RION TECH

V1.1

HIGH ACCURACY 3D DIGITAL COMPASS

RION HCM370B/HCM375B-N

Technical Manual

PRODUCTION IMPLEMENTATION STANDARD REFERENCE

○ Enterprise Quality System Standard: ISO9001: 2008 Standard (Certification No.: 128101)

○ The Intellectual Property Management System Complies With The Standard: GB/T29490-2013 (Certificate No.: 18117IP1529R0S)

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

○ China National Intellectual Property Appearance Patent (Patent No.: ZL201730609573.9)

○ Angle Sensor Production Standard: SJ20873-2003 General Specification For Sensor And Spirit Level

○ Gyro Acceleration Test Standard: QJ 2318-92 Gyro Accelerometer Test Method

○ Software Development Reference Standard: GJB 2786A-2009 General Requirements For Military Software Development

○ Product Environmental Test Detection Standard: GJB150

○ Revision Time: 2020-5-16

○ Product Functions, Parameters, Appearance, Etc. Will Be Adjusted With Technology Upgrades, Please Contact The Company's Pre-Sales Business To Confirm When Buying

▶ INTRODUCTION

HCM370B-HCM375B is a high accuracy 3D digital compass of strip shape, its width is only 1.6cm, IP67 protection grade, suitable for many harsh environment such as drilling measurement. it adopts advanced hard iron and soft iron calibration algorithm, it can provide the high precision heading value output when both pitch and roll angle at any angle within 360°. it is small and low power consumption, suitable for current miniaturization sensitive measurement system. Sealed complete item and signal board are available.

HCM370B-HCM375B integrated patented three -axis flux-gate technology. It calculates heading value in real-time by CUP, and perform heading value compensation in wide tilt range by using three axis accelerometer. It is high performance and excellent stability militarily level compass sensor. Its volume is small, power consumption is low. It could widely used in many application such as antenna installation, vehicle and integrated system, and so on.

▶ MAIN FEATURE

- ●Heading Accuracy: 0.5°
- ●Tilt Resolution: 0.1°
- ●Working Temp.: -40℃~+85℃
- ●With Hard And Soft Magnetic Calibration
- ●Roll&Pitch Measuring Range:±180°
- ●Tilt Accuracy: <0.2°(Full Range)
- ●Dimension: L110×W19.5×H19.5mm
- ●Rs232/Rs485/Ttl Output

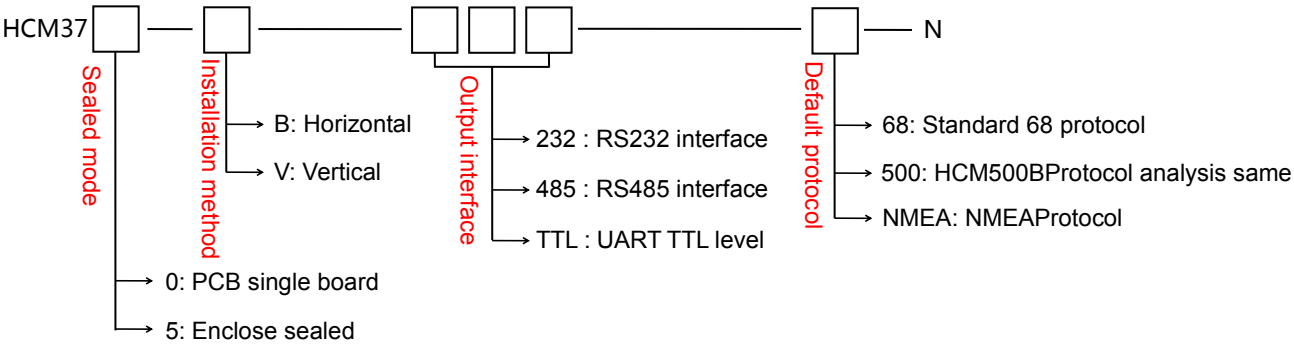
▶ APPLICATION

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

▶ PRODUCT PARAMETERS

HCM370B / HCM375B		Index
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°<90° (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 TO 19200baud
	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℃~+100℃
	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、3Times/Axis(Half Sinusoid)	
Anti--Shock	10grms、10 ~ 1000Hz	
Dimension	L110×W19.5×H19.5mm	
Weight	80g(Not Include Cable)	

▶ PRODUCT ORDERING INFORMATION



E.g : HCM375B-232-68-N: enclosure packaging / horizontal installation / RS232 digital interface / factory default standard 68 protocol.

