

# WT931 Attitude Angle Sensor SPECIFICATION



Model : WT931

Description : Nine axis attitude angle sensor

Production Standard

Enterprise quality system standard: ISO9001:2016

Tilt switch production standard : GB/T191SJ 20873-2016

Criterion of detection : GB/T191SJ 20873-2016

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# 1 Description

◆ Module integrates high-precision gyroscopes, accelerometer, geomagnetic sensor, high-performance microprocessors and advanced dynamics solves dynamic Kalman filter algorithm to quickly solve the current real-time movement of the module attitude .

◆ The use of advanced digital filtering technology, can effectively reduce the measurement noise and improve measurement accuracy.

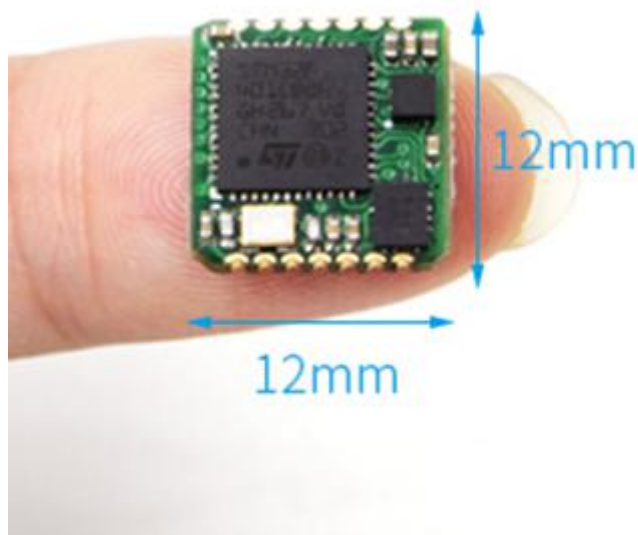
◆ Integrates gesture solver, with dynamic Kalman filter algorithm, can get the accurate attitude in dynamic environment, attitude measurement precision is up to 0.05 degrees with high stability, performance is even better than some professional Inclinator!

◆ Working voltage is 3.3v ~ 5v.

◆ Highest 500Hz output data rate. The data rate can be adjusted 0.1~500HZ.

◆ 4 layer PCB technology, thinner, smaller, and more reliable.

◆ Package size is PLCC-28, convenience to embed in PCB board. Note: So as not to interfere with the magnetometer, do not route under the MPU9250 chip.



## 2 Product Parameters

1. Voltage 3.3V
2. Consumption current <25mA
3. Volume: 12mm X 12mm X 2mm
4. Pad spacing: Up and down 1.27mm, Left and Right 12mm
5. Measuring dimensions:  
Acceleration: X Y Z  
Angle: X Y Z  
Gyro: X Y Z  
Magnetic field: X Y Z

6. Range:

Acceleration:  $\pm 2/4/8/16g$

angular velocity:  $\pm 250/500/1000/2000^\circ/s$

Angle: X Z  $\pm 180^\circ$ , Y  $\pm 90^\circ$

7. Stability: Acceleration: 0.01g, Angular speed  $0.05^\circ/s$ .

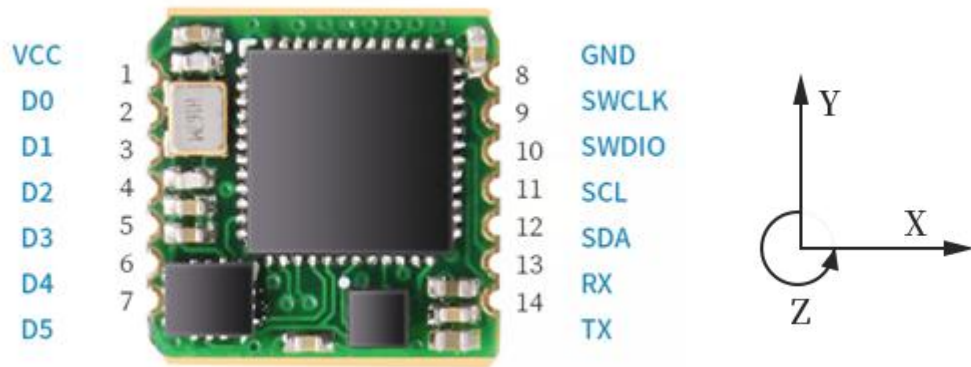
8. Angle accuracy: X Y dynamic  $0.1^\circ$  static  $0.05^\circ$  Z axis  $1^\circ$  (No magnetic interference and after calibration)

9. Data output: Time, Acceleration, Angular velocity, Angle, Magnetic field, Quaternion

10. The data output frequency: 0.1Hz ~ 500Hz(500Hz default).

11. Data Interface: UART(TTL , Baud rate support 2400,4800,9600,19200,38400,57600,115200,230400,460800,921600(default) )

### 3 Pin Description



Number	Name	Function
1	VCC	Power supply, 3.3V
13	RX	UART TTL Receiver
14	TX	UART TTL Transmitter
8	GND	GND
11	SCL	I2C Clock
12	SDA	I2C Data
2	D0	Expansion port 0
3	D1	Expansion port 1
4	D2	Expansion port 2
5	D3	Expansion port 3
6	D4	Expansion port 4
7	D5	GPS input
9	SWCLK	Download clock
10	SWDIO	Download data transmission

## 4 Axial Direction

As shown in the figure above, the coordinates of the module are indicated, and the right is the X-axis, the upper is Y axis, the Z axis is perpendicular to the surface of the paper to yourself. The direction of rotation is defined by the right hand rule. that is, the thumb of the right hand is pointed to the axial direction, and the four is the direction of the bending of the right hand.

## 5 Hardware Connection

### 5.1 Connect to PC software

#### 5.1.1 UART Connection

Embed WT931 into evaluation board.

Connect to PC software by the USB - TTL serial tool. The following USB -TTL module is recommended:

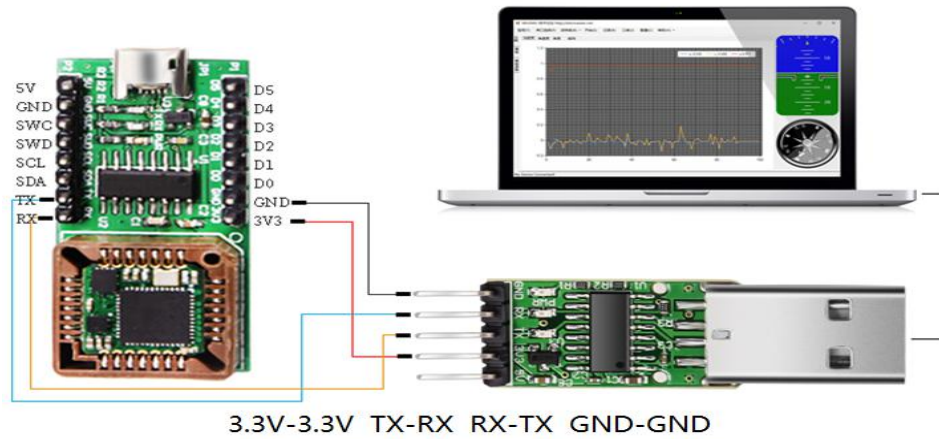
[https://www.aliexpress.com/store/product/Usb-converter-cp2102-usb-ttl-485-232-3-3v-and-5v-output-three-multifunctional-functions/2029054\\_32873159970.html](https://www.aliexpress.com/store/product/Usb-converter-cp2102-usb-ttl-485-232-3-3v-and-5v-output-three-multifunctional-functions/2029054_32873159970.html)



USB -TTL module: Connect the module to the USB-TTL and plug it into the computer.

The module and USB-TTL connection method is: the module's 3V/5V TX RX GND is connected to the 3V/5V RX TX GND of the USB serial port module respectively. Note that TX and RX need to cross, that is, TX is connected to RX, and RX is connected to TX.

Is a focus on inclinometer and attitude sensor, the rotary controller is a focus on inclinometer and attitude sensor, the RC measurement sensors, deep learning sensors, deep learning measurement sensors, deep learning

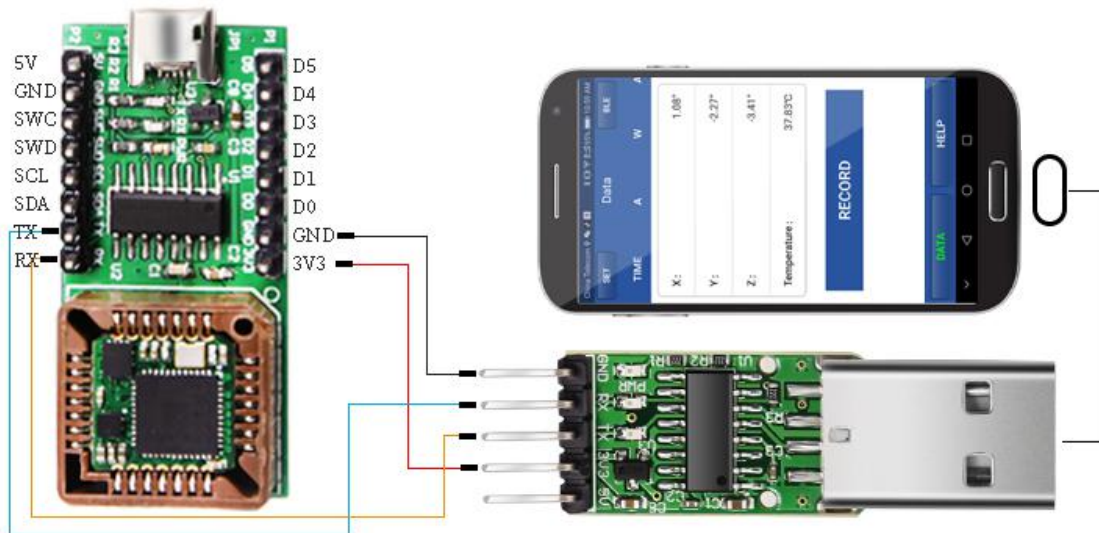


## 5.1.2 Cell phone Data

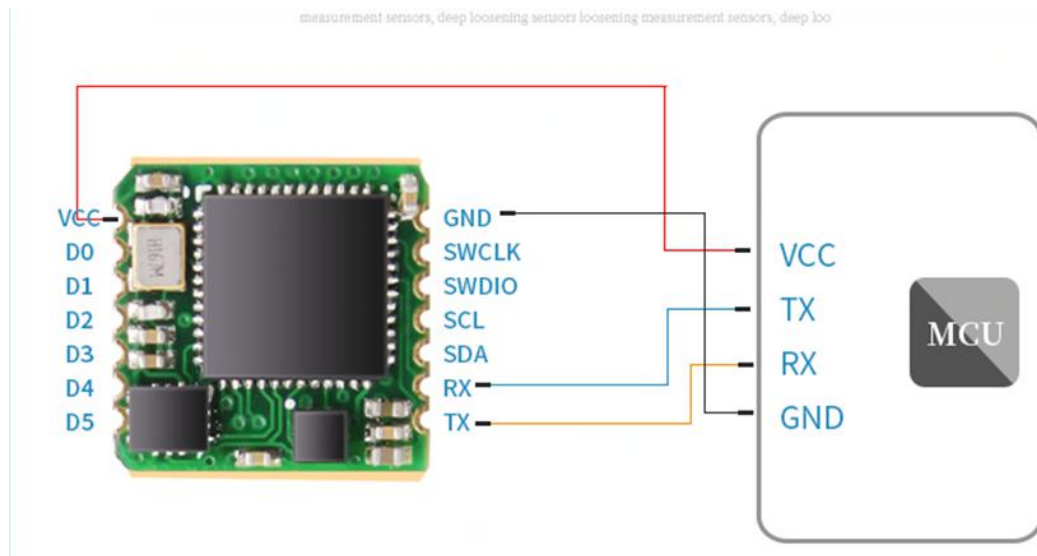
Embed WT931 into evaluation board.

Connect evaluation board to PC software by cellphone data cable (OTG)

Note: The cellphone data cable which can transfer file and data, not the ordinary charging cable.



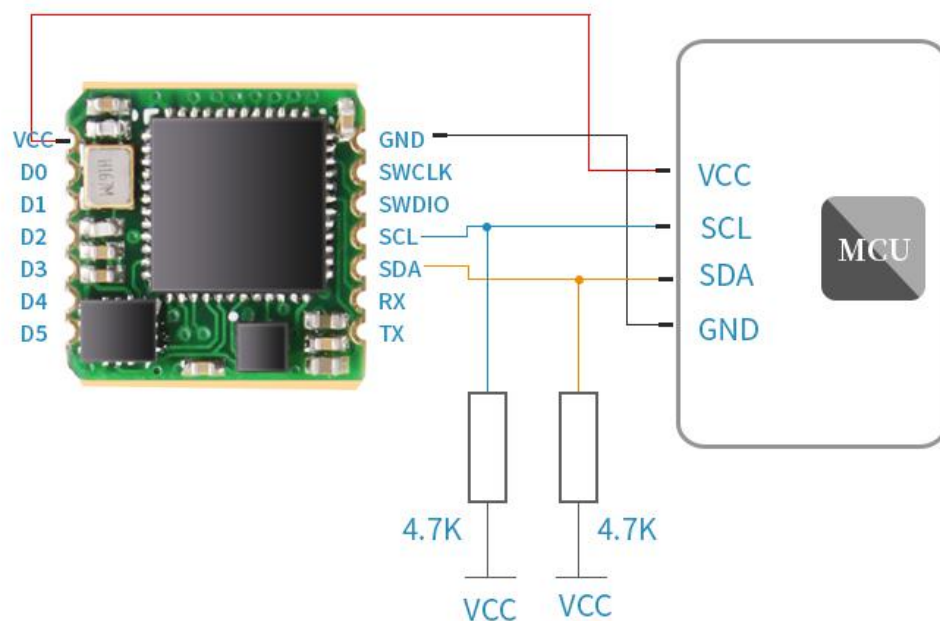
## 5.2 Connect to MCU



## 5.3 IIC Connection

WT931 modules can be connected through the IIC interface to MCU, connection method as shown below. Note that, in order to connect several modules on IIC bus, module IIC bus is open-drain output, MCU need a 4.7K resistor pulled to VCC when connecting the module.

