

# USER MANUAL

## HWT905(RS485)

IP67 Inclinometer



## Tutorial Link

[Google Drive](#)

**Link to instructions DEMO:**

[WITMOTION Youtube Channel](#)

[HWT905 RS485 Playlist](#)

If you have technical problems or cannot find the information that you need in the provided documents, please contact our support team. Our engineering team is committed to providing the required support necessary to ensure that you are successful with the operation of our AHRS sensors.

## Contact

[Technical Support Contact Info](#)

## Application

- AGV Truck
- Platform Stability
- Auto Safety System
- 3D Virtual Reality
- Industrial Control
- Robot
- Car Navigation
- UAV
- Truck-mounted Satellite Antenna Equipment

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# 1 Introduction

The HWT905 is a multi-sensor device detecting acceleration, angular velocity, angle as well as magnetic field. The robust housing and the small outline makes it perfectly suitable for industrial retrofit applications such as condition monitoring and predictive maintenance. Configuring the device enables the customer to address a broad variety of use cases by interpreting the sensor data by smart algorithms.

HWT905's scientific name is AHRS IMU sensor. A sensor measures 3-axis angle, angular velocity, acceleration, magnetic field. Its strength lies in the algorithm which can calculate three-axis angle accurately.

HWT905 offers several advantages over competing sensor:

- Heated for best data availability: new WITMOTION patented zero-bias automatic detection calibration algorithm outperforms traditional accelerometer sensor
- High precision Roll Pitch Yaw (X Y Z axis) Acceleration + Angular Velocity + Angle + Magnetic Field output
- Low cost of ownership: remote diagnostics and lifetime technical support by WITMOTION service team
- Developed tutorial: providing manual, datasheet, Demo video, free software for Windows computer, APP for Android smartphones , and sample code for MCU integration including 51 serial, STM32, Arduino, Matlab, Raspberry Pi, communication protocol for project development
- WITMOTION sensors have been praised by thousands of engineers as a recommended attitude measurement solution

## 1.1 Warning Statement

- Putting more than 36 Volt across the sensor wiring of the main power supply can lead to permanent damage to the sensor.
- VCC cannot connect with GND directly, otherwise it will lead to the burning of the circuit board.
- For proper instrument grounding: use WITMOTION with its original factory-made cable or accessories.
- Do not access the I2C interface.
- For secondary developing project or integration: use WITMOTION with its compiled sample code.

## 2 Use Instructions with PC

### 2.1 Connection Method

PC software is only compatible with Windows system.

[Link to HWT905's demo video](#)

#### 2.1.1 Serial Connection

**Step 1.** Connect the sensor with a serial converter

PIN Connection:

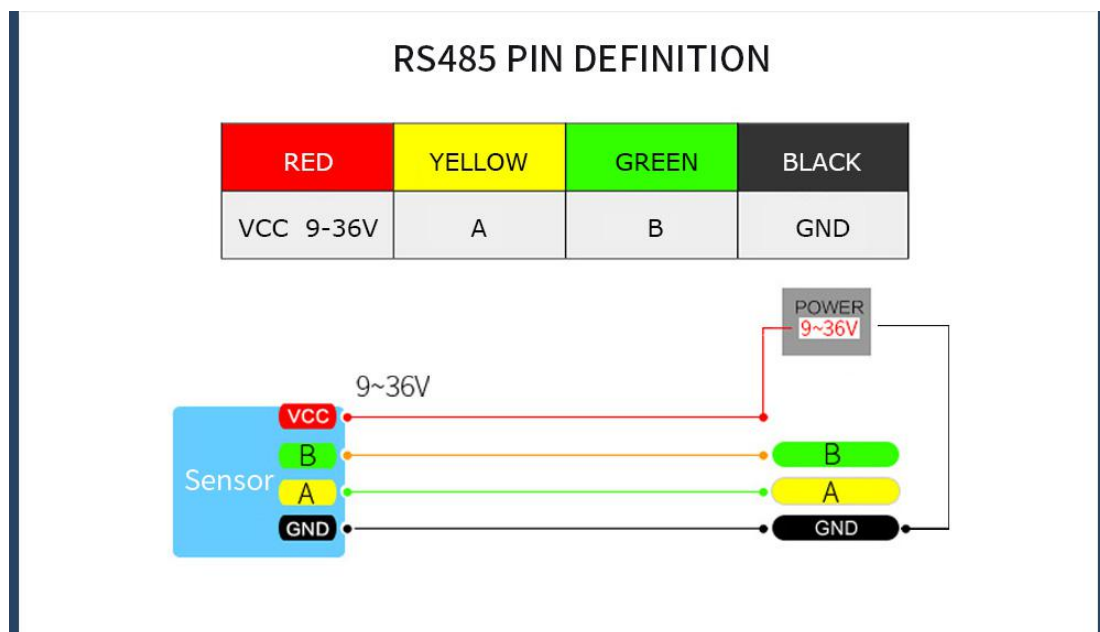
VCC - 9~36V

B - B

A - A

GND - GND

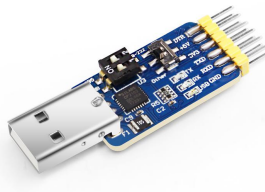
(VCC 9~36V is recommended for connection)



## Recommended tools:



3-in-1 serial converter

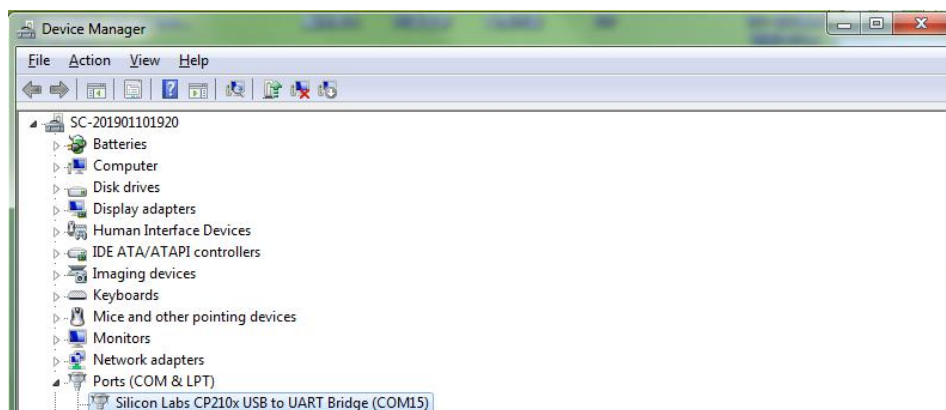


6-in-1 serial converter

[Link to tutorial of 3-in-1 serial converter\(CH340 driver\)](#)

[Link to tutorial of 6-in-1 serial converter \(CP2102 driver\)](#)

**Step 1.** Unzip the software and install the driver CH340 or CP2102 (Depending on which accessory for usage.)



**Step 2.** Insert the converter to computer and confirm the "com port" in device manager

**Step 3.** Open the software(Minimu.exe)  
Data will appear after auto-search finishes

**Notice:** If not successful, please operate manually  
Choose the com port and baud rate 9600, data will be shown on the software.



