Boxing Buddy

Group 15

Nicholas Ebert

Electrical

Catherine Sailor

Mechanical

Sabrina Mead

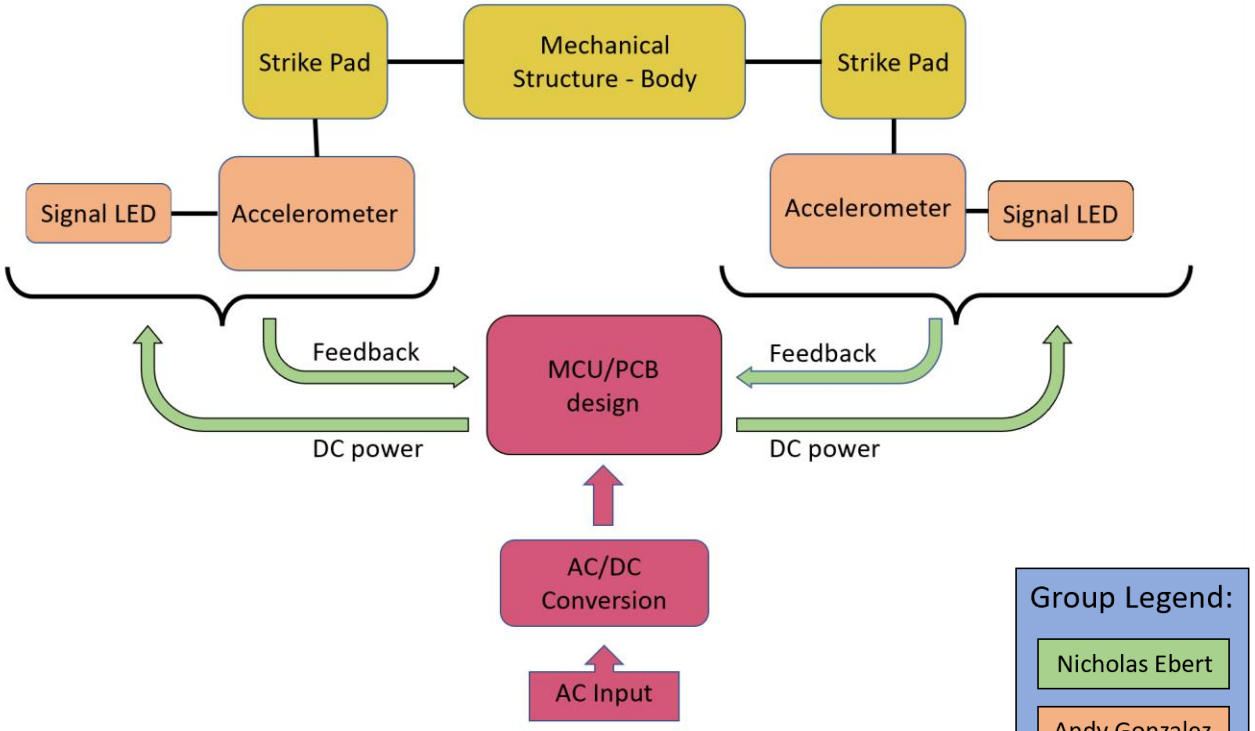
Electrical

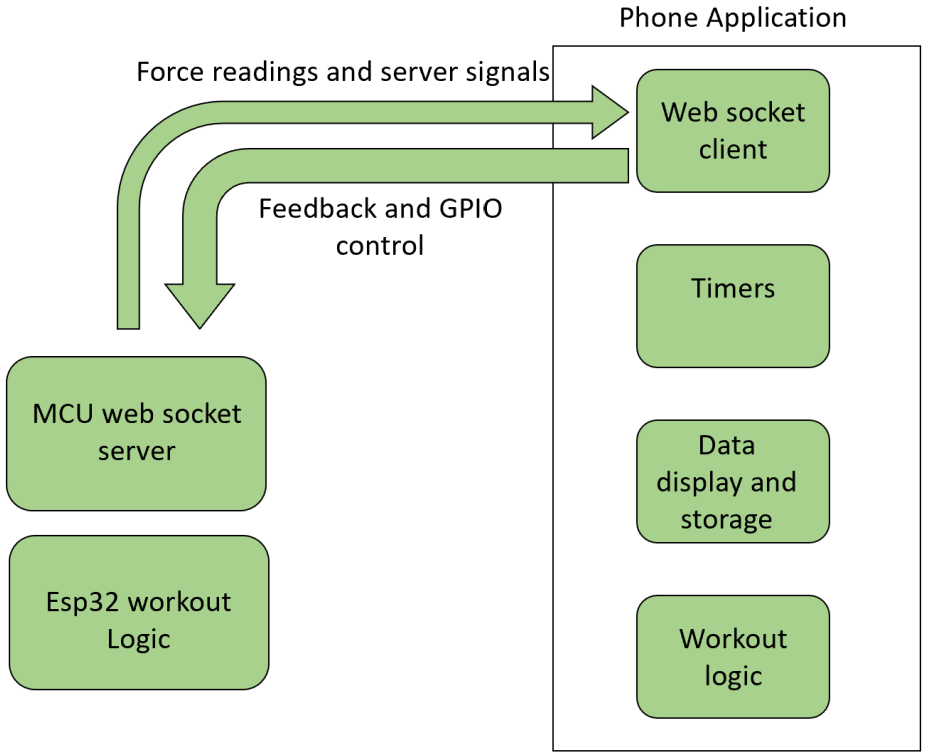
Andy Gonzalez

Electrical

Block Diagrams

Nick, EE



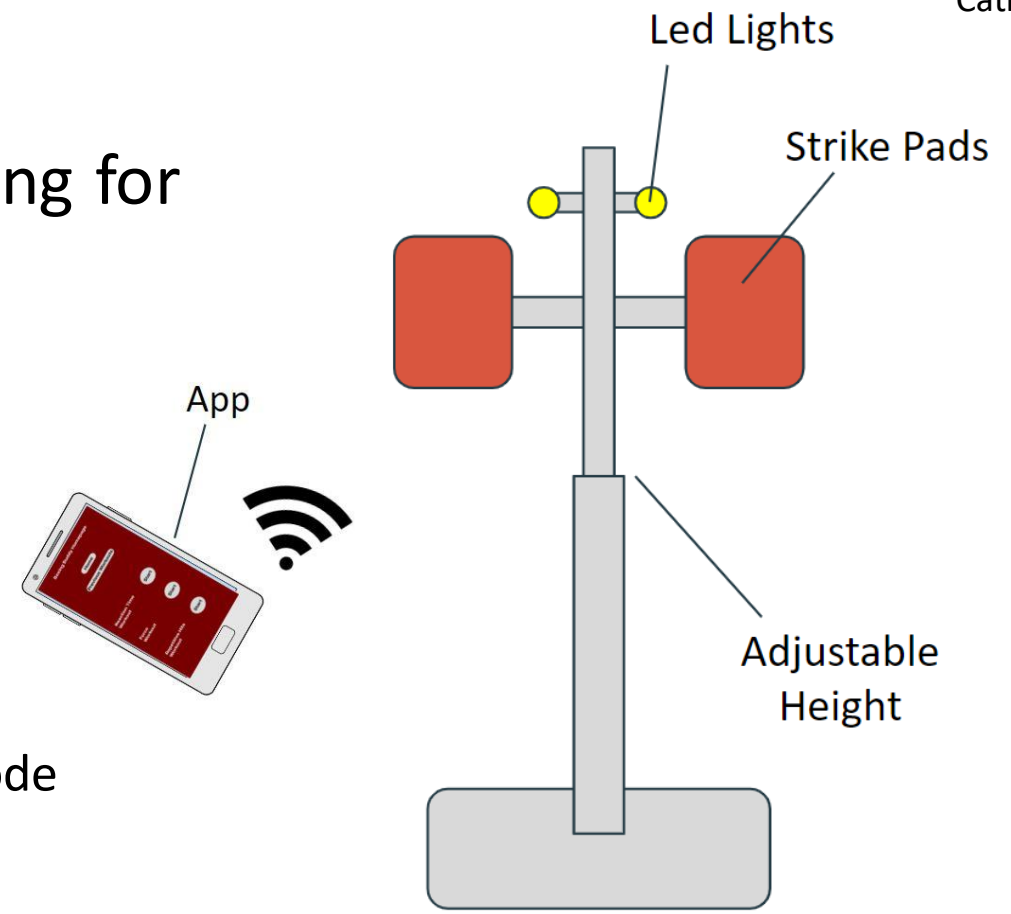


Catherine, ME

Objectives & Design Goals

- Provide affordable live feedback training for boxing

- Design Goals
  - 2 strike pads with accelerometers
  - Interactive User App
  - 2 Training Workout Options with live feedback
  - LED Light used for reaction time and training mode
  - Durable structure with an adjustable height



