



# LoRaWAN LWHD-WM400

## Long-distance Triaxial inclinometer

# Technical Manual



## Introduction

LoRaWAN LWHD-WM400 Long-distance wireless triaxial inclinometer is designed for structural health monitoring (SHM). It can be used for up to 10 years (In condition of sending data every hour). Data can be uploaded through the LoRaWAN G500 gateway (optional accessory) connected to TTN or Chirpstack and APP server.

All modules are designed with ultra-low power consumption, the sleep current is lower than  $4\mu\text{A}$ , and have timed wake-up and motion detective wake-up functions. Working temperature is  $-40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$ .

## Main Feature

- Accuracy:  $0.005^{\circ}$
- LoRaWAN Wireless network, star network
- Battery life up to 10 years\*
- Resolution  $0.001^{\circ}$
- Triaxial tilt measurement, range  $\pm 60^{\circ}$
- The default installation method can be freely set, Horizontal or Vertical installation
- External circular Magnetic switch, built-in Toggle switch, Dual switch design

Note: \* means under laboratory conditions

## Functions

- Working frequency 868/915/923, etc MHz optional
- Built-in EEPROM to automatically save time-stamped data in case of poor signal
- Built-in EEPROM can save up to 60,000 sets of data (20Bytes per set of data)
- Automatic sleep
- It can be connected to an Android phone through OTG USB Type-C, and using the APP for parameter configuration and data reading
- Temperature measurement
- Timed wakeup, Vibration wakeup
- Wake up immediately after plugging in Android phone/laptop

### Application

- Dangerous housing monitoring
- Bridge tower inclination measurement
- Dam monitoring
- Slope disaster prevention
- Ancient building protection monitoring
- Tunnel monitoring
- Foundation pit monitoring
- Tower tilt monitoring

### Product Feature



#### Mechanical Index

Connector	Aviation connector
Protection level	IP68 (1m underwater, 24h)
Shell material	Magnesium aluminum alloy anodizing
Installation	Four M6 screws



#### Performance Index

Measuring range(°)		≤5	5~30	30~60
Measuring axis			X-Y-Z	
Accuracy(°)	At room temperature	0.005	0.006	0.007
Resolution(°)	Completely stationary		0.001	
Zero temperature drift(°/°C)	-40°C ~ +85°C		±0.001	
Cross-axis error(°)	At room temperature	0.005	0.006	0.007
Output frequency (Hz)	Up to <b>100</b> (Connect Android Phone or PC via cable), Up to <b>0.1</b> (via LoRa)			
Auto-sleep mode	Support			
Timed Wake-up	Support			
Movement Detected Wake-up	Support			
MTBF	100,000 hours			
Electromagnetic compatibility	Accordance to GBT17626			
Insulation resistance	≥100 MΩ			
Impact-resistant	2000g, 0.5ms, 3Times/axis			
Size (mm)	L105.2*W85*H67mm (without antenna) L105.2*W85*H101.8mm (with radome)			
Weight (g)	450 (±10) (with battery)			

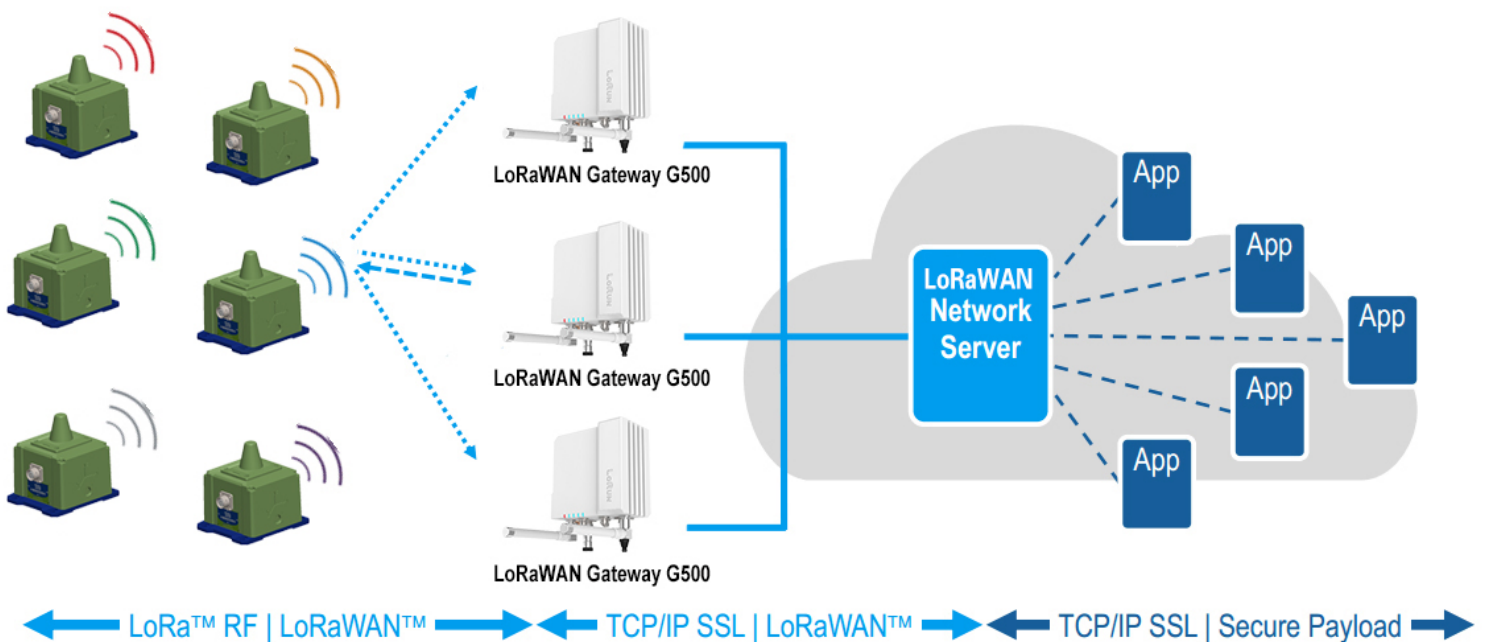
**Resolution:** The smallest change value of the measured value that the sensor can detect and distinguish within the measurement range.

**Accuracy:** The root mean square error of the actual angle and the sensor measuring angle for multiple ( $\geq 16$  times) measurements.

### Electrical Index

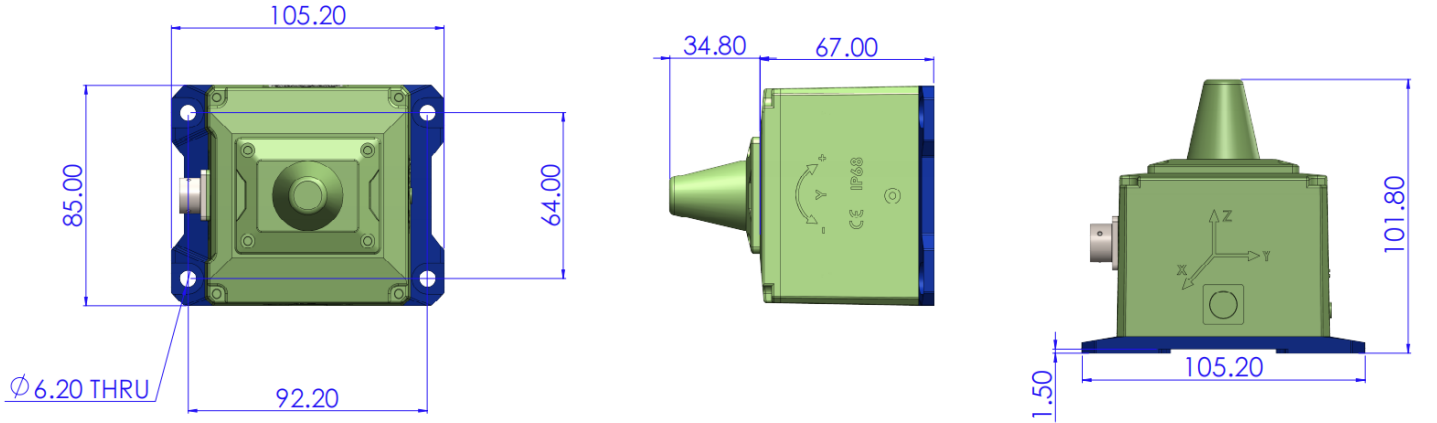
Power	Power voltage	3.6VDC~5VDC
	Working current	100mA (Peak)
	Stand-by current	4 $\mu$ A
	Battery capacity	3.6V 19000mAh
Communication distance	Maximum: 15km	
Data frame	20Bytes or 36Bytes(extra included three-axis acceleration)	
Reliability	The mean time between failures (MTBF) is not less than 100,000 hours Ultra-low power consumption design, including automatic sleep mode, timing wake-up, motion wake-up	

### Network topology

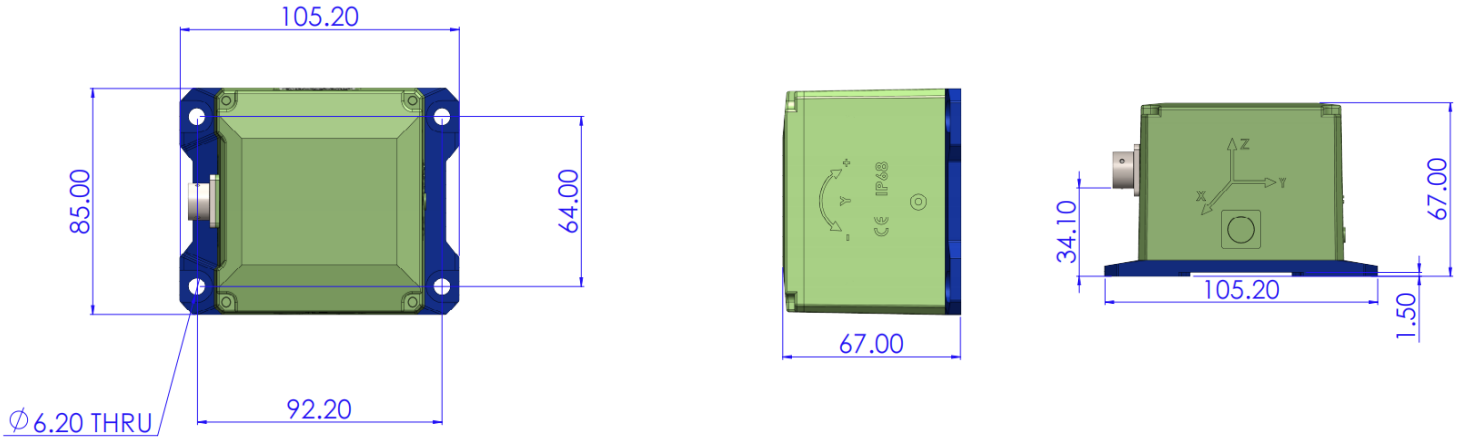


### Package product size

Product size: L105.2\*W85\*H101.8mm (with radome)



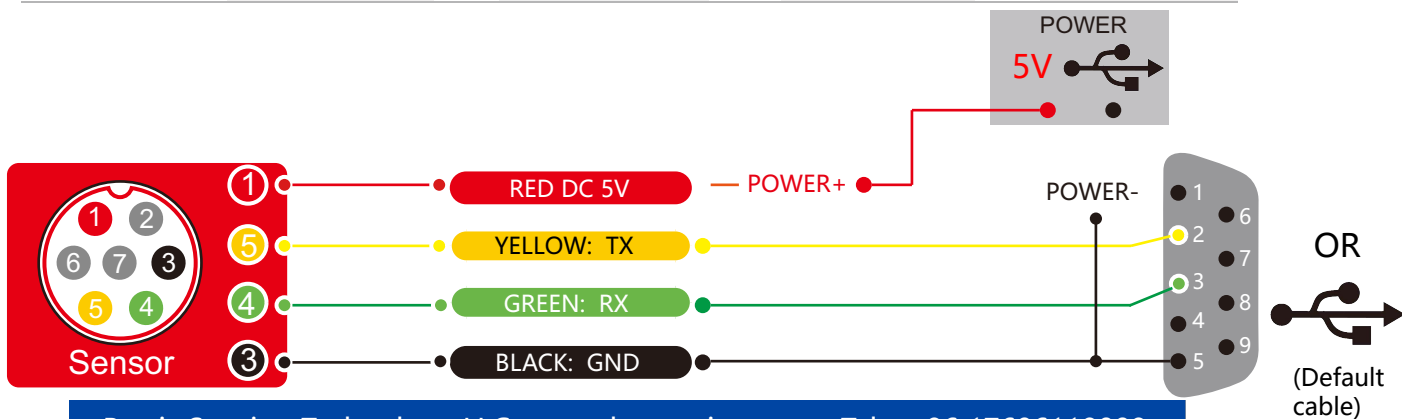
Product size: L105.2\*W85\*H67mm (without antenna)



### Electrical Interface

Aviation plug wiring definition

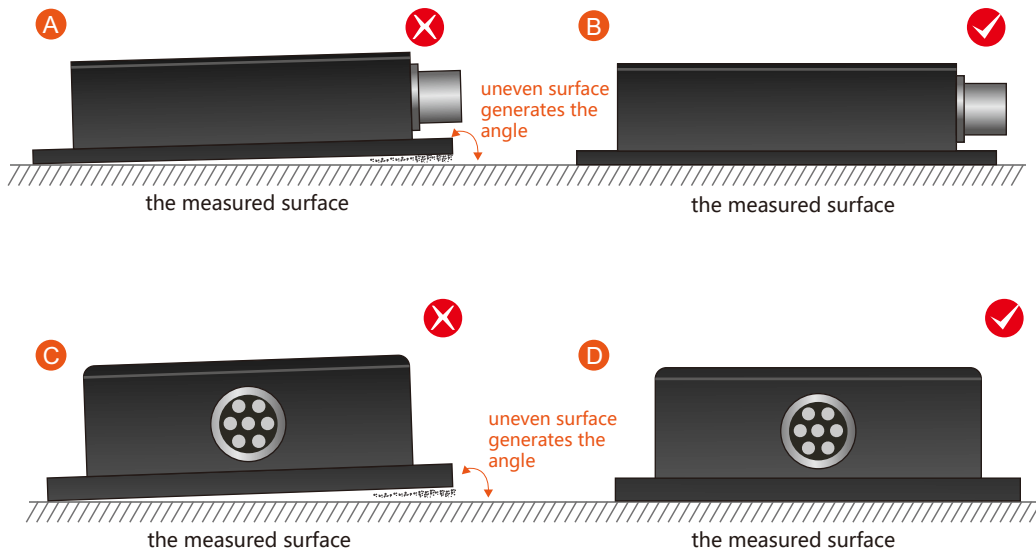
Wire color & function	RED	BLACK	GREEN	YELLOW
	1	3	4	5
	5VDC	GND ground	Receive RXD	Send TXD



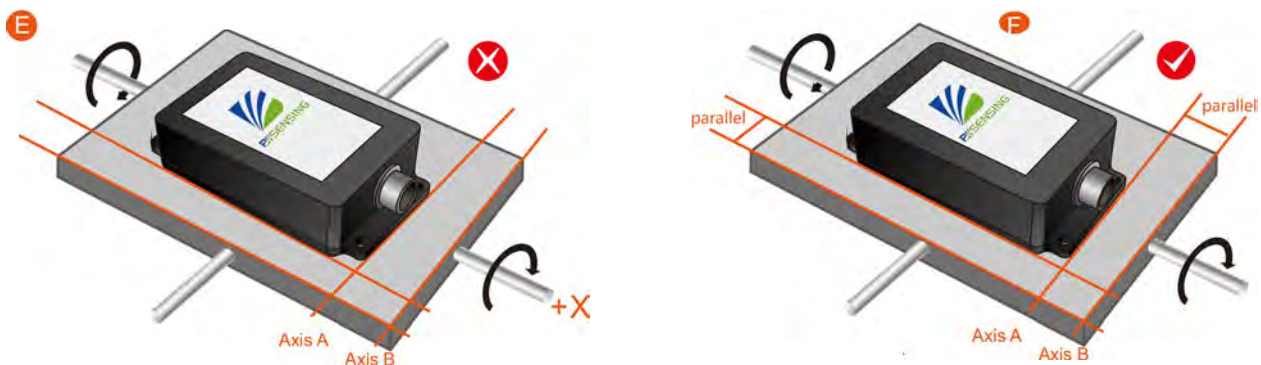
### Installation

The correct installation method can avoid measurement errors. The following points should be done when installing the sensor:

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



Secondly, the bottom line of the sensor and the axis of the measured object cannot have an angle as shown in Figure E, and the bottom line of the sensor should be kept parallel or orthogonal to the axis of rotation of the measured object during installation. This product can be installed horizontally or vertically (vertical installation needs to be customized), and the correct installation method is shown in Figure F.



Finally, the mounting surface of the sensor and the surface to be measured must be tightly fixed, smooth in contact, and stable in rotation, and measurement errors due to acceleration and vibration must be avoided.

### Packing list



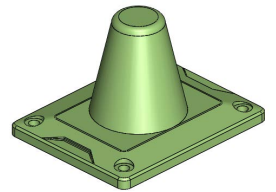
LWHD-WM400 \*1PC



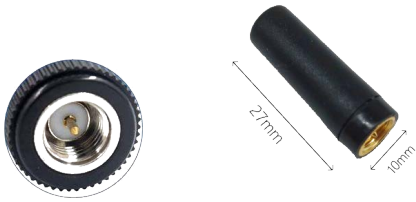
EVE ER34615 \*1PC



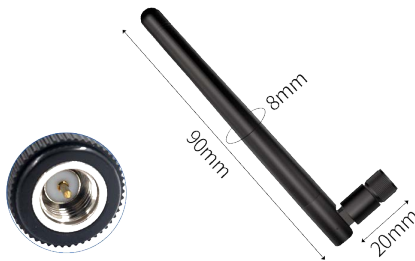
EVE SPC1550 \*1PC  
(Optional)



Radome \*1PC (Optional)



2.7cm 2dBi antenna \*1PC  
Frequency band (860-930MHz)



9cm 3dBi antenna \*1PC (Optional)  
Two types of antennas available  
Frequency band (848-888MHz) or (895-935MHz)



Aviation plug-USB Power&Data  
2in1 cable \*1PC



NdFeB strong magnetic screws \*4PCS  
(Optional)



OTG USB Type-A to Type-C \*1PC

## Executive standard

- Enterprise Quality System Standard: ISO9001:2015 Standard (Certificate No.064-21-Q-3290-RO-S)
- CE certification (certificate number: M.2019.103. U Y1151)
- ROHS (certificate Number: G 190930099)
- GB/T 191 SJ 20873-2003 General specification for inclinometer and level
- GBT 18459-2001 The calculation method of the main static performance index of the sensor
- JJF 1059.1-2012 Evaluation and expression of measurement uncertainty
- GBT 14412-2005 Mechanical vibration and shock Mechanical installation of accelerometer
- GJB 450A-2004 General requirements for equipment reliability
- GJB 909A Quality control of key parts and important parts
- GJB899 Reliability appraisal and acceptance test
- GJB150-3A High temperature test
- GJB150-4A Low temperature test
- GJB150-8A Rain test
- GJB150-12A Sand and dust experiment
- GJB150-16A Vibration test
- GJB150-18A Impact test
- GJB150-23A Tilt and rock test
- GB/T 17626-3A Radio frequency electromagnetic field radiation immunity test
- GB/T 17626-5A Surge (impact) immunity test
- GB/T 17626-8A Power frequency magnetic field immunity test
- GB/T 17626-11A Immunity to voltage dips, short-term interruptions and voltage changes
- GB/T 2423.22-2012 Environmental Test Part 2: Test Method Test N: Temperature Change (IEC 60068-2-14:2009, IDT)
- GB/T 10125-2012 Artificial atmosphere corrosion test Salt spray test (ISO 9227:2006, IDT)

# LoRaWAN Series

## Long-distance Triaxial Inclinometer

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