AIT

EC-3243-R02 Series

Tilt-Compensated 3D Electronic Compass

Technical Manual

V1.0

FEATURES

- Accuracy：1°(RMS)
- -40℃～+85℃ wide operating temperature
- Small size：L55 x W37 x H24 (mm)
- Resolution：0.1°
- Roll/ pitch accuracy：0.1°
- With hard, soft magnetic and tilt compensation
- RS232/RS485/TTL Output optional

APPLICATIONS

- Power supply：5-12V
- Satellite tracking
- Petroleum geological survey
- Optical rangefinder
- GPS assisted navigation
- Individual combat equipment
- Marine survey
- Underwater navigation
- Mechanical control

DESCRIPTION

The EC-3243-R02 from AIT Sensing is a cost-effective, three-dimensional electronic compass designed for high-precision heading data in demanding applications. Its patented hard and soft iron calibration algorithm enables exceptional accuracy even at extreme inclinations of up to 90°.

This compact, low-power module integrates a three-axis magnetometer and a three-axis accelerometer. The onboard processor uses the accelerometer for real-time tilt compensation, ensuring reliable heading information from 0° to 360° even in harsh environments.

For maximum flexibility, the EC-3243-R02 supports RS232, RS485, and TTL interfaces with a configurable baud rate from 2400 to 115200 bps. It offers both hexadecimal and Modbus protocol outputs, allowing for quick and easy integration into a wide range of miniature, high-precision measurement systems.

SPECIFICATIONS

Table 1.

Parameter	Test Conditions	Min.	Typ.	Max.	Unit/Note
Power Supply Voltage		5		12	V
Operating Current	No load		30	40	mA
Operating Temperature Range		−40		85	°C
Storage Temperature Range		−55		100	°C

Table 2.

Compass heading parameters	Heading accuracy	1°(RMS)
	Resolution	0.1°
	Repeatability	0.3°
Compass tilt parameters	Pitch accuracy	0.1°
	Roll accuracy	0.1°
	Resolution	0.01°
	Tilt range	±40°

Calibration	Hard magnetic calibration	Yes
	Soft magnetic calibration	Yes
Physical properties	Dimension	L55 x W37 x H24 (mm)
	Weight	130g
	Output form	RS232/485/TTL Interface
Interface characteristics	Start-up delay	<3s
	Maximum output frequency	50Hz
	RS232 communication rate	2400 to 115200 Baud rate
Environment	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.

ELECTRICAL INTERFACE

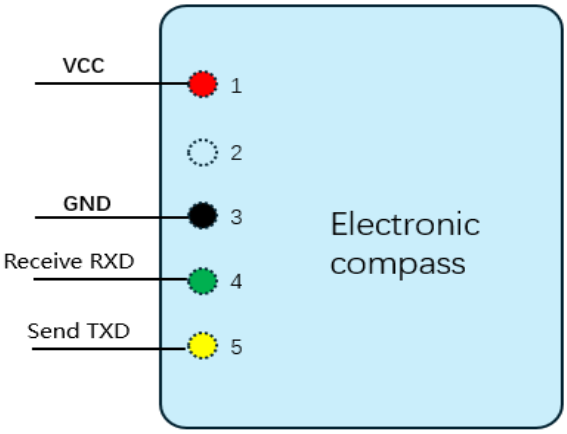

Figure 2. Pin Names

Table 3. Pin Number, Colors and Functions

No.	Color		Functions
1		Red	VCC: DC 9V ~ 36V
2		Blue	-
3		Black	Ground
4		Green	Receive RXD
5		Yellow	Send TXD

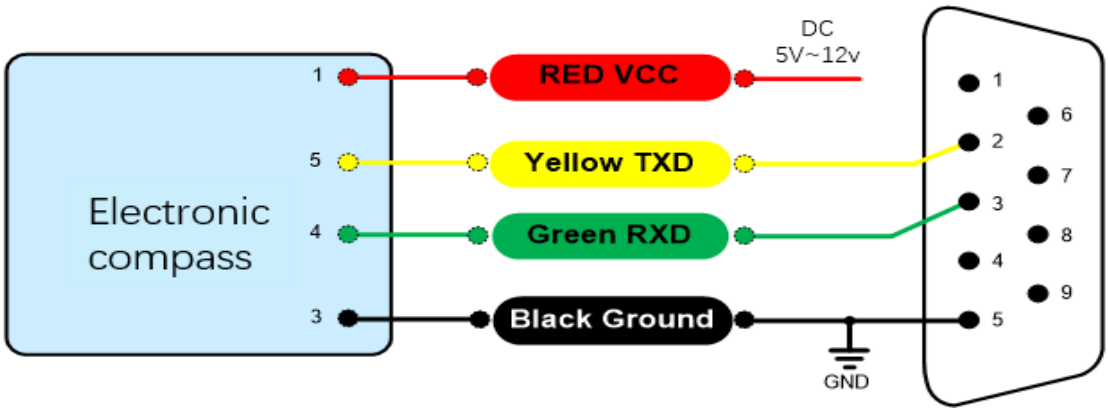

Figure 3. RS 232 Wiring Diagram

INSTALLATION

The EC-3243-R02 sensor integrates a magnetometer and an accelerometer as its core sensing elements. The magnetometer measures the Earth's magnetic field to determine heading, while the accelerometer measures the tilt angle relative to gravity, providing essential inclination compensation for accurate azimuth calculation.

As the geomagnetic field is susceptible to distortion, careful installation is critical. Ensure the sensor is exposed to the ambient geomagnetic field and avoid proximity to ferromagnetic materials or dynamic magnetic sources. These include engines, iron plates, ferrous fasteners, power cables, motors, speakers, and antennas. Strong magnetic materials, such as permanent magnets and motors, must be strictly kept outside a 10 cm radius of the compass, as they can cause irreversible degradation of measurement accuracy.

