

“PCB Fab-In-A-Box”

Info Pack and Instructions

The “Direct Etch” process is basically very simple, Print, Fuse Toner to Copper, Release Image, Etch... done. But like anything that is unique, there are certain parameters for proper operation. If you’re within the “window” of operability it works flawlessly every time, speeding up your board fabrication in under 10 minutes. This info pack contains a lot of information to give you a full understanding of the process and specifications to get perfect single & double sided boards in minutes.

1) TONER TRANSFER PAPER (or “TTP”)

The specialty “transfer” paper medium is coated on the BLUE side with a non-toxic, non-hazardous starch-based, water-release starch-based coating called Dextrin. This topical coating lies in between the printed toner image from the fibers of the paper. It is safe to use in all laser printers and photo-copier devices. It is NOT to be used with inkjet or wax printers!

• Commercial Quick-Print Companies (FedEx/Kinkos, Office Supply Stores, etc):

If taking this paper to your local quick-printer and they are leery of this paper being run through their printers/copiers, as they should be since many types of transfer mediums out there should never be run through laser printers which can cause printer damage. Have them read the Safety Certification on the front of the Toner Transfer Paper package to explain that nothing about this paper can cause any damage to any modern toner-based printing device. Water is the only thing that can activate this paper. You could put a match to the paper and it will just burn like an ordinary sheet of paper.

• Handling The Paper:

Handle the paper only by the edges to prevent fingerprints over the blue coated side... and ALWAYS with dry hands! If the paper was to get accidentally wet with droplets of water do not run it through any printer as the Dextrin release coating will be activated and could transfer to the printer rollers or paper path requiring disassembly and cleaning.

• Which Side To Print:

Print only on the blue side. If you were to print on the white-side, the image will refuse to the copper surface but the paper will not release the image and you will have wasted that sheet. Once wet, the paper can not be reused.

• Keep The Paper Sealed:

This paper is dimensionally stable (e.g. lies flat or slightly convex) at 70+% RH. If the paper is left out and in a dry environment (< 50% RH) it will begin to make a concave curl as the paper loses its moisture content which can result in printer jams or poor print quality as the fibers become stiffer as it dries out and won't ride up smoothly against the printing drum. After the paper has been run through your printer it will have a noticeable curl as the hot fuser rollers reduce the paper's moisture level. Unused paper that has been run through a printer should NOT be printed to so always cut a sheet to the size needed, then put the excess paper back in the envelope and re-seal the package envelope.

- Economize on Paper Usage:

Laser printers and copiers normally want to see at least a 5" length of paper to make it through the printer's path without getting lost inside. The following technique will enable you to run very small pieces of transfer paper through the printer (as small as a 1" piece) using a simple 'carrier sheet' technique. Here's how to do this...

Print your circuit image to a regular sheet of white paper, then cut a small piece of Toner Transfer Paper (TTP) about 1/2" larger than the size of the printed image. Lay the TTP blue-side up, directly over the printed image. Using an Avery® type of laser label (or any paper-based tape) secure the 'top' of the TTP to the white 'carrier' sheet, place in the manual-feed tray and print again.

If this 'carrier' sheet jams during printing, it means the total paper thickness is too much for your printer - some printers are very sensitive. To fix this, use an X-Acto knife to remove the white paper under the TTP paper so it can float inside the opening. Apply the tape so as to hinge the small piece of blue TTP, like that of a doggy-door. Place the 'carrier' back into the manual-feed tray and print. The 'carrier' should exit with the image printed onto the small piece of transfer paper.

2) PRINTERS & PRINTING

Important information on your printer. Most printers will work great without any setting changes, others may require some parameter changes and a few will not work well with our process.

- Problem Printers:

Laser printer and photostatic copiers have historically contained about 55% of a Styrene plastic in their toner formulas. Styrene plastic is what makes the rest of the 8 ingredients of conventional toner fuse (melt) into the fibers of paper or stick to metal surfaces. Around 2010 several manufacturers changed their formula, replacing Styrene with a very-high temperature epoxy-based substitute and that is what has caused a problem with the Direct Etch technique. Our process deals with low-temperatures in the range of 270°F to 330°F. However, some of these newest laser printer manufacturers use this new breed of toner which works on much higher temperatures to fuse and it's these manufacturers that do not play well with our process:

- ✓ Brother (all models)

- ✓ Samsung (some)

- ✓ HP (only the 3-digit model numbers - older 4-digit models work good)

- Color vs. B&W Printers:

You do not want to use color laser printers or color copiers! Even though you are only printing black, the BLACK toner in a color printer is completely different than that of a B&W-Only printer. All color toners (Cyan, Magenta, Yellow & Black 'K') are extremely thin toners and are actually transparent. Any single CMYK toner lacks the density needed to fuse toner directly to a metal surface because it just doesn't have enough Styrene plastic to fuse the image properly.

