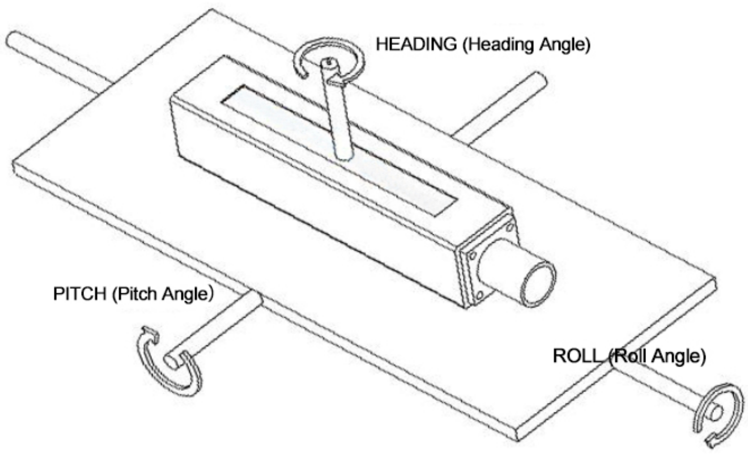
HCM365 3D Electronic Compass Sensor -Modbus RTU User Manual



1、 Product Characteristics

The HCM365 is a high-precision, all-attitude 3D electronic compass. It employs a self-developed hard and soft iron calibration algorithm, enabling it to provide high-precision heading information across a 360° roll and +/-90° tilt range. Its compact size and low power consumption make it ideal for power- and size-sensitive measurement systems.

The HCM365 outputs precise attitude data for its carrier, making it suitable for systems with full-range rotation. This product features hard magnetic, soft magnetic, and tilt compensation, providing high-precision, calibrated compass measurements. The HCM365 integrates a patented three-axis fluxgate technology, calculating heading in real-time via a central processing unit and using a three-axis accelerometer to compensate for tilt angles, ensuring accurate heading data even in extremely harsh environments. The HCM365 is compact and consumes little power, making it widely used in oil well logging, antenna pointing, vehicle navigation, attitude control systems, and many other fields.

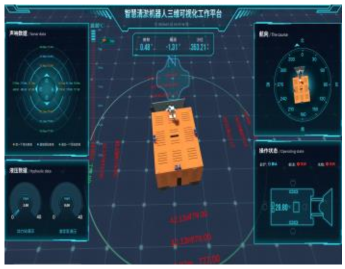
2、Product Performance

- Heading: 0-360°, all attitudes
- Accuracy: Heading 0.3-5°, Tilt 0.1°
- Operating Voltage: DC +5V (DC +9~36Vcustomizable)
- Operating Current: 40mA
- Protection Rating: IP67 (IP68 customizable)
- Features hard magnet, soft magnet, and tilt compensation
- Output: RS232/RS485/TTL/RS422 (optional)
- Wide operating temperature: -40 ~ +85℃
- Dimensions: (113*20*20mm) (customizable)

3. Product Application

- Mobile communication equipment
- Petroleum geological logging
- Underwater navigation
- Marine surveying
- Ship navigation attitude measurement
- AGV vehicle tracking
- Tilt monitoring
- Satellite solar antenna positioning
- Unmanned aerial vehicles
- GPS navigation





Product Ordering Information

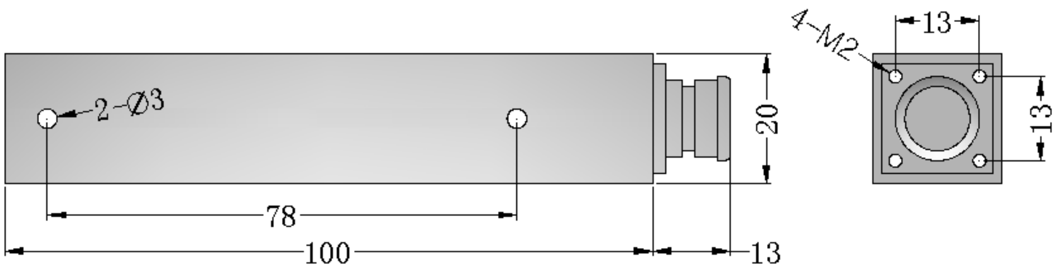
HCM36□ —— (□ □ □)