## 2.2 Software Introduction

[Link to download software](#)

### 2.2.1 Main Menu



Main Menu of software		
Button		Function
File		Launch recorded HEX file (Bin format)
Tools		Hide or display tools box on left side
Record		Record function
3D		3D DEMO
Config		Configuration setting
Help	Language	English or Chinese
	Bluetooth Set	Binding device or unbind
	Firmware update	Option for firmware update
	About Minimu	Info about Minimu.exe
	Factory test	For manufacturer internal test only
Auto-search		Auto searching the sensor
Port		Com port selection

Baud	Baud rate selection
Type	Fixed setting as Modbus for HWT905
Open	Open com port
Close	Close com port

## 2.2.2 Menu of Configuration

Modbus - Config

Read Config
Lock
Unlock
Calibrate Time

System

Reset
Sleep
Alarm
Algorithm: 9 - axis
Install Direction: Horizontal
Instruction Startup

Calibrate

Acceleration
Magnetic Filed
Reset Z-axis Angle
Gyro Auto Calibrate
Reset Height
Angle Reference

Communication

Baud Rate: 9600
Device Address: 0x50
change

Range

Acceleration: 16 g
Gyro: 2000 deg/s
Band Width: 20 Hz
GPS Time Zone: UTC

Display Interface

Port

D0 model: AIN
pulse width: 0
cycle: 0
D1 model: AIN
pulse width: 0
cycle: 0
D2 model: AIN
pulse width: 0
cycle: 0
D3 model: AIN
pulse width: 0
cycle: 0

Save Config
Online

Read Configuration Completed

Menu of Configuration	
Button	Function
Read Config	Reading the current configuration
Lock	Lock the sensor
Unlock	Unlock the sensor
Calibrate Time	Calibration time of chip
Save Config	Save configuration

System

Algorithm: 
 Install Direction: 
☐ Instruction Startup

Menu of System	
Button	Function
Reset	Reset to factory setting
Sleep	Sleep function
Alarm	Alarm function
Algorithm	6-axis algorithm or 9-axis
Installation Direction	Vertical or horizontal installation
Instruction Start-up	Instructions sending to start-up the sensor

Calibrate

☒ Gyro Auto Calibrate

Menu of Calibrate	
Button	Function
Acceleration	Accelerometer calibration
Magnetic Field	Magnetometer calibration
Reset Height	Reset height data to 0 (only for sensor built-in barometer, including WT901B, WTGAHRS2, WTGAHRS1, HWT901B)
Reset Z-axis Angle	Reset Z-axis angle to 0 degree, not available for HWT905 in 9-axis algorithm
Angle Reference	Setting current angle as 0 degree
Gyro Auto Calibrate	Auto-calibration of gyroscope

Range

Acceleration:  Gyro:  Band Width:  GPS Time Zone:

Menu of Range	
Button	Function
Acceleration	Acceleration measurement range
Gyro	Gyroscope measurement range
Band Width	Bandwidth range
GPS Time Zone	GPS positioning of time zone

Communication

Baud Rate:  Device Address:

Menu of Communication	
Button	Function
Baud Rate	Baud rate selection
Device Address	0x50

## 2.3 Calibration

Preparation:

Make sure the sensor is "Online".

Calibration on PC software:

It is required to calibrate for the first time usage.

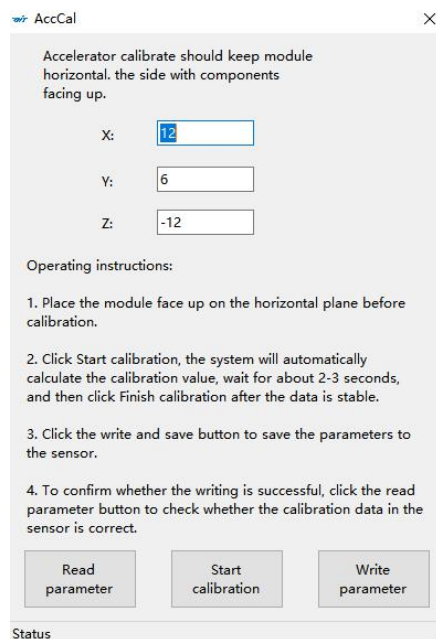
### 2.3.1 Accelerometer Calibration

#### Purpose:

The accelerometer calibration is used to remove the zero bias of the accelerometer. Before calibration, there will be different degrees of bias error. After calibration, the measurement will be accurate.

#### Methods:

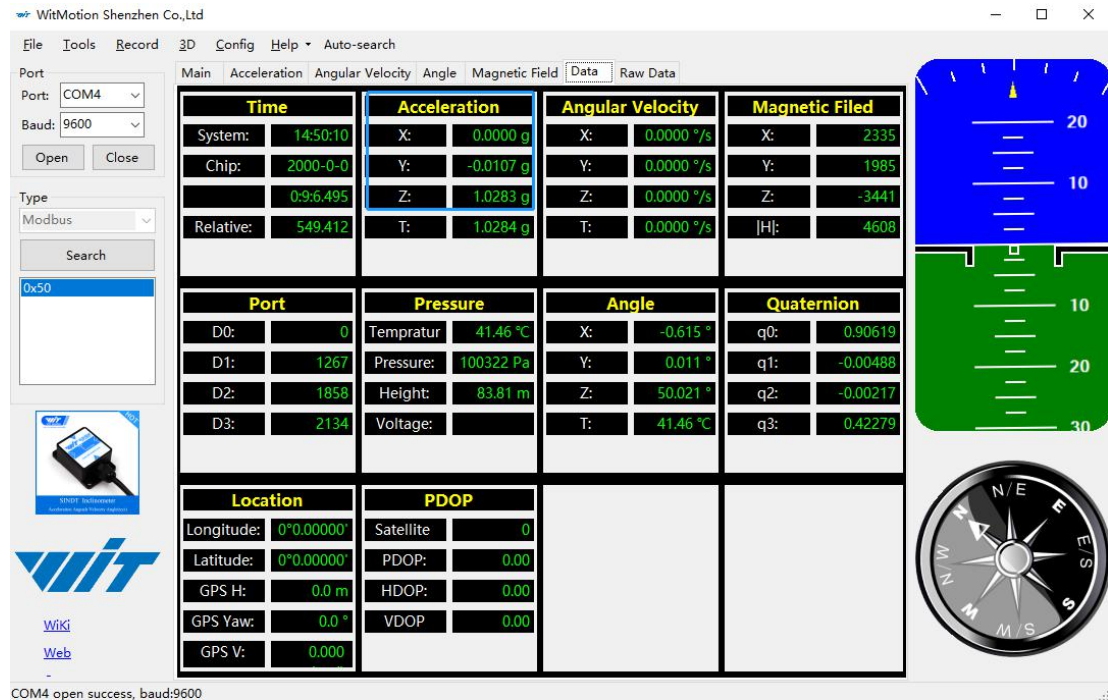
- Step 1. Keep the module horizontally stationary
- Step 2. Click the accelerometer calibration
- Step 3. Click the "Start calibration" and wait for 3 seconds



