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# Residual chlorine sensor

## Preface

- Thank you for purchasing our product.
- This manual is about the various functions of the product, wiring methods, setting methods, operating methods, troubleshooting methods, etc.
- Please read this manual carefully before operation, use this product correctly to avoid unnecessary losses due to incorrect operation.
- After you finish reading, please keep it in a place where it can be easily accessed at any time for reference during operation.

**Note**

- Modification of this manual’s contents will not be notified as a result of some factors, such as function upgrading.
- We try our best to guarantee that the manual content is accurate, if you find something wrong or incorrect, please contact us.
- The content of this manual is strictly prohibited from reprinting or copying.

**Version**

U-SUP-ADI7000-EN3

## Disclaimer

- The company does not make any guarantees for the terms outside the scope of this product warranty.
- This company is not responsible for damage to the instrument or loss of parts or unpredictable damage caused directly or indirectly by improper operation of the user.

### Package contents

| Serial number | Item Name | Quantity |
| --- | --- | --- |
| 1 | Residual chlorine sensor | 1 |
| 2 | Manual | 1 |
| 3 | Certificate | 1 |

After opening the box, please confirm the package contents before starting the operation.If you find that the model and quantity are incorrect or there is physical damage in appearance, please contact us.

## Content

# Chapter 1 Introduction

## 1.1 Product introduction

This residual chlorine sensor is a three-electrode constant potential current measurement sensor that can be used to measure the concentration of residual chlorine, chlorine dioxide (high purity), ozone and other disinfectants. The sensor has a built-in ARM processor and efficient filtering algorithm, which can effectively avoid noise interference. It has an RS485 interface for easy access to computers and network monitoring systems. Widely used in tap water factory water, pipe network, secondary water supply, terminals, swimming pools and other scenarios.

## 1.2 Measurement principle

The film-free digital disinfectant sensor consists of two platinum electrodes and a silver chloride electrode forming a three-electrode measurement system. The electrodes have a built-in high-precision potentiostat, which can maintain the stability of the working electrode potential. Disinfectant components such as hypochlorous acid are oxidized at the working electrode. The reduction reaction produces an electric current that follows Faraday's law, thereby measuring the disinfectant concentration.

## 1.3 Product features

- Electrochemical sensors have no reagent consumption and pollutant emissions.
- The membrane-less design eliminates the need to replace the membrane head and add electrolyte.
- Three-electrode design ensures zero-point stability and high sensitivity.
- Built-in high-precision sampling circuit makes the sensor linear.
- When the pH changes little, it can be accurately compared with the DPD measurement method.

# Chapter 2 Parameters

Table 1 Technical Parameters

| | |
|---|---|
| Measured variables | Residual chlorine, chlorine dioxide (high purity), ozone, etc. |
| Measuring range | (0~5)mg/L (standard), (0~20)mg/L |
| Accuracy | ±5% (DPD comparison error ±10% or ±0.05mg/L, whichever is greater) |
| Sensitivity | 0.001mg/L |
| Temperature compensation | NTC 10K |
| Communication | RS485 interface，Modbus-RTU protocol |
| Power supply | (9~24)VDC |
| Power consumption | ⩽0.5W |
| sensor interface | Aviation plug |
| Medium temperature | (0～50)℃ |
| Process pressure | ⩽0.1MPa |
| Water flow rate | (0.5~1)L/min(And the flow rate needs to be kept stable) |
| Cable length | 2m(standard), other lengths can be customized |

# Chapter 3 Constructions

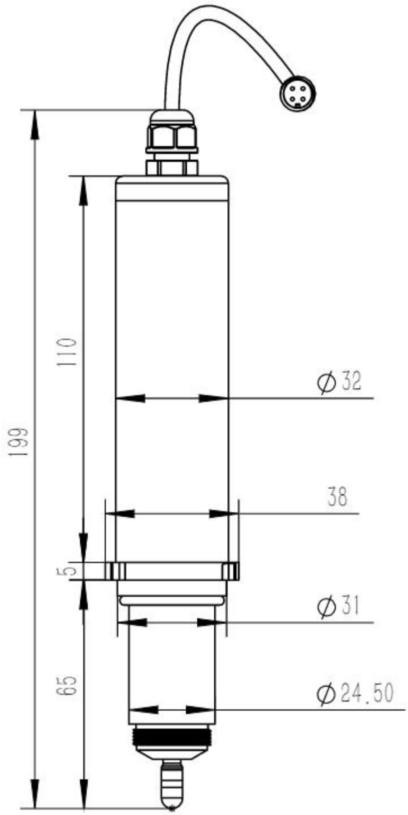


Figure 1 sensor dimensions (unit: mm)

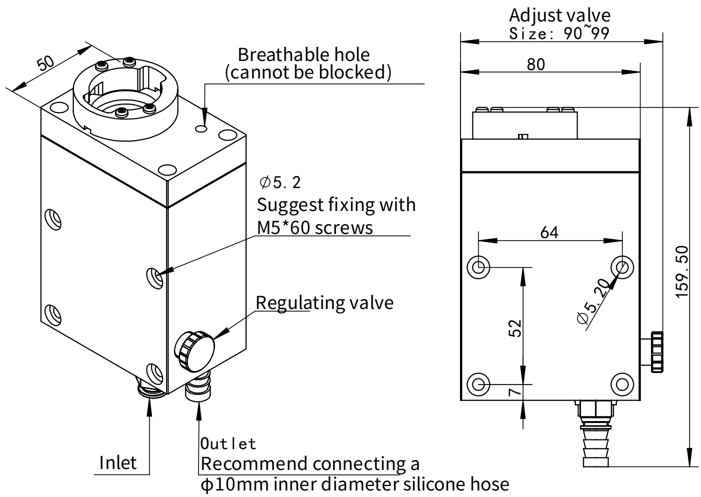


Figure 2 Dimensions of flow cell (unit: mm)

### 3.2 Material

Electrode material: Platinum Pt

Shell material: POM

### 3.3 Weight

Weight: 165g

# Chapter 4 Installation

It is recommended to install the residual chlorine sensor in the flow-through type.

The installation steps are as follows:

(1) Insert the sensor into the flow cell (note that the size of the notch on both sides of the installation ring is different).

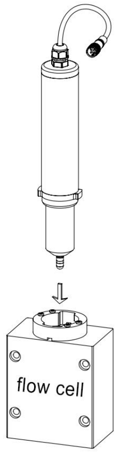


Figure 3 Inserting sensors

(2) While pressing the sensor downward, rotate it 90 degrees clockwise to secure it in the slot.

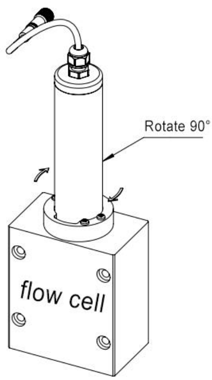


Figure 4 Fixed sensor

Recommended installation method:

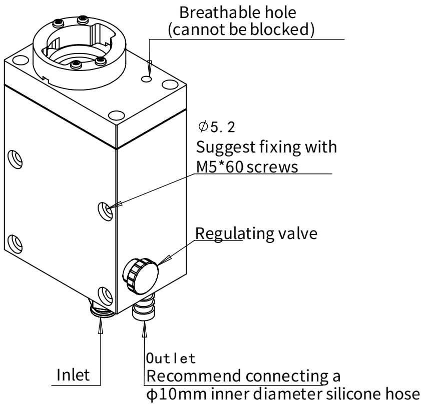


Figure 5 Water inlet and outlet (unit: mm)

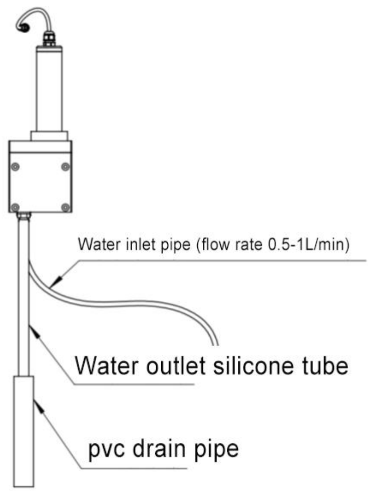


Figure 6 Recommended installation diagram

# Chapter 5 Electrical connections

Please carefully follow the instructions for wiring the sensors, otherwise the sensors may be damaged. The wiring method of the sensors is shown in Table 2:

Table 2 sensor wiring

| Color | Description |
|---|---|
| Red | Power+ |
| Black | Power- |
| Green | 485A |
| Yellow | 485B |

# Chapter 6 Calibration

The sensor can be calibrated. Please allow the sensor to run normally for 2 hours before calibrating after powering on for the first time or after a long power outage. Both on-site comparison calibration method and laboratory calibration method can be used. It is recommended to use on-site comparison calibration method during the use of sensors, and laboratory calibration method can be used in laboratory environment.

