UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Bluetooth Burner

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Agenda

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Introduction & Objective

Objective

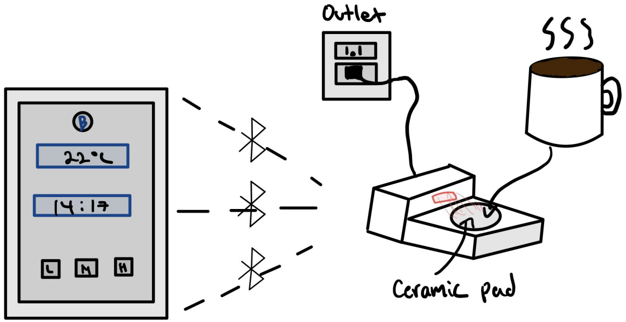
- People commonly face the challenge of keeping coffee, tea, and soup at the ideal temperature
- Traditional methods of reheating can degrade the quality of the drink or food
- Current beverage warmer market is polarized

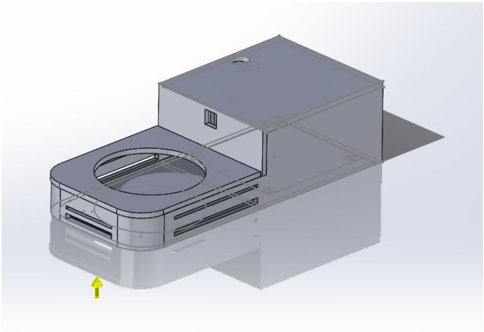
High-end

Low-end

Introduction

- Bluetooth capabilities for temperature control at four different settings
- Energy efficient, durable, and smart-touch detection for shutdown
- Ceramic pad with sensors to accommodate varying cup/bowl sizes



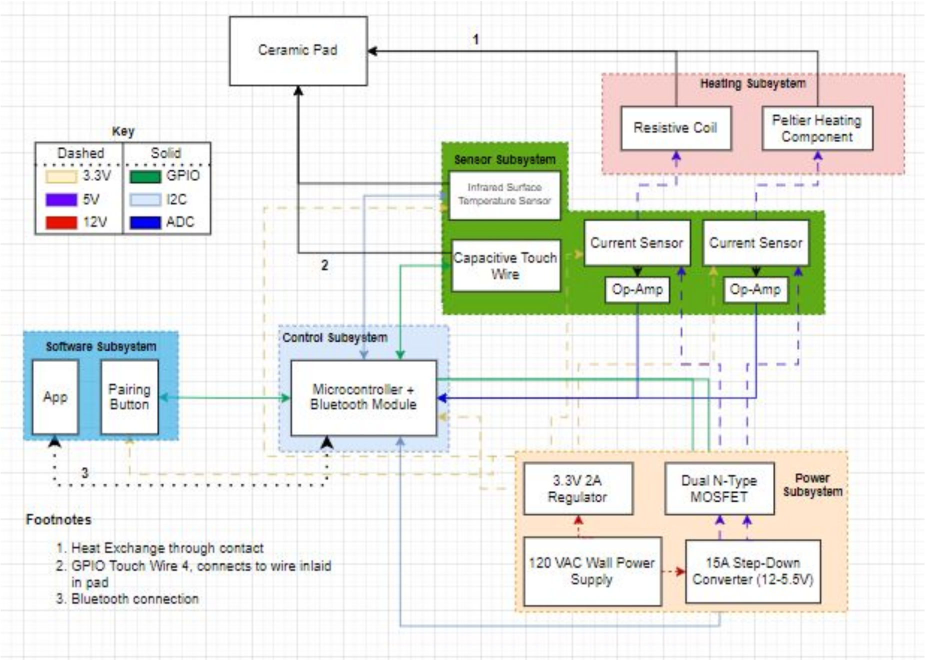


Design

High Level Requirements

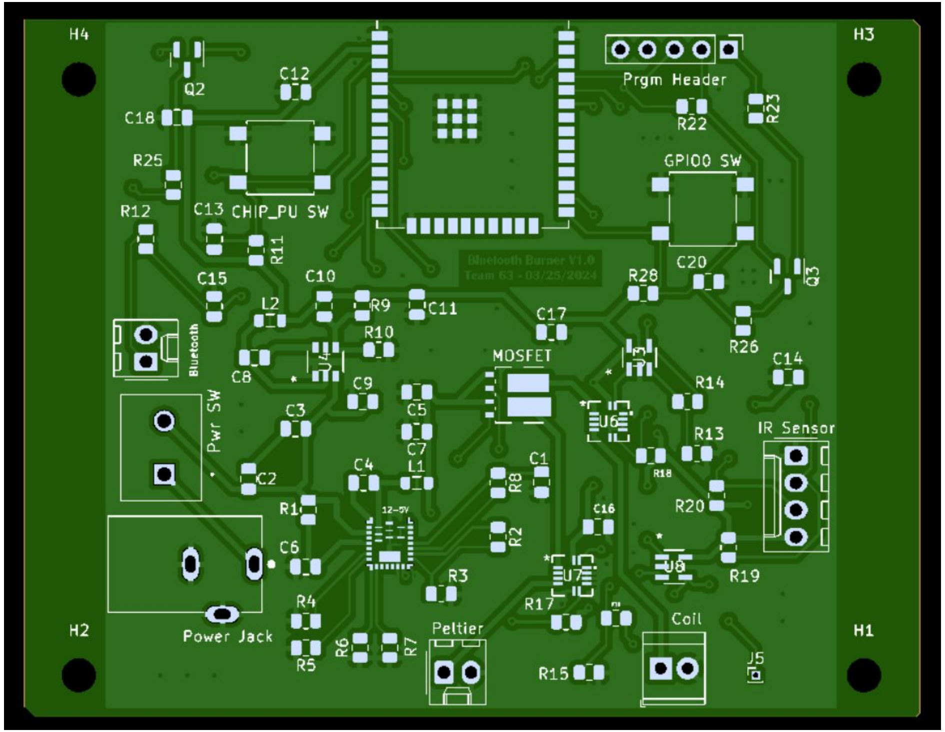
- The heating pad should have temperature capabilities of 30-60 °C for heating and reach at least -10 °C for cooling.
- The infrared sensor observing the heating pad should be able to identify pad temperature within at most 1 °C
- The device should communicate and receive information such as change in temperature via a phone application within a range of at least 10 - 20 meters.

