Conductivity/Temperature Sensor
User manual

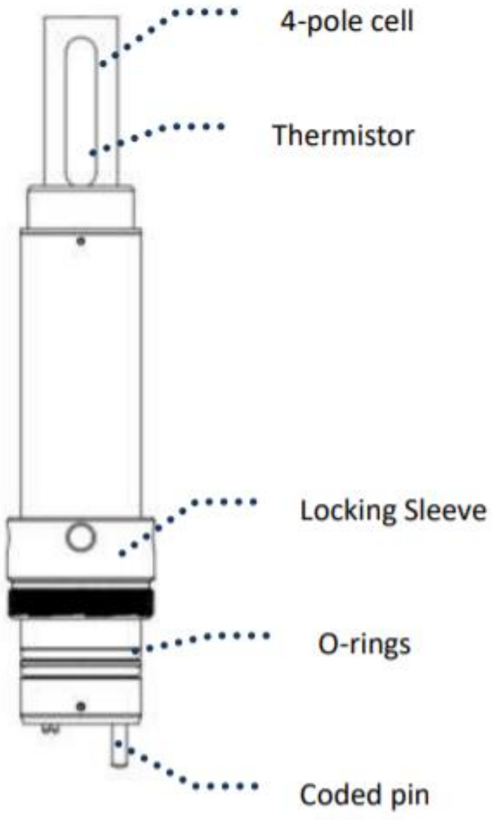
1 Description

The sensor combines two parameters: conductivity measurement and temperature measurement. The conductivity measurement is provided by a 4-poles cell. The advantage of the 4-poles cell is its low sensitivity to parasitic resistance, dirt or polarization.

Temperature measurement is ensured by a thermistor that guarantees a fast response time and good stability over the time.

Mounting the conductivity/temperature sensor (CT) on a WiMo or WiMo Plus sonde gives access to calculated parameters. It is possible by combining with pressure parameter to determine salinity, specific conductance, velocity, total dissolved solids or chlorides. For information on how to connect the sensor to the WiMo probe please refer to the WiMo manual.

The CT sensor is also compatible with Mosens Modbus



Conductivity

Technologie / Technology	4 carbon electrodes cell
Gamme / Range	0 - 100 mS/cm
Exactitude / Accuracy	± 0,5% of reading
Résolution / Precision	0,001 mS/cm

Temperature

Technologie / Technology	Thermistor
Gamme / Range	-2° à +35°C
Exactitude / Accuracy	± 0.02°C
Résolution / Precision	0,001°C

2 Sensor response time

The response time of a sensor is the time required for the sensor to respond to a known change in its measurement and reach a percentage of its final value. A response time of 63% (T63) or 90% (T90) of the final value is often mentioned. In order to compare response times between sensors it is essential to know what percentage of the final value has been calculated.

Response Time	***Type***	***Value***
Temperature	T63	< 1 sec
Conductivity	T63	< 2 sec

3 Calculated parameters

Thanks to the conductivity sensor often combined with the pressure sensor, a number of parameters can be calculated. Refer to the WiMo probe manual to see how to activate these parameters.

3.1 Salinity

The salinity calculated from conductivity sensors is based on the measurement of conductivity ratios determined by the 'Practical Salinity Scale' of 1978. With this definition, salinity has no unit and is expressed in PSU (Practical Scale Unit).

Range	2-42 PSU
Accuracy	0,1PSU or ± 1% of reading
Resolution	0,001 mS/cm

3.2 Specific conductivity

The specific conductivity, i.e. the electrical conductivity at 25 °C, with reference to the International Standard ISO 7888 and the potassium chloride solutions used for calibration, is expressed in mS/cm.

Conductivity is temperature compensated by the temperature measurement performed by the CT sensor itself. Conversions to electrical conductivity at 25 °C, γ 25, are made according to the equation:

$$\gamma_{25} = \frac{\gamma_\theta}{1 + (\alpha / 100)(\theta - 25)}$$

Where:
α is the temperature coefficient of electrical conductivity ;
γ_θ is the electrical conductivity at the measurement temperature θ ;
θ is the measurement temperature, in degrees Celsius, of the sample.

Range	0 - 100 mS/cm
Accuracy	25uS/cm or ± 0,5% of reading
Resolution	0,001 mS/cm

3.3 Water velocity

The speed of sound is the distance traveled per unit time by a sound wave propagating through an elastic medium. The speed of sound in seawater depends on pressure (hence depth), temperature (a change of 1 °C ~ 4 m/s) and salinity (a change of 1‰ ~ 1 m/s). Empirical equations were derived to accurately calculate the speed of sound from these variables. The one used for the WiMo probe is the international standard algorithm, often known as the UNESCO algorithm (due to Chen and Millero (1977)). For the original UNESCO document see Fofonoff and Millard (1983). Wong and Zhu (1995) recalculated the coefficients of this algorithm after the adoption of the 1990 international temperature scale. Their form of the UNESCO equation is :