Reminder: The power supply VCC is 3.3V which should be powered by other power. The direct use of the power supply of the module may cause voltage drop, so that the actual voltage of the module can not reach to 3.3V.





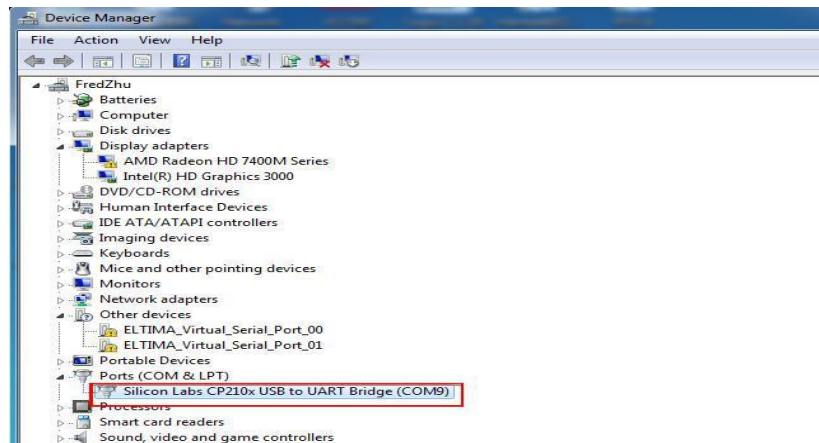
# 6 PC Software Methods

## 6.1 Methods

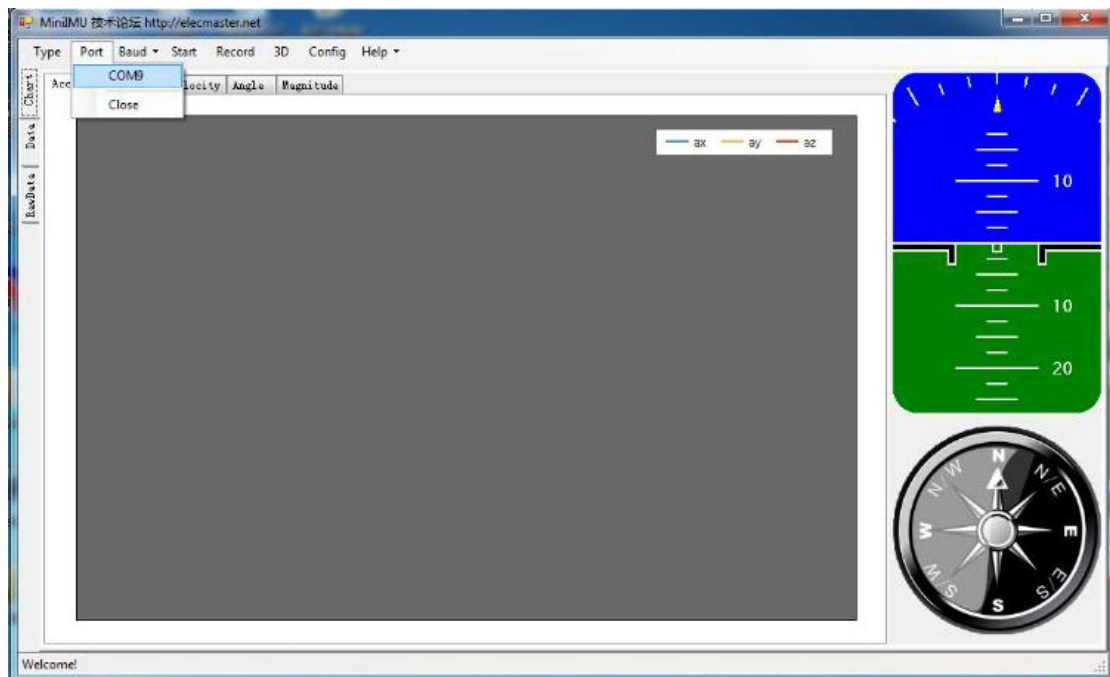
Note: Please download **.net framework4.0** the users who cannot run the PC Software:

<http://www.microsoft.com/zh-cn/download/details.aspx?id=17718>

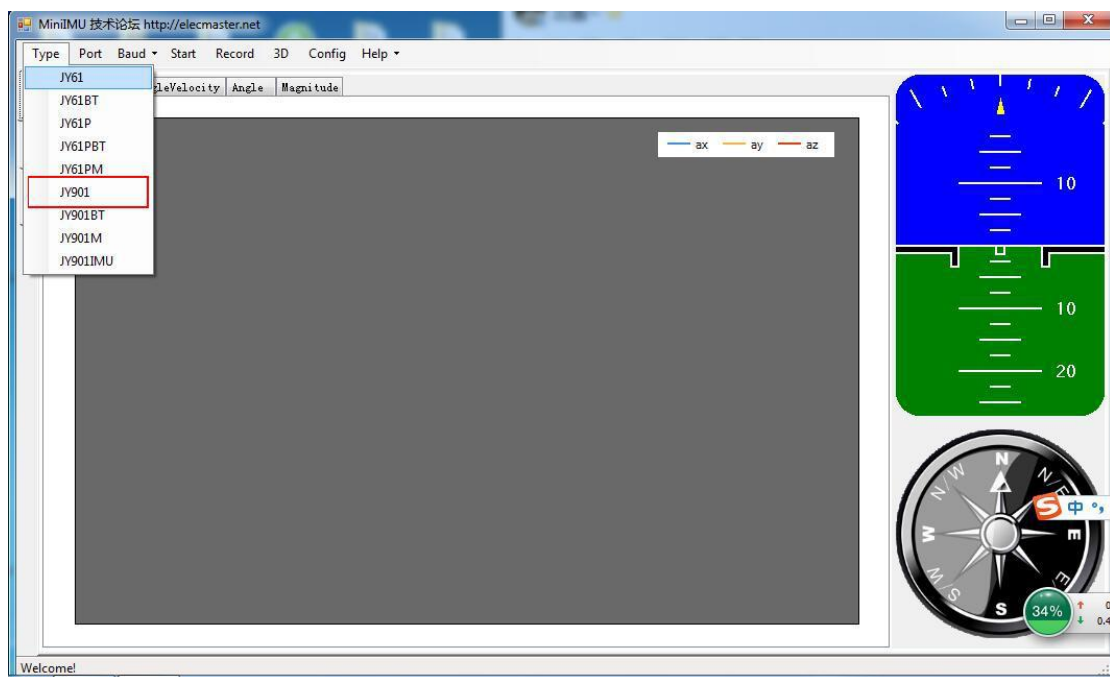
Connect the computer through the USB -TTL module and open the software. You can query the corresponding port number in the drive manager after installing the drive CP210X or CH340. As shown below:



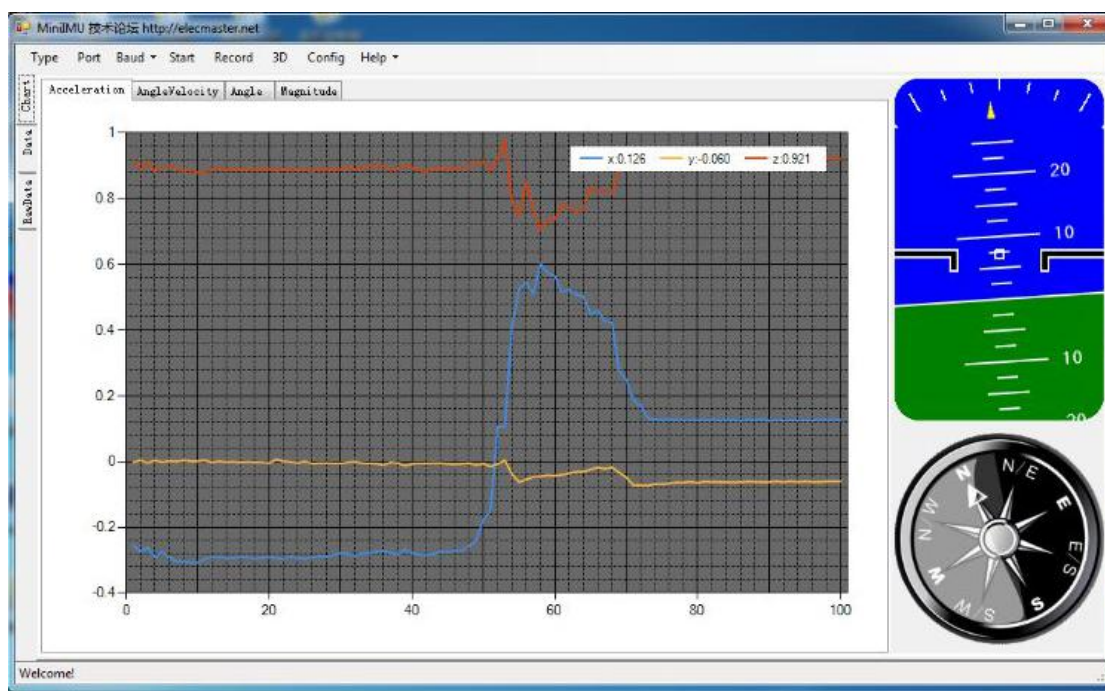
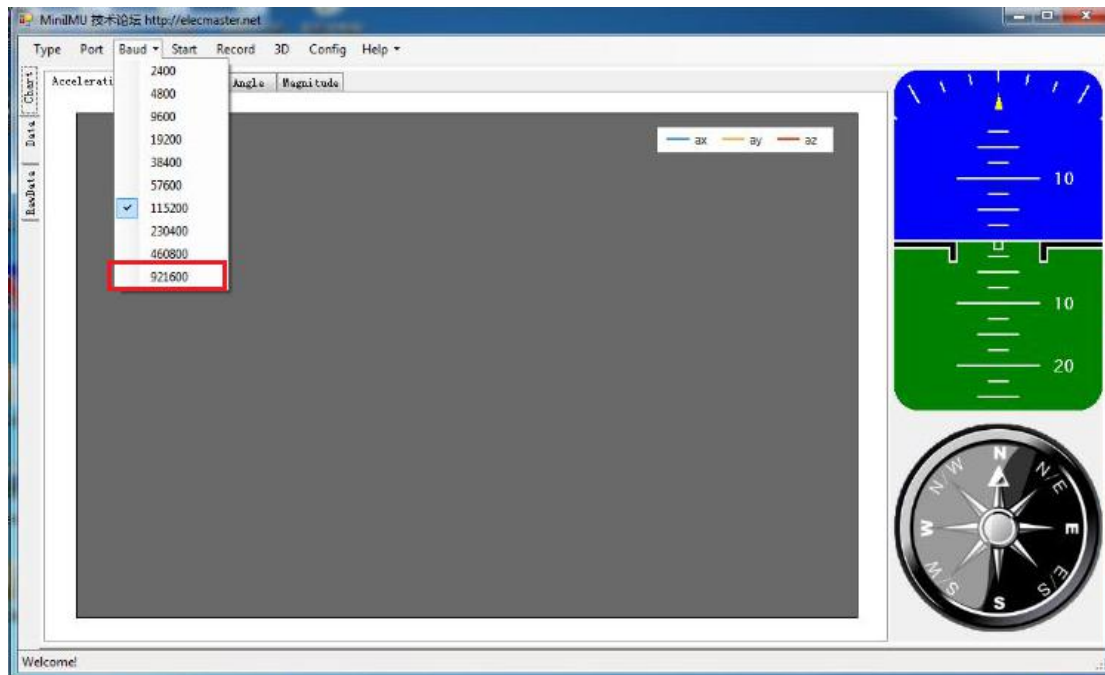
Open the software MiniIMU.exe, Click “Port” and select the com number you just saw in the device manager.



Click the “Type” and select model “JY901”.

