WiT HWT906 AHRS IMU Sensor User Manual

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henzhen Co., Ltd| Datasheet

AHRS IMU Sensor | HWT906

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

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The HWT906 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](#)

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

Contents

1 Overview

HWT906's scientific name is AHRS IMU sensor. A sensor measures 3-axis angle, angular velocity, acceleration and magnetic field. Its strength lies in the algorithm which can calculate three-axis angle accurately. HWT906 is employed where the highest measurement accuracy is required. HWT906 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, PC software, mobile phone APP, and 51 serial, STM32, Arduino, and Matlab sample code, communication protocol
- WITMOTION sensors have been praised by thousands of engineers as a recommended attitude measurement solution

2 Features

- Working voltage 3.3-5V, easy to connect.
- Support three communication interfaces serial port, IIC, SPI
- Internal temperature compensation, suitable for use in variable temperature environments
- The aluminum shell protects the chip against environmental interference, and the size is small and easy to use
- The module consists of a high precision gyroscope, accelerometer, geomagnetic field and barometer 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. Up to 1000Hz data output rate.
- The input content can be selected arbitrarily, and the output rate can be adjusted from 0.2 to 1000HZ.
- In a dynamic environment, the current attitude of the module is accurately output, and the attitude measurement accuracy is 0.05 degrees static and 0.1 degrees dynamic, with high stability.

3 Specification

3.1 Parameter

Parameter	Specification
➢ Working Voltage	3.3V-5V
➢ Current	<30mA
➢ Size	19.95mm x 19.95mm X 7.94mm 0.785" x0.785" x 0.313"
➢ 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	0.2Hz--1000Hz (Default 1000HZ)
➢ Interface	Serial TTL level
➢ Baud rate	4800、9600、19200、38400、57600、115200、230400 、 460800 、 921600(default, could be changed)

Measurement Range & Accuracy		
Sensor	Measurement Range	Accuracy/ Remark
➢ Accelerometer	X, Y, Z, 3-axis ±2/4/8/16 g	Stability: 0.01g
➢ Gyroscope	X, Y, Z, 3-axis ±±250/500/1000/2000°/s	Stability: 0.05°/s
➢ Angle/ Inclinometer	X, Y, Z, 3-axis X, Z-axis: ±180° Y ±90° (Y-axis 90° is singular point)	Accuracy:X, Y-axis: 0.1°Dynamic 0.05° Static Z-axis: 1°(after magnetic calibration)

Accelerometer Parameters

Parameter	Condition	Typical Value
Range		±16g
Resolution	±16	0.01(g/LSB)
RMS noise	Bandwidth =100Hz	0.75~1mg-rms
Static zero drift	Placed horizontally	±20~40mg
Temperature drift	-40°C ~ +85°C	±0.15mg/℃
Bandwidth		5~256Hz

Gyroscope parameters

Parameter	Condition	Typical Value
Range		±2000°/s
Resolution	±2000°/s	0.05(°/s)/(LSB)
RMS noise	Bandwidth =100Hz	0.028~0.07(°/s)-rms
Static zero drift	Placed horizontally	±0.5~1°/s
Temperature drift	-40°C ~ +85°C	±0.005~0.015 (°/s)/℃
Bandwidth		5~256Hz

Magnetometer parameters

Parameter	Condition	Typical Value
Range	Cycle count value (200)	-800uT to +800 uT
Noise	Cycle count value (200)	20nT
Resolution @3V (LSB/uT)	Cycle count value (200)	38nT
Linearity ±200uT	Cycle count value (200)	0.5%
Measuring range	Cycle count value (200)	26nT

Pitch and roll angle parameters

Parameter	Condition	Typical Value
Range		X:±180°
		Y: ±90°
Inclination accuracy	Static	0.1°
	Dynamic	0.5°
Resolution	Placed horizontally	0.0055°
Temperature drift	-40°C ~ +85°C	±0.5~1°

