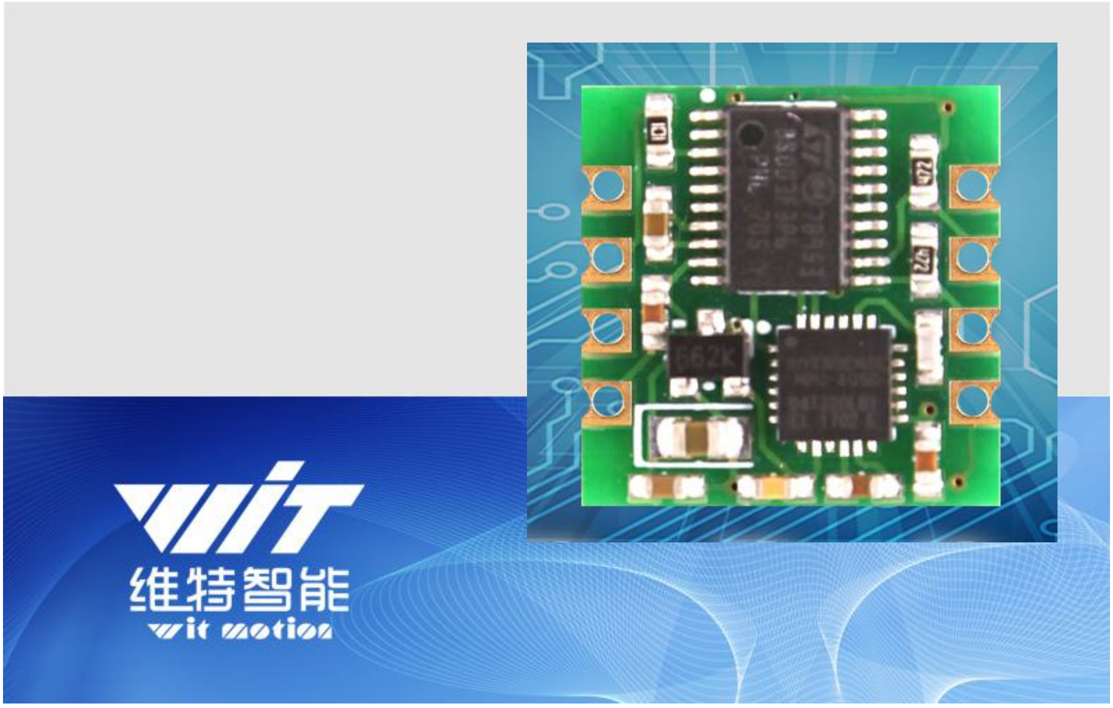
http://www.wit-motion.com

JY61 Attitude Angle Sensor SPECIFICATION



Model ： JY61

Description ： Six 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

Revision date：2017.10.09

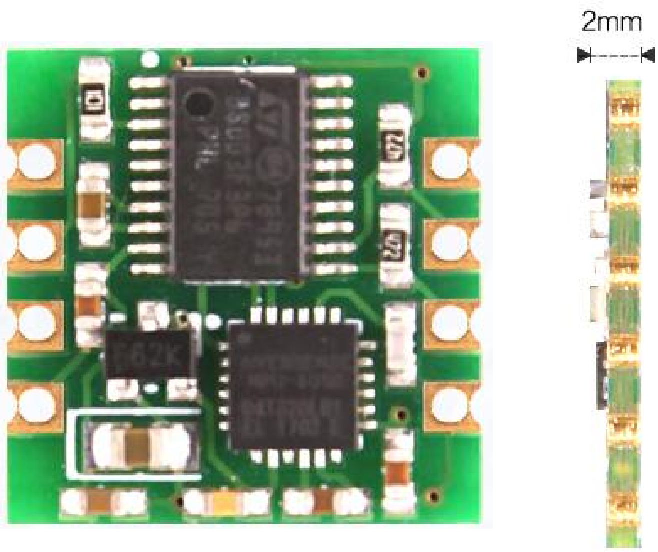
Version	Update content	Author	Date
V1.0	Release	Snow	20171009

Catalog

1 Description

- This six axis module adopts high precision gyroscope accelerometer MPU6050 module. Users don´t have to develop MPU6050 complex IIC protocol themselves because the measured data of MPU6050 is read through the process, then output through the serial port.
- An internal voltage stabilizing circuit module, voltage 3.3v~5v, pin compatible with the 3.3V/5V embedded system, convenient connection.
- The advanced digital filtering technology of this product can effectively reduce the measurement noise and improve the measurement accuracy.
- Module retains MPU6050 IIC interface, in order to meet the needs of advanced users to get the original data of MPU6050
- Integrates gesture solver, with dynamic Kalman filter algorithm, can get the accurate attitude in dynamic environment, attitude measurement precision is up to 0.01 degrees with high stability, performance is even better than some professional inclinometers.
- Stamp hole gold plating PCB design, can be embedded in the user´s PCB board.

  Note: This module does not contain magnetometer, no filtering for the yaw angle, so yaw angle is calculated by integration, it will drift, the yaw angle is accurate only in a short time. The X, Y axis angle is accurate because it can be filtered by gravity field, it will not drift.

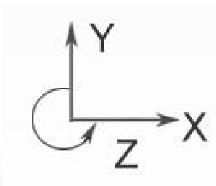


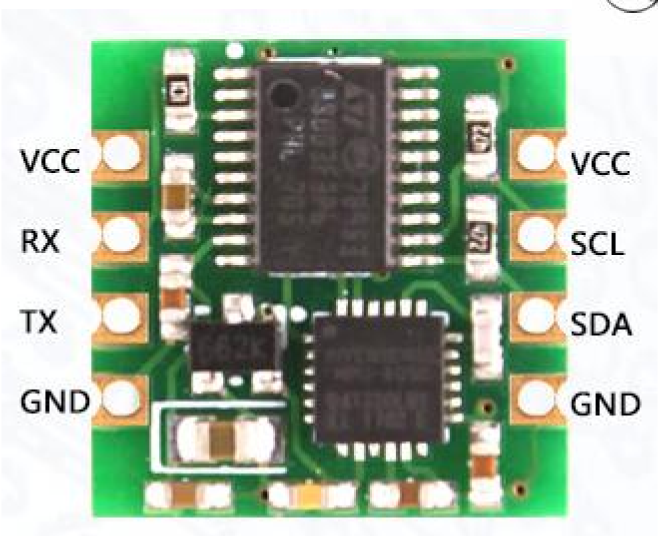
2 Product Parameters

1) Input voltage: 3V-5V.
2) Consumption current: <10mA.
3) Volume: 15.24mm X 15.24mm X 2mm.
4) Pad pitch: up and down 100mil (2.54mm), left and right 600mil (15.24mm).

5) Measuring dimensions: Acceleration: 3D Angular Velocity: 3D Attitude angle: 3D Magnetic field：3D
6) Range: Acceleration: ± 16g, angular velocity: ± 2000 ° / s.
7) Resolution: Acceleration: 6.1e-5g, Angular velocity: 7.6e-3 ° / s.
8) Stability: Acceleration: 0.01g, angular velocity 0.05° / s.
9) Attitude stabilization measurement: 0.01 °.
10) Data output: time, acceleration, angular velocity, angle.
11) Data output frequency 100Hz (baud rate 115200) / 20Hz (9600 baud).
12) Data interface: Serial port(TTL) IIC(Direct connection to MPU6050, without attitude angle output)

3 Pin Description





Pin	Function
VCC	Power supply，3.3V/5V input
RX	Serial data input，TTL level
TX	Serial data output，TTL level
GND	GND
SCL	IIC clock line
SDA	IIC signal line

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

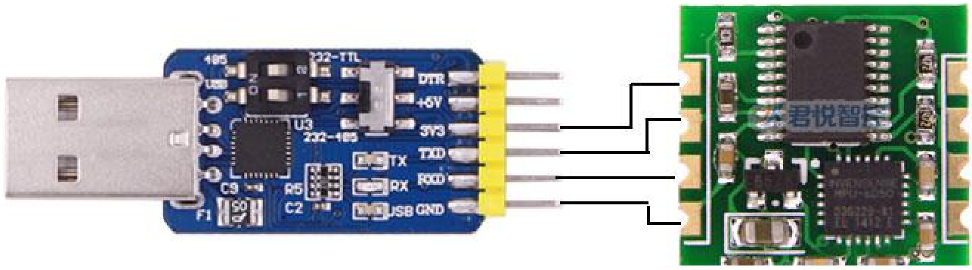
5.1 Serial (TTL) Connection

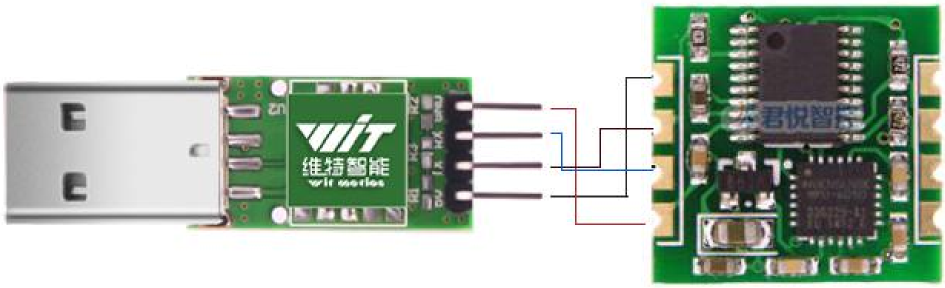
When connected to the PC software, you need a USB -TTL module. Recommend the following two USB -TTL module:

1. Serial module TTL: Firstly connect the module with the USB - TTL and then connect them to the computer. The ways of connecting module with USB -TTL are:

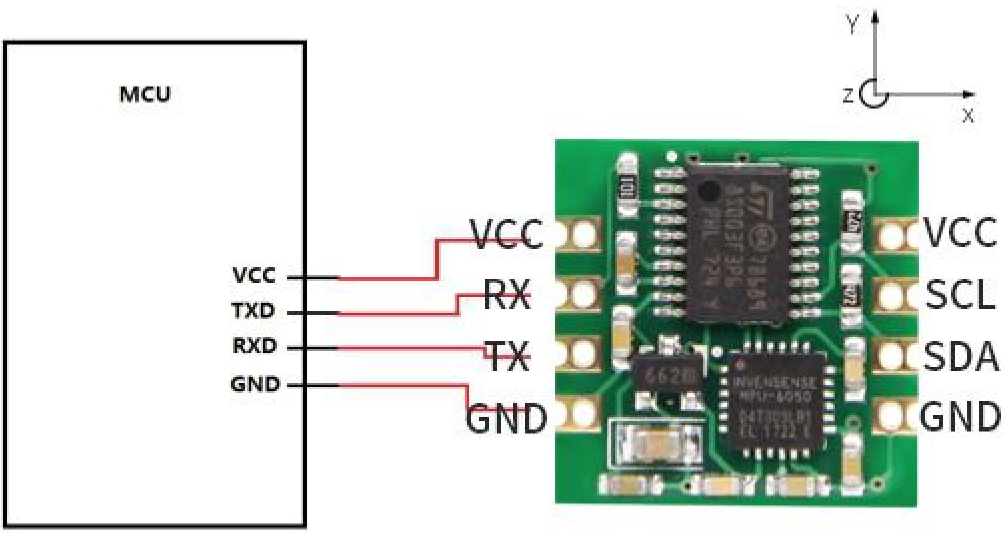
VCC TX RX GND of the module connected to +3.3/5V RX TX GND of the serial module respectively. It is noteworthy that TX and RX need to be crossed--- RX connected to TX, TX connected to RX.

2. Serial debugging artifacts: set switch 1 to ON, set switch 2 to (silk) 2, switch S1 dial to the lower (near the figure near 232-485 silk screen), VCC TX RX GND of the module connected to +3.3/5V RX TX GND of the serial module respectively.





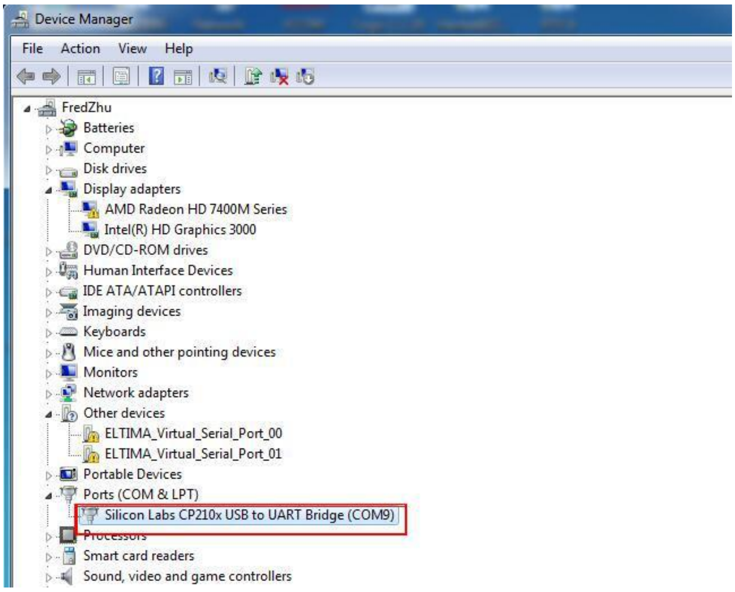
5.2 Connect to MCU



6 PC Software Method

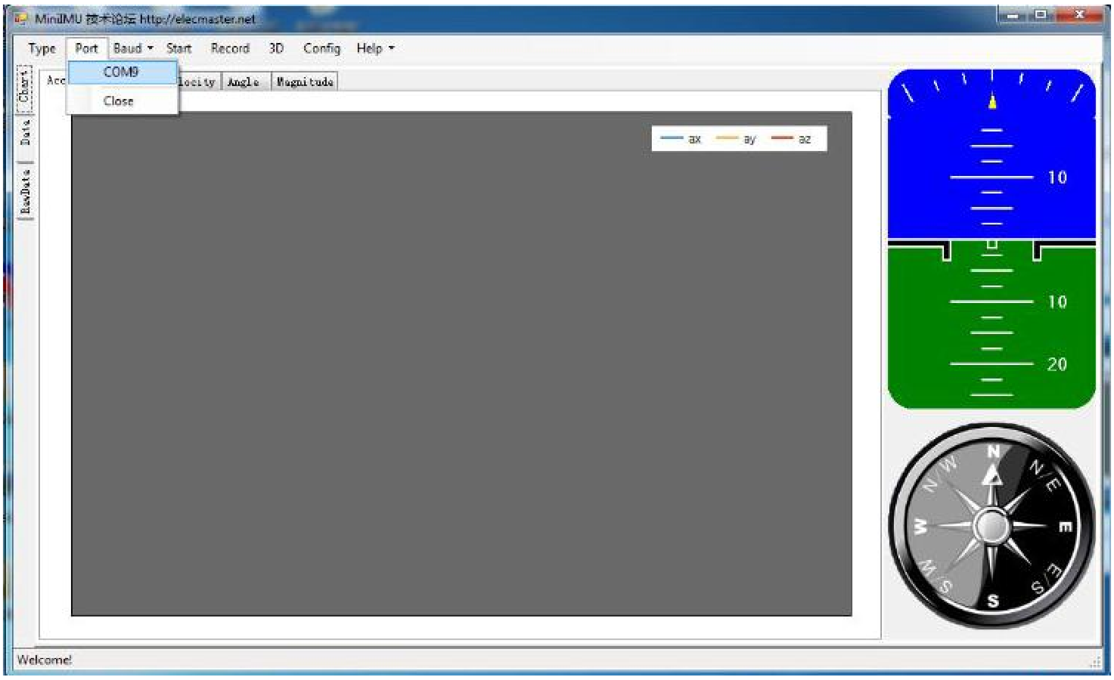
6.1 Method

1．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. As shown below:

