



# StacSense

User manual

Version 1.0



The most recent version of this manual is available on our website:

<https://www.aqualabo.fr/>

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## 1. WARRANTY

The new materials and equipment sold by the AQUALABO company are guaranteed against all manufacturing defects for a period of 1 year excluding consumables (unless expressly stipulated by AQUALABO) from:

- the date on which the buyer or authorized representative declares technical acceptance of the equipment at the factory,
- or alternatively,
  - for mainland France: from the date of the delivery note,
  - for other destinations: from the date of shipment certified by LTA, way bill, or bill of lading.

AQUALABO's warranty applies exclusively to flaws resulting from a design or inherent defect. It is strictly limited to the free delivery of replacement parts (except consumables) or the repair of the device in our workshops within 10 working days, transport not included.

The following are, by express agreement, formally excluded from our warranty:

- Any economic damage, such as staff costs, loss of profit, business disruption, etc.
- Any failure due to improper use of the device (unsuitable mains power, fall, attempted conversion, etc.), lack of maintenance by the user or poor storage conditions.
- Any failure due to using parts, not supplied by AQUALABO, on its equipment.
- Any failure due to transporting equipment in non-original packaging.
- Batteries, aerals, and in general, any item listed under "accessories".

Our customers are asked to always request our agreement before sending us a device for repair. No returns will be accepted without the prior written consent from our after-sales service which will stipulate the return procedure. In this case, the items will be returned in their original packaging, carriage paid, to the following address:

**AQUALABO - 115 Rue Michel Marion 56850 Caudan - France**

We reserve the right to reship any device received without this agreement. Regardless of the type and conditions of transport chosen to ship the equipment for repair under guarantee, in the original packaging, the related expenses as well as insurance costs will be the customer's responsibility.

Any damage resulting from returning the equipment falls within the framework of the guarantee on the express condition that customers have sent their claims to the carrier, by registered letter with acknowledgment of receipt, within forty-eight hours, with a copy of the letter sent to AQUALABO.

For devices with a warranty form, it only applies if the form received with the device is returned to AQUALABO duly completed.

### SOFTWARE WARRANTY

The software is guaranteed by the software publisher or distributor under the conditions specified in the documentation related to those software packages.

AQUALABO does not, under any circumstances, guarantee the software packages.

By express agreement, we formally exclude from our warranty all economic damage, in particular for staff costs, loss of profit, business disruption, etc.

Customers are informed that AQUALABO may not, under any circumstances, be held responsible for any failure or bugs the software contain.

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## 2. INFORMATION

AQUALABO equipment has been designed, manufactured, tested and inspected in accordance with ISO 9001 procedures.

If the equipment is not used immediately, it should be stored in a clean, dry place. Abide by the following storage temperatures (10-35°C).

AQUALABO equipment is carefully inspected before packaging. Upon receipt of your device, check the condition of the packaging and if you notice an anomaly, submit the usual reservations with the carrier **within 48 hours**. Then consult the packing list and check that everything is in order. Finally, if you notice that something is missing or the equipment damaged, contact AQUALABO without delay.

**STACSENSE sensors are entirely designed and manufactured by AQUALABO in France.**



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## 3. SAFETY

### 3.1 SAFETY INSTRUCTIONS

#### 3.1.1 SAFETY INSTRUCTIONS IN THE MANUAL

This manual provides important information on how to operate the product safely. Read it carefully to familiarize yourself with the product before commissioning and using it. This manual should be kept near the product so that the information you need is always easy to find.

Important safety instructions are highlighted in this manual. They are indicated by the warning symbol (yellow triangle) on the left-hand side.



##### CAUTION

Indicates a potentially hazardous situation that may result in serious (irreversible) injury, death, product damage, or destruction if the safety instructions are not followed.

#### 3.1.2 LABELS ON THE PRODUCT

Be aware of all information labels and safety symbols affixed to the product.

### 3.2 OPERATING SAFETY

#### 3.2.1 INTENDED USE

Comply with the following points for safe operation:

- Store and use the device under the environmental conditions mentioned in this manual ([see Characteristics](#))
- Do not disassemble the device
- Power the device in compliance with the specified DC voltage range.
- Comply with the use restrictions given below

#### 3.2.2 UNAUTHORIZED USE

The product must not be operated if:

- it is visibly damaged (e.g. after being transported)
- it has been stored under adverse conditions for a long period of time

#### 3.2.3 USER QUALIFICATION

We assume that operators know how to manage this equipment by virtue of their professional training and experience. In particular, operators must be able to understand and correctly implement the safety instructions/labels when using the product. Trained personnel should be familiar with and follow the instructions in this manual.



## 3.3 NOTES ON HANDLING

StacSense sensors are electronic devices. As such, they must be treated with care. Always protect the device from conditions that could adversely affect its components. In particular, adhere to the following points:

- The ambient temperature and humidity, when using and storing, must be within the limits indicated in the TECHNICAL CHARACTERISTICS section.
- Regardless of the circumstances, the device must be protected from the following influences:
  - Intensive exposure to light and heat
  - Corrosive or caustic fluids, organic solvents or vapor with a high solvent content.
- This sensor is an optical measurement device. As a result, the optical path and more particularly the two optical windows must be protected. Dirt and scratches may affect measurement performance.
- All work on the inside of the instrument, must be performed by AQUALABO or by AQUALABO-approved technicians.

## 3.4 PACKAGING

The StacSense sensor is shipped in packaging designed to protect it during transport. It is essential that you keep the original packaging as well as the inner packing in such a way as to ensure optimum protection of the device from impact in the event of transport. The original packaging is also required for return transport under appropriate conditions if repair is needed. Please remember that we shall decline any warranty claim for damage caused by unsuitable transportation.

## 4. OVERVIEW OF THE STACSENSE SENSOR

### 4.1 PACKAGE CONTENTS

You have just received your sensor:



*Model shown: 2 mm optical path*

The package consists of a StacSense sensor with a single power and communication cable. A USB stick containing this manual and all the product-related information.  
Cable length varies depending on the model ordered.

Upon receipt of your device, check the condition of the packaging and if you notice an anomaly, submit the usual reservations with the carrier **within 48 hours**. If you notice that something is missing or the equipment damaged, contact AQUALABO without delay.



**CAUTION:**

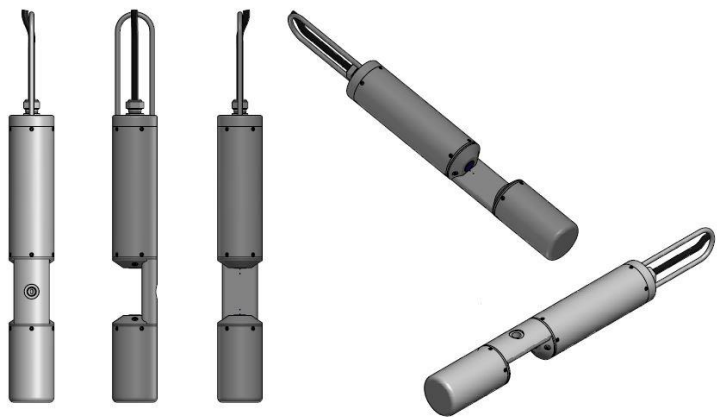
**The sensor and cable (along its entire length) must be in perfect condition before immersion in the fluid studied.**

## 4.2 GENERAL VIEW OF THE STACSENSE SENSOR

The STACSENSE sensor has a largely cylindrical shape extended by a fastening ring or grip, which protects the cable outlet area. The optical path is determined at the time of order, depending on the sensor's field of use. The optical windows are located on two separate mechanical components. A female thread located on the opposite side of the main measuring area adapts to a compressed air supply connection.



General views - 2mm optical path sensor



General views - 50mm optical path sensor



**CAUTION:**

The cable is used to power the sensor and communicate with the master device. The product's seal is not guaranteed when the sensor is suspended by its cable or when the cable is damaged (cut or partial abrasion of the outer sheath).



**CAUTION:**

The STACSENSE sensor outer shell is made of 316L stainless steel. This material is not compatible with use in salt water (seawater, spray): risk of corrosion in the short term.

## 4.3 MEASURING PRINCIPLE

The STACSENSE sensor is an optical sensor for measuring absorption in aqueous solution (natural or wastewater). The optical system consists of five major components:

- Main optical source, UV-C LED, peak wavelength 255 +/- 5nm,
- Secondary optical source, visible LED, peak wavelength 530 +/- 5nm,
- Assembly of optical components to manage light beams
- Optical path through the observed fluid,
- Detector, photo-diode.

The light emitted by the source is guided through the optical windows and fluid studied. The latter absorbs part of the radiation. The intensity of the light  $I$  captured by the optical receiver is used. The reference light intensity  $I_0$  is obtained in a sample of clear, pure water at a stable temperature.

Transmittance  $T$  is defined by the following equation:

$$T = I/I_0$$

Absorbance  $A$  is defined by the equation:

$$A = -\log_{10} T$$

The SAC 254 parameter is obtained by using absorbance at 254 nm as well as at 530 nm and the optical path length  $L$  expressed in meters.

$$SAC\ 254 = [A_{(254nm)} - AT_{(530nm)}] / L$$

NOTE: reference document DIN 38404-3; July 2005

NOTE: Absorbance at 530nm is used to perform a turbidity correction. The initial light beam is mitigated by the scattering of light particles and the insoluble substances in the medium analyzed.



