

Boxing Buddy

Group 15

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Sabrina Mead - Electrical Engineering

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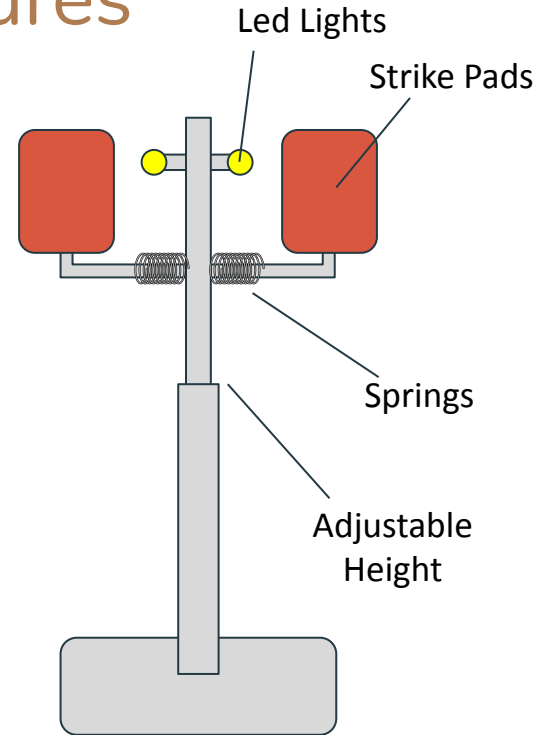
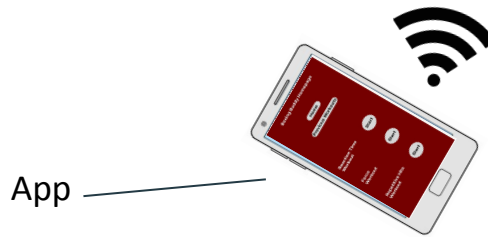
Motivation

- Boxing training with feedback requires gym or coach
- Gym memberships and coach often expensive and require working with others' schedules
- Coaches may not keep a record of the feedback they provide, and feedback may be inconsistent
- Boxing device with feedback allows for at home training and on- time purchase



Design Goals/Objectives/Features

- 2 strike pads with accelerometers
 - Used to measure force and reaction time
- Interactive app interface
- 3 training modes
- Led lights used for reaction time training mode
- Feedback for each training recorded and stored on the app



Requirements/Specifications

	Type	Description/ Requirement	Quantitative Requirement
1	Performance	The system should measure the amount of force and reaction time with a high accuracy	> 80%
2	Performance	Each strike pad should have LED indicators that flash when prompted by the mobile app with a minimal delay.	< 5 seconds
3	Performance	Startup time for application and device will be minimal.	< 15 seconds
4	Software	An interactive mobile app should be connected to the Boxing Buddy systems and will receive and display the input data in a short time.	< 5 seconds
5	Software	The mobile app should display previous workouts.	≥ 5 workouts
6	Software	The system should be able to operate autonomously for the 3 pre-programmed training session(s) that can be selected through the app	= 3 training sessions
7	Structure	The structure should have an adjustable height.	< 7 feet
8	Structure	The system will have 2 strike pads with all functionality.	= 2 strike pads
9	Structure	The strike pads should be able to withstand a high punching force.	> 500 lbs

Block Diagrams

Status Legend:

TBA: To Be
Acquired
A: Acquired
R: Research
D: Design
P: Prototype
C: Completed

Group Legend:

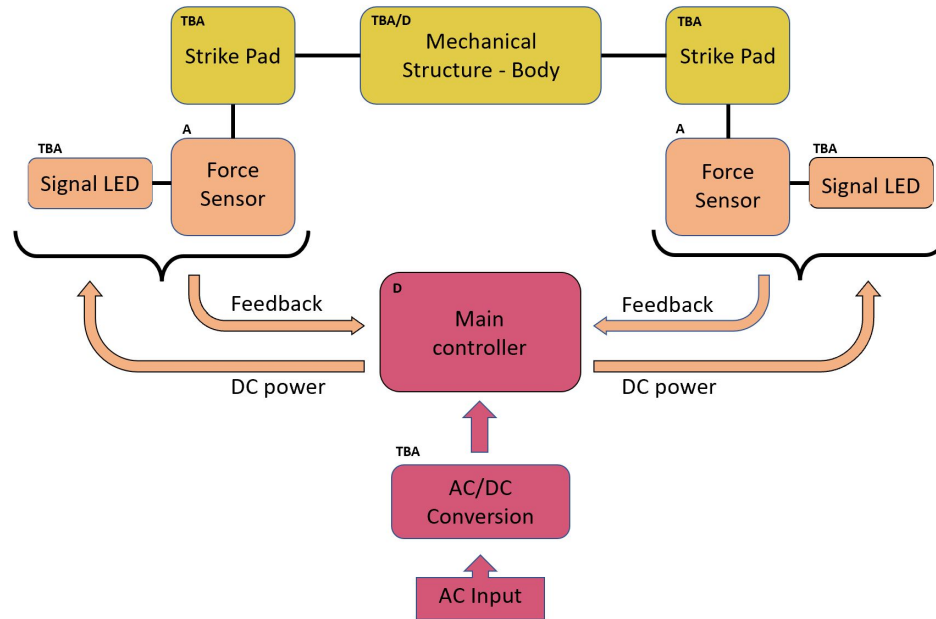
Nicholas Ebert

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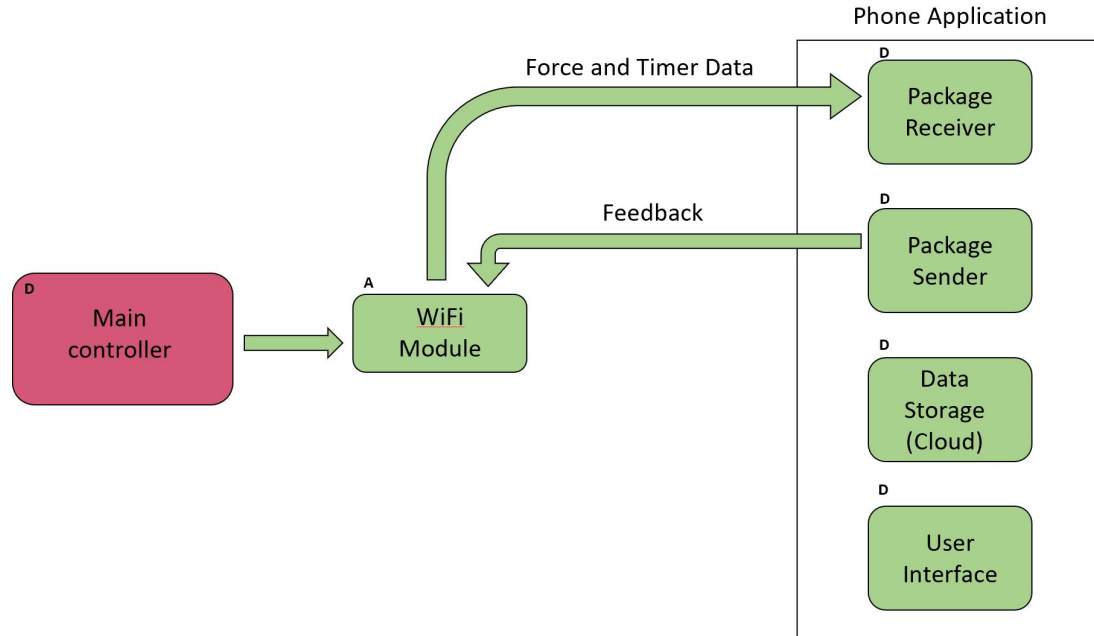
Sabrina Mead