Block Diagram

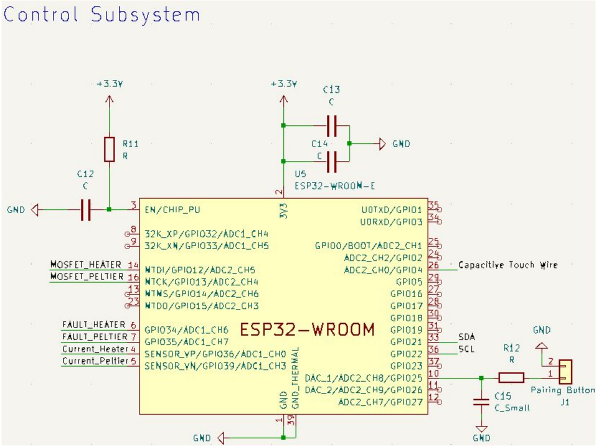


Design Overview

PCB Design



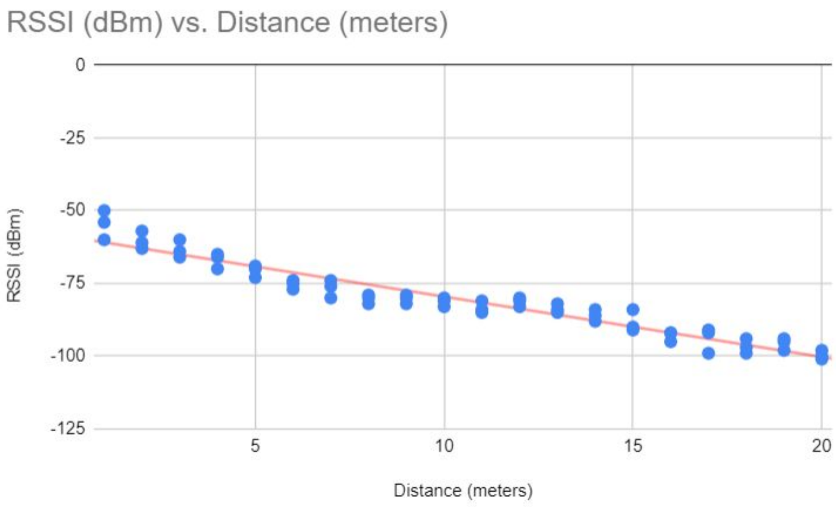
Control Subsystem



Overview

- ESP32-WROOM w/Bluetooth Module to communicate with mobile device
- Reads data from IR sensor and sends data to mobile device
- Adjust power relay based on temperature settings
- Calculate PWM cycle and control P-type mosfet output

Control Subsystem



Received Signal Strength Indicator Verification

Successes

- Able to connect to mobile device within a range of 20 meters
- Transmit data from IR sensor to mobile device
- Determine power cycle for power subsystem
- Implement capacitive touch wire on GPIO pin

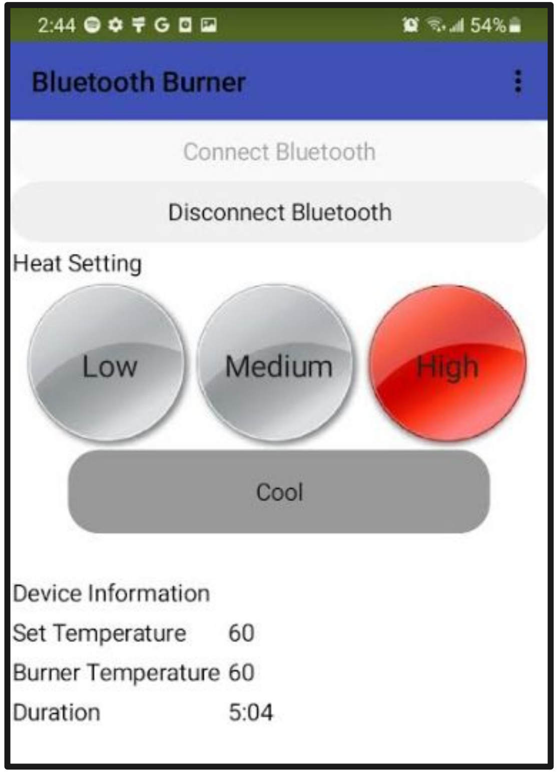
Challenges

- Determining bluetooth library: BLE or bluetooth serial
- Housing ESP32 on breadboard with limited space

Overview

- Software app that users can use to control bluetooth burner.
- Utilizes bluetooth channels to transmit and receive data for temperature and duration
- Sends signals to adjust temperature based on user input

Software Subsystem



Successes

- Application with user-friendly interface
- Display shows accurate temperature reading
- Bluetooth Connect/Disconnect button
- Buttons to control MOSFET for Low/Med/High

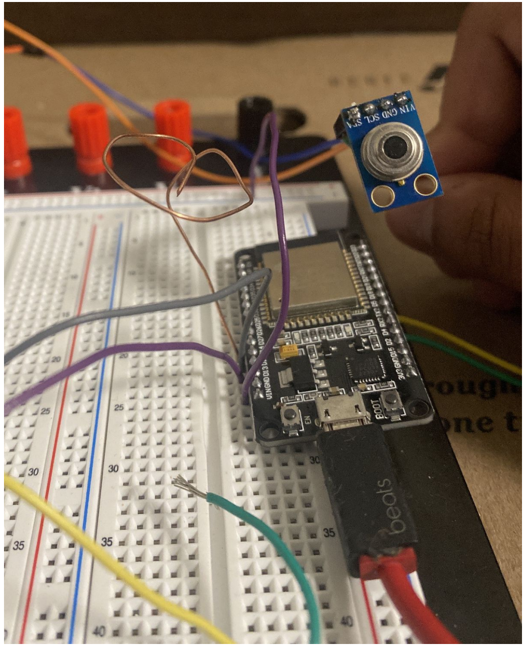
Challenges

- Bluetooth enablement in Swift (iOS)
- Duration setting configuration
- Device Information display

Software Verifications

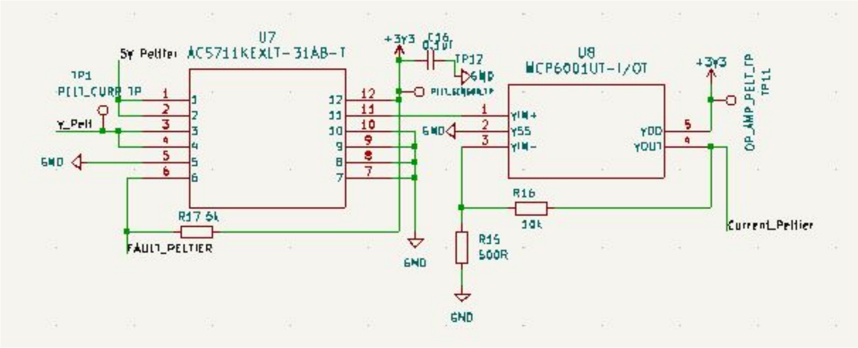
```
Sending Temperature: 22.99C
Sending Temperature: 23.39C
Sending Temperature: 23.35C
Sending Temperature: 23.33C
Sending Temperature: 23.33C
Heat Change to: 45C
Sending Temperature: 23.35C
Sending Temperature: 23.33C
Sending Temperature: 23.39C
Heat Change to: 60C
Sending Temperature: 23.33C
Sending Temperature: 23.29C
Sending Temperature: 23.33C
Heat Change to: 30C
Sending Temperature: 23.35C
Sending Temperature: 23.35C
Heat Change to: -10C
Sending Temperature: 23.29C
Sending Temperature: 23.53C
Sending Temperature: 23.57C
```

Sensor Subsystem

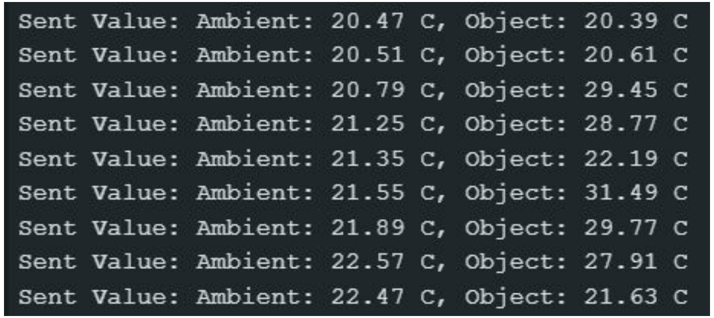


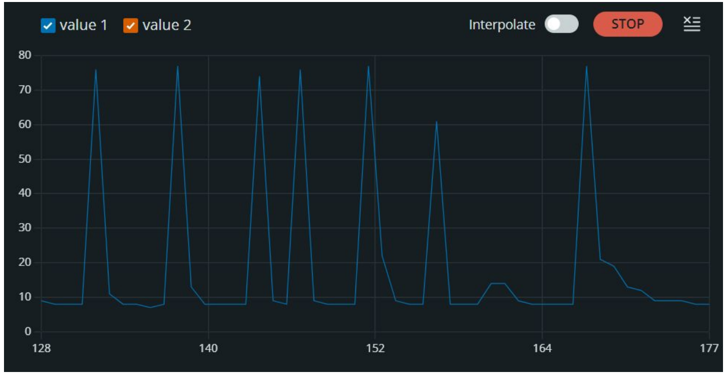
Overview

- MLX90614 IR Temperature Sensor
  - Object & Ambient
- Capacitive Touch Wire
- Current Sensors
  - Op-Amp for ESP32 ADC pins



