USER MANUAL

3S-CHL
Online chlorophyll sensor

3S Analyzers S.r.l. Italy www.3s-analyzers.eu October 2022

Electrical equipment marked with this symbol can not be disposed of through home or public waste disposal systems after 12 August 2005. In accordance with local and national European regulations (EU Directive 2002/96 / EC), users must return the equipment which is unsuccessful or can no longer be used to the manufacturer, which have to provide free of charge disposal.

Note: To return devices at the end of their useful life, accessories supplied by the manufacturer and all auxiliary items for recycling, contact the manufacturer or the vendor of the device to
arrange proper disposal.

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1 - SAFETY INFORMATION

1.1 Warnings and safety information

Before installing and operating the analyzer, read this manual thoroughly. Please pay particular attention to all the labels applied to the analyzer and to all the hazard information indicators in this manual.

This symbol indicates that you must refer to this manual for proper use of the equipment. Only qualified operators, properly trained on the use and maintenance of the analyzer can carry out service activities on the equipment.

The instrument operates with low power UV radiation. Do not look directly at the light source and do not disassemble the light source enclosure.

Parts involved:
- UV source

The manufacturer shall not be held responsible under any circumstances for improper use of the equipment.
The head of department and the machine operator must comply with the following rules and with the provisions of current legislation on the safety and health of workers.
The use, maintenance, and repair of the instrument are permitted only to persons authorised for such operations. These operators must be physically and mentally capable to perform such activities, which can not be performed under the influence of alcohol and drugs.
When the instrument is not being used it must be protected from voluntary or involuntary activation, after disconnecting the power supply.
Failure to follow the instructions given and/or failure to pay attention to the hazard indicators may cause serious risks of physical damage to operators and breaks or malfunctioning of the analyzer.
All the components of the instrument are placed within a panel closed by a door with a special key, supplied only to maintenance operators.
The instrument must then be used under operating conditions with the door closed.

2 - GENERAL INFORMATION

2.1 Technical specifications

Measured parameters	Chlorophyll, as a method to estimate and monitor the total concentration of algae in water bodies.
Measuring principle	Fluorescence photometry.
Measuring range	0 - 500 ppb (µg/l)
Resolution	0.01 ppb (µg/l)
Accuracy	±5% or 0.5 ppb (µg/l)
Analysis Frequency	Continuous (aquisition time < 1 s)
Sample	Pressure-free vessel (up to 3 bar) Temperature: 0 - 50 °C (32 - 122 °F)
Dimensions	∅ 36 mm, L 198.2 mm
Weight	Approx. 1 kg (2.2 lbs)
Body Material	Titanium
Power Supply	Voltage: 12 - 24 VDC Power consumption: max. 0.5 VA
Output	Modbus via RS485
Operating temperature	0 - 50 °C (32 - 122 °F)
Installation	Flow cell, immersion pipe or brackets (optional accessories)
Protection Grade	IP68

2.2 Instrument description

The 3S-CHL is a sensor for water monitoring. The probe needs minimum maintanance and can be installed right out of the box, without initial configuration. The design is compact and robust, the titanium body offer great protection up to a depth of 60 m.
Data is transmitted using the widespread industrial Modbus protocol.

2.3 Applications

The sensor works with the principle of UV fluorescence and can be used to measure the concentration of chlorophyll in water as a method to estimate the total concentration of algae.

2.4 Method description

Fluorescence spectroscopy, or fluorimetry, is a technique that measures the amount of light emitted by a fluorescent sample when excited with an incoming radiation of appropriate wavelength. Fluorescence is a property of some substances that are able to absorb energy from the incoming light and then release it as a radiation with a lower energy (longer wavelength) and partially as heat.
It's strictly related to absorption spectroscopy where a sample absorbs part of the incoming radiation and releases it exclusively as heat.
In fluorescence spectroscopy we can measure the intensity of the emitted radiation and correlate it to the concentration of the analyte.
Compared to the absorbance spectroscopy the technique presents a greater selectivity and sensitivity, since only fluorescent compounds are detected.
The light beam from an LED source in the UV region irradiate the sample. Some photons get absorbed by the substances in the sample and re-emitted as a polychromatic radiation (photons with different wavelengths). A second filter selects a target wavelength and its intensity is measured by a detector and correlated to the analyte concentration. The light emitted by the sample is diffused in every direction therefore the detector is placed at an angle to avoid interference with the incident light.

3 - INSTALLATION

3.1 Opening the package

For safety reasons, when removing the packaging of the equipment, please check for any visible defects and, if necessary, inform the supplier.

Parts inside the package apart from the user manual:

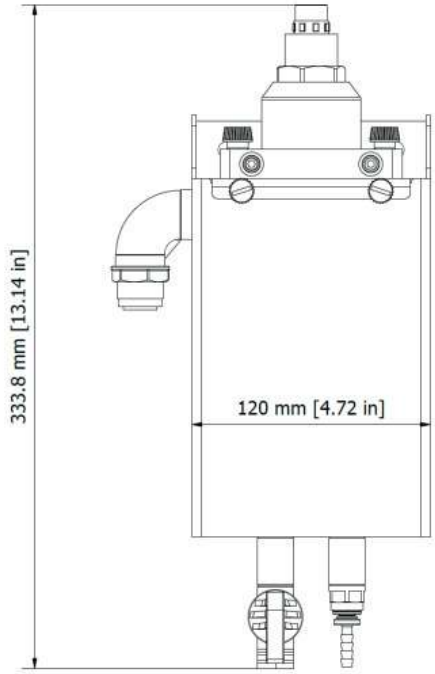
A	3S-CHL chlorophyll sensor
B	Probe cable (6 m)

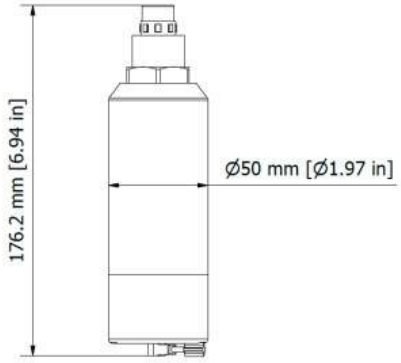
3.2 Product code

The product code is an alphanumeric code that identify your 3S Analyzers product and its configuration. For the 3S fluorescence sensor the code is the following:

3S-CHL

3.3 Wall mounting dimensions





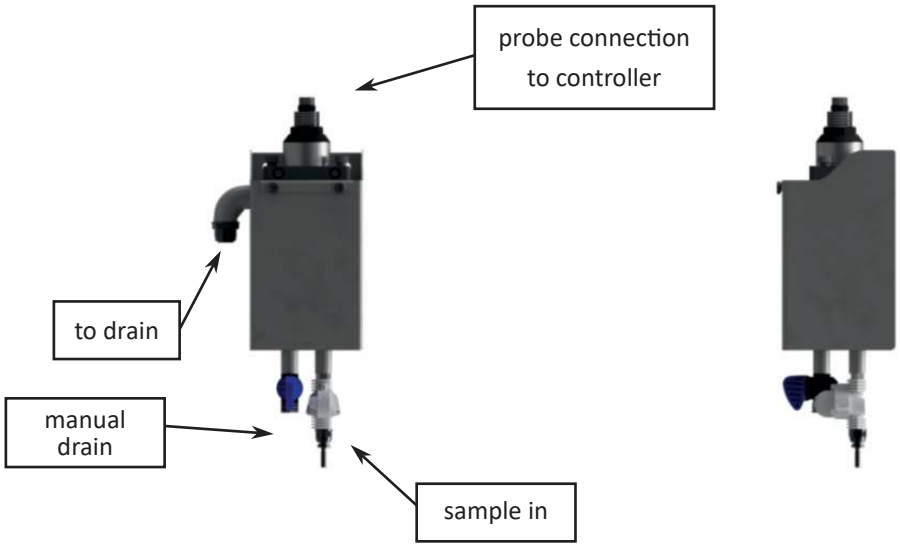
Recirculating sample reservoir cod. A46U10035 is included in the scheme as a reference but should be purchased separately.

3.4 Mounting the instrument (example with 3S-PC1000)

The 3S-PC1000 controller and the sample reservoir must be mounted vertically on a wall or support suitable for their weight and not subject to vibrations. Use suitable screws (not included in the supply) and fasten them only on the side brackets (ear clips) of the instrument and in the holes of the tank metal plate. Mount them so as to get the display at eye height (160 cm, 63 in).

Since the probe connections and flow sensor connectors are on the right side of the analyzer, install sample reservoir underneath the analyzer, in a way that is reachable from the right side. Please, also consider that the surrounding space must allow easy opening of the analyzer door and easy access to the sample reservoir for cleaning or mantainance.

A minimum distance of 10 cm is required between the sides of the instrument and any other obstacle.



The sample reservoir (cod. A46U10035) should be mounted preferably under the controller. The sample line must be connected to the inlet below the container, optionally a flow sensor can be installed on the same line to detect the presence of the sample.

The reservoir has a side arm to drain the excess liquid and to maintain a constant sample flow. The side arm must be connected to the drain.

When the container is installed in a proper position the probe can be inserted into its slot and secured with the clamp.

Finally, attach the probe connector to the analyzer.

4 - CALIBRATION

4.1 About the method

The probe is calibrated using standard solutions which are analyzed in the same way as the sample.

In order to ensure correct measurement performance, the probe should be calibrated periodically, best results are obtained if it has been recently cleaned and serviced.

