SZ4000
Online
Multi-parameter Sensor
User Manual

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Catalog

Preface

Dear customer

Thank you for using our product.Reading the entire manual before use is highly recommended for operation and maintenance the instrument and out of unnecessary trouble.

Please observe the operating procedures and precautions in this manual.

To make sure the effective after-sales protection provided by the instrument, please do not use any operation or maintenance other than which mentioned in the manual.

Due to non-compliance with the precautions specified in this manual, any fault and loss caused shall not be covered by the warranty, and the manufacturer shall not bear any relevant responsibility. If you have any questions, please contact our after-sales service department or representative.

Carefully unpack the instrument and accessories from the shipping container, and inspect for possible damage during shipping. Check received parts with items on the packing list. If any parts or materials are damaged or missing, please contact our customer service or the authorized distributor immediately.

Save all packing materials until you are sure that the instrument functions properly. Any damaged or defective items must be returned in their original packaging materials.

1 Overview

1.1 Introduction

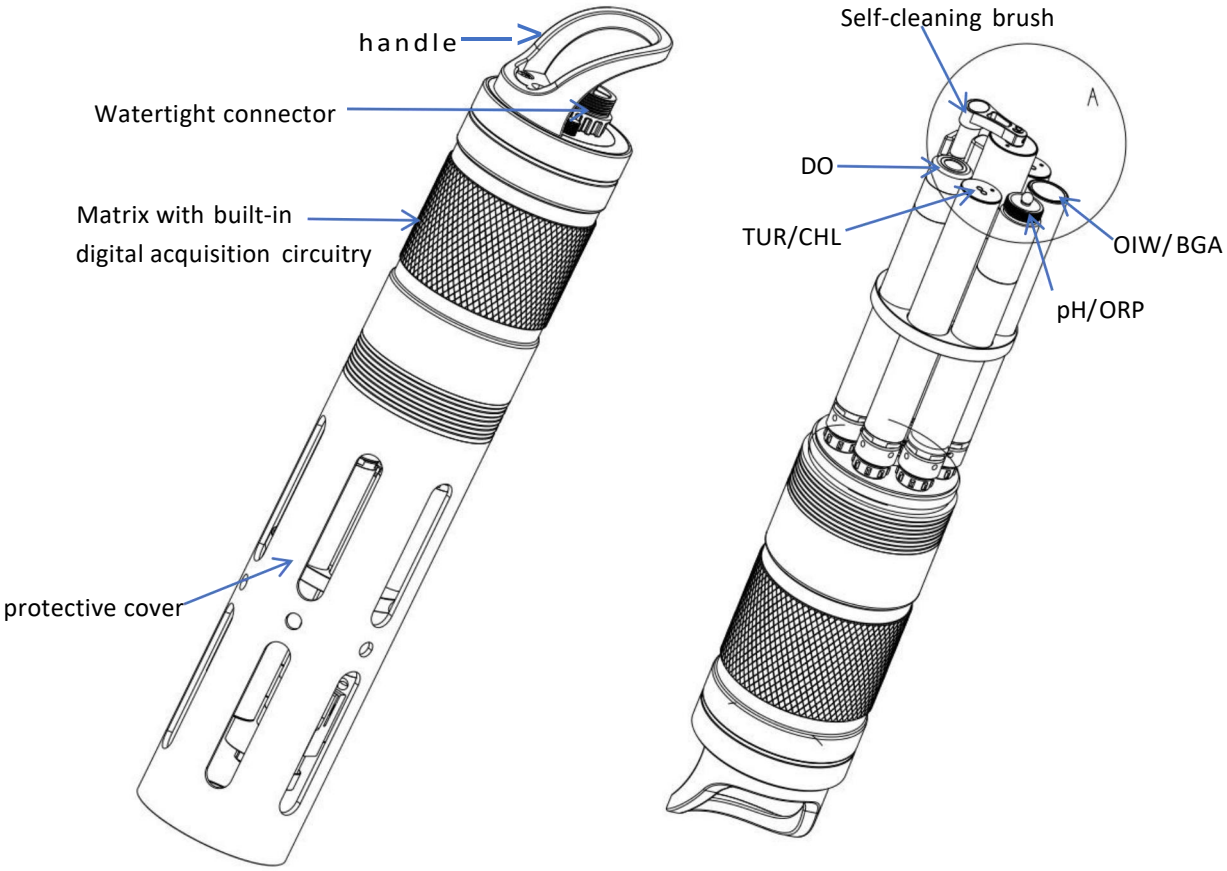
Online multi-parameter sensor adopts all-in-one structural design. Each single-parameter sensor is an RS485 digital probe tightly connected to the main unit, with calibration data stored in the sensor for easy on-site calibration or replacement. It can monitor five conventional water quality parameters (water temperature, pH/ORP, dissolved oxygen, conductivity, turbidity) online, and can also monitor chlorophyll, blue-green algae, and oil in water. The main unit supports up to 6 probes and can detect 7 parameters.

online multi-parameter sensor with a cleaning brush can effectively clean the measuring end face, remove bubbles, and prevent microbial attachment. It is suitable for monitoring various water environment conditions such as sewage treatment, surface water, ocean, and groundwater. With excellent reliability and the ability to operate for months without maintenance, online multi-parameter sensor has been tested in the market and undergone technological iteration for years.

