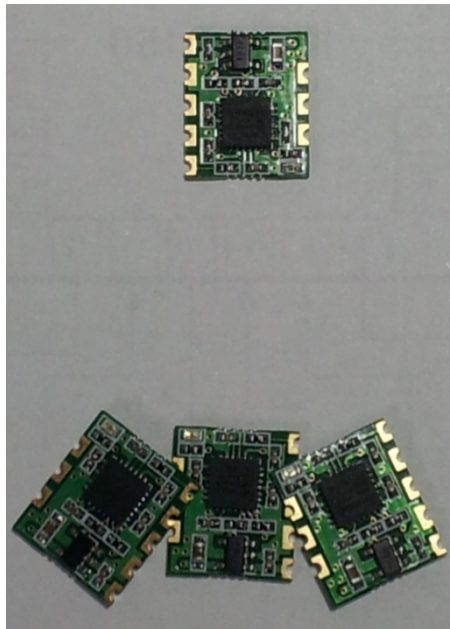


OSTSen-6050 User Guide



Onsystemch

1. OSTSen-6050 Overview

OSTSen-6050 is a high performance motion tracking module, which is based on InvenSense MPU-6050. The MPU-6050 is the world's first integrated 6-axis Motion Tracking device that combines a 3-axis gyroscope, a 3-axis accelerometer, and a Digital Motion Processor™ (DMP™) hardware accelerator engine.

With its dedicated I2C sensor bus, it directly accepts inputs from an external 3-axis compass to provide a complete 9-axis MotionFusion™ output. The MPU-6050 MotionTracking device, with its 6-axis integration, on-board MotionFusion™, and run-time calibration firmware, enables manufacturers to eliminate the costly and complex selection, qualification, and system level integration of discrete devices, guaranteeing optimal motion performance for consumers. The MPU-6050 is also designed to interface with multiple non-inertial digital sensors, such as pressure sensors, on its auxiliary I2C port.

2. Applications

- *BlurFree™* technology (for Video/Still Image Stabilization)
- *AirSign™* technology (for Security/Authentication)
- *TouchAnywhere™* technology (for “no touch” UI Application Control/Navigation)
- *MotionCommand™* technology (for Gesture Short-cuts)
- Motion-enabled game and application framework
- InstantGesture™ iG™ gesture recognition
- Location based services, points of interest, and dead reckoning
- Handset and portable gaming
- Motion-based game controllers
- 3D remote controls for Internet connected DTVs and set top boxes, 3D mice
- Wearable sensors for health, fitness and sports
- Toys

3. Features

3.1 Gyroscope Features

The triple-axis MEMS gyroscope in the MPU-6050 includes a wide range of features:

- Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full-scale range of ± 250 , ± 500 , ± 1000 , and $\pm 2000^\circ/\text{sec}$
- External sync signal connected to the FSYNC pin supports image, video and GPS synchronization
- Integrated 16-bit ADCs enable simultaneous sampling of gyros
- Enhanced bias and sensitivity temperature stability reduces the need for user calibration
- Improved low-frequency noise performance
- Digitally-programmable low-pass filter
- Gyroscope operating current: 3.6mA
- Standby current: 5 μ A
- Factory calibrated sensitivity scale factor
- User self-test

3.2 Accelerometer Features

The triple-axis MEMS accelerometer in MPU-6050 includes a wide range of features:

- Digital-output 3-Axis accelerometer with a programmable full scale range of $\pm 2g$, $\pm 4g$, $\pm 8g$ and $\pm 16g$
- Integrated 16-bit ADCs enable simultaneous sampling without external multiplexer
- Accelerometer normal operating current: 500 μ A
- Low power accelerometer mode current: 10 μ A at 1.25Hz, 20 μ A at 5Hz, 60 μ A at 20Hz, 110 μ A at 40Hz
- Orientation detection and signaling
- Tap detection
- User-programmable interrupts
- High-G interrupt
- User self-test

3.3 Additional Features

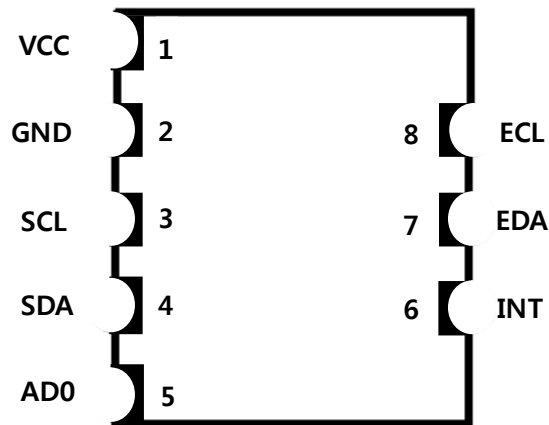
The MPU-6050 includes the following additional features:

- 9-Axis MotionFusion via on-chip Digital Motion Processor (DMP)
- Auxiliary master I2C bus for external sensors (e.g., pressure sensor)
- 3.9mA operating current when all 6 motion sensing axes and the DMP are enabled
- VDD supply voltage range of 2.375V-3.46V
- Flexible VLOGIC reference voltage supports multiple I2C interface voltages
- Smallest and thinnest package for portable devices: 4x4x1mm LGA
- Minimal cross-axis interference between the accelerometer, gyroscope and magnetometer axes
- 1024 byte FIFO buffer reduces power consumption by allowing host processor to read the data in burst mode and then it goes into a low-power mode during the MPU collects more data
- Digital-output temperature sensor
- User-programmable digital filters for gyroscope, accelerometer, and temp sensor
- 10,000 g shock tolerant
- 400kHz Fast Mode I2C for communicating with all registers
- MEMS structure hermetically sealed and bonded at wafer level
- RoHS and Green compliant

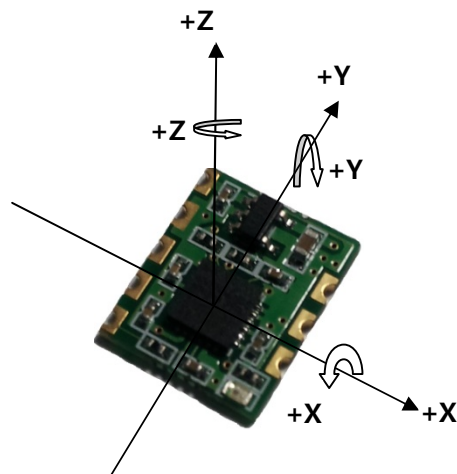
4. Application Information

4.1 Module Pin Out and Signal Description

Pin Number	Pin Name	Pin Description
1	VCC	Power supply voltage
2	GND	Power supply ground
3	SCL	I2C serial clock (SCL)
4	SDA	I2C serial data (SDA)
5	AD0	I2C Slave Address LSB (AD0) In case AD0 is low, device address is 0x68 In case AD0 is high, device address is 0x69
6	INT	Interrupt digital output (totem pole or open-drain)
7	EDA	Auxiliary I2C master serial data
8	ECL	Auxiliary I2C master serial clock



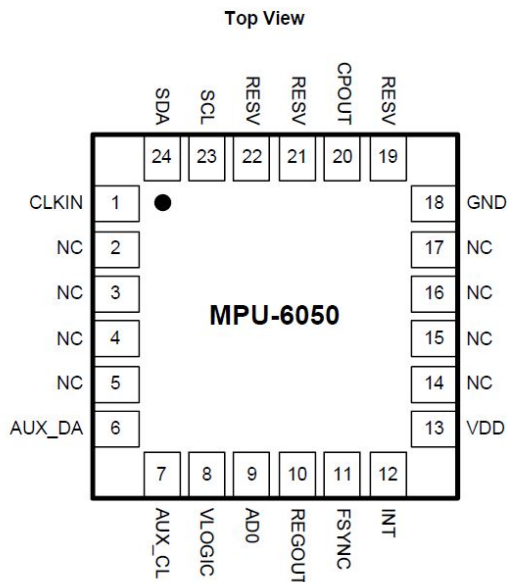
< Top View >



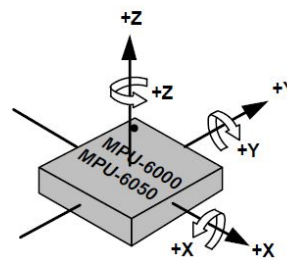
Orientation of Axes of Sensitivity
and Polarity of Rotation

4.2 MPU-6050 Pin out and Signal Description

Pin Number	Pin Name	Pin Description
1	CLKIN	Optional external reference clock input. Connect to GND if unused
6	AUX_DA	Auxiliary I2C master serial data for connecting to external sensors
7	AUX_CL	Auxiliary I2C master serial clock for connecting to external sensors
8	VLOGIC	Digital I/O supply voltage
9	AD0	I2C Slave Address LSB (AD0)
10	REGOUT	Regulator filter capacitor connection
11	FSYNC	Frame synchronization digital input. Connect to GND if unused
12	INT	Interrupt digital output (totem pole or open-drain)
13	VDD	Power supply voltage and Digital I/O supply voltage
18	GND	Power supply ground
20	CPOUT	Charge pump capacitor connection
23	SCL	I2C serial clock (SCL)
24	SDA	I2C serial data (SDA)
19,21,22	RESV	Reserved. Do not connect
2,3,4,5,14, 15,16,17	NC	Not internally connected. May be used for PCB trace routing

