



# ECE 445 Final Presentation

Electrical & Computer Engineering

Group 67

TA: Zicheng Ma

Professor: Jonathon Schuh

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## Team Members

- Eric Lin

Computer Engineering

Focus on software programming and testing

- Carl Xu

Computer Engineering

Focus on software programming and testing

- Laurenz Nava

Electrical Engineering

Focus on power circuit design and some general circuit design

## Main challenge:

Every morning, waking and getting up by the time the alarm rings.

## Current Solution:

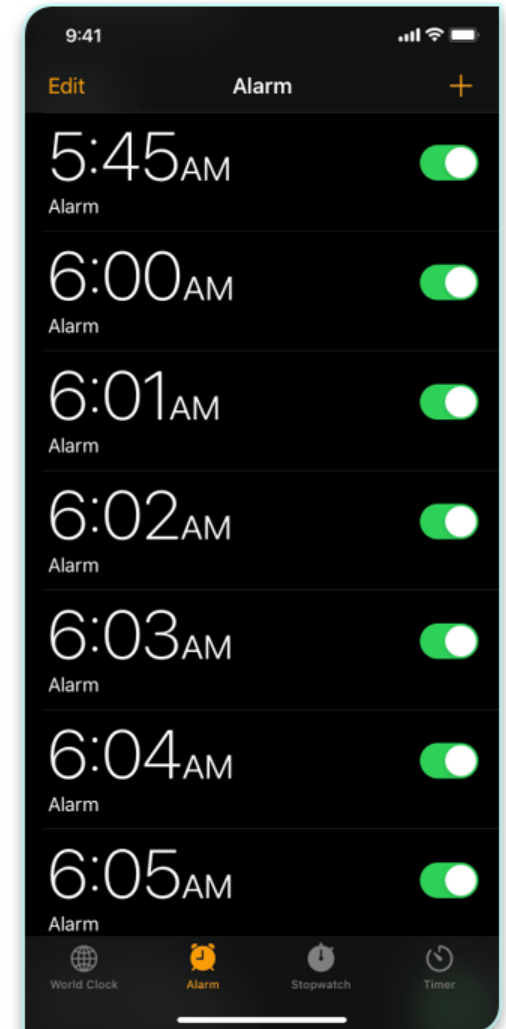
Have a snooze button!!!

Traditional alarms provide less time for sleep and are inefficient wake-ups.

Setting multiple alarms may still result in oversleeping.

## Negative effects:

Disrupted daily schedule, reduced productivity, increased stress, and more!





## Idea/Objective

- The alarm will ring at the designated time
- The user must get up and go to the bathroom to brush their teeth
- The alarm will only turn off after the user brushes their teeth for 2 minutes
- Goal/Objective: efficiently wake up, more sleep, and get out of bed

## Conditions for correct brushing

- 2.2 mN min force
- 10 Hz max frequency

## Conditions for user detection

- Within 3 m
- 180°

## Conditions for the alarm to stop

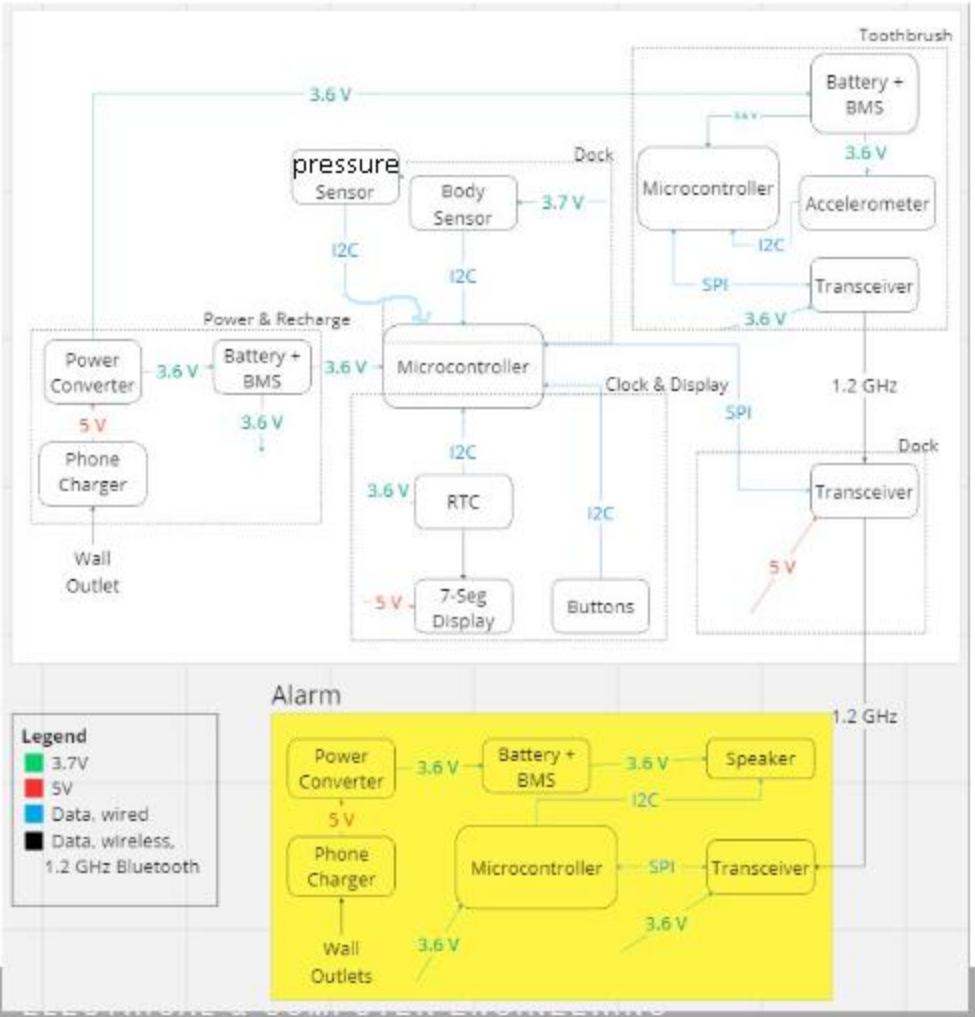
- Brush teeth for 2 mins
- Override Buttons 10 secs
- Unattended 30 mins.



