

Design of Engineering Systems Project Report

Title	Gundalf the Magical Pistol (Formerly "Pete's Pistol")
Author Names	Derrian Glynn (Project Manager) Evan Peterson (Lead Engineer) Joseph Rodenbaugh Logan Sirbaugh Andrew Slater
Submission Date	April 29, 2016

Summary (5 points)

- Describe what this product does aim this description at the end user.
- Provide background information assuming the user does not know the context this product is used in.
- Describe briefly all inputs and outputs that are relevant to the end user (not a technical description)

Gundalf is a weapon for the MAGE 2.0 Game System whose main purpose is to fire IR spell packets. Gundalf additionally features an internal, rechargeable, Li-Po battery with a 2+ hour battery life, a player-facing speaker that provides audio feedback, an LCD screen, an LED ring that provide visual feedback, and a BlueTooth 2.0 module that communicates with the MAGE 2.0 game server.

Instructions

Submit this report to the appropriate folder on D2L site in Microsoft Word format. The report should be in Times New Roman or Arial font, no smaller than 10 point and double spaced. Note that all reports are scored on a 100 point scale. If the report is worth more or less than 100 points the score will be normalized to the points for the course

DO NOT REMOVE TEXT OR BULLETS FROM UNDER SECTION HEADINGS!

Description (10 points)

- Describe what this product does for a technical user short on time (be brief).
- Write a bulleted list of the products features.
- Provide enough background information to put the project in a technical context.
- Describe briefly inputs and outputs of the product (a technical description but not tables of data).
- Provide a level 0 functional block diagram. This block diagram should be a physical layout of the product showing the physical location of connections to the device.

Gundalf the Magical Pistol is a weapon meant to be used within the MAGE 2.0 Gaming System. Its function is comparable to a laser tag gun. Gundalf is powered by an internal 4.0 V Li-Po battery that is rechargeable via a micro USB charging port. The battery will power Gundalf for a minimum of 2 hours of gameplay. Gundalf fires 38 kHz IR packets that can be received by the headsets (known as Player Interface Units, or “PIU”s) of other players. Through these bursts, the pistol is able to either damage, stun, or heal other players, depending on the type of spell associated with the burst. Using its internal 2.4 GHz BlueTooth 2.0 module, the pistol communicates these shots with the MAGE 2.0 Game Server. The game server keeps track of all players’ health, stun, damage, alive and dead statuses.

Through audio/visual feedback elements including an RGB LED ring, a 2.8” LCD screen, and an audio controller, amplifier, and speaker circuit, Gundalf provides any surrounding players feedback related to when and what it is firing. The audio/visual feedback elements give additional information to its user including their PIU connection status, battery charge, operational state, clip size, and currently selected bullet type and stats.

Gundalf’s features as summarized as follows:

- IR Transmitter:
 - Transmits IR packets that act as “magic bullets”. The IR packets are intended to be fired at other players’ PIUs and weapons capable of receiving IR signals (e.g. the Magic Mine and Elemental Shield).
- 4.0 V Micro USB Rechargeable Li-Po Battery:
 - Rechargeable battery that provides electrical power for 2+ hours of gameplay

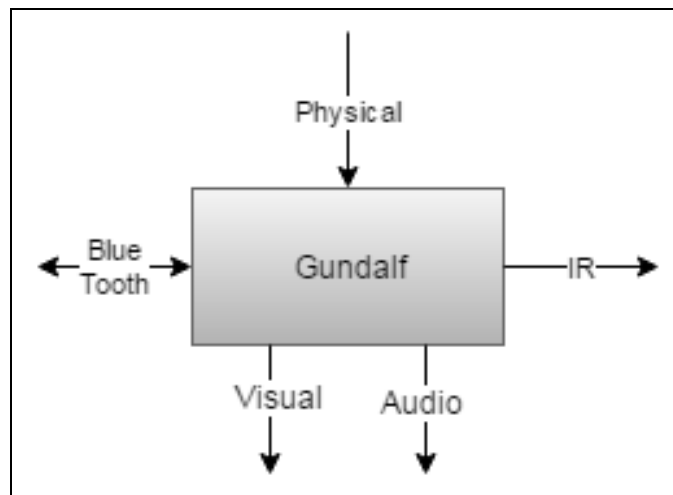
- 2.8" LCD Screen:
 - Provides information on the pistol's current clip, selected spell type, PIU connection status, battery charge status, operational mode (e.g. selection mode or firing mode), and player stun/death/alive status.
- BlueTooth 2.0 Module:
 - Communicates with the MAGE 2.0 Game Server to coordinate attacks and receive stun, death, and alive status updates.
- Audio Controller, Amplifier, and Speaker:
 - Features 24 unique sound effects and voice lines to be played when:
 - A new spell type is selected
 - The pistol is fired
 - The pistol is turned on
 - The user dies
 - The user is revived
 - The user is stunned
 - The pistol is reloaded
 - The pistol's clip is emptied
- Color-Coded Muzzle Flash RGB LED Ring:
 - Flashes either Red, Green, or Blue when a spell from the Damage, Heal, or Stun categories, respectively, are fired.
- Under 5 lb. Carrying Weight
- Weighted, Randomized Bullet Spell Types

The inputs of Gundalf are as follows:

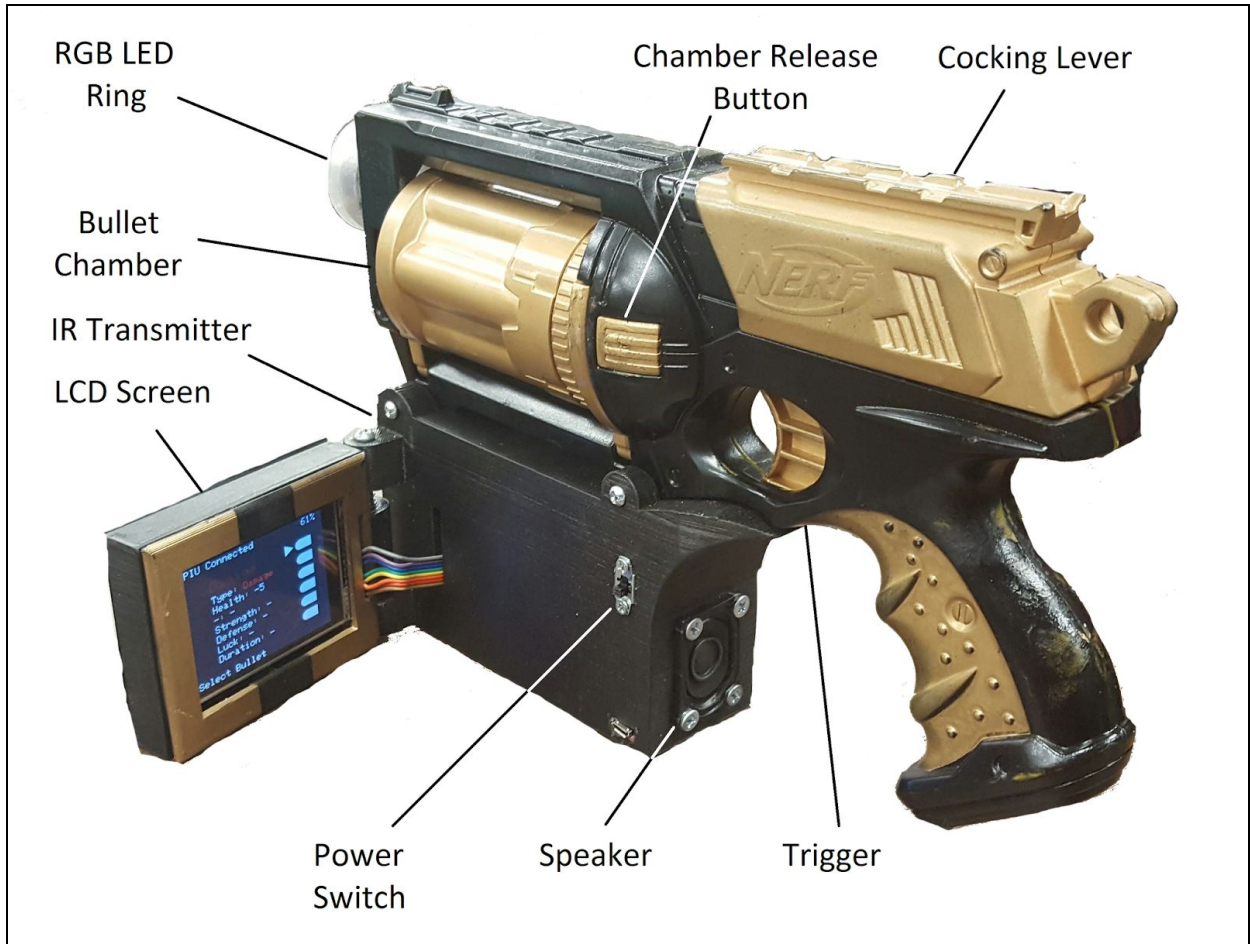
- BlueTooth:
 - Receives updates relative to the user's alive/dead status, stun status, and PIU connection status via BlueTooth.
- Physical:
 - Navigation control is operated via trigger, chamber, and cocking lever buttons.
 - Can be powered on with a side-mounted slide switch

The outputs of Gundalf are as follows:

- BlueTooth:
 - Sends updates to the Game Server via the user's PIU to indicate when a shot has been fired and what type of shot was fired
- IR:
 - Sends IR packets to other players' PIUs and weapons
- RGB LED Ring:
 - Emits a colored flash when the pistol is fired
- Audio Controller / Amplifier / Speaker Circuit:
 - Plays sounds when the pistol is booted, the pistol is fired, a new spell type is selected, the user dies, the user is revived, the user is stunned, the clip is empty, and the clip is being reloaded.
- 2.8" LCD Screen:
 - Provides the user with information about their clip, battery, stun status, death status, and PIU connection status.



Level 0 Functional Block Diagram



Physical Location of External Components

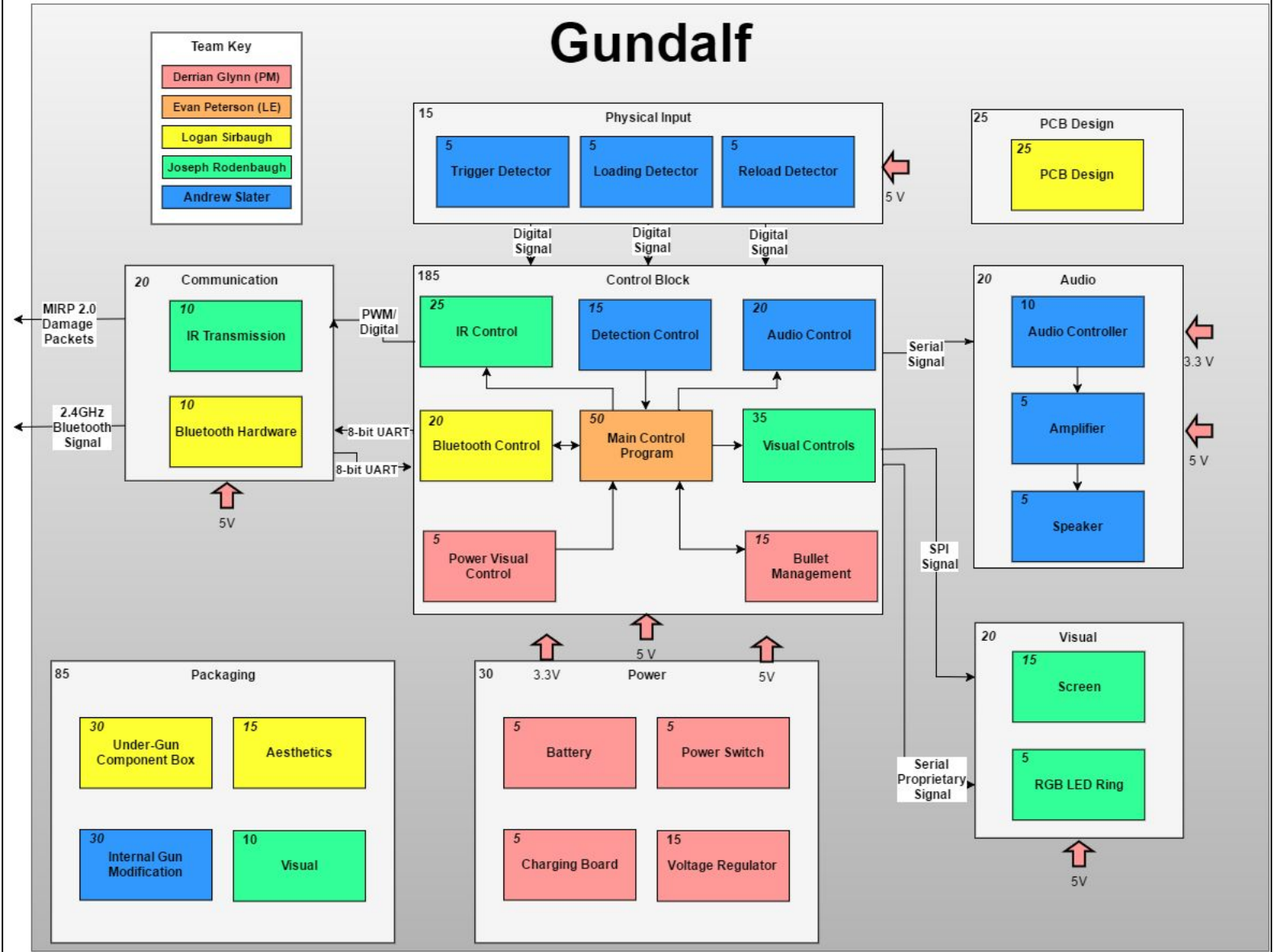
Product Block Diagram and pinout diagram (10 points)

- On one sheet of paper provide a level 1 functional block diagram of your product.
- On a separate sheet of paper provide a diagram of the inputs and outputs for the level 1 block diagram as a system. If you are doing a project that has a significant high-level (e.g. C or C++) software component, include a table of public functions.
 - ONLY INCLUDE INPUTS AND OUTPUTS OF THE SYSTEM FROM THE LEVEL 1 BLOCK DIAGRAM.
 - DO NOT INCLUDE INTERNAL CONNECTIONS/FUNCTIONS THAT ARE NOT ACCESSIBLE TO THE USER.
 - If your device has visual/tactile/audible user interfaces (such as displays, sounds, buttons) include these in the table.
 - Make sure you include detailed diagrams of any connectors with pin numbers.
 - The pin numbers and connector designations should match the Reference Designators from your layout and also the terminology used in your level 1 block diagram.

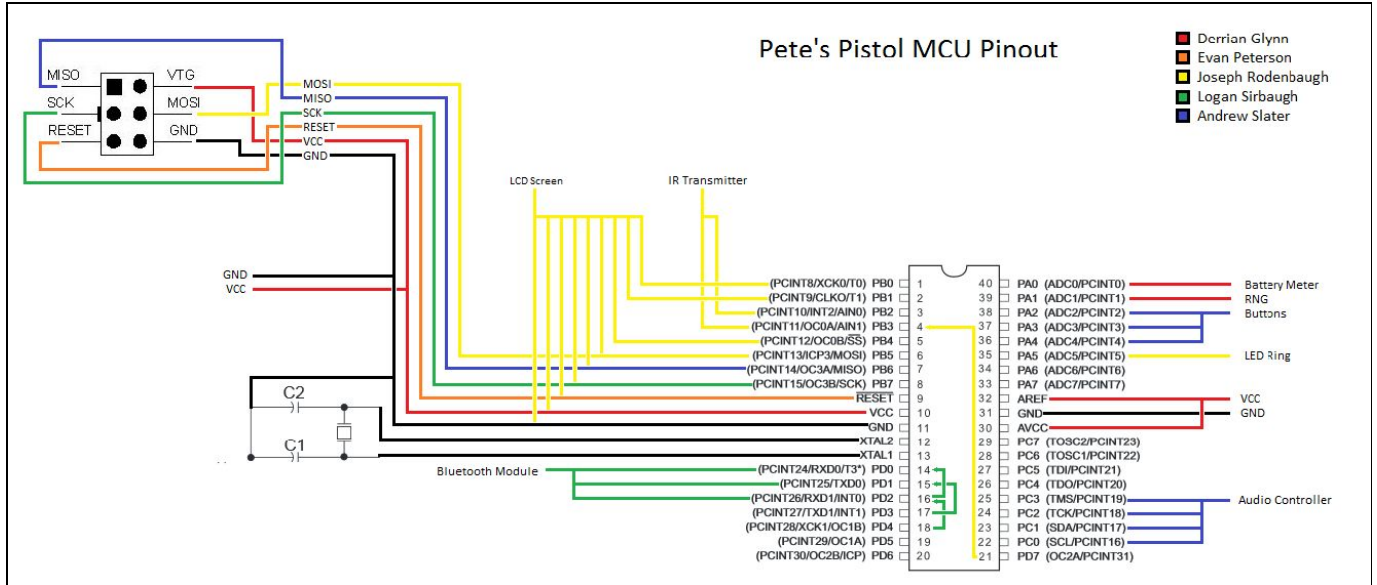
NOTE: No text on any drawing or schematic can be less than 10 point font, and the minimum component dimension on any drawing is $\frac{1}{4}$ " (6 mm). Your block diagram must identify each part of your system and who was responsible for that part. Your block diagram may be on a separate page if required. If needed you are encouraged to insert a page larger than the standard letter size. To do this: 1) *Insert* ® *Break* ® *Page Break*. 2) *File* ® *Page Setup*. In the dialog box select the *Paper* tab and set the size to custom. Then select *From this point forward*, from the *Apply to:* pull-down menu. 3) Select the paper size you need for your drawing. Sizes up to 22"×22" are supported. 4) Insert another page break. Follow the instructions in step 2 to set the rest of the document back to letter size (from the new page break forward)

Team 3: PBS Gun Team
 Gundalf
 Level 1 Functional Block Diagram

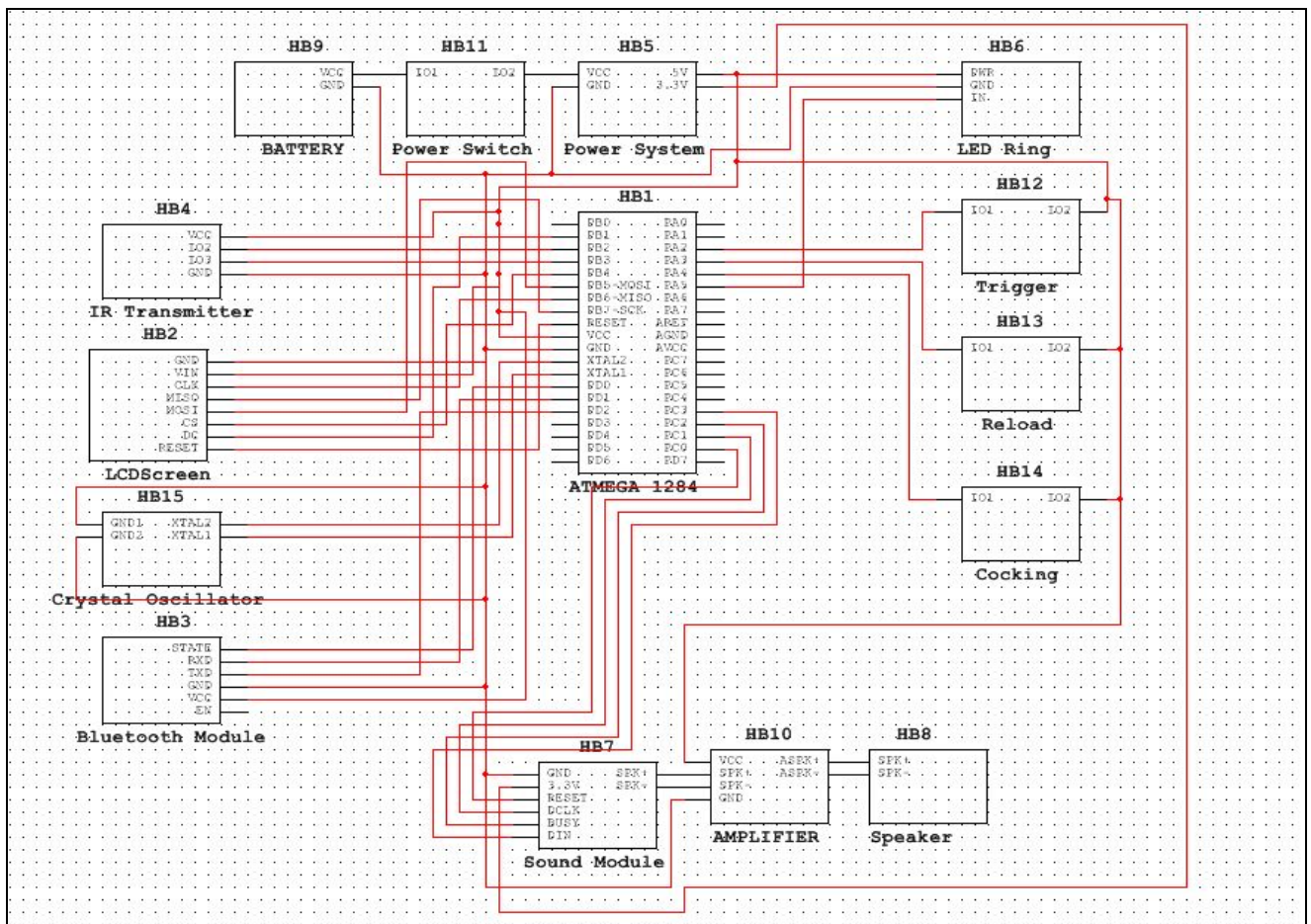
ECEN 4013
 Apr 26, 2016



Final Level 1 Functional Block Diagram



Final MCU Pinout



Final Level 1 Project Pinout

Summary of Main I/O Functions

Function	Input(s)	Output(s)
getBatteryPercentage()	None	Current battery charge percentage
isPIUConnected()	None	PIU connection status
isPlayerDead()	None	Player death status
isPlayerStunned()	None	Player stun status
BTFireShot()	Unique shot identifier	None
isTriggerPulled()	None	Status of trigger
isCockingLeverPulled()	None	Status of cocking lever
isChamberOpen()	None	Status of chamber
IRFireShot()	Unique shot identifier	None
draw<item name> (13 total functions)	Screen instance	None
NeoFlashMuzzle()	Spell type	None
asyncPlayVoice()	Sound effect number	None
stopVoice()	Sound effect number	None

Detailed Technical Description (15 points)

- Describe the principles of operation of your device in detail.
- Provide a brief description of the signals/data at all inputs, outputs and internal test points.
- Describe the test procedures used to verify proper device operation.
- Provide a brief description of debugging techniques and common problems the user might encounter with your device.

Device Summary:

At Gundalf's core is an ATmega1284 microcontroller chip programmed to manage all necessary functionality. Through the use of an external crystal oscillator, the ATmega1284 runs at a clock speed of 16MHz, allowing for the smooth integration of interrupts from Timer0 for the screen, Timer1 for Bluetooth output, Timer2 for IR, and USART Rx flag for Bluetooth input response. These interrupts make the immediate audio/visual response as well as the burst of wireless communication upon physical input feasible.

Gundalf has two primary states of operation that it toggles between. Which state it's in is determined by its the Bluetooth connection to its paired PIU. When connected, Gundalf is fully receptive to the physical inputs integrated into the Gun's reload, cocking, and trigger mechanisms. Based on the particular button pressed, Gundalf toggles between a variety of states differing in clip contents and status, while offering complete audio/visual feedback via the user-facing speaker, LCD screen, and RGB LED muzzle flash ring. When disconnected, Gundalf maintains near-complete functionality, only losing its ability to fire. This ensures that IR packets cannot affect other users when Gundalf is not registered as an active MAGE 2.0 game component. Functionality can be fully disrupted if the user is either stunned or killed. In either of these cases, the LCD screen will alert the user to their current incapacitative status.

Bluetooth Input:

The HC-05 Bluetooth module has one serial UART input that reads data sent from the ATmega1284's serial UART transmit output. This information is flushed through the 2.4GHz Bluetooth signal to the connected PIU unit. If bad bit encoding is encountered, either an oscilloscope or a brainstem can be used to dissect the integrity and periodicity of the transmitted serial data.

