

Ammonia Nitrogen Sensor



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Preface

Thank you for purchasing ammonium ISE 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-ADI3050-EN3.1

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	Qty	Note
1	Online Ammonium Sensor	1	
2	Cable	1	Standard supply: 10m
3	NH ₄ ⁺ standard	1	
4	pH Electrode storage solution	1	
5	Reference electrode storage solution	1	
6	ISA ionic strength adjuster	1	
7	Rubber protective cap	1	
8	Manual	1	
9	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.

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1 Introduction

1.1 Overview

The online ammonia nitrogen ion-selective sensor enables real-time ammonia nitrogen monitoring without the use of reagents, making it a reagent-free and environmentally friendly solution for water quality monitoring.

The standard configuration includes an ammonium ion-selective sensor, pH sensor, and reference sensor, with a potassium ion-selective sensor available as an option. During ammonia nitrogen measurement, the sensor provides automatic pH and temperature compensation to improve measurement accuracy.

The sensor provides an RS485 digital output and supports the Modbus protocol for easy system integration. It can be immersed directly into the water without sample pretreatment or sample transfer, simplifying installation and operation.

The sensor is suitable for water quality monitoring in a wide range of applications, including surface water and tap water.

Measurement Principles

1.2 Measurement Principle

The ammonia nitrogen sensor measures ammonium ion concentration using the ion-selective sensor (ISE) method. The sensor assembly primarily consists of an ion-selective sensor, a reference sensor, an ion-selective membrane, and an internal electrolyte. The ion-selective membrane selectively allows ammonium ions in the sample to interact with the sensing element, generating a potential that varies with the logarithm of the ammonium ion concentration.

The reference sensor provides a stable reference potential for measuring the potential difference. The ammonium ion concentration is then calculated according to the Nernst equation.

Because the measurement is based on a potentiometric method, the measurement is not affected by water color or turbidity.

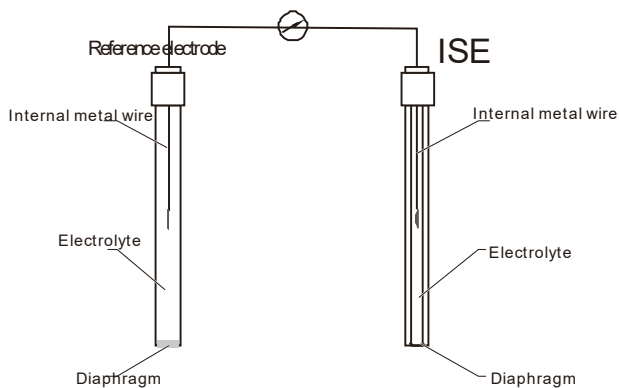


Fig.1

1.3 Features

- Digital sensors,RS-485output,MODBUS support;
- No reagent,no pollutants,more economic and environmentally friendly;
- Automatic compensation for NH_4^+ , pH and potassium ion (optional) in water, making it suitable for a variety of working conditions;
- Coming standard with pH measurement;
- Every sensor can be independently replaceable, with operation simple and minimized maintenance.

Note: the ion sensor is suitable for freshwater rather than seawater applications.

2 Technical Parameters

Table 1 Technical parameters

Measured variables	NH ₄ -N, pH		
Measuring range	NH ₄ -N: (0~100) mg/L, (0~1000) mg/L pH: (4~10) pH		
Accuracy	NH ₄ -N: $\pm 10\%$ or $\pm 0.5\text{mg/L}$, whichever is greater pH: $\pm 0.1\text{pH}$		
Resolution	NH ₄ -N: 0.01mg/L pH: 0.01pH		
Repeatability	$\leq 3\%$		
Compensation	Temperature	pH	K+(Optional)
	Temperature sensor: NTC Compensation scope: 0°C~50°C	Compensation: (4~10)pH	Compensation: (0~100) mg/L
Response time	$\leq 2\text{min}$		
Reference system	Ag/AgCl reference salt bridge		
Communication	RS-485, Modbus protocol		
Connector	Aviation gland		
Power supply	(9~24) VDC, $\geq 1\text{A}$		
Power consumption	$\leq 0.5\text{W}$		
Pressure resistance	$\leq 2\text{bar}$		
Medium pH value	(4~10) pH		
Temperature range	(0~50) °C		
Protection level	IP68		
Cable length	Default 10m, customizable for other lengths		
Installation method	Immersion installation		

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.