There is, however, one way to use a color device using this "two-step" technique: First export your circuit image in a format that your graphics program (Photoshop, Illustrator, CorelDraw, etc) can import and manipulate. After importing the circuit layout, select all circuit traces, pads, etc and change

all elements from black to a dark-green, then print. Doing this will cause 2-1/2 toners to be dumped to the TTP (100% Cyan & Yellow and about 50% Black). The printed circuit pattern will now be dense enough to fuse to the copper surface. The resolution of the image may suffer a very small amount due to color registration, but if you keep traces to .015" or wider, this technique will work well.

- Setting Laser Printer "Density" and "Paper Type":

All laser printers have a toner density control for the amount of toner being laid down. Factory settings are generally set to a "mid-setting". On some printers, finding the printer "density" control may be a bit elusive to locate - but it's there somewhere! If your printer does not have an LCD window for making parameter changes, you will then use the printer's "Utility" program to make changes. Copiers on the other hand just use the "Contrast" control to adjust density of the printout. Don't confuse Density with Resolution or any other printer modifier. Also, turn off all "economy mode" settings because you want the most toner you can get out of the printer.

The second parameter you want to set is the "Paper Type" (a reference to the paper's weight). Most papers have a name like Coated, Uncoated, Transparency, Bond, Card Stock, which relates to a particular paper weight. Our transfer paper does not have a name, but rather a weight number. It is referred to as 170gsm (gsm = grams per square meter or reflected as "gm2"). It's the number that's of importance here. When going through the printer's parameters, look for a list of these paper names (these are the "Paper Types"). Look for an entry with no name but rather a range of numbers like "150 to 180" or perhaps "> 160" and select one of those. You may also see a list of named papers with a weight shown next to it. Just find one that incorporates the "170" for the TTP. If you do not see any numbers, select 'Card Stock' or something that sounds heavy. Setting the Paper Type tells the printer what to expect coming through and will dump toner accordingly. In recap, DENSITY and PAPER TYPE are the two most important parameters to set.

- Toner Cartridges:

There are two types of toner cartridges... OEM and After-Market. The cheaper "After-Market" carts are great for everything EXCEPT printing a dense image for transfer to metals. For making PCBs and other maskings for etching metals, always use an "OEM" toner cartridge to get quality toner (high plastic content) to get reliable, repeatable etching masks. Many will get the more expensive OEM cartridge and mark it as "PCB-Only" and swap cartridges when making an etching image mask.

- Laser Printer Alternative:

Many customers who have just an inkjet printer and don't want to purchase a B&W laser printer just to use this product have opted for any of the low-cost used 'desktop' copiers (not to be confused with inkjet printers with a scanner on top). A true photo-copier uses an 8" wide toner cartridge like that of a laser printer. One good choice we've found that works very well is the Canon "PC" Series. Three older models can be found on eBay, Amazon, etc called the PC-140, PC-150 or PC-160. They are out of production and relatively inexpensive in the used-market. To use a copier, you simply print your original artwork from any inkjet printer on white paper and run a sheet TTP through the copier. If however, you choose to go to your local copy house to use their copiers, review the procedure we have on the website under TECH SUPPORT > Instructions > Printer Setup (Calibrating A Photo-Copier) to set the parameters and know the unit will give you satisfactory results before wasting a sheet of TTP!

- Orientation of PCB Patterns for making Single or Double-sided Boards:

Every software package handles printing a bit differently to the orientation of the TOP and BOTTOM traces of a board layout, so you'll need to play with this to know how to orient your images (eg. you may have to force the printer to reverse an image). Keep in mind that the paper is going to give you one-level of reversal of the image. Remember that when laying out a pattern, you're normally looking at the traces in an "X-Ray" view. In other words, the screen view of your board, you're looking THROUGH the circuit board. The printout for the bottom traces (solder side of 'thru-hole' board) will be right-reading, meaning it will look just like what's on screen. If you printout the TOP of the board's traces, it should be reversed. It's a little confusing until you play with it. A common technique for proper orientation is to print onto Vellum (semi-transparent) sheets of paper. This way, you can sandwich the two patterns with an invisible board between the pages to verify everything is correct before printing to the TTP.

