

FlyBox Assembly Instructions

Brandeis's Rosbash Lab does groundbreaking research on circadian rhythms and neuroscience. This research relies upon data collected by the FlyBox, a box designed to house 96 flies in a stable and replicable environment with means for providing video footage of the flies. The improved FlyBox provides a better working experience for researchers at Brandeis and other labs around the world.



Please consult the Bill of Materials document at

<https://github.com/Rosbash-Lab-FlyBox/FlyBox/tree/main/Directions%20and%20Bill%20of%20Materials> to ensure that you have all required parts.

Have the following tools and supplies on hand:

- Electric screwdriver with M2, M3, M4, small flathead bits
- Vise-grip or slip joint pliers
- Wire cutters
- Wire strippers
- Paper towels
- Blue tape
- Sandpaper (about 40 grit) or a small hand file

Optional:

- Soldering iron and supplies

Table of Contents

Laser Cutting Instructions	1
3D Printing Instructions	3
FlyBox Frame Assembly Instructions	4
Hardware Attachment	4
Right and Left Walls	4
Bottom Panel (IR and Fans)	4
Front Wall	7
Removing the Camera IR Filter	9
LED Diffuser Panel	9
Upper Floor	10
Back Wall	10
Bottom Side of Electronics Panel	11
Top Side of Electronics Panel	11
Box Structure Assembly	14
Final Wiring	20
Firmware Loading	22
Setting up the Arduino IDE	22
Setting up the Arduino IDE for ESP32 Microcontroller	22
Installing the necessary libraries in Arduino	22
Downloading the Firmware	23
FlyBox Running a Test	27
General FlyBox Use Procedure	28
Appendix	29

Laser Cutting Instructions

The FlyBox laser-cut files can be found at

<https://github.com/Rosbash-Lab-FlyBox/FlyBox/tree/main/fabrication-files/laser-cut-files>.

The FlyBox frame is assembled from 17 laser-cut panels, of which 15 are cut from opaque $\frac{1}{4}$ " black acrylic and 2 are cut from translucent $\frac{1}{8}$ " diffuser acrylic. There are 7 cutsheets, each needing a 12"x24" panel. In addition, a lightproofing curtain is cut from an 18"x18" felt sheet and a 1" radius IR filter is cut from IR filtering acrylic.

Material (cutsheets)	Part name (Cutsheet #)
Opaque $\frac{1}{4}$ " Black Acrylic (Six 12"x24" cutsheets)	<input type="checkbox"/> Bottom Panel (1) <input type="checkbox"/> Back Wall (1) <input type="checkbox"/> Outer Top (2) <input type="checkbox"/> Inner Top (2) <input type="checkbox"/> Top Hatch (2) <input type="checkbox"/> Electronics Panel (2) <input type="checkbox"/> Outer Front (3) <input type="checkbox"/> Inner Front (3) <input type="checkbox"/> Front Door (3) <input type="checkbox"/> IR Alignment Panel (4) <input type="checkbox"/> Fly Tray Holder (4) <input type="checkbox"/> Lower Floor (4) <input type="checkbox"/> Upper Floor (5) <input type="checkbox"/> Left Wall (5) <input type="checkbox"/> Right Wall (6) <input type="checkbox"/> Curtain Clamp (6)
Translucent $\frac{1}{8}$ " White Acrylic (One 12"x24" cutsheet)	<input type="checkbox"/> LED Diffuser Panel (7) <input type="checkbox"/> IR Diffuser Panel (7)
Opaque Black Felt (One 18"x18" cutsheet)	<input type="checkbox"/> Lightproofing curtain (8)
IR Filtering Acrylic (One 12"x12" cutsheet)	<input type="checkbox"/> Camera IR filter

Suggested Laser Settings

The provided cutting files are color-mapped: black lines (#000000) should be completely cut through the material, blue lines (#0000ff) should be lightly vectored and rastered to engrave the part, and red lines (#ff0000) should not be cut at all. The suggested settings listed below apply to an Epilog Helix 60-watt laser cutter and should be verified before being used on other laser cutters.

There is a small (1" x 12") test cut file included with this file set that can be used to test that your laser settings are correct. To avoid wasting material, on the black acrylic this should be cut out from cutsheets 3, 4, or 6 that will have excess material on the right side of the sheet.

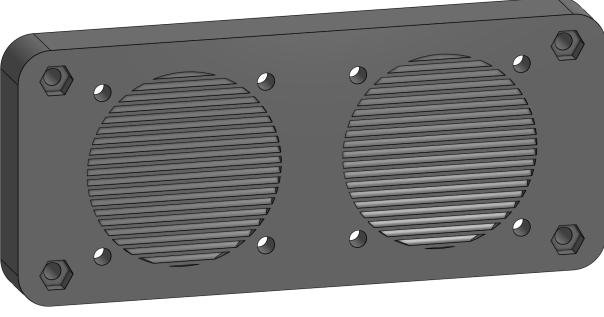
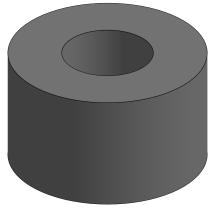
Opaque 1/4" Black Acrylic		Translucent 1/8" White Acrylic		Opaque Black Felt	
		Black lines	Blue lines	Black lines	Black lines
Raster	Speed: 100% Power: 30%	Speed: 100% Power: 30%	Speed: 100% Power: 30%	Speed: 100% Power: 30%	Speed: 20% Power: 100% Freq: 5000
Vector	Speed: 9% Power: 100% Freq: 5000	Speed: 100% Power: 30% Freq: 5000	Speed: 20% Power: 100% Freq: 5000	Speed: 100% Power: 30% Freq: 5000	

3D Printing Instructions

The FlyBox also has a few 3D printed components. 3D-printable STL files are available at
<https://github.com/Rosbash-Lab-FlyBox/FlyBox/tree/main/fabrication-files/3d-print-files>

These are the parts that need to be printed:

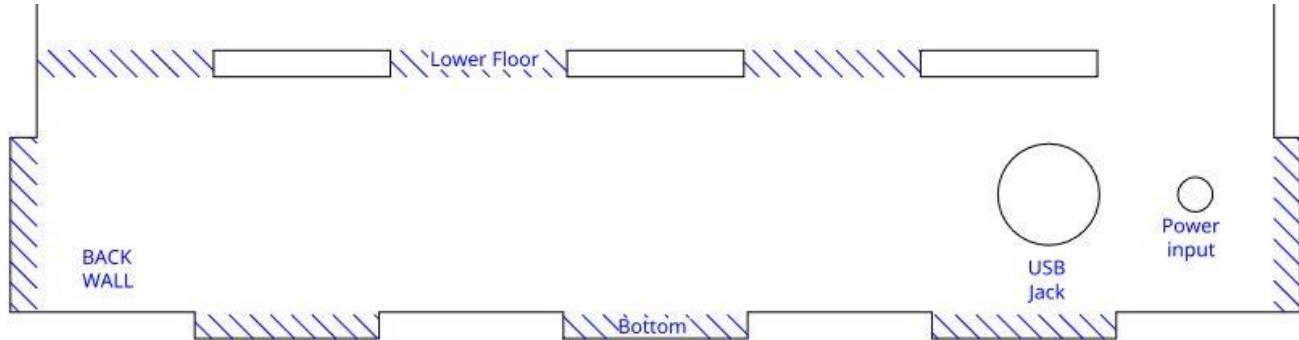
Part Name	Qty	Image	Print Settings
Camera Mount	1		Print with side facing <u>away from</u> camera face down No supports necessary
SD Card & Rotary Encoder Mount	1		Print with side facing <u>away from</u> camera face down No supports necessary except possibly in the channel for rotary encoder. Either print with supports or verify the channel is clean after printing.

Fan Baffle	2		Print with side facing camera face down Print with supports
Spacer	14		Print as shown No supports necessary

FlyBox Frame Assembly Instructions

The laser-cut parts of the FlyBox are labeled with their names and the names of connecting parts. On most parts, the engraved labels face inward to the center of the box, such that they will be hidden when assembly is complete. The name of the part is on the main body of the part in ALL CAPS; lowercase letters indicate where connecting parts attach.

For example, below is a portion of the **Back Wall**, as is labeled at left. The finger joints of the **Lower Floor** and **Bottom** panels fit to the slots and dashed tabs. The **USB Jack** and **Power Input** are attached in the holes at the right.



Hardware Attachment

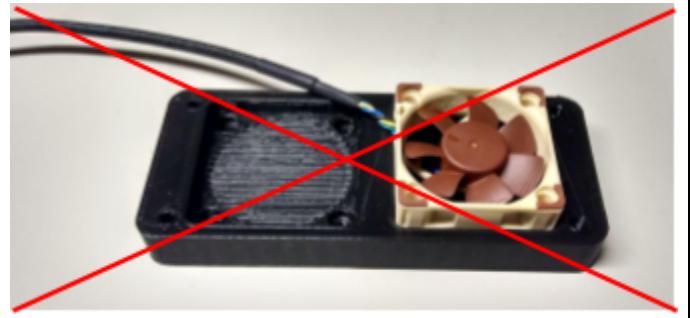
Generally, when attaching hardware, the screw heads should be on the outer, unengraved side of panels and the nuts should be on the inside. This will make it easier to replace parts if any component breaks.

Right and Left Walls

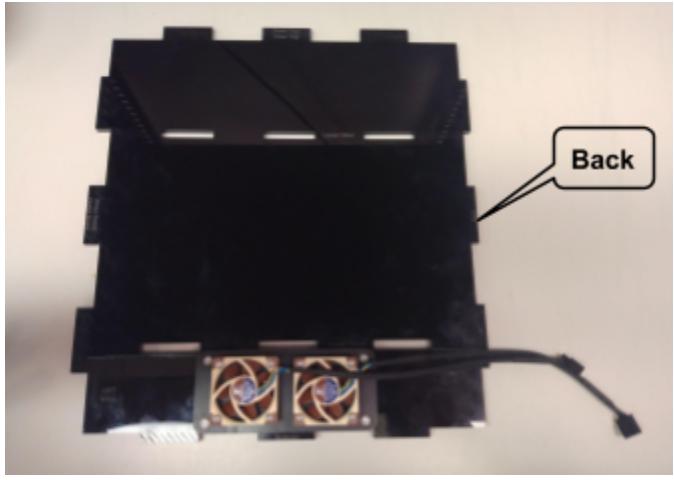
- 1 Take the four **Fans** and two **Fan Baffles**. On each **Fan Baffle**, attach two **Fans** to the flat faces of the baffle with eight M3x20 screws and nuts (sixteen total).

Fans on each baffle should face the same direction, so they push air in one direction. The fans attached to one baffle should point in the opposite direction to the fans on the other baffle, so that one baffle is pushing air in and one is pulling air out.

Rotate the fans so the cables on each baffle are pointing the same direction. This will make wiring easier later.

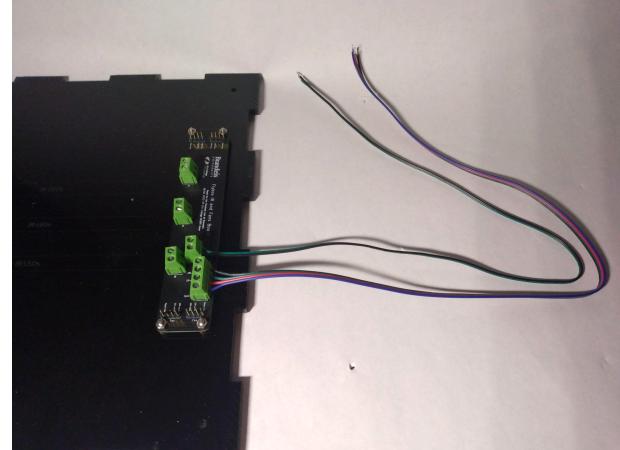
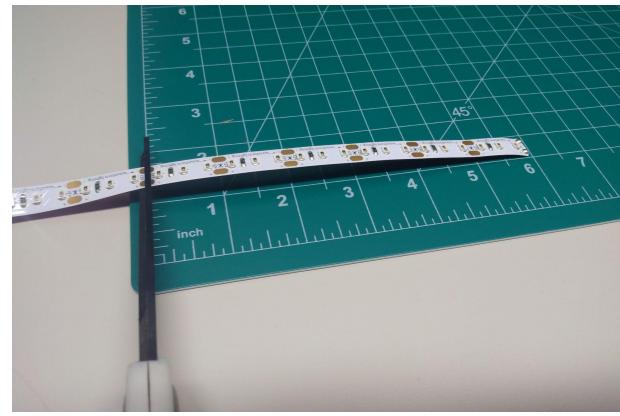


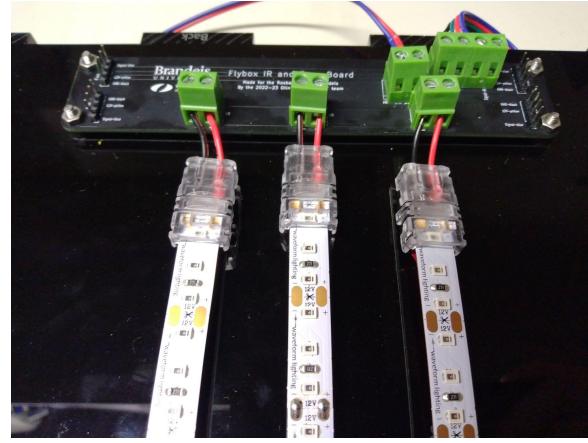
Incorrect attachment: Fan is placed inside square recess.

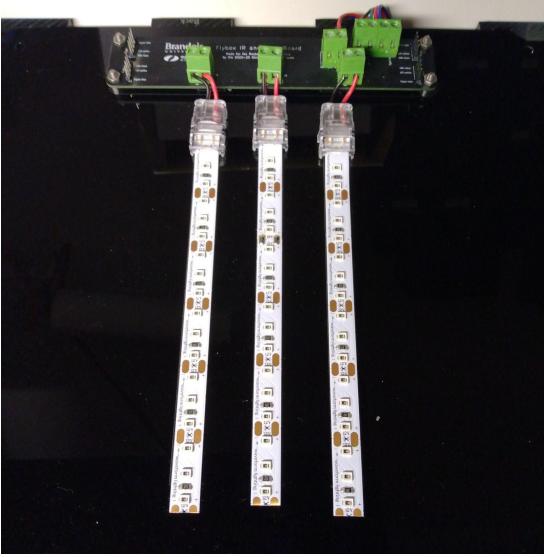
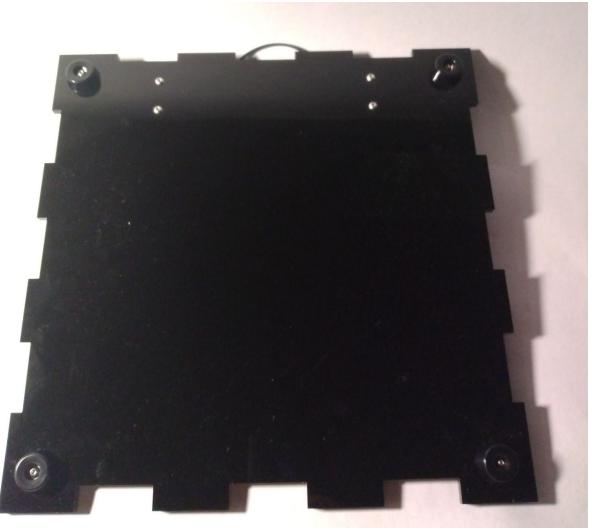
	 <p><i>Correct attachment: Fan is on flat face.</i></p>  <p><i>Nuts set into recesses on underside</i></p>
2	<p>Using eight M3x20 screws and nuts, attach one Fan Baffle Assembly to the engraved side of the Right Wall, and one to the Left Wall.</p> <p>The cables of the fans should point toward the Back Wall, as marked on the engraved tabs.</p> 

Bottom Panel (IR and Fans)

1	<p>Using four M3x16 screws and nuts, and four Spacers attach the IR and Fans Board to the Bottom in the orientation shown by the engraving</p> 
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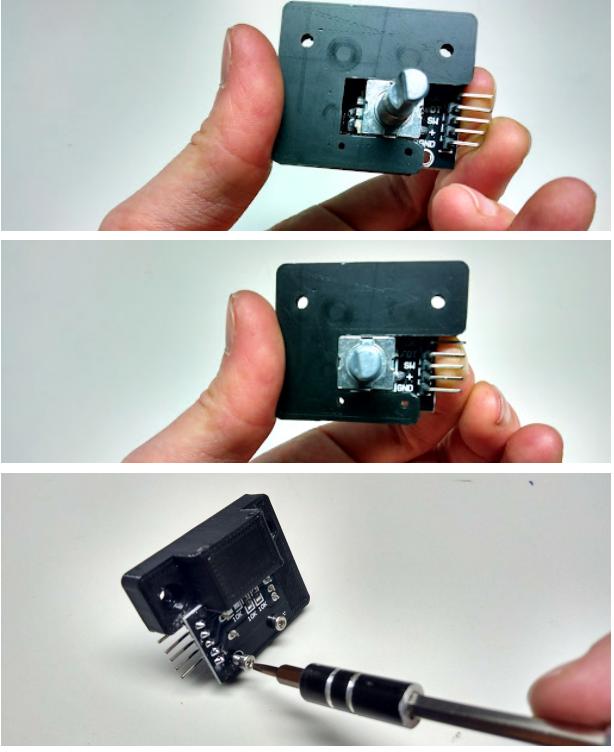
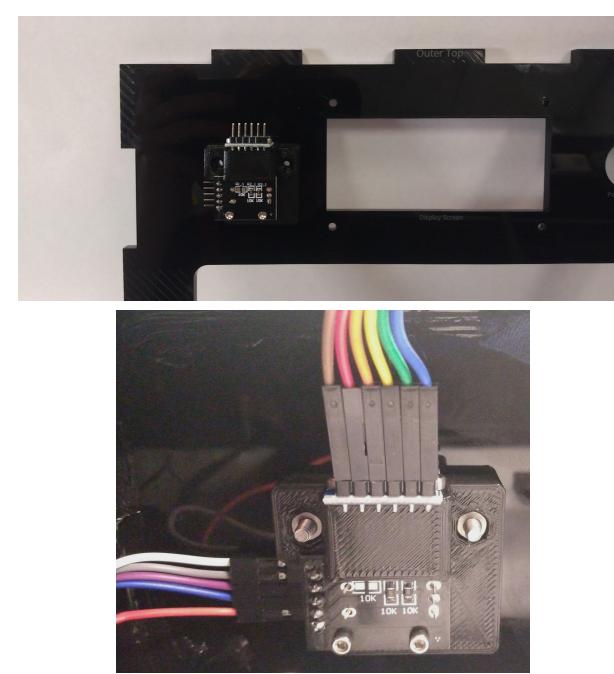
2	<p>Cut about 20 inches of 4 strand wire and 20 inches of 2 strand wire. Connect the 4 strand wire to the terminals labeled Fans from above and the 2 strand wire to the terminals labeled IR from above. Leave the other ends of the wire loose, they will be routed up the corner channel to the main board later.</p>					
3	<p>Cut three 6 inch sections of IR LED strip. Cut on the indicated cut lines with contacts.</p>					
4	<p>Connect each IR LED strip to the LED strip connectors. Conventionally, red wires connect to positive and black to negative. Cut the wires to a length of roughly 1 inch and strip the exposed ends.</p> <p>Make sure to insert the LED strip and wires all the way into the LED strip connector, they should not come loose when pulled gently.</p>	<p style="text-align: center;">Strip Install Steps</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; width: 50%;">  Step 1 Open the cap cover </td> <td style="text-align: center; width: 50%;">  Step 2 Peel off back tape </td> </tr> <tr> <td style="text-align: center;">  Step 3 Insert strip into connector directly </td> <td style="text-align: center;">  Step 4 Close the cap cover with pliers </td> </tr> </table>	 Step 1 Open the cap cover	 Step 2 Peel off back tape	 Step 3 Insert strip into connector directly	 Step 4 Close the cap cover with pliers
 Step 1 Open the cap cover	 Step 2 Peel off back tape					
 Step 3 Insert strip into connector directly	 Step 4 Close the cap cover with pliers					

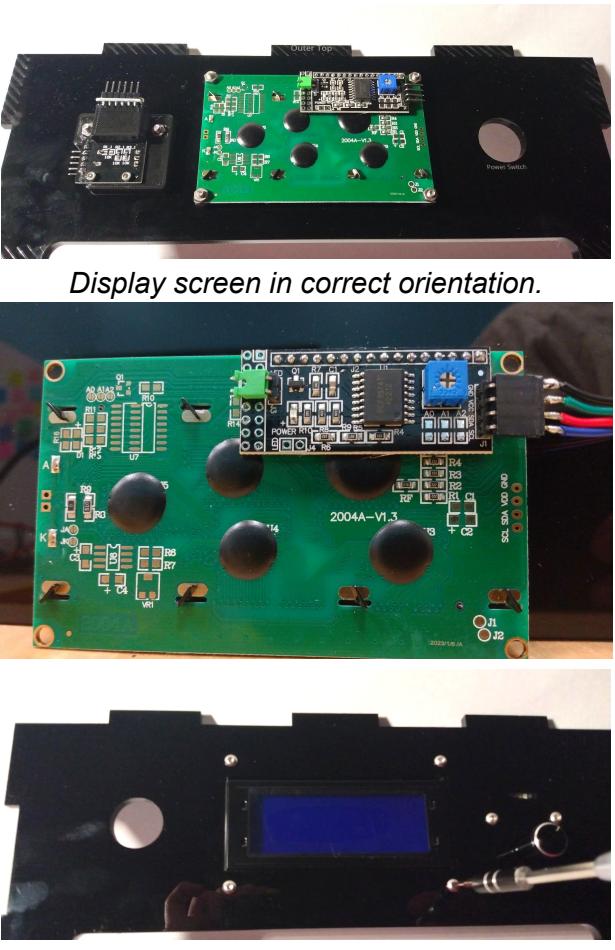
	 <p>Step 1 Insert wire into guide slot No stripping</p>  <p>Step 2 Make sure positive wire is aligned correctly</p> <hr/>  <p>Step 3 Close the cap cover with pliers</p>  <p>Step 4 End installation</p>
	<p><i>Image from manufacturer Supernight</i></p>  <p>Connected LED strip with positive and negative markings on LED strip indicated.</p>
5	<p>Connect the wire end of the LED strip connectors to the corresponding screw terminals on the IR Fans Board.</p> 

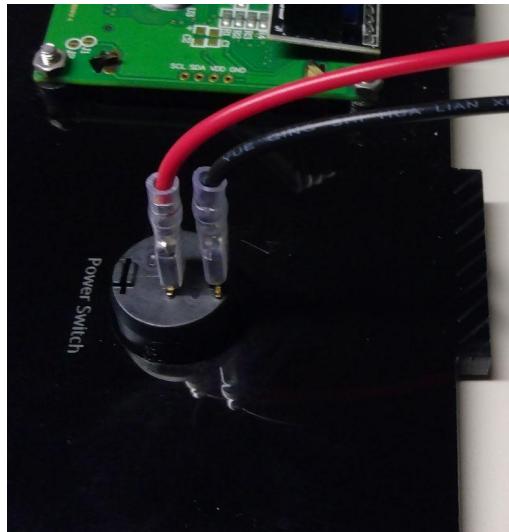
6	<p>Remove the paper backing and apply the three 6" IR Light Strips in the marked rectangular spaces on the Bottom.</p>	
7	<p>Attach the 4 Feet to the unengraved side of the Bottom using four M3x16 screws and nuts</p>	

Front Wall

1	<p>If the Rotary Encoder came with a knob attached, remove it by gently pulling it until detaches. Set aside the knob and any hardware</p>	
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2	<p>If the SD Card & Rotary Mount was printed with supports, make sure the small channel on the back-side is completely clear of support material.</p> <p>Slide the square, silver base of the Rotary Encoder into the large slot on the SD Card & Rotary Mount, with the stem of the encoder extending through the flat face of the mount. It should fit into the slot snugly. Make sure the Rotary Encoder is pressed into the slot as far as it can go. Flip over the assembly and attach using 2 M2x6 screws.</p> <p>You may need to apply more pressure than expected. This is intentionally a very tight fit.</p>	
3	<p>Using two M2x6 screws, attach the SD Card Reader to the top square bumpout of the SD Card & Rotary Encoder Mount. It should be positioned such that the board sits flat and the SD card slot is pointing in the same direction as the rotary knob.</p>	
4	<p>Attach the SD Card & Rotary Encoder Mount to the engraved side of the Outer Front using two M3x16 screws and nuts. The stem of the encoder should protrude through the unengraved face. Replace the knob of the Rotary Encoder.</p> <p>Attach a five strand female-to-male jumper cable to the Rotary Knob pins and a six strand female-to-male jumper cable to the SD Card Reader pins.</p>	