3 Structure and Dimensions

Dimensions: $\Phi 36\text{mm} * 265\text{mm}$ (with protective cover)

Process connection: NPT3/4 thread.

Material: POM+316L

Weight: 310g

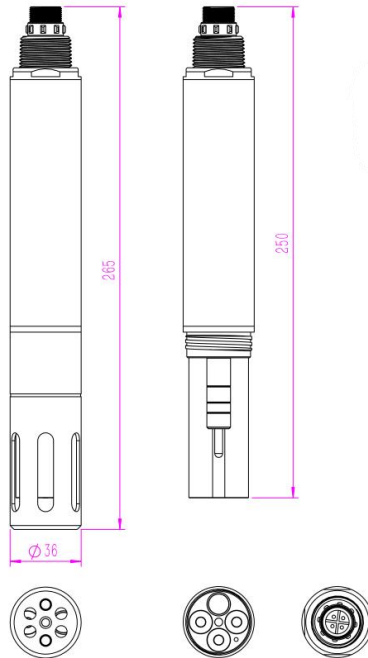


Fig.2 Product dimensions (Unit: mm)

4 Installation

4.1 Installation Method

- (1) Vertical installation is required, with the sensors facing downward. Horizontal installation or installation with the sensors facing upward is not permitted.
- (2) The sensor should be positioned at least 30 cm below the minimum water level to prevent the sensors from being exposed to air when the water level drops.
- (3) A location free of air bubbles is recommended for sensor installation. The sensor should be positioned as far away as practical from aeration outlets.

4.2 Installation Methods

The rear part of the sensor is compliant with threaded fixed installation.

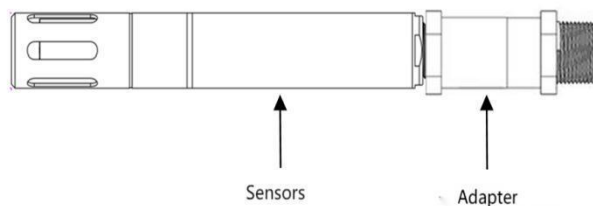


Fig.3 Assembly adapter

4.3 Before Use

(1) Take off the protect cap:

Please take off the rubber protective cap of reference sensor and pH sensor before installation. Furthermore, the protective cap should be properly stored.

Note: The ammonium ion sensor is not equipped with a protective cap and should generally be stored dry.

(2) Cleaning and activation:

The sensor should be rinsed with deionized water. Rinsing is sufficient; do not wipe or brush the electrode surface.

Before use, the electrode requires conditioning. The sensor should be immersed in a 10 ppm ammonium chloride standard solution for 24 hours. For instructions on preparing the standard solution, see the section on "Standard Solution Preparation".

5 Electrical Connection

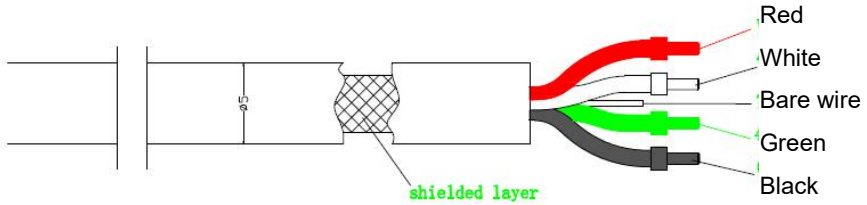


Fig.4

Table 2

Pin No.	Color	Definition
1	Red	Power (VCC)
2	White	485 Data_B (485_B)
3	Green	485 Data_A (485_A)
4	Black	Ground (GND)
5	Bare wire	Ground (Public grounding wire)

Wiring precautions:

- (1) Do not use sensor cables to lift sensors. It is recommended to install cable protection covers to ensure good power supply and water tightness of the cables.
- (2) Before powering on, make sure the line sequence and supply voltage are accurate.

6 Calibration

6.1 Brief Description

(1) Regular sensor calibration is recommended based on the water quality and operating conditions at the installation site. The sensor supports one-point or two-point calibration. Calibration is performed through the transmitter, in accordance with the transmitter's operating instructions.

(2) For a new sensor or an sensor that has been out of use for an extended period, a 5–10 minute immersion in purified water or an ammonia nitrogen standard solution is recommended before use. Prolonged immersion in purified water or the ammonia nitrogen standard solution should be avoided.

