# BWM427 Serials

## Modbus Dual-Axis Inclinometer
## Technical Manual
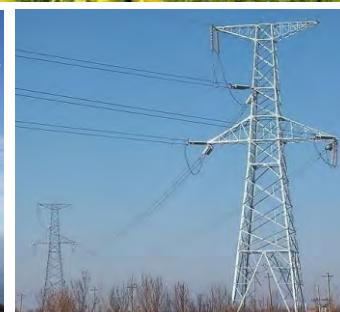
## Introduction

Designed by BWSENSING, BWM427 is a cost-effective dual-axis inclinometer with MEMS technology and digital output. It has a measuring range of ± 90° 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

- Dual-axis inclination measurement
- Resolution: 0.001°
- Product size: L90*W40.5*H26(mm)
- Voltage input: 9~35V

- Max accuracy: 0.01°
- Measuring range: ±90°
- IP67 protection
- Communication: RS232/485/TTL optional

## Applications

- Industrial automatic leveling
- Medical devices
- The solar automatic tracking system
- 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 | BWM427-90 | Units |
|---|---|---|---|
| Measuring range | | ±90 | ° |
| Measuring axis | | X-Y | |
| Accuracy | Indoor | 0.01 | ° |
| Resolution | | 0.001 | ° |
| Zero temperature drift | -40~+85℃ | ±0.005 | °/℃ |
| Cross axis error | 25℃ | 0.01 | ° |
| Frequency response | Max | 100 | Hz |
| Shock resistance | 2000g,0.5ms,3times/axis | | |
| N.W. | 150g(Excludes box) | | |
| MTBF | ≥100000hs | | |
| 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)
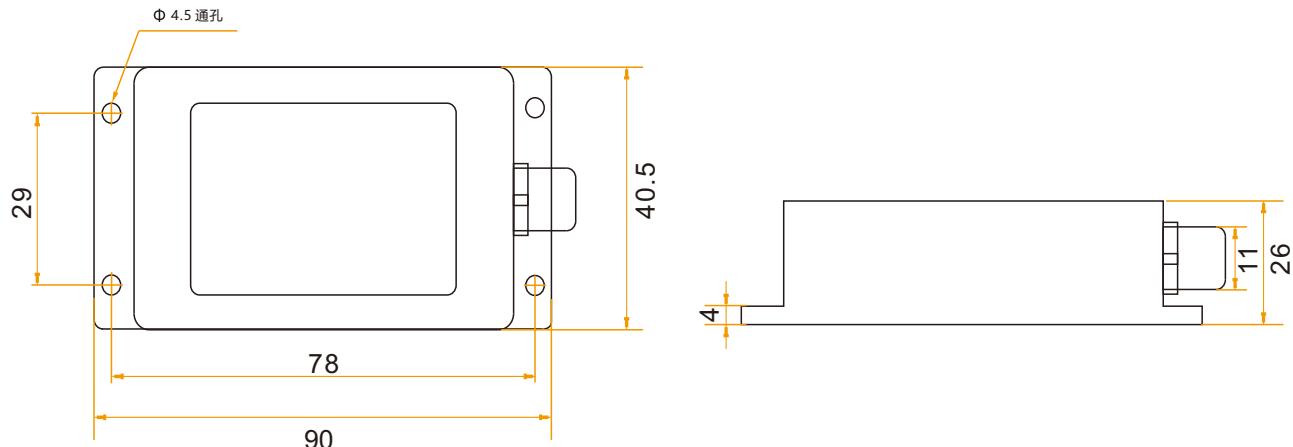


## Bare plate product size

Product size: L47*W36*H15(mm)

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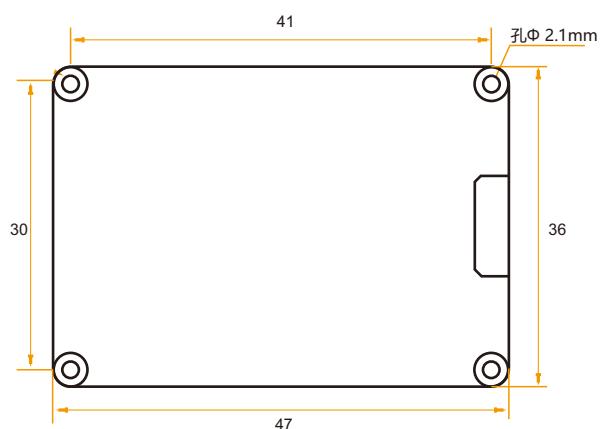
# Installation direction

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.
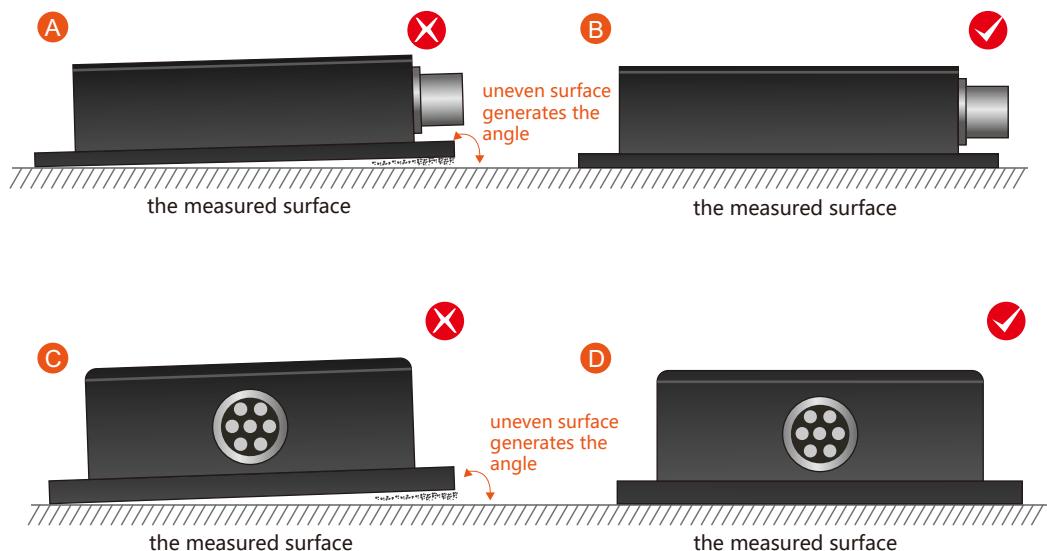


Secondly, the bottom cable of the sensor and the axis of the measured object shouldn't generate the angle shown in E. When installing, the bottom cable of the sensor should be kept parallel or orthogonal to the rotation axis of the measured object. This product can be installed horizontally or vertically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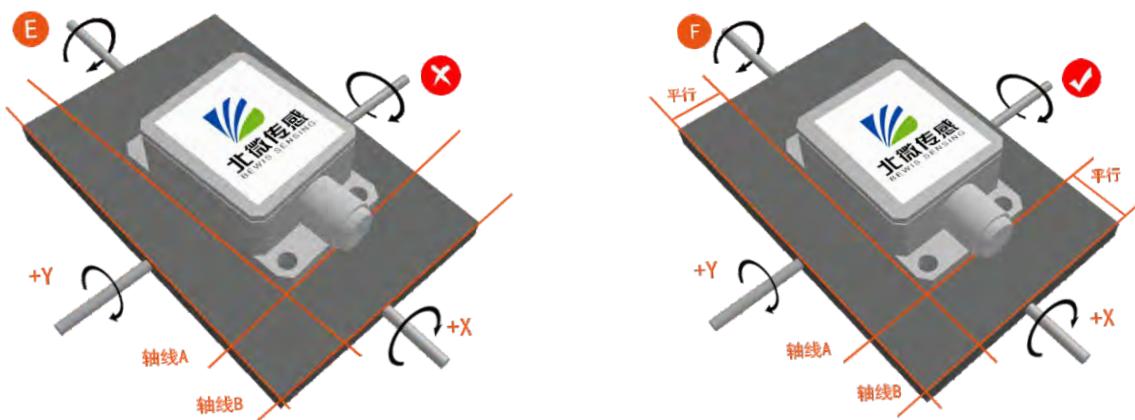


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

# 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+) |
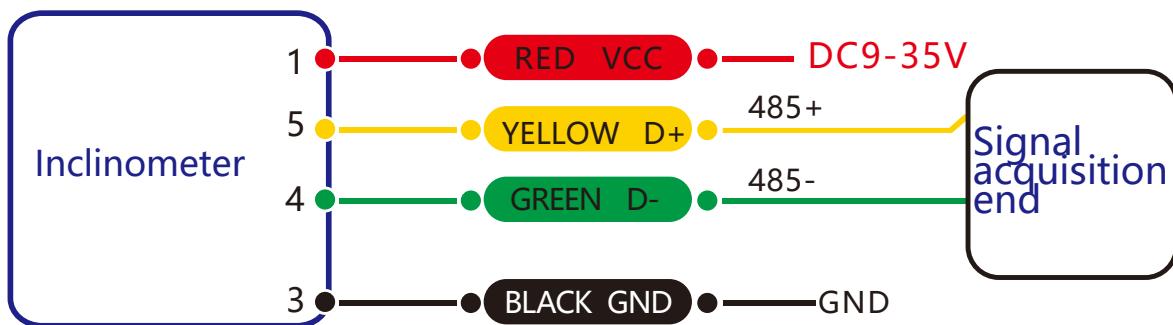
**RS 485 wiring diagram**
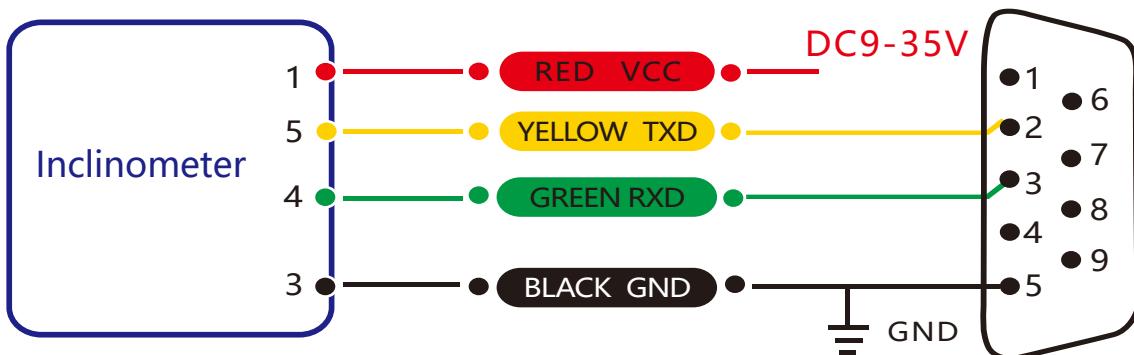
**RS 232 wiring diagram**

# Debug software

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

BWM427 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/Y 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 /Y direction will be displayed on the

**Note** you can switch to Chinese or English version by the Upper right button
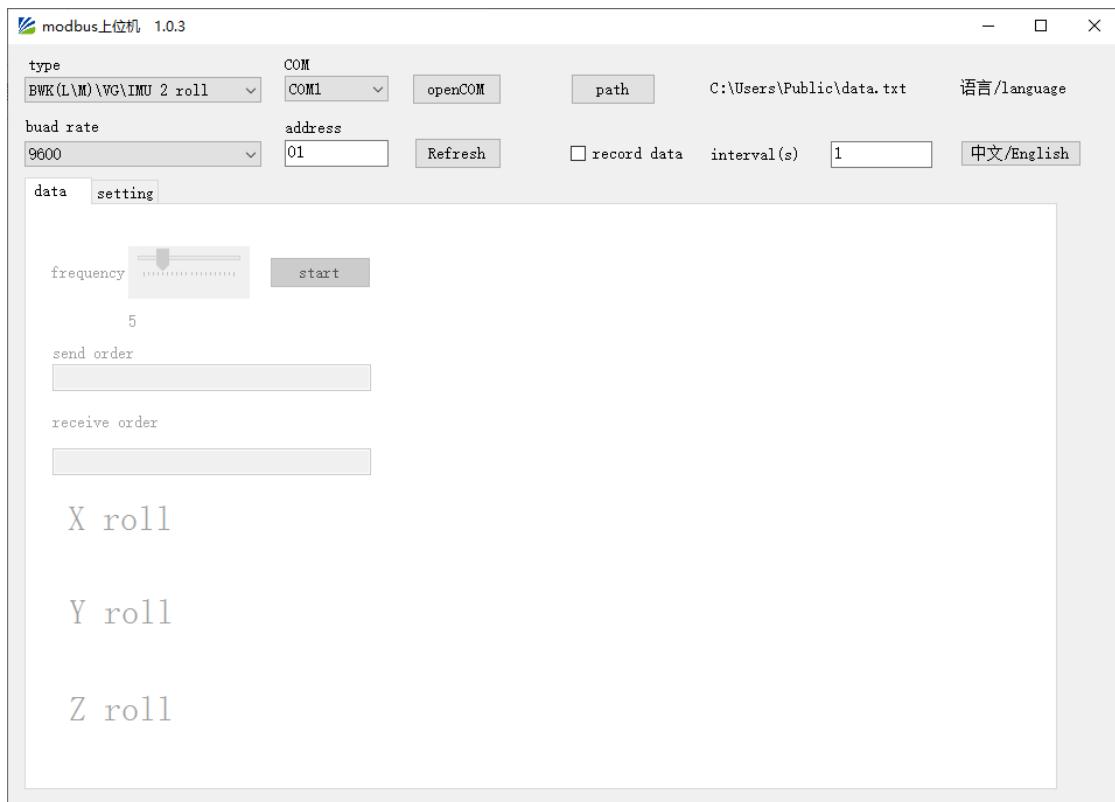
# Protocol

## 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 FF)

**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:** it is calculated by the host. (We recommend that users need to use the CRC calculation software.)

X-**axis Angle:** Register 00 01
Y-**axis Angle:** Register 00 02
**Product Address:** Register 00 03
**Zero Type:** Register 00 04

## 2 Command Format:

### 2.1 Read angle of X-axis   Command: 01 03 00 01 00 01 D5 CA

| 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 | 0xD5CA |

### Command response:

| Address Code (1byte) | Function Code (1byte) | Number of bytes (1byte) | High number (1byte) | Low number (1byte) | Wrong CRC checksum (2byte) |
|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x02 | xx | xx | xxxx |

**Note:** The data field is a hexadecimal number (PLC or configuration software reads the data directly with a 16-bit register is decimal). After converting to decimal, the real data = (data field -10000)/100. If the data field is 3D52, it is converted to decimal 15698, real data = (15698-10000)/100 = 56.98 degrees; the data field is 1230, converted into decimal 4656, real data = (4656-20000)/100 = -53.44 degree.

### 2.2 Read angle of Y-axis   Command: 01 03 00 02 00 01 25 CA

| 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 | 0x02 | 0x00 | 0x01 | xxxx |

Command response:

| Address Code (1byte) | Function Code (1byte) | Number of bytes (1byte) | Data field high (1byte) | Data field low (1byte) | Checksum (2byte) |
|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x02 | xx | xx | xxxx |

### 2.3 Read angle of both X-axis and Y-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 | 0x02 | xxxx |

Command response:

| Address Code (1byte) | Function Code (1byte) | Number of bytes (1byte) | X axis Angle (2byte) | Y axis Angle (2byte) | Checksum (2byte) |
|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x04 | xx xx | xx xx | xxxx |

### 2.4 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; 0003represents 19200.
The default is 0002:9600.

### 2.5 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 |

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 | 0xA9 C8 |

**Note:** absolute zero: Based on the factory-calibrated zero point.

relative zero: Reference to the zero after the current installation.

### 2.6 Query relative/absolute zero  Command: 01 03 00 04 00 01 C5 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 | 0x04 | 0x00 | 0x01 | 0xC5CB |

Command response:

| Address Code (1byte) | Function Code (1byte) | Number of bytes (1byte) | High number (1byte) | Low number (1byte) | Wrong CRC checksum (2byte) |
|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x02 | xx | xx | xxxx |

### 2.7 Set module address  Command: 01 06 00 0D 00 03 58 08

| 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 | Module address | xx xx |

Command response:

| Address Code (1byte) | Function Code (1byte) | The high address register (1byte) | The low address register (1byte) | Data field (2byte) | Checksum (2byte) |
|---|---|---|---|---|---|
| Module address | 0x06 | 0x00 | 0x0D | Module address | xx xx |

## 2.8 Save settings   Command:  01 06 00 0F00 00 B9 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 | 0x0F | 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 |

**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 |
|---|---|---|
| BWM427-90-232 | RS232 | IP67 Package/Metal Connector |
| BWM427-90-485 | RS485 | IP67 Package/Metal Connector |
| BWM427-90-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

# BWM427 Serials

## Modbus Dual-Axis Inclinometer

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