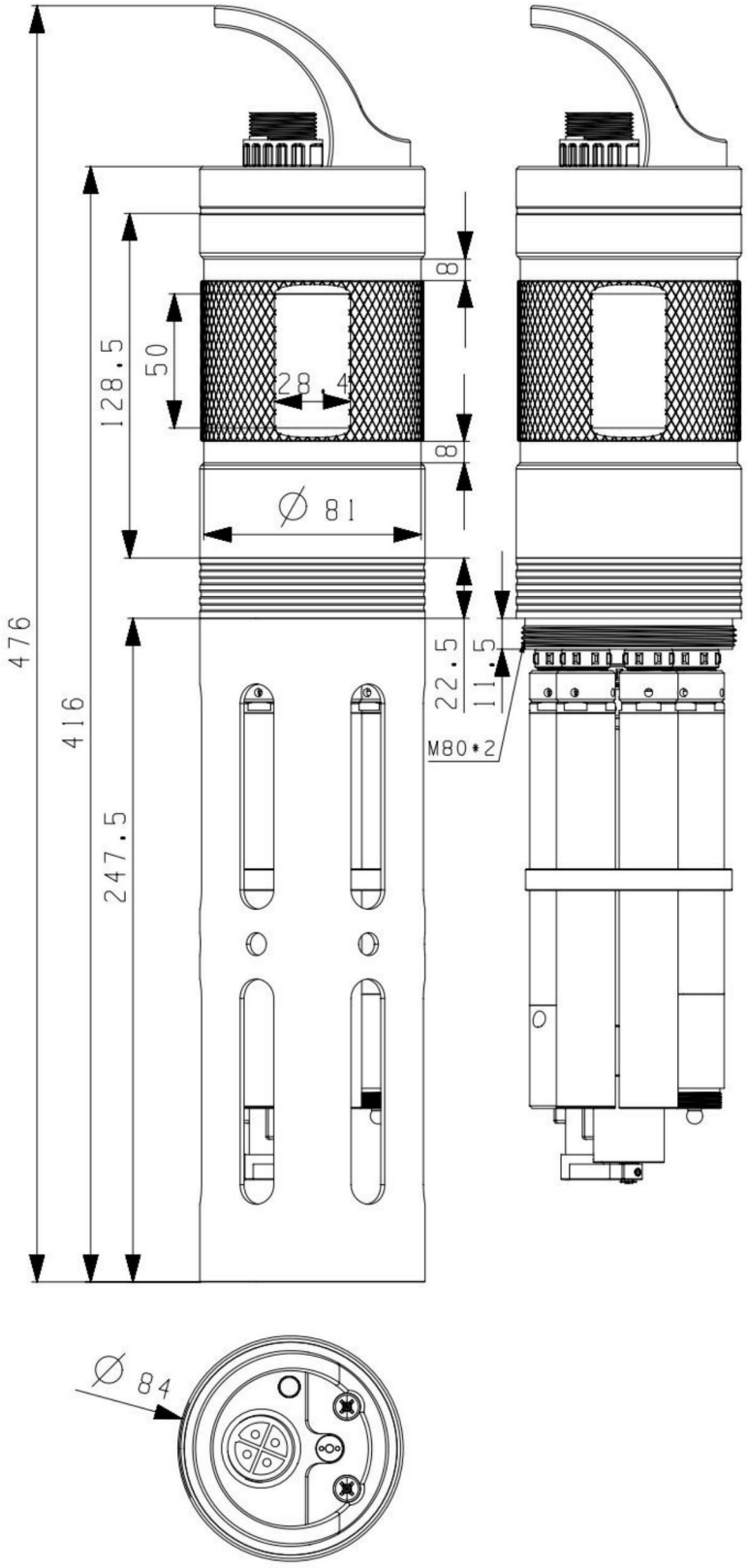
Product features:

- Digital sensor with RS485 output and standard MODBUS protocol.
- All calibration parameters are stored in the sensor, and each probe is equipped with a waterproof connector for easy plug-in and replacement.
- Equipped with a self-cleaning brush for regular cleaning at set intervals to eliminate errors caused by bubbles or contamination, suitable for long-term unattended online monitoring.
- The main unit can be connected to up to 6 probes, allowing for the use of various sensors such as dissolved oxygen, conductivity (salinity), turbidity, pH, ORP, chlorophyll, blue-green algae, and oil in water.
- Each sensor can be replaced, calibrated, and maintained on site, providing flexibility and convenience to users.
- Efficient acquisition algorithm with a whole machine response time of ≤ 30s, main unit integrated voltage abnormal shutdown, communication abnormal alarm, and cleaning brush abnormal alarm for convenient operation and maintenance judgment.

