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# LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

# -LIGO-

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| Document Type | DCC Number<br>T0900190-v1 | April 21, 2009 |
|---|---|---|

**AdL Triple Low Current 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 Adl Triple Suspension Low Current Coil Driver. These drivers are being designed by the US and build by the UK group located at the University of Birmingham. These boards will be used to drive the middle stage of the cavity/IMC triple suspensions. The design requirements for the driver can be found in LIGO document number T080065-E-C, “AdL Beam Splitter, Input Mode Cleaner, Large Recycling and Small Recycling Triple Suspension Electronics Requirements”.

These tests are not comprehensive and will only be utilized to verify that the driver board meets the design requirements. It is assumed that a more comprehensive test of the assembled production chassis will be conducted by the UK prior to shipment.

# 2 Test Equipment

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

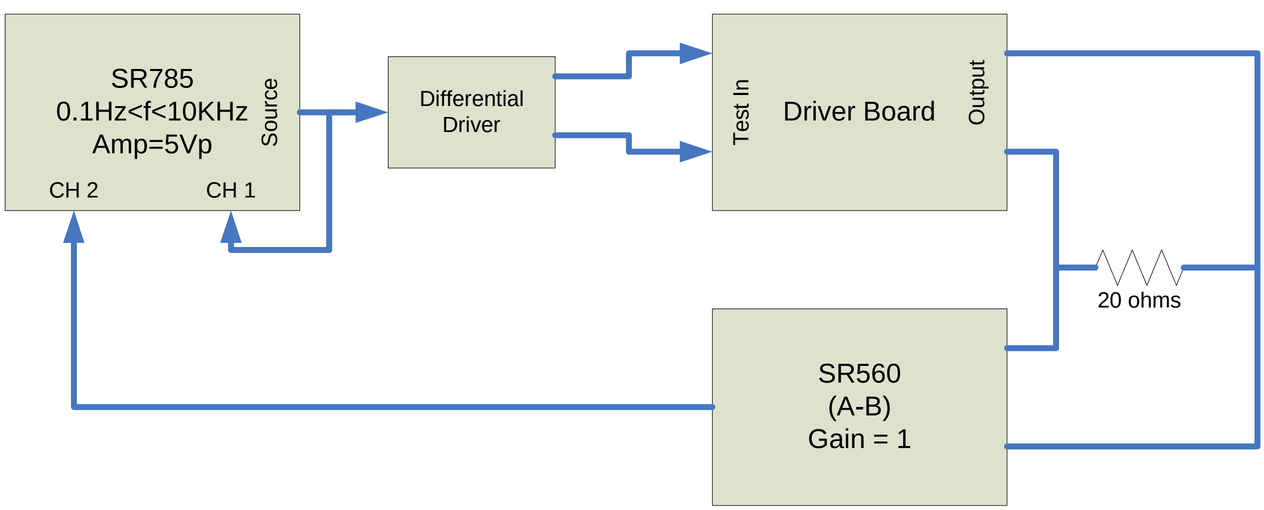
# 3 Tests

The tests are broken into the same categories used in the design requirements document, noise, dynamic range and monitors/controls. The tests for each of these categories are described in the sections below. Note that jumper W2 should be installed in each channel for all tests. The tests also assume that relay K1 (input enable) is energized for each channel.

## 3.1 Dynamic Range and Transfer Function Tests

### 3.1.1 Transfer Function Measurements

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.




The nominal response of the coil driver is zeros at 5Hz and 20Hz, and poles at 1Hz and 100Hz 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 voltage measurements made across the 20 ohm load resistor need to be scaled by -26dB.

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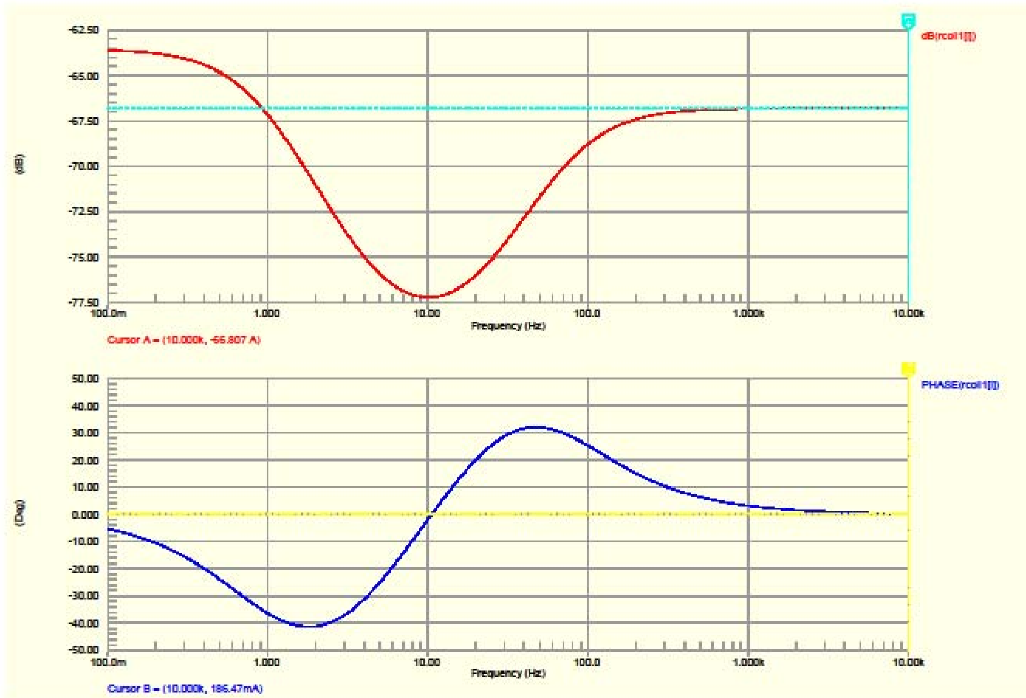


**Figure 1: Low Current Driver Transfer Function**

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.

**Table 1: Channel 1 Transfer Function Measurements**

| Freq (Hz) | Nominal Gain (dBamps/Volt) | Nominal Phase (Degrees) | Actual Gain (dBamps/Volt) | Actual Phase (Degrees) |
|---|---|---|---|---|
| 0.1 | -63.6 | -5.3 | | |
| 1 | -67.2 | -36.2 | | |
| 10 | -77.2 | -1.9 | | |
| 100 | --68.8 | 25.3 | | |
| 1K | -66.8 | 3.2 | | |
| 10K | -66.8 | 0.2 | | |

**Table 2: Channel 2 Transfer Function Measurements**

| Freq (Hz) | Nominal Gain (dBamps/Volt) | Nominal Phase (Degrees) | Actual Gain (dBamps/Volt) | Actual Phase (Degrees) |
|---|---|---|---|---|
| 0.1 | -63.6 | -5.3 | | |
| 1 | -67.2 | -36.2 | | |
| 10 | -77.2 | -1.9 | | |
| 100 | --68.8 | 25.3 | | |
| 1K | -66.8 | 3.2 | | |
| 10K | -66.8 | 0.2 | | |

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**Table 3: Channel 3 Transfer Function Measurements**

| Freq (Hz) | Nominal Gain (dBamps/Volt) | Nominal Phase (Degrees) | Actual Gain (dBamps/Volt) | Actual Phase (Degrees) |
|---|---|---|---|---|
| 0.1 | -63.6 | -5.3 | | |
| 1 | -67.2 | -36.2 | | |
| 10 | -77.2 | -1.9 | | |
| 100 | --68.8 | 25.3 | | |
| 1K | -66.8 | 3.2 | | |
| 10K | -66.8 | 0.2 | | |

**Table 4: Channel 4 Transfer Function Measurements**

| Freq (Hz) | Nominal Gain (dBamps/Volt) | Nominal Phase (Degrees) | Actual Gain (dBamps/Volt) | Actual Phase (Degrees) |
|---|---|---|---|---|
| 0.1 | -63.6 | -5.3 | | |
| 1 | -67.2 | -36.2 | | |
| 10 | -77.2 | -1.9 | | |
| 100 | --68.8 | 25.3 | | |
| 1K | -66.8 | 3.2 | | |
| 10K | -66.8 | 0.2 | | |

File Name for transfer function measurement:________________________

### 3.1.2 Dynamic Range Tests

The dynamic range requirement for the Triple Low Current Driver is for the driver to be capable of providing 3mA peak currents for frequencies below 1KHz. 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.

**Table 9: Channel 1 Output Current vs. Input Voltage**

| Input Voltage Peak (1KHz) | Nominal Output Current (mApeak) | Actual Output Current (mApeak) | Notes |
|---|---|---|---|
| 1V | 0.46 mA | | |
| 7V | 3.2mA | | |

**Table 10: Channel 2 Output Current vs. Input Voltage**

| Input Voltage Peak (1KHz) | Nominal Output Current (mApeak) | Actual Output Current (mApeak) | Notes |
|---|---|---|---|
| 1V | 0.46 mA | | |
| 7V | 3.2mA | | |

**Table 11: Channel 3 Output Current vs. Input Voltage**

| Input Voltage | Nominal Output Current (mApeak) | Actual Output Current | Notes |
|---|---|---|---|