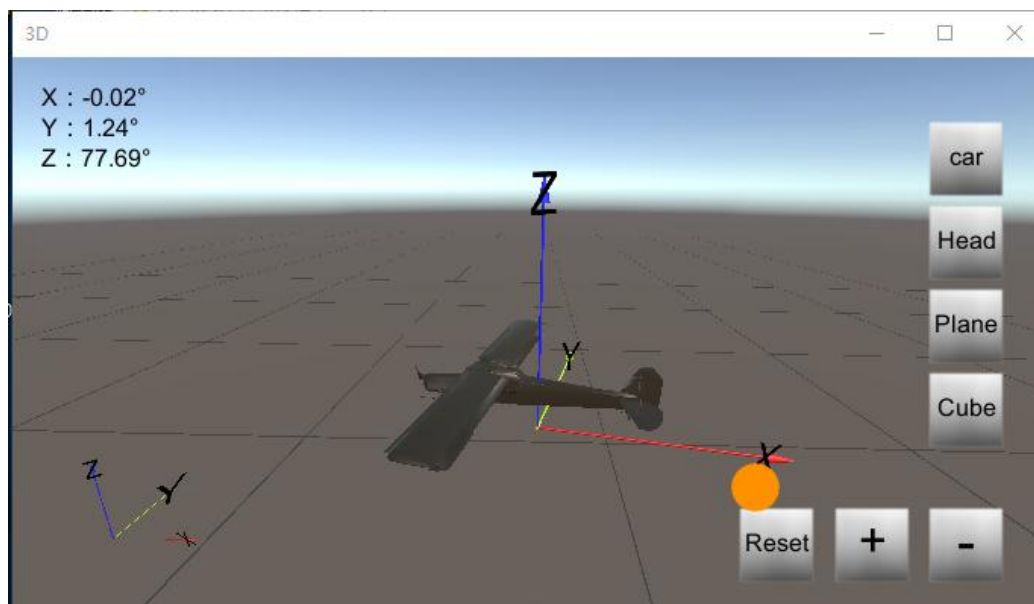


Click the “Baud” and select “921600”, after all those selections are completed, the software can display data.

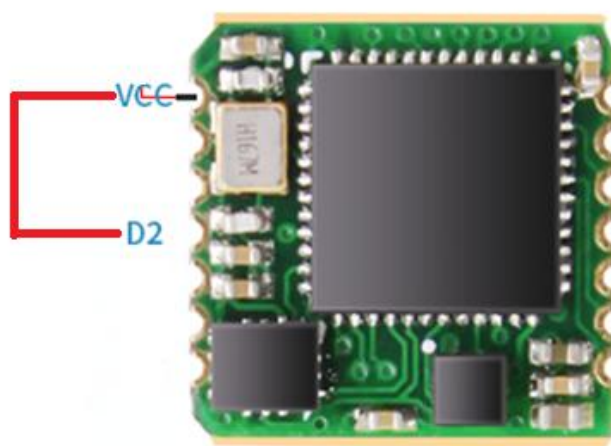


When the data rate longer than last time, chart update is slowly. Right click on the chart and click clear option to speed up data rate.

Click the “3D” and you can bring up the three-dimensional display interface, which displays the three-dimensional posture of the module.



## 6.2 Restore Factory Setting



1. Short VCC and D2
2. Power on
3. After 2s or 3s, ok

Short circuit method: Short VCC and D2 of the module and power on. Complete the factory reset after 2s or 3s.

Instruction method : WT931 module connected to a PC via USB-TTL module , click the Settings tab and make sure it online. Click “Recovery”. After restore the factory settings ,need to restart the module again. (This method requires advance knowledge to know baud rate of the module, if the baud rate does not match the command will not take effect, try using a short-circuit recovery method).

## 6.3 Module Calibration

Reminder: The module calibration and configuration should be carried out under the online state which displayed in the low right corner of the software configuration bar.

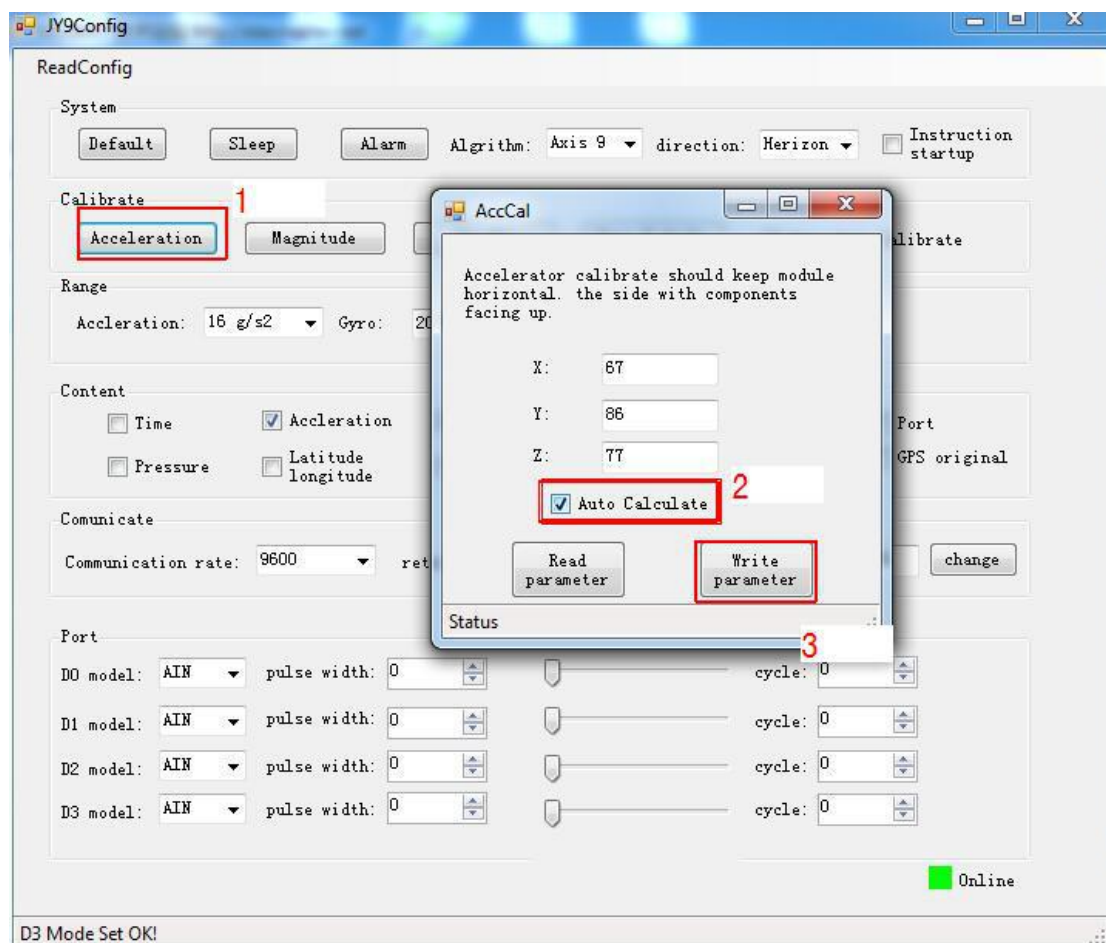
The module need to be calibrated before the module is used. The calibration of WT931 includes accelerometer calibration and magnetic calibration.

### 6.3.1 Accelerometer Calibration

The accelerometer calibration is used to remove the zero bias of the accelerometer. When the sensor is out of the factory, there will be different degrees of bias error. After manual calibration, the measurement will be accurate.

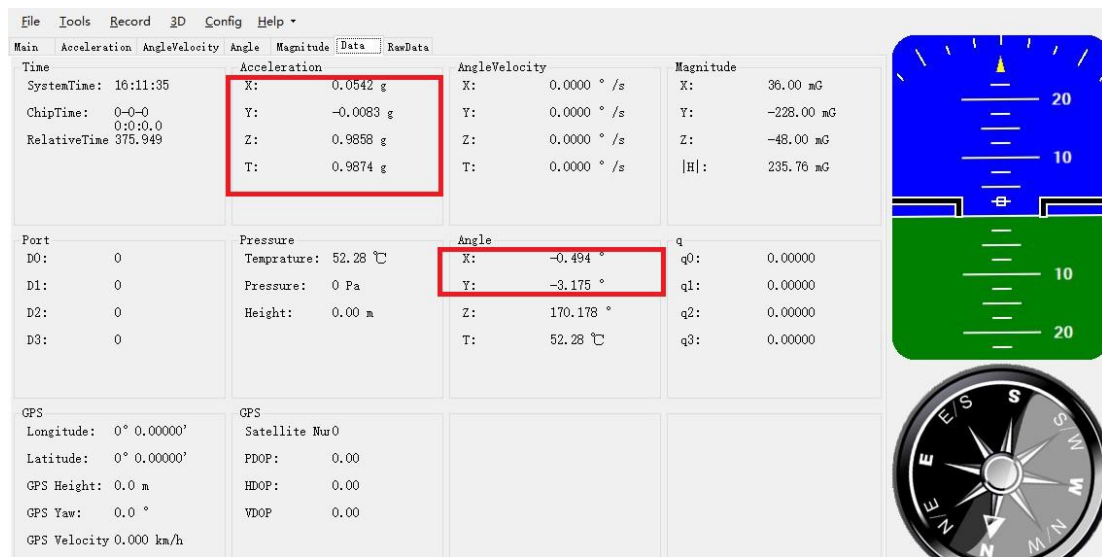
Methods as follow:

1. Firstly keep the module horizontally stationary, in the “Config” of the software click “Acceleration” and a calibration interface will pop up.
2. Check the “Auto Calculate” option, the software will automatically calculates the zero bias value and then click “Write parameter”



3. After 1 to 2 seconds, the three axes of the module acceleration will be around 0 0 1 and the X and Y axes will be around 0°. The X-axis angle after calibration is exactly the same.

Note: When the Z-axis is horizontally stationary, there is 1 G of gravitational acceleration.



## 6.3.2Magnetic Calibration

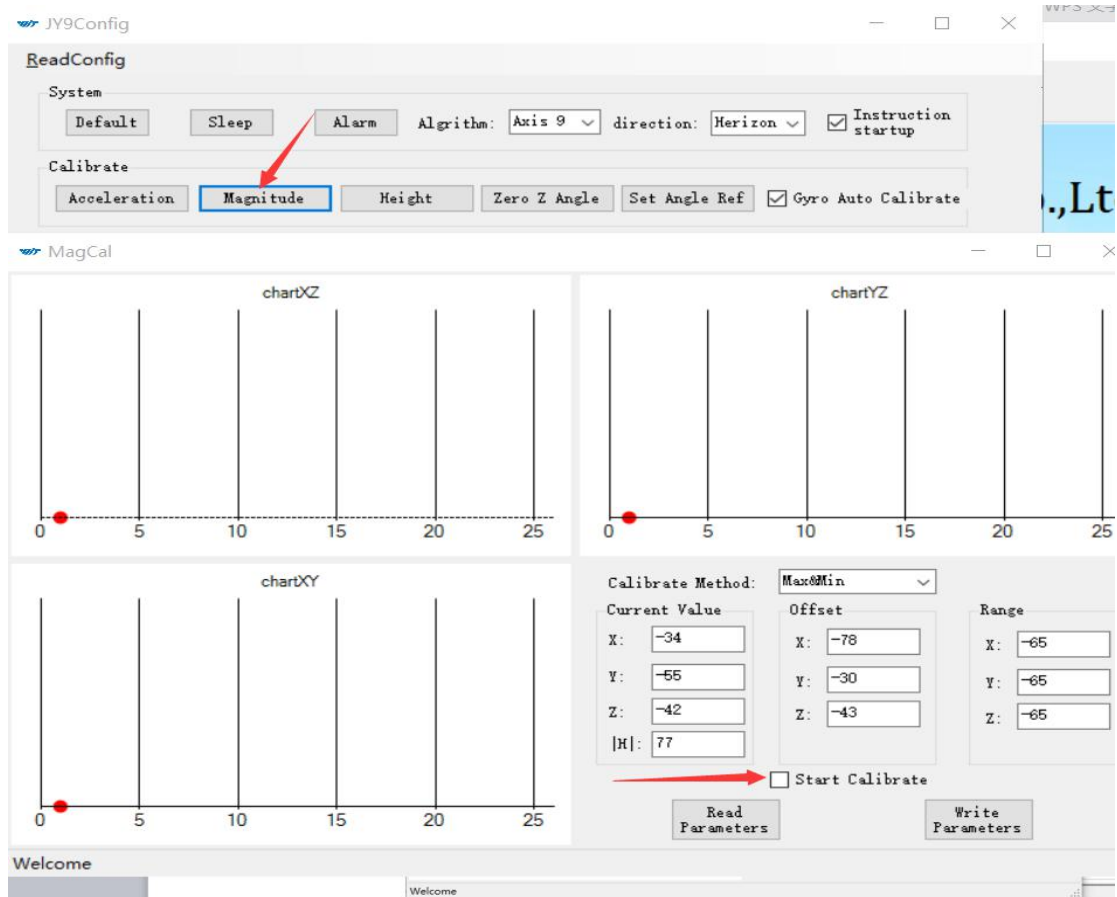
Magnetic field calibration is used to remove the magnetic field sensor's zero offset. Usually, the magnetic field sensor will have a large zero error when it is manufactured. If it is not calibrated, it will bring about a large measurement error and affect the accuracy of the Z-axis angle measurement of the heading angle.

Calibration methods as follow:

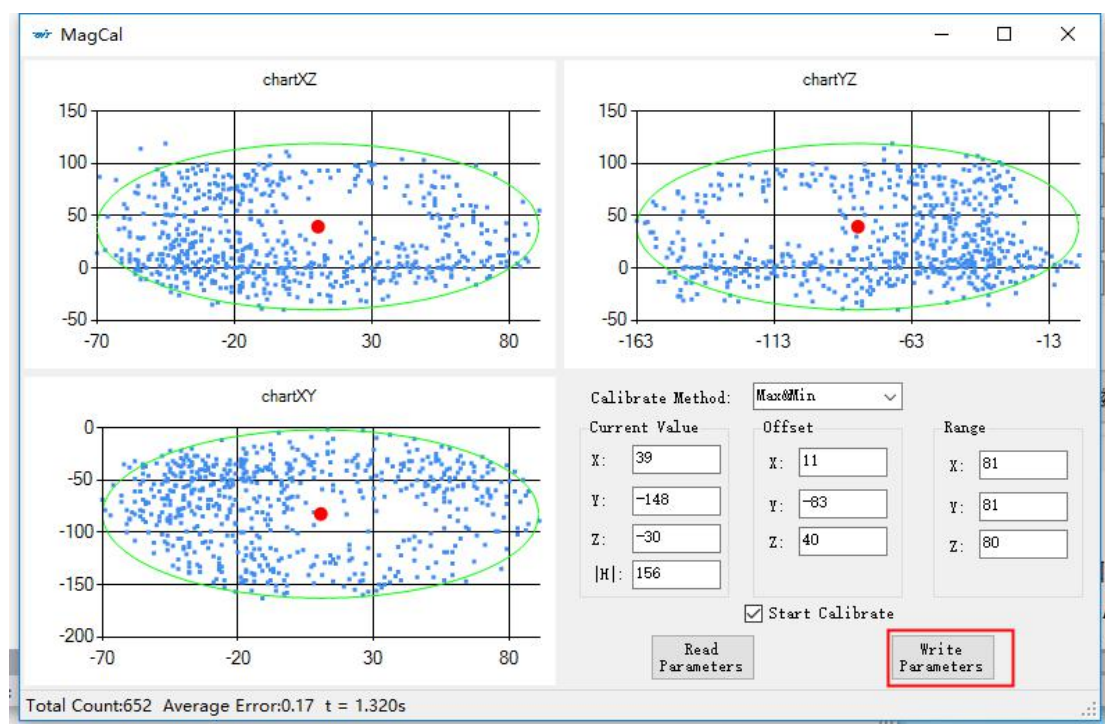
1. When calibrating, first connect the module and the computer, and place the module in a place far away from the disturbing magnetic field (ie, more than 20 CM away from magnets and iron, etc.), and then open the upper computer software.

2. In the settings page, click on the magnetic field button under the calibration bar to enter the magnetic field calibration mode. At this time, the MagCal window pops up. Click on the calibration button in this window.





3. Then slowly rotate the module around the three axes, let the data points draw points in the three planes, you can rotate a few more times, and after you draw a more regular ellipse, you can stop the calibration. After the calibration is completed, click Write Parameters.



Note: The data points should be within the ellipse but not outside the ellipse. If you cannot draw the ellipse, please keep away from the magnetic field interference. Then refer to the calibration video and place the module on the north-south axis of the Earth's magnetic field.

Calibration video:

[https://drive.google.com/drive/folders/1jQcYuTRDi\\_dPnlvVK5dITyqPTCkfYNaC](https://drive.google.com/drive/folders/1jQcYuTRDi_dPnlvVK5dITyqPTCkfYNaC)

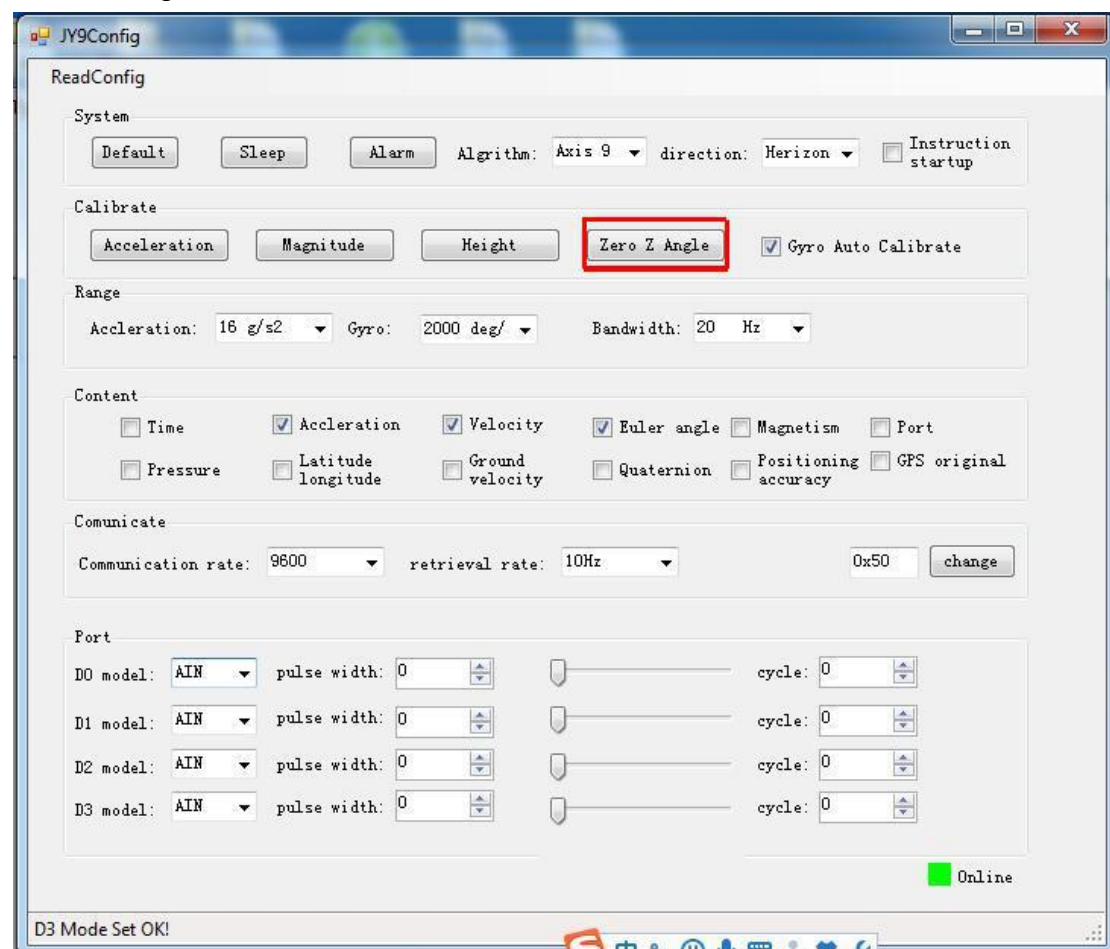
### 6.3.3 Z axis To 0

Reminder: Z axis to 0 is valid for WT931 at 6 axis mode only.

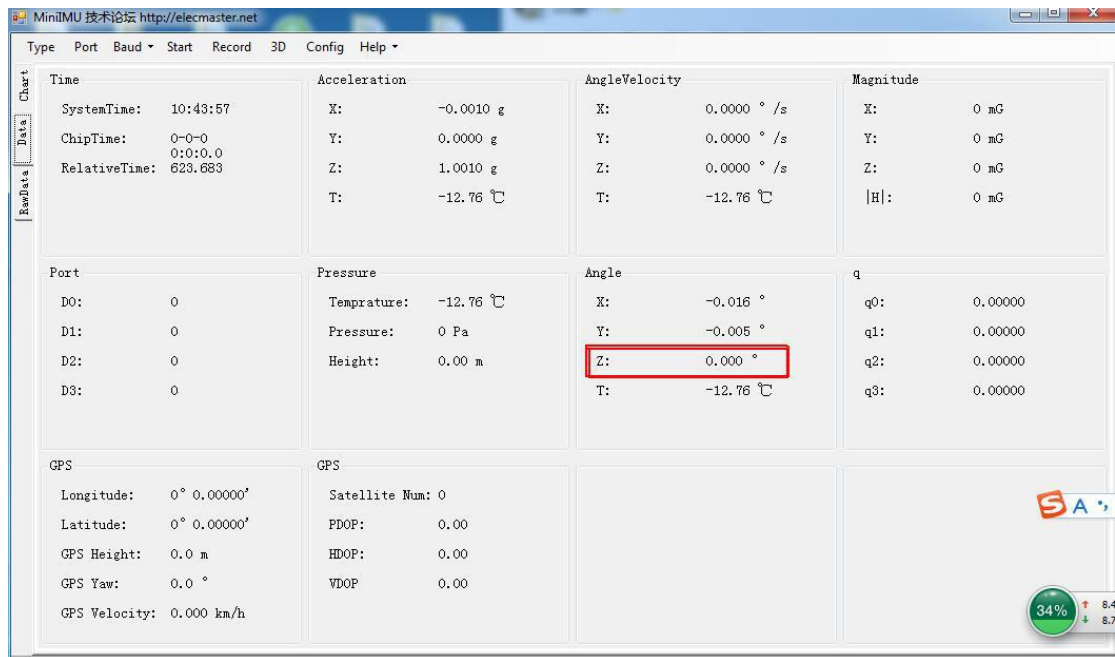
The z-axis angle is an absolute angle, and it takes the northeast sky as the coordinate system can not be relative to 0 degree.

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 “Zero Z Angle” option, you will see the the angle of the Z axis backs to 0 degree in the module data bar.







### 6.3.4 Gyroscope Automatic Calibration

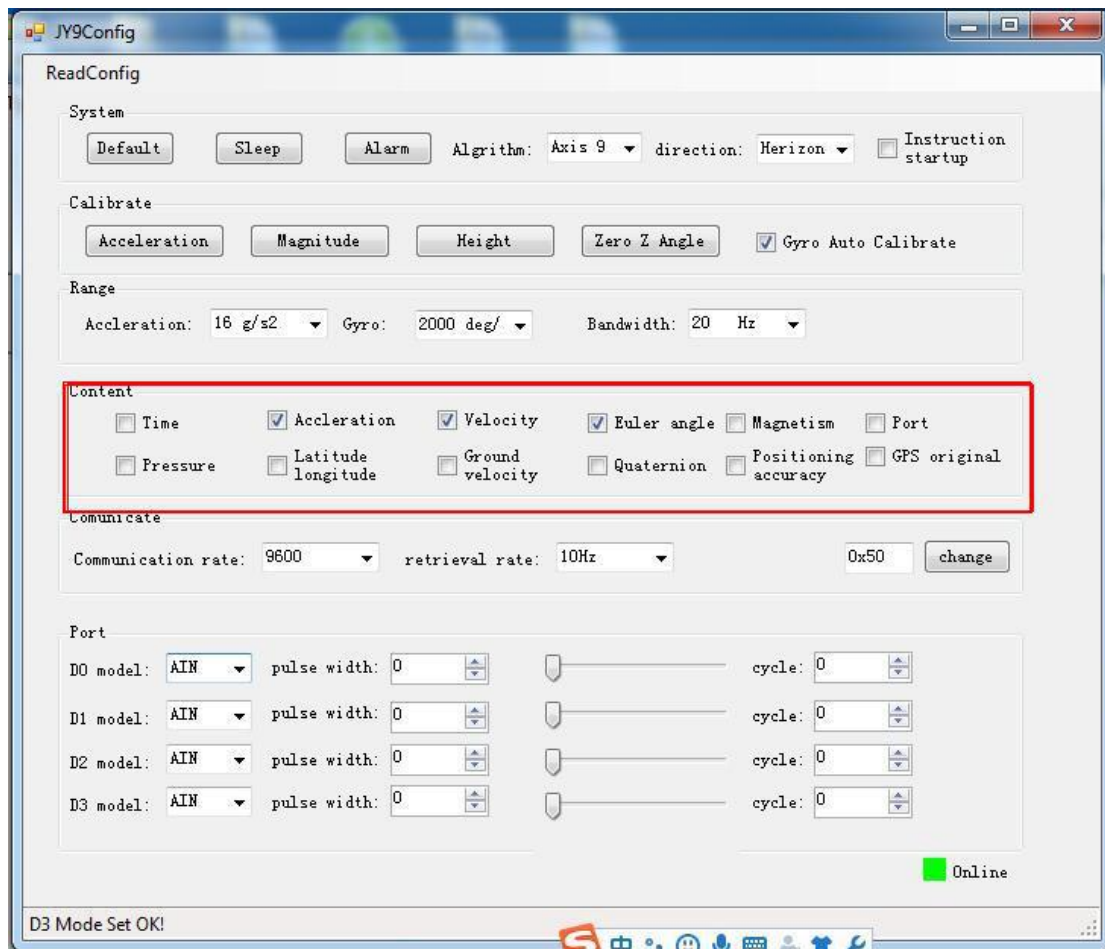
The gyroscope calibration is to calibrate the angular velocity, and the sensor will calibrate automatic.

## 6.4 Set Return Content

Setting method: The content of returned data can be customized according to the user's needs, click "Config" to open configuration bar, and hook the data content option that you want. Take JY901 as an example, the default output of the module is acceleration, angular velocity angle and magnetic field.

