

The Toner Transfer Method

For Creating HomeBrew PCBs

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Take Away Notes

For

Valley Camp

pQRP - Salmoncon VI - July 2011

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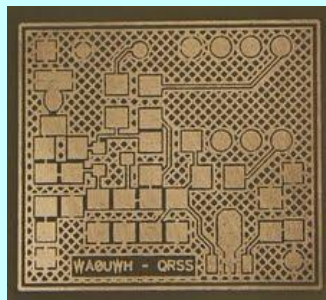
Toner Transfer

One of the methods used to create Homebrew Printed Circuit Boards (PCBs) is known as the Laser Print Toner Transfer Method. This method transfers Laser Print circuit image from paper to blank PCB material. The Transferred Toner is used as the Copper Etch Resist for creating the desired PCB pattern. This Transfer process can also be used to create and label front panels for Homebrew projects.

This method is documented on the Internet by many users, with just as many opinions of the process.

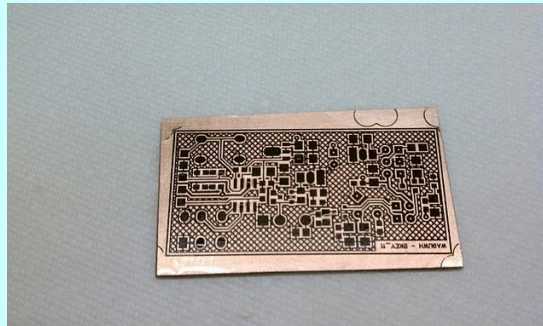
Google: PCB Toner Transfer

This is an example of a PCB created via the Toner Transfer Method, The finished board is about 3/4 inch x 3/4 inches with 6 mil traces, the four pads (upper right) are on 1/10 inch centers.

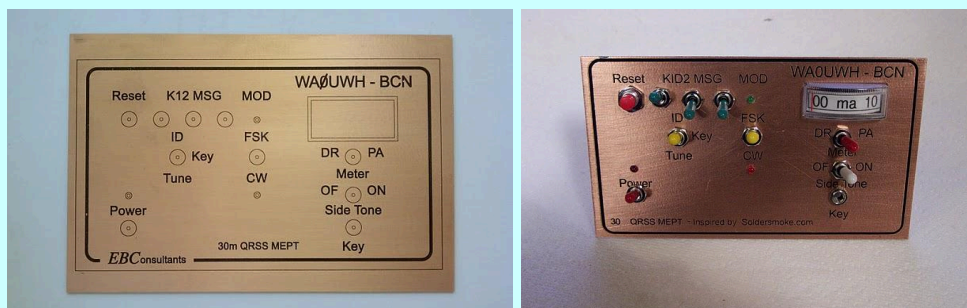


Overview

1. The Homebrew Toner Transfer Method
 - a. Inexpensive, It can be Safe and with Easy Cleanup
 - b. Supplies Per Board are Not Expensive
 - c. Process Can be used to Create both Through Hole and/or SMT PCBs
 - d. Double Sided Boards are Possible, But a Little More Complex
 - e. UV Curable Epoxy Solder Mask Can be Applied, but not Documented Here
 - f. Note: Toner is Heated, but not Melted!
2. The Expected Results
 - a. High Resolution Trace (6x6 mil) Board Possible (Industry Standard)
 - b. Easily Completed within an Hour
3. Toner Transfer Can be Used to:
 - a. Apply PCB Etch Resist



b. Label Front Panels



4. So Why Homebrew PCBs?
 - a. Fast, Easy, Fun, Inexpensive, for One-Off' and Prototype Projects
 - b. For Self Satisfaction
 - c. For Alternatives, See Addendum
5. -

Selection of Supplies and Approach

Safety

1. Safety Glasses and Gloves should be used.

Printer

1. Laser Printer should be:
 - a. Set for Highest Resolution (1200x1200 dpi)
 - b. Set for Darkest Image
 - c. Set for Thickest Paper
2. Laser Printers (Note: not ALL are the Same)
 - a. Printer Manufacturer uses Low or High Temp Toners
 - i. HP Laser Printer (low Temp) are Recommended by most Web Users
 - ii. Note: The Brother Laser Printers (high Temp) are Not Recommended by Pulsar and/or Web Users, see:
http://www.pcbfx.com/main_site/pages/start_here/printer_info.html
 - b. The Brother HL5250NW - ***My Preference, used for prints for this Demo***

