EGR 304 - Team 106

Design Review

Not Creepy Elf

Adriana Juarez, Sai Srinivas Tatwik Meesala,
Noah Blevins, Ian Mansfield

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Problem Definition

Problem Statement

The purpose of our project is to create an electronic decoration piece that will help entertain guests during the Halloween and/or Christmas holidays. Building this product will satisfy the user's need for a scary decoration on the Halloween holiday, while at the same time satisfying their need for a traditional Elf on The Shelf on the Christmas holiday. The Not Creepy Elf will bring guests fear, laughter, and excitement. It is perfect for the holidays as well as for normal usage throughout the year.

Customer Impact

The Not Creepy Elf is an electronic holiday that comes with two settings that could be used for both Halloween as well as Christmas. This may come with some positive and negative effects. This device will encourage laughter and immersion during both holidays. The device may also spook people during both holidays, which is the goal of the decoration during Halloween but not during Christmas.

Benchmarking

Appendices A through E are an overall representation of the Not Creepy Elf competitors during the benchmarking process.

Performance Specifications

The performance specifications for the product are shown in Table 1.

Table 1. Performance Specifications

#	Metric	Unit	Marginal Value	Ideal Value	Actual Value
1	Range of Detection	Meters	> 1	2	5
2	Weight	Kg	> 0.75	> 0.5	TBD
3	Range of Motion	Degrees	< 160	150	120
4	Variation of Voltage Input	Volts	± 0.2	± 0.1	TBD
5	Height	Cm	25	25	TBD
6	Water resistance	IPX	IPX2	IPX4	TBD
7	Proper Acceleration	Degrees	± 20	± 20	TBD
8	Lights	Lumens/Watt	80	60	75

Rationale & Plan

Specification 1: The Not Creepy Elf will track a person(s) in a room. The product will need to be able to detect where the person(s) is standing from both a short distance and a far distance. The product's abilities will be limited to how far or close the person is. A PIR motion sensor will be used in the range between 1 and 2 meters.

Specification 2: The Not Creepy Elf will be moved around and placed in different areas around the user's home. Because of this, it is necessary to specify the weight of the product to the customer. The product must be light enough to carry and from a position and heavy enough for it to sit on its own without much support. We anticipate the product's weight to be between 500 and 750 grams.

Specification 3: The Not Creepy Elf will have the ability to turn its head a certain amount. The degrees of freedom the device has to move its head to track the motion of a person is necessary to specify to the customer. This limitation will help the customer determine the best area to place the product in their home. A servo motor will be used to allow the product to function properly. The degrees of freedom will vary depending on the product's setting.

Specification 4: The Not Creepy Elf will more than likely be turned on for long periods of time. The device will be powered from a 5V wall power supply. A variation between 4.8V and 5.2V is expected during the usage of the product.

Specification 5: Because the Elf on the Shelf is a very commonly used holiday decoration, it is reasonable to build the device close to the size of the traditional Elf on the Shelf. Not Creepy Elf will have its unique features apart from the traditional design, but it will look very similar. The dimensions of the product will be approximately 25 centimeters tall.

Specification 6: There may be instances where the customer would prefer to use the decoration in an outdoor environment. Because of this, the Not Creepy Elf, during normal operation, may come into contact with water. Identifying the amount of moisture that the product can withstand is crucial to its functionality in an outdoor environment. The failure of the product due to rain exposure is to be determined later in the course of the project.

Specification 7: In the case where the Not Creepy Elf is lifted from its position, it will sense a change in pressure, allowing it to perform additional features. This pressure will be dependent on the weight of the Elf.

Specification 8: To further the effect of the Not Creepy Elf on the Halloween holiday, the Not Creepy Elf will need to have LED lights in each eye socket. These LEDs will turn on and glow when motion is detected and tracked. Two red LEDs will most likely be used, lighting at approximately 60 lumens.

Design Concept

Visually Engaging Representation

A computer-generated sketch with the device's components is shown in Figure 1 (The power supply will be stored behind all other components for the user's ease of replacing batteries when necessary). An overall representation of the Not Creepy Elf is shown in Figure 2.

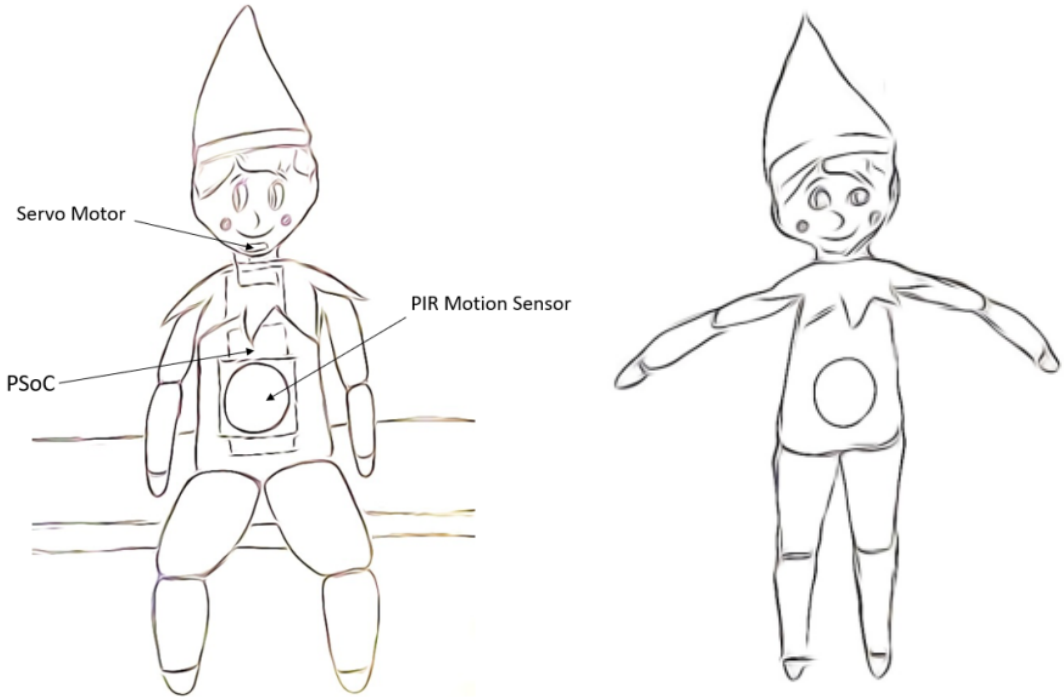


Figure 1 & 2. Sitting and Standing Visually Engaging Representation of Not Creepy Elf

Visual Story-Based Representation

Below is a brief visual representation of how the elf will function during a holiday party (See Figure 3). The storyboard is annotated at the top of each section.