The screenshot shows a software window titled "AccCal" with a close button (X) in the top right corner. Inside the window, there is a text instruction: "Accelerator calibrate should keep module horizontal, the side with components facing up." Below this, there are three input fields for calibration parameters: "X:" with a value of "12", "Y:" with a value of "6", and "Z:" with a value of "-12". Below the input fields, there is a section titled "Operating instructions:" followed by four numbered steps: 1. Place the module face up on the horizontal plane before calibration. 2. Click Start calibration, the system will automatically calculate the calibration value, wait for about 2-3 seconds, and then click Finish calibration after the data is stable. 3. Click the write and save button to save the parameters to the sensor. 4. To confirm whether the writing is successful, click the read parameter button to check whether the calibration data in the sensor is correct. At the bottom of the window, there are three buttons: "Read parameter", "Start calibration", and "Write parameter". A "Status" label is located at the bottom left of the window.

- Step 4. Click "Complete Calibration"

## Step 5. Judge the result--confirm if there is 1g on Z-axis acceleration



1. After 1 ~ 2 seconds, the three axial acceleration value of the module is about 0, 0, 1, the X and Y axis Angle is around 0°. After calibration, the x-y axis Angle is accurate.

Note: When putting the module horizontal, there is 1g of gravitational acceleration on the Z-axis.

## 2.3.2 Magnetic Field Calibration

### Purpose:

Magnetic calibration is used to remove the zero bias of the magnetic field sensor. Usually, the magnetic field sensor will have a large zero error when it is manufactured. If it is not calibrated, it will bring a large measurement error, which will affect the accuracy of the measurement of the z-axis Angle of the heading Angle.

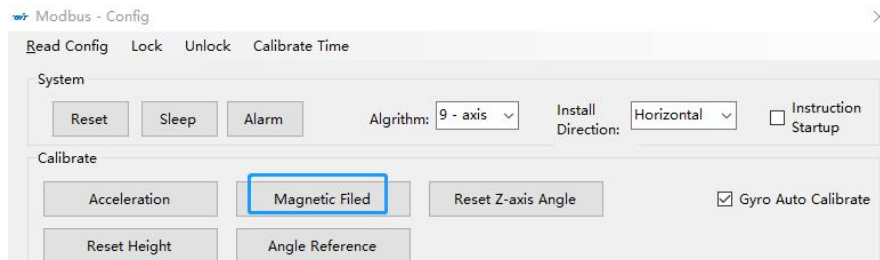
### Preparation:

Sensors should be 20CM away from magnetic and iron and other materials

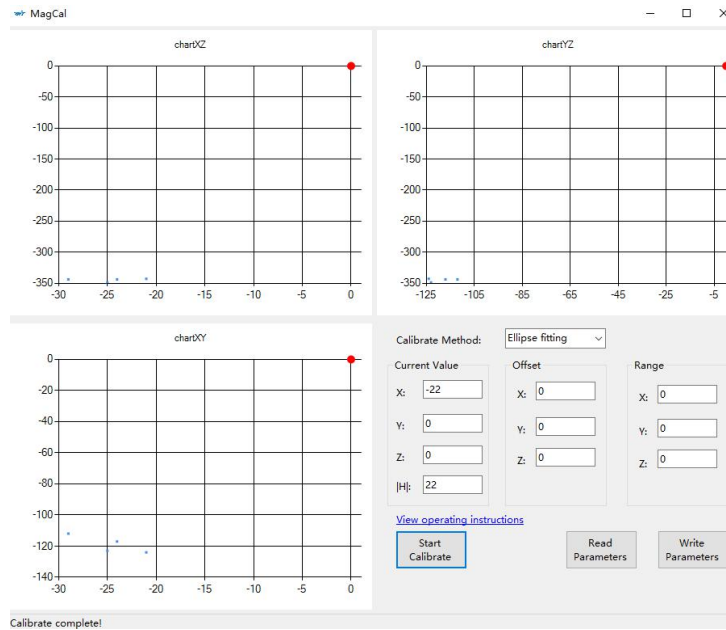
Methods:

Step 1. Open the Config menu

Step 2. Click the magnetic field calibration button then click the "Start calibration"

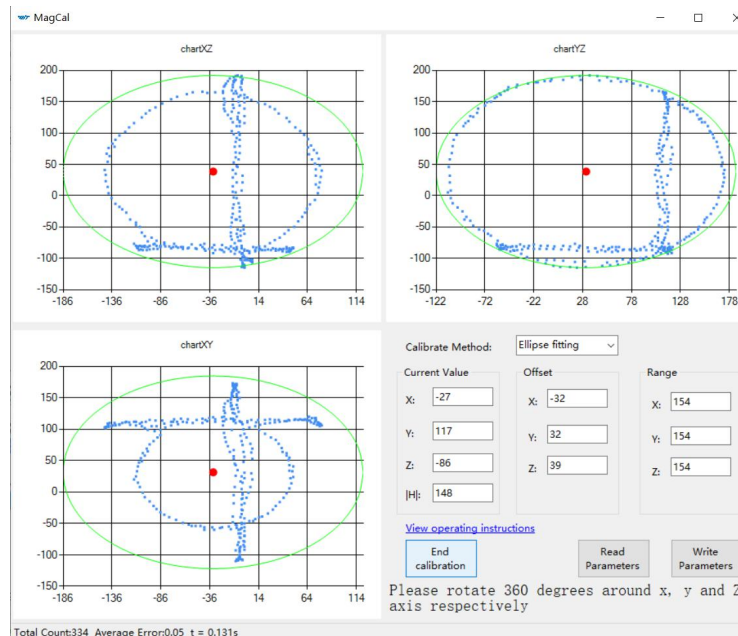






Step 3. Slowly rotate the module 360° around X, Y, Z, 3-axis accordingly

Step 4. After rotation, click "End calibration"



Successful result:

Most of data dots will be within the ellipse.

If not successful, please stay away from the objective that can create magnetic field interference.

### 2.3.3 Gyroscope Automatic Calibration

The gyroscope calibration is to calibrate the angular velocity, and the sensor will calibrate automatically.

It is recommended that the automatic calibration of gyroscopes can be inactivated only if the module rotates at a constant speed.

### 2.3.4 Reset Z-axis Angle

Note: If you want to avoid magnetic interference, you can change the algorithm to 6-axis, function of resting Z-axis angle can be used.

The z-axis angle is an absolute angle, and it takes the northeast sky as the coordinate system can not be relative to 0 degree.

Z axis to 0 is to make the initial angle of the z axis angle is relative 0 degree. When the module is used before and z - axis drift is large, the z - axis can be calibrated, When the module is powered on, the Z axis will automatically return to 0.

Calibration methods as follow: firstly keep the module static, click the "Config" open the configuration bar and then click "Reset Z-axis Angle" option, you will see the the angle of the Z axis backs to 0 degree in the module data bar.

### 2.3.5 Reset Height to 0

Only available for the module built-in barometer like WT901B, HWT901B, WTGAHRS1, WTGAHRS2.

## 2.4 Configuration

### 2.4.1 Baud Rate

The module supports multiple baud rates, and the default baud rate is 9600. To set the baud rate of the module, you need to select the baud rate to be changed in the communication rate drop-down box in the configuration bar based on the correct connection between the software and the module.

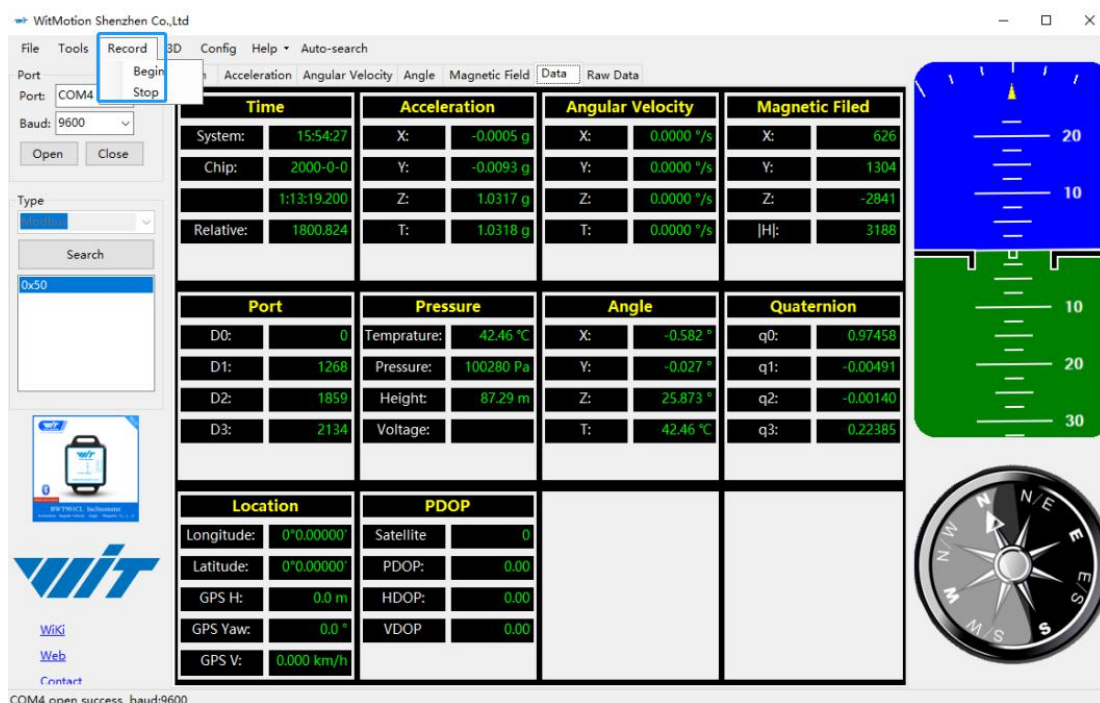
Note: After the change, the module will no longer output data at the original baud rate. The data will be output only when the baud rate that has been changed is selected on the PC software again.

### 2.4.2 Data Recording

Method are as follows:

Step 1: Click "Record" and "Begin"

Step 2: Click "Stop"



The screenshot shows the WIT Motion software interface. The top menu bar includes File, Tools, Record, 3D, Config, Help, and Auto-search. The 'Record' menu is open, showing 'Begin' and 'Stop' options. The 'Tools' menu is also open, showing 'Open' and 'Close' options. The 'Config' menu is open, showing 'Acceleration', 'Angular Velocity', 'Angle', 'Magnetic Field', 'Data', and 'Raw Data' options. The 'Data' menu is selected, displaying a table of sensor data. The 'Raw Data' menu is also visible. The 'Data' table contains the following data:

Time		Acceleration		Angular Velocity		Magnetic Filed	
System:	15:54:27	X:	-0.0005 g	X:	0.0000 °/s	X:	626
Chip:	2000-0-0	Y:	-0.0093 g	Y:	0.0000 °/s	Y:	1304
Relative:	1:13:19.200	Z:	1.0317 g	Z:	0.0000 °/s	Z:	-2841
	1800.824	T:	1.0318 g	T:	0.0000 °/s	[H]:	3188

Port		Pressure		Angle		Quaternion	
D0:	0	Temperature:	42.46 °C	X:	-0.582 °	q0:	0.97458
D1:	1268	Pressure:	100280 Pa	Y:	-0.027 °	q1:	-0.00491
D2:	1859	Height:	87.29 m	Z:	25.873 °	q2:	-0.00140
D3:	2134	Voltage:		T:	42.46 °C	q3:	0.22385

Location		PDOP	
Longitude:	0°0.00000'	Satellite	0
Latitude:	0°0.00000'	PDOP:	0.00
GPS H:	0.0 m	HDOP:	0.00
GPS Yaw:	0.0 °	VDOP:	0.00
GPS V:	0.000 km/h		

On the right side of the interface, there are two vertical scale indicators. The top one is a blue scale with markings at 10, 20, and 30. The bottom one is a green scale with markings at 10, 20, and 30. Below these scales is a compass rose showing the cardinal directions (N, E, S, W) and intermediate directions (NE, SE, SW, NW).

The status bar at the bottom left indicates 'COM4 open success, baud:9600'.



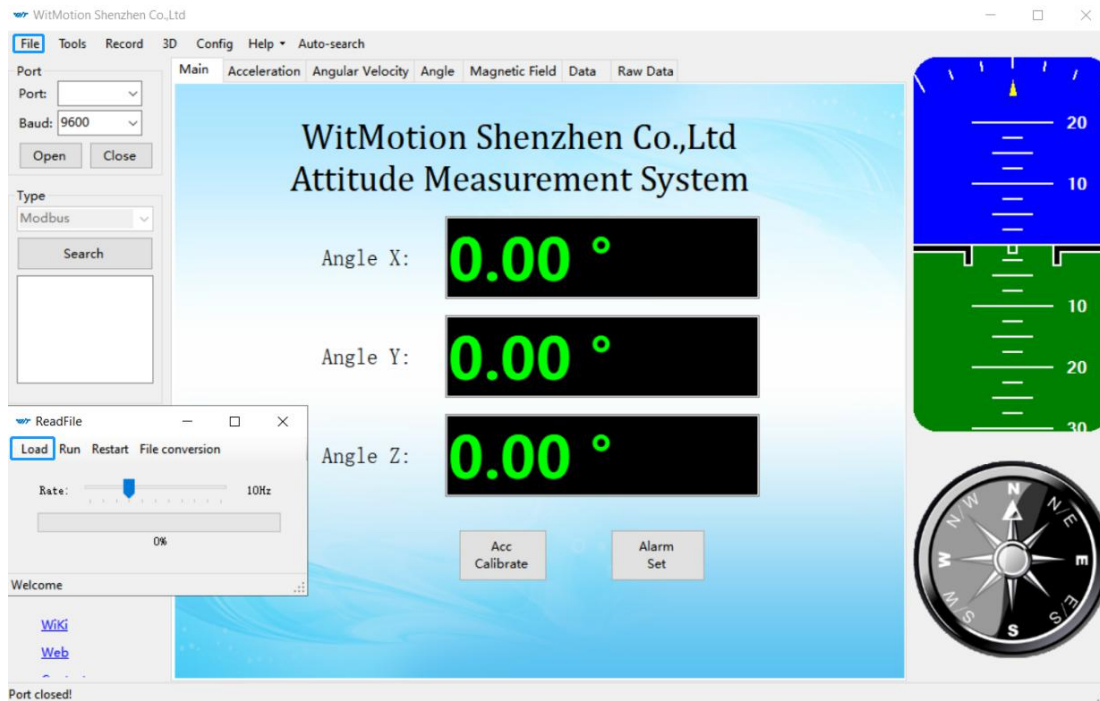
### 2.4.3 Data Playback

New function: When creating recorded file each time, there will a BIN file created in the folder of record file in path of installed software meanwhile.

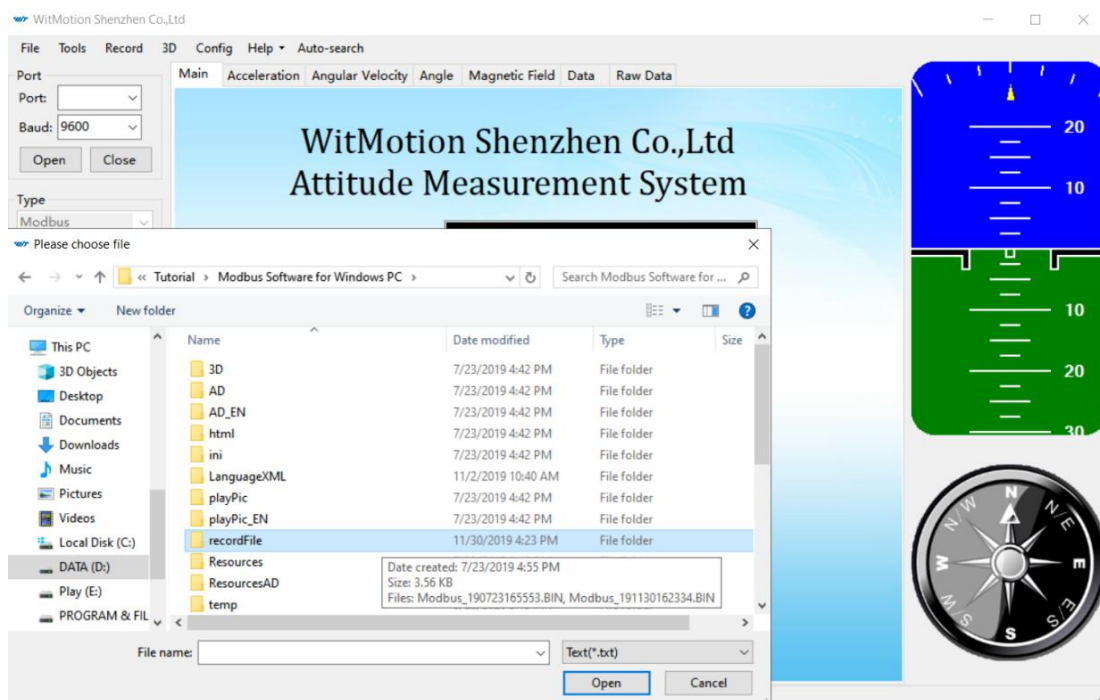
Recorded data playback method:

Step 1: Disconnect the sensor

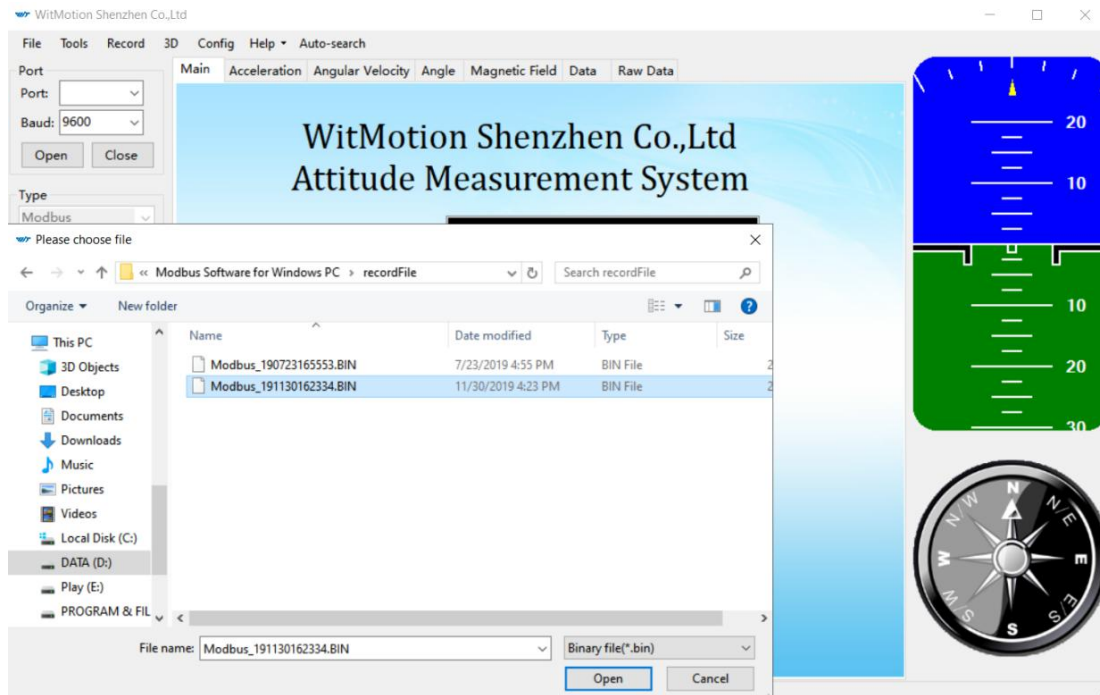
Step 2: Click "File" Button and then click "Load"



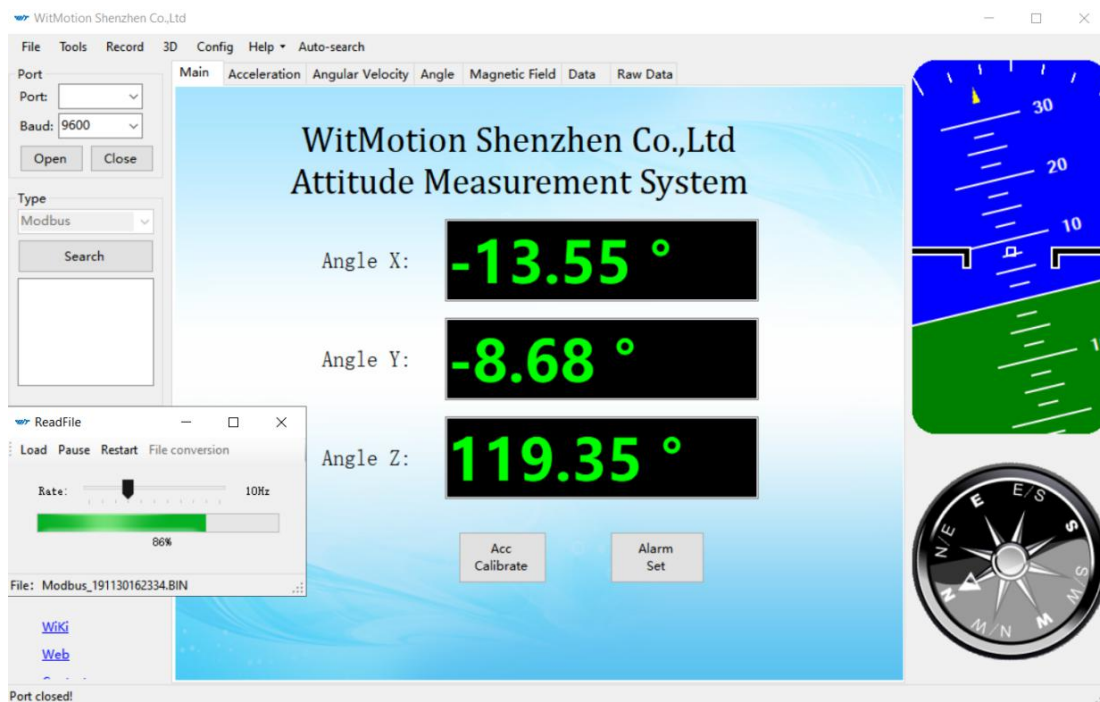
Step 3: Choose the original path of software installation and load the Bin file







Step 4: Click "Run" and the Binary file will be playback  
When playback, the rate can be editable.

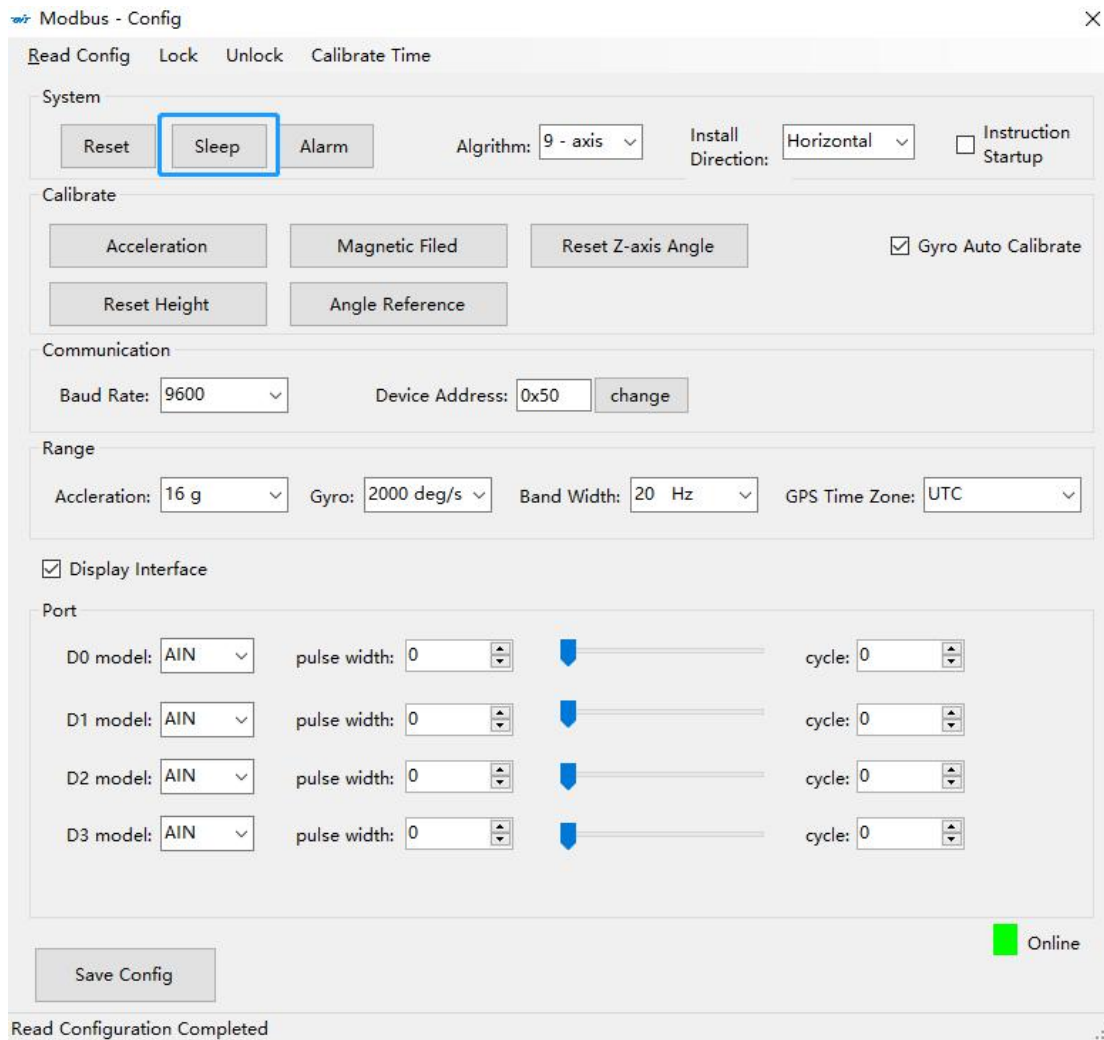


## 2.4.4 Standby and Wake Up

**Sleep:** The module paused working and entered the standby mode. Power consumption is reduced after sleeping.

**Wake up:** The module enters the working state from the standby state.

The module defaults to a working state, in the "Config" of the software, click "Sleep" option to enter the sleep state, click "Sleep" again to release sleep.



Modbus - Config

Read Config Lock Unlock Calibrate Time

**System**

Reset **Sleep** Alarm Algorithm: 9 - axis Install Direction: Horizontal ☐ Instruction Startup

**Calibrate**

Acceleration Magnetic Filed Reset Z-axis Angle ☒ Gyro Auto Calibrate

Reset Height Angle Reference

**Communication**

Baud Rate: 9600 Device Address: 0x50 change

**Range**

Acceleration: 16 g Gyro: 2000 deg/s Band Width: 20 Hz GPS Time Zone: UTC

☒ Display Interface

**Port**

Model	Pulse Width	Direction	Cycle
D0 model: AIN	pulse width: 0	Blue Arrow	cycle: 0
D1 model: AIN	pulse width: 0	Blue Arrow	cycle: 0
D2 model: AIN	pulse width: 0	Blue Arrow	cycle: 0
D3 model: AIN	pulse width: 0	Blue Arrow	cycle: 0

Save Config

Online

Read Configuration Completed

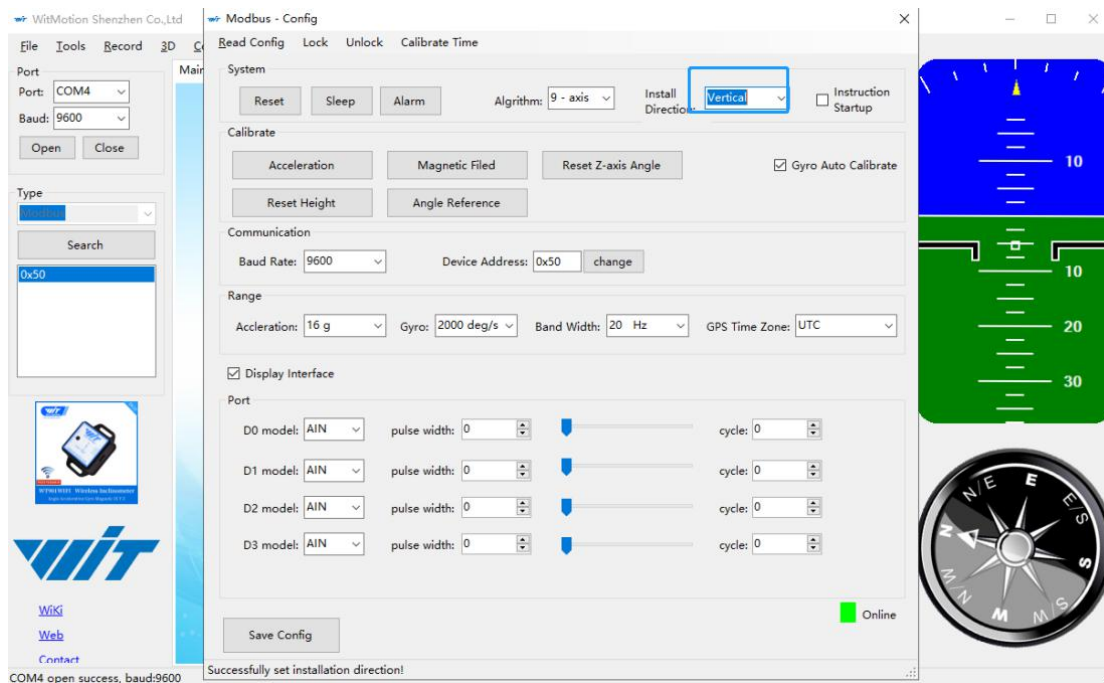
## 2.4.5 Placement Direction

The default installation direction of the module is horizontal. When the module needs to be installed vertically, the vertical installation can be set.

Step 1: Rotate the module 90 degrees around the X-axis

Step 2: Place the sensor 90 degrees vertically

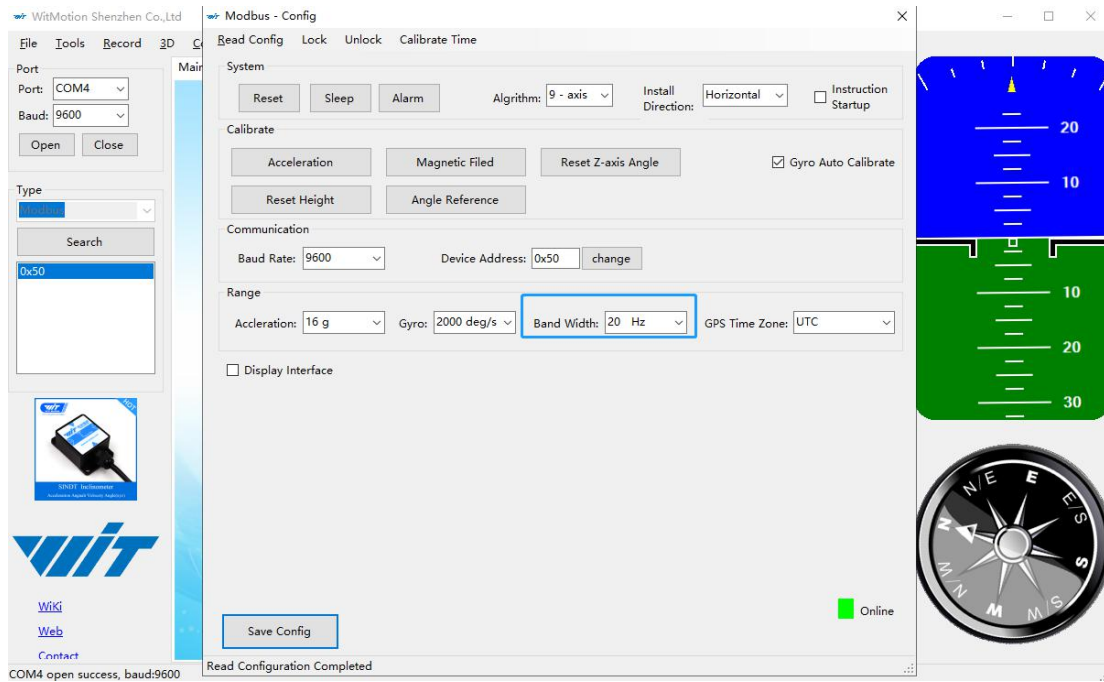
Step 3: Click "Vertical" as install directions on "Config" menu





## 2.4.6 Bandwidth

Default bandwidth is 20Hz.

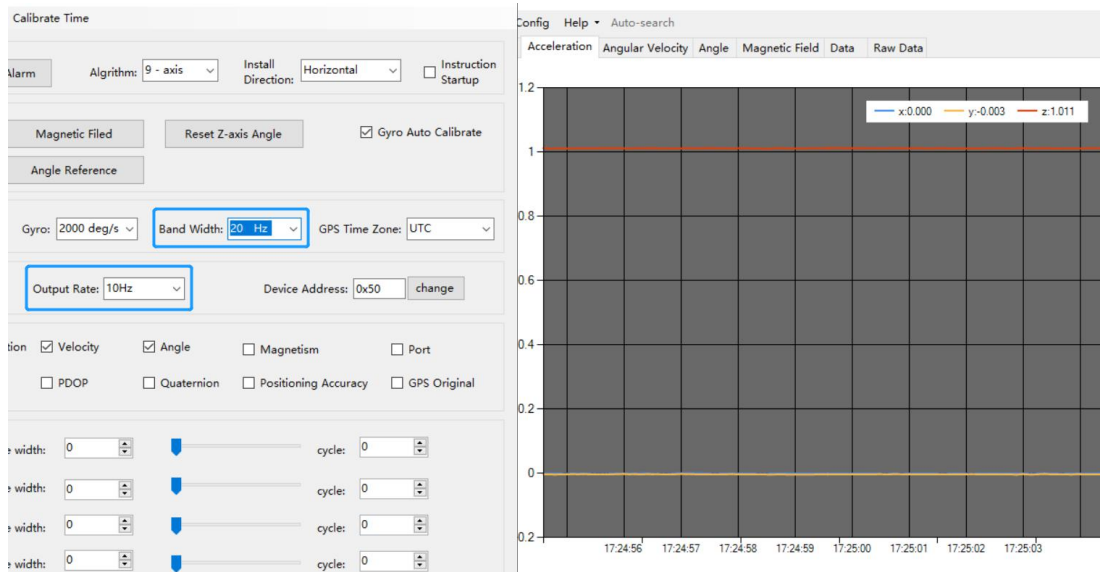


Function:

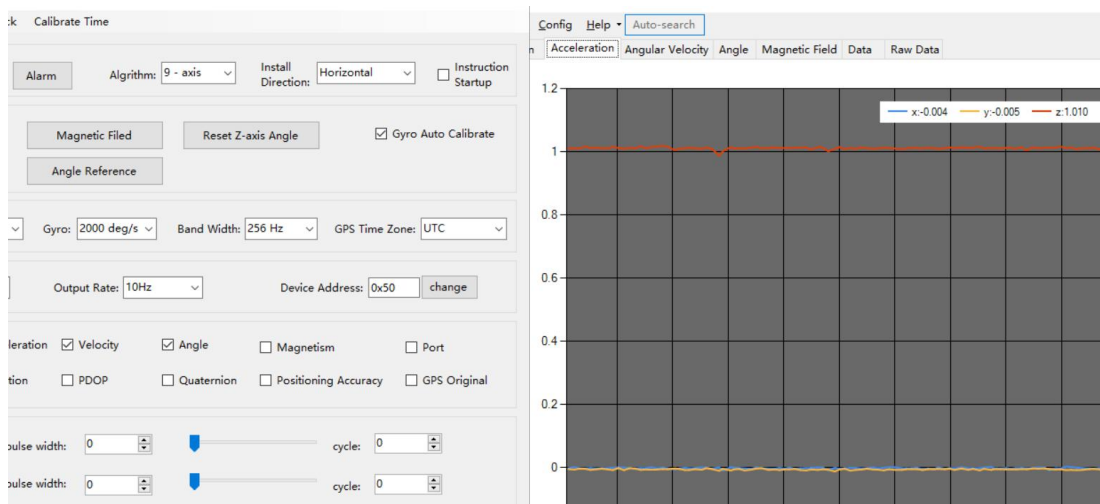
1. The higher rate of bandwidth setting will lead to the higher fluctuation in data waveform. Conversely, the lower rate of bandwidth, data will become more fluent.

For example:

Bandwidth as 20Hz, Output rate as 10Hz. The waveform is very steady.



Bandwidth as 256Hz, Output rate as 10Hz. The waveform will show more fluctuation.



2. The higher rate of bandwidth will solve the data-repeating problem.

For example, if the bandwidth setting is 20Hz, retrieval rate as 100Hz, there will be 5 repeating data.

If you prefer there is no repeating data, it is required to increase the bandwidth more than 100Hz.

### 2.4.7 Restore Factory Setting

Operation method:

Connect the HWT905 to the computer through the USB to RS485 module, click the configuration option, open the configuration bar, and click "Reset".

After restoring the factory settings, power on the module again. (This method needs to know the baud rate of the module in advance, if the baud rate does not match the instruction will not take effect.)

## 2.4.8 6-axis/ 9-axis Algorithm

6-axis algorithm: Z-axis angle is mainly calculated based on angular velocity integral. There will be calculated error on Z-axis angle.

9-axis algorithm: Z-axis angle is mainly calculated and analyzed based on the magnetic field. Z-axis angle will have few drift.

The default algorithm of HWT905 is 9-axis. If there is magnetic field interference around installed environment, it is recommended to switch to 6-axis algorithm to detect the angle.

Method:

Step 1: Switch to the "6-axis" algorithm on "Config" menu

Step 2: Proceed the "Accelerometer calibration" and "Reset Z-axis angle" calibration.

After the calibration is completed, it can be used normally.

