



BWS4800 Series

High Accuracy Current
Dual-Axis Inclinometer
Technical Manual



Introduction

Designed by Bewis Sensing Technology LLC, BWS4800 is a dual-axis super high-accuracy inclinometer with MEMS technology and current output. It has a measuring range of $\pm 90^\circ$ and a full-scale accuracy of 0.008° . 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 current 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: 0.008°
- Output mode: 4-20mA/0-20mA/RS232 optional
- IP67 protection
- Baud rate: 2400~115200(Adjustable)
- Measuring range: $\pm 90^\circ$
- Voltage input: 12~35V(DC)
- Operating temperature: $-40 \sim +85^\circ\text{C}$
- 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		12		35	V
Operating current	Non-loaded	20	50	60	mA
Output load	Max	0		500	KΩ
Operating temperature		-40		+85	°C
Store temperature		-55		+100	°C

Performance Specifications

Measuring range(°)	Conditions	±5	±10	±30	±60	±90
Measuring axis	Vertically	X-Y	X-Y	X-Y	X-Y	X-Y
Accuracy(°)	Indoor	0.008	0.008	0.008	0.008	0.008
Resolution(°)	Completely static	0.001	0.001	0.001	0.001	0.001
Zero temperature drift(°/°C)	-40 ~ 85°C	±0.0007	±0.0007	±0.0007	±0.0007	±0.0007
Cross axis error(°)	Max	0.008	0.008	0.008	0.008	0.008
Power-on time		<3s	<3s	<3s	<3s	<3s
Frequency response (Hz)	5 ~ 100Hz (Adjustable)	100	100	100	100	100
Baud rate	Adjustable	2400~115200	2400~115200	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).



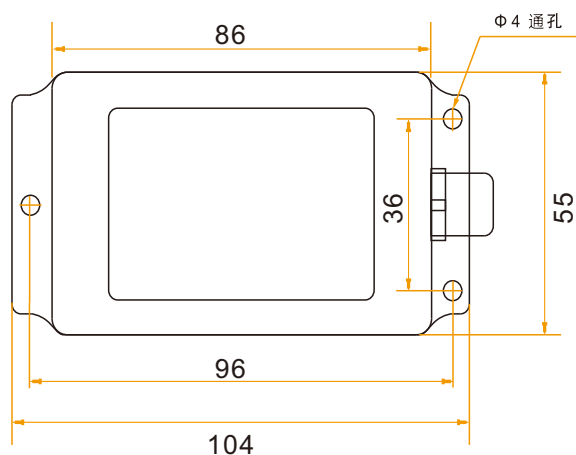
Mechanical Characteristic

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

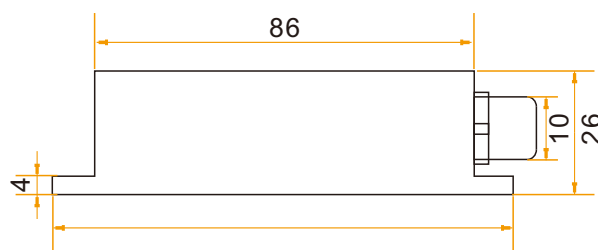


Package size

Product Size: L103.8*W55.4*H26 (mm)



Top view



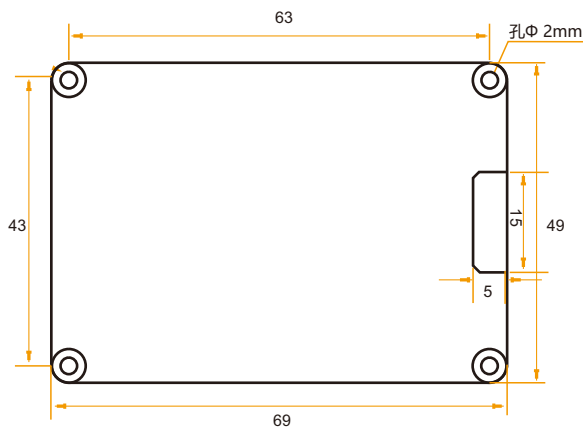
Aviation connector: 116
Metal connector: 105



Bare plate product size

Product size: L69*W49*H12(mm)

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

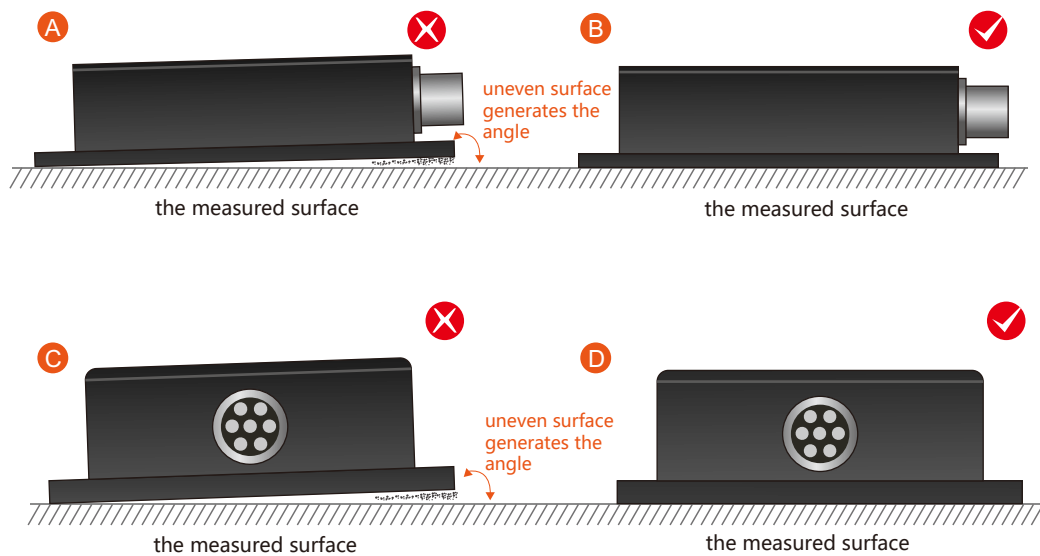




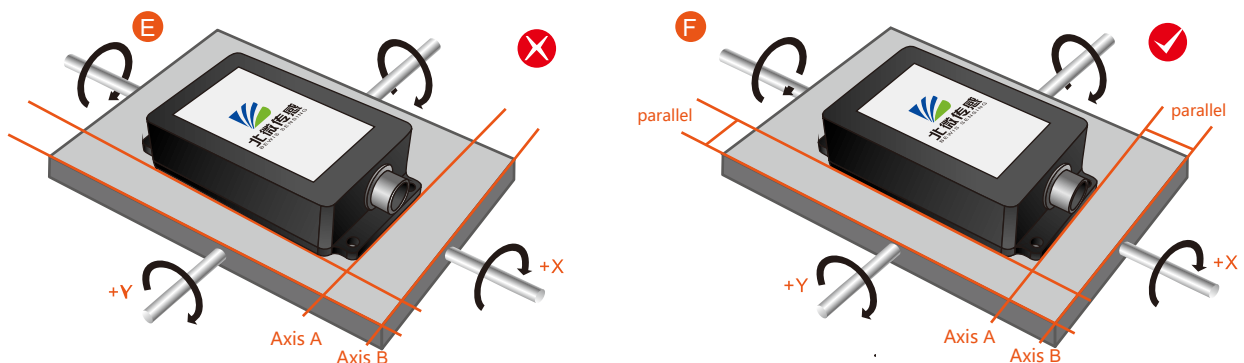
Installation direction

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.

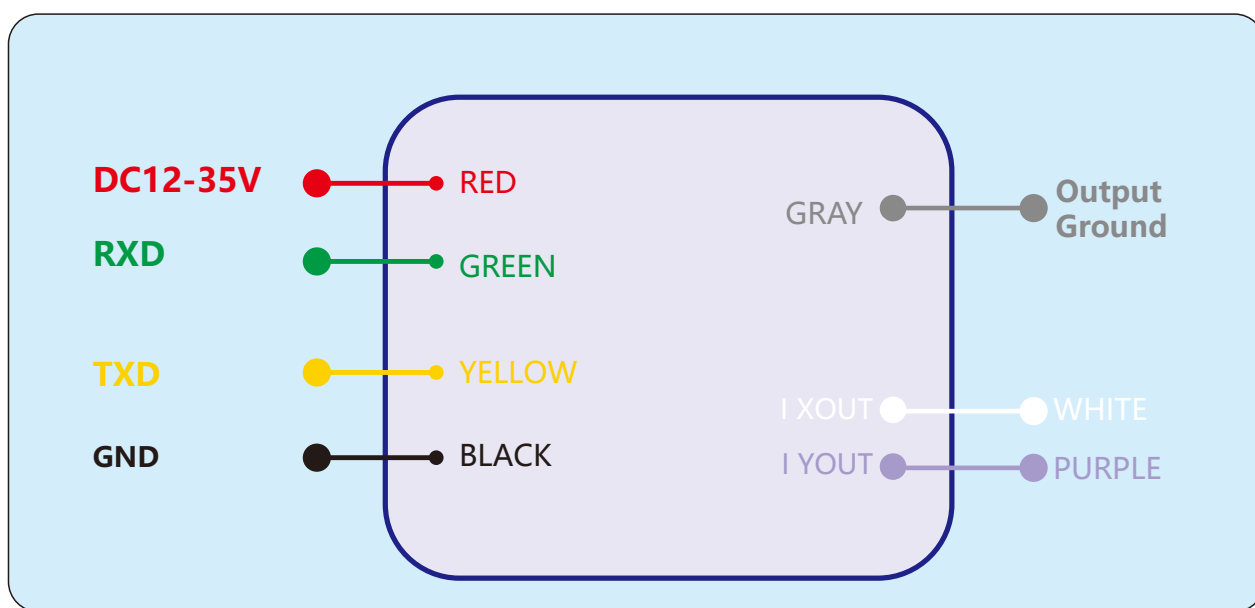


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

Electrical connections

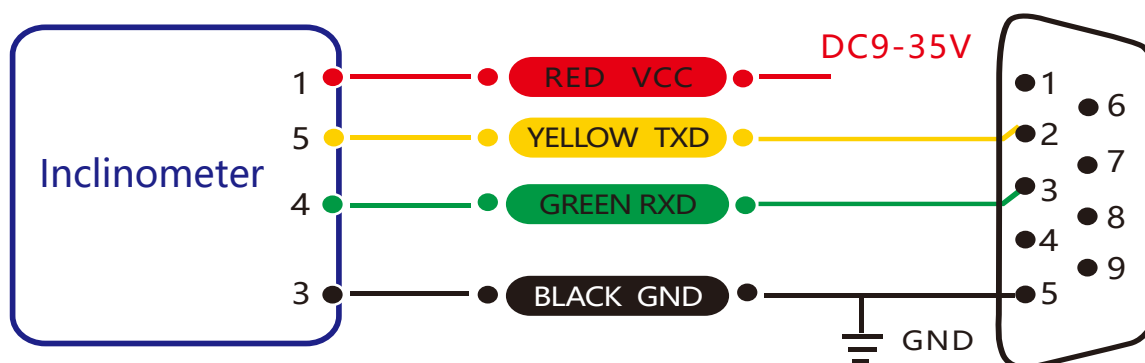
Electrical interfaces

Cable color & Function	RED	BLACK	GREEN	YELLOW	WHITE	PURPLE	GRAY
	1	3	4	5	6	7	10
	VCC DC 12-35V	GND	RXD	TXD	I XOUT	I YOUT	Output Ground



Electrical interfaces

Cable color & Function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC DC 12-35V	NC	GND	RXD	TXD



RS 232 wiring diagram

Debug software

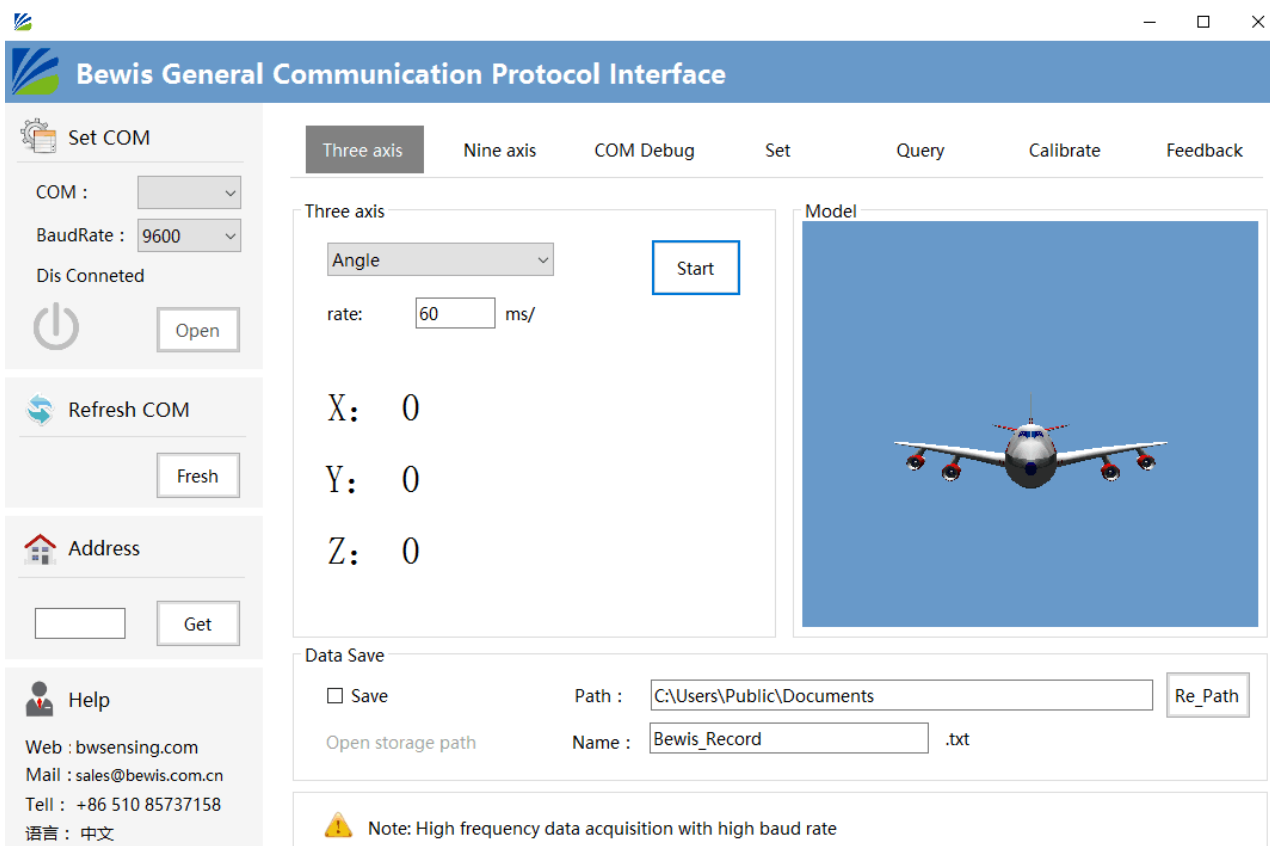
Users can directly download serial assistant on official website (Supports-Download). You can also use more convenient and intuitive PC software.

BWS4800 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: Data represents 4 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, 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		

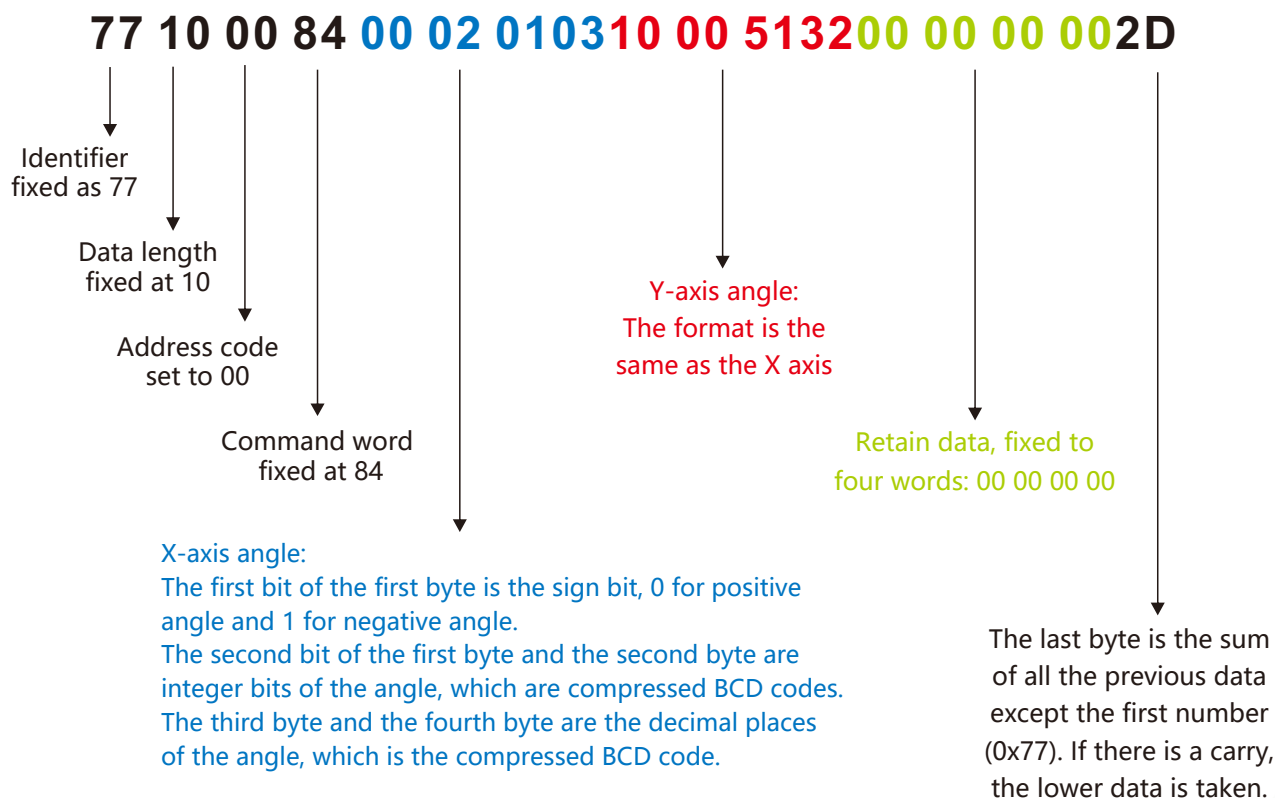
Command response:

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

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

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		0x11

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 baud rate command is executed successfully, the command response will be return in the original baud rate and then communicate with new baud rate.

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 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	

2.9 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	

2.10 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.

Ordering Information

Product number	Way of communication	Package condition
BWS4800-90-420	4-20mA current/RS232	IP67 Package/Metal Connector
BWS4800-90-020	0-20mA current/RS232	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

BWS4800 Serials

High Accuracy Current
Dual-Axis Inclinometer

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