LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

LIGO-T1600505-v1 *LIGO* 12/22/2016

Test Procedure for RF Frequency Multiply-by-5

Paul Schwinberg and Daniel Sigg

Distribution of this document:
LIGO Scientific Collaboration

This is an internal working note
of the LIGO Laboratory.

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – NW22-295
185 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

http://www.ligo.caltech.edu/

1 Introduction

The following Test Procedure describes the test of proper operation of the RF Frequency Multiply-by-5.

2 Test Equipment

- Voltmeter
- Oscilloscope
- Stanford Research SR785 analyzer
- Tektronix AFG3101 function generator (or similar)
- RF Power Meter HP E4418A
- Board Schematics--Frequency Multiply-by-5

3 Tests

The RF Frequency Multiplier comes with a number of different power supply boards so I will assume that we are using the latest which is the Low Noise Power Module (D0901846) with the RF Distribution Amplifier: Interface (D1000064).

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 _____ 0.1 A Nom.

–24 Volt current _____ 0.0 A Nom.

+17 Volt current _____ less than 1.0 A

–17 Volt current _____ less than 0.01 A

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

TP1 (+17V) _____ TP2 (–17V) _____

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

TP6 (–15V) _____ TP7 (+24V) _____

TP8 (GND) TP9 (–24V) _____

TP10 (GND) TP11 (+15V) _____

TP12 (+VREF) _____ TP13 (–VREF) _____

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._____

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

TP12 noise _____less than 20 nVrms/√Hz at 140 Hz

TP13 noise _____less than 30 nVrms/√Hz at 140 Hz

TP11 noise _____ less than 40 nVrms/√Hz at 140 Hz

TP6 noise _____ less than 60 nVrms/√Hz at 140 Hz.

5) **Test the RF monitor by applying a 40 MHz RF signal to J1.** Monitor the nominal output power at J2 and measure the output voltage at mon1.

Nom output pwr	Input pwr dBm	Mon volt (M)	Measured volt.	Measured Pwr
13 dBm		**2.9V (0.725)**		
10 dBm		**3.2V (0.800)**		
7 dBm		**3.5V (0.875)**		
0 dBm		**4.2V (1.05)**		
-10 dBm		**5.2V (1.30)**		
none		**6.2V (1.55)**		

6) Test the RF output powers by applying a 40 MHz/10dBm RF signal to J1. With a RF power meter measure the power at the output (13 dBm nominal). If the output power is consistently too high an attenuator A1 has to be adjusted accordingly. Nominal output power is 13 dBm.

Output: _____ (13 dBm nominal)

7) Measure the phase noise of a 40MHz OCXO driving the RF Frequency 5x Multiplier. Use a 200MHz OCXO as the second oscillator to compare the output signal of the divider, using the Wenzel single channel phase noise measurement technique (3.5.3), Figure 3.5.2-1, which can be found at

http://www.wenzel.com/pdffiles1/BP1000Manual/BP_1000_v101_2_.pdf .

A reasonable FFT analyzer is the SR785, which can be set to measure power units if you start in Display Setup. A Reference Source must be provided which can be just a Wenzel crystal oscillator of frequency close enough to lock, properly powered and connected to the Wenzel phase noise measurement system. The output of the RF Frequency Divider will need to be attenuated to the amplitude needed by the Wenzel phase noise measurement system (about 10 dBm). Compare to the phase noise of the OCXO datasheet, subtract 6dB to the noise of the 40MHz unit and add it in quadrature to the noise of the 200MHz unit. The noise of the multiplier be within 14dB.

Offset (Hz)	Phase noise spec (dB/Hz)			Measured (dB/Hz)
	40 MHz	200 MHz	Total	
10	**–90**	**–96**	**–82**	
100	**–110**	**–116**	**–102**	
1000	**–140**	**–146**	**–132**	
10000	**–160**	**–166**	**–152**	