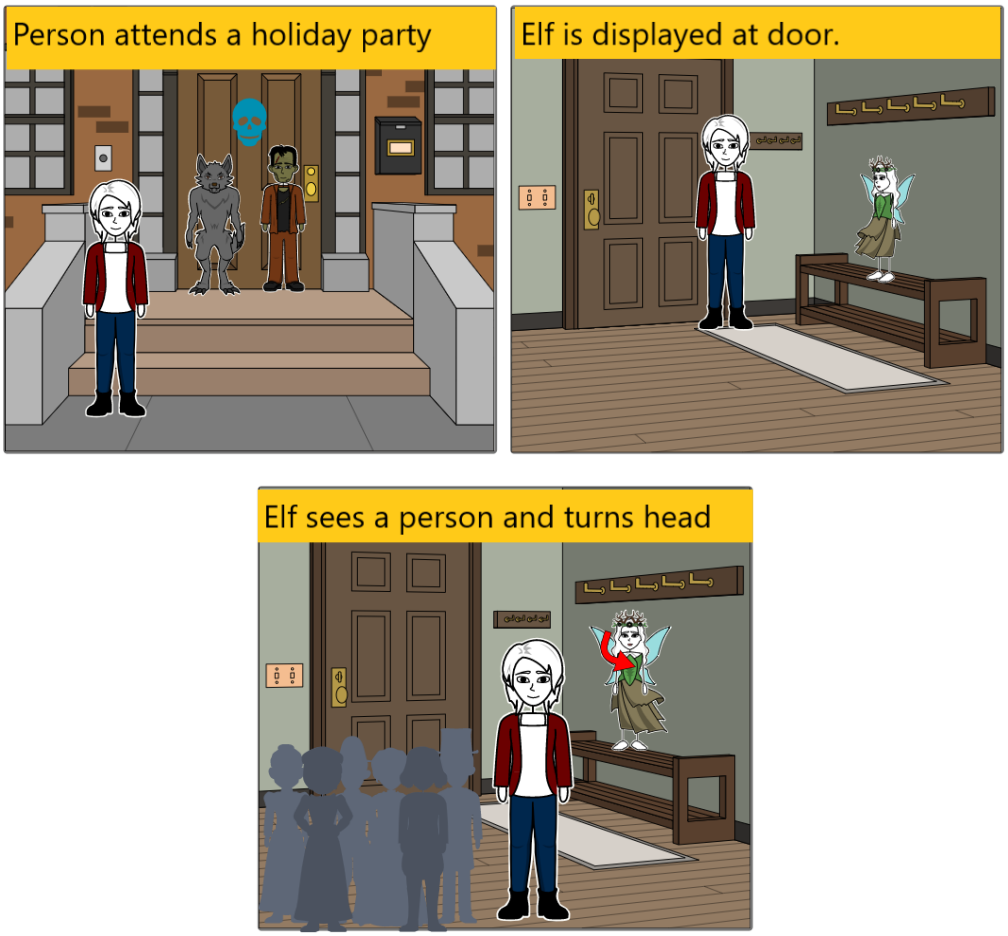


Figure 3. Comic Strip of Not Creepy Elf

Product Prototype

Figure 4 displays the current CAD rendering prototype of the product. Modifications will be made to the Elf's build as the design process progresses.

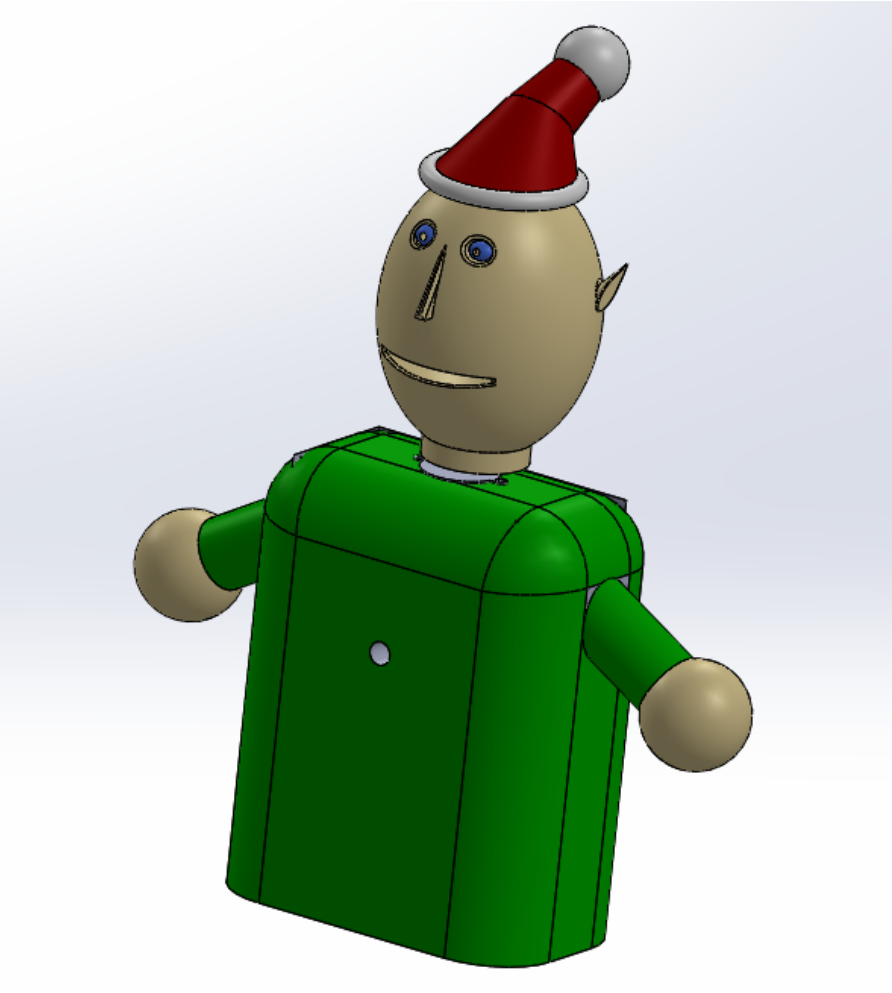


Figure 4. CAD rendering of the Not Creepy Elf

Block Diagram

The block diagram for the Not Creepy Elf is shown in Figure 1. This diagram represents all the major components and subsystems of the product.

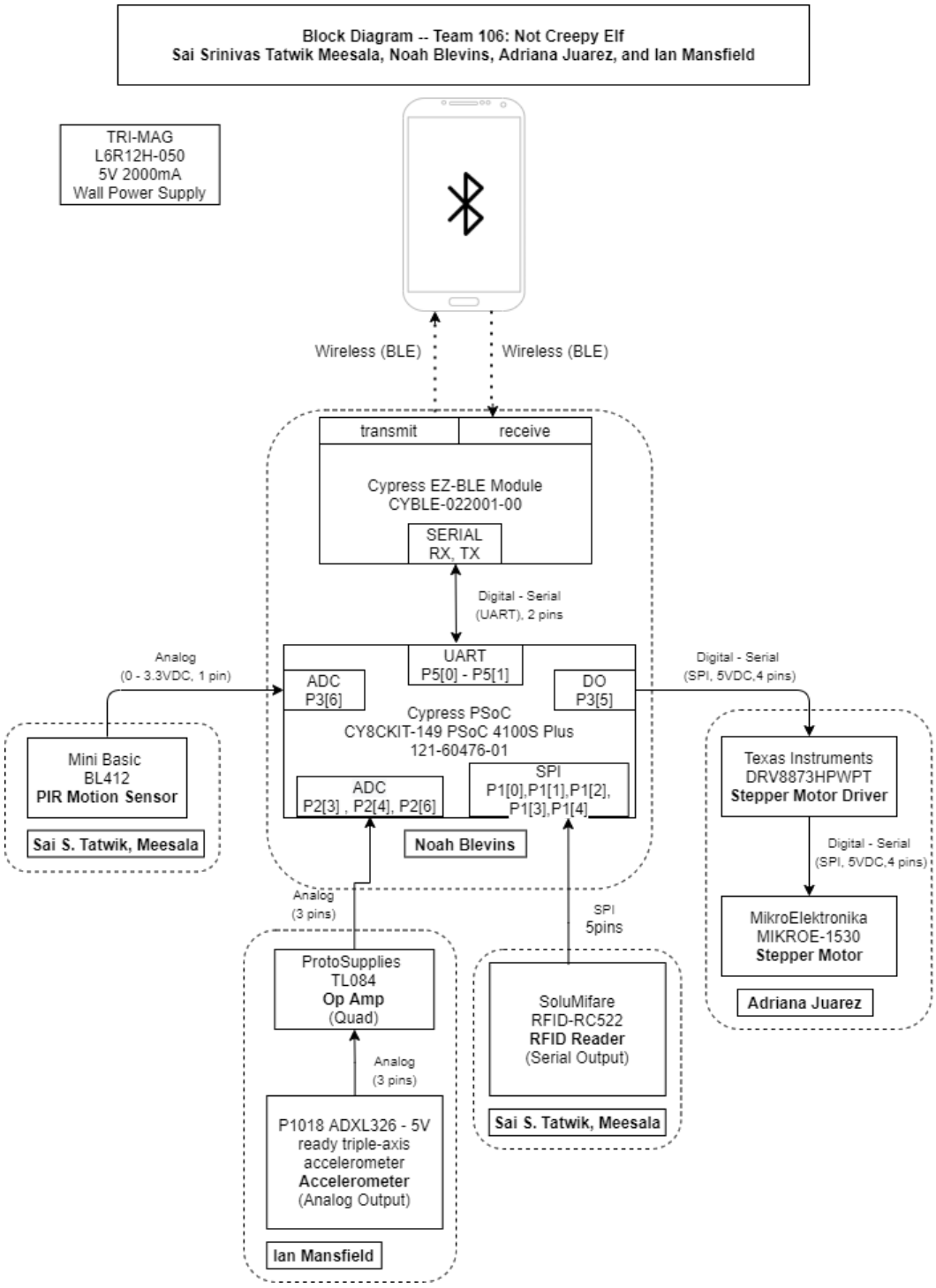


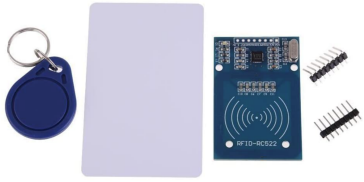
Figure 5. Not Creepy Elf Block Diagram

Major Component Selection

Several potential off-the-shelf electrical and mechanical components that could be used in the project were researched for the device's main subsystems: RFID Reader, Accelerometer, and Stepper Motor. See Tables 2 - 8 for each final solution.

