Modification of the Lexmark E260 Laser Printer for Direct Laser Printing of Double Sided Printed Circuit Boards

by **mlerman** on February 7, 2016

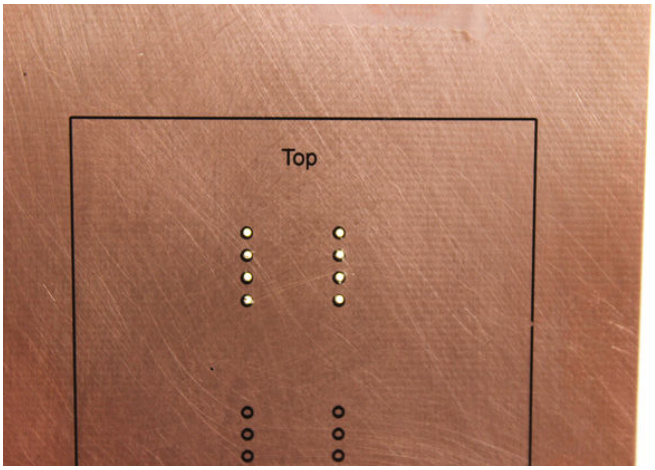
Table of Contents

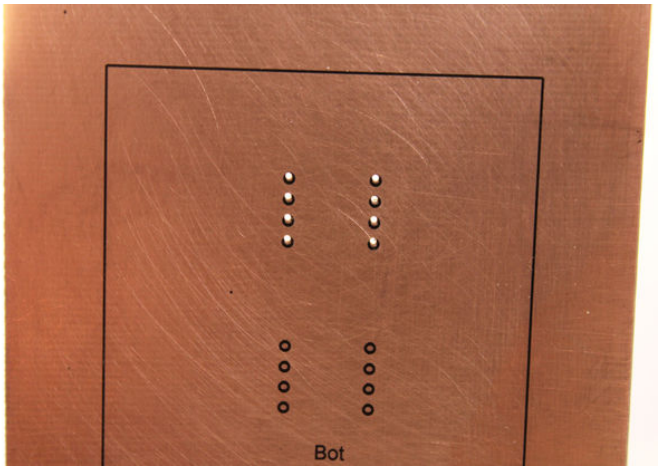
Intro: Modification of the Lexmark E260 Laser Printer for Direct Laser Printing of Double Sided Printed Circuit Boards

This is the third version of my Instructable for repurposing a Lexmark E260 laser printer to print toner directly on copperclad boards. Once printed and "fixed" to the copper by acetone vapor, the toner acts as a resist during the normal etching process, producing a finely detailed printed circuit board (PCB). I call this process DLP for Direct Laser Printing. This version makes the printer capable of making fast, accurate double sided PCBs with traces down to 5 mil. And, as a bonus, this version is able to print PCBs up to 6 inches wide, compared to 4 inches for the original.

For reference, the original versions are Here and Here.

The images above are the "first run" of of a quick test board, and are two sides of the same pcb. As you can see, registration is not perfect, but it is pretty darn good! Especially considering that it took all of 20 minutes from design to ready to etch!





Step 1: Parts and Tools

Parts

E260 Laser Printer - This can be a E260, E260d, E260dn. Ebay

McMaster-Carr

1x1x.062 Aluminum Angle x 12 inches 8982K39

6"x24"x.016 Aluminum Sheet 89015K115

1/8"x3/4"x 12"' Aluminum Bar 89755K26

Copper Tape with Conductive Adhesive .250" x 18' 76555A711

Other Parts

2.7K ohm resistor various sources

2 #8 Ring Terminals or Spade Lugs (optional)

MCU Board see text

Tools

E260 Service Manual

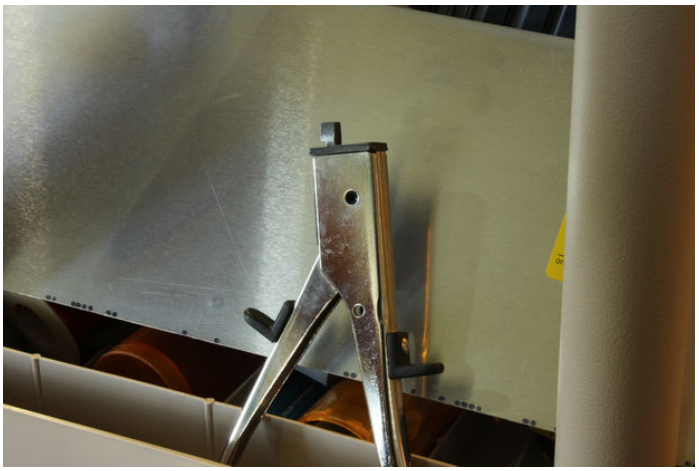
Nibbling Tool (optional) see [Photo 27]

Dremel or similar rotary tool (optional)

Shop vacuum

Standard workshop tools - screwdrivers, wire cutters, small saw, soldering iron, etc.

The table above has a parts and tool list for this project. Most of the parts are available at McMaster-Carr, but many can also be found at local hardware stores.



Step 2: Testing The Printer

Remove all tape and packing materials.

Make sure there is a toner cartridge and drum present.

Install the printer. Go to the Lexmark E260 site.

Select your operating system and your version. Click on the “Complete List of Software” link near the bottom of the page. Find and install the Universal Print Driver and the Local Printer Settings Utility (LPSU). Connect the printer and it should install and be ready for use. Note that when the printer is turned on it goes through a complex self-test. If there is an error, a series of error codes, most of which are detailed in the Service Manual, is displayed on the operating manual.

Using the appended User Guide, print something to be sure the printer is working correctly.Then remove the toner cartridge and put it safely away in a dark enclosure. A black garbage bag works well.

File Downloads

E260 User Guide.pdf (2 MB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'E260 User Guide.pdf']

e260 Service Manual.pdf (5 MB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'e260 Service Manual.pdf']

Step 3: Stripping Down The Printer

Warning: Wear safety glasses at all times! Some of these operations can result in metal or plastic pieces flying towards your eyes!

To successfully complete this project you will need to have and use the Service Manual (SM) for the printer. Steps that are thoroughly covered in the SM (Section 4:Repair Information, Removal) will not be detailed here. I will add (SM) to those steps covered in the Service Manual. For the location of parts on the bottom of the Paper Platform see photos.

In this step you will be opening up the printer and exposing the Paper Platform for cutting. As you remove each part be sure to keep track of which screws were removed. You might want to tape the screws to the part or label them. Removal of some of the subsections below may require removal of other subsections or parts, so pay attention to the SM. To replace a subsection or part, reverse the removal steps. Using the SM as a guide do the following:

Remove the Right Side Cover (SM). It is the side with the access door.

Remove the Left Side Cover (SM)

Remove the Lower Front Cover (SM)

Open the Front Door.

Remove the Paper Feed Guide with the 6 small rollers. It is held in place by 2 screws on each side, not by the 8 screws on top. Discard it.

Remove the Manual Feed Paper Guide and discard it.

Remove the Transfer Roller (SM). Save it. Be sure to remove and save the small spring under the right bearing clip and save it. The spring on the left side is attached to the transfer roller cable and should not be removed. The left bearing can slide off the transfer roller, so remove it and put it safely aside with the spring. Note that the clips on the bearing are oriented to the outside of the shaft. Also note that the bronze bearing can slide out of the clip and get lost if you are not careful.

Close the Front Door and remove and discard the pivoting beige Paper Holder.

Remove the Rear Door and Cover (SM).

Remove the Top Cover Assembly (SM).

Remove the Rear Exit Guide Assembly (SM) – Note that the longer screws are at the top. Disconnect the connectors from the Narrow Media Sensor (J11) and the Duplex Solenoid (J10) at the Controller pcb and free the wires. Remove the Narrow Media Sensor from the top piece. SAVE this sensor - you will be using it later. Remove the blue Duplex Solenoid and discard it.

Remove the Fuser (SM). The only part we need from the Fuser assembly is the three wire cable to the Exit Sensor and the two wire Thermistor cable. Cut the Exit Sensor cable where it enters the Fuser.

Locate the Thermistor cable on the Controller Board at J-12. Cut the cable leaving about 1.5 inches of wire. Remove the connector and solder a 2.7K resistor across the two wires. Discard the rest of the Fuser. This resistor makes the printer think it has a Fuser heated to 200 C still attached. Without this resistor the printer will error out when booting. The resistor can be covered with tape or heat shrink. Replace the connector with its resistor at J-12.

Pull the Fan connector (J9) out and leave it hanging. You can remove the Fan entirely if you want, it is not needed.

Replace the Rear Exit Guide assembly using only the 4 upper screws (SM). Be sure to put the longer ones in the top holes.

Replace the top cover Assembly(SM).

Turn the printer upside down.

Remove the LVPS/HVPS (power supply) (SM). Remove and discard the thick 2 wire cable to the Fuser power supply. When removing the power supply note that one screw is different than the other 3 – that one screws into the plastic. Make special note of where the power supply tabs go under that screw. As you are removing the power supply, note which cable goes where and their orientation. Remove the Transfer Roller cable connector first using long nose pliers to pull it sideways out of its slot. Note its orientation. Press the connector tab to remove the two and three pin connectors. The multipin connector just pulls out.

Remove the 3 screws holding the power supply shield and remove the shield.

Remove the Duplex Assembly (SM) and discard it.

Turn the printer to topside up position.

Remove the Operator Panel cable connector (J5) from the Controller pcb, then remove the Front Door (SM). Be careful detaching the plastic Fuser Link.

Turn the printer to left side up and remove the Main Motor Gear Drive Assembly (SM). Be careful detaching the motor cable. The loose large gear with the big spring under it is not needed, so you can discard both rather than trying to figure out where they go.

