ATAMI Standard Operating Procedure

LPKF Microline 2820P Laser Cutter

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Revision	Date	Description/Change	Curator
0	May 14, 2019	New document	Randy Greb
1	June 19, 2019	Added additional information about DXF file conversions and Tool library setups.	Randy Greb
2	August 21, 2019	Added recipe example, added notes regarding sample thickness, cleaned up some formatting.	Randy Greb
3	11/4/2019	Updated contents to make it easier to read. Added a procedure for making parts that can translate to DXF files for milling.	Randy Greb

Contents (you can click on the title to go to the subject page)

Scope:

Operations of the laser including:

- How to prepare files
- How to run standard recipes for cutting
- How to update your specific recipes
- Advanced applications such as circuit board cutting, via hole cutting, fiducial alignments.

System Specifications:

Please see the system description the ATAMI website for general specifications of this system.

Safety

General

Laser energies and pinch hazards are present in this sytem. Use extreme caution when opening and closing the door and **never defeat any laser interlocks**.

PPE Required

Safety glasses

Nitrile gloves should always be used for handling and cleaning samples. Samples may have contaminants as a result of the laser cutting.

Hazardous Energies

Electrical

Only ATAMI staff and qualified supplier maintenance personnel are allowed to open outside panels and work on the system. All electrical hazard controls must be in place for maintenance. General users are not allowed to open system panels.

Mechanical

Use caution when loading and unloading samples to avoid getting pinched.

Stored/Potential

Laser radiation is present in this system. Never operate the system without the front cover and all other safety protections in place.

Thermal

Laser cutting may generate heat on the sample surface. Use caution when removing the sample after cutting.

Direct exposure to laser radiation can cause burns.

Materials/Consumables Hazards

Use caution when removing cut samples. Always use nitrile gloves when handling cut samples.

If appropriate use 100% IPA and a white Texwipe towel to clean the sample and the surface of the vacuum stage after cutting.

Interlocks

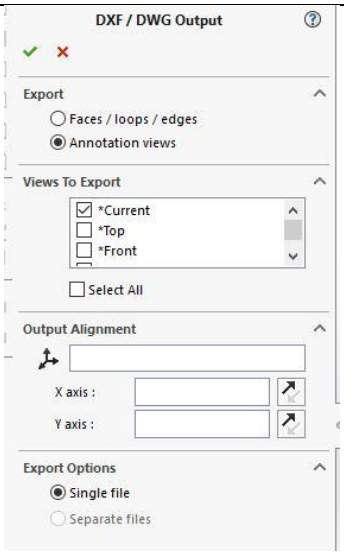
Interlocks are in place to prevent exposure to laser radiation and the moving stage. Never defeat interlocks.

Training Requirements

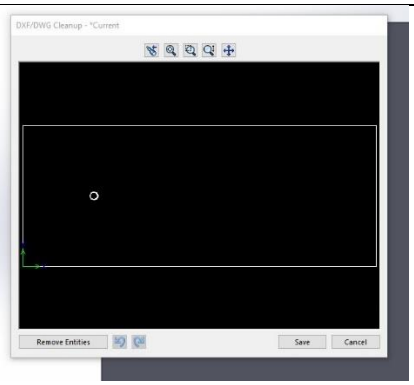
1. Pass all ATAMI required safety courses
2. Finish lab tour with qualified ATAMI trainer.
3. Complete all hands on training for this system and signed off by trainer.
4. Verify access to this document for reference.

Procedures

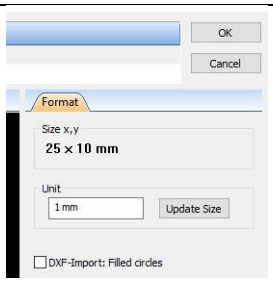
Convert a Solidworks part to DXF for full cut-through:

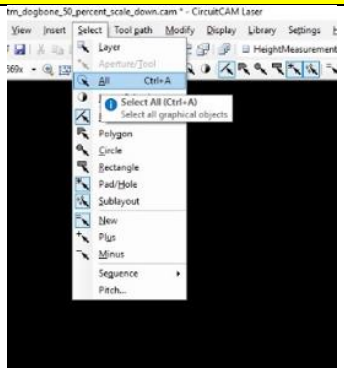
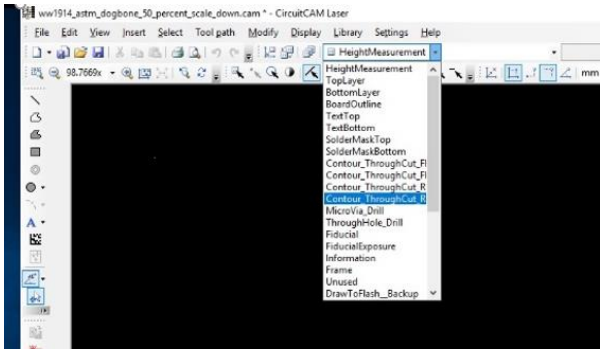
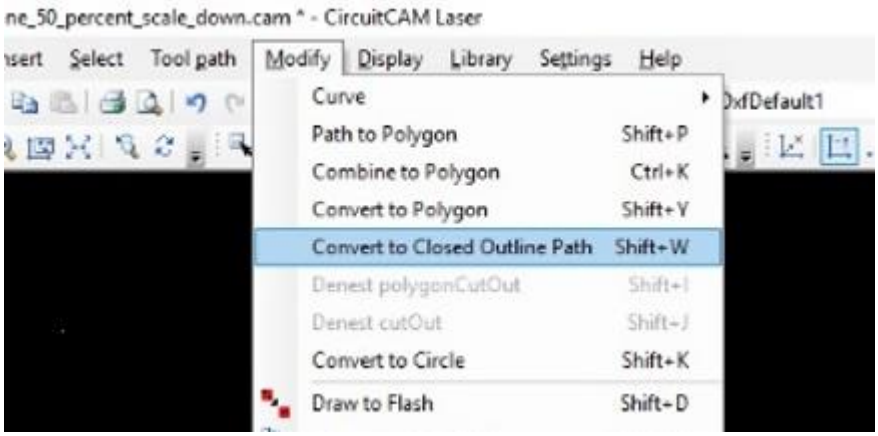
Step	Action	Notes
1	In Solidworks, open the file an orient the part to the plane that you want to cut.	
2	Choose the “File-Save As” menu and safe file as type “DXF”.	
3	After you click “Save”, you’ll need to click the green check sign to export the current view, as shown here.	

