

Low-g Three-axis Accelerometer

Guadalupe Garcia
Brooke Cosko
Victor Echeverria
Colleen Dallons

In the instrument validation we calibrated each axis to the force of gravity. We measured gravity with the log-g three-axis accelerometer and found the precision, accuracy, and resolution.

3-Axis Low-g Accelerometer

The instrument we chose to validate was a three-axis low-g accelerometer. This is an instrument which uses integrated circuits with tiny “fingers” carved out of silicon and arranged like a capacitor. As the “fingers” flex, due to some force (gravity) or acceleration, they change the capacitance. The changed capacitance is converted into voltage and graphed linearly.

Experiment

We will find the resolution, as well as precision and accuracy, of the instrument. To do this we first stabilized the accelerometer on a table and graphed the x-, y-, and z-axis with the x-axis pointed down, then up. We repeated this with each axis. Because the different axes are at ninety degree angles the one pointing up or down should have registered the force of gravity and the other two should have read zero. This was not true. Contrary to the manufacturer’s claims they were initially more than 2 m/s^2 off. To fix this problem we calibrated each axis to the force of gravity. This should have fixed the instruments inaccuracies so we continued.

Data

We took seven measures of gravity for each axis.

m/s^2	x-axis	y-axis	z-axis
1.	9.687	9.771	9.768
2.	9.702	9.556	9.780
3.	9.719	9.690	9.792
4.	9.703	9.777	9.789
5.	9.716	9.761	9.863
6.	9.711	9.763	9.889
7.	9.645	9.724	9.859

Avg.	9.698	9.720	9.820
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Calculations

To calculate accuracy we used the equation:

$$\% \text{ Error} = \frac{\text{Accepted} - \text{Average Measured}}{\text{Accepted}} \times 100$$

The accepted value for gravity is 9.81 m/s^2 . To calculate precision we used the same value for gravity as well as the equation:

$$\% \text{ Error Precision} = \frac{\text{Average} \pm \text{lowest/highest}}{\text{Average}} \times 100$$

Average

By these means we found the accuracy and precision of the instrument to be as follows:

Axis	Accuracy (%)	Error Accuracy (%)	Error Precision (%)
X	98.9	1.1	.2
Y	99.1	0.9	1
Z	99.7	.1	.1

We also found the resolution of the instrument by examining the graphs to be $\pm .01 \text{ m/s}^2$.

Conclusion

This instrument works well under controlled conditions, such as when it is not held by hand or steadied on a surface that is bumped very often. This is because even the slightest movement can bend the capacitance in the integrated circuit and change the voltage, thereby obscuring the collected data. We have found that the three-axis low-g accelerometer is a reliable instrument and is fairly accurate.