Figure 1. Top View of EC-6313-R08

FEATURES

- Tri-Axial Accelerometer and Magnetometer
- Static Measurement Accuracy of Up to ±0.25°
- Offset Tracking Algorithm Eliminates Drift
- High Accuracy, Low Cost
- Wide Temperature Range: −40°C ~+85°C
- Size: L33*W31*H13.55 (mm)
  1.30×1.22×0.53 (inch)
- With Hard and Soft Magnetic and Tilt Compensation
- Standard RS232 and TTL Output Interface

APPLICATIONS

- Satellite Tracking
- Petroleum Geological Well Surveys
- Optical Rangefinders
- GPS-Assisted Navigation
- Personal Equipment
- Marine Surveys
- Underwater Navigation
- Night Vision Devices

DESCRIPTION

The EC-6313-R08 is a high-precision electronic compass engineered for reliability in demanding applications. It integrates an industrial-grade microcontroller with exceptional anti-interference capabilities, a high-precision magnetic sensor, and a dedicated driver chip.

This module is enhanced with AIT Sensing's patented hard and soft magnetic calibration algorithms. Coupled with a built-in three-axis accelerometer for real-time tilt compensation, it delivers accurate heading data even in challenging magnetic environments.

Utilizing an optimized extended Kalman filter algorithm, the EC-6313-R08 provides real-time, high-precision attitude information. It is specifically designed to excel in static measurement scenarios and maintains superior accuracy in the presence of fixed magnetic interference.

The unit can be easily customized to meet specific client requirements and is designed for quick and seamless integration into a wide range of products.

SPECIFICATIONS

Table 1.

Parameter		Min.	Typ.	Max.	Unit/Note
Power Supply Voltage			5		V DC
Operating Current			30	40	mA
Operating Temperature Range		−40		70	°C
Power			150	200	mW
Compass Heading Parameters	Measurement Range	0		360	°
	Accuracy	after spatial calibration≤±0.3°(RMS) (inclination range −20° ~ 20°)			
	Measuring range	0		360	°
	Repeatability		0.05		° (RMS)
Compass Tilt Parameters	Pitch accuracy		0.2		°
	Roll accuracy		0.2		°
	Resolution		0.01		°
	Measuring range	−90		90	
Calibration	Plane calibration		Yes		
	Multi-sided calibration		Yes		
	High-precision magnetometer calibration		Yes		
	16 Point calibration		Yes		

Parameter		Min.	Typ.	Max.	Unit/Note
Interface characteristics	Startup delay		3		s
	Maximum sampling rate			50	Hz
	Baud Rate	9600		115200	
Weight			100		g
			0.22		lbs
			3.53		Oz

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

*Accuracy: the root mean square error of multiple (≥16) measurements of the actual angle and the measured angle of the sensor.

ELECTRICAL INTERFACES

Table 2. Pin Number, Colors and Functions

No.	1	2	3	4
Color	●	●	●	●
	BLACK	RED	YELLOW	GREEN
Functions	GND	VCC DC 5V	Send TXD (A, D+)	Receive RXD (B, D−)

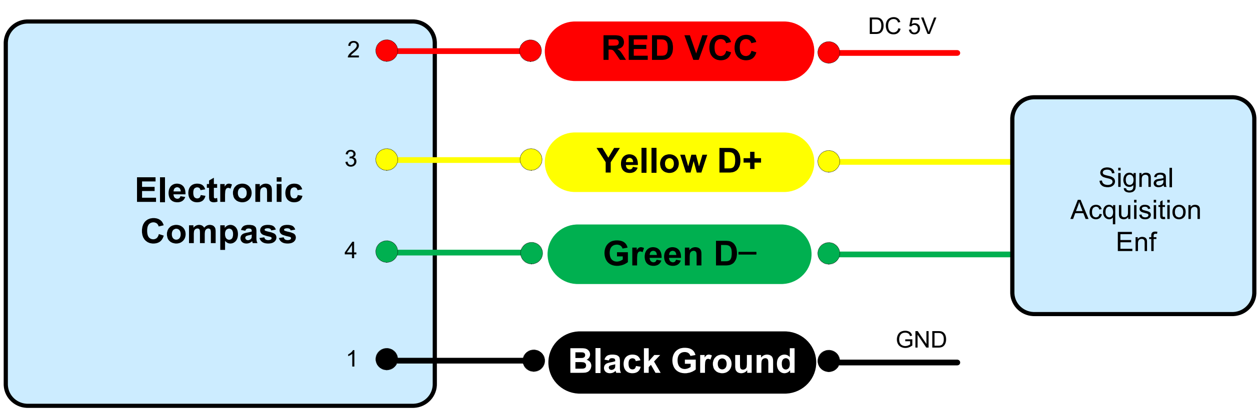


Figure 2. TTL Wiring Diagram

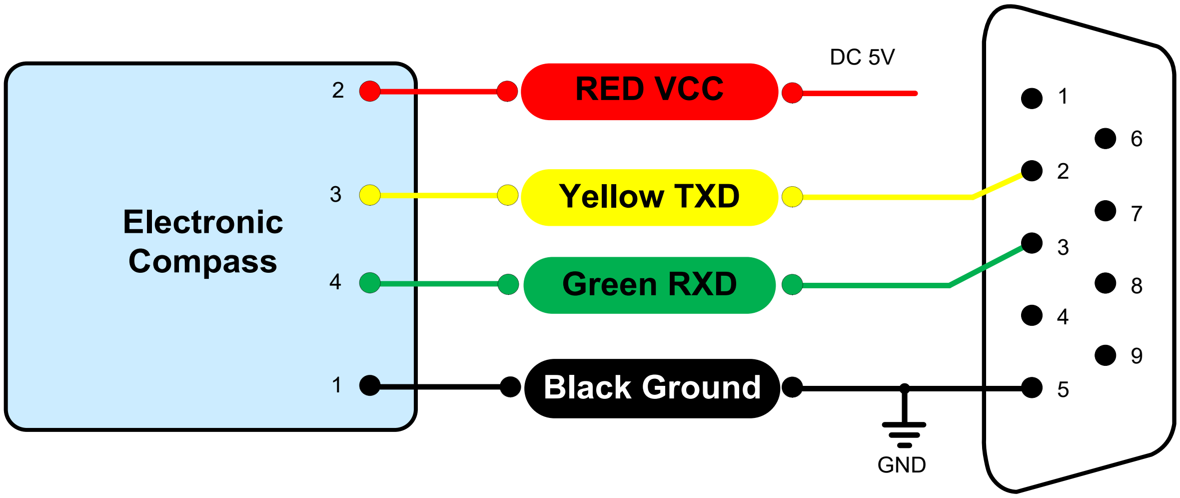


Figure 3. RS 232 Wiring Diagram

INSTALLATION DIRECTION

The sensor utilizes a magnetometer and an accelerometer as its primary 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 calculating the true azimuth.

As the Earth's magnetic field is susceptible to distortion, careful installation is critical. To ensure optimal performance:

- **Ensure** the sensor is exposed to the ambient geomagnetic field.
- **Avoid** installation near ferromagnetic materials or dynamic magnetic sources, such as engines, iron plates, ferrous fasteners, power cables, motors, speakers, and antennas.
- **Strictly prohibit** the presence of strong magnetic materials like magnets and motors within a 10 cm radius of the compass. Proximity to such items can cause irreversible degradation of measurement accuracy.

We strongly recommend performing a magnetic field calibration after installation and following any change in the magnetic environment. Once calibrated using the procedure in the user manual, the DMC5000's firmware can effectively compensate for these measured interferences. If the sensor's position and surrounding magnetic conditions remain unchanged, no further compensation is required.

When installed correctly and calibrated in accordance with the user manual, the sensor achieves a heading accuracy of better than **0.5° (RMS)**. Furthermore, after a high-precision magnetometer calibration, the relative horizontal angular error is reduced to less than **0.2° (RMS)**.

For verification of performance, install the DMC5000 sensor horizontally on a non-magnetic platform, isolated from all magnetic interference. Ensure no additional magnetic disturbances are present during measurement.

CALIBRATION METHOD

The sub compass has been calibrated in the factory. In places where the magnetic field environment has little impact, there is no need for environmental calibration during use, and it can be used directly. When conditions permit, calibrate again before use to further improve accuracy.

Azimuth calibration steps:(we suggested III and IV for accurate accuracy)

I. Plane Calibration:

1. Fix the electronic compass in the use environment and try not to carry magnetic objects such as keys and mobile phones during calibration.
2. Connect the product to the system and place the product in a horizontal state.
3. Open the serial port debugging assistant and send the start calibration command in hexadecimal format: 77 04 00 11 15.
4. Rotate the product 2-3 times in the horizontal plane (both pitch and roll angles are within ±5°)around the z-axis (z-axis is the vertical direction). The rotation process should be as slow and nearly uniform as possible. The time for one revolution is about 10~15 seconds.
5. Rotate the product 2-3 times around the X-axis or Y-axis. The rotation process should be as slow and nearly uniform as possible, and the time for one revolution is about 10-15 seconds.
6. After completing the calibration, send the command to save the calibration: 77 04 00 12 16.

II. Multi-Faceted Calibration

1. Fix the electronic compass in the use environment, and try not to carry magnetic objects such as

keys and mobile phones during calibration.

2. Connect the product to the system and place the product in a horizontal state (within ±5°).
3. Open the serial port debugging assistant, send the start calibration c format: 77 04 00 08 0C, the return value is 77 05 00 88 00 8D.
4. The product is placed in a horizontal state, the front is facing upwards (both pitch and roll are within ±5°), and it rotates approximately at a constant speed, and it takes more than 10 seconds to rotate once.
5. The product is placed in a horizontal state with the installation surface facing upwards (both pitch and roll are within ±5°), and it rotates approximately at a constant speed for one revolution, and it takes more than 10 seconds for one revolution.
6. The product is placed in a vertical state, with the smooth side of the shell facing down (both pitch and roll are within ±5°), and it rotates at approximately a constant speed, and it takes more than 10 seconds to rotate

once.

7. The product is placed in a vertical state, with the other smooth side of the shell facing down (both pitch and roll

are within ±5°), and it rotates approximately at a constant speed, and it takes more than 10 seconds to rotate once. Among them, step 4.5.6.7 can be exchanged.

8. After the four faces are rotated, send the save calibration command 77 04 00 09 0D, and return to 77 05 00 89 XX YY. Where XX represents the calibration error coefficient, the smaller the value, the better, less than 1 is ideal, FF represents the calibration failure, YY is the checksum of the command.

9. The calibration is complete.

III. High Precision Magnetometer Calibration:

High-precision magnetometer calibration is suitable for products that have already been packaged. Please use other methods for bare boards.

1. Fix the electronic compass in the use environment and try not to carry magnetic objects such as keys and mobile phones during calibration.

2. Connect the product to the system and place the product in a horizontal state. (within ±5°)

3. Open the serial port debugging assistant and send the start calibration command in hexadecimal format: 77 04 00 A0 A4rotates as slowly and nearly as possible at a uniform speed, and the time for one rotation is about 10 to15 seconds.

4. Starting from the 0 degree defined by yourself, send a collection command every 30 degrees, and wait for the return command to continue to rotate until the product rotates around the Z axis for a total of 13 points.

Acquisition command: 77 04 00 A1 A5, return command: 77 05 00 A1 XX YY, XX is the hexadecimal number corresponding to the acquisition point, and the return value corresponding to the last point is 0D.

5. Send the end calibration command: 77 04 00 A2 A6, and receive the return value: 77 05 00 A2 00 A7.

6. Wait about 20~30s until the sensor returns the end command: 77 05 00 A2 01 A8, the calibration is complete. Do not power off or send other commands before receiving the end command to prevent the sensor from losing data.

IV. 12 Point Magnetometer Calibration.

Calibration 1: Applicable for plane use

Attitude 1: Point the magnetic compass to 0°, the pitch angle is 0°, and the roll angle is 0°;

Attitude 2: Point the magnetic compass to 90°, the pitch angle is 0°, and the roll angle is 0°;

Attitude 3: Point the magnetic compass to 180°, the pitch angle is 0°, and the roll angle is 0°;

Attitude 4: Point the magnetic compass to 270°, the pitch angle is 0°, and the roll angle is 0°;

Attitude 5: Point the magnetic compass to 30°, the pitch angle is 45°, and the roll angle is 0°;

Attitude 6: Point the magnetic compass to 120°, the pitch angle is 45°, the roll angle is 0°;

Attitude 7: Point the magnetic compass to 210°, the pitch angle is 45°, the roll angle is 0°;

Attitude 8: Point the magnetic compass to 300°, the pitch angle is 45°, the roll angle is 0°;

Attitude 9: Point the magnetic compass to 60°, the pitch angle is −45°, the roll angle is 0°;

Attitude 10: Point the magnetic compass to 150°, the pitch angle is −45°, the roll angle is 0°;

Attitude 11: Point the magnetic compass to 240°, pitch angle −45°, roll angle 0°;

Attitude 12: Point the magnetic compass to 330°, the pitch angle -45°, and the roll angle 0°. The azimuth angle mentioned in the introduction to the above posture placement is not an absolute azimuth angle, but a relative angle. For example, in posture 1, the azimuth angle of the magnetic compass can point to any angle, such as 42°, but in posture 2, The azimuth angle of the magnetic compass needs to be placed at about 132°, and so on, while the pitch angle and roll angle refer to absolute angles. When placing the above postures, the azimuth, pitch, and roll angles do not need to be particularly strict, and the error of each angle is acceptable within ±15°.

Note:

1. When calibrating, please ensure that the electronic compass is tightly fixed on the device, if possible, please fix it with screws.

2. When calibrating, the electronic compass needs to be calibrated together with the device to obtain an accurate heading value instead of just calibrating the electronic compass.

3. After each single point turning to the position, the sensor needs to be in a static state before sending command.

Start magnetic field calibration
Send command: 77 04 00 3C 40
Return: 77 05 00 3C 00 41
Send after the first point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 00 43
Send after the second point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 01 44
Send after the third point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 02 45
Send after the fourth point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 03 46
Send after the fifth point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 04 47
Send after the sixth point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 05 48
Send after the seventh point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 06 49
Send after the eighth point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 07 4A
Send after the ninth point is in place: 77 04 00 3E 42
Return: 77 05 00 3E 08 4B
Send after the tenth point is in place: 77 04 00 3E 42

Return: 77 05 00 3E 09 4C

Send after the eleventh point is in place: 77 04 00 3E 42

Return: 77 05 00 3E 0A 4D

Send after the twelfth point is in place: 77 04 00 3E 42

Return: 77 05 00 3E 0B 4E

eg: after the 12point calibration, wait 5s to automatically return to the calibration score: 77 07 00 3F 00 00 02 48

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 bits, such as 00 00 02 means the score 0.02, the closer the score is to 0 means the calibration effect is better, if the score> 1, we suggest recalibration.

If you want to terminate the calibration in the process of calibration send: 77 04 00 3D 41 Return: 77 05 00 3D 00 42.

If you want to clear the calibration data after the calibration is completed: 77 04 00 10 14 Return: 77 05 00 90 00 95.

PROTOCOL

1. Data Frame Format: (8 data bits，1 stop bit，No parity check，default baud rate 9600)

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (N byte)	Checksum (1 byte)
0×77					

Data Format: Hexadecimal (The following command interprets Table 0X as a hexadecimal identifier. You do not need to enter 0X, such as 0x77, you only need to enter 77.)

Identifier: Fixed to 77

Frame Length: Length from Frame Length to Checksum (included)

Address Code: Address of acquiring module, default 0x00

Data: Content and length variable according to Command

Checksum: Sum of Frame Length, Address Code, Command and Data. (Please pay attention that when the command or data changes, the checksum will change.)

2. Command Format

2.1. Read angle of X axis Command: 77 04 00 01 05

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0×77	0×04		0x01		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (4 byte)	Checksum (1 byte)
0×77	0×08		0x81	SXXX.YY	

Note: The data field is a 4-byte return angle value, which is a compressed BCD code. S is the sign bit (0 means positive, 1 means negative), XXX is the three digit integer part, YY is the two fractional parts. The data of another axis is the same format. For example, 10 26 87 means -026.87 °, 00 34 77 means +34.77.

2.2. Read angle of Y axis Command: 77 04 00 02 06

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0×77	0×04		0x02		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (4 byte)	Checksum (1 byte)
0×77	0x07	0x00	0x82	SXXX.YY	

2.3 Read heading azimuth angle Command: 77 04 00 03 07

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0×77	0x04		0x03		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (12 byte)	Checksum (1 byte)
0×77	0x07		0x83	SXXX.YY	

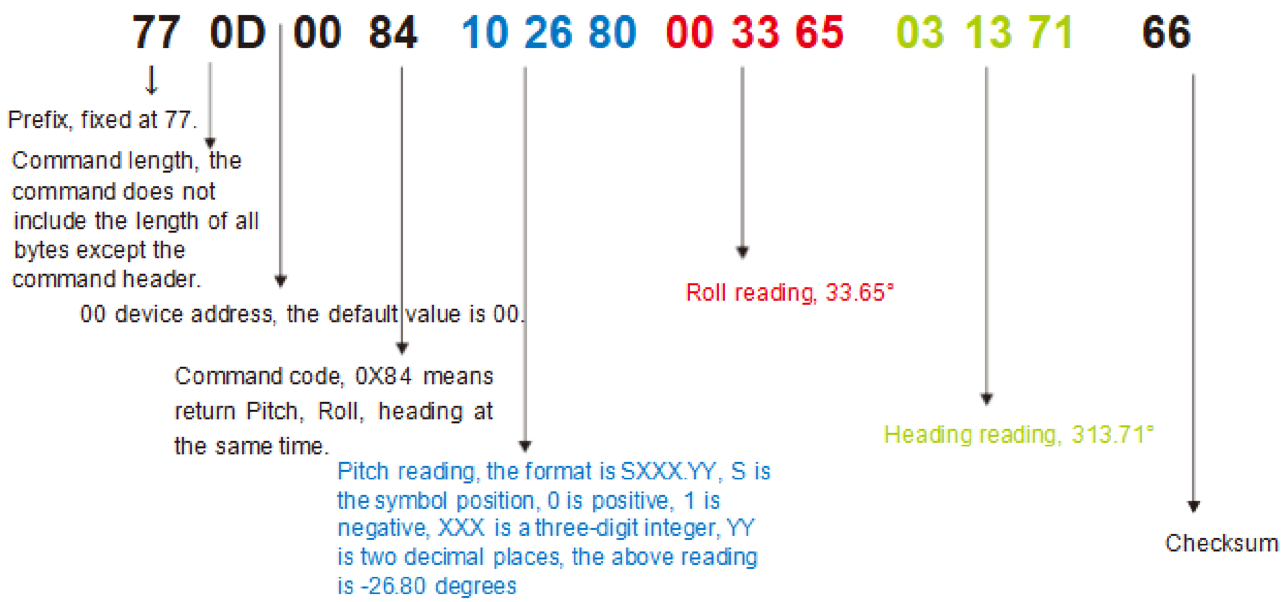
2.4 Read PITCH, ROLL and Heading axis angle Command: 77 04 00 04 08

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0×77	0x04		0x04		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (12 byte)	Checksum (1 byte)
0×77	0x0D		0x84	*	

Note: The data field contains 9 bytes which are pitch (Pitch), roll (Roll) and azimuth (Heading) angle values, which are compressed BCD codes, each of which is a group of three bytes, for example, the return command is 77 0D 00 84 10 26 80 00 33 65 03 13 71 66, where Pitch is 10 26 80, Roll is 00 33 65, and Heading is 03 13 71. For the three bytes of the return value for each angle, the format is SX XX YY, S is the sign bit (0 positive, 1 negative) XXX is a three-digit integer value, and YY is a decimal value. The corresponding readings of the three angles in this example are: -26.8°, 33.65°, and 313.71°.



2.5. Set magnetic declination Command: 77 06 00 06 02 08 16

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (2 byte)	Checksum (1 byte)
0x77	0x06		0x06	SX XY	

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (12 byte)	Checksum (1 byte)
0x77	0x05			0x00: success 0xFF: failure	

Note: S represents the sign, 0 is positive and 1 is negative, XX is a two-digit integer, and Y is a decimal. For example, 02 08 is +20.8°. The checksum of this command is 16 (hexadecimal). 16 = 06+00+06+02+08. If the declination angle is set to -3.2°, the command is 77 06 00 06 10 32 4E, where 4E = 06+00+06+10+32. The same goes for other magnetic declination angles.

2.6. Declination Command: 77 04 0070B

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0x77	0x04		0x07		

Command response:

Note: The format of SX XY is the same as the format of the magnetic declination to be set in the 2.5 command.

2.7. Set communication rate Command: 77 05 00 0B 02 12

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05		0x0B		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05		0x8B	0x00: success 0xFF: failure	

2.8. Set module address Command: 77 05 00 0F 01 15

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data 1 byte)	Checksum (1 byte)
0x77	0x05		0x0F	XX	

Command response

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05		0x8F	0x00: success 0xFF: failure	

2.9. Query current address Command: 77 04 00 1F 23

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0x77	0x04		0x1F	-	

Command response

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05		0x1F		

Note: The default address in the sensor is 0x00. When sending the query address command, the returned Data is the hexadecimal device address.

