



# FLAG

## Flexible Linear Aeroelectrostatic Generator Demonstration Assembly Instructions

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## Introduction

These instructions are for the assembly of a Flexible Linear Aeroelectrostatic Generator or FLAG. This exciting new technology has roots in the earliest commercial electrical generators, developed in the late 1800's using electric fields to generate electricity. These "influence machines" were quickly abandoned for the electromagnetic generators that remain common today. Modern materials combined with airflow-induced motion creates a new family of wind generators which are lightweight, quiet, visually appealing, and recyclable.

This demonstration FLAG design has an operating range of approximately 15-50 km/h, and generates high voltage, low current electrical output at ~500 V and 0.75  $\mu$ A (20 km/h windspeed). Constructed from .002" thickness polyester film, the FLAG can be operated using an ordinary indoor fan to run small loads such as fluorescent lights, neon lights, or multiple LED's in series. Constructed from .005" inch polyester film, the generator has a higher cut-in speed but is more robust for experimentation.

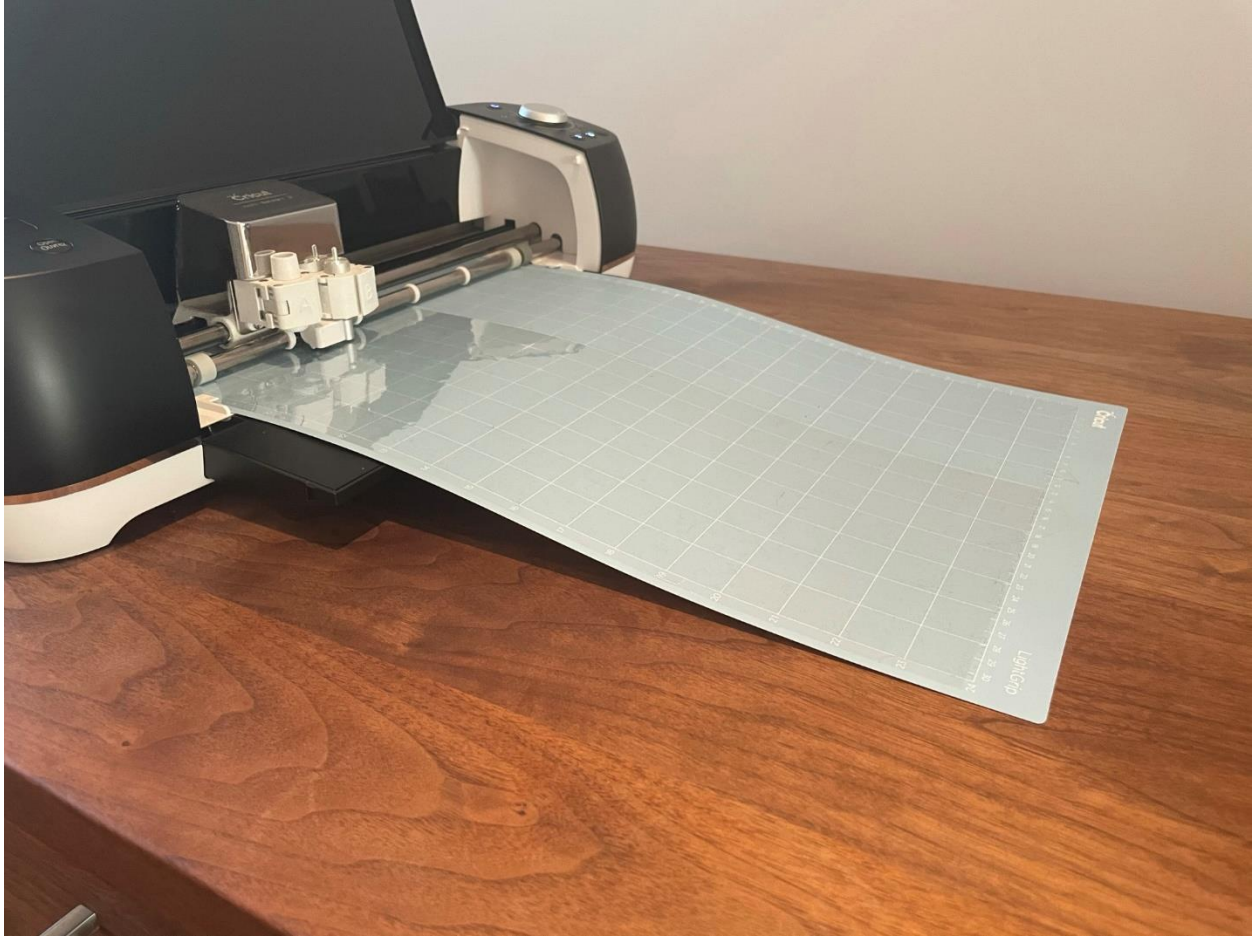
Please note, this particular design has been prepared with in mind for demonstration purposes, not longevity or performance. At high windspeeds, the specified diodes will occasionally break due to excessive repeated bending, or tears in the polyester can occur. Running the generator without an electrical load (with no lightbulb connected), will also sometimes damage the generator. More robust FLAGs can be constructed using 3D printed components to support the diodes, alternative materials, and different designs.

For more information, please visit [www.windfluence.ca](http://www.windfluence.ca).



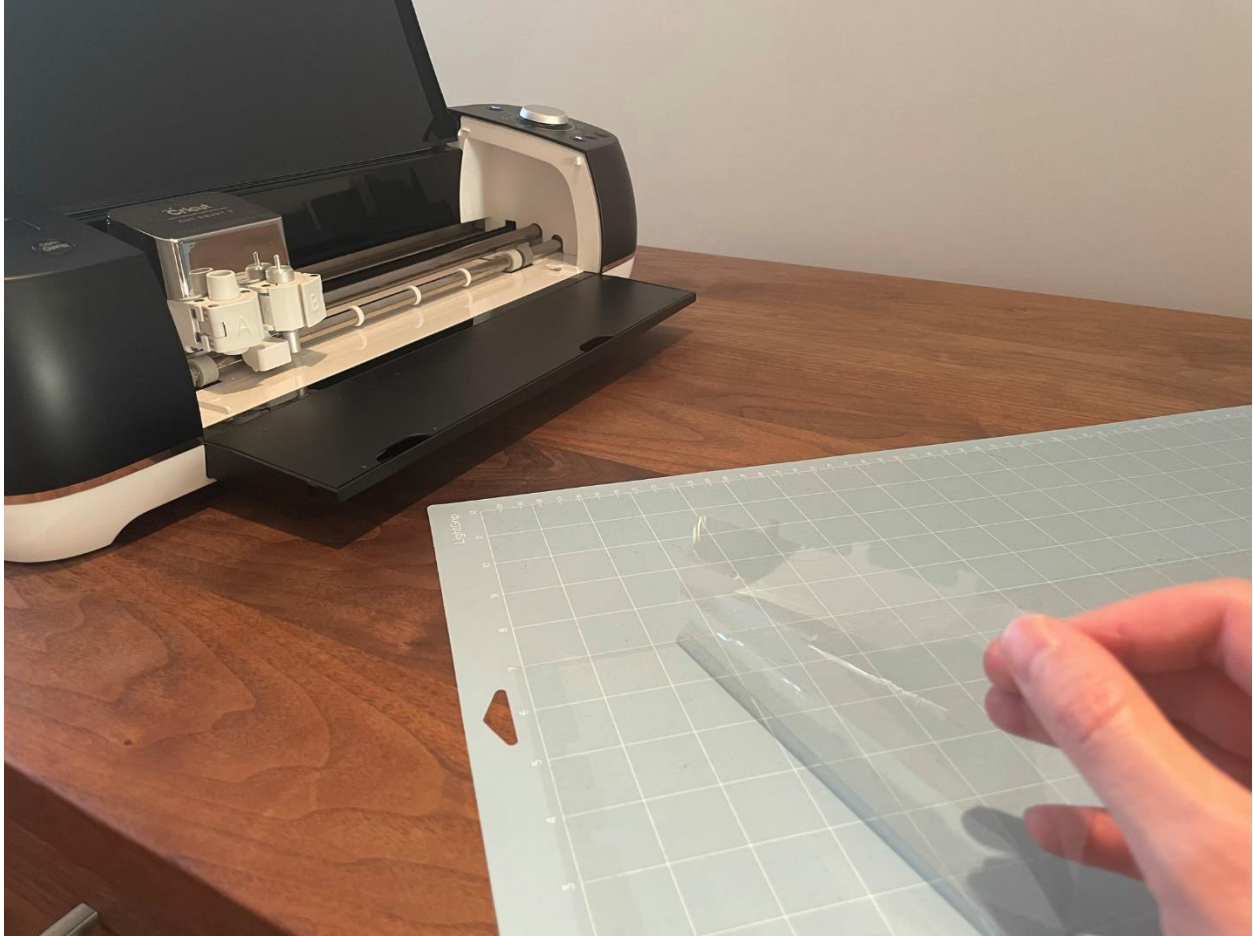
### Step 1: Collect Materials

- One piece of .002 - .005" thickness, 7"x24" polyester film.
- Two sheets of 3M CN3190-10.3X10 conductive film.
- Three M100FF3 10 kV diodes from Voltage Multipliers Inc. Alternative diodes should be rated for 1 kV or greater
- Cricut Explore Air 2 or Cricut Maker.
- 12"x24" Cricut Light Grip Mat, 12"x12" Cricut Standard Grip Mat (not shown)
- Generator load (not shown): One T4 fluorescent bulb (12"-18" long), or a small fluorescent bulb, neon bulb, or LED's (LED's should be connected in series and require a very small spark gap. The FLAG can blink at least 100 LED's).



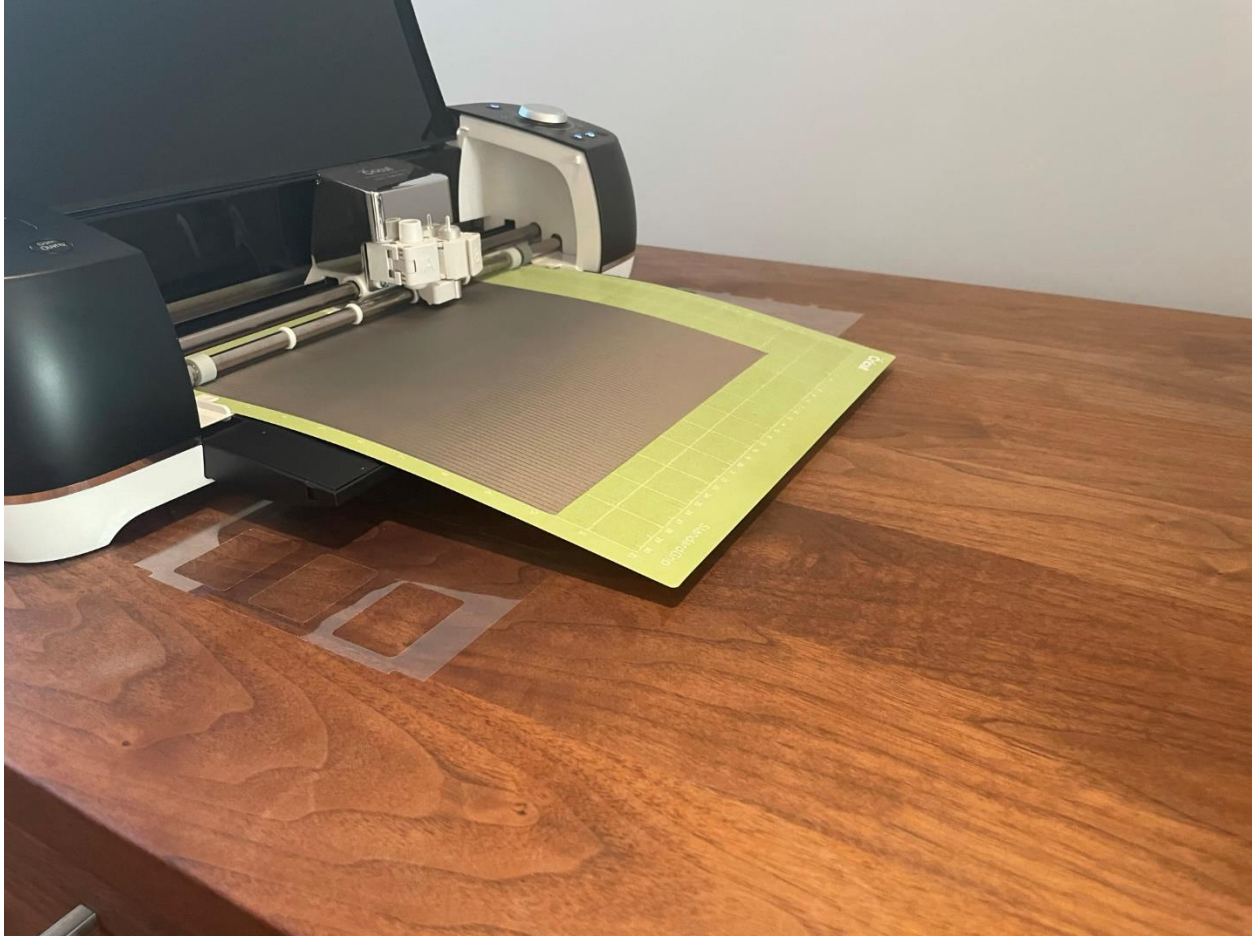
## Step 2

- Apply polyester film to the upper left corner of a 12" x 24" Cricut Light Grip mat.
- Load the Cricut Design Space project at the following link:  
<https://design.cricut.com/landing/project-detail/606f8af5ba942d082cfa6276>
- Cut the film.



### Step 3

- Peel the cut plastic from the mat.



#### Step 4

- Apply one sheet of CN3190 to a 12' x 12" Cricut Standard Grip mat
- Load the Cricut Design Space project at the following link:  
<https://design.cricut.com/landing/project-detail/606f7b57dd207f0e8036c6a3>
- Cut the film. This should make enough conductors to construct three generators.



### Step 5

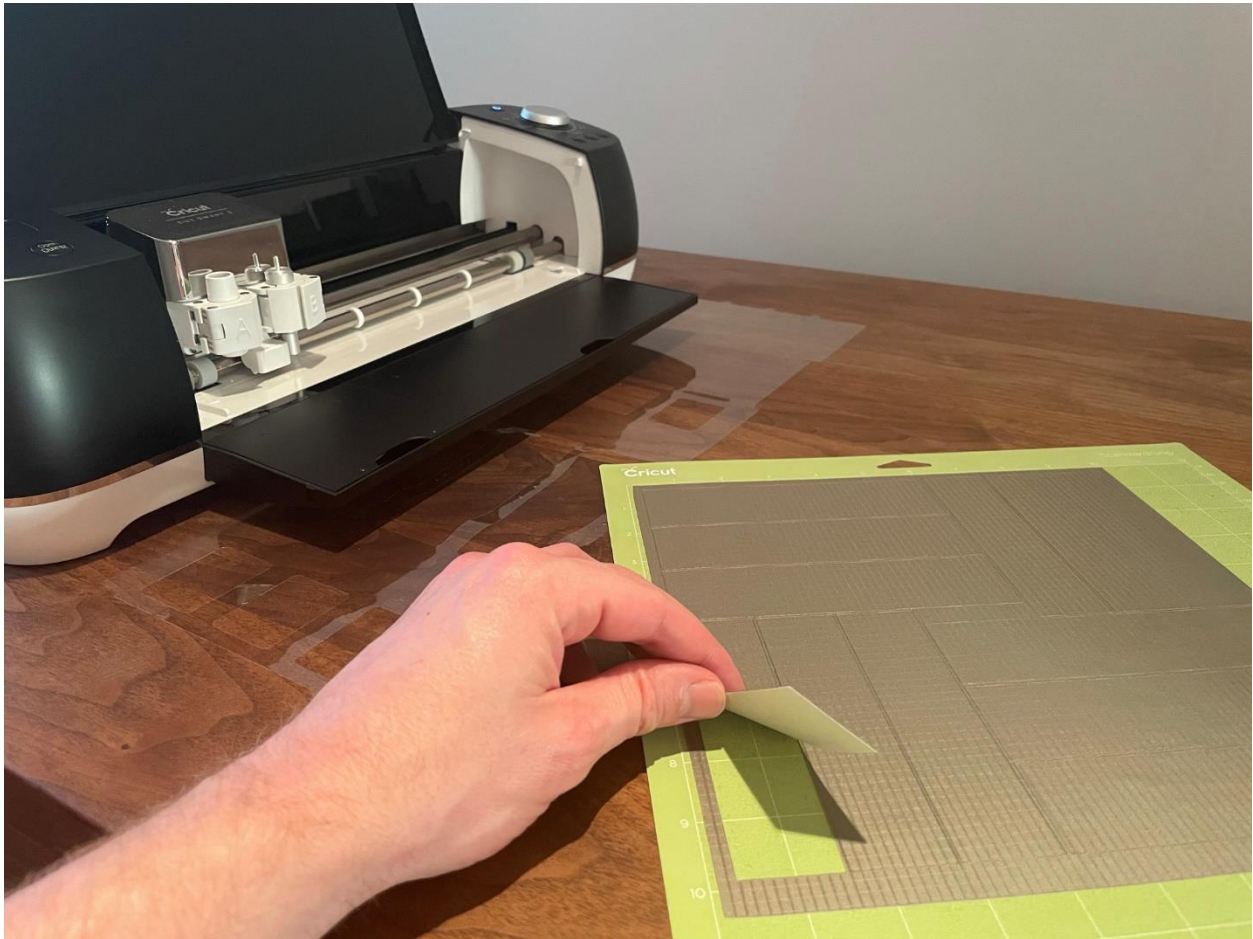
- Remove the cut out conductors from the mat. The conductive film has a paper backing to protect the conductive adhesive. Be sure to peel the film and backing off the mat together.



## Step 6

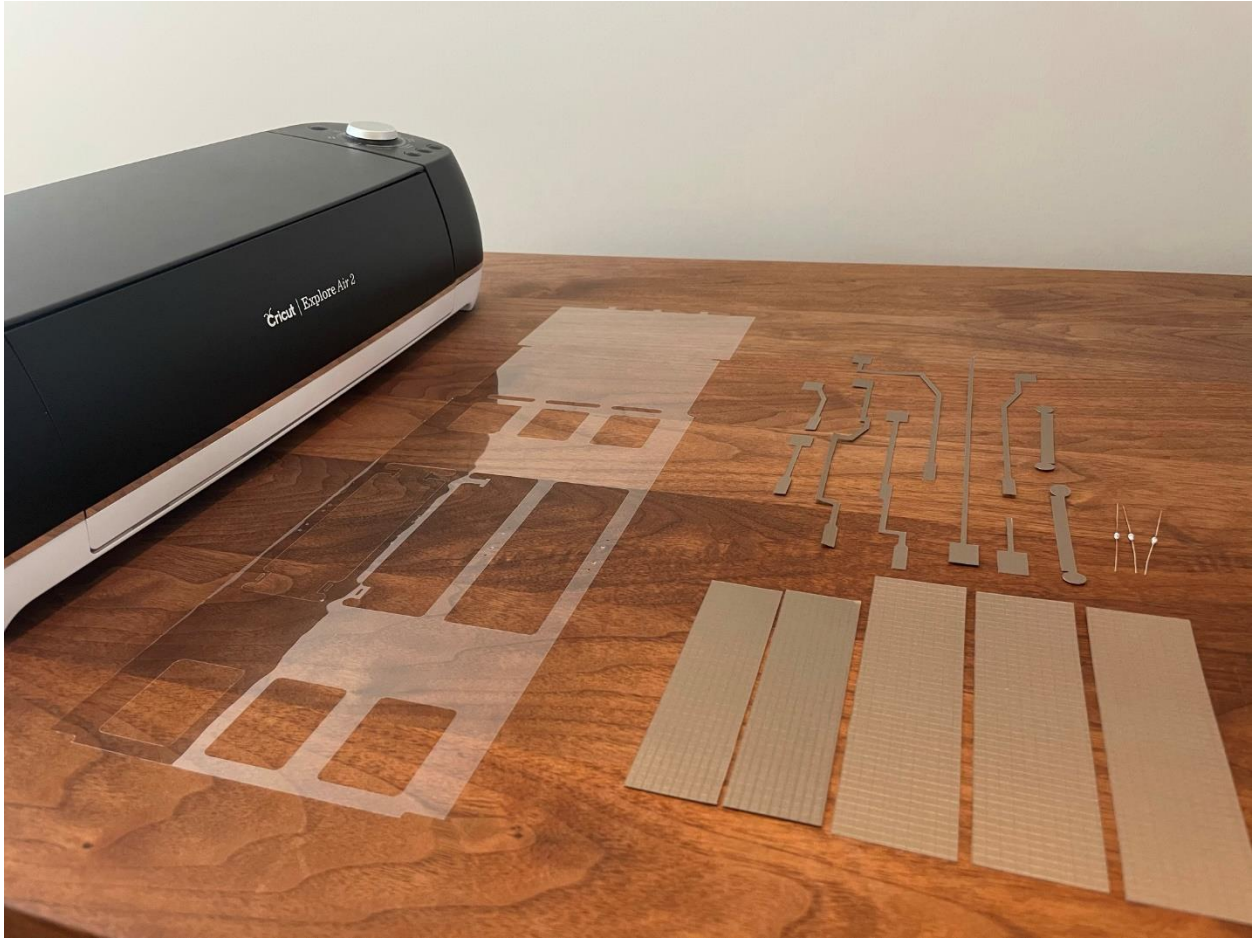
- Apply the second sheet of CN3190 to a 12' x 12" Cricut Standard Grip mat
- Load the Cricut Design Space project at the following link:  
<https://design.cricut.com/landing/project-detail/604be68ac5cef40d544ce69f>
- Cut the film. This will cut out the rectangles that will be referred to as sectors (the large rectangles are actually the electrostatic machine sectors, and the small rectangles are part of an energy storage capacitor which is mounted on the generator for convenience).
- This should cut enough sectors to construct two generators.





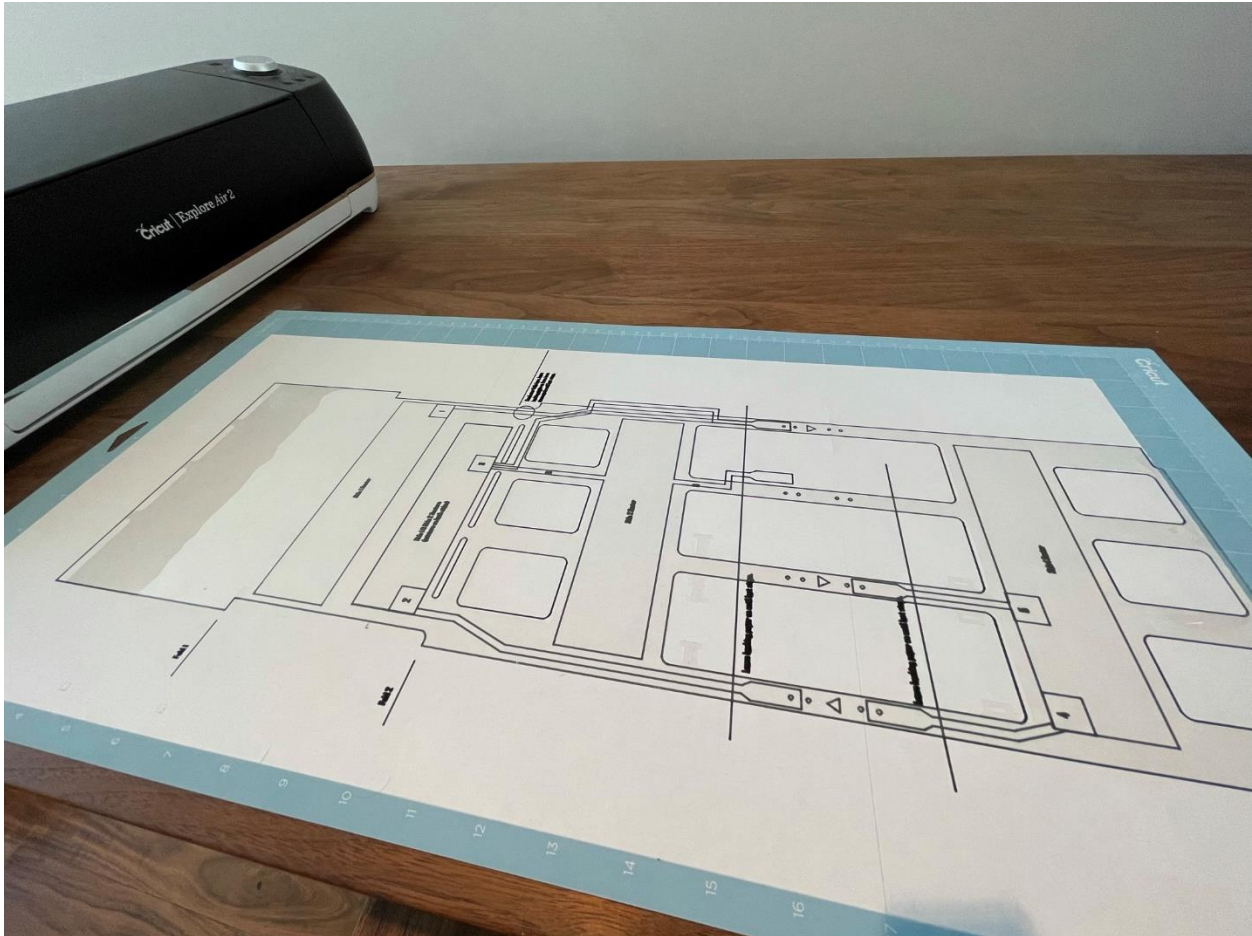
### Step 7

- Remove the sectors and backing from the mat.



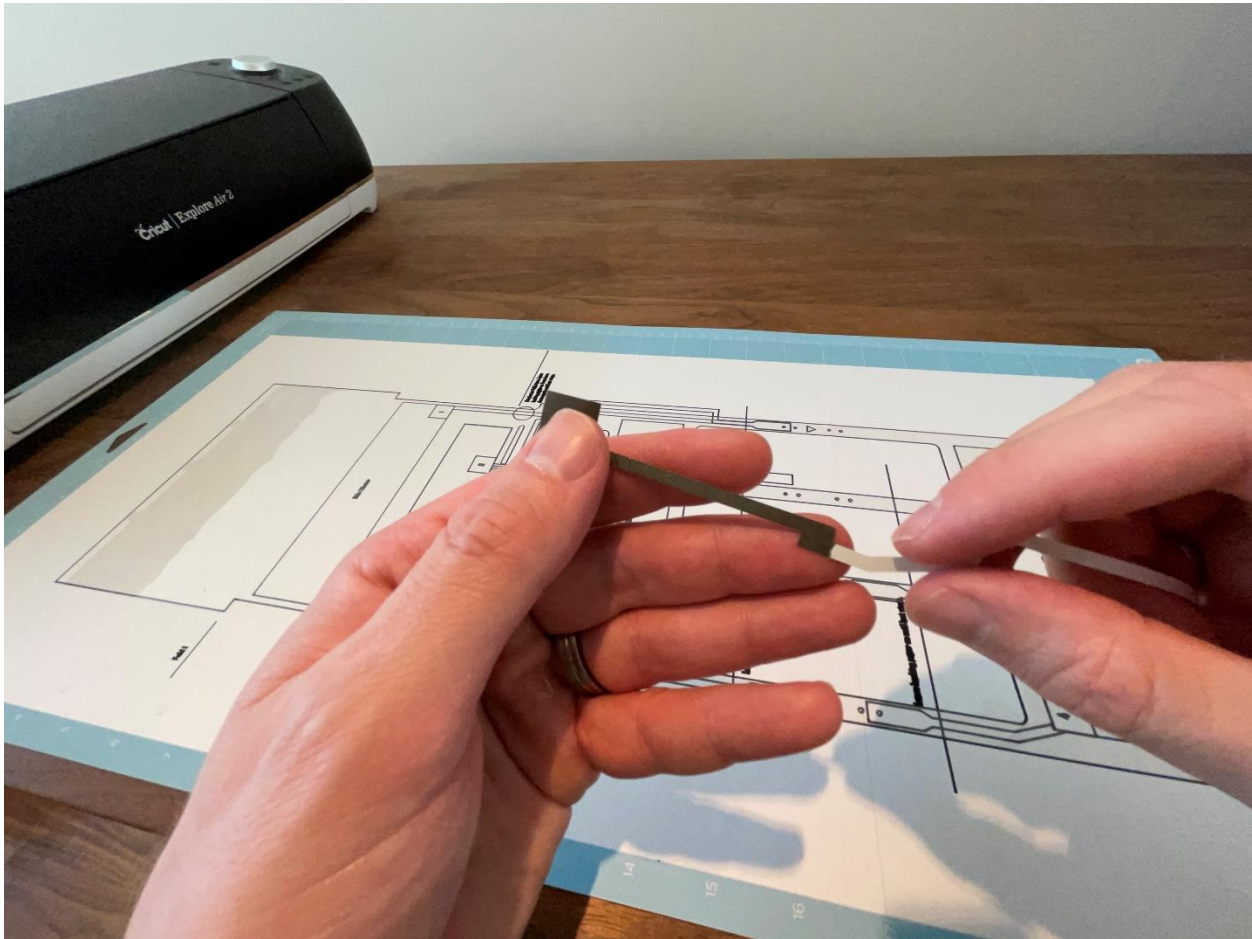
## Step 8

- You should now have these parts ready to go.



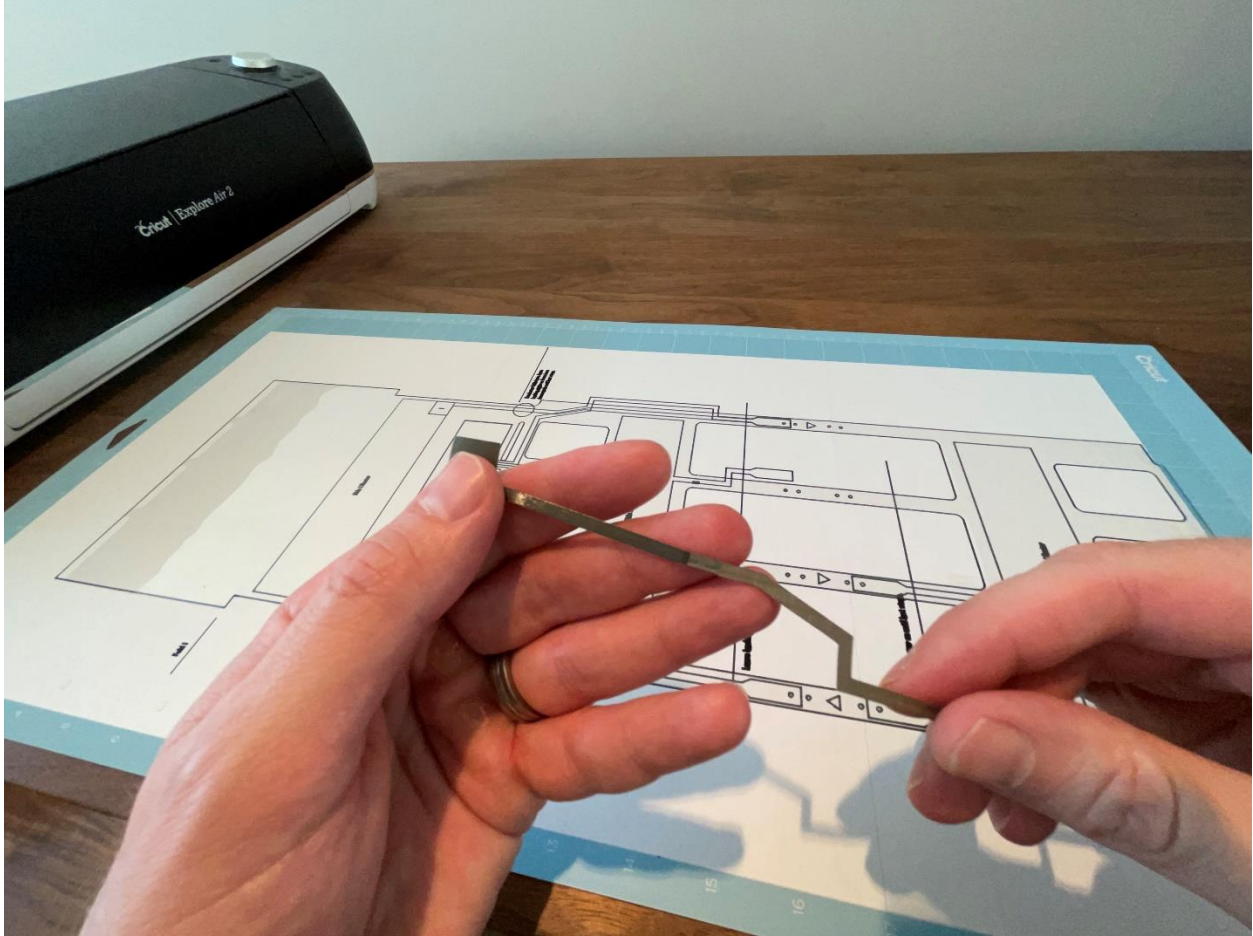
## Step 9

- In order to more easily locate the adhesive conductors and sectors on the polyester film, print the last two pages of these instructions as a mounting template. Tape them together, and down to a work surface so they don't move around.
- Alternatively, a Cricut Design Space project can be loaded, and printed on the Cricut using paper stuck to an old 12x24" Cricut mat. <https://design.cricut.com/landing/project-detail/606f8c0f7fdc9b0d4c5ab8d6>
- Put the polyester film on top of the printout.
- It's not absolutely necessary, but a couple small pieces of tape can be used to hold the corners of the polyester in place on the template.



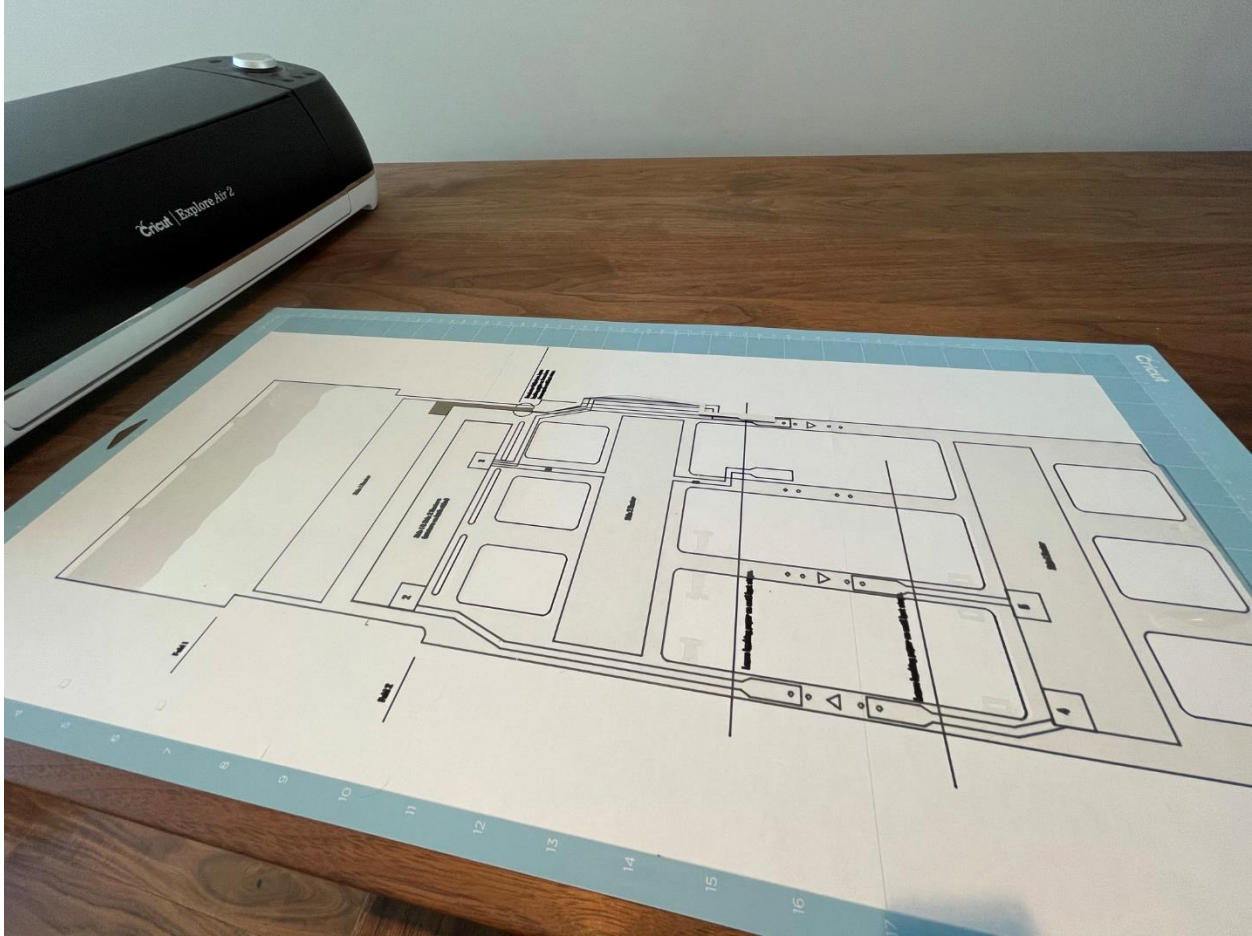
### Step 10

- For the conductor corresponding to “1” on the template, peel the backing paper off to the indicated location. This will keep the bottom part from sticking things until we are ready for it later.



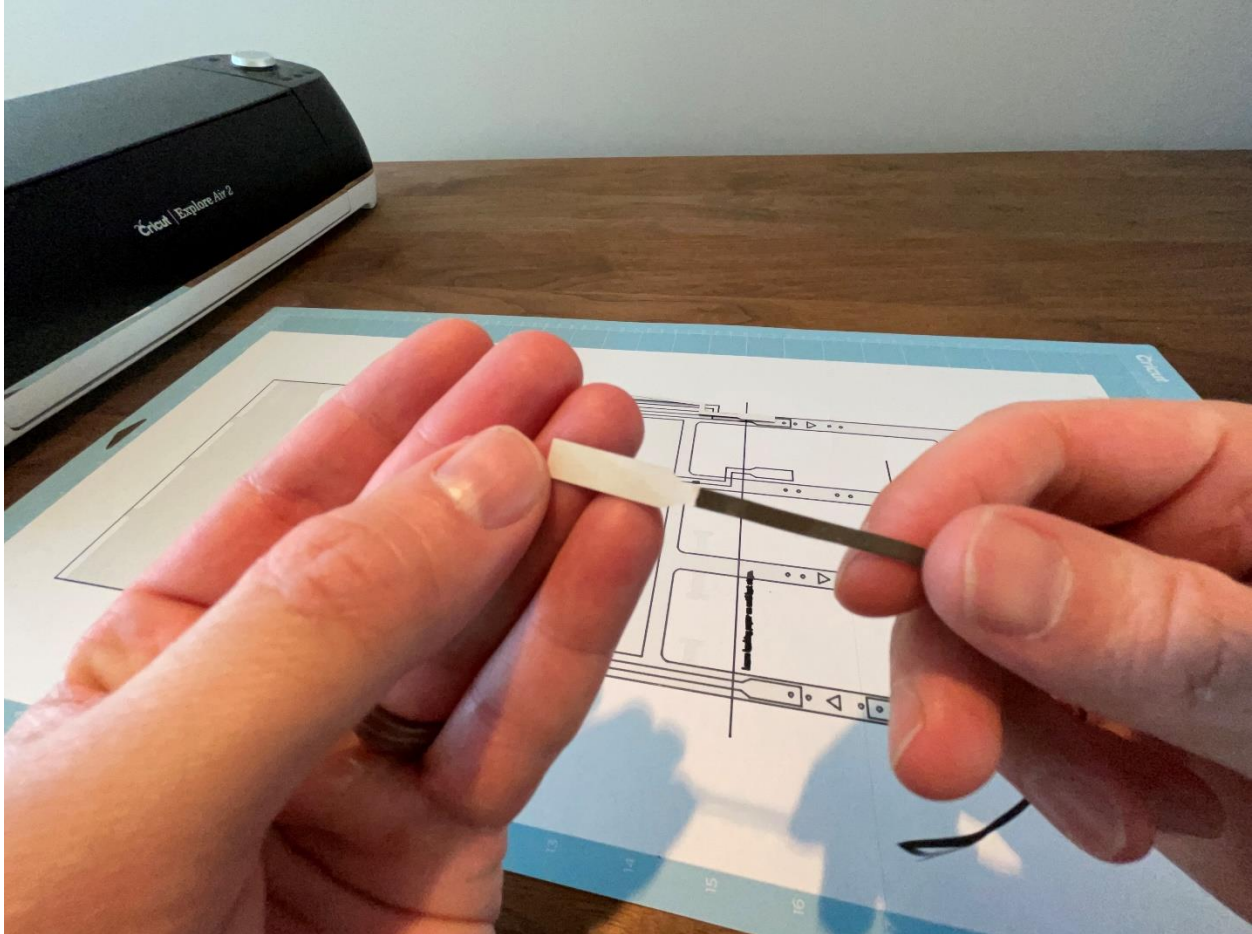
### Step 11

- Fold over the bottom portion of conductor 1 so it appears as shown.



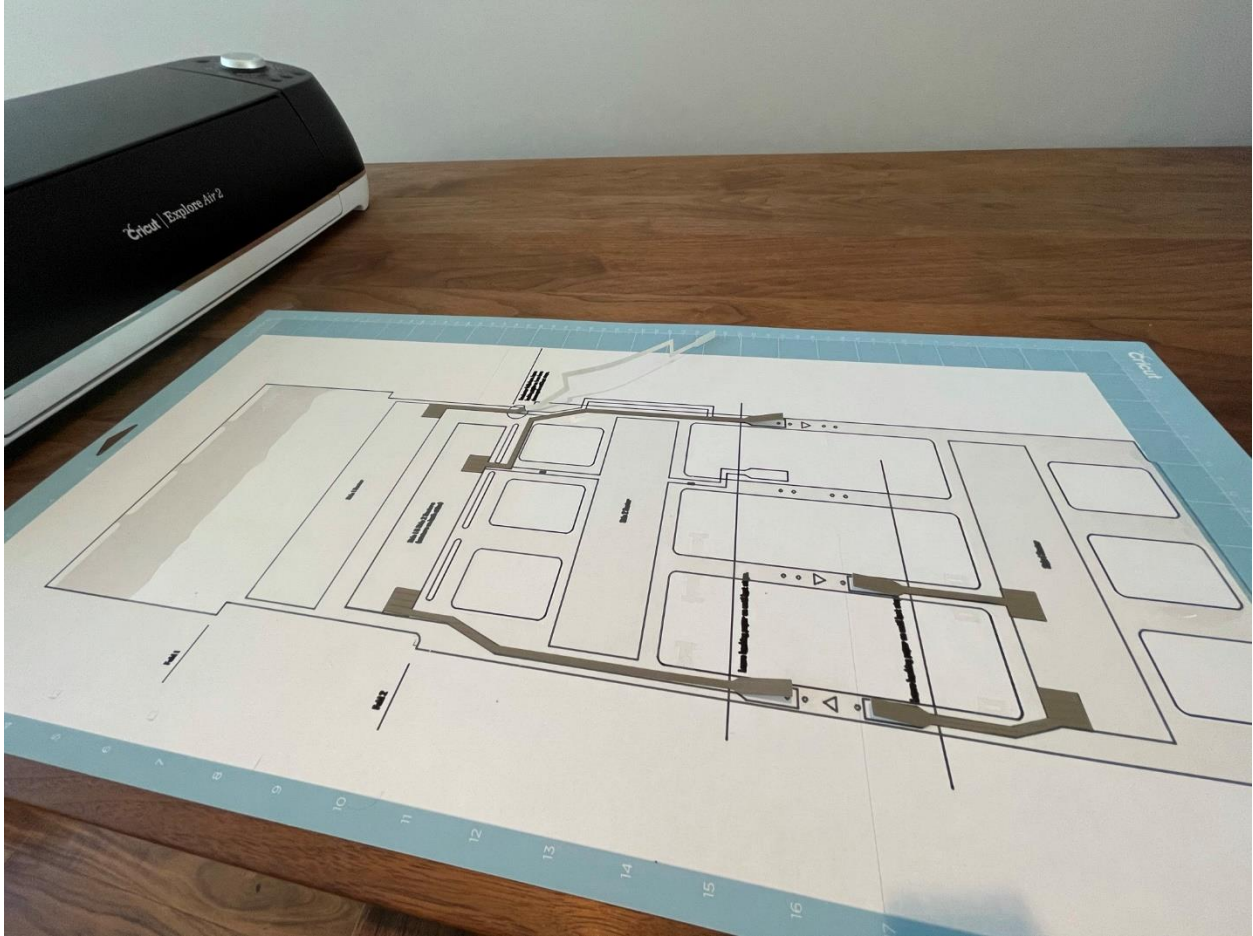
## Step 12

- Apply conductor 1 to the polyester film in the indicated location. The portion with the paper backing should be left this way until later.



### Step 13

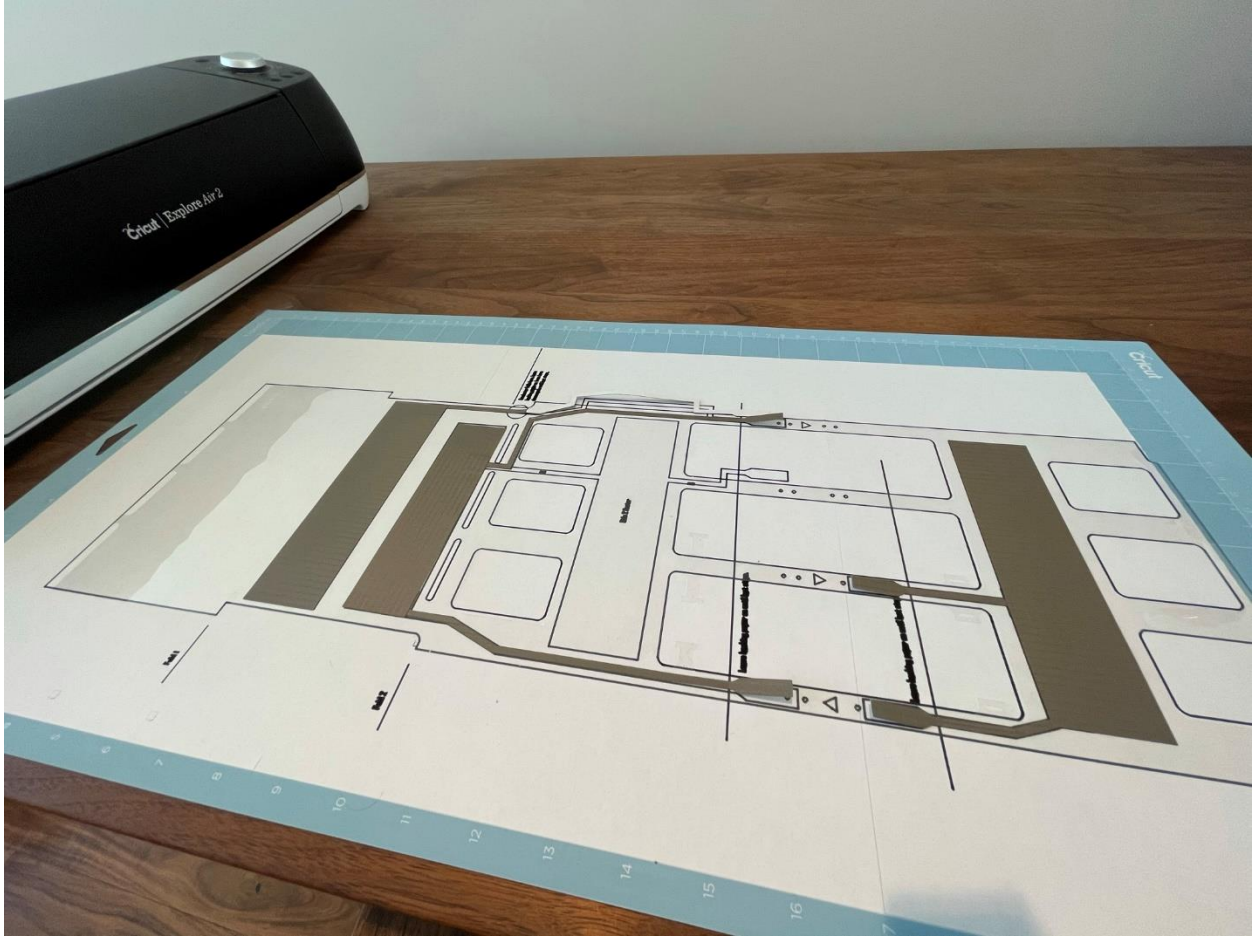
- Conductors 2, 3, 4, and 5 can now be applied. For all of these, leave the backing on the end of the conductor as shown for now (the last 1" on the end that is not square). This will make it easier to put in the diodes later.
- If you accidentally peel off all the backing paper, don't worry. Just apply the conductor in the indicated location and when it comes time to install the diode, it can be peeled back to install the diode, or the diode can alternatively be taped down using another piece of the conductive CN3190 film.



### Step 14

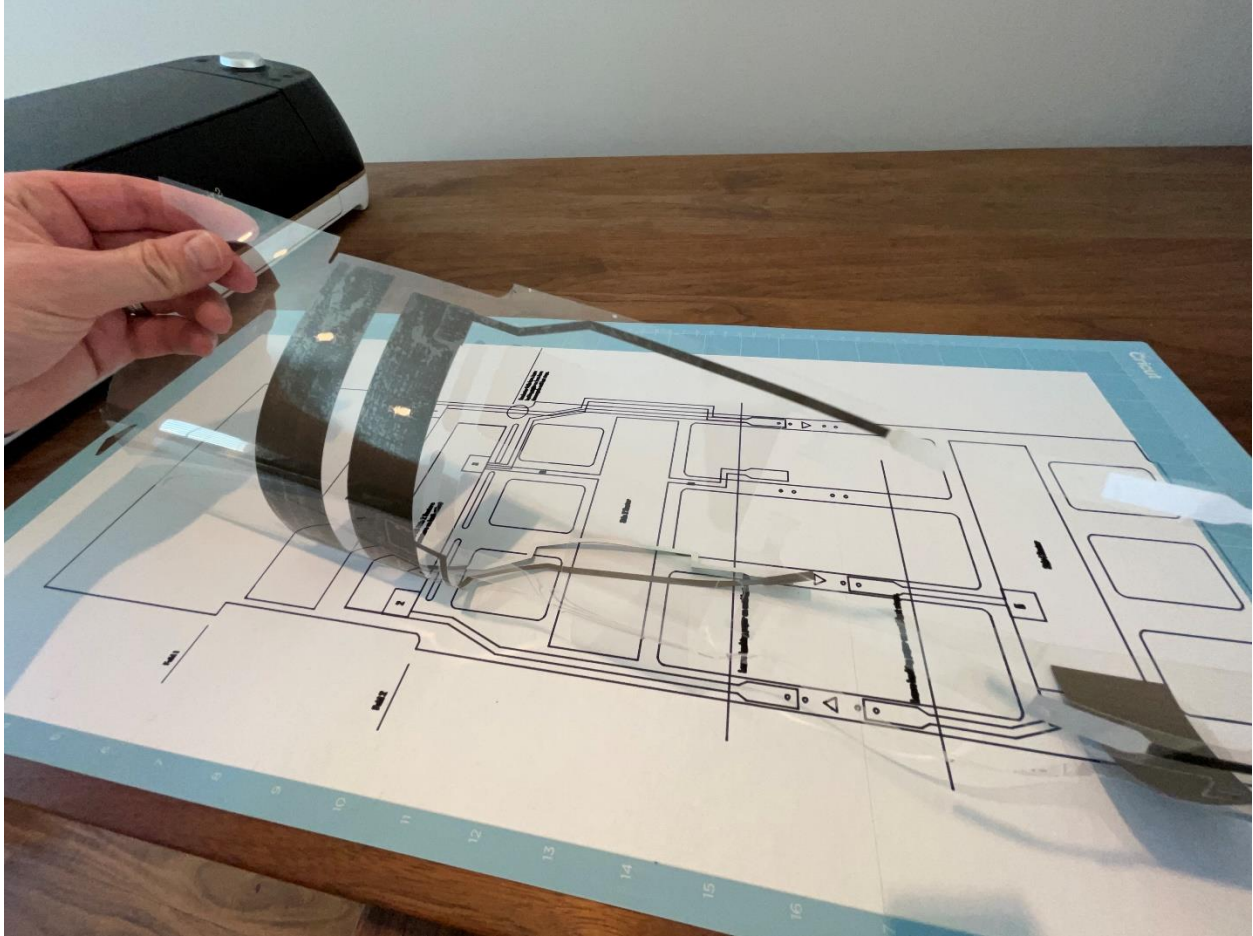
- The conductors should now be applied as shown.





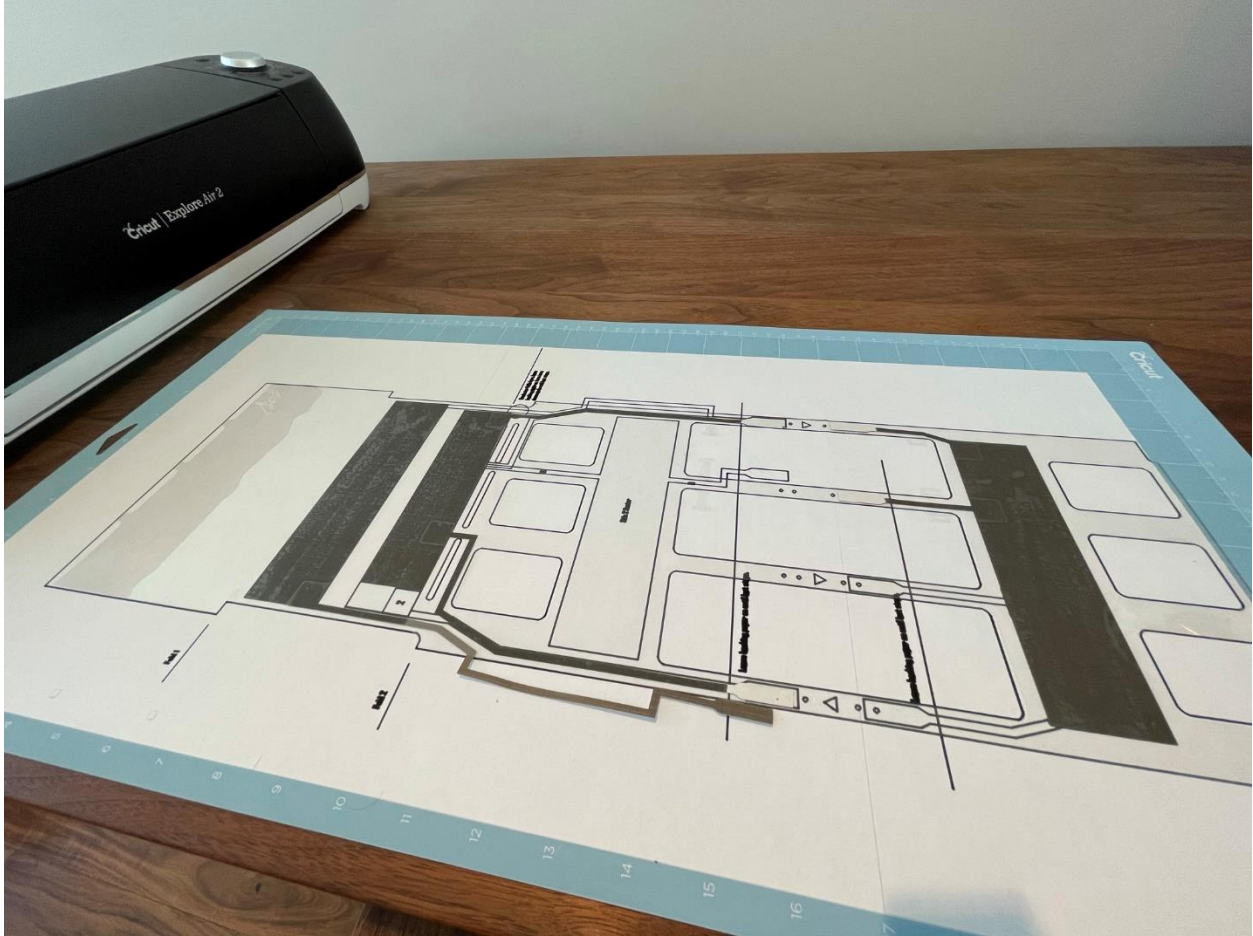
## Step 15

- Apply the sectors to the indicated locations. Note that there are two different sizes.



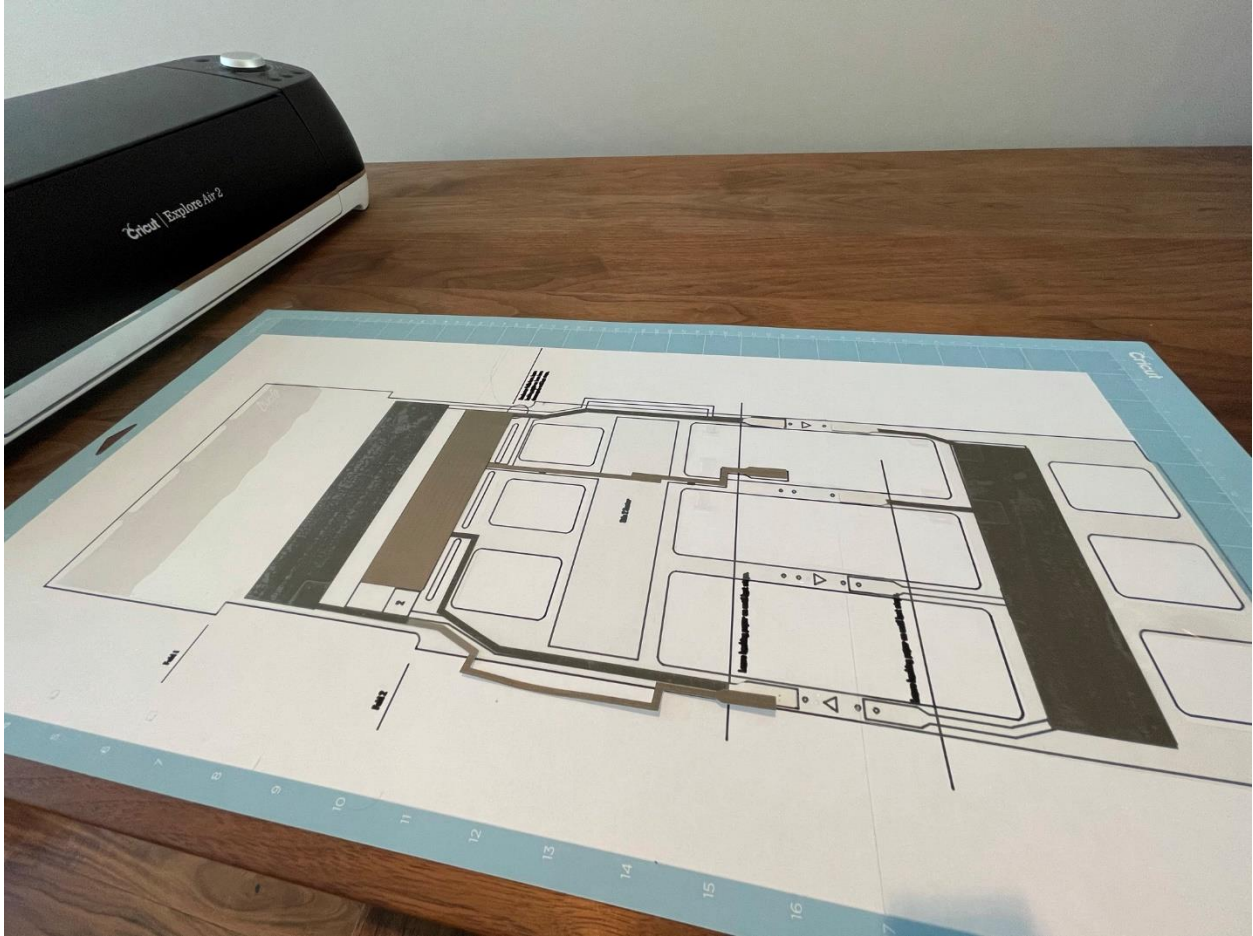
### Step 16

- Flip over the polyester, and put it back on the template. Line it up as exactly as possible.



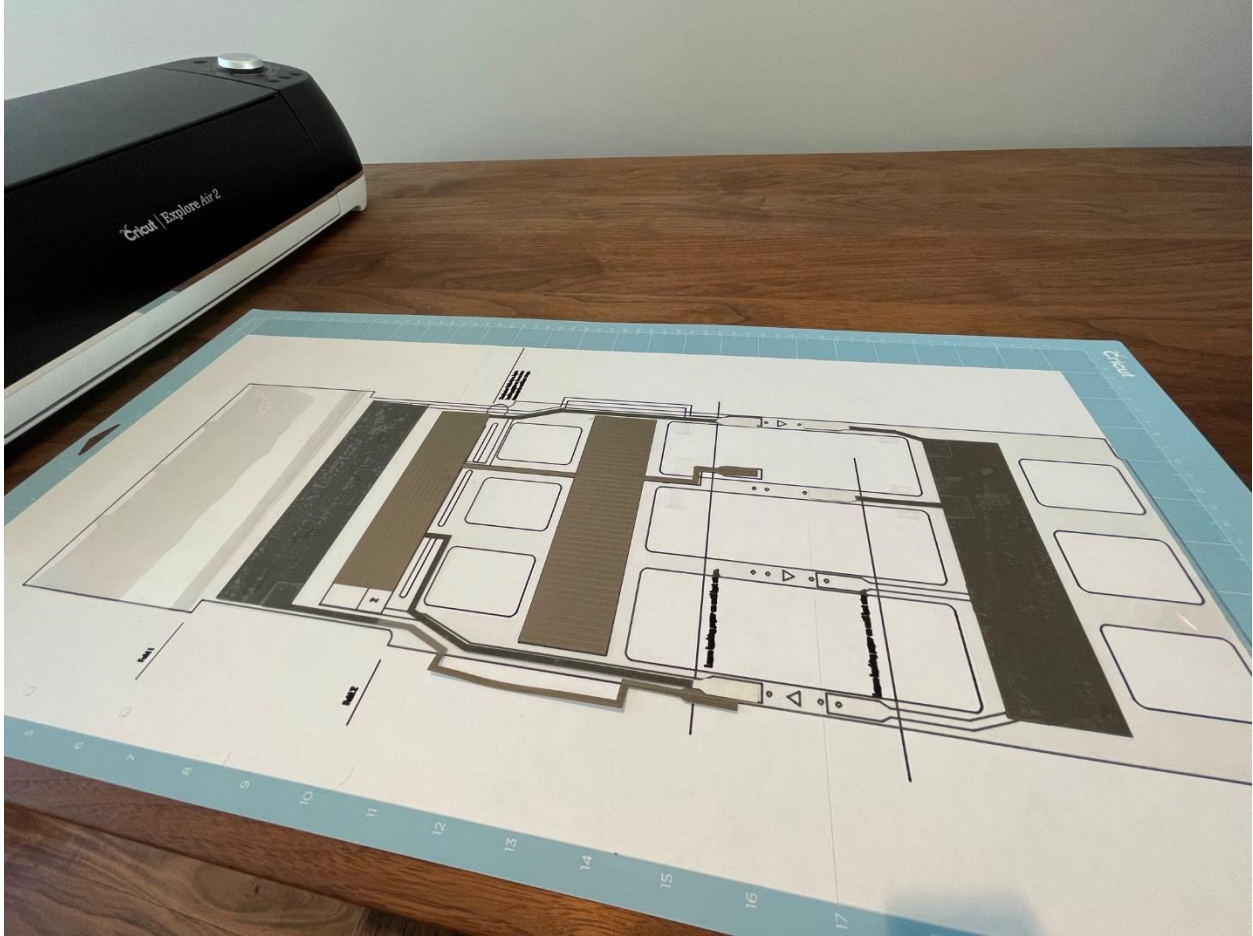
## Step 17

- It should now look like this.



### Step 18

- Apply the last remaining conductor 6 to the polyester film (leaving the last one inch of backing paper in place as before).
- Apply the remaining small sector in the indicated location. It goes right on top of the other small sector.



## Step 19

- Apply the remaining large sector in the indicated location.



## Step 20

- Flip over the polyester onto the other side.
- Fold down the polyester as shown. There are notches on both sides in the appropriate fold location, and the three small curved tabs should line up with the bottom of the three oval shaped slots.
- Apply some pressure to the folded edge with your fingernail or a ruler to give it a nice crease.



### Step 21

- It should now look like this.



## Step 22

- Flip everything over everything towards yourself as shown.
- Fold the bottom four inches upwards as shown. This fold crease should be at the bottom of the three horizontal ovals. The sectors should also align fairly well when you fold this over (if they are out of alignment by a few mm, it is not a concern).





### Step 23

- It should now look like this.



## Step 24

- It is time to use the double sided tape. Cut three 1" long pieces.



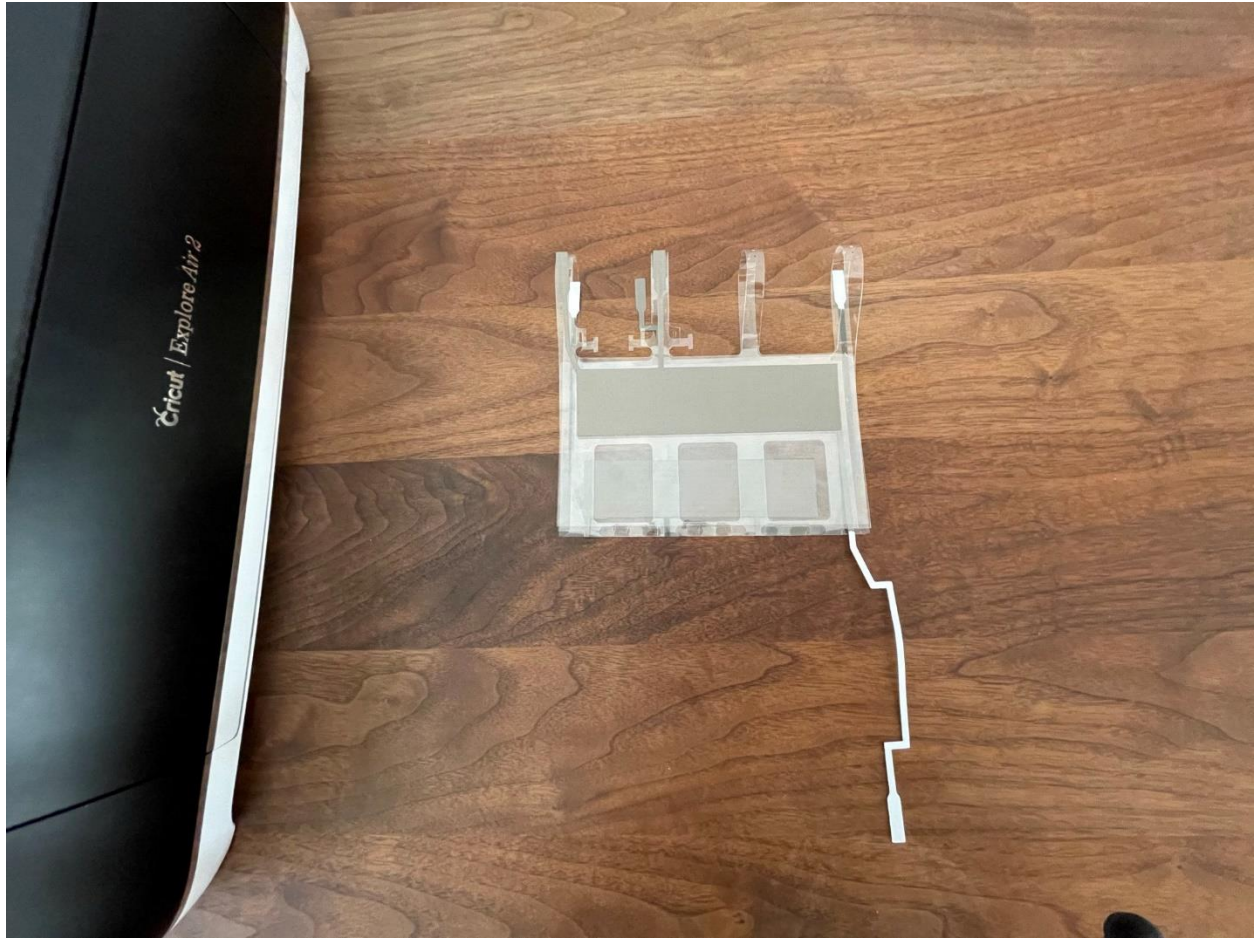
## Step 25

- Put the three pieces of double sided tape in the indicated location. They should align with the bottom edge.
- Once you have them stuck down, remove the red backing to expose the other sticky side.



## Step 26

- Fold down the top edge of the generator, and using two hands, hold the edge at the corners with some tension so it is straight.
- Stick it onto the double sided tape in alignment with the bottom edge.



### Step 27

- The generator should now look like this.



### Step 28

- Peel off the backing from conductor 1 leaving the backing paper in place only on the last 1”.



### Step 29

- Press the generator down flat to your work surface, and stick down the rest of conductor 1 as shown. There should be a portion of the conductor overhanging the edge of the generator.



### Step 30

- Fold over the overhanging portion of conductor one, onto the other side of the polyester. The purpose of this is just to route the conductive surface further away from the sector.





### Step 31

- It's now time to install the diodes. Give your diode a bend like this.



### Step 32

- Insert the ends of the diode through the holes in the polyester. Note the orientation of the diode- the black end of the diode should face conductor 2.
- Look at the picture on the next page before proceeding.
- Peel off the backing from the conductors, and stick down the last .25" of the diode to the polyester. It is important to leave the diode out a distance from the polyester as shown, and not tight to the mylar. If it is tight to the mylar, the back and forth motion of the generator causes the diode to break after a few minutes.
- If you accidentally installed the diode backwards- don't worry. The orientation of all the diodes can be reversed and it will still work fine.



### Step 33

The completed diode installation should look like this.



### Step 34

- Install the other two diodes in the same way, except in the opposite orientation (with the black end pointing the other way).



### Step 35

- There are some small T-shaped protrusions on the polyester that must be inserted through a matching hole on the opposite side. These are called “opening distance restrictors”. In order to get the T through the hole, you will need to fold it temporarily. As it is transparent and small, this step can be a little tough to see, so make sure you are working in good light.
- The purpose of these are to restrict the opening of the generator. This improves the performance and prevents the inner sector from being bent over and inverted by the wind.
- Caution- these can tear at high windspeeds, but can be repaired or replaced with a piece of tape.



### Step 36

- This is what it should look like with the opening distance restrictors completed. You can also see how the T was folded diagonally in order to pass it through the hole.
- If you bend the “tee” opening restrictors inwards so that the generator naturally sits more open, it will run more easily.



### Step 37

- Now you are ready to connect the generator to a load.
- The remainder of these instructions are for using the generator to blink a T4 fluorescent lightbulb, which is also used as a physical support to hold up the generator in the wind.
- You can connect the generator to any load or storage device that will accept approximately  $0.75 \mu\text{A}$  and 500 V.
- For alternative loads, the generator can be supported by a string under tension or a plastic tube.
- For alternative loads- the power outputs should be connected to conductors 4, and 1.



### Step 38

- Apply the conductors as shown, these will create an electrical connection from the generator to the ends of the bulb.





### Step 39

- Apply four pieces of double sided tape to the bulb, in alignment with the diode mounts on the generator.



#### **Step 40**

- Some small connector conductor strips have been provided, with small circular ends. Fold this in half lengthwise to turn it into a wire with two sticky ends.



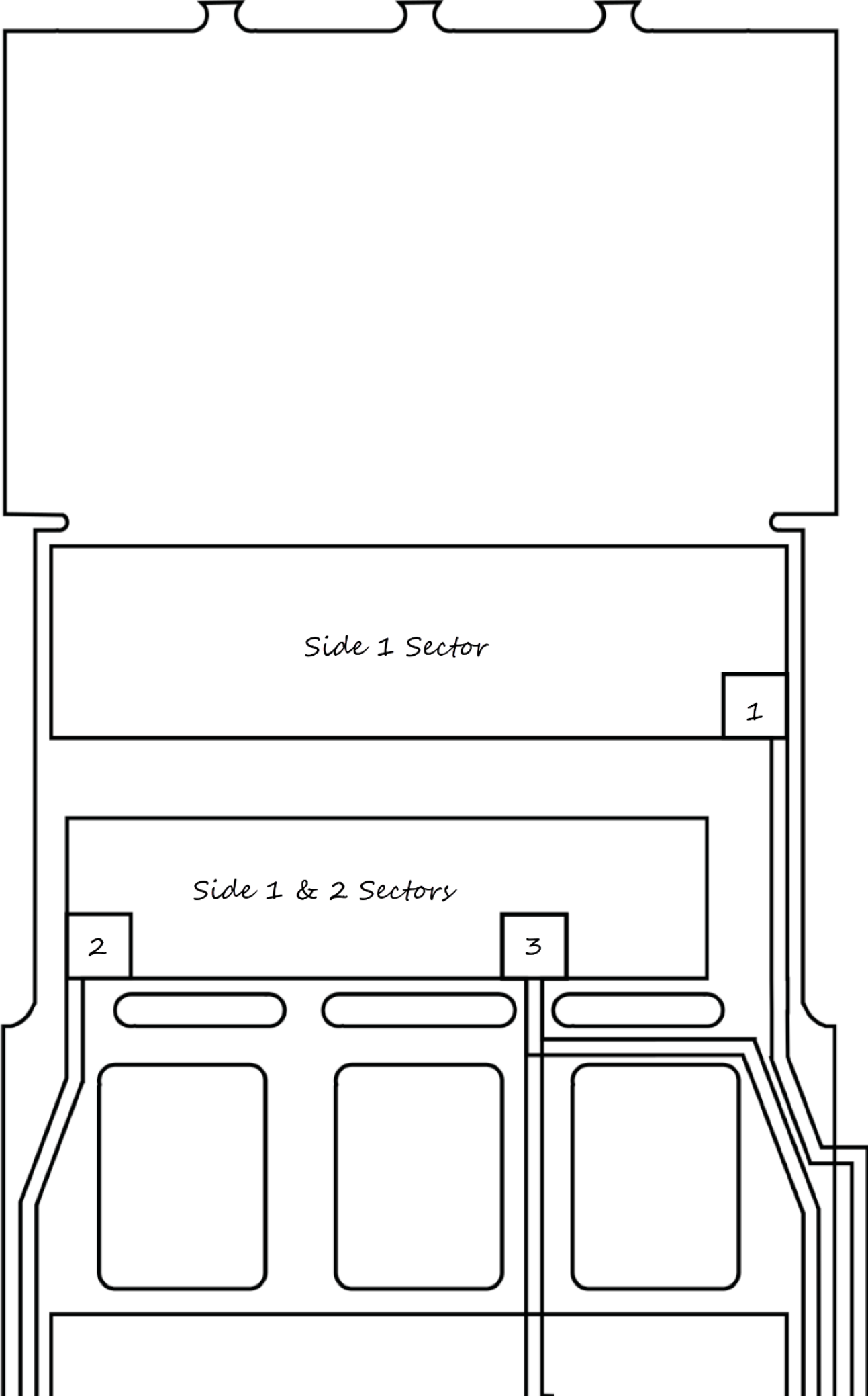
### Step 41

- Stick the generator onto the fluorescent bulb as shown.
- Stick the circular end of a connector to the end of the bulb, and to conductor 4.
- Stick the circular end of another connector to conductor 1, and to the bulb conductor as shown.
- In all cases make sure the conductors have been applied with a reasonable amount of pressure to make a good quality circuit.



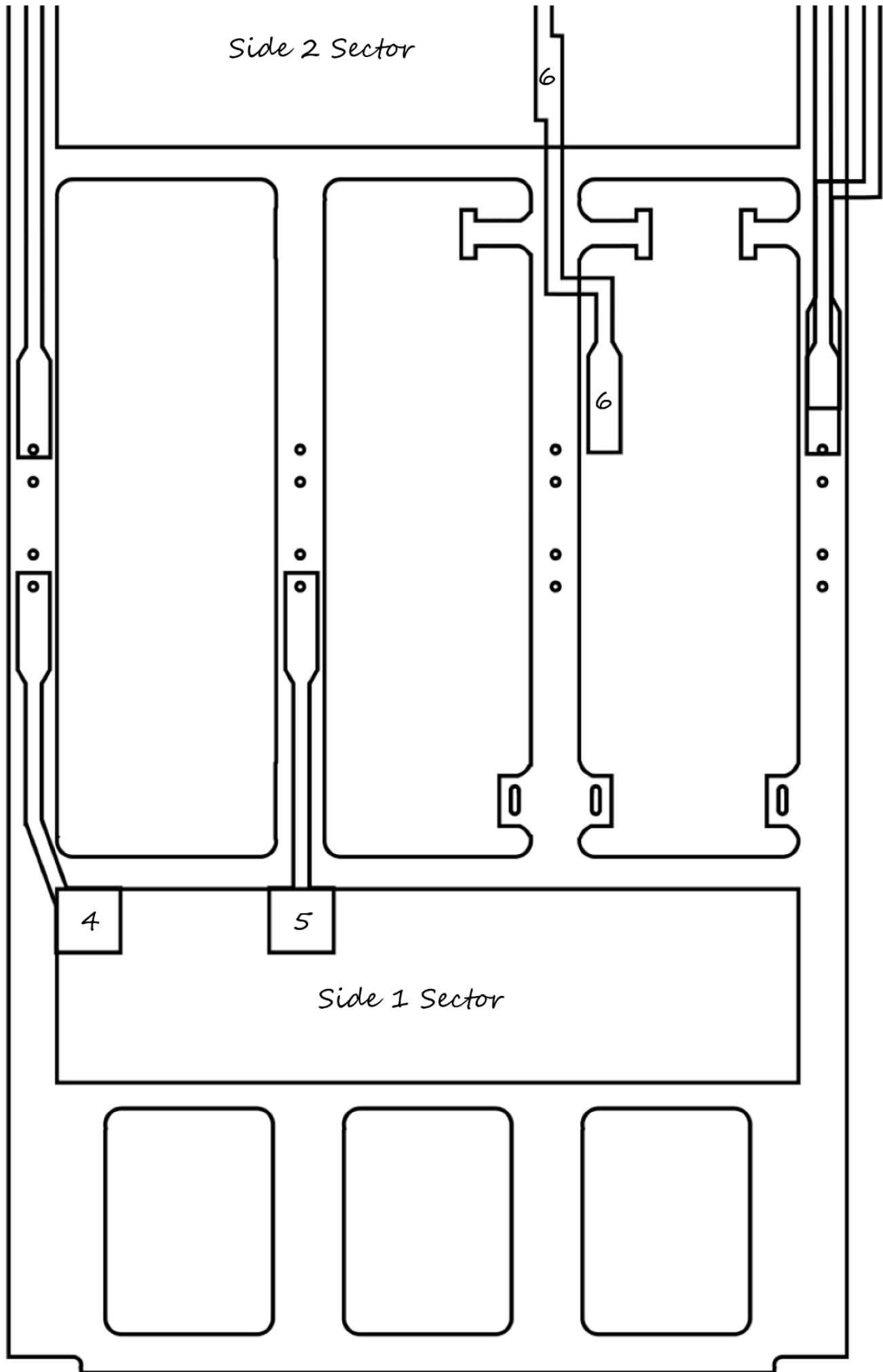
### Step 42

Congratulations, you have built a FLAG! Depending on the materials used, you will need an indoor fan or outdoor wind of approximately 15 km/h to cause the FLAG to oscillate and blink the light. This is best viewed in the dark, or low light.





Side 2 Sector



6

6

4

5

Side 1 Sector