Design Constraints

Andy, EE

Type	Standard/Constraint
Economic	•Self funded
Time	•Two Semesters •Juggling work and school with project
PCB Standards	•IPC Standards: IPC-2221 generic design, IPC-2223 flexible/rigid boards, IPC-7801 Reflow Oven
Manufacturing	•Limitations of available machinery
Sustainability	•Dependability and reliably working
WiFi	•802.11
Power	•ANSI wall outlet

Project Management

Catherine, ME

Discord

Texting

Lab Meetings 3 times a week

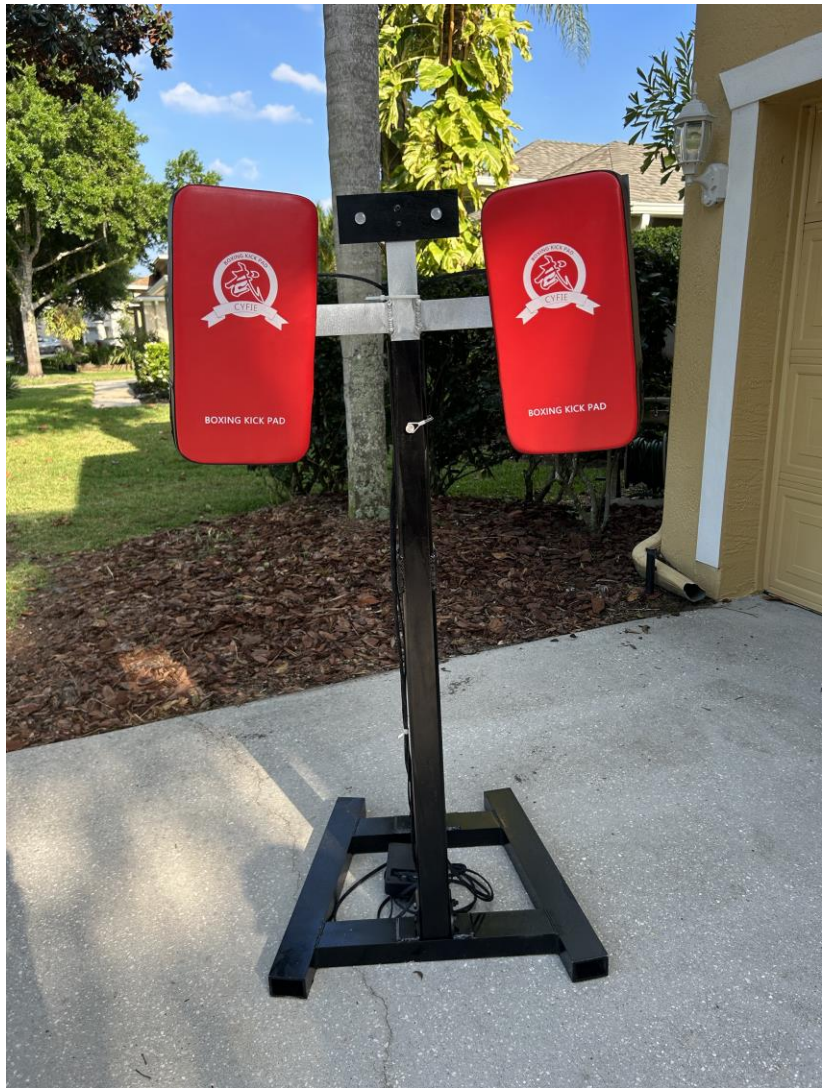
Specifications


Sabrina, EE

	Description	Requirement
1	The system should measure the reaction time accurately.	>= 80%
	The system should measure the force accurately.	>= 80%
2	The structure of the Boxing Buddy should be adjustable and reach a tall maximum height.	>= 6' max height and >= 1' of adjustable height
	The spring should allow enough movement for the accelerometer to get a reading.	Spring constant <= 30lbs/in
	Startup time for application and device will be minimal.	<= 10 seconds
3	The mobile application should receive and display input data from the esp32 in a short time.	<= 5 seconds
	Each strike pad should have LED indicators that flash when prompted by the app with minimal delay.	<= 5 seconds

Catherine, ME

Mechanical Structure



Mechanical Designs Changes

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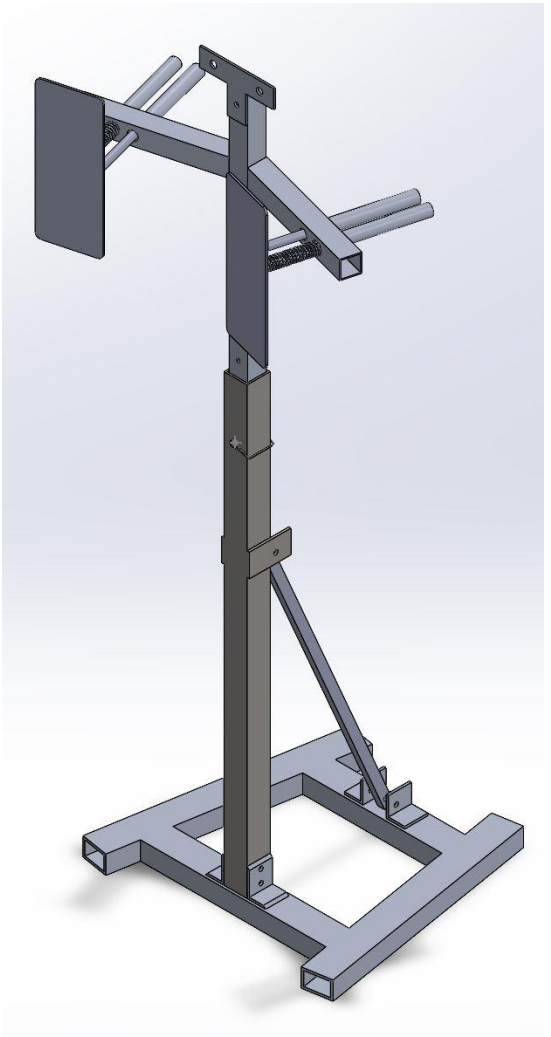
Initial Design

Final Design



Catherine, ME

Strike Pads

- Proper material and thickness for boxing
- Larger surface area for larger strike zone
- Adjustable straps for easy attachment and replacement

Catherine, ME

Springs

- Spring constant ~22lbs/in to allow movement
- Diameter large enough to fit rod and around hole
- Closed and ground ends to sit flat against other parts

Catherine, ME

Structure

- Steel and aluminum
  - Make the structure heavier
  - Stronger material
- Free materials used to lower cost
- Wire-lock clevis pin with tab for telescoping tubes
  - Latches to keep secure
  - Easily unlatched by hand
  - Made of steel to prevent damage

