

Thermal Transfer PCB Process

1.0 Introduction

This paper presents a PCB fabrication method that does not require PCB layout software program. All that is needed is a computer with a simple drawing program, a laser printer, an etch solution and a heat press¹.

Once the PCB foil is laid out, it is printed on a laser printer using thermal transfer film. Once printed, the thermal transfer film is placed face down on the foil side of a copper clad FR4 or similar material board.

The heat press transfers the plastic laser toner onto the copper as an etch resist. After a dwell time, sufficient enough to melt the toner, the film is rolled with an art roller to complete the toner transfer. After which the film and board are quenched in cool running water. The resist coated copper clad board is now ready to be etched in ferric chloride² or similar solution.

After the board is etched, it is drilled and sanded of drill burrs. Then the process is repeated to print a Legend on the component side of the board.

Foot Notes:

1. A clothes iron is suggested in some literature, but I do not recommend using one.
2. Used (containing copper) Ferric Chloride is disposed of in a hazardous waste facility
- Do Not poor down community sewer -.

Disclaimer:

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2.0 Film

Do not use clear film. Only coated film such as “Press-n-Peel Blue PCB Transfer Film”

Ordered from SciencePurchase.com.

Coated film has additional fine plastic coating that adheres to a laser printer’s plastic toner when heated. This results in a denser resist coating than clear sheets, which only transfer the toner.

Be careful with the film as the coating scratches fairly easily. Of coarse print on the coated side.

3.0 Printer Settings

Use all CYMK toners to maximum (all 100%) in document settings.

Set Printer Settings to “Color Transparency”.

4.0 Heat Press

Vevor Model: SJYHPM230 (Walmart)

Set temperature and dwell time as indicated in specific steps to follow.

5.0 Fab Process

Cut copper clad FR4, or other suitable material to size first. Figure 1 shows the blank board is cut 1.25” larger than the desired finished PCB, this allows for a 0.625” film margin. This margin allows features near the finished board edges to be transferred clearly, which otherwise may be distorted due to the heat press.

The film must have an additional 0.25” margin beyond the Blank Board size to allow the board *to be taped to the film*. Important to understand the board is taped to the film on the backside of what will become the resist deposited board. Tapping the board to the film allows the film to naturally lay flat on the board surface.

Once the board is cut to “process size”, which is not the same as finished size, the copper clad must be scrubbed with soap and steel wool pad. All burrs and imperfection in the copper finish must be removed. Rinse clean under running water. Final cleaning step is to clean the dry board with acetone to remove any film or grease. Do not clean board until ready for the heat press.

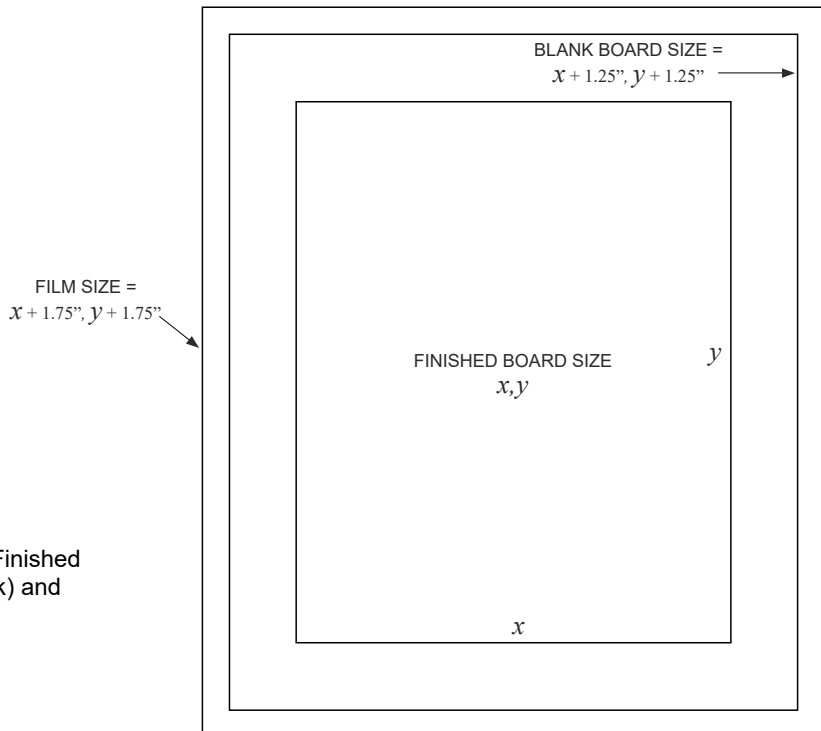


Figure 1. Relative sizes of Finished PCB, Substrate (board blank) and Film.

