Focus on Attitude Sensor

https://wiki.wit-motion.com/english

WT931 Attitude Angle Sensor SPECIFICATION

Model ： WT931

Description ： 9 Axis Attitude Angle Sensor

Quality system standard: ISO9001:2016

Tilt switch production standard：GB/T191SJ 20873-2016

Criterion of detection：GB/T191SJ 20873-2016

Revision date：2019.09.09

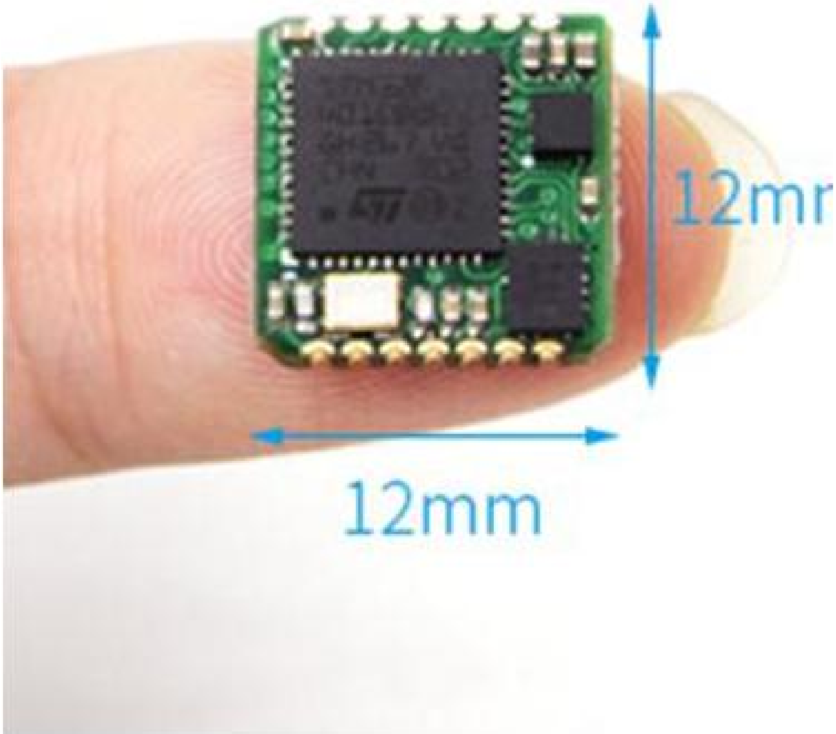
Download Link(software, manual, etc.):

https://drive.google.com/file/d/12k5WNHwQBn8ScTalinA4SENPuhnj27V4

Catalog

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 Inclinometer!
- Working voltage is 3.3~5v
- Highest 500Hz output data rate. The output data can be adjusted 0.1~500HZ
- 4layer 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.

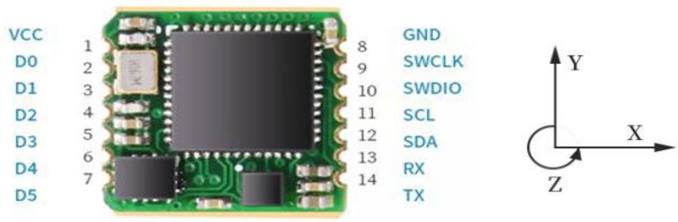


2 Features

1) Input voltage: 3.3V-5V
2) Consumption current: <25mA
3) Volume: 12mm X 12mm X 2mm
4) Pad pitch: up and down 1.27 mm, left and right 12 mm
5) Measuring dimensions: Acceleration: X Y Z
   Angular: X Y Z
   Magnetic field：X Y Z
6) Range: Acceleration: ± 2/4/816g, angular velocity: ± 250/500/1000/2000 ° / s
   Angle : X Z ±180° ， Y ±90°
7) Stability: Acceleration: 0.01g, angular speed 0.05° / s.
8) Angle accuracy: X Y dynamic 0.1 ° static 0.05 ° Z axis 1 ° （No magnetic interference and after calibration）
9) Data output : time, acceleration, angular velocity, Magnetic field, quaternion
10) The data output frequency 0.1Hz to 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

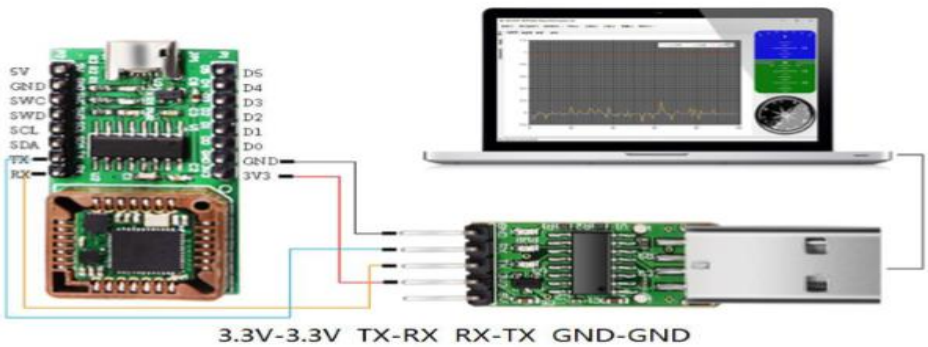
4 Axial Direction

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.

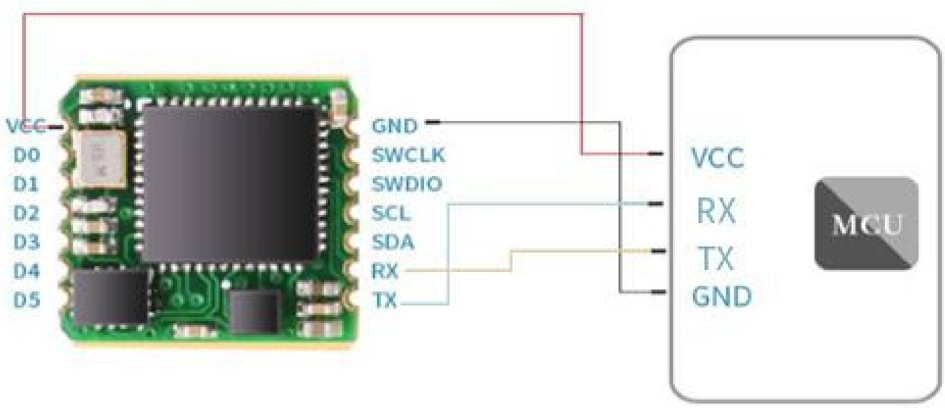
5Hardware Connection

5.1 Serial Connection

5.1.1 Connect to PC



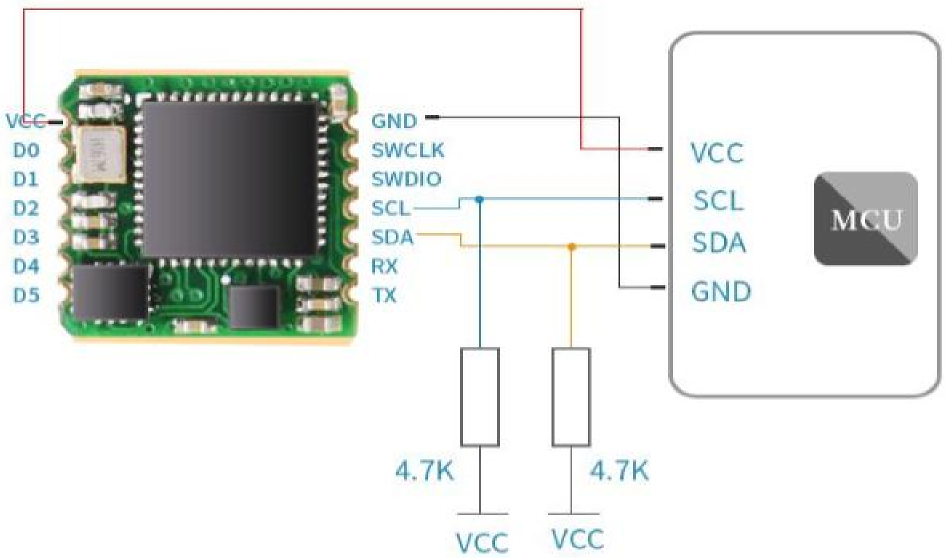
5.12Connect to MCU



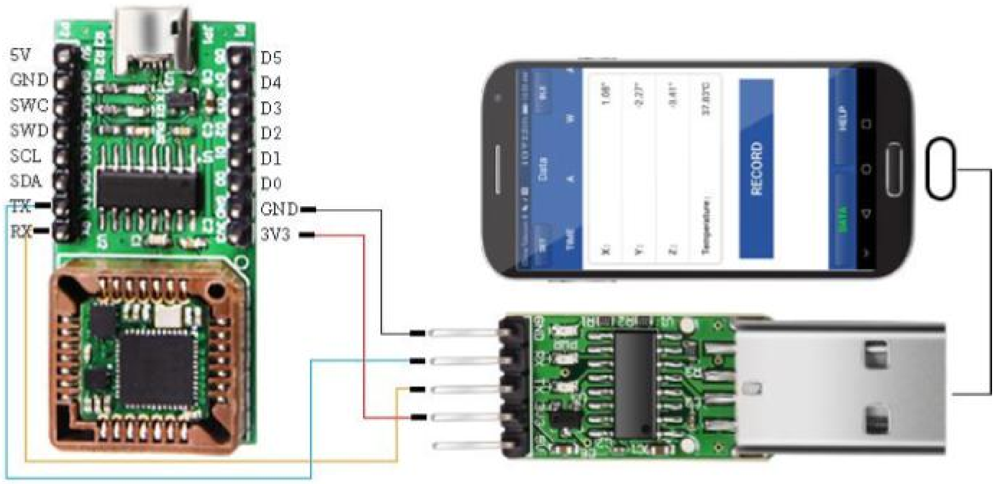
5.2 IIC Connection

JY-901 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 3.3-5V.



5.3 Connect to phone

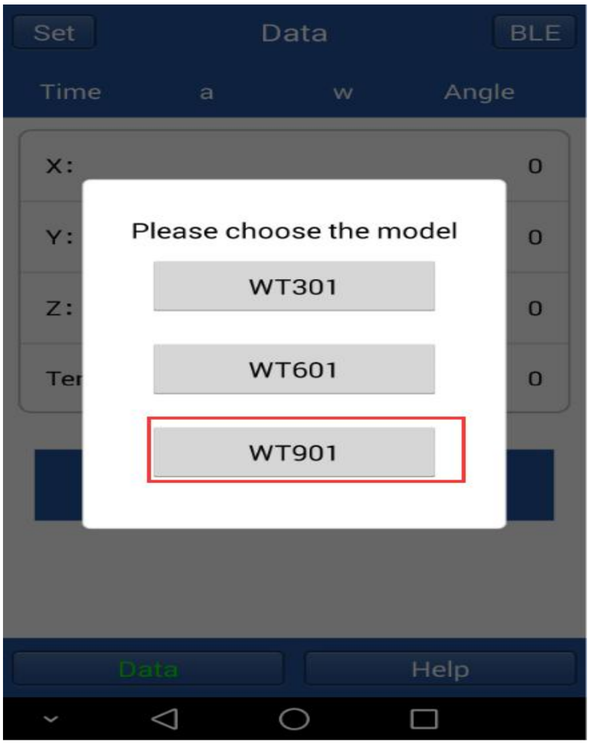


1)Install the app in the Phone, open the app

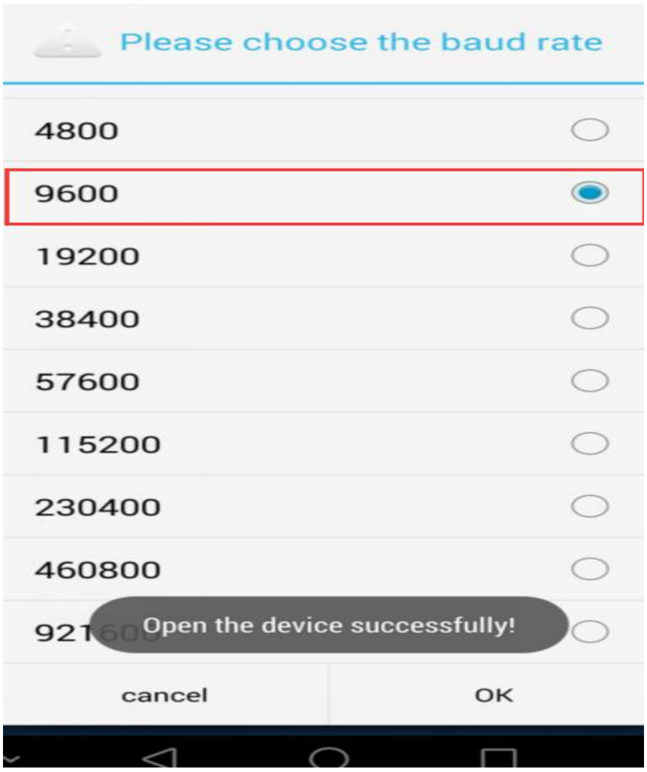
App address: https://wiki.wit-motion.com/english/doku.php?id=module

WT931	3.3-5V	TTL	XYZ ±2、4、8、16	X Y Z	X Y Z	X Y 0.05	yes	yes	yes	Expandable

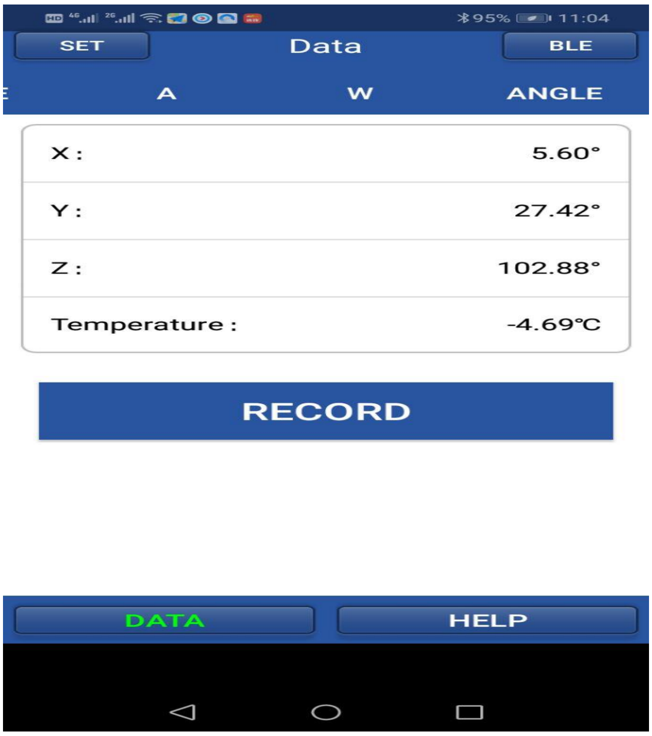
2) choose WT901



3）choose 9600

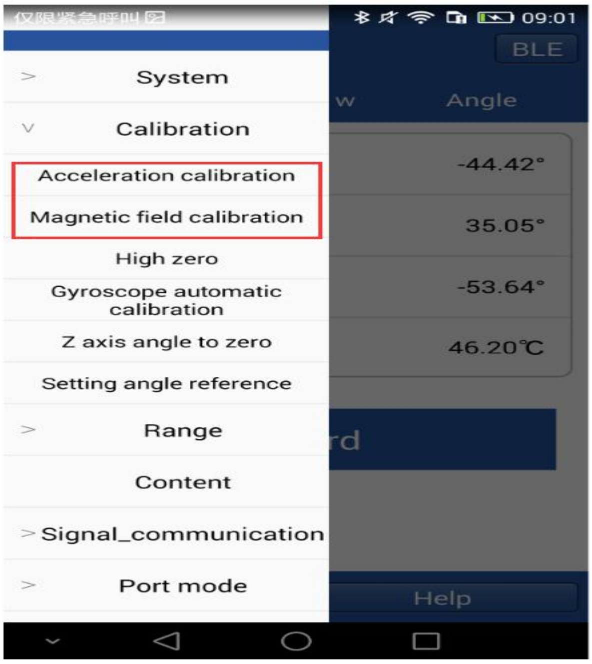


Then the data will show



5.3.1 Calibrate on phone

Please keep the Wt901 on the horizontal level and make the "acceleration calibration" and "Magnetic field calibration" as below:



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.

1、Methods as below: Firstly keep the module horizontally stationary, click "Acceleration", after 1~2s the acceleration X Y Z value will at 0 0 1. X Y angle: 0°.After calibration the value will be accurate.

2) Magnetic 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.Click the "Magnetic Field Calibration" and rotate 360° around the X axis of the module (you can rotate around the Y axis or the Z axis first). Rotate a few turns, then turn 360° around the Y axis. Then turn 360° around the Z axis, then turn a few turns at random, then click the "Finish" to complete the calibration.

5 Software Methods

6.1 Installation USB - TTL Module Driver

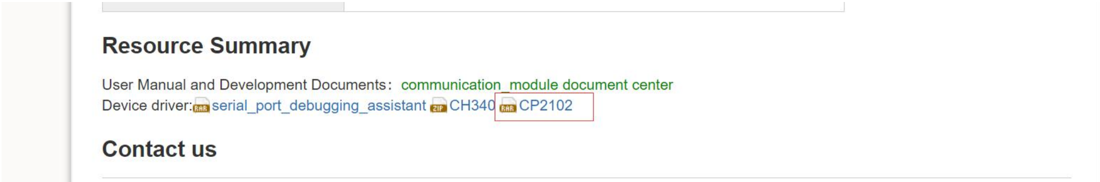
VCC = 3.3 V, RX = TX , TX = RX , GND = GND

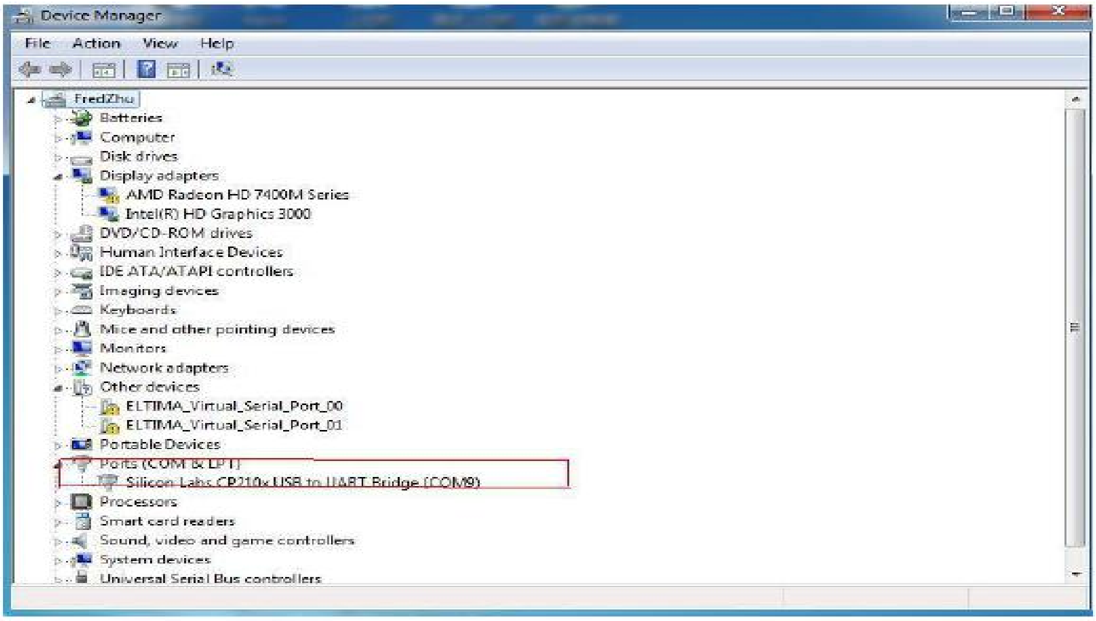
Module 6 in 1 Convert:

Driver installation:

First, install the driver CP2102X when we used the USB serial module ,after installed the driver. then get the corresponding Com number in the device manager. Driver as followed:

https://wiki.wit-motion.com/english/doku.php?id=communication_module

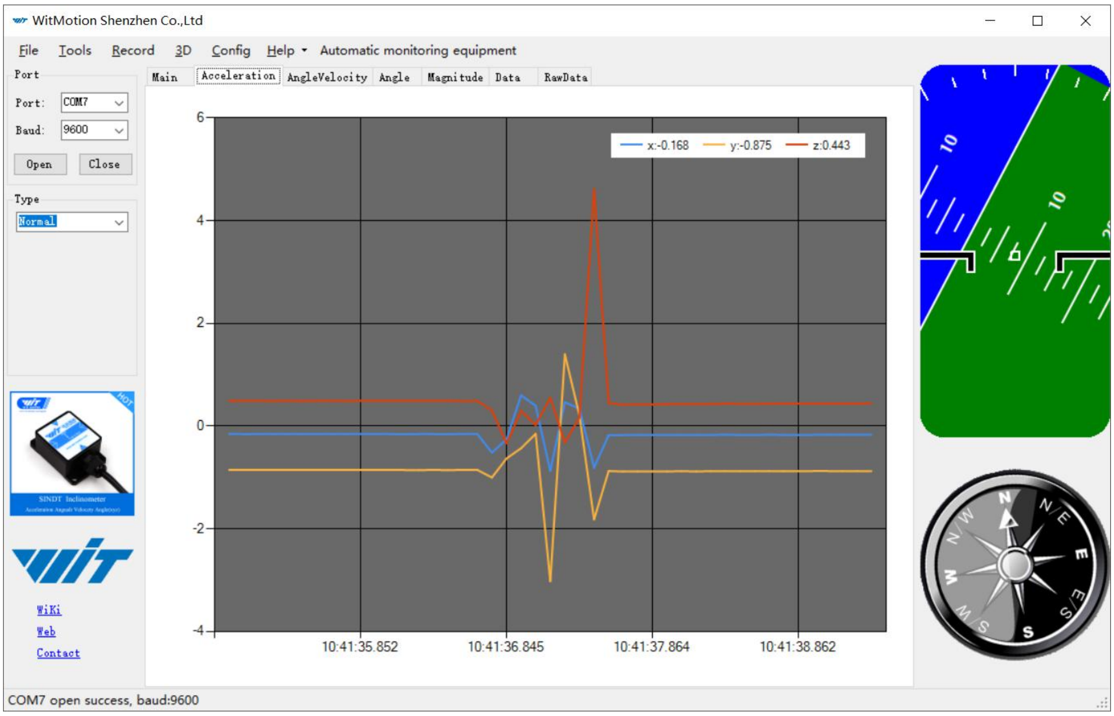




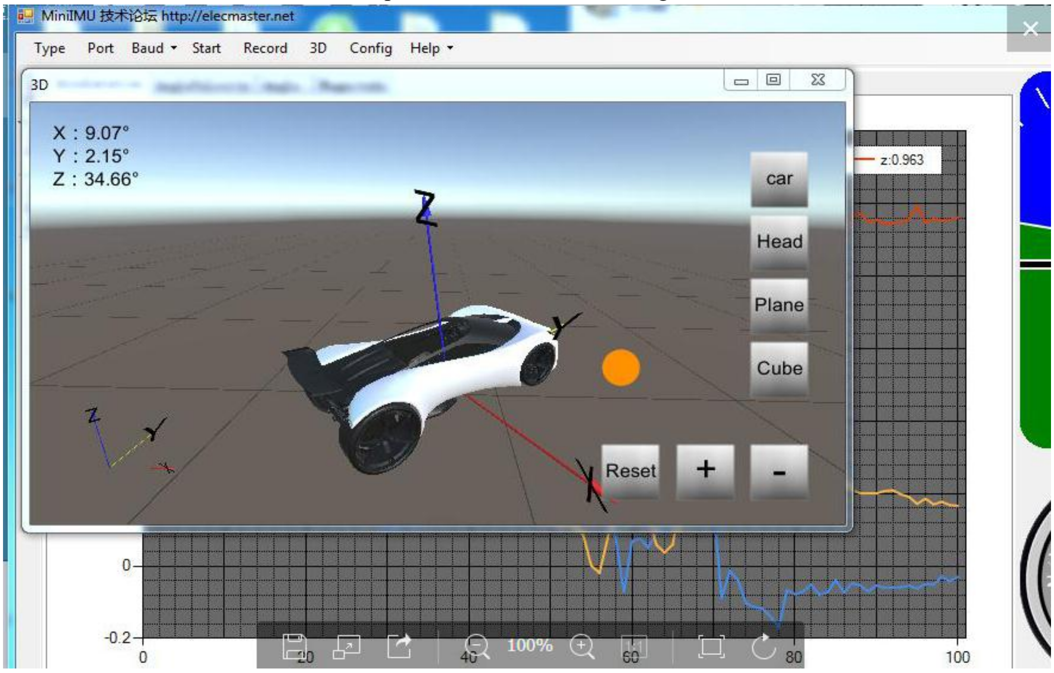
Open the software MiniIMU.exe, Click "Port" and select the com number you just saw in the device manager.

Click the "Type" and select model "Normal.

Click the "Baud" and select "9600", after all those selections are completed, the software can display data.



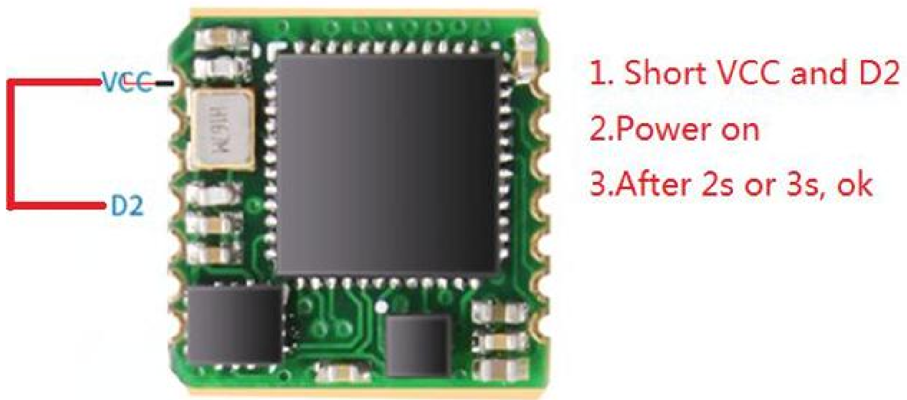
Click the "3D" and you can bring up the three-dimensional display interface, which displays the three-dimensional posture of the module.



6.2 Restore Factory Setting

There are two methods, short circuit method and instruction methods.

Short Circuit Method : D2 pin are short to VCC pin, then power on the module, the module LED lights long bright, lasts about two seconds, LED light is off, complete restore factory settings operation.



Short circuit method: Short VCC and D2 of the module and power on. Complete the factory reset after2sor3s.

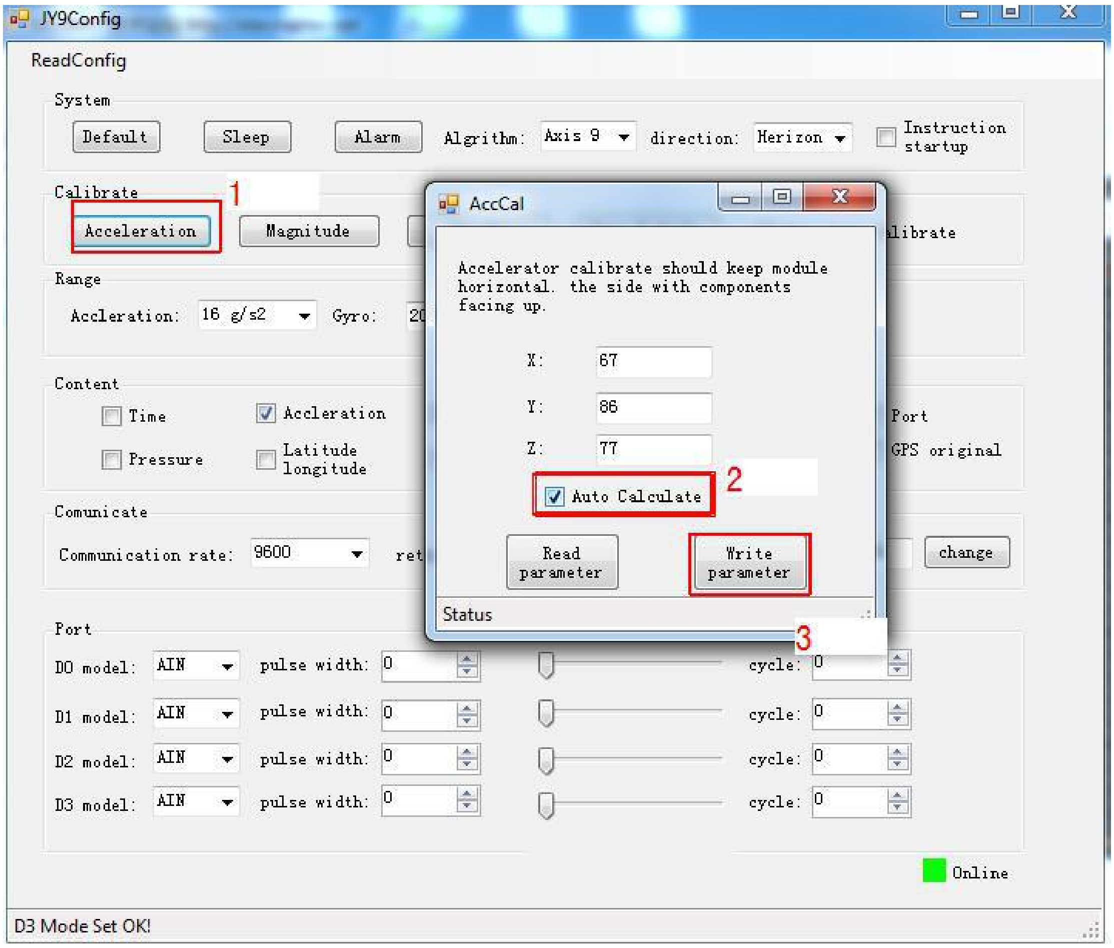
Instruction method : WT931 module connected to a PC via USB-TTL module , click the Settings tab and make sure it online. Click “Recovery”. After restore the factory settings ,need to restart the module again. (This method requires advance knowledge to know baud rate of the module, if the baud rate does not match the command will not take effect, try using a short-circuit recovery method).6.3 Module Calibration

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”



6.3.2 Magnetic Calibration

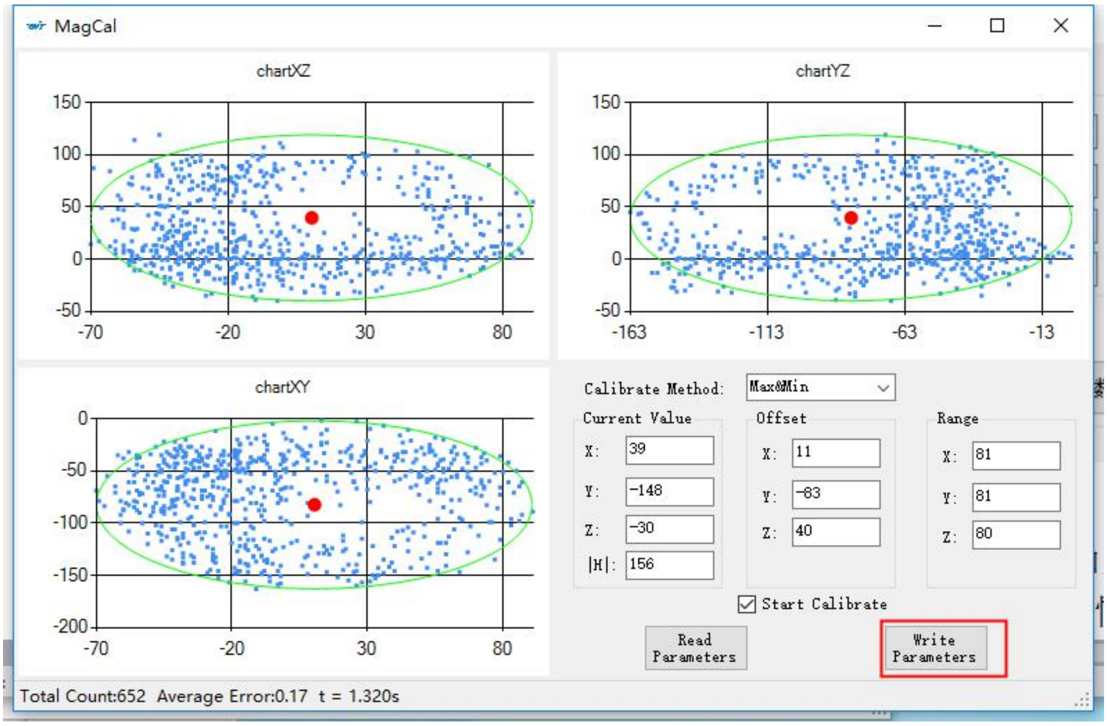
Magnetic field calibration is used to remove the magnetic field sensor's zero offset. Usually, the magnetic field sensor will have a large zero error when it is manufactured. If it is not calibrated, it will bring about a large measurement error and affect the accuracy of the Z-axis angle measurement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

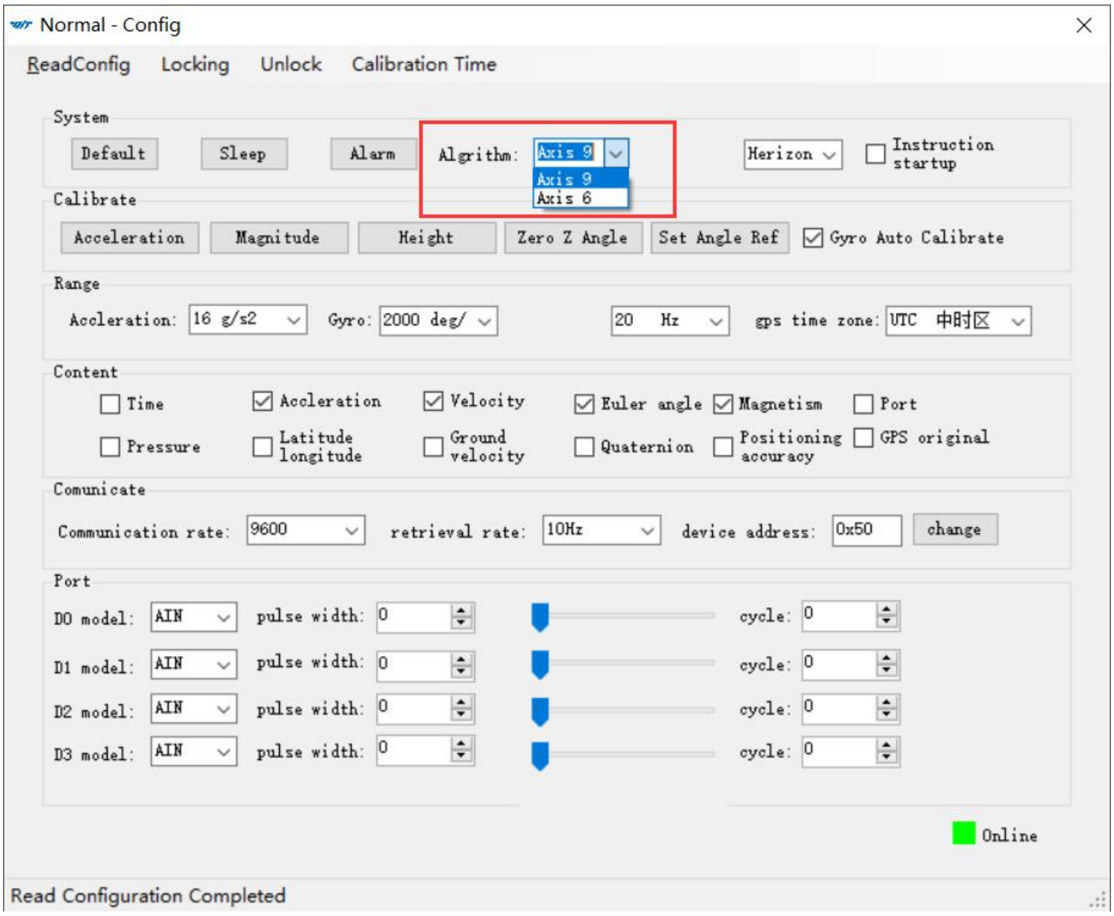


Note: The data points should be within the ellipse but not outside the ellipse. If you cannot draw the ellipse, please keep away from the magnetic field interference.

Video address:
https://www.youtube.com/channel/UCxBLgvYQNk-sGVDp42ch-Ug

6.3.3 Z axis To 0

Ps: If you want to avoid magnetic interference, you can change the algrithm to Axis 6, the you can use Z axis to 0

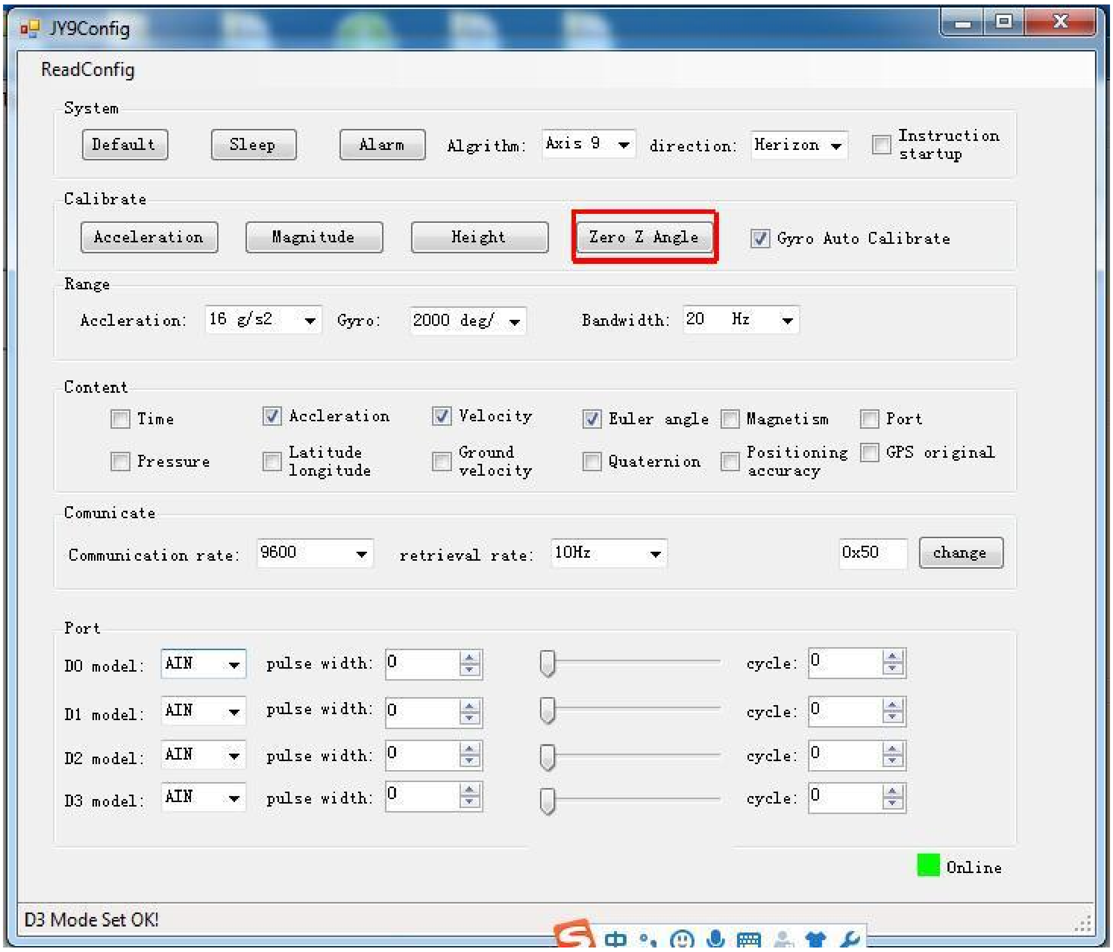


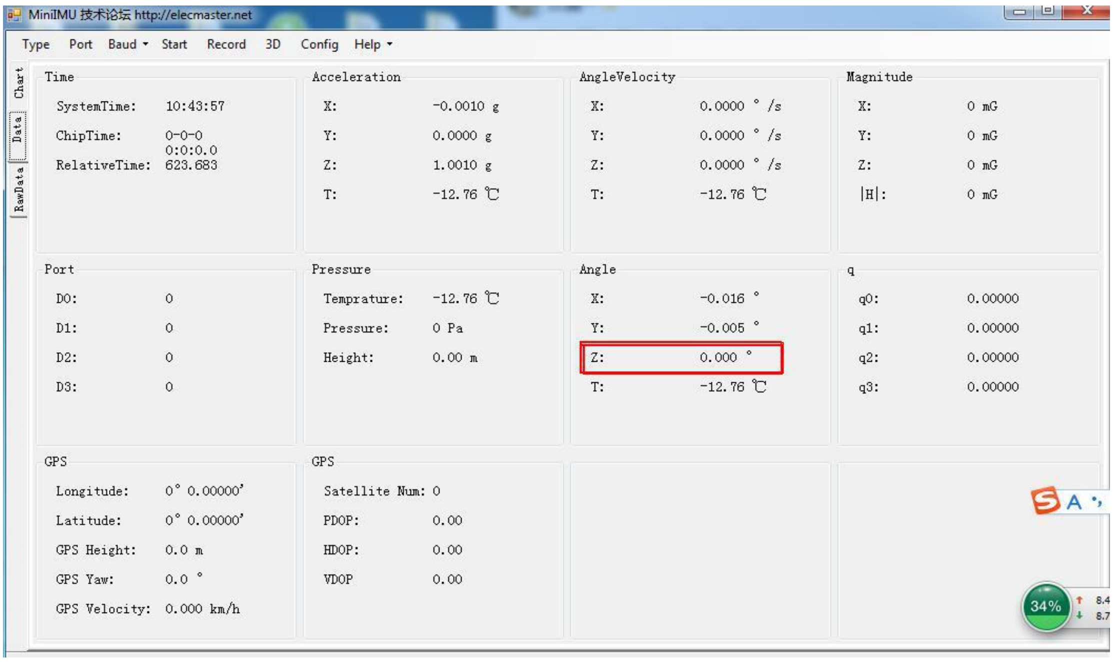
Reminder: Z axis to 0 is valid for JY61P only.

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.


JY9Config
ReadConfig
System
Default
Sleep
Alarm
Algrithm: Axis 9
direction: Herizon
Instruction startup
Calibrate
Acceleration
Magnitude
Height
Zero Z Angle
Gyro Auto Calibrate
Range
Accleration: 16 g/s2
Gyro: 2000 deg/
Bandwidth: 20 Hz
Content
Time
Accleration
Velocity
Euler angle
Magnetism
Port
Pressure
Latitude longitude
Ground velocity
Quaternion
Positioning accuracy
GPS original
Comunicate
Communication rate: 9600
retrieval rate: 10Hz
0x50
change
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
Online
D3 Mode Set OK!


MiniIMU 技术论坛 http://elecmaster.net
Type Port Baud Start Record 3D Config Help
Time
SystemTime: 10:43:57
ChipTime: 0-0-0 0:0:0.0
RelativeTime: 623.683
Acceleration
X: -0.0010 g
Y: 0.0000 g
Z: 1.0010 g
T: -12.76 ℃
AngleVelocity
X: 0.0000 °/s
Y: 0.0000 °/s
Z: 0.0000 °/s
T: -12.76 ℃
Magnitude
X: 0 mG
Y: 0 mG
Z: 0 mG
|H|: 0 mG
Port
D0: 0
D1: 0
D2: 0
D3: 0
Pressure
Temprature: -12.76 ℃
Pressure: 0 Pa
Height: 0.00 m
Angle
X: -0.016 °
Y: -0.005 °
Z: 0.000 °
T: -12.76 ℃
q
q0: 0.00000
q1: 0.00000
q2: 0.00000
q3: 0.00000
GPS
Longitude: 0° 0.00000'
Latitude: 0° 0.00000'
GPS Height: 0.0 m
GPS Yaw: 0.0 °
GPS Velocity: 0.000 km/h
GPS
Satellite Num: 0
PDOP: 0.00
HDOP: 0.00
VDOP 0.00

6.3.4 Height Setting 0

The height setting 0 is an operation to make the height of the module returns to 0, the height output of the module is calculated on the basic of the air pressure. Only with barometer modules(JY901B, JY61PB) output height.

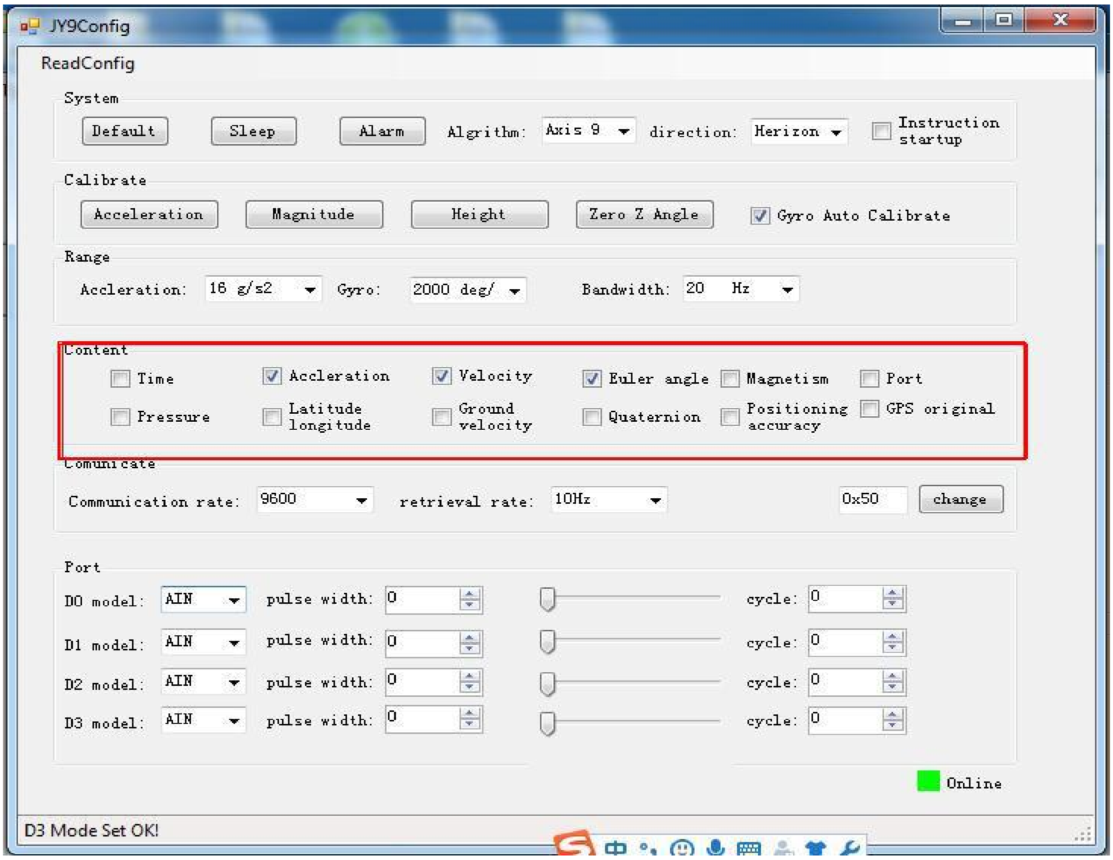
6.3.5 Gyroscope Automatic Calibration

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

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.

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.



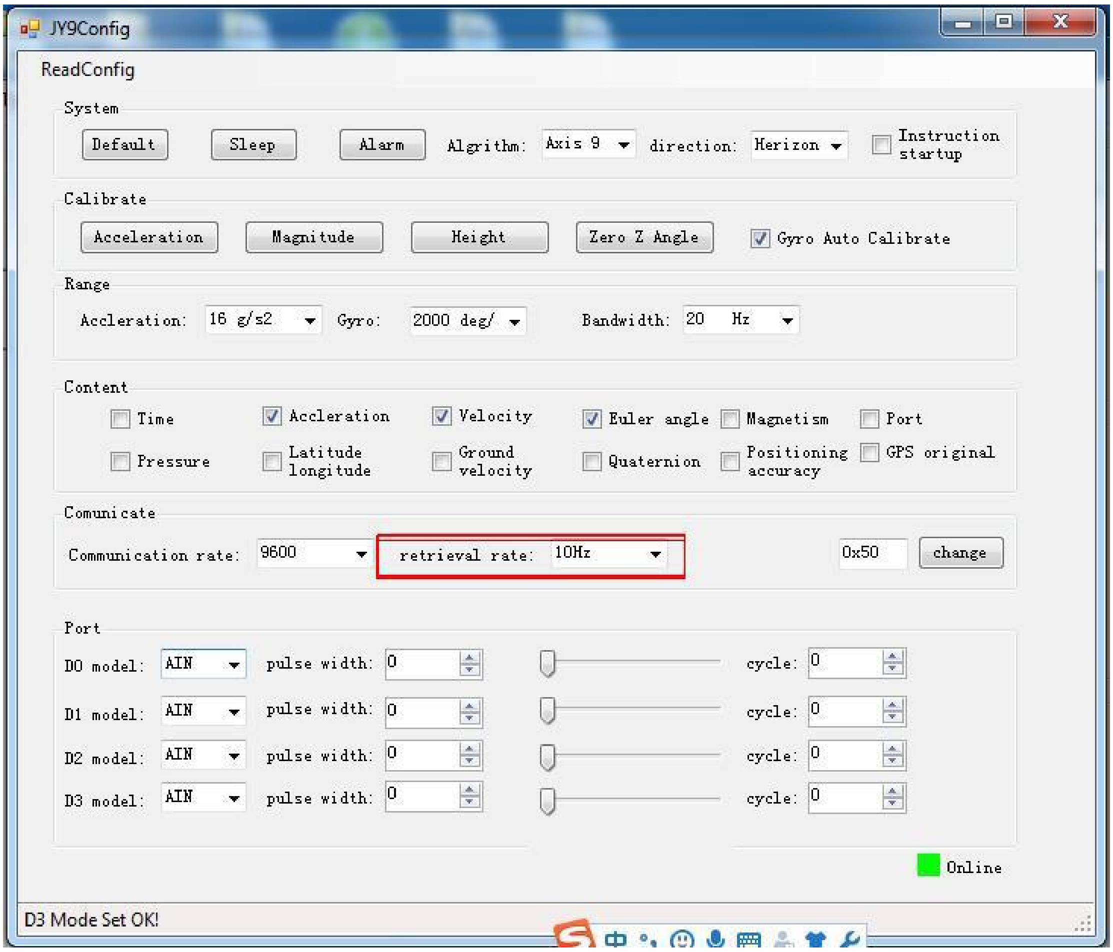
6.5 Set Return Rate

Setting methods: click “Config” to open configuration bar and than set the “retrieval rate” is 0.1HZ-200HZ optional.

The default return rate of the module is 10HZ, the highest return rate supports 200HZ.

10HZ refers to 10 packets returned every second. There contains 33bytes in a data packet in default.

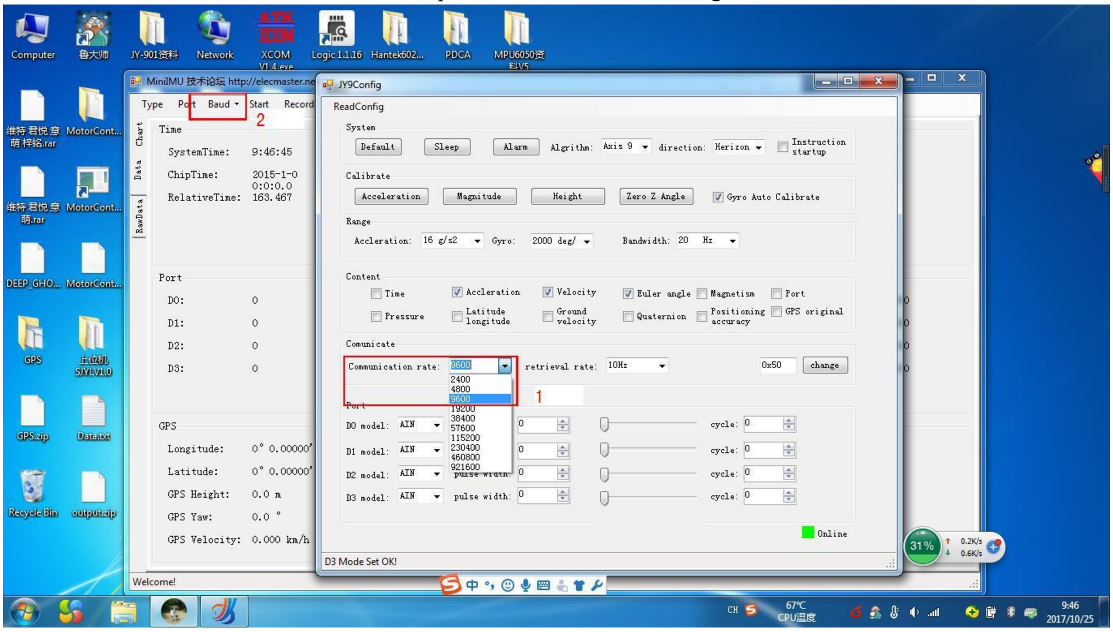
Reminder: If there being a lot of return content and low baud rate of communication, the module will automatically reduce the frequency and output at a maximum allowable output rate. The default baud rate is 115200.



6.6 Set Baud Rate

Module supports multiple baud, 9600 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.

StartTime: 2019-07-24 10:45:13.047

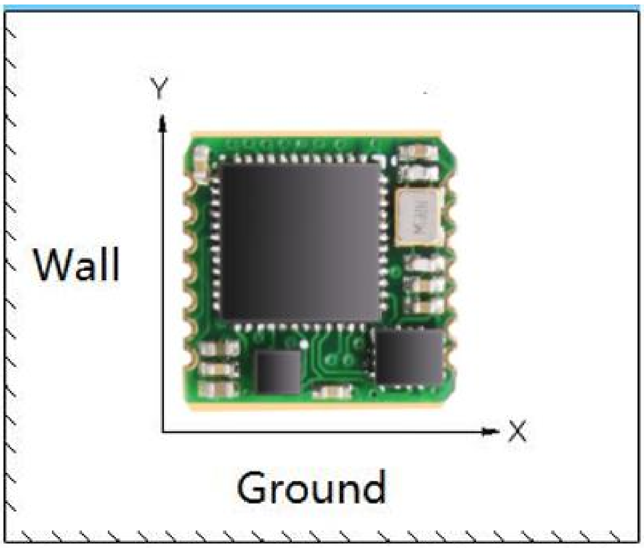
address	Time(s)	ax(g)	ay(g)	az(g)	wx(deg/s)	wy(deg/s)		wz(deg/s)	AngleX(deg)		AngleY(deg)		AngleZ(deg)		T(°)	hx	hy	hz
0x50	10:48:55.760		-0.1670	-0.8496	0.4971	0.6714	-0.1221	-0.0610	-60.0623	9.6075	12.6727	38.6900	66	84	380			
0x50	10:48:55.860		-0.1670	-0.8530	0.4878	0.2441	0.0610	0.1221	-60.0677	9.6130	12.6672	38.6800	67	85	381			
0x50	10:48:55.960		-0.1665	-0.8521	0.4878	-0.1831	0.0000	0.0000	-60.0787	9.6185	12.6727	38.6800	65	86	379			
0x50	10:48:56.059		-0.1660	-0.8545	0.4932	0.0000	-0.1831	0.0000	-60.0677	9.6185	12.6617	38.6900	69	86	384			
0x50	10:48:56.160		-0.1675	-0.8525	0.4927	-0.0610	0.0000	-0.0610	-60.0677	9.6185	12.6727	38.6900	65	85	382			
0x50	10:48:56.260		-0.1660	-0.8516	0.4873	-0.0610	0.0000	0.0000	-60.0732	9.6185	12.6782	38.6900	67	87	384			
0x50	10:48:56.360		-0.1670	-0.8496	0.4937	-0.0610	0.0000	0.0000	-60.0623	9.6185	12.6947	38.6900	66	83	385			

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.

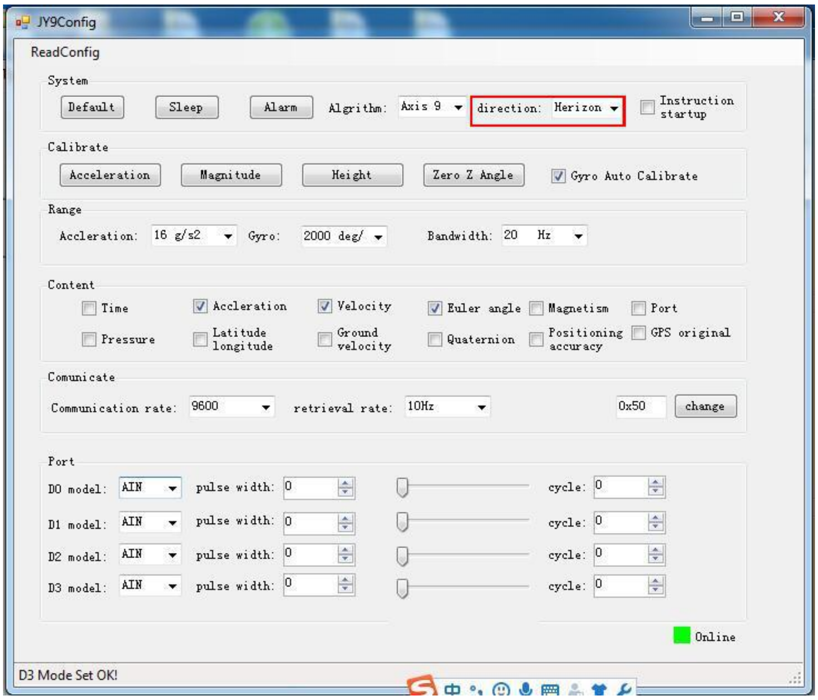
Data can be imported into the Exel or analysis in Matlab. In the Matlab environment running xxx.m document and it can plot of the data.

6.8 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

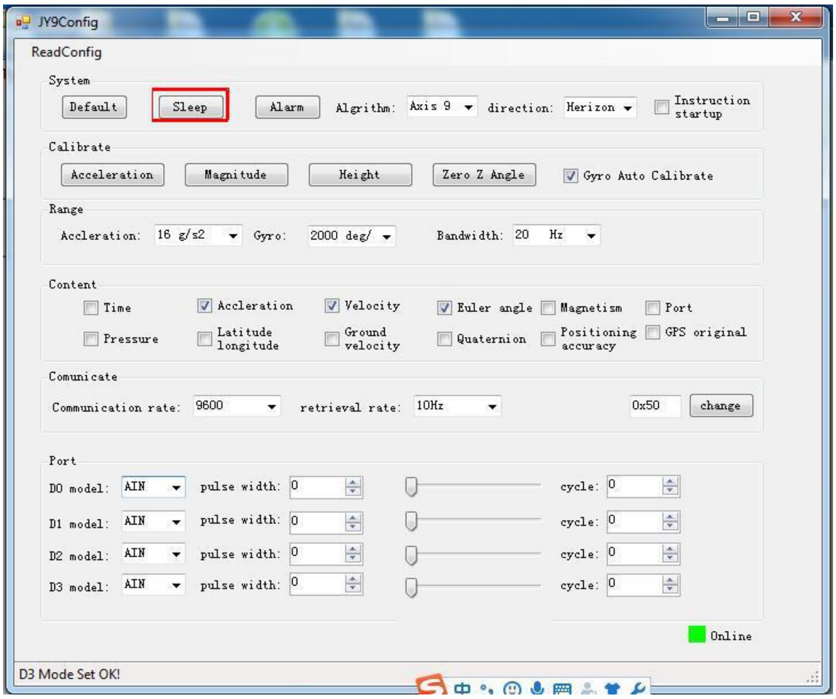


6.9 Sleep/ Wake up

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.



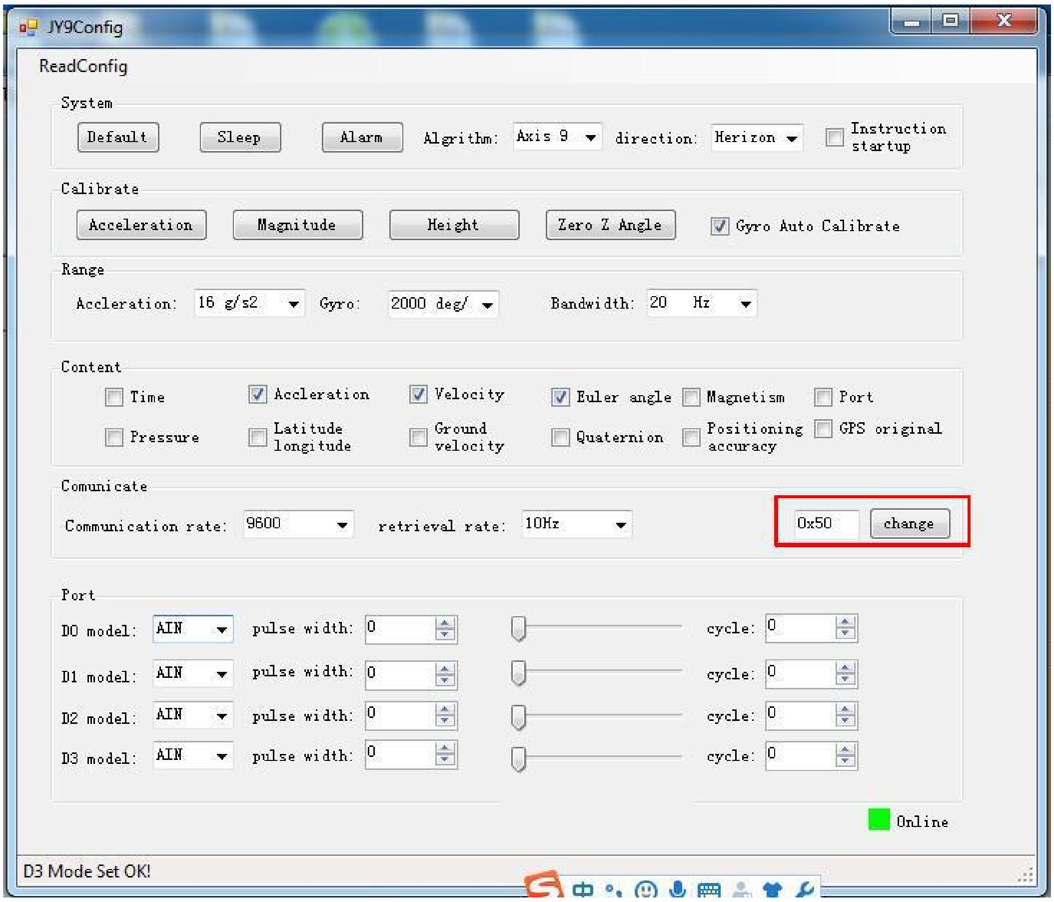
6.10 Set Bandwidth

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.



6.13 Six axis/ Nine axis Algorithm

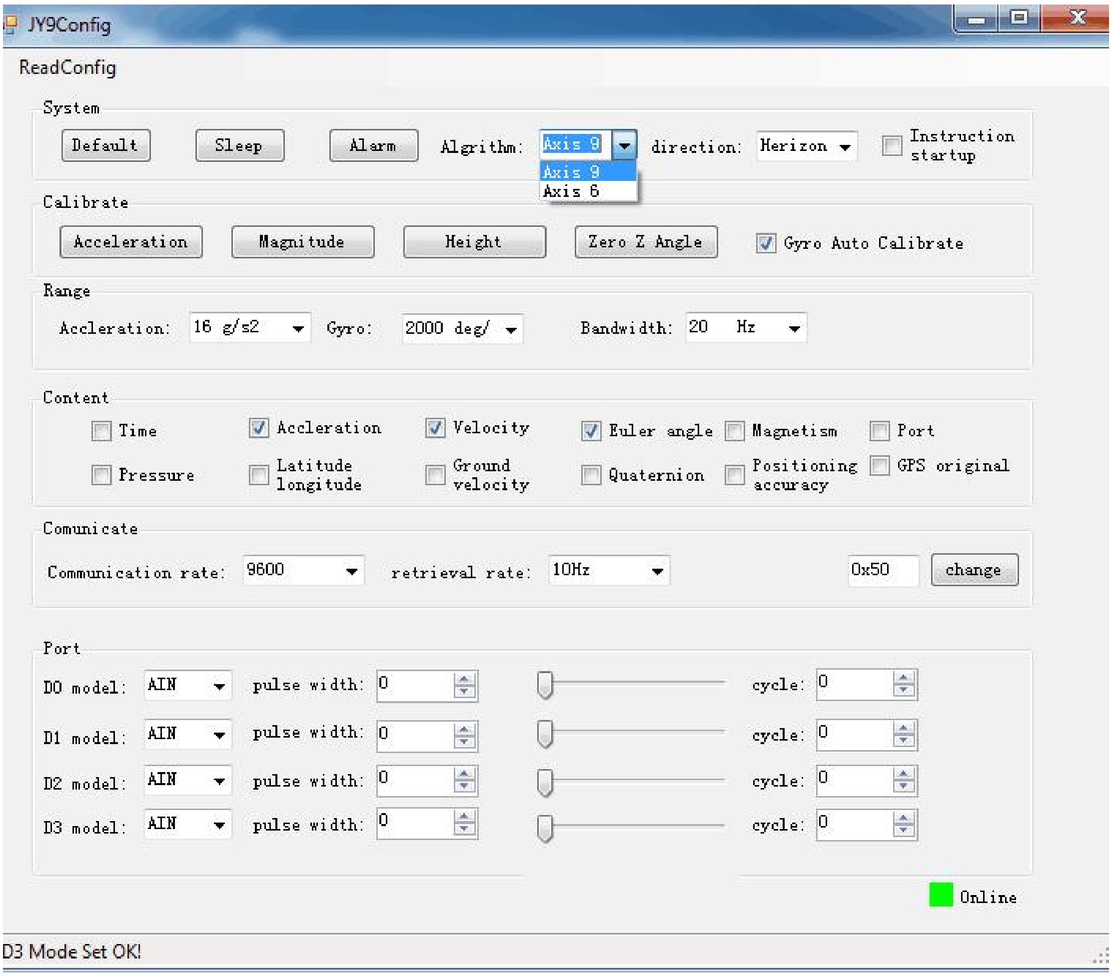
JY61P uses the 6 axis algorithm, and the z axis angle is calculated mainly according to the angular velocity integral.

JY901 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 JY901 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.

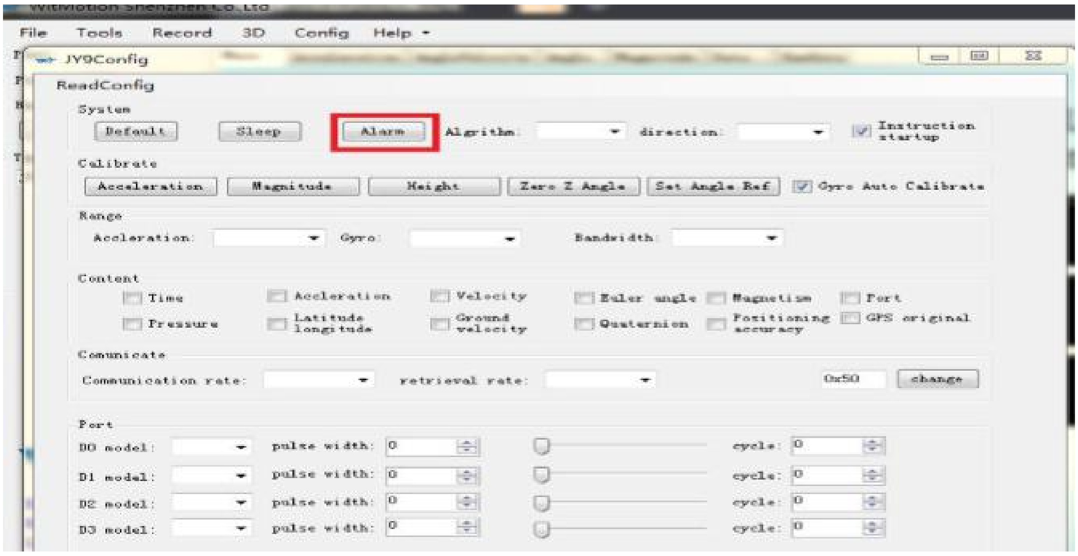
Reminder: here only JY901 can do the algorithm conversion, and the system defaults to the 9 axis algorithm. JY61P is unable to convert algorithms.



6.14 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° or <10 °theportoutputis3.3V.

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



6 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 (default), 19200 38400, 57600, 115200, 230400, 460800, 921600, 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+0x51+YY+MM+DD+hh+mm+ss+ms+TL

7.1.2 Acceleration Output:

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

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) /100 ℃

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.

7.1.3 Angular Velocity Output

0x55	0x52	wxL	wxH	wyL	wyH	wzL	wzH	TL	TH	SUM

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) /100 ℃

Checksum:

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

7.1.4 Angle Output:

0x55	0x53	RollL	RollH	PitchL	PitchH	YawL	YawH	TL	TH	SUM

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) /100 ℃

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

7.1.5 Magnetic output：

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

Calculated formular：

Magnetic（x axis）Hx=((HxH<<8)| HxL)

Magnetic（y axis）Hy=((HyH <<8)| HyL)

Magnetic（z axis）Hz =((HzH<<8)| HzL)

Temperature calculated formular：

T=((TH<<8)|TL) /100 ℃

Checksum：

Sum=0x55+0x53+HxH+HxL+HyH+HyL+HzH+HzL+TH+TL

7.1.6 Data output port status：

0x55	0x55	D0L	D0H	D1L	D1H	D2L	D2H	D3L	D3H	SUM

Calculated formular：

D0 = (D0H<<8)| D0L

D1 = (D1H<<8)| D1L

D2 = (D2H<<8)| D2L

D3 = (D3H<<8)| D3L

Note：

Analog input port mode:

U=DxStatus/1024*U_{vcc}

Uvcc is the power supply voltage of the module, because the module has LDO, if the module power supply voltage is greater than 3.5V, Uvcc is 3.3V. If the module supply voltage is less than 3.5V, Uvcc equal to the supply voltage minus 0.2V

Digital input mode:

Voltage level is high, the data is 1,

Voltage level is low, the data is 0.

Digital output mode:

Output is high， the data is 1。

Output is low， the data is 0。

PWM output mode:

When the port is set to PWM output mode, port status data indicates high level width , the unit is us.

7.1.7 Atmospheric pressure and Height output：

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

Calculated formular：

Atmospheric pressure P = ((P3<<24)| (P2<<16)| (P1<<8)| P0 （Pa）

Height H = ((H3<<24)| (H2<<16)| (H1<<8)| H0 （cm）

Checksum：

Sum=0x55+0x54+P0+P1+P2+P3+H0+H1+H2+H3

7.1.8 Longitude and Latitude Output：

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

Calculated formular：

Longitude Lon = ((Lon 3<<24)| (Lon 2<<16)| (Lon 1<<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/100000000;

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

Latitude Lat = ((Lat 3<<24)| (Lat 2<<16)| (Lat 1<<8)| Lat 0 （cm）

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/100000000;

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

Checksum：

Sum=0x55+0x54+ Lon 0+ Lon 1+ Lon 2+ Lon 3+ Lat 0+ Lat 1+ Lat 2+ Lat 3

7.1.9 Ground speed output：

0x55	0x58	GPSHeightL	GPSHeightH	GPSYawL	GPSYawH
GPSV0	GPSV 1	GPSV 2	GPSV 3	SUM	

Calculated formular：

GPSHeight = ((GPSHeightH<<8)| GPSHeightL)/10 （m）

GPSYaw =((GPSYawH <<8)| GPSYawL)/10 （°）

GPSV = (((Lat 3<<24)| (Lat 2<<16)| (Lat 1<<8)| Lat 0)/1000（km/h）

Checksum：

Sum=0x55+0x54+ GPSHeightL + GPSHeightH + GPSYawL + GPSYawH + GPSV0+ GPSV 1+ GPSV 2+ GPSV 3

7.1.10 Quaternion：

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

Calculated formular：

Q0=((Q0H<<8)|Q0L)/32768

Q1=((Q1H<<8)|Q1L)/32768

Q2=((Q2H<<8)|Q2L)/32768

Q3=((Q3H<<8)|Q3L)/32768

Checksum：

Sum=0x55+0x59+Q0L+Q0H+Q1L +Q1H +Q2L+Q2H+Q3L+Q3H

7.1.11 Satellite positioning accuracy output：

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

Calculated formular：

Satellite quantity：SN=((SNH<<8)|SNL)

Location positioning accuracy：PDOP=((PDOPH<<8)|PDOPL)/32768

Horizontal positioning accuracy：HDOP=((HDOPH<<8)| HDOPL)/32768

Vertical positioning accuracy：VDOP=((VDOPH<<8)| VDOPL)/32768

Checksum：

Sum=0x55+0x59+ SNL + SNH + PDOPL + PDOPH + HDOPL + HDOPH + VDOPL + VDOPH

7.2 Software to Module

Remider:

1. Factory settings default to use serial port, band rate is 9600, frame rate is 10HZ. 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

RSW 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

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

0x01：0.1Hz

0x02：0.5Hz

0x03：1Hz

0x04：2Hz

0x05：5Hz

0x06：10Hz（default）

0x07：20Hz

0x08：50Hz

0x09：100Hz

0x0a：125Hz

0x0b：200Hz

0x0c：Single

0x0d: Not 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（default）

0x03：19200

0x04：38400

0x05：57600

0x06：115200

0x07：230400

0x08：460800

0x09：921600

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 <<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 <<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	GXOFFSETL	GXOFFSETH

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 <<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 <<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 <<8) | HXOFFSETL

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

7.2.20 Set port D0 mode

0xFF	0xAA	0x0e	D0MODE	0x00

D0MODE：

0x00：Analog Input（default）

0x01：Digital Input

0x02：Digital Output high

0x03：Digital Output low

0x04：PWM Output

7.2.21 Set port D1 mode

0xFF	0xAA	0x0f	D1MODE	0x00

D1MODE：

0x00：Analog Input（default）

0x01：Digital Input

0x02：Digital Output high

0x03：Digital Output low

0x04：PWM Output
0x05：Connect to TX of GPS

7.2.22 Set port D2 mode

0xFF	0xAA	0x10	D2MODE	0x00

D2MODE：

0x00：Analog Input（default）
0x01：Digital Input
0x02：Digital Output high
0x03：Digital Output low
0x04：PWM Output

7.2.23 Set port D3 mode

0xFF	0xAA	0x11	D3MODE	0x00

D3MODE：

0x00：Analog Input（default）
0x01：Digital Input
0x02：Digital Output high
0x03：Digital Output low
0x04：PWM Output

7.2.24 Set the PWM width of Port D0

0xFF	0xAA	0x12	D0PWMHL	D0PWMHH

D0PWMHL：the PWM width of Port D0 low byte
D0PWMHH：the PWM width of Port D0 high byte
D0PWMH = (D0PWMHH<<8) | D0PWMHL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.

7.2.25 Set the PWM width of Port D1

0xFF	0xAA	0x13	D1PWMHL	D1PWMHL

D1PWMHL：the PWM width of Port D1 low byte
D1PWMHH：the PWM width of Port D1 high byte

D1PWMH = (D1PWMHH<<8) | D1PWMHL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.

7.2.26 Set the PWM width of Port D2

0xFF	0xAA	0x14	D2PWMHL	D2PWMHL

D2PWMHL：the PWM width of Port D2 low byte

D2PWMHH：the PWM width of Port D2 high byte

D2PWMH = (D2PWMHH<<8) | D2PWMHL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.

7.2.27 Set the PWM width of Port D3

0xFF	0xAA	0x15	D3PWMHL	D3PWMHL

D3PWMHL：the PWM width of Port D3 low byte

D3PWMHH：the PWM width of Port D3 low byte

D3PWMH = (D3PWMHH<<8) | D3PWMHL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.

7.2.28 Set period of Port D0

0xFF	0xAA	0x16	D0PWMTL	D0PWMTH

D0PWMTL：PWM period of Port D0 low byte

D0PWMTH：PWM period of Port D0 high byte

D0PWMT = (D0PWMTH<<8) | D0PWMTL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.Period is 20000us, just set D0PWMT 20000.

7.2.29 Set period of Port D1

0xFF	0xAA	0x17	D1PWMTH	D1PWMTL

D1PWMTL：PWM period of Port D1 low byte

D1PWMTH：PWM period of Port D1 high byte

D1PWMT = (D1PWMTH<<8) | D1PWMTL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.Period is 20000us, just set D0PWMT 20000.

7.2.30 Set period of Port D2

0xFF	0xAA	0x18	D2PWMTH	D2PWMTL

D2PWMTL：PWM period of Port D2 low byte

D2PWMTH：PWM period of Port D2 high byte

D2PWMT = (D2PWMTH<<8) | D2PWMTL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.Period is 20000us, just set D0PWMT 20000.

7.2.31 Set period of Port D3

0xFF	0xAA	0x19	D3PWMTH	D3PWMTL

D3PWMTL：PWM period of Port D3 low byte

D3PWMTH：PWM period of Port D3 high byte

D3PWMT = (D3PWMTH<<8) | D3PWMTL

Note: The unit of PWM high-level width and period is us, such as high-level width is 1500us, just set D0PWMH 1500.Period is 20000us, just set D0PWMT 20000.

7.2.32 Set IIC Address

0xFF	0xAA	0x1a	IICADDR	0x00

IICADDR：

IIC address of the module, default is 0x50. IIC address using 7bit address, can not exceed the maximum 0x7f. After the setup is complete , need to click save, and re-power the module to take effect.

7.2.33 Set LED

0xFF	0xAA	0x1b	LEDOFF	0x00

LEDOFF：

0x01：Turn off LED

0x00：Turn on LED

7.2.34 Set GPS baud

0xFF	0xAA	0x1c	GPSBAUD	0x00

GPSBAUD：

Baud: Time information pack

0x00：2400

0x01：4800

0x02：9600（default）

0x03：19200

0x04：38400

0x05：57600

0x06：115200

0x07：230400

0x08：460800

0x09：921600

After set it up, you need to save the configuration button and then restart the module.

7 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	……

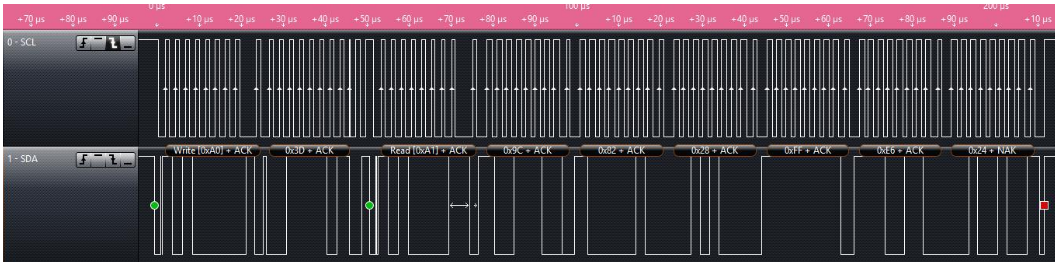
First IIC host sends a Start signal to JY-901 module， then write IICAddr to register address, then IIC host sends a read signal(IICAddr<<1)|1) to JY-901 module, if the IIC address is 0x50(default),then the host send 0xa0

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

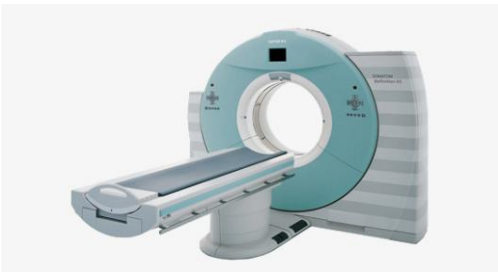
Agricultural machinery

Internet of things

Solar energy

Power monitoring

Medical instruments



Construction machinery

Geological monitoring

WitMotion ShenZhen Co., Ltd

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