For making double-sided PCB's we have three methods of doing this on the website (See: TECH SUPPORT > Register 2x PCB). Of these 3 methods, we prefer doing one side at a time (transfer and etch) as it can be a lot faster in that you don't have to blind-register two opaque pages of transfer paper.

3) SAMPLE CIRCUIT IMAGES

In the kit you'll find a preprinted sheet of sample circuit images used to trouble-shoot image transferring problems. This page has been printed from a known-good OEM toner cartridge. Use one of these images to determine if the problem is with your printer or the heating device (laminator or iron). If for example, a preprinted image transfers properly, it points to your printer's toner quality or settings (explained above in "Printers & Printing"). Alternatively, if the image does not transfer properly, it points to your heating device not providing enough heat and/or pressure.

4) COPPER CLAD BOARDS

Conventional laminate that you see most everywhere else is .064" thickness with 1oz copper. All of our laminate board is conventional "FR4/G10" fiberglass, laminated to .032" thickness with 1/2oz CU (except for our 'FlexPCB' which is only .005" thick, for making interconnect, membrane key-pads, etc). The bonded strength of 1/2oz copper is the same as 1oz.

There is good reason why our board is .032" with 1/2oz copper. Thinner .032" board makes for easy cutting using any conventional (long arm type of guillotine style) paper-cutter, and by using lighter 1/2oz copper you get much faster etching time. Shorter etch time means less under-cutting... the trick for making very fine circuit traces down to .005" width. Additionally, by using our "Contact Etch" technique you can etch your boards in about 1 minute without needing an etching tank! (See: TECH SUPPORT > No Etching Tank).

- Preparing The Copper Surface:

Copper starts to oxidize right after the board has been laminated at the factory. The time between manufacturing, transport, cutting and packaging, creates a little oxidation that needs to be cleaned off before transferring your images. Additionally, toner images like to see a lightly scratched up surface for something to bite into, not unlike the fibers of paper for normal printing.

The ideal way to clean and prep the copper surface is to use a drop of dish-washing soap on the green side of a regular kitchen ScotchBrite® scouring pad (or plain green scrubbing pads available most anywhere) with plenty of water in a sink. Simply do a quick, light scrubbing and rinse well to remove oxidation particles and all traces of soap. Dry with a paper towel and you're ready to transfer your circuit image.

- High Current Requirements:

Using thinner 1/2oz copper does limit the maximum current through a trace, so if you're needing high current, simply fatten those traces a tad. But how much? We have a great chart on our site to show you just how wide the traces need to be for any given current. Reference the '[Current vs. Trace Width](#)' chart at LIBRARY > Miscellaneous.

- Etching Chemistry:

Common etchants use for etching copper are Amonium (or Sodium) Persulphate & Ferric Chloride (FeCl). The fastest chemical is FeCl as it is a 'corrosive' vs. an 'oxidizer'. FeCl is easier to find and has an indefinite shelf life whereas the slower acting Persulphates, once mixed with water has about a 1-month shelf life before it's dead. If you use our novel "Contact Etch" technique, you can etch your boards in about 1 minute using a micro-amount of FeCl in a sponge. (See: TECH SUPPORT > No Etching Tank?). All in all, using 1/2oz CU with the sponge technique gets you a board that's done in less than a couple of minutes... you just can't beat that!

5) TONER REACTIVE FOILS (TRF)

The Green foil is heat-transferred to seal the entire toner-printed circuit image which prevents pitting (or 'etch-thru'). The WhiteTRF foil is applied over a silk-screen image to convert the black toner to white making it look like a professionally fabricated board.

Toner by its very nature is porous. It's nothing but particles of dust. So, if an image is transferred to your board and etched, you run a very high chance of having the etching chemical get through the toner image particles and start attacking the copper beneath. To prove this to yourself, print a box about 4" square on a white sheet of paper. Hold the page up to a sun-lit window. What you thought was a solid black box is actually very transparent. However, the toner particles are close enough together that when the GreenTRF foil is transferred on top of any toner image, it will fully cover the toner image giving you a hermetically sealed toner image, that is impervious to all etchants. After etching is done, both the GreenTRF foil and the toner image are wiped away using regular Acetone from any hardware store.

For adding a Silk Screen image from your software, you transfer it to the circuit board the same way you transferred your circuit image and GreenTRF. You want to add your silk-screen image after all etching has been completed. Optionally, leaving the silk-screen image as just black is quite nice looking too. Our boards are a light green "natural" epoxy which gives good visual contrast to black toner images.