Housing encapsulation
- 5 : Standard housing package
- 0 : OEM Without encapsulation

Output interface
- 232 MB: RS232 Interface
- 485 MB: RS485 Interface
- 422 MB: RS422 Interface
- TTL MB: USART TTL
- Modbus Protocol

For example: HCM365 (RS232): Full attitude 3D/with encapsulation/RS232 output; horizontal installation (when the compass is placed horizontally, the roll and pitch angle outputs are zero degrees) is the default. It needs to be installed vertically downwards with the connector facing down (when the compass is placed vertically downwards, the roll and pitch angle outputs are zero degrees). Please make a note when ordering.

Product Dimensions



Product dimensions: L113*W20*H20MM.

Default horizontal installation: During installation, the sensor mounting surface should be parallel to the target surface. Please refer to the rotation diagram for installation instructions. For other installation methods, please refer to the "Product Installation Method" diagram and specify your requirements when ordering.

Mechanical properties

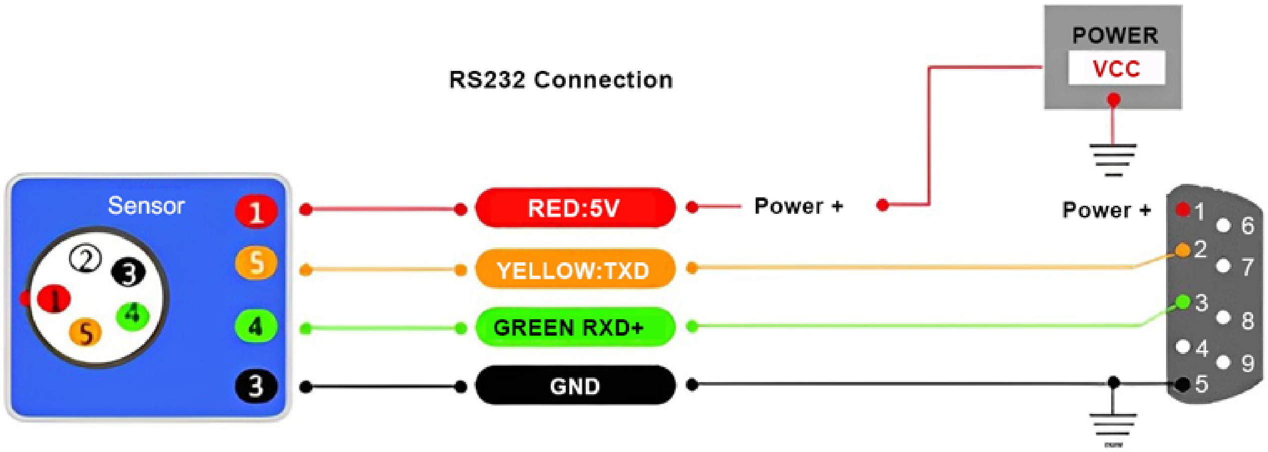
Connector	Lead cable (1.5m) or waterproof aviation socket (customizable)
Protection rating	IP67
Housing material	Aluminum alloy, brushed anodized
Mounting	Two M3 screws