(3) For improved measurement accuracy, a second calibration is recommended after the first sample measurement. Interfering ions may be present in the sample and affect the measured potential, resulting in inaccurate readings. Recalibration helps account for the effect of these interfering ions as part of the sample background, thereby improving measurement accuracy.

(4) Calibration should proceed from the lower-concentration solution to the higher-concentration solution. No rinsing is required when moving from a lower to a higher concentration. When moving from a higher to a lower concentration, the sensor should be thoroughly rinsed several times before measurement.

6.2 Calibration Standard Solution And Calibration Formula

(1) pH standard solution (when pH calibration is required, customized by the customers)

We recommend to purchase the pH standard solution with the value of 4.00, 6.86 and 9.18, respectively. pH user calibration formula:

$$\text{pH}(\text{standard value}) = K * \text{pH}(\text{measurement}) + B$$

Normal factory default: K=1, B=0

(2) NH₄⁺ standard solution

Factory supplied with a bottle of NH₄⁺ mother standard solution (NH₄⁺ concentration: 1000mg/L), customer can use the NH₄⁺ mother standard solution to dilute to obtain the corresponding concentration of standard solution;

Notes: before the test, the configured NH₄⁺ standard solution needs to add ISA ion

activator and stir well to ensure the ionic strength, and the addition ratio is 2% of the standard solution capacity. The amount of solution required can be immersed in three single-sensor heads.

NH_4^+ user calibration formula (LG(X) is calculated logarithmic in base 10):

$$\lg[\text{NH}_4^+(\text{standard value})] = K * \lg[\text{NH}_4^+(\text{measurement})] + B$$

Normal factory default: $K=1$, $B=0$

Notes: one-point calibration, keep $K=1$, calculate B , and write K and B at the same time;

Two-points calibration, calculate K and B according to quadratic equation with one variable, and write K and B at the same time.

(3) Potassium ion standard solution (when equipped with potassium ion sensor)

① Take 1.9067g of KCl and dissolve in deionized water, fixed capacity to 1L. At this time, the 1000mg/L K^+ mother solution is prepared;

② Take 1mL of the 1000mg/L K^+ mother solution and dissolve in deionized water, fixed capacity to 1L. At this time, the 1mg/L K^+ standard solution is prepared;

③ Take 10mL of the 1000mg/L K^+ mother solution and dissolve in deionized water, fixed capacity to 1L. At this time, the 10mg/L K^+ standard solution is prepared;

④ Take 100mL of the 1000mg/L K^+ mother solution and dissolve in deionized water, fixed capacity to

1L. At this time, the 100mg/L K^+ standard solution is prepared;

Notes: all the above standard solutions need to standardize the use of deionized water to determine the volume, and Wahaha's pure water can be used instead when the preparation conditions of deionized water are insufficient. K^+ user calibration formula:

$$\text{K}^+(\text{standard value}) = K * \text{K}^+(\text{measurement}) + B$$

Normal factory default: $K=1$, $B=0$

7 Maintenance Schedule And Methods

7.1 Maintenance Schedule

Cleanliness is very important for maintaining accurate readings. The frequency is according to the use environment.

Table 3

Maintenance task	Recommended maintenance frequency
Sensor cleaning	Cleaning every 2 to 3 weeks
Calibration sensor	Every 3 to 4 weeks

7.2 Maintenance Methods

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

(3) Sensor Cleaning:

① Wash the outer surface of sensor with soft brush. Note that do not touch sensitive membrane of NH_4^+ sensor.

② Use clean water to wash the pH and reference sensor. Then gently wipe off with a lint free cloth or a soft brush.

③ Do not use anything to wipe sensitive membrane of NH_4^+ sensor. Only rinse it with clean water (DI water is best).

④ If sensor needs calibration after cleaning, use a lint free cloth to dry the surface sensor case exclude sensitive membrane. It is recommended to dry by blowing or gently wiping with absorbent paper!

⑤ During calibration, sensor cleaning with DI water shall be repeated for each step to avoid polluting the standard solution.

(4) Store the sensor:

Regular sensor maintenance requires pH and reference sensor to be stored in protected solutions which equipped with sensor. Please keep NH_4^+ sensor in 1ppm NH_4^+ solution.

Note: If the membrane is kept in a dirty or dry state for a long time, it will lead to sensor failure and is not within the warranty scope.

(5) Replace the sensor:

- ① NH_4^+ , reference and pH sensor are all consumable parts. Please replace them in time according to the actual situation.
- ② Return to the factory every 18 months to replace the dynamic sealing ring.