Remove the Manual Feed Clutch (SM) and discard it.

Remove the Manual Feed Clutch Solenoid. It is the blue thing adjacent to the Clutch. Cut the wires and remove the Solenoid by removing its two mounting screws.. You can discard it, too, but keep the connector and wires.

Turn the printer upside down again.

Remove the screws holding the Paper In Sensor (PIS) and the Duplex Sensor in place. Each is held by one screw.

Remove the wires to these sensors from the wire guides. Cut the wires to the Duplex Sensor close to the connector (J27). Be sure you are cutting the correct wires (Red/Black/White). Cut the wires to the PIS near the sensor and pull the wires back into the controller compartment. You will not need the sensor, but you will need the cable and connector.

Remove the Media Feed Clutch (SM) and its cable (J26). The clutch is an interesting mechanism, but you will not be needing it.

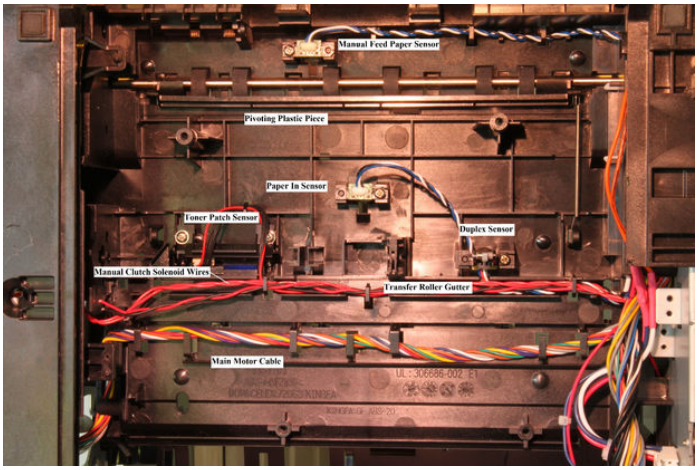
Remove the wires going to the Manual Clutch Solenoid from the same wire guide if you haven't done it before. Save the wire and connector.

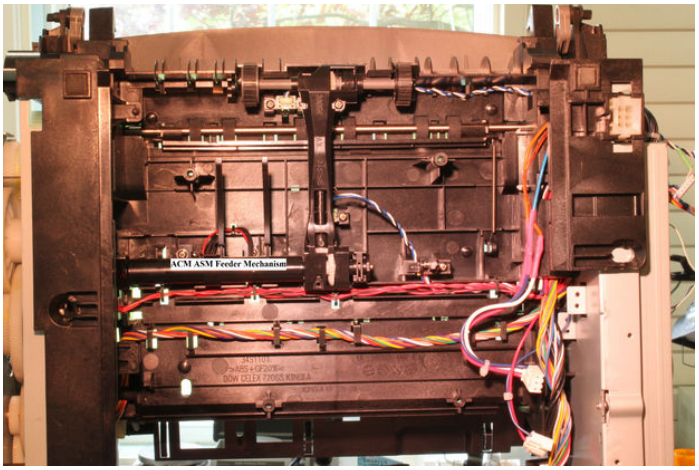
Remove the screw holding the Manual Feed Paper Sensor (MFPS) in place. Cut the cable near the sensor and pull the cable back into the controller compartment. You will not need the sensor but you will need the cable and connector.

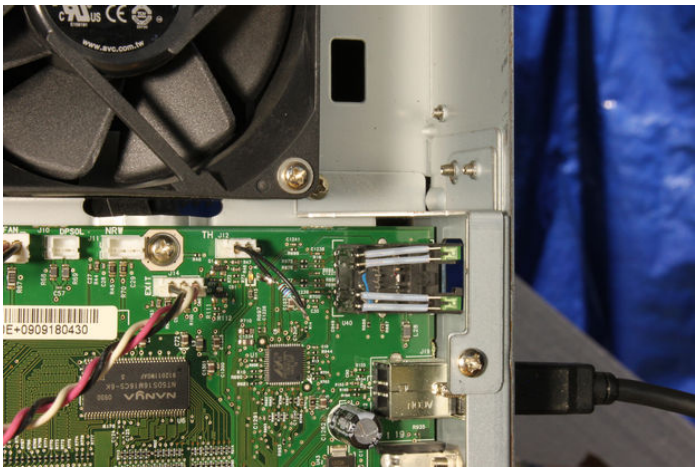
Remove the Media ACM ASM Feeder Mechanism (SM). All of these parts can be discarded, so it does not matter if you damage them in removal.

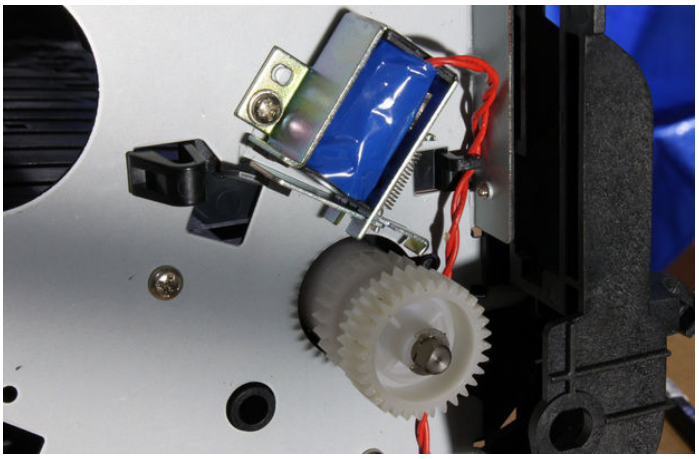
Remove and discard the pivoting plastic piece and spring that sits just behind the paper drive shaft and rollers.

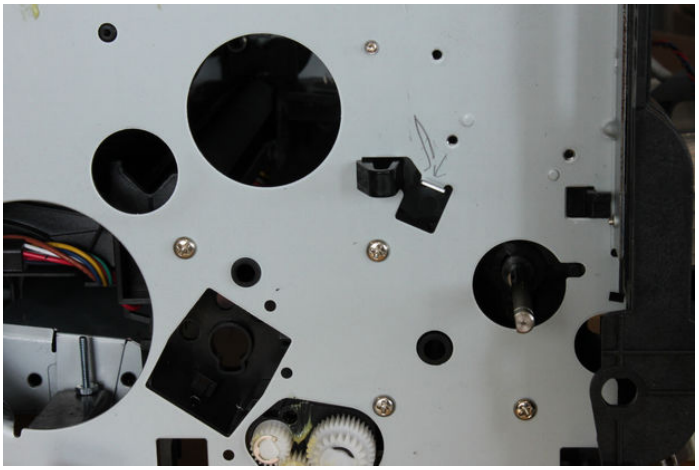
Remove the Toner Patch Sensor. It is held in place by 2 screws in the bottom of the paper platform, near the Media Feed Mechanism. Also remove the spring loaded sliding plastic window located just behind the Toner Patch Sensor These parts, too, can be discarded.











Step 4: Cutting the Paper Platform

We are now going to cut a piece out of the Paper Platform. This is necessary to allow the carrier and pcb to easily pass through the printer without hitting the bottom of the toner cartridge. I used a Dremel [Photo] with a router bit, but you can also use a small saw. The most important precautions in cutting this platform are protecting the laser openings and removing all the plastic chips!

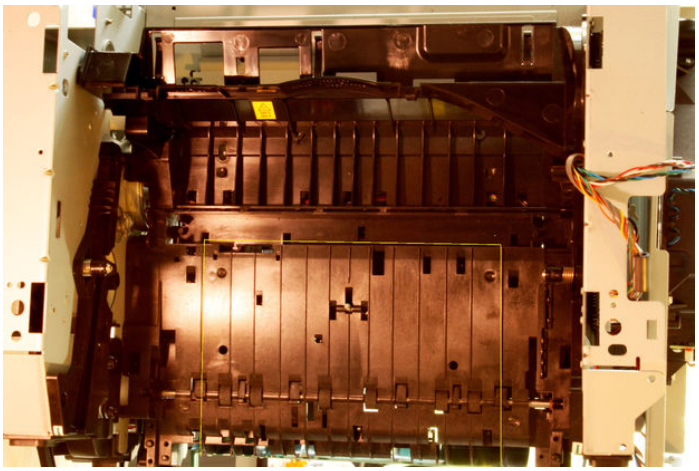
The openings to the laser mechanism must be covered. I used strips of four inch painter's tape to cover all the openings. I also covered any areas where chips could lodge and cause trouble later on while printing [Photo].

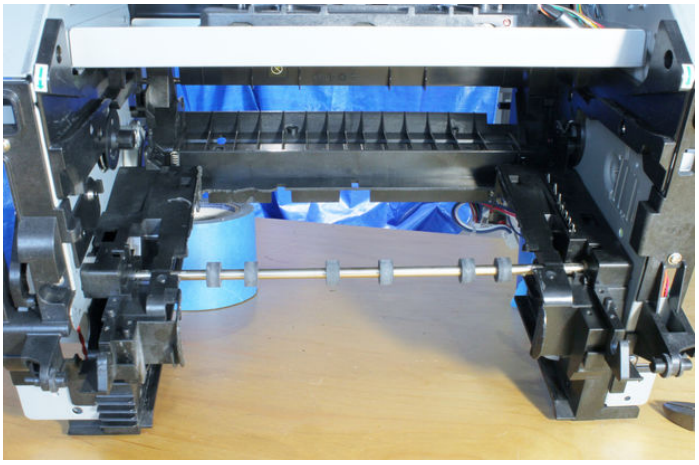
We are going to remove an approximately 7.5 inch wide piece of the Paper Platform extending from just inside the Transfer Roller gutter up to and through the front of the printer. The right and left guides are the first and last "ridges" in the Paper Platform. The yellow lines in the photo outlines the area to be removed. Another photo shows the finished inside of the printer after the Center Platform and Input Rollers are installed.

