μIMU
Random Vibration Testing
Revision 1

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Introduction

A μIMU was subjected to a series of random vibration tests on an electrodynamic shaker system. A set of twenty trials were performed with the overall acceleration levels ranging from 1 *g*-rms to 20 *g*-rms. The profile was chosen to represent a flat random input from 50Hz to 3kHz. The shaker can be configured to produce a multitude of random vibration inputs. The specification used in this study is intended to be a base from which to further investigate the effects of vibration on noise in the μIMU.

Random Vibration Induced Angular Rate Noise

This study has begun in a simple manner with the calculation of the change in the standard deviation of the rate output of an IMU subjected to random vibration. A bare μIMU was mounted to the shaker body via an aluminum test fixture. It was mounted with the standard three bolt pattern provided stock with an μIMU. The reference accelerometer for control of the shaker was mounted in the same plane as the device under test (DUT). A baseline was established by collecting sixty seconds of data and comparing the noise to the statistically derived values in our database. A typical noise level in the μIMU is 0.56º/s. The noise levels found in the test device were consistent with this value. The standard deviation, σ, has been plotted as a function of the acceleration level (Figure 1). The plots show the dependence of the noise on total random vibration levels.

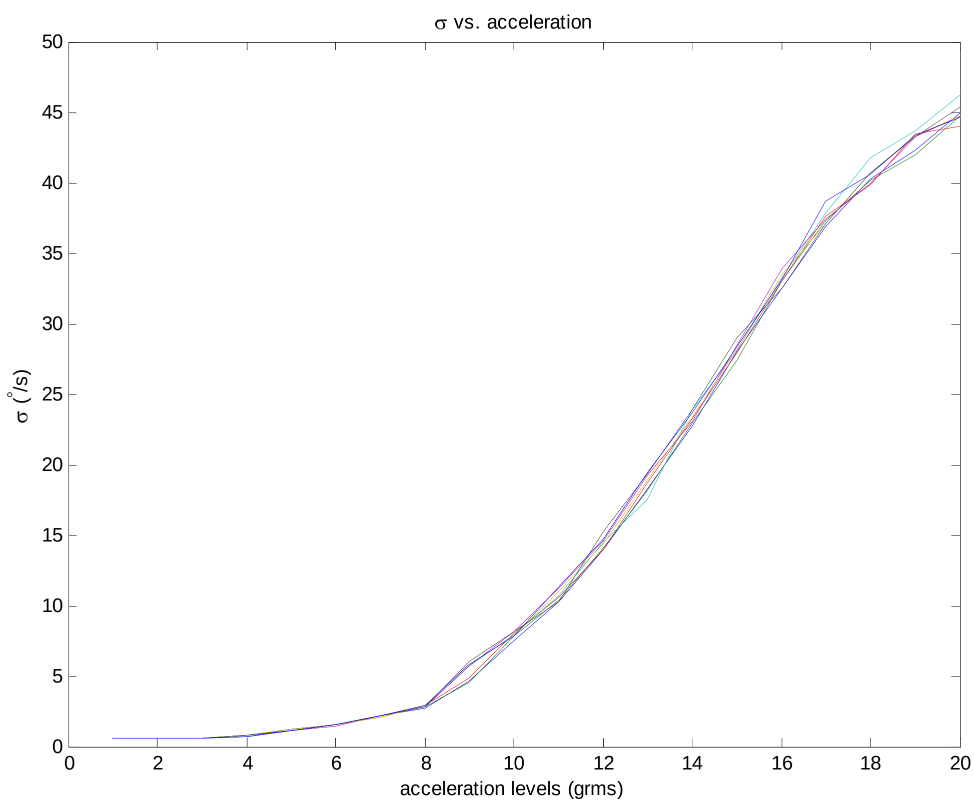

Figure 1: Standard Deviation (º/s) as a Function of Random Acceleration Levels: 50Hz µIMU Z-axis

Results and Applications

Random vibration is almost exclusively used to evaluate system performance in the presence of vibration due to turbulent flow of some type (e.g. wind turbulence, vehicle noise on pavement). The lower levels of random vibration, 1-5 *g*-rms may be encountered in vehicle applications, whereas the higher levels (+15*g*-rms) may be representative of skin vibration in a rocket application. However, the acceleration levels encountered in the intended application are highly dependent on mounting location. The performance of the inertial sensor package can be evaluated for noise and the designer can judge if additional vibration damping will be required in the mounting of the IMU.