Transfer Paper

1. Plain Bond Paper
 - a. Expect Minimal Success
 - b. Considerable Rubbing Required to Remove Paper Fibers
2. Blue Press-n-Peel Transfer Film
 - a. One of the first Transfer Material on the market
 - b. See: <http://www.techniks.com/>
3. Magazine Paper
 - a. Slick Used Magazine Pages, Clay Coated Paper (ink is OK)
 - b. Dissolves in Warm Water (about 20 minutes)
 - c. Some Rubbing Required to Remove Paper Fibers

4. Backing-Paper form Avery Labels and/or Shelf Paper
 - a. Peel when cool, Results Vary
5. Magic Paper
 - a. Dissolves in water
 - b. Fiber ends embed in Toner, difficult to remove
6. Pulsar Transfer Paper - ***My Preference***
 - a. Dextrose Coating, Dissolves in Warm Water (within minutes)
 - b. No Rubbing to Remove Paper Fibers
 - c. See: <http://www.pulsarprofx.com/>

Transfer Heat Source

1. Cloth Iron and a Dowel
 - a. Aluminum Welding Rod (~ 1/8 inch) under material to be Ironed
2. Large Image Transfer T-Shirt Press
 - a. Expensive
3. Pouch Laminator - Typical Used to Laminate Luggage Tags, etc
 - a. Not ALL Laminators are equal
 - i. Some Laminators, Heat then Press via Rollers
 - ii. Best Laminators, Heat via Press Rollers
 - b. GBC Laminator - ***My Preference***
 - i. Heat via Press Rollers
 - ii. Model H-65 (stock = 110 and 120 Deg C)
 - iii. 130 Deg C Mod - Digi-Key P/N 317-1550-ND

Select Etch Method/Supplies

1. Muriatic Acid (Hydrochloric Acid) and Peroxide
 - a. Recommended by most Web Users
 - b. Acid: Available from Pool Supply or Hardware Stores
 - c. Peroxide: Available from Drug Store at 3%
 - d. Typical Mix: Acid 60%, Peroxide 20%, Water 20%
 - e. Remember the Rule: Add Acid to Water
 - f. **CAUTION:** It is an Acid, Gloves MUST/SHOULD be used

- g. Low Viscosity and Low Surface Tension - not good
 - h. Vapor - Should be Vented or Used Outside
 - i. Avoid Spills - Very Corrosive - Avoid Metal
 - j. Can Be Re-activated with Air or more Peroxide
 - k. To Discard: Neutralize and Dilute
 - l. See: http://www.xertech.net/Tech/CuCl_etch.html
 - m. This is considered the Newer Method (*but, I do not prefer it*)
2. Ferric Chloride - **My Preference**
- a. Available from Electronic Supply Houses, Typical: \$15 / Quart
 - b. Higher Viscosity and Higher Surface Tension - this helps avoid under cutting
 - c. No Vapor - Can be Used Inside
 - d. Avoid Spills - Very Corrosive - Avoid Metal - Stains Most Things
 - e. Once Spent, Evaporated to a Solid (or use Kitty Litter) and Discarded
 - f. See: http://www.polymetaal.nl/beguïn/mape/edinburgh_etch.htm
 - g. This is Considered an Older Method, Some people do not Like it
3. Vinegar and Salt (a very slow etch)
- a. Available from the Kitchen
 - b. Very Slow, but very Friendly, See: <http://quinndunki.com/blondihacks/?p=351>
2. My Observation
- a. Etch with Higher Viscosity and Higher Surface Tension Produces a Better Etched Image Quality

Cutting PCB Material

1. PCB Material Typically .032 or .064, Single or Double Sided
2. Hand Tin Snips
3. Mini Shear-Brake (Grizzly)
4. Thin Saw or Dremel Tool
5. Vinyl Tile Cutter - See Home Depot (I have not tried this, but it looks very good)
 - a. Model # 30002
 - b. Store SKU # 729019
6. Heavy Duty Guillotine Paper Cutter with a Guide and Safety Hold-down - ***My Preference***
 - a. See Addendum
 - b. Google search: "Photo Materials Guillotine Paper Cutter"
 - c. To avoid curl, cut by holding the material near the center of the cutter blade using reference lines for a guide
 - d. Use hold down blocks for safety
 - e. Cut slowly, but with force
 - f. Watch out for fingers
 - g. Note, a very thin sliver can be cut using this method

