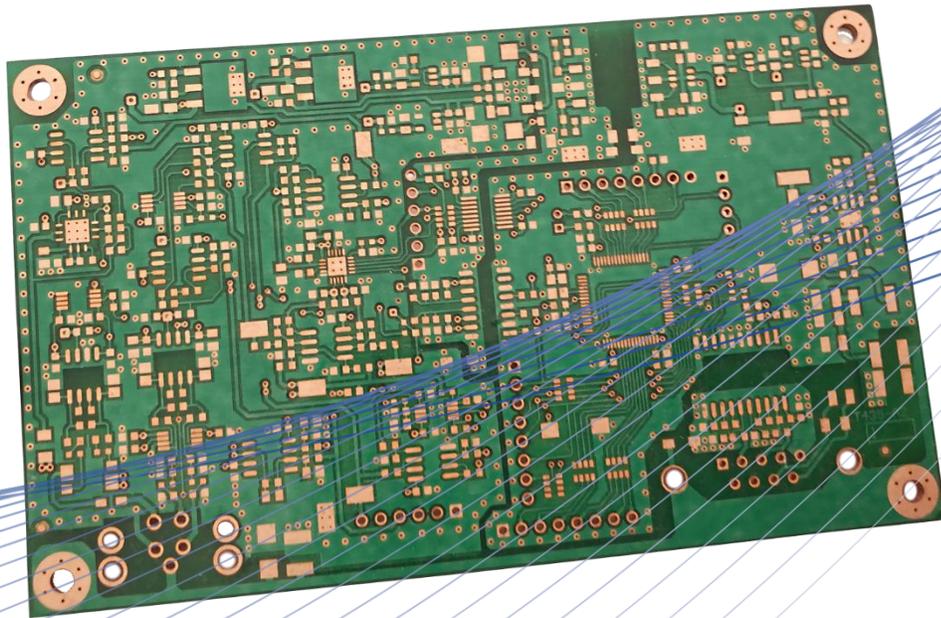


4-Layer PCB in a Day  
Winning combination for  
rapid digital board prototyping



# 4-Layer PCB in a Day

A typical member of electronics development team is time pressure. With a lack of electronics components nowadays, urgent redesigns additionally stress electronic teams. Though sophisticated software simulation tools and advanced CAD system helps a lot towards error free design, prototypes are necessary. When comes to very fast switching electronics, multilayers are a must to keep impedances under control and reduce signal paths.

As a machine building company, we are experiencing all these new challenges too. Our electronic prototyping laboratory is busy round a clock. For the article describes we documented a selected 4-layer PCB prototyping process, from importing CAD data to finished PCB with our new line: LPKF ProtoLaser H4, LPKF MultiPress S4 and LPKF Contac S4. The selected electronics design is a precise 4-point measurement unit, with a bunch of op-amps detecting and amplifying microvolt differences to final digital data, to be communicated via serial data line. Necessary voltage regulators are also part of the necessary 4-layer design.

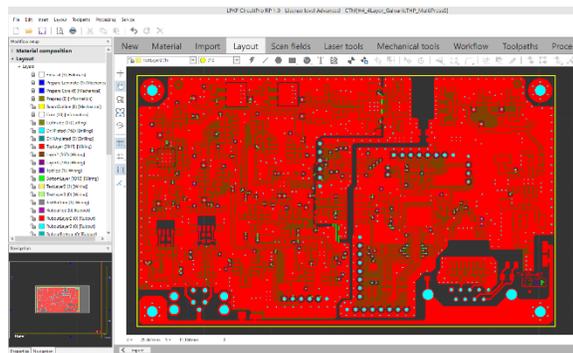


Fig. 1: The individual layers are prepared for production in the LPKF CircuitPro system software. Choose a template, load the layout and the software guides you through the process.

## Seamless collaboration

The systems used are designed for problem-free cooperation: LPKF ProtoLaser H4, LPKF MultiPress S4 and LPKF Contac S4 are the systems of choice.

- LPKF ProtoLaser H4: tabletop laser structuring system for super-fast PCB prototyping with mechanical tools for drilling and routing. Build in PC with MS Windows and CircuitPro RP software. Target material e.g. single and double sided FR4.

Build in PC with MS Windows and CircuitPro RP software. Target material e.g. single and double sided FR4.

