Portable Anti-Theft Package Container

ECE 445

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Team Members

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1 Introduction

Objective and Background

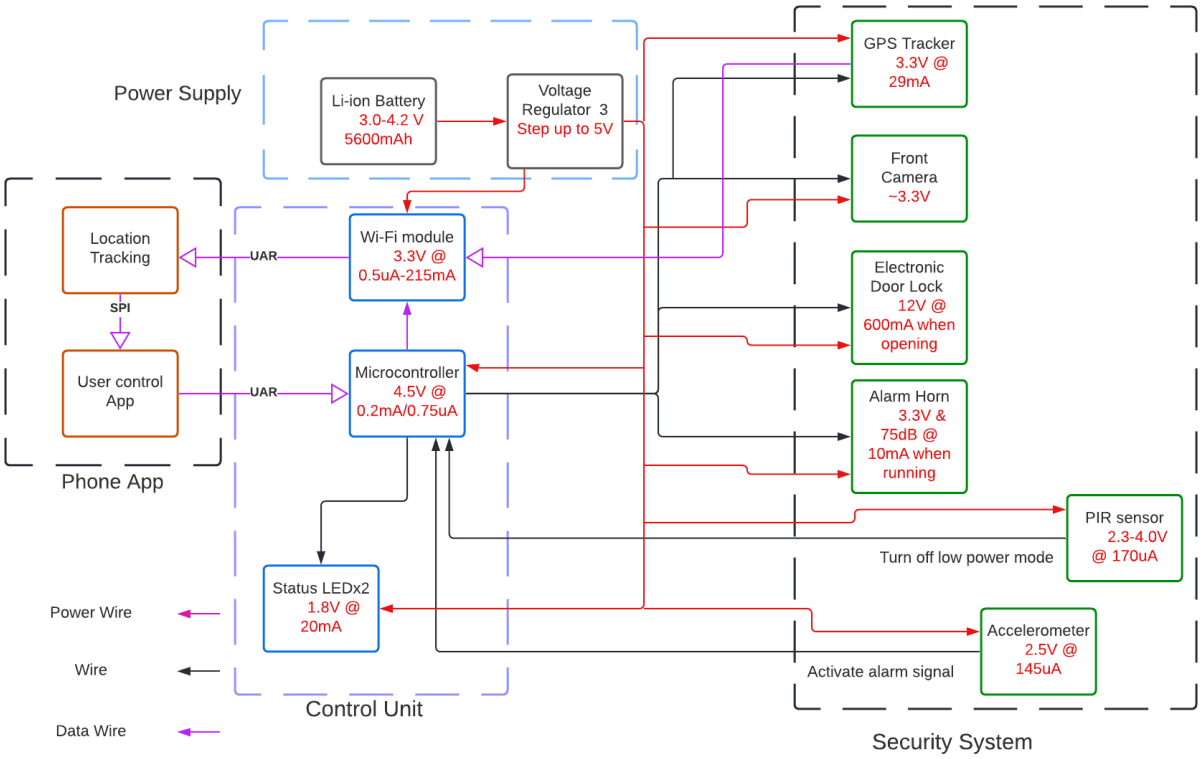
- Deter package theft in areas where delivery lockers may not be available
- Provide online retailers a means to ensure secure and delivery of goods to customers
- Mobile container for packages can easily be retrieved and redeployed by companies
- A plain and inconspicuous exterior prevent potential thieves from noticing the container
- Preventing theft will cut losses online retailers face due to refunding orders to customers

High Level Requirements

- Container must be able to communicate with a phone app that locks and unlocks the door to the package inside
- The container must be able to detect when a theft attempt is occurring, such as being carried away or broken into
- Systems must be able to operate on battery life for up to 12 hours and be recharged externally when out of power

