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LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

-LIGO-

CALIFORNIA INSTITUTE OF TECHNOLOGY

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aLIGO HAM-A Coil Driver Board Prototype Test Plan		
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1 Introduction

The tests described below will be utilized to test the first prototype of the aLIGO HAM-A Coil Driver (D1100117). These boards will be used to drive the HAM-A mirrors in the Input Optics Sections of the IFOs. The design requirements for the driver can be found in LIGO document number T0900495-v4, "HAM Auxiliary Suspensions Electronics Requirements".

2 Test Equipment

- Stanford Research SR785 analyzer
- Voltmeter
- Oscilloscope
- Board Schematics- TBD

3 Tests

3.1 Input Enable Relay Operation

In this section the operation of the input relay (K1) will be tested. If this relay is not energized, the inputs to each coil driver channel are tied to circuit ground. The operation is tested using the jumpers on the board (P4). Each channel can be controlled separately and has an indicator LED. There is also an external monitor signal that can be used by the control system to verify the position of this relay. Operation of this monitor signal will also be verified. The test is performed by connecting a 1KHz 1Vp-p sine wave to each input and verifying that the signal only propagates to the output when the relay is energized using the appropriate jumper. In the table below record the results of the tests for each channel.

Channel	Channel Enable Monitor Signal Pins (Pin 5 is return)	Relay NOT Energized- Signal not at Output and LED OFF and J9 monitor HIGH?	Relay Energized- Signal at Output and LED ON And J9 Monitor LOW?
1	J9- 6, 5		
2	J9- 7, 5		
3	J9- 8, 5		
4	J9- 9, 5		

The jumpers used to energize each of the input relays in this section should be left in for the remainder of the testing.

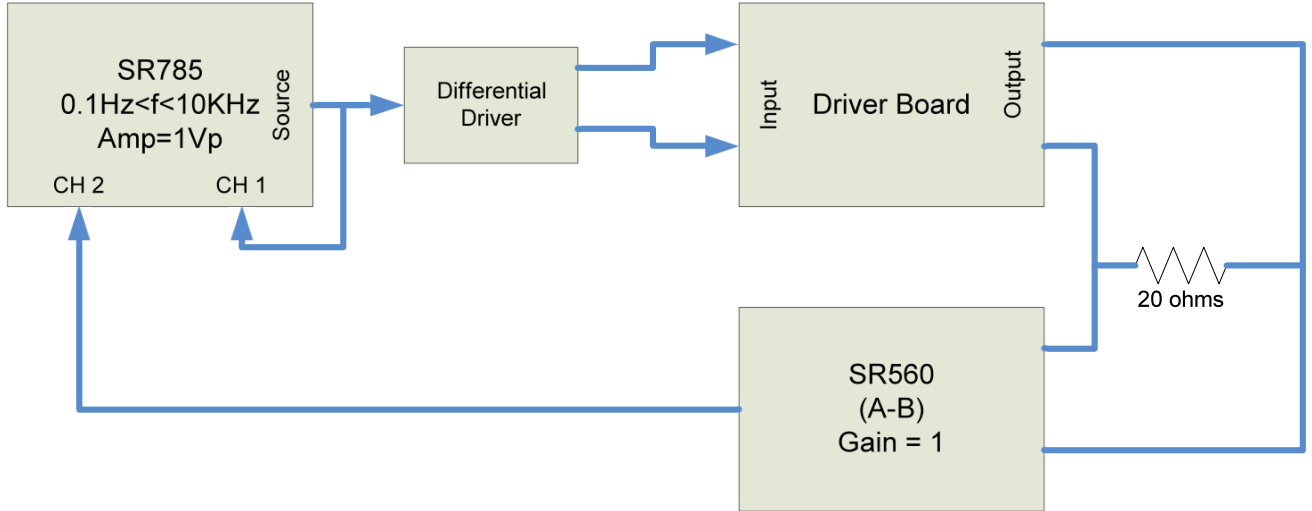
3.2 Transfer Function Tests

The transfer function for each mode of operation is measured by injecting a signal into the input of a channel and measuring the current through a 20 ohm resistor connected across the corresponding channel output. Measurements are made for frequencies from 0.1Hz to 10KHz. A block diagram of the test setup is shown in the figure below.

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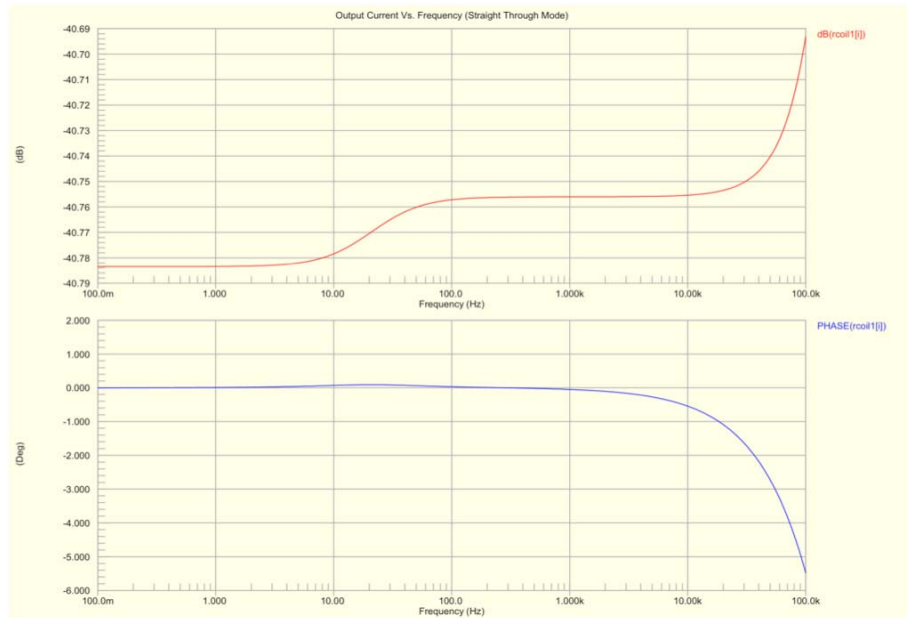
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3.2.1 Straight Through Mode

In the straight through mode, relay K2 is NOT energized. The nominal response of the coil driver in this mode essentially flat and is shown in the plot below. Note that the transfer function is in units of volts in to amps output into a 20 ohm load, so if the transfer function is measured by measuring the voltage across the load resistor 26dB must be subtracted from the measurement to convert to dBA/V.



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Figure 1: Straight Through Mode Transfer Function

In the tables below, record the measured magnitude and phase of the response for each channel. In addition, save the transfer function for one representative channel to disk and record the file name in space provided below. Gains should be +/- 1dB and phases should be +/- 5 degrees for all measurements. Also record that the LED showing that the channel is in Straight-through mode is

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NOT illuminated and that the remote indicator provided on connector J9 LOW. Note that J9 pin 5 is the return for all indicators on J9.

Table 1: Channel 1 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED OFF?	J9- 1, 5 LOW?
1	-40.7	0.0				
10	-40.7	0.0				
100	-40.7	0.0				
1K	-40.7	0.0				
10K	-40.7	0.0				

Table 2: Channel 2 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED OFF?	J9- 2, 5 LOW?
1	-40.7	0.0				
10	-40.7	0.0				
100	-40.7	0.0				
1K	-40.7	0.0				
10K	-40.7	0.0				

Table 3: Channel 3 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED OFF?	J9- 3, 5 LOW?
1	-40.7	0.0				
10	-40.7	0.0				
100	-40.7	0.0				
1K	-40.7	0.0				
10K	-40.7	0.0				

Table 4: Channel 4 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED OFF?	J9- 4, 5 LOW?
1	-40.7	0.0				
10	-40.7	0.0				
100	-40.7	0.0				
1K	-40.7	0.0				
10K	-40.7	0.0				

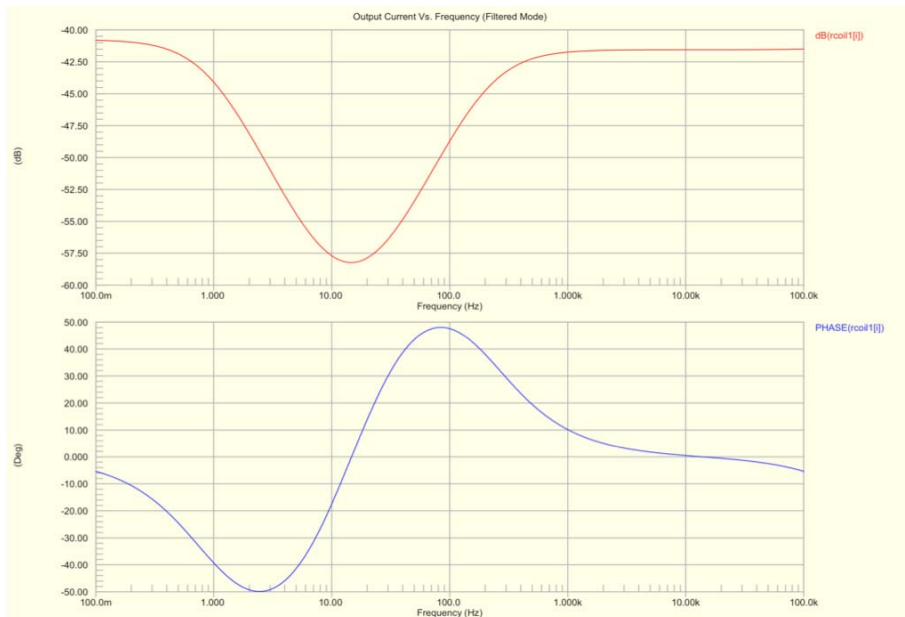
3.2.2 Filtered Mode

In the Filtered mode, relay K2 is energized using on board jumpers on P3. The nominal response of the coil driver in Filtered mode is poles at 1Hz and 200Hz, and zeros at 10Hz and 20Hz and is shown in the plot below. Note that the transfer function is in units of volts in to amps output into a 20 ohm load, so if the transfer function is measured by measuring the voltage across the load resistor 26dB must be subtracted from the measurement to convert to dBA/V.

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Figure 2: Filtered Mode Transfer Function

In the tables below, record the measured magnitude and phase of the response for each channel. In addition, save the transfer function for one representative channel to disk and record the file name in space provided below. Also record that the LED showing that the channel is in Filtered mode is illuminated and that the remote indicator provided on connector J9 HIGH. Note that J9 pin 5 is the return for all indicators on J9.

Table 5: Channel 1 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED ON?	J9- 1, 5 HIGH?
0.1	-40.8	-5.3				
1	-44.1	-39.5				
10	-57.7	-17.3				
100	-48.7	47.6				
1K	-41.7	10.2				
10K	-41.5	0.5				

Table 6: Channel 2 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED ON?	J9- 2, 5 HIGH?
0.1	-40.8	-5.3				
1	-44.1	-39.5				
10	-57.7	-17.3				
100	-48.7	47.6				
1K	-41.7	10.2				
10K	-41.5	0.5				

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Table 7: Channel 3 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED ON?	J9- 3, 5 HIGH?
0.1	-40.8	-5.3				
1	-44.1	-39.5				
10	-57.7	-17.3				
100	-48.7	47.6				
1K	-41.7	10.2				
10K	-41.5	0.5				

Table 8: Channel 4 Transfer Function Measurements

Freq (Hz)	Nominal Gain (dBamps/Volt)	Nominal Phase (Degrees)	Actual Gain (dBamps/Volt)	Actual Phase (Degrees)	LED ON?	J9- 4, 5 HIGH?
0.1	-40.8	-5.3				
1	-44.1	-39.5				
10	-57.7	-17.3				
100	-48.7	47.6				
1K	-41.7	10.2				
10K	-41.5	0.5				

3.2.3 Dynamic Range Tests

The dynamic range requirement for the aLIGO HAM-A Driver is 35mA peak for frequency < 1KHz. The tests below will verify that the design meets this requirement. In addition the board components will be checked for overheating. The tests for all channels should be conducted simultaneously and each test step/reading should be held for a minimum of 5 minutes to allow the temperature of the chassis and components to stabilize. In the tables below, record the output current versus input voltage (both peak), note any component heating and if possible the temperature of the component. Output current should be measured across the 20 ohm load resistor connected to the channel under test. The input signal used for this should be a 1KHz sine wave. The driver board should be in the Straight Through mode configuration used in section 3.1.1 of this test plan.

Table 9: Channel 1 Output Current vs. Input Voltage

Input Voltage Peak (1KHz)	Nominal Output Current (mApeak)	Actual Output Current (mApeak)	Notes
1V	9.2		
5V	45.8		

Table 10: Channel 2 Output Current vs. Input Voltage

Input Voltage Peak (1KHz)	Nominal Output Current (mApeak)	Actual Output Current (mApeak)	Notes
1V	9.2		
5V	45.8		

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Table 11: Channel 3 Output Current vs. Input Voltage

Input Voltage Peak (1KHz)	Nominal Output Current (mApeak)	Actual Output Current (mApeak)	Notes
1V	9.2		
5V	45.8		

Table 12: Channel 4 Output Current vs. Input Voltage

Input Voltage Peak (1KHz)	Nominal Output Current (mApeak)	Actual Output Current (mApeak)	Notes
1V	9.2		
5V	45.8		

3.3 Noise Tests

The noise requirements for the aLIGO HAM-A Driver are very modest, $10 \text{ nA}/\sqrt{\text{Hz}}$ at 10 Hz. The actual output noise of the driver itself is much lower than this, approximately $0.4\text{nA}/\sqrt{\text{Hz}}$ at 10Hz. It is very difficult to measure noise currents of this magnitude, so the output voltage noise of the driver will be measured using TP3 and TP7 to verify proper functioning of the driver. The output noise of the driver should be less than $100\text{nV}/\sqrt{\text{Hz}}$ at 10Hz.

Table 13: Noise Monitor Test Results

Channel Number	Measured Noise at 10Hz
1	
2	
3	
4	