Heading angle parameter

Parameter	Condition	Typical Value
Range		Z:±180°
Heading accuracy	6-axis algorithm, static	0.5° (Dynamic integral cumulative error exists)
Resolution	Placed horizontally	0.0055°

Module parameters

Basic parameters

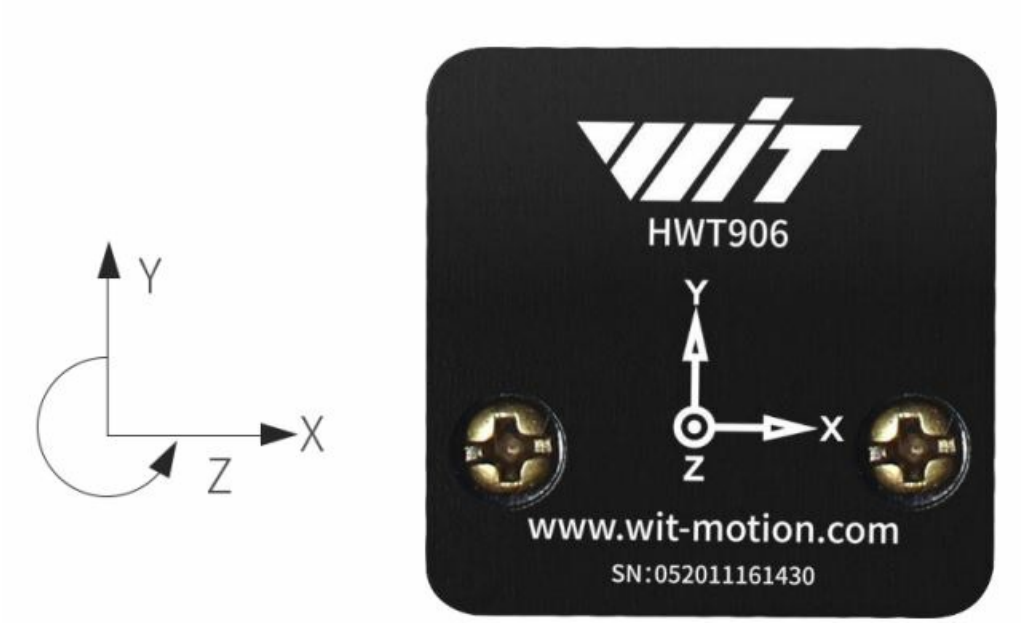
Parameter	Condition	Min	Default	Max
Interface	UART	4800bps	921600bps	921600bps
	HardwareI2C			400K
	Simulation I2C			100K
	SPI			9MHz
Output content		Time, 3-axis acceleration, 3-axis angular velocity, 3-axis angle, 3-axis magnetic field, four elements		
Start Time		0.2Hz	500Hz	1000Hz
Operating temperature		-40℃		85℃
Storage temperature		-40℃		100℃
Shockproof				20000g
Degree of protection				IP67

Electrical parameters

Parameter	Condition	Min	Default	Max
Supply voltage		3.3V	5V	5.5V
Working current	Work（3.3V~5V）		25mA	

3.2 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

Number	Name	Function	Number	Name	Function
1	VCC	3.3-5V	2	MOSI	SPI output input
3	GND	Power ground	4	SCK	SPI clock line
5	SWDIO	Reserved	6	MISO	SPI output input
7	SWCLK	Reserved	8	CS	Reserved
9	SCL	IIC clock line	10	RX	TTL Serial Rx
11	SDA	IIC data cable	12	TX	TTL Serial TX
13	NC	Reserved	14	DRDY	Data Status Pin
15	NC	Reserved	16	PPS	Breathing light pin

Number	Name	Function	Number	Name	Function
17	NC	Reserved	18	RESET	Reset pin
19	GND	Power ground wire	20	NC	Reserved

5 Communication Protocol

Level: TTL level Baud rate: 4800960019200384005760011520023040046080 0 921600(default, could be changed)

Link to WITMOTION protocol.

