



USER MANUAL



3S-UVO

UV254 absorption sensor for organic load



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 analyser 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 analyser can carry out service activities on the equipment.



This symbol indicates the existence of a risk of electric shock and/or electrocution. Only operators qualified for these activities can perform maintenance and control operations on the equipment bearing this label, always after unplugging it.

Parts involved:
- input terminal block in the upper box



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	CODeq, TOCeq, BOD eq, SAC254, UV254Abs
Measuring principle	UV254 absorption photometry
Measuring range	Low range COD 0 - 370 mg/l eq. KHP / TOC 0 - 150 mg/l High range COD 0 -1000 mg/l eq. KHP / TOC 0 - 400 mg/l
Reproducibility	± 2.5 % of the full scale
Limit of detection	0.75 ppm (KHP equivalents)
Analysis Frequency	1 s
Sample	Pressure: pressure-free vessel (depth up to 60 m) Temperature: 5 - 50 °C (41 - 122 °F) Flow Rate: 80 to 500 mL/min Connection: 6 mm (¼-in.) Drain: pressure-free, atmospheric drain
Body material	Stainless steel 316L
Dimensions	∅ 50 mm, L 175.8 mm
Weight	Approx. 1 Kg (2.2 lbs)
Power Supply	Voltage: 5 - 12 VDC Power consumption: max. 0.5 VA
Outputs	ModBUS RTU RS485
Installation	With optional fast-loop reservoir (not included), pipe-mounted or wall mounted with appropriate brackets
Protection Grade	IP68

2.2 Instrument description

The 3S-UVO is a sensor for water monitoring. The sensor works with the principle of UV fluorescence and can be used to detect many common pollutants such as hydrocarbons/oil-in-water, BTEX, PAH/PAC. In many cases the measurements can be correlated with sum parameters like CODeq, TOCeq, BODeq. The design is compact and robust, the stainless steel body offer great protection up to a depth of 60 m.

2.3 Applications

The instrument can be used to monitor the concentration of various parameters in aqueous samples and it finds application in civilian and industrial wastewater control, oil industry, hydrocarbons transport and storage and every other application that requires a fast and sensitive determination of possible pollutants.

2.4 Method description

The probe is sensitive to dissolved organic matter, through absorption measuring in the UV region.

Most organic molecules in aqueous solution have spectral characteristics capable of absorbing a fraction of energy associated with a light beam to which it is exposed.

This characteristic is due to the presence of chromophore groups (aromatic bonds, double covalent bonds and triple bonds) which is typical of organic substances.

Therefore, the greater the amount of organic molecules dissolved in the volume of the measuring cell, the less the light intensity, at this specific wavelength, that will reach the detector.

The intensity of the absorbance is measured by using as a reference the intensity detected for another wavelength (in the visible region) which is not influenced by the presence of organic substances.

This photometric investigation method allows, using the Lambert-Beer law, to calculate the absorbance and after calculating a calibration curve, to determine the concentration of the organic substances expressed as TOC, DOC, COD, BOD or as SAC254 Absorption coefficient.

The related results are expressed in concentration units (mg/l, ppm, ppb) for cumulative parameters obtained by correlation or extinction per meter m (1/m) as required by DIN 38404-3 standard for SAC254.

The ultraviolet light source of the probe is a highly-stable LED.

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-UVO UV254 absorption sensor for organic load
B	Probe cable (6 m)