It is easiest to cut the left and right sides from the top, following the ridges in the platform. Be careful cutting the areas around the rollers – you don't want to damage the shaft or rollers. Then turn the printer over and make the back cut, being sure the back cut includes the front edge of the Transfer Roller gutter.

Once the cut is done remove the section of plastic and smooth all the burrs. If you used the Dremel there will be pieces of melted plastic along the edges of the cut that can easily be removed with a screwdriver or your fingers. If necessary, use a file or sandpaper to smooth the edges.

Then clean up all the chips! Use a vacuum to suck up all the chips, then canned air to clean anything you missed. It is vital to prevent chips getting into the laser mechanism. It is also vital to keep chips from scratching the drum, so clean, blow and vacuum! Do a final cleanup of plastic chips, then remove the protective covering from over the laser openings.





Step 5: Replace Some Things

Replace the power supply shield (SM). Note the wires are all routed in front of the shield.

Replace the LVPS/HVPS (power supply) (SM). Replace the 3 internal connectors first, being careful to replace the cables in the correct connectors and in proper orientation. Don't forget to reattach the Transfer Roller high voltage connector. Note that the screw in the left front tab is different from the other screws since it threads into plastic. If that screw strips the plastic, replace it with a 4-40 machine screw and nut. The power supply should slip easily into place - it should not need to be forced.

Replace the Right Rear Foot by its 2 screws.

Replace the Main Motor Gear Drive Assembly (SM). The large gear with the large helical spring can be removed and discarded. It was used to drive the Fuser and is not needed. Be sure to attach the motor cable. The Fuser Link goes through the slot in the front of the printer. It will later be attached to the door. You may have to "wiggle" it a bit to get the gears to mesh, but the assembly should slip easily into place. Do not force it!

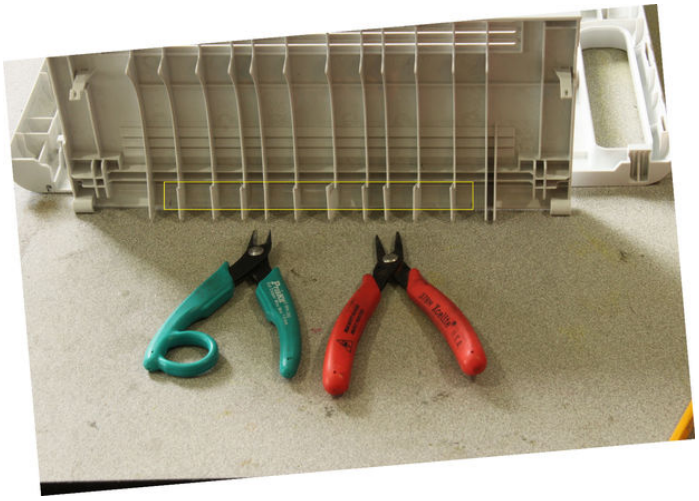
Replace the Transfer Roller (SM). The spring on the right side slides onto a short post.

Replace the Left Side Door (SM).

Replace the Rear Door (SM) but not the Rear Door Cover.

Step 6: The Rear Door Cover Slot

The Rear Door Cover is designed to swing open to guide media that is too stiff to bend well, out the back of the printer. For our purposes we will leave it closed, but we need to make a cutout to allow the PCB on its carrier to pass. Using a Dremel or a saw, cut a rectangle from the bottom of the cover using the horizontal "shelf" on the inside as a guide. Smooth the edges and replace the Rear Door Cover.



Step 7: Carrier Feed Decisions and Theory

This step describes some of my thoughts in deciding how to feed the Carrier and its mounted PCB through the printer to achieve maximum accuracy. You can skip it if you are not interested.

The previous two iterations of this project used the Manual Paper Feed Mechanism to drive the Carrier forward into the printer. This worked (mostly) because I allowed the Carrier to move forward with minimal friction or constraint, with the front of the carrier far from the Drum/Transfer Roller Interface (DTRI).

In these versions, the hole in the Carrier hit the NPIS well before the front of the Carrier entered the DTRI. While this works well for single sided PCBs, the variation in speed as the DTRI is hit causes a small, but noticeable, variation in the timing of the print, leading to mis-registration in the Y axis. The X axis had its own problems due to the short "timing window" allowable in the firmware of the E260 printer. Anything that impeded motion (such as friction) of the Carrier caused an error.

For maximum top to bottom registration accuracy, it is necessary that the Carrier is moving at its stable, final rate when the NPIS is triggered. To achieve this, we want the Carrier to be already positioned in the Drum/Transfer Roller Interface (DTRI) when the Paper In Sensor (PIS) goes low.

To do this, however, requires that the starting point of the leading edge of the carrier be just forward of the DTRI, and that the PIS trigger point be located at least two inches and preferably a bit more from the starting location of the Carrier.

Unfortunately, the internal timing requirements of the E260 makes this difficult to achieve, especially using the inconsistent Manual Feed Clutch Solenoid built into the printer. This Solenoid has a tendency to "stick", both as it opens and closes, narrowing the timing "window" of the Clutch Assembly. So, while it is barely possible to use the Manual Feed Mechanism to drive the Carrier into the DTRI, the Clutch Solenoid has to be carefully adjusted to make it release the Clutch as quickly as possible.

The other problem with this narrow timing window is that any friction, including that inherent in keeping the Carrier perfectly aligned side-to-side, slows the carrier, sometimes making it "late" in arriving at the PIS, which causes the printer to error out.

After a lot of thought and experimentation, I decided that simplest is best. Instead of using the printer mechanism to push the Carrier into The Interface, I removed the entire Clutch and Solenoid Assembly and I let the user just manually "slide" the carrier into The Interface by hand. The MCU monitors the timing by detecting the proper time to advance the Carrier and notifies the user when to "push" via a piezo "beeper".

Step 8: Carrier Guide and New Paper In Sensor

We are now going to make and mount the new Carrier Guide (CG) and the New Paper In Sensor (NPIS).

Cut a 4.5 inch piece of 1x1 inch angle aluminum. Drill two .125 inch holes in one leg of the angle, centered on the face and 1.75 inches apart. Place the angle on the inside of the Front Cover, centered and aligned with the plastic “ridge” as shown, and mark the location of the holes. Drill .125 inch holes and use 4-40 hardware to attach the Carrier Guide to the Front Cover. Carefully align the Carrier Guide with the ridge on the Front Cover. Replace the Front Cover.

The Narrow Media Sensor will be used as the NPIS. This is a U shaped sensor with a phototransistor (PT) in one leg and an IR led in the other. A thin slit in the plastic housing allows a beam of IR light to go from led to PT. The output is normally low, but when the beam is interrupted it goes high. We will later be drilling a small hole in the edge of the Carrier to trigger the NPIS.

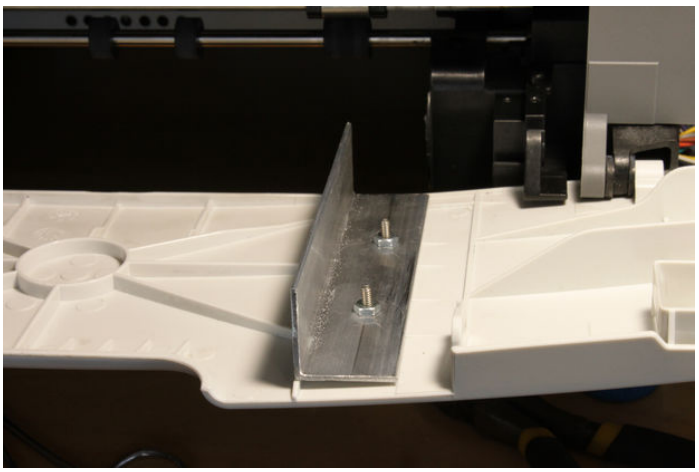
Cut the 6 inch wide x .016 aluminum sheet to 16 inches. Place it against the Carrier Guide (CG), resting on the Front Cover with the front edge at the interface of the Input Rollers. Push the leading edge of the carrier into the rubber rollers. As shown in the photos, use a pencil to mark the path of the carrier across the CG, then remove the carrier.

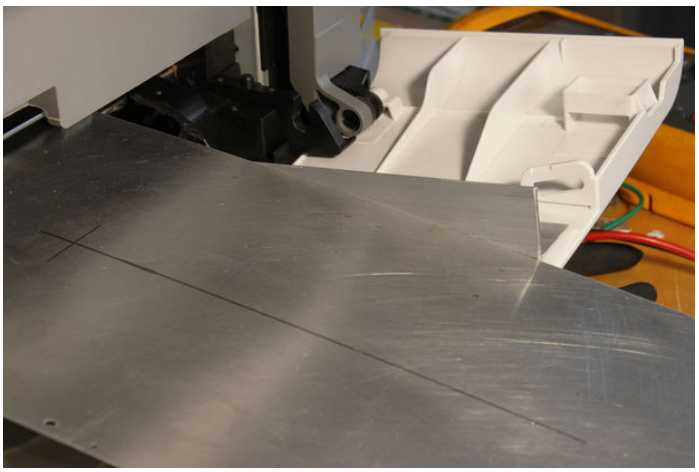
Remove the CG from the Front Cover. Hold the NPIS against the CG aligned so that the bottom of the pencil line is centered in the U and the NPIS is perpendicular to the pencil line. Make sure you are forward enough on the CG that the mounting lug of the NPIS will fit in the angle, then draw a line on the CG along both sides of the NPIS. See the photo.

