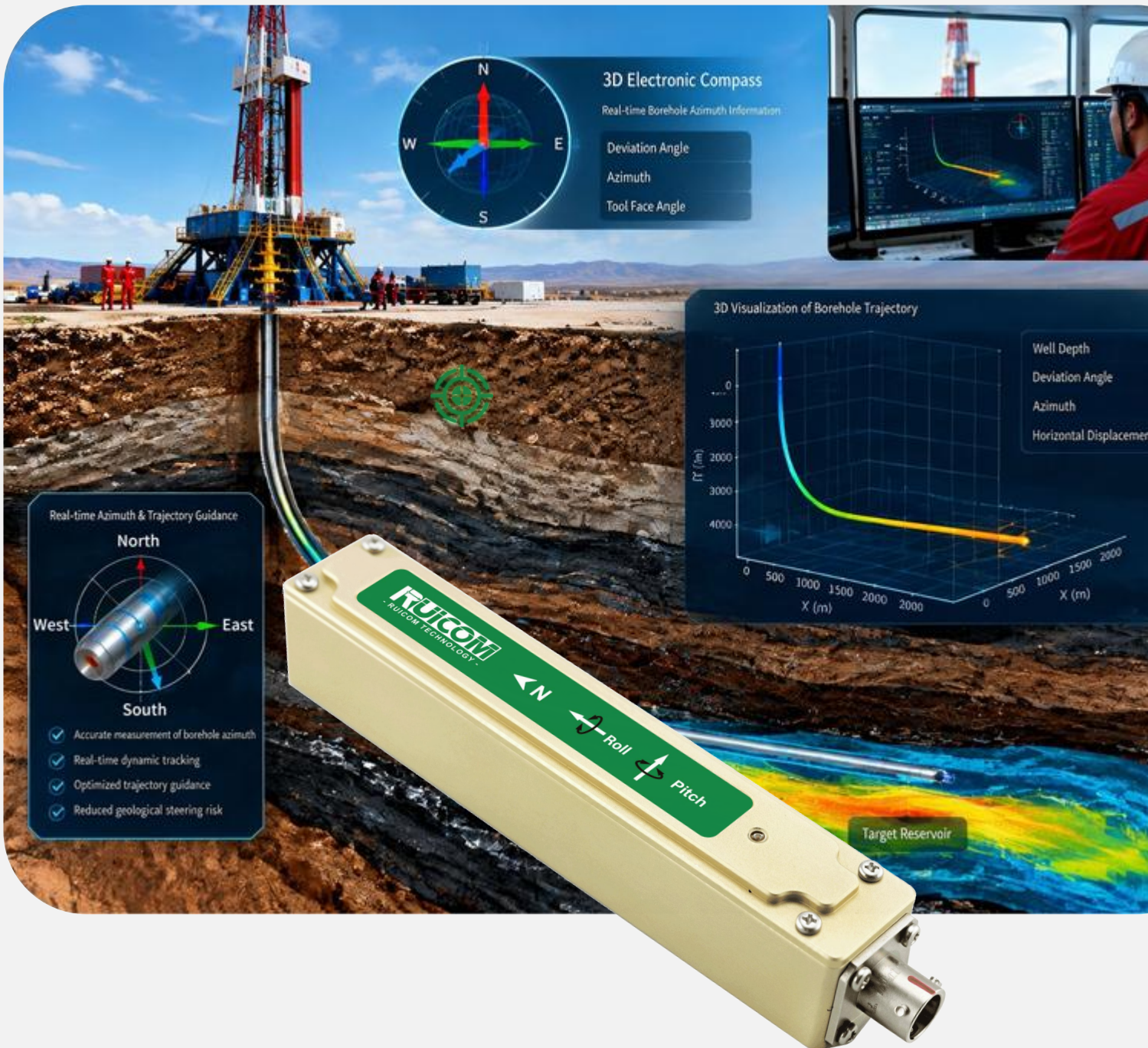




GCM508 3D Electronic Compass with Analog Output Product Manual

V1.9-2023-9-21

✓ Technical Highlights

- ❖ Azimuth accuracy: 0.3° – 0.5° ;
- ❖ Roll angle measurement range: $\pm 180^{\circ}$;
- ❖ Analog 4–20 mA output;
- ❖ Optional RS232/RS485/TTL output interfaces;
- ❖ Includes hard-iron, soft-iron, and tilt compensation.



✓ Product Introduction

The GCM508 3D compass is a high-precision attitude measurement sensor independently developed by Ruicom Technology. It supports both RS232 digital output and 4–20mA analog output, features an IP67 ingress protection rating, and is well-suited for drilling measurement applications. The device incorporates calibration algorithms for hard-iron and soft-iron magnetic field interference, ensuring high-precision heading data output across the full 360° range of roll angles and any tool-face orientation.

Utilizing a three-axis magnetic sensing solution, the GCM508 employs a main control unit to calculate heading in real time. It integrates a three-axis accelerometer, enabling heading compensation for tilt across a wide range of inclination angles, while delivering high performance and exceptional stability. With its compact form factor and low power consumption, the GCM508 is ideal for a variety of applications—including antenna attitude monitoring, vehicle-mounted equipment, and integrated system solutions—making it a perfect fit for diverse miniaturized precision measurement systems.

✓ Application Scope

Typical application areas for the GCM508 3D electronic compass:

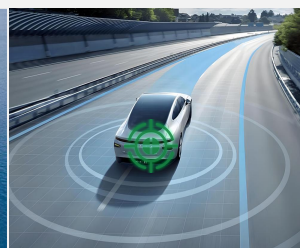
- ❖ Marine Navigation and Surveying & Mapping
- ❖ GPS-Integrated Navigation Systems
- ❖ Antenna Servo Control
- ❖ Infrared Imager Integration
- ❖ Laser Ranging Equipment Coordination
- ❖ Marine Surveying Instrument Support
- ❖ Map Updating/Supplementation System Support
- ❖ Specialized Robot Applications
- ❖ ROV (Remotely Operated Vehicle) Navigation

Marine

Navigation and Surveying/Mapping



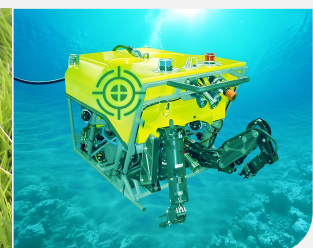
GPS integrated navigation system



Infrared Imager Integration



ROV (Remotely Operated Vehicle) Navigation



Performance Parameters

GCM508		Parameters indicators
Compass Heading Parameters	Optimal Heading Accuracy	0.3°
	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 Tilt 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°
Calibration	Hard-Iron Calibration	Yes
	Soft-Iron Calibration	Yes
	Magnetic Interference Calibration Method	24-Point (3D Calibration)
Physical Characteristics	Enclosure Dimensions	L125×W22×H24mm
	Enclosure Weight	90g
	Digital Interface Connector	5-Pin Aviation Connector
Interface Characteristics	Startup Delay	<50ms
	Maximum Output Rate	20Hz/s
	Communication Baud Rate	2400 to 19200baud
	Output Format	High-performance binary protocol
Analog Output	4–20 mA FS (0–360°)	4–20 mA output (azimuth only)
Power Supply	Supply Voltage	DC 12V (default)
	Current (Maximum)	40mA
	Active Mode	28mA
	Sleep Mode	TBD
Environmental	Operating Range	-40℃ ~ +85℃
	Storage Temperature	-40℃ ~ +85℃
	Vibration Resistance	2500g
Electromagnetic Compatibility (EMC)	In accordance with EN 61000 and GB/T 17626	
Mean Time Between Failures (MTBF)	≥98,000 hours/cycles	
Insulation Resistance	≥100 MΩ	
Shock Resistance	100g @ 11 ms, three axes (half-sine wave)	
Vibration Resistance	10grms、10 ~ 1000Hz	

✔ Ordering and Selection

Model	Enclosure	Signal Output	Installation Method
GCM50	6: PCBA Single Board	232: RS232	H: Horizontal installation measurement
	8: Enclosure housing	485 : RS485	V: Vertical installation measurement
		TTL : TTL	
Example: GCM508-232-H: Enclosure housing/RS232/Horizontal installation measurement.			