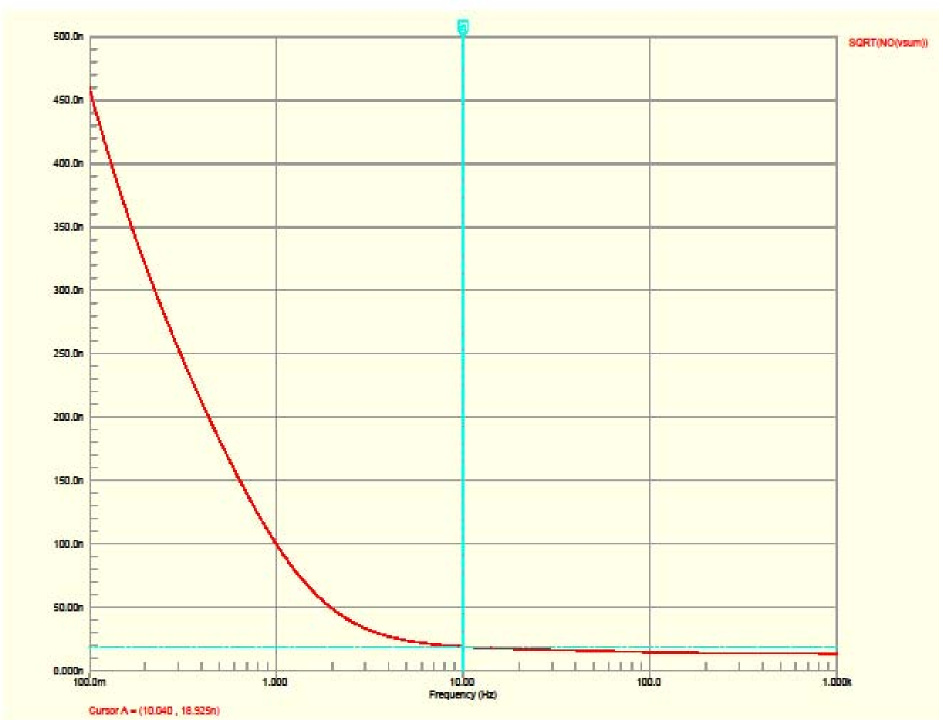
| Peak (1KHz) | | (mApeak) | |
|---|---|---|---|
| 1V | 0.46 mA | | |
| 7V | 3.2mA | | |

**Table 12: Channel 4 Output Current vs. Input Voltage**

| Input Voltage Peak (1KHz) | Nominal Output Current (mApeak) | Actual Output Current (mApeak) | Notes |
|---|---|---|---|
| 1V | 0.46 mA | | |
| 7V | 3.2mA | | |

## 3.2 Noise Tests

The most stringent noise requirement for the Triple Low Current Driver is from 10-15Hz where the output noise current from the driver needs to be less than 125 pA/√Hz . Measuring the actual noise current into the 20 ohm load resistor is a very difficult measurement, so the noise current must be implied by measuring the output noise voltage of the driver using test points on the board (TP4 and TP5). The output noise voltage measured between TP4 and TP5 needs to be less than 228nV/√Hz at 10Hz to meet the current noise requirement. A plot of the simulated noise versus frequency is shown in the figure below. Note that noise is well below the requirement and corresponds to approximately 11pA/√Hz at 10Hz.



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The simulation predicts that the noise at 10Hz should be approximately 19nV/√Hz. In the table below, record the output noise at 10Hz measured between TP4 and TP5 for each channel. The inputs to the channel under test should be tied to circuit ground. In addition, save the noise data for one representative channel to disk and record the file name in space provided below. The frequency range for the saved file should be from 0.1Hz to 100Hz.

**Table 13: Noise Monitor Test Results**

| Channel Number | Measured Noise at 10Hz |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

File Name for noise measurement (Run Mode):__________________
Channel Number for saved file: ________

## 3.3 Monitors, Controls and PD and LED Signal Pass Through

### 3.3.1 Relay Command and Monitors

Each relay used in the design has been provided with a separate monitor of its state. These tests will verify the proper operation of the relay status monitors. In the tables below document the operation of the monitors for each relay. Note that each relay is energized by grounding the appropriate pin on connector J7. The status reading for the channel enable relays (K1) is high when the relay is not energized.

**Table 14: Channel Enable Relay Monitors**

| Channel/ Pin on J7 | Monitor pin on J6 | Relay Enabled- Monitor Low? | Relay Disabled- Monitor High? |
|---|---|---|---|
| CH 1 / J7-1 | J6-1 | | |
| CH 2 / J7-2 | J6-2 | | |
| CH 3 / J7-3 | J6-3 | | |
| CH 4 / J7-4 | J6-14 | | |

### 3.3.2 PD and LED Signal Pass Through

The coil driver also provides a path for connecting the PD and LED monitor signals from the Satellite Amplifier to the AA chassis. These are just traces on the board that route signals from connector J1 to the appropriate pins on connectors J2 and J5. A meter is used to verify continuity of the connections. The tables below are used to record the results.

**Table 18: PD Signals**

| Pin on J1 | Pin on J2 | Continuity? |
|---|---|---|
| 1 | 1 | |
| 14 | 6 | |
| 2 | 2 | |
| 15 | 7 | |
| 3 | 3 | |
| 16 | 8 | |

| | | |
|---|---|---|
| 4 | 4 | |
| 17 | 9 | |

**Table 18: LED Signals**

| Pin on J1 | Pin on J3 | Continuity? |
|---|---|---|
| 5 | 1 | |
| 18 | 6 | |
| 6 | 2 | |
| 19 | 7 | |
| 7 | 3 | |
| 20 | 8 | |
| 8 | 4 | |
| 21 | 9 | |