

Demo Kit Assembly Guide

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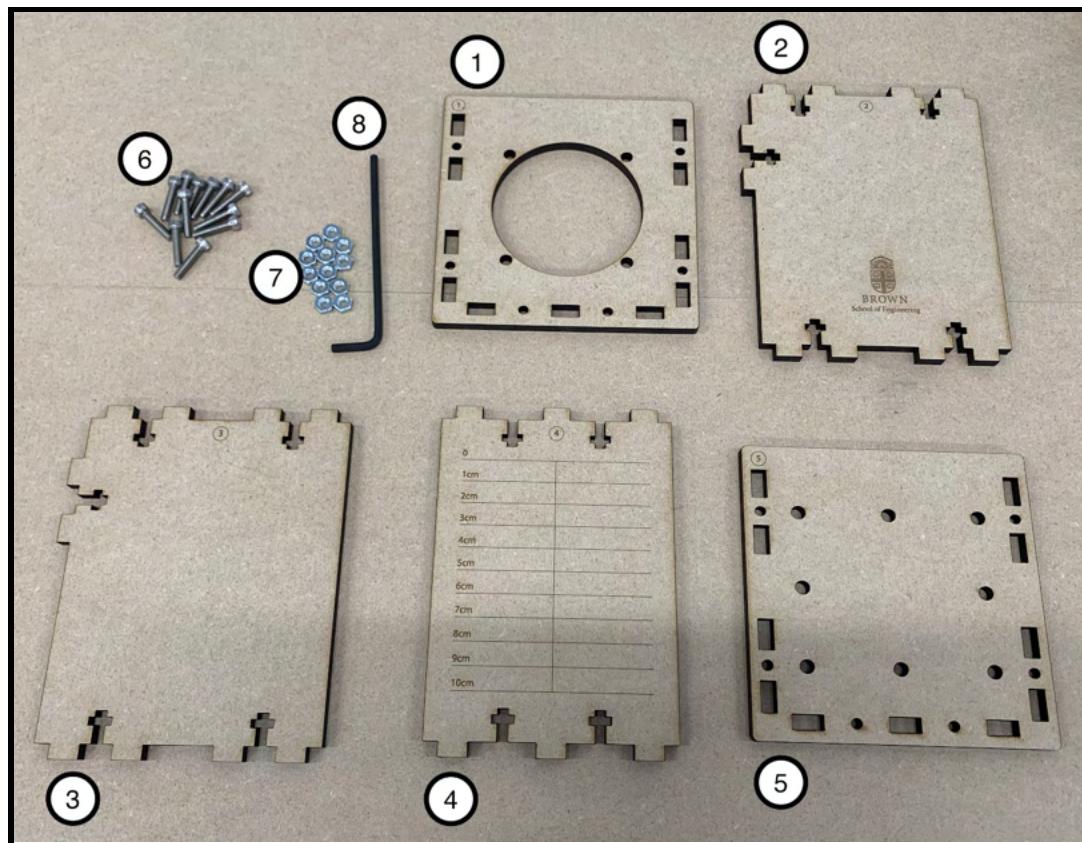


Warning: Use of the LED strobing for the activities described in this document is strictly optional. Do not connect the lighting system if you have any sensitivity to flashing lights.

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(A) Housing Assembly

Materials:

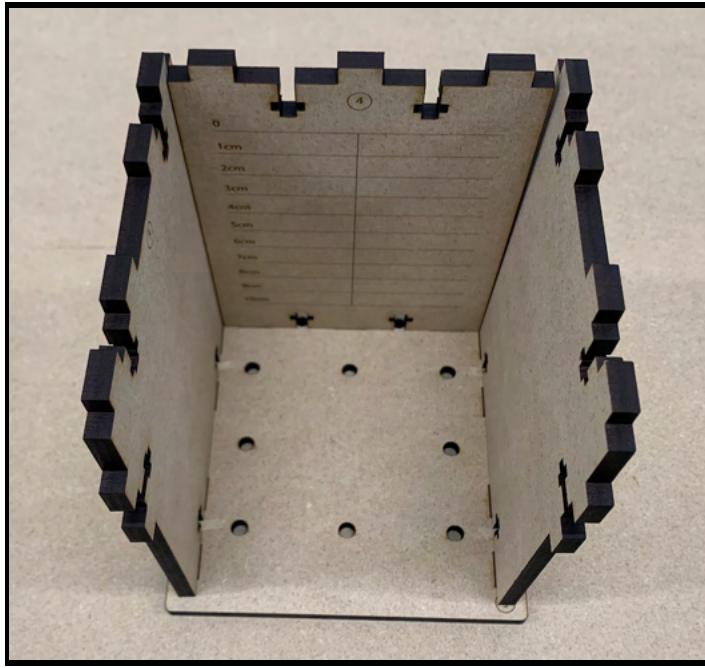


Number	Item	Quantity
1	Top Plate	1
2	Left Plate	1
3	Right Plate	1
4	Back Plate	1
5	Base Plate	1
6	8-32 x 3/4" Hex head screw	12
7	8-32 Hex nut	12
8	9/64" Allen Key	1

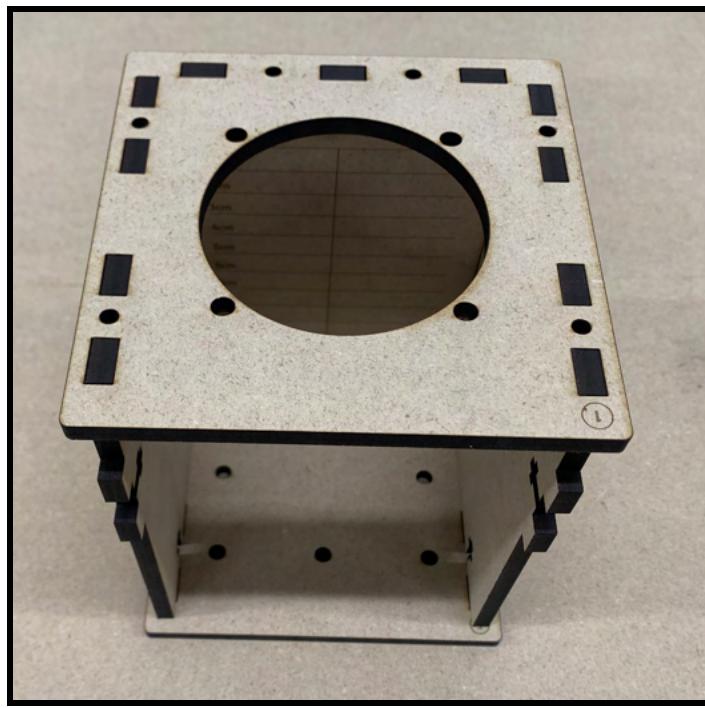
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Assembly Steps:

- 1) Mount the Left Plate (2), Right Plate (3), and Back Plate (4) on the Base Plate (5) by inserting the rectangular extrusions into the corresponding slots.

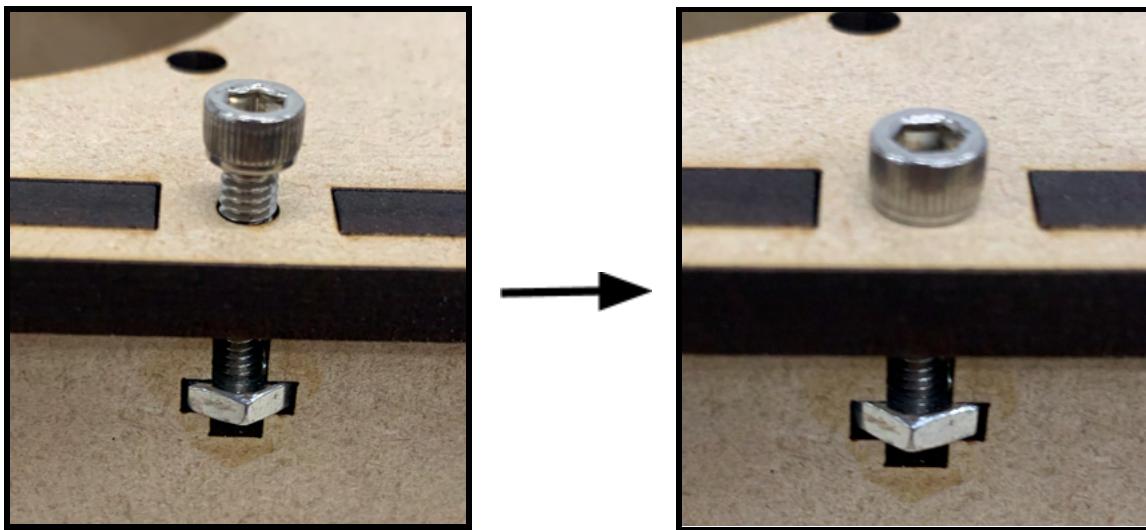


- 2) Mount the Top Plate (1), once again making sure the slots are aligned.

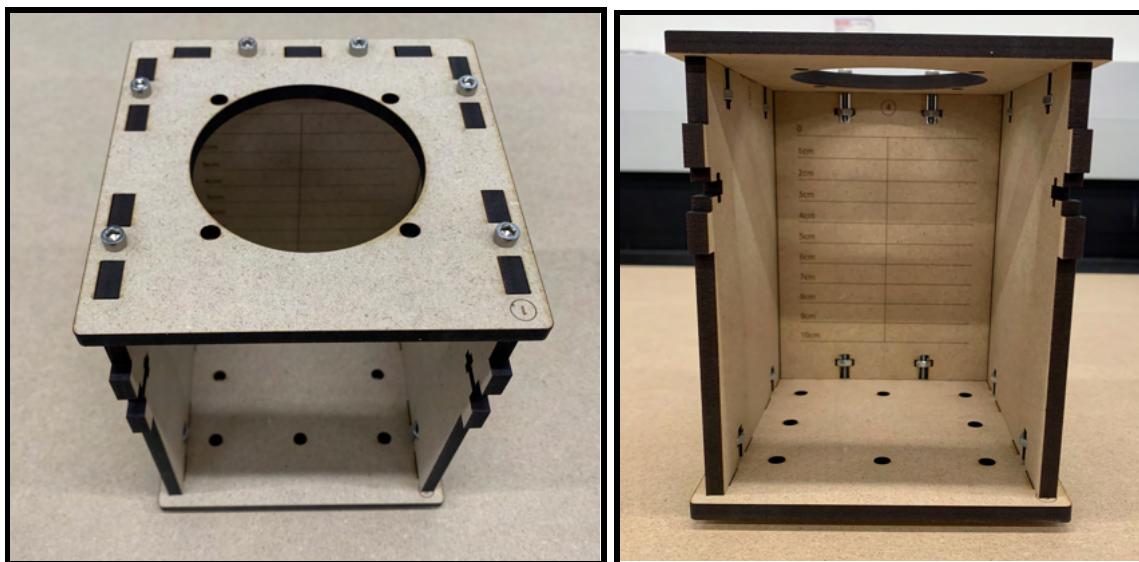


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- 3) Fasten the plates together by inserting 8-32 Hex head screws (6) into the mounting holes while inserting hex head nuts (7) into the rectangular side slots. Tighten the screw by hand until flush with the plate then tighten with the Allen key (8). There are twelve mounting holes/cut outs in total.



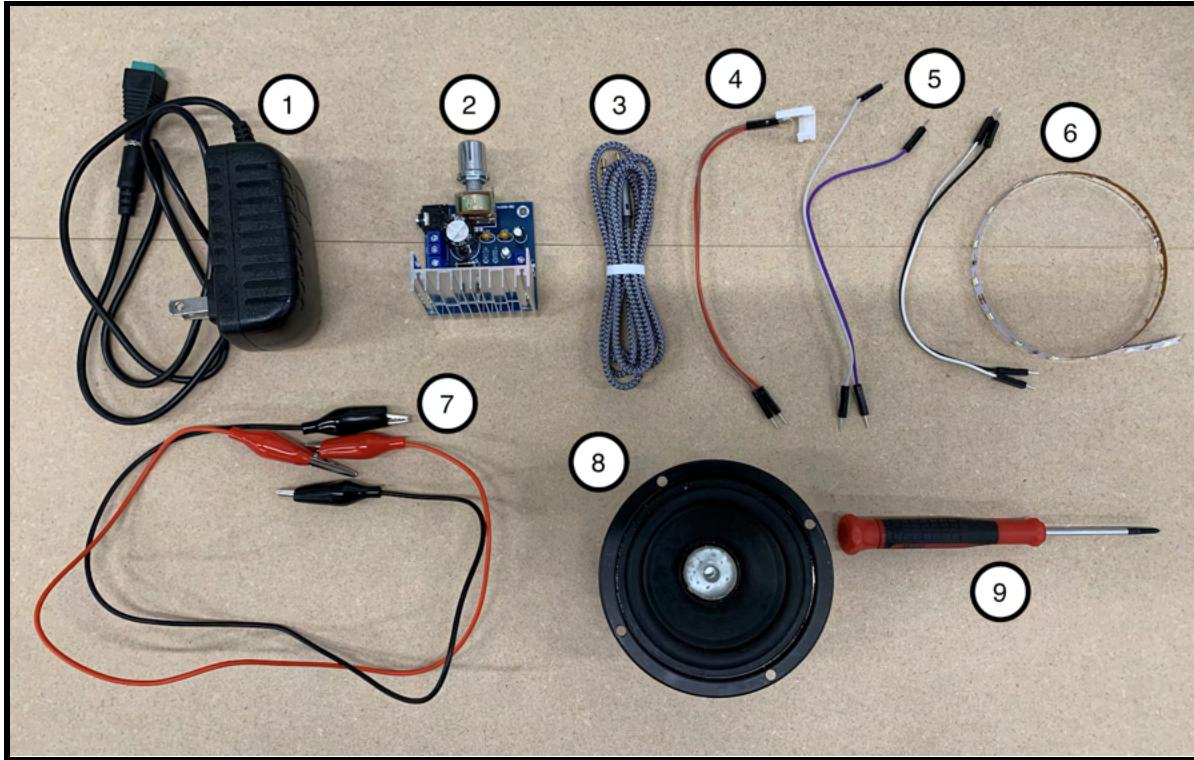
Final Results:



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(B) Electronics Assembly

Materials:



Number	Item	Quantity
1	12V Power Supply	1
2	Amplifier	2
3	Aux Cable	1
4	Jumper Wire (with LED strip connector)	1
5	Jumper Wires	4
6	LED Lights (with Acrylic disk)	1
7	Alligator Clips	2
8	Speaker	1
9	Screw Driver	1

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Important: Do not plug the power supply into the outlet until all steps in this section are completed! Always unplug the power supply if making any changes.

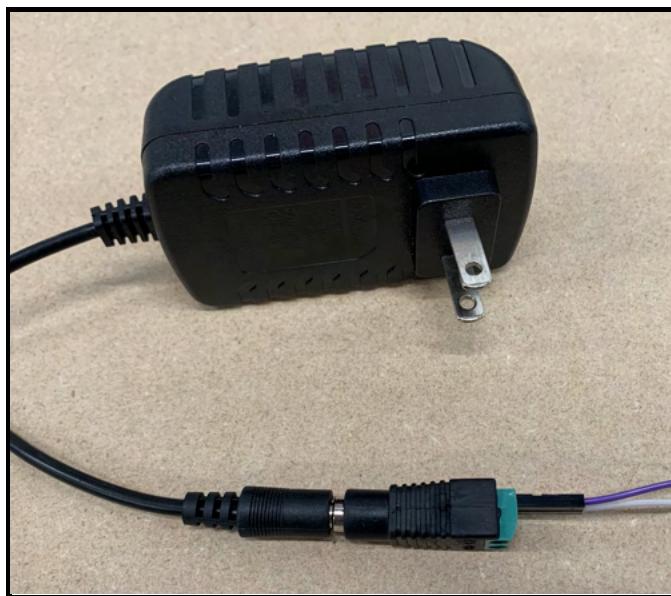
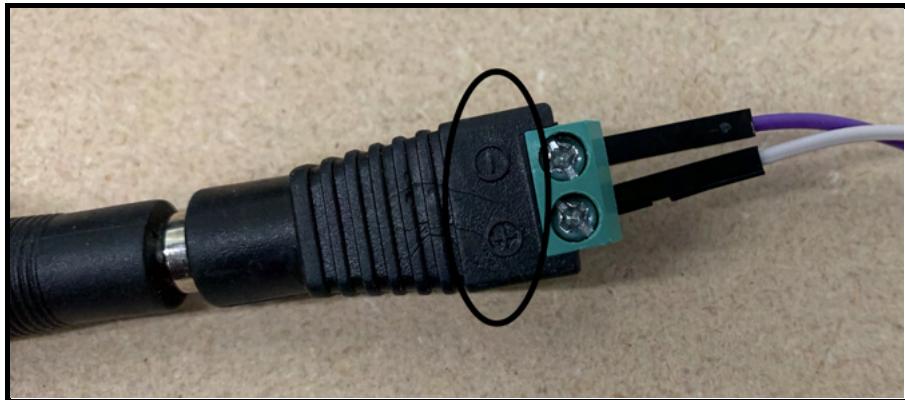
Assembly Steps:

- 1) Slip the end of the LED strip (6) into the connecting terminal piece (4) that has already been soldered to some jumper wires. Ensure that the positive and negative ends are correctly orientated (the LED specifies which end is positive and which end is negative). Snap over the cap to secure the LED strip.



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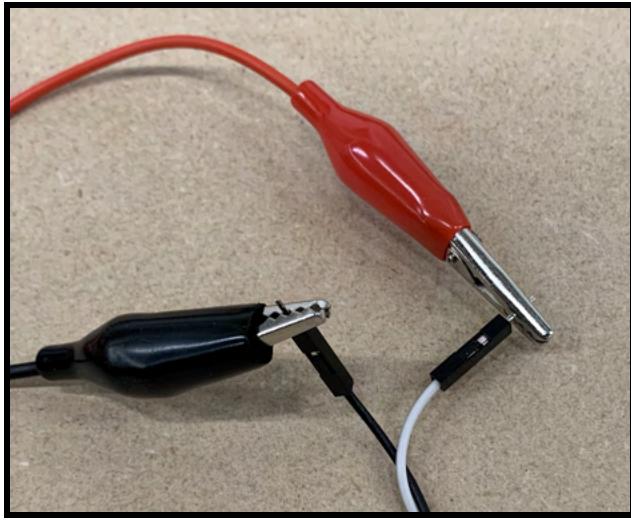
- 2) Insert the end pins of a new pair of jumper wires (5) (that are not soldered to anything) into the connector terminal of the power supply (1). Use the screwdriver (9) to secure the pins of the wires.



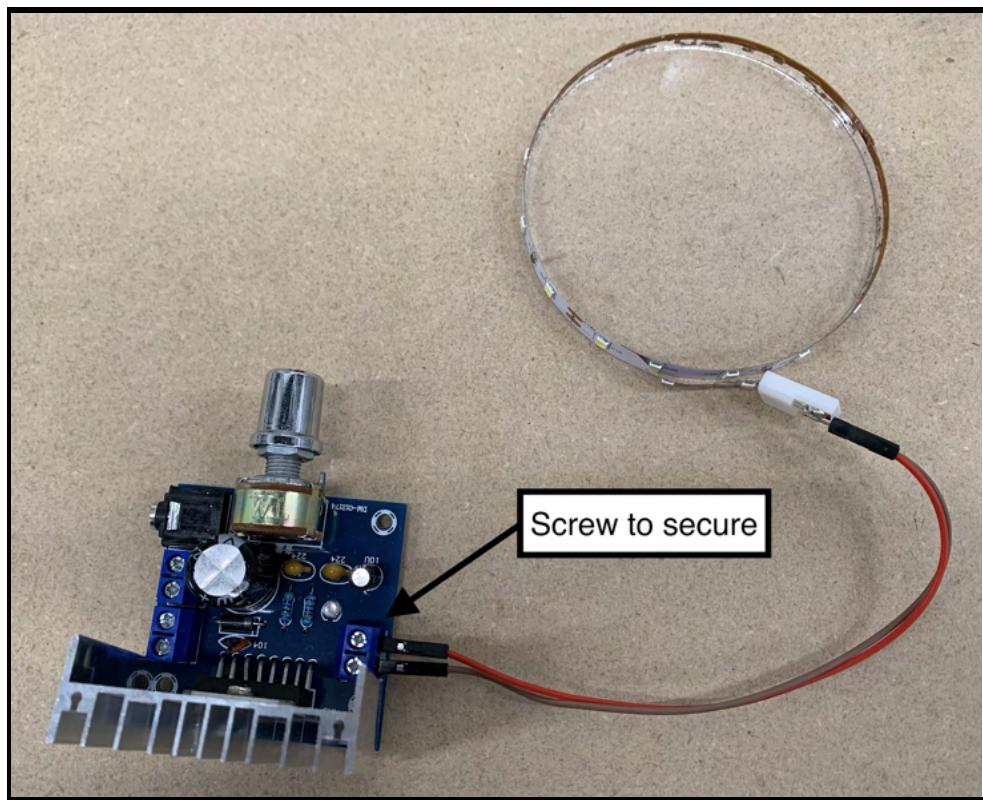
**Take note of the positive and negative ends for later.*

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- 3) Clip the alligator clips (7) to the end of a second new pair of jumper wires (5).

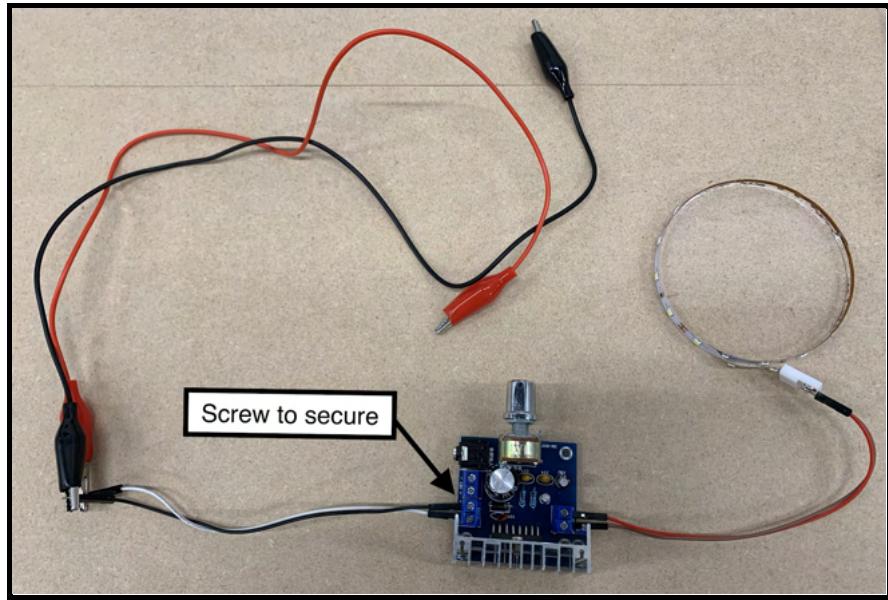


- 4) With the amplifier (2) placed down and its knob facing away, attach the LED strip and its jumper wire (assembled in step 1) to the right hand terminals on the amplifier as depicted below. Screw down on the terminal connection ends to secure the wire pins. Ensure that the positive and negative terminals on the LED strip line up properly with the terminals on the amp.

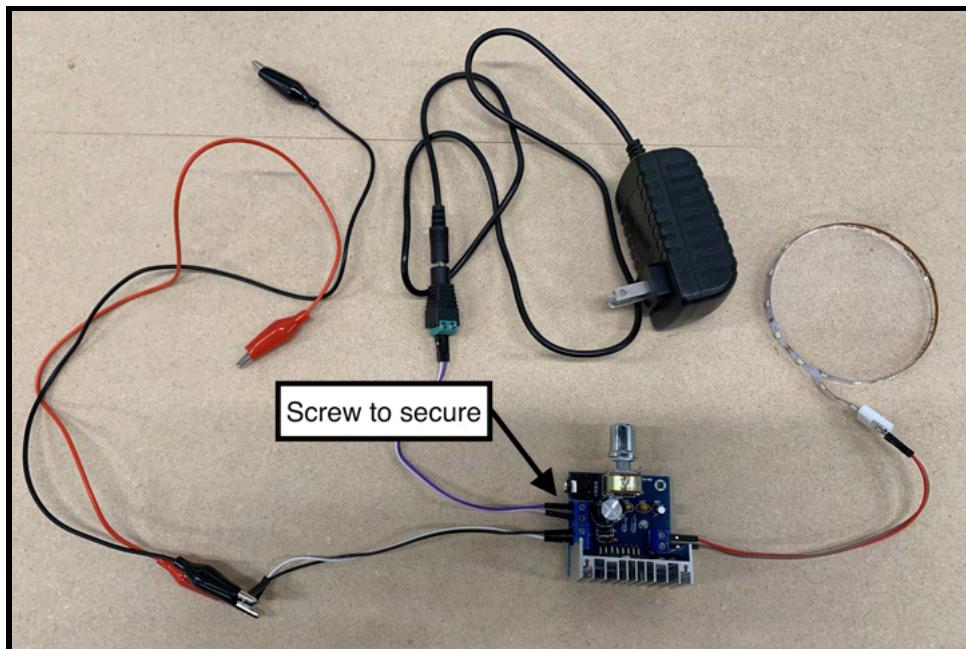


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- 5) Attach the alligator clips and its jumper wire (assembled in step 2) to the left-bottom hand terminals on the amplifier. Screw down on the terminal connection ends to secure the wire pins.

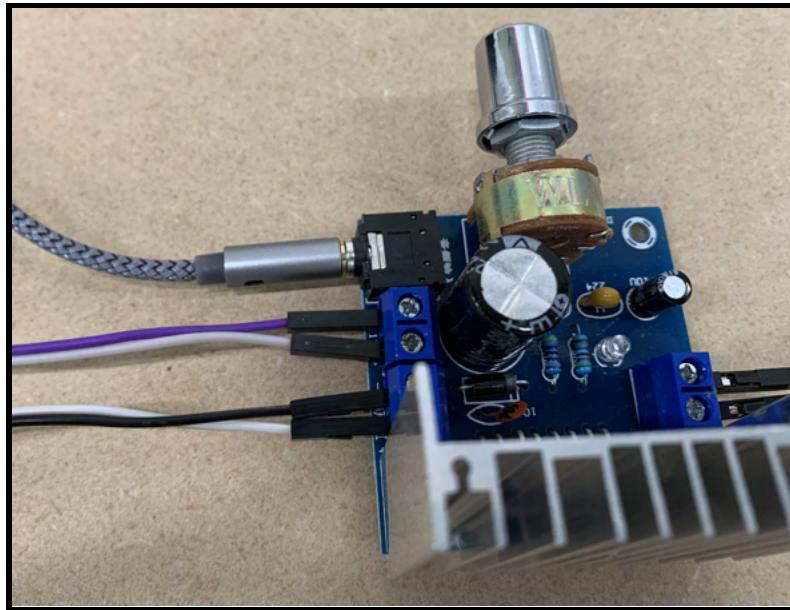


- 6) Attach the power cord and its jumper wire (assembled in step 3) to the left-top hand terminals on the amplifier. Screw down on the terminal connection ends to secure the wire pins. Ensure that the positive and negative terminals line up properly with the terminals on the amp.



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- 7) Attach the aux cable (3) on the top left audio jack port.

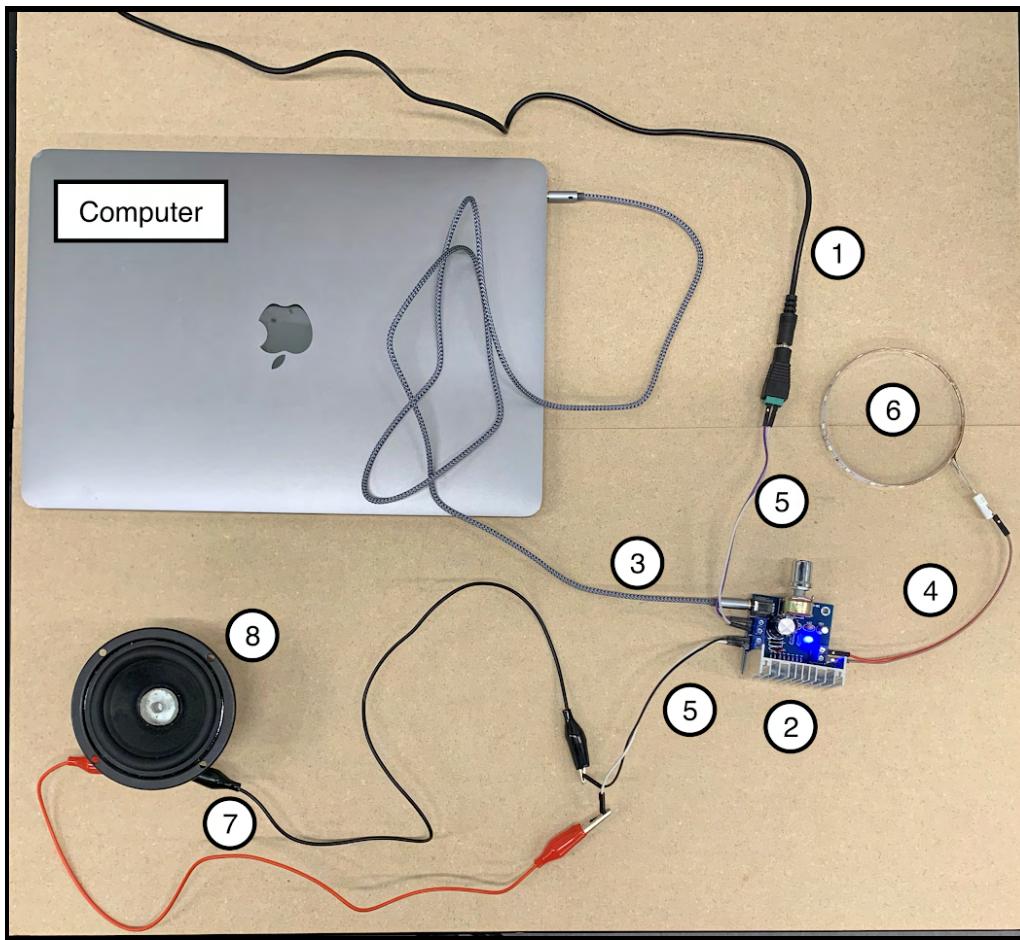


- 8) Clip the alligator clips on the two terminals on the speaker (8) being careful that the two clips do not come into contact with each other. For this step, the positive and negative terminals do not matter, so either of two configurations would work.



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Final result:



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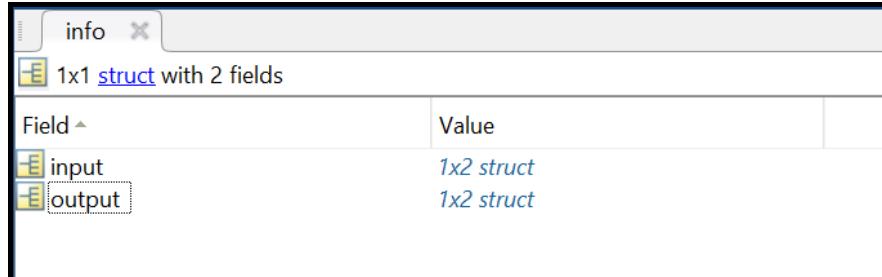
(C) User Interface (MATLAB)

A user interface has been designed on MATLAB to drive the speaker. You will need MATLAB installed on your local machine. We will control the speaker using the audio output system in your computer. We will use the ability to send different signals to the left and the right side of an audio channel and create a sinusoidal driving and a square wave for strobing simultaneously. This will allow us to control the amplitude and frequency of the strobing and driving for our set up. As an alternative to the MATLAB UI, a tone generator function has been developed for use in the open-source software Octave, and is described in section (G) of this document.

1. It is important to first connect your speaker to MATLAB. The speaker ID is unique to each computer. To find out the speaker ID of your system, start MATLAB and follow the instructions.
 - 1.1. Run the following on the command window, “ `info = audiodevinfo` ”
 - 1.2. In your workspace tab, double click on the ‘info’ variable.



- 1.3. You will see two structured variables on your editor namely ‘input’ and ‘output’.



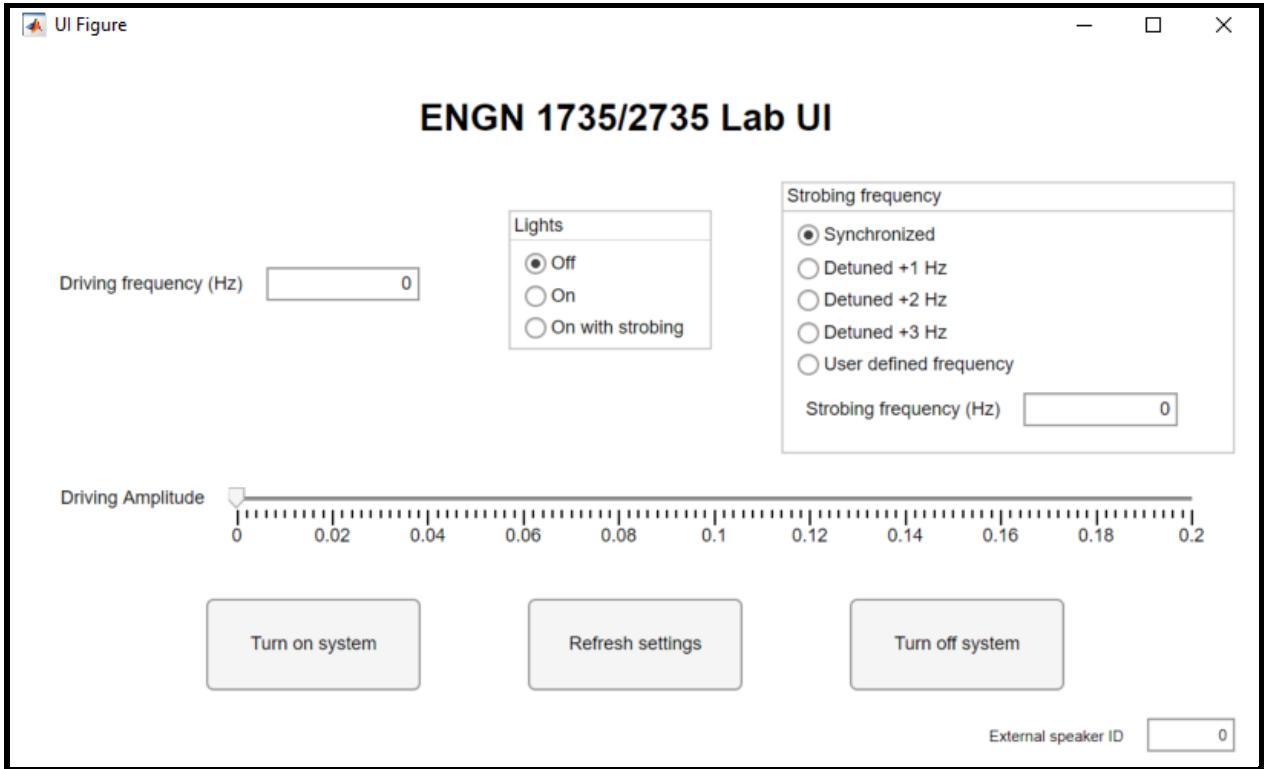
- 1.4. Double click on the output option. You will see 3 columns, ‘Name’, ‘DriverVersion’ and ‘ID’. In the name column find the connection for the speaker. It will be something like “Speaker / Headphones ...” or “External ...” depending on your machine. Locate the external headphones/speaker option. Obtain the corresponding ID number from the 3rd column. This ID is important to establish a connection between the speaker and MATLAB.

