

Team: System Solutions

Pound-Drever-Hall Instrument Test

PDH Instrument Test 1

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Revision History

Name	Date	Revision Made	Version Number
Alexis Wilson	02/12/2020	Creation of Document	1.0

Purpose of Test:

The purpose of this test is to make sure that all of the Thorlabs equipment is all functioning as should from the box. This test will make sure the laser diode is functioning and the beam is splitting into the center of the photo-detectors. It will also make sure that one understands the basic setup of the equipment and adjust the pieces as needed.

Requirements:

To be able to perform this test, one will need all the Thorlabs equipment specified in the power point labeled optical_setup_guide as well as one STEMLab125-14 Field Programmable Gate Array (FPGA) with a power cable and an Ethernet cable. One will also need a switch/hub, an Ethernet cable, and a laptop/computer. No internet or outside source will be required to send signals. Knowledge of signals and external noise on a system may help with interpreting any irregularities in the input signal coming from the output of the other board.

NOTE: This test can be run across more than 1 board, it will just require taking the outputs from the photodetectors and placing them on the inputs of two different Red Pitayas.

CAUTION: Before touching the STEMLab 125-14 board, make sure to ground oneself by touching metal or wearing an ESD strap so that no electric discharge can cause harm to the components on the board.

CAUTION: Before touching the laser diode, make sure one is fully ESD safe, including and ESD approved mat and wrist pad for one to ground themselves. Make sure one's hair is fully pulled back so no hair will scratch the laser.

CAUTION: While testing the laser, use the Safety Glasses included with the Thorlabs equipment.

Test Implementation:

Setup:

1. Unpackage all the Thorlabs equipment and lay it out
2. Remove the breadboard and two metal rods attached to them from the bottom breadboard that has the beam sampler and photodetectors attached to it.
 - a. Figure 1 shows the PDH loop instrument from shipment

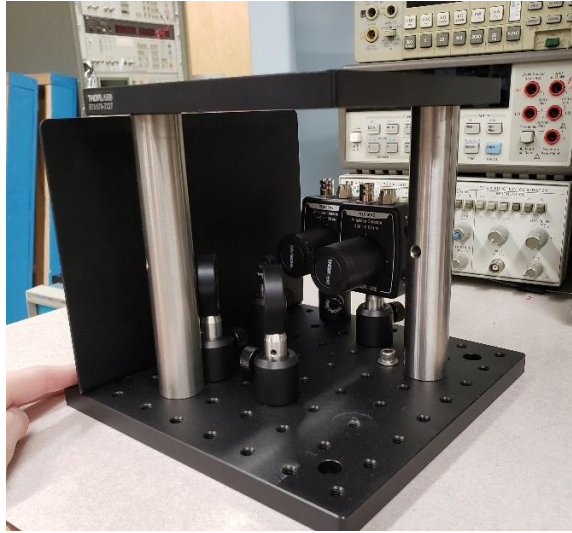


Figure 1: PDH Loop from Shipment

3. After removing the top breadboard and rod, remove the beam sampler farthest from the laser shield and add on the amplifier boards
 - a. The result is shown in the Figure 2 below

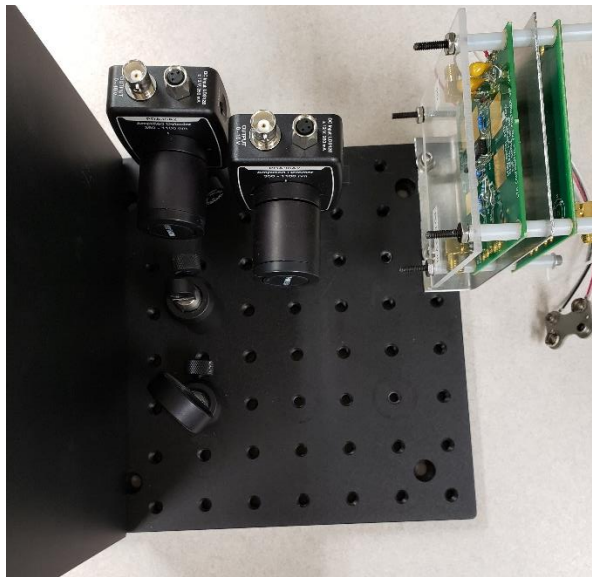


Figure 2: Amplifier On

4. Once the amplifier is on, attach the laser diode mount in the spot four over from the beam sampler
5. Reattach the beam sampler that was removed.
 - a. The result is shown in Figure 3 below:

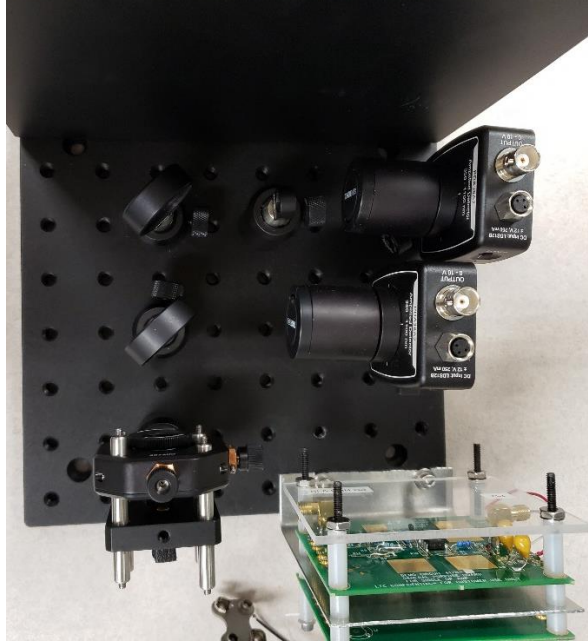


Figure 3: Laser Diode Mount and 2nd Beam Sampler On

6. Once the laser is mounted and the beam sampler is back on, attach the split SMA/SMA cable to the amplifier sides
 - a. Attach the PD side to the PD SMA connection (Figure 4 below)
 - b. Attach the LD side to the LD SMA connection (Figure 5 below)

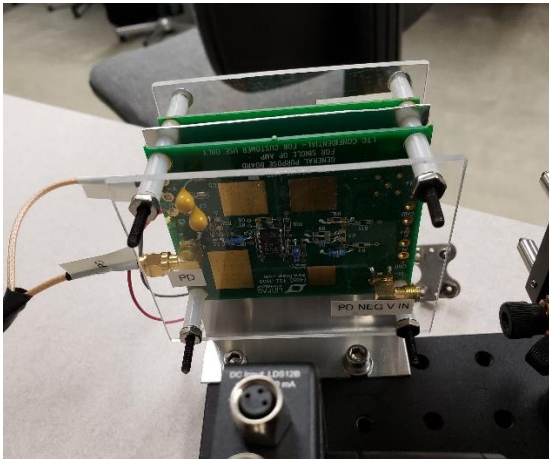


Figure 4: Photo Diode (PD) Connection

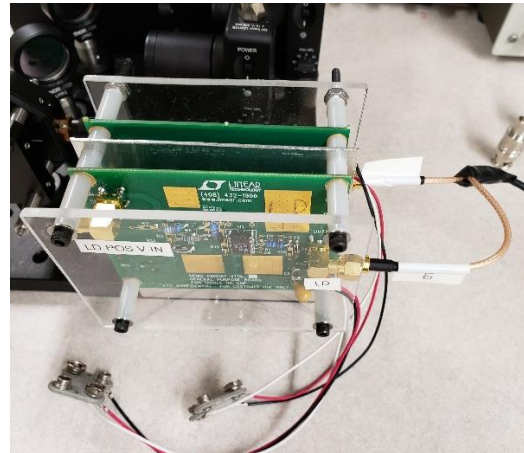


Figure 5: Laser Diode (LD) Connection

7. Attach the other side of this SMA/SMA cable, called the laser harness, to the laser diode mount
8. Attach the 2 SMA-SMA cables to the Vin spots on the other side of the amplifiers
 - a. 1 SMA-SMA attached to PD NEG Vin
 - b. 1 SMA-SMA attached to LD POS Vin
9. The results from step 7 and 8 are shown in the figure below:

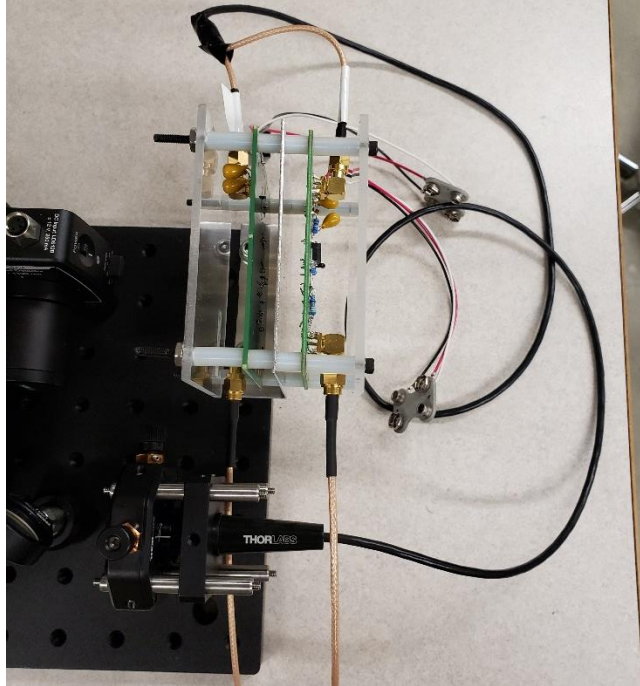


Figure 6: Amplifier Connections

10. Using the two battery pads attached to the Amplifier, attach two 9V batteries to each

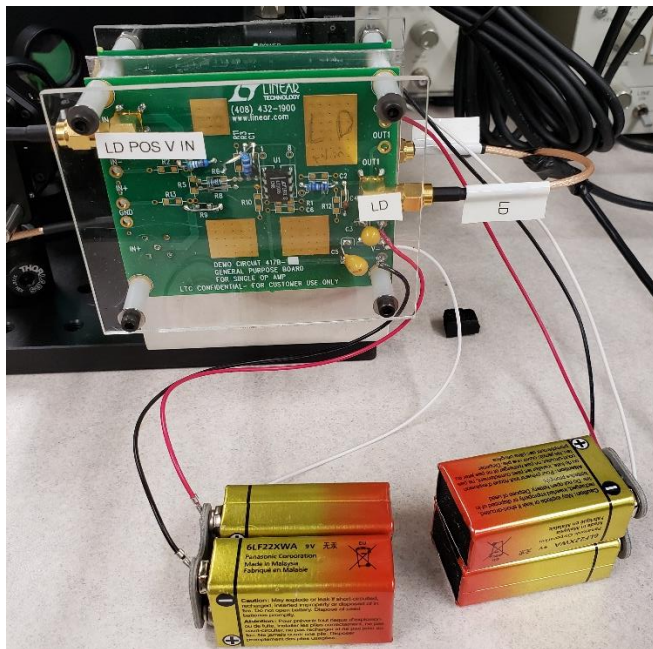


Figure 7: Amplifiers with Batteries Attached

11. The amplifier and laser diode are now set up.
12. Next attach both the power sources for the two amplifiers as well as the 50 ohm terminating feedthrough resistors

13. Attach one BNC connector to each photodetector and attach the other side to BNC-SMA connectors and then into the Red Pitaya Board.
 - a. Photo-detector 1 to IN1
 - b. Photo-detector 2 to IN2
 - c. The result is shown in Figure 8 below:

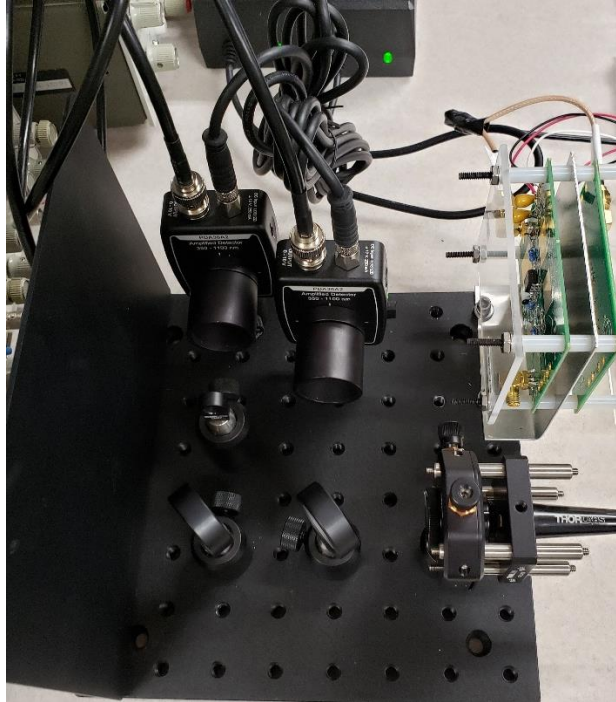


Figure 8: Photodetector Setup

14. Turn the gain (dB) on both of the Photo-detectors side to 40 dB.
15. The Pound-Drever-Hall loop instrument is now setup, but it needs to be hooked up to the Red Pitaya
 - a. Take the STEMLab 125-14 board out of the box and plug in the FPGA to an outlet.
 - i. The power plug in is on the left side of the board far left of the ethernet cable.
 - b. Take an ethernet cable and plug it back into ethernet slot on the FPGA.
 - c. Take the other end of the ethernet cable and plug it into a LAN slot of the network switch/hub.
 - d. Take the second Ethernet cable and plug it into the Ethernet port of the computer/laptop.
 - e. Plug the other end into a LAN slot of the network switch/hub.
 - f. Once the board is on and link light is coming from the switch for both ethernet connections, use an internet browser to connect to the board through Ethernet
 - i. Type `rp-xxxxxx.local/` and press enter
16. Once the Red Pitaya interface is setup, connect the first SMA connection from LD POS Vin to OUT1 of the Red Pitaya

17. Connect the second SMA connection from PD NEG Vin to OUT2 of the Red Pitaya
18. Open up the Oscilloscope and Function Generator option on the Red Pitaya
19. The setup is now complete. It is shown in Figure 9 below:

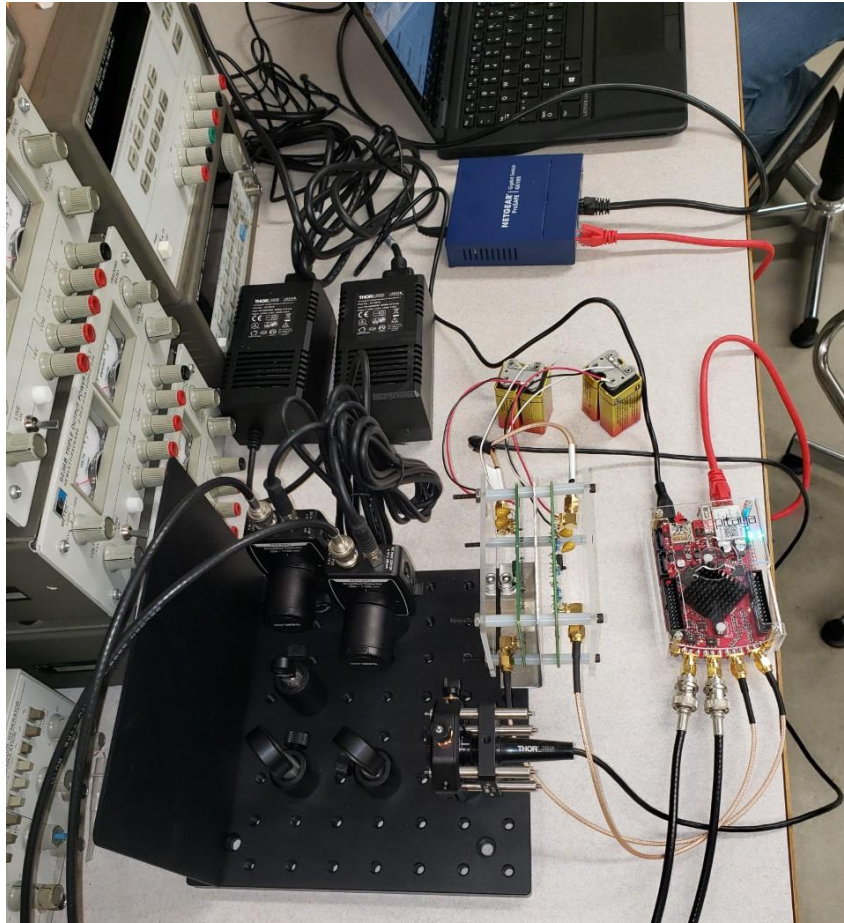


Figure 9: Completed Pound-Drever-Hall Loop Setup

Procedure:

1. On the Red Pitaya Oscilloscope and Function Generator, click on the settings for IN1
 - a. Click show
2. Go back and Click on the settings for IN2
 - a. Click show
3. Go back and Click the 'MEAS' option on the middle-right hand of the screen
 - a. Choose IN1
 - i. Click RMS and done
 - b. Choose IN2
 - i. Click RMS and done
4. Click Run at the top right-hand side of the screen
 - a. After a while one can click stop at the top right-hand side of the screen

5. Go back and Select the settings for OUT1
 - a. Change the Voltage to 1 V
 - b. Click show
6. Go back and Select the settings for OUT2
 - a. Change the Voltage to -1 V
 - b. Click show
7. Click Run at the top of the screen (if not still running already)

Results:

1. After Step 5 of the procedure, one should see the resting output voltages of the Amplifiers at 40dB. This is shown in Figure 10 Below:

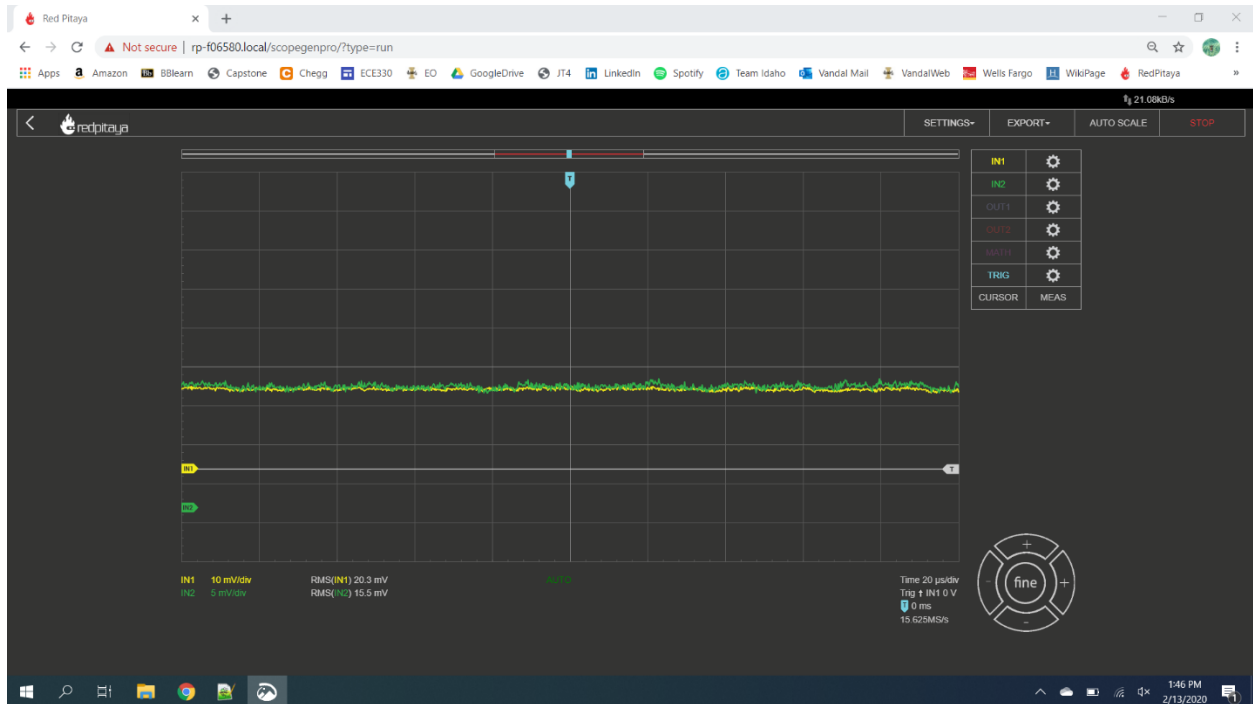


Figure 10: Photo-Detector Resting Voltages (40 dB)

2. After Step 7 of the procedure, one will see what the output voltages of the Photo-detectors are at 40dB with the laser turn on and pointing at them. This is shown in Figure 11 Below:



Figure 11: Photo-detector Voltages with Laser On (40 dB)

Conclusion:

This test should have verified that all of the Thorlabs Equipment for the Pound-Drever-Hall Loop Instrument was functioning as desired. It will verify that the laser diode is shooting an adequate beam and the photodetectors can read the beam when it is split. It will also verify that the amplifier boards are sending out a voltage to the laser diode.