



BWN827

**Cost-effective Dual-Axis
Digital Output with Modbus
Inclinometer
Technical Manual**



Introduction

Designed by Bewis Sensing Technology LLC, BWN827 is a cost-effective dual-axis inclinometer with MEMS technology and digital output. It has a measuring range of $\pm 30^\circ$ and the highest accuracy is 0.01° and a operating temperature of $-40^\circ\text{C} \sim +85^\circ\text{C}$. 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

- Dual-axis inclination measurement
- Measuring range: $\pm 30^\circ$
- Accuracy: 0.01° (Max)
- Voltage input: 9~35VDC
- Output mode: RS485/RS232/TTL optional
- Operating temperature: $-40^\circ\text{C} \sim +85^\circ\text{C}$
- IP67 protection
- High vibration resistance $> 2000\text{g}$
- High resolution: 0.001°
- Product size: L90*W40.5*H26 (mm)

Applications

- Dangerous building monitoring
- Bridge monitoring
- Satellite antenna positioning
- Laser level
- Slope monitoring
- High-speed rail monitoring
- Piling monitoring
- Ancient building protection monitoring

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 | °C |
| Store temperature | | -55 | 25 | +100 | °C |

Performance Specifications

| Parameters | Conditions | BWN827-30 | Units |
|-------------------------------|-------------------------|-----------|-------|
| Measuring range | | 0 ~ ±30 | ° |
| Measuring axis | | X-Y | |
| Accuracy | Indoor | 0.01 | ° |
| Resolution | | 0.001 | ° |
| Zero temperature drift | -40~+ 85°C | ±0.001 | °/°C |
| Cross axis error | 25°C | 0.01 | ° |
| Frequency response | Max | 100 | Hz |
| Shock resistance | 2000g,0.5ms,3times/axis | | |
| N.W. | 150g (package included) | | |
| MTBF | ≥ 100000 h | | |
| Electromagnetic compatibility | According to GBT17626 | | |
| Insulation resistance | ≥100MΩ | | |

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

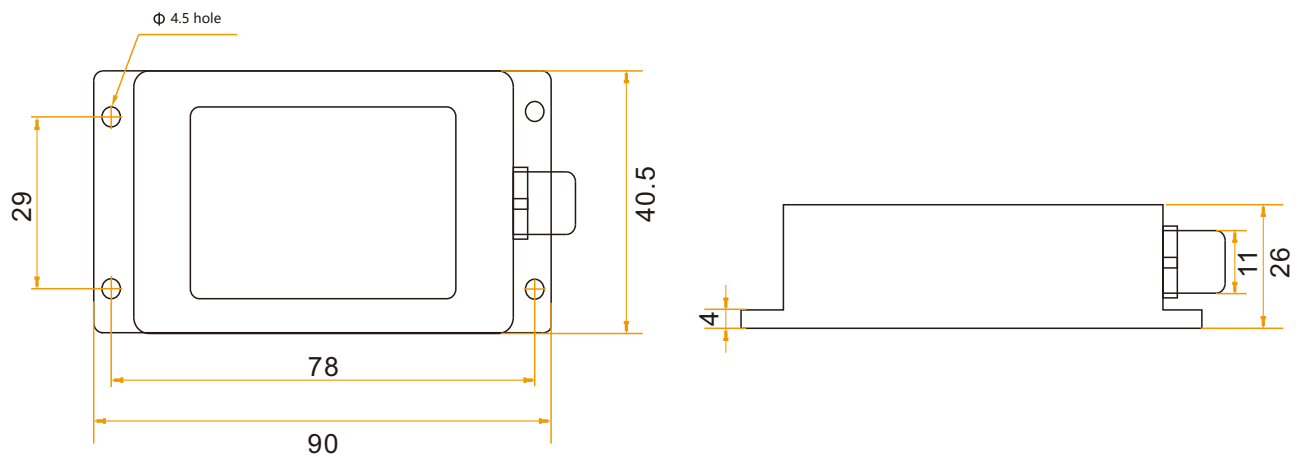
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

Mechanical Characteristic

| | |
|------------------|---------------------------|
| Connector | Metal connector |
| Protection level | IP67 |
| Shell material | Magnesium alloy anodizing |
| Installation | Four M4 screws |

Package size

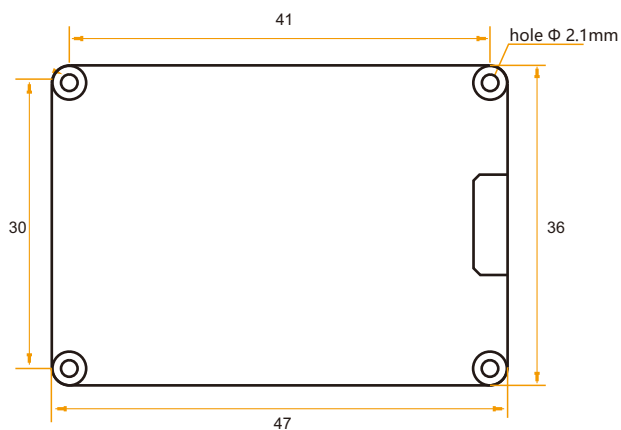
Product Size: L90*W40.5*H26 (mm)



Bare plate product size

Product size: L47*W36*H15(mm)

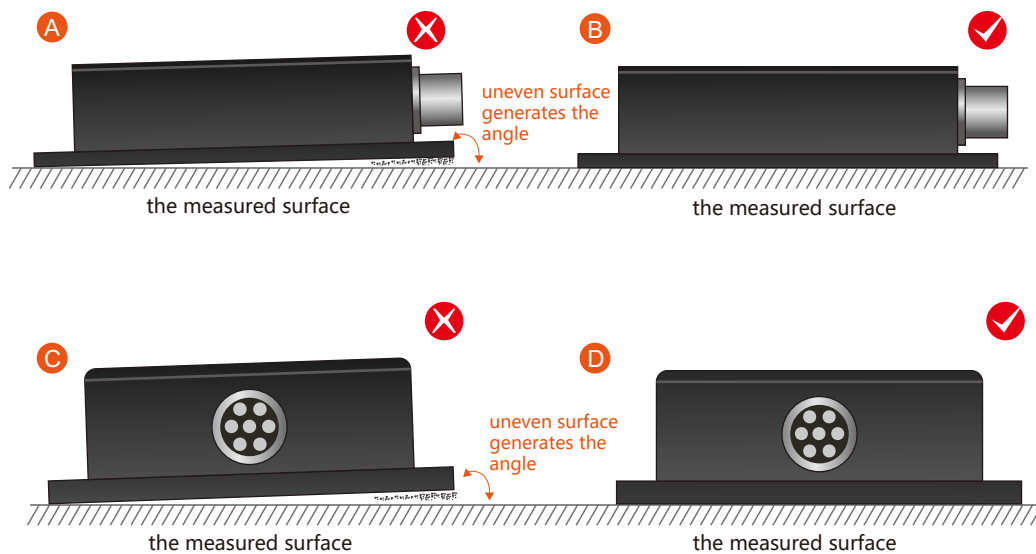
Note: ± 1 mm error for length and width dimensions, please refer to actual size.



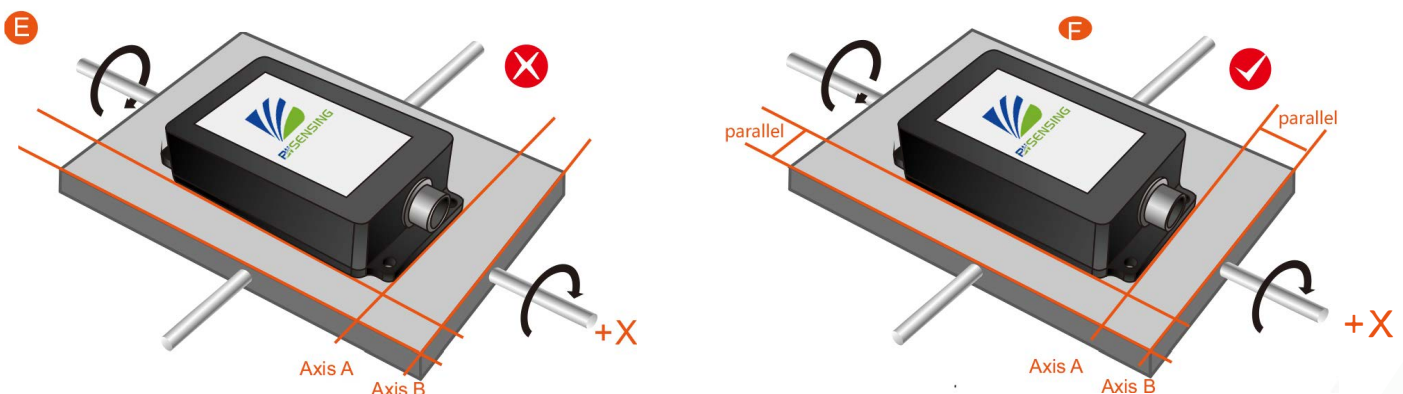
Installation direction

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.

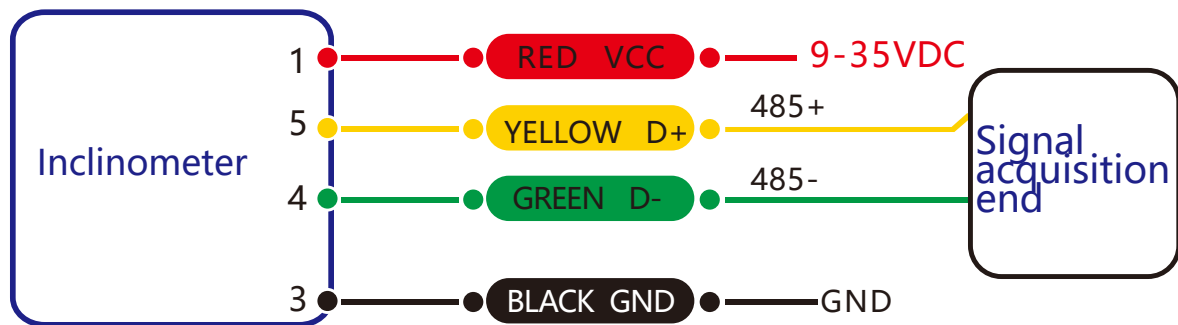


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

Electrical connections

Electrical interfaces

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



RS 485 wiring diagram

Debug software

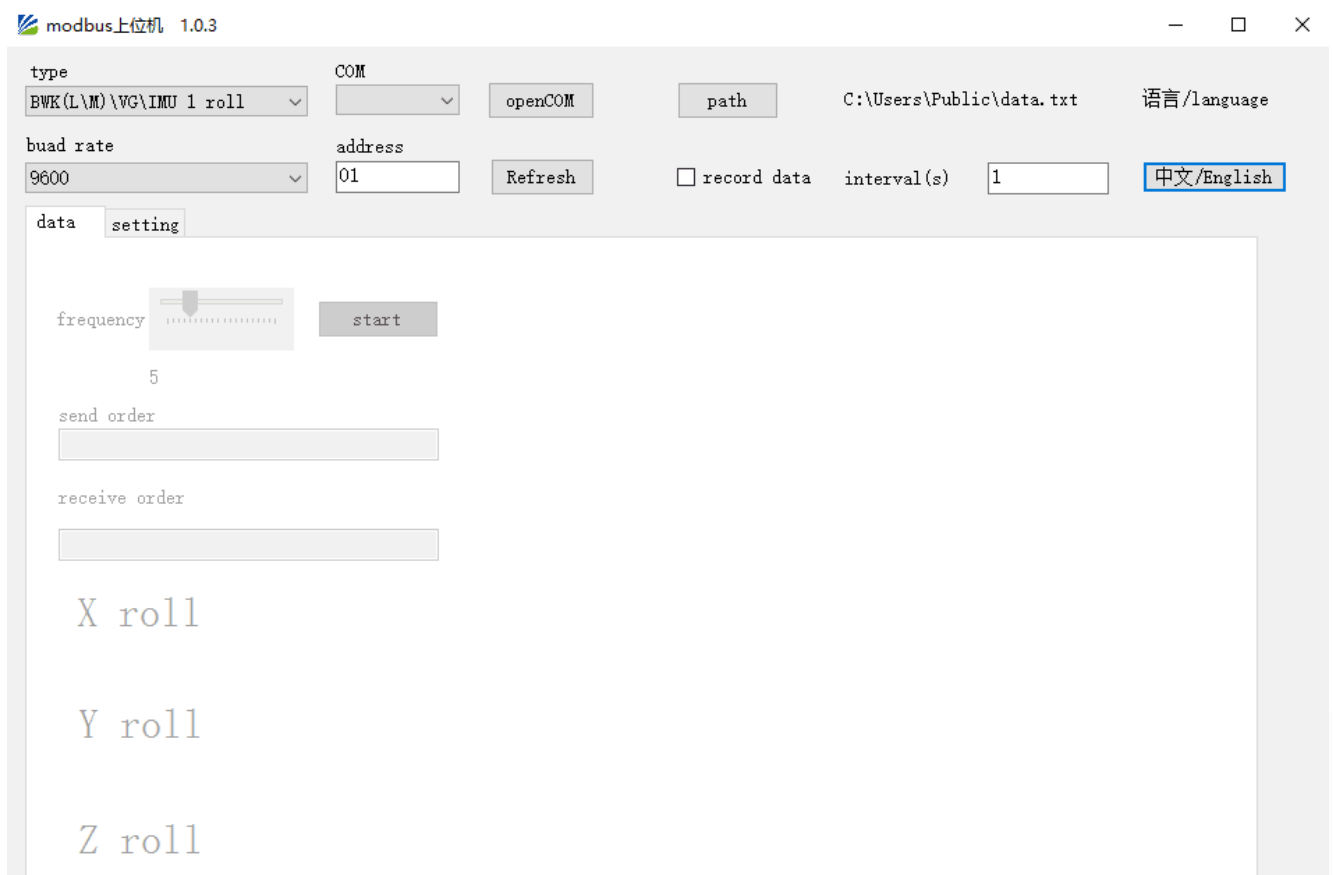
Users can directly download serial assistant on official website (Supports-Download). You can also use more convenient and intuitive PC software.

BWN827 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, 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 | 15 C9 |

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: 0000 represents 2400; 0001 represents 4800; 0002 represents 9600; 0003 represents 19200.

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 |

Executive standard

- Enterprise quality system standard: ISO9001:2015 standard (certificate number: 23919Q10455R0S)
- CE certification (certificate number:M.2019.103.UY1151)
- RoHS (Certificate: G190930099)

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