Fields	ch	Name	ch	DriverVersion	ch	ID
1		'Primary Sound Driver (Windows DirectSound)'		'Windows DirectSound'		2
2		'Speakers / Headphones (Realtek Audio) (Wind...'		'Windows DirectSound'		3

Here, the ID is ‘3’. Remember this ID as it will be required later.

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2. Download the UI application. Navigate to the folder you have saved the application in (typically downloads folder) and start the application by double clicking the icon named "ENGN1735_2735_Vibrations_Lab_GUI". It will take a few seconds to load. You should see the following User Interface screen load.

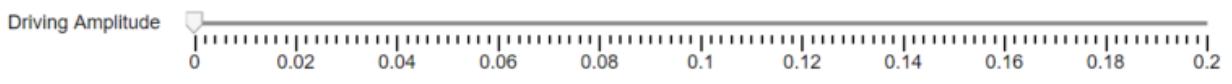


On the bottom right side of the screen, there is a small textfield. Enter the ID obtained in the previous section (point 1) before running the program. Note that this number might change between setups, so be sure to double check the ID each time.

A close-up view of the 'External speaker ID' textfield, which contains the value '3'.

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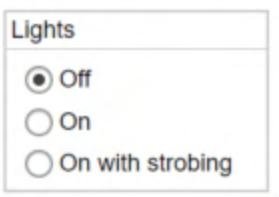
3. The slider bar can be used to set the amplitude of the speaker. Note that the magnitude of the resulting speaker amplitude varies from computer to computer. The driving amplitude can be set to zero by sliding the slider to the zero position. To test if you are connected to the GUI, attach a pair of headphones to your computer using the AUX port.
SET YOUR COMPUTER OUTPUT VOLUME TO ZERO AT FIRST. YOU CAN ADJUST IT LATER. We will call this the test case to check if everything works. **CAUTION: IF ANYTHING GETS VERY LOUD AND UNCOMFORTABLE HIT THE “TURN OFF SYSTEM” BUTTON IMMEDIATELY. AT ANY STEP IF THERE IS AN ERROR YOU WILL HEAR THE ERROR SOUND. MAKE SURE THE SPEAKER ID ENTERED IS CORRECTLY.**



4. For our first test case, we will test the connection for the GUI to send a signal to the shaker. Enter 60 Hz as the driving frequency in the text field as shown below. (This field accepts values up to 150 Hz). This is the forcing frequency for your set up. Then, slide the driving amplitude up to a value of approximately 0.05. Under the lights box, ensure that the “Off” radio button is selected. Then, press the “Turn on system” button to send a signal to your headphones. This will trigger one of the channels (left or right) of your headphones. Turn up your computer volume until a sound can be heard. Hit the “Turn off system” once an audible tone can be heard and make sure the sound stops playing.

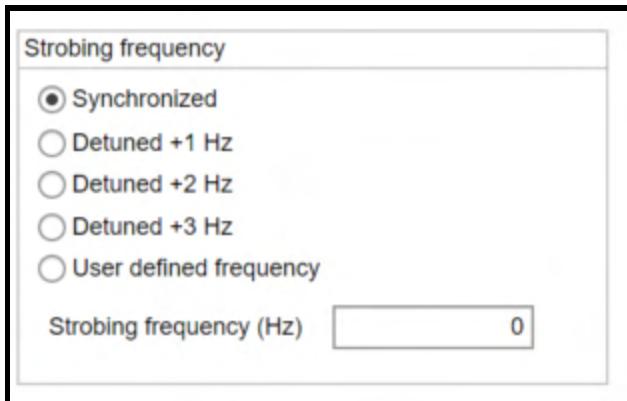
Driving frequency (Hz)

5. **REDUCE YOUR COMPUTER SYSTEM’S VOLUME TO ZERO AGAIN BEFORE RUNNING THE FOLLOWING TEST CASE.** Next, we will test the connection for the GUI to send a signal to the strobing lights. Press the “On” radio button under the lights box. Then, press the “Turn on system” button again to send a signal. This will trigger a sound on the other channel of your headphones. Slowly turn up your computer’s volume until an audible tone can be heard. However, do not press the “Turn off system” button.
CAUTION: THIS IS A LOUD SIGNAL. IF THE AUDIO IS VERY LOUD THEN HIT THE “TURN OFF SYSTEM” BUTTON.

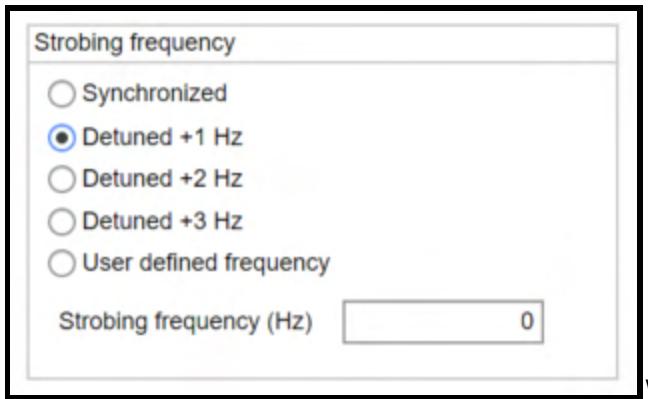
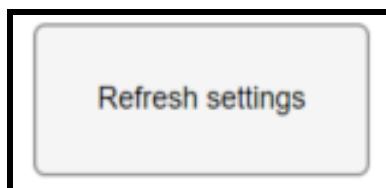


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6. **ONCE AGAIN, REDUCE YOUR COMPUTER'S VOLUME TO ZERO.** Next, we will test the strobing function that will ultimately be used for the lights. Change the lights radio button from “On” to “On with Strobing”. With a very low system volume hit the “Refresh Settings Button”. This button allows for any parameters on the GUI to be dynamically updated. Once again slowly increase your computer’s audio until a sound can be heard. There are five options for strobing under the “strobing frequency” box. Choosing the “Synchronized” radio button. This will set the strobing frequency to match the driving frequency.

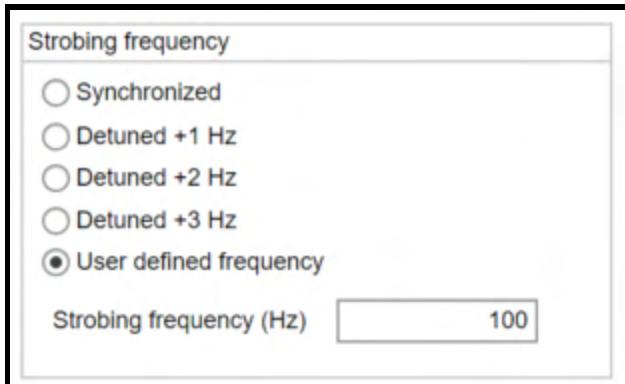


The second option is to have an offset strobing frequency of +1 Hz. There are additional options to increase the offset frequency to +2 Hz and +3 Hz .



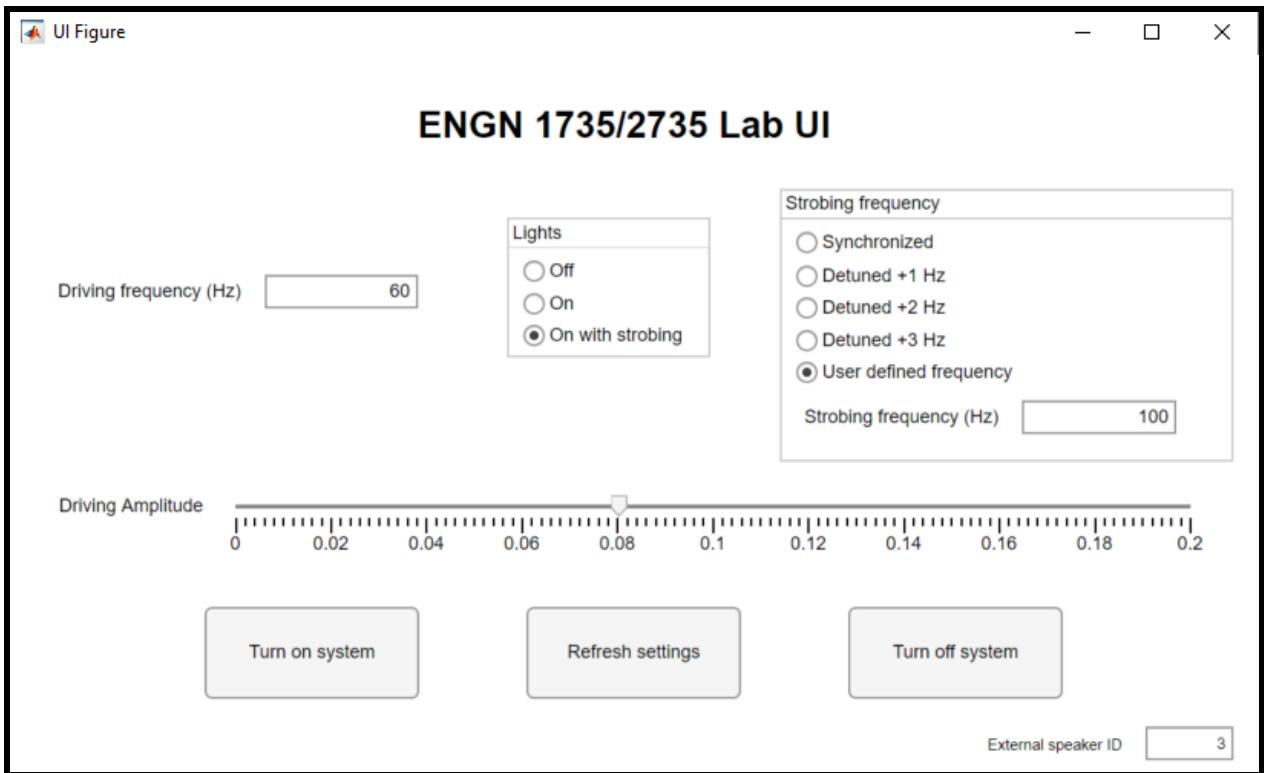
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- The last option allows for any positive value between 0 and 150 Hz to be set as the strobing frequency, independent of the driving frequency.



Press the “Refresh Settings” button if you wish to test the other options for the offset frequency. Note that you won’t be able to hear any appreciable difference in sound, but this function’s effect will become much more evident once the lights are actually attached.

- You can turn off the system by pressing the “Turn off system” button and the system will stop. To close the app just press the “x” on the UI window.



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(D) Testing the UI with the Speaker and Lighting

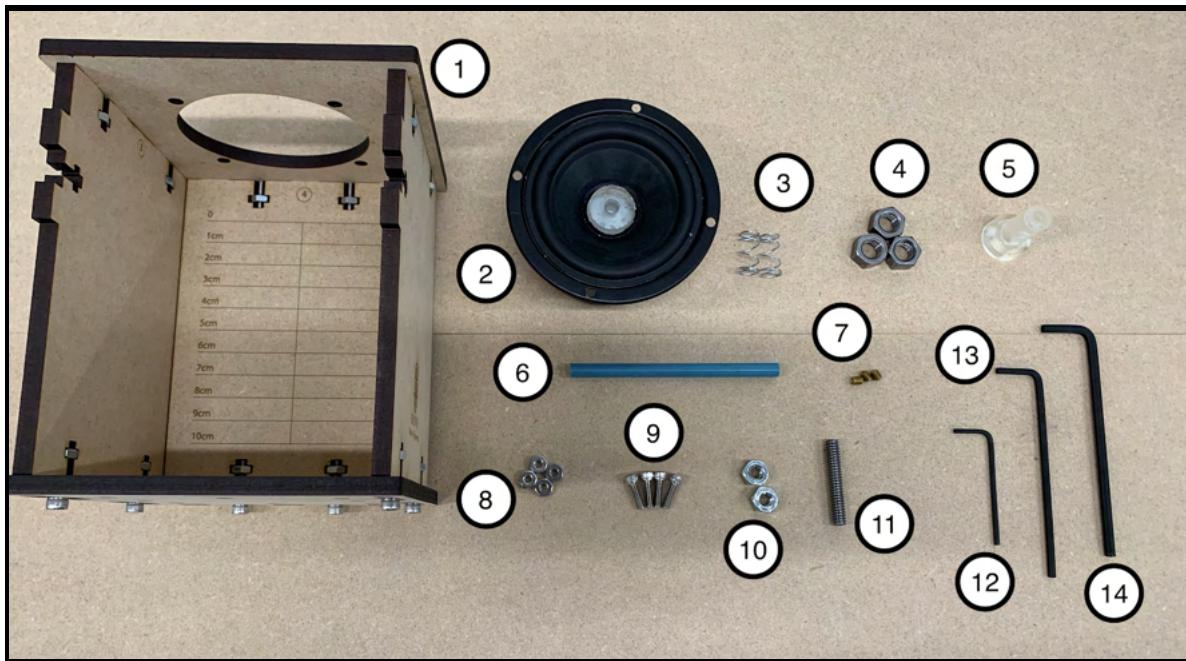
1. Attach the electronics circuit assembled in part B to the computer by inserting the AUX cable attached to the amplifier to your computer. Start the UI and enter the correct “External speaker ID.”
2. **SET YOUR COMPUTER’S VOLUME TO ZERO.** Keep the “Driving Amplitude” value to zero as well.
3. Turn the knob on the amplifier clockwise until it hits a stop in its rotation.
4. On the GUI, change the radio button on the lights to “On”. Then, press the “Turn on system” button. Adjust the volume on your computer until the LED lights turn on and adjust the volume until the intensity of the lights are at a suitable level. Then, leave the volume on your computer fixed for the duration of the demo.
5. Next set a driving frequency of 10 Hz, and switch the Lights option to “On with strobing”. Hit refresh. You should see the lights begin to flash.
6. In very small increments, move the slider to increase the “Driving Amplitude” and hit refresh. You should see the speaker will start vibrating with a frequency of 10Hz.
Ensure that the amplitude isn’t too great such that the speaker starts bottoming out (you will hear a loud rattling sound) as it could cause permanent damage. If this happens, immediately turn the volume of your computer down and restart the process.
7. Note that as you change the frequency of the signal sent to the speaker, the relationship between amplitude of the signal and the response amplitude of the speaker changes. Thus, if there is a large jump in the input frequency, it is safer to reduce the driver amplitude on the GUI before hitting refresh.

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(E) Experiments

(1) 1 DOF and 2 DOF Assembly

Materials:



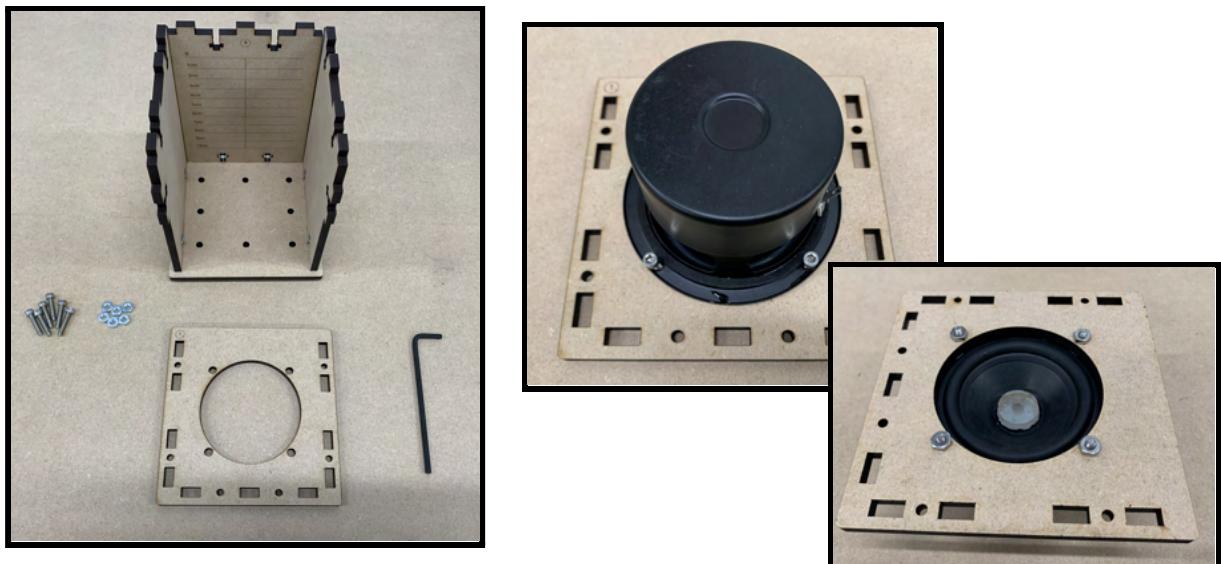
Number	Item	Quantity
1	Housing Assembly	1
2	Speaker	1
3	Compression Springs	2
4	3/8"-16 Hex nuts	3
5	Custom Adapter	1
6	Plastic Linear Shaft	1
7	8-32 Set Screw	3
8	6-32 x 1/2" Hex head screw	4
9	6-32 Hex nut	4
10	1/4"-20 Hex nut (Aluminum)	2

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11	1/4"-20" Threaded Rod (Aluminum)	1
12	5/64" Allen Key	1
13	7/64" Allen Key	1
14	9/64" Allen Key	1

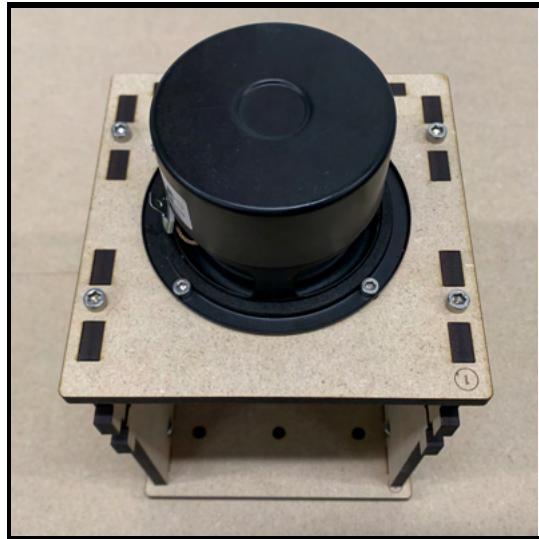
Assembly Steps:

- 1) Remove the top plate of the housing assembly (1). Fasten the speaker (2) to the top plate using four 6-32 hex head screws (8) and nuts (9). Ensure that the head of the screw lies flush on the back side of the speaker.