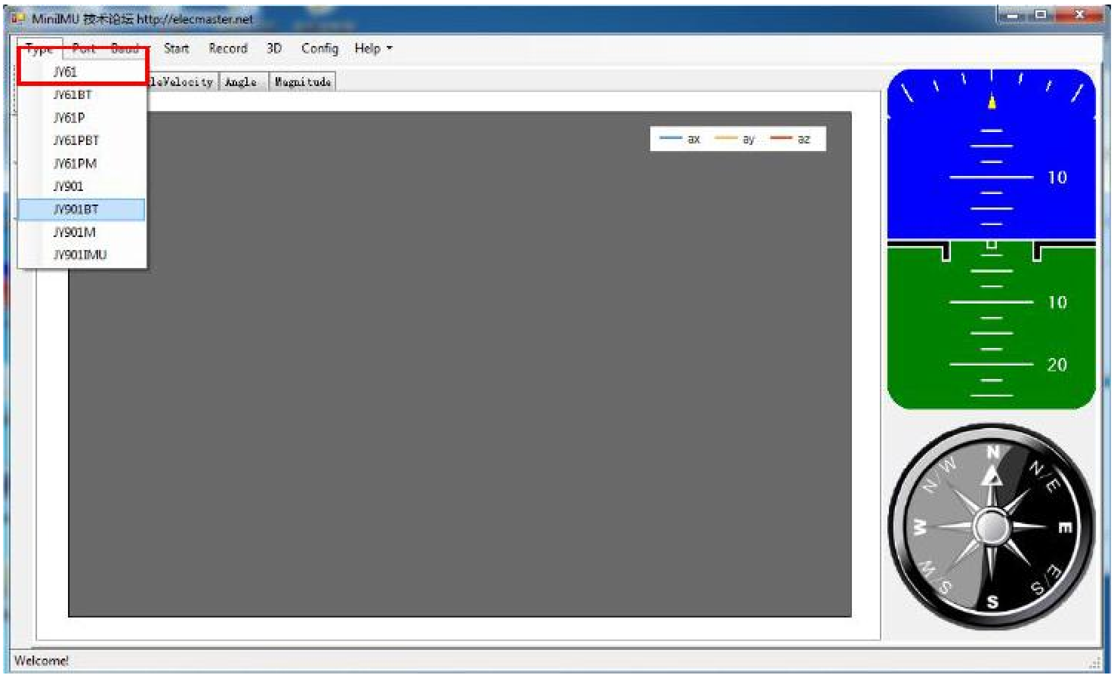


The drive CP210X:http://pan.baidu.com/s/1o6Rleae?frm=fujian

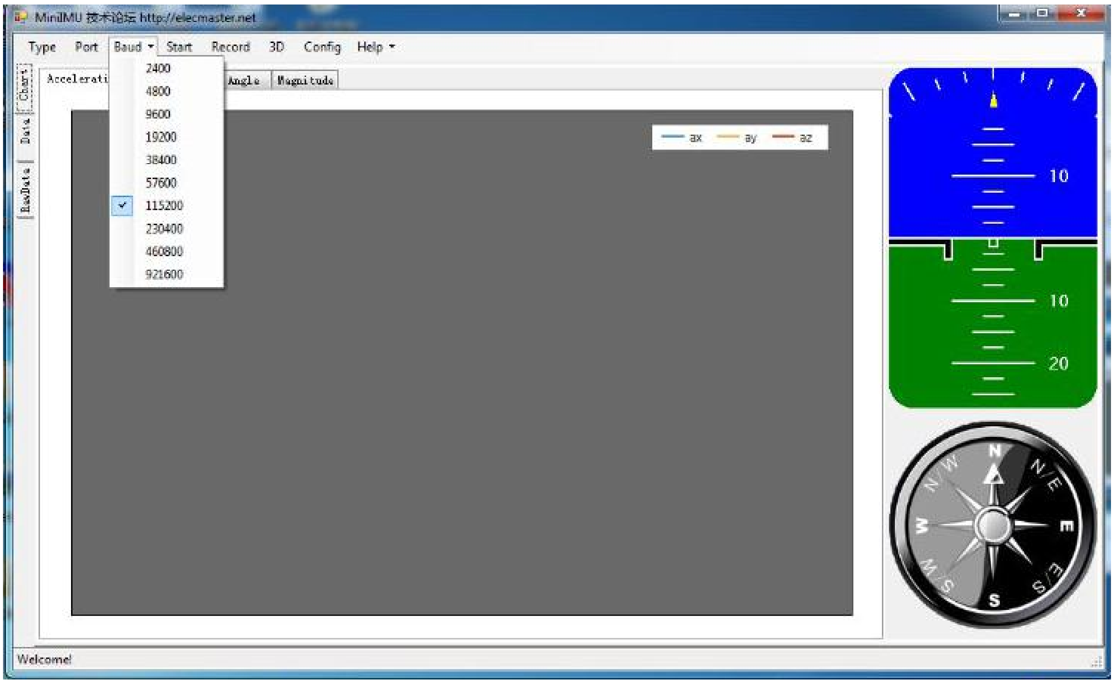
2．Open the software MiniIMU.exe, Click "Port" and select the com number you just saw in the device manager.

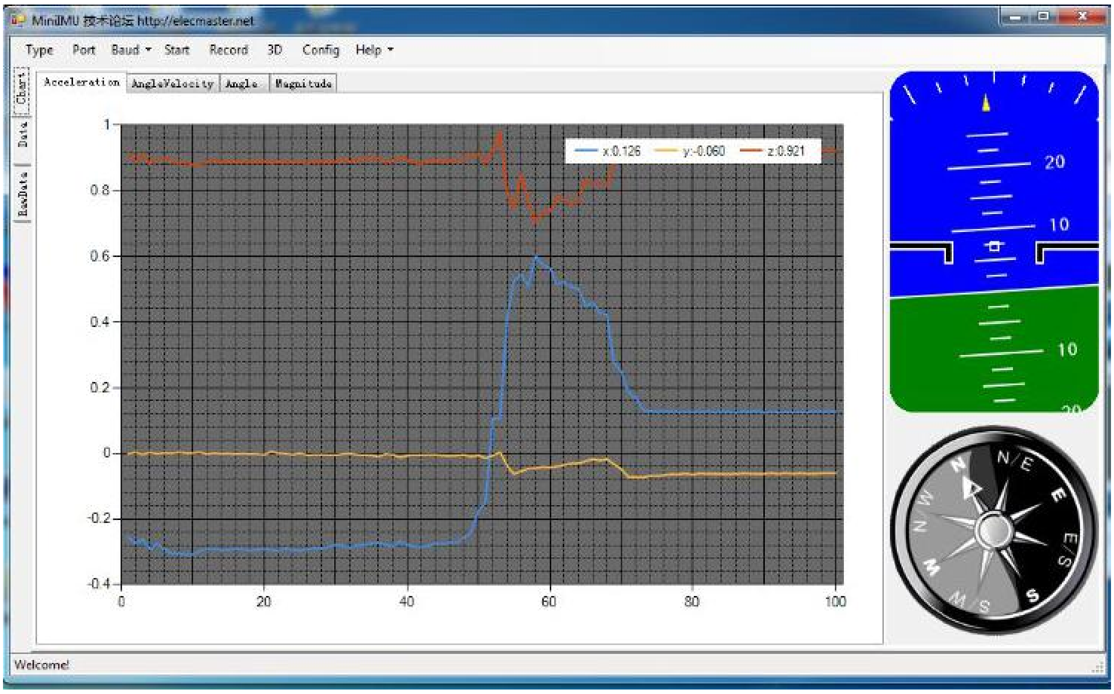


3．Click the “Type” and select model “JY61”.

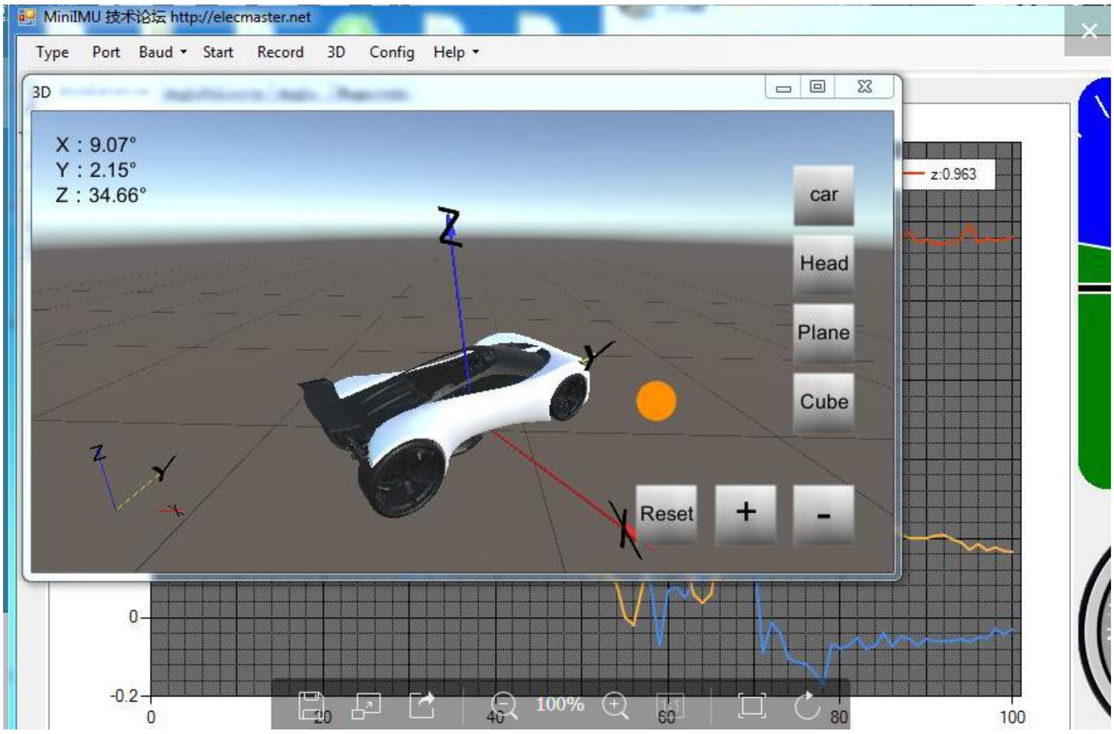


4．Click the “Baud” and select “115200”, after all those selections are completed, the software can display data.