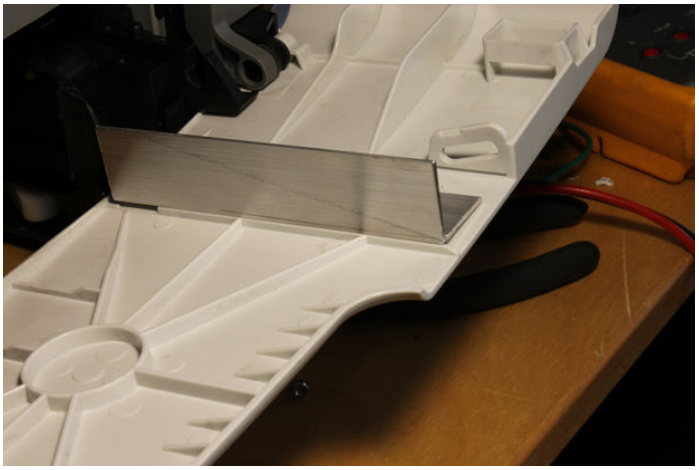
We are now going to cut a slot in the CG for the NPIS. The easiest tool to use is a Nibbler as shown in the Tool section, but you can also use a small saw and a file. The exact size is not critical. Make the slot deep enough so that the center of the opening in the sensor is centered just below the pencil line you drew along the top of the carrier. The slot should be perpendicular to the pencil line.

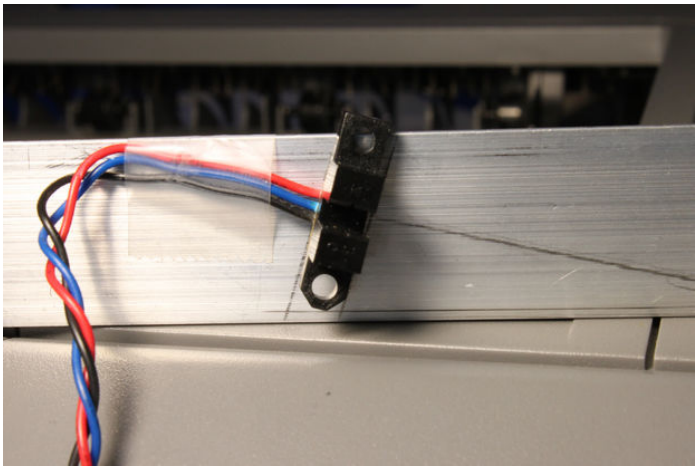
Align the sensor in the slot and mark the location of the mounting hole on the triangular end of the sensor. Drill a .125" hole there and use 4-40 hardware to mount the NPIS to the CG. Then, using the "rib" on the Front Cover, mount this assembly back on the inside of the Front Cover. Run the wires from the NPIS through the same opening as the Operator Panel cable and leave them in the Controller Compartment to be connected to the MCU later.

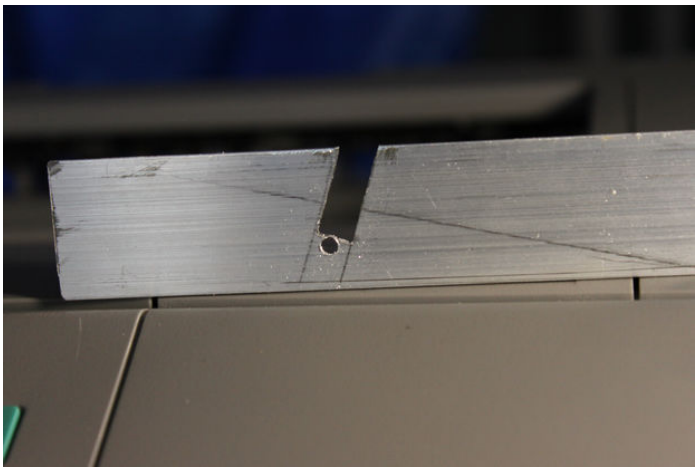
Replace the Front Cover.

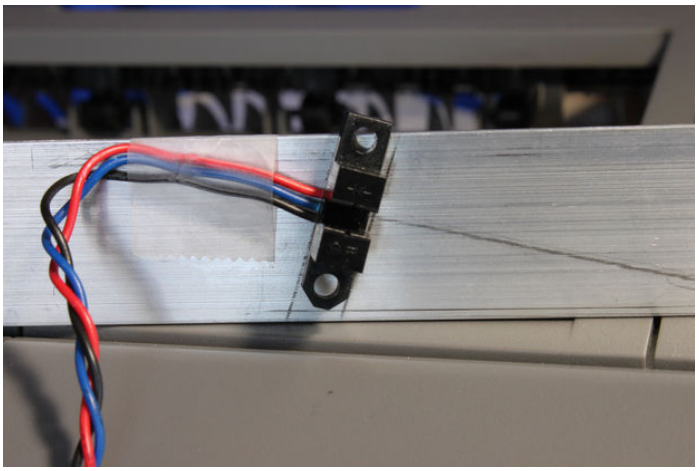


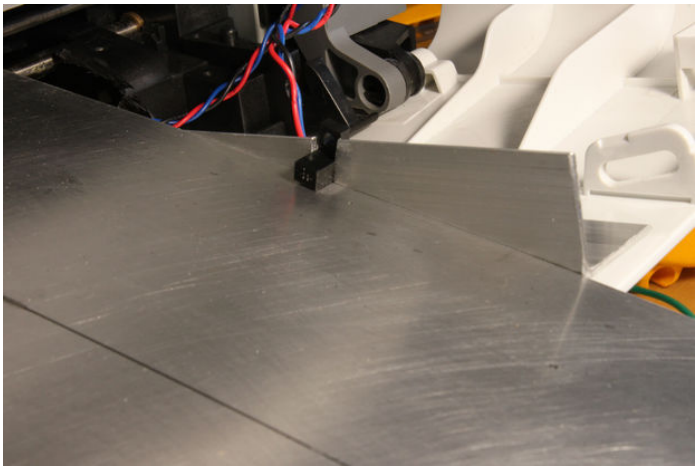


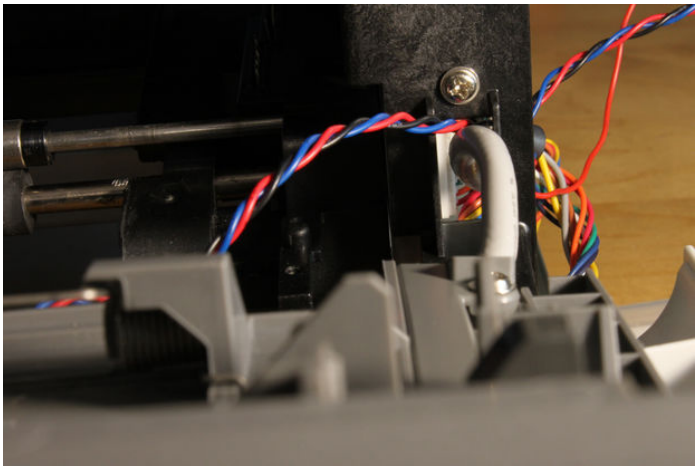












Step 9: Front Carrier Support and Lateral Paper Guide

Cut a 9 inch piece of .75 inch wide by .125 thick aluminum bar to be used as the Front Carrier Support (FCS). As you can see in the photos, it is mounted on the front edge of the Paper Platform, just in front of the rubber rollers. Drill a .172 (11/64) inch diameter hole .375 from each end, centered on the bar.

If there are any ridges of plastic on the cut edges of the front of the Paper Platform, remove them with a side-cutter or knife and smooth them down.

Place the aluminum bar on the front of the Paper Platform, lightly pressing on the rollers and mark the position of the holes. I used a silver Sharpie, but you could put some masking tape over the area and use a pencil to mark the spots. Drill the holes in the Paper Platform and mount the Front Carrier Support using 8-32 hardware.

We are now going to make and mount the Lateral Paper Guide (LPG) to the Front Carrier Support (FCS). This guides, in conjunction with the Carrier Guide added in the previous step will hold the Carrier squarely in place as it moves through the printer.

Leave the Front Door off, but install the Front Cover with the Carrier Guide (CG) on its posts. Cut a 2.5 inch piece of the .75 inch by .125 inch thick aluminum bar. Smooth the cut edges and drill a .1875 (3/16) inch hole in the center of it. Mark Front and Rear so that if the holes are not perfectly centered it will still align properly.

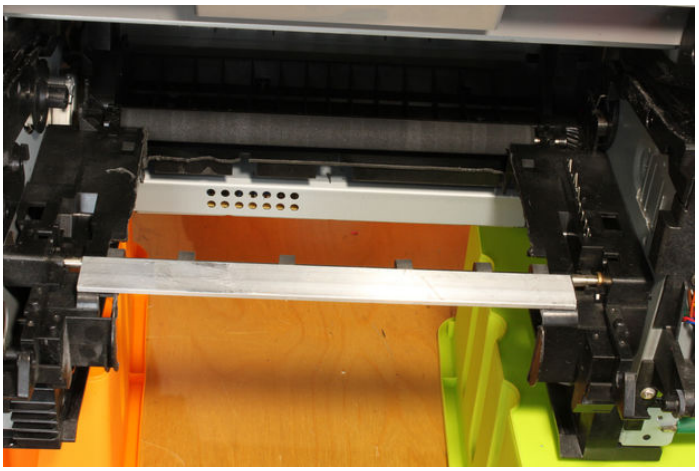
Slide the Carrier through the NPIS and into the printer. Place the LPG on the FCS and, while holding the Carrier firmly against the CG, mark the center of the hole on the FCS. Mark the right or left side of the FCS so that you can replace it in the same orientation. Remove the FCS and drill a .172 (11/64) inch mounting hole for the LPG. Use 8-32 hardware, including lock washers, to mount the LPG to the FCS. Do not tighten the bolts at this time.