### CAUTION:

The STACSENSE sensor has an optical system based on a UV-C light source. Never look directly into the light source. Risk of irreversible damage to sight.



### CAUTION:

An external, intense light source may saturate the sensor's optical system receiver and therefore distort the measurement.

## 4.4 CHARACTERISTICS

|                               |                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                             |                                                                                                                        |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| <b>Digital communications</b> | <b>RS485, MODBUS RTU protocol</b><br><p>The STACSENSE sensor is a modbus slave. The master device configures and commands the measurement then records the result(s) by reading logs defined in the magnetic core plane.</p>                                                                                                                                    | <b>SDI-12</b><br><p>Measurements made by the sensor are also accessible via the SDI-12 protocol.</p>                                                                                                                                                        |                                                                                                                        |
| <b>Class</b>                  | <b>Overall dimensions</b><br>Diameter: 48mm<br>Length: <i>see footprint diagram</i> .<br><br>2mm optical path:<br>50mm optical path:                                                                                                                                                                                                                            | <b>Weight</b><br>1600 - 1800 g according to the optical path (cable not included)<br><br><b>Materials</b> <ul style="list-style-type: none"> <li>316 L stainless steel</li> <li>Corning 7980</li> <li>O-rings: Fluoro-elastomer (FPM / FKM)</li> </ul>      | <b>Connections</b><br><br>Standard cable length:<br><br>3, 7 and 15 meters.<br><br>Bare wires or 6-male-contact plugs. |
| <b>Power Supply</b>           | DC voltage range:<br>5.2 to 28.0 VDC.                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                             |                                                                                                                        |
| <b>Environment</b>            | <b>Ingress protection rating</b><br>IP68                                                                                                                                                                                                                                                                                                                        | <b>Temperature</b><br>Storage: -10°C to + 50°C<br>Use: 0°C to +40°C                                                                                                                                                                                         | <b>Standards</b><br>Compliant to EC marking                                                                            |
| <b>Identification</b>         | The product serial number is written on the outer casing of the sensor.                                                                                                                                                                                                                                                                                         | The sensor is identified by a label affixed to the outer casing.                                                                                                                                                                                            |                                                                                                                        |
| <b>Accessible settings</b>    | <b>Standard settings</b><br>Fluid temperature (°C)<br><br>Spectral Absorption Coefficient, SAC 254 (m-1)<br><br>COD equivalent (mg/L)*<br><br>BOD equivalent (mg/L)*<br><br>TOC equivalent (mg/L)*<br><br>* The conversion coefficients are determined in the factory from aqueous solutions of potassium hydrogen phthalate (KHP) under laboratory conditions. | <b>Extended settings</b><br>Turbidity (530nm) (FAU) **<br><br>Transmittance and Absorbance.<br><br><br><br><br><br><br><br><br>** The equivalent turbidity is determined in the factory, from aqueous suspension of formazine, under laboratory conditions. |                                                                                                                        |

5. CONNECTION AND WIRING

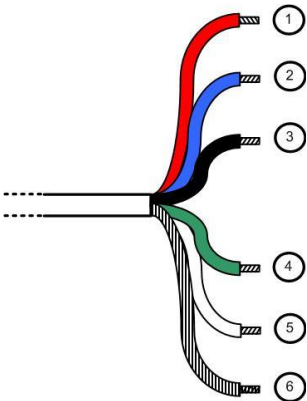
The STACSENSE sensor comes with a factory-installed cable and connector.



CAUTION:

The modification of the connector installed by the manufacturer, bare wire or 6-contact plug, represents a major transformation of the product and entails a loss of guarantee.

Conductor IDENTIFICATION TABLE:



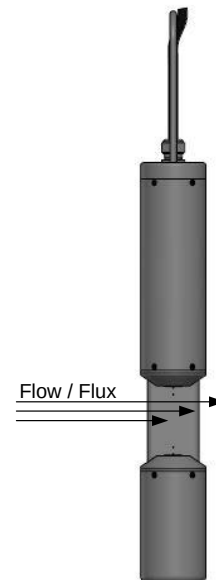
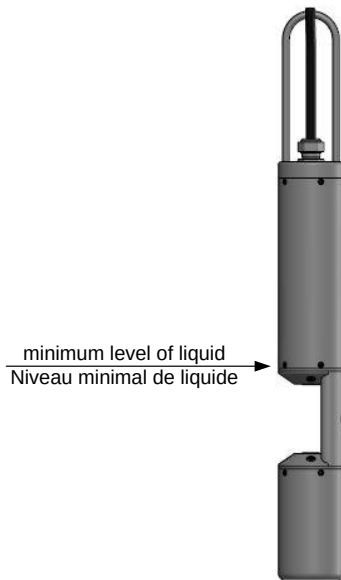
| Cable length up to 15m included |                  | Cable length from 15 to 100 m             |                  |
|---------------------------------|------------------|-------------------------------------------|------------------|
| 1 - Red                         | Power Supply, V+ | Red<br>Yellow<br>Orange<br>Purple<br>Pink | Power Supply, V+ |
| 2 - Blue                        | SDI-12           | 2 - Blue                                  |                  |
| 3 - Black                       | Weight           | 3 - Black                                 |                  |
| 4 - Green                       | B "RS-485"       | 4 - Green                                 |                  |
| 5 - White                       | A "RS-485"       | 5 - White                                 |                  |
| 6 -<br>Green/Yellow             | Cable shielding  | 6 -<br>Green/Yellow                       | Cable shielding  |
| Connect wires 3 and 6 together  |                  | Connect wires 3 and 6 together            |                  |

## 6. CONDITIONS OF USE

### 6.1 SITUATION SIMULATION

The STACSENSE sensor may be fully immersed. In the case of partial immersion, the entire optical path must be kept in the fluid studied.

Lateral flow is recommended to prevent particles from building up, deposits or gas bubbles in the measuring zone between the optical windows.



### 6.2 SENSOR FASTENING

A sturdy system is required to hold the sensor, in order to:

- keep the sensor in the circulating fluid, according to the appropriate position, away from any sedimentation zone and thus obtain representative measurements of the medium,
- avoid impacts on the sensor, contact with the walls, bottom of the tank, floor or any other object in the fluid.
- eliminate mechanical strain on the power and communication cable.



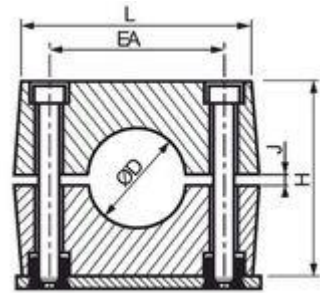
#### CAUTION:

The power and communication cable shall not be used to move or transport the sensor. The ring located at the end of the sensor is designed for this purpose.

As an example, a clamp consisting of two half-shells with a stainless steel base (see illustration below, 48.3mm diameter model) can be used to permanently position the sensor in the fluid analyzed. This mechanical system using a polypropylene shell, completely isolates the body of the sensor from its support.



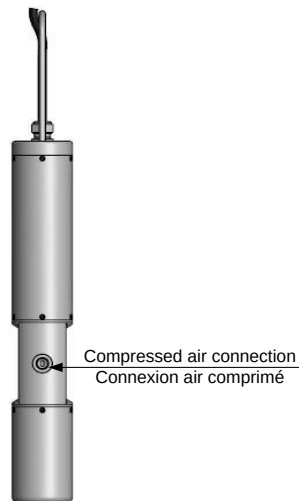
*Mechanical sensor-holding system  
(front view)*



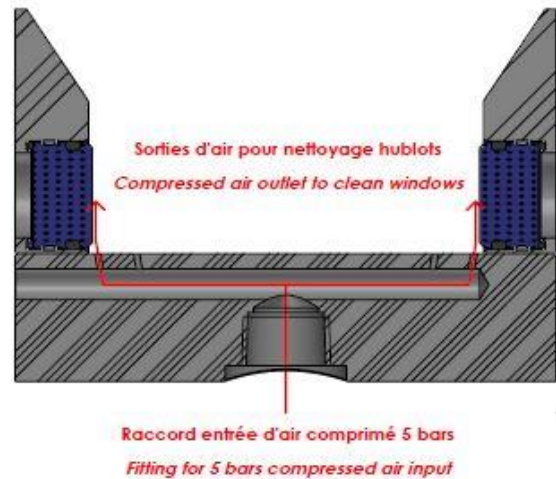
*Clamp (side view) - D48.3mm  
compatible with the sensor*

## 6.3 LOCALIZED AIR INJECTION SYSTEM

A female thread (1/8 NPT) located on the opposite side of the main measuring zone is used to connect a compressed air supply. This air injection device, located near the two optical windows removes residue from the measurement zone.