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

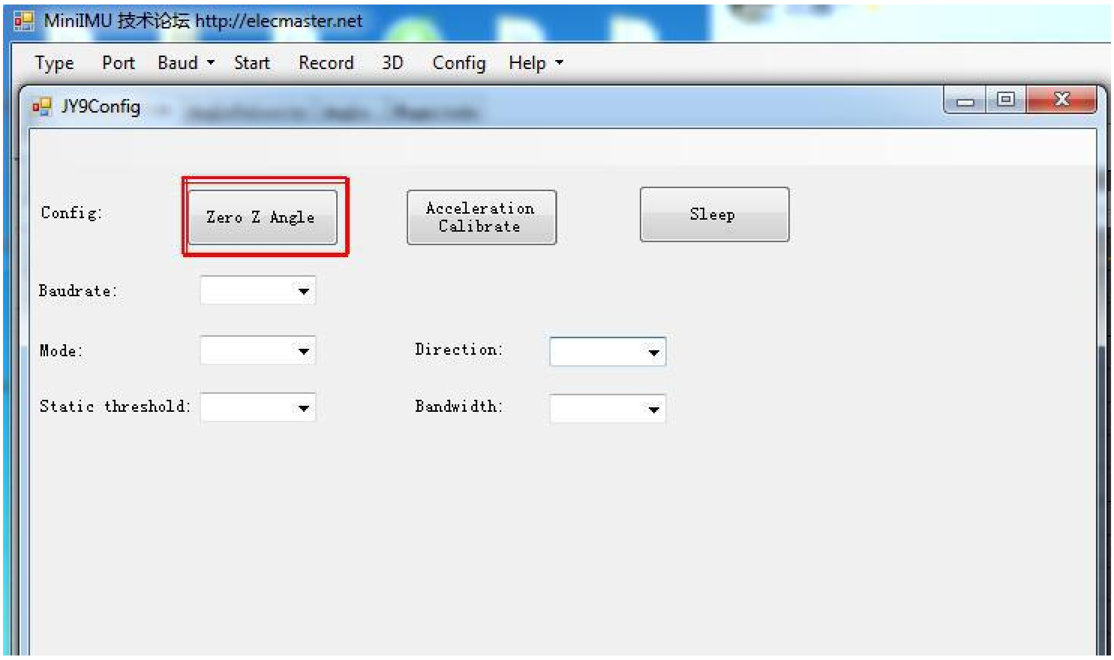


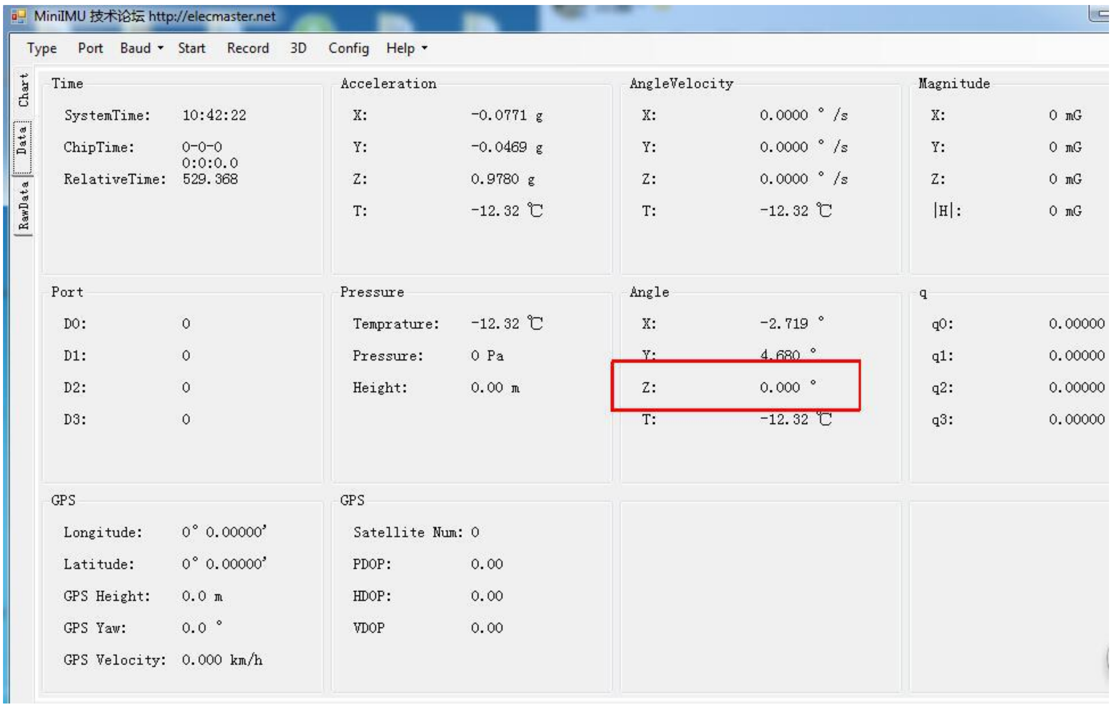
6.2 Module Calibration

Reminder: Module calibration and configuration should be set when it displayed online.
You should calibrate the module before you use it. First， put the modules horizontally. The calibration of the module contains accelerometer calibration and Z-axis to 0.

6.2.1 Z-axis to 0

Z-axis to 0 is to make the initial angle of z-axis relative 0 degree angle. You should take the "Z-axis to 0" before you use the module or there being a large Z-axis drift. When the module is powered on, the z-axis will automatically return to 0.
Methods are as follows: firstly put the module placed horizontally, and then click "Config" to open the configuration bar, choose the "Zero Z Angle" option, the z-axis angle inside the module data column returns to 0.

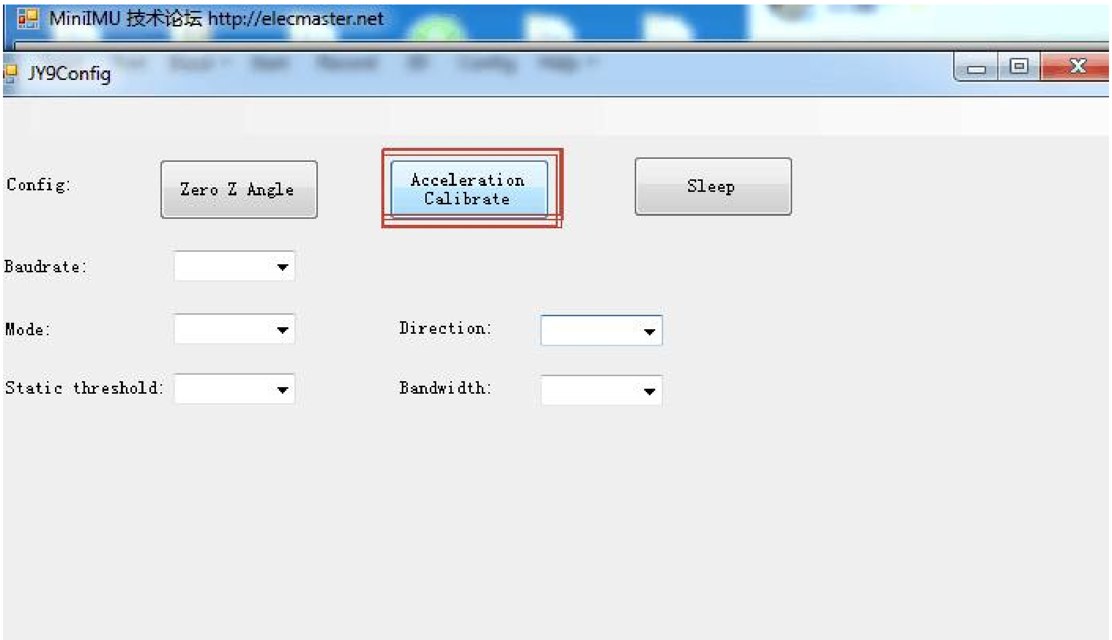


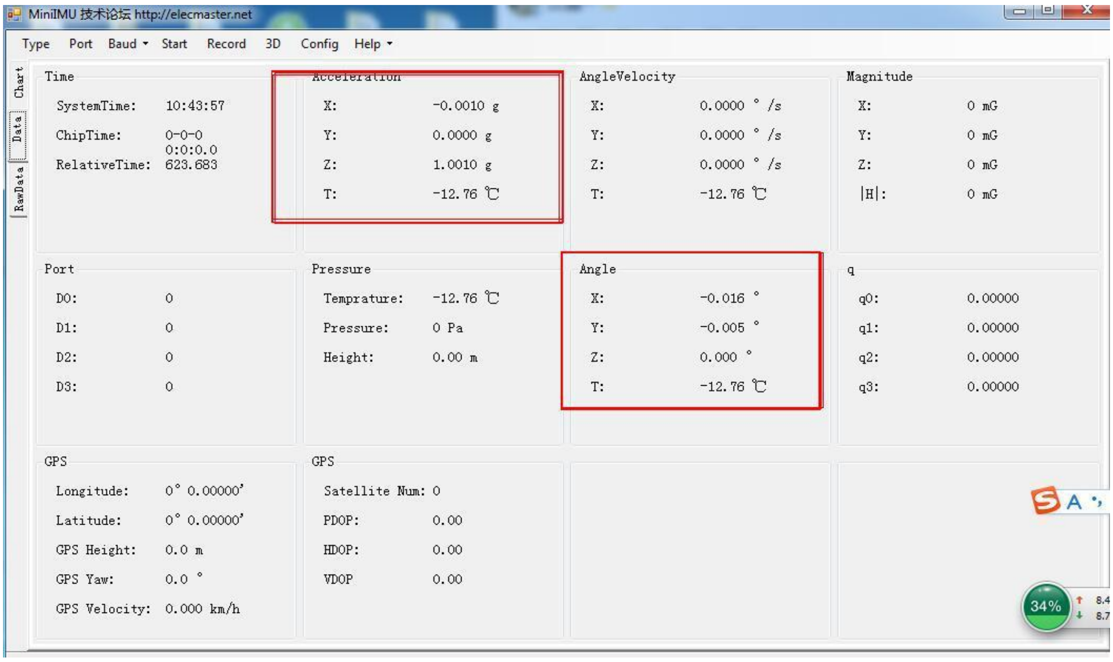


6.2.2 Accelerometer Calibration

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 are as follows: Firstly keep the module horizontal, click “Config” and ‘Acceleration calibration’ the acceleration of X Y Z will be at 0,0,1. The angle of X-axis and Y-axis will be at 0. After calibration, the X Y axis angle is more accurate.