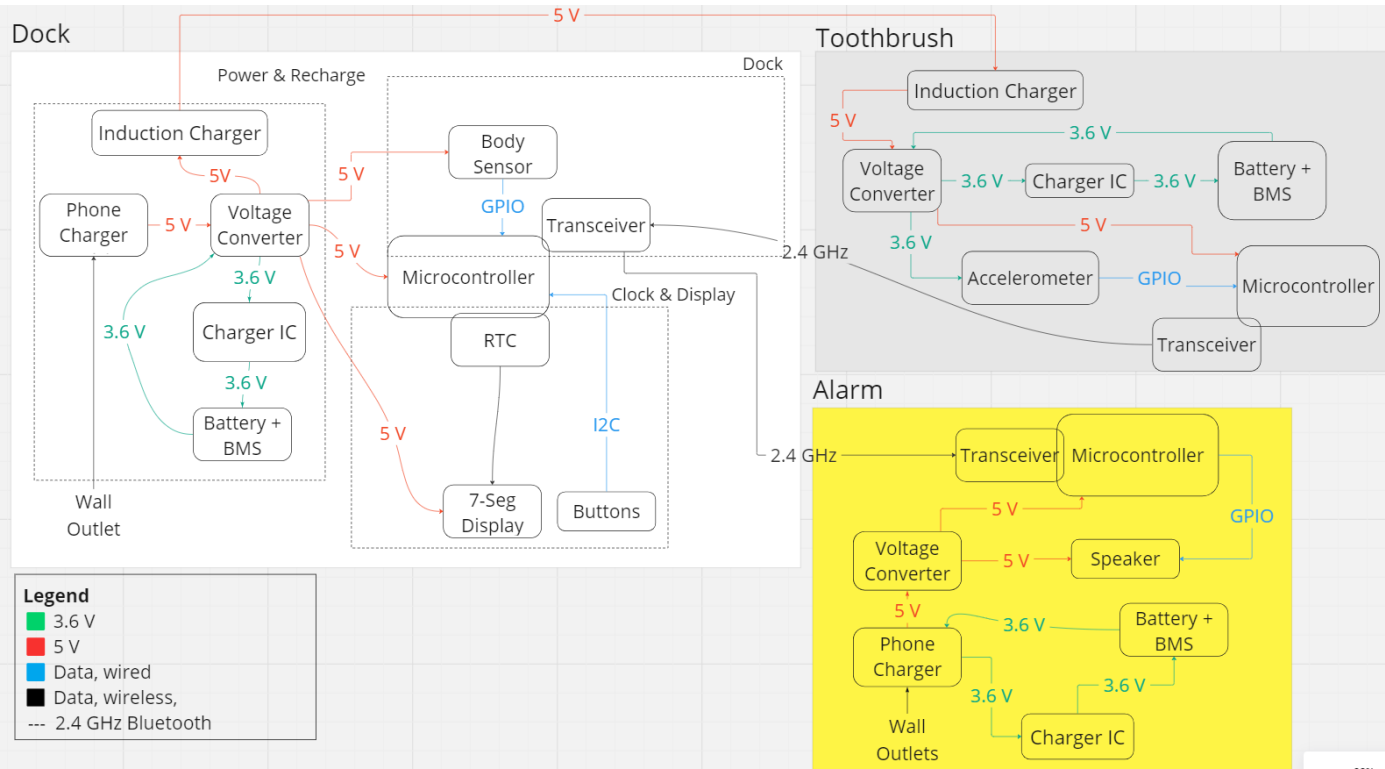
# Block Diagram



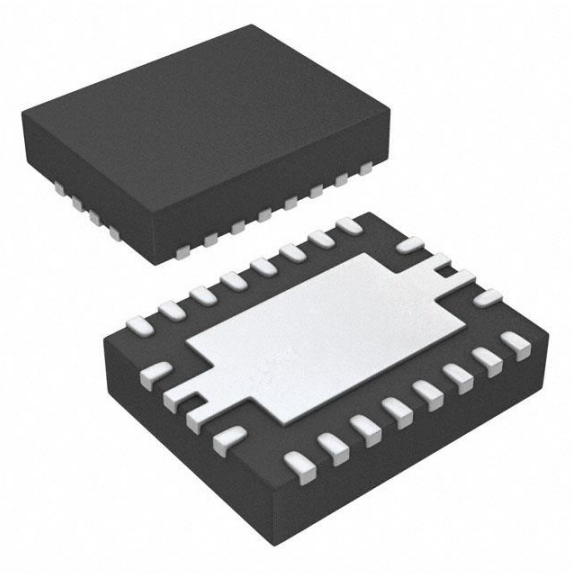
## Initial



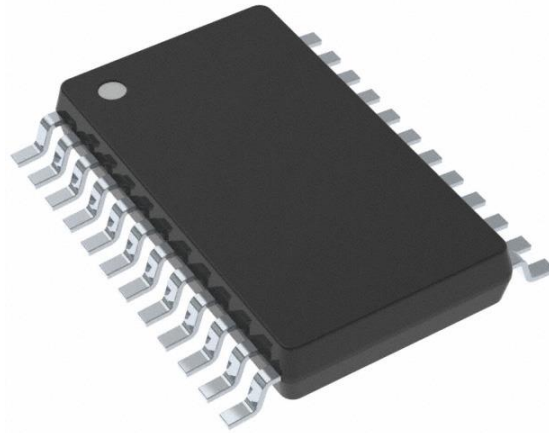
## Final



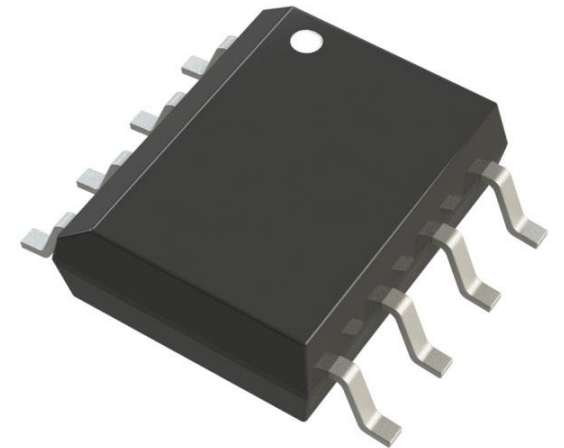
BQ24115RHLR  
(Recharging IC)

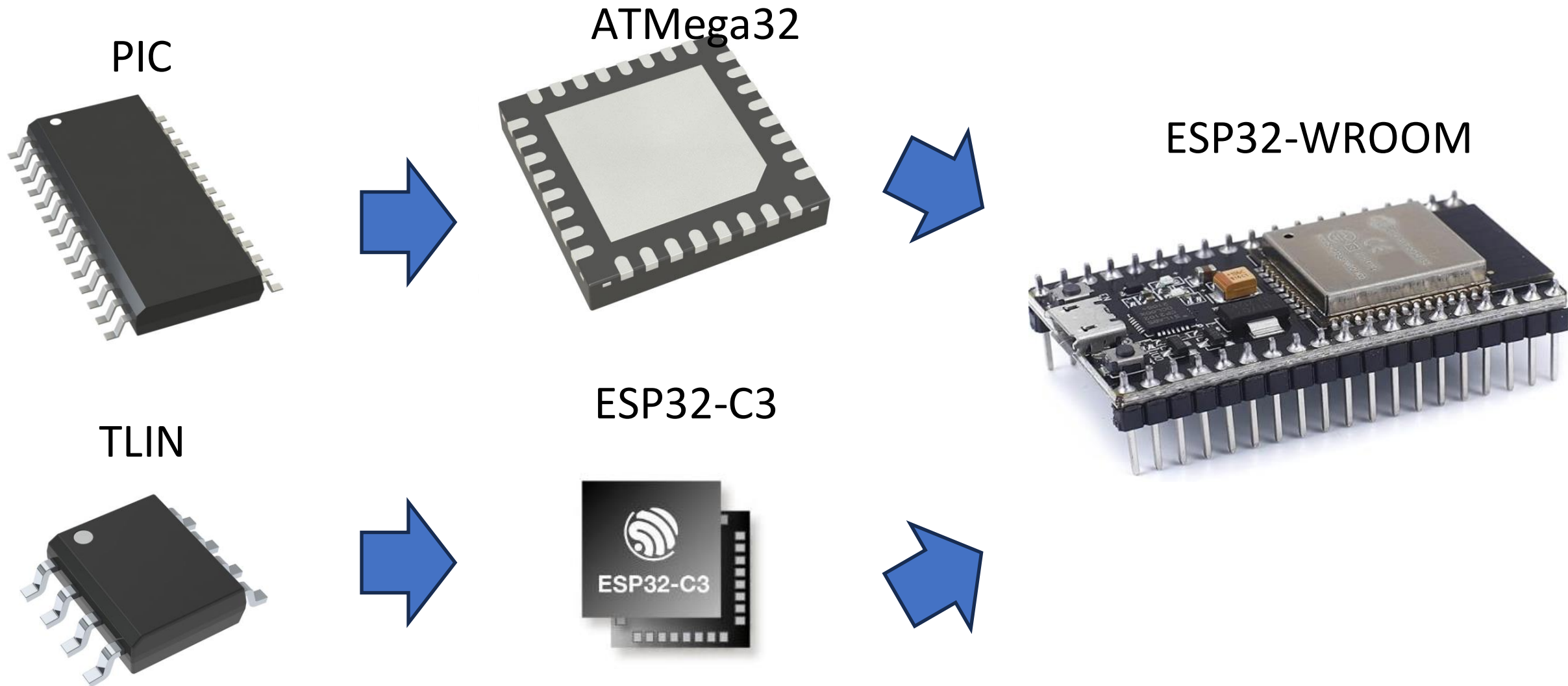


BQ7791501PWR  
(BMS)