2.10. Set output angle mode Command: 77 05 00 0C 00 11

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77H	0x05		0x0C	0x00: Question-and-answer 0x01: 5Hz Data Rate 0x02: 10Hz Data Rate 0x03: 20Hz Data Rate 0x04: 25Hz Data Rate 0x05: 50Hz Data Rate 0x06: 100Hz Data Rate	

*The default output mode is 00.

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77H	0x05		0x8C	0x00: success 0xFF: failure	

Note: 5Hz Data Rate means automatically output data 5 times per second, and so on. When the product is set to automatic output mode, there will be no output within 10 seconds after the product is powered on. At this time, the product can effectively receive external setting commands.

2.11. Save Settings Command: 77 04 00 0A 0E

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0x77	0x04		0x0A		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05		0x8A	0x00: success 0xFF: failure	

*For various parameter settings, if the save setting command is not sent after the setting is completed, these settings will disappear after power off.

2.12. Switch calibration output Command: 77 04 00 A3 A7

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (0 byte)	Checksum (1 byte)
0x77	0x04		0xA3		

Command response:

Identifier (1 byte)	Frame Length (1 byte)	Address Code (1 byte)	Command (1 byte)	Data (1 byte)	Checksum (1 byte)
0x77	0x05	0x00	0xA3	0x00 (close) 0x01 (open)	0xA9

Table 3. Mechanical Index

Connector	Leading Wire
Protection level	IP67
Shell material	Magnesium aluminum alloy oxidation
Installation	Three M2 screws

DIMENSIONS

Outline Dimensions

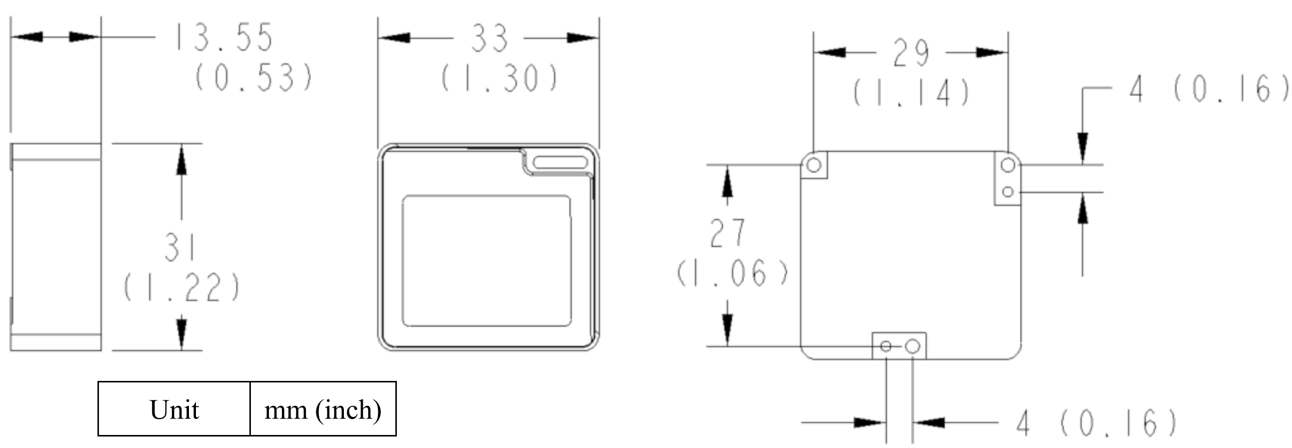


Figure 4. Outline Dimensions

ORDERING INFORMATION

Part Number	Communication Mode	Package Situation	Buy Now
EC-6313-R08-TTL	TTL	Metal package	* *
EC-6313-R08-232	RS232	Metal package	* *

*: both and are our online store icons. Our products can be ordered from either one of them with the same pricing and delivery time.

EXECUTIVE STANDARD

- Enterprise Quality System Standard: ISO9001:2008 Standard (Certificate No.10114Q16846ROS)
- CE certification (certificate number: 3854210814)
- RoHS CE (certificate number: G190930099)

NOTICE

1. It is important to carefully read and follow the warnings, cautions, and product-specific notes provided with electronic components. These instructions are designed to ensure the safe and proper use of the component and to prevent damage to the component or surrounding equipment. Failure to follow these instructions could result in malfunction or failure of the component, damage to surrounding equipment, or even injury or harm to individuals. Always take the necessary precautions and seek professional assistance if unsure about proper use or handling of electronic components.
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