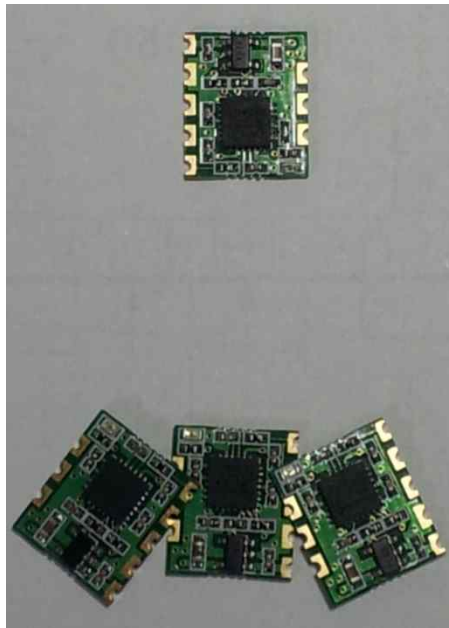


OSTSen-9150 User Guide



Hara Systems Inc.

1. OSTSen-9150 Overview

OSTSen-9150 is a high performance motion tracking module, which is based on InvenSense MPU-9150. The MPU-9150 is the world's first integrated 9-axis Motion Tracking device that combines a 3-axis MEMS gyroscope, a 3-axis MEMS accelerometer, a 3-axis MEMS magnetometer, and a Digital Motion Processor™ (DMP™) hardware accelerator engine.

The MPU-9150 is an ideal solution for handset and tablet applications, game controllers, motion pointer remote controls, and other consumer devices. The MPU-9150's 9-axis Motion Fusion combines acceleration and rotational motion plus heading information into a single data stream for the applications. This Motion Processing™ technology integration provides small footprint and has inherent cost advantages compared to discrete gyroscope, accelerometer, plus magnetometer solutions.

The MPU-9150 is also designed to work with multiple non-inertial digital sensors, such as pressure sensors, on its auxiliary I2C port to produce a 10-Axis sensor fusion output. The MPU-9150 is a 3rd generation motion processor and is footprint compatible with the MPU-60X0 and MPU-30X0 families.

2. Application

- *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
- Pedestrian based navigation
- Navigation
- Electronic Compass

3. Features

3.1 Gyroscope Features

The triple-axis MEMS gyroscope in the MPU-9150 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

- Factory calibrated sensitivity scale factor
- User self-test

3.2 Accelerometer Features

The triple-axis MEMS accelerometer in MPU-9150 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
- Orientation detection and signaling
- Tap detection
- User-programmable interrupts
- High-G interrupt
- User self-test

3.3 Magnetometer Features

The triple-axis MEMS magnetometer in MPU-9150 includes a wide range of features:

- 3-axis silicon monolithic Hall-effect magnetic sensor with a magnetic concentrator
- Wide dynamic measurement range and high resolution with low current consumption.
- Output data resolution is 13 bits (0.3 μT per LSB)
- Full scale measurement range is $\pm 1200 \mu T$
- Self-test function with internal magnetic source to confirm magnetic sensor operation on end products

3.4 Additional Features

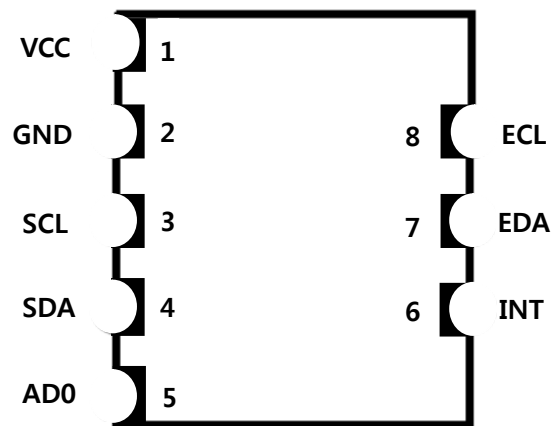
The MPU-9150 includes the following additional features:

- 9-Axis MotionFusion via on-chip Digital Motion Processor (DMP)
- Auxiliary master I2C bus for external sensors (e.g., pressure sensor)
- 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

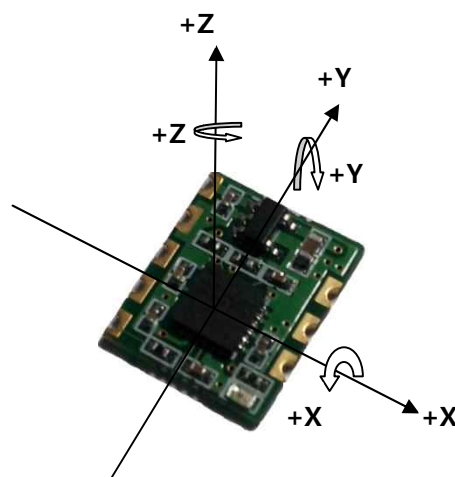
4. Application Information

4.1 Module Pin Out and Signal Description

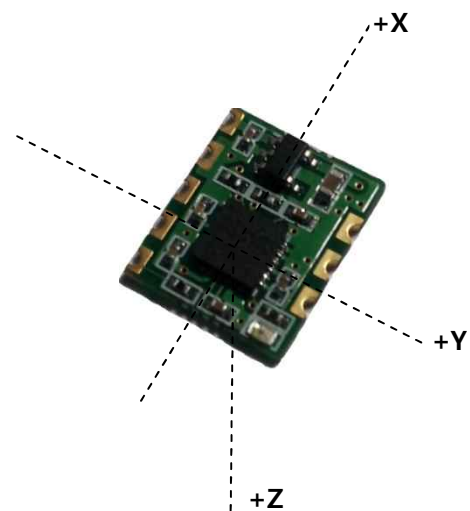
Pin Number	Pin Name	Pin Description
1	VCC	Power supply voltage
2	GND	Power supply ground
3	SCL	I2C serial clock (SCL)
4	SDA	I2C serial data (SDA)
5	AD0	I2C Slave Address LSB (AD0) In case AD0 is low, device address is 0x68 In case AD0 is high, device address is 0x69
6	INT	Interrupt digital output (totem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



< TopView >



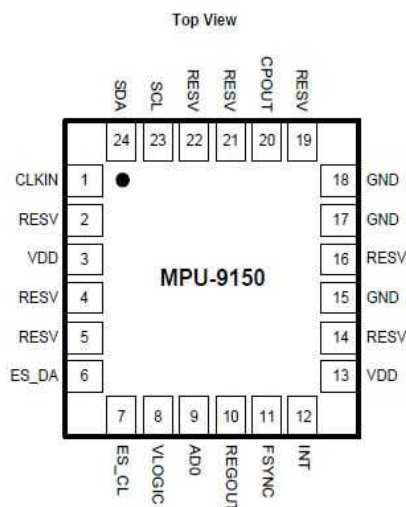
Orientation of Axes of Sensitivity
and Polarity of Rotation
for **Accel & Gyro**



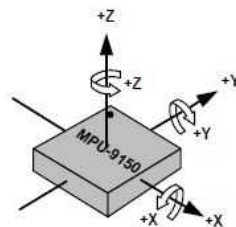
Orientation of Axes of
Sensitivity
for **Magnetometer**

4.2 MPU-9105 Pin out and Signal Description

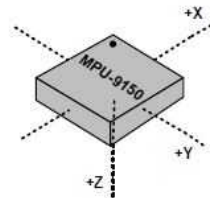
Pin Number	Pin Name	Pin Description
1	CLKIN	Optional external reference clock input. Connect to GND if unused
6	ES_DA	Auxiliary I2C master serial data
7	ES_CL	Auxiliary I2C master serial clock
8	VLOGIC	Digital I/O supply voltage
9	AD0	I2C Slave Address LSB (AD0)
10	REGOUT	Regulator filter capacitor connection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



LGA Package
24-pin, 4mm x 4mm x 1mm

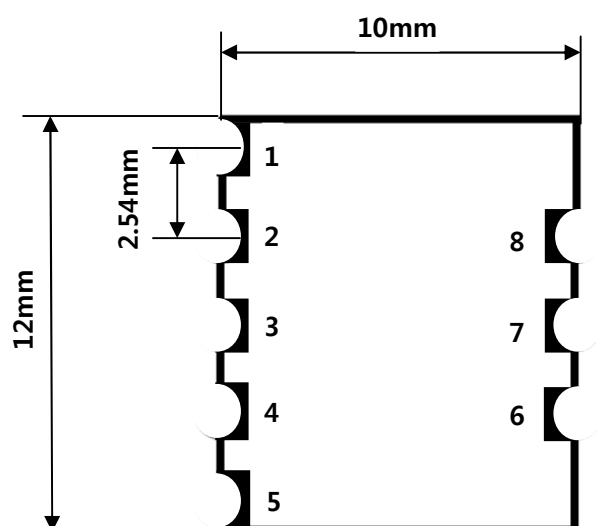


Orientation of Axes of Sensitivity and
Polarity of Rotation for Accel & Gyro



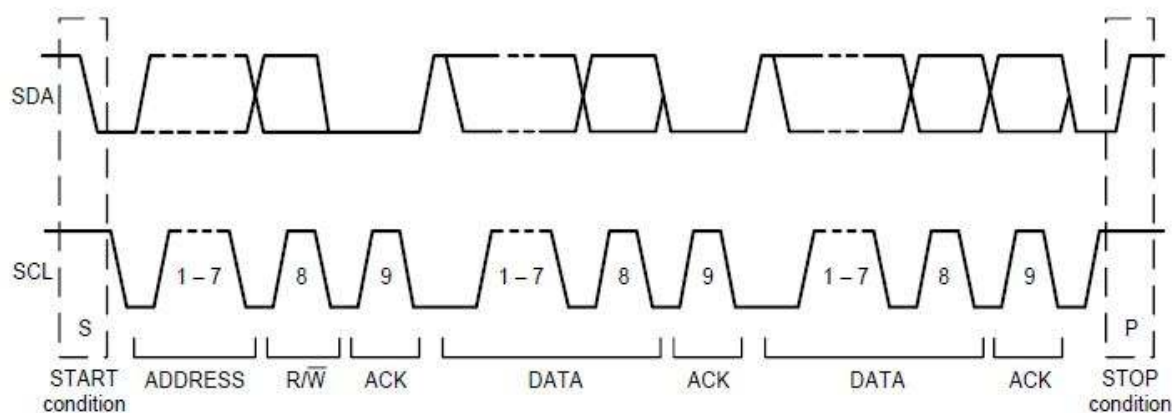
Orientation of Axes of Sensitivity for
Magnetometer

5. Module Dimension



< OSTSen-9150 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	

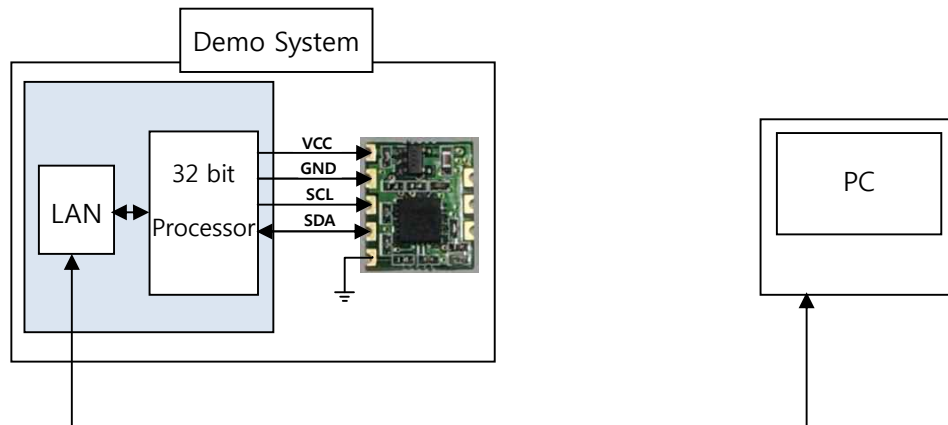
Single-Byte Read Sequence

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

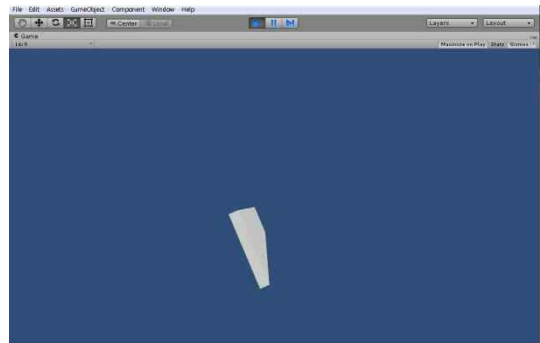
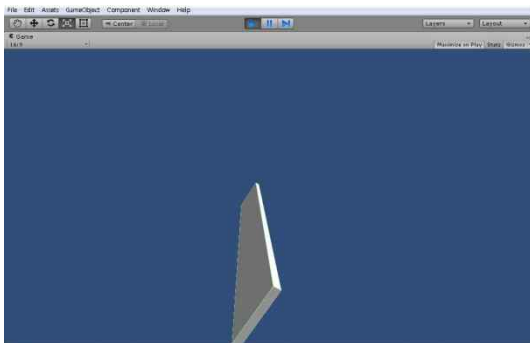
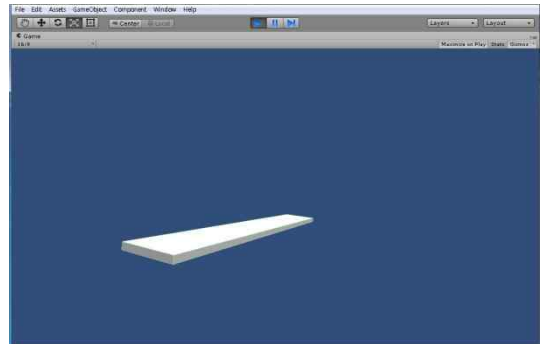
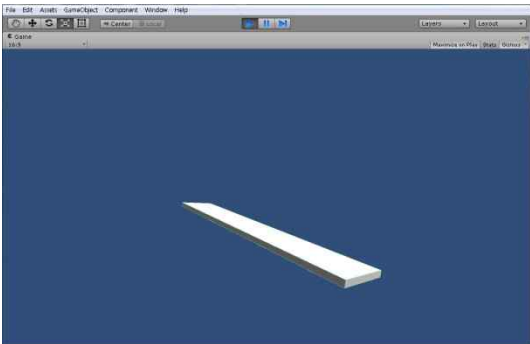
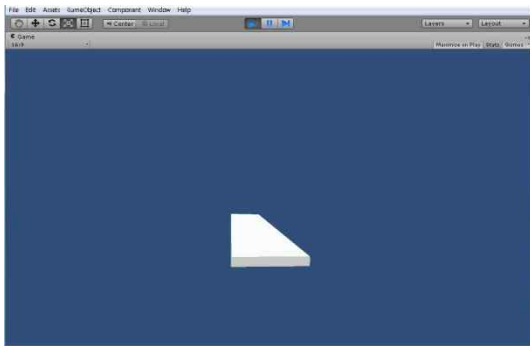
Burst Read Sequence

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

7. Demo System



OSTSen-9150 Data Display on PC



8. Reference

- 1) http://invensense.com/mems/gyro/documents/PS-MPU-9150A-00v4_3.pdf
 - 2) http://www.invensense.com/mems/gyro/documents/RM-MPU-9150A-00v4_2.pdf
 - 3) <http://www.invensense.com/mems/gyro/documents/AN-MPU-9150EVB-00.pdf>
 - 4) <http://invensense.com/mems/gyro/documents/PB-MPU-9150IMF%20MotionFit%20Wireless%20Developer%20Kit%20Product%20Brief.pdf>
 - 5) http://www.invensense.com/developers/index.php?_r=default
- If you need some information or have some questions about OSTSen-9150, contact ostsen@hanmail.net