Final Report

Desk Lamp

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Executive Summary

Our goal with this desk lamp was to provide people with ADHD and limited motor skills an easier to use desk lamp than normal. People with limited motor skills could find trouble working to operate a desk lamp with multiple buttons/switches and they may have trouble turning on smaller buttons/switches. Not only was our goal to create a desk lamp that was easy to use but was also to create a desk lamp that helps with sensory processing dysfunction. People with ADHD and autism can sometimes have a sensory overload problem which stems from light sensitivity and is caused by unnecessary overhead lights and excessive blue light exposure. To meet these demands we created a flexible desk lamp with only one large on/off touch censored button that controls the whole lamp. We also embedded a light sensor which can take in information regarding the intensity of the RGB LED to control the brightness intensity of the lamp and reduce the amount of blue light exposure at night. To finalize this product working we tested it over the range of several days to make sure our results were correct and accurate and that the goals mentioned above were met.

Our motivation behind making a desk lamp can be summed up by our problem statement which is to - Design a light source with varying brightness that can be used on a desk by someone with limited fine motor skills and learning disabilities. We wanted to create a desk lamp that was usable by those with limited motor skills and with limited steps to use. Including that we wanted a desk lamp that would suit people with sensory processing dysfunction which happens when light becomes too sensitive to them. This happens more frequently when the user is exposed to blue light, and blue light after the natural sunset makes it more difficult for the user to go to sleep and can mess up their sleep pattern. However, this can be counteracted if the user interacts with blue light in the morning. For this project the key objectives that we focused on the most were that (2): 1. The lamp is easy to control with limited motor skills (1), we found that using a TTP223B Capacitive Touch Sensor worked for us - 2. Does not hurt people who have a light sensitivity problem (1), with our 10W RGB LED which is extremely bright so to counteract that we dimmed the brightness of it using arduino code - 3. The RGB LED puts out the required intensity and color at the right time so as to not disturb one's sleep pattern (1), to sense the light we used a BH1750 light sensor and coded the RGB LED to display certain colors at certain intensities - 4. It must illuminate a standard 24'' x 36'' desk area (1), for this we calculated the spot size of our RGB LED which was found to be 40'' x 40'' which is greater than what we originally thought.

As stated above we used a TTP223B Capacitive Touch Sensor to be of use for people with limited motor skills. This innovative choice was made by turning on and off the lamp and all its commands are controlled by this sensor (3), it is also not a super sensitive touch sensor which means that a quick brush by someone's hand or a piece of paper falling on it will not turn it on. Another innovation we made is that the lux at natural sunset is always between 400 and 600 lux (8), we coded our desk lamp so whenever the light sensor senses that the lux has hit or fallen below that threshold all bluish-white light will turn off in the RGB LED therefore leading to better sleep (6). We also made it so bluish-white light would be more prevalent during the morning to noon time as that's when the lux is usually the greatest (8). A third innovative design we chose was to include a flexible neck for our lamp. This gives the user much more flexibility in how they want their desk lamp positioned based on the goosenecks flexibility.

The final product is a desk lamp that is around 18.95in in height (11, 12). It has an adjustable gooseneck in order to allow the user to adjust the angle of the light emitted. The desk

lamp needs to be connected to any open outlet and requires no recharging or replacement of parts.

The desk lamp works as it is supposed to. It can provide light that spans a 3 to 4 foot radius (1). The touch sensor is not very sensitive, and hence the lamp will not accidently turn on if an object falls on it, or the user brushes against the touch sensor. The light sensor and LED code work as well (6), as the lamp changes to an amber light under dark conditions, but reverts to a white light when the surroundings are light. The lamp was also tested to remain on for prolonged periods of time, and no dip in light intensity was noticed.

Throughout this project we learn how to break complex tasks into parts and steps, starting from brainstorming ideas at the initial stage on how we are going to approach the design to the prototype stage, and ultimately to the final stage. We learned how to manage time and assign roles and responsibilities to members by creating a Gantt chart so that we know each week what we are going to work on, and what aspects each member is going to work on in that given week, as we come together to refine our understanding through discussion and explanation. We learn that at any point in the design phase it's always helpful to do research that could challenge our assumptions and ultimately lead to a better design. Overall working in groups helps us learn how to tackle more problems than we could on our own and develop stronger communication skills.

