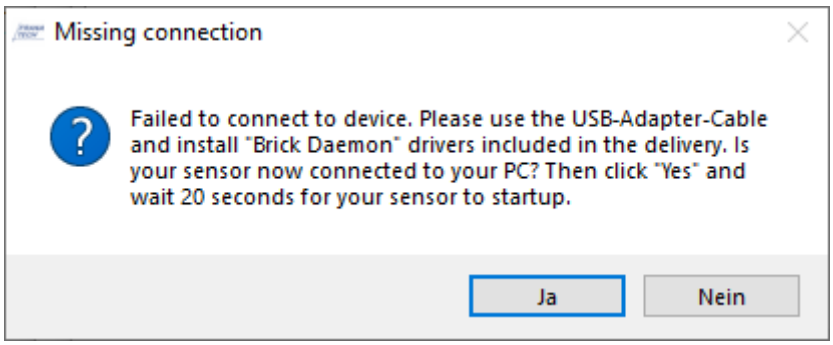
The software allows:

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

7.2 DESKTOP SOFTWARE INSTALLATION

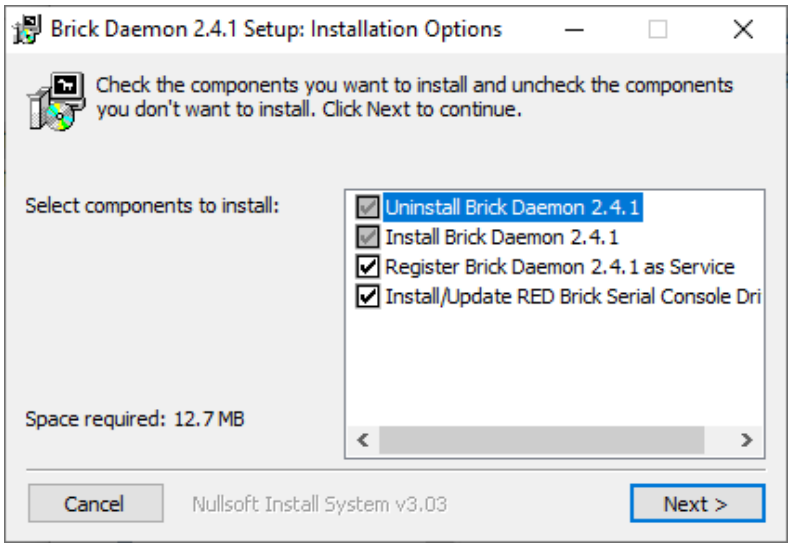
NOTE: only the drivers will be installed.
The software can be operated directly without installation.
Simply copy it to a destination of your choice and operate from there.
Operating system required: Windows 7 and upwards

The drivers have to be installed in order to be able to operate the software. If they are not installed or the installation failed, when trying to start the software the following message will be displayed:

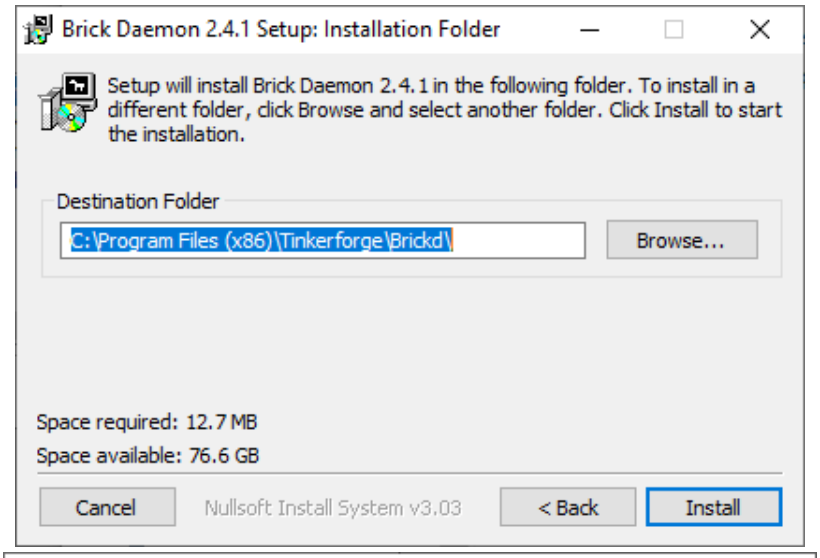


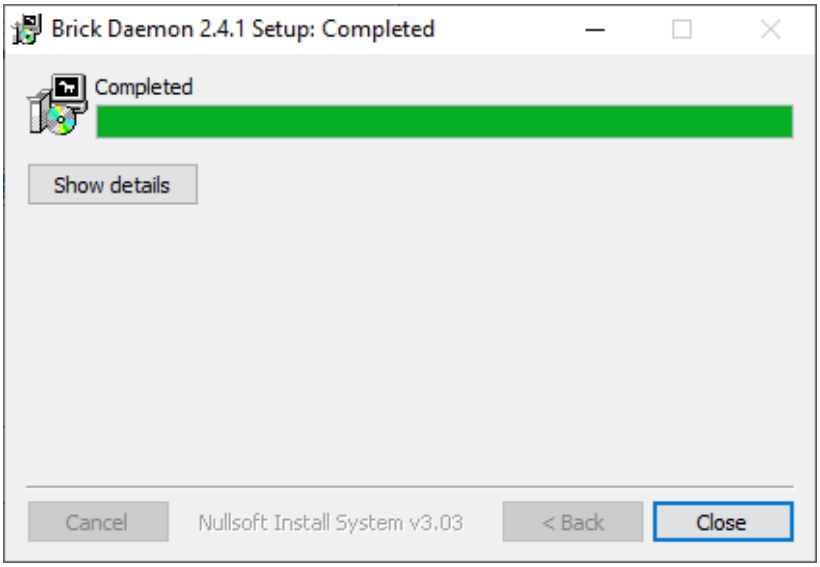
To install the drivers, insert the USB stick in your PC. You need administrator rights to launch “brickd_windows_2_4_1.exe”

The following window appears. As a standard we recommend to select all options.



