BH-485-NO3

Digital Nitrate Nitrogen Sensor

Operation Manual

Shanghai BOQU Instrument Co.,Ltd

www.boquinstruments.com

Table of Contents

Chapter 1 Specifications

Specifications	Details
Measurement Range	0.1～40.0mg/L (2mm)
Measurement Accuracy	±5%
Repeatability	±2%
Resolution Ratio	0.01 mg/L
Pressure Range	≤0.4Mpa
Material	Main Body: SUS316L (Ordinary Version), Titanium Alloy (Seawater Version) Upper and Lower Cover：PUR
Power Supply	Direct current supply：9~36VDC
Communication Protocol	MODBUS RS485
Storage Temperature	-15 ~50℃
Operating Temperature	0 ~ 45℃ (not freeze)
Weight	3.2KG
Level of Protection	IP68/NEMA6P
Cable Length	10-meter standard cable which can be extended up to 100 meters.

Table 1 Technical Specifications of Spectroscopic Nitrate Sensor

Note: The specifications of the product are subject to change without prior notice.

Chapter 2 Product Overview

2.1 Product Information

NO3 absorbs at 210 nm UV light. When the Spectrometer Nitrate sensor is working, the water sample flows through the slit. When the light from the light source in the probe passes through the slit, part of the light is absorbed by the sample flowing in the slit, and the other light passes through the sample and reaches the other side of the probe. Calculate the concentration of nitrate.

It is widely used in drinking water, surface water, industrial production process water, sewage treatment and other fields. Continuously monitor the concentration of nitrate dissolved in water, especially for monitoring sewage aeration tanks, controlling denitrification process. The size of the nitrate sensor is shown in Figure 1.

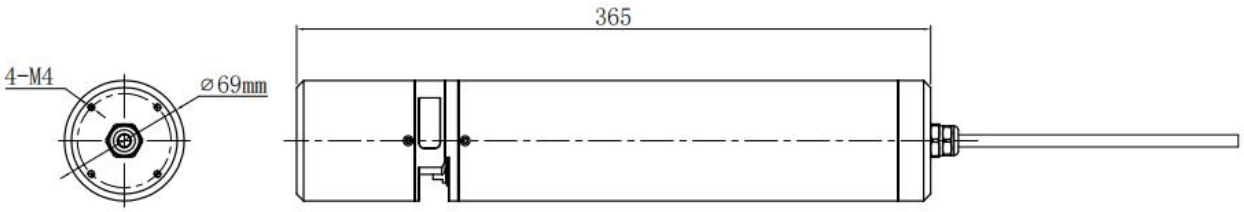


Figure 1 Dimensional Drawing of Spectroscopic Nitrate Sensor

2.2 Safety Information

Please read this manual completely before opening the package, installing or using. Otherwise it may cause personal injury to the operator, or cause damage to equipment.

Warning labels

Please read all labels and signs on the instrument, and comply with the security label instructions, otherwise it may cause personal injury or equipment damage.

When this symbol appears in the instrument, please refer to the operation or safety information in the reference manual.

While this symbol indicates an electric shock or risk of death from electric shock.

Please read this manual completely. Pay particular attention to some notes or warnings, etc. To ensure that the protective measures provided by the equipment are not destroyed.

Chapter 3 Installation

3.1 Installation of Sensors

3.1.1 Handrail-style Installation

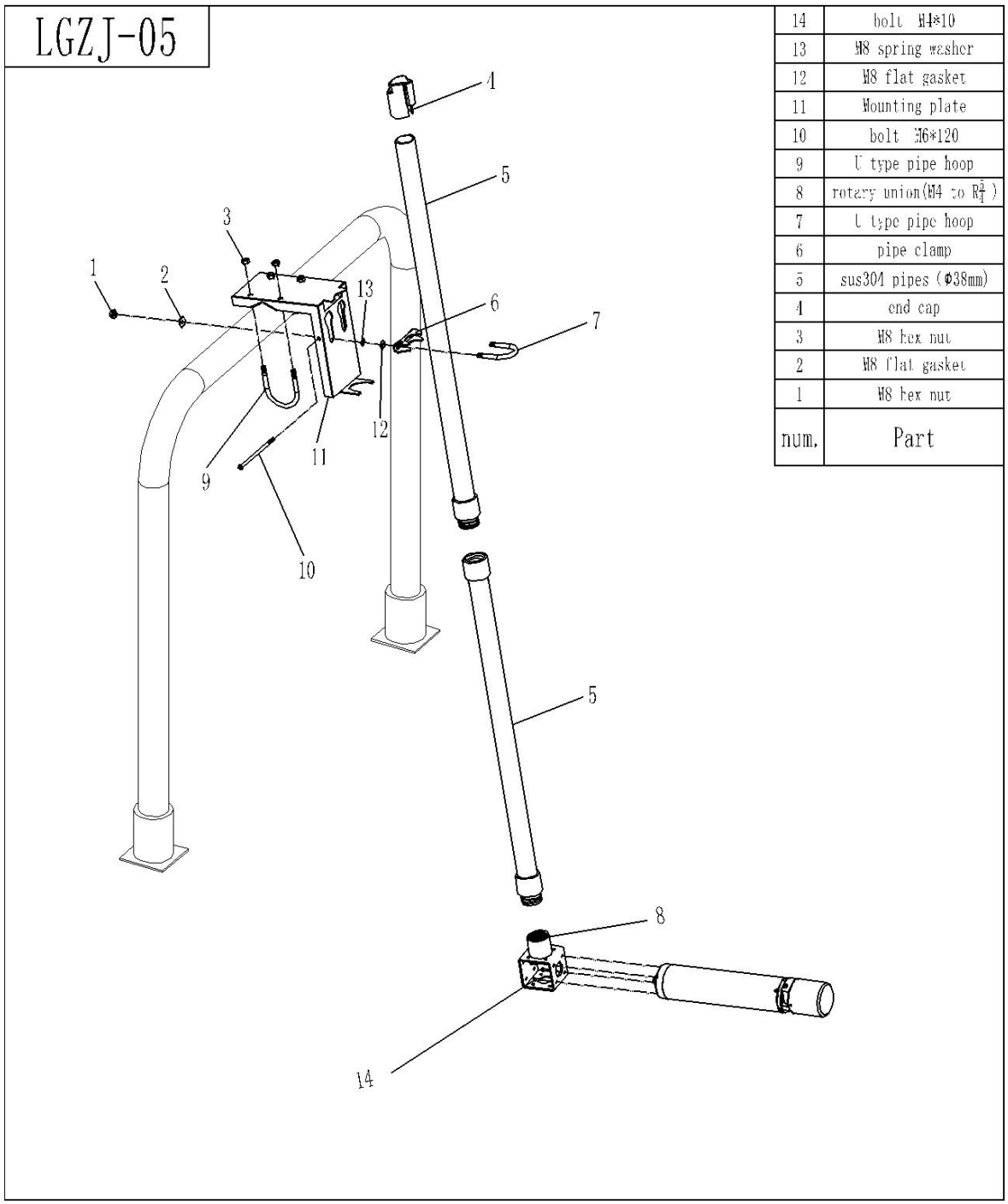
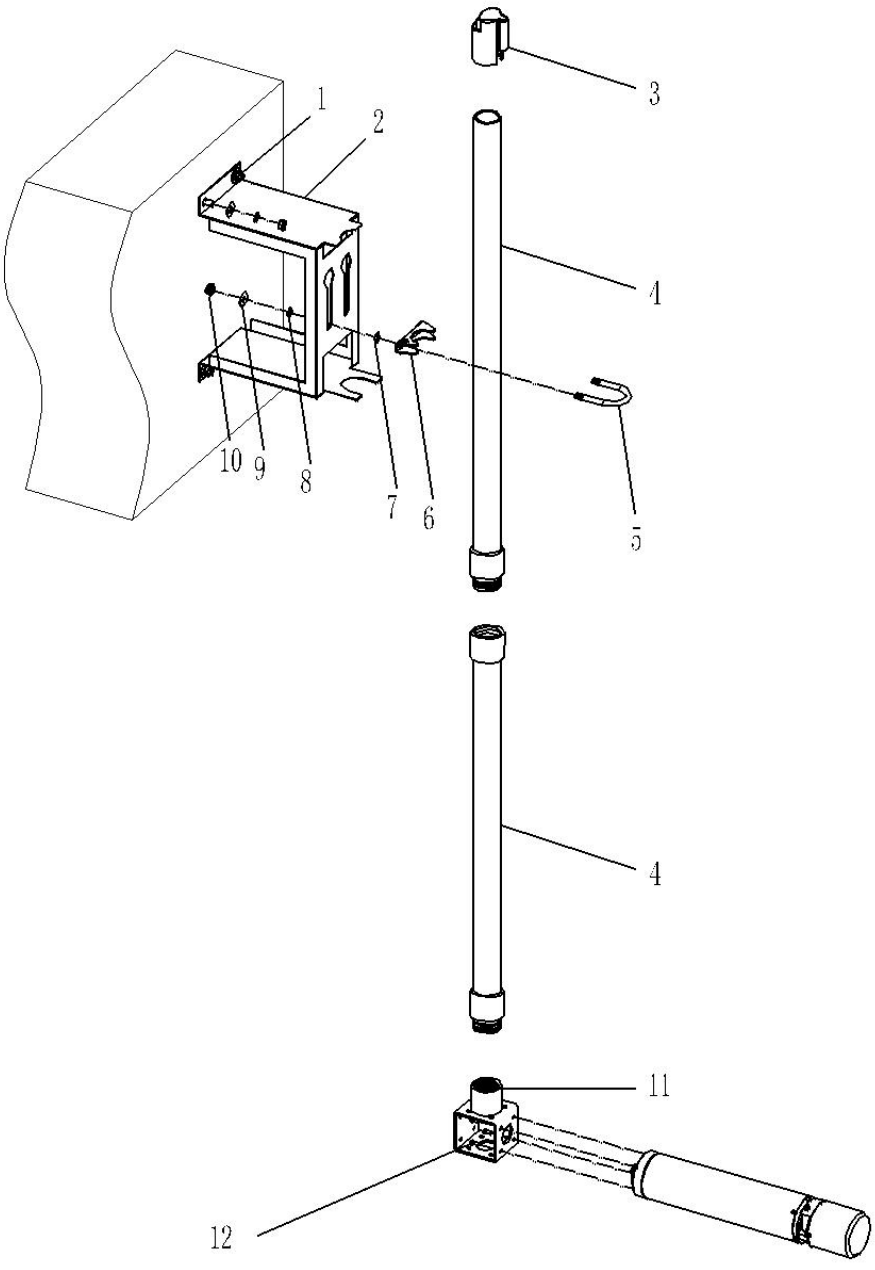


