

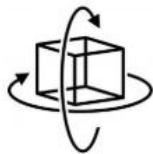
## AHRS IMU Sensor | WT901

*The Robust Acceleration, Angular velocity, Angle & Magnetic filed Detector*

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*The WT901 is a IMU sensor device, detecting acceleration, angular velocity, angle as well as magnetic filed. The robust housing and the small outline makes it perfectly suitable for industrial applications such as condition monitoring and predictive maintenance. Configuring the device enables the customer to address a broad variety of application by interpreting the sensor data by smart algorithms and Kalman filtering.*

### BUILT-IN SENSORS



Accelerometer



Gyroscope



Magnetometer



## Tutorial Link

[Google Drive](#)

**Link to instructions DEMO:**

[WITMOTION Youtube Channel](#)

[WT901 Playlist](#)

If you have technical problems or cannot find the information that you need in the provided documents, please contact our support team. Our engineering team is committed to providing the required support necessary to ensure that you are successful with the operation of our AHRS sensors.

## Contact

[Technical Support Contact Info](#)

## Application

- AGV Truck
- Platform Stability
- Auto Safety System
- 3D Virtual Reality
- Industrial Control
- Robot
- Car Navigation
- UAV
- Truck-mounted Satellite Antenna Equipment

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# 1 Overview

WT901's scientific name is AHRS IMU sensor. A sensor measures 3-axis angle, angular velocity, acceleration, magnetic field. Its strength lies in the algorithm which can calculate three-axis angle accurately.

WT901 is employed where the highest measurement accuracy is required. WT901 offers several advantages over competing sensor:

- Heated for best data availability: new WITMOTION patented zero-bias automatic detection calibration algorithm outperforms traditional accelerometer sensor
- High precision Roll Pitch Yaw (X Y Z axis) Acceleration + Angular Velocity + Angle + Magnetic Field output
- Low cost of ownership: remote diagnostics and lifetime technical support by WITMOTION service team
- Developed tutorial: providing manual, datasheet, Demo video, free software for Windows computer, APP for Android smartphones , and sample code for MCU integration including 51 serial, STM32, Arduino, Matlab, Raspberry Pi, communication protocol for project
- WITMOTION sensors have been praised by thousands of engineers as a recommended attitude measurement solution



## 2 Features

- The default baud rate of this device is 9600 and could be changed.
- The interface of this product only leads to a serial port
- The module consists of a high precision gyroscope, accelerometer and geomagnetic field sensor. The product can solve the current real-time motion posture of the module quickly by using the high-performance microprocessor, advanced dynamic solutions and Kalman filter algorithm.
- The advanced digital filtering technology of this product can effectively reduce the measurement noise and improve the measurement accuracy.
- Maximum 200Hz data output rate. Output content can be arbitrarily selected, the output speed 0.2HZ~ 200HZ adjustable.

## 3 Specification

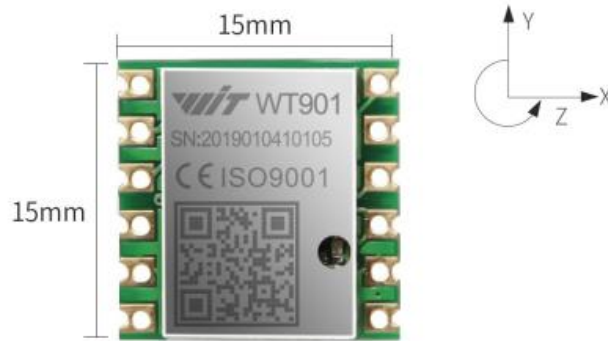
### 3.1 Parameter

Parameter	Specification
➤ Working Voltage	3.3V-5V
➤ Current	<25mA
➤ Size	15mm x 15mm X 2mm
➤ Data	Angle: X Y Z, 3-axis Acceleration: X Y Z, 3-axis Angular Velocity: X Y Z, 3-axis Magnetic Field : X Y Z, 3-axis Time, Quaternion
➤ Output frequency	0.1Hz--200Hz
➤ Interface	Serial TTL level
➤ Baud rate	4800,9600(default),19200,38400,57600, 115200,230400,460800,921600

#### Measurement Range & Accuracy

Sensor	Measurement Range	Accuracy/ Remark
➤ Accelerometer	X, Y, Z, 3-axis ±16g	Accuracy: 0.01g Resolution: 16bit Stability: 0.005g
➤ Gyroscope	X, Y, Z, 3-axis -±2000°/s	Resolution: 16bit Stability: 0.05°/s
➤ Magnetometer	X, Y, Z, 3-axis ±4900μT	0.15μT/LSB typ. (16-bit)
➤ Angle/ Inclinometer	X, Y, Z, 3-axis X, Z-axis: ±180° Y ±90° (Y-axis 90° is singular point)	Accuracy:X, Y-axis: 0.05° Z-axis: 1°(after magnetic calibration)

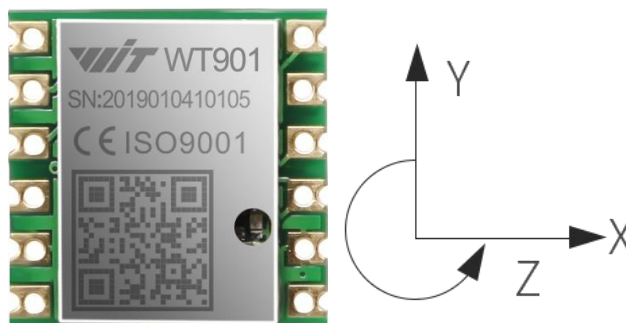
### 3.2 Size



Parameter	Specification	Tolerance	Comment
Length	15	$\pm 0.1$	Unit: millimeter.
Width	15	$\pm 0.1$	
Height	2	$\pm 0.1$	
Weight	1	$\pm 0.1$	Unit: gram

### 3.3 Axial Direction

The coordinate system used for attitude angle settlement is the northeast sky coordinate system. Place the module in the positive direction, as shown in the figure below, direction right is the X-axis, the direction forward is the Y-axis, and direction upward is the Z-axis. Euler angle represents the rotation order of the coordinate system when the attitude is defined as Z-Y-X, that is, first turn around the Z-axis, then turn around the Y-axis, and then turn around the X-axis.





## 4 Pin Definition



PIN	Function
➤ VCC	3.3-5V input supply
➤ RX	Serial data input, TTL interface
➤ TX	Serial data output, TTL interface
➤ GND	Ground
➤ D0	Analog input, digital input and output, PWM
➤ D1	Analog input, digital input and output, PWM, connect GPS
➤ D2	Analog input, digital input and output, PWM
➤ D3	Analog input, digital input and output, PWM
➤ SDA	I2C signal line
➤ SCL	I2C clock line



## 5 Communication Protocol

Level: TTL level

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

### 5.1 Output Data Format

#### 5.1.1 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:

$ms = ((msH < 8) | msL)$

$Sum = 0x55 + 0x51 + YY + MM + DD + hh + mm + ss + ms + TL$



## 5.1.2 Acceleration Output

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

Calculate formula:

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

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

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

Temperature calculated formula:

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

Checksum:

$$\text{Sum} = 0x55 + 0x51 + AxH + AxL + AyH + AyL + AzH + AzL + TH + TL$$

Note:

1. The data is sent in hexadecimal, not ASCII code.

Each data is transmitted in turn of low byte and high byte, and the two are combined into a signed short type data.

For example, X-axis acceleration data Ax, where AxL is low byte and AxH is high byte. The conversion method is as follows:

Assuming that Data is actual data, DataH is its high byte, and DataL is its low byte, then: Data = (short) (DataH < < 8 | DataL).