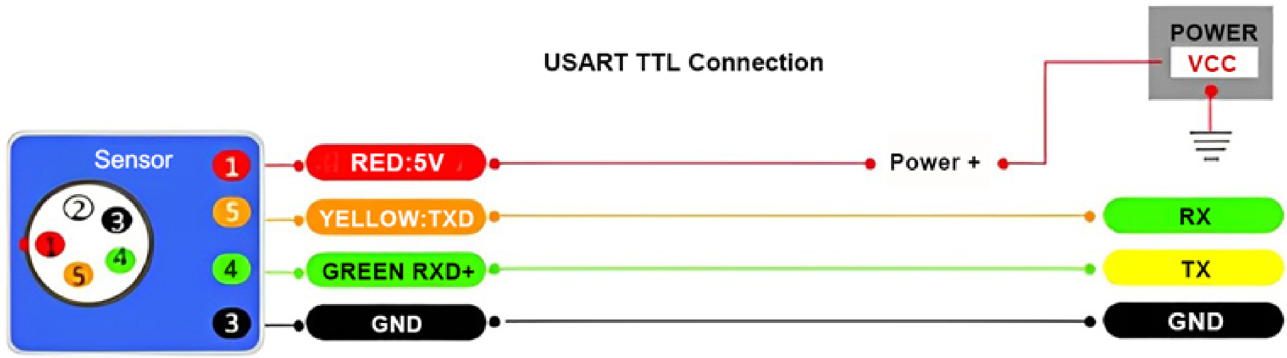
Product performance indicators

Compass heading parameters	Heading accuracy	0.3~0.5°（RMS，Pitch<85°）
	Resolution	0.1°
	Repeatability	0.05°
Compass tilt parameters	Pitch accuracy	0.1°
	Roll accuracy	0.1°（Pitch<65°）
		0.2°（Pitch<80°）
		0.5°（Pitch<86°）
	Tilt resolution	0.01°
	Tilt range	Pitch±90°；Roll 360°
Calibration	Hard iron calibration	√
	Soft iron calibration	√
	Tilt calibration	√
Physical characteristics	Dimension	L113 x W20 x H20 (mm)
	Weight	110g
	RS-232/RS485 interface connector	5 pin aviation plug
Interface characteristics	Startup delay	<50ms
	Maximum sampling rate	50 times/second
	RS-232 communication rate	2400~19200 baud rate
	RS-485 communication	Optional
	TTL communication	Optional
	Output format	Hexadecimal
Power supply	Supported voltage	DC+5V(9~36V)
	Maximum current	40mA
	Operating mode	30mA
Environment	Storage range	-40℃--+125℃
	Operating temperature	-40℃--+85℃
	Vibration resistance	3000g

Electrical Connection

Line color / function — Output interface	RED	WHITE	BLACK	GREEN	YELLOW
	1	2	3	4	5
RS232	VCC	NC	GND	RXD	TXD
RS485	VCC	NC	GND	(B、D-)	(A、D+)
TTL	VCC	NC	GND	RXD	TXD



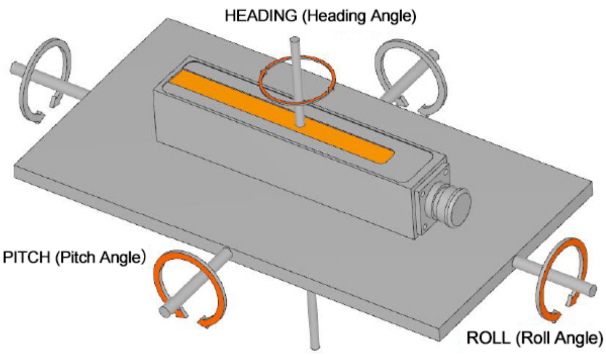


Electrical Connection

Line color / function — Output interface	RED	BLACK	GREEN	YELLOW	WHITE	BROWN
RS422	1	2	3	4	5	6
	VCC	GND	RXD- (B-)	RXD+ (A+)	TXD+ (A+)	TXD- (B-)

ATO

Measurement and Installation



Although the HCM365 can compensate for magnetic interference, users should choose an environment with minimal magnetic interference for installation and use. Keep the HCM365 away from iron, nickel, magnets, engines, and other magnetic materials as much as possible. If such magnetic media are present, maintain a distance of at least 0.5 meters. To ensure optimal measurement results, use non-magnetic screwdrivers and non-ferrous screws during installation. Strictly avoid placing magnets, motors, or other strong magnetic materials within 10cm of the compass, as this may cause irreversible degradation of the compass's measurement accuracy.

Each HCM365 electronic compass comes with a 1.6-meter cable; cable length is optional. While the HCM365 can compensate for magnetic deviations in stable magnetic environments, it cannot compensate for varying magnetic interference. For example, a DC-powered wire generates a magnetic field; if the DC current changes, the magnitude of the magnetic field will also change. Batteries are another source of varying interference. The magnetic field environment is different for each installation location; users must assess the feasibility of installation under that operating environment.