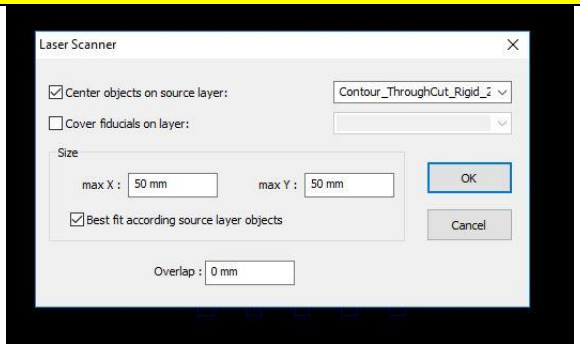
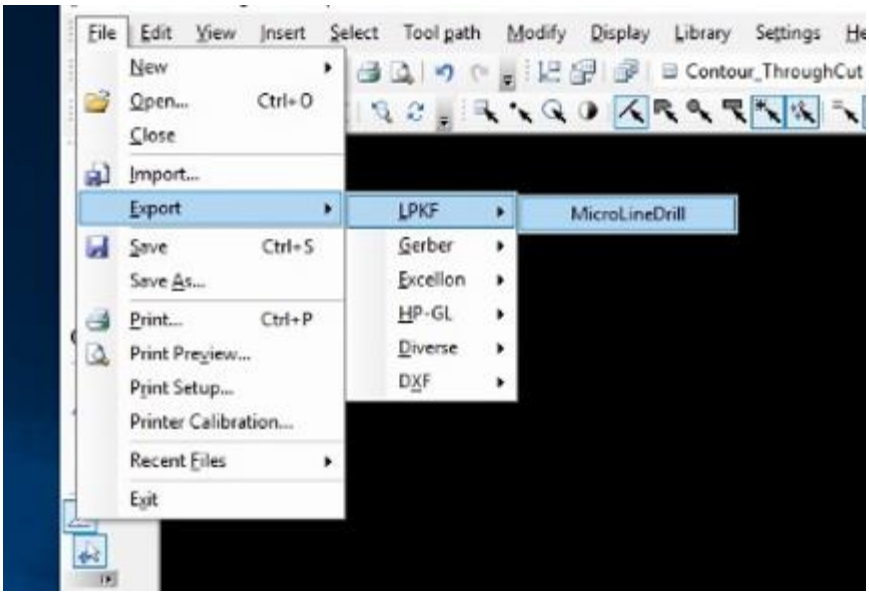
(back to contents)

4	The next step allows you to remove unwanted entities (this mainly applies to the border). Select unwanted entities by clicking on them. To select multiple lines hold down the “Ctrl” key while clicking. To remove entities, click “Remove Entities”.	
5		
6	Click save to finish.	

Use the Design Studio Workstation to convert DXF to LMD format for use on LPKF:

Step	Action	Notes
1	Log in with the following account: Username: “ .\b11guest “ Password: “ b11guest ”	
2	Open CircuitCam 6.2 with the desktop icon:	
3	Select ”File->Import” and use the DXF file you created earlier. Change the units to match your imported part. For example, if you are using inches, change “Unit” to 1inch and press update size. For mm sizes, just leave as 1mm.	
4	Select “Select->All” (or ctrl-A) to select your entire drawing.	

Step	Action	Notes
		
5	Use the drop-down list box that is on the screen under the Library and Settings menus to pick the cut type. Use the last of the four "Contour_ThroughCut_R…" options. This is the current default. As more analysis is completed, the suggestions for additional options will be added.	
6	Select one of the following: "Modify->convert to closed line path (shift-W)" – for objects such as closed boxes, dogbone structures, discs,… "Modify->Convert to One Flash (shift-H): - for complicated cuts with multiple shapes that may not intersect. See attachment below for examples.	

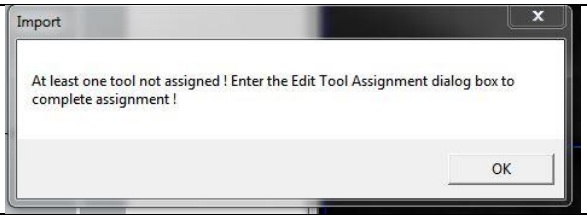
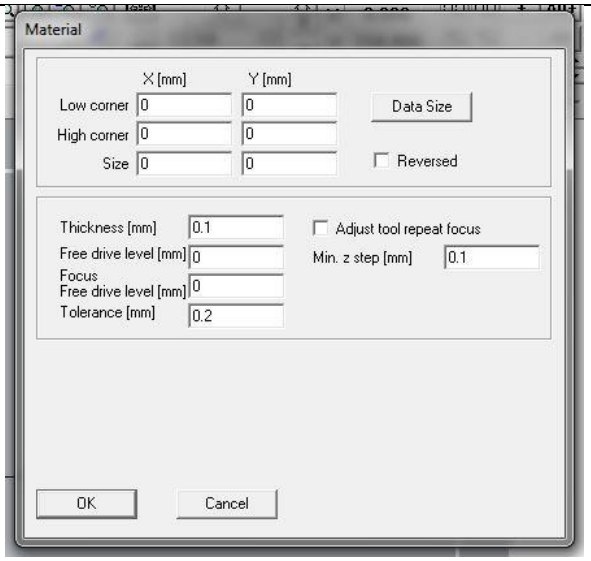
Step	Action	Notes
7	Select “Tool Path -> Laser Scanner”	 Make sure that the drop down menu has the correct “Contour_ThroughCut” option. This should be the outermost “Contour_ThroughCut” you used. If you only used one, select that one. The values in “max X” and “max Y” fields do not need to be changed. Select “OK”
8	Select “File->export->LPKF->MicroLineDrill” The file will be exported to the same location as the file that was imported.	
9	Close the CircuitCam application, log off the computer and sign out of the card scanner.	

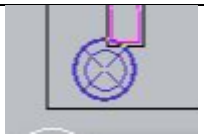
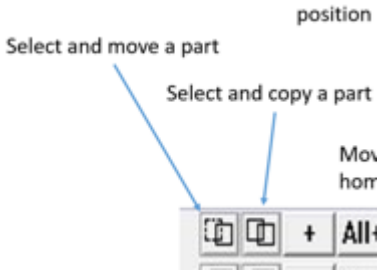
How to Load a Flat sheet in the laser:

Step	Action	Notes
1	Put the stage in the home position.	**Refer to the attachment below for a descriptions of the LPKF user interface buttons**.

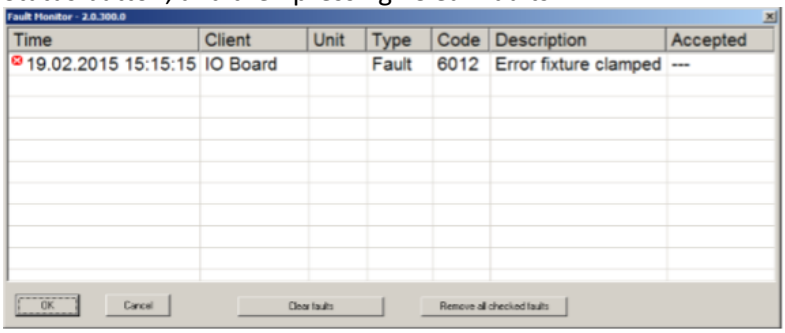
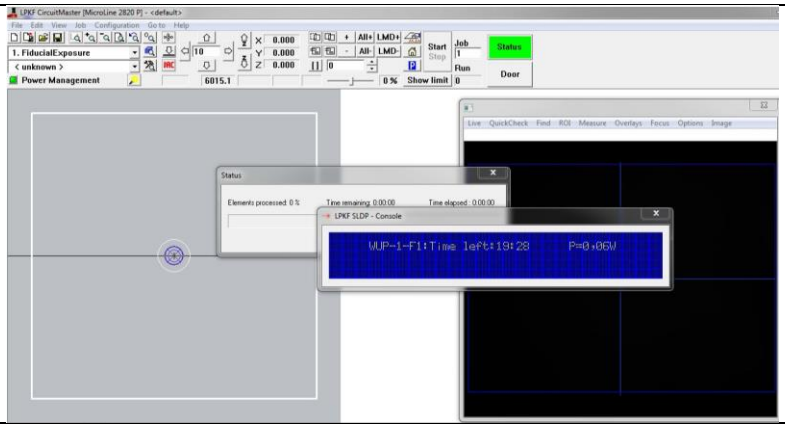
Step	Action	Notes
2	Turn on Vacuum and let the system sit for 30 seconds.	This will clear any residual contaminants from the previous cuts.
3	Move the stage to the exchange position.	Use caution, this will open the front door.
4	Wipe the vacuum surface with a Texwipe white towel and IPA to clean it of particles and contaminants.	This improves vacuum, prevents cross-contamination and
5	Place your sheet on the surface. If it does not cover the whole surface, you can use some of the plastic sheets to cover open areas and improve vacuum on your sample.	
6	Turn on the vacuum and press the door button to close the door.	

How to Process a Cut Through:

Step	Action	Notes
1	Select “File” → “Import” → “LMD/LPR…”	
2	Select your file then click “Open”	
3	Select “OK” at the Import message box.	
4	From the menu bar, select “Job” → “Material”	
5	Enter the correct material thickness in “Thickness” and then press OK.	 It is not required to edit other parameters for a cut through job. The defaults are sufficient.
6	From the menu bar, select “Job” → “Tool Assignment…”	

Step	Action	Notes
7	Select the “Tool Library” you want to pick your tool from.	
8	Select the “Tool Name” that you want to use.	
9	Select the “Phase” that you want to use. If you have only one phase, leave the phase assignment as is. If you have multiple phases, the phase with the lower number will cut first.	
10	Select “OK”	
11	Move your part to the desired location on the sheet that you loaded. The red light on the physical stage will roughly match the location of the target on the display.	  This button works by pressing it, then placing the cursor over your part, holding down the left mouse button, and moving it. It’s not intuitive at first, but once you do it a couple of times, it’s straightforward. Copy works in a similar way.
12	To ensure that you part is aligned as desired, click “Show limit”.	A red light will flash around the perimeter of your part. The scanning field, where the red light flashes, is larger than the area which will be cut.
13	Press the start button to start the cut job.	The display will show progress and let you know when it is done. If you need to stop the job (if it is in the incorrect location), then you can press this button again to stop it.

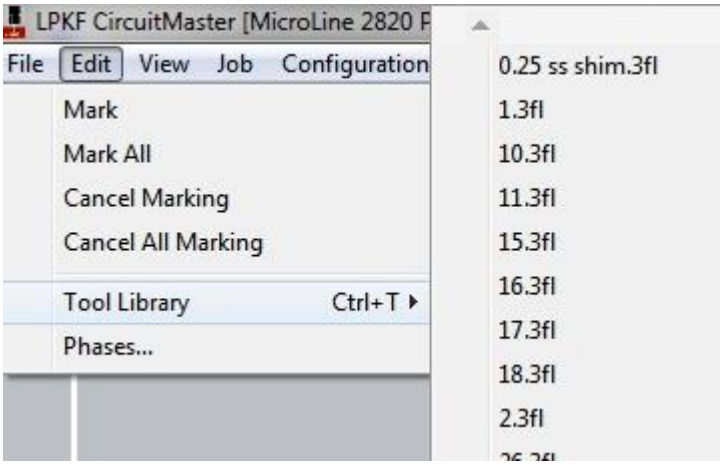
Startup Procedure:

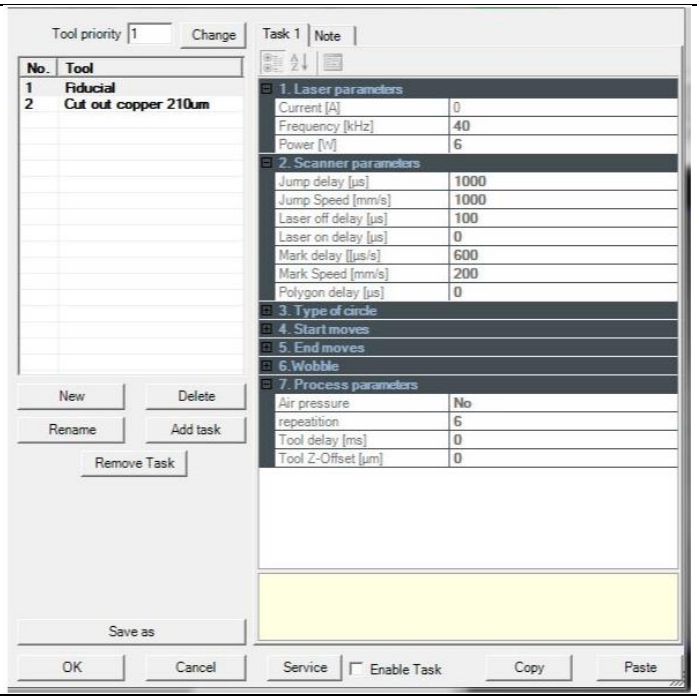
Step	Action	Notes
1	If the system is powered down do the following:	
2	Press the power button, as sown to the right. Do not press the red EMO button, unless you have an emergency situation.	
3	Double click the icon on the desktop to start the LPKF software.	If you get startup errors (and the alarm is sounding, and the pole light is blinking red), you can try to clear them by pressing the Status button, and then pressing “Clear Faults”. 
4	Each time the software starts up, the laser will have a 20 minute warmup period.	

Shutdown/standby Procedure:

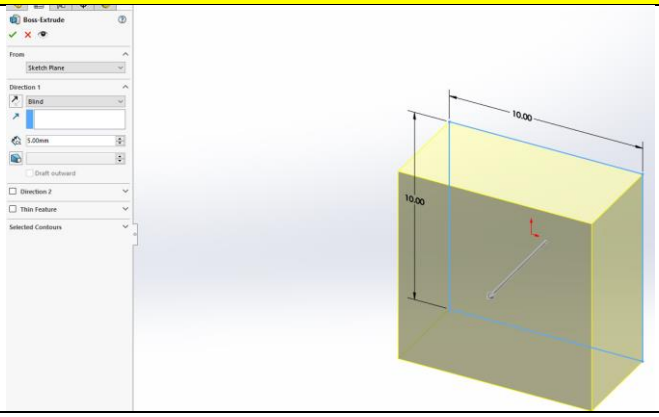
Step	Action	Notes
1	If you plan to use the tool within the day, you can leave the tool started up after you are done with our first sample.	
2	If it is Friday after 1pm, Go ahead and shutdown the software first. Then after the software has fully closed, press the power button.	

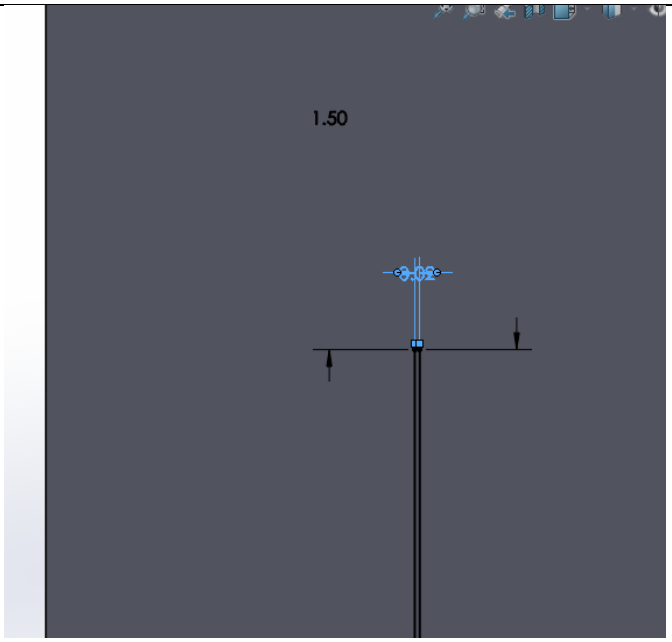
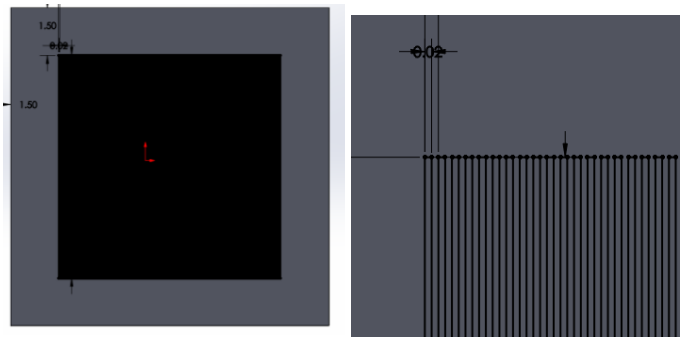
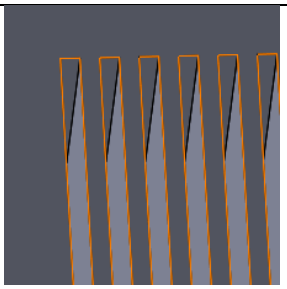
How to Edit Tool Libraries:

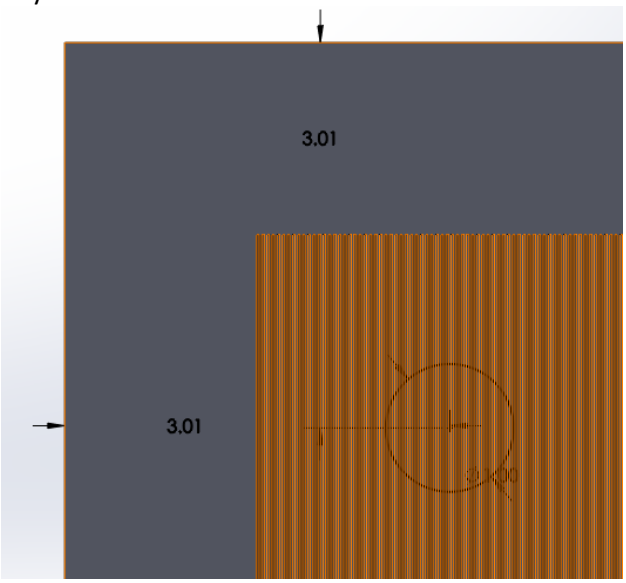
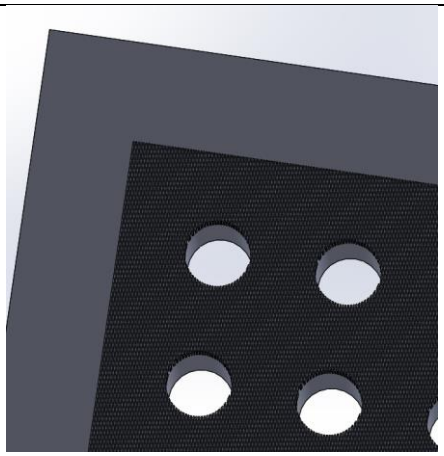
Step	Action	Notes
1	Select “Edit->Tool Library”, and pick the library you need to edit.	You may need to edit tool libraries for different material properties, thickness, or cut features. **Never edit tool properties for Tool Libraries that are not owned by you.** You must have your own tool library before editing. 

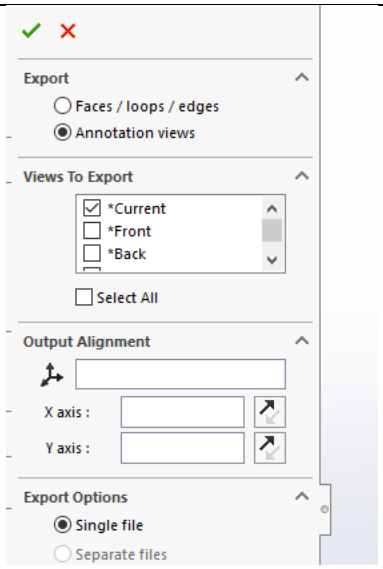
2	You will then get to the tool library editing screen. You will need to c reference the LPKF User manual and run experiments to determine the effects of these parameters on your materials and how they affect your cut. Laser parameters and Scanner parameters have the most impact. Many people use multiple tasks, with the same laser/scanner parameters and different “Tool Z-offset” to work through thick materials. By moving z-position up (stage up), the laser will be focus deeper in to the sample.	

How to Use Solidworks to create a DXF file for milling:

Step	Action	Notes
1	Create an extruded boss base.	

2	Create a box on the top surface that has a width equal to the cutting width. In the case of the LPFF 2820, this is 20 microns.	
3	Select the box and create a repeating structure across the face. In this case I used a 40micron spacing for the linear pattern spacing to get parallel lines evenly spaced at 20microns.	These will be the scan lines for milling out material: 
4	Create an extruded blind cut with the drawn boxes that goes part way into the extruded boss/base.	
5	Now create the pattern that will not be milled out on top of this.	This can be a bit tricky. In this case it's an array of posts. If the end of the top feature lines up tangentially with one of the 20micron cut lines, you will get a zero thickness geometry error when you try to do a throughcut. You can avoid this by offsetting the pattern, In the example shown here, it is offset by 10 microns for the 1mm

		diameter hole, so that hole will not be exactly tangent to any of the vertical lines. 
6	Then create a through cut that is cut “through all” for this pattern.	

7	Then, after saving the solidworks file, save it as a DXF file and use the current view.	
8	Then use Circuit CAM to convert to an LMD file.	You'll need to use the "Modify->Convert to One Flash" option.
9	Then develop a throughcut Tool Library and tool that will cut the lines and thus mill material to the depth of interest.	

Standard or Example Recipes

Example of Recipe for cutting Stainless Steel Shims:

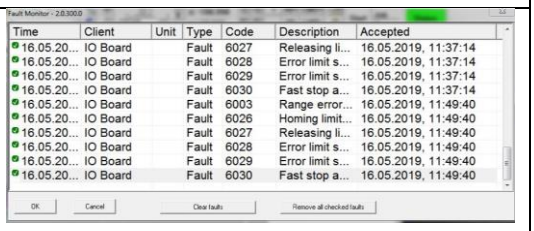
Test Group	Test Parameter	Recommended	Range			
NA	**Tool Name**	xxx	xxx	**304_4mil**	**304_8mil_standard**	**304_8mil_fine**
Laser parameters	**Current (A)**	displayed	displayed	100	75	75
Laser parameters	**Frequency (kHz)**	100	25-200	9.54	11	10
Laser parameters	**Power (W)**	displayed	displayed	2000	2000	2000
Scanner parameters	**Jump delay (us)**	1000	1-1,000,000	1	1	1
Scanner parameters	**Jump speed (mm/s)**	=mark speed	1-6,000	100	100	100
Scanner parameters	**Laser off delay (us)**	100	2-1,000	0	0	0
Scanner parameters	**Laser on delay (us)**	50	0-1,000	2000	2000	2000

Scanner parameters	**Mark delay (us)**	600	1-10,000	600	600	600
Scanner parameters	**Mark speed (mm/s)**	depends	1-2,000	250	250	250
Scanner parameters	**Polygon delay (us)**	50	0-1,000	No	No	No
Start moves	**Active**	No	Yes/no	1	1	1
Start moves	**Length (um)**	1	1-n	jump	jump	jump
Start moves	**Type**	jump	jump	No	No	No
End moves	**Active**	No	Yes/no	1	1	1
End moves	**Length (um)**	1	1-n	jump	jump	jump
End moves	**Type**	jump	jump	yes	yes	yes
Process parameters	**Air pressure**	no	Yes/no	20	20	20
Process parameters	**Repetitions**	1	1-n	20	40	30
Process parameters	**Tool delay (ms)**	0	0-n	0	0	0
Process parameters	**Tool Z-offset (um)**	0	0-11mm (depends on sample thickness)			
	Top Image			20	20	20
Type of circle	**Beam Diameter (um)**	20	depends	1	1	1
Type of circle	**Circle Diameter Factor**	1	1	0	0	0
Type of circle	**Circle Inner Diameter (um)**		depends	outer	outer	outer
Type of circle	**Circles type**	Outer Circle	depends			
Type of circle	**File name**	blank	depends	1	1	1
Type of circle	**No of turns**	1	depends	no	no	no
Type of circle	**Outward**	No	Yes/no	0	0	0

Type of circle	**Overlap (um)**	0	depends			

Basic Troubleshooting

If you get startup errors or hear beeping from the system:

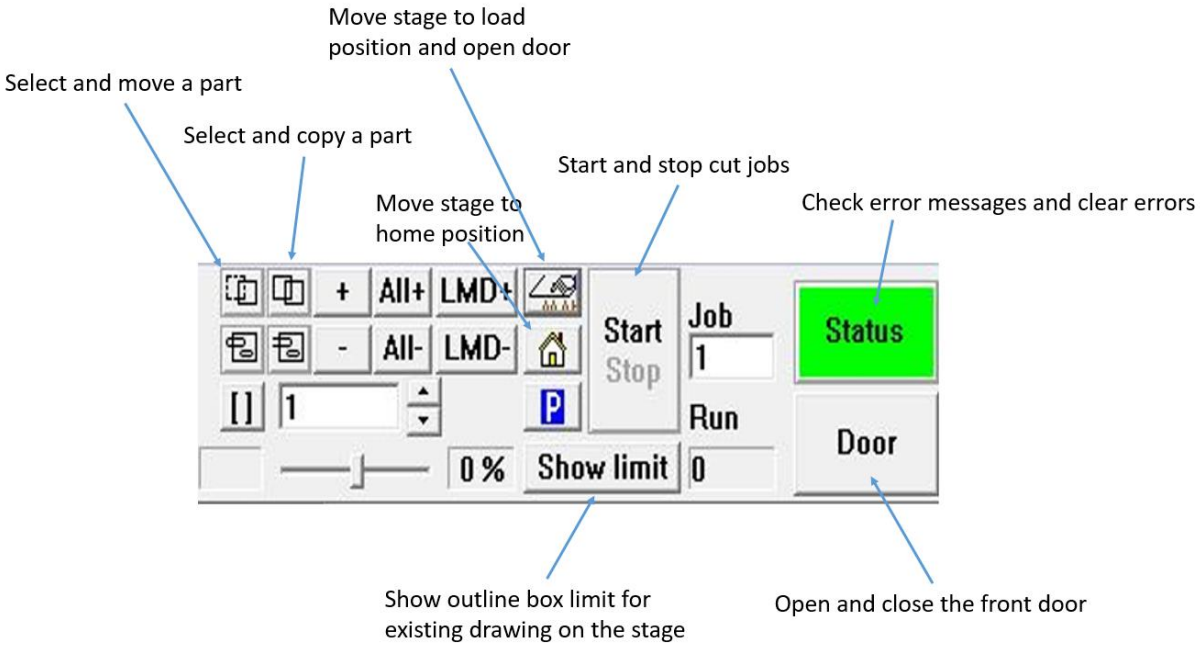
Step	If	Then	Notes
1	You get startup errors.	Press the status button to get the Fault Monitor Display and then press “Clear faults”. Do not press “Remove all checked faults”.	
2	You cannot clear them.	Contact ATAMI staff.	

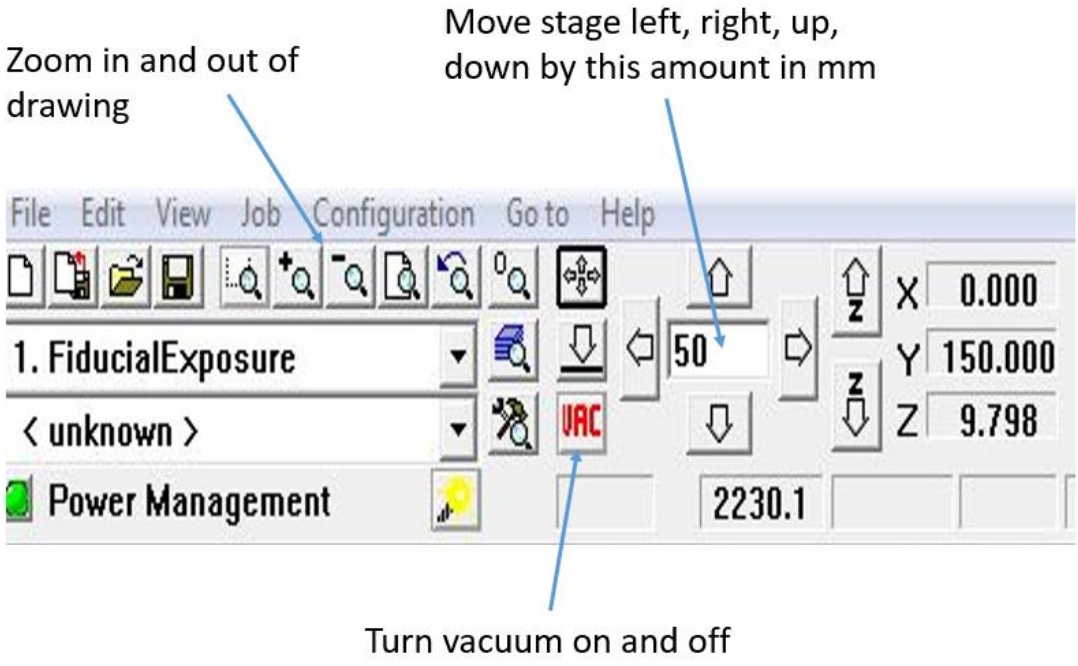
Hints for addressing laser burn quality issues:

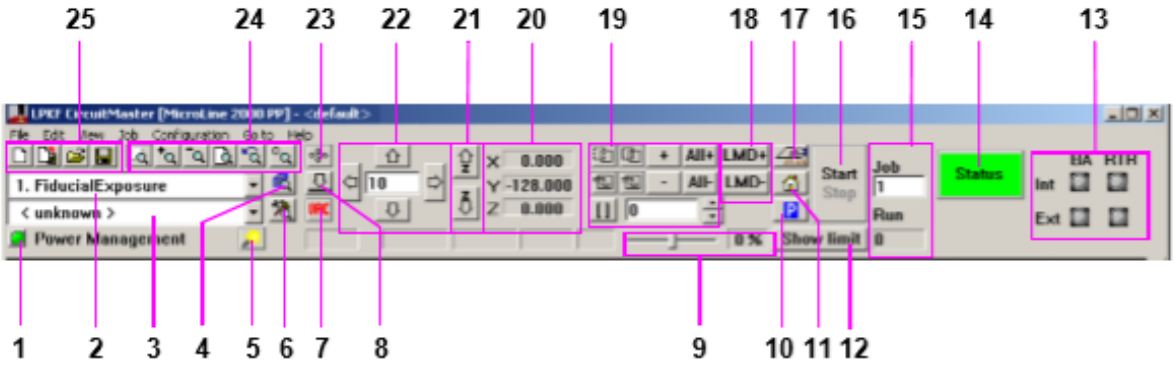
Problem	Possible cause	Remedy
Laser beam burns at the starting points	Laser - ON - delay too short	Laser ON - increase delay
Laser beam burns at the end points	Laser -OFF - delay too long	Laser OFF - reduce delay
When structuring closed lines there are remaining webs	Starting point Laser - ON - delay too long	Laser ON - reduce delay
Structures are not lasered completely	End point Laser - OFF - delay too short	Laser OFF - increase delay
At the structure start an inlet or overshoot is visible	Jump - delay too short	Jump - increase delay
Corners of polygons have been rounded off	• Polygon - delay too short • Mark - speed too high	• Polygon - increase delay • Mark - reduce speed
Burn-in effects at the endpoints of the polygon vector	Polygon - delay too long	Polygon - reduce delay

Attachments

LPKF User Interface button functions







1 Power Management
2 Display/Selection of the current production phase
3 Display/Selection of the current tool, that is used for the current production phase.
4 Configuration phase
5 Camera light (button active: white light, not active: red light)
6 Configuration active tool library
7 Vacuum ON/OFF
8 Height measurement
9 Mark speed adjustment (+/- 10 %)
10 Go to pause position
11 Go to home position
12 Displays the process data with the pilot laser
13 Displays the status of the automated loading system (only for *ML 2000 Si*, *ML 2000 Ci*, see page 68)
14 Display status
15 Count of job runs in batch mode (only for *ML 1000* and *ML 2000 P/S*)
16 Start/Stop working process (see page 32)
17 Go to work piece replace position
18 Remove LMD data
19 Copy, select, mark or displace objects
20 Displays the position of the processing table
21 Up/Down Z axis
22 Manual moving worktable
23 Move laser head via mouse
24 Zoom function
25 File functions (new, import, export, open, save)

Health Hazards:

Safety notes

Danger to life!

Missing or inadequate fuse protection may result in deadly electric shocks and/or cause fire.

N e v e r bridge the automatic fuse switch!

Risk of injury!

Since the materials you are handling with have a small size and razor-sharp rough edges, a big risk of injury exists.

Make sure to wear protective gloves!

Health hazard!

Direct contact of the laser beam with the skin results in intensive burn and causes invisible interior injuries. Diffused light which contacts your skin over a space of time takes the same effects as well.

Beware in any case of direct contact between the laser beam and the skin.

Health hazard!

Hazardous substances can be generated when materials are processed by the laser beam. These may be cancer-causing.

Only use materials which are approved by LPKF for work with and always activate the provided extraction system during operation.

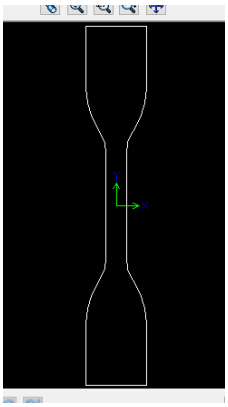
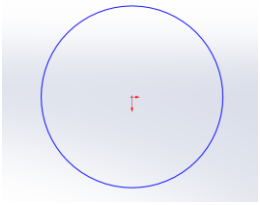
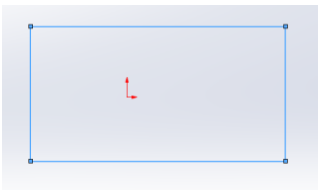
Health hazard!

All safety measures which are described in the material safety data sheets must be strictly adhered to!

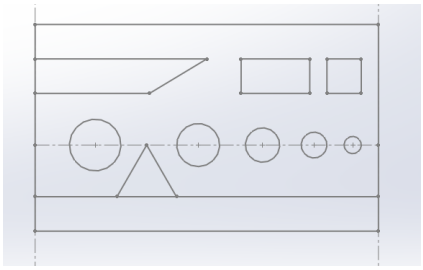
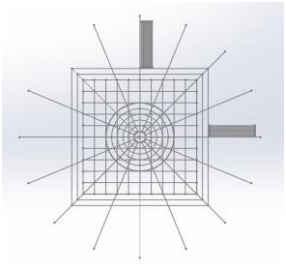
Keep the safety data sheets near by the system. It is necessary to read the safety data sheets carefully and to adhere to all required safety measures.

Examples of what type of shape goes with which Modify Choice:

Convert to Closed Line Path:

Convert to One Flash:

Creating and Editing Tool Libraries:

You can create and edit tool libraries from the "Edit->Tool Library" drop down menu in the Circuit Master software on the LPKF computer. Refer to the manual and the attachments here for editing guidelines.

Never edit a Tool Library that was not created by you.

Recipe development spreadsheets and tool characterization whitepapers are available from ATAMI staff.

Information on Sample Size:

- The range of Z for the station is 0-11mm. The stage is at 11mm when it's at the top, and the 0mm at the bottom (furthest away from the lens).
- The top of the Porex plate is at roughly 8.4mm. This is where optical and laser focus is set.
- If you have a sample that is 5mm thick, the stage will move to roughly 3.4mm.
- The maximum sample thickness that can be cut in focus will be roughly 8.4mm.

- If you need to do cuts or marks on samples that are thicker than 8.4mm, then it will be out of focus, or we will need to develop a custom sample holder.