

## Using the PCB Writer

### 1) Turn on the Writer

- a. Open the cover and hit the green switch to the right and below the table (the area on which the copper plate is mounted)

### 2) Open LPKF CircuitPro 2.1 from the shortcut on the desktop

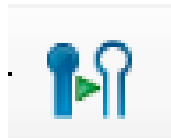
- a. The machine should automatically connect to the computer. If it does not, go to **Machining > Connect**. The Writer is the **S63** model

### 3) Load/Create your design

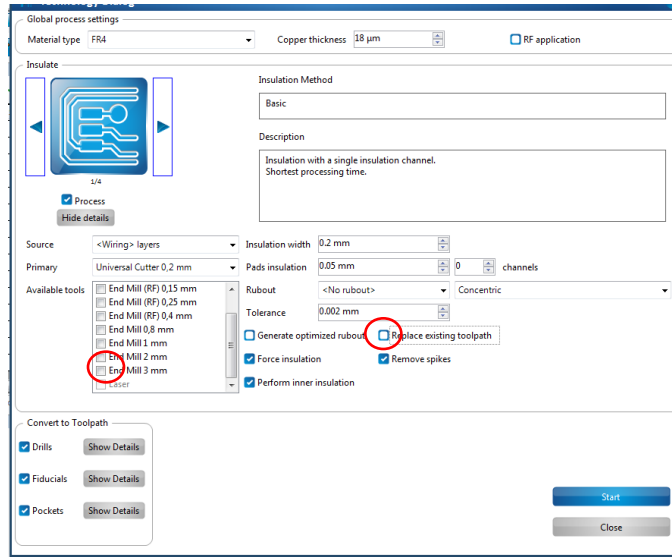
- a. Loading a design (recommended)
  - i. Save the design as a DXF file
  - ii. Follow the printed “importing DXF file” instructions
- b. Creating a design (not recommended)
  - i. Using the vertical design toolbar on the left side of the UI, create the shapes necessary for your design. By default, shapes will be polygons (filled in). This is necessary for entire areas with a given characteristic (e.g. a filled in box means that this entire space will be have copper in it). To convert to an outline (not filled in), right-click and click **convert to outline**. This is necessary for paths (e.g. the outline of the board)
  - ii. The horizontal modification bar at the top can be used to repeat, scale, mirror, etc.
  - iii. To insert a rubout area (i.e. an area that will be completely devoid of copper after the write), go to **insert > rubout area**
  - iv. Left-click each object to highlight it and then right-click to assign it to a layer. The design is created in layers with common properties. The outline of the board goes to **BoardOutline**, the drill holes to **DrillUnplated/Plated**, and most features (e.g. wiring) to **TopLayer**.

### 4) Create Toolpaths

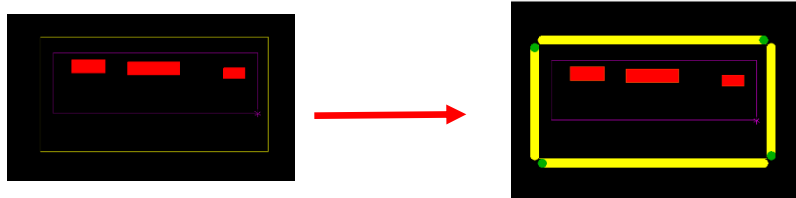
- a. Hit the “Technology Dialog” button.



- b. Select the appropriate settings for your project (e.g. insulation level)

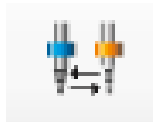


- c. De-select any unavailable tools in **show details** so that the toolpaths are not generated using these tools (e.g. we have no 3mm end mill, therefore this tool must be de-selected so the program does not create that paths thinking that this tool is available)
- d. If creating multiple paths with different properties, make sure to de-select **replace existing toolpath** if you want to keep previously made toolpaths.
- e. Hit **start**. The necessary toolpaths will be created and any errors will be displayed.
- f. The design should now appear different with visible toolpaths. It should also be visible in the **machining** view. If it is not, something has gone wrong.