8 Troubleshooting

Table 2 lists symptoms, possible causes, and recommended solutions for common problems encountered with the sensor. If your symptom is not listed, or if none of the solutions solves your problem, please contact us.

Table 4

Trouble	Cause	Solution
Abnormal communication	Controller and cable connection error	Reconnect the controller and cables
	Interface and protocol problems	1. Use our Smart PC upper computer software to check whether the communication is normal; 2. Check according to the product supporting communication protocol.
No change in value	Software and hardware anomalies	Please contact us
The measured value is too high or too low. Or the value continues to be unstable.	Sensors are seriously contaminated	Clean the sensor body and special light window surface
	sensor loss failure	Replace the new sensor
	Calibration Required	Carry out user calibration
Other errors	Please contact us	

9 Communication

This instrument provides a standard RS485 serial communication interface, adopts the international common standard Modbus-RTU communication protocol, and supports the 0x03 read holding register command, 0x06 write single register command, and 0x10 write multiple registers.

Data transmission mode: Big-endian mode;

Float: 1-0-3-2;

Int32(long): 1-0-3-2

9.1 Protocol Specification

9.1.1. Query Device Address (0x00)

If the device address is unknown, you can use the address 0x00 to send the 03 instruction to query the device address.

9.1.2. Broadcast Address (0xFF)

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

9.1.3. Frame Format

(1) Read Holding Registers (0x03)

Request Frame

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x03	1
Starting Address	M	2
Register Quantity	N	2
CRC	CRC16	2

Response Frame

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x03	1

Field	Data	Length (bytes)
Byte Count	$N \times 2$	1
Register Data	Data	$N \times 2$
CRC	CRC16	2

(2) Write Single Register (0x06)**Request Frame**

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x06	1
Register Address	M	2
Register Value	Data	2
CRC	CRC16	2

Response Frame

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x06	1
Register Address	M	2
Register Value	Data	2
CRC	CRC16	2

(3) Write Multiple Registers (0x10)**Request Frame**

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x10	1
Starting Address	M	2
Register Quantity	N	2

Field	Data	Length (bytes)
Byte Count	$N \times 2$	1
Register Data	Data	$N \times 2$
CRC	CRC16	2

Response Frame

Field	Data	Length (bytes)
Device Address	Addr	1
Function Code	0x10	1
Starting Address	M	2
Register Quantity	Data	2
CRC	CRC16	2

9.2 Register list**9.2.1. Communication Parameters**

Table 5 Communication Parameters

Address	Name	Data Type	Registers	Byte Count	RW	Description
0x1100	Device address	uint8_t	1	2	R/W	1-247, default is 1
0x1101	Baud rate	uint8_t	1	2	R/W	2= 9600 (default) , 3= 14400 ,4= 19200 , 5= 38400, 6= 57600, 7= 115200, 8= 1200, 9= 4800
0x1102	Serial port format	uint8_t	1	2	R/W	1= N81(default), 2 = N82 3 = E81, 4 = O81 N: None E: Even O: Odd 8: 8 data bits 1: 1 stop bit 2: 2 stop bits

9.2.2. Measurement Parameter Registry

Table 6 Measurement Parameter Registry

Address	Name	Data Type	Registers	Byte Count	RW	Description
0x1200	Number of measurement parameter	uint8	1	2	OR	Range: 1-10
0x1201	Measurement parameter 1	uint16	1	2	OR	The high byte is the parameter type, refer to 9.2.3 for measurement parameter types; low byte represents the unit, refer to 9.2.4 units. If the register is 0xFFFF, then this register is meaningless.
0x1202	Lower limit of range 1	float	2	4	OR	The lower limit of the range of sensor parameter 1. If the value of the parameter 1 register is 0xFFFF, then this register is assigned 0.
0x1204	Lower limit of range 1	float	2	4	OR	The upper limit of the range of sensor parameter 1. If the value of the parameter 1 register is 0xFFFF, then this register is assigned 0.
0x1206	Optional measurement parameter 2	uint16	1	2	OR	The high byte is the parameter type, 0x0e: COD; The low byte represents the unit, 0x08: mg/L. If the register is 0xFFFF, then this register is meaningless.
0x1207	Lower limit of range 2	float	2	4	OR	The lower limit of the range of sensor parameter 2. If

Address	Name	Data Type	Registers	Byte Count	RW	Description
						the value of the parameter 2 register is 0xFFFF, then this register is assigned 0.
0x1209	Upper limit of range 2	float	2	4	OR	The upper limit of the range of sensor parameter 2. If the value of the parameter 2 register is 0xFFFF, then this register is assigned 0.
0x120B	Optional measurement parameter 3	uint16	1	2	OR	Same as above
0x120C	Lower limit of range 3	float	2	4	OR	Same as above
0x120E	Upper limit of range 3	float	2	4	OR	Same as above
0x1210	Optional measurement parameter 4	uint16	1	2	OR	Same as above
0x1211	Lower limit of range 4	float	2	4	OR	Same as above
0x1213	Upper limit of range 4	float	2	4	OR	Same as above
0x1215	Optional measurement parameter 5	uint16	1	2	OR	Same as above
0x1216	Lower limit of range 5	float	2	4	OR	Same as above
0x1218	Upper limit of range 5	float	2	4	OR	Same as above

9.2.3. Measurement Parameters

Table 7

Type	Name	Type	Name	Type	Name
0x00	None	0x10	Nitrate Nitrogen (NO ₃ -N)	0x20	Mercury Ion (Hg ²⁺)
0x01	pH	0x11	UV Nitrate	0x21	Lead Ion (Pb ²⁺)
0x02	ORP	0x12	Chlorine Dioxide (ClO ₂)	0x22	Sulfide Ion (S ²⁻)
0x03	Dissolved Oxygen Concentration	0x13	Sodium Ion (Na ⁺)	0x23	Lg (Ion Concentration)
0x04	Dissolved Oxygen Saturation	0x14	Potassium Ion (K ⁺)	0x24	
0x05	Salinity	0x15	Ammonium Ion (NH ₄ ⁺)	0x25	
0x06	Atmospheric Pressure	0x16	Silver Ion (Ag ⁺)	0x26	Temperature
0x07	Conductivity	0x17	Fluoride Ion (F ⁻)	0x27	Resistance
0x08	Resistivity	0x18	Chloride Ion (Cl ⁻)	0x28	Current (e.g., for Dissolved Oxygen Electrodes)
0x09	TDS	0x19	Bromide Ion (Br ⁻)	0x29	UV Optical Path Length
0x0A	Turbidity	0x1A	Iodide Ion (I ⁻)	0x2A	Electrode Sensitivity
0x0B	Sludge Concentration	0x1B	Nitrate Ion (NO ₃ ⁻)	0x2B	
0x0C	Residual Chlorine	0x1C	Calcium Ion (Ca ²⁺)	0x2C	
0x0D	Total Organic	0x1D	Water Hardness	0x2D	

Type	Name	Type	Name	Type	Name
	Carbon (TOC)		(as CaCO_3)		
0x0E	Chemical Oxygen Demand (COD)	0x1E	Copper Ion (Cu^{2+})	0x2E	
0x0F	Ammonia Nitrogen ($\text{NH}_4\text{-N}$)	0x1F	Cadmium Ion (Cd^{2+})	0x2F	

9.2.4. Units

Unit	ID	Unit	ID
$^{\circ}\text{C}$	0x00	$^{\circ}\text{F}$	0x01
mV	0x02	pH	0x03
$\mu\text{S/cm}$	0x04	mS/cm	0x05
ppm	0x06	ppt	0x07
mg/L	0x08	g/L	0x09
$\mu\text{g/L}$	0x0A	%	0x0B
hPa	0x0C	g/kg	0x0D
$\text{M}\Omega\cdot\text{cm}$	0x0E	mmHg	0x0F
NTU	0x10	μA	0x11
mA	0x12	A	0x13
mbar	0x14	Ω	0x15
k Ω	0x16	M Ω	0x17
nA	0x18	kPa	0x19
mol	0x1A	MPa	0x1B
pX	0x1C	cm	0x21
m	0x20	S/cm	0x23
mm	0x22	mS/m	0x25
$\mu\text{S/m}$	0x24	$\text{k}\Omega\cdot\text{cm}$	0x27
$\text{M}\Omega\cdot\text{m}$	0x26	$\Omega\cdot\text{m}$	0x29
$\text{k}\Omega\cdot\text{m}$	0x28	PPb	0x2B