Follow the instructions.





Close to complete the installation.

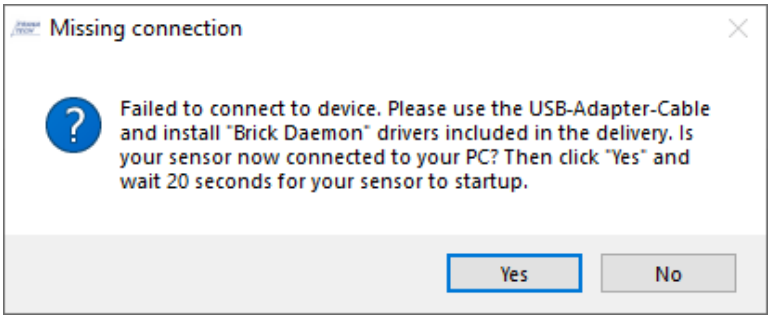
7.3 SETTING THE LOGGER: STORAGE RATE, DATE AND TIME

Connect the Junction Box with the PC on which the software has been copied.

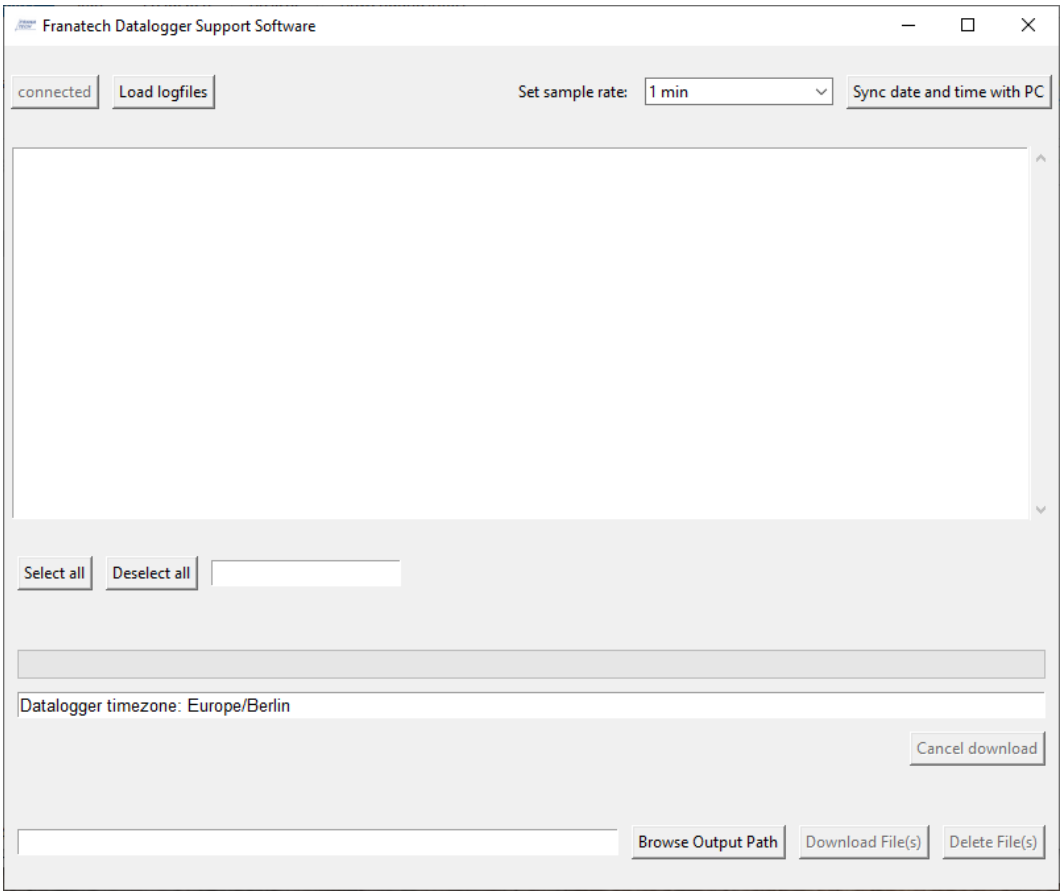
The sensor does not need to be connected to the Junction Box.
Switch the Junction Box on.

Launch the Franatech Datalogger Support Software.

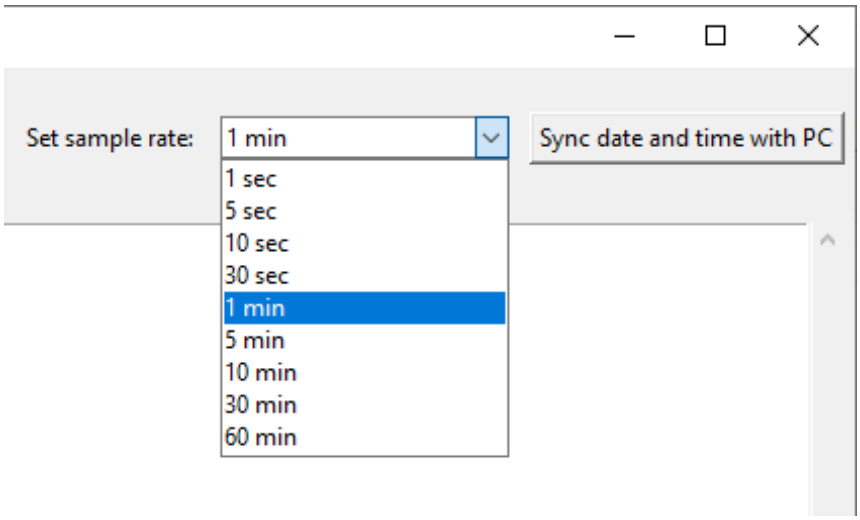
In case of a connection issue the following message will appear:



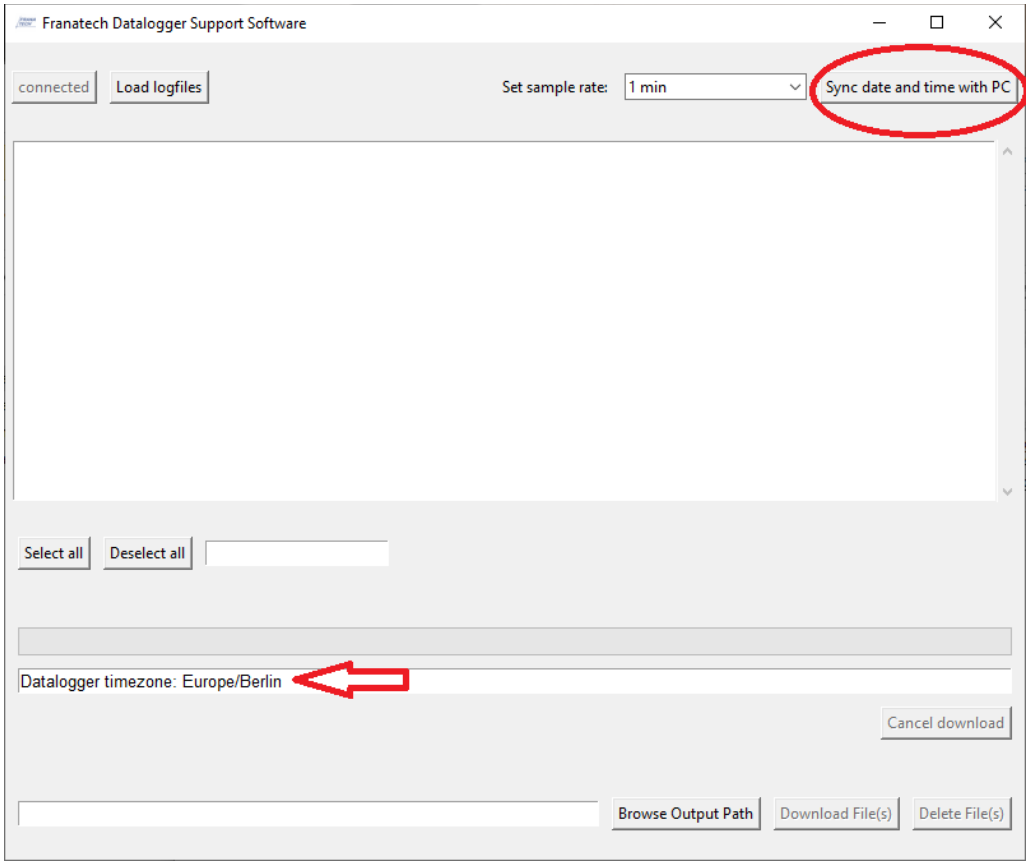
The software main window appears as below.



The preset sample rate (storage rate) is displayed. Select the required rate in the roll-down menu.



Synchronize logger data and time with the PC. The setting is displayed as per the red arrow.



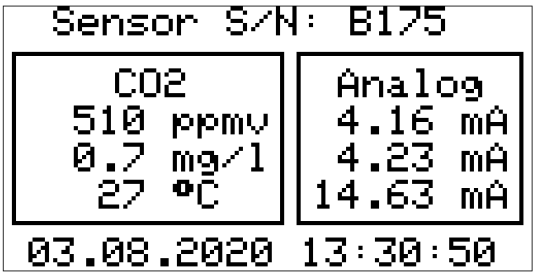
NOTE: the update inside the logger takes approximately 10 sec before the correct data and time are displayed on the Junction Box screen

Eventual time change scheme between Summer and Winter time are automatically imported from the PC

7.4 DESCRIPTION OF DISPLAY ON JUNCTION BOX

Switch the Junction Box on.

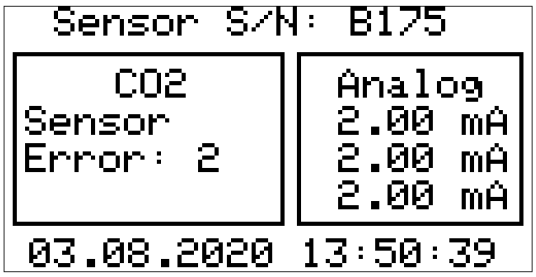
The sensor serial number is factory preset. Date and time can be updated or synchronized as described in previous section.



The left column “CO2” displays the actual measured values.
The right column “Analog” displays their equivalent transmitted over the analog output

The display helps to identify two possible errors:

Error 2 corresponds to failed or missing connection, for instance if the sensor is not connected.



Error 3 (not displayed) corresponds to invalid data received from the sensor.
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 a supplementary confirmation all values are set to 2 mA in both error cases 2 and 3.

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 has to 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, in particular § 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

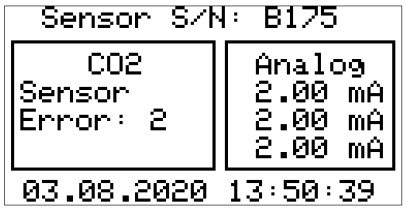
The internal data logging starts as soon as the assembly sensor and junction box are powered.
A file contains a maximum of 7200 datasets. A new file is created automatically once this figure is reached.
This means that with a storage rate set at 1 dataset per second, a file will represent a maximum of 2 hours of recording.

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

8.5 DOWNLOAD DATA FROM THE DATALOGGER

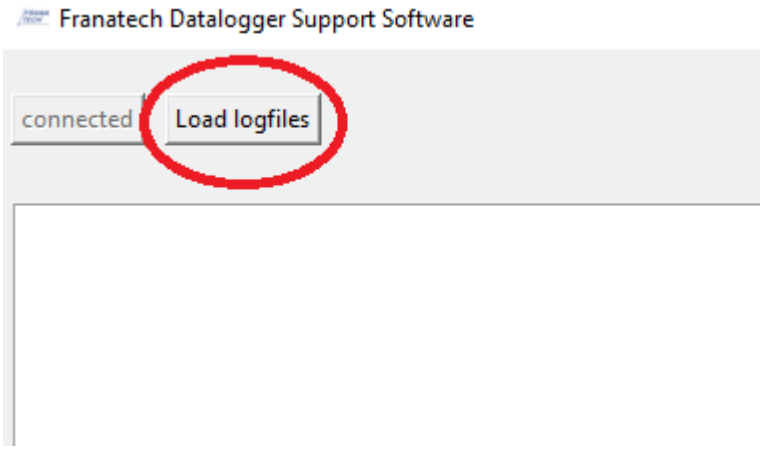
The Junction Box has to be connected to the PC over the USB cable and powered.

The download can be done without the sensor being connected to the Junction Box. In that case the display on the box will show “error 2”:

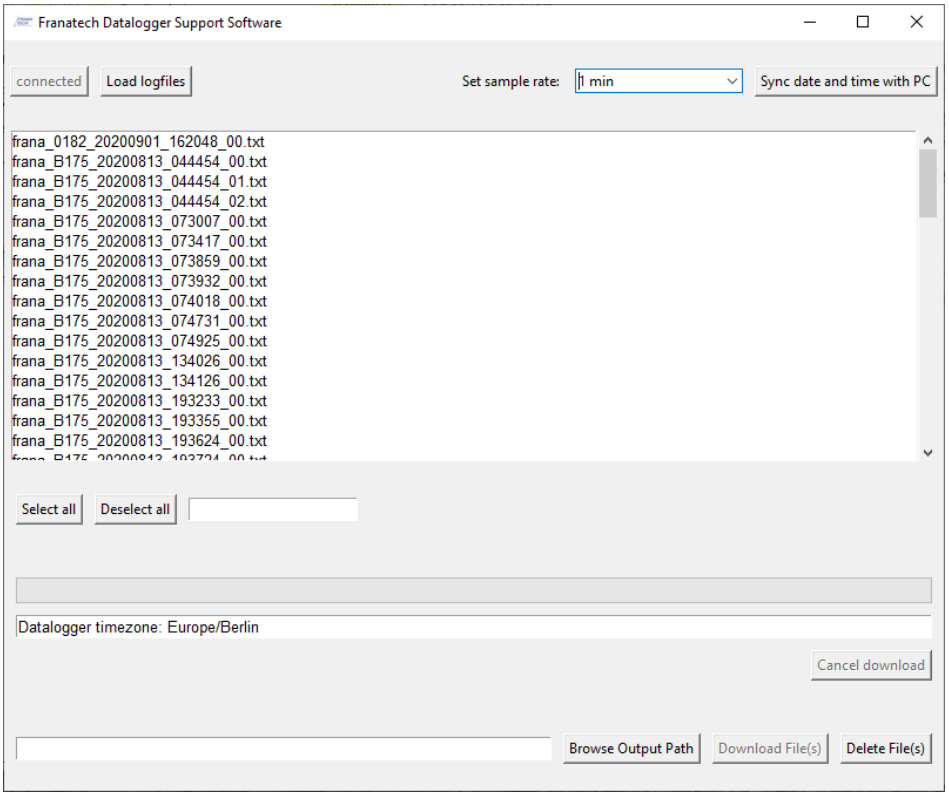


If the sensor is connected to the Junction Box, the measurement will continue in the background and new files created. The new files will be however visible only after restarting the software.

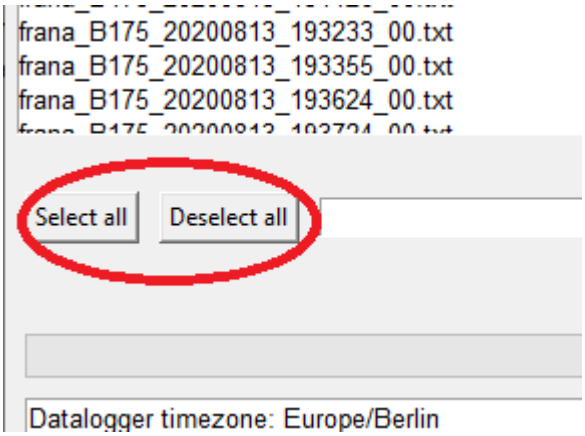
Start “Franatech Datalogger Support Software”. In the main window, select “Load logfiles”

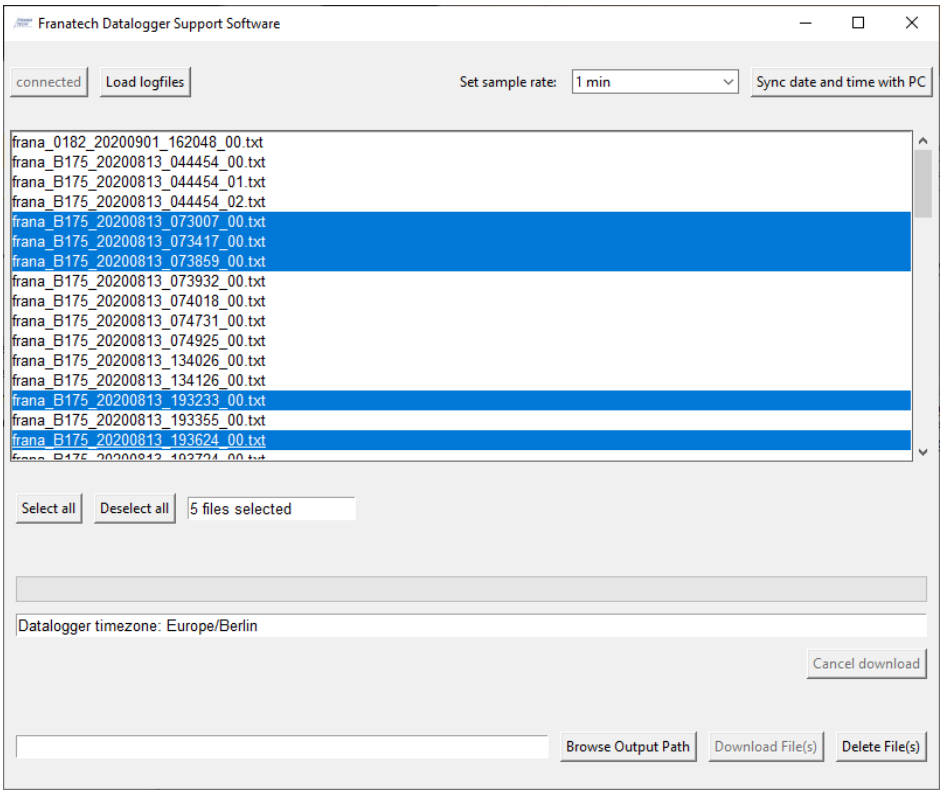


The list of available files is displayed

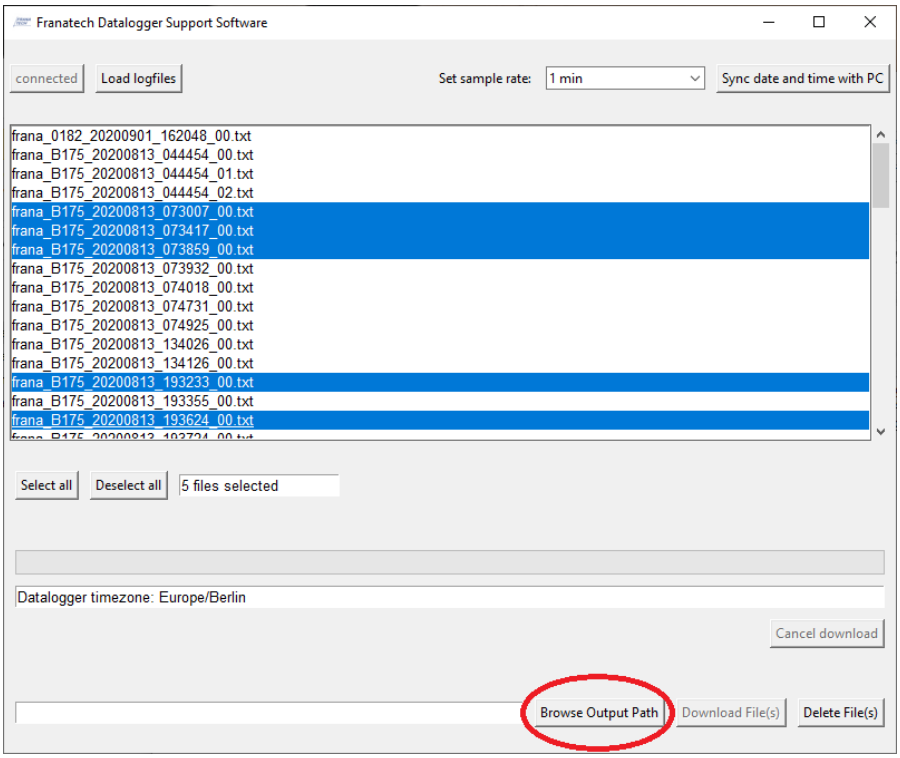


"Select all" if all files are to be downloaded. Otherwise select individual files or several files. "Deselect all" to undo.