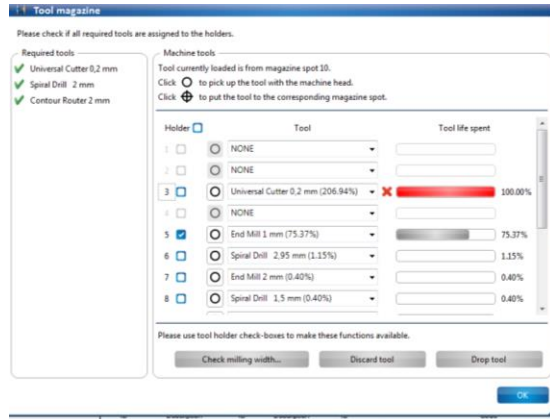
## 5) Prepare to begin the productions process

- a. Ensure that the tool magazine is appropriately equipped
  - i. Hit the **tool magazine** button



- ii. A list of necessary for the write will appear on the left side of the pop-up display. To the right, the currently equipped tools as well as their positions in the toolbar are displayed. Ensure that all necessary tools are in the

magazine and ensure that each listing (tool, position) is reflective of the actual magazine. To insert a tool, ensure that its colored ring is in between the two metal pieces that hold each tool, and ensure that the tool is completely vertical and snug in its designated space.

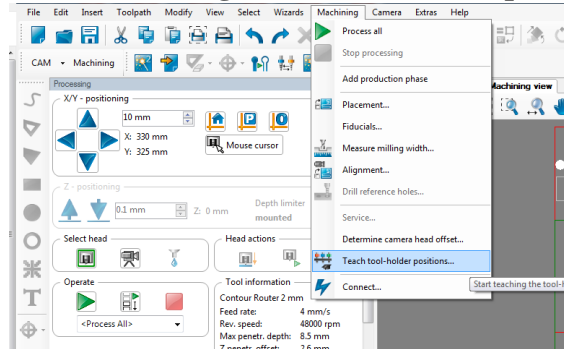


iii. Tools:

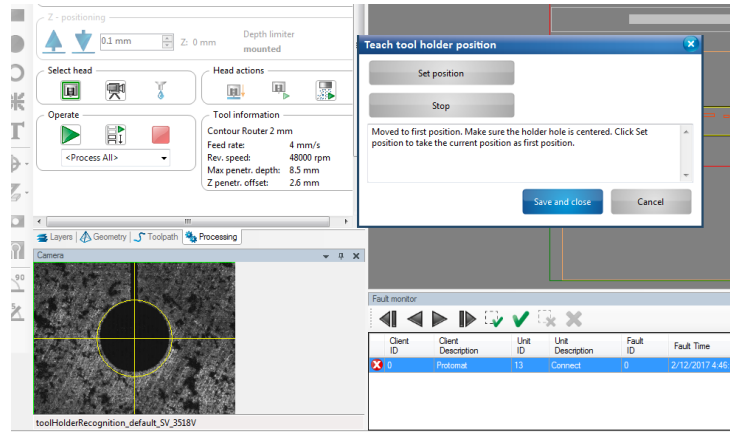
1. Red ring = uni/micro cutter
2. Purple ring = end mill
3. Green ring = drill
4. Yellow ring = contour router
5. Lime green = long mill

b. Calibrate the writing head to the toolbar

i. Go to **machining > teach tool holder position**



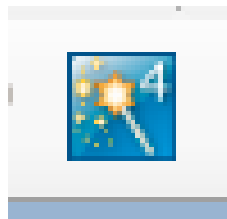
ii. Set the increments to  $\sim 0.01$ mm and adjust the yellow circle to coincide with the black circle seen in the camera. Hit **set position**



- iii. The writing head will then go to the last position. Repeat the above process. Once both positions have been taught, the machine will divide the length between the points amongst the 15 positions and check to make sure each one lines up accordingly. If the check fails, repeat the process and change one of the positions that were set earlier slightly, maybe going down to .005mm increments.
- iv. Once the check works out, hit **apply to machine**. This is **VERY IMPORTANT** as if you do not the new positions will not be written to the machine and it could malfunction and break a tool, the magazine, or the write head.