*Overview view, rear of the sensor*

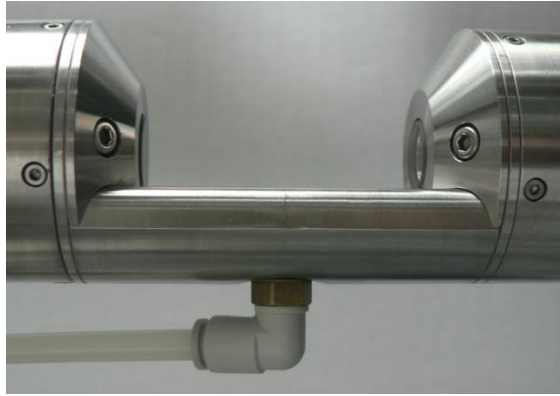


*Detailed view of the compressed air  
circuit*

### NOTE:

Using a compressed air supply quick-release connector, bent to 90°, compatible with a standard semi-flexible hose, and with a 6mm external diameter is recommended. The 90° elbow connects the air supply tube along the sensor body to the communication cable.





*50mm optical path sensor with 90° elbow connection*



**CAUTION:**

Installing a compressed air quick-release coupling, made of metal other than stainless steel, may generate corrosion phenomena locally that damage the sensor.

## 6.4 UPKEEP OF THE SENSOR

The STACSENSE sensor is an optical sensor which is sensitive to pollution in the measuring zone. The user must, during maintenance operations, check the status of the two optical windows and identify any scratches that may require calibration in clear water. Routine servicing of the optical windows can be performed by rinsing in clear water, followed by cleaning with a clean rag soaked in isopropyl alcohol (IPA).



**CAUTION:**

The use of an abrasive cleaning product may permanently damage the optical windows.

The use of an organic solvent such as acetone may damage the product's seals as well as the cable sheath.

## 7. COMMUNICATION

### 7.1 GENERAL POINTS

#### 7.1.1 COMMUNICATION AND PROTOCOL

The STACSENSE sensor has two digital serial communication modes:

- The Modbus RTU protocol (RS485 physical medium) enables the exchange of information between the master device and the sensor (slave) such as, the measurement configuration, measurement values and calibration of the available parameters.
- The SDI-12 protocol (TTL/5V Half-Duplex Series physical medium) triggers measurements and collects results from the main measurements.

## 7.1.2 SENSOR ADDRESS:

The StacSense sensor's RS485/Modbus communication address is factory set. Its value is constant (70) and different from that attributed to any other model in the DIGISENS range, for example, OPTOD sensor (10). The broadcast address (0) is aimed at a sensor whose address is unknown to change its Modbus address.

Similarly, the ex-factory default SDI-12 address is 7.

These addresses can be modified by an operator wishing to manage a network of several sensors, thereby avoiding any conflict.

## 7.2 SETTINGS

The parameters accessible via the STACSENSE sensor are fall into three categories:

### I\_Main parameters:

- a. Temperature of the fluid, expressed in °C,
- b. Spectral Absorption Coefficient SAC 254, based on absorbance at 254 and 530nm, expressed in  $m^{-1}$

### II\_Parameters deduced according to a first degree polynomial law (offset and slope)

- a. Chemical Oxygen Demand (COD) equivalent, expressed in mg/L
- b. Biological Oxygen Demand (BOD) equivalent, expressed in mg/L
- c. Total Organic Carbon (TOC) equivalent, expressed in mg/L of carbon

### III\_Estimated parameter

Turbidity of the fluid based on absorbance at 530 nm of a formazine aqueous suspension.

NOTE: The conversion coefficients, offset and slope, for each of the three deduced parameters (COD, BOD, and TOC), are factory set by default. However, these coefficients are dependent on the application and type of fluid observed. They must be defined by the user during any lasting measurement campaign.

## 7.3 MEMORY PLAN: LIST OF MAIN REGISTERS

The document describing the memory layout, common to sensors in the DIGISENS range, is the reference for exchanges between the master device and the sensor(s) connected to it.

The StacSense sensor provides most of the communication aspects of DIGISENS sensors.

The key components for collecting measurements are the following:

| ACTIONS / DATA                                             | Modbus address<br>(as a hexadecimal) | Read, write | VALUE         | TYPE     | UNIT            |
|------------------------------------------------------------|--------------------------------------|-------------|---------------|----------|-----------------|
| Order of measurement                                       | 0x0001                               | Write       | FF            | full     | /               |
| Time required for the sensor to refresh the measurements*. | 0x00A4                               | Read        | Response Time | full     | milliseconds    |
| fluid temperature                                          | 0x0053                               | Read        | data          | floating | ° Celsius       |
| parameter 1 SAC                                            | 0x0055                               | Read        | data          | floating | m <sup>-1</sup> |
| parameter 2 COD eq.                                        | 0x0057                               | Read        | data          | floating | mg/L            |
| parameter 3 BOD eq.                                        | 0x0059                               | Read        | data          | floating | mg/L            |
| parameter 4 COT eq.                                        | 0x005B                               | Read        | data          | floating | mg/L carbon     |

\* The sensor is silent for this period of time, at the most, subsequent to the measurement request.

Extended measurement data is accessible over a second address range:

| ACTIONS / DATA             | Modbus address<br>(as a hexadecimal) | Read, write | VALUE | TYPE     | UNIT            |
|----------------------------|--------------------------------------|-------------|-------|----------|-----------------|
| fluid temperature          | 0x007F                               | Read        | data  | floating | ° Celsius       |
| parameter 1 SAC            | 0x0081                               | Read        | data  | floating | m <sup>-1</sup> |
| parameter 2 DCO eq.        | 0x0083                               | Read        | data  | floating | mg/L            |
| parameter 3 DBO eq.        | 0x0085                               | Read        | data  | floating | mg/L            |
| parameter 4 COT eq.        | 0x0087                               | Read        | data  | floating | mg/L carbon     |
| UV Compensated absorbance. | 0x0089                               | Read        | data  | floating | <i>no units</i> |
| GR Compensated absorbance  | 0x008B                               | Read        | data  | floating | <i>no units</i> |
| Turbidity eq.              | 0x008D                               | Read        | data  | floating | FAU             |
| UV transmittance           | 0x008F                               | Read        | data  | floating | <i>no units</i> |
| GR transmittance           | 0x0091                               | Read        | data  | floating | <i>no units</i> |

## 7.4 CALIBRATION

### 7.4.1 ACTIONS REQUIRED TO CALIBRATE A PARAMETER:

General case in 5 steps:

1. Restore the factory coefficients (optional),
2. Make measurements until a sufficiently stable value is obtained,
3. Write the known standard value related to this step,
4. If the calibration requires several steps, repeat actions 2 and 3 for the other coefficients,
5. Validate the coefficients of the parameter by writing the date and operator's name.

### 7.4.2 FLUID TEMPERATURE SETTING:

#### 7.4.2.1 General points:

Sequence in two steps, i.e. two independent conditions for stabilized temperature.  
The operator must have a reference thermometer.

#### 7.4.2.2 Detailed calibration of the temperature setting:

| Temperature Calibration |                     |                      |                   |                   |                       |
|-------------------------|---------------------|----------------------|-------------------|-------------------|-----------------------|
| Step                    | Modbus Name         | Calibrated Parameter | Description       | Sensor conditions | Reference Input Value |
| 1                       | Temp. Offset Coeff. | Temperature          | Offset (°C) (CTN) | Water T1          | T1 °C                 |
| 2                       | Temp. Slope Coeff.  | Temperature          | Slope (%) (CTN)   | Water T2          | T2 °C                 |

Step 1:

Place the sensor under steady low temperature conditions, fluid at T1.  
The master sends requests for repeated measurements until a sufficiently stable measurement is obtained,  
Write the temperature value T1 (°C), delivered by the reference equipment, in the "Standard" Modbus register of the sensor, related to the temperature offset.  
The temporary offset coefficient generated by the sensor is activated for the next step.

Step 2:

Place the sensor under stabilized upper temperature conditions, fluid at T2, significantly different from T1.  
The master sends requests for repeated measurements until a sufficiently stable measurement is obtained,  
Write the temperature value T2 (°C), delivered by the reference equipment, in the "standard" Modbus register of the sensor, related to the temperature slope.  
The slope coefficient is generated by the sensor.

Validation:

The coefficients generated by the sensor are considered to be temporary until final validation. This action is performed by the master by writing the operator's name and the date. The temporary coefficients will also have to be cleaned using the appropriate Modbus commands.

### 7.4.3 REFERENCE OPTICAL SIGNAL:

#### 7.4.3.1 General points

This is a measurement in clear, pollution-free water, without bubbles or particles in suspension, at stabilized temperature.

#### 7.4.3.2 Detailed calibration of the SAC 254 main parameter:

| Clear water: SAC254 Calibration (UV and GR Transmittance Calibration) |             |                      |                                   |                   |                       |
|-----------------------------------------------------------------------|-------------|----------------------|-----------------------------------|-------------------|-----------------------|
| Step                                                                  | Modbus Name | Calibrated Parameter | Description                       | Sensor conditions | Reference Input Value |
| 1                                                                     | Coeff 1     | SAC 254 (Param. 1)   | UV User Clear Water Tx Comp Slope | Clear water       | 0                     |
| 2                                                                     | Coeff 3     | SAC254 (Param.1)     | GR User Clear Water Tx Comp Slope | Clear water       | 0                     |

Step 1: Zero adjustment of the UV light source (UV absorbance at 0, UV transmittance at 1)

Place the sensor under the following conditions: clear water stabilized at temperature T, degassed.  
The master sends requests for repeated measurements until a sufficiently stable measurement is obtained,  
Write the value Zero ( $\Leftrightarrow$  clear water) as the standard value of coefficient 1, in the related Modbus register.  
The coefficient required to adjust the UV zero of the sensor is calculated automatically by the sensor.