	
5	<p>Attach the Display Screen to the Outer Front using four M3x16 screws and nuts and four Spacers. The spacers are placed between the LCD screen and the outer front panel. They ensure that the display screen is flush to the front. The pins should point toward the space for the Power Switch.</p> <p>Attach a 4 strand male-to-female jumper cable to the pins.</p>  <p><i>Display screen in correct orientation.</i></p>
6	<p>Press the Power Switch through from the unengraved face of the Outer Front.</p> <p>Connect the included quick connect wires to the Power Switch by pressing them into the tabs. It does not matter which wire is connected to which tab.</p> 



Removing the Camera IR Filter

Remove the **Camera** IR filter and base by carefully following this video:

[▶ Removing IR filter from Logitech C920](#)

Important notes:

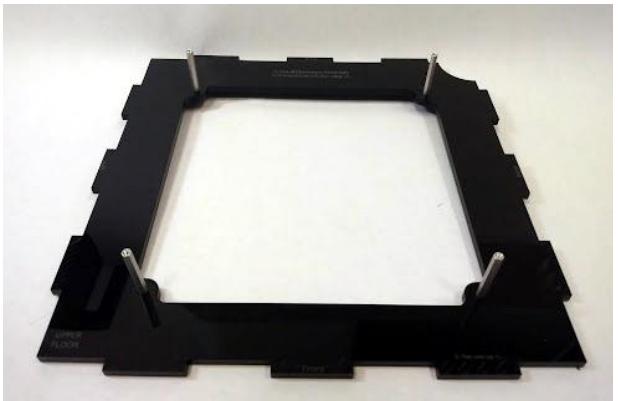
- If you are capable of soldering small components, you may choose to desolder and later resolder the two leads connected to the lens casing
 - This avoids breaking two of the pins on the lens casing (as described at 13:06)
- Disregard 18:08-19:00, this step is unnecessary
- Do not replace the webcam's base, as shown at 19:00
 - The base does not fit into the FlyBox

LED Diffuser Panel

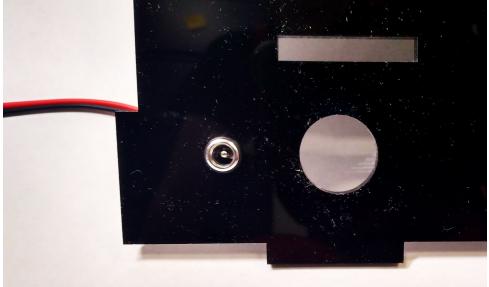
1	On the LED Diffuser Panel , attach the Camera Mount using four M3x12 screws and nuts.	
2	Place the IR Filter into the round space in the Camera Mount . Hold the filter by the edges to avoid smudges that could interfere with the camera's view.	

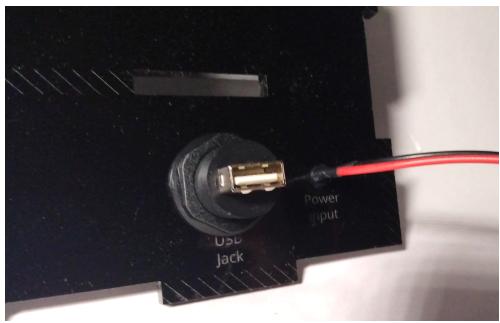
3	<p>Slot the Camera into the Camera Mount, such that the lens is pointing through the hole in the diffuser panel.</p>	
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Upper Floor

1	<p>Add four M3x35 standoffs extending upward from the <u>engraved side</u> of the Upper Floor using four M3x12 screws</p>	
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Back Wall

1	<p>On the Back Wall, attach the Power Input by pressing it in from the unengraved side.</p>	
2	<p>Unscrew the collar from the USB Jack, press it through from the unengraved side, and screw the collar back on to hold it in place.</p>	

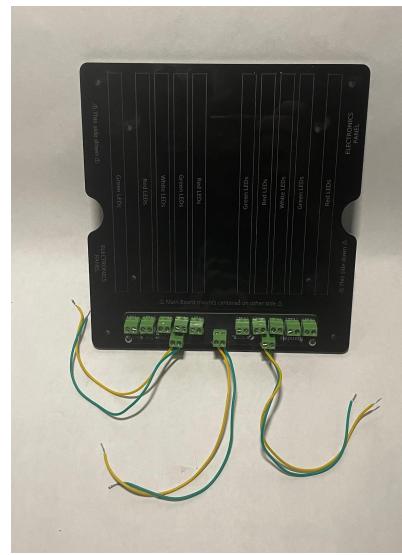


Bottom Side of Electronics Panel

- 1 On the engraved side of the **Electronics Panel**, attach the **RGW Board** in the orientation shown by the engraving using two M3x16 screws and nuts, and two **Spacers**.

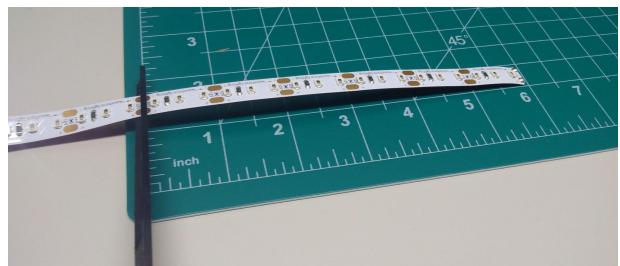


- 2 For the **R from above**, **W from above**, and **G from above** screw terminals, cut about 5 inches of wire (6 pieces total). Connect one end of the wire to the screw terminals on this board, and leave the other ends loose for now.



- 3 Cut four 6 inch sections of **red LED strip**, four 6 inch sections of **green LED strip**, and two 6 inch sections of **white LED strip**. Cut on the indicated cut lines with contacts.

Because the red and green strips look identical when unlit, you may want to mark them to avoid confusion.



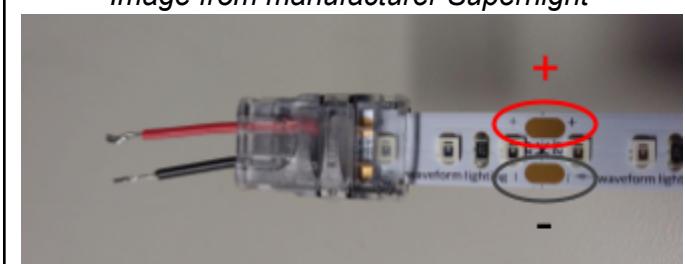
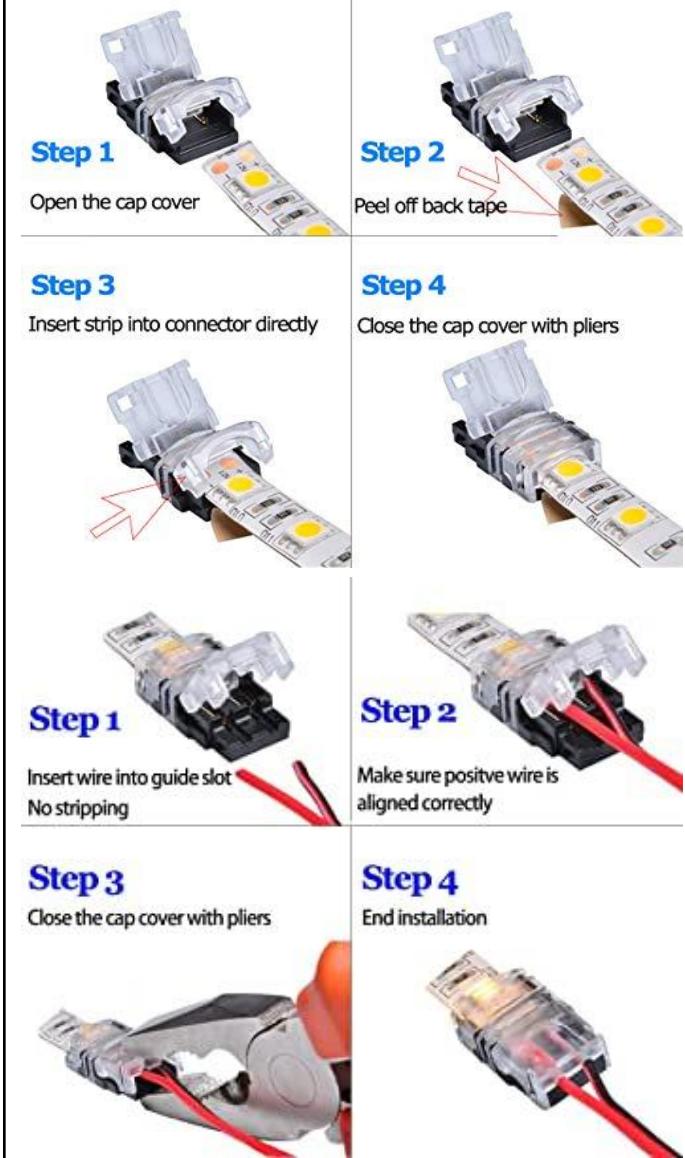
4

Just as done with the IR strips, connect each of the **10 LED strips** to the **LED strip connectors** making sure to insert wires in the opposite side. Cut the wires to a length of roughly 1 inch and strip the exposed ends.

The typical convention is that red wires denote the positive connection and the black is the negative connection.

Make sure to insert the **LED strip** and wires all the way into the **LED strip connector**, they should not come loose when pulled gently.

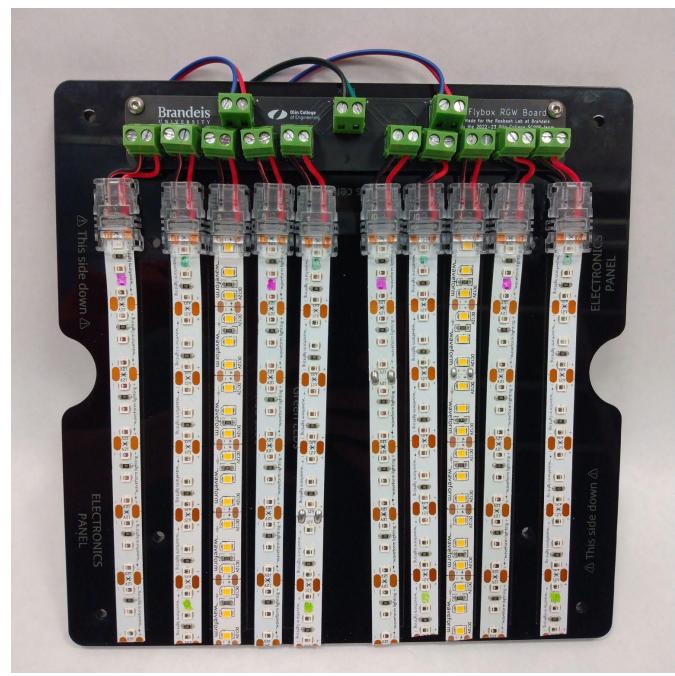
Strip Install Steps



Connected LED strip with positive and negative markings on LED strip indicated

- 5 Insert the ends of the **LED strip connector** into the corresponding screw terminal on the **LED board** making sure to connect the positive wire to the positive side of the screw terminal and vice-versa for the negatives. Remove the tape backing on the **LED Strips** and press them down into position, as indicated by the engraving.

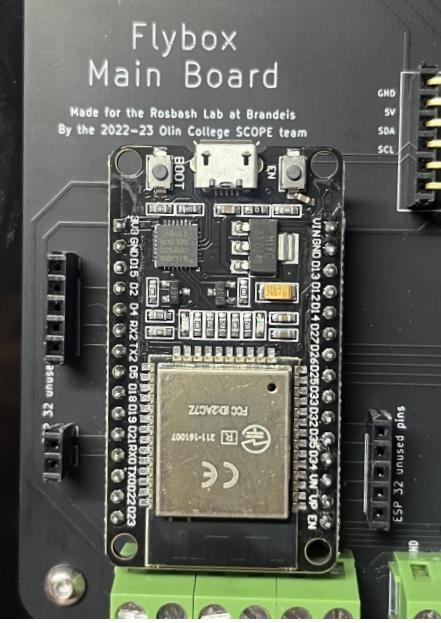
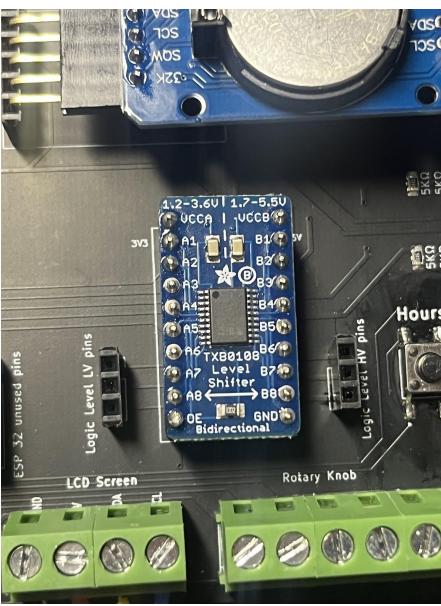
These are a tight fit! It is recommended to start on the outside edges and work your way to the center.

