32 Cue Arduino Firework Sequencer

Construction and wiring

Created by

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Enclosure

The enclosure can be built or purchased with many different options or configurations. The two key features are: there must be room for all the components; and the materials used for the construction of the enclosure must prevent the buildup and discharge of static electricity. All components must be held in place securely.

If building the enclosure using the original design, fabricate the parts using the design drawings in Appendix A.

Please note: the holes sizes and locations for switches, power charge port, USB data communications and other electronic components may be different based on the individual components purchased for this project. Check and make adjustments accordingly.

Once all the parts are fabricated the box should be assembled using glue and brad nails. The top instrument control panel and terminal block plates should be held in place using #4 x ½ wood screws or button head screws.

It is a good idea to spray the box inside and out with primer. Then use a durable paint and clear coat on the outside of the box.

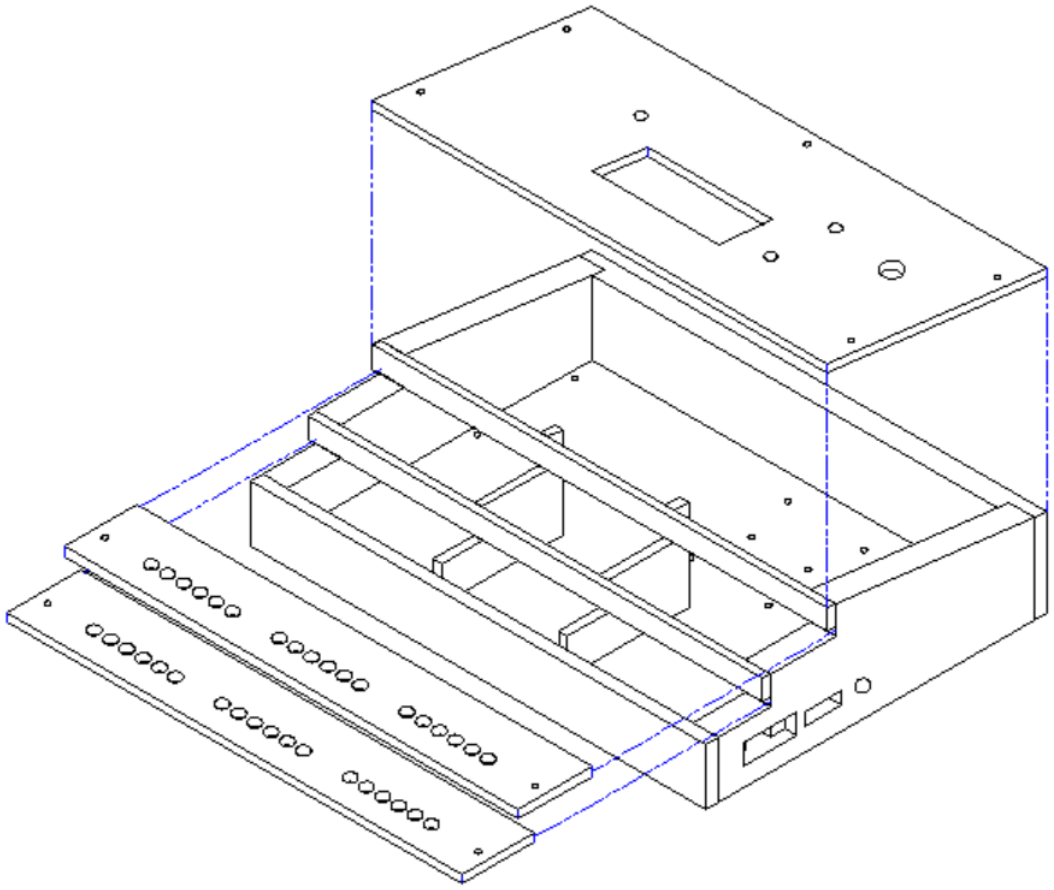


Figure 1

Install Component to the Instrument Panel

1. Install the LCD screen first using #4 x ½ button head cap screws. You may need to use several #4 flat washers between the LCD circuit board and the instrument panel for it to sit properly do not over tighten. Be careful not to drive the screw so far that the screw protrudes out of the front of the instrument panel
2. Install the Fire push button make sure it is secure
3. Install the guarded Arming switch. You may need to remove an extra nut between the guard and the switch itself to have enough room for nut to attach from the front side of the instrument panel
4. Install the rotary encoder. It is not necessary, but installation and wire placement will be easier if you point the contacts toward the other buttons and switches. It is a good idea to use a sharpie or pen to write the label of each pin directly onto the back of the instrument panel next to the pin. You may not be able to read the label once it is installed.

Wiring Components Mounted to the Instrument Panel

Supplies needed for this step	
16	40 cm dupont connector wires – male to female
2	1K ohm resisters
2	330 ohm Resisters
1	470 ohm resister
1	Tricolor LED light 5mm
1	5mm LED socket
1	Guarded toggle switch
1	momentary push button
1	rotery encoader with push button
1	2004 LCD screen with I2C control
2	Wire Nut
	Blank and Red - 22 AWG solid core wire
	Heat shrink or electrical tape

I used the 5 VDC and ground connection from the Arduino for all components mounted to the lid. When reading the value of the switches, it is important to use the ground on the board so it can complete the circuit. A 1k resister is used on the ground wire coming off the switches / buttons to remove some of the noise from the line that could accidently trigger the launch of the fireworks. Without this you could trigger it to go off simple by rubbing your hand next to the switch.

Notice, the signal wires are placed on the ground post of the switches / buttons before the resister as shown in the diagram.

For the wires running to the Arduino board, use 40 CM DuPont connectors so there is room to remove the lid and keep everything connect.

Connect all the grounds together using a wire nut. Do the same with the 5V DC wires. You will need to cut the female pin off the ground and 5v DC DuPont wires and include them with the proper wire nut bundle.

Use a 40 cm Dupont female to female connection wire cut in half to supply power and ground to the rotary encoder and LCD screen. Connect the other end to the wire nut bundle. When finished, each wire nut should have 6 wires. (40 CM DuPont wire to Arduino, LED light, rotary encoder, arming switch, fire bush button, and LED screen)

When make connections to the components, cover all exposed wire with heatshrink or electrical tape.

Take care to ensure the connections on the tri color LED are in the correct order. They produce two flavors of this type of LED. Check the specifications for the LED you purchased. (the most common type is shown in the diagram).

When finished, set the instrument panel asside until final assembly

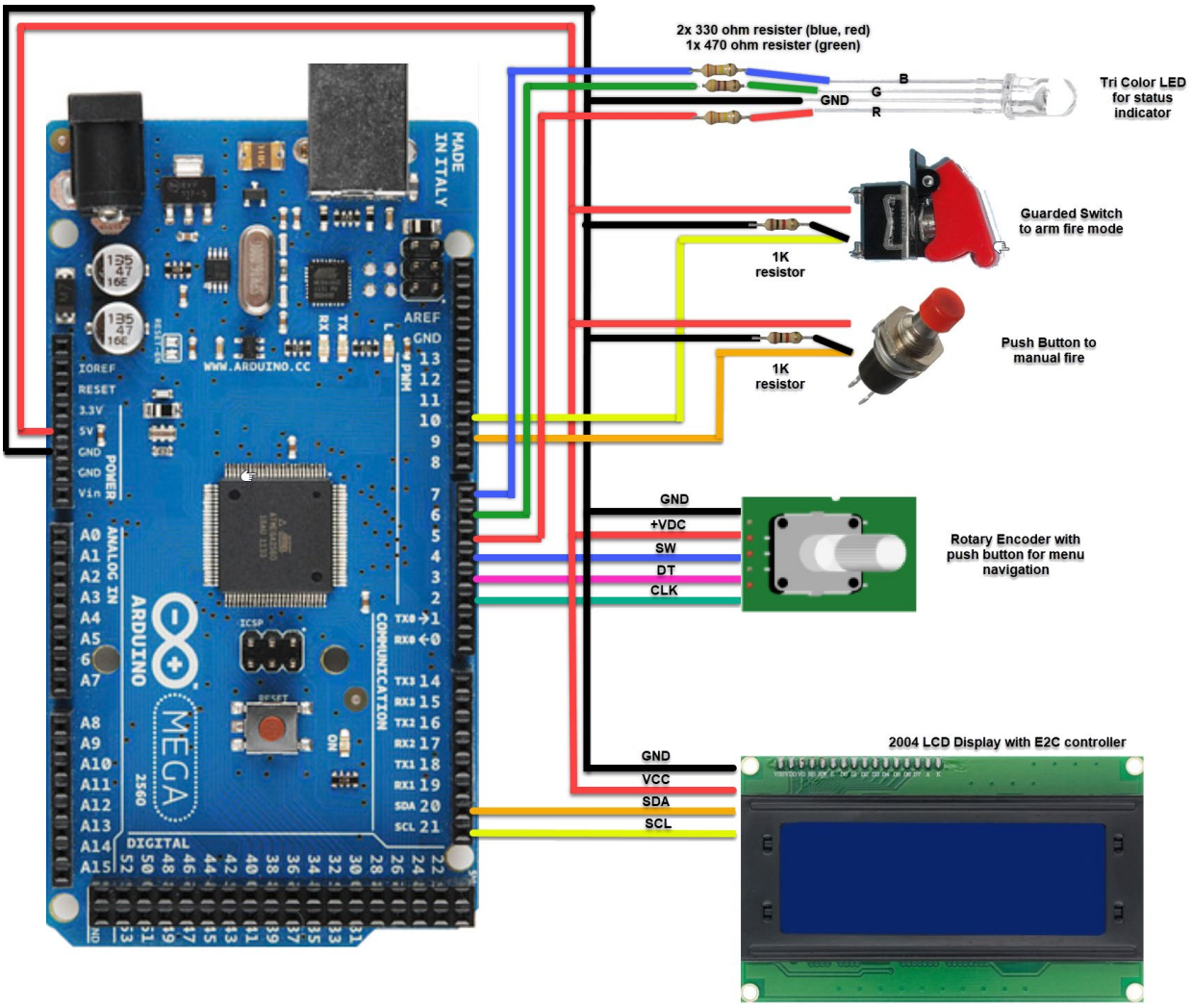


Figure 2

Preperation of other components

Enclosure

Insert the (11) 5mm x 6mm brass standoffs into the base of the enclosure. Do not over tighten.

Supplies needed for this step	
1	Enclosure
11	5mm x 6mm Brass Hex standoff spacers

(Image simplified for clarity)

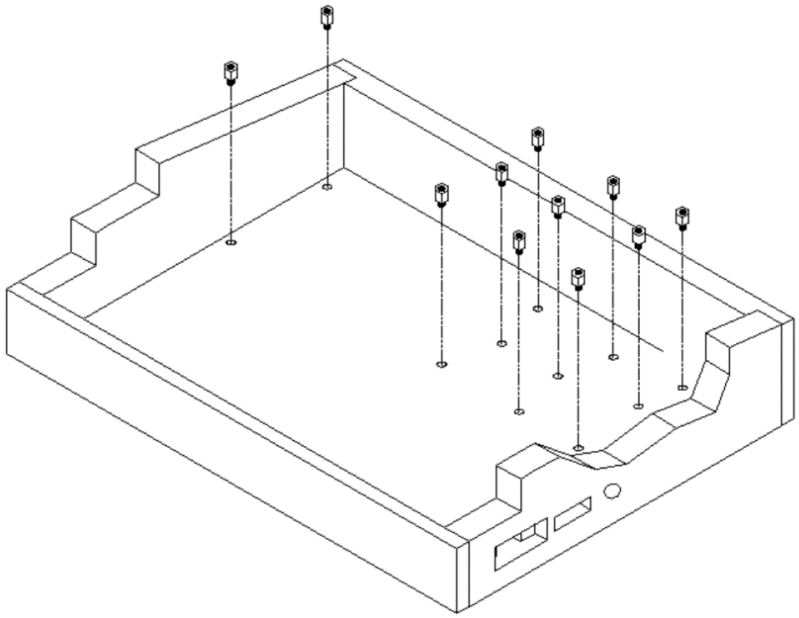


Figure 3

Modify the Terminal Connector Plate

The terminal connector plate needs some modifications to fit correctly with enclosure.

