10 DOF IMU Sensor (C)

From Waveshare Wiki
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Introduction

10 DOF IMU Sensor (C)
Low Power

(http://www.waveshare.com/10-DOF-IMU-Sensor-C.htm?amazon)

10 DOF IMU Sensor (C), Inertial Measurement Unit, Lower Power Consumption

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More (http://www.waveshare.com/10-DOF-IMU-Sensor-C.htm?amazon)

Application

- Quadcopter
- Action game controller
- Indoor inertial navigation
- Self-balancing Robot
- Altimeter
- Industrial measuring instrument

Feature

Driver IC	MPU9255 (3-axis accelerometer 3-axis gyroscope 3-axisdigital compass)	Built-in 16-Bit AD convertor Gyroscope full-scope range: ±250, ±500, ±1000, ±2000°/sec Accelerometer full-scale range: ±2, ±4, ±8, ±16g Compass full-scale rage: ±4800uT
	BMP280 (Digtal pressure sensor)	Built-in temperature sensor with temperature measurement compensation Pressure measuring range: 300~1100hpa (+9000m ~ -500m relating to sea level) Accuracy: ±0.12hPa(±1m) (700hPa~900hPa,25°C~40°C)
Working voltage	3.3V，5V	
Supported interface	I2C	
Dimensions	31.2mm*17mm	

Table 1: Product features

(/wiki/File:10_DOF_IMU_Sensor_(C)01.png)

Interface

Pin No.	Symbol	Descriptions
1	VCC	3.3V or 5V power supply
2	GND	Supply ground
3	SDA	I2C serial bus data
4	SCL	I2C serial bus clock input
5	INT	MPU9255digital interrupt output
6	FSYNC	MPU9255frame synchronous signal

Table 2: Interface descriptions

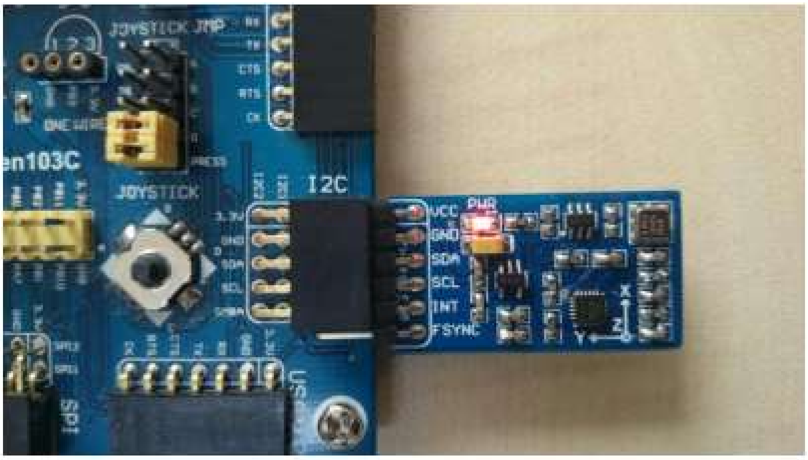
(/wiki/File:10_DOF_IMU_Sensor_(C)_2.png)

Operation

Next, take the Waveshare STM32 development board as an example to demonstrate the 10 DOF IMU Sensor module.

① Download the supporting program to the corresponding development board.

② Connect the serial port cable and the module to the development board, insert the 10 DOF IMU Sensor module into the I2C-2 interface of the development board, and note that the module pins must correspond to the I2C-2 interface, and the FSYNC pin should stay disconnected.



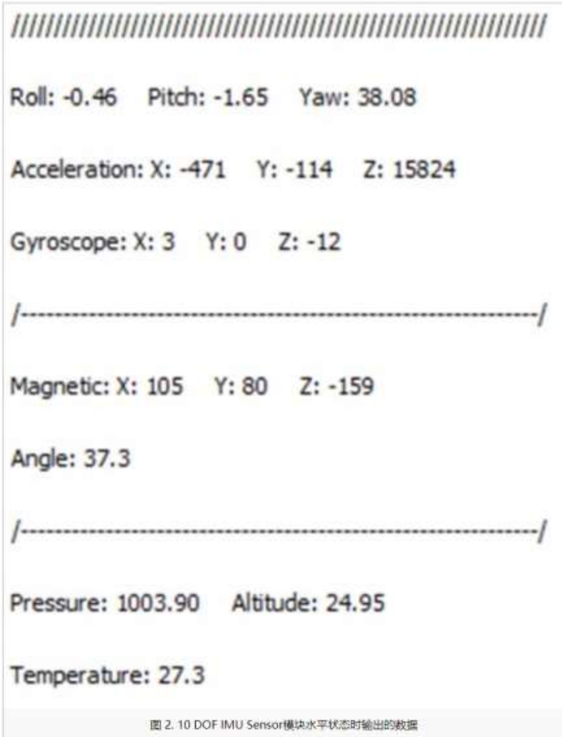
(/wiki/File:10_DOF_IMU_Sensor_(C)_3.png)

③ The serial port configuration is shown in the table

Baud rate	115200
Data bit	8
Stop bit	1
Parity bit	none

(/wiki/File:10_DOF_IMU_Sensor_(C)_4.p
Serial Debugging

④ After the 10 DOF IMU Sensor is powered on, it should be in magnetic calibration first so as to output the correct data. Specific steps are as follows:
A. Put the 10 DOF IMU Sensor in a horizontal position and make it still. When the serial terminal receives stable data, press the JOYSTICK key. At this time, LED1 flashes, and LED2 and LED3 are off.
B. The 10 DOF IMU Sensor is placed in a horizontal position and rotated 180° around the Z-axis. When the serial terminal receives stable data, press the JOYSTICK key, then LED2 flashes, and LED1 and LED3 are off.
C. Invert the 10 DOF IMU Sensor, that is, keep the back of the 10 DOF IMU Sensor up and the front down, when the serial terminal receives stable data, press the JOYSTICK key, then LED3 is always on, indicating that the magnetic calibration is completed, and LED1 and LED2 are off .
D. By placing the 10 DOF IMU Sensor in a horizontal position and rotating 180° around the Z-axis, record and compare the magnetic data received by the serial port terminal before and after the rotation. If the size is equal and the direction is opposite, the magnetic calibration is successful, otherwise it fails.


```
/////////////////////////////////////////////////////////////////

Roll: -0.46    Pitch: -1.65    Yaw: 38.08

Acceleration: X: -471    Y: -114    Z: 15824

Gyroscope: X: 3    Y: 0    Z: -12

/---------------------------------------------------------------/

Magnetic: X: 105    Y: 80    Z: -159

Angle: 37.3

/---------------------------------------------------------------/

Pressure: 1003.90    Altitude: 24.95

Temperature: 27.3
```

图 2. 10 DOF IMU Sensor模块水平状态时输出的数据

(/wiki/File:10_DOF_IMU_Sensor_(C)_5.png)
DOF IMU Sensor Data Output

⑤ After calibrate successfully, output the following data respectively:

The meaning of serial output data is as follows:

Roll, Pitch, Yaw	**Roll angle (°), Pitch angle (°), Yaw angle (°)**
Acceleration	Acceleration value (LSB, translatable into the unit:g)
Gyroscope	Acceleration value (LSB, translatable into the unit: g)
Magnetic	Digital compass title angle (°)
Pressure	Pressure value (hPa)
Altitude	Altitude value (m)
Temperature	Temperature value (℃)

Parameter calibration and calculation

Calibrate Altitude

The module calculates the sea level (P0) as a reference with the altitude in the current position (known) and the air pressure value (known), which will result in the altitude value output by the module having a large error. Please refer to BST-BMP180-DS000-09.pdf:

3.7 Calculating pressure at sea level

With the measured pressure *p* and the absolute altitude the pressure at sea level can be calculated:

$$p_0 = \frac{p}{\left(1 - \frac{\text{altitude}}{44330}\right)^{5.255}}$$

Thus, a difference in altitude of Δaltitude = 10m corresponds to 1.2hPa pressure change at sea level.

(/wiki/File:Parameter_calibration.png)

Based on P0, the Altitude of the current position of the module can be calculated:

3.6 Calculating absolute altitude

With the measured pressure *p* and the pressure at sea level p_0 e.g. 1013.25hPa, the altitude in meters can be calculated with the international barometric formula:

$$\text{altitude} = 44330 * \left(1 - \left(\frac{p}{p_0}\right)^{\frac{1}{5.255}}\right)$$

(/wiki/File:Parameter_calibration2.png)

Therefore, the user needs to give the value of the current position of the module in the sample code 10 DOF IMU Sensor\SRC\HardWare\BMP180\BMP180.h as a reference (generally, the altitude value of the ground is used as the reference, in mm). E.g

```
#define LOCAL_ADS_ALTITUDE      2500          //mm     altitude of your position now
```

(/wiki/File:Parameter_calibration3.png)

Calculate acceleration

The unit of acceleration measured by the program is LSB (least significant bit), and the unit is often converted to gravitational acceleration (g) in actual use. The sample program of the module sets AFS_SEL=0 by default, and the corresponding range is 16384 LSB/g (±2g), so the actual acceleration measured is:
a=Acceleration/16384 ,$Unit$:g Please refer to
PS-MPU-9255.pdf page 8 (https://www.waveshare.com/w/upload/0/01/PS-MPU-9255.pdf)
RM-MPU-9255.pdf page 14 (https://www.waveshare.com/w/upload/d/d9/RM-MPU-9255.pdf)

Calculate gyroscope angular velocity

The unit of angular velocity measured by the program is LSB (least significant bit). In practice, the unit is often converted to angular velocity (°/sec). The sample program of the module sets FS_SEL=2 by default, and the corresponding range is 32.8 LSB/(°/s) (±1000°/s), so the actual angular velocity measured is:
ω=Gyroscope/32.8 ,Unit:°/s
Please refer to
PS-MPU-9255.pdf page 8 (https://www.waveshare.com/w/upload/0/01/PS-MPU-9255.pdf)
RM-MPU-9255.pdf page 14 (https://www.waveshare.com/w/upload/d/d9/RM-MPU-9255.pdf)

Resources

- User Manual (/wiki/File:10-DOF-IMU-Sensor-C-User-Manual-EN.pdf)
- Schematic (/wiki/File:10-DOF-IMU-Sensor-C-Schematic.pdf)
- Code (/wiki/File:10-DOF-IMU-Sensor-C-code.7z)
- Datasheets (/wiki/10_DOF_IMU_Sensor_Datasheets)

FAQ

Question:What is the data output frequency of the acceleration and angular velocity of this module?

Answer:
Acceleration output frequency: 4~4000Hz

Angular velocity output frequency: 4~8000Hz

Question:How to calibrate the acceleration of this module?

Answer:
Accelerometers generally do not need to be calibrated. Do you want to be a warm float? Simply put it in the incubator to do segmental zero drift collection at each temperature. If the ambient temperature changes little, no calibration is required.

Question:Why is there a big difference between the morning and the afternoon when the module uses the barometer to test the altitude value?

Answer:
Barometers can only be used to measure relative altitudes, and measurements are not repeatable (unless in a specific laboratory environment). Therefore, barometers are generally used to measure short-term altitude differences.

Absolute altitude (altitude) is generally measured using GPS.

Support

If you require technical support, please go to the Support (https://support.waveshare.com/hc/en-us/requests/new) page and open a ticket.