It must be noted that DataH needs to be coerced into a signed short data and then shifted, and the data type of Data is also a signed short type, so that it can represent negative numbers.

## 5.1.3 Angular Velocity Output

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

Calculated formula:

$$w_x = ((wxH < < 8) | wxL) / 32768 * 2000 \text{ (} ^\circ/s)$$

$$w_y = ((wyH < < 8) | wyL) / 32768 * 2000 \text{ (} ^\circ/s)$$

$$w_z = ((wzH < < 8) | wzL) / 32768 * 2000 \text{ (} ^\circ/s)$$

Temperature calculated formula:

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

Checksum:

$$\text{Sum} = 0x55 + 0x52 + wxH + wxL + wyH + wyL + wzH + wzL + TH + TL$$



## 5.1.4 Angle Output

0x55	0x53	RollL	RollH	PitchL	PitchH	YawL	YawH	VL	VH	SUM
------	------	-------	-------	--------	--------	------	------	----	----	-----

Calculated formula:

Roll(X axis) $Roll = ((RollH < < 8) | RollL) / 32768 * 180(^{\circ})$

Pitch(Y axis) $Pitch = ((PitchH < < 8) | PitchL) / 32768 * 180(^{\circ})$

Yaw(Z axis) $Yaw = ((YawH < < 8) | YawL) / 32768 * 180(^{\circ})$

Version calculated formula:

Version $Version = (VH < < 8) | VL$

Checksum:

Sum $Sum = 0x55 + 0x53 + RollH + RollL + PitchH + PitchL + YawH + YawL + VH + VL$

Note:

1. The coordinate system used for attitude angle settlement is the northeast sky coordinate system. Place the module in the positive direction, as the figure shown in Chapter 3.3, direction right is the X-axis, the direction forward is the Y-axis, and direction upward is the Z-axis. Euler angle represents the rotation order of the coordinate system when the attitude is defined as Z-Y-X, that is, first turn around the Z-axis, then turn around the Y-axis, and then turn around the X-axis.
2. Although the range of the roll angle is  $\pm 180$  degrees, in fact, since the coordinate rotation sequence is Z-Y-X, when expressing the attitude, the range of the pitch angle (Y-axis) is only  $\pm 90$  degrees, and it will change to less than 90 after exceeding 90 degrees Degrees while making the X-axis angle greater than 180 degrees. For detailed principles, please Google Euler angle and posture-related information.
3. Since the three axes are coupled, they will show independent changes only at small angles, and the attitude angles will change at large angles. For example, when the Y-axis is close to 90 degrees, even if the attitude only rotates around the Y-axis, the angle of the axis will also change greatly, which is an inherent problem with Euler angles indicating attitude.

## 5.1.5 Magnetic Output

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

Calculated formula:

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

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

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

Temperature calculated formula:

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

Checksum:

$\text{Sum} = 0x55 + 0x53 + H_{xH} + H_{xL} + H_{yH} + H_{yL} + H_{zH} + H_{zL} + T_H + T_L$

## 5.1.6 Data Output Port Status

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

Calculated formula:

$D_0 = (D_{0H} \ll 8) | D_{0L}$

$D_1 = (D_{1H} \ll 8) | D_{1L}$

$D_2 = (D_{2H} \ll 8) | D_{2L}$

$D_3 = (D_{3H} \ll 8) | D_{3L}$

Note:

### Analog input port mode:

$U = D_x \text{Status} / 1024 * U_{vcc}$

$U_{vcc}$  is the power supply voltage of the module, because the module has LDO, if the module power supply voltage is greater than 3.5V,  $U_{vcc}$  is 3.3V.

If the module supply voltage is less than 3.5V,  $U_{vcc}$  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".