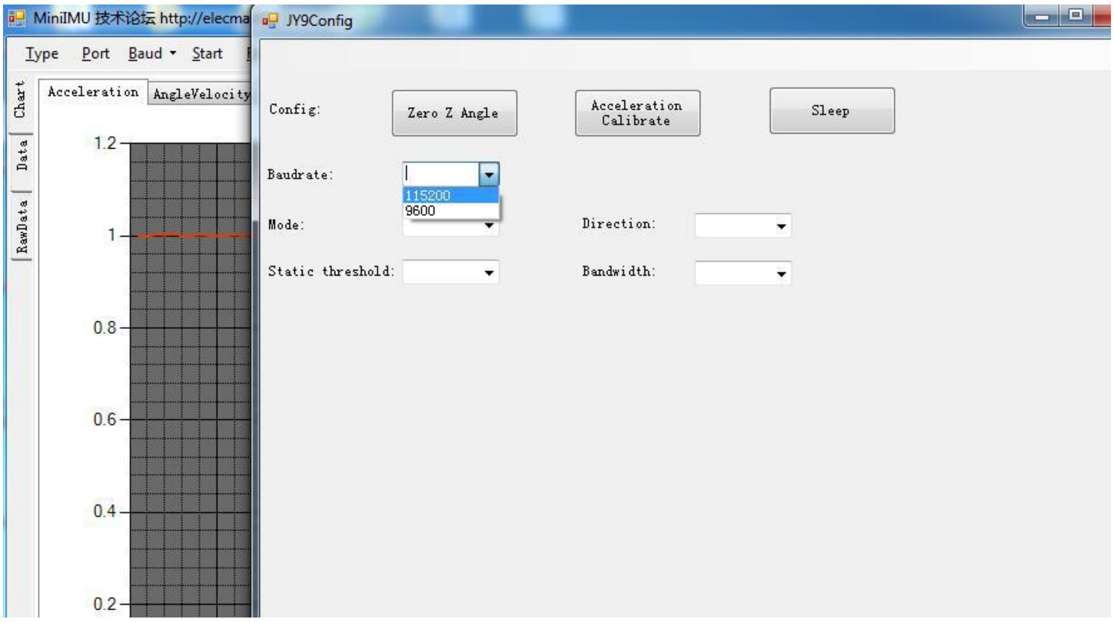




6.3 Set the Baud Rate

The module supports a variety of baud rates, the default baud rate is 115200. Setting the baud rate of the module should be based on the current connection between the software and the module. Select the baud rate in the configuration bar to change the baud rate. When the baud rate is 115200, the return rate of the module is 100HZ, when the baud rate is 9600, the return rate is 20HZ.

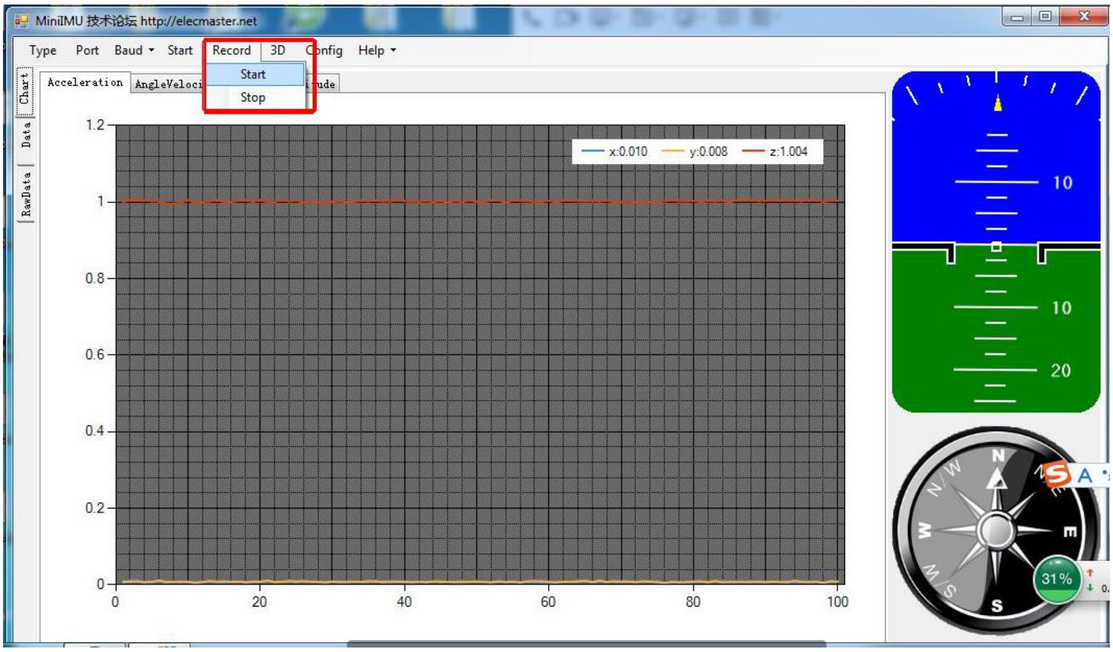
Reminder: After changing the baud rate, the module does not output the data under the original baud rate. You should select the baud rate again in the software and then it will output the data.

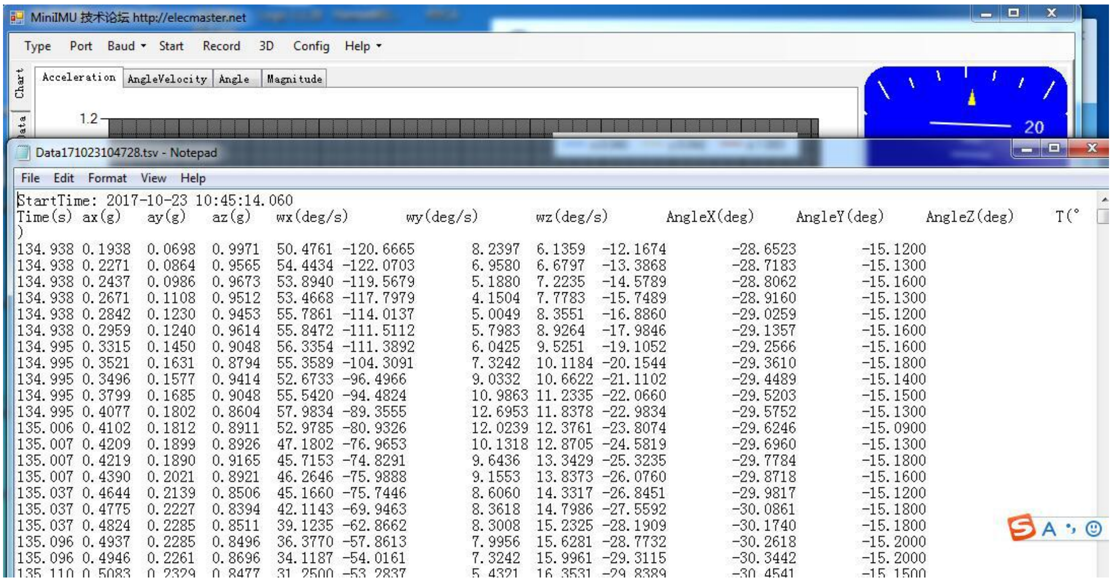


6.4 Data Recording

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.

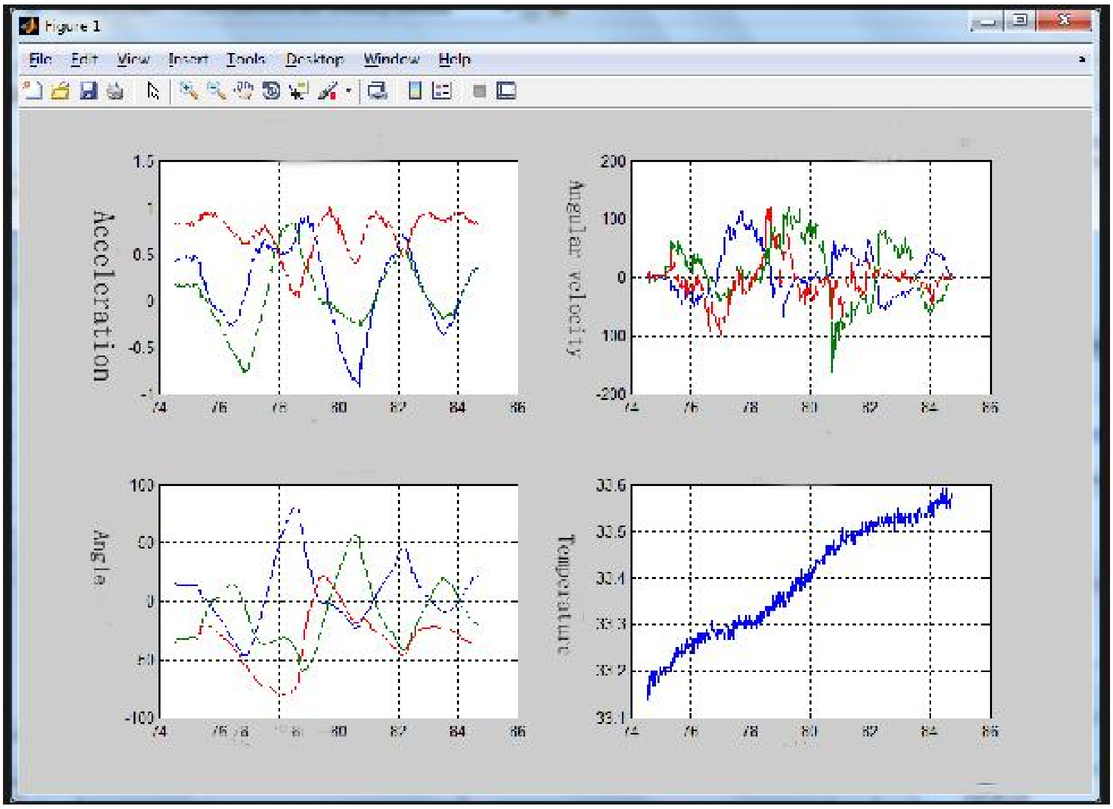




The saved file is in the directory of the software Data.tsv:

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.

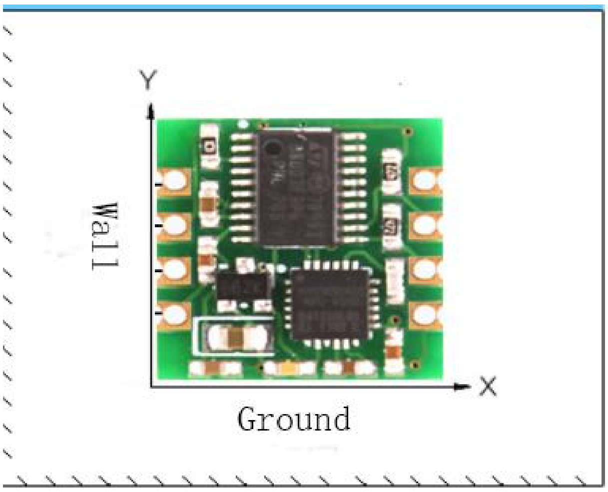
Data can be imported into the Exel or analysis in Matlab. In the Matlab environment running xxx.m document and it can plot of the data.

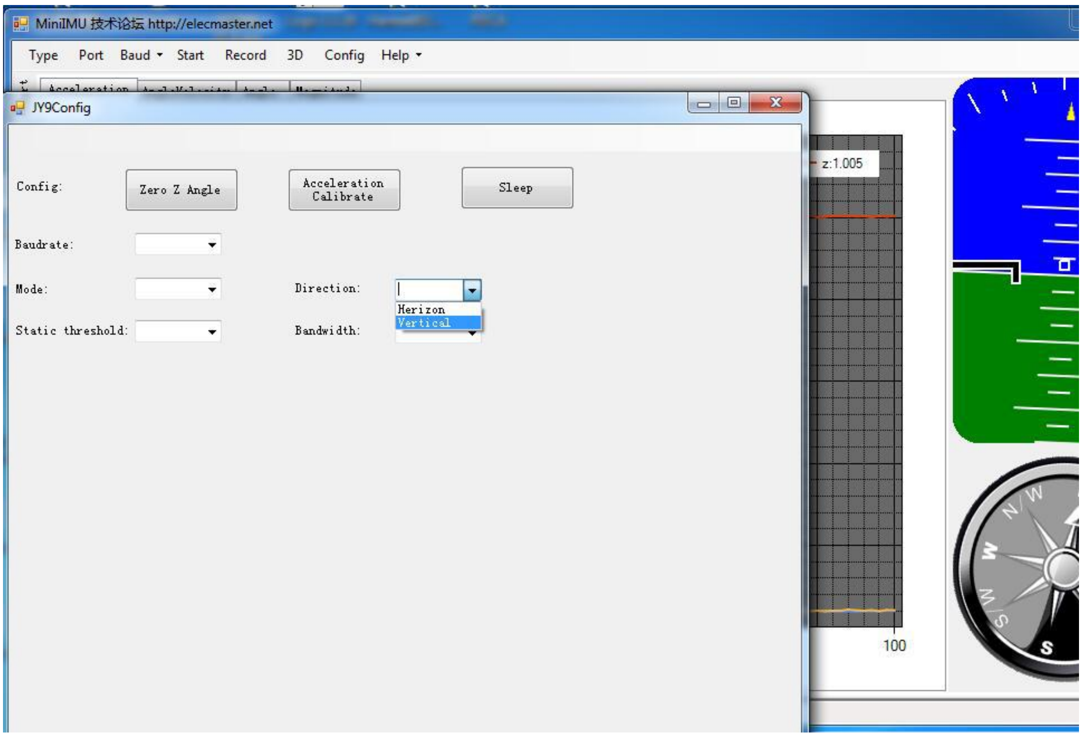


6.5 Installation Direction

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

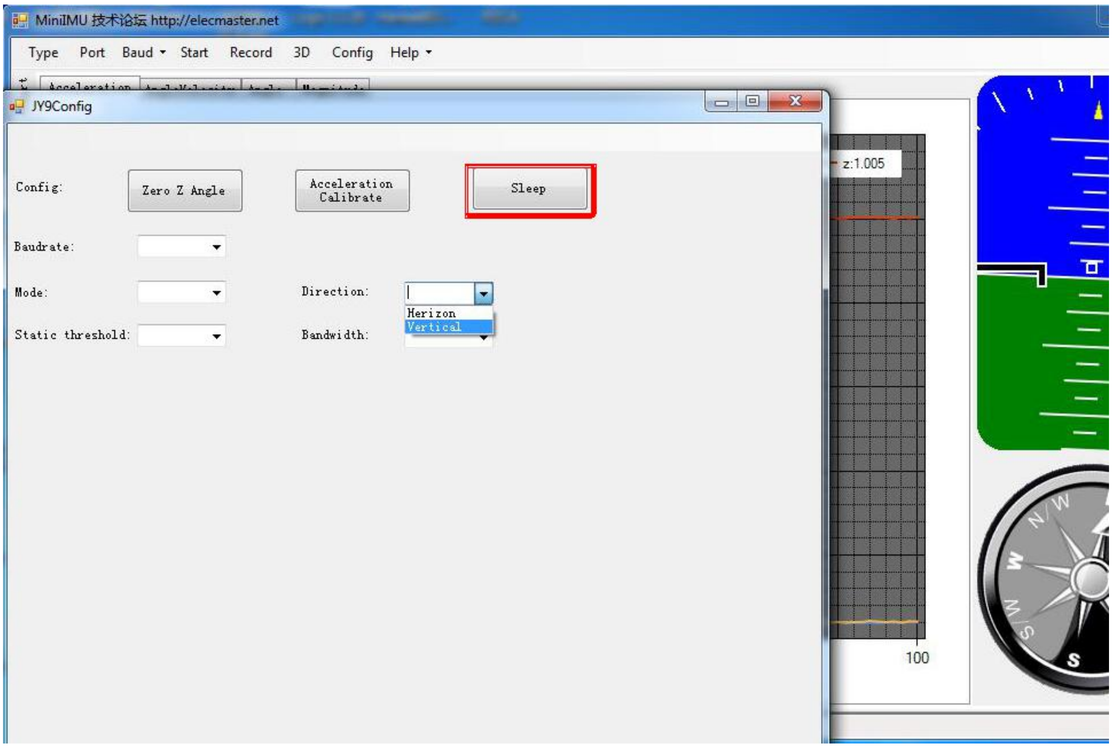
Vertical installation method: Put the module around X-axis rotation 90 degrees vertical placement. In the “Config” of the software, click “Vertical” option. The calibration can be used after the setup is completed.





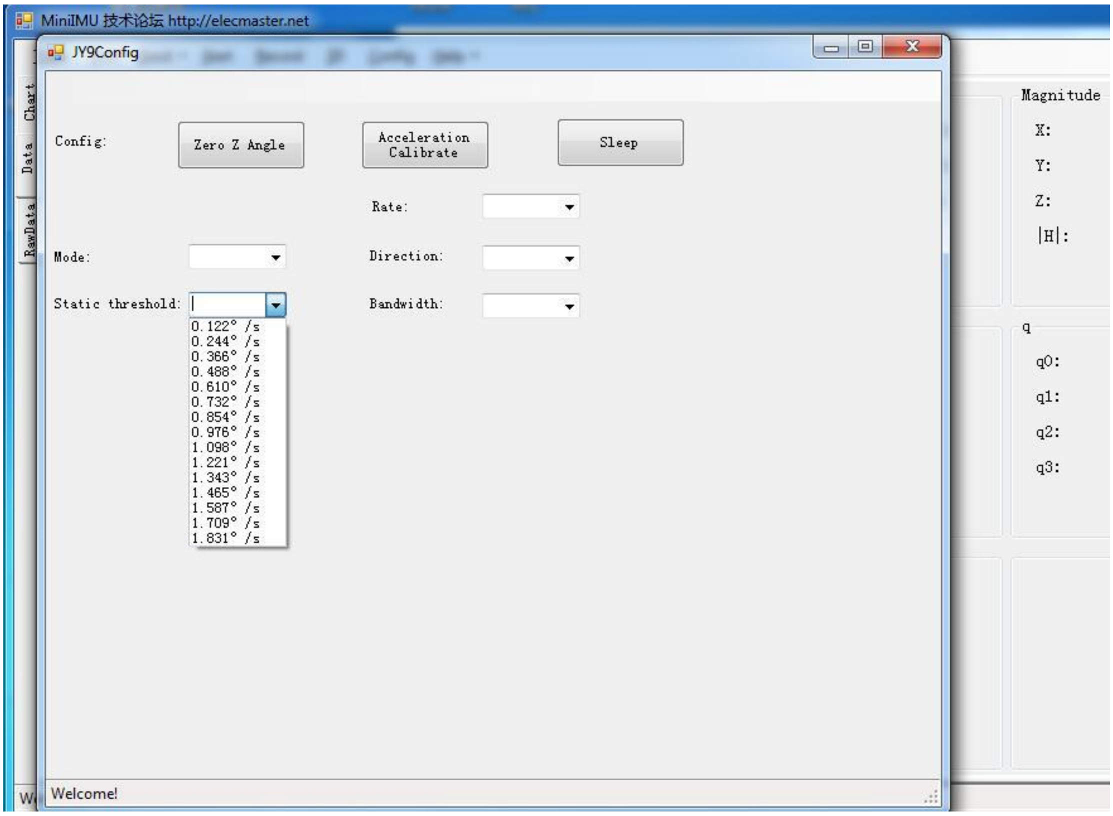
6.6 Sleep/ Wake up

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.



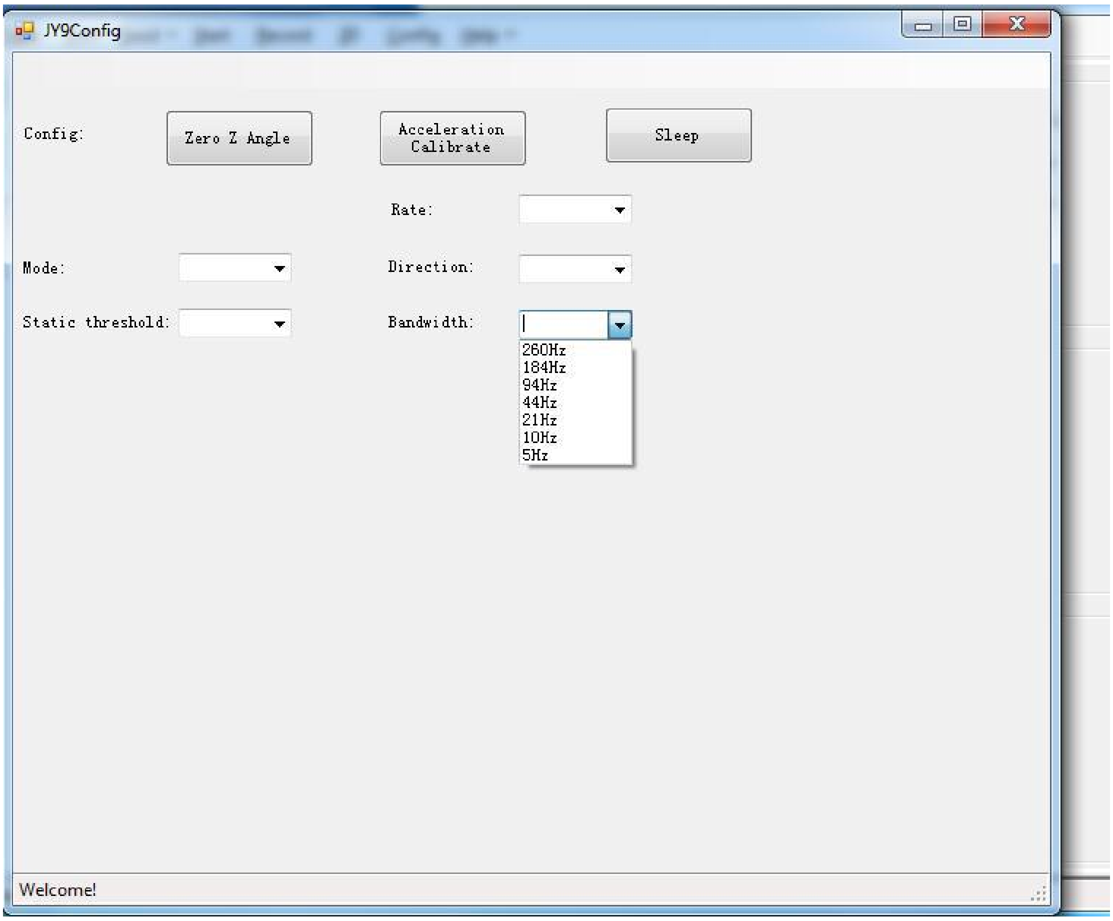
6.7 Static threshold/ Bandwidth

Static threshold: When the module is stationary, the angular velocity measured by the gyroscope chip varies slightly. The function of static threshold is that when the angular velocity is less than the threshold, the output angular velocity is 0.
In the "Config" of the software, click "Static threshold" to set the static threshold, the default is 0.122°/s.



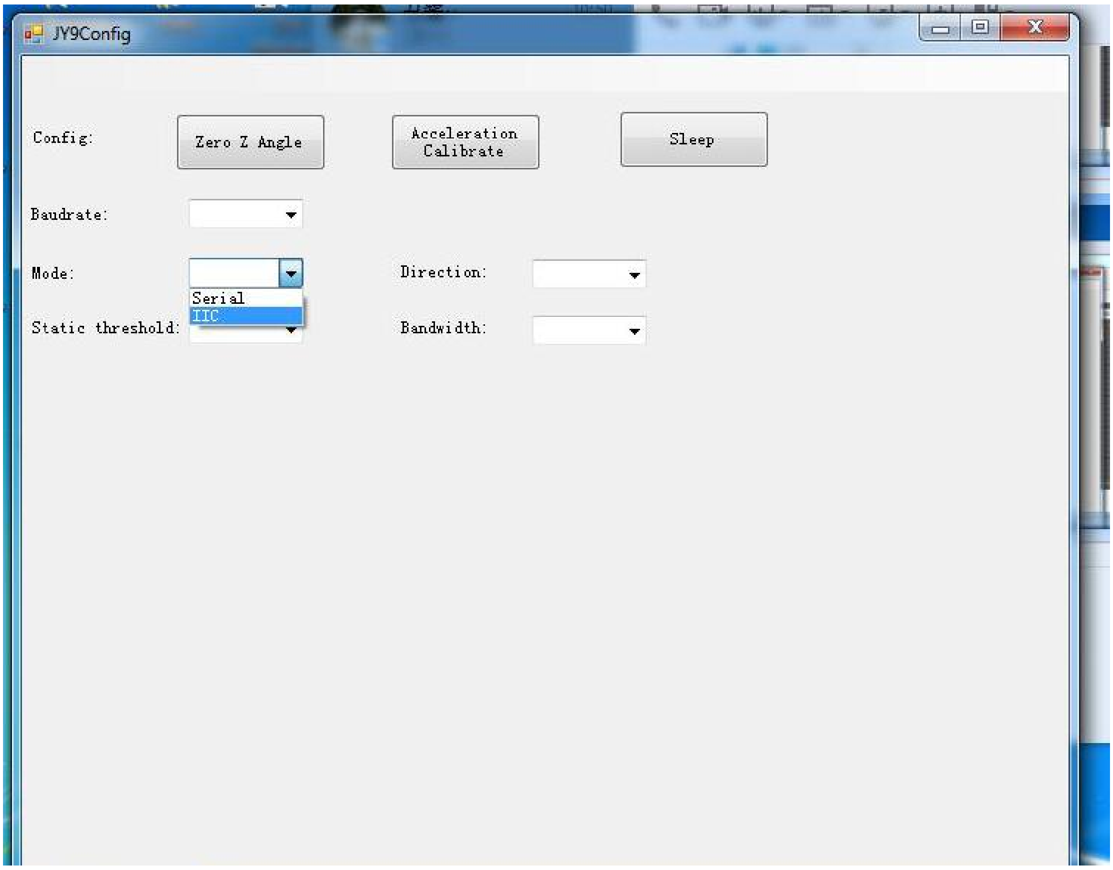
Bandwidth: The module outputs only the data within the measurement bandwidth, and the data which is larger than the bandwidth will be filtered automatically.

In the "Config" of the software, click "Bandwidth" option to set it, the default setting is 10HZ.



6.8 Set IIC Mode

The module JY61 supports the IIC mode, and the IIC bus is directly connected to the MPU6050 chip, so the IIC outputs only the original data of the gyroscope chip -the acceleration and angular velocity of three axis, not including the angle. In the “Config” of the software, click “Mode” to change the mode to IIC mode. The module will release the MPU6050 IIC bus. If you received the data packet beginning of 0X50, 0X51 , it shows that the module has entered the IIC mode.



Reminder: The access to the IIC mode please refer to the MP6050 data manual, hardware connection needs a 4.7k pull-up resistor.

Data number	Data content	Implication
0	0x55	Packet header
1	0x50	Enter IIC mode
2	0x00	
3	0x01	
4	0x00	
5	0x02	
6	0x00	
7	0x03	
8	0x00	
9	0x04	
10	Sum	Checksum

7 Communication Protocol

Level: The TTL level(if the module is connected to the RS232 level, it may cause damage to module)

Baud rate: 9600 Stop bit: 1 Check bit: 0

7.1 PC Software to Module

Instruction	Function	Remarks
0xFF 0xAA 0x52	Angle initialization	Z axis angle to 0
0xFF 0xAA 0x67	Accelerometer calibration	Zero bias calibration
0xFF 0xAA 0x60	Sleep and wake up	Standby mode/active mode
0xFF 0xAA 0x61	Serial port(available) IIC(not available)	Set to serial output
0xFF 0xAA 0x62	IIC(available) Serial port(not available)	Set to IIC output
0xFF 0xAA 0x63	Baud rate 115200，Return rate 100HZ	Set baud rate 115200
0xFF 0xAA 0x64	Baud rate9600，Return rate 20HZ	Set baud rate 9600
0xFF 0xAA 0x65	Horizontal installation	Horizontal placement
0xFF 0xAA 0x66	Vertical installation	Vertical placement

Reminder：

1.After the module is powered up, the MCU will be automatically calibrated at first to eliminate the gyro zero drift, and Z axis will be re initialized to 0.

2.The default baud rate is 115200,return rate 100Hz, Configuration can be configured by PC program, suggest to use the PC program to set the JY-61 module.

7.2 Module to PC Software

The module sends the data to the host computer into 3 data packets, acceleration packet, angular velocity packet and the angle packet, and the 3 packet are sent in sequence .

7.2.1 Acceleration Output

Data number	Data content	Implication
0	0x55	Packet header
1	0x51	Acceleration packet
2	AxL	X-axis acceleration low byte
3	AxH	X-axis acceleration high byte
4	AyL	Y-axis acceleration low byte
5	AyH	Y-axis acceleration high byte
6	AzL	Z-axis acceleration low byte
7	AzH	Z-axis acceleration high byte
8	TL	Temperature low byte

9	TH	Temperature high byte
10	Sum	Checksum

Calculate formula：

a_x=((AxH<<8)|AxL)/32768*16g(g is Gravity acceleration，9.8m/s^2)

a_y=((AyH<<8)|AyL)/32768*16g(g is Gravity acceleration，9.8m/s^2)

a_z=((AzH<<8)|AzL)/32768*16g(g is Gravity acceleration，9.8m/s^2)

Temperature calculated formular：

T=((TH<<8)|TL) /340+36.53 ℃

Checksum：

Sum=0x55+0x51+AxH+AxL+AyH+AyL+AzH+AzL+TH+TL

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 Ax, where AxL is the low byte, AxH 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: Data=((short) DataH<<8) |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.

7.2.2 Angular Velocity Output

Data number	Data content	Implication
0	0x55	Packet header
1	0x52	Angular velocity packet
2	wxL	X-axis angular velocity low byte
3	wxH	X-axis angular velocity high byte
4	wyL	Y-axis angular velocity low byte
5	wyH	Y-axis angular velocity high byte
6	wzL	Z-axis angular velocity low byte
7	wzH	Z-axis angular velocity high byte
8	TL	Temperature low byte
9	TH	Temperature high byte
10	Sum	Checksum

Calculated formular：

w_x=((wxH<<8)|wxL)/32768*2000(°/s)

w_y=((wyH<<8)|wyL)/32768*2000(°/s)

w_z=((wzH<<8)|wzL)/32768*2000(°/s)

Temperature calculated formular:

T=((TH<<8)|TL) /340+36.53 ℃

Checksum:

Sum=0x55+0x52+wxH+wxL+wyH+wyL+wzH+wzL+TH+TL

7.2.3 Angle Output

Data number	Data content	Implication
0	0x55	Packet header
1	0x53	Angle packet
2	RollL	X-axis angle low byte
3	RollH	X-axis angle high byte
4	PitchL	Y-axis angle low byte
5	PitchH	Y-axis angle high byte
6	YawL	Z-axis angle low byte
7	YawH	Z-axis angle high byte
8	TL	Temperature low byte
9	TH	Temperature high byte
10	Sum	Checksum

Calculated formular:

Roll（x axis）Roll=((RollH<<8)|RollL)/32768*180(°)

Pitch（y axis）Pitch=((PitchH<<8)|PitchL)/32768*180(°)

Yaw（z axis）Yaw=((YawH<<8)|YawL)/32768*180(°)

Temperature calculated formular:

T=((TH<<8)|TL) /340+36.53 ℃

Checksum:

Sum=0x55+0x53+RollH+RollL+PitchH+PitchL+YawH+YawL+TH+TL

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 ±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 X axis close to 90 degrees, even if the attitude angle around the X axis, Y axis angle will have a big change, which is the inherent characteristics of the Euler angle

7.3 Data Analysis Sample Code(Language C)

```
double a[3],w[3],Angle[3],T;
void DecodeIMUData(unsigned char chrTemp[])
{
        switch(chrTemp[1])
        {
        case 0x51:
                a[0] = ((short)(chrTemp[3]<<8|chrTemp[2]))/32768.0*16;
                a[1] = ((short) (chrTemp[5]<<8|chrTemp[4]))/32768.0*16;
                a[2] = ((short) (chrTemp[7]<<8|chrTemp[6]))/32768.0*16;
                T = ((short) (chrTemp[9]<<8|chrTemp[8]))/340.0+36.25;
                break;
        case 0x52:
                w[0] = ((short) (chrTemp[3]<<8|chrTemp[2]))/32768.0*2000;
                w[1] = ((short) (chrTemp[5]<<8|chrTemp[4]))/32768.0*2000;
                w[2] = ((short) (chrTemp[7]<<8|chrTemp[6]))/32768.0*2000;
                T = ((short) (chrTemp[9]<<8|chrTemp[8]))/340.0+36.25;
                break;
        case 0x53:
                Angle[0] = ((short) (chrTemp[3]<<8|chrTemp[2]))/32768.0*180;
                Angle[1] = ((short) (chrTemp[5]<<8|chrTemp[4]))/32768.0*180;
                Angle[2] = ((short)(chrTemp[7]<<8|chrTemp[6]))/32768.0*180;
                T = ((short)(chrTemp[9]<<8|chrTemp[8]))/340.0+36.25;
                printf("a = %4.3f\t%4.3f\t%4.3f\t\r\n",a[0],a[1],a[2]);
                printf("w = %4.3f\t%4.3f\t%4.3f\t\r\n",w[0],w[1],w[2]);
                printf("Angle = %4.2f\t%4.2f\t%4.2f\tT=%4.2f\r\n",Angle[0],Angle[1],Angle[2],T);
                break;
        }
}
```

7.4 Data Analysis Sample Code in embedded environment

The code is divided into two parts, one is in interrupt to receive, to find the data's head, and then put the packet into the array. The other is data analysis in the main code.

Interrupt part(The following is the AVR microcontroller code. The other microcontroller will be a little difference)

```
unsigned char Re_buf[11],counter=0;
unsigned char sign;
interrupt [USART_RXC] void usart_rx_isr(void) //USART receive
 {
        Re_buf[counter]=UDR;// Slight difference between different microcontroller
        if(counter==0&&Re_buf[0]!=0x55) return;        // if the first data is not frame header, skip
        counter++;
        if(counter==11) // Receive 11 data
        {
            counter=0; // Re assignment, prepare for the next frame of data receiving
            sign=1;
```

```
        }
}
```

Main code：

```
float a[3],w[3],angle[3],T;
extern unsigned char Re_buf[11],counter;
extern unsigned char sign;
while(1)
{
    if(sign)
    {
        sign=0;
        if(Re_buf[0]==0x55)          //check the head
        {
            switch(Re_buf [1])
            {
            case 0x51:
                a[0] = (short(Re_buf [3]<<8| Re_buf [2]))/32768.0*16;
                a[1] = (short(Re_buf [5]<<8| Re_buf [4]))/32768.0*16;
                a[2] = (short(Re_buf [7]<<8| Re_buf [6]))/32768.0*16;
                T = (short(Re_buf [9]<<8| Re_buf [8]))/340.0+36.25;
                break;
            case 0x52:
                w[0] = (short(Re_buf [3]<<8| Re_buf [2]))/32768.0*2000;
                w[1] = (short(Re_buf [5]<<8| Re_buf [4]))/32768.0*2000;
                w[2] = (short(Re_buf [7]<<8| Re_buf [6]))/32768.0*2000;
                T = (short(Re_buf [9]<<8| Re_buf [8]))/340.0+36.25;
                break;
            case 0x53:
                angle[0] = (short(Re_buf [3]<<8| Re_buf [2]))/32768.0*180;
                angle[1] = (short(Re_buf [5]<<8| Re_buf [4]))/32768.0*180;
                angle[2] = (short(Re_buf [7]<<8| Re_buf [6]))/32768.0*180;
                T = (short(Re_buf [9]<<8| Re_buf [8]))/340.0+36.25;
                break;
            }
        }
    }
```

8 Application Area

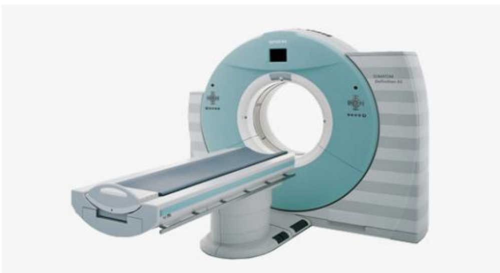
Agricultural machinery

Internet of things

Solar energy

Power monitoring

Medical instruments



Construction machinery

Geological monitoring

深圳维特智能科技有限公司

WitMotion ShenZhen Co., Ltd

JY61 Attitude Angle Sensor

TEL : (+86) 755-33185882
E-mail : wit@wit-motion.com
Website : www.wit-motion.com
Address : Honghai building 1306 Songgang town Baoan District Shenzhen Guangdong Province China