RFID Reader Subsystem

Table 2. RFID Reader

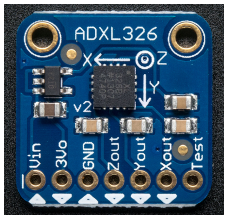
Solution	Pros	Cons
 SoluMifare Rc522 Card Read $5.99 Link to Product	• Inexpensive • Runs with 3.3V • Product includes blank card, special-shaped card, Straight Row of Pin, Curved Row of Pin • Comes in a relatively small size 40mm × 60mm • Operating temp range: -40 to +185 °F (-40 to +85 °C)	• 13.56Mhz frequency lower security when compared to 125kHz RFID readers • Reading range 2-3cm

Selection: The chosen RFID reader is **SoluMifare Rc522 Card Read**. See Appendix F for further information on the RFID reader selection process.

Rationale: SoluMifare Rc522 Card Read comes at a very affordable price, and the module comes with a relatively small footprint suitable for Not Creepy Elf. It is compatible with PSoC. Even with Amazon as a merchant, the product comes with very detailed specifications. The shipping is very fast, but the merchant says there is only one product left.

Accelerometer and Operational Amplifier Subsystem

Table 3. Accelerometer

Solution	Pros	Cons
 Adafruit ADXL326 Triple axis Accelerometer $17.95 Link to Product	• Small form factor(19mmx19mm) • 3.3V or 5V intake • Already on a PCB (comes as a breakout board)	• Expensive • Soldering header pins required

Selection: The chosen accelerometer is **Adafruit ADXL326** Triple Axis Accelerometer. See Appendix G for further information on the accelerometer selection process.

Rationale: The Adafruit ADXL326 is ready to handle 5V and has the highest precision of measurement of the other potential solutions. While it is the most expensive solution, the difference in quality is worth the price. The outputs are analog and ratiometric, meaning that the 0g measurement is set at 1.65V, allowing for high precision in all directions of measurement.

Operational Amplifier

Table 4. Operational Amplifier

Solution	Pros	Cons
 LM358 $0.42 Link to Product	• Inexpensive • Commonly used general-purpose OP Amp • Stable in DIY circuits • Easily obtainable • Number of channels: 2 • Supply: 3V - 32V • Bipolar	• Low slew rate and limited bandwidth • Bad for audio circuits

Selection: The chosen operational amplifier is **LM358**. See Appendix H for further information on the operational amplifier selection process.

Rationale: While the LM358 is an older product and has a lower slew rate, it is reliable, easily obtainable, and fits our specifications. We do not believe the low slew rate will prove detrimental to our project. We are using the through-hole version for easy soldering. Additionally, because the LM358 is older and widely used, there are many examples of its use in the case where troubleshooting is necessary.

Stepper Motor and Motor Drive Subsystem

Table 5. Stepper Motor

Solution	Pros	Cons
 MIKROE-1530 (STEPPER MOTOR PM GEARED UNI 5V) $8.00 Link to Product	• 5VDC • Inexpensive • Unipolar (doesn't need reverse current, multiple leads per phase) • 4096 Steps per revolution • Lightweight • Step angle 0.088 • In stock	• Unipolar (less torque, less efficient) • 4 weeks lead time • Does not come with a compatible motor driver

Selection: The chosen stepper motor is the **MIKROE-1530** manufactured by MikroElektronika. See Appendix I for further information on the motor selection process.

Rationale: The MIKROE-1530 stepper motor is compatible with PSoC, running at 5VDC. The MIKROE-1530 stepper motor is inexpensive at $8.00. Of the three solutions, it has the smallest step angle (increases accuracy), and the highest steps per revolution (controls position more precisely). As opposed to a bipolar stepper motor, a unipolar stepper motor can be less efficient and have less torque, but it has multiple leads per phase and does not require a reverse current when operating.

Table 6. Motor drive for stepper motor

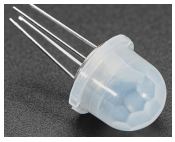
Solution	Pros	Cons
 DRV8873HPWPT $5.75 Link to Product	• Works with unipolar stepper motors • Inexpensive & Lightweight • Supply: 0V - 5.5V • Load: 4.5V - 38V • SPI Interface • Max current: 10A	• More expensive than its competitors • 35 weeks lead time • Surface mount

Selection: The chosen stepper motor drive is the **DRV8873HPWPT** manufactured by Texas Instruments. See Appendix J for further information on the motor driver selection process.

Rationale: The DRV8873HPWPT is compatible with the chosen motor. The stepper motor is unipolar and the motor drive works with unipolar stepper motors. The motor pulls about 200mA of current and this motor driver can handle up to 10A of current, which is more than enough! The DRV8873HPWPT is inexpensive at $5.75, can run at 5VDC, and is lightweight and compact. Additionally, the component is currently in stock.

PIR Motion Sensor Subsystem

Table 7. PIR Motion Sensor

Solution	Pros	Cons
 Mini Basic PIR Sensor - BL412 $1.95 Link to Product	• Small size • Inexpensive • Up to 8m range • 120 degree spread	• Needs external components to function correctly • Runs on 3.3V power • Low Range

Selection: The chosen PIR motion sensor is the **Mini Basic PIR Sensor** manufactured by Adafruit Industries LLC. See Appendix K for further information on the motion sensor selection process.

Rationale: The Mini Basic PIR Sensor is perfect for our needs. Its small design will be easy to hide and not ruin the aesthetic of the product as a whole. Additionally, a full-size PIR sensor would dig too deeply into our project budget to be comfortably viable. With some fine-tuning and potentially some troubleshooting, the mini Basic circumvents those issues.

Power Budget and Bill of Materials

The power budget for Not Creepy Elf can be accessed here. See Appendix R for BOM.

PIR Motion Sensor

The PIR motion sensor will sense heat energy when a person walks by and will trigger the stepper motor.

PIR [3[6]]

Stepper Motor

The stepper motor will move the Elf's head when the motion sensor is triggered.

[4[0]] SM1 [4[1]] SM2 [4[2]] SM3 [4[3]] SM4

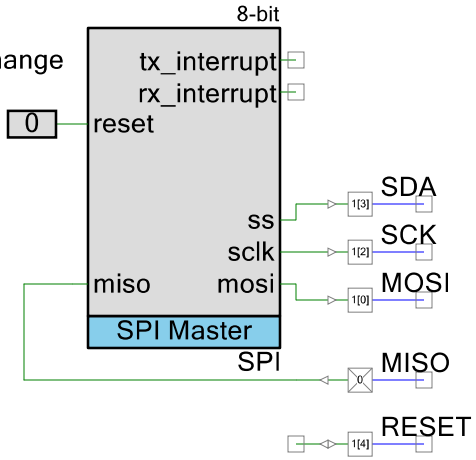
Eye Socket LEDs

Two LEDs will be placed in the Elf's eye sockets and will turn on when the motor and motion sensor are triggered.

[4[7]] LED1
[5[6]] LED2
[3[5]] LED3

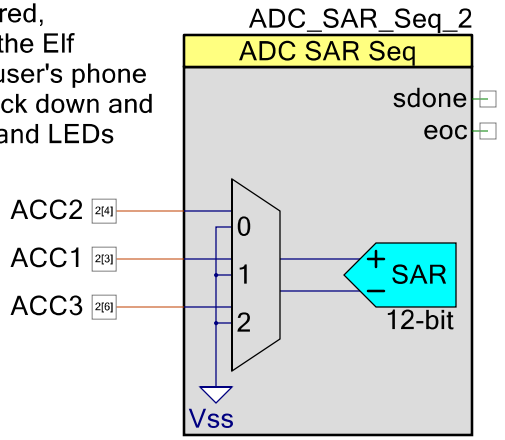
RFID Reader

The RFID reader will be used to change the holiday mode on the Elf.



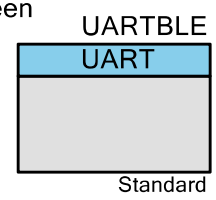
Accelerometer

The accelerometer will be used to sense when the Elf is lifted from it's original position. When this is triggered, a notification from the Elf will be sent to the user's phone urging to be put back down and the stepper motor and LEDs will be triggered.



BLE Module

The BLE module integrated on the PSoC microcontroller will be used for Bluetooth communication between the users cellphone and the Elf.



Debugging LED

This LED will be used for debugging.

[3[4]] DebugLED

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Not Creepy Elf
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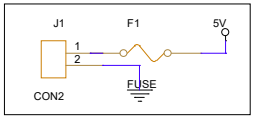
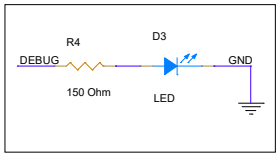
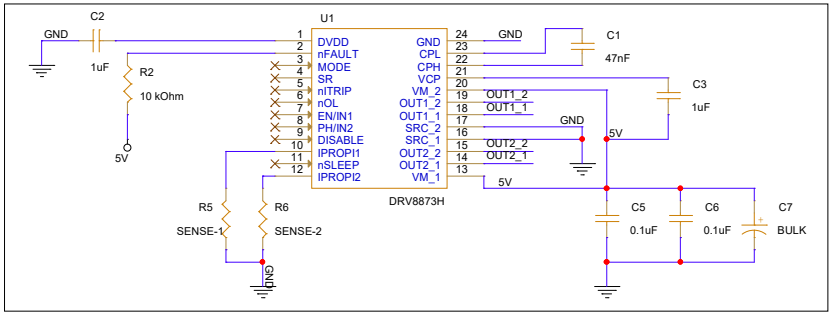
POWER SYSTEM (L6R12H-050)



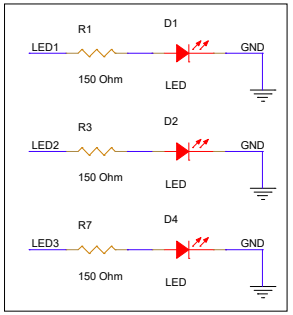
DEBUGGING LED



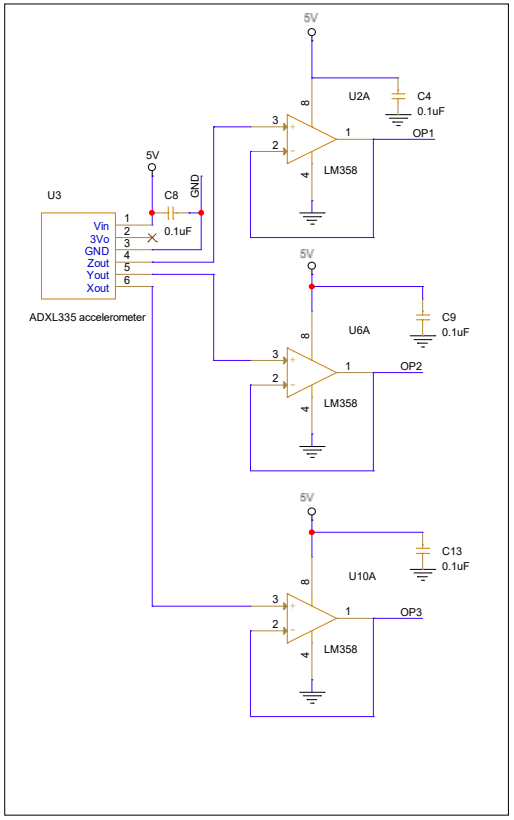
UNIPOLAR STEPPER MOTOR DRIVER (DRV8873H)



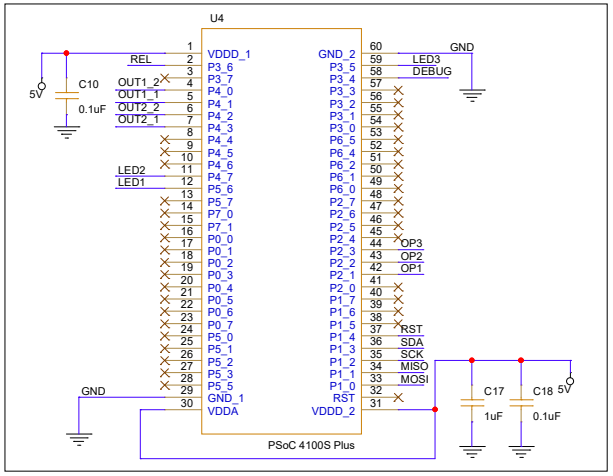
LEDs



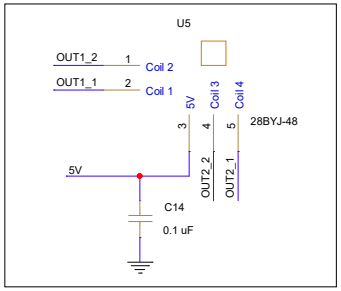
Accelerometer



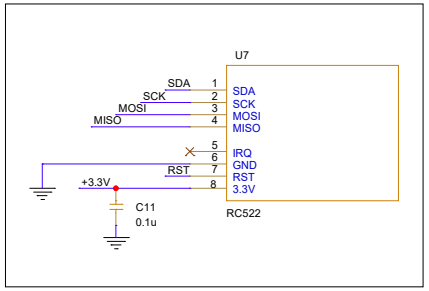
MICROCONTROLLER (PSoC 4100S Plus)



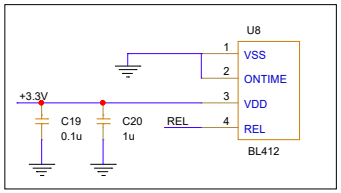
STEPPER MOTOR (28BYJ-48, 5VDC)



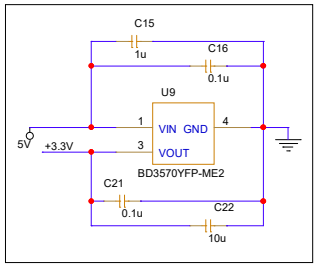
RFID Reader



PIR Motion Sensor



+3.3V Regulator



Hardware Design

NOTE: EACH RESISTOR IS 1/4 WATTAGE UNLESS OTHERWISE SPECIFIED

Title: Not Creepy Elf		
Size: Custom	Document Number: Team 106 - Adriana J., Noah B., Sai Tatwik M., Ian M.	Rev: 1.0
Date: Friday, October 22, 2021	Sheet 1 of 1	