The time is the internal time of the module. By default, the initial time of the above power is 0:0:0.0 on January 1, 2015. If you connect a GPS module, use the GPS time as the module's time. Note that GPS time will be 8 hours later than Beijing time.

Longitude and ground velocity information are effectively when connected to the GPS module. In order to get the correct data we need to set the content.

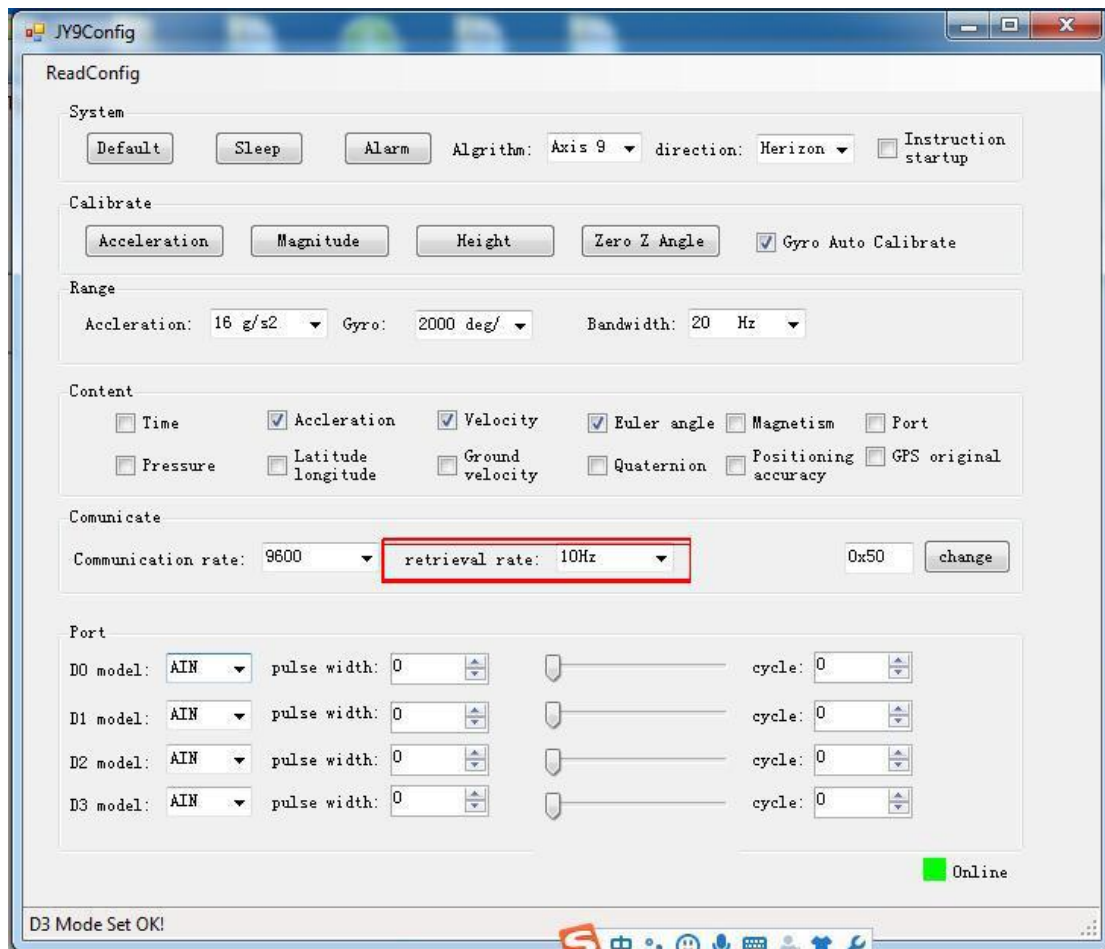


## 6.5 Set Return Rate

Setting methods: click “Config” to open configuration bar and than set the “retrieval rate” is 0.1HZ-500HZ optional.

The default return rate of the module is 500HZ, the highest return rate supports 500HZ. 500HZ refers to 500 packets returned every second. There contains 44 bytes in a data packet in default.

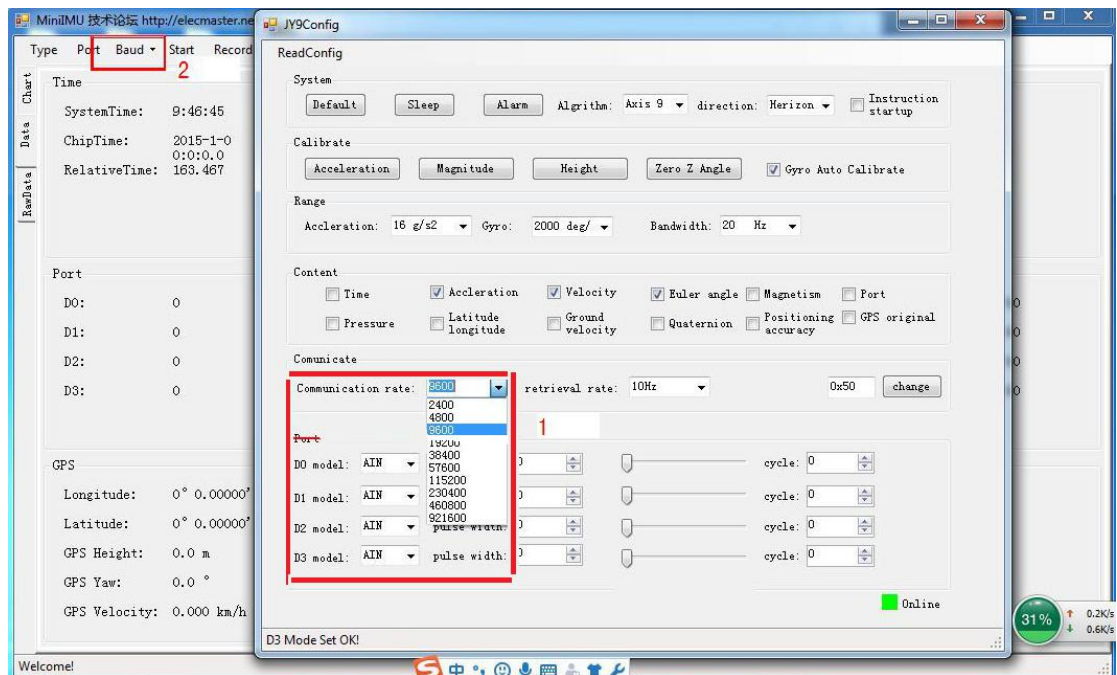
Reminder: If there being a lot of return content and low baud rate of communication, the module will automatically reduce the frequency and output at a maximum allowable output rate. The default baud rate is 921600.



## 6.6 Set Baud Rate

Module supports multiple baud, 921600 default. Change baud rate only when the module connect to PC program successfully, choose the baud rate and Click “Change” button.

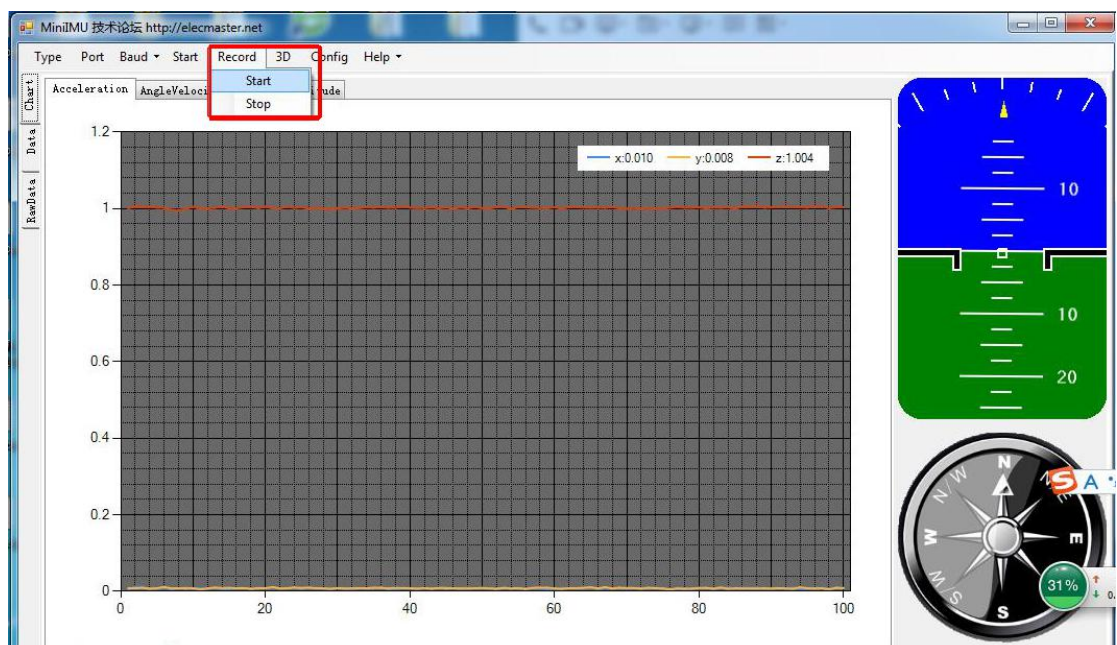
Reminder: After changing the baud rate, the module does not immediately take effect, need to re-power and then it will take effect.

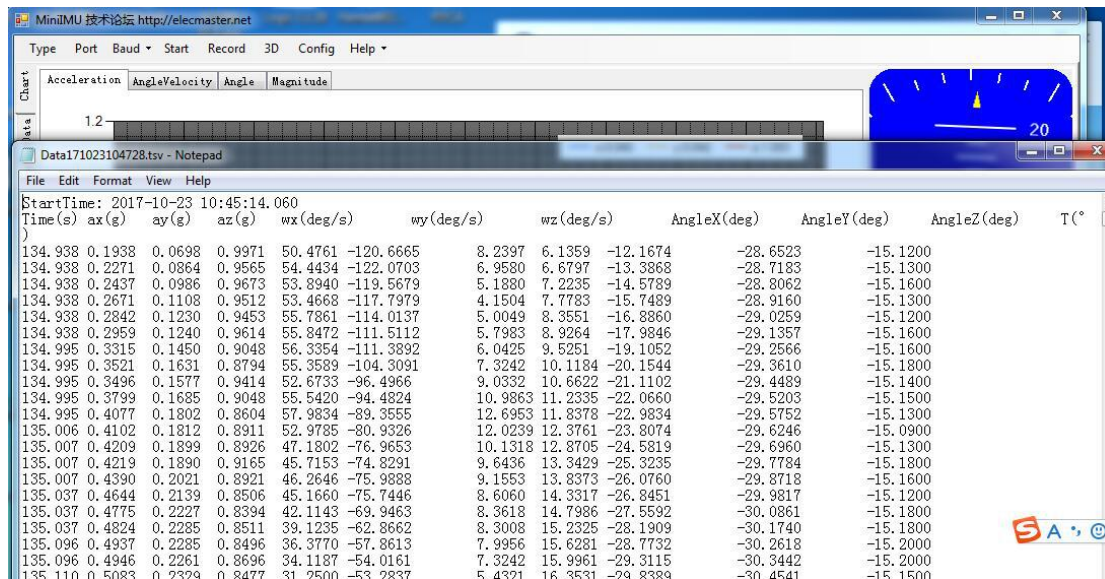


## 6.7 Data Recording

There is no memory chip in the sensor module, and the data can be recorded and saved in the software.

Method are as follows: Click “Record” and “Start” will save the data as a file.





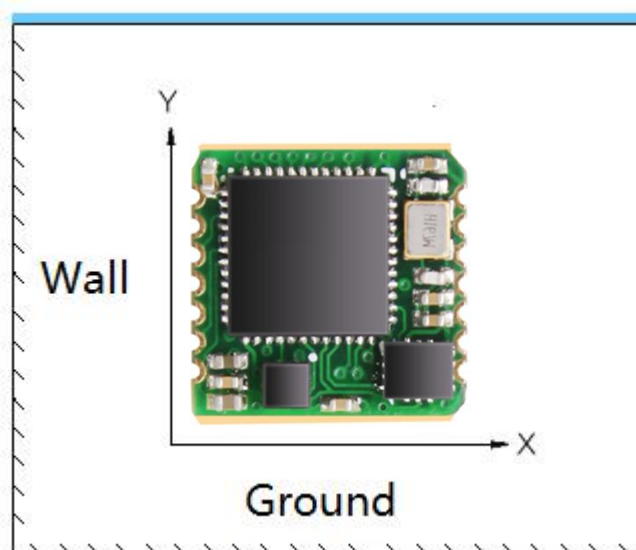
The saved file is in the directory of the software Data.tsv:

The file begins with a value indicating the data. “Time” stands for time, “ax, ay, az” respectively represents the acceleration of X, Y, Z axis. “wx, wy, wz” respectively represents the angular velocity of X, Y, Z axis. “AngleX, AngleY, AngleZ” respectively represents the angle of the X, Y, Z axis. T represents the temperature. “hx, hy, hz” respectively represents the magnetic field of X, Y, Z axis.

## 6.8 Installation Direction

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

Vertical installation method: Put the module around X-axis rotation 90 degrees vertical placement. In the “Config” of the software, click “Vertical” option. The calibration can be used after the setup is completed.



Vertical installation



## 6.9 Sleep/ 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 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.

## 6.10 Set Bandwidth

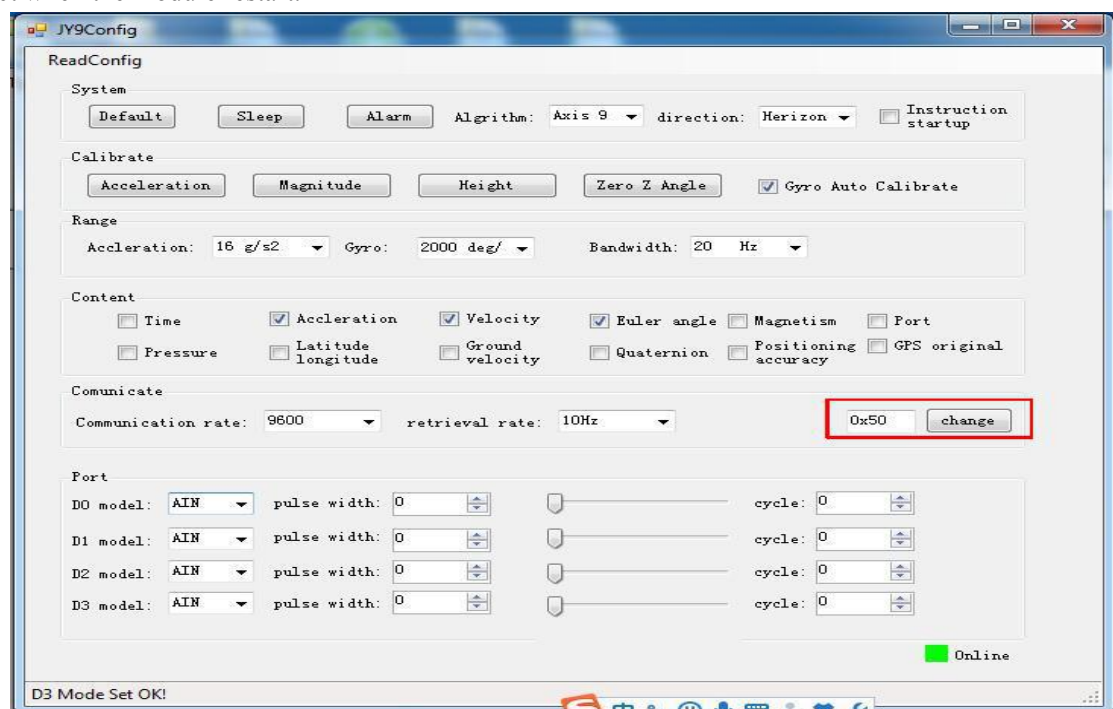
**Bandwidth:** The module outputs only the data within the measurement bandwidth, and the data which is larger than the bandwidth will be filtered automatically.

In the “Config” of the software, click “Bandwidth” option to set it, the default setting is 20HZ.

## 6.11 Set IIC Address

The module's IIC address is 0x50, which can be changed by software. Change the IIC address only when the module connect to PC program successfully, and enter the new 16 hexadecimal IIC address and click the “change” button.

Reminder: The IIC address of the module will not be changed immediately, and it will take effect when the module restart.



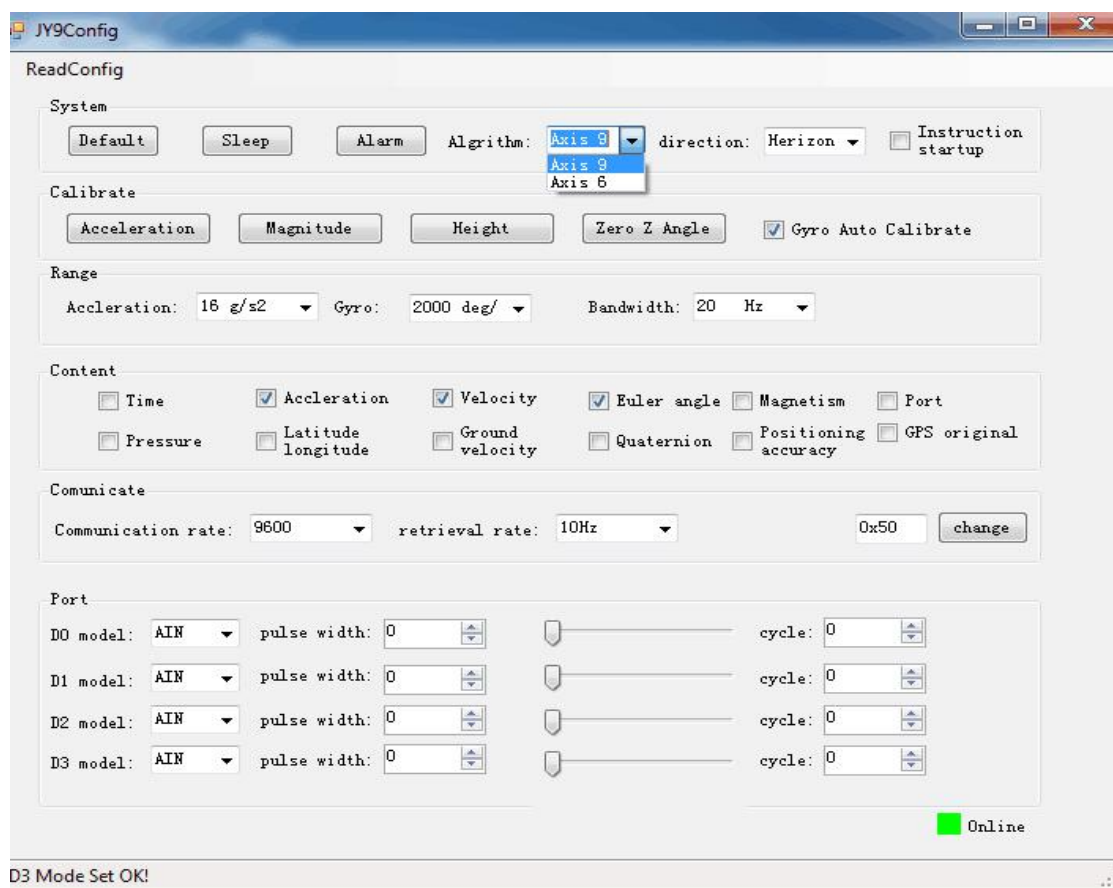
## 6.12 Six axis/ Nine axis Algorithm

JY61P uses the 6 axis algorithm, and the z axis angle is calculated mainly according to the angular velocity integral.

WT931 uses the 9 axis algorithm, the z axis angle is mainly calculated according to the magnetic field, there will be no drift phenomenon.

When the WT931 environment is disturbed by magnetic field, the 6 axis algorithm can be used to detect the angle.

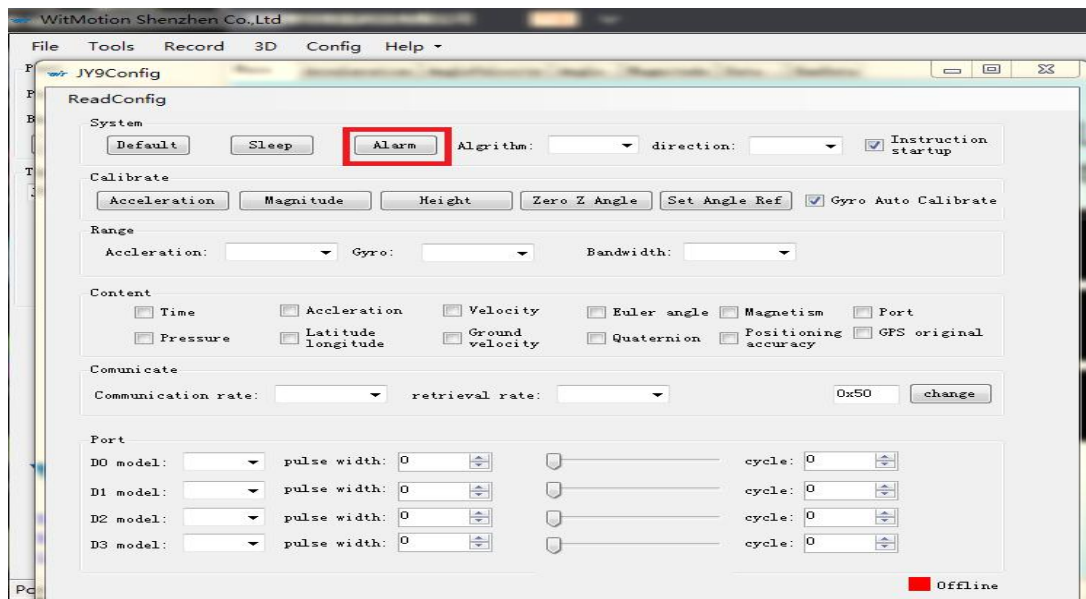
Nine axis algorithm to use 6 axis algorithm: in the PC configuration bar, the algorithm changed to "Axis6", and then additional calibration and Z axis zeroing calibration. The calibration will be ready for use.



## 6.13 Alarm Status Setting

Setting alarm status below by PC software, for example as below: 4 Ports output is 0V at normal state. When X Y angle  $>10^{\circ}$  or  $<10^{\circ}$  the port output is 3.3V.

Pin	Function
D0	X + alarm
D1	X- alarm
D2	Y + alarm
D3	Y- alarm



## 7 Communication Protocol

Level: TTL level (non RS232 level, if the module is wrong to the RS232 level may cause damage to the module)

Baud rate: 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600(default), stop bit and parity bit 0

### 7.1 Module to PC Software

#### 7.1.1 Time Output

0x55	0x50	YY	MM	DD	HH	MM	SS	MSL	MSH	SUM
------	------	----	----	----	----	----	----	-----	-----	-----

YY: Year, 20YY Year

MM: Month

DD: Day

hh: hour

mm: minute

ss: Second

ms: Millisecond

Millisecond calculate formula:

$MS = ((MSH < 8) | MSL)$

$Sum = 0x55 + 0x50 + YY + MM + DD + HH + MM + SS + MSL + MSH$

#### 7.1.2 Acceleration Output

0x55	0x51	AxL	AxH	AyL	AyH	AzL	AzH	TL	TH	SUM
------	------	-----	-----	-----	-----	-----	-----	----	----	-----



Calculate formula:

$$a_x = ((A_{xH} \ll 8) | A_{xL}) / 32768 * 16g \text{ (g is Gravity acceleration, } 9.8m/s^2)$$

$$a_y = ((A_{yH} \ll 8) | A_{yL}) / 32768 * 16g \text{ (g is Gravity acceleration, } 9.8m/s^2)$$

$$a_z = ((A_{zH} \ll 8) | A_{zL}) / 32768 * 16g \text{ (g is Gravity acceleration, } 9.8m/s^2)$$

Temperature calculated formular:

$$T = ((T_H \ll 8) | T_L) / 100 \text{ } ^\circ C$$

Check sum:

$$\text{Sum} = 0x55 + 0x51 + A_{xH} + A_{xL} + A_{yH} + A_{yL} + A_{zH} + A_{zL} + T_H + T_L$$

Note:

- 1、 the data is transmitted in accordance with the 16 hexadecimal, not ASCII code
- 2、 Each data is transmitted in a low byte and a high byte, and the two is combined into a short type of symbol. Such as X axis acceleration data  $A_x$ , where  $A_{xL}$  is the low byte,  $A_{xH}$  is high byte.

The conversion method is as follows:

Assuming Data is the actual data, DataH for its high byte, DataL for its low byte part, then:  $\text{Data} = ((\text{short}) \text{DataH} \ll 8) | \text{DataL}$ . Here we must pay attention to that force the DataH to be converted into a symbol of the short type of data and then after shift 8 bit, and the type of Data is also a symbol of the short type, so it can show a negative.

### 7.1.3 Angular Velocity Output

0x55	0x52	w <sub>xL</sub>	w <sub>xH</sub>	w <sub>yL</sub>	w <sub>yH</sub>	w <sub>zL</sub>	w <sub>zH</sub>	T <sub>L</sub>	T <sub>H</sub>	SUM
------	------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	----------------	----------------	-----

Calculate formula:

$$w_x = ((w_{xH} \ll 8) | w_{xL}) / 32768 * 2000(^{\circ}/s)$$

$$w_y = ((w_{yH} \ll 8) | w_{yL}) / 32768 * 2000(^{\circ}/s)$$

$$w_z = ((w_{zH} \ll 8) | w_{zL}) / 32768 * 2000(^{\circ}/s)$$

Temperature calculated formular:

$$T = ((T_H \ll 8) | T_L) / 100 \text{ } ^\circ C$$

Check sum:

$$\text{Sum} = 0x55 + 0x52 + w_{xH} + w_{xL} + w_{yH} + w_{yL} + w_{zH} + w_{zL} + T_H + T_L$$

### 7.1.4 Angle Output:

0x55	0x53	RollL	RollH	PitchL	PitchH	YawL	YawH	T <sub>L</sub>	T <sub>H</sub>	SUM
------	------	-------	-------	--------	--------	------	------	----------------	----------------	-----

Calculate formula:

$$\text{Roll (x axis)} \text{ Roll} = ((\text{RollH} \ll 8) | \text{RollL}) / 32768 * 180(^{\circ})$$

$$\text{Pitch (y axis)} \text{ Pitch} = ((\text{PitchH} \ll 8) | \text{PitchL}) / 32768 * 180(^{\circ})$$

$$\text{Yaw (z axis)} \text{ Yaw} = ((\text{YawH} \ll 8) | \text{YawL}) / 32768 * 180(^{\circ})$$

Temperature calculated formular:

$$T = ((T_H \ll 8) | T_L) / 100 \text{ } ^\circ C$$

Check sum:

$$\text{Sum} = 0x55 + 0x53 + \text{RollH} + \text{RollL} + \text{PitchH} + \text{PitchL} + \text{YawH} + \text{YawL} + T_H + T_L$$

Note:

1. Attitude angle use the coordinate system for the Northeast sky coordinate system, the X axis is East, the Y axis is North, Z axis toward sky. Euler coordinate system rotation sequence defined attitude is z-y-x, first rotates around the Z axis. Then, around the Y axis, and then around the X axis.
2. In fact, the rotation sequence is Z-Y-X, the range of pitch angle (Y axis) is only  $\pm 90$  degrees, when the pitch angle (Y axis) is bigger than 90 degrees and the pitch angle (Y axis) will become less than 90 degrees. At the same time, the Roll Angle (X axis) will become larger than 180 degree. Please search on Google about more information of Euler angle and attitude information.
3. Since the three axis are coupled, the angle will be independent only when the angle is small. It will be dependent of the three angle when the angle is large when the attitude angle change, such as when the Y axis close to 90 degrees, even if the attitude angle around the Y axis, X axis angle will have a big change, which is the inherent characteristics of the Euler angle.



### 7.1.5 Magnetic output:

0x55	0x54	HxL	HxH	HyL	HyH	HzL	HzH	TL	TH	SUM
------	------	-----	-----	-----	-----	-----	-----	----	----	-----

Calculate formula:

Magnetic (x axis)  $H_x = ((H_{xH} \ll 8) | H_{xL})$

Magnetic (y axis)  $H_y = ((H_{yH} \ll 8) | H_{yL})$

Magnetic (z axis)  $H_z = ((H_{zH} \ll 8) | H_{zL})$

Temperature calculated formular:

$T = ((TH \ll 8) | TL) / 100 \text{ } ^\circ\text{C}$

Check sum:

$Sum = 0x55 + 0x54 + H_{xH} + H_{xL} + H_{yH} + H_{yL} + H_{zH} + H_{zL} + TH + TL$

### 7.1.6 Atmospheric pressure and Height output:

0x55	0x56	P0	P1	P2	P3	H0	H1	H2	H3	SUM
------	------	----	----	----	----	----	----	----	----	-----

Calculate formula:

Atmospheric pressure  $P = ((P3 \ll 24) | (P2 \ll 16) | (P1 \ll 8) | P0)$  (Pa)

Height  $H = ((H3 \ll 24) | (H2 \ll 16) | (H1 \ll 8) | H0)$  (cm)

Check sum:

Sum = 0x55 + 0x56 + P0 + P1 + P2 + P3 + H0 + H1 + H2 + H3

### 7.1.7 Longitude and Latitude Output:

GPS should be agree with NMEA-0813 protocol (V2.0)

0x55	0x57	Lon0	Lon 1	Lon 2	Lon 3	Lat0	Lat 1	Lat 2	Lat 3	SUM
------	------	------	-------	-------	-------	------	-------	-------	-------	-----

Calculate formula:

**Longitude Lon** =  $((Lon\ 3 \ll 24) | (Lon\ 2 \ll 16) | (Lon\ 1 \ll 8) | Lon\ 0)$

In NMEA0183 standard, GPS output format is ddmm.mmmmm (dd for the degree, mm.mmmmm is after decimal point), JY-901 removed output decimal point, so the degree of longitude can be calculated:

dd = Lon / 10000000;

mm.mmmmm = (Lon % 10000000) / 100000; (% calculate Remainder)

**Latitude Lat** =  $((Lat\ 3 \ll 24) | (Lat\ 2 \ll 16) | (Lat\ 1 \ll 8) | Lat\ 0)$

In NMEA0183 standard, GPS output format is ddmm.mmmmm (dd for the degree, mm.mmmmm is after decimal point), JY-901 removed output decimal point, so the degree of longitude can be calculated:

dd = Lat / 10000000;

mm.mmmmm = (Lat % 10000000) / 100000; (% calculate Remainder)

```
sprintf(str, "Longitude:%ldDeg%.5fm Latitude:%ldDeg%.5fm\r\n", stcLonLat.lLon/10000000, (double)(stcLonLat.lLon % 10000000)/1e5, stcLonLat.lLat/10000000, (double)(stcLonLat.lLat % 10000000)/1e5);
```

Check sum:

Sum = 0x55 + 0x57 + Lon 0 + Lon 1 + Lon 2 + Lon 3 + Lat 0 + Lat 1 + Lat 2 + Lat 3

### 7.1.8 Ground speed output:

0x55	0x58	GPSHeightL	GPSHeightH	GPSTimeL	GPSTimeH
GPSTimeL	GPSTimeH	SUM			

Calculate formula:

GPSHeight =  $((GPSHeightH \ll 8) | GPSHeightL) / 10$  (m)

$$\text{GPSYaw} = ((\text{GPSYawH} \ll 8) | \text{GPSYawL}) / 10 \quad (^\circ)$$

$$\text{GPSV} = (((\text{GPSV3} \ll 24) | (\text{GPSV2} \ll 16) | (\text{GPSV1} \ll 8) | \text{GPSV0}) / 1000 \quad (\text{km/h})$$

Check sum:

$$\text{Sum} = 0x55 + 0x54 + \text{GPSHeightL} + \text{GPSHeightH} + \text{GPSYawL} + \text{GPSYawH} + \text{GPSV0} + \text{GPSV1} + \text{GPSV2} + \text{GPSV3}$$

### 7.1.9 Quaternion:

0x55	0x59	Q0L	Q0H	Q1L	Q1H	Q2L	Q2H	Q3L	Q3H	SUM
------	------	-----	-----	-----	-----	-----	-----	-----	-----	-----

Calculate formula:

$$Q0 = ((Q0H \ll 8) | Q0L) / 32768$$

$$Q1 = ((Q1H \ll 8) | Q1L) / 32768$$

$$Q2 = ((Q2H \ll 8) | Q2L) / 32768$$

$$Q3 = ((Q3H \ll 8) | Q3L) / 32768$$

Check sum:

$$\text{Sum} = 0x55 + 0x59 + Q0L + Q0H + Q1L + Q1H + Q2L + Q2H + Q3L + Q3H$$

### 7.1.10 Satellite positioning accuracy output:

0x55	0x5A	SNL	SNH	PDOPL	PDOPH	HDOPL	HDOPH	VDOPL	VDOPH	SUM
------	------	-----	-----	-------	-------	-------	-------	-------	-------	-----

Calculate formula:

$$\text{Satellite quantity: } \text{SN} = ((\text{SNH} \ll 8) | \text{SNL})$$

$$\text{Location positioning accuracy: } \text{PDOP} = ((\text{PDOPH} \ll 8) | \text{PDOPL}) / 100$$

$$\text{Horizontal positioning accuracy: } \text{HDOP} = ((\text{HDOPH} \ll 8) | \text{HDOPL}) / 100$$

$$\text{Vertical positioning accuracy: } \text{VDOP} = ((\text{VDOPH} \ll 8) | \text{VDOPL}) / 100$$

Check sum:

$$\text{Sum} = 0x55 + 0x5A + \text{SNL} + \text{SNH} + \text{PDOPL} + \text{PDOPH} + \text{HDOPL} + \text{HDOPH} + \text{VDOPL} + \text{VDOPH}$$

## 7.2 Software to Module

Reminder:

1. Factory settings default to use serial port, band rate is 921600, frame rate is 500HZ. Configuration can be configured through PC software. All configuration are power down storage, so you just need to configure it just once on the line.
2. Data format

0xFF	0xAA	Address	DataL	DataH
------	------	---------	-------	-------

### 7.2.1 Register Address table

Address	Symbol	Meaning
0x00	SAVE	Save

0x01	CALSW	Calibration
0x02	RSW	Return data content
0x03	RATE	Return data Speed
0x04	BAUD	Baud rate
0x05	AXOFFSET	X axis Acceleration bias
0x06	AYOFFSET	Y axis Acceleration bias
0x07	AZOFFSET	Z axis Acceleration bias
0x08	GXOFFSET	X axis angular velocity bias
0x09	GYOFFSET	Y axis angular velocity bias
0x0a	GZOFFSET	Z axis angular velocity bias
0x0b	HXOFFSET	X axis Magnetic bias
0x0c	HYOFFSET	Y axis Magnetic bias
0x0d	HZOFFSET	Z axis Magnetic bias
0x0e	D0MODE	D0 mode
0x0f	D1MODE	D1 mode
0x10	D2MODE	D2 mode
0x11	D3MODE	D3 mode
0x12	D0PWMH	D0PWM High-level width
0x13	D1PWMH	D1PWM High-level width
0x14	D2PWMH	D2PWM High-level width
0x15	D3PWMH	D3PWM High-level width
0x16	D0PWMT	D0PWM Period
0x17	D1PWMT	D1PWM Period
0x18	D2PWMT	D2PWM Period
0x19	D3PWMT	D3PWM Period
0x1a	IICADDR	IIC address
0x1b	LEDOFF	Turn off LED
0x1c	GPSBAUD	GPS baud rate
0x30	YYMM	Year、Month
0x31	DDHH	Day、Hour
0x32	MMSS	Minute、Second
0x33	MS	Millisecond
0x34	AX	X axis Acceleration
0x35	AY	Y axis Acceleration
0x36	AZ	Z axis Acceleration
0x37	GX	X axis angular velocity
0x38	GY	Y axis angular velocity
0x39	GZ	Z axis angular velocity
0x3a	HX	X axis Magnetic
0x3b	HY	Y axis Magnetic
0x3c	HZ	Z axis Magnetic
0x3d	Roll	X axis Angle

0x3e	Pitch	Y axis Angle
0x3f	Yaw	Z axis Angle
0x40	TEMP	Temperature
0x41	D0Status	D0Status
0x42	D1Status	D1Status
0x43	D2Status	D2Status
0x44	D3Status	D3Status
0x45	PressureL	Pressure Low Byte
0x46	PressureH	Pressure High Byte
0x47	HeightL	Height Low Byte
0x48	HeightH	Height High Byte
0x49	LonL	Longitude Low Byte
0x4a	LonH	Longitude High Byte
0x4b	LatL	Latitude Low Byte
0x4c	LatH	Latitude High Byte
0x4d	GPSHeight	GPS Height
0x4e	GPSYaw	GPS Yaw
0x4f	GPSVL	GPS speed Low byte
0x50	GPSVH	GPS speed High byte
0x51	Q0	Quaternion Q0
0x52	Q1	Quaternion Q1
0x53	Q2	Quaternion Q2
0x54	Q3	Quaternion Q3

## 7.2.2 Save Configuration

0xFF	0xAA	0x00	SAVE	0x00
------	------	------	------	------

SAVE: Save

0: Save current configuration

1: set to default setting

## 7.2.3 Calibrate

0xFF	0xAA	0x01	CALSW	0x00
------	------	------	-------	------

CALSW: Set calibration mode

0: Exit calibration mode

1: Enter Gyroscope and Accelerometer calibration mode

2: Enter magnetic calibration mode

3: Set height to 0

## 7.2.4 Set Installation direction

0xFF	0xAA	0x23	DIRECTION	0x00
------	------	------	-----------	------

DIRECTION: set installation direction

0: set to horizontal installation

1: set to vertical installation

## 7.2.5 Sleep/ Wake up

0xFF	0xAA	0x22	0x01	0x00
------	------	------	------	------

Sent this instruction to enter sleep state, sent it once again, module enter the working state from the standby state.

## 7.2.6 Algorithm transition

0xFF	0xAA	0x24	ALG	0x00
------	------	------	-----	------

ALG: 6-axis/ 9-axis algorithm transition

0: set to 9-axis algorithm

1: set to 6-axis algorithm

## 7.2.7 Gyroscope automatic calibration

0xFF	0xAA	0x63	GYRO	0x00
------	------	------	------	------

GYRO: gyroscope automatic calibration

0: set to gyroscope automatic calibration

1: removed to gyroscope automatic calibration

## 7.2.8 Set return content

0xFF	0xAA	0x02	RSWL	RSWH
------	------	------	------	------

RSWL byte definition

byte	7	6	5	4	3	2	1	0
Name	0x57 pack	0x56 pack	0x55 pack	0x54 pack	0x53 pack	0x52 pack	0x51 pack	0x50 pack
default	0	0	0	1	1	1	1	0

RSWH byte definition

byte	7	6	5	4	3	2	1	0
Name	X	X	X	X	X	0x5A 包	0x59 包	0x58 包
default	0	0	0	0	0	0	0	0

X no definition

0x50 pack: time pack

0: Not output 0X50 pack  
 1: Output 0X50 pack  
 0x51 pack: Acceleration pack  
 0: Not output 0x51 pack  
 1: Output 0x51 pack  
 0x52 pack: Angular velocity pack  
 0: Not output 0x52 packet  
 1: Output 0x52 pack  
 0x53 pack: Angle Pack  
 0: Not output 0x53 pack  
 1: Output 0x53 pack  
 0x54 pack: Magnetic Pack  
 0: Not output 0x54 pack  
 1: Output 0x54 pack  
 0x55 pack: Port status pack  
 0: Not output 0x55 pack  
 1: Output 0x55 pack  
 0x56 pack: Atmospheric pressure & Height Pack  
 0: Not output 0x56 pack  
 1: Output 0x56 pack  
 0x57 pack: Longitude and Latitude Output Pack  
 0: Not output 0x57 pack  
 1: Output 0x57 pack  
 0x58 pack: GPS speed Pack  
 0: Not output 0x58 pack  
 1: Output 0x58 pack  
 0x59 pack: Quaternion Pack  
 0: Not output 0x59 pack  
 1: Output 0x59 pack  
 0x5A pack: Satellite position accuracy  
 0: Not output 0x5A pack  
 1: Output 0x5A pack

## 7.2.9 Set return rate

0xFF	0xAA	0x03	RATE	0x00
------	------	------	------	------

RATE: return rate

0x00: 0.1Hz  
 0x01: 0.2Hz  
 0x02: 0.5Hz  
 0x03: 1Hz  
 0x04: 2Hz  
 0x05: 5Hz  
 0x06: 10Hz



- 0x07: 20Hz
- 0x08: 50Hz
- 0x09: 100Hz
- 0x0a: 125Hz
- 0x0b: 250Hz
- 0x0c: 500Hz
- 0x0d: Single output

After the setup is complete , need to click save,and re-power the module to take effect.

## 7.2.10 Set baud rate

0xFF	0xAA	0x04	BAUD	0x00
------	------	------	------	------

BAUD:

- 0x00: 2400
- 0x01: 4800
- 0x02: 9600
- 0x03: 19200
- 0x04: 38400
- 0x05: 57600
- 0x06: 115200
- 0x07: 230400
- 0x08: 460800
- 0x09: 921600 (default)

## 7.2.11 Set X axis Acceleration bias

0xFF	0xAA	0x05	AXOFFSETL	AXOFFSETH
------	------	------	-----------	-----------

AXOFFSETL: X axis Acceleration bias low byte

AXOFFSETH: X axis Acceleration bias high byte

$AXOFFSET = (AXOFFSETH \ll 8) | AXOFFSETL$

Note: When set the acceleration bias, the output equal the value of the acceleration sensor output value minus the bias value

## 7.2.12 Set Y axis Acceleration bias

0xFF	0xAA	0x06	AYOFFSETL	AYOFFSETH
------	------	------	-----------	-----------

AYOFFSETL: Y axis Acceleration bias low byte

AYOFFSETH: Y axis Acceleration bias high byte

$AYOFFSET = (AYOFFSETH \ll 8) | AYOFFSETL$

Note: When set the acceleration bias, the output equal the value of the acceleration sensor output value minus the bias value.

### 7.2.13 Set Z axis Acceleration bias

0xFF	0xAA	0x07	AZOFFSETL	AZOFFSETH
------	------	------	-----------	-----------

AZOFFSETL: Z axis Acceleration bias low byte

AZOFFSETH: Z axis Acceleration bias high byte

AZOFFSET= (AZOFFSETH <<8) | AZOFFSETL

Note: When set the acceleration bias, the output equal the value of the acceleration sensor output value minus the bias value.

### 7.2.14 Set X axis Angular velocity bias

0xFF	0xAA	0x08	GXOFFSETL	GXOFFSETH
------	------	------	-----------	-----------

GXOFFSETL: Set X axis Angular velocity bias low byte

GXOFFSETH: Set Y axis Angular velocity bias high byte

GXOFFSET= (GXOFFSETH <<8) | GXOFFSETL

Note: When set the Angular velocity bias, the output equal the value of the sensor output value minus the bias value.

### 7.2.15 Set Y axis Angular velocity bias

0xFF	0xAA	0x09	GYOFFSETL	GYOFFSETH
------	------	------	-----------	-----------

GYOFFSETL: Set X axis Angular velocity bias low byte

GYOFFSETH: Set X axis Angular velocity bias high byte

GYOFFSET= (GYOFFSETH <<8) | GYOFFSETL

Note: When set the Angular velocity bias, the output equal the value of the sensor output value minus the bias value.

### 7.2.16 Set Z axis Angular velocity bias

0xFF	0xAA	0x0a	GZOFFSETL	GZOFFSETH
------	------	------	-----------	-----------

GZOFFSETL: Set Z axis Angular velocity bias low byte

GZOFFSETH: Set Z axis Angular velocity bias low byte

GZOFFSET= (GZOFFSETH <<8) | GZOFFSETL

Note: When set the Angular velocity bias, the output equal the value of the sensor output value minus the bias value.

### 7.2.17 Set X axis magnetic bias

0xFF	0xAA	0x0b	HXOFFSETL	HXOFFSETH
------	------	------	-----------	-----------

HXOFFSETL: Set X axis magnetic bias low byte

HXOFFSETH: Set X axis magnetic bias high byte

$HXOFFSET = (HXOFFSETH \ll 8) | HXOFFSETL$

Note: When set the magnetic bias, the output equal the value of the sensor output value minus the bias value.

### 7.2.18 Set Y axis magnetic bias

0xFF	0xAA	0x0c	HXOFFSETL	HXOFFSETH
------	------	------	-----------	-----------

HXOFFSETL: Set Y axis magnetic bias low byte

HXOFFSETH: Set Y axis magnetic bias high byte

$HXOFFSET = (HXOFFSETH \ll 8) | HXOFFSETL$

Note: When set the magnetic bias, the output equal the value of the sensor output value minus the bias value.

### 7.2.19 Set Z axis magnetic bias

0xFF	0xAA	0x0d	HXOFFSETL	HXOFFSETH
------	------	------	-----------	-----------

HXOFFSETL: Set Y axis magnetic bias low byte

HXOFFSETH: Set Z axis magnetic bias high byte

$HXOFFSET = (HXOFFSETH \ll 8) | HXOFFSETL$

Note: When set the magnetic bias, the output equal the value of the sensor output value minus the bias value.

## 8 IIC Protocol

JY-901 module can be fully accessed through IIC, the maximum IIC communication speed support 400khz, slave module address is 7bit, default address is 0x50, you can change the command through the serial port or the methods of IIC writing address ways. Many GY-901 modules can be connect to IIC bus at the same time, The precondition is that the module has the different IIC address.

IIC protocol module using the register address accessible way. The length of each address are 16bits, two bytes. The register address is defined in the following table:

RegAddr	Symbol	Meaning
0x00	SAVE	Save
0x01	CALSW	Calibration
0x02	RSW	Return data content
0x03	RATE	Return data Speed
0x04	BAUD	Baud rate
0x05	AXOFFSET	X axis Acceleration bias
0x06	AYOFFSET	Y axis Acceleration bias
0x07	AZOFFSET	Z axis Acceleration bias
0x08	GXOFFSET	X axis angular velocity bias
0x09	GYOFFSET	Y axis angular velocity bias

0x0a	GZOFFSET	Z axis angular velocity bias
0x0b	HXOFFSET	X axis Magnetic bias
0x0c	HYOFFSET	Y axis Magnetic bias
0x0d	HZOFFSET	Z axis Magnetic bias
0x0e	D0MODE	D0 mode
0x0f	D1MODE	D1 mode
0x10	D2MODE	D2 mode
0x11	D3MODE	D3 mode
0x12	D0PWMH	D0PWM High-level width
0x13	D1PWMH	D1PWM High-level width
0x14	D2PWMH	D2PWM High-level width
0x15	D3PWMH	D3PWM High-level width
0x16	D0PWMT	D0PWM Period
0x17	D1PWMT	D1PWM Period
0x18	D2PWMT	D2PWM Period
0x19	D3PWMT	D3PWM Period
0x1a	IICADDR	IIC address
0x1b	LEDOFF	Turn off LED
0x1c	GPSBAUD	GPS baud rate
0x30	YYMM	Year、Month
0x31	DDHH	Day、Hour
0x32	MMSS	Minute、Second
0x33	MS	Millisecond
0x34	AX	X axis Acceleration
0x35	AY	Y axis Acceleration
0x36	AZ	Z axis Acceleration
0x37	GX	X axis angular velocity
0x38	GY	Y axis angular velocity
0x39	GZ	Z axis angular velocity
0x3a	HX	X axis Magnetic
0x3b	HY	Y axis Magnetic
0x3c	HZ	Z axis Magnetic
0x3d	Roll	X axis Angle
0x3e	Pitch	Y axis Angle
0x3f	Yaw	Z axis Angle
0x40	TEMP	Temperature
0x41	D0Status	D0Status
0x42	D1Status	D1Status
0x43	D2Status	D2Status
0x44	D3Status	D3Status
0x45	PressureL	Pressure Low Byte
0x46	PressureH	Pressure High Byte

0x47	HeightL	Height Low Byte
0x48	HeightH	Height High Byte
0x49	LonL	Longitude Low Byte
0x4a	LonH	Longitude High Byte
0x4b	LatL	Latitude Low Byte
0x4c	LatH	Latitude High Byte
0x4d	GPSHeight	GPS Height
0x4e	GPSYaw	GPS Yaw
0x4f	GPSVL	GPS speed Low byte
0x50	GPSVH	GPS speed High byte
0x51	Q0	Quaternion Q0
0x52	Q1	Quaternion Q1
0x53	Q2	Quaternion Q2
0x54	Q3	Quaternion Q3

## 8.1 IIC Write the Module

When IIC write the module, the format is as below:

IICAddr<<1	RegAddr	Data1L	Data1H	Data2L	Data2H	.....
------------	---------	--------	--------	--------	--------	-------

First IIC host sends a Start signal to JY-901 module, then write IICAddr to register address and then write RegAddr , write the Data1L Data1H Data2L Data2H .... Sequentially, , when the last data has been written, the host sends a stop signal to the module to release the IIC bus.

When finish writing the data, the register will be updated and module will execute the order. At the same time, the address of the module will add 1 automatically . The address Pointer will point to next address. So it can be written Continuously

For example:

Set D0 as Digital output high

RegAddr :0x0e DataL:0x02 DataH:0x00

Logic Analyzer captures waveforms as shown below:



Register set up by the module approach is consistent with the serial protocol, please refer 7.1

## 8.2 IIC Read the Module

IIC read the module, the format is as follow:

IICAddr<<1	RegAddr	(IICAddr<<1) 1	Data1L	Data1H	Data2L	Data2H	.....
------------	---------	----------------	--------	--------	--------	--------	-------

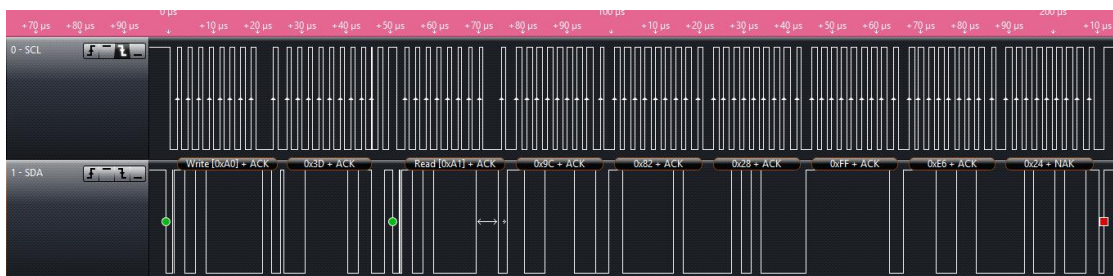
First IIC host sends a Start signal to JY-901 module , then write IICAddr to register address, then IIC host sends a read signal(IICAddr<<1)|1) to JY-901 module, if the IIC address is 0x50(default),then the host send 0xa0

Thereafter the module will export the data follow the rule: low byte first, high byte Sequentially. The host will make SDA bus low after receiving each byte, and sends a response signal to the module .After the specified number of data has been received completely, the host stop sending response signal back to the module, then the module will stop export data.The host send a stop signal to end this operation.

For example:

Read the Angle of the module,

RedAddr: 0x3d, read 6 bytes continuously, the logic analyzer captures waveforms as shown below:



Start reading out data from 0x3d,the data is 0x9C, 0x82,0x28,0xFF, 0xE6,0x24. That means X-axis angle is 0x829C, Y-axis angle is 0xFF28, Z-axis angle is 0x24E6. According to section 5.1.4 , X axis angle is -176.33 °, Y-axis angle is -1.19 °, Z-axis angle is 51.89 °

# 9 Application Area

Agricultural machinery



Internet of things



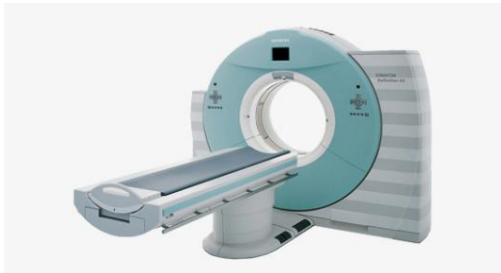
Solar energy



Power monitoring



Medical instruments



Construction machinery



Geological monitoring





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