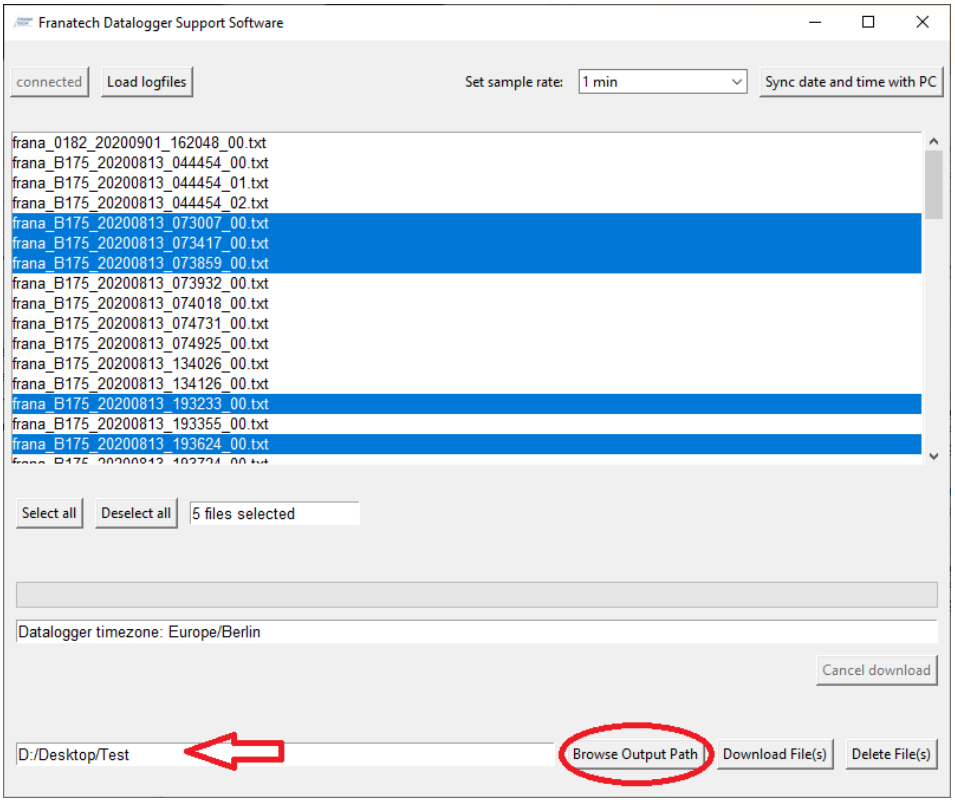




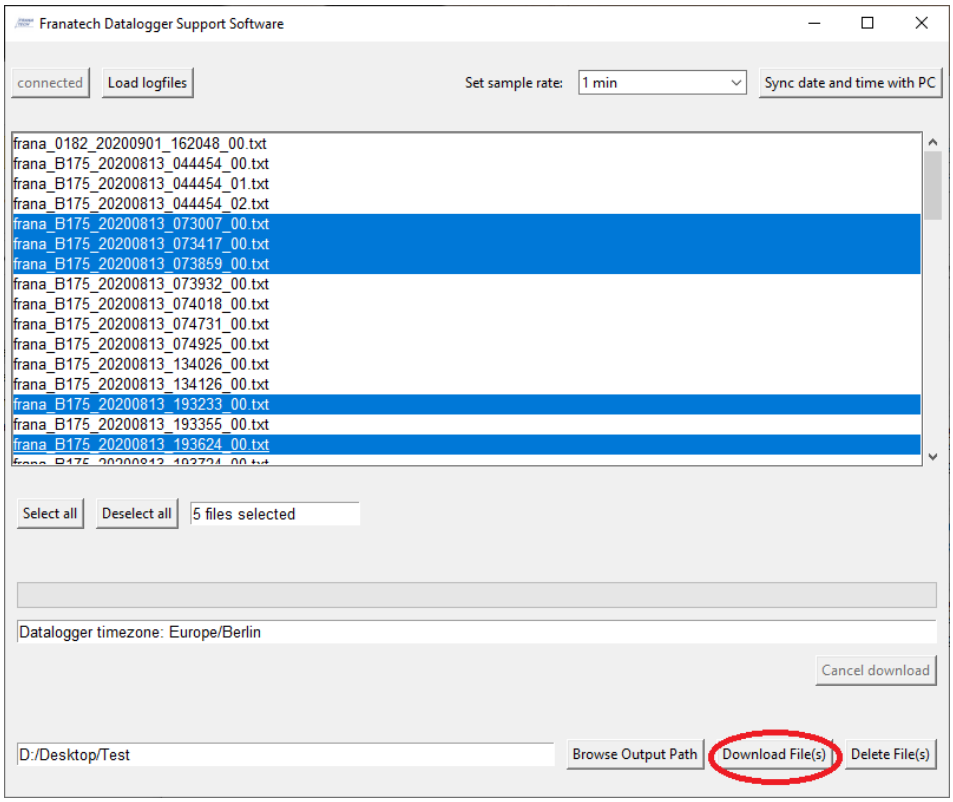
Once the files selected, activate the selection of storage location by clicking on “Browse Output Path”.



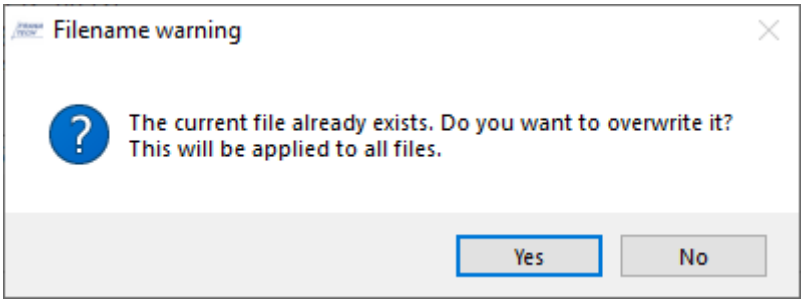
The accessible destinations and the corresponding paths will be displayed



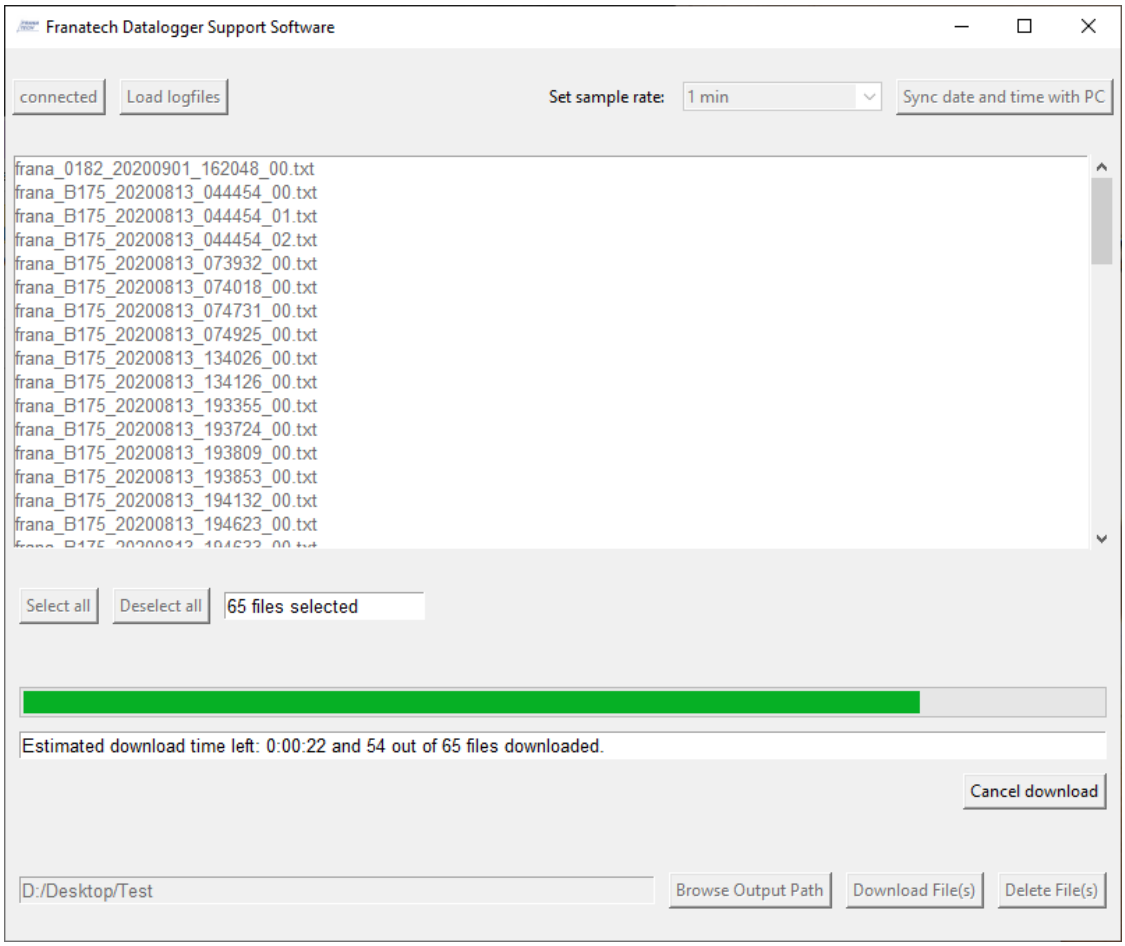
Launch the download by clicking “Download Files(s)”

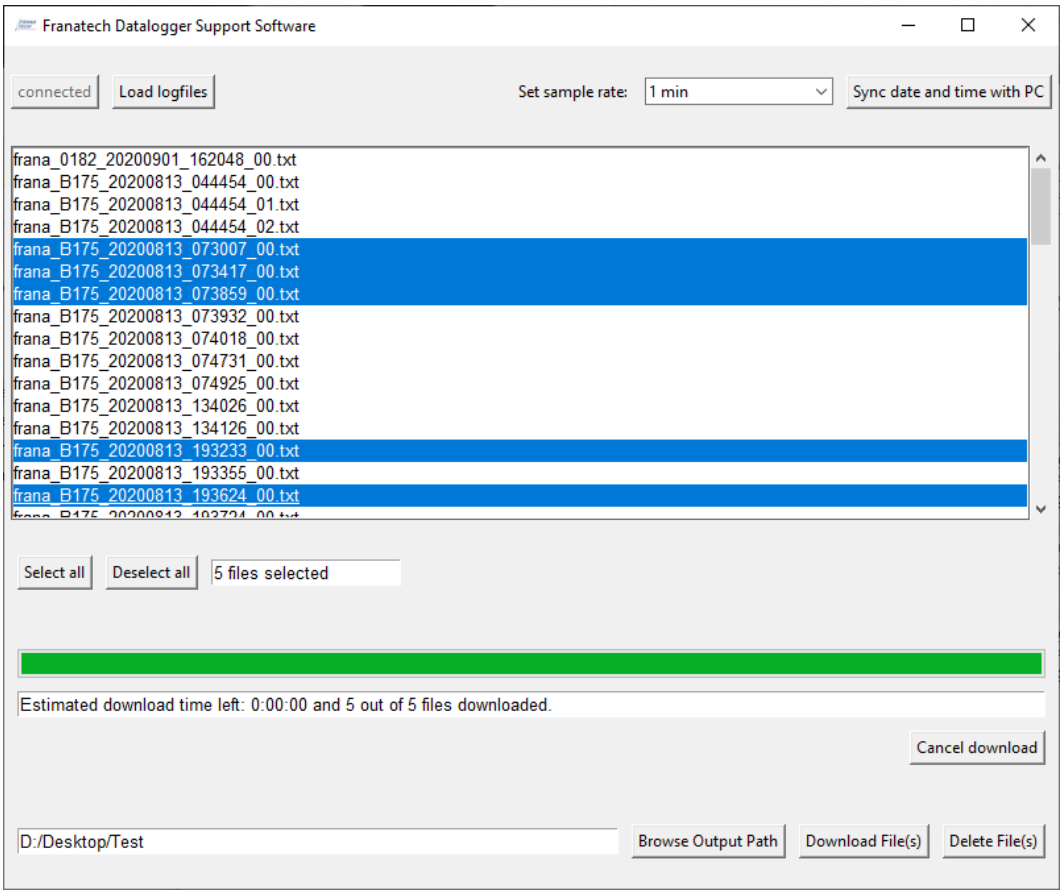


In case of name conflicts a warning message will appear. Change names at storage location or deselect the file.



The download progress will be shown, until completion.