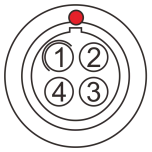
▶ ELECTRICAL CONNECTION

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+)

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



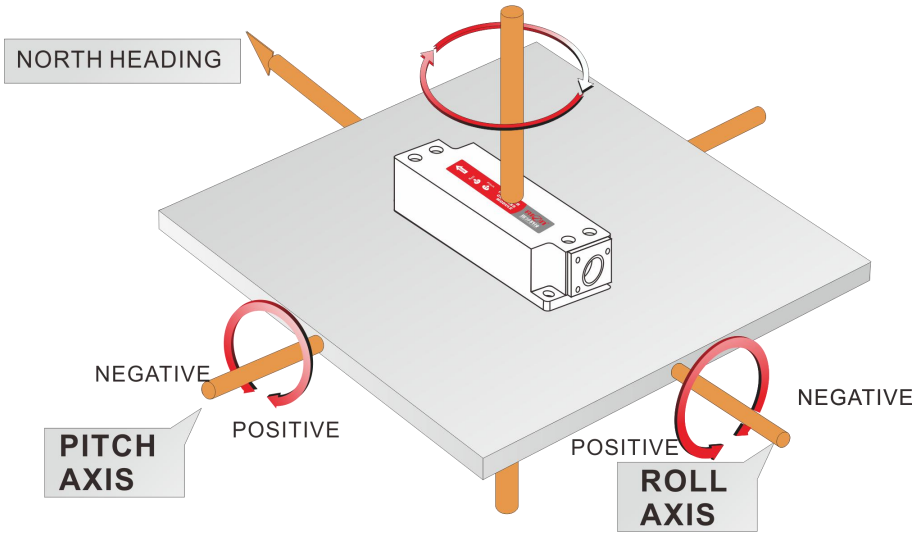
1:DC 5V
2:RXD
3:TXD
4:GND

▶ MEASURING DIRECTIONS&FIX

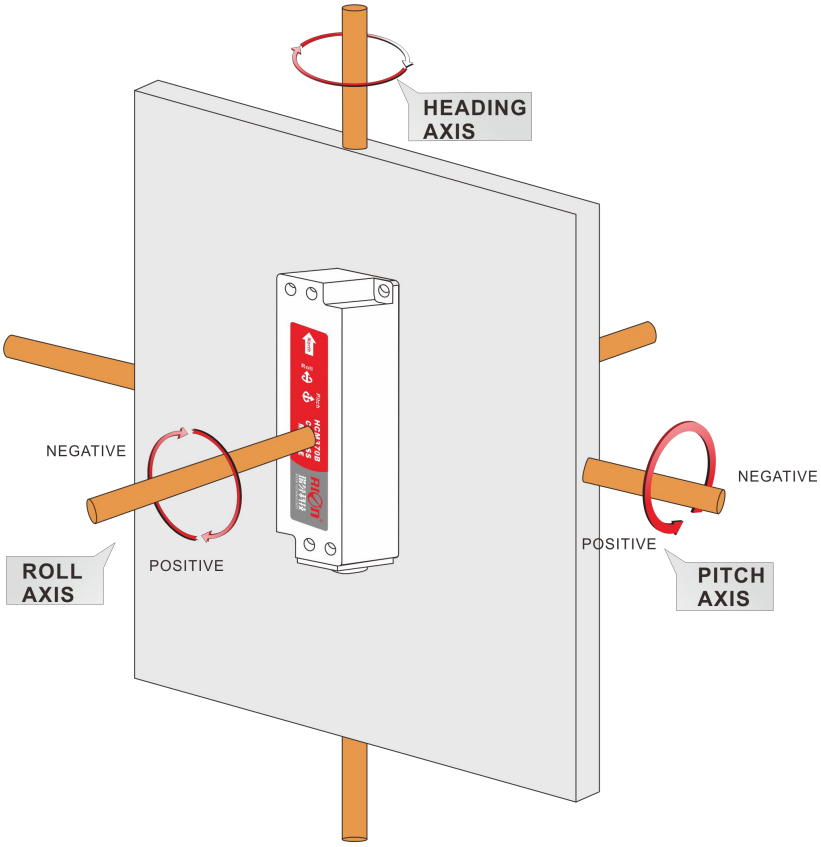
HCM370B-HCM375B 3D electronic compass azimuth is using geomagnetic principle, so it is very important to select a minimum magnetic interference environment for installation positon. Please place and install the it away from the iron, magnets, engines and other magnetic objects as much possible as you 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.

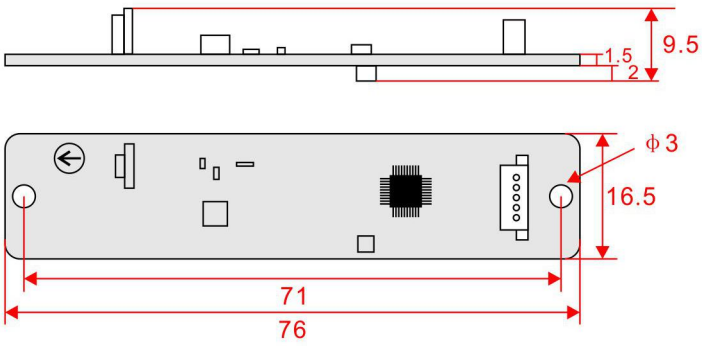


Horizontal Installation Diagram



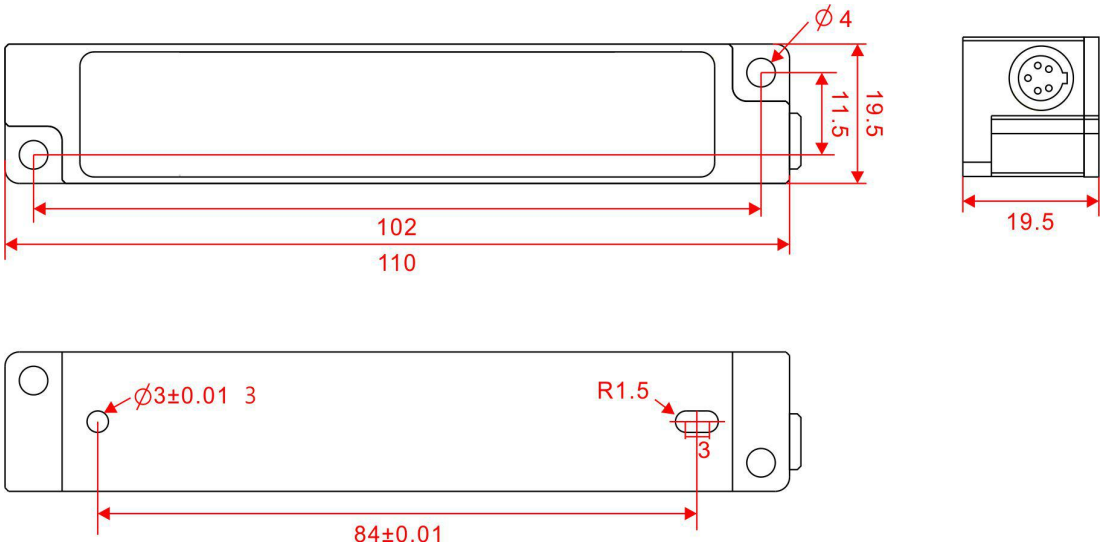
Vertical Installation Diagram

▶ SINGLE BOARD SIZE CHART



Dismenion : L76×W16.5×H9.5mm

▶ SHELL SIZE CHART



Dismenion : L110×W19.5×H19.5mm

▶ CALIBRATION METHOD

Calibration prerequisite:
1) The accuracy of testing compass can not reach the requirements;
2) compass installation environment have 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 can not be calibrated,only can install it in a very far away , safe distance control in above 30cm).

Horizontally Install Calibration Mode:

1) Connect the DCM compass to the RS232 communication port and turn on the power.

2) Plane rotation - 360° or more:

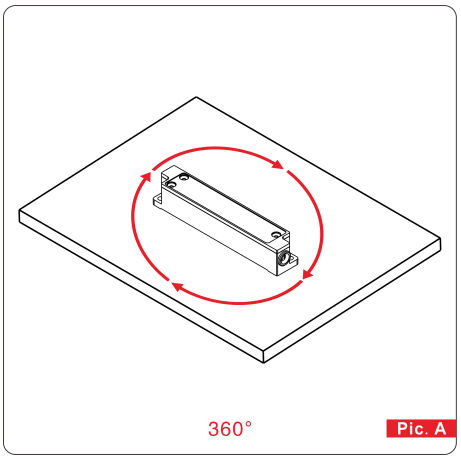


Figure A

Horizontal start calibration command

68 04 00 41 45

Data field (0byte)

Horizontal rotate for more than 1 revolution at a constant speed, the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands horizontally

68 04 00 51 55

Data field (0byte)

No data field command

2) Rotate 360° vertically upwards

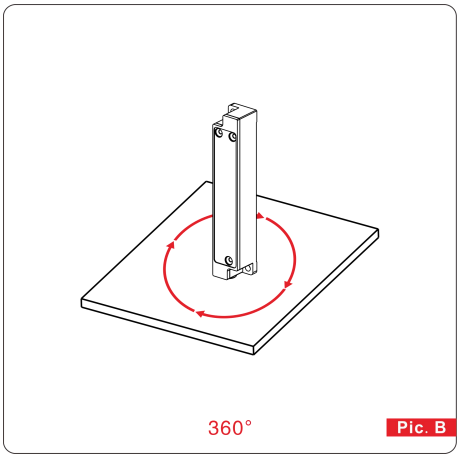


Figure B

Start calibration command vertically upwards

68 04 00 42 46

Data field (0byte)

North facing sky, rotate vertically for more than 1 revolution at a constant speed, the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands vertically upwards

68 04 00 52 56

Data field (0byte)

No data field command

3) Rotate 360° vertically downwards

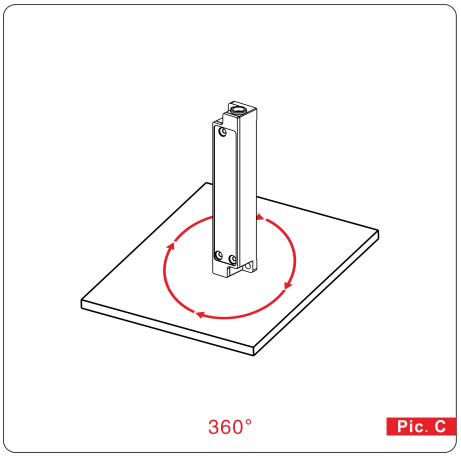


Figure C

Start calibration command vertically downwards

68 04 00 43 47

Data field (0byte)

North facing the ground,rotate vertically for more than 1 revolution at a constant speed, the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands vertically downwards

68 04 00 53 57

Data field (0byte)

No data field command

Vertical Installation Calibration Mode:

1) Connect the DCM compass to the RS232 communication port and turn on the power.

2) Plane rotation - 360° or more:

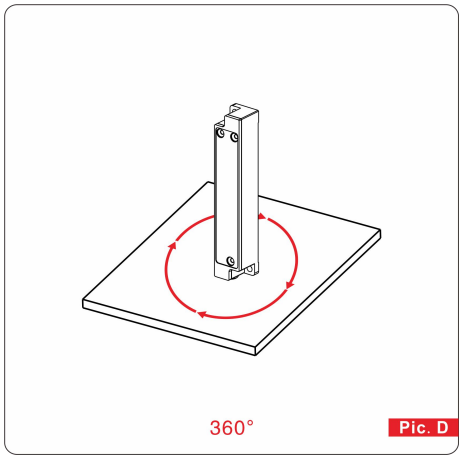


Figure D

Horizontal start calibration command

68 04 00 41 45

Data field （0byte）

Horizontally rotate more than 1 revolution at a constant speed，the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands horizontally

68 04 00 51 55

Data field （0byte）

No data field command

2）Rotate 360° vertically upwards

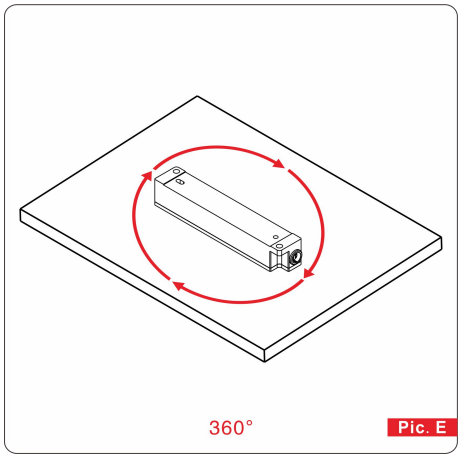


Figure E

Start calibration command vertically upwards

68 04 00 42 46

Data field （0byte）

North facing sky, rotate vertically for more than 1 revolution at a constant speed，the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands vertically upwards

68 04 00 52 56

Data field （0byte）

No data field command

2）Rotate 360° vertically downwards

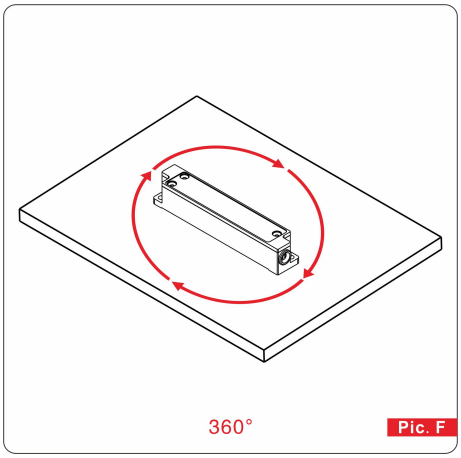


Figure F

Start calibration command vertically downwards

68 04 00 43 47

Data field （0byte）

North facing the ground,rotate vertically for more than 1 revolution at a constant speed,the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.

Save calibration commands vertically downwards

68 04 00 53 57

Data field （0byte）

No data field command

▶ RION PRODUCT 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 respond **(Reply to select standard protocol)** E.g: 68 0E 00 84 00 10 50 10 10 05 01 04 01 00 1D	Data field （10byte） AA AB BB CC CD DD EE EF FF AA AB BB:3 red characters indicate the Pitch axis CC CD DD:3 blue characters indicate the Roll axis EE EF FF:3 green characters indicate the Heading angle Angle format with same analytic method as Pitch、Roll、Heading On the left example , the angle is : Pitch: +010.50°,Roll:-010.05°，Heading+104.01° BYTE13(Count from 0) : It is 1 when the magnetic field exceeds the threshold, and 0 when it does not exceed the threshold.
0X84	Sensor respond **(Reply with 500 protocol)** E.g: 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 red characters indicate the Pitch axis CC CD DD:3 blue characters indicate the Roll axis EE EF FF:3 green characters indicate the Heading angle Angle format with same analytic method as Pitch、Roll、Heading On the left example , the angle 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 symbol 0 positive, 1 negative AA: two digits integer，B: two digits decimals E.g：02 08 is +20.8 deg
0X86	Sensor respond E.g: 68 05 00 86 00 8B	Data field （1byte） Data domain in the number means the sensor response result 00 Setting successfully FF Setting failure
0X07	**read magnetic declination**	Data field （0byte）

	command 68 04 00 07 0b	No data field command
0X87	Sensor respond E.g: 68 06 00 87 02 08 97	Data field (2byte) Number in data filed indicates the responding result from sensor
0X41	**Horizontal calibration star command** 68 04 00 41 45	Data field (0byte) Horizontal rotate for more than 1 revolution at a constant speed, the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.
0X41	Sensor respond E.g: 68 04 00 41 45	Data field (0byte) No data field command
0X51	**Horizontal calibration save command** 68 04 00 51 55	Data field (0byte) No data field command
0X51	Sensor respond command E.g: 68 04 00 51 55	Data field (0byte) No data field command
0X42	Vertical upwards start calibration command 68 04 00 42 46	Data field (0byte) North facing sky, rotate vertically for more than 1 revolution at a constant speed,the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.
0X42	Sensor respond E.g: 68 04 00 42 46	Data field (0byte) No data field command
0X52	**Vertical upwards calibration save command** 68 04 00 52 56	Data field (0byte) No data field command
0X52	Sensor respond command E.g: 68 04 00 52 56	Data field (0byte) No data field command
0X43	Vertical downwards start calibration command 68 04 00 43 47	Data field (0byte) North facing ground, rotate vertically for more than 1 revolution at a constant speed,the guaranteed time is above 20s. The value saved above 20s is valid, and the value saved below 20s is invalid.
0X43	Sensor respond E.g: 68 04 00 43 47	Data field (0byte) No data field command
0X53	**Vertical downwards calibration save command** 68 04 00 53 57	Data field (0byte) No data field command
0X53	Sensor respond command E.g: 68 04 00 53 57	Data field (0byte) No data field command
0X5a	**Clean calibration command** 68 04 00 5a 5e	Data field (0byte) Sending 3 times continuously is valid(clean current calibration data, factory calibration data will not be covered)
0X5a	Sensor respond command E.g: 68 04 00 5a 5e	Data field (0byte) No data field command

0X0e	Factory reset command 68 05 00 0e aa bd	Data field （1byte） Invoke factory default value(current calibration data will be covered)
0X0e	Sensor respond command E.g: 68 05 00 8e 00 93	Data field （1byte） No data field command
0X0B	**Set baud rate command** 68 05 00 0B 02 12	Data field （1byte） Baud rate：default :9600 00 means 2400 01 means 4800 02 means 9600 03 means19200 04 means38400 05 means115200
0X8B	Sensor respond command E.g: 68 05 00 8B 00 90	Data field （1byte） The data in the data domain means the response of the sensor 00 Success FF Failure
0X0F	**Setting module address command** 68 05 00 0F 01 15	Data field （1byte） XX module address, address from 00 to EF range Note: Our products have a unified address: **FF, If forgot the set address when operating ,can use the FF address to operate the product, still normal response.**
0X8F	Sensor respond command E.g: 68 05 00 8F 00 94	Data field （1byte）， The data in the data domain means the response of the sensor 00 Success FF Failure
0X0C	**Setting angle output mode** 68 05 00 0C 00 11	Data field （1byte） 00：Question-answer mode 01：Auto output 20Hz 02：Auto output 5Hz 03：Auto output 10Hz 04：Auto output 25Hz 05：Auto output 50Hz Factory default：Question-answer mode
0X8C	Sensor respond command E.g:68 05 00 8C 00 91	Data field （1byte）， The data in the data domain means the response of the sensor 00 Success FF Failure
0X50	Set magnetic threshold value command 68 05 00 50 01 56	Data field （1byte） BYTE4 value range：1~10，more than threshold is interference, power failure save, factory default set is : 4: 0.44/1.4~ 0.44*1.4 Corresponding threshold value table： 1: 0.44*0.99~ 0.44/0.9 2: 0.44/1.2~ 0.44*1.2 3: 0.44/1.3~ 0.44*1.3 4: 0.44/1.4~ 0.44*1.4 5: 0.44/1.7~ 0.44*1.7 6: 0.44/1.9~ 0.44*1.9 7: 0.44/2.3~ 0.44*2.3 8: 0.44/2.5~ 0.44*2.5 9: 0.44/2.9~ 0.44*2.9 10: 0.44/3.5~ 0.44*3.5 Other values 4: 0.44/1.4~ 0.44*1.4

0XD0	Sensor respond command E.g:68 05 00 D0 00 D5	Data field （1byte）, The data in the data domain means the response of the sensor 00 Success FF Failure
0X2A	Set Installation Mode Command E.g:68 05 00 2a 01 30(Vertical setting) E.g:68 05 00 2a 00 2f(Horizontal setting)	Data field （1byte） 00： Horizontal 01: Vertical
0XAA	Set installation mode respond command E.g:68 05 00 AA 00 AF 68 05 00 AA 00 AF	Data field （1byte） 00 Success FF Failure
0X60	Read accelerometer commands E.g：68 04 00 60 64	Data field （0byte）
0XE0	respond accelerometer commands Respond 68 0D 00 E0 00 00 01 10 00 00 00 01 02 01	Data field （9byte） Parsing three bytes means one axis AA AB BB CC CD DD EE EF FF AA AB BB means X-axis acceleration CC CD DD means Y-axis acceleration EE EF FF means Z-axis acceleration On the left example, X-axis acceleration=0.01g,Y-axis acceleration=-0g,Z-axis acceleration=1.02g The upper four bits of the first byte is the sign bit The lower four bits of the first byte hundred bits The upper four bits of the second byte are ten bits The lower four bits of the second byte are one bits The high-order four bits of the third byte are tenths bits The lower four bits of the third byte are percentiles bits
0X61	Read Magnetometer Command E.g：**68 04 00 61 65**	Data field （0byte）
0XE1	Respond Magnetometer Command Respond 68 0D 00 E1 00 04 15 10 31 48 00 12 93 35	Parsing three bytes means one axis AA AB BB CC CD DD EE EF FF AA AB BB means X-axis magnetometer CC CD DD means Y-axis magnetometer EE EF FF means Z-axis magnetometer On the left example X-axis magnetometer=415, Y-axis magnetometer=-3148, Z-axis magnetometer=1293 (75LSB/uT) X：415/75=5.53uT Y：-3148/75=-41.97uT Y：1293/75=17.24uT The upper four bits of the first byte are the sign bit The lower four bits of the first byte are ten thousand bit

		The upper four bits of the second byte are thousands bit The lower four bits of the second byte are hundred bit The upper four bits of the third byte are ten bit The lower four bits of the third byte are one bit

▶ NMEA0183 COMMUNICATION PROTOCOL

Communication RS232 ,NMEA0183（ASCII）, retain original 68 protocol

Baud rate 4800 \9600\19200, could set(default as 19200, one start bit + 8 data bit+non-parity +1 stop bit)

Data protocol

Communicate use NMEA special sentence (ASCII).

After power on module, baud rate is 19200 as default and 0 data output.

During operation, compass output sentence as below:

$PTNTHPR,X.X,A,X.X,A,X.XA*hh<cr><lf>

Heading ,pitch,roll

Set Data Refresh Rate

Command	Description
#BAD=0*4A	set 0-readouts per minute
#BAD=1*4B	set 1-readout per minute
#BAD=2*48	set 2-readouts per minute
#BAD=3*49	set 3-readouts per minute
#BAD=4*4E	set 6-readouts per minute
#BAD=5*4F	set 12-readouts per minute
#BAD=6*4C	set 20-readouts per minute
#BAD=7*4D	set 30-readouts per minute
#BAD=8*42	set 60-readouts per minute
#BAD=9*43	set 120-readouts per minute
#BAD=10*7B	set 180-readouts per minute
#BAD=11*7A	set 300-readouts per minute

Baud Rate Set Command

Command	Description
#BA4H=8T*2E	Set baud rate as 4800
#BA4H=16T*11	Set baud rate as 9600
#BA4H=32T*17	Set baud rate as 19200

Installation Mode

Command	Description	Response	Description
$PSILSET,S,1*26	Set horizontal install	#PSILSET,C,1*36	Module back confirm
$PSILSET,S,2*25	Set vertical install	#PSILSET,C,2*35	Module back confirm

Activation Message

#F33.6=1*52　Message to be sent after any of the above commands has been sent to reinitialize and activate any change.

Heading Angle Calibration Command

Start command	Response	Remark
#F33.4=0*51<CR><lf>	#F33.4=0*51<CR><lf>	Horizontal command
#F33.4=1*50<CR><lf>	#F33.4=1*50<CR><lf>	Vertical up
#F33.4=2*53<CR><lf>	#F33.4=2*53<CR><lf>	Vertical down
Store command	**Response**	**Remark**
#F2FE.2=1*67<CR><lf>	#F2FE.2=1*67<CR><lf>	Horizontal command
#F2FE.2=2*64<CR><lf>	#F2FE.2=2*64<CR><lf>	Vertical up
#F2FE.2=3*65<CR><lf>	#F2FE.2=3*65<CR><lf>	Vertical down

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