The HCM365's heading accuracy can reach 0.3~0.5°, which has been rigorously verified and is beyond doubt. Scientific testing methods are equally crucial. Our recommended testing method is to mount the HCM365 electronic compass on a vertically erected aluminum (or other non-magnetic material) rod for heading accuracy measurement (the rotating rod should be perpendicular to the rotating platform to minimize interference from large external magnetic fields).

Calibration Method

Calibration prerequisites:
1): The test compass does not achieve the required accuracy.
2): The compass installation environment has magnetic field interference. This interference is fixed, and the distance between this interfering magnetic field and the compass will not change after installation (e.g., the compass is mounted on an iron material; because iron will have magnetic field interference, the iron and compass need to be rotated together for calibration. Furthermore, this iron will not separate from the compass during use (it must be fixed in place). If they separate, recalibration is required.

This electronic compass has undergone sensor calibration in a non-magnetic environment at the factory, so no additional environmental calibration is required when using it in a non-magnetic environment. However, when ferrous or alloy materials (such as iron, nickel, etc.), batteries, microphones, high-current coils, or motors are present around the compass, the geomagnetic field around the compass will be distorted (including hard magnetic interference and soft magnetic interference: hard magnetic refers to a constant magnetic field, such as the magnetic field generated by a permanent magnet; soft magnetic refers to a magnetic field that can be altered by magnetization, such as silicon steel sheets). In such cases, we recommend environmental calibration. During environmental calibration, the relative position of surrounding interfering materials to the compass should remain unchanged during the compass's rotation (i.e., rotate with the compass). During environmental calibration, the compass can learn the surrounding interfering magnetic field environment and compensate for the effects of hard and soft magnetic fields, improving the compass's accuracy.

【Note】 The operator must not have a mobile phone, keys, or any metal or electrically powered devices that could affect the electromagnetic field during environmental calibration.

1. Manual Calibration

The principle of manual calibration is to rotate the compass to a known position where it will be used to collect more calibration points. For example, if you know the compass will be used around 0 degrees roll and 30 degrees tilt, then during calibration, place the compass around these positions and select more calibration points, while selecting fewer calibration points at other tilt and roll angles. If the azimuth position is unknown, select azimuth points evenly. After rotating to a certain position, manually send the command to save the calibration points. You can collect as many calibration points as needed (minimum 12 points). The compass will compensate for surrounding interference magnetic fields based on the data points collected at different orientations.

Calibration Procedure:

1). Fix the electronic compass in the operating environment. During calibration, the compass and any other devices affecting it need to be rotated together.

2). Send the following calibration command in hexadecimal format: **68 04 00 65 69**, and then click the Start Calibration button.

3). After rotating to a suitable orientation, send the command **68 04 00 67 6B** to save the calibration points.

4). After successful sampling, the compass will return the command **68 04 00 66 + 15 bytes of magnetic field value + 1 byte of valid point count + 1 byte of checksum**. The valid point count refers to the number of magnetic azimuth values collected by the compass for calibration calculation.

5). To exit calibration, send a stop calibration command in hexadecimal format: **68 04 00 12 16.**

6). If calibration is complete, save the calibration using the hexadecimal command **68 04 00 09 0D**. If saving the calibration data is successful, it will return the hexadecimal command: **68 09 00 89 FitErr YY** (see the command list below for details). **FitErr** is the calibration error; a smaller value is better. If this value > 10, recalibration is required. **YY** is the checksum.

2. Automatic Omnidirectional Calibration

The principle of automatic omnidirectional calibration is for the user to rotate the compass to as many attitude positions as possible. The compass's tilt, pitch, and azimuth combinations cover all attitudes. The compass will automatically collect appropriate data points; the more data points collected, the more accurate the calibration. A maximum of 96 calibration points can be collected. This method is theoretically the most accurate calibration method across all attitudes.

Calibration Procedure:

1). Fix the electronic compass in the operating environment. During calibration, the compass and other devices affecting it need to be rotated together.