▲ **Online Multi-parameter Sensor**



▲ **Online Multi-parameter Sensor Component Diagram**



▲ **Online Multi-parameter Sensor Size**

1.2 Technical specification

Name	Online multi-parameter sensor
Measured depth	0-30m
Main body information	Support up to 6 sensor access, 1 central cleaning brush, probe and cleaning brush can be disassembled, free combination
Size	Φ84mm*476mm
Operating temperature	0-50℃
IP range	IP68
Calibration data	The calibration data is stored in the probe, which can be disassembled for direct calibration
Output	Supports RS-485, MODBUS protocol
Weight	2.3kg（Matrix+6 sensors)
Brush control	The default cleaning time is 30 minutes. the cleaning interval can be setted
Full load power consumption	0.8W（non wiping），2W（wiping)
Power supply requirement	Complete machine：DC 12-24V,≥1A；probe：9-24V,≥1A
Operating temperature	0-50℃
Material	POM, titanium alloy, anti-fouling copper
Status alert	Internal power supply exception alarm, internal communication exception alarm, and cleaning brush exception alarm
Cable length	With waterproof connector, 10m (default), customizable

Sensor	Principle	Range	Accuracy	Material
DO	Fluorescence method	0-50mg/L or 0-500% Saturation	0-20mg/L:±1% or ±0.2mg/L > 20mg/L:±5% or ±0.6mg/L	Ti+POM
TUR	90°Scattered light	0-1000NTU or 0-4000NTU	±5% or 0.3NTU	Titanium alloy
CT (SAL)	Four-electrode	CT：0-200mS/cm (0-2mS/cm、2-20mS/cm、20-200mS/cm) SAL：0-175ppt TDS：0-128000mg/L	±1% or 0.01mS/cm ±1ppt /	PEEK+Ti
OIW	Ultraviolet fluorescence method	0-50ppm or 0-150ppm	Linearity：R^2 > 0.999	Titanium alloy
pH	Glass electrode method	0-14 pH	±0.02 pH	POM+Ti

ORP	Platinum electrode method	- 1999-1999mV	±20mV	POM+Ti
CHL	Fluorescence method	0-500μg/L	±5% or 0.5μg/L	Titanium alloy
BGA	Fluorescence method	0-300000cells/mL(0~2000000cells/mL)	Linearity: R^2 > 0.999	Titanium alloy
Depths	Differential pressure	0m-2m...100m	< 0.1% F.S.	316L(Ti)

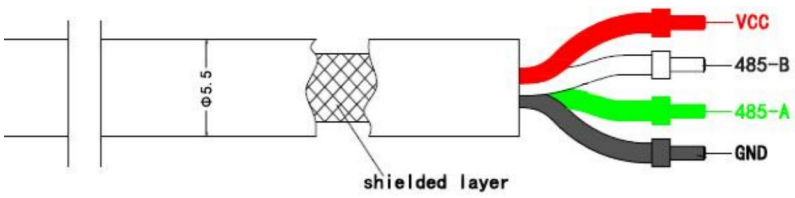
Note:

The above technical parameters are all data under laboratory standard liquid environment.

Sensor life and maintenance calibration frequency are related to actual field conditions.

1.3 Definition of cable

Cable: 4 wire AWG-24 OR AWG-26 shielding wire,OD=5.5mm.



1, Red—Power (VCC)
2, White—485 Date_B (485_B)
3, Green—485 Date_A (485_A)
4, Black—Ground (GND)

Since the cleaning brush starts cleaning when it is powered on, please make sure to remove the pH/ORP protective cap and dissolved oxygen protective rubber sleeve before powering on the brush. Please make sure the power supply and wiring sequence are correct. Damage to the product caused by improper operation is not covered by the warranty.

2 Installation

2.1 Configuration

Item	Number	Unit	Note
Online multi-parameter sensor	1	pcs	
Cable	1	pcs	10m
Test cable	1	pcs	1m
316L U-bolt	2	pcs	M6*89 sensor Installation
316L installing sheet metal	2	pcs	Sensor Installation

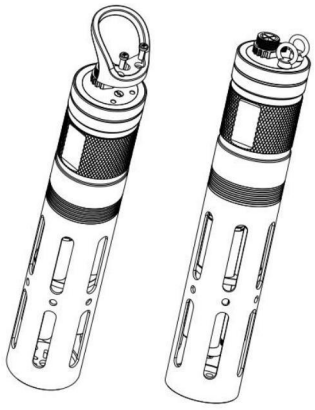
M6 stainless steel flange hex nuts	4	pcs	M6 Installation accessories
316L hexagon socket set screws bolts nuts flat spring washers set	2	group	M6*60 Installation accessories
Handhold DTT-lever	1	pcs	316L,φ8*29.5
M6*12 316L eyebolt screw	2	pcs	M6*12 Sensor lifting use
Waterproof cap	2	pcs	

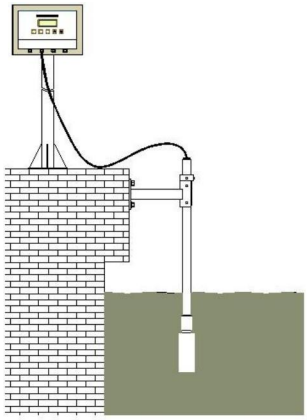
*The configuration sheet is a generic accessory, additional accessories are available on request.

2.2 Field installation method

2.2.1 Ring suspension mount

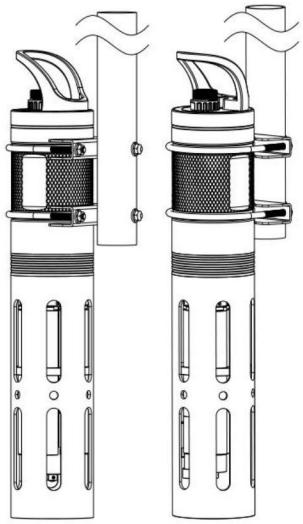
After removing the sensor, the sensor handle needs to be replaced with a hanging ring, The sensor and the ground plane are installed with 90°vertical angle suspension as far as possible. As shown in the figure below, recommended for scenarios with no rapids, little pollution, etc.





