# Multi-elements Integrated Weather Station Sensors

User’s Manual V.052


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# Product Introduction

BGT-AWS Multi-elements Integrated Weather Station is an integrated sensor for the measurement of CO2, PM2.5, PM10, PM100 (TSP), illumination, noise, temperature, humidity, air pressure, wind speed, wind direction and other environmental factors.

The Multi-Plate Radiation Shield protects temperature,relative humidity,barometric pressure and other factor sensors from error-producing solar radiation and precipitation. This shield relies on a combination of plate geometry, material and natural ventilation to provide effective shielding. The radiation shield reflect sunlight from any direction, prevent sun direct radiation and reflection on the ground to the sensor radiation, to protect the instrument from the effects of strong winds, rain, snow, etc.Freely through the air, making instrument work in ventilated environment, to ensure the accuracy of measured data.Products with high reflectivity and low thermal conductivity, resistance to ultraviolet ray function, can be used in extreme weather conditions.

# Features

1. High degree of integration: all sensors are integrated into one, and only a few screws are needed to fix them, which is very convenient to install.
2. Simple and beautiful appearance: this type of sensor is designed as an integral part, with only one signal line, simple and convenient wiring, and simple and beautiful appearance of the whole equipment.
3. Any combination of sensors: customers can choose various sensors according to their actual needs and combine them into two or three elements or other elements, such as a sensor integrating temperature and humidity, a sensor integrating temperature, humidity and light illumination, a sensor integrating temperature, humidity, wind speed and direction, etc.
4. Good material quality: ultraviolet and aging resistant materials are added to plastic discs in shelters. Besides, their unique structural design makes them have high reflectance, low thermal conductivity and ultraviolet resistance, and they can be used in extreme weather conditions.

## Element Options and Technical Parameters

| Element | Measuring Range | Accuracy | Resolution | Power Consumption |
|---|---|---|---|---|
| □ Wind speed direction | □0-45m/s（Analog）<br>□0-70m/s（Digital）<br>Direction：0-359° | Speed：<br>±(0.3+0.03V)m/s<br>Direction：±3° | Speed：0.1m/s<br>Direction：1° | 0.1W |
| ☐ Illuminance | □ 0-200000Lux(Outdoor)<br>□ 0~65535Lux（indoor) | ±4% | 1 Lux | 0.1mW<br>0.1mW |
| □ CO2 | 0~5000ppm | ±(50ppm+5%) | 1ppm | 100mW |
| □ PM2.5/10 | 0-500μg/m3 | ±30μg/m3±20% | 1μg/m3 | 0.5W |
| □ PM100 | 0-20000μg/m3 | ±30μg/m3±20% | 1μg/m3 | 0.4W |
| ☐ Temperature | -20~50℃ (Analog) | ☐ ±0.3℃ | 0.1℃ | 1mW |
| | -40~100℃（Digital） | | | |
| □ Humidity | 0~100%RH | □ ±3%RH | 0.1%RH | |
| □ Pressure | 300~1100hPa | ±1 hPa（25℃） | 0.1 hPa | 0.1mW |
| □ Noise | 30~130dB(A) | ±3dB(A) | 0.1 dB(A) | 100mW |
| Total power consumption of sensor = multi-element power consumption + basic power consumption of main board | | | Main Board | 200mW |

| | | |
|---|---|---|
| Radiation shield | □ 7 plates □ 10 plates | **Note:** PM2.5/PM10,CO2 Sensor should Choose 10 plates |
| Bracket Type | □ Bend（Default） □ U type flange | □ other |
| Power Supply | □ DC5V □ DC9-30V | □ other |
| Output | □ 4-20mA □ 0-20mA □ 0-5V □ 0-2.5V □ 1-5V | |
| | **Note:** when output is voltage/current analog signal, Max 4 elements sensors can be integrated in solar radiation shield . | |
| | □ RS485（Modbus-RTU） □ RS232（Modbus-RTU） | |

| | | | |
|---|---|---|---|
| Cable Length | □ 2M (Standard) | □ Other | |
| Load capacity | 500Ω（12VDC Power Supply） | Ingress protection | IP54 |
| Working Environment | -40℃~+75℃，-20℃~+55℃（PM Sensor） | | |