6. IIC Communicate Protocol

The HWT906 module can be accessed completely through the IIC, the IIC communication rate supports a maximum of 400khz, the slave address is 7bit, and the default address is 0x50, which can be changed through serial port commands or IIC writing address.
Multiple HWT906 modules can be attached to the IIC bus, but the IIC address of the module needs to be modified to a different address in advance.
The module's IIC protocol adopts the way of register address access. The data in each address is 16-bit data, occupying 2 bytes.

6.1 Read IIC

The format of timing data written by IC is as follows:

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

First, the IIC host sends a Start signal to the HWT906 module. Then write the IIC address IICAdr of the module. After writing the register address RegAddr, the host sends a read signal (IICAddr<<1)|1 to the module. If the default address is 0x51, the data sent is 0xa1. After that, the module will output data in the order of low byte first, then high byte. After receiving each byte, the host needs to pull down the SDA bus and send a response signal to the module. After receiving the specified amount of data, pc no longer returns an acknowledgement signal to the module. The module will no longer output data, and the host will send a stop signal to the module to end the operation.

Take reading the angle data of the module as an example, RedAddr is 0x3d, 0x3e, 0x3f, read 6 bytes continuously, the waveform captured by the logic analyzer is shown in the figure below:

The data read from 0x3d is 0x9C, 0x82, 0x28, 0xFF, 0xE6, 0x24 in sequence. That is to say, the angle of the X axis is 0x829C, the angle of the Y axis is 0xFF28, and the angle of the Z axis is 0x24E6. According to the formula, the converted angles can be calculated as: X-axis angle -176.33°, Y-axis angle -1.19°, Z-axis angle 51.89°.

6.2 Write IIC

The format of timing data written by IC is as follows:

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

First, the IIC host sends a Start signal to the HWT906 module.

Then write the IIC address IICAdr of the module, and write the register address RegAddr.

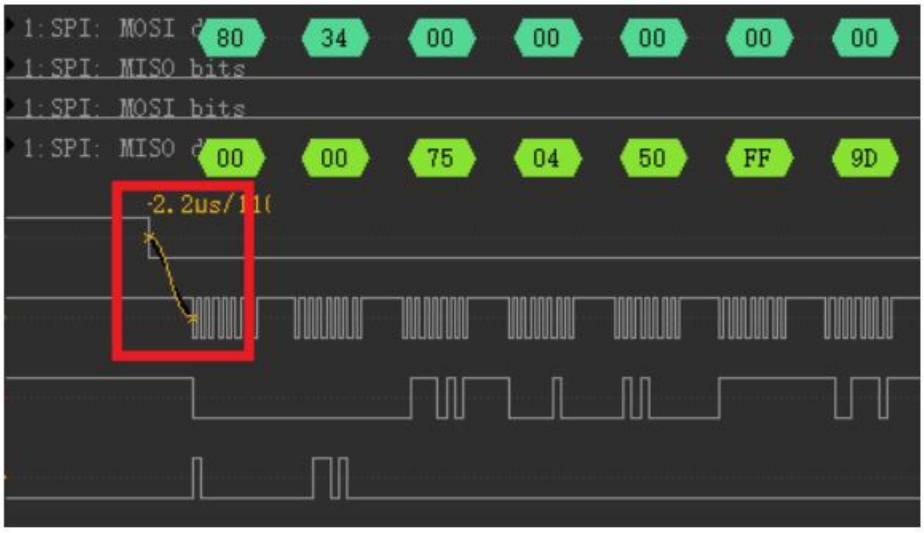
In order to write the low byte of the first data, the high byte of the first data, if there is still data, you can continue to write in the order of the low byte and then the high byte, when the last data is written. , the host sends a stop signal to the module to give up the IIC bus.