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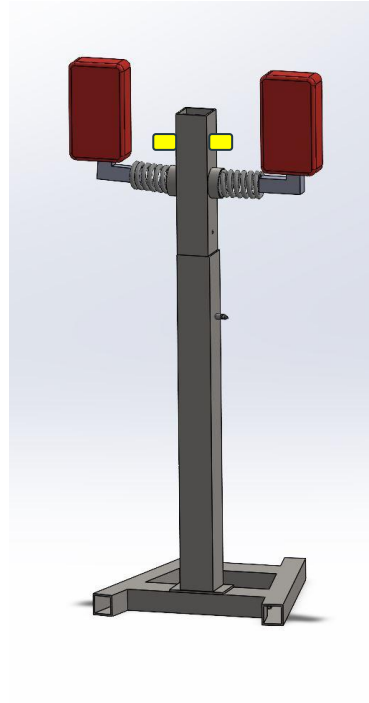
Hardware Block Diagram



Software Block Diagram

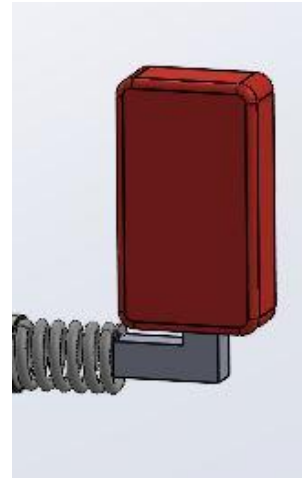


Mechanical Design



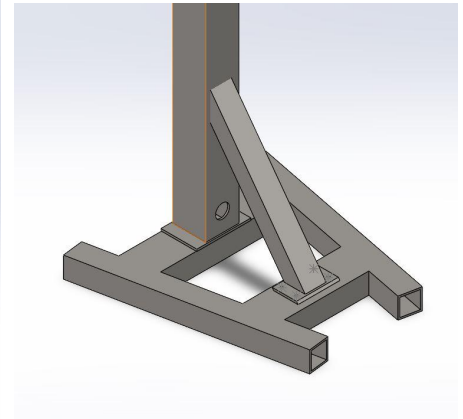
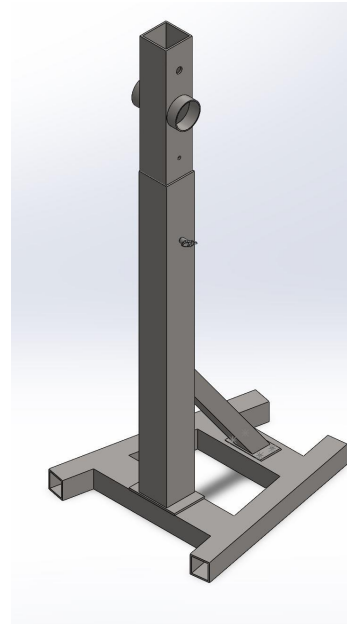
Strike Pads

- Proper material and thickness for boxing
- Larger surface area to allow for larger strike zone
- Adjustable straps to allow for easy replacement
- Attached with springs to allow for movement
- LEDs attached to separate part of support beam to prevent damage



Support Tubing and Adjustable Height

- Steel to provide weight and sturdy structure
- Adjustable height to accommodate a variety of users
- Use pin to lock in place at each height
- Provide housing for electrical components



Force Sensing

- Cost, size, durability, and measurable force will be factors that will help us in our decision making.
- Many different types of force sensors.
- Three top contenders: Piezoelectric sensor, button load cell, accelerometer.

Sensor	Cost (\$)	Maximum amount of force
Piezoelectric	~\$15 a pack	~30kg
Button Load Cell	~\$166	~500lbs
Accelerometer	~\$30	~200g

Accelerometer

- How each pin works.
- 3.3V
- X, Y, Z, to analog to digital converter
- How it will work into measuring the force of the punch.



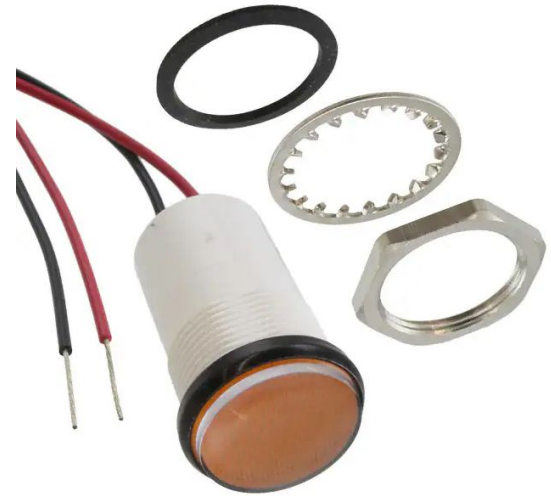
Reaction time

- It will be implemented by visual representation.
- LED light will indicate when to strike the pad.
- Time will be measured between when the LED lit up VS when the pad was struck.

