Lazer Pong

Senior Design 2 CDR Presentation

The Team

Group 1

Matthew Brislenn

PSE

Jeffery Cain

PSE

Michael Dodd

CpE

Kyle Fallejo

EE

Sean McElvogue

CpE

Background

Matthew Brislenn
PSE

Thoughts on Previous Designs

Matthew Brislenn
PSE

Limitations

- Limited surface lighting
- Few game management features
- Slow reaction/imprecise sensors

Improvements

- Full surface lighting
- Add accessibility features
- Tighten up sensor quality

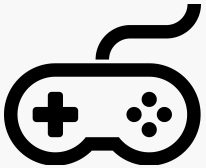
Matthew
Brislenn
PSE

Motivation

To design a beer pong inspired arcade cabinet that is more entertaining and more accessible than the current designs.

Michael Dodd
CPE

Achieved Goals

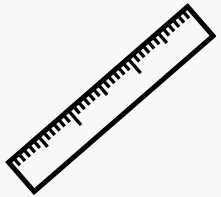


Game Management

Assist the player with understanding, playing, and keeping score of the game.

Impressive Lighting

Enhance the game experience with immersive lighting effects across the full table area.



Half Scale

Implement these features across a 2’x4’ play area, or one side of a beer pong table.

Sensor Improvement

Employ advanced optical surface sensors capable of tracking objects on the table surface.

Missed Stretch Goals

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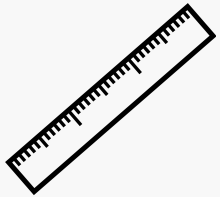
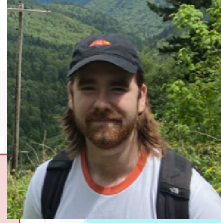
Audio Visualization

Enhance lighting by timing dynamic lighting effects to the rhythm of ambient music.



Full Scale

Implement these features across a 2’x8’ play area, or a full beer pong table.



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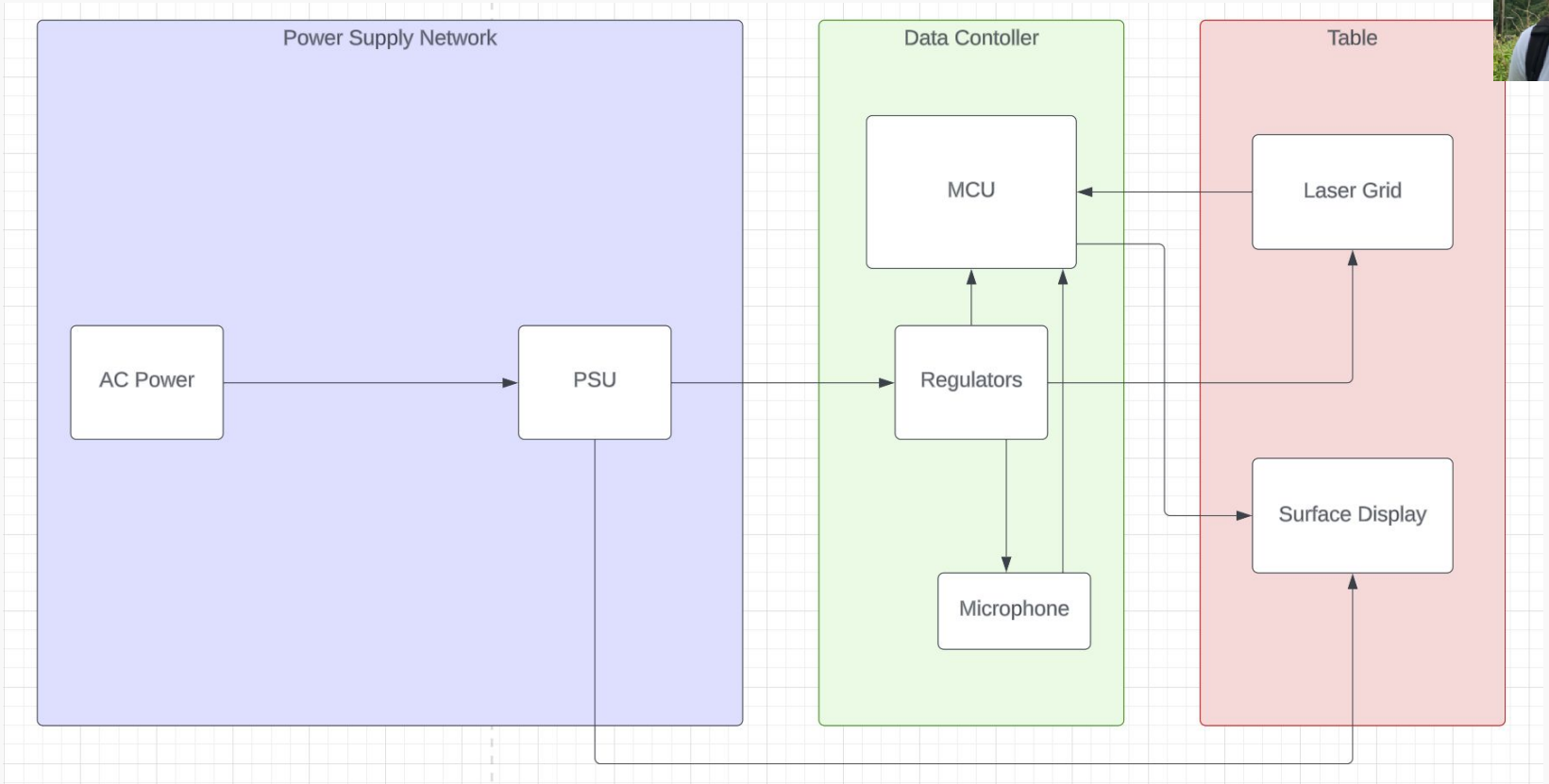

Objectives

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CPE

Objectives	Values
Create an infrared laser sensor grid that is tight enough to detect a ping pong ball.	<40mm between lasers
Assemble an addressable LED array display to cover the play area.	2’x4’ area
Use a condenser microphone to find the rhythm of ambient sound.	20Hz – 20kHz
Establish an overall response time that is sufficiently quick to not obstruct enjoyment of the game.	250ms

Requirements and Specifications

Kyle Fallejo
ECE

Requirement	Specification	Priority
Table Dimensions	Minimum 4’ x 2’ Overall (L x W x H): 4.5’ x 2.5’ x 27.5” - 36”	Mid
Laser Grid Dimensions	>20 mm above play area, <40 mm between adjacent lasers	High
Laser Classification	<Class 3B	High
Laser Spread	No more than 20mm diameter after traveling up to 4’	High
Microcontroller Pin Count and Capability	48 GPIO pins, 1 SPI, 1 ADC	High
Overall Response Time	<0.25 sec.	High

