High precision6Axis Inertial Navigation Module Instructions

1product description

This six-axis module uses a high-precision gyro accelerometerMPU6050, read through the processorMPU6050The measurement data is then output through the serial port, It eliminates the need for users to develop their ownMPU6050complicatedI2Cagreement, while carefullyPCB The layout and workmanship ensureMPU6050It receives the least external interference and has the highest measurement accuracy.

The module has its own voltage stabilization circuit and is compatible with3.3V/5VEmbedded system, easy to connect.

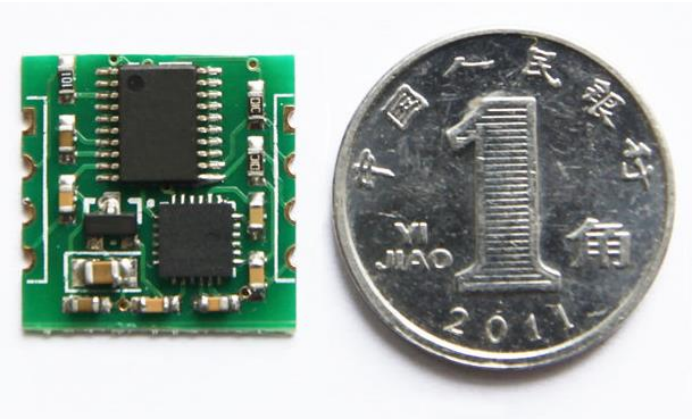
The module remainsMPU6050ofI2Cinterface to meet the needs of advanced users wishing to access underlying measurement data.

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

The module integrates an attitude solver and cooperates with the dynamic Kalman filter algorithm to accurately output the current attitude of the module in a dynamic environment, with high attitude measurement accuracy.0.01It has extremely high stability, and its performance is even better than some professional inclinometers!

Using stamp hole gold plating process, quality assurance, can be embedded in the user'sPCBboard.

Note: This module does not contain a magnetic field meter. There is no magnetic field observation to filter the yaw angle. Therefore, the yaw angle is calculated through pure integration. There will inevitably be drift and only a short period of rotation angle can be achieved. Measurement. andX, YThe axis angle can be filtered and corrected by the gravity field without drift.



2Performance parameters

1,Voltage:3V~6V

2, current: <10mA

3,volume:15.24mm X 15.24mm X 2mm

4, pad spacing: up and down100mil(2.54mm),about600mil(15.24mm)

5, Measurement dimension: acceleration:3Dimensions, angular velocity:3Dimension, attitude angle:3dimension

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 velocity0.05°/s.

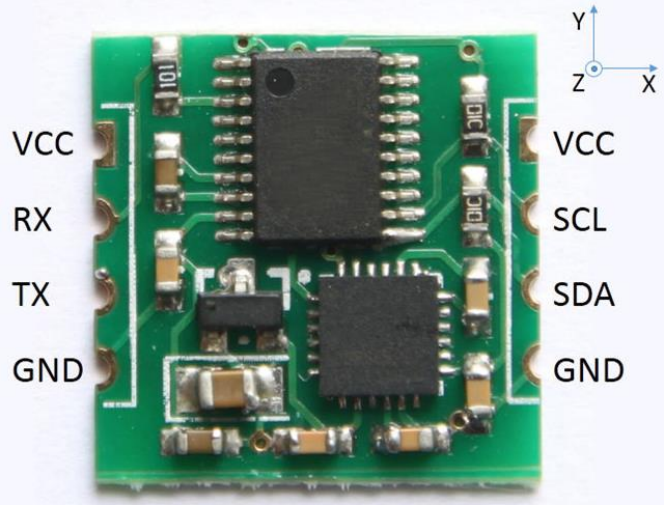
9, Attitude measurement stability:0.01°.

10, data output frequency100Hz(baud rate115200)/20Hz(baud rate9600).

11, Data interface: serial port (TTLlevel),I2C(directly connected toMPU6050, no attitude output)

10, baud rate115200kps/9600kps.

