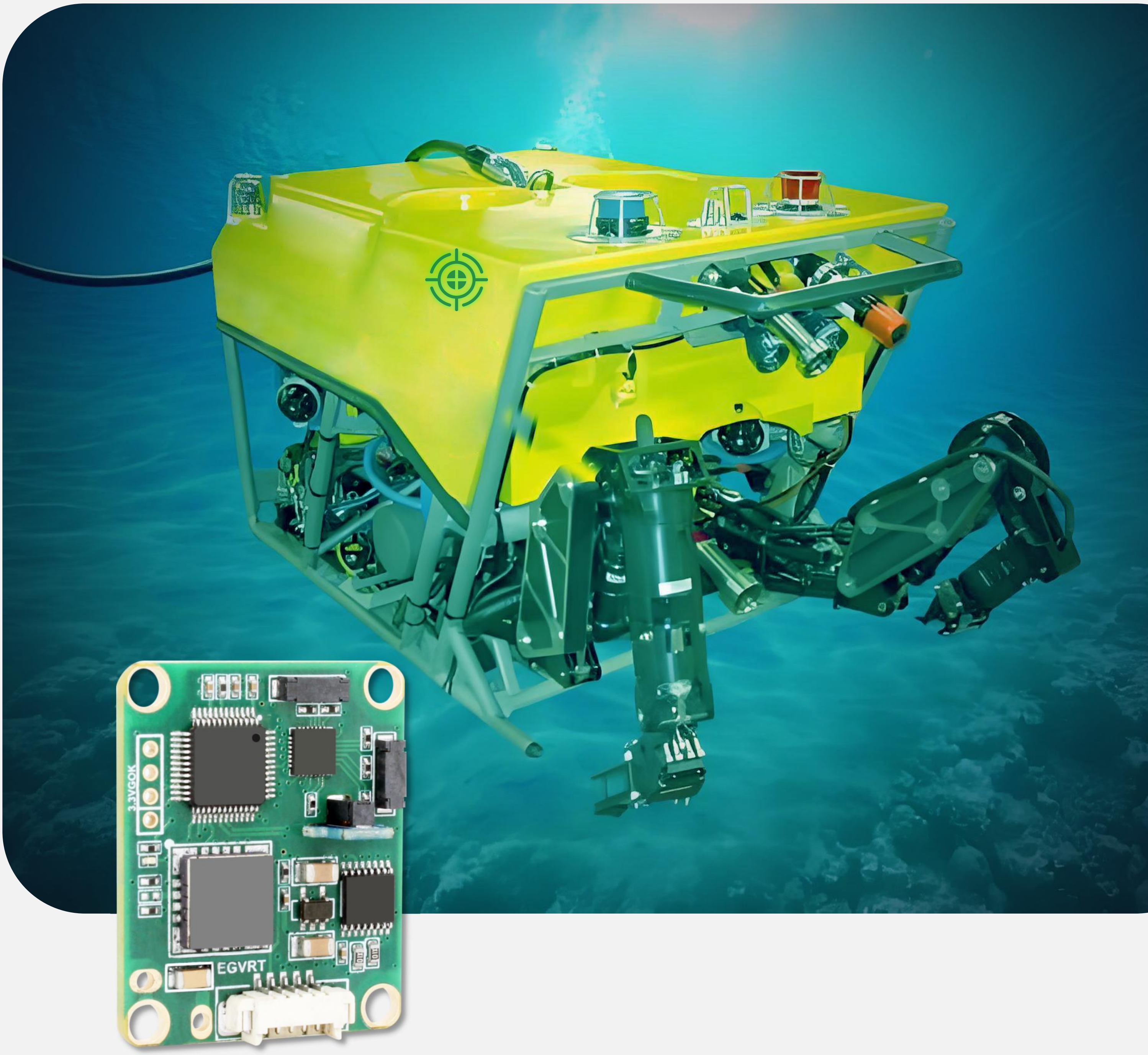


GCM387 3D Electronic Compass Module

Product Manuel

V1.5-20241210

Technical Highlights

- ❖ Azimuth accuracy: 0.5°;
- ❖ Roll angle measurement range: ±180°;
- ❖ Tilt resolution: 0.1°;
- ❖ Tilt accuracy: <0.2° (full range);
- ❖ Standard RS232/TTL output interface optional;
- ❖ With hard magnet, soft magnet and tilt compensation.

