

# In-House Rapid PCB Prototyping Product Catalog

ProtoMat

S103

Status

**New:**  
LPKF ProtoLaser U3

New production  
options for the  
electronic lab

Circuit Board Plotters

Laser Circuit Structuring

Through-Hole Plating

Multilayer Prototyping

SMT/Finishing

TechInfo

**LPKF**  
Laser & Electronics

# Questions about your Order? In Need of Service and Support?

Here you will find all information related to sales and service.

Our competent staff is looking forward to assisting you.

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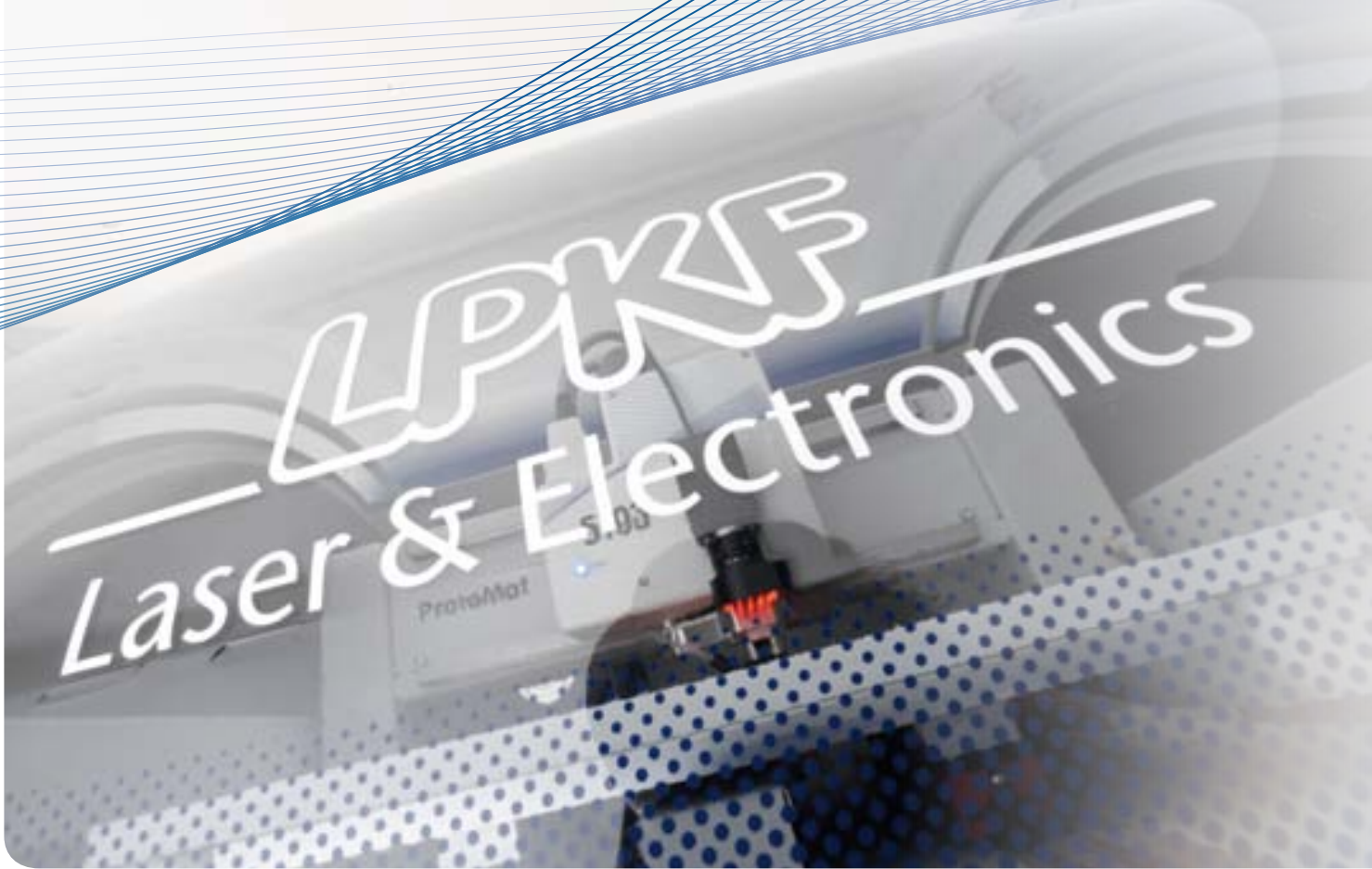
Website [www.lpkf.cn](http://www.lpkf.cn)

## Worldwide LPKF representation

LPKF AG maintains a global sales distribution network. Please see page 116 for an overview of all LPKF distributors.

For additional information please visit our website at [www.lpkf.com](http://www.lpkf.com).





# Welcome to LPKF Rapid PCB Prototyping

Thank you for your interest. This catalogue features everything needed for Rapid PCB Prototyping: machines, tools, consumables, accessories and software. The chapter “Technical Information” describes the individual process steps and provides useful information for achieving the best results using LPKF systems.

## **Why in-house prototyping?**

Because with today’s fast-paced technological advances, in-house PCB prototyping is key in staying a step ahead of the competition. Instead of waiting for outside suppliers, with in-house prototyping everything from planning to optimized layout is performed right at your own company. After all, even security matters. With in-house prototyping all data and designs remain secure – in house. To top it off, LPKF Rapid PCB Prototyping means a simple process.

Producing high-quality PCBs in your own development department or lab presents a key advantage.

LPKF products can produce single- or double-sided PCBs, multilayers, high performance circuits, RF- and microwave PCBs, rigid or flexible PCBs. Even non-PCB products, such as polyimide stencils, plastic and aluminum parts and many other applications, can be crafted easily and cost-effectively.

## **About LPKF**

More than 35 years of experience and many customized solutions make LPKF the global market leader in Rapid PCB Prototyping. A staff of more than 600 employees ensures professional sales and service support worldwide.

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# Rapid PCB Prototyping – PCBs at Top Speeds

Rapid development – increased time-to-market. The Rapid PCB Prototyping solution by LPKF makes implementation easy. From structuring the base material to complex production-level multilayers in less than one day. With LPKF the entire prototyping process – design, production, testing and optimization – can be completed in a single day. Producing PCB prototypes in-house can be this cost-effective!

## Structuring PCBs

The LPKF ProtoMat series sets worldwide standards in precision, flexibility and user-friendliness. The LPKF circuit board plotters are simply irreplaceable when it comes to rapid in-house PCB production, whether for single units development projects, or small batch production. They're perfectly suited for high-performance, analogue-, digital-, RF- and microwave applications. Made in Europe: LPKF circuit board plotters have been the standard for milling, drilling and contour-routing PCBs for more than three decades.

A new pair is available for entirely new production methods: PCB structuring and micromachining of materials using the compact laser systems LPKF ProtoLaser S and ProtoLaser U3 sets new standards in quality, speed and materials.

## Multilayer, through-hole plating and assembly

The LPKF circuit board plotters are excellent for multilayer Rapid PCB Prototyping. When combined with a multilayer press such as the MultiPress S and through-hole plating system they create high-quality multilayer PCBs, which are then populated with the LPKF ProtoPlace S.

The advantages become particularly evident during the development phase of a complex design.

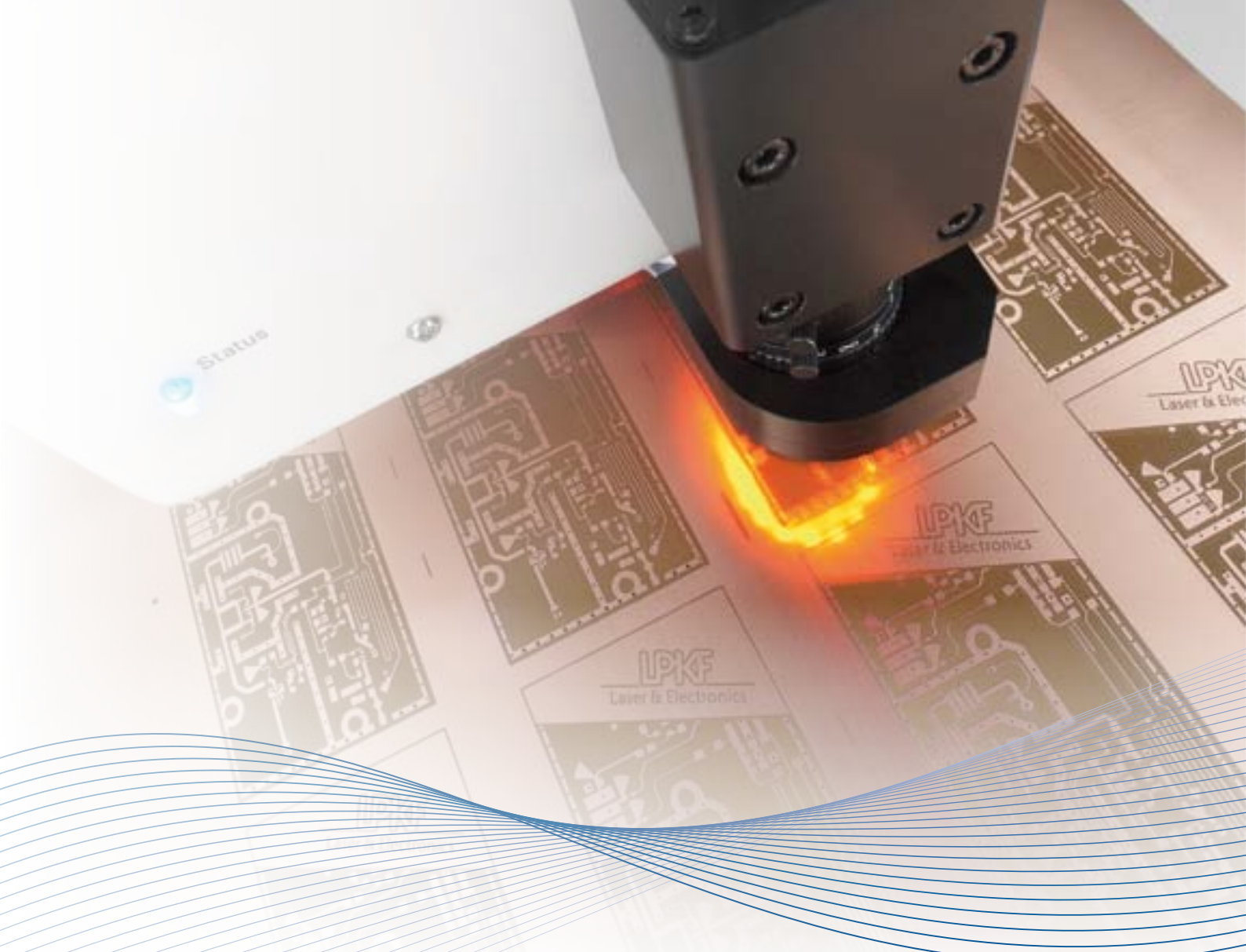
## Versatile software

All LPKF structuring systems include a comprehensive software package optimized for easy operation, the highest level of quality and quick results. LPKF CircuitPro will import any common CAD data and transmit the production data to the structuring systems.

## Other applications

In addition to producing PCBs in record time, the LPKF systems have proven their versatility in a vast array of applications: housings, front plates, aluminum and plastic finishing, depanelizing populated PCBs, cutting and engraving plastic film, all the way to structuring RF boards on ceramics with unmatched geometric accuracy.



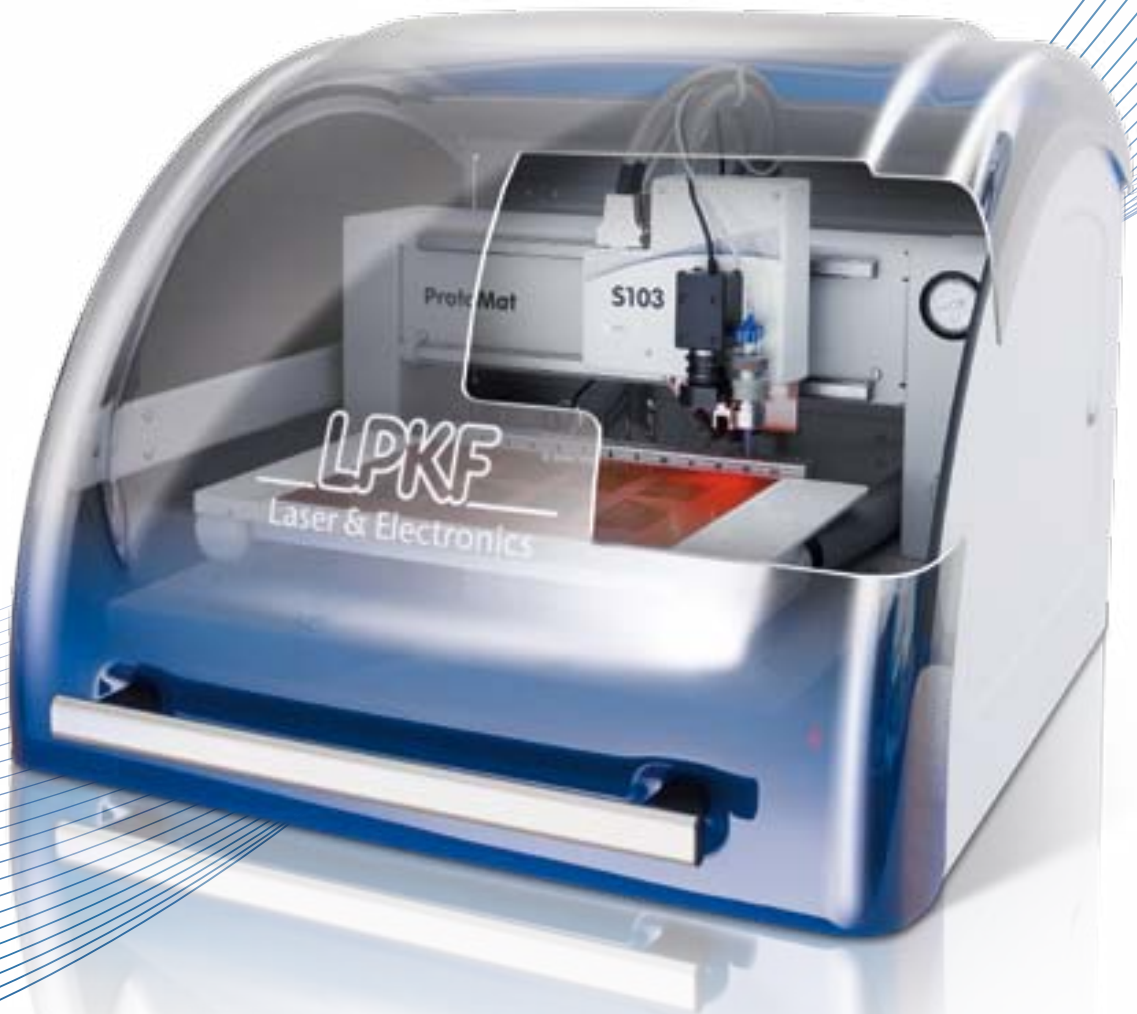


# LPKF Circuit Board Plotters

## In-House Production of PCB Prototypes and Small Batches

Quick, precise and simple – circuit board plotters by LPKF have been meeting these user requirements for more than 35 years. The latest generation offers growth potential: all ProtoMat series circuit board plotters can be upgraded step-by-step until fully equipped. Three specialized systems complete the spectrum top down.

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## Top equipment: series or upgrade

Features vary by series or model – please refer to the respective model for a complete list. For example:

- Milling spindles with 40,000, 60,000 or 100,000 rpm.
- The tool changer automatically switches tools during production. This reduces set-up time and allows for unattended operation. The automatic tool changer features a built-in tool ramp. With this ramp the ProtoMats automatically adjust the working depth of the tools.
- The optical fiducial recognition, used to accurately determine the PCB position, is available for virtually all circuit board plotters. The LPKF software recognizes the fiducials and references the milling head position accordingly.
- Custom settings allow the built-in dispenser to apply soldering paste.
- The vacuum table secures the work piece, ensuring a flat surface.











**All LPKF circuit board plotters include system software to convert standard CAD data into optimized production flows.**

# LPKF ProtoMat S103

## The Specialist for RF- and Microwave Applications

**Product:** LPKF ProtoMat S103  
**Part no.:** 127410  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Milling/drilling RF- & microwave substrates
-  Multilayer PCBs up to 8 layers
-  Contour routing of circuit boards
-  Flexible and rigid-flex circuit milling
-  Front panels/sign engraving
-  Machining cut-outs in front panels
-  SMD stencil cutting
-  Housing production
-  Wave solder pallets
-  Depanelizing, reworking PCBs
-  Test adapter drilling
-  Inspection templates
-  Dispensing solder paste

**High travel speed:**  
max. 150 mm/s (6"/s)



The ProtoMat S103 is one of the top of the line LPKF circuit board plotters. The extensively equipped system is suitable for all application areas including multilayer and RF – in FR4 18/18 Cu material it can achieve PCB track widths up to 100  $\mu\text{m}$ . The high rotation speed and precision ensures production of the latest generation of PCBs. The pneumatic non-contact working depth limiter allows substrates with delicate surfaces to be machined.

The ProtoMat S103 is an indispensable tool for any prototype or small batch production. Ease-of-use and utmost reliability are the basis for cost-effective and high-quality production.

- Fully automated operation
- Highest available speed (100,000 rpm), highest resolution (0.5  $\mu\text{m}$ ) and repeatability ( $\pm 0.001$  mm)
- Automatic 15-position tool changer
- Automatic milling width adjustment
- Pneumatic non-contact working depth limiter
- Optical fiducial recognition
- Built-in vacuum table
- Dispenser option

## Features

### 2.5-dimensional operation with Z-axis control

The sophisticated Z-axis drive makes the ProtoMat S103 perfect for finishing front panels and housings as well as depth milling microwave PCBs. Even machining populated PCBs is no problem at all.

### 100,000 rpm spindle motor

The ProtoMat S103 is extremely fast and accurate with a spindle speed of 100,000 rpm, a max. travel speed of 150 mm/s and a resolution of 0.5 µm. This ensures the accuracy required for drilling and milling ultra fine structures – especially for high-end applications in the RF- and microwave field.

### Dispensing

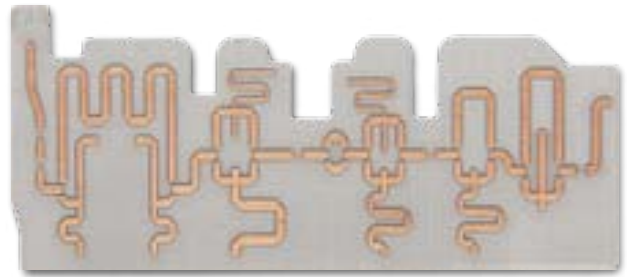
The built-in dispenser applies solder paste onto the substrates fully automatically with minimum data preparation.

### Options & accessories

- Dust extraction (Part no. 114647)
- Compressor incl. 50 l tank (Part no. 104863)
- Status light (Part no. 120128)
- Measuring microscope (Part no. 113495)

Other options and tools start on page 19.

## Applications



### RF- and microwave PCB

The ProtoMat S103 meets the highest standards in geometry and accuracy for structuring RF- and microwave prototypes. Special carbide tools produce straight sidewalls and reduce the penetration depth in the substrate.

### Contour routing and cut-outs

The S103 also routes complex shapes and cut-outs, or depanelizes populated circuit boards, housing parts or front panels.



Technical Specifications: LPKF ProtoMat S 103	
Part no.	127410
Max. material size and layout area (X/Y/Z)	229 mm x 305 mm x 35/22 mm (9" x 12" x 1.4/0.9")*
Resolution (X/Y)	0.5 µm (0.02 mil)
Repeatability	± 0.001 mm (± 0.04 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 100,000 rpm, software controlled
Tool change	Automatic, 15 positions
Milling width adjustment	Automatic
Tool holder	3.175 mm (1/8"), automatic holder
Drilling speed	120 strokes/min
Travel speed (X/Y)	Max. 150 mm/s (6"/s)
X/Y-drive, Z-drive	3-phase stepper motor, 2-phase stepper motor
Solder paste dispense	≥ 0.3 mm (0.011") (dot), ≥ 0.4 mm (0.015") (pad)
Dimensions (W x H x D)	670 mm x 540 mm x 840 mm (26.4" x 21.3" x 33")
Weight	60 kg (132 lbs)
Operating conditions	
Power supply	100 – 240 V, 50 – 60 Hz, 450 W
Compressed air supply	6 bar (87 psi), 100 l/min (3.5 cfm)
Required accessories	Exhaust, please refer to page 21

\* Value for Z without/with vacuum table













Technical specifications subject to change.

# LPKF ProtoMat S63

## The All-Rounder for Rapid PCB Prototyping

**Product:** LPKF ProtoMat S63  
**Part no.:** 127411  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Milling/drilling RF-, microwave substrates
-  Multilayer PCBs up to 8 layers
-  Contour routing of circuit boards
-  Front panels/sign engraving
-  Machining cut-outs in front panels
-  SMD stencil cutting (vacuum table required)
-  Housing production
-  Depanelizing, reworking PCBs
-  Test adapter drilling
-  Inspection templates
-  Dispensing solder paste

**High travel speed:**  
max. 150 mm/s (6"/s)



**Available upgrade kit:**  
• ProtoMat S63 to S103

**For more information about upgrades please see page 107 in the TechInfo.**

The ProtoMat S63 is the ideal system for virtually all in-house prototyping applications where speed and security are crucial. It's also perfectly suited for multilayer- and RF applications. The high rotational speed ensures the fine structures of up to 100  $\mu\text{m}$  required by many modern applications.

The extensive features make the S63 the perfect addition to any development environment. The precision and performance of this compact circuit board plotter are the foundation for producing PCB prototypes in just one day.

- Fully automated operation
- High speed (60,000 rpm), highest resolution (0.5  $\mu\text{m}$ ) and repeatability ( $\pm 0.001$  mm)
- Automatic 15-position tool changer
- Automatic milling width adjustment
- Optical fiducial recognition
- Dispenser option
- Upgradeable to ProtoMat S103

# Features

## Automatic tool change

Up to 15 tools are automatically changed during production. This reduces set-up times and allows for unattended production.

## Automatic milling width adjustment

The conical milling cutters produce different insulation channels depending on the penetration depth. The automatic milling width adjustment maintains uniform PCB track widths.

## Dispensing

The built-in dispenser applies solder paste onto the substrates fully automatically with minimum data preparation.

## 60,000 rpm spindle motor

The 60,000 rpm milling spindle ensures the shortest machining times and highest accuracy.

## Upgradeable to ProtoMat S103

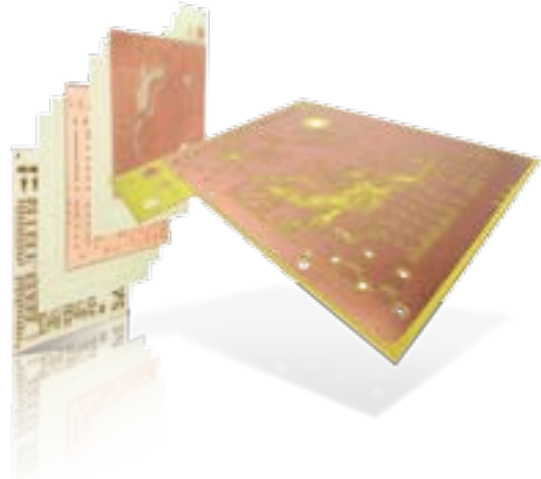
Upgrade kit includes 100,000 rpm spindle and pneumatic non-contact working depth limiter (Part no. 127702) and vacuum table.

## Options & accessories

- Dust extraction (Part no. 114647)
- Compressor incl. 50 l tank (Part no. 104863)
- Vacuum table (Part no. 127688)
- Status light (Part no. 120128)

Other options and tools start on page 19.

# Applications



## Multilayer PCBs

When it comes to manufacturing multilayer prototype PCBs the ProtoMat S63 is part of the basic equipment. A through-hole plating system (pg. 45) and a multilayer press (pg. 48) complete the set-up.

## Housings

In addition to machining PCBs and signs the LPKF ProtoMat S63 will also machine, route-out and depth mill materials such as aluminum and plastic, e.g. in housings.



Technical Specifications: LPKF ProtoMat S63	
Part no.	127411
Max. material size and layout area (X/Y/Z)	229 mm x 305 mm x 35/22 mm (9" x 12" x 1.4/0.9")*
Resolution (X/Y)	0.5 µm (0.02 mil)
Repeatability	± 0.001 mm (± 0.04 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 60,000 rpm, software controlled
Tool change	Automatic, 15 positions
Milling width adjustment	Automatic
Tool holder	3.175 mm (1/8")
Drilling speed	120 strokes/min
Travel speed (X/Y)	Max. 150 mm/s (6"/s)
X/Y-drive, Z-drive	3-phase stepper motor, 2-phase stepper motor
Solder paste dispense	≥ 0.3 mm (0.011") (dot), ≥ 0.4 mm (0.015") (pad)
Dimensions (W x H x D)	670 mm x 540 mm x 840 mm (26.4" x 21.3" x 33")
Weight	58 kg (128 lbs)
<b>Operating conditions</b>	
Power supply	100 – 240 V, 50 – 60 Hz, 450 W
Compressed air supply	For dispensing function only: 4 bar (58 psi), 50 l/min (1.76 cfm)
Required accessories	Exhaust, please refer to page 21

\* Value for Z without/with vacuum table





Technical specifications subject to change.

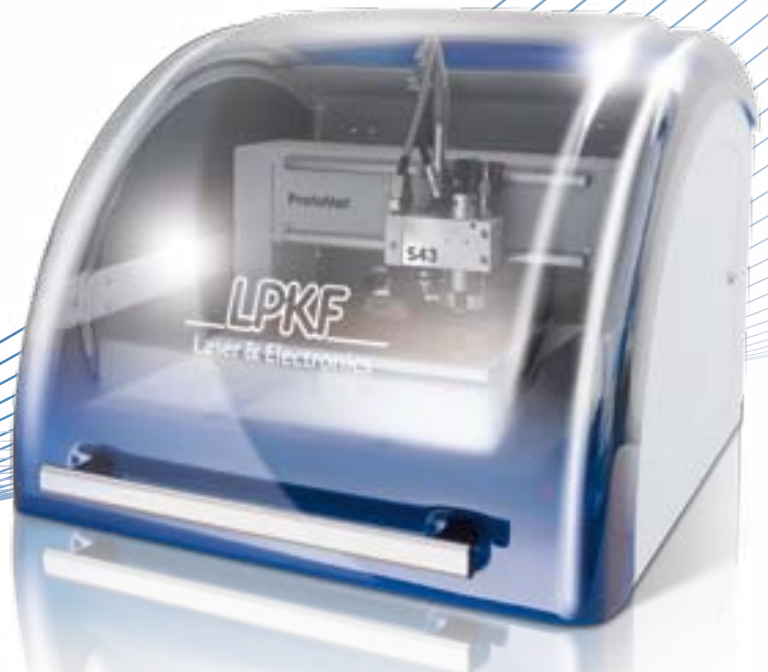
# LPKF ProtoMat S43

## Entry-Level with Upgrade Options

**Product:** LPKF ProtoMat S43  
**Part no.:** 127686  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Contour routing of circuit boards
-  Front panels/sign engraving
-  SMD stencil cutting



**Available upgrade kits:**

- ProtoMat S43 to S63
- ProtoMat S43 to S103

For more information about upgrades please see page 107 in the TechInfo.

The LPKF ProtoMat S43 is the entry-level model in the ProtoMat S-series. It can be upgraded in two steps to have the same features as the top of the line model, the S103.

The precision and capacity of the compact system ensure quick and easy PCB prototype production in mere hours – easily handling multiple cycles in one day.

The S43 is the perfect entry into the world of professional Rapid PCB Prototyping, especially for occasional use or limited budgets.

- 40,000 rpm spindle speed, highest resolution (0.5  $\mu\text{m}$ ) and repeatability ( $\pm 0.001$  mm)
- Acoustic cabinet for quiet operation
- Easy handling with quick-release tool holder
- Many options available – upgradeable to S63 or S103

## Features

### 40,000 rpm milling spindle

At a maximum travel speed of 150 mm per second (approx. 6"/s) and a spindle speed of 40,000 rpm the S43 is the perfect entry level model for high-quality circuit board prototypes produced in-house.



### Upgradeable to ProtoMat S63 and S103

Upgrading to the S63 includes a milling head with 60,000 rpm spindle, camera, 15-position tool changer, automatic milling width adjustment, dispenser and automatic width adjustment.

Upgrading to the S103 includes a milling head with 100,000 rpm spindle, pneumatic non-contact working depth limiter, 15-position tool changer, automatic milling width adjustment, camera, dispenser and vacuum table.

### Options & accessories

- Vacuum table (Part no. 127688)
- Optical fiducial recognition (Part no. 127689)
- Dust extraction (Part no. 114647)
- Status light (Part no. 120128)

Other options and tools start on page 19.

## Applications



### Single- and double-sided PCBs on different materials

The main area of application for the LPKF ProtoMat S43 is fabricating high-quality professional FR4-based PCB prototypes. The included software reliably and accurately converts the original CAD data to PCB production data.

Technical Specifications: LPKF ProtoMat S43	
Part no.	127686
Max. material size and layout area (X/Y/Z)	229 mm x 305 mm x 27 mm (9" x 12" x 1")
Resolution (X/Y)	0.5 µm (0.02 mil)
Repeatability	± 0.001 mm (± 0.4 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 40,000 rpm, software controlled
Tool change	Manual, quick-release holder
Milling width adjustment	Manual
Tool holder	3.175 mm (1/8")
Drilling speed	100 strokes/min
Travel speed (X/Y)	Max. 150 mm/s (6"/s)
X/Y-drive	3-phase stepper motor
Z-drive	2-phase stepper motor
Dimensions (W x H x D)	670 mm x 540 mm x 840 mm (26.4" x 21.3" x 33")
Weight	55 kg (121 lbs)
Operating conditions	
Power supply	90 - 240 V, 50 - 60 Hz, 450 W
Required accessories	Exhaust, please refer to page 21



Technical specifications subject to change.

# LPKF ProtoMat E33

## Extra Small, Easy-to-Use and Precise

**Product:** LPKF ProtoMat E33  
**Part no.:** 127687  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Front panels/sign engraving



Hardly larger than a size A3 sheet (11.7" x 16.5"): the LPKF ProtoMat E33 presents a budget-priced and compact circuit board plotter limited to machining PCBs. This system is sturdy and intended for application areas where time isn't crucial. Yet the LPKF ProtoMat E33 doesn't need to shy away from having the structuring results compared its bigger brothers.

The compact system will structure single- or double-sided PCBs, drill holes for through-hole plating, mill individual units from the base material and also engrave front plates of housings. The powerful software included with the machine effectively supports the user during the machining process.

The E33 is the perfect introduction to printed circuit boards for training or limited budgets, structuring without wet chemistry.

- 33,000 rpm spindle speed, resolution 0.8  $\mu\text{m}$  and repeatability  $\pm 0.005$  mm
- Easy-to-use tool holder
- Includes powerful LPKF software package for data transfer
- Cost-effective introduction to PCB structuring

## Features



### Manual tool holder

All common drilling and milling tools are quickly and easily ready for use.