Step 2: Zero adjustment of the green light source (Green absorbance at 0, Green transmittance at 1)  
Immediately after step 1, write the value Zero ( $\Leftrightarrow$  clear water) as the standard value of coefficient 3, in the related Modbus register.  
The coefficient needed to set the sensor's Green zero is calculated automatically by the sensor.

Validation:

The coefficients generated by the sensor are considered to be temporary until final validation. This action is performed by the master by writing the operator's name and date of parameter 1. The temporary coefficients will also have to be cleaned using the appropriate Modbus commands.

## 7.4.4 COD, BOD OR TOC EQUIVALENCE

### 7.4.4.1 General points

SAC 254 is a parameter for organic substances dissolved in water that absorb UV radiation. It provides information on water contamination. Despite the similarities, the parameters can not always be inter-converted.  
However, a correlation can be established between the SAC 254 parameter and another parameter such as TOC or COD. The STACSENSE sensor then provides equivalence data.

To obtain the correlation, it is recommended to measure the SAC for a few days on samples of polluted water which will also be analyzed using laboratory measuring equipment according to the standardized method.  
The conditions for obtaining useful data for efficient conversion represent daily monitoring with periods of low and high loads, as in the case of urban effluent. During these peak periods, you have to:

- read the SAC value delivered by the StacSense sensor,
- take a representative fluid sample at the sensor location,
- stabilize and store successive samples at 4°C until analysis,
- perform laboratory analyses of the parameter to be correlated.
- use the data to determine a conversion law.

COD, BOD or TOC equivalences are calculated directly in the sensor according to a first degree law.  
This pair of coefficients (offset and slope) is specific to each parameter.

Example:  $\text{COD th.} = \text{Slope}_{\text{COD}} * \text{SAC254} + \text{Offset}_{\text{COD}}$

As per the usual calibration process, the user value of the coefficient, offset or slope, such as a reference input value, is entered in a sensor register instead of the factory coefficient.

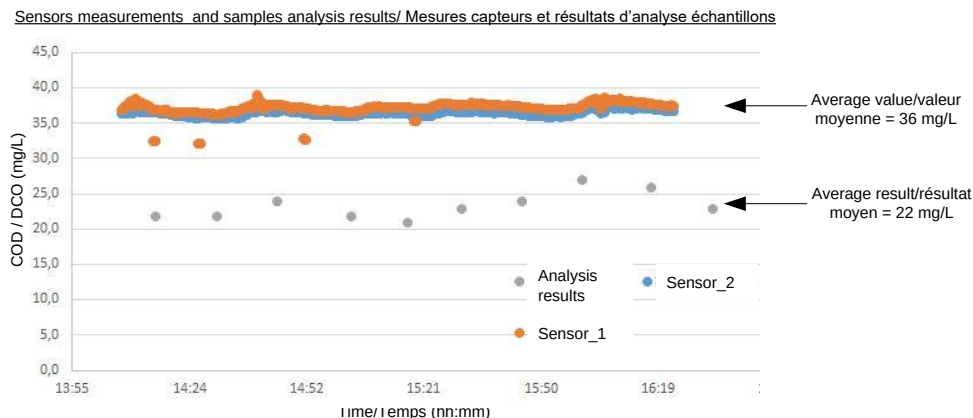
The default conversion coefficients, filled in at the factory ,are as follows :

- $\text{CODEq} = 1,81 * \text{SAC254} + 0,0$
- $\text{BODEq} = 0,48 * \text{SAC254} + 0,0$
- $\text{TOCEq} = 0,69 * \text{SAC254} + 0,0$

The user changes this linear relationship according to the results of a significant measurement campaign with two techniques in parallel, the UV sensor and the laboratory analysis of samples taken regularly, in the same place.

Example of experimental determination of the SAC conversion coefficient to COD (50mm optical path):

At the beginning of the measurement campaign and sampling, the conversion of the SAC254 coefficient to factory COD is active (slope value 1,81 ; offset 0).



We observe the average values of each method:  
 Average COD value supplied by the sensor = 36 mg/L  
 Average result of laboratory analyzes on samples = 22 mg/L

We adjust the conversion slope SAC254 to COD in the sensor such as  $1.81 \times 22 / 36 = 1.11$

For instance, this coefficient equal to 1.11 was determined for the outlet of the waste water treatment plant.

## 7.4.4.2 COD Equivalence

| COD customer-user coefficient input |             |                      |                        |                   |                       |
|-------------------------------------|-------------|----------------------|------------------------|-------------------|-----------------------|
| Step                                | Modbus Name | Calibrated Parameter | Description            | Sensor conditions | Reference Input Value |
| 1                                   | Coeff 11    | COD (Param. 2)       | COD Calculation Offset | Not required      | Offset Value          |
| 2                                   | Coeff 12    | COD (Param. 2)       | COD Calculation Slope  | Not required      | Slope Value           |

Step 1: No special operating condition. The master device enters the coefficients that are useful for the law of conversion.  
 Write the offset value as a Reference input value related to coefficient 11.  
 The sensor automatically copies the offset value written in the standard into the related coefficient memory box.

Step 2: Immediately after step 1, write the slope value as a Reference input value related to coefficient 12.  
 The sensor automatically copies the slope value written in the standard into the related coefficient memory box.

Validation:  
 Write the operator name and date of parameter 2 to validate the user coefficients needed to obtain the COD equivalence. The temporary coefficients will also have to be cleaned using the appropriate Modbus commands.

## 7.4.4.3 BOD Equivalence

| BOD customer-user coefficient input |             |                      |                        |                   |                       |
|-------------------------------------|-------------|----------------------|------------------------|-------------------|-----------------------|
| Step                                | Modbus Name | Calibrated Parameter | Description            | Sensor conditions | Reference Input Value |
| 1                                   | Coeff 13    | BOD (Param. 3)       | BOD Calculation Offset | Not required      | Offset Value          |
| 2                                   | Coeff 14    | BOD (Param. 3)       | BOD Calculation Slope  | Not required      | Slope Value           |

Step 1: No special operating condition. The master device enters the coefficients that are useful for the law of conversion.  
 Write the offset value as a Reference input value related to coefficient 13.  
 The sensor automatically copies the offset value written in the standard into the related coefficient memory box.

Step 2: Immediately after step 1, write the slope value as a Reference input value related to coefficient 14.  
 The sensor automatically copies the slope value written in the standard into the related coefficient memory box.

Validation:

Write the operator name and date of parameter 3 to validate the user coefficients needed to obtain the BOD equivalence. The temporary coefficients will also have to be cleaned using the appropriate Modbus commands.

#### 7.4.4.4 TOC equivalence

| TOC customer-user coefficient input |             |                      |                        |                   |                       |
|-------------------------------------|-------------|----------------------|------------------------|-------------------|-----------------------|
| Step                                | Modbus Name | Calibrated Parameter | Description            | Sensor conditions | Reference Input Value |
| 1                                   | Coeff 15    | TOC (Param. 4)       | TOC Calculation Offset | Not required      | Offset Value          |
| 2                                   | Coeff 16    | TOC (Param. 4)       | TOC Calculation Slope  | Not required      | Slope Value           |

Step 1: No special operating conditions. The master device enters the coefficients that are useful for the law of conversion.  
Write the offset value as a Reference input value related to coefficient 15.  
The sensor automatically copies the offset value written in the standard into the related coefficient memory box.

Step 2: Immediately after step 1, write the slope value as a Reference input value related to coefficient 16.  
The sensor automatically copies the slope value written in the standard into the related coefficient memory box.

Validation:

Write the operator name and date of parameter 4 to validate the user coefficients needed to obtain the TOC equivalence. The temporary coefficients will also have to be cleaned using the appropriate Modbus commands.

## 8. ANNEX : USING THE CALSENS SOFTWARE

### 8.1 CALSENS, VERSION 1.4: GENERAL INFORMATION

The CALSENS software tool manages all the sensors in the DIGISENS range.  
Version 1.4 also supports the StacSense UV probe.

This version specifically manages:

- a) Extended parameter support for sensors that provide more than 5 parameters,
- b) The system of editable parameters to directly enter an offset and a slope for specific StacSense probe parameters,
- c) The real-time view supports a larger number of parameters including UV and visible green (530nm) absorbance and transmittance.



/ Click this icon to see details about the sensor and settings.

### 8.2 EQUIPMENT REQUIRED

- Windows PC
- RS485/USB converter, reference model: RS485/USB converter NC-FIX-C-00020, 1 MODULE 4201 sensor input
- 12VDCA power supply

### 8.3 INSTALLATION

The installation involves 2 steps:

- 1 software installation;
- 2 driver installation for the FTDI USB adapter cable.