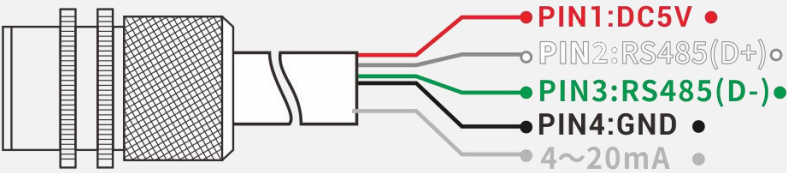
✔ Interface Definition

PIN/Thread Color	Definition	Description
PIN1 Red	DC 5V	Positive power supply terminal
PIN2 White	TTL(RXD)/RS232(RXD)/RS485(D+)	Receive data
PIN3 Green	TTL(TXD)/RS232(TXD)/RS485(D-)	Receive data
PIN4 Black	GND	Negative power supply terminal
PIN5 Gray	4 ~ 20mA	Current output

RS485



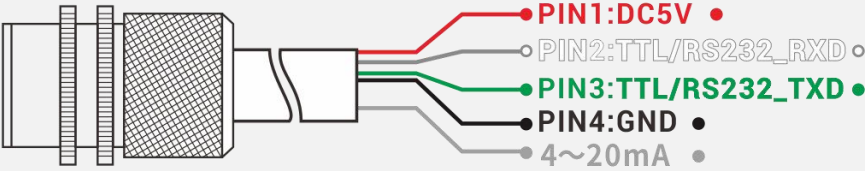
View from the outside



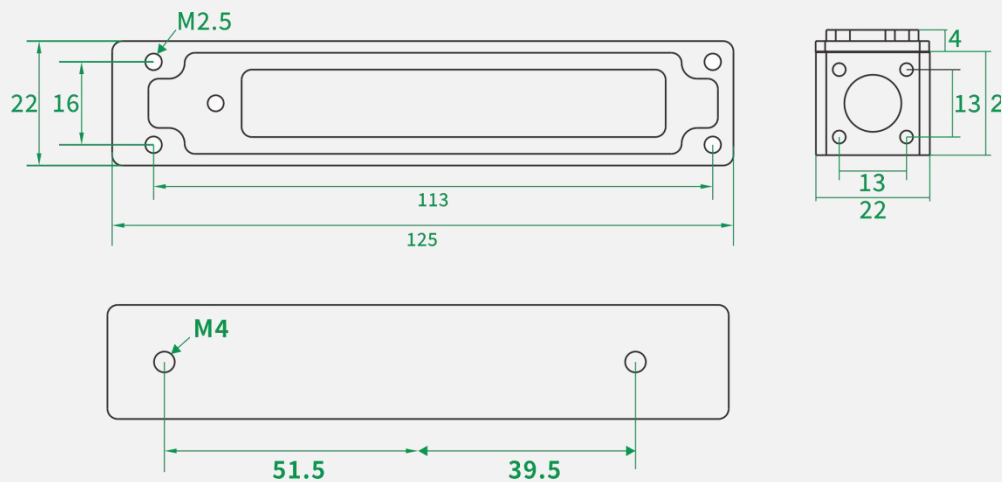
RS232



View from the outside



Product Dimensions



Housing dimensions: W125xL22xH24mm

Mounting screws: 2 x M4 screws

Measurement Direction and Installation Requirements

The 3D electronic compass measures azimuth based on geomagnetic principles; therefore, it should be installed in an environment with minimal magnetic interference. To ensure measurement accuracy, please adhere to the following installation guidelines:

1. Magnetic Interference Mitigation:

- ◆ Keep the device away from iron, magnets, engines, and other magnetic objects.
- ◆ Maintain a distance of at least 30 cm from known sources of magnetic interference (the required distance may vary depending on the specific magnetic field).
- ◆ Use M4 non-magnetic (interference-free) screws for fixed installation.