2.2.2 Fixed mounting of the throat band

Attach the sensor to the mounting bracket through the laryngeal hoop, the sensor and ground plane shall be fixed at 90° vertical angles as far as possible. As shown in the figure below, suitable for scenarios such as rapids, unstable water conditions, etc.



2.3 Installation precautions

（1） Before use, need to check that each probe and cleaning brush body is connected to the parent body. If loose, please use the matching stainless steel special screw to tighten one by one.

（2） The sensor shall be installed vertically with the sensor facing down, avoid horizontally installation or with sensor face upward. The sensor must be securely mounted to avoid any damage caused by water flow and other unknown factors.

（3） Considering the influence of water level, the sensor is recommended to be installed under water surface level of 30cm. Probe shall be fully submerged into water.

2.4 Precautions for use

（1） As the default setting of the cleaning brush is to turn on after power-on, please be sure to remove the protective caps of dissolved oxygen sensor and pH sensor before power-on to prevent motor damage caused by blocking the rotation of the cleaning brush.

The dissolved oxygen sensor needs to be kept wet. When not in use, it is recommended to put it in water or cover it with a protective cap, and pay attention to keep the sponge wet. pH electrode can not be dry for a long time, when not in use, use 3mol/L potassium chloride (KCl) solution to preserve.

（2） The pH electrode should be handled gently to avoid electrode bulb rupture.

（3） Waterproof connectors cannot be plugged or unplugged with water. To avoid moisture ingress during connector disassembly. before probe disassembly, first dry the water on the outside of the probe, then remove it again. If water enters inside the connector, you need to

blow out the water. Avoid oxidizing the copper pins inside the connector.

（4） If the probe needs to be removed from the field.The female connector needs to be plugged with a waterproof cap.Prevents water damage to the copper pins of the connector and short-circuiting of the female body.

3 Calibration

3.1 Calibration method

3.1.1 Complete machine calibration

Online multi-parameter sensor supports whole machine calibration， Can be calibrated by our PC software： Multi Sensor or multi-parameter Modbus protocol for calibration. Before calibration, you need to prepare the corresponding standard liquid, and then put the online multi-parameter sensor machine into the corresponding standard liquid for calibration.

For this calibration method, first prepare a larger container, put 2-3L of standard solution in the container. After each sensor has been calibrated, online multi-parameter sensor needs to be removed from the standard solution and rinsed with pure water. Wipe clean with a soft dust-free cloth. Wipe clean with a dust free cloth before placing in the next calibration solution. It prevents residual liquid from entering the next standard solution and affecting other sensor calibrations.

3.1.2 Single probe calibration

Each single probe on the online multi-parameter sensor is an RS485 digital sensor. Calibration data is stored in each probe. Remove probe for individual calibration, connects to PC, industrial control or handheld instrument using the supplied single probe test lead.

This method reduces the amount of standard solution used. Remove the probe to be calibrated from the online multi-parameter sensor, connect a single probe test lead, and calibrated using the corresponding standard solution.

3.1.3 Handheld meter calibration

If the site is not convenient to use a computer, external power supply. A handheld meter can be used. To calibrate, remove the single probe from the online multi-parameter sensor and connect the handheld meter, turn it on and follow the handheld meter calibration prompts for step-by-step calibration.

▲ **Handheld Meter**

3.2 Calibration Solution Preparation and Test Precautions

3.2.1 DO standard solution（Take two points as an example）

① **Preparation for zero oxygen environment:** take 200mL distilled water and pour it into the prepared beaker, then add anhydrous sodium sulfite, add and stir at the same time, until anhydrous sodium sulfite is insoluble and solid crystallization occurs, then the standard solution can be regarded as close to 0 oxygen.

② **Preparation for 100% oxygen environment:** Prepare 1 beaker, take 200mL purified water (or distilled water) and pour it into the cup, add to the air pump, and fully aerate the solution (at least 30 minutes). If the field conditions really do not allow, the sensor can be directly put into the air (calibration accuracy will be slightly deviated).

Note: Because the zero oxygen standard contains anhydrous sodium sulfite. When the sensor is taken out of the zero oxygen standard, the sensor needs to be rinsed out with tap water or purified water.

3.2.2 CT standard solution（Take two points as an example）

① **Zero standard liquid:** use deionized water or ultra-pure water. It is also possible to put the conductivity sensor into the air.

②**Common concentration standards:** configuration with reference to national standard methods. The configuration of the standard solution is shown in the table.

Solution code	Approximate concentration mol/L	Conductivity values S/cm				
		15℃	18℃	20℃	25℃	35℃
A	1	0.09212	0.09780	0.10170	0.11131	0.13110
B	0.1	0.010455	0.011163	0.011644	0.012852	0.015353
C	0.01	0.0011414	0.0012200	0.0012737	0.0014083	0.0016876
D	0.001	0.0001185	0.0001267	0.0001322	0.0001465	0.0001765

▲ Table 1 Potassium chloride concentration corresponds to conductivity values

Solution number	Approximate molar concentration Mol/L	Potassium chloride required to prepare 1 L of solution g
A	1	74.2457
B	0.1	7.4365
C	0.01	0.7440
D	0.001	dilute 100 mL of C solution 10-fold

▲Table 2 Composition of solution

Notes:

① Due to the electric field propagation characteristics, only 1 sensor is allowed to be placed in 1 container during the test. The temperature of the standard solution should be stabilized, and it should be gently shaken when it is put in to avoid that there are no air bubbles in the flow-through holes at the front end of the conductivity.

