Final Presentation

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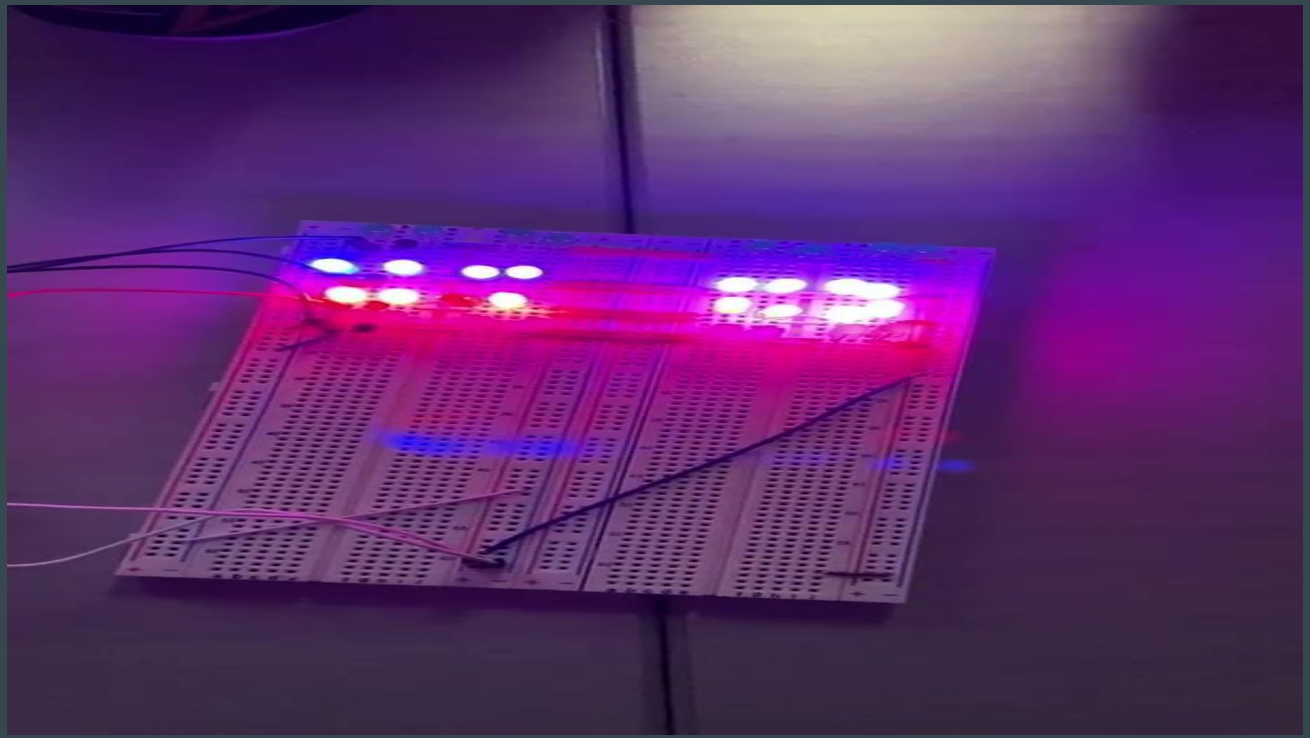
Prototyping



