Baseline Vibration Testing for a Test Fixture

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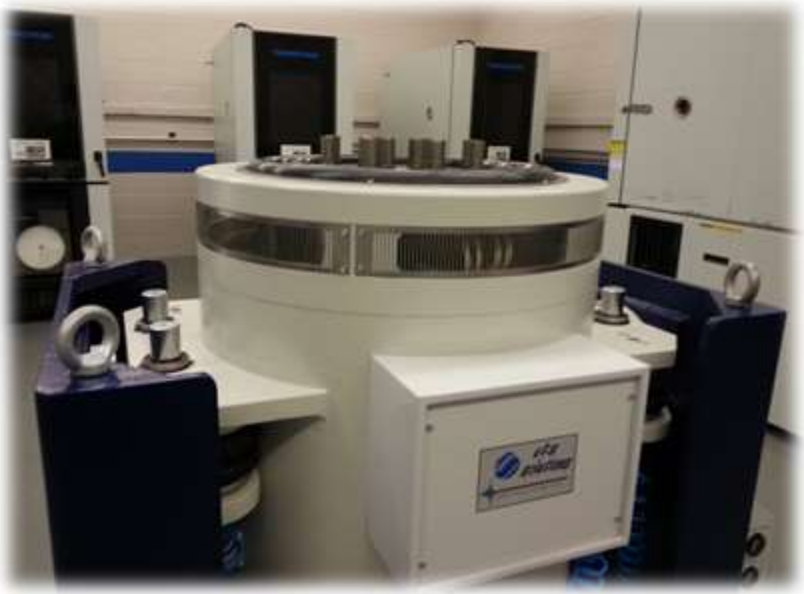
Purpose

- The purpose of this testing is to validate the test set-up for a proof of concept fixture.
  - This will provide information for the later test of a gyro sensor.
- Vibration testing is a vital part of understanding how kinematic systems behave over time.



Background

- Gyroscopic sensors are found in most modern electronic devices
  - Some examples:
  - Smart Phones, RC Helicopters, Digital Cameras, Car Navigation Devices, Robot Balance control
  - These Gyro sensors operate by sensing angular velocity via the Coriolis force.

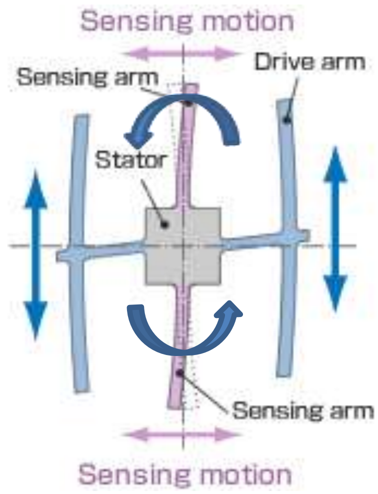
http://www.xaircraft.org/2010/10/influence-of-body-structure-vibration.html

http://www.brandfreak.com/2009/04/segway-realizing-most-people-are-lazy-and-just-want-to-sit-down.html

Theory

- There are many types of gyro sensors
- Main type uses piezoelectric crystal elements
- Piezoelectric devices operate via a phenomenon of crystals
- Output a potential difference with the application of a force
- The Stator is the piezoelectric