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Set the heat press temperature and dwell time as follows;
 $T = 375^{\circ}\text{F}$ and $t = 450$ seconds (7.5 minutes). Pad height
 $= 0.65''$ (sets pressure).

Preheat press with Flat Platen rotated away from the Flat Base and pads. Place a sheet of vellum on the Flat Base pad to prevent sticking.

A beep will indicate when the Flat Platen reaches the set temperature.

Place the film/board onto the vellum protected Flat Base pads with the film side up (film coating is down on the copper clad surface). Rotate the Flat Platen to align with the Flat Base and pads. Carefully latch the Flat Platen into "press" position and start the timer.

When the beeper sounds time elapsed, carefully open the Flat Platen and rotate it to the side. Be careful that the film is not stuck to the Flat Platen surface. If it is, gently pry it loose before rotating the Flat Platen.

Immediately roll the film onto the copper clad surface using an art roller. This finishes the melted toner transfer to the surface.

Do not disturb the film while rolling or when transferring to the cold water quench. Quench the film and board under running water until the board is cool to touch. Remove film by peeling from one corner. Inspect the resist and touch up as necessary.

Figure 2 shows an example of the printed film. Figure 3 shows an example of resist coated board, showing some need for touch up.

Some copper oxidation will be present which can be partially removed by washing with soapy water. Caution, while the toner is well attached at this point, be careful not to scrape it. I have found this step unnecessary.

Have etch solution heated and ready to use so that the resist deposited board can be moved directly into etching. Ferric chloride at 155°F will result in appropriate etch time of 5 to 7 minutes. Watch carefully to prevent undercutting. Remember, etching cuts into the foil, leaving an exposed side that will continue to etch.

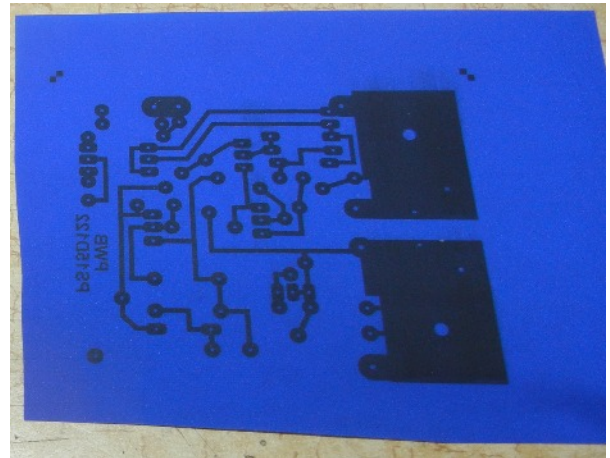


Figure 2. Example of printed film.

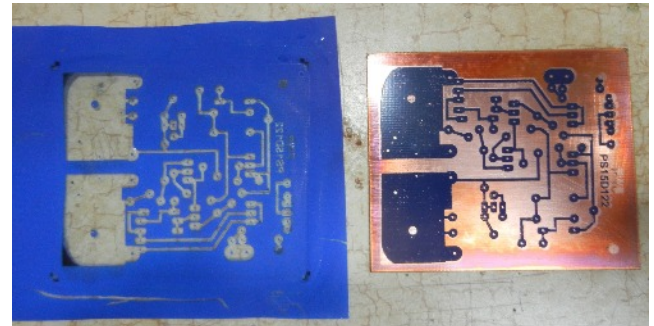


Figure 3. Example of resist coating as came off of heat press. some touch up is needed, but the corner roll off is due to film not having prescribe margins.

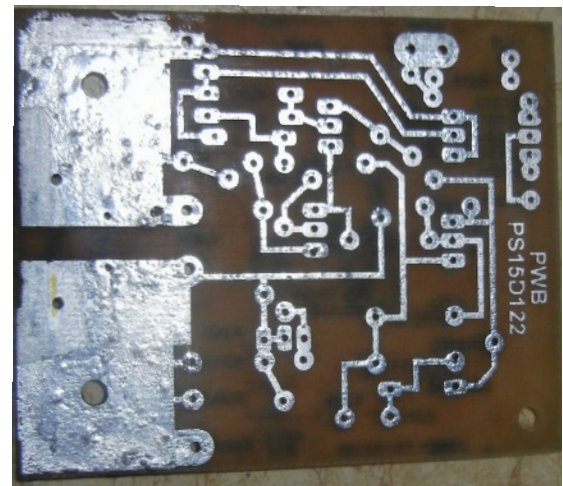


Figure 4. Example of etched and solder coated board. Note Figure 2 is not the film used for this board.

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Once unwanted copper is removed, immediately rinse in running cold water. Once completely clean of any etch residue the resist is stripped using acetone. After which the board is drilled. Figure 4 is an example of an etched and solder coated PCB. Drill burrs are removed from both sides of the PCB by sanding with fine grit paper.

Before soldering coating traces, the Legend should be applied. Figure 5. is an example of flux bleed when the Legend was heat press applied after flux was insufficiently cleaned.

Note: the brownish board color tint is due to this material being used in many heat cycles, not necessarily to the flux bleed. Figure 6 is an example of the Legend printed onto the film.

Figure 7 is an example of the Legend printed before any solder or flux was introduced to the PCB. Note the Legend degraded around the edge of the PCB, again this was due to improper margins used in this example.

Print the legend following the exact procedure for the foil etch pattern, except $t = 300$ seconds. Alignment marks are placed on the drawing so that the Legend can be aligned with the foil pattern. Set the Legend to print using CYMK dark blue. The film adds a blue tint to the toner during the thermal transfer process, so the toner color will improve the blue Legend when printed onto the PCB.

Be sure to perform rolling and quench steps as described for the foil pattern.

Clear lacquer applied over the Legend will improve durability, but be careful using acetone in latter steps, because both are easily removed by acetone.

Summary

When this process is done properly, the film will have a clear image remaining after the heat press operation, indicating all the coating adhered to the board along with the toner.

Figure 3 shows clear areas, but also some coating remaining. This indicates the transfer was substandard for a successful etch pattern.

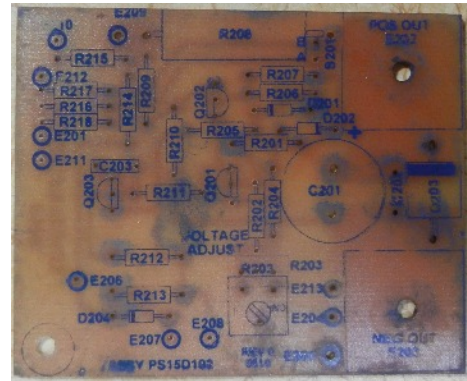


Figure 5. Example of flux bleeding out of drilled holes when Legend was printed - after the PCB was solder coated and inadequately cleaned of flux.

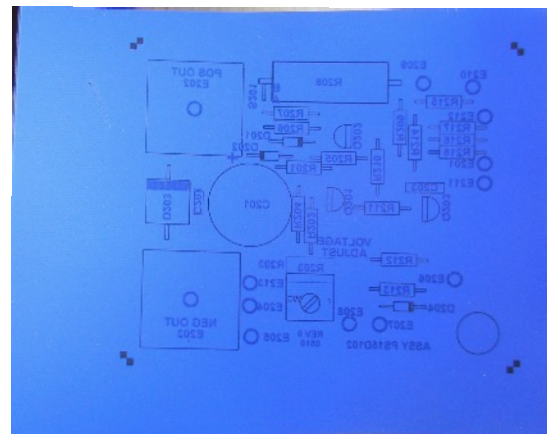


Figure 6. Example of Legend printed on film.

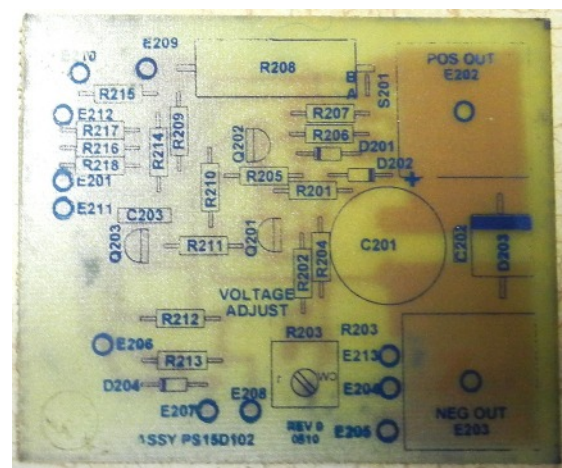


Figure 7. Example of Legend printed before soldering or flux being introduced.

