BEST PRACTICES FOR VIBRATION TESTING SPACE HARDWARE

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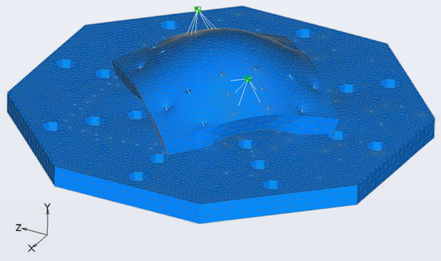
PRE-TEST CONSIDERATIONS

FIXTURE STIFFNESS

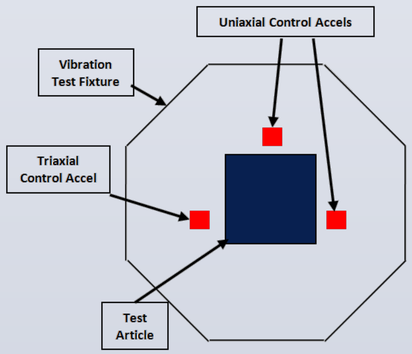
- Ideally 1/3 octave above max test frequency (i.e. 2500 Hz first mode for a 2000 Hz random vibration test)
- Alternately, at least twice as stiff as test article
- Verify via FEA or heritage fixtures that have been used during test



Output Set: MODE 1, FREQ=2924.1621, Deformed(0.912): TOTAL TRANSLATION

CONTROL STRATEGY

- Three control accelerometers on vibration fixture will detect any shaker rocking mode
- Measure cross-axis fixture behavior for at least one location because fixture/shaker modes can sometimes result in cross axis input higher than in-axis input



- Average vs. Extremal control for multiple control channels
  - Average will adjust shaker input such that the average of the channels is at the prescribed input
  - Extremal will adjust shaker input such that the maximum of the channels is at the prescribed input
  - Extremal is recommended unless otherwise specified in order to limit the risk of overtest

MASS SIMULATOR TESTING

GOALS

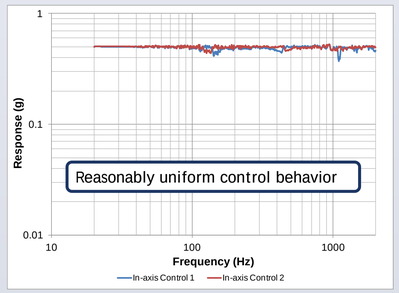
- Verify shaker and fixture capability
- Verify control accelerometer placement
- Discover any undesirable shaker or fixture modes

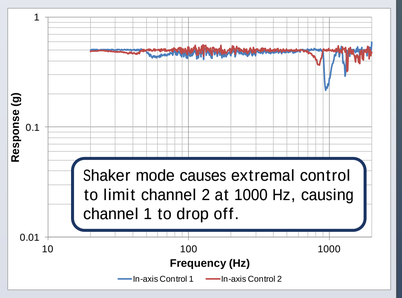
MASS SIMULATOR DESIGN

- Design to match mass and CG of test article
- Matching stiffness (and modes) is usually not necessary
- In many cases, can be a simple metallic block

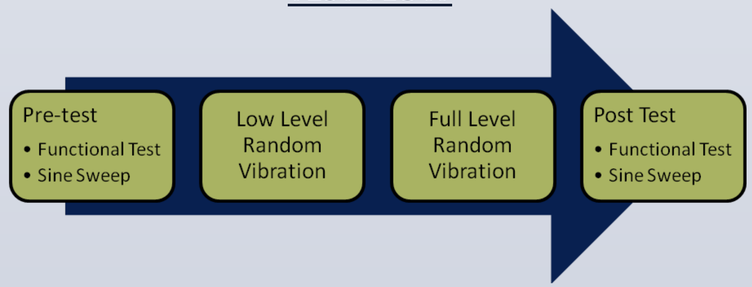
TESTS TO RUN

- Low level sine, look for control uniformity. Non-uniform control could indicate fixture or shaker modes, improper accelerometer setup, etc. (see plots below)
- Full level test to verify that input is within tolerance and there aren't issues with shaker, fixture, or instrumentation





TEST FLOW



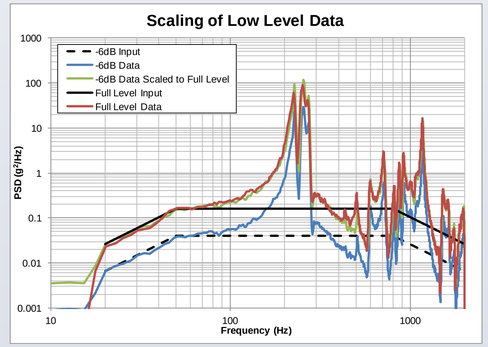
PRE-TEST

- Functional test to establish performance baseline that will serve as comparison to data taken after the test
- Low level test to identify key responses

TEST FLOW (continued)

LOW LEVEL VIBRATION

- Perform testing at level(s) lower than prescribed input in order to determine expected responses
- Good idea to start at very low levels (-12dB and lower) and work up to full level
- For linear systems, this will allow for scaling up data to predict expected responses at full level (see plot below)
- These predictions may be compared to established allowable levels to determine any issues before applying full level loads and risking the test article
- If any notching to the input is required, low level runs give a chance to test notching limits provided that they are scaled to the appropriate level



FULL LEVEL VIBRATION

- Apply prescribed input and monitor responses during the test

POST TEST

- Inspect test article
- Run low level test to identify key frequencies and compare to initial baseline. Changes in response may indicate mechanical failure.
- Run functional test to compare to pre-test baselines and identify anomalous behavior

OTHER RESOURCES

- NASA-HDBK-7005 *Dynamic Environmental Criteria*
- GSFC-STD-7000 *General Environmental Verification Standard (GEVS)*
- MIL-STD-810 *Environmental Test Methods*