3Pin description



name	Function
VCC	module power supply,3.3Vor5Venter
RX	serial data input,TTLlevel
Tx	serial data output,TTLlevel
GND	Ground wire
SCL	I2Cclock line
SDA	I2Cdata cable

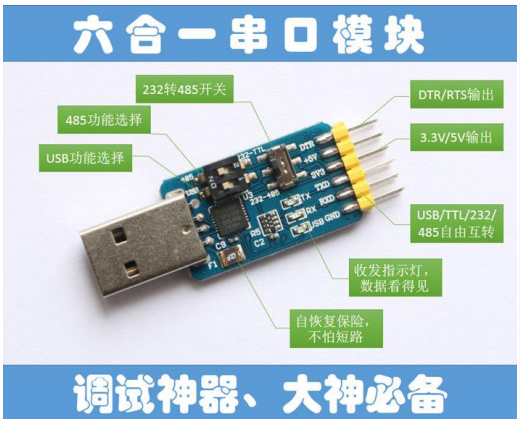
4Axial description

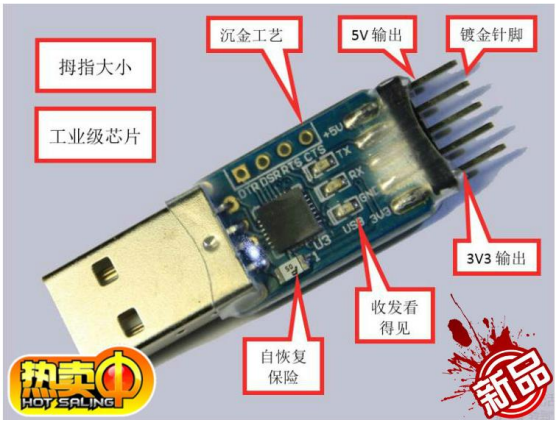
As shown in the figure above, the axial direction of the module is marked in the upper right corner of the figure above, and to the right isXaxis, upwardYaxis, perpendicular to the paper facing outward, isZaxis. The direction of rotation is defined according to the right-hand rule, that is, the thumb of the right hand points toward the axis, and the direction in which the four fingers are bent is the direction of rotation around the axis.

5Hardware connection method

5.1with computer

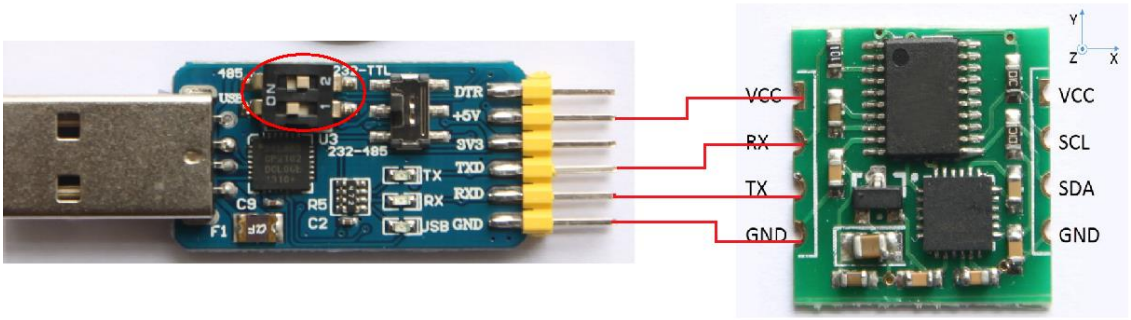
To connect to the computer, it is requiredUSBchangeTTLlevel serial port module. Recommend the following two modelsUSBConvert to serial port module.

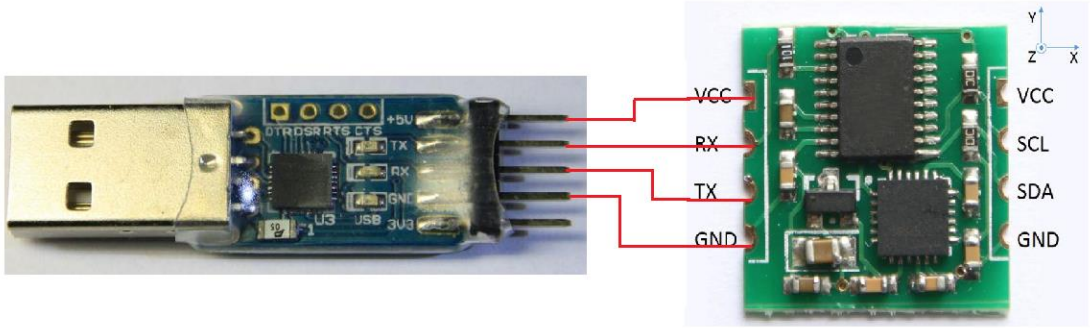




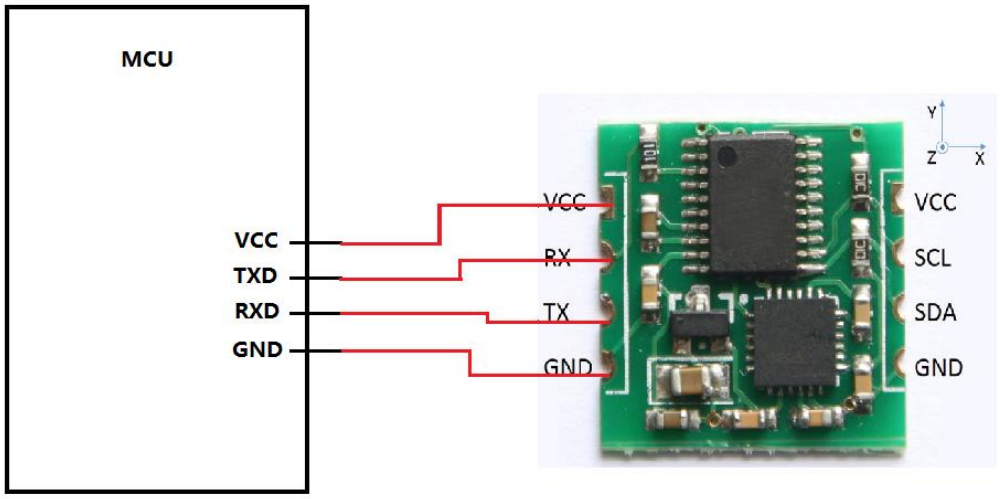
USBSerial port module connection6050The module method is:USBSerial port module +5V,TxD,RXD ,GNDcatch 6050ModularVCC,RX,Tx,GND. NoticeTxDandRXDof cross.

(Note: Six-in-one serial port module connection6050module needs to be2Turn the dial switch toOFFend, as shown below:)



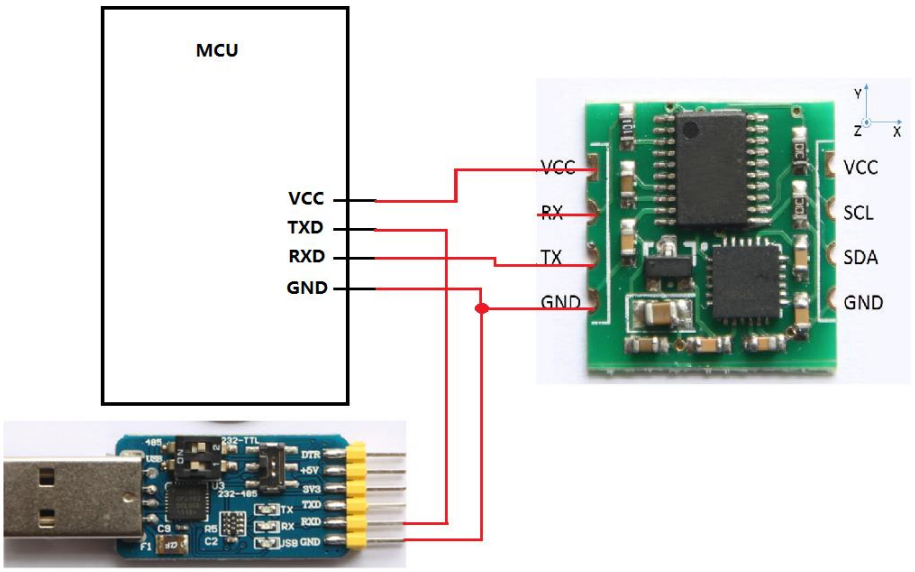


5.2Even microcontroller



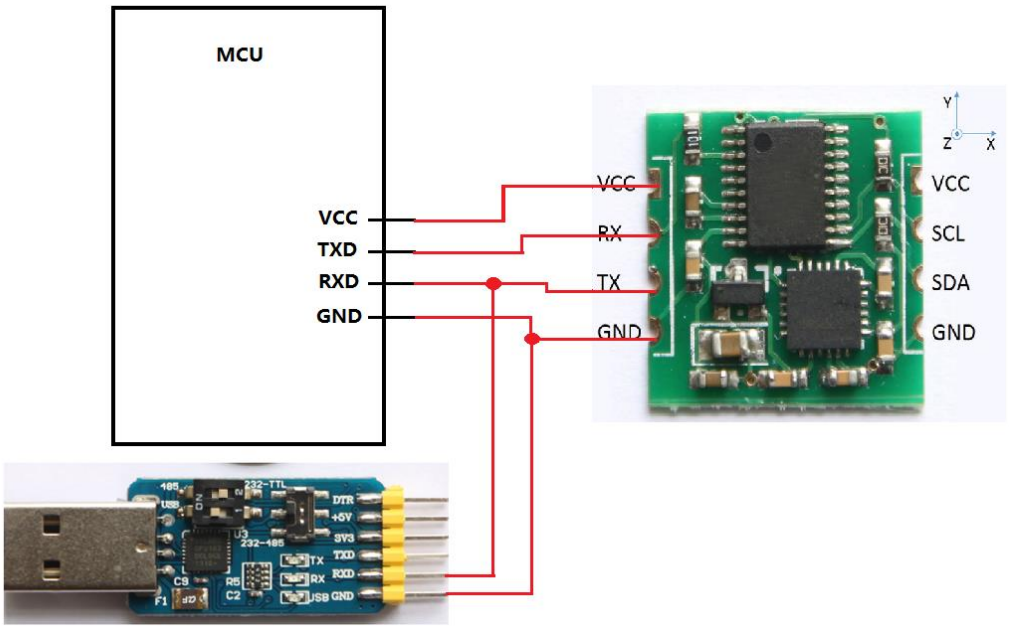
5.3 MCUConnect to the microcontroller and output debugging information.

usually,MCUThe serial port resources are relatively tight. Some microcontrollers only have one serial port, and debugging information needs to be output through the serial port during debugging. In this case, you canMCUofTxpins connected toUSBConverter to serial port moduleRXsuperior, 6050ModularTxreceivedMCUofRXpins, like thisMCUBoth can be received6050Module data can now output debugging information. onlyMCUUnable to output serial port command to6050module, but the configuration of the module can be saved after power-off, and the calibration can be automatically executed in the third second after power-on. Normally, it can work without sending any instructions.



5.4Use the host computer to monitor the communication between the module and the microcontroller.

If needed inMCUaccept6050While the module outputs data, use the host computer to monitor the current data. You canUSB Converter to serial port moduleRXReceived from the moduleTxpins and share the ground.



6letter of agreement

Level:TTLlevel (notRS232level, if the module is connected to the wrongRS232Level may cause damage to the module) Baud rate:115200/9600, stop bit1,Check Digit0.

6.1Host computer to module

Command content	Function	Remark
0xFF 0xAA 0x52	Angle initialization	makeZAxis angle reset to zero
0xFF 0xAA 0x61	Use serial port, disabledI2C	Save after power off, it is recommended to use the host computer to modify
0xFF 0xAA 0x62	To disable the serial port, useI2Cinterface	Save after power off, it is recommended to use the host computer to modify
0xFF 0xAA 0x63	baud rate115200, frame rate100Hz	Save after power off, it is recommended to use the host computer to modify
0xFF 0xAA 0x64	baud rate9600, frame rate20Hz	Save after power off, it is recommended to use the host computer to modify

illustrate:

1.After the module is powered on, it needs to remain stationary first.MCUAutomatic calibration will be performed when the module is stationary (disabled Except gyro zero drift). after calibrationZThe angle of the axis is reinitialized to0,ZThe axis angle output is0, it can be regarded as a signal that automatic calibration is completed.

2.Factory default settings use serial port, baud rate115200, frame rate100Hz. The configuration can be configured through the host computer software. Because all configurations are saved when power is turned off, you only need to configure them once.

6.2Module to host computer:

Each frame of data sent by the module to the host computer is divided into3data packets, namely acceleration packet, angular velocity packet and angle packet,3 Data packets are output sequentially. baud rate115200every time10msoutput1Frame data, baud rate9600every time50ms Output one frame of data.

