Dissolved oxygen sensor

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Preface

Thank you for purchasing online optical dissolved oxygen sensor. Please read this manual carefully before operating and using it correctly to avoid unnecessary losses caused by false 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.
- This product is forbidden to use in explosion-proof occasions.

Version

U-SUP-DO-7018-EN1

Safety Precautions

In order to use this product safely, be sure to follow the safety precautions described.

About this manual

- Please submit this manual to the operator for reading.
- Please read the operation manual carefully before applying the instrument. On the precondition of full understanding.
- This manual only describes the functions of the product. The company does not guarantee that the product will be suitable for a particular use by the user.

Precautions for protection, safety and modification of this product

- To ensure safe use of this product and the systems it controls, Please read carefully the operation manual and understand the correct application methods before putting into operation, to avoid unnecessary losses due to operation mistakes. If the instrument is operated in other ways not described in the manual, the protections that the instrument give may be destroyed, and the failures and accidents incurred due to violation of precautions shall not be borne by our company.
- When installing lightning protection devices for this product and its control system, or designing and installing separate safety protection circuits for this product and its control system, it needs to be implemented by other devices.
- If you need to replace parts of the product, please use the model specifications specified by the company.
- This product is not intended for use in systems that are directly related to personal safety.Such as nuclear power equipment, equipment using radioactivity, railway systems, aviation equipment, marine equipment, aviation equipment and medical equipment.If applied, it is the responsibility of the user to use additional equipment or systems to ensure personal safety.

- Do not modify this product.
- The following safety signs are used in this manual:

 Hazard, if not taken with appropriate precautions, will result in serious personal injury, product damage or major property damage.

 Warning:Pay special attention to the important information linked to product or particular part in the operation manual.

- Confirm if the supply voltage is in consistent with the rated voltage before operation.
- Don't use the instrument in a flammable and combustible or steam area.
- To prevent from electric shock, operation mistake, a good grounding protection must be made.
- Thunder prevention engineering facilities must be well managed: the shared grounding network shall be grounded at is-electric level, shielded, wires shall be located rationally, SPD surge protector shall be applied properly.
- Some inner parts may carry high voltage. Do not open the square panel in the front except our company personnel or maintenance personnel acknowledged by our company, to avoid electric shock.
- Cut off electric powers before making any checks, to avoid electric shock.
- Check the condition of the terminal screws regularly. If it is loose, please tighten it before use.
- It is not allowed to disassemble, process, modify or repair the product without authorization, otherwise it may cause abnormal operation, electric shock or fire accident.
- Wipe the product with a dry cotton cloth. Do not use alcohol, benzine or other organic solvents. Prevent all kinds of liquid from splashing on the product. If the product falls into the water, please cut off the power

immediately, otherwise there will be leakage, electric shock or even a fire accident.

- Please check the grounding protection status regularly. Do not operate if you think that the protection measures such as grounding protection and fuses are not perfect.
- Ventilation holes on the product housing must be kept clear to avoid malfunctions due to high temperatures, abnormal operation, shortened life and fire.
- Please strictly follow the instructions in this manual, otherwise the product's protective device may be damaged.

⚠

- Don't use the instrument if it is found damaged or deformed at opening of package.
- Prevent dust, wire end, iron fines or other objects from entering the instrument during installation, otherwise, it will cause abnormal movement or failure.
- During operation, to modify configuration, signal output, startup, stop, operation safety shall be fully considered. Operation mistakes may lead to failure and even destruction of the instrument and controlled equipment.
- Each part of the instrument has a certain lifetime, which must be maintained and repaired on a regular basis for long-time use.
- The product shall be scrapped as industrial wastes, to prevent environment pollution.
- When not using this product, be sure to turn off the power switch.
- If you find smoke from the product, smell odor, abnormal noise, etc., please turn off the power switch immediately and contact the company in time.

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.

No.	Name	Quantity	Note
1	Online Optical Dissolved Oxygen 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.

Contents

1. Product Overview

Optical dissolved oxygen sensor measures dissolved oxygen using the principle of oxygen dynamic luminescence quenching technique. When blue light excites sensor film, the sensing film emits red light. The phase difference between the blue excitation and returned red emission is measured, and the result is used to calculate DO concentration.

