Supplementary materials

Supplementary material 1

Build Instructions for Light Calibration Box (APDS 9960 - SENSOR)

Download and 3-D print the case in any RepRap-class [1–3] fused filament 3-D printer oriented as shown in Figure 1.1=11 with the input parameters show in Table 1.1.

Table 1.1 - Print Settings

Nozzle Temperature	210 C
Bed Temperature	60 C
Infill	15%
Supports	none
Layer Height	0.2 mm
Perimeters	3
Speed	40 mm/s
First layer speed	20 mm/s
Brim	not required

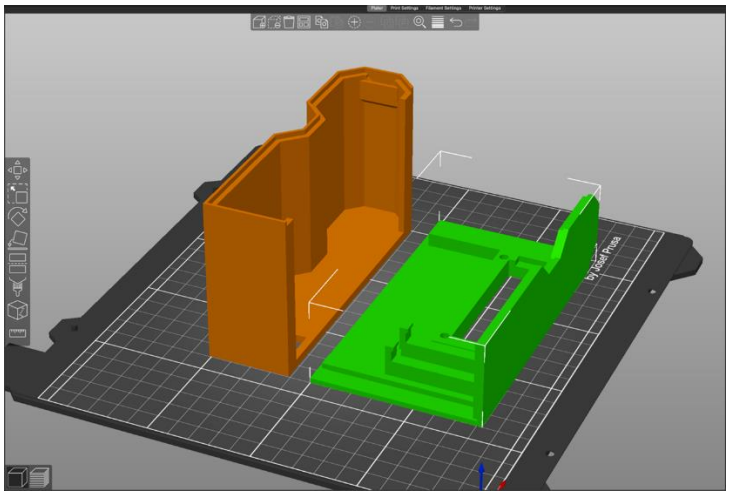

Figure 1.1 – Print Orientation for APDS 9960 Case

1) Gather the parts as shown or see bill of materials as shown in Figure 1.2.

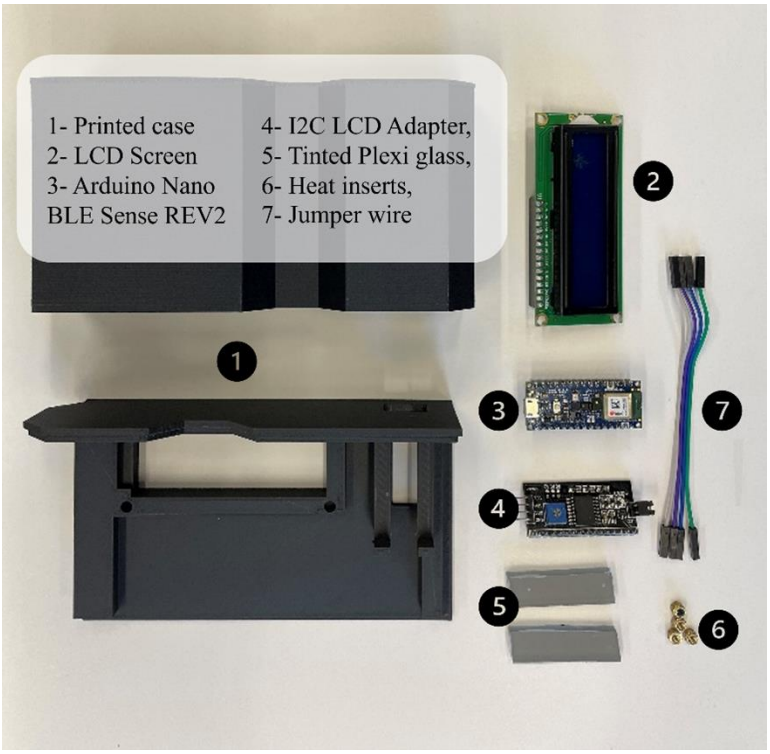

Figure 1.2- Gathered components.

2) Install heat inserts with a hot soldering iron (Figure 1.3).