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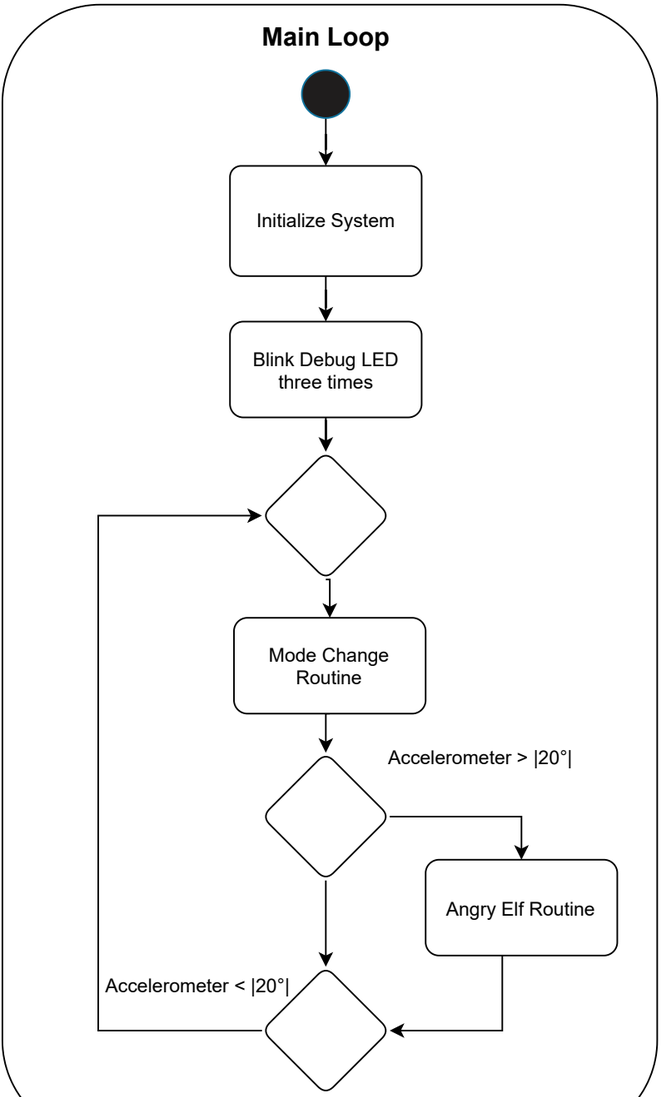
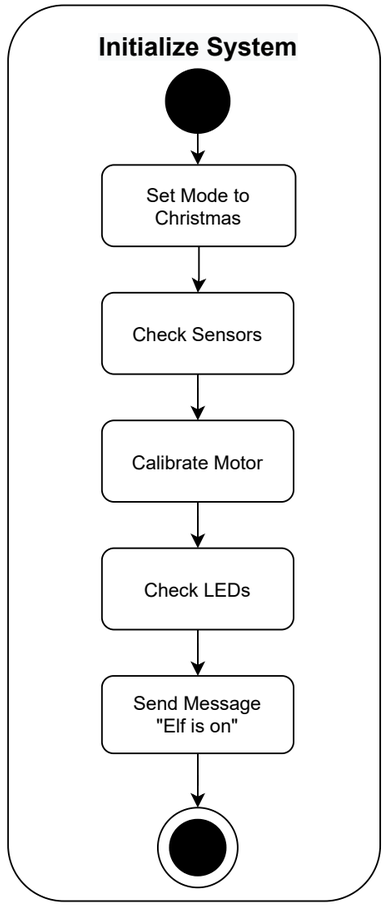
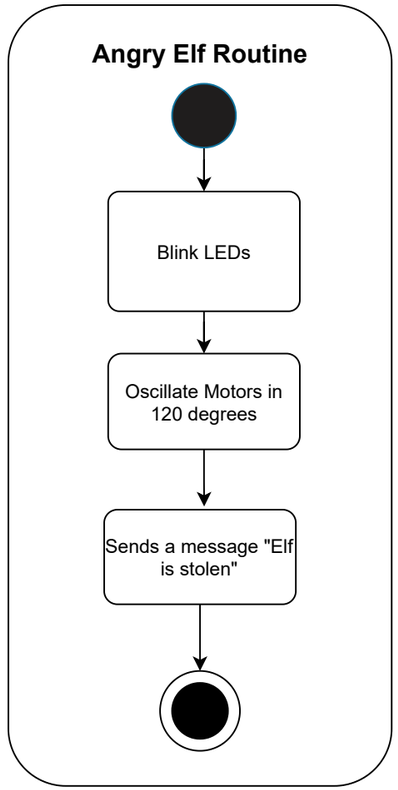
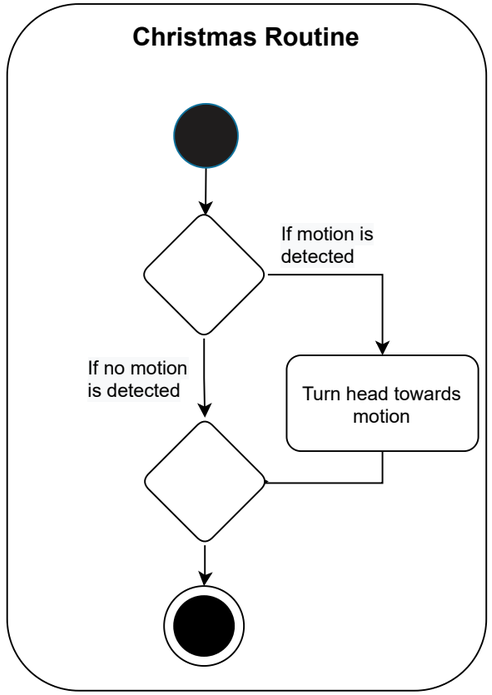
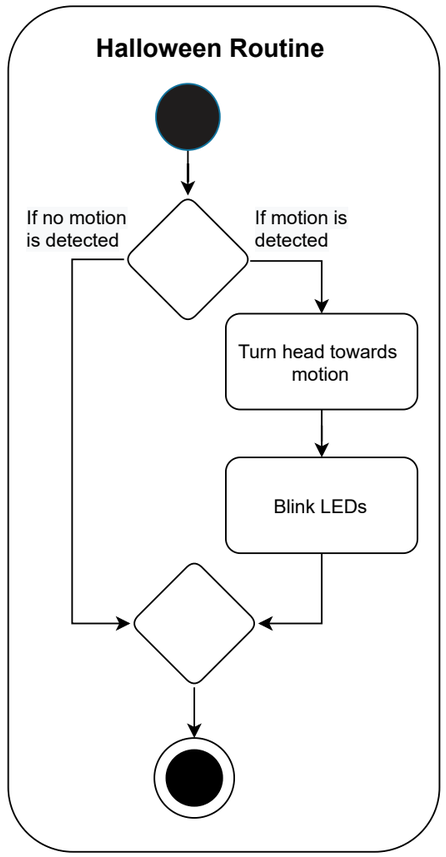
Software Design

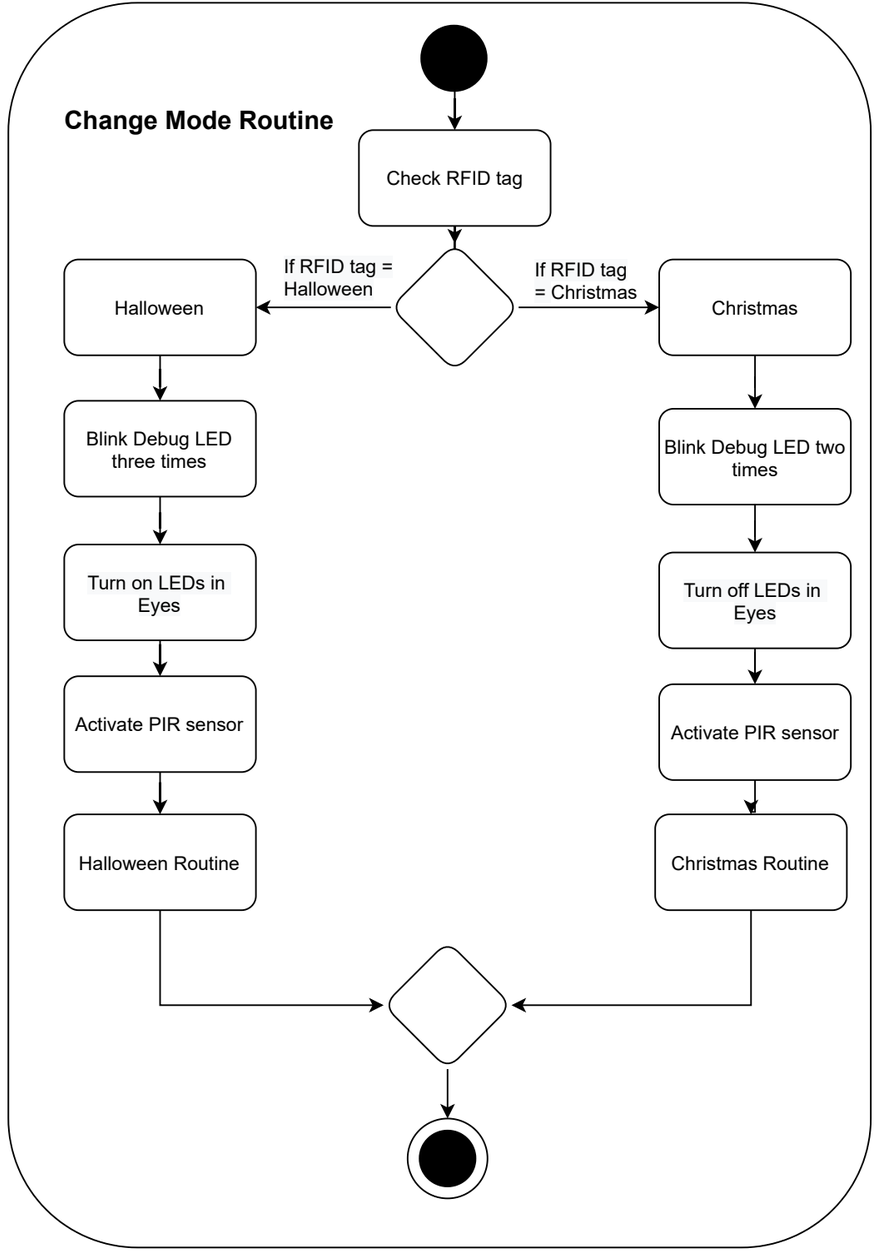












The state diagram for the Not Creepy Elf can be accessed here.