- LPKF MultiPress S4: stand alone, plug and play pressing system with small footprint, build in vacuum, freely adjustable temperature, pressure and time control via large touch display for rigid, rigid-flex, flexible and RF multilayers.
- LPKF Contac S4: tabletop electroplating system for reliable through-hole plating of rigid, flex and RF double sided or multilayers, supported with build-in PC interface with large touch display for easy and convenient operation.

All systems come with templates and libraries of tools, profiles and processes which enables smooth and guided workflow even for novice. The ProtoLaser H4 and MultiPress S4 are both our freshly launched products while Contact S4 already builds its reputation over last few years.

The process starts with LPKF CircuitPro RP which runs on LPKF ProtoMat H4's build-in computer. First step of starting new project is a definition of template, which then guide operator through the process. In our case is a 4-layer multilayer with galvanic through-hole plating and with use of MultiPress S4. Once template is loaded, next is a material definition, which is in our case common double-sided 1 mm FR4 core with 18  $\mu\text{m}$  copper on both sides and 0.2 mm thick ML 104 with 5  $\mu\text{m}$  Cu on each side of the core. Those 5  $\mu\text{m}$  copper will be plated additional with 12.5 mm Cu which will define standard thickness of top and bottom side. Use of related prepreg is also defined within template.

Template is defined to ¼ panel size, 12" x 9", which is supported with all systems. Next step is import of CAD data. Typically, different layers from CAD software, defined by file type abbreviation, are associated with CircuitPro, clearly named layers. After import, layout is visible and editable. At this point, way to be ready for processing can include just one click or, for advanced users, more options are available.

Aligning stack of layers is realized using reference pins in a press tool of the MultiPress S4. Positions of these pins are defined also in a template for CircuitPro. Following suggested workflow from software, first outer layers cutouts for reference pins and fiducials openings are done. Next is processing of core layer, starting with fiducials drilling and reference openings and structuring of both inner layers. Complete process required close to 25 minutes.

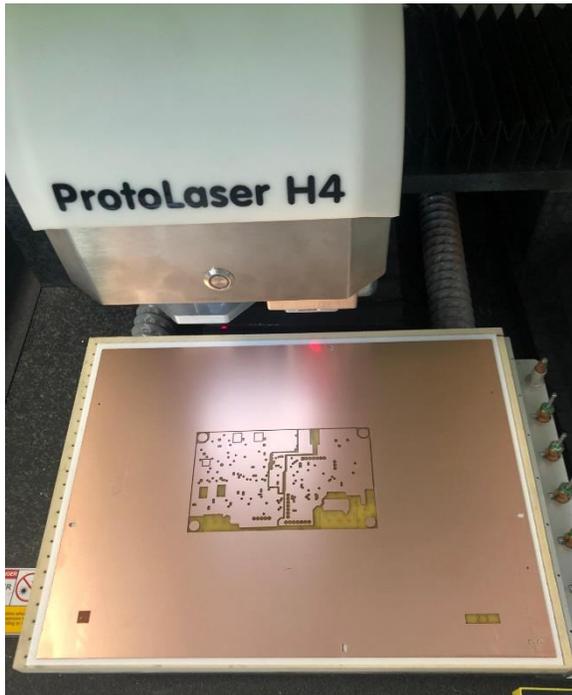


Fig. 2: In the first production step, the laser tool of the ProtoLaser H4 structures the core layer.

After cleaning each layer with isopropanol, stack is being built from the bottom layer up on a bottom of the press tool. The position of the pins and marked text at the edge of each layer, guide operator to correctly align layers. The prepreg placed between the layers is aligned to the center of the material. Once the stack is completed and the cover of the press tool is assembled, a complete setup is placed into the LPKF MultiPress S4. Pressing process of default

program runs automatically, without any user intervention, for two hour and 45 minutes. At the end of pressing process, e-mail notification can be sent to operator, if set up so. There is no damage to the multilayer, if material remain in the press for longer time.