#### 8.3.1 INSTALLATION OF THE CALSENS SOFTWARE TOOL

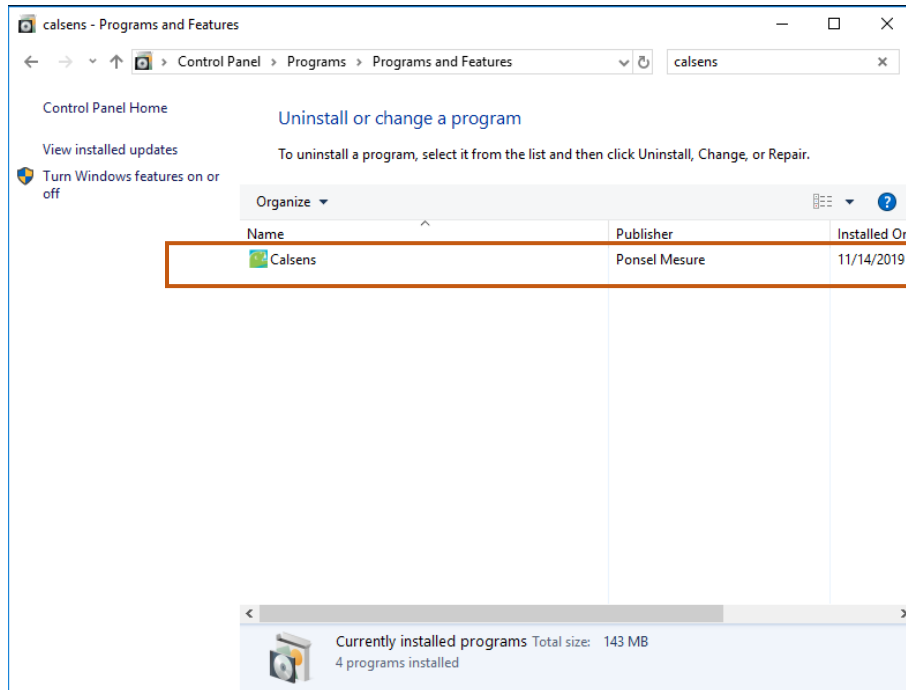
To install Calsens, run the “**Calsens Installer.msi**” and follow the instructions.

|                                                                                                           |                  |                    |          |
|-----------------------------------------------------------------------------------------------------------|------------------|--------------------|----------|
|  Calsens Installer.msi | 29/10/2019 16:00 | Package Windows... | 6 835 Ko |
|  setup.exe             | 29/10/2019 16:00 | Application        | 444 Ko   |

#### IF YOU HAVE AN OLDER VERSION OF CALSENS

You need to uninstall the older version. Go to the “**Control Panel**” in Windows. Click on “**Uninstall a program**” in “**Program**”.

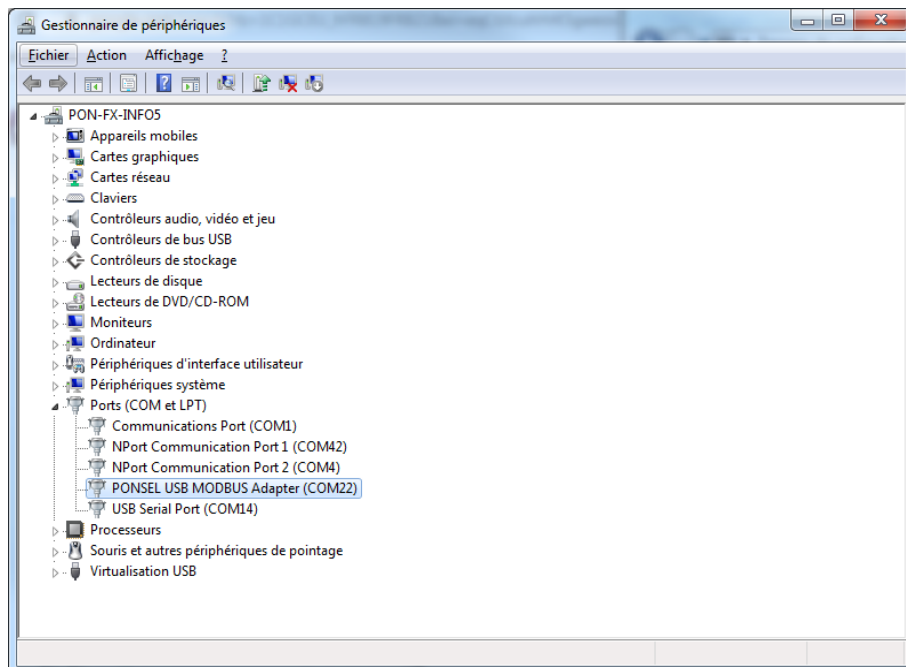




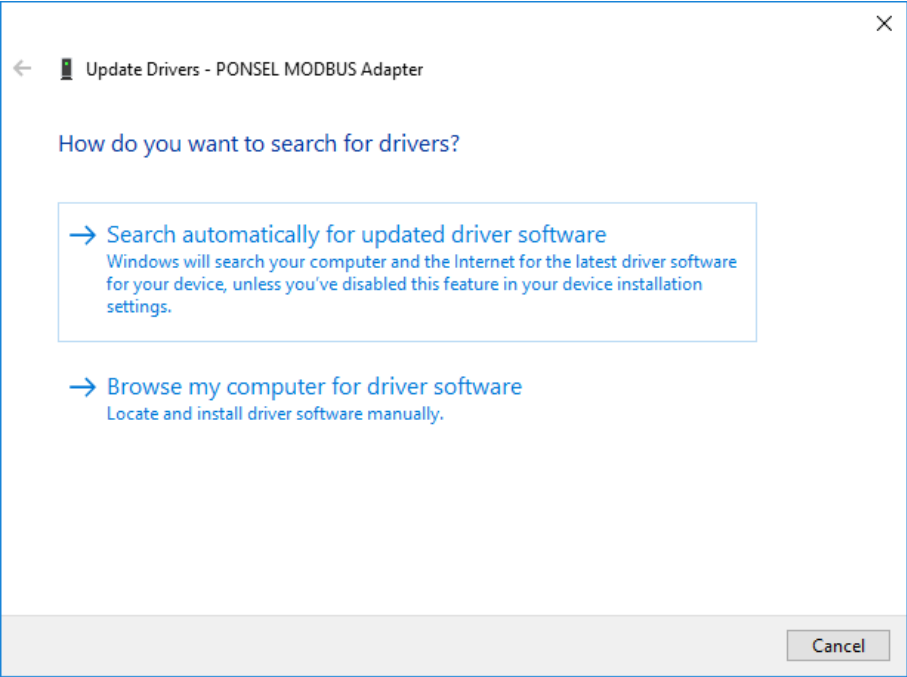
Then search for “**Calsens**” in the search bar. Then do a right click on “**Calsens**” > “**Uninstall**” and follow the uninstall instructions. Finally install Calsens as previously stated.

## 8.3.2 INSTALLATION OF DRIVERS

To install the drivers, open the “**peripheral device manager**” and select “**PONSEL MODBUS Adapter**”

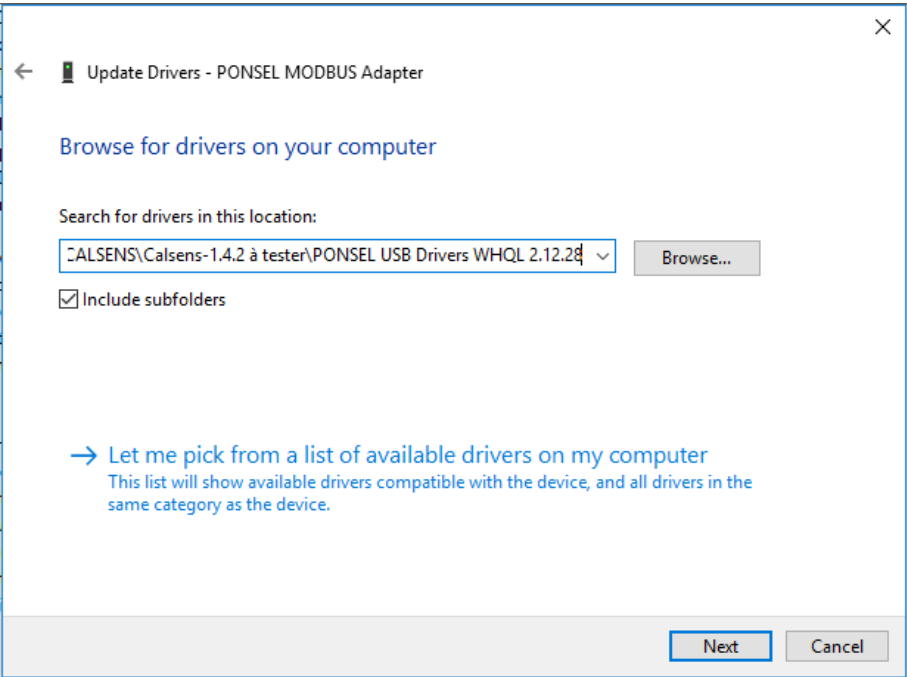


Right click on “**PONSEL MODBUS Adapter**” and click “**update the driver**”.

