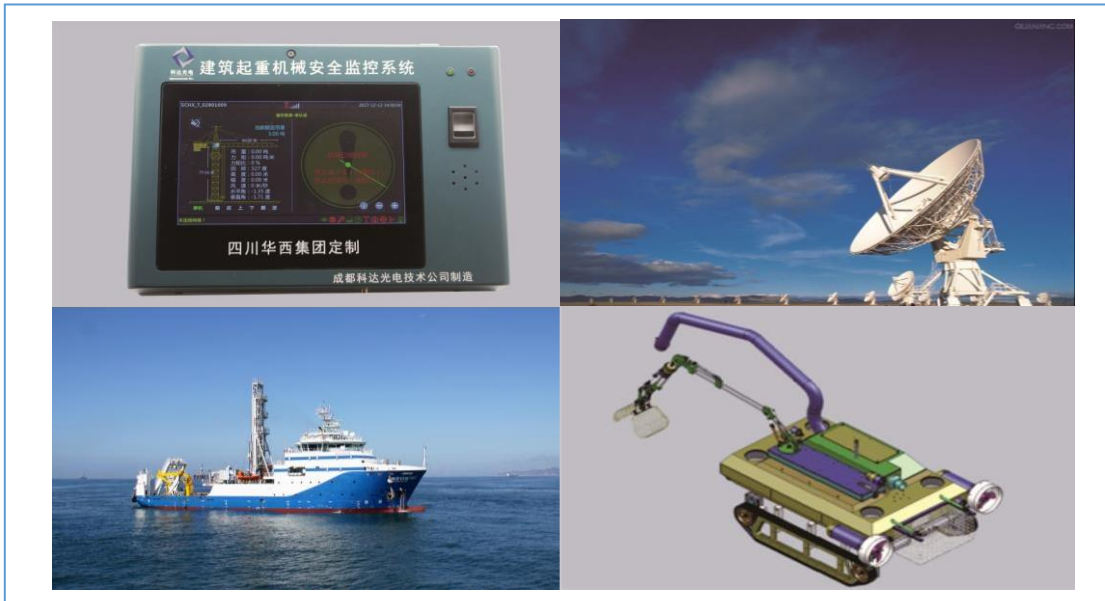




SEC385M Series

Inclination compensation Modbus
3D electronic compass

Technical Manual



Introduction

SEC385M is a cost-effective three-dimensional electronic compass developed and produced by Bewis Sensing. The product adopts the hard iron and soft iron calibration algorithm of Bewis Sensing patent technology, so that it can still provide high-precision heading information when its inclination reaches 90°. It has the advantages of small size and low power consumption, and is suitable for miniaturized, high-precision sensitive measurement systems.

SEC385M integrates a three-axis magnetic sensor. When the heading is calculated by the central processing unit in real time, a three-axis accelerometer is used to compensate the tilt angle, so that it can provide accurate heading data even in extremely harsh environments. It supports RS232, RS485 and TTL level output interfaces. The output baud rate is 2400-115200, the output angle is 0° ~ 360°, there are two types of hexadecimal and Modbus protocol. It can be adapted to the needs of different application scenarios, and the electronic compass function can be integrated into various systems very conveniently and quickly.

Feature

- Accuracy: 0.5°(RMS)
- -40°C ~ +85°C wide temperature work
- Small size: L60 x W59 x H29 (mm)
- Power supply: 9-36V
- Resolution: 0.1°
- Roll/ pitch accuracy: 0.1°
- With hard magnetic, soft magnetic and tilt compensation
- RS232/RS485/TTL Output optional

Application

- Satellite tracking
- Petroleum geological survey
- Optical rangefinder
- GPS assisted navigation
- Handheld devices
- Marine survey
- Underwater navigation
- Mechanical control

Product Feature

Electrical Index

Power voltage	9-36V DC
Working current	30mA (40mA max)
Operating temperature	-40°C~85°C
Storage temperature	-55°C~100°C

Performance Index

Compass heading parameters	Heading accuracy	0.5° (pitch < 40°) 0.7°(pitch < 60°) 1°(pitch < 80°)
	Resolution	0.01°
	Repeatability	0.1°
Compass tilt parameters	Pitch accuracy	0.1°
	Roll accuracy	0.1° for pitch < 80°
	Resolution	0.01°
Calibration	Tilt range	±80°
	Hard magnetic calibration	Yes
	Soft magnetic calibration	Yes
Physical properties	Limited tilt user calibration	Yes
	Dimension	L60 x W59 x H29 (mm)
	Weight	180g
Interface characteristics	Output form	RS232/485/TTL Interface
	Start-up delay	<3s
	Maximum output frequency	50Hz
Environment	RS232 communication rate	2400 to 115200 Baud rate
	Anti-vibration performance	2000g

Resolution: The smallest change value of the measured value that the sensor can detect and distinguish within the measurement range.