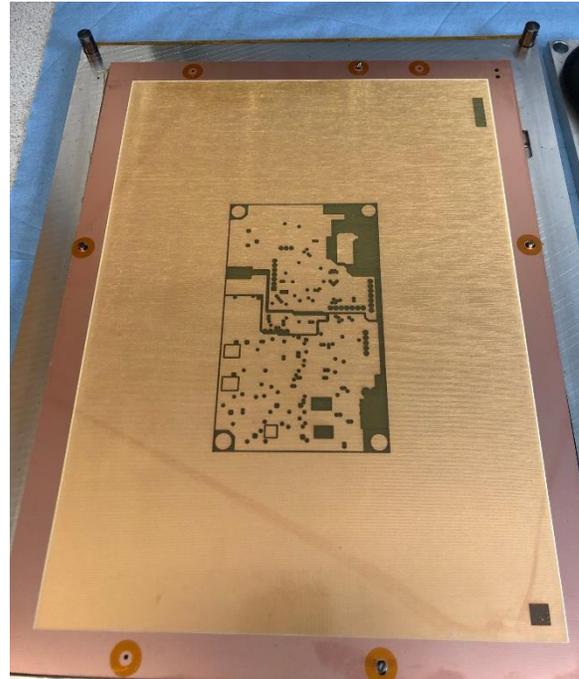


Fig. 3: The structured core layer, the prepregs and the outer layers are arranged on top of each other for pressing.

Pressed multilayer stack is returned to ProtoLaser H4 for drilling. Fiducials previously drilled on the core layer are used to automatically align complete panel. PCB layout contains 12 different diameters of holes, thus 12 different drills are necessary. Drilling process starts from the smallest diameter up; first six thinner tools are loaded into a toolbox for uninterrupted process. When these holes are being drilled, communication window asks for the missing tools, which are manually replaced into tool holder and assigned within CircuitPro. Drilling process continues and all of 762 holes are drilled in 33 minutes.

The stack is now prepared for through-hole plating. The electroplating is used to grow 12,5 µm of copper. Process instructions on the display guide the operator through the cleaning phases, a black hole activation, drying and the final preparation for plating. Complete process run about 2,5 hours, while the operator assistance is occasionally required within first hour.

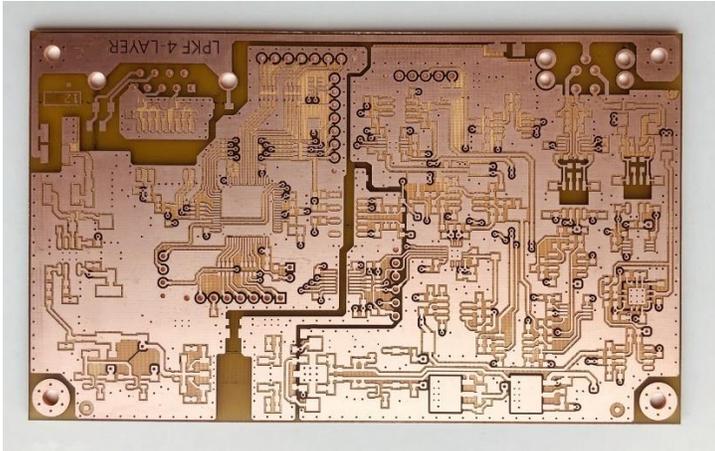


Fig. 4: After pressing, drilling is done, then the through-hole plating follows and finally the structuring of the outer layers. The result: a 4-layer PCB in less than a day.

The final stage, structuring of the outer layers is same as would be for double-sided board. The only difference is a thicker substrate, without influence on the process. High structuring speed of the LPKF ProtoLaser H4 processed bottom layer in 6 minutes and 16 seconds while more complex top layer required almost 9 minutes. Mechanical cut out of PCB took 3 minutes and 7 seconds.

### Conclusion

Despite relatively long pressing and through-hole plating processes, the four-layer multilayer PCB had been produced within 7 hours. Additional step, protection of PCB with solder resist, would require additional one hour due to needed curing time. Overall, LPKF ProtoLaser H4, together with MultiPress S4 and Contac S4 enable in-house 4-layer PCB production within a working day

### About LPKF

LPKF Laser & Electronics AG is a leading provider of laser-based solutions for the technology industry. Laser systems from LPKF are crucial for the production of printed circuit boards, microchips, automotive parts, solar modules and many other components.

The "DevelopmentEquipment" area specializes in systems for in-house circuit board prototyping and provides solutions for FR4 processing and demanding HF, flex or ceramic substrates.

Founded in 1976, the company has its headquarters in Garbsen near Hanover and is active worldwide through subsidiaries and agencies. Around 20 percent of the employees work in research and development.

### Kontakt:



### LPKF Laser & Electronics AG / Lars Führmann

Osteriede 7 Phone +49 (0) 5131 7095-1591  
30827 Garbsen Fax +49 (0) 5131 7095-90

[Lars.fuehrmann@lpkf.com](mailto:Lars.fuehrmann@lpkf.com), [www.lpkf.com](http://www.lpkf.com)