Figure 2 Schematic Diagram of Handrail-style Installation

3.1.2 Poolside Installation

CBZJ-05

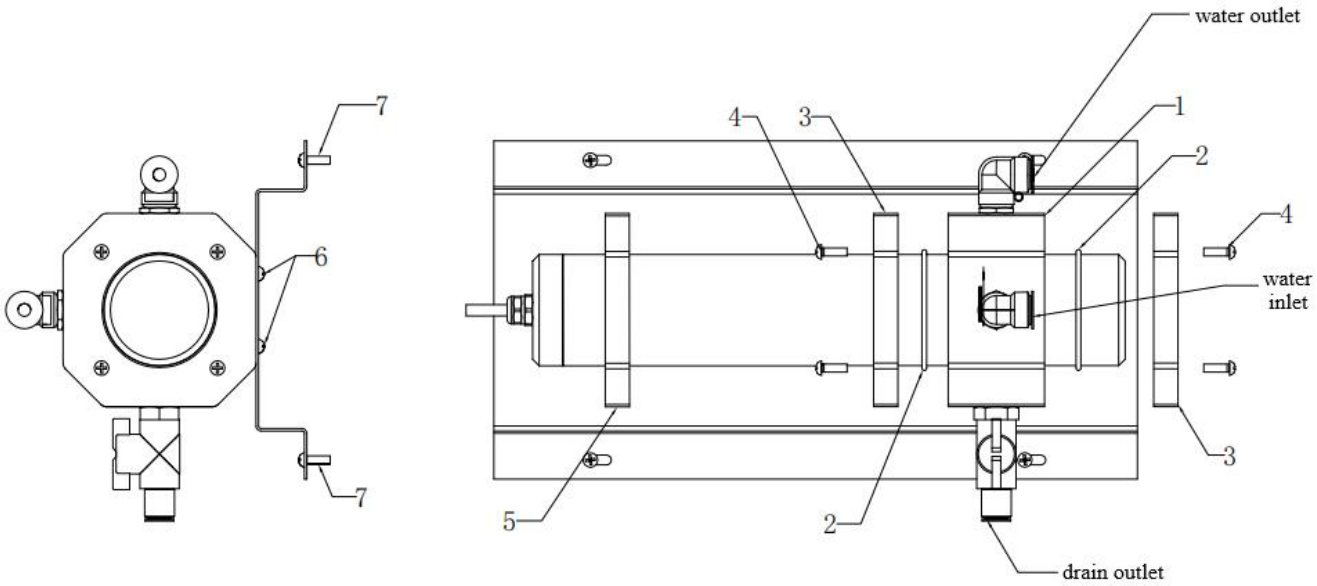


num.	Part
14	bolt M4*10
11	rotary union(M4 to R$\frac{5}{4}$)
10	M8 hex nut
9	M8 flat gasket
8	M8 spring washer
7	M8 flat gasket
6	pipe clamp
5	U type pipe hoop
4	sus304 pipes (ϕ38mm)
3	end cap
2	Mounting plate
1	M8 expansion bolt

Figure 3 Schematic Diagram of Poolside Installation

3.1.3 Bypass facility installation

When it is impossible to directly measure the medium (such as in tap water) or when the medium load requires the measurement of filtered water samples (such as high-content TS, sewage treatment plant water, waste dumps, etc.), you can use Figure 4 method.



Number	Model	Name	Quantity	Material
1		Main body of flow chamber	1	
2	Outer dia. 75* wire dia. 3	O-ring	2	Red silicone
3		Flow chamber cover	2	PMMA
4	M5*20	Phillips pan head combination screw	8	304
5		Flow chamber cover	1	PMMA
6	M5*10	Phillips combination screw	6	304
7	M5*10	Phillips combination screw	4	304

Figure 4 Schematic diagram of bypass facility installation

Installation steps: (this installation is only applicable to sensors with 2 and 5mm optical path)

1. Place the main body of the flow chamber at the position of the measuring tank;

2. Install the O-ring on the main body of the flow chamber;

3. Install the flow chamber cover;

4. Fix the flow chamber cover to the main body of the flow chamber with screws;

5. Install the flow chamber cover for support;

6. Fix the flow chamber and the probe on the mounting part with screws;

7. Install the assembled kit on the customer site with screws;

8. Connect the water inlet pipe, drain pipe, and sewage pipe.

3.2 Connection to Sensor

The sensor is correctly connected according to the definition of the following cores:

Serial No.	1	2	3	4	5
Sensor Cable	Brown	Black	Blue	White	Yellow + Green
Signal	+12VDC	AGND	RS485 A	RS485 B	Ground Lead

Special note: In order to protect the nitrate sensor, please be sure to ground the sensor.

Chapter 4 Interface and Operation

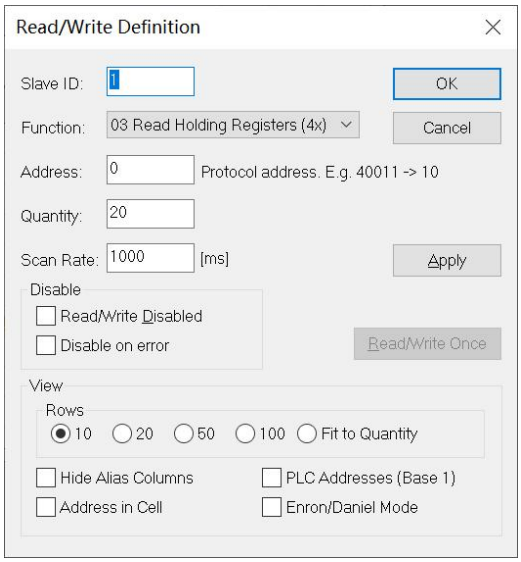
4.1 User Interface

The sensor is connected to the computer using RS485 to USB, and then use Modbus Poll to connect.

Note: Modbus Poll software is a general software that can be downloaded online.

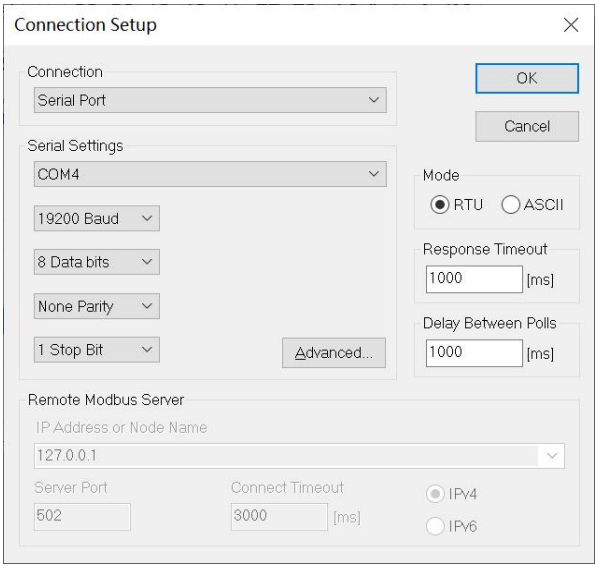
4.2 Parameter Setting

1、Click “Setup” on the menu bar, select “Read / Write Definition”, and then set the parameters (The slave address for the first time is the slave label), then enter “20” for Quantity in the dialog box , click “OK” .



Note: After the slave address is changed, the new address will be used for communication and the slave address for the next time connection is also the most recently changed address.

2、Click “Connection” on the menu bar, select the first line in the drop-down menu “Connection setup” (The baud rate for the first time is the slave label) and click “OK”.



Note: Port is set according to the Port number of the connection.

Note: If the sensor has been connected as described, and “Timeout Error” appears on the software “Display status”, it means that the connection is failed; remove and replace the USB port or check the USB to RS485 converter, repeat the above procedure until the sensor connection is successful.