2). Place the compass in a horizontal position.

3). Send the following calibration command in hexadecimal format: **68 04 00 08 0C.**

4). Rotate the compass around the z-axis (the vertical direction) for 2-3 revolutions. Use variable speed rotation as much as possible during the rotation, such as: acceleration -> deceleration -> acceleration -> deceleration... The time for one revolution can be controlled between 10 and 15 seconds.

5). Rotate the compass around the x-axis and y-axis slowly and almost uniformly, 1-2 revolutions around each axis, with one revolution taking approximately 10 seconds.

6). Rotate the compass randomly, slowly and almost uniformly, ensuring the rotation axis does not coincide with the axes in steps 4 and 5, and that the compass orientation covers all directions.

7). After successful sampling, the compass will return the command **68 04 00 66 + 15 bytes of magnetic field value + 1 byte of valid point count + 1 byte of checksum**. The valid point count refers to the number of magnetic azimuths collected by the compass for calibration calculation.

8). To exit calibration, send a stop calibration command in hexadecimal format: **68 04 00 12 16**.

9). If calibration is complete, save the calibration using the hexadecimal command **68 04 00 09 0D**. If the calibration data is saved successfully, a hexadecimal command will be returned: **68 09 00 89 FitErr YY (see the command list below for details)**. **FitErr** represents the calibration error; a smaller value is better. If this value is greater than 10, recalibration is required. **YY** is the checksum.

3. Automatic 12-Azimuth Small Tilt Calibration

This calibration method is suitable for applications where the roll angle change is very small (<5°). After starting the calibration, the compass needs to be turned to the attitude position shown in the table below. Once the compass is in the appropriate position, it will automatically collect data points. The compass can collect data points in up to 12 azimuths.

Serial Number	Heading(°)	Pitch(°)	Roll(°)
1	0	-5~+5	-5~+5
2	90	-5~+5	-5~+5
3	180	-5~+5	-5~+5
4	270	-5~+5	-5~+5
5	30	>+45	-5~+5
6	120	>+45	-5~+5
7	210	>+45	-5~+5
8	300	>+45	-5~+5
9	60	<-45	-5~+5
10	150	<-45	-5~+5
11	240	<-45	-5~+5
12	330	<-45	-5~+5

Calibration Procedure:

1). Fix the electronic compass in its operating environment. During calibration, the compass and any other devices affecting it must be rotated together.

2). Send the following calibration command in hexadecimal format: **68 04 00 64 68**, and then click the "Start Calibration" button.

3). Rotate the compass to the appropriate orientation as required.

4). After successful sampling, the compass will return the command **68 04 00 66 + 15 bytes of magnetic field value + 1 byte of valid point count + 1 byte of checksum**. The valid point count refers to the number of magnetic azimuth values collected by the compass for calibration calculation.

5). To exit calibration, send the "Stop Calibration" command in hexadecimal format: **68 04 00 12 16**.

6). If calibration is complete, save the calibration using the hexadecimal command **68 04 00 09 0D**. If the calibration data is saved successfully, a hexadecimal command will be returned: **68 09 00 89 FitErr YY** (see the command list below for details). **FitErr** represents the calibration error; a smaller value is better. If this value is greater than 10, recalibration is required. **YY** is the checksum.

4. Plane Calibration

This calibration method is suitable for compasses used only in a plane. After starting calibration, slowly and uniformly rotate the compass one full circle within the plane. During rotation, the compass will automatically sample appropriate data; the compass can collect a maximum of 12 points.

Calibration Procedure:

1). Fix the electronic compass in the operating environment. During calibration, the compass and any other devices affecting it must be rotated together.

2). Place the compass in a horizontal position.

3). Send the following calibration command in hexadecimal format: **68 04 00 60 64,** and then click the Start Calibration button.

4). Slowly and uniformly rotate the compass one full circle within the plane as required.

5). After successful sampling, the compass will return the command **68 04 00 66 + 15 bytes of magnetic field value + 1 byte of valid point count + 1 byte of checksum**. The valid point count refers to the number of magnetic azimuth points collected by the compass for calibration calculations.

