

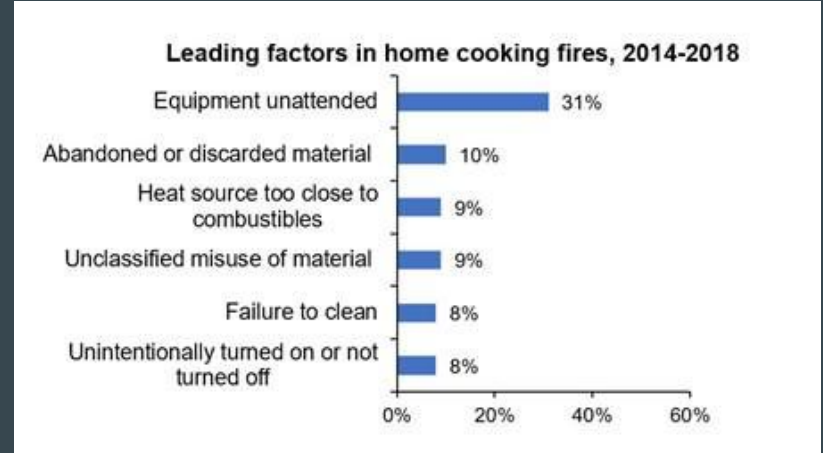
# Gas Stove Safety Device



Group 25  
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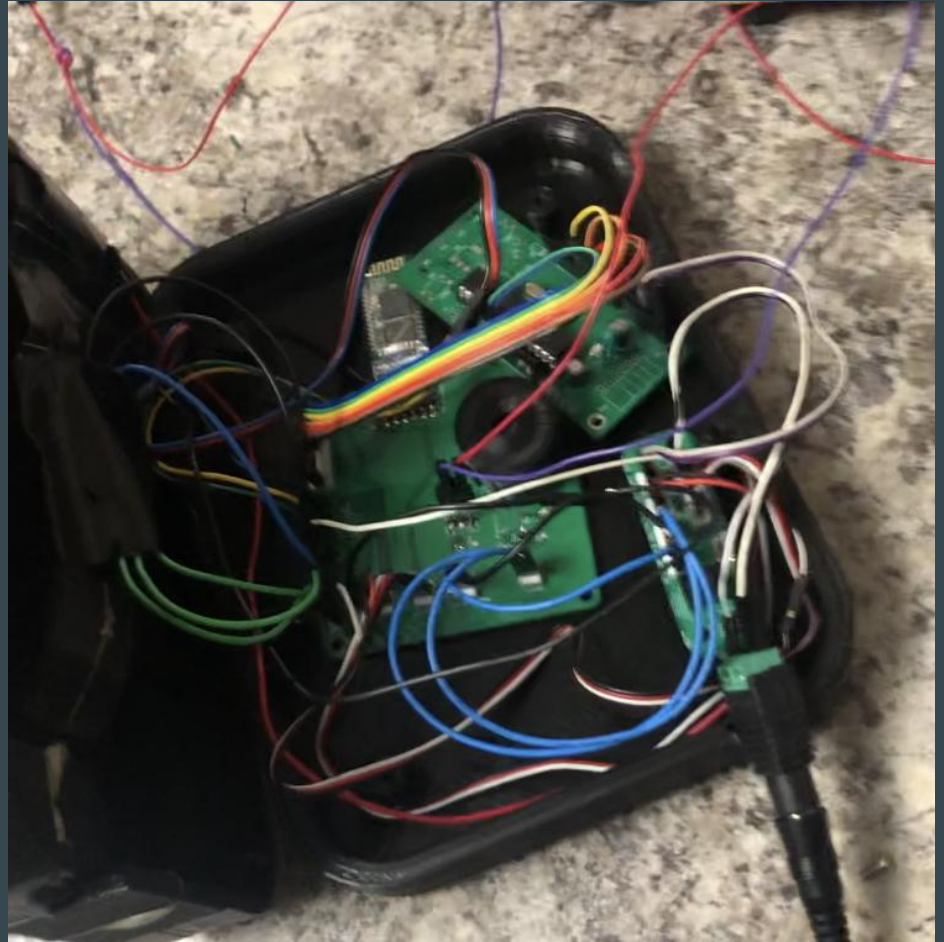
# The Need For Safety

- 172,000 homes burn down every year due to cooking-related incidents [1]
  - Gas stove devices have many issues [5]
    - Expensive (\$500+)
    - Hard to install
    - Mechanically complex
  - Our solution addresses all of these



# Gas Stove Safety System

- Stop trying for automated shutoff
  - Alert the user instead
  - Reduces cost and complexity
  - Less complex = smaller size
- Solution will be a sensor suite + alarm



# Features

- Methane, Propane, and Butane gas sensing
- Reminders when the stove is on
- Distance-based alarm
- Small footprint

# System Overview

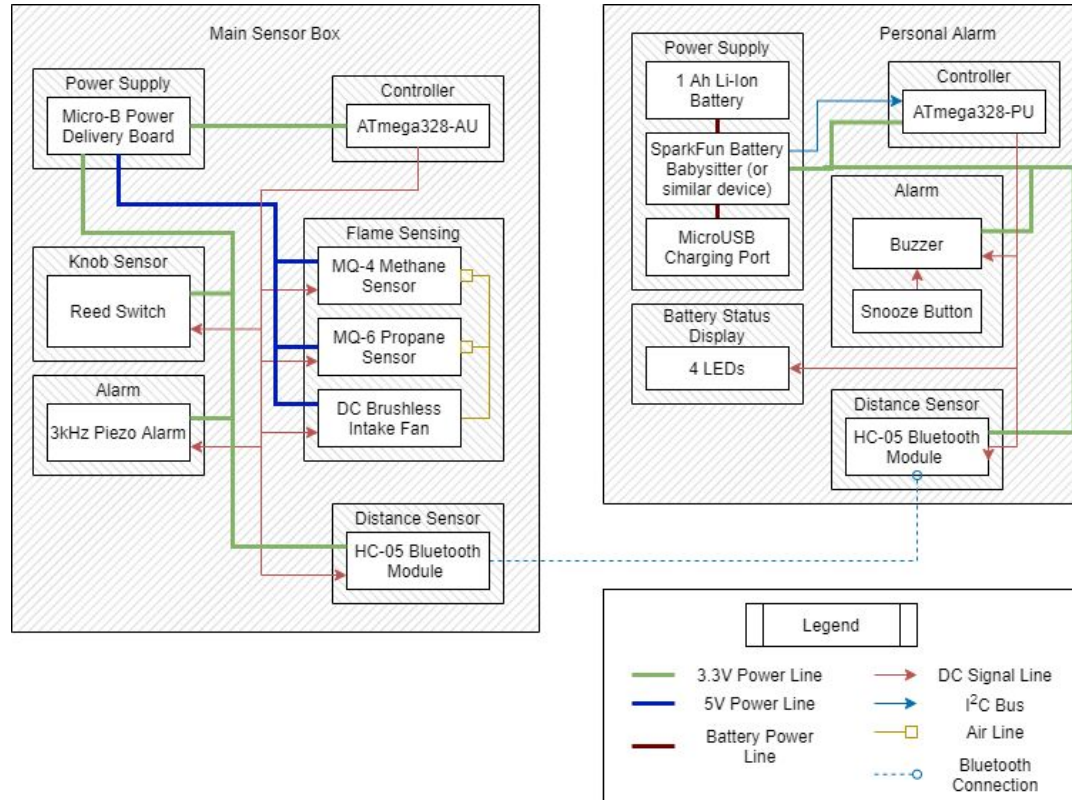
## Main Sensor Box

- Hardware:
  - Micro-B Power Supply Intake
  - ATmega328-AU
  - Methane, Propane, and Butane Gas Sensors
  - Intake Fan for gas
  - Bluetooth distance sensing
  - 70dB sound alarm
  - Stove On/Off Sensor
- Firmware:
  - Analog/Digital sensor output conversion
  - Internal timers

## Personal Alarm

- Hardware:
  - Micro-USB Power Supply Intake
  - ATmega328-PU
  - Battery status monitoring
  - Bluetooth distance sensing
  - 70dB sound alarm
- Firmware:
  - Square wave signal generator
  - Internal timers

# System Overview



# Hardware Overview - Main Sensor Box

- Power Supply
  - Takes 5V - 1A from AC/DC wall converter
  - Converts to a 3.3V and 5V rail
- Controller
  - Provides general logic in the system
- Flame Sensing
  - Detects the presence of methane, butane, and propane, which is emitted in the absence of flame
- Knob Sensing
  - Detects whether the stove is on or off
- Alarm
  - Emits sound to alert the user
- Distance Sensor
  - Provides a point for the personal alarm to connect to

# Hardware Overview - Personal Alarm

- Power Supply
  - Takes in 3.7V from a Li-Ion battery and converts it to a 3.3V rail
  - Also responsible for determining the charge of the battery
- Controller
  - Provides general logic in the system
- Battery Status Display
  - Outputs the current charge level of the battery
- Distance Sensor
  - Determines when the user has walked too far from the stove
- Alarm
  - Emits sound to alert the user



# Hardware Overview - In House Manufactured Main Sensor Box

## Casing - In House Main Sensor Box

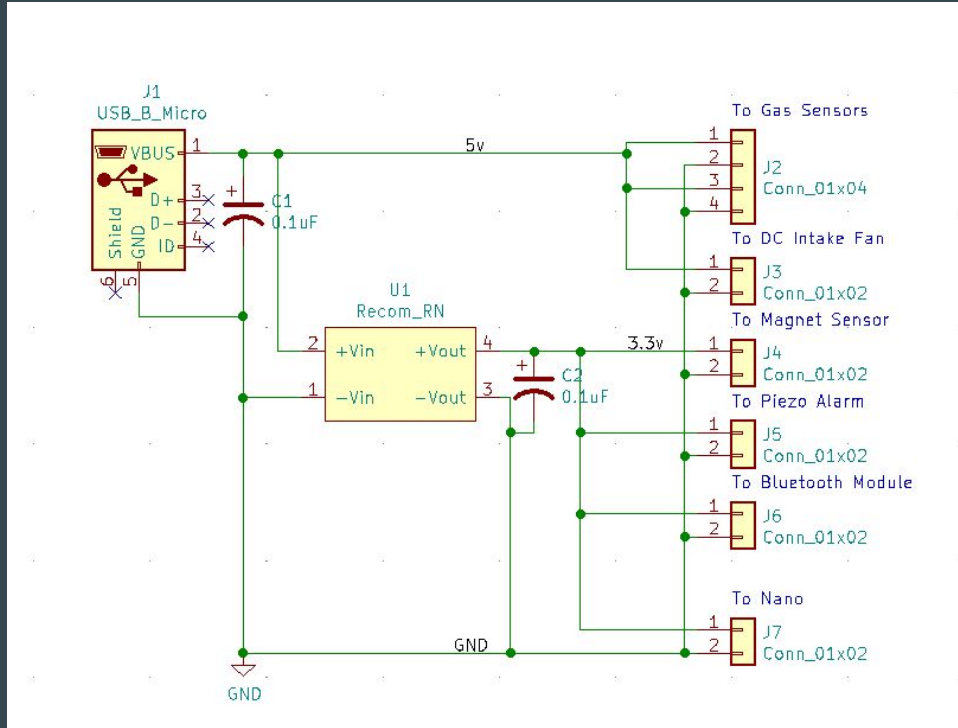
- No electronics in this component
- Air intake/exhaust vent for gas
- 3D printed PLA
- IP51 Water Protection Rating
- Verified using a water test



# Power Supply - In House Main Sensor Box

- Supplies GND, 3.3V and 5V rails
- Maximum current: 1A
- Focuses more on voltage conversion
- Regulation relies on a charging brick
  - Common and reliable





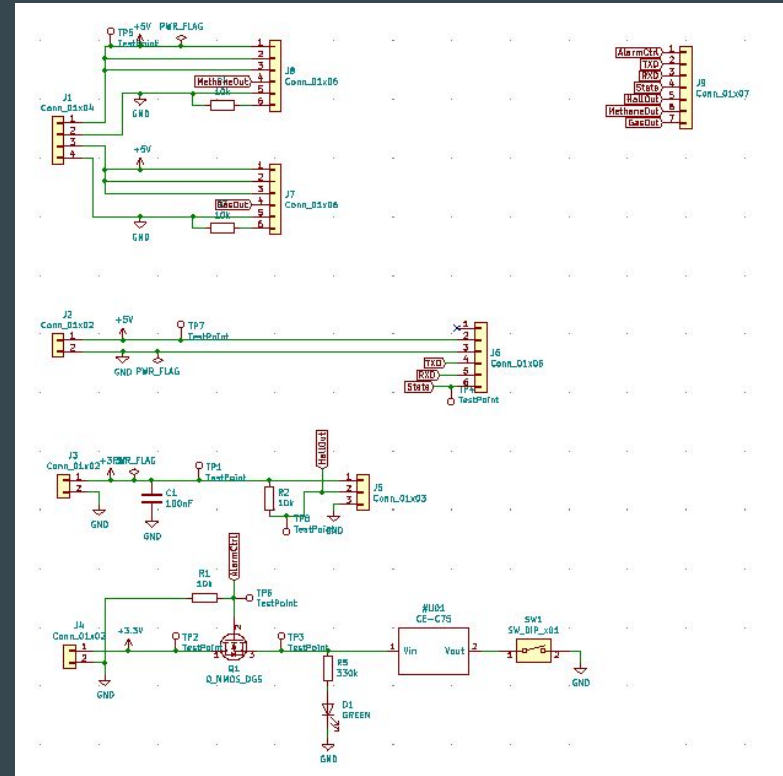
- Verification: Load attached to 3.3v and 5v rail

	5V Line	3.3V Line
Open Load	5V 26mA	5V No Current
16 Ohm Load	5V 310mA	3.384V 208mA

# Hardware Overview - Sensor Suite

# Hardware Overview - Sensor Suite

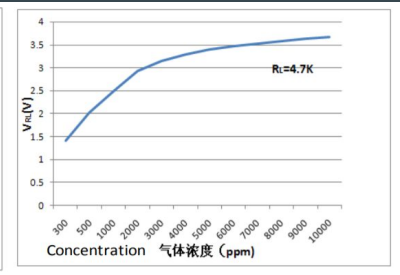
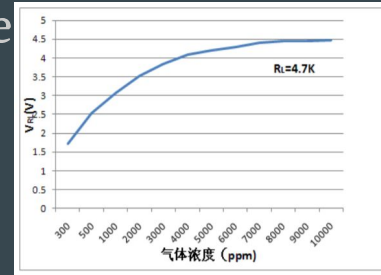
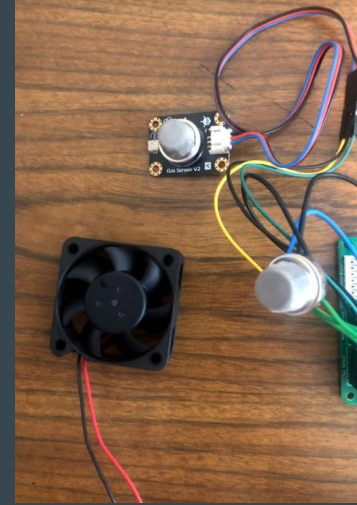
- Flame Sensing
  - 5V DC Brushless Fan
  - MQ-4 Methane Sensor
  - MQ-6 Propane/Butane Sensor
- ATmega328-AU
- AH1815 Non-Latching Hall Effect Sensor
- 3kHz Piezo Alarm
- HC-05 Bluetooth Chip



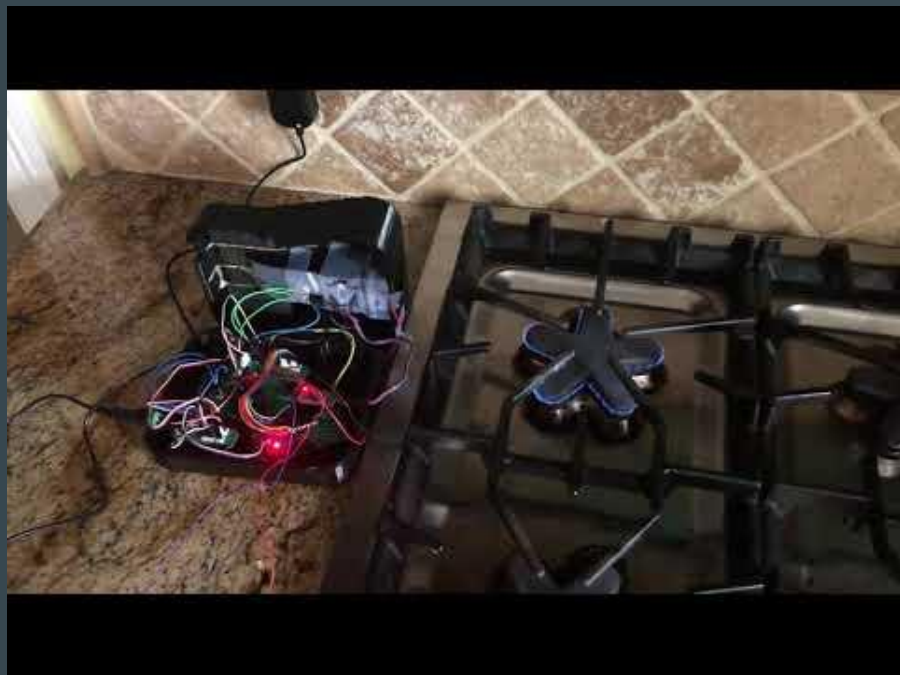
Sensor Suite - Schematic  
Main Sensor Box

# Flame Sensor - Main Sensor Box

- 5V DC Intake Fan (AFB0505MB)
  - 12.4 CFM air flow
- MQ-4 Methane Sensor
  - 300ppm~10kppm Methane
- MQ-6 Propane Sensor
  - 300ppm-10kppm propane and butane
- Flame Detection by presence of gas
- Verified by introduction of gas



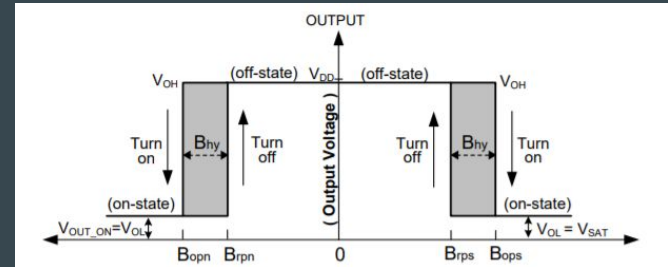
# Gas Sensor Suite Gas and Flame Test





## Knob Sensor - Main Sensor Box

- AH1815 Non-Latching Hall Effect Sensor
  - Stove Knob Position Detection
  - Logical 1 above 395 Gauss
  - Logical 0 below 335 Gauss
  - Magnet placed inside knob's north end



## Alarm - Main Sensor Box

- CE-C75 Miniature Piezoelectric Alarm
  - Emits sounds roughly 75dB
  - Driven by MCU controller
  - Potential damping with foam



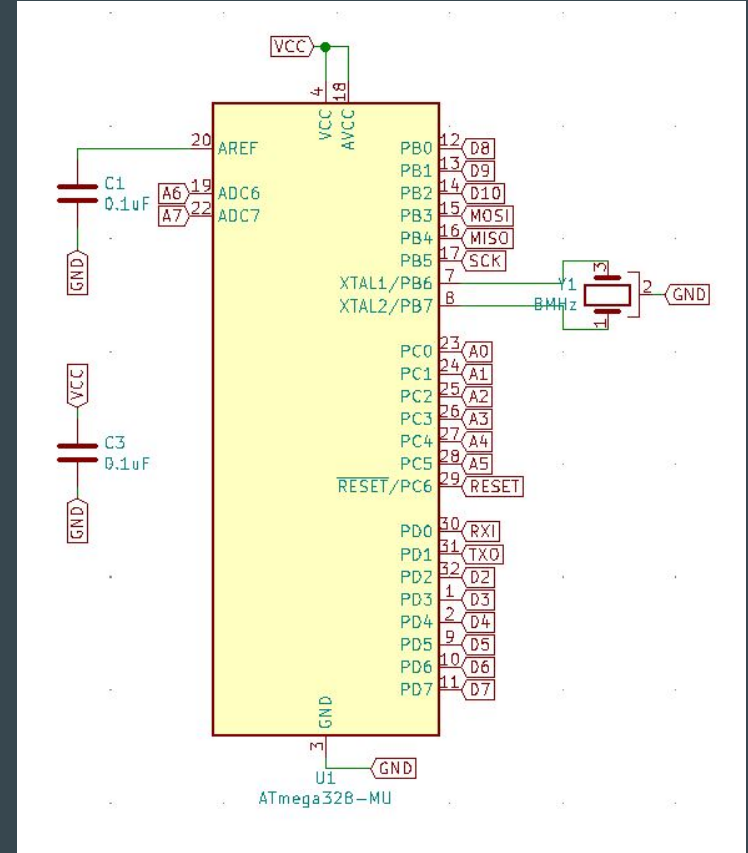
## Distance Sensor - Main Sensor Box

- HC-05 Bluetooth Module
  - Connection and disconnection determines distance
  - Rated at a range of 10 meters
  - 5V logical reading of STATE pin
  - No need to power cycle for reconnection



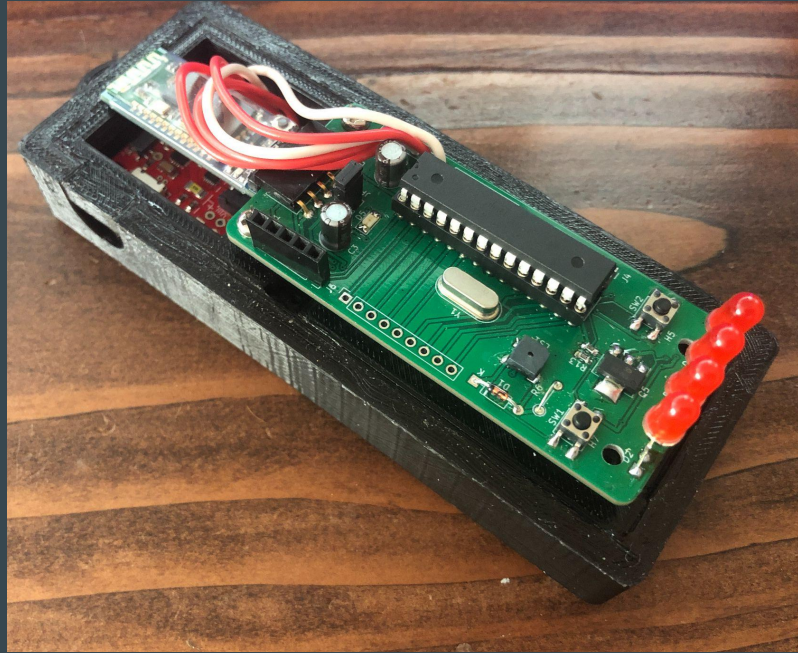
# Controller - Main Sensor Box

- ATmega328-AU
  - Reads sensor outputs and drives alarm
  - Serves as analog/digital converter for gas sensors
  - Accepts 3.3V and 5V logic
  - Operates on an 8MHz clock
  - Maintains internal timer to alert user



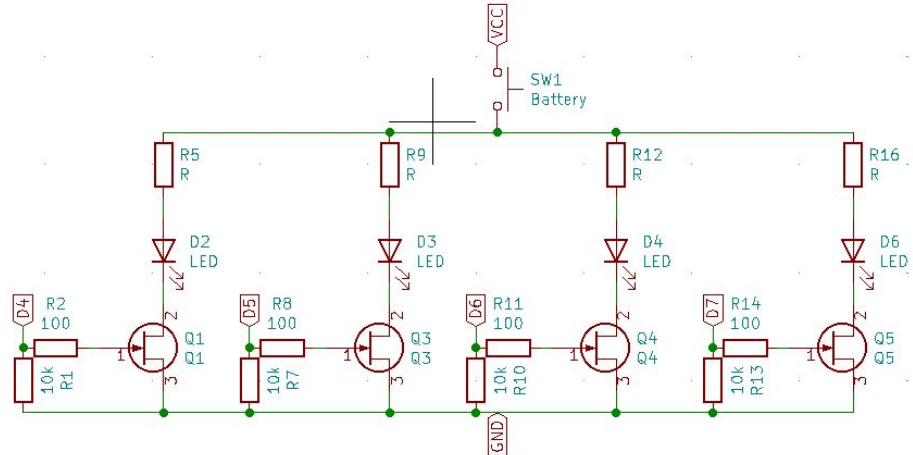
# Hardware Overview

## Personal Alarm



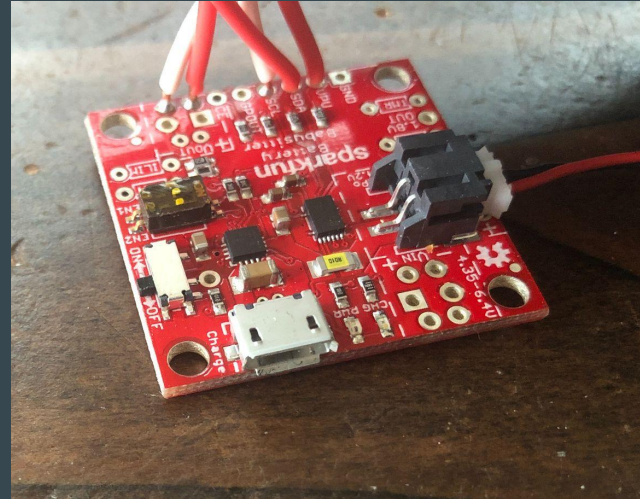
# Battery Display Personal Alarm

- Each LED represents 25 percent
- 4 MOSFETs Control the LEDs
- Power is supplied to LEDs by a push button



# Power Supply - Outsourced Personal Alarm

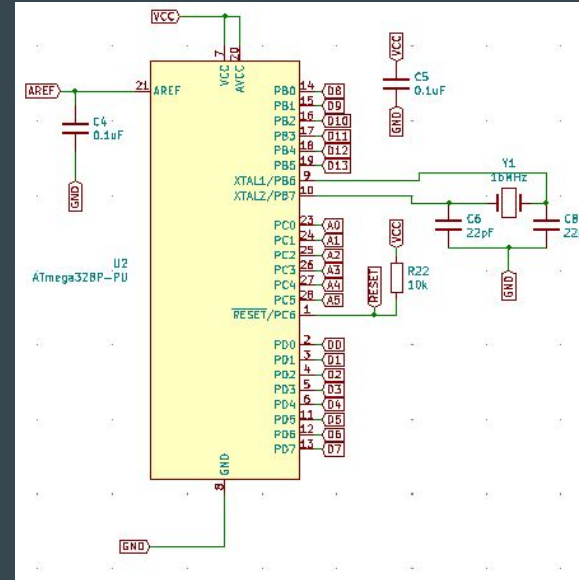
- SparkFun Battery Babysitter
  - Monitors battery health and charge remaining
  - Compatible with 3.7V LiPo batteries
  - Uses 3.3V for I<sup>2</sup>C bus
- Prefab breakout used
  - LiPo safety purposes; a circuit failure would result in large issues
  - Better to take the expensive but reliable solution





# Controller Personal Alarm

- ATmega328-PU
  - Implemented Internal timer and snooze like an alarm clock
  - Monitors distance sensor output for when user has walked too far
  - I<sup>2</sup>C bus gives current battery status
  - Accepts 3.3V logic
  - Operates on an 16MHz clock

