**Memo**

**Senior Design**

ENG EC 463

To: Professor Pisano

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Team: 3

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Subject: First Deliverable Test Plan

**1.0 VCSEL PCB**

**1.1 Description & Goal:**

Our DOSI probe differs from existing probes with its use of miniaturized components as well as the ability to output four different wavelengths of light through a single source. The source in our optode is a newly designed and manufactured 4-wavelength VCSEL. To begin testing components, taking measurements for analysis, and eventually designing the final probe, an important first step is to create a PCB for the VCSEL. To do this, we make a schematic of the PCB, design the PCB itself in software while taking into account principles of PCB design, and send out our design for printing. Once we get the board, we cut it to shape and solder components into it. The final step involves testing the board by verifying that we can pick up the four separate wavelengths of the VCSEL through spectroscopy.

**1.2 Procedure:**

*1.2.1 PCB Design*

To design a PCB, one first needs a circuit diagram to base it off of. We are using a different VCSEL than from the lab’s previous system which was a three wavelength VCSEL. To make the PCB and schematic, a few adjustments were made to the current design to accommodate the new component.

The PCB design software ExpressPCB was used to design the board. The pins of the VCSEL were connected to the RF pads with traces. Multiple designs were made to optimize for different qualities, such as pad accessibility for testing or compactness to minimize board size in a final product. Once the PCBs were received, Ultra Miniature Connector (UMC) pads were soldered to the RF pads on the PCB, along with 5 sockets for the VCSEL pins. After everything was soldered, a continuity test was performed by applying a voltage to each socket and by using an ammeter to measure the voltages along the traces, at the pins for the UMC pads, and at the ground plane.

*1.2.2 PCB Testing*

To begin testing, first place the VCSEL inside the sockets on the PCB. Connect the UMC pads to the RF switch box and laser current supplier using the appropriate wires and adapters. Power the RF switch with a 5 V DC supply. Place the PCB sideways on the table to reduce outside light and also risk of injury. Hold the optical fiber connected to the spectrometer towards the VCSEL. At this time, everyone in the lab should put on laser safety glasses. Turn the computer software AvaSoft on and make sure the spectrometer is connected to the computer and powered via USB. Turn the current source on and assure that the appropriate currents are being used for the wavelengths being tested, in accordance to the table below. Currents too high may blow out the VCSEL and currents too low may cause the optical fiber to not pick up any signal. Also make sure to use the correct integration time to reduce outside noise. Click “Single” for the measurement option to obtain a graph of the wavelength sweep versus intensity of the signal. If the signal is saturated or noisy, adjust the integration time, angle of the optical fiber, or current value. The peaks of the graph should be at the wavelength the VCSEL is expected to be outputting. Repeat for each of the four wavelength outputs.

**Table 1: VCSEL Testing Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pin Number** | **Wavelength** | **Current** | **Integration Time** |
| **1** | 660 nm | 10 mA | 2 ms |
| **2** | 680 nm | 15 mA | 10 ms |
| **3** | 775 nm | 5 mA | 10 ms |
| **4** | 795 nm | 10 mA | 2 ms |
| **5** | Ground | N/A | N/A |

**1.3 Verifiable Result:**

If the VCSEL board is operating correctly, the spectrometer should output a signal that’s amplitude peaks at the wavelength of the laser that’s currently on. For example if laser 1 is on, the signal should peak at a wavelength of 660 nm. This test will be done for each laser so the end result should be four separate graphs that peak at each of the individual laser wavelengths.

**2.0 APD Measurements - Frequency Modulation Sweep Testing**

**2.1 Description & Goal:**

The current source-detector pair set up will be analyzed for its ability to pick up signals sent from the source through a phantom and into the fiber coupled detector. The signal-to-noise ratio that is generated from these measurements will be maximized by changing the settings on the current APD evaluation board.

**2.2 Procedure:**

Leave the current connections to the VCSEL PCB and RF switch in place. Make sure the evaluation board switches are in the correct configuration. For the first test, they should be in Low Gain, DCFB off. These correspond with the table below. Connect the voltage source to the low voltage input of the APD Evaluation Board and set it for 3.3 V. The high voltage inputs should be connected to a source set to 200 V DC. Make sure all of the USB connections are in place and the computer is running in 32-bit mode for LabView control of components. Make sure that output 1 for the evaluation board is connected to Port 2 on the network analyzer. Turn on the network analyzer, the current control, the DC power supplies, and the high voltage supply.

For the network analyzer, change measurement to S21 and autoscale the graph. The start and stop frequencies are set to 50 MHz and 500 MHz with a 6 dBm power limit. On the current supply, the current for the lasers should be as written in the table above (can be changed in “Change Settings”). The lasers that are connected should be turned on.

**Table 2: Switch Settings**

|  |  |
| --- | --- |
| **Switch 1** | **Switch 2** |
| 1 – High Gain | 1 – DCFB off |
| 2 – Low Gain | 2 – DCFB on |

On the computer, open the DOS System -> Benchtop DOS System -> Senior Design to open the LabView system. Enable saving, and input a file name and ID. Hold the VCSEL so it outputs into the Acrin 009 phantom (This phantom is used because it simulates breast tissue). Take the fiber optic cable for the detector and place it flush against the phantom along with the VCSEL. Secure the other end of the optical fiber so it outputs into the APD. Measure and input the source/detector separation into the LabView program. Finally, hit the “Take Measurements” button to start the measurements. Repeat this measurement for the next test setting with the switches set to Low Gain and Background Correction (DCFB) on. Also, take noise-floor measurements for each of the two settings. This is done by placing the VCSEL and fiber flush onto a piece of rubber which allows no light scattering.

**2.3 Verifiable Result:**

For the first test, the signal obtained will likely have a low signal-to-noise ratio. For the second test the signal-to-noise ratio should be much higher. The separation between the signal and the noise floor in this graph should be the greatest. This is because the settings are optimized for this purpose.