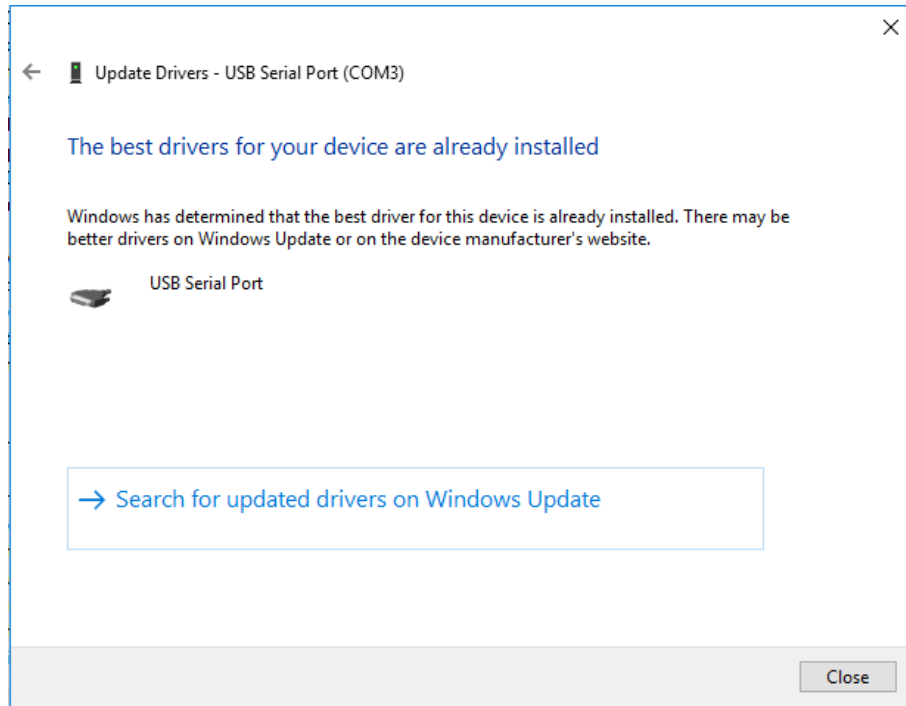


Click **"Find a driver on my computer"**.

Select the **"PONSEL USB Driver WHQL 2.12.28"** folder on the installation CD to install the correct drivers.



Once the driver is installed, Calsens is ready to use.



## MISSING DLL

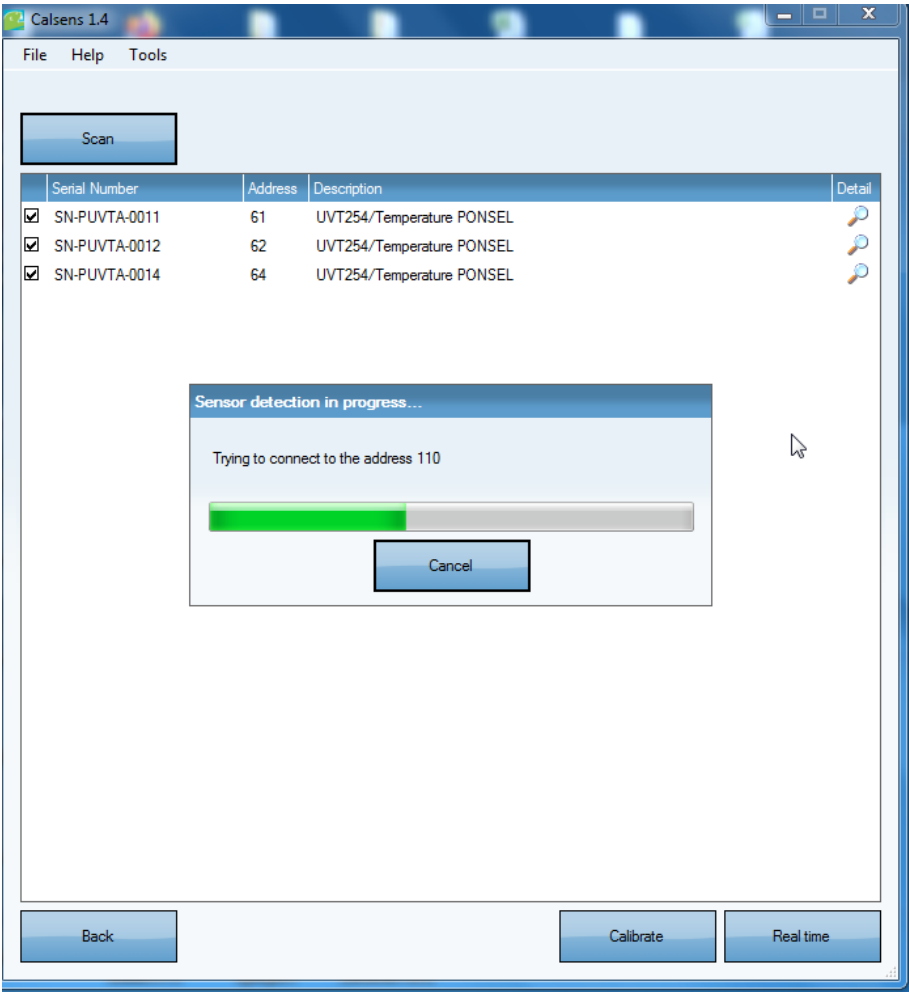
When Calsens is started and you try to use USB port for Modbus for the first time, the software may indicate that the DLL **ftd2xx.dll** is missing. It's needed to copy the right DLL in the Calsens repertory. To do this action you have to determine your system's architecture : 32 bits or 64 bits (Computer > right click > properties > system type).

- If the system is 64 bits, you have to copy the DLL **ftd2xx64.dll** present in folder **PONSEL USB Drivers WHQL 2.08.28\amd64** to the Calsens Application folder. Then you need to rename it in **ftd2xx.dll**.
- If the system is 32 bits, you need to copy the DLL **ftd2xx64.dll** present in folder **PONSEL USB Drivers WHQL 2.08.28\i386** to the Calsens Application folder.

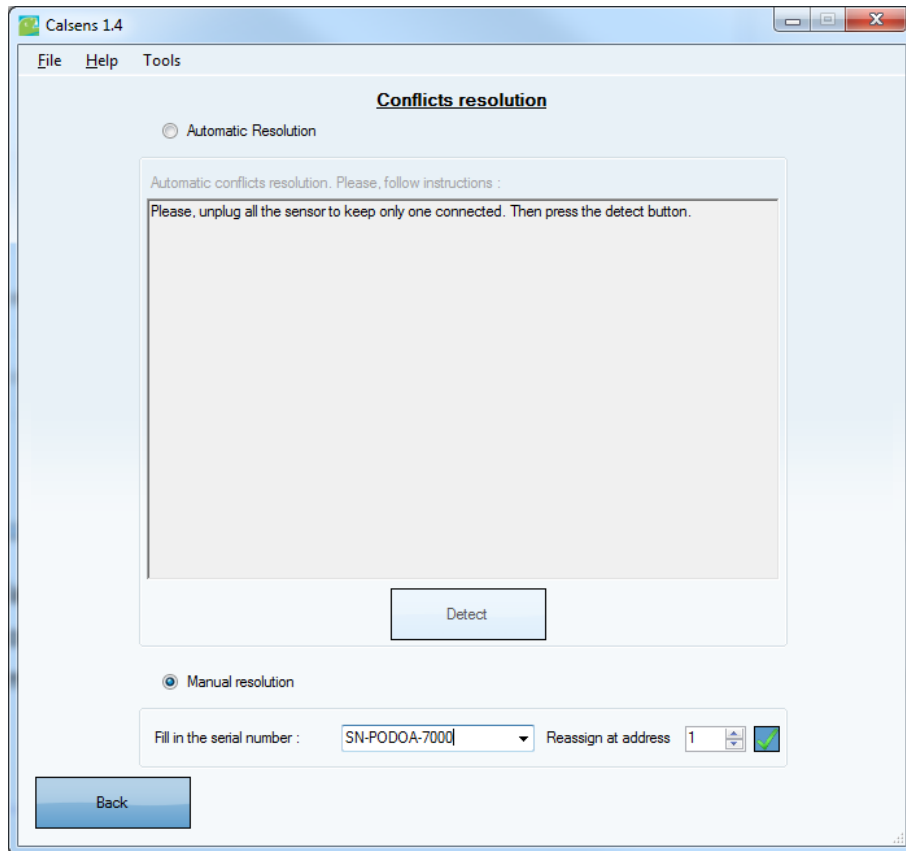
When these actions are done, you can re start Calsens and use normally the PONSEL USB Cable for Modbus.

8.4 SCAN FUNCTION

To detect the StacSense probe, scan the Modbus addresses using the SCANNER button on the CALSENS interface.  
This operation consists in testing each RS485/Modbus network address in order to detect connected, compatible sensors.



