

User Manual of

Smart water sensor

pH/ORP digital water sensor

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Version
U-SUP-PH8001/ORP8001-EN4

1. Safe precautions

Please follow the operating procedures and precautions of this manual when using

- Do not power on before wiring is completed to avoid danger.
- If you find that the instrument works abnormally or is damaged during use, please contact us instead of repairing it yourself.
- In order to make the measurement more accurate, the meters must be calibrated frequently with sensors.
- If your electrode has been purchased for nearly a year or there is a quality problem with the electrode, please replace it.
- Please power on the instrument to warm up for 30 minutes before calibration.
- If the product is updated, this manual may be changed, but we will not notice.

2. Applications

Aquaculture, water testing, informatization data collection, IoT water testing

3. Features

- Isolated power supply design, data stability, strong anti-interference ability
- pH supports automatic/manual temperature compensation, (Automatically detect whether the temperature probe is disconnected or faulty, then switch to manual temperature compensation) The default is 25.0℃

- Support USA/NIST/custom pH calibration solution, and user-defined ORP standard solution
- Communication: RS485 interface*1 (Modbus RTU protocol)

4. Protocol function

- Protocol instructions support pH, ORP user-defined calibration solution
- Protocol commands can support ID modification (1-255)
- Protocol instructions support factory reset
- Other functions to be inquired

5. Product Introduction

The pH digital sensor designed by our company for the aquaculture industry, with a digital interface (RS485*1), can be used to measure changes in the pH/ORP value of the aqueous system within the range

It has a standard RS485 Modbus RTU protocol interface function, which can communicate with the host computer remotely

6. Parameters

Measurement	pH or ORP
Measurement range	0.00-14.00pH, -1000mV~+1000.0mV
Resolution	0.01pH, 0.1mV
Temperature range	0- 60℃@0.1℃
Transducer tyoe	pH electrode or ORP electrode
Accuracy	0.02pH 0.5℃
	0.2mV
Output type	RS485 interface*1

Communication protocol	Standard MODBUS-RTU protocol RS485
Setting method	RS485 remote setting calibration and parameters
Power supply	12VDC
Power consumption	30mA @12VDC

Ordering information **[Please specify pH or ORP before ordering]**

Standard: pH/ORP digital sensor*1

Customized cable length: dedicated for cleaning the floating body (40cm), electrode cable length 5m

7. Communication protocol

7.1 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
Byte Length	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

7.2 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	0xD3A2

Data response:

Device Address	Function Code	Start Address	Data Quantity	CRC
0x01	0x10	0x0001	0x0002	0x1008

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

7.3 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.

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.

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 PH electrode: 0x31 ORP electrode: 0x32
pH	0x2001	0x03	short	R	Range: 0 ~ 1400
Decimals and Units	0x2002	0x03	short	R	Decimal Places: 2 Unit: pH
	0x2003	0x03/0x06	short	W/R	Range: -100~1100
Decimals and Units	0x2004	0x03/0x06	short	W/R	Decimal Places: 1 Unit: ℃
Voltage Value of pH Sensor	0x2005	0x03	short	R	Range:-1000 ~ 1000mV
Decimals and Units	0x2006	0x03	short	R	Decimal Places: 0 Unit: mV
ORP	0x2007	0x03	short	R	Range: -2000mV ~ 2000mV
Decimals and Units	0x2008	0x03	short	R	Decimal Places: 0 Unit: mV
Reserve		0x03	short	R	Register 0x0209-0x200B reserved, write 0
Temperature Mode	0x200C	0x03/0x06	short	W/R	1: Automatic (default) 2: Manual
Fault Code	0x200D	0x03	long	R	Reference 7.0 Fault Code
PH Calibration Status	0x200F	0x03	short	R	BIT0: Point L BIT1: Point M BIT2: H-point 0: Not calibrated 1: Calibrated
ORP Calibration Status	0x2010	0x03	short	R	BIT0: The first point BIT1: Second point 0: Not calibrated 1: Calibrated
Filter Coefficient	0x2011	0x03/0x06	short	W/R	0 ~ 9:
Restore Factory Settings	0x2020	0x06	short	W	0x01
Calibration Solution Type	0x3000	0x03/0x06	short	W/R	1: (L 点 4.01 M 点 7.00 H 点 10.01) 2: (L 点 4.00 M 点 6.86 H 点 9.18)