② After placing the conductivity sensor in another conductivity standard solution, wash the electrode with deionized water and dry it with a dust-free cloth.

③ When testing temperature compensation accuracy , Tested after single-point calibration at 25°C for a solution of 1.4083mS/cm. The sensor is placed in the solution for more than 15min. Wait for the sensor temperature to stabilize before taking a reading.

3.2.3 Turbidity standard solution（Take two points as an example）

① **Zero standard liquid:** deionized water.

② **Mother liquor standard solution （4000NTU）：** the raw materials required for preparing turbidity standard solution are considered as controlled drugs.Users are not qualified to configure themselves. It is recommended to purchase 4000NTU turbidity standard solution.

Notes:

After placing the sensor in another conductivity standard solution, wash the sensor with deionized water and dry it with a dust-free cloth.

For calibration, put the standard solution into a brown wide-mouth bottle and fix the sensor with an iron frame.

Place the sensor slowly into the standard solution to avoid air bubbles.

The front of the sensor should be kept at a distance of >10cm from the bottom of the container and >3cm from the side walls.

3.2.4 pH standard solution

pH standard concentration is 4.00, 6.86, 9.18 (25℃).

Notes:

① When the electrode is not in use, it needs to be stored in 3.3mol/L KCL solution or saturated KCl solution.

② The electrode should not be exposed to air for too long time.

③ The electrode should be handled gently to avoid electrode bulb rupture.

④ After calibrating a standard solution, it's necessary to rinse the electrode with deionized water, gently wipe it with dust-free paper or cloth, then put it into the next standard solution.

3.2.5 Chlorophyll standard solution

Zero standard liquid: Use ultrapure water or deionized water as the zero standard solution.

Other concentration standards: use of Rhodamine WT as a standard substance.

Standard solution configuration

① **Placement 200mg/L Rhodamine WT solution：**

Take 0.5mL of Rhodamine WT,20% solution into 500mL volumetric flask,dissolve in deionized water to mark of 500 mL, which is 200mg/L Rhodamine WT stock solution.

② **Placement 2mg/L Rhodamine WT solution：**

Take 10mL of ① into a 1000 mL volumetric flask, dissolve in deionized water to mark of 1000mL, which is 2mg/L Rhodamine WT stock solution, can be used as a standard solution of chlorophyll.

Rhodamine WT solution of 2mg/L- temperature - chlorophyll corresponding table

temperatur （℃）	30	28	26	24	22	20	18	16
chlorophyll （μg/L）	176.7	186.9	194.5	204.9	214.2	227.1	240.5	249.3

Notes:

Standard stock solutions must be stored at low temperatures in dark glass vials. The solution is be used within 24 hours.

After placing the sensor in another conductivity standard solution, wash the sensor with deionized water and dry it with a dust-free cloth.

For calibration, put the standard solution into a brown wide-mouth bottle and fix the sensor with an iron frame.

Place the sensor slowly into the standard solution to avoid air bubbles.

The front of the sensor should be kept at a distance of >10cm from the bottom of the container and >3cm from the side walls.

Gloves must be worn when calibrating.

3.2.6 BGA standard solution

Zero standard liquid: use ultrapure water or deionized water as zero standard solution.

Scale standard liquid: rhodamine B solid(CAS: 81-88-9) as a standard substance.

Standard solution configuration

Take 0.1g of rhodamine B solid(CAS: 81-88-9) and dissolve in deionized water, fixed capacity to 1L. At this time, the 100ppm rhodamine B standard solution is prepared.

Take 1mL of 100ppm rhodamine B standard solution (step1) and dissolve in deionized water, fixed capacity to 1L. At this time, the 100ppb rhodamine B standard solution is prepared. (Its fluorescence intensity at 26°C is similar to the 54000 cells/mL BGA standard solution, so it can be used as an indicator solution).

Range calibration liquid use

Rhodamine B shows fluorescence intensity inversely proportional to temperature.With 100ppb rhodamine B standard solution, set the sensor correctly.Please enter the calibration values according to the temperature standards corresponding to the table below.

Temperature (℃)	BGA (cells/mL)
34	37463
32	40847
30	46193
28	49430
26	54000
24	59995
22	64776
20	70975
18	76405

Notes:

After placing the sensor in another conductivity standard solution, wash the sensor with deionized water and dry it with a dust-free cloth.

For calibration, put the standard solution into a brown wide-mouth bottle and fix the sensor with an iron frame.

Place the sensor slowly into the standard solution to avoid air bubbles.

The front of the sensor should be kept at a distance of >10cm from the bottom of the container and >3cm from the side walls.

The solution is be used within 24 hours.

4 Maintenance Methods And Common Problems

4.1 Maintenance Schedule

Although online multi-parameter sensor is equipped with a self-cleaning brush, the bad working conditions will still cause contamination and attachment of the sensor. To ensure accuracy measurement, cleaning is very important, regular cleaning and maintenance of the sensor, contribute to the sensor work and measurement of long-term stability qualitative.

Maintenance task	Frequency
Sensor cleaning	Every 4 to 8 weeks. If the environment is dirty, shorten the cleaning period
Calibration	According to the actual situation, a single parameter reading is not accurate can be removed to separate calibration
Replace pH chemical electrodes regularly	Because the pH chemical electrode is a loss product, it is recommended to replace the electrode every 6 months, not replacing the electrode for a long time will cause inaccurate pH measurement
Maintain or replace the cap of the DO sensor	During cleaning, don't use hard objects to scratch the fluorescent film to avoid shedding of fluorescent materials, which may lead to abnormal data. In addition, it is recommended to replace the cap once a year
Maintain and inspect self-cleaning brushes	Every 3-6 months
Check/replace the sealing ring of each sensor watertight connector	Please check after each disassembly. If the sealing ring is damaged, it should be replaced immediately

4.2 Maintenance

Clean the overall inner and outer surface of the sensor and the sensor: wash the outer surface of the sensor with tap water first, wash off the sediment, if there are still algae, dirt residue, can be brushed off with a soft brush; Then remove the sensor cover, clean the inner wall of the cover in the same way; Next and cleaning brush with a soft brush to clean the probe, note please do not use hard objects scratch the front of dissolved oxygen, optical fiber type turbidity, PH sensor measuring contrate, pay special attention to, the front glass PH electrode ball bubble is fragile, please be careful when cleaning, clean another four electrode conductivity sensor, we need to use custom long hair brush, used to clean the electrode hole clean.

Check the cable of the sensor: Do not tighten the cables during normal operation. Otherwise, the wires in the cables may be broken, causing the sensor to fail to work properly.

Check motor function and cleaning brush: check whether the cleaning brush rotates normally, whether it is loose, whether the bristles are deformed or damaged; If the rotation is abnormal or the stop position is wrong, it is necessary to return to the factory for maintenance of the motor and Hall components; If the bristles are loose, tighten the fixing screws; If the bristles are deformed or damaged, replace the whole bristles.

Calibration: One point or two points calibration of the sensor. Select the appropriate standard solution according to the corresponding sensor.

Check the water tightness of each sensor: when used, the sensor must be tightly screwed with the main body, not loose, if loose, need to use custom screw for tightening; When removing the sensor each time, check whether the sealing ring in the watertight connector is damaged. If it is worn or deformed seriously, it must be replaced immediately to avoid short circuit caused by water entering the connector.

Proper storage: When there is no test/power supply for a long time, please take out the sensor, clean it, cover the protective cover of the dissolved oxygen sensor and pH sensor and store it at room temperature, which can effectively prolong the service life of the sensor.

4.3 Attention

As the default setting of the cleaning brush is to turn on after power-on, please be sure to remove the protective caps of dissolved oxygen sensor and pH sensor before power-on to prevent motor damage caused by blocking the rotation of the cleaning brush.

The dissolved oxygen sensor needs to be kept wet. When not in use, it is recommended to put it in water or cover it with a protective cap, and pay attention to keep the sponge wet.

pH electrode can not be dry for a long time, when not in use, use 3mol/L potassium chloride (KCl) solution to preserve.

Do not turn the cleaning brush by external force under any circumstances. Clean brush-operated seals should be maintained or replaced every 18 months.

The sensor contains sensitive optical and electronic components. Make sure the sensor is not subjected to severe mechanical impact.

4.4 Trouble Shooting

ERROR	POSSIBLE CAUSE	SOLUTION
Abnormal communication	1. Power supply error 2.Communication setup problems	1.Check the output voltage of power supply; 2.Reconnect and check Modbus address.
High deviation of measured values	There may be biological attachment at the front of the sensor	1.Check whether there is dirt attached to the front of the sensor, if so, please clean the sensor. 2.Check whether the cleaning brush is normal, whether there is loosening, deformation, stuck, block the optical sensor
The values of conductivity, turbidity, chlorophyll and BGA are close to 0	1.Check the water level of the sensor installation position 2.Check whether the connector is loose	1.check whether the sensor is exposed to the air, the water level becomes low, the sensor exposed to the air these sensors may appear 0 value. 2.check whether the connector is loose, resulting in water.
The sensor does not work and is obviously damaged	That cannot be eliminated on the spot	Contact customer service

5 Quality Assurance

（1）Warranty Period

Warranty Period	
DO sensor	1 Year
Turbidity Sensor	1 Year
4-electrode CT(SAL) sensor	1 Year
Ph sensor	Hardware 1 year, electrodes 6 months
ORP sensor	Hardware 1 year, electrodes 6 months
BGA sensor	1 Year
CHL sensor	1 Year
OIW sensor	1 Year
Temperature sensor	1 Year
Online multi-parameter sensor parent	1 Year
Other consumables	3 months

（2） This quality assurance does not cover the following cases.

① Due to force majeure, natural disasters, social unrest, war (declared or undeclared), terrorism, the War or damage caused by any governmental compulsion.

②damage caused by misuse, negligence, accident or improper application and installation.

③Freight charges for shipping the goods back to our company.

④ Freight charges for expedited or express shipping of parts or products covered by the warranty.

⑤Travel to perform warranty repairs locally.

(3) This warranty includes the entire contents of the warranty provided by our company with respect to its products.

①This warranty constitutes a final, complete and exclusive statement of the terms of the warranty, and no person or The agent is authorized to establish other warranties in the name of our company.

② The remedies of repair, replacement, or return of payment as described above are exceptional cases that do not violate this warranty, and the remedies of replacement or return of payment are for our products themselves. Based on strict liability or other legal theory,our company shall not be liable for any other damage caused by a defective product or by negligent operation, including any subsequent damage that is causally related to these conditions.

6 Communication protocols

The RS485 communication protocol uses MODBUS communication protocol, and the sensors are used as slaves.

Data byte format.

Baud rate	9600
Starting position	1
Data bits	8
Stop bit	1
Check digit	N

Read and write data (standard MODBUS protocol)

The default address is 0x01, the address can be modified by register

6.1 Reading data

Host call (hexadecimal)

01 03 00 00 00 01 84 0A

Code	Function Definition	Remarks
01	Device Address	
03	Function Code	
00 00	Start Address	See register table for details
00 01	Number of registers	Length of registers (2 bytes for 1 register)
84 0A	CRC checksum, front low and back high	

Slave answer (hexadecimal)

01 03 02 00 xx xx xx xx

Code	Function Definition	Remarks
01	Device Address	
03	Function Code	
02	Number of bytes read	
XX XX	Data (front low and back high DCBA)	See register table for details
XX XX	CRC checksum, front low and back high	

6.2 Writing data

Host call (hexadecimal)

01 10 1B 00 00 01 02 01 00 0C C1

Code	Function Definition	Remarks
01	Device Address	
10	Function Code	
1B 00	Register Address	See register table for details
00 01	Number of registers	Number of read registers
02	Number of bytes	Number of read registers x2
01 00	Data (front low and back high DCBA)	
0C C1	CRC checksum, front low and back high	

Slave answer (hexadecimal)

01 10 1B 00 00 01 07 2D

Code	Function Definition	Remarks
01	Device Address	
10	Function Code	
1B 00	Register Address	See register table for details
00 01	Returns the number of registers written	
7D 2D	CRC checksum (front low and back high)	

6.3 Calculating CRC Checksum

(1) Preset one 16-bit register as hexadecimal FFFF (i.e., all 1s) and call this register the CRC register.

(2) Iso-oring the first 8-bit binary data (both the first byte of the communication information frame) with the lower 8 bits of the 16-bit CRC register and placing the result in the CRC register, leaving the upper 8 bits of data unchanged.

(3) Shift the contents of the CRC register one bit to the right (toward the low side) to fill the highest bit with a 0, and check the shifted-out bit after the right shift.

(4) If the shifted out bit is 0: repeat step 3 (shift right one bit again); if the shifted out bit is 1, CRC register and polynomial A001 (1010 0000 0000 0001) for the iso-or.

(5) Repeat steps 3 and 4 until the right shift is made 8 times so that the entire 8-bit data is processed in its entirety.

(6) Repeat steps 2 through 5 for the next byte of the communication information frame.

(7) Exchange the high and low bytes of the 16-bit CRC register obtained after all bytes of this communication information frame have been calculated according to the above steps.

(8) The final CRC register content is obtained as follows: CRC code.

6.4 Register Table

Start address	Command Description	Number of registers	Data format (hexadecimal)
0x0700H	Get Software and Hardware Rev	2	4 bytes in total 00 ~ 01: hardware version 02 ~ 03: software version For example, reading 0101 represents 1.1
0x0800H	Sensor Status (read/write)	2	4 bytes in total 00： Error flag bit 01： Power supply error flag bit 02~03： Probe error flag bit **Error flag bit description:** Bit0: Brush state 0： normal 1： anomaly Bit1: Power state 0： normal 1： anomaly Bit2: Probe state 0：normal 1：abnormal or not fully inserted **Power supply error flag bit：** Bit0： First road power supply Bit1： Second road power supply Bit2： Third road power supply Bit3： Fourth road power supply Bit4： Fifth road power supply Bit5： Sixth road power supply 0： anomaly 1： normal **Probe communication error flag bit:** Bit0： Dissolved Oxygen Flag Bit Bit1： Conductivity flag bit Bit2： Turbidity flag bit Bit3： Chlorophyll flag bit Bit4： pH flag bit Bit5： OIW/BGA flag bit Bit6： retention Bit7： retention Bit8： ORP flag bit Bit9： Salinity flag bit 0: Probe not inserted or abnormal communication 1： Probe plugged in and communicating normally
0x0E00H	Brush repeated start time setting (read and write)	1	2 bytes in total 00~01: Time Take the reading value 1E 00 (default) as an example, the actual value is 0x001E, that is, 30 minutes. For example, if you need to write for 60 minutes, convert it to 3C 00 for writing.