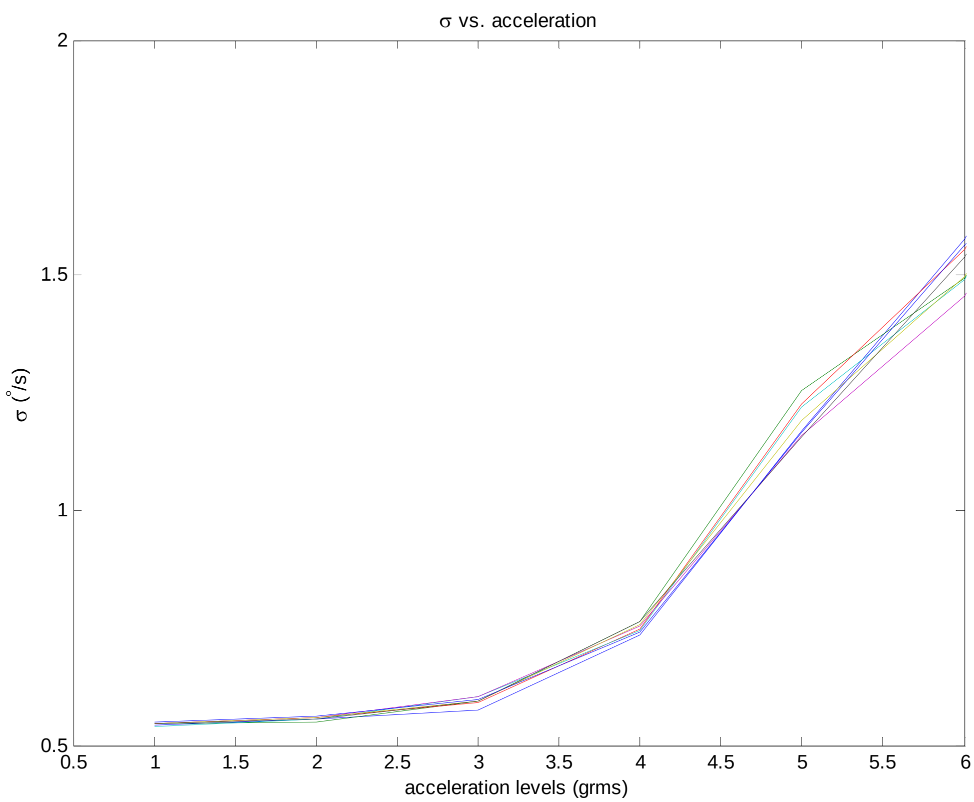

Figure 2: Detail: Standard Deviation as a Function of Random Acceleration Levels (º/s)

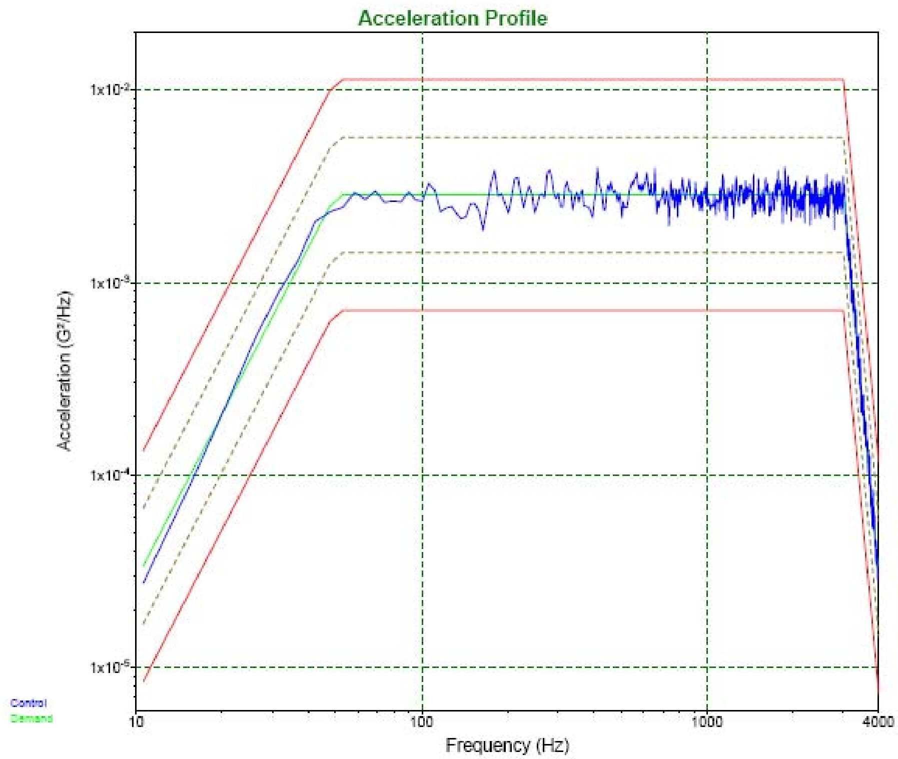

Figure 3: Example Test Profile 3 *g*-rms

Example Test Profile

Frequency (Hz)	*3 g-rms profile (* $\frac{g^2}{Hz^{0.5}}$)
10	3×10^{-5}
50	3×10^{-3}
3000	3×10^{-3}
4000	3×10^{-5}

Table 1: Test Profile 3 g-rms

Summary

MEMSense has the capability to measure vibration noise in our sensors to very high random, sine, and shock levels in our laboratories. Performance depends on the specific environment encountered. A precise acceleration survey aids greatly in determining the suitability of our products.

MEMSense IMU's have been successfully utilized in high speed spinning munitions, high shock vibration cannon fire, among other severe vibration environments by way of additional shock mounting systems. The design team at MEMSense has much experience in these emerging applications for MEMS based IMUs.