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The temperature and dwell times are empirical and effected by several factors; toner type in use, printer type, board size and pressure. This work was done with a constant pressure set by the height of the Flat Platen above the Flat Base.

For the printer and toner used in making the example boards, it appears 375°F is sufficient to melt the toner. The dwell time was adjusted to optimize the transfer. I suggest this approach to process other size boards and when using other equipment.

This work resulted from approximately 20 runs. Only the last five produced useable boards. The board made with the instructions above, was the best and is shown in Figure 4. never mind the sloppy solder coat and scorched board.

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6.0 Film Process

- 6.1 Layout the circuit foil pattern using a computer drawing program.
- 6.2 Create the component side Legend using the same process.
- 6.3 Allow a 0.625" margin around the finished PCB size and locate alignment marks on both drawings that align with the corners of this rectangle.
- 6.4 Allow an extra 0.25" margin beyond the alignment marks to tape board to the film.
- 6.5 Use all CYMK toners to maximize print density for the foil pattern.
- 6.6 Use a dark blue CYMK color for the Legend.
- 6.7 Layout multiple Foil and Legend patterns, with margins to fit on an 8½ x 11 inch sheet of film.
- 6.8 Set up printer for "color transparency".
- 6.9 Insert Film into the laser printer so that the print will be on the coated side of the film and Print.
- 6.9 Handle the printed film gently as the coating scratches easily.

7.0 Heat Press Transfer Process

- 7.1 Cut a copper clad FR-4 or similar material to fit exactly in the alignment marks on the film. Careful to not scratch the film.
- 7.2 Clean trimmed board blank using soapy steel wool. Ensure all oxidation and foreign material is removed.
- 7.3 Remove any burrs or features that will prevent the film laying flat on the surface.
- 7.4 Set Thermal Press T = 375°F and t = 450 seconds (7.5 minutes).
- 7.5 Preheat Press until it begins to cycle with the Flat Platen rotated away from Pads.
- 7.6 Tape the board to the film using Kapton® or other heat resistant tape.

- 7.7 Place board with film taped to it on the vellum buffer sheet on the Flat Base pads.
- 7.8 Check that the film coated side is down on the copper clad surface and the non-coated film side is facing up toward the Flat Platen.
- 7.9 Carefully rotate the Flat Platen over the Flat Base until aligned.
- 7.10 Carefully close the Press being careful not to twist it.
- 7.11 Start the Heat press Timer.
- 7.12 Once the heat cycle completes (timer elapsed) carefully release the Press.
- 7.13 Check to see if film is stuck to the Flat Platen, if so carefully pry it loose.
- 7.14 Rotate the Flat Platen away from the Flat Base, Pads and film/board.
- 7.15 Quickly but gently roll the film onto the board using an art roller. Be careful NOT to slide the film.
- 7.16 Carefully move the board, with film attached, under cold running water to quench and solidify the resist.
- 7.17 Once board is cool to the touch, peel the tape and film off.
- 7.18 Re-rinse the board and etch resist and dry.
- 7.19 Inspect for defects and touch up as required using a water proof ink or paint.

8.0 Etch Process

- 6.29 Have etch solution prepared and heated.
- 8.1 Etch board only until unwanted copper is removed. DO NOT Leave unattended!! Remove promptly.
- 8.2 Rinse board in cold running water.
- 8.3 Strip resist using Acetone.

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8.4 Drill etched PCB and using fine grit paper, sand both sides to remove drill burrs.

8.5 Rinse board to remove any drill debris and wipe clean using Acetone.

9.0 Legend Process

9.1 Tape the component side of the board to the coated side of the Legend film.

9.2 Use the alignment marks to ensure Legend is aligned with the foil pattern.

9.3 Preheat the Press as done in the foil transfer, except $t = 300$ seconds (5 minutes).

9.4 Once temperature is cycling, place the board with the non-coated film side up, facing the Flat Platen.

9.5 Rotate Flat Platen into position, as before.

9.6 Close Press and start timer.

9.7 Once timer expires, open the Press and rotate Platen away from Base - Be sure film is not stuck to it.

9.8 Roll film onto board - carefully.

9.9 Remove board/film and quench under cold running water.

9.10 Peel film and tape from board.

9.11 If desired, scrub copper side - removing all oxidation.

9.12 Solder coat traces and be sure to remove any excess from holes.

Be careful with cleaning solvents such as Acetone - the Legend can be removed

9.13 Or, store the board until it is to be assembled.

9.14 Scrub copper foil before use.