Requirements and Specifications

Kyle
Fallejo
ECE

Requirement	Specification	Priority
Power Consumption	<150W	High
Power Delivery	Maximum 5 V at 30 A	High
AC to DC Conversion	100-240 VAC down to 5 VDC	High
Microcontroller Performance	CPU speed at least 1 MHz RAM at least 16KB	Mid
Weight	20 - 30 lbs.	Low

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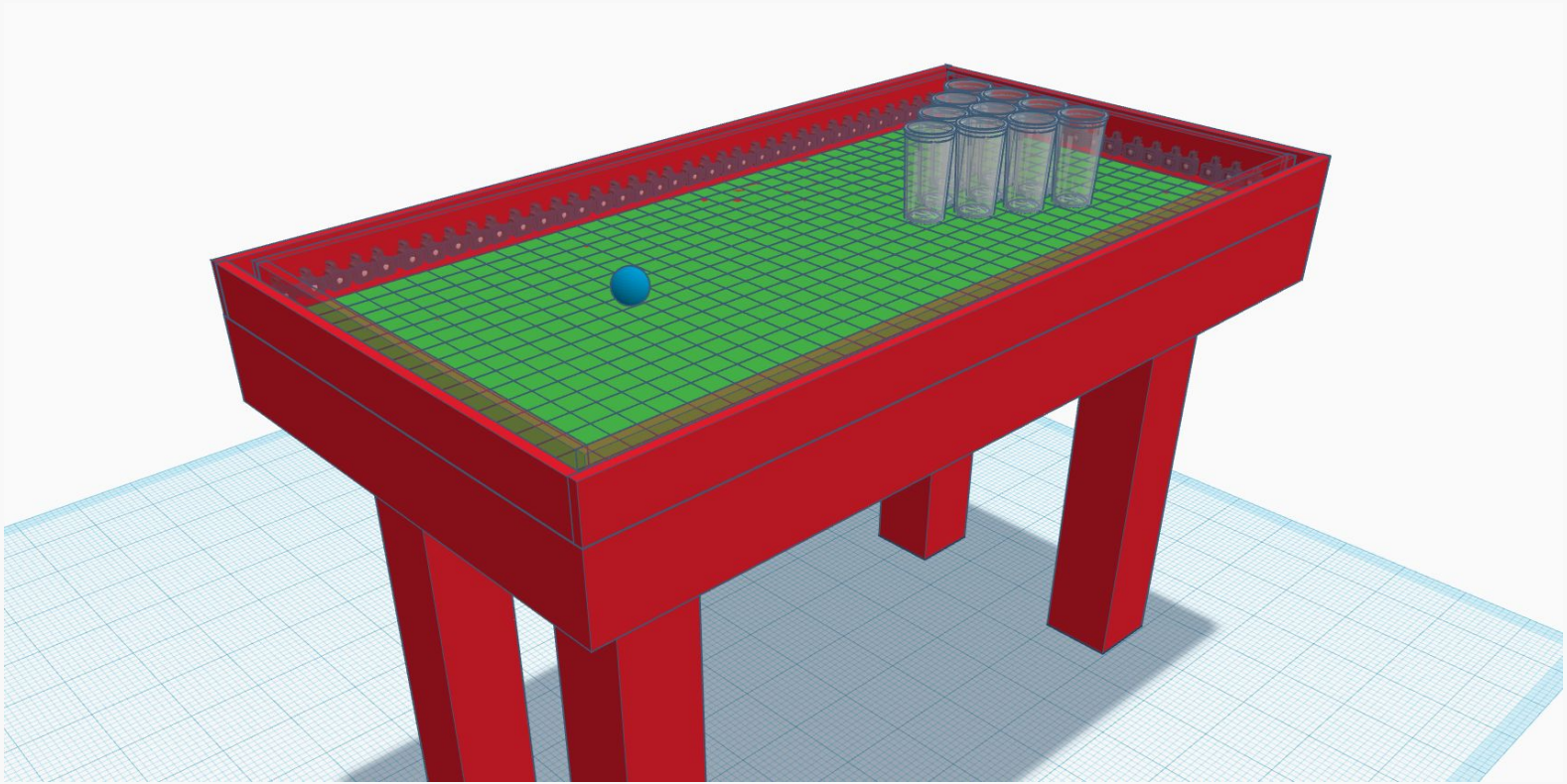

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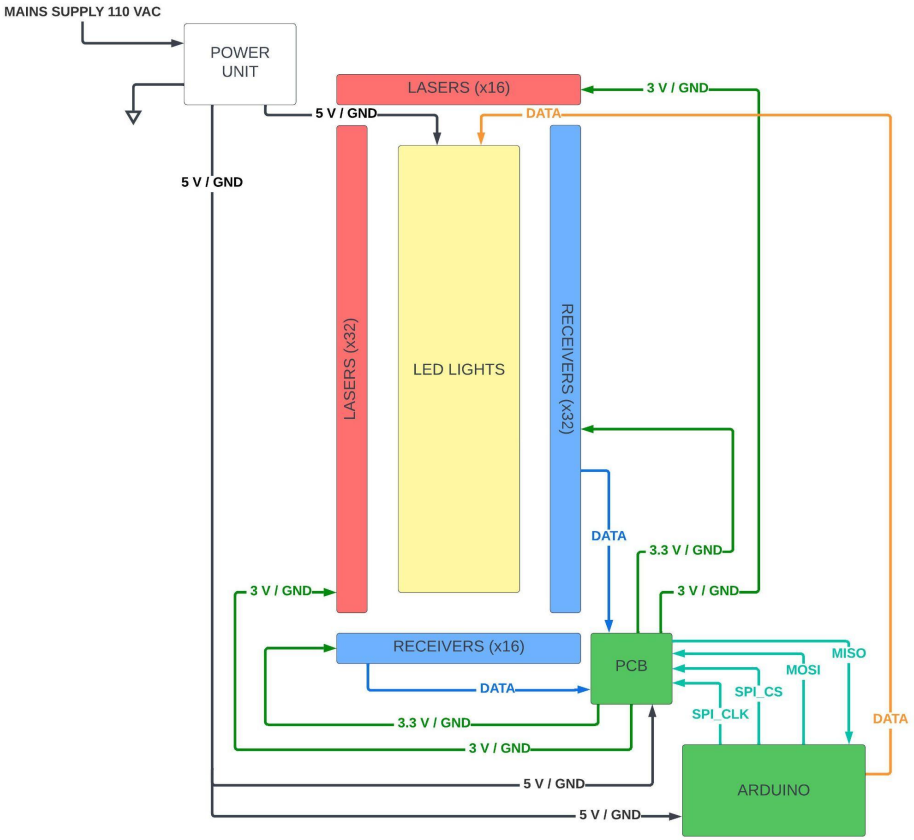