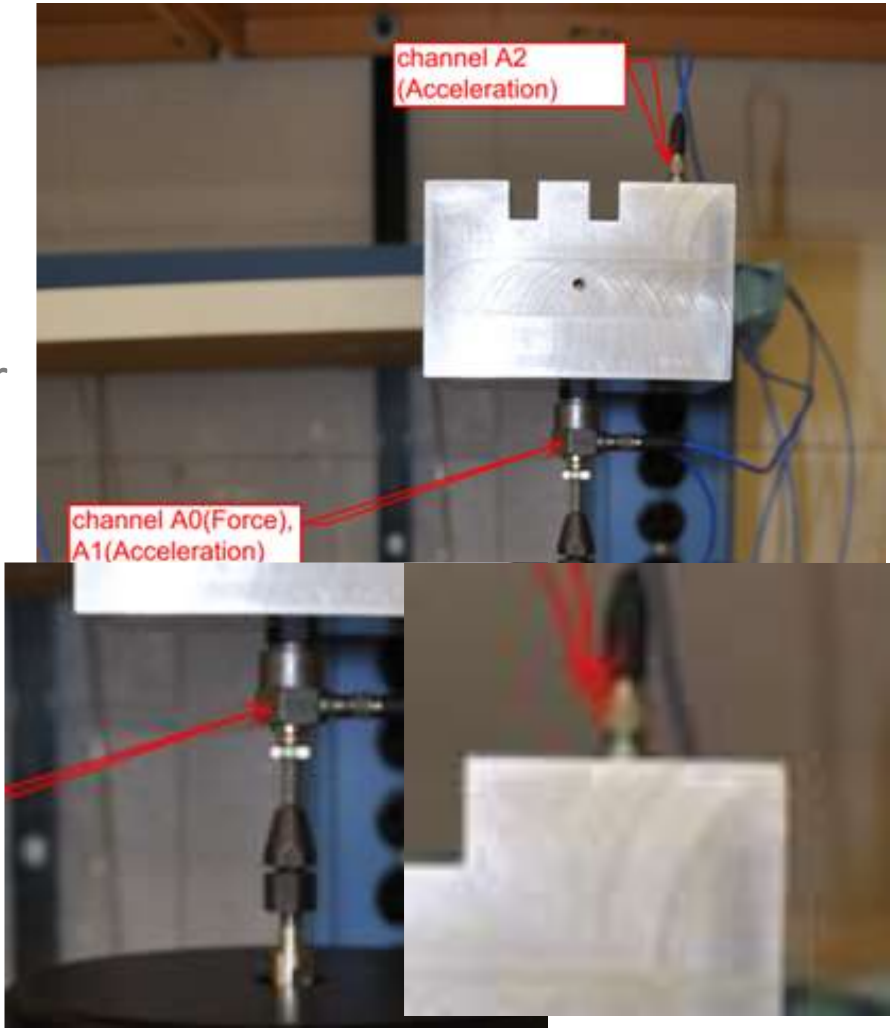
- Double T structure gyro sensor
- Drive arms vibrate in a particular direction.
- Rotation causes drive arms to vibrate in a different direction
- A potential difference is created and output as an electrical signal



http://www5.epsondevice.com/en/sensing_device/gyroportal/about.html

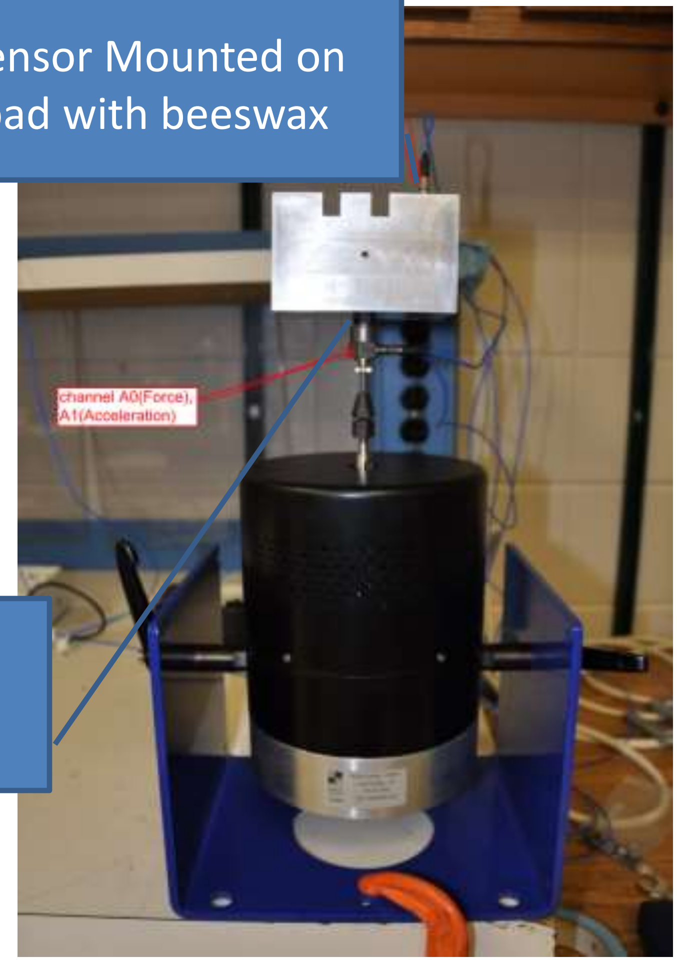
Test Plan

- To provide a baseline for design a fixture was created to mount a gyro sensor
- The fixture was created to solidly mount to a modal shaker
- It is important the stinger be mounted rigidly to the fixture
- Sensors mounted to the fixture use beeswax for mounting
- All vibration sensors are piezoelectric



Test Set-up

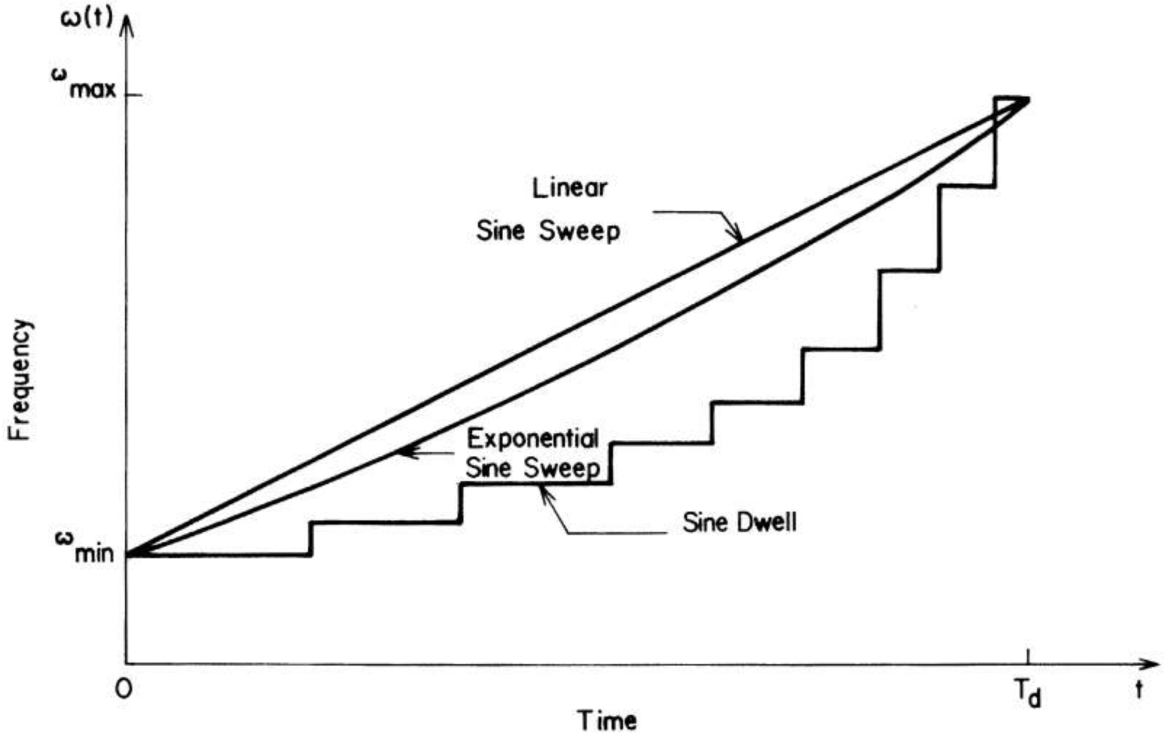
- Fixture is rigidly mounted to the exciter
- Accelerometer is placed on the top of the test fixture.
- Load and acceleration are directly below the fixture.
- Channels must be defined for each recording device.
- A Virtual Interface program is created to output a sine sweep from 20-3000Hz at 4 octave/min. Total test time is 116 seconds.
- 1 octave from 20Hz = 40Hz
- 2 octave = 80Hz
- 3 octave = 160Hz
- 4 octave = 320Hz
- 5 octave = 640Hz
- 6 octave = 1280Hz
- 7 octave = 2560Hz
- 8 octave = 5120Hz



Test Set-up

- How to determine total test time given an octave/min rate?
  - Count the total number of octaves to get to the final frequency
    - 40…80…160…320…640…1280…2560…3000
    - 1.....2......3.......4........5........6.........7.......7.72
  - Calculating total test time to cover the frequency range =
  - 7.72 octaves/(4octaves/min) = 1.93mins *60s/min= 116s
    - What type of sweep is required?
      - Exponential? Linear? Sine Dwell?
- Exponential sweep integral in discovering response frequencies
  - Mathematical expression: $\omega(t) = \omega_{start}(\omega_{end}/\omega_{start})^{t/T_d}$
    - Where T_d = test duration, ω = frequency

Common Sine Sweeps



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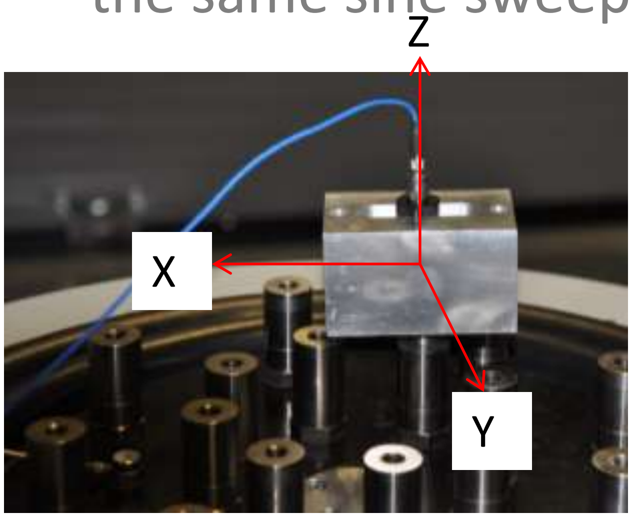
Data Acquisition

- Data collected via National Instruments™ 9234 modules
- After data was collected it was analyzed and modified through Matlab®
- Signal is output in g's and N per unit time
- Data is most often interpreted by amplitude of force vs. frequency applied through post processing of data
- Frequency response functions are found by applying FFT

Data Acquisition Cont.

- Another set of data was collected using software from ETS Solutions 3,300lbf modal shaker
- Test of the fixture was performed on this shaker table to verify the mounting scheme
- Test data reported back the response at each frequency for the same sine sweep



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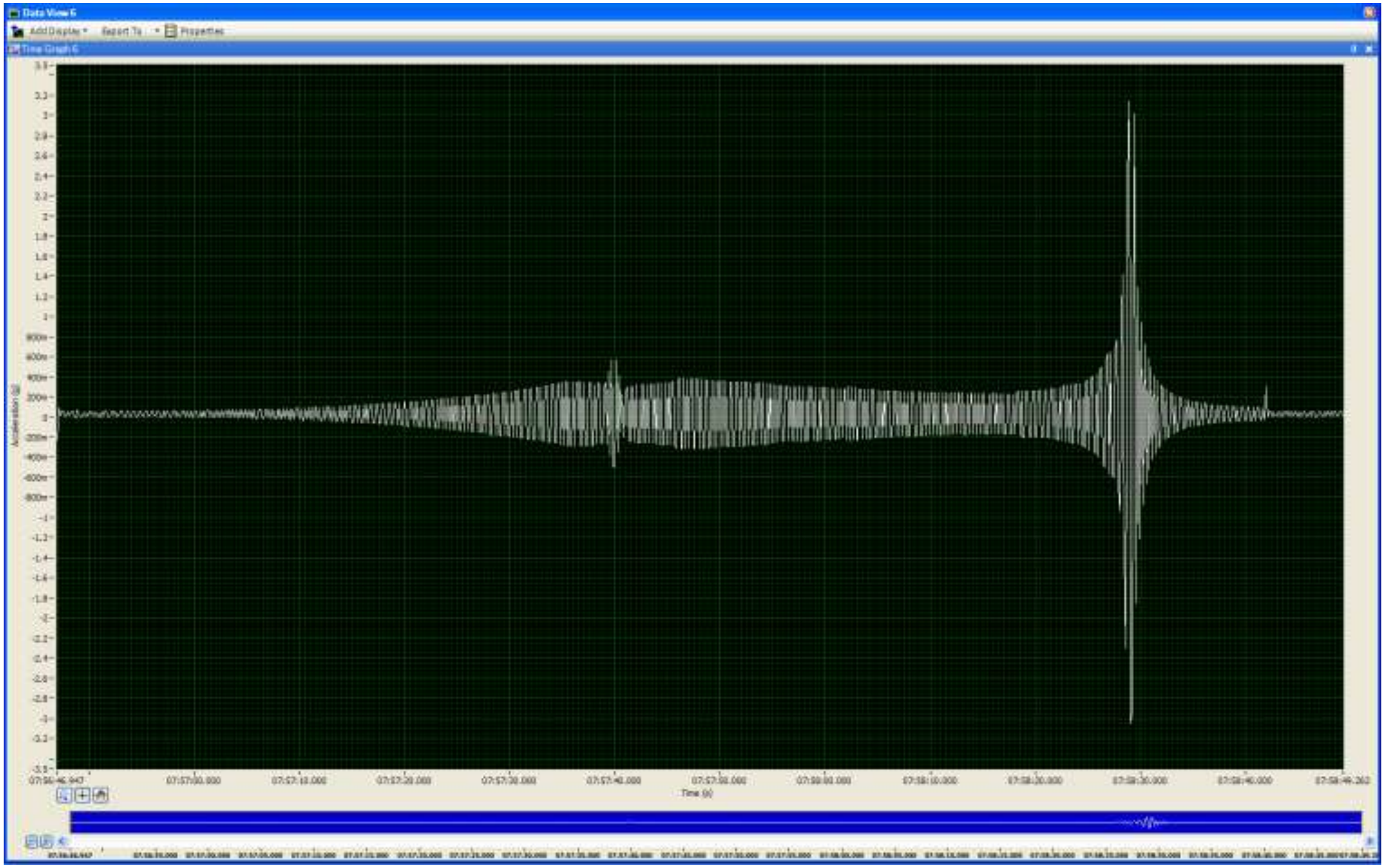
Results In Labview



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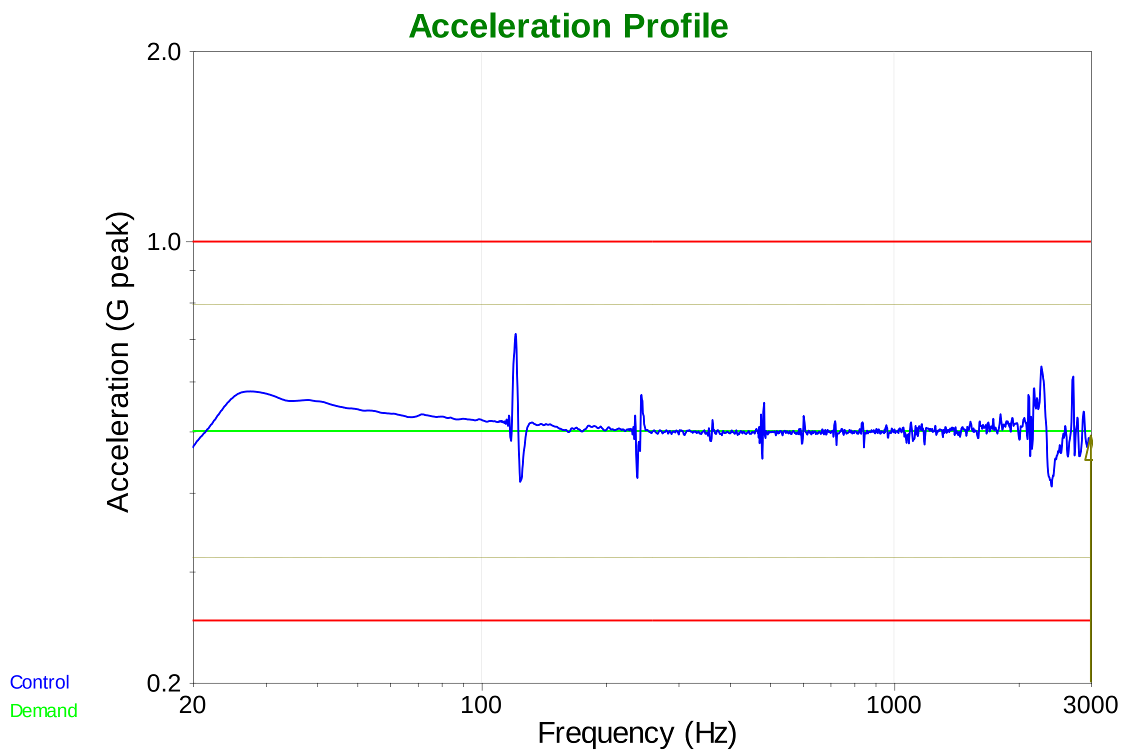
Experimental Results



- The first harmonic was seen in the fixture at 2200Hz

Conclusion

- Discussed some basics of vibration testing
- Why it is important to understand
- Example of a software and virtual interfaces
- Example of how to perform a test to determine frequency response of a fixture

Questions

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