Chapter 5 Calibration of Sensor

Spectroscopic nitrate sensor has been calibrated at the factory. If there is a need to re-calibrate, please follow the steps below. (**Note: Make sure to clean the glass window before performing the calibration. Depending on the application, any deviation from the factory calibration may be caused by contamination of the optics. If the calibration verification fails, please clean the glass window again and repeat these steps)**. The calibration of spectroscopic nitrate sensor includes factor calibration、zero point calibration、sample calibration and standard solution calibration. **Factory default is standard solution calibration.**

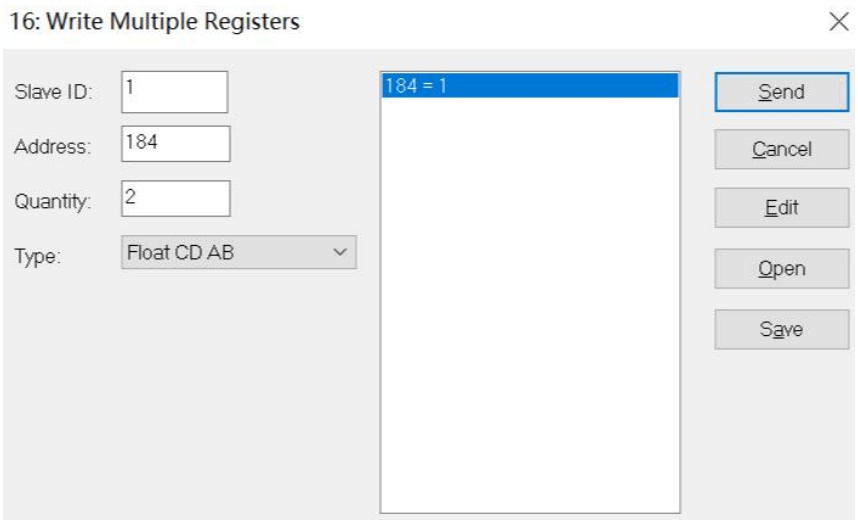
5.1 Factor Calibration

If there is a large deviation between the measured value and the standard value, the slope of the calibration curve needs factor calibration.

1、Connect the sensor to the Modbus software;

2、Set the relevant parameters and wipe the sensor;

3、Select “16” in the menu bar to enter “184” for Address in the dialog box, “2” for Quantity, and change type into “Float CD AB”. Double-click the up on the right to enter “1” for the value. Click “OK”, then click “Send”, as shown below;



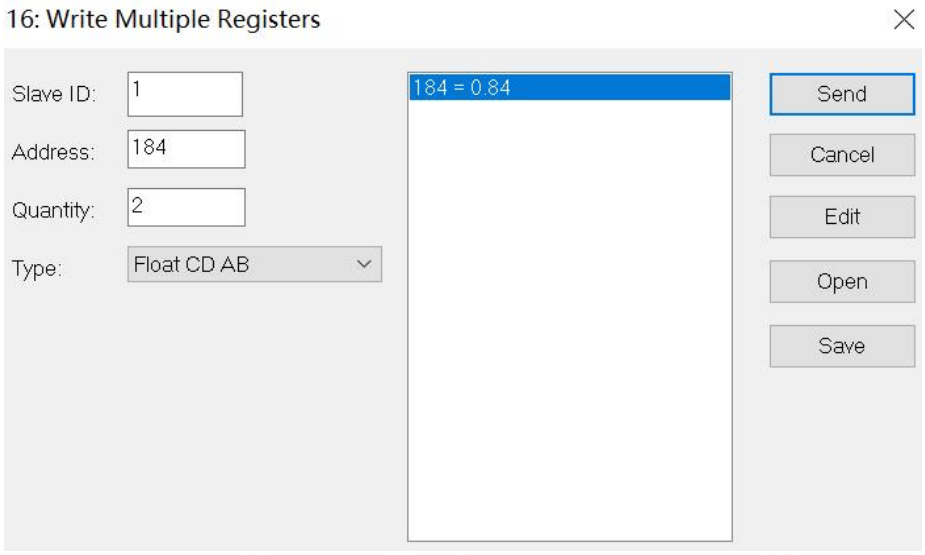
4、Slowly immerse the sensor into the nitrate standard solution and ensure that the optical path is measured horizontally;

5、Wait for the value to be stable and record the measured value;

6、Calculate the correction factor. The correction factor equals to the standard solution value divided by the value measured in the 5 step. (Factor = standard solution value / measured value);

7、Select “16” in the menu bar to enter “184” for Address in the dialog box, “2” for Quantity and change type into “Float CD AB”. Double-click the up on the right to enter “Factor Value” for the value (The factor value is the calculated value in step 6). Click “OK”, then click “Send”.

Assume that the factor value calculated in step 6 is 0.84, as shown in the figure below. Finally the NOx-N value and nitrate calibration standard solution are close at address 0.



	Alias	00000	Alias	00010
0	NOx-N	19.9536	measurement cycle (s)	15
1		--		0
2		19.9536		16256
3		--		21727
4		19.9536		-15502
5		--		--
6	UV254	23.7542	wiper cleaning cycle (min)	1
7		--	wiper pattern	2
8	Main measuring value unit	0		4
9		9	response time	1

5.2 Zero Point Calibration

1、Connect the sensor to the Modbus software;

2、Set the relevant parameters and wipe the sensor;

3、Refer to step 3 in 5.1, set the calibration method to factor, and the factor value is 1；

4、Slowly immerse the sensor in distilled water to ensure the level of the measuring light path；

5、After waiting for the value to stabilize, calibrate the zero point according to the communication protocol: select “06” in the menu bar and enter “90” for Address in the dialog box, and the following operations keep Address: “90” unchanged

Enter “62” in Value (62 zero point calibration menu), and click “Send”

Enter “25” in Value (25 Preparation), click “Send”;

Enter “18” in Value (18 ready), click “Send”;

Enter “61” (61 calibration status) in Value, and click “Send”;

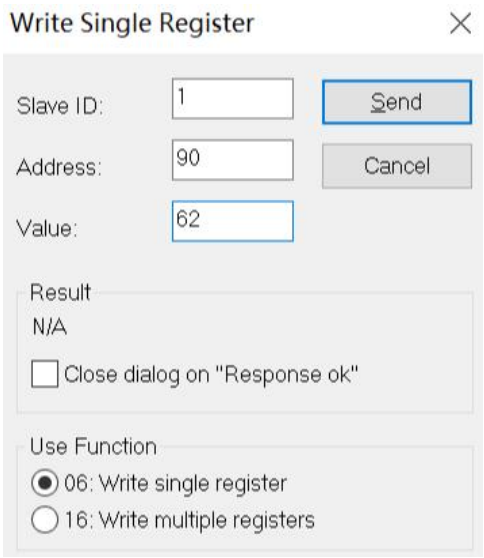
Enter “85” in Value (85 wipe) and click “Send”;

