YANTAI
研泰进出口
Yantai Import and Export

XF-CQ10

Visibility Meter Sensor

Agricultural Internet of Things and Smart Weather Solution Provider!
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1、Product Introduction

The Visibility Meter Sensor (XF-CQ10) is a meteorological observation device developed by Yantai to measure the visibility (meteorological optical distance) data of the ground atmosphere through optical means. The equipment can monitor the visibility conditions in the installation area in real time, and the visibility measurement data is widely used in transportation, aviation, navigation, military activities, air pollution and atmospheric physics research.

1.1 Working Principle

Atmospheric visibility refers to the maximum distance at which a sighted person can identify an object of a certain size from the background (sky or ground), also known as meteorological sight.

According to the altitude and relative position of the observer and the target, atmospheric visibility can be divided into horizontal visibility, strabic visibility and vertical visibility. Visibility in meteorological observations generally refers to horizontal visibility, that is, effective visibility in the horizontal direction (the so-called effective visibility refers to the maximum horizontal distance that can be seen in more than half of the surrounding field of vision). Unless otherwise specified, the visibility referred to in this manual is effective visibility in the horizontal direction as defined herein.

According to the definition of meteorological optical visual range

$$MOR = \ln(0.05)/\delta$$

where δ is the extinction coefficient.

The atmospheric extinction coefficient is mainly affected by small solid particles, aerosol particles, and other atmospheric molecules in the air. During the propagation of light, light waves are absorbed or scattered by the above-mentioned objects, resulting in the attenuation of light radiation. We calculate the attenuation coefficient of light in the atmosphere mainly using the effect of scattering, so as to derive atmospheric visibility. Atmospheric scattering

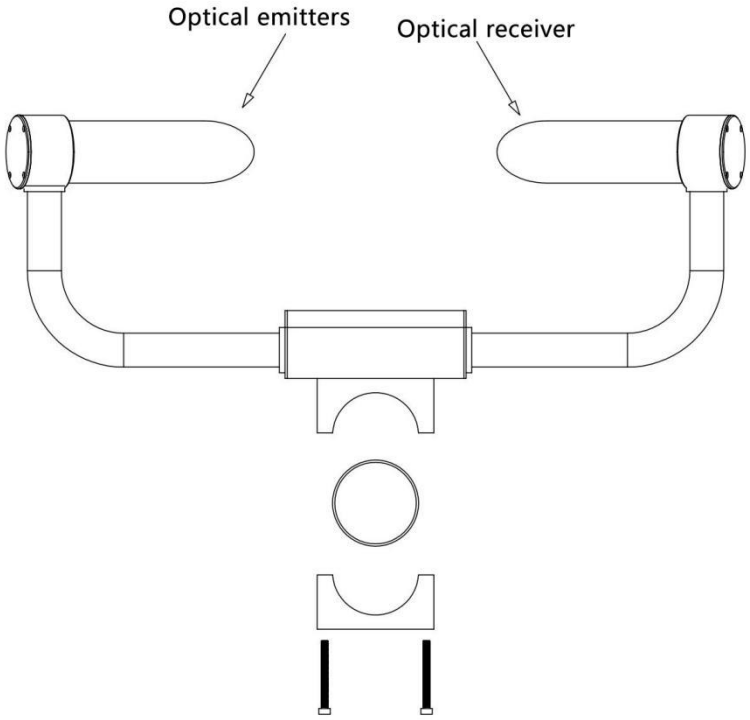
refers to the fact that when light travels in the air, due to the influence of solid small particles and aerosol particles on light, the propagation direction of light changes, and radiates to different directions with a certain regularity, and this scattering phenomenon is proportional to the radius of scattered particles in the atmosphere and the wavelength of light. According to different relationships, scattering is divided into MIE scattering and Rayleigh scattering. According to the theoretical study of MIE scattering, the influence of the absorption part of the scattered particles in the atmosphere on the light attenuation coefficient is negligible. MIE scattering is the main object of study when we study visibility measurements.