Physical Input:

There are a total of four button inputs available for user-interaction within Gundalf; three of which are lodged within the body of the Nerf Maverick Rev-6, and one is mounted in the

Under-Gun Component Box. A simple push button is used to detect when the cocking lever is pulled back. For reloading, a wedge switch breaks a data line when the chamber opens thus implementing inverse button logic to communicate a reload. For the trigger switch, a flex resistor is mounted behind the trigger arm so that when pulled, the pull-up resistance in a data line increases. An experimentally determined resistor seats below the flex resistor and is calibrated to have a high or low input level depending on the state of the flex resistor. The final switch is a simple slide switch used to connect battery voltage to the power board, thus powering Gundalf. If the reload, cocking, or power switches fail, voltage received at their corresponding microcontroller pin connections can be checked to verify if the buttons are physical functioning. If the reload fails, the voltage at its corresponding microcontroller pin can be checked for definite clearance of the high-to-low voltage threshold. A change in circuitry load could lead to the need for recalibration of the flex resistor's pull-down complement.

Bluetooth Output:

The HC-05 BlueTooth module has one serial UART output that channels data received from the PIU to the ATmega1284's serial UART receive input. When a byte of data enters the HC-05 output terminal, a flag is thrown in the microcontroller that serial data has been received which launches the appropriate software necessary to store and decode arrays of hexadecimal inputs. If bad bit encoding is encountered, either an oscilloscope or a brainstem can be used to dissect the integrity and periodicity of the transmitted serial data.

IR Output:

Gundalf's IR transmitter is controlled using 2 microcontroller pins. One pin outputs a high-frequency PWM signal and one pin turns on and off with a larger periodicity than the PWM signal. The IR transmitter's circuitry allows the bit banging second pin to mask the PWM signal. The ratio with which the bit banging pin masks the PWM signal is what differentiates a 1 sent from a 0 sent. By connecting an oscilloscope to the output line running through the IR LED, MIRP packets can be debugged.

RGB LED Ring Output:

Each of the RGB LED Ring's 12 LEDs is capable of receiving 24-bits that determine its color and brightness. Since the RGB LED has 12 LEDs, 12 sets of these 24-bit codes must be sent to fully define the colors on the ring. The 24 bits are comprised of 3 8-bit codes that represent the LEDs green, red, and blue values. An oscilloscope connected to the Data In RGB Ring input can debug errors in bit encoding.

2.8" LCD Screen Output:

The 2.8" LCD Screen is controlled via a suite of pre-written libraries. The most notable of these libraries are the Adafruit_ILI9341 and Adafruit_GFX libraries. These libraries facilitate the SPI communication necessary to abstract the control of the screen to drawing shapes and writing text. The screen draws on an enormous amount of library information, so debugging is best done through serial analysis of MISO and MOSI lines.

Audio Output:

The operational principle of the audio is to play the sound files that are on the microSD card that has been placed inside the audio controller. It uses its busy, digital clock, digital input, and reset pins to call upon different sound files based on a number that is matched with the corresponding audio file. It then sends the audio through the amplifier and to the speaker. To test if the audio system would work, the MCU was programmed to play a stream of all audio files that would run their full extent or move in rapid succession.

Common Issues & Their Solutions:

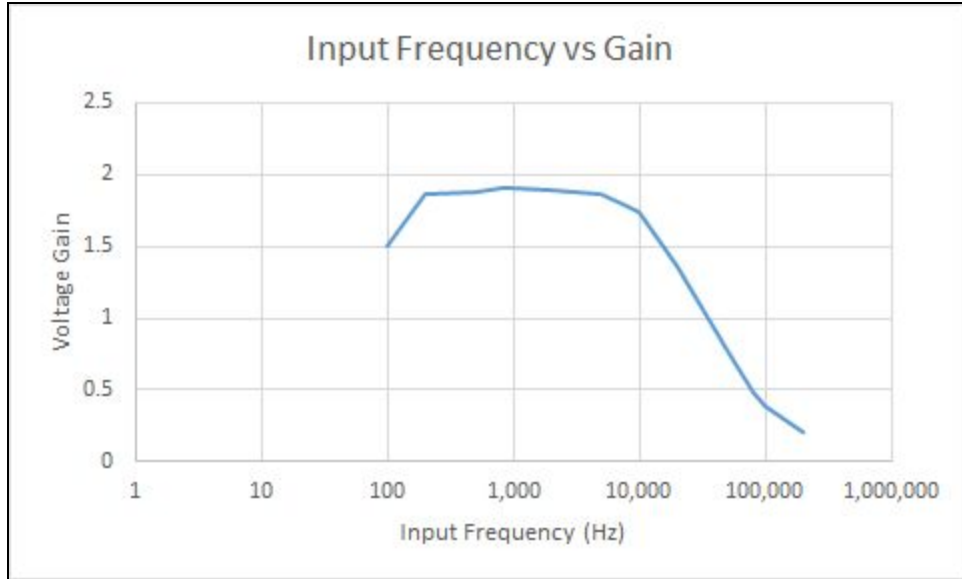
Issue	Possible Solution(s)
Screen flickers and/or device will not boot	Because the main power switch is damaged, it has difficulty remaining in the "ON" position. Check to make sure that the switch is firmly in the "ON" position.
Pistol allows the selection of bullets, but will not shoot	Check to make sure that the message at the top left of the LCD screen reads "PIU Connected". If the pistol is not connected to a

	PIU, it will not allow the user to fire.
Sound effects do not play or Bluetooth does not connect to PIU	The audio controller and BlueTooth module are sensitive to repeated power cycling, as can happen if the power switch does not firmly stay in either the "ON" or the "OFF" position. Try holding the power switch firmly in the "OFF" position for several seconds, then moving it firmly to the "ON" position.

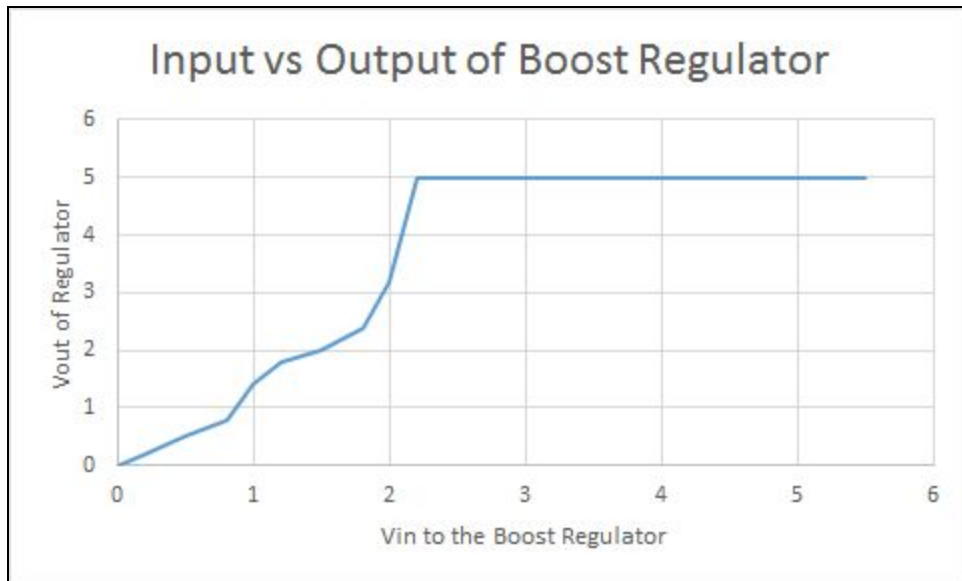
Tables of Detailed Technical Specifications Explaining your Design (15 points)

Describe the models, drawing, simulations, etc. that your team used to understand and make predictions about your design project. You should write one to three paragraphs on each of the points below:

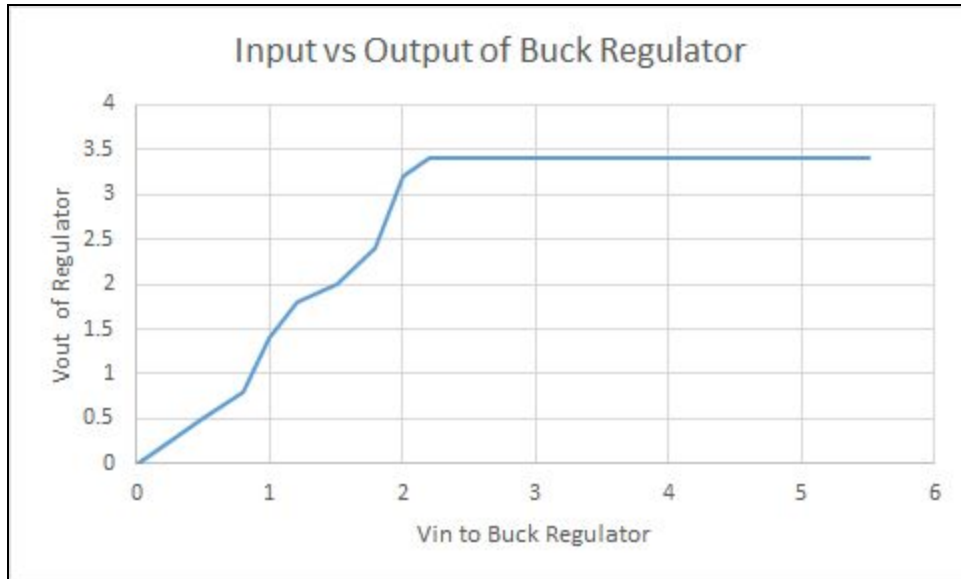
- List in tables measured values of all input and output pins/calls to the device during normal operation.
- Provide graphs or figures of any:
 - Measured time dependent inputs, outputs, and signals at all test points.
 - For high level software components describe data passed (i.e. between functions, databases, I/O devices, etc.) and provide examples of actual data.
 - Measured change in output with changing input parameters (i.e. variation of gain with operating voltage for an amplifier)
 - Considering all components used list the Absolute minimum and maximum operating ranges.



Voltage Gain Plot of the Audio Amplifier



Input to Output Results of the Boost Regulator Circuit



Input to Output Results of the Buck Regulator Circuit

Detailed Application Information (15 points)

This section provides instructions to users on how to get your device working (in one or two paragraphs).

- Describe in detail how to use the device
- Describe in detail how to connect the device to other systems
- Describe common fault conditions and how to correct them
- Describe any variable voltages, resistances, currents, or any other user selectable hardware features
- Describe if necessary how to calibrate the device and or test for proper operation.
- Describe how to program any onboard memory or microprocessor

The first thing that the user needs to do in order to operate the pistol is to turn it on by pressing down on the power switch on the left side of the component box. The next step is to pull out the screen. To do this, the user must push the screen upward, rotate it away from the pistol, and set it back down. Next, the user must wait for the pistol to connect to its PIU. One can tell that it is connected to its PIU by looking for the “PIU Connected” message in the top left corner of the LCD screen. The pistol is now ready to use.

To begin firing the pistol, press the gold button on the left side of the pistol to release the chamber, extend the bullet chamber towards the LCD screen, and push the chamber back into its original position. Upon reloading, the pistol will randomly generate six new bullets. During this time, the pistol will be in "Selection Mode", indicated by a message in the bottom left corner of the LCD screen that reads "Select Bullet". This mode allows the user to rotate through the clip and chose the bullet that they would like to fire. Once the user is ready is ready to fire their selected bullet, they must pull the cocking lever to transition the pistol into "Firing Mode", indicated by a message in the bottom left corner of the LCD screen that reads "Ready to Fire".

To fire, the user must aim the pistol at their intended target and squeeze the trigger. A successful firing will be indicated by a flash of the muzzle RGB LED ring, a "Bang!" sound effect, and an emptying of the selected chamber on the LCD screen. When fired, the pistol will send an IR packet in the direction that it is pointed. It will also inform the MAGE 2.0 Game Server that it has fired a shot of a particular type.

The pistol connects automatically to its assigned PIU via the pistol's internal BlueTooth module..

Once connected, the pistol will send periodic heartbeats to let the MAGE 2.0 Game Server know that it is still active.b No other 2-way wireless connections are made by the pistol.

A common cause of fault with the pistol is its power switch. The switch is damaged and does not firmly remain in either the "on" or "off" positions, instead sliding semi-freely between the two states. This issue can cause the audio controller and BlueTooth module to misbehave. In the case that either the sound does not play or the pistol does not connect to its PIU, it is recommended that the user firmly slide the power switch to the "off" position for several seconds before firmly sliding the pistol's power switch back to the "on" position.

An additional issue with the pistol is its screen hinge. Due to a printing error, the wire cluster that connects the component box to the LCD screen does not slide freely back into the component box when the LCD screen is closed. This causes the wire cluster to bunch up and press against the LCD screen. This has previously caused the screen to crack, and, if done again, may break the screen. Given this, it is not advisable to try to close the screen entirely.

None of the pistol's hardware is user-adjustable and its only variable resistor is in its grip. The variable resistor in the pistol's grip is a flex resistor, which acts as an element of a voltage divider that signals the controller when the trigger is pulled.

The pistol does not need to be calibrated in order to function as intended.

To program the pistol's on-board microcontroller, first slide the door off of the right side of the component box. Next, move any obstructive cables out of the way of the main control board. After clearing any obstructions, a 6-pin SPI programming header should be visible on the top side of the board. Once the programming header is found, plug an Atmel ICE programmer into the header. Then, plug a micro USB to USB cable into the Atmel ICE and the USB port of a PC, respectively.

Application Example (10 points)

- Describe in detail an example of how the device would be used by the end user.
- Provide a connection diagram specifying needed hardware, cables, power supplies, etc.

General Operation:

1. Flip the power switch downward to turn on the pistol. The power switch can be found on the left-hand side of the component box, below the trigger.
 - a. Note: The pistol takes 3-4 seconds to boot.
2. Open the LCD screen. This can be done by lifting the screen upward out of the "closed" position, rotating the screen a quarter turn away from the pistol, and setting the screen back down into its "open" position.
3. Wait until the pistol connects to the user's PIU. The status of the PIU connection can be found at the top left corner of the LCD screen. If the pistol is connected to a PIU, the screen will read "PIU Connected". If it is not connected to a PIU, the screen will read "PIU Disconnected."
4. Open the bullet chamber by pressing the gold button on the left-hand side of the pistol between the chamber and the trigger. Pull the chamber out and away from the body of the pistol.

5. Push the bullet chamber back into the pistol. The pistol's LCD screen should reflect that the clip has been refilled by displaying six white bullets on the right side of the screen and saying "Reloaded."
6. Pull the trigger to cycle through the clip.
7. Pull back on the cocking slide after selecting a spell. The cocking lever is located above the trigger. The cocking lever will indicate that it is cocked by making a clicking sound.
8. Aim the pistol at the intended target and pull the trigger to fire a spell. The user may now choose another spell to fire, be allowed to empty their clip, or, if they're out of ammunition, be asked to reload.

Charging:

1. Connect the pistol to a micro USB charging cable. The charging port can be found below the power switch on the left side of the component box.
2. Connect the other end of charging cable to a powered USB port.
 - a. Note: The charging status of the pistol can be determined via 2 methods:
 - i. The percent charge of the pistol's battery can be found at the top right of the LCD screen.
 - ii. A red light above the charging port will turn on when the pistol's battery is actively being charged.



Team Organization and Management (10 points)

- State how your team was organized and what role each team member played. Describe the ground rules set up for meetings.
- Describe how your team determined whether work was performed to a professional standard and how the team addressed issues of individuals who did not meet expectations.
- Identify specific and practical suggested improvements in team organization and management.
- Identify any specific weaknesses of your approach/performance and how you would fix them.

Gundalf the Magical Pistol was designed and constructed by The PBS Team, which consisted of Derrian Glynn, Evan Peterson, Logan Sirbaugh, Joseph Rodenbaugh, and Andrew Slater. Derrian Glynn was responsible for managing the team and the power. Evan Peterson was responsible for programming the microcontroller and integrating the project's constituent elements. Joseph Rodenbaugh was responsible for the LCD screen, RGB LED ring, and IR transmitter. Logan Sirbaugh was responsible for PCB design, packaging (namely the under-gun component box), and aesthetics (i.e. painting and the metal faceplate). Andrew Slater was responsible for physical controls, audio, and gun modifications.

Team meetings were held every Wednesday at 3:30 PM. Derrian Glynn kept track of attendance and Evan Peterson organized the meeting topics. The meetings generally lasted as long as was required to cover the necessary topics. The purpose of the meetings was to get everyone up to speed on the project's status and assign new duties for the period between the current meeting and the next meeting. Additional meetings were held as needed.

The team remained relatively informed about each other's sections throughout the project. As a result, the team knew early on when a member's section was not being completed to a professional standard. In such a case, the team attempted to help the struggling member as much as was reasonable, then recorded and reported the incident(s) to Dr. Rajamani and the TAs.

An improvement that would have benefited the team would be to set smaller, more frequent deadlines. The team would frequently lose perspective on just how much time and energy it takes to meet some of the larger deadlines, which lead to a failure to frontload their workload and less-than-optimal results on some of the earlier deadlines.

The issues that the team faced that resulted from a failure to frontload their work were largely fixed later in the semester by meeting and working together more frequently and transitioning from single weekly deadlines to deadlines due every one or two days. Communication also improved as the semester went on, which was greatly beneficial.

References (5 points)

Use the IEEE Style. Details can be found on the course web site or in the IEEE Authors Manual. References must be cited in the body of the text.

- [1]"Jacob-Dixon/MAGE2", *GitHub*, 2016. [Online]. Available: <https://github.com/Jacob-Dixon/MAGE2/wiki>. [Accessed: 08- Feb- 2016].
- [2]"cherwa/ECEN-4013-Fall-2015-E-Bow", *GitHub*, 2016. [Online]. Available: <https://github.com/cherwa/ECEN-4013-Fall-2015-E-Bow/wiki>. [Accessed: 12- Feb- 2016].
- [3]*Atmel.com*, 2016. [Online]. Available: <http://www.atmel.com/>. [Accessed: 17- Feb- 2016].
- [4]"Adafruit Industries - Makers, hackers, artists, designers and engineers!", *Adafruit Industries - Makers, hackers, artists, designers and engineers!*, 2016. [Online]. Available: <http://blog.adafruit.com>. [Accessed: 29- Apr- 2016].
- [5]"Home", *AVR Freaks*, 2016. [Online]. Available: <http://avrfreaks.net>. [Accessed: 29- Apr- 2016].
- [6]"SparkFun Electronics", *Sparkfun.com*, 2016. [Online]. Available: <http://sparkfun.com>. [Accessed: 29- Apr- 2016].
- [7]"MicrocontrollersAndMore/Atmel_Programming_Tutorial_1_1st_Programming_and_Blink_a_LED", *GitHub*, 2016. [Online]. Available:

https://github.com/MicrocontrollersAndMore/Atmel_Programming_Tutorial_1_1st_Programming_and_Blink_a_LED. [Accessed: 29- Apr- 2016].

[8]"Analog, Embedded Processing, Semiconductor Company, Texas Instruments - TI.com", *Ti.com*, 2016. [Online]. Available: <http://ti.com>. [Accessed: 29- Apr- 2016].

[9]P. Marian, "Electronics Projects Circuits", *Electroschematics.com*, 2016. [Online]. Available: <http://Electroschematics.com>. [Accessed: 29- Apr- 2016].

[10]"Treehouse Projects | Engineering, Science, & Technology Project Blog", *Treehouseprojects.ca*, 2016. [Online]. Available: <http://Treehouseprojects.ca>. [Accessed: 29- Apr- 2016].

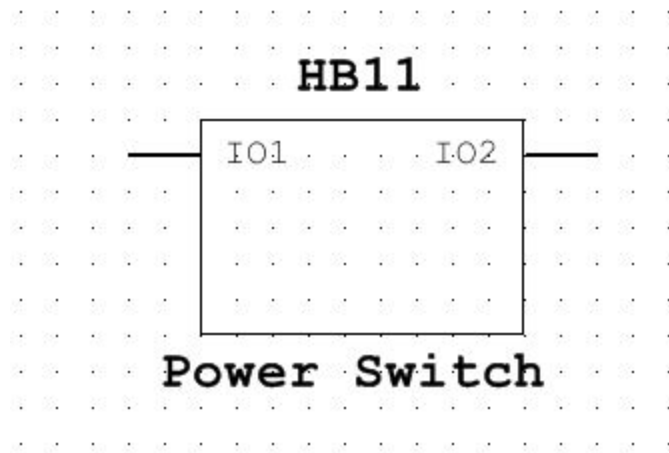
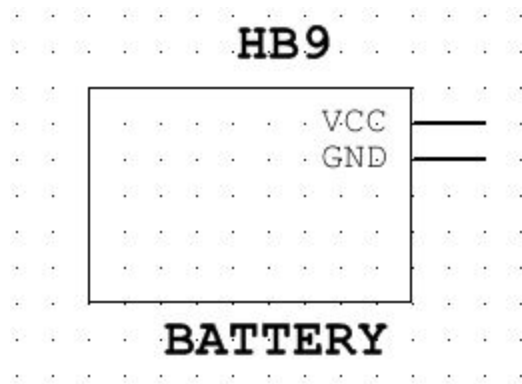
[11]A. Mahidharia, "Hackaday | Fresh hacks every day", *Hackaday.com*, 2016. [Online]. Available: <http://Hackaday.com>. [Accessed: 29- Apr- 2016].

[12]"limor", *Ladyada.net*, 2016. [Online]. Available: <http://ladyada.net>. [Accessed: 29- Apr- 2016].

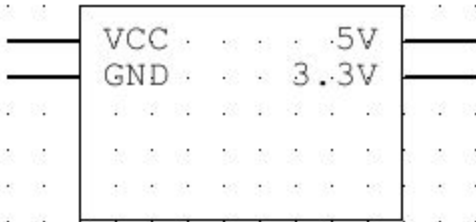
Appendix (5 points)

- Provide any relevant diagrams, schematics, PCB Layouts, Code, or other technical documentation.

