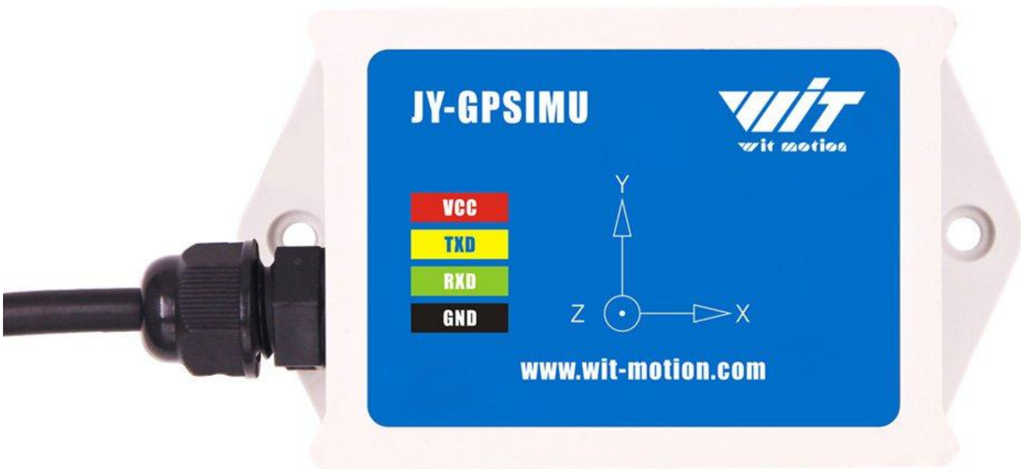
USER MANUAL

WTGAHRS2

GPS IMU



Tutorial Link

Google Drive

Link to instructions DEMO:
WITMOTION Youtube Channel
WTGAHRS2 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

Contents

1 Introduction

The WTGAHRS2 is a multi-sensor device detecting acceleration, angular velocity, angle, magnetic filed as well as GPS. 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.

WTGAHRS2's scientific name is GPS IMU sensor. A sensor measures 3-axis angle, angular velocity, acceleration, magnetic field and GPS data. Its strength lies in the algorithm which can calculate three-axis angle accurately.

WTGAHRS2 is employed where the highest measurement accuracy is required. It 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+GPS data

• 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 5 Volt across the sensor wiring of the main power supply can lead to permanent damage to the sensor.
- GPS positioning requires to be operated outdoors.
- 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

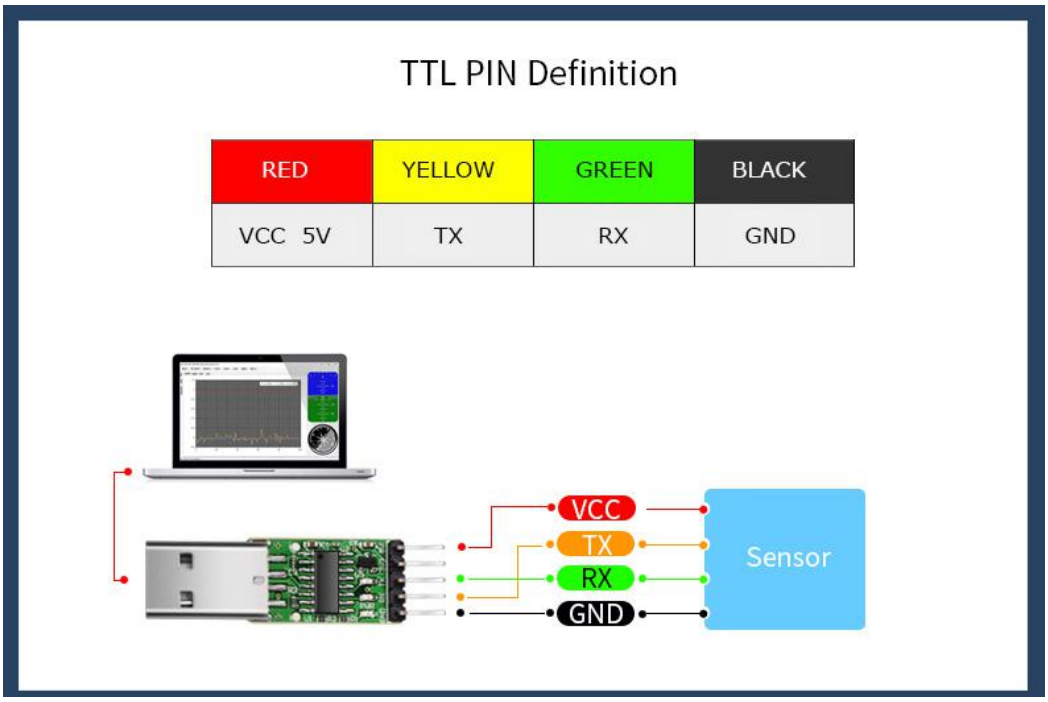
PC software is only compatible with Windows system.

Link to WTGAHRS2's demo video

2.1.1 Serial Connection

Step 1. Connect the sensor with a serial converter
PIN Connection:
VCC - 5V
TX - RX
RX - TX
GND - GND

(When connecting with computer, VCC-5V is recommended.)



Recommended tools:

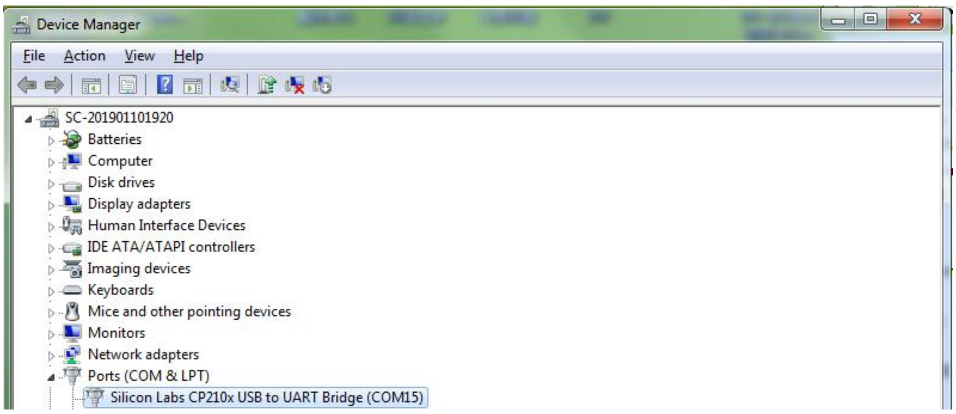
3-in-1 serial converter

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

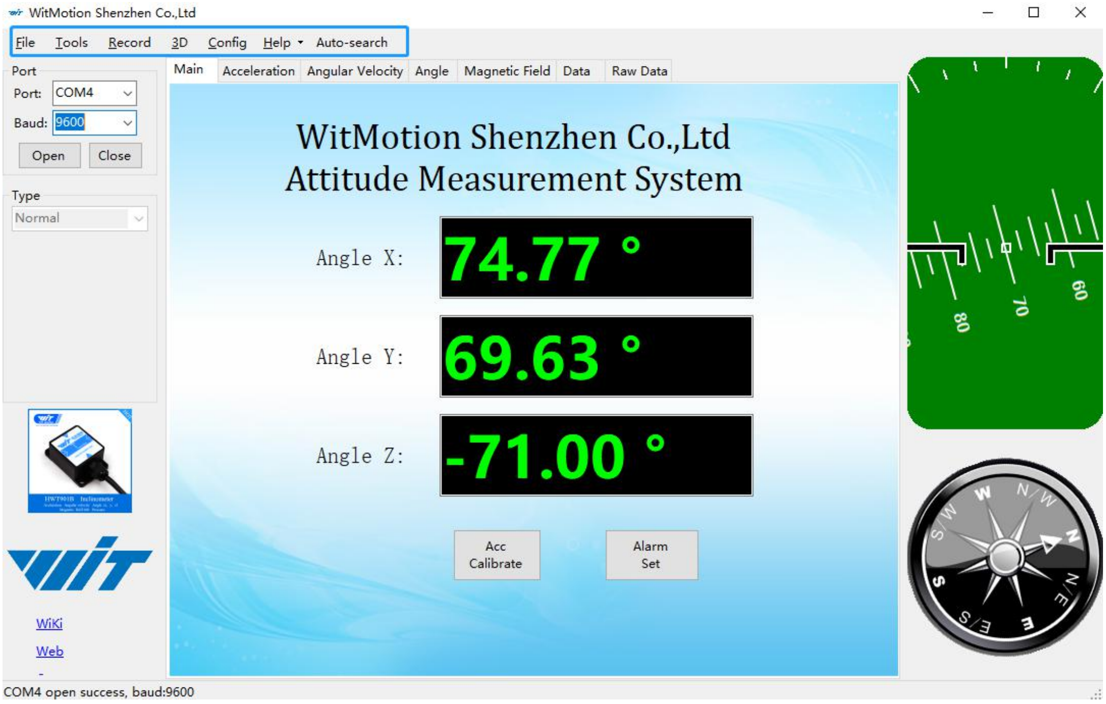
Step 3. Open the software(Minimu.exe)
Data will appear after auto-search finishes

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

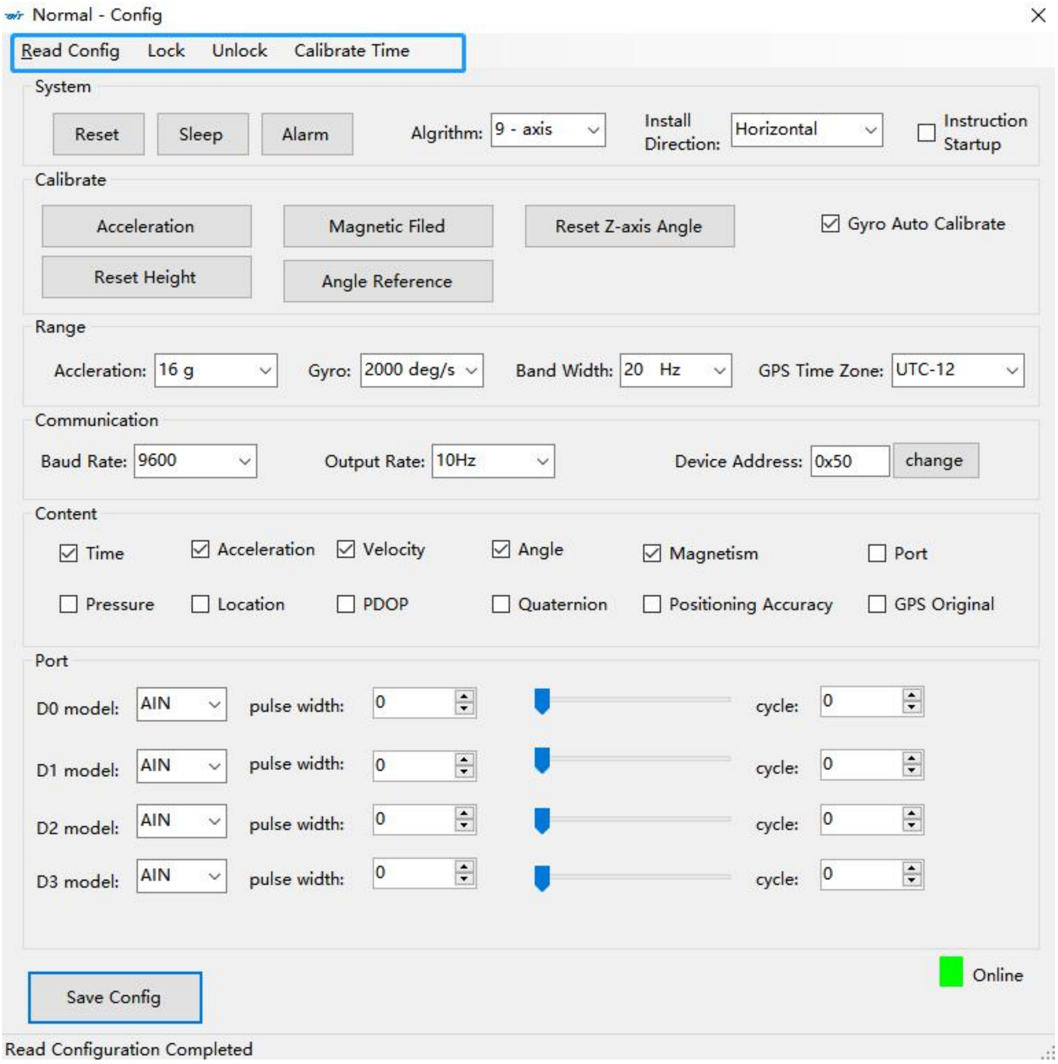
[Link to download software]()

2.2.1 Main Menu

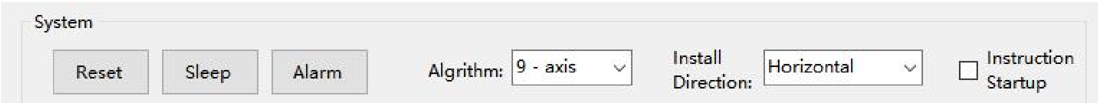


Main Menu of software		
Button		Function
File		Launch recorded HEX file (Bin format)
Tools		Hide or display tools box on left side
Record		Record function
3D		3D DEMO
Config		Configuration setting
Help	Language	English or Chinese
	Bluetooth Set	Binding device/ unbind, only for Bluetooth sensor series
	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
Open		Open com port
Close		Close com port

2.2.2 Menu of Configuration

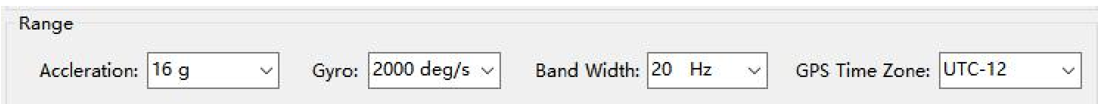


Menu of Configuration	
Button	Function
Read Config	Reading the current configuration
Lock	Lock the sensor
Unlock	Unlock the sensor
Calibrate Time	Calibration time of chip
Save Config	Save configuration



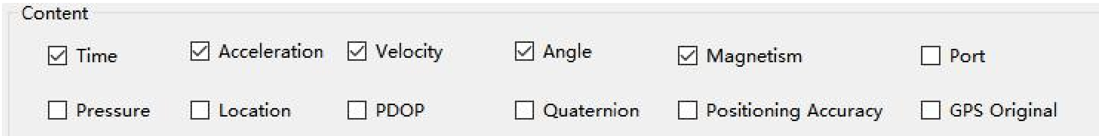
Menu of System	
Button	Function
Reset	Reset to factory setting
Sleep	Sleep function
Alarm	Alarm function
Algorithm	6-axis algorithm or 9-axis
Installation Direction	Vertical or horizontal installation
Instruction Start-up	Instructions sending to start-up the sensor

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, WTGAHRS1, HWT901B, WTGAHRS2)
Reset Z-axis Angle	Reset Z-axis angle to 0 degree, not available for WTGAHRS2 in 9-axis algorithm
Angle Reference	Setting current angle as 0 degree
Gyro Auto Calibrate	Auto-calibration of gyroscope

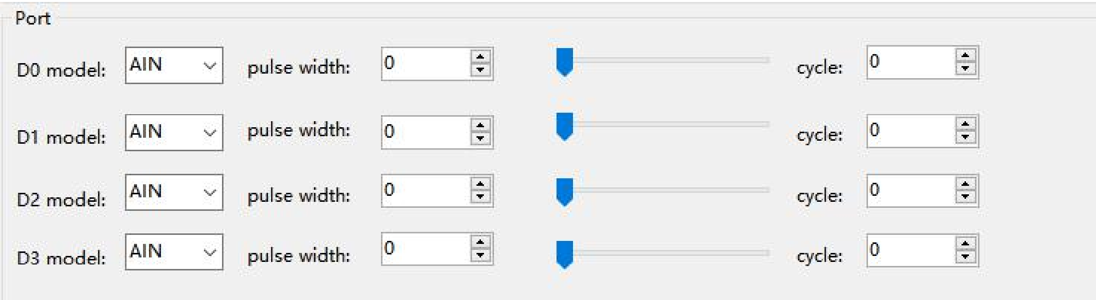


Menu of Range	
Button	Function
Acceleration	Acceleration measurement range
Gyro	Gyroscope measurement range
Band Width	Bandwidth range
GPS Time Zone	GPS positioning of time zone

Menu of Communication	
Button	Function
Baud Rate	Baud rate selection
Output Rate	Return rate selection
Device Address	Interface for R&D



Menu of Content	
Button	Function
Time	Time data output
Acceleration	Acceleration data output
Velocity	Angular velocity data output
Angle	Angle data output
Magnetism	Magnetic field data output
Port	Port data output
Pressure	Pressure output, only available with the sensor built-in barometer like HWT901B, WTGAHRS1, WTGAHRS2, WT901B, etc
Location	Latitude&Longitude data output, only for GPS IMU series, such as WTGAHRS1, WTGAHRS2
PDOP	Ground velocity data output, only for GPS IMU series, such as WTGAHRS1, WTGAHRS2
Quaternion	Quaternion data output
Positioning Accuracy	Option for GPS positioning accuracy output, including Satellite quantity, PDOP, HDOP, VDOP data, only for GPS IMU series, such as WTGAHRS1, WTGAHRS2
GPS Original	Only output GPS raw data, only for GPS IMU series, such as WTGAHRS1, WTGAHRS2
Menu of Port	
D0 Model	Extended port D0
D1 Model	Extended port D1
D2 Model	Extended port D2
D3 Model	Extended port D3
Pulse width	Pulse width of PWM
Cycle	Cycle of PWM


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

2.3 Calibration

Preparation:
Make sure the sensor is "Online".

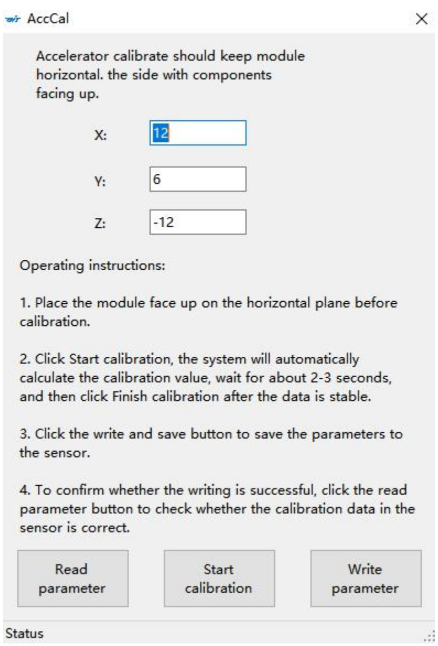
Calibration on PC software:

It is required to calibrate for the first time usage.

2.3.1 Accelerometer Calibration

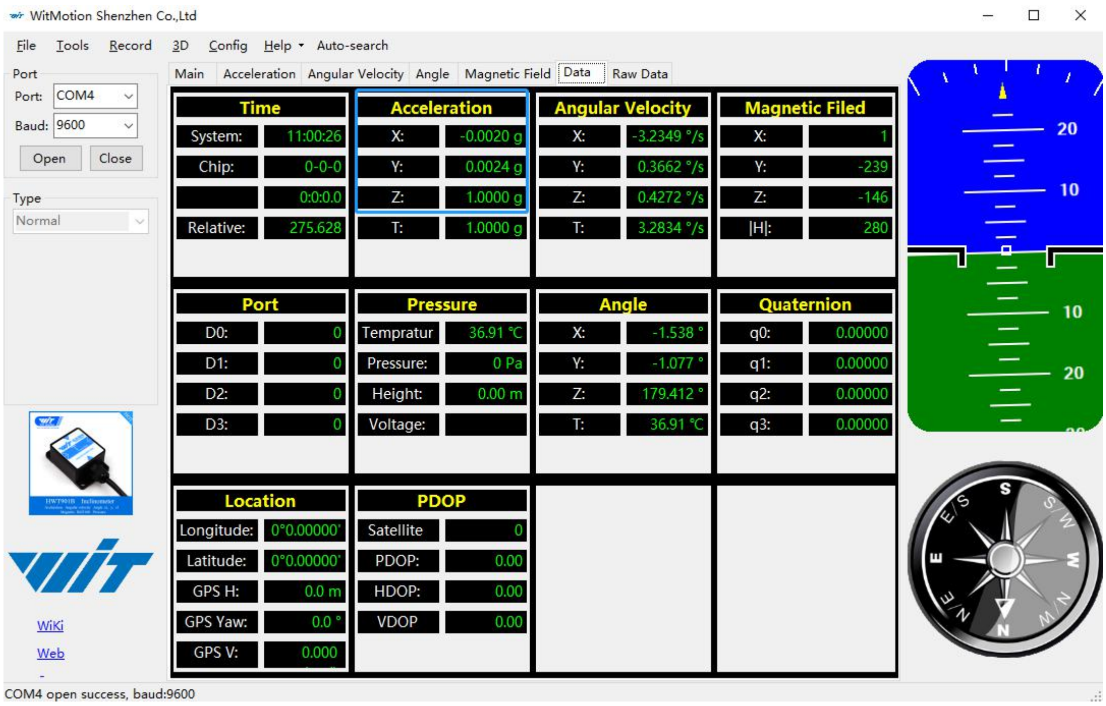
Purpose:
The accelerometer calibration is used to remove the zero bias of the accelerometer. Before calibration, there will be different degrees of bias error. After calibration, the measurement will be accurate.

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



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.

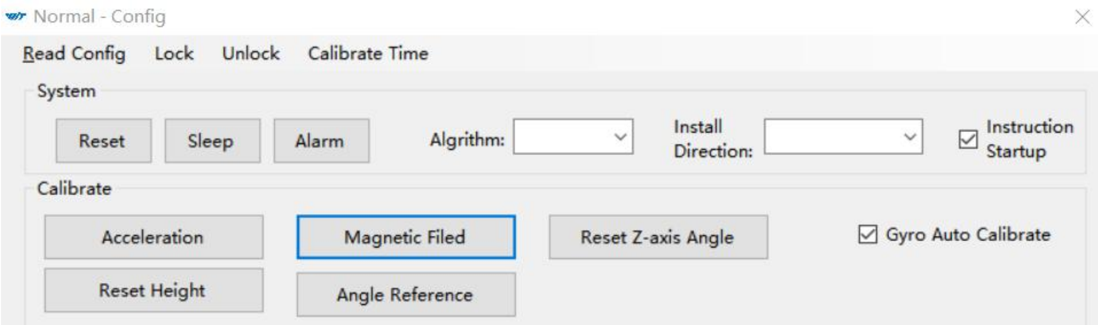
Preparation:

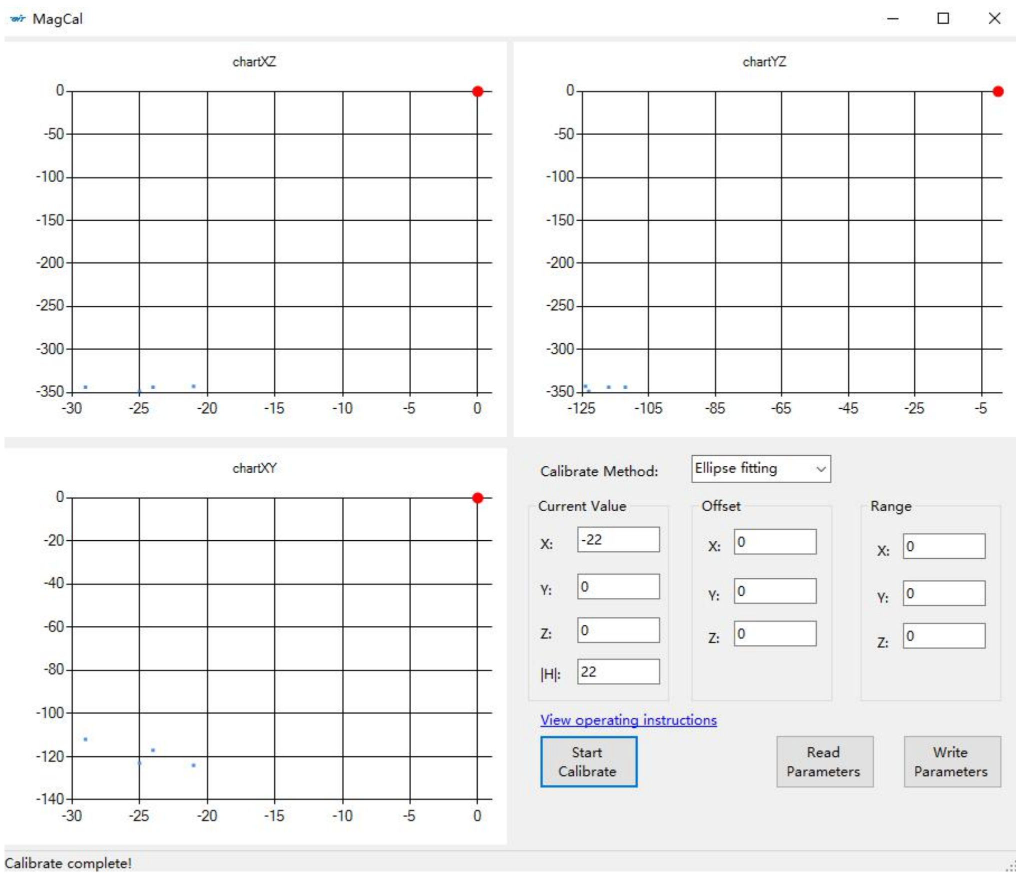
Sensors should be 20CM away from magnetic and iron and other materials

Methods:

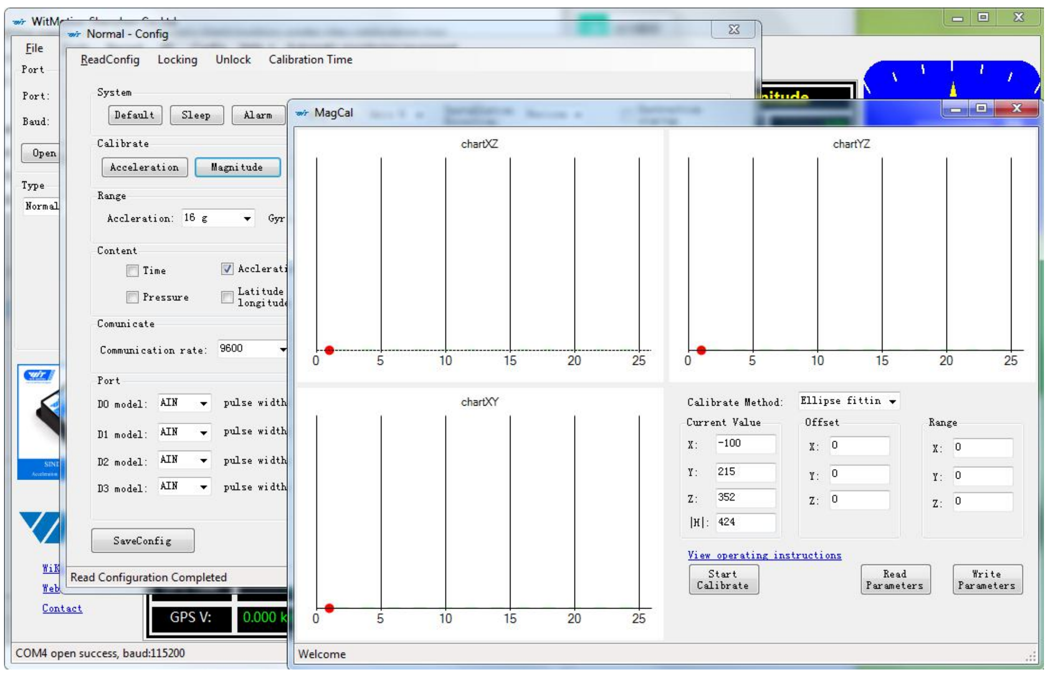
Step 1. Open the Config menu

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

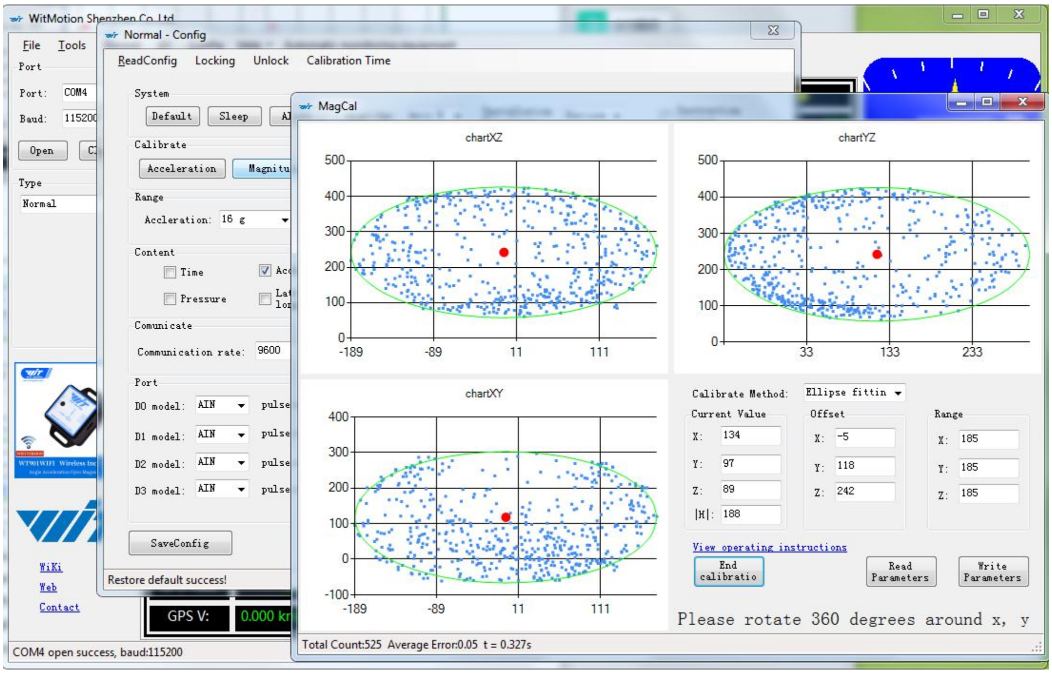




Step 3. Slowly rotate the module 360° around X, Y, Z, 3-axis accordingly



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 resetting 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

You can click the "Reset Height" in the " config" to complete the setting.

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

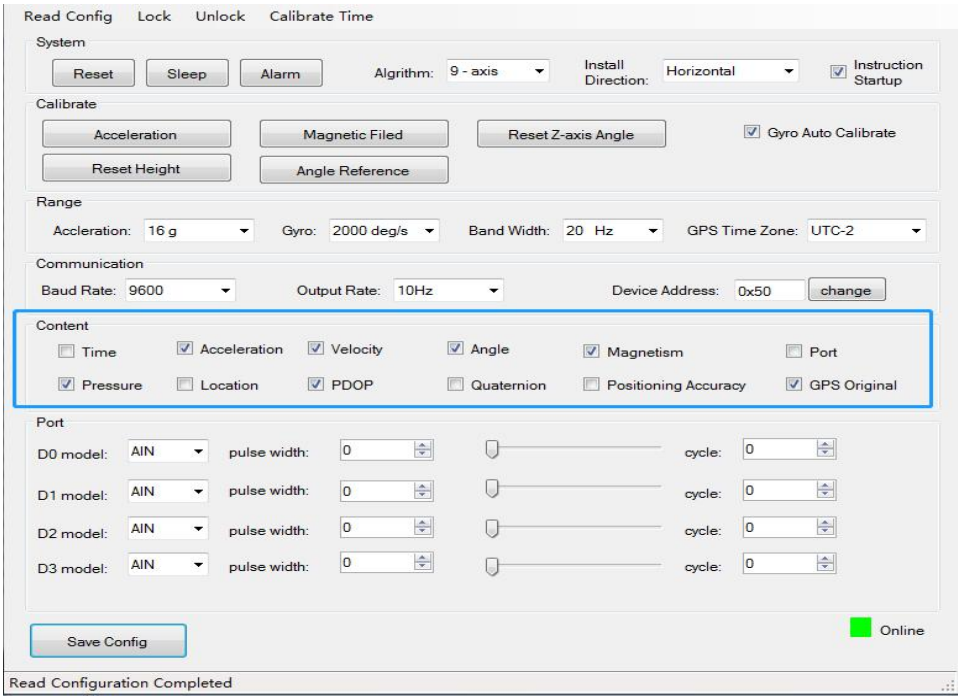
2.4 Configuration

2.4.1 GPS Positioning

Notice:
The WTGAHRS2 is built-in antenna, which is requiring operation outdoor.

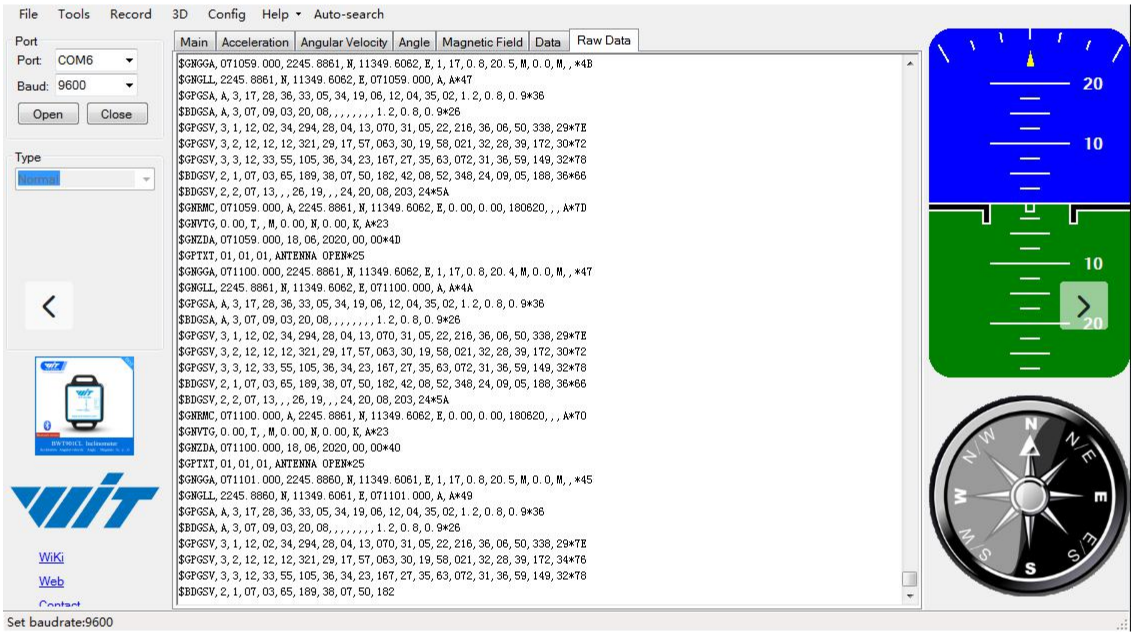
To set GPS positioning, you need to check whether the GPS has original data output.

Step 1:
Open the configuration bar and click the "GPS original"as output data.



The PC software will display the original GPS output data.

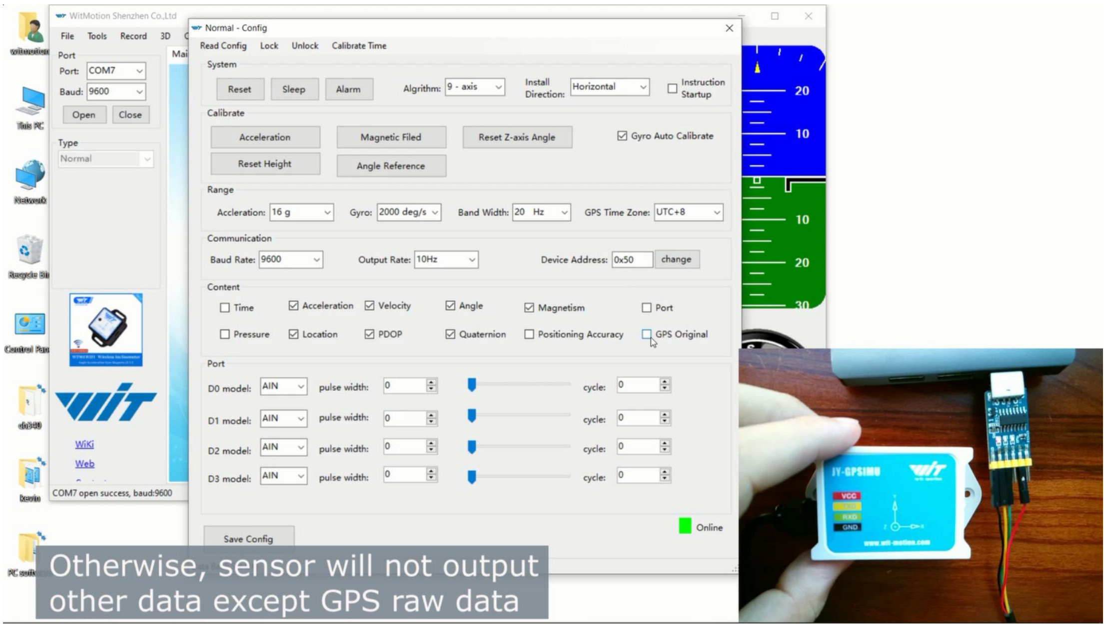
Confirm if there is NMEA-0183 GPS raw data ensuring positioning is actually working.



Note:
If the device showing as offline, try to click other data as output data, and then reopen the configuration to see if it is online.

Step 2:
After the verification is completed, unclick "GPS original".
Otherwise, the module only outputs the original GPS data and no other data.

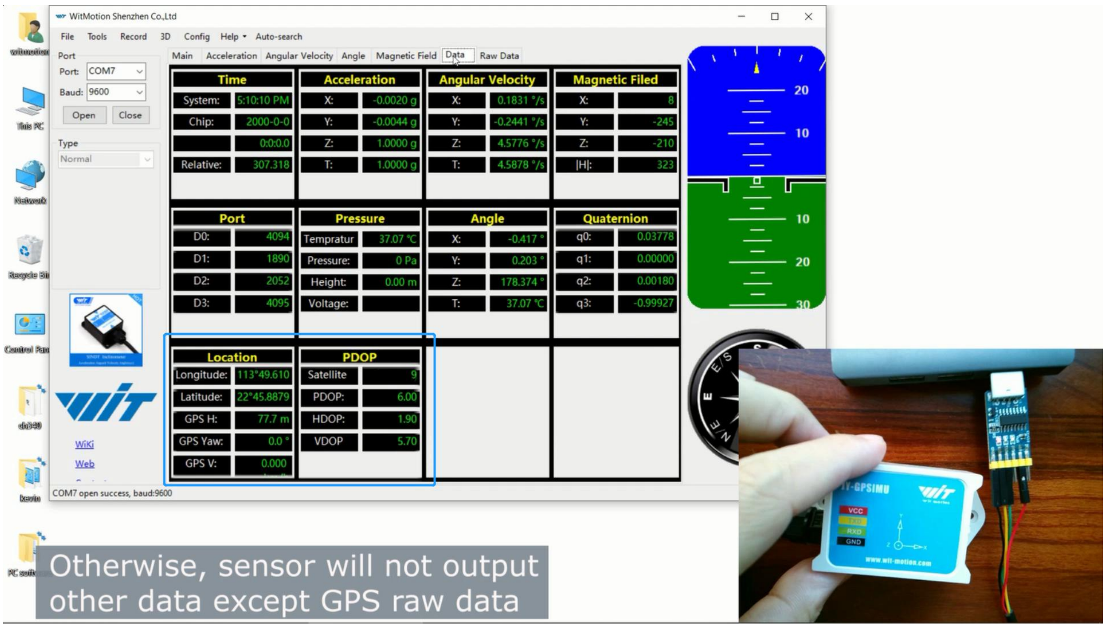
Step 3:
Click the Location, PDOP, GPS positioning as output data according to the preference.



Step 4. Click the "Save Config".

Remember to increase the output rate and baud rate to higher level, if you require many kinds of output content.

Step 5. Check the GPS positioning result
There will be data shown on the Location and PDOP.



2.4.2 Return Content

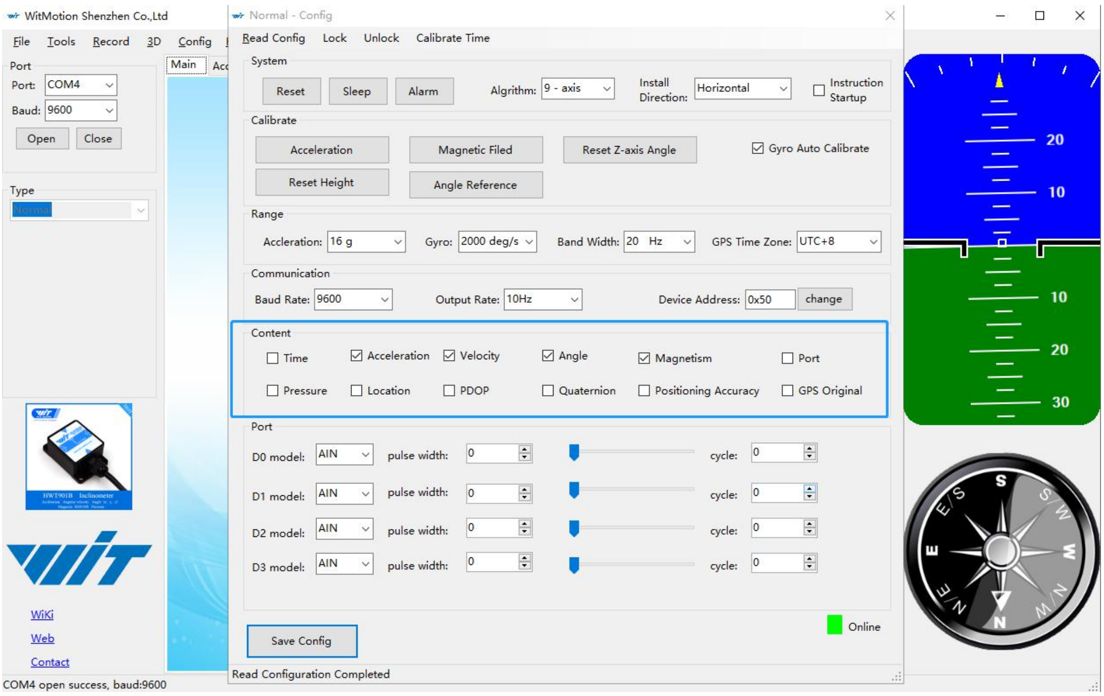
Setting method: The content of the data return can be set according to user needs, click the configuration option bar, and check the data content to be output.

Taking WTGAHRS2 as an example, the default output of the module is acceleration, angular velocity, angle, and magnetic field.

GPS time will be based on the time zone up there.

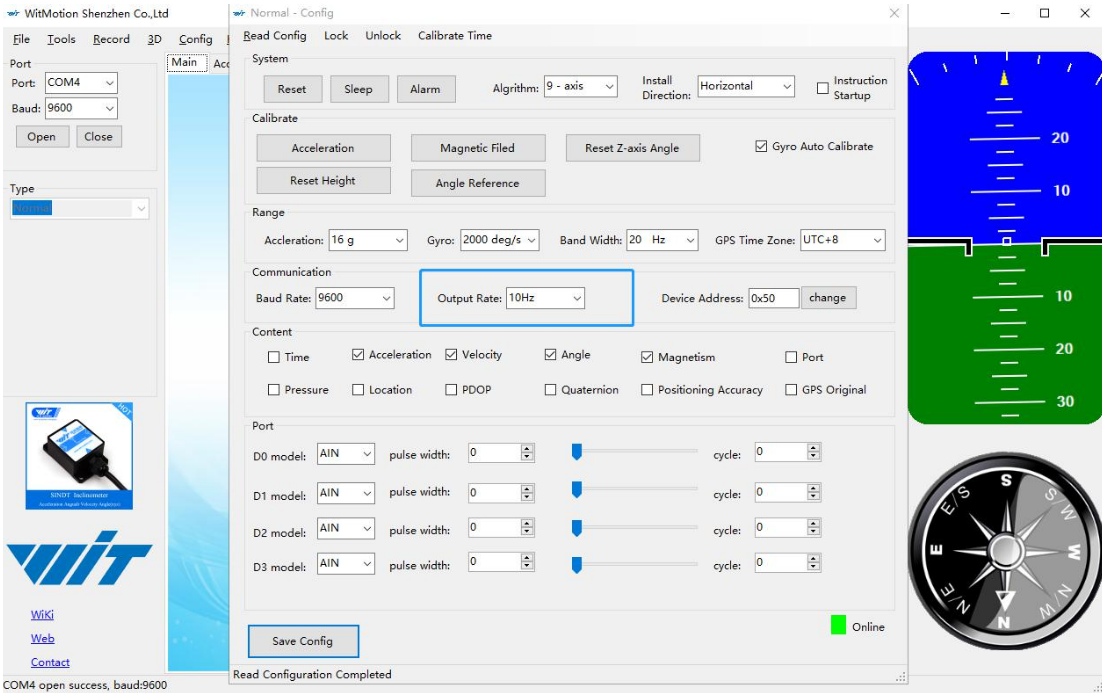
The latitude, longitude, and ground speed information are only valid when the module is connected to the GPS module. To get the correct data, you need to check the "Location", "PDOP", and "Positioning Accuracy" in the settings.

Note: After selecting "GPS original", the module will only output the original GPS information, and no other data will be output.



After completing the above settings, you can see the GPS information after a few minutes of successful GPS positioning.

2.4.3 Output Rate



The default return rate of the module is 10Hz, the highest return rate supports 200Hz. The return rate of the GPS module is 1 Hz, which cannot be changed.

Note: If there are more backhaul contents and the communication baud rate is lower, it may not be possible to transmit so much data. Then the module will automatically reduce the frequency and output at the maximum allowable output rate. To put it simply, if the return rate is high, the baud rate should also be set higher, generally 115200.

2.4.4 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.

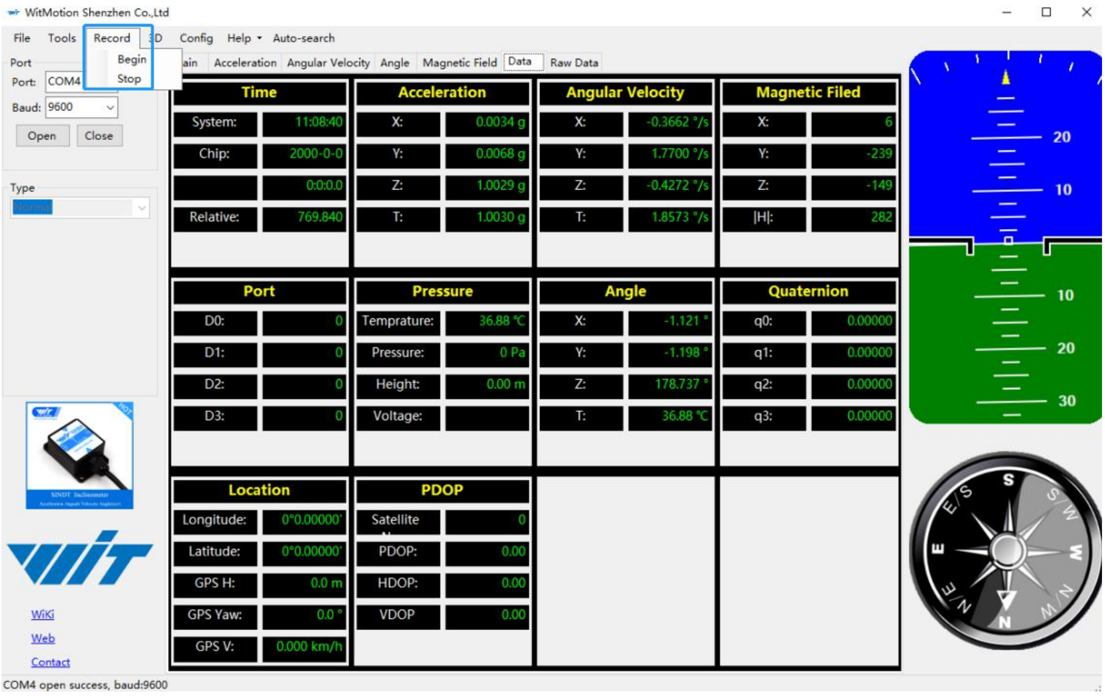
Note: After the change, the module will no longer output data at the original baud rate. The data will be output only when the baud rate that has been changed is selected on the PC software again.

2.4.5 Data Recording

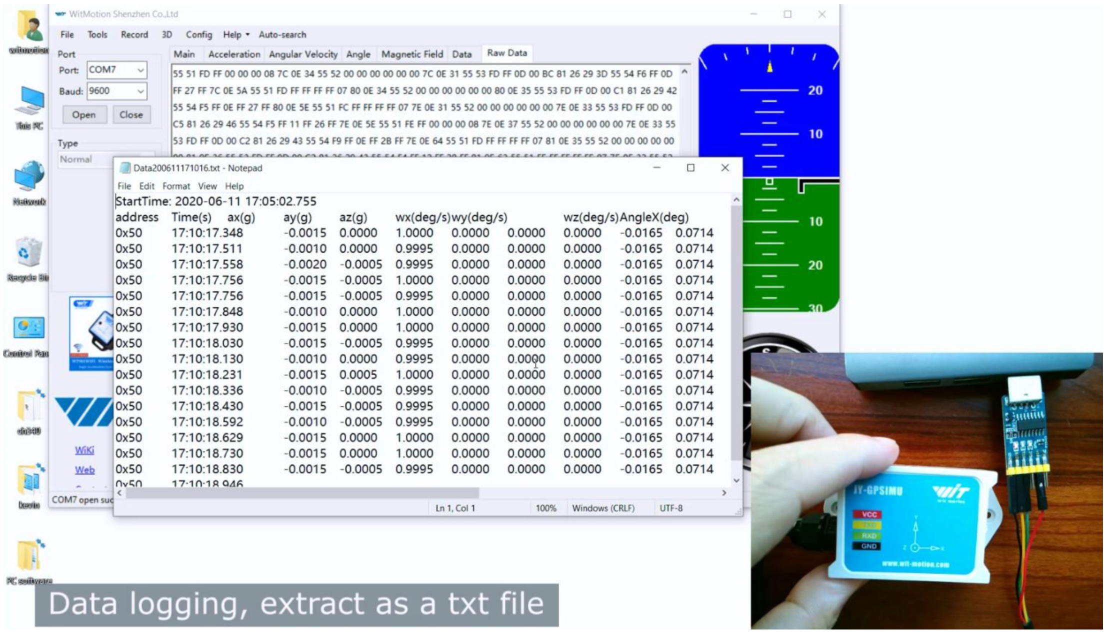
Method are as follows:

Step 1: Click “Record” and “Begin”

Step 2: Click “Stop”



Step 3: Extract the data as “txt” file



Notice: If there is repeated “TIME” of data, that’s caused by low-resolution of the Windows system’s time. The changes in other data is correct.

It is highly recommended that data can be pasted to a Excel file. In this way, all data will be shown in order.

StartTime: 2020-04-11 16:54:24.437

address	Time(s)	ChipTime	ax(g)	ay(g)	az(g)	wx(deg/s)	wy(deg/s)	wz(deg/s)	AngleX(deg	AngleY(deg	AngleZ(deg)	T(°)	hx	hy	hz
0x50	43:06.4	02:40.4	0.4443	0.1777	-0.8696	3.1738	-0.3662	-29.541	166.0364	-29.2072	120.6299	29.97	0	50	313
0x50	43:06.5	02:40.5	0.02	0.5796	-0.7739	-192.0166	283.9355	-700.2563	142.0532	-24.884	154.8907	30	-29	7	312
0x50	43:06.6	02:40.6	-0.2896	0.8599	-0.5571	-8.2397	-3.7842	-264.5264	124.0741	20.0171	-158.2196	30	-7	-85	291
0x50	43:06.7	02:40.7	-0.771	0.5322	-0.4761	36.0718	43.8232	-226.8677	132.984	41.4514	-138.0872	30	38	-93	289
0x50	43:06.8	02:40.8	-0.5601	0.4233	-0.5562	55.7861	101.9897	274.1699	144.5087	35.5792	-132.4292	30	22	-58	301
0x50	43:06.9	02:40.9	-0.0059	0.5503	-1.0103	139.0991	-32.7759	432.251	141.4929	1.8073	-174.1113	30	-22	-9	308
0x50	43:07.0	02:41.0	0.2656	0.3887	-0.8594	124.3896	7.8735	341.1865	154.6985	-15.5896	157.3077	30.01	-14	46	307
0x50	43:07.1	02:41.1	0.3911	0.1104	-0.8467	40.7715	11.9019	257.1411	177.3303	-25.7684	127.7325	30	0	104	294
0x50	43:07.2	02:41.2	0.3896	0.3022	-0.8994	-90.0879	135.3149	-268.9819	163.4601	-31.9867	128.6829	30.03	-2	67	308
0x50	43:07.3	02:41.3	0.2939	0.9531	-0.2837	-251.5259	48.645	-750.4272	119.0149	-0.3625	-174.1608	30.03	-30	-56	295
0x50	43:07.4	02:41.4	-0.4614	0.7075	-0.3384	-27.3438	-19.4702	-226.9287	112.8021	30.6519	-161.4001	30	33	-122	272
0x50	43:07.5	02:41.5	-0.7988	0.6279	-0.5044	28.0762	81.7261	122.1924	122.0087	39.8035	-151.1389	30	63	-110	275
0x50	43:07.6	02:41.6	-0.2495	0.8135	-0.5327	36.377	5.6763	93.0176	121.8494	15.7214	-161.109	30	12	-108	288
0x50	43:07.7	02:41.7	0.3057	0.7432	-0.5996	74.0356	-0.061	379.7607	126.7603	-11.4478	-176.6711	30.03	-51	-68	295
0x50	43:07.8	02:41.8	0.4922	0.4653	-0.7129	134.7656	24.231	268.9819	145.3656	-32.4756	163.3832	30.02	-83	10	295
0x50	43:07.9	02:41.9	0.4507	0.4272	-0.7871	-186.5234	-36.3159	420.6543	166.2616	-49.1583	130.2924	30.02	-86	71	292
0x50	43:08.0	02:42.0	0.6045	-0.062	-0.8027	37.9028	7.6294	-138.0005	173.4357	-45.8514	118.0206	30.03	-66	75	298
0x50	43:08.1	02:42.1	0.4712	0.6011	-0.5688	-172.6685	-7.1411	-537.6587	137.6312	-31.2396	163.8171	30.03	-78	20	300
0x50	43:08.2	02:42.2	-0.0649	0.873	-0.4028	-115.6616	2.3193	-276.2451	113.6481	4.6417	-169.8761	29.98	-37	-101	283
0x50	43:08.3	02:42.3	-0.4092	0.856	-0.1816	-134.8877	-38.208	-155.7007	99.8822	26.933	-165.943	30.03	32	-166	244
0x50	43:08.4	02:42.4	-0.5171	0.8809	-0.1152	84.1064	0.9155	86.2427	94.8285	33.2666	-167.5415	30.06	72	-186	218
0x50	43:08.5	02:42.5	-0.1782	0.9595	-0.2793	243.2861	29.3579	406.8604	110.7367	13.3429	-169.0686	30.03	29	-156	254

Time represents time, ax ay az represents the acceleration in the three axes of x y z, wx wy wz represents the angular velocity in the three axes of x y z. Anglex Angley Anglez represents the angles of the three axial directions of x y z, T represents the temperature, and hx hy hz represents the magnetic fields of the three axial directions of x y z respectively.

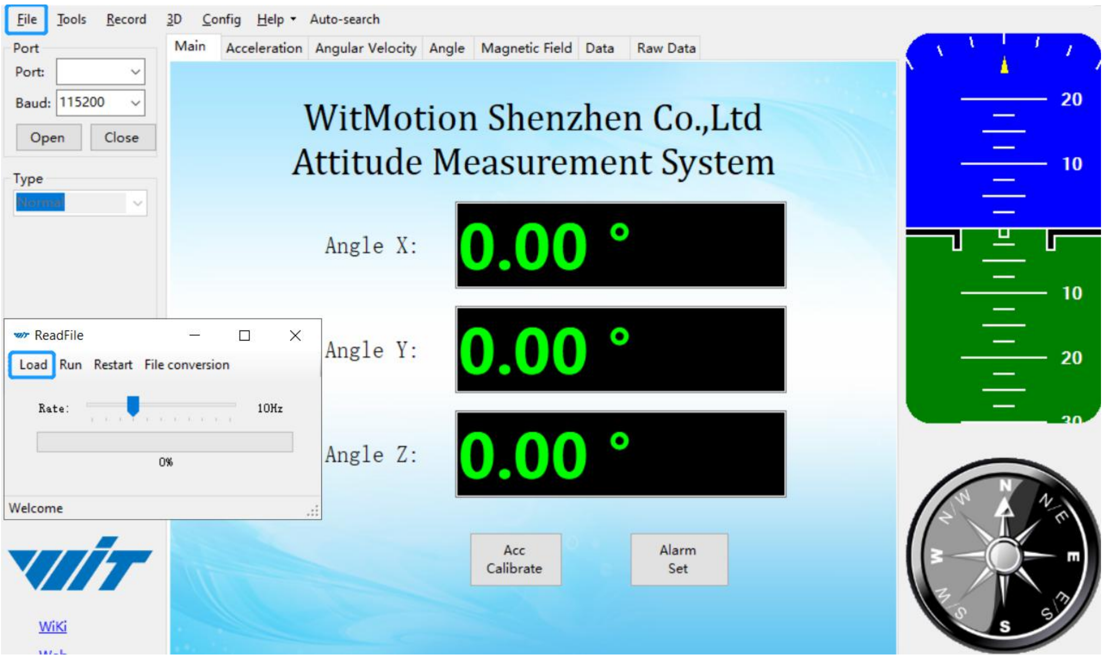
2.4.6 Data Playback

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.

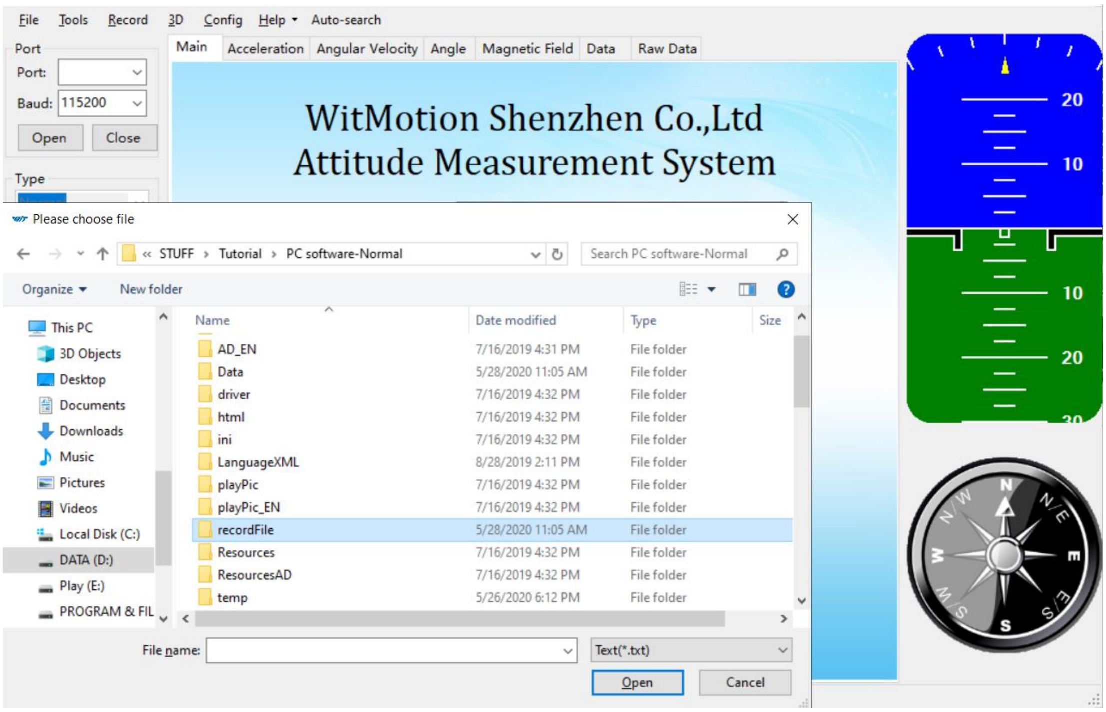
Recorded data playback method:

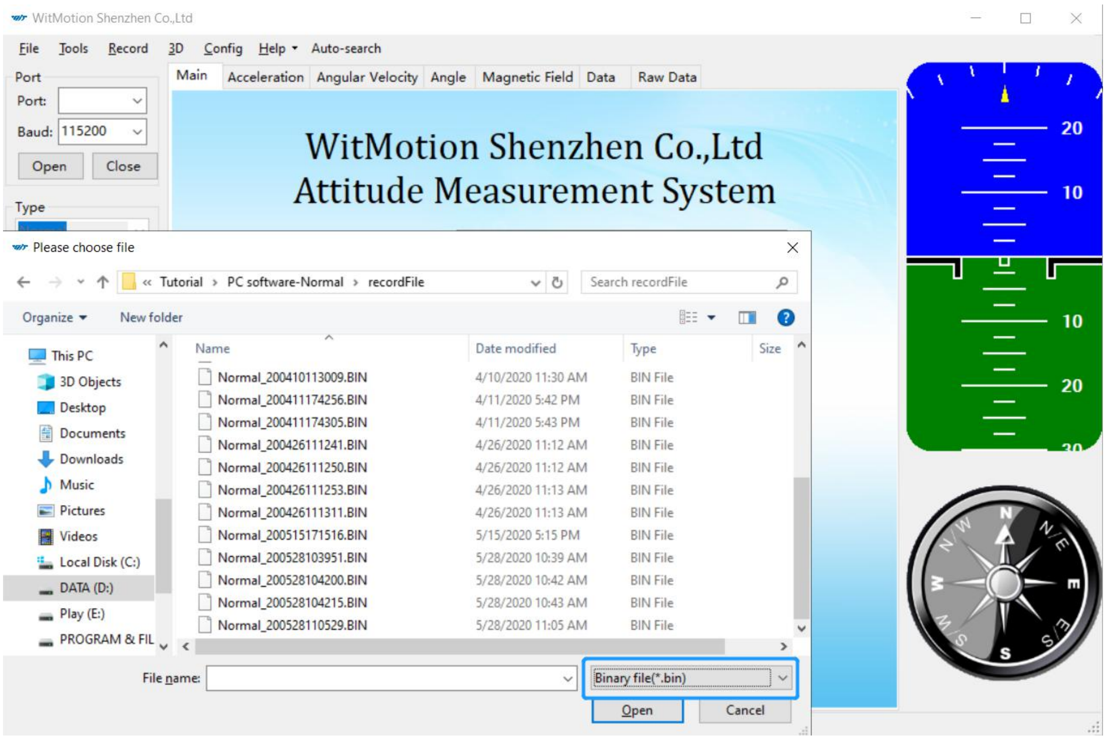
Step 1: Disconnect the sensor

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

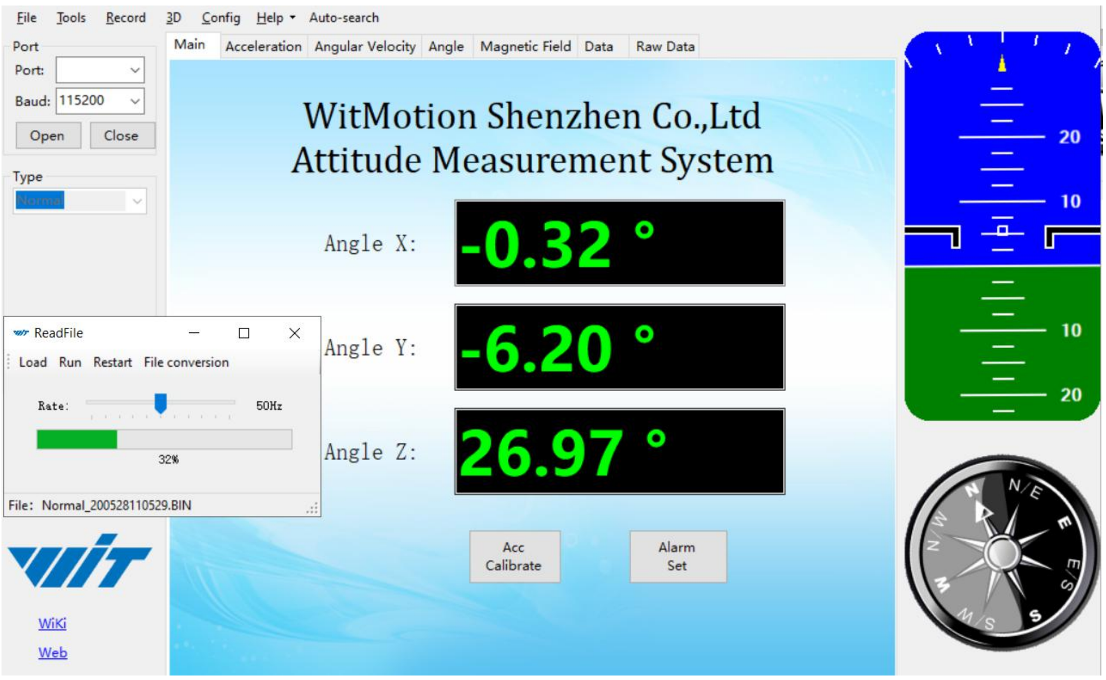


Step 3: Choose the original path of software installation and load the Bin file





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

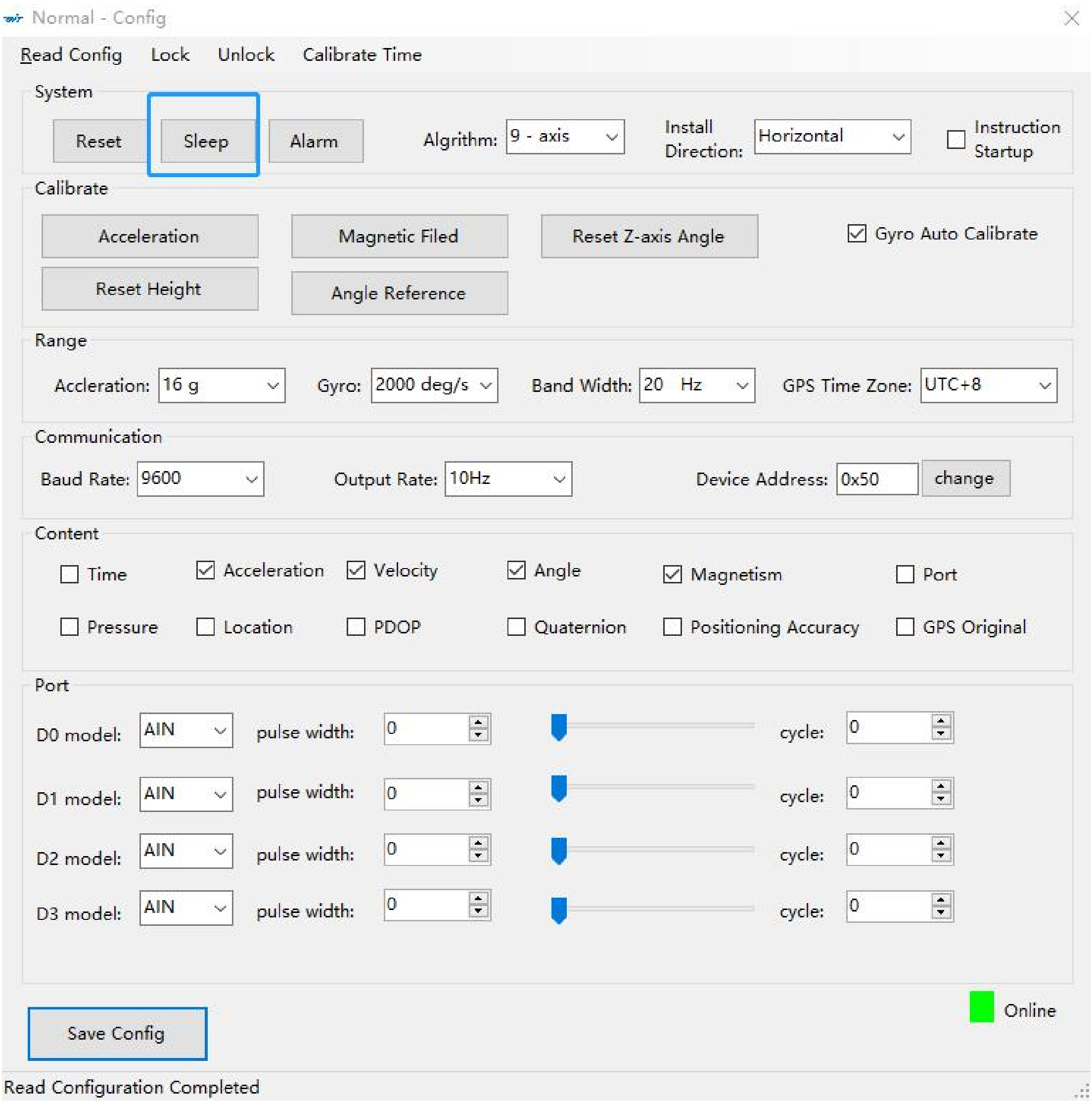


2.4.7 Standby and Wake Up

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.



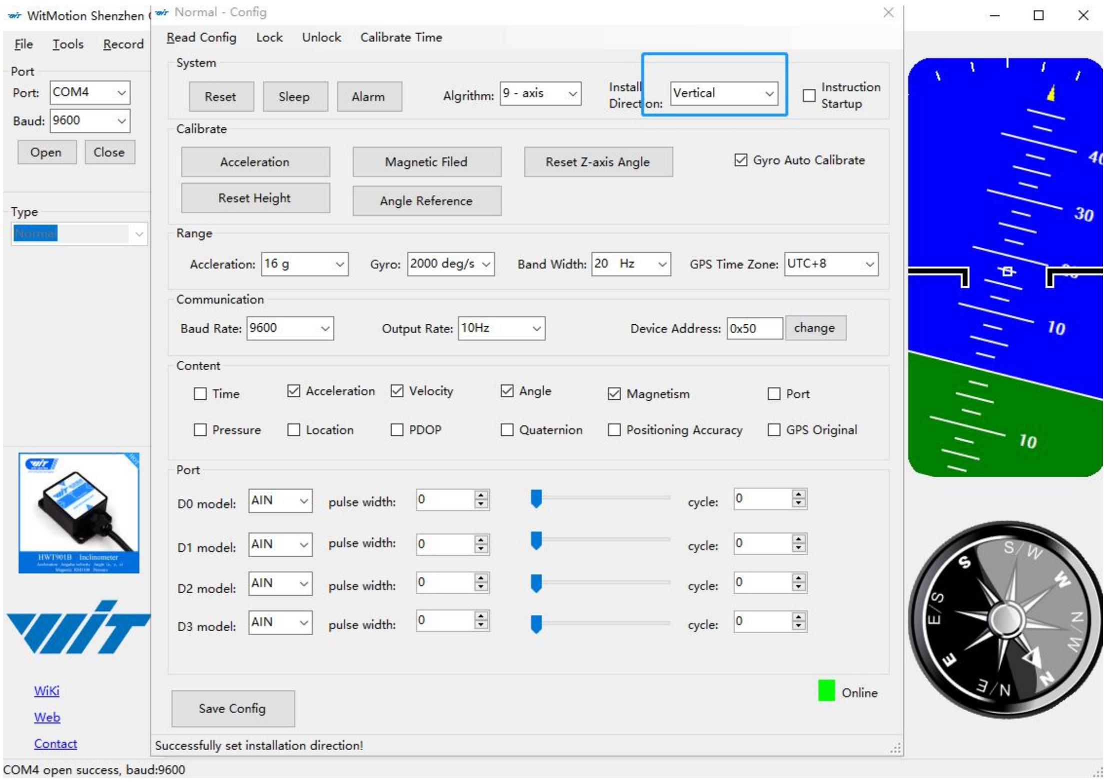
2.4.8 Placement Direction

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

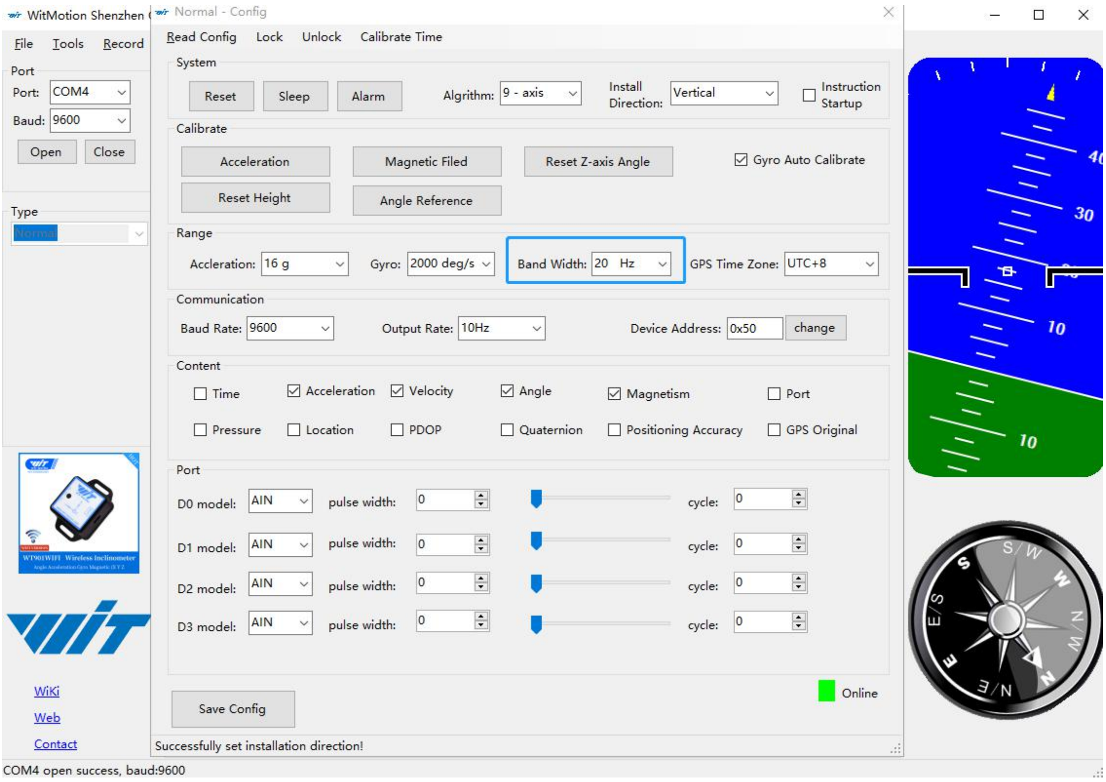
Step 3: Click “Vertical” as install directions on “Config” menu



Step 4: After the setting is completed, calibration is required before use.

2.4.9 Bandwidth

Default bandwidth is 20Hz.

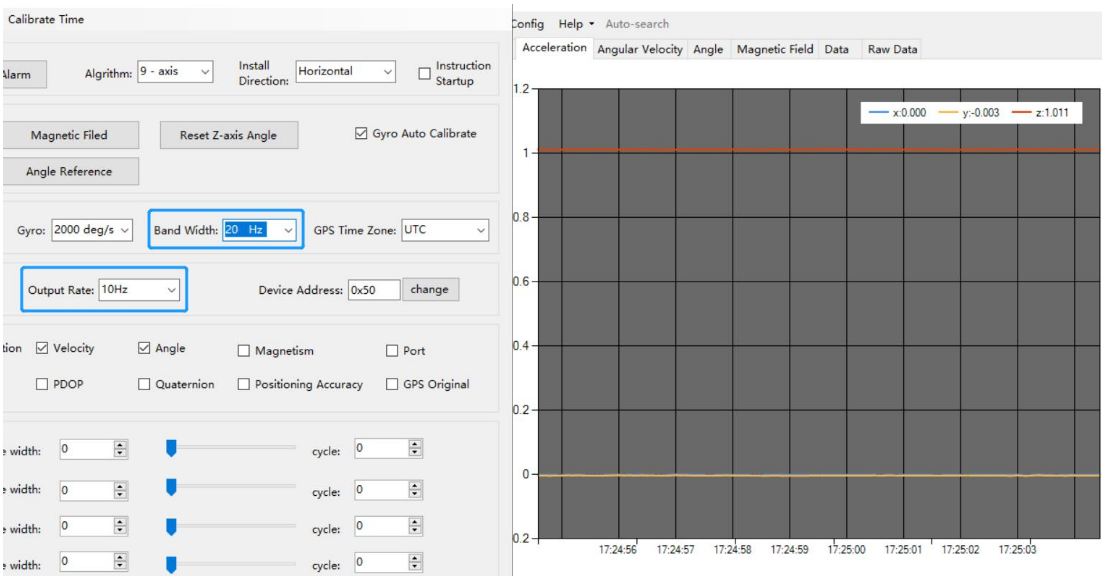


Function:

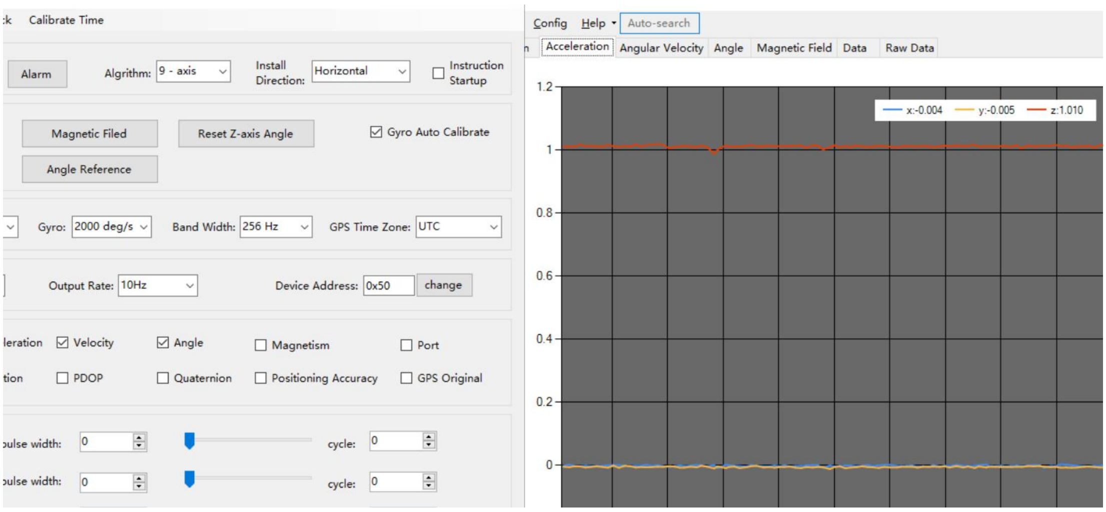
1. The higher rate of bandwidth setting will lead to the higher fluctuation in data waveform. Conversely, the lower rate of bandwidth, data will become more fluent.

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.

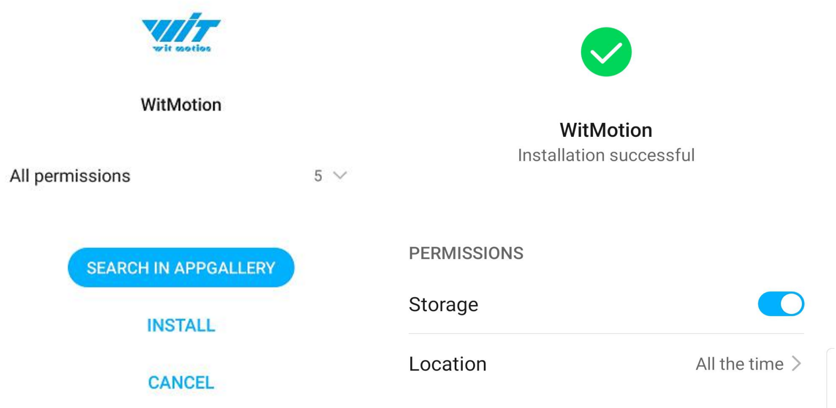
If you prefer there is no repeating data, it is required to increase the bandwidth more than 100Hz.

3 Use Instructions with Android Phone

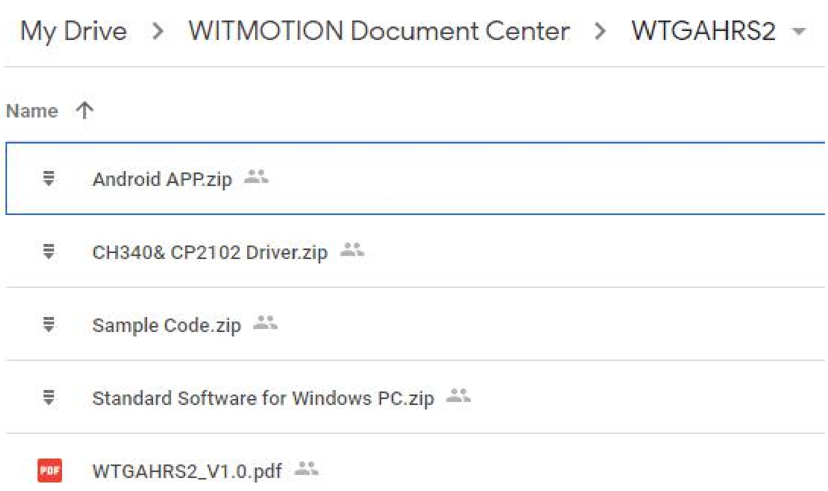
For APP configuration introduction, please referring to the Chapter 2.2

3.1 APP Installation

Install the APK file, give permission of Location and Storage

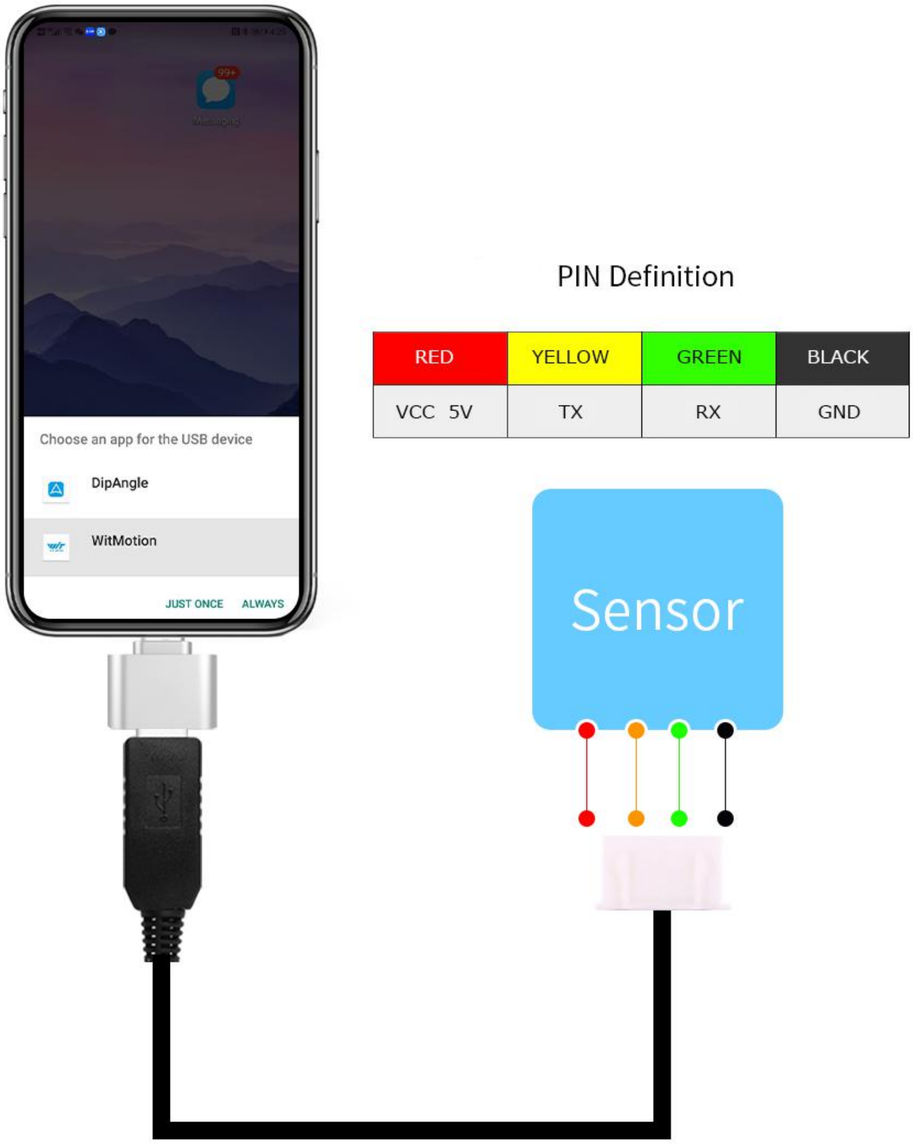


[Link to download Android APP]



3.2 Hardware Preparation

Connecting with Android smartphone requires a serial cable and a Type-C converter or OTG converter according to phone’s interface.



3.3 Connection

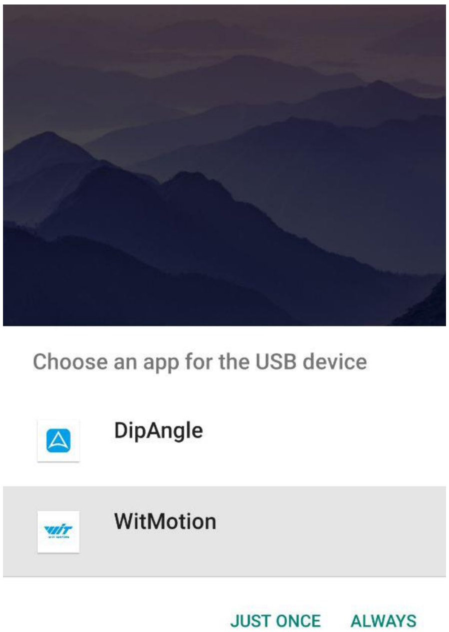
Step 1. Install the APK file, give permission of Storage.

Step 2: Connect the sensor with TTL cable. Then connect the cable with type-c converter. Plug in the device “type-c converter” to the phone.

