1. Introduction

LPKF Protolaser R is a full-scale production level CNC laser cutter which can be used to cut or ablate materials such as PCBs, Si wafers, glass, metals and polymers such as PDMS and Polyimide. Its picosecond laser ablates materials with virtually no heat input. It practically eliminates heat transfer; the targeted material evaporates immediately minimizing the damage to the surrounding material. This allows even complex thin film systems, temperature-sensitive substrates, and OLED coatings on glass to be ablated or structured with a high degree of control. The laser system requires no masks or films to accomplish these tasks.
2. Features

1. Maximum substrate size: 12” x 9”
2. Minimum substrate size: 5 mm x 5 mm
3. Substrate thickness: 0.02 to 10 mm
4. Beam diameter 15 um
5. Minimum cut width 20 um
6. Camera system for substrate inspection, alignment, and basic measurement functions
7. Conversion software for DXF, Gerber files
8. Picosecond Laser Module (1030 nm), 1 ps pulse duration, max 200 kHz pulse frequency, max 3.73 W power

3. Safety

Follow general safety guidelines in the lab and the specific safety rules as per follows:

1. **Laser Hazard:** This equipment utilizes a Class 4 laser. The unit is secured with safety interlocks so that the high power lasers will not operate when the loading window is open. **Under no circumstances users should open any optical enclosure panels.**
2. **Pinch Point Hazard:** Front loading window is operated manually. Make sure to move away before closing the window.
3. **Electric Hazard:** Fatal electrical shock and/or severe burns can be caused by the supply voltage of up to 120VAC 15A for the system. **Do not remove any covers or tamper the system.**

4. Main equipment components for user operation

There are two main components for user interface as shown in the image above:

1. Main Unit
2. The control PC

5. Available processes

Cutting conditions for various materials are available in CircuitMaster Suite. Consult staff for further assistance.

6. Process Notes

1. Your sample has to be relatively flat.
2. Make sure the back side of your substrate is clean.
3. Make sure to remove any items except your sample from the processing area.
4. Samples has to be trasported in a sealed container to an appropriate hood for further cleaning.
7. Operating the system

This section contains important information on operating the system and the associated software programs.

For detailed information on operating the software refer to the corresponding user manual. Ask NUFAB Staff for further assistance.

a. Safety

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of injury by laser radiation!</strong></td>
</tr>
<tr>
<td>As soon as the system is switched into the service mode, the system is classified as laser class 4.</td>
</tr>
<tr>
<td>► Always wear the personal protective equipment.</td>
</tr>
<tr>
<td>► Never look directly into the laser beam.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>WARNING</th>
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<tbody>
<tr>
<td><strong>Health hazard by gases or dusts!</strong></td>
</tr>
<tr>
<td>Processing materials with laser beams can produce gases or dusts hazardous to health.</td>
</tr>
<tr>
<td>► Only process materials that are approved by the staff.</td>
</tr>
<tr>
<td>► Always ensure that the extraction system is switched on and working properly.</td>
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</tbody>
</table>

b. Typical production process

This chapter describes a typical production process. The following steps are performed:

- Switching on the system
- Starting CircuitPro PL
- Opening a template
- Importing the data
- Saving the document
- Generating toolpaths
- Exporting the project
- Starting CircuitMaster PL and importing the LMD file
- Checking the tool library assignment
- Placing the material on the x/y table
- Defining the material size
- Placing the layout
- Starting processing and processing the job
- Switching off the system
- Cleaning the system
i. Switching on the system

Activate the system in NUcore

- **Switching on the system**
  1. Press the on/off button at the system front.
  2. Start the CircuitMaster PL and Circuit Pro PL softwares at the control PC.

The system has been switched on.

The system requires a warm-up time of approx. 20 minutes for the laser source to attain a constant diode temperature. The warm-up phase starts automatically with the start of the system.

ii. Data preparation with CircuitPro PL

This chapter explains the steps that are necessary for further data preparation in CircuitPro PL and exporting the data into an LMD file.

The following steps are covered in this chapter:

- Starting CircuitPro PL
- Opening the template
- Importing the data
- Saving the document
- Generating toolpaths
- Exporting the project

- **Starting CircuitPro PL**
  1. Start CircuitPro PL by double-clicking on its desktop icon.

The splash screen is displayed:

![Splash screen CircuitPro PL](image)

CircuitPro PL has been started.
Opening a template

1. In CircuitPro PL, click on File > New.
   - The following dialog is displayed:

   ![Fig. 50: Dialog New document](image)

2. Click on the tab Templates.
   - The dialog changes as follows:

   ![Fig. 51: Tab Templates](image)

3. Click on LPKF ProtoLaser R – single sided top.cbf.
   - The dialog is closed and the user interface changes as follows:
The template has been opened.

Importing the data

1. Click on File > Import.
2. Navigate to the folder in which your file is stored.
3. Click on [Open].
4. The following dialog is displayed:

   ![Dialog Import](image)

5. The CAM view changes as follows:
The data have been imported.

4. Transfer your structures to corresponding layers by right clicking and selecting “assign to layer” as described below.
   • Alignment marks > Fudicial
   • Device outline > Board Outline
   • Etching > robout top
   • Holes > drill plated
   • Any pattern that needs to stay untouched > Toplayer

Use 1.5 mm circles as alignment marks

Saving the document
1. In CircuitPro PL, click on File > Save.
The following dialog is displayed:

2. Enter PL_PL as file name.
3. Select your desktop as saving location of the file.
4. Click on [Save].
The document has been saved.
### Generating toolpaths

For producing the printed circuit board, the toolpaths for laser insulation have to be generated.