## 6.1 On-site comparison calibration

(1) When the sensor is powered on and the water is flowing normally, and after the sensor completes polarization, use the DPD portable disinfectant measuring device (disinfectants are divided into residual chlorine, chlorine dioxide and ozone) to take water from the outlet of the flow cell. Measure the sample, take multiple water measurements, and take the average of the multiple measurements.

(2) Write the disinfectant value measured by the DPD portable device into register 123 of the sensor. Assuming that the measured disinfectant value is 0.5 mg/L, write 500000 to register 123 (since the unit of register 123 is ng /L, the value measured by the portable device is mg/L, there is a conversion factor), and on-site comparison and calibration is completed.

## 6.2 Laboratory calibration

(1) When the sensor is powered on and after polarization is completed, flow in chlorine-free tap water (you can use a water pump to circulate chlorine-free tap water) and wait for the sensor voltage signal (register 31) to stabilize.

(2) After the sensor voltage signal is stable, write the value 0 to register No. 121 to complete the low point calibration step.

(3) Assume that the disinfectant is residual chlorine, add an appropriate amount of 84 disinfectant to the circulating water sample, and add the disinfectant manually; add acetic acid to the circulating water sample, and adjust the pH of the water sample to be the same as the pH used on site; wait for the water sample to Mix the

84 disinfectant and acetic acid evenly.

(4) After half an hour, use the DPD portable device to measure the residual chlorine at the outlet of the flow cell, take multiple water measurements, and take the average of the multiple measurements.

(5) Assume that the measured residual chlorine value is 0.5mg/L, write 500000 to the sensor's register 123 (since the unit of register 123 is ng/L, the value measured by the portable device is mg/L, there is a Conversion coefficient), complete the high point calibration step.

In the laboratory calibration method, the same disinfectant used in the field can be used for calibration. For example, if residual chlorine is used for disinfection on site, 84 disinfectant is used, chlorine dioxide effervescent tablets are used for chlorine dioxide, and ozone generators are used for ozone.

# Chapter 7 Maintenance

### (1) Cleaning

Clean the sensor regularly depending on the water quality and pollution conditions. If necessary (sensitivity <50mVL/mg), perform sandpaper polishing (sandpaper specification >5000 mesh). Polishing steps:

a) Remove the sensor from the flow cell.

b) Rinse the electrode with tap water.

c) Wet the sandpaper with tap water, wrap the two platinum ring sensors with the sandpaper, and rotate and polish for at least 2 turns. Stop polishing after the silver-white metallic luster of the sensors returns.

d) After cleaning the polished part with tap water, install the sensor back into the flow cell.

e) Calibrate the sensor after running it with water and electricity for 2 hours.

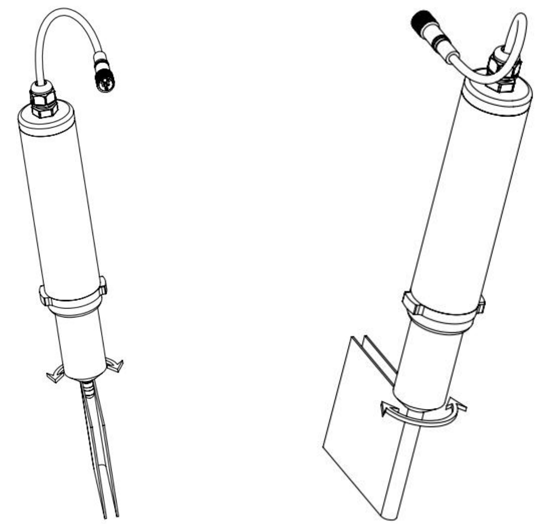

Figure 7 Polishing

### (2) Calibration

New electrodes passivate quickly during the first period of use, so it is recommended to calibrate them once a week. Later, they passivate slowly, so it is recommended to calibrate them once a month. The calibration uses the DPD colorimetric method for regular calibration. During the calibration process, the pH value and disinfectant content of the water sample are ensured to be stable.

