Board Serial Number:

TTFSS________________________ TTFSS Interface Board__________________________

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
-LIGO-
CALIFORNIA INSTITUTE OF TECHNOLOGY
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Technical Note	**LIGO-E1000405-v1**	8/4/10

Test Plan
Table Top Frequency Stabilization Servo (TTFSS) - D0901897 and TTFSS Interface Board – D0902048

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Tested by ____

This plan tests both the TTFSS and the TTFSS Interface Board. The two modules should be connected via a 37-pin cable.

Note: No signals are applied via the P1 connector on the TTFSS Interface Board (switches and variable gain stages) unless specified. All measurements are made using active probes, where applicable.

1) **Current draw:**
Connect TTFSS Interface Board to the TTFSS card (with TTFSS Daughter Card installed) using the 37-conductor interconnect cable. Apply +,- 24V as specified on the TTFSS Interface Board drawing (using a Euro-card extender card works too).

+24V:
Design value: 200 mA +/-10% Measured value:_____________ Pass/Fail ____________

-24V:
Design value: 200 mA +/-10% Measured value:_____________ Pass/Fail ____________

2) **Test TTFSS Interface Board voltage regulator outputs:**

+15V:
Design value: +15V +/- 5% Measured value: _______________ Pass/Fail ____________

-15V:
Design value: -15V +/- 5% Measured value: _______________ Pass/Fail ____________

3) **Test TTFSS voltage regulator outputs:**

+15V:
Design value: +15V +/- 5% Measured value: _______________ Pass/Fail ____________

+5V:
Design value: +5V +/- 5% Measured value: ________________ Pass/Fail ____________

-15V:
Design value:: -15V +/- 5% Measured value: _______________ Pass/Fail ____________

-5V:
Design value: -5V +/- 5% Measured value: ________________ Pass/Fail ____________

4) **Check that TTFSS daughter card is getting power:**

+15V:
Design value: +15V +/- 5% Measured value: _______________ Pass/Fail ____________

-15V:
Design value:: -15V +/- 5% Measured value: _______________ Pass/Fail ____________

5) **Check for overall offset; TP19 to ground:**

Design value: < +/- 2 V Measured value: ______________ Pass/Fail ____________

6) **Test LO mon indicator:**
Drive the LO input on the TTFSS front panel with a 21.5 MHz sine wave at 7 dBm.
Measure pin P1-13 to pin P1-14.

Design value: 5V +/- 0.5V Measured value: ____________ Pass/Fail ____________

7) **Test switches:**

a) Short pin P1-23 on the P1 connector of the TTFSS Interface Board to ground and observe that the path from Test In of the TTFSS front panel to TP1 on the TTFSS closes (normally opened).

Measurement result: Pass/Fail ____________

b) While pin P1-23 is shorted to ground, short pin P1-25 on the P1 connector of the TTFSS Interface Board to ground and observe that the path from Test In of the TTFSS front panel to TP4 on the TTFSS opens (normally closed).

Measurement result: Pass/Fail ____________

c) Short pin P1-27 on the P1 connector of the TTFSS Interface Board to ground and observe that the path from EXC In of the TTFSS front panel to TP5 on the TTFSS closes (normally open).

Measurement result: Pass/Fail ____________

8) **Test variable gain stages:**

Note: measurements can be made, for instance, by driving TEST IN (-30 dBm) while pin 23 is shorted to ground and measuring the TF (10 kHz to 100 kHz span) between specified points using active probes).

a) **Common gain**: apply voltage between pin P1-3 and P1-4 on the P1 connector of the TTFSS Interface Board. Verify gains between TP5 and TP4 as follows. Note that the gain measured with 0 V applied is the "nominal" gain.

Voltage applied	Design Gain	Measured Gain
0 V	3 to 4 dB	______(nom.) Pass/Fail ____________
-6.25 V	nom. -20 +/-2 dB	____________ Pass/Fail ____________

+6.25 V	nom. +20 +/-2 dB	____________	Pass/Fail ____________

b) **FAST gain**: apply voltage between pin P1-7 and P1-8 on the TTFSS Interface Board P1 connector. Verify gains between TP4 and TP17 as follows. Note that the gain measured with 0 V applied is the “nominal” gain.

Voltage applied	Design Gain	Measured Gain	
0 V	2 +/- 0.5 dB	______(nom.)	Pass/Fail ____________
-6.25 V	nom. -20 +/-2 dB	____________	Pass/Fail ____________
+6.25 V	nom. +20 +/-2 dB	____________	Pass/Fail ____________

9) **Test variable voltage outputs:**

a) **Input offset**: Apply voltage between P1-6 and P1-5 on the TTFSS Interface Board P1 connector. Measure on the TTFSS card between TP3 and ground. Note: voltages are inverted.

Voltage applied	Design Voltage	Measured Voltage	
0 V	0 +/- 0.25 V	_______________	Pass/Fail ___________
-10 V	+5 +/- 0.25 V	_______________	Pass/Fail ___________
+10 V	-5 +/- 0.25 V	_______________	Pass/Fail ___________

b) **SLOW voltage**: Apply voltage between P1-9 and P1-10 on the TTFSS Interface Board P1 connector. Measure at the SLOW out BNC on the front of the TTFSS box Note: BNC shield is the common.

Voltage applied	Design Voltage	Measured Voltage	
0 V	0 +/- 0.1 V	______________	Pass/Fail ___________
-10 V	+2.2 +/- 0.2 V	______________	Pass/Fail ____________
+10 V	-2.2 +/- 0.2 V	______________	Pass/Fail ____________

10) **Test fast channel monitor points (on the Interface card front panel):**

a) **MIXER**: Drive Test In and measure the TF between TP5 on the TTFSS and the front panel MIXER monitor point on the TTFSS Interface Board.
Design value: 0 +/- 0.5 dB @ 100 kHz Measured value: ___________ Pass/Fail_______

b) **FAST**: Drive Test In and measure the TF between TP19 on the TTFSS and the front panel FAST monitor point on the TTFSS Interface Board.
Design value: 0 +/- 0.5 dB at 100 kHz. Measured value: ___________ Pass/Fail_______

c) **EOM**: Power the PA85 with +,- 100V using the CPC connector on the front of the TTFSS Interface Board. **CAUTION**: HIGH VOLTAGE- current drawn should not exceed 30 mA!. Drive the Test In input with a 100 kHz sine wave @ -10 dBm. Measure the DC voltage at the EOM front panel connector on the TTFSS Interface Board. NOTE: Voltage may vary greatly depending on cabling configuration.

Design value: 3.16 +,-0.5 V Measured value: ___________ Pass/Fail_______

11) **Transfer functions:** Eventually they will be compared with a model. For now make hard copies and record data files. Drive Test In input.

a) **Verify 21.5 MHz notch**: Measure TF between Test In (ref.) and TP1 and measure the notch frequency. Range: 4 MHz to 40 MHz; BW: 100 Hz; Source: -30 dBm.

Design value: 21.5 +,-.25 MHz. Measured value: ___________ Pass/Fail___________

File__________________

b) **Mixer to common**: Measure TF between Test In (ref.) and TP4. Range: 10 kHz to 20 MHz; BW: 100 Hz; Source: -30 dBm; Marker: 1 MHz.

Design marker value: +12.2 +,- 1 dB. Measured value:__________ Pass/Fail________

File__________________

c) **PZT path 1**: Measure TF between TP4 (ref.) and TP14. Range: 1 kHz to 10 MHz; BW: 100 Hz; Source: -30 dBm; Marker: 10 kHz. Verify the pole at 10 kHz.

Design marker value +17.6 +,- 1 dB. Measured value:____________ Pass/Fail_______

File___________________

d) **PZT path 2**: Measure TF between TP14 (ref.) and TP15. Range: 1 kHz to 10 MHz; BW: 100 Hz; Source: -30 dBm; Marker: 34.3 kHz. Verify the pole at 34 kHz.

Design marker value: +9 +,- 1 dB. Measured value:______________ Pass/Fail_______

File___________________

e) **PZT path 3**: Measure TF between TP15 (ref.) and TP16. Range: 1 kHz to 10 MHz; BW: 100 Hz; Source: -30 dBm; Marker: at notch frequency (~222 kHz). Note: Notch frequency to be optimized during installation - PZT-specific.

Design value: 200-400 kHz Measured value: ___________ Pass/Fail_______

File____________________

f) **EOM path 1**: Measure TF between TP4 (ref.) and TP11. Range: 1 kHz to 10 MHz; BW: 100 Hz; Source: -30 dBm; Marker: 100 kHz.

Design marker value: -7.2 +.- 1 dB Measured value:_________ Pass/Fail_______

File______________________

g) **EOM path 2**: Measure TF between TP11 (ref.) and TP12. Range: 100Hz to 10 MHz; BW: 100 Hz; Source: -30dBm; Marker: 33.4 kHz.

Design marker value: 3.6 +,- 1 dB. Measured value:_________ Pass/Fail_______

File______________________

h) **EOM path 3**: Measure TF between TP4 (ref.) and TP13. Range: 1 kHz to 10 MHz; BW: 100 Hz; Source: -50 dBm; Marker: 333.7 kHz.

Design marker value: 7 +,- 2 dB. Measured value:_____________ Pass/Fail_______

File______________________

i) **EOM path 4**: Measure TF between TP4 (ref.) and TP13. Range: 1.5 MHz to 1.8 MHz; BW: 100 Hz; Source: -50 dBm; Marker: at notch. Adjust variable capacitor C13 to tune notch frequency.

Design value: 1.67 +/-0.015MHz Measured value: ___________ Pass/Fail_______

File______________________

j) **EOM path 5**: Power the PA85 with +/- 100V using the CPC connector on the front of the TTFSS Interface Board. **CAUTION**: HIGH VOLTAGE - current drawn should not exceed 30 mA!.
Measure TF between TP1 (ref.) and TP3 on the TTFFS:HV/Interface. Range: 20 kHz to 20 MHz; BW: 100 Hz; Source: -50 dBm; Marker: 1 MHz. Note: 100 V available at TP3; check with oscilloscope before connecting to network analyzer. Do not exceed +/- 10 V or acive probes will be damaged.

Design marker value: 0 +,- 1 dB. Measured value:_____________ Pass/Fail_______

File______________________

12) **Noise measurements:**

a) **EOM path**: active probe at TP13; input not connected; spectrum analyzer mode; Range: 100 Hz to 100 kHz; BW: 100 Hz; Attenuator: 0 dB; Averages: 16; Marker: 50 kHz.

Design marker value: -100 +,- 10 dBm. Measured value:_________ Pass/Fail_______

File_______________________

b) **PZT path**: active probe at TP19; input not connected; Spectrum analyzer mode; Range: 100 Hz to 100 kHz; BW: 100 Hz; Attenuator: 0 dB; Averages: 16; Marker: 50 kHz.

Design marker value (TBD): __________Measured value:_________ Pass/Fail_______

File__________

13) **Interface board test switches:**

The local/remote switch should be now be set to local, and all the knobs should be turned to a value of 500 to begin. The other switches should all be set to their off position. Return all knobs to a value of 500 and all switches to off when not in use.

a) Flip the test/off/ramp switch from OFF to TEST and observe that the path from Test In of the TTFSS front panel to TP1 on the TTFSS closes (normally opened). Suggestion: Inject a 1kHz sine wave into the RF TEST IN, and then use the clips connected to an oscilloscope to see the signal. Set the switch to OFF when done.

Measurement result: Pass/Fail ____________

b) Flip the excitation/off switch from OFF to EXC and observe that the path from EXC In of the TTFSS front panel to TP5 on the TTFSS closes (normally open). Suggestion: Inject a 1kHz sine wave into the RF TEST IN, and then use the clips connected to an oscilloscope to see the signal. Set the switch to OFF when done.

Measurement result: Pass/Fail ____________

c) Connect the 1 kHz signal to FAST OUT2. Check the signal at the FAST output on an oscilloscope. It should only come out if the test/off/ramp switch is set to RAMP. The signal is much smaller than what's put out by the scope, so a large voltage from the function generator should be used. The switch should be set back to off when done.

Measurement result: Pass/Fail ____________

14) **Test interface board knobs**

a) **Common Gain**: put a 0.05 V peak-to-peak signal into RF TEST IN. Enable TEST IN by flipping the test/off/ramp switch to TEST position. Connect TP4 to the scope. Adjust the Common Knob to the specified values and measure the peak to peak value of the sine wave at TP4.

Common Knob	Expected Voltage (peak to peak)	Measured Voltage	Pass/Fail
1000	1.3 V		
750	0.44 V		
500	0.135 V		

250	0.045 V		
0	0.015 V		

b) **Fast Gain**: Put a 0.05 V peak-to-peak signal into RF TEST IN. Enable TEST IN by flipping the test/off/ramp switch to TEST position. Connect TP17 to the scope. Adjust the Fast Knob to the specified values and measure the peak-to-peak value of the sine wave at TP4.

Fast Knob	Expected Voltage (peak to peak)	Measured Voltage	Pass/Fail
1000	1.72 V		
750	0.57 V		
500	0.135 V		
250	0.045 V		
0	0.015 V		

c) **Slow output:** Adjust the Coarse Knob to the specified values and measure the DC voltage of the Slow Output on the front panel of the TTFSS.

Coarse Knob	Expected Voltage (peak to peak)	Measured Voltage	Pass/Fail
1000	2.2 V		
750	1.1 V		
500	0 V		
250	-1.1 V		
0	-2.2 V		

Now adjust the Fine Knob to the specified values and measure the DC voltage of the slow output on the front panel of the TTFSS.

Fine Knob	Expected Voltage (peak to peak)	Measured Voltage	Pass/Fail

1000	0.22 V		
750	0.11 V		
500	0 V		
250	-0.11 V		
0	-0.22 V		

d) **Offset:** Adjust the Offset Knob to the specified values and measure the DC voltage on TP19.

Fine Knob	Expected Voltage (peak to peak)	Measured Voltage	Pass/Fail
1000	5 V + nom.		
750	2.5 V + nom.		
500	< +/- 2 (nom.)	(nom.)	
250	-2.5 V + nom		
0	-5 V + nom		

14) **Test integrator:**

Return all knobs to 500, except set FAST GAIN to 1000 and COMMON GAIN to 1000.
Connect the FAST OUT to the oscilloscope.
Connect the SLOW OUT to the RF TEST IN.
Set the test/off/ramp switch to TEST.
Set the signal generator to create a 0.1 Hz, 10 V peak-to-peak sine wave, and connect it to the FAST EXC connector, and set the switch on the TTFSS to turn the FAST EXC on (should light up the LED).
a. Set the servo/off/inv switch from OFF to INV and set the polarity switch for the FAST OUT to positive, or set the servo/off/inv switch from OFF to SERVO and set the FAST OUT polarity switch to negative.
The signal on the scope should be DC coupled. It may have a large DC offset at first, but settle at some fixed value(~1V) after ~10 seconds or so. Record the value it settles at. NOTE: If it does not settle to ~1 V, try setting the servo to OFF and then back to INV.

Design value: ~1 V Measured value: _____________ Pass/Fail _____________

b. Adjust the time scale of the scope to be 1s or 5s / division. You should see a very small 0.1 Hz sine wave from the FAST OUT on the scope. Measure peak-to-peak value.

Design value: ~0.130 V Measured value: ____________ Pass/Fail ____________

c. Very slightly turn the Offset Knob. You should see the DC voltage on the scope, then decay slowly back to its steady value.

Measurement result: Pass/Fail ____________

d. Return OFFSET knob to 500. Disconnect the cable that connects the SLOW output to the RF TEST IN. The 0.1 Hz sine wave on the scope should now be much larger. Adjust the offset knob to bring this sine wave close to 0. Measure the peak-to-peak value.

Design value: ~1 V Measured value: ____________ Pass/Fail ____________

END___________________________