### 33,000 rpm spindle speed

Like all ProtoMats each ProtoMat E33 is carefully calibrated at the LPKF factory. This ensures it will produce the finest structures in any common material. With a maximum travel speed of 60 mm per second (approx. 2"/s) and a spindle speed of 33,000 rpm the E33 is the perfect entry-level model for in-house prototyping.

## Applications



### Single- and double-sided PCBs on different materials

The LPKF ProtoMat E33 is mainly used to produce high-quality, FR4-based PCB prototypes. The software reliably and accurately converts the original CAD data into the respective circuitry layout.

### Front panels and signs

The LPKF ProtoMat E33 engraves front panels and signs with extraordinary precision. Use for materials such as plastic, plexiglas, aluminum, brass and many more.

### Technical Specifications: LPKF ProtoMat E33

Part no.	127687
Max. material size and layout area (X/Y/Z)	229 mm x 305 mm x 10 mm (9" x 12" x 0.4")
Resolution (X/Y)	0.8 µm (0.04 mil)
Repeatability	± 0.005 mm (± 0.02 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 33,000 rpm, software controlled
Tool change	Manual
Milling width adjustment	Manual
Tool holder	3.175 mm (1/8")
Drilling speed	100 holes/min
Travel speed (X/Y)	Max. 60 mm/s (2"/s)
X/Y-drive	2-phase stepper motor
Z-drive	2-phase stepper motor
Dimensions (W x H x D)	370 mm x 300 mm x 450 mm (14.6" x 11.8" x 17.7")
Weight	15 kg (33 lbs)
Operating conditions	
Power supply	90 – 240 V, 50 – 60 Hz, 450 W
Required accessories	Exhaust, please refer to page 21










Technical specifications subject to change.

# LPKF ProtoMat H100

## Fully Automated for High-Performance Rapid PCB Prototyping

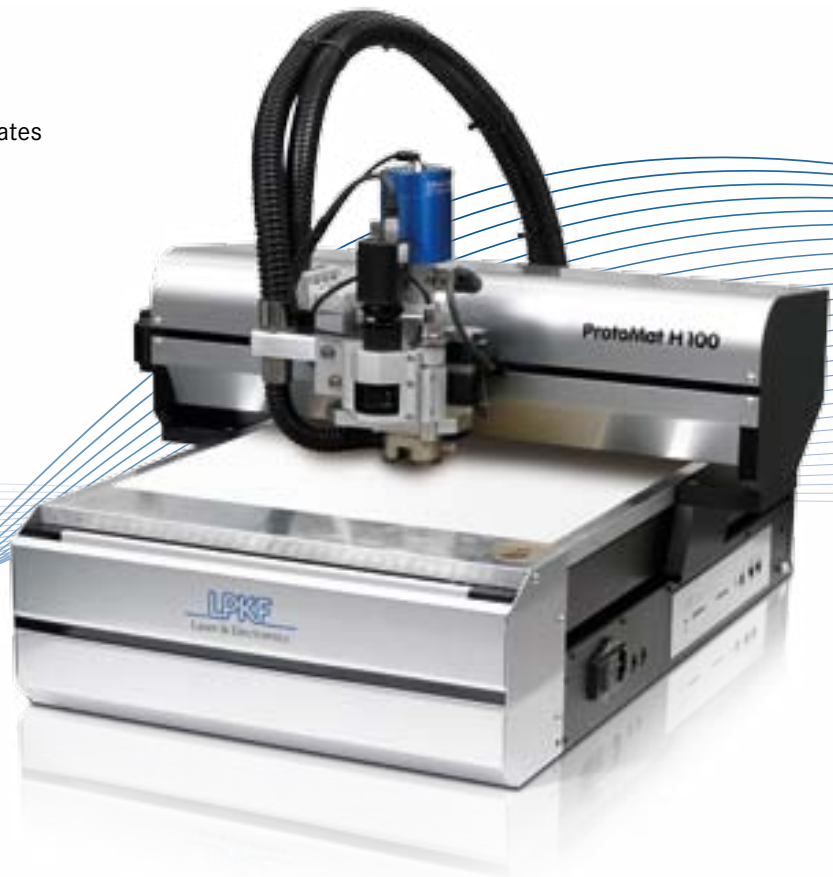
**Product:** LPKF ProtoMat H100  
**Part no.:** 111424  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Milling/drilling RF- & microwave substrates
-  Multilayer PCBs up to 8 layers
-  Contour routing circuit boards
-  Flexible and rigid-flex circuit milling
-  Front panels/sign engraving
-  Machining cut-outs in front panels
-  SMD stencil cutting
-  Inspection templates

380 mm (15")  
365 mm  
(14.4")

**Also ideal for  
large substrates**



The ProtoMat H100 is a top of the line LPKF circuit board plotter. The ProtoMat H100 is the perfect system for the fully automated in-house production of complex PCB prototypes, especially for RF- or microwave applications. The high speed and precision ensure it produces the latest generation PCBs. The pneumatic non-contact working depth limiter allows substrates with delicate surfaces to be machined.

With a 30-position tool changer and a large working surface able to handle up to 380 x 365 x 14 mm (15" x 14.4" x 0.55"), it's a first-class tool for any prototype or small batch production. The highly automated operation for ease-of-use is the foundation for cost-effective and high-quality production.

- Fully automated operation
- Spindle speed up to 100,000 rpm, resolution 0.25  $\mu$ m, repeatability 0.001 mm
- Automatic 30-position tool changer
- Automatic milling width adjustment
- Pneumatic non-contact working depth limiter
- Optical fiducial recognition
- Built-in vacuum table

## Features

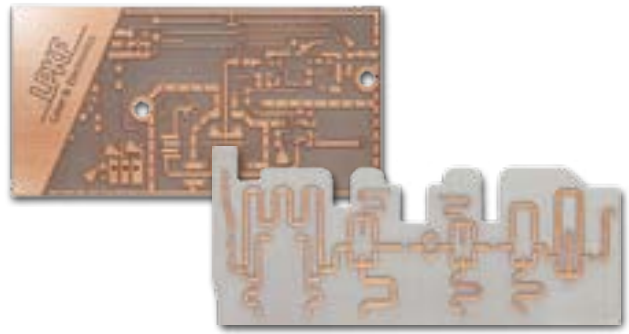


### Fully equipped

The ProtoMat H100 is fully equipped, no upgrades required. Even a dust extraction unit is included, and can optionally be built into the spacious acoustic cabinet.

Other options and tools starting on page 19.

## Applications



### RF- and microwave PCBs

RF- and microwave prototypes require special substrates to be processed, such as PTFE-based or ceramic-filled (RO4000) substrates, in addition to superior structuring accuracy. The H100 meets all of these requirements with high accuracy.

### Flexible and rigid-flex PCBs

Then non-contact working depth limiter combined with the built-in vacuum table make the ProtoMat H100 virtually predestined for processing flexible or rigid-flex PCB materials for today's high-end applications. Whether prototypes or small batch production, the H100 quickly delivers high-quality production results.

### Technical Specifications: LPKF ProtoMat H 100

Part no.	111424
Max. material size and layout area (X/Y/Z)	380 mm x 365 mm x 14 mm (15" x 14.4" x 0.55")
Resolution (X/Y)	0,25 µm (0.01 mil)
Repeatability	± 0.001 mm (± 0.04 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 100,000 rpm, software controlled
Tool change	Automatic, 30 positions
Milling width adjustment	Automatic
Tool holder	3.175 mm (1/8"), pneumatic release holder
Drilling speed	120 strokes/min
Travel speed (X/Y)	Max. 150 mm/s (6"/s)
X/Y-drive	3-phase stepper motor
Z-drive	Pneumatic, 14 mm (0.55")
Dimensions (W x H x D)	650 mm x 430 mm x 750 mm (25.6" x 17" x 29.5")
Weight	50 kg (110 lbs)
Operating conditions	
Power supply	115/230 V, 50 – 60 Hz, 300 W
Compressed air supply	6 bar (87 psi), 100 l/min (3.5 cfm)
Required accessories	Exhaust, included









Technical specifications subject to change.

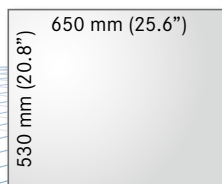
# LPKF ProtoMat X60

## Big in Rapid PCB Prototyping

**Product:** LPKF ProtoMat X60  
**Part no.:** 109643  
**Ordering info:** See front sleeve

### Applications

-  Milling/drilling 1- & 2-sided PCBs
-  Multilayer PCBs up to 8 layers
-  Contour routing circuit boards
-  Front panels/sign engraving
-  Machining cut-outs in front panels
-  SMD stencil cutting
-  Depanelizing
-  Inspection templates



**Specifically for large substrates**



The LPKF ProtoMat X60 is the pro for machining large substrates. Despite the large working space it offers the stability, speed and precision LPKF machines are known for. It features a non-contact, pneumatic depth working limiter for delicate substrates.

- For large material sizes up to 650 mm x 530 mm (25.5" x 20.8")
- Spindle speed up to 60,000 rpm, resolution 1  $\mu$ m, repeatability 0.001 mm
- Optical fiducial recognition optional
- Pneumatic non-contact working depth limiter
- Reliable, solid technology

# Features

## Maximum material size

The ProtoMat X60 features an extended layout area of 650 mm x 530 mm (25.6" x 20.8") and is ideal for large PCBs, antennas and depanelizing, but also for engraving plastics and soft metals. The ProtoMat X60 can quickly and easily engrave or mill 19" front plates.

## 60,000 rpm spindle motor

The ProtoMat X60 delivers superior precision: the resolution of the ProtoMat X60 yields up to 1 µm (0.04 mil). The circuit board plotter is ideal for producing fine structures in any material including RF- and microwave PCBs. The powerful 60,000 rpm spindle motor makes the X60 the first choice for Rapid PCB Prototyping large, high-quality PCBs.

## Non-contact working depth limiter

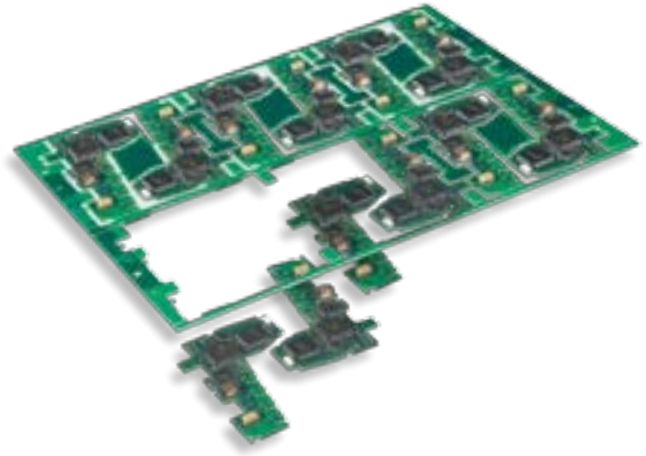
The pneumatic non-contact working depth limiter glides across the surface of the base material on an air cushion. Only the tool touches the base material for machining.

## Options & accessories

- Dust extraction (Part no. 114647)
- Compressor incl. 50 l tank (Part no. 104863)
- Optical fiducial recognition (Part no. 114487)
- Brush head (Part no. 113815 plus 109688 [micrometer screw])

Other options and tools start on page 19.

# Applications



The LPKF ProtoMat X60 is a cost-effective and flexible option in utilizing production lines to full capacity, for example when depanelizing unpopulated PCBs. Even complex contours, cut-outs and other routings can easily be programmed.



Technical Specifications: LPKF ProtoMat X60	
Part no.	109643
Max. material size and layout area (X/Y/Z)	650 mm x 530 mm x 14 mm (25.6" x 20.8" x 0.55")
Resolution (X/Y)	1 µm (0.04 mil)
Repeatability	± 0.001 mm (± 0.04 mil)
Precision of front-to-back alignment	± 0.02 mm (± 0.8 mil)
Milling spindle	Max. 60,000 rpm, software controlled
Tool change	Manual, quick-change holder
Milling width adjustment	Manual
Tool holder	3.175 mm (1/8")
Drilling speed	120 strokes/min
Travel speed (X/Y)	Max. 100 mm/s (3.94"/s)
X/Y-drive	3-phase stepper motor
Z-drive	Pneumatic, 14 mm (0.55")
Machine baseplate	Al-Plan precision plate
Dimensions (W x H x D)	750 mm x 420 mm x 900 mm (29.5" x 16.5" x 35.4")
Weight	69 kg (151.8 lbs)
Operating conditions	
Power supply	115/230 V, 50 – 60 Hz, 300 W
Compressed air supply	6 bar (87 psi), 100 l/min (3.5 cfm)
Required accessories	Exhaust, please refer to page 21

# LPKF Circuit Board Plotter Comparison

## Performance and features

Feature	ProtoMat S103	S63	S43	E33	H100	X60
<b>Max. material size and layout area (X/Y)</b>	3-Phase SM	3-Phase SM	3-Phase SM	2-Phase SM	3-Phase SM	3-Phase SM
<b>mm</b>	229 x 305	229 x 305	229 x 305	229 x 305	380 x 365	650 x 530
<b>inch</b>	9 x 12	9 x 12	9 x 12	9 x 12	15 x 14.4	25.6 x 20.8
<b>Resolution (X /Y)</b>						
<b>µm</b>	0.5	0.5	0.5	0.8	0.25	1
<b>mil</b>	0.02	0.02	0.02	0.04	0.01	0.04
<b>Travel speed (X/Y)</b> (mm/s)	150	150	150	60	150	100
<b>Repeatability</b>						
<b>mm</b>	±0.001	±0.001	±0.001	±0.005	±0.001	±0.001
<b>mil</b>	±0.04	±0.04	±0.04	±0.2	±0.04	±0.04
<b>Precision of front-to-back alignment</b>						
<b>mm</b>	±0.02	±0.02	±0.02	±0.02	±0.02	±0.02
<b>mil</b>	±0.8	±0.8	±0.8	±0.8	±0.8	±0.8
<b>Max. material size and layout area (Z)</b>	Stepper motor	Stepper motor	Stepper motor	Stepper motor	Pneumatic	Pneumatic
<b>mm</b>	22	35	27	10	14	14
<b>inch</b>	0.9	1.4	1	0.4	0.55	0.55
<b>Resolution (Z)</b>						
<b>µm</b>	0.2	0.2	0.4	0.85	X	X
<b>mil</b>	0.008	0.008	0.016	0.033		
<b>Travel speed (Z)</b> (mm/s)	25	25	25	20	X	X
<b>Spindle speed</b> (x1,000 rpm)	100	60	40	33	100	60
<b>Drilling speed strokes/min</b>	120	120	100	100	120	120
<b>Temperature sensor</b>	•	•	•	X	X	X
<b>Dispenser</b>	•	•	Optional	X	X	X
<b>Software LPKF CircuitPro</b>	Full	Full	Lite	Lite	Full	Full
<b>Automatic tool change</b>	15	15	Optional	X	30	X
<b>Vacuum table</b>	•	Optional	Optional	X	•	X
<b>Optical fiducial recognition</b>	•	•	Optional	X	•	Optional
<b>Brush head</b>	X	X	X	X	X	Optional
<b>Acoustic cabinet</b>	•	•	•	X	•	X
<b>Automatic milling width adjustment</b>	•	•	Optional	X	•	X
<b>Working depth limiter</b>	Pneumatic	Mechanical	Mechanical	Mechanical	Pneumatic	Pneumatic
<b>Status light</b>	Optional	Optional	Optional	X	Optional	X
<b>Ports</b>	USB	USB	USB	USB	RS-232	RS-232
<b>Footprint (W x D)</b>					Without cabinet	
<b>mm</b>	670 x 840	670 x 840	670 x 840	370 x 450	650 x 750	750 x 900
<b>inch</b>	26.4 x 33	26.4 x 33	26.4 x 33	14.6 x 17.7	25.6 x 29.5	29.5 x 35.4
<b>Weight</b>						
<b>kg</b>	60	58	55	15	50	69
<b>lbs</b>	132	127	121	33	110	151.8
<b>Compressed air supply required?</b>	For operation	For dispensing	With upgrade to S63 or S103	Not required	For operation	For operation
<b>bar</b>	6	4			6	6
<b>psi</b>	87	58			87	87
<b>l/min</b>	100	5			100	100
<b>cfm</b>	3.5	1.76			3.5	3.5
<b>Upgrade (see also page 105)</b>	X	S63→ S103	S43→ S63 S43→ S103	X	X	X

• = Standard      X = Not available      Optional = Optionally available for upgrade/accessories

All specifications are subject to technical modifications.



- Advanced functionality
- Quality components
- High-quality construction
- Perfectly matched

## Options & Accessories for LPKF Circuit Board Plotters

The capabilities of LPKF circuit board plotters and other LPKF systems can be upgraded with accessories and options. High-quality materials and precise machining ensure high reliability and a long life for all upgrades. The accessories can quickly and easily be installed on-site. The ProtoMat S-series circuit board plotters can be upgraded to turn an entry-level system into a high-end model.

**i** Ordering info: See front sleeve.

# Options

## Upgrade kits

The LPKF ProtoMat S43 and S63 circuit board plotters can be upgraded to an S103 high-end system at any time. All that's needed is the corresponding upgrade kit.

Upgrade	Part no.	ProtoMat S43/S63
<b>Upgrade ProtoMat S43 to S63</b>	127700	Milling head S63 with tool change bar (automatic tool change and milling width adjustment), camera, dispenser with pneumatic components and software upgrade LPKF CircuitPro Full
<b>Upgrade ProtoMat S43 to S103</b>	127701	Milling head S103 with pneumatic non-contact working depth limiter, tool change bar (automatic tool change and milling width adjustment), camera, dispenser with pneumatic components, vacuum table and software LPKF CircuitPro Full
<b>Upgrade ProtoMat S63 to S103</b>	127702	Milling head S103 with pneumatic non-contact working depth limiter (milling head S103 without camera, already installed on S63) and vacuum table.



## Optical fiducial recognition with drill bit inspection

Referencing a PCB with optical fiducial recognition is more precise and significantly faster than front-to-back alignment – making it virtually indispensable for structuring multilayer boards. The LPKF software supported camera automatically locates fiducials, then determines the material position. The camera system further provides for automatic bit status inspection and direct measuring function. The camera on the S-series merely requires a computer with a USB 2.0 port, the ProtoMat X60 requires a Windows computer with an empty PCI slot.

Optical fiducial recognition	ProtoMat S43	ProtoMat X60
<b>Part no.</b>	127689	114487



## Vacuum table

The vacuum table secures the work piece tightly across the entire work surface and prevents the substrate from buckling. The use of a vacuum table allows flexible and rigid-flex PCBs to be machined.

Vacuum table	ProtoMat S43/S63
<b>Part no.</b>	127688



# Accessories

## Dust extraction

The LPKF dust extraction with absolute filter ensures a clean workspace – no fibers, no shavings, no fine dust. The built-in AutoSwitch automatically turns the vacuum on and off. This ensures safety and an extended vacuum life while eliminating unnecessary noise when the machine is not in operation.

Dust extraction	ProtoMats	ProtoLaser S and U3
<b>Part no.</b>	114647	124391
<b>Vacuum pressure</b>	Max. 22,500 Pascal	Max. 21,000 Pascal
<b>Air flow rate</b>	241 m <sup>3</sup> /hour (142 cfm)	320 m <sup>3</sup> /hour (188 cfm)
<b>Power consumption</b>	800 W (230 V) or 960 W (120 V)	1.6 kW (230 V, 50/60 Hz)
<b>Dimensions (W x H x D)</b>	250 mm x 300 mm x 350 mm (10" x 12" x 14")	365 mm x 740 mm x 501 mm (14" x 29" x 20")
<b>Acoustic pressure</b>	50 dB(A)	Approx. 65 dB(A)
<b>Absolute filter</b>	HEPA filter	HEPA filter
<b>Remote control</b>	Software controlled	Software controlled

All specifications are subject to technical modifications.



## Measuring microscope

The LPKF measuring microscope with its 60x magnification and metric scale facilitates setting the isolation widths and quality control.

Measuring microscope	
<b>Part no.</b>	113495



## Precision ring setter

The LPKF precision ring setter, consisting of an adjustment unit with measuring microscope, accurately places distance rings on the tool. The tools can then be used with ease without the need for readjustments.

Precision ring setter	ProtoMat S43/E33
<b>Part no.</b>	116698



## Brush head (for ProtoMat X60 only)

The brush head, used primarily for reworking populated PCBs, maintains low-pressure for dust extraction. The workspace is kept dust-free without damaging the placed components.

Brush head	ProtoMat X60
<b>Part no.</b>	113815 (plus 109688 [micrometer screw])



## Accessories (continued)

### Compressor

The LPKF compressors ensure a constant, reliable supply of compressed air for LPKF systems using compressed air supply.

Compressor	Small compressor	Large compressor	ProtoLaser S & U3
<b>Part no.</b>	101092	104863	122805
<b>Tank size</b>	6 liter	50 liter	60 liter
<b>Max. pressure</b>	6 bar (116 psi)	10 bar (145 psi)	10 bar (145 psi)
<b>Output</b>	33 l/min (1.1 cfm)	165 l/min (5.8 cfm)	240 l/min (8.5 cfm)
<b>Outside dims. (W x H x D)</b>	360 x 430 x 360 mm (14.2" x 16.9" x 14.2")	1000 x 770 x 390 mm (39.4" x 30.3" x 15.4")	970 x 770 x 480 mm (38" x 30" x 19")
<b>Weight</b>	21 kg (46.2 lbs)	56 kg (123.2 lbs)	90 kg (198.4 lbs)
<b>Acoustic noise at a distance of 4 m (157.5")</b>	32 dB(A)	68 dB(A)	83 dB(A)
<b>Recommended for</b>	LPKF ProtoPlace S	LPKF ProtoMat S103 LPKF ProtoMat H100 LPKF ProtoMat X60	LPKF ProtoLaser S & U3

All specifications are subject to technical modifications.



### Status light

The LPKF StatusLight indicates the LPKF ProtoMat operating status. This allows a constant monitoring of the ProtoMat in large production halls without a need for operating personnel to be in close proximity.

Status light	ProtoMat S-Series	ProtoMat H100
<b>Part no.</b>	127781	119036



### Adjustment tool (ProtoLaser S&U3)

This precision tool set is helpful for adjusting the work bench and laser.

Adjustment tool	ProtoLaser S & U3
<b>Part no.</b>	118005



# LPKF Drilling, Milling and Routing Tools

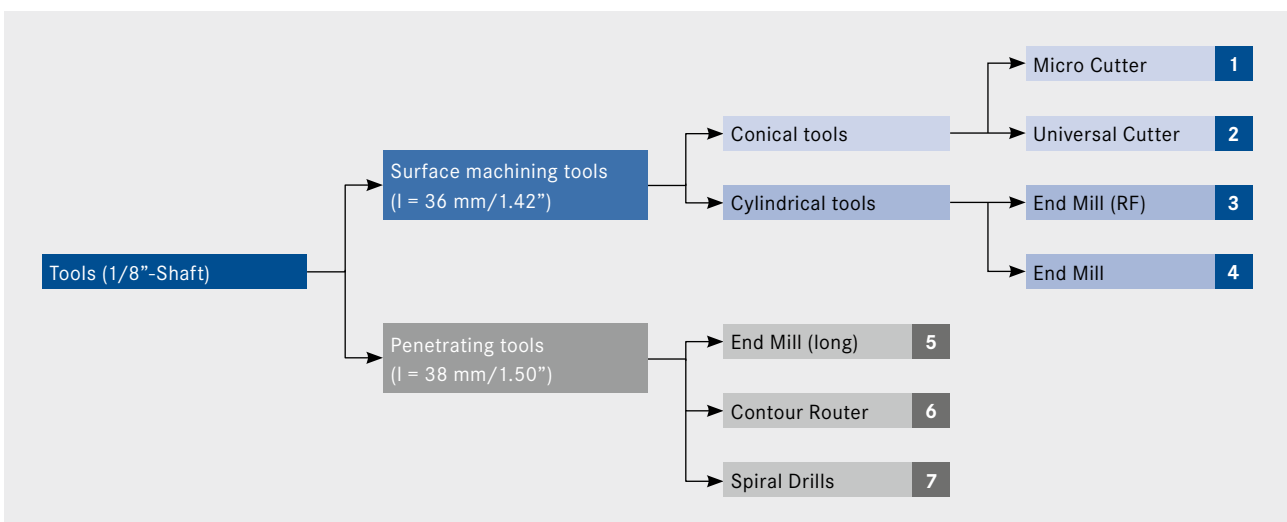
Developed Specifically for LPKF Circuit Board Plotters



LPKF's commitment to the highest-quality components extends to every piece of tooling. The drill and router bits developed specifically for LPKF are premium carbide tools. They ensure long life, precise cuts and clean milling edges.

The tools are divided into two main groups: Surface machining tools with 36 mm (1.42") total length for surface work (cutter and end mills) and penetrating tools with 38 mm (1.5") total length for working through the base material (spiral drills, contour router and end mills).

**i** Ordering info: See front sleeve.



### Micro Cutter/Fine-Line Milling Tool 1/8"

Conical custom-designed tool with orange distance ring.

1	Part no.	Length, milling width	Application
	115836	36 mm, 0.10 – 0.15 mm (4 – 6 mil)	For fine isolation tracks on 18 µm thick Cu.

### Universal Cutter 1/8"

Conical custom-designed tool with orange distance ring.

2	Part no.	Length, milling width	Application
	115835	36 mm, 0.2 – 0.5 mm (8 – 20 mil)	For milling different isolation track widths in any copper-plated base material.

### End Mill (RF) 1/8"

Cylindrical custom-designed tool with blue distance ring.

3	Part no.	Length, milling width	Application
	115832	36 mm, d = 0.15 mm (6 mil)	Finest isolation tracks in RF applications.
	115833	36 mm, d = 0.25 mm (10 mil)	
	115834	36 mm, d = 0.40 mm (16 mil)	

### End Mill 1/8"

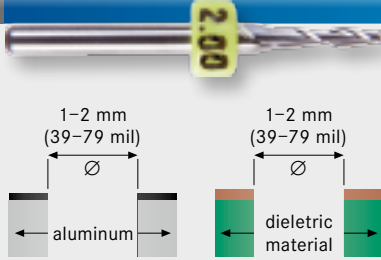
Cylindrical custom-designed tool with violet distance ring.

4	Part no.	Length, milling width	Application
	115839	36 mm, d = 0.80 mm (31 mil)	For wider isolation tracks, rub-out areas and engraving aluminium front panels.
	115840	36 mm, d = 1.00 mm (39 mil)	
	129100*	36 mm, d = 2.00 mm (79 mil)	
	129101*	36 mm, d = 3.00 mm (118 mil)	

\* Shaft 25 mm (984 mil)

## End Mill long 1/8"

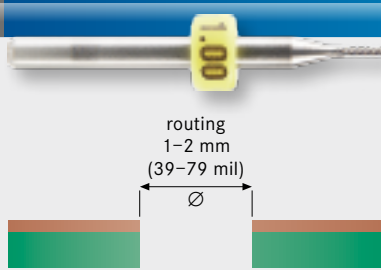
Cylindrical custom-designed tool with light green distance ring.

5	Part no.	Length, milling width	Application
	115837	38 mm, d = 1.00 mm (39 mil)	For cutting aluminium and routing soft base materials for RF- and microwave applications.
	129102*	38 mm, d = 2.00 mm (79 mil)	

\* Shaft 25 mm (984 mil)

## Contour router 1/8"


Cylindrical custom-designed tool with yellow distance ring.

6	Part no.	Length, milling width	Application
	115844	38 mm, d = 1.00 mm (39 mil)	For milling inner and outer contours and holes > 2.4 mm (> 94 mil).
	129099*	38 mm, d = 2.00 mm (79 mil)	

\* Shaft 25 mm (984 mil)

## Spiral Drill 1/8"

Cylindrical tool with green distance ring.

7	Part no.	Length, milling width	Application
	115846	38 mm, d = 0.20 mm (8 mil)	For drillholes < 2.4 mm (< 94 mil).
	115847	38 mm, d = 0.30 mm (12 mil)	
	115848	38 mm, d = 0.40 mm (16 mil)	
	115849	38 mm, d = 0.50 mm (20 mil)	
	115850	38 mm, d = 0.60 mm (24 mil)	
	115851	38 mm, d = 0.70 mm (28 mil)	
	115852	38 mm, d = 0.80 mm (31 mil)	
	115853	38 mm, d = 0.85 mm (33 mil)	
	115854	38 mm, d = 0.90 mm (35 mil)	
	115855	38 mm, d = 1.00 mm (39 mil)	
	115856	38 mm, d = 1.10 mm (43 mil)	
	115857	38 mm, d = 1.20 mm (47 mil)	
	115858	38 mm, d = 1.30 mm (51 mil)	
	115859	38 mm, d = 1.40 mm (55 mil)	
	115860	38 mm, d = 1.50 mm (59 mil)	
	115861	38 mm, d = 1.60 mm (63 mil)	
	115862	38 mm, d = 1.70 mm (67 mil)	
	115863	38 mm, d = 1.80 mm (71 mil)	
	115864	38 mm, d = 1.90 mm (75 mil)	
	115865	38 mm, d = 2.00 mm (79 mil)	
115866	38 mm, d = 2.10 mm (83 mil)		
115867	38 mm, d = 2.20 mm (87 mil)		
115868	38 mm, d = 2.30 mm (91 mil)		
115869	38 mm, d = 2.40 mm (94 mil)		
115870	38 mm, d = 2.95 mm (116 mil)		
115871	38 mm, d = 3.00 mm (118 mil)		

## Tool set with 1/8" shaft and distance rings

For all LPKF ProtoMat models. Includes tools with pressed-on distance rings.

Part no.	Contents
129103	<p>10x Universal Cutter 1/8", 36 mm (1.4"), 0.2 - 0.5 mm (8 - 20 mil)</p> <p>2x Micro Cutter 1/8", 36 mm (1.4"), 0.10 - 0.15 mm (4 - 6 mil)</p> <p>1x End Mill 1/8", 36 mm (1.4"), d = 0.8 mm (31 mil)</p> <p>2x End Mill 1/8", 36 mm (1.4"), d = 1.00 mm (39 mil)</p> <p>2x End Mill 1/8", 36 mm (1.4"), d = 2.00 (79 mil)</p> <p>1x End Mill Long 1/8", 38 mm (1.5"), d = 1.00 mm (39 mil)</p> <p>1x End Mill Long 1/8", 38 mm (1.5"), d = 2.00 (79 mil)</p> <p>2x Contour Router 1/8", 38 mm (1.5"), d = 1.00 (39 mil)</p> <p>2x Contour Router 1/8", 38 mm (1.5"), d = 2.00 (79 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.40 (16 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.50 (20 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.60 (24 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.70 (28 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.80 (31 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 0.90 (35 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 1.00 (39 mil)</p> <p>1x Spiral Drill 1/8", 38 mm (1.5"), d = 1.20 (47 mil)</p> <p>1x Spiral Drill 1/8", 38 mm (1.5"), d = 1.40 (55 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 1.50 (59 mil)</p> <p>1x Spiral Drill 1/8", 38 mm (1.5"), d = 1.60 (63 mil)</p> <p>1x Spiral Drill 1/8", 38 mm (1.5"), d = 1.80 (71 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 2.00 (79 mil)</p> <p>2x Spiral Drill 1/8", 38 mm (1.5"), d = 3.00 (118 mil)</p>



## RF- and microwave tool set with distance rings

Part no.	Contents
116394	<p>Tools with distance rings:</p> <p>5x End mill (RF) 1/8", 36 mm, d = 0.25 mm (10 mil)</p> <p>3x End mill (RF) 1/8", 36 mm, d = 0.40 mm (16 mil)</p> <p>3x End mill (RF) 1/8", 36 mm, d = 0.15 mm (6 mil)</p> <p>5x End mill 1/8", 36 mm, d = 1.00 mm (39 mil)</p> <p>2x End mill 1/8", 36 mm, d = 2.00 mm (79 mil)</p> <p>2x End mill 1/8", 38 mm, d = 2.00 mm (79 mil)</p>

### **i Please note:**

LPKF recommends using only original LPKF tools and assumes no warranty for machine or secondary failures resulting from the use of non-LPKF tools. All specifications are subject to technical modifications.