References:

- https://rgbcolorcode.com/ - For the information on light color and code
- https://www.cdc.gov/niosh/emres/longhourstraining/color.html - Info about which colors are better at what times
- https://www.seeedstudio.com/blog/2019/12/31/what-is-touch-sensor-and-how-to-use-it-with-arduino/#:~:text=A%20touch%20sensor%20works%20like,currents%20to%20flow%20through%20it. - What is the touch sensor used for?
- https://www.amazon.com/Chanzon-Power-Common-Anode-300mA/dp/B01DBZK64K - 10W RGB LED that we bought
- https://www.amazon.com/HiLetgo-TTP223B-Capacitive-Digital-Raspberry/dp/B00HFQEFWQ/ref=asc_df_B00HFQEFWQ/?tag=hyprod-20&linkCode=df0&hvadid=242008278630&hvpos=&hvnetw=g&hvrand=6256477825253359260&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9012099&hvtargid=pla-405218536202&psc=1 - Touch Sensor we bought
- https://www.amazon.com/HiLetgo-GY-302-BH1750-Intensity-Illumination/dp/B00M0F29OS/ref=asc_df_B00M0F29OS/?tag=hyprod-20&linkCode=df0&hvadid=366418790600&hvpos=&hvnetw=g&hvrand=10265352350612568207&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9012099&hvtargid=pla-813489382031&psc=1&tag=&ref=&adgrpid=73048859021&hvpone=&hvptwo=&hvadid=366418790600&hvpos=&hvnetw=g&hvrand=10265352350612568207&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9012099&hvtargid=pla-813489382031 - Light Sensor we bought

Appendix

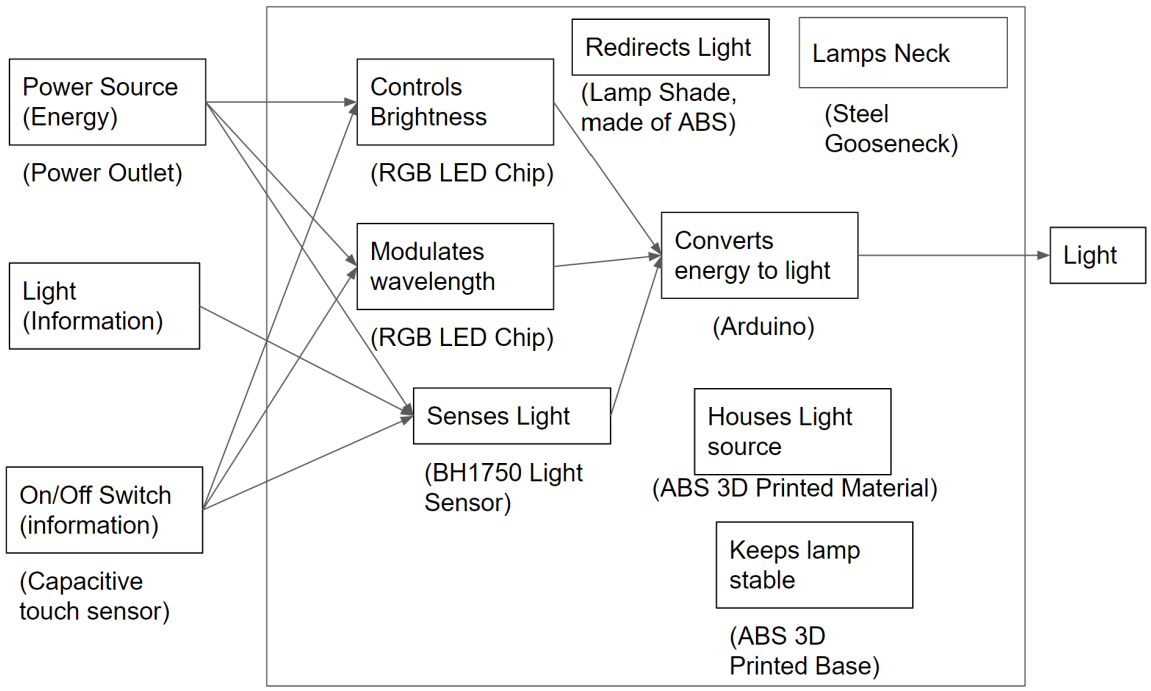
Objectives - Metrics (1)

- Lamp is easy to control with limited motor skills - No small buttons/switches
- Lamp is safe - No sharp edges
- Lamp is within cost of targeted market - At most $200 USD
- Light doesn't interrupt natural circadian rhythm, lamp does not emit blue light in the evening - Lux < 500
- Light complements natural circadian rhythm, lamp emits blue light in the morning to noon - Lux > 500
- Lamp is stable / not easily knocked over - Impact tests
- Lamp fully illuminates desk for studying - 40'' x 40''
- Lamp doesn't damage eyesight by not directly illuminating at eye level - RGB LED intensity < 105 (out of 255 scale)

PCC (2)

	Doesn't require fine motor skills	**Safe**	**Affordable**	**Doesn't interrupt sleep**	**Doesn't damage eyesight**	**Durable**	**Fully illuminates desk**	
Doesn't require fine motor skills		1	1	1	1	1	1	**6**
Safe	0		1	1	1	1	1	**5**
Fully illuminates desk	0	0	1	1	1	1		**4**
Doesn't interrupt sleep	0	0	1		1	1	0	**3**
Doesn't damage eyesight	0	0	1	0		0	0	**1**
Affordable	0	0		0	0	1	0	**1**
Durable	0	0	0	0	1		0	**1**

Glass Box (3)



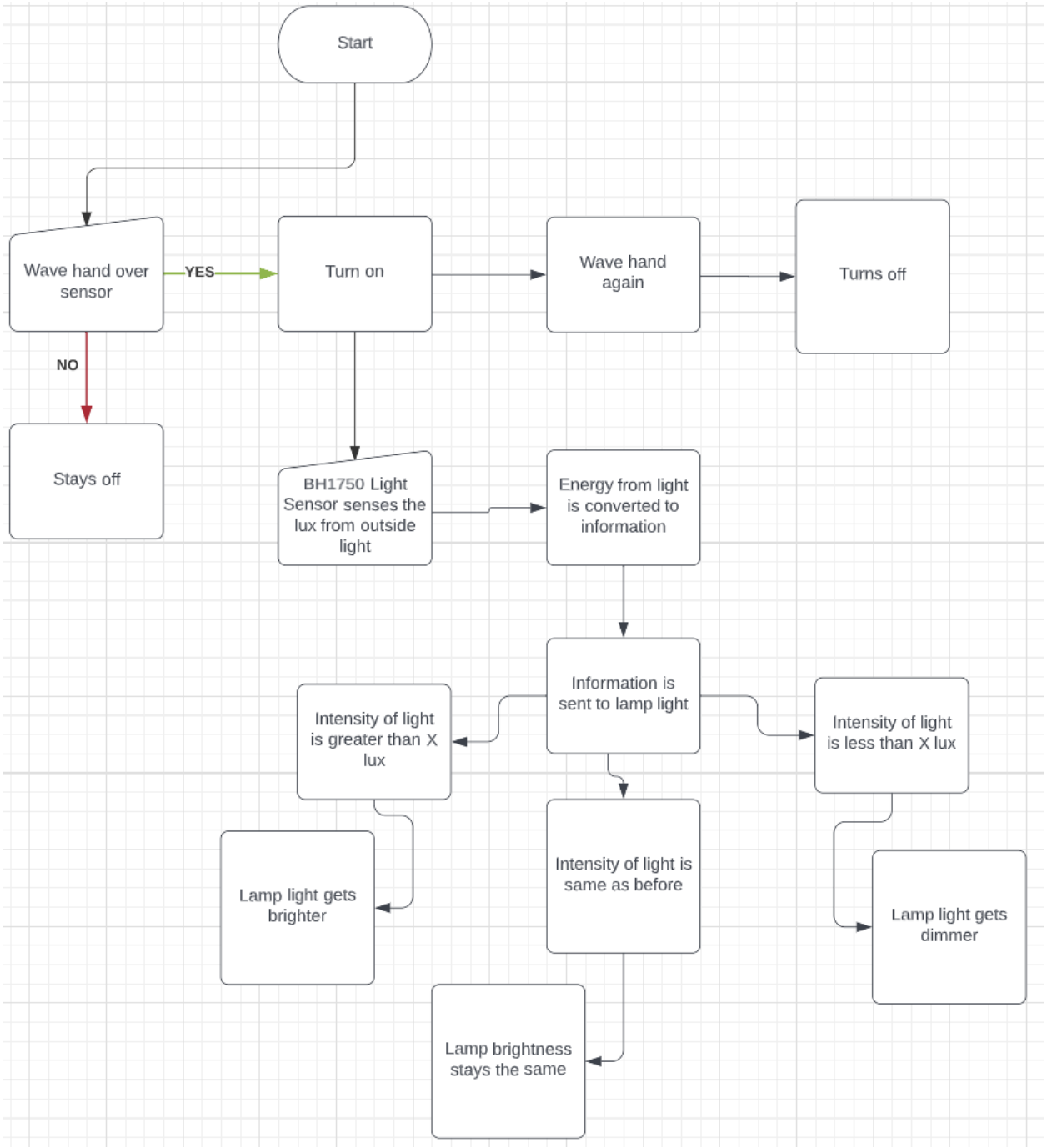
Morph Chart (4)

Function	Means 1	Means 2	Means 3		
Brightness controller	**Pulse width modulation (PWM pins)**	Potentiometer	Delta-sigma modulation (DSM)		
Light sensor	Light dependent resistor (LDR)	Camera	**Phototransistors**		
Wavelength modulator	**Multiplexed pins to LED array across range of wavelengths**	Polychromator filter of broad spectrum source (e.g. incandescent)	**Two broad-spectrum bulbs of warm and cold temperatures with power switching linearly between them**		
Energy-to-light converter	LEDs controlled by Arduino	LEDs controlled indirectly by transistor controlled by Arduino	**Incandescent light bulb activated indirectly via transistor controlled by Arduino**	Multicolor bulb (with LEDs within)	
Lamp casing	**3D printed ABS casing**	Aluminum casing	3D printed resin casing		
On/off	**Capacative touch sensor on base (sensitivity can be a setting)**	and a main power switch			

Parts List (5)

BOM Level	Part #	Description	Qty	Unit Cost	Cost
1	TTB223B	Capacitive Touch Sensor	1	$0.51	$0.51
1	1DGL-JC-10W-RGB	RGB LED Chip	1	$6.99	$6.99
1	BH1750	Light Sensor	1	$4.50	$4.50
1	GFW-MIC-GN13	13" Flexible Gooseneck	1	$8.99	$8.99
1	B092V92YLW	9V 2000mA Power Supply	1	$6.99	$6.99
2	LB1	ABS Base	1	$10.53	$10.53
2	LB2	ABS Base Cover	1	$23.10	$23.10
3	A000066	Arduino Uno	1	$28.50	$28.50
3	B01MT530B8	Jumper Wire Lot	1	$9.49	$9.49
4	LH1	Acryllic Lamp Head	1	$10.00	$10.00
4	#10	1" Phillips Flat-Head Wood Screws	4	$0.07	$0.28
		Total Number Parts	14	Total Cost	$109.88

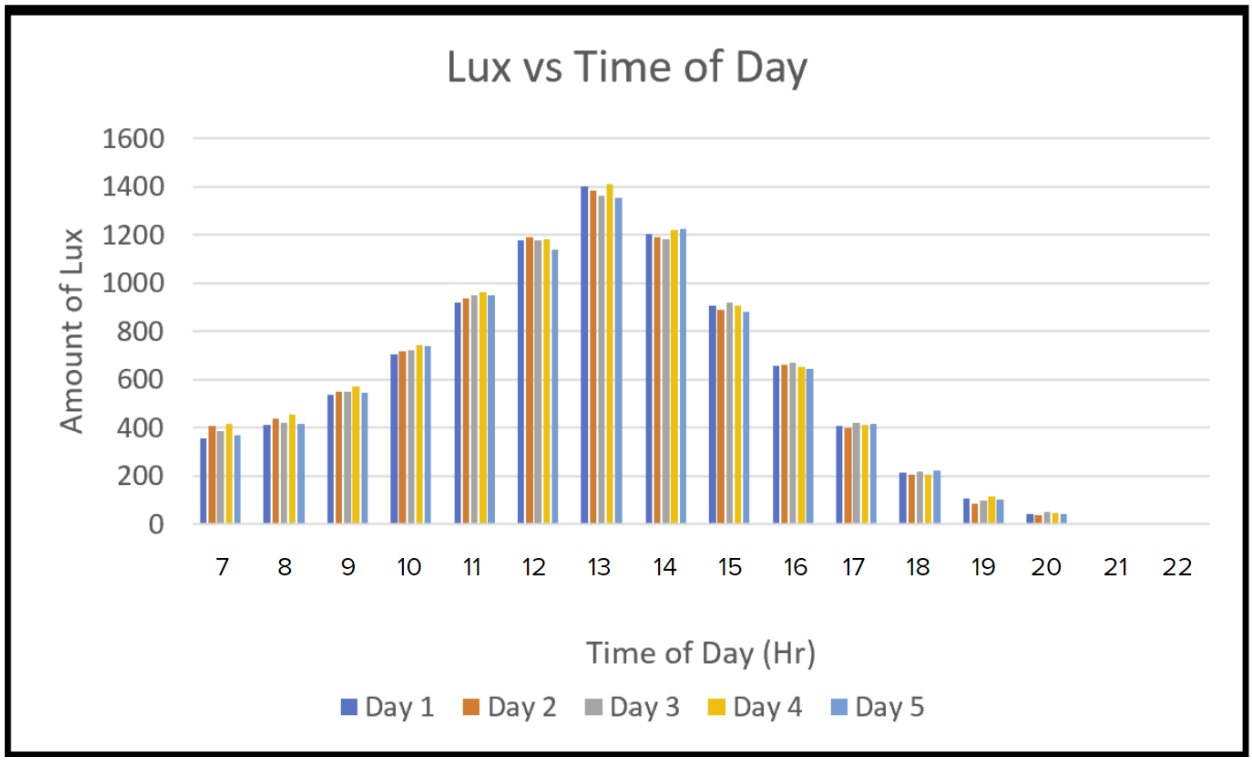
Code Flow Chart (6)



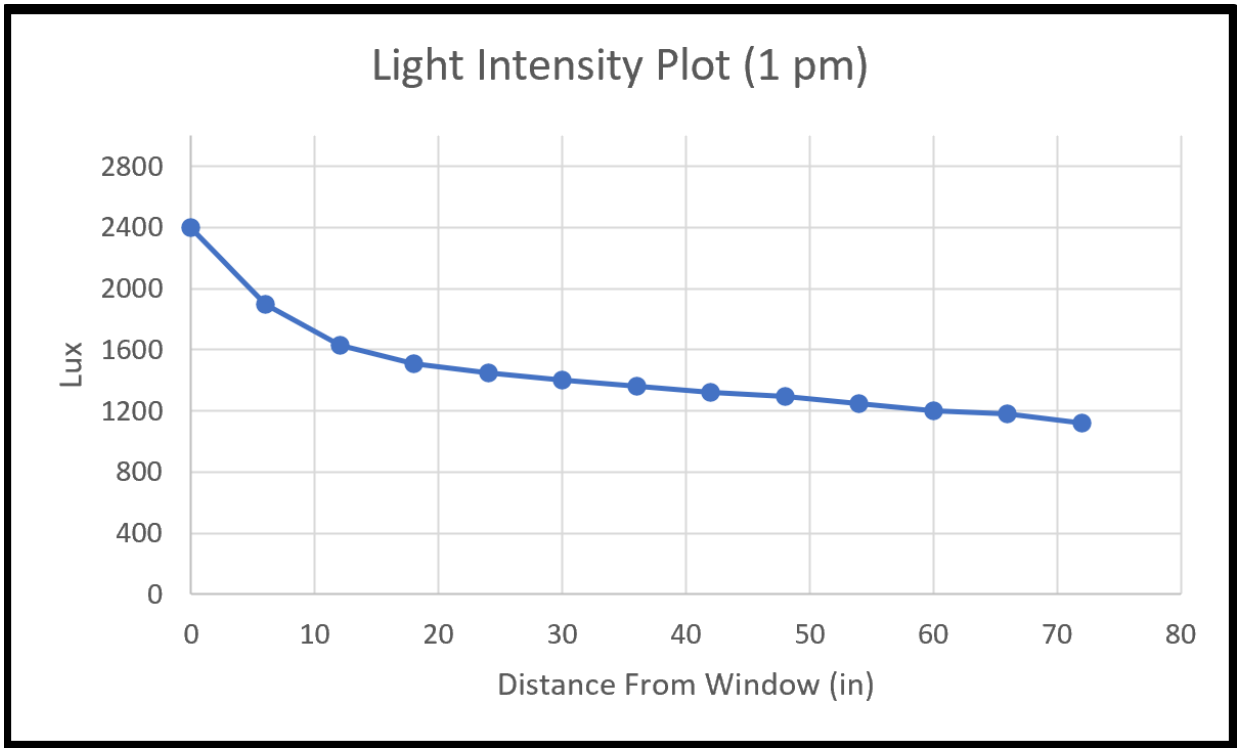
Power Budget (7)

Name of Component	Voltage	Current	Power (V*C)	Duty Cycle (% hr)	Total Power (W)	Uncertainty %	Grand Total Power (W)
Arduino	5V	100mA	0.5 W	21%	0.105 W	5	0.11025
BH1750 Light Sensor	3.3V	100mA	0.33 W	21%	0.0693 W	10	0.07632
Capacitive touch sensor	5.5V	105mA	0.5775 W	100%	0.5775 W	20	0.693
Red LED	7V	350mA	2.45 W	21%	0.5145 W	15	0.591675
Green LED	11V	350mA	3.85 W	21%	0.8085 W	15	0.929775
Blue LED	11V	350mA	3.85 W	21%	0.8085 W	15	0.929775
Total							3.330795
						Total time (hrs)	5
						Total Energy Used (mWh)	16,654

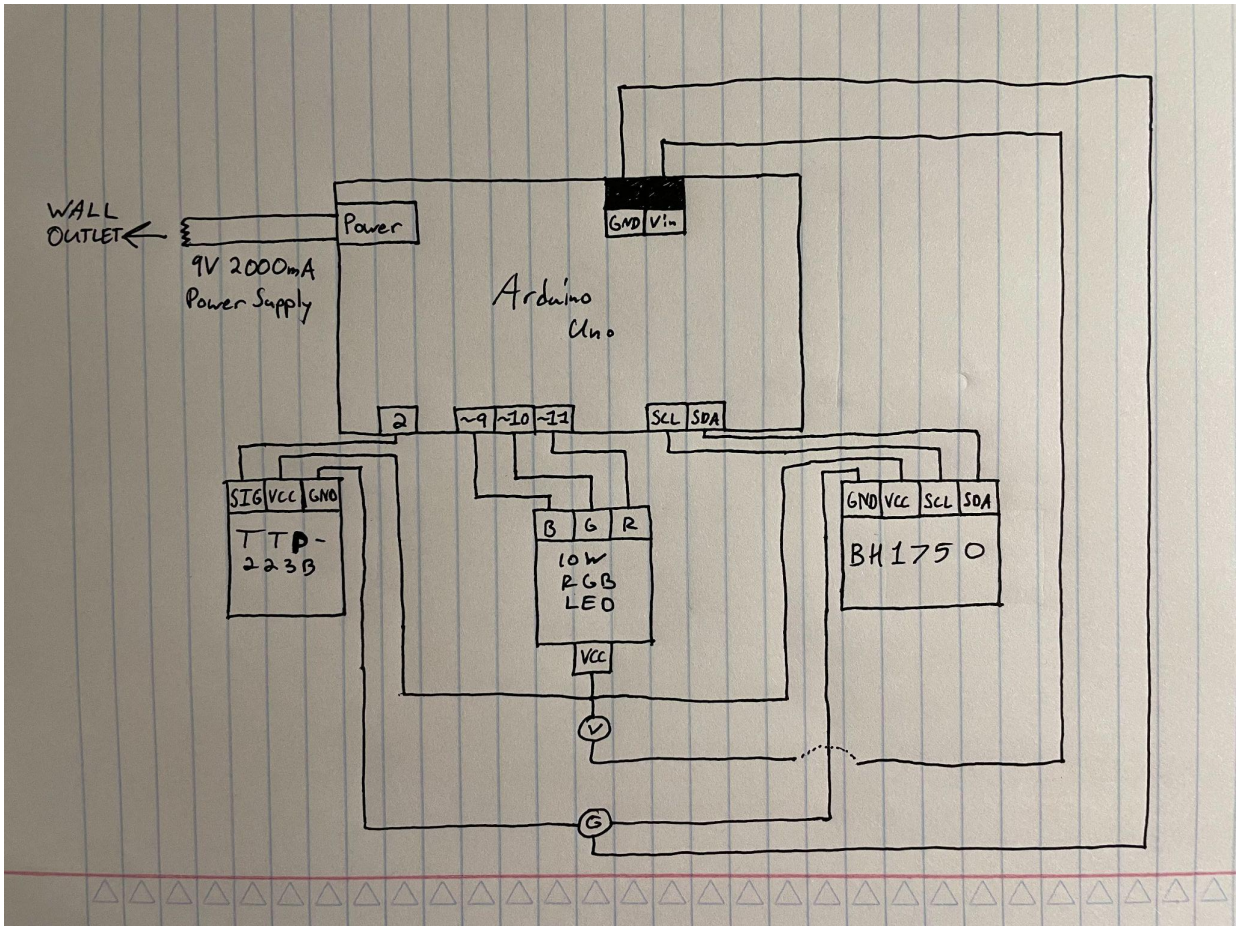
Lux Measurement (8)



