BMI160 shuttle 9-axis sensor orientation

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1   Introduction

BMI160 is a highly integrated low power MEMS inertial measurement unit (IMU) that includes a 16-bit 3-axis accelerometer and a 16-bit 3-axis gyroscope. BMI160 is in mass production. Its datasheet is available online at http://www.bosch-sensortec.com/en/homepage/products_3/6_axis_sensors_2/inertial_measurement_unit_1/bmi160/bmi160_1 after clicking the "Documents & drivers" tab.

The dimension of BMI160 is 2.5mm x 3.0mm x 0.83mm in LGA-14 package. There are 4 pins on each of 2.5mm sides and 3 pins on each of 3.0mm sides.

This document illustrates BMI160 shuttle board reference coordinate and 9-axis sensor orientation with pin-1 location. This information can be used for axis remapping when testing BSX sensor fusion library.

2 BMI160 shuttle board

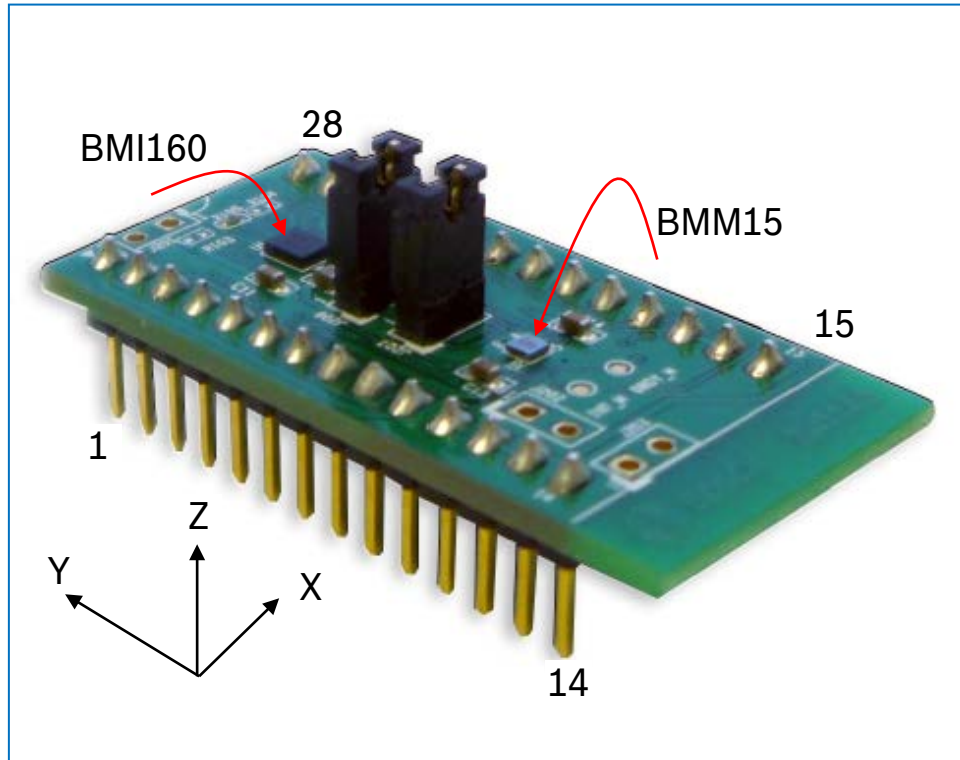The BMI160 shuttle board and its reference coordinate is as shown in Figure 1.

Figure 1 BMI160 shuttle board orientation

The 9-axis sensor orientation should be aligned to this shuttle board reference coordinate so that the BSX sensor fusion library will output correct Euler angles according to Android definition.
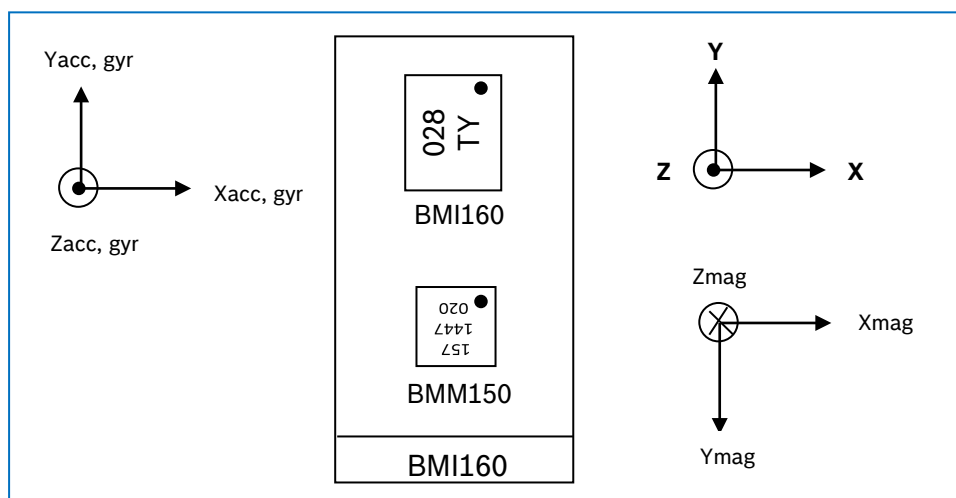

Figure 2 9-axis sensor orientation

3   Axis remapping

According to Figure 2, the orientation of the BMI160 accelerometer and gyroscope axes is aligned to the BMI160 shuttle board reference coordinate. Therefore, there is no need to do axis remapping on BMI160.

For BMI160 ACC part,

> Xacc = BMI160_ACC_X;
> Yacc = BMI160_ACC_Y;
> Zacc = BMI160_ACC_Z;

Where, BMI160_ACC_X, Y, Z are the raw data in the unit of m/s2 from the BMI160 accelerometer part and Xacc/Yacc/Zacc are the axis remapped data to feed the BSX library.

For BMI160 GYR part,

> Xgyr = BMI160_GYR_X;
> Ygyr = BMI160_GYR_Y;
> Zgyr = BMI160_GYR_Z;

Where, BMI160_GYR_X, Y, Z are the raw data in the unit of radians from the BMI160 gyroscope part and Xgyr/Ygyr/Zgyr are the axis remapped data to feed the BSX library.

However, the orientation of BMM150 axes is not aligned to the BMI160 shuttle board reference coordinate. Users can do the axis remapping as below.

> Xmag = BMM150_X;
> Ymag = -BMM150_Y;
> Zmag = -BMM150_Z;

Where, BMM150_X, Y, Z are the raw data in the unit of uT from BMM150 and Xmag/Ymag/Zmag are the axis remapped data to feed the BSX library.

4   Android definition for Euler angles

Bosch Sensortec BSX sensor fusion uses Android definition for Euler angles by default. The Android rotation vector definition can be found at http://developer.android.com/guide/topics/sensors/sensors_motion.html with X axis pointing to East, Y axis to earth magnetic North and Z axis to the sky as shown in Figure 3.
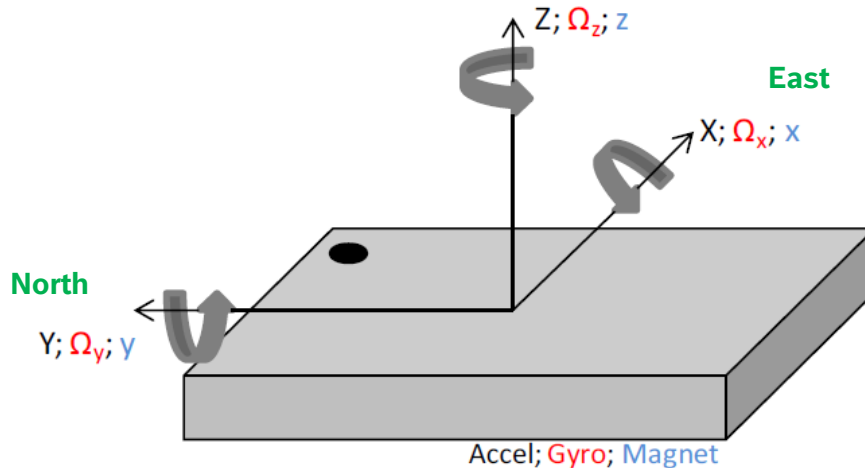

Figure 3 BSX Android definition for Euler angles

- Heading: rotation around Z axis [0° <= heading < 360°). 0° = North, 90° = East, 180° = South, 270° = West. The heading value increases when rotate around Z axis clockwise from top view of Figure 3.

- Pitch: rotation around X axis [-180° <= pitch <= 180°] with positive values increasing when Z axis moves toward Y axis.

- Roll: rotation around Y axis [-90° <= roll <= 90°] with positive values increasing when X axis moves toward Z axis.

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6 Document history and modification

Rev. No	Chapter	Description of modification/changes	Date
1.0		Document creation	October 29th, 2015
1.1	Section 2	BMM150 chip laser marking text orientation is rotated 90 degrees counterclockwise from the original drawing	March 1st, 2016

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