## Consumables for LPKF Circuit Board Plotters

LPKF offers only high-quality consumables. From copper-clad base materials to cleaning pads or custom adhesive tape, LPKF guarantees first-class product quality – because a high-quality end product starts with the basic raw material.

**i** Ordering info: See front sleeve.

## Starter sets (for initial ProtoMat set-up)

LPKF starter sets include an extensive assortment of work material, bits, and other accessories needed for quick set-up. We offer customized starter sets for each circuit board plotter.

### LPKF ProtoMat S103

Part no.	Contents
122159	<b>For use with vacuum table:</b> 2 x Sinter backing plate white 315 mm x 239 mm x 5 mm (12.4" x 9.4" x 0.2")
Also included:	10 x Base material FR4, 229 mm x 305 mm (9" x 12"), 0/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm (9" x 12"), 35/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm (9" x 12"), 18/18 µm (predrilled) 5 x Micro cutter with 1/8" distance ring, 36 mm (1.4"), d = 0.1 – 0.15 mm (4 – 6 mil) 3 x End mill (RF) with 1/8" distance ring, 36 mm (1.4"), d = 0.15 mm (6 mil) 10 x End mill (RF) with 1/8" distance ring, 36 mm (1.4"), d = 0.25 mm (10 mil) 3 x End mill (RF) with 1/8" distance ring, 36 mm (1.4"), d = 0.40 mm (16 mil) 5 x End mill with 1/8" distance ring, 36 mm (1.4"), d = 1.00 (39 mil) 2 x End mill with 1/8" distance ring, 36 mm (1.4"), d = 2.00 (79 mil) 2 x End mill with 1/8" distance ring, 38 mm (1.5"), d = 2.00 (79 mil) 1 x Custom adhesive tape 3 x Board cleaning pad 1 x Tool set with 1/8" shaft and distance rings (Part no. 129103, see page 26 for contents)



### LPKF ProtoMat S63

Part no.	Contents
115791	<b>For use without vacuum table:</b> 10 x Drill underlay material 229 x 305 mm (9" x 12"), d = 2 mm (0.08") (predrilled)
122157	<b>For use with vacuum table:</b> 2 x Sinter backing plate white 315 mm x 239 mm x 5 mm (12.4" x 9.4" x 0.2")
Also included in both sets:	10 x Base material FR4, 229 mm x 305 mm (9" x 12"), 0/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm (9" x 12"), 35/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm (9" x 12"), 18/18 µm (predrilled) 5 x Micro cutter with 1/8" distance ring, 36 mm (1.4"), d = 0.1 – 0.15 mm (4 – 6 mil) 5 x End mill (RF) with 1/8" distance ring, 36 mm (1.4"), d = 0.25 mm (10 mil) 1 x Custom adhesive tape 3 x Circuit board cleaning pad 1 x Tool set with 1/8" shaft and distance rings (Part no. 129103, see page 26 for contents)

### LPKF ProtoMat S43

Part no.	Contents
117717	<b>For use without vacuum table:</b> 10 x Drill underlay material 229 x 305 mm (9" x 12"), d = 2 mm (0.08") (predrilled)
122158	<b>For use with vacuum table:</b> 2 x Sinter backing plate white 315 mm x 239 mm x 5 mm (12.4" x 9.4" x 0.2")
Also included in both sets:	10 x Base material FR4, 229 mm x 305 mm (9" x 12"), 0/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm (9" x 12"), 35/35 µm (predrilled) 1 x Custom-designed adhesive tape 3 x Board cleaning pad 1 x Tool set with 1/8" shaft and distance rings (Part no. 129103, see page 26 for contents)

### LPKF ProtoMat H100

Part no.	Contents
113867	10 x Base material FR4, DIN A3, 35/35 µm 10 x Base material FR4, DIN A4, 18/18 µm 10 x Base material FR4, DIN A3, 18/18 µm 10 x End Mill 1/8", 38 mm (1.5"), d = 1.00 (39 mil) 10 x End Mill (RF) 1/8", 36 mm (1.4"), d = 0.25 mm (10 mil) 10 x Micro Cutter 1/8", 36 mm (1.4"), 0.1 – 0.15 mm (4 – 6 mil) 1 x Tool set with 1/8" shaft (Part no. 129103, see page 26 for contents) 2 x Sinter backing plate for vacuum table, 369 mm x 427 mm x 5 mm (14.5" x 16.8" x 0.2") 1 x Circuit board cleaning pad

### LPKF ProtoMat X60: Upon request



**Please note:** tool set contents may vary by country. Please contact your local distributor for details (see page 112). All specifications are subject to technical modifications.

## LPKF ProtoMat E33

Part no.	Contents
127696	10 x Drill underlay material, 229 mm x 305 mm, (9" x 12"), d = 2 mm (predrilled) 10 x Base material, 229 mm x 305 mm, (9" x 12"), 0/35 µm (predrilled) 5 x Base material FR4, 229 mm x 305 mm, (9" x 12"), 35/35 µm (predrilled) 1 x Custom adhesive tape 1 x Board cleaning pad 1 x Tool set with 1/8" shaft and distance rings (Part no. 129103, see page 26 for contents)

## Multilayer sets for multilayer PCB production

The LPKF multilayer starter sets include all the materials necessary for producing high-quality multilayers using a LPKF circuit board plotter and a MultiPress S.

Part no.	Description	Contents
121103	4-layer multilayer set for MultiPress S, H and S series/electroplating 	Material size: 229 mm x 305 mm (9" x 12") Base and auxiliary material for 10 multilayers consisting of: 20 x Laminate multilayer 0/5 µm, (229 mm x 305 mm x 0.2 mm) with protective foil 40 x Prepreg (200 mm x 275 mm x 0.1 mm) 5 x Pressing cardboard cushion (229 mm x 305 mm) 10 x Base material FR4 18/18 µm, (229 mm x 305 mm x 1 mm) 1 Pack seal rings
121102	4-layer multilayer set for MultiPress S, H and S series/chemical-free through-hole plating	Material size: 229 mm x 305 mm (9" x 12") Base and auxiliary material for 10 multilayers consisting of: 20 x Laminate multilayer 0/18 µm, (229 mm x 305 mm x 0.2 mm) without protective foil 40 x Prepreg (200 mm x 275 mm x 0.1 mm) 5 x Pressing cardboard cushion (229 mm x 305 mm) 10 x Base material FR4 18/18 µm (229 mm x 305 mm x 1 mm) 1 Pack seal rings
121093	6-layer multilayer set for MultiPress S, H and S series/electroplating 	Material size: 229 mm x 305 mm (9" x 12") Base and auxiliary material for 10 multilayers consisting of: 20 x Laminate multilayer 0/5 µm (229 mm x 305 mm x 0.2 mm) with protective foil 60 x Prepreg (200 mm x 275 mm x 0.1 mm) 5 x Pressing cardboard cushion (229 mm x 305 mm) 20 x Base material FR4 18/18 µm (229 mm x 305 mm x 0.36 mm) 1 Pack seal rings
124481	8-layer multilayer set for MultiPress S, H and S series/electroplating	Material size: 229 mm x 305 mm (9" x 12") Base and auxiliary material for 10 multilayers consisting of: 20 x laminate multilayer 0/5 µm (229 mm x 305 mm x 0.2 mm) with protective foil 80 x Prepreg (200 mm x 275 mm x 0.1 mm) 5 x Pressing cardboard cushion (229 mm x 305 mm) 30 x Base material FR4 18/18 µm (229 mm x 305 mm x 0.36 mm) 4 x Set screw with slot, Ø 13 mm 1 x Package reinforcing rings

## Drill underlay material and parts for vacuum table

Drill underlay materials line the base material and prevent damage to the machine table. The honeycomb or anchoring plates safely secure the base material to the vacuum table and can be changed individually.

Part no.	Description	Plates per package
116148	Vacuum table honeycomb plates for ProConduct and ProtoMat S series, 5 mm thick, Ø 3.5 mm	4
114297	Vacuum table honeycomb plates for ProtoMat H 100, 5 mm thick, Ø 2.5 mm	4
116099	Vacuum table sinter backing plates for ProtoMat S-series	4
116002	Vacuum table sinter backing plates for ProtoMat H100	2
106388	Drill underlay material, DIN A4, d = 2 mm	10
106389	Drill underlay material, DIN A3, d = 2 mm	10
SET-10-1052	Drill underlay material (predrilled), 229 mm x 305 mm (9" x 12"), d = 2	10



## Copper-clad FR4 board material

(1.5 mm thick)

Part no.	Description	Plates per package
SET-10-1053	Base material FR4, 229 mm x 305 mm (9" x 12"), 5/5 µm with protective film, predrilled with 3 mm registration holes	10
115968	Base material FR4, 229 mm x 305 mm (9" x 12"), 0/18 µm with protective film, predrilled with 3 mm registration holes	10
115967	Base material FR4, 229 mm x 305 mm (9" x 12"), 18/18 µm, predrilled with 3 mm registration holes	10
SET-10-1001	Base material FR4, 229 mm x 305 mm (9" x 12"), 0/35 µm, predrilled with 3 mm registration holes	10
SET-10-1000	Base material FR4, 229 mm x 305 mm (9" x 12"), 35/35 µm, predrilled with 3 mm registration holes	10
112059	Base material FR4, DIN A3, 5/5 µm with protective film	10
106398	Base material FR4, DIN A3, 18/18 µm	10
106400	Base material FR4, DIN A3, 0/35 µm	10
106401	Base material FR4, DIN A3, 35/35 µm	10



## Multilayer material

Part no.	Description	Plates per package
119574	Base material FR4 18/18 µm, 229 mm x 305 mm (k) x 1 mm (9" x 12" x 0.04")	1
119575	Base material 104 ML, 18/18 µm, 229 mm x 305 mm (k) x 0.36 mm (9" x 12" x 0.01")	1
119571	Thin laminate 104 ML, 0/5 µm, 229 mm x 305 mm (k) x 0.2 mm (9" x 12" x 0.008") with protective film for electroplating multilayer set	1
119818	Thin laminate 104 ML, 0/18 µm, 229 x 305 (k) x 0.2 mm (9" x 12" x 0.008") without protective film for ProConduct multilayer set	1
119572	Prepreg type 2125, 275 mm (k) x 200 mm x 0.1 mm (10.8" x 7.9" x 0.004") for multilayer	2
120999	Pressing pad for MultiPress S, 229 mm x 305 mm x 1.7 mm (9" x 12" x 0.067") with alignment pin holes	1
120345	Pressing metal sheet for MultiPress S, 229 mm x 305 mm x 1.6 mm (9" x 12" x 0.063") with alignment pin holes	1

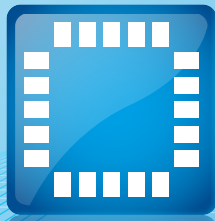
## Cleaning pads

Part no.	Description	Pads per package
106403	The metal-free, ultra fine board cleaning pads remove oxidation from the copper surface of a work piece.	10



## Custom adhesive tape

Part no.	Description
106373	The custom adhesive tape secures the base material flat to the work surface and removes without residue.



# CircuitPro



## LPKF CircuitPro – The Intelligent Software Suite

All LPKF circuit board plotters include powerful system software for converting layout data into actual printed circuit boards: it takes the data from the design software, edits it for production, breaks it down into individual process steps and guides the user, step-by-step, through the manufacturing process.



LPKF CircuitPro will import all data exchange formats, offers extensive editing options and controls the circuit board plotters. In addition the software produces stencils for solder resist masks and assembly prints.

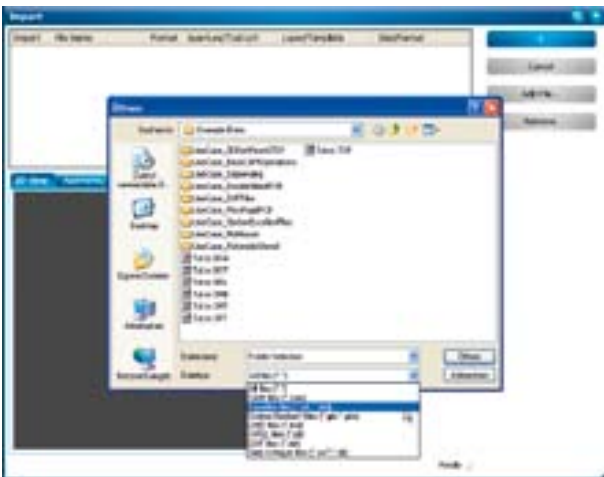
LPKF CircuitPro Lite is a simpler version of LPKF CircuitPro for entry level LPKF circuit board plotters.

## The CAD/EDA software interface

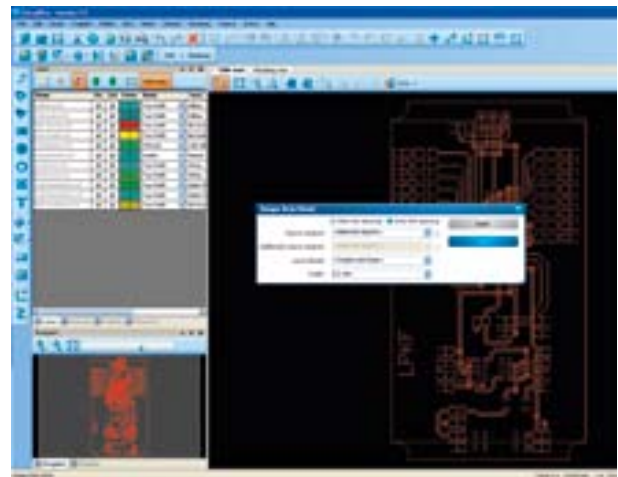
Powerful yet user friendly: these two attributes were at the top of the list of requirements for developing the new LPKF CircuitPro system software. Even less experienced users can fabricate complex circuit board prototypes with the well-thought-out user interaction and helpful wizards. The sophisticated functions for calculating control commands are hidden behind a simple control concept.

LPKF CircuitPro processes precisely the data required by circuit board manufacturers. CircuitPro automatically imports aperture tables and tool lists, Gerber and NC data:

- Data import: Gerber, GerberX, HP-GL, Excellon, Sieb & Meier, DXF, IGES, LMD, STEP.
- Data export: LMD.
- Creating blanks: copies individual PCB layouts and arranges them into one blank on the PCB.
- Intelligent isolation: time- and tool optimized milling in milling cycles with all tools available per cycle. Arbitrary rub-out areas, including polygons.
- Design Rule Check: checks conductor path spacing.
- Contour generator: generates milling paths for depaneling PCBs with automatically defined spacing.
- Direct entry: text entry and direct drawing to create front-boards or PCBs.
- Editor: data manipulation for parameters specific to electronics, such as conductor path width, drill hole diameter, moving drill holes, adding copper areas, etc.
- TrueType Fonts: text function uses TrueType fonts.
- User interface: hides controls depending on the task.
- Technology dialogue: simple and clear merging of various editing processes.
- Ground plane: produces ground planes with automatically exempted conductor paths.
- Automatic milling depth adjustment: measures and calibrates the milling depth in conjunction with circuit board plotter hardware options.
- Automated production control: automatically swaps available tools in a tool magazine. LPKF CircuitPro minimizes tool changes.
- Project profiles: once jobs are defined they can be saved and later opened for reproduction.
- User-friendly user interface: WYSIWYG display and color coding the editing layer/layout layer. Quickly and easily navigate complex layouts.
- Monitoring: permanently displays the current milling status and the current milling head position.



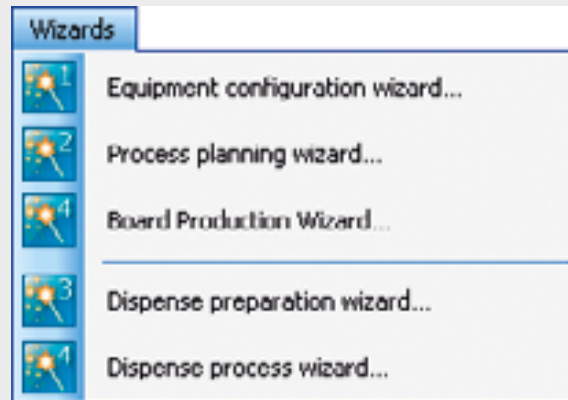
Data import: LMD, GerberX, Excellon, DXF



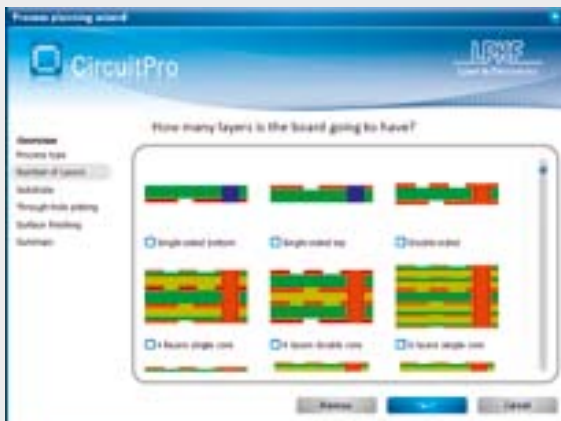
Design Rule Check: checks PCB track width/-distance

## Intelligent assistants

The LPKF CircuitPro wizards provide confidently and quickly guide even occasional users through the entire process. They help with preparing data and show required user interaction. This reduces training time and yields quick results.



### Process wizard guides through the production of multilayer PCBs:



1. Select number of layers



2. Select substrate



3. Set throughplating method



4. Select solder resist mask and assembly print

The wizard controls LPKF CircuitPro according to the data entered and suggests the most efficient production method. For example galvanized throughplating requires the structuring process to be carried out after the PCB has been galvanized – which the wizard considers.

## Technical specifications

	LPKF CircuitPro Lite	LPKF CircuitPro Full
<b>Import formats</b>	Gerber Standard (RS-274-D), Extended Gerber (RS-274-X), Excellon NC Drill (Version 1 and 2), Sieb & Meier NC Drill, IGES	Gerber Standard (RS-274-D), Extended Gerber (RS-274-X), Excellon NC Drill (Version 1 and 2), Sieb & Meier NC Drill, HP-GL™, DPF, Auto-CAD™ DXF, IGES, LMD, STEP
<b>Supported shapes</b>	Circle, square, rectangle (also rounded or angled), octagon, oval, step, special (arbitrary definable)	
<b>Editing functions</b>	Original modification, relocating, duplicating, rotating, mirroring, erasing, extending/severing lines, line/path extension/shortening, line path/segment parallel shifting, line path/object polygon conversion (Fill), curve linking/closing	
<b>Special functions</b>	Contour routing path generator with breakout tabs	Routing path generator with breakout tabs, joining/separating objects, step & repeat (multiple PCB), polygon cut-out, ground plane generation with defined clearance
<b>Display functions</b>	Zoom window (freely definable), zoom in/out, overview, redraw, individual layers selectable/visible, panning (keyboard), layer in solid/outline/center line display, 16 pre-set colors (up to 16 million freely available), different colors for tracks and pads of the same layer, different colors for insulation tools	
<b>Marker functions</b>	Single element, total layer, all layers, pad groups, selection and limiting to specific layers possible for lines/polygons/circles/rectangles/pads/holes (multiple choice and restriction to specific layers possible)	
<b>Graphic functions</b>	Lines (open/closed), circle, polygon, rectangle, pad, hole, text (TTF, TTC)	
<b>Control functions</b>	Measuring	Measuring, design rule check
<b>Insulation methods</b>	Single, insulation method, additional multiple insulation of pads, removal of residual copper spikes (spike option), milling out of large insulation areas (rub-out), concentric or in serpentine maintaining minimum insulation spaces, inverse insulation	
<b>Insulation tools</b>	1 - 2 tools	all
<b>Languages</b>	English, German (other languages coming soon)	
<b>Hard-/software minimum requirements</b>	Microsoft® Windows® 2000 or higher, 2 GHz Processor with 2 GB RAM, screen resolution 1024 x 768 pixels	
<b>Supplied with</b>	LPKF ProtoMat S 43, E33	LPKF ProtoMat S 63, S103

All specifications are subject to technical modifications.

- Innovative laser technology
- Broad machining spectrum
- Compact and affordable
- Includes powerful CAM software



# Innovative Laser Technology for Rapid PCB Prototyping

The natural transition from traditional PCB prototyping to small batch production and special requirements.

LPKF is expanding its material micromachining range with contactless laser processes – from structuring and printed circuit board machining to machining of internal traces or ceramic materials.

Two laser systems are available: The ProtoLaser S is ideal for structuring printed circuit boards. The ProtoLaser U3 can structure laminated substrates as well as a large number of other materials. It is one of the most competitively priced UV laser systems on the market and can be used in a wide range of applications. Both systems are delivered with powerful CAM software.

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# LPKF ProtoLaser S

## Laser Structuring Circuit Boards

**Product:** LPKF ProtoLaser S  
**Part no.:** 124102  
**Ordering info:** See front sleeve

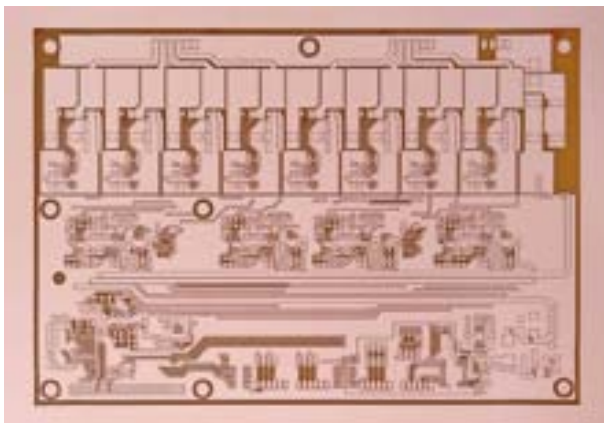
- IR-Laser for laser structuring
- Material size up to 229 mm x 305 mm x 10 mm (9" x 12" x 0.4")
- Structuring speed:  $\varnothing$  6 cm<sup>2</sup>/min
- Minimum cutting channel width: 25  $\mu$ m
- Minimum corner radius: 12.5  $\mu$ m
- Minimum PCB track width/-distance: 50/25  $\mu$ m\*

\* on ceramic substrate with 5  $\mu$ m CU electro-plating



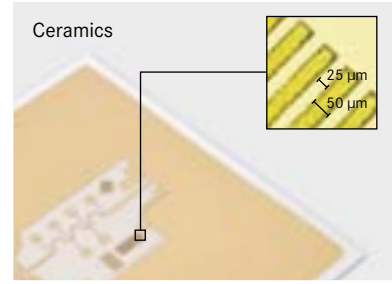
When do you need the finished PCB prototype?  
How quickly do you need a small batch set up?  
All too often the answer is: Now!

The compact LPKF ProtoLaser S allows PCB designers to take great strides toward their goal. Using the patented LPKF laser method the ProtoLaser S structures PCBs in minutes – with accurate geometries on virtually any substrate. Yet the ProtoLaser S is compact and fit for any lab environments. It can be rolled through any standard lab door and requires only an outlet and compressed air supply connection to operate.



229 x 305 millimeters (9" x 12") – structured in 20 minutes.

- Highest resolution, precise geometries, optimal repeatability
- Compact and reliable: Fit for labs
- For virtually all popular circuit board materials
- Prototyping and on-demand production of custom small batches



## Laser structured circuit layouts

The LPKF ProtoLaser S selectively ablates the conductive layer – typically copper – from the substrate. This cuts the insulation channels throughout the planned PCB tracks and pad surfaces. The ProtoLaser S is the solution for efficiently prototyping complex digital and analogue circuits, RF- and microwave PCBs up to a size of 229 mm x 305 mm (9" x 12"). It achieves unmatched geometric accuracy on virtually any material and represents the ideal system for manufacturing antennas, filters and many other applications where precise, steep edges are essential.

## Options

- Compressor system for supplying compressed air (Part no. 122805)
- Dust extraction (Part no. 124391)
- Adjustment tool (Part no. 118005)

**Accessories and materials start on page 19.**

**i** For additional info see TechInfo page 84.

Technical Specifications: LPKF ProtoLaser S	
<b>Part no.</b>	124102
<b>Max. material size and layout area (X/Y/Z)</b>	229 mm x 305 mm x 10 mm (9" x 12" x 0.4")
<b>Structuring speed</b>	∅ 6 cm <sup>2</sup> /min (∅ 0.93" <sup>2</sup> /min) <sup>a</sup> (∅ on laminated substrate)
<b>Diameter of focused laser beam</b>	25 µm (1 mil)
<b>Minimum line/space</b>	50 µm/25 µm (2 mil / 1 mil) <sup>a</sup>
<b>Accuracy*</b>	2 µm (0.08 mil)
<b>Repeatability</b>	± 2 µm (± 0.08 mil) <sup>b</sup>
<b>Laser pulse frequency</b>	15 – 200 kHz
<b>Dimensions (W x H x D)</b>	875 mm x 1,430 mm x 750 mm (34.4" x 56.3" x 29.5") <sup>c</sup>
<b>Weight</b>	260 kg (573.2 lbs)
<b>Operating conditions</b>	
<b>Power supply</b>	110/230 V, 50 – 60 Hz, 1.4 kW
<b>Compressed air supply</b>	8 bar (116 psi), 160 l/min (5.66 cfm)
<b>Cooling</b>	Air-cooled (internal cooling cycle)
<b>Ambient temperature</b>	22 °C ± 2 °C (71.6 °F ± 4 °F)
<b>Exhaust</b>	
<b>Power supply</b>	230 V, 50/60 Hz, 1.2 kW
<b>Air flow rate</b>	320 m <sup>3</sup> /h, max. vacuum pressure 21,000 PA
<b>Filter</b>	Active carbon filter and HEPA filter
<b>Dimensions (W x H x D)</b>	365 mm x 740 mm x 501 mm (14.4" x 29.1" x 19.7")
<b>Weight</b>	80 kg (176.4 lbs)
<b>Required accessories</b>	Exhaust, compressor, standard PC
<b>Hardware and software requirements</b>	Microsoft® Windows® 2000 or higher, 2 GHz Processor with 2 GB RAM, screen resolution 1024 x 768 pixels, USB 2.0

a Depending on material and laser beam parameters

b Direct repeat of laser beam movement

\* Resolution scanfield

c Height with open door 1,730 mm (68.1")

Technical specifications subject to change.

# LPKF ProtoLaser U3

## The Multi-Purpose Tool for the Electronics Lab

**Product:** LPKF ProtoLaser U3  
**Part no.:** 10011576  
**Ordering info:** See front sleeve

- UV-laser for innovative micromachining of materials
- Compact and suitable for labs
- Material size up to 229 mm x 305 mm x 10 mm (9" x 12" x 0.4")

One system, many applications – it's all possible with a laser. The LPKF ProtoLaser U3 provides a compact system that can handle tasks previously requiring large industrial systems. The integrated UV laser can machine nearly all materials, is easy to install and is even easier to use.

The ProtoLaser U3 shows how fast applications can be processed. The high pulse energy of the UV laser leads to residue-free ablation, resulting in precise contour geometries. Conversion to other products is easy and flexible: Just load the new project file, and start using the ProtoLaser U3.

The LPKF ProtoLaser U3 can quickly, cleanly and precisely depanel or structure a wide range of materials. A UV laser beam can easily and accurately cut individual boards out of large boards, cut LTCCs and prepregs, drill holes and microvias, and cut through solder masks. An extensive material library supplies the laser parameters for the most important materials. Tool costs are no longer an issue, as the ProtoLaser U3 is a contactless system.

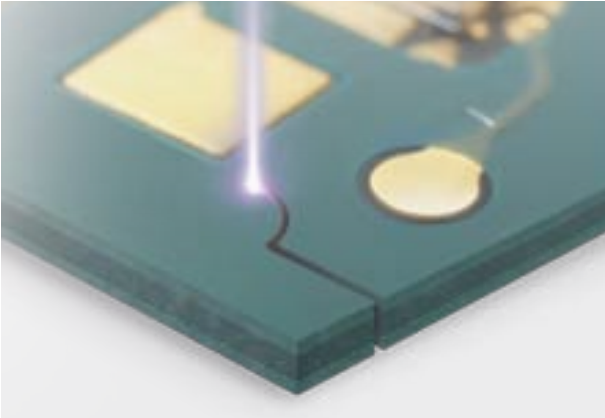


- Contactless depaneling of rigid, rigid-flex, and flexible printed circuit boards
- Structuring of laminated substrates
- Drilling and depaneling of ceramics
- Laser focus of less than 20  $\mu\text{m}$
- Machining with no material stressing or residues

## The multifunction tool for laser materials processing

The wavelength used by the laser makes the UV laser a truly multifunctional tool. It can be used to separate or structure materials, or for direct exposure. And in the process, the micromachining of materials benefits from the fine diameter of the laser beam, the ultra precise Z-axis focus and the precise selection of machining positions.

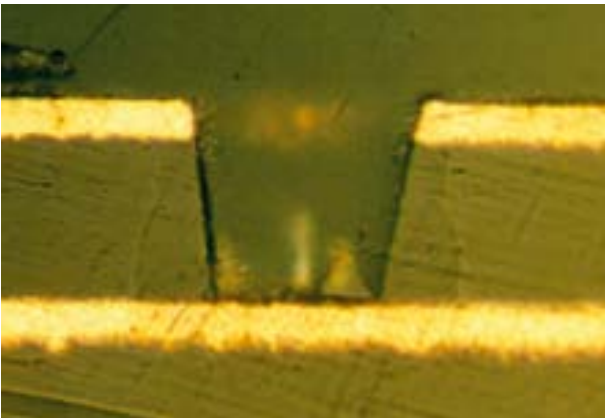
### An overview of a applications:



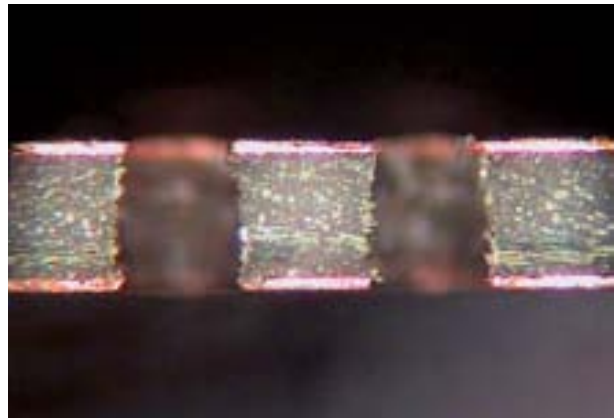
Depaneling and cutting thin and flexible PCB materials: populated or unpopulated, without thermal or mechanical strain on materials, in any shape



With the new hood (left), the LPKF ProtoLaser U3 can also structure laminated substrates



Drilling holes and blind holes (Microvias) in conventional and PTFE- or ceramic-filled PCB substrates with perfect drill hole geometry



Cutting, drilling or trimming ceramics, e.g. LTCC



Ablating solder resist and cover layers – ultra precise, with a diameter of 30  $\mu\text{m}$  and larger



Structuring transparent conductive oxides (TCO) – without visible marks on the substrate

## Prepared for anything

The new laminated substrate structuring capability is based on the use of compressed air to remove detached metal strips from the machining area. A special hood for the machining head supports the removal process perfectly guiding the airstream directly to the extraction unit. Changing between hoods requires no tools and takes just a few minutes.