Enter “61” (61 calibration status) in Value, and click “Send”;

Enter “19” in Value (19 Wait Steady), and click “Send”;

Enter “42” in Value (42 End of calibration), click “Send”;

Enter “52” in Value (52 Return to main value), and click “Send”;



	Alias	00000	Alias	00010
0	NOx-N	0.16	measurement cycle (s)	15
1		--		0
2		0.16		16256
3		--		4081
4		0.16		-15509
5		--		--
6	UV254	0.135	wiper cleaning cycle (min)	1
7		--	wiper pattern	2
8	Main measuring value unit	0		2
9		9	response time	1

5.3 Sample Calibration

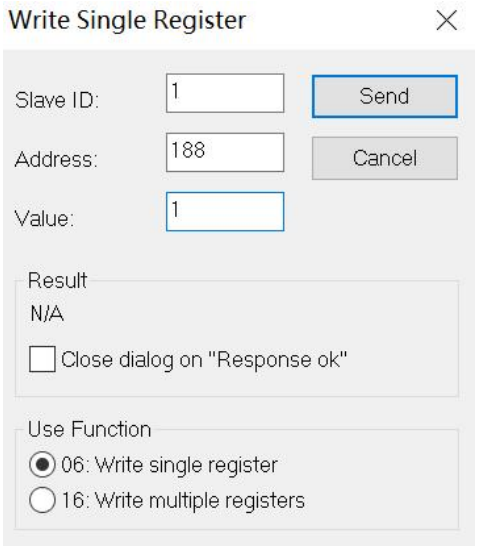
1、Connect the sensor to the Modbus software;

2、Set the relevant parameters and wipe the sensor;

3、Refer to step 3 in 5.1, set the calibration method to factor, and the factor value is 1；

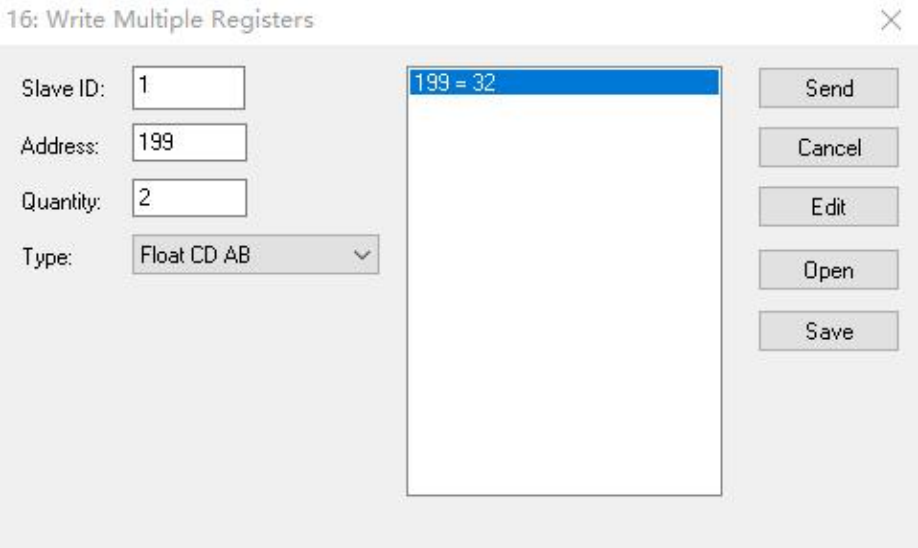
4、Slowly immerse the sensor in sample of known concentration to ensure the level of the measuring light path；

5、 Select “06” in the menu bar and enter “188” for Address and “1” for Value (sample calibration mode), and click “Send”

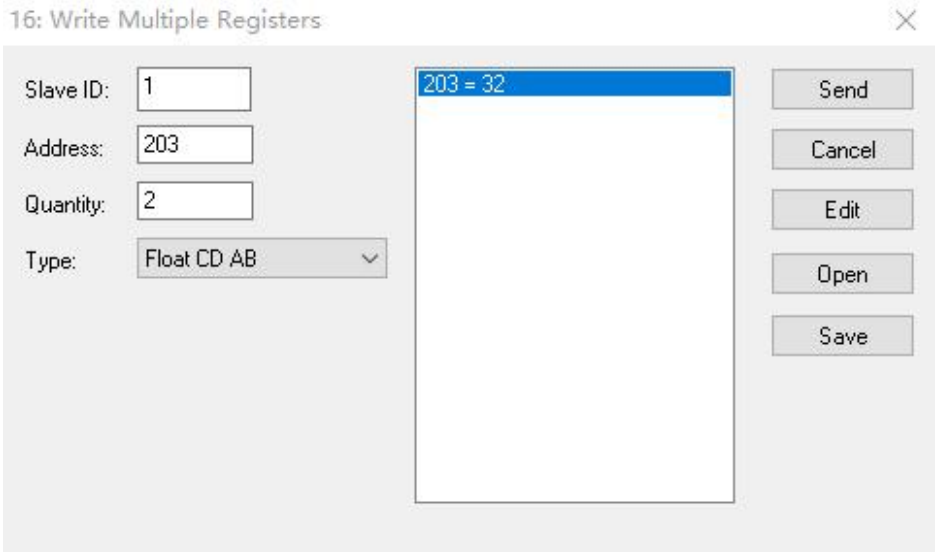


6、Wait for the value to stabilize, and record the stable UV value; select “16” in the menu bar to enter “199” (sample calibration UV value address) for Address in the dialog box, “2” for Quantity, and change

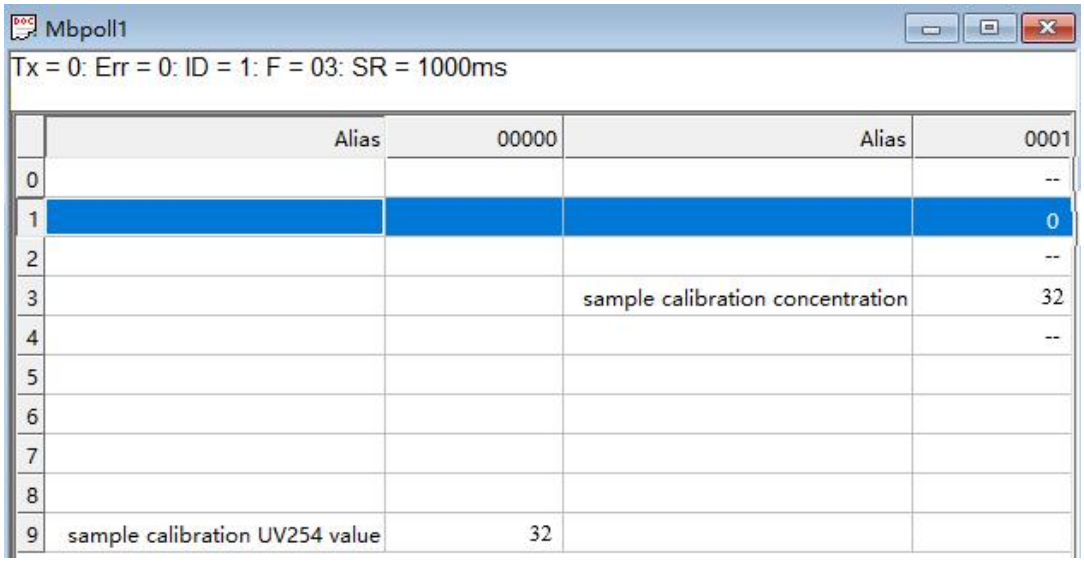
type into “Float CD AB”, Double-click the up on the right to enter sample calibration stable value UV value for the value.



7、Select “16” in the menu bar to enter “203” (sample calibration concentration address)for Address in the dialog box, “2” for Quantity, and change type into “Float CD AB”. Double-click the up on the right to enter sample calibration actual concentration value for the value.



8、The final result is shown in the figure below



9、Take out the sensor, wash the sensor and wipe dry.

5.4 Standard solution calibration

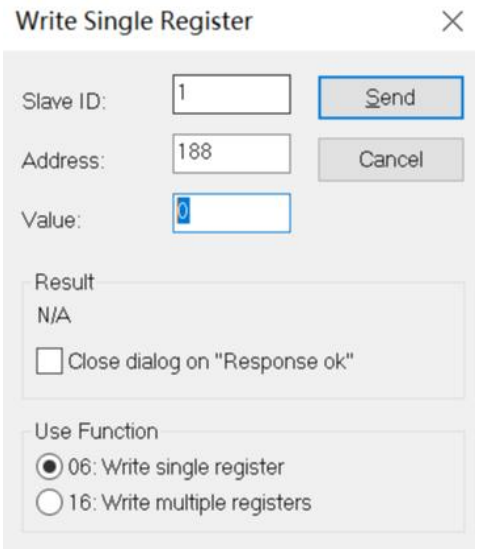
1、Connect the sensor to the Modbus software;

2、Set the relevant parameters and wipe the sensor;

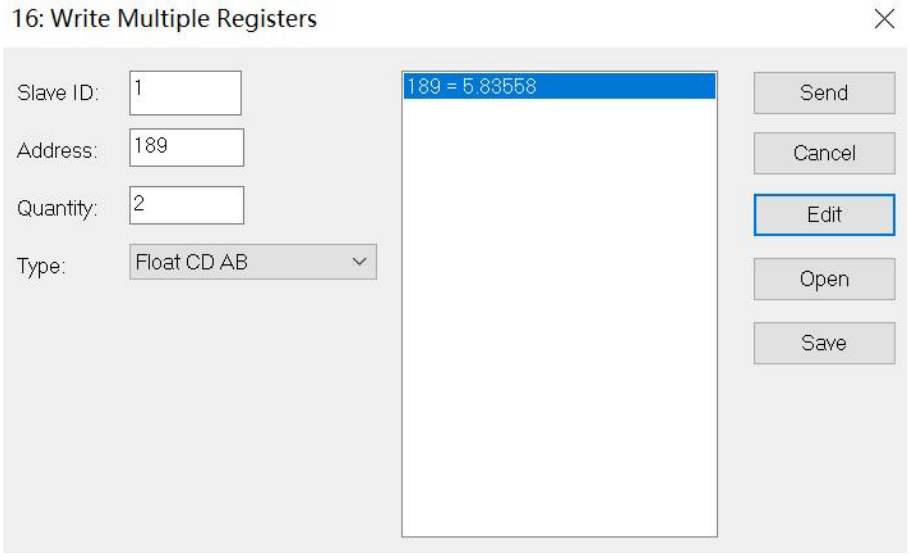
3、Refer to step 3 in 5.1, set the calibration method to factor, and the factor value is 1；

4、Slowly immerse the sensor in standard solution of known concentration to ensure the level of the measuring light path；

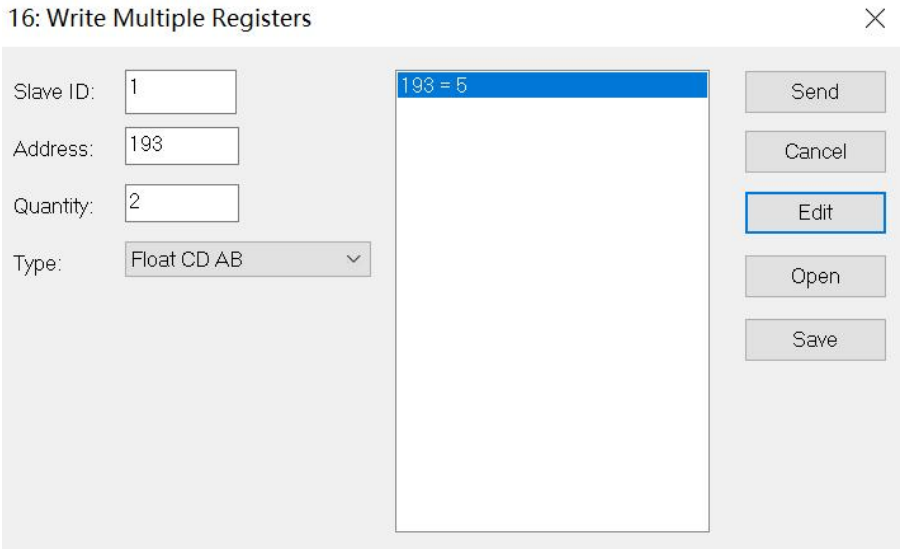
5、 Select “06” in the menu bar and enter “188” for Address and “0” for Value (standard solution calibration mode), and click “Send”；



6、Wait for the value to stabilize, and record the stable UV value; select “16” in the menu bar to enter “189” (standard solution calibration 1 UV value address) for Address in the dialog box, “2” for Quantity, and change type into “Float CD AB”, Double-click the up on the right to enter standard solution calibration 1 stable value UV value for the value.