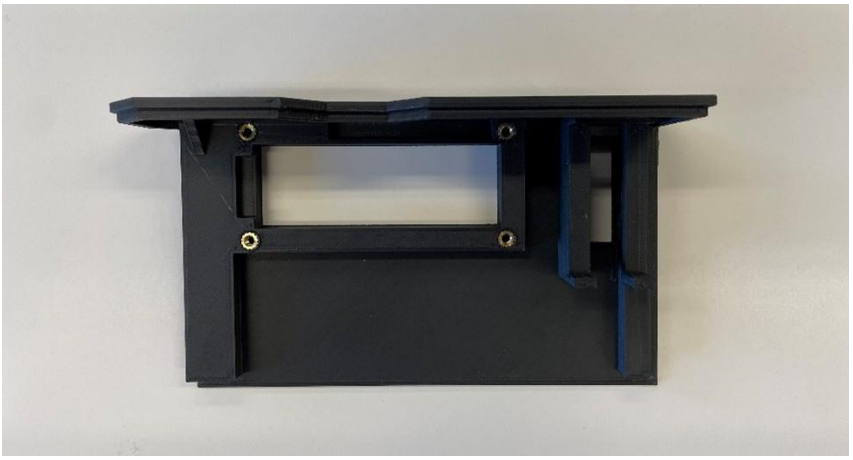

Figure 1.3- Heat inserts in place.

3) Connect the I2C adapter to the LCD screen (Figure 1.4).

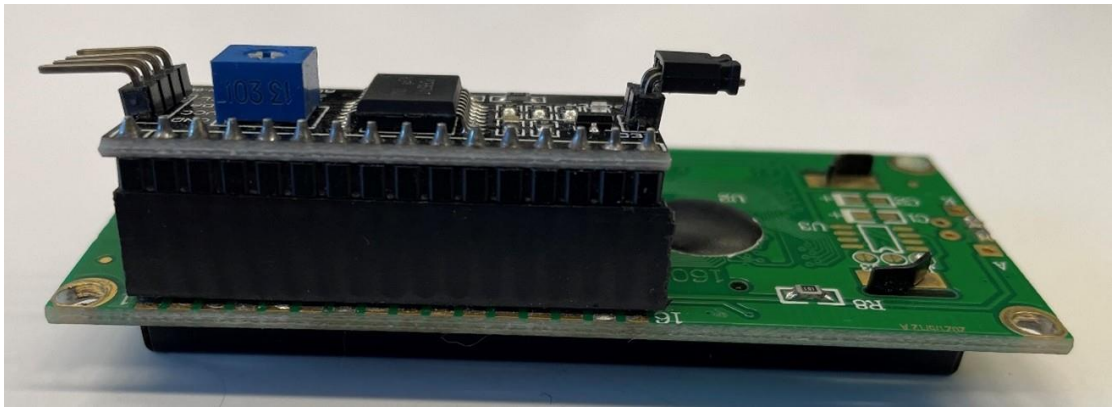

Figure 1.4- I2C LCD Assembly

4) Place a single layer of clear tape of each side of the plexiglass filter (Figure 1.5).

Figure 1.5- Filter preparation.

5) Slot the filter into place and secure screen assembly to case with M3 screws (Figure 1.6).

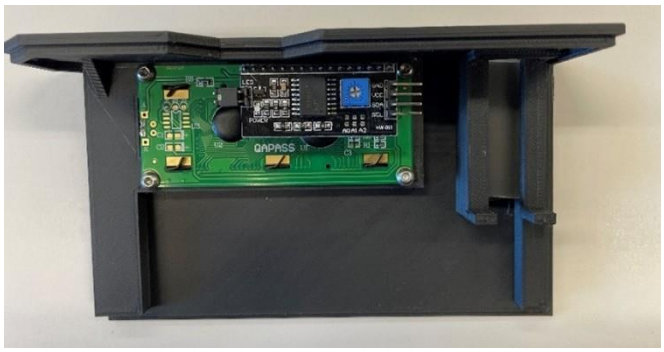

Figure 1.6- Screen and Filter in place.

6) The LCD Screen only works with 5V power. To access 5V from the pins, solder the VUSB pads together as shown in Figure 1.7.

Figure 1.7- Soldered pads to access 5V.

7) Connect the Arduino and screen together. GND pin goes to Arduino GND, VCC connects to Arduino 5V, SDA connects to pin 4 and, SCL connects to pin 5. Hot glue can then be placed on the rails which supports the microcontroller (Figure 1.8).

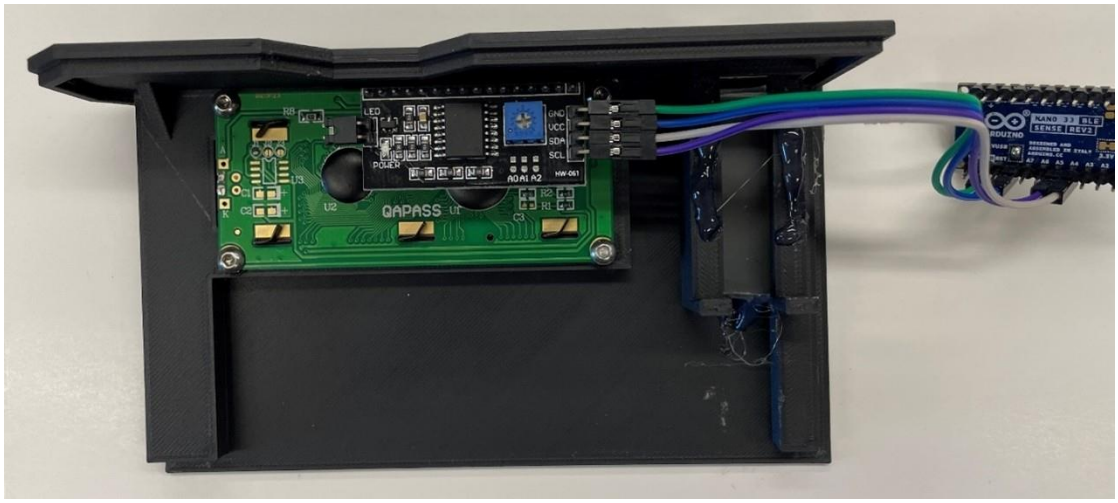

Figure 1.8- Screen connected to Arduino microcontroller.

8) The Arduino is secured in place as shown until the glue solidifies (Figure 1.9). Note: the orientation of the Arduino can be flipped depending on whether you would like the USB port to face inside or outside the case. Facing the port inwards allows more convenient battery-operated access.

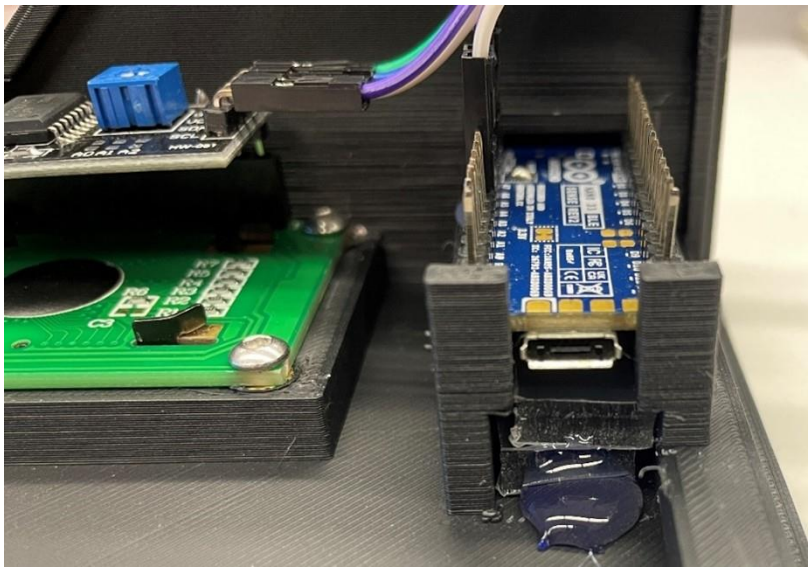

Figure 1.9- Arduino mounted in place.

9) Upload the 'APDS9960_LightCalibration.ino' file to the board and close case. Power from USB port to operate the completed system (Figure 1.10)

Figure 1.10- Completed Irradiance Meter with APDS9960 Sensor.

Supplementary material 2

Build Instructions- Light Calibration Box with SPARKFUN AS7265x Sensor.

Download and 3-D print the case in any RepRap-class [1–3] fused filament fabrication (FFF) 3-D printer with the input parameters show in Table 2.1.

Table 2.1- 3-D Print Settings

Slicing Setting	**Value**
Nozzle Temperature	210 ^{o}C
Bed Temperature	60 ^{o}C
Infill	15%
Supports	recommended
Layer Height	0.2 mm
Perimeters	3
Speed	40 mm/s
First layer speed	20 mm/s
Brim	not required

Gather the required components as per BOM (see and shown in Figure 2.1.

