Print Your Own Circuit Boards

Created by Adam Kohring


Well

https://learn.adafruit.com/how-to-print-your-own-circuit-board

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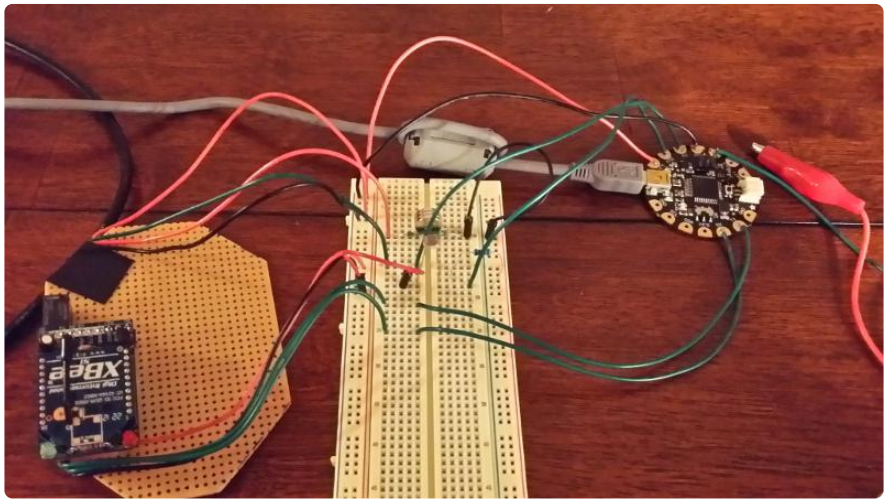
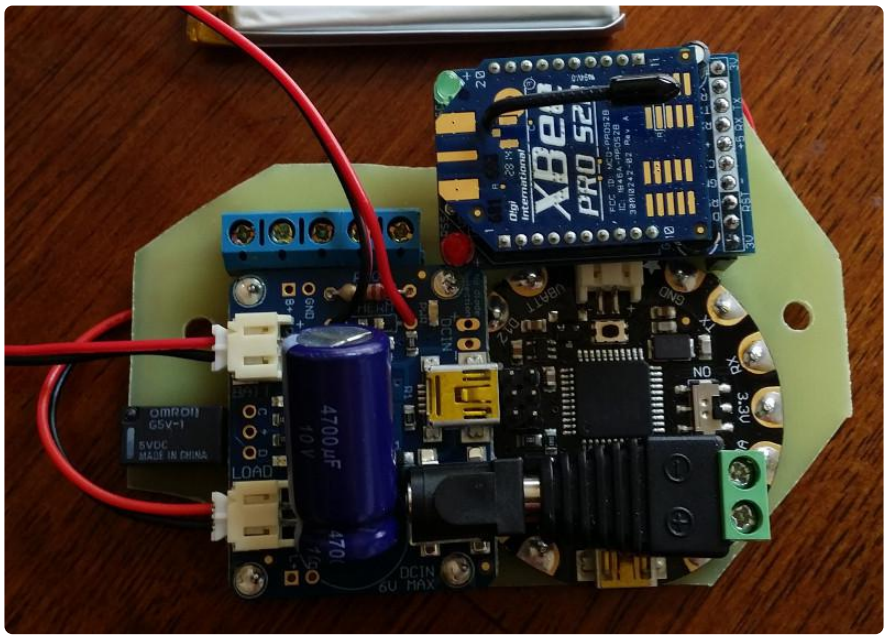
Overview

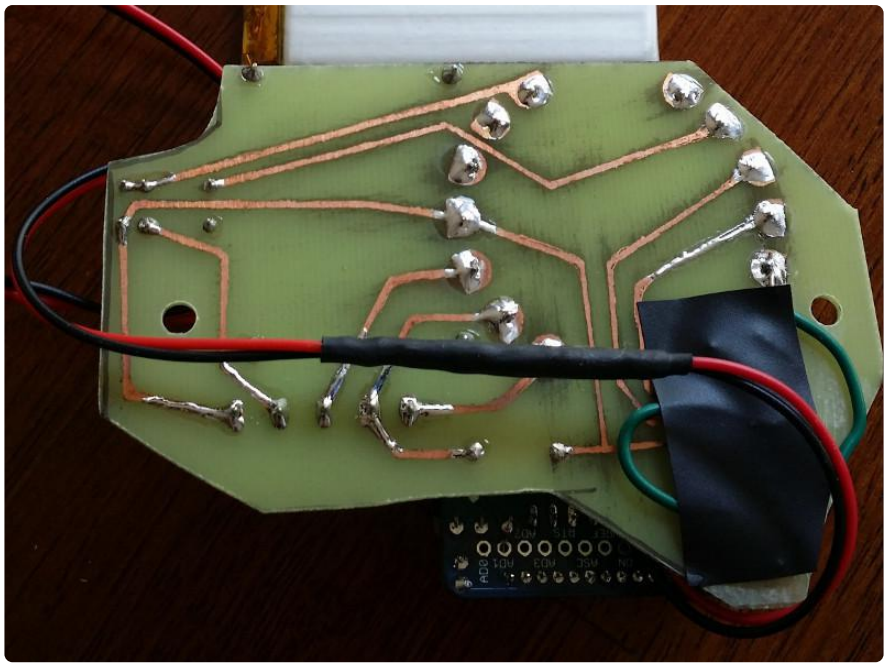
Get rid of that rat's nest of wires and print your own circuit board! This guide will walk you through the process of taking your EAGLE PCB Design from the software program to the physical board.

BEFORE



AFTER





Supplies Needed

Safety Equipment

- Latex Gloves
- Chemical Goggles
- Respirator
- Safety Glasses

Printing Supplies

- EAGLE PCB or other PCB design software
- Laser Printer (I used a HP LaserJet P1606dn Laser Printer)
- Printer Paper
- Magazine Paper
- Clear Tape
- Scissors

Single Sided Board Supplies

- Copper Clad
- Fine Grain Sand Paper
- Ultra Fine Point Sharpie
- Dish Soap
- Wash Cloth
- Oven
- Oven Mitt
- Flat Baking Sheet
- Parchment Paper
- Sink Water Bath
- Iron
- Ironing Board
- 2x4 Wood Block

Additional Supplies for Double Sided Boards

- Black Electrical Tape
- Thumb Tacks

Chemical Bath Supplies

- Non-metallic Measuring Cup
- Non-metallic Disposable Container
- Plastic Spoon
- Mason Jar
- 4oz Muriatic Acid (Pool Cleaner)
- 4oz Hydrogen Peroxide
- 100% Acetone
- Paper Towels

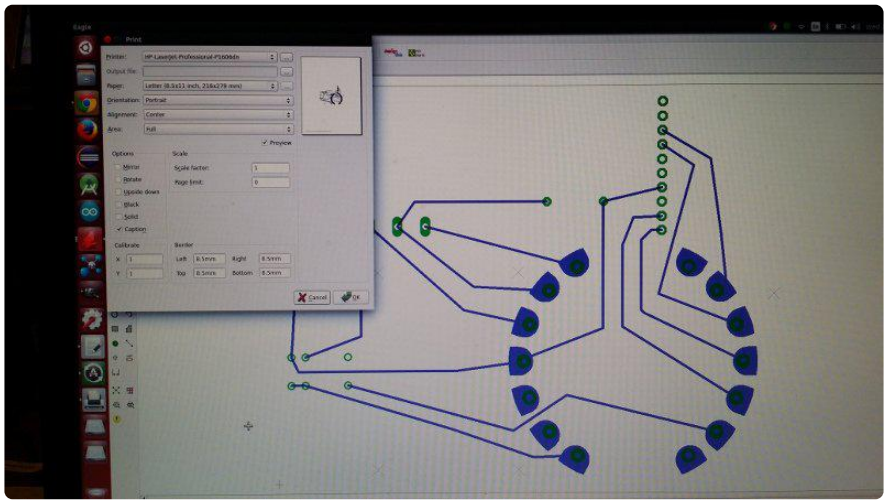
Finishing Supplies

- Drill Press
- Carbide Rotary Micro Bits
- Band Saw or Coping Saw
- Multimeter

- Solder
- Soldering Iron
- Desoldering Iron
- Dremel Rotary Tool

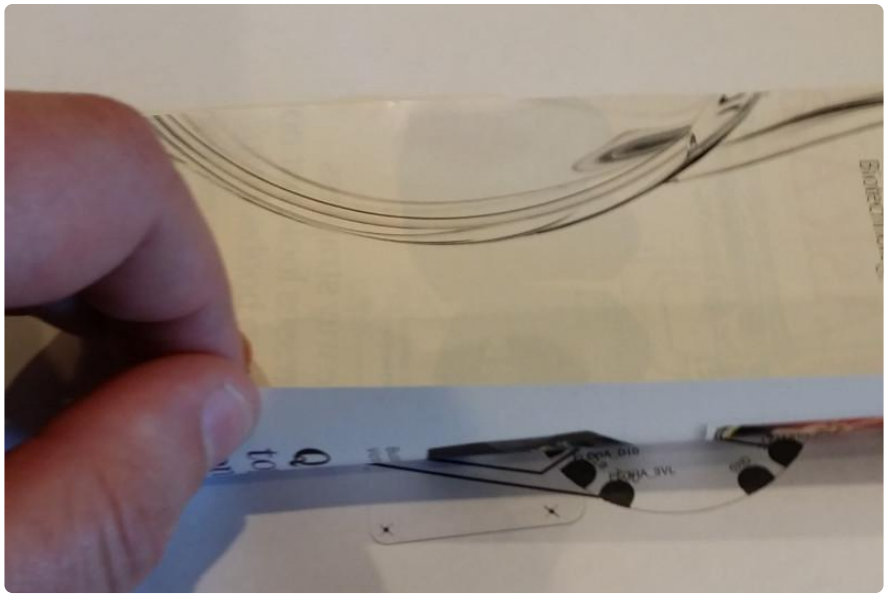
Print the Bottom Board Design

You will use a Laser Printer to print your bottom board design onto a sheet of magazine paper. Do NOT select the mirror option when printing the bottom board design or your image will be flipped and not usable. I used an HP LaserJet P1606dn Laser Printer, but any laser printer will do. If you are printing your design from Eagle, remember to only display the layers you are interested in printing. In this example, I only displayed Bottom (16), Pads (17), Vias (18), and Holes (45) layers. If you are printing a double sided board, you will want to add at least two drill holes to opposite sides of your board design before printing. This will allow you to line up the top portion of your board in a later step.

