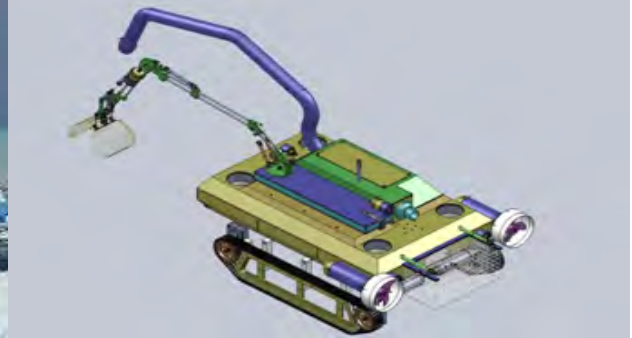# LEC210 Serials

2D Electronic Compass

Technical Manual

Introduction

The LEC210 developed by Bewis Sensing Technology LLC is a low-cost 2D electronic compass that measures the heading angle of an object based on changes in the Earth's magnetic field. This product consists of industrial-grade magnetometers, microcontrollers, and driver chips. The patented technology of hard magnetic interference and soft magnetic interference compensation is suitable for mini intelligent systems with small size, low power consumption and cost-effective.

The LEC210 supports RS232, RS485 and TTL output interfaces. The output baud rate is 2400-115200hz, and the output angle is 0°~360°. There are two types ——hexadecimal and Modbus protocolsfor optional. It can be adapted to different application. Users can integrate the electronic compass function into various systems very conveniently and quickly.

Features

- Accuracy: 2° (RMS)
- Operating temperature: -40 ° C ~ +85 ° C
- Small size: L33 x W27 x H5 (mm)
- Supply voltage: 5V
- Hard magnetic, soft magnetic and inclination compensation
- Resolution: 0.1°
- Horizontal heading measurement
- RS232/RS485/TTL interface optional

Applications

- Satellite tracking
- Petroleum geological exploration
- Optical range finder
- GPS-assisted navigation
- Individual combat equipment
- Ocean test
- Underwater navigation
- Mechanical control

Specifications

⚡ Electrical Specifications

Power supply	+5V DC
Operating current	30mA（Max40mA）
Operating temperature	-40℃~85℃
Store temperature	-55℃~100℃

🔧 Performance Specifications

Compass heading parameter	Heading accuracy	2°（RMS）
	Resolution	0.1°
	Repeatability	0.5°
Calibration	Hard magnetic calibration	Yes
	Soft magnetic calibration	Yes
	Tilt calibration	Yes
Physical specifications	Size	L33 x W27 x H5 (mm)
	Weight	10g
	Output form	RS232/485/TTL Optional
Interface specifications	Start delay	<3s
	Frequency response	50Hz
	RS-232Communication rate	2400-115200 baud rate
Environment	Anti-vibration performance	2000g

Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).
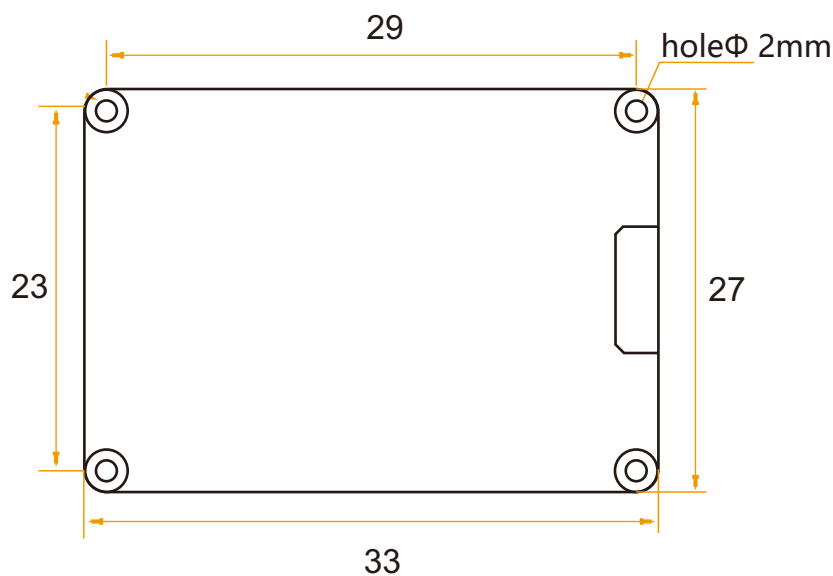
Mechanical Characteristic

Connector	Cable socket (30cm cable)
Installation	Four M2 screws

Package size

Product Size: L33*W27*H5(mm)

Measurement & Installation

The main sensitive components of the LEC210 sensor are magnetometers and accelerometers. The compass uses a magnetometer to sense the geomagnetic field to calculate the direction of the sensor. The accelerometer is used to measure the angle between the compass and the gravity, and provides the tilt compensation when the compass calculates the azimuth. The earth's magnetic field is easily interfered by the external magnetic field. Users should pay attention to the surrounding magnetic field during installation to ensure that the sensor is exposed to the earth's magnetic field and avoid using it near ferromagnetic materials and changing magnetic fields, Such as engines, iron plates, iron bolts and nuts, wires, motors, speakers, antennas, etc. It is important to strictly avoid magnets, motors and other strong magnetic substances within 10cm of the compass, which may cause the measurement accuracy of the compass to irreversibly decrease.We strongly recommend magnetic field calibration after installation and every time the magnetic field environment changes. After the calibration in accordance with the manual, the firmware and program in the LEC210 can effectively eliminate the interference of the magnetic field. As long as the position of the compass and the surrounding magnetic field environment have not changed, it is no longer necessary to compensate the sensor.

Tests have shown that if the user performs the calibration operation according to the manual and ensure the compass meet the above requirements during installation and calibrate the sensor correctly , for that, the heading accuracy of the sensor will be less than 2 degrees (RMS). The recommended test method is to mount the LEC210 sensor horizontally on a non-magnetic material away from interference for heading angle measurement. Avoid extra magnetic field interference during measurement.

Calibration

1. Place the product in a level state from interference,then connect it to the RS232 interface correctly, turn on the power;
2. Send the calibration start command in hexadecimal format: 77 04 00 08 0C;
3. The compass will return a response command;
4. Rotate the compass in situ from 0° to 360° (or more than one turn), and the compass collects the surrounding magnetic field data(Rotating speed should not be too fast, control is above 40 seconds / lap);
5. After returning to 0°, resend the stop calibration command in hexadecimal format: 77 04 00 09 0D, the calibration is successful;
   Note: If the compass is fixedly installed in other supporting equipment, after install the compass ,please rotate it together with the supporting equipment to collect the interference source of the supporting product to ensure accurate measurement of the compass.

Electrical connections

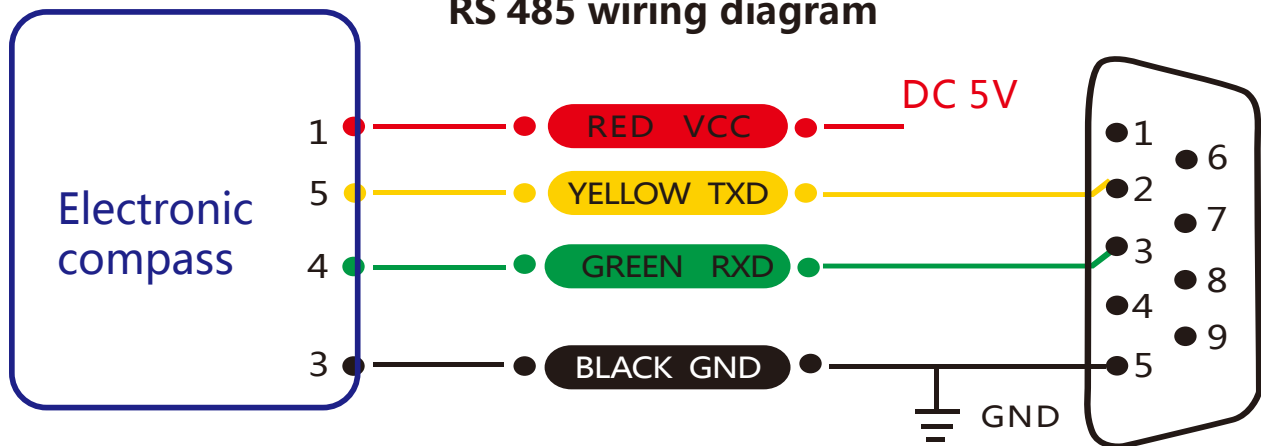## Electrical interfaces

Cable color & function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC DC 5V	NC	GND	RXD (B、D-)	TXD (A、D+)
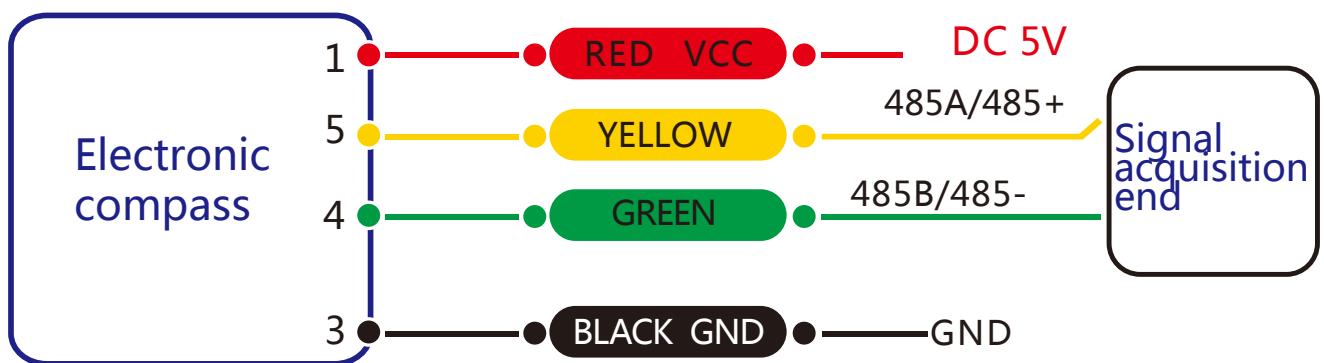
RS 485 wiring diagram

RS 232 wiring diagram

Protocol

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

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

Data Format: Hexadecimal
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.)
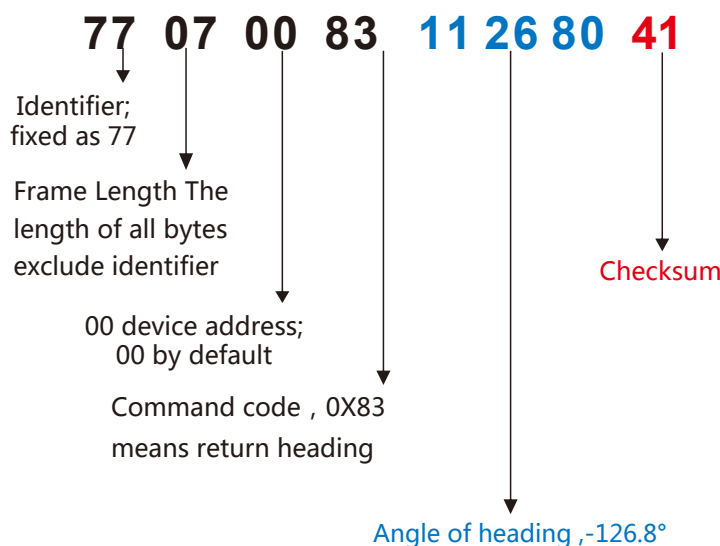
2 Command Format:

2.1 Read direction data command : 77 04 00 03 07

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x01		0x05

Command response：

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x81	SXXX.YY	

Note: Data represents 3 byte angle value in format of compressed BCD code. S is the sign bit (0 means positive, 1 means negative), XXX is the three digit integer part, YY is the fractional part. The Data of other axis is the same format. For example, 11 26 80 means -126.8 °.

77 07 00 83 11 26 80 41

Identifier; fixed as 77

Frame Length The length of all bytes exclude identifier

00 device address; 00 by default

Command code , 0X83 means return heading

Checksum

Angle of heading ,-126.8°

2.2 Set baud rate   Command：77 05 00 0B 02 12

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

Command response：

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

Note: 00:2400,01:4800,02:9600,03:19200,04:115200,05:38400,6:57600. If the baud rate is set to 19200, the command is 77 05 00 0B 03 13, where 13 = 05+ 00+ 0B+ 03, and so on when setting other baud rates.
Note: After setting the baud rate, the device will return the response command at the original baud rate. After that, the baud rate setting will take effect and the host computer needs to make the corresponding baud rate change to re-communicate with the device.

2.3 Set the magnetic declination   Command：77 06 00 06 02 08 16

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (2byte)	Checksum (1byte)
0x77	0x06		0x06	SXXX.YY	0x06

Command response：

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x86	0x00: success 0xFF: failure	

Note: S indicates a symbol, 0 is positive 1 is negative, XX is a two-digit integer, and Y is 1 decimal. For example, 02 08 is +20.8°. The checksum of the command is 16 (hex).16 = 06+00+06+02+08. If the declination is set to -3.2°, the command is 77 06 00 06 10 32 4E, where 4E = 06+00+06+10+32. Other magnetic declinations are analogous.

2.4 Read magnetic declination   Command：77 04 00 07 0B

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

Command response：

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (2byte)	Checksum (1byte)
0x77	0x06		0x87	SXXY	

2.5 Set address Command: 77 05 00 0F 01 15

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

Command response：

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

2.6 Query address   Command： 77 04 00 1F 23

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

Command response：

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

Note: The default address of the sensor is 0x00. When the query address command is sent, the returned data field is the hexadecimal device address.

2.7 Set output mode   Command： 77 05 00 0C 00 11

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0C	0x00: question and answer Mode 0x01: 5Hz Data Rate 0x02: 10Hz Data Rate 0x03: 20Hz Data Rate 0x04: 25Hz Data Rate 0x05: 50Hz Data Rate 0x06: 100Hz Data Rate	

Note: The default output mode is 00(when setting 100HZ output frequency.

Set baud rate to 115200 in high speed mode.

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8C	0x00: success 0xFF: failure	

Note: 5Hz Data Rate means that 5 sets of angle data are automatically output every second, and so on. When the product with the half-duplex RS485 interface is set to automatically outputs data to the outside, it may not be able to receive the input command effectively. At this point you may need to repeatedly send the command so that product can receive it. Therefore, if you need to send commands to interact with the product, it is recommended to set the product to work in Q&A mode. In addition, when the product is set to the automatic output mode, there will be no output within 10 seconds after the product is powered on, and the product can effectively receive the external setting command.

2.8 Save setting   Command：77 04 00 0A 0E

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

Command response：

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

Note: If Save setting command is not executed, all setting will be invalid after power off.

Ordering Inf

Product number	Way of communication	Package condition
LEC210-232	RS232	Bare board
LEC210-485	RS485	Bare board
LEC210-TTL	TTL	Bare board

Executive standard

- Enterprise Quality System Standard: ISO9001:2008 Standard (Certificate No.:10114Q16846ROS)
- CE certification (certificate number: 3854210814)
- ROHS (certificate number: SO81426003)
- GB/T 191 SJ 20873-2003 General specifications for tiltmeters and spirit levels
- GBT 18459-2001 sensor main static performance index calculation method
- JF 1059-1999 Evaluation and Expression of Measurement Uncertainty
- GBT 14412-2005 mechanical vibration and shock mechanical installation of accelerometer
- General requirements for GJB 450A-2004 equipment reliability
- Quality control of key parts and important parts of GJB 909A
- GJB 899 Reliability Qualification and Acceptance Test
- GJB 150-3A high temperature test
- GJB 150-4A low temperature test
- GJB 150-8A rain test
- GJB 150-12A dust test
- GJB 150-16A vibration test
- GJB 150-18A impact test
- GJB 150-23A Tilt and Swing Test
- GB/T 17626-3A RF electromagnetic radiation immunity test
- GB/T 17626-5A surge (hit) impulse immunity test
- GB/T 17626-8A power frequency magnetic field immunity test
- GB/T 17626-11A voltage dips, short interruptions and voltage changes immunity

LEC210

2D Electronic Compass

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