## 5.1.7 Atmospheric Pressure and Height Output

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

Calculated formula:

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

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

Checksum:

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

Note: This only applies to devices with barometer (WT901B, HWT901B, BWT901BCL, WTGAHRS1, WTGAHRS2)

## 5.1.8 Longitude and Latitude Output

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

Calculated formula:

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

In NMEA0183 standard, GPS output format is ddmm.mmmmm (dd for the degree, mm.mmmmm is after decimal point), the module removes the decimal point during output, so the degree of longitude can be calculated as follows:

dd = Lon / 100000000;

mm.mmmmm = (Lon % 100000000) / 100000; (% calculate Remainder)

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

In NMEA0183 standard, GPS output format is ddmm.mmmmm (dd for the degree, mm.mmmmm is after the decimal point), the module removes the decimal point during output, so the degree of latitude can be calculated as follows::

dd = Lat / 100000000;

mm.mmmmm = (Lat % 100000000) / 100000; (% calculate Remainder)

**Checksum:**

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

Note: This only applies to devices with GPS module (WTGAHRS1, WTGAHRS2)



## 5.1.9 Ground Speed Output

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

Calculated formula:

GPS Height= ((GPSHeightH<<8)|GPSHeightL)/10 (m)

GPS Yaw=(GPSYawH <<8)|GPSYawL)/10 (°)

GPSV = (((GPSV 3<<24)|GPSV 2<<16)|GPSV 2<<8)|GPSV0)/1000(km/h)

Checksum:

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

Note: This only applies to devices with GPS module(WTGAHRS1, WTGAHRS2)

## 5.1.10 Quaternion

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

Calculated formula:

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



## 5.1.11 Satellite Positioning Accuracy Output

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

Calculated formula:

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:

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

Note: This only applies to devices with GPS module(WTGAHRS1, WTGAHRS2)



## 5.2 Config Commands

Reminder:

1. Data format

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

### 5.2.1 Register Address

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	MMYY	Month , Year
0x31	HHDD	Hour , Day
0x32	SSMM	Second , Minute
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

## 5.2.2 Save Configuration

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

SAVE: Save

- 0: Save current configuration
- 1: set to default setting

## 5.2.3 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

## 5.2.4 Installation Direction

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

DIRECTION: set installation direction

- 0: set to horizontal installation
- 1: set to vertical installation

## 5.2.5 Sleep/ Wake up

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

After sending the command, the module enters the sleep (standby) state, and once again, the module enters the working state from the standby state.

Eg:

1. FF AA 69 88 B5(Unlock)
2. FF AA 22 01 00 (Sleep State)
3. FF AA 22 01 00 (Unsleep State)

## 5.2.6 Algorithm Transition

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

ALG: 6-axis/ 9-axis algorithm transition

0: switch to 9-axis algorithm

1: switch to 6-axis algorithm

## 5.2.7 Gyroscope Automatic Calibration

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

GYRO: gyroscope automatic calibration

0: set to gyroscope automatic calibration

1: removed to gyroscope automatic calibration

## 5.2.8 Return Content

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

RSWL byte definition

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

RSWH byte definition

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

X is an undefined value.

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

## 5.2.9 Return Rate

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

RATE: return rate

- 0x01 :0.2Hz
- 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.

Eg(20Hz of Return Rate):

1. FF AA 69 88 B5(Unlock)
2. FF AA 03 07 00(20HZ)
- 3.FF AA 00 00 00(Save Config)

## 5.2.10 Baud Rate

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

BAUD:

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

## 5.2.11 Set X Axis Acceleration Bias

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

AXOFFSETL: X axis Acceleration bias low byte

AXOFFSETH: X axis Acceleration bias high byte

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

Note: After setting the acceleration bias, the output value of the acceleration is the sensor measured value minus the bias value.

## 5.2.12 Set Y Axis Acceleration Bias

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

AYOFFSETL: Y axis Acceleration bias low byte

AYOFFSETH: Y axis Acceleration bias high byte

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

Note: After setting the acceleration bias, the output value of the acceleration is the sensor measured value minus the bias value.



### 5.2.13 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: After setting the acceleration bias, the output value of the acceleration is the sensor measured value minus the bias value.

### 5.2.14 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: After setting the angular velocity zero deviation, the output value of the angular velocity is the sensor measurement value minus the zero deviation value.

### 5.2.15 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: After setting the angular velocity zero deviation, the output value of the angular velocity is the sensor measurement value minus the zero deviation value.

## 5.2.16 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 high byte

$GZOFFSET = (GZOFFSETH \ll 8) | GZOFFSETL$

Note: After setting the angular velocity zero deviation, the output value of the angular velocity is the sensor measurement value minus the zero deviation value.

## 5.2.17 Set X Axis Magnetic Bias

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

HXOFFSETL: Set X axis magnetic bias low byte

HXOFFSETH: Set X axis magnetic bias high byte

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

Note: After setting the magnetic field bias, the output value of the magnetic field is the sensor measured value minus the zero bias value.

## 5.2.18 Set Y Axis Magnetic Bias

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

HXOFFSETL: Set Y axis magnetic bias low byte

HXOFFSETH: Set Y axis magnetic bias high byte

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

Note: After setting the magnetic field bias, the output value of the magnetic field is the sensor measured value minus the zero bias value.

## 5.2.19 Set Z Axis Magnetic Bias

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

HXOFFSETL: Set Y axis magnetic bias low byte

HXOFFSETH: Set Z axis magnetic bias high byte

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

Note: After setting the magnetic field bias, the output value of the magnetic field is the sensor measured value minus the zero bias value.

## 5.2.20 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

## 5.2.21 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

## 5.2.22 Set port D2 mode

0xFF	0xAA	0x0e	D2MODE	0x00
------	------	------	--------	------

D2MODE:

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

## 5.2.23 Set port D3 mode

0xFF	0xAA	0x0e	D3MODE	0x00
------	------	------	--------	------

D3MODE:

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

## 5.2.24 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

$D0PWMH = (D0PWMHH \ll 8) | D0PWMHL$

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

## 5.2.25 Set the PWM width of Port D1

0xFF	0xAA	0x13	D1PWMHL	D1PWMHH
------	------	------	---------	---------

D1PWMHL: the PWM width of Port D1 low byte

D1PWMHH: the PWM width of Port D1 high byte

$D1PWMH = (D1PWMHH \ll 8) | D1PWMHL$

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

## 5.2.26 Set the PWM width of Port D2

0xFF	0xAA	0x14	D2PWMHL	D2PWMHH
------	------	------	---------	---------

D2PWMHL: the PWM width of Port D2 low byte

D2PWMHH: the PWM width of Port D2 high byte

$D2PWMH = (D2PWMHH \ll 8) | D2PWMHL$

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

## 5.2.27 Set the PWM width of Port D3

0xFF	0xAA	0x15	D3PWMHL	D3PWMHH
------	------	------	---------	---------

D3PWMHL: the PWM width of Port D3 low byte

D3PWMHH: the PWM width of Port D3 high byte

$D3PWMH = (D3PWMHH \ll 8) | D3PWMHL$

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

## 5.2.28 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

$D0PWMT = (D0PWMTH \ll 8) | D0PWMTL$

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.

## 5.2.29 Set period of Port D1

0xFF	0xAA	0x17	D1PWMTL	D1PWMTH
------	------	------	---------	---------

D1PWMTL: PWM period of Port D1 low byte

D1PWMTH: PWM period of Port D1 high byte

$D1PWMT = (D1PWMTH \ll 8) | D1PWMTL$

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.

## 5.2.30 Set period of Port D2

0xFF	0xAA	0x18	D2PWMTL	D2PWMTH
------	------	------	---------	---------

D2PWMTL: PWM period of Port D2 low byte

D2PWMTH: PWM period of Port D2 high byte

$D2PWMT = (D2PWMTH \ll 8) | D2PWMTL$

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.

### 5.2.31 Set period of Port D3

0xFF	0xAA	0x19	D3PWMTL	D3PWMTH
------	------	------	---------	---------

D3PWMTL: PWM period of Port D3 low byte

D3PWMTH: PWM period of Port D3 high byte

$D3PWMT = (D3PWMTH \ll 8) | D3PWMTL$

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.

### 5.2.32 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.

### 5.2.33 LED

0xFF	0xAA	0x1b	LEDOFF	0x00
------	------	------	--------	------

LEDOFF:

0x01: Turn off LED

0x00: Turn on LED



## 5.2.34 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.

## 5.2.35 Set alarm of module

### 1. Setting minimum value of X-axis angle

0xFF	0xAA	0xAA	DATEL	DATAH
------	------	------	-------	-------

For example, FF AA 5A E4 F8 sets the minimum X-axis angle to -10 degrees.

### 2. Setting maximum value of X-axis angle

0xFF	0xAA	0x5B	DATEL	DATAH
------	------	------	-------	-------

For example, FF AA 5B 1C 07 sets the maximum X-axis angle to 10 degrees.

### 3. Setting minimum value of Y-axis angle

0xFF	0xAA	0x5E	DATEL	DATAH
------	------	------	-------	-------

For example, FF AA 5E E4 F8 sets the minimum Y-axis angle to -10 degrees.

### 4. Setting maximum value of Y-axis angle

0xFF	0xAA	0x5F	DATEL	DATAH
------	------	------	-------	-------

For example, FF AA 5F 1C 07 sets the maximum Y-axis angle to 10 degrees.

### 5. Setting of confirm time

0xFF	0xAA	0x68	DATEL	DATAH
------	------	------	-------	-------

For example, the confirmation time set by FF AA 68 00 00 is 0ms.

### 6. Setting of hold time setting

0xFF	0xAA	0x59	DATEL	DATAH
------	------	------	-------	-------

For example, the hold time set by FF AA 59 64 00 is 100ms.

### 7. Setting of alarm level

0xFF	0xAA	0x62	DATEL	DATAH
------	------	------	-------	-------

For example, the alarm level set by FF AA 62 00 00 is 0.

## 6 IIC Protocol

WT901 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 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	MMYY	Month , Year
0x31	HHDD	Hour , Day
0x32	SSMM	Second , Minute
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

## 6.1 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 WT901 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 6.1

## 6.2 IIC Read the Module

IIC read the module, the format is as follow

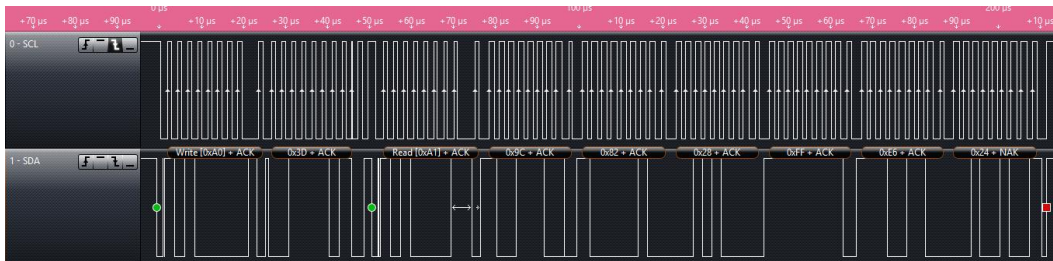
IICAddr<<1	RegAddr	(IICAddr<<1) 1	Data1L	Data1H	Data2L	Data2H	.....
------------	---------	----------------	--------	--------	--------	--------	-------

First IIC host sends a Start signal to WT901 module, then write IICAddr to register address, then IIC host sends a read signal  $(IICAddr \ll 1) | 1$  to WT901 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  $-176.33^\circ$ , Y-axis angle is  $-1.19^\circ$ , Z-axis angle is  $51.89^\circ$