BWSENSING

AH100C

Cost-effective AHRS

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Introduction

AH100C is a cost-effective AHRS with built-in accelerometer, gyroscope and magnetometer. It provides reliable heading angle, roll angle, pitch angle, angular velocity, acceleration and other information for the moving carrier through a multi-sensor fusion algorithm. The attitude data deviation is estimated by the 6-state Kalman filter with appropriate gain, which is suitable for the navigation, positioning and dynamic attitude measurement of unmanned vehicles. AH100C uses high-quality and reliable MEMS devices, and ensures measurement accuracy through temperature compensation and zero-drift correction algorithms. At the same time, the sealing design and strict production process ensure that the product can still work reliably in harsh environments. AH100C has a digital interface, which can be easily integrated into the user's system. This product is widely used in assisted driving, unmanned vehicles, unmanned aerial vehicles, robots, and underwater equipment.

Feature

- Heading accuracy: 1°
- Inclination accuracy: 1°
- Special offset tracking algorithm to eliminate drift
- Size： L60 × W59× H29（mm）
- Output interface: RS232/485/TTL optional
- Wide temperature range: -40℃~+85℃
- Dynamic and static measurement
- Voltage input: 9~35VDC

Application

- Satellite tracking
- Self-driving car
- Stable platform
- Underwater robot navigation
- Measurement and control of drilling equipment
- Ocean survey instrument
- Robot control
- Unmanned aerial vehicle

Introduction

Electrical Specifications

Voltage	9-35 VDC
Working current	30mA（40mA Max）
Operating temperature	-40~+85℃
Storage temperature	-55~+100℃

Performance Specifications

Attitude parameters	Roll and pitch accuracy	1°
	Heading accuracy	1°
	Measuring range	Pitch ± 90º, Roll ± 180º
Gyro	Resolution	0.01°/sec
	Range	±400°/sec
	Bias stability at full temperature	30 °/h（10s,1σ）
	Angle random walk coefficient	< 0.1 °/√h
	Bias repeatability	< 50 °/h（1σ）
	Scale factor nonlinearity	≤100ppm（1σ）
	Scale factor repeatability	≤100ppm（1σ）
	Bandwidth	100Hz
Accelerometer	Range：X,Y,Z	±3.6 g
	Bias stability	0.001mg（25℃，100s，1σ） 0.01mg（25℃，10s，1σ）
Interface characteristics	Output form	RS232/RS485/TTL
	Maximum Output Rate	200Hz
MTBF	≥100000 h	
Electromagnetic compatibility	According to GBT17626	
Insulation resistance	≥100 MΩ	
Shock resistance	2000g,0.5ms,3times/axis	
Weight（g）	280g	

Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.

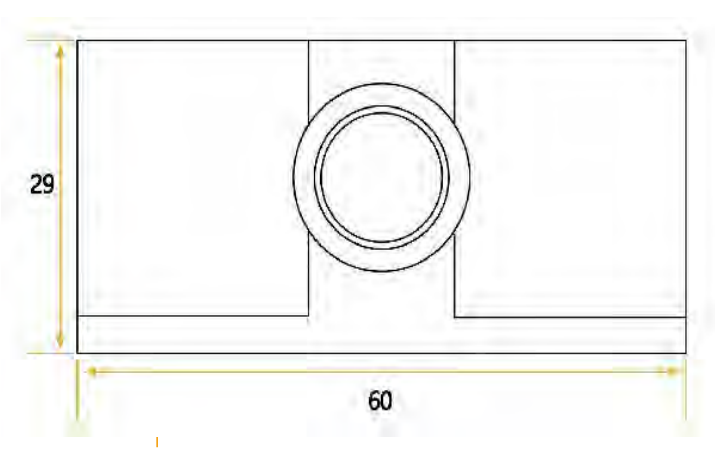
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

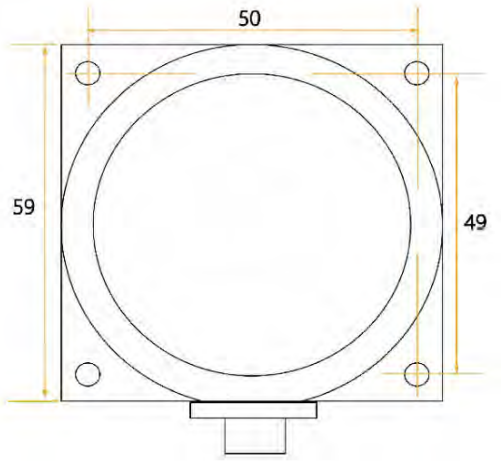
Mechanical Characteristic

Connector	Metal connector
Protection level	IP67
Shell material	Magnesium alloy sanding oxidation
Installation	Three M4 screws

Package size

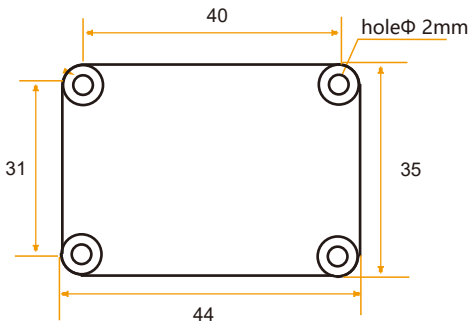
Size：L60*W59*H29（mm）





Bare plate product size

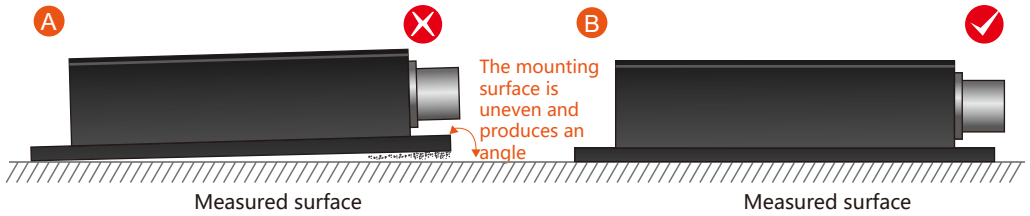
Size：L44*W35*H11（mm）
Note: ±1mm error for length and width dimensions, please refer to actual size.

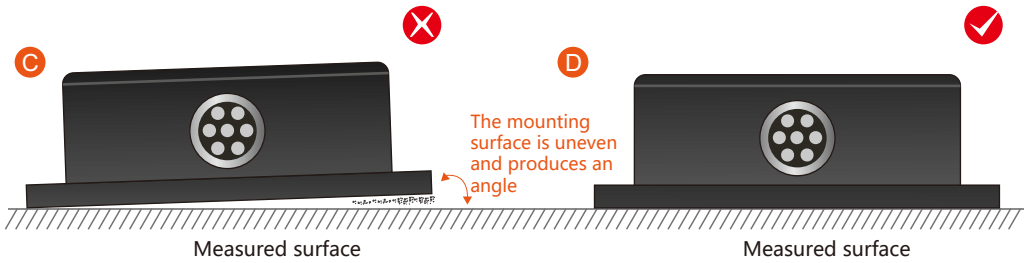


Product installation

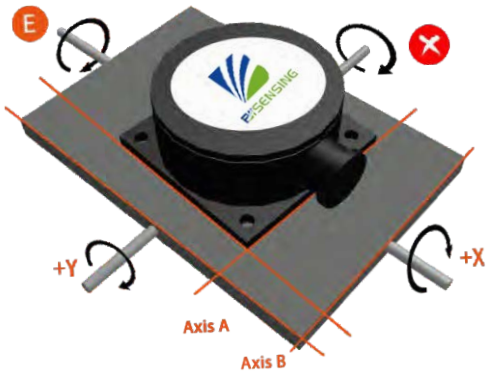
The correct installation method can avoid measurement errors, and the following points should be taken when installing the sensor:

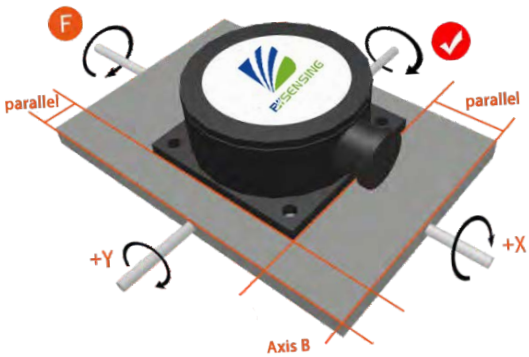
First of all, to ensure that the sensor mounting surface is completely close to the measured surface, the measured surface should be as horizontal as possible, and there should be no angle shown in Figure A and Figure C. The correct installation method is shown in Figure B and Figure D.





Secondly, the bottom edge of the sensor and the axis of the object to be measured cannot be generated at an angle as shown in Figure E. The bottom edge of the sensor should be kept parallel or orthogonal to the axis of rotation of the object to be measured. This product can be installed horizontally or vertically (vertical installation requires customization), and the correct installation method is shown in Figure F.





Finally, the mounting surface of the sensor and the surface to be measured must be fixed, the contact is flat, and the rotation is stable. The measurement error caused by acceleration and vibration should be avoided.

Measurement installation

Although the AH100C can compensate for magnetic interference, the user should select an environment with minimal magnetic interference for installation and use. Try to keep the AH100C away from iron, nickel, magnets, engines and other magnetic materials.

It is important to strictly avoid the proximity of strong magnetic materials such as magnets and motors to the product, which may cause the measurement accuracy of the product to decrease irreversibly .

Each AH400C is supplied with a 1.5 m cable and the cable length is optional. The magnetic field environment is different for each installation location and the user must evaluate the installation feasibility of the operating environment.

The recommended test method is to mount the AH100C on a vertically erected aluminum (or other non-magnetic material) rod for heading accuracy measurement (the rotating rod is perpendicular to the rotating platform to avoid large external magnetic field interference).

Calibration method

The product has been calibrated at the factory. In places where the influence of the magnetic field environment is small, it is not necessary to perform environmental calibration when using it, and it can be used directly. During actual use, it is recommended to perform calibration.

Azimuth calibration step：

Method 1 - Plane calibration:

1. Connect the product to the system and place the product in a horizontal state;
2. Open the serial port debugging assistant and send 77 04 00 11 15;
3. Rotate the product in the horizontal plane (with the pitch and roll angles within ±5°) around the z-axis (z-axis is vertical) and rotate 2-3 turns, the rotation process is as slow as possible and rotates at a constant speed. The time of one rotation is controlled between 10 seconds and 15 seconds.
4. Rotate the compass around the X or Y axis. The rotation can be performed at a slow speed and near constant speed. Rotate 2-3 turns around each axis. The rotation time is about 15 seconds.
5. Complete the calibration and send 77 04 00 12 16 to save the calibration.

Method 2 - Multi-face calibration:

1. Fix the product in the use environment, and try not to carry magnetic items such as keys and mobile phones during calibration;
2. Place the product in a horizontal state (within ±5°);
3. Send the following calibration command in hexadecimal format: 77 04 00 08 0C, return value 77 05 00 88 00 8D;
4. The product is placed horizontally, face up (pitch and roll are within ±5°), approximate rotates at a uniform speed for one week, and rotation takes more than 10 seconds.
5. The product is placed in a horizontal state with the mounting surface facing up (with a pitch of 0±5 degrees and a horizontal roll of 180±5 degrees),rotate one revolution at a constant speed approximately and use for more than 10 seconds.

6.The product is placed in a vertical state, and the other smooth side of the casing faces downward (the pitch and the roll are both within ±5°), rotate one revolution at a constant speed approximatelyand use for more than 10 seconds.

7.The product is placed in a vertical state, and the other smooth side of the casing faces downward (the pitch and the roll are both within ±5°), rotate one revolution at a constant speed approximately and use for more than 10 seconds.
[Where step 4.5.6.7 can be exchanged];

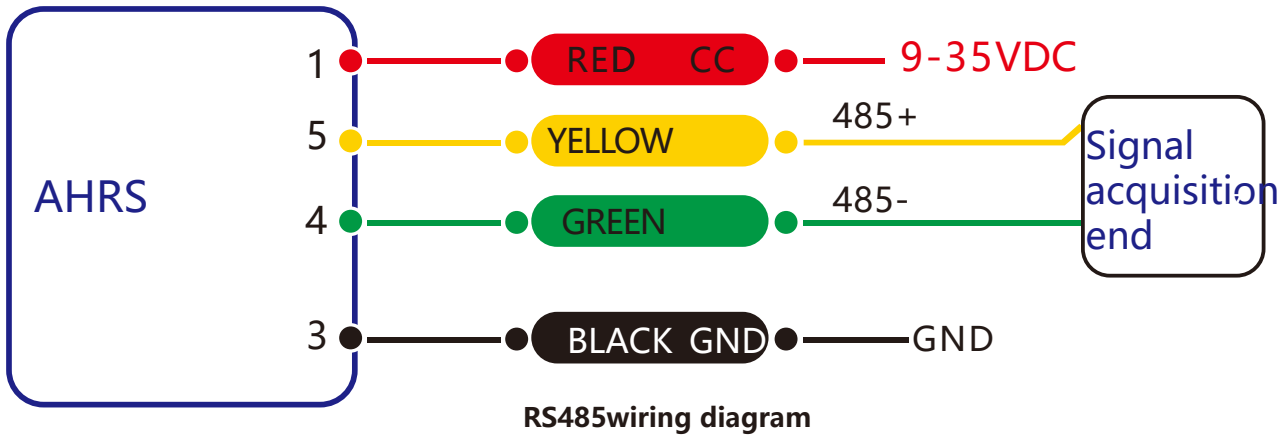
8.After the four faces have been rotated, send the hexadecimal command 77 04 00 09 0D to save the calibration and return to 77 05 00 89 XX YY. (XX represents the calibration error coefficient, the smaller the value, the better, less than 1 is ideal, FF indicates calibration failure, and YY is the checksum of the command);

9.Calibration completed.

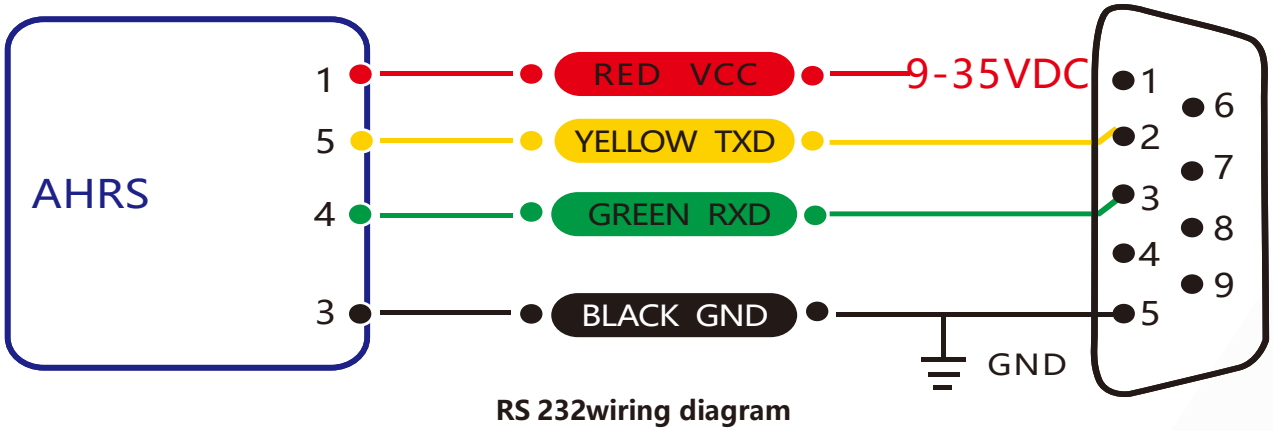
Electrical connections

Wiring definition

Cable color & function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC 9-35VDC	NC	GND	RXD (B、D-)	TXD (A、D+)



RS485wiring diagram



RS 232wiring diagram

The RS232 interface needs to connect the ground wire of the product, the ground wire of the serial device, and the power ground.

Protocol

1Data Frame Format: (8 data bits，1 stop bit，No parity check，default baud rate 9600)

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (Xbyte)	Checksum (1byte)
0x77					

Data Format: Hexadecimal
Identifier: Fixed to 77
Frame Length: Length from Frame Length to Checksum（included）
Address Code: Address of acquiring module, default 0x00
Data: Content and length variable according to Command
Checksum: The sum of the data length, address code, command word and data field hexadecimal (if there is a carry, only the last two digits are taken).
Note: The checksum will change when the command word or data field changes. Change the checksum accordingly when you change the data field.For the product's change settings, you will need to send the save settings command after the change. Otherwise, if the power is turned back on, the previous setting items will disappear, and the baud rate will not be saved and will take effect immediately after the change.

2 Command Format:

2.1 Read PITCH angle Command: 77 04 00 01 05

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x01		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x81	SXXX.YY	

Note: Data represents 4 byte angle value in format of compressed BCD code. S is the sign bit (0 means positive, 1 means negative), XXX is the three digit integer part, YY is the fractional part. The Data of other axis is the same format. For example, 10 26 87 means -026.87 °.

2.2 Read ROLL roll angle command:77 04 00 02 06

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	04		0x02		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x82	SXXX.YY	

Note: The data field is a 3-byte return angle value, which is a compressed BCD code, S is the sign bit (0 positive, 1 negative), XXX is a three-digit integer value, and YY is a two-digit decimal value. If the return value is 77 07 00 82 01 23 57 04, the roll angle data is "01 23 57", which means "123.57 degrees".

2.3 Read Heading azimuth angle Command: 77 04 00 03 07

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x03		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x83	SXXX.YY	

Note: The data field is a 3-byte return angle value, which is a compressed BCD code, S is the sign bit (0 positive, 1 negative), XXX is a three-digit integer value, and YY is a two-digit decimal value. If the return value is 77 07 00 83 01 47 03 D5, the azimuth angle data is "01 47 03", which means "147.03 degrees".

2.4 Read PITCH,ROLL,HEADING axis angle Command: 77 04 00 04 08

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x04		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x84	3 groups SXXX.YY	

PITCH: -1.47°, ROLL: -2.70°, YAW: 90.91°

77 0D 00 84 10 01 47 10 02 70 00 90 91 8C

Identifier; fixed as 77

Data length, fixed to 0D means that in addition to 77, there are 13 bytes behind

Address code, default is 00

Command word, fixed at 84

PITCH axis angle:
The first bit of the first byte is the sign bit, 0 means positive angle, 1 means negative angle
The second and second bytes of the first byte are the integer bits of the angle, which are compressed BCD codes
The third byte is the decimal place of the angle, which is the compressed BCD code

ROLL axis angle:
The format is the same as the PITCH axis

YAW axis or reserved position angle: the format is the same as the PITCH axis

The last byte is the sum of all the previous data except the first number (0x77). If there is a carry, take the lower data

2.5 Set the communication rate Command: 77 05 00 0B 02 12

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0B	XX	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8B	0x00: success 0xFF: failure	

Note: 0x00 means 2400, 0x01 means 4800, 0x02 means 9600, 0x03 means 19200, 0x04 means 115200, 0x05 means 38400, 0x06 means 57600, 0x07 means 460800, the default value is 0x02:9600, each time the communication baud rate is successfully changed , Will send back the response command at the original baud rate, and then immediately change the device communication baud rate.
Note: If you need high frequency output, please set the baud rate to 115200 or 256000. Modifying the baud rate does not need to send a save command, it will take effect immediately.

2.6 Set module address Command: 77 05 00 0F 01 15

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	Pre-modification address	0x0F	new address	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	new address	0x8F	0x00: success 0xFF: failure	

Note: For example, sending the following command "77 05 00 0F 0A 1E" means changing the product address from hexadecimal address 00 to 0A.

2.7 Query current address Command: 77 04 00 1F 23

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x1F		23

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	new address	0x1F	new address	

Note: The Query Address command is a fixed command.

2.8 Set the output frequency Command: 77 05 00 0C 00 11

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0C	XX	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8C	00	

The sent data field XX is the automatic output frequency option: 00 indicates the response mode
01 means 5Hz automatic output data
02 means 10Hz automatic output data
03 means 20Hz automatic output data
04 means 25Hz automatic output data
05 means 50Hz automatic output data
06 means 100Hz automatic output data

Note: 1. When the automatic output frequency is set higher, the baud rate needs to be set to a high baud rate. In some data types, 100HZ cannot be output due to the limitation of the baud rate. 2. The automatic output data type parameter is determined according to the following data type selection command, and the default is automatic output angle.

2.9 Query gravitational acceleration g value Command: 77 04 00 54 58

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x54		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x54	3 groups SXYYYY	

Note: The data field part is the g value of pitch, roll, and Z axis (vertical horizontal plane), which is composed of 1 sign bit + 1 integer bit + 4 decimal places. If the return value is "77 0D 00 54 00 01 07 00 94 21 10 06 30 64", the values are 0.0107g, 0.9421g, -0.0630g, respectively.

2.10 Query angular velocity Command: 77 04 00 50 54

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x50		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x50	3 groups SXXXYY	

Note: The data field part is the angular velocity of pitch, roll, Z axis (vertical horizontal plane), which is composed of 1 sign bit + 3 integer bits + 2 decimal places. For example, the return value is "77 0D 00 50 10 93 76 14 98 87 00 14 03 C0", the data fields are respectively: angular velocity of pitch axis: -93.76°/s, angular velocity of roll axis: -498.87°/s, Z axis Angular velocity: +14.03°/s.

2.11 Save Settings Command: 77 04 00 0A 0E

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x0A		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8A	0x00	

Note: Setting the baud rate does not need to save the settings, other setting items need to be sent to save the settings.

2.12 Quaternion Command: 77 04 00 57 5B

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x57		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (16byte)	Checksum (1byte)
0x77	0x14		0x57	4 groups SXYYYYYY	

Note: The data field contains 16 bytes, 4 bytes are a group, respectively quaternary q0, q1, q2, q3, which is a compressed BCD code, the format is SX YY YY YY,

S is a 1-bit sign bit (0 positive, 1 negative), X is a 1-bit integer bit, and YYYYYY is a 6-digit decimal place.For example, if the return command 77 14 00 57 00 99 99 96 00 00 02 90 10 00 26 73 10 00 00 01 7F, the quaternion data is: where q0 is 00 99 99 96, which means 0.999996

q1 is 00 00 02 90, which means 0.000290

q2 is 10 00 26 73, which means -0.002673

q3 is 10 00 00 01, which means -0.000001

2.13 Read angle, accelerometer, gyroscope, quaternion at the same time Command: 77 04 00 59 5D

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x59	-	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (43byte)	Checksum (1byte)
0x77	0x2F		0x59	Data	

Note: Data contains 43 bytes, which are angle, gravitational acceleration g value, angular velocity, and quaternion, which are compressed BCD codes. The four elements are the last 16 bytes, and 4 bytes are a group, a total of 4 groups. The rest is a group of 3 bytes, and the representation method is shown in the return value of the corresponding parameter. For example, the return value is:

77 2F 00 59 10 00 60 10 03 06 01 21 02

10 01 07 10 05 43 01 01 54

10 00 13 10 00 04 00 00 09

10 87 06 35 00 01 76 91 00 02 06 94 00 49 11 75 80

Then: the three axis angles are -0.6 degrees, -3.06 degrees, and 121.02 degrees respectively;

The g values of the three axes are -0.0107g, -0.0543g, 1.0154g;

The angular velocities of the three axes are -0.13°/s, -0.04°/s, and 0.09°/s;

The four quaternions are -0.870635, 0.017691, 0.020694, 0.491175.

2.14 Automatic output data type selection

Command: 77 05 00 56 00 5B

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x56	XX	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x56	00	

Note: The data field XX is the corresponding output data type, which needs to be carried out in automatic output mode:
0x00: During automatic output, the output parameter is three-axis angle data, and the output format refers to command 2.4;
0x01: During automatic output, the output parameter is the three-axis acceleration value, and the output format refers to command 2.9;
0x02: During automatic output, the output parameter is the value of the three-axis gyroscope, and the output format refers to command 2.10;
0x03: During automatic output, the output parameter is three-axis angle data (other data types are reserved);
0x04: During automatic output, the output parameter is a quaternary value, and the output format refers to command 2.12;
0x05: During automatic output, the output parameters are composed of angle, acceleration, angular velocity, and quaternion. For the output format, refer to command 2.13.

Executive standard

- Enterprise Quality System Standard: ISO9001:2015 Standard (Certificate No.23919Q10455R0S)
- CE certification (certificate number: M.2019.103.UY1151)
- RoHS (certificate number: G190930099)

AH100C

Cost-effective AHRS

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