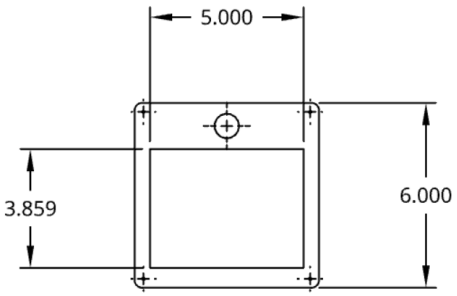
Light Intensity (9)

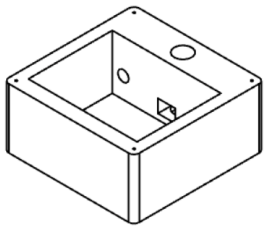

Light Intensity Plot (1 pm)
Lux
2800
2400
2000
1600
1200
800
400
0
0
10
20
30
40
50
60
70
80
Distance From Window (in)

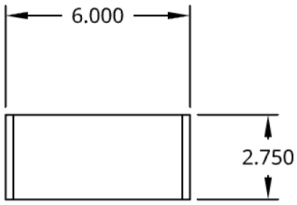
Circuit (10)

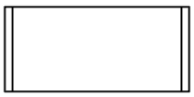


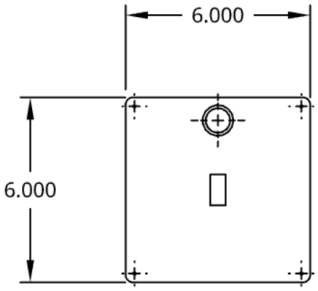
CAD Drawing (Base) (11)

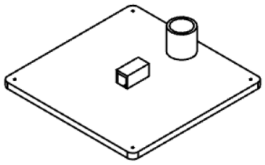


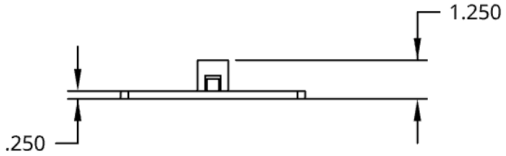


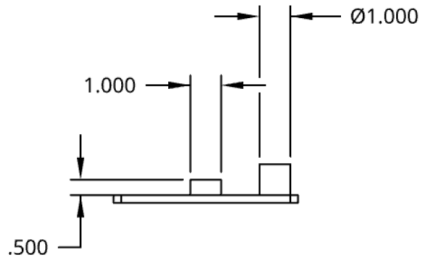












CAD Drawing (Head) (12)