2 Design

Block Diagram



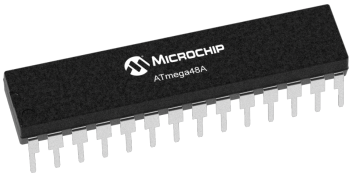
2.1 Power Supply

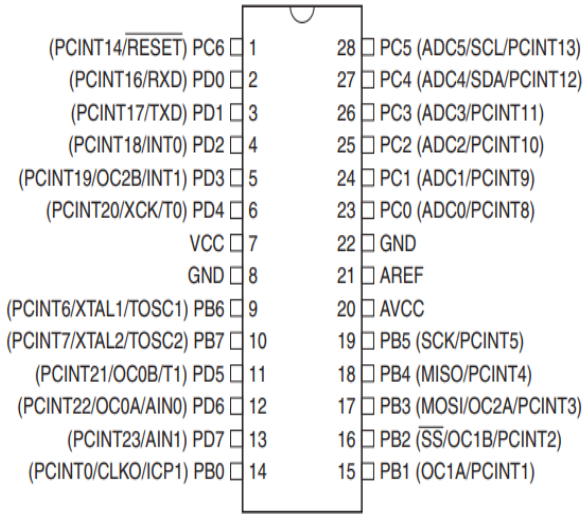
- 2.1.2 Li-ion battery
    - ***The greatest safety concern in the device.***
    - Two 3.7V batteries will power the device
        - **18650 Cell** (**2600mAh** with solder tab and battery holder)
    - Will be taken out to recharge. Can easily be replaced
    - *Requirement 1:* Need to be isolated in a separate chamber to prevent short circuits.
    - *Requirement 2*: Need a capacity of ~2000mAh each or greater.
- 2.1.3 Voltage regulator
    - Keep the circuit's voltage at a desired voltage (3.65 V/cell)

- *Requirement 1:* Needs to cut off power to the system if battery voltage decays below 3.0V/cell or exceeds 4.2 V/cell
- *Requirement 2:* Also includes a step converter to give us the appropriate amount of voltage for the security and control systems

2.2 Control Unit

- 2.2.1 Microprocessor
  - Our chosen microprocessor will be the ATMEGA48A-PU
    - **28 pins** on a **SPDIP** layout

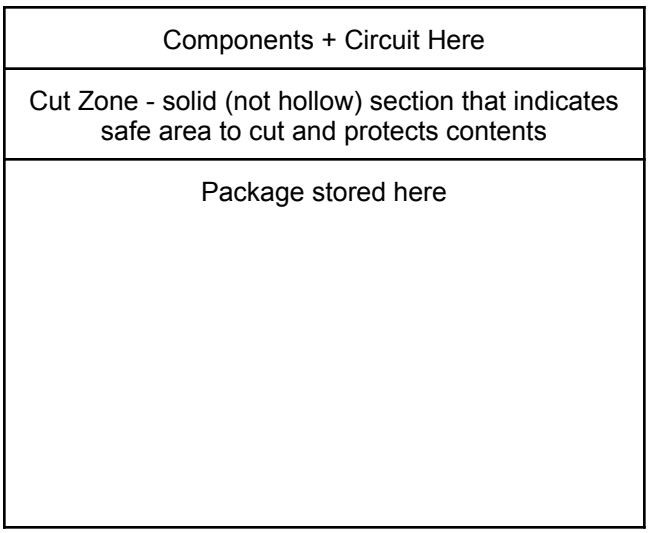




    - Operate at **4.5V** on a **20 MHz clock**
    - Power consumption
      - Active mode: **0.2 mA**
      - Power saver mode: **0.75 µA**
    - Our microprocessor will mostly be used to control our internal security system such as the door lock and alarm through our app
- 2.2.2 Status LED
  - Two simple 5mm LEDs
    - Green LED indicates power on/off
    - Red LED indicates the system is armed/disarmed
  - Current draw: **20mA each**

2.3 Security System

- 2.3.1 Exterior Casing
    - *Requirement 1:* Reasonable tamper-proofing
        - Resist blunt attacks
        - Protect contents from damage
    - *Requirement 2:* Worst-case consideration
        - Must be openable with high-power equipment if system fails
        - Designed so product is not damaged when opened this way



- 2.3.2 Electronic door lock
    - Electromechanical latch lock
        - Draws 600mA at 12V to release the latch
        - Latch is in locked state when not powered
    - Microprocessor will control the latch
    - *Requirement 1:* Reasonable tamper-proofing
        - Resist blunt attacks, power overloading, lack of power, etc.
        - Internally housed to prevent external access
    - *Requirement 2:* App Control
        - Locked/Unlocked controlled through app
- 2.3.3 Front camera

    - A front mounted camera that will take photos when the microprocessor tells it to
        - Signal delivered at 3.3V from the microcontroller will activate the camera
        - Captured photo will be sent to the Wi-Fi module and uploaded to the phone app
    - *Requirement 1:* Cameras must be aligned properly to cover full FOV
        - Package placed in a way to limit angles of approach (corner)
        - Cameras on multiple sides of casing
    - *Requirement 2:* Photos must be taken when tampering is detected
        - Responds to an alert signal determined by PIR sensor
    - *Requirement 3:* Photos must be sent and stored on phone app
        - Limited/no data storage in container unit
        - Must have wifi connection in order to send images
    - *Requirement 3:* Protected against potential damages
        - Protect from blunt attacks
        - Want security system to be durable
- 2.3.4 Passive Infrared Sensor
    - A PIR sensor will monitor for any activity around the box and send a signal to take the device out of low power mode when activated
        - Draws 3.0V at 170uA
        - Will always be in operating mode while system is armed
    - *Requirement 1:* Calibrated Sensitivity
        - Need to set minimum required interference
        - Prevents unnecessary photos/alarm triggers
    - *Requirement 2:* Control alarm signal
        - Must be able to activate rest of security system
        - Turn off alarm signal in absence of interference
        - Turn off alarm signal from microprocessor instructions

- 2.3.5 Alarm Speaker
    - An alarm horn inside the container will sound when it receives an intrusion signal from the microcontroller
        - The model we're looking at has a sound range of 78dB to 100dB
            - 3V at 78db & 18V at 100dB
            - **100dB has the potential to damage hearing**
    - *Requirement 1:* Activates with alarm signal
        - Alarm is off when alarm signal is not active
    - *Requirement 2:* Loud/Annoying Noise
        - Must actually serve as a deterrent
        - Alert others nearby that something is wrong
    - *Requirement 3:* App Control
        - Alarm able to be triggered/silenced/deactivated by app
        - Plays quieter noise when triggered by app to assist in locating
- 2.3.5 GPS tracker
    - Likely the most expensive component
    - SAM-M8Q GPS board
        - Draws 3.3V at 29mA in operation mode
    - *Requirement 1:* Long Distance Communication
        - Must be able to send location to app over long distances
        - Most likely requires wifi access
    - *Requirement 2:* Low Power Draw
        - Needs to last a long time to be worth price
        - Option for non-constant transmission to save battery life
    - *Requirement 3:* Accuracute Enough
        - Accurate enough to where package can be located with alarm
- 2.3.6 Accelerometer
    - Will allow the container to know when it's being stolen (picked up) and send a signal to the microcontroller to sound the alarm
        - Draws 2.5V at 145uA
    - *Requirement 1:* Works in all directions

    - *Requirement 2:* Calibrated Specifications
        - Must have appropriate triggers
        - Prevents unnecessary alarm system triggers

2.4 Phone App

- 2.4.1 User control app
    - Ideally, the app will be the means by which we turn the device on/off
    - Will be Android based
    - Coded in Java
    - *Delivery crew able to activate alarm system once package is dropped off*
- 2.4.2 Location tracking service
    - Wi-Fi module will transmit the location the GPS shows the box being at
    - *Requirement 1:* Be accurate enough to allow us to find a container in the event one is stolen and tossed somewhere
- 2.4.3 Notify the user when suspicious things happen
    - *Requirement 1:* Threshold for suspicion must not cause frequent false positives
- 2.4.4 Receive video streaming/ signal from the device through the Wi-Fi module in the Device
    - *Requirement 1:* Will be able to receive the photos the front camera takes and uploads over the Wi-Fi module

3 Ethics & Safety

3.1 Ethical Concerns

- Upholding the safety, health, and welfare of the public
    - Our device will be placed in areas that are accessible to the public.
    - Theft counter-measures cannot be designed to inflict harm.
        - This is just dangerous to the public and asking for a lawsuit. We don't want to design something that could end up tear gassing somebody's puppy for being curious.
- Disclose promptly factor that might endanger the public or environment

    - Though the container should be inconspicuous, providing notice of the alarm system on the container is necessary.
        - Alarm must receive an appropriate amount of voltage to serve as an effective deterrent but also not cause hearing damage from excess volume

3.2 Safety

- Our only safety concern at the moment is the Lithium-ion battery pack that we plan to use in the device due to its portable nature.
    - Lithium-ion technology has some flammability concerns
        - Put the battery pack in a compartment with fire suppression?
        - Give the horn a secondary function as a fire alarm?
    - The final product should have means to mitigate dangerous levels of energy flow to the systems
    - Isolate & insulate the battery pack from the rest of the system to prevent short circuits from occurring
    - Rely on charging our Li-ion batteries from outside the device and in a safe environment
- Voltage regulator will need to include the function of preventing the battery voltage from decaying below 3.0V or exceeding 4.2V
    - In the event this threshold is breached, the microcontroller should detect this and give an emergency shutdown signal