7、 Select “16” in the menu bar to enter “193” (standard solution calibration 1 concentration address)for Address in the dialog box, “2” for Quantity, and change type into “Float CD AB”. Double-click the up on the right to enter standard solution calibration 1 actual concentration value for the value.



8、The final result is shown in the figure below

	Alias	00189
189	standard solution calibration1 UV254 value	5.83558
190		--
191	standard solution calibration2 UV254 value	32
192		--
193	standard solution calibration1 concentration	5
194		--
195	standard solution calibration2 concentration	32
196		

9、Take out the sensor, wash the sensor and wipe dry, slowly immerse the sensor in the second standard solution of known concentration to ensure the level of the measuring light path

10、The operation of standard solution calibration 2 is similar to that of standard solution calibration 1. From steps 6 to 7, input “191” for standard solution calibration 2 UV value address, Value input standard solution calibration 2 stable value UV value; standard solution calibration 2 concentration address input “195”, Value input standard solution calibration 2 actual concentration value. The standard solution calibration has been completed.

5.5 Preparation of standard solution

NO3-N standard stock solution (100mg/L):

Weigh 0.8502g of nitrate of potash (reference reagent) for two hours in a 100mL beaker, add 50mL of deionized water, mix until the powder is completely dissolved, transfer it to a 1000mL volumetric flask, and dilute to the scale with deionized water. Shake it and store it. (The solution has a NO_3-N value of 100 mg/L)

Preparation of NO_3-N solutions:

1、5mg/L: Measure 50mL of prepared NO3-N stock solution. Transfer to a 1000 mL volumetric flask, dilute to the mark with deionized water and shake it.

2、10mg/L: Measure 100mL of prepared NO3-N stock solution. Transfer to a 1000 mL volumetric flask, dilute to the mark with deionized water and shake it.

3、20mg/L: Measure 200mL of prepared NO3-N stock solution. Transfer to a 1000 mL volumetric flask, dilute to the mark with deionized water and shake it.

4、40mg/L: Measure 400mL of prepared NO3-N stock solution. Transfer to a 1000 mL volumetric flask, dilute to the mark with deionized water and shake it.

Chapter 6 Communication Protocol

The sensor embraces MODBUS RS485 communication function which communicates in RTU mode. The specific MODBUS-RTU table is shown in the following table.

MODBUS-RTU	
Baud Rate	19200
Data Bits	8 Bits
Odd-even Check	None
Stop Bit	1 Bit
Function Code	03、06、16

Register Name	**Address**	**Date Type**	**Register Number**	**Read/ Write**	**Instruction**
03 Function Code					
NOx-N	0	Float	2	R	Nitrate Value
UV Value	6	Float	2	R	UV Value
Main measuring	8	signed	1	R	0:“mg/L”

Value Unit					2:“PPM”
06 Function Code					
Modify NOx-N Value Unit	8	signed	1	W/R	0: “mg/L” 2: “PPM”
Modify the measurement cycle	10	signed	1	W/R	Measurement Cycle (Unit: Second) The shortest 15s 15 times (default 30 seconds)
Modify the wiper cleaning cycle	16	signed	1	W/R	4096: Scratch once before measurement (default)Other: wiper cycle (unit: minute) Minimum 1 minute, maximum 720 minutes
Zero Point Calibration	90	signed	1	W/R	0X3E:62 Zero point calibration menu | 0X19:25 Preparation | 0X12:18 Ready | 0X3D:61 Calibration Status | 0X55:85 Wipe | 0X3D:61 Calibration Status | 0X13:19 Wait Steady | 0X2A:42 End of calibration | 0X34:52 Return to main value

Remove wiper	90	signed	1	W/R	0X21:33 Remove calibration menu | 0X19:25 maintain | 0X52:82 Remove to wipe
Restore wiper	90	signed	1	W/R	0X43:67 Return to maintenance | 0X28:40 Maintenance steps | 0X34:52 Return to main value
Nitrate Measurement Pattern	188	signed	1	W/R	0: Nitrate standard curve 1: Nitrate sample curve
Modify Baud Rate	61961	signed	1	W/R	0:4800bps 1:9600bps 2:19200bps 3:38400bps 4:57600bps
Modify Slave Address	61967	signed	1	W/R	Slave Address Min Address:1 Max Address: 255
16 Function Code					
Factor	184	Float	2	W/R	Range of Factor: 0.1~10
Deviation Value	186	Float	2	W/R	Range: 2mm Optical Path：±32mg/L
standard solution calibration 1[1/m]	189	float	2	W/R	UV Value

standard solution calibration 2[1/m]	191	float	2	W/R	UV Value
standard solution calibration 1[mg/l]	193	Float	2	W/R	Range: 2mm Optical Path：0~40mg/L
standard solution calibration 2[mg/l]	195	Float	2	W/R	Range: 2mm Optical Path：0~40mg/L
sample calibration [1/m]	199	Float	2	W/R	UV Value
sample calibration [mg/l]	203	float	2	W/R	Range: 2mm Optical Path：0~40mg/L

485 analysis：

1、Read the Nitrate value

Register Name	Address	Date Type	Register Number	Read/Write	Instruction
NOx-N	0	Float	2	R	Nitrate Value

Send the command：01 03 00 00 00 02 C4 0B

The equipment return：01 03 04 00 00 40 E0 CA 7B

Send command parsing：

01：device address 01

03：Function code 03 for reading register content

00 00：The starting register address read is 0000

00 02：Read 2 registers

C4 0B：CRC16 check code

The device returns the analysis:

01：device address 01

03：Function code 03 for reading register content

04：The length of the returned data is 4 bytes

00 00 40 E0：The Nitrate value read is 7.00 (analyze 40 E0 00 00 using IEEE 754)

CA 7B：CRC16 check code

2、Read the main measuring value unit

Register Name	Address	Date Type	Register Number	Read/Write	Instruction
Main measuring Value Unit	8	signed	1	R	0:“mg/L” 2:“PPM”

Send the command：01 03 00 08 00 01 05 C8

The equipment return：01 03 02 00 0A B8 44

Send command parsing：

01：device address 01

03：Function code 03 for reading register content

00 08：The starting register address read is 0008

00 01：Read 1 registers

05 C8：CRC16 check code

The device returns the analysis：

01：device address 01

03：Function code 03 for reading register content

02：The length of the returned data is 2 bytes

00 0A：The main measuring value unit read is 10

B8 44：CRC16 check code

3、Modify the measurement cycle

Register Name	Address	Date Type	Register Number	Read/Write	Instruction
Modify the measurement cycle	10	signed	1	W/R	Measurement cycle (Unit: Second) The shortest 15s 15 times (default 30 seconds)

Send the command： 01 06 00 0A 00 0F E9 CC

The equipment return：01 06 00 0A 00 0F E9 CC

Send command parsing：

01：device address 01

06：Function code 06 for writing register content

00 0A：The register address of write data is 0010

00 0F：Write data content of 0015

E9 CC：CRC16 check code

The device returns the analysis：

01：device address 01

06：Function code 06 for reading register content

00 0A：The register address of the return write data is 0010

00 0F：Returns modified data content of 0015

E9 CC：CRC16 check code

4、Set Factor Value

Register Name	Address	Date Type	Register Number	Read/Write	Instruction
Factor	184	Float	2	W/R	Range of Factor: 0.1~10

Send the command：01 10 00 B8 00 02 04 00 00 3F 80 E9 2D

The equipment return：01 10 00 B8 00 02 C1 ED

Send command parsing：

01：device address 01

10：Function code 16 for writing register content

00 B8：The starting register address write is 0184

00 02：Write 2 registers

04：The length data is 4 bytes

00 00 3F 80：The factor value write is 1.00 (analyze 3F 80 00 00 using IEEE 754)

E9 2D：CRC16 check code

The device returns the analysis：

01：device address 01

10：Function code 16 for writing register content

00 B8：The starting register address of the return write data is 0184

00 02：Returns 2 registers

C1 ED：CRC16 check code

Chapter 7 Maintenance

In order to obtain the best measurement results, it is very necessary to maintain the sensor regularly. Maintenance mainly includes cleaning, inspecting damage of the sensor. You can also view the sensor's

status during maintenance and inspection.

7.1 Sensor Cleaning

In the measurement path of the sensor, the cleanliness of the two measurement windows is critical to the accuracy of the measurement. The measurement window should be checked if it is contaminated once a week, and the wiper should also be checked once a week to see if is damaged. **The maintenance schedule is shown in the following table:**

Job Duties	**Frequency**
Visual Check	Once per week
Checking Calibration	Conduct a comparative measurement once a week (depending on the measurement environment)
Replacement of Wiper Blade	Depend on the actual situation.

Caution: Damage to the sealing structure of the probe will cause water to enter the inside of the probe, which will seriously damage to the equipment, therefore, it should be taken care of during application.

7.2 Inspection on the Damage of Sensor

Check the appearance of the sensor to see if it is damaged, and if the probe is sealed; if there is any damage, please contact the after-sales service center for replacement to prevent the damage to the sensor from dipping into the water.

7.3 Remove Wiper

Note：Removing the wiper is a combined command，Under the same 485 address，continuous input of different values，make sure you enter it correctly.

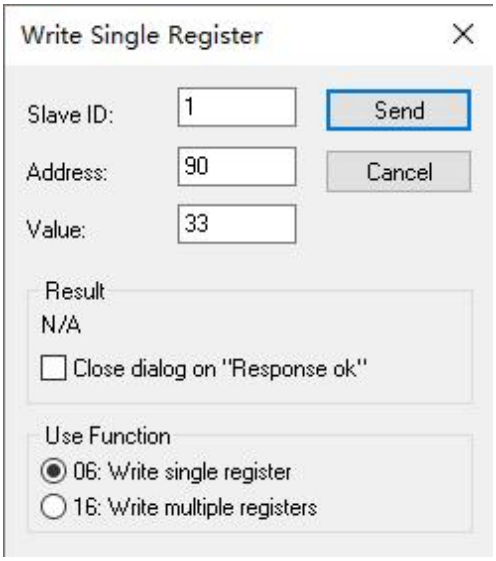
1、Connect the sensor to the Modbus software;

2、select “06” in the menu bar and enter “90” for Address in the dialog box, and the following operations keep Address: “90” unchanged.

（1）Enter “33” in Value and click “Send”;

（2）Enter “25” in Value and click “Send”;

（3）Enter “82” in Value and click “Send”.



7.4 Restore wiper

Note：Restore the wiper is a combined command，Under the same 485 address，continuous input of different values，make sure you enter it correctly. In addition, power off and restart, the instrument will automatically restore the wiper.

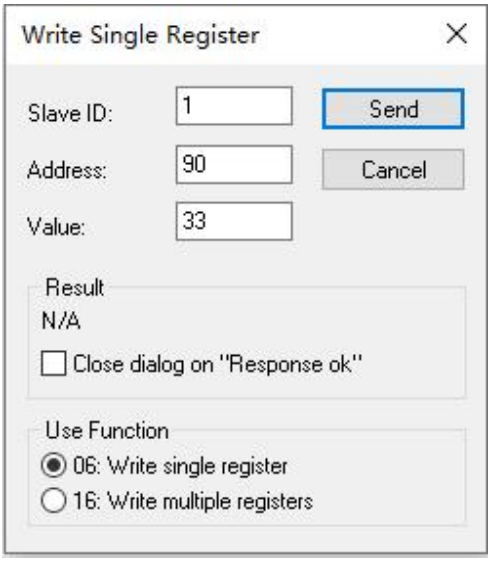
1、Connect the sensor to the Modbus software;

2、select “06” in the menu bar and enter “90” for Address in the dialog box, and the following operations keep Address: “90” unchanged.

（1）Enter “67” in Value and click “Send”;

（2）Enter “40” in Value and click “Send”;

（3）Enter “52” in Value and click “Send”.



7.5 Manual Cleaning

The sensor needs to use a cleaning sheet, dust-free cloth and a cleaning agent to clean the mirror surface.

Note: The cleaning agent needs to be purchased separately.

Chapter 8 Special Description

The self-cleaning wiper is driven by the motor. Do not manually turn it to avoid damage to the internal motor gear. The malfunction/damage caused by turning the wiper manually is not covered by the warranty!