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

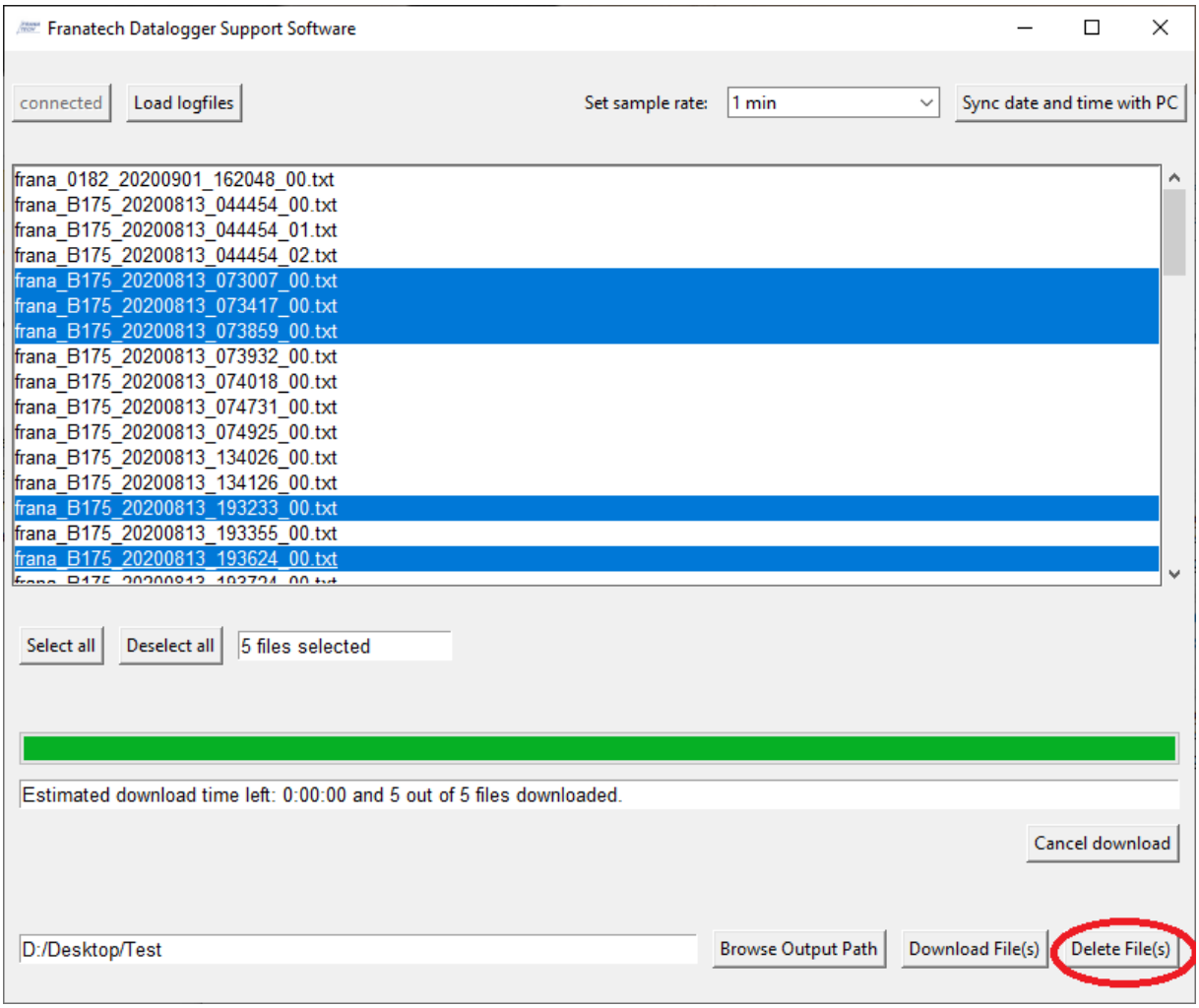
Eventually close the window to quit the software.

8.6 DELETE DATA FROM THE DATALOGGER

As for the download, this can be done without the sensor connected to the Junction Box.

CAUTION: It is possible to delete files without prior download, thus ensure that selected files have either been downloaded or can be deleted without being saved.

Proceed exactly as for the download in previous section for selecting the files. Then, instead of “Browsing Output Path” click on “Delete File(s)”.



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

Eventually close the window to quit the software.

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, a new file will be started.
- Data-logger settings are untouched, as they are written in a specific file

Power interruption with junction box connected to PC:

- During download of a data file, the download will be interrupted.
- When power returns, restart download of that file and select overwrite.
- If the interruption occurs during deletion, verify how far the process was and repeat eventually.

8.9 COMMUNICATION INTERRUPTION

If the USB cable is broken or pulled off: the impact on data download or file deletion 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 reach from once a week (typically in a bio-filter) to once every 4 month (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.

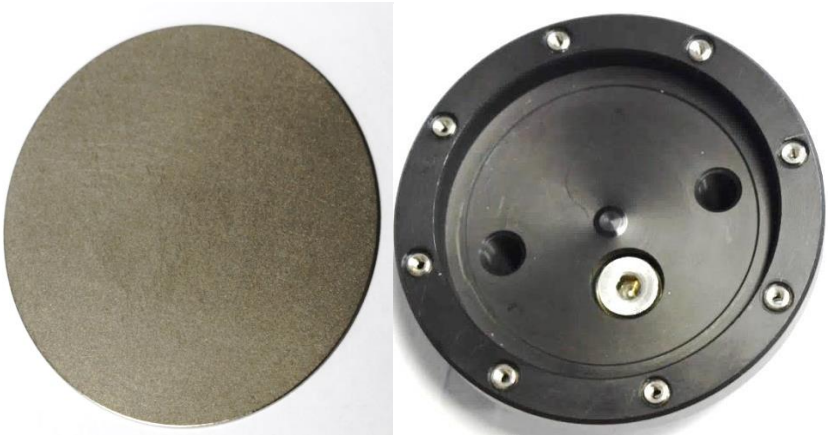
WARNING: avoid contact with sharp edges, finger nails, do not scrape or scratch.

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 and its support sintered disc

CAUTION: note the side of the sintered disc looking to the inside (to the seat).



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.

Position the new membrane carefully on the disc to ensure that it is centered, press it carefully down on the disc. To avoid folds and bulges, use fingers or a smooth cloth and start from the center towards the edges.

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 cross-wise in order to avoid slanting of the flange, for instance according to the following plan: