RION 瑞芬

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V1.1

HIGH ACCURACY 3D DIGITAL COMPASS

RION HCM370B/HCM375B-MP

Technical Manual

RION QUALIFICATION CERTIFICATION

○ Enterprise quality system standard: ISO9001:2015 standard (Certification No.: 128101)

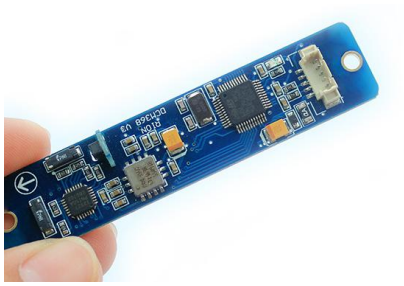
○ High-tech Enterprise (Certificate No.: GR201844204379)

○ China National Intellectual Property Appearance Patent (Patent No.: ZL 201730609573.9)

○ Revision time: 2021-6-3

○ Product functions, parameters, appearance, etc. will be adjusted as technology upgrades. Please contact our pre-sales business to confirm when purchasing.

HCM370B&375B-MP HIGH ACCURACY 3D DIGITAL COMPASS



HCM SERIES HIGH ACCURACY
3D DIGITAL COMPASS

▶ INTRODUCTION

HCM370B/HCM375B-MP is a high-precision 3D compass with high resolution, strong anti-noise ability, and stable temperature drift; it adopts advanced hard iron and soft iron calibration algorithms, and uses high-precision accelerometers for tilt compensation, allowing it provide high accurate heading at any roll angle in 360°. In an environment with fixed interference, this product can provide high accurate measurement.

Long strip shape, the width is only 1.95CM. It is IP67 grade and is more suitable for drilling measurement; it is small and consumes low power, which can be quickly and conveniently integrated into various products. Both complete product and PCBA of the senor are available.

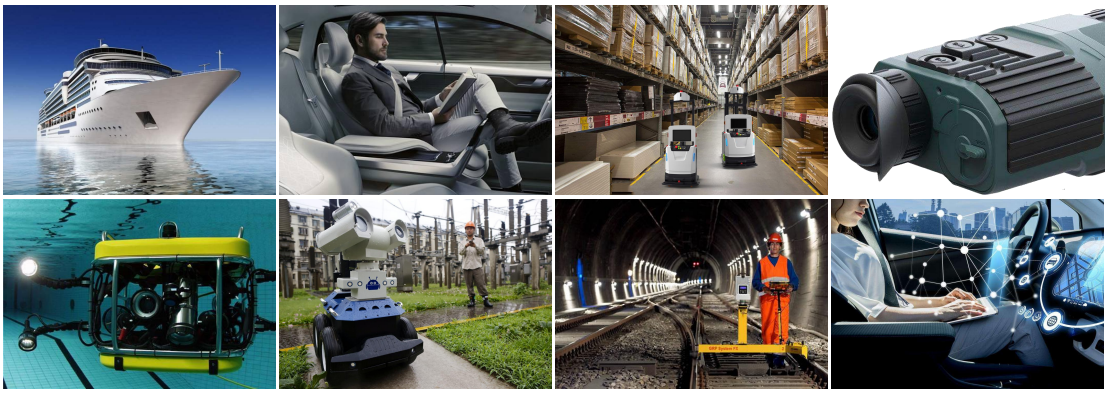
This product integrates a three-axis magnetic field sensor and a three-axis acceleration sensor. It uses an industrial single-chip computer with high reliability and strong anti-interference ability to calculate heading data in real time, and uses a three-axis accelerometer to compensate for a wide range of tilt angles. With high-performance, high-stability products, small size and low power consumption, make it suitable for many fields such as handheld devices, mobile devices, antenna stability, vehicles, and system integration.

▶ MAIN FEATURE

★ Heading Accuracy: 0.5°
★ Roll Measure Range:±180°
★ Tilt Resolution: 0.1°
★ Tilt Accuracy: <0.2°(Full Range)
★ Working Temp.: -40℃~+85℃
★ Size : L110×W19.5×H19.5mm
★ With Hard And Soft Magnetic Calibration
★ RS232/RS485/TTL Output

▶ APPLICATION

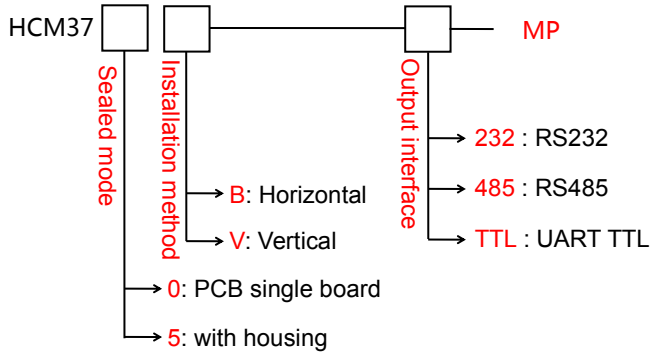
★ Satellite antenna search satellite
★ Marine navigation surveying and mapping
★ GPS integrated navigation
★ Antenna servo control
★ Gun emission system
★ Infrared imager
★ Laser range finder
★ Map for plotter
★ ROV underwater robot navigation
★ Oceanography measurement instruments
★ Special occasion robot
★ Unmanned aircraft



▶ PRODUCT PARAMETERS

HCM370B / HCM375B		PARAMETER
Heading	Heading Accuracy	0.5° Tilt < 10°
		2.0° Tilt < 60°
		3.0° Tilt < 80°
	Resolution	0.1°
Tilt	Pitch Accuracy	0.1°<15° (Measure Range)
		0.1°<30° (Measure Range)
		0.1°<60° (Measure Range)
		0.2°<85° (Measure Range)
	Pitch Range	±85°
	Roll Accuracy	0.1°<15° (Measure Range)
		0.1°<30° (Measure Range)
		0.1°<60° (Measure Range)
		0.2°<180° (Measure Range)
	Roll Range	±180°
	Resolution	0.1°
Calibration	Hard Magnetic Calibration	Available
	Soft Magnetic Calibration	Available
	Magnetic Filed Interference Calibration Method	Rotate 360° Horizontally; Vertical Rotation(Optional)
	RS-232/RS485/TTL	5Pin Quick Plug Connector
Interface	Start Delay	<50ms
	Max Output Rate	20Hz/s
	Communication Rate	2400~115200baud
	Output Format	Binary High Performance Protocol
Power Supply	Power Voltage	(Default) DC+5V
	Current(Max)	30ma
	Ideal Current	26ma
	Sleep Mode	TBD
Environment	Working Temp.	-40℃~+85℃
	Storage Temp.	-40℃~+85℃
	Anti-Shock Performance	100g
	Protection Level	IP67
Electromagnetic Compatibility	According TO EN61000 and BT17626	
Mtbf	≥40000 Hour/Time	
Insulation Resistance	≥100M.O.	
Anit-Impact	100g@11ms、3 Axial Direction (Half Sinusoid)	
Anti--Shock	10grms、10 ~ 1000Hz	
Dimension	L110×W19.5×H19.5mm	
Weight	70g(Not Include Cable)	

▶ 产品订购信息



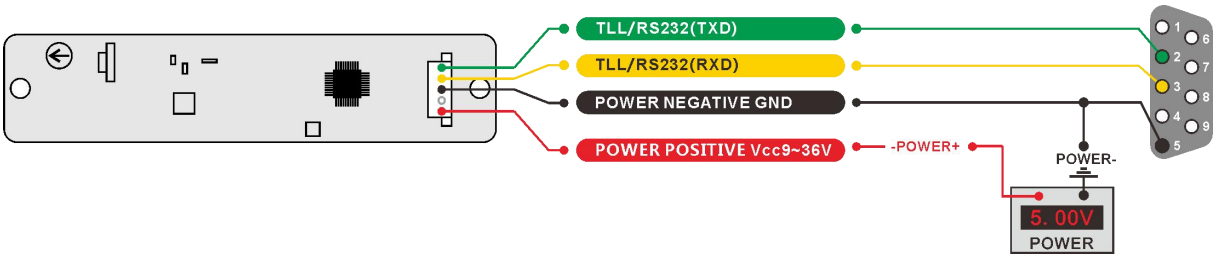
E.g : HCM375B-232-MP: enclosure packaging / horizontal installation / RS232 digital interface / 24-point calibration.

▶ ELECTRICAL CONNECTION

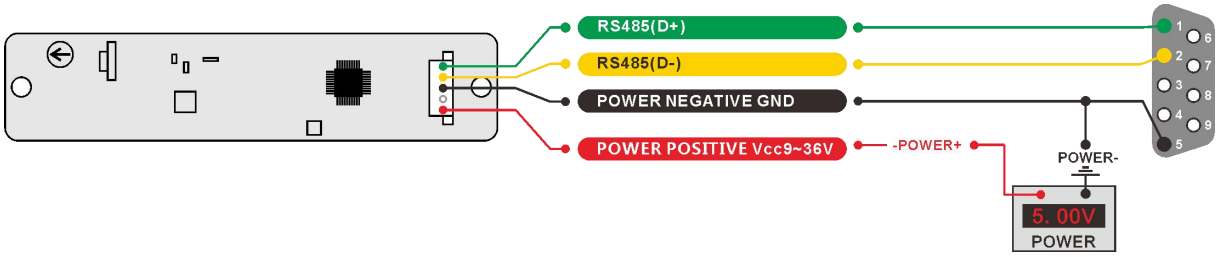
HCM370B Single Board 232/TTL Output Wiring Definition

Cable Color Definition	BLACK	RED	YELLOW	GREEN
	GND Power negative	DC 5V Power positive	TTL/RS232(RXD) OR RS485(D-)	TTL/RS232(TXD) OR RS485(D+)

HCM370B single board RS232/TTL output wiring map

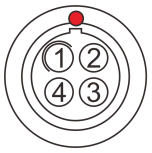


HCM370B single board RS485 output wiring map



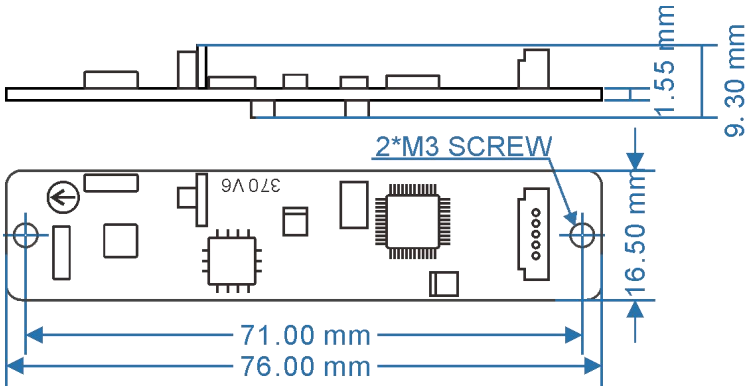
HCM375B Wiring Definition

Cable Color Definition	BLACK	PINK	BLUE	BROWN
	GND Power negative	RS232(RXD) OR RS485(D+)	RS232(TXD) OR RS485(D-)	DC 5V Power positive



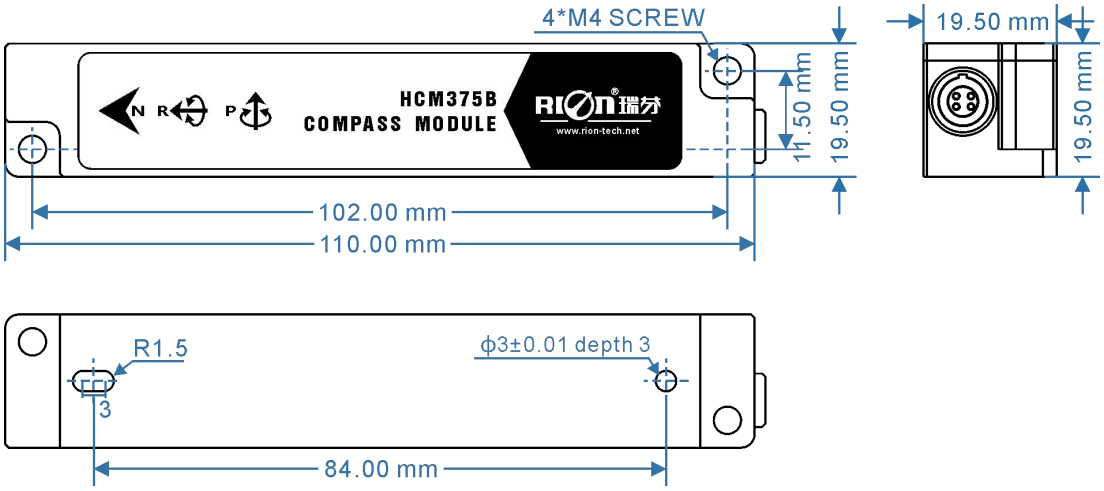
1:DC 5V
2:RXD
3:TXD
4:GND

▶ SINGLE BOARD SIZE CHART



SIZE : L76×W16.5×H9.3mm

▶ SHELL SIZE CHART



SIZE : L110×W19.5×H19.5mm

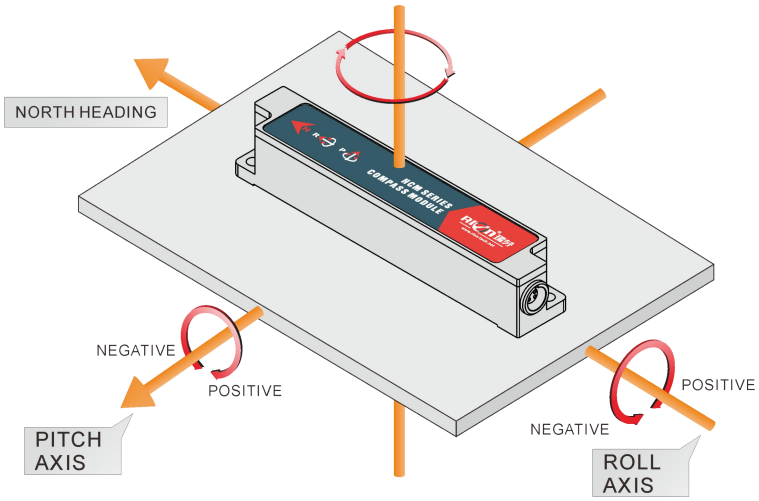
▶ MEASURING DIRECTIONS&FIX

HCM375B 3D electronic compass azimuth is using geomagnetic principle, so it is very important to select a minimum magnetic interference environment for installation positon. Please place and install the it away from the iron, magnets, engines and other magnetic objects as much possible as you can. Need control over 30CM distance(different magnetic interfere with the compass in different distance) at least even there are these magnetic medium around . In order to ensure optimal measurement environment please must use the M3 anti-interference screws for installation .

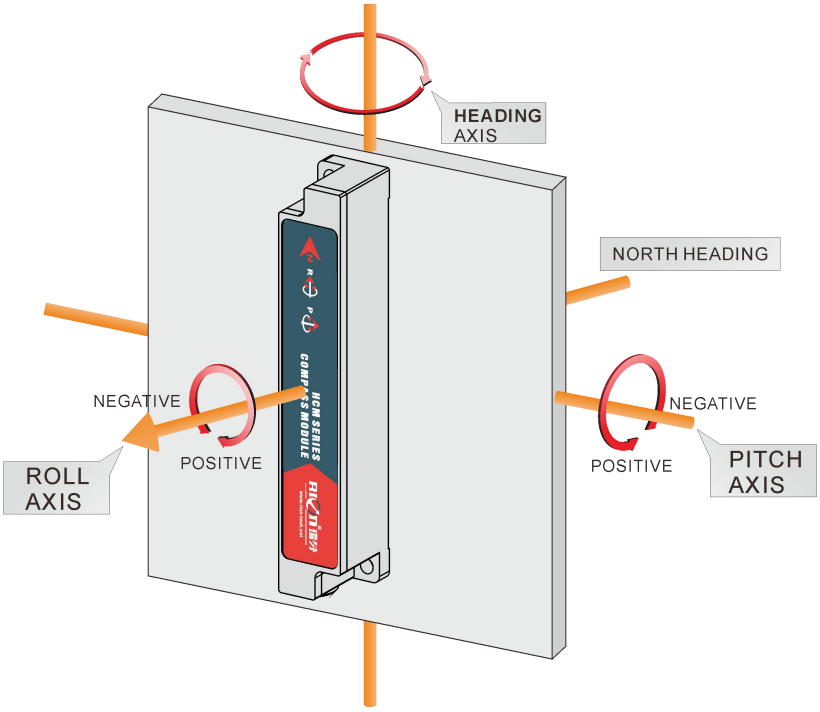
Although it can compensate the moderate deviation in the stable magnetic environment, but it can not compensate the changed magnetic interference. Please pay much attention to the wire with DC will generates a magnetic field , because if the DC change then the magnetic field will also change in size . The battery also is another interference source of changing . Each installation is different, and the user must evaluate the feasibility of installation under all possible operating environment.

The optimal heading accuracy of it can reach 0.3°~0.5°, this undergo a rigorous validation indisputable, the most scientific test method is equally crucial. The test method we recommend is: Please install the electronic compass to a vertical and erect aluminum pole (non-magnetic material), then proceed with

heading accuracy measurement (of course the rotating rod perpendicular to the rotating platform, as much as possible to avoid large external magnetic field interference). Doing so can reduce the compass turning radius, to scientifically improve the measurement accuracy. This is just to provide the installation of the laboratory, must be flexible to deal with the specific situation.E.g: is mounted in the car, HCM505B should do its installation in the perpendicular to the movement direction.



HORIZONTAL INSTALLATION



VERTICAL INSTALLATION

▶ CALIBRATION DESCRIPTION

Calibration lemmas:

1) The accuracy of testing compass cannot reach the requirements.

2) compass installation environment has magnetic interference, the interference is fixed, and the interference magnetic field and compass installation will not happen again in distance changes (example: compass to be installed above an iron material, because the iron will have magnetic interference, at this time then need to rotate and calibrate the iron and compass, and the iron and compass will not be separated when using, once they are separated then need to recalibrate. If the iron size is not fixed, or with a compass distance change is not fixed, the interference cannot be calibrated, only can install it in a very far away, safe distance control in above 30cm).

1) correctly connect to the signal output interface, then power on.

2) Select automatic calibration mode or manual calibration mode:

Automatic calibration mode: send the command "68 04 00 44 48" (click the **SET** button after selecting automatic calibration);

Manual calibration mode: send the command "68 04 00 43 47" (click the **SET** button after selecting manual calibration);

Send the calibration start command in hexadecimal format: "68 04 00 08 0C" (click the start button).

3) The electronic compass will return a response command, and the compass will return a response every time it takes a point. Please refer to the communication protocol.

4) After taking 24 calibration points according to the calibration procedure, send the stop calibration command: "68 04 00 09 0D" (click the stop button), at this time the electronic compass pauses for about 1 second, the internal CPU automatically calculates the sampled data and returns a set of data which represents the scoring value of the obtained data.

5) Save the calibration command: Send the command "68 04 00 0A 0E" (click the save button), the compass will return a response command. If the save is successful, it can work normally. If the unsuccessful message is returned, the user will recalibrate.

6) after 2) Send the calibration start command to start the calibration, keep the compass stable, and wait for the first point to be sampled.

7) After the first point is sampled, rotate the module about 90° horizontally to keep the compass stable and wait for the next point to be sampled.

8) Repeat the above steps until 24 points are sampled, and then send the calibration command and click stop button.

9) Send the calibration save command to end the calibration.

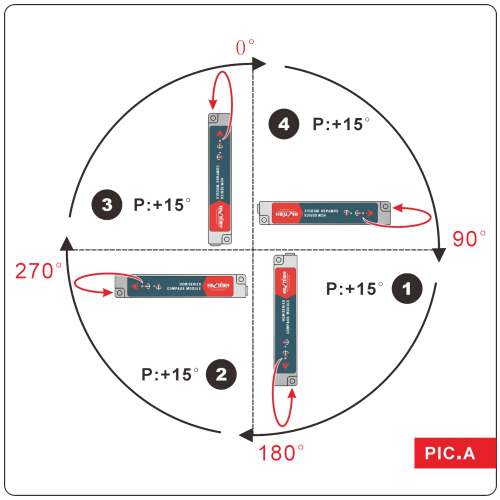
When calibrating, if the distance between the magnetic interference source and the compass itself changes, the accuracy will be affected.

Note: When starting to calibrate and take points, calibrate the compass corresponding to the following series of calibration charts. Please note that these points are not absolute headings, but a relative heading change value with reference to the heading which is sampled at the first point, and sampling angle vaule error is allowed. Do not require strict accuracy.

The calibration steps are as follows:

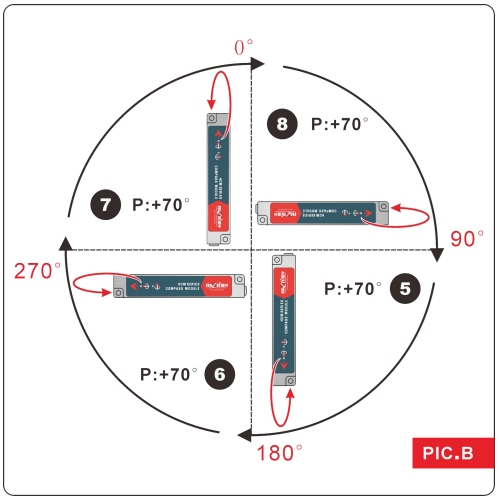
The starting point of the calibration can be in any point in 360°, as long as it keeps about 90° for every change of angle (accuracy is not required).