With the new hood (right), the LPKF ProtoLaser U3 can also structure laminated substrates

## Easy machine control

The LPKF CAM software can handle all standard layout data formats and converts them into production data. In most cases, it just takes a push of a button to operate the LPKF ProtoLaser U3 – process parameters are supplied for a large number of applications. Administrator mode allows full control over all system settings.

## Small batches and prototypes

High repeatability: The optimum focal point position for the laser is set automatically; a camera localizes the workpiece position using registration marks. The integrated vacuum table reliably keeps flexible and thin substrates in place.

## Options

- Dust extraction (item no. 124391)
- Adjustment tool (item no. 118005)
- Compressor system compressed air supply (item no. 122805)

Accessories and materials starting on page 19.

 For additional info see TechInfo page 84.

Technical Specifications: LPKF ProtoLaser U3	
<b>Part no.</b>	10011576
<b>Max. material size and layout area (X/Y/Z)</b>	229 mm x 305 mm x 7 mm (9" x 12" x 0.28")
<b>Laser wavelength</b>	355 nm
<b>Output</b>	5 W
<b>Diameter of focused laser beam</b>	20 µm (0.8 mil)
<b>Accuracy*</b>	2 µm (0.08 mil)
<b>Repeatability</b>	± 2 µm ( ± 0.08 mil) <sup>a</sup>
<b>Laser pulse frequency</b>	25 – 200 kHz
<b>Dimensions (W x H x D)</b>	875 mm x 1,430 mm x 750 mm (34.5" x 56.3" x 29.5") <sup>b</sup>
<b>Weight</b>	300 kg (661 lbs)
<b>Operating conditions</b>	
<b>Power supply</b>	110/230 V, 50 – 60 Hz, 1.4 kW
<b>Compressed air supply</b>	8 bar (116 psi), 160 l/min (5.66 cfm)
<b>Cooling</b>	Air cooled (internal cooling cycle)
<b>Ambient temperature</b>	22 °C ± 2 °C (71.6 °F ± 4 °F)
<b>Exhaust</b>	
<b>Power supply</b>	230 V, 50/60 Hz, 1.2 kW
<b>Air flow rate</b>	320 m <sup>3</sup> /h, max. vacuum pressure 21,000 PA
<b>Filter</b>	Active carbon filter and HEPA filter
<b>Dimensions (W x H x D)</b>	365 mm x 740 mm x 501 mm (14.4" x 29.1" x 19.7")
<b>Weight</b>	60 kg (132.3 lbs)
<b>Required accessories</b>	Exhaust, standard PC
<b>Hardware and software requirements</b>	Microsoft® Windows® 2000 or higher, 2 GHz Processor with 2 GB RAM, screen resolution 1024 x 768 pixels, USB 2.0

a Direct repeat of laser beam movement

b Height with open door 1,730 mm (68.1")

\* Resolution scanfield

Technical specifications subject to change.

# Through-Hole Plating

Producing high-quality through-hole platings is critical in the production of modern multilayer PCBs. LPKF offers several processes to complement the range of products for in-house PCB prototype production.

LPKF through-hole plating drastically reduces production time. New products can be developed and introduced to the market quicker. LPKF offers a total of three powerful processes to cover almost any application area imaginable.

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**i** For additional information on the through-hole plating methods please refer to the TechInfo starting on page 95.

# LPKF ProConduct

## Through-Hole Plating without Chemicals

**Product:** LPKF ProConduct  
**Part no.:** 115790  
**Ordering info:** See front sleeve

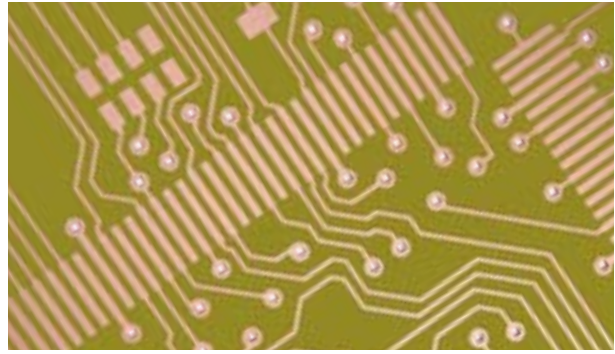


LPKF ProConduct is an innovative system for cost-effective through-hole plating without wet chemistry. No electroplating baths required. The parallel process will quickly, easily and reliably connect even PCBs with a large number of drillings.

ProConduct is perfect for small batches as well as labs and companies where chemical electroplating is not viable.

When combined with a LPKF circuit board plotter or ProtoLaser S the LPKF ProConduct system is a key component of in-house PCB prototyping. It facilitates reliable, flexible and quick production of prototypes.

- No plating tanks or chemicals required
- Reliable, thermally stable platings
- Compact
- Quick and easy operation
- Also suitable for PTFE and other sophisticated substrates



### Easy to use

A special conductive paste is the heart of the LPKF ProConduct. A vacuum draws the paste through the drill holes – this simple process for smooth coating yields perfect results in mere minutes.

**i** For additional information and a process description please refer to the technical specifications starting on page 96.

### Accessories

- Hot air oven (Part no. 115877)
- Vacuum table (Part no. 115878)
- Dust extraction (Part no. 114647)

For further information about options see page 66.

### Reliable contacts

The LPKF ProConduct system metalizes vias as small as 0.4 mm (15 mil) and up to an aspect ratio of 1:4. Smaller sizes can be drilled under special conditions. The basic process takes only a few minutes for double-sided as well as multilayer PCBs. At only about 20 mΩ with the LPKF ProConduct the electric resistance of vias is extremely low.

Technical Specifications: LPKF ProConduct	
Part no.	115790
Max. material size	229 mm x 305 mm (9" x 12")
Min. hole diameter	0.4 mm (15 mil) up to an aspect ratio of 1:4 <sup>a</sup>
Number of plated holes	No limit
Number of layers	4
Solderability	Reflow soldering 250 °C (482 °F), manual soldering 380 °C (716 °F) <sup>b</sup>
Base material types	FR4, RF- and microwave materials (incl. PTFE-based materials)
Processing time	Approx. 35 min
Electric resistance (Hole diameter 0.4 – 1.0 mm at 1.6 mm / 63 mil material thickness)	Average 19.2 mΩ with standard deviation of 7.7 mΩ

a Smaller hole diameters upon request  
 b Soldering agent recommendation upon request  
 Technical specifications subject to change.

# LPKF Contac RS / LPKF MiniContac RS

## Electroplating of Through-Holes

Product:	LPKF Contac RS	LPKF MiniContac RS
Part no.:	120742	119987
Ordering info:	See front sleeve	



LPKF Contac RS

LPKF MiniContac RS

The LPKF Contac RS and the LPKF MiniContac RS are electroplating systems for professional through-hole platings in PCB prototypes and small batches. The compact desktop design allows it to also be used in labs with limited space. The optional LPKF Reverse Pulse Plating function and formaldehyde-free black-hole technology employed in both systems ensure consistent metallization of through-holes, even with small hole diameters.

The LPKF Contac RS can handle PCBs up to 460 mm x 330 mm (18" x 13"). The system is also equipped for chemical tin-coating. A spray basin with external water supply assists in the PCB cleaning process.

The LPKF MiniContac RS can handle PCBs up to 230 mm x 330 mm (9" x 13"). The system requires no external connections.

- High-quality through-hole plating at your own lab
- Even copper deposit through reverse pulse plating (RPP)
- No special chemical knowledge required
- Chemical tinning with LPKF Contac RS
- Through-hole plating even with small diameters of > 0.2 mm (8 mil)
- Ideal for through-hole plating multilayer-PCBs

## Easy to operate

The microprocessor-controlled systems feature easy menu-guided operation. An acoustic signal indicates process is complete.

## Simple process

The through-hole plating process starts by cleaning and degreasing the PCB in two baths. This is followed by activation and copper buildup in additional baths. After the final cleaning the PCB is ready for further processing.

The LPKF MiniContac RS only needs four baths. The LPKF Contac RS also features a spray basin and a bath for chemical tin-plating. All baths are easy to change. No special chemical knowledge required.

## Chemical tin-plating

The LPKF Contac RS features a bath for chemical tin-plating. Tin-plating protects the through-plated PCB from oxidation and is the ideal primer for the soldering process.

## Advantages of Reverse Pulse Plating

Both systems offer a process for consistently coating the annular rings by brief current reversals. Please refer to page 97 for additional information.

Consumable	Part no.	Description
Electroplating chemicals – MiniContac RS	119986	Covers the complete fill of electroplating chemicals for MiniContac RS. Includes 6 l Cleaner 110, 5 l Cleaner 210, 4 l Activator 310, 16 l Copper Plater 400 and 0.25 l Shine 400.
Electroplating chemicals – Contac RS	120743	Covers the annual supply of electroplating chemicals for Contac RS. Includes 30 l Cleaner 110, 30 l Cleaner 210, 10 l Activator 310, 35 l Copper Plater 400, 0.5 l Shine 400.

All materials can be ordered separately. Please contact your local LPKF representative.

Technical Specifications	LPKF Contac RS	LPKF MiniContac RS
Part no.	120742	119987
Activator	Carbon	Carbon
Max. material size	460 mm x 330 mm (18.1" x 13")	230 mm x 330 mm (9" x 13")
Max. layout size	430 mm x 290 mm (16.9" x 11.4")	200 mm x 290 mm (7.8 x 11.4)
Hole diameter	>0.2 mm (>8 mil)	>0.2 mm (>8 mil)
Number of through-plated holes	No limit	No limit
Max. number of layers	8	8
Max. contact resistance	<10 mΩ	<10 mΩ
Environmental compatibility	Good	Good
Processing reliability	Very good	Very good
Processing time	Approx. 90 min – 120 min	Approx. 90 min
Base material types	FR4, RO3000®, RO4000®, TMM® *	FR4, RO3000®, RO4000®, TMM® *
Power supply	115/230 V, 50–60 Hz, max. 1.5 kW	115/230 V, 50–60 Hz, 0.6 kW
Ambient temperature	18–25 °C (64–77 °F)	18–25 °C (64–77 °F)
Dimensions (W x H x D)	900 mm x 540 mm x 800 mm (35.4" x 21.2" x 31.5")	750 mm x 525 mm x 500 mm (29.5" x 20.4" x 19.7")
Chemical tinning	Yes	No
Reverse Pulse Plating	Yes	Yes
Weight	85 kg (187.4 lbs) unfilled; 150 kg (330.7 lbs) filled	42 kg (92.5 lbs) unfilled; 71 kg (156.5 lbs) filled

\* Additional materials available upon request. Technical specifications subject to change.

# LPKF EasyContac

## Manual Through-Hole Plating for Double-Sided PCBs

**Product:** LPKF EasyContac  
**Part no.:** 110914  
**Ordering info:** See front sleeve



LPKF EasyContac is a manual system for through-hole plating double-sided PCBs with copper-alloy rivets. Perfect for applications where double-sided soldering is impractical. LPKF EasyContac requires no special tools or chemical baths. The portable tool set includes all the required tools. For additional information on through-hole plating refer to the TechInfo starting on page 95.

### Portable tool set

All the required utensils are packed in a handy tool box, perfect for service technicians.

- Fast and cost-effective for small projects
- Complete with tools
- Easy to learn

Technical specifications: LPKF EasyContac	
<b>Part no.</b>	110914
<b>Max. material size</b>	Unlimited
<b>Number of layers</b>	2
<b>Max. contact resistance</b>	10 mΩ
<b>Environmental compatibility</b>	Excellent
<b>Through-plated holes/min</b>	2 or 3
<b>Process reliability</b>	Good
<b>Base material types</b>	FR4, 1.5 mm (59 mil) thickness

Quantity	Description
1	Automated punch tool with stamp tip A for 0.6 mm (24 mil) and 0.8 mm (32 mil) rivets (inside diameter*)
1	Stamp tip B for 1.0 (40 mil) and 1.2 mm (48 mil) rivets (inside diameter*)
1	Tweezers
1	Anvil
Copper alloy rivets	
1.000	0.8 mm (32 mil)
1.000	1.0 mm (40 mil)
1.000	1.2 mm (48 mil)
1.000	1.4 mm (56 mil)

Technical specifications subject to change.

\* The inside diameter is 0.2 mm (8 mil) or 0.4 mm (16 mil) smaller than the desired outside diameter.

# LPKF ViaCleaner

## Reliable Contacting with Microvias

**Product:** LPKF ViaCleaner  
**Part no.:** 10012137  
**Ordering info:** See front sleeve



- Reliably removes activator layer in microvias
- Short process time
- Supplements galvanic through-hole plating



Multilayers offer additional circuit paths and are a prerequisite for reliable connections in complex circuit layouts on PCBs with high integration densities.

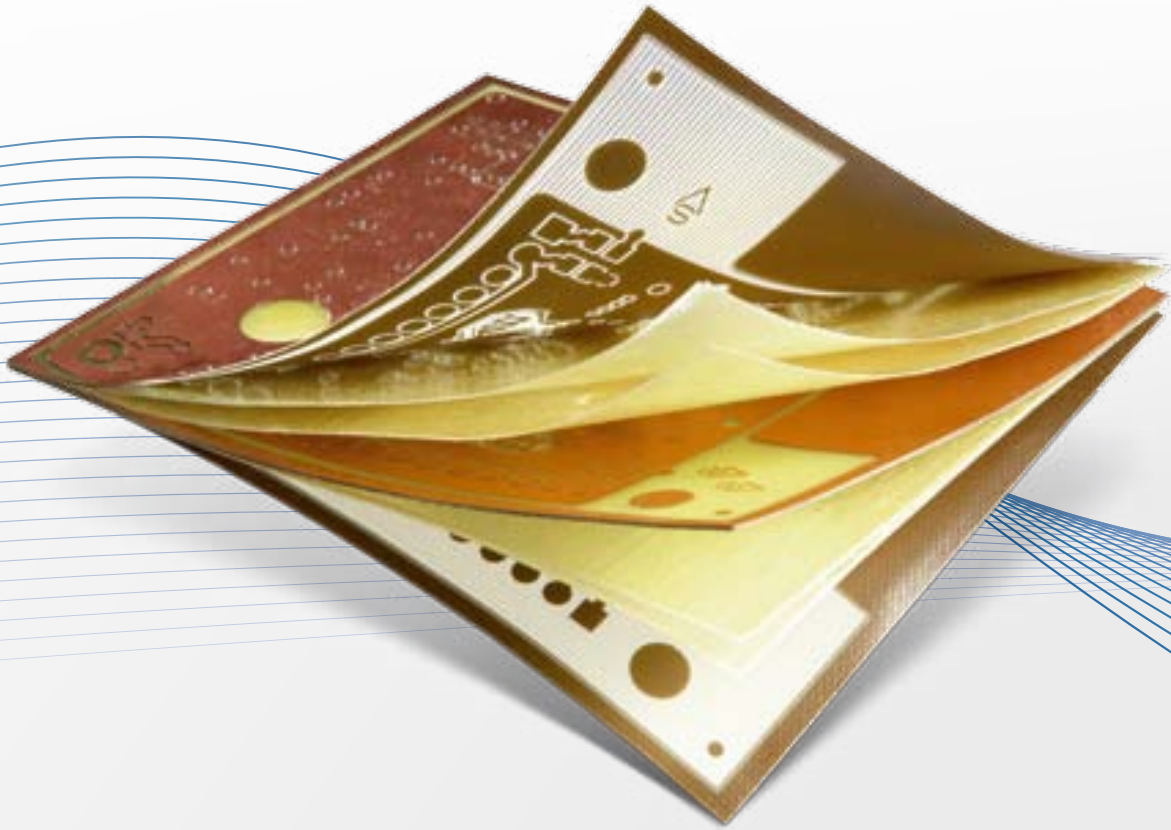
The individual layers are electrically connected by means of via plating. Multilayer boards are connected galvanically through liquid media after activator coating. What functions reliably for vias is challenging for blind vias: The activator accumulates at the bottom of the via and forms a contact resistance to the insulation. The LPKF ViaCleaner removes the activator from the copper layer, whereas the activator layers on the via walls are not removed.

The basin is transparent and is mounted in a tank in the existing LPKF Contac RC / MiniContac RS galvanic via plating units. To avoid additional steps, the board holders on the Contac RS and the MiniContac RS both fit on the ViaCleaner. If there are no existing LPKF galvanic via plating units, the board holders can be ordered separately. A thermometer and a temperature table are available to determine the perfect residence time.

After the activator has been applied and dried, the printed circuit board is moved around in the ViaCleaner solution for 120 to 300 seconds. It is then rinsed and can be copper-plated in the next step.

### Technical specifications: LPKF ViaCleaner

<b>Part no.</b>	10012137
<b>Filling volume</b>	4 l
<b>Dimensions (W x H x D)</b>	530 mm x 150 mm x 380 mm (20.8" x 5.9" x 14.9")
<b>Process temperature</b>	18 °C – 25 °C (64 °F – 77 °F)
<b>Max. base material size</b>	305 mm x 230 mm (12" x 9")
<b>Consumables (included in set)</b>	Chemical set, Part no. 10013451 (ViaCleaner Part I and Part II)



## Multilayer-PCBs Produced In-House

Shorter and shorter product cycles: Rapid PCB Prototyping is a key factor in developing new products and in their market introduction. Fast and easy prototyping methods determine the success or failure of a new development.

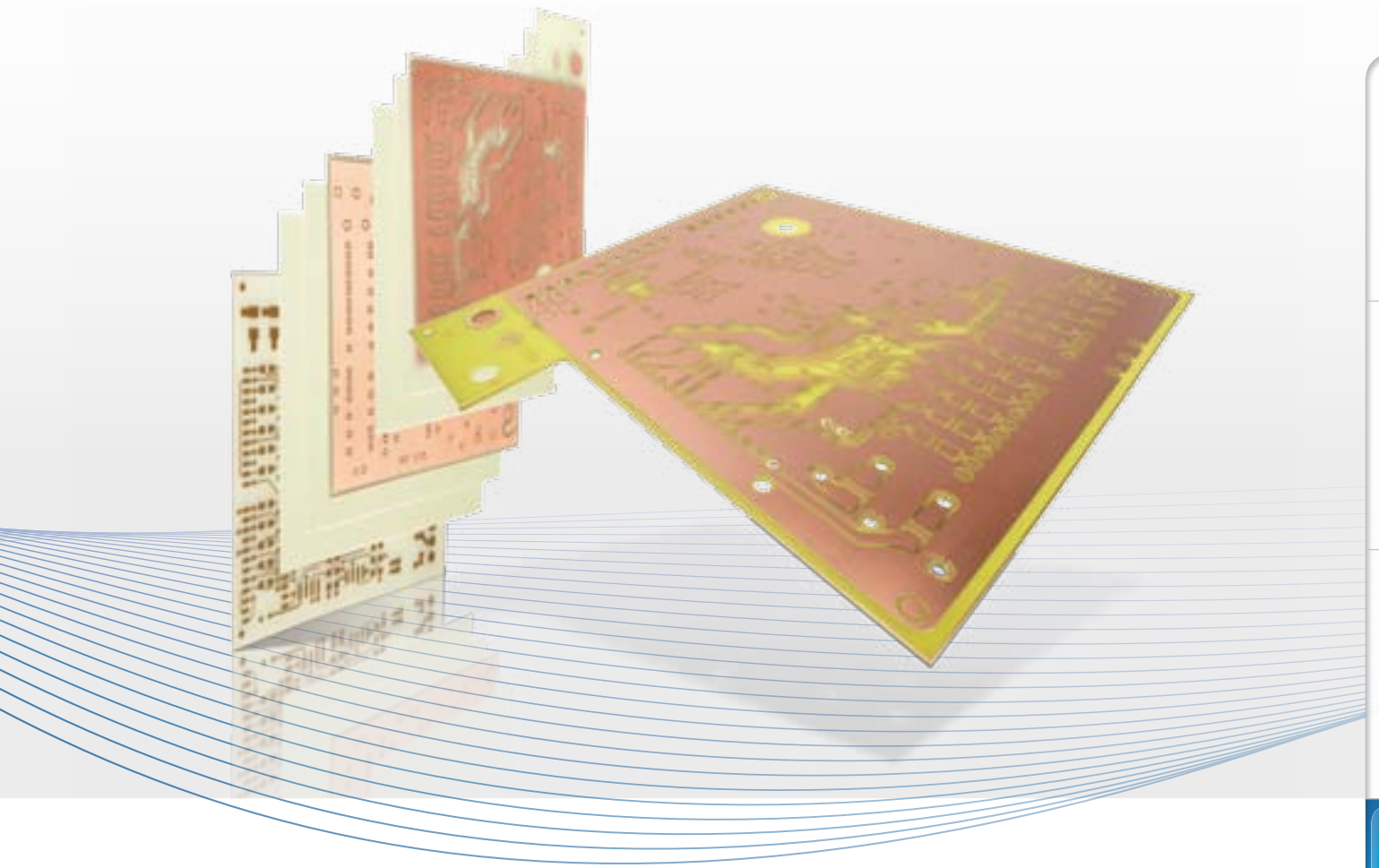
Yet the number of functions to be accommodated on a PCB keeps growing. The high circuit density and the associated high number of circuitries require complex PCB prototypes to be laid out as multilayers, allowing circuits to be arranged over several layers.

A typical PCB multilayer with any number of layers includes:

- PCBs, typically FR4, with the circuits.
- Prepregs, as insulative layer inserted between the layers.

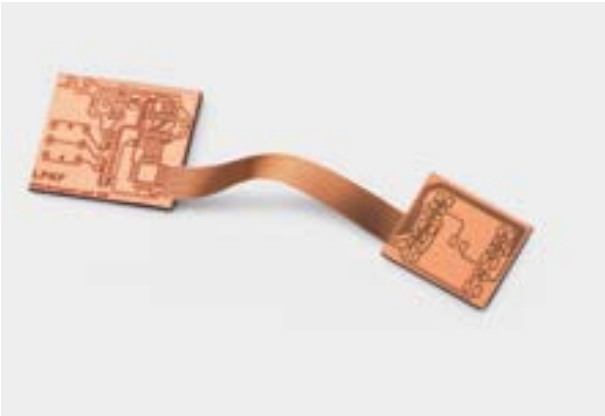
The different layers must be bonded properly to eliminate pockets of air or impurities. For additional information on the method please refer to the TechInfo starting on page 92.

In multilayer production the electrical connections are created between the individual layers. This requires a through-hole plating method suitable for multilayers, such as LPKF ProConduct – more information starting on page 96.



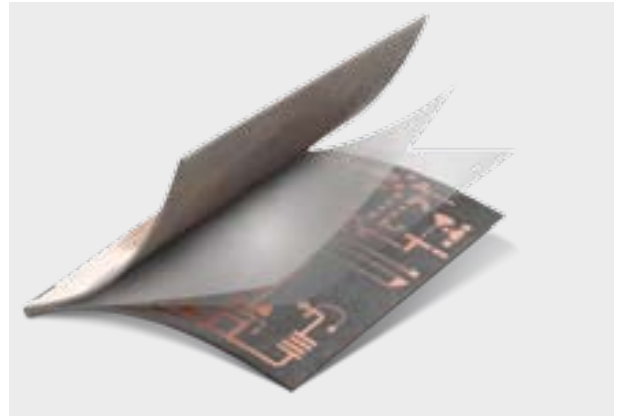
## Typical applications

The classic case is a design with FR4 substrate material and two prepregs.



### Rigid-flex

Rigid-flex PCBs are a combination of flexible and rigid PCB sections. In principle they can be processed similar to multilayers. Achieving professional bonding results in rigid-flex PCBs, unlike bonding rigid multilayers, merely requires an increase in the bonding temperature and pressure.



### RF multilayer

RF multilayers are created on special substrate materials and prepregs. RF bonding films and RF prepregs require a higher laminating temperature and pressure compared to FR4-based multilayers.

# LPKF MultiPress S

## Press for Producing Multilayers

**Product:** LPKF MultiPress S  
**Part no.:** 120734 <sup>1</sup> / 120736 <sup>2</sup>  
**Ordering info:** See front sleeve

<sup>1</sup> Incl. manual pump   <sup>2</sup> Incl. automatic hydraulics



The LPKF MultiPress S is a desktop system for laminating multilayers in your own lab. The short cycle time of only approx. 90 minutes and simple operation make this system the perfect tool for the reliable production of multilayer prototypes and small batches.

The LPKF MultiPress S bonds complex PCBs with up to eight layers in one pass. Different pressure-, temperature- and time profiles provide the greatest possible flexibility in material selection and the number of layers.

The prototype quality is no different from those produced by PCB manufacturers – but only takes a fraction of the time required for an external supplier. The entire process from design and structuring the PCBs all the way to the final bonded and populated product sample can be completed within one business day.

- In-house production of multilayer prototypes and small batches
- Very fast process
- Easy menu navigation via LCD display
- Preset and custom process profiles
- Bonds rigid and flexible materials, RF materials
- Upgradeable to automatic hydraulics

## The key in multilayer prototyping

The LPKF MultiPress S bonds multilayer circuits of rigid, rigid-flex and flexible circuit board materials. Even distribution of pressure and up to nine different pressure-, temperature- and time profiles provide a uniform material bond. Special process profiles can even bond RF materials. Temperatures up to 250 °C are reached within a short period. Efficient heat transmission ensures short cool-down phases, resulting in optimal processing times.

The microprocessor control stores up to nine profiles. Upon request it can also be equipped with a hand pump instead of an automatic press.



## Low space requirement

The LPKF MultiPress S with a laminating pressure of up to 286 N/cm<sup>2</sup> requires a mere 600 mm x 530 mm (23.6" x 20.9") – fitting for any lab. The system can be placed on any surface rated for at least 170 kg (375 lbs). LPKF also offers an optional mobile table for the MultiPress S.

More information about options on page 66.

## Options



Mobile table (Part no. 107050)



Automatic hydraulics (Part no. 120744)

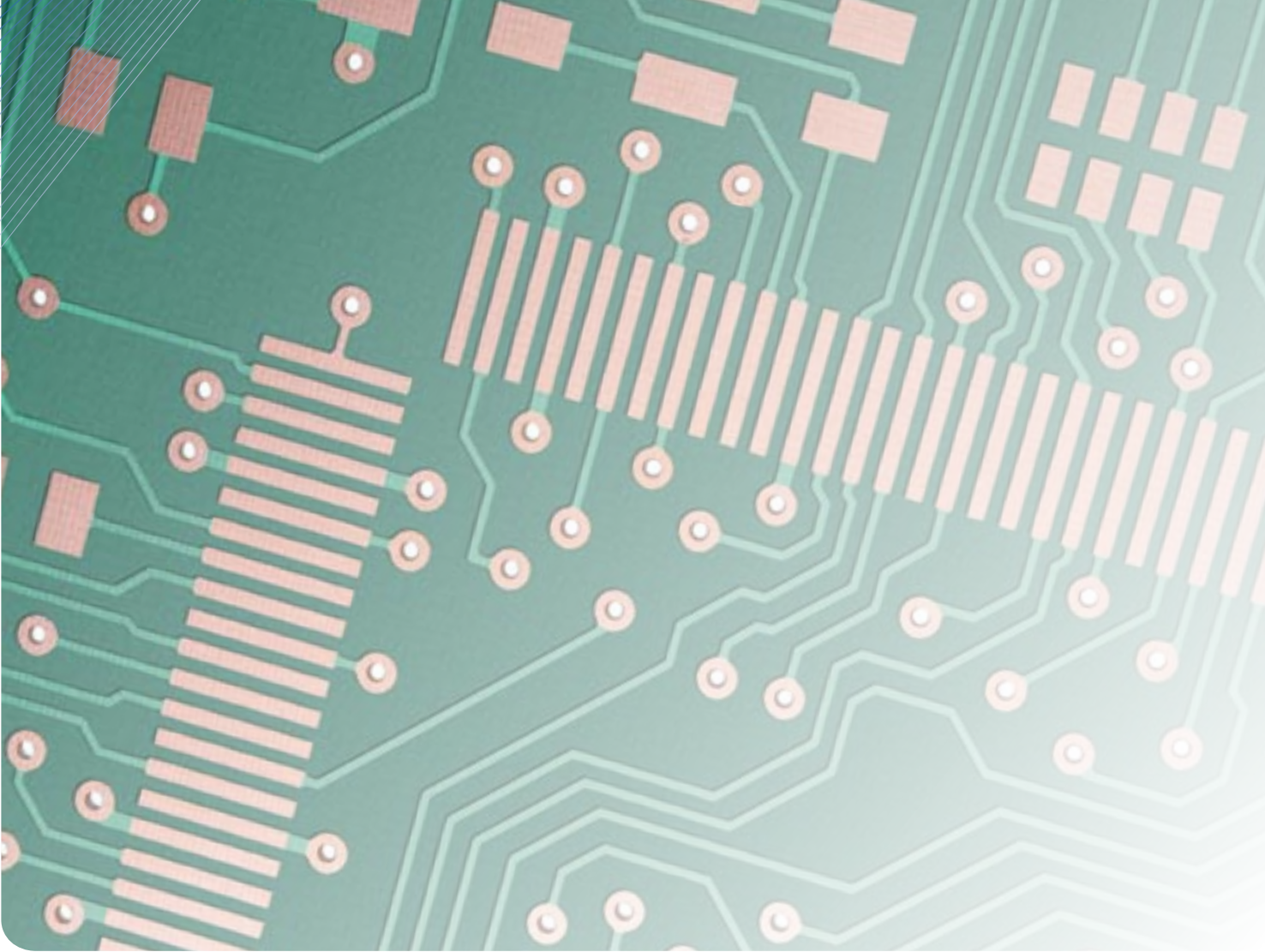
Technical specifications: LPKF MultiPress S <sup>1</sup> with automatic hydraulics	
Part no.	120734 / 120736 <sup>1</sup>
Max. layout size	200 mm x 275 mm (7.8" x 10.8")
Max. laminating area	229 mm x 305 mm (9.0" x 12.0")
Max. laminating pressure	286 N/cm <sup>2</sup> at 229 x 305 mm (9.0" x 12.0")
Max. temperature	250 °C (480 °F)
Max. number of layers	8 (depending on material and layout)
Pressing time	Approx. 90 min <sup>a</sup>
Dimensions (W x H x D)	600 mm x 620 mm x 530 mm (23.6" x 24.4" x 20.9")
Weight	170 kg (375 lbs) <sup>b</sup>
Power supply	230 V, 50/60 Hz, 2.3 kW/2.8 kW <sup>1</sup>
Microprocessor controlled	9 pressure-/temperature-/time profiles
Hydraulic unit dimensions (W x H x D)	260 mm x 410 mm x 280 mm (10.4" x 16.2" x 11.0") 100 mm x 150 mm x 700 mm (3.9" x 5.9" x 27.6") <sup>1</sup>
Hydraulic unit weight	15 kg (33 lbs), 5 kg (11 lbs) <sup>1</sup>
Base materials	FR4, others upon request, multilayer starter-sets on page 29

a Depending on material compound

b Plus weight of hand pump or automatic hydraulics

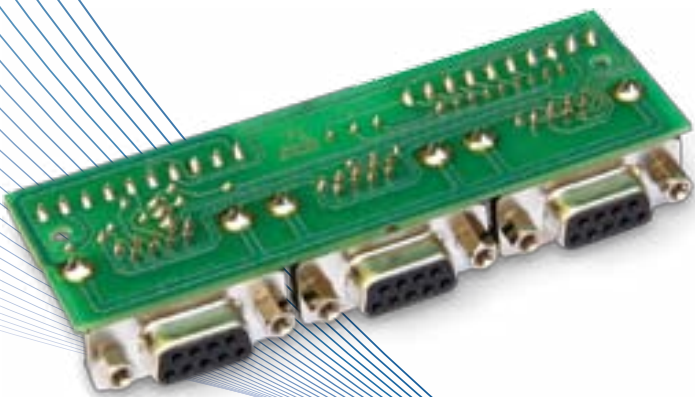
<sup>1</sup> with automatic hydraulics

Technical specifications subject to change.