3.2 Product code

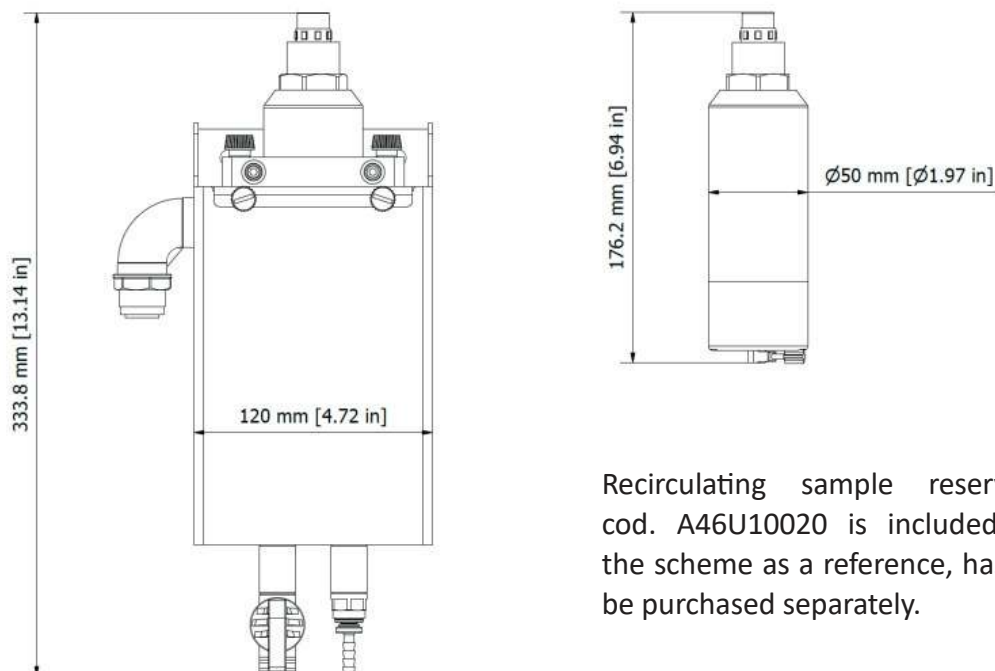
The product code is an alphanumeric code that identify your 3S Analyzers product and its configuration. For the 3S fluorescence sensor the code is the following:

3S-UVO-X

X =

L	Low range COD 0 - 370 mg/l eq. KHP / TOC 0 - 150 mg/l
H	High range COD 0 -1000 mg/l eq.KHP / TOC 0 - 400 mg/l

3.3 Wall mounting dimensions



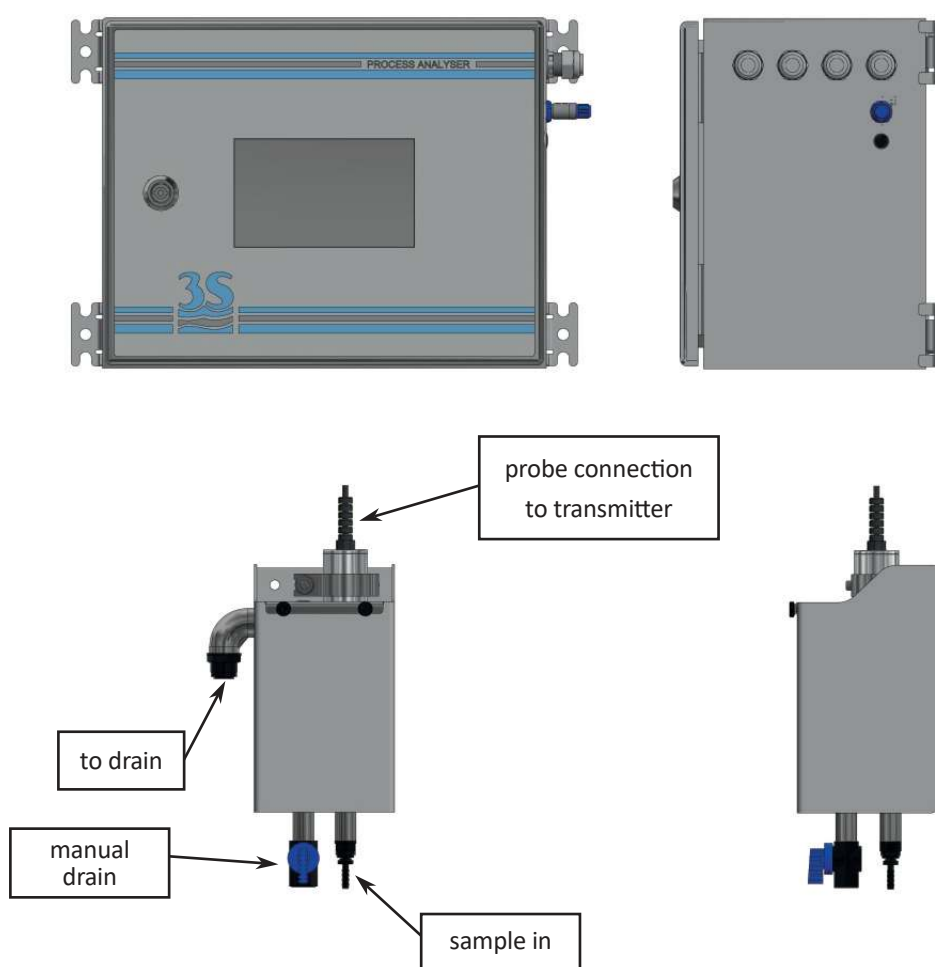
Recirculating sample reservoir cod. A46U10020 is included in the scheme as a reference, has to be purchased separately.

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 maintenance.

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



The sample reservoir (cod. A46U10020) can be mounted preferably under the instrument. 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.

3.5 Probe connection to the data acquisition system

To connect the probe to the data acquisition system (3S-PC1000, not supplied with the probe or other controller), proceed as follows:

- Connect the wires from the probe extension cord according to the following table:

Red	Black	White	Green
5-12 VDC	GND	RS485 D-	RS485 D+

- Connect the connector of the extension cord to the probe (probe must be already correctly installed in its final position).

- Turn on the controller

3.6 ModBUS connection parameters

The probe has a ModBUS RTU interface for the transmission of measurement data and settings read/write. Connect your data line to the D+/D- wires as described in the previous paragraph.

Configure your network using the following parameters:

Protocol	ModBUS RTU
Baudrate	9600
Node number	1
Byte order	Little endian
Word order	Little endian

3.7 ModBUS commands

Get node number

Use this command to read the device current node number. Use fixed device address 0x255 to communicate with an unknown device address.

Command: Read Register (0x03)

Address: 0x3000

Data length: 1

Data format: u16

Set node number

Set a new device ModBUS node number.

Command: Write Register (0x10)

Address: 0x3000

Data length: 1

Data format: u16

Get serial number

Get the serial number of the sensor as a string of characters.

Command: Read Register (0x03)

Address: 0x0900

Data length: 7

Data format: char[14]

Get hardware and software versions

Get the hardware and software versions of the sensor.

Command: Read Register (0x03)

Address: 0x0700

Data length: 2

Data format: hw_version: u16, sw_version: u16

Start measurements

This command turns the UV source on and starts the measurement routine of the sensor.

Command: Read Register (0x03)

Address: 0x2500

Data length: 1

Data format: ignore

Get temperature

Get the temperature value measured by the probe.

Command: Read Register (0x03)

Address: 0x2600

Data length: 2

Data format: f32

Get signal value

Get the signal (OIW) value measured by the probe.

Command: Read Register (0x03)

Address: 0x2602

Data length: 2

Data format: f32

Get brush error

Read the probe error register. If equal 0xFF the brush is in the wrong position and measurements stop.

Command: Read Register (0x03)

Address: 0x2604

Data length: 1

Data format: u16 (0x00 = OK, 0xFF = error)

Stop measurements

Stop the measuring routine.

Command: Read Register (0x03)

Address: 0x2E00

Data length: 1

Data format: ignore

Get calibration factors

Get the span and offset values as an array of two floats.

Command: Read Register (0x03)

Address: 0x1100

Data length: 4

Data format: span: f32, offset: f32

Set calibration factors

Set the new calibration factors, span and offset.

Command: Write Register (0x10)

Address: 0x1100

Data length: 4

Data format: span: f32, offset: f32

Activate brush

Make the brush rotate once.

Command: Write Register (0x10)

Address: 0x3100

Data length: 0

Data format: ignore

Get brush interval

Get the interval between brush cleaning operation.

Command: Read Register (0x03)

Address: 0x3200

Data length: 1

Data format: u16

Set brush interval

Set the interval between brush cleaning operation.

Command: Write Register (0x10)

Address: 0x3200

Data length: 1

Data format: u16

Get brush mode

Read the current brush mode, automatic or manual.

Command: Read Register (0x03)

Address: 0x1b00

Data length: 1

Data format: u16 (0x00 = MANUAL, 0x01 = AUTO)

Set brush mode

Set the current brush mode as automatic or manual.