Example picture Pic.A: Starting point H=0°, R=0°, P=+15° (first adjust the pitch value P) Please keep this position for 2 to 3 seconds, and the system will take the first point. After taking the first point, rotate it 90° horizontally to sample 2nd point, so as for 3rd and 4th point.

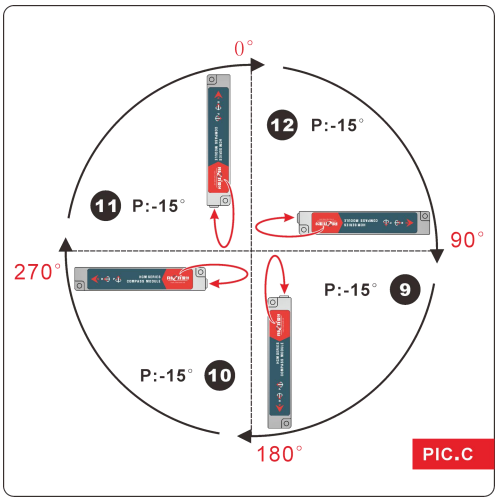


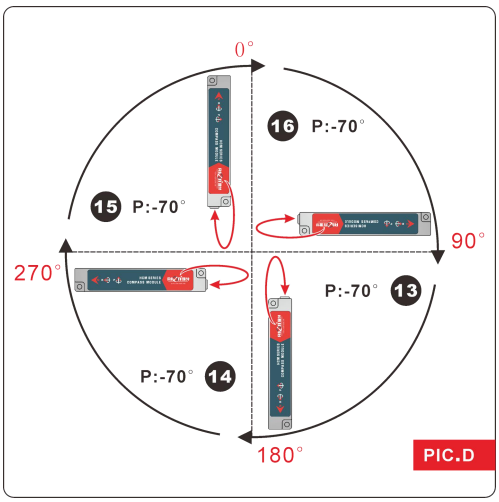
After taking the 4th point, both H and R remain unchanged, and then increase the +P angle value.

Refer to Pic.B: Starting point H=0°, R=0°, P=+70° , the same way to take point 5th,~8th.



After taking the 8th point, both H and R remain unchanged, and then calibrate the -P angle. Refer to Figure Pic.C: starting point H=0°, R=0°, P=-15°, and take point from 9th to 12th.

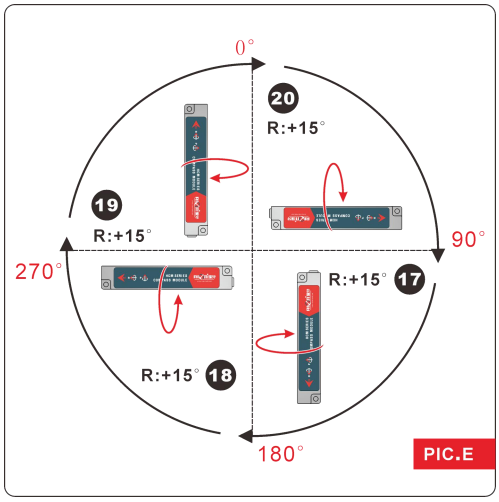




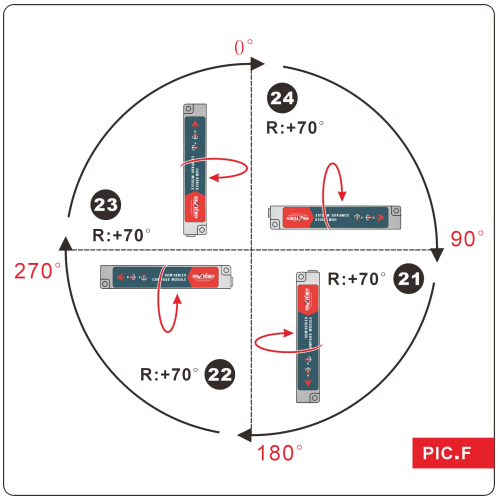
After taking the 12th point, H and R remain unchanged, and then increase the -P angle value.

Refer to Pic.D: Starting point H=0°, R=0°, P=-70° , and take point from 13th to 16th as the same way.

P calibration is completed after the 16th point is collected and then R, R (roll value) can be calibrated alternately. Refer to Pic.E: Starting point H=0°, R=+15°, P=0° Please keep this attitude for 2 to 3 seconds, the system will take the 17th point. After taking the 17th point, rotate it horizontally by 90° and change the negative roll value R=-15°. Keep this posture for 2 to 3 seconds without moving, and the system will take the 18th point. Finish picking the 18th point.