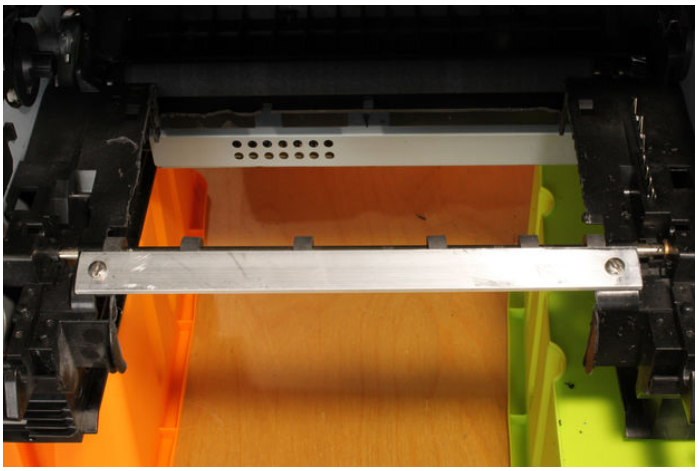
Now remount the FCS on the printer. It is important that the FCS be mounted parallel to the Roller Shaft, touching the rubber rollers. On the left side use 8-32 x 1/2 inch hardware. On the right side use 8-32 x 1 inch hardware because we are going to connect a ground wire to this screw.

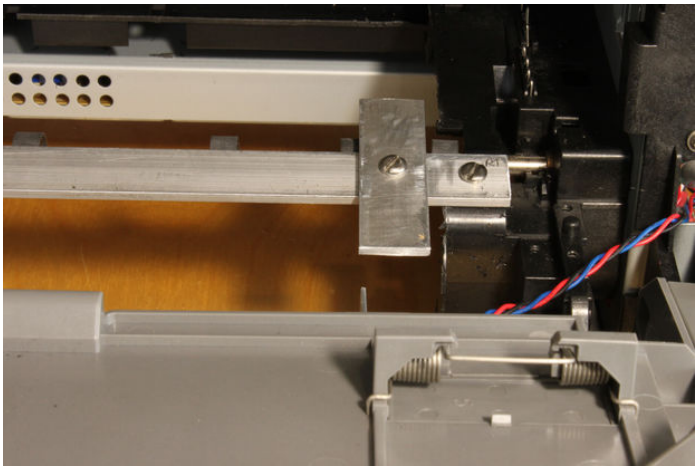
Strip both ends of a 6 inch piece of wire and solder a #8 Ring on each end. Attach one end to the right FCS mounting screw. Run the wire through an opening and into the Controller Enclosure. Using one of the extra screws, attach it to the printer Frame as shown. The screw will make its own thread in the thin steel.

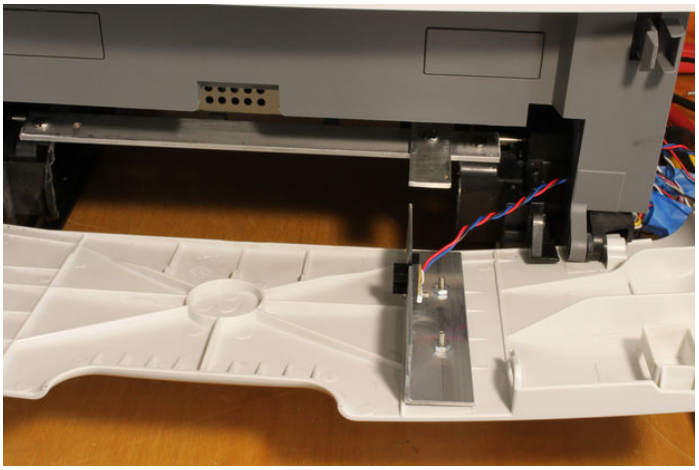
Slide the Carrier through the NPIS as you did previously, then using a small metal square or other right angle, adjust and tighten the LPG. Final adjustment will be made later when you are ready to print.

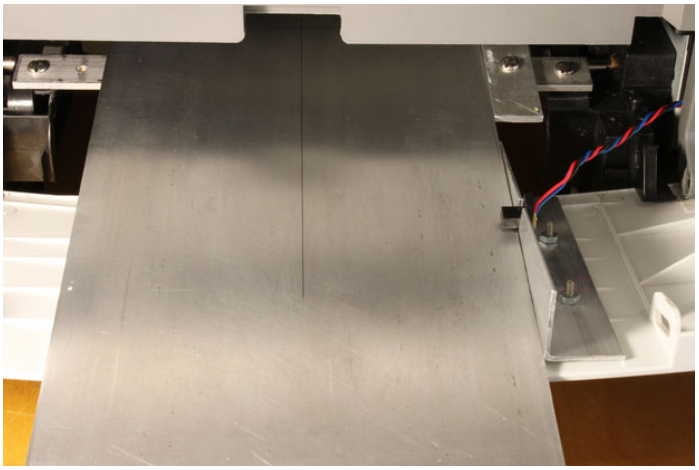
Replace the Front Door. It is easiest to attach the Fuser Link before you mount the door. Don't forget to connect the cable from the Operator Panel to J5.

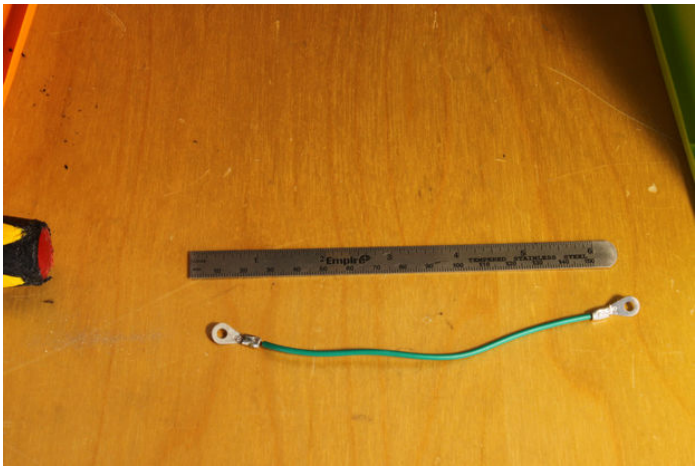


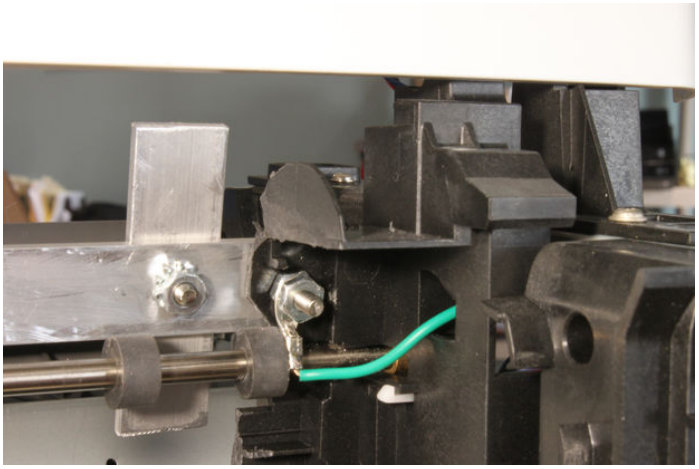


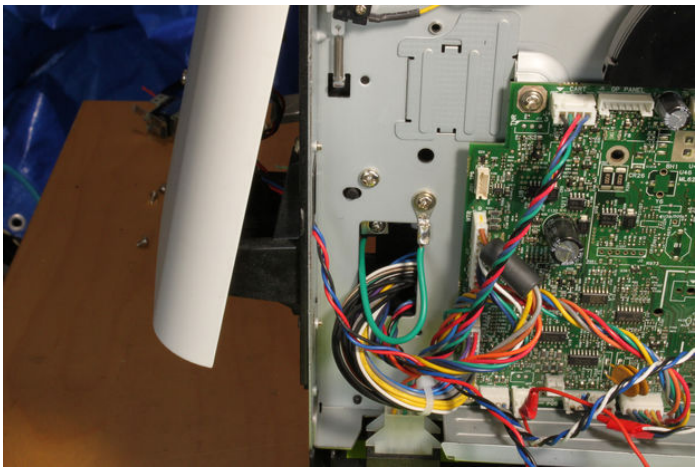












Step 10: The MCU Board

If you have not done so before, now is a good time to program the MCU. Note that if you are programming the MCU after the NPIS is connected you MUST BLOCK THE SLOT IN THE NPIS for it to program!!

The E260 (in Manual Feed Mode) uses 3 sensors to monitor the path through the printer.

The first, the Manual Feed Paper Sensor (MFPS) detects the presence of an object at the Manual Feed Rollers. When it gets hit, the input rollers run for a second or so to pull the PCB into the rollers an inch or so.

After “Print” is clicked on the computer, the paper starts moving into the printer. When it reaches the second sensor, the Paper In Sensor (PIS), the PIS goes low. This sensor starts the actual print cycle and starts the timing of the print. The final sensor, the Exit Sensor (ES), goes low when the PCB exits the printer. If these sensors are not hit and released at the correct times the printer will “jam” and flash an error light.

In this hack we will be using an external MCU to provide the correct sensor timing to the printer. The only physical sensor we need is the PIS, using the new sensor mounted to the Front Cover as our new PIS (NPIS). The MFPS and the ES will be emulated by the MCU and do not actually exist.

The MCU I am using is an 8 pin Atmel ATtiny13. The circuit is very simple and is appended at the end of this document. I designed a small PCB which is also appended.

Use the diagram on page 5-2 of the SM (mistakenly labeled 6-2 in the SM) to identify the connectors for the following steps.