Appendix

The appendix consists of benchmarking of related solutions, additional information about major component selection, and additional schematic images.

Appendix A. Competitor 1 (Wicked Cauldron Witches)

1. **Solution:** Animated LED Wicked Cauldron Witches
   Cost: $199
2. **Description:** The Animated LED Wicked Cauldron Witches help entertain guests during the Halloween holiday by using motion detection and motorized parts.

3. **Pros:**
   a. Liked by many reviewers
   b. The product not only creates motion but also has light and sound effects

4. **Cons:**
   a. Very expensive (~$200)
   b. Can only be used for Halloween decorations

Appendix B. Competitor 2 (Outdoor White Motorized Motion-Tracking Halogen Security Light)

1. **Solution:** 220-Degree Outdoor White Motorized Motion-Tracking Halogen Security Light
   Cost: $89.97
2. **Description:** The Outdoor White Motorized Motion-Tracking Halogen Security Light solves lighting problems in outdoor spaces by a motorized moving light activated by heat or motion detection.

3. **Pros:**
   a. 220 Light Beam Angle and Weather Resistant
   b. Microprocessor tracks movement up to 60 ft. away
4. **Cons:**
   a. Expensive at ~$90
   b. According to customers, the product is not very durable
   c. Not a decoration piece

Appendix C. Competitor 3 (Rocking Chair Babysitting Witch)

1. **Solution:** LED Rocking Chair Babysitting Witch
   Cost: $149
2. **Description:** The Rocking Chair Babysitting Witch solves helps entertain guests during the Halloween holiday by using motion detection and motorized parts.

3. **Pros:**
   a. Liked by many reviewers
   b. Measures at 4 feet height
4. **Cons:**
   a. Very expensive ($149)
   b. Can only be used for Halloween decorations

Appendix D. Competitor 4 (Halloween Animated LED Headless Horseman)

1. **Solution:** Halloween Animated LED Headless Horseman
   Cost: $129
2. **Description:** The Halloween Animated LED Headless Horseman helps to entertain guests during the Halloween holiday by using motion detection and motorized parts.

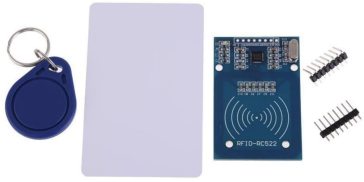
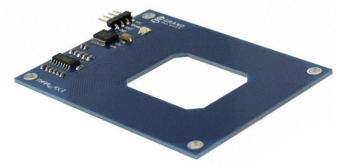
3. **Pros:**
   a. Measures at 7.5 feet height
   b. The product not only creates motion but also has light effects
4. **Cons:**
   a. Very expensive ($129)
   b. Can only be used for Halloween decorations

Appendix E. Competitor 5 (Standing Halloween Scientist and Mini Scene)

1. **Solution:** Standing Halloween Scientist and Mini Scene
   Cost: $249
2. **Description:** The Standing Halloween Scientist and Mini Scene helps entertain guests during the Halloween holiday by using motion detection and motorized parts.

3. **Pros:**
   a. Measures at 76 in. height
   b. The product not only creates motion but also has light and sound effects
4. **Cons:**
   a. Not suitable for outdoor environment with any protection
   b. Very expensive ($250)
   c. Can only be used for Halloween decorations
   d. Comes with a complicated assembly kit

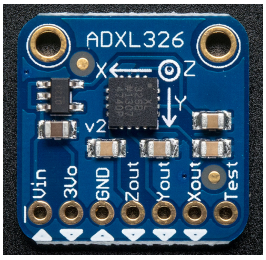
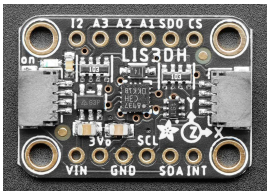
Appendix F. RFID Reader selection process

Solution	Pros	Cons
 SoluMifare Rc522 Card Read $5.99 Link to Product	• Inexpensive • Runs with 3.3V • Product includes blank card, special-shaped card, Straight Row of Pin, Curved Row of Pin • Comes in a relatively small size 40mm × 60mm • Operating temp range: -40 to +185 °F (-40 to +85 °C)	• 13.56Mhz frequency lower security when compared to 125kHz RFID readers • Reading range 2-3cm
 Parallax RFID Card Reader: 28140 $49 Link to Product	• Comes with Bi-color LED for visual indication of status • 125kHz is much more secure than 13.56Mhz • Reading range 10cm. • Operating temp range: -40 to +185 °F (-40 to +85 °C)	• Very Expensive • Min Voltage required to power 5V • Relatively big when compared to other products (Dimensions: 62.2 x 82.5 x 5.57 mm)
 DAOKI PN532 NFC RFID Module $21.67 Link to Product	• The product also comes with 1 x 2.54mm spacing, 4pin Cable, 3 x White Card, 3 x One S50 Key Card, 1 x 12P bent male pins • Runs with 3.3V • Also works with NFC in smartphone • compatible with SPI, IIC, and UART interface for communication. • Comes with an onboard antenna	• Relatively more expensive than its competitors • Relatively big when compared to other products (Dimensions: 7.8 x 4.8 x 1.2 cm) • Very small communication distance of 3 cm

Selection: The chosen RFID reader is **SoluMifare Rc522 Card Read**.

Rationale: SoluMifare Rc522 Card Read comes at a very affordable price, and the module comes with a relatively small footprint suitable for Not Creepy Elf. It is compatible with PSoC. Even with Amazon as a merchant, the product comes with very detailed specifications. The shipping is very fast, but the merchant says there is only one product left.

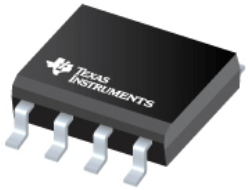
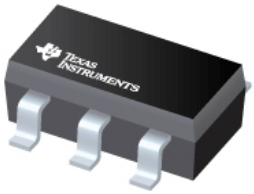
Appendix G. Accelerometer selection process

Solution	Pros	Cons
 Adafruit ADXL326 Triple Axis Accelerometer $17.95 Link to Product	• Small form factor(19mmx19mm) • 3.3V or 5V intake • Already on a PCB (comes as a breakout board)	• Expensive • Soldering header pins required
 LIS3DSHTR $2.92 Link to Product	• Inexpensive • High Sensitivity • 3.6V intake • Adjustable Bandwidth • Selectable Scale • Temperature Sensor • Very small form(3mmx3mm) • Low power consumption	• Surface mount component • Not widely used
 Adafruit LIS3DH Triple Axis Accelerometer $10.64 Link to Product	• 3.3V intake • Internal shift lever • Popular accelerometer • SPI or I2C communication	• Expensive • Soldering header pins required

Selection: The chosen accelerometer is **Adafruit ADXL326** Triple Axis Accelerometer.

Rationale: The Adafruit ADXL326 is ready to handle 5V and has the highest precision of measurement of the other potential solutions. While it is the most expensive solution, the difference in quality is worth the price. The outputs are analog and ratiometric, meaning that the 0g measurement is set at 1.65V, allowing for high precision in all directions of measurement.

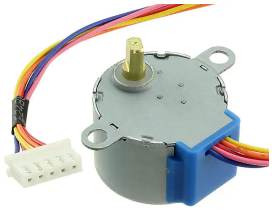
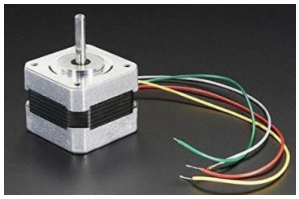
Appendix H. Operational Amplifier selection process

Solution	Pros	Cons
 LM358 $0.42 Link to Product	• Inexpensive • Commonly used general-purpose OP Amp • Stable in DIY circuits • Easily obtainable • Number of channels: 2 • Supply: 3V - 32V • Bipolar	• Low slew rate and limited bandwidth • Bad for audio circuits
 OP07 N/a Link to Product	• Low Noise • No External Components Required • Supply: 5V - 44V • Bipolar	• Out of stock • Cost of component not given
 OPA210 $2.33 Link to Product	• Precision Op amp • Supply: 4.5V - 36V • Bipolar	• More expensive than its competitors

Selection: The chosen operational amplifier is **LM358**.

Rationale: While the LM358 is an older product and has a lower slew rate, it is reliable, easily obtainable, and fits our specifications. We do not believe the low slew rate will prove detrimental to our project. We are using the through-hole version for easy soldering. Additionally, because the LM358 is older and widely used, there are many examples of its use in the case where troubleshooting is necessary.