## 8.4.1 CONFLICT OF ADDRESS:



/

When two sensors have the same address there is a conflict. The conflict can be resolved automatically or manually. The automatic method requires the sensors to be connected one by one so that CALSENS can re-address the sensors. The manual method specifies the serial number of each sensor.

## 8.4.2 MANAGING AN UNDETECTED SENSOR:

If the StacSense probe is not detected, several things have to be checked:

1. Connection status of the probe cable with the USB/RS485 converter,
2. Sensor 12VDC power supply connection status,
3. If the power supply is enabled,
4. If the RS485 A/B communication lines are used properly.

8.5 SENSOR DETAIL

The sensor detail shows the StacSense probe's parameters. The magnifying glass icon  / shows the details of the parameters and indicates which parameters can be calibrated.

Calsens 1.4

File Help Tools

SN-PUVTA-0014 sensor detail

Serial Number : SN-PUVTA-0014

Description : UVT254/Temperature PONSEL

Firmware version : 0.05 

Hardware version : 0.01

Modbus address : 64 

SDI12 address : 7 

| Parameter      | Value | Unit | Status                                                                              | Range   | Detail                                                                                |
|----------------|-------|------|-------------------------------------------------------------------------------------|---------|---------------------------------------------------------------------------------------|
| Temperature    | 24.90 | °C   |    | 0/40 °C |    |
| SAC 254        | 0.57  | 1/m  |    | 0/X 1/m |    |
| COD equivalent | 1.03  | mg/l |    |         |    |
| BOD equivalent | 0.27  | mg/l |   |         |   |
| TOC equivalent | 0.41  | mg/l |  |         |  |

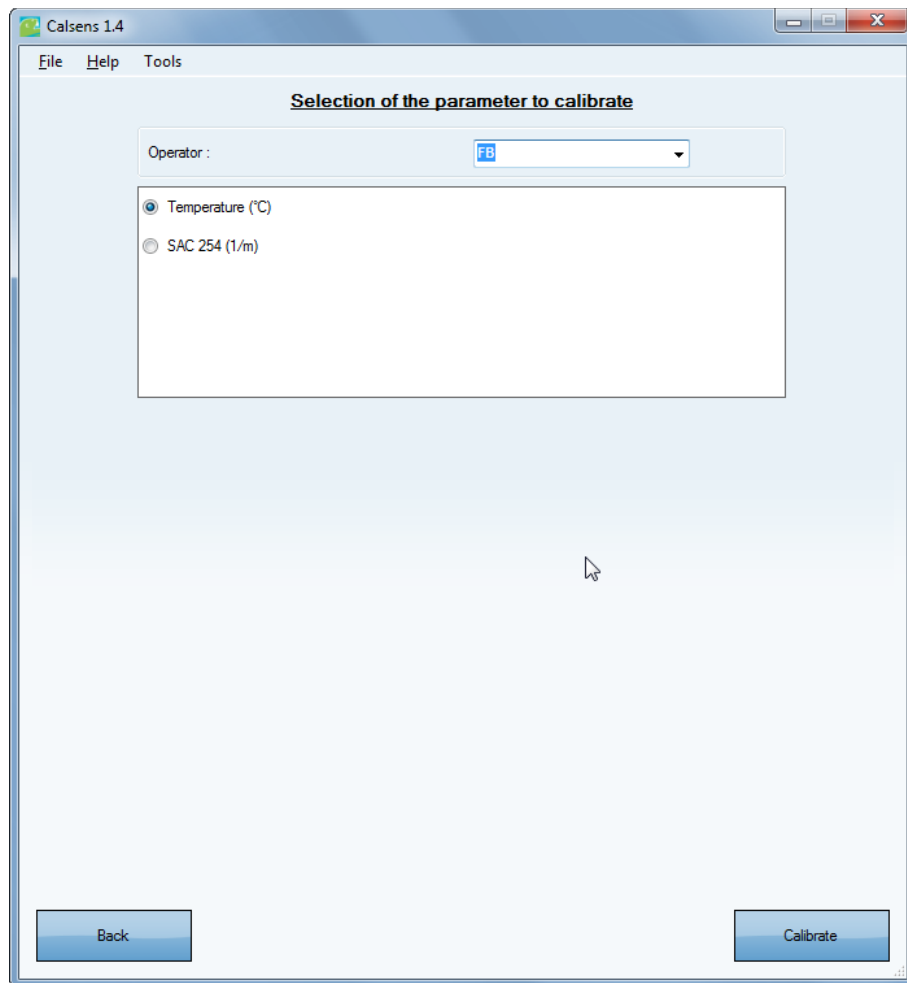
Back

Refresh measures

## 8.6 CALIBRATION

Two parameters can be calibrated on the UV probe: temperature and SAC 254 using the "**Calibrate**" button on the main screen. Additional parameters: COD, BOD, or TOC equivalence can be configured via the parameters "**detail**" screen.

Selecting the parameter to be calibrated:



### 8.6.1 TEMPERATURE

Similar to other sensors in the DIGISENS range, see the documentation built into the CALSENS software tool.

### 8.6.2 SAC254, REFERENCE SIGNAL IN CLEAR WATER

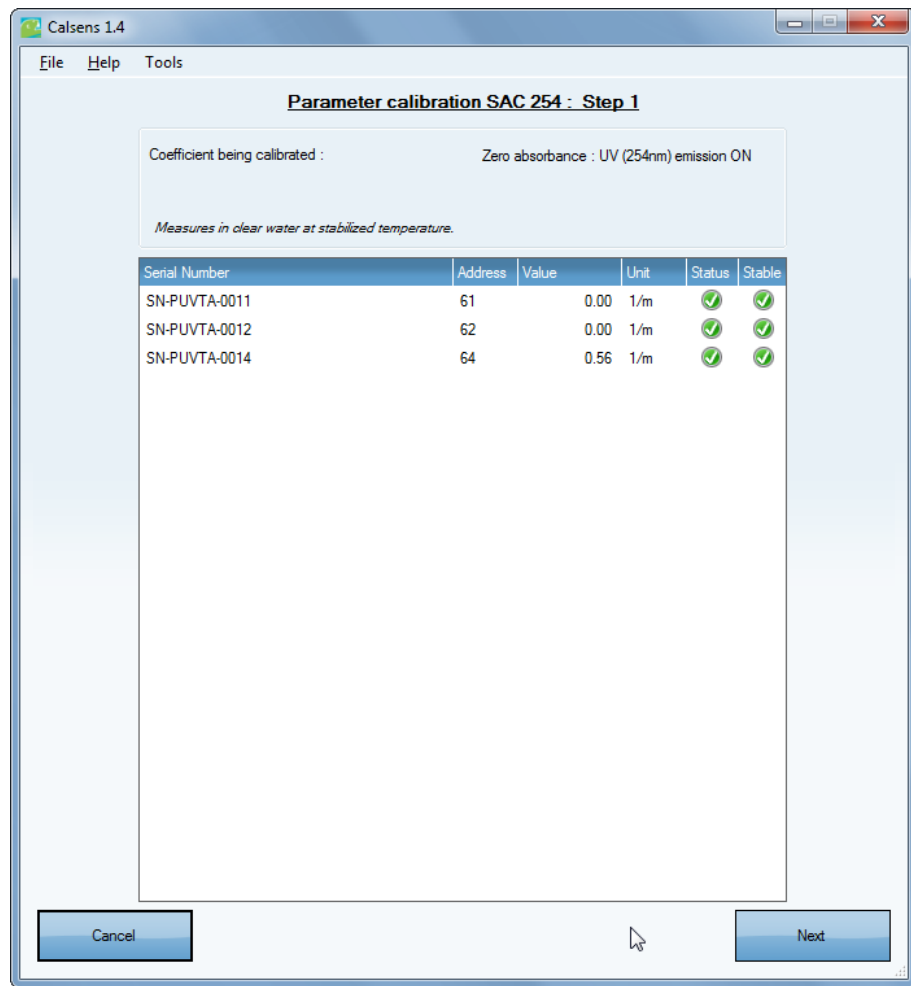
The calibration of SAC 254 is useful when adjusting the optical reference signal. Place the sensor in clear, temperature-stabilized water. Eliminate any bubbles trapped in the measurement zone (optical path of the sensor). Follow steps 1 and 2. Wait a few seconds at each step until the values stabilize.

Step 1:

In this step, the UV probe emits UV radiation at a wavelength of 254 nm to calibrate the zero absorbance.