Demo Assumptions

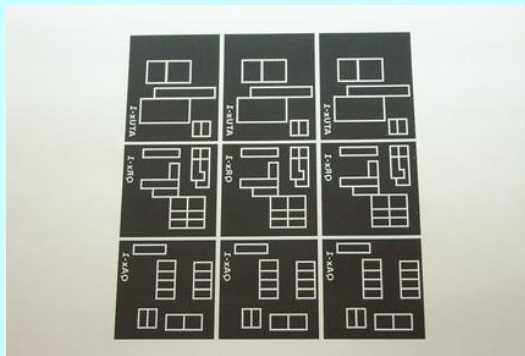
For this Presentation and Demonstration the following are assumed

- Artwork Printed via a Brother Laser Printer
- PCB Material will be cut with a Heavy Duty Paper Cutter
- A GBC Direct Heat Roller Laminator will be used
- Pulsar Toner Transfer Paper and Supplies will be Used
- Ferric Chloride Etch will be Used
- After Etch, The Copper Traces will be protected with Solder Wipe

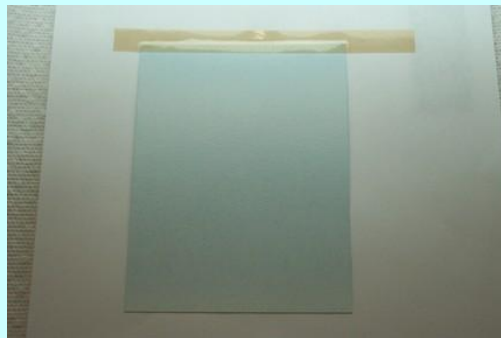
The Circuit Board Creation Procedure

The following is the Hands-on Demonstration

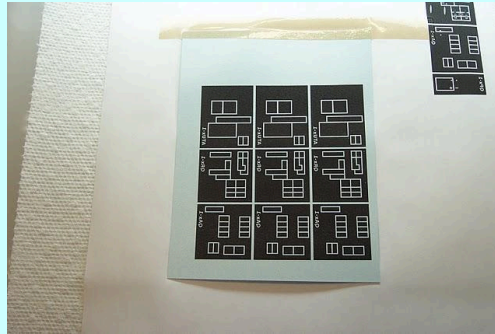
1. Print Artwork to Laser Printer on Normal Paper
 - a. Most often - the Image should be Mirrored
 - b. Included Crop Marks are Useful



2. Overlay the Image with cut Pulsar Transfer Paper
 - a. Cut Size Larger than intended PCB Stock Material
 - b. Tape only the Leading Edge



3. Re-Print Artwork (same as before) on this Paper Stack
 - a. Inspect Image Details with Magnification

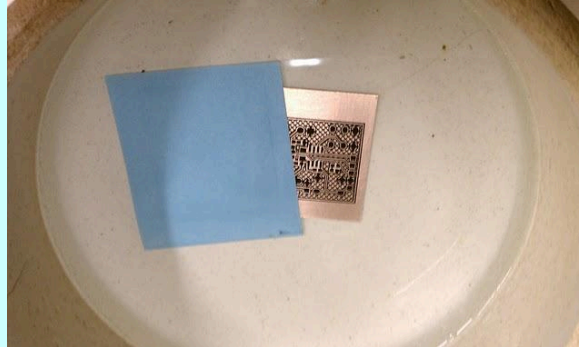


4. Prepare PCB Material
 - a. Cut PCB Material and Deburr Edges - Burrs prevent good transfer at edges
 - b. Clean Copper Surface with Scotch Brite, Water, and a Drop of Dish Soap
 - c. Rinse with Warm Running Water
 - d. Air Dry or with Heat Gun
5. Sandwich PCB Material with Transfer Paper
6. Laminate Several Time in Different Directions
 - a. Use a Thin Laminating Packet
 - i. A cut section of a Manila Folder
 - ii. Or, Folded Paper
 - iii. Note: When the temperature and pressure is correct, the Dextrose (paper coating) will stick to the copper. With too much temperature or pressure the image will smear.



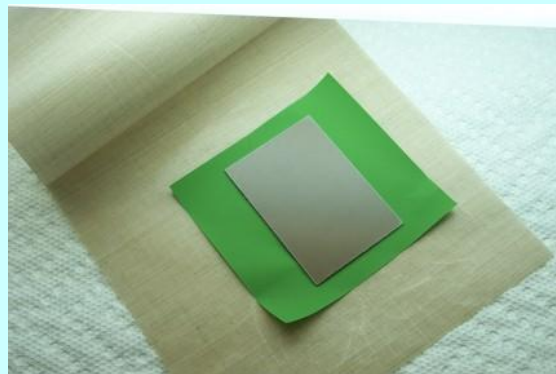
7. Quickly, Immerse While HOT in Warm Water
 - a. Try to wet the paper in one quick action, if NOT the reduced heat contraction may shear or lift the image.

