

How to Etch Printed Circuit Boards

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Items required for etching

- Photo paper such as Press-n-Peel (printed circuit board transfer film) or Decal Pro Toner Transfer Paper by Pulsar Professional
- A Laser Printer capable of 1200 dpi (Brother HL2240 used by author)
- Copper Clad FR4, 1.6oz to ~7oz (3.16oz typically) (depending on requirements) and ~0.035" to 0.05" (max thickness of board)
- Clothes iron or laminator with a straight feed path
- A fan
- Water in a tub with soap solution
- Protective eye wear
- Plastic, non-reactive bowls or tupperware tubs and a plastic spoon or tongue depressor
- Paper towels
- Muriatic Acid (Hydrochloric Acid, sold as a pool supply)
- Hydrogen Peroxide (3% w/v) USP 10 volume
- Acetone
- Nitrile or Latex Gloves
- Baking Soda (~2 tsp) in a tub with water
- Drill Press or Dremel W/Drill press
- Drill bits 0.030 to 0.050 typically (depending on artwork requirements)

1. **Printing:** First do a proof copy on regular 20lb paper to determine where the image is going to come out. Place your transfer film into the printer shiny side up. Keep in mind, the image that is to be printed has to be a negative. If copper is on the top side do a horizontal flip while in your drawing program. If copper on bottom, image should look the same as the artwork on the program. Check the size of your artwork in your PCB program, make sure to note the dimensions of the board, as that information needs to be entered into the print set-up before printing. Also ensure the highest resolution is used, use 1200 DPI if available on your printer. Multiple images can be printed on a sheet if one notes where each image is carefully placed for each print, this saves on the toner paper.
2. **Prepare Board:** Using gloves, cut out the image of the board leaving a ~1/4" border around the circuit, handle carefully. Avoid touching the dull side. Using a proof copy of your image on regular paper, cut out the design and line it up with your copper-clad board. Once you have an idea for how much PCB you'll need, score the board on both sides with a utility knife, and break off the proper amount. (The proper amount is just *slightly* larger than your PCBs). Cut your copper board to size. Be sure to scrape any burrs that appear on the edge of the board that may have resulted from the cutting/shearing process. A fine file may be used for removing any rough edges. Burrs tend to keep the iron from making solid contact with the Press-n-Peel Film. Rough up your PCB under running water using some Scotchbrite or S.O.S. (rub lightly). You don't want to remove copper, you just want to make the surface a little rougher than it was before. Rinse cleaned board with soap and water, be sure to remove all soap residue. After this step, be careful not to touch the surface of the PCB until after etching. Dry the PCB thoroughly with lint-free cloth. Place Press-n-Peel with image face down onto clean copper board. Use Scotch or masking tape to hold two different sides of film to board. Careful not to force the board or move it against the toner surface as this might remove some of the toner.

3. **Iron Press-n-Peel Film:** Use a piece of plain paper between the iron and the film to reduce friction. Temperature setting on the iron is critical, and dependant upon your laser printer or photocopier. Suggested starting temperature is 275-325 degrees F. **DO NOT USE THE STEAM SETTING** . Iron setting is generally "polyester". Iron temperatures vary. Apply smooth, even pressure, and go over the PCB several times. Be very careful and consistent during this step, or you'll get unreliable results. Iron until board has completely and fully reached the temperature of the iron. Time varies with the size and thickness of the board. Generally this is 1.5 to 5 minutes. Allow board to cool down sufficiently before attempting to remove transfer film. Alternative; quench the board/film combination under cold running water. Carefully peel the film off.
4. **Decal Pro Toner Paper:** If using Decal Pro Toner Paper, rinse the board under warm running water. Then lightly rub the paper off with your pads of your finger. After a few minutes of this, you should be left with the toner only. Be very careful, and make sure there isn't a thin layer of paper or glossy film still attached. This paper residue will not etch properly, and will cause bridges. If your board doesn't look right at this point, use acetone and wash the toner off. Then, repeat these steps from the beginning.
5. **Mix Chemicals:** **Please, exercise EXTREME caution in this next step. These chemicals can badly burn you. Wear latex gloves, wear safety goggles or glasses, and ALWAYS add the Muriatic Acid to the Hydrogen Peroxide, NOT the other way around.** Do this outside, or in a well ventilated room. Muriatic Acid is not pleasant in the lungs. Using non-reactive measure cups if larger volumes are required. A small baby food jar works great for measuring. Mark the side of the jar with a felt pen showing where the half way point is and the top. Mix 2 parts hydrogen peroxide and 1 part muriatic acid; (1 cup hydrogen peroxide and 1/2 cup muriatic acid is plenty to etch a larger PCB). Do this outside, or in a well ventilated room. Muriatic Acid is not pleasant in the lungs.
6. **Etching:** Prepare a tupperware tub with a couple of teaspoons of baking soda and warm water to neutralize any acid. Do the following work in a well ventilated area, preferably with a fan blowing across the work area. Using latex gloves, place the PCB in the acid bath copper side down and watch the copper dissolve. As the etch progresses, it helps to agitate the acid mixture. I simply rock the tub back and forth lightly. The copper turns the bath lime green. Here we're nearly done. After a couple of minutes, turn the board over using a plastic tong or similar tool. Continue to monitor for a couple or more minutes while observing the copper traces. Use a light under the bath to see better. When all the copper is gone (check between all the pads and traces), remove the board from the acid bath (using tongs or wood sticks) and dip it in the prepared tupperware tub containing water and baking soda. At this point, the board is safe to handle with gloved hands. When you're done with the etchant, pour it into a non-reactive container with a lid and keep it in a glass jar with a lid and put aside for later disposal at a local chemical disposal facility.
7. **Remove Toner:** In a well ventilated area, prepare a glass tub container of Acetone. Using gloves, rinse the board with acetone, and scrub with a super-fine steel wool (S.O.S. pads) until all the toner is gone. (Alternative; using gloves, dampen a large paper towel soaked in acetone and wipe off toner, take care not to inhale any fumes). Do this in a well ventilated area, again remove the board with clean tongs and place the acetone in a glass jar with a lid and put aside for later disposal at a local chemical disposal facility.

8. **Clean board:** Use a liquid detergent and warm water to remove any residual acetone, use a bristel brush as required. Dry with a paper towel, then place aside taking care not to touch the copper, handle the sides only.

9. **Drill:** Using a drill press and tiny drill bits, drill out your PCB in the appropriate spots. In order to avoid breakage, and reduce hole ovularity, adjust the drill press so that it begins just above the surface of the PCB, and stops just beyond the other side of the PCB (adjust press for minimal travel). Removing any burrs on the opposite side of the board using a slightly larger drill bit and do by hand rather with a drill press. Clean board using paper wipes and IPA. Board is now ready for parts. Pre-tinning of pads especially the small ground pads will help in the soldering process.