# SMT Rapid PCB Prototyping

Once the unassembled PCB is finished there are only a few steps left to an electrically functional, populated product. For these production steps LPKF again offers powerful, cost-effective and easy to implement method.



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## An Overview:



### LPKF ProMask and LPKF ProLegend

Simple application of a green solder resist mask to protect the conductor paths during production. ProLegend can be used to apply professional legend print.



### LPKF ProtoPrint S

Manual fine-pitch stencil printer for accurately positioning and dispensing solder paste onto PCBs.



### LPKF ProtoPlace S

Pick&Place system for accurately positioning SMT components on PCBs – from small chips to large QFPs.



### LPKF ProtoFlow S

Reflow oven also suitable for lead-free soldering features a large material size and precisely controlled temperature profile.

**LPKF reduces the production time of PCB prototypes to a fraction of the time required when using external suppliers. The finely tuned LPKF tool spectrum allows several full product cycles to be completed in one day – resulting in quicker product introduction.**

# LPKF ProMask and LPKF ProLegend Solder Resist Masks and Assembly Print

Product:	LPKF ProMask	LPKF ProLegend
Part no.:	117072	117584
Ordering info:	See front sleeve	



LPKF ProMask is an easy to apply green solder resist mask: easy to use and cost-effective for a professional solder resist application during in-house production. The structured PCB prototypes receive a perfect surface finish for safely soldering SMD or conventional components. The professional surface finish is especially ideal for SMT prototypes with minimal track spacing.

LPKF ProLegend is the easiest method of legend printing, adding logos and labeling PCB prototypes.

- Compact, quick and easy to use
- Protective surface finish and perfect soldering
- Only four simple steps, meaning less training
- Professional legend print
- No environmental considerations

A special lacquer, initially applied to the entire PCB, is the key component in the LPKF ProMask and LPKF ProLegend. A laser printer prints the layout to be transferred onto a transparency, a photo-chemical production process transfers it onto the lacquer. See page 100 for an illustration of the process.



### Perfect results for in-house prototyping

LPKF ProMask protects the conductor paths with a special lacquer and prevents short circuits in PCBs populated with SMD- or conventional components.

LPKF ProMask includes all instructions, tools and process materials. All process materials are sealed in sections. No waste requiring special disposal.

### Reliability and quick time-to-market

In-house Rapid PCB Prototyping speeds up development of electronic circuits from design to prototype, reducing the time-to-market. This avoids delays or high costs associated with external suppliers. All CAD data safely remain in house.

### Options



UV-Exposure. With use of the artwork the pattern is transferred to the surface of the circuit board.

230/240 V: Part no. 117050

110/120 V: Part no. 117192



Reflow oven. For pre-drying the PCB and hardening the resist.

230/240 V: Part no. 115877

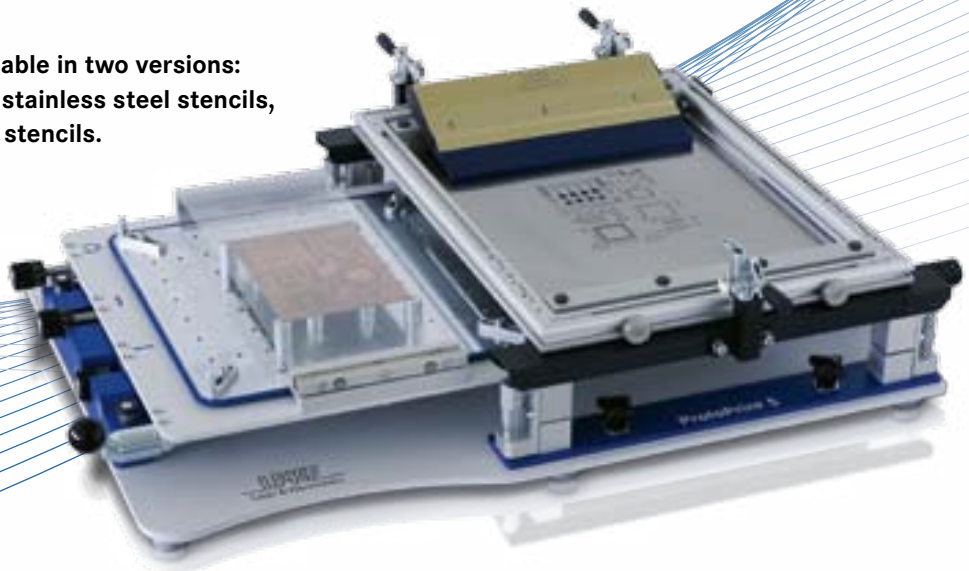
Technical Specifications:	LPKF ProMask	LPKF ProLegend
Part no.	117072	117584
Max. material size	229 mm x 305 mm (9" x 12")	
Max. layout area of image exposer	240 mm x 340 mm (9.5" x 13")	
Processing time	Approx. 60 min/cycle	
Pad separation	≥0.5 mm (20 mil) fine pitch	
Adhesive strength	Class H and T, test method: IPC-SM-840 C, item 3.5.2.1	
Solder bath resistance	20 s at 265 °C (509 °F), test method: IPC-SM-840 C, item 3.7.2 10 s at 288 °C (550 °F), test method: MIL-P 55 110 D 20 s at 288 °C (550 °F), test method: UL 94 (lead-free)	
Surface resistance	2 x 10 exp 14 Ω, test method: VDE 0303, Part 30, DIN IEC 93	
Moisture resistance and isolation resistance	Class H and T, test method: IPC-SM-840 C, item 3.9.1	
Solving/cleaning agent resistance	IPC-SM-840 C, item 3.9.1 (10 percent alkaline cleaner, Isopropanol, monoethanolamine)	
Minimum capital height	2.0 mm (with 1,200 dpi laser printer)	
Minimum capital strength	0.1 mm (with 1,200 dpi laser printer)	
Hardware requirements	Min. 600 dpi laser printer	
Software requirements	LPKF CircuitPro	

Technical specifications subject to change.

# LPKF ProtoPrint S and ProtoPrint S RP Solder Paste Printers

Product:	LPKF ProtoPrint S	LPKF ProtoPrint S RP
Part no.:	127067	127066
Ordering info:	See front sleeve	

**The LPKF ProtoPrint S is available in two versions:  
ProtoPrint S for printing with stainless steel stencils,  
ProtoPrint S RP for polyimide stencils.**



When populating PCBs with tiny SMD components the developer relies on an accurate solder paste application. Large numbers of solder deposits are easiest and quickest applied by stencil print. The ProtoPrint S LPKF provides an accurate manual stencil print for SMT prototypes and small batches.

Its superior positioning accuracy, ease-of-use and usability of milled polyimide stencils are impressive. The SMD fine-pitch print, accurate parallel separation of stencil and PCB and simple stencil frame clamping guarantee a state of the art stencil print. Before the PCBs are produced a test film is printed – to easily verify the expected print result and fine tuning.

The LPKF ProtoPrint S features a LPKF ZelFlex frame but is also compatible with many other stencil frames.

The LPKF ProtoPrint S RP features a LPKF ZelFlex frame with adapter for directly inserting size DIN A4 polyimide stencils. The polyimide stencils can be produced on an LPKF ProtoMat.

- SMD fine-pitch print to 0.3 mm
- Parallel stencil separation
- Prints assembled double-sided PCBs
- Compatible with many stencil frames
- Test film print
- Screen printing, applying adhesives
- Optional vacuum table for securing rigid and flexible PCBs

## SMD fine-pitch print

The precision multi-dimensional settings (X, Y, Z, distance and rotation of PCB and stencil) via micrometer screws are the basis for outstanding print results. The resolution up to a grid size of 0.3 mm/12 mil (polyimide stencils 0.65 mm/25 mil) fits in the ultra-fine pitch range. The lever arm developed specifically for speed-controlled parallel separation of PCB and stencil allows the ultra-fine pitch print. The print height can be precisely adjusted with micrometer screws.

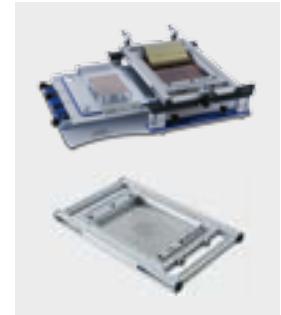


## Intelligent nesting pins

The LPKF ProtoPrint S features freely adjustable PCB nesting pins, allowing the backside of assembled PCBs to be printed. Stencil frames such as the LPKF ZelFlex can easily be set with height- and length-adjustable fixing clamps. Test film printing makes it easy to set up new print jobs.



The LPKF ProtoPrint S RP, unlike the ProtoPrint S, includes a ZelFlex frame with adapter for use with polyimide stencils up to a size of 210 mm x 297 mm (A4).



## Accessories

The LPKF stencil printers can be upgraded with additional squeegees, mechanical or pneumatic stretching frame and special material feeders. These and other options are shown starting on page 67.

Technical Specifications:	LPKF ProtoPrint S	ProtoPrint S RP
Part no.	127067	127066
Frame dimensions	<ul style="list-style-type: none"> <li>Width to 430 mm (16.9")</li> <li>Length adjustable from 420 mm to 520 mm (16.5" to 20.5")</li> <li>Height adjustable from 20 mm to 40 mm (0.8" to 1.6")</li> </ul>	
Max. print area	260 mm x 330 mm (10.2" x 13")	164 mm x 230 mm (6.5" x 9.1")
Print type	Manual	
Print table adjustment	X and Y $\pm 10$ mm (0.4"/400 mil), $\vartheta \pm 5^\circ$	
Max. PCB thickness	5 mm (0.2"), optionally thicker	
Frame type	Zelflex QR 362 mm x 480 mm (14.3" x 18.9")	Zelflex QR 266 mm x 380 mm with adapter (10.5" x 15")
Squeegee type	Hand squeegee, rubber, 260 mm (10.2")	Hand squeegee, metal, 150 mm (5.9")
Accuracy (machine)	$\pm 0.025$ mm ( $\pm 1$ mil)	
Double-sided print	Max. component height 15 mm (0.59")	
Dimensions (W x H x D)	850 mm x 180 mm x 530 mm (33.4" x 7.1" x 20.9")	
Weight	30 kg (66 lbs)	
Operating conditions	Temperature: 15 – 35 °C (59 – 95 °F); humidity: 30 – 80 %	

Technical specifications subject to change.

# LPKF ProtoPlace S

## Pick & Place Assembly

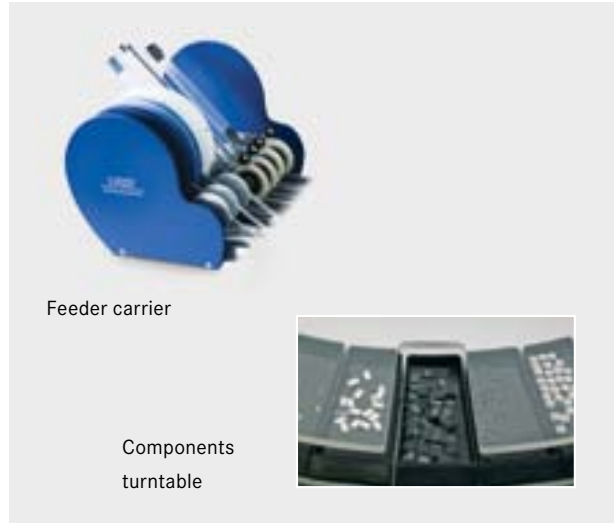
**Product:** LPKF ProtoPlace S  
**Part no.:** 126979  
**Ordering info:** See front sleeve



Populating PCBs with tiny components requires very steady hands – or the help of an assembly system. The LPKF ProtoPlace S is a manual, ergonomic Pick&Place system for professional SMT assembly. The menu-guided navigation and LCD display virtually eliminate the need for training.

The optional camera system with color screen supports the operator in positioning components with precision. For accurately placing complex SMD components, the X, Y and Z direction can be locked in on the manipulator. The PCB can then be fine-tuned using micrometer screws. Pneumatics then securely and accurately lower the component.

- Accurate assembly of fine-pitch components
- Pneumatic component placement
- Built-in adhesive and soldering paste dispenser
- Microprocessor control
- Optional camera system to assist with positioning components
- Various feeders available
- Optional vacuum table for flexible PCBs



### Many contacts, many functions

Ensuring each contact on complex SMT components meets its matching position on the PCB requires precision. The LPKF ProtoPlace S picks electronic components from a feeder or component tray via vacuum. After the initial manual positioning fine adjustments are made via the micrometer screws. Finally, the vacuum needle places the component in exactly the desired location.

In addition to assembly the ProtoPlace S can also be used as a dispenser for soldering paste, adhesive and additives.

### Accessories

The ProtoPlace S can be upgraded with optional equipment. A vacuum table, a components turntable with up to 90 component bins, rod and roller feeder and a feeder carrier are available as upgrades. The micro-camera and an LCD monitor are useful during fine-pitch assembly, while a compressor and air pressure regulator ensure the pressure required for dispensing. A description of the various options and accessories can be found starting on page 68.

Technical Specifications: LPKF ProtoPlace S	
Part no.	126979
Max. PCB size	297 mm x 420 mm (11.8" x 16.5")
Min. component size	0201 chip components
Pulse/pause duration	0.1 – 9 s / 0.1 – 2 s
Dosing quantity	Min. 0.2 µLiter
Component turntable position	Rear
Feeder position	Left
Adjustable air pressure	0.1 – 4 bar (1.4 – 58 psi)
Vacuum	Max. 0.8 bar (11.6 psi)
Weight	25 – 35 kg (55 – 77 lbs) depending on accessories
Dimensions (W x H x D) (with all feeders and turntable)	1,000 mm x 500 mm x 900 mm (40" x 20" x 35")
Dimensions (W x H x D) (machine only)	760 mm x 250 mm x 760 mm (30" x 10" x 30")
Operating conditions	Temperature: 15 – 35 °C, (59 – 95 °F); humidity: 30 – 80 %
Compressed air supply	6 bar (87 psi), min. 10 l/min (0.35 cfm), unlubricated, waterless
Power supply	115/230 V, 50–60 Hz, 10 W

Technical specifications subject to change.

# LPKF ProtoPlace BGA

## BGA Circuit Board Assembly

**Product:** LPKF ProtoPlace BGA  
**Part no.:** 111433  
**Ordering info:** See front sleeve



Modern electronics layouts increasingly rely on complex built-in components with many I/O connections such as microprocessors, DSPs and FPGAs. With these components the number of external contacts can reach four digits. These connections are typically in form of BGAs, combining high connection density with excellent manageability.

A visual inspection of the contact areas is hardly realistic and x-ray inspection costly: accurate placement gains importance.

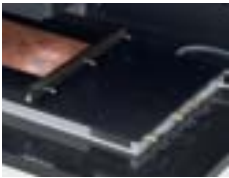
The LPKF ProtoPlace BGA will accurately assemble BGA components, CSPs or flip-chip components. The system can be used in development labs just as well as for producing custom layouts or small batches.

- Semi-automated BGA, uBGA, PLCC and QFP component placement sized 5 x 5 mm to 45 x 45 mm
- Granite-based
- Air cushioned work table
- Optical position monitoring



### Assembling components with concealed pins

Special optics and adjustable, two-colored lighting allow the PCB pads and pins to simultaneously be viewed and positioned on the component.



The rough and fine adjustments are made on an air cushioned table with micrometer screws.

Once the component is aligned it is automatically placed with just a single push of a button.



### Options

#### Vacuum table

Vacuum table for securing flexible or rigid PCBs with ease. The vacuum table is compatible with the LPKF ProtoPrint S and LPKF ProtoPlace S. See also page 67 for details.

#### MicroBGA

This retrofit option assists in placing the smallest components with a pitch of 0.25 mm/0.50 mm and a size of approx. 2 x 2 mm (0.08" x 0.08"). The set includes a micro pipette and optical converters

Technical Specifications: LPKF ProtoPlace BGA	
Part no.	126979
Max. PCB size	229 mm x 305 mm (9.0" x 12.0")
Max. size of view area	50 mm x 50 mm (2" x 2")
Min. size of view area	8 mm x 8 mm (0.3" x 0.3")
Max. size of view area – MicroBGA option	22 mm x 22 mm (0.9" x 0.9")
Min. size of view area – MicroBGA option	4 x 4 mm (0.2" x 0.2")
Pitch (QFP)	0,3 mm (12 mil)
Placement accuracy	± 50 µm (± 2 mil)
Power supply	115/230 V, 50 – 60 Hz, 20 W
Compressed air supply	6 bar (87 psi), min. 5 l/min (0.18 cfm), oil-free
Dimensions (W x H x D)	600 mm x 430 mm x 435 mm (23.6" x 17" x 17.1")
Weight	35 kg (77 lbs)

Technical specifications subject to change.

# LPKF ProtoFlow S and ProtoFlow S/N2 Reflow Ovens for Lead-Free Soldering

Product:	LPKF ProtoFlow S	LPKF ProtoFlow S/N2
Part no.:	126978	126977
Ordering info:	See front sleeve	



The compact convection oven LPKF ProtoFlow S is perfect for lead-free, RoHS compliant reflow soldering. The large motorized drawer automatically opens for cooling the PCB. The special MultiZone function allows the soldering process to be broken down into five separate phases, each featuring its own temperature profile. Three internal temperature sensors ensure even and precisely controlled heat distribution across the entire PCB surface. The LPKF ProtoFlow S also cures adhesives and conductive polymers.

The LPKF ProtoFlow convinces in SMD reflow soldering, curing conductive through-plating paste and other thermal processes requiring accurate control. The LPKF ProtoFlow S/N2 with controlled inert gas function (nitrogen) significantly reduces oxidation during the soldering process, optimizing the soldered connections.

- RoHS compliant lead-free reflow soldering
- Simple menu navigation via LCD display and arrow keys
- Preprogrammed and custom reflow profiles
- Process control and analysis via USB port
- Motorized drawer for automatic cool-off after soldering
- Model with program-controlled inert gas supply to reduce oxidation
- Additional temperature sensors optional

## Ease-of-use and powerful

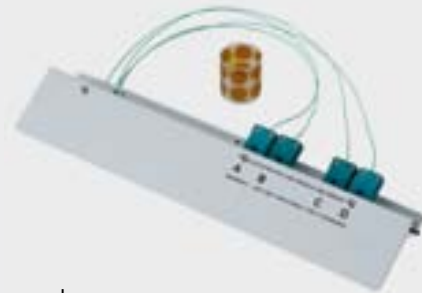
All parameters such as temperature, processing time and cool-off can easily be set with the arrow keys and LCD display. The attuned parameters can be stored as custom profiles.



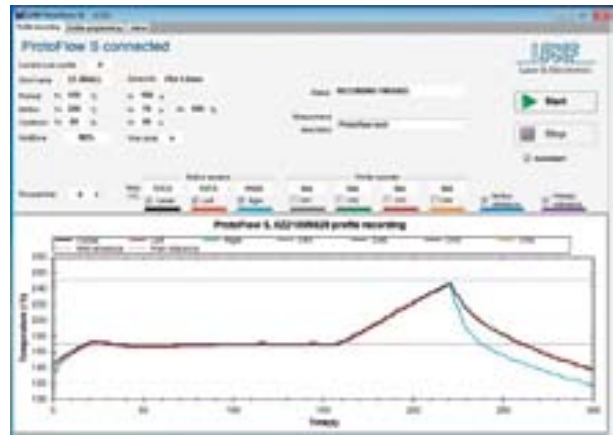
The lighted process chamber and a front window allow a visual inspection of the reflow process. USB connectivity and included system software LPKF FlowShow allow it to be controlled via PC. It can save profiles and record temperature profiles in real time – even data from the four (optional) temperature sensors which can be placed anywhere.



## Options



Profile recorder  
(Part no. 117850)



LPKF FlowShow

Technical Specifications:	LPKF ProtoFlow S	LPKF ProtoFlow S/N2
Part no.	126978	126977
Max. PCB size	230 mm x 305 mm (9" x 12")	
Max. preheat temperature/time	220 °C (428 °F), 999 s	
Max. reflow temperature/time	320 °C (608 °F), 600 s	
Long thermal treatment: temperature/time	220 °C (428 °F), 64 h	
Temperature stabilizing time	<5 min	
PCB cooling	Two fans, adjustable speed, mounted on base	
Power supply	230 V, 50 – 60 Hz, single-phase	
Max. power consumption	3.2 kW	
Dimensions (W x H x D)	647 mm x 315 mm x 450 mm (25.5" x 12.4" x 17.7")	
Weight	22 kg (48.5 lbs)	
Operating conditions	Temperature: 15 – 30 °C (59 – 95 °F) Humidity: 30 – 80 %	
Nitrogen pressure	–	7 bar (101.5 psi)
Nitrogen flow rate	–	200 – 500 l/h (0.12 – 0.29 cfm)
Software requirements	Windows® XP® or higher; MS Office XP or higher; USB 2.0	

Technical Specifications subject to change.

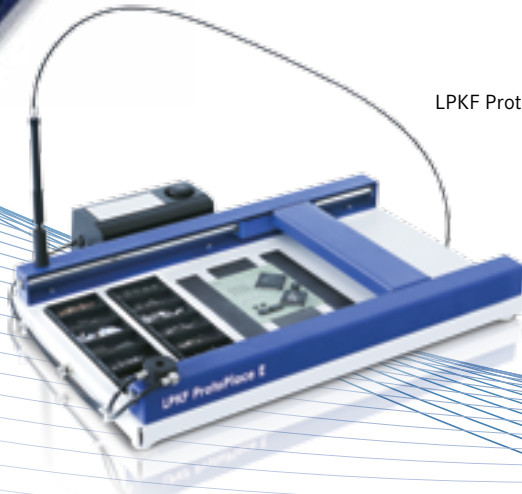
# Economical Solutions for SMT-Prototyping

## The LPKF E-Series

Product:	LPKF ProtoPrint E	LPKF ProtoPlace E	LPKF ProtoFlow E
Part no.:	127056	127055	127065
Ordering info:	See front sleeve		



LPKF ProtoPrint E



LPKF ProtoPlace E



LPKF ProtoFlow E

Quality at an affordable price. The LPKF E-series provides three options for efficient prototyping and small batch production: the stencil printer LPKF ProtoPrint E, LPKF ProtoPlace E for manual PCB assembly, and the LPKF ProtoFlow E convection oven. The three systems feature all the key functions and a maximum material size of up to 160 x 200 millimeters. Along with the LPKF ProtoMat E33 these three systems are an especially economic solution for professional LPKF quality Rapid PCB Prototyping.

- Compact and ergonomic
- Super economical
- For prototypes and small batches
- Great for education

## LPKF ProtoPrint E

The LPKF ProtoPrint E is an inexpensive SMT stencil printer for metal and polyimide stencils. A double-sided quick-clamp frame for frameless stencils (Zelflex QR) is included.

## LPKF ProtoPlace E

This manual, vacuum-assisted Pick&Place system is designed for components up to 0603 format, SO-ICs or smaller QFPs. The LPKF ProtoPlace E features 14 antistatic components bins.

## LPKF ProtoFlow E

The LPKF ProtoFlow E convection oven offers reliable reflow soldering across the entire PCB, including lead-free solder materials. Its temperature limit isn't reached until temperature 320 °C (608 °F). The reflow oven with a max. material size of 160 x 200 millimeters (6.3" x 8") is perfectly matched to the LPKF ProtoPrint E. A drawer window offers a view of the lighted process chamber, and the USB connection allows the LPKF ProtoFlow E to also be programmed from a PC for faster and easier process analysis.

### Technical Specifications: LPKF E-Series

Max. PCB size	160 mm x 200 mm (6.3" x 8")
PCB thickness	0.5 mm – 3 mm (12 – 80 mil)
Operating conditions	Temperature: 15 – 30 °C, humidity: 30 – 80 %

### Technical Specifications: LPKF ProtoPrint E

Part no.	127056
Frame type	Zelflex QR 266 mm x 380 mm (part of the system)
Film size (max.)	214 mm x 310 mm (8.4" x 12.2")
Print type	Manual, 220 mm
Squeegee type	Metall, 180 mm (7.1"), (included)
Printer table adjustment	X and Y ± 5 mm (0.2"), ± 9 5°
Min. grid size	0.625 mm (25 mils)
Dimensions (W x H x D)	270 mm x 115 mm x 470 mm (10.6" x 4.5" x 18.5")
Weight	8 kg (17.6 lbs)

### Technical Specifications: LPKF ProtoPlace E

Part no.	127055
Min. component size	0603, mini-melf, SOIC, SOT, QFP44 (0.8 mm pitch)
Power supply (vacuum pump)	230 V, 50 – 60 Hz, 6 VA
Dimensions (W x H x D)	485 mm x 80 mm x 280 mm (19.1" x 3.1" x 11")
Weight	5.8 kg (12.8 lbs)

### Technical Specifications: LPKF ProtoFlow E

Part no.	127065
Max. preheat temperature/time	220 °C (428 °F), 999 s
Max. reflow temperature/time	320 °C (608 °F), 600 s
Long thermal treatment: temperature/time	220 °C (428 °F), 64 h
Temperature stabilizing time	<5 min
Power supply	Single-phase 220 – 240 V, 50 – 60 Hz, 1,650 W (max.)
Dimensions (W x H x D)	400 mm x 280 mm x 380 mm (15.7" x 11" x 14.7")
Weight	18 kg (40 lbs)

Technical Specifications subject to change.

# Additional Options for Through-Hole Plating, Multilayer Production and SMT Prototyping

All systems and methods are delivered to the customer complete with sufficient basic supplies. Additional options open the door to special application areas. Here is a selection:

## Accessories for through-hole plating with LPKF ProConduct



### **Convection oven** (Part no. 115877)

The convection oven is used for curing the ProConduct paste, pre-drying the PCB for solder resist and curing the solder resist/labeling, in about 30 minutes. With timer and precise temperature control.



### **Vacuum table** (Part no. 115878)

Vacuum table developed specifically for the ProConduct system for extracting excess paste prior to the curing process.



### **Dust extractor** (Part no. 114647)

The dust extractor ensures a consistent vacuum across the entire vacuum table.

## Accessories for bonding multilayers with the LPKF MultiPress S



### **Rolling table** (Part no. 107050)

A rolling table with sturdy casters specifically for the MultiPress S.



### **Automatic hydraulics upgrade** (Part no. 120744)

The automatic hydraulic unit is an extension of the MultiPress S.

## Accessories for the LPKF ProMask and LPKF ProLegend



### UV exposer

230/240 V: Part no. 117050

110/120 V: Part no. 117192

Transfers the transparency master onto the PCB in about 30 seconds.



### LPKF ProMask consumables set (Part no. 117108)

Includes ProMask solder resist, developer, conditioner, laser printer film.

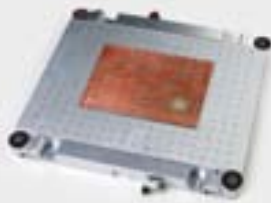
### LPKF ProLegend consumables set (Part no. 117564)

Includes ProLegend labeling paint, developer, conditioner, laser printer film.

### Convection oven (Part no. 115877)

See page 66.

## Accessories for LPKF ProtoPrint S/ProtoPrint S RP



### Vacuum table (Part no. 119684)

The vacuum table secures any PCB type from rigid to flexible, regardless of their thickness. It can be transferred between systems without breaking the vacuum. An optional ceramic slab (Part no. 125021) allows the vacuum table to also be used for the subsequent reflow process.

<b>Max. material size</b>	229 mm x 279 mm (9" x 11")
<b>Max. compressed air</b>	7 bar (102 psi)
<b>Compressed air supply</b>	1.7 – 6 bar (24.7 – 87 psi), 0.3 – 0.79 l/s

Technical specifications subject to change.



### Magnetic edge support

Magnetic edge support (4 pieces) Part no. 126507

Magnetic support pin (4 pieces) Part no. 128946

Positioning pin (4 pieces) Part no. 128947



### Mechanical stretching frame

ZelFlex QR 362x480, double-sided  
(included with ProtoPrint S).

ZelFlex QR 266x380, double-sided  
(included with ProtoPrint S RP).

## Continued: Accessories for LPKF ProtoPrint S/ProtoPrint S RP



**Pneumatic stretching frame** (Part no. 127094)  
ZelFlex Z4P 406 x 508 x 25 mm slim, four-sided  
(print area 306 x 408 mm [12"x16.1"])



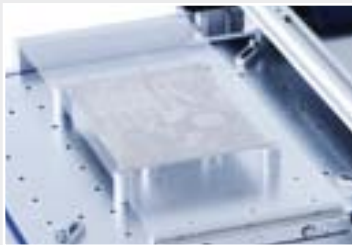
### Squeegee

Various squeegees for applying solder paste.

Hand-held squeegee, rubber, 150 mm (5.9"):	Part no. 101325
Hand-held squeegee, rubber*, 260 mm (10.2"):	Part no. 108140
Hand-held squeegee, metal**, 150 mm (5.9"):	Part no. 124869
Hand-held squeegee, metal, 260 mm (10.2"):	Part no. 124870
Hand-held squeegee, Permallex, 150 mm (5.9"):	Part no. 122242
Hand-held squeegee, Permallex, 260 mm (10.2"):	Part no. 122257

\* included with LPKF ProtoPrint S.

\*\* included with LPKF ProtoPrint S RP.



### Test print film

 (Part no. 115632)

Test print film makes setting up new print jobs easier and quicker.

### Polyimide film

 (Part no. 108321)

Set (10 sheets, 210 x 297 mm, 0.125 mm thick)

## Accessories for SMT assembly with the LPKF ProtoPlace S



### Micro-camera

 (Part no. 115040)

The micro-camera is mounted directly to the manipulator. The optional color monitor shows an enlarged view of the components placement. The vision-system effectively supports users in placing fine-pitch components.



### LCD color monitor

 (Part no. 119777)

The LCD monitor displays the image transmitted by the optional camera with detailed accuracy, allowing the smallest of components to be positioned accurately.