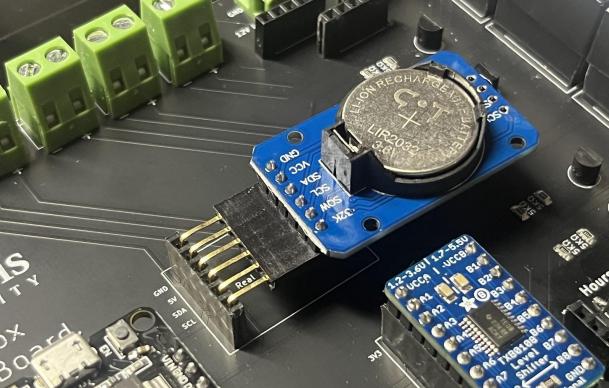


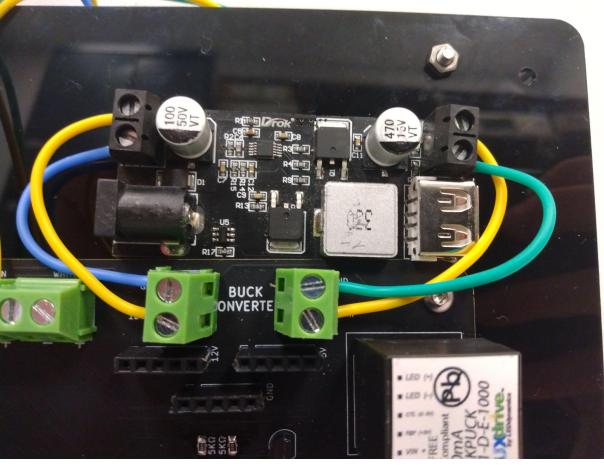
Top Side of Electronics Panel

- 1 On the un-engraved side of the **Electronics Panel**, attach the **Main Board** using four M3x16 screws and nuts, and four **Spacers**. The main text on the board should face the front door.



2	<p>Insert the ESP-WROOM-32 component into the corresponding area on the Main Board (lower left), plugging the male pins on the component into the female pins on the main board, with the micro USB slot facing upward.</p>	 <p>The image shows the Flybox Main Board with the ESP-WROOM-32 module inserted. The module is labeled "ESP32" and has "FCC ID: 2ABH9" and "IC: 2ABH9" printed on it. It is connected to various pins on the board. A green terminal block is visible at the bottom right.</p>
3	<p>Insert the Logic Level component into the corresponding area on the Main Board (lower middle), plugging the male pins on the component into the female pins on the main board. Make sure the 3V3 and 5V labels on the main board match up with their corresponding labels on the Logic Level component.</p>	 <p>The image shows the Flybox Main Board with the Logic Level component inserted. The component is labeled "TXB0108" and has "A1", "A2", "A3", "A5", "A6", "A7", "A8", "B1", "B2", "B3", "B4", "B5", "B6", "B7", and "B8" pins. It is connected to various pins on the board. A green terminal block is visible at the bottom right.</p>

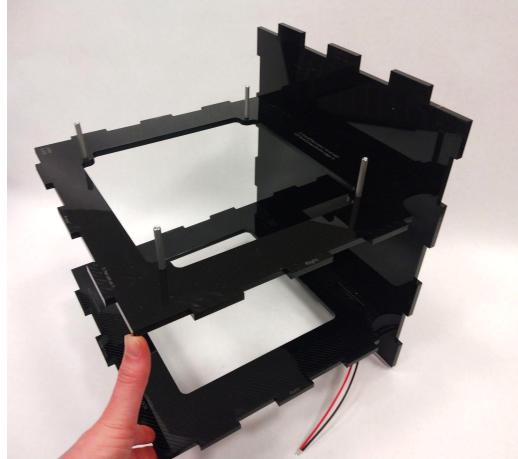
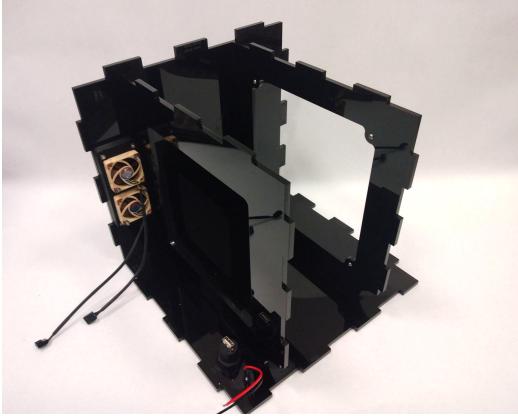
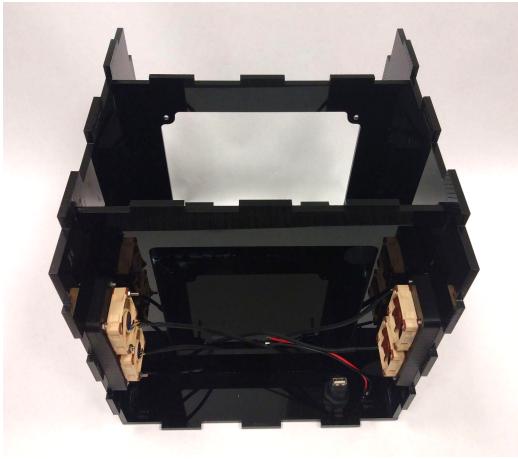
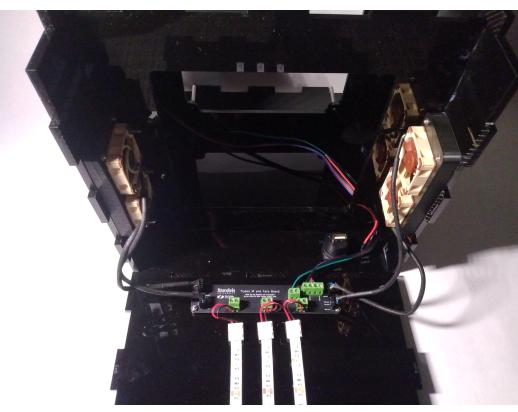
4	<p>Insert each of the four BuckPuck components into the corresponding area on the Main Board (right side), plugging the male pins on the component into the female pins on the main board.</p>	
5	<p>First, insert the Button Cell Battery into the Real Time Controller component. Then, insert the Real Time Controller male pins into the female end of the 90 Degree Header Pins, and connect the male pins into the Real Time Controller area indicated on the Main Board (middle left).</p>	
6	<p>Insert the Audio Potentiometer component into the corresponding area on the Main Board (lower right), plugging the male pins on the component into the female pins on the main board. The pins will be to the left of the knob, as indicated in the photo.</p>	

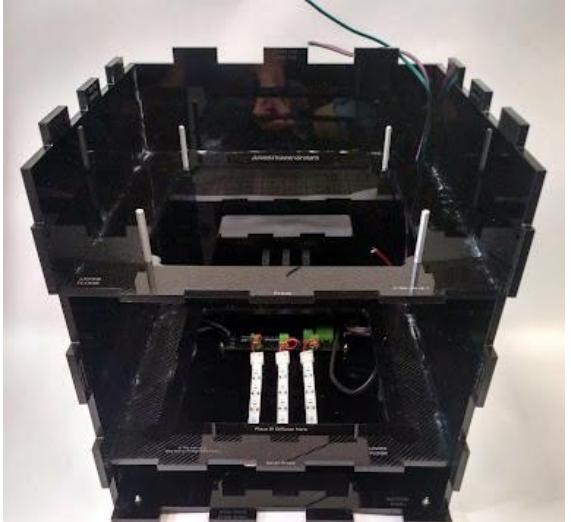
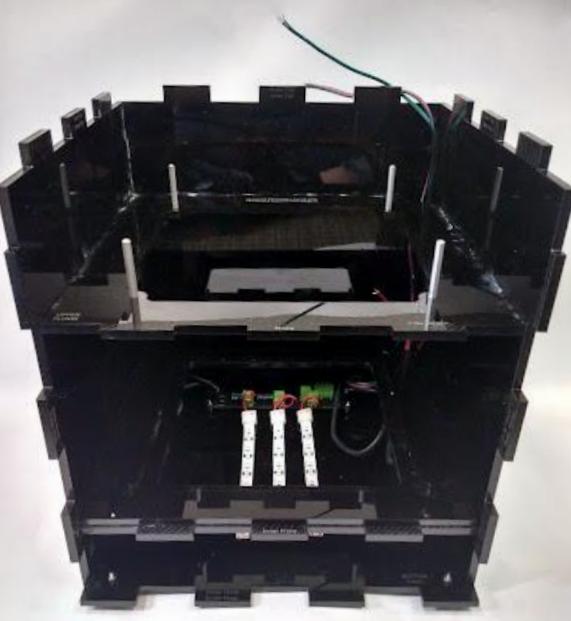
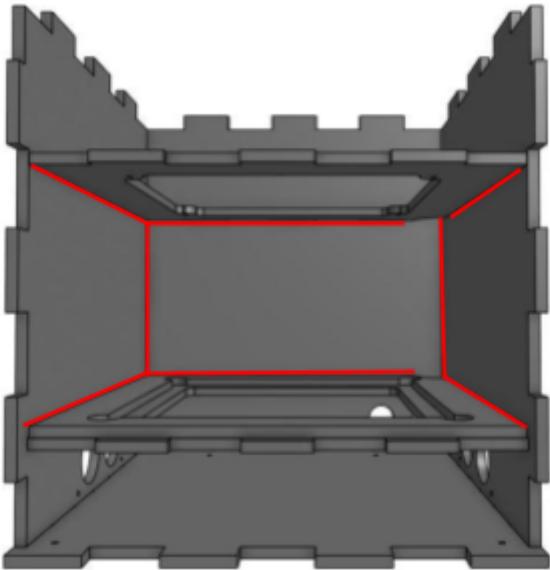
7	<p>Place the Buck Converter above the Main Board. Terminals are labeled on the back of the buck converter</p> <p>Connect the VIN+ screw terminal on the Buck Converter to the 12V in on the Main Board</p> <p>Connect the VIN- screw terminal on the Buck Converter to the GND on the Main Board</p> <p>Connect the 5V screw terminal on the Buck Converter to the 5V in on the Main Board</p> <p>Connect the GND screw terminal on the Buck Converter to the GND on the Main Board</p> <p>NOTE: Be very careful when wiring this component. Wiring this component incorrectly may cause significant damage to the box and to any laptop connected to it. Make sure the 12V and the 5V sides are facing the correct direction.</p>	
8	Connect the Red screw terminal in the top left corner to the corresponding wires from the LED Board .	
9	Connect the Green screw terminal in the top left corner to the corresponding wires from the LED Board .	
10	Connect the White screw terminal in the top left corner to the corresponding wires from the LED Board .	