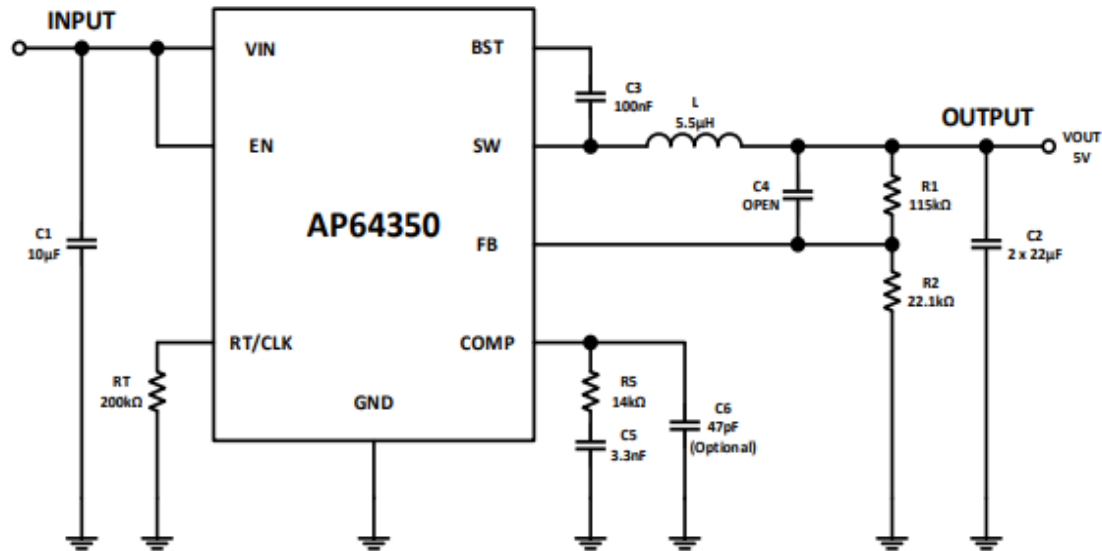
AP64350SP-13  
(Regulator)



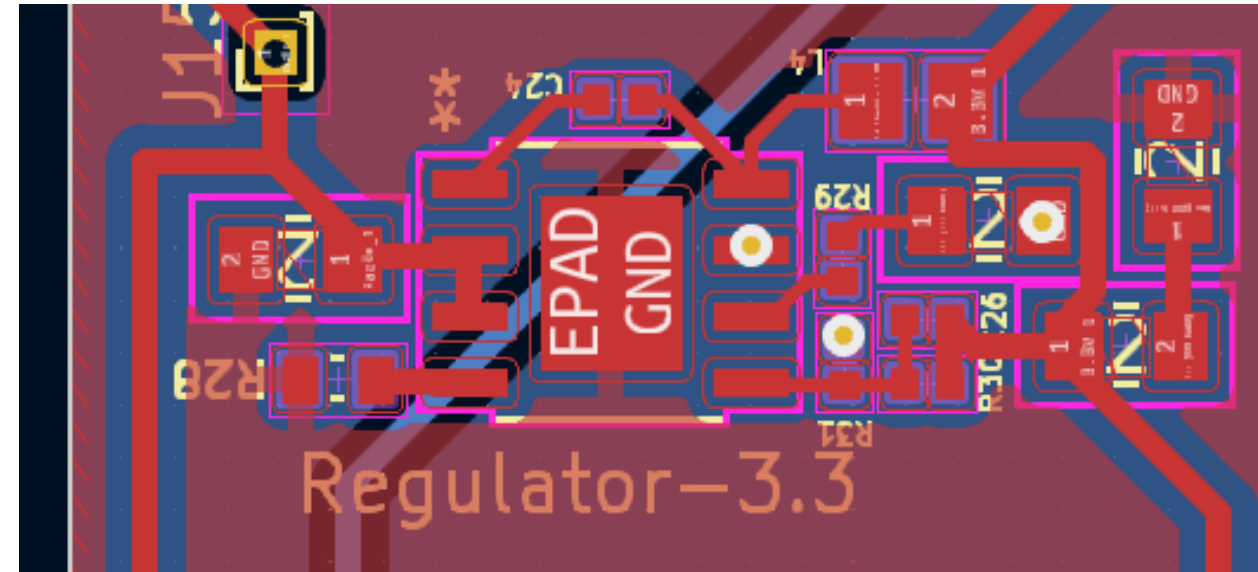




## Typical Application

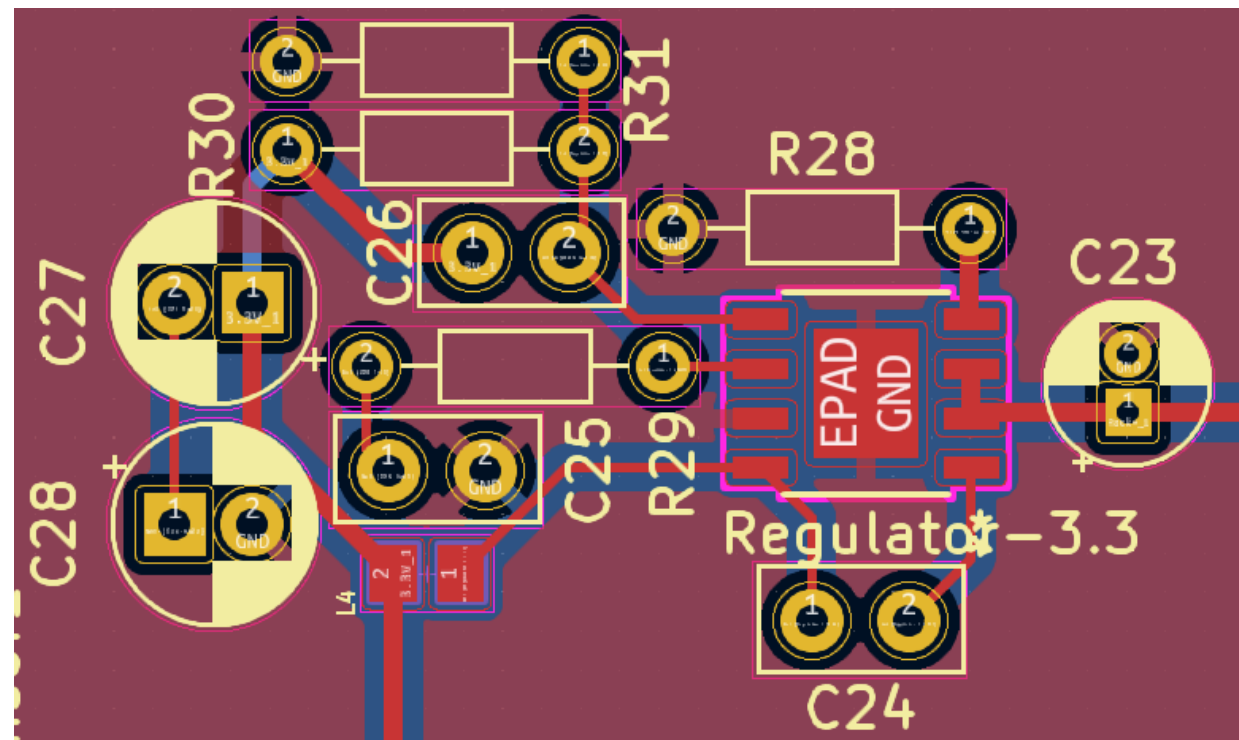


## Latest Design



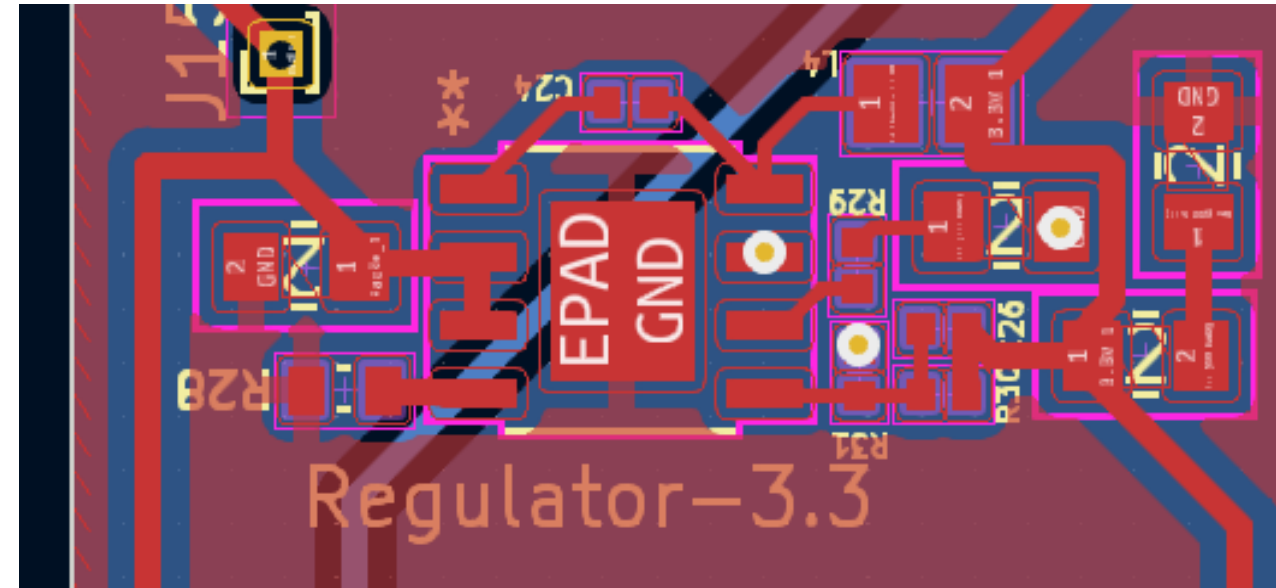
## First Design

- Through-holes
- Bulky

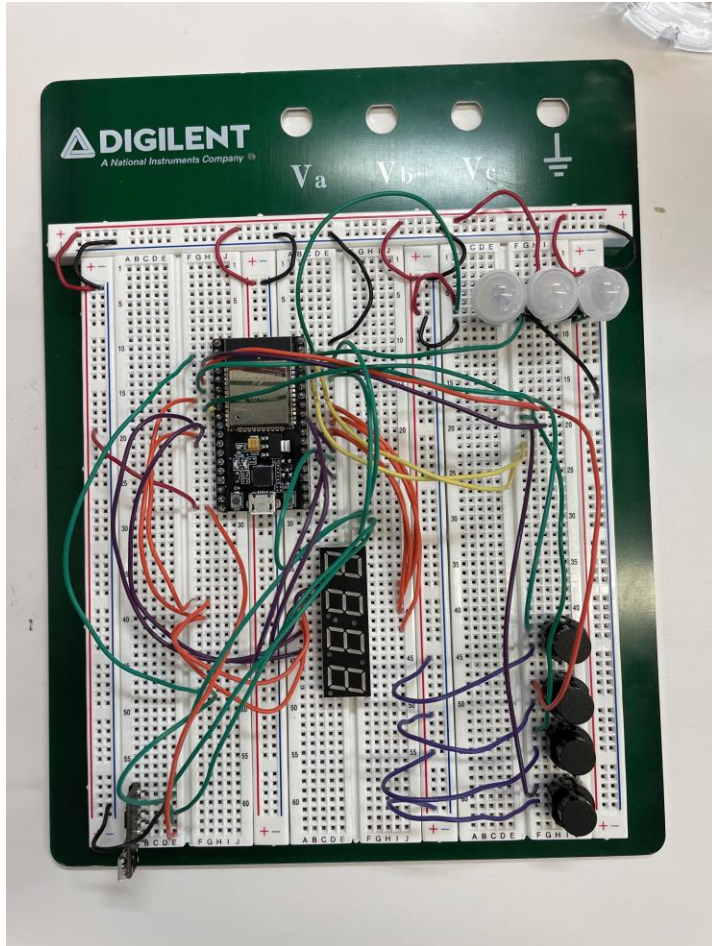


## Latest Design

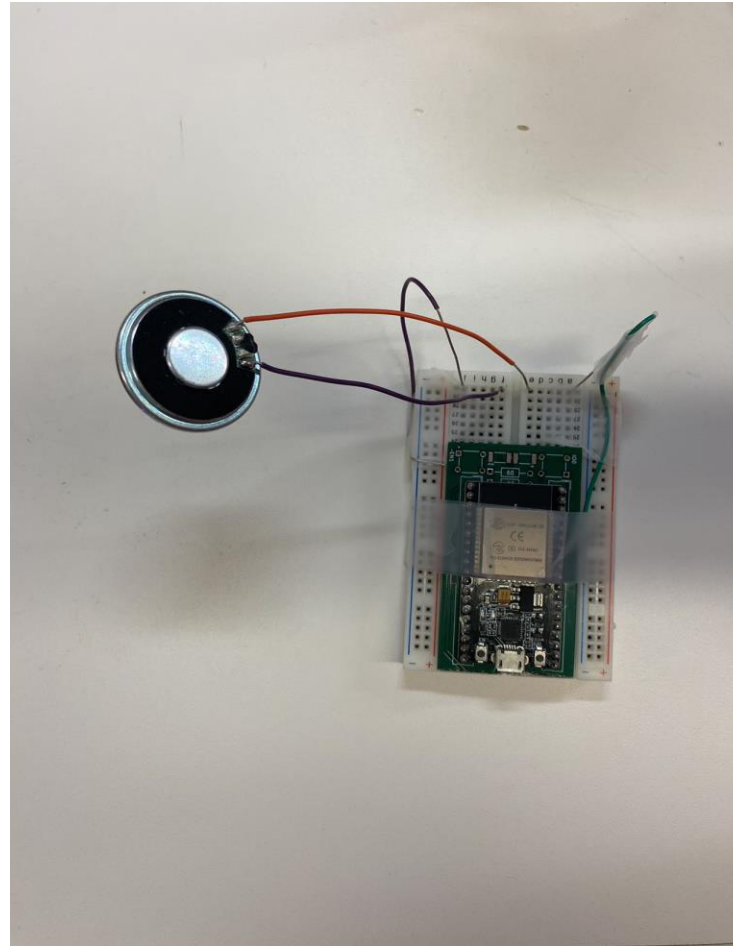
- Surface-mounted
- Better organized



