BW-VG500 Serials

High Precision Digital Dynamic Inclination Sensor

Technical Manual

BW-VG500

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Introduction

The BW-VG500 Dynamic Inclination Sensor is a high precision inclinometer that measures the attitude parameters (roll and pitch) of the motion carrier. The attitude deviation is estimated by a 6-state Kalman filter with appropriate gain and is suitable for tilt measurement in motion or vibration.

The BW-VG500 uses high-quality and reliable MEMS accelerometers and gyroscopes, and guarantees measurement accuracy through algorithms. At the same time, the seal design and strict process ensure that the product can accurately measure the roll angle and pitch angle of the carrier under harsh environment. Through various compensations such as nonlinear compensation, quadrature compensation, temperature compensation and drift compensation, the error caused by interference can be greatly eliminated, and the product precision level can be improved. The BW-VG500 has a digital interface that can be easily integrated into the user's system.

Features

- Nonlinear compensation, quadrature compensation
- Dynamic static measurement
- Special offset tracking algorithm eliminates the drift
- Gyro drift compensation
- RS232/RS485/TTL/CAN interface output for optional
- Operating temperature: -40°C~+85°C
- High performance Kalman filter algorithm
- Small size: L103.8 × W55.4× H26(mm)

Applications

- Underwater unmanned boat
- Fan tower sloshing monitoring
- Platform stability
- Large ships
- Photoelectric pod
- Unmanned driving
- Automatic artillery
- Unmanned aerial vehicle

Specifications

Electrical Specifications

Power supply	9-35V DC
Operating current	30mA（Max40mA）
Operating temperature	-40℃~85℃
Store temperature	-55℃~100℃

Performance Specifications

Attitude parameter	Dynamic accuracy	0.1°
	Static accuracy	0.01°
	Resolution	0.01°
	Tilt range	Pitch ± 90°, Roll ±180°
Physical characteristics	Size	L103.8× W55.4× H26（mm）
	Weight (including cable)	280g
	Weight (including package)	360g
Interface characteristics	Start delay	<50ms
	Maximum output frequency	100Hz
	Serial communication rate	2400 to 115200 baud rate
	Digital output format	Binary high performance protocol
MTBF	≥90000 hours/time	
Electromagnetic compatibility	According to GBT17626	
Insulation resistance	≥100 MΩ	
Impact resistance	2000g，0.5ms，3 times / axis	

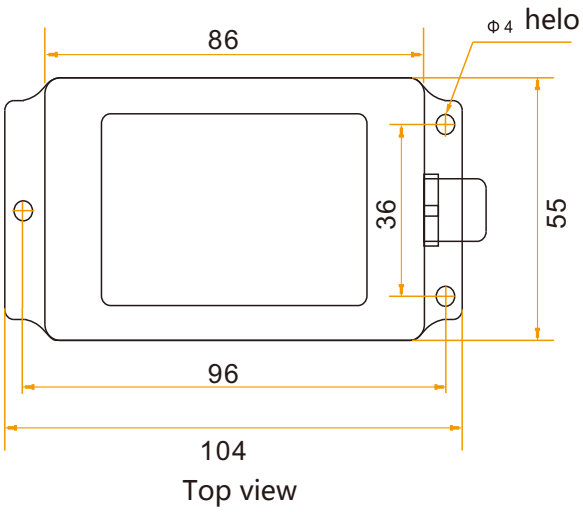
Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

Mechanical Characteristic

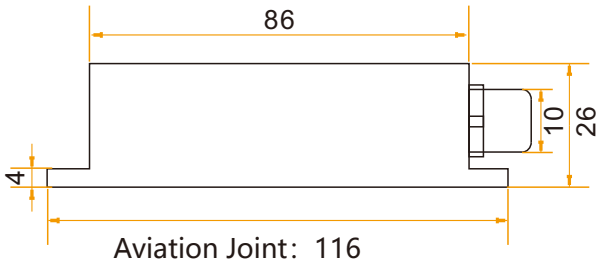
Connector	Aviation joint（standard cable is 1.5m）
Protection level	IP67
Shell material	Magnesium alloy anodizing
Installation	Four M4 screws

Package size

Product Size:L103.8× W55.4× H26（mm）



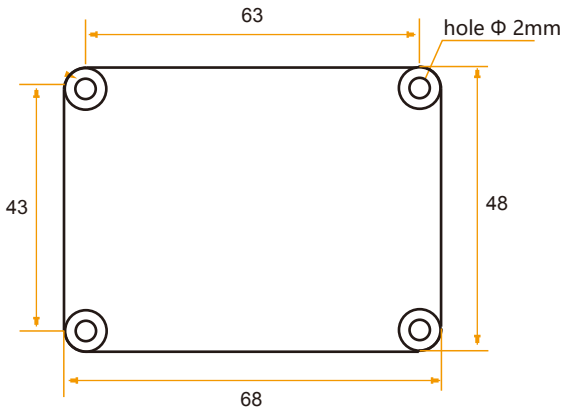
Top view



Aviation Joint：116
Metal Connector：105

Bare plate product size

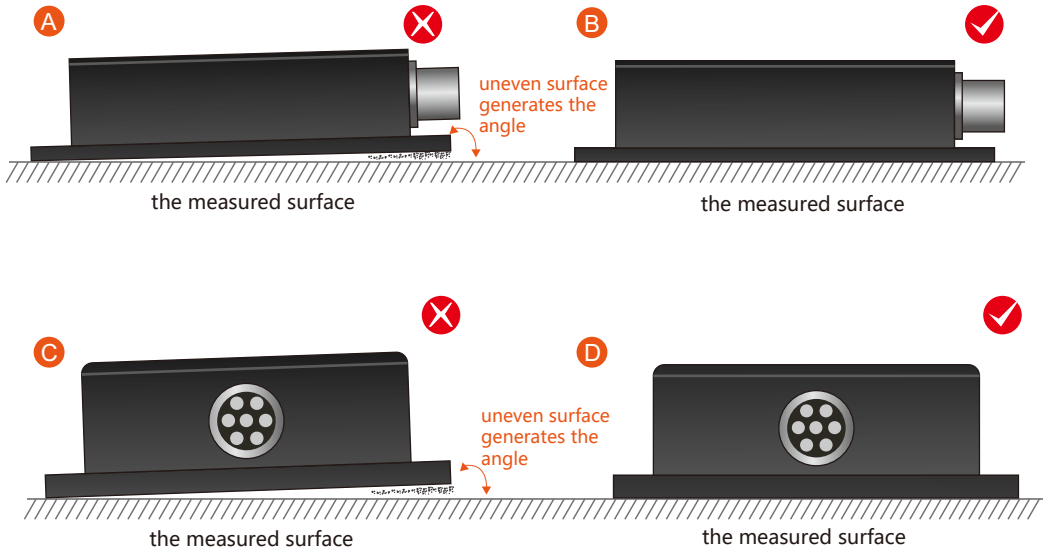
Product Size: L68*W48*H12（mm）,±1mm error for lengh and width dimensions, please refer to actual size



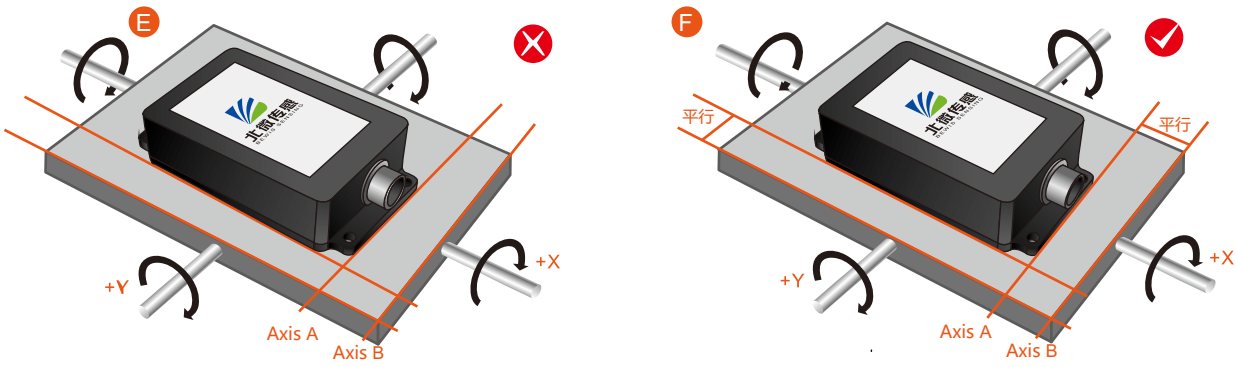
Installation direction

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.

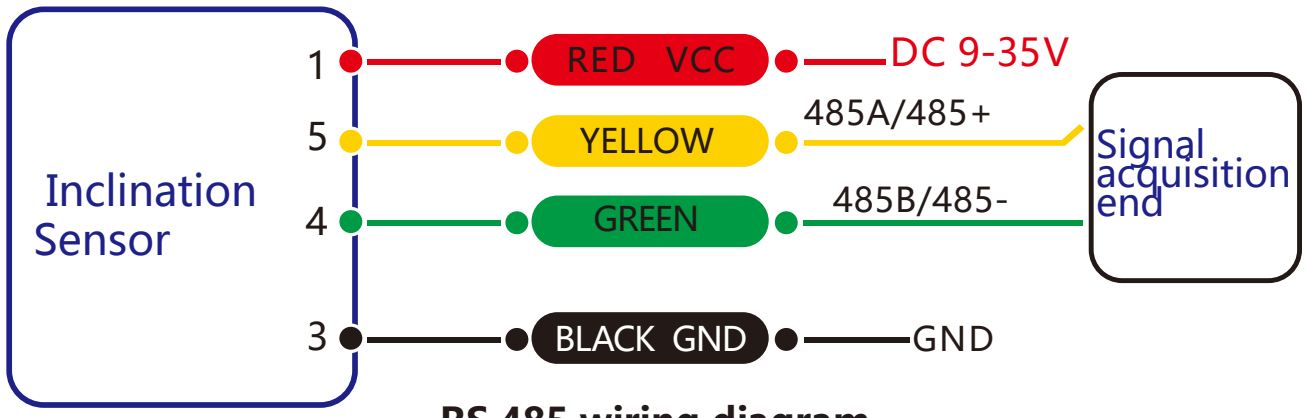


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

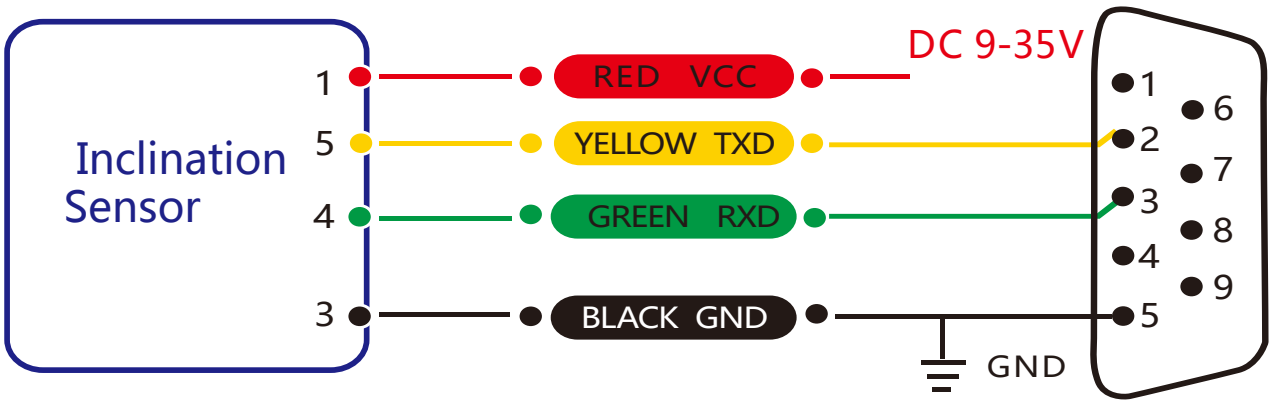
Electrical connections

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.

BW-VG500 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.

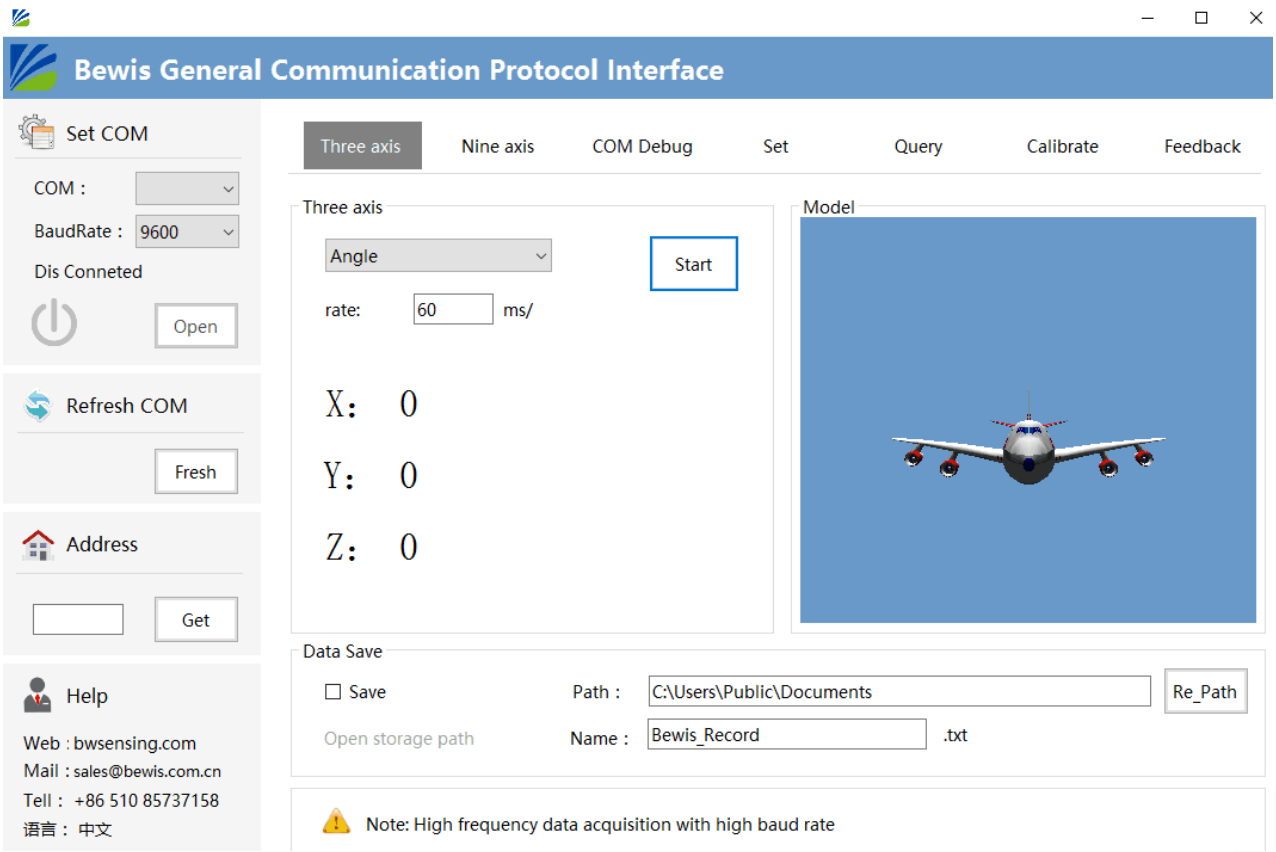
Software use steps:

① Connect the serial port hardware of the inclinometer correctly and connect the power supply.

② Select the correct device model (select azimuth series).

③ Select the computer serial port and baud rate and click to connect to the serial port.

④ Click Start and the tilt angle of the inclinometer in the X and Y directions will be displayed on the screen.



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 (0byte)	Checksum (1byte)
0x77					

Data Format: Hexadecimal
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 PITCH angle Command: 77 04 00 01 05

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x01		0x05

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x81	SXXX.YY	

Note: The data field is a 3-byte return angle value, which is a compressed BCD code, S is a sign bit (0 positive, 1 negative) XXX is a three-digit integer value, and YY is a two-digit decimal value.
The other axis data is the same. For example, 102770 means -27.70 degrees.

2.2 Read ROLL angle Command: 77 04 00 02 06

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x02		0x06

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x82	SXXX.YY	

2.3 Read Heading azimuth angle 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 (3byte)	Checksum (1byte)
0x77	0x0D		0x84	3 SXXX.YY	

PITCH: +2.01°, ROLL: -0.51°

77 0D 00 84 00 02 01 10 00 51 00 00 00 F5

Header, fixed at 77

Data length, fixed at 10

Address code, fixed at 00

Command word, fixed at 84

PITCH axis angle:
The first digit of the first byte is the sign bit, 0 is the positive angle, and 1 is the negative angle.
The second byte and second bytes of the first byte are integer bits of the angle, which is the compressed BCD code.
The third byte and the fourth byte are the decimal places of the angle, which is the compressed BCD code.

ROLL axis angle:
The format is the same as the PITCH axis

Retain data, fixed to four words: 00 00 00 00

The last byte is the sum of all the previous data except the first number (0x77). If there is a carry, the lower data is taken.

2.4 Set baud rate Command: 77 05 00 0B 02 12(Set the baud rate to 9600)

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0B	XX	

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		x8B		

Note: 00:2400,01:4800,02:9600,03:19200,04:115200,05:38400,6:57600. If the baud rate is set to 19200, Each time the communication baud rate is changed successfully, the response command is sent back at the original baud rate, and then the device communication baud rate is immediately changed.
Note: If high frequency output is required, set the baud rate to 115200.

2.5 Set address Command: 77 05 00 0F 01 15(Set the module address from 00 to 01)

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0F	XX Address	

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	XX	0x0F	YY	

2.6 Query address Command: 77 04 00 1F 23

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	00	0x1F		0x23

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	XX	0x1F	XX	

Note: The default address of the sensor is 0x00. When the query address command is sent, the returned data field is the hexadecimal device address.

2.7 Set the automatic output frequency send command: 77 05 00 0C 00 11

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0 byte)	Checksum (1byte)
0x77	0x05		0x0C	XX	

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8C	0x00	

The data field XX sent is the automatic output frequency option.:

00 indicates the answer mode
01 means 5Hz automatic output triaxial angle
02 means 10Hz automatic output triaxial angle
03 means 20Hz automatic output triaxial angle
04 means 25Hz automatic output triaxial angle
05 means 50Hz automatic output triaxial angle
06 means 100Hz automatic output triaxial angle

When the automatic output frequency setting is high, the baud rate needs to be set to a high baud rate.

2.8 Save setting Command: 77 04 00 0A 0E

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0 byte)	Checksum (1byte)
0x77	0x04		0x0A		

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8A	0x00	

2.9 Query filter parameters

send command: 77 04 00 81 85

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0 byte)	Checksum (1byte)
0x77	0x04		0x81	-	

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x08		0x81	SXXX,YYYYY	

Note: The data field contains four bytes, which is a compressed BCD code in the format SX XX YY YY, S is a sign bit (0 positive, 1 negative), X is a three-digit integer bit, and YY is a decimal place, for example, the return command: 77 08 00 81 00 01 01 80 0B, the corresponding parameter is 1.018.

2.10 Set filter parameters Command: 77 08 00 80 00 01 01 80 0A

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0 byte)	Checksum (1byte)
0x77	0x08		0x80		

Command response:

Identifier (1byte	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x08		0x80		

Note: The data field contains four bytes, which is a compressed BCD code. The parameter range is 1-1.5 (excluding 1 and 1.5). If the parameter is changed to 1.001, the complete command is 77 08 00 80 00 01 00 01 8A, the successful setting will automatically return to the same instruction and will be saved automatically.

Ordering Information

Product number	Way of communication	Package condition
BW-VG500-232	RS232	IP67 Package/Aviation Joint
BW-VG500-485	RS485	IP67 Package/Aviation Joint
BW-VG500-TTL	TTL	IP67 Package/Aviation Joint

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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