Accuracy: The root mean square error of the actual angle and the sensor measuring angle for multiple (≥16 times) measurements.



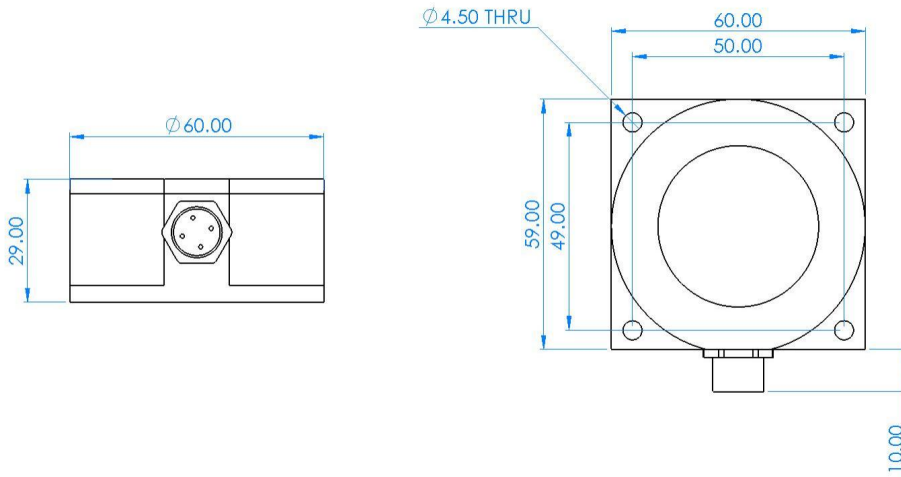
Mechanical properties

Connector	Metal connector (cable length 1.5m)
Protection level	IP67
Shell material	Magnesium aluminum alloy anodizing
Installation	Four M4 screws



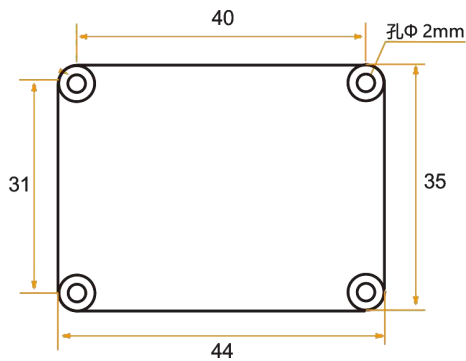
Package Product size

Product size: L60*W59*H29 (mm)



PCB Size

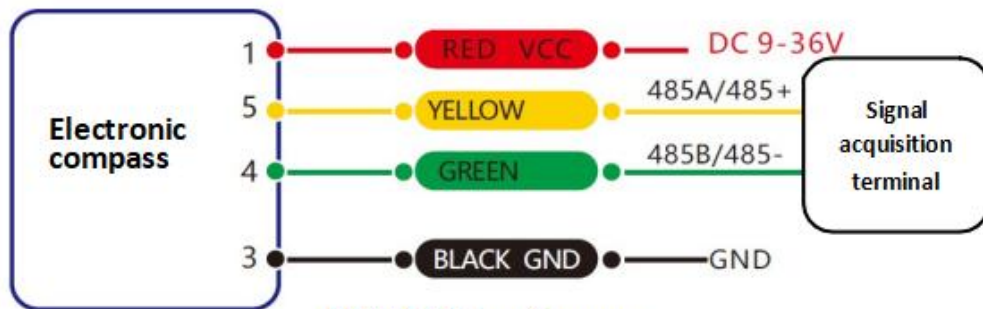
Product size: L44*W35*H11 (mm) The length and width may have an error of ± 1 mm, please refer to the actual product



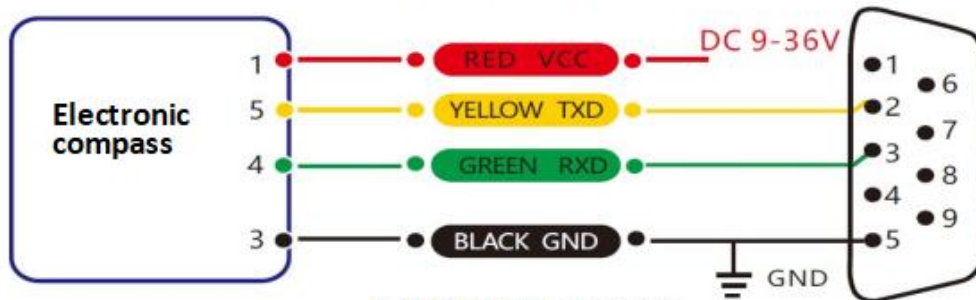
Electrical Interface

Wiring definition

	RED	BLUE	BLACK	GREEN	YELLOW
Wiring color	1	2	3	4	5
Wiring function	VCC DC 9-36V	NC	GND	RXD (B, D-)	TXD (A, D+)



RS485 Wiring diagram



RS232 Wiring diagram

Measurement Installation

The main sensitive devices of SEC385M sensor are magnetometer and accelerometer. The compass uses a magnetometer to sense the earth's magnetic field to calculate the sensor's pointing, uses an accelerometer to measure the angle between the compass and gravity, and provides inclination compensation when the compass calculates the azimuth angle. The geomagnetic field is easily interfered by external magnetic fields. Users still need to pay attention to the surrounding magnetic field when installing, ensure that the sensor is exposed to the geomagnetic field, and try to avoid using it near ferromagnetic materials and changing magnetic fields, such as engines, iron plates, Install sensors near ferrous bolts and nuts, wires, motors, horns, and antennas. Be sure to strictly avoid magnets, motors and other strong magnetic materials within 10cm of the compass, which may cause an irreversible decrease in the measurement accuracy of the compass.

We strongly recommend to calibrate the magnetic field after the installation is complete and after each change in the magnetic field environment. After the calibration is completed according to the method in the manual, the firmware and program in SEC385M can effectively eliminate the interference of the magnetic field after calibration. As long as the position of the compass and the surrounding magnetic field environment do not change, there is no need to compensate the sensor.

The test shows that if the user performs the calibration operation in accordance with the requirements of the user manual, the compass can meet the above requirements when installing, and the sensor is calibrated correctly, the heading accuracy of the sensor will be less than 0.5 degrees (RMS). Our recommended test method is to install the SEC385M sensor horizontally on a non-magnetic material away from the interference to measure the heading angle. Please avoid additional magnetic field interference during the measurement.

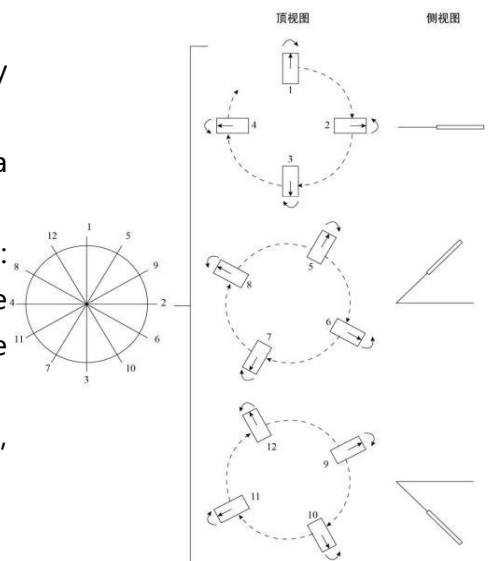
Calibration

The magnetic field calibration method can not only calibrate the magnetometer, but also effectively correct the hard magnetic interference, soft magnetic interference and various manufacturing and installation errors that exist on the installation equipment. After the calibration is completed, it can ensure that the magnetic field is under various large tilt angles. The angle measurement accuracy of the compass.

When the user chooses to use the magnetic field calibration method, in order to ensure the accuracy of the angle measurement of the magnetic compass, the user can perform the calibration regularly (6-12 months) according to the actual situation and accuracy requirements.

