



EW S3000 高精度倾角计

High Accuracy Inclinometer
Technical Manual



Introduction

Designed by Bewis Sensing Technology LLC, BWS3000 is a dual-axis high-accuracy inclinometer with MEMS technology and digital output. It has a measuring range of $\pm 30^\circ$ and a full-scale accuracy of 0.001° . It is a highly accurate product in the industry for now. The product uses a high-resolution differential digital-to-analog converter with built-in automatic compensation and filtering algorithms to reduce errors caused by environmental changes. It measures the change of static gravitational field and converts it into angle change. The change directly outputs the current roll angle and pitch angle through digital mode. It is easy to install and simple to use, small in size, resistant to external electromagnetic interference, and capable of withstanding vibration shock. It apply to military equipment, industrial automation, surveying and mapping, etc.

Features

- Dual-axis inclination measurement
- Resolution: 0.0005°
- Accuracy: 0.001°
- Output mode: RS485/232/TTL optional
- Voltage input: 9~35V(DC)
- Operating temperature: $-40^\circ\text{C}\sim+85^\circ\text{C}$
- Output frequency: Adjustable
- Accept OEM customization

Applications

- Bridge deflection monitoring
- Building health monitoring
- Precision platform automatic leveling
- Military equipment automation
- Tunnel and dam monitoring
- Tower tilt monitoring
- Measuring and mapping instrument
- Wind tower monitoring



Specifications

Electrical Specifications

Power supply	9-35V DC
Operating current	50mA (12V) ; 40mA (24V)
Operating temperature	-40~85°C
Store temperature	-55~100°C

Performance Specifications

Measuring range(°)	Conditions	±5	±15	±30
Measuring axis	Vertically	X-Y	X-Y	X-Y
Accuracy(°)	Indoor	0.001	0.003	0.005
Resolution(°)	Completely static	0.0005	0.0005	0.0005
Zero temperature drift(°/°C)	-40 ~ 85°C	±0.0007	±0.0007	±0.0007
Cross axis error(°)	Max	0.001	0.001	0.001
Power-on time		<3s	<3s	<3s
Frequency response (Hz)	5 ~ 100Hz	100	100	100
Baud rate	Adjustable	2400~115200	2400~115200	2400~115200
MTBF	≥90000 hours/time			
Electromagnetic compatibility	according to GBT17626			
Insulation resistance	≥100 MΩ			
Shock resistance	2000g,0.5ms,3times/axis			
Weight (g)	20 N.W.			

Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.

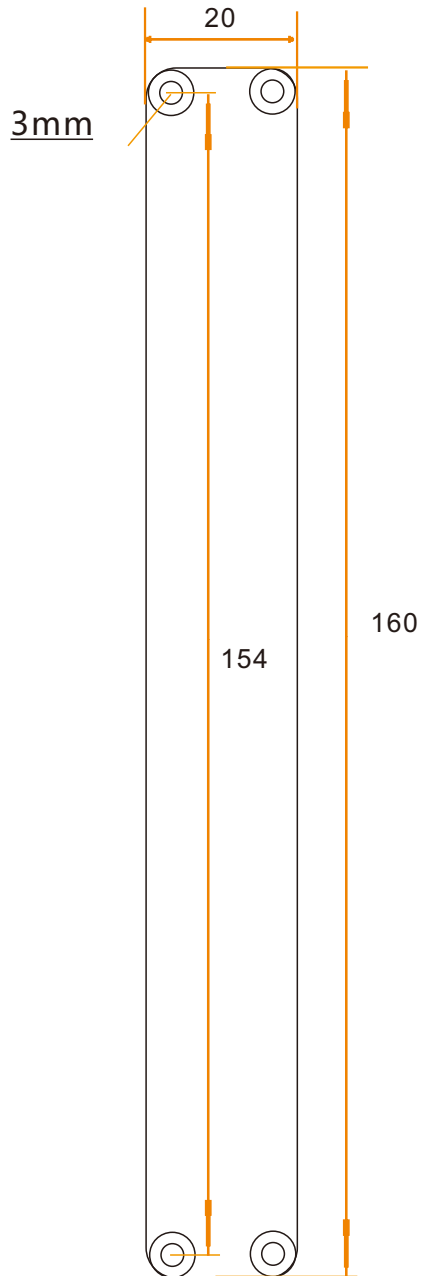
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

 Mechanical Characteristic

Connector	Direct lead (Cable length is 1.5m)
Installation	Four M3 screws

 Package size

Product Size: L160*W20*H20 (mm)

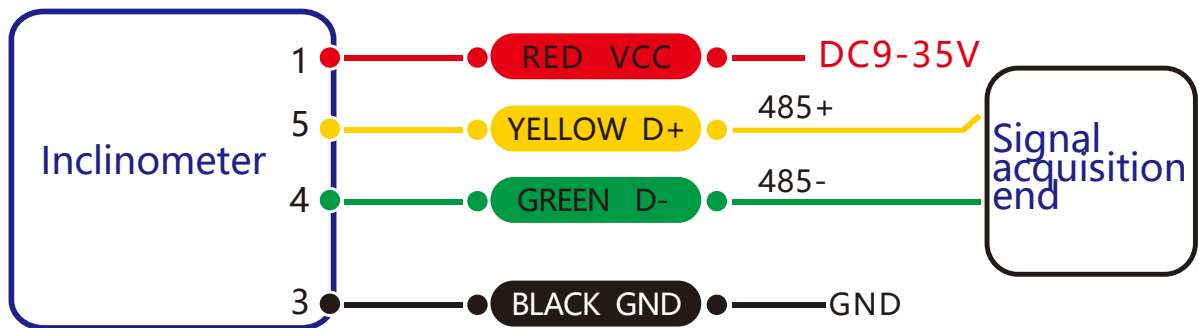




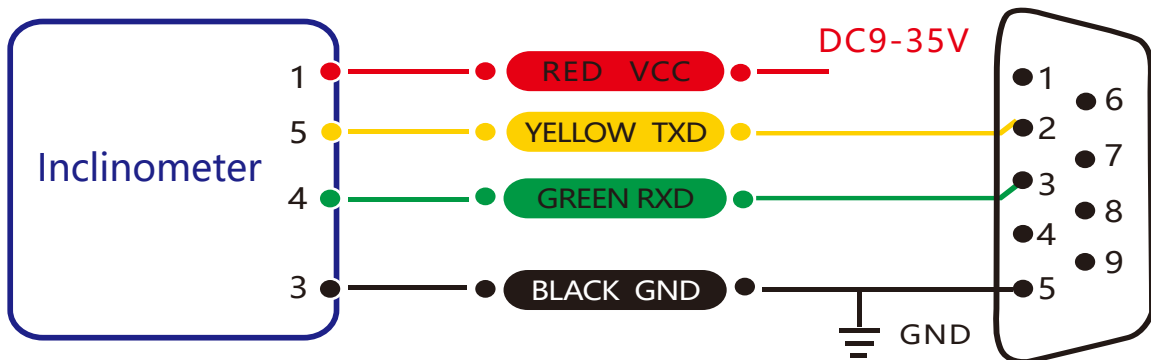
Electrical connections

Electrical interfaces

Cable color & Function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC DC 9-35V	NC	GND	RXD (B, D-)	TXD (A, D+)



RS 485 wiring diagram



RS 232 wiring diagram

Debug software

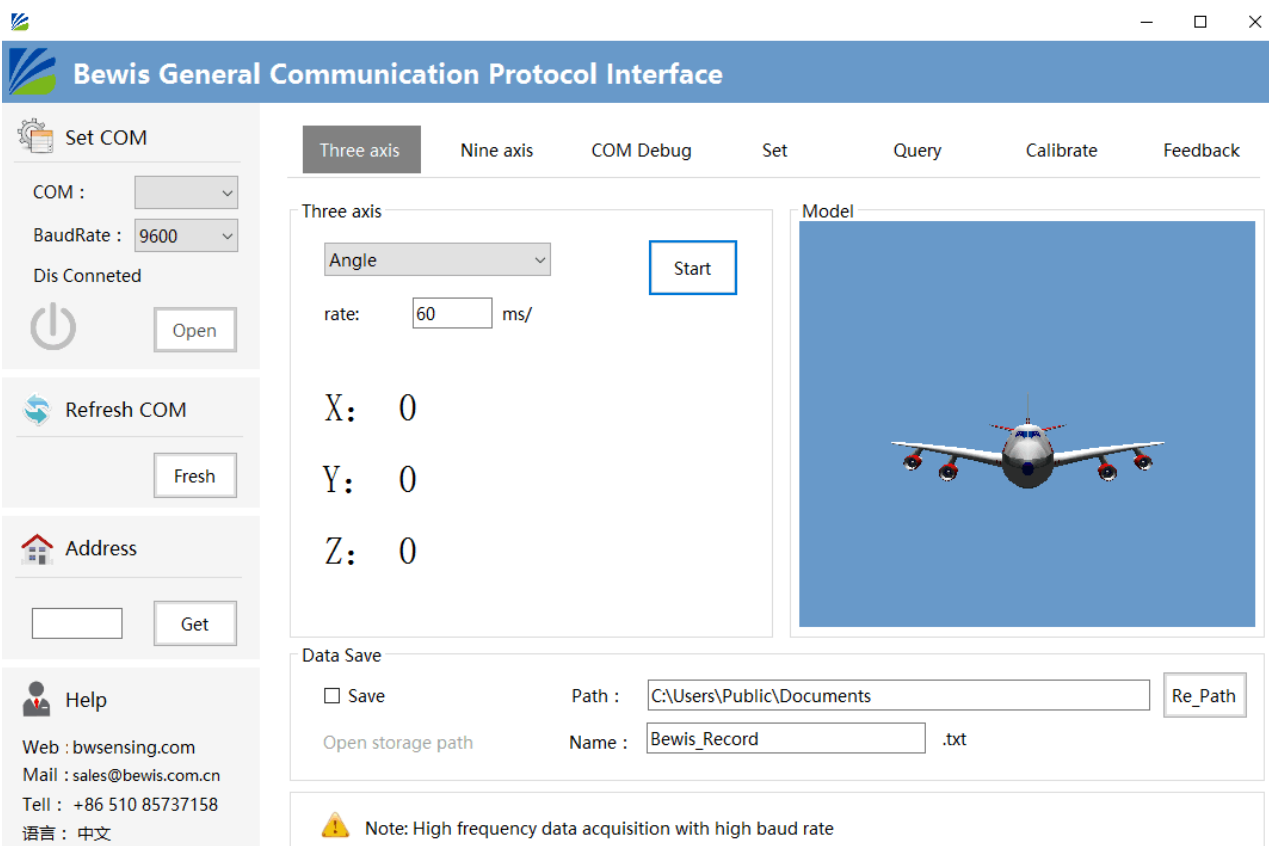
Users can directly download serial assistant on official website (Supports-Download). You can also use more convenient and intuitive PC software.

BWS3000 supporting serial debugging software can be connected to the inclinometer on the computer for angle display. The software debugging interface is as shown in the figure below. Using the debug software, it can conveniently display the current X-direction tilt angle, and you can also modify and set other parameters by yourself.

Software use steps:

- ① Correctly connect the inclinometer serial port hardware and connect the power supply.
- ② Select the computer serial port and baud rate and click connect Serial Port.
- ③ Click Start and the tilt angle of the tilter in the X direction will be displayed on the screen.

Note: You can switch to Chinese or English version by the bottom left button.





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 (Nbyte)	Checksum (1byte)
0x77					

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 (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x01	-	0x05

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (4byte)	Checksum (1byte)
0x77	0x08	0x00	0x81	SXXX.YYYY	

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, YYYY is the four fractional part. The Data of other axis is the same format. For example, 10 26 87 60 means -026.8760°, 00 34 77 70 means +34.7770.

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

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x02	-	0x06

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (4byte)	Checksum (1byte)
0x77	0x08	0x00	0x82	SXXX.YYYY	



2.3 Read angle of X,Y axis Command: 77 04 00 04 08

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

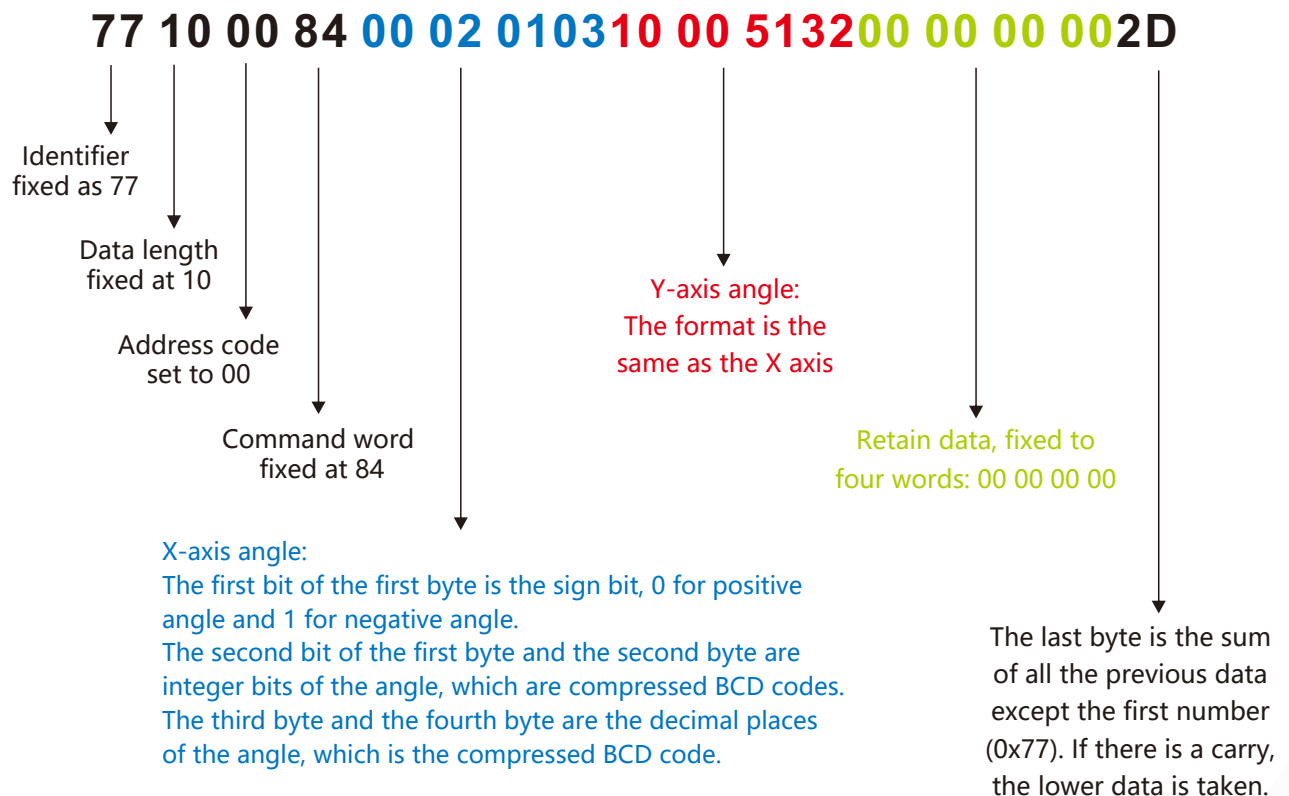
Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (12byte)	Checksum (1byte)
0x77	0x10		0x84	Three groups SXXX.YYYY	

Note: The data field is a 12-byte return angle value divided into three groups, each group being one sign bit and three compressed BCD codes. They are the X-axis angle, the Y-axis angle, and 0.

For example: X axis: +2.0103°, Y axis: -0.5132°

X axis: +0002.0103°, Y axis: -00.5132°



**2.4 Set absolute/relative zero point Command: 77 05 00 05 00 0A**

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00	0x05	0x00: absolute zero 0x01: relative zero	

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00	0x85	0x00: success 0xFF: failure	

Note: If set to absolute zero, the measurement angle is based on the zero point of the chip;
 If set to a relative zero point, the measurement angle is zero based on the current position;
 The maximum energy angle of the sensor is related to setting the zero point.

2.5 Query relative / absolute zero Command: 77 04 00 0D 11

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x0D		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00	0x8D	0x00: absolute zero 0xFF: relative zero	

Note: This command refers to whether the zero point reference used in the current state is relative zero or absolute zero.

2.6 Set baud rate Command: 77 05 00 0B 03 13

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00	0x0B	0x03	0x13

Command response:

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

Note: For data, 00: 2400, 01: 4800, 02: 9600, 03: 19200, 05: 115200, Default 02:9600.

Note: Set baud rate to 115200 in high speed mode. When the Set rate command is executed successfully, the command response will be return in the original baud rate and then communicate with new baud rate.

Note: If high frequency output is required, set the baud rate to 115200.If high frequency output is required, set the baud rate to 115200.

**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	0x00	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 the 50Hz and 100Hz output frequencies, you need to adjust the baud rate to 115200.

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00	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 you are using is the RS485 interface, because this interface is half-duplex, when the product 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 that the product can receive it. So if you need to send commands to interact with the product, it is recommended to set the product to work in Q&A mode.

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

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x0A		0x0E

Command response:

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

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

**2.9 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	0x00	0x0F	XX Address	

Command response:

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

2.10 Query address Command: 77 04 00 1F 23

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x1F		0x23

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	0x00 current address	0x1F	0x00 current address	



Ordering Information

Product number	Way of communication	Package condition
BWS3000-30-485	RS485	9Xi \ Yf Xi [
BWS3000-30-232	RS232	9Xi \ Yf Xi [
BWS3000-30-TTL	TTL	9Xi \ Yf Xi [

Executive standard

- Enterprise Quality System Standard: ISO9001:2008 Standard (Certificate No.:23919Q1045IROS)
- CE certification (certificate number: M.2019.103.UY1151)
- RoHS (certificate number:G 190930099)

BWS3000 Serials

High Accuracy Inclinometer

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