## 6) Begin the production process

- a. Hit **board production wizard** and follow the process:



### b. Mount material

- i. Put your copper clad board onto the table. Ensure that the boards sides are nearly parallel with the sides of the underlying board and fix the left and right sides with masking tape
- ii. If you have a smaller board that you want to cut from, put it in one corner rather than the center of the board. If you pick, for example, the top left corner, fix it both along the left side as well as the top with tape. More can be used if you feel that the board may move during production

### c. Material Settings

- i. Enter the specific material settings of your board

- ii. Overall thickness as well as copper thickness are the most important factors here
- iii. Here the bottom left and top right corner of your copper clad board are found and indicated to the system with the following buttons: set these by doing the following
- iv. Using the green directional arrow and the camera, find the respective corners of your board. **ENSURE THAT WHEREVER YOU MARK IS IN FACT COPPER AND NOT TAPE.** It should be obvious in the camera which area is tape and which is copper. It is better to leave a little extra space here than not enough,

**d. Placement**

- i. Place your design in the board space that you just marked off by specifying its coordinates. The design can then be repeated along each axis or in a grid, or rotated.

**e. Milling**

- i. From here on out, the machine/computer perform do the remaining steps. The machine will pick up the first tool and then warm up for 2 minutes. After this, it will run through the milling process continuously by milling each layer. If multiple boards are printed, the same layer will be done for all copies rather than each copy being finished before moving on to the next one, so keep this in mind if you need a board quickly.

**f. Finishing**

- i. When the production is complete, exit the program.
- ii. When asked “Would you like to move the write head in a safe position to switch off” hit **yes**. Allow the machine to move the head and then exit the program
- iii. Turn the machine off
- iv. The board can now be taken off and the PCB can be snapped out of the board. The edges can be sanded if necessary

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Ryan O'Connor, '19  
Contact: oconnoob@bc.edu

**Troubleshooting**

- 1) The resolution on the print is poor or shapes within the board are too small. This could be a variety of issues:
  - a. The material settings are not correct
    - i. If the board thickness is set thicker than it truly is, the head will not lower enough and some features may not be printed

- ii. If the board thickness is set thinner than it truly is, the head will lower too far and, since the tools are tapered, trim a certain distance off the edge of each feature
- b. The tool cutting width could not be calibrated correctly
  - i. Go to **tool magazine > check milling width** for each mill (purple) and micro/universal cutter (red), unless it is known which tool is causing a problem, in which case just do that one.
  - ii. Perform the given instructions. Sandpaper is a good idea here to sand down the jagged edges created by the tools so that the camera can calculate an accurate thickness
  - iii. Step-by-step instructions can be found in another file in this folder
- c. Some tools could be old. Considerable wear can amount to a poor write. **NOTE:** just because a tool says that it is “100% used” or has “0% lifetime left” in the **tool magazine** menu does not mean this is truly the case. People tend to switch tools without paying attention and therefore this wear could truly be distributed across multiple different tools of the same type
- d. The table height needs to be calibrated. This should not be the case, as it was calculated in August 2016 and does not need to be calibrated until ~1 year of continuous use (which this machine does not come close to seeing). The instructions for this process can be found in another file in this folder

## Other Troubleshooting:

These procedures can be performed if printed boards are not remotely close to the intended design. This is close to a ground-up recalibration, so be aware of the entire process/how long it will take/whether or not you have everything required before trying this.

### Changing Default Values

There are a couple of values that we have found to work better than the defaults. Each time you install circuit pro, this section of items has to be re-entered.

1. Go to the extras menu and select options. Click on the machine line on the left. On the right, change the dust reduction from false to true. This will make the contour routing do a second pass and clean up majority of the debris from the first cut.
2. In this same section, you can change the default end mill depth to whichever you find to be the offset between getting the end mills to cut at the depth that you want without necessarily doing the check milling width function through the tool magazine window. See more specifics below. I like to increase this value from 0.03 to 0.05mm.
3. In the options window still, on the top line on the left, on the right, change the user level to service. Password for circuit pro 2.3 is now **cpro (LPKF** in version 2.1). Close this window. Go to the machining menu and select service. Then press the machine settings button. Scroll to the height level parameters section. Increase the tool z hub from 1 to 1.5. This will help with linear consistency.
4. In the field below the tool z hub, increase the free drive level from 1.5 to 4. This will make the head lift a little higher over the material before moving in the X/Y axis so that the tools do not drag on the material.

### Verifying Settings

1. We will want to look at the black foot. If you unsnap it from its location, please measure the overall thickness. This does wear over time, which will affect tool depth if worn enough. The thickness is expected to be around 11.1mm. If necessary, in your accessory kit, you should have a spare foot.

2. At this point, we will want to reset a couple of alignments. The first one is the table height. The procedure for the table height is attached. Do not perform the 2.5D offset if prompted. This may be the item that truly fixes your problem with the depth of cut on the router.

3. Align toolbar. Even though the machine seems like the current alignment is good, let's load the 1.5mm drill manually. Physically remove the 1.5mm drill from its tool holder. Have the machine go through the pickup process for the 1.5mm drill (physically empty tool position). If necessary, move the milling head to the pause/park position.

Go to the machining menu and select service, then the setup dialogue. Press the open clamp button, underneath the red stop field. It may say change clamp state. Manually load the 1.5mm drill into the collet, so that there is a gap above the ring on the tool equal to the thickness of the ring. While holding the drill in place, press the close clamp button on screen. (the open clamp button switches to close clamp) Close the service menu and go back to the main screen. Follow the camera offset procedure, as well as the toolbar alignment procedure). The system will have you manually remove the 1.5mm drill before completing the toolbar alignment.

4. Please perform the collet maintenance. Procedure is listed within the preventive maintenance document.

5. In short, we need to look at the values for when the tool is over the top of the ramp. There is no written procedure for this, but I can walk you through it. Please pickup the 1.5mm drill. While it is over the ramp, watch for two things. The first Z movement down to the ramp is what we refer to as the drop depth. The tip of the bit should barely hover over the angled part of the ramp. From here, the collet will open. The second Z movement over the tool is referred as the pickup depth. If you are looking at the bottom of the black foot, there should be a CD thickness of gap between the bottom of the foot and the ramp rails.

If you need to adjust these, go to the machining menu, service, then the milling width adjuster config. Scroll up to the top most section. Increasing the drop depth or pickup depth makes the Z movement go lower.

If the pickup depth is set too high, the tool will sit higher in the collet and the ring on the tool has the chance to clip the top prongs of the tool holder. If this value is too low, it will cut deep into the vacuum table insert. The expected cut depth into the insert is roughly 0.5mm.

6. Once the values over the ramp are updated/verified, you can proceed to the ramp calibration (milling width adjuster document). You will need to know what the copper weight is on the board you are using. The system likes ½ ounce better than 1 ounce. For the universal cutter and micro cutter, the camera is used. When testing the end mill, a set of digital calipers is needed to measure the depth of the cuts.

For the micro/universal cutters, once the camera measures the width, press accept. It may take several cuts to dial in these tools.

If the cut for the micro cutter is not clean, or the system has problems measuring, you can left click on each side of the line in the camera view, then enter the value in the entered value field on the result acceptance window.

After the ramp calibration is complete, you will need to do the check milling width function for the universal cutter and micro cutter.

You can also do this for the end mills. If you find that you are having to adjust each end mill the same amount, you can increase the default end mill depth (described in step 1), by the this increment. This will make it so that you will not ever have to adjust the depth of the end mills. The universal cutter and micro cutter would still need to be completed periodically, especially after replacing the bit.

7. This is really not a procedure, but more of something to watch. When the collet opens, it should take 4-5 seconds to open, or close. If the duration is shorter, then there is a mechanical error in the collet assembly.

This may explain why the spindle voltage errors are occurring. This would require the collet limit switches to be replaced. As we discussed, there could be a probability of sending the head unit to us for repair. The collet limit switches would be replaced under warranty. The system would be out of action for a couple of days. Lets cross that bridge when it happens.