BWS4700

Super High Accuracy Digital output with Modbus Dual-Axis Inclinometer

Technical Manual

BWS 4700

High Accuracy Modbus Dual-Axis Inclinometer

Introduction

Designed by Wuxi Bewis Sensing Technology LLC , BWS4700 is a dual-axis super high-accuracy inclinometer with MEMS technology and digital output. It has a measuring range of ±90° and a full-scale accuracy of 0.003°. 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
- Accuracy: 0.003°
- Output mode: RS232/485/TTL Optional with Modbus
- IP67 protection
- Baud rate: 2400~115200 (Adjustable)
- Measuring range: ±90°
- Voltage input: 9~35VDC
- Operating temperature: -40~+85℃
- Output frequency: 5~100Hz(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

Parameters	Conditions	Min	Typical	Max	Units
Power supply		9	12	35	V
Operating current	Non-loaded	20	30	40	mA
Operating temperature		-40		+85	℃
Store temperature		-55		+100	℃

Performance Specifications

Measuring range(°)	Conditions	±30	±60	±90
Measuring axis	Vertically	X-Y	X-Y	X-Y
Accuracy(°)	Indoor	0.003	0.003	0.003
Resolution(°)	Completely static	0.001	0.001	0.001
Zero temperature drift(°/℃)	-40～85℃	±0.0007	±0.0007	±0.0007
Cross axis error(°)	Max	0.003	0.003	0.003
Power-on time		<3s	<3s	<3s
Frequency response (Hz)	5～100Hz (Adjustable)	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）	320（Metal connector）/350（Aviation connector）			

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

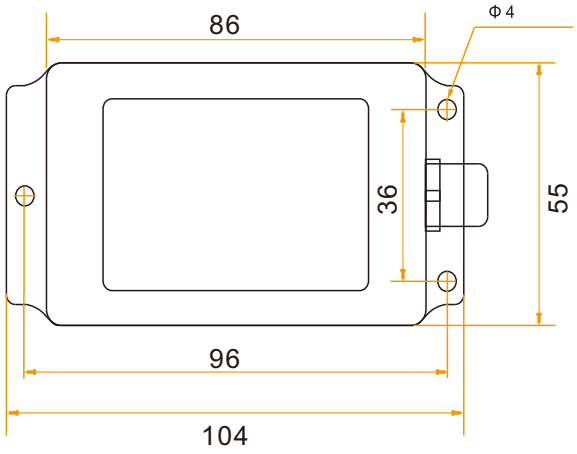
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

Mechanical Characteristic

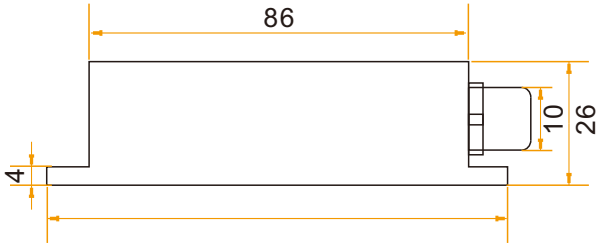
Connector	Metal connector（standard cable length 1.5m）
Protection level	IP67
Shell material	Magnesium alloy anodizing
Installation	Three M4 screws

Package size

Product Size：L103.8*W55.4*H26（mm）



Top view

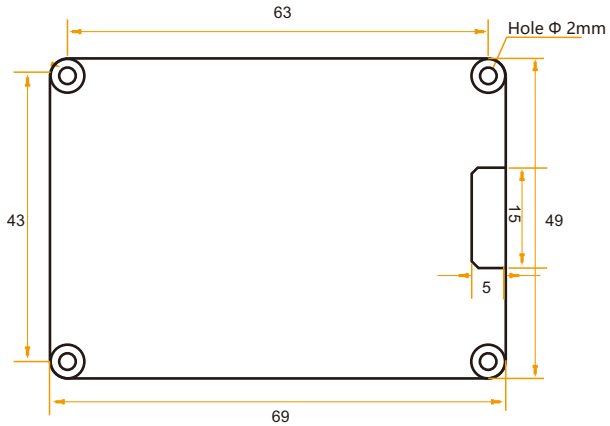


Aviation connector：116
Metal connector：105

Bare plate product size

Product size: L69*W49*H12(mm)

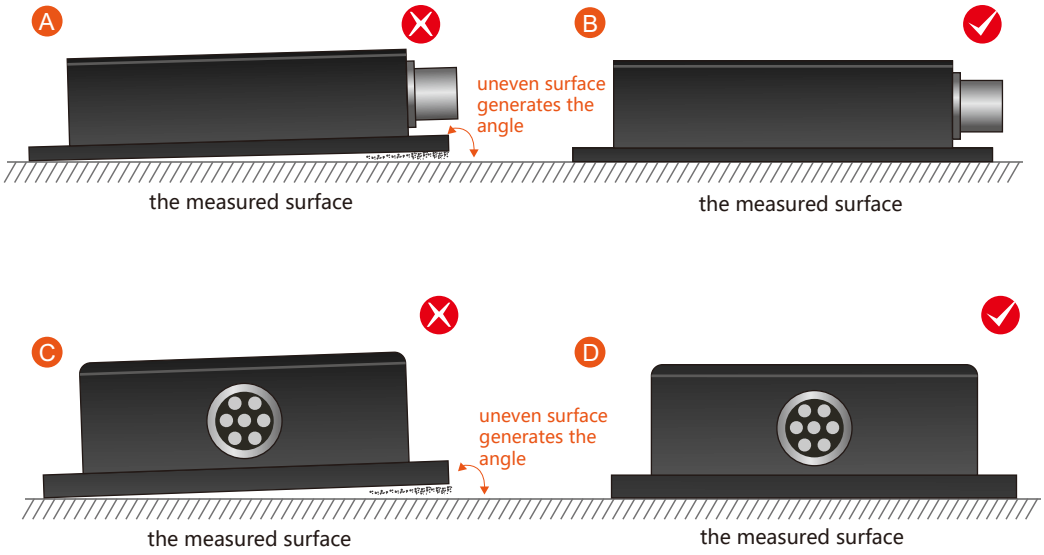
Note: ±1mm error for length and width dimensions, please refer to actual size.



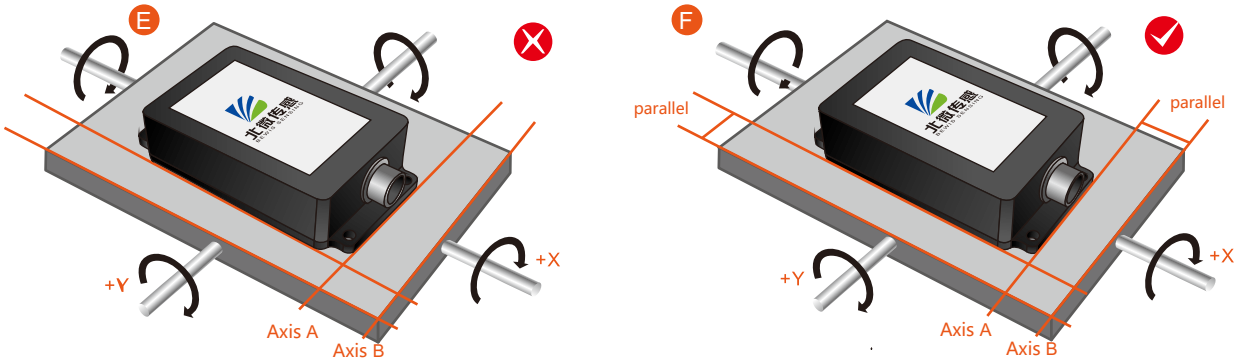
Installation direction

The correct installation method can avoid measurement error. The following points should be made when installing the sensor:

First of all, to ensure that the sensor mounting surface and the measured surface completely close, the measured surface should be as horizontal as possible, can not have the angle shown in Figure A and Figure C, the correct installation is shown in Figure B and Figure D.



Secondly, the bottom cable of the sensor and the axis of the measured object shouldn't generate the angle shown in E. When installing, the bottom cable of the sensor should be kept parallel or orthogonal to the rotation axis of the measured object. This product can be installed horizontally or vertically (vertical installation requires customization). The correct installation method is shown in Figure F.

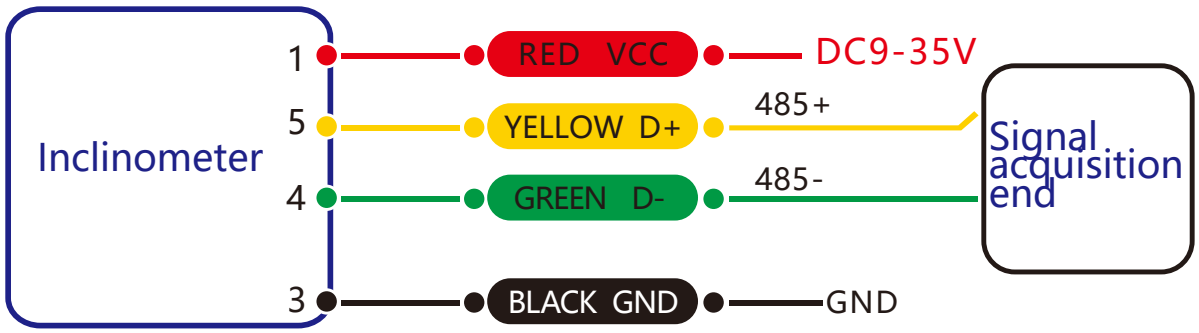


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

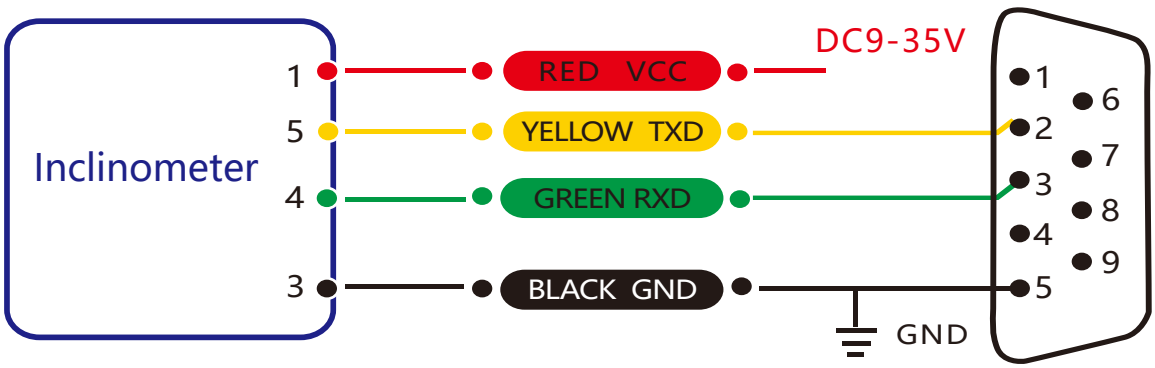
Electrical connections

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.
BWS4700 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.

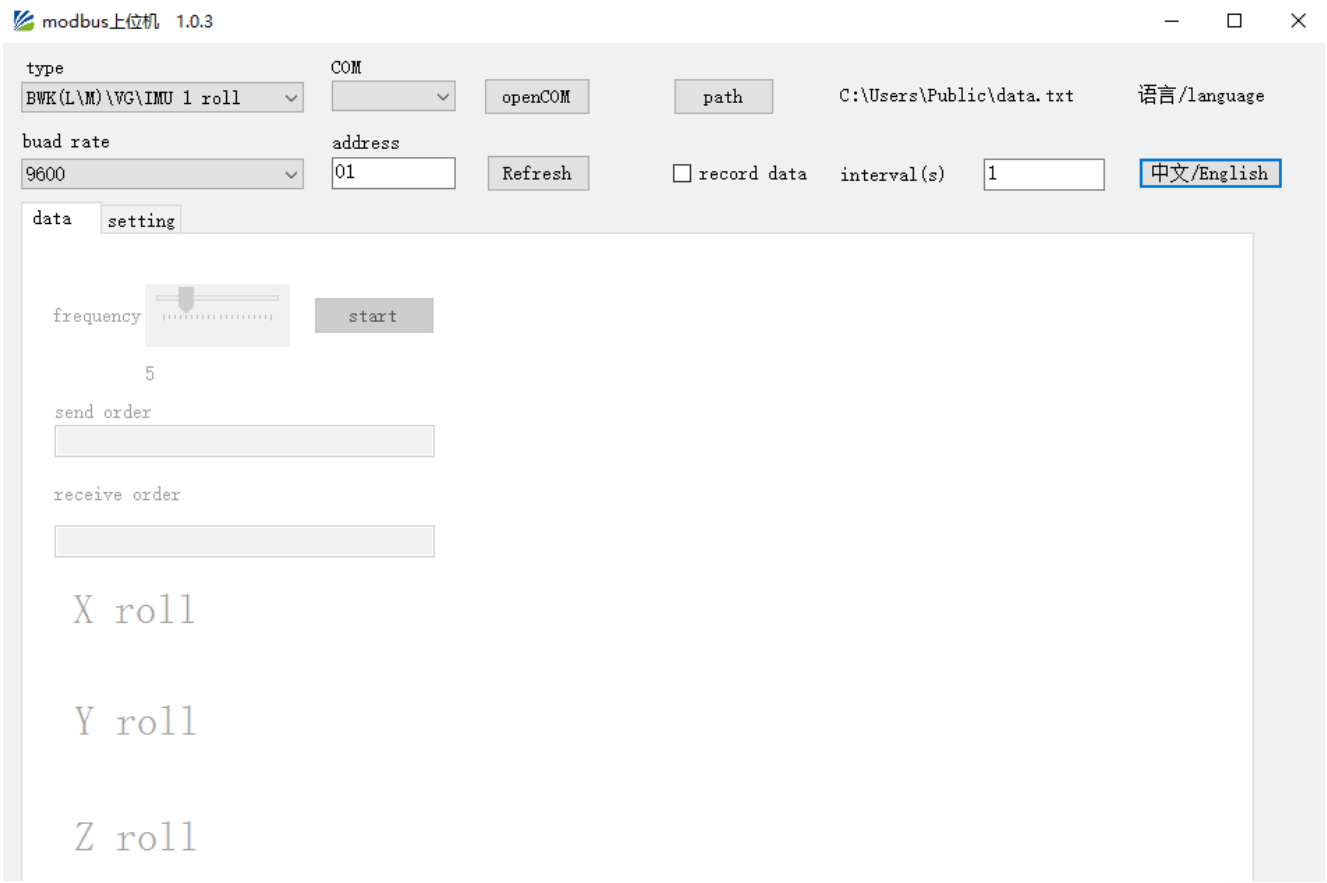
Software use steps:

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 Upper right button



Protocol

1 Data Frame Format: (8 data bits, 1 stop bit, non verification, default rate 9600)

Address Code (1byte)	Function Code (1byte)	The first high address register (1byte)	The first low address register (1byte)	High register number (1byte)	Low register number (1byte)	Checksum (2byte)
0x01	0x03 (read) 0x06 (write)	xx	xx	xx	xx	xxxx

Data format: Hexadecimal
Address code: Default 01 (**note:** it should not exceed 25)
Function Code: 03 represents reading register,06 represents presetting register.
Register Address: The starting address the register need to be operated
Register amount: The amount need to operate
Checksum: The CRC 16 (Modbus RTU) is calculated by the host (recommended by the CRC calculation software).

2 Command Format:

2.1 Read angle of X-axis Command: 01 03 00 01 00 02 95 CB

Address Code (1byte)	Function Code (1byte)	The first high address register (1byte)	The first low address register (1byte)	High register number (1byte)	Low register number (1byte)	Checksum (2byte)
0x01	0x03	0x00	0x01	0x00	0x01	0x95CB

Command response:

Address Code (1byte)	Function Code (1byte)	Number of bytes (1byte)	High number (2byte)	Low number (2byte)	Wrong CRC checksum (2byte)
0x01	0x03	0x04	xxxx	xxxx	xxxx

Note: The data high and data low are expressed in hexadecimal, the actual angle = (data high -10000) + (data low -10000) x0.0001, such as 271E 4602, 271E is the data high, converted to decimal 10014, 10014-10000=14; 4602 is the lower level of the data, converted to decimal in 17922, (17922-10000) x0, 0001 = 0.7922, so the final angle is 14.7922.

2.2 Read angle of Y-axis Command: 01 03 00 03 00 02 34 0B

Address Code (1byte)	Function Code (1byte)	The first high address register (1byte)	The first low address register (1byte)	High register number (1byte)	Low register number (1byte)	Checksum (2byte)
0x01	0x03	0x00	0x03	0x00	0x02	34 0B

Command response:

Address Code (1byte)	Function Code (1byte)	Number of bytes (1byte)	Data field high (2byte)	Data field low (2byte)	Checksum (2byte)
0x01	0x03	0x04	xxxx	xxxx	xxxx

2.3 Read angle of both X-axis and Y-axis Command: 01 03 00 01 00 04 15 C9

Address Code (1byte)	Function Code (1byte)	The first high address register (1byte)	The first low address register (1byte)	High register number (1byte)	Low register number (1byte)	Checksum (2byte)
0x01	0x03	0x00	0x01	0x00	0x04	0x15C9

Command response:

Address Code (1byte)	Function Code (1byte)	Number of bytes (1byte)	X-axis data high (2byte)	X-axis data low (2byte)	Y-axis data high (2byte)	Y-axis data low (2byte)	Checksum (2byte)
0x01	0x03	0x08	xxxx	xxxx	xxxx	xxxx	xxxx

The angle value is a hexadecimal number (the number read by the PLC or the configuration software is directly a decimal number).
The angle is calculated as follows:
Actual angle = ((data high -10000) + (data low -10000) * 0.0001),
For example, the serial assistant sends the following command:
01 03 00 01 00 04 15 C9
The sensor returns the following command:
01 03 08 27 1E 46 02 27 10 2D 19 88 A5 ,
Then the X-axis angle is: 27 1E 46 02, and the Y-axis angle is: 27 10 2D 19,
The 271E is converted to a decimal number of 10014 and a 10014-10000 of 14.
4602 is converted to a decimal number of 17922, 17922-10000 is 7922, 7922 multiplied by 0.0001 is 0.7922, and the final X-axis angle is 14+0.7922=14.7922 degrees, and the corresponding Y-axis angle is 0.1545 degrees.

2.4 Set relative/absolute zero Command:01 06 00 0A 00 00 A9 C8

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0A	0000: absolute zero 0001: relative zero	0xA9 C8 0x68 08

Command response:

Address Code (1byte)	Function Code (1byte)	The first high address register (1byte)	The first low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0A	0000: absolute zero 0001: relative zero	XXXX

Note: absolute zero: Based on the factory-calibrated zero point.
relative zero: Reference to the zero after the current installation.

2.5 Set communication rate Command: 01 06 00 0B 00 02 79 C9

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0B	0x0002	0x79C9

Command response:

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0B	0x0002	0x79C9

Note: 00: 2400; 01: 4800; 02: 9600; 03: 19200; 04: 115200; The default is 0002:9600.

Every time after changing the communication rate, the command response will be sent through the original rate. Then the rate will be changed.

2.6 Set module address Command: 01 06 00 0D 00 01 D9 C9

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0D	XXXX	XXXX

Command response:

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
XX	0x06	0x00	0x0D	XXXX	XXXX

Note: XXXX indicates that the address range to be modified is 0000~00FF

2.7 Save settings Command: 01 06 00 0F 00 00 B9 C9

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	High number of registers (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0F	0x00	0x0000	0xB9C9

Command response:

Address Code (1byte)	Function Code (1byte)	The high address register (1byte)	The low address register (1byte)	Data field (2byte)	Checksum (2byte)
0x01	0x06	0x00	0x0F	0x0000	0xB9C9

Ordering Information

Product number	Way of communication	Package condition
BWS4700-90-232	RS232	IP67 Package/Metal Connector
BWS4700-90-485	RS485	IP67 Package/Metal Connector
BWS4700-90-TTL	TTL	IP67 Package/Metal Connector

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

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