### Compressor

 (Part no. 101092)

The compressor with 6 liter pressure tank is very quiet (52 dB) and provides a air pressure of 6 bar and a volume of 33 l/min (1.2 cfm).

## Continued: Accessories for SMT assembly with the LPKF ProtoPlace S



### **Air pressure regulator** (Part no. 124919)

Air pressure regulator with water trap and 5 µm particle filter mounts to the side of the ProtoPlace S.



### **Motorized components turntable**

The motorized carousel significantly accelerates components intake. The components are stored in inscribable bins.

45 component trays: Part no. 114460

75 component trays: Part no. 114461

90 component trays: Part no. 114462



### **Feeder carrier** (Part no. 115590)

The feeder carrier holds up to 12 feeders at a time. Required for optional roller or rod feeders.

### **Roller feeder**

Roller feeders for components of various widths are available for the LPKF ProtoPlace.

Roller feeder 8 mm: Part no. 116004

Roller feeder 12 mm: Part no. 116008

Roller feeder 16 mm: Part no. 116009



### **Rod feeder**

The LPKF ProtoPlace can be used with rod feeders for various components.

S08-S028: Part no. 101356

S08L-S028L: Part no. 101356

PLCC28-PLCC44: Part no. 101357

PLCC52-PLCC84: Part no. 103897

### **Vacuum table** (Part no. 119684)

## Reflow soldering accessories for the LPKF ProtoFlow S/ProtoFlow S N2



### **Temperature indicating device** (Part no. 117850)

A freely positionable auxiliary module with four temperature sensors completes the LPKF ProtoFlow S. The temperature sensors detect the precise temperatures of critical components or the PCB in real time. The temperature curves for all four sensors are displayed on the monitor in a temperature/time view and stored for future analysis. The profile recorder requires a PC with USB port as well as standard software (spreadsheet).

## Accessories for ProtoPlace E / ProtoPrint E



### Magnetic fixing pins

Set of magnetic fixing pins (Part no. 10015381)  
Allows double-sided printing. Set includes:  
Magnetic edge supports (4 pieces), Magnetic support pins (4 pieces),  
Magnetic positioning pins (2 pieces)



Magnetic edge supports (4 pieces)  
(Part no. 126507)



Magnetic support pins (4 pieces)  
(Part no. 10015383)



Magnetic positioning pins (2 pieces)  
(Part no. 10015385)

## Accessories for ProtoFlow E



### Software Licence: FlowShow SE (Part no. 128821)

The LPKF FlowShow SE software controls the LPKF ProtoFlow E reflow oven directly via the USB port of a PC. It also handles programming, data logging and optimization of the soldering process.

Software requirements: Windows® XP® or higher; MS Office XP or higher;  
USB 2.0

# Customer Testimonials

**“The LPKF ProtoMat is small and easy to use. It is very useful to make all kinds of small-series PCBs. And it corresponds fast to design changes!”**

Tomokazu Watanabe  
DENSO CORPORATION  
Japan

**“Enercon has been using a ProtoMat S62 for years: as a leading manufacturer of innovative wind power plants, the ProtoMat hardly ever gets a break: we use it to produce various test equipment, but also measuring adapters, receiving devices and signs for wind power plants throughout the world. The materials we use are e.g. plastic, hard paper, aluminum or GRP. The LPKF ProtoMat yields perfect results within short periods.”**

Holger Lübben  
Enercon GmbH  
Aurich, Germany



**“When it comes to implementing precision RF designs on ceramic materials, the ProtoLaser S is clearly more advanced than conventional methods. Instead of four weeks we now only need a few hours for our high frequency boards. The outstanding geometric accuracy and clearly laid out controls of the laser system allow us to also produce sophisticated PCBs in small batches or on demand.”**

Michael Kuri  
Fraunhofer Institute for Applied Solid State Physics  
Freiburg, Germany



**“Qualified training is the best recipe for a successful start to a career. SICK AG has recognized this and also relies on professional equipment for training. Our training departments feature a LPKF ProtoMat S62. The S62 is constantly in use and has proven to be extremely reliable.**

**Our trainees transform theoretic knowledge into functional printed circuit boards – in the process learning all about prototyping methods.”**

Nico Zimmermann  
SICK AG  
Waldkirch, Germany





LPKF StencilLaser G 6080



LPKF Fusion3D 1500



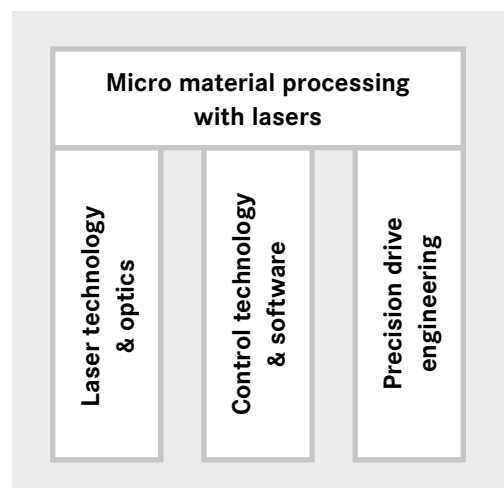
LPKF Fusion3D 6000

# Specialist in Micro Material Processing

Our high-precision milling technology goes all the way back to the company’s beginnings. LPKF developed additional divisions and markets such as automotives, consumer electronics, and medical and solar technology based on precision drives and controls, and the laser as a tool. In addition to sophisticated methods for producing circuit board prototypes and small batches, the company also offers laser systems for micro material processing.

Building powerful milling plotters requires a great range of skills. Control systems and precision drive technology laid the foundation, experience and continued enhancements to products and methods account for the rest. LPKF has been dedicated to circuit board prototyping for more than 35 years, and this expertise is built into each milling plotter.

At the end of the 1980’s, the laser became an item of interest for industrial production: the laser promised new production forms and technologies. LPKF has delivered on this promise and in 1993 already provided the first laser systems for manufacturing electronics. Ever since, laser technology – at LPKF in the micromachining of materials – has been playing an ever increasing role.





LPKF MicroLine 6000 P



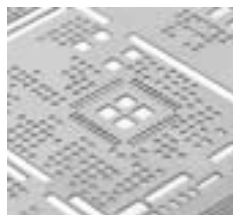
LPKF MicroLine 6000 S



LPKF MicroLine 1000 S

### Soldering paste stencils with LPKF StencilLasers

LPKF is a worldwide leading supplier of StencilLasers featuring groundbreaking technology for producing SMT soldering paste stencils and micro-cutting parts. LPKF StencilLasers are characterized by accuracy, reliability and high capacity. LPKF offers a wide range of machines for any cutting application imaginable, with material thicknesses up to 1000  $\mu\text{m}$ .



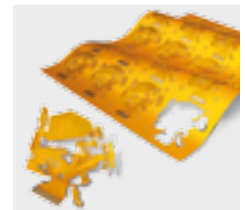
### Laser direct structuring (LDS) three-dimensional interconnect devices

LPKF 3D laser systems are designed specifically for producing three-dimensional interconnect devices (MID). Components combine mechanical and electrical functions in confined spaces. Previous methods for producing MIDs required expensive product-specific tools to create the circuitry on the component. The patented LDS method allows ultra-fine conductive patterns to be transferred right from the layout to the component, using LPKF 3D laser systems.

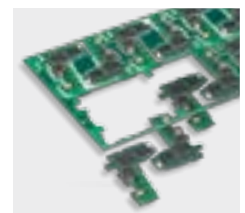


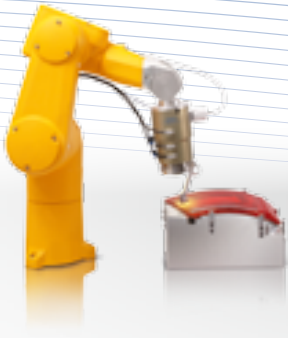
### LPKF MicroLine UV laser systems for cutting PCBs and cover-layers

LPKF MicroLine UV laser systems are production machines for non-contact contour cutting/depanelling flexible and flex-rigid interconnect devices without any burrs, and for making apertures in cover-layers – with utmost precision and flexibility. Changeover times when switching products are reduced and reworking costs are eliminated.



LPKF MicroLine laser systems are designed for cutting assembled and unassembled circuit boards. User-defined panels can quickly be cut from larger circuit boards without mechanical stress. Electronic components can be positioned closer to the edge and the electronic design engineers benefit from maximum design freedom.





LPKF TwinWeld 3D



LPKF LQ-Vario RT



LPKF Allegro

### Laser Plastic Welding

Laser plastics welding offers technological and economic advantages compared to conventional plastics welding. The plastics welding division is focused on this innovative technology, supporting users during implementation, and offers systems for stand-alone and in-line manufacturing.



### Innovative motor controllers, precise drive technology, integrated inspection

The LPKF subsidiary LPKF Motion & Control GmbH develops, plans and manufactures innovative automation solutions for manual and fully automated stand-alone and in-line production systems. The product range includes laser machining systems, systems for inline inspection and micro material processing, and more. Special expertise is provided for developing and implementing precision drive technology and innovative control engineering.

### Laser systems for structuring thin film solar modules

Thin film solar modules feature lower production costs and enhanced low-light properties compared to crystalline modules, which is why its market share keeps growing. The Allegro series laser scribing systems with their precision, high output and innovative technological details contribute to the production of increasingly more powerful modules with sinking production costs.



### General services for industrial laser micro material processing

LaserMicronics GmbH offers a broad range of general services in the area of industrial laser-micromachining of materials and process development. The spectrum covers all current LPKF technologies – from process development to process optimization, all the way to small batch or mass production. LaserMicronics GmbH has manufacturing sites in Garbsen and Erlangen, Germany, operated in strict compliance with ISO-9001 quality guidelines.



# Technical Information

This technical information provides an introduction to the innovative prototyping solutions offered by LPKF. One comprehensive system allows you to manufacture production quality printed circuit boards (PCBs) close-to-production in house.

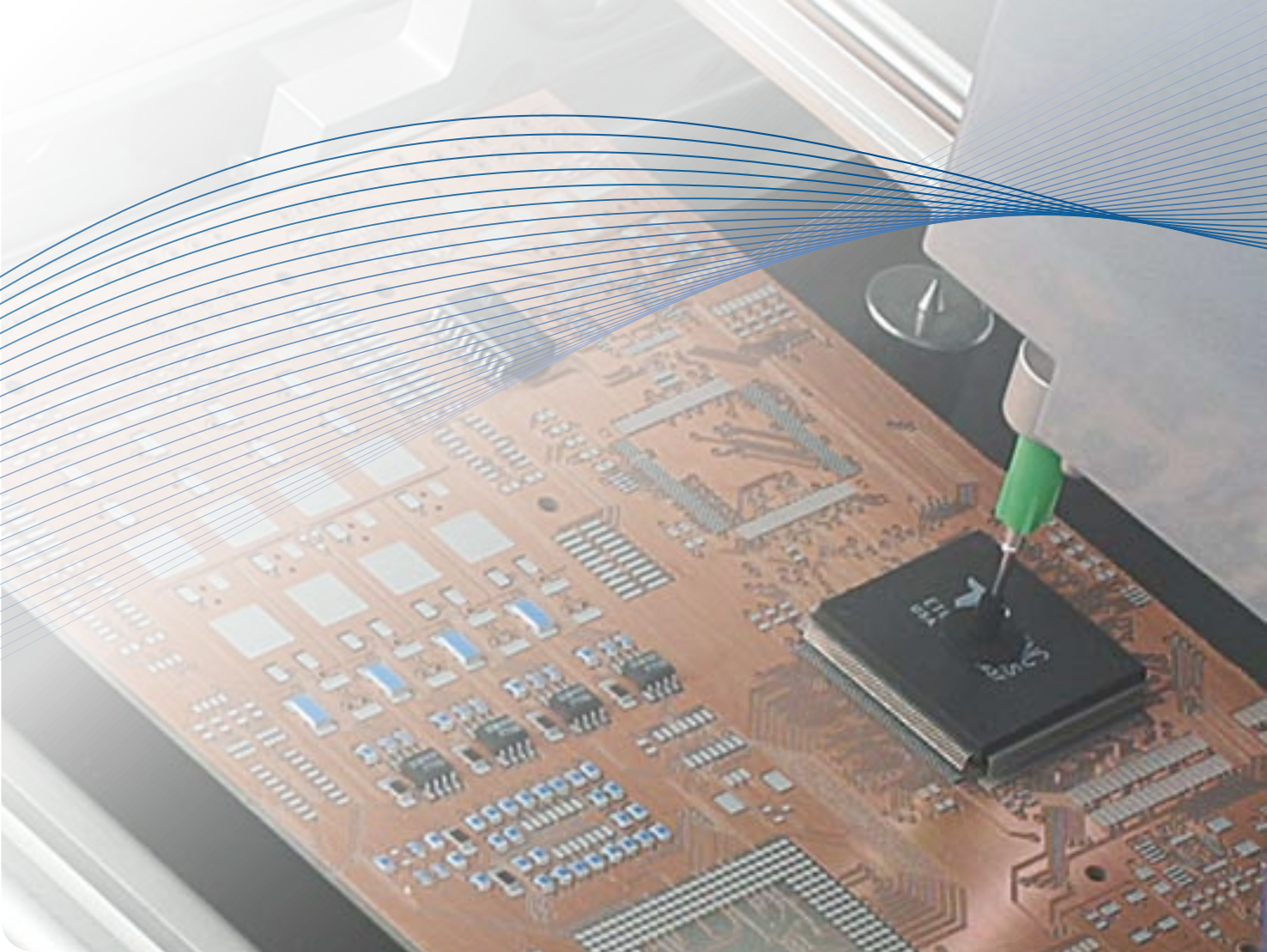
Mere hours pass from design to the finished prototype without sensitive design data leaving your company. The LPKF processes are also suitable for in-house manufacturing of low-volume production on-demand.

PCB prototyping by LPKF means: reliable results within a short period using environmentally friendly methods.

**i This catalogue does not replace the manuals for the individual products. Always observe the safety precautions and particularly the legal regulations.**

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## Process Steps of PCB Prototyping

From concept to finished product – after being designed with the design software the PCB must physically be manufactured. During the first step a circuit board plotter or a laser system creates the circuit tracks on a substrate. Additional process steps quickly result in a functional PCB.

### **Structuring PCBs**

The LPKF ProtoMat series circuit board plotters set worldwide standards in precision, flexibility and ease of operation. The equipment mills the structure of the printed circuit board on a fully coated substrate. The LPKF circuit board plotters significantly reduce production times of PCB prototypes and therefore the development time of new products. High-speed spindles with speeds ranging from 33,000 – 100,000 rpm, a resolution of up to 0.25  $\mu\text{m}$  (0.01 mil) as well as a very high repeatability ensure the finest structures are produced even in RF- and microwave applications.

Multilayer PCBs and the plug-in assembly of electronic components require drill holes. Even these drill holes are produced by the LPKF ProtoMat systems.

When it comes to extreme precision two laser systems set new standards: the LPKF ProtoLaser S and U3 offer tool-less and non-contact structuring and are already preconfigured for many substrates and conductive coatings. Special capabilities on RF- and ceramic boards make these systems unique worldwide.

- Fast structuring with LPKF circuit board plotters
- Easy and reliable: multilayer with up to eight layers
- Complete in-house finishing

## Surface Mounted Technology (SMT)

SMT is a design principle where tiny electronic components are applied directly onto a PCB. These components are SMDs (surface mount devices). SMT prototyping includes solder paste printing as well as SMD assembly.

In-house SMT Prototyping saves time and contributes to ensuring sensitive data is not needlessly made accessible to third parties. SMT Prototyping requires an accurately coordinated production system.

### Drilling and through-hole plating

Another process step is the through-hole plating of PCBs. Through-hole plating can be voltaic, with a paste or a riveting technology, depending on the application field of the PCBs and the technical requirements. LPKF offers professional systems for all methods.

### Multilayer

Even complete multilayer circuits can be produced within a short period with professional results. The LPKF MultiPress S provides developers with a state-of-the-art multilayer lamination press for in-house production.

### Separating PCBs

Separating the PCBs from a larger panel is another task performed by the LPKF ProtoMat. One or more boards are arranged on a substrate and singularized with a milling machine or the LPKF ProtoLaser U3.

### Solder resist

The use of solder resist is often essential in SMD assemblies. Applying a solder resist mask to the PCB prevents subsequent short-circuits and corrosion.

### Legend printing

LPKF also offers an ecological and easy-to-use manage solution for labeling the PCB with the components or the manufacturer's logo – the ProLegend.

### Solder paste stencils

An SMD solder paste is applied onto all pads to be assembled using a solder paste stencil. Prototyping stencils can be produced with an LPKF ProtoMat or laser system. They are then printed using a special stencil printer such as the LPKF ProtoPrint S.

### SMD assembly

Assembling SMD components onto the PCB requires high accuracy. Therefore a semi-automatic assembly system such as the LPKF ProtoPlace S is used for PCB prototyping, where the exact placement of the elements is monitored via a camera system.

### Reflow soldering

The last production step in SMT prototyping is reflow soldering. The lead on the PCB is carefully heated in a reflow oven at a predefined temperature profile. This melts the solder paste and connects the PCB and components.

# Basic Knowledge of Printed Circuit Boards

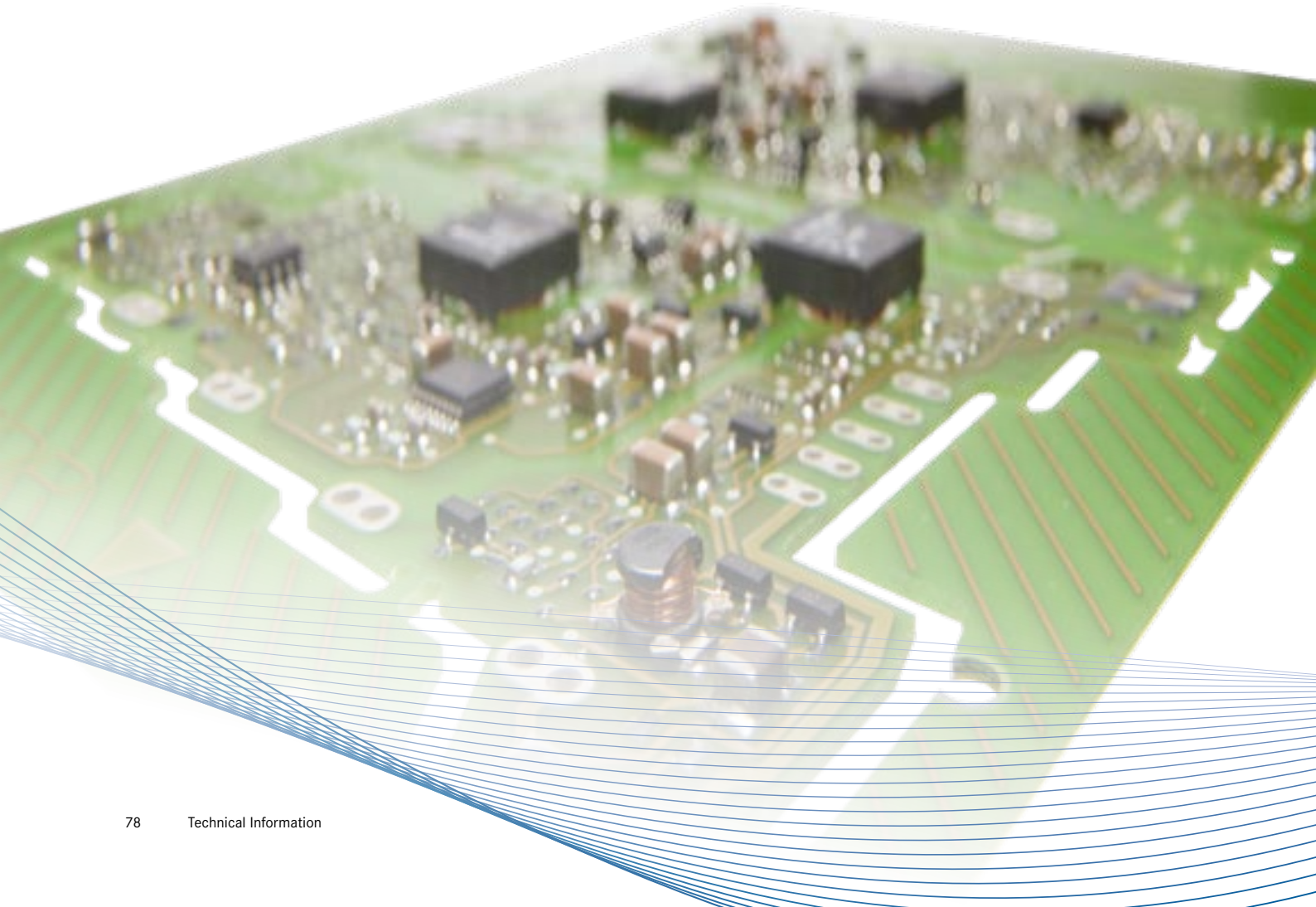
The PCB not only holds electronic components but also provides their electronic connection through PCB tracks, shielding against electronic fields or thermal conduction. With increasing complexity, more tracks and components must fit into the same space – and prototyping offers various technical solutions.

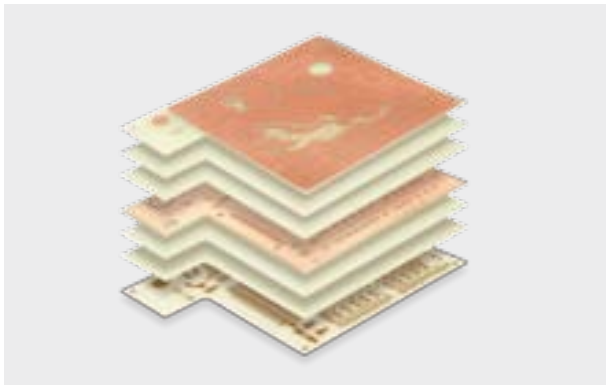
## Single-sided PCBs

The substrate of a single-sided PCB consists of an electrically isolating substrate coated with a conductive material. Primarily FR4 substrates are used, a fiber-glass reinforced epoxy resin with the conductive layer typically made from copper. The copper application is indicated in copper thickness (micrometers or  $\mu\text{m}$ ) or copper weight (oz – ounces per square foot). Typically lamination thicknesses of  $35\ \mu\text{m}$  (1 oz) are used. For some applications the copper is also coated with an additional metal such as nickel, tin or gold (surface finish). The FR4 substrate varies in thicknesses ranging from 0.25 mm (10 mil) to 3.125 mm (125 mil). The most common substrate thicknesses used are 0.76 mm (30 mil) or 1.5 mm (62 mil).

## Double-sided PCBs

On double-sided PCBs the bottom face of the board is also coated with conductive material – generally copper – in addition to the top face. The LPKF circuit board plotters feature a mechanical passer system or a camera which automatically captures the position when drilling and milling double-sided PCBs. This ensures the structures on the top and bottom of the double-sided PCB are identical. The two ProtoLaser systems each come with a vacuum table and a vision system.

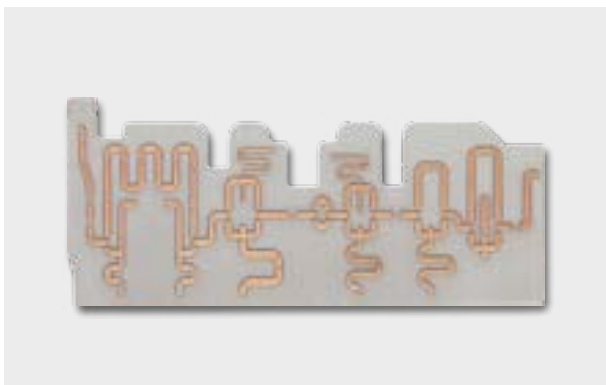




Multilayer

## Multilayer

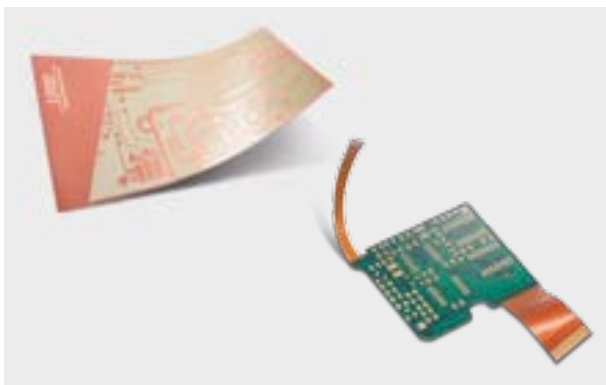
Multilayer refers to PCBs with multiple layers. They are laminated from multiple layers of PCBs and insulating material. In theory the number of conductive layers insulated from each other is infinite. Multilayers can be assembled with double-sided structured PCBs in the inner layers and single-sided PCBs in the outer layers. A through-hole plating process adapted to multilayers is required in order to create the electrical connections between the individual layers.



TMM substrate and PTFE substrate

## RF- and microwave circuits

RF- or microwave PCBs are made from materials with special electrical and mechanical properties, for example fiberglass-reinforced polymer resin with the addition of RO4000® ceramic particles and many more. Machining these sometimes highly sensitive surfaces and the exact geometries requires maximum precision – circuit board plotters with high spindle speeds or the LPKF ProtoLaser S ensure a precise match between design/simulation and structuring result.



Flexible and rigid-flex substrates

## Flexible and rigid-flex PCBs

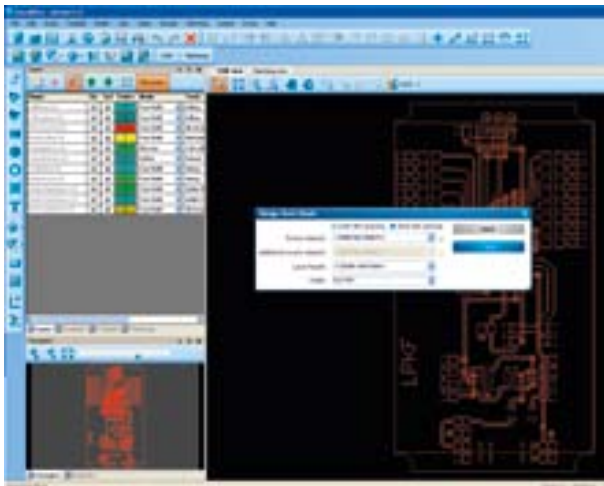
Flexible PCBs typically consist of polyimide films with copper tracks. Rigid-flex PCBs are formed by combining flexible substrates with rigid PCBs. Producing rigid-flex PCBs is similar to multilayer boards.

# LPKF Software – Intelligent Helper for Prototyping

Precision counts – which makes controlling modern prototyping systems unthinkable without sophisticated software. LPKF CircuitPro is the latest generation powerful CAM and machine software. It combines data preparation and system control in one program.



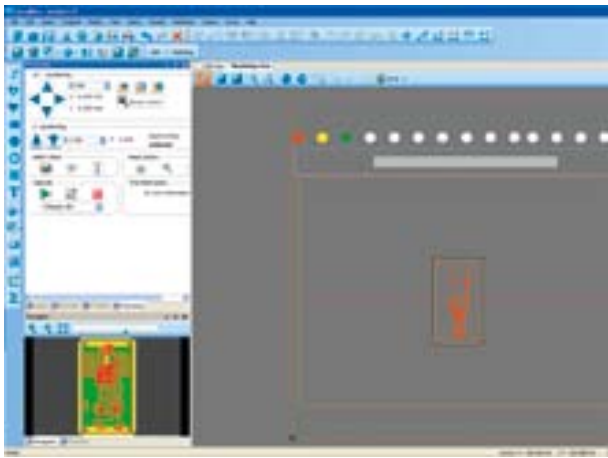
Already during the installation process LPKF CircuitPro checks, which prototyping units will be used and includes them in the production process. LPKF CircuitPro transfers design data from CAD/EDA systems. The process planning assistant prompts e.g. the number of layers, the material used and the type of finishing. Step-by-step the project parameters are created.



Then it comes down to optimizing the data for prototyping. After that the Design Rule Check is initiated: it determines whether the design can actually be physically machined with the existing tools, and for example indicates if the conductor path spacing is too small.

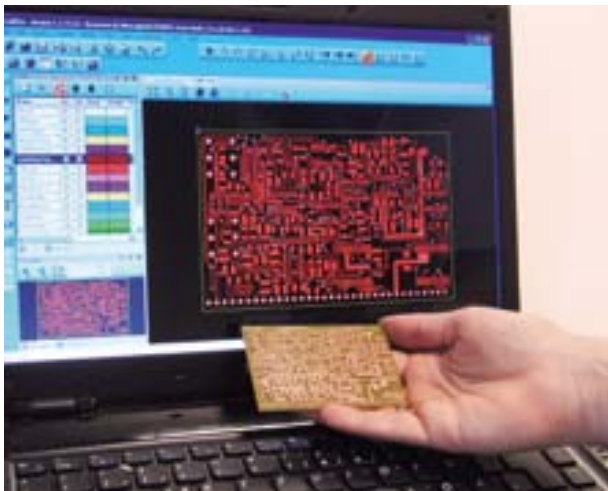


In the next step the LDKF CircuitPro produces milling lines for isolating conductor paths and the contours for cutting out the PCB – both with the newly designed Technology Dialogue. One action combines all tasks specific to PCB.



Additional production controls are handled by the Production Assistant, which guides the user through the production process. After switching from CAM to machine view the LDKF CircuitPro prompts for material properties and defines the position on the working table.

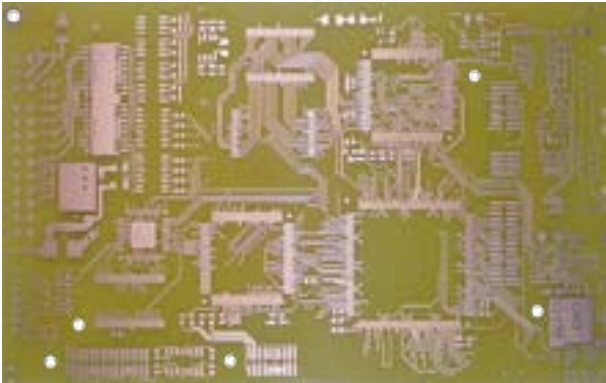
The project is then placed on the yet empty virtual work surface – and production could technically start now. At this point multiple PCB for a project can be positioned on one board. This allows multiple PCBs to be manufactured from a base material.



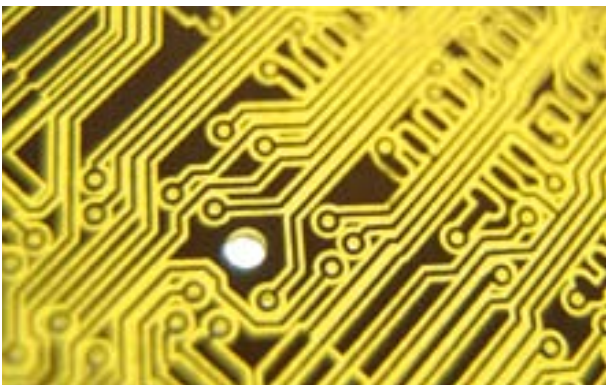
The assistant indicates user interaction required during the machining process of the blank. This can be e.g. turning the machined board, throughplating or a tool change. If in the end the project is saved, all production data will right away be available for the next run.

# Structuring and Machining PCBs

After designing the circuit, the planned layout must be transferred onto a board. In PCB prototyping the negative method prevails: insulating areas are milled into a fully coated PCB. The insulating channels form the contours of the tracks and pads. Depending on the requirements, two finishing options are available: mechanical structuring through milling and laser structuring.



Single- and double-sided PCBs and multilayer



Wiring systems are created by milling contours



Interconnect device for RF- and microwave technology

## Creating circuitry through contour milling

During the milling process the PCB layout of the outer and inner layers is transferred onto the substrate. During this process the conductive material is removed from the insulating substrate using a high-speed milling machine.

The higher the speed, the finer the tools that can be used for milling. This is particularly beneficial in substrates for RF applications. The maximum speed of the milling spindle determines how fine the structures can be and the smallest possible drill diameter.

All PCB tracks and soldering areas are first edged with the standard milling cutter. This ensures clean and identical edge geometries, which has a positive impact on the electrical properties of a PCB. A small milling cutter is only used in areas with small insulating spacing. Larger insulated areas are automatically milled out with the largest possible milling tool to save time and money.

Some milling tools for structuring PCBs have a conical point. At the beginning of the milling process the milling width and along with it the minimal insulating distance is determined based on the milling depth in the substrate (immersion depth).

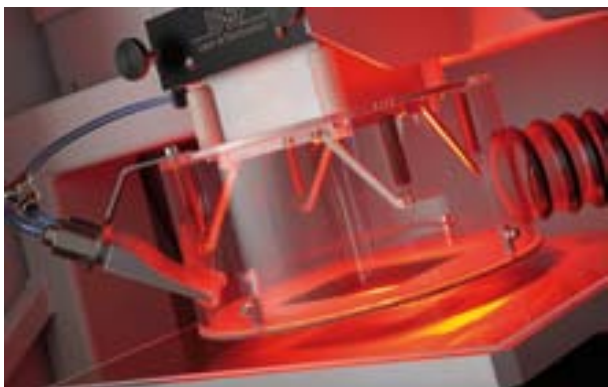
There are various methods for adjusting the milling depth: if an automatic tool change is installed, the drilling and milling tools are automatically changed during the milling process. The tool change is combined with an automatic milling width adjustment. This facilitates unattended machining. In manual tool changes the milling depth is adjusted with a micrometer screw.

The change is controlled via the system software, LPKF CircuitPro. The service life of the various tools is stored in the control software. A warning message indicates the pending tool change. The acoustic cabinet on the LPKF circuit board plotters minimize noise emissions. They further ensure optimal occupational safety in any working environment.

### Laser structuring

Laser offers the best conditions for direct structuring copper-plated PCBs. High precision and edging accuracy qualify the laser process particularly for RF layouts. Laser micromachining convinces with high energy densities in the smallest areas, excellent focusing capabilities and free control of the laser spot.

Since the layers in composite materials have different ablation thresholds the patented process of targeted etching is used in laser structuring. Here the laser beam first creates the PCB track structure on the surface of the PCB with a precisely metered energy input, then systematically removes the conductive layer – typically copper – using less energy, without compromising the substrate of the PCB. This patented process allows the laser to be used for direct structuring PCBs made from laminated materials at an etching rate of up to 6 cm<sup>2</sup>/min. Since this has minimal impact on the substrate the measured insulating resistances comply with the requirements of IPC standard TM 650.

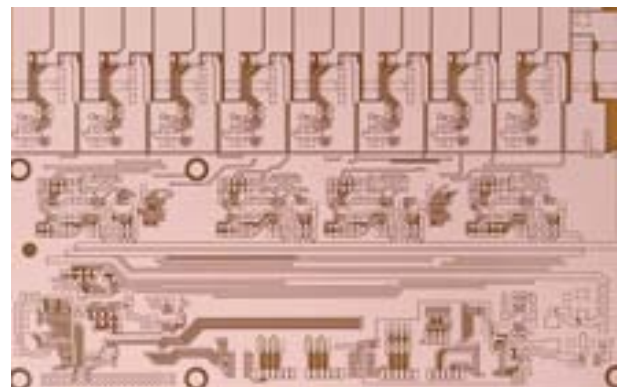


LPKF ProtoLaser S

When structuring purely ceramic interconnect devices the conductive metal layers are vaporized with high laser energy, not etched. Here the laser implements an isolation gap of 25 µm. With this material class the LPKF ProtoLaser S can also be used for separating the material. For drilling and cutting laminated PCBs we recommend combining it with the LPKF ProtoMat. The new ProtoLaser U3 can do both: It structures laminated substrates and then cuts them out of larger boards.

### Powerful machine software

The CAM software LPKF CircuitPro is the basis for easy operation of the LPKF ProtoMats. It converts the designs from common design programs into control data for the structuring systems, allows optimizations to the layout elements and offers check routines. This enables any user to create individual pieces and small batches with ease. LPKF systems are ideal for high-performance, analog, digital, RF- and microwave applications. Options such as a vacuum table or the vision system further simplify handling and reduce the required user interventions to a minimum.



FR4 PCB structured with ProtoLaser S

# Laser-Micromaterial Machining

There is a fundamental difference between laser light and conventional light, in several aspects in fact. Laser light is monochrome; it only has a marginal spread spectrum. At the same time laser beams can easily be bundled – the high amounts of energy are concentrated on an area closely limited to the diameter of the beam. The focus of the laser has a higher energy density than the surface of the sun.

The wavelength of the laser changes depending on the source emitting the laser – a crucial aspect of a wide range of applications. The different materials have different absorption properties. The higher the absorption of a material the more energy is transmitted by the laser.

The laser energy brought to the material is split into the effects:

- Transmission – the part of the laser light which goes through the material.
- Reflection – the part of the laser energy reflected by the material.
- Absorption – the energy effective in the material.

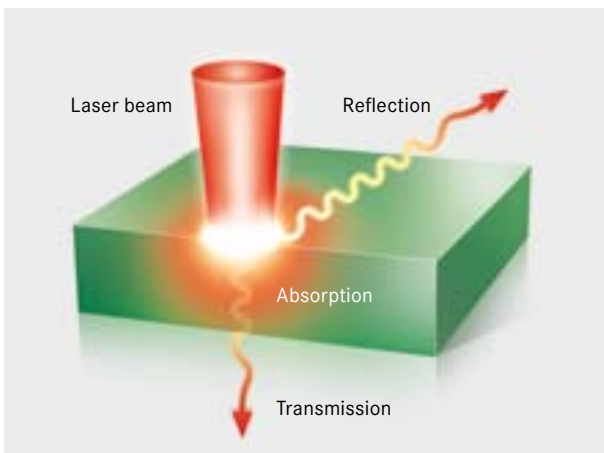
The laser applies energy onto the material without touching it. The absorbed energy activates electrons in the target material. This results in three kinds of effects:

- The applied energy breaks up chemical bonds
- The material fuses from the applied energy
- High pulse energies vaporize the material

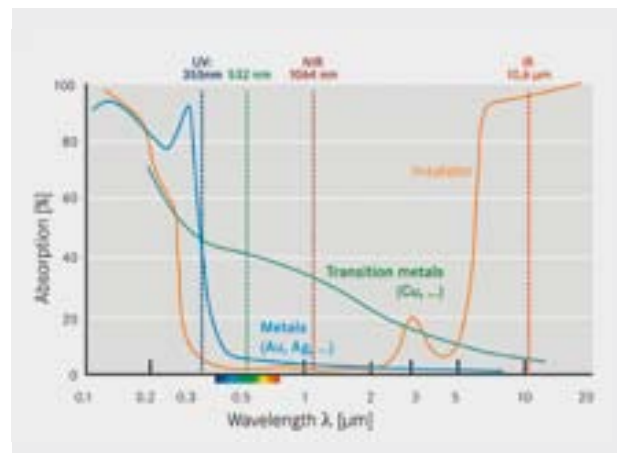
In addition, photochemical reactions can be evoked in suitable materials. Laser processes are tool-less processes, meaning they require no tools. This makes the process cost-effective, quick and sturdy.

Laser micromachining is among the core competences of LPKF. Lasers cut, drill and structure. Lasers machine thin multilayers, rigid, rigid-flex and flexible PCBs. They are ultra precise, gentle and quick. Engraving, scoring and marking were typical applications for first generation laser systems. Over the years the application spectrum has broadened, for example invisible, micro-structured layouts on films and glass mediums for touch screens.

Micromachining ceramics is gaining importance. Lasers can be used for direct structuring by vaporizing a conductive coating as well as for precision cuts in material.



Only the absorbed energy is effective in the component



Absorption values vary depending on laser wavelength and materials

## LPKF ProtoLaser S

The LPKF ProtoLaser S stands for efficient prototyping of complex digital and analogue circuits, RF- and microwave PCBs up to a size of 229 mm x 305 mm (9" x 12"). The system can be used for non-laminated and laminated PCBs. The ProtoLaser S structures a A4 size layout in about 20 minutes. Track thicknesses of 50 µm and gaps of 25 µm with exact geometries can be produced on ceramics. The precise process control also allows circuits to be produced based on aluminum-coated PET films, copper-coated FR4, ceramic and RF substrates.

## LPKF ProtoLaser U3

The LPKF ProtoLaser U3 is equipped with a UV laser, which can be used to perform a multitude of tasks due to its high beam quality and absorption properties. The system can cut and drill or depanel boards made of nearly any material – even delicate ceramics – without stressing the material. With expert control of the overall system, the ProtoLaser U3 can now also precisely structure and machine laminated substrates such as FR4.

The specific wavelength of the UV laser enables gentle ablation and precise contours. Because the depth of laser machining can be controlled, the ProtoLaser U3 can perform structuring, engraving, and depaneling in one pass.



# PCB Structuring with the LPKF ProtoLaser S

The ProtoLaser S transfers circuit layouts onto the PCBs with previously unseen speeds and precision. It's the only laser system also suitable for direct structuring laminated substrates. The compact system can structure PCBs up to a maximum layout area of 229 mm x 305 mm (9" x 12"). The LPKF ProtoLaser S works in the near infrared range. With this it creates complete layouts on PCBs without chemicals.



## Another dimension of prototyping

The ProtoLaser S masters both the delaminating and vaporizing methods of structuring and is therefore vastly impartial to the substrate material. The process control allows copper-coated FR4 material to be structured just as easily as aluminum-coated PET film. Even thermoplastics such as PTFE as well as ceramic filled and purely ceramic substrates from RF technology are suitable as substrates. On ceramics track width of 50  $\mu\text{m}$  and 25  $\mu\text{m}$  gaps can be produced with exact geometries. Its high precision and edge accuracy make the ProtoLaser S recommended for use wherever precise, steep edges are required. The reproducibility of the results surpasses mechanical, tool-bound or chemical processes. The non-contact laser process particularly unfolds its strengths on flexible and delicate materials.

## Laser structuring of laminated PCBs

The LPKF ProtoLaser S applies a patented process on laminated PCBs. First, the laser structures the outlines of the circuit and then delaminates the copper layer. Superfluous copper comes off in chunks. With this setting the ProtoLaser S will structure a complex design layout at A4 size in a mere 20 minutes.

## Laser structuring ceramic interconnect devices

In purely ceramic interconnect devices without an adhesive layer between the conductive material and the substrate the ProtoLaser S utilizes an alternate method. An ultrahigh-energy laser beam fuses the affected material within fractions of a second. Due to its temperature resistance the ceramic substrate remains intact. Insulation spaces of 25  $\mu\text{m}$  and track widths of 50  $\mu\text{m}$  can be realized on these materials.

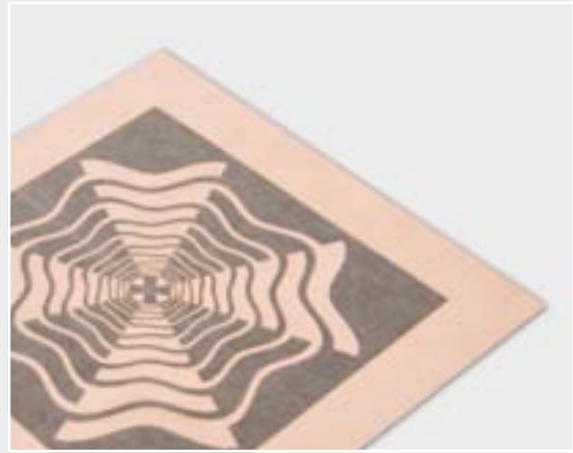
Even when it comes to power electronics applications the ProtoLaser S is a great fit. Vaporization will also structure thick-film boards: the laser beam is guided over a position multiple times until the conductive layer has been removed.

## Mass-production quality in-house

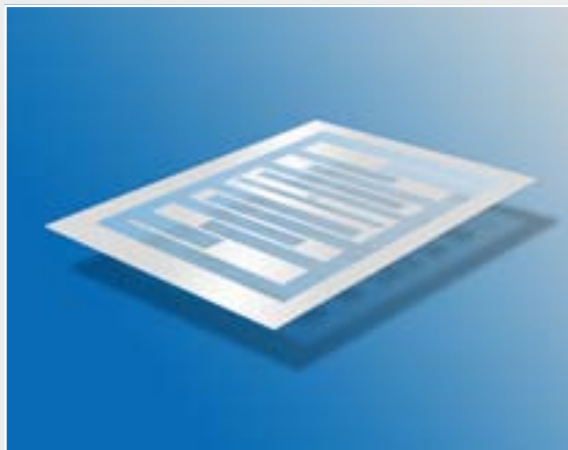
Sophisticated applications – fabricated from substrates in mere minutes with the LPKF ProtoLaser S.



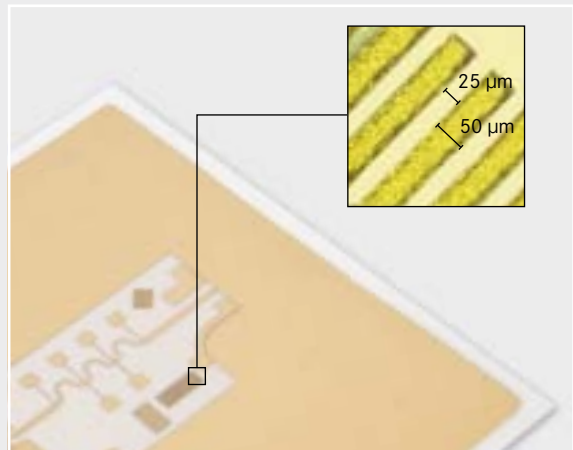
Cu (18  $\mu\text{m}$ ) on FR4



PTFE



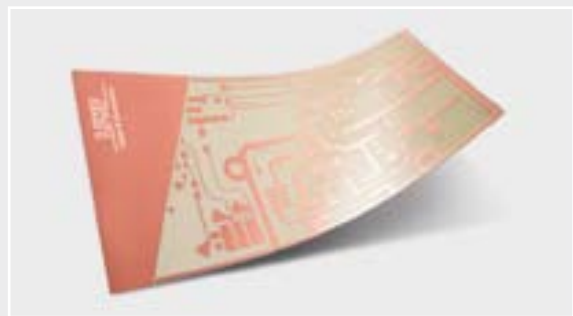
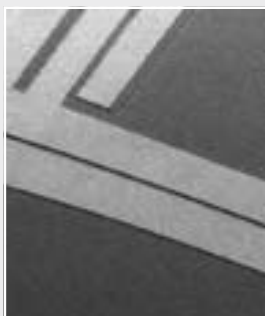
Al (15  $\mu\text{m}$ ) on PET film



Ceramic



RF structure, Au on  $\text{Al}_2\text{O}_3$  ceramic



Semi-Flex material, Cu layer thickness 18  $\mu\text{m}$

# An All-Purpose Tool: The LPKF ProtoLaser U3

The ProtoLaser U3 is a universal tool for material micromachining. The UV laser system can cut, drill, or structure nearly any material. Prototyping tasks that were previously prohibitively complex and expensive or had to be done by external service providers can now be performed with the LPKF ProtoLaser U3.



The LPKF ProtoLaser U3 is also capable of structuring uncommon materials such as TCO/ITO layers. With a precisely controlled energy density, the laser beam can generate the finest structures with an extremely high accuracy. The UV laser can also cut through solder masks and protective films.

The high pulse energy of the UV laser leads to nearly residue-free ablation. The targeted material evaporates quickly. For drilling and cutting, the laser beam can achieve clean edges and precise contour geometries.

The ProtoLaser U3 guarantees high repeatability. The perfect focal point position for the laser is set automatically; a camera localizes the workpiece position using registration marks. The integrated vacuum table reliably keeps even flexible and thin substrates in place, enabling complex contours to be cut without mechanically stressing the material.

## ProtoLaser U3 for prototyping and small batches

The LPKF ProtoLaser U3 is ideal for prototyping and small batch production on demand. It can be used to machine various materials quickly, cleanly, and precisely. The UV laser beam can be used for many applications, including accurate contactless depaneling and cutting of LTCCs and prepregs. The ProtoLaser U3 can depanel boards made of all types of materials – without creating stresses, with flexible contours, and with or without components mounted.

## Drilling, cutting and structuring

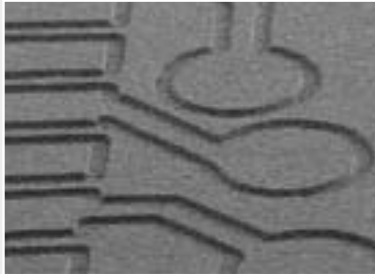
The ProtoLaser U3 can cut holes and microvias to a minimum diameter of just 100  $\mu\text{m}$  in HDI boards. The laser beam pierces through the copper layer and then the epoxy resin and glass fiber substrate.

## Parameter library for easy operation and flexibility

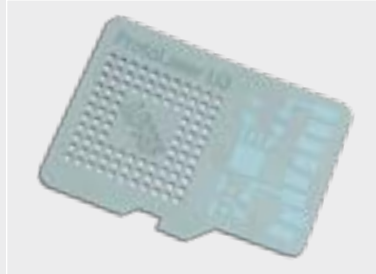
The efficient CAM software imports existing CAD data and converts them to laser processes. Changes to the circuit layout can be made in mere minutes as pre-configured parameters are available for the numerous applications. A large parameter library provides the settings for the main materials – the user mode makes processing saved projects easy. The administrator mode provides full control of all system settings.

## Peak performance in laser machining

The UV laser cuts, drills and structures a wide range of materials.



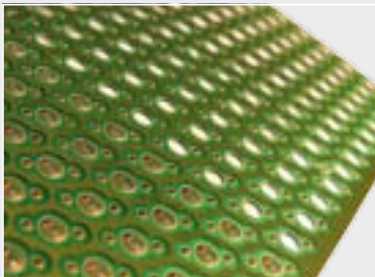
Structuring micro-tracks in etch resists (e.g. electroless tin)



Structuring, engraving, drilling, and depaneling in a single pass: the ProtoLaser U3 can also handle delicate LTCC ceramics.



TCO/ITO: Invisible conductive lines on transparent materials



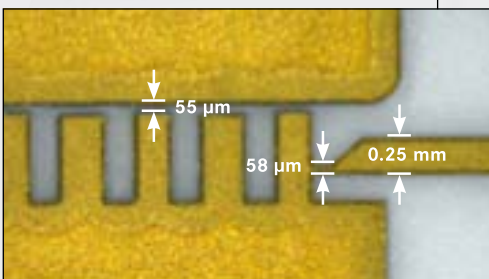
50  $\mu\text{m}$  micro-vias and drilling in RF material or FR4



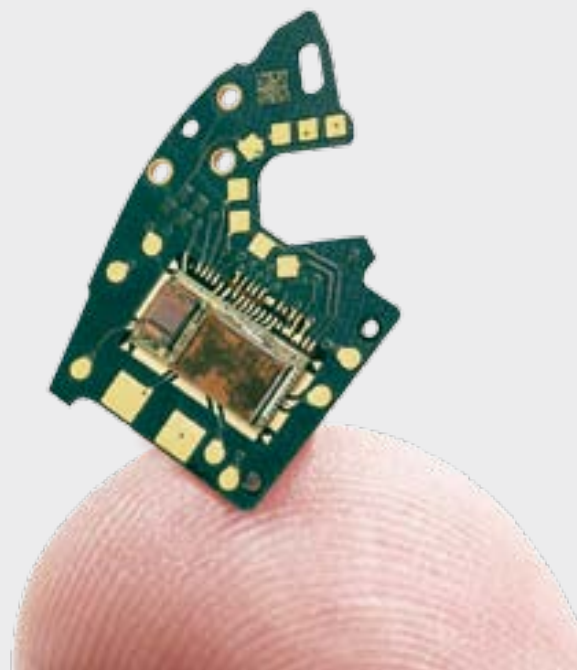
Laser-structured FR-4 boards feature high agreement between layout and actual geometry



Accurate cuts in populated and unpopulated materials – even complex shapes: ceramics, polyimide and FR4



Top results on delicate ceramic materials



# Selecting the Mechanical Systems for PCB Structuring

LPKF offers a complete line for manufacturing fully equipped PCBs. The first step is structuring the PCB tracks. Depending on the application requirements there generally are two processes: mechanical or laser-based.

## LPKF circuit board plotters

A spectrum of mechanical PCB structuring covers the LPKF ProtoMat series circuit board plotters. LPKF circuit board plotters differ in the size of work space, spindle speed and features. They can be categorized by the maximum PCB size:

- S series up to 229 mm x 305 mm (9" x 12")
- H 100 up to 380 mm x 365 mm (15" x 14.4")
- X 60 up to 650 mm x 530 mm (25.6" x 20.8")
- E 33 up to 229 mm x 305 mm (9" x 12")

The spindles on the LPKF circuit board plotters S63, S103, H100 and X60 with maximum speeds of 60,000 or 100,000 rpm respectively can easily produce structures down to a size of 100 µm and drill holes smaller than 0.4 mm.



### Milling and drilling single- and double-sided PCBs

The main application of the LPKF circuit board plotters is the production of sophisticated PCBs prototypes. They mill PCB tracks and gaps to 100 µm (4 mil) and drill holes to 200 µm (8 mil). Prototypes are produced right from the original CAD data, including precise geometries for BGAs, fine-pitch SMT, RF and other applications.



### Milling and drilling RF- and microwave substrates

RF- and microwave prototypes use special substrates such as ceramic-filled (RO4000®) substrates, and require extremely precise structuring. LPKF circuit board plotters with high-speed spindles produce just these fine structures with high accuracy. Custom hard metal tools produce straight edges and reduce the substrate penetrating depth.



### Milling and drilling multilayers with up to 8 layers

LPKF circuit board plotters are key components in manufacturing multilayer prototypes. Prototypes with up to eight layers can quickly and easily be produced using a LPKF ProtoMat in connection with a through-hole plating system such as the Contac RS and a multilayer press such as the MultiPress S. The use of a fiducial camera is recommended for accurate positioning when producing multilayers.



### Flexible and rigid-flex circuit milling

Some ProtoMats feature a vacuum table which ensures the PCB materials are firmly secured to the work surface. A high spindle speed helps to safely structure and separate these delicate boards.

Application	ProtoMat					
	S103	S63	S43	E33	H100	X60
Milling and drilling single- and double-sided PCBs	•	•	•	•	•	•
Milling/drilling RF- & microwave substrates	•	•	-	-	•	•
Milling/drilling multilayers with up to 8 layers	•	•	•	-	•	•
Contour routing of PCBs	•	•	•	•	•	•
Milling flexible, rigid-flex PCBs	•	-	-	-	•	•
Engraving front panels/labels	•	•	•	•	•	•
Machining cut outs in front panels	•	•	-	-	•	•
Milling SMT soldering paste stencils	•	•	•	-	•	-
Housing production	•	•	-	-	-	-
Wave solder pallets	•	•	-	-	-	-
Reworking PCBs	•	•	-	-	•	•
Test adapter drilling	•	•	-	-	-	-
Inspection templates	•	•	-	-	•	•
Depanelization of populated boards	•	•	-	-	-	•



### Engraving front panels / labels

LPKF circuit board plotters engrave plastic, Plexiglas, aluminum, brass and other front panels and labels with extraordinary precision.



### Machining cut-outs in front panels

LPKF ProtoMats with high milling speeds quickly and easily mill cut-outs, even in aluminum front panels.



### Milling SMT solder paste stencils

Polyimide stencils are especially important in the production of SMT PCBs, as they're required for solder paste printing.



### Housing production

The LPKF circuit board plotter can not only machine flat housing fonts and labels. Using a Z-axis (up to 50 mm) housing parts can be produced at the prototype lab.



### Wave solder pallets

Soldering jigs secure the PCBs during soldering. LPKF circuit board plotters with multiphase-motor driven Z-axis are ideal for milling the designs into thick heat-resistant materials such as aluminum or durostone.



### Depanelization and rework

An LPKF ProtoMat can effectively be applied for separating units of populated and unpopulated PCBs. LPKF circuit board plotters are also suitable for rework.



### Test adapter drilling

LPKF ProtoMats with high spindle speed and Z-axis drives by a multiphase-motor are perfect for drilling individual adapter plates on needle bed test adapters.



### Inspection templates

LPKF circuit board plotters are always well suited for accurately structuring soldering jigs and inspection templates.



### Dispensing

The dispenser accurately applies solder paste to the PCB using compressed air supply.

**i A chart containing technical specifications and system features of the individual ProtoMats can be found on page 18. It is followed by other system options and tools.**

### Laser structuring

Laser systems can produce considerably finer and more precise structures than mechanical systems are capable of achieving. Both ProtoLasers generate trace widths of 50 µm and spacings of 25 µm on ceramic material. The ProtoLaser S is specially designed for the structuring of laminated and non-laminated printed circuit boards. Due to the working principle of the ProtoLaser U3, the range of materials that can be machined with this system is broader.

## Application notes

LPKF recommends the S103 or H100 for primarily RF- / microwave products.

LPKF recommends the optical fiducial recognition for increased accuracy and ease-of-use (the camera system is standard on the S63, S103 and H100).

A vacuum table is required for flexible substrates, sold separately for the S63, standard on the H100 and S103.

LPKF recommends the S103 or S63 for routing aluminum front plates.

A vacuum table is required for flexible substrates, optionally for the S63, standard on the H100 and S103.

LPKF recommends the S103 and S63 with Z-axis control for machining plastic and aluminum housings.

LPKF recommends the S103 and S63 for its stepper motor controlled milling depth adjustment.

LPKF recommends the S103 and S63 because of the optical fiducial recognition.

LPKF recommends the S103 or S63 because of the stepper controlled Z-axis.

LPKF recommends the S103 or another ProtoMat with high-speed spindle to avoid melting of plastic.

LPKF recommends the S103, S63 or X60 because of the Z-axis control.



## Multilayer: Fabricating and Laminating

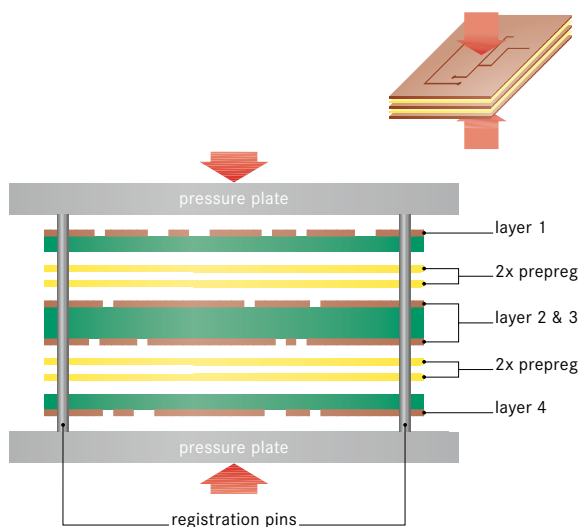
Multilayers are PCBs with more layers, each featuring conductive structures.

They are manufactured in three steps: structuring of the individual layers, laminating and through-hole plating.

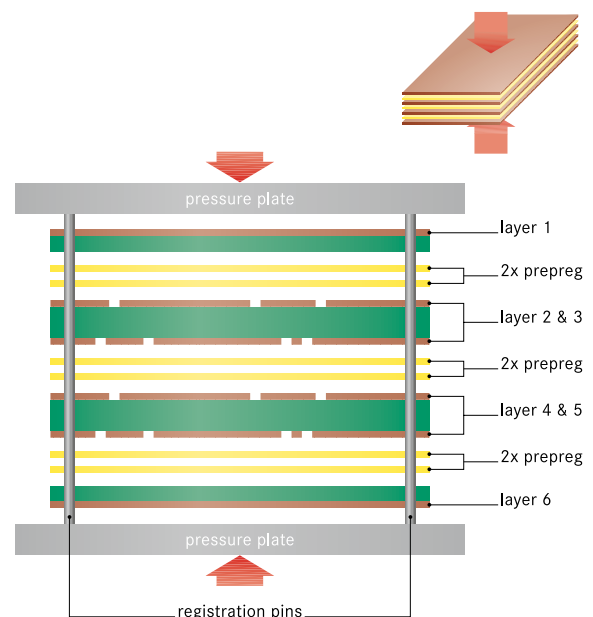
### A PCB with several layers

A multilayer board consists of multiple layers which are bonded to form one PCB. The outer layers of a multilayer often consist of PCBs structured on one side, the inner layers from material coated on both sides. Insulating layers, so-called prepregs, are inserted between the conductive layers.

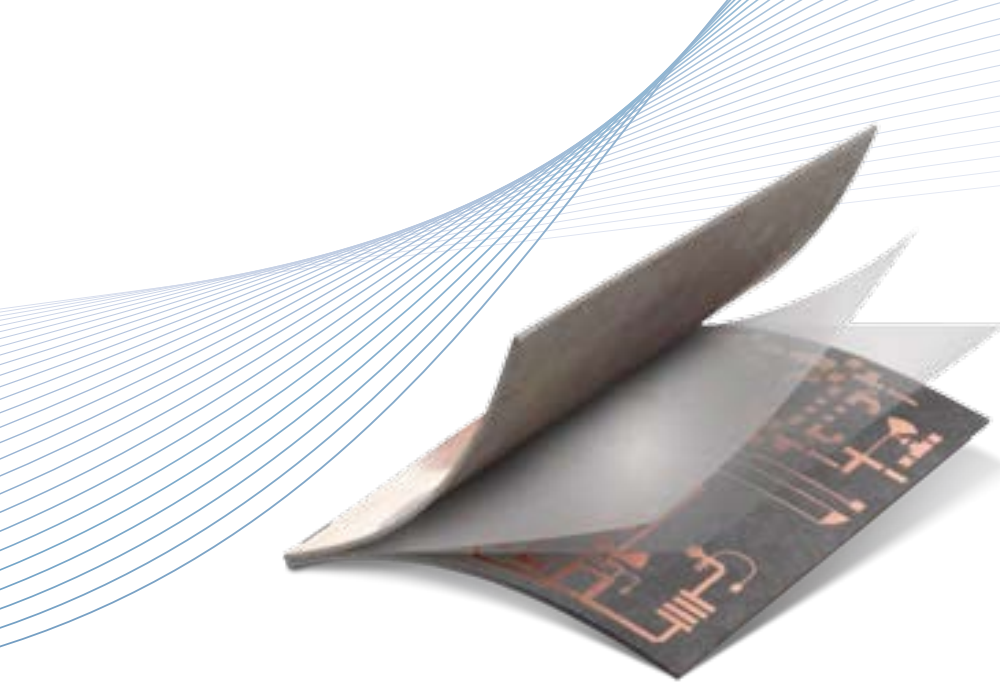
The outer layers of the PCB, top layer and bottom layer, are bonded with the inner layers using heat and pressure. Pressing plates and pads ensure the optimal distribution of the pressure inside the pressing mold. During lamination the resin from the prepregs liquefies due to the high temperature, ensuring an optimal bond.