Product Introduction

The GCM387 is a high-performance, cost-effective 3D electronic compass. It employs innovative 24-point rotating acquisition and calibration technology, effectively enhancing anti-interference capabilities while simplifying operation. An integrated high-precision accelerometer supports full-range (±180°) tilt compensation, ensuring accurate heading data even under complex attitude conditions. It maintains stable measurement accuracy in environments with fixed magnetic field interference and supports flexible configuration via RS232/TTL dual-mode communication interfaces.

This product integrates a triaxial magnetometer and a triaxial accelerometer, featuring excellent resolution and strong noise suppression capabilities. It achieves low power consumption and high stability in a compact design. Suitable for handheld devices, mobile terminals, antenna stabilization, vehicle navigation, and system integration, it meets the diverse application needs for high-performance orientation measurement.

Application Scope

Typical application areas of the GCM387 3D electronic compass:

- ❖ Marine navigation and surveying
- ❖ Antenna servo control
- ❖ Laser ranging equipment collaboration
- ❖ ROV underwater robot navigation
- ❖ Special robot applications
- ❖ GPS integrated navigation system
- ❖ Infrared imager integration
- ❖ Map completion system support
- ❖ Marine survey instrument support

Performance parameters

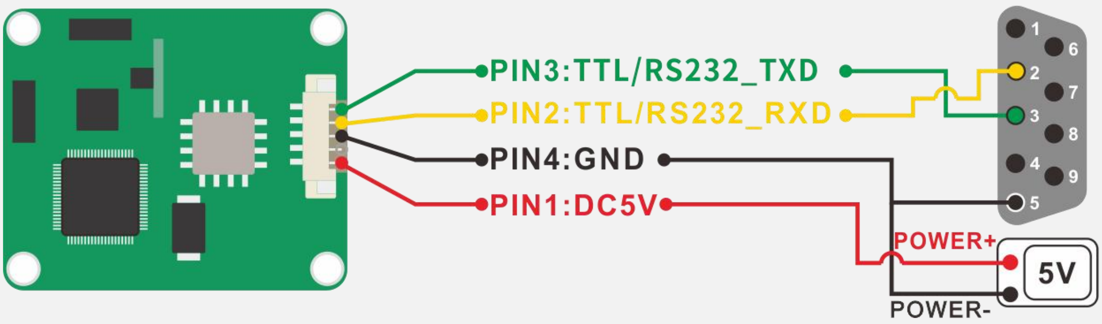
GCM387		Parameter Indicators
Compass heading parameters	Optimal heading accuracy	0.5°
	Resolution	0.1°
Compass Tilt Parameters	Pitch accuracy	0.1°<15°(Measurement Range)
		0.1°<30°(Measurement Range)
		0.1°<60°(Measurement Range)
		0.2°<85°(Measurement Range)
	Pitch roll range	±85°
	Roll accuracy	0.1°<15°(Measurement Range)
		0.1°<30°(Measurement Range)
		0.1°<60°(Measurement Range)
		0.2°<180°(Measurement Range)
	Roll tilt range	±180°
	Resolution	0.1°
Compass Tilt Parameters	Hard iron calibration	Yes
	Soft iron calibration	Yes
	Magnetic field interference calibration method	24-point rotation acquisition calibration
Interface Characteristics	Startup delay	<50ms
	Maximum output rate	20Hz/s
	Communication rate	2400 to 115200 baud
	Output format	Binary high-performance protocol
Power Supply	Supply voltage	Binary high-performance protocol
	Current (typical)	50mA
	Sleep mode	TBD
Environment	Operating temperature	-40℃ ~ +85℃
	Storage temperature	-40℃ ~ +85℃
	Vibration resistance	100g
Electromagnetic Compatibility	Compliant with EN61000 and GBT17626	
Mean Time Between Failures (MTBF)	≥99000hours / time	
Insulation Resistance	≥100 megohms	
Shock Resistance	100g@11ms, triaxial (half-sine wave)	
Vibration Resistance	10grms、10 ~ 1000Hz	
Product Dimensions	33×27×9.5mm	
Weight	<15g	