**CAUTION:**  
UV radiation may cause irreversible damage to eyesight.

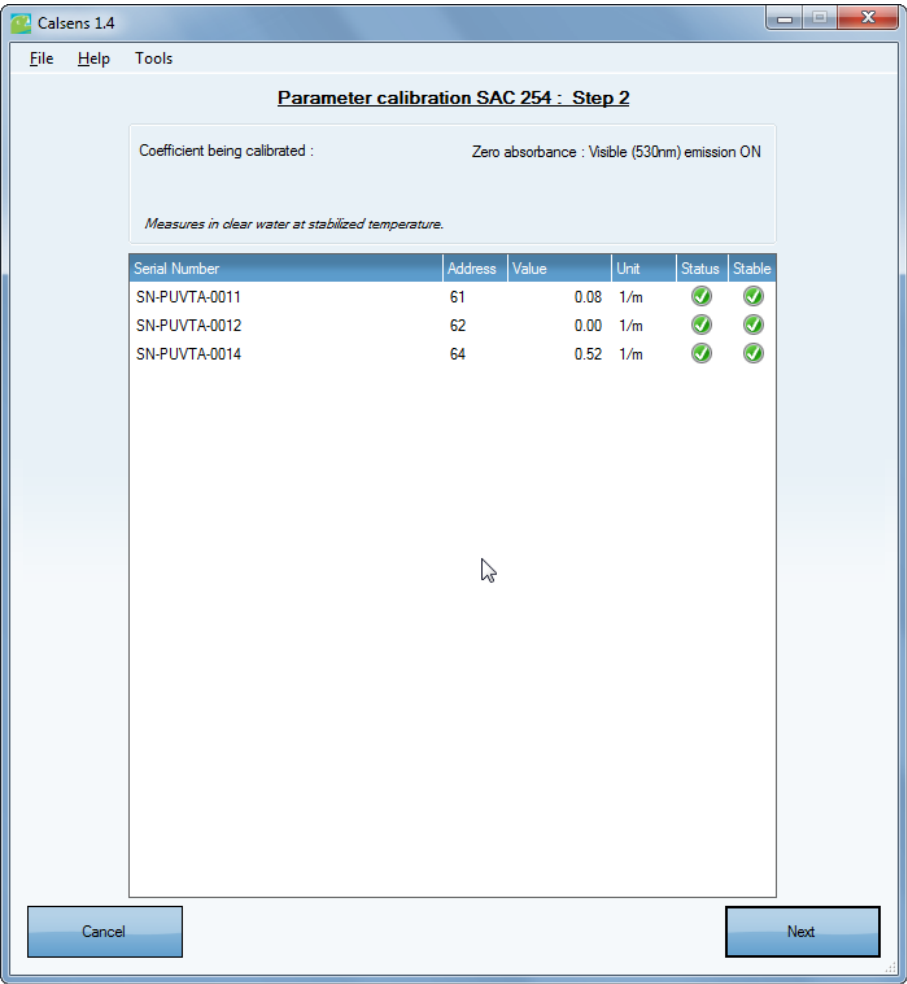


**Note:**

As shown in the above figure, the CALSENS tool manages single or multiple calibration. In the second case, a set of identical sensors can be adjusted simultaneously in the same solution.



Step 2:  
In this step, the UV probe emits visible radiation at a wavelength of 530 nm to calibrate the zero absorbance. The measurement status is visible as well as the stability.



/

## Assessment:

The assessment step validates the temporary coefficients defined during the previous two steps. Check that the coefficients are consistent before validating them.

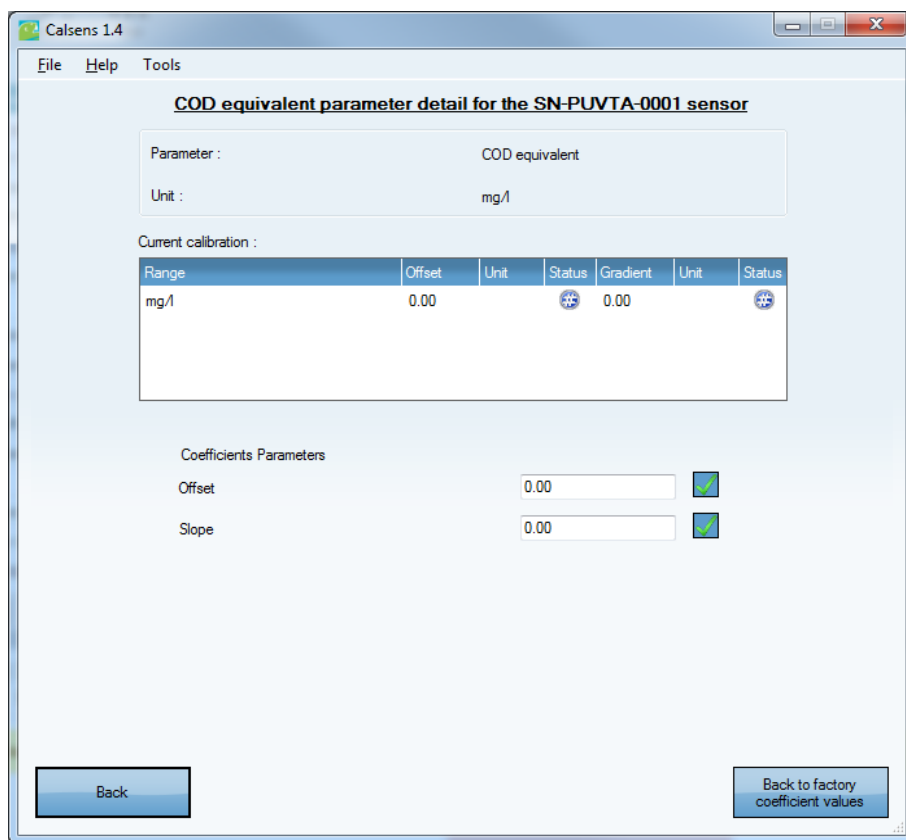
After validating the calibration (VALIDATE CALIBRATION button), SAC 254 is calibrated.

## 8.6.3 COEFFICIENTS FOR COD, BOD OR TOC EQUIVALENCE

There is no calibration step for COD, BOD and TOC coefficients. You can enter the offset and slope values directly in the parameter "detail" view.

///

This component (see area outlined in red) replaces the list of calibration logs. In the example below, set the desired values and validate to write the appropriate values of the fine-tuned conversion coefficients, in the sensor, from SAC254 to COD.



**Calsens 1.4**

File Help Tools

**COD equivalent parameter detail for the SN-PUVTA-0001 sensor**

Parameter : COD equivalent

Unit : mg/l

Current calibration :

| Range | Offset | Unit | Status | Gradient | Unit | Status |
|-------|--------|------|--------|----------|------|--------|
| mg/l  | 0.00   |      | ⚙️     | 0.00     |      | ⚙️     |

Coefficients Parameters

Offset  ☒

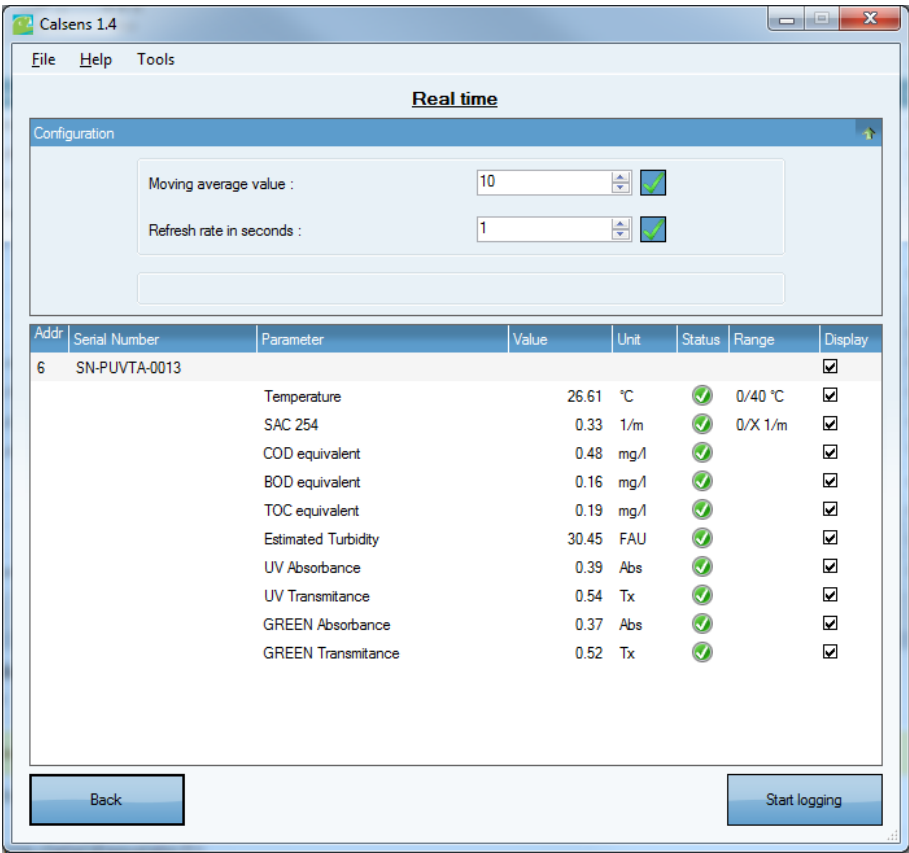
Slope  ☒

Back

Back to factory coefficient values

## 8.7 REAL-TIME VIEW

The 5 main parameters (Temperature, SAC 254, COD, BOD or TOC) can be seen in the real-time view as well as the extended parameters (turbidity, UV absorbance and UV transmittance).



Select the desired parameters using the boxes in the **"Display"** tab. The display window is then made lighter to display data from several sensors.

/

When the desired parameters are selected, values can be stored in a CSV file, named at the beginning of the acquisition campaign (START THE LOG button).

Note:  
Only the selected settings will be saved.

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