UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Habit Forming Key Station

Electrical & Computer Engineering

Team 17

Team Members

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Agenda

1. Objective
2. Design and High Level Requirements
3. Functional Requirements
4. Successes and Challenges
5. Conclusions and Further Work

Objective

Habit Forming Key Station

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Objective

Problem

- People leave their keys around the house, making it difficult to locate them when it's time to leave
- Might result in people being late or add stress to people's lives

Solution

- Our habit-forming key station is a designated home for your keys
- It detects when you've come home
- Place the keys in the dish within a certain time period or it will sound an alarm
- Utilizes negative reinforcement to build a good habit for the user

Design

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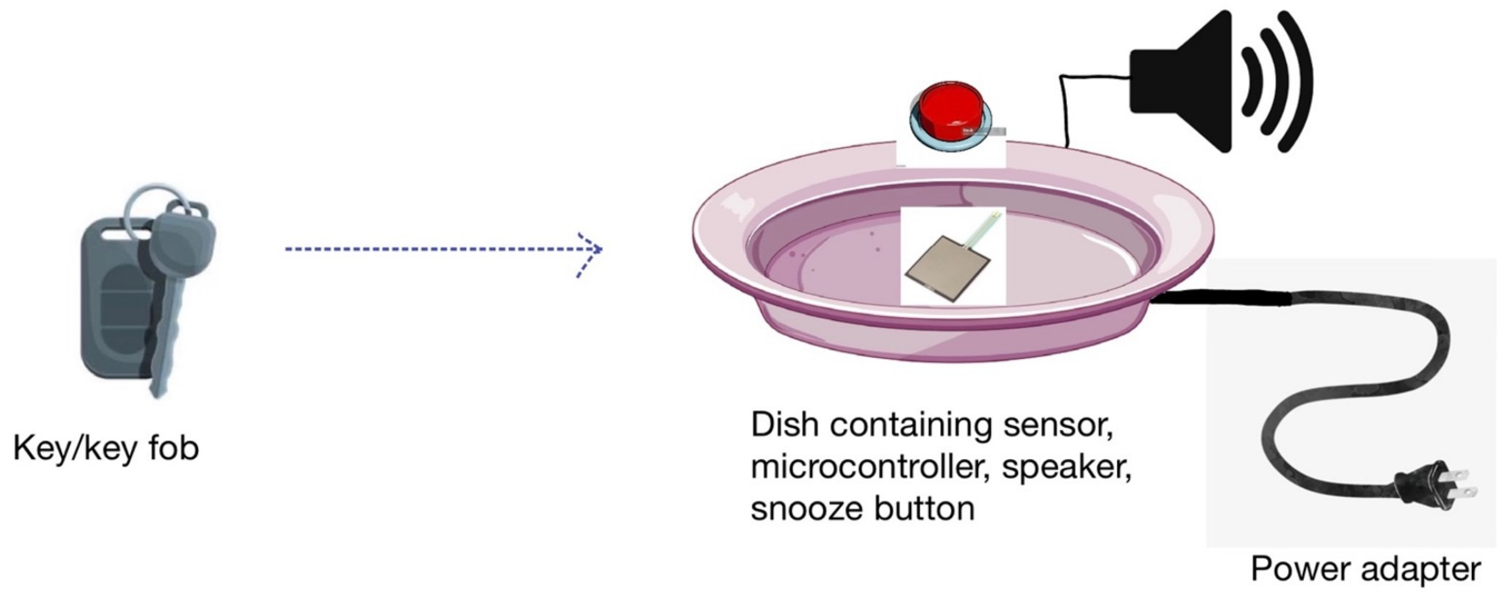

Components

-Force resistor
-Speaker
-Button
-Power Adapter
-Microcontroller
-Transceiver on dish and keychain

High Level Requirements

- The microcontroller waits 2 - 4 minutes after removing the keys from the pressure plate before enabling the proximity subsystem to detect the keys ✓
- The proximity subsystem should detect the key fob at a minimum of 15 feet from the dish. Upon detecting the keys, it should wait 30-90 seconds before sounding the alarm. ✓
- The alarm turns off by either placing the keys in the dish or pressing the snooze button within 5 seconds of either method ✓

Design Criteria

- Attached to keys are a transceiver that detects distance from station
- As keys enter a certain radius, alarm will start buzzing
- If user does not want to place keys in and is leaving residence soon, snooze button is available.
- As user leaves with the keys, station enters waiting state.

