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Refer to:	LIGO-E1300845-v1
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Phase locked loop Board Test Procedure

Test Preparation

Enter Name, Date, Revision, Board Serial Number VCO chassis serial number:

Test Engineer	**Date**	**Pass**
Sheila Dwyer	12/7/13	
Board	**PLL Board Serial Number**	**VCO chassis serial number**
D1300812		S1200563

Required Test and Ancillary Equipment

- 1 – One PLL Tester D1300797
- 1 - Tektronix AFG 3101 Signal Generator or equivalent
- 1 - Tektronix TDS 210 Oscilloscope or equivalent
- 1 – Fluke Multimeter or equivalent
- Calibrator (or DC voltage source)
- 1 - HP 4395A Network analyzer (1Hz to 10MHz) or equivalent
- 1 - Stanford Research Systems Signal Analyzer Model SR785
- 1 - GPIB to Cat5 adapter
- 1 - Cat5 cable
- 1 – Laptop CPU using Windows operating system
- 1 – Folder containing Test File Scripts
- 2 - DC Power Supplies (Five Channels Required. Continuous Supply Voltages: +/- 24VDC, +/- 17VDC, and +5VDC)
- 1 - 17VDC Power Cable
- 1 - 24VDC Power Cable
- 1 – 5VDC Power Cable (Banana Plug to Banana Plug Cable and Jumper)
- 1 - custom cable adapting the DB9 Monitor port on the D0901781 front panel into three BNCs. (Refer to Common Mode Board: DAQ, Number D040180 Rev E, Sheet 17 of 17 for DB9 pinout detail)
- 1 - 25 pin D sub cable male to female
- 3 – TNC male to BNC female adapters
- 1 – 2 pin lemo to BNC adapter
- 3 – BNC Female to Female Adapters (Barrels)
- 1 - BNC Tee Connector
- 1 – BNC to grabber adapter

Table of Contents

Tests Part 1.

On the PLL board, **Connect** the positive multimeter test lead to the following test points and **Connect** the negative multimeter test lead to GND.

Record the observed voltages in the data boxes below, place a check if the front panel OK LED is lit.

TP17	TP18	TP19	TP20	TP21	TP22	TP23	TP24	TP25	TP26	OK
15	14.97	5.02	0	0	0	NA	0	0	0	✓
+15V	-15V	+5V	GND	GND	GND	GNC	GND	GND	GND	lit

Power Supplies

Turn OFF Power Supplies, first turning off 17V then 24V each time.

Connect 25 pin PLL control cable to corresponding jacks on tester (on rear, labeled controls) and VCO chassis rear panel (labeled PLL).

Turn ON Power Supplies

Check current draw from the ±17V power supply is about 1 Amp.

On the front panel of Power Supplies, **Observe** and **Record** the amperage displayed.

Power supply	Current	Nominal
+24V	0.094 A	0.1
-24V	0.02	0.02
+17V	0.93	1
-17V	0.25	0.26

Adjust DC Bias

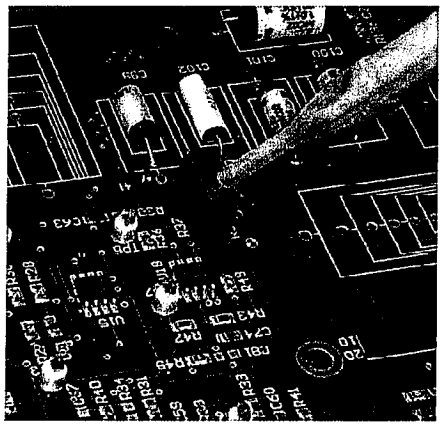

Figure 1: Potentiometer similar to R46

Set Oscilloscope coupling to DC Coupling.

Connect On tester connect Input Mon (D17) to the oscilloscope.

Ground IN using a BNC 50 ohm termination.

Adjust DC bias (R46) for zero volts observed at Input Mon.

Connect Multimeter to VCO output, disable LF compensation filter by flipping D2 down. Readjust R46 for 0V observed at VCO output.

Enable the first compensation filter, flipping D2 up. Adjust R46 for zero volts observed at VCO out.

Enable the second compensation filter, flipping D3 down. Adjust R46 for zero volts observed at VCO out.

Return switches to defaults.

Use a voltage calibrator to send a voltage into Offset Adjust (D19) on the tester.

Input to Offset Adjust (D19)	0V	10V	-10V
Input Mon (D17)	65mV	61	-49
Nominal Input Mon	0	55mV	-55mV

Connect Function Generator Output (sine wave, 100Hz, 1 Vpp, 1 V offset) to PLL IN jack.

Connect Test1 to the oscilloscope.

Toggle Sign (Input polarity, D1) on tester, and check that polarity of the signal on oscilloscope flips. Circle here if correct.

Toggle Enable (D0), check that signal goes to zero when disabled. Circle here if correct.

Gain slider:
Set offset on function generator to 0V.

Individually, **Toggle** each switch down (GND) and **Record** observed voltage. After each voltage observation, **Return** the switch to default position. Tolerance is +/-0.5dB (6%).