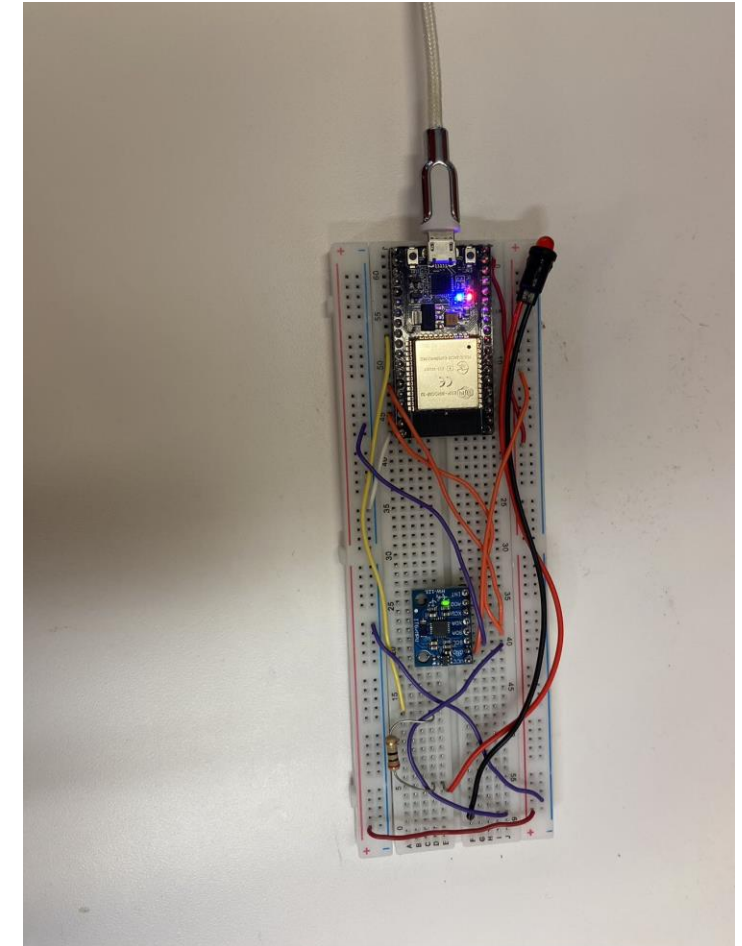
## Dock



## Alarm



## Toothbrush

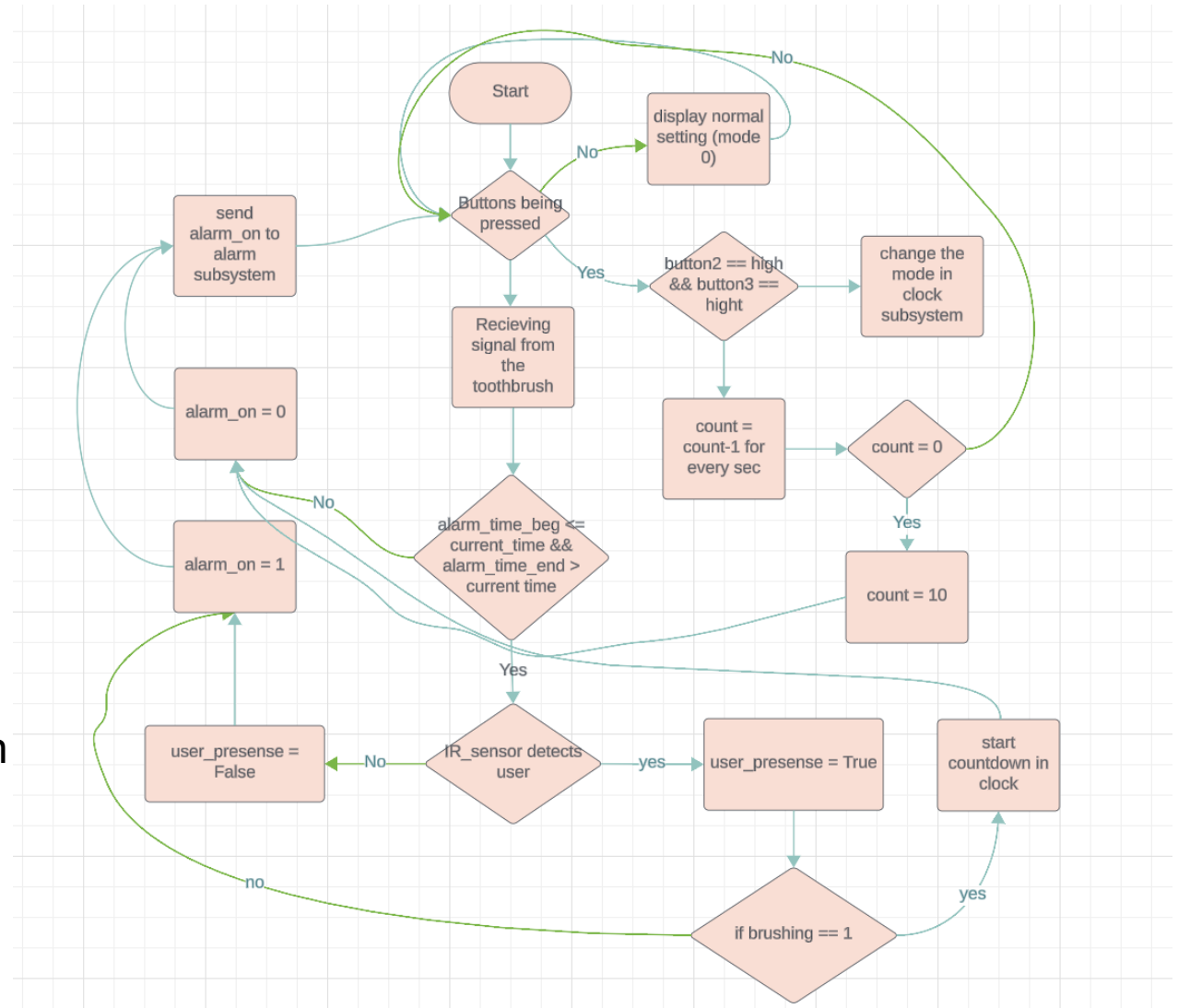




# Subsystems

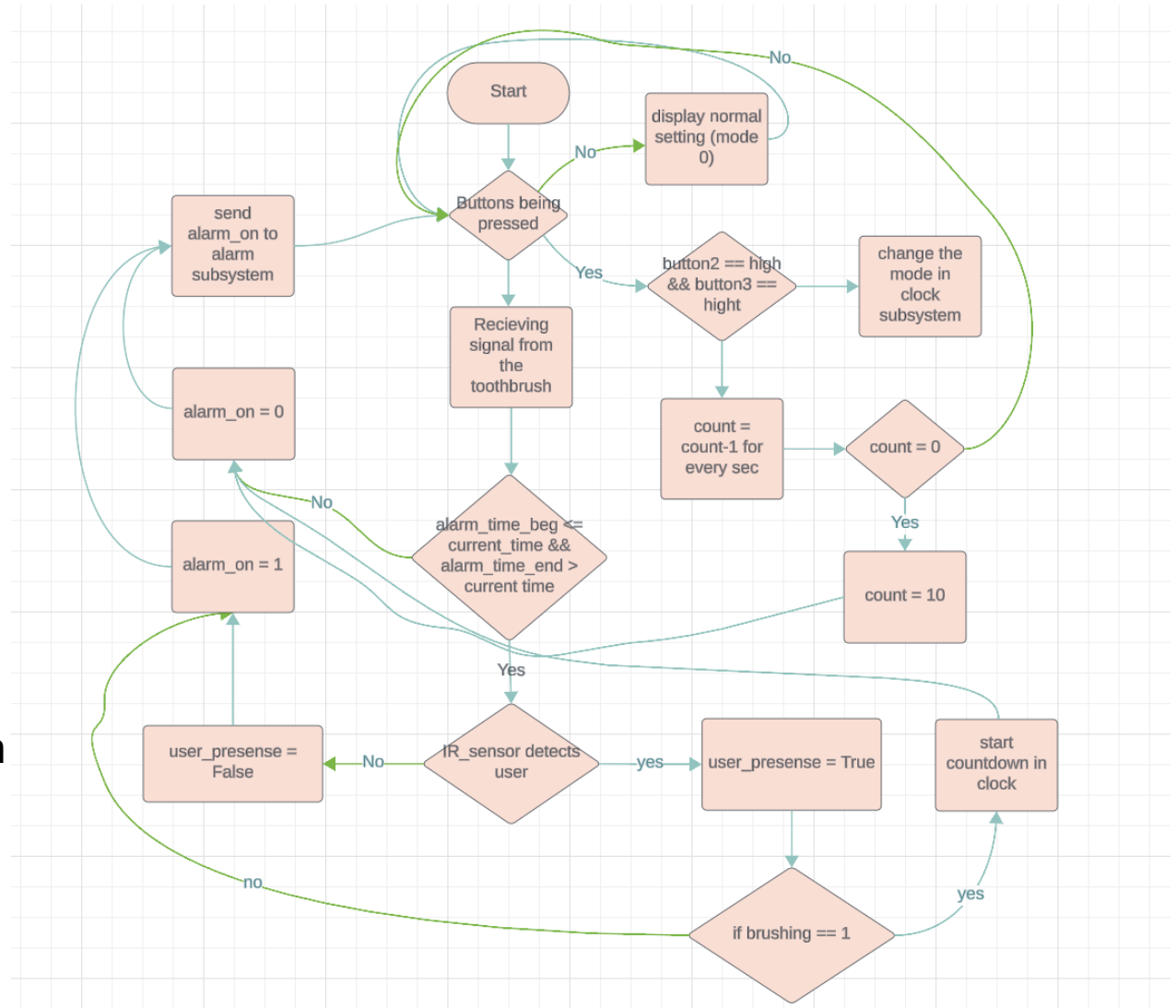
(Main section divider slide option two, or transition slide.)

- Acts as the central control hub of our Toothbrush Alarm system
- Ensures accurate monitoring of brushing activity
- Have an IR sensor embedded to detect user presence in the area
