Portable Anti-Theft Package Container

ECE 445

Date: 2/7/2022

Team Members

- Conor Mueller
- Ethan Fransen
- Yufei Zhu

TA: Qingyu Li

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

<table>
<thead>
<tr>
<th>Components + Circuit Here</th>
</tr>
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<tbody>
<tr>
<td>Cut Zone - solid (not hollow) section that indicates safe area to cut and protects contents</td>
</tr>
<tr>
<td>Package stored here</td>
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- 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: Accurate 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