Rotate it horizontally by 90°, change the positive and roll value R=+15°, keep this posture for 2 to 3 seconds, and the system will take the 19th point. After taking the 19th point, rotate it horizontally by 90°, change the negative roll value R=-15°, keep this attitude for 2 to 3 seconds, and the system will take the 20th point.



After taking the 20th point, increase R (roll value) for calibration. Refer to the picture Pic.F: Starting point H=0°, R=+70°, P=0° Please keep this attitude for 2 to 3 seconds, the system will take the 21st point. After taking the 21st point, rotate it horizontally by 90° and change the negative roll value R=-70°. Keep this posture for 2 to 3 seconds without moving, and the system will take the 22nd point. After taking the 22nd point, rotate it horizontally by 90°, change the positive roll value R=+70°, keep this posture for 2 to 3 seconds, and the system will take the 23rd point. After taking the 23rd point, rotate it horizontally by 90°, change the negative roll value R=-70°, keep this attitude for 2 to 3 seconds, and the system will take the 24th point. Send stop command---compass response---send save command again---compass response save successfully!

▶ COMMUNICATION PROTOCOL

1. DATA FRAME FORMAT：（8 Bits Date，1 Bit Stop，No Check，Default Baud Rate 9600）

Identifier (1byte)	Date Length (1byte)	Address code (1byte)	Command word (1byte)	Date domain	Check sum (1byte)
68					

Identifier：Fixed68H

Data length：From data length to check sum（including check sum）length

Address code：Accumulating module address，Default :00

Date domain will be changed according to the content and length of command word

Check sum：Data length、Address code、Command word and data domain sum,No carry.

2. COMMAND WORD ANALYSIS

code	Meaning/example	explain
0X04	**Read Pitch/Roll/Heading angle command at the same time** ***68 04 00 04 08***	Data field （0byte） No data field command
0X84	sensor repsond Eg.: **68 0D 00 84 00 10 50 10 10 05 01 04 01 1C**	Data field（9byte） AA AB BB CC CD DD EE EF FF AA AB BB:3 characters indicate Pitch. CC CD DD: 3 characters indicate Roll. EE EF FF: 3 characters indicate Heading. The angle format has the same parsing method as Pitch, Roll and Heading The angle in the left example is Pitch: +010.50°, Roll:-010.05° , Heading+104.01°
0X06	**Set magnetic declination command.** ***68 06 00 06 02 08 16***	Data field (2byte): SA AB S is the sign, 0 plus, 1 minus, AA: two integers, B: one decimal Example: 02 08 is +20.8°
0X86	sensor repsond Eg.: **68 05 00 86 00 8B**	Data field（1byte） The number in the data field represents the result of the sensor response. 00 setting succeeded FF setting failed
0X07	**Read magnetic declination command.** ***68 04 00 07 0b***	Data field（0byte） no data command
0X87	sensor repsond Eg.: **68 06 00 87 02 08 97**	Data field (2byte): SA AB S is the sign, 0 plus, 1 minus, AA: two integers, B: one decimal Example: 02 08 is +20.8° The number in the data field represents the result of the sensor response
0X08	**Start calibration command** ***68 04 00 08 0C***	data field（0byte） no data command
0X88	sensor repsond Eg.: **68 05 00 88 00 8D**	data field（1byte） The number in the data field represents the result of the