1. Using a coping saw or back saw remove the larger screw mounting lugs
2. The plastic guards in front of the speaker connectors can be broken off with pliers
3. Use a small file to smoothen out any remaining protrusions.
4. Repeat this for all 6 terminal blocks

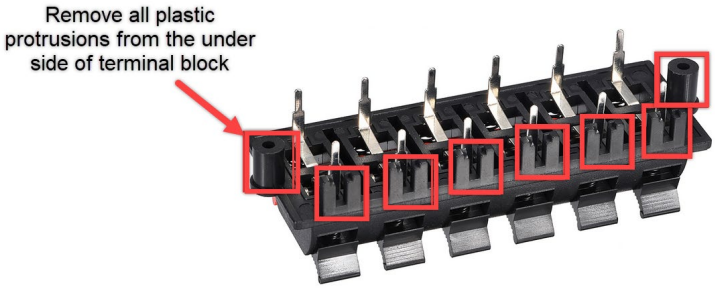


Figure 4

12v DC distribution board

Supplies needed for this step	
1	Mini Solderable Breadboard prototype shield
2	16 pin 8 x 2 double row IDC socket
2	22 AWG Red solid core wire (1 foot)
	Solder

1. Place (2) 16 pin 8x2 IDC sockets on the mini prototype breadboard as indicated by the yellow boxes.
2. Flip components over to show the back side with the exposed pins showing.
3. Strip enough sheathing off the ends of the red 22 AWG wire to allow good contact with the exposed pins.
4. Solder the wire to each pin. DO NOT OVERHEAT the socket, you could disform the plastic on the socket.

When finished, the 12v DC distribution board should look like the image shown.

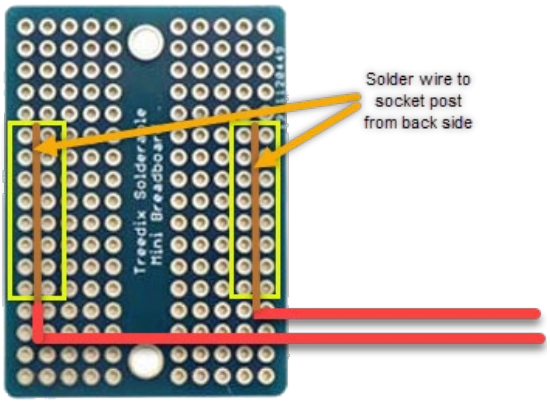


Figure 5

Modifying the Battery Pack - (depends on battery source selected)

The battery pack selected for this project was a 12x DC lithium Ion pack that has a built in 5.5mm x 2.1 AC charge port and a 5.5mm x 2.1 female DC connection port. This product also has a built in switch for turning the pack on and off. When installed, the switch is left in the "ON" position. Unfortunatly, there is also a built in LED for battery status. Thios causes the battery to drain over a 3 to 4 day period. To correct the led connection to the ground wire needs to be cut.

1. Using a utility know, gentally cut the blue plastic wrap away from the on off switch. (About 1" each side) as shown in figure 7
2. Carefully pull the protective chipboard packageing away from the switch to allow you to pull the switch out exposing the LED wiring.
3. Be carefull not to pull to hard. It is easy to discoonect wires from the battery pack.
4. Snip the led wire conned to the black ground wires. As shown in figure 8 (all packaging was removed in image for clarity)
5. Wrap the led with electrical tape so it does not accidently touch anything.
6. Push the switch back into the battery pack and close it up
7. Wrap the battery pack with electrical tape to secure the closure.

Figure 6

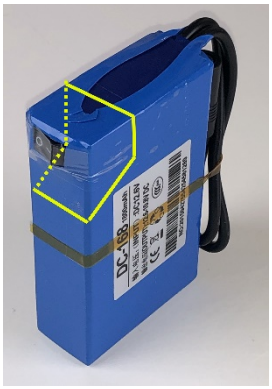


Figure 7

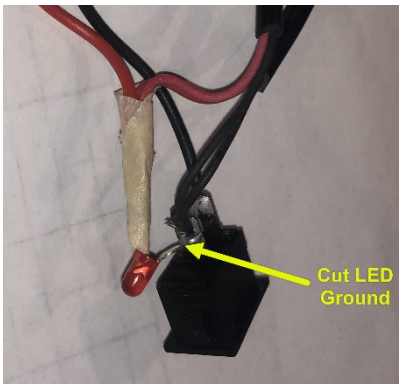


Figure 8

Install USB port and On / Off Switch

At this point in the build, it is a good time to install the USB port and the On/Off switch.

1. Install the USB port by simply placing it in the appropriate location and screw it place to secure it. If the pigtail coming off the USB flush mount extension cable is too, simple wrap it a few times and secure it with a sip tie.
2. Install the switch into the enclosure and place a red 10” lead coming off of one post. Use appropriated wire connector when performing this action. Wire connector may very based on the switch you selected.

The box should look something like the image below.

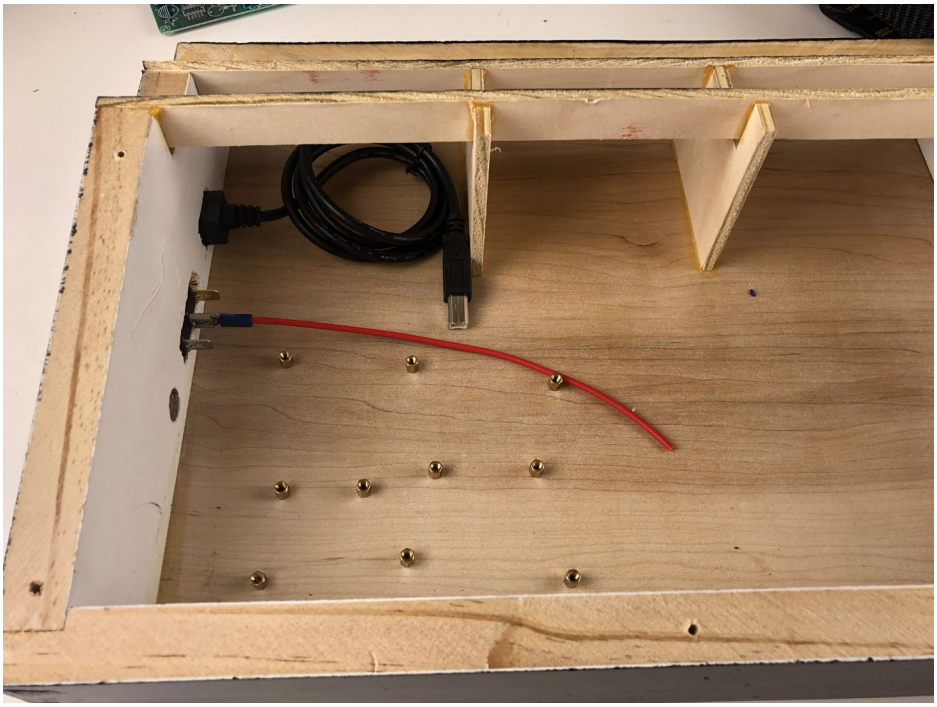


Figure 9

Install Battery

1. Place the 5.5 x 2.1 mm Female plug from the battery pack into the pre-drilled hole in the enclosure. This should be a snug fit. If the plug is loose, you may need to use an epoxy or glue to secure it into the hole. If this is the case, be sure not to get any glue / epoxy inside of the plug.
2. Secure the battery pack to the side of the enclosure using some webbing or strap material.
3. The battery pack should be resting on top of the 5.5 x 2.1 mm Female plug.
4. The enclosure should like something like figure…

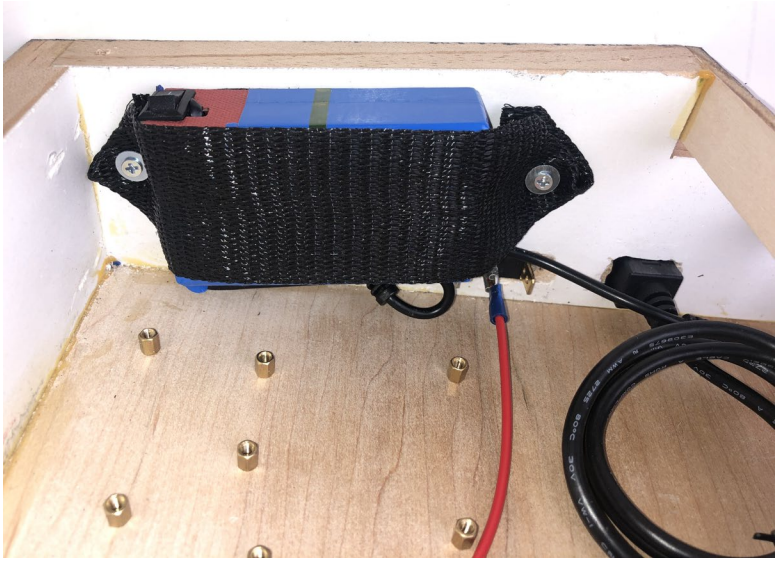


Figure 10

12v Power Connections

1. Connect the 12x 5.5 x 2.1 Male connection from the battery to a 5.5 x 2.1 female pigtail connector. The red wire from the pigtail should be connected to the available post on the On/Off Swith. The Black wire from the pigtail should be routed to the center of the box that will become the main 12v ground connection.
2. Connect a 5.5x 2.1mm Male pigtail connector to the input terminal of the Arduino board. Route the red and black wires of this pigtail to the center of the box, this will be connected to the main 12x power supply and ground later during the install process.
3. Install the Arduino board to the enclosure using M3 x 5 mounting screws.

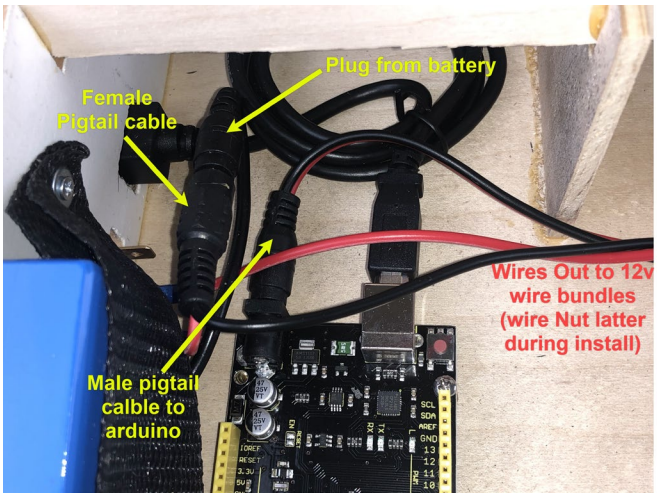


Figure 11

4. Install the 12x DC distribution board using M3 x 5 mounting screws.
5. Connect the 4 red wires together using a wire nut. (the image only shows 3 wires but was later changed to have to separate wires feeding the 12v DC distribution board. 1 wire for each bank.

