1st Nov 2023

Certus Evo & Motus Gyroscope Allan Variance

Revision History

VERSION	DATE	CHANGES
1.0	1st Nov 2023	Initial Release

Table 1. Revision history

Introduction

Motus is a micro-electromechanical systems (MEMS) inertial measurement units (IMU). Motus is further embedded in Certus Evo to combine data from a Motus IMU, with a dual antenna RTK GNSS receiver. These are coupled in a sophisticated fusion algorithm to deliver accurate and reliable position, navigation and timing (PNT).

This report uses the Allan Variance method to demonstrate bias instability and angular random walk values for the gyroscopes. This is useful for comparing the raw sensor performance of an AHRS or INS product. This report facilitates decision making in the suitability and performance of both Motus and Certus Evo for a wide range of applications.

For further application, performance, or reference needs, please contact your account manager or support@advancednavigation.com for more information. Advanced Navigation also offers loan units, if needed, to help determine product performance and suitability.

Allan Variance

The Allan Variance method is used to determine the Bias instability and Angular Random Walk (ARW) of the gyroscopes.

PERFORMANCE GRADE	BIAS STABILITY
Consumer/Hobby	> 30 °/h
Industrial & Tactical	1 – 30 °/h
High-end Tactical	0.1 – 1 °/h
Navigation	0.01 – 0.1 °/h
Strategic	0.0001 – 0.01 °/h

Bias Instability (sometimes referred to by others as Bias Stability, or In-run Bias Stability) is a comparative figure of merit for gyroscope drift. Lower numbers mean a lower error in orientation estimation when integrating the gyroscope output over time. It is often used to divide gyroscope performance into grades, for example; consumer, industrial, tactical, navigation or strategic. It is represented in the units of °/hr.

Angular Random Walk (ARW) is the angular error buildup with time due to white noise in the angular rate. It is represented in the units of °/√hr. It can also be represented as Noise Density, in the units of °/h/√Hz, by multiplying ARW by 60. More precisely, the conversation is as follows:

$$ARW\ (°/\mathrm{h}) = \frac{1}{60} \cdot \mathrm{FFT}\ (°/\mathrm{h}/\sqrt{Hz})$$

Certus Evo & Motus published specifications are:

- A gyroscope bias instability of 0.1 °/hr
- A angular random walk (ARW) of 0.2 °/√hr

Method

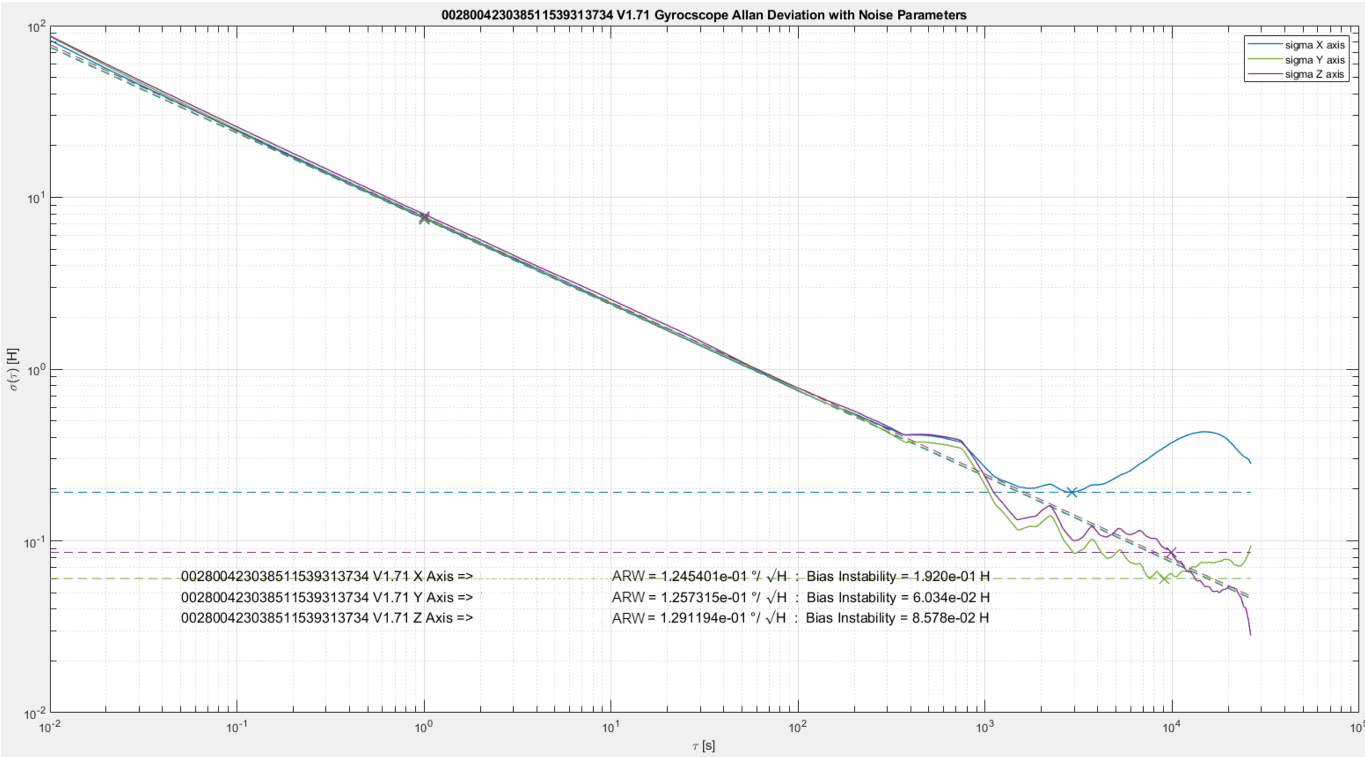
In order to carry out an Allan Variance test, a Certus Evo unit is situated in a low noise/vibration environment with a relatively stable temperature. The unit is mounted in a stationary fashion. For the range of units tested below, these were situated in either an office environment overnight on an optical table. These environments are suitable to prove the performance of the units, however are imperfect, whereby artefacts can be seen on the Allan Variance plot. Tests are run for a duration of 8+ hours in order to collect sufficient data.

Results

The average result across multiple tests is:

- **Gyro Bias Instability = 0.12 °/hr (or 12 x 10^{-2})**
- **Angular Random Walk (ARW) = 0.12 °/√hr (or 12 x 10^{-2})**

The image below is representative of the Allan Variance test result of a Certus Evo unit.



Allan Variance of unit of 002800423038511539313734

Representative Unit Test Results

#	Unit Serial Number	Hardware version	Gyro Bias Instability (°/hr) (x/y/z axis)	Angular Random Walk (°/√hr) (x/y/z axis)
1	002800423038511539313734	v1.0	0.19 0.06 0.09	0.12 0.13 0.13