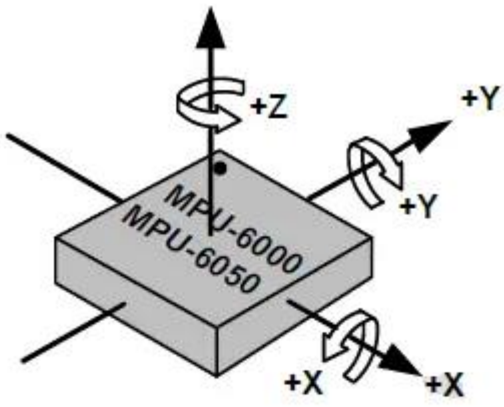
The coordinate system of the MPU6050 chip is defined as follows: Make the chip surface face you, and turn the text on the surface to the correct angle. At this time, with the internal center of the chip as the origin, the horizontal axis to the right is the X axis, and the vertical axis is the Y axis. Axis, the one pointing towards you is the Z axis.



Accelerometer

The three acceleration components are all expressed in multiples of gravity acceleration g. The acceleration range that can be expressed, that is, the magnification can be set uniformly. There are 4 optional magnifications: 2g, 4g, 8g, and 16g. Taking ACC_X as an example, if the magnification is set to 2g (default), it means that when ACC_X takes the minimum value -32768, the current acceleration is 2 times the gravity acceleration along the positive direction of the X-axis; if it is set to 4g, when it takes -32768 Represents 4 times the gravitational acceleration along the positive direction of the X-axis, and so on. Obviously, the lower the magnification, the better the accuracy. The higher the magnification, the wider the range. This should be set according to the specific application.

Taking ACC_X as an example, if the currently set acceleration magnification is 4g, then the formula for converting the ACC_X reading into acceleration is:

$$a_x = 4g \times \mathrm{ACC}\backslash\_\mathrm{X}/32768 \qquad \text{g=9.8 m/s^2}$$

Angular velocity meter

The angular velocity components GYR_X, GYR_Y and GYR_Z rotating around the three coordinate axes of X, Y and Z are all 16-bit signed integers. Looking from the origin toward the rotation axis, a positive value indicates clockwise rotation, and a negative value indicates counterclockwise rotation.

The three angular velocity components are all in "degree/second". The range of angular velocity that can be expressed, that is, the magnification can be set uniformly. There are 4 optional magnifications: 250 degrees/second, 500 degrees/second, 1000 degrees/second, 2000 degrees/second. Taking GYR_X as an example, if the magnification is set to 250 degrees/second, it means that when GYR takes the positive maximum value of 32768, the current angular velocity is 250 degrees/second clockwise; if it is set to 500 degrees/second, when 32768 is taken, the current The angular velocity is 500 degrees/second clockwise. Obviously, the lower the magnification, the better the accuracy, and the higher the magnification, the wider the range.

Taking GYR_X as an example, if the currently set angular velocity magnification is 1000 degrees/second, then the formula for converting GRY_X readings into angular velocity (clockwise) is: $g_x = 1000 \times \text{GYR}\backslash\_\text{X}/32768$。

Specification of MPU6050

1. Chip built-in 16bit AD converter, 16-bit data output
2. Driver Chip: MPU6050
3. Operating Voltage: 3-5V DC
4. Communication: I2C/IIC Protocol
5. Gyro Range: ± 250, 500, 1000, 2000 °/s
6. Accelerometer Range: ± 2 ± 4 ± 8 ± 16 g

1. Sensitivity and Range

Objective: Determine the sensor's ability to detect minimal movements and its maximum measurable limits.

Method: Use a smartphone with a built-in gyroscope and accelerometer as a reference. Most smartphones have high-precision sensors, and various apps can log sensor data I choose phyphox as the Accelerometer.

Equipment: MPU6050 module, smartphone, Arduino or similar microcontroller, breadboard, and jumper wires.

Procedure: Secure both the MPU6050 and the smartphone on a flat, stable surface. Use an app to record the smartphone's sensor data while simultaneously logging data from the MPU6050 as you gently tilt the surface to introduce slight movements. Compare the two data sets to evaluate sensitivity and range.

2. Accuracy and Error

Purpose: Compare sensor measurements to known standards to determine accuracy and error range.
Method: Conduct three free falls at the same height and compare the data obtained by the mobile app phyphox with the sensor data.
Equipment: MPU6050, arduino mega, smartphone breadboard.
Steps: Fix the MPU6050 and smartphone on a stable, horizontal surface. Three free falls were made from the same height (10cm) and the readings from the MPU6050 were compared to those from the phyphox. Calculate the average error and accuracy of sensor readings.

3. Drift

Objective: Assess how much the sensor's measurements vary over time without any external movement.

Method: Long-term stationary observation.

Equipment: MPU6050, microcontroller, data logging software or setup.

Procedure: Set up the MPU6050 in a stationary position without any movement for an extended period (e.g., 24 hours). Log the sensor output continuously. Analyze the data for variations that would indicate drift.