When the high-byte data is passed into the HWT906 module, the internal registers of the module will be updated and the corresponding instructions will be executed. At the same time, the internal register address of the module will be automatically incremented by 1, and the address pointer will point to the next register address to be written, so that enter continuous writing can be realized.

7. SPI Communication Protocol

7.1 Hardware Configuration

The HWT906 module can be accessed completely through SPI. The SPI communication rate supports a maximum of 9MHz. The idle state of the clock line remains high, and data acquisition starts from the second clock edge.



Note: It takes at least 2us to start communication when the chip select pin is pulled low, so as to avoid data misalignment caused by slave identification errors.

7.2 Communication Protocol

The SPI protocol of the module adopts the way of register address access. The data in each address is 16-bit data, occupying 2 bytes. The address and meaning of the register are defined in the following table: For the register address table, please refer to the [Chapter 5] register address table of this article.

7.3 SPI Transmission

The transmitted timing data format is as follows:

RegAddrH	RegAddrL	Data1L	Data1H	Data2L	Data2H	.....

Read and write operations:

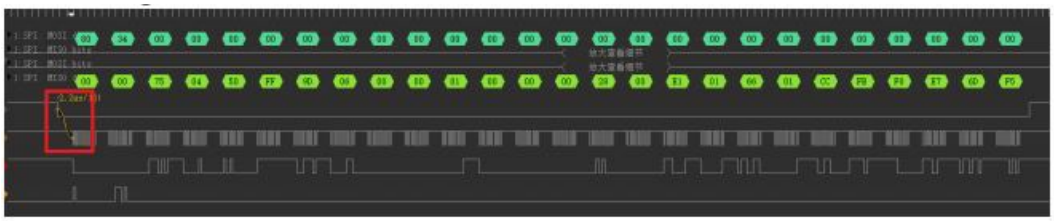
When the highest bit of the register address is 1, it is the function of reading the register.

Example: When the starting address of the read register is 0x34, then RegAddrH is 0x80 and RegAddrL is 0x34.

When the highest bit of the register address is 0, it is the function of writing to the register.

Example: When the start address of writing is 0x34 register, then RegAddrH is 0x00, RegAddrL is 0x34.

The acquisition waveform with a length of 12 register data starting from reading the 0x34 register is as follows:



The chip select pin is pulled low for at least 2us, and the high and low bits of the register are 0x80 and 0x34. The data returned by the HWT906 device is 0x75, 0x04… (the data received by MISO in the figure above).
According to the register list, the acceleration X register value is 0x0475, and the protocol solution is 0.557g.
According to the register list, the acceleration Y register value is 0xFF50, and the protocol solution is 0.085g.

According to the register list, the acceleration Z register value is 0x069D, and the protocol solution is 0.826g.
According to the register list, the angular velocity X register value is 0x0000, and the protocol solution is 0.000°/s.
According to the register list, the angular velocity Y register value is 0x0001, and the protocol solution is 0.061°/s
According to the register list, the angular velocity Z register value is 0x0000, and the protocol solution is 0.000°/s
According to the register list, the magnetic field X register value is 0x0028, and the protocol solution is 40
According to the register list, the magnetic field Y register value is 0x01E1, and the protocol solution is 481
According to the register list, the magnetic field Z register value is 0x0166, and the protocol solution is 358
According to the register list, the value of the angle X register is 0xFBCC, and the protocol solution is -5.91°
According to the register list, the value of the angle Y register is 0xE7F0, and the protocol solution is -33.83 °
According to the register list, the value of the angle Z register is 0xF56D, and the protocol solution is -16.87 °

Documents / Resources

	WiT HWT906 AHRS IMU Sensor [pdf] User Manual MPU-9250, HWT906 AHRS IMU Sensor, HWT906, AHRS IMU Sensor, IMU Sensor, Sensor

References

- Market leader in solar radiation & heat flux measurement
- Welcome to nginx!
- User Manual