1. Click on **Toolpath > Laser insulate**.

   - The following dialog is displayed:
     ![Dialog Laser insulate](image)

   ![Fig. 56: Dialog Laser insulate](image)

2. Select the insulation method **Complete rubout** by clicking on the arrow button.
3. Check whether the material **Non Laminated Substrate** is selected.
4. Click on [Start].

   - The **CAM view** changes as follows:
     ![CAM view with toolpaths for laser insulation](image)

   ![Fig. 57: CAM view with toolpaths for laser insulation](image)

5. Click on [Close].

   - The dialog is closed.

   - The toolpaths have been generated.

### Exporting the project

Processing the printed circuit board with the ProtoLaser R requires that the file is exported from CircuitPro PL. The LMD file generated in this step is imported into CircuitMaster PL in the next step.

1. Click on **File > Export…**
The following dialog is displayed:

![Dialog Export](image)

The phase file is automatically attached. The columns *Map to phase* and *Map to tool name(s)* are filled with the necessary information from the phase file.

If the phase file is not attached automatically you can find it in the following folder depending on the operating system:

**iii. Win 7:**
C:\Users\All Users\AppData\LPKF Laser & Electronics\LPKF CircuitMaster 1.12\ProtoLaser Pico.phs

**iv. Win XP:**
C:\Programs\LPKF\LPKF CircuitMaster 1.12\ProtoLaser Pico.phs

2. Enter *PL_PL.LMD* as file name.
3. Select your desktop for storing the file.
4. Click on [Export].

The project has been exported.

**v. Working with CircuitMaster PL and the system**

This chapter explains the steps that are necessary for importing the LMD file into CircuitMaster PL and the subsequent processing of the circuit board in the system.

The following steps are covered in this chapter:
- Starting CircuitMaster PL and importing the LMD file
- Checking the assignment of the tool library
- Placing the material on the x/y table
- Determining the material size
- Placing the layout
- Starting the production and processing the job

**Starting CircuitMaster PL and importing the LMD file**

1. Start CircuitMaster PL by double-clicking on its desktop icon.
2. The splash screen is displayed:
2. Click on File > Import > LMD/LPR…

☐ The following dialog is displayed:

3. Select the previously created LMD file PL_P_L.MMD and click on [Open].

☐ The following dialog is displayed:

4. Select a tool library according to your material, such as LPKF FR4 18um 0,5
5. Click on [Open].
☐ The job is displayed in CircuitMaster PL.
☐ CircuitMaster PL has been started and the LMD file has been imported.

■ Checking the assignment of the tool library
1. Click on Edit > Tool Library.
☐ The submenu with the tool libraries is displayed:

![Submenu Tool Library](image)

2. Check the assignment.
3. Click on the correct tool library if necessary.
☐ The assignment of the tool library has been checked.

■ Placing the material on the x/y table
1. Measure the thickness of the material using a calliper gauge.
2. Click on to move the x/y table to the position for material change.
Clean the material surface with a micro etchant (e.g. ViaCleaner), if a discoloration is visible (oxide layer).
Thus, a surface is achieved that always has the same characteristics.
3. Open the cover.
4. Place the material onto the x/y table.
5. Fasten the material along its edges with adhesive tape.
6. Click on Job > Material > Size…
The following dialog is displayed:

7. Enter the measured value in the field *Thickness [mm]*.
8. Click on [OK].
9. Close the cover.

The material has been placed on the x/y table.

### Determining the material size

1. Click on [ ] to switch on the pilot laser.
2. Click on [ ] to move the x/y table using the mouse.
3. Move the x/y table using the mouse in such a way that the laser dot is positioned at the left front corner.

4. Click on Job > Material > Set Low Corner.
5. Move the x/y table using the mouse in such a way that the laser dot is positioned at the right rear corner.
6. Click on Job > Material > Set High Corner
☐ The material size has been determined.

■ Placing the layout
1. Click on Job > Placement...
☐ The following dialog is displayed:

2. Click on [Center].
3. Click on [OK].
☐ The layout has been placed in the center of the material.

■ Starting processing and processing the job
1. Click on Edit > Phases...
☐ The following dialog is displayed:
2. Activate required phases.
   An activated phase is marked with an asterisk and the check box Enabled is active.
   - Make sure to select Read_Top phase if you need to do alignment.

3. Click on [OK].
4. Click on All to select the data of all activated production phases.
5. Click on to start processing.
   - The processing of the material is started and the following message is displayed:

   ![Waiting for warmup ...]

   - The processing has been started and the job is being processed.

In some cases, residual material can remain on the printed circuit board. Check the result and remove any residual material, if present.
vi. **Switching off the system**

- **Switching off the system**
  1. Close the software CircuitMaster PL and CircuitPro PL.
  2. Press the *On/Off button* at the front of the system.

  The system has been switched off.

- Use a vacuum cleaner to remove chips and residues from the processing area.

**Logout from the system in NUcore**