D2 (LF comp)	0.2	0.2	0.96	1.00
D2+D3 (LF +HF comp)	2.02	2	9.84	10.0
D12 (boost)	3.96	3.9 (may have DC offset)	17.6	17.8
D13 (filter)	3.6	3.9	17.6	17.8
D14 (VCO)	3.52	3.6	17.6	17.8
D15 (low pass)	1.6	1.6	17.6	17.8

Connect SMA to BNC adapter to J7 (towards rear of board). With 100Hz/1Vpp Sine wave still injected into IN, observe signal at J7.

Binary input	**J7**	**Nominal Vpp**
D2	0.96	1.0
D2 and D11	ϕ	off

EPICS Readbacks

Inject a 1Hz/0.1V pp or 100Hz/1Vpp **Sine wave** to IN and **Record** the observed voltage.
**The voltage tolerance is 1 dB of the nominal value.

EPICS readback	**1Hz/0.1Vpp**	**Nominal Vpp**	**100Hz/1Vpp**	**Nominal Vpp**
D17 (input mon)	0.1	0.09	76mV	0.080
D18 (output mon)	4.88	4.8	1.4	1.6

Tests Part 2: SR785 Signal Analyzer Tests

Important Notes: 1.Switch LF comp and VCO comp to off on the tester (D2 and D14 down) for all the measurements in this section, unless otherwise directed. 2. Closely Read and follow all On-Screen prompts.

On a Windows operating system laptop, **Create** and **Save** a file called PLL_TEST_DATA to C: drive. The path is C:\PLL_TEST_DATA\.

Save Test Scripts in PLL_TEST_DATA. Test scripts are available as a zip file attached to this procedure in the DCC.

Connect an SR785 Signal Analyzer to the laptop with a GPIB to Cat5 adapter.

From the DOS CMD window, **Type** cd.. , Enter, **Type** cd.. ,Enter and **Type cd** TEST_DATA.

Noise Spectra (SR785NoiseMeasurements.bat)

Type resetSR785 and **Allow** the SR785 to reset. **Type** SR785NoiseMeasurements

Terminate IN using a 50 ohm terminatior. **Measure** the noise density at VCO out and f/phi. **Record** the values at 100Hz, 1kHz, 10kHz and 100kHz in the table below. See Appendix A1 for typical examples.

Frequency	VCO	< [nV/√Hz]	f/φ	< [nV/√Hz]
100Hz	30	40	25.5	30
1kHz	25	40	19.6	30
10kHz	24.2	40	15.7	30
100kHz	25	40	14.9	30

Basic Transfer Functions (SR785BasicTFs.bat)

Type SR785BasicTFs

Sweep the frequency from 100kHz down to 10Hz with 10mV source amplitude and **Measure** the transfer function from IN1 to VCO, with D3 down (HF comp) and all other switches on tester up (including D2, LF comp). Then repeat measurement from IN to f/phi with D2 down, D3 up, D12, D13 and D14 down (all other switches up), using a 500mV source amplitude. Then repeat measurement from IN to f/phi with D2 down, D3 up, D12, D13 and D14 up and D15 down (all other switches up), using a 500mV source amplitude. **Record** the values at 1Hz, 100Hz, 1kHz, 10kHz and 100kHz in the table below. See Appendix 5 for typical examples.
** Tolerances must be within 1dB and 5deg of nominal.

VCO out/IN	dB	Nom	deg	Nom
1Hz	53.5	54dB	165	172deg
100Hz	44.9	45dB	111	111deg
1kHz	25.5	25dB	95	95deg
10kHz	6.4	6.3dB	117	117deg
100kHz	-0.135	0.0dB	162	163deg

f/φ/IN(D2, D12, D13, D14 down)	dB	Nom	deg	Nom
1Hz	12.4	12dB	-31	-31deg

High Frequency Transfer Function (AG4395AHighFreqTF.bat)

These measurements should be done with D2 and D14 down, all other switches up.

Type AG4395AHighFreqTF

Use a network analyzer to measure the transfer function from IN1 to SERVO. Sweep the frequency from 10MHz down to 10kHz with –20dBm source. To remove cable delays first measure the transfer function against a BNC barrel and use as a reference. **Record** the displayed values at 100kHz, 300kHz and 1MHz in the table below. See Appendix A3 for typical examples.

** Tolerances are within 1dB and 5deg of nominal.

Frequency	VCO/IN [dB]	Nominal	VCO/IN [deg]	Nominal
100kHz	-0.47	0dB	167	170deg
300kHz	-1	0dB	139	150deg
1MHz	-5.4	-5dB	62	52deg

Check for gain peaking around 4-5 MHz. If there is none, circle here.

Frequency	VCO/IN [dB]	Nominal	VCO/IN [deg]	Nominal
100kHz	-14.7	-15dB	-9.3	-9deg
300kHz	-14.8	-15dB	-27.6	-28deg
1MHz	-16.4	-16.3dB	-90	-90deg

Check for gain peaking around 4-5 MHz. If there is none, circle here.