0x1100H	User calibration K/B (read/write)	4	Total 8 bytes 00~03: K 04~07: B Flat head conductivity sensor with 24 bytes K1,B1,K2,B2,K3,B3 To read K for example, read out as 4 bytes of data (low bit in front, DCBA format, need to convert this data to floating point, see below for conversion method) To write k, for example, we need to convert k to 32-bit floating point and write it in (DCBA format) address offset (base 0x1100)： 01： DO 02： Turbidity 03： CT 04： pH 05： ORP 06： CHL 07： OIW 08： BGA 09： DEPTH Dissolved oxygen reading K/B as an example, read the command as follows： 01 03 11 01 00 02 90 F7 Flat head conductivity sensor reading K/B as an example, read the command as follows：01 03 11 03 00 0C 90 F7
0x1400H	Get SN (write only)	7	14 bytes in total 00: reserved 01 ~ 12: serial number 13: Reserved The 12 bytes of the serial number are translated according to ASCII code, i.e. the factory serial number
0x1600H	Salinity and barometric pressure writing (read and write)	4	8 bytes in total 00~03: Salinity values 04~07： Air pressure values （When salinity sensor is present, the default is to use the sensor salinity value to automatically bring it into the calculation） Take the salinity reading for example, read out as 4 bytes of data（The low is ahead, DCBA format, this data needs to be converted to floating point numbers, see below for conversion） Take writing salinity for example, salinity needs to be converted to a 32-bit integer first. Write in (DCBA format)

0x1B00H	Brush power-on startup settings	1	2 bytes in total 00~01: 0x0000 Power-on does not start 0x0100 Power-on self-start
0x2600H	Measured value acquisition	22	Multi-parameter measurements can be acquired either in one frame or by individual address offsets.Single-frame multi-parameter acquisition of a total of 44 bytes 00~03： DO（mg/L） 04~07： Turbidity value 08~11： Conductivity value 12~15： pH 16~19： Temperature 20~23： ORP 24~27： Chlorophyll 28~31： OIW/BGA/Depth 32~35： Salinity 36~39： TDS 40~43： DO（%） Take address 1 as an example： 01 03 26 00 00 16 CF 4C Single reference reading， address offset(base：0x2600) 01： DO（mg/L） 02： Turbidity 03： Conductivity 04： pH 05： Retention 06： Temperature 07： Retention 08： Salinity 09： Retention 0A： Dissolved oxygen percentage 0B： ORP 0C： Chlorophyll 0D： OIW/BGA/Depth 0E： Retention 0F： TDS Take DO as an example: 01 03 26 01 00 02 9E 83 Read the measured value as 4 bytes of data each (low bit first, DCBA format, this data needs to be converted to floating point numbers, see below for conversion method)

0x2F00H	Brush startup (write only)	0	Send a write command with a write length of 0
0x3000H	Device address (read and write)	1	2 bytes in total 00~01: Device address The range can be set from 1~254 For example, the data obtained is 02 00 (If the low position is in the front, it means that the address is 2) Take address 15 as an example, then 0F 00 Write the corresponding address (low in front) When the current device address is unknown, you can use FF as a common device address to ask for the current

6.5 Conversion algorithms for floating point numbers

6.5.1 Converting floating point numbers to hexadecimal numbers

Step 1: Convert the floating point representation of 17.625 to binary floating point

First find the binary representation of the integer part

$17 = 16 + 1 = 1\times2^4 + 0\times2^3 + 0\times2^2 + 0\times2^1 + 1\times2^0$

So the binary representation of the integer part 17 is 10001B

Then find the binary representation of the fractional part

$0.625 = 0.5 + 0.125 = 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

So the binary representation of the decimal part 0.625 is 0.101B

So the floating point number in binary form for 17.625 expressed in floating point form is 10001.101B

Step 2: Shift to find the exponent.

Shift 10001.101B to the left until there is only one place left before the decimal point to get 1.0001101B, and

10001.101B = 1.0001101 B x 2^4. So the exponential part is 4, which, when added to 127, becomes 131, whose binary representation is 10000011B

Step 3: Calculate the end number

Removing the 1 before the decimal point of 1.0001101B gives the trailing number 0001101B (because the 1 before the decimal point must be 1, the IEEE specifies that only the one after the decimal point should be recorded). An important note for 23-bit trailing numbers: the first bit (i.e. the hidden bit) is not compiled. The hidden bit is the bit to the

left of the separator, which is usually set to 1 and suppressed.

Step 4: Symbol bit definition

A positive number has a sign digit of 0 and a negative number has a sign digit of 1, so 17.625 has a sign digit of 0.

Step 5: Convert to floating point

1 digit sign + 8 digits exponent + 23 digits mantissa

0 10000011 00011010000000000000000B (corresponding to 0x418D0000 in hexadecimal)

6.5.2 Converting hexadecimal numbers to floating point numbers

Step 1: Convert hexadecimal number 0x427B6666 to binary floating point number 0100 0010 0111 1011 0110 0110 0110 0110B into sign, exponent and mantissa bits

0 10000100 11110110110110011001100110b

1 digit sign + 8 digits exponent + 23 digits mantissa

Sign bit S: 0 means positive

Index bit E: 10000100B $=1\times2^7+0\times2^6+0\times2^5+0\times2^4+0\times2^3+1\times2^2+0\times2^1+0\times2^0$

$=128+0+0+0+0+4+0+0=132$

Last digit M: 11110110110011001100110B = 8087142

Step 2: Calculating floating point numbers

$$D=(-1)^S\times(1.0+M/2^{23})\times2^{E-127}$$

$$=(-1)^0\times(1.0+8087142/2^{23})\times2^{132-127}$$

$$=1\times1.964062452316284\times32$$

$$=62.85$$