Overview of Functional Requirements

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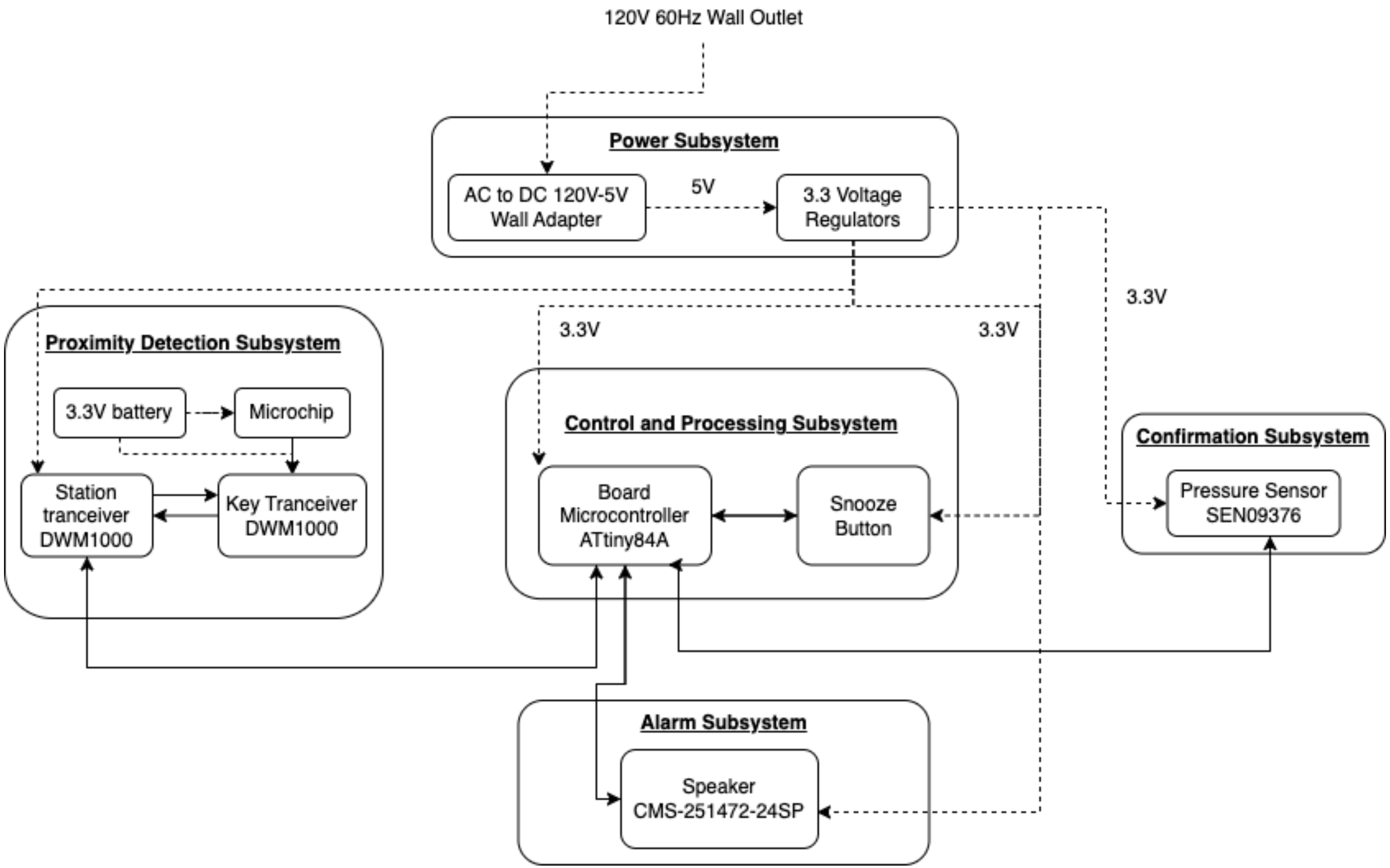
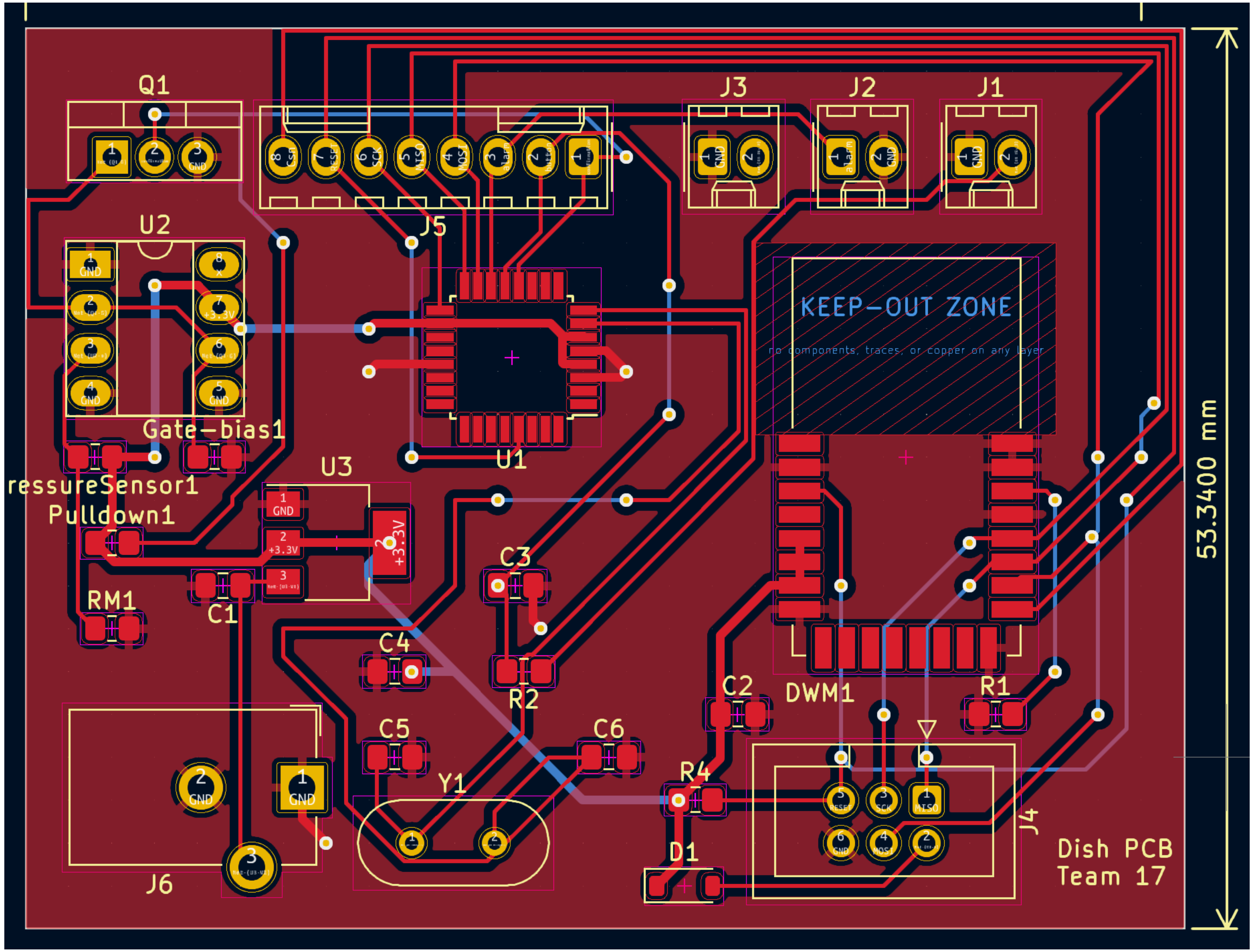
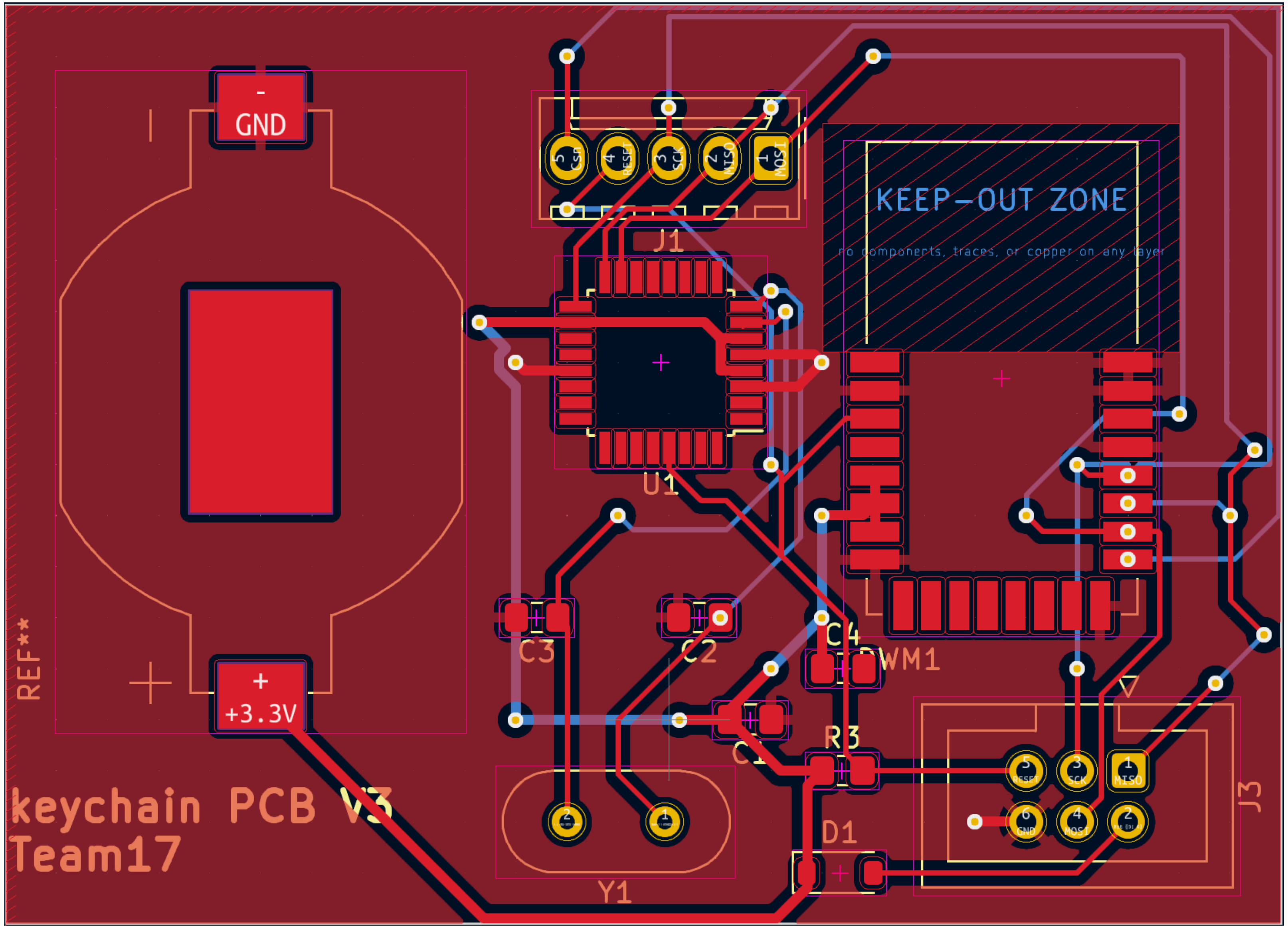
Block Diagram



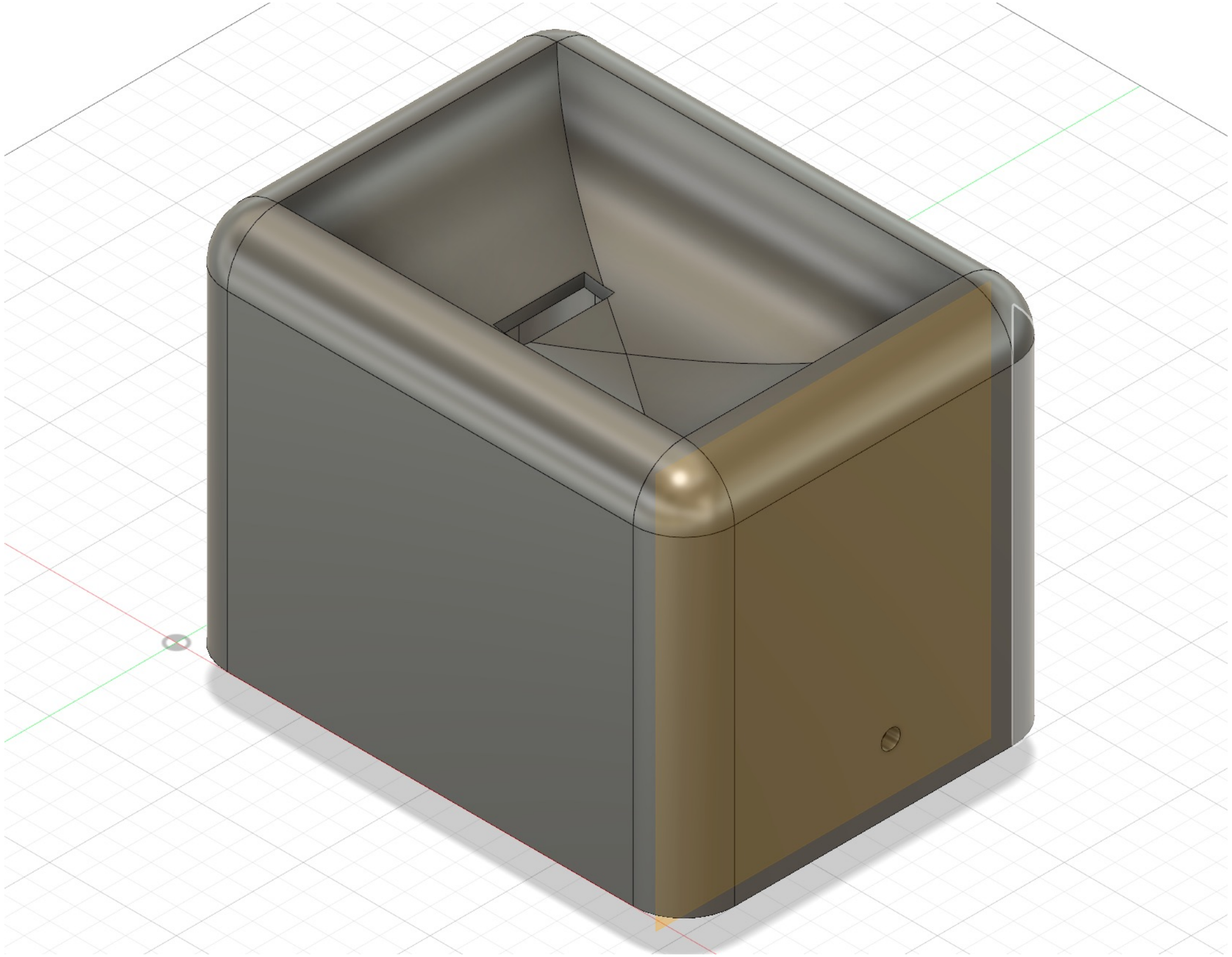
PCB Design - Station



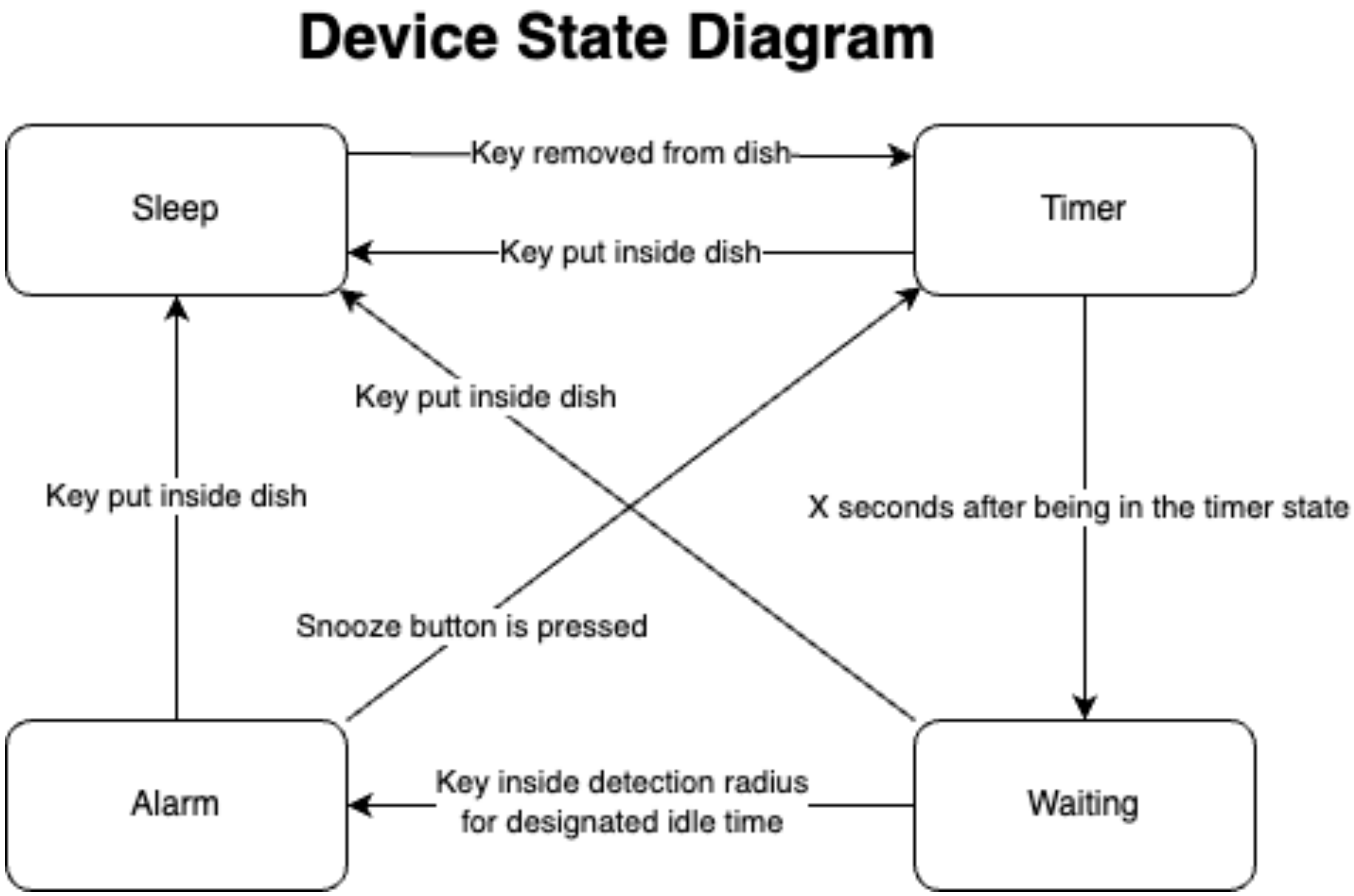
PCB Design - Keychain



Overall Design



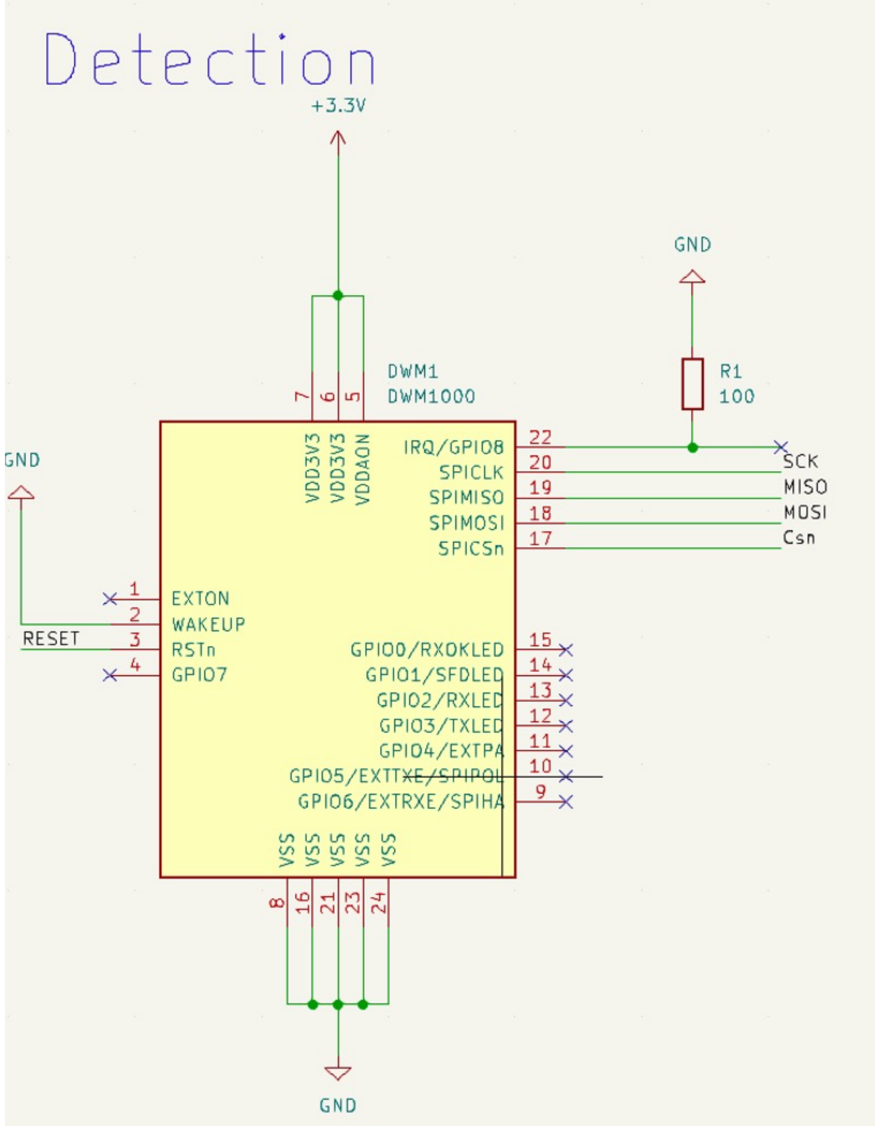
Software State Diagram

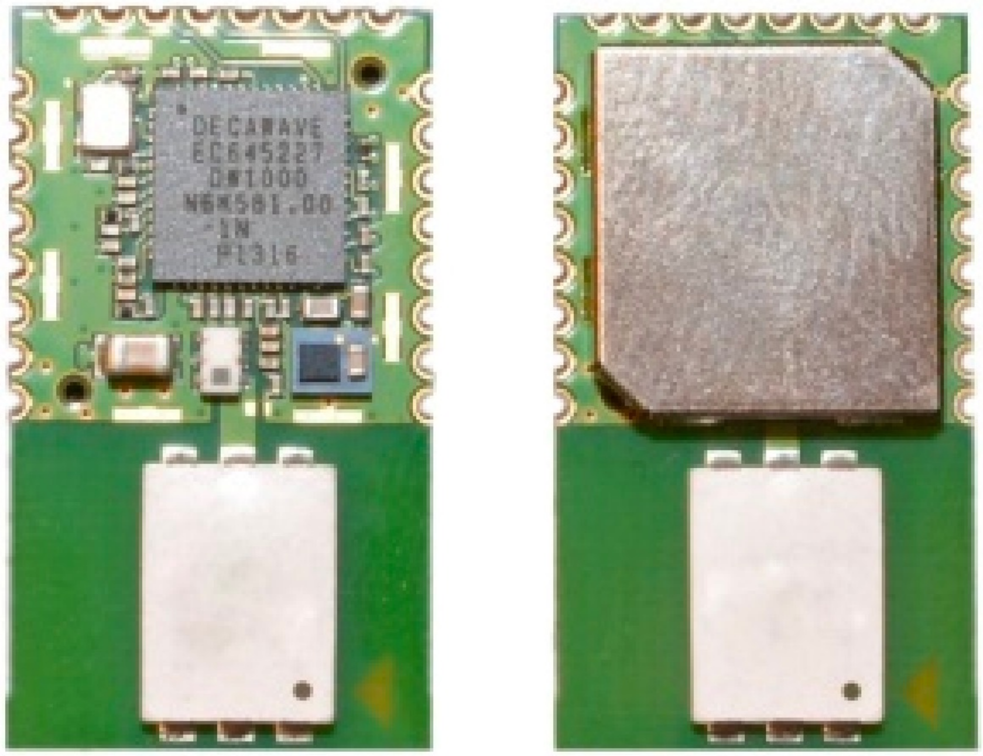


Control Subsystem

Requirements	Verifications
Transition between four states when provided the appropriate input	• Simulate software stimuli to ensure sound control logic. • Develop test harness which projects state to an LED. Provide stimuli to change states • Test each path to ensure safety of state reachability

Proximity Detection

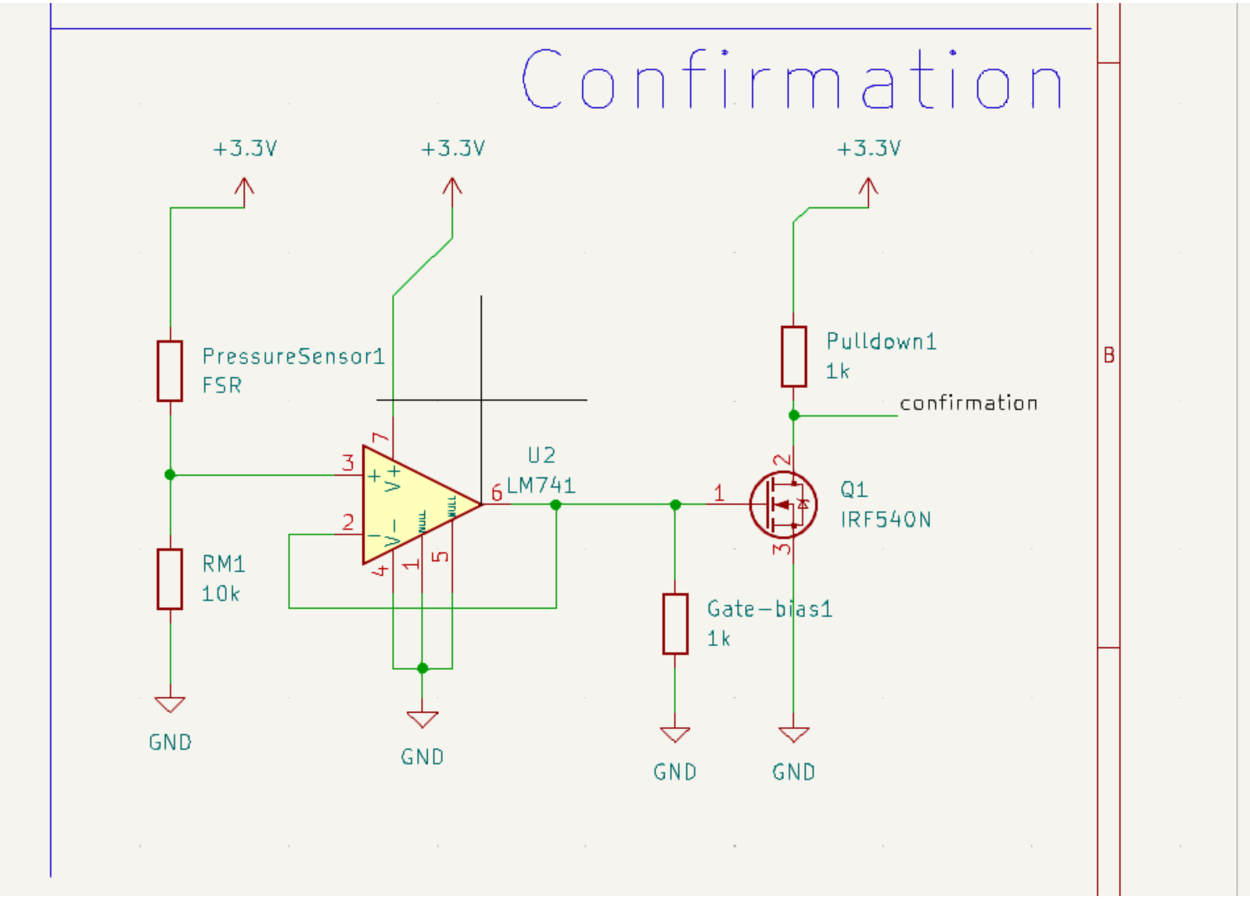


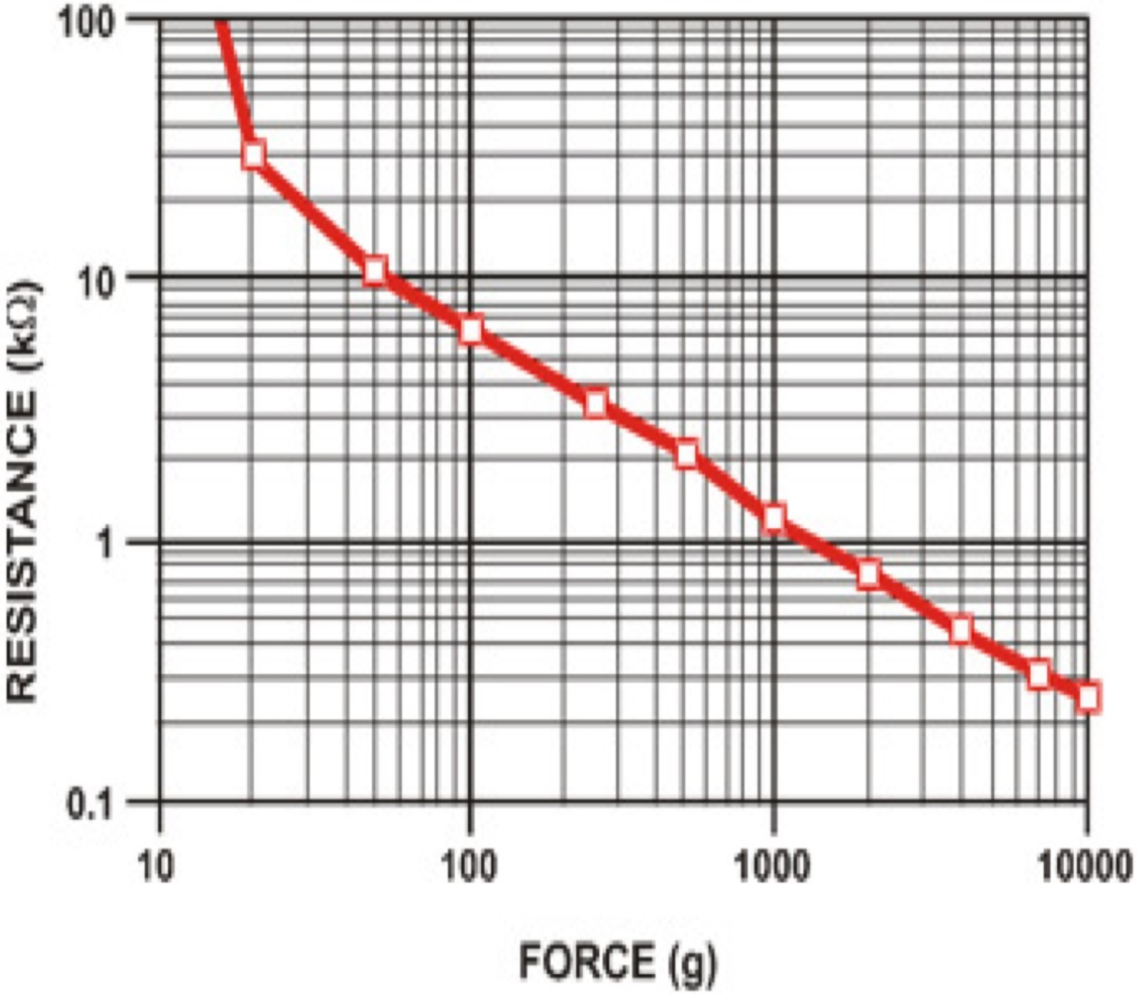


Proximity Detection

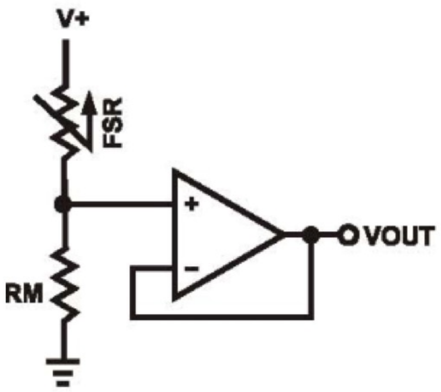
Requirements	Verifications
The subsystem shall detect the key fob within a 5 meters radius.	· Perform a series of detection tests at 1-foot intervals up to 5 meters.The system must detect the key fob at all distances, with a detection rate of 100% within 5 meters.
The subsystem shall accurately measure the distance of the key fob using time-of-flight calculations.	· Compare the system's distance measurements against a set of known distances, from 1 to 15 feet, in a controlled environment. · The system's measured distances must have a maximum deviation of less than 5% from the actual distances.

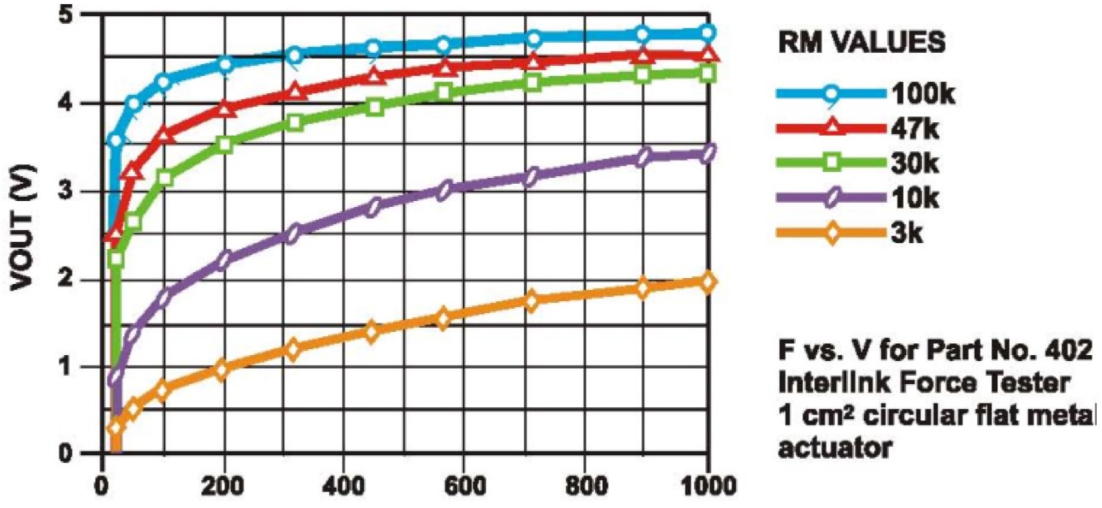
Confirmation





Confirmation





$$V_{OUT} = \frac{R_M V+}{(R_M + R_{FSR})}$$

Confirmation

Requirements	Verifications
Detect placement of objects weighing between 45g to 55g, simulating key weight, with a tolerance of ±5g.	· Place an object weighing 50 grams on the pressure sensor to simulate the presence of keys. · The system must recognize the presence of the object as keys within 2 seconds of placement.
The subsystem shall trigger an alarm if the keys are not placed back within 2 minutes after being removed.	· Remove the keys and wait for 2 minutes to observe if the alarm is triggered.

Alarm Subsystem

Requirements	Verifications
The alarm must be audible at 80 dB SPL at 1 meter.	· Test with a sound level meter at 1 meter. · Confirm SPL meets/exceeds 80 dB
Speaker power consumption should not exceed 2W.	· Measure power usage with a multimeter. · Connect load to test voltage at differing current levels · Ensure it is within 2W during operation

Power

Requirements	Verifications
Provide a stable 5V output under load.	· Conduct load testing with a multimeter · Ensure voltage remains within 5% of 5V.
Voltage regulators must be able to output 3.3 VDC +/- 0.1 V with at most 1A of current	· Connect adapter to voltage regulators · Connect test load resistors · Confirm voltages at differing current values · Confirm results are in range of 3.3V +/- 0.1V

Successes and Challenges

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Successes and Failures

Control Subsystem:

Successes:

- Software implemented correctly
- Follows state diagram
- Sends the proper signals to alarm.

Changes:

- Microcontroller changed for more pins

Successes and Failures

Confirmation Subsystem:

Successes:

- Correctly uses pressure sensor to detect change in voltage
- Sends signal to control system

Proximity Detection Subsystem:

Successes:

- Transceivers are able to detect each other in a 5+ meter range

Changes:

- Operated under 5 Volts instead of 3.3 Volts

Successes and Failures

Alarm subsystem:

Successes:

- Outputs an 80 dB noise when prompted by control subsystem.

Changes:

- Switched to a piezo buzzer for breadboard testing purposes

Power Subsystem:

Successes:

- All components worked under expected voltages and did not exceed power capabilities

Failures:

- Power adapter not functional, cannot power the PCBs

Conclusions and Further Work

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Conclusions

What We Learned

- Soldering experience
- CAD Design
- Deepened understanding on a wide variety of concepts
- Impact of good time management
- Technical writing and presentation

What We Would Have Done Differently

- Having a more timely product ordering schedule
- Starting development earlier
- Testing components regularly

Further Work

PCB Implementation

- Find alternates for power components
- Compact power system for key PCB

Housing

- Cost and Space efficient design

Questions?

The Grainger College of Engineering

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