Unit	ID	Unit	ID
PSU	0x2A		
FTU	0x2C		

9.2.5. Data Register

Table 8 Data Register

Address	Name	Data Type	Registers	Byte Count	RW	Description
0x2000	Protocol version + device type	uint16	1	2	R	High byte: Data version, low byte: Device type Device type: For example, 0x34 represents conductivity
0x2001	Supplementary protocol type	uint16	1	2	R	Not in use, fill with 0s
0x2002	Parameter 1 value	float	2	4	R	Measurement value of parameter 1 is based on the measurement parameter registry; otherwise, the value of this register is meaningless
0x2004	Temperature value	float	2	4	R	This register is fixed as the temperature measurement value, in degrees Celsius. If there is no temperature, set the value to -999.0
0x2006	Parameter 2 value	float	2	4	R	Same as above
0x2008	Parameter 3 value	float	2	4	R	Same as above
0x200A	Parameter 4 value	float	2	4	R	Same as above
0x200C	Parameter 5 value	float	2	4	R	Same as above
0x2410	Restore factory settings	uint8_t	1	2	W	Write 1 to execute the factory settings of the sensor

Measurement value reading method:

Read continuously starting from the address 0x2000, and the reading length refers to the number of measurement parameters in 0x1200. For example, if the number of measurement parameters is 4, then read from 0x2000 to 0x200B.

9.2.6. Calibration Register

Table 9 Calibration Register

Address	Name	Data Type	Registers	Byte Count	RW	Description
0x3000	Read the number of calibration points	uint8_t	1	2	R	The number of calibration points (m) supported by the sensor parameters to be calibrated, with a maximum of 5 points supported.
0x3001	Current calibration point	uint8_t	1	2	R/W	Current range: 1-m
0x3002	Calibration parameter type	uint8_t	1	2	R/W	Specific types refer to the measurement parameter registration table. 0 - Temperature 1 - Parameters of register 0x1201 in the registration table 2 - Parameters of register 0x1206 in the registration table 3 - Parameters of register 0x120B in the registration table 4 - Parameters of register 0x1210 in the registration table 5 - Parameters of register 0x1215 in the registration table
0x3003	Sensor	uint8_t	1	2	R	0x0000: Calibration

Address	Name	Data Type	Registers	Byte Count	RW	Description
	calibration status					successful 0x0001: Calibration not yet completed 0x0002: No standard liquid information received or no such standard liquid available 0x0003: Signal cannot be stabilized or signal is out of range 0x0004: Slope or offset out of allowed range
0x3004	Exit calibration	uint8_t	1	2	W	Write 1 to exit calibration
0x3005	Reference standard value	float	2	4	W	Standard liquid value, data format is float
0x3007	Measured value	float	2	4	R	Unadjusted original measured value. (If the standard value refers to CalA and the measured value refers to MeasA, refer to section 6.1 of the calibration procedure)

9.3 Communication examples

9.3.1. Example of Reading Measurement Parameters

When obtaining the number of measurement parameters, the sensor responds with 4:

Send Hex: 01 03 12 00 00 06 c0 b0

Recv Hex: 01 03 0c 00 04 10 06 00 00 00 00 c0 00 46 5a 22 2e

To obtain the registration table for all 4 measurement parameters, read (1 + 5x4) registers

Send Hex: 01 03 12 00 00 15 81 7d

Recv Hex: 01 03 2a 00 04 10 06 00 00 00 00 c0 00 46 5a 10

02 00 00 42 c8 00 00 43 fa 10 1a c5 ac 37 27 00

00 3f 80 10 1c 00 00 00 00 00 00 40 a0 13 73

To read the measurement values, read 4 measurement values and temperature:

Send Hex: 01 03 20 00 00 0c 4e 0f

Recv Hex: 01 03 18 20 14 00 00 00 00 42 d4 66 66 41 ca 13

33 43 95 c2 8f 3b f5 df 3b 40 47 a0 d8

9.3.2. Calibration example

Taking the first point of calibration as an example

Calibration parameter type 0x01

Send Hex: 01 06 30 02 00 01 e6 ca

Recv Hex: 01 06 30 02 00 01 e6 ca

Write the value of the standard solution:

Send Hex: 01 10 30 05 00 02 04 00 00 41 20 56 19

Recv Hex: 01 10 30 05 00 02 5e c9

Write the current calibration point and initiate the first calibration point:

Send Hex: 01 06 30 01 00 01 16 ca

Recv Hex: 01 06 30 01 00 01 16 ca

Query calibration status:

Send Hex: 01 03 30 03 00 01 7b 0a

Recv Hex: 01 03 02 00 00 b8 44