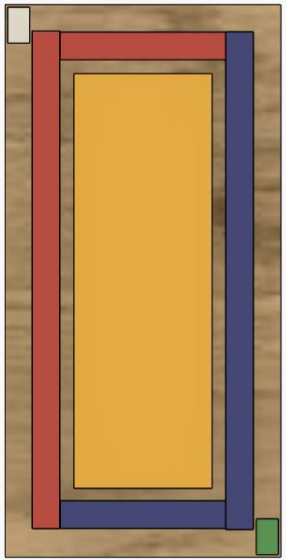

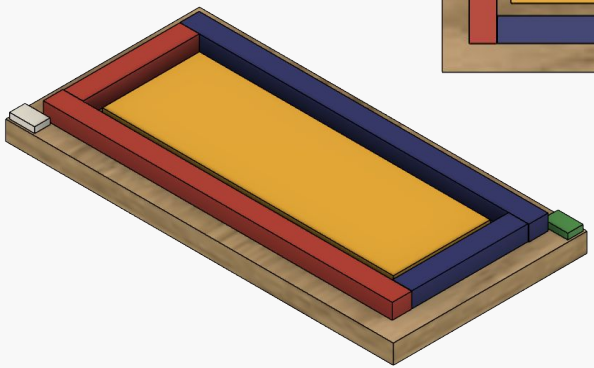

Part Selection

Hardware

Jeffrey
Cain
PSE

Infrared Laser Transmitter

Laser	Q-BAIHE IR Laser Diode Module	THORLABS L785P5 Laser Diode	MITSUBISHI ML925B45F Laser Diode
Center Wavelength	780 nm	785 nm	1550 nm
Cost	$3.18 per ea.	$12.68-10.14 per ea.	$56.48-53.66 per ea.
Optical Power	3 mW	5 mW	5 mW
Input Voltage	3 V	2 V	1.5 V
Input Current	100 mA	40 mA	50 mA
Collimating Lens	Included	Not Included	Not Included

Jeffrey Cain
PSE

Infrared Laser Receiver

Photodetector	CHANZON 940nm IR Receiver	THORLABS FDS100 - Si Photodiode	LUCKLIGHT LL-503PDD2E Photodiode	DKARDU IR Infrared Flame Sensor Module
Cost	$0.0799 per ea.	$16.08 per ea.	$0.20 - 0.099 per ea.	$1.30 per ea.
Response time	Not listed	10 ns	45 ns	Not listed
Responsivity ranges	Only 940 nm listed	350 - 1100 nm	700 - 1200 nm	Infrared - No range listed
Sensor Area	3 x 3 mm	3.6 x 3.6 mm	5 x 5 mm	5 x 5 mm
Max Reverse Voltage	Not listed	25 V	35 V	Not listed
Dark Current	Not listed	1-20 nA	2-10 nA	Not listed
Visible Light Filter	Yes	No	Yes	Yes
Built in Amplifier	No	No	No	Yes

Matthew Brislenn
PSE

LED Light Strips

LED Strip	BTF-LIGHTING WS2812B Flexible Strip	Tenmiro Led Lights	BTF-LIGHTING WS2812B Fairy String
WS2812B Addressable LED	✔	✘	✔
Distance between LED	1.33”	2.22”	3.93”
Number of LED per strip	150	540	50
Waterproof rating	IP30	N/A	IP65
Length	16.4 feet	100 feet	16.4 feet
Cost	$32.99	$19.99	$9.99

Diffuser Panel

Matthew
Brislenn
PSE

Microcontroller

Sean McElvogue CPE

MCU	ATSAM3X8E	STM32F205VC	TMS320F280033
Processing Speed	84MHz	120MHz	120MHz
Flash Memory Capacity	512KB	Up to 1MB	384KB
Memory Capacity	100KB SRAM	Up to 128KB SRAM	69KB SRAM
GPIO Pin Count	103	Up to 140	Up to 100
Package/Size	LQFP-144, 20mm^2	LQFP-100, 14mm^2	LQFP-100, 16mm^2
Price	$13.15/ea	$11.28/ea	$5.84/ea

Arduino Controller for Addressable LEDs

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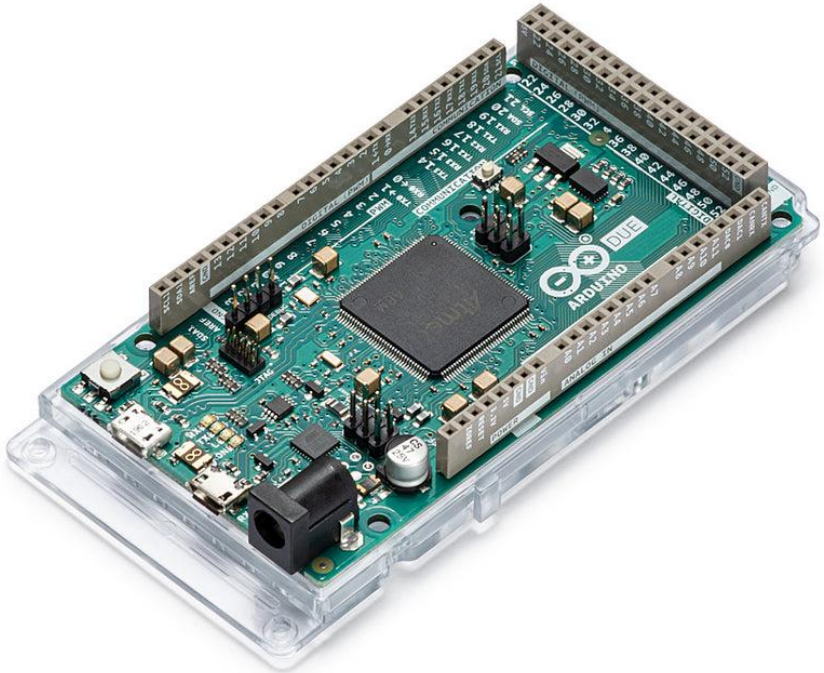
McElvogue
CPE



Arduino DUE:

- FastLED drivers are only compatible with official Arduino systems.
- STM32 MCU reads sensor data, transmits to DUE over SPI as coordinates of grid break.
- DUE is the only official Arduino platform to operate at 3.3v, required for SPI with STM32.
- DUE processes coordinate data and sends necessary display changes to FastLED.