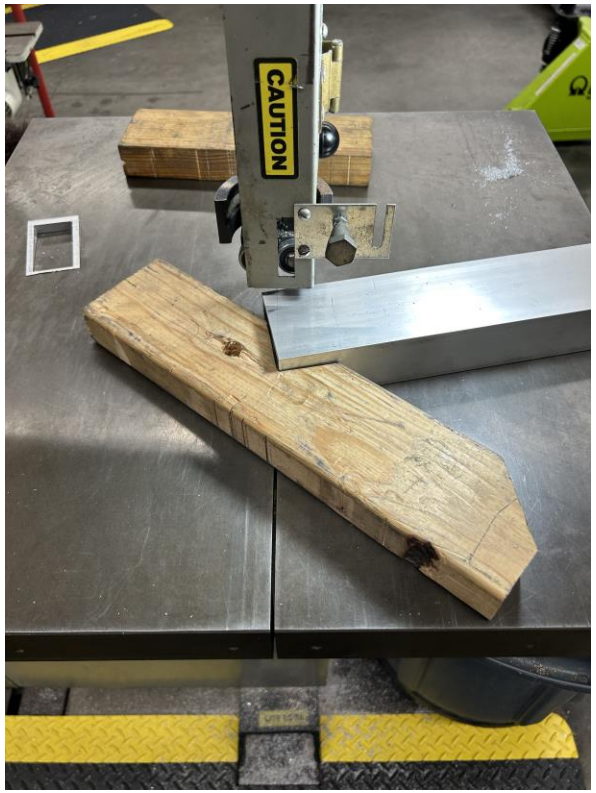
Catherine, ME

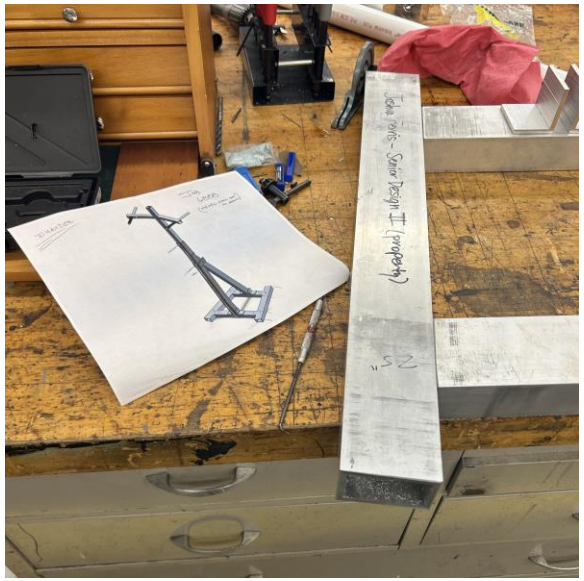
Pad Holder Attachment

- Rod allows for attachment with movement
- Washer holds everything in place, while allowing for movement
- Second rod prevents rotation
- Spring compressed 3/8" to stay in place

Machining

Catherine, ME





Force Sensing

Andy, EE

- Cost
- Size
- Durability
- Measurable Force

Sensor Type	Cost	Measurable Force
Piezoelectric sensor	$10-$15 per pack of 8	~65 lbs
Accelerometer	$25.84 per unit	+/- 200g
Button Load Cell	~$350.00 per unit	2000 lbs of force.

Accelerometer (ADXL377)

- How each pin works
- 3.3 V
- Only using the Z axis for our application
- Self test pin (ST)
- Mounted on the back of the pad

Andy, EE

Measuring the Force

Andy, EE

- The accelerometer outputs a number between 0 and 4095
- A scale is then used to output g's
- g's are turned to meters per second squared
- Mass is calculated and inputted as a variable
- Finally, we divide by 0.225 to get the final calculation in pounds of force

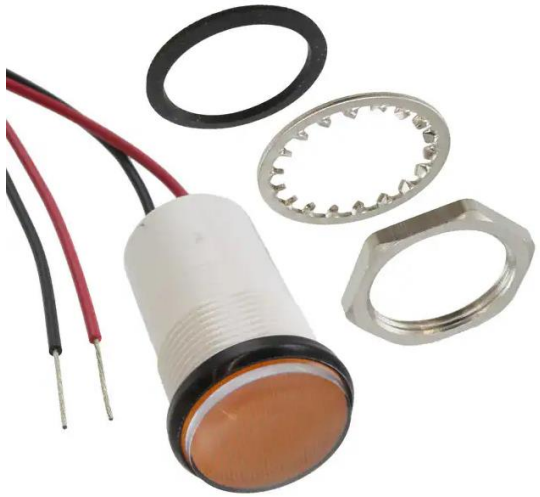
Reaction time

Andy, EE

- This is implemented by visual representation
- Choosing the Reaction type workout will prompt an LED light to turn on after a random time
- Time will be measured between when the LED lit up and when the pad was struck

LEDs

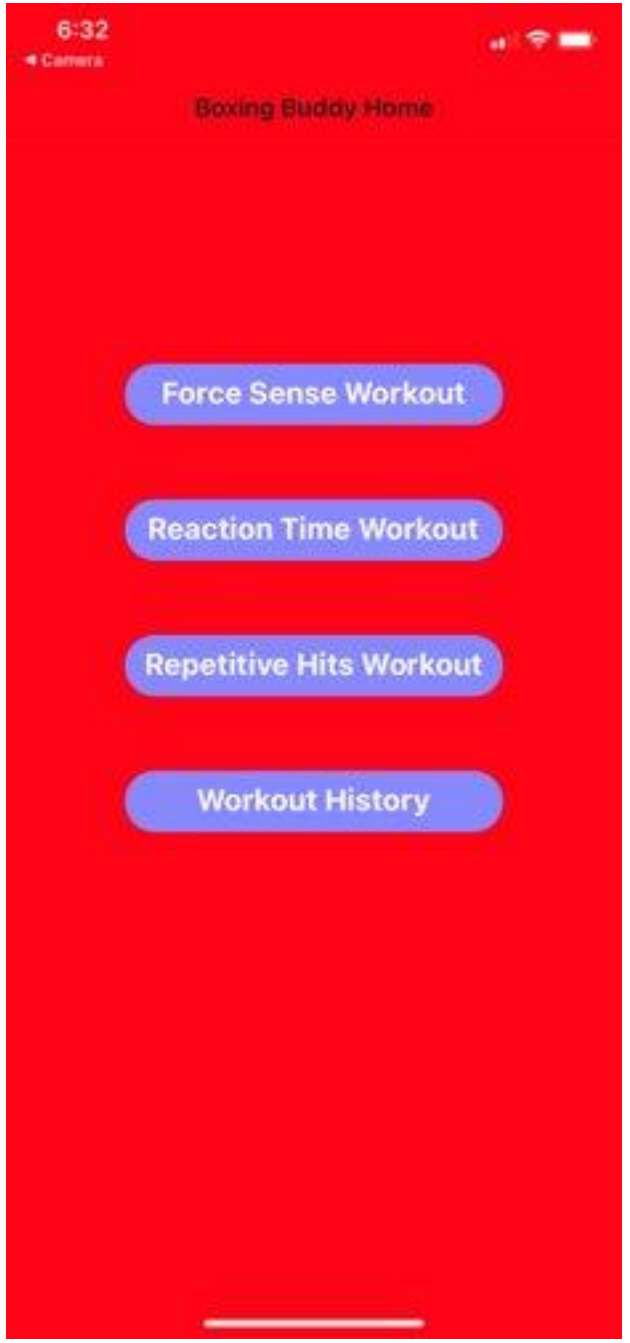
- Requires 5V
- Brighter than traditional small LEDs



Andy, EE

LED	Price	Size
Pre-wired Light	$9.99 @ 12 pcs	3mm round top bulb
Indicator Light	$18 @ 1 pc	17.5mm diameter

Software Design



Nick, EE

4 Types of Mobile Applications

Nick, EE

Type of Application	Main Advantage	Main Disadvantage
Native	More user friendly and gives increased access to OS and platform specific tools on a device.	Lower accessibility
Hybrid	Much more accessible. Android and Apple users both can use it.	Slower and more limited access to OS and platform specific tools on a device.
"Drag and Drop"	Speed of development and easy to learn.	Poor customization and limited uses. Not very complex.
Web Application	Quicker to develop than Native and Hybrid and very adaptable to changes.	Limited functionality and nonnative feel, that is, poor user friendliness.

Mobile App Framework Selection

Nick, EE

Framework	Languages	Main use and Benefits
Ionic	JavaScript, CSS, HTML	Primarily used for web-based applications that exist both on mobile devices and on the internet.
React Native	JavaScript	Hybrid mobile application development with great user friendliness from native tools.
Flutter	Dart	Hybrid mobile application with higher degrees of control and precision.
Xamarin	C#, .NET, and Swift	Hybrid mobile application development.

Mobile Application Original Structure Vs. Current Structure

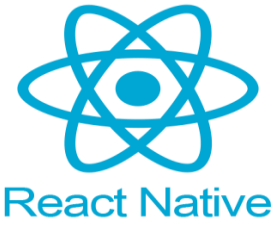
Nick, EE

ESP32-WROOM-32E

Wi-Fi
802.11

AWS
Database

AWS Amplify
API

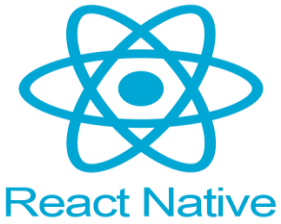


React + JavaScript

Mobile
Device

ESP32-WROOM-32E

Wi-Fi
802.11



React + JavaScript

Mobile
Device

How the Current Structure Works

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Server

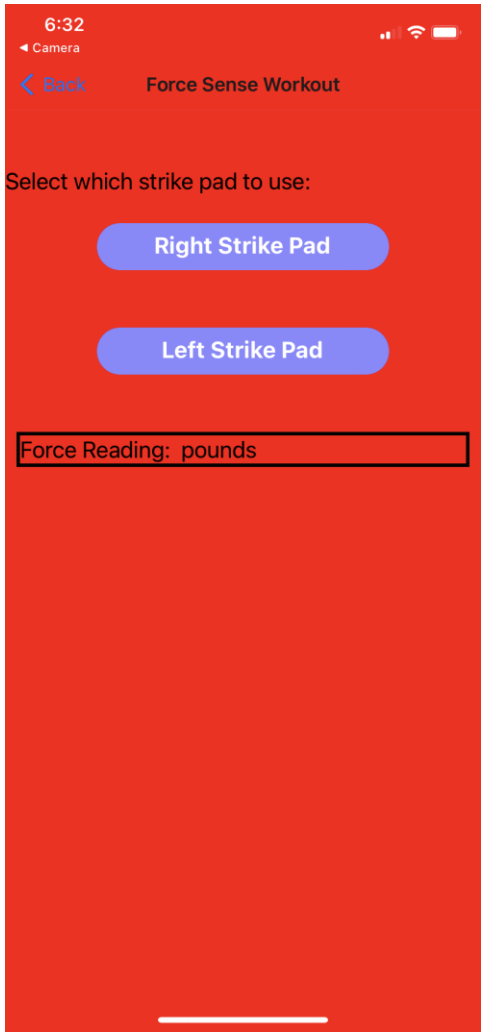
ESP32-WROOM-32E

Force Sense Socket

Reaction time socket

Client 1

Client 2



How We Run the App

Nick, EE

Expo Go

QR code (not our actual QR code)

Mobile Device

Workout Logic Design – Filtering

Nick, EE

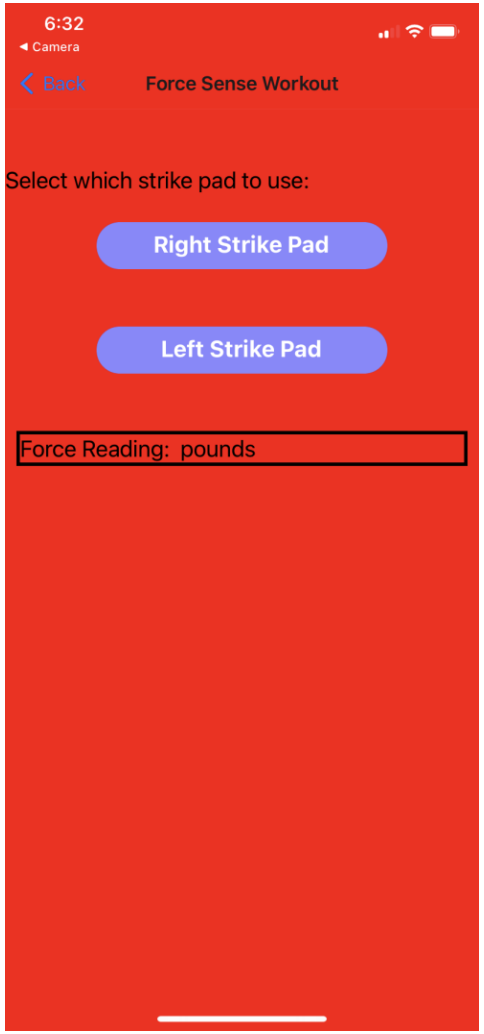
- ESP32 has ADC connected to two accelerometers
  - There is a noise issue
  - Digital filter (exponentially weighted moving average)
    - CurAvg = lastAvg(weight) - rawValue(1 – weight)
  - Use filtered values for threshold
  - Display unfiltered data

ESP32-WROOM-32E

Workout Logic Design – Force Sense Workout

- Select which strike pad to use
- LED lights up
- Force is displayed after hitting the pad
- Continue to workout as desired.
- Problems – Threshold is high

Nick, EE



Workout Logic Design – Reaction Time

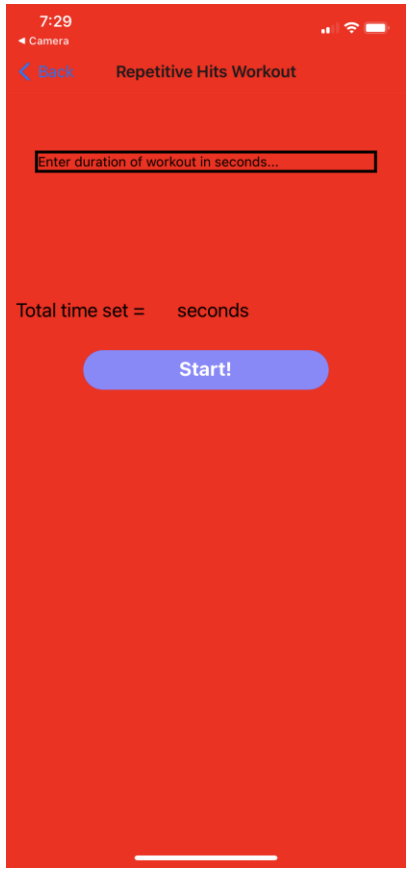
Nick, EE

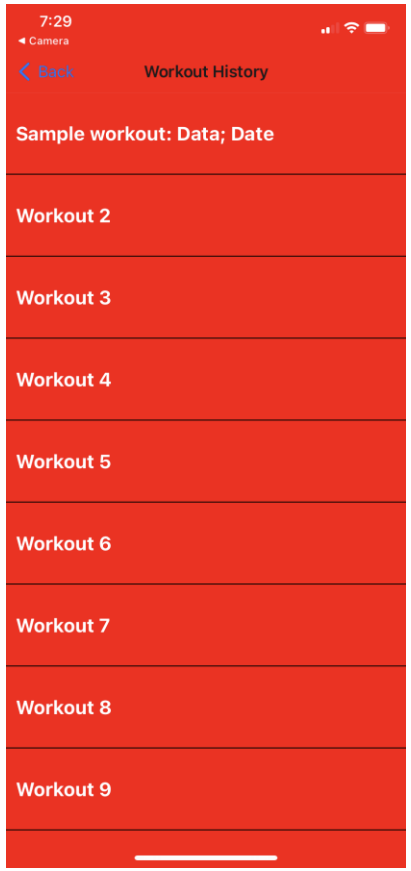
- Pressing "Start" starts a random delay up to 8 seconds.
- One of the indicator lights will turn on at random after the delay
- The user strikes the pad
- Reaction time is displayed