Sensor Subsystem





Successes

- IR Sensor accurately sends data, to the hundredths place
- Capacitive touch wire detects contact past a threshold for cutting power to heating subsystem

Challenges

- Integrating with power subsystem components
- Soldering
  - QFN packages
- IR Sensor FOV & ambient readings

Heating Subsystem

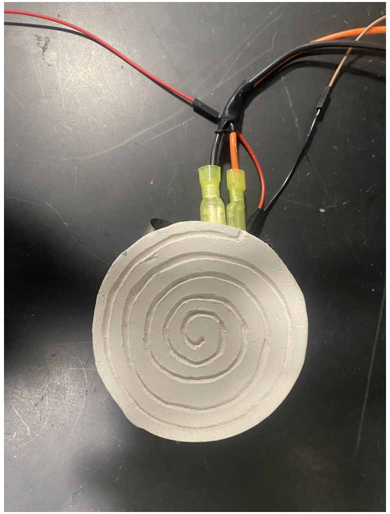
Overview

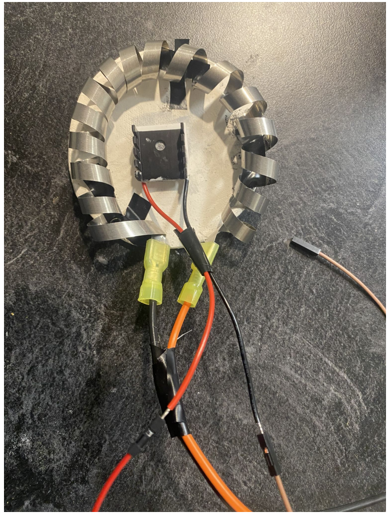
- Ceramic Pad
- Nichrome Wire Coil
- Peltier Module w/Heatsink

MODEL NO.	LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
CP40136	15 ±0.3	15 ±0.3	3.6 ±0.1
CP40236	20 ±0.3	20 ±0.3	3.6 ±0.1
CP40336	30 ±0.3	30 ±0.3	3.6 ±0.1

CP40 Series Peltier Module Model Dimensions

Heating Subsystem





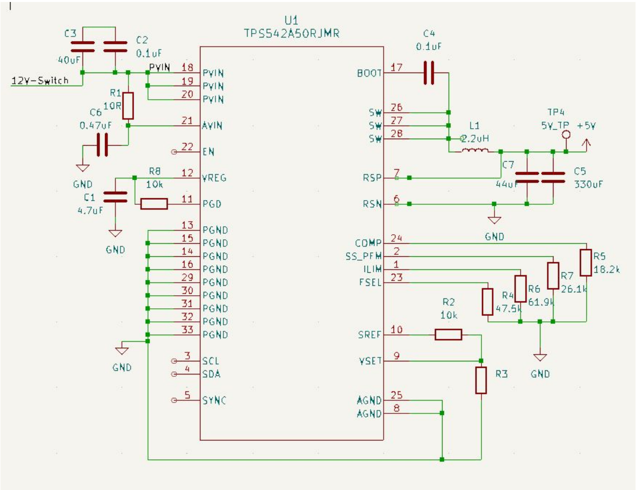
Successes

- Ceramic pad with spiral groove
- Coil and peltier module connected to pad with wiring for PCB

Challenges

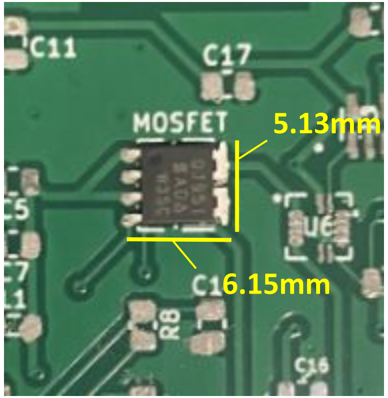
- Forming and binding coil to shape
- Attaching heating elements to pad