Power Supply Unit

Kyle
Fallejo
ECE

Power Supply Unit	BTF-LIGHTNING Switching Power Supply	IMAYCC Adjustable Power Supply	Wefomey Adjustable Power Adapter
Input Voltage	110-240 VAC	110-240 VAC	100-240 VAC
Output Voltage	5 VDC	Adjustable 0-24 VDC	Adjustable 4-24 VDC
Max Output Current	30 A	Adjustable 0-20 A	5 A
Max Output Power	150 W	1-480 W	20-120 W

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Regulator for Power

Voltage Regulator for Power	Texas Instruments LM317T	Texas Instruments LM7805	STMicroelectronics LDL1117
Input Voltage Range	3-40 V	~0-10 V	2.5-18 V
Output Voltage Range	1.25-37 V	5 V	3 V, 3.3 V, other various fixed outputs
Max Output Current	1.5 A	1.5 A	1.2 A
Max Output Power	55.5 W	7.5 W	3.60 W, 3.96 W

Part Selection

Software

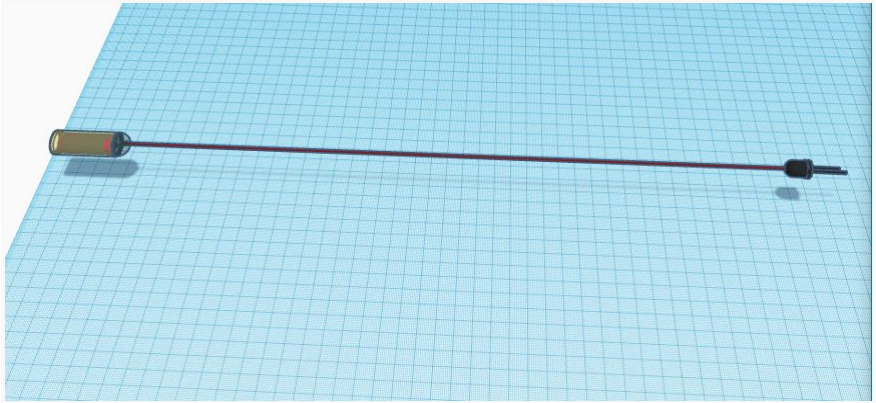
Michael
Dodd
CPE

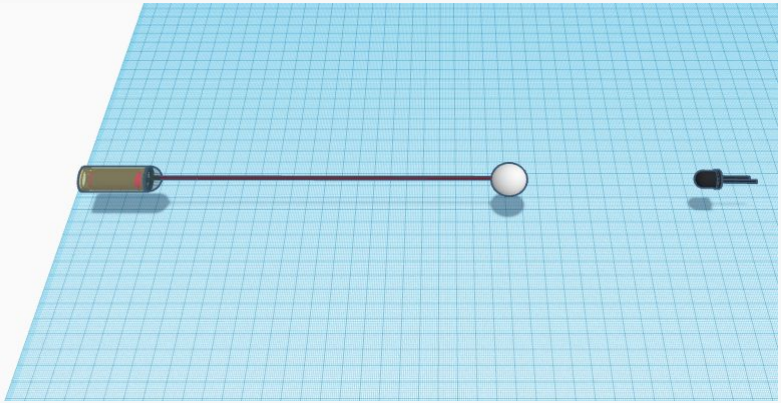
Design

Hardware

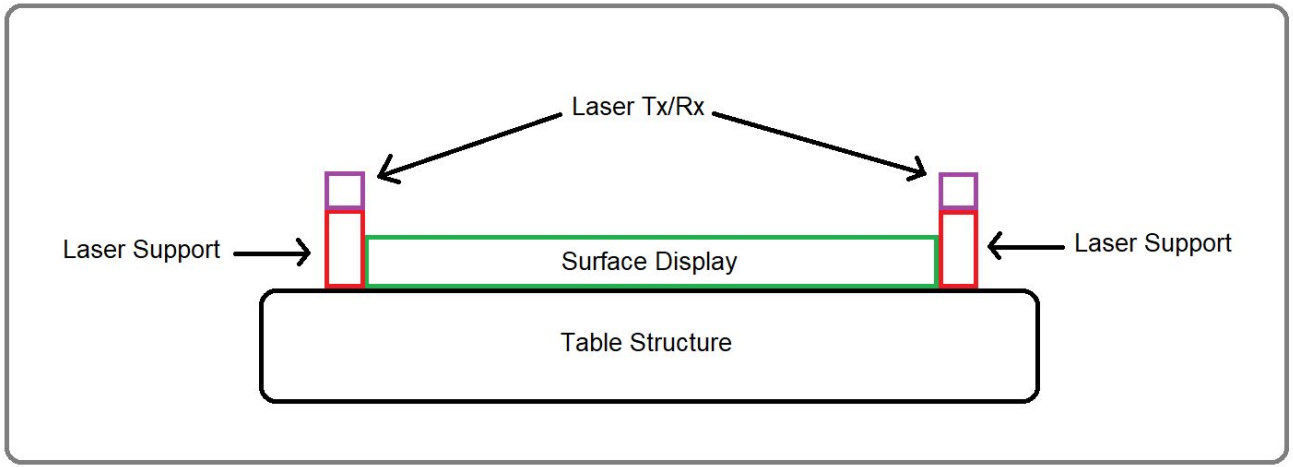
Optical Design: Function

Jeffrey
Cain
PSE





Optics Design: Layout



Composite Optical Subsystem

Jeffrey Cain
PSE

Jeffrey
Cain
PSE

Optical Design: Considerations

Reliability

The reliability of the optical design is integral to the project functioning as intended.

Durability

Must be durable enough to not lose alignment when playing the game.

Safety

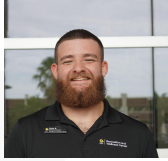
3R lasers will be utilized, so it is important to consider health risks.

Signal Integrity

A constant reliable signal to avoid false trips is a must.

Cost

We want the table to be competitive with other market products, so cost-effective optics will be utilized.



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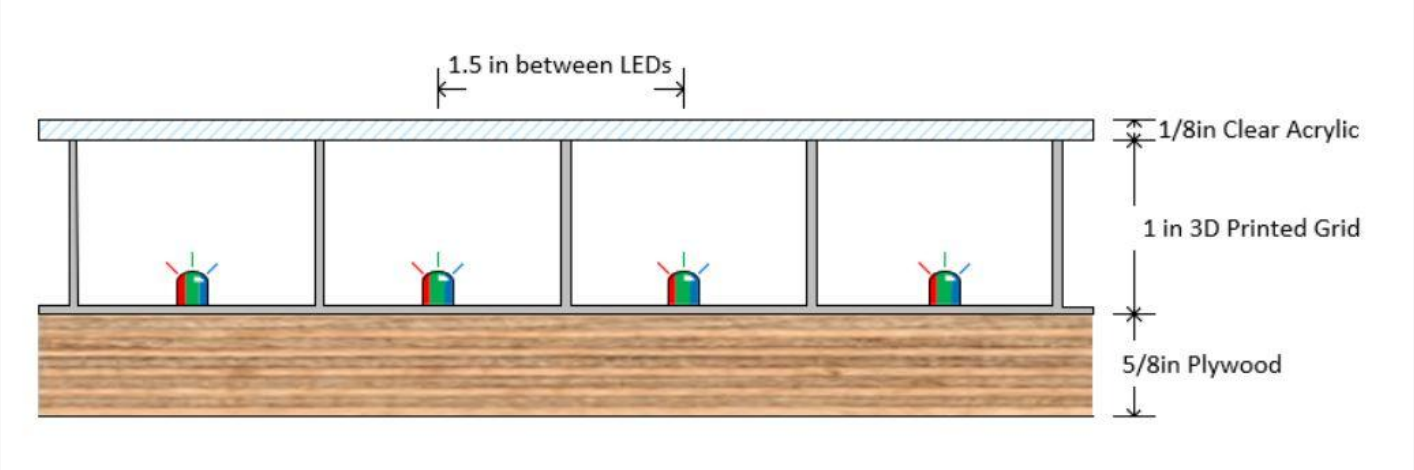
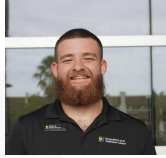
LED Display Cross Section





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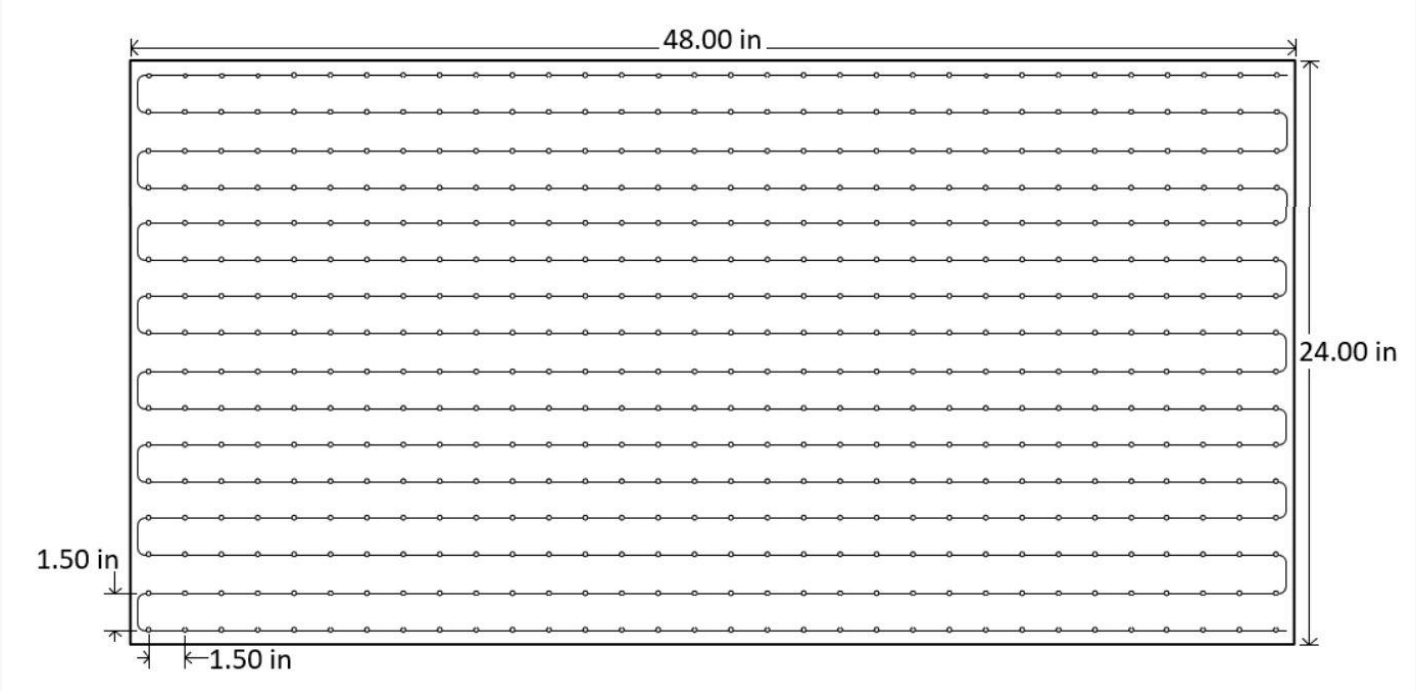
LED Strip Layout



Power Supply: Wiring Diagram

Kyle
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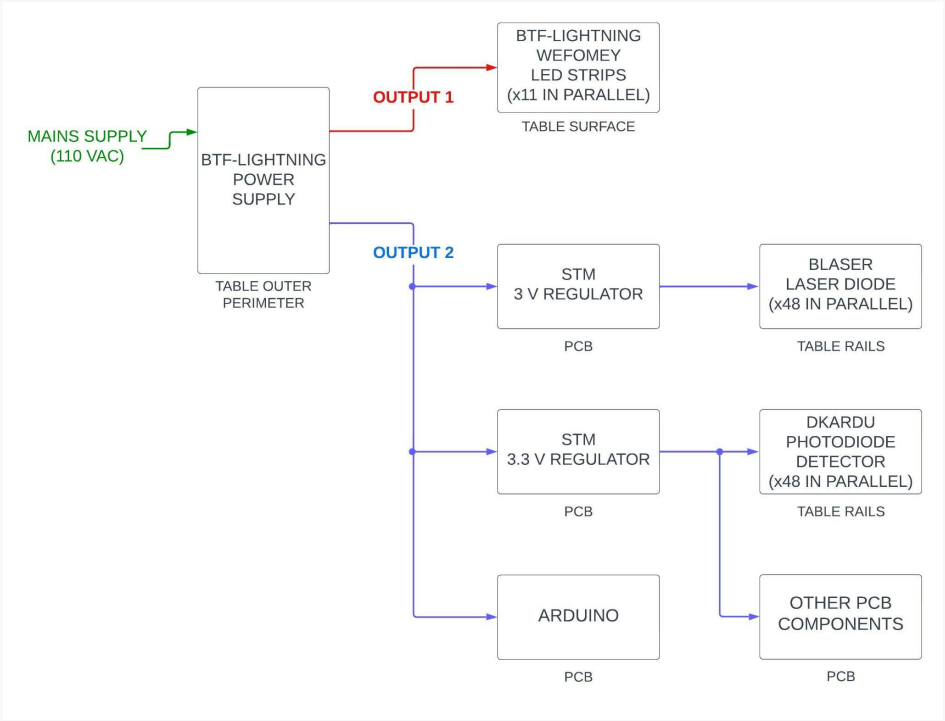
ECE



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Power Supply: Power Schedule

Device	Operating Voltage (V)	Current Draw (A)	Power Consumption (W)
BTF-LIGHTNING Wefomey LEDs (x512)	5.0	0.030 (per LED) 15.36 (for 512 LEDs)	76.800
Blaser Laser Diode (x48)	3.0	0.100 (per Module) 4.800 (for 48 Modules)	14.400
DKARDU Laser Receiver (x48)	3.3	0.015 (per Module) 0.720 (for 48 Modules)	2.376
STMicroelectronics Microcontroller	3.3	0.120	0.396
	Totals:	21.00	93.972

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ECE

Power Supply: Final Checks

Do our requirements fit within the power supply's specifications?

Supply Specs:

30 Amps

Max Current Output

150 Watts

Max Power Output

Requirements:

21 Amps

Estimated Current Draw

93.9 Watts

Estimated Power Consumption

Yes!