6) TRANSFERRING IMAGES

There are two common methods used to re-fuse circuit images to copper-clad boards. Some have tried to use a waffle iron as well as other home-brew methods with limited success because it takes more than just temperature to properly fuse toner images.

It takes pressure... and as much as you can give it. Pressure is just as important as temperature which is why the "laminator" approach is the best method for transferring images. The roller pressure of a 10-mil type laminator equates to hundreds of PSI being delivered (as extrapolated by the contact point of heated round rollers down the linear travel of a board through the device). If for example, you were using an iron (which will work great if you first calibrate it) you could literally stand on the iron and only get a few dozen PSI. It's all due to the size of the platen. Laminators have rollers with a micro-small contact line. This is why the laminator is the best heat & pressure device available.

IRON: You can use a household iron to get reliable, repeatable results with trace widths down to about .020" wide, after doing a simple calibration. (See: TECH SUPPORT > Instructions > Using An Iron. Also look under TECH SUPPORT > Tips 'n Tricks > Roll Your Own.)

LAMINATOR: The much preferred method for ease, performance and speed is to use a "10-mil" type pouch-laminator... a far better method over the iron approach in that it has basically no limitations on trace widths, allowing you to transfer circuit traces down to .005" using any conventional B&W 1,200dpi printer. If laser printers go higher than 1,200dpi, your traces too can get thinner. Keep in mind that most of the low-cost commercial board fabrication houses will not accept designs under .010"... we're talking about a level of magnitude twice of that, all done under your roof. Two .005" can be run in between two thru-hole IC pins. All SMT patterns can be imaged with this simple process.

There are two inexpensive 12" wide, 10-mil type laminators units commonly available in the USA/Canada. Most all laminators you see in stationary stores and online are the conventional "3~5mil" type units. They are very low performing units and not recommended as they generally lack total pressure and heat capacity for most board designs. These two are:

Apache AL-13P (and) TruLam TL-320B:

Average Street Price: \$90~\$150

Requires adjustment of roller pressure springs from factory settings.

Tamerica SM-330: (We stock this preferred unit)

Price: \$139.95 (MSRP: \$159)

Superior design and construction. No mods or adjustments required.

• Removing An Image:

If you've made a bad transfer (hiccup, mis-registration, etc) you can easily remove the toner from the board by using Acetone (not "Fingernail Polish Remover" as that is not plain Acetone anymore). Best to get a small pint size from any local hardware store. Using a new, dry paper towel, wet it with a liberal amount of Acetone and 'wet' the toner as you wipe.

It will instantly remove the toner on contact. If the toner smears, it means you either have the presence of water on the paper towel (or on the board) or you're not wetting the towel enough. Use the same way to remove the etching mask from a completely etched board - toner and GreenTRF foil in a few wipes. (Use a new piece of paper towel for a second clean-up wipe down.)

- How To Transfer TRF Foils: (Same for both Green and WhiteTRF foils)

If using an iron with a single-sided board, place an oversized piece of the foil over the board and using any paper-type tape (not Scotch tape!) secure all 4 corners then apply heat for about 20 seconds. Allow the board to cool down to room temperature before peeling the foil back over itself.

If using a laminator, cut a piece of foil about an inch longer than the board so that you can wrap the excess length around the leading edge of the board and insert into the laminator. As soon as the rollers grab both foil and board, either, pull back on the tail end of the foil, or drop your fingers down over the foil to induce drag on the foil, thus prevent any wrinkles from forming as the board goes through the unit. Run through a second time without touching the foil, then put the board in a tray of water to instantly cool down or just wait for the board to cool to room temperature before peeling off the foil.

IMPORTANT! If you see wrinkles in the foil after the board has gone through the laminator, you most likely have an un-true leading edge going into the laminator. Any 'waviness' from a poor cut WILL induce wrinkles that no amount of pulling back on the foil will stop from forming.

- Residual Foil Left Behind:

If after you have applied either foil, you see residual foil left behind where it shouldn't be, this is caused by either an un-washed board after the TTP was transferred, or simple 'surface-tension'.

1) Board Cleaning: After the TTP was transferred and floated off the board, you must ensure that all Dextrin has been removed from the board. If any Dextrin is left on the board after drying, the foil will stick to it and it can't be removed and will mess with your etch. So, when the TTP has released in the water bath, put the paper back over the board and rub it around. That will break residual Dextrin trapped between finely spaced traces and donut hole pads. Rinse thoroughly under heavy tap water.