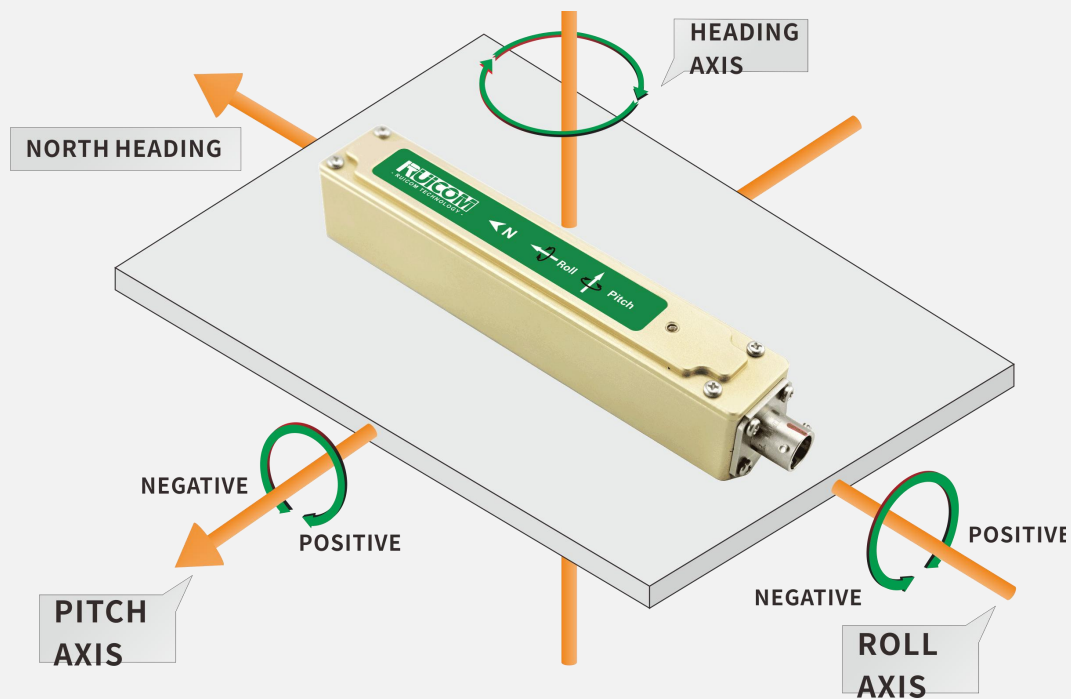
2. Cabling and Electrical Considerations:

- ◆ The device comes with a standard 1-meter cable, with custom lengths (1–10 meters) available upon request. It is recommended to keep the cable as short as possible to minimize signal noise.
- ◆ While the device can compensate for moderate, constant magnetic offsets, it cannot compensate for dynamic or fluctuating magnetic interference.
- ◆ Pay particular attention to magnetic fields generated by DC power lines; fluctuations in DC current will alter the magnetic field strength. Batteries should also be considered potential sources of variable magnetic interference.
- ◆ As operating conditions vary by site, users must evaluate the feasibility of the installation for their specific working environment.

3. Optimizing Accuracy:

- ◆ Optimal heading accuracy is 0.3°–0.5°, a specification that has been rigorously verified.
- ◆ Recommended testing method: Mount the compass on a vertical aluminum rod (or another non-magnetic material) to measure heading accuracy.
- ◆ During testing, ensure the rod remains perpendicular to the rotating platform; minimizing the compass's rotation radius helps reduce external magnetic interference.

Note: The testing protocol above is designed for laboratory environments and should be adapted for field applications. For instance, in vehicle-mounted installations, we recommend to orient the electronic compass perpendicular to the vehicle's direction of motion.



Calibration Method

Calibration prerequisites: 1) The compass accuracy fails to meet the required specifications;
 2) If the installation environment contains a constant magnetic interference source (e.g., the compass is mounted on a ferrous material), the interference source must be rotated synchronously with the compass during calibration. Furthermore, their relative positions must remain fixed during operation; otherwise, recalibration will be necessary. If the interference source is variable in terms of size or distance (e.g., movable iron objects), calibration is not possible; in such cases, a minimum safety distance of 30 cm must be maintained between the compass and the source.

