LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO

LIGO Laboratory / LIGO Scientific Collaboration

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Shake Table Options
for Quad / 2x HLTS / TMS /SUS Testing

K Mailand / Calum Torrie

**California Institute of Technology
LIGO Project**

**Massachusetts Institute of Technology
LIGO Project**

LIGO Hanford Observatory

LIGO Livingston Observatory

http://www.ligo.caltech.edu/

1   Introduction

The purpose of this document is to define a Shaker Table Design, used in a testing procedure, for assembled SUS Quad / 2x HLTS and TMS suspensions. The mass of the assembled suspensions is between xxx lbs and xxx lbs. The Shake table built to satisfy the requirements of the testing scenario selected below, and used at Caltech.

2   Shaker Table Requirements

1. List the mechanical Shake Table Design requirements.

2.1   Parameters of Shaker Table Design (Calum T.)

1.   Parameters for shaking the assembled Sus Quad and TMS suspensions

2. Design shaker table - Table top version that eg. to fit on low bench in modal lab.

3. Investigate availability of commercially off the shelf shaker table and compare against designing and making one.

4. Should be ~ 4ft x 4ft with holes on pattern.

5. X, Y and Z excitation. Excitation should be small i.e. not for flight or transport or earthquake. More for excitation of multi stage suspension system.

6. Consider (*if going route of in-house design) whether either a iLIGO HAM ISIS could work or if a Newport table is right or other. (I am worried about extra damping from a Newport optics table.

7. Big enough (strong enough) to hold a Quad or BS or e.g. 2x HLTS suspensions.

2.2   Specifics re. Shaker Table Design (In-House Design or Purchased Part)

The questions below address the: Complexity, Drive Components, Size, Frame Stiffness, Control Methods.

1. Frequency range

2. Acceleration (G's)

3. Wave form: (assuming sinusoidal)

4. Stiffness Requirement of Shaker Table

5. Mass and Size of Shaken assemblies

7. CG of Shaken assemblies (Stress on tested assemblies and, Shaker Table)

8. Axis of Movement (x-y-z) One or more, and Singularly, or in Combination.

9. Control input Method or Program

10. Neutral Drive System Balance

11. Acceptable Tested Structure Hold-Down Methods

12. Movement: Displacement / Travel

13. Orientation of the Tested Structure (attached from above ?)

14. Table to Tested Structure Support (to avoid structure flexing)

3   In House Shaker Table Design Approaches:

3.1   Mechanical (Cam /Spring) (Shaft / Link)

3.1.1   Variable speed gear motor w/ link, or Cam on follower w/ spring return.

Table guided on Thompson bearings or Roller slides. This could be used for x and y, and z, setup would be more difficult

3.2   Electro- Mechanical (Electrical Coil Method)

3.2.1   Using the same type of coil we have used in the past testing, using a Ball Rod End Link connection. This could be used for x / y and z movement. Pneumatic pads for table, with stabilization guides.

3.3   Pneumatic (Air) (Cylinder / Valve)

3.3.1   Using air cylinders with an air logic manifold, a Ball Rod End Link connection. This could be used for x / y and z movement. Pneumatic pads for table, with stabilization guides.

3.4   Hydraulic (Fluid) (Cylinder / Valve)

3.4.1   Using Hydraulic cylinders with a logic manifold, a Ball Rod End Link connection. This could be used for x / y and z movement. Pneumatic pads for table, with stabilization guides.

4   Table Construction: Materials and Form Depend on Type selection in paragraph 3

4.1   The table may use metal flexures, if travel is small. The other consideration is the Table orientation, does the Tested Structure hang down from the table.

5   Control Systems

1. Mechanical System may be a variable speed control and, travel adjustment link, the motor speed may also be programmed

2. Electro-Mechanical System may be controlled by computer setting wave form, acceleration g's, travel and various ramp scenarios.

3. Pneumatic and Hydraulic Logic Systems may be controlled by computer setting wave form, acceleration g's, travel and various ramp scenarios.

6   Outside Shaker Table Testing Services

6.1   Select Type Of Shaker Modes Needed, from Paragraph 2.2 above

6.1.1   Consider the Availability of the service / Cost / Transport issues / Setup Compatibility with our assemblies.

6.1.2   Cost Depends on Test Requirement.

6.2   Examples of Outside Shaker Table Services Available

1. https://dcc.ligo.org/LIGO-T1300622

7   Purchase Part, Shaker Table

7.1   Select Type Of Shaker Modes Needed, from Paragraph 2.2 above

7.1.1   Consider the Availability / Cost / Transport issues / Setup and Compatibility with our Structure Assemblies.

7.1.2   Cost Depends on Test Requirement.

7.2   Examples of Purchase available Shaker Tables

1. https://dcc.ligo.org/LIGO-T1300622