LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Test Procedure for RF diplexer amplifier

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1 Introduction

The following Test Procedure describes the test of proper operation of the RF diplexer amplifier (E1300852). The unused outputs should always be properly terminated.

2 Test Equipment

- Voltmeter
- Oscilloscope
- Agilent Network/Spectrum analyzer (e.g. AG4395A)
- Agilent ESG-1000 signal generator (or similar signal source with f_{max}>150MHz)
- RF Power Meter (e.g. HP E4418A or N1914A)
- Board Schematics--D1300989

3 Tests

The RF Preamplifier comes with the Low Noise Power Module (D0901846.

1) **Verify the proper current draw.** Using a bench DC supply apply ±24Volts to P7 and ±17 Volts to P6 of the low noise power Module (D0901846). Measure the current draw of the board.

+24 Volt current	0.02 A	0.02 A Nom.
–24 Volt current	0.02 A	0.02 A Nom.
+17 Volt current	0.35 A	0.2~0.3 A Nom.
–17 Volt current	0.03 A	0.03 A Nom.

2) On the low noise power module check the voltage on TP 1-13.

TP1 (+17V) _____+17.27 V___ TP2 (-17V) _____-17.22 V____

TP3 , 4 (GND) TP5 (+ 5V)_____+5.07 V___

TP6 (-15V) _____-15.00 V___ TP7 (+24V) _____+24.17 V___

TP8 (GND) TP9 (-24V) _____-24.08 V___

TP10 (GND) TP11 (+15V) ____+15.0 V__

TP12 (+VREF) __+10.00 V___ TP13 (-VREF) _-10.00 V___

3) If TP 1 , 2, 7 , 9 and 8 are correct then pin 5 on U1 and U7, TP14 (OK) should be Logic high ~3Volts. The front panel LED should be on.

Confirm._____OK_____

4) The noise on TP 12, 13, 11 and 6 should be measured with a SR785 using an rms power spectrum.

TP12 noise __29.9 nVrms/sqrtHz___less than 200 nVrms/sqrt Hz at 140 Hz

TP13 noise __17.99 nVrms/sqrtHz___less than 900 nVrms/sqrt Hz at 140 Hz

TP11 noise __10.59 nVrms/sqrtHz___ less than 1 uVrms/sqrt Hz at 140 Hz

TP6 noise __20.18 nVrms/sqrtHz___ less than 1 uVrms/sqrt Hz at 140 Hz.

5) **Test the output powers of each port by applying the RF signal to the "In" port at the below specified power and frequency.** With an RF power meter measure the power at the three output ports (i.e. "Direct", "LF", HF). Compare the output with the specification.

Frequency: 27.3MHz, Input power -20dBm

Output port	Measured Power	Specification (dBm)	Judgement (Pass/NG)
Direct	**-32.0 dBm**	**-32 +/- 1 dBm**	**Pass**
LF	**-0.34 dBm**	**> -2 dBm**	**Pass**
HF	**-33.0 dBm**	**< -27 dBm**	**Pass**

Frequency: 136.5MHz, Input power -40dBm

Output port	Measured Power (dBm)	Specification (dBm)	Judgement (Pass/NG)
Direct	**-52.5 dBm**	**-52 +/- 1 dBm**	**Pass**
LF	**-108 dBm**	**< -72**† **dBm**	**Pass**
HF	**3.5 dBm**	**> +3 dBm**	**Pass**

† This power level may be too small to be measured with the power meter. An RF spectrum analyzer may be needed.

6) **Measure -0.5dB pass and -50dB rejection bandwidth by changing the input frequency from the above setting.** Change the signal frequency, starting from the above specified signal frequency. Record the upper and lower frequency where the output is reduced by 0.5dB and 50dB. Confirm the pass and rejection band with the specification.

LF port, center frequency: 27.3MHz, Input power -20dBm

Lower boundary of the -0.5dB band	Upper boundary of the -0.5dB band	Pass band width $df=f_{0.5dBHI} - f_{0.5dBLO}$	Spec.	Judgement (Pass/NG)
$f_{0.5dBLO}$=26.11MHz	$f_{0.5dBHI}$=28.34MHz	df = 2.23 MHz	df > 1MHz	Pass

Lower boundary of the -50dB band	Upper boundary of the -50dB band	Rejection band specification	Judgement (Pass/NG)
f_{50dBLO}=11.10MHz	f_{50dBHI}=40.79MHz	f_{50dBLO} > 18.2MHz f_{50dBLO} < 45.5MHz	NG Pass

HF port, center frequency: 135.6MHz, Input power -40dBm

Lower boundary of the -0.5dB band	Upper boundary of the -0.5dB band	Pass band width $df=f_{0.5dBHI} - f_{0.5dBLO}$	Spec.	Judgement (Pass/NG)
$f_{0.5dBLO}$=137.0MHz	$f_{0.5dBHI}$=141.8MHz	df =4.8 MHz	df > 2MHz	Pass

Lower boundary of the -50dB band	Upper boundary of the -50dB band	Rejection band specification	Judgement (Pass/NG)
f_{50dBLO} = 90.6 MHz	f_{50dBHI} = 176.7MHz	f_{50dBLO} > 127.4MHz f_{50dBLO} < 145.6MHz	NG NG

7) **Measure the input power level to give the harmonic distortion of -30dBc.** Connect the LF or HF ports to an RF spectrum analyzer. Setup the harmonic distortion measurement (the function "Multi Peak search" is useful). Increase the signal amplitude with a 0.1dB step until the largest harmonics is 30dB relative to the main signal peak ("Delta Marker" is useful for this measurement). Record the power of the harmonic (up to 5th harmonics for 27.3MHz and 3rd harmonics for 136.5MHz). Confirm the output power level is larger than the specification.

LF port, Signal frequency: 27.3MHz

Input power for 30dBc harmonics	Power level of the main signal	Specification	Judgement (Pass/NG)
-2.86 dBm	16.87 dBm	> 16 dBm	Pass

Harmonics			
2nd (54.6MHz)	3rd (81.9MHz)	4th (109.2MHz)	5th (136.5MHz)
-42.7 dBc	-30.0 dBc	-41.3 dBc	-37.9 dBc

HF port, Signal frequency: 136.5MHz

Input power for 30dBc harmonics	Power level of the main signal	Specification	Judgement (Pass/NG)
-26.4 dBm	16.66 dBm	> 16 dBm	Pass

Harmonics			
2nd (273.0MHz)	3rd (409.5MHz)		
-42.4 dBc	-30.1 dBc		

8) **Measure the output noise level of the LF and HF output ports.** A

Output Port	Measured noise level	Specification	Judgement (Pass/NG)
LF (27.3MHz)	14.1 nV/rtHz	< 20 nV/rtHz	Pass
HF (136.5MHz)	162 nV/rtHz	< 300 nV/rtHz	Pass