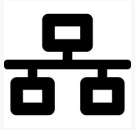
Design Software

Software Design: Considerations

Michael
Dodd
CPE

Reliability

Software works properly all the time.



Communication

MCU, LEDs, Laser Receivers, Microphone

Accessibility

Software is easy to use for all.

Speed

Software must track ball quickly.

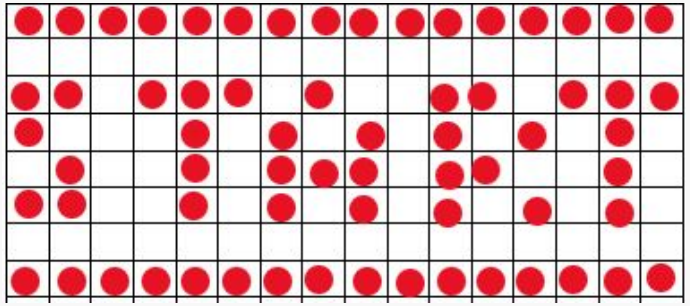
Efficiency

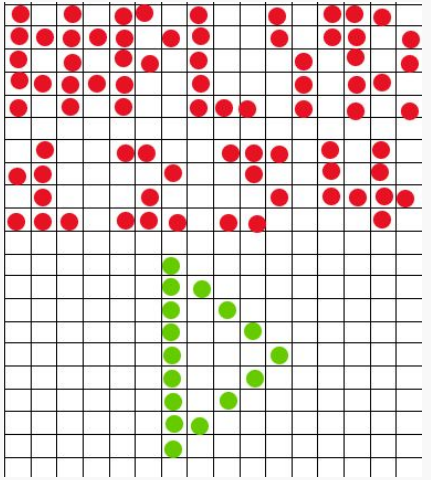
Small interface, use all space efficiently.

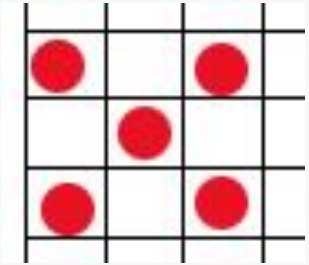
Accuracy

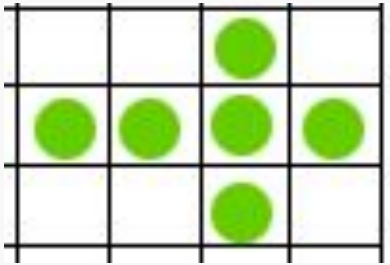
Software must accurately track ball.

User Interface









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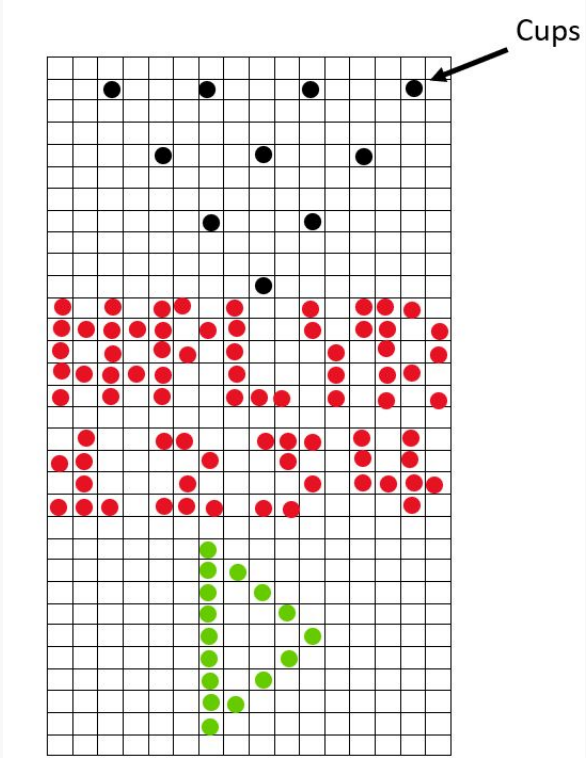
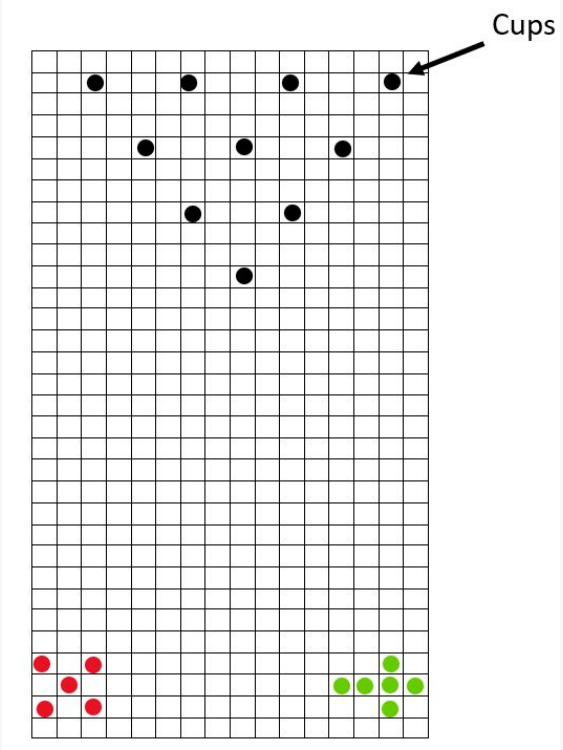
User Interface





Michael Dodd
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Software Design Function

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Dodd
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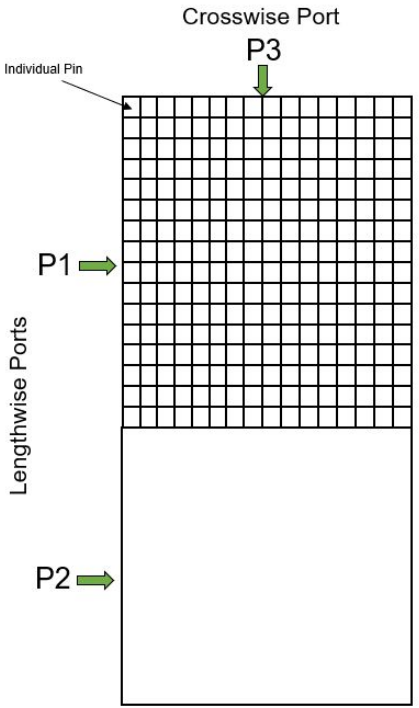
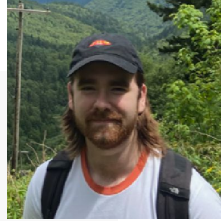