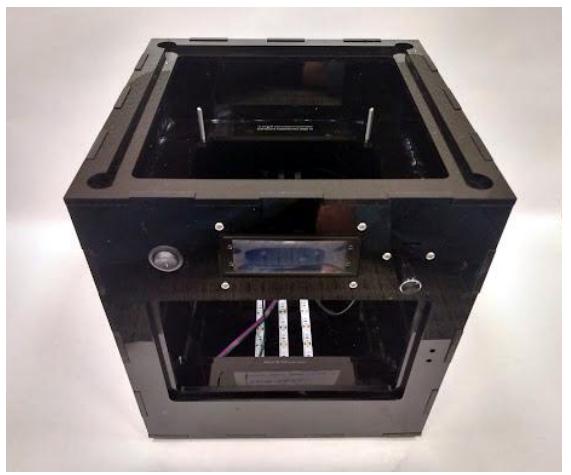
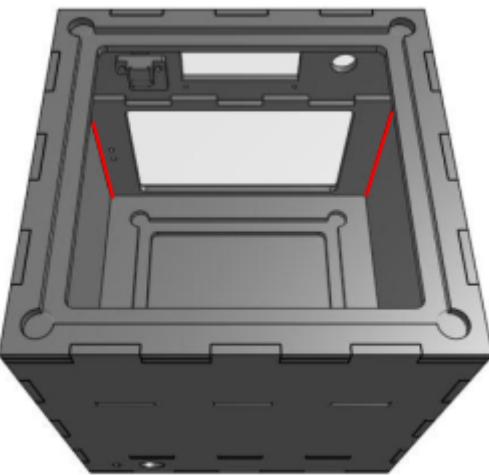
Box Structure Assembly

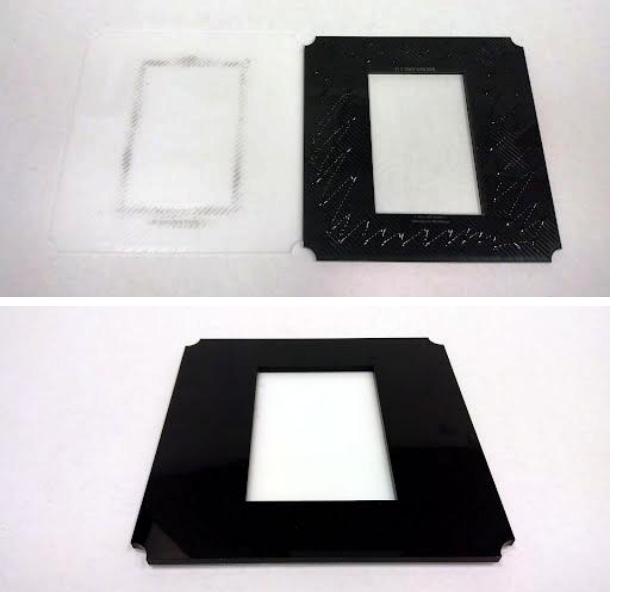
As noted above, the laser-cut FlyBox panels are marked with the name of the part in ALL CAPS, and attaching parts in lower case. On most panels, the engraved side faces into the inside of the box.

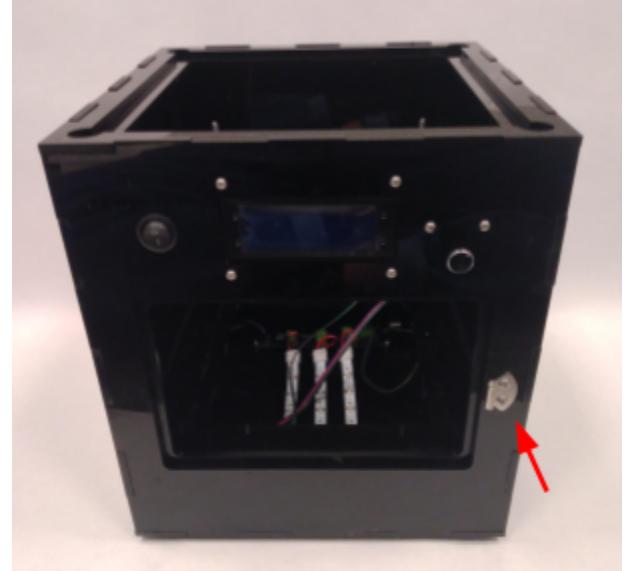
Striped hatching patterns indicate areas where glue should be applied when joining panels. A row of striped finger-joint tabs or a striped panel face will have the name of the attaching panel in lower case. A “dry fit” without glue can be done first to understand how the box is assembled without permanently fixing the pieces.

1	<p>Glue Upper Floor and Lower Floor into the Back Wall panel, referring to markings on each panel for alignment. The rounded corner cut-outs in the Upper and Lower Floor should be facing toward the right side of the Back Wall.</p>	
2	<p>Glue on the Left Wall and Right Wall, with the fans facing in.</p>	 
3	<p>Take the Bottom, plug in each Fan to the male header pins on the board. For Noctua Fans, orient the plug with the black wire in the ground position. For other fans, see the appendix.</p>	

4	<p>Glue on the Bottom, with the IR lights and board facing in. The 20 inch wires of the Fans from above and IR from above screw terminals can be routed upward through the round channel in the back right corner.</p>	
5	<p>Apply glue to the striped surface of the Lower Floor. Glue on the IR Alignment Panel, striped face to striped face. The round corner cutouts on the back right of each panel should align.</p>	
6	<p>Apply light-proofing silicone to the inside corners of the central chamber, as shown by the highlighted edges to the right. This will prevent any external light from leaking into the center chamber.</p> <p>Silicone should be smoothed over with a finger, and these corners can be tested for light-tightness by shining a flashlight over them and checking that light doesn't reach the outside of the box.</p> <p>A piece of tape can be used to hold the wires in the back right channel out of the way during application.</p>	

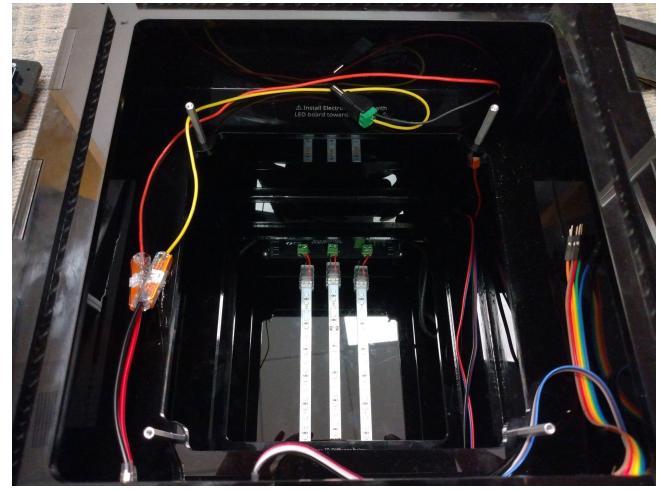
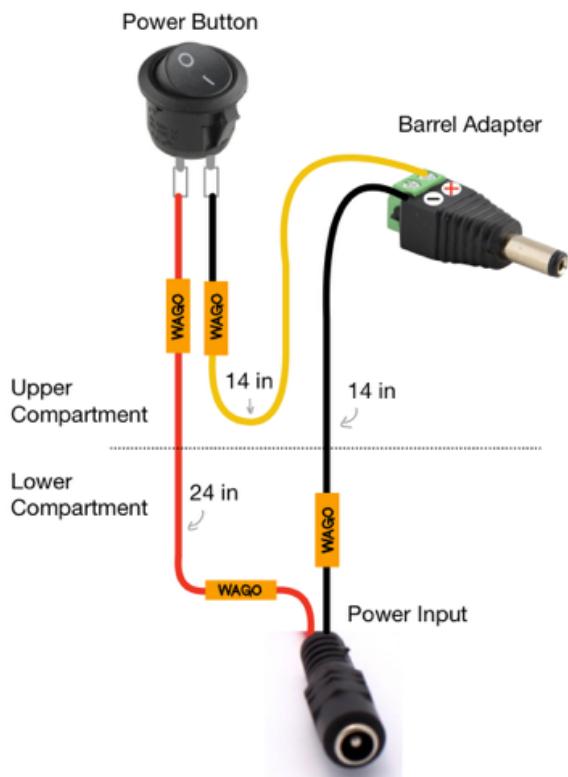
7	<p>Glue on the Inner Top and Inner Front. These panels should have the striped sides facing outward.</p>	
8	<p>Apply glue to the striped sections of the Inner Front and Inner Top, then affix the Outer Front and Outer Top.</p>	
9	<p>Reaching in from the top, apply silicone to the corners of the center chamber where the Inner Front meets the Left Wall and Right Wall, as shown by the highlighted edges to the right.</p>	 <p><i>The Upper Floor has been hidden in this image for clarity</i></p>

10	<p>Glue the Fly Tray Holder to the IR Diffuser Panel aligning the two striped regions.</p>	
11	<p>Let glue dry! Blue tape can be used to secure parts in place as they dry.</p>	
12	<p>Using 2 M4x12 screws and nuts, screw in the larger latch piece on the unengraved side of the Front Door, such that the side with the spring mechanism is closer to the edge.</p>	

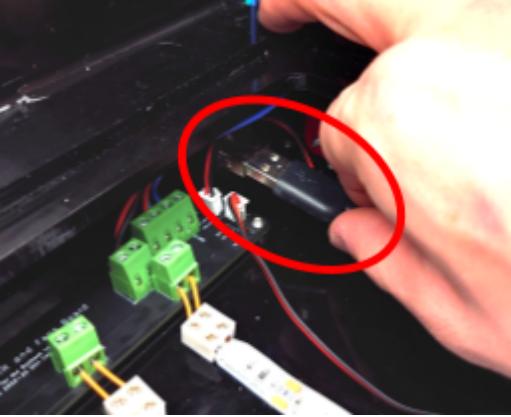
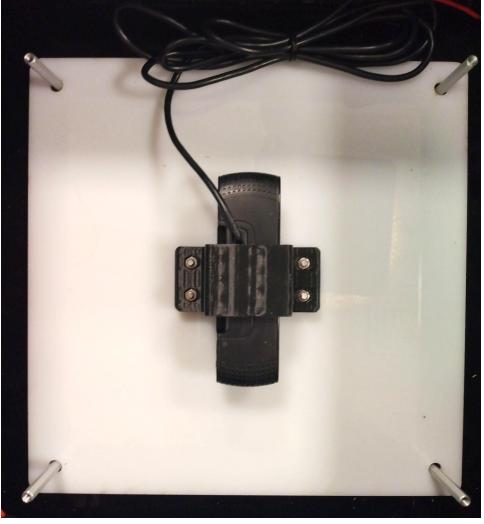
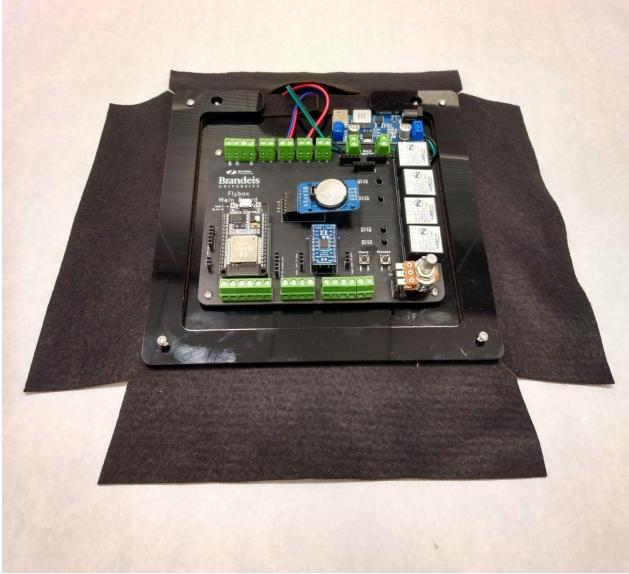
13	<p>Using 2 M4x20 screws and nuts, screw in the smaller latch piece on the right side of the Outer Front, such that the hook-shaped side is nearest the front door opening.</p>	
14	<p>Rough up the inner faces of both hinges using sandpaper to increase adhesion surface area.</p>	
15	<p>Gently press the Front Door into place on the front of the box with the latch on the right side. Ensuring each hinge is vertical and aligned over the gap, glue them to the left side of the Front Door and Outer Front.</p>	
16	<p>Let glue dry! Blue tape can be used to secure parts in place as they dry. Do not open the Front Door until the glue has had time to set fully.</p>	

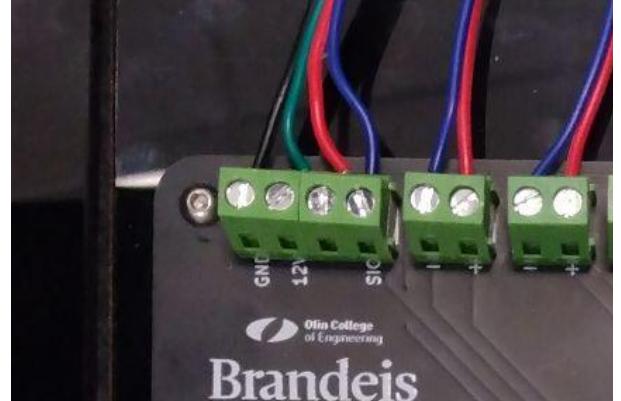
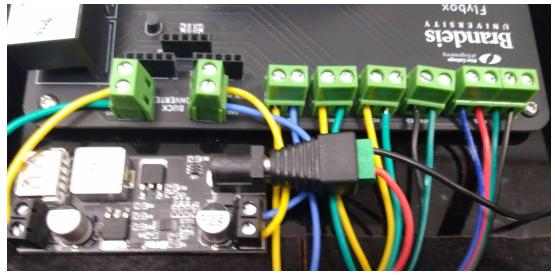
Final Wiring

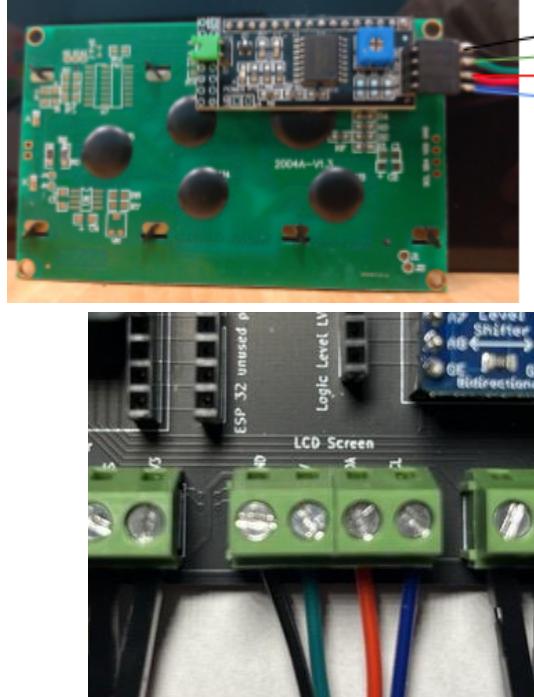
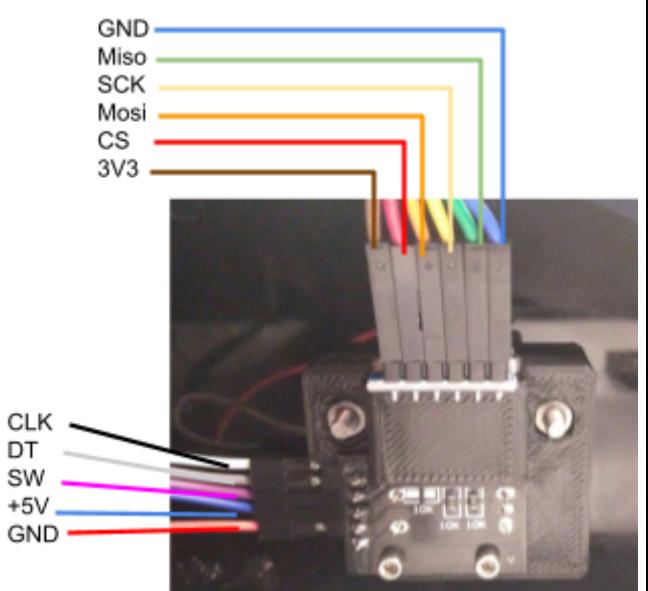
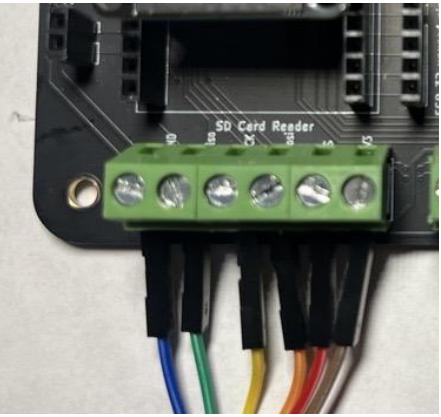
- 1 Attach a **WAGO inline wire connector** to each end of the **Power input**.
Attach a **WAGO inline wire connector** to each end of the **Power Switch** wires.
Cut a 24 inch length of red wire. Connect it to the red wires of the **Power Input** and **Power Switch** using the **WAGO inline wire connectors**.
Cut a 14 inch length of yellow wire. Connect one end to the black wire of the **Power Switch** using the **WAGO inline wire connector**. Connect the other end to the + side of the **Male Barrel Adapter**.
Cut a 14 inch length of black wire. Connect one end to the - side of the **Male Barrel Adapter**. Connect the other side to the black wire of the **Power Input** using the **WAGO inline wire connector**.



Top view showing WAGO connectors attached to the Power Switch and Male Barrel Adaptor

2	<p>Take the LED Diffuser Panel and attached Camera. Run the camera cable down the back right corner channel, and plug it into the inside side (USB A port) of the USB Jack.</p>	
3	<p>Slot the LED Diffuser Panel and attached Camera over the standoffs on the Upper Floor. The Camera lens should point into the center chamber and the cable of the Camera should extend toward the Back Wall.</p>	
4	<p>Place the felt Lightproofing Curtain on top of the Electronics Panel and the Curtain Clamp on top of that. The wires from the LED Board should run through the slit in the Lightproofing Curtain and the gap in the Curtain Clamp.</p> <p>Place four M3x20 screws through the corners of the three parts, pointing down.</p>	 <p><i>Wires from the LED board are not pinched by the Curtain Clamp.</i></p>

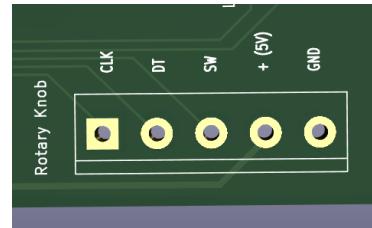
5	<p>Place the Electronics Panel on top of the standoffs. It should be positioned such that the screw terminals in the Main Board for the SD Card Reader, LCD Screen, and Rotary Knob are at the front.</p> <p>Screw the four M3x20 screws into the standoffs.</p>	
6	<p>The Fans and IR wires (pulled through the corner channel earlier) can be connected to the IR and Fans screw terminals on the Main Board. Take care to connect the correct wires</p>	
7	<p>Plug the Male Barrel Adapter into the Buck Converter.</p>	 <p><i>Barrel Adapter plugged into the Buck Converter</i></p>

8	<p>Connect the pins from the Display component in the front panel to the display screw terminal portion on the main electronics board, matching the labels on the board to the display, using the male-to-female jumper wires.</p>	
9	<p>Using male-to-female jumper wires attached earlier, connect the SD Card Reader pins to the SD card screw terminals on the Main Board, matching the labels on the board to the display.</p> <p>Using male-to-female jumper wires attached earlier, connect the Rotary Encoder pins to the Rotary Knob screw terminals on the Main Board, matching the labels on the board to the display.</p>	 <p><i>SD card reader and rotary encoder pins with label</i></p> 

SD card reader terminal on main board



Rotary knob terminal on main electronics board



Labeled pins for rotary knob on main electronics board

Remove any protective film from the **Display Screen**. The **IR Diffuser Panel** (with the **Fly Tray Holder** glued on top) can be set inside the box short edge to the front, loosely fitting in the **Alignment Panel**. Tuck the **Lightproofing Curtain** down around the edges of the **Electronics Panel**. The **Top Hatch** can be placed in the space on top of the box, flush with the **Outer Top** panel.



Congratulations! You have completed assembly of the FlyBox. Now on to loading firmware!

Firmware Loading

Before you can use the box, you will need to install its firmware. You should only ever need to install the firmware on the box once, unless further updates are made.

Setting up the Arduino IDE

You will need to set up an Arduino IDE. You can download and install the Arduino IDE by following the following setup guide:

<https://docs.arduino.cc/software/ide-v2/tutorials/getting-started/ide-v2-downloading-and-installing>

Setting up the Arduino IDE for ESP32 Microcontroller

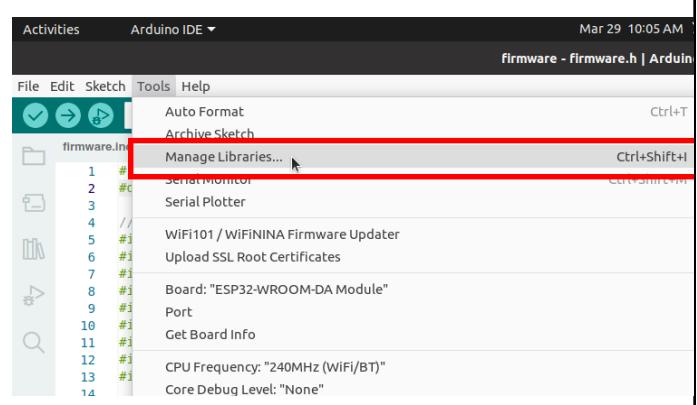
By default, the Arduino IDE doesn't support the microcontroller in the FlyBox. To add compatibility with the FlyBox, follow the following guide:

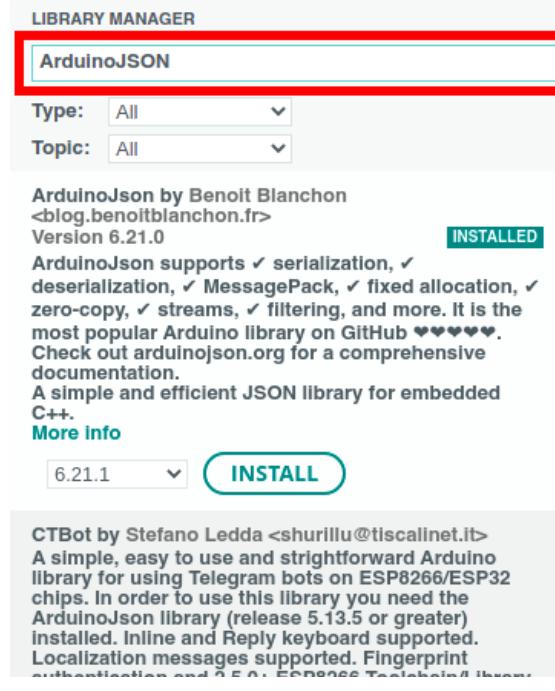
<https://randomnerdtutorials.com/installing-the-esp32-board-in-arduino-ide-windows-instructions/>

Installing the necessary libraries in Arduino

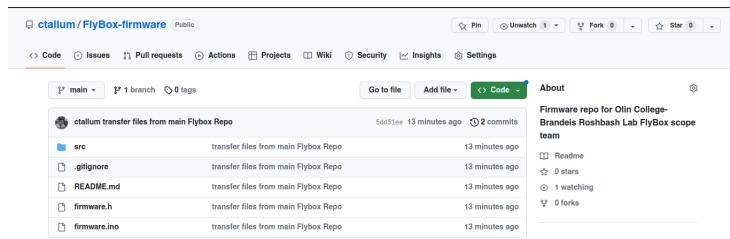
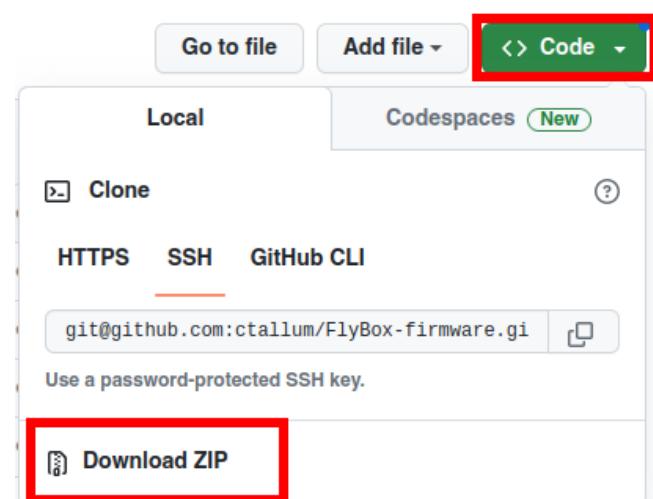
There are a few external libraries that you will need to install in Arduino.

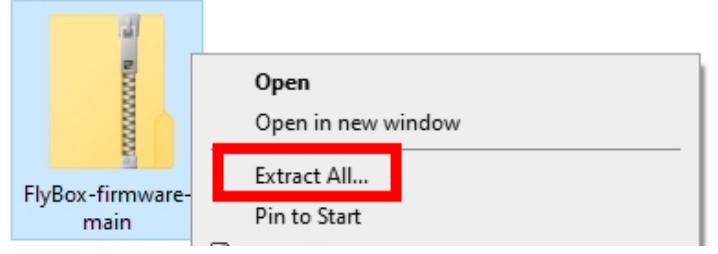
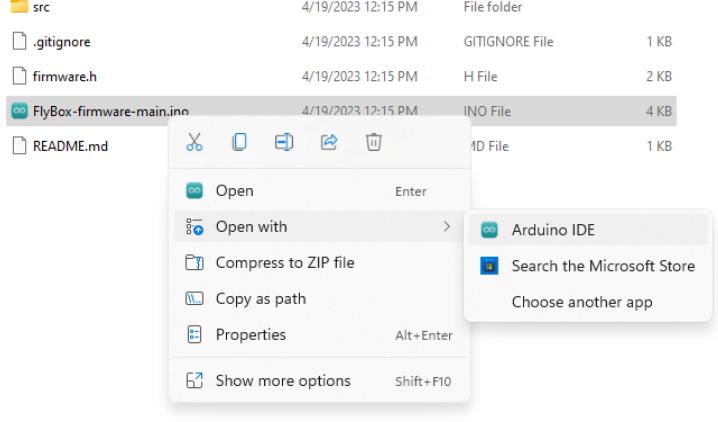
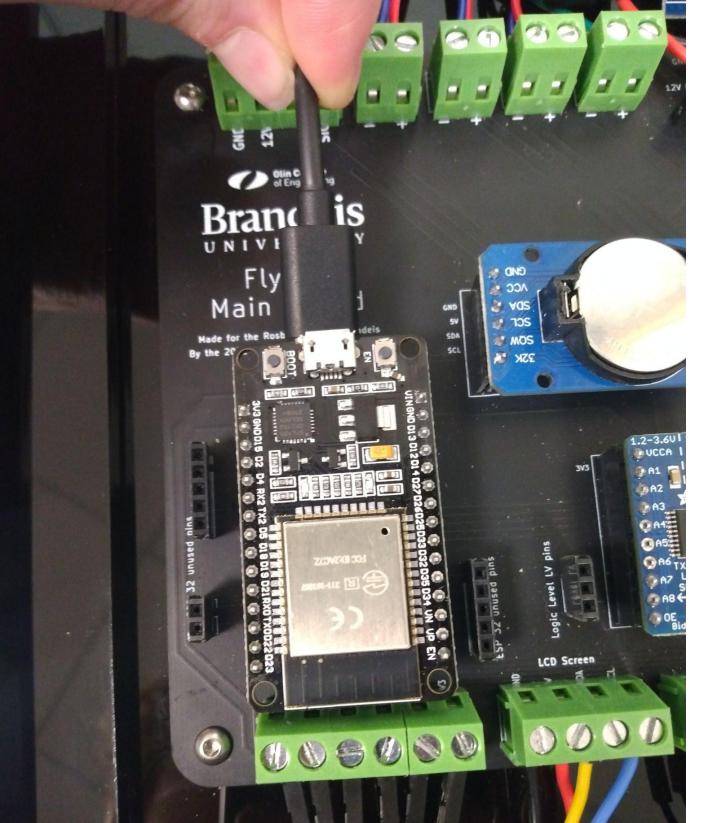
- 1 Go to “Tools” in the top menu bar, then under the drop down menu, select “Manage Libraries...”

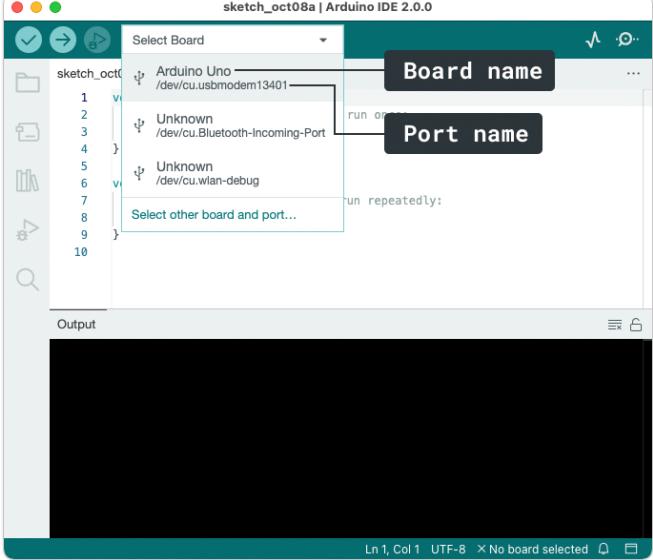
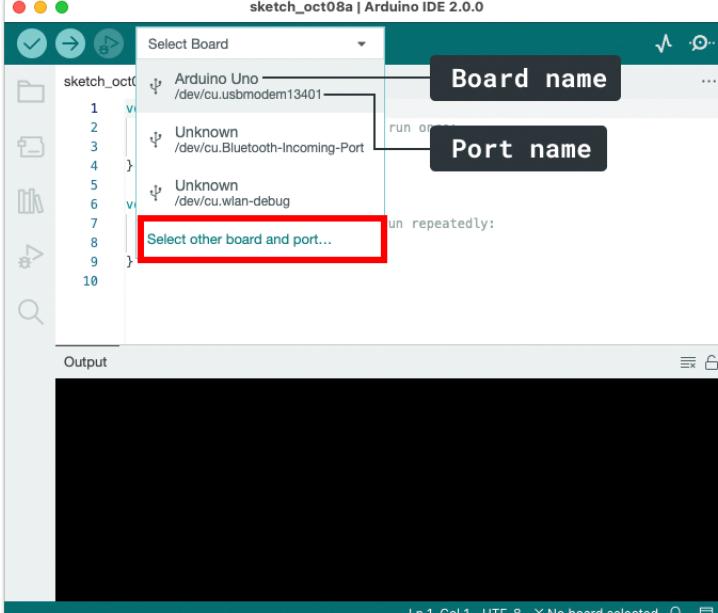


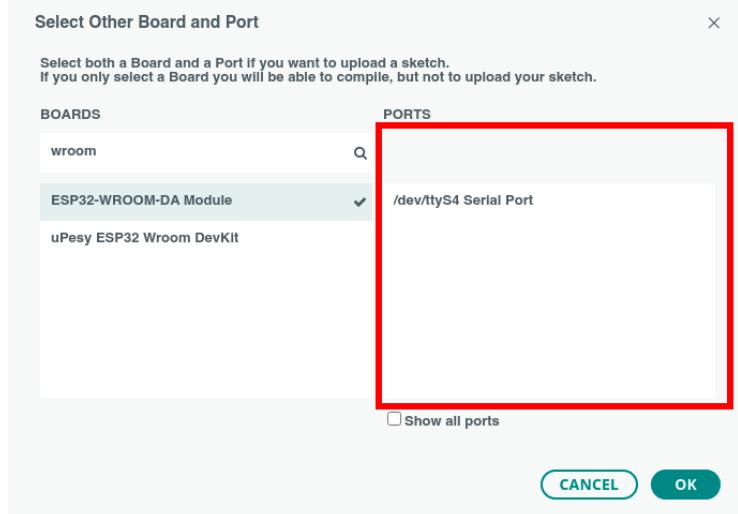
2	<p>To add a library to the Arduino IDE, Search and install the following libraries</p> <ul style="list-style-type: none"> - ArduinoJson by Benoit Blanchon - RTClib by Adafruit <ul style="list-style-type: none"> - May require additional downloads, complete these - LiquidCrystal I2C by Frank de Brabander - ESP32Encoder by Kevin Harrington 	 <p>The screenshot shows the Arduino Library Manager interface. A red box highlights the search bar containing "ArduinoJSON". Below it, the library details are shown: "ArduinoJson by Benoit Blanchon <blog.benoitblanchon.fr> Version 6.21.0 INSTALLED". A description follows: "ArduinoJson supports ✓ serialization, ✓ deserialization, ✓ MessagePack, ✓ fixed allocation, ✓ zero-copy, ✓ streams, ✓ filtering, and more. It is the most popular Arduino library on GitHub ❤️❤️❤️❤️. Check out arduinojson.org for a comprehensive documentation. A simple and efficient JSON library for embedded C++." A green "More Info" button is visible. At the bottom, a dropdown shows "6.21.1" and a green "INSTALL" button.</p> <p>Below this, another library entry is partially visible: "CTBot by Stefano Ledda <shurillu@tiscaliinet.it> A simple, easy to use and straightforward Arduino library for using Telegram bots on ESP8266/ESP32 chips. In order to use this library you need the ArduinoJson library (release 5.13.5 or greater) installed. Inline and Reply keyboard supported. Localization messages supported. Fingerprint authentication and ECDH support available."</p>
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Downloading the Firmware

1	<p>Go to https://github.com/Rosbash-Lab-FlyBox/FlyBox-firmware</p>	 <p>The screenshot shows the GitHub repository page for "ctallum/FlyBox-firmware". The repository is public and has 1 branch and 0 tags. The code tab is selected. A green "Code" button is highlighted with a red box. The repository description is: "Firmware repo for Olin College-Brandeis Rosbash Lab FlyBox scope team". The repository has 0 stars, 1 watching, and 0 forks. The code listing shows files transferred from the main Flybox Repo: .arc, .gitignore, README.md, firmware.h, and firmware.ino, all updated 13 minutes ago.</p>
2	<p>Click on the green button labeled “Code” then choose “Download ZIP”</p>	 <p>The screenshot shows the download options for the GitHub repository. A red box highlights the green "Code" button, which is part of a larger "Code" dropdown menu. Below it, the "Local" and "Codespaces" tabs are shown. Under "Local", there are options for "Clone" (with "HTTPS", "SSH", and "GitHub CLI" buttons), a password field for "git@gitHub.com:ctallum/FlyBox-firmware.git", and a "Download ZIP" button, which is also highlighted with a red box.</p>

3	Unzip the downloaded folder. It should be titled "FlyBox-firmware-main"	
4	Within the "FlyBox-firmware-main" folder, open the "FlyBox-firmware-main.ino" file in the Arduino IDE	
5	Connect the ESP32 to your computer using a micro USB to USB A cable	

6	Open up the board selection menu									
7	Click "Select Other Board and Port"									
8	Search and select "ESP32-WROOM-DA Module"	<p>Select Other Board and Port</p> <p>Select both a Board and a Port if you want to upload a sketch. If you only select a Board you will be able to compile, but not to upload your sketch.</p> <table border="1"> <thead> <tr> <th>BOARDS</th> <th>PORTS</th> </tr> </thead> <tbody> <tr> <td>wroom</td> <td>/dev/ttyS4 Serial Port</td> </tr> <tr> <td>ESP32-WROOM-DA Module</td> <td></td> </tr> <tr> <td>uPesy ESP32 Wroom DevKit</td> <td></td> </tr> </tbody> </table> <p><input type="checkbox"/> Show all ports</p> <p>CANCEL OK</p>	BOARDS	PORTS	wroom	/dev/ttyS4 Serial Port	ESP32-WROOM-DA Module		uPesy ESP32 Wroom DevKit	
BOARDS	PORTS									
wroom	/dev/ttyS4 Serial Port									
ESP32-WROOM-DA Module										
uPesy ESP32 Wroom DevKit										

9	On the right half of the menu, select the port your ESP32 is connected to, and click "OK" to close the menu	
10	Click to upload the file	

Running a Test

To run a test, first design a test using <https://rosbash-lab-flybox.github.io/FlyBox/>. You can then download the test and upload it to the box. On the box, you can then select and run the file.

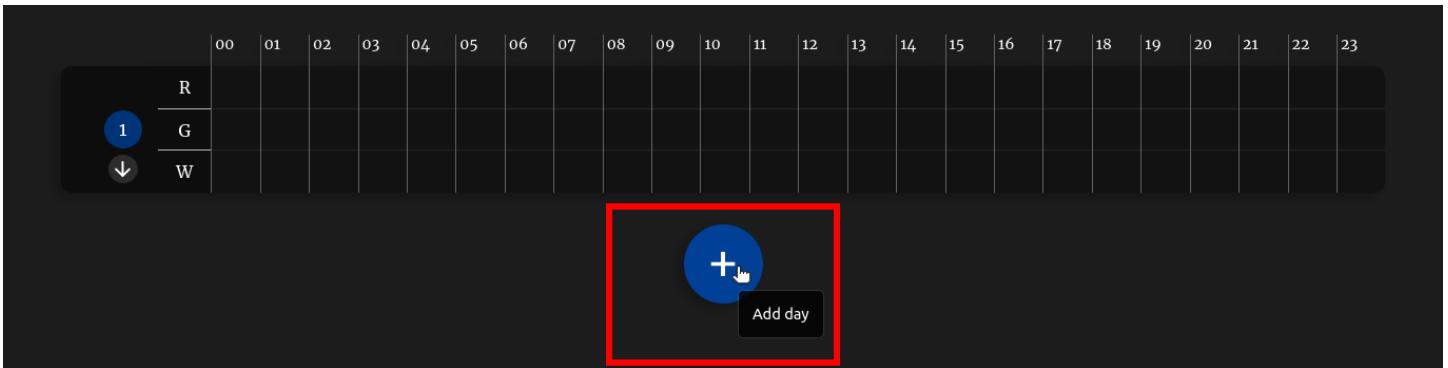
Using the Rosbash Lab FlyBox Test Creator

The screenshot shows the Rosbash Lab FlyBox Test Creator interface. At the top, the Brandeis University logo and the title "Rosbash Lab FlyBox Test Creator" are displayed, along with buttons for help, refresh, upload test, and download test. Below the header, a message indicates "1 Days, 0 Events". The main area features a 24-hour grid from 00 to 23. On the left, a sidebar for "Day 1" lists actions: R (Read), G (Write), and W (Delete). A large blue "+" button is centered below the grid.