Features：

- Membraneless, no electrodes design No oxygen consumption
- Flow Independent
- Automatic temperature compensation No H2S Interference
- Low Drift, fast response, and more accurate Low Maintenance, low operating cost
- Easy sensor cap replacement
- RS-485; MODBUS protocol compatible

2. Structure Chart
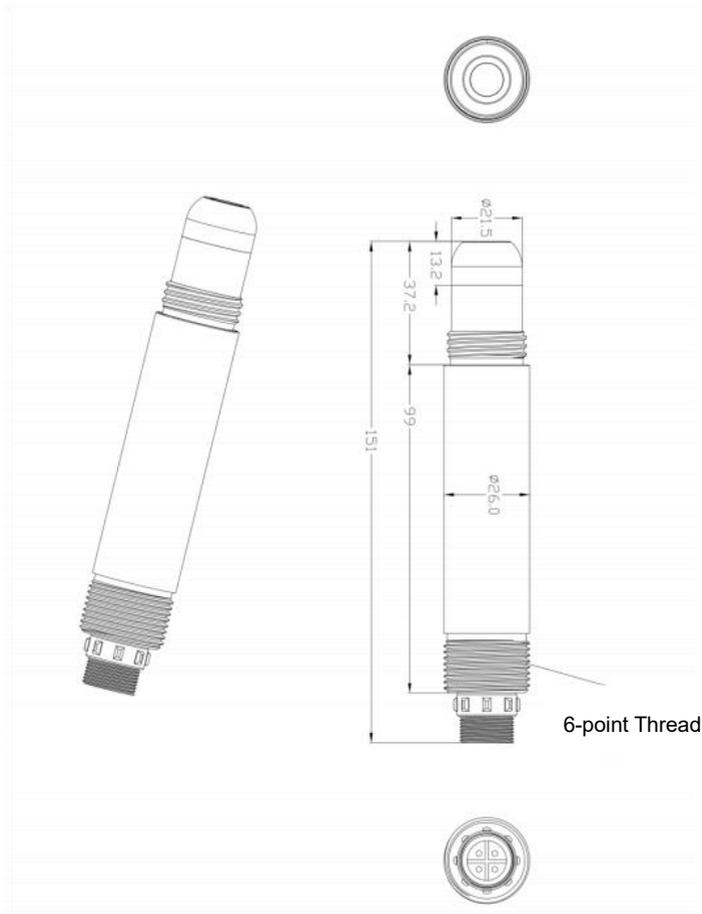
Fig. 1

3. Cable Definition

1. Power Supply Requirements

Power Supply DC 8-26V　±10% ，　Current <50mA

2. Sensor Cable

4 wire AWG-24 or AWG-26 shielding wire. OD=5mm
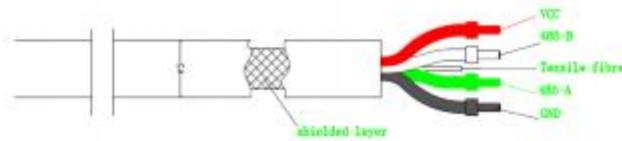
Fig. 2

Table 1

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

4. Technical Specifications

Table 2

Name	Parameter
Range	0-20mg/L or 0-200% Saturation
Response Time	10 sec
Housing IP Rating	IP68
Accuracy	±1%
Drift	<1% per year
Working Temperature Range	0～50℃
Temperature Accuracy	±0.2℃
Interface	Support RS-485，MODBUS protocols
Construction	3/4 inch NPT
Power Requirements	DC：6~24V+/-5%，current<50mA
Temperature Sensor Type	NTC
Sensor OD	26mm
Sensor Length	151mm
Cable Length	10m standard; 5m, 15m, and 30m optional
Calibrations	Support one point and two-points calibrations
Sensor Cap Lifetime	1 Year（at normal use）
Body materials	Ti 2

The above technical specifications are tested under standard solution in laboratory environment.

5. Installation

Part List

<div align="center">Table 3</div>

Item	Number	Note
ODO Sensor	1	
Cable	1	10m
Protective Cover	1	
Rubber Protective Cap	1	

Before Use

1) Take off the protect cap: Please take off the protect cap of Optical dissolved oxygen

sensor , before installation and keep them properly for future use.Meanwhile, tighten the protective cover.

Sensor Installation

1) Wiring and power supply:

- The female and male connector of sensor cable should be screwed tightly to avoid moisture incursion
- Do not use the sensor cable to pull the sensor! It is required to install sensor in a secure and stable mounting bracket.
- Make sure power supply voltage is correct before power on.

2) Sensor installation:

- It is recommended to install the sensor vertically with electrodes facing down.
- Considering water level change, the sensor should be installed 30cm below water level. The sensor should not be installed no more than 2m below water surface for maintenance purpose.
- The sensor must be securely installed to avoid damage caused by water flow and other things.