4-layer multilayer



6-layer multilayer

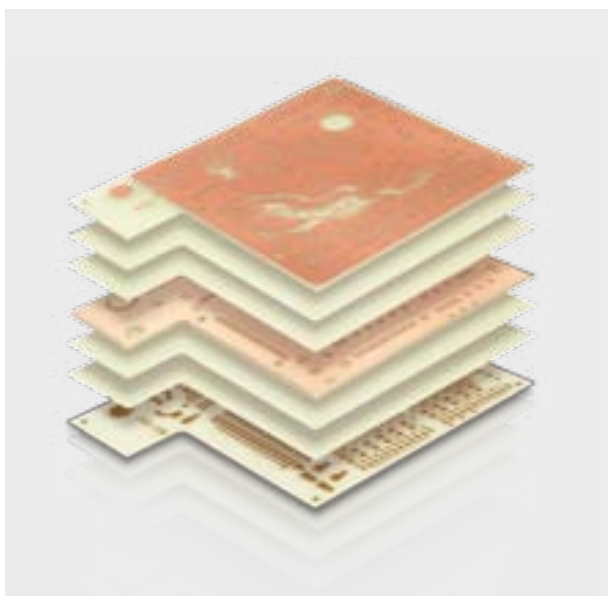


Air pockets must be eliminated during laminating. This requires working with the right laminating pressure and the proper temperature profile, suitable for the materials and number of layers. The laminating temperature of a standard multilayer is approx. 180 °C (355 °F). On the LPKF MultiPress S with automatic hydraulics the multilayers automatically pass through the different heating and laminating phases of a process profile.

The type of through-hole plating used impacts the structuring sequence. The outer layers are structured during chemical-free through-hole plating before to laminating, in electroplating afterwards. The inner layers of a multilayer must always be structured before laminating.

### **Eight-layer multilayer with the LPKF MultiPress S**

The LPKF MultiPress S laminates up to eight-layers from rigid, rigid-flex or flexible substrates. Distributing pressure evenly across the entire pressing surface of 229 mm x 305 mm (9" x 12") ensures a harmonious material bond. The LPKF MultiPress S stores up to nine different time temperature and pressure profiles; which can be accessed via the menu-guided LCD screen. Standard profiles for common PCB materials are stored directly from the factory. Special process profiles also ensure laminating RF materials, which require a laminating temperature of about 230 °C (445 °F). The LPKF MultiPress S achieves optimal results with brief warm-up period (temperature can reach up to 250 °C [490 °F]) and short cooling phases.



Up to 8 layers in-house: LPKF Prototyping



LPKF MultiPress S

# Center-Punching, Drilling and Cutting-Out

A functional double-sided or multilayer PCB requires the drilling of vias. The drill holes are required for through-hole plating of the individual layers and also serve as holes for registration pins in double-sided structuring or for later attaching the PCB.



An assortment of tools

## Drilling and center-punching PCBs

All drill holes on a PCB can be made with LPKF circuit board plotters. Drilling tools with diameters from 0.2 to 3 mm are available for this purpose. Drill holes with a diameter larger than 2.4 mm (94 mil) are milled.

The system software LPKF CircuitPro automatically converts these drill holes into milling circles. The drilling parameters such as spindle speed and sinking time, and for spindles with motor-controlled Z-axis also the feed rate, are stored in the software. Additional user intervention is not required.

Very thin or dull drilling tools bring with them the risk of the drill giving way and incorrectly positioned drill holes. When center-punching with a milling tool, brief spot drilling with a small penetration depth prevents the drill from giving way. The 90° polished tip of the 1/8" universal milling cutter, typically used for 200 µm wide milling grooves, features the optimal geometry for center-punching.

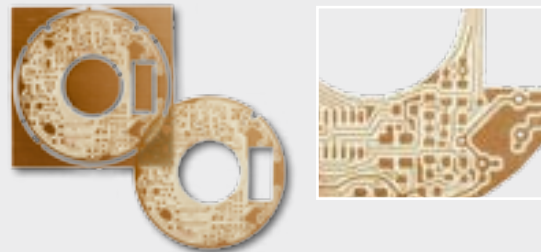
LPKF CircuitPro automatically produces the corresponding production data.

## Cutting the PCB/router milling

With the right milling tools all LPKF circuit board plotters can also be used for router milling. The PCB is then milled in its entire material thickness.

The inner disruptions or contours can be produced with various shapes, including complex shapes. LPKF circuit board plotters can also be used for separating units – for separating strips of different sizes and variations.

The selection of the respective milling tool for one depends on the desired milled width, and also on the material being machined. Milling tools with larger diameters are sturdier and can therefore operate at a higher feed rate. FR4 material is machined with a router milling cutters. For soft RF substrates or aluminum a double-edged end mill is used for cutting.



Router milling and rub-out areas



Multiple printed panels



Front panel

# Systems for Through-Hole Plating

When the circuits of a PCB are spread across several layers, these layers must be connected. This is done with drill holes which are then plated with conductive material.

LPKF offers three different through-hole plating systems to suit the respective application:



Manual: LPKF EasyContac



Chemical-free: LPKF ProConduct



Electroplating: LPKF Contac RS and LPKF MiniContac RS

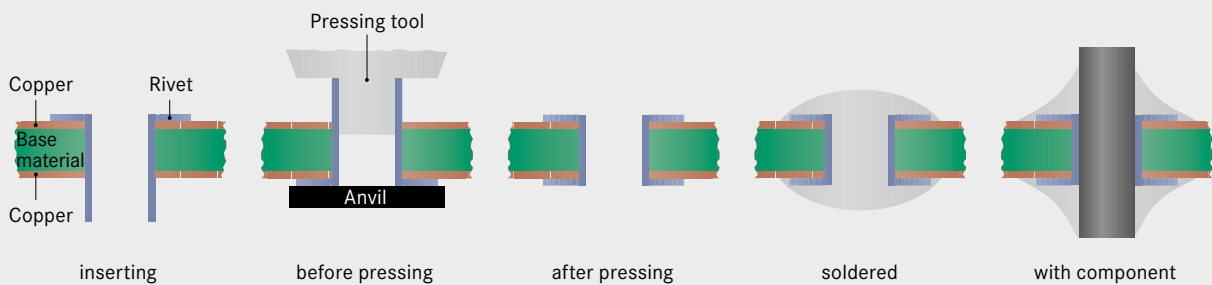
## Through-hole plating with rivets

LPKF EasyContac is an easy to use system for through-hole plating double-sided standard FR4 based PCBs. The diameter of the rivets ranges from 0.6 and 1.2 mm (+0.2 mm outside diameter). The system is ideal for PCB prototypes with up to 50 through-holes and for repairing PCBs.



### Easy to learn

The rivets are simply placed into the drill holes by hand and inserted with a pressing tool. The rivet is then soldered to the copper layer.



## Chemical-free through-hole plating

LPKF ProConduct is a professional process for prototyping numerous through-holes – without the need for chemicals. It is suitable for up to four layers with a minimum hole diameter of 0.4 mm at an aspect ratio of up to 1:4.

The maximum size of the PCBs is merely limited by the required hot air oven. For a hole diameter of 0.4 mm the contact resistance is about 25 mΩ.

Since LPKF ProConduct doesn't apply additional copper to the structured surfaces, they do not impact the calculations in RF applications.

Based on the more favorable production flow, in chemical-free through-hole plating the outer layers of the multilayer are already milled before through-hole plating occurs.

### LPKF ProConduct: Simple steps for through-hole plating

#### 1. Protection foil:

Apply self-adhesive custom-designed film to the surfaces.



#### 2. Drill:

Drill all through-holes with a LPKF circuit board plotter – through the film.



#### 3. Apply contact paste:

Spread paste onto the PCB with squeegee. The vacuum table will draw the paste through the holes. Also apply paste onto the rear side and vacuum.



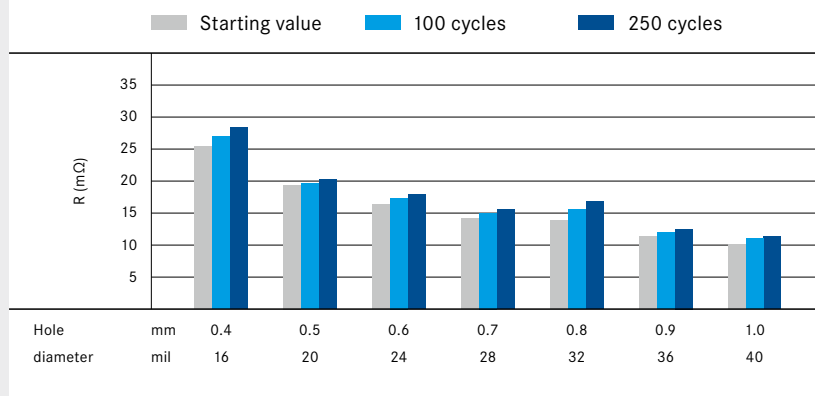
#### 4. Curing:

Carefully remove protection foil, cure PCBs in the hot air oven, then clean with ProConduct cleaner under running water.



#### Quick temperature change cycles

-40 °C/125 °C (-40 °F/250 °F) @ 1.6 mm (64 mil) FR4 PCB



The electric resistance of a finished plated through-hole ranges between 10 – 25 mΩ. Even after 250 temperature change cycles the resistance increases only minimally (max. 28 mΩ).

Basis: Double-sided FR4 PCB with 35 μm (1 oz/ft<sup>2</sup>) copper.

## Electroplating

Electroplating is suitable for professionally fabricated PCB prototypes and small batches. In principle the chemical process is equivalent to the process used in mass production. Both LPKF systems can machine multilayers with up to eight layers and a minimum hole diameter of 0.2 mm at an aspect ratio of up to 1:10. The reverse-pulse plating process ensures an even structure without excess copper deposits at the drill hole inlets.

In multilayers the outer layers are not milled until after through-hole plating, as the entire copper surface on the outer layer is used as a cathode. Since all inner layers are structured, the drill holes must be made before through-hole plating.

One difference between the two LPKF systems is the maximum PCB size. The LPKF MiniContac RS has a maximum size of 230 mm x 330 mm (9" x 13"), while the LPKF Contac RS is 460 mm x 330 mm (18" x 13").

Another difference is the features. The MiniContac RS features four chemical baths: two cleaning baths, one activator bath and the galvanic bath. The Contac RS also features a bath for chemical tinning plus a sink bath to assist with the cleaning process.

The through-hole plating systems are easy-to-use, no special chemical expertise required for operation or maintenance. The operating process is largely automated. The menu guides the user through all phases, step-by-step.

### LPKF Contac RS and LPKF MiniContac RS: Four steps in through-hole plating

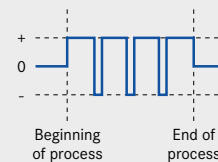
- 1. Clean and degrease:** The PCB is cleaned and degreased in two baths.
- 2. Apply activator:** Following the blackhole process a carbon activator is applied to the surfaces of the drill holes to be coated.
- 3. Electroplating:** The entire LPKF electroplating process is controlled by the system. The user only needs to add the PCB and enter base parameters.
- 4. Clean:** As the last step the PCB is cleaned.

The entire process takes approx. 90 to 120 minutes depending on the thickness of the copper coat. After through-hole plating on multilayers the double-sided PCB or the outer layer are structured.



#### Reverse Pulse Plating

Reverse pulse plating interrupts the electroplating process with reverse currents. This prevents excess copper deposits on the process and hole inlets.



# LPKF ViaCleaner – A Pinpoint Solution



The additional LPKF ViaCleaner bath system cleans microvias in multilayer boards

Successful galvanic coating requires a current flow. For the substrate material for a PCB, which is normally based on synthetic resins, this is not the case. Before galvanic via plating, an activator, usually carbon-based, is flushed through the vias. It coats the non-conducting wall and forms the basis for the metal layer in the drilled hole. However, it is also deposited on the copper layers and generates a contact resistance.

With the LPKF ViaCleaner, the activator can be selectively removed from the copper layer. The ViaCleaner reacts with extremely small amounts of copper in the copper layer and spalls off the activator layer. Because the LPKF ViaCleaner is activated in a warm condition, a thermometer and a temperature table are helpful for estimation of the required bath dwell time. Three to five minutes are generally sufficient for reliable cleaning.

For the process to be carried out in the fine through-holes, there must be no air bubbles in the microvias. The air bubbles may be removed easily through continuous agitation of the board during cleaning.



Without cleaning, the activator required for metallization forms a barrier



The result: perfect, reliable via plating

# Comparison of Through-Hole Plating Methods

LPKF offers three different through-hole conductivity methods. Each of these methods has its certain advantages.

The application determines the most suitable through-hole plating. Basic information such as the material- and layout size are quite instrumental, but also special factors such as specific substrates, PCB types, etc. play a role.

## The methods at a glance:

### LPKF ProConduct

A versatile manual through-hole conductivity option without chemical baths. The LPKF ProConduct uses a special conductive polymer to quickly and easily plate drill holes within minutes.

### LPKF Contac RS/MiniContac RS

Professional chemical electroplating method with reverse pulse plating. The Contac RS and MiniContac RS systems are self-contained and require no chemical expertise for use.

### LPKF EasyContac

An easy to use manual through-hole plating method for small quantities. EasyContac is easy, compact and portable, making it the ideal entry into through-hole plating prototypes.

Application	EasyContac	Contac RS/ MiniContac RS	ProConduct
<b>Small production run, low hole count</b> Although the Contac RS/MiniContac RS and ProConduct systems are also perfectly suited for small production quantities and low drill hole counts (less than 50), the EasyContac is a system developed specifically for these applications.	•		
<b>Small production runs, high hole count</b> Small production quantities and an infinite number of drill holes are quickly and easily through-plated with ProConduct, Contac RS and MiniContac RS.		•	•
<b>Average production quantities</b> The chemical electroplating systems Contac RS and MiniContac RS are the right choice for average production quantities. PCBs of various shapes and sizes can be through-plated non-stop.		•	
<b>Complex surfaces</b> Substrates with special requirements, such as pure PTFE.		•	•
<b>RF-/microwave PCBs</b> The LPKF ProConduct is the best match for the strict geometric requirements of RF-/microwave PCBs.		•	•
<b>Tin-plating</b> Voltaic through-hole platings with the LPKF Contac RS include a “chemical tin-plating” option.		•	
<b>Chemical restrictions</b> The LPKF EasyContac and the ProConduct are suitable for where the use of chemicals is a concern. Both methods do without a single chemical bath.	•		•
<b>High-power circuitry</b> High-power circuitry requires larger drill holes and heavier platings. For these applications LPKF recommends the Contac RS.		•	
<b>Reverse Pulse Plating</b> The reverse pulse plating on the LPKF Contac RS and MiniContac RS provides substantially cleaner through-hole plating. Reverse pulse plating ensures the copper is applied evenly and eliminates build-up or even clogging at the mouth of the through-hole.		•	

\* Material options upon request.

# Solder Resist and Screen Printing

The solder resist LPKF ProMask protects surfaces and tracks on a PCB. A professional surface finish protects pads with minimal spacing from short-circuits during the soldering process.

LPKF ProMask is an easy-to-apply green solder resist mask. The professional surface finish is particularly ideal for SMT prototypes with small track spacing.

LPKF ProLegend adds any marking to the PCB – without the use of environmentally hazardous wet chemistry.



## Applying solder resist: Four steps to a solder resist mask

### 1. Create film template:

Each PCB side requires one film template. It is printed onto a transparency from LPKF CircuitPro using a standard laser printer.



### 2. Apply solder resist:

The solder resist is mixed from the portioned components of enamel and curing agent and applied onto the entire PCB side with a foam roller. The PCB is then pre-dried in a hot air oven at 80 °C for ten minutes.



### 3. Expose PCB with film template:

The film template is accurately positioned over the pads. The PCB is then placed in the UV-exposer unit for 30 seconds. This sets the unprinted sections of the film template on to the PCB. After the PCB is removed from the laser setter the film template is removed.



### 4. Develop and cure solder resist mask:

The development bath is prepared by dissolving the developing powder in warm water. The development bath releases the unexposed sections from the solder resist. Paint residue is rinsed off with a brush and water. The solder resist then cures in the hot air oven for 30 minutes. Finally, oxidation residue is removed from the PCB and the PCB is cleaned.



**i** The component legends are printed in white paint with LPKF ProLegend using the same exact method. Since the areas which are to later remain unpainted must likewise be exposed, the film template must be negative-printed.

# Solder Paste Printing

Applying solder paste to all pads to be populated with components requires maximum precision. The LPKF ProtoPrint S is a manual stencil printer for creating SMT prototypes and small batches.

The resolution up to a grid dimension of 0.3 mm (12 mil) ensures ultra-fine pitch range stencil printing. The thickness of the template (between 100 µm and 250 µm) is determined by the solder paste application.

The stencil frames can easily be secured with adjustable retaining clips. The freely adjustable nesting pins allow the unpopulated side of populated PCBs to be printed. The PCB is accurately aligned in the X and Y position as well as height using micrometer screws. A lever allows PCB to be separated parallel from the template at a controlled speed. The PCB simply being secured on a slide allows quick and easy replacement when producing small batches.

The LPKF solder paste printer is suitable for polyimide templates – limited to a grid-dimension of 0.625 mm (25 mil) at a thickness of 125 µm. Polyimide templates can be produced with an LPKF circuit board plotter, saving time and cost compared to steel stencils.



LPKF ProtoPrint S

## Applying solder paste: The solder paste is applied to the PCB in six steps

### 1. Secure PCB:

The PCB nesting pins are mounted onto the slide and the PCB is inserted. Then the film for the test film print is clamped onto the PCB.

### 2. Clamp stencil:

Move the slide into printing position and secure the stencil frame in its rough position with the adjustable PCB nesting pins.

### 3. Test film print:

The lever presses the test film on the stencil. Solder paste is then evenly spread onto the film with a squeegee and the pad image printed onto the film.

### 4. Fine adjustment:

The test film is released from the stencil using the lever and the slide is moved into loading position. The PCB is now accurately aligned with the micrometer screws for test film printing. Afterwards the test film is cleaned and removed.

### 5. Apply solder paste:

The slide is moved to printing position and the PCB pressed on the stencil with the lever. Then solder paste is evenly applied to the PCB with a squeegee.

### 6. Release PCB:

The PCB is released from the template using the lever. During this process the applied solder paste must remain on the PCB and may not stick to the template. The slide is then moved to loading position.



# SMD Assembly

Accommodating many functions in a small space requires tiny components. The small size of modern electronic components makes it difficult to manually populate PCBs. With the ProtoPlace S LPKF offers users a semi-automatic, ergonomic pick & place system for complex SMD populating.

## Semi-automatic populating PCBs with SMD components

SMT PCBs are populated in as little as three steps. First a vacuum needles takes the SMD component from an anti-static bin or from a feeder. Two different types of feeders are common here: tape feeder, stick feeder or motorized turntables. All types can be connected to the LPKF ProtoPlace S.

The vacuum needle is mounted to a manipulator which helps with accurate positioning. The SMD component is manually moved or turned in X and Y axes. The optional camera and an LCD color monitor help with correct positioning.

Finally the component is accurately lowered onto the PCB. The bond from the solder paste prevents the component from shifting.

For more complex SMD components such as QFPs and PLCCs the component is first roughly positioned before the manipulator is locked in the X-, Y- and Z axes. The PCB can be micro-adjusted under the SMD component with the help of a camera and micrometer screws.

A 4-line LCD screen on the LPKF ProtoPlace S guides the user through the individual adjustment and work phases. Virtually all user functions are executed via the four ergonomically arranged directional keys. The optional camera system with color monitor assists the user in accurately positioning components even on complex PCBs.



Bestücken der Leiterplatte

Solder paste, adhesive or low-viscosity auxiliary materials are applied to the built-in standard solder paste dispenser by adjusting the transfer pressure accordingly.

The LPKF ProtoPlace S is optimized for precision assembly with fine-pitch components. The maximum configuration features several feeders, a camera system and a dispenser.



LPKF ProtoPlace S

# Reflow Soldering

Once the PCB is structured and populated only one step remains before it's functional: Soldering the components to the lead structure. In modern SMT boards the soldering iron stays cold; a reflow oven connects all soldering points in one step.

## Lead-free and leaded

The compact LPKF ProtoFlow is the ideal reflow oven for leaded as well as for lead-free, RoHS compliant reflow soldering, curing through-hole plating pastes and other thermal processes requiring precise control. The special function MultiZone allows the soldering process to be broken down into five separate phases, each with its own temperature sequence. Four internal temperature sensors accurately control the temperature spread across the entire PCB. The temperature curve of the sensors is displayed on a monitor in a temperature/time-diagram. They can be stored for later analysis. The LPKF ProtoFlow S processes PCBs up to a size of 229 mm x 305 mm (9" x 12") at a maximum temperature of 320 °C.

## Inert gas option

The LPKF Protoflow S/N2 can be externally connected to inert gas with a digital flow regulator. The nitrogen atmosphere significantly reduces oxidation during the soldering process, thus optimizing the solder connections.

Preprogrammed standard reflow profiles are stored from the factory; additional profiles can be individually programmed and stored.



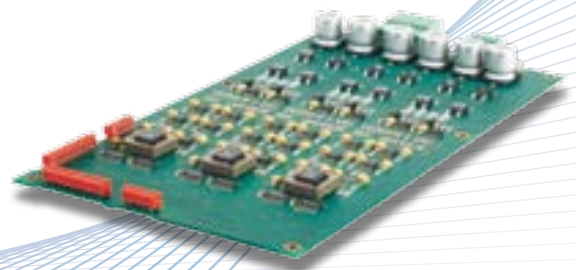
A lighted process chamber allows visual inspection during reflow soldering

The LPKF ProtoFlow S can be connected to a computer via USB interface. The included intuitive PC software is used for recording temperature in real-time, and programming and storing profiles.

The LPKF ProtoFlow S can be equipped with a sensor module which records temperature sequences in up to four freely selectable locations – including components.



LPKF ProtoFlow S



PCB produced and populated with LPKF technology

# Applications

From design to completed board: the modular prototyping systems by LPKF implement complex designs in no time; from structuring to functional PCB.

## Flexible and rigid-flex PCBs

Flexible or rigid-flex PCBs often cause problems with handling as they are quite difficult to secure to a work surface. Almost all LPKF structuring systems can be equipped with a vacuum table to securely position the PCB; making setup easier, quicker and more accurate.

Since the substrate of flexible PCBs is comparatively soft, primarily RF tools are used for machining. RF tools have the added benefit of not penetrating the material as deeply. Structuring a flexible PCB is similar to the milling process in rigid substrates.

Rigid-flex PCBs combine flexible PCBs with rigid ones. The method used for producing rigid-flex PCBs is similar to producing multilayers. The rigid component(s) are structured on one unit.



The surface in which the flexible part is to be inserted remains unstructured in the unit and is covered with a barrier sheet. The flexible section is then laminated onto the structured rigid sections. Afterwards the unstructured section below the flexible PCB is milled off. The same LPKF systems also used for producing multilayers can be used here.

## Engraving plastic and aluminum (2.5 D)

All LPKF circuit board plotters can engrave, drill mounting holes, and mill front plates and almost any type of shapes and lines. Many LPKF circuit board plotters can also be used to drill and mill plastic and soft metals in 2.5 dimensions.

The machining result essentially depends on the spindle speed. LPKF circuit board plotters with a minimum of 60,000 rpm produce very clean surfaces when milling or cutting.

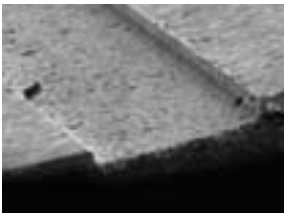
Multiple passes may be required depending on the milling depth. As a rule of thumb, the milling depth should not be more than half the tool diameter.



The parameter library of the LPKF CircuitPro software supports machining aluminum and other soft metals. The optimal feed and spindle speed for a long tool life are already stored in LPKF CircuitPro by default.

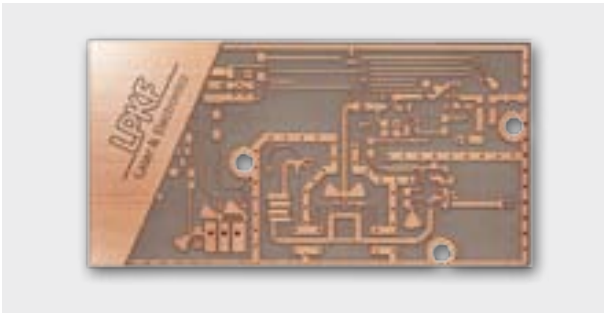
## RF- and microwave applications

Producing PCBs for RF- and microwave applications is quite challenging. On one hand materials with special electrical properties are used which also required the corresponding machining. Further, extremely delicate surfaces are to be structured. And last but not least, it oftentimes requires very precise geometries.



Precise geometries produced by an end mill RF tool

All of these requirements are fulfilled by LPKF systems and LPKF tools. The LPKF ProtoMat S103 and H100 circuit board plotters feature a high-speed spindle with 100,000 rpm.

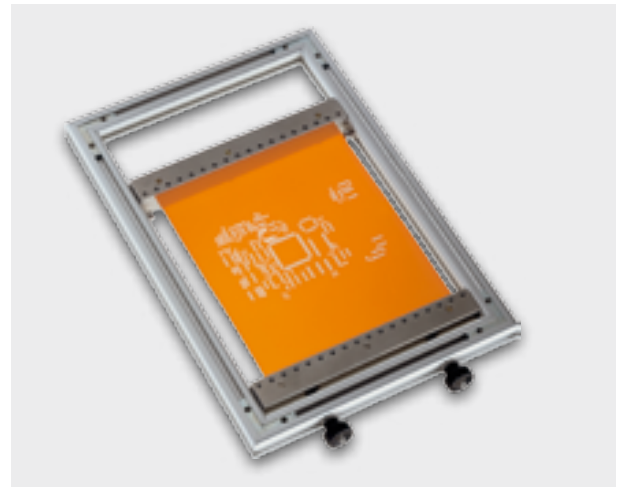


This combined RF tools and precisely adjustable milling depth ensures a clean vertical geometry; even in soft RF substrates. The pneumatic, non-contact depth limiter, which allows the milling head to glide on an air cushion above the substrate without physical contact to ensure scratch-free milling.

The LPKF ProtoLaser laser systems are unsurpassed in speed and precision. Super fine structures and even large insulating rubout areas are produced quickly – on soft as well as particularly hard substrate materials.

## Milling stencils

Milling polyimide stencils with LPKF circuit board plotters is a very appealing alternative to steel stencils, particularly from a cost perspective. The solder paste stencils can be milled in-house in less than ten minutes. Generating the milling data by LPKF CircuitPro through inverse isolation is easy. The pad surfaces are then not circumscribed for insulating, but instead milled out.



Milling polyimide templates brings with it the benefits of speed and accuracy when applying solder pastes. When combined with the SMT stencil printer LPKF ProtoPrint S, stencil printing becomes a cost-effective solution when creating the prototype, especially compared to the amount of work involved in manual dispensing or soldering.

## Depaneling

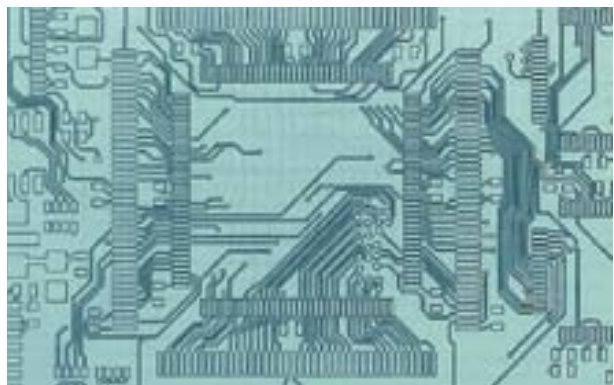
LPKF ProtoMats mills through the break-out tabs connecting an individual PCB in one panel. This process is only indirectly connected to the actual process of manufacturing a PCB and its later function. Therefore the required milling time is only granted on high-volume drilling/milling equipment; which can result in bottlenecks in production. The LPKF circuit board plotters are a great alternative to laser use. Combining a vacuum table and fiducial camera turns inserting and aligning a panel into a quick and easy task. The break-out tabs are cut clean, providing the user has a PCB with an exact contour.



One particularly interesting system is the LPKF ProtoLaser U3. This laser system cuts any contour in thin rigid, rigid-flex or flexible PCB materials – without mechanical stress on the substrate material and the components.

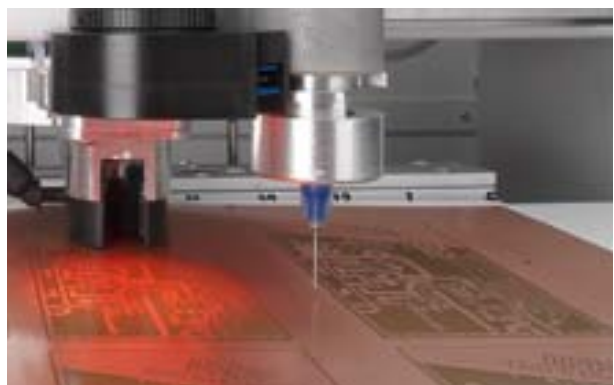
## Structuring super fine conductive tracks

One special application relies on the LPKF ProtoLaser U3 – a combination of laser structuring and etching the PCB. The completely copper-plated substrate is first chemically coated with a homogenous tin surface. The UV laser beam then removes the tin resist in the area to be etched. This technique allows super fine lead ranges of  $< 50 \mu\text{m}$  to be produced in the circuit track width and gaps.



## Dispensing

The dispenser introduced with the new S-Series accurately applies low-viscosity auxiliary materials such as solder paste onto the PCB.



# Growing with the Job: ProtoMat Upgrades

The new generation of S-series ProtoMats is designed for growth. Easy to install upgrade kits turn the entry-level system LPKF ProtoMat S43 into the all-rounder LPKF ProtoMat S63 or even the top of the line system LPKF ProtoMat S103. The new features come in a compact upgrade box containing all the required parts and components. A utility film shows the steps required to give the ProtoMat its new abilities. With a little mechanical skill the upgrade is installed in no time without the ProtoMat leaving the building.

## The S43 and S63 ProtoMats can be upgraded all the way to the top of the line S103:



An upgrade kit will turn a ProtoMat S43 or S63 into a ProtoMat S103 in no time!

## The upgrade kits at a glance (see also page 20):

Upgrade	S43 to S63	S43 to S103	S63 to S103
Part no.	127700	127701	127702
Milling spindle (rpm)	60.000	100.000	100.000
2½D milling	✓	✓	✓
Fiducial recognition camera	✓	✓	✓
Automatic tool change	✓	✓	✓
Vacuum table	-	✓	✓
Solder paste dispenser*	✓	✓	✓
Pneumatic non-contact working depth limiter*	-	✓	✓
Software LPKF CircuitPro Full	✓	✓	✓

Included/with upgrade possible
 Included in upgrade kit

\* For the use of the dispenser and the pneumatