

# HWT905 Attitude Angle Sensor SPECIFICATION



Model : HWT905

Description : High-precision 9-Axis Attitude Angle Sensor With Temperature &

Magnetic Compensation

Quality system standard: ISO9001:2016

Tilt switch production standard: GB/T191SJ 20873-2016

Criterion of detection: GB/T191SJ 20873-2016

Revision date: 2019.12.17

Link to tutorial of HWT905(software, manual, etc.): https://drive.google.com/file/d/1mOx3Pusab-TKJ7K9Pt5FnH3x-yOHj3JW/





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# 1 Description

This product is built-in RM3100 module and SCA330 Accelerometer, the communication protocol and specific parameters please refer to the information.

WT905	3.3-5V	TTL/RS232/RS485	XYZ	XYZ	XYZ	X Y 0.05	yes	yes	yes
https:/	//drive.googl	e.com/open?id=1FCn1HZ	+2、4、8、 FiviTRypdnLyNr	Bu9Upxr4hz-O	]				

• Module integrates high-precision gyroscopes, accelerometer, RM3100 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!

• Integrate voltage stabilization circuit, working voltage is  $3.3v \sim 5v(TTL)$  or 9v-36v(RS232/RS485).

• Supports serial port TTL/RS232/RS485 digital interface, Serial port rate is adjustable from 2400kbps ~ 921600 kbps (9600 default)

- Highest 200Hz output data rate. The output data and rate can be adjusted.
- ◆ 4layer PCB technology, thinner, smaller, and more reliable.



## 2 Features

1. Input voltage:  $3.3 \sim 5 \text{ V(TTL)}$  or 9-36 V(RS232/RS485).

- 2、Consumption current: <40mA
- 3、Volume: 55mm X 36.8mm X 24mm

4. Measuring dimensions: Acceleration: X Y Z Angular Velocity: X Y Z Attitude angle: X Y Z Magnetic field: X Y Z
5. Range: Acceleration: ± 16g, angular velocity: ± 2000 ° / s, Attitude angle:(X,Z±180°, Y ±90°)
6. Stability: Acceleration: 0.01g, angular speed 0.05° / s.

7. Measurement Accuracy: X Y axis  $0.05^{\circ}$ , Z axis  $1^{\circ}$  (magnetic field calibration is good, and no magnetic field interference).

- 8. Data output: time, acceleration, angular velocity, angle ,magnetic field,
- 9、The data output frequency 0.1Hz to 200Hz(10Hz default).
- 10, Data Interface:

Serial (TTL/232/485 level baud rate upport2400,4800,9600(default),19200,38400,57600, 115200,230400,460800,921600)

11, Mag: RM3100



Decomptor	Cycle Counts							
Parameter	50	100	200					
Field Measurement Range	-800 µ⊤ to +800 µ⊤							
Noise	30 nT	30 nT 20 nT						
Gain @ 3V (LSB/ µ T)	20 nT	38 nT	75 nT					
Linearity over ±200 $\mu$ T	0.5 % (typical)							
Sensitivity	50 nT	26 nT	13 nT					
Max 3 Axis Sample Rate	534 µA	284 µA	147 µ A					
Current Usage @ 8 Hz, 3 Axes	70 µ A	135 µ A	260 µ A					
Circuit Oscillation Frequency	180 kHz							
Bias Resistor (RB)	121 Ω							

# 3 Product Size(Unit :mm)



## 4 Line Color Function

(TTL Version)



Line func	RED	YELLOW	GREEN	BLACK
color	VCC 5V	ТХ	RX	GND

(RS232/RS485 Version)

Line func	RED	YELLOW	GREEN	BLACK
color	VCC 9-36V	ТХ	RX	GND

# 5 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 other four finger is the direction of the bending of the right hand. The X axis angle is the angle of rotation about the X axis, The Y axis angle is the angle of rotation about the Y axis, The Z axis angle is the angle of rotation about the Z axis

## 6 Hardware Connection



## 6.1 232 Level Connection



6.2 TTL Level Connection



6.3 RS485 Level Connection



If the type you bought is RS232 / RS485, please pay attention to the connection with GND as below:



1. The red wire is used for power supply



2. Please make the black line (GND) of sensor connected with two wires,



one is serial port convert (GND) and another one is power line (GND).



# 7 Host Computer Instructions

# 7.1 Instructions

# Note that the user whose computer can not run please download and install .net framework4.0:

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

1.Connecting to a computer requires a 3-IN-1(CH340) (USB to TTL/RS232/RS485) serial port module. The following USB-to-serial module is



recommended:



### Driver installation:

First, install the driver CH340 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

#### Resource Summary

#### Contact us

2.Connecting to a computer requires a 6-IN-1(CP210X) (USB to TTL/RS232/RS485, TTL to RS232/RS485, RS232 to RS485) serial port module. The following USB-to-serial module is recommended:



If choose the 6-IN-1(CP2102), the driver is : CP210X: https://wiki.wit-motion.com/english/doku.php?id=communication\_module



#### **Resource Summary**

After installing the module driver, and then Device Manager can query corresponding serial number, as below figure shows:



Open the software MiniIMU.exe, In the "Packet



Click "Port" and select the com number you just saw in the device manager





Click the "Type" and select model "Normal".

Ps: "Normal" type just applicable to "TTL/RS232", if you want to use "RS485", you should change the type to "Modbus", then click search to use it.





Modbus	~
Search	
0x53	

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







When the time interval between the current acquisition data and the previous acquisition data is long, the chart update will be slow. At this time, you can right-click the image and pop up the clear diagram bar. Click the clear diagram option to speed up the data refresh rate.

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





# 7.2 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 HWT901B includes accelerometer calibration and magnetic calibration.

Ps: All the calibration must be maintained at a level, unless you want to Vertical Installation, and the upper computer sets the vertical position of the vertical installation.



Vertical installation

## 7.2.1 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"



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D2 model:	AIN -	pulse width: 0		0	cycle: 0	
	AIN 👻	pulse width: 0	* *	0	cycle: 0	

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  $0^{\circ}$ . 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.



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GPS Velocity	y 0.000 km/h							

## 7.2.2 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.



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



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://www.youtube.com/channel/UCxBLgvYQNk-sGVDp42ch-Ug

The altitude return to zero operation is to calculate the current barometric pressure as zero height position. To do this, click on the "Height" option in the configuration bar.

## 7.3 Set output data

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. The default output of the module is acceleration, attitude velocity, 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.

The HWT901B sensor can output content: acceleration, angular velocity, magnetic field, pressure and height the quaternion.



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

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7.4 Set data 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.

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 9600.



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

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7.5 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.



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# 7.6 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. "Angle X, Angle Y, Angle Z" 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.

StartTime: 2019-07-19 16:51:16.927													
address	Time(s) ax(g)	ay(g)	az(g)	wx(deg/	5)	wy(deg/	s)	wz(deg/	s)	AngleX(deg)	Angle	(deg)	AngleZ(deg)
0x50	16:53:50.075	0.0562	0.1475	1.0732	0.0000	0.0000	0.0000	7.8497	-2.9443	-30.1135 41.7700	-567	1172	810
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0x50	16:53:50.870	0.0557	0.1484	1.0732	0.0000	0.0000	0.0000	7.8442	-2.9498	-30.1904 41.8100	-566	1175	810
0x50	16:53:50.969	0.0557	0.1484	1.0742	0.0000	0.0000	0.0000	7.8442	-2.9443	-30.1904 41.7800	-565	1177	807
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## 7.7 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

## 7.8 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.

## 7.9 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.

8 Connect to phone (Just for 232/TTL)

# Note: please take care about the lines connection with type RS232 which offered with 9-36V.

# Please have a reference with the Part 6 hardware connection for safety of connection.

1)Install the app in the Phone, open the app ,then choice WT901

App address:

https://drive.google.com/open?id=1FCn1HZFiviTRyodnLyNrBu9Upxr4hz-O







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	Υ:		27.42°
	Z:		102.88°
	Temperature :		-4.69℃







Please keep the HWT901B 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.



## 9 Application area

### Agricultural machinery



Solar energy



Medical instruments



Geological monitoring



Internet of things



Power monitoring



Construction machinery







## HWT905 High Precision Inclinometer

- Contact: Mr. Kyle Tsang
- E-mail: <a href="mailto:support@wit-motion.com">support@wit-motion.com</a>
- Skype: live:kyle\_8394
- WhatsApp: +86 136 523 39539
- Amazon in USA: <u>www.amazon.com/witmotion</u>
- Amazon in Canada: www.amazon.ca/witmotion
- Amazon in Japan: <u>www.amazon.co.jp/witmotion</u>
- Official Direct Store: <a href="http://www.aliexpress.com/store/4709011">www.aliexpress.com/store/4709011</a>
- Address : Honghai building 1405 Songgang town Baoan District
- Shenzhen Guangdong Province China