LEDs

- Require 5V
- Bigger and brighter than traditional small LEDs

LED	Price	Size
Indicator Light	\$18.00 @1pc	17.5mm diameter
Pre Wired LED	\$9.99 @12pcs	3mm round top bulb



Microcontroller 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

Requirements:

6 ADC ports

2 Digital I/O Pins

Ability to Transmit data wirelessly



Micro-Controller Testing

Development Kit: Sparkfun Thing Plus

Chip: ESP32-WROOM-32D

- Integrated 802.11b/g/n WiFi 2.4GHz transceiver
- Integrated dual-mode Bluetooth (classic and BLE)

```
rst:0x10 (RTCWDT_RTC_RESET),boot:0x13 (SPI_FAST_FLASH_BOOT)
configsp: 0, SPIWP:0x00
clk_drv:0x00,q_drv:0x00,d_drv:0x00,cs0_drv:0x00,hd_drv:0x00,wp_drv:
mode:DIO, clock div:1
load:0x3fff0008,len:8
load:0x3fff0010,len:2036
load:0x40078000,len:9988
load:0x40080000,len:252
entry 0x40080034
Connecting to WiFi..
Connecting to WiFi..
Connected to the WiFi network
```

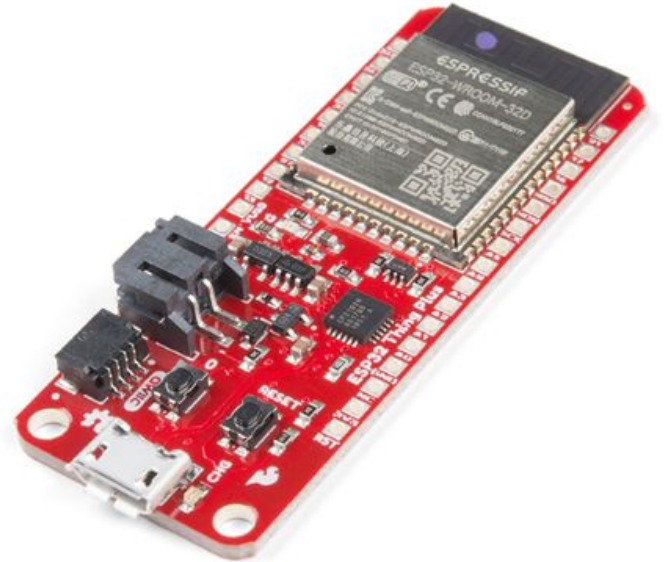
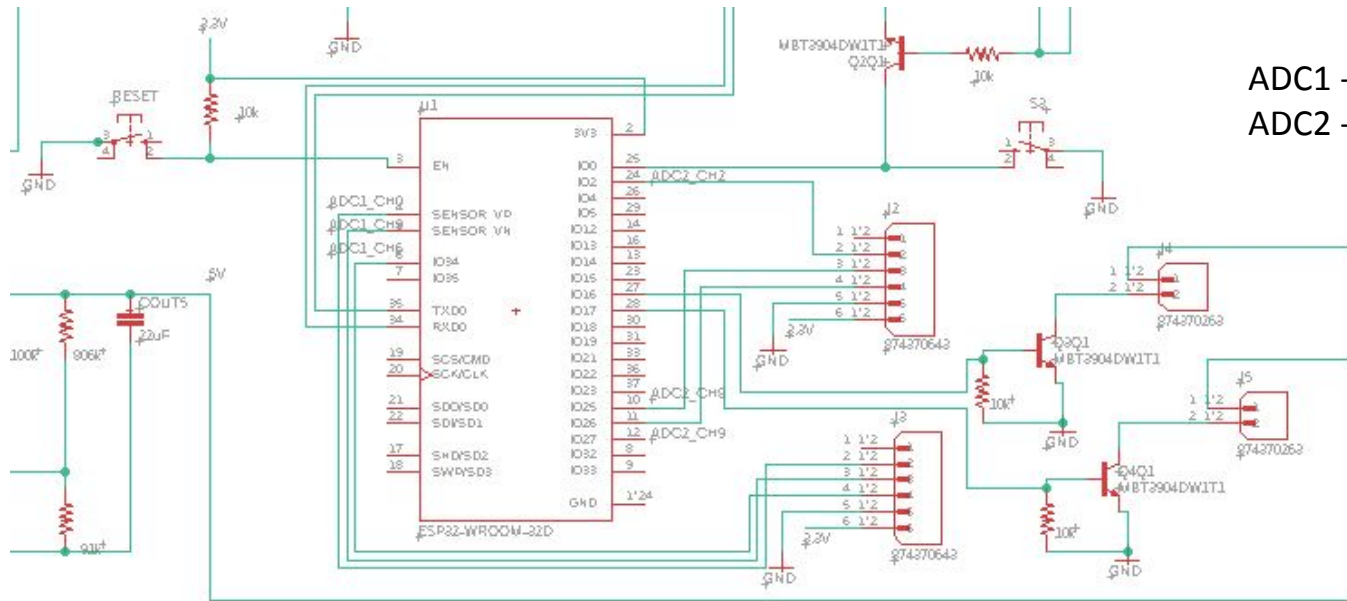


Figure 7.4: WiFi Testing Terminal Window

MCU and Sensor Connectors



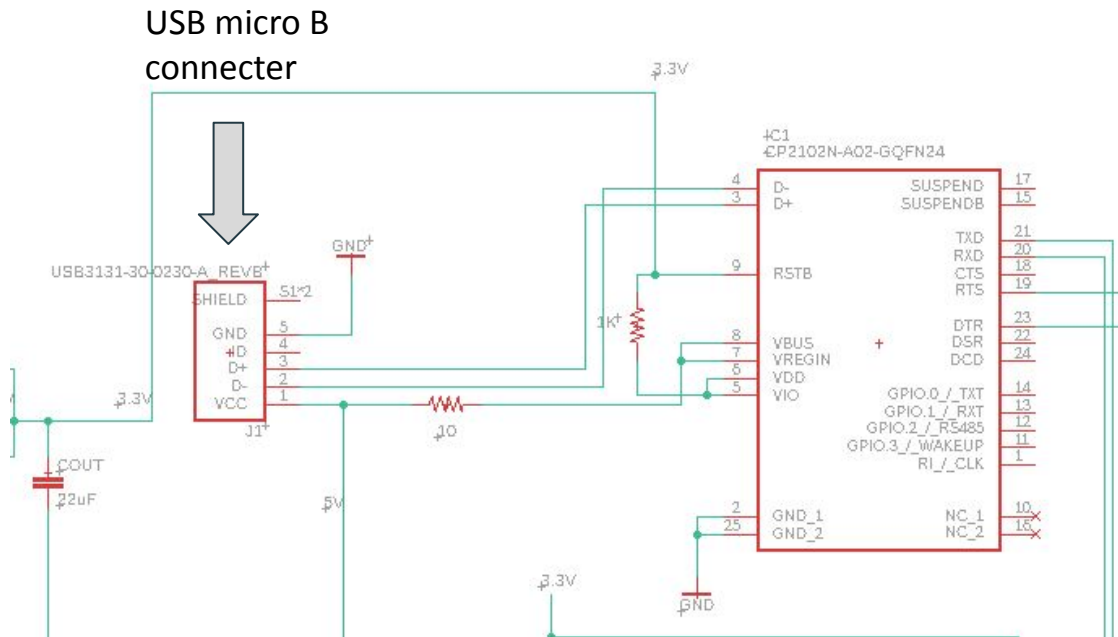
ADC1 - accelerometer #1
ADC2 - accelerometer #2