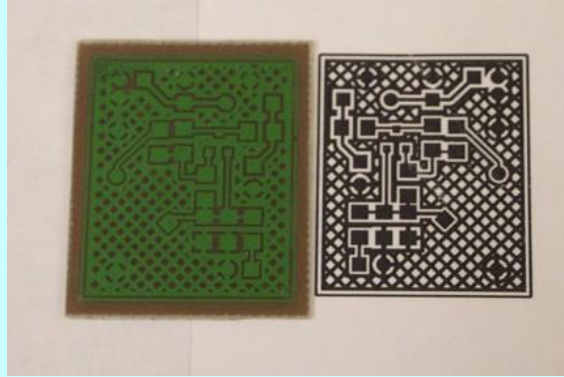
- b. In a few minutes the Pulsar Transfer Paper will Float Away
- c. Rinse and Rub PCB with Cool Running Water
- d. Inspect with Magnification



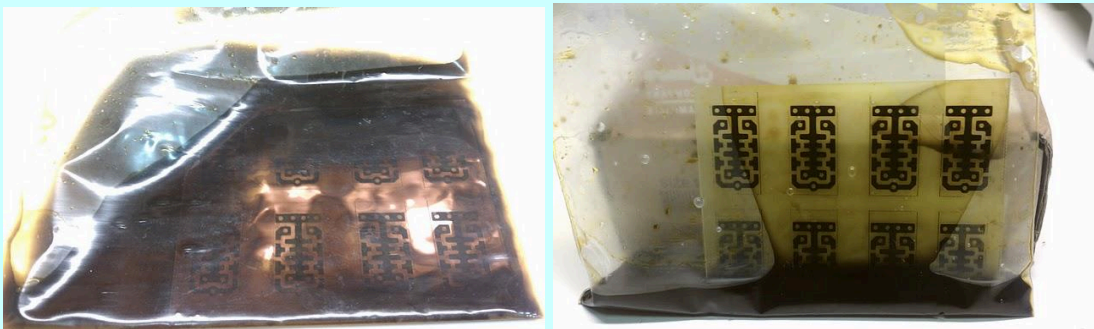
8. Add Pulsar Green Foil Layer - Optional

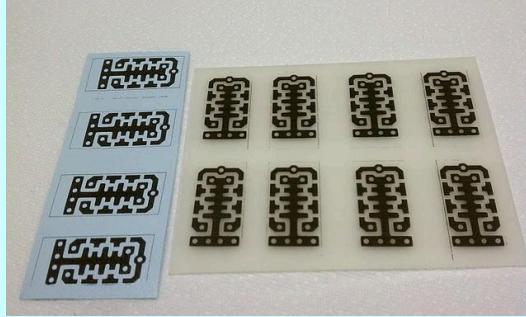
- a. Cut Foil to Larger than PCB Material
- b. Fold Foil and Tape Over One Edge of PCB Material
- c. Laminate Starting with Folded Edge, Holding the Foil Taught
- d. Let Air Cool
- e. Peel/Rip Green Foil off of PCB to leave Green Foil covered Toner
- f. Inspect with Magnification





9. On Two Sided PCB Material, Cover Backside with Tape
10. Gross Trim PCB Around Image, Leave About ½ Inch Border - Optional
11. Etch as Necessary
 - a. Ferric Chloride with a Sponge
 - i. Wet Sponge with Ferric Chloride
 - ii. Paint/Wipe to remove Copper
 - b. Ferric Chloride in a Zip Lock Bag (very little Ferric Chloride is needed)
 - i. Immerse Bag in Hot Water
 - ii. Inspect and Agitate the Bag as Necessary
 - iii. Rinse PCB under Cool Running Water
 - iv. Inspect the Details with Magnification
 - c. Note: Fast Etching Provides the Best Circuit Image
 - i. Speed Helps Avoids: Pitting, Undercutting, and Trace Thinning
 - d. Inspect with Magnification





12. Remove Backside Tape

13. Drill as Necessary

14. Remove Laser Print Image (and Green Foil) with Scotch Brite under Running Water

- a. Chemicals are not recommended, they smudge and require additional clean up
- b. The resulting shinny board will be ready for the next step

15. Trim and Deburr PCB as Desired

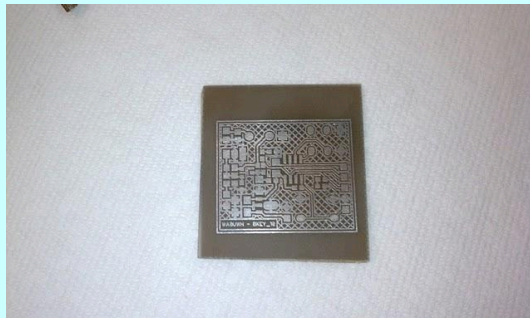
16. Double Bag Unspent Etch (for the Next Project) in Vertical Storage

17. -

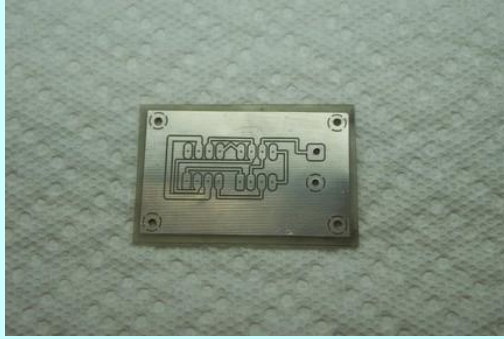
Post Etch Processing - Optional

Solder Wipe

1. Solder Wipe to Protect Traces
 - a. With Solder Wick, A Small Amount of Solder, and Generous amount of Rosin
 - b. Push Solder Wick with Soldering Iron around on the Traces
 - c. Cover all Traces and Copper Pour, use as Little Heat as Necessary
 - d. Clean with Alcohol
 - e. Scotch Brite to Remove the Shine (very distracting when soldering)



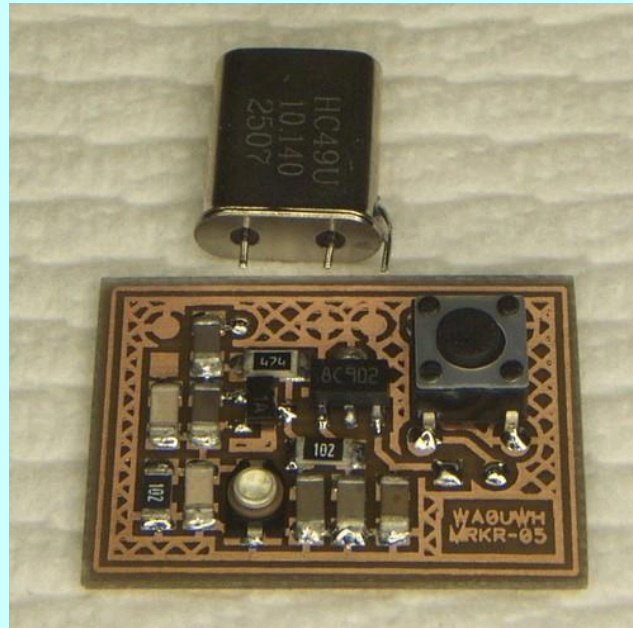
2. Trim to Final Size and Deburr Edges
3. Apply and Develop Solder Mask (A Topic for Another Demo?)
4. Rub on a Thin Layer of Rosin, also Rosin can be used to Seal the Edges
5. Let Air Dry Until Rosin is no Longer Sticky (maybe 5 minutes)



6. -

Finished

The Printed Circuit Boards is Ready for Components.



Expected Future Developments

Efforts by Web Users to Expand and Develop New Homebrew PCB Production Methods.

- Direct Laser Printing of Resist onto PCB Material
- Direct Ink Jet Printing of Resist onto PCB Material
- Laser Light Print onto Etch Resist and UV Curable Epoxy
- Homebrew, Easy to Produce "Via's" for Two Sided PCBs
- Low Cost CNC Equipment for Drilling Holes

Conclusion

- The Toner Transfer Method can be used to create Etch Resist Circuit Patterns for Homebrew PCB Production, and Labels and Artwork for Homebrew Project Front Panels.
- Expect High Resolution, High Quality Printed Transfers.
- Elapsed time; From Laser Print to Finished Single Sided PCB, maybe as little as 20 minutes.
- It is **Fun, Fast, Inexpensive** and **Easy**
- Anyone can do it, even a young Engineer.

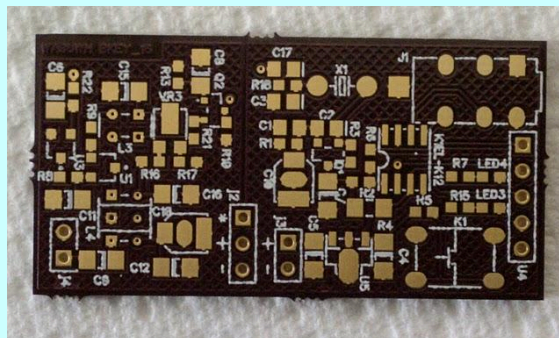


Addendum

Inexpensive High Quality HB Alternatives

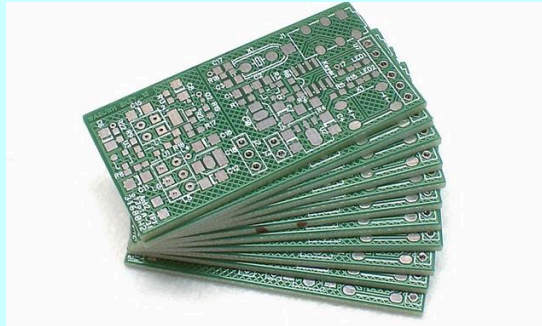
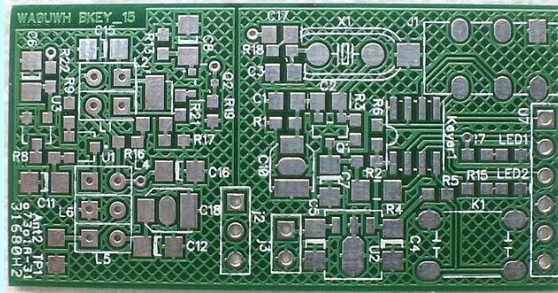
DorkBotPDX

- http://dorkbotpdx.org/wiki/pcb_order
- \$5.00 (free shipping) per Sq Inch for **three copies**
- Made in USA - 12-15 Days
- Example: Three 2x2 inch Boards with shipping = \$20.00
- Example: Three 4x4 inch Boards with shipping = \$80.00
- Note: Price per sq inch is the same regardless of size or aspect ratio of boards



ITeadStudio

- http://iteadstudio.com/store/index.php?main_page=index&cPath=19_20
- \$12.00 (+ \$4.00 shipping) per 5x5cm (about 2x2 inch) for **ten copies**
- Made in China - 21-28 Days
- Example: Ten 2x2 inch Boards with shipping = \$16.00
- Example: Ten 4x4 inch Boards with shipping = \$34.00
- Note: Other prices available for larger or other aspect ratio boards



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The Paper Cutter

The paper cutter that I use is OLD and sturdy compared to newer more available models.

Disassemble the paper cutter, inspect and sharpen both Blades if necessary (which is an art in itself).

Then tightened the spring for more than normal side force and lifting force.

When cutting PCB material;

- Cut mid blade to avoid curl of the cut scrap, use alignment squares as necessary.
- Try to keep the good piece on the flat table of the cutter (on the left), scrap to the right.
- Start the cut with the blade touching the far edge of the PCB material.
- Cut with force (down) while pushing a little to the left.
- The cutting motion does not have to be fast, but it should be forceful.
- With practice, even very thin sliver can be cut.

Software

This is not a software review or evaluation demonstration, but software is necessary to print images. Any software that can print a 1:1 scale image on a laser printer can be used with Toner Transfer. Here are a few suggestions.

- For artwork for Front Panels I use Inkscape. **Inkscape** is free and available from <http://inkscape.org/> for Linux, Microsoft and Mac.
- For PCB layout
 - **DipTrace** from <http://www.diptrace.com/> is available free for evaluation with limited pin count. ***My current preference.***
 - **AutoTrack** is available from <http://www.kov.com/> but only runs on Microsoft
 - **DesignSpark** is available from <http://www.designspark.com/> for Free, but does not work well with my limited Ubuntu machine. It is reported to work well will Larger Microsoft systems.

There are many more PCB Layout Programs available, Google PCB Layout.

The URL of this Document

- https://docs.google.com/document/d/1KQ_ZgSuv5aYPFcG7D_bZfGAsTM2bOYWzaXR4oNziLI/edit?hl=en_US
- This is a live online document that will be updated as information and/or photos are added or changed.



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