Name	Register Address	Function Code	Data Type	Access Type	Description
Electrode Calibration Status	0x3001	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	0x3002	0x06	short	W	PH electrode: 0x0001: Starting calibration of electrode L point 0x0002: Starting calibration of electrode M point 0x0003: Electrode H-point calibration begins ORP electrode: 0x0011: Calibration begins at the first point of the electrode 0x0012: Calibration begins at the second point of the electrode
ORP value of standard solution	0x3003	0x06	short	W	If 86mV, send decimal 86
Exit calibration	0x3004	0x06	short	W	0x01 exits calibration state

Note:

- Combining pH and ORP electrode protocols, distinguishing by device type;
- The pH values of standard solutions are divided into two types: 4.00, 6.86, 9.18, and 4.01, 7.00, 10.01, which correspond to different sensors and are distinguished by the type of calibration solution in register 0x3000.

7.4 Calibration process

● PH calibration

Taking M-point calibration as an example:

- Write the calibration solution type to register 0x3000;
- Write 0x0002 to the pH electrode register 0x3002, causing the sensor to enter the M-point calibration state;
- Read the calibration status of pH electrode register 0x3001 and check if the current calibration is completed.

● ORP calibration

Taking the first point calibration as an example:

- ORP electrode register 0x3002 writes 0x0011, causing the sensor to enter the first point calibration state;
- ORP electrode register 0x3003 writes calibration solution information;
- Read the calibration status of ORP electrode register 0x3001 and check if the current calibration is completed.

● Calibration timeout period

- Entering the calibration state for more than 5 minutes without successful calibration, or register 0x3004 receiving an exit calibration instruction, the electrode exits the calibration state;
- The ORP electrode enters the calibration state. If no standard solution information is received within 2 minutes, it will exit the calibration state.

7.5 Unit information

Unit	Data	Unit	Data
℃	0x00	℉	0x01
mV	0x02	pH	0x03
uS/cm	0x04	mS/cm	0x05
ppm	0x06	ppt	0x07
mg/L	0x08	g/L	0x09
ug/L	0x0A	%	0x0B
hpa	0x0C	g/kg	0x0D
MΩ*cm	0x0E	mmHg	0x0F
NTU	0x10	uA	0x11
mA	0x12	A	0x13
mbar	0x14	Ω	0x15
KΩ	0x16	MΩ	0x17

7.6 Fault code

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

Fault Code	Description
Bit0	Storage unit exception, write data failed
Bit1	Temperature sensor abnormal, out of range
Bit2	Abnormal sensor probe, out of range
Bit3	Not calibrated, check if the sensor has completed the calibration operation
Bit4-Bit31	reserve

8. pH/ORP digital electrode preservation and maintenance

- **Electrode preservation:**
When the electrode is not in use for a short time, please use the rubber sleeve protective cover + wet sponge to ensure that the electrode is in a wet state. The protective cover and sponge are used to protect the electrode, please do not discard.
- **Parts replacement cycle**
Electrode: The electrode is recommended to be replaced in 12 months
Electrode slope: <70% Slope is recommended to be replaced
- **Maintenance - cleaning the old sensor**
Observe the glass measuring part of the electrode head. If the glass contact surface is covered, use a moistened cotton swab to gently wipe the surface until it is clean.
- **Maintenance - pH before use**
Observe whether there is liquid in the bulb of the pH electrode sensitive membrane. If it is not filled with liquid or there are bubbles, shake the electrode gently to fill the bulb with liquid without bubbles.
- **Maintenance - pH repair - unable to calibrate / after a long time dry**
If the sensor is left dry for a long time or its performance is reduced, you can try to soak it in pH4.00 buffer for a few minutes, and then soak it in pH 7.00 buffer for a few minutes before attempting calibration
- **Maintenance - pH calibration**

Please pay attention to the buffer used during calibration. Place the electrode in the buffer for 1 minute before subsequent operations. After rinsing the electrode, only use a soft tissue to absorb the water.

► Do not rub the pH sensitive membrane

9. Digital pH/ORP sensor wiring definition instructions

Please check the color and wiring definition carefully before wiring. If wiring is wrong, the sensor may be damaged.

Sensor power supply	<u>(6-30)VDC</u>
Working current	<u>25mA</u>
communication interface	<u>RS485</u>
communication format	<u>N 8 1</u>
baud rate	<u>9600</u>
communication protocol	<u>Modbus-RTU</u>

● **Wiring definition**

Color	Red	Black	Green	White
Description	VCC	GND	485A	485B