2) Surface Tension: After either foil has been transferred and peeled off, you see extra foil where it shouldn't be, it's due to plain 'surface tension' and can be easily lifted off using standard "3M Temporary" (or Re-positionable) Scotch® tape. Providing the board was fully cleaned all you need to do is lay down strips of tape over the offending area and lift up to remove residual foil.

FOR LAMINATOR USERS

- Carrier Envelope:

All laminators come with a light cardboard envelope which is used for transporting "pouches" through the unit for sealing prints, etc. We don't use that Carrier with our process as boards are rigid and have no problem getting lost inside the unit (as long as the board is at least 3-1/2" long to be able to pass completely through the laminator) plus the Carrier only reduces the total heat getting to the target board.

- Maximum Board Thickness:

The 10-mil type laminator is the largest of the pouch-type unit on the market. Generally, they can handle up to about .080" total thickness going through the unit, equal to an .064" board and 2 sheets of .008" TTP (if doing a double-sided board in one pass).

- Safety Reminder:

Whenever using a heated device like a laminator you should always be present in the room in case of a malfunction. (The Tamerica SM-330 has an overheat sensor but the Apache AL13P does not). In any case, we recommend putting a simple, inexpensive smoke-detector above your work area. It is easy to forget the unit is running since they are very quietly. Perhaps putting a little note on the exit door that the unit is on!

STEP-BY-STEP INSTRUCTIONS

STEP 1: SURFACE PREP

Clean the copper surface with a drop of soap and lightly scrub with a green "ScotchBrite" pad. Rinse well with running tap water and dry with paper towel.

STEP 2: TRANSFER PCB IMAGE

The edges of the print should not overlap the board.

IRON: Print and trim the transfer paper to size. Lay the printed image into position over the copper and apply iron pressure (as per calibration done prior).

LAMINATOR: Insert board/paper combination into the laminator. As soon as the rollers grab the board and paper you can let go. When the board exits, reinsert for a second pass to ensure full even heating.

STEP 3: WATER BATH

After the second pass, immediately slip the board into a tray of water. Do not let it cool down! After about a minute or two the paper will separate/lift away from board. Don't help it! When released, put the paper back over the board (slippery blue-side down) and rub lightly all around the board to break-up any surface tension of the Dextrin release agent that can get trapped between finely spaced traces, donut holes, etc. Rinse the board under hard tap water flow. Dry with paper towel.

STEP 4: ADD FOIL

IRON: Cut a piece of GreenTRF an inch larger all around the board's dimensions. Using a paper tape (not plastic cellophane 'Scotch Tape') tape the 4 corners of the foil so it is held taught. Apply iron directly over the foil with heat and pressure established from prior "calibration".

LAMINATOR: Cut a piece of GreenTRF about 1" longer than the board. Lay the foil, dull/gray side down over the board with about 1" flipped around the leading edge of the board to be inserted into the laminator. Insert into the laminator in one smooth motion until the rollers grab the board. Pull back on the tail of the foil until it is fully pulled into the laminator, or drop

your fingers down over the foil to put drag on the foil as the board is pulled through. Insert the board a second time without touching the foil. Let the board cool down to room temperature or slip the board into the water bath for an immediate chill. Peel the GreenTRF 180° back over itself. Inspect for any foil bridging.

STEP 5: ETCH

Etch in usual fashion. Check out our "Contact Etch" technique on our website to see how to etch extremely fast without even needing an etching tank. (See: TECH SUPPORT > No Etching Tank?) After etching, wash thoroughly and dry the board. Remove the GreenTRF and black toner mask with Acetone (or any hot solvent). Using a dry paper towel, heavily wet it with Acetone. It's important that there is no moisture present on the board or paper towel otherwise you'll get a lot of smearing of the toner. After this, use the green ScotchBrite with drop of dish washing soap to polish up the copper ready for tin-plating (if desired) to protect against oxidation. We recommend using "Liquid Tin" by MG Chemicals from Mouser Electronics (#590-421-125ML)

STEP 6: SILK SCREENING

After etching is done, a silkscreen layer can now be applied directly over the board the same way the circuit image was sealed using the GreenTRF. Many users just leave the black toner as the silkscreen layer as it has good contrast and looks quite good. White of course makes the board look like it was commercially fabricated.

WE WANT YOUR FEEDBACK!

Please feel free to contact us at any time. We're always receptive to your comments on how to improve our process or anything else you'd like to share with us. Contact info below.