When the user equipment cannot realize the various postures required by the spatial calibration method, but can realize the various postures required by the magnetic field spatial calibration method, it is recommended to use the magnetic field spatial calibration method. When calibrating the magnetic field space, it is recommended to collect the data in the following 12 postures. As shown in the figure, the main points of the various postures are introduced as follows:

1. Fix the electronic compass in the use environment, try not to carry keys, mobile phones and other magnetic objects when calibrating;
2. Plug the product into the system, the product is placed in a horizontal state (within $\pm 5^\circ$);
3. First send the command to start calibration: **77 04 00 3C 40**, return: **77 05 00 3C 00 41**, indicating that the calibration has begun. Please note that there should be no additional interference introduced into the calibration at this time, otherwise the calibration quality will be affected;
4. Start to pick points, divided into twelve positions (twelve attitudes), as shown below:



Attitude 1: Point magnetic compass azimuth to 0°, the pitch angle is 0°, and the roll angle is 0°;
Attitude 2: Point Azimuth to 90°, the pitch angle is 0°, and the roll angle is 0°;
Attitude 3: Point Azimuth to 180°, the pitch angle is 0°, and the roll angle is 0°;
Attitude 4: Point Azimuth to 270°, the pitch angle is 0°, and the roll angle is 0°;
Attitude 5: Point Azimuth to 30°, the pitch angle is 45°, and the roll angle is 0°;
Attitude 6: Point Azimuth to 120°, the pitch angle is 45°, and the roll angle is 0°;
Attitude 7: Point Azimuth to 210°, the pitch angle is 45°, and the roll angle is 0°;
Attitude 8: Point Azimuth to 300°, the pitch angle is 45°, and the roll angle is 0°;
Attitude 9: Point Azimuth to 60°, the pitch angle is -45°, and the roll angle is 0°;
Attitude 10: Point Azimuth to 150°, the pitch angle is -45°, and the roll angle is 0°;
Attitude 11: Point Azimuth to 240°, the pitch angle is -45°, and the roll angle is 0°;
Attitude 12: Point Azimuth to 330°, the pitch angle -45°, and the roll angle is 0°.

Acquisition command: **77 04 00 3E 42**, return command: **77 05 00 3E XX YY**, XX is the hexadecimal number of the corresponding acquisition point, stabilise the pose, send a acquisition command, the corresponding return command. If the same value is returned continuously, it indicates that the current position acquisition point fails, and the sensor needs to be stabilised again and then sampled again, the return value of the last point is 0B, and YY is the checksum of the current collection.

If you want to terminate the calibration during the calibration process, send: **77 04 00 3D 41**, return: **77 05 00 3D 00 42**.

5. After twelve points are collected, the calibration score will be returned automatically in 3-5s, for example: **77 07 00 3F 00 00 03 49**

3F is the command word, the data field is 3 bytes to return the score value, for the compressed BCD code, four integer bits, two decimal places, such as 00 00 03, it means that the score is 0.03, the closer the score is to 0, the better the calibration effect is, and it is recommended to recalibrate if the score is greater than 1.

6. Calibration is complete

The azimuth mentioned in the above introduction is not an absolute azimuth, but a relative angle, for example, when posing attitude 1, the magnetic compass can point to any angle.

For example, in attitude 1, the magnetic compass azimuth can point to any angle, such as 42°, but in attitude 2, the magnetic compass azimuth needs to be placed at about 132°, and so on.

In attitude 2, the magnetic compass azimuth should be about 132°, and so on, while the pitch and roll angles are absolute angles. When placing the above attitudes, the azimuth, pitch and roll angles do not need to be particularly strict.

The error of each angle within $\pm 15^\circ$ is acceptable.

Order Information

Model	Communication mode	Package situation
SEC385M-232	RS232	IP67 package
SEC385M-485	RS485	IP67 package
SEC385M-TTL	TTL	IP67 package

Executive standard

- Enterprise Quality System Standard: ISO9001:2015 Standard (Certificate No.064-21-Q-3290-RO-S)
- CE certification (certificate number: M.2019.103. U Y1151)
- ROHS (certificate Number: G 190930099)
- GB/T 191 SJ 20873-2003 General specification for inclinometer and level
- GBT 18459-2001 The calculation method of the main static performance index of the sensor
- JJF 1059.1-2012 Evaluation and expression of measurement uncertainty
- GBT 14412-2005 Mechanical vibration and shock Mechanical installation of accelerometer
- GJB 450A-2004 General requirements for equipment reliability
- GJB 909A Quality control of key parts and important parts
- GJB899 Reliability appraisal and acceptance test
- GJB150-3A High temperature test
- GJB150-4A Low temperature test
- GJB150-8A Rain test
- GJB150-12A Sand and dust experiment
- GJB150-16A Vibration test
- GJB150-18A Impact test
- GJB150-23A Tilt and rock test
- GB/T 17626-3A Radio frequency electromagnetic field radiation immunity test
- GB/T 17626-5A Surge (impact) immunity test
- GB/T 17626-8A Power frequency magnetic field immunity test
- GB/T 17626-11A Immunity to voltage dips, short-term interruptions and voltage changes

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