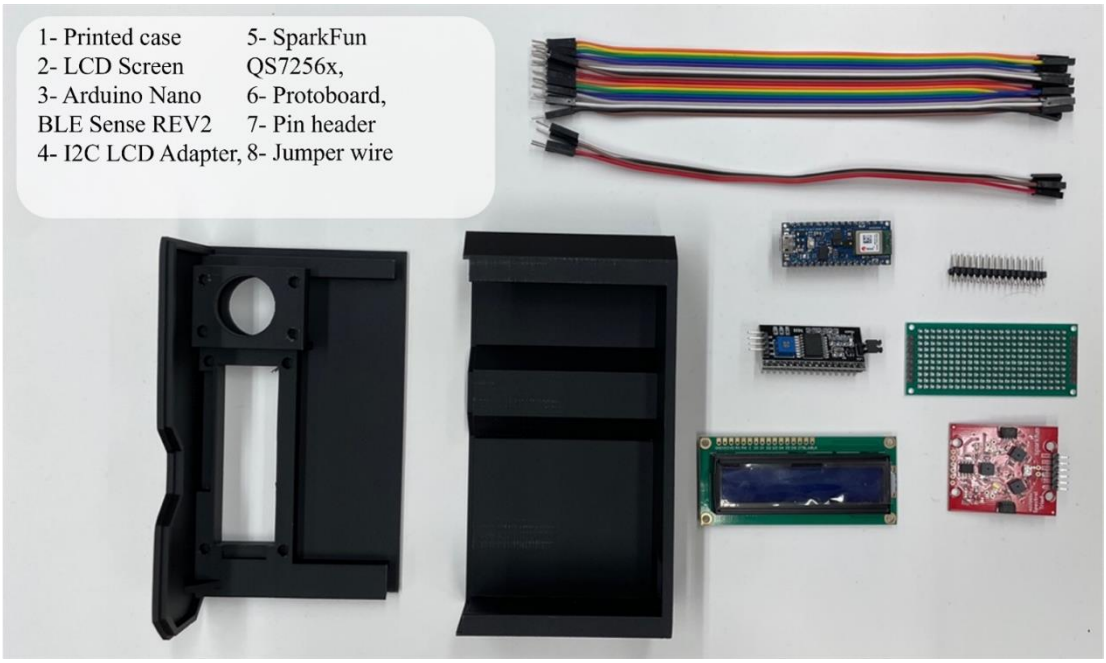

Figure 2.1 - Components of SparkFun AS7265x sensor-based open source light calibration box.

1. Install heat inserts using the soldering iron as shown in Figure 2.2.

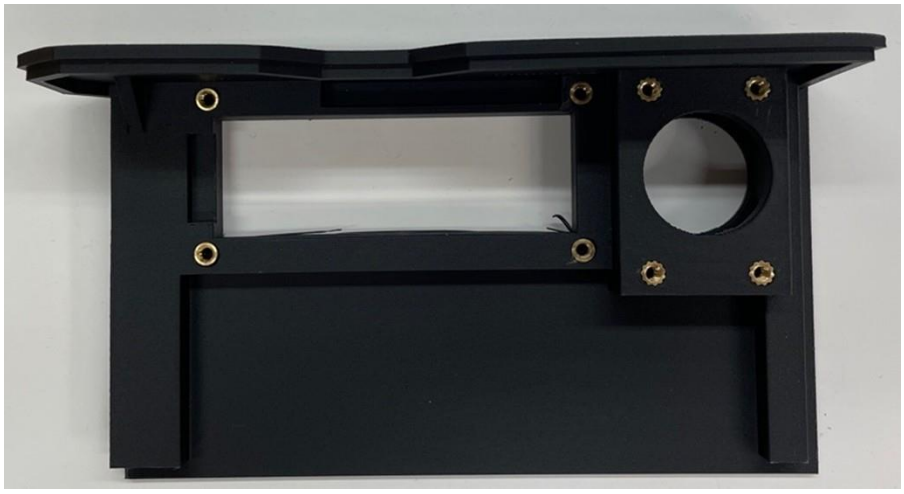

Figure 2.2- Device with heat inserts installed.

2. Solder the LCD screen too I2C Adapter as shown and secure to the case with M3 screws as shown in Figure 2.3. The screen in place should look like Figure 2.4.

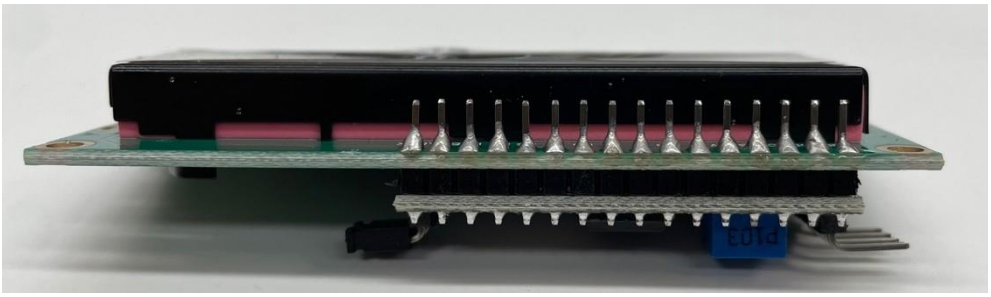

Figure 2.3- I2C Adapter to LCD screen pin connect

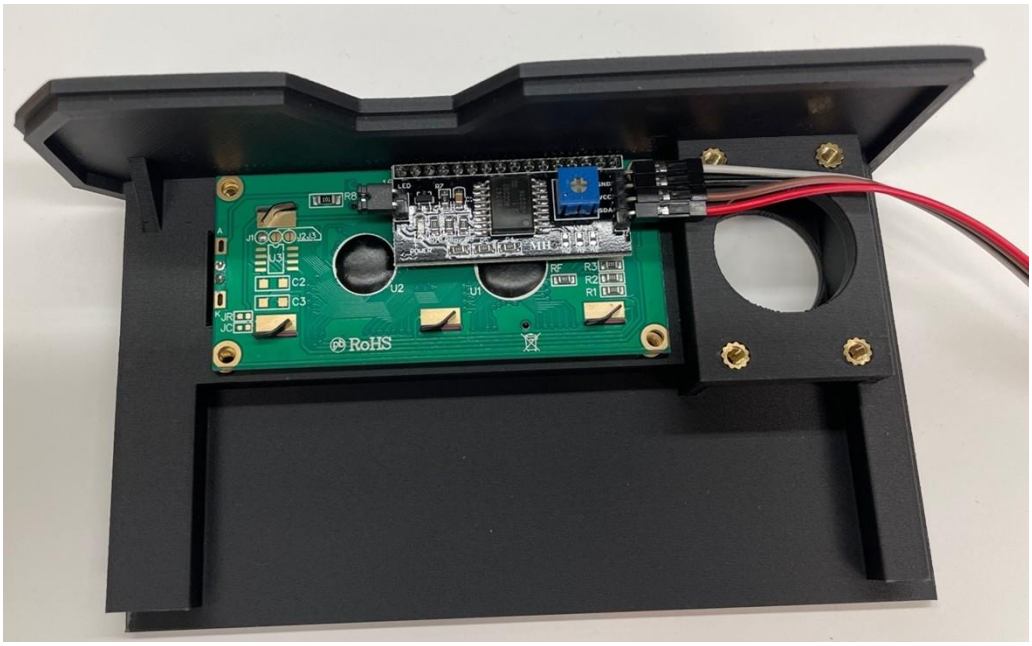

Figure 2.4- Screen in place with wires.

3. Screw down the AS7265x Sensor using either a standoff or a pair of hex nuts as a spacer (Figure 2.5).

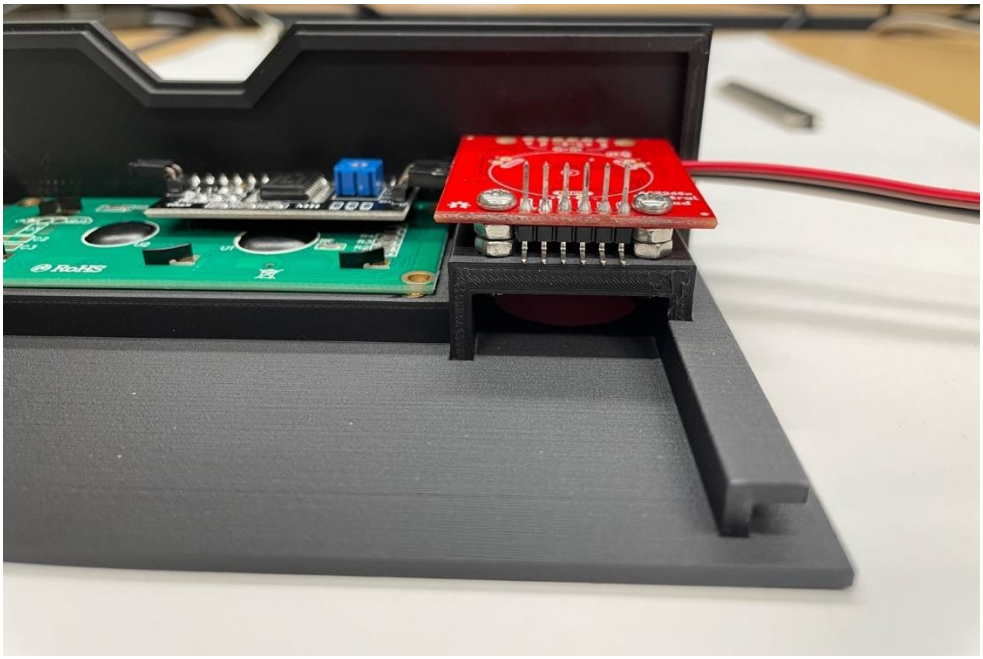

Figure 2.5 – AS7265x Sensor being mounted.

4. Remove the protective film from the plexiglass filter and apply a single layer of masking tape to both the top and bottom face of the filter (Figure 2.6). Insert and hot glue the filter in the filter slot. The clear tape is required to further attenuate the incoming light so that the filter operates within range (Figure 2.7 and Figure 2.8).

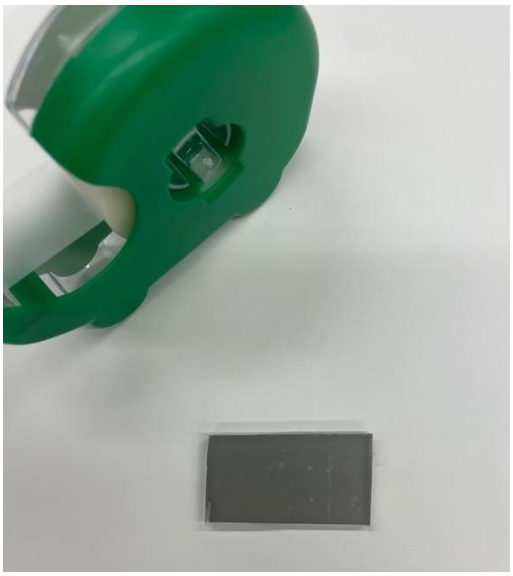

Figure 2.6 - Single layer of scotch tape placed in either side.

Figure 2.7 - Comparison of plexiglass with tape and without

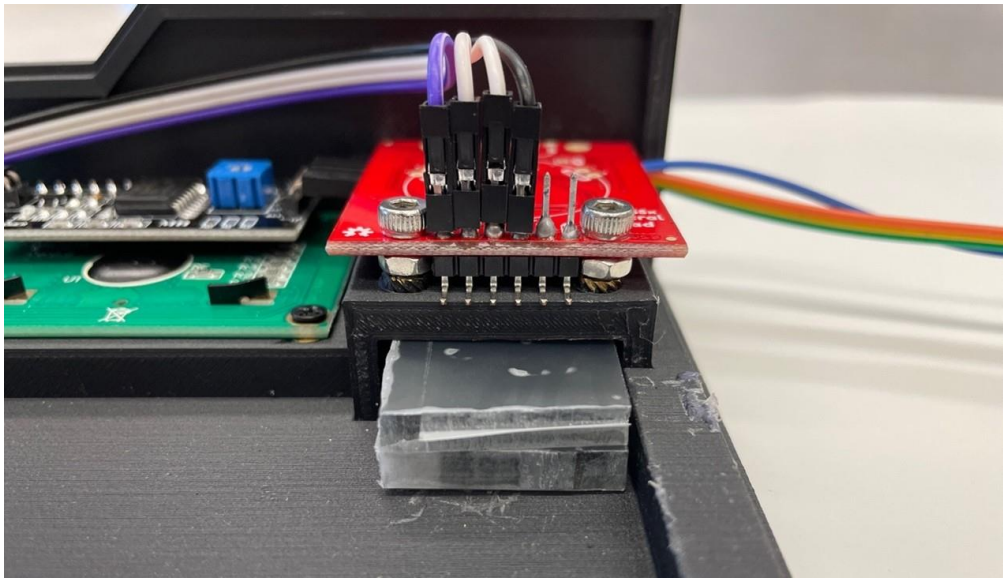

Figure 2.8 - Filter in place

5. For the Arduino nano to provide 5V, the VUSB pads need to be soldered together as shown in Figure 2.9.

Figure 2.9 - 5V pin activated.

6. The Arduino can then be soldered to the protoboard along with the pin headers as shown. Note: the usb connector should extend beyond the board as shown with the pin headers closer to the analogue pin side (left side) of the board. See Figure 2.10.

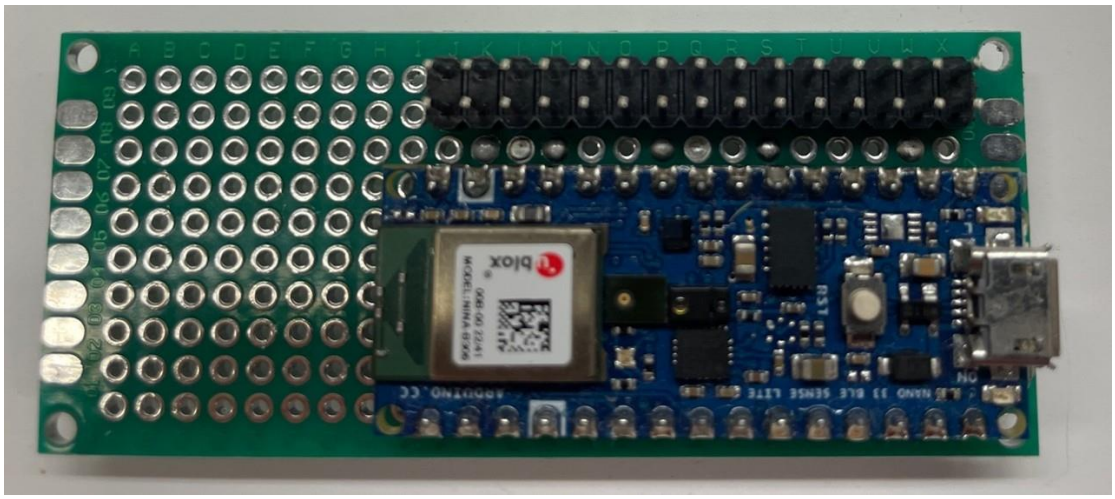

Figure 2.10 - Top side of board and pins

8) Solder the ground pin, 5V pin, 3V pin, A4 pin and A5 pin across to their corresponding headers as shown in Figure 2.11.

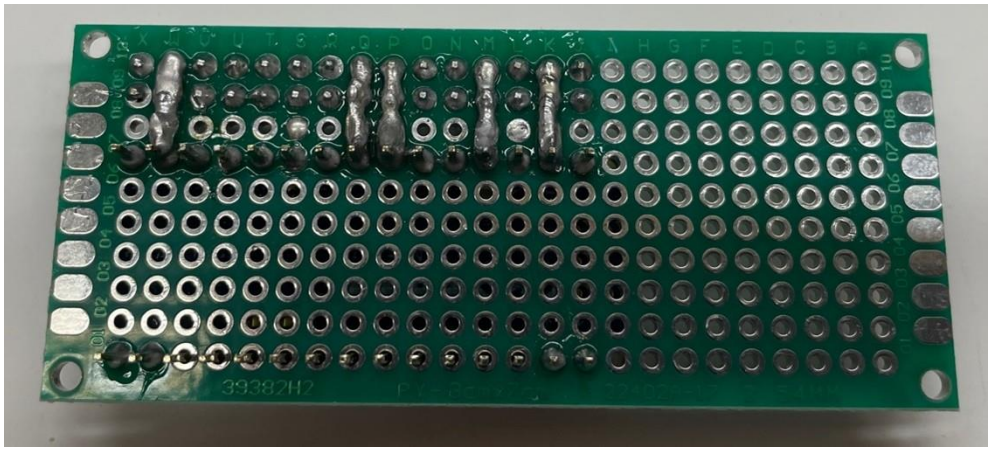

Figure 2.11 - Reverse side of board and pins

7. Wire the LCD and AS7265x sensor ground wires to ground on the Arduino. Wire the 5V output pin of the Arduino to the LCD Screen 5V input. Wire the 3V output pin of the Arduino to the 3V input of the ADPS sensor. Both the screen and the sensor have SDA and SCL pins that should be connected to pins 4 and pins 5 respectively. The completed device is shown in Figure 2.12.

