# SZ561-A

# Ammonium ISE Sensor

# User Manual

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# 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

Online ammonium ISE sensor measures ammonium electron concentration without using any chemicals. No reagent, no pollutants, more economic and environmentally friendly. The sensor uses pH, Ammonium Ion electrodes, and an optional potassium ion electrode to determine the NH4+-N concentration.It is designed for use in all kind of natural water, such as lakes, streams, rivers, as well as wastewater plants.

## Features：

Digital sensors, RS-485 output, MODBUS support;

No reagent, no pollutants, more economic and environmentally friendly ;

Automatic compensation for NH4+, pH and temperature in water;

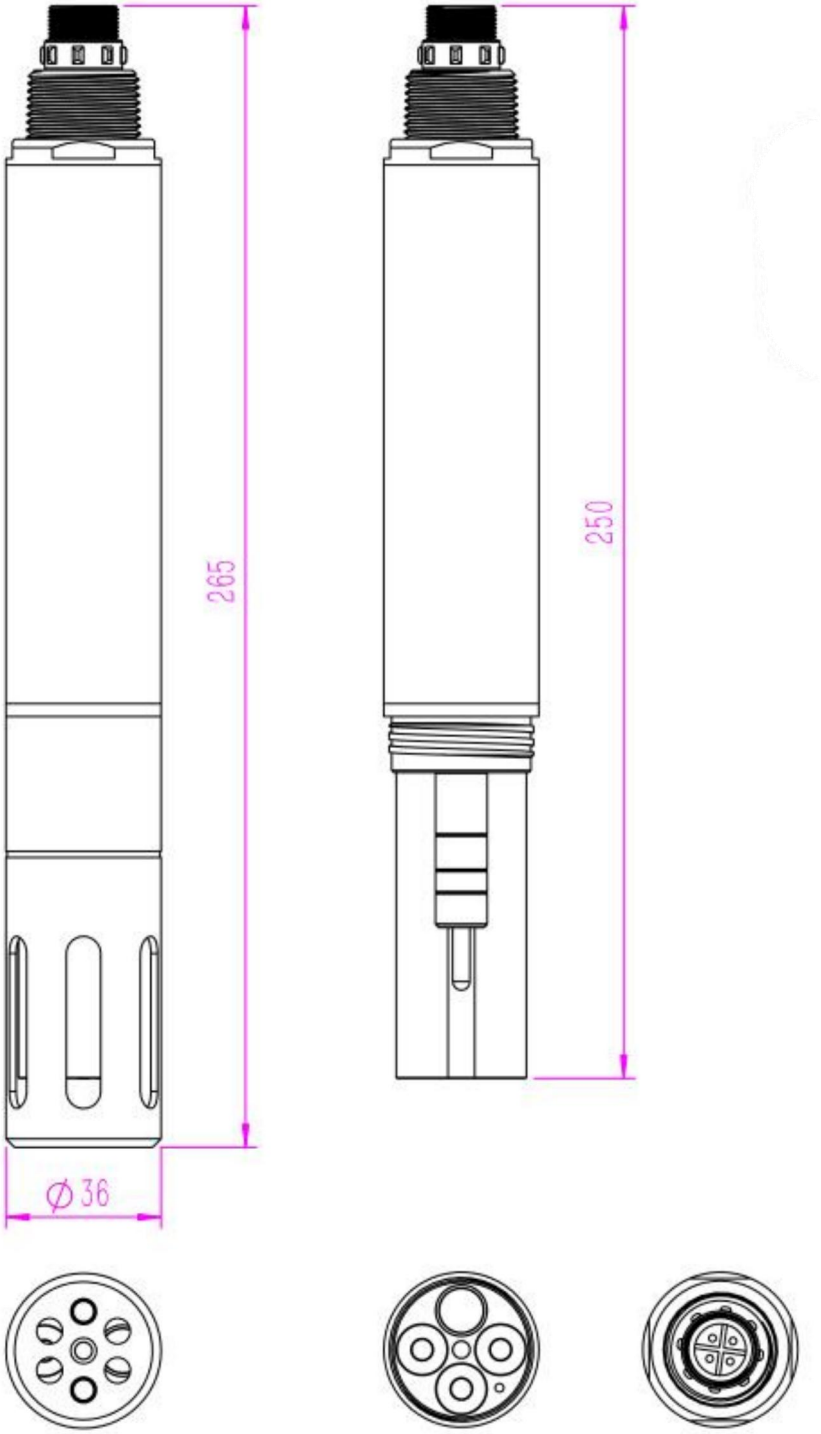
Can be directly connected to our company's controller, handheld meter, more convenient to use.

**Note:** Ion electrodes are for fresh water only, not seawater.

## 1.1 Introduction



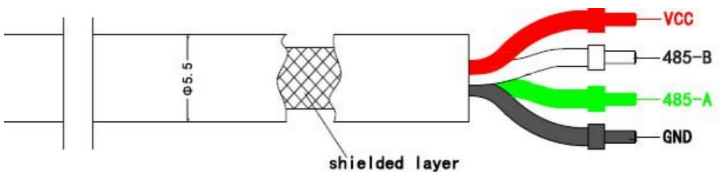
▲Ammonium ISE Sensor




▲ **Ammonium ISE Sensor size**

## 1.2 Cable definition

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)

## 1.3 Technical Specifications

| Name | Ammonium ISE Sensor |
|---|---|
| NH4_N Range | 0-100mg/L （0-1000mg/L optional） |
| NH4_N Accuracy | ±10% or ±0.5mg/L |
| NH4_N Resolution | 0.01 mg/L |
| pH Range | 4-10pH |
| pH Accuracy | ±0.1pH |
| pH Resolution | 0.01 |
| Size | Φ36mm * 265mm （with protective cover） |
| Housing IP Rating | IP68 |
| Deepest Depth | 10m underwater |
| Temperature Range | 0 - 50℃ |
| Sensor Interface | Supports RS-485, MODBUS protocol |
| Construction | NPT3/4 thread, submersible mounting |
| Power | 0.25W （suggested power supply: DC 9-24V,≥1A） |
| Cable Length | 10m(default), customizable |
| Calibration | one-point or two-points calibration |
| Sensor housing material | POM+316L （customizable titanium alloy） |

**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.

# 2 Installation

## 2.1 Configuration table

| Item | Number | Note |
|---|---|---|
| NH4-N Sensor | 1 | |
| Cable | 1 | 10m |
| Rubber protective Cap | 1 | |

## 2.2 Before use

**（1） Take off the protect cap:**

Before installation, carefully remove the protective rubber covers of the reference electrode and pH electrode, and store the covers properly;

Note: Ammonium ion electrode can be stored without protective cover and dry.

**（2） Cleaning and activation:**

First use deionized water to wash the electrodes (do not use wet wipes as they may damage the electrode sensing film.).

It needs to be re-activated before use. Activation method: soak the electrode in 10ppm NH4CL solution for more than 24 hours (see standard solution preparation for details).

## 2.3 Sensor Installation

**（1） Wiring and power supply**

① The female and male connector of sensor cable should be screwed tightly to avoid moisture incursion.

② Do not use the sensor cable to pull the sensor! It is required to install sensor in a secure and stable mounting bracket.

③ Make sure power supply voltage is correct before power on.

**（2） Sensor installation**

① It is recommended to install the sensor vertically with electrodes facing down.

② Considering water level change, the sensor should be installed 30cm below water level.

③ The sensor must be securely installed to avoid damage caused by water flow and other things.

# 3 Calibration

## 3.1 Brief description

Ammonium ISE Sensor supports one-point or two-points calibration. The calibration tool can be used with our Smart PC software or according to sensor communication protocol. For our Smart PC software, please can the QR code on the right to get it. Customers can also develop by themselves according to the communication protocol.

**SmartPC User Manual:**

（1） Open the SmartPC and select "Language" in the title bar: English.

（2） Select the correct port and click "Connect".

（3） Check calibration to perform calibration operation. Press F1 to get the help document. Find the calibration instructions for the NH4-N probe.

（4） You can also use the tool to measure and record data, referring to the help documentation.

## 3.2 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:**

pH(standard value)=K*pH(measurement)+B

Normal factory default:K=1, B=0

**（2） NH4+ standard solution**

NH4+ mother standard solution (NH4+ concentration:1000mg/L), 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-electrode heads.

NH4+ user calibration formula (LG(X) is calculated logarithmic in base 10):

**LG[NH4+(standard value)]**=K*LG[NH4+(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 the system of univariate quadratic equations, and write K and B at the same time.

**（3） Potassium ion standard solution (when equipped with potassium ion electrode)**

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

②Take 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;

③Take 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;

④Take 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:**

K+(standard value)=K* K+(measurement)+B

Normal factory default:K=1, B=0

# 4 Maintenance schedule and methods

## 4.1 Maintenance schedule

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

| Maintenance task | Recommended maintenance frequency |
|---|---|
| Sensor cleaning | Cleaning every 2 to 3 weeks |
| Calibration sensor | Every 3 to 4 weeks(depending on operating conditions) |

## 4.2 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) Electrode Cleaning：**

① Wash the outer surface of electrode with soft brush. Note that do not touch sensitive membrane of NH4+ electrode.