- Orchestrates seamless communication between components:
  - Wireless signal to the alarm speaker
  - Receive wireless signals from toothbrush
  - Wired connected to the clock display





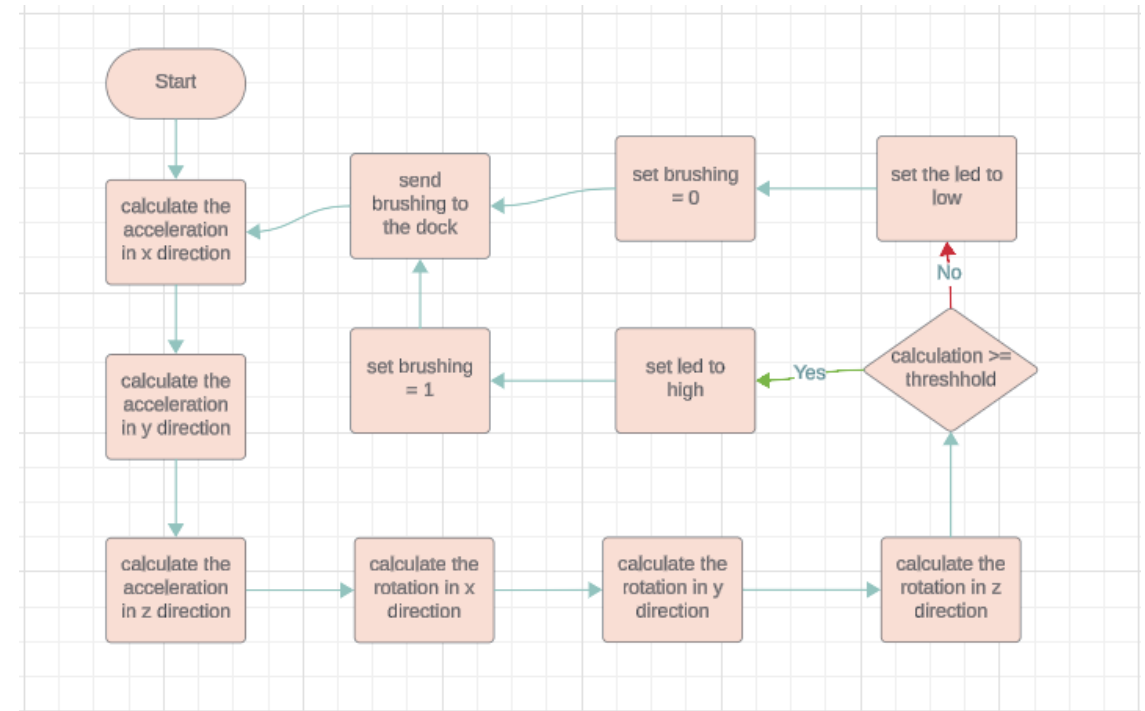
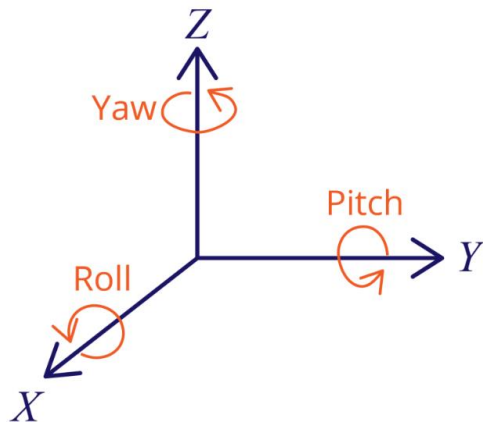
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# Toothbrush Subsystem