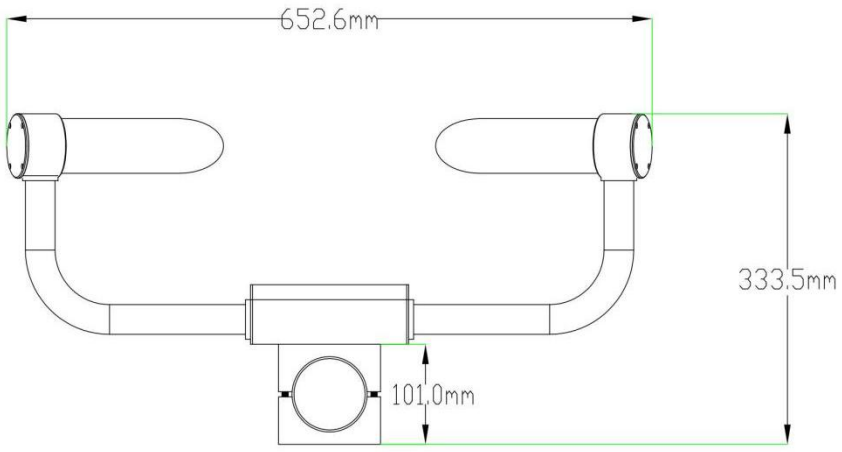
Based on the above theory, our visibility sensor chooses the forward scattering principle with a scattering angle of 35-50° and a selected center wavelength of 850 nm for the measurement spectrum.

1.2 Hardware structure

The visibility sensor is a stand-alone device that can be mounted to a suitable pole via the mounting accessories that come with the device. The equipment is basically composed of four parts: optical transmitter, optical receiver, built-in heating component and control processing unit.

1.3 Drawing





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1.4 Data

Supply	DC12V～24V
Power Consumption	Non-Heating ≤2W
Heat	≤6W
Out Put	RS48(MODBUS)
Measurement Range	10m～10km
Measurement Accuracy	≤2km ±2%; 2km～10km ±5%
Data Update Rate	15s/60s
Product weight	＜10kg

1.5 Working Environment

Operating temperature	-40℃～+60℃
Working humidity	0-100%RH
Storage temperature	-50℃～+85℃

2. Testing and installation

2.1 Cable interface definition

485 output color definitions	
Red	Power supply positive
Black	Power supply aside
Yellow	A
Blue	B

2.2 Installation location

Visibility sensors are optical measurements that are susceptible to environmental interference, and selecting a suitable, representative area for installation is critical to the

accuracy of the data. When choosing a location, you should pay attention to the following principles:

1) The condition of the selected location should be representative of the surrounding weather conditions, it should be far away from tall buildings (the distance should not be less than 100m), and there should be no plants near the installation point.

2) The selected site should be free of obstructions and reflective surfaces that affect the optical measurement, and there should be no obvious sources of contamination.

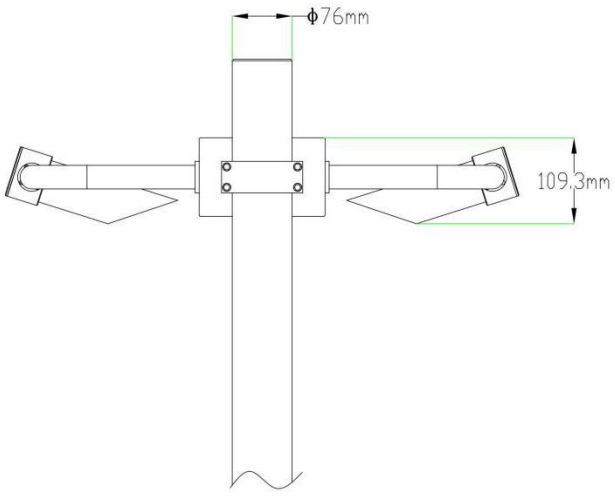
3) There are no obstacles in the line of sight of the optical transmitter and optical receiver.