Power Subsystem

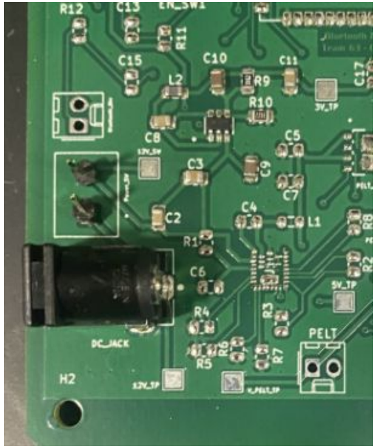


Overview

- TPS542A50RJMR 5V-15A Buck Converter
  - Input from 12V Wall Adapter
- AP62200WU 3.3V Buck Converter
- Dual P-Type MOSFET
  - Changed from N-Type
  - PWM Switching for temperature control



Power Subsystem



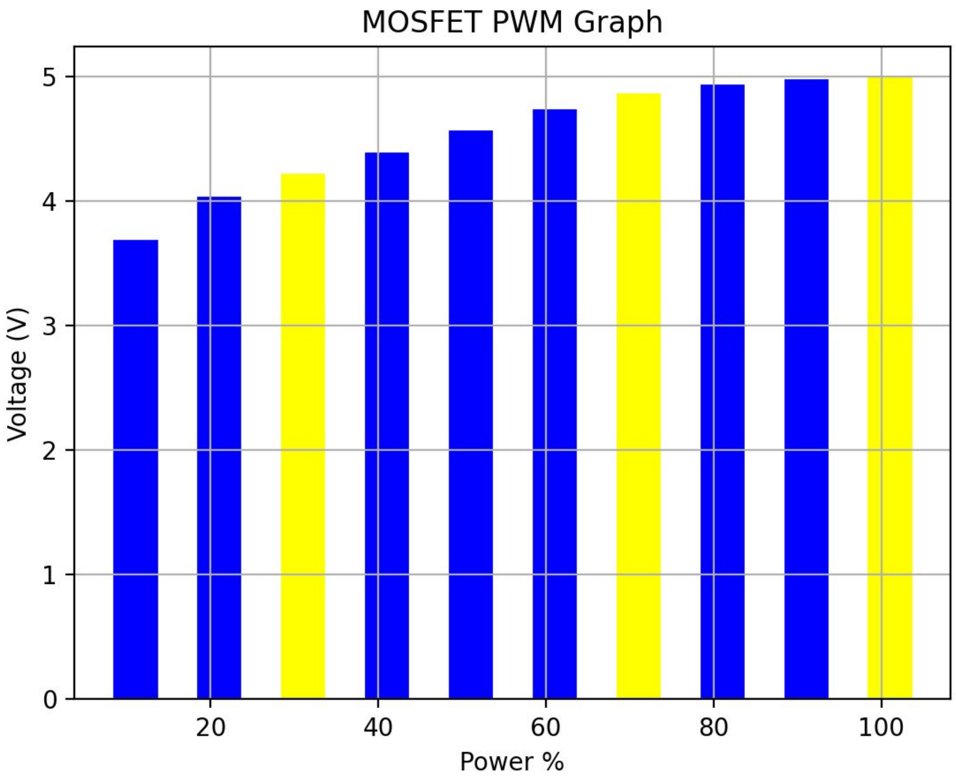
Successes

- Provided 12V inputs to both buck converters
- Regulated power through MOSFETS

Challenges

- Soldering
  - 5V & 3.3V were QFN Package
  - 3.3V Converter shorted
- Passive Components

Power Verifications



Conclusion

Conclusion

Results

- Subsystems functional on breadboard, not on PCB
    - Lacking resources compared to SMD components
- Two of our three high level requirements satisfied expectations
- Ceramic pad and enclosure finished

Things to Do Differently

- Utilize peltier module for heating
- Incorporate high current amplifiers
- Test/Break PCBs early

Future Considerations

Further Work Recommendations

- Allow for broader temperature range in phone application
- Enlarge ceramic pad for extended heating
- Pairing button on product rather than application
- Data logging and analytics

Questions