NPN transistor to
control 5V input to
LED connectors

Power Intake

Input into Circuit: 5V DC

From Wall Plug using AC to DC converter

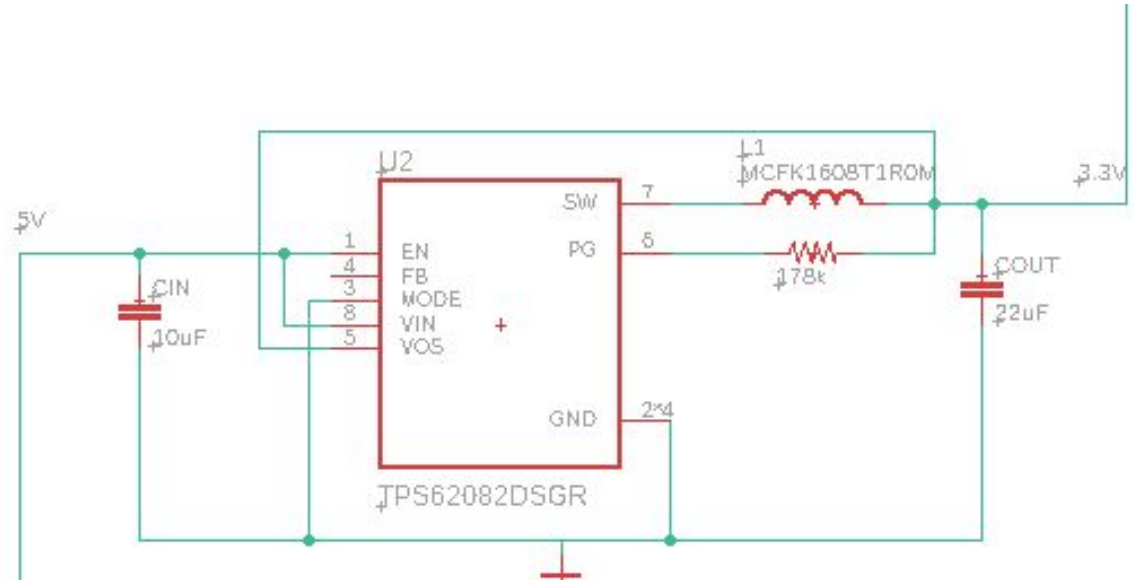


Voltage Regulation - 5V to 3.3V

Summary

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

Regulator FootPrint:
9.61 mm²



Regulates power to: ESP32-WROOM Chip and Accelerometer sensors

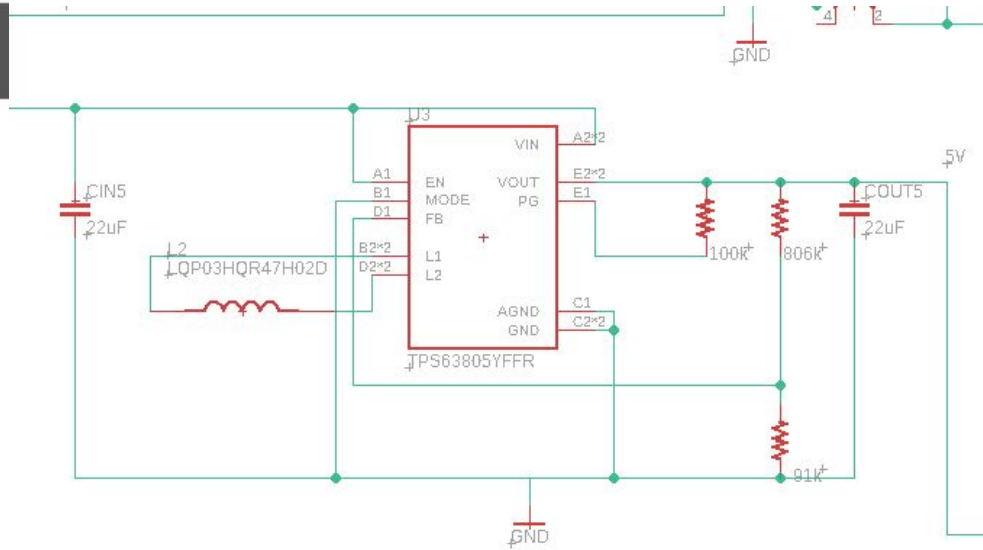
Voltage Regulation - 5V to 5V

Summary