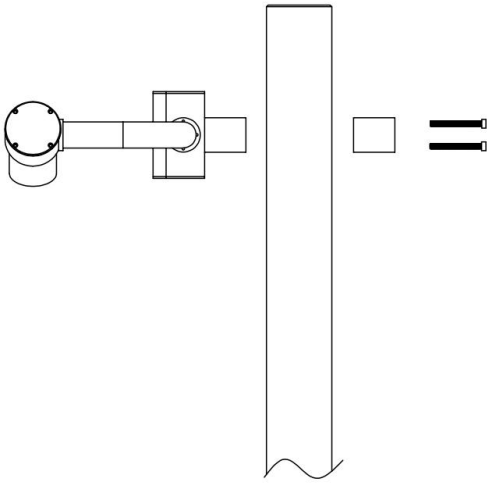
4) Installation position to avoid direct sunlight entering the receiver. In bright light, the receiver may be saturated with data, and the program will output a warning. Strong daylight also increases the noise level of the optical receiver.

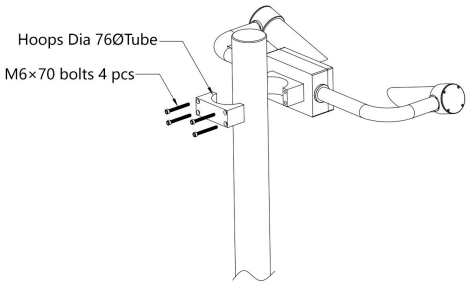
5) In the road environment, the optical receiver should be kept away from the vehicle. The preferred direction is along the road.

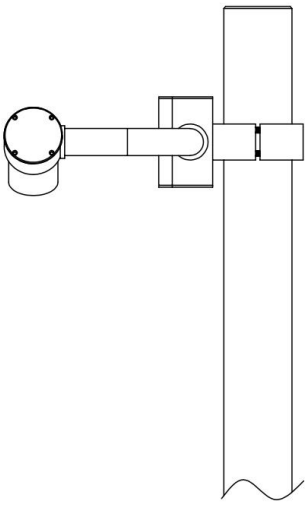
2.3 How to Installation

Installation diagram









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三、Communication Protocols

3.1 RS485 bus

Default serial port settings:

Baud rate 9600;

Verification digit: None;

data bit 8;

Stop bit 1.

3.2 MODBUS PROTOCOL

Using standard MODBUS communication protocol, a frame of complete command address bytes, command bytes, data start address bytes, data length, data, and verification.

Address: Each device can set its own address 1-255 (0x00ff), and the host computer can orient different devices through different addresses.

Command: i.e. function code, which is used in this software includes 03 (read multiple registers) and 06 (write a single register).

Data Start Address: The address of the data to be read (Note 1).

Data Length: the number of data to be read this time.

Data: Valid data, in a format with high bytes first, low bytes last.

Check: Used to determine whether there is an error in the received information, the verification method uses a 16-bit redundant cycle code (CRC16), and the verification object is all bytes except the check byte itself. The check digit uses the low byte first, and the high byte last.

The code of the verification calculation method is as follows:

```
int    CRC_Check(unsigned char *m_Data,short m_Size)
{
    int i0,i1;
    char CRC16Lo,CRC16Hi, SaveHi,SaveLo;
    CRC16Lo = 0xFF; CRC16Hi = 0XFF;
    for(i0=0; i0<m_Size; i0++)
   {
        CRC16Lo = CRC16Lo ^ *(m_Data+i0);
        for(i1=0; i1<8;i1++)
       {
            SaveHi = CRC16Hi;
            SaveLo = CRC16Lo;
            CRC16Hi >>=1;
            CRC16Lo >>=1;
```

```
if((SaveHi & 1) == 1)
                {
                        CRC16Lo |=0x80;
                }
                    if((SaveLo & 1) == 1)
            {
                        CRC16Hi ^=0XA0;
                        CRC16Lo ^=1;
                }
            }
        }
        return ( CRC16Hi << 8 )| CRC16Lo;
}
```

3.2.1、Read the sensor address command

Send：00 03 00 00 00 01 85 DB

00	03	00 00	00 01	85 DB
Reserve addresses	Feature codes	Register address	Number of registers	CRC16 check digit

Answer：00 03 02 00 FF C5 C4

00	03	02	00 FF	C5 C4
Reserve addresses	Feature codes	Number of registers	Register data	CRC16 校验位

The data segment data is 0x00FF, which means that the sensor address is 0xFF, and the current sensor address can be in the range of 0x01-0xFF, where 0xFF is the default address。

3.2.2、Modify the sensor address command（Change 0x01）

Send：00O ptical emitters

00	06	00 00	00 01	49 DB
Reserve addresses	Feature codes	Register address	New address	CRC16 check digit

Answer：00 06 00 00 00 01 49 DB

00	06	00 00	00 01	49 DB
Reserve addresses	Feature codes	Register address	New address	CRC16 check digit

The reply is the same as the sent data, indicating that the address modification is successful,

and the current sensor address is 0x01。

3.2.3、Modify sensor baud rate (changed to 9600)

Set the baud rate to 9600, please do not change it by yourself for non-professionals!

