BWM416

Digital Single-Axis Inclinometer

Technical Manual

BWM 416
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Introduction

Designed by Bewis Sensing Technology LLC, BWM416 is a cost-effective single-axis inclinometer with MEMS technology and digital output. It has a measuring range of ± 180° and a full-scale accuracy of 0.01° and a operating temperature of -40℃~+85℃. The product uses a high-accuracy MEMS accelerometer and 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 horizontal angle value through digital mode. It has high long-term stability, small temperature drift, simple use and strong resistance to external interference. It apply to military equipment, industrial automation, surveying and mapping, etc.

Features

- Single-axis inclination measurement
- Resolution: 0.001°
- Product size: L90*W40.5*H26(mm)
- Voltage input: 9~35V
- Max accuracy: 0.01°
- Measuring range: ±180°
- IP67 protection
- Communication: RS232/485/TTL optional

Applications

- Industrial automatic leveling
- Medical devices
- The automatic tracking system of solar angle
- Tower tilt monitoring
- Hoisting angle control
- Structural deformation monitoring
- Measuring and mapping instrument
- Military equipment automation

Specifications

Electrical Specifications

Parameters	Conditions	Min	Typical	Max	Units
Power supply(DC)		9	12	35	V
Operating current	Non-loaded	20	30	40	mA
Operating temperature		-40	25	+85	℃
Store temperature		-55	25	+100	℃

Performance Specifications

Parameters	Conditions	BWM416	Units
Measuring range		0~±180	°
Measuring axis		X	
Accuracy	Indoor	0.01	°
Resolution		0.001	°
Zero temperature drift	-40~+85℃	±0.005	°/℃
Frequency response	Max	100	Hz
Shock resistance	2000g,0.5ms,3times/axis		
N.W.	150g(Exclude box)		
MTBF	≥30000 hours/time		
Electromagnetic compatibility	according to GBT17626		
Insulation resistance	≥100 MΩ		

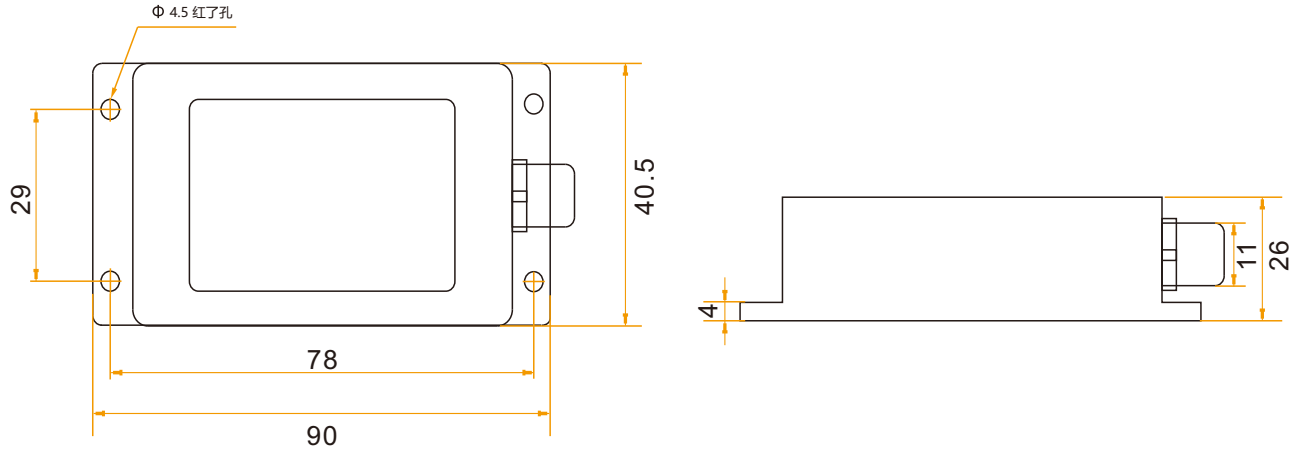
Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

Mechanical Characteristic

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

Package size

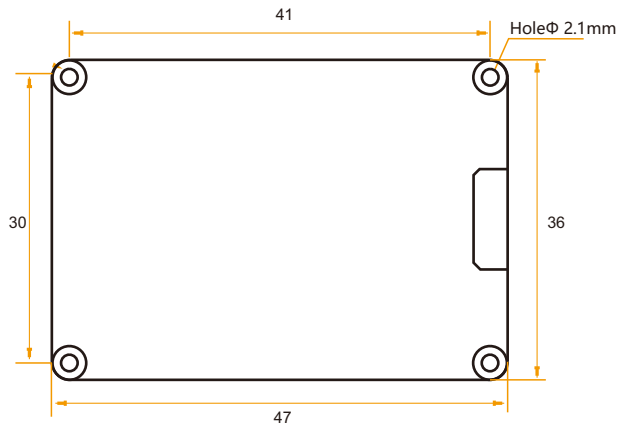
Product Size: L90*W40.5*H26(mm)



Bare plate product size

Product size: L47*W36*H15(mm)

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

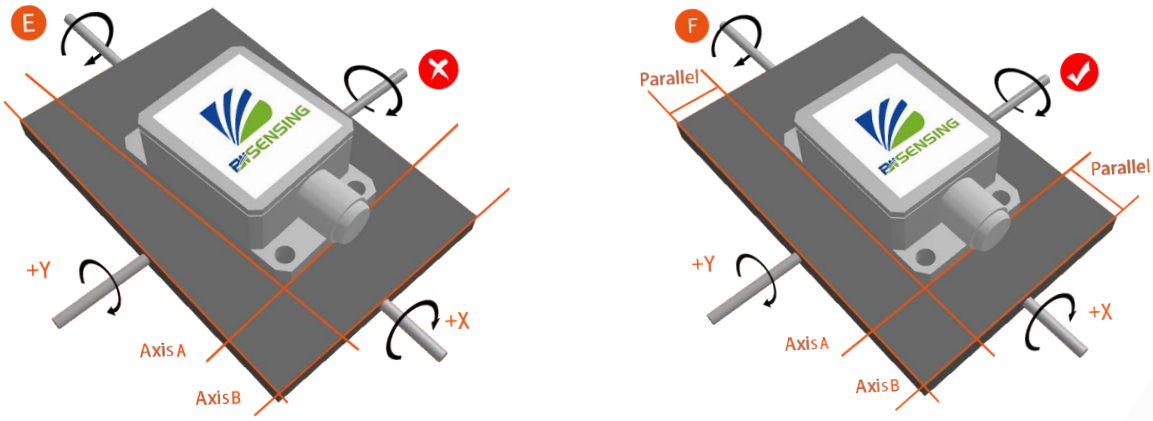


Installation direction

This series of products can be installed vertically or horizontally, the following points should be done when installing the sensor:

First of all, to ensure that the sensor mounting surface is completely close to the measured surface, the measured surface should be as horizontal as possible, and there should be no angle shown in Figure A and Figure C. The correct installation method is shown in Figure B and Figure D.

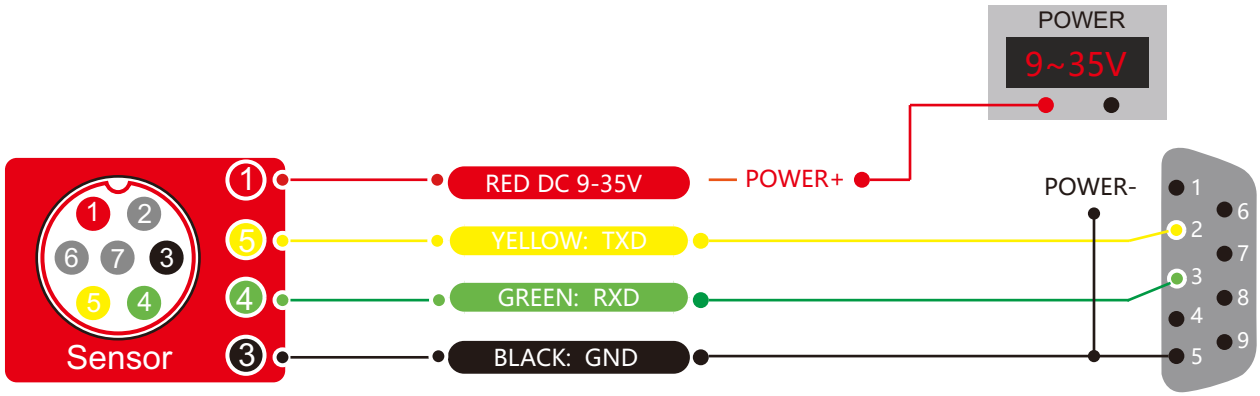
Secondly, the bottom cable of the sensor and the axis of the measured object shouldn't generate the angle shown in E. When installing, the bottom cable of the sensor should be kept parallel or orthogonal to the rotation axis of the measured object. This product can be installed horizontally or vertically (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.

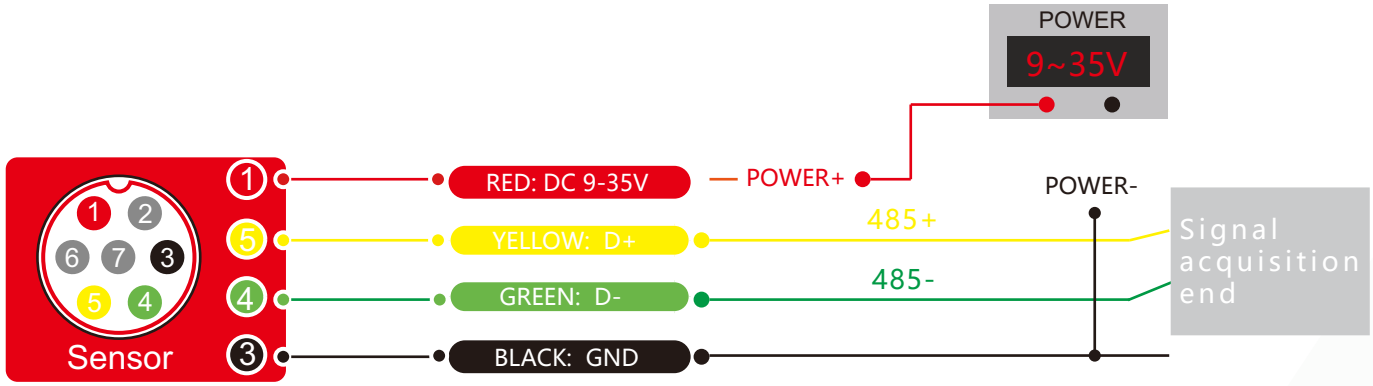
RS232 Electrical interfaces

Cable color & Function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC DC 9-35V	NC	GND	RXD	TXD



RS485 Electrical interfaces

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



Debug software

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

BWM416 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.

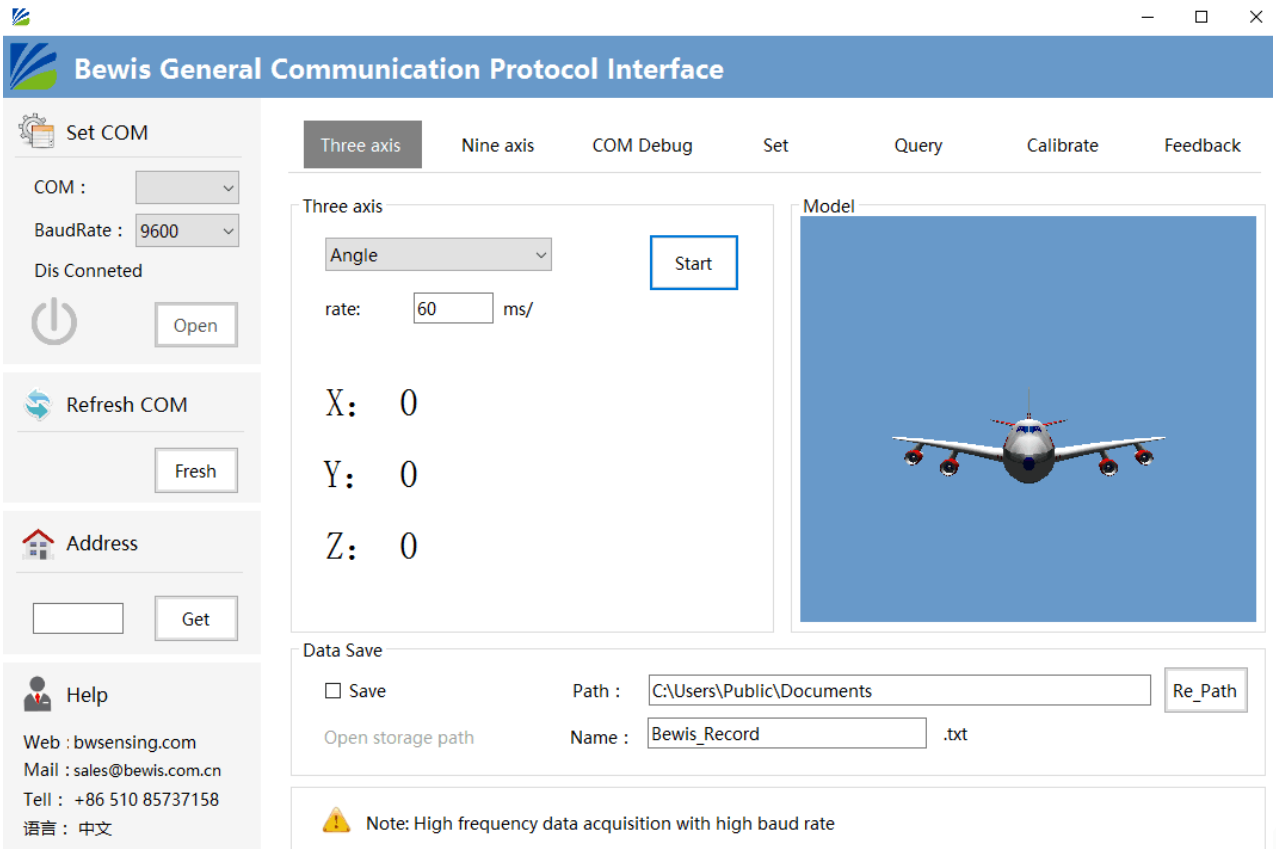
Software use steps:

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

1Data 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
Identifier: Fixed to 77(partly 68)
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		

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 °.

2.2 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.

2.3 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, 04: 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.

2.4 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 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	0x00	0x8C	0x00: success 0xFF: failure	

Note: 5Hz Data Rate means that 5 sets of angle data are automatically output every second, others and so on.

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	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	

2.6 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.

2.7 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.

2.8 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		0x23

Command response:

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

Ordering Information

Product number	Way of communication	Package condition
BWM416-180-485	RS485	IP67 Package/Metal Connector
BWM416-180-232	RS232	IP67 Package/Metal Connector
BWM416-180-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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