**(3)Cover the sensor with a protective cap when not in use.**

# Chapter 8 Troubleshooting

## 8.1 Common troubleshooting

The following table lists possible sensor problems and solutions. If your problem is not listed or the solution cannot solve your problem, please contact us.

Table 3 Common troubleshooting

| Phenomenon | Reason | Solution |
|---|---|---|
| Unable to communicate | The power is not connected | Check whether there is voltage value between the power terminals |
| | Incorrect power connection | Check and restore normal power |
| | Communication error | Please ask professionals to judge |
| Display is unstable | Unstable water quality | Use a stable water source to eliminate module causes |
| The displayed value is too high | The sensor has not completed the polarization reaction | Wait for the polarization reaction to complete |
| The displayed value is too low | The flow rate into the medium is too small | Ensure normal traffic |

## 8.2 Handling of abnormal residual chlorine/chlorine dioxide under special circumstances

(1) The value measured by the DPD portable device is less than 0.05, but the

device displays a value that is less than the value measured by the DPD portable device or is 0. Do not perform calibration in this case, because the DPD portable device has almost reached the lower limit of measurement at this time, and the impact of the error will be great. Increase the dosage and calibrate again when the value measured by the DPD portable device is greater than 0.3mg/L.

(2) The electrode is covered with stains, and the value displayed by the device is much smaller than the value measured by the DPD portable device. Please clean the electrode. If the problem still cannot be solved, you can use 5000 grit sandpaper to polish the electrode. For the polishing steps, please refer to Chapter 7.

(3) On-site water samples contain a lot of ammonia nitrogen, and ammonia will react with chlorine in many ways:

$NH_4^+ + HOCl \rightarrow NH_2Cl + H_2O + H^+$

$NH_2Cl + HOCl \rightarrow NHCl_2 + H_2O$

$NHCl_2 + HOCl \rightarrow NCl_3 + H_2O$

$2NH_4 + + 3HOCl \rightarrow N_2 + 5H^+ + 3Cl^- + 3H_2O$

$NH_4^+ + 4HOCl \rightarrow NO_3 - + 6H^+ + 4Cl^- + H_2O$

And with different chlorine content, the reaction may be different, generating various chloramines. Experiments have shown that monochloramine will cause the free chlorine value measured by the DPD method to be too high. Reading within one minute, every 0.3 mg/L of monochloramine will cause the free chlorine value measured by the DPD method to be too high by 0.1, while the digital residual chlorine of the equipment The sensor cannot measure monochloramine. It is recommended to use high-purity chlorine dioxide for disinfection.

(4) On-site water samples contain a lot of high-valent iron ions. High-valent iron ions have strong oxidizing properties, which will make the value measured by the DPD method higher. In this case, the value can also be measured by using the DPD method to measure the raw water, and The device's electrodes cannot measure iron ions. Chlorine dioxide can oxidize iron ions to produce rust. Increasing the dosage of chlorine dioxide can oxidize some iron ions to produce free chlorine dioxide. The equipment can detect the value but it is smaller than the

value measured by the DPD method. It takes several days for residual chlorine to oxidize high-valent iron ions. Most of the iron ions are not oxidized, and the value detected by the equipment will be far smaller than the value measured by the DPD method.

(5) The on-site water samples contain a lot of nitrite ions, and the situation of containing nitrite is the same as that of iron ions.

(6) On-site water samples contain a lot of high-valent manganese ions. High-valent manganese ions have strong oxidizing properties, which will make the value measured by the DPD method higher. In this case, the value can also be measured by using the DPD method to measure the raw water. The device's electrodes cannot measure manganese ions.

Chlorine dioxide can oxidize high-valent manganese ions. Increasing the dosage of chlorine dioxide can oxidize part of the high-valent manganese ions, thereby producing free chlorine dioxide. The equipment can detect the value but it is smaller than the value measured by the DPD method.

The efficiency of residual chlorine in removing high-valent manganese ions is low, and most of the manganese ions are not oxidized. The equipment can read the value but it will be far less than the value measured by the DPD method.