6). To exit calibration, send a stop calibration command in hexadecimal format: **68 04 00 12 16**.

7). If calibration is complete, save the calibration using the hexadecimal command **68 04 00 09 0D**. If saving the calibration data is successful, it will return the hexadecimal command: **68 09 00 89 FitErr YY** (see the command list below for details). **FitErr** represents the calibration error; a smaller value is better. If this value > 10, recalibration is required. **YY** is the checksum.

The four calibration methods provided here are characterized in the table below. You can choose the appropriate calibration method based on your actual usage:

Calibration Methods	Suitable calibration scenarios	Calibration Evaluation	Application Limitations
Manual Calibration	Definitely define the pitch and roll ranges, and select the most commonly used attitude points for calibration.	Best results were achieved at the selected calibration points.	Inappropriate selection of calibration points may seriously affect the calibration results.
Automatic Omnidirectional Calibration	The compass and corresponding fixing mechanism allow for omnidirectional rotation, and are suitable for complex magnetic field environments.	Overall results were good. Highest accuracy was achieved in complex magnetic field environments.	Inappropriate calibration point selection may severely affect calibration results.
12-Aspect Planar Calibration	The compass rotates only in a plane, with pitch and roll angles both <2°.	Best results were achieved during in-plane rotation.	Pitch and roll angles should be <2° during use.
Automatic 12-Aspect Small Tilt Calibration	The compass roll angle is <5°, while pitch can move over a wide range.	Best calibration results were achieved with a roll angle < 5°.	Pitch angle must be >45°.

Device Model: Select the corresponding product model.
Serial Port: Select the COM port corresponding to the device.
Device Address: Enter the current address code of the sensor. The factory default is 00.
Baud Rate: Select the current baud rate of the sensor. The factory default is 9600.
Status Monitoring: Connect to the serial port and click Start to collect data.
Status Settings: Configure the sensor's functional parameters.

Communication Protocol

If you wish to access the compass directly, you can do so through the compass's communication protocol, allowing for easy integration into your system.

1. Data Frame Format: (RTU mode: 8 data bits, 1 stop bit, no parity, default rate 9600)

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03 Read 0x06 Write	XX	XX	XX	XX	XX	XX

Data Format: Hexadecimal

Address Code: Factory default 0x01 (User can set as needed, maximum 0xFF)

Function Code: 0x03 Read holding register 0x06 Preset single register

Register Address: Starting address of the register to be read/written

Number of Registers: Number of registers to be read/written

CRC Check: Address code, function code, register starting address, number of registers, CRC checksum. Calculated by the computer using a dedicated CRC16 checksum tool. (Note: The CRC checksum will change when the address code, function code, or register starting address changes. Please change the CRC checksum accordingly when your command changes.)

Note: When using Modbus serial port assistant software to access sensor communication, CRC checksum is not required; it is required by ordinary serial port debugging assistants.

Note: Please read the following items carefully before use:

1) Due to MODBUS The protocol specifies a minimum of 3.5 bytes of time between two data frames (e.g., at a baud rate of 9600, this time is 3.5 × (1/9600) × 11 = 0.004 s). However, to allow sufficient margin, this sensor increases this time to greater than 10 ms. Therefore, please allow at least a 10 ms time interval between each data frame.

Master sends command – 10 ms idle – Slave replies command – 10 ms idle – Master sends command...

If the user needs to implement CRC16 MODBUS calculation themselves, the C language program implementation is as follows, for reference:

```
unsigned short ModBusCRC (unsigned char *ptr,unsigned char size)
{
```

```
    unsigned     short     a,b,tmp,CRC16,V;
    CRC16=0xffff;//CRC  Register  initial  value
    for (a=0;a<size;a++) //N bytes
{
    CRC16=*ptr^CRC16;
    for (b=0;b<8;b++) //8 bits data
{
    tmp=CRC16 & 0x0001;
    CRC16 =CRC16 >>1; //Right shift by one bit
    if (tmp)
    CRC16=CRC16 ^ 0xa001; //XOR Polynomial
}
    *ptr++;
}
    V = ((CRC16 & 0x00FF) << 8) | ((CRC16 & 0xFF00) >> 8) ;//High/low byte conversion
    return V;
}
```

For example: The checksum of "01 06 00 0B 00 02" is "79 C9"

2 Command Format

2.1 Read PITCH Axis Angle (Tilt Angle)

Send Command: 01 03 00 01 00 02 95 CB

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x00	0x01	0x00	0x02	0x95	0xCB

Response Command:

Address Code	Function Code	Number of Bytes	Registry Data		CRC Check	
Address (1byte)	Function (1byte)	Byte Count (1byte)	DataH (2byte)	DataL (2byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x04	XXXX	XXXX	XX	XX

Note: For example, in the response frame: 01 03 04 BD A3 D7 0A F1 8A, the PITCH axis is bytes 1-4 of the register data (the register stores 32-bit floating-point numbers, standard IEEEE754), where bytes 1-2 are the high byte (high bit), and bytes 3-4 are the low byte (low bit), with the high byte first and the low byte last;

MODBUS RTU standard protocol, according to... The IEEE E754 standard uses the following angle representation:

PITCH axis angle (0xBDA3D70A) = -0.080000

2.2 Reading ROLL Axis Angle (Roll Angle, Gravity Tool Face Angle)

Send Command: 01 03 00 03 00 02 34 0B

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x00	0x02	0x00	0x02	0x34	0x0B

Response Command:

Address Code	Function Code	Number of Bytes	Registry Data		CRC Check	
Address (1byte)	Function (1byte)	Byte Count (1byte)	DataH (2byte)	DataL (2byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x04	XXXX	XXXX	XX	XX

Note: For example, in an acknowledgment reply frame: 01 03 04 3F BD 70 A4 42 78, the ROLL axis represents bytes 1-4 of the register data (the register stores 32-bit floating-point numbers, standard IEEE E754), where bytes 1-2 are the high-order bytes and bytes 3-4 are the low-order bytes, with the high byte first and the low byte last.

The MODBUS RTU standard protocol, according to the IEEEE754 standard, uses the following angle representation:

ROLL axis angle (0x3F BD 70 A4) = 1.48000

2.3 Read HEADING Axis Angle (Azimuth Angle)

Send Command: 01 03 00 05 00 02 D4 0A

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x00	0x05	0x00	0x02	0xD4	0x0A

Response Command:

Address Code	Function Code	Number of Bytes	Registry Data	CRC Check

Address (1byte)	Function (1byte)	Byte Count (1byte)	DataH (2byte)	DataL (2byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x04	XXXX	XXXX	XX	XX

Note: For example, in the response frame: 01 03 04 41 6C 41 89 DF 14. The HEADING axis data consists of bytes 1-4 of a register (the register stores 32-bit floating-point numbers, according to the IEEE E754 standard). Bytes 1-2 are the high-order bytes (high byte), and bytes 3-4 are the low-order bytes (low byte), with the high byte first and the low byte last.

According to the MODBUS RTU standard protocol and the IEEEE754 standard, the angle representation is as follows:

HEADING axis angle（0x41 6C 41 89）= 14.766000°

2.4 Read PITCH, ROLL, and HEADING Axis Angles

Send Command: 01 03 00 01 00 06 94 08

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x00	0x01	0x00	0x06	0x94	0x08

Response Command:

Address Code	Function Code	Number of Bytes	Registry Data			CRC Check	
Address (1byte)	Function (1byte)	Byte Count (1byte)	X Angle (4byte)	Y Angle (4byte)	Z Angle (4byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x0C	XXXX XXXX	XXXX XXXX	XXXX XXXX	XX	XX

Note: For example, response frame: 01 03 0C BD A3 D7 0A 3F BD 70 A4 43 87 01 48 0A B5，the registers store 32-bit floating-point values in accordance with the IEEE754 standard. The **PITCH** axis angle corresponds to bytes 1–4 of the register data, the **ROLL** axis angle corresponds to bytes 5–8, and the **HEADING** axis angle corresponds to bytes 9–12; data is in high-byte-first and low-byte-last order. According to the MODBUS RTU protocol and the IEEE754 standard, the data representation is as follows:

PITCH axis angle（0xBDA3D70A）= -0.080000°

ROLL axis angle（0x3FBD70A4）= 1.480000°

HEANDING axis angle（0x43870148）= 270.01

2.5 Set Communication Rate

Send Command: 01 06 00 0C 00 04 48 0A

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0C	0x00	0x04	0x48	0x0A

Response Command:

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0C	0x00	0x04	0x48	0x0A

Note: In the register data field, 0x0000 represents 2400, 0x0001 represents 4800, 0x0002 represents 9600, 0x0003 represents 19200, 0x0004 represents 115200, 0x0005 represents 14400, 0x0006 represents 38400, and 0x0007 represents 57600. The default value is 0x02 (9600). After each successful change of the communication baud rate, a save command should be sent; the device will respond using the original baud rate, then restart, and immediately switch to the new baud rate after power-up.

Remark: For high-frequency output, set the baud rate to 115200.

2.6 Set Module Address

Send Command: 01 06 00 0D 00 02 99 C8

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0D	0x00	0x02	0x99	0xC8

Note: The sensor's default address is 01.

Response Command:

Address Code	Function Code	Register Address		Registry Data		CRC Check	

Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x02	0x06	0x00	0x0D	0x00	0x02	0x99	0xFB

1. If multiple sensors are connected to a single bus, such as MODBUS, each sensor must be assigned a different address to achieve separate control and response speeds.

2. After successfully changing the address, all subsequent command and response data packets must use the new address code to take effect; otherwise, the sensor will not respond to commands.

3. The XX module address ranges from 00 to FE.

2.7 Query Module Address

Send Command: FF 03 00 0D 00 01 00 17

Address Code	Function Code	Register Address		Number of Registers		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	NumH (1byte)	NumL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0xFF	0x03	0x00	0x0D	0x00	0x01	0x00	0x17

Note: Because the MODBUS protocol stipulates that the product must know the module address to communicate, the address is known in advance during MODBUS protocol communication, and therefore cannot be queried. The query address for this product uses a custom protocol to query the MODBUS protocol address FF, or it can be queried based on the known address code.

Response Command:

Address Code	Function Code	Number of Bytes	Registry Data		CRC Check	
Address (1byte)	Function (1byte)	Byte Count (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x03	0x02	XX	XX	XX	XX

2.8 Restore Factory Settings

Send Command: 01 06 00 0E 00 00 E8 09

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0E	0x00	0x00	0xE8	0x09

Response Command:

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0E	0x00	0x00	0xE8	0x09

Note: Factory reset and power-on are required for the changes to take effect.

2.9 Update Flash (Save Settings)

Send Command: 01 06 00 0F 00 00 B9 C9

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0F	0x00	0x00	0xB9	0xC9

Response Command:

Address Code	Function Code	Register Address		Registry Data		CRC Check	
Address (1byte)	Function (1byte)	AddrH (1byte)	AddrL (1byte)	DataH (1byte)	DataL (1byte)	CRC16L (1byte)	CRC16H (1byte)
0x01	0x06	0x00	0x0F	0x00	0x00	0xB9	0xC9

* For all parameter settings, if a save setting command is not sent after setting, these settings will be lost after power failure.

Appendix. IEEE 754 Conversion

1) .Single-precision floating-point number conversion to standard 4-byte number

```
//float  converted to IEEE754 4-byte  big_endian
//If the compiler uses little-endian mode, please reverse the bdat array first.
void float2byte(float fdat,unsigned char * bdat)
{
unsigned char i;
//Obtain the 4-byte address of the float data.
unsigned char *tmp=(unsigned char *)&fdat;
//Indirect addressing to obtain the value at the 4-byte address of the float.
```

```
for(i=0;i<(sizeof(float));i++)
*(bdat+i)=*(tmp+i);
}
```

2) .4 Byte to standard single-precision floating-point function

```
//IEEE754 4-byte to float  float big_endian
//If the compiler uses little-endian mode, please reverse the bdat
array first.
byte2float(unsigned char *bdat)
{
return *((float *)bdat);
}
```