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

③ Do not use anything to wipe sensitive membrane of NH4+ electrode. 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, electrode cleaning with DI water shall be repeated for each step to avoid polluting the standard solution.

**(4) Store the sensor:** Regular electrode maintenance requires pH and reference electrode to be stored in protected solutions. Please keep NH4+ electrode in 1ppm NH4+ solution.

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

**(5) Replace the electrode:**

NH4+, reference and pH electrode are all consumable parts. Please replace them in time according to the actual situation.

## 5 Trouble Shooting

Table 5-1 lists the 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.

| ERROR | POSSIBLE CAUSE | SOLUTION |
|---|---|---|
| Abnormal communication | Controller and cable connection error | Reconnect the controller and cables |
| | Interface and protocol problems | 1.Use our SmartPC upper computer software to checkwhether the communication is normal;<br>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 |
| | Electrode loss failure | Replace the new electrode |
| | Calibration Required | Carry out user calibration |
| Remaining Issues | Please contact us | |

**Table 5-1 List of frequently asked questions**

## 6 Warranty Description

(1) Sensor warranty period is 1 year, Electrode warranty period is 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.

③ Freight 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.

⑤ Travel to perform warranty repairs locally.

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

① This 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.

# 7 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

## 7.1 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 | |

## 7.2 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) | |

## 7.3 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.

## 7.4 Register Table

| Start address | Command Description | Number of registers | Data format (hexadecimal) |
|---|---|---|---|
| 0x0700H | Get Software and Hardware Rev | 2 | 4 bytes in total<br>00 ~ 01: hardware version<br>02 ~ 03: software version<br>For example, reading 0101 represents 1.1 |
| 0x0900H | Get SN | 7 | 14 bytes in total<br>00: reserved<br>01 ~ 12: serial number<br>13: Reserved<br>The 12 bytes of the serial number are translated according to ASCII code, i.e. the factory serial number |
| 0x3000H | Device address (read and write)<br>The factory default is 01 | 1 | 2 bytes in total<br>00~01: Device address<br>The range can be set from 1~254<br>For example, the data obtained is 02 00 (If the low position is in the front, it means that the address is 2)<br>Take address 15 as an example, then 0F 00<br>Write the corresponding address (low in front)<br>When the current device address is unknown, you can use FF as a common device address to ask for the current |
| 0x3600H | LGNH4+<br>User calibration K/B(read/write) | 4 | Total 8 bytes<br>00~03: K<br>04~07: B<br>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)<br>To write k, for example, we need to convert k to 32-bit floating point and write it in (DCBA format) |
| 0x1100 | pH<br>User calibration K/B(read/write) | 4 | Total 8 bytes<br>00~03： K<br>04~07： B |
| 0x2900 | pH original internal factory parameters(read/write)<br>**Notes: If the customer only do pH 2 point calibration， This item is not concerned about.<br>But don't change it** | 12 | Total 24 bytes<br>00~03： K1<br>04~07： K2<br>08~11： K3<br>12~15： K4<br>16~19： K5<br>20~23： K6<br>The default parameter is **K1=6.86,K2=6.72,K3=0.04, K4=6.86,K5=-6.56,K6=-1.04**。 |

| | | | |
|---|---|---|---|
| | **arbitrarily** | | |
| 0x3400 | LGNH4+<br>Value acquisition | 2 | Total 4 bytes<br>00~03： LGNH4+<br>This value is used for the user calibration |
| 0x2600H | Potential/pH<br>Value acquisition | 4 | Total 8 bytes<br>00~03： Potential Value<br>04~07： pH<br>The reading Potential value/pH value is 4 bytes of data.<br>(The low position is in the front, DCBA format, and this data needs to be converted to a change floating point number. The conversion method is shown below) |
| 0x2800 | NH4_N 、 K+ and NH4+<br>Value acquisition | 6 | Total 12 bytes<br>00~03： NH4_N value<br>04~07： K+ value<br>08~11： NH4+ value |
| 0x2400 | Temperature value acquisition | 2 | Total 4 bytes<br>00~03： Temperature value |

## 7.5 Conversion algorithms for floating point numbers

### 7.5.1 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)

**7.5.2 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表示正数

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

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

Last digit M: 11110110110011001100110B = 8087142

Step 2: Calculating floating point numbers

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

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

= 1 x 1.964062452316284 x 32

= 62.85