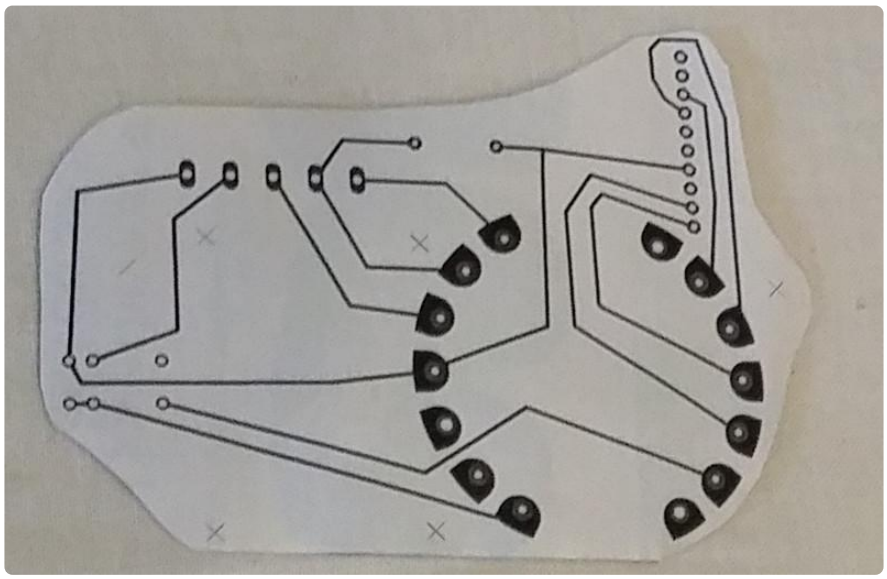


The easiest way to print onto the magazine paper is to first print your design onto a sheet of normal printer paper. This will provide you a guide so you know where your printer is going to actual print the ink on the paper. Once you have your design printed on normal printer pager, cut out a section from a page in a magazine that contains little or no ink. Tape the section of magazine paper over your design on the printer paper and reprint your design onto this paper. The less ink on the magazine page the better! You do not want to print onto a page that is already covered in ink or you will get unwanted toner transfered to your board (see below).

Tape glossy magazine paper over your printed design on normal printer paper and reprint.

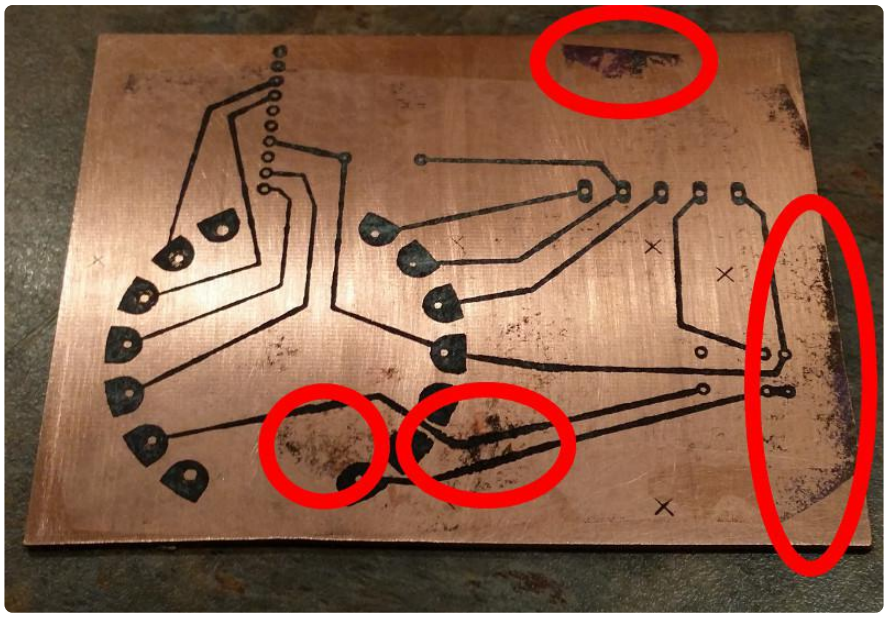


Magazine Paper Print



Do NOT print on a section of magazine paper that is heavily covered in ink...

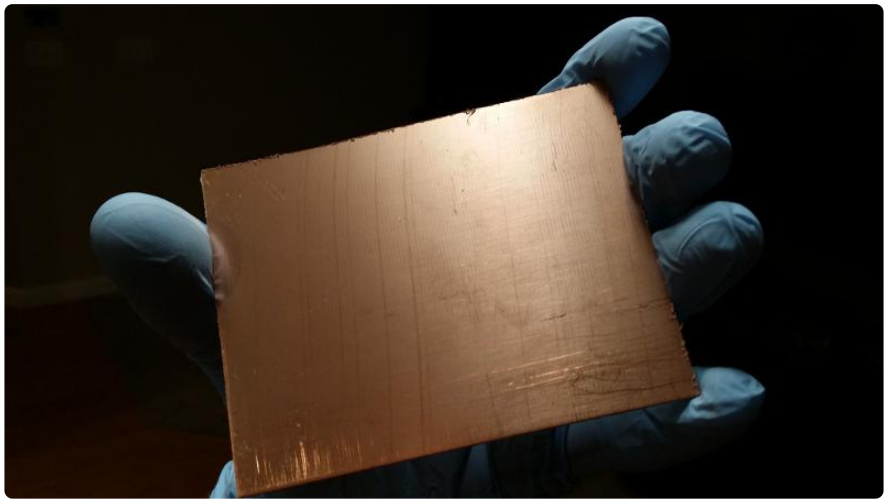
...or your board could end up with undesired toner transfers...



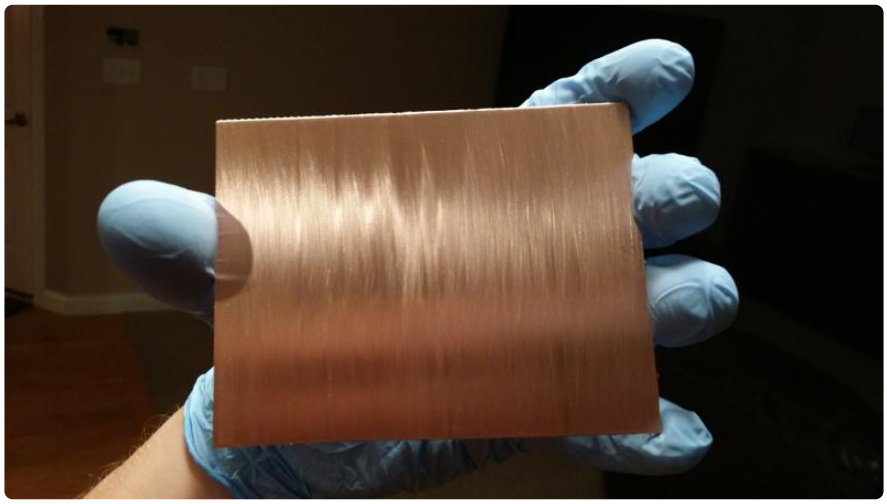
Prepare the Copper Clad

Use a band saw or coping saw to cut your copper clad to size. In order to prepare the copper clad for ink transfer, you will use fine grain sand paper to gently abrase the surface of the copper clad on the side in which you will be transferring the ink. This is to allow for better adhesion of the toner to the copper. Do NOT apply excessive force or over sand the copper. Gently sand up and down the board only moving the sand paper in one direction. Once sanded, rinse with warm water and dish soap. Try not to touch with copper with your fingers. Wearing latex gloves is recommended for keeping the surface clean.

BEFORE SANDING



AFTER SANDING



Transfer the Toner

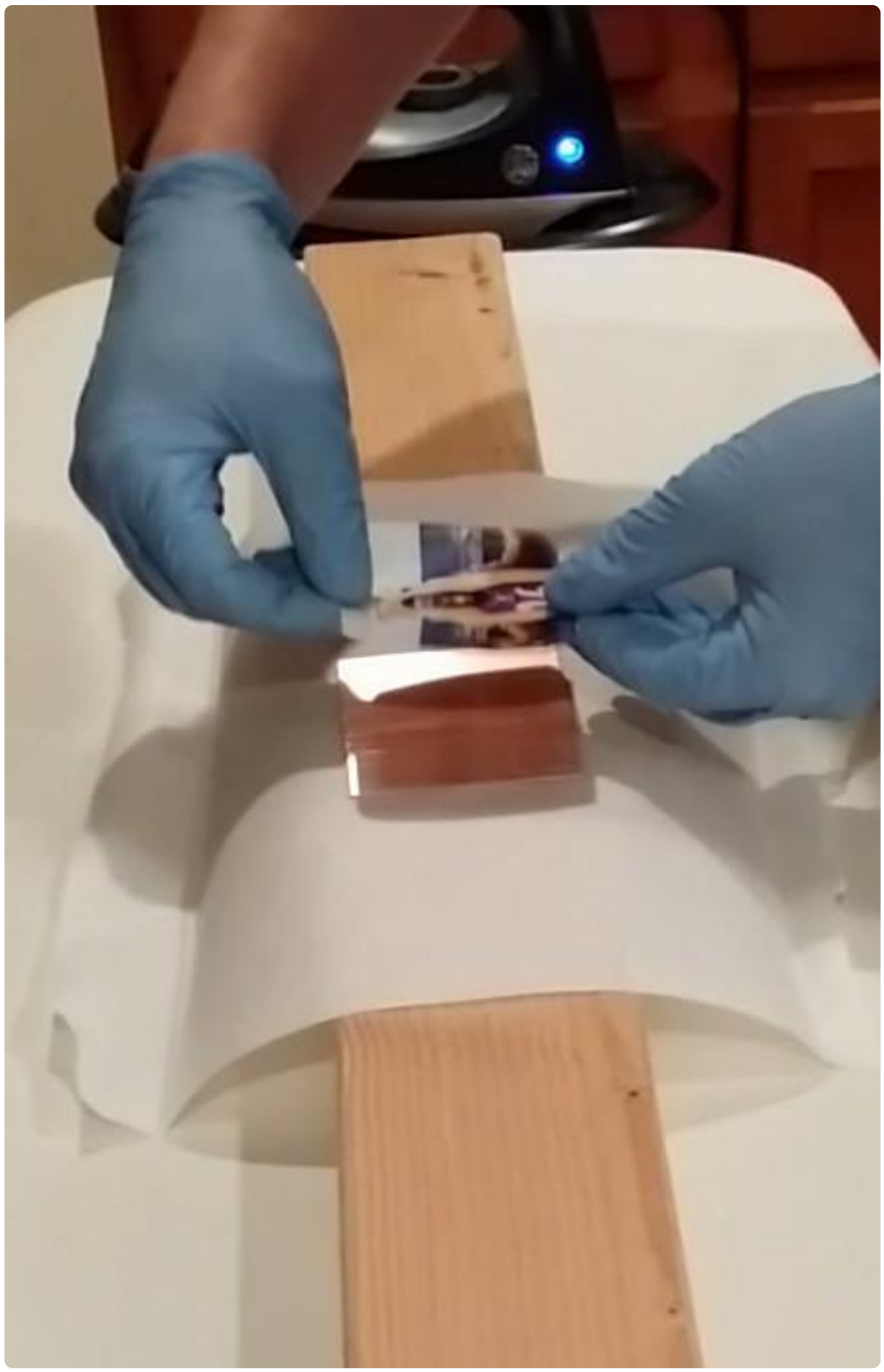
Mise en Place

1. Turn your oven on to 350 degrees and plug in an iron turned to the hottest setting (cotton linen for the iron I am using).
2. Set up an ironing board and ensure a solid surface for ironing the copper. In this example, I'm using a 2 by 4 on top of my ironing board to provide a hard surface for ironing the circuit board design onto the copper.
3. Cut out the design you printed on the magazine paper to fit the copper board. Set aside the design.

4. Prepare a cold water bath in your sink or large bowl.
5. To enable easier transfer we will be heating up both the copper plate as well as the iron - this will ensure equal heat distribution for consistent ink transfer.
6. Cover a flat baking sheet with parchment paper, folding the sides of the parchment upwards to use as handles when removing the parchment and copper plate from the oven.
7. Place the copper sheet onto the parchment covered baking sheet, scuffed side facing up.
8. Once the oven is heated, place the baking sheet with copper clad into the oven for 2 minutes.

Setting the Design

After 2 minutes, remove pan from oven and use the parchment paper as handles to move the parchment and copper plate onto the hard surface for ironing. Carefully place your design onto the hot copper plate, ink design facing down toward the copper.



Pressing the Design

Take the iron and gently place it flat down onto your design, pressing down hard for 20 seconds without moving the iron. Pick the iron up and place it down on another part of the design - repeat this as necessary for the size of your design, taking care to make sure the edges are transferring. You do not want to use an "ironing motion" until you have firmly transferred all of the toner onto the copper. Continue transfer for about 2 minutes.

Here I am using an ironing motion with one hand to ensure the edges are fully transferred. I have an oven mitt on my other hand so I can hold the hot board while ironing.

Cooling Bath

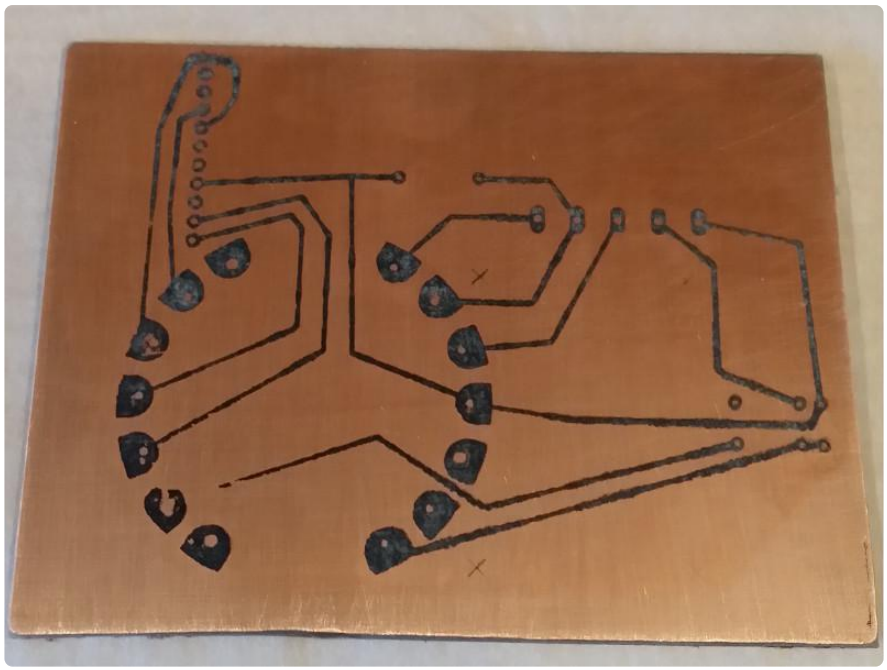
Pickup parchment paper with copper and put the copper into the cold water bath, leave for 10 minutes.

Remove the Paper

After 10 minutes begin removing the magazine paper from the copper. Use a wash cloth or dish sponge to remove any remaining magazine paper fragments.

Toner Transfer Complete

If the transfer is not satisfactory, do not continue! You need to start over by using Acetone to remove all the transfered ink, resand with fine grained paper, and repeat from the beginning. You will waste a copper clad if you proceed with an improper transfer.
Once your transfer is complete, review the board and look for any gaps or partial transfers.



Touch up the Traces

Use an ultra fine point Sharpie marker to fill in any gaps or missing traces. I retraced every line to ensure no gaps and filled in all vias (drill holes).
Make sure everything looks correct and that no ink bled over connecting any copper trails that should not be connected. The way your board looks now is the way it will look after the acid bath.

Dissolve the Copper

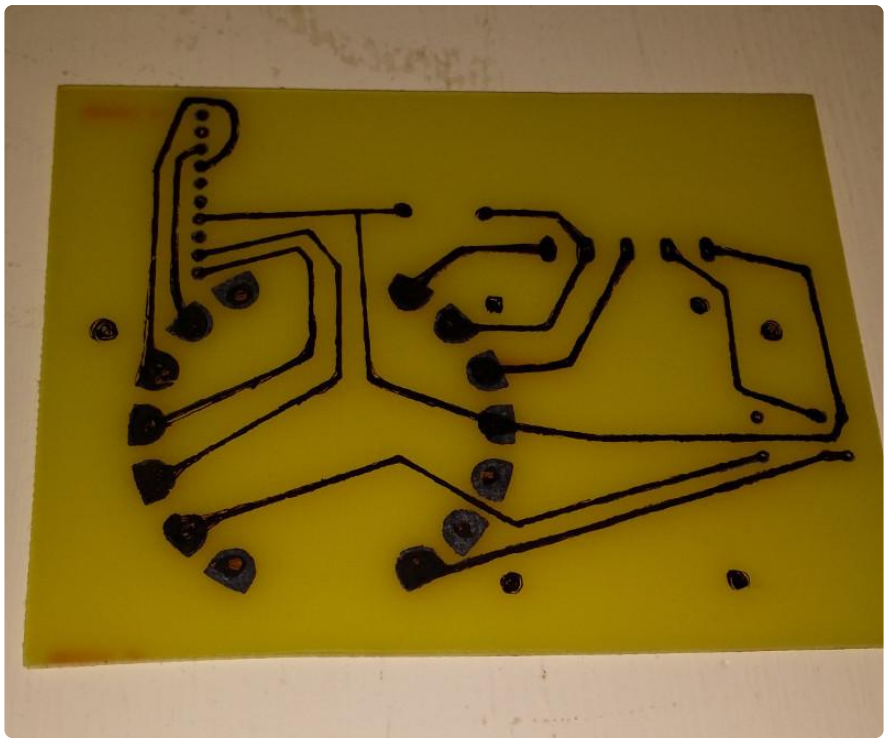
If you are printing a double sided board, cover top part of the board (the side with no ink) with black electrical tape to protect it from the acid. Be sure to fold the tape over the edges of the board so no acid gets between the tape and the top layer of the board. If you are printing a single sided board on a double sided copper clad, leave the electrical tape off, the unprinted side will just dissolve.

Put on chemical goggles, latex gloves, and a respirator mask and work in a well ventilated area. Using a disposable, non-metallic measuring cup, measure out 4oz of hydrogen peroxide and pour into a non-metallic disposable container. Using a new disposable, non-metallic measuring cup, measure out 4oz of muriatic acid (you can purchase this at your local pool supply store) and pour into the non-metallic disposable container to mix with the hydrogen peroxide.

Carefully place the copper clad in the acid bath and leave in a well ventilated area for 10 minutes.

After 10 minutes, check to see if the copper has been dissolved. If there is still copper left on the board, use a plastic disposable spoon to gently stir the acid, moving it across the surface of the board. Be extremely careful not to splash the acid. You should be wearing latex gloves, chemical goggles, and a respirator.

Once the copper is completly dissolved, remove the board and dry with paper towels. Rinse with water and dry again. Make sure to store the acid in a properly labeled glass mason jar for reuse on another board.



Print the Top Board Design

If you are only printing a single sided board, skip this step.

1. Remove the black electrical tape from the top layer of the board.
2. Drill small holes through the two to four alignment holes you added to your design in the previous step. You will be feeding thumb tacks through these holes to easily align the top of your design with the already printed bottom.
3. Sand the unprinted side with fine grained sand paper and rinse with dish soap and water.
4. Place the sheet of parchment paper under the board and using thumb tacks, punch through the parchment paper and alighment holes. The thumb part of the tack should be pressed against the parchment paper and the sharp end of the tack should be pointed up in the air through the board. You will be using the thumb tacks as guides to align your top layer design.
5. Print your top layer design with the mirror option enabled to a clean sheet of magazine paper. Pre-punch holes in the magazine paper to be aligned with the thumb tacks later.
6. Following the same procedure from the previous steps, place the board in the oven (with thumb tacks through the drilled holes).
7. After the board is heated, remove from oven, place on ironing board, and use the thumb tacks to align and set your design on the board.
8. Remove the thumb tacks by pulling the parchment away from the board.
9. Using an iron, press the design into the copper clad as you did in the previous step.
10. Move the copper clad to a cold water bath.
11. Peal away the magazine paper and fill in any gaps with a sharpie as before.
12. Cover the dissolved side of the board with black electrical tape and dissolve in the acid bath as before. Once dissolved, remove the electrical tape.
13. You should now have a double side board with ink trails over top of copper trails.

Remove the Ink

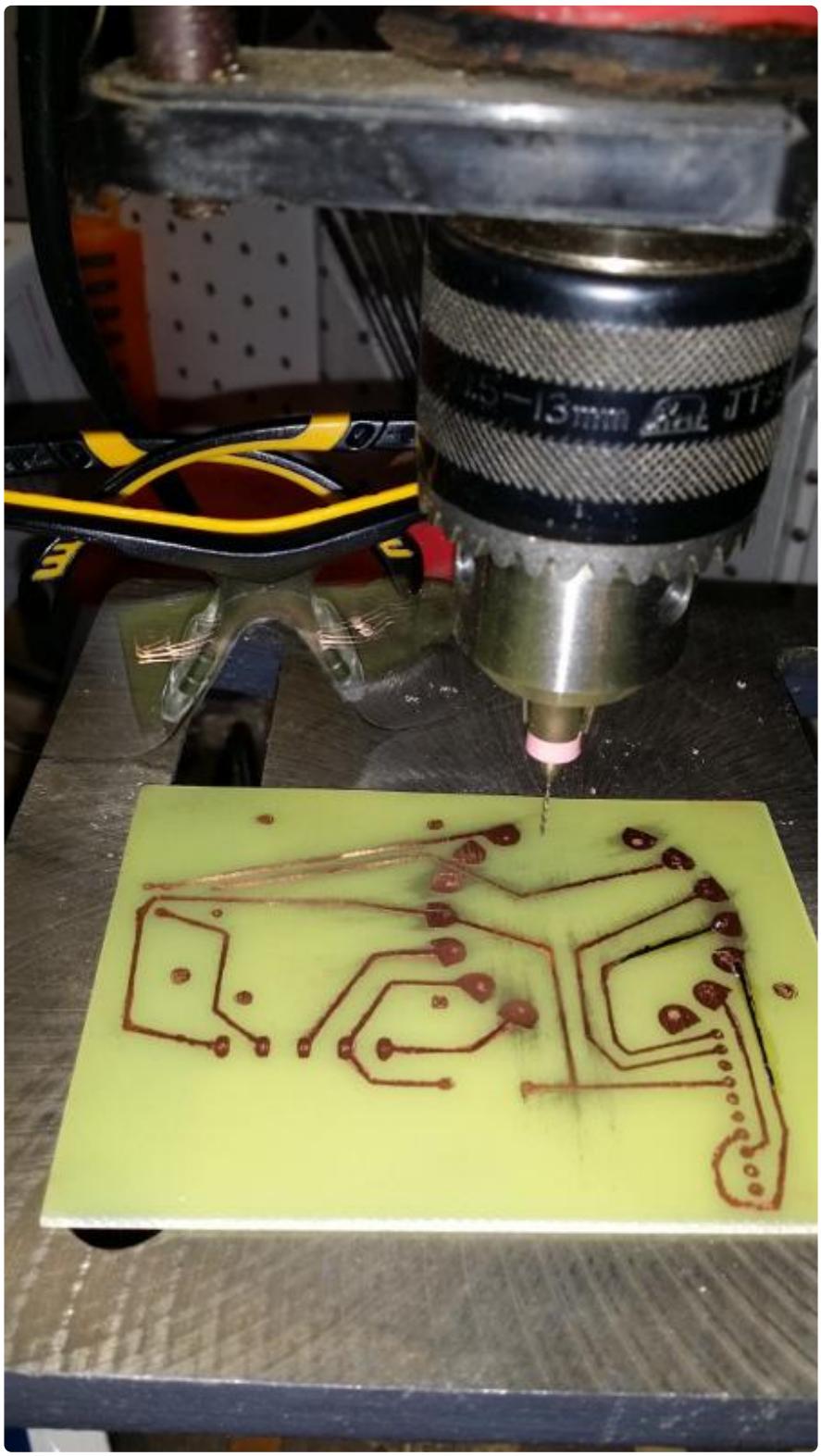
Using 100% Acetone (nail polish remover), wipe down the board to remove the ink over top the copper trails.

Drill Through Holes

Your board will most likely have vias and through holes for part components. Now is the time to drill holes through the board. I picked up this 20 piece set of Carbide Rotary Micro bits from a local Harbor Freight. http://www.harborfreight.com/20-pc-carbide-rotary-micro-bit-assorted-set-62379.html (https://adafru.it/fo3) For double

sided boards, place bare wire through the vias (holes connecting the top and bottom layer) and solder on both sides.

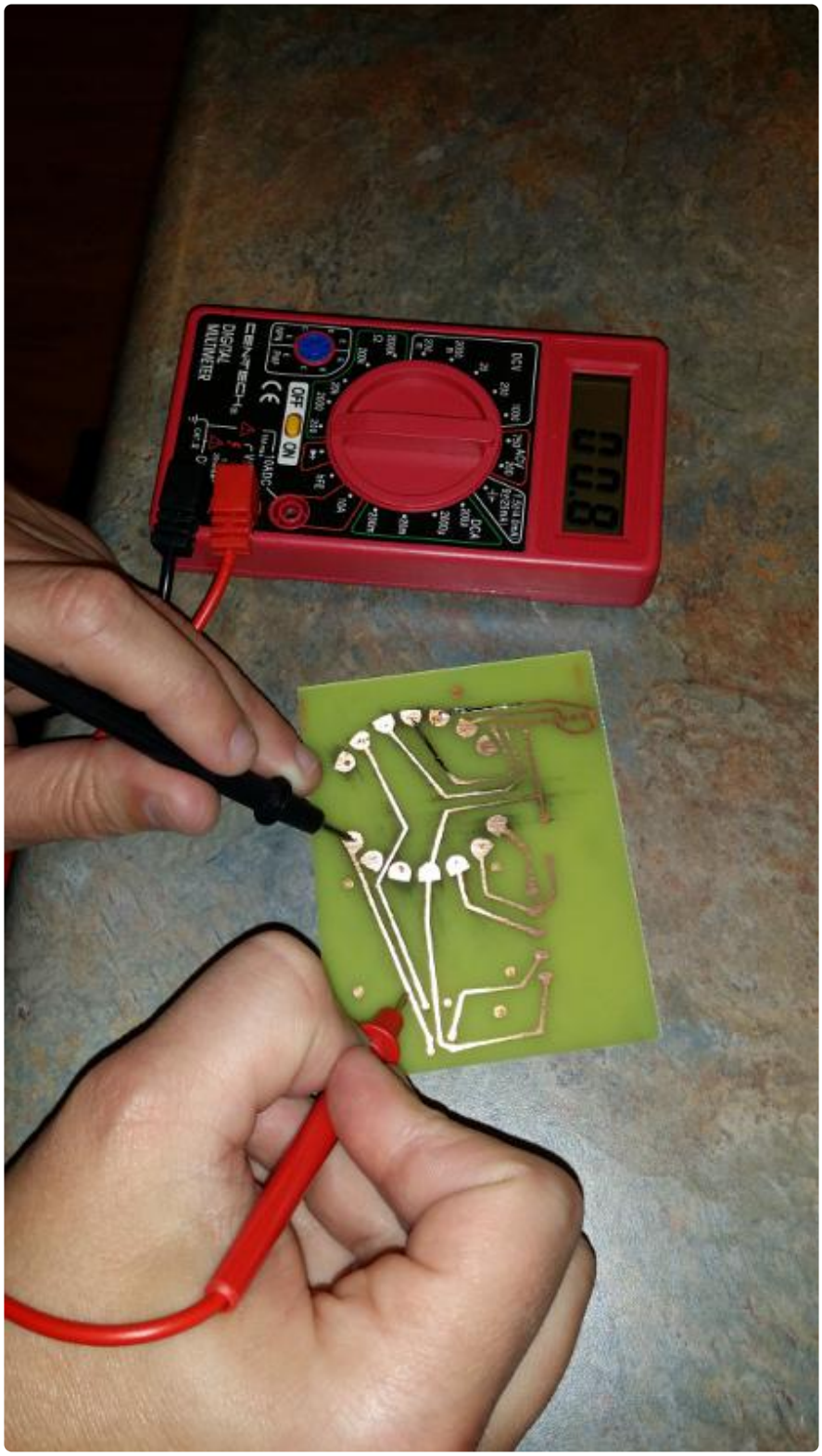
Wear Safety Glasses!



Test Your Board

Set your multimeter to the lowest resistance setting, mine is set on 200 ohms. Use the leads to probe the board and verify trails that should be connected show near 0 resistance and trails that should not be connected show infinite resistance.

Connected Trails



Non Connected Trails

Fix Errors

If you have a gap in a copper trail, you can solder over the trail to ensure a good connection. If you have two trails that are connected and should not be, use a dremel

rotary tool to remove the copper connecting the trails. If a trails is damaged beyond repair, use a dremel rotary tool to remove the trail and replace it with a normal insulated wire.