		sensor response 00 start succeeded FF start failed
Note: compass will return data every point is take until calibration stop, format as below:		
0X88	Compass reply calibration take point number Eg.: **68 05 00 88 07 94**	Data field (1byte) The number in the data field that represents the calibration point picked up by the sensor (hexadecimal)
0X09	**Stop calibration command** ***68 04 00 09 0D***	data field (0byte) no data command
0X89	sensor repsond Eg.: **68 10 00 89 00 00 78 00 01 13 00 00 40 00 64 74 5B**	Data field (12byte) SA AA BB SC CD DD SE EF FF SG GG HH SA AA BB: 3 characters represent the calibration residual coefficient of the sampling point. < 1 is normal. The smaller the value is, the more reliable the calibration is. SC CD DD: The three characters represent the uniformity of the distribution of sampling points in all directions of the 3D calibration. The score should be less than 6%. The smaller the value, the more uniform the distribution of sampling points is. SE EF FF: 3 characters represent the distribution range of the tilt Angle of the 3D calibration sampling point, and the score should be between 0 and 1. The smaller this value is, the more extensive the spatial coverage of the sampling point is. SG GG HH: 3 characters represent the amplitude of the single side of the maximum Angle of pitch Angle and roll Angle of the compass calibration sampling point, and the score should be > 45°. The larger this value is, the more sufficient the spatial distribution of the calibration sampling point will be. Note: the above score values are for reference only. If the above score requirements are met, it means that the sampling conditions of this calibration are excellent and the accurate azimuth accuracy is not necessarily obtained. The first byte high 4 bits is sign bit, 1 negative, 0 positive ; The first byte low 4 bits is hundreds. The second byte high 4 bites are tens. The second byte low 4 bites are ones. The third byte high 4 bits are tenths. The third byte low 4 bits are percentile. In the left example, the Angle is SA AA BB：0.78 SC CD DD：1.31% SE EF FF：0.4 SG GG HH：64.74°
0X44	***Auto calibration mode command*** ***68 04 00 44 48***	Data field (0byte) no data command
0XC4	sensor repsond	Data field (1byte)

	Eg.: ***68 05 00 C4 00 C9***	The number in the data field represents the result of the sensor response 00 start succeeded FF start failed
0X43	***Manual calibration mode command*** ***68 04 00 43 47***	Data field (0byte) no data command
0XC3	sensor repsond Eg.: ***68 05 00 C3 00 C8***	Data field (1byte) The number in the data field represents the result of the sensor response 00 start succeeded FF start failed
0X45	***Manual collecting command*** ***68 04 00 45 49***	data field (0byte) no data command
0X88	**24 points taken reply command :** **68 05 00 88 01 8E (1)** **68 05 00 88 02 8F (2)** **68 05 00 88 03 90 (3)** **...** **68 05 00 88 18 A5 (24)**	data field (1byte) The number in the data field that represents the calibration point picked up by the sensor (hexadecimal)
0X0A	**Save calibration command** ***68 04 00 0A 0E***	Data field (0byte) no data command
0X8A	sensor respond command Eg.: **68 05 00 8A 00 8F**	Data field (1byte) The number in the data field represents the result of the sensor response. 00 succeeded FF failed
0X0B	**Set baud rate command** ***68 05 00 0B 02 12***	Data field (1byte) baud rate: defaulted as 9600 00 indicate 2400 01 indicate 4800 0 indicate 9600 03 indicate 19200 04 indicate 38400 05 indicate 115200
0X8B	sensor respond command Eg.: **68 05 00 8B 00 90**	Data field (1byte) The number in the data field represents the result of the sensor response. 00 succeeded FF failed
0X0F	**Set sensor address command** ***68 05 00 0F 01 15***	Data field (1byte) The address of XX module ranges from 00 to EF. Note: Our products have a unified address:**FF. If you forget the address set during the operation, you can use FF address to operate the product and still respond normally.**
0X8F	sensor respond command Eg.: **68 05 00 8F 00 94**	Data field (1byte) , The number in the data field represents the result of the sensor response. 00 succeeded FF failed
0X0C	**Set angle output mode.** **68 05 00 0C 00 11**	Data Field (1byte) 00: Q&A 01: Automatic output Factory default: Q&A
0X8C	sensor respond command	Data field (1byte) ,

	Eg.:**68 05 00 8C 00 91**	The number in the data field represents the result of the sensor response. 00 succeeded FF failed
0X2A	Set angle output mode 68 05 00 2A 00 2F	Data field (1byte) 00: Horizontal installation 01: Vertical installation (connector facing down) Factory default: horizontal installation
	Horizontal installation: When the compass is placed horizontally, the roll and pitch angle output is zero degrees. Vertical downward installation: When the compass is placed vertically downward, the roll and pitch angle output is zero degrees.	
0XAA	sensor respond command Eg.:**68 05 00 AA 00 AF**	Data field (1byte) , The number in the data field represents the result of the sensor response. 00 succeeded FF failed
0X41	Query installation type command ***68 04 00 41 45***	Data field (0byte)
0XC1	sensor respond command Eg.:68 05 00 C1 00 C6	Data field (1byte) , The number in the data field represents the result of the sensor response 00 horizontal installation 01 vertical installation
0X42	Query output type command 68 04 00 42 46	Data field (0byte)
0XC2	sensor respond command Eg.:68 05 00 C2 00 C7	Data field (1byte) , The number in the data field represents the result of the sensor response 00: Q&A 01: Automatic output

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