Due to the nature of some analytical methods the concentration/signal plot is not linear in the whole range of our interest. Therefore the analyzer uses a multi-point calibration curve. The first point is the blank (zero), which is usually done by analyzing demineralized water. A part from the blank, other points are needed for the calibration curve, covering the whole range of interest.

The 3S-PC1000 controller is able to manage two probes with independent calibration curves, up to five points each.

Please refer to the 3S-PC1000 user manual for detailed instructions to perform a multi-point calibration with the 3S-CHL probe.

4.2 Calibration

The probe can be calibrated in µg/l chlorophyll. Chlorophyll solution whose value has been predetermined by extractive methods can be used as calibration standards and usually give the best results (see 4.6).

Alternatively standard solutions of rhodamine B (CAS 81-88-9), a common dye, can be used.

The following example shows a 2-point calibration for the 3S-CHL chlorophyll sensor using rhodamine B.

Chemicals

- Rhodamine B
- Demineralized water

Instrumentation

- A 25 ml glass measuring cylinder
- 2000 ml glass beacker
- 500 ml volumetric flask
- 2000 ml volumetric flask

Stock solution

Prepare a stock solution (100 mg/l) of rhodamine B by weighting 0.05 g of solid rhodamine B and quantitatively transfer it to a 500 ml volumetric flask. Fill the flask up to the mark with demineralized water.

Store the concentrated standard solution in a darkened glass bottle in a refrigerator to delay decomposition.

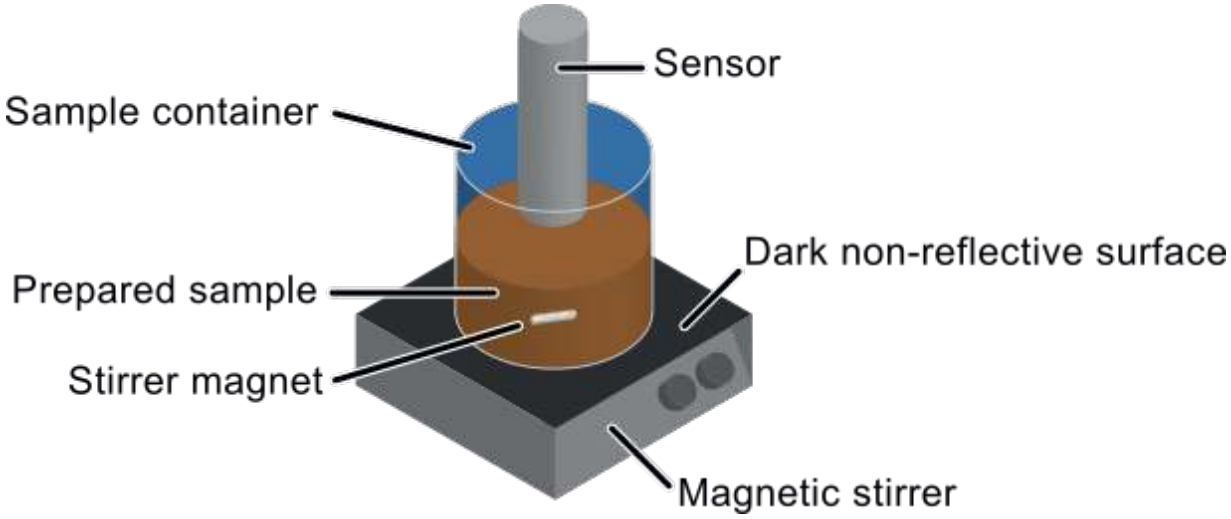
Blank

The blank is measured using demineralized water.

Standard

Accurately transfer 10 ml of the solution prepared in the above step to a 2000 ml volumetric flask and then fill the flask to the mark with demineralized water. The obtained solution has a concentration of 0.5 mg/l rhodamine B in water.

The dilute standard solution should be used within 24 hours from its preparation.



Procedure

Fill the 2 liters beaker with water.

