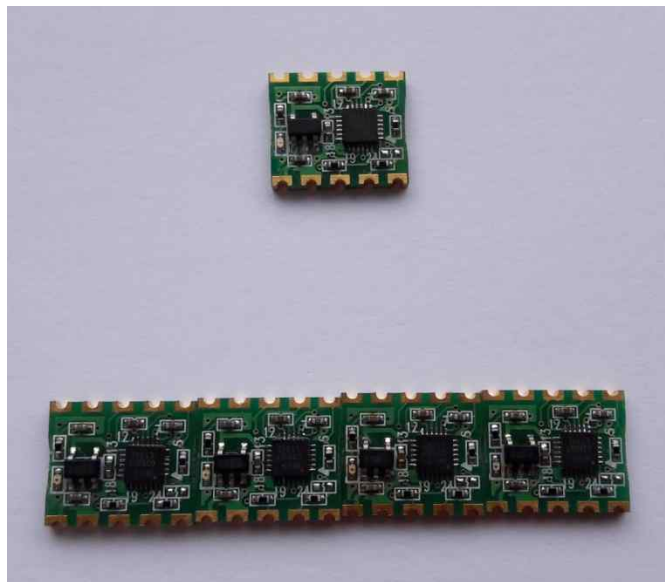# OSTSen-6500   User Guide

Ver 1.0

Onsystech

1. OSTSen-6500   Overview

OSTSen-6500 is a high performance motion tracking module, which is based on InvenSense MPU-6500. The MPU-6500 is the a 6-axis Motion Tracking device that combines a 3-axis gyroscope, a 3-axis accelerometer, and a Digital Motion Processor™ (DMP™) all in a small 3x3x0.9mm package. It also features a 4096-byte FIFO that can lower the traffic on the serial bus interface, and reduce power consumption by allowing the system processor to burst read sensor data and then go into a low-power mode. With its dedicated I2C sensor bus, the MPU-6500 directly accepts inputs form external I2C devices. MPU-6500, with its 6-axis integration, on-chip DMP, 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. MPU-6500 is also designed to interface with multiple non-inertial digital sensors, such as pressure sensors, on its auxiliary I2C port.

The Gyroscope has a programmable full-scale range of ±250, ±500, ±1000, and ±2000 degrees/sec and very low rate noise at 0.01dps/√Hz. The accelerometer has a user-programmable accelerometer full-scale range of ±2g, ±4g, ±8g, and ±16g. Factory-calibrated initial sensitivity of both sensors reduces production-line calibration requirements.

Other industry-leading features include on-chip 16-bit ADCs, programmable digital filters, a precision clock with 1% drift from -40°C to 85°C, an embedded temperature sensor, and programmable interrupts. The device features I2C and SPI serial interfaces, a VDD operating range of 1.71 to 3.6V, and a separate digital IO Supply, VDDIO from 1.7V to 3.6V.

Communication with all registers of the device is performed using either I2C at 400kHz or SPI 1MHz. For applications requiring faster communications, the sensor and interrupt registers may be read SPI at 20MHz.

By leveraging its patented and volume-proven CMOS-MEMS fabrication platform, which integrated MEMS wafers with companion CMOS electronics through wafer-level bonding, InvenSense has driven the package size down to a footprint and thickness of 3x3x0.90mm (24-pin QFN), to provide a very small yet high performance low cost package. The device provides high robustness by supporting 10,000*g* shock reliability.

2. Applications

- *TouchAnywhere*™ technology (for "no touch" UI Application Control/Navigation)
- *MotionCommand*™ technology (for Gesture Short-cuts)
- Motion-enabled game and application framework
- 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

3. Features of MPU-6500
3.1 Gyroscope Features

The triple-axis MEMS gyroscope in the MPU-6500 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 ±2000°/sec and

integrated 16-bit ADCs
- Digitally-programmable low-pass filter
- Gyroscope operating current: 3.2mA
- Factory calibrated sensitivity scale factor
- Self-test

3.2 Accelerometer Features

The triple-axis MEMS accelerometer in MPU-6500 includes a wide range of features:
- Digital-output X-, Y-, and Z-axis accelerometer with a programmable full scale range of ±2g, ±4g, ±8g and ±16g and integrated 16-bit ADCs
- Accelerometer normal operating current: 450µA
- Low power accelerometer mode current: 6.37µA at 0.98Hz, 17.75µA at 31.25Hz
- User-programmable interrupts
- Wake-on-motion interrupt for low power operation of application processor
- Self-test

3.3 Additional Features

The MPU-6500 includes the following additional features:
- Auxiliary master I2C bus for reading data from external sensors(e.g. magnetometer)
- 3.4mA operating current when all 6 motion sensing axes active
- VDD supply voltage range of 1.8 ~ 3.3V ±5%
- VDDIO reference voltage of 1.8 ~ 3.3V ±5% auxiliary I2C devices
- Smallest and thinnest QFN package for portable devices: 3x3x0.9mm
- Minimal cross-axis sensitivity between the accelerometer, gyroscope axes
- 4096 byte FIFO buffer enables the applications processor to read the data in bursts
- 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
- 1MHz SPI serial interface for communication with all registers
- 20MHz SPI serial interface for reading sensors and interrupt 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); SPI serial clock(SCLK)
4	SDA	I2C serial data (SDA); SPI serial data input(SDI)
5	AD0	I2C Slave Address LSB (AD0); SPI serial data output(SDO)
6	NCS	Chip select (SPI mode only)
7	INT	Interrupt digital output (totem pole or open-drain)
8	ADA	Auxiliary I2C master serial data
9	ACL	Auxiliary I2C master serial clock
10	FSYNC	Frame synchronization digital input. Connect to GND if unused

< Top View >

Orientation of Axes of Sensitivity
and Polarity of Rotation
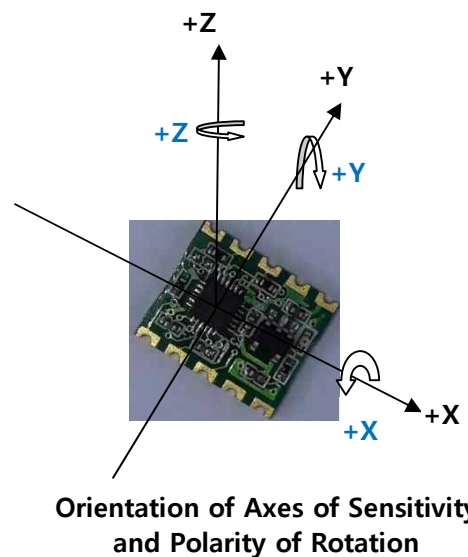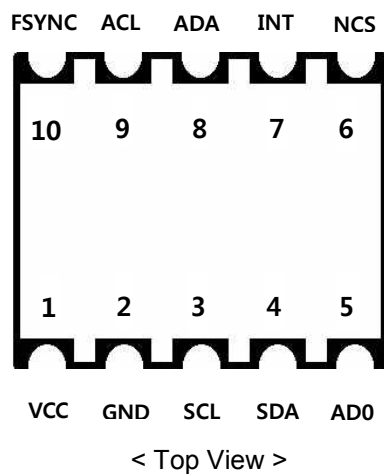
4.2 MPU-6500 Pin out and Signal Description

Pin Number	Pin Name	Pin Description
7	AUX_CL	I2C master serial clock for connecting to external sensors
8	VDDIO	Digital I/O supply voltage
9	AD0/SDO	I2C Slave Address LSB (AD0); SPI serial data output(SDO)
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) *Note: The Interrupt line should be connected to a pin the Application Processor(AP) that can bring the AP out of suspend mode.*
13	VDD	Power supply voltage and Digital I/O supply voltage
18	GND	Power supply ground
19	RESV	Reserved. Do not connect
20	RESV	Reserved. Connect to GND
21	AUX_DA	I2C master serial data, for connecting to external sensors
22	nCS	Chip Select (SPI mode only)
23	SCL/SCLK	I2C serial clock (SCL); SPI serial clock(SCLK)
24	SDA/SDI	I2C serial data(SDA); SPI serial data input(SDI)
1-6, 14-17	NC	No Connection Pin. Do not connect

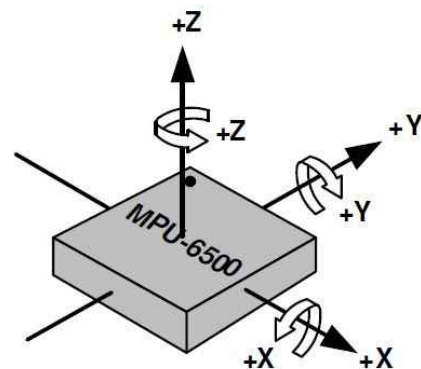● **MPU-9250 I2C 7bit device address: 0x69 (In module : AD0 is HIGH)**
0x68 (In module : AD0 is LOW)

In case, 7bit device address is 0x68:

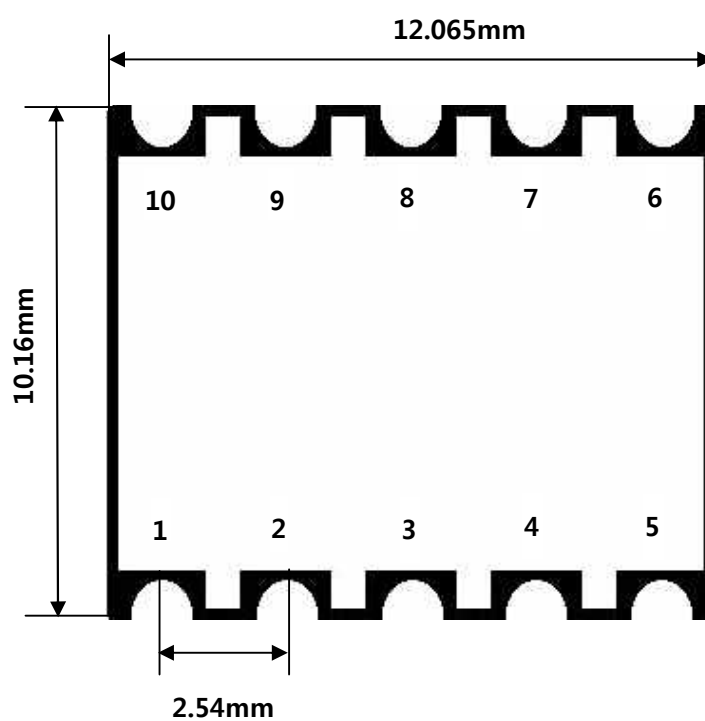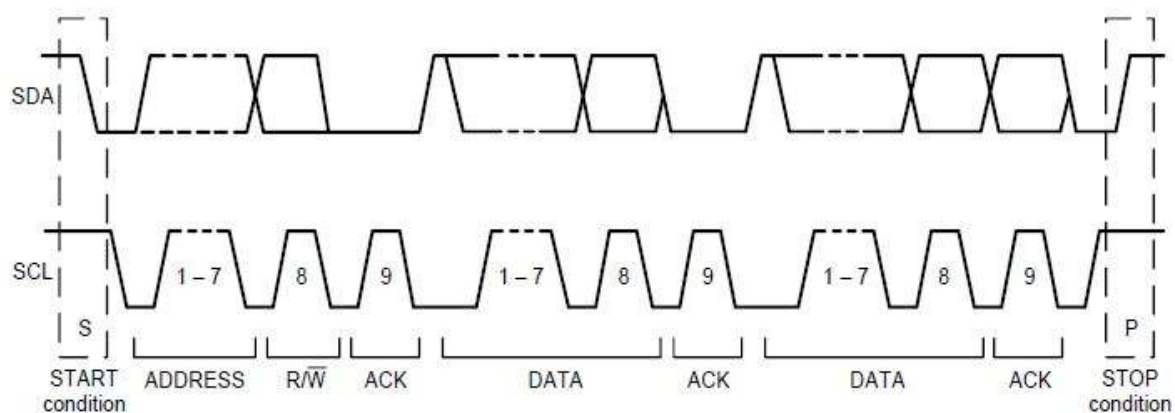MSB   LSB

1	1	0	1	0	0	0	R/W
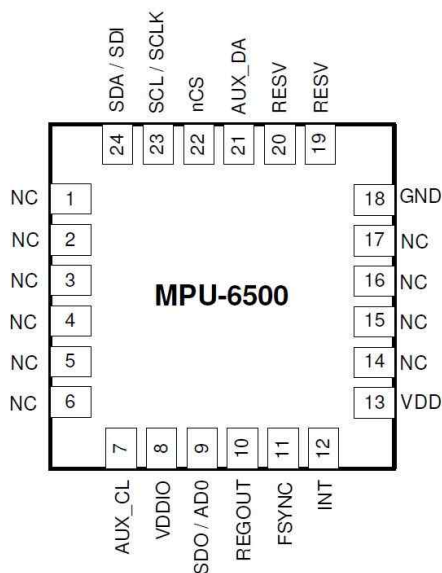
< MPU-6500 Pinout (Top View) >   < Orientation of Axes of MPU-6500 >

5. Module Dimension

12.065mm

10.16mm

| 10 | 9 | 8 | 7 | 6 |

| 1 | 2 | 3 | 4 | 5 |

2.54mm

< OSTSen-6500 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
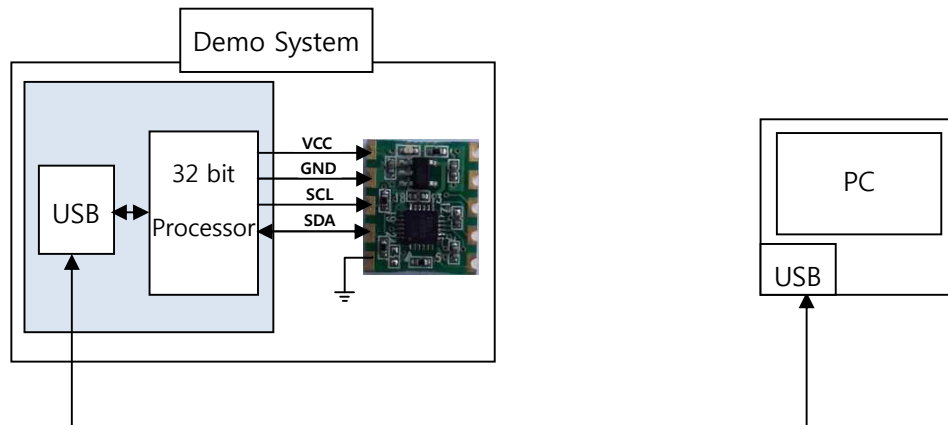
OSTSen-6500 Data Display on PC

8. Reference

1) https://www.invensense.com/products/motion-tracking/6-axis/mpu-6500/
2) https://www.invensense.com/wp-content/uploads/2015/02/MPU-6500-Datasheet2.pdf
3) https://www.invensense.com/wp-content/uploads/2015/02/MPU-6500-Register-Map2.pdf
4) https://www.invensense.com/wp-content/uploads/2015/02/AN-IVS-0001EVB-00-v1-3.pdf
5) https://github.com/rpicopter/ArduinoMotionSensorExample
6) https://create.arduino.cc/projecthub/Aritro/getting-started-with-imu-6-dof-motion-sensor-96e066

- If you need some information or have some questions about OSTSen-6500, contact ostsen@naver.com.