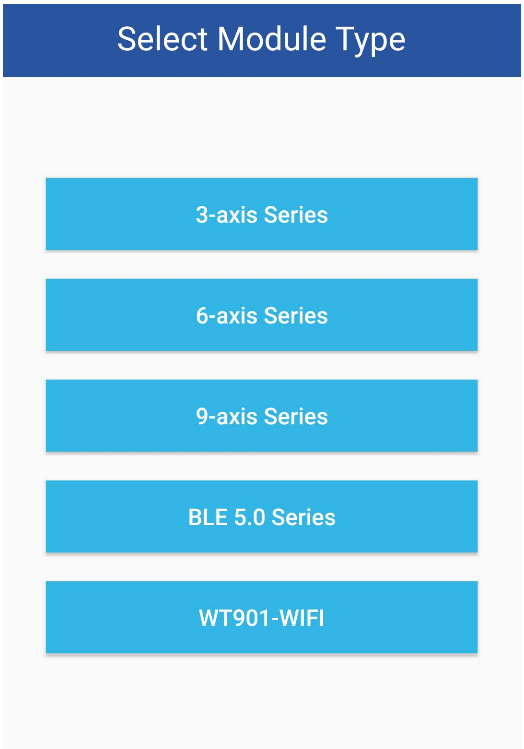
Notice:

1. After successful connection, there will be a notification reminding that “Choose an APP for the USB device”, which means that the device has been detected. Choose “WitMotion”, “ JUST ONCE” or “ALWAYS” is optional.

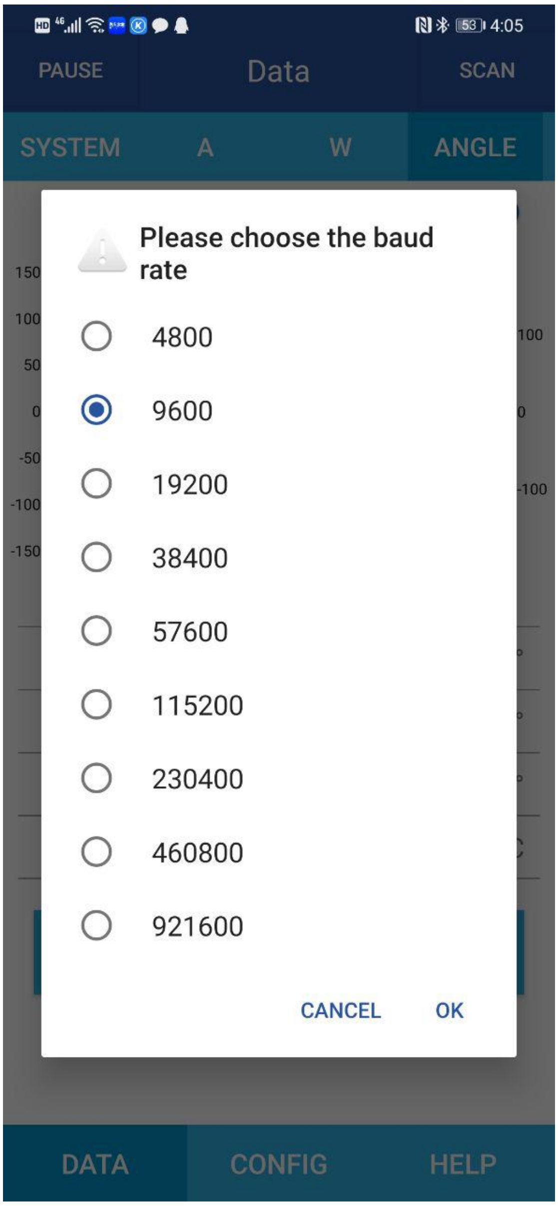
2. Only CH340 driver can be detected via WitMotion APP.



Step 3. Open APP and choose “9-axis Series” as sensor series



Step 4. Select the baud rate- 9600.



After selection and wait for a few seconds, the data will show automatically.

Notice: GPS data will not be shown on the APP at present.

3.4 Calibration

[WTGAHRS2 Playlist]

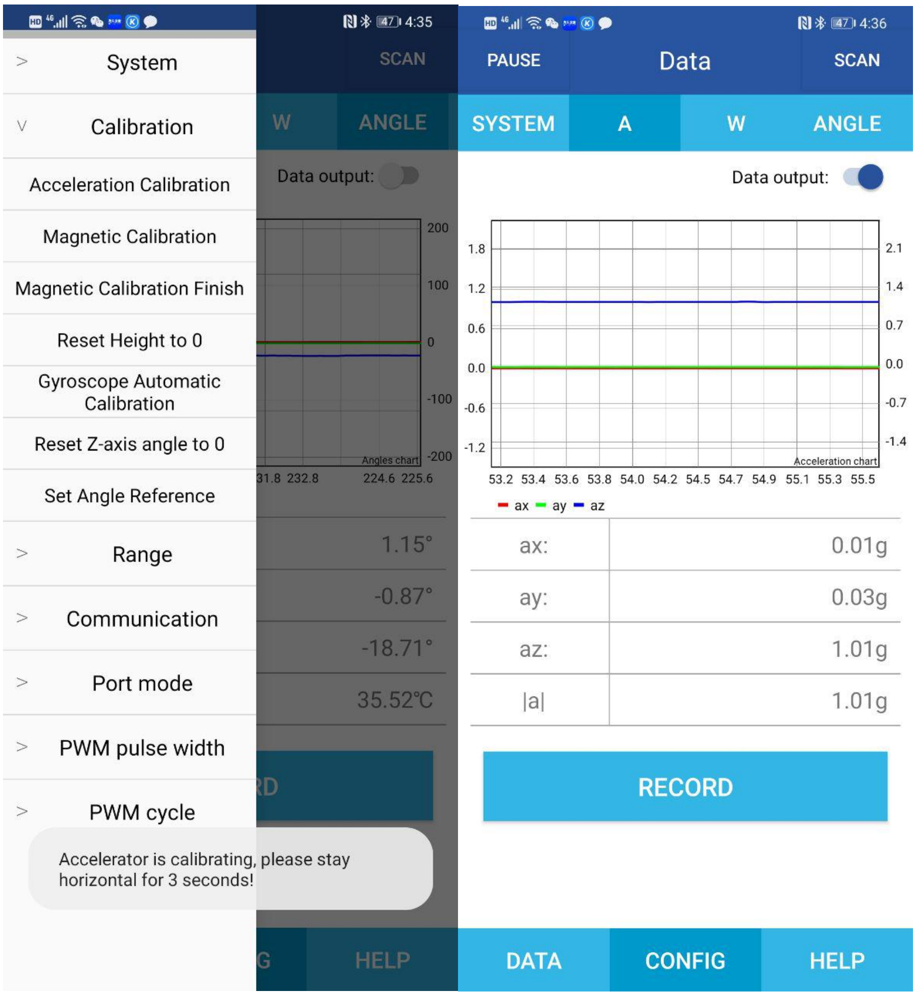
3.4.1 Acceleration Calibration

Step 1. Keep the module horizontally stationary

Step 2. Click the "Calibration" menu

Step 3. Click the "Acceleration Calibration" and wait for 3 seconds

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



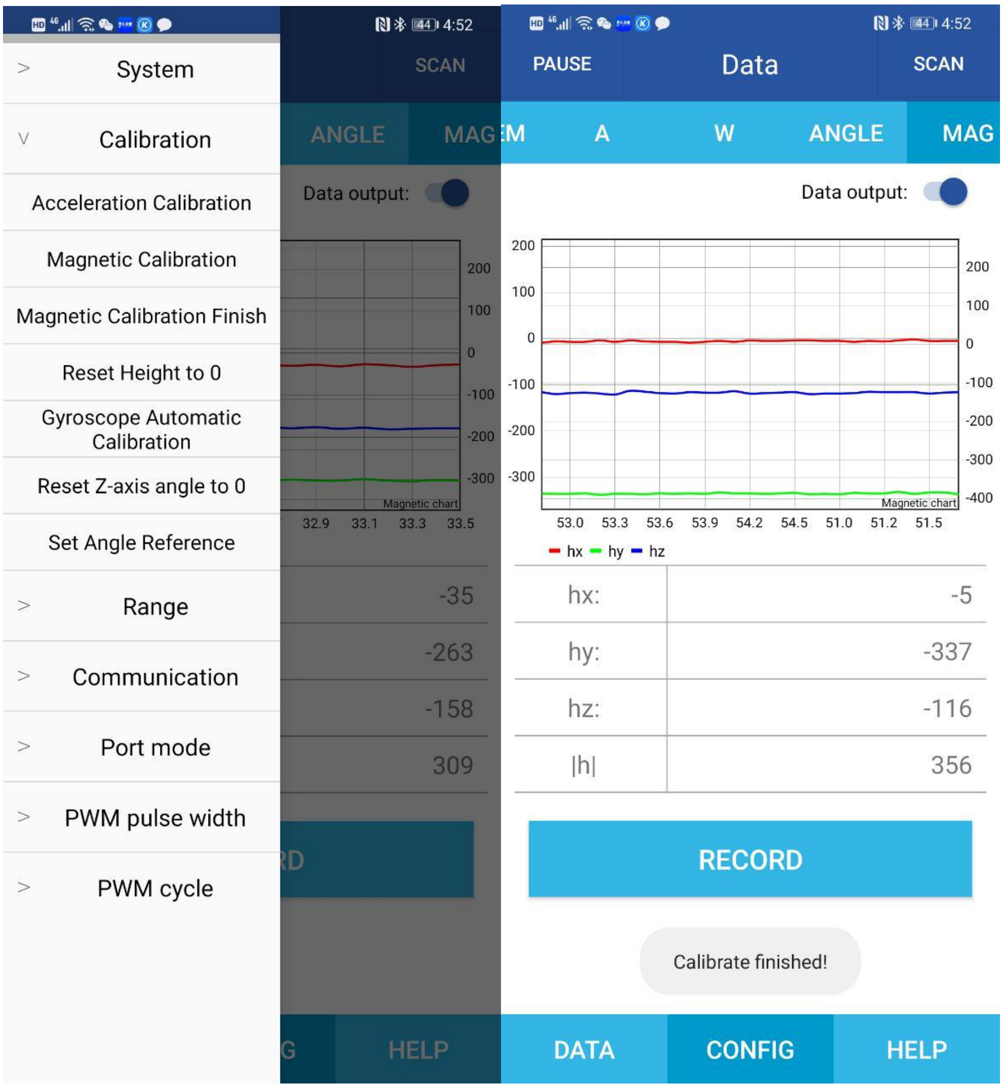
3.4.2 Magnetic Field Calibration

Step 1. Click "Calibration" menu

Step 2. Click the "Magnetic calibration" button

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

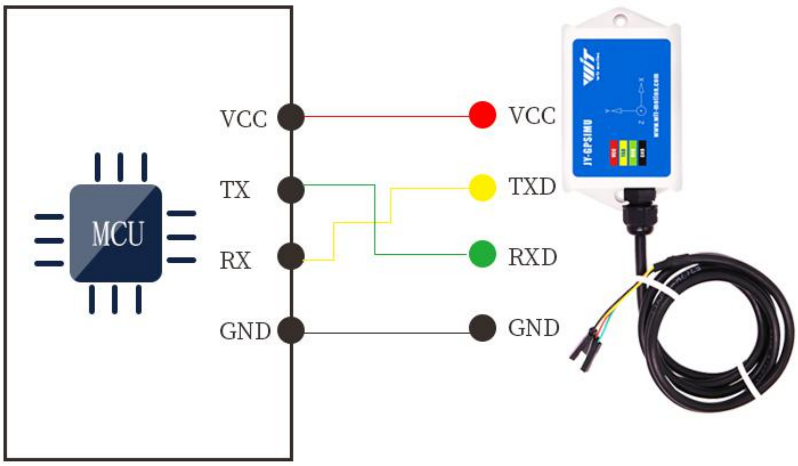
Step 4. After rotation, click "Magnetic Calibration Finish"



Check the result: The Z-axis angle will have fewer drift than before.
Notice: If not successful, please stay away from the objective that can create magnetic field interference.

4 MCU Connection

VCC-5V、TXD-RX、RXD-TX、GND-GND



Link to download all sample code

Link to sample code instructions demo

Notice: There is no sample code provided for Linux or Python system at present.

4.1 Arduino

Download link

Arduino UNO3 Demo Link

4.2 STM32

Download link

4.3 Raspberry pi

Tutorial link

4.4 C#

DEMO link

4.5 C++

DEMO link

4.6 Matlab

Receive Sample Code

Dataplot DEMO