LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

-LIGO-

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Length Sensing and Control Photodiode Test Procedure

Joe Suina

This is an internal working note
of the LIGO Project.

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

Massachusetts Institute of Technology
LIGO Laboratory MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

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

REFERENCE DOCUMENTS

“ASSEMBLY INSTRUCTIONS, LSC PHOTODIODE BOX”. It will prompt the test technician when to perform a test step mentioned in this document.

“LSC PHOTODIODE CIRCUIT” page 1, filename PD2SC1.SCH. Pay particular attention to the Notes.

“LSC PHOTODIODE CIRCUIT” page 2, filename PD2SC2.SCH. The DB-9 bulkhead connector J5 pinout is listed, as well as the external interfacing circuit setup for the temperature sense test.

LSC Lab Notebook -- Contains examples of typical network analyzer response plots.

Hewlett Packard 4195A Network/Spectrum Analyzer Operating Manual

ITEMS OF NOTE

- It is assumed the component values for the 2-ω and 1-ω filter sections have been calculated and have been soldered onto the PCB.

- When the PCB under test is to be powered up, always first place PCB on a non-conductive surface.

REQUIRED ITEMS

Triple output DC power supply, BK Precision 1760
Hewlett Packard 4195A network/spectrum analyzer
Fluke 77 multimeter
Fluke 45 dual display multimeter
Infrared temperature probe, Fluke 80T-IR
Mercury thermometer
Test equipment: 6.8KOhm and 200-Ohm resistors in parallel
Bulkhead connector ribbon cable assembly
Test cable – provides hook-ups for power, temp sense, and disable/otemp logic control
TNC male –to- BNC female adapter connectors, quantity 3
BNC 50Ω cables, quantity 2
BNC female –to- female adapter
Label maker, Brother P-Touch adhesive strip label maker
Notebook with Photodiode Assembly serial number listing
6” long 24-gauge wire with 1Kohm ¼ Watt resistor & micro-clip
Heat gun
Data diskette with network analyzer “1PDST1” configuration file
Blank diskette
Tuning tool for MC 152 style variable inductors
Small flat head screwdriver for tuning the surface mount variable capacitor
Calculator (optional)
Table top 120Volt AC incandescent lamp, 40Watt or higher
PanaVise table mount vise with plastic jaws
Plotter and paper
Jackscrews and associated hardware, quantity 2 sets

PRODUCTION TEST PROCEDURE

☐ VISUAL INSPECTION

Visually inspect the PCB after all the components, except for U7 and D1, have been soldered:

- Check for correct placement, polarity, etc., of soldered components
- Check for unintentional short circuits to +/-15VDC & ground nets
- Check any board modifications that were made
- Check all resistor values; compare with the values on the schematic.

☐ RESISTANCE-TO-GROUND MEASUREMENT

Use a Fluke multimeter to measure the resistance-to-ground of the following nodes on the PCB. Compare measured values with the values on the following table:

SIGNAL	PIN	RESISTANCE [Ω]	SIGNAL	PIN	RESISTANCE [Ω]
+15VDC	C30+	~2M	D1 CATHODE	U2-6	~3K
+5VDC	C3+	~3K	D1 ANODE	D1	31
-15VDC	C31-	~2M	L1-L2 node	**X** L1	31
-5VDC	C2-	10.5K	DC BIAS V	**X** R4	31
U9 output	C28+	1110	U5 OUT	R12 **X**	~0.303M
U2 IN+	U2-1	203K	U6 IN-	**X** R11	~1K
U9 ADJ	C38+	910	U6 OUT	**X** R16	~1.9K
DISABLE IN	FLT7	~1.4M	DC OUT	J3	~1.9K
U2 DISABLE	U2-7	21K	L3/C10	**X** C10	31
STATUS/OTEMP	FLT8	~1.2M	U1 IN+	**X** L7	2.4
L8/C40 node	**X** L8	1.9	U1 IN-	R2 **X**	75.6
L4/C13 node	L4 **X**	Floating	U1 OUT	R1 **X**	755
U2 IN-	U2-2	997	RF OUT	J2	775
			TEST INPUT	R15 **X**	51.8

Investigate any large deviations from the values given in the table above and troubleshoot before proceeding further.

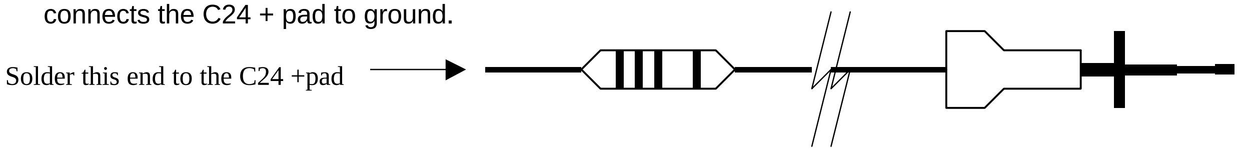
☐ SMOKE TEST

- Place PCB under test on a non-conductive surface.
- Set the dual power supply to provide +/-15 VDC. Check voltages and then turn power off.
- Connect the bulkhead connector ribbon cable assembly to the PCB J4 connector; pin 1 lines up with black arrow on IDC connector.
- Connect the DB-9 connector ends of the test cable and the bulkhead connector ribbon cable assembly.
- Turn on the dual power supply; keep your face and arms away from PCB for the first several seconds.
- Watch for smoke and smell for overheating. If no smoke appears, gingerly touch the various ICs to detect overly warm parts. U3 will get too hot without a heatsink so make sure there is a heatsink on U3. Keep in mind the U3 case is at ground potential but the U4 case is at **–15VDC.** The items that may feel warm to the touch are U3, U4, U9, U5, U6, U1, from warmest to coolest.
- Investigate any overheating problems and troubleshoot before proceeding further.

INSTALL ITEMS

Return to assembler to have the following items installed:

- Thermal block with thermal grease on bottom surface and inside U7 well
- D1 with tubing on the leads and thermal grease only on the bottom surface of D1
- D1 securing plate with flat washers & screws
- U7
- Lock washers, flat washers, and Allen head screws to secure the thermal block onto the PCB
- Solder the 6” long 24-gauge wire with 1KΩ ¼ Watt resistor & micro-clip through the via which connects the C24 + pad to ground.



REPEAT VISUAL INSPECTION

- The thermal block must be centered within the rectangle silkscreened on the PCB.
- Thermal block must lie flat onto the surface of the PCB. Its securing screws must not protrude past the bottom of the PCB.
- Clean off any excess thermal grease with an isopropanol soaked Q-tip.
- Be careful not to scratch the glass lens of D1 while the PCB assembly is being tested.
- Screws shall not be over-tightened.
- D1 shall not protrude above the upper surface of the thermal block.
- The position of TNC connectors J1-J3 shall be mutually perpendicular to the PCB surface both vertically and horizontally.

LABEL 1-ω FREQUENCY ONTO PCB

Using the label maker, label the 1-ω frequency onto the white silkscreened rectangle within the RF cage.

MARK SERIAL NUMBER ON PCB

Consult the notebook with the Photodiode Assembly serial number listing for the next available serial number. Write the next available serial number in the lower left corner of the white silkscreened rectangle within the RF cage. Write the serial number on the top of the RF cage cover. Log the following information in the notebook:

- The serial number
- The 1-ω frequency
- Any relevant notes pertaining to the PCB (e.g., rev #, modifications made)
- The release date

RESISTANCE-TO-GROUND MEASUREMENT

Measure the resistance-to-ground of the following nodes:

SIGNAL	PIN	RESISTANCE [Ω]
TSENSE IN	U7-1	~1.6M
U7 OUT	U7-2	200
TSENSE OUT	U7-3	0

Investigate any large deviations from the values given in the table above and troubleshoot before proceeding further.

☐ REPEAT THE SMOKE TEST
Investigate any overheating problems and troubleshoot before proceeding further.

☐ DC VOLTAGE MEASUREMENT
Use a Fluke multimeter to measure the DC voltages of the following nodes on the PCB.
The multimeter COMMON lead shall be connected to the RF cage for ground connection.

SIGNAL	PIN	DC VOLTAGE [VDC]	SIGNAL	PIN	DC VOLTAGE [VDC]
+15VDC	C30+	+15.01	D1 CATHODE	U2-6	+6.90
+5VDC	C3+	+5.13	D1 ANODE	D1	0
-15VDC	C31-	-15.04	L1-L2 node	**X** L1	0
-5VDC	C2-	-5.05	DC BIAS V	**X** R4	0
U9 output	C28+	+6.90	U5 OUT	R12 **X**	-0.004
U2 IN+	U2-1	+2.28	U6 IN-	**X** R11	-0.007
U9 ADJ	C38+	+5.65	U6 OUT	**X** R16	-0.013
DISABLE IN	FLT7	Either 0 or 5.0	DC OUT	J3	-0.013
U2 DISABLE	U2-7	Either 5.0 or 0	L3/C10	**X** C10	0
STATUS/OTEMP	FLT8	Either 0 or 5.0	U1 IN+	**X** L7	0
L8/C40 node	**X** L8	0	U1 IN-	R2 **X**	0
L4/C13 node	L4 **X**	Floating	U1 OUT	R1 **X**	+0.011
U2 IN-	U2-2	+2.29	RF OUT	J2	+0.011
			TEST INPUT	R15 **X**	0

Investigate any large deviations from the values given in the table above and troubleshoot before proceeding any further.

☐ TEST THE U2 DISABLE INPUT
The output of U2 is disabled when the DISABLE IN input J5-8 is at +5VDC.
The DISABLE IN input must be grounded to enable the photodiode.

- On the test cable, connect the DISABLE IN micro-clip to ground.
- U2 output pin U2-6 voltage should be +6.9 VDC.
- Disable pin U2-7 voltage should be +5.1 VDC.
- Press the Current Meter buttons on the power supply. The +15VDC current consumption should be 0.080A. The –15VDC current consumption should be 0.030A.
- Connect DISABLE IN to the +5VDC micro-clip which is soldered to the C24 + via.
  WARNING: When connecting DISABLE IN to +5VDC, always connect it **through the 1KΩ resistor** connected to the C24 + via! Connecting the DISABLE IN input straight to +5VDC will damage U8.
- U2 output pin U2-6 voltage should be +0.1 VDC.
- Disable pin U2-7 voltage should be +0.0 VDC.
- The +15VDC current consumption should be 0.070A. The –15VDC current consumption shouldn’t change.
- Investigate any problems and troubleshoot before proceeding further.
- The U2 DISABLE INPUT function is working properly if the above voltages are detected.

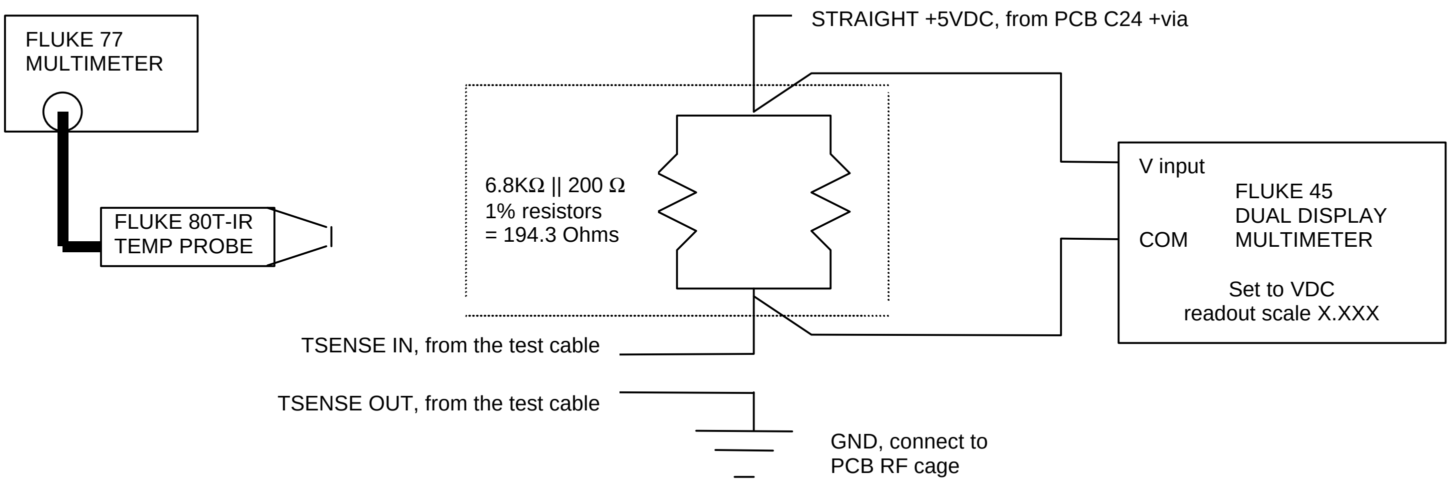
☐ TEST THE STATUS/OTEMP OUTPUT

The voltage of the STATUS/OTEMP output is +5.0 VDC when U2 is in either a disabled or overtemp condition. Overtemp may be determined by also reading the U7 temperature sensor voltage. For the purpose of this test, TTL logic HI means U2 is disabled. The voltage of the STATUS/OTEMP output is 0 VDC when U2 is enabled.

- Connect the DISABLE IN micro-clip to ground.
- The STATUS/OTEMP output voltage should be 0.0 VDC.
- Connect DISABLE IN to the +5VDC micro-clip which is soldered to the C24 + via.
- The STATUS/OTEMP output voltage should be +5.0 VDC.
- Investigate any problems and troubleshoot before proceeding further.
- The STATUS/OTEMP output function is working properly if the above response is observed.

☐ TEST THE U7 TEMPERATURE TRACKING FUNCTION

- Set up the following test circuit; use the test equipment 6.8KΩ and 200Ω resistors in parallel.



- Measure the ambient room temperature with a mercury thermometer; log it in the table below.

- Warm the thermal block slightly with the heat gun. U7 must respond with an increase in DC voltage across the 6.8KΩ and 200Ω resistors in parallel.

- The DC voltage displayed on the multimeter gives the temperature of the photodiode region of the thermal block to the nearest tenth of a degree Celsius, 10 mV/°C,
  e.g., detected voltage 0.283 VDC = 28.3 °C

U7 detected voltage [VDC]	U7 corresponding voltage [°C]	NOTES
		Ambient temperature (Mercury thermometer =)

- Point the Fluke temperature probe at the thermal block; the measured temperatures displayed on the two meters should be within 2°C of each other.

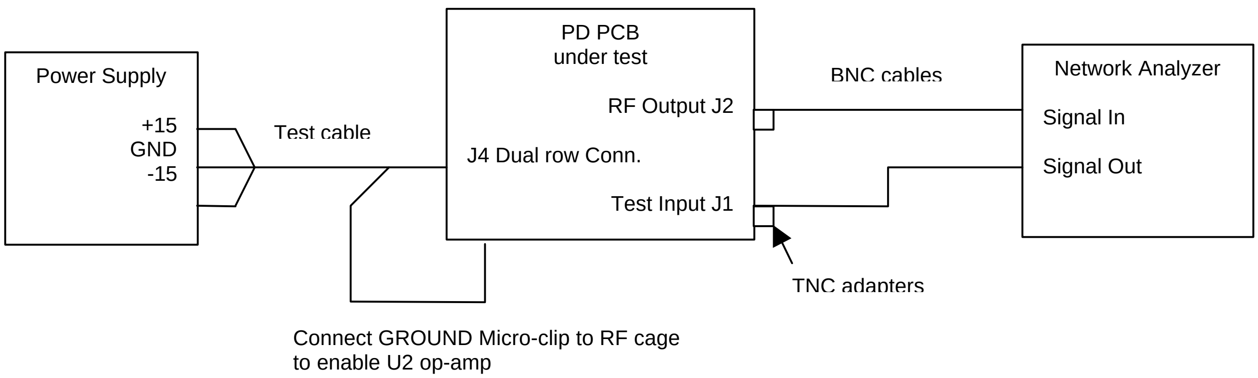
- Investigate any problems and troubleshoot before proceeding further.

☐ TUNING THE 2-ω BANDSTOP FILTER

- Power up the PCB under test.
- Insert into the analyzer disk drive the data diskette with the analyzer “1PDST1” configuration file
- Press **SAVE/GET** key
- Press the **GET** soft key.
- Enter “1PDST1” at the prompt. Be sure to use double quotes.
- If necessary, change the network analyzer START/STOP frequencies so that the desired 2-ω frequency is in the middle of the display with 20 MHz on either side of the 2-ω frequency.
- Connect a 50Ω BNC cable to the analyzer input.
- Connect a 50Ω BNC cable to the analyzer output.
- Connect the two BNC cables with the BNC female –to- female adapter
- Press the **CAL** key
- Press the **TRANS CAL MENU** soft key
- Press the **THRU** soft key
- Press the **ENTER/EXECUTE** key
- Press the **CORRECTION ON** soft key if prompted
  Press the **TRIG/RESET** key.
- Press the **CONT MODE** soft key
- Remove the BNC female –to- female adapter

Calibration procedure for network analyzer

- Install the TNC male –to- BNC female adapters onto the free ends of the BNC cables
- Set up the following circuit:



- The response of the 2-ω Bandstop filter can be seen on the network analyzer as a deep notch occurring at approximately twice to three times the frequency of a large peak. The initial 2-ω frequency will typically be far below where it should be. This is to be expected. The values of C39, C40 & L8 determine the 2-ω frequency. The 2-ω frequency is tuned first because the 1-ω frequency is greatly dependent on the frequency of 2-ω.

- Refer to the photodiode lab notebook for examples of typical network analyzer response plots.

- Set the C40 variable capacitor to the center of its tuning range with a small flat head screwdriver. Use the current network analyzer configuration. Be sure to remove the screwdriver blade away from the capacitor to get a true analyzer reading. Make a note of what tuning direction of rotation produces a decrease in 2-ω frequency. Make use of the two analyzer markers **o** & ∗ and also the **mkr-min** & **mkr-max** soft keys to determine the minimum and maximum tuning frequency range of C40. Refer to the analyzer operating manual.

- Do not re-adjust C40 until instructed to do so.

- Place the RF cage cover onto the RF cage; make sure it seats all the way down. The 2-ω frequency is dependent on whether the RF cage cover is installed onto the PCB. Notice the 2-ω frequency **decreases** approximately 0.800 MHz. **The RF cage cover must be installed with each iteration of L8 before obtaining a measured 2-ω frequency.**

- Fill in the three entries of iteration #1 on the following table.

- In order to increase the 2-ω frequency the inductance L8 must be DECREASED, and vice versa, according to the generalized equation

$$f_{2\text{-}\omega} = \frac{1}{2\pi \times (LC)^{1/2}}, \qquad \text{where } L=L8,\ C=C39+C40$$

such that $\downarrow$ L8 value produces $f_{2\text{-}\omega} \uparrow$

A number of iterations will be needed to get the right value of L8.

- Fill in the following table as you try various values of L8.
The **Value of L8 [nH]** column shall reflect values that are available from the Coilcraft inductor kit.
The **2-ω frequency [Hz]** column shall contain the notch frequency read off the network analyzer.
The **Δfreq. from desired [+/- Hz]** column is an account of how far below [-Hz] or how much above [+Hz] the notch is from the desired frequency.

- At some value of L8 the measured 2-ω frequency will be above the desired frequency. The previous value of L8 ***in series with*** a small value of inductor shall be soldered onto the L8 pad. Continue the iteration with the small value of inductor until the measured 2-ω frequency is to within ±0.100 MHz.

Write the DESIRED 2-ω Frequency here:

ITERATION	Value of L8 [nH]	Measured 2-ω frequency [Hz]	Δfreq. from desired [+/- Hz]
1			
2			
3			
4			
5			
6			
7			
8			

- Fine tune the 2-ω notch frequency by adjusting C40. Remember to adjust C40 in order to increase 2-ω frequency so as to compensate for the frequency shift of the covered RF cage. Write the final values below.

Final value of L8 [nH]	Final 2-ω frequency [Hz]	Δfreq. from desired [+/- Hz]

☐ TUNING THE 1-ω BANDPASS FILTER

- The response of the 1-ω Bandpass filter can be seen on the network analyzer as a large peak occurring at approximately half the frequency of the 2-ω notch. The initial 1-ω frequency could be somewhat far from, either above or below, the desired frequency. The values of L1, L2, & the capacitance of the photodiode determine the 1-ω frequency once the 2-ω has been tuned.

- Refer to the photodiode lab notebook for examples of typical network analyzer response plots.

- Change the network analyzer START/STOP frequencies so that the desired 1-ω frequency is in the middle of the analyzer display with 20 MHz on either side of the 1-ω frequency. Be sure to calibrate the network analyzer using the procedure mentioned earlier.

- Set the L1 variable inductor to the center of its tuning range with the tuning tool for MC 152 style variable inductors. Make a note of what tuning direction of rotation produces a decrease in 1-ω frequency. Use the current network analyzer configuration. Be sure to remove the tuning tool away from the inductor to get a true analyzer reading. Make use of the two analyzer markers **o** & ∗ and also the **mkr-min** & **mkr-max** soft keys to determine the minimum and maximum tuning frequency range of L1.

- Do not re-adjust L1 until instructed to do so.

- In order to increase the 1-ω frequency the inductance L2 must be DECREASED, and vice versa, according to the same equation used in the tuning of the 2-ω frequency modified with the capacitance of the photodiode. A number of iterations will be needed to get the right value of L2. Keep in mind that ↓ **L2 causes 1-ω frequency** ↑ and vice versa.

- Fill in the following table as you try various values of L2.
  The **Value of L2 [nH]** column shall reflect values that are available from the Coilcraft inductor kit.
  The **1-ω frequency [Hz]** column shall contain the peak frequency read off the network analyzer.
  The **Δfreq. from desired [+/- Hz]** column is an account of how far below [-Hz] or how much above [+Hz] the peak is from the desired frequency.

- At some value of L2 the measured 1-ω frequency will be slightly above the desired frequency. Solder the previous value of L2 ***in series with*** a small value of inductor onto the L2 pad. Continue the iteration with the small value of inductor until the measured 1-ω frequency is to within ±0.050 MHz.

Write the DESIRED 1-ω Frequency here:

ITERATION	Value of L2 [nH]	Measured 1-ω frequency [Hz]	Δfreq. from desired [+/- Hz]
1			
2			
3			
4			
5			

6			
7			
8			

- Fine tune the 1-ω notch frequency by adjusting L1. The adjustment of the 1-ω frequency seems to be much less dependent on whether the RF cage cover is installed; however, make final adjustments and measurements with the RF cage cover installed. Write the final values below.

Final value of L2 [nH]	**Final 1-ω frequency [Hz]**	**Δfreq. from desired [+/- Hz]**

☐ TEST DC BIAS RESISTORS

The values of DC bias resistors R4 || R5 must be tested to provide the proper DC bias gain feedback. If R4 || R5 are of the correct values, a voltage change across R4 || R5 will produce TWICE the voltage change at the U2 op-amp output.

Proper DC bias means $\Delta V_{U2\ output} = 2 \times \Delta V_{R4||R5}$

Note that initially R4 = 30.9Ω and the R5 pad is empty.

- Position the PCB under test on the PanaVise so that light from the table top incandescent lamp will impinge upon the photodiode window and the PCB is easily accessible with a multimeter probe.

- Set the Fluke 45 multimeter to measure DC voltage, readout X.XXX scale.

- Shine light onto the window of the photodiode; position the lamp so that the DC voltage at R4 is a steady 0.020 VDC. The R4 DC voltage shall increase as the photodiode receives more light.

- Measure the DC voltage at U2-6 when the DC voltage at the R4 resistor is 0.020 VDC. Enter this value in the table below. Do not reposition the lamp.

- Measure the DC voltage at the DC OUT connector J3. Enter this value in the table below.

- Reposition the lamp so that the DC voltage at R4 is a steady 0.120 VDC.

- Measure the DC voltage at U2-6 when the DC voltage at the R4 resistor is 0.120 VDC. Enter this value in the table below. Do not reposition the lamp.

- Measure the DC voltage at the DC OUT connector J3. Enter this value in the table below.

- A decrease in the value of the parallel resistance R4||R5 causes an increase in the voltage change at U2-6.

The effect: $\downarrow$ **R4||R5 causes** $\uparrow \Delta V_{U2\ output}$

- If the voltage change at U2-6 is less than twice that of R4, solder a 316Ω resistor at R5 to lower R4||R5, and repeat the voltage measuring steps above, iteratively decreasing the value of R5 until $\Delta V_{U2\ output} = 2 \times \Delta V_{R4||R5}$.

- If the voltage change at U2-6 is greater than twice that of R4, replace the 30.9Ω of R4 with a 39.2Ω and repeat the voltage measuring steps above, iteratively increasing the value of R4 until $\Delta V_{U2\ output}$ **= 2 X** $\Delta V_{R4||R5}$. Leave the R5 pad empty.

R4 value: **R5 value:**

DC bias voltage $V_{R4\|\|R5}$ **[VDC]**	**Op-amp output voltage** V_{U2-6} **[VDC]**	**DC OUT J3 voltage** $V_{DC\ OUT\ J3}$ **[VDC]**
0.020		
0.120		
DC bias voltage change $\Delta V_{R4\|\|R5}$ **[VDC]**	**Op-amp output voltage change** ΔV_{U2-6} **[VDC]**	**DC OUT J3 voltage change** $\Delta V_{DC\ OUT\ J3}$ **[VDC]**
0.100		

R4 value: **R5 value:**

DC bias voltage $V_{R4\|\|R5}$ **[VDC]**	**Op-amp output voltage** V_{U2-6} **[VDC]**	**DC OUT J3 voltage** $V_{DC\ OUT\ J3}$ **[VDC]**
0.020		
0.120		
DC bias voltage change $\Delta V_{R4\|\|R5}$ **[VDC]**	**Op-amp output voltage change** ΔV_{U2-6} **[VDC]**	**DC OUT J3 voltage change** $\Delta V_{DC\ OUT\ J3}$ **[VDC]**
0.100		

Repeat the tables as needed.

☐ SETTING THE DC OUT VOLTAGE GAIN

The DC voltage at the DC OUT connector J3 is a transfer function representing the DC current through the photodiode. The photodiode maximum DC current is 150mA which translates to an arbitrarily selected J3 DC voltage of 10 VDC.

The following values in italics correspond to the case where R4 = 30.9 Ω and R5 is empty.

The corresponding maximum DC bias voltage across R4||R5 is *4.635 VDC* = (150mA)(*30.9* W). The gain of the U6 amplifier is *2.157* = 10V / *4.635V*.

The value of R16 is *1157* W = (*2.157* – 1)(*1000* W). Closest available value is *1.15K*.

Second column value = first column value times gain of U6 amplifier (*2.157*)
Fourth column value = first column value divided by equivalent resistance R4||R5

DC bias voltage $V_{R4\|\|R5}$ **[VDC]**	**Ideal DC OUT connector J3 voltage [VDC]**	**Measured DC OUT connector J3 voltage (**copy previous table third column values here**) [VDC]**	**Corresponding DC current through PD [mA]**
0.020	*0.043*		
0.120	*0.259*		

- If the measured DC OUT connector J3 voltages of the third column are below the ideal voltages of the second column, replace R16 with larger values until the voltages in the two columns match to within ±0.001 VDC.

- If the measured voltages of the third column are below the ideal voltages of the second column, replace R16 with smaller values until the voltages in the two columns match to within ±0.001 VDC.

Record final value of R16 here:

☐ ASSEMBLE THE PHOTODIODE ASSEMBLY
Return PCB to the assembler to install the following items:
- Thermal block hardware onto PCB
- PCB into enclosure
- Bulkhead connector ribbon cable assembly
- Jackscrews and associated hardware
- RF cage cover
- Enclosure side cover
- TNC male –to- BNC female adapters, qty 3
- Labels on the connectors. Wording must match those used on the schematic.
- Label "xx.xxx MHz PHOTODIODE BOX" and the serial number on the exterior of the enclosure.
- Clean excess thermal grease from applied areas

Check the photodiode assembly to verify the above operations have been completed.

☐ SAVE FILES ON DISK
- Format a blank diskette on the network analyzer. The analyzer will NOT save files on an IBM-formatted diskette. Refer to the 4195A network/spectrum analyzer operating manual.
- Save the following network analyzer data and machine configuration files on a disk:
  1. Analyzer configuration, 100KHz-100MHz, filename PDST1
  2. Photodiode mag/phase data, 100KHz-100MHz, filename PDDATA1
  3. Analyzer configuration, 20MHz-70MHz, filename PDST2
  4. Photodiode mag/phase data, 20MHz-70MHz, filename PDDATA2
  5. Analyzer configuration, 5MHz-500MHz, filename PDST3
  6. Photodiode mag/phase data, 5MHz-500MHz, filename PDDATA3
- Use the 4195A network/spectrum analyzer to perform a SPECTRUM ANALYSIS to detect oscillations between 100KHz – 200MHz; use a resolution bandwidth of 30KHz. Refer to the 4195A network/spectrum analyzer operating manual. Save the spectrum analyzer data and machine configuration files to disk.
- Label the disk with the serial number.
- Store the disk with the other photodiode disks.

☐ PLOT MAGNITUDE/PHASE DATA
Plot the three magnitude/phase data, and also plot the spectrum analysis data, and save the plots in the project notebook.
Make a copy of the 5MHz-500MHz PDDATA3 plot to go with the photodiode box.

☐ LOG FINAL COMPONENT VALUES
- Write in the space below any modifications performed to the assembly and any other items of note pertaining to the assembly.
- File this report into the project notebook, completely filled in with the values of all components that were changed, added, or deleted.

--- END OF DOCUMENT ---