We strongly recommend performing a magnetic field calibration after installation and following any subsequent change in the magnetic environment. Once properly calibrated using the method detailed in the user manual, the EC-3243-R02's firmware can effectively compensate for measured magnetic interference. Provided the sensor's position and surrounding magnetic conditions remain unchanged, no further compensation is required.

Testing demonstrates that when installed correctly and calibrated in accordance with the user manual, the sensor achieves a heading accuracy of better than 0.5 degrees (RMS). For optimal verification of performance, install the sensor horizontally on a non-magnetic platform, away from all magnetic interference, and ensure no additional magnetic disturbances are present during measurement.

CALIBRATION

The electronic compass is calibrated at the factory. If the magnetic environment at your installation site is stable and free from significant interference, the sensor can be used directly without additional calibration. However, for optimal accuracy in any real-world application, we strongly recommend performing an on-site environmental calibration.

Method 1: Planar Calibration

This method is suitable for applications where the sensor will remain nearly level (±5°) during use.

1. **Preparation:** Connect the product to your system and ensure it is in a horizontal state.
2. **Initiate Calibration:** Using a serial communication tool, send the following hexadecimal command to begin the planar calibration process: 77 04 00 11 15
3. **Horizontal Rotation:** Slowly and steadily rotate the device **around its Z-axis** (vertical axis) 2-3 times. Maintain a nearly constant speed, completing each full rotation in **10-15 seconds**. Keep the pitch and roll angles within ±5° throughout this step.
4. **Tilt Rotation:** Slowly and steadily rotate the device **around its X-axis and Y-axis** 2-3 times each. Again, aim for a consistent speed, taking approximately **15 seconds per full rotation**.
5. **Save Parameters:** Upon completing the rotations, send the following command to save the new calibration parameters: 77 04 00 12 16

Method 2: Multi-Faceted Calibration

This advanced method is recommended for applications where the sensor may experience significant tilt, as it calibrates the compass across multiple orientations for superior accuracy.

1. **Preparation:** Secure the compass in its final operating environment. Remove magnetic objects (e.g., keys, phones) from the immediate vicinity.
2. **Initial Position:** Place the product in a horizontal state (pitch and roll within ±5°).
3. **Initiate Calibration:** Send the following hexadecimal command to begin multi-face calibration:
   77 04 00 08 0C
   The expected return value is: 77 05 00 88 00 8D
4. **Orientation Sequence:** Perform slow, constant-speed rotations (one full rotation every **10+ seconds**) for the device in each of the following four orientations. The order of these steps can be changed:

- **Face Up:** Place the product horizontally with its **top side facing up**. Rotate it 360°.
- **Side 1 Down:** Place the product horizontally with its **primary installation side facing down**. Rotate it 360°.
- **Side 2 Down:** Place the product **vertically** with one smooth side of the shell **facing down**. Rotate it 360°.
- **Side 3 Down:** Place the product **vertically** with the other smooth side of the shell **facing down**. Rotate it 360°.

5. **Save Parameters:** After rotating through all four orientations, send the command to save the calibration:
   77 04 00 09 0D
   The device will respond with: 77 05 00 89 XX YY

- XX represents the calibration error coefficient. A value **less than 1 is ideal**. A value of FFindicates calibration failure.
- YY is the command checksum.

6. The calibration is now complete.

DIMENSIONS

Outline Dimensions

Top View	Side View
Unit	mm (inch)

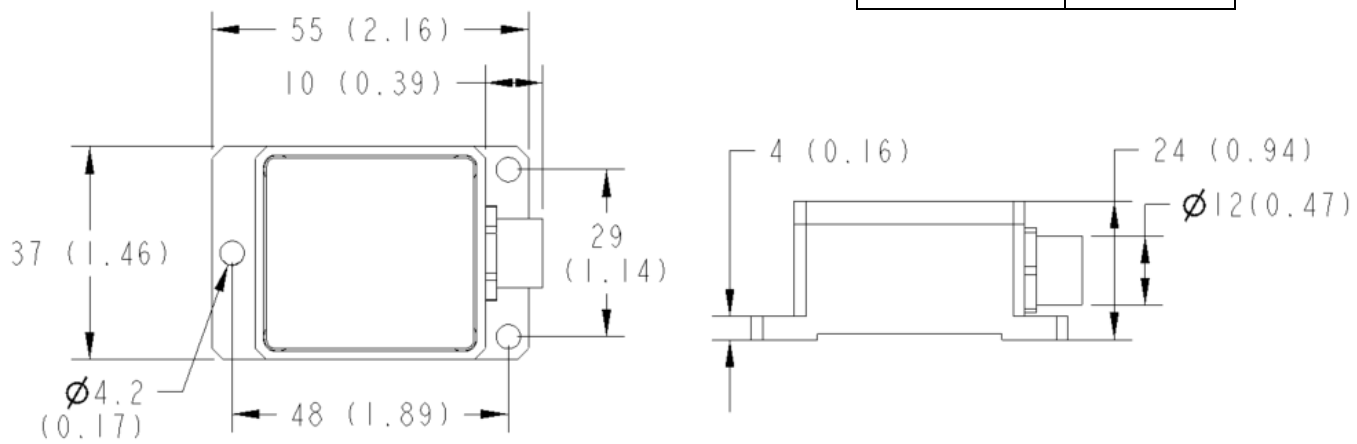

Figure 4. Outline Dimensions

Table 4. Mechanical Index

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

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