6.2.1 Acceleration output:

Data number	Data content	meaning
0	0x55	Baotou
1	0x51	Mark this package as an acceleration package
2	AXL	XAxis acceleration low byte
3	AH	XAxis acceleration high byte
4	AHr	yAxis acceleration low byte
5	AHr	yAxis acceleration high byte
6	AZ	zAxis acceleration low byte
7	AHr	zAxis acceleration high byte
8	TL	Temperature low byte
9	TH	Temperature high byte
10	Sum	Checksum

Acceleration calculation formula:

a_x=((AxH<<8)|AxL)/32768*16g(gis the acceleration due to gravity, it is desirable9.8m/s_2) a_y

=((AyH<<8)|AyL)/32768*16g(gis the acceleration due to gravity, it is desirable9.8m/s_2) a_z=((AzH<<8)|

AzL)/32768*16g(gis the acceleration due to gravity, it is desirable9.8m/s_2) Temperature calculation

formula:

T=((TH<<8)|TL) /340+36.53℃

Checksum:

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

6.2.2 Angular velocity output:

Data number	Data content	meaning
0	0x55	Baotou
1	0x52	Indicates that this package is an angular velocity package
2	wxya	XAxis angular velocity low byte
3	wxya	XAxis acceleration high byte
4	wxya	yAxis acceleration low byte
5	wxya	yAxis acceleration high byte
6	wxya	zAxis acceleration low byte
7	wxya	zAxis acceleration high byte
8	TL	Temperature low byte
9	TH	Temperature high byte
10	Sum	Checksum

Angular velocity calculation formula:

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 calculation formula:

T=((TH<<8)|TL) /340+36.53℃

Checksum:

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

6.2.3 Angle output:

Data number	Data content	meaning
0	0x55	Baotou
1	0x53	Indicates that this package is an angular package
2	RollL	XAxis angle low byte
3	Roll H	XAxis angle high byte
4	PitchL	yAxis angle low byte
5	PitchH	yAxis angle high byte
6	yawL	zAxis angle low byte
7	AHr	zAxis angle high byte
8	TL	Temperature low byte
9	TH	Temperature high byte
10	Sum	Checksum

Angular velocity calculation formula:

roll angle (xaxis)Roll=((RollH<<8)|RollL)/32768*180(°) Pitch angle(y axis)Pitch=((PitchH<<8)|PitchL)/32768*180(°) Yaw angle (zaxis) Yaw=((YawH<<8)|YawL)/32768*180(°) Temperature calculation formula:

T=((TH<<8)|TL) /340+36.53℃

Checksum:

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

Note:

1. The coordinate system used when calculating the attitude angle is the northeast sky coordinate system. Place the module in the positive direction. As shown in the figure below, the X axis is to the left, the Y axis is to the forward direction, and the Z axis is to the upward direction. The rotation sequence of the coordinate system when the Euler angle represents the attitude is defined as zyx, that is, first rotate around the z-axis, then rotate around the y-axis, and then rotate around the x-axis.

2. Although the range of the roll angle is ±180 degrees, in fact, since the coordinate rotation sequence is ZYX, when expressing the attitude, the range of the pitch angle (Y-axis) is only ±90 degrees. If it exceeds 90 degrees, it will transform to less than 90 degrees. degrees, while making the angle of the X-axis greater than 180 degrees. For detailed principles, please refer to Baidu for relevant information on Euler angles and attitude representation.

3. Since the three axes are coupled, they will only show independent changes at small angles. At large angles, the attitude angle will change coupledly. For example, when the X-axis is close to 90 degrees, even if the attitude only rotates around the X-axis, the Y The angle of the axis will also change greatly, which is an inherent problem of Euler angles representing attitude.

6.2.4 IICMode indication:

This data packet is used to instruct the module to enterICmode, the module will be releasedMPU6050ofICbus, users can pass by themselvesICaccessMPU6050chip. if received0x55 0x50The data packet at the beginning indicates that the module works inIC mode, if you need to switch to serial port mode, please send a command0xFF 0xAA 0x61, or use the host computer to modify.

Data number	Data content	meaning
0	0x55	Baotou
1	0x50	Identity module entryICmodel
2	0x00	

3	0x01	
4	0x00	
5	0x02	
6	0x00	
7	0x03	
8	0x00	
9	0x04	
10	Sum	Checksum

6.3Data parsing sample code:

```
doublea[3],w[3],Angle[3],T;
voidDecodeIMUData(unsigned charchrTemp[]) {

    switch(chrTemp[1])
    {
    case0x51:
        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;

    case0x52:
        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;

    case0x53:
        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;

    }
}
```

6.4Example of parsing data in embedded environment

Divided into two parts, one is to interrupt reception, find the header of the data, and then put the data packet into the array. The other is data analysis, which is placed in the main program.

Interruption part (hereinafter referred to asAVRMCU code, the registers read by different MCUs are slightly different and need to be adjusted according to the actual situation):

```
unsigned char Re_buf[11],counter=0;
unsigned char sign;
interrupt [USART_RXC] void usart_rx_isr(void) //USARTserial receive interrupt {

    Re_buf[counter]=UDR;//Different microcontrollers have slight
    differences if(counter==0&&Re_buf[0]!=0x55) return;          //No.0The number data is not the frame header, skip it
    counter++;
    if(counter==11) //received11data {

        counter=0; //Reassign the value and prepare to receive the next frame of
        data. sign=1;
```

```
        }
    }
```

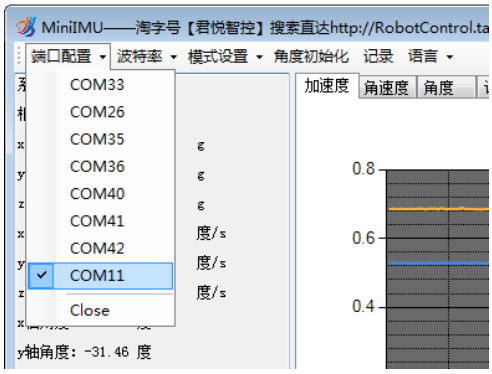
Main program part:

```
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 frame header
        {
            switch(Re_buf[1])
            {
            case0x51:
                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;

            case0x52:
                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;

            case0x53:
                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;

            }
        }
    }
```

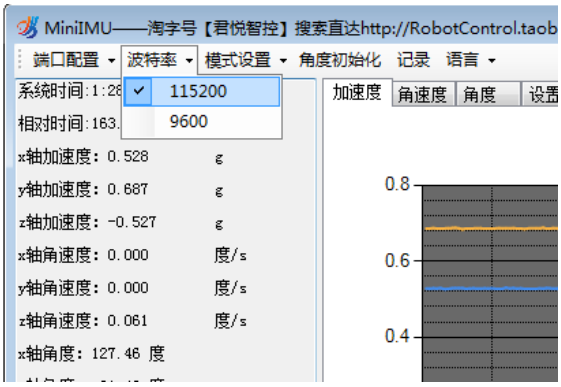
7How to use the host computer

Note, if the host computer cannot run, please download and install it.net framework4.0: http://www.microsoft.com/zh-cn/download/details.aspx?id=17718

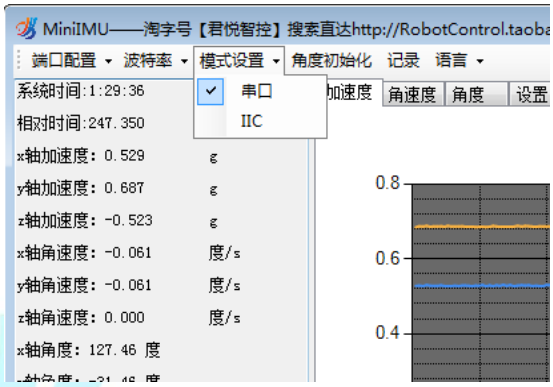
Choose the correct serial port



Under normal circumstances, you can see the data by selecting the correct serial port. If you need to configure the baud rate, please click the baud rate menu.

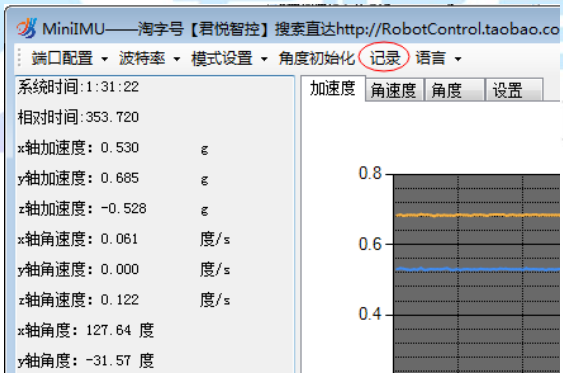


Click the mode menu to set the module's working mode and rotate the serial port mode.

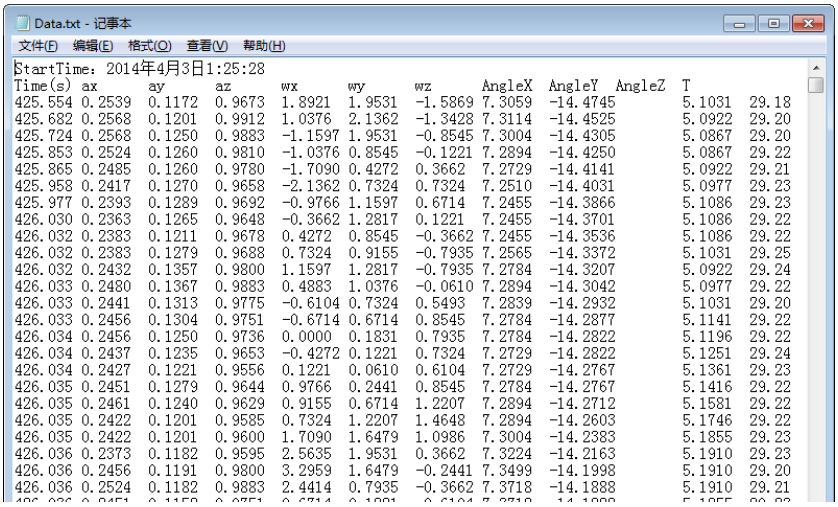


Angular initialization is used to letZThe angle data of the axis is reset to zero.

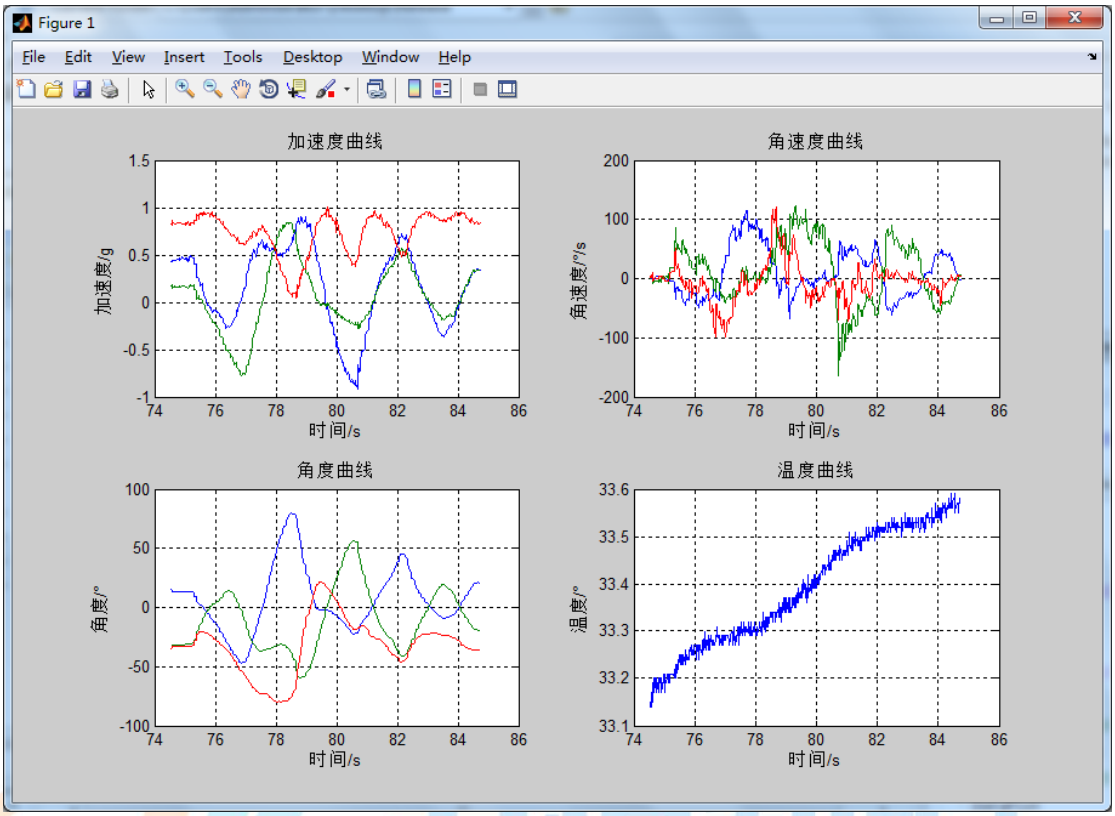
Click the record button to save the data as a file



The saved files are in the directory of the host computer programData.txt:



Data can be imported intoExelorMatlabfor analysis. existMatlabEnvironment, run "MatlabDrawing.m"file to draw data curves.



8Mechanical Dimensions