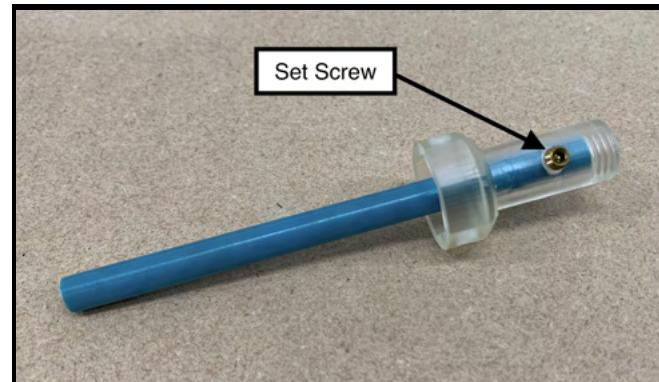


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- 2) Reattach the top plate of the housing now that the speaker is attached. For steps 1 and 2, review the housing assembly guide to refresh on assembling the housing plates.

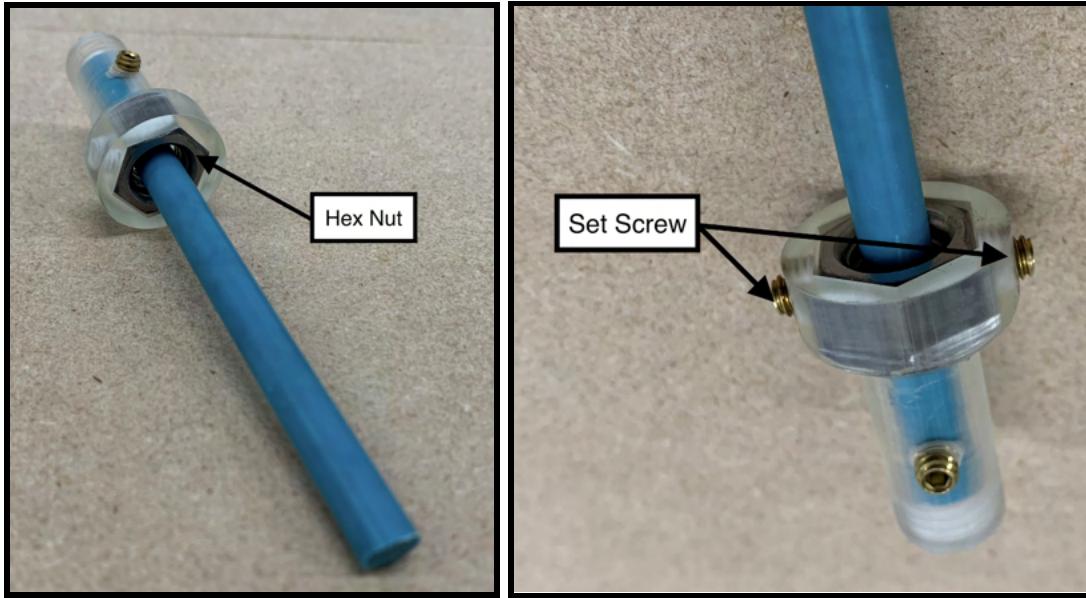


- 3) Secure the linear shaft (6) into the custom adapter (5) by inserting a 8-32 set screw (7) into the middle side of the adapter and tightening. Be careful to not overtighten. *Note that this step is optional, please only add the linear shaft if you are finding that the demo requires aligning (if significant side to side vibration of the nut is observed). Otherwise, the shaft should be omitted.

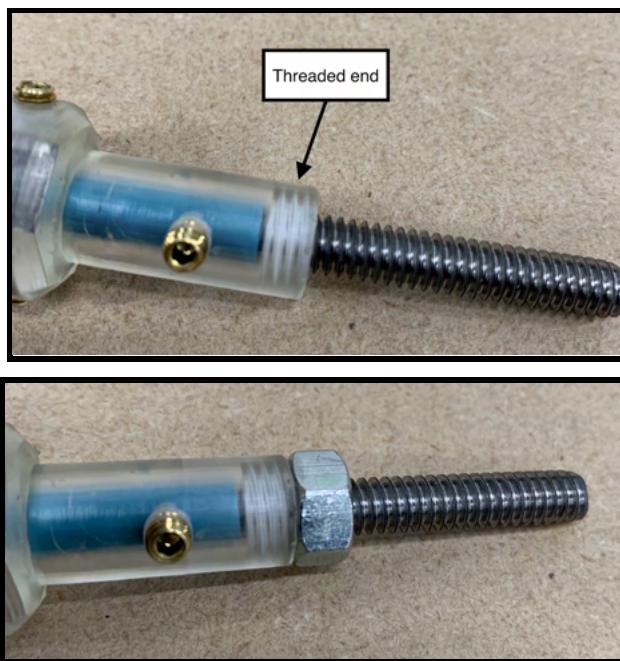


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- 4) Place a $\frac{3}{8}$ " nut (4) on the top hexagonal slot of the custom adapter, and use two 8-32 set screws (7) to secure the nut in place.



- 5) Thread the $\frac{1}{4}$ "-20 aluminum rod (11) into the end of the custom adapter (5) until the rod is flush with the linear shaft (6). Secure a $\frac{1}{4}$ "-20 aluminum hex nut (10) at the same end for a positive lock. Ensure that the $\frac{1}{4}$ "-20 rod and nut are both aluminum (there are both aluminum and steel rods given in the package). The aluminum rod and nuts are lighter in weight and are non-ferromagnetic (you can try placing the magnet around 3" away from the pieces to feel if an attractive force is felt).

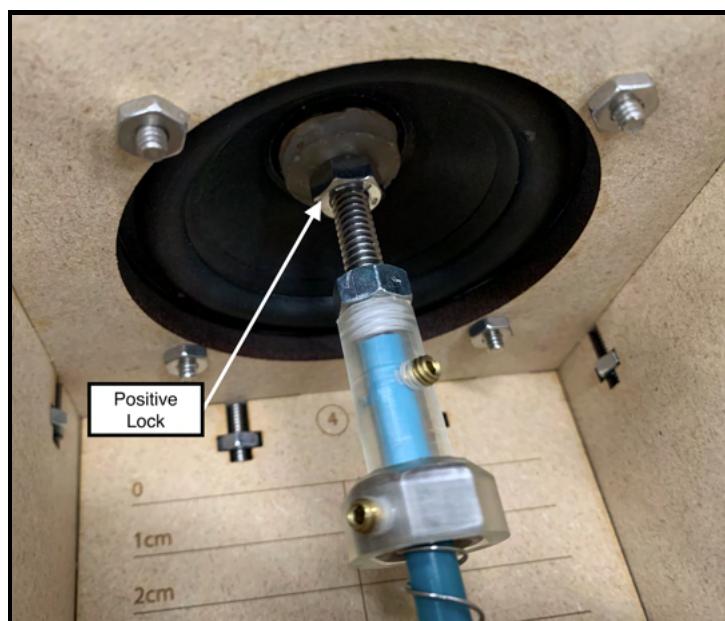


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- 6) For the 1DOF system, thread (twisting motion) one compression spring (3) to the hex nut attached in the custom adapter for approximately one full rotation (note that all the spring and nuts are left handed and thread in the opposite direction to traditional screws and nuts). Ensure that the compression springs aren't threaded too deep into the nut otherwise the spring constant will be affected (limit it to one revolution). Then thread another $\frac{3}{8}$ hex nut to the end of the compression spring. For the 2DOF system, repeat the process and add another compression spring, hex nut pair.

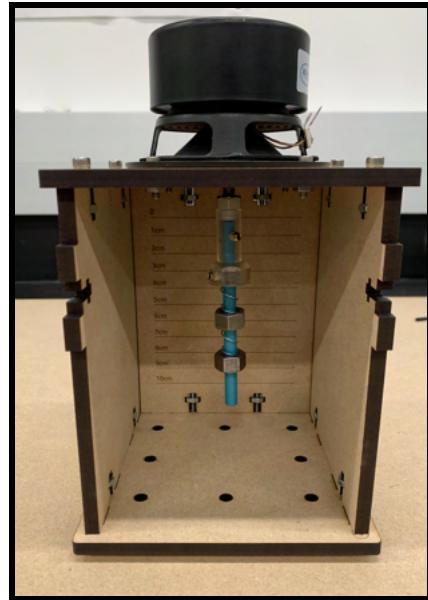


- 7) Thread the end of the spring nut assembly (steps 3-7) into the speaker (2) until the screw bottoms out, adding another $\frac{1}{4}$ "-20 nut (10) as a positive lock.



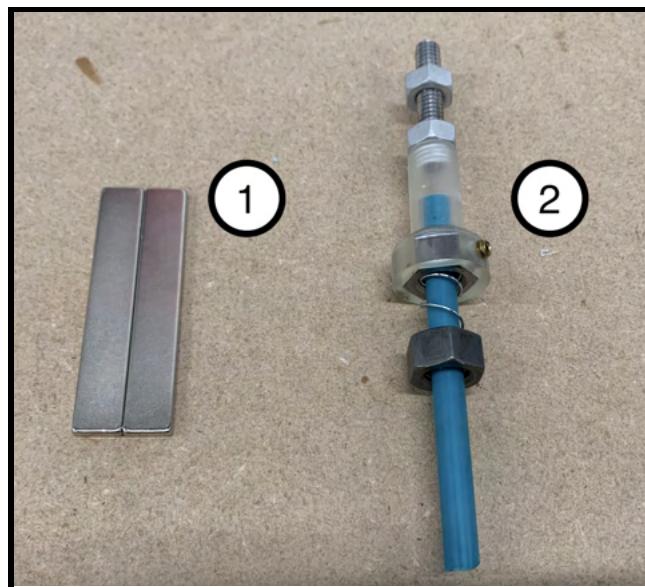
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Final Results:



(1.1) Alternative assembly for use with magnet (1DOF Lab)

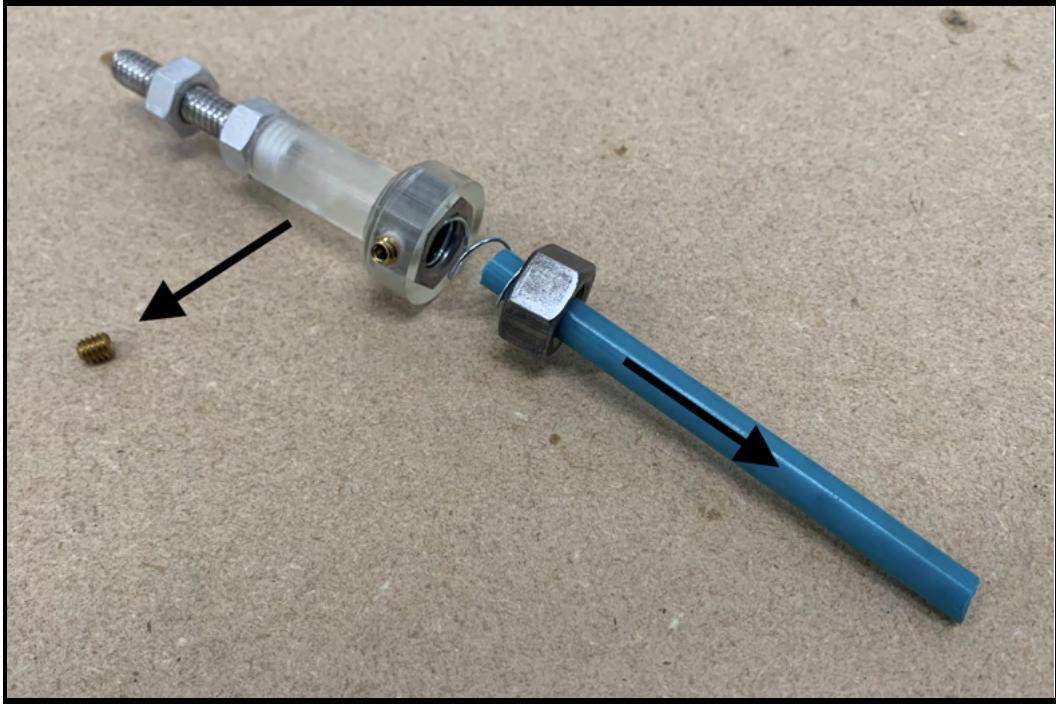
Materials:



Number	Item	Quantity	Bag Number
1	Magnets	2	5
2	Custom mount assembly from step 6	1	1,3

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- 1) Remove the linear threaded rod from the assembly by unscrewing the corresponding 8-32 set screw that is holding the rod.



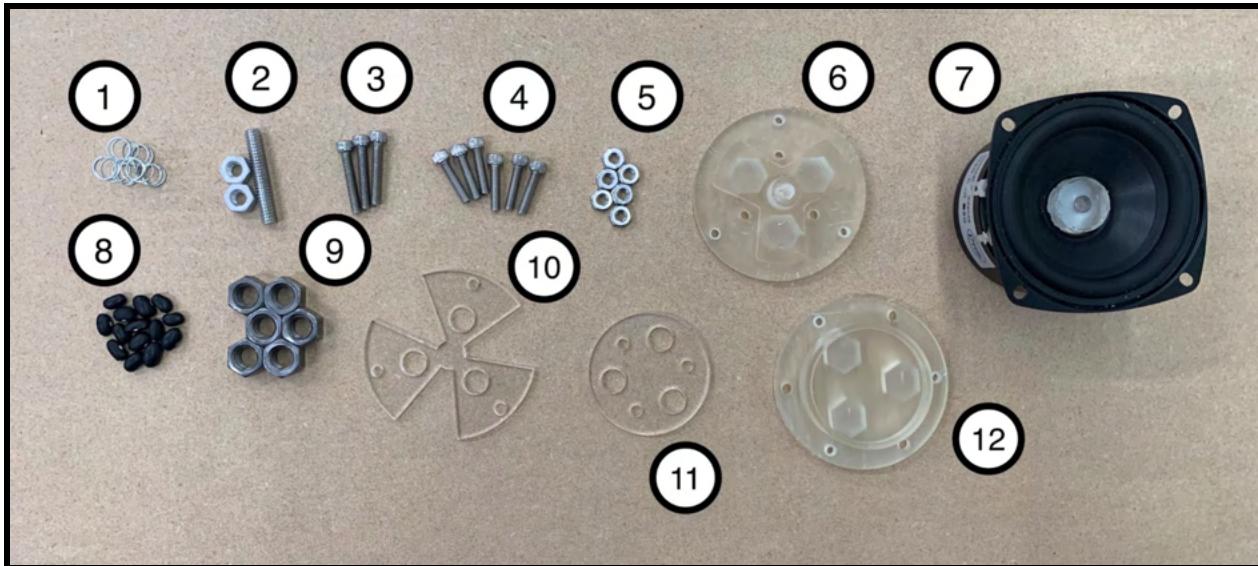
- 2) The HW1 demo assignment will ask you to test three configurations illustrated below. The first case contains the mount assembly as is. For the second configuration, attach one magnet to the end of the free nut. For the third configuration, attach another magnet on top of the previous one. Be careful to place the magnets gently on one another as they have large pull power and may be damaged if snapped together too quickly. Also ensure that the magnets are centered around the nut such that during oscillation, no side to side motion is induced.



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(2) Vibration Isolation Assembly

Materials:

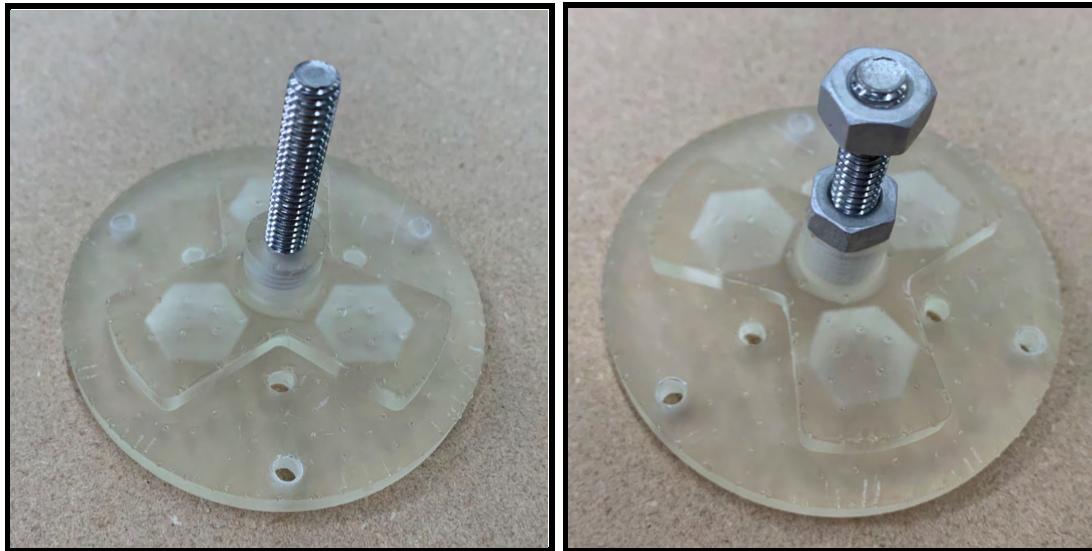


Number	Item	Quantity
1	Springs	3
2	$\frac{1}{4}$ "-20 Nut+threaded rod	2 (nut) 1 (rod)
3	8-32 x $\frac{3}{4}$ " screw	3
4	8-32 x 1" screw	6
5	8-32 nut	6
6	Bottom platform	1
7	Speaker	7
8	Beans	8
9	$\frac{3}{8}$ "-16 Hex nuts	6
10	Top acrylic plate	1
11	Bottom acrylic plate	1
12	Top platform	1

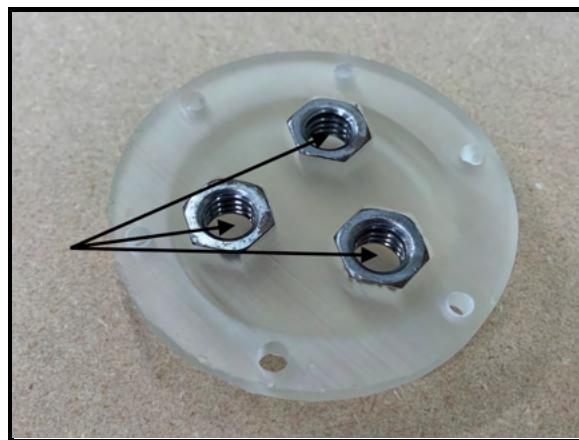
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Assembly Steps:

- 1) Thread the (2) $\frac{1}{4}$ "-20 rod to the (6) bottom platform. Thread two of the (2) $\frac{1}{4}$ " nuts to the rod.

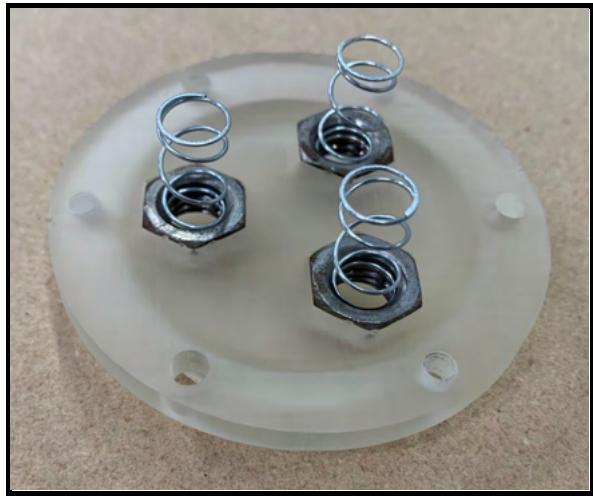


- 2) Insert three (9) $\frac{3}{8}$ "-16 Hex nuts in the hexagonal slots on the (12) top platform.



- 3) Thread three (1) springs to the three (9) $\frac{3}{8}$ "-16 hex nuts on the (12) top platform. Make sure that the springs are approximately level.

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- 4) In order to secure the hex nuts to the platform, fasten the (10) top acrylic plate to the (12) top platform using three 8-32 x $\frac{3}{4}$ " screws.

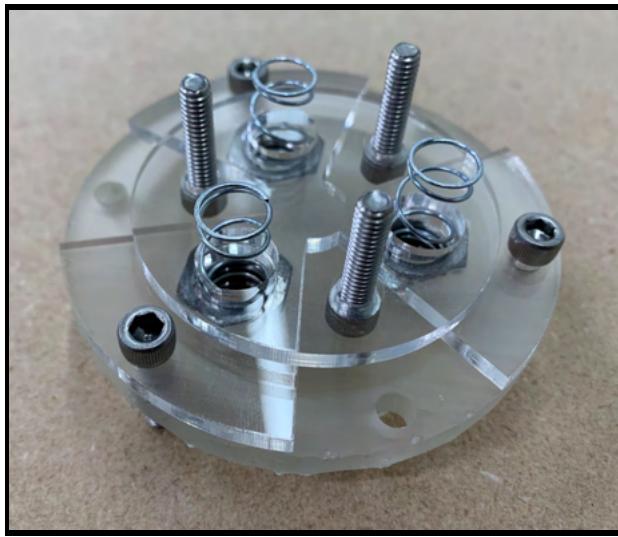


- 5) Pass three (3) 8-32 x $\frac{3}{4}$ " screws through the holes on the (11) bottom acrylic plate.

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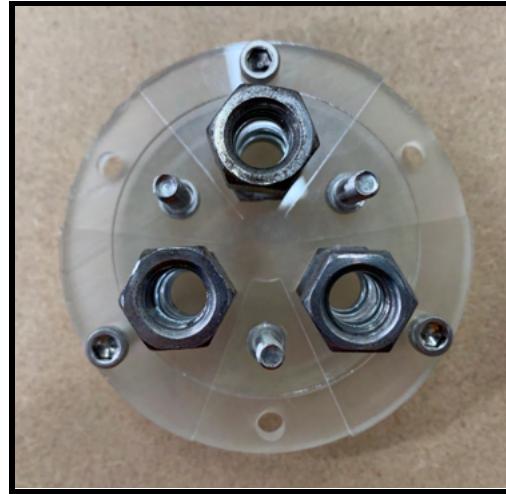


- 6) Pass the springs from step 4 through the three large holes on the (11) bottom acrylic plate such that the orientation matches the image below.

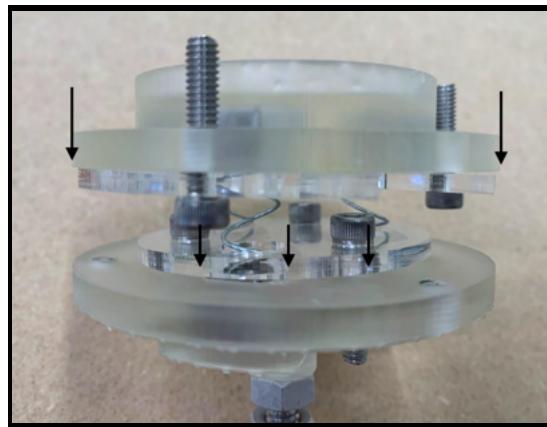


- 7) Thread the three remaining (9) $\frac{3}{8}$ "-16 Hex nuts onto the ends of the spring. Make sure the nuts are approximately level with each other once threaded on. Additionally the nuts should be orientated such that they match the nuts below.

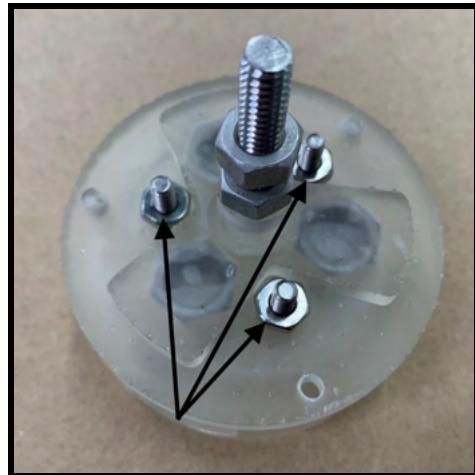
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- 8) Combine the bottom platform from step 1 with the assembly from step 7 by inserting the three (9) $\frac{3}{8}$ "-16 hex nuts into the empty hexagonal slots on the (6) bottom platform. Additionally pass the three (3) 8-32 x $\frac{3}{4}$ " screws through the through holes on the (6) bottom platform.



- 9) Fasten the (11) bottom acrylic plate to the (6) bottom platform by using three (5) 8-32 nuts.

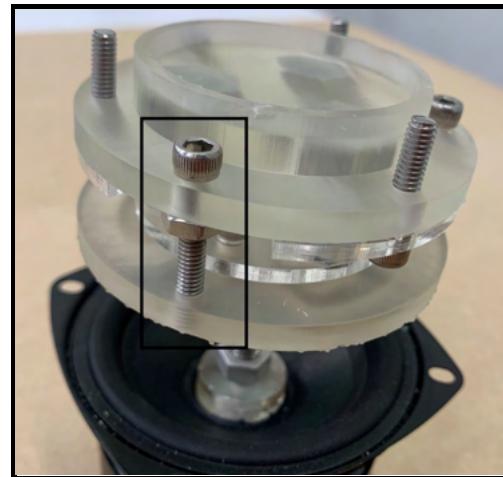


Demo Kit Assembly Guide

- 10) Fastening the (2) 1/4"-20 rod at the underside of the bottom platform to the (7) shaker.



- 11) In the case where the springs need to be locked, pass three 8-32 x 1" screws through the remaining holes on the (12) top platform. Fasten the screws by threading them to the (6) bottom platform. Sandwich a (5) 8-32 nut between the top and bottom platforms on each screw. Tighten the screw against the (12) top platform.



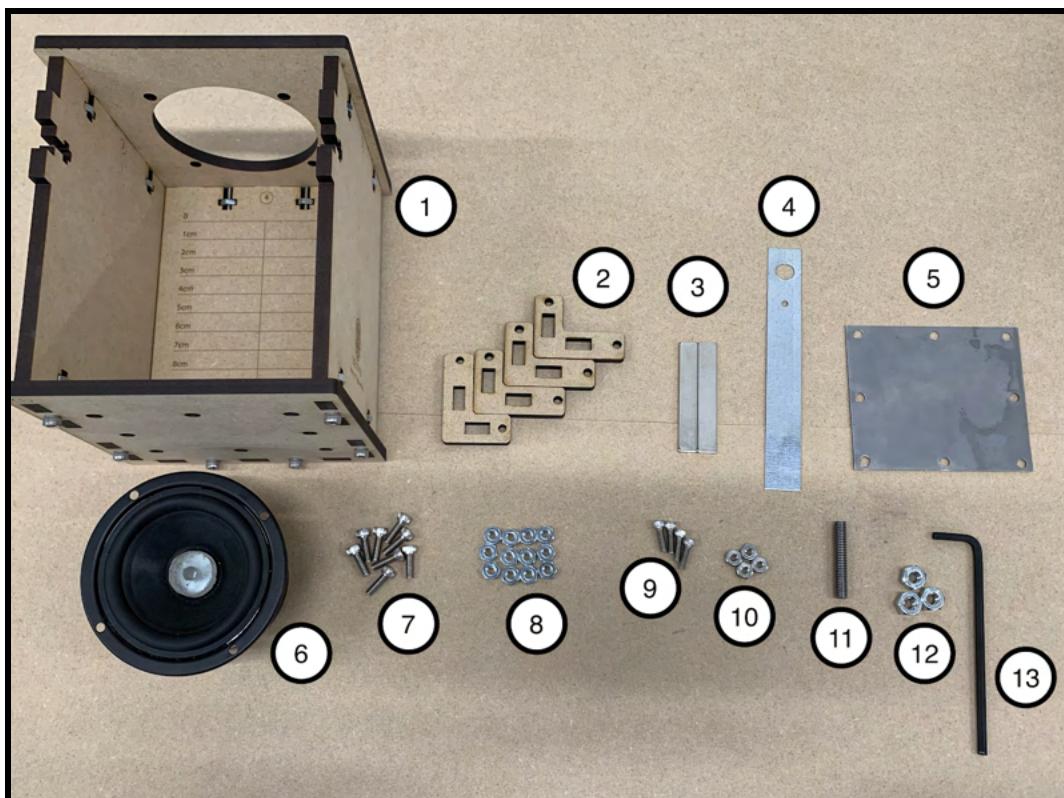
Demo Kit Assembly Guide

Final Results:



(3) Nonlinear Oscillator Assembly

Materials:



Number	Item	Quantity
--------	------	----------

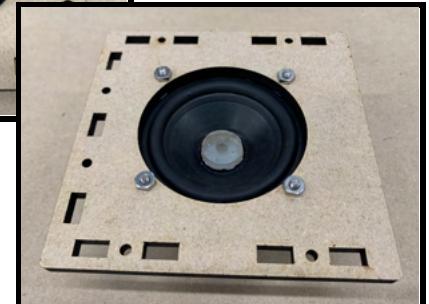
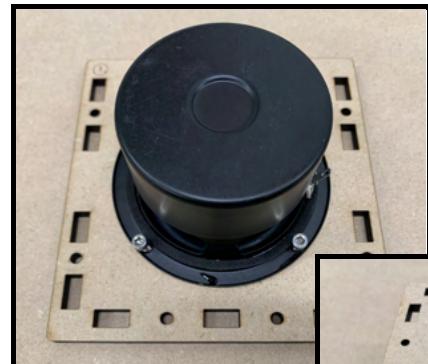
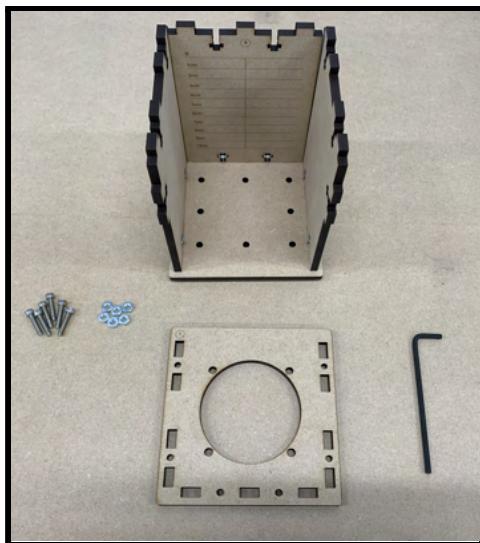
Demo Kit Assembly Guide

1	Housing Assembly	1
2	L-bracket	4
3	Neodymium Magnet	2
4	Sheet Metal Strip	1
5	Sheet Metal Plate	1
6	Speaker	1
7	8-32 x 1/2" Hex head screw	8
8	8-32 Hex nut	12
9	6-32 x 1/2" Hex head screw	4
10	6-32 Hex nut	4
11	1/4"-20" Threaded Rod (Aluminum)	1
12	1/4"-20 Hex nut (Aluminum)	3
13	9/64" Allen Key	1

*The Housing item includes all fasteners that belong to that assembly; view “(A) Housing Assembly” for more information.

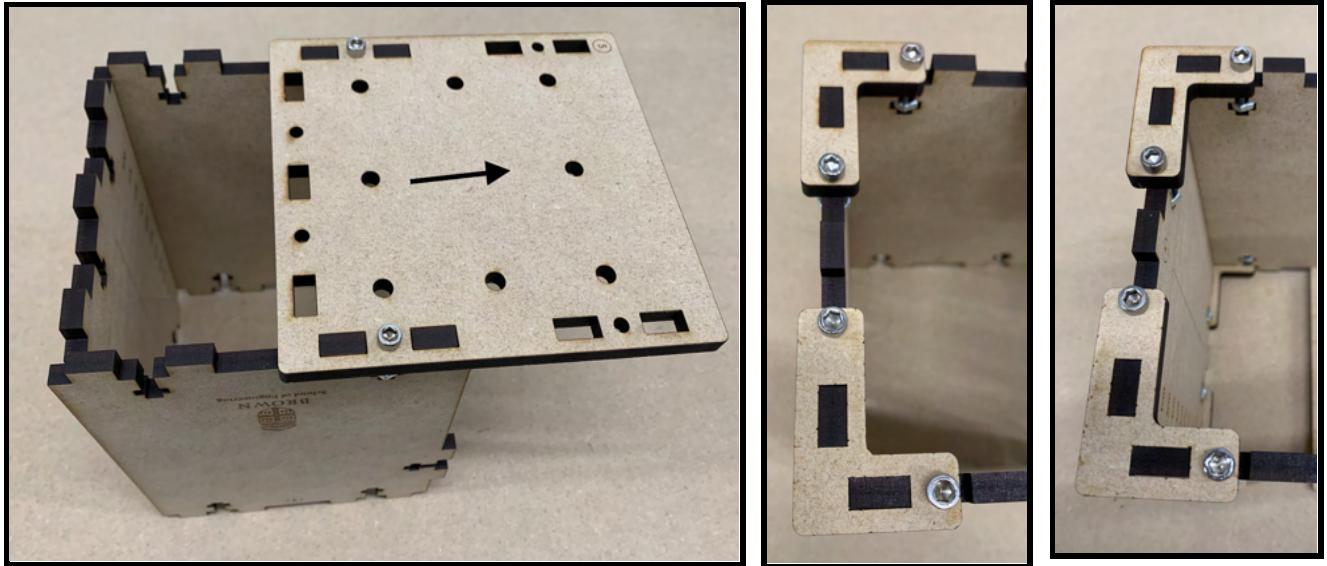
Assembly Steps:

- 1) Remove the top plate of the housing assembly. Fasten the speaker to the top plate using four 6-32 hex head screws (9). Ensure that the head of the screw lies flush on the back side of the speaker. Review the housing assembly guide to refresh on the terminology used to denote specific pieces in the housing.

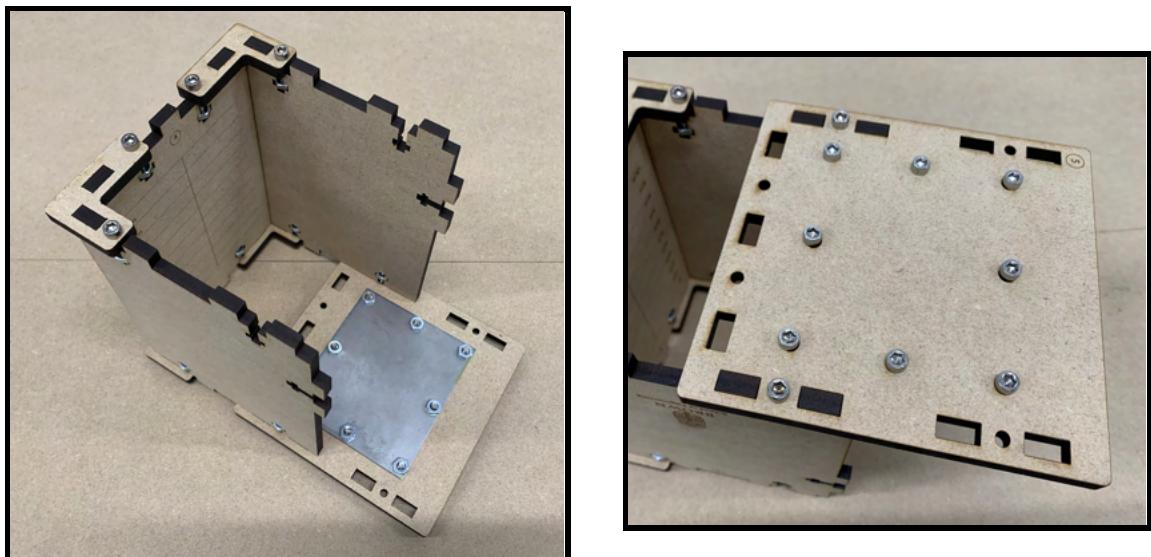


Demo Kit Assembly Guide

- 2) Shift the bottom plate back by one slot. Insert two L-brackets (2) on the top and two L-brackets on the bottom. This connects the back plate to the right and left plate.



- 3) Use eight 8-32 x ½" screws (7) and nuts to fasten the metal plate (5) to the through holes on the bottom plate. Ensure that the screw head is flush on the back surface of the bottom plate.

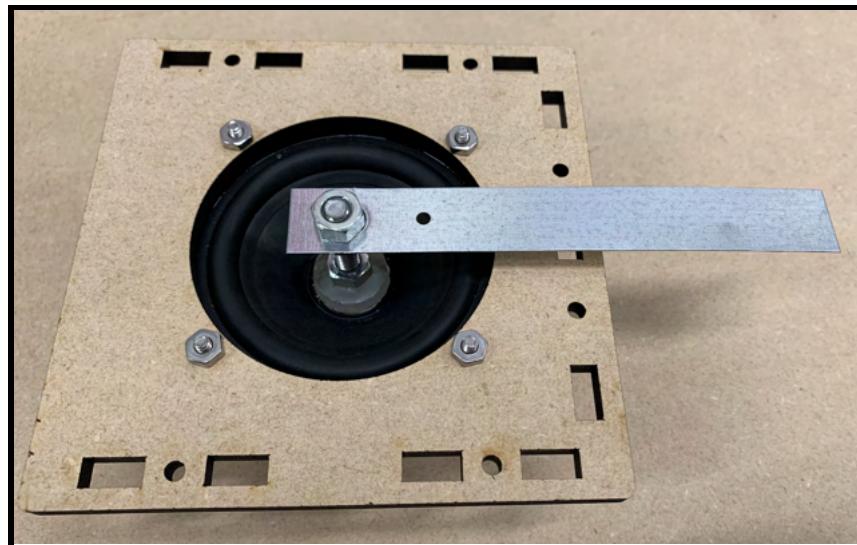


Demo Kit Assembly Guide

- 4) Thread the $\frac{1}{4}$ "-20 aluminum od (11) into the speaker (6). Use one $\frac{1}{4}$ "-20 aluminum hex nut (12) to fasten the rod in place. Thread a second aluminum nut just above the other.

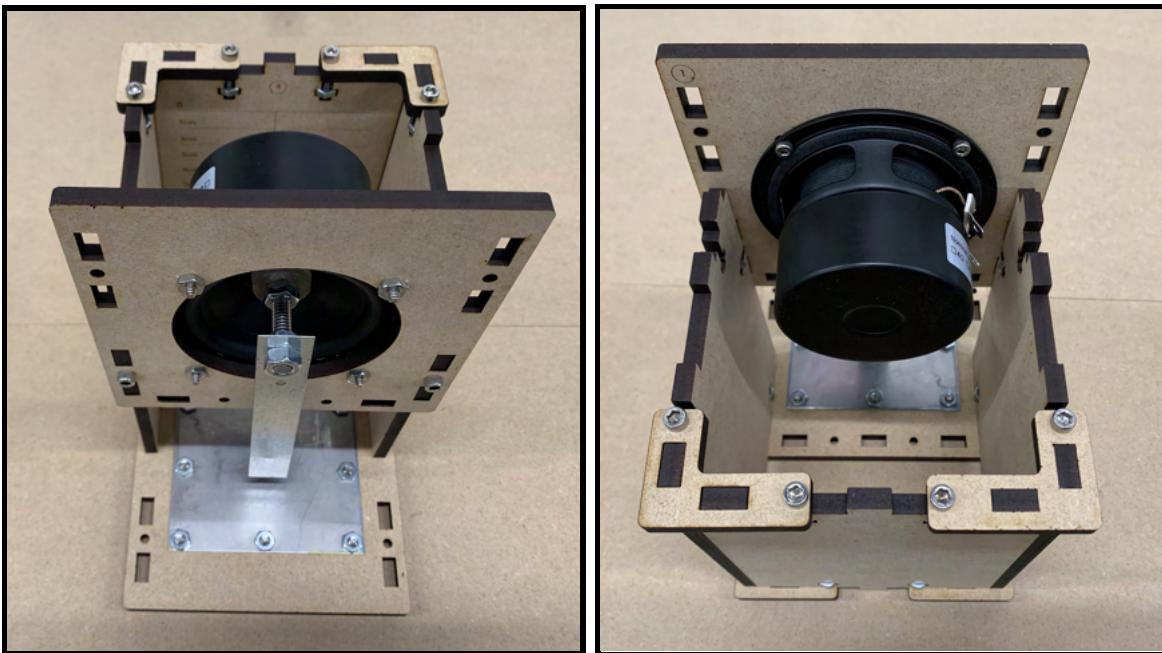
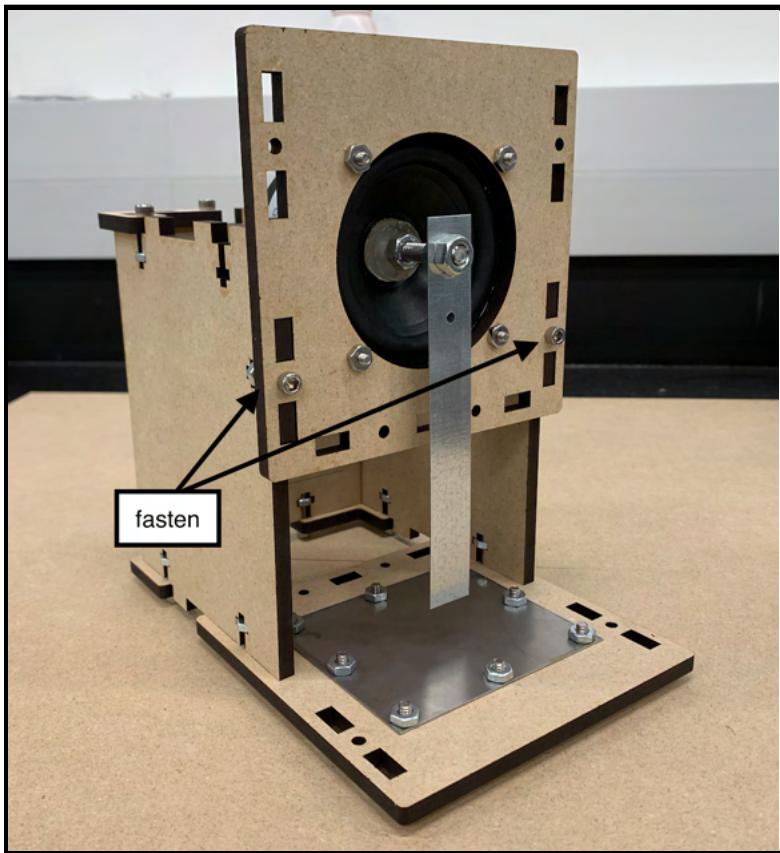


- 5) Stick the large hole on the metal strip (4) through the threaded rod, and clamp the strip in place using a third $\frac{1}{4}$ "-20 hex nut (12).



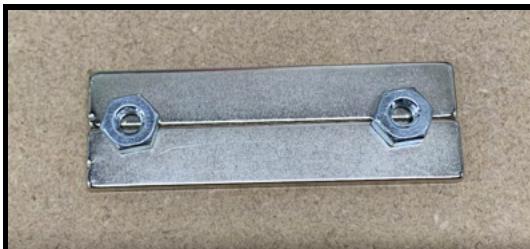
Demo Kit Assembly Guide

- 6) Mount the top panel (with the attached speaker) onto the side of the modified housing assembly (fastening with screws as previously done).

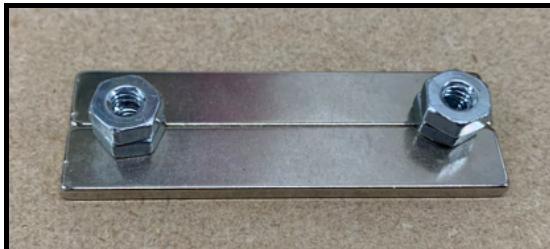


Demo Kit Assembly Guide

- 7) Attach the two magnets (3) together in a side by side configuration. Attach two 8-32 hex nuts (12) to the bottom surface of the magnet. To adjust the offset height of the magnet, stack two additional hex nuts on the same surface.

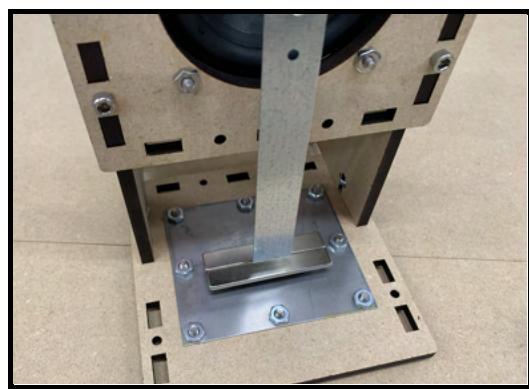
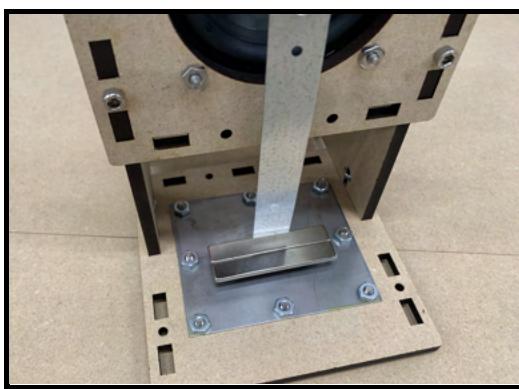


One layer



Two layers

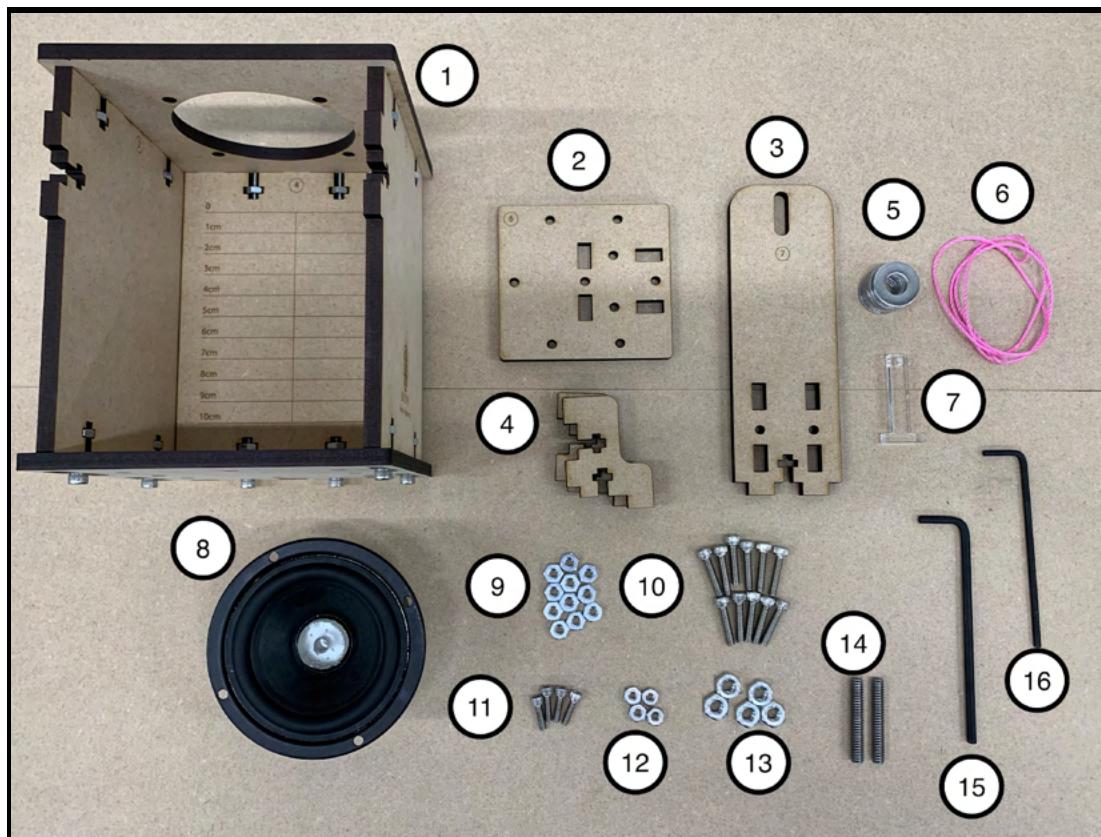
Final Results:



Demo Kit Assembly Guide

(4) String-Wave Assembly

Materials:



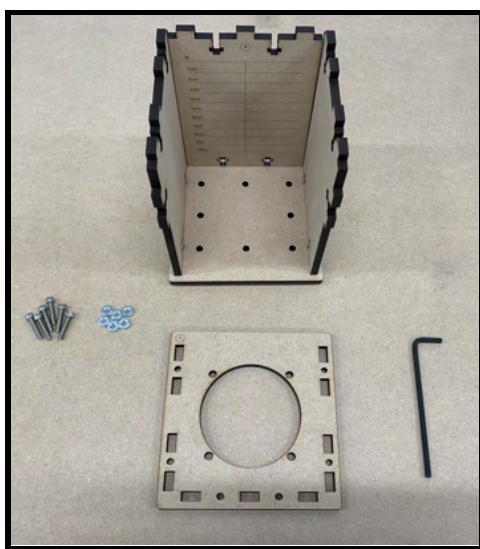
Number	Item	Quantity
1	Housing Assembly	1
2	String Mount Base Plate	1
3	String Mount Panel	2
4	String Mount Rib	2
5	Washer	10
6	String	1
7	T-Piece	1
8	Speaker	1
9	8-32' Hex nut	11

Demo Kit Assembly Guide

10	8-32 x 3/4" Hex head screw	11
11	6-32 x 1/2" Hex head screw	4
12	6-32 Hex nut	4
13	1/4"-20 Hex nut (Aluminum x2, Steel x3)	5
14	1/4"-20" Threaded Rod (Aluminum x1, Steel x1)	2
15	9/64" Allen Key	1
16	7/64" Allen Key	1

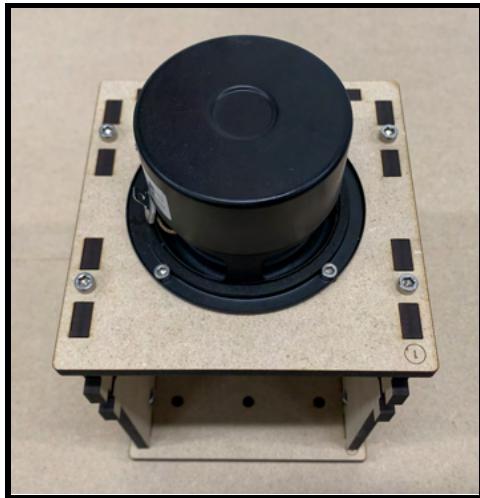
Assembly Guide:

- 1) Remove the top plate of the housing assembly. Faster the speaker to the top plate using four 6-32 hex head screws. Ensure that the head of the screw lies flush on the back side of the speaker. Review the housing assembly guide to refresh on the terminology used to denote specific pieces in the housing.