# Chapter 9 Warranty & After-sales Service

We promises that if there are any product quality problems during the warranty period, we will provide unconditional three-guarantee service for the products with quality problems, that is, free repair, replacement or return. All non-customized products are guaranteed to be returned or exchanged within 7 days (excluding products damaged by use). Customized products are subject to the warranty stipulated in the contract.

Disclaimer：

During the warranty period, product failure caused by the following reasons does not fall within the scope of the three-guarantee service:

- Product failure caused by improper use by customers.
- Product failure caused by customers’ own disassembly, repair and modification of the product

# Appendix A Communication Protocol

The sensor adopts RS485 Modbus-RTU protocol and supports 0x03 read command and 0x10 write command. The default Modbus slave address is 0x01.

RS485 port configuration:

Baud rate: 9600

Data bits: 8

Stop bit: 1

Verification: No verification

The register address is shown in Table 4:

Table 4 Register address

| No | Register name | Register address | Length | Data type | Permissions | Explanation |
|---|---|---|---|---|---|---|
| 1 | Device slave address | 1 | 1 | UINT16 | Read and write | Modbus slave address, 1-247 |
| 2 | Disinfectant value | 23 | 2 | UINT32 | Read only | Unit ng/L |
| 3 | temperature value | 29 | 2 | UINT32 | Read only | Unit u℃ |
| 4 | Electrode voltage signal | 31 | 2 | INT32 | Read only | Unit uv |
| 5 | Disinfectant calibration point low value | 55 | 2 | UINT32 | Read and write | Unit ng/L |
| 6 | Disinfectant Calibration Point Low Point Voltage | 57 | 2 | INT32 | Read and write | Unit uv |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Disinfectant Calibration Point High Point Value | 59 | 2 | UINT32 | Read and write | Unit ng/L |
| 8 | Disinfectant Calibration Point High Point Voltage | 61 | 2 | INT32 | Read and write | Unit uv |
| 9 | Electrode sensitivity | 63 | 2 | UINT32 | Read only | mVL/mg |
| 10 | Disinfectant factory calibration point low value | 65 | 2 | UINT32 | Read only | Unit ng/L |
| 11 | Disinfectant factory calibration point low point voltage | 67 | 2 | INT32 | Read only | Unit uv |
| 12 | Disinfectant factory calibration point high point value | 69 | 2 | UINT32 | Read only | Unit ng/L |
| 13 | Disinfectant factory calibration point high point voltage | 71 | 2 | INT32 | Read only | Unit uv |

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 | Disinfectant Low Point Calibration | 121 | 2 | UINT32 | Write only | Unit ng/L |
| 15 | Disinfectant High Point Calibration | 123 | 2 | UINT32 | Write only | Unit ng/L |
| 16 | Temperature single point calibration | 317 | 2 | UINT32 | Write only | Unit m℃ |
| 17 | Restore factory calibration | 321 | 1 | UINT16 | Write only | Write 1 to restore the disinfectant factory calibration |

Note: To convert ng/L to mg/L, you need to divide the obtained value by one million. Similarly, to convert uV to V, you need to divide the obtained value by one million.

1mg/L=1000ug/L, 1ug/L=1000ng/L;

1℃=1000m℃,1m℃=1000u℃;

1V = 1000mV, 1mV = 1000uV.

Communication example:

(1) Read the modbus slave address of the electrode

Read command: 01 03 00 01 00 01 D5 CA

Read command reply: 01 03 02 00 01 79 84

(2) Modify the modbus slave address of the electrode and modify the device slave address to 5

Write instructions: 01 10 00 01 00 01 02 00 05 67 82

Write command reply: 01 10 00 01 00 01 50 09

(3) Read the disinfectant value

Read command: 01 03 00 17 00 02 74 0F

Read command reply: 01 03 04 00 07 A1 20 33 BA

Among them, 00 07 A1 20 is the disinfectant value, which is converted to decimal

500000, and the unit is ng/L.

(4) Calibrate disinfectant low point

Pour chlorine-free tap water into the flow cell, and after the electrode voltage stabilizes, calibrate the low point of the disinfectant to 0

Write command: 01 10 00 79 00 02 04 00 00 00 00 34 E1

Write command reply: 01 10 00 79 00 02 90 11

If you forget the device slave address, you can use broadcast address 0. Read the modbus slave address of the electrode using the broadcast address

Read command: 00 03 00 01 00 01 D4 1B

Read command reply: 01 03 02 00 01 79 84