Send：00 06 01 02 00 02 A9 E6

00	06	01 02	00 02	A9 E6
Reserve addresses	Feature codes	Register address	Newport rate	CRC16 check digit

Answer：00 06 01 02 00 02 A9 E6

00	06	01 02	00 02	A9 E6
Reserve addresses	Feature codes	Register address	Newport rate	CRC16 check digit

The reply is the same as the sent data, indicating that the baud rate modification is successful and needs to be restarted to take effect.

00-06 represents 2400, 4800, 9600, 19200, 38400, 57600, and 115200 respectively

3.2.4、Read sensor data command (default address is 0xFF)

Send：FF 03 00 02 00 02 70 15

FF	03	00 02	00 02	70 15
Sensor address	Feature codes	Register address	Number of registers	CRC16 check digit

Answer：FF 03 04 00 00 15 F4 EA EB

FF	03	04	00 00 15 DC	EA EB
Sensor address	Feature codes	Number of registers	Register data	CRC16 check digit

15s visibility = 0 + 0x15F4 = 5620m.

15s visibility is 5620m.

Note：

Address	operate	content	Note
0x0002	Read	15s visibility value, direct reading, unit m.	
0x0004	Read	60s visibility value, direct reading, unit m.	

3.3 ASCII code protocol

3.3.1 Device startup

Visibility sensor output after instrument start-up:Power ON!↵

Soft Version 230101.00↵

If there is no callback, check whether the communication cable is connected correctly。

3.3.2 Baud rate setting
The default baud rate is 9600
UART ID BPS 0/1/2/3/4/5/6↵

Send:
UART 001 BPS 2↵
0-6 represents 2400, 4800, 9600, 19200, 38400, 57600, and 115200, respectively

Device Reply:
UART 001 BPS 2↵
OK↵

3.3.3 Read the address

Send:

ID ?↵

Reply:

ID 255↵

Address range: 001-255, default is 255.

3.3.4 Write address

Send:

ID 255 001↵

Reply:

ID 001↵

Change the address to 001.

3.3.5 Alarm settings

Send:

LMT1 500↵

Reply:

LMT1 500↵

Send:

LMT2 5000↵

Reply:

LMT2 5000↵

Send:

LMT SET↵

Upon success, send:

LMT OK↵

Otherwise, send:

LMT ERROR↵

LMT1 < LMT2 are required, and the user can set these two positions as the visibility change point that he is most concerned about, so that the visibility can be divided into three warning sections: > LMT2 is the normal section, LMT1-LMT2 is the warning section 1, and < LMT1 is the warning section 2.

3.3.6 Read data

DRAW ID DATA↵

Send：

DRAW 001 DATA↵ Asks for device data with device

Reply：

DATA VM 001 04500 04800 01 00↵

15s visibility is 4500m, 60s visibility is 4800m, alarm status is 1, and reserve status is 0

Alarm status 00 60s visibility > LMT2
01 LMT1 < 60s visibility < LMT2
02 60s visibility < LMT1

3.3.7 Switch to active reporting
DRAW ID DATA AUTO↵
Send:
DRAW 001 DATA AUTO↵ Asks for device data with device address 001.
Reply:
DATA VM 001 04500 04800 01 00↵
The device automatically uploads data at a frequency of once per minute.

4、 May meet problems and solutions of equipment

Phenomenon	Solution
There is no communication	Check the power supply Check the cables Check the communication configuration parameters
Data anomalies	Check that the sensor is not contaminated with foreign objects Check if there are any reflective surfaces around Check for IR-emitting devices (e.g. infrared cameras) nearby

If the fault still cannot be eliminated, please contact the manufacturer
Disassembling the equipment without permission will no longer enjoy the warranty, and legal responsibility will be investigated for infringement!