$$c(S,T,P) = Cw(T,P) + A(T,P)S + B(T,P)S^{3/2} + D(T,P)S^2$$

$$\begin{aligned} Cw(T,P) = {} & (C_{00} + C_{01}T + C_{02}T^2 + C_{03}T^3 + C_{04}T^4 + C_{05}T^5) + \\ & (C_{10} + C_{11}T + C_{12}T^2 + C_{13}T^3 + C_{14}T^4)P + \\ & (C_{20} + C_{21}T + C_{22}T^2 + C_{23}T^3 + C_{24}T^4)P^2 + \\ & (C_{30} + C_{31}T + C_{32}T^2)P^3 \end{aligned}$$

$$\begin{aligned} A(T,P) = {} & (A_{00} + A_{01}T + A_{02}T^2 + A_{03}T^3 + A_{04}T^4) + \\ & (A_{10} + A_{11}T + A_{12}T^2 + A_{13}T^3 + A_{14}T^4)P + \\ & (A_{20} + A_{21}T + A_{22}T^2 + A_{23}T^3)P^2 + \\ & (A_{30} + A_{31}T + A_{32}T^2)P^3 \end{aligned}$$

$$B(T,P) = B_{00} + B_{01}T + (B_{10} + B_{11}T)P$$

$$D(T,P) = D_{00} + D_{10}P$$

T = temperature in degrees Celsius
S = salinity in Practical Salinity Units (parts per thousand)
P = pressure in bar

Range of validity: temperature 0 to 40 °C, salinity 0 to 40 parts per thousand, pressure 0 to 1000 bar (Wong and Zhu, 1995).

Range	1300 - 1700 m/s
Accuracy	0,001 m/s
Resolution	not specified

3.4 Total Dissolved Solids (TDS)

The amount of dissolved matter in a sample is correlated with the electrical conductivity. The calculation of total dissolved solids from conductivity is not recommended for accurate quantitative analysis in critical applications. However, the calculation is in accordance with the 23rd edition of Standard Methods for the Examination of Water and Wastewater. Indeed, there is no reliable relationship between specific conductivity and TDS that is valid for all media encountered. The relationship must be adapted to the medium studied. The relation used is the following one:

TDS = Specific_conductivity * K

K = 0.65 constant by default, TDS = Total Dissolved Solids (mg/l), Specific_conductivity = conductivity at 25°C (uS/cm)

The default constant of 0.65 is only a rough average for natural samples. The actual constant is dependent on the types of dissolved materials, temperature, etc. This constant can be adapted to the medium under study and modified in the probe. For normal water, the TDS factor value should be between 0.50 and 0.70.

Range	0 - 100 000 mg/l
Accuracy	variable
Resolution	not specified

3.5 Chlorides

Salinity [1] is composed of non-carbonate salts dissolved in water. Unlike chloride (Cl-) concentration, salinity can be seen as a measure of total salt concentration, composed mainly of Na+ and Cl- ions. Although there are smaller amounts of other ions in seawater (e.g., K+, Mg2+, or SO42-), sodium and chloride ions make up about 91% of all ions in seawater. Salinity is an important measure in seawater or in estuaries where freshwater from rivers mixes with saltwater from the ocean. The salinity level of seawater is fairly constant at about 35 PSU, while brackish estuaries can have salinity levels between 1 and 10 PSU. Since most of the anions in seawater or brackish water are chloride ions, the chloride concentration can be estimated from the salinity with a linear relationship:

Cl- (mg/L) = Cte * salinity (PSU) with Cte = 1 / 0.0018066

This type of conversion is not valid for freshwater or low salinity brackish water due to the varying concentrations of chloride ions compared to other types of ions present in the water. Several factors exist for the linear conversion which is often dependent on the medium under study. The default coefficient in the WiMo probe is Cte = 569.

Range	0 - 18 000 mg/l-Cl
Accuracy	± 5mg/l-Cl or ± 15% of reading
Resolution	0,01 mg/l

[1] : Water Quality with Vernier

4 Adjustment

Sensor adjustment is a simple process requiring the use of adjustment standards.

nke Instrumentation will provide you with the procedure to perform this adjustment.

You will also need the "Metrology Interface" tool and the dedicated "WiMo_Calibration-Tool" to perform this adjustment.

https://nke-instrumentation.fr/produit/wimo-calibration-tool-2/

We recommend to contact our sales department for more information.

5 Recommandations

The sensor must always be kept clean, especially in the area around the 4-electrode carbon cell.

The presence of deposits leads to measurement errors.

Deposits such as biofilm (or silt) must be carefully removed with warm soapy water and a sponge. Never use abrasive agents (e.g. a scouring sponge)

If the sensor is taken out of service, it must be rinsed and ready for dry storage.

Before deployment, if the sensor has been stored dry, it is recommended to wait at least one hour of immersion in the medium before obtaining a qualitative measurement.

The sensor cannot be cleaned. The standard protection supplied with the WiMo probe is a passive copper based protection that acts as a biocide.

The pressure measurement is done at the top of the probe. There is therefore a position offset between the pressure measurement and the measurements made by the sensors. The position offset in relation to the pressure sensor is: 10.5 cm.

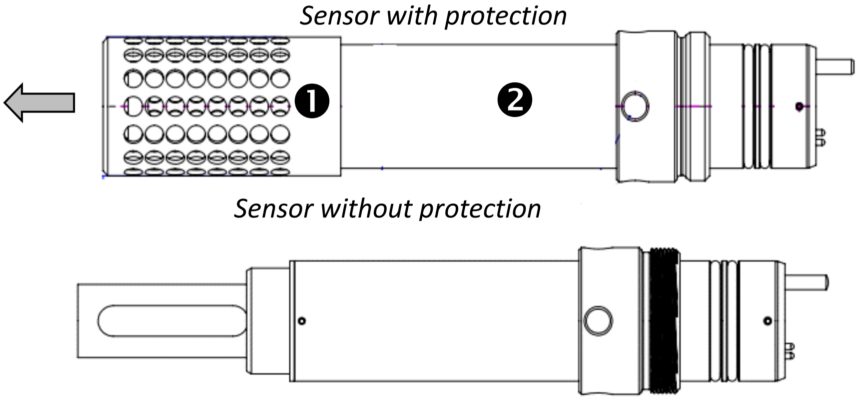
6 Passive protection dismantling

The conductivity/temperature sensor is equipped with a passive protection ❶ that can be removed to clean the sensor.

This protection is clipped on the CT sensor. To remove it, it is necessary to pull on the protection ❶ while holding the CT sensor ❷ firmly.

⚠ It should be noted that the extraction must be done by pulling without rotating the protection at the risk of damaging the CT sensor. To reassemble the passive protection, check that the seal located inside the protection is present. Push on the sensor the protection until you feel a click.

Your protection is installed.



7 Maintenance

7.1 Routine maintenance

Regular maintenance of the equipment will ensure maximum longevity. A thorough visual inspection should be performed regularly and any damaged parts should be replaced.

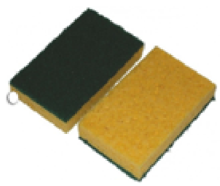
7.1.1 O-rings maintenance

The O-rings seal the probe. Any O-rings damaged can affect the reliability of the sonde. A visual inspection must be done each time a sensor is plugged or unplugged and also when battery compartment is opened. Check that no hair-type, particle-like elements are found on the O-rings. If the surface has impurities, gently clean them with a non-fluffy wipe and lightly grease the O-rings with molykote grease. Any damaged O-rings must be changed.

7.2 Preventive maintenance

It is necessary to regularly clean the CT sensor to maintain an operational product and a qualitative measurement. Depending on the site conditions encountered, the cleaning frequency must be adapted.

7.2.1 Tools



cellSponge

Flat brush

Cotton buds

Cleaning solutions (bleach, acetic acid)

Beaker

Plastic brush

Plastic scraper

7.2.2 Cleaning the product

⚠ Before starting the cleaning operations, check that the sensor is not running (measurements stopped).

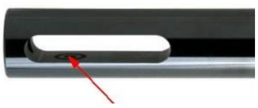
In the field, use available clean water (sea, lake, river).

First, use the plastic brush and the scraper to remove all the important dirty deposits. Then use the sponge and clean the whole body of the product thoroughly.

7.2.3 Sensor cleaning

Remove the passive protection (see section 6). Use the plastic brush and the sponge and clean the CT sensor and the UV system thoroughly, without touching the conductivity cell.

Conductivity sensor ⇨ Use the yellow side of the sponge to clean only the outside of the sensor. Rinse the inside of the sensor with clear water. Using a cotton swab, remove any deposits in the sensor opening.



Inside Conductivity

Sensor aperture

⚠ Do not clean the inside of the conductivity cell. Rinse with clean water only.

7.2.4 Advanced cleaning (extensive biofouling)

In case of heavy contamination with barnacles (or calcifying organisms), rinsing the sensor with water may not be sufficient. Depending on the degree of contamination, we recommend the following steps.

7.2.4.1 Light soiling: Detergents and soft water

Use detergents to remove light biological soiling. Placing the sensor in a warm bath of detergent solution (such as dishwashing liquid) is a gentle method that is unlikely to interfere with sensor calibration.

7.2.4.2 Pronounced Biofilm: placing the sensor in a hypochlorite solution

Prepare a 0.5% bleach solution (final concentration), preferably with warm water. Place the sensor in the solution for 15 to 30 minutes and rinse the sensor with fresh water. Use a soft sponge to remove the remaining biofouling.

⚠ Make sure your work area is well ventilated. Outgassing of hypochlorite is a potential health hazard

7.2.4.3 Presence of barnacles or calcifying organisms: place sensor in acetic acid solution

Prepare a 5% acetic acid (white vinegar) solution, preferably with warm water. Place the sensor in the solution for 15 to 30 minutes and rinse the sensor with fresh water. Use a soft sponge to remove any remaining biofouling.

8 Return a product to the factory

For a consideration of your product by our after-sales service it is essential to follow the RMA procedure. Any material returned without an RMA number will not be taken into account.

- In case of shipment for repair or expertise, obtain an RMA number by using the procedure available on the website:
  https://nke-instrumentation.com/product-return-form/

- Pack the product in its original shipping box to prevent damage in transit.