- 1) Connect the electronic compass to the signal output interface and power it on.
- 2) Send the **calibration start command**: in hexadecimal format: **"68 04 00 08 0C"** (or click the **"CALI-START"** button in the 3D debugging software).
- 3) The DCM compass will return a response command; additionally, the compass will send an acknowledgment each time a data point is sampled. Please refer to the communication protocol for details.
- 4) Follow the rotation rules provided below to collect at least 12 calibration points, then send the **calibration stop command**: **"68 04 00 09 0D"** (or click the **"CALI-STOP"** button in the 3D debugging software). The compass will pause for approximately 2 seconds while its internal CPU automatically processes the sampled data. Once the calculation is complete, it will return a set of data representing the percentage of the collected samples.
- 5) Send the **calibration save command**: **"68 04 00 0A 0E"** (or click the **"CALI-SAVE"** button in the 3D debugging software). The compass will return an acknowledgment. If the save is successful, the device is ready for normal operation. If an error message is returned, you

may repeat the calibration steps above or revert to the factory-default calibration data.

6) Send the calibration start command (**as described in step 2**) to begin the process. Keep the module's orientation stable and wait for the first data point to be sampled.

7) After the first point is sampled, rotate the module approximately 90 degrees horizontally, hold it steady, and wait for the next data point to be sampled. (Refer to the calibration steps in the diagram below.)

8) Repeat these steps until 24 data points have been collected, then send the calibration stop command.

9) Send the calibration save command to finalize the calibration process.

During calibration, accuracy will change if the distance between the magnetic interference source and the compass itself varies.

Note: When you begin the calibration sampling process, move the compass into the positions described below. Please be aware that these points do not represent absolute compass headings; rather, they indicate relative changes in orientation with respect to the heading captured at the first sampling point—meaning you do not need to know the exact location of true north. Furthermore, the specified 90-degree rotations and 15-degree pitch angles are intended as general references; a certain margin of error in the sampling angles is acceptable, and extreme precision is not strictly required. You must collect data at a minimum of 12 points (24 points are recommended). To improve accuracy, you may collect additional samples—up to a maximum of 50 points—following the same general procedure, with an increased number of samples taken across various pitch and roll angles.

The calibration steps are as follows:

Calibration can begin from any orientation within the 360° range; simply ensure that each subsequent position involves a horizontal rotation of approximately 90° (high precision is not required).

See Pic. A: Start at $H=0^\circ$, $R=0^\circ$, $P=+15^\circ$ (calibrate the pitch/P value first). Hold this position steady for 2–3 seconds; the system will then capture the first data point.

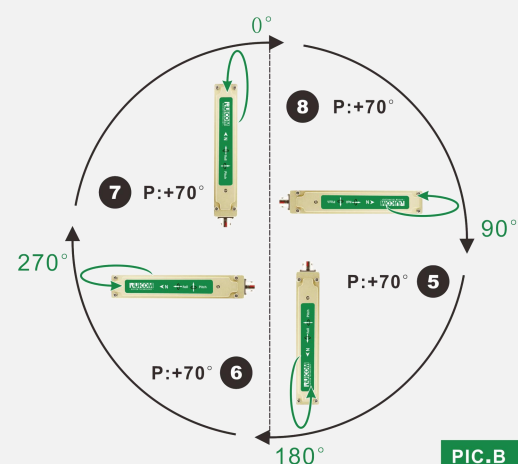
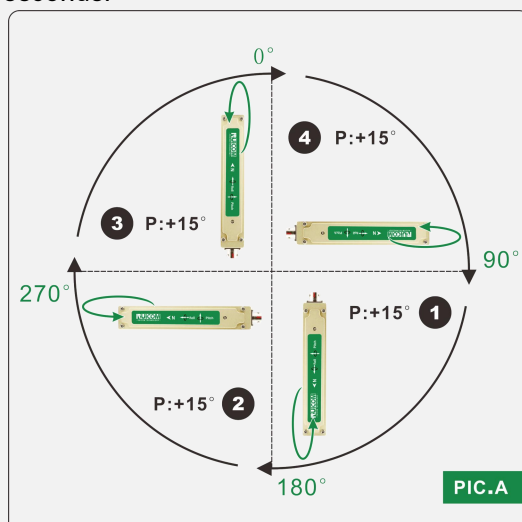
After capturing the first point, rotate the device 90° horizontally and hold it steady for 2–3 seconds to capture the second data point. Repeat this process—rotating 90° horizontally and holding for 2–3 seconds—to capture the third and fourth data points.