Software Block Diagram



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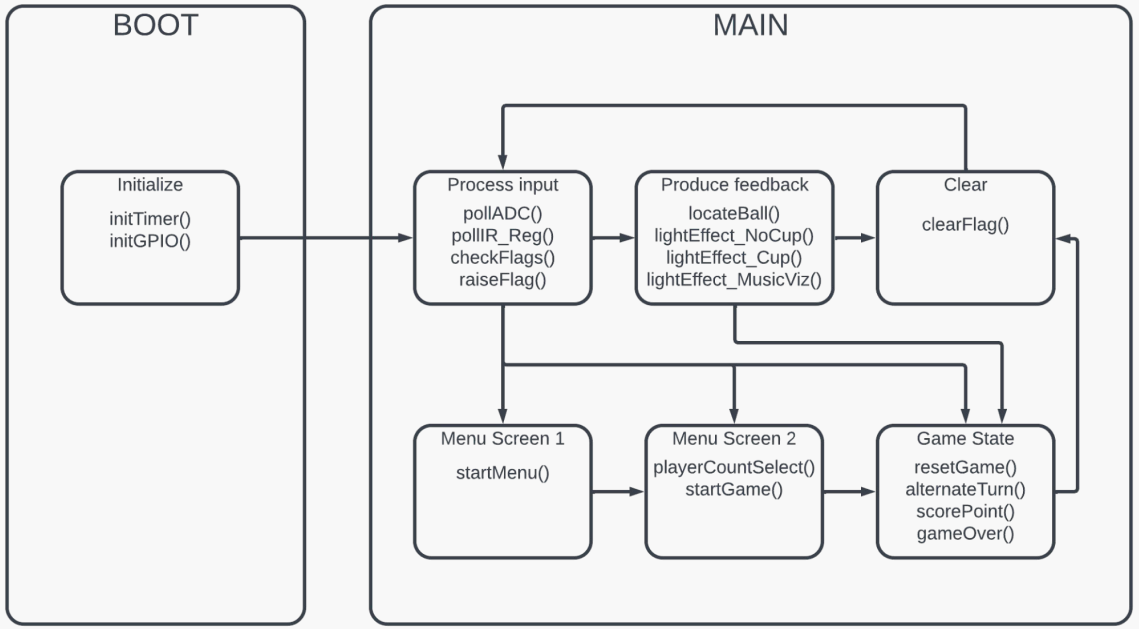

Design

PCB

Sean
McElvogue
CPE

Lazer Pong SD PCB

GPIO Connections

J1 Conn_02x13_Odd_Even — J2 Conn_02x13_Odd_Even

DBUS in from optical sensors

Power Devices

U2 LDL1117S30R — U3 LDL1117S33R

J3 Screw_Terminal_01x02 (VBUS) — J4 Screw_Terminal_01x02 — J5 Screw_Terminal_01x02

D1 LED — R1 1k — D2 LED — R2 1k

VBUS/GND from off-board PSU (nom. +5V/0V)
Min. 1uF in/out decoup. cap. (4.7uF output sug.)
3V out for lasers, 3.3V out for photoreceivers

1x100nF per VDD pin + 1x4.7uF bulk

VDDA filtering

U1 STM32F205VC1x

J7 Conn_01x05_Pin — SPI_NSS, SPI_CLK, MISO, MOSI

R3 2.2k — MK1 CMC-2742PBJ-A — C17 1u — MIC_OUT

J6 Conn_01x04_Pin — SWDIO, SWCLK

Mounting Holes

H1 MountingHole
H2 MountingHole
H3 MountingHole
H4 MountingHole

University of Central Florida
Sheet: /
File: SD_Lazer_Pong.kicad_sch
Title: Lazer Pong SD PCB
Size: A4 | Date: 2023-10-02 | Rev: 0.1
KiCad E.D.A. eeschema 7.0.9 | Id: 1/1

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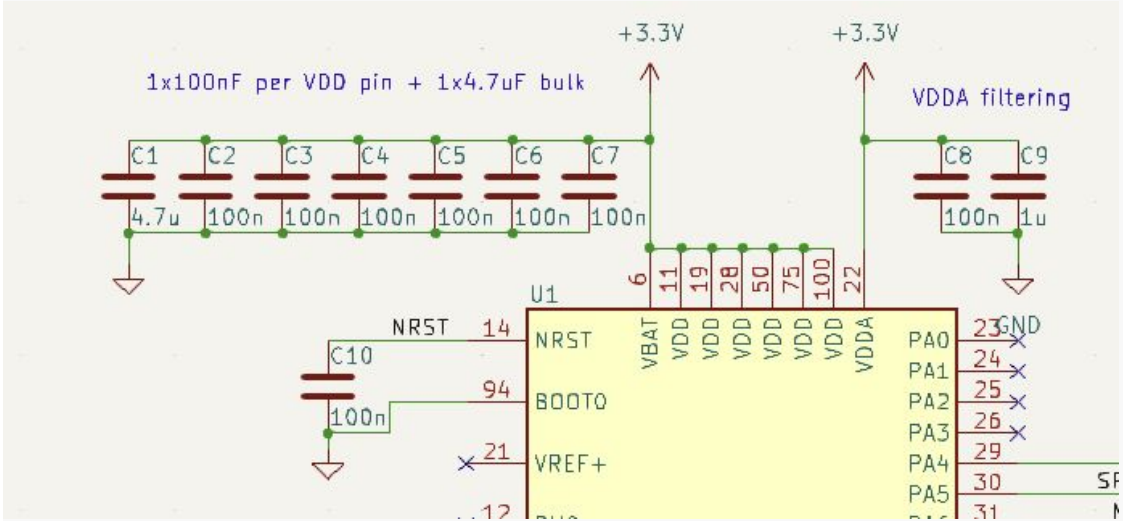
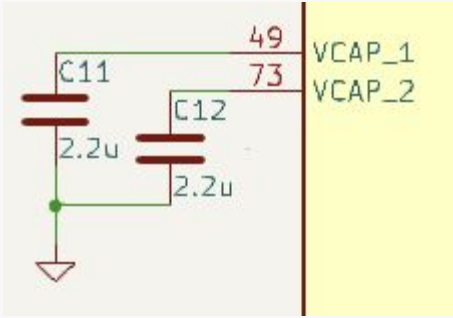
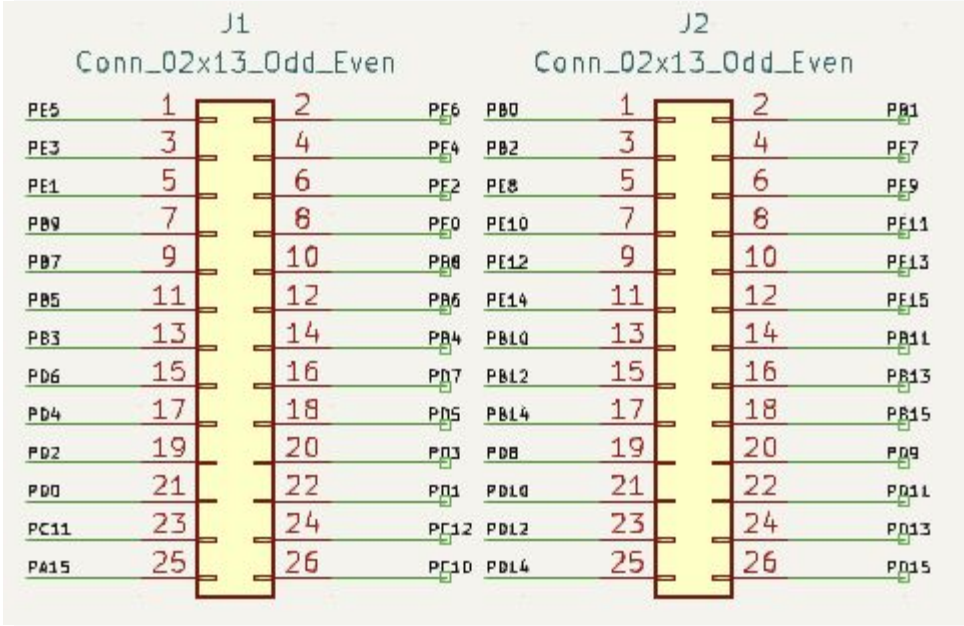
Microcontroller Enable

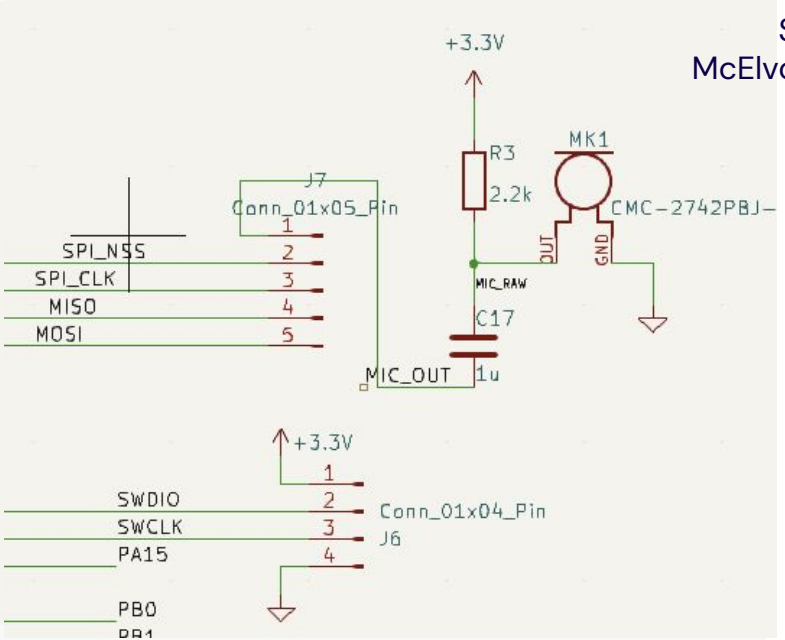




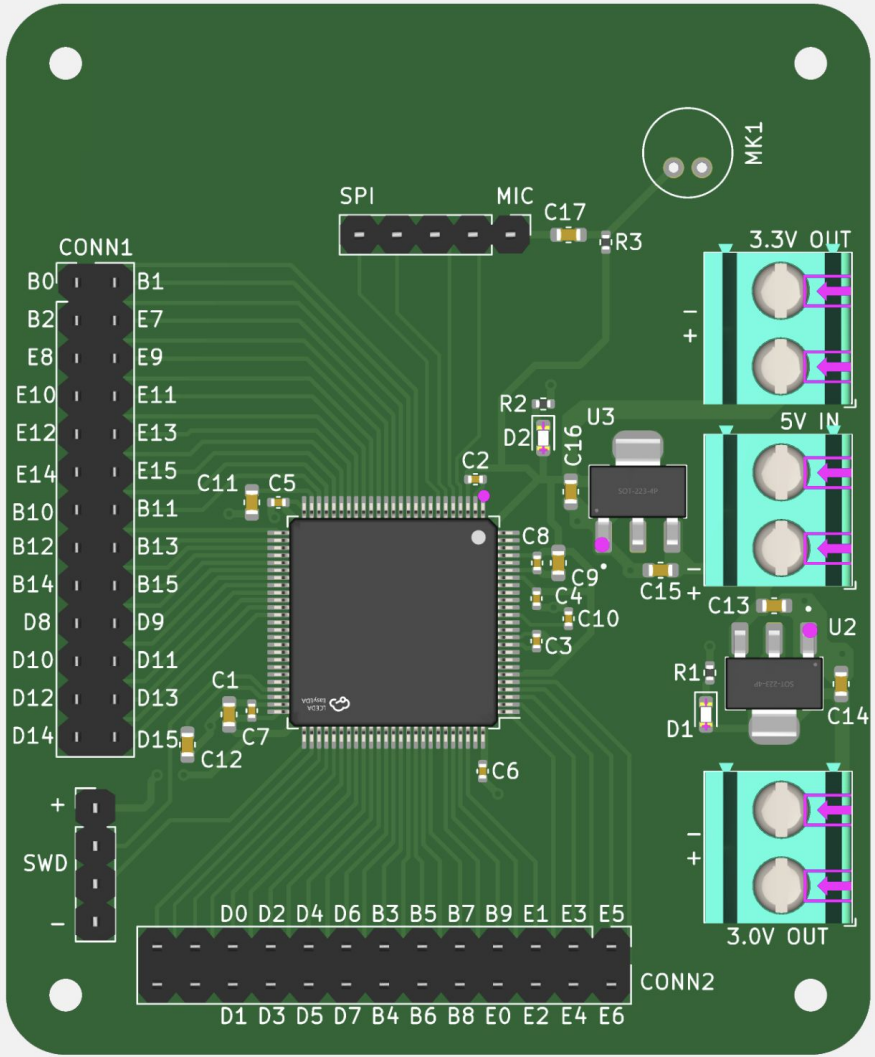
Inputs and Outputs

Sean
McElvogue
CPE





PCB Final Version



Sean McElvogue CPE

Administrative Content

Budget

Item Description	Budget	Final Cost
Photoelectric Tx/Rx Device	$250	$200
LED strip	$100	$120
Table Construction Materials	$200	$200
Microcontroller	$30	$400
PCB/Misc Electronics	$150	
Total	$730	$920

Sean McElvogue
CPE

Division of Labor

- Matthew Brislenn
  - Surface Display Design
  - Surface Display Construction
  - Laser Alignment
- Jeffrey Cain
  - Laser Grid Design
  - Laser Grid Assembly
  - Laser Alignment
- Michael Dodd
  - Software Design
  - Graphics Design
  - STM32/PCB Programming
  - Arduino Programming
- Kyle Fallejo
  - Power Schedule Assessment
  - Power Design
  - Voltage Regulation Design
  - Video Editing (presentations and demos)
  - Website Management
- Sean McElvogue
  - Project Management
  - PCB Design
  - Prototype Construction
  - Bring-up Arduino Programming
  - Assistance with STM32/PCB Programming

Sean McElvogue CPE

Thanks!

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