The MCU board needs 5 volts to operate. The easiest place to get this is from the J21, the Parallel Printer Port, located at the far lower right of the printer Controller Board. Conveniently, the bottom wire is +5 volts and the wire just above it is ground, making it easy to solder wires to. See the photo. Solder the wires to the MCU board where indicated.

Use the diagram in the SM also reproduced here to connect the MCU board to the printer. Note that some of the connectors are numbered left to right, while others are numbered right to left!

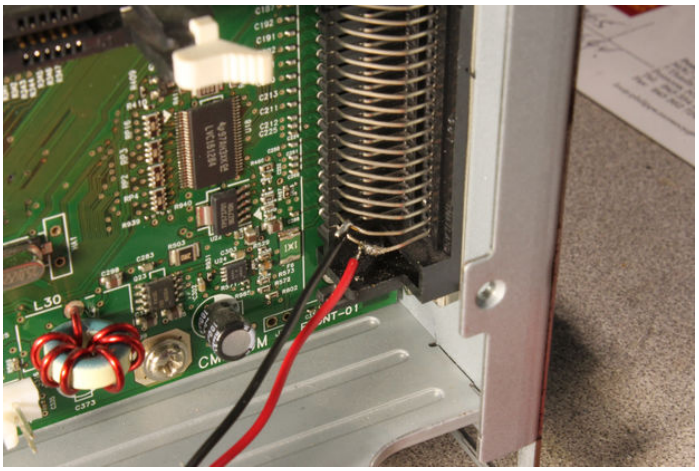
Since the starting point for a print cycle is when the user clicks on "Print" on a computer, the MCU has to know when that occurs. Fortunately, there is an easy way to do this. At "Print" the Manual Paper Feed Clutch pulls in to allow the printer to do its "warmup" without moving the media that has already been loaded into the rollers. When this clutch is activated, the voltage at Pin 2 of J25 drops from 24 volts down to close to 0. To detect this we need to bring a wire from J25, Pin 2 to the MCU. Cut the wire at Pin 1 close to the connector - we will not be using it. Cut the wire from Pin 2 leaving about 6 inches of wire attached to the connector. Solder the free end of this wire to the MCU board where indicated. Note that the actual Clutch Solenoid has been removed earlier and is not necessary for the printer to work in printing PCBs!

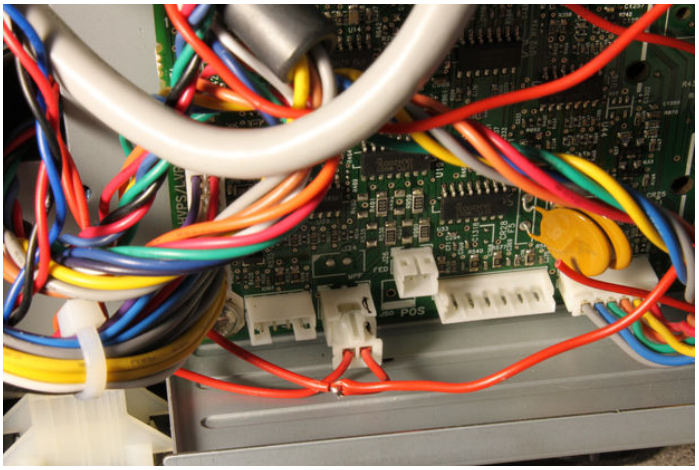
Follow the diagram and connect the leads from J14-2, J23-2, and J27-5, i.e. the ES, MFPS, and PIS inputs to the printer's control board. Note that the pins on each of the connectors are numbered from right to left. I also connected the ground wires (black) from each sensor to the MCU board ground, though this is probably not necessary. Also note that J14-1 supplies voltage for the NPIS LED.

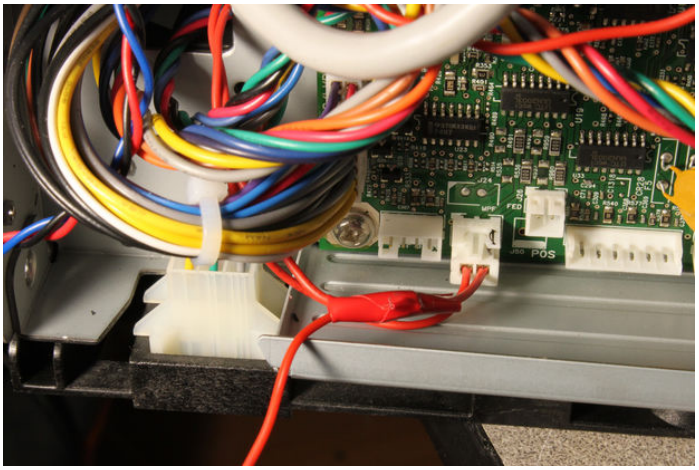
Bring the 3 wires from the NPIS to the controller board, cut off the connector, then solder the wires to the MCU board. The black lead goes to ground, the red wire goes to LED, and the blue wire goes to PT on the MCU board where it has a 4.99K resistor pull up to the 5 volt line.

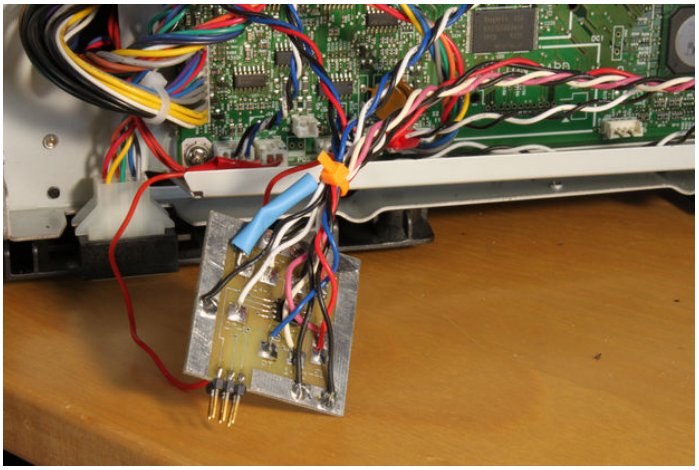
We are using a piezo "beeper" to signal the Clutch activity. Solder the two wires where indicated, observing the correct polarity.

If you are not concerned re the location of the MCU Controller board, just wrap it in electrical tape and leave it in the Controller Compartment. Replace the Right Side Cover.









File Downloads

Locations.pdf (143 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Locations.pdf']

Schematic.pdf (109 KB)
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PCB.pdf (81 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'PCB.pdf']

Step 11: The MCU Firmware

Note that if you are programming the MCU after the NPIS is connected you MUST BLOCK THE SLOT INTHE NPIS for it to program!!

I have written the controller software in Assembly Language for the Atmel ATtiny13 MCU. The Source and Hex Files are appended. Since I am "self taught", I might (probably) use some conventions and notation that are not standard. If anyone wants to write a more "professional" version, I would be happy to include it, giving proper credit. Likewise, if anyone wants to write an Arduino version or a C version, I would be happy to include those as well.

File Downloads

Assembly File.pdf (114 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Assembly File.pdf']

E260_ATtiny13.hex (431 bytes)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'E260_ATtiny13.hex']

Step 12: Preparing the Carrier

Make a 6x16 carrier by cutting a 14” piece of the 6 inch wide x .016 thick aluminum sheet, then beveling all 4 corners and sanding all edges smooth. Place a piece of either vinyl electrical tape or Kapton tape over the leading edge of the carrier, folding it so half is on each side of the carrier. Kapton tape is thinner than the vinyl, making insertion into the rollers a bit easier, but the vinyl works quite well. Cut the tape around the beveled corners. This protects the printer drum from getting gouged as the carrier enters. If there is lettering printed on your carrier you can remove it with acetone on a paper towel. Using a 6" carrier the maximum PCB width is 6 inches, but I usually use 4 inch wide PCBs.

Insert the toner/drum cartridge. Slide the Carrier through the slot of the NPIS, past the Roller Shaft, and gently forward till it just touches the cartridge. Mark the spot on the carrier at the rear edge of the NPIS, then back the Carrier away from the cartridge.

Remove the carrier. Now drill a small hole in the carrier, located about 2 inches behind from that mark and about 3mm from the edge of the carrier. I used a .026 inch drill.

This hole is the "trigger" for the NPIS. As the carrier moves into the printer, the NPIS is blocked by the opaque metal carrier. However when the hole arrives in the center of the NPIS, the IR from the led hits the phototransistor and the output of the sensor goes from high to low for a very short time (6.7 msec for a .026 inch hole). The MCU recognizes this transition and starts the timing for the print.

Step 13: Using the Printer

Note that the Paper Tray must be open 2 inches for the printer to

work!!

For this printer to work properly, PCBs must be FLAT as they pass through the printing interface. For thin PCBs that is no problem because they will be flattened by the printer. For .062 PCBs you must flatten the PCB before using it. Try bending it against the "bow" till it is flat.

See the section on "Making a Double Sided PCB" for more information, but in general, to make a print:

Turn the printer on. It will do a 30 second or so boot routine ending with the Ready LED lit. A few seconds later you will hear a short whirr as the MCU "cheats" and tells the printer to get ready to print from the front Manual Feed Slot.

Then,

1 - Lightly sand or file the edges of the PCB so that they will not damage the drum as the PCB goes through the printer.

2 - Clean the PCB with a Scotch Brite Scouring Pad then wipe with acetone on a paper towel till the paper towel comes off clean.

3 - Mount the PCB to the Carrier using a small piece of .25 inch wide copper foil tape to connect the upper surface of the PCB to the Carrier. Be sure the copper tape has conductive adhesive - not all of them do!

4 - Cover the leading and trailing edges of the PCB with .75 inch wide vinyl electrical tape, attaching the PCB firmly to the Carrier and covering the copper foil tape. If necessary, you can now do a final clean with acetone.

5 - Slide the Carrier through the NPIS and between the Lateral Paper Guides.

6 - Advance the Carrier till it reaches the Drum, then back it off about .25 inches. When you make the Carrier you should mark this position so that you don't actually have to hit the drum in this step.

7 - Set the top margin for your print to be about 1.5 inches, select 1200 dpi in "Printer Preferences". You will have to experiment with your printer settings to get maximum density and resolution, but the process isn't at all fussy.

8 - Be sure the Carrier is firmly pressed to the Carrier Guide, the click "Print" on your software.

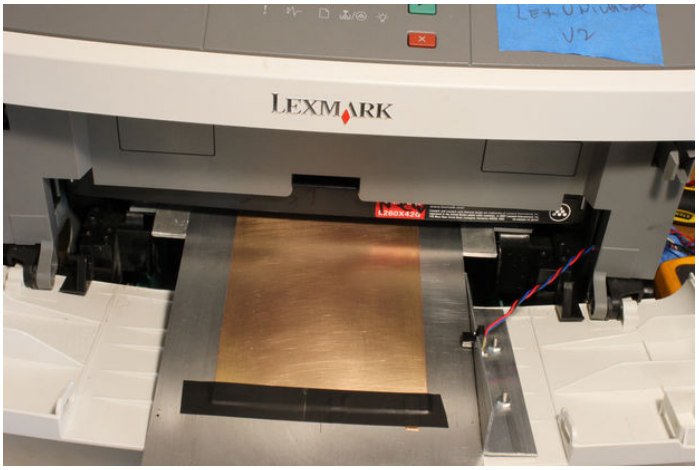
9 - You will hear a "Beep" from the piezo beeper on the MCU board.

10 - After about 3.5 seconds the beep will stop. This is the start of your "timing window".

11 - Holding the Carrier firmly against the Carrier Guide, quickly but gently slide the carrier forward till it is engaged by the Drum/Transfer Roller Interface, then release. It is now printing!

12 - When the print finishes there will be a short pause , then the printer will "whirr" again as it gets ready for the next print.

If you mistime it and the printer errors out, open the Front Door and remove the Cartridge. Then remove the Carrier and replace the Cartridge. This prevents damaging the Drum. With the carrier removed, press the "X" button, followed by the green "Go" button, and the printer will reset and be ready to go again. Wipe the PCB with acetone if any toner got on it during the aborted run.



Step 14: Printing the Centerline

You can design your PCBs on any software that produces a printable image. However, at the very least it should have a way to place the print wherever you want on the PCB. Additionally, if you are going to make double sided boards you should be able to print a mirror image of the design. I use the free version of Eagle. The learning curve is a bit annoying, but it does get the job done and is very flexible.

The printer creates double sided PCBs by printing each side of the board on a separate pass. To do this successfully we need to know the centerline of the printers X axis, and also have a reference point on the Y axis. To do that we are going to print a cross on the midline of the Carrier .

Use your software to make a line about 7 inches long on the centerline. The line should be relatively thin - .005 inches works well. Draw a cross piece about .5 inches from the top. Set your software to print the line at the top center of the print with all 4 margins as small as possible. In Eagle I used .2 inches for the margins.

Sand the Carrier with a Scotch Brite green scrubby to smooth it and remove any oxide. Then clean the Carrier with acetone on a paper towel till the towel comes off the Carrier clean. Let it dry. The carrier will be cold from the evaporation of the acetone, so let it come back up to room temperature before printing.

Put in your best Toner and Drum Cartridge. Connect the USB cable and turn the printer on. It should boot fully then "twitch" the input rollers for a second or so. You are now ready to print.

Note that the Paper Tray must be open 2 inches for the printer to work!!

Place the carrier in the NPIS slot and through the Lateral Carrier Guides (LCG). Advance it till the front of the carrier gently touches the drum, then pull it back about .25 inches. Lightly press the Carrier against the CG. Press "Print" on your computer to print the cross.

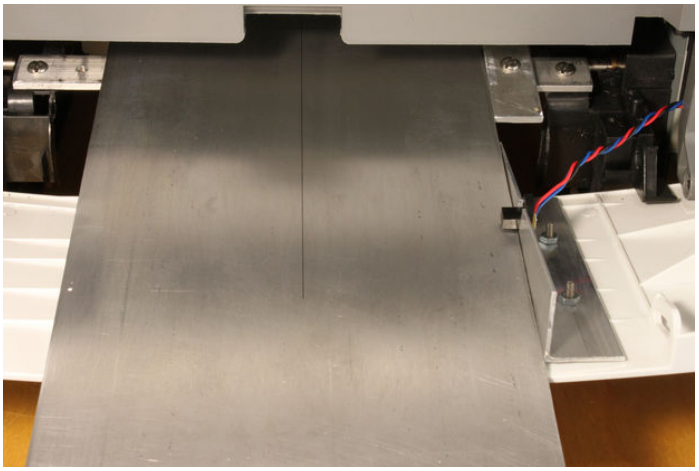
You will hear a beep when the Clutch signals it is ready to print. When the beep stops it is time to slide the Carrier gently forward into the printer. You will have about .7 seconds to do this. While .7 seconds seems like a very short time, you will find it quite easy to do once you have made a few prints.

If your timing is off and the printer "errors out", remove the Carrier from the printer and wipe it down with acetone to remove any toner. Then press the "X" button on the Operator Panel, followed by pressing the green "Go" button. The printer should now be ready to print again.

Print the cross. Then reinsert the Carrier and print it again, exactly in the same position. Print it a third time, selecting "Mirror Image" this time. All prints should be superimposed, both in the X and Y axis. If they are not, wipe off the toner with a paper towel and clean the Carrier with a light acetone wipe. Repeat the print, being sure the Carrier is against the CG. You may need to reposition the CG and/or the LCGs to get it exactly square, but you can run it through as many times as you want till you are sure the alignment is perfect.

Note that any time you make a change in the position of the CG or LCGs you will have to reprint the center cross!!

As printed, the line will adhere to the Carrier very tightly, but will easily be wiped off with a paper towel. To "fix" it in place will suspend it in acetone vapor. In a well ventilated area pour a small amount of acetone into a glass baking dish or an aluminum foil "loaf pan" that is at least 8 inches long. Lay the Carrier on the top, print down, facing the acetone. Put a small weight on top to help seal the carrier to the dish. Leave it there 15 minutes, then allow the Carrier to air dry for a few minutes. This fixes the toner firmly to the Carrier. Should you ever need to remove or reprint the cross, just wipe it down with acetone and it will come right off.




sunnyside
acetone
Acetona

Step 15: Making a Double Sided PCB

When you design your PCB, leave a "frame" in the same position on both the top and bottom of the PCB to "center" the print. If your software allows, these lines can be zero width. If necessary, these lines can be removed later with acetone.

Important Note: The Paper Tray must be open about 2 inches to avoid pushing the Front Cover up and jamming the mechanism.

1 - Lightly mark the midline at the top and bottom edges of the copper pcb on one side.

2 - Drill a small (e.g. .050 inch) hole on this midline near both the top and bottom edges. These holes do not have to be perfectly centered on the midline.

3 - Sand the edges of the PCB to protect the drum using a green Scotch Brite Scouring Pad or some fine sandpaper..

4 - Scrub both sides of the PCB with a Scotch Brite Pad and clean them with acetone.

5 - Using a bright light and magnifier, position the top hole of the PCB over the Cross, so that the Cross is centered in the hole. While holding it in place, position the bottom hole on the pcb so that the midline on the carrier is visible running through the center of the hole and put a small tag of transparent tape on each end of the PCB, leaving the other end hanging over the Carrier..

6 - Position carefully on the Cross and line, then press the ends of the transparent tape firmly on the Carrier, locking it in place. Recheck the position and reposition if necessary.

7 - Place a .5 inch long piece of copper tape on the bottom edge of the PCB, connecting the PCB to the Carrier.

8 - Cover both top and bottom edges of the PCB with thin vinyl electrical tape. The tape should cover the transparent tape and the copper foil tape. **Do not use acetone on the mounted PCB - acetone vapor will creep under the PCB and damage the Centerline printed on the Carrier.**

9 - Print the top side, centering the image on the PCB. Be sure to print only the layers you need - you do NOT want to print both top and bottom at the same time!

10 - Remove the PCB from the carrier.

11 - Fix the toner to the pcb with acetone vapor. You can suspend the PCB from one of the holes in a covered wide mouth glass or polypropylene container with a small amount of acetone on the bottom. Leave it in the vapor for 2 minutes or so, then allow it to thoroughly air dry.

12 - Clean the PCB with acetone **before mounting**. If you do it while the PCB is mounted on the Carrier acetone vapor will creep under the PCB and damage the image and the Centerline.

13 - Remountt the PCB with the other side up following per steps 5-9.

13 - Clean the PCB with acetone, then print the bottom of the PCB, but using the "mirror image".

14 - Remove the PCB from the carrier.

15 - Suspend the PCB in acetone vapor again to fix the toner to the copper on both sides. This time leave it in the vapor for 15 minutes. Allow it to air dry a few minutes.

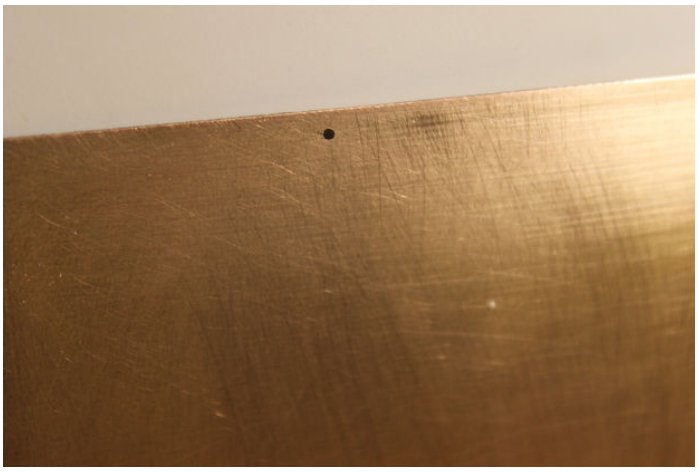
16 - Drill. **Drill the first hole in a place where registration is not too critical, such as a mounting hole or via. If the registration is not perfect, you can "split the difference", in the rest of the holes, thereby halving the error.**

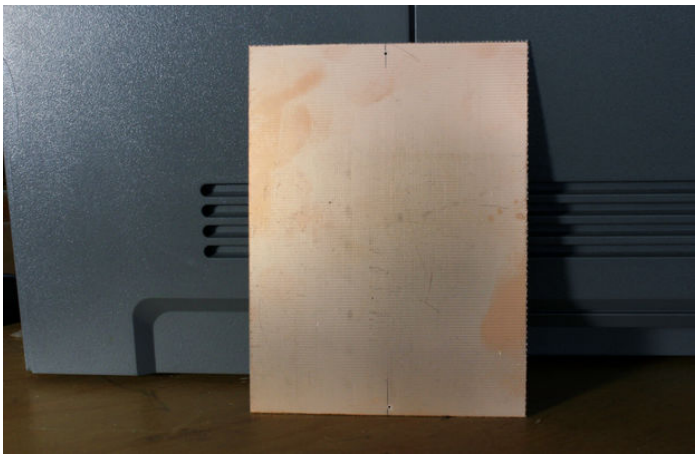
17 - Etch in your favorite etchant.

18 - Remove the toner with acetone.

19 - Solder thin wires in any vias.

20 - Done.






3PACK
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SCOUR PADS
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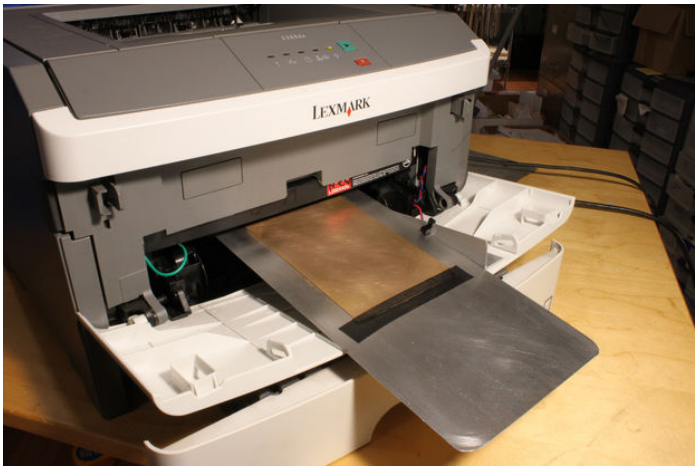
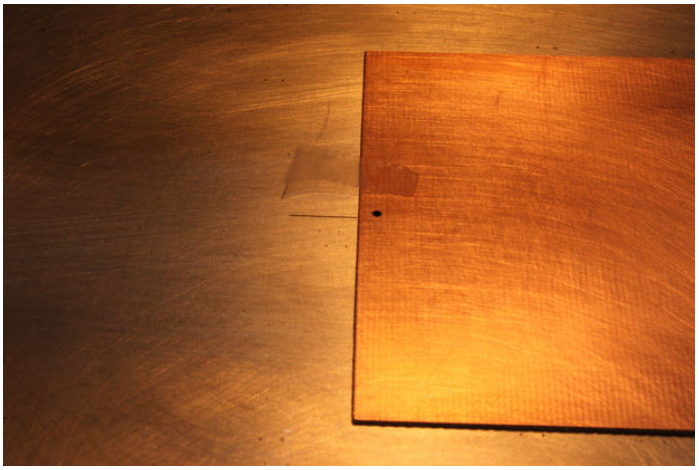
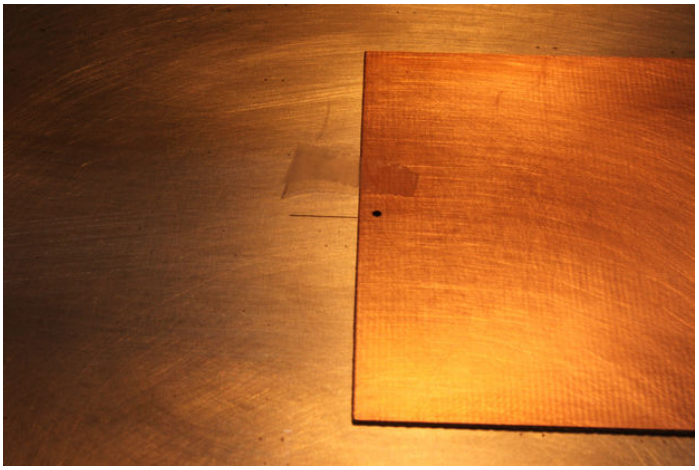
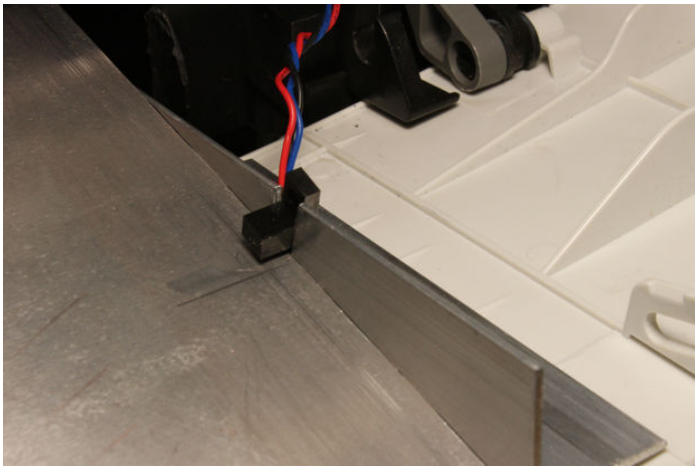
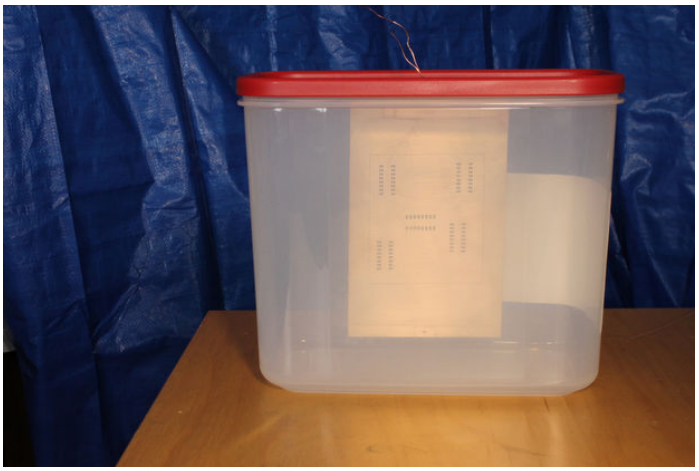
3M


LEXMARK









Step 16: Future Improvements

The modified E260 printer works well, but there are a number of improvements that can be made:

I am using the human eye to visually align the PCB to the X and Y axes of the Carrier. This could be made more accurate by using a smaller hole and a USB microscope to align the PCB on the Carrier.

A second, more complex but potentially more accurate way of alignment uses a .125 inch hole in the Carrier at the crosspiece instead of the Cross. The top hole in the PCB is then drilled to .125 diameter A fixture is made holding a .125 steel pin. The Carrier is placed on the pin, then the PCB is slid over the pin. The bottom (small) hole in the PCB is aligned with the centerline and the bottom edge is taped in place. The top edge of the PCB is then taped to the Carrier and the Carrier/PCB is lifted off the pin. The print is made as detailed above. This technique only requires visual alignment of one edge, but is a bit more complicated to execute. Also, over time the hole in the Carrier may degrade, leading to inaccuracies and the need to replace the Carrier.

I am only guiding the Carrier on one side. Unfortunately, the 6" Carrier I purchased from McMaster-Carr was apparently cut from a larger piece of aluminum so that both of the side edges are a bit uneven over the length of the carrier. This makes the travel through the printer slightly inconsistent, and makes the use of a guide on both sides of the Carrier problematical. A precision cut carrier would be better and allow more accuracy in the X axis.

I am currently investigating the the modification of a very inexpensive laser printer ($29.99 retail) for DLP. I have demonstrated that it can, indeed, print on copperclad, but the mechanics of feeding the PCB through the printer are still undetermined. More to follow!!

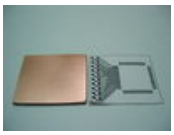
Step 17: Conclusion

Using just the Carrier Guide and LCGs, the E260 can achieve registration that allows double sided boards of some complexity to be made. Registration of the top and bottom is not perfect, but is more than adequate for through-hole parts and reasonably sized vias. By simply "splitting the difference" while drilling, even this small error in registration can be halved.

Overall, I believe I have successfully done what I set out to do: DLP works, is reliable, and is very fast. Using Muriatic Acid/Hydrogen Peroxide high speed etchant I can go from design to ready-to-use double sided PCB in less than 30 minutes!

Related Instructables

Heatless (cold) Toner Transfer for PCB making by simpletronic



Cheap and Easy Toner Transfer for PCB Making by hilarycheng

Modified laminator for PCB Toner transfer by hobby16

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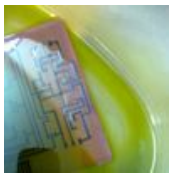

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