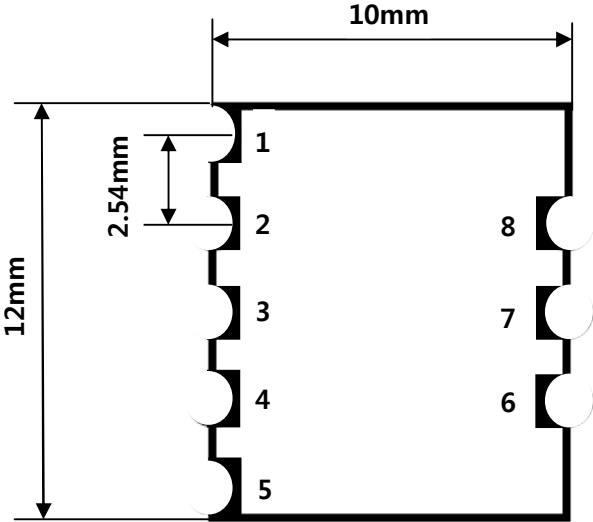


QFN Package
24-pin, 4mm x 4mm x 0.9mm



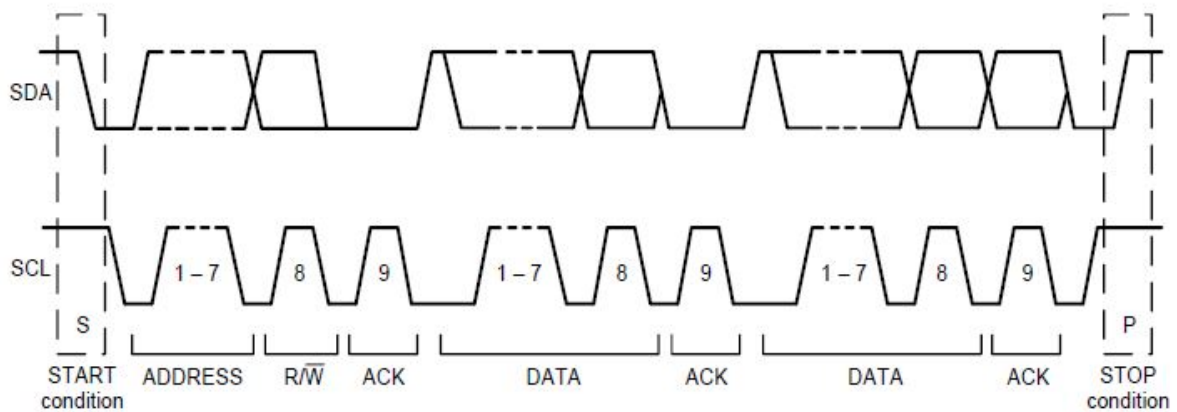
Orientation of Axes of Sensitivity and
Polarity of Rotation

5. Module Dimension



< OSTSen-6050 module >

6. I2C Communications



Single-Byte Write Sequence

Master	S	AD+W		RA		DATA		P
Slave			ACK		ACK		ACK	

Burst Write Sequence

Master	S	AD+W		RA		DATA		DATA		P
Slave			ACK		ACK		ACK		ACK	

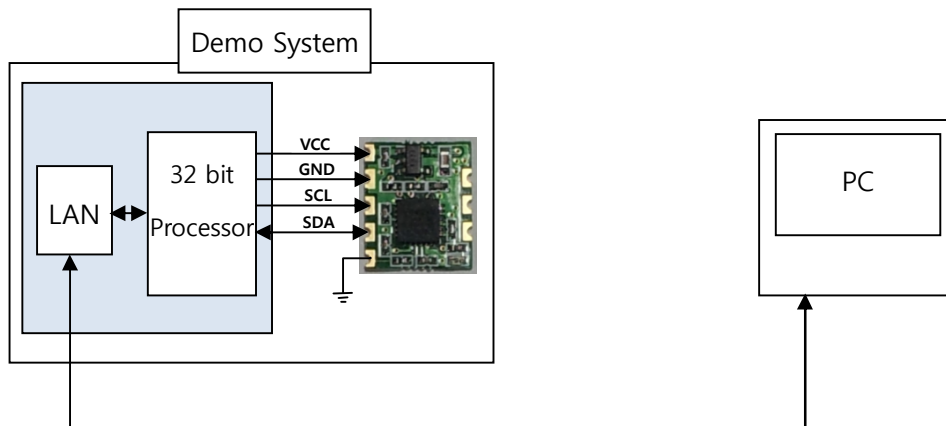
Single-Byte Read Sequence

Master	S	AD+W		RA		S	AD+R			NACK	P
Slave			ACK		ACK			ACK	DATA		

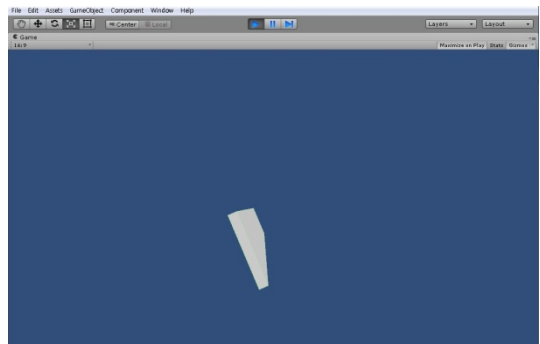
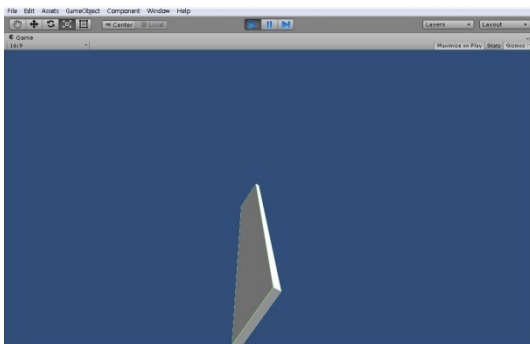
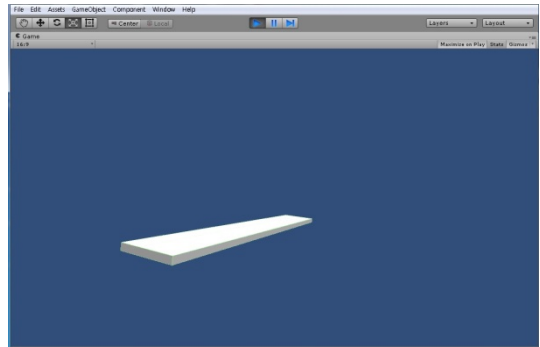
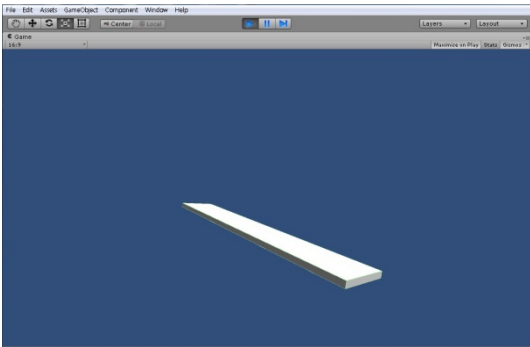
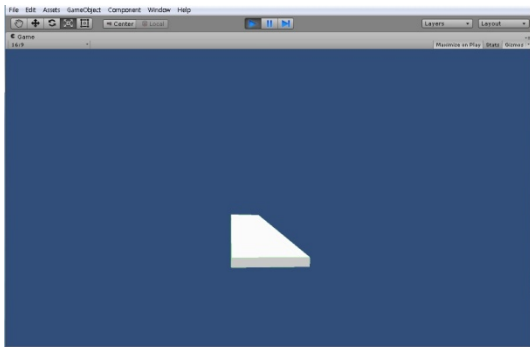
Burst Read Sequence

Master	S	AD+W		RA		S	AD+R			ACK		NACK	P
Slave			ACK		ACK			ACK	DATA		DATA		

7. Demo System



OSTSen-6050 Data Display on PC



8. Reference

- 1) <http://www.invensense.com/mems/gyro/documents/PS-MPU-6000A-00v3.4.pdf>
- 2) <http://www.invensense.com/mems/gyro/documents/RM-MPU-6000A-00v4.2.pdf>
- 3) <http://www.invensense.com/mems/gyro/documents/AN-MPU-6000EVB.pdf>
- 4) http://invensense.com/mems/gyro/documents/eb_armat91_xxaxx_b%20rev%201.2.pdf
- 5) <http://invensense.com/mems/gyro/documents/PB-MPU-9150IMF%20MotionFit%20Wireless%20Developer%20Kit%20Product%20Brief.pdf>
- 6) http://www.invensense.com/developers/index.php?_r=default