Once the fourth point has been captured, keep H and R unchanged, but increase the pitch (P) angle.

See Pic. B: Set the orientation to $H=0^\circ$, $R=0^\circ$, $P=+55^\circ$. Hold this position steady for 2–3 seconds; the system will capture the fifth data point.

After capturing the fifth point, rotate the device 90° horizontally and hold it steady for 2–3 seconds to capture the sixth data point.

After capturing the sixth point, rotate the device 90° horizontally and hold it steady for 2–3 seconds.



The system will capture the 7th point. After capturing the 7th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will then capture the 8th point.

Once the 8th point is captured, keep the H and R values unchanged, and proceed to calibrate the P (pitch) angle.

Refer to Pic. C: Starting at $H=0^\circ$, $R=0^\circ$, and $P=-15^\circ$, hold this position steady for 2–3 seconds; the system will capture the 9th point.

After capturing the 9th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will capture the 10th point.

After capturing the 10th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will capture the 11th point. Then, rotate the device 90° horizontally again and hold this position steady for 2–3 seconds; the system will capture the 12th point.

Once the 12th point is captured, keep the H and R values unchanged, and adjust the P (pitch) angle value.

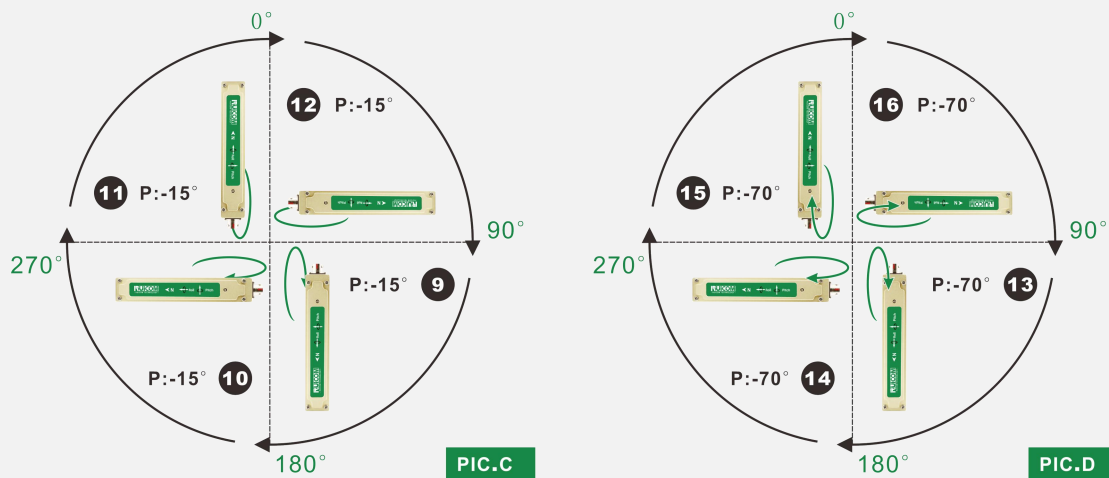
Refer to Pic. D: Starting at $H=0^\circ$, $R=0^\circ$, and $P=-55^\circ$, hold this position steady for 2–3 seconds; the system will capture the 13th point.

After capturing the 13th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will capture the 14th point.

After capturing the 14th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will capture the 15th point.

After capturing the 15th point, rotate the device 90° horizontally and hold this position steady for 2–3 seconds; the system will capture the 16th point.

Capturing the 16th point completes the P-axis calibration. Next, proceed to calibrate the R (roll) axis; an alternating calibration method can be used for the R value.



Refer to Pic. E: Starting position: $H=0^\circ$, $R=+15^\circ$, $P=0^\circ$. Hold this orientation steady for 2–3 seconds; the system will then capture the 17th data point.

After capturing the 17th point, rotate the device 90° horizontally.

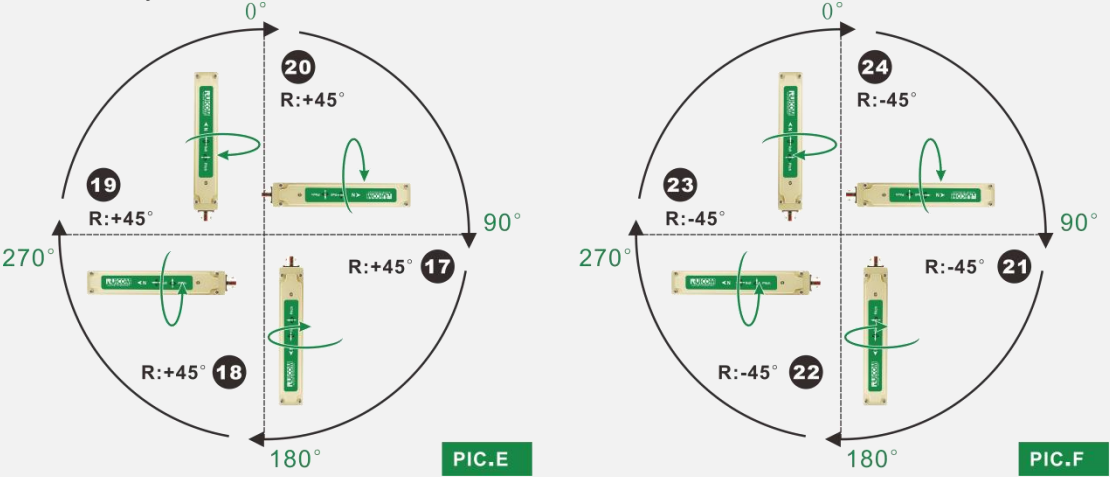
Adjust the roll (R) to -15° and hold this orientation steady for 2–3 seconds; the system will capture the 18th data point. Once the 18th point is captured,

rotate the device another 90° horizontally, adjust the roll (R) to $+15^\circ$, and hold this orientation steady for 2–3 seconds; the system will capture the 19th data point. After capturing the 19th point, rotate the device another 90° horizontally, adjust the roll (R) to -15° , and hold this orientation steady for 2–3 seconds; the system will capture the 20th data point.

After capturing the 20th point, continue the calibration by increasing the roll (R) value. Refer to "Pic. F": Starting position $H=0^\circ$, $R=+55^\circ$, $P=0^\circ$. Hold this orientation steady for 2–3 seconds; the system will capture the 21st data point.

After capturing the 21st point, rotate the device 90° horizontally, adjust the roll (R) to -55° , and hold this orientation steady for 2–3 seconds; the system will capture the 22nd data

point. After capturing the 22nd point, rotate the device another 90° horizontally, adjust the roll (R) to +55°, and hold this orientation steady for 2–3 seconds; the system will capture the 23rd data point. After capturing the 23rd point, rotate the device another 90° horizontally, adjust the roll (R) to -55°, and hold this orientation steady for 2–3 seconds; the system will capture the 24th data point. Send the "stop" command—the compass will respond—then send the "save" command; the compass will confirm that the data has been saved successfully!



Communication Protocol

One. Data frame format: (8 data bits, 1 stop bit, no parity, default baud rate 9600)

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

Identifier: Fixed as 68H;

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

Address code: The address of the data acquisition module; defaults to 00;

Data field: Content and length vary according to the command word;

Checksum: The sum of the data length, address code, command word, and data field (ignoring any carry).

Two. Command Word Parsing

Command Word	Meaning / Example	Description
0X04	Read Pitch, Roll, and Heading simultaneously Angle command 68 04 00 04 08	Data Field (0 bytes) No Command data field
0X84	Sensor Response Example: 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 red characters representing the Pitch axis CC CD DD:3 blue characters representing the Roll axis EE EF FF:3 green characters representing the Heading angle AA AA BB represents the Pitch angle value in packed BCD format. 00 10 50 three red bytes represent the Pitch angle value in packed BCD format: the high bit of the first

		byte 0 is the sign bit (0 for positive, 1 for negative) 01 0 represents the three-digit integer part, and 50 represents the two-digit fractional part. The parsing method for other axes is the same; the parsed Pitch angle is +10.50°. 10 10 05 three blue bytes represent the Roll return value; the parsing method is the same as for Pitch. Parsed Roll angle: -010.05°. 01 04 01 three green bytes represent the Heading return value; the parsing method is the same as for Pitch. Parsed Heading angle: +104.01°.
0X06	Set Magnetic Declination Command 68 06 00 06 02 08 16	Data field (2 bytes): SA AB S = Sign (0: positive, 1: negative); AA = 2-digit integer part; B = 1-digit decimal part. Example: 02 08 represents +20.8°.
0X86	Sensor Response Example: 68 05 00 86 00 8B	Data field (1 byte) The value in the data field represents the sensor's response result. 00: Setting successful FF: Setting failed
0X07	Read Magnetic Declination Command 68 04 00 07 0b	Data field (0 bytes) No Command data field
0X87	Sensor Response Example: 68 06 00 87 02 08 97	Data field (2 bytes) The value in the data field represents the sensor's response result.
0X08	Start Calibration Command 68 04 00 08 0C	Data field (0 bytes) No Command data field
0X88	Sensor Response Example: 68 05 00 88 00 8D	Data field (1 byte) The value in the data field represents the sensor's response result. 00: Start successful FF: Start failed
Note: From this point on, the module will return data each time a calibration point is sampled, until calibration is stopped. The format is as follows:		
0X88	Sensor response indicating the number of calibration points sampled Example: 68 05 00 88 07 94	Data field (1 byte) The value in the data field represents the number of calibration points sampled by the sensor (hexadecimal).
0X0A	Save Calibration Command 68 04 00 0A 0E	Data field (0 bytes) Command with no data field
0X8A	Sensor Response Example: 68 05 00 8A 00 8F	Data field (1 byte) The value 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) Baud rate: 00: 2400 01: 4800 02: 9600 (default) 03: 19200
0X8B	Sensor Response Example: 68 05 00 8B 00 90	Data field (1 byte) The value 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; address range is 00 to EF. Note: Our products share a universal address: FF. If the user-configured address is forgotten during operation, the product can still be operated using the FF address and will respond normally.
0X8F	Sensor Response Example: 68 05 00 8F 00 94	Data Field (1 byte) The value in the data field indicates the sensor's response result. 00: Success FF: Failure
0X0C	Set Angle Output Mode 68 05 00 0C 00 11	Data Field (1 byte) 00: Request-Response Mode (factory default) 01: Automatic Output Mode
0X8C	Sensor Response Example:68 05 00 8C 00 91	Data Field (1 byte) The value in the data field indicates the sensor's response result. 00: Success FF: Failure
0X2A	Set angle output mode 68 05 00 2A 00 2F	Data Field (1 byte) 00: Horizontal mounting (factory default) 01: Vertical mounting (connector facing down)
	Horizontal mounting: When the compass is placed horizontally, roll and pitch outputs are zero degrees. Vertical downward mounting: When the compass is placed vertically facing down, roll and pitch outputs are zero degrees.	
0XAA	Sensor response command Example:68 05 00 AA 00 AF	Data Field (1 byte) The value in the data field indicates the sensor's response result. 00: Success FF: Failure
0X41	Query mounting mode command 68 04 00 41 45	Data Field (0 bytes)
0XC1	Sensor response command Example:68 05 00 C1 00 C6	Data Field (1 byte) The value in the data field indicates the sensor's response result. 00: Horizontal mounting mode 01: Vertical mounting mode
0X42	Query output mode command 68 04 00 42 46	Data Field (0 bytes)
0XC2	Sensor response command Example:68 05 00 C2 00 C7	Data Field (1 byte) The value in the data field indicates the sensor's response result. 00: Request-Response Mode 01: Automatic Output Mode