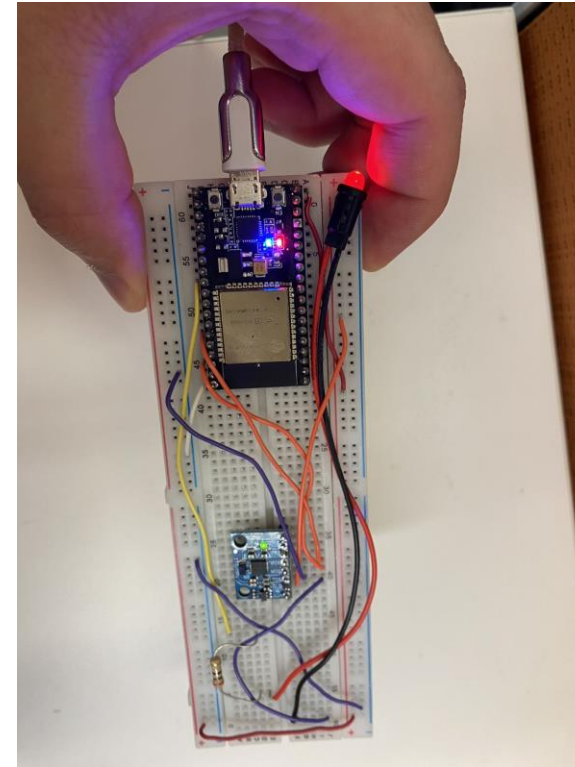
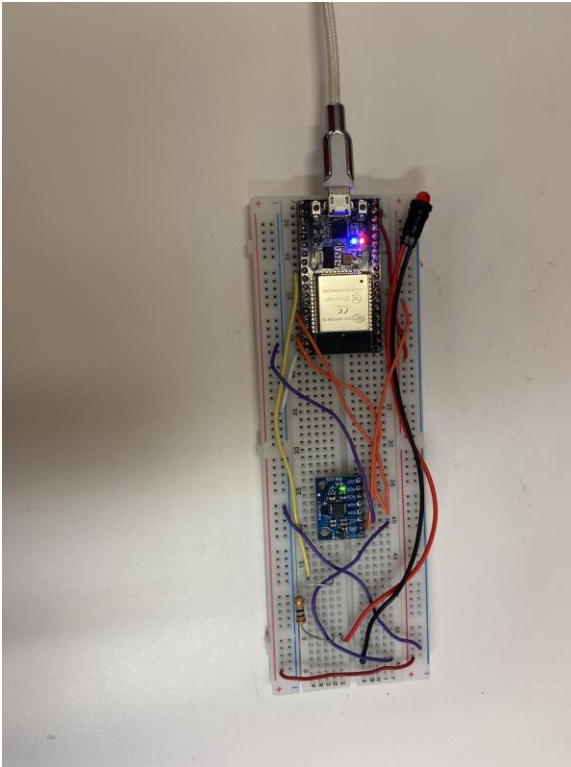
- The gyroscope measures rotational velocity (rad/s), the change of the angular position over time along the X, Y, and Z axis (roll, pitch and yaw)
- The accelerometer measures acceleration (rate of change of the object's velocity) in the X, Y, and Z axis
- Sends the wireless signal to the dock when the user is using the toothbrush



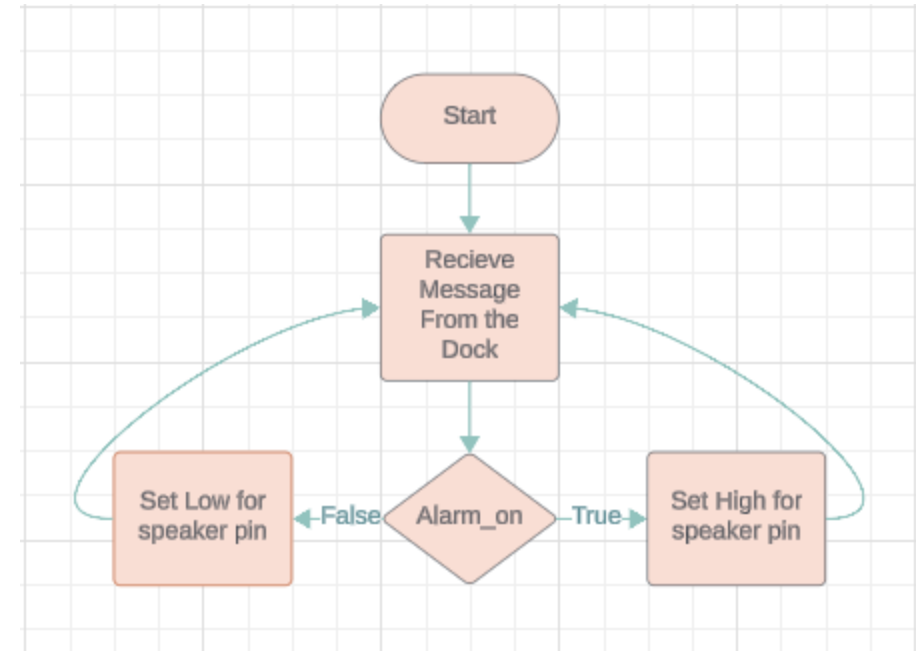
# Toothbrush Subsystem



- Sends the wireless signal to the dock when the user is using the toothbrush,
- If it detects motion, led is on, otherwise is off.



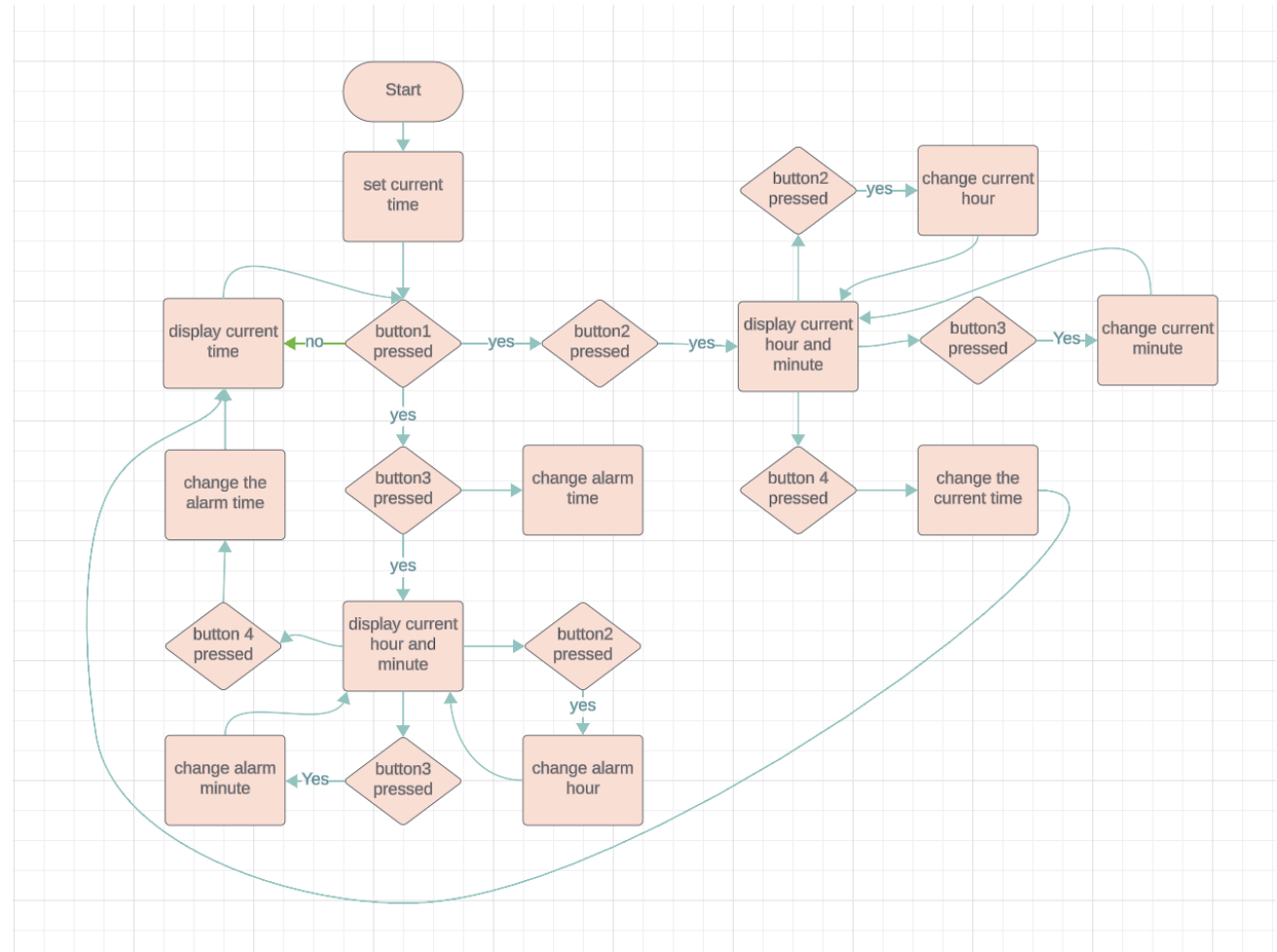
- Receive alarm\_on/alarm\_off Signal from the Dock
- Have roughly about 60 dB for volume
- Sound Alarm at the Set Alarm Time
- Stop Alarm when the User Starts Brushing Teeth
- Resume Alarm for Incomplete Brushing
- Stop Alarm after 30 minutes once started



# Clock & Display Subsystem



- Serves as the central hub for time management
- Main purpose: real-time clock information and alarm settings
- Equipped with a 7-segment display and a real-time clock module
- Has intuitive button controls enabled users to set and modify alarm times



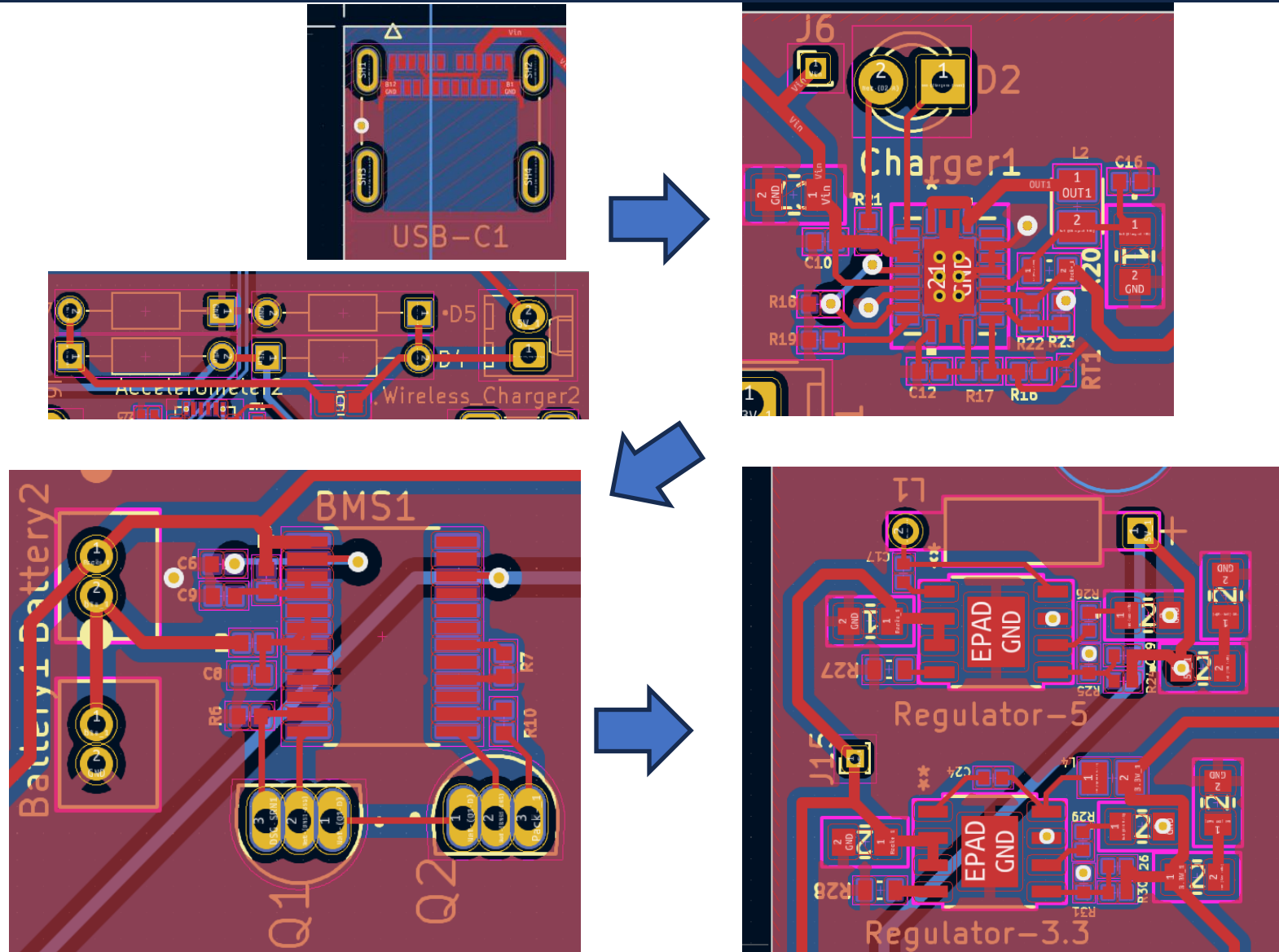


# Battery & Power Subsystem



Powers and recharges all other subsystems

- Energy enters via USB-C or wireless charger
- Recharging IC
- Battery and battery management system
  - Travel friendly
- 3.3 V and 5 V regulators to all other components



## Dock

- Motion sensor range: 3.78m
- Wifi range: 20+m



## Toothbrush

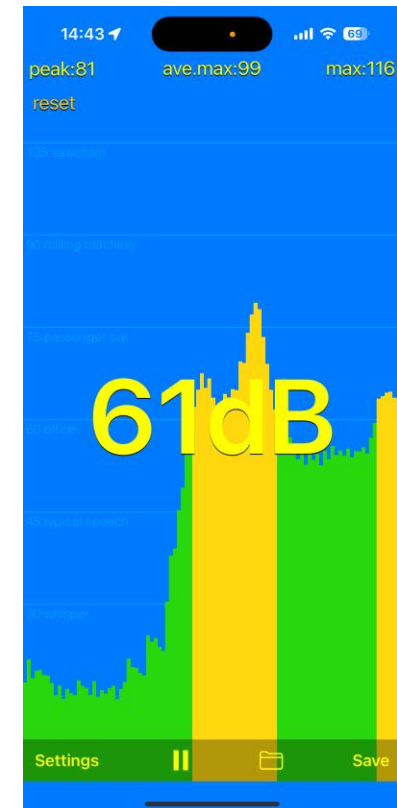
- Acceleration resolution: 0.2 mN

$$0.01 \text{ rad/s} * 120 \text{ cm} * 20 \text{ g} = 0.2 \text{ mN}$$

```
14:40:39.647 -> Last Packet Send Status:      Delivery Success
14:40:40.648 -> LOOP START
14:40:40.648 -> Rotation X: -0.05, Y: 0.05, Z: 0.01 rad/s
14:40:40.648 ->
14:40:40.648 -> Sent with success
14:40:40.648 -> LOOP END
```

## Alarm

- Average volume of speaker: 60 dB





(Short video for working Toothbrush Alarm)

## What did we learn:

- PCB design
- Hardware software integration
- Product design
- Parts selection

## What would you do differently if you redesigned your project:

- Start earlier
- Test more on breadboard before PCB design
- Check datasheet more carefully before designing

## Recommendations for further work:

- Louder speaker
- Fix PCB implementation
- Wireless batter charging
- More methods to turn of the alarm other than brushing teeth



# Thank You

Eric Lin  
Carl Xu  
Laurenz Nava