Command: Write Register (0x10)

Address: 0x1b00

Data length: 1

Data format: u16 (0x00 = MANUAL, 0x01 = AUTO)

4 - CALIBRATION

4.1 About the method

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

In order to ensure correct measurement performance, the probes should be calibrated periodically, best results are obtained if they have 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. In case the calibration curve is linear only a blank and a span points are needed.

The probe can be calibrated internally (via the ModBUS interface) or externally (via the controller).

The probe is commonly calibrated in absorbance unit (m^{-1}), to correlate the measurement to sum parameters such as TOCeq, CODEq, BODEq the probe is further calibrate with a process calibration.

4.2 Internal calibration

The probe has the possibility to store blank and slope values. If a linear calibration is enough, the probe can be calibrated internally via the ModBUS interface (see section 3.7).

After collecting the values for blank and span, trace a calibration curve and take note of offset and slope values. Overwrite the corresponding registers to calibrate the probe.

The new values transmitted by the probe will use the new calibration curve.

4.3 External calibration

If a non-linear calibration curve or deeper data analysis are needed, the probe can be calibrated using an external controller.

In this case the logic must be implemented in the controller. 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 or other controller user manual for the instructions to perform a multi-point calibration with the 3S-OIW probe.

4.4 Blank calibration

The blank calibration is simply performed by analyzing demineralized water. The blank calibration is particularly sensitive to impurities so is advisable to thoroughly clean the probe before starting the calibration.

To perform a blank calibration, submerge the probe in pure water. If the result is stable, take note of it.

4.5 Span calibration

The instructions shows a multi-point calibration. Single-point calibration is performed in the same way.

Some probes require a non-linear calibration. In that case we need to make measurements at different concentrations to draw the calibration curve. If the probe response is linear only one point is necessary.

As an example the next paragraph describes a 5-point calibration with an absorbance standard solution.

An absorbance standard is a solution capable of providing a specific absorbance value at a specific wavelength (254 nm). It is commonly prepared with KHP. After the calibration with the standard solution the measurement can be converted in the final measurement unit with a process calibration.

To perform a multi-point calibration, proceed as follow:

Chemicals

- Potassium hydrogen phthalate (KHP)
- Demineralized water

Instrumentation

- 2 L glass beaker
- 1 L volumetric flask
- 100 mL measuring cylinder

Stock solution

Prepare a stock solution (10000 m^{-1}) of KHP by weighting 12.7 g and inserting it into the 1 L volumetric flask, fill the flask with demineralized water upto the flask mark.

Blank

The blank is measured using pure water. If the application is not demanding tap water can be used. The blank is the first point of our calibration curve.

Standard

We need other four points in addition to the blank. It is better if the four points cover the full scale.

Procedure

Fill the 2 L beaker with 800 ml of the blank 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.

Turn on the stirrer at 500 rpm and wait at least 90 seconds for the sensor to give a stable reading. Take note of the sensor reading, this is your blank.

Now, prepare the other standard solutions. In this example we will calibrate the 0-1000 mg/l COD probe, we'll need to prepare four standard solutions that will cover the whole range. From the 10000 m^{-1} standard solution take the amount listed in the table below, pour it in a graduated flask and fill the flask with demineralized water up to the mark. Repeat the operation for all the necessary standard solutions.

Concentration (m^{-1})	Volume addition (ml)
0	0
250	25
500	50
750	75
1000	100

Now empty the beaker containing the blank water and fill it with the standard solution at lower concentration. Insert the probe in the solution and when the result is stable take note of it, then discard the solution, clean the beaker and proceed in the same way for the other points.

When you have collected all the points, insert them in the controller (follow the controller instruction on how to do it).

4.6 Process cal

Once the probe is calibrated with the standard solution we can proceed further and align the measurement to process parameters such as TOC, COD, BOD.

These parameters depends on the nature of the specific substances contained in the sample, therefore it is not always possible to prepare standard solutions for them.

What we can do is compare the measurement to a laboratory analysis (cuvette tests or other analytical methods), calculate a conversion factor and apply to the probe measurement.

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 parameter of interest (COD, TOC, BOD) using a reference instrument or a laboratory analysis of the sample .
3. Submerge the probe in the sample and wait for a stable result.
4. Calculate a multiplication factor then follow the instructions of the controller to apply it to the measurement.
5. The calibration is now over, the following measurements will be calculated with the new process factor.