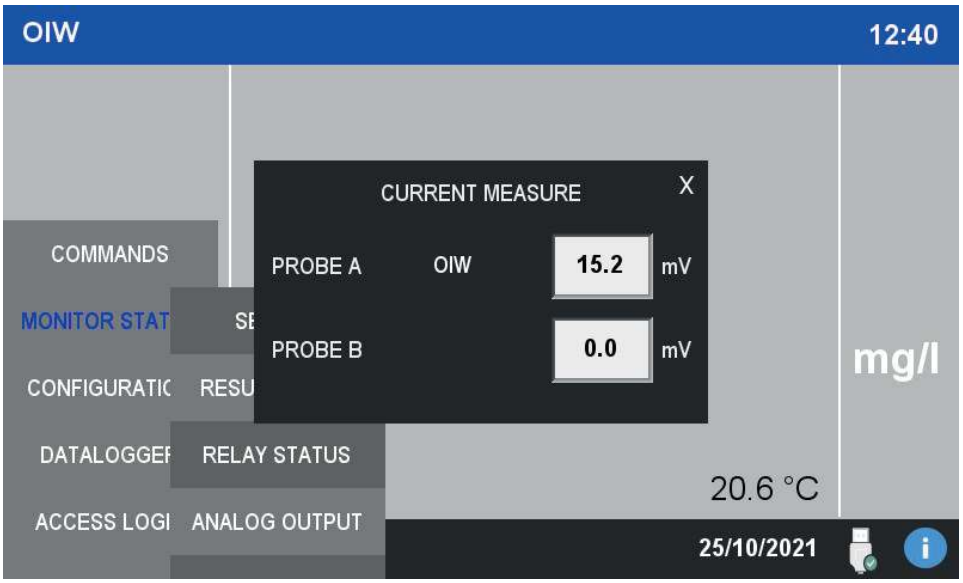
Clean the probe with a clean cloth and a drop of isopropanol. Place the probe into the beaker, dipped 2-3 cm into the solution, at least 5 cm from the container walls. You can use a stand to help the probe stay in position. Make sure no air bubbles are trapped below the sensor. Be also sure to place a dark, non reflective sheet under the beaker.

Take note of the sensor reading, this is your blank.

Now, replace the demineralized water in the beaker with the standard solution prepared in the previous step.

After waiting at least 90 seconds then take note of the sensor response.

The sensor signal can be read from the MONITOR STATUS > SENSOR page.



To convert the concentration of rhodamine B in chlorophyll equivalents we need to apply a conversion factor. The fluorescence of rhodamine B shows an inverse relationship with temperature. To properly set the sensitivity of the sensor using the 0.5 mg/l rhodamine B standard, please apply the value from the conversion table below.

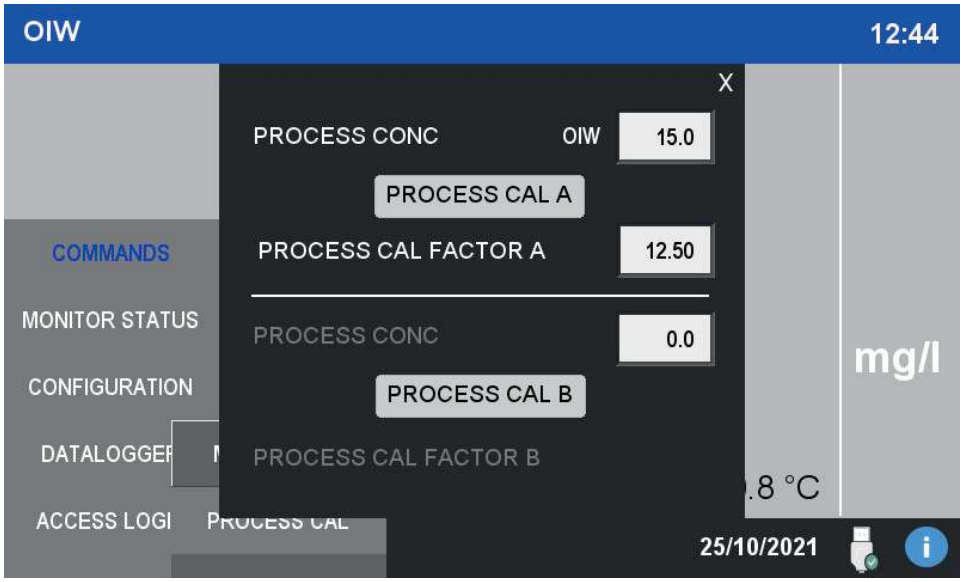
Temp (°C)	Chlorophyll (µg/l)
8	100
10	98.0
12	95.1
14	93.2
16	90.8
18	86.4
20	82.0
22	79.4
24	77.0
26	75.6
28	74.1
30	72.6

4.3 Process calibration

Alternatively, the probe can be calibrated using a real sample whose concentration is known. To do this, the same setup described in the previous section can be prepared. The calibration can also be done directly on the installed sample line, if real time results are available.

The process calibration can be performed through the following steps:

1. Take a sample representative of the water stream to be analyzed, at least 1 liter. Follow good sampling techniques to have reliable results.
2. Determine the concentration of the analyte of interest using a reference instrument or a laboratory analysis of the sample .
3. Immerge the probe in the sample and wait for a stable result.
4. Go to COMMANDS > PROCESS CAL



5. Press and hold PROCESS CAL A (or B depending on the probe you want to calibrate if more than one are present).
6. The process calibration is now completed, the new measurements will be corrected with the factor calculated in the procedure.

Note: is it possible to calculate the factor analyte/standard and put it directly in the process factor field on the same page.