Difficulties

Nick, EE

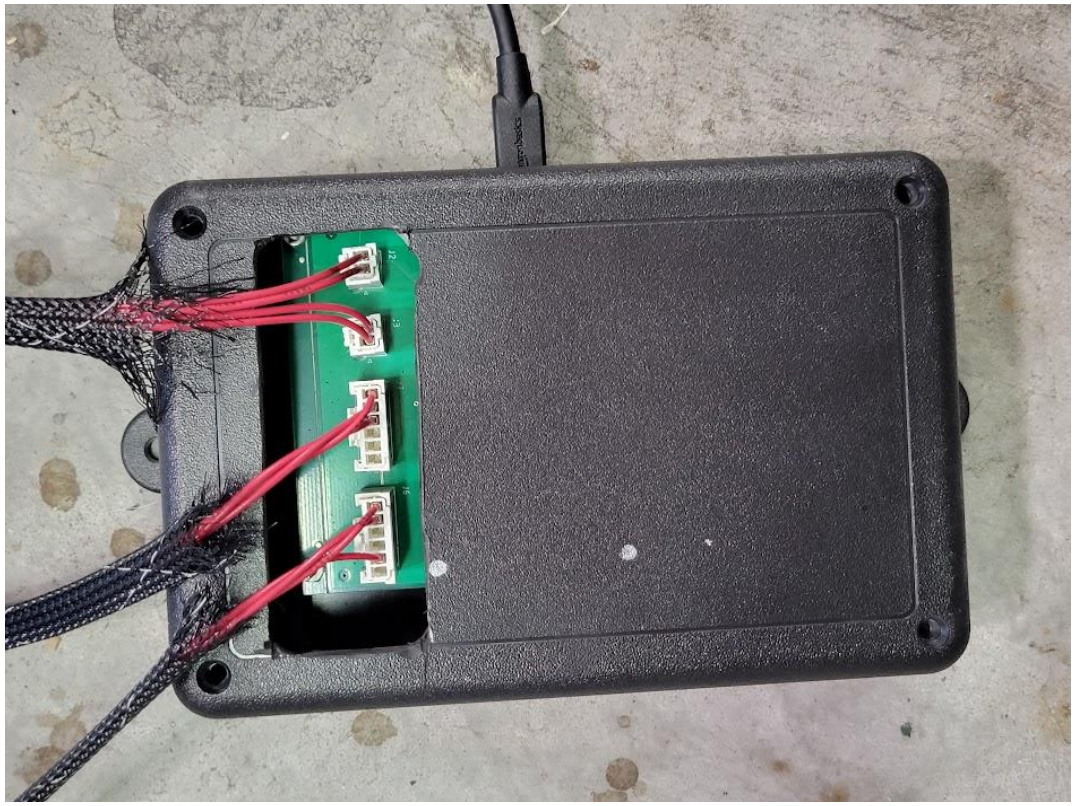
- Repetitive Hits Workout
- Hitting the strike pad correctly
- Saving workout data on the app.





PCB Design

Sabrina, EE



Parts Selection PCB


Sabrina, EE

- Functionalities Needed:
  - Voltage Regulation
  - USB to Serial Capabilities
  - Wifi Communication
  - Sensor/LED Connectors
  - Power Intake
  - Analog to Digital

- MCU Selection

	ESP32-WROOM	ATMEGA2560
Operating Voltage	2.3 - 3.6 V	5 V
Digital I/O Pins	21	54
Analog Input Pins	13	16
DC current per I/O pin	80 mA	40 mA
Wifi Capabilities	Capable	Not Capable

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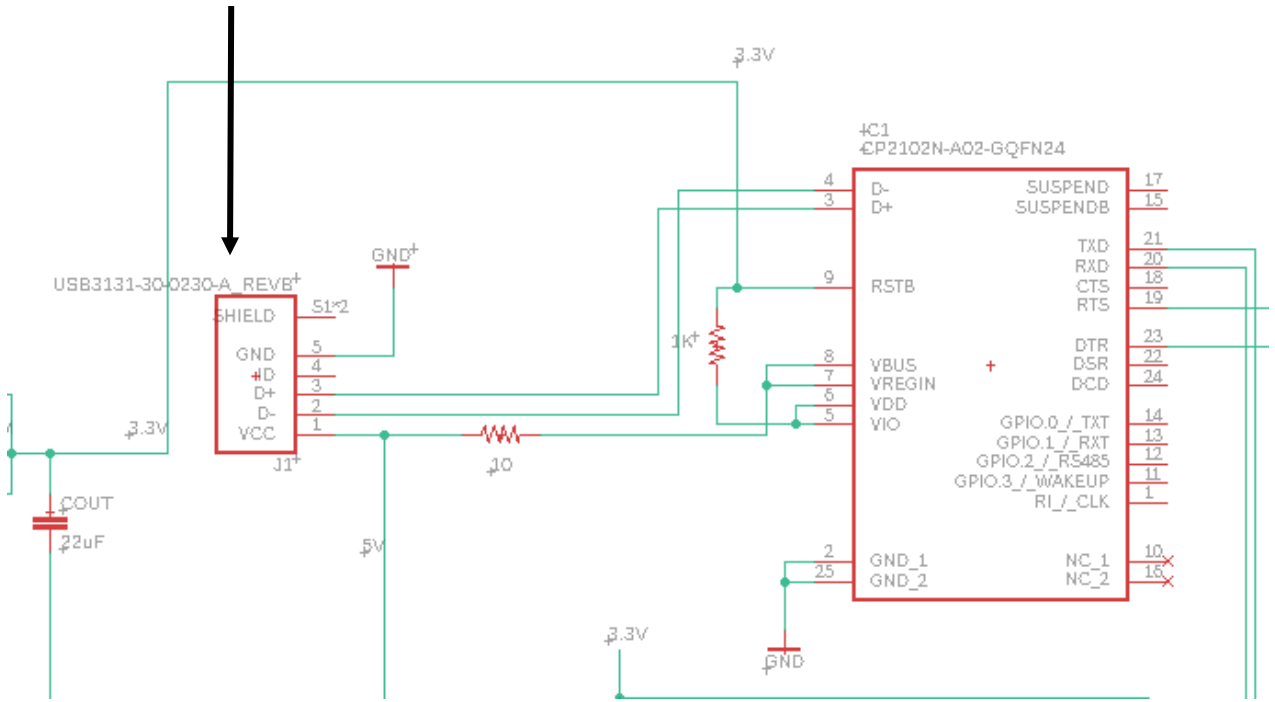
Power Intake

- Input into Circuit: 5V DC
- From Wall plug using AC to DC converter

USB micro B connector



Initial Voltage Regulation

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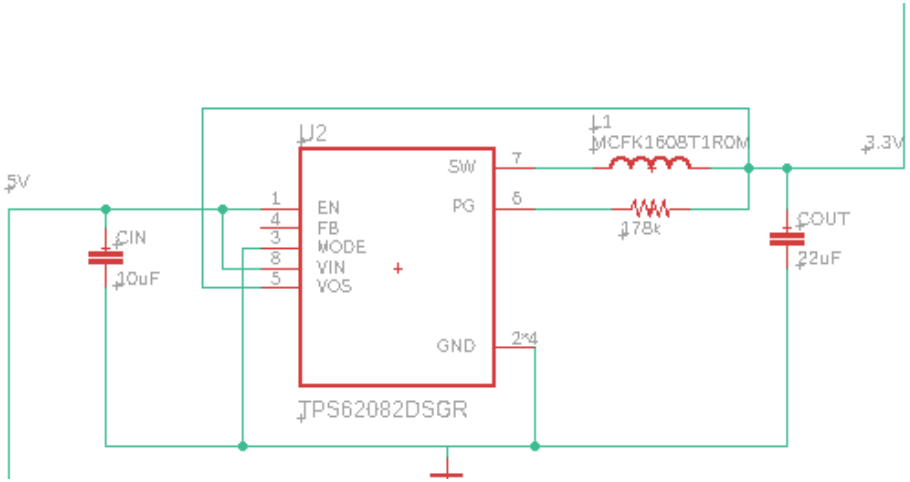
5V to 3.3V