Ordering and Selecting

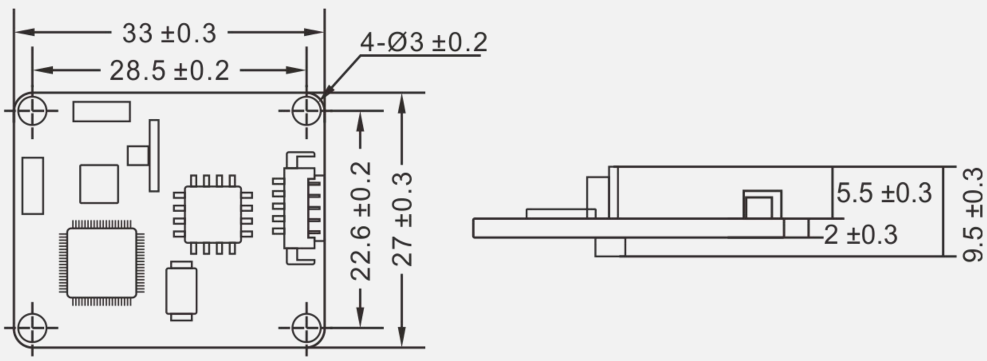
Model		Signal Output		Installation Direction		Calibration Method
GCM387	-	232: RS232	-	H:Horizontal installation	-	MP: 24-point calibration
		TTL: TTL				R:Planar rotation calibration
E.g: GCM387-232-H-MP: RS232 output / Horizontal mounting/24-point calibration.						

PIN Definition

PIN / Thread color	Definition	Description
Black	GND	GND
Red	DC 5V	VCC
Yellow	TTL/RS232_RXD	Receive Data
Green	TTL/RS232_TXD	Transmit Data



Product Dimensions



PCBA Dimensions: L33×W27×H9.5mm
Installation Dimensions: L28.5×W22.6×H2mm
Recommended screws: 4 M3 screws (copper screws)

Measurement direction and installation requirements

The 3D electronic compass azimuth measurement is based on the principle of geomagnetic induction. Installation requires an environment with minimal magnetic field interference. To ensure measurement accuracy, please follow these installation guidelines:

1. Magnetic Interference Protection Requirements:

❖ Keep away from ferrous materials, permanent magnets, motors, and other magnetic objects.

❖ Maintain a distance of at least 30cm from known sources of magnetic interference (the specific distance needs to be adjusted according to the magnetic field strength).

❖ Use copper fasteners for secure installation.

2. Cable and Electrical Precautions:

❖ A 20cm terminal cable is included as standard. It is recommended to shorten the cable length as needed to reduce signal noise.

❖ Pay special attention to electromagnetic interference generated by DC power supply lines.

❖ Avoid installation near batteries or other sources of variable magnetic fields.

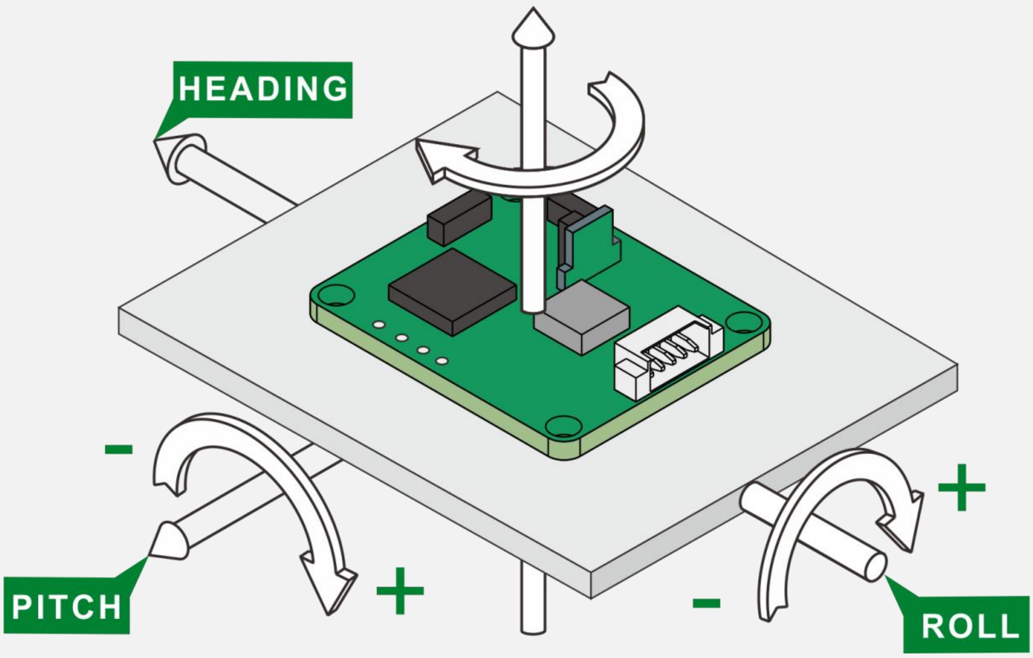
3. Accuracy Optimization Recommendations:

❖ Optimal heading accuracy: 0.5° (typical value).

❖ Recommended testing method: Mount the compass on a vertical aluminum bracket (or other non-magnetic material) for heading measurement.

❖ During testing, keep the bracket perpendicular to the turntable to minimize the rotation radius and reduce external magnetic field interference.

Note: This product can compensate for deviations in stable magnetic field environments, but it is not suitable for scenarios with dynamic magnetic field interference. A comprehensive magnetic field assessment is required for actual installation based on the specific application environment. The above instructions are primarily for laboratory environments; on-site installation requires adjustments based on actual working conditions.

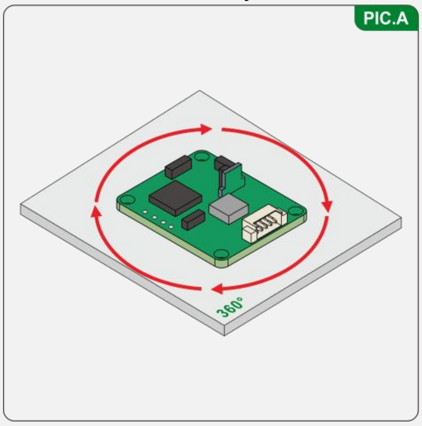


Calibration method

Calibration prerequisites:
1) The compass accuracy does not meet the requirements;
2) If there is a fixed magnetic field interference in the compass installation environment (e.g., installed on ferrous materials), the interference source and the compass must be rotated synchronously for calibration, and their relative positions must be kept fixed during use; otherwise, recalibration is required. If the size or distance of the interference source is not fixed (e.g., a variable iron component), calibration is not possible; a safe installation distance of at least 30cm should be maintained.

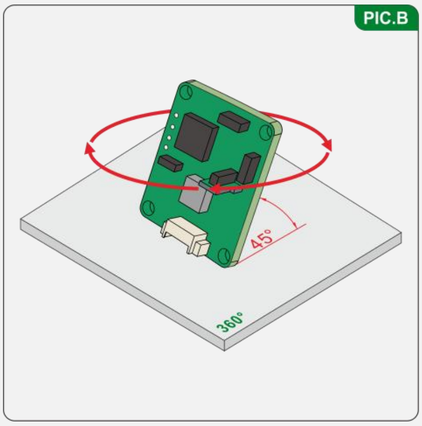
1) Connect the electronic compass correctly to the signal output interface and turn on the power.
2)Send the calibration start command in hexadecimal format:"68 04 00 08 0C"(click the **start** button).Do not respond to commands during this period.
3)After the host computer completes the calibration of 24 calibration points, the electronic compass will rotate three full rotations: **one rotation horizontally, one rotation at +45° PITCH, and one rotation at -45° PITCH.**(More rotations are allowed, but fewer are not; ensure that the host computer automatically acquires and displays 24 points simultaneously.) After completing three full rotations, send the stop calibration command:"68 04 00 09 0D"(click the **stop** button).The electronic compass will pause for approximately 1 second while the internal CPU automatically calculates the sampled data and returns a set of data.
4)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 will work normally. If an unsuccessful message is returned, the user must re-calibrate the procedure.
***During calibration, the accuracy will change if the distance between the magnetic field interference source and the compass itself changes.**

24-point automatic acquisition calibration mode:
Connect the product correctly to the communication port and turn on the power.
①Rotate horizontally at a constant speed for one full circle: As shown in Figure **A**