The enclosure should look something like this. (The ground wire was pulled back for clarity)

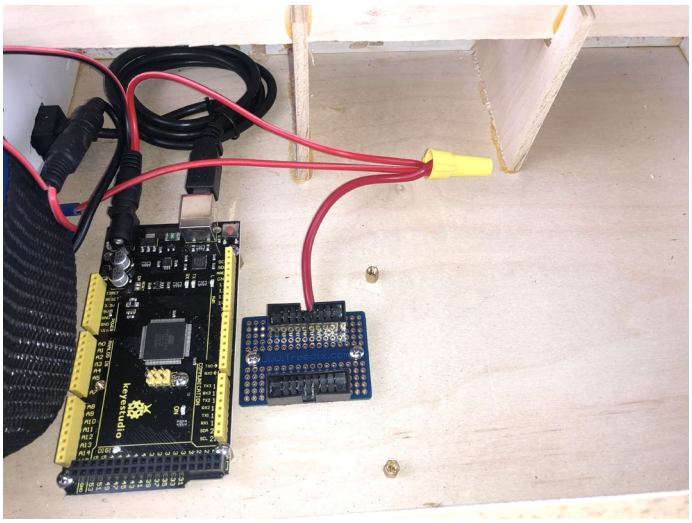


Figure 12

Mounting Terminal Connector blocks

1. Mount the spring clip terminal connector blocks to the terminal mounting plates using #4 -3/8 screws.
2. You will need to straighten the wire connections first and feed them through the holes drilled in the plates. I placed the black ground terminals away from the internal components (facing the back of the box) to lessen the chance of the positive and negative wires touching.
3. Once the terminal blocks are mounted to the plates, I stripped black ground wire to expose 2-1/2 to 3 inches bare wire, then soldered the wire to the ground posts as shown below. Leaving 10 to 12” of extra wire for connecting to a main ground wire later.
4. Please note the first grounding post was not connected as that will be used later for an input signal to the Arduino board.
5. Repeat this for both terminal mounting plates.

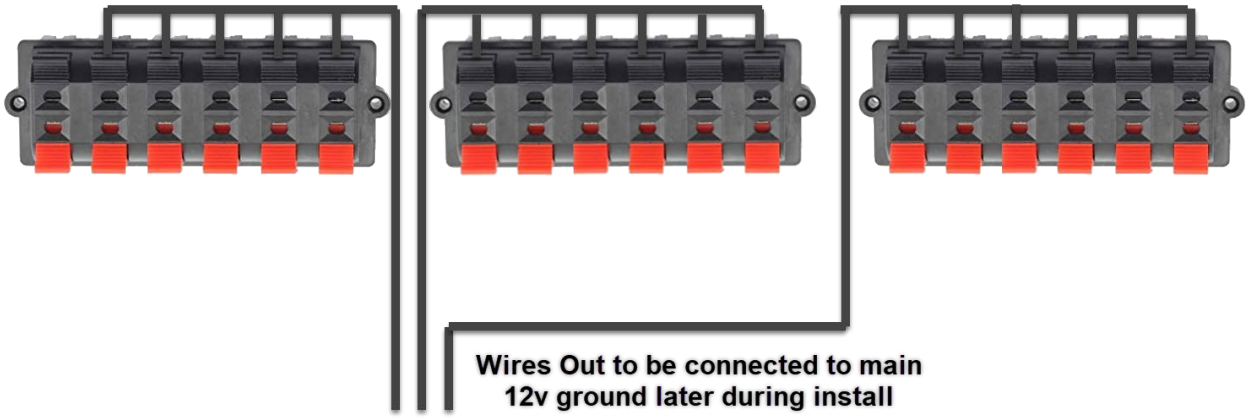


Figure 13

Connecting the 12V DC to Relay Board (Channel 17-32)

1. A 16 pin ICD ribbon cable was used to supply power to the individual relays. Start by cutting one cable end off and splitting the ribbon cable in sets of two. Shorten each pair by the length of one relay. Each pair will supply power to one upper and one lower relay board example channel 1 and 17. Note the cable only fits into the power socket one way so ensure the cable can be plugged in and routed the direction you want it before cutting the remaining end off. The cable should look something like this.

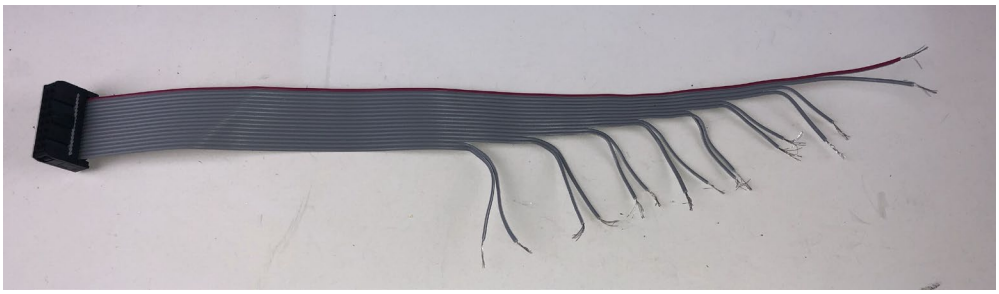


Figure 14

2. Make all the wire connections to one relay board. You should use one wire from each cable pair. (Do not mount the Relay board into the enclosure yet)

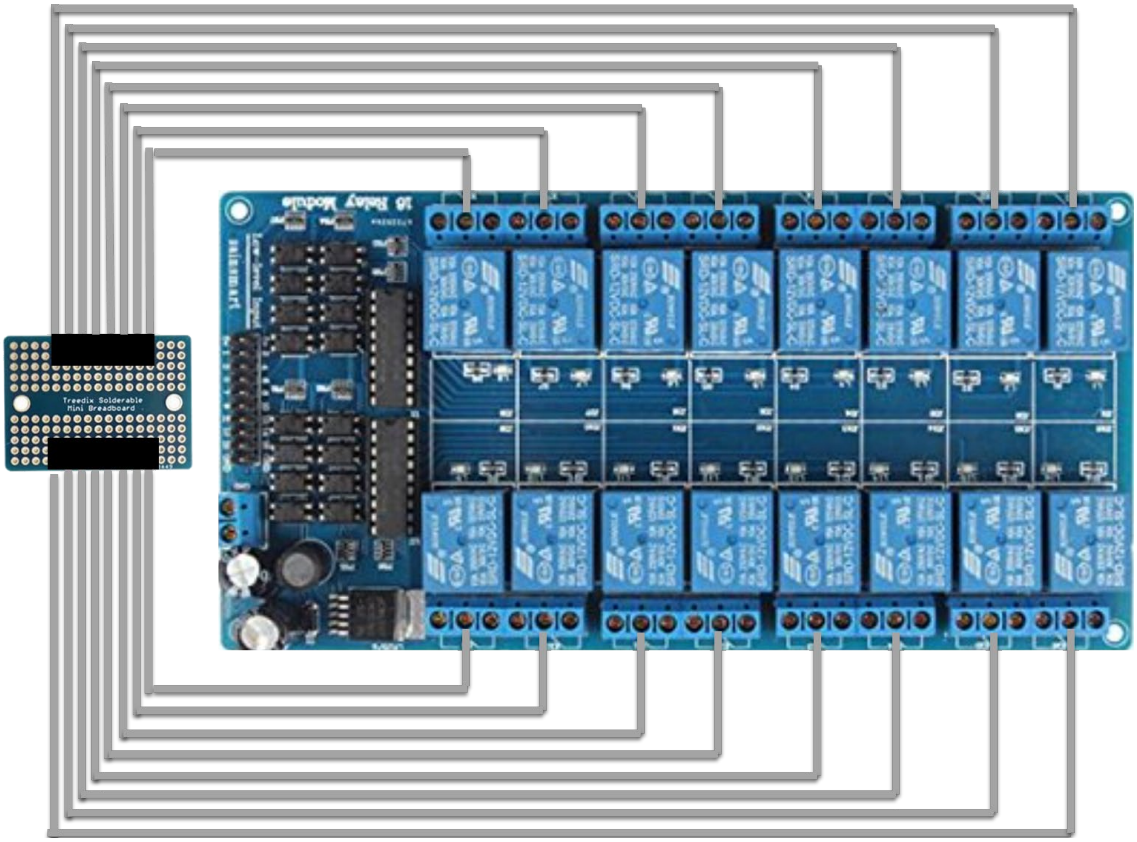


Figure 15

Connecting the 12v DC Relays to Power Terminals (Channel 17 – 32 and output)

1. Using (18) 40 cm DuPont Male to female connectors, connect the normally open (NO) side of the relay to the corresponding terminal. The 17-32 channel terminals should be the row closest to the outside of the box. The terminal connection plate should not be mounted yet. Feed each wire end through the available space and press the DuPont connector onto the terminal post. DO THIS CAREFULLY!! Hold the post as you press it on. The metal may be fatigued from when you straighten them out. If one breaks off you will need to solder it back on. Trust me it not fun.
2. Channel 32 should have 3 wires coming out of it. One to supply power to channel 32, the other two to supply power to both output terminals