## Wire Connection Methods

| Color | Signal Output | |
|---|---|---|
| | RS485 (Digital Output) | Current/Voltage (Analog Output) |
| Red | VCC + | VCC + |
| Green | GND - | GND - |
| Black | 485-A | Sigal1: Temperature or Reference label |
| Yellow | 485-B | Sigal2: Humidity or Reference label |
| White | | Sigal3 Reference label |
| Brown | | Sigal4 Reference label |

**Note：** Communication can only be established by wiring in the correct way,when the sensor is multi-channel ((Max 4) analog signal output , refer to the cable label definition or consult the company

## Analog Output Formula

| Current: | |
|---|---|
| 4-20mA | Formula: F = (I-4) / 16 * A + B |
| 0-20mA | Formula: F = (I-4) / 20 * A + B |
| Voltage: | |
| 0-2.5V | Formula: F = V / 2.5 * A + B |
| 0-5V | Formula: F = V / 5 * A + B |
| 1-5V | Formula: F =（V-1）/ 4 * A + B |

**Note**: F in the table is the value of the sensor, and I and V are the current and voltage detected on the signal line respectively.

A is the range width of the sensor, which is equal to the upper limit of the sensor minus the lower limit (positive or negative). For example, if the temperature is -20~50℃, A=70.

B is the lower limit of the sensor, which can be positive or negative, such as the lower limit of temperature (range -20~50℃) -20.Such as humidity (range 0~100%RH).

Example: the customer bought 4-20 mA temperature and humidity sensors. Detection current on signal line 1 is I=8mA, detection current on signal line 2 is 15 mA.

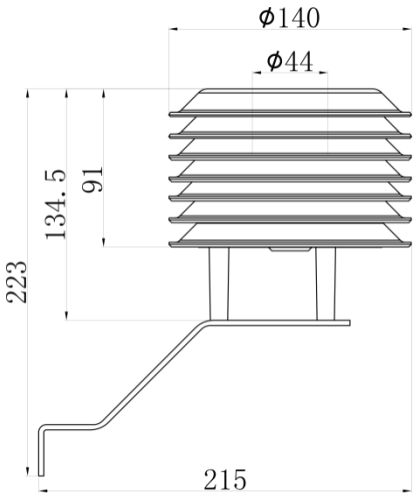
(1) Temperature range A = 70, lower limit B = -20.

Then the calculated temperature F=(i-4)/16*A+B= (8-4)/16* 70+ (-20) = -2.5℃

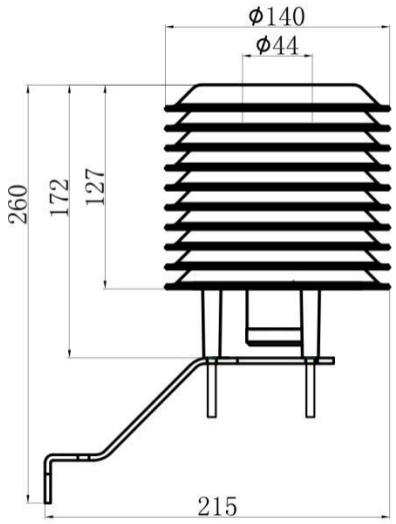
(2) humidity range A=100, humidity lower limit B=0.

Then the calculated humidity value F=(i-4)/16*A+B= (15-4)/16* 100+0 = 68.7%RH

## Product and Installation Accessories Dimension

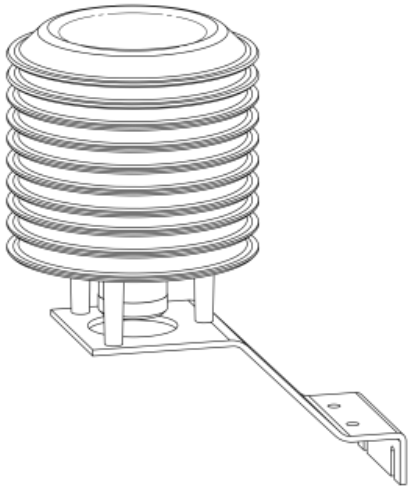


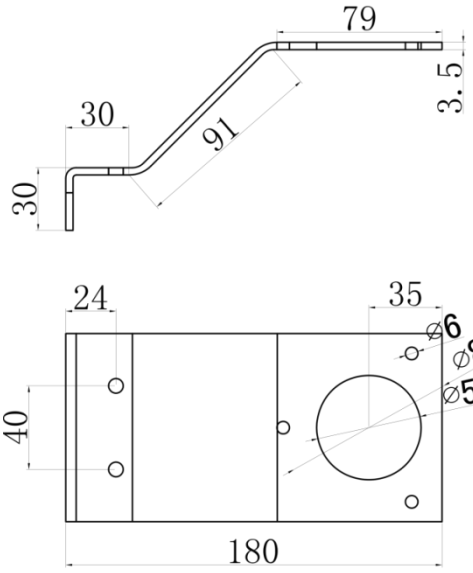

7 plates Solar Radiation

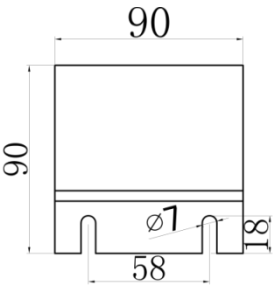



10 plates Solar Radiation Shield

1. Type 1：Solar Radiation Shield with sensors + Bend type bracket (Default).

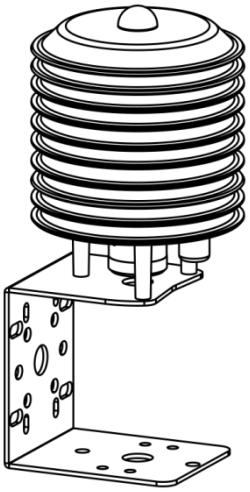




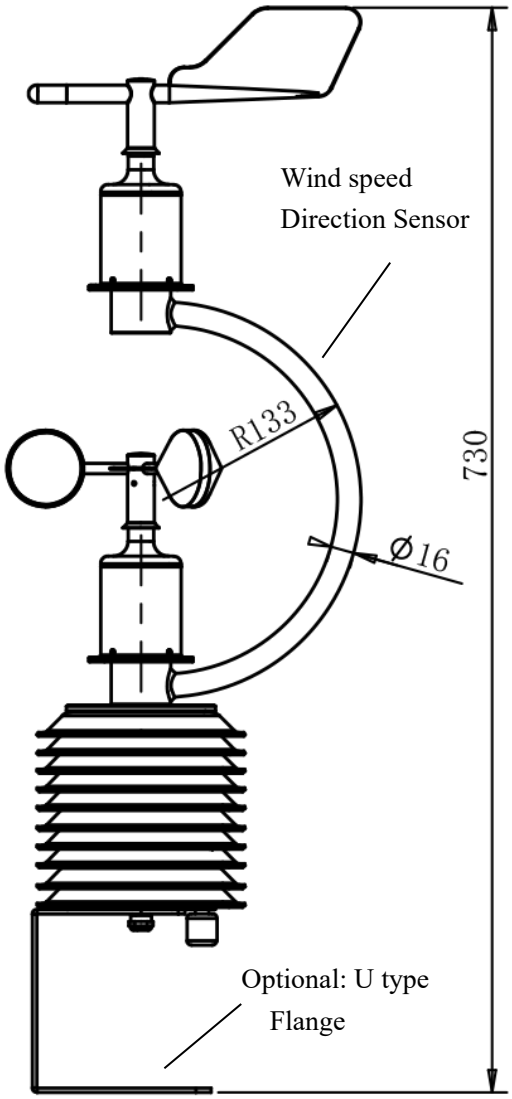



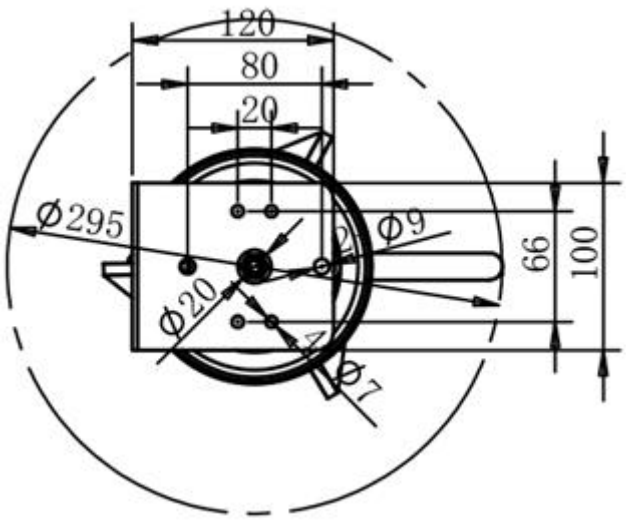

Bracket Size

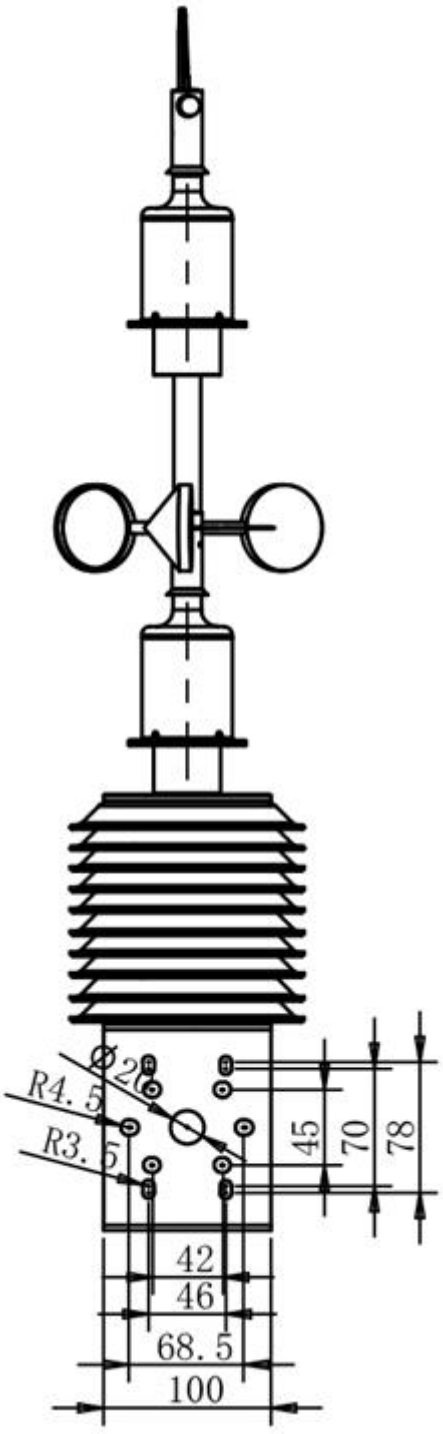
2. Solar Radiation Shield with sensors + U type bracket (Optional).



Type3. Wind speed direction sensor + Solar radiation shield with sensors + U type Flange (Note:if this configuration has an illumination sensor, the illumination should be fixed separately.)




U Type Flange Dimension

## Solar Radiation Shield Dimension

| Plates | Inner diameter (mm) | Out diameter (mm) | Inner height (mm) | O(mm) |
|---|---|---|---|---|
| 7 | 44 | 140 | 60.5 | 134.5 |
| 10 | 44 | 140 | 98 | 172 |
| N（N＞3） | 44 | 140 | 12.5*N-27 | 12.5*N+47 |

## Communication Protocol RS485 Modbus

Communication type is RS485 bus communication, with standard MODBUS-RTU Protocol.

Baud Rate: 9600

Data bit: 8

Stop bit: 1

Check bit: No

Two communication intervals of at least 500ms, default address: 1

Communication Format

| Send | Address | Command | Register address | Data | Check |
|---|---|---|---|---|---|
| number of bytes | 1byte | 1 byte | 2 byte | N byte | 2 byte |

## （1）Register address

| | | Data description |
|---|---|---|
| 0x0000 | Channel 1(digital Temperature)<br>Signed(-40~100℃) | 0x7FFF (Invalid/not connected)<br>0x01 0x2C=30.0℃ |

| | | |
|---|---|---|
| 0x0001 | Channel 2（digital humidity）<br>Signed (0~100%RH) | 0x7FFF (Invalid/not connected)<br>0x02 0x8D=65.3%RH |
| 0x0002 | Channel 3 (outdoor illumination）<br>Signed (0-20000) | 0x7FFF (Invalid/not connected)<br>unit10 Lux<br>0x01 0xF4=5000 Lux |
| 0x0003 | Channel 4 (outdoor or indoor illumination single digits)<br>Signed 0-9 Lux | 0x7FFF (Invalid/not connected)<br>0x00 0x09=9 Lux |
| 0x0004 | Channel 5（indoor illumination）<br>Signed （0~6553） | 0x7FFF (Invalid/not connected)<br>unit 10 Lux<br>0x0B 0xCD=30210 Lux |
| 0x0005 | Channel 6（CO2）<br>Signed（0~5000ppm） | 0x7FFF (Invalid/not connected)<br>0x04 0x00=1024ppm |
| 0x0006 | Channel 7（atmosphere pressure ）<br>Signed（300~1100hPa） | 0x7FFF (Invalid/not connected)<br>0x25 0xF4=971.6 hPa |
| 0x0007 | Channel 8（noise）<br>Signed（30~130dB(A)） | 0x7FFF (Invalid/not connected)<br>0x02 0x1C=54.0 dB(A) |
| 0x0008 | Channel 9（PM2.5）<br>Signed0-500μg/m3 | 0x7FFF (Invalid/not connected)<br>0x01 0xF4=500 μg/m3 |
| 0x0009 | Channel 10（PM10）<br>Signed 0-500μg/m3 | 0x7FFF (Invalid/not connected)<br>0x01 0xF4=500 μg/m3 |
| 0x000A | Channel 11（PM100）<br>Signed 0-20000μg/m3 | 0x7FFF (Invalid/not connected)<br>0x01 0xF4 =500 μg/m3 |
| 0x000B | Channel 12（wind speed）<br>Signed 0-45.0m/s | 0x00 0x09=9m/s |
| 0x000C | Channel 13（wind direction）<br>Signed 0-359° | 0x7FFF (Invalid/not connected)<br>0x00 0x09=9° |
| 0x000D | Channel 14（Analog Temperature）<br>Signed（-20~50℃） | 0x7FFF (Invalid/not connected)<br>0x00 0xFA=25.0℃ |

## （2）Configuration Address and Baud Rate

The write device address command for all sensors is the same; Eg. write address 01

| Send | 00 | 06 | 00 | 20 | 00 | 01 | 48 | 11 |
|---|---|---|---|---|---|---|---|---|
| Description | Broadcast Address | Write command | register | | New device address | | CRC check | |
| Return | 00 | 06 | 00 | 20 | 00 | 01 | 48 | 11 |
| Description | Broadcast Address | Return 0x86 =unsuccessful | Register | | New device address | | CRC check | |

When return and send command is same, it's mean configuration successful. Return 01 86 ****it indicates that the configuration was not successful.

The write device baud rate command for all sensors is the same; Eg. write baud rate 9600

| Send | 01 | 06 | 00 | 10 | 00 | 02 | 09 | CE |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Write command | register | | New device baud rate | | CRC check | |
| Return | 01 | 06 | 00 | 10 | 00 | 02 | 09 | CE |
| Description | Address | Return 0x86 =unsuccessful | Register | | New device baud rate | | CRC check | |

Baud rate = data*4800. Return data 00 02, then baud rate =4800*2=9600. Support baud rate: 4800, 9600, 14400, 19200, 38400, 57600, 115200.

When return and send command is same, it's mean configuration successful. Return 01 86 ****it indicates that the configuration was not successful.

## （3）Get Sensor Data

Multi-elements weather station can integrate up to 13 different sensors, and the real-time value of each sensor can be obtained by reading the address value of Modbus register.One or more register values can be read at a time, such as send 01 03 00 00 00 01 84 0A, reading only the temperature value of the digital temperature sensor. For example, send 01, 03, 00, 00, 00, 02, C40B, and read the value of two registers from register 0-1, including the sensor value of digital temperature and digital humidity.

Conversion of sensor negative values (inverse binary plus 1): For example, the temperature hexadecimal code is "FF 3D", translated into binary as "1111111100111101", its binary first digit is "1", so its value is negative, if the first digit is "0", then it is positive.The specific conversion steps are as follows

(1) Replace the first digit of its binary with "0" to get: "01111111 00111101"

(2) After the reverse of the last 15 bits, we get: "00000000 11000010"

(3) Add "1" and you get: "00000000 11000011"

According to the positive number representation method, the decimal value "195" is obtained, because it is negative, it is "-195", the temperature takes 1 decimal point, the result is divided by 10, the final result is "-19.5", so: FF 3D → -19.5℃.

The following is a description of the commands commonly read by sensors.The device address of all sensors is default 1.

（1）Digital temperature sensor

Digital temperature to read register 0 data.The reading format of sensor device address 1 is as follows:

| Send | 01 | 03 | 00 | 00 | 00 | 01 | 84 | 0A |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 00 | 26 | 39 | 9E |
| Description | Description | Address | Read Command | | Data length | | Sensor data | |

Sensor returns data 0x0026 converted to decimal 38 add 1 decimal point, and the temperature value is 3.8℃.

(2)Analog temperature sensor (including air temperature and soil temperature sensor)

Analog temperature reads the register address 0x0D

| Send | 01 | 03 | 00 | 0D | 00 | 01 | 15 | C9 |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 00 | 26 | 39 | 9E |
| Description | Description | Address | Read Command | | Data length | | Sensor data | |

Sensor returns data 0x0026 converted to decimal 38 add 1 decimal point, and the temperature value is 3.8℃.

(3). Atmospheric humidity sensor

Atmospheric humidity value needs to read register address 1

| Send | 01 | 03 | 00 | 01 | 00 | 01 | D5 | CA |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 25 | F4 | A3 | 53 |
| Description | Description | Address | Read Command | | Data length | | Sensor data | |

Sensor returns data 0x028D converted to decimal 653 add 1 decimal point, atmospheric humidity value is 65.3%RH.

(4). Atmospheric temperature humidity

Atmospheric temperature humidity value needs to read register address 0 and 1

| Send | 01 | 03 | 00 | 00 | 00 | | 02 | | C4 | 0B |
|---|---|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | | | CRC Check | |
| Return | 01 | 03 | 04 | | 01 | 2C | 02 | 8D | FB | 03 |
| Description | Address | Read Command | Data length | | Digital temperature | | Digital humidity | | CRC Check | |

Sensor returns register 0 and 1 with data of 0x012C and 0x028D, and converts them into decimal digits of 300 and 653 respectively, add 1 decimal point, indicating that the temperature value is 30.0℃ and the humidity value is 65.3%RH respectively

(5). Indoor illumination sensor

The illuminance sensor is divided into two types according to its range: one indoor illuminance sensor has a range of 0-65535 Lux.

Indoor illumination value reads register 3, 4 data.The data in register 4 is 10 times the illumination value, and register 3 contains the remaining bits of illumination.

| Send | 01 | 03 | 00 | 04 | 00 | 01 | C5 | CB |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 0B | CD | 7E | E1 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x0BCD converted to decimal 3021 and illuminance 30210 Lux.

(6). Outdoor illumination sensor

The range of outdoor illumination is 0-200000Lx, and the outdoor illumination value reads the data in registers 2 and 3.The data in register 2 is 10 times the value of outdoor illumination, and register 3 contains the remaining unit values of outdoor illumination.

| Send | 01 | 03 | 00 | 02 | 00 | | 02 | | 65 | CB |
|---|---|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Comman | Start Address | | Read decimal point value | | | | CRC Check | |
| Return | 01 | 03 | 04 | | 01 | F4 | 00 | 09 | 7A | 3B |
| Description | Address | Read Comman | Data length | | 10 times the illumination | | Single digit of illumination | | CRC Check | |

Sensor returns data 0x01F4 and 0x0009, and when converted to decimal 500 and 9, the outdoor illumination value =500*10+9=5009 Lux.

(7). CO2 Sensor

The CO2 value needs to read register address 5.

| Send | 01 | 03 | 00 | 05 | 00 | 01 | 94 | 0B |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 04 | 00 | BA | 84 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x0400 converted to decimal 1024, CO2 value of 1024ppm.

(8).Atmospheric pressure sensor

Atmospheric pressure value needs to read register address 6

| Send | 01 | 03 | 00 | 06 | 00 | 01 | 64 | 0B |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 25 | F4 | A3 | 53 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x25F4 converted to decimal 9716 and add 1 decimal point, atmospheric pressure 971.6hPa.

(9). Noise sensor

Noise value needs to read register address 7

| Send | 01 | 03 | 00 | 07 | 00 | 01 | 35 | CB |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 02 | 1C | B8 | ED |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x021C converted to decimal 540 and add 1 decimal point, noise value 54.0dB(A).

(10). PM2.5 sensor

PM2.5 Value needs to read register address 8.

| Send | 01 | 03 | 00 | 08 | 00 | 01 | 05 | C8 |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |

| Return | 01 | 03 | 02 | 01 | F4 | B8 | 53 |
|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Data length | Sensor data | | CRC Check | |

Sensor returns data 0x01F4 converted to decimal 500, PM2.5 concentration 500 g/m3.

(11).PM10 sensor

PM10 Value needs to read register address 9

| Send | 01 | 03 | 00 | 09 | 00 | 01 | 54 | 08 |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 01 | F4 | B8 | 53 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x01F4 converted to decimal 500, PM10 concentration 500 g/m3.

(12). PM100 Sensor

PM100 Value needs to read register address 0x0A.

| Send | 01 | 03 | 00 | 0A | 00 | 01 | A4 | 08 |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 01 | F4 | B8 | 53 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x01F4 converted to decimal 500, PM100 concentration 500 g/m3.

(13). Wind speed sensor

Wind speed Value needs to read register address 11.

| Send | 01 | 03 | 00 | 0B | 00 | 01 | F5 | C8 |
|---|---|---|---|---|---|---|---|---|
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 00 | 1D | 78 | 4D |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data 0x001D converted to decimal 29, wind speed value is 2.9m/s.

(14). Wind direction sensor

Wind direction Value needs to read register address 12.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Send | 01 | 03 | 00 | 0C | 00 | 01 | 44 | 09 |
| Description | Address | Read Command | Start Address | | Read decimal point value | | CRC Check | |
| Return | 01 | 03 | 02 | | 00 | CD | 79 | D1 |
| Description | Address | Read Command | Data length | | Sensor data | | CRC Check | |

Sensor returns data of 0x00CD converted to decimal value of 205 , wind direction value is 205°

## ModBus CRC Check Steps

1. Preset 16-bit register hexadecimal FFFF, said the register for the CRC register;

2. The first 8-bit data and CRC register low or XOR, the result placed in the CRC register;

3. The contents of the register to the right one (toward the low),with 0 to fill the most significant bit, check the lowest bit;

4. If the least significant bit is 0: Repeat step 3 (shift again) If the least significant bit is 1: The CRC register is XOR'ed with the polynomial A001 (1010 0000 0000 0001)

5. Repeat steps 3 and 4 until 8 shifts to the right so that the entire 8-bit data is completely processed;

6. Repeat step 2 to step 5 for the next 8-bit data processing;

7. The resulting CRC register is the CRC code (the resulting CRC code is low after high).

## Installation site requirements

- ✧ Good air circulation all around
- ✧ Stay away from exhausts and motors
- ✧ Stay away from standing water, fountains, and sprinklers

## Announcements

1. Please check whether the package is in good condition, and check whether the product model is consistent with the type selection.
2. Do not connect the wire on line. After the connection is completed and checked, the power can be switched on;
3. The sensor wire length will affect the output signal of the product. Do not change the product when using it.
4. The sensor is a precision device. Please do not disassemble or touch the surface of the sensor with sharp objects or corrosive liquid to avoid damaging the product.

## Trouble shooting

1. Analog signal or RS232, RS485 output instrument display value is not correct. May not be able to get the correct data due to wiring problems or communication serial port failure. Please check the wiring is correct, solid,serial port is occupied, the serial port settings are correct;
2. If not for the above reasons, please contact the manufacturer.