Pinouts:

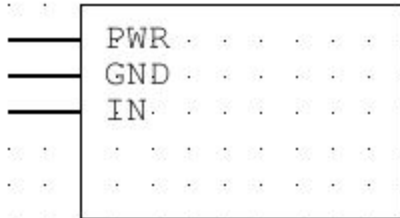


HB5



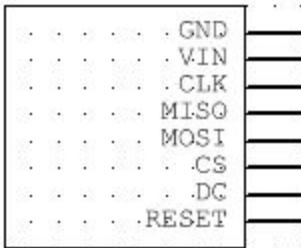
Power System

HB6



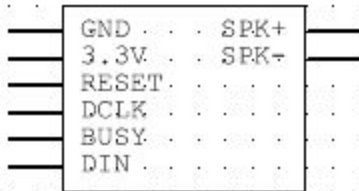
LED Ring

HB2



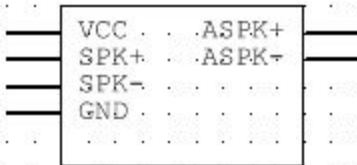
LCDScreen

HB7



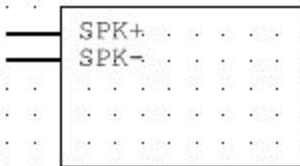
Sound Module

HB10



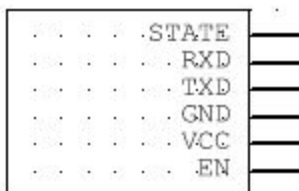
AMPLIFIER

HB8



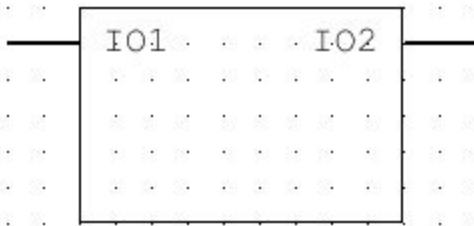
Speaker

HB3



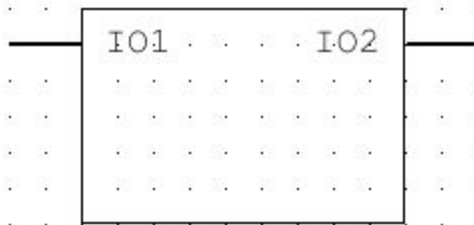
Bluetooth Module

HB13



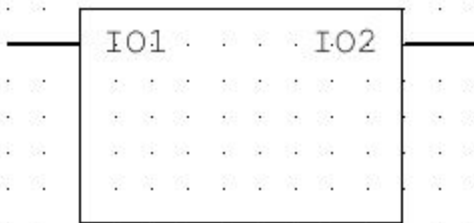
Reload

HB14



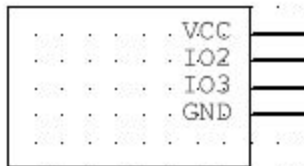
Cocking

HB12



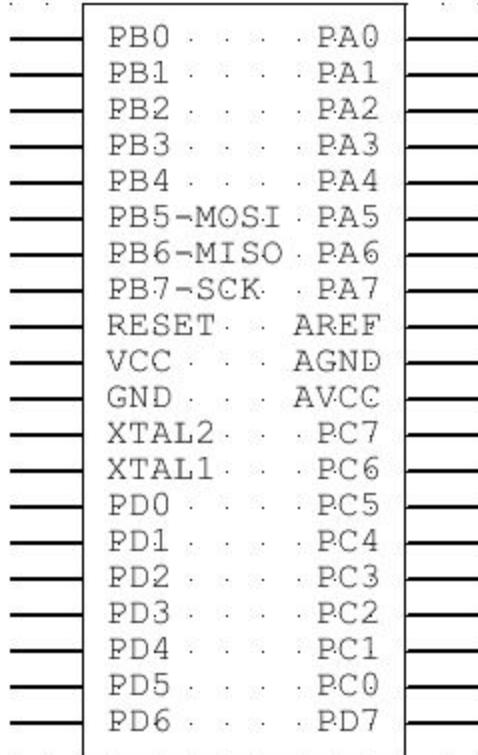
Trigger

HB4



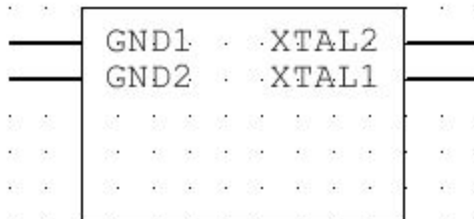
IR Transmitter

HB1



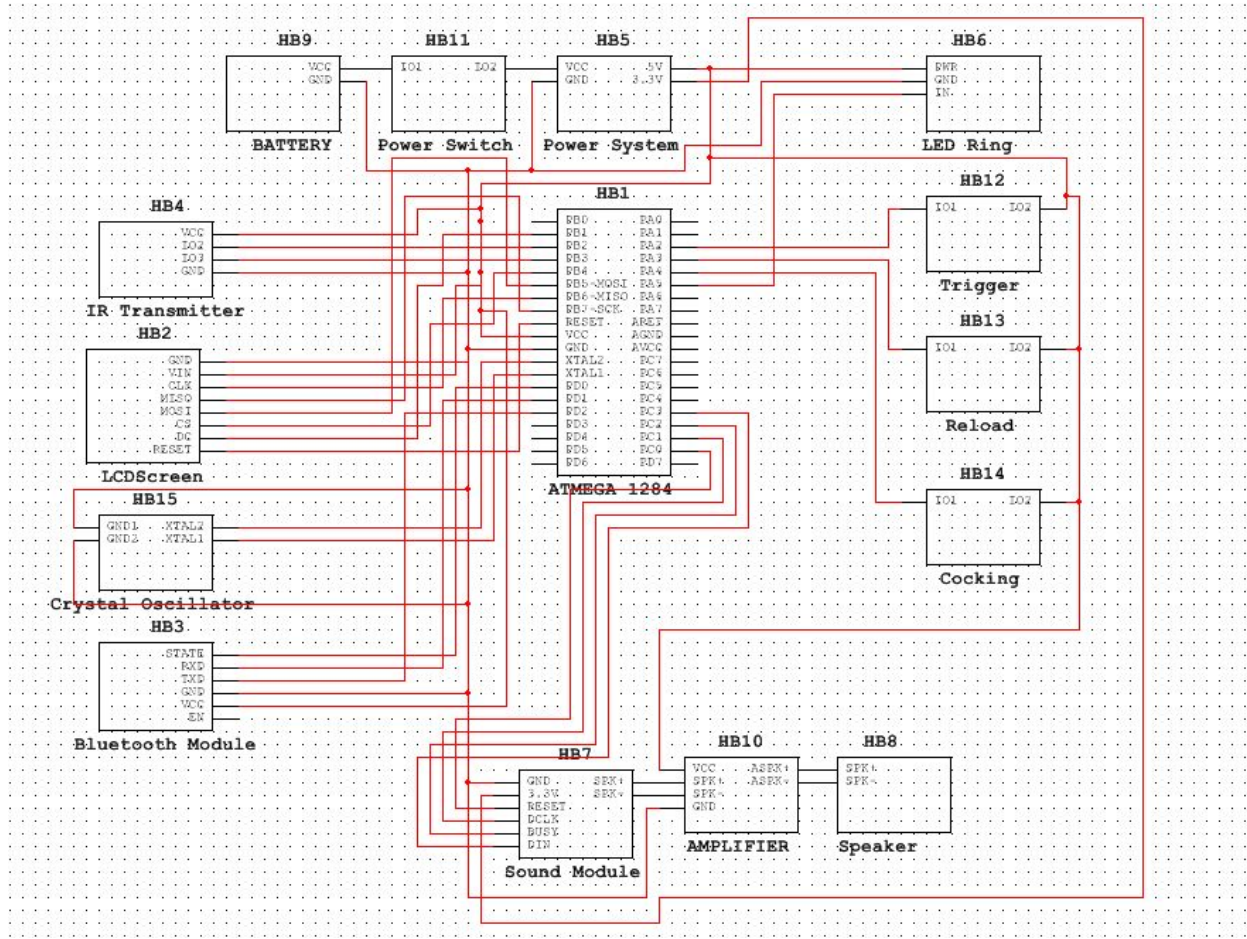
ATMEGA 1284

HB15



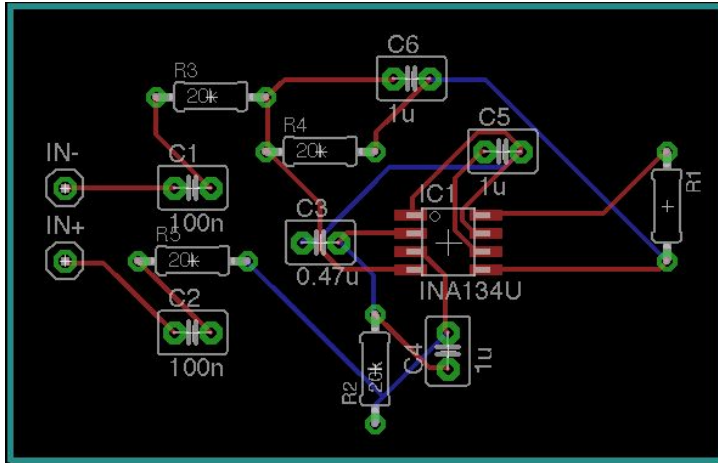
Crystal Oscillator

Final Pinout:

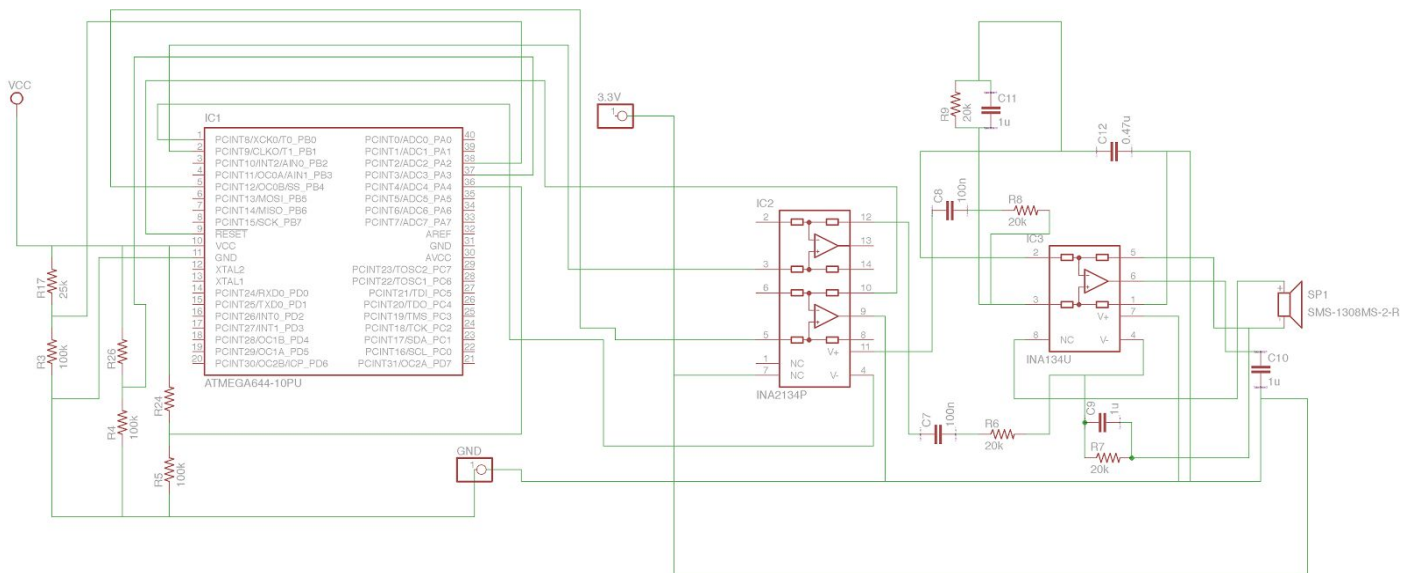


Prototyping: PCB Design

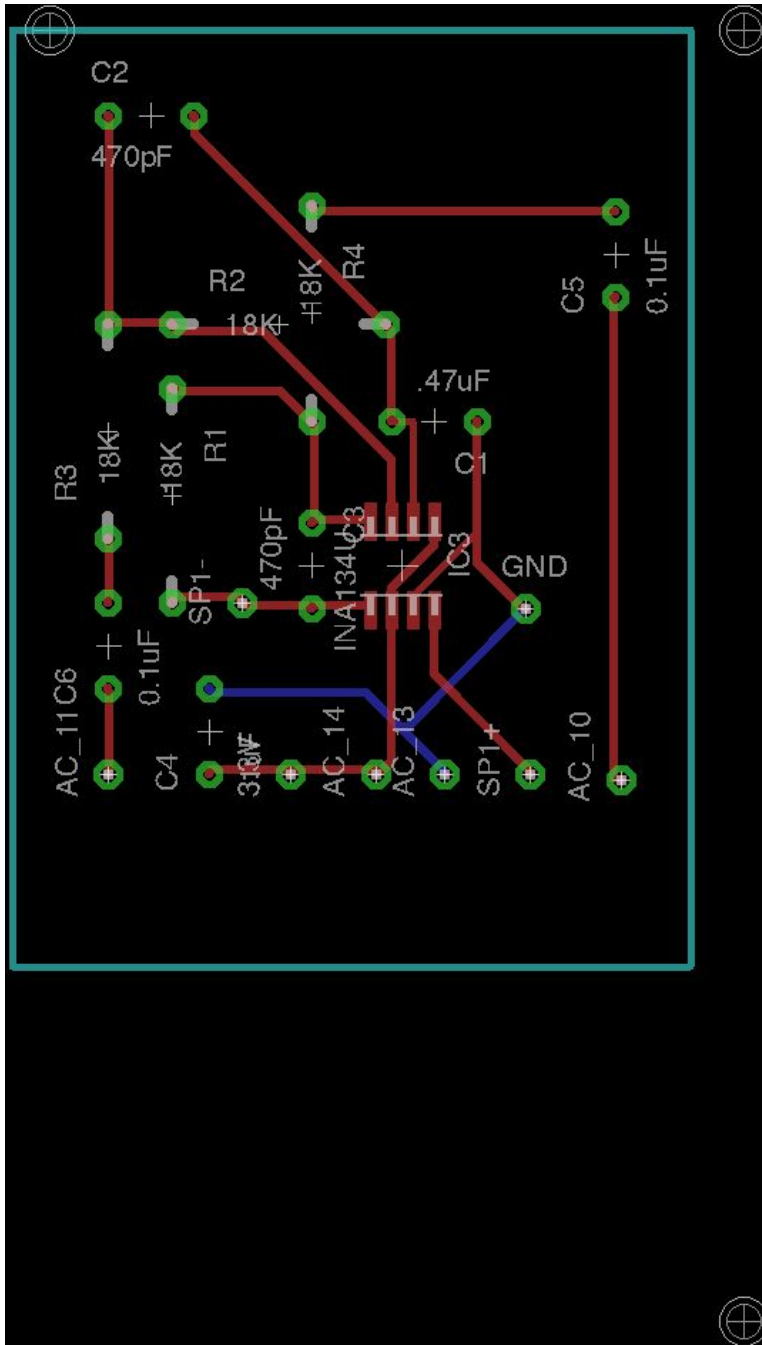
- Audio V1 Board:



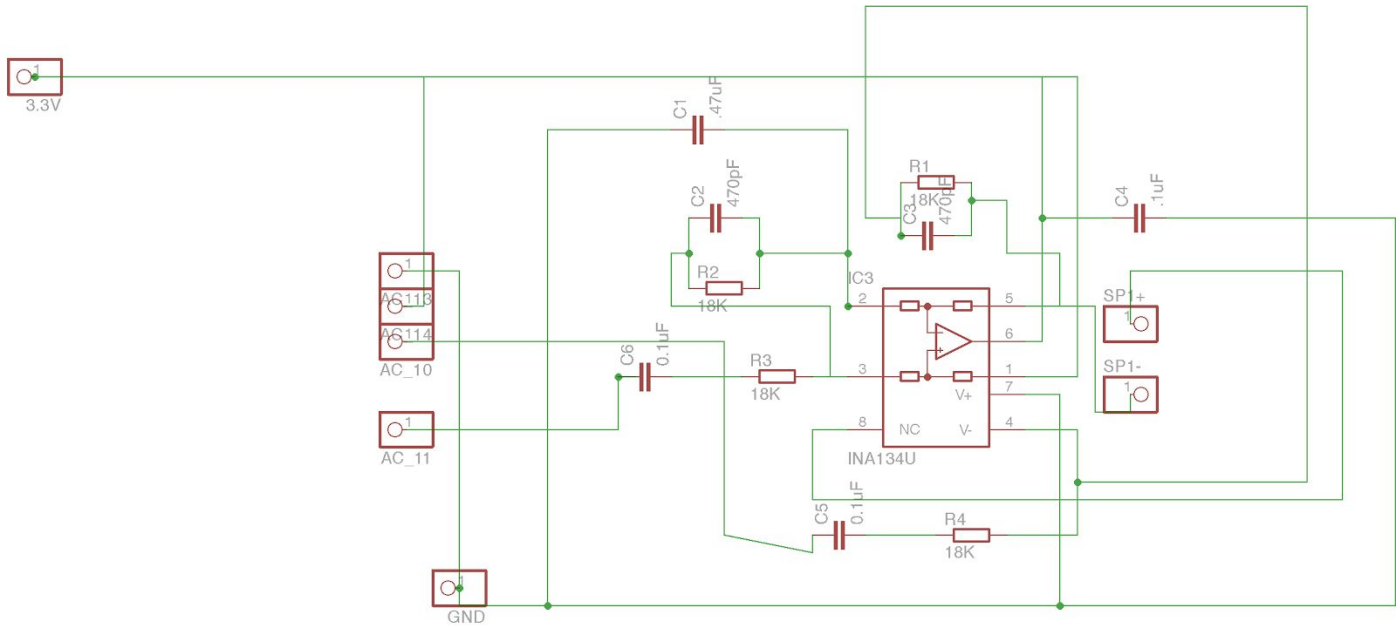
- Audio V1 Schematic:



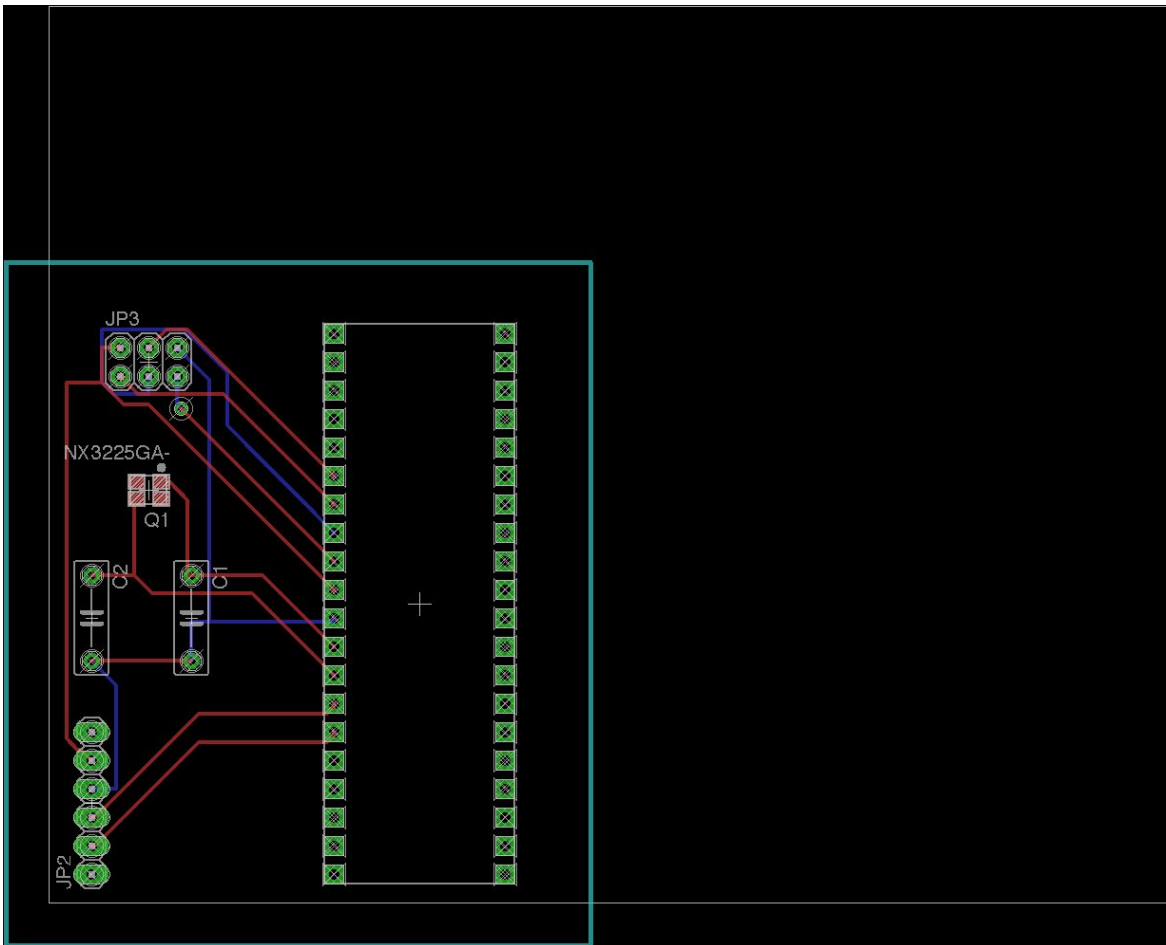
- Audio V2 Board:



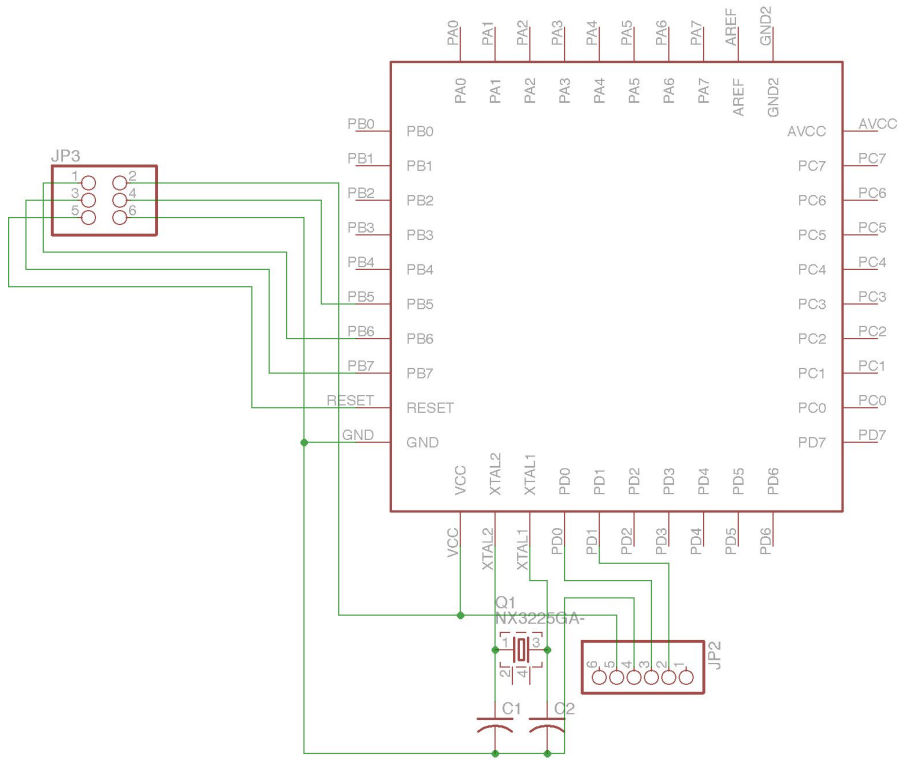
- Audio V2 Schematic:



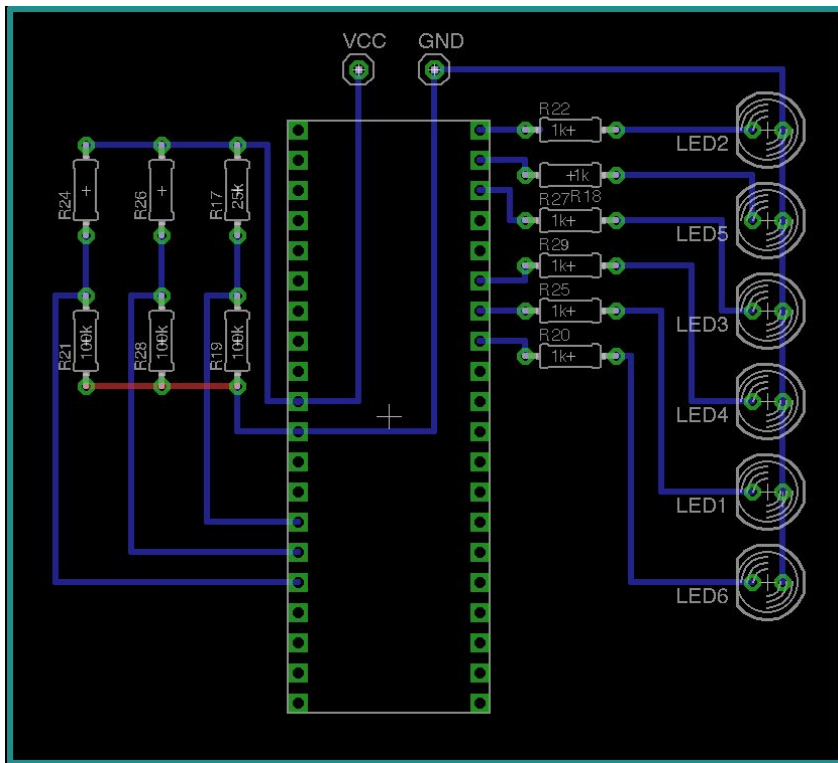
- Bluetooth V1 Board:



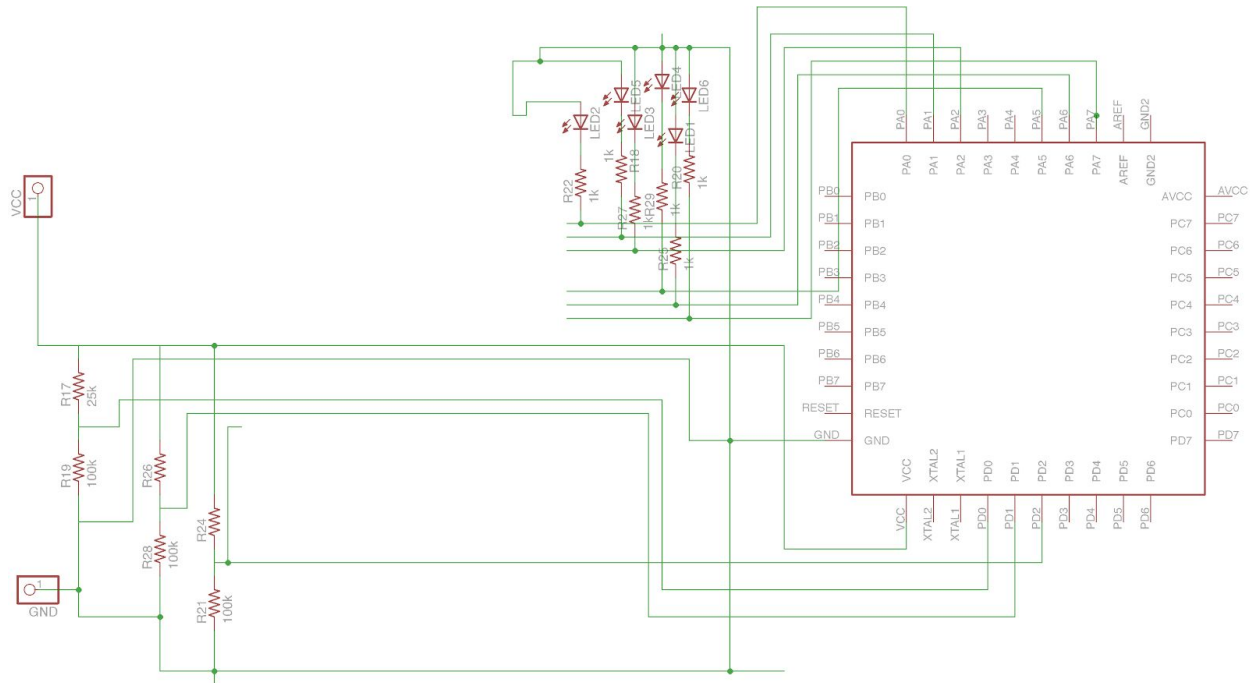
- Bluetooth V1 Schematic:



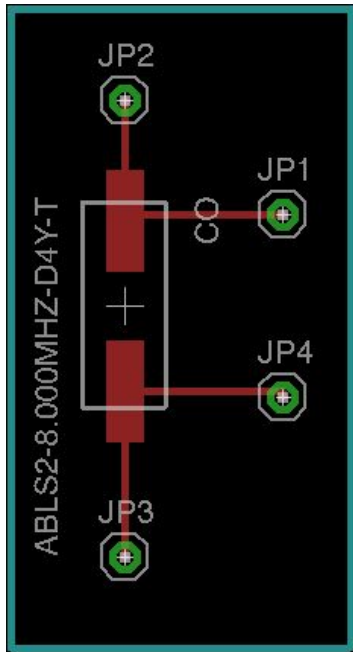
- Buttons V1 Board:



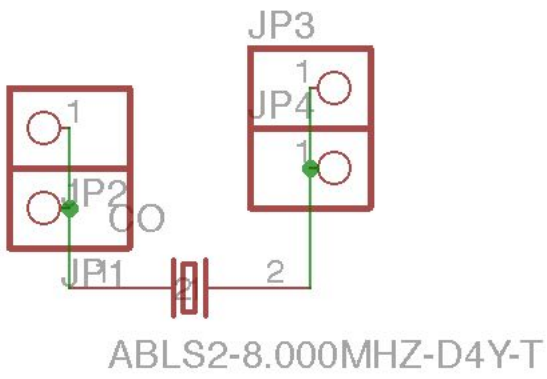
- Buttons V1 Schematic:



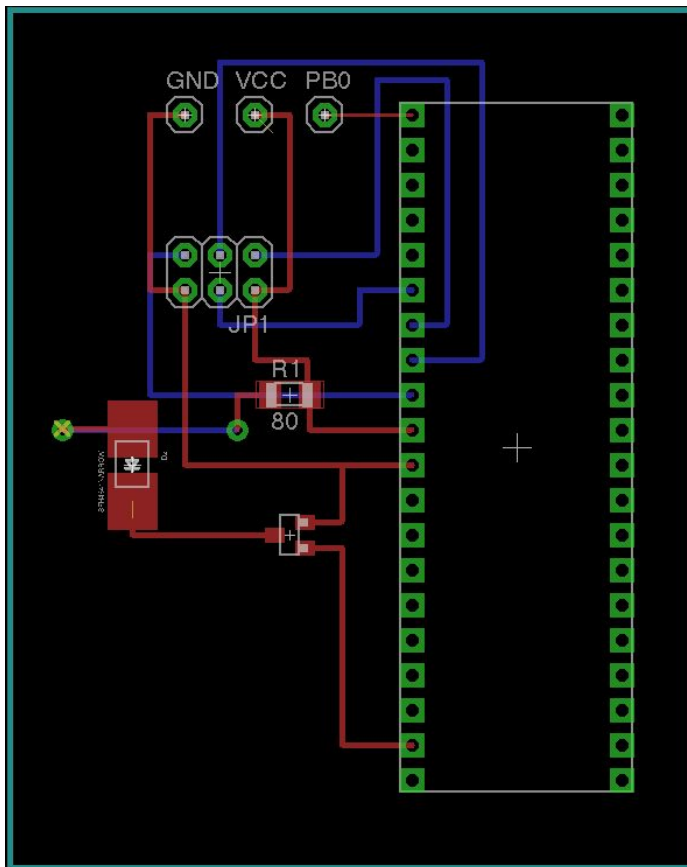
- Crystal Oscillator V1 Board:



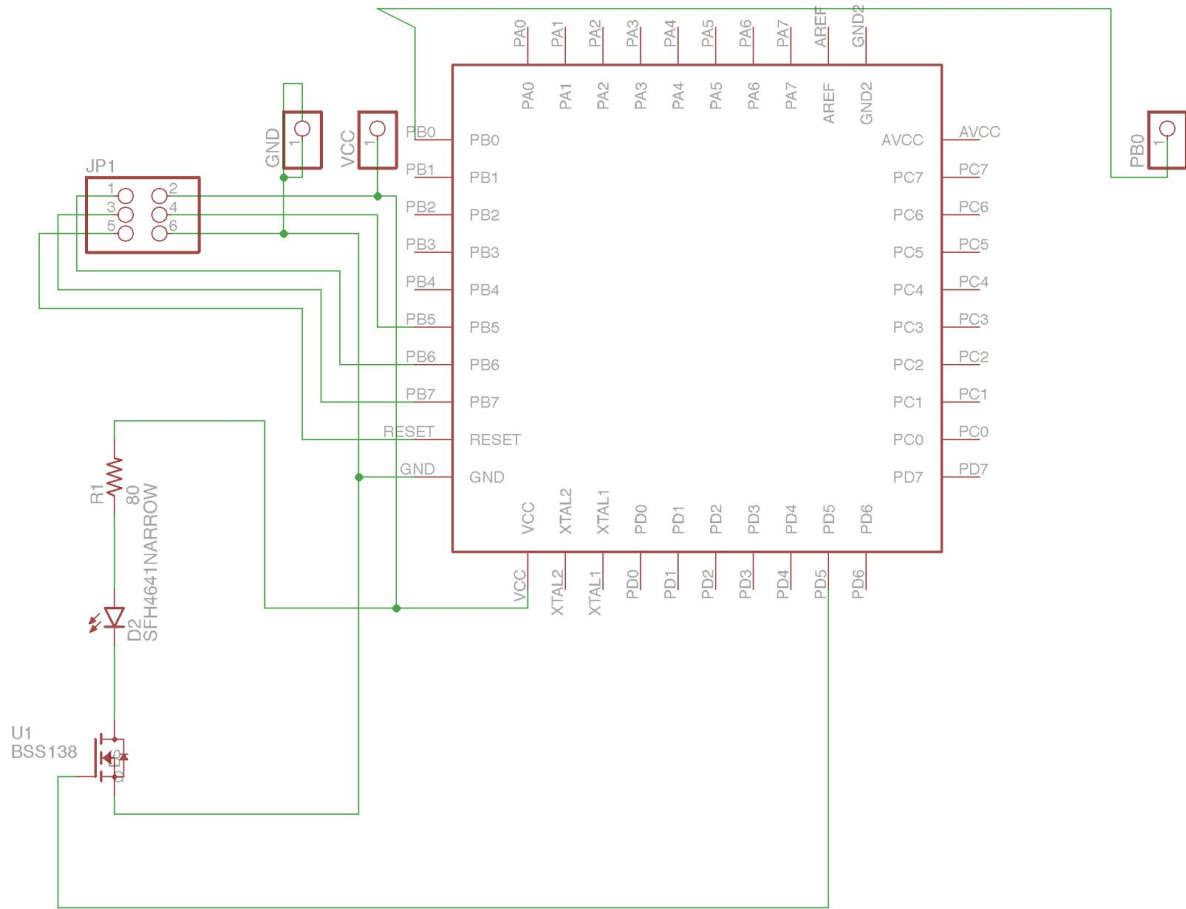
- Crystal Oscillator V1 Schematic:



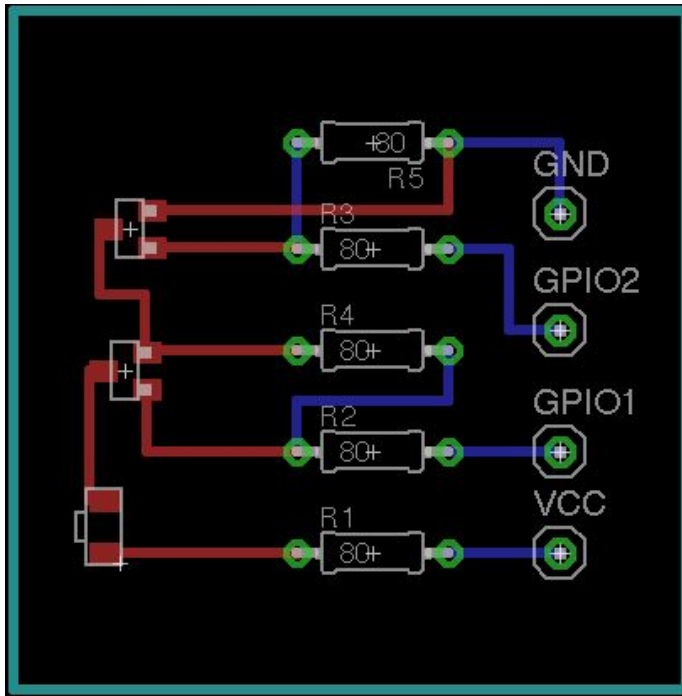
- IR V1 Board:



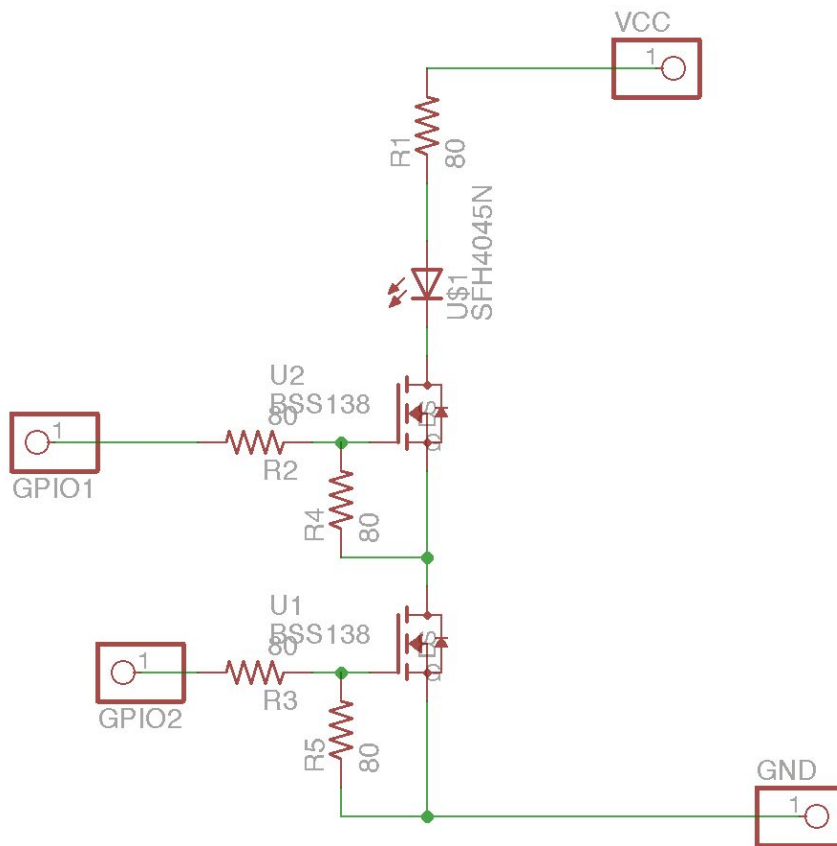
- IR V1 Schematic:



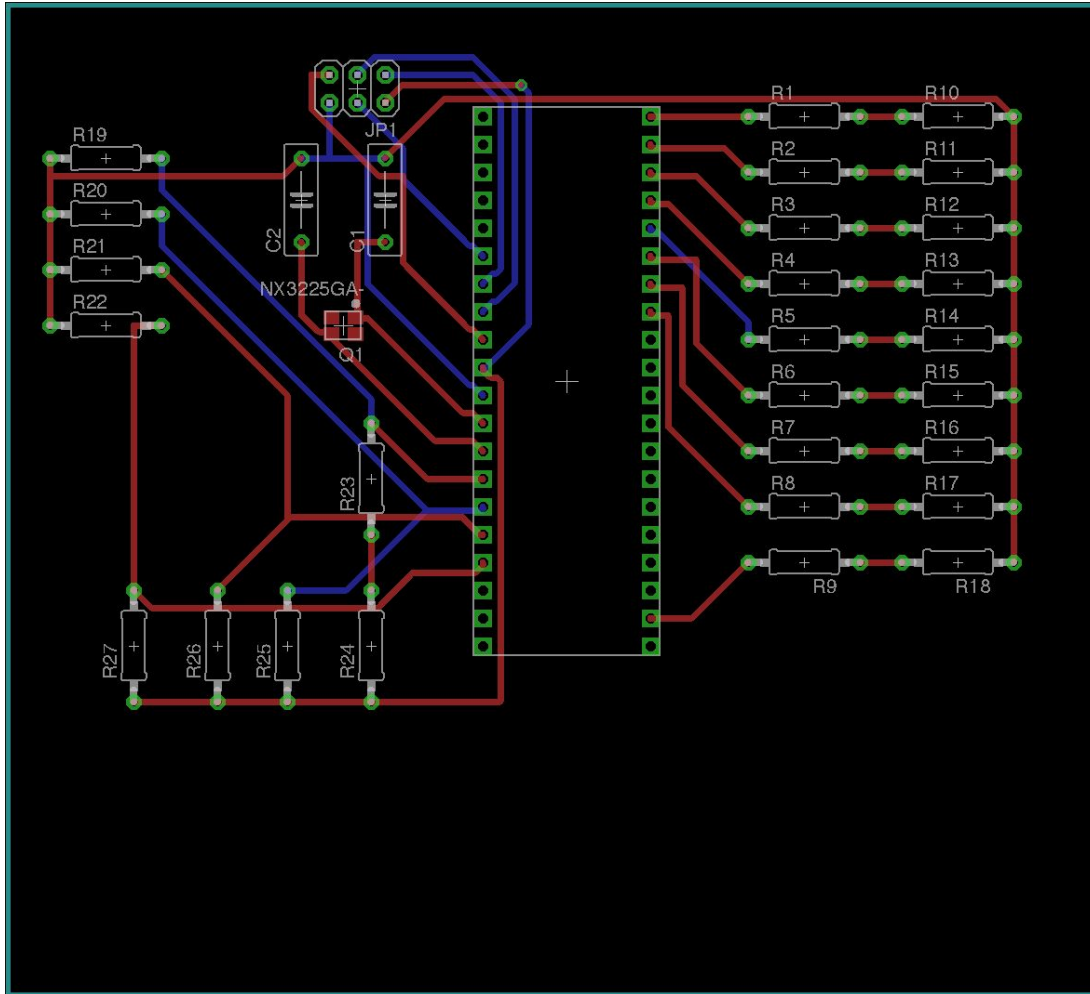
- IR V2 Board:



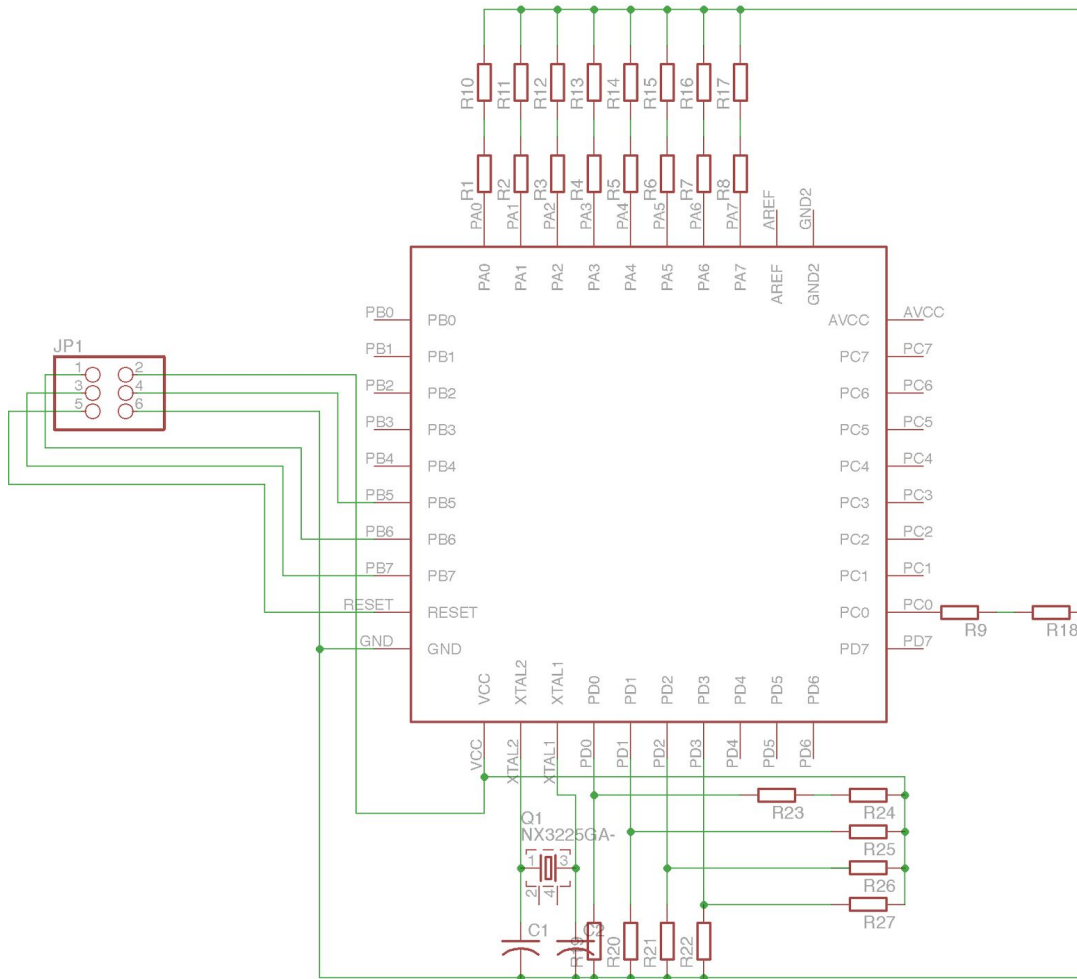
- IR V2 Board:



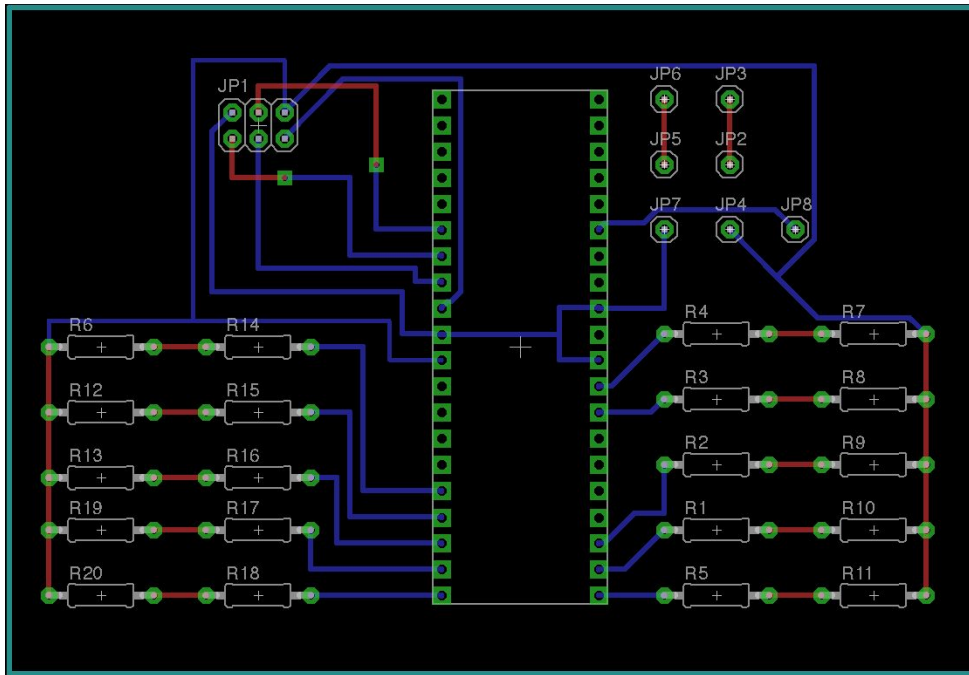
- MCU V1 Board:



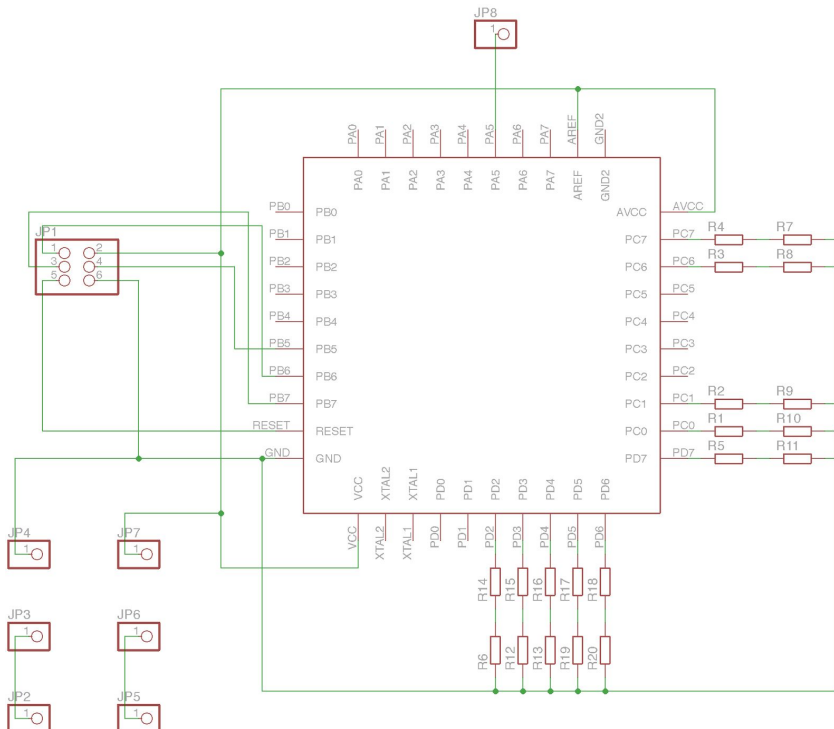
- MCU V1 Schematic:



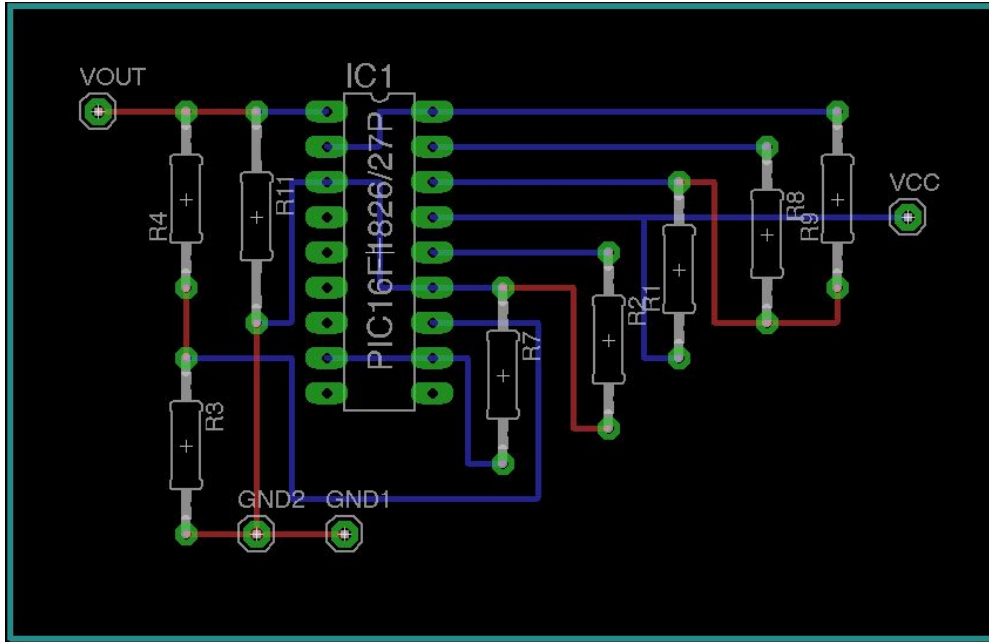
- Battery Meter and Random Number Generator V1 Board:



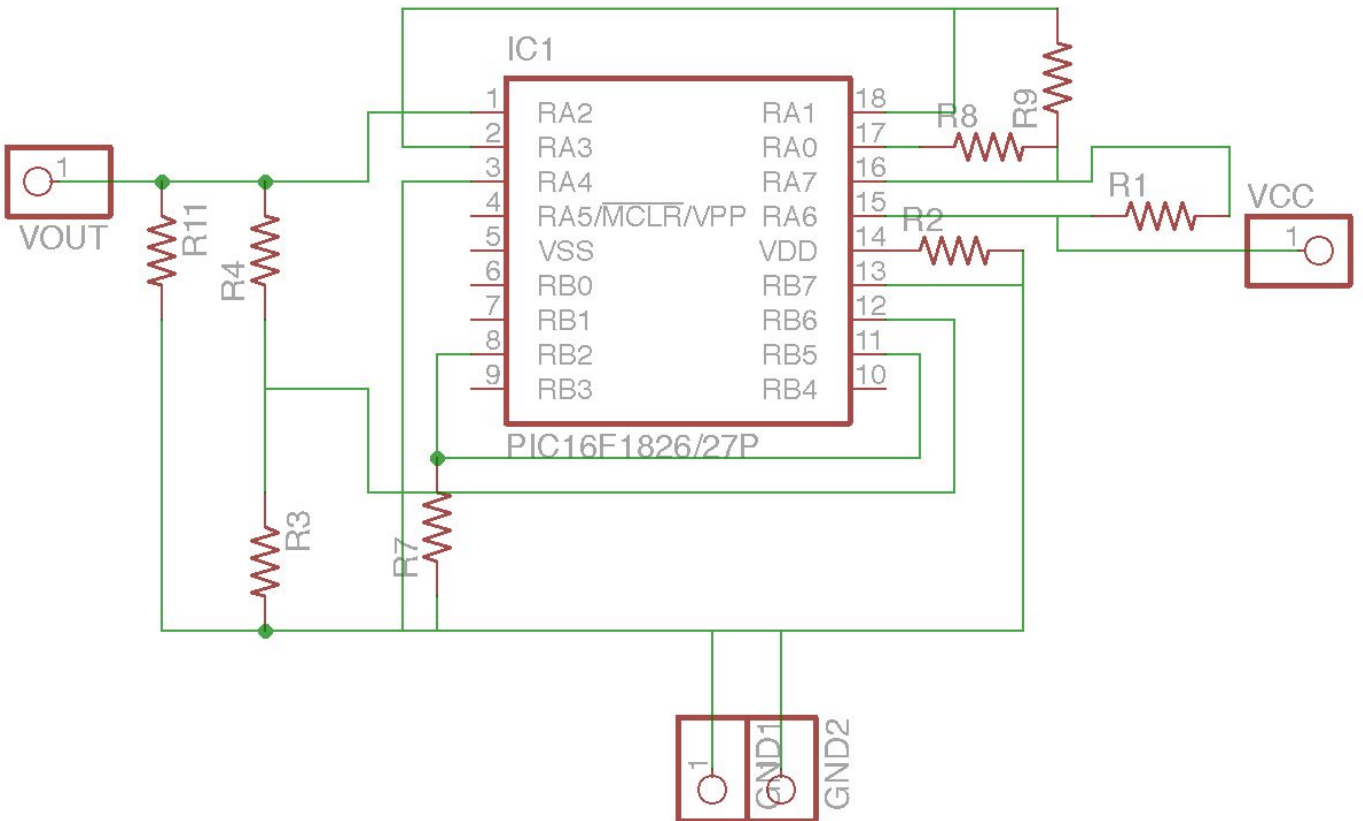
- Battery Meter and Random Number Generator Schematic:



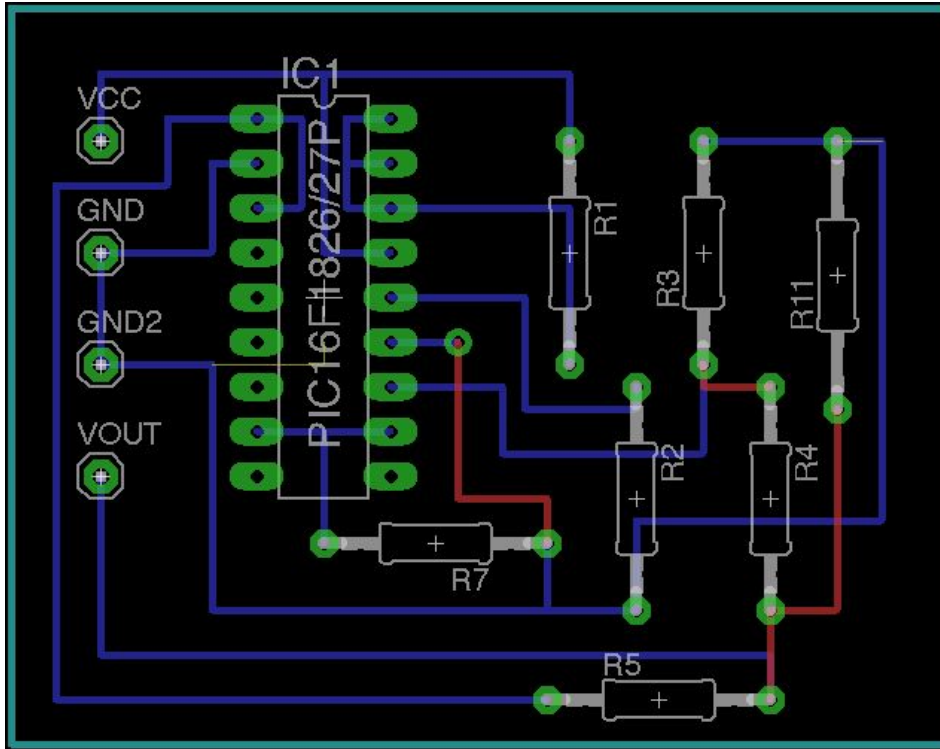
- Boost V1 Board:



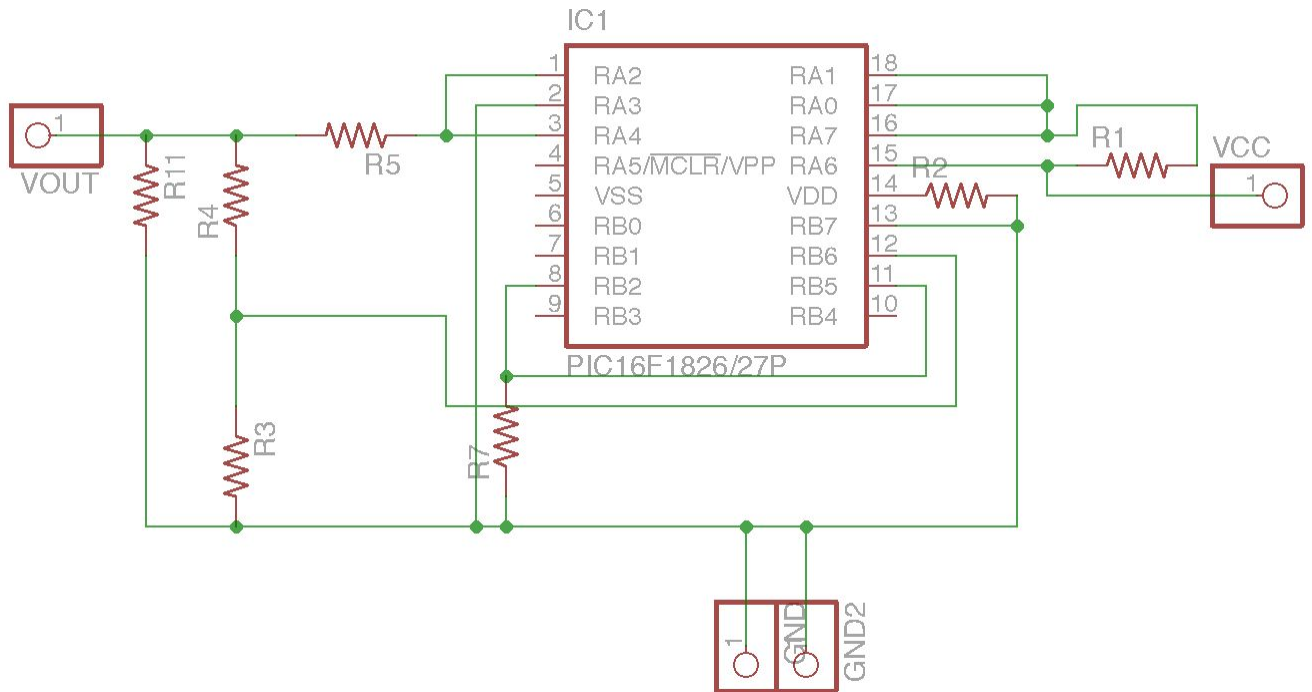
- Boost V1 Schematic:



- Buck V1 Board:

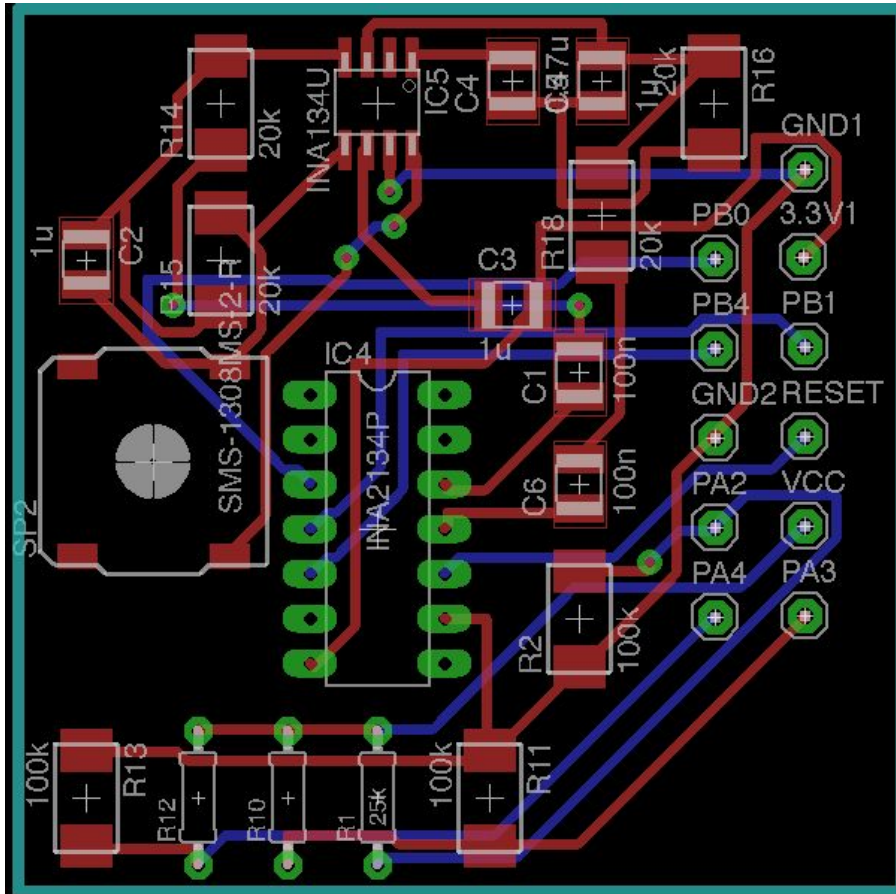


- Buck V1 Schematic:

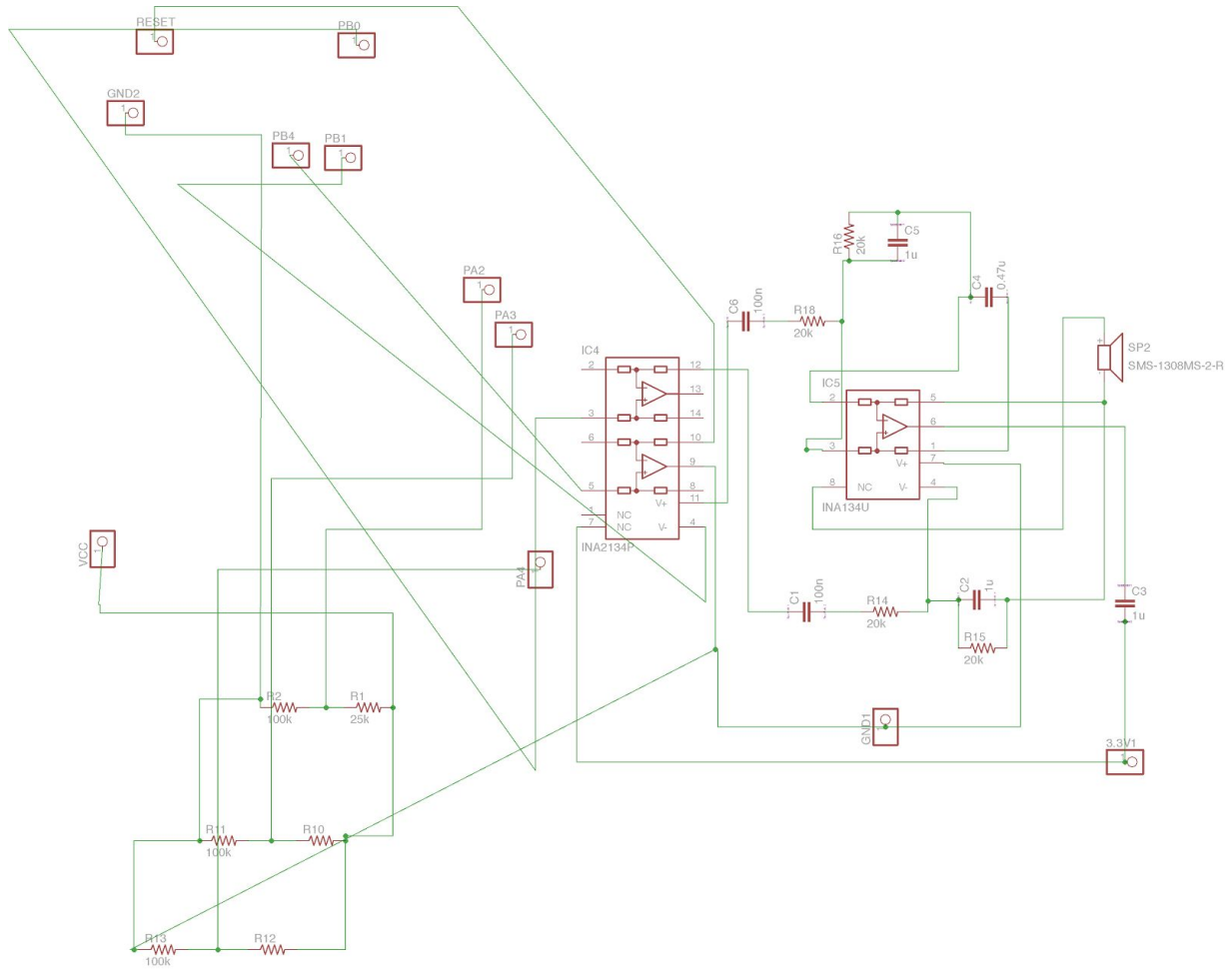


Integration I: PCB Design

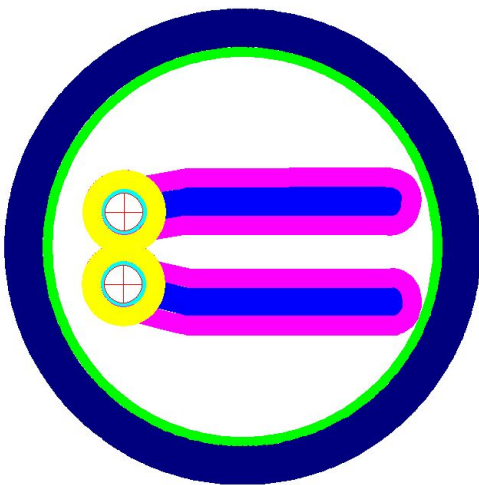
- Audio V1 Board



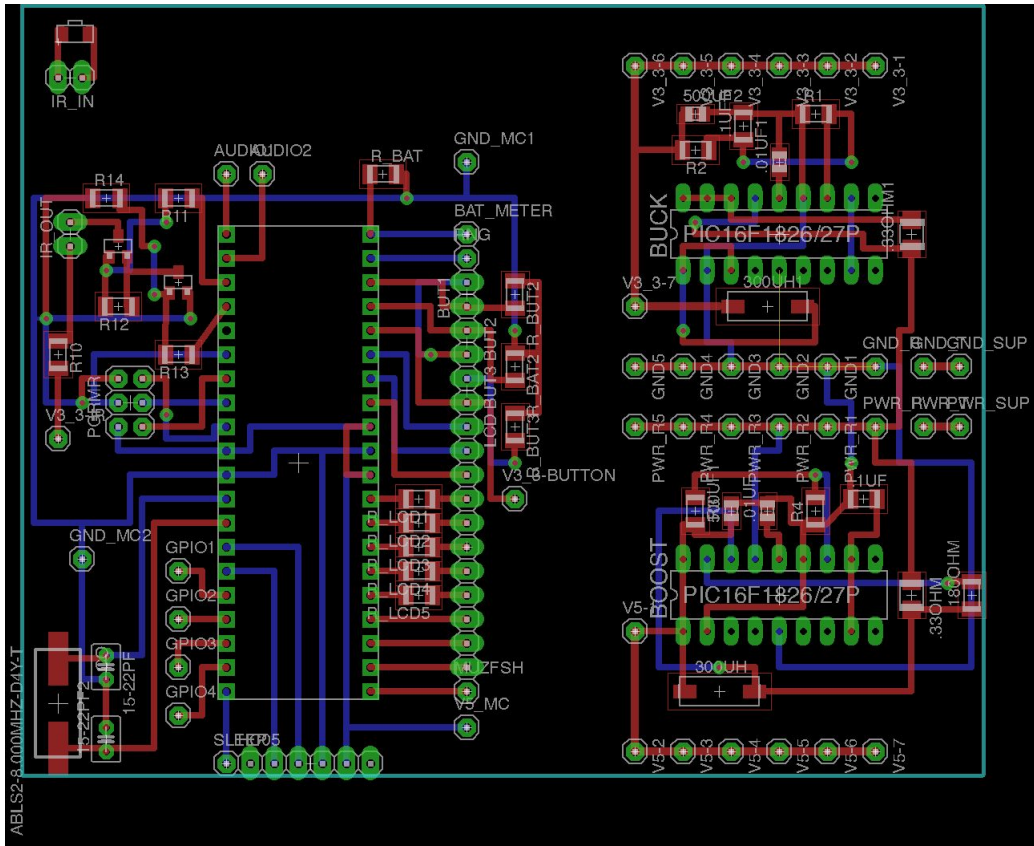
- Audio V1 Schematic



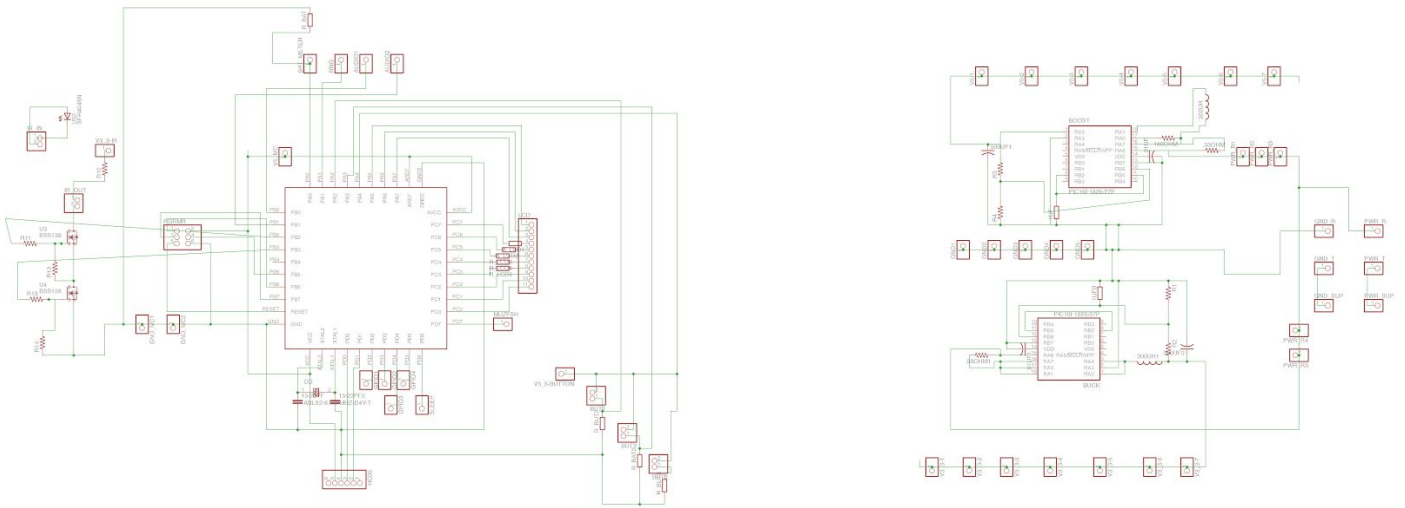
- Cocking Detector Button V1 Board



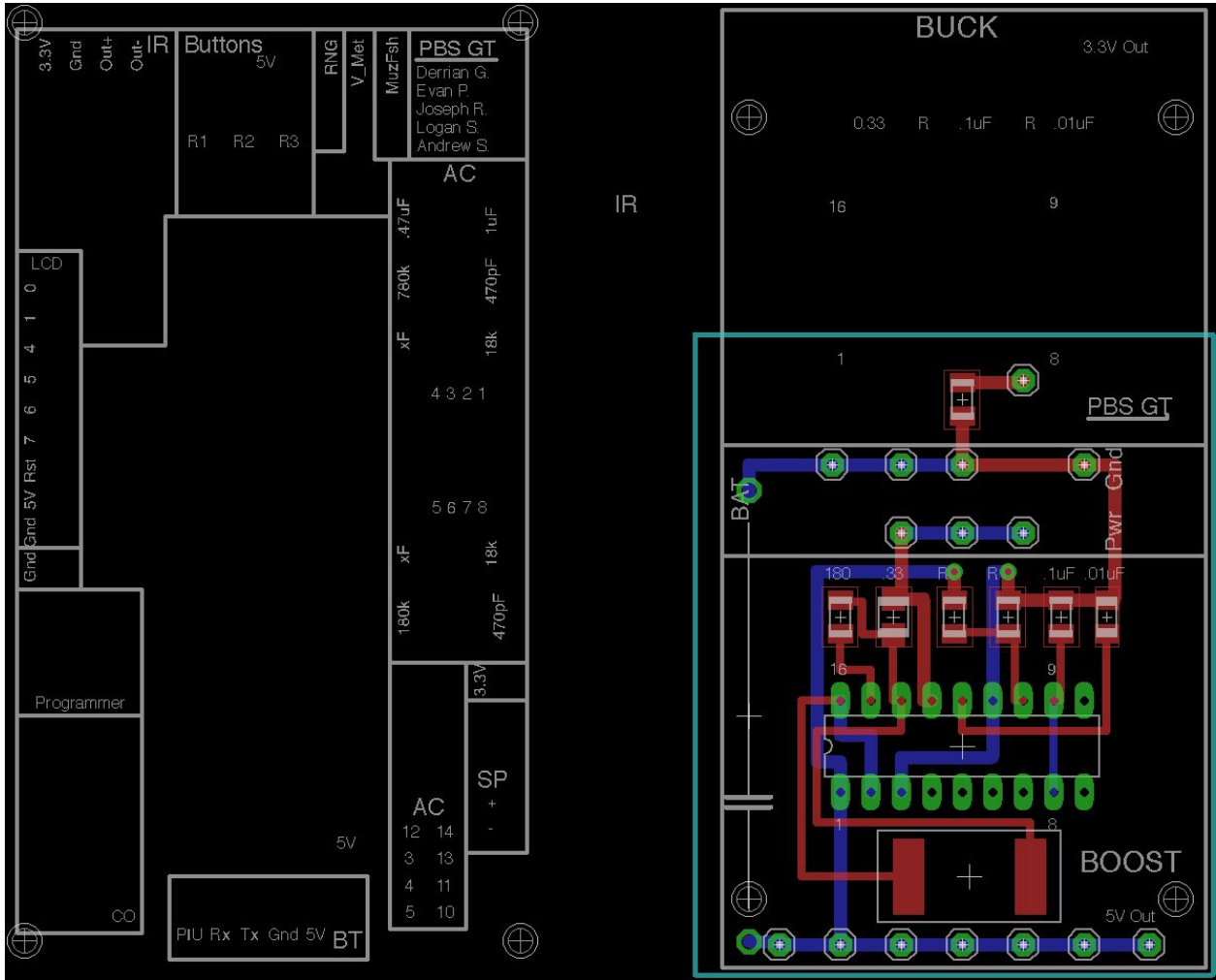
- Main Board V1 Board



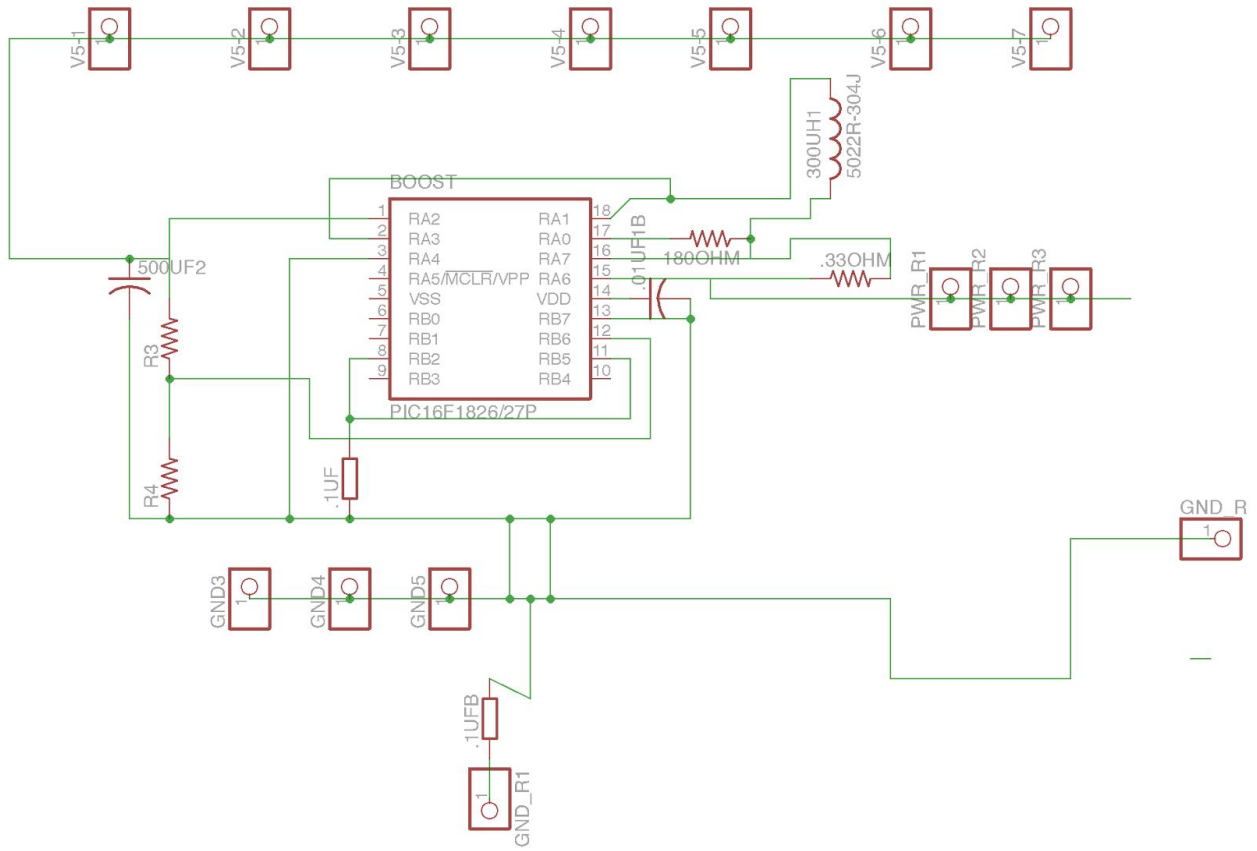
- Main Board V1 Schematic



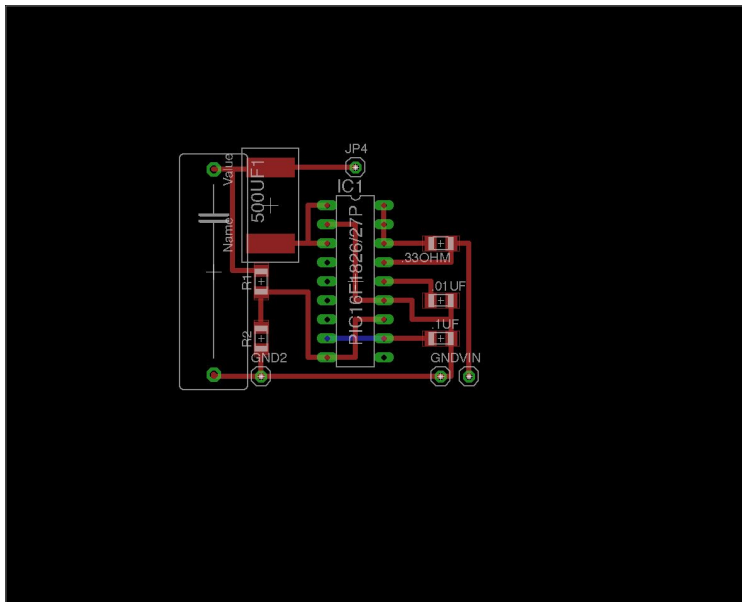
- Boost V1 Board



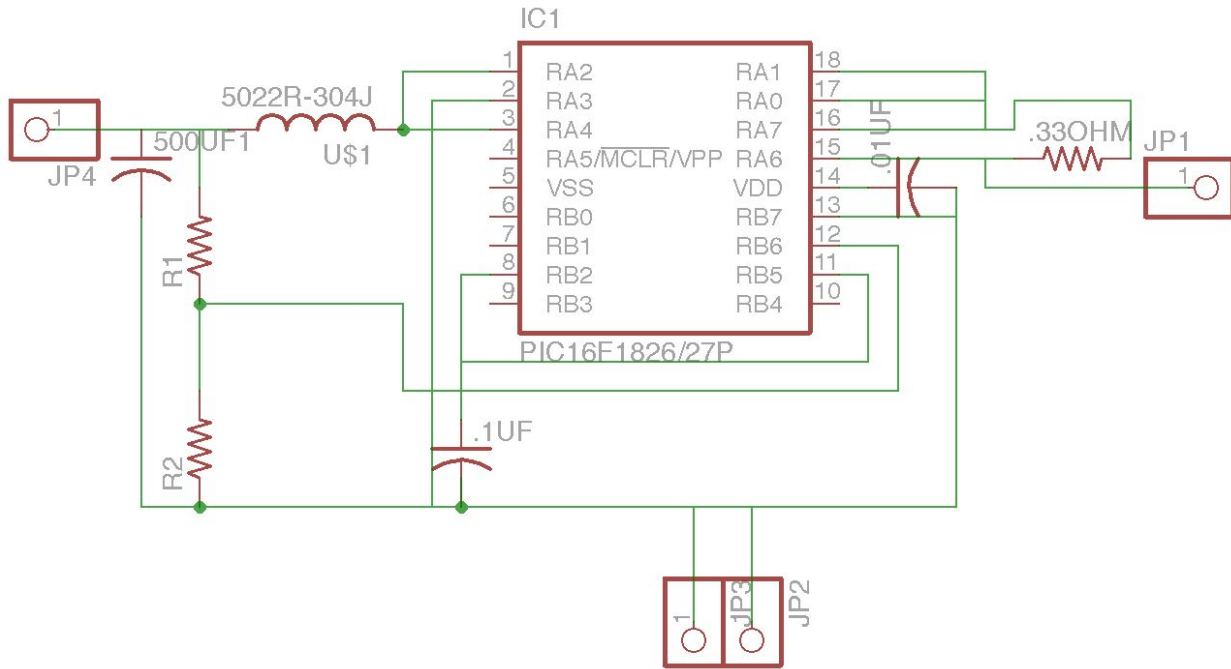
- Boost V1 Schematic



- Buck V1 Board

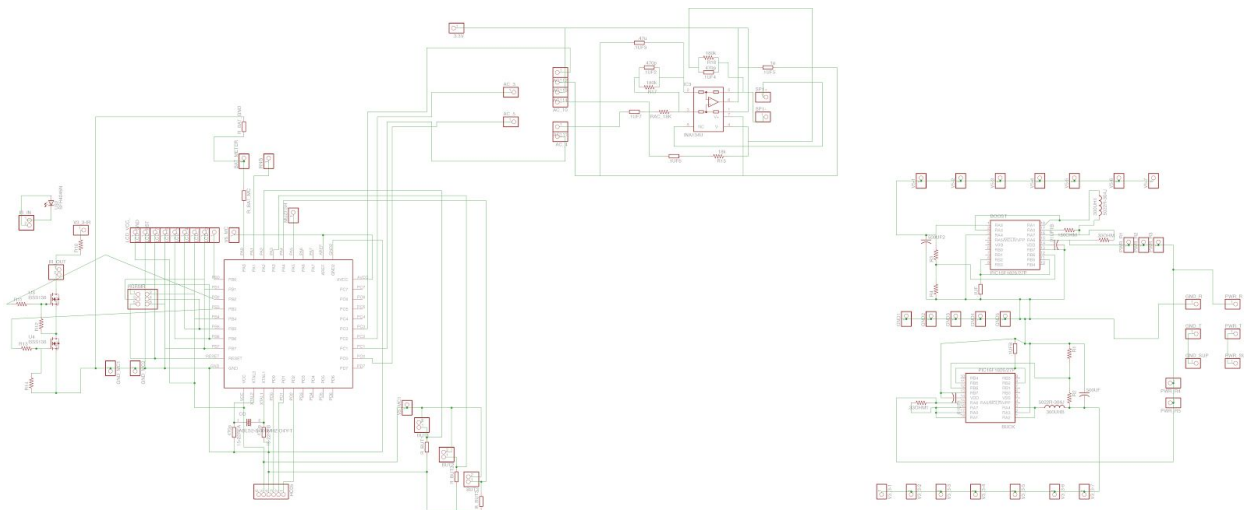


- Buck V1 Schematic

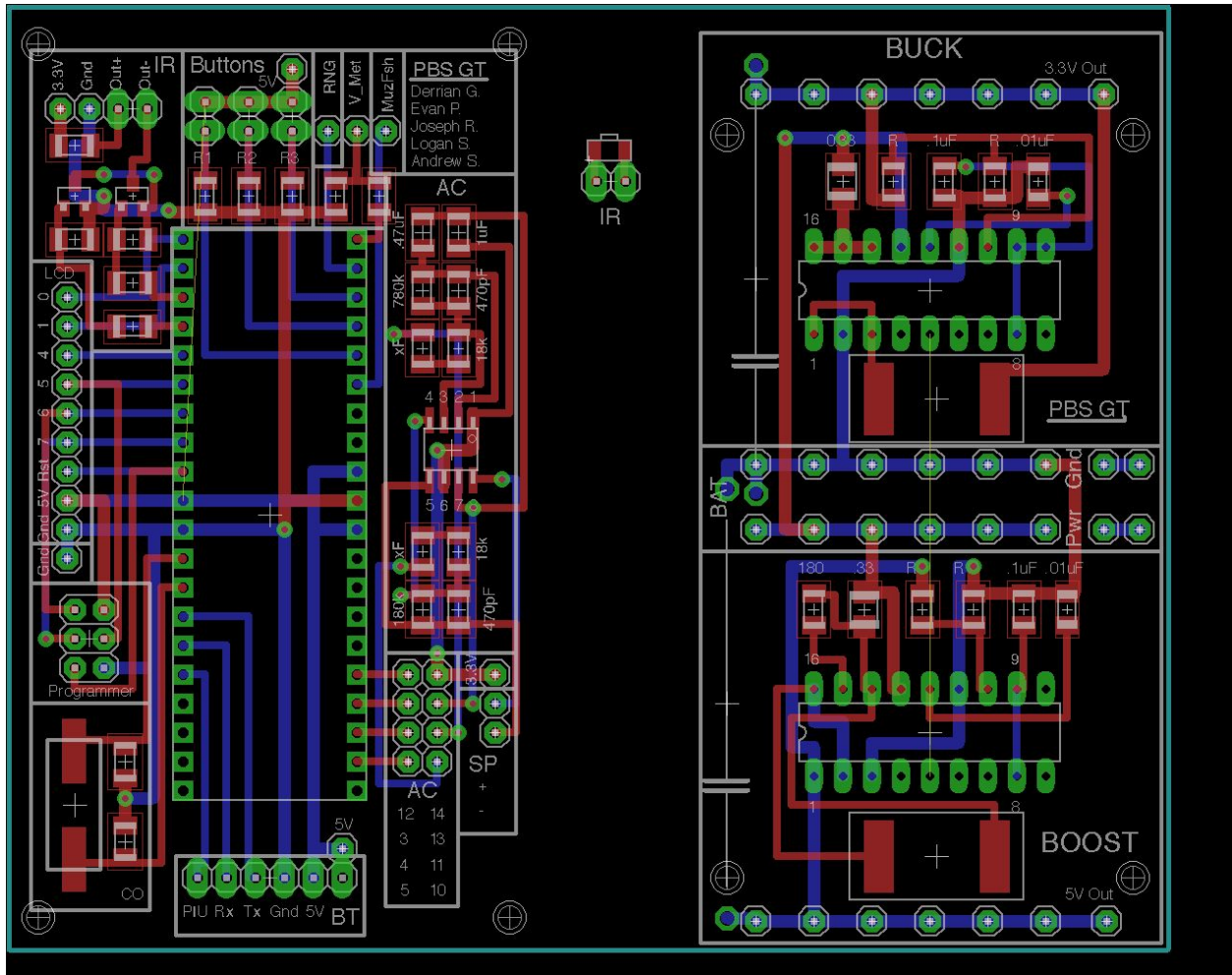


Integration II: PCB Design

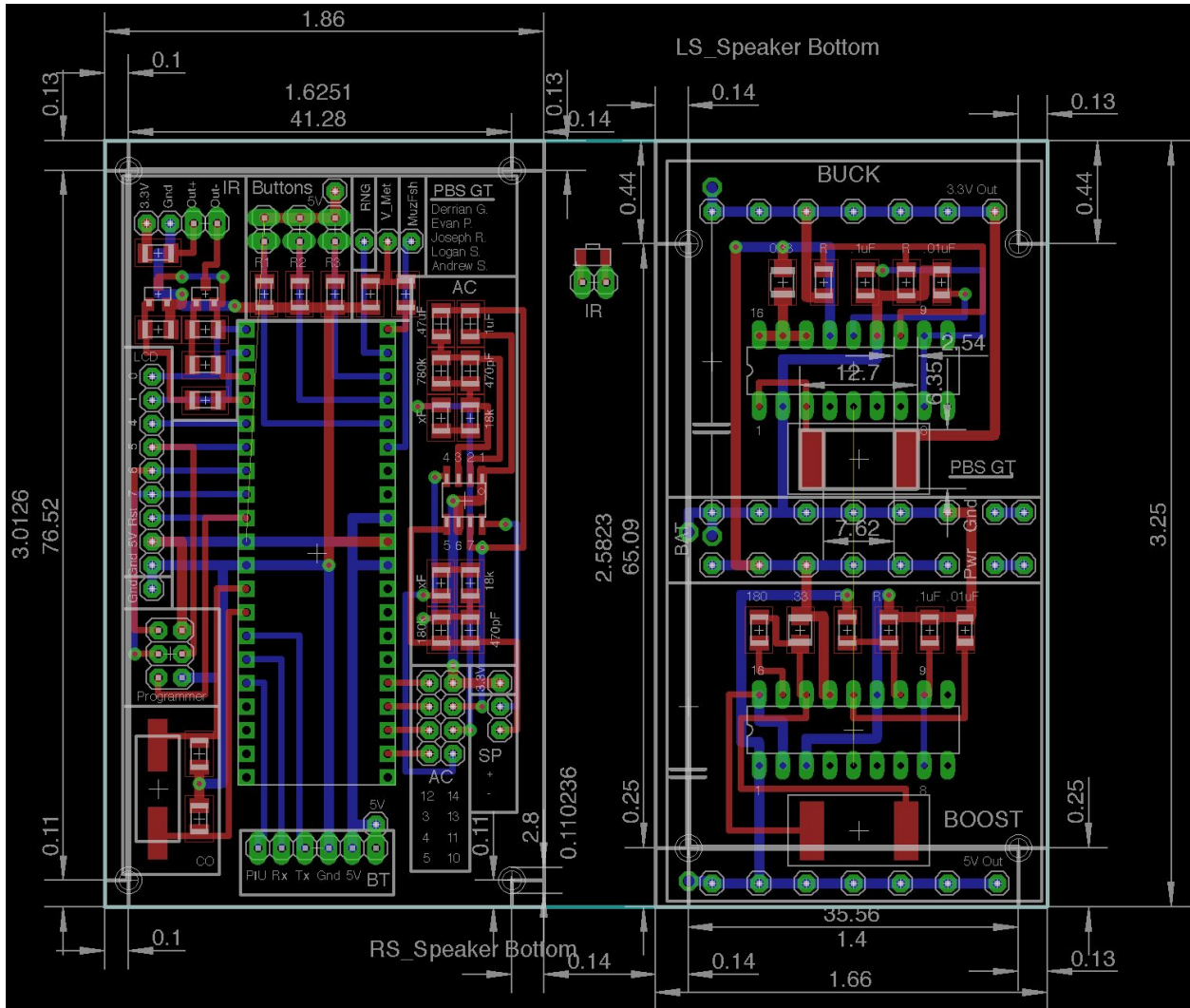
- Main Board V1 Schematic



- Main Board V1 Board



- Main Board V1 (Dimensions)



3D Modeling

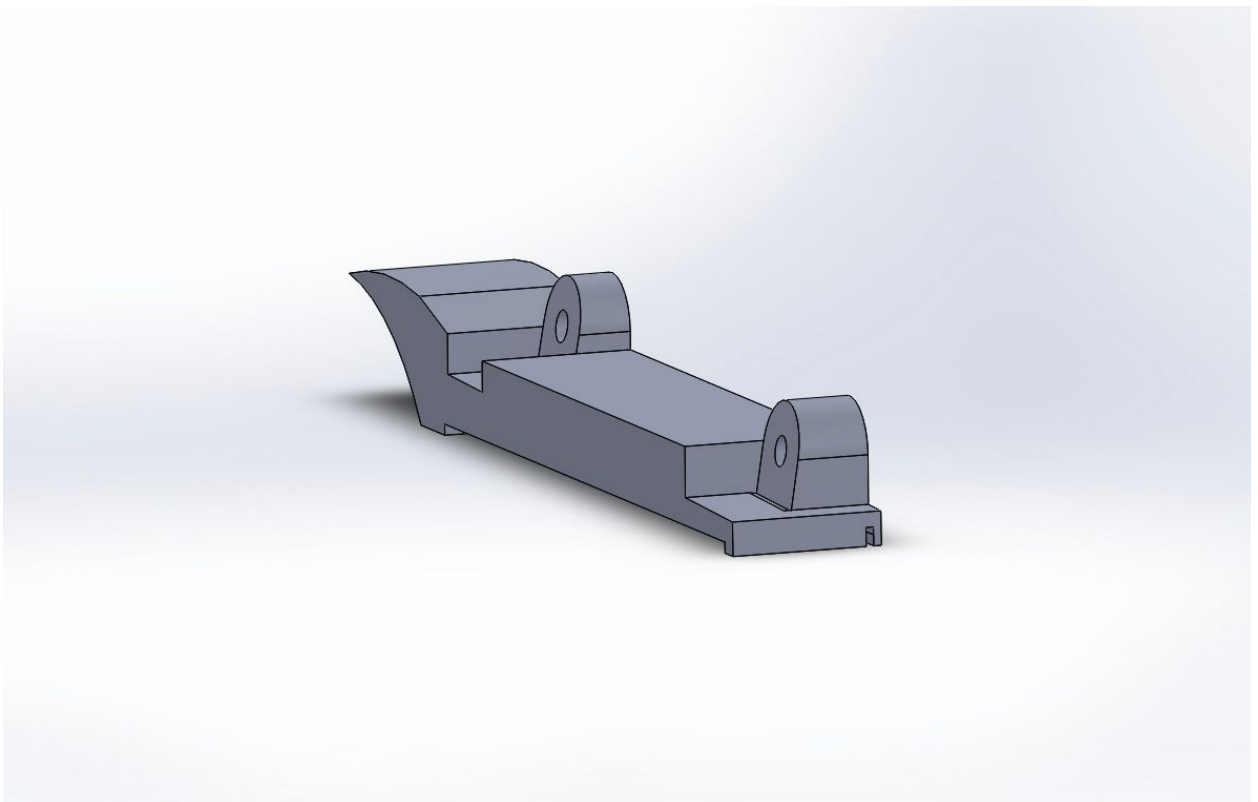
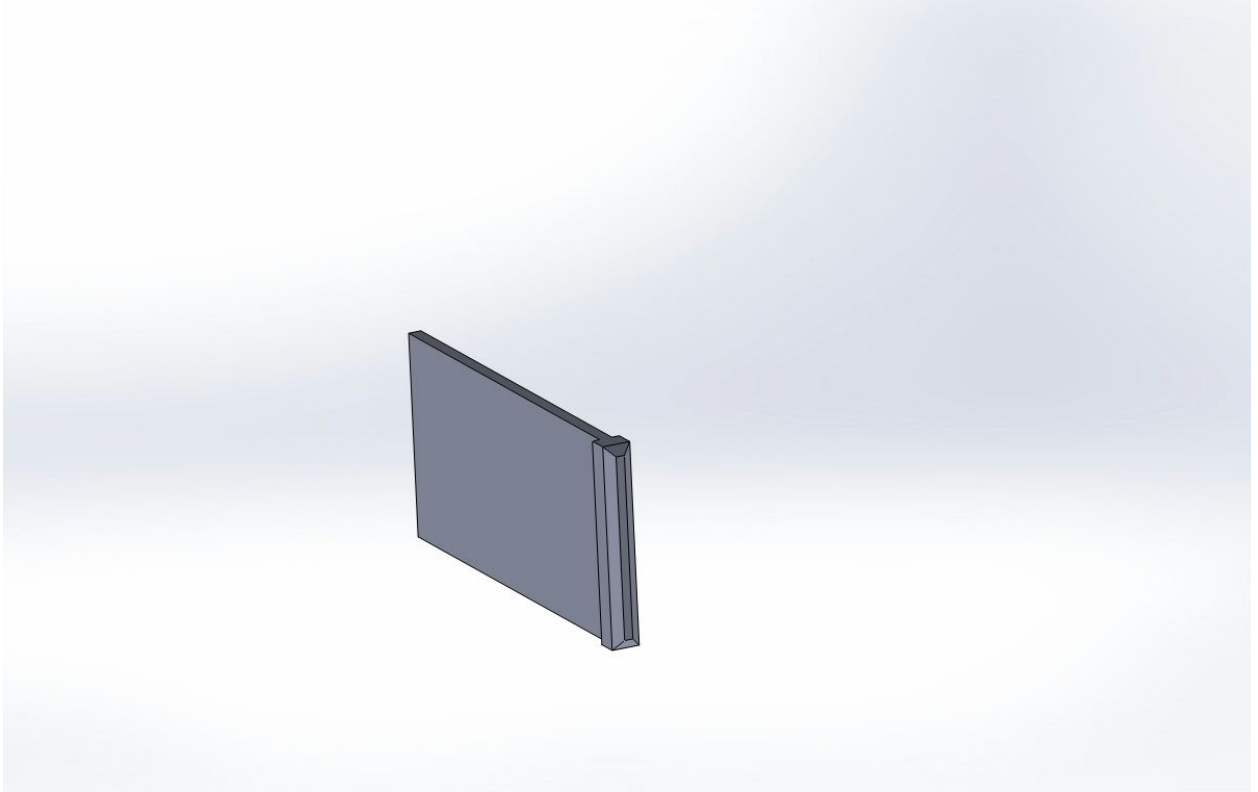
Under-Gun Component Box

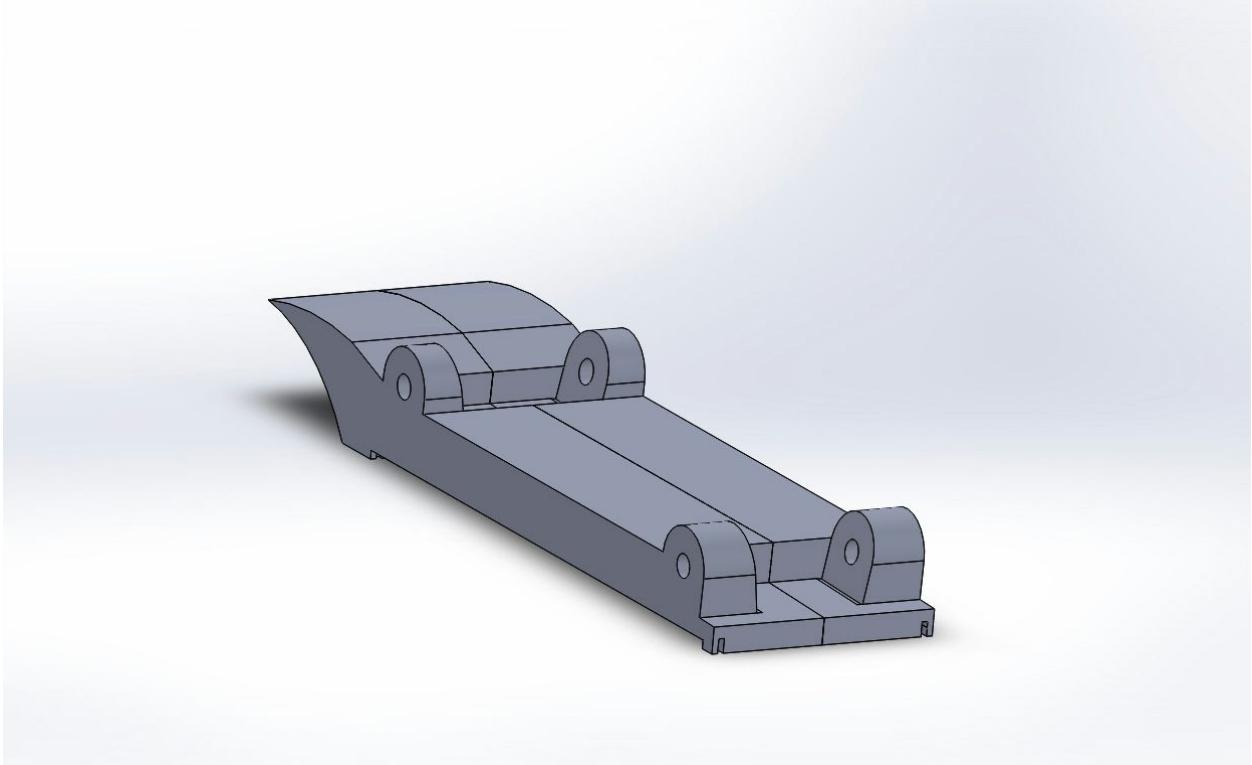
- Nerf Maverick Side Cut



- Version I

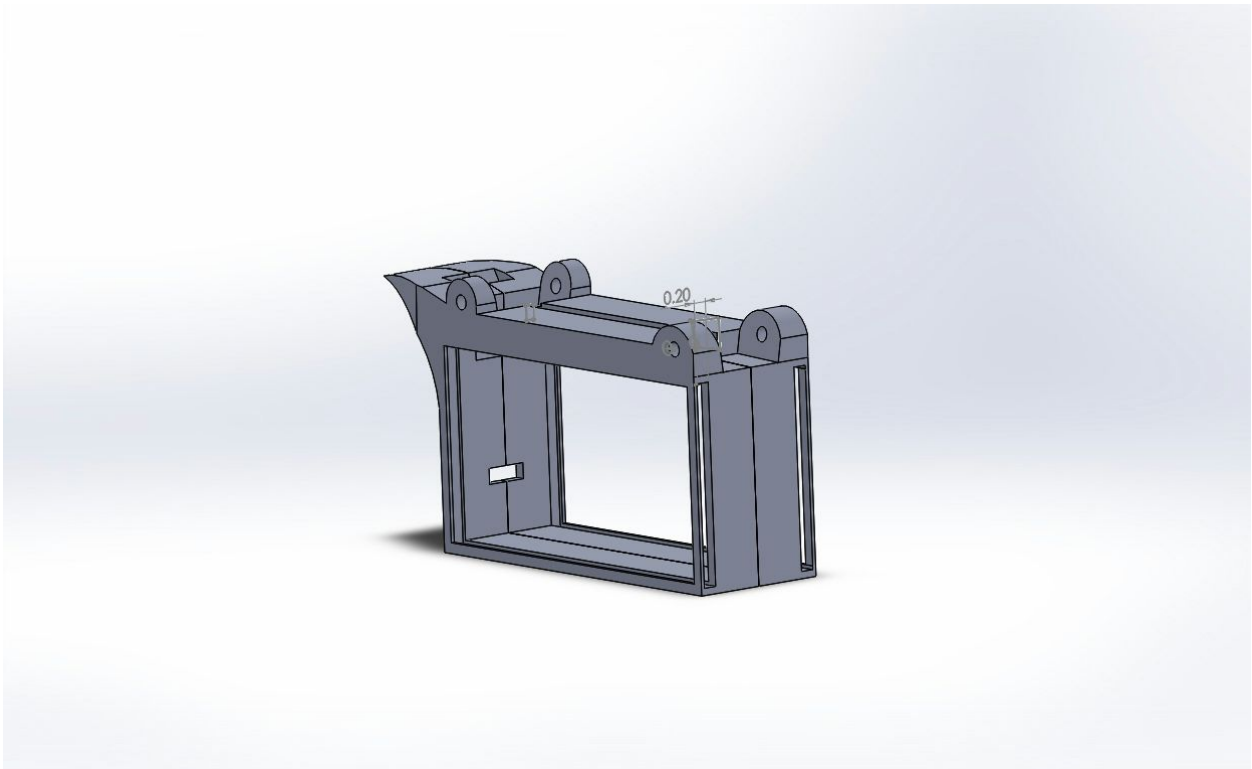


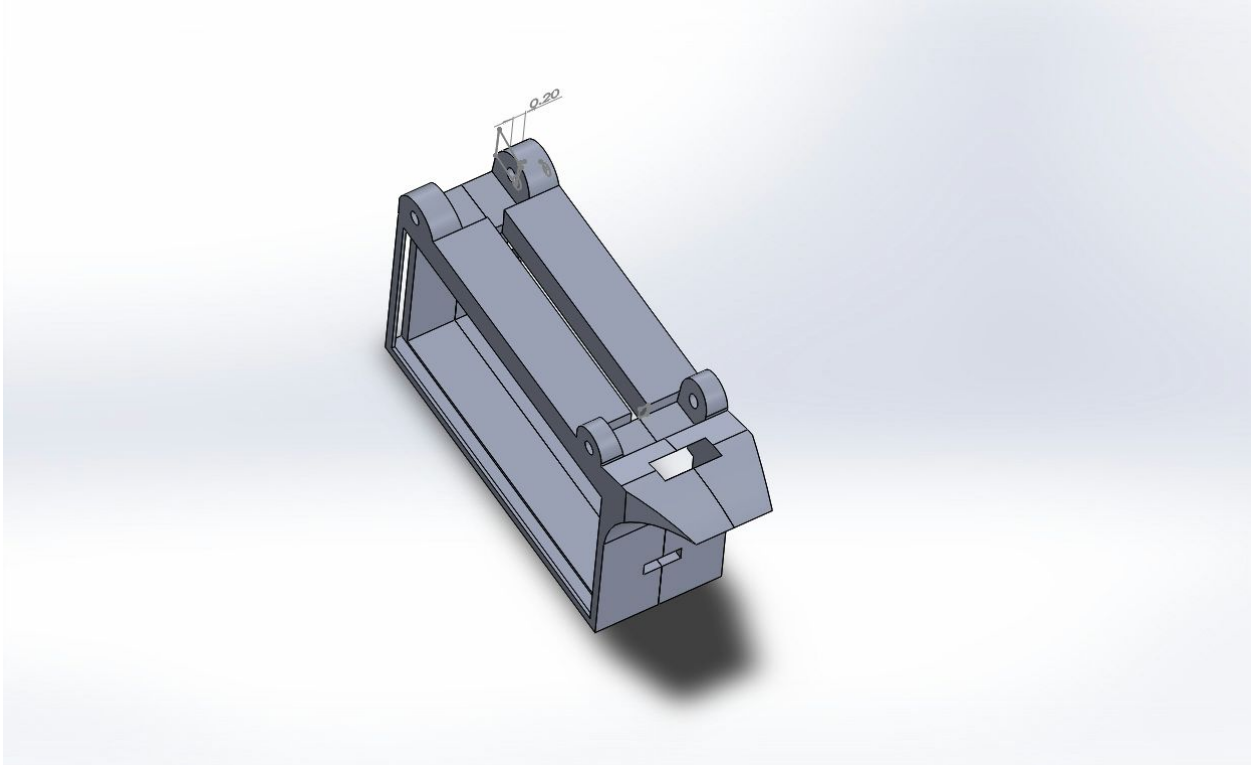




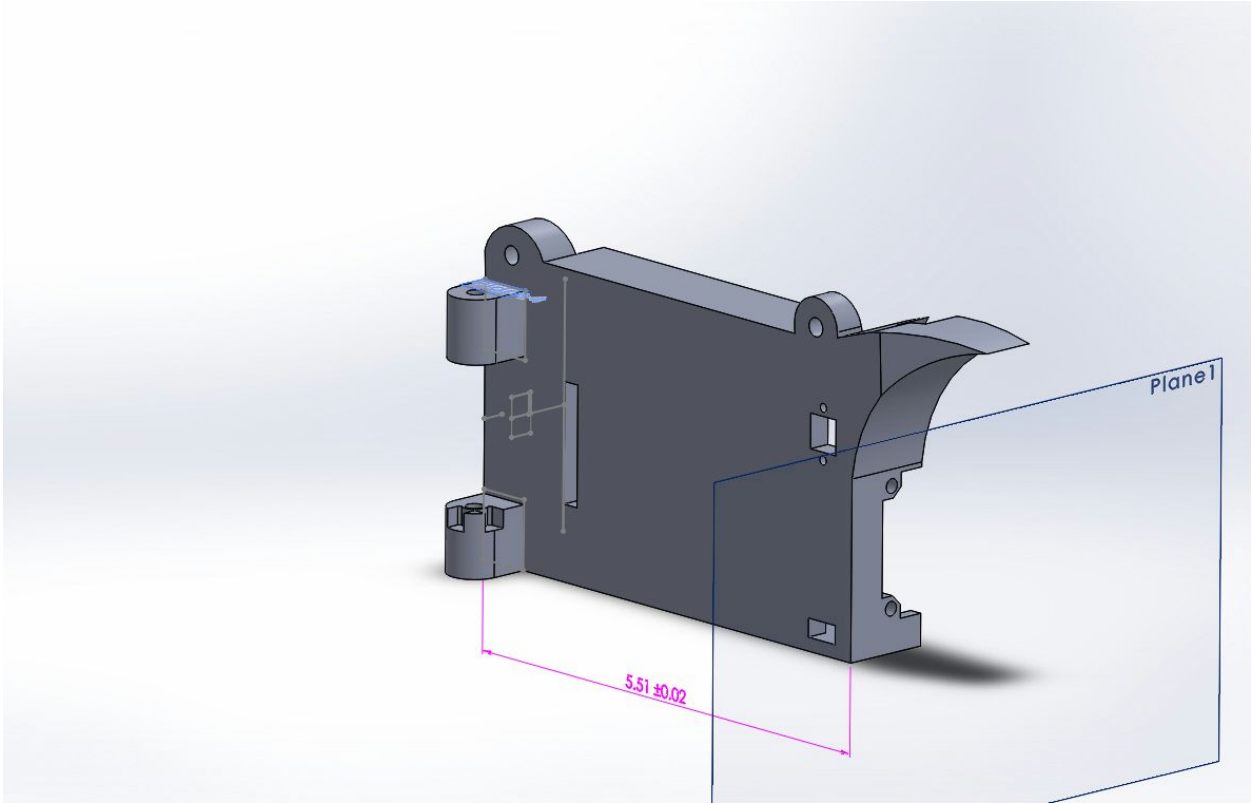
- Version II

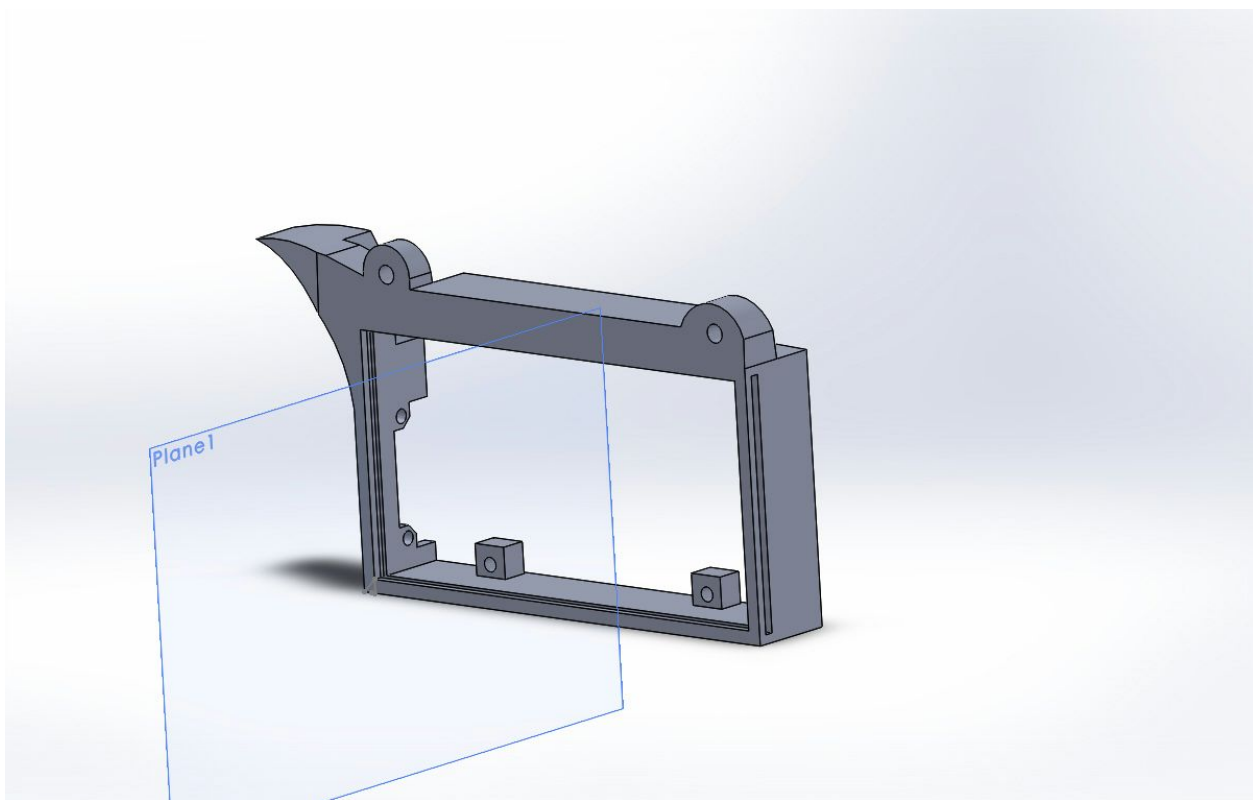
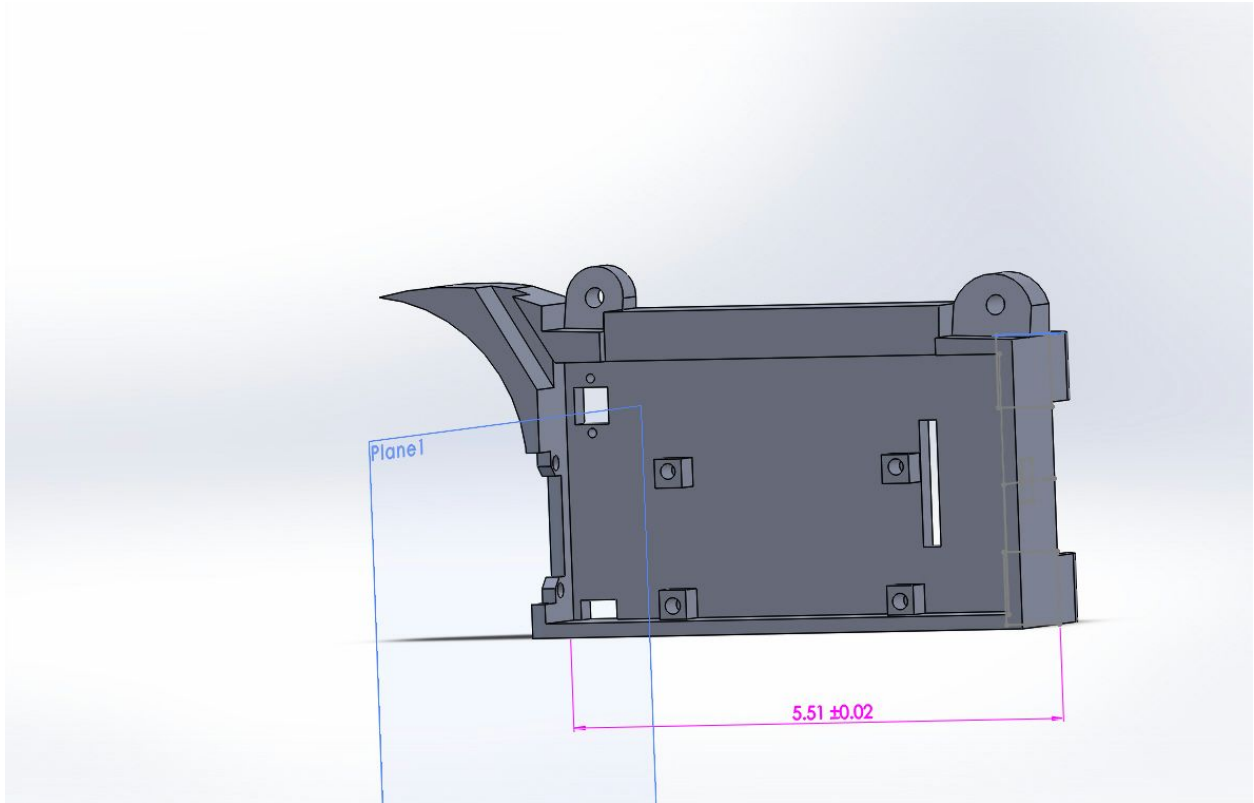


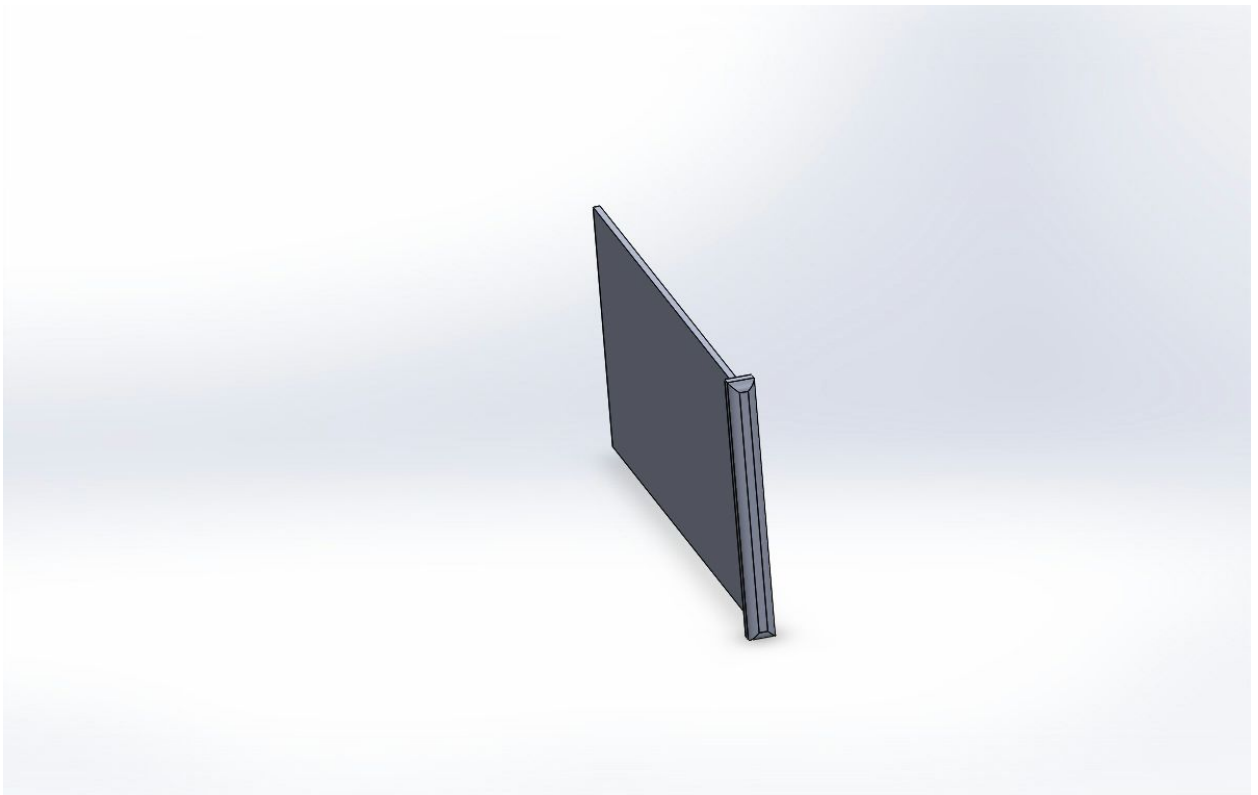
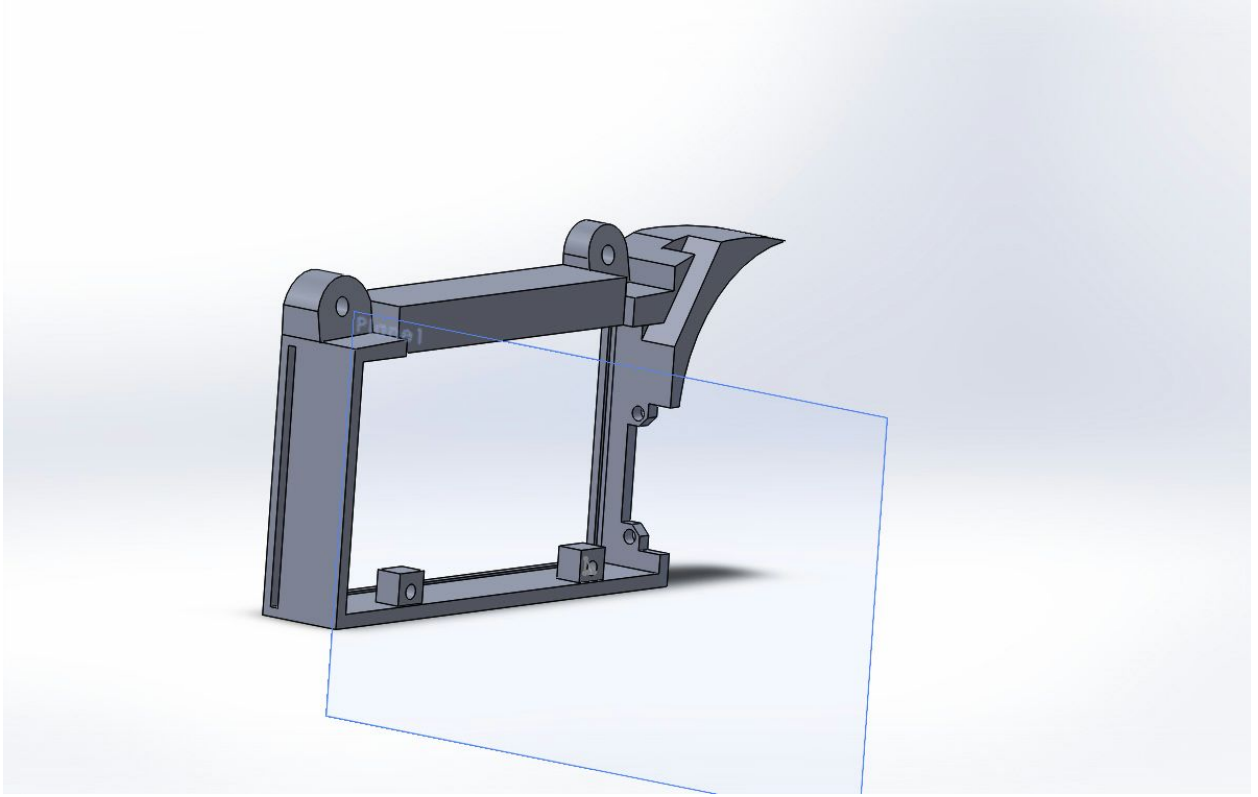


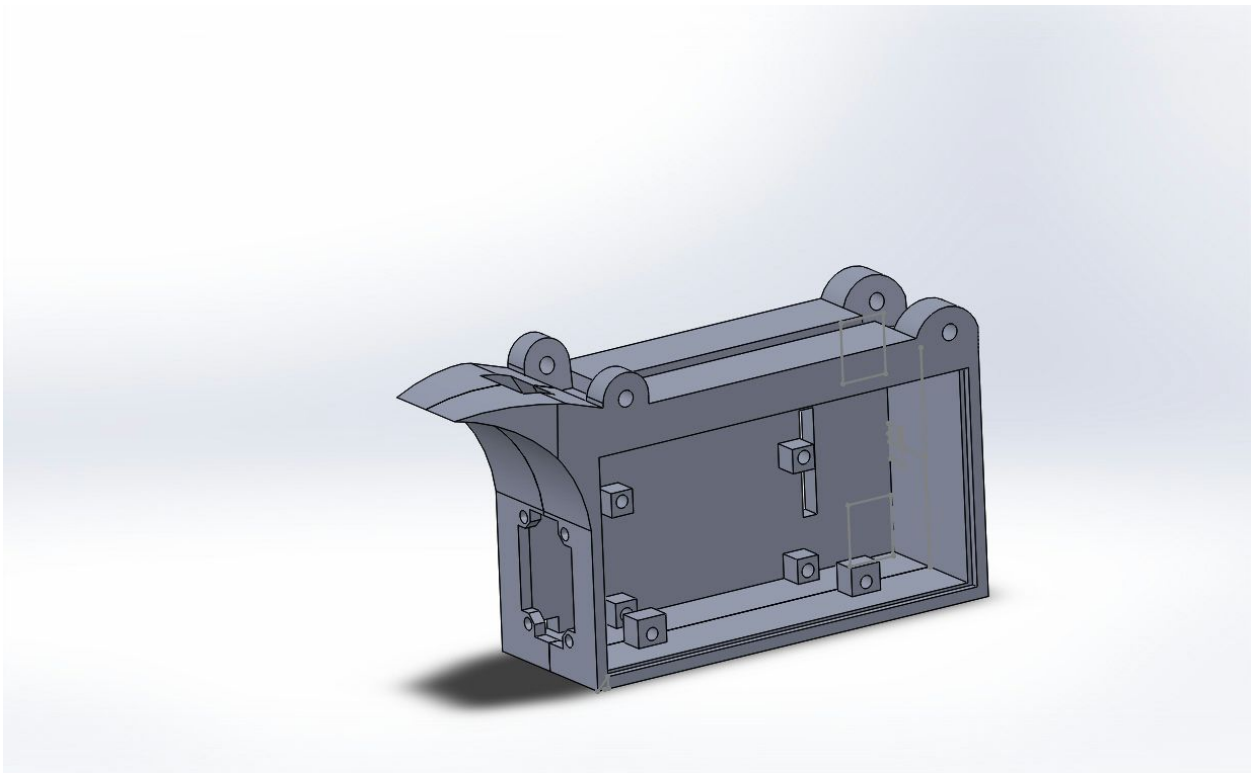
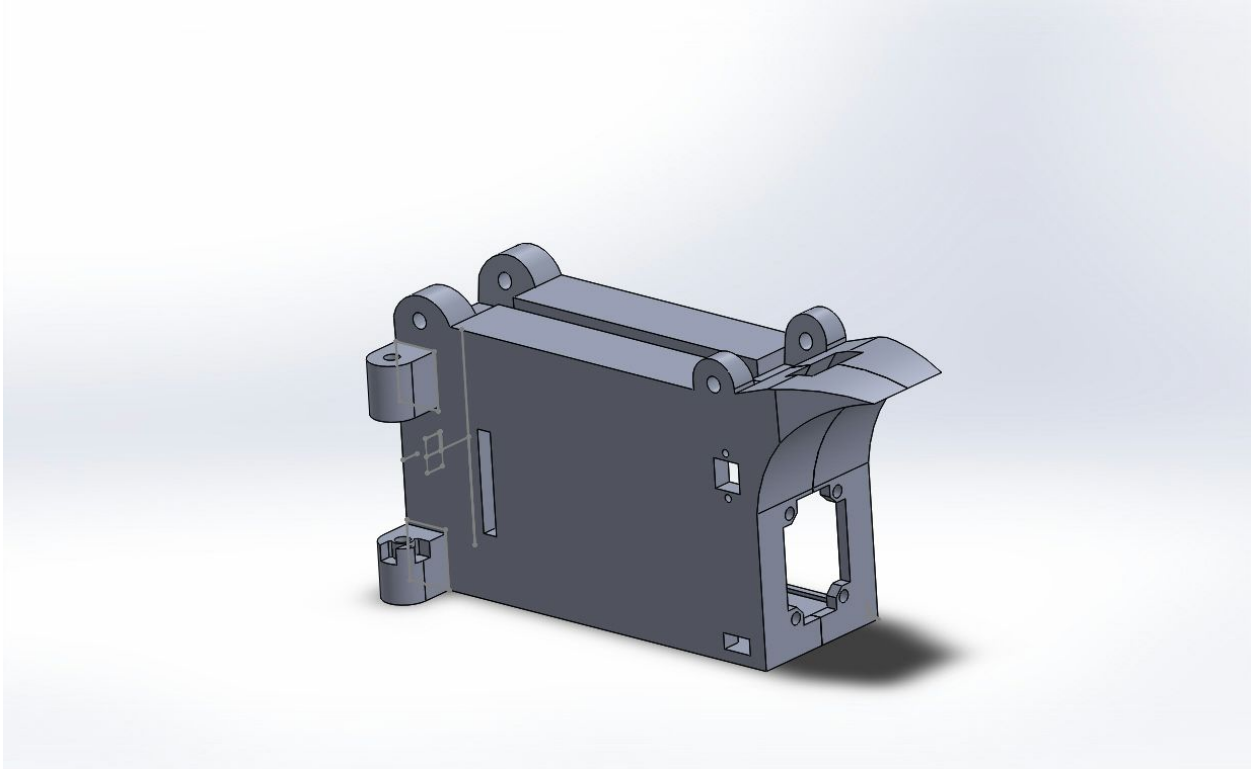


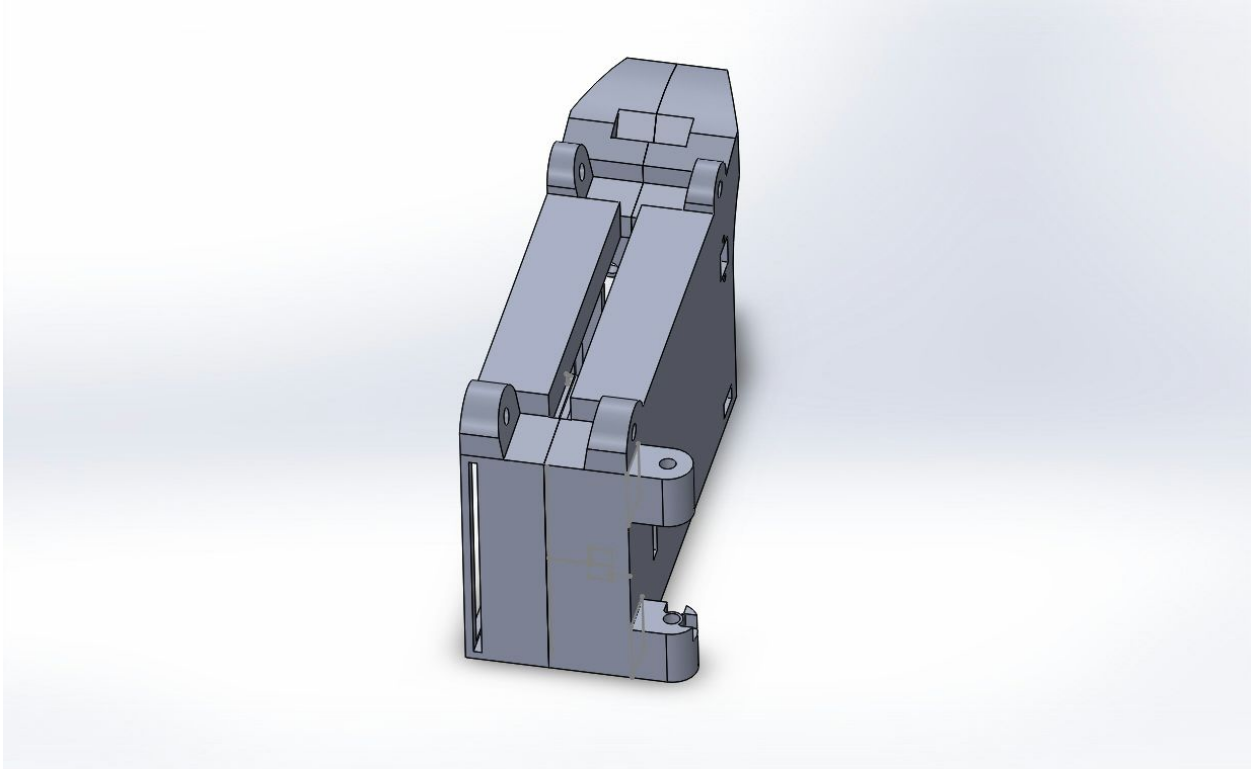
- Version III



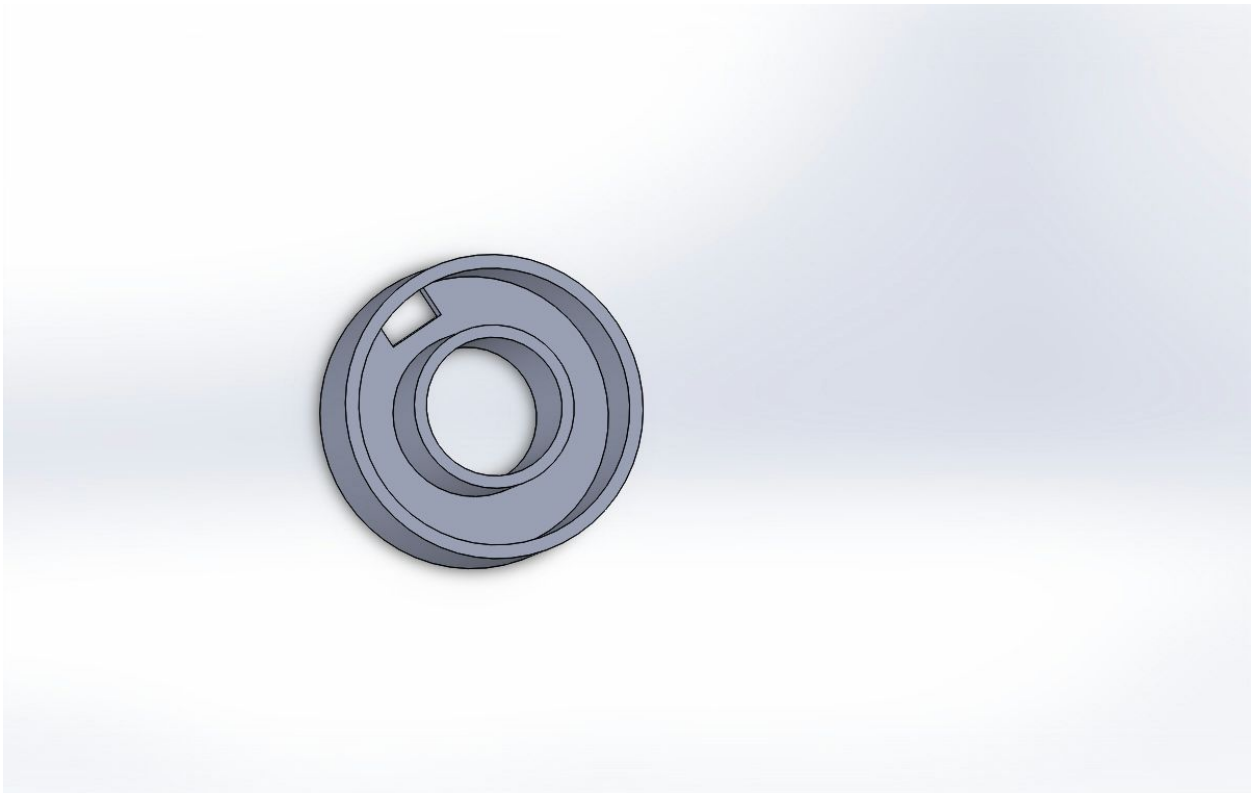


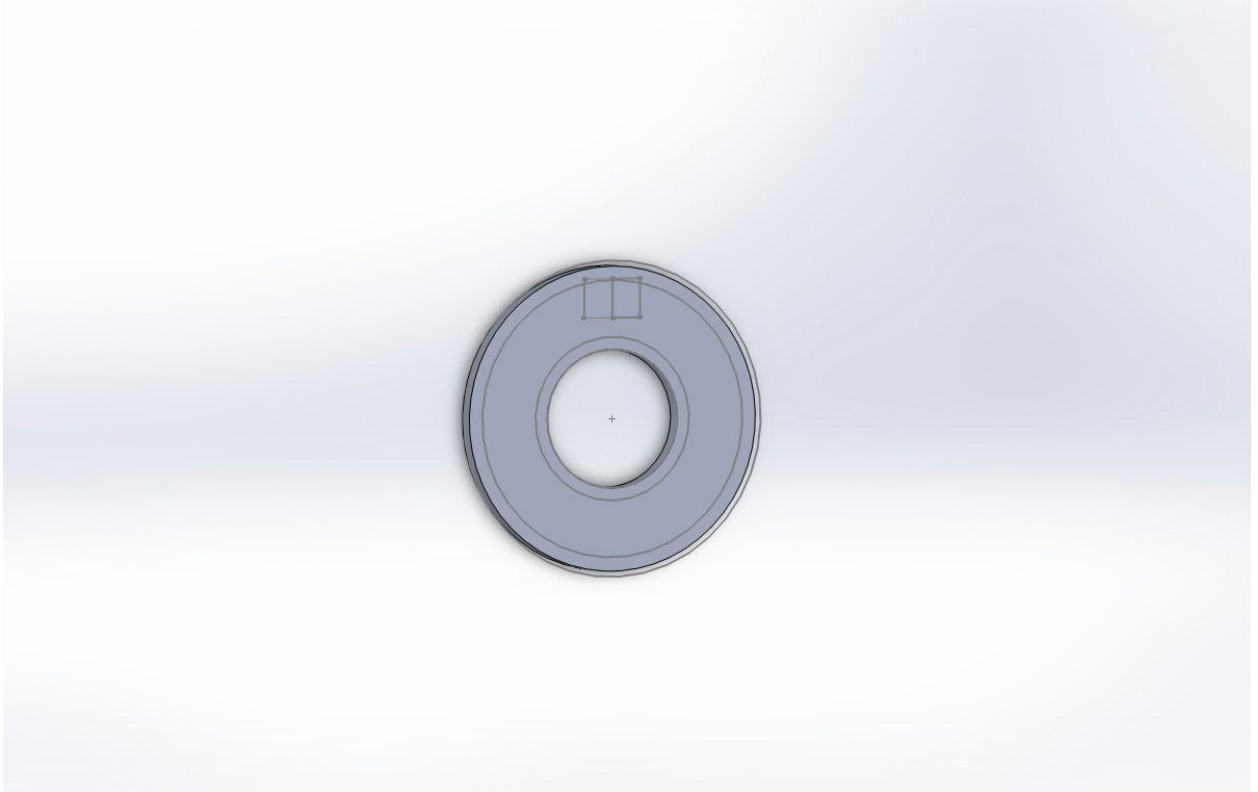




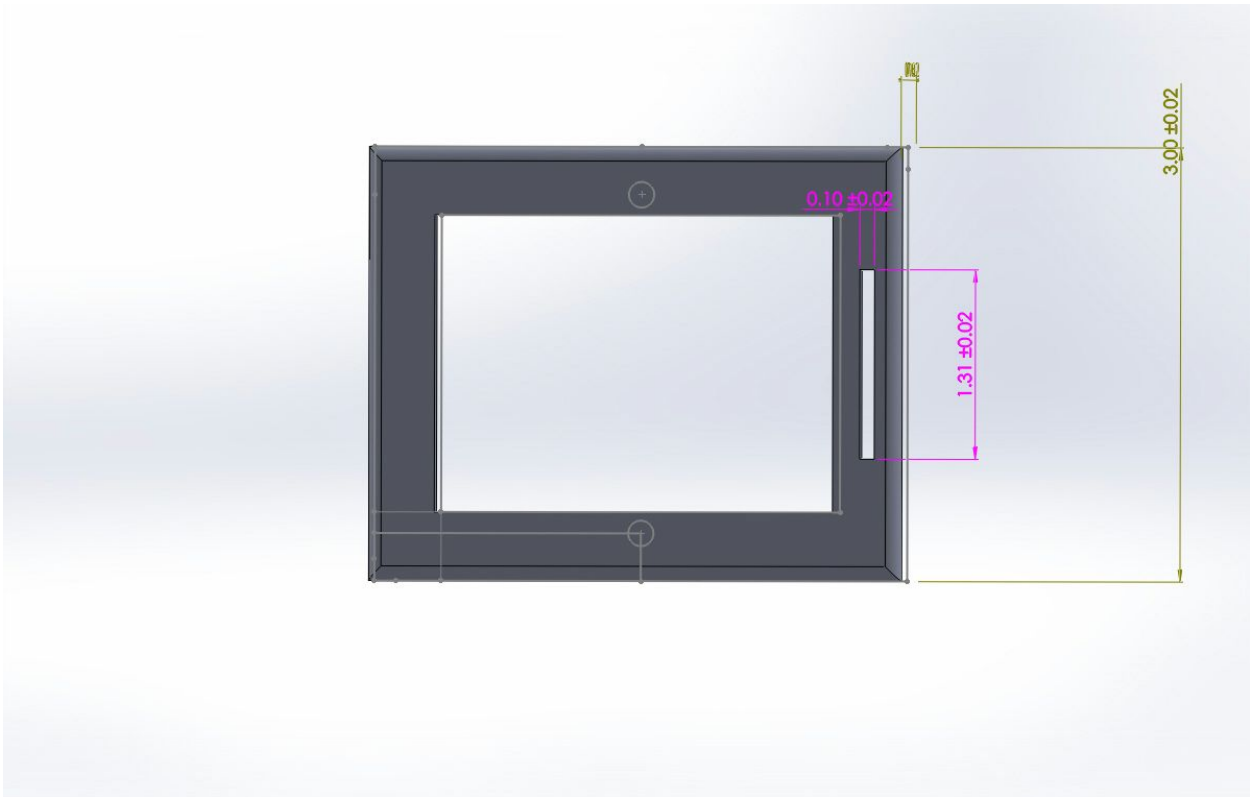
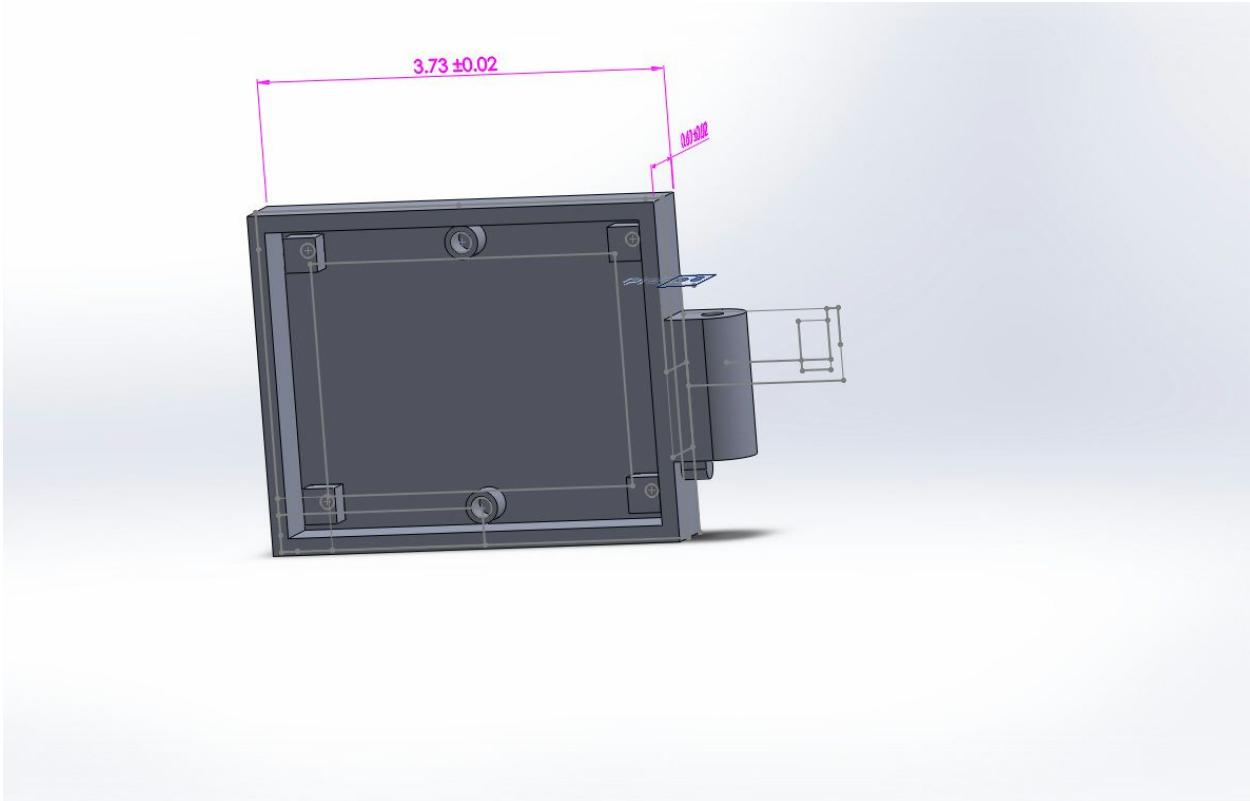


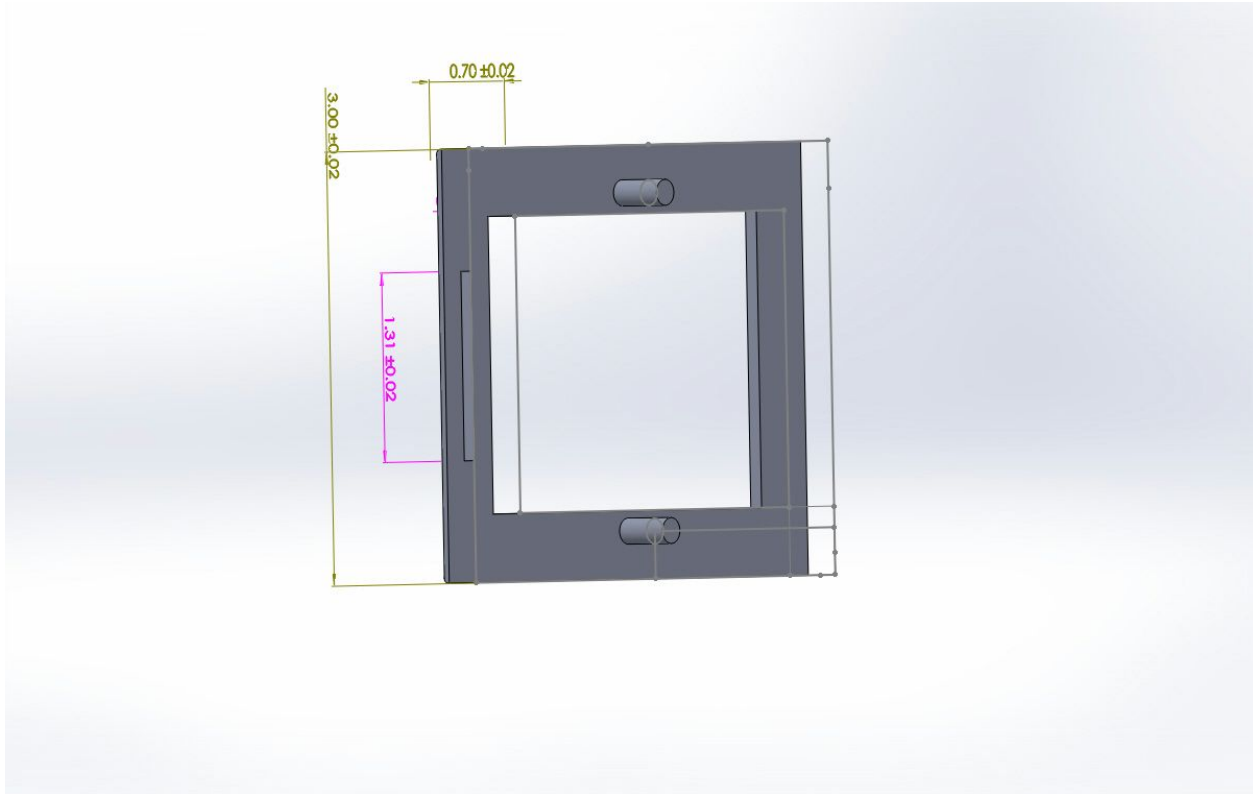
Muzzle Flash





Screen Case





Metal Plate