Ryan, 11/2/21, RGB Flow Sensor Team, 21F11

Prototyping

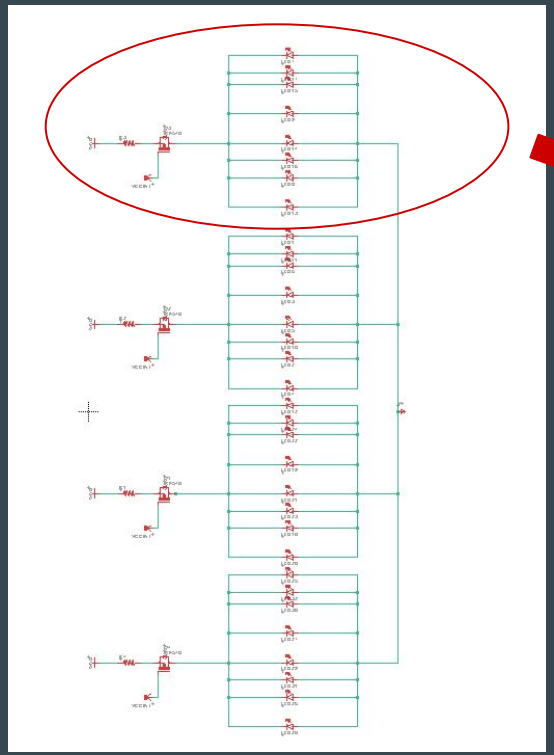


Figure 1: Complete Prototype Circuit

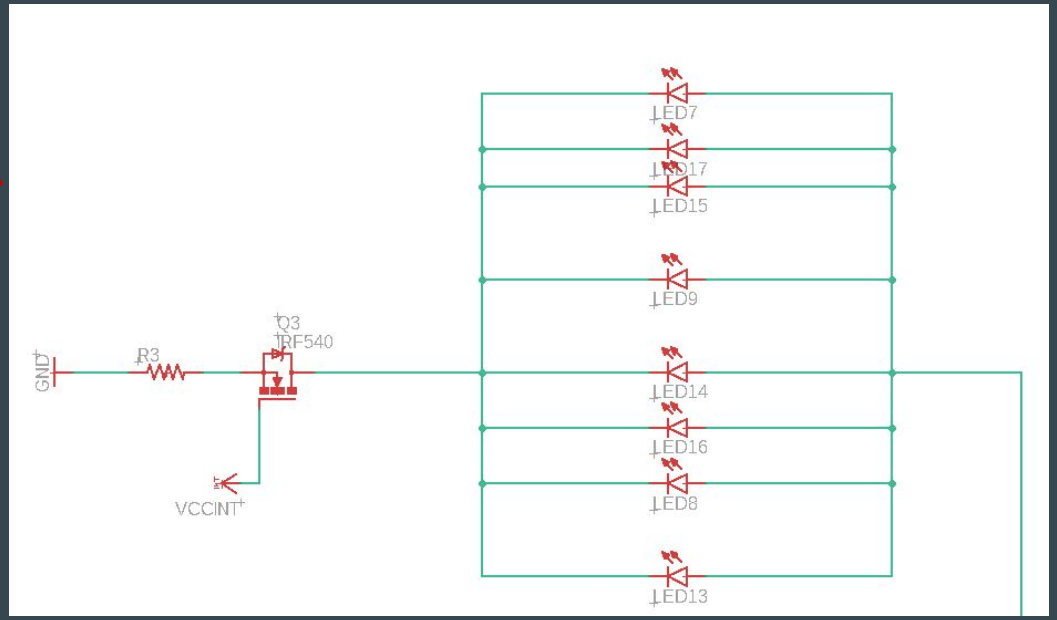


Figure 2: Partial Prototype Circuit

Ryan, 11/2/21, RGB Flow Sensor Team, 21F11

Project Description

• This project is based on flow visualization technology to design and produce a LED matrix to realize the light source supply of the particle image velocimetry (PIV) system.

• The RGB light system has three separate channels that control three different colors individually and operate within a $1000 budget. This project provides the same functions of laser equipments with less money.

Prototyping

- The Red and Blue LEDs pulse at a frequency of 1000 hz
- The Green and White LEDs pulse at 500 hz
- Circuit is simplified due to the lower voltage and current within the prototype