Summary

Efficiency:	92.7%
BOM Cost:	$2.34
Footprint:	76 mm²

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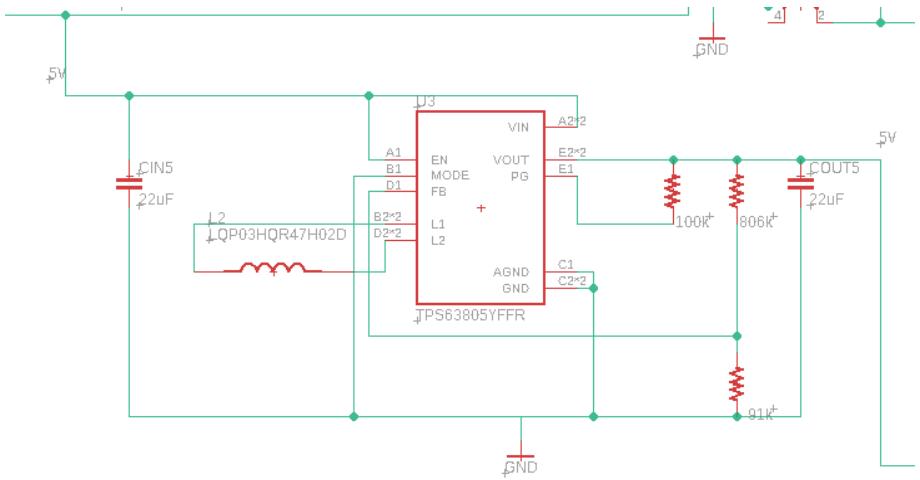
5V to 5V

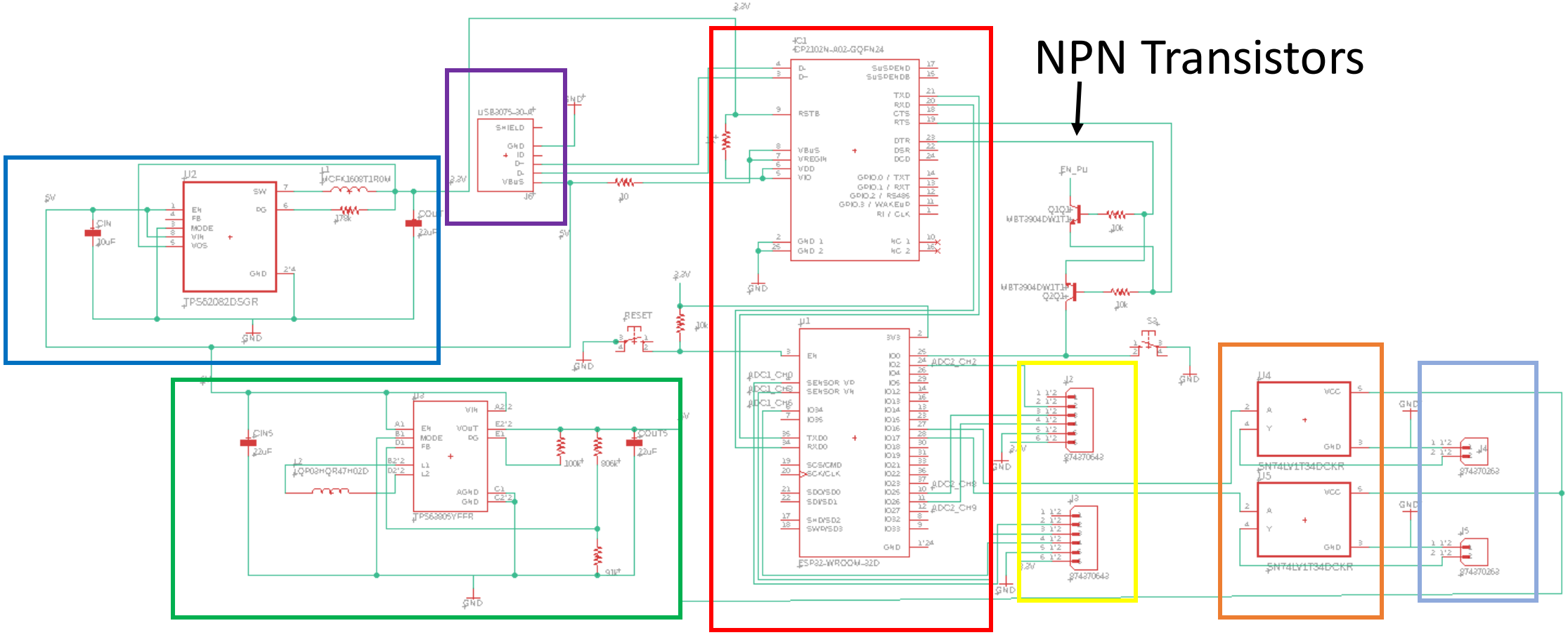


Summary

Efficiency:	95.1%
BOM Cost:	$1.73
Footprint:	61 mm²

PCB Version 1

Sabrina, EE

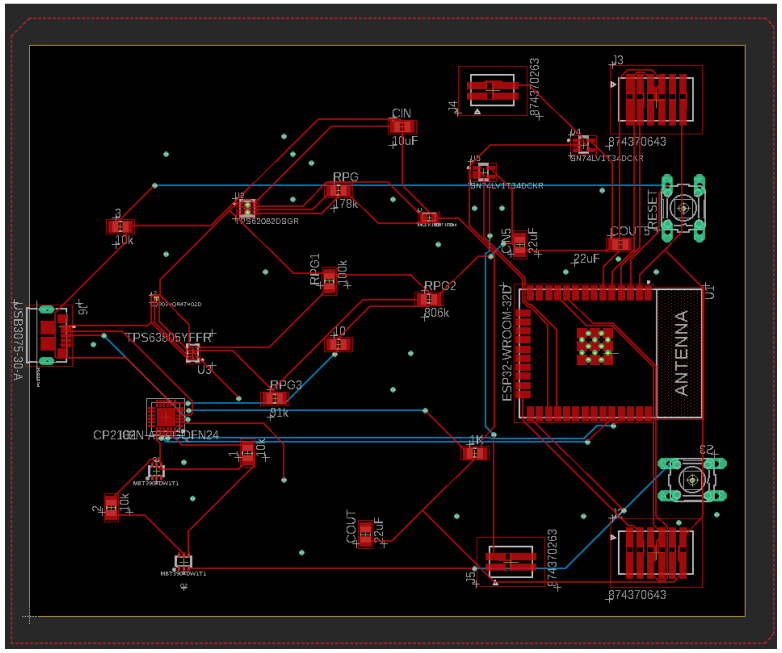


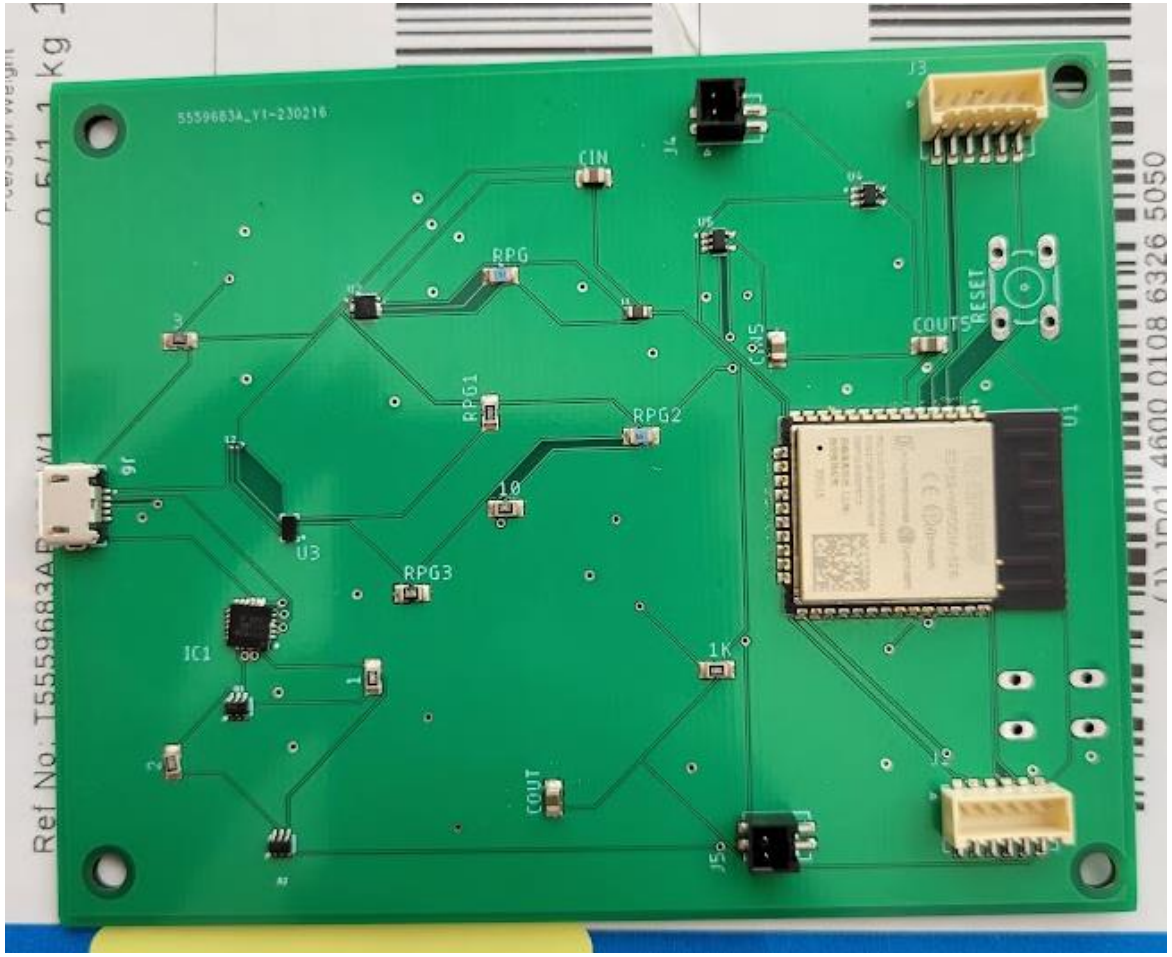
PCB Board 1

Worked	Did not Work
5 V regulator	3.3 V regulator

Sabrina, EE

- Main Issues:
  - Parts Selection
  - Soldering Error

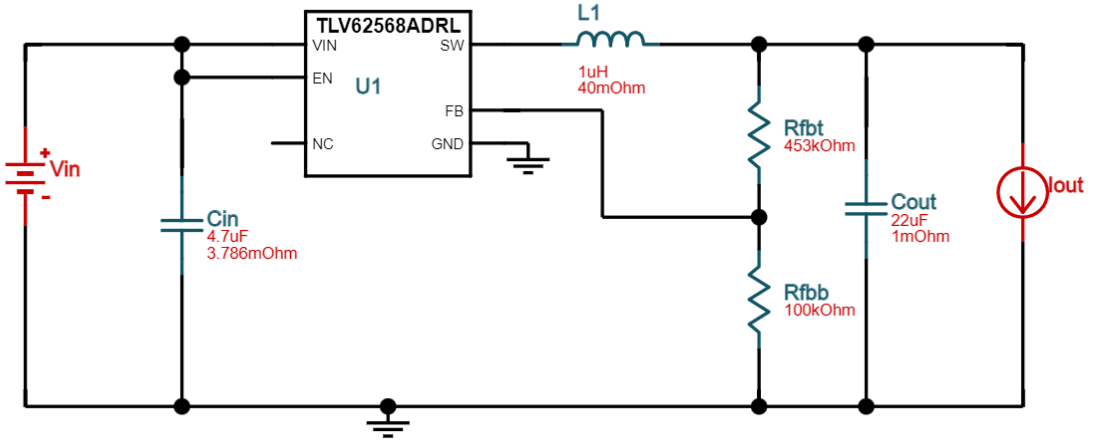




Updated Voltage Regulator Circuits

Sabrina, EE

5V to 3.3V



Summary

Efficiency:	94.2%
BOM Cost:	$0.39
Footprint:	44 mm²

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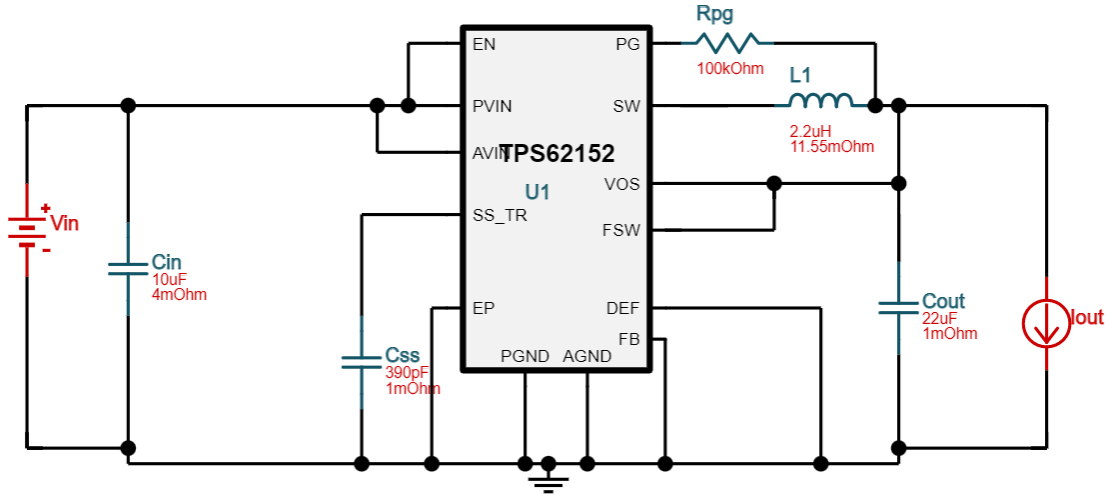
5V to 5V



Summary

Efficiency:	95.4%
BOM Cost:	$2.22
Footprint:	110 mm²

Final PCB Schematic

Sabrina, EE

Serial Connection and MCU

5 V Power Intake from wall

5 V to 3.3 V regulator

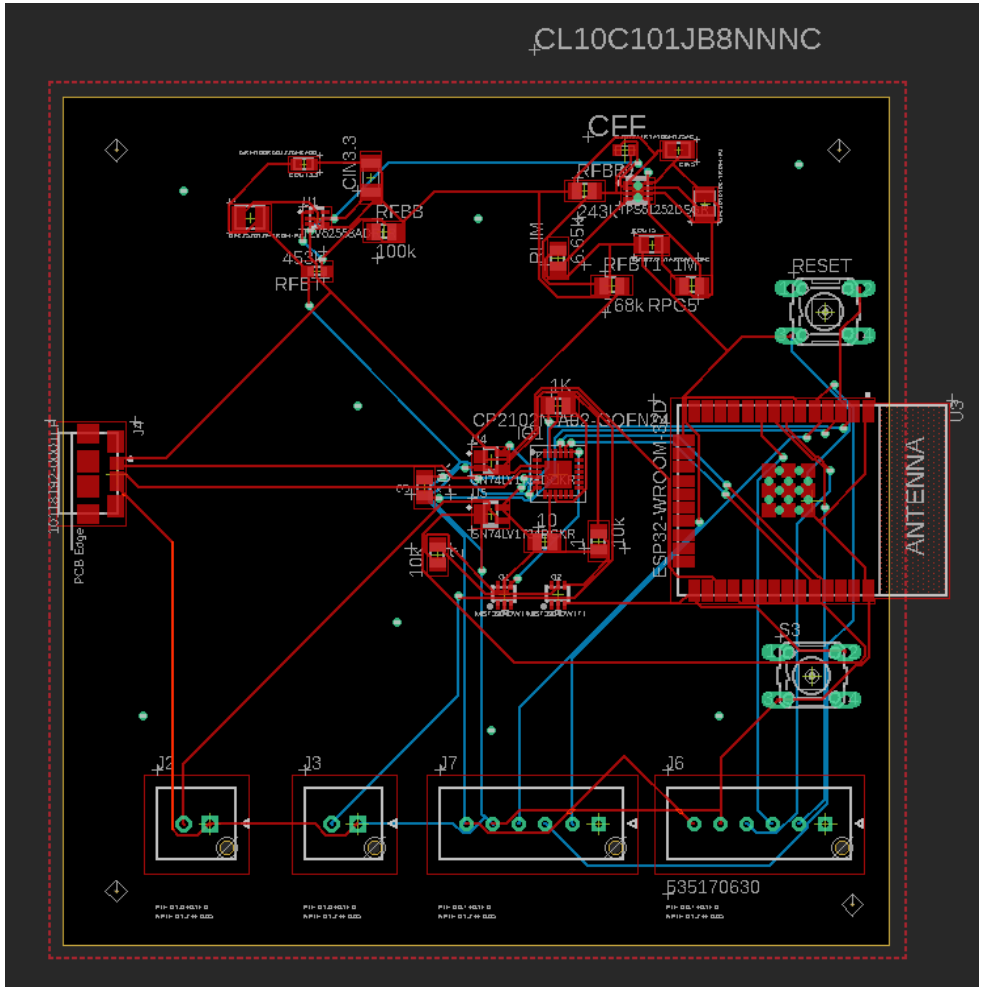
Voltage Shifter

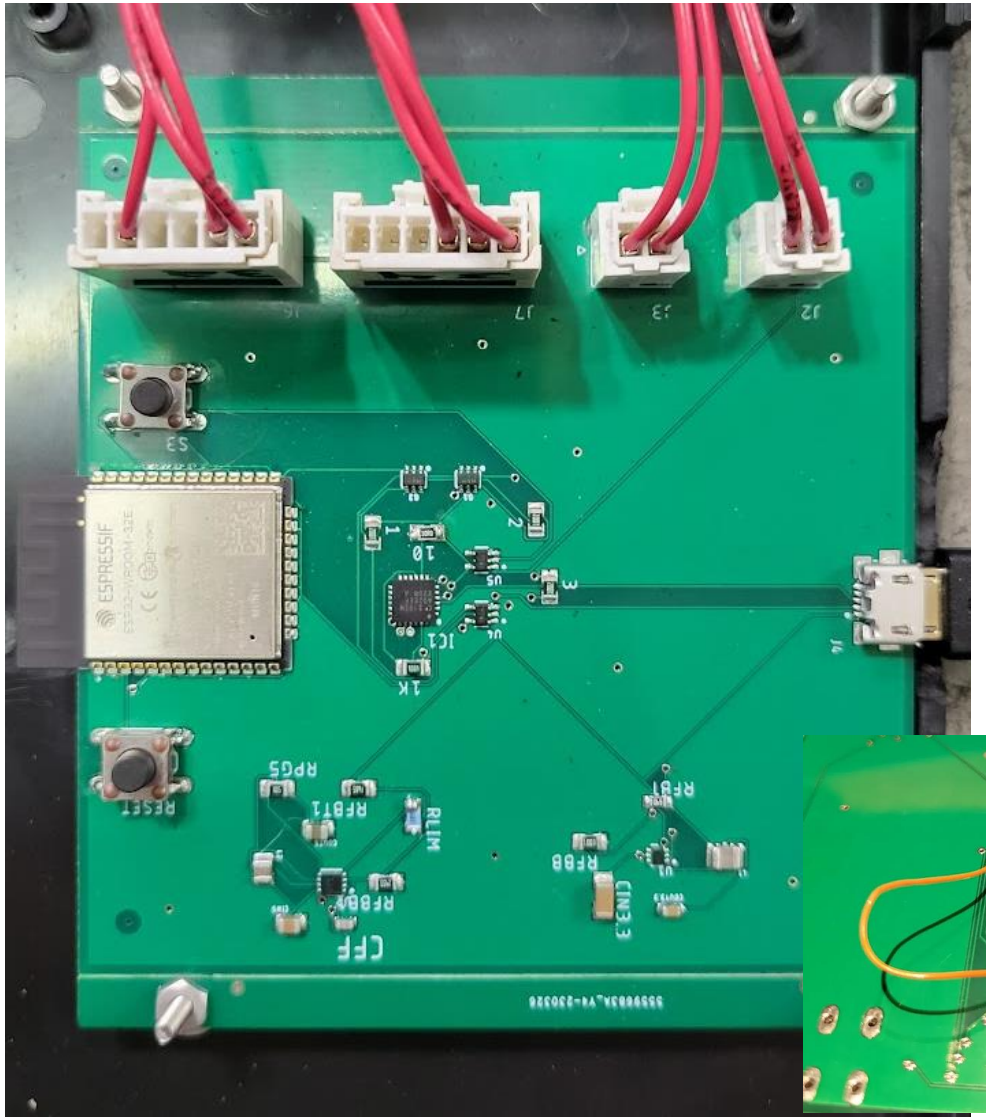
LED Connectors

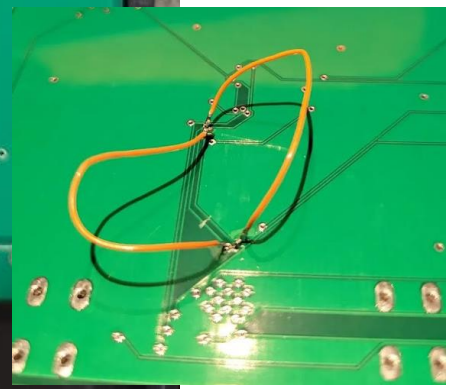
5 V to 5 V regulator

Accelerometer Connectors

Final Board Design







Sabrina, EE

Future work

Increase Functionality	Mechanical
Add more sensitive accelerometer (+/- 3g) for additional repetitive hits workout.	

Budget

Catherine, ME

Item	Price	Quantity	Total
Microcontroller	$25	1	$25
WiFi Module	$25	1	$25
Analog to Digital Converter	$10	1	$10
Force Sensors	$166.3	2	$332.6
LED lights	$1.3	2	$2.6
Metal/Material for the body of the object	$200	1	$200
Striking Pad	$12.5	2	$25
		Total Estimate:	~$620.2

Cost and BOM

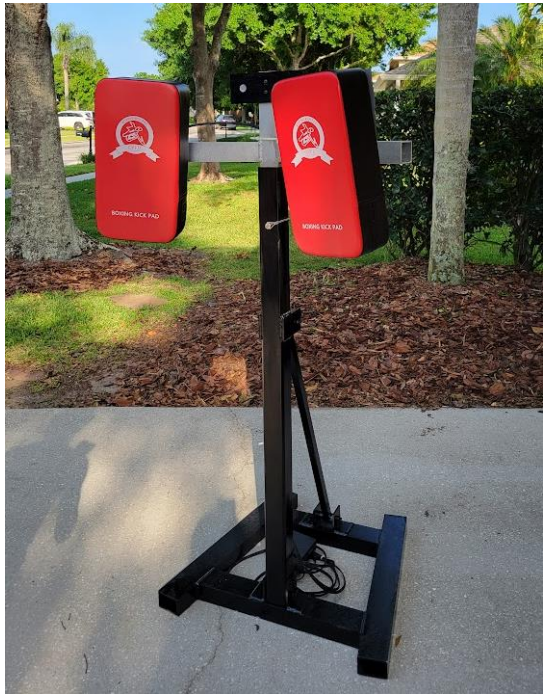
Catherine, ME

Category	Type	Selection	Price
PCB Enclosure	Electrical	Black Box	$3
Power Cable	Electrical	6 ft 2 A male USB to micro B cable	$8
LEDs	Electrical	Indicator light 5V	$18 x 2 = $36
Force sensor	Electrical	Accelerometer	$26 x 2 = $52
AC-DC Plug	Electrical	5V 1A Wall Charger Power Adapter with Plug 5.5 x 2.5mm / 5.5 x 2.1mm	$3.33
PCB	Electrical	JLCPCB	$142.69
Wire/Wire Control/Screws/Nuts	Electrical	Assorted	$8
Structure Material	Mechanical	Aluminum and Steel	Free ($300)
Strike Pads (2 pack)	Mechanical	Seisso Kick Pads	$26.00
Springs (2 pack)	Mechanical	Prime-Line 3 in. L X 1-1/8 in. D Compression Spring	$6.99
Nuts and Bolts	Mechanical	Home Depot nuts and bolts	$5.00
MSS Labor	Mechanical	UCF Machine Shop	$472.50
		Total:	$1063.51


Sabrina, EE

Conclusion

- Created a working product
- Learned valuable skills to take with us



- Acknowledgements:
  - James (Jim) Essad
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  - Dr. Abichar
  - Dr. Yuksel
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  - Guilford Cantave
  - Chris Hamilton