6. Calibration

Calibration Solution Preparation

● 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.

● 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).

Note: If the field conditions really do not allow, the sensor can be directly put into the air (calibration accuracy will be slightly deviated).

Calibration (take 2-point calibration as an example)

1) Restore user calibration data by default, K=1, B=0(see modbus documentation for details).

2) Take the sensor out of the zero oxygen, wipe the sensor measurement end face with a paper towel, put the sensor into 100% environment (air), read the value of dissolved oxygen, wait for the data to stabilize, the value is close to 1 (Saturation is 100%), and record the value as Y.

3) Place the sensor in the prepared zero-point solution, immerse the front end of the sensor completely in the solution, read the value of dissolved oxygen, and wait for the data to stabilize, with the value approaching 0.01 (Saturation is 1%), for example Dissolved oxygen = 0.015, recorded as X.

4) Record K and B values according to the following formula:

K=(1-0)/(Y-X), B= - KX

Write K, B values to the sensor. (See modBus documentation)

Sensor has also developed pc-based calibration software for Dissolved oxygen sensor. You only need to connect the probe to the calibration software through the computer interface, and you can easily complete the calibration of

the sensor according to the software prompts.

Appliances and raw materials required

Anhydrous sodium sulfite powder

Distilled water or deionized water (Watsons distilled Water) Beakers, gloves, stirring rod, air pump

7. Maintenance

Maintenance Schedule

Unlike traditional electrical chemical sensors, optical DO sensors require low maintenance. There are no need for frequent solution filling and calibrations.

Table 4

Maintenance Task	Frequency
Sensor Cleaning	Every 30 days
Sensor and Sensor Cap Inspection	Every 30 days
Sensor cap replacement	Every one year
Calibration	Calibration based on required schedule

Maintenance

(1)Clean the sensor surface：

Wash the outer surface of sensor with tap water, if there is still residue, using soft brush, for some stubborn dirt, household detergent can be added in tap water to clean.

(2)Clean the cap outer surface：

Remove the protective cover, flush the dirt on the light window of the sensor with clean water, and finally put the cover on; If you need to wipe it, please wipe it gently with a soft cloth and do not scratch it forcefully. Otherwise, once the fluorescent film is scratched or scratched, the sensor will not work properly.

(3)Clean the cap inner surface:

If water vapor or dust gets inside the fluorescent cap, the cleaning steps are as follows:

● Remove the fluorescent cap

● Rinse the inner surface of the fluorescent cap with tap water

● For dirt containing fat and oil, wash it in warm water with household detergent

● Rinse the inner surface of the fluorescent cap with deionized water

● Gently dry all surfaces with a clean flannelless cloth and place in a dry place to allow water to completely evaporate.

(4)Check the cable：inspect the sensor cable if there is damage.

(5)Store the cap：Regular electrode maintenance requires cap to be stored ina protective cover with a damp sponge and checked and watered regularly, so as to keep the fluorescent film in a moist state for a long time. If the sensor fluorescent cap head is dry for a long time, the measurement results will drift, and it needs to be soaked in water for 48 hours before continuing to work.

Attention

Protect the inner surface of the fluorescent cap from sun exposure.

Do not touch the fluorescent film with your hands.

Avoid applying any mechanical stress (pressure, scratch, etc.) directly to the fluorescent film during use.

8. Trouble Shooting

Table 5 lists the symptoms, possible causes, and recommended solutions for common problems encountered with the ODO sensor. If your symptom is not listed, or if none of the solutions solves your problem, please contact us.

Table 5

Error	Possible Cause	Solution
No data displayed on controller (if sensors are connected)	Connection issue	Reconnect sensor to controller
	Cable failure	Contact customer service
	Bad sensor cap or loose sensor cap	Reinstall sensor cap or replace
Unstable DO reading	Dirty sensor cap	Clean sensor cap
	Damaged sensor cap	Replace sensor cap
	Sensor cap expired	
	Hardware failure	Contact customer service
Bad Temperature reading	Bad connection	Reconnect sensor to controller
	Dirty temperature sensor	Contact customer service

9. Quality Assurance

Warranty period:

Sensor warranty period is 1 year

Electrode warranty period is 4 months (Non-chemical environment, Non industrial wastewater).

If there are defects found during the warranty period, Our company promises to repair or replace defective products, or return the payment of product except the charge for the first time for transport and related formalities. In the warranty period, repair or replacement of any product will only enjoy the rest of the original warranty. After receiving feedback for the product quality problems from the customer, The company will confirm whether the product needs to be repaired within two weeks; It can't be returned without approval to repair the product.

This warranty does not include the following：

- Damage caused due to force majeure, natural disasters, social unrest, war (published or unpublished), terrorism, civil war or any government forced.
- Damage caused due to improper use, negligence, accident, or caused by the improper application and installation.
- Freight of products shipped back to the company.
- Freight for parts or products express or express delivery within the warranty.
- Travel expense for repair in local in warranty.

Quality assurance includes all products provided by the company.

It constitutes the final, complete and exclusive statement about the quality guarantee, no person or agent is authorized to develop other warranties in the name of the company. As described above, the remedial measures such as repair, replacement or return the payment for product is not in violation of the warranty, and it aim at our own products only. Based on the strict liability or other legal theory, the company is not responsible for defects or any other damage caused by careless operation, including the subsequent damage with a causal connection between these situations.

10. Communication Protocols

10.1. ModBus protocol information

●**Protocol specifications**

Name	Description
Communication Interface	RS485
Transport Mode	ModBus RTU
Port Settings	9600,N,8,1 (Default)
Device Address	0x01 (Default)

●**Function code**

Function Code	Description
0x03	Read register data, error return code 0x83
0x06	Write a single register, error return code 0x86
0x10	Write multiple registers, error return code 0x90

●**Error code**

Error Code	Description
0x01	Invalid instruction or current instruction unavailable, this feature is not supported.
0x02	The content of this address cannot be written with data.
0x03	The current input data is invalid and exceeds the input range.

●**Query device address (standalone mode)**

The device address is unknown. You can use address 0x00 to send the 03 command to query the device address.

●**Broadcast instruction**

When the host sends a device address of 0xff, it is a broadcast command, and the slave does not respond when receiving the broadcast command.

●**Frame format**

Read register data (0x03)

Inquiries：

Name	Device Address	Function Code	Start Address	Number of Registers	CRC
Data	Addr	0x03	M	N	CRC16
Byte Length	1	1	2	2	2

Reply frame:

Name	Device Address	Function Code	Return Bytes	Return Data	CRC
Data	Addr	0x03	N*2	Data	CRC16
ByteLength	1	1	1	N*2	2

Write a single register (0x06)

Inquiries：

Name	Device Address	Function Code	Start Address	Data Value	CRC
Data	Addr	0x06	M	Data	CRC16
Byte Length	1	1	2	2	2

Reply frame:

Name	Device Address	Function Code	Start Address	Data Value	CRC
Data	Addr	0x06	M	Data	CRC16
Byte Length	1	1	2	2	2

Write multiple registers (0x10)

Inquiries：

Name	Device Address	Function Code	Start Address	Data Quantity	Byte Count	Data Value	CRC
Data	Addr	0x10	M	N	N*2	Data	CRC16
Byte Length	1	1	2	2	1	N*2	2

Reply frame:

Name	Device Address	Function Code	Start Address	Byte Count	CRC
Data	Addr	0x10	M	Data	CRC16
Byte Length	1	1	2	2	2

10.2. Examples

●**Read data**

The starting register address is 0x0000, and the number of read registers is 2:

Device Address	Function Code	Start Address	Number of Registers	CRC
0x01	0x03	0x0000	0x0002	0xC40B

Data response: Read register data as 0x0001,0x0002:

Device Address	Function Code	Return Bytes	Return Data	CRC
0x01	0x03	0x04	0x0001,0x0002	0x2A32

If the current command is unavailable, return an error response:

Device Address	Function Code	Error Code	CRC
0x01	0x83	0x01	0x80F0

● **Write data**

Register address 0x0001, write data 0x0002:

Device Address	Function Code	Start Address	Data Value	CRC
0x01	0x06	0x0001	0x0002	0x59CB

Data response:

Device Address	Function Code	Start Address	Data Value	CRC
0x01	0x06	0x0001	0x0002	0x59CB

If the current register is not writable, return an error response:

Device Address	Function Code	Error Code	CRC
0x01	0x86	0x02	0xC3A1

● **Continuously writing data**

Write 2 consecutive register values from register address 0x0001, 0x0002, 0x0003:

Device Address	Function Code	Start Address	Data Quantity	Byte Count	Data Value	CRC
0x01	0x10	0x0001	0x0002	0x04	0x0002, 0x0003	0xD3 A2

Data response:

Device Address	Function Code	Start Address	Data Quantity	CRC
0x01	0x10	0x0001	0x0002	0x100 8

If the written data is invalid, return an error response:

Device Address	Function Code	Error Code	Check Code
0x01	0x90	0x03	0x0C01

●**Address inquiry (single machine mode)**

The device address is unknown. You can use the address 0x00 to send the 03 command:

Device Address	Function Code	Start Address	Number of Registers	CRC
0x00	0x03	0x0000	0x0002	0xC5DA

10.3. ModBus register information

●**Register data**

The following register data adopts big endian mode, with high byte first and floating-point number sequence 1234.

The public part including registers marked with * must be supported, while other registers cannot be filled with 0.

Table 6

Name	Register	Function Code	Data Type	Access Type	Description
RS485 Slave Address	0x1100	0x03/0x06	short	W/R	1-254，default 1
RS485 Baud Rate	0x1101	0x03/0x06	short	W/R	1= 2400, 2= 9600 (default) , 3= 14400 4= 19200 5= 38400
Serial Port Configuration	0x1102	0x03/0x06	short	W/R	1= N81(default) 2 = N82 3 = E81, 4 = O81 N:No parity E:even parity check O:Odd Parity 8：Data bit 8 1：Stop position 1

					2：Stop position 2

● **Digital sensor**

The continuous read operation of digital sensor registers 0x2000 to 0x2011 contains unsupported register functions in between, and writing 0 returns.

Register functions that are not supported except for the digital sensor registers 0x2000 to 0x2011 are returned in error code 0x01 format.

The decimal and unit occupy 2 bytes, with the high byte representing the decimal digits and the low byte representing the unit value. Please refer to the unit information.

Table 7

Name	Register Address	Function Code	Data Type	Access Type	Description
Data Version and Device Type	0x2000	0x03	short	R	High byte: data version, Low byte: device type Data version: 0x01 Device Type: 0x33
Dissolved oxygen value	0x2001	0x03	short	R	
Decimals and Units	0x2002	0x03	short	R	Decimal Places：2 Unit：mg/L
Temperature	0x2003	0x03/ 0x06	short	W/R	Range：-100~1100
Decimals and Units	0x2004	0x03/ 0x06	short	W/R	Decimal Places：1 Unit：℃
Dissolved oxygen saturation	0x2005	0x03 /0x06	short	W/R	Range：0-200
Decimals and Units	0x2006	0x03	short	R	Decimal Places：0 Unit：%
Salinity compensation	0x2007	0x03	short	W/R	0~4000 0.0ppt（default）

Name	Register Address	Function Code	Data Type	Access Type	Description
Decimals and units	0x2008	0x03	short	R	Decimal Places：2 Unit：ppt
Atmospheric pressure compensation	0x2009	0x03	short	W/R	760.0mmHg（default）
Decimals and units	0x200A	0x03	short	R	Decimal Places：1 Unit：mmHg
Temperature Mode	0x200C	0x03/0x06	short	W/R	1: Automatic (default) 2: Manual
Error code	0x200D	0x03	long	R	Refer to10.6 Error code
Calibration Status	0x200F	0x03	short	R	0: Not calibrated 1: Calibrated
Filter Coefficient	0x2011	0x03/0x06	short	W/R	0～9 0: No Filter
Restore Factory Settings	0x2020	0x06	short	W	0x01
Electrode calibration status	0x3000	0x03	short	R	0x0000: Successfully calibrated 0x0001: Calibration not yet completed 0x0002: Standard solution information not received or not available 0x0003: Signal instability or signal out of range 0x0004: Slope or bias exceeds allowable range
Electrode Calibration	0x3001	0x06	short	W	0x0001: Air calibration 0x0002: Zero point calibration

Name	Register Address	Function Code	Data Type	Access Type	Description
Exit calibration	0x3003	0x06	short	W	0x01 exits calibration state

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10.4. Calibration process

Taking air calibration as an example:

Dissolved oxygen electrode register 0x3001 writes 0x0001 to enter the air calibration state of the sensor

Read the calibration status of the dissolved oxygen electrode register 0x3000 and check if the current calibration is complete

Entering the calibration state for more than 5 minutes without successful calibration, or register 0x3003 receiving an exit calibration instruction, the electrode exits the calibration state.

10.5. Error code

The Error code consists of 32 bits of data, each representing a type of fault.

Error code	Description
Bit0	Storage unit exception, write data failed
Bit1	Temperature sensor abnormal, out of range
Bit2	Abnormal sensor probe, out of range
Bti3	Not calibrated, check if the sensor has completed the calibration operation
Bit4-Bit31	reserve