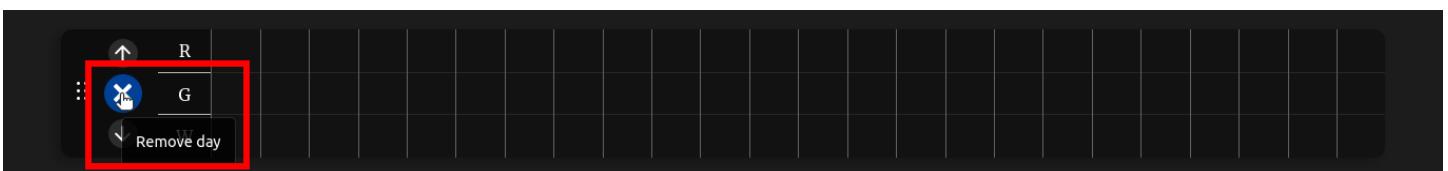
Above is an image of the test creator website. You can use this website to generate and modify test files. To create a test file, you can click and drag to create an event.

This screenshot shows the same interface but with two days of events. The header now says "2 Days, 0 Events". The first day's grid is highlighted with a red box. The sidebar for Day 1 remains the same. The second day's grid shows a new entry: "2 G" at hour 01. A large blue "+" button is centered below the second day's grid.

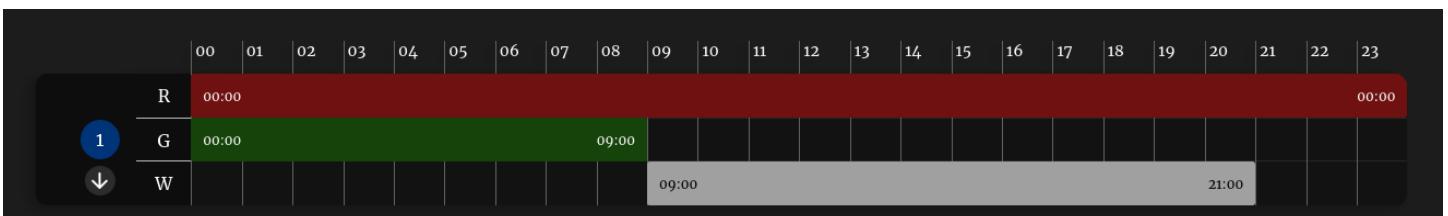
Each individual day of the test is grouped together as seen in the image above. The 24 hours of the day are displayed at the top of the day.



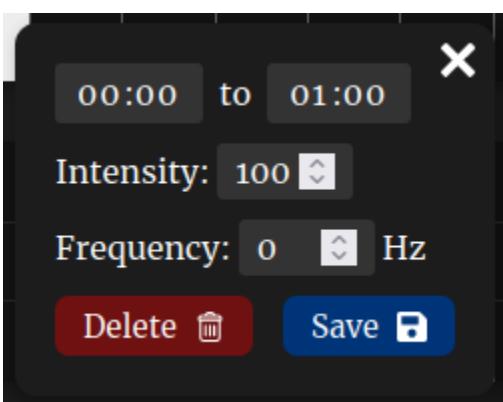
You can add more days to the test by clicking the large circular plus button at the bottom of the screen.



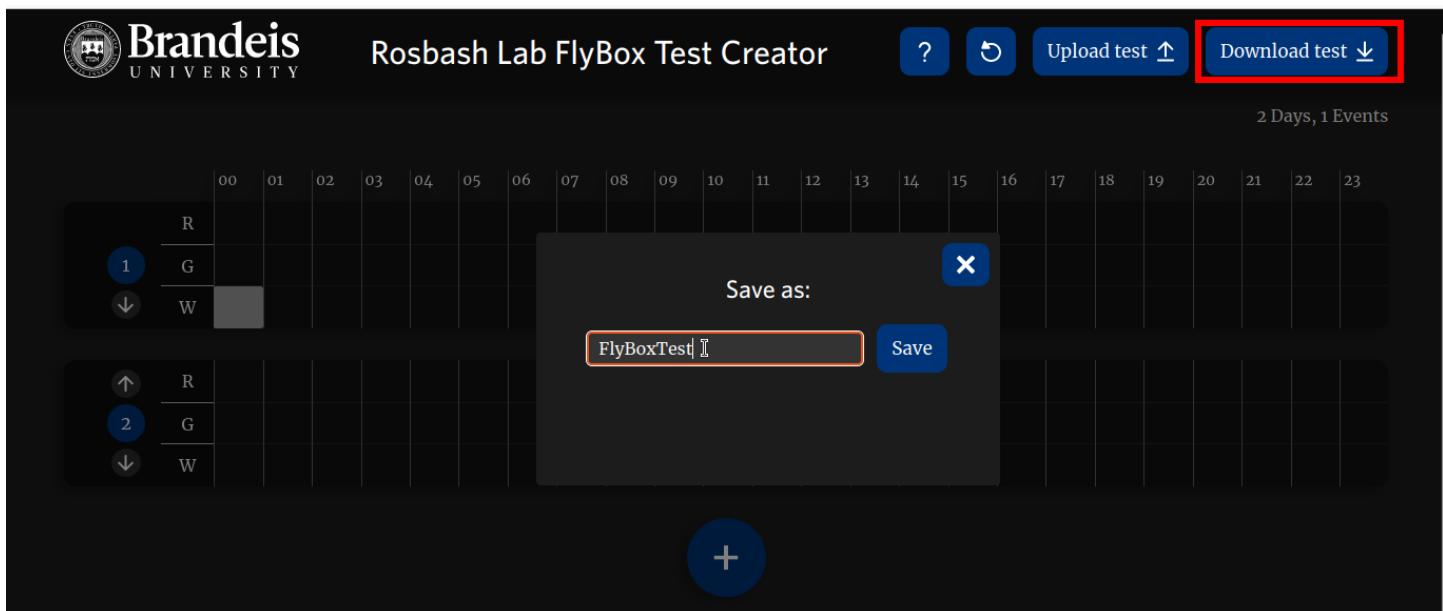
You can delete a day by hovering over the day indicator on the left.



Horizontally, across each day, you can add discrete lighting events. As shown in the image above, the top row is red light events, the middle row is green light events, and bottom is white light events.



If you click on any event, there is an info panel that appears. In this modal, you can modify the start and stop time, the intensity of the light (from 0-100) and change the frequency of the lights (0 Hz is solid).

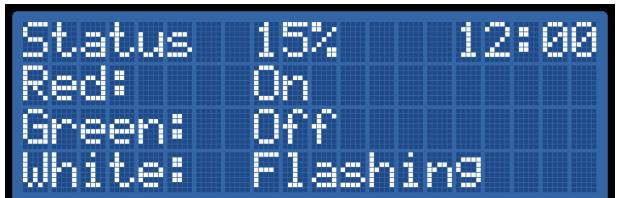


Once you are satisfied with your test, you can download the test file locally to your computer using the “Download test” button.

Running a test file on the FlyBox

After downloading your test file from the FlyBox test creator website, load the file onto an SD card, and insert into the SD card reader slot on the right side of the FlyBox. The FlyBox camera can be connected to your computer using a USB B to USB A cable from the USB output on the back of the FlyBox.

1 This is the intro screen for the box. Click the knob to enter the main menu screen.	
2 This is the main menu screen. You have three options here: select a test file, toggle the IR on and off, and change the time on the box. You can scroll between the options using the rotary knob. If you click Select Test , you will be brought to a screen where you can select your test file. You can scroll between the files using the rotary knob. If you click Toggle IR , you can turn the IR light on and off. The main menu screen will display the current status of the IR light.	

	<p>If you click Adjust Box Time, you will be brought to a screen where you can adjust the hour and minute on the box. You can change the hour and minute by clicking the hour and minute button on the main electronics panel. Clicking each button will increment the hour/minute by one minute.</p>	 <pre>Select Test > > Toggle IR - on Adjust Box Time ></pre>  <pre>12:00 Adjust hour and min using buttons on top Press knob to save</pre>
3	As you run a file, it has a live display indicating percent through the test, which lights are on/off, and the current time	 <pre>Status 15% 12:00 Red: On Green: Off White: Flashing</pre>
4	When the test is over, you have the option to return to the main menu by pressing the knob.	 <pre>Finished! Press knob to return to home</pre>

Appendix

Calibrating IR

- The toggle IR option in the main menu will turn on the IR lights. While connected to the camera, you can twist the potentiometer (shown on the right) on the Main Electronics Board to decrease or increase the brightness.



Camera focus

We have noticed issues with the camera sometimes not being able to focus on the tray of flies. This results in a pulsing sort of effect as the camera repeatedly shifts focal length, trying to find an object to focus on. When we ran into this issue, we found that the solution was to simply replace the camera with a different one. This resolved the issue.

If switching to a different camera does not work, another solution is to lock the focus of the camera. To do this, you can use the Logitech Capture software ([download here](#)). Using the Logitech Capture software, it is possible to turn off auto-focus and have a fixed focal length. We found some success with this software in it being able to fix the pulsing focus issue.

Another solution is to shift the fly tray up by a small amount. Sometimes, just moving the tray up by a slight amount allows the camera to focus.

Buying the PCBs from PCBway

<https://www.pcbway.com/>

Each of the manufactured boards should be available through PCBway's "Share and Sell Program." The links for each board are as follows:

- FlyBox Main Board:
https://www.pcbway.com/project/shareproject/W547848AS1D13_MainBoardGerber3_5fe985dc.html
- FlyBox IR Board:
https://www.pcbway.com/project/shareproject/FlyBox_IR_Board_50aa739c.html
- FlyBox RGW Board:
https://www.pcbway.com/project/shareproject/FlyBox_RGW_Board_fc0900b7.html

Be sure to order it as PCB+Assembly if you are looking for the PCBs to arrive ready to use (around 4-5 weeks) or just PCB if you have the ability to solder yourself.

General troubleshooting

If the box isn't turning on correctly, most likely something is wired incorrectly. Common issues are incorrectly wiring the display or the SD card reader. Check that these components have wires connected firmly and in the right place

Strange clock readings

- It is possible that the coin battery in the RTC component has died. If so, replace battery and update the time using the build in time modification screen

- If the RTC is broken, replace component

Strange display artifacts

- If the display is broken, there are a few symptoms. It might not turn on, it may stream random characters, or it may show incorrect text.

Cleaning

- The FlyBox can be dusted with a microfiber cloth or canned air
- Use water and mild soap (such as dish soap) to clean the FlyBox. Be sure not to get electronic components wet.
- Don't use alcohol to clean the box, it can degrade the acrylic panels.
- Don't use abrasive cleaners, they will scratch the surface of the FlyBox

FlyBox on a Budget

To lower the cost of the FlyBox, a couple changes can be made:

PCBs

If you have the ability to solder, you can order unassembled PCBs from PCBway and assemble them yourself. The components of the PCBs are listed in the PCB BOM on PCBway and will need to be ordered separately; they are not included in the FlyBox BOM.

Fans

The suggested Noctua fans are expensive. Cheaper brands of fans will have two wires, red and black. Put the black wire in the ground position, and the red wire in the power position on the IR/Fans board.

MDF

Instead of black opaque acrylic, medium density fiberboard can be used for the wall panels (cutsheets 1-6)

Kitting

There are a number of small pieces of hardware (nuts, bolts, standoffs, etc.) that are easy to miscount or confuse for one another. This may not be an issue in the Rosbash lab. However, if kits are someday made to be sent to another lab or organization, a large bag of unsorted hardware won't be ideal. Instead, we recommend kitting the hardware, which means putting the proper quantity of each type of hardware into an individual bag. There are many companies that offer this service. Here are a few that we found:

- <https://www.associatedfastening.com/products-services/hardware-polybagging/>
- <https://www.mudgefasteners.com/custom-kitting-packaging>
- <https://www.autobag.com/markets-served/hardware-fasteners>
- <https://www.foremostfastener.com/kitting-custom-bagging-services.html>