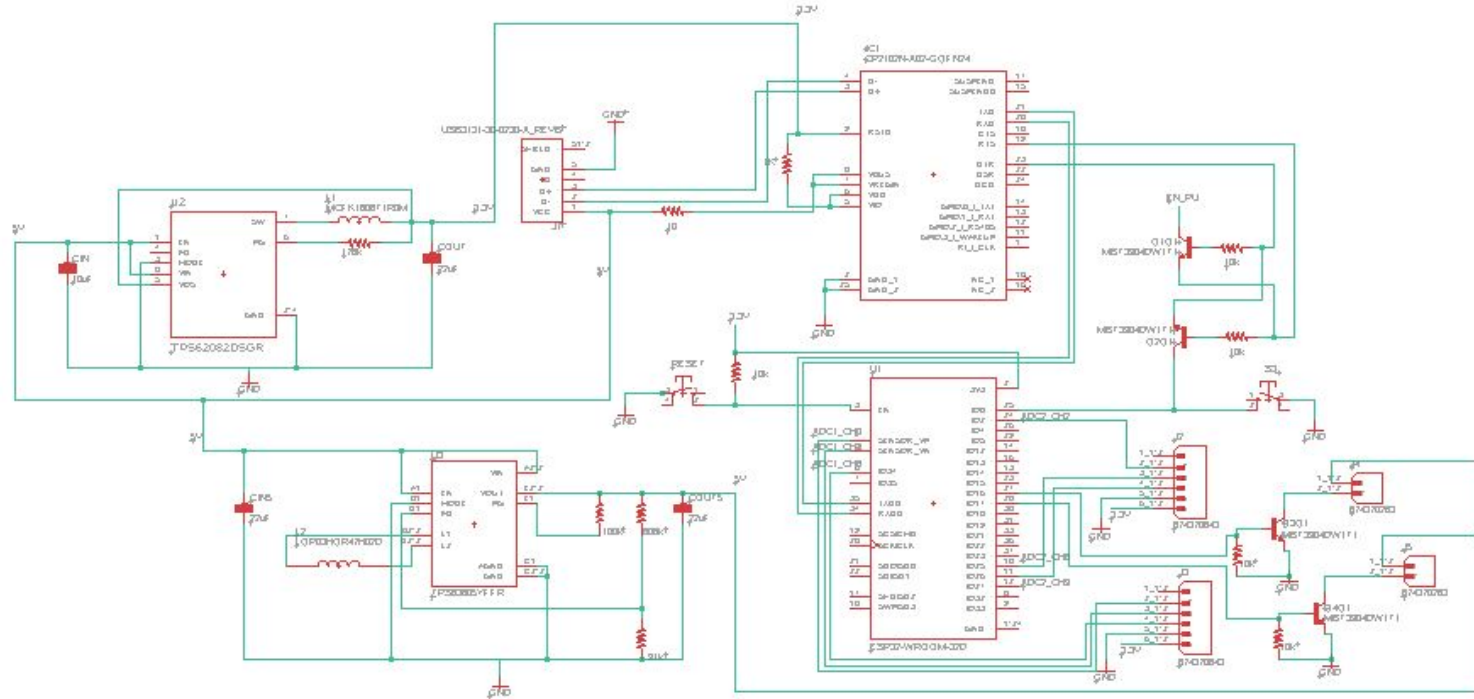
Efficiency: 95.1%
BOM Cost: \$1.73
Footprint: 61 mm²

Regulator Footprint:
7.84 mm²

Regulates Power to: 5V LED indicator lights



Full PCB Schematic



PCB Creation

Due to the small size of chips and regulators needed for our board, will be utilizing a reflow oven.

Order:

- PCB board [JLCPCB]
- Stencil
- Components separately



Mobile application - 4 types

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 non native feel.

Communication Diagram

Esp32 -> Network -> AWS cloud (database) -> AWS amplify API -> React Native app/User Interface



ESP32-WROOM-32E



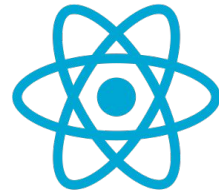
WiFi
802.11



AWS
Database



AWS
Amplify
API



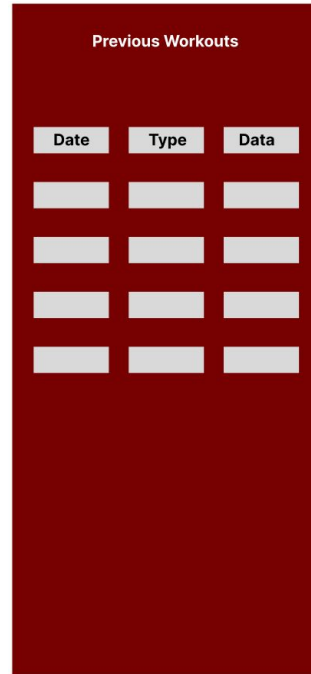
React Native

React +
Javascript

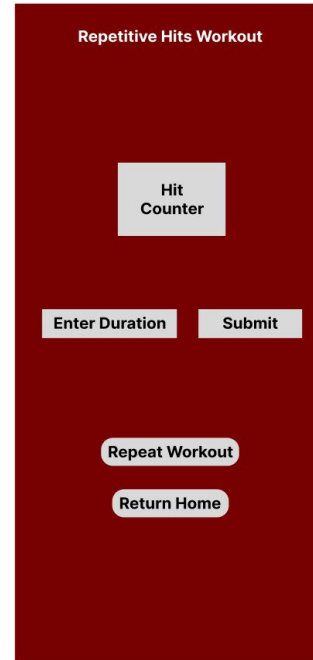
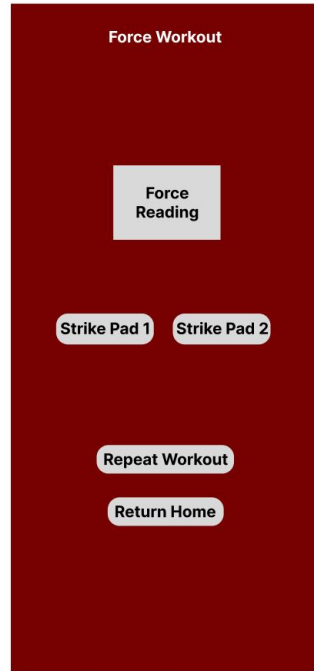


Mobile
Device

User Interface Design



User Interface - Workouts Page



Design Constraints

Type	Standard/Constraint
Economic	<ul style="list-style-type: none">- Self funded
Time	<ul style="list-style-type: none">- Two Semesters- Juggling work and school with project
PCB Standards	<ul style="list-style-type: none">- IPC Standards: IPC-2221 generic design, IPC-2223 flexible/rigid boards, IPC-7801 Reflow Oven
Manufacturing	<ul style="list-style-type: none">- Constraints on welding and bending abilities for structure
Sustainability	<ul style="list-style-type: none">- Dependability and reliably working
WiFi	<ul style="list-style-type: none">- 802.11
Power	<ul style="list-style-type: none">- ANSI wall outlet

Project Management



Discord



Texting



Lab Meetings 3 times a week

Cost and BOM

Category	Type	Selection	Price
Back-end API	Software	Amazon Web Services	TBD
MCU/Wifi Module	Electrical	ESP32-WROOM32E	\$3.60
LEDs	Electrical	Indicator light 5V	\$18 x 2 = \$36
Force sensor	Electrical	Accelerometer	\$18 x 2 = \$36
AC/DC adapter	Electrical	5V 1A Wall Charger Power Adapter with Plug 5.5 x 2.5mm / 5.5 x 2.1mm	\$3
3.3V Voltage Regulator	Electrical	TPS62082DSGR	\$1.73
5V Voltage Regulator	Electrical	TPS63805YFFR	\$2.83
Structure	Mechanical	TBD	TBD
Strike Pads	Mechanical	TBD	TBD