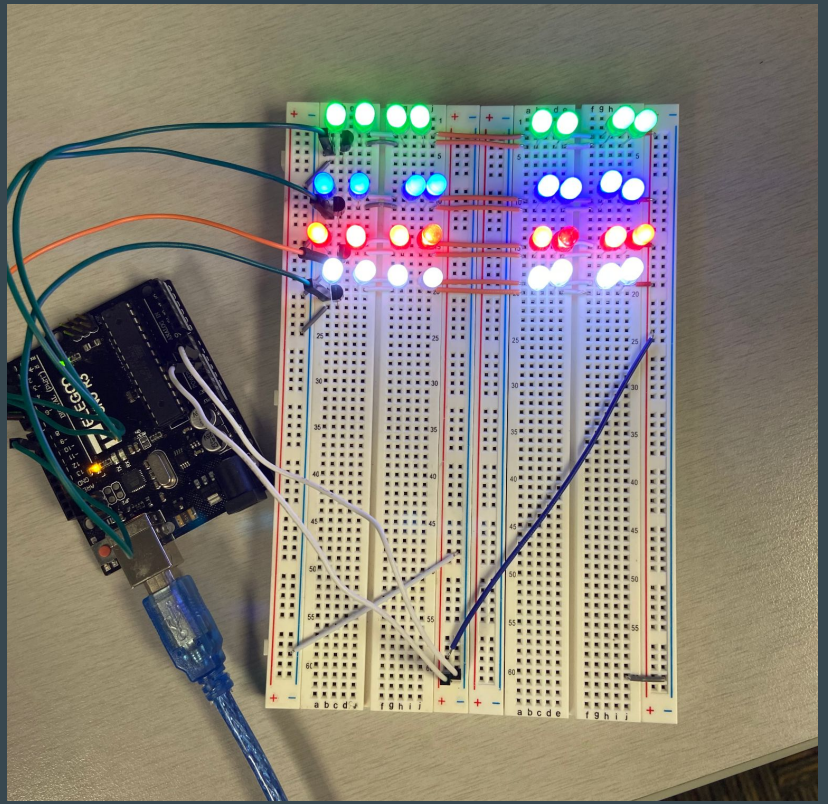


Figure 3: Prototype #1

brief

Design Description: Circuit

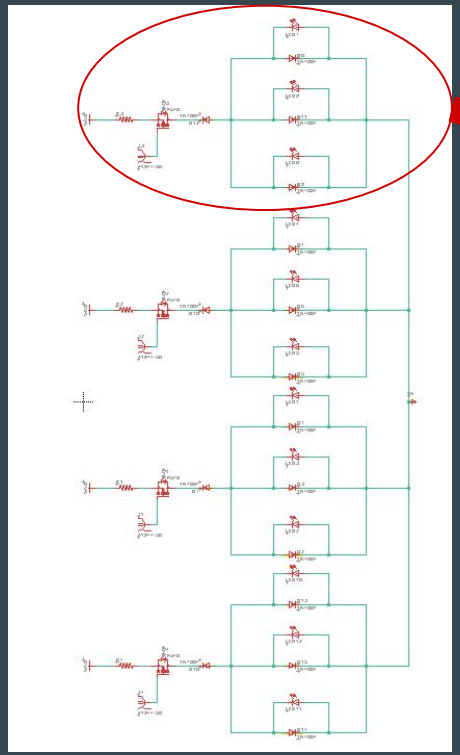


Figure 4: Complete Circuit Design

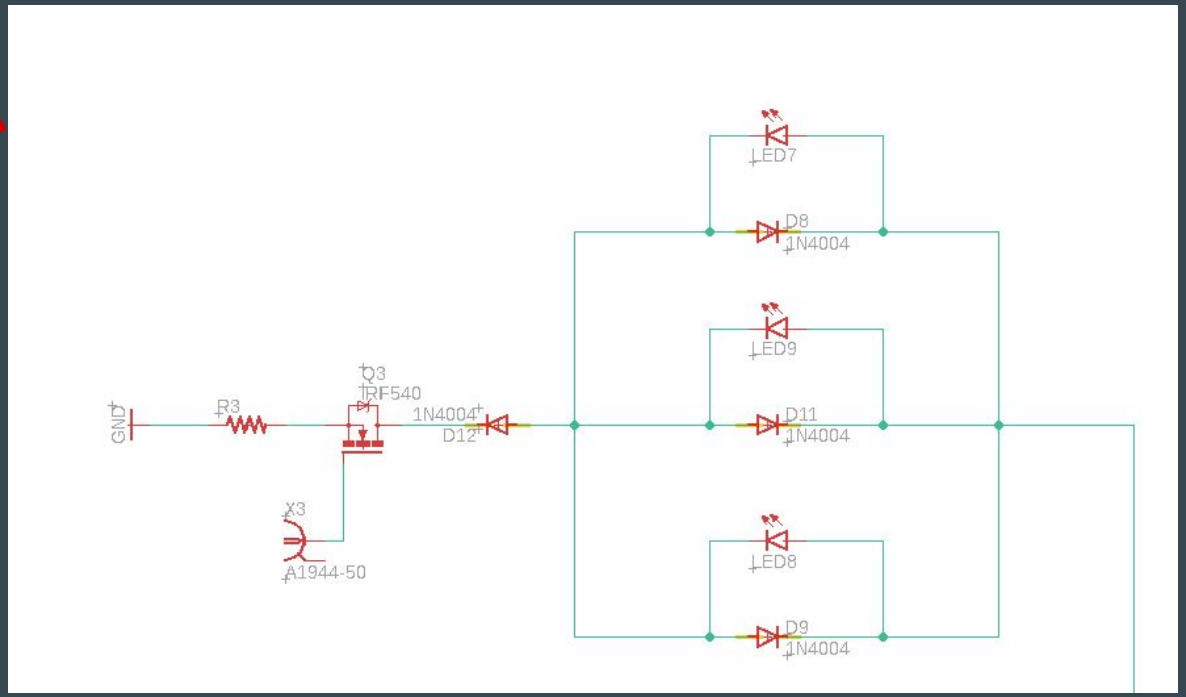


Figure 5: Partial Circuit Design

Design Description: SolidWorks Design #1

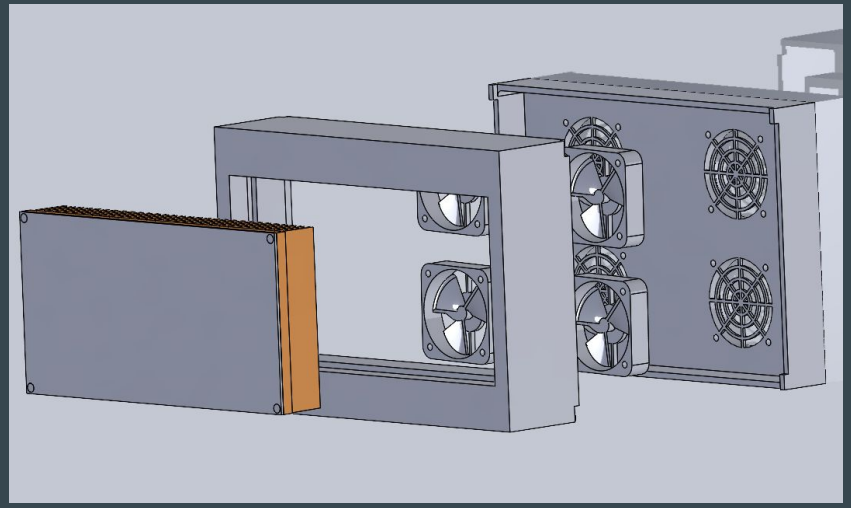


Figure 6: Housing

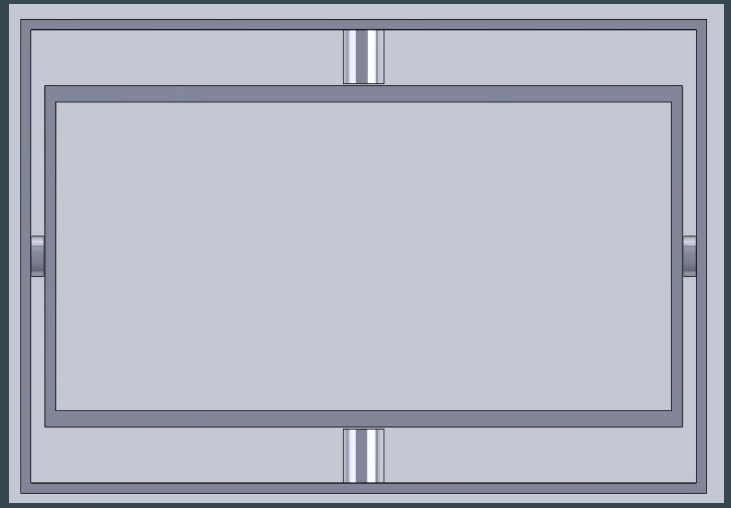


Figure 7: Section view of top housing

Functionality

- Fitted Design
- Vents for hot air escape
- 4 Fans blowing air at heat sink to help with cooling
- Heat sink attached to circuit board

Material

- Copper Heat sink
- 3d-printed PLA plastic

Design Description: SolidWorks Design #2

Functionality

- Screw Design
- Vents and louvers for hot air escape
- Heat sink and six fans help cooling

Material

- Sheet metal for housing
- Copper heat sink
- Plastic fans

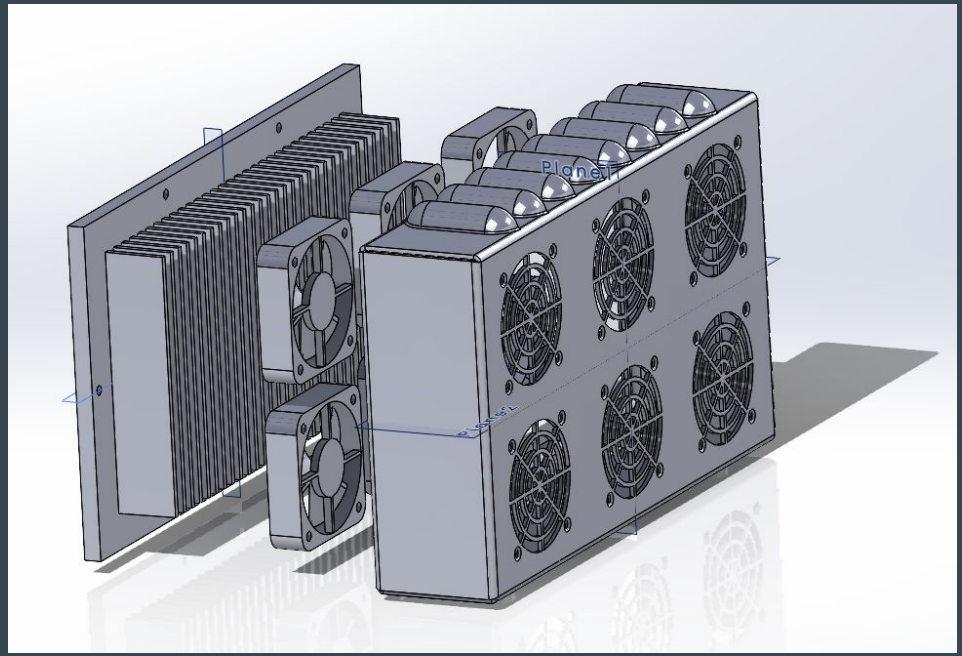


Figure 8: Exploded View of Design #2

Design Requirements

Customer Requirement

- High frequency
- Short pulses
- Adjustable intensity
- Reliability
- Durability
- Adjustable color
- Minimal jitter and delay
- Cost

Validation

- Prototype shows that a high frequency, with a short pulse is possible with a transistor gate.
- The prototype also demonstrates an adjustable intensity due to the previous requirements.
- By adjusting the intensity of each colors of light outputted, the average color can be adjusted.
- The Reliability, Jitter and Delay will be tested through 2 of the technical analysis.

Design Requirements: Analytical Analysis - Theoretical

1. Heat Transfer analysis
- Copper heat sink
- LEDs and Circuit Boards
- SolidWorks, Matlab, HandWritten Calculations

2. Circuit Analysis
- Number of LEDs in the system
- Values for needed resistors and capacitors
- Exact layout of the circuit board

Design Requirements: Analytical Analysis - Experimental

3. Luminous Flux Analysis

- Lumens (Im)
- Overall brightness of light source
- Used for light intensity calculations

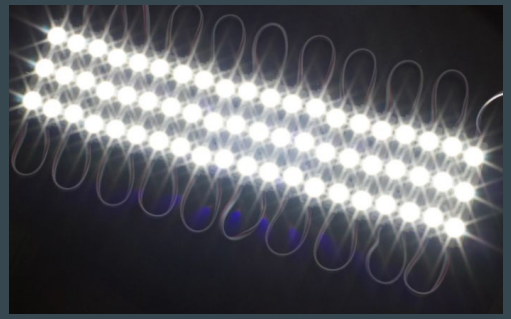


Figure 10: Bright LEDs

4. Synchronization Analysis

- Measure the time needed between signal sent and the light out of the LEDs
- Make sure the camera and the LED light can work simultaneously