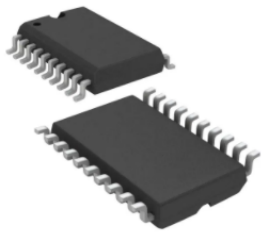
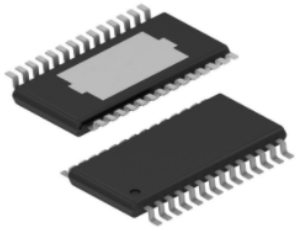
Appendix I. Stepper Motor selection process

Solution	Pros	Cons
 858 (STEPPER MOTOR PM GEARED UNI 5V) $4.95 Link to Product	• 5VDC • Inexpensive • Unipolar (doesn't need reverse current, multiple leads per phase) • 513 Steps per revolution • Lightweight • Step angle 0.702 • In stock	• Unipolar (less torque, less efficient) • 13 weeks lead time • Does not come with a compatible motor driver
 MIKROE-1530 (STEPPER MOTOR PM GEARED UNI 5V) $8.00 Link to Product	• 5VDC • Inexpensive • Unipolar (doesn't need reverse current, multiple leads per phase) • 4096 Steps per revolution • Lightweight • Step angle 0.088 • In stock	• Unipolar (less torque, less efficient) • 4 weeks lead time • Does not come with a compatible motor driver
 324 (NEMA-17) $14.00 Link to Product	• Bipolar (more torque, more efficient) • 200 Steps per revolution • Step angle 1.8 Inexpensive • Lightweight • In stock	• 12V rated voltage • Expensive • Bipolar (single winding per phase, needs reverse current) • Requires two full H-bridges (not provided) • Does not come with a compatible motor driver
 5V DC Stepper Motor $7.50 Link to Product	• Comes with a compatible motor driver (ULN2003) • 5VDC • Inexpensive • Lightweight • In stock	• 64 Steps per revolution • Not as powerful as its competitors • Motor driver is a daughter board (Does not meet requirements)

Selection: The chosen stepper motor is the **MIKROE-1530** manufactured by MikroElektronika.

Rationale: The MIKROE-1530 stepper motor is compatible with PSoC, running at 5VDC. The MIKROE-1530 stepper motor is inexpensive at $8.00. Of the three solutions, it has the smallest step angle (increases accuracy), and the highest steps per revolution (controls position more precisely). As opposed to a bipolar stepper motor, a unipolar stepper motor can be less efficient and have less torque, but it has multiple leads per phase and does not require a reverse current when operating.

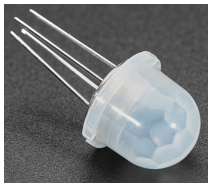
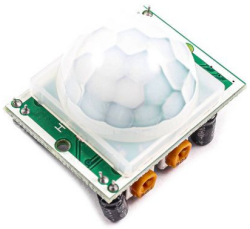
Appendix J. Motor driver selection process

Solution	Pros	Cons
 DRV8804DW $3.78 Link to Product	• Works with unipolar stepper motors • Inexpensive • Small size • Lightweight • SPI Interface • 129 in stock • Max current: 800mA	• Surface mount • 6 weeks lead time • Supply: 8.2V - 60V Load: 8.2V - 60V
 DRV8873HPWPT $5.75 Link to Product	• Works with unipolar stepper motors • Inexpensive • Small size • Lightweight • Supply: 0V - 5.5V • Load: 4.5V - 38V • SPI Interface • Max current: 10A	• More expensive than its competitors • 35 weeks lead time • Surface mount
 DRV8811PWP $4.73 Link to Product	• Inexpensive • Small size • Lightweight • Supply: 3V - 5.5V • Load: 8V - 38V • 250 in stock • Max current: 1900mA	• Only works with bipolar stepper motors • 35 weeks lead time • Logic Interface • Surface mount

Selection: The chosen stepper motor drive is the **DRV8873HPWPT** manufactured by Texas Instruments.

Rationale: The DRV8873HPWPT is compatible with the chosen motor. The stepper motor is unipolar and the motor drive works with unipolar stepper motors. The motor pulls about 200mA of current and this motor driver can handle up to 10A of current, which is more than enough! The DRV8873HPWPT is inexpensive at $5.75, has the ability to run at 5VDC, and is lightweight and compact. Additionally, the component is currently in stock.

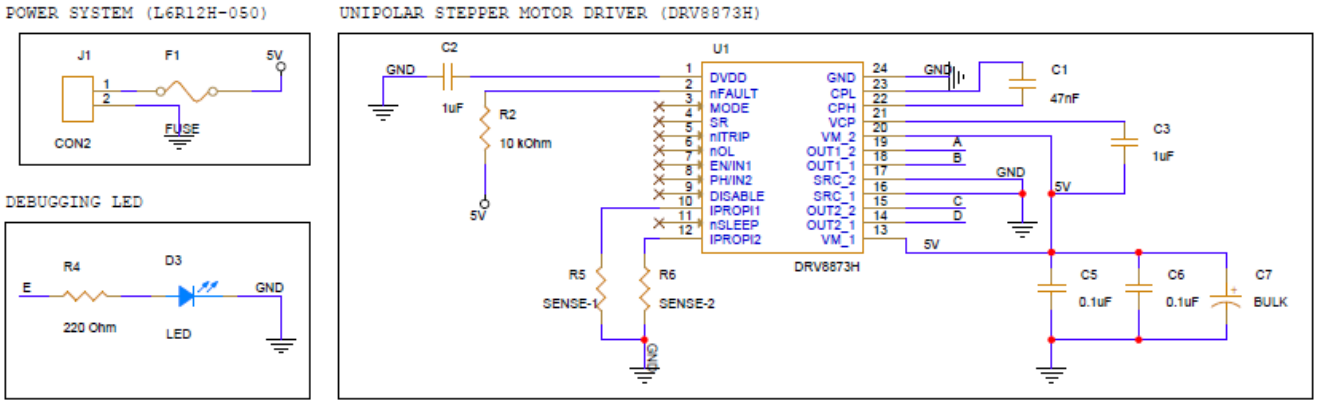
Appendix K. PIR Motion Sensor selection process

Solution	Pros	Cons
 Mini Basic PIR Sensor - BL412 $1.95 Link to Product	• Small size • Inexpensive • Up to 8m range • 120 degree spread	• Needs external components to function correctly • Runs on 3.3V power • Low Range
 HC-SR501 PIR Motion Detection Sensor $8.99 Link to Product	• Up to a 7-meter range • Integrated circuit • Works with 5V - 20V • 110-degree spread	• Bulky due to integrated circuit • Expensive
 PIR Motion Sensor (JST $9.95 Link to Product	• Easy wiring • Greater range • Works with 5V - 12V	• Expensive • Degree spread not provided

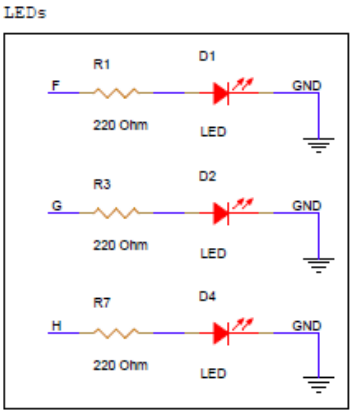
Selection: The chosen PIR motion sensor is the **Mini Basic PIR Sensor** manufactured by Adafruit Industries LLC.

Rationale: The Mini Basic PIR Sensor is perfect for our needs. Its small design will be easy to hide and not ruin the aesthetic of the product as a whole. Additionally, a full-size PIR sensor would dig too deeply into our project budget to be comfortably viable. With some fine-tuning and potentially some troubleshooting, the mini Basic circumvents those issues.

Appendix L. Power system, debugging LED, and motor driver schematic.

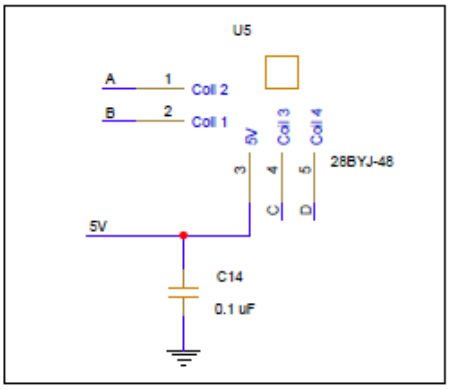


Appendix M. Overall system LED schematics.

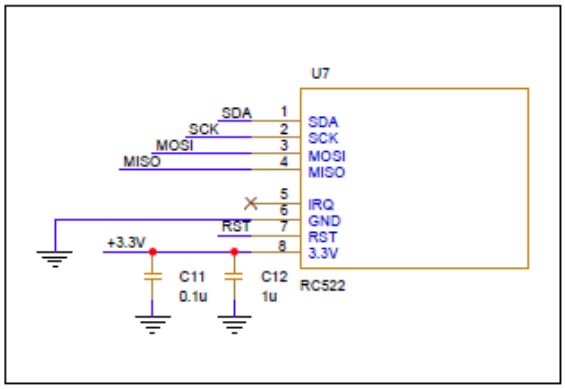


Appendix N. Stepper motor schematic and RFID reader schematic.

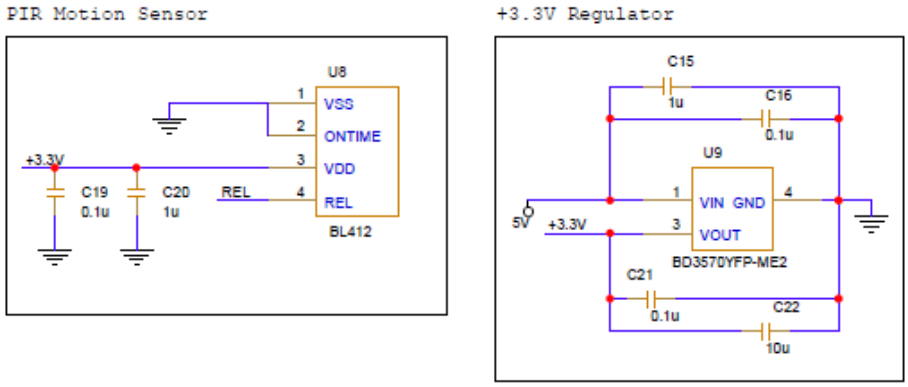
STEPPER MOTOR (28BYJ-48, 5VDC)



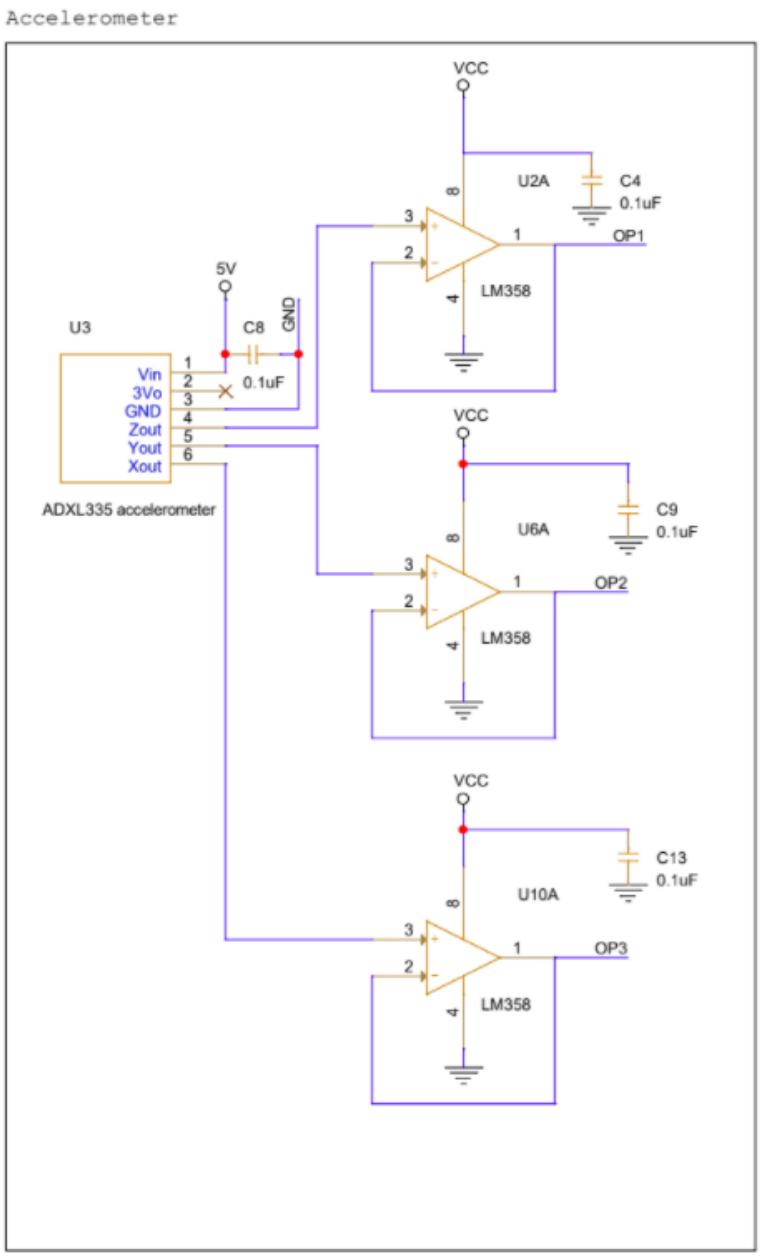
RFID Reader



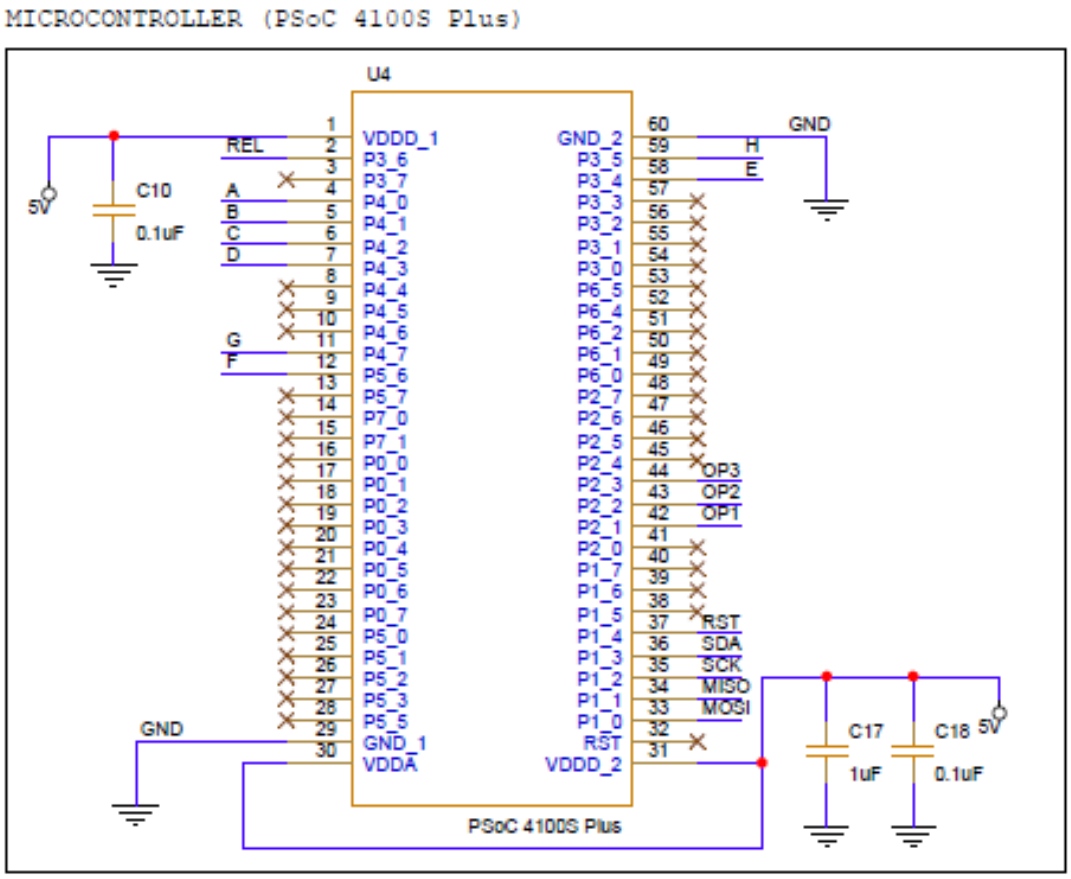
Appendix O. PIR motion sensor and voltage regulator schematic.



Appendix P. Accelerometer schematic.



Appendix Q. PSoC 4100s Plus microcontroller schematic.



Appendix R. Updated Bill of materials

Please click here to navigate to the product's Bill of Materials.