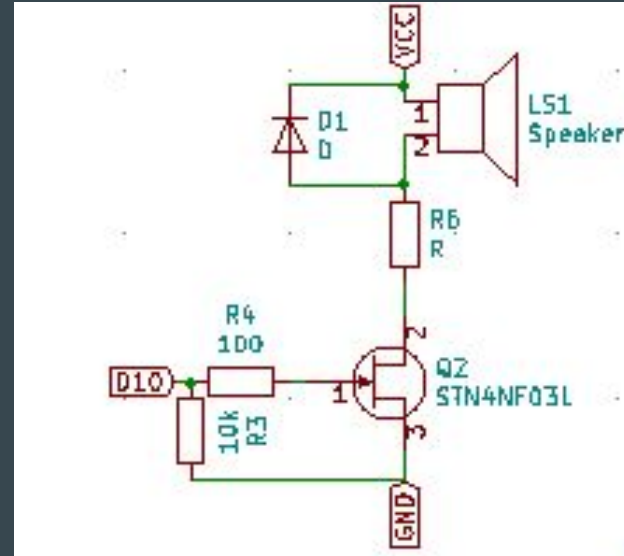




# Alarm

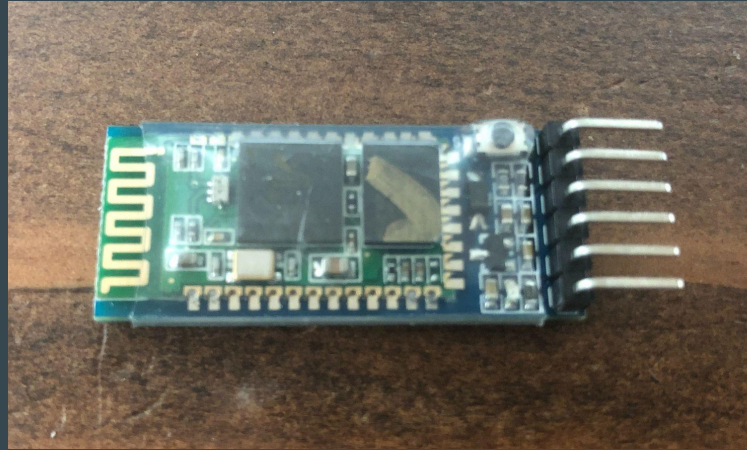
## Personal Alarm

- CMT-0525-75-SMT-TR Magnetic Buzzer
  - Alerts the user with a loud sound
  - Accepts a square wave from 100Hz-10kHz
  - Square wave generated by Controller



# Distance Sensor - Outsourced Personal Alarm

- HC-05 Bluetooth Module
  - Uses connection determine distance
  - Rated at a range of 10 meters
  - 3.3V logic configuration includes a STATE pin
  - Set to create outbound connections



# Factors Influencing Performance

- Primary issue: Distance sensor
  - Microwaves, walls, and other Bluetooth devices may interfere with the signal, causing a shorter effective range
  - This is not an issue we need to fix, as 10 meters is a very long distance, and shorter distances enforce more safety, especially if the interference is something that distracts the user

# Development Process: Why two different processors?

- Mostly a communication issue
  - Exact microcontroller not specified
  - Libraries only had one of two controllers
  - We only ordered the ATmega328-PU at first, then realized the issue later
  - A learning experience in clarity of communication

# Development Process: The Reed Switch

- Necessitated by hardware component failure
  - Reed switch was more readily available
  - Functionality was similar to original sensor
  - Overall a good replacement

# Future Improvements: Smaller Footprint

- Sensor box can be smaller
  - Vertical design may help
  - Optimizing airflow route for size
  - Mount PCBs on sides of casing
  - Weights on bottom of casing
  - Simple but good improvement

# Future Improvements: Automated Shut-Off

- Stepper Motor driving a gear turns knob
  - This can allow automated shut-off
  - Stepper motors are highly reliable
  - External feature; can be swapped out
  - Very useful if gas is leaking
  - Supports future smart home integration

# Future Improvements: Mobile App

- Phones are much more powerful
  - Reduces consumer costs
  - Phones are much more well made
  - Automated Shut-Off function compatibility



# References

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