Figure 11: SYNC setting in Flash Head

Design Validation - Failure Modes and Effects Analysis (FMEA)

Table 1: FMEA

Part # and Functions	Potential Failure Mode	Potential Effect(s) of Failure	Severity (S)	Potential Causes and Mechanisms of Failure	Occurance (O)	Current Design Controls Test	Detection (D)	RPN	Recommended Action
LED Chips	Temperature Induced Deformation	Decreased Light Intensity, Failure to operate	8	Assembly of cooling syste	4	Multimeter	1	32	Replace LEDs
Heat Sink	Thermal Fatigue	Unable to cool LEDs	10	Dust and debris on heat s	4	Compressed	1	40	Clean heatsink frequently
Fan (bearing)	Corrosion, Yielding	Decreased cooling	2	Overstressing	5		3	30	Replace Fan
Fan (blade)	Brittle Fracture	Decreased cooling	3	Poor maintenace, and ass	2		5	30	Replace Fan
Fan (motor)	Thermal Fatigue and Aging	Decreased cooling	3	Overheating, Poor mainte	1		5	15	Replace Fan
Circuit Board	Thermal Fatigue , Temperature deformation	Light intensity, Light display, Circuit Control	10	Light failure	2	Multimeter	1	20	Replace Circuit Board
BNC Port	Thermal Fatigue	Short circuiting, breaking circuit	4	Debris, lack of cooling	1		3	12	Replace Port
Rectifier Diode	High-cycle fatigue	Dimmed lights, poor power suppply, revered current shorting LEDs	5	Over voltage,current,heat	2	Multimeter	1	10	Replace Diode
NPN Transistor	Avalanche failure	Unable to control voltage and current	6	Over voltage	7	Multimeter	7	42	Replace Transistor
Housing	Ductile Rupture, Brinelling	Parts won't be encased, system can not function properly	7	Heavy loads, bad assemb	2		2	28	Evaluate design and make changes
Wiring	Thermal Fatigue	Dimmed lights, poor power suppply	4	Lack of cooling, Over Voltage/current	5	Multimeter	1	20	Replace Circuit Board

Design Validation: Testing and Equipment

Equipment and Testing :

- Multimeter - Used to measure values of main electric components
- Photoresistor - Used to measure illumination of LEDs
- High Resolution Camera - Used to synchronize with light pulse
- Thermocouple - Used to measure temperature
- Heat Source - Used to heat up housing material to see

Schedule and Budget

Finalizing Design			
Final design solution 2	100%	10/16/21	10/18/21
Solid works parts	100%	10/24/21	11/1/21
Analytical analysis memo	100%	10/22/21	10/24/21
solidworks drawings and assembly	60%	11/1/21	11/7/21
solidworks analytic	0%	11/1/21	11/8/21
Final CAD and Protoype			
Final Report	0%	11/5/21	11/14/21
Final CAD	0%	11/9/21	11/19/21
Final BOM	0%	11/9/21	11/19/21
Final Prototype	0%	11/15/21	12/3/21
Prototype Testing	0%	11/15/21	11/30/21
Website	0%	11/15/21	12/7/21

Figure 12: Schedule

Table 2: Bill of Materials

No.	Qt.	Name	Function	Cost
1	75	LED Chip	Convert the electrical energy into light	$300
2	1	Heat Sink	Fill gaps between the fan and cooling part, make cooling more efficient	$50
3	4	Fan	Push air and keep cooling	$24
4	1	Circuit Board	Control the system	$150
5	4	BNC port	Cable Input port for the TTL signal	$10
6	4	Rectifier diode	Keep the current from flowing in reverse through the LEDs	$5
7	4	NPN Transistor	An N-Channel power transistor to stabilize the pulse input.	$5
8	1	Housing	Holds the system together	$55
9	32	Standard LED	Prototype LEDs	$0
10	1	Arduino	Prototype Power Source and Control	$0
11	2	BreadBoard	Prototype circuit Base	$0
12	-	Misc	Miscellaneuos components such as wires	$0
13	6	Screws	Holds together housing assemblies	$2
Total Budget ($1000)				$601.00

Thank You

Are there any questions?