Single Stage ISI
HAM views

springs and sensors under the table top

access to a vertical sensor
HAM ISI Sensors

Pod 1
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

Pod 2
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

Pod 3
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

Witness
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

To ISI Interface 1
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

To ISI Interface 2
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite

To STS-2 Interface
- Vertical GS-13
- Horizontal GS-13
- Vert. Pos. Sensor
- Horiz. Coil
- H. CPS
- Capactive Position Sensor Satellite
Stage 2 Control at Stanford

Tech Demo Stage 2 Performance, X

- STS stg1, #2
- stg2 GS13 X, damping only
- stg2 GS13 X&Y isolation ON
- HAM req

Preliminary data

- stage 1 motion
- stage 2 motion w/ feedback isolation
- HAM req
- stage 2 motion w/ damping
Seismic Isolation Electronics

HAM 6 Racks

1Y30

1. Timing Slave
2. GS-13/STS-2 Locker/Unlocker
3. Binary IO Chassis
4. Binary IO Chassis
5. ISI Interface Pod 1 & 2
6. ISI Interface Pod 3
7. Anti Alias Rev. 79
8. AdL Anti-Image Chassis
9. ISI Coil Driver Pod 1 & 2
10. ISI Coil Driver Pod 3
11. SUS Coil Driver
12. SUS Anti-Image
13. SUS Receiver
14. Anti Alias Filter Rev. 10
15. STS-2 Interface
16. SS-SS/SS PCIX IO Int. Chassis

OMC SUS

ISI STS-2 Input

1Y31

1. HV Power Supply
2. Anti Alias Filters
3. AdL Anti-Image Chassis
4. PZT Heater
5. Binary IO Chassis
6. Anti Alias Filters
7. SUS Coil Driver
8. SUS Receiver
9. STS-2 Interface
10. SS-SS/SS PCIX IO Int. Chassis
11. TT/ISC PCIX IO Int. Chassis

ISCI

TIP/TLIT

December 19, 2007
LIGO-G070xxx-00-M
Seven kinds of Electronics modules are needed for the HAM ISI Installation.

- Binary I/O Interface
- Anti-Image Chassis
- Anti-Alias Chassis Rev.7B
- STS-2 Interface
- ISI Interface Chassis
- ISI Coil Driver
- Capacitive Position Sensor Field Interface Box
- LSU Locker/Un locker

Some Electronics are shared in the HAM6 rack.

- Timing Board
- PCIX I/O Chassis
- Anti-Alias Chassis Rev.10
Inputs come from 4 GS-13 seismometers, and 4 Capacitive position Sensors. Chassis interfaces signals with ADCs, DACs and Binary I/O modules.

GS-13 Interface has switchable x1 and x10 gain, and two stages of simultaneously switchable whitening with 0.1 Hz zeroes, and 1 Hz poles.

Capacitive Position Interface Card supplies power, and routes signals. It has no gain or filtration.
Capacitive Position Sensor Noise

Coarse Sensor Noise

$\text{calib} = 1 \times 10^{-4}$\ m/V

\[
\begin{array}{c}
\text{Frequency (Hz)} \\
0.010 & 0.100 & 1.000 & 10.000 & 100.000 & 1000.000 \\
\text{uV/sqrt(Hz)} \\
0.001 & 0.010 & 0.100 & 1.000 & 10.000 & 100.000
\end{array}
\]
Capacitive Position Sensor Interface

3rd Order, 800Hz, Butterworth LPF
1. The Coarse and Fine actuators used in the ISI are custom manufactured by PSI (Planning Systems Inc.).

2. The coarse actuators are used to actuate in the horizontal and vertical directions at each of the three locations around the HAM.

3. Coarse actuator is capable of generating a continuous force of maximum 20 lb and the Coil Driver is capable of providing the current to produce this force.
<table>
<thead>
<tr>
<th>Actuators</th>
<th>Coarse</th>
<th>Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude Wire Gauge</td>
<td>18 AWG round wire</td>
<td>24 AWG round wire</td>
</tr>
<tr>
<td>Continuous Force</td>
<td>20 lb</td>
<td>10 lb</td>
</tr>
<tr>
<td>Resistance(@25 deg C)</td>
<td>6.1 ohm</td>
<td>9.3 ohm</td>
</tr>
<tr>
<td>Inductance</td>
<td>~5 mH</td>
<td>~3 mH</td>
</tr>
<tr>
<td>Self-resonant frequency</td>
<td>~200 KHz</td>
<td>~275 KHz</td>
</tr>
<tr>
<td>Hi-Pot Test(500 VDC for 60 sec)</td>
<td>&gt;500 MOhm</td>
<td>&gt;500 MOhm</td>
</tr>
<tr>
<td>Force Constant at Central Position</td>
<td>6.74 lb/amp</td>
<td>6.9 lb/amp</td>
</tr>
</tbody>
</table>

\[
I_{max} = \frac{(20 \text{ lb})}{(6.74 \text{ lb/amp})} = 3 \text{A}
\]

\[
V_{max} = (3 \text{ A}) \times (6.1 \text{ ohm}) = 18.3 \text{ volts}
\]

(neglect the cable loss)
The output current noise requirements are most restrictive for the Fine driver and are as follows:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Noise Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq &gt; 30 Hz</td>
<td>3 nA/sqrt(Hz)</td>
</tr>
<tr>
<td>10 Hz &lt; freq &lt; 30 Hz</td>
<td>8 nA/sqrt(Hz)</td>
</tr>
<tr>
<td>1 Hz &lt; freq &lt; 10 Hz</td>
<td>45 nA/sqrt(Hz)</td>
</tr>
<tr>
<td>freq &lt; 1 Hz</td>
<td>(45 nA/sqrt(Hz) * (1/freq)</td>
</tr>
</tbody>
</table>
• The DAC input is +/- 20 V and noise level is 5µV/sqrt(Hz).

• The DAC stage is surrounded by a digital whitening and analog de whitening filter to address the noise associated with the DAC.

• De whitening Filter 2 Poles @ 0.4 Hz and 2 Zeros @ 15.9 Hz is added to lower the noise after the differential DAC Input.
Noise measured using the SR785
Complete assembled chassis