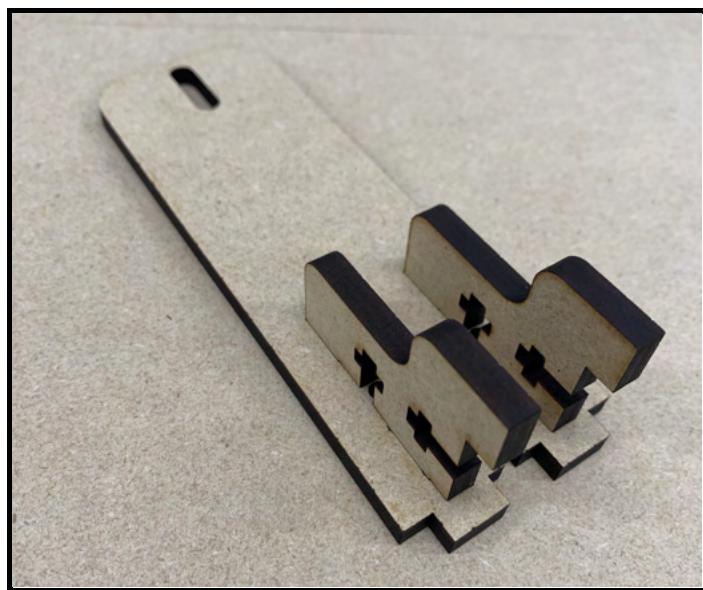


Demo Kit Assembly Guide

- 2) Reattach the top plate of the housing now that the speaker is attached.

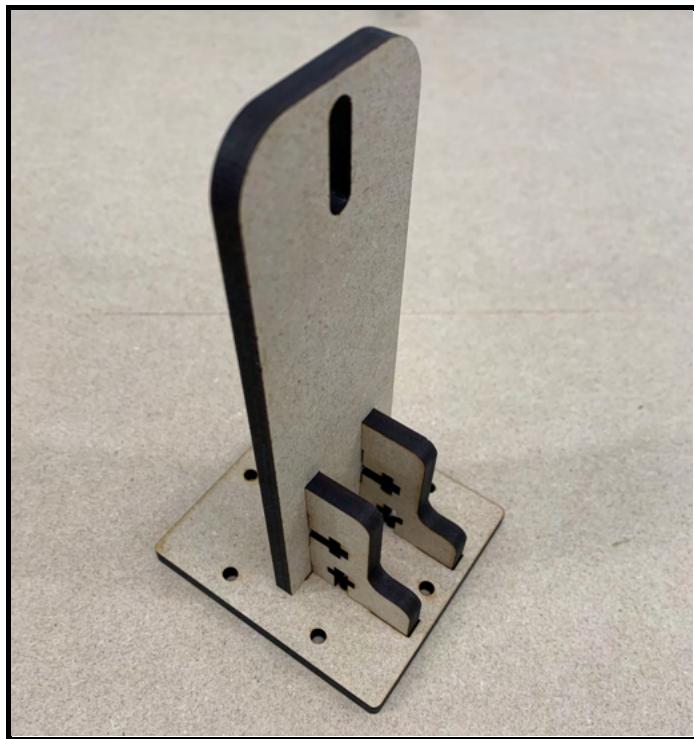


- 3) Insert two of the mounting ribs (4) into the string mount panel (3) slots. The string mount plate is marked with a number 7.

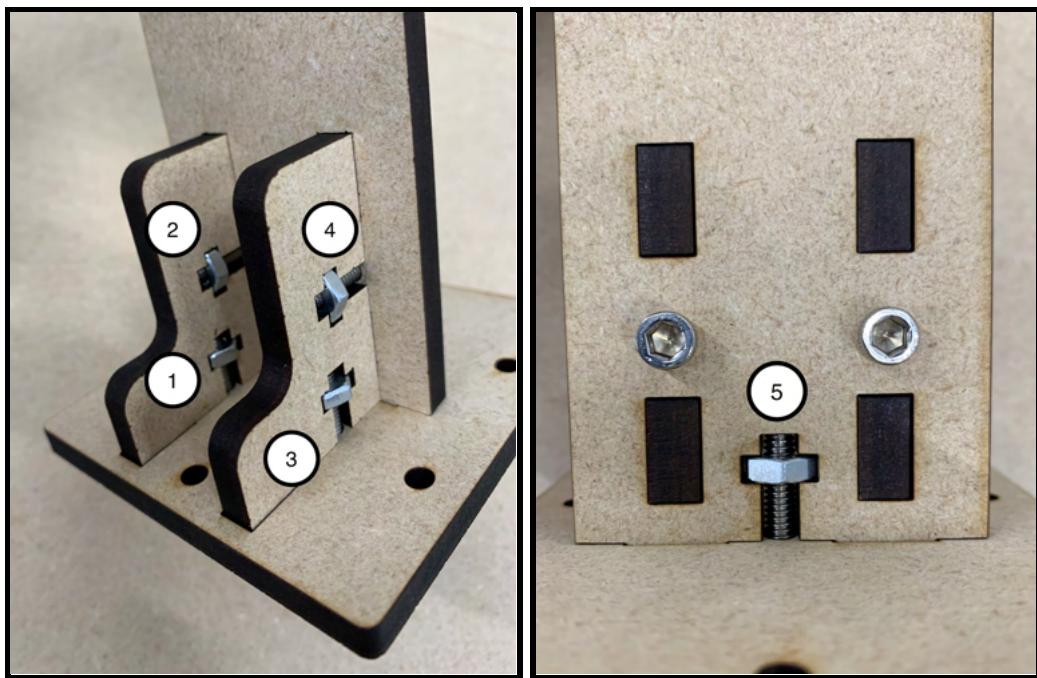


Demo Kit Assembly Guide

- 4) Then, insert this assembly (step 3) into the string mount base plate (2). The base plate is marked with a number 6.

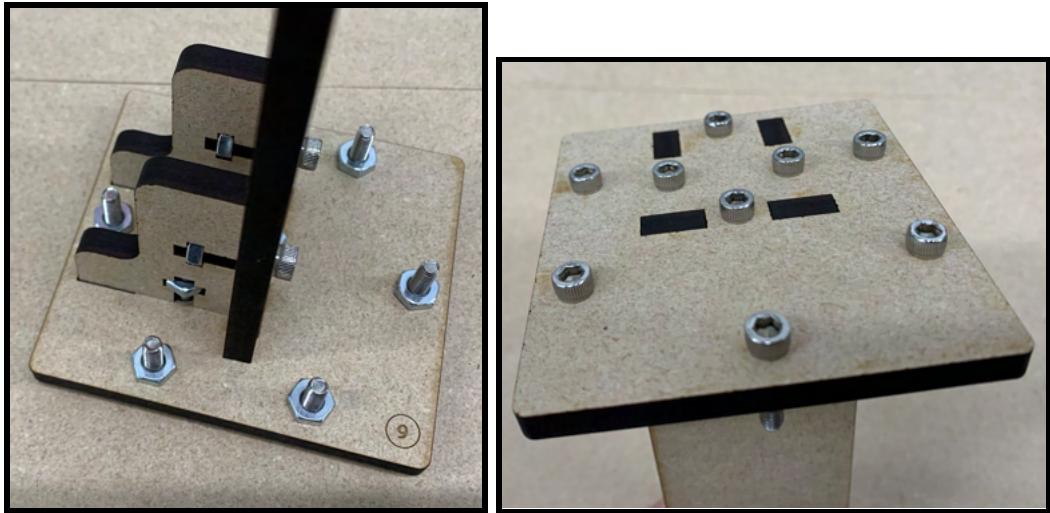


- 5) Use two 8-32 screws (10) and nuts (9) to secure the two ribs to the string mount panel (3). Use two 8-32 screws (10) and nuts (9) to secure the ribs (4) to the base plate, and one 8-32 screw and nut to secure the panel to the base plate.

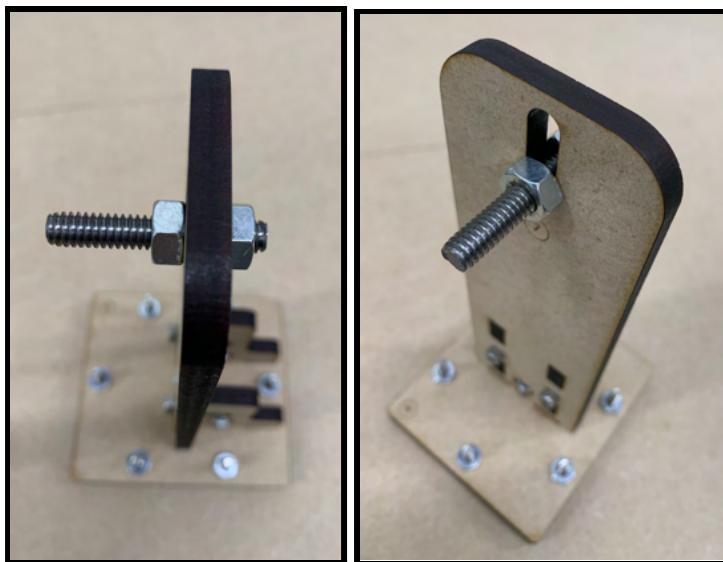


Demo Kit Assembly Guide

- 6) Insert six additional pairs of 8-32 screws (10) and nuts (9) to the peripheral holes on the base plate. Ensure that the screw head is flush at the bottom of the base plate. Tighten the nuts.

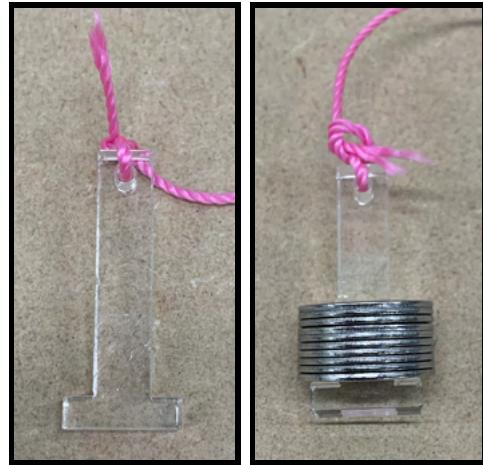


- 7) Clamp a $\frac{1}{4}$ "-20 steel rod (14) through the slot on the string mount panel (3) using two $\frac{1}{4}$ "-20 steel hex nuts (13).

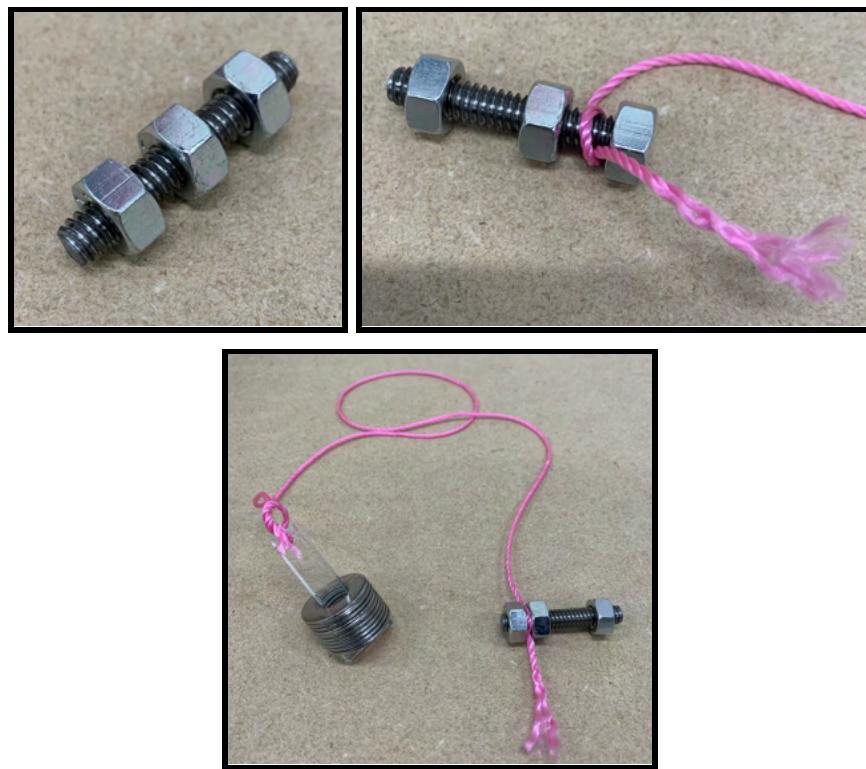


Demo Kit Assembly Guide

- 8) Thread the string (6) through the top hole of the T-piece (7) and tie a double knot to ensure the string does not untie. Slide washers (5) through the string and onto the T-piece.

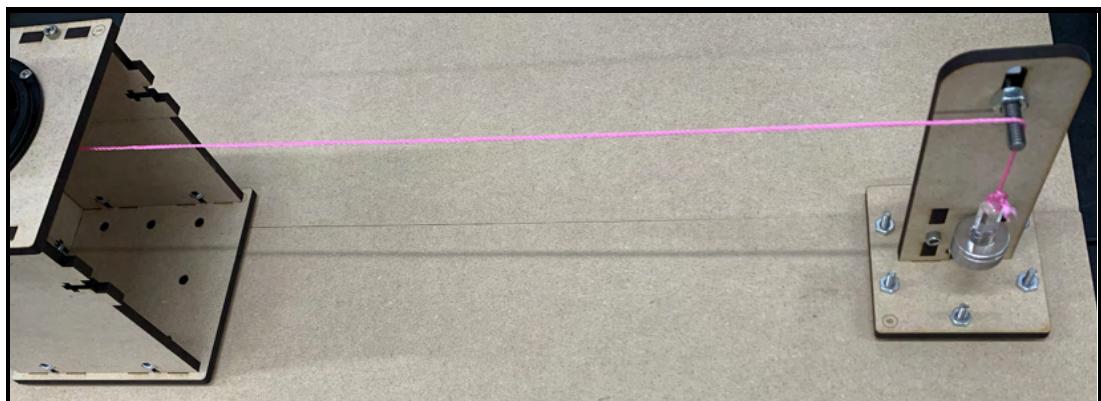
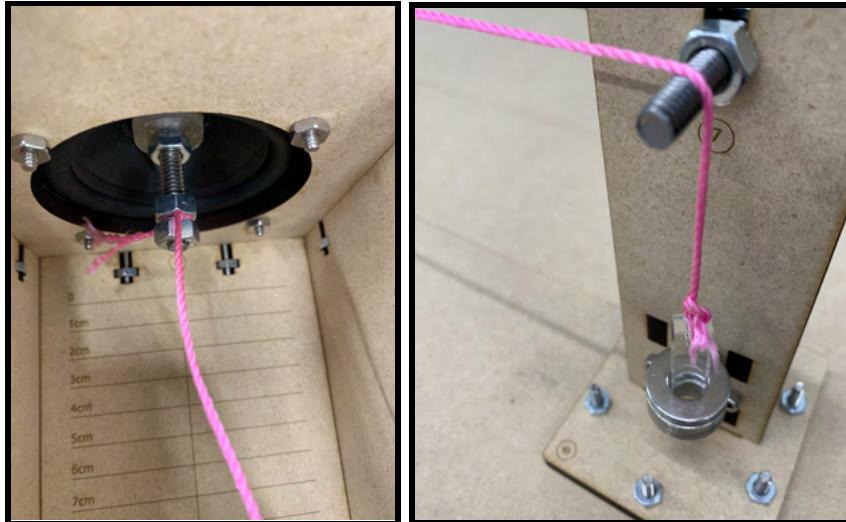


- 9) Thread three aluminum nuts (13) onto a $\frac{1}{4}$ "-20 aluminum rod (14). Tie a knot between two of the nuts. Screw the nuts together to clamp down on the string (6).



Demo Kit Assembly Guide

- 10) Thread the other end of the rod (assembled in step 9) into the speaker (8). Hang the T-piece (7) over the rod on the string mount panel (3). Move the housing and string mount apart until the T-piece and washer are suspended from the base and the string is tensioned. Slide the rod on the string mount along its slot in order to level the string.



**Add weights onto the string mount or tape it to the ground to prevent movement as the speaker vibrates.*

Demo Kit Assembly Guide

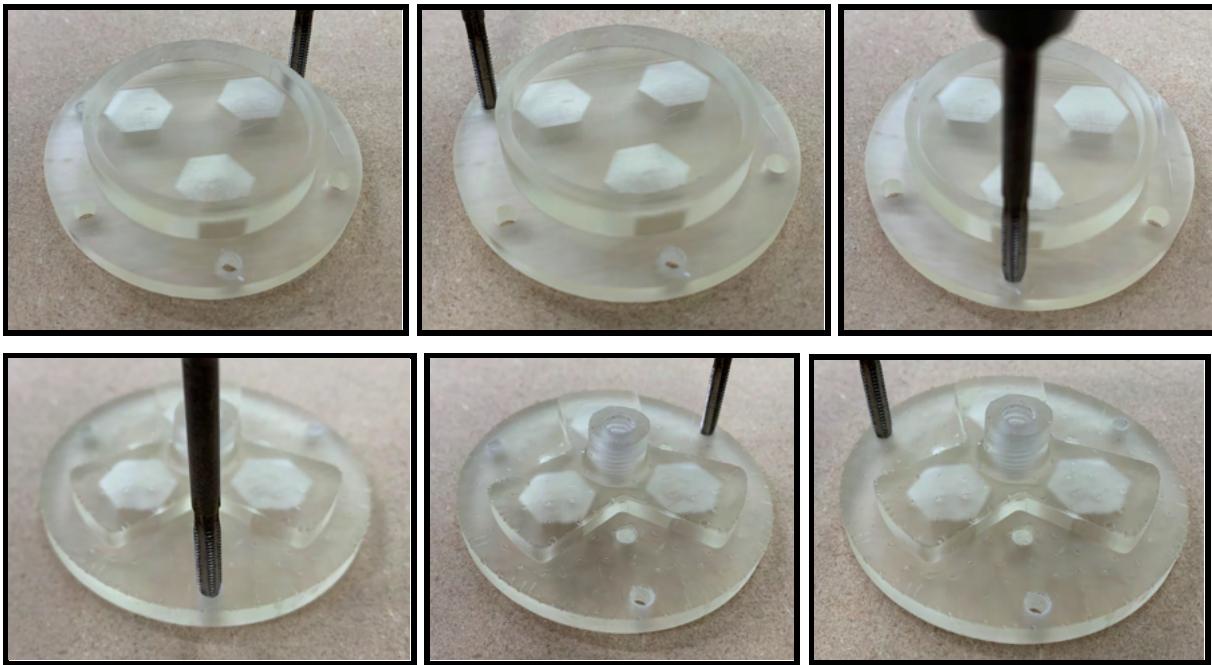
(F) Manufacturing Steps

(i) Tapping 3D printed pieces:

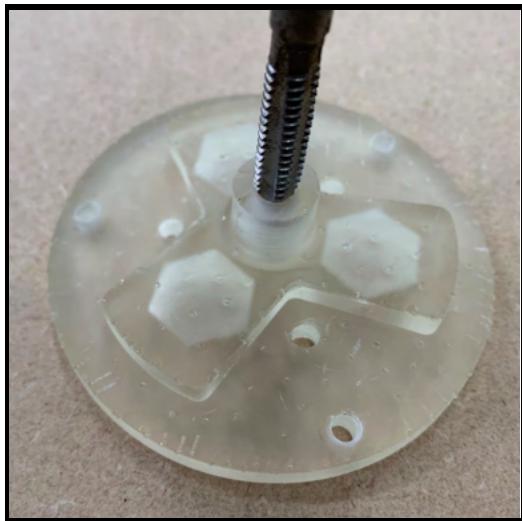


- a. Use a 1/4-20" tap to rethread the bottom section of the custom adapter.
- b. Use a 8-32" tap to rethread the side and central portions of the custom adapter.

Demo Kit Assembly Guide



c. Use a 8-32" tap to rethread three outer holes of the top and bottom platforms.



d. Use a 1/4-20" tap to rethread the underside of the bottom platform.

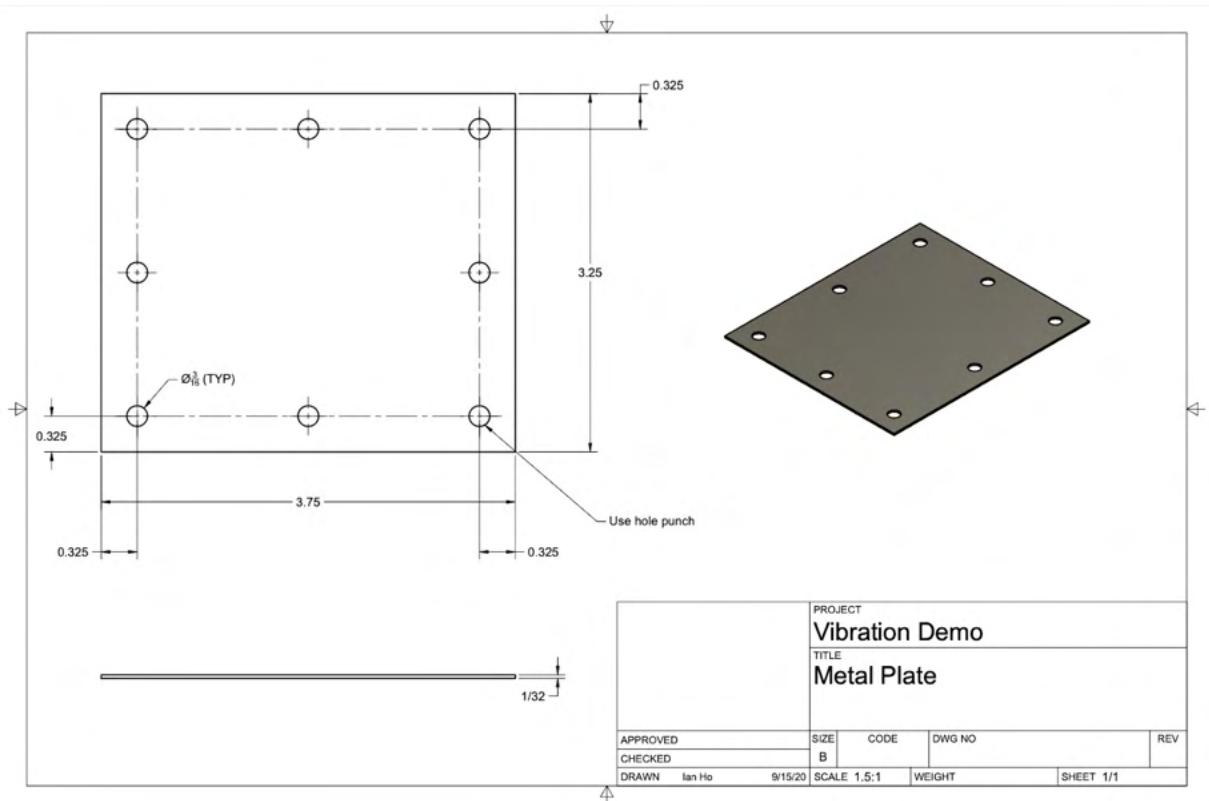
Demo Kit Assembly Guide

(ii) Shaker construction:

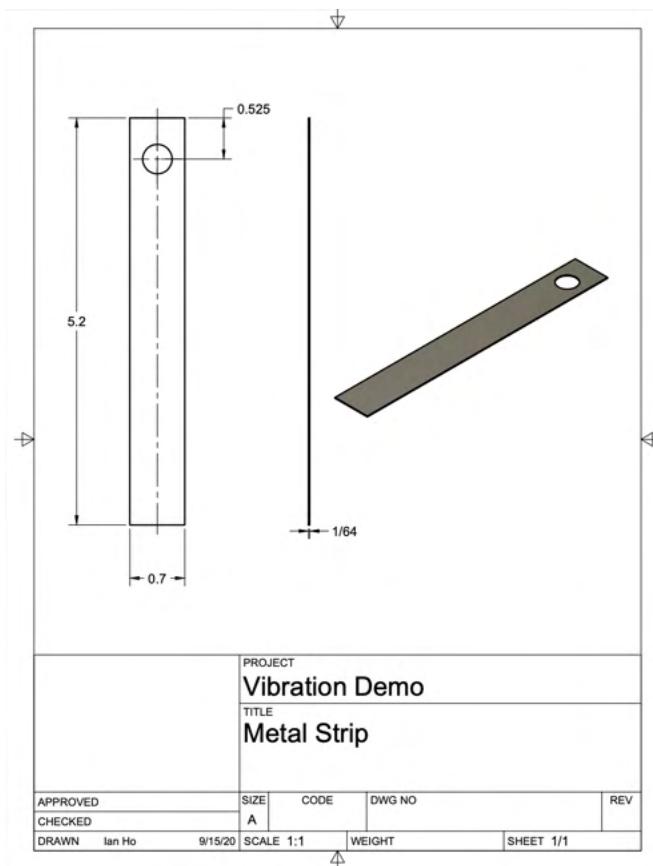


- a. Cut off the dust cap on the shaker to expose the voice coil.
- b. 3D print the threaded cylindrical attachment piece (labeled " ") and epoxy half of it full body length to the inner edge of the voice coil.
 - i. Use a threaded rod to manually keep the cylindrical attachment piece in place and to ensure that it remains perpendicular to the ground.

(iii) Sheet metal construction

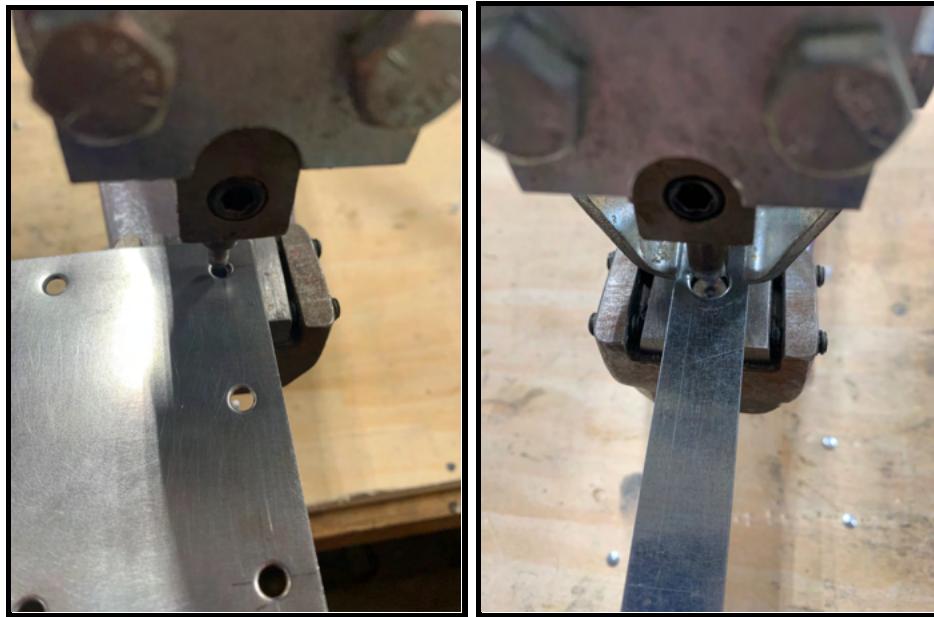


Demo Kit Assembly Guide



Demo Kit Assembly Guide

- a. Using a hand or floor shear, cut out the outer profile of the metal strip and plate according to the dimensions provided in the engineering drawings above. The metal plate and strip should be manufactured out of 1/32" and 1/64" sheet metal respectively.



- b. Using hole punches, cut through holes in the metal plate and strip according to the dimensions provided in the engineering drawings.

Demo Kit Assembly Guide

Appendix: Full BOM

Item	Quantity	Manufacturing
¾" Hex nut	6	NA
Compression Spring	3	NA
8-32 set screw	3	NA
Linear Shaft	1	NA
3D Printed Custom Adapter	1	3D Printing
8-32 x ¾" Hex head screw	23	NA
8-32 x ½" Hex head screw	8	NA
8-32 Hex nut	23	NA
6-32 x ½" Hex head screw	7	NA
6-32 Hex nut	4	NA
¼"-20 Threaded rod (aluminum)	1	NA
¼"-20 Threaded rod (steel)	1	NA
¼"-20 Hex nut (aluminum)	3	NA
¼"-20 Hex nut (steel)	2	NA
Small washer	6	NA
Large washer	10	NA
5/64" Allan key	1	NA
7/64" Allan key	1	NA
9/64" Allan key	1	NA
Mini screwdriver	1	NA
Top platform (vibration isolation)	1	3D Printing
Bottom platform (vibration isolation)	1	3D Printing
Top acrylic plate (vibration isolation)	1	Laser Cut-¼" Acrylic

Demo Kit Assembly Guide

Bottom acrylic plate (vibration isolation)	1	Laser Cut-1/4" Acrylic
T piece (string demo)	1	Laser Cut-1/4" Acrylic
String	1	NA
Top Plate (1)	1	Laser Cut-1/4" Particle Board
Left Plate (2)	1	Laser Cut-1/4" Particle Board
Right Plate (3)	1	Laser Cut-1/4" Particle Board
Back Plate (4)	1	Laser Cut-1/4" Particle Board
Base Plate (5)	1	Laser Cut-1/4" Particle Board
String Mount Base Plate (6)	1	Laser Cut-1/4" Particle Board
String Mount Panel (7)	1	Laser Cut-1/4" Particle Board
String Mount Rib	2	Laser Cut-1/4" Particle Board
L-bracket	4	Laser Cut-1/4" Particle Board
Sheet Metal Strip	1	Sheet Metal-1/64"
Sheet Metal Plate	1	Sheet Metal-1/32"
Magnets	2	NA
12V Power Supply	1	NA
Amplifier	2	NA
Aux Cable	1	NA
Jumper Wire (with LED strip connector)	1	NA
Jumper Wires	4	NA
LED Lights	1	NA
Acrylic disk (for LED)	1	Laser Cut-1/4" Acrylic
Alligator Clips	2	NA
Speaker	1	NA
Cylindrical Attachment (for speaker)	1	3D print

Demo Kit Assembly Guide

(G) User Interface Alternative (Octave)

As an alternative to the MATLAB user interface, a simple version of the dual-channel tone generator required to operate the speaker and lighting has also been developed in the open-source software Octave. The instructions below serve as setup instructions for the Octave version, only needed if used in place of the MATLAB UI described in the earlier sections (C) and (D).

You will need Octave installed on your local machine. We will control the speaker using the audio output system in your computer. We will use the ability to send different signals to the left and the right side of an audio channel and create a sinusoidal driving and a square wave for strobing simultaneously. This will allow us to control the amplitude and frequency of the strobing and driving for our set up.

1. It is important to first connect your speaker to Octave. The speaker ID is unique to each computer. To find out the speaker ID of your system, start Octave and follow the instructions.
 - 1.1. Run the following on the command window, “ `info = audiodevinfo` ”
 - 1.2. In your **workspace tab**, double click on the ‘info’ variable.

Workspace				
Filter <input type="checkbox"/>				
Name	Class	Dimension	Value	At
info	struct	1x1	...	

- 1.3. You will see two structured variables on your editor namely ‘input’ and ‘output’.

info	
	Values
input	[1x1 struct]
output	[1x4 struct]

Demo Kit Assembly Guide

- 1.4. Double click on the output option. You will see 3 columns, 'Name', 'DriverVersion' and 'ID'. In the name column find the connection for the speaker. It will be something like "Speaker / Headphones ..." or "External ..." depending on your machine. Locate the external headphones/speaker option. Obtain the corresponding ID number from the 3rd column. This ID is important to establish a connection between the speaker and Octave.

info.output			
	Name	DriverVersion	ID
1	DisplayPort C...	Core Audio	0
2	USB Audio Dev...	Core Audio	1
3	External Head...	Core Audio	3
4	Mac mini Spea...	Core Audio	4

Here, the ID is '3'. Remember this ID as it will be required later.

2. Download the .m file designed for Octave. This file represents a function that will be called through the command window.
3. The function can be called in the command window using the following format:
“ *octave_vibrations_lab_audio_out_v2 (audiodevinfoID, runtime, f1, f2, A1, A2)* ”
 - 3.1. The input variables should be replaced with numerical values that are defined as follows. Appropriate values for the amplitudes A1 and A2 will be determined in the following steps.

audiodevinfoID = value of ID previously identified in step 1.4

runtime = duration of tone generation in seconds

f1 = frequency of vibration in Hz

f2 = frequency of strobe lighting in Hz

A1 = amplitude of vibration signal

A2 = amplitude of lighting signal

4. Attach the electronics circuit assembled in part B to the computer by inserting the AUX cable attached to the amplifier to your computer.
5. **SET YOUR COMPUTER'S VOLUME TO ZERO.**
6. Turn the knob on the amplifier clockwise until it hits a stop in its rotation.

Demo Kit Assembly Guide

7. For the first test, in the command window, define the following variables:

```
audiodevinfoID = 3 (or value of ID that you identified in step 1.4)  
runtime = 5  
f1 = 30  
f2 = 29  
A1 = 0  
A2 = 1
```

Then run the tone generator by inputting the following command into the command window:

```
" octave_vibrations_lab_audio_out_v2 (audiodevinfoID, runtime, f1, f2, A1, A2) "
```

8. Turn on the volume on the computer, and slowly turn the amplifier knob counter-clockwise until the lights begin to flash brightly. If they do not illuminate, try turning up the computer volume and repeating the process. Once they are illuminated, leave the volume on your computer and amplifier setting fixed for the duration of the demo.
9. Run the tone generator again, but increase the value of A1 to 0.1. You should hear and feel the vibration of the speaker. If you cannot notice any vibration slowly increase the amplitude parameter A1 in subsequent runs.
Ensure that the amplitude isn't too great such that the speaker starts bottoming out (you will hear a loud rattling sound) as it could cause permanent damage. If this happens, immediately turn the volume of your computer down and restart the process.
10. Note that as you change the frequency of the signal sent to the speaker, the relationship between amplitude of the signal and the response amplitude of the speaker changes. Thus, if there is a large jump in the input frequency, it is safer to reduce the driver amplitude A1 before running the code again.