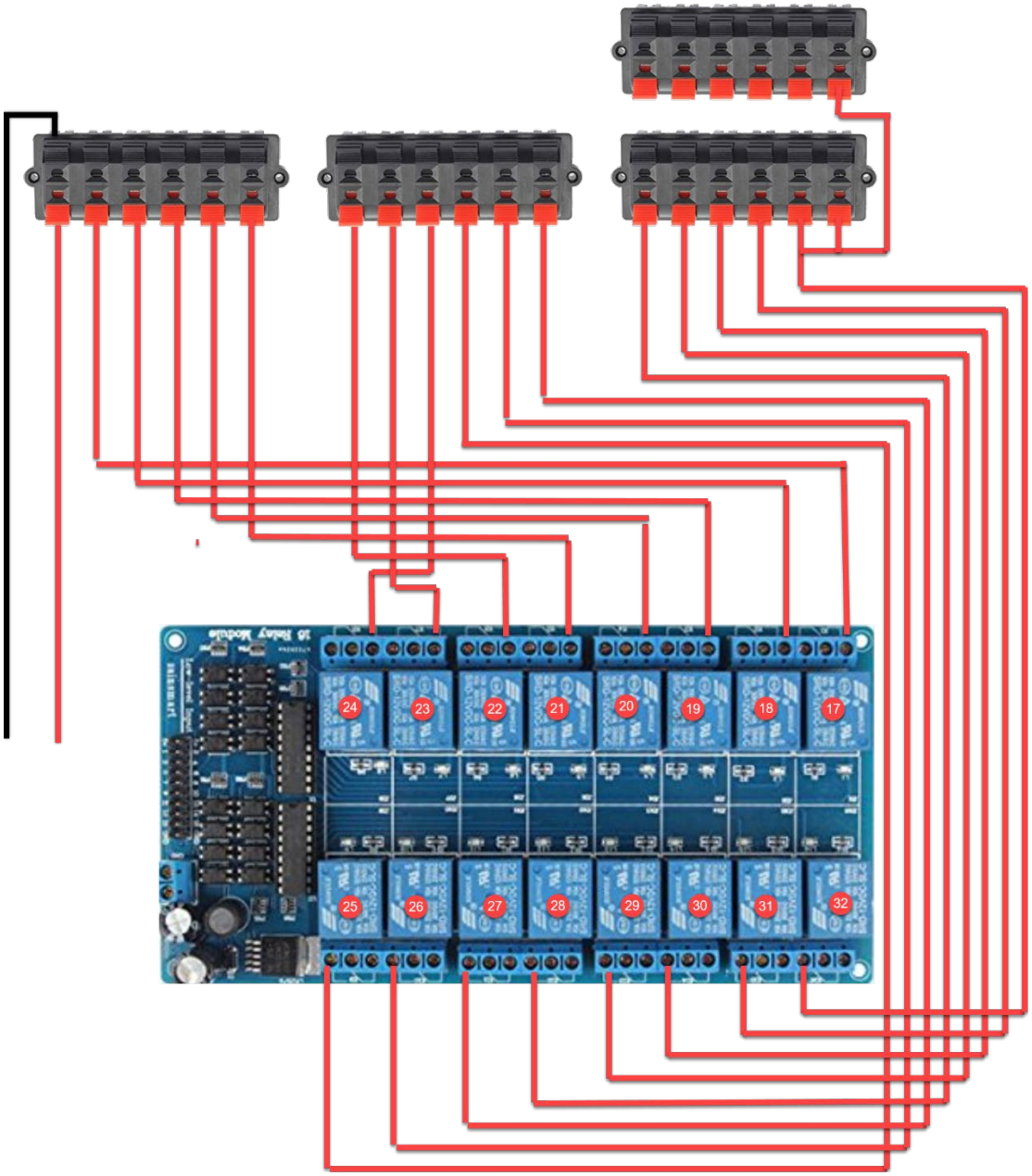


Figure 16

3. Connect an extra set of Dupont connector wires to the first set of terminals. This will be used later in the install process
4. Once you have connected all the DuPont wires to the terminal plates you can now attach the First Terminal plate to the enclosure. Carefully slide the terminal plate into place and fasten them with #4 x ½ screws.
5. Inspect all connections to the terminal plates and relay board carefully. You should be able to give the wires on the relay board a soft tug to make sure they are connected securely. If they all look good, proceed. You should be able to continue
6. Mount the relay board in place using m3 x 26 hex brass stand off post. (if you do not have those, you can use (4) m6 x m6 stand stacked together.

Connect Signal lines and low voltage to relay board Channel 17 – 32

1. Depending on whether you purchased a 5v DC relay board or 12v DC relay board, the main power supplied to the relay board will be different. If you are using a 5v DC board, make the connections to 5v dc and ground as shown in the image below. If you are using a 12v DC board, connect the main power to the 12v main bundle supplied directly from the battery.
2. Connect the signal wires from the Arduino to the relay board keeping them in order. It is easiest to start with pin 53 and connecting it to pin 16 on the relay board. Work backwards until all 16 connections have been made.

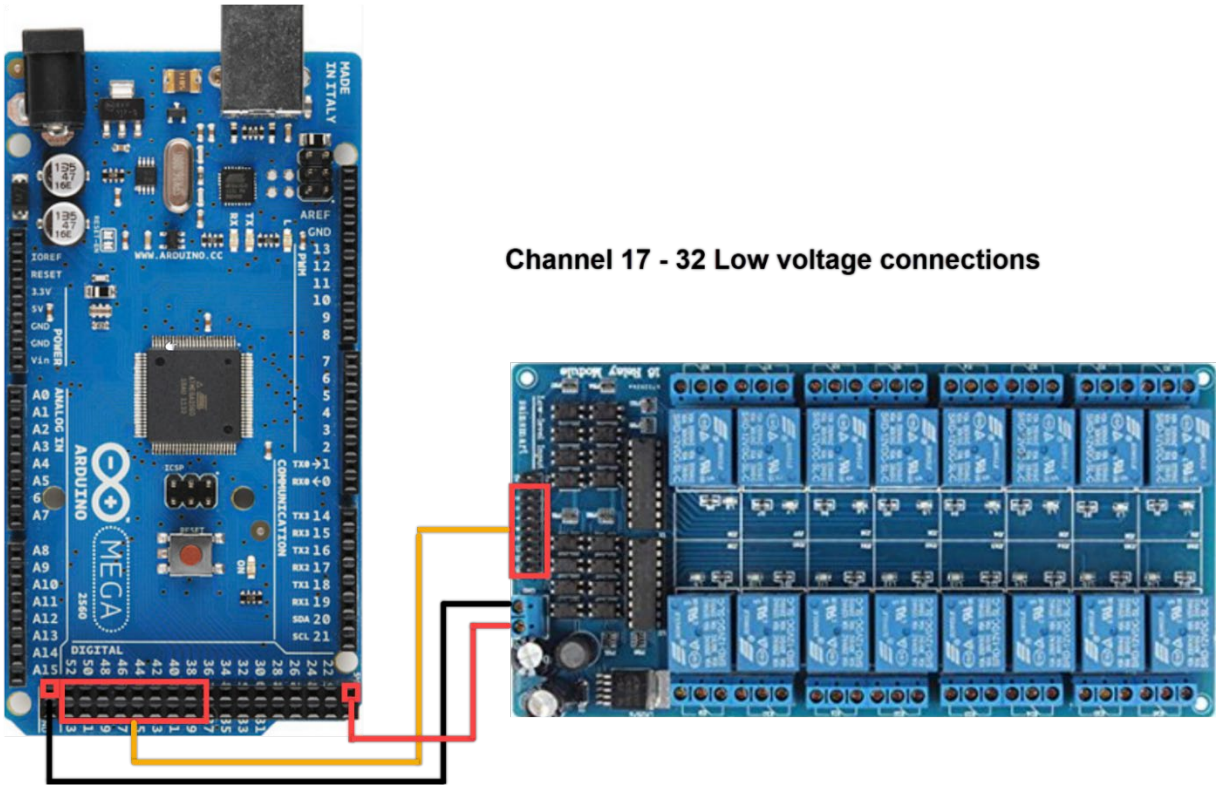


Figure 17

Connecting the 12V DC to Relay Board (Channel 1-16)

Connect the remaining 12v DC wire from each pair from the ribbon cable from the supply bus to each relay as done before with the previous relay board.

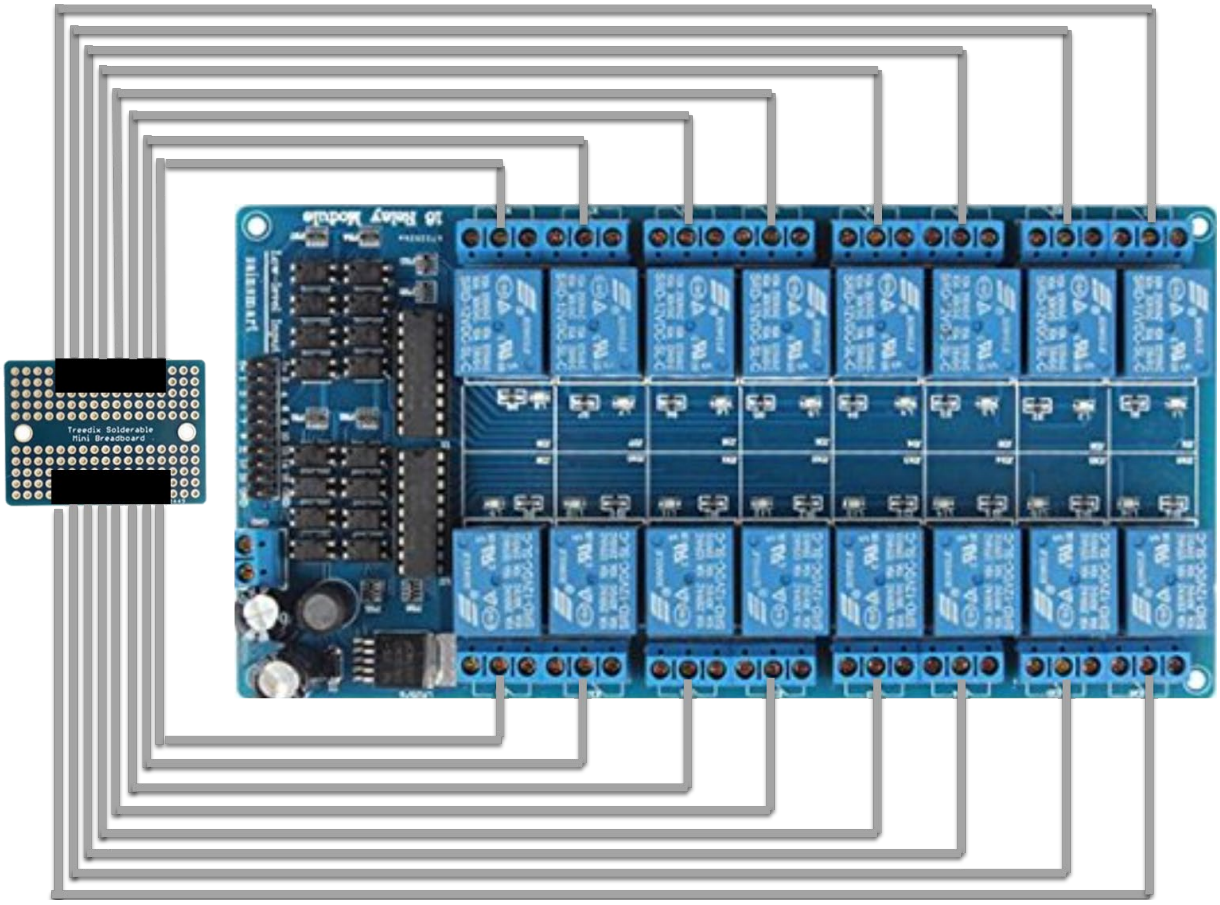


Figure 18

Connecting the 12v DC Relays to Terminal Blocks (Channel 1 – 16)

1. Using (16) 40 cm DuPont Male to female connectors, connect the normally open (NO) side of the relay to the corresponding terminal. The 1-16 channel terminals should be the row closest to the center of the box. The terminal connection plate should not be mounted to the enclosure yet. Feed each wire end through the available space and press the DuPont connector onto the terminal post. DO THIS CAREFULLY!! Hold the post as you press it on. The metal may be fatigued from when you straighten them out. If one breaks off you will need to solder it back on. Trust me it not fun.

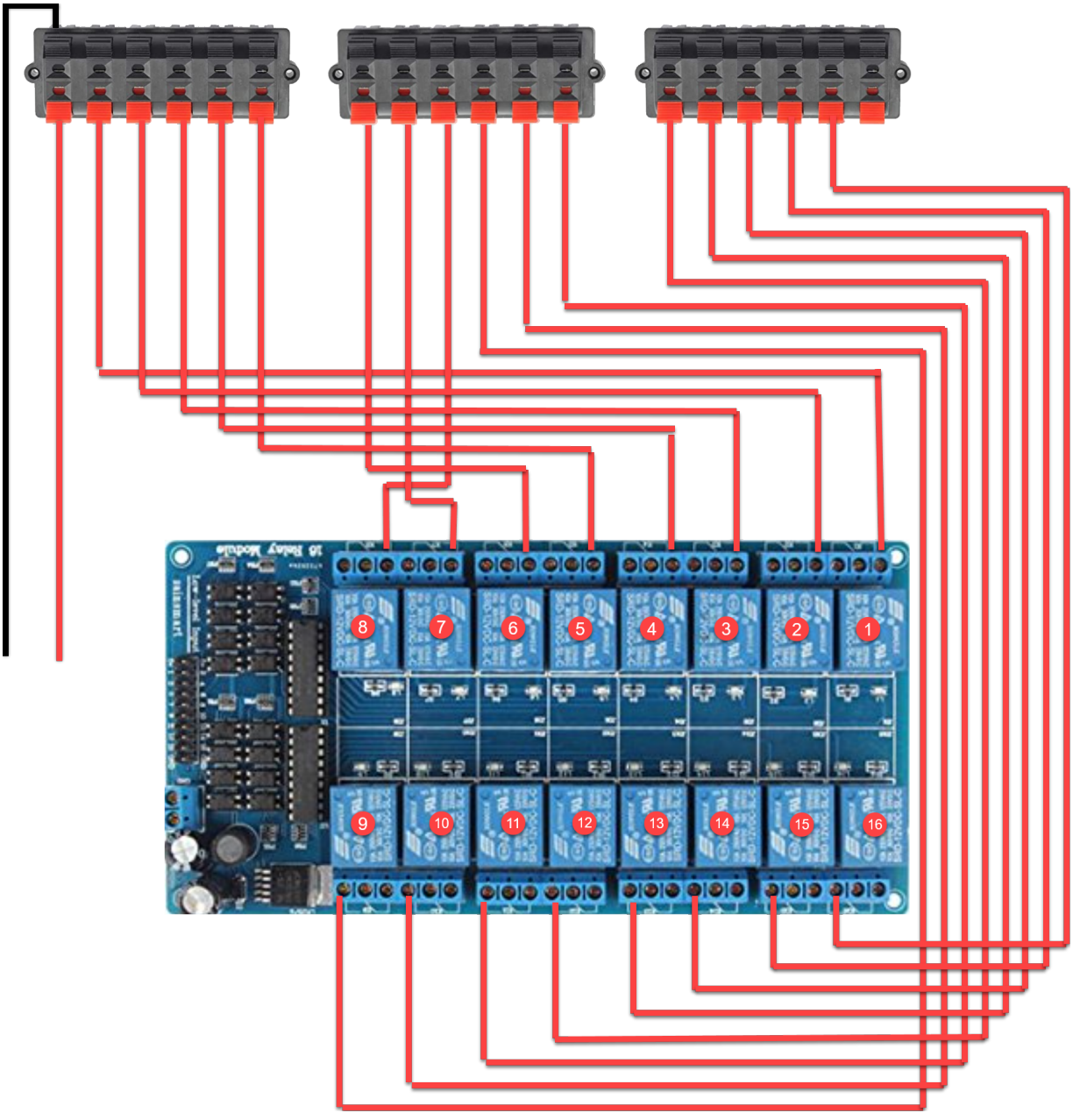


Figure 19

2. Connect an extra set of Dupont connector wires to the first set of terminals. This will be used later in the install process
3. Once you have connected all the DuPont wires to the terminal plates you can now attach the terminal plate to the enclosure. Carefully slide the terminal plate into place and fasten them with #4 x ½ screws.
4. Inspect all connections to the terminal plates and relay board carefully. You should be able to give the wires on the relay board a soft tug to make sure they are connected securely. If they all look good, proceed. You should be able to continue
5. Mount the relay board in place using m3 x 5 mounting screws.

Connect Signal lines and low voltage to relay board Channel 1 – 16

1. Depending on whether you purchased a 5v DC relay board or 12v DC relay board, the main power supplied to the relay board will be different. If you are using a 5v DC board, make the connections to 5v dc and ground as shown in the image below. If you are using a 12v DC board, connect the main power to the 12v main bundle supplied directly from the battery.
2. Connect the signal wires from the Arduino to the relay board keeping them in order. It is easiest to start with pin 37 and connecting it to pin 16 on the relay board. Work backwards until all 16 connections have been made.

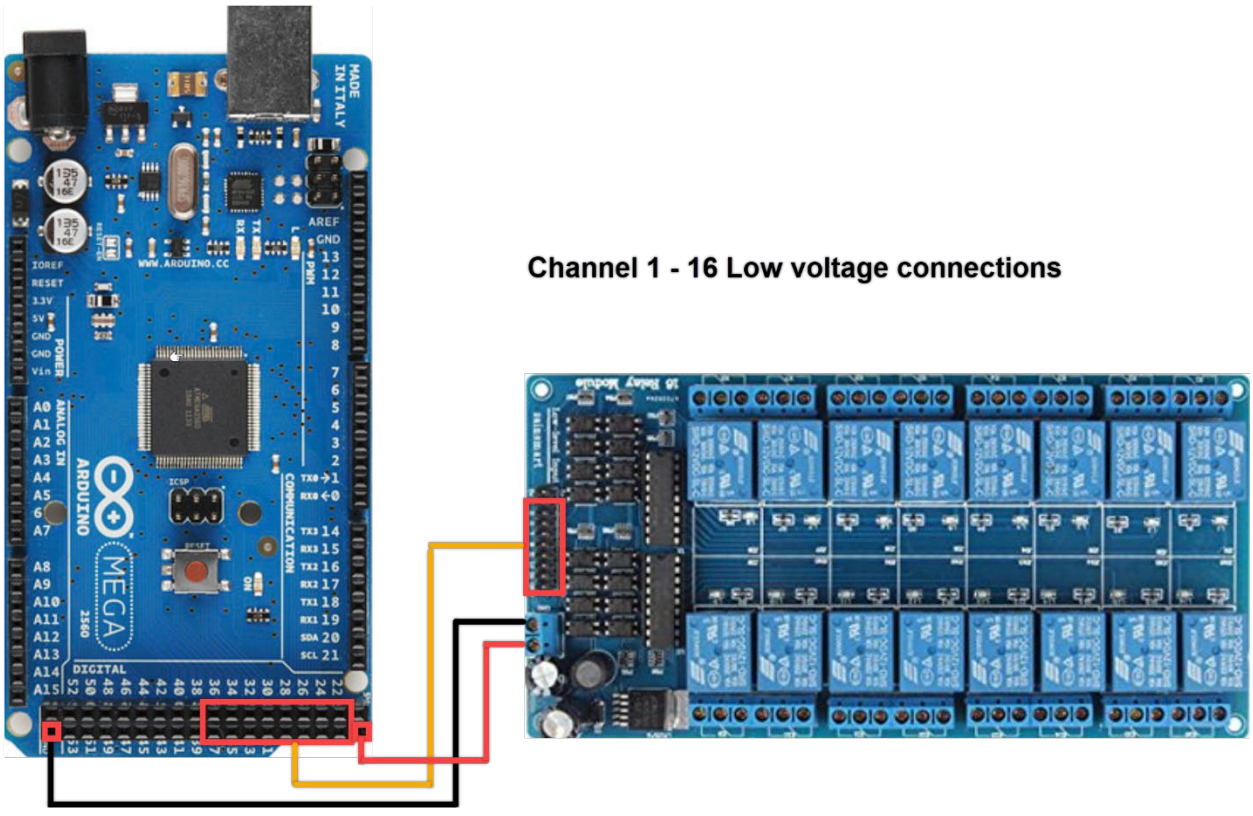


Figure 20

Connecting the Input Signal

Connect Terminal to Buck Converter

1. Using the two sets of extra wires installed with the terminal plates Connect the two ground wires together and solder them to the "- In" location on the buck converter. Do the same with the signal in + wires.

Adjusting the Buck Converter

1. Apply a 12v DC signal to one set of input terminals.
2. Using a multimeter read the voltage from the "+Out" and "-Out" positions.
3. Turn the brass screw counter clockwise until the voltage reads 4.25 volts This will help reduce voltage from a wide range of voltages

Connecting Buck converter to Arduino

1. From the "- Out" location solder on a 1K ohm resister. This is to prevent noise on the line that could trigger accidental firing of the fireworks.
2. From the other end on the resister connect a ground wire to the ground pin on the Arduino.
3. From the "+Out" position connect a wire to the A3 pin on the Arduino.

Connect Main Ground Wires

At this point the connect the 6 ground wires from the terminal blocks together with the ground wire from the 12v battery and the ground wire from the pigtail that supplied power to the Arduino. These should fit nicely into a medium size (yellow) wire nut.

Ensure all components are held securely.

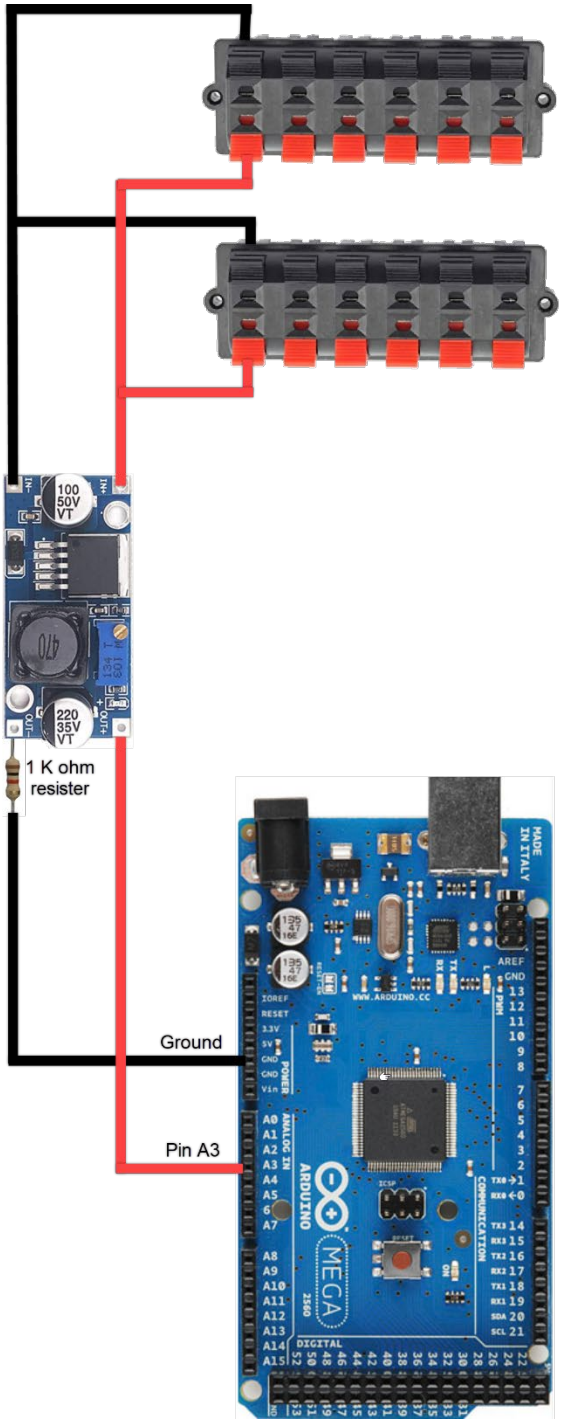


Figure 21

Connecting the Controls from the Lid to Arduino

1. Connect the Ground wire to the ground pin
2. Connect the 5v DC wire to the 5V pin
3. Connect the Armed switch signal wire to Pin 10
4. Connect the Fire push button to Pin 9
5. Connect the LED Blue line to Pin 7
6. Connect the LED Green line to Pin 6
7. Connect the LED Red line to Pin 5
8. Connect the rotary encoder SW line to Pin 4
9. Connect the rotary encoder DT line to Pin 3
10. Connect the Rotary encoder CLK line to Pint 2
11. Connect the LCD i2c SDA line to Pin 20 SDA
12. Connect the LCD i2c SCL line to Pin 21 SCL

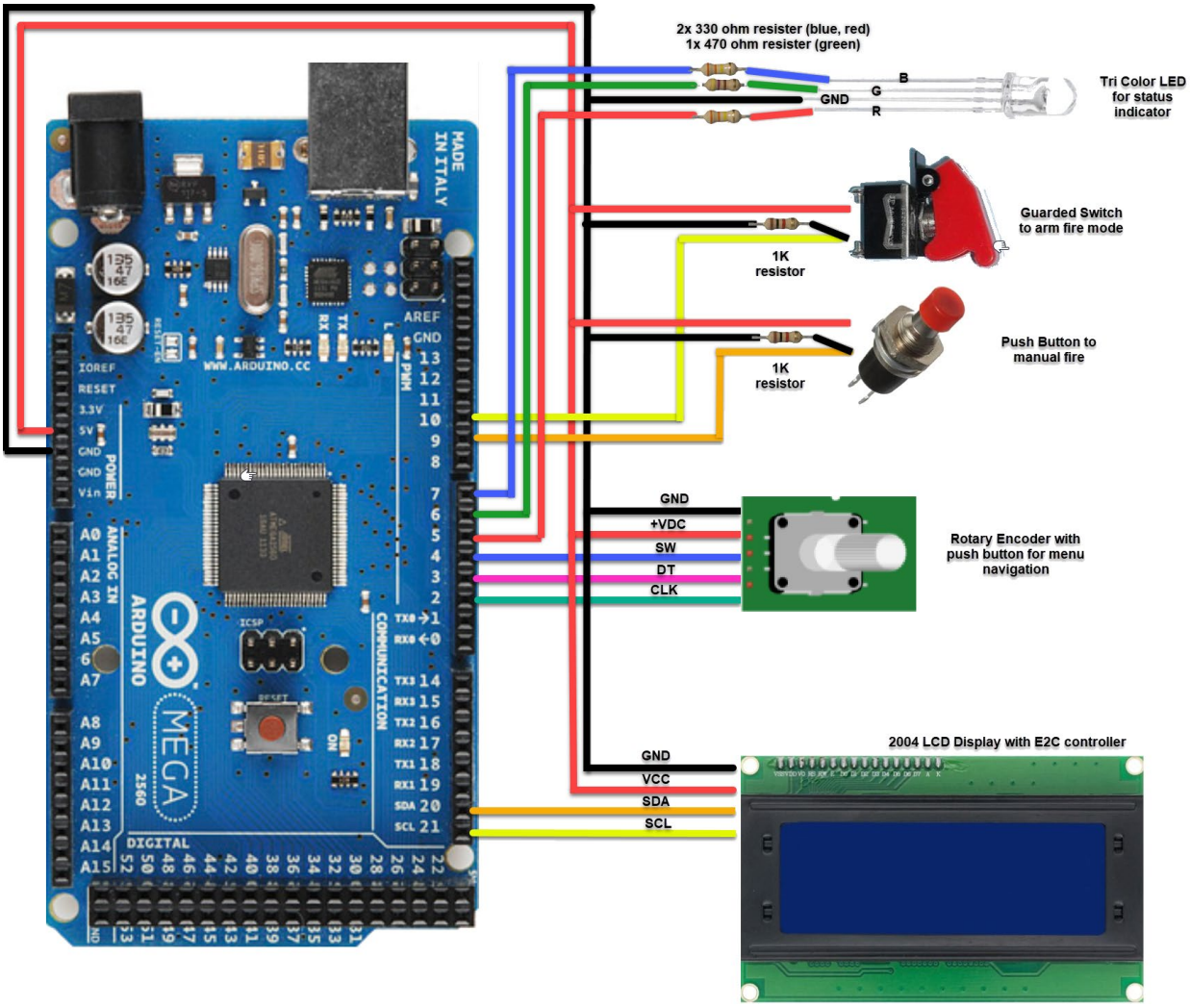
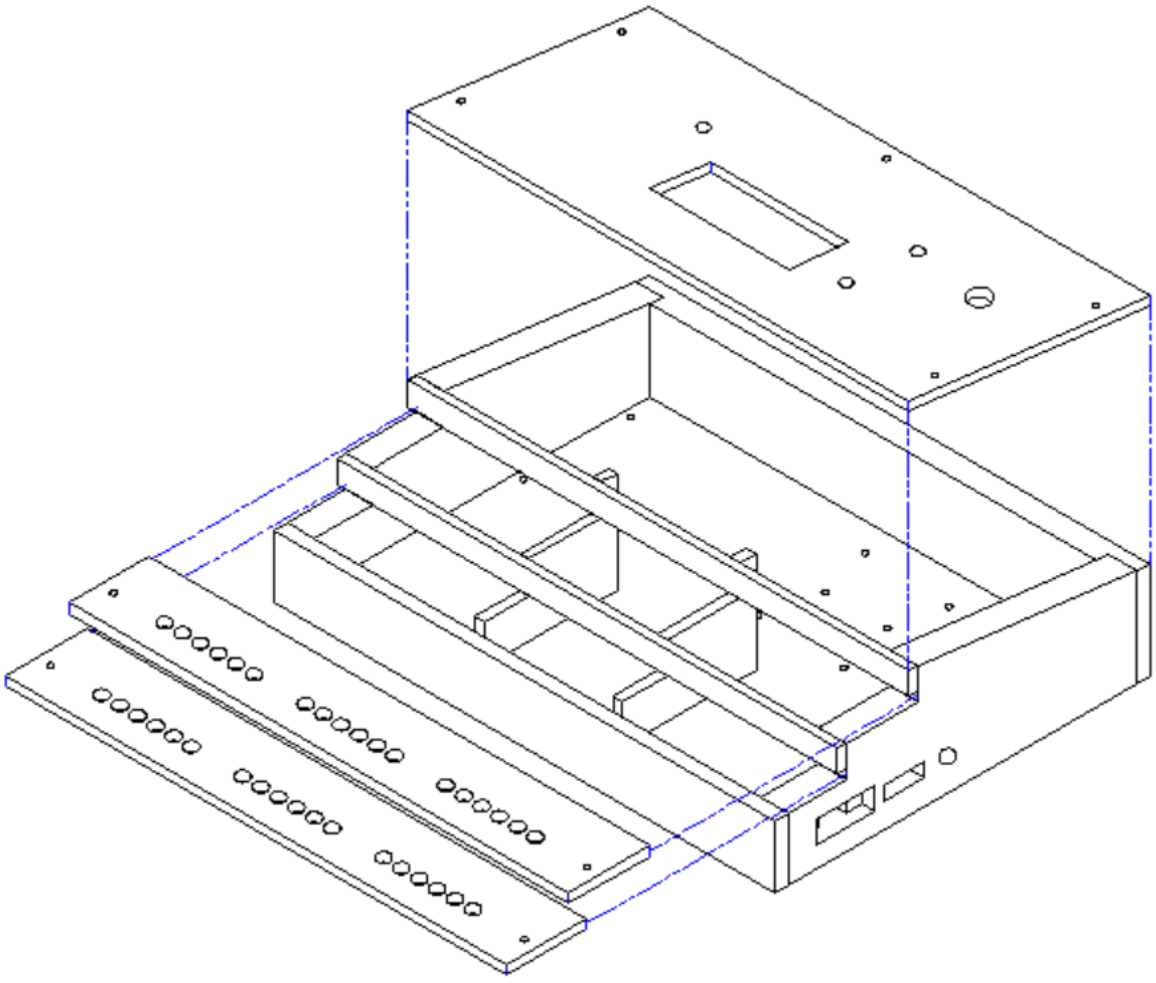
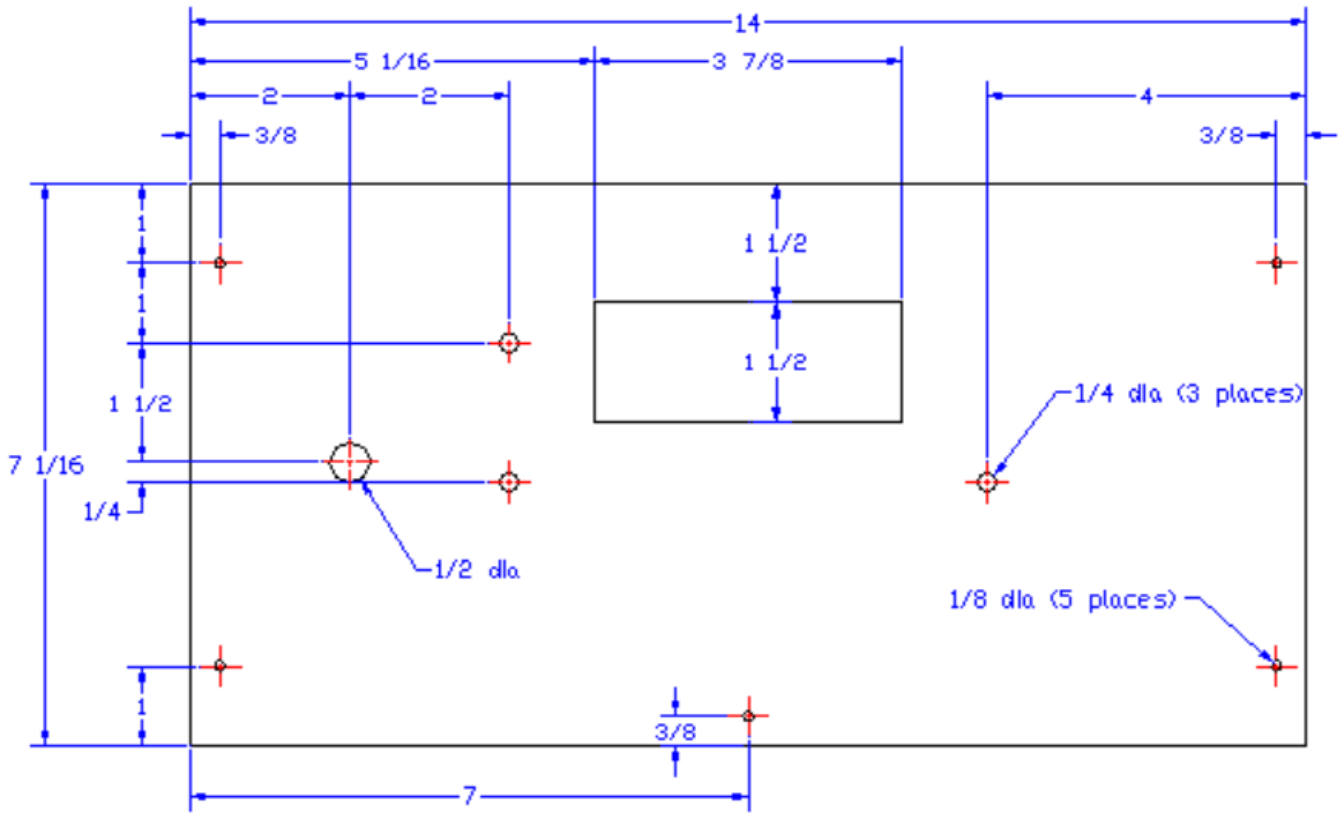


Figure 22

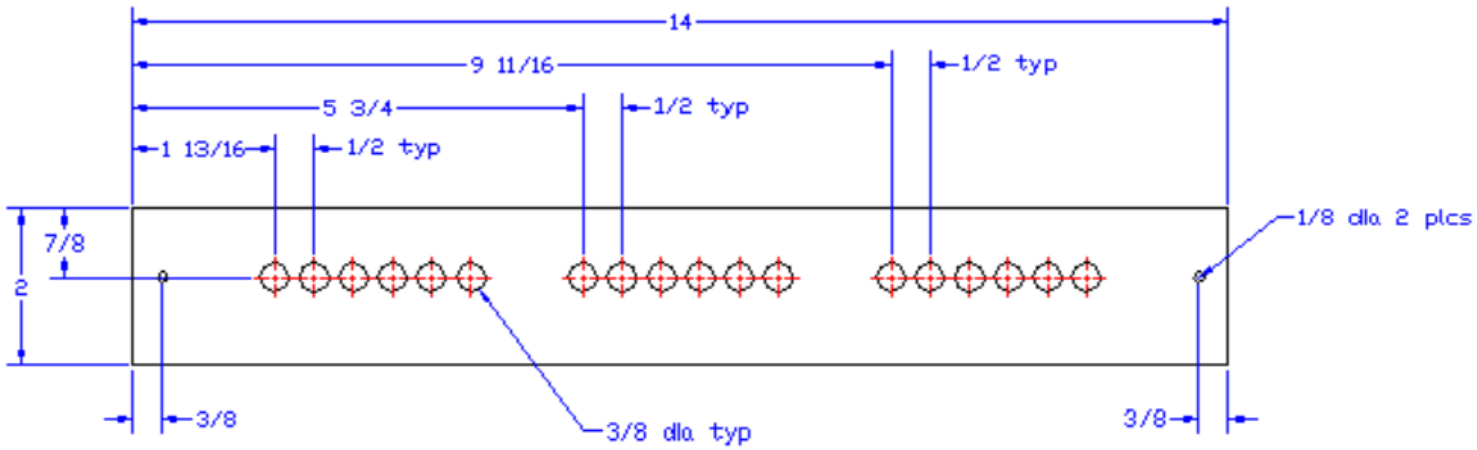
Appendix A

1. This section will provide the drawings needed to build the enclosure. Hole sizes and locations may change based on the actual components purchased for this project. Make changes as needed.
2. Once all parts are fabricated, assemble parts as shown in image below.
3. Try to fit all components to ensure they fit properly adjust as needed.
4. Once ensuring fit, spray entire unit with primer, then paint with two coats of epoxy spray finish. Lightly sand between coats.
5. Attach vinyl lettering. You may temporarily assemble components for proper placement of lettering.
6. Once vinyl letter is attached, remove all components and spray two coats of acrylic clear coat. Simi gloss or high gloss. Lightly sanding between coats.
7. Apply rubber or felt stick on pads to the bottom corners to act a feet and to provide protection



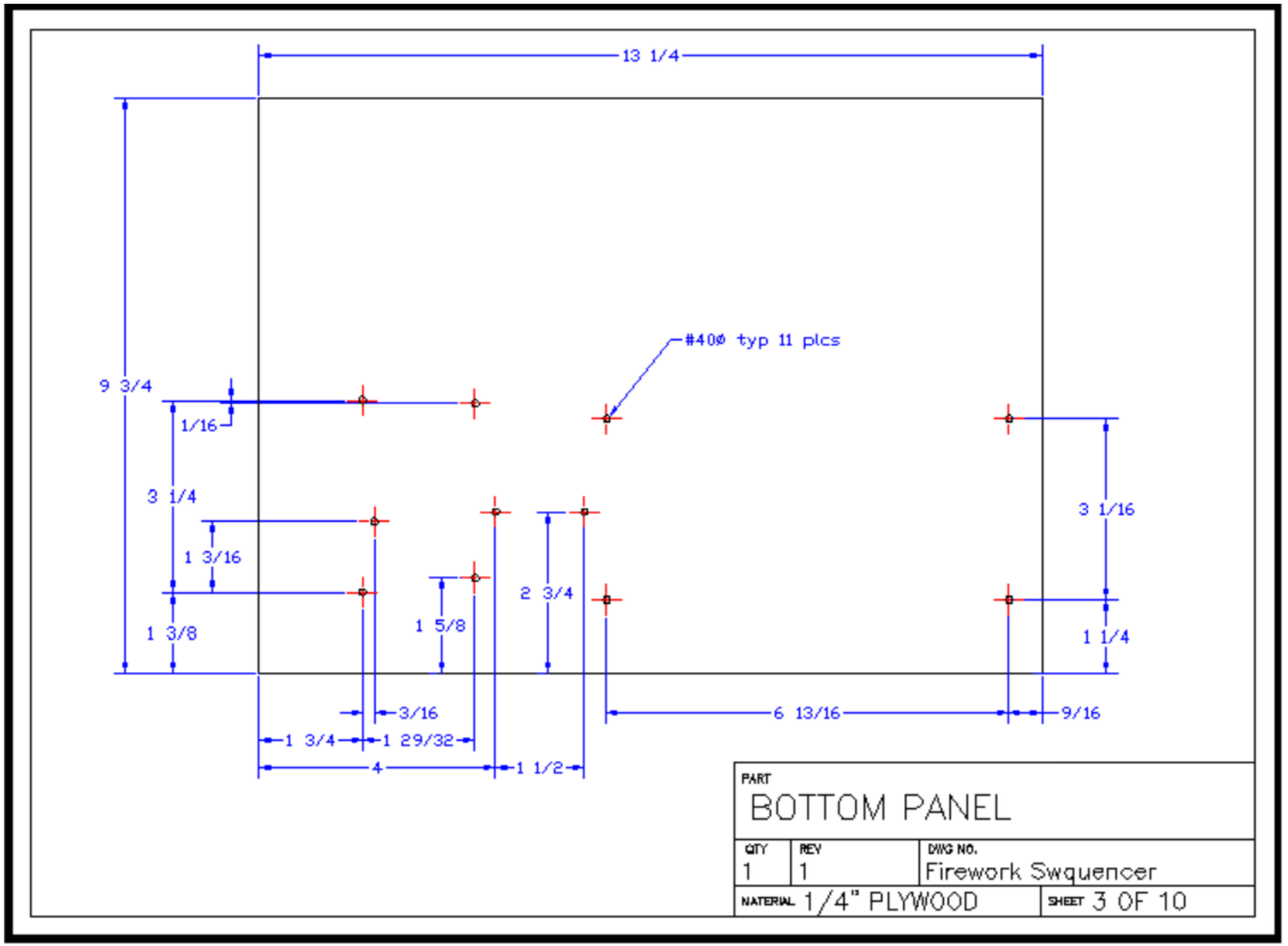


PART: INSTRIMENT PANEL			
QTY: 1	REV: 1	DWG NO.: Firework Swquencer	
MATERIAL: 1/4" PLYWOOD		SHEET: 1 OF 10	



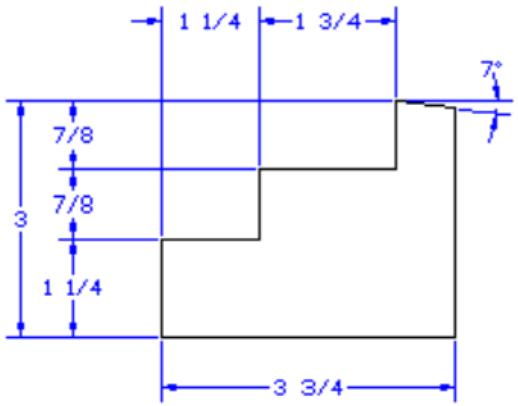
PART
TERMINAL MOUNTING PLATES

QTY	REV	DWG NO.
2	1	Firework Swquencer
MATERIAL 1/4" PLYWOOD		SHEET 2 OF 10



PART
BOTTOM PANEL

QTY	REV	DWG NO.
1	1	Firework Swquencer
MATERIAL 1/4" PLYWOOD		SHEET 3 OF 10

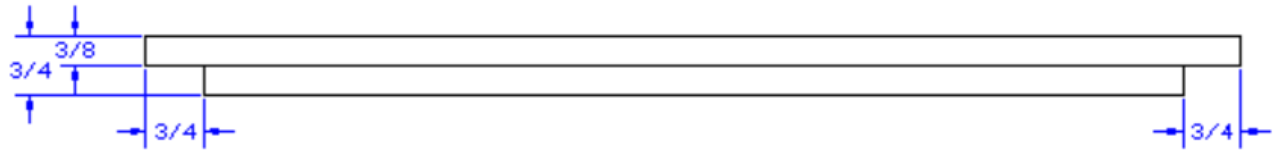


PART
INTERMEDIATE SUPPORT

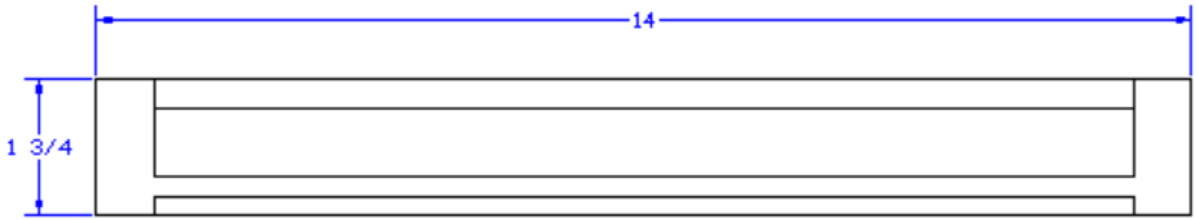
QTY	REV	DWG NO.
2	1	Firework Swquencer

MATERIAL 1/4" PLYWOOD

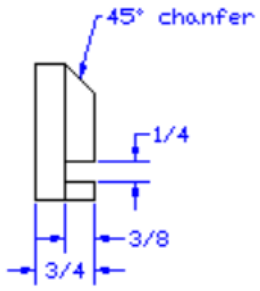
SHEET 4 OF 10



TOP VIEW

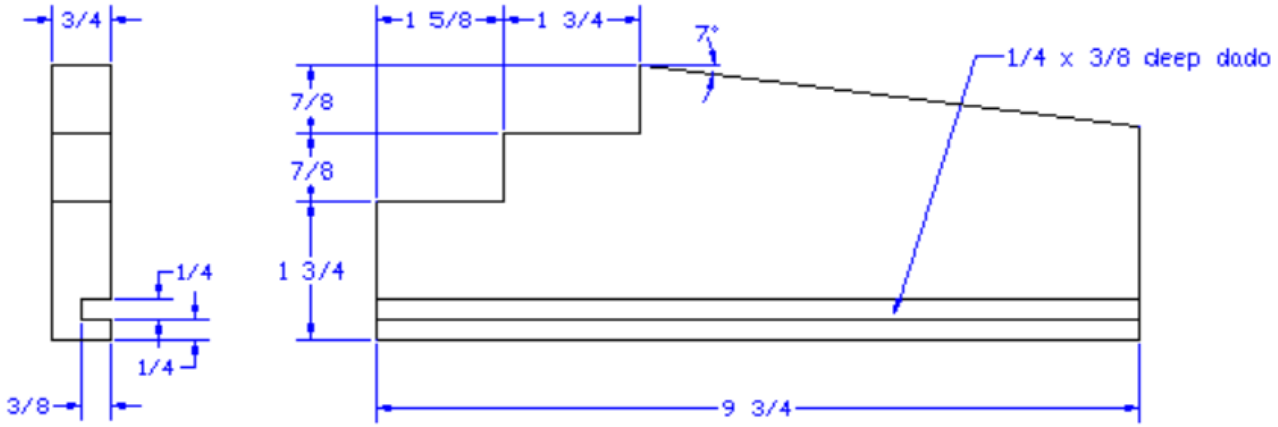


FRONT VIEW



SIDE VIEW

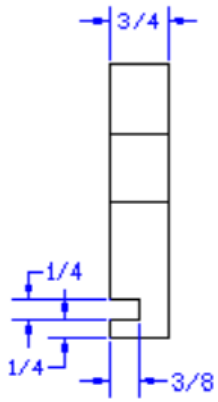
PART: BACK SIDE PANEL		
QTY: 1	REV: 1	DWG NO.: Firework Swquencer
MATERIAL: 1 x 4 PINE / FUR		SHEET: 5 OF 10



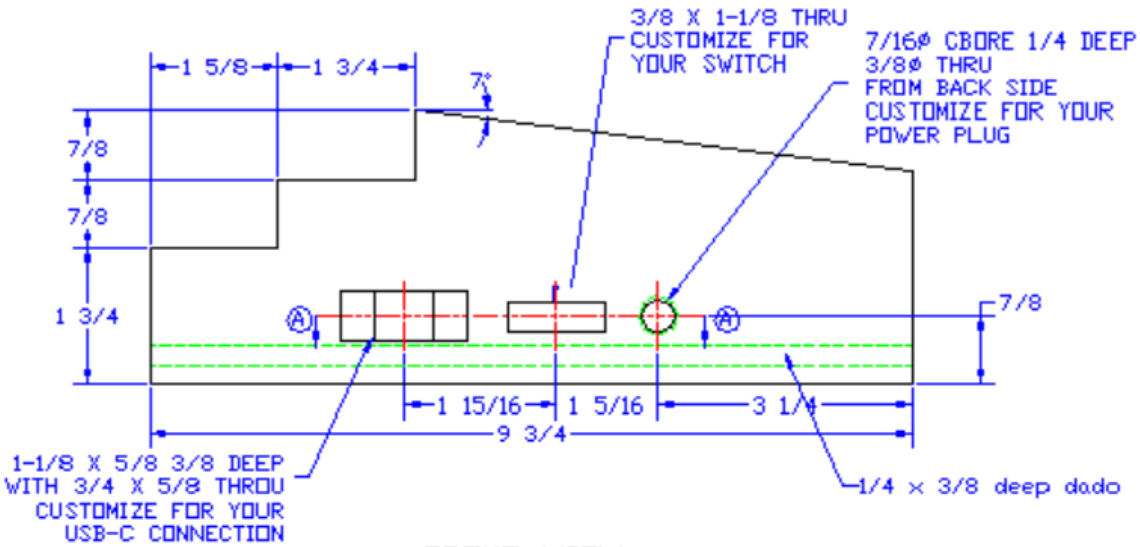
SIDE VIEW

FRONT VIEW

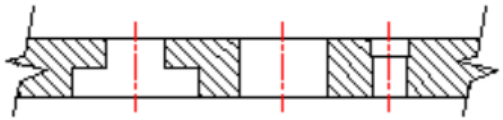
PART: RIGHT SIDE PANEL		
QTY: 1	REV: 1	DWG NO.: Firework Swquencer
MATERIAL: 1 x 4 PINE / FUR		SHEET: 6 OF 10



SIDE VIEW

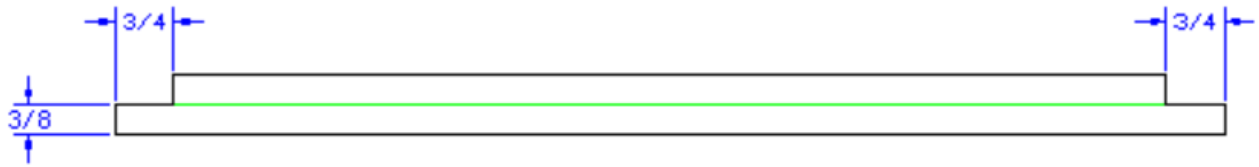


FRONT VIEW

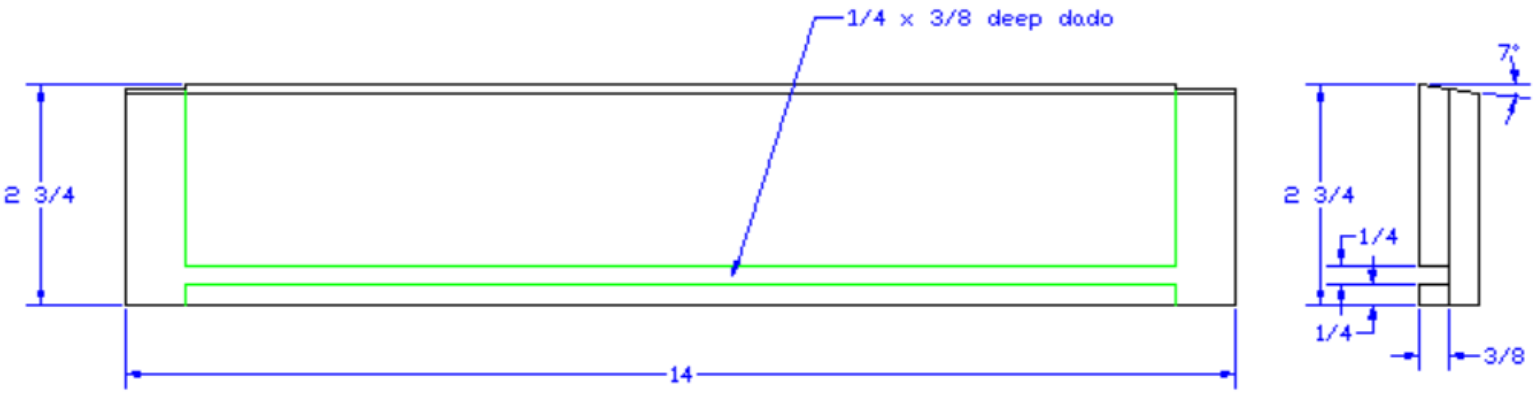


DETAIL A-A

PART: LEFT SIDE PANEL			
QTY: 1	REV: 1	DWG NO.: Firework Swquencer	
MATERIAL: 1 x 4 PINE / FUR		SHEET: 7 OF 10	



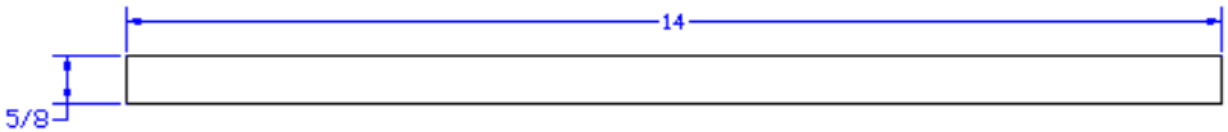
TOP VIEW



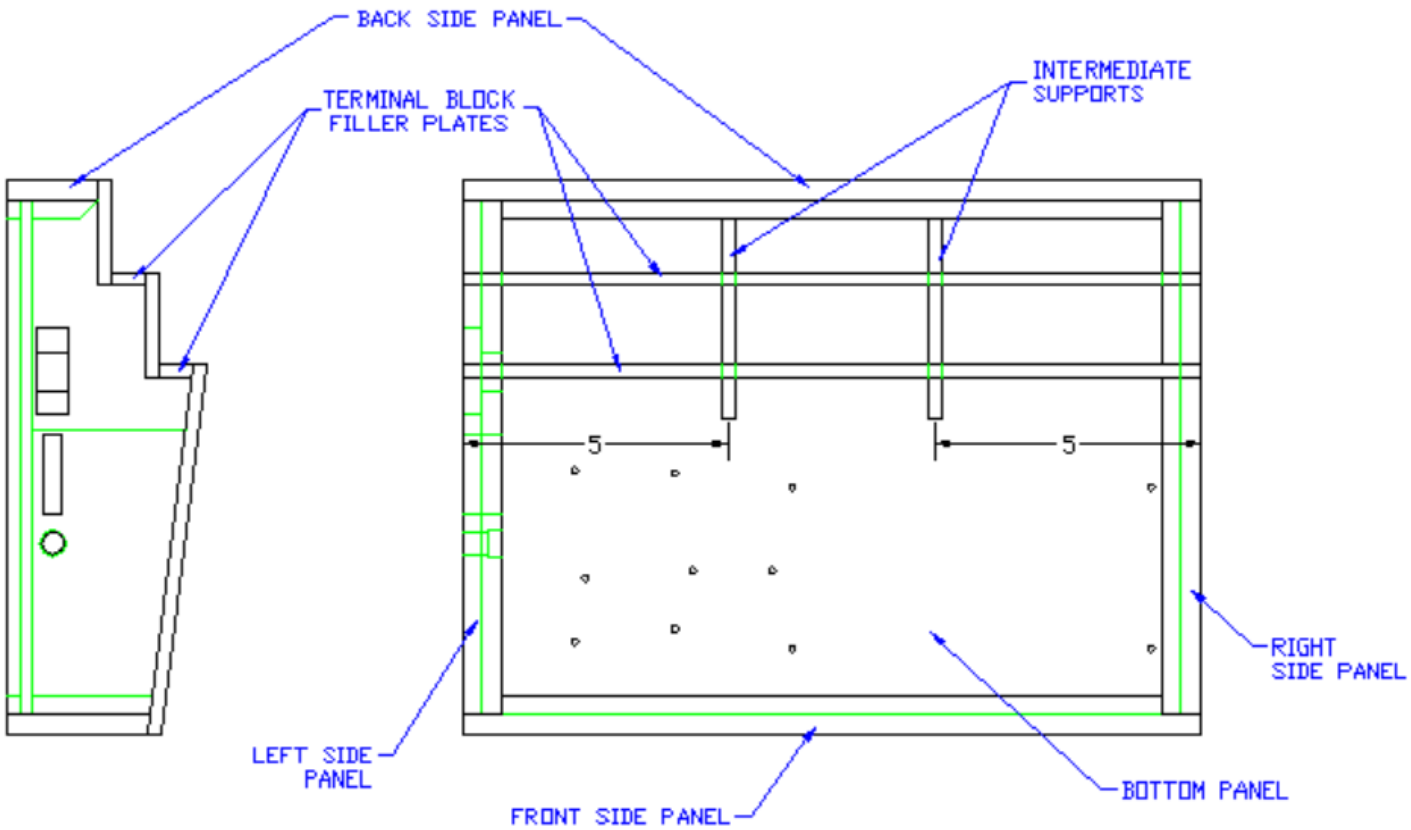
FRONT VIEW

SIDE VIEW

PART: FRONT SIDE PANEL		
QTY: 1	REV: 1	DWG NO.: Firework Swquencer
MATERIAL: 1 x 4 PINE / FUR		SHEET: 8 OF 10



PART: TERMINAL BLOCK FILLER PLATE			
QTY: 2	REV: 1	DWG NO.: Firework Swquencer	
MATERIAL: 1/4 PLYWOOD			SHEET: 9 OF 10



PART: FRONT SIDE PANEL			
QTY: 1	REV: 1	DWG NO.: Firework Swquencer	
MATERIAL: 1 x 4 PINE / FUR		SHEET: 10 OF 10	

Appendix B – Hardware list

Supplies needed for this step	
50	40 cm dupont connector wires – male to female
32	20 cm Dupont connector wires – male to female
2	5 volt or 12 volt 16 channel relay board
1	Arduino Mega 2560
1	Guarded toggle switch
1	Momentary push button
1	Rotery encoader with push button
1	2004 LCD screen with I2C control
1	12 v Litium Ion Battery pack
1	DC to DC Buck / Down converter
3	1K ohm resisters
2	330 ohm Resisters
1	470 ohm resister
1	5.5 x 2.1 mm male pigtail
1	5.5 x 2.1 mm female pigtale
1	On / Off rocker switch
1	Flush mount USB-C extension cable 12”
1	Tricolor LED light 5mm
1	5mm LED socket
31	#4 x ½ button cap screw
10	#4 flat washers
11	6mm x 6mm brass hex stand off post
4	26mm x 6mm brass hex stand off post
11	3m x 5 button cap screw
1	Mini prototype bread board
2	16 pin 2 x 8 row ICD socket
2	16 pin 2 x 8 ICD ribbon cable
1	10” webbing/ strap material
	22 AWG solid core red wire
	22 AWG Solid core Black wire
Enclosure	Primer
Enclosure	Epoxy paint
Enclosure	Clear coat
Enclosure	Vynal lettering
Enclosure	Rubber stick on pads