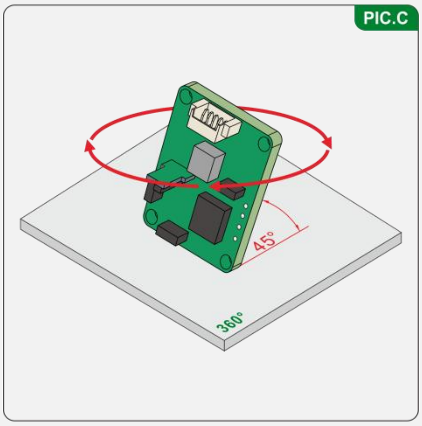


Start calibration command
68 04 00 08 0C Data field (0byte)
Rotate horizontally at a constant speed for more than one full circle,

②Rotate at a constant speed of PITCH+45° for one full circle: As shown in Figure **B**



③Rotate at a constant speed of PITCH-45° for one full circle: As shown in Figure **C**



During the rotation acquisition process, the compass will reply with the rotation acquisition and 24 points, the number of acquisition points,
24 point acquisition 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)
Calibration must acquire 24 points and complete the rotation simultaneously. One full circle horizontally, one full circle at +45° PITCH, one full circle at -45° PITCH, then click Stop. The electronic compass will pause for about 1 second while the internal CPU automatically calculates the sampled data and returns a set of data. Save calibration command: Send the command "68 04 00 0A 0E" (click the **Save** button).

Communication Protocol

1. Data frame format: (Default settings: 8 data bits, 1 stop bit, no parity, baud rate 115200)

Identifier (1byte)	Data Length (1byte)	Address Code (1byte)	Command Word(1byte)	Data Field	Checksum (1byte)
68h					

Identifier: Fixed at 68H;

Data Length: Length from the data length to the checksum (inclusive);

Address Code: Address of the acquisition module, default is 00;

Data Field varies depending on the content and length of the command word;

Checksum: The sum of the data length, address code, command word, and data field, without considering carry.

2. Command Word Parsing

CMD	Meaning/E.g	Description
0X04	**Read the Pitch, Roll, and Heading angle commands.** ***68 04 00 04 08***	Data Field (0 bytes) No Data Field Command
0X84	Sensor Response E.g: **68 0D 00 84 00 10 50 10 10 05 01 04 01 1C**	Data Field (9 bytes) **AA AB BB CC CD DD EE EF FF** **AA AB BB**:3 characters representing the Pitch axis **CC CD DD**:3 characters representing the Roll axis

		EE EF FF:3 characters representing the Heading angle AA AA BB is the angle value returned by the Pitch, in compressed BCD code. **00 10 50 Red** The three red bytes are the angle value returned by the Pitch, in compressed BCD code. The high-order bit of the first byte is **0,** which is the sign bit (0 for positive, 1 for negative). **01 0** is a three-digit integer value, and **50** is a two-digit decimal value. The parsing method for other axis data is the same; the pitch angle is parsed as +10.50°; **10 10 05 Green** The three green bytes represent the Roll return value, parsed using the same method as Pitch, and the angle is Roll: -010.05°; **01 04 01 Blue** The three blue bytes represent the Heading return value, parsed using the same method as Pitch, and the angle is Heading: +104.01°.
0X06	**Set Magnetic Declination Command** ***68 06 00 06 02 08 16***	Data Field (2 bytes) SA AB S is the sign (0 for positive, 1 for negative); AA: two-digit integer, B: one-digit decimal E.g: 02 08 is +20.8°
0X86	Sensor Response E.g: **68 05 00 86 00 8B**	Data Field (1 byte) The number in the data field represents the sensor's response result. 00 Successful setting FF Failed setting
0X07	**Read Magnetic Declination Command** ***68 04 00 07 0b***	Data Field (0 bytes) No data field command
0X87	Sensor Response E.g: **68 06 00 87 02 08 97**	Data Field (2 bytes) The number in the data field represents the sensor's response result.
0X08	**Start Calibration Command** ***68 04 00 08 0C***	Data Field (0 bytes) No data field command
0X88	Sensor Response E.g: **68 05 00 88 00 8D**	Data Field (1 byte) The number in the data field represents the sensor's response result. 00 Start successful FF Start failed
Note: The module will return data once for each point taken until calibration stops, in the following format.		
0X88	Automatic Reply to Calibration Point Count During Sensor Calibration E.g: **68 05 00 88 01 8E** **24-Point Automatic 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 (1 byte) The number in the data field represents the numerical value (hexadecimal) of the calibration point sampled by the sensor.
0X09	**Stop Calibration Command**	Data Field (0 bytes) No data field command

	68 04 00 09 0D	
0X0A	**Save Calibration Command** ***68 04 00 0A 0E***	Data Field (0 bytes) No data field command
0X8A	Sensor Response Command E.g: 68 05 00 8A 00 8F	Data Field (1 byte) The number in the data field represents the sensor's response result: 00 Success FF Failure
0X0B	**Set Communication Baud Rate Command** ***68 05 00 0B 02 12***	Data Field (1 byte) 00 represents 2400 01 represents 4800 02 represents 9600 03 represents 19200 04 represents 38400 **05 represents 115200 (default value)**
0X8B	Sensor Response Command E.g: 68 05 00 8B 00 90	Data Field (1 byte) The number in the data field represents the sensor's response result: 00 Success FF Failure
0X0F	**Set Module Address Command** ***68 05 00 0F 01 15***	Data Field (1 byte) XX module address, the address ranges from 00 to EF. Note: Our company's unified address is **FF. If you forget the address you set during operation, you can use the FF address to operate the product, and it will still respond normally.**
0X8F	Sensor Response Command E.g: 68 05 00 8F 00 94	Data Field (1 byte) The number in the data field represents the sensor response result. 00 Success FF Failure
0X0C	**Set Angle Output Mode** ***68 05 00 0C 00 11***	Data Field (1 byte) **00: Question-and-answer mode (factory default)** 01: Auto output 20Hz 02: Auto output 5Hz 03: Auto output 10Hz 04: Auto output 25Hz 05: Auto output 50Hz
0X8C	Sensor Response Command E.g:**68 05 00 8C 00 91**	Data Field (1 byte) The number in the data field represents the sensor response result. 00 Success FF Failure
0X41	**Query Installation Method Command** ***68 04 00 41 45***	Data Field (0 bytes)
0XC1	Sensor Response Command E.g:68 05 00 C1 00 C6	Data Field (1 byte) The number in the data field represents the sensor response result. 00 Horizontal installation 01 Vertical installation
0X42	**Query Output Method Command** ***68 04 00 42 46***	Data Field (0 bytes)
0XC2	Sensor Response Command E.g:68 05 00 C2 00 C7	Data Field (1 byte) The number in the data field represents the sensor response result. 00 Question-and-answer mode 01 Auto output mode
0X60	**Read Accelerometer Command** ***68 04 00 60 64***	Data Field (0 bytes)
0XE0	Sensor Response	Data Field (9 bytes) The number in the data field represents

	Command E.g:68 0D 00 E0 00 00 01 10 00 00 00 01 02 01	the sensor response result. Analyzing three bytes represents one axis. AA AB BB CC CD DD EE EF FF AA AB BB represents X-axis acceleration CC CD DD represents Y-axis acceleration EE EF FF represents Z-axis acceleration In the example on the left, X-axis acceleration = 0.01g, Y-axis acceleration = -0g, Z-axis acceleration = 1.02g The high four bits of the first byte are the sign bit (0 for positive, 1 for negative) The low four bits of the first byte are the hundreds digit The high four bits of the second byte are the tens digit The low four bits of the second byte are the units digit The high four bits of the third byte are the tenths digit The low four bits of the third byte are the hundredths digit (Note: The maximum range of the accelerometer is ±20g; exceeding 20g displays a special value of 20.66g.)
0X61	**Read magnetometer command** ***68 04 00 61 65***	Data Field (0 bytes)
0XE1	Sensor response command E.g:68 0D 00 E1 00 04 15 10 31 48 00 12 93 02	Data Field (9 bytes) The numbers in the data field represent the sensor's response result AA AB BB CC CD DD EE EF FF AA AB BB represents the X-axis magnetometer CC CD DD represents the Y-axis magnetometer EE EF FF represents the Z-axis magnetometer In the example on the left, the X-axis magnetometer = 415, the Y-axis magnetometer = -3148, and the Z-axis magnetometer = 1293 (75 LSB/uT) The high four bits of the first byte are the sign bit (0 for positive, 1 for negative) The low four bits of the first byte are the ten-thousands place The high four bits of the second byte are the thousands place The low four bits of the second byte are the hundreds place The high four bits of the third byte are the tens place The low four bits of the third byte are the units place