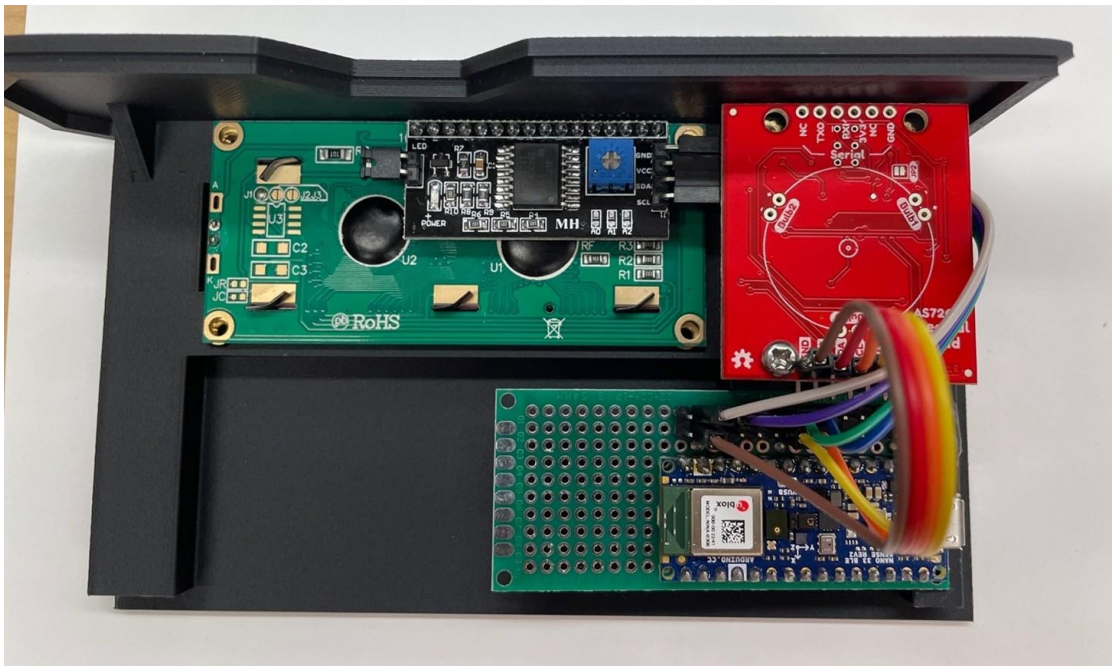

Figure 2.12 - Completed device internals.

8. Upload code from either source the OSF: https://osf.io/7dqp6/ or GitHub: https://github.com/JoshuaGivans-uwo/FAST_IrradianceMeter
9. Close Case (Figure 2.13)

10. Power though battery bank or any other 5V DC source (PC, wall adapter ect.). Consider printing Case_File_Large.stl if a large sized power bank is used

Figure 2.13- Irradiance Meter displaying calibrated results

11. Ocean Insight, calibrated light, and spectrometer Wavelength, irradiance, distance from source

12. Calibration curve from Ocean Optics and how you use the software

Figure showing peak irradiance at 465 nm at specific distance from light source

Possible files to include:

Calibration curve for cosine corrected fiber optic

STL Files for case

Supplementary material 3

Build Instructions – Battery Option

Either device may be powered from a mobile power bank. Any power bank supplying at least 5V will work. The specific power bank used in this version can be found in the BOM. The larger case which was designed to house this particular bank can be found as an STL file in the OSF repository [4]. NOTE: Most power banks have a low power detection system which powers off when the current drawn is too low. This system is

triggered when connected to the Arduino and will automatically power down after 20 seconds. A double tap on the power button after it is on will switch the battery bank into low power mode to avoid automatic shut off. It is important that this feature is available if another power bank is used.

Assembly is the same as Supplementary material 2 with the additional step that the battery is tapped to the inside of the back of the unit. If the battery bank used is larger than 15.75 × 7.37 × 1.91 cm it is recommended to print the original case and mount the battery on the outside of the device. See Figure 3.1 and 3.2 for the unassembled and assembled battery back variation, respectively.

Figure 3.1- Unassembled Battery Pack Variation

Figure 3.2- Assembled Battery Operated AS7265X Irradiance meter

References

1. Jones R, Haufe P, Sells E, Iravani P, Olliver V, Palmer C, et al. RepRap – the replicating rapid prototyper. *Robotica*. 2011;29:177–91. [DOI: 10.1017/S026357471000069X]
2. Sells E, Bailard S, Smith Z, Bowyer A, Olliver V. RepRap: The Replicating Rapid Prototyper: Maximizing Customizability by Breeding the Means of Production. In: Handbook of Research in Mass Customization and Personalization. *Handb Res Mass Cust Pers*. 2009:568–80. [DOI: 10.1142/9789814280280_0028]
3. Bowyer A. 3D Printing and Humanity's First Imperfect Replicator. *3D Print Addit Manuf*. 2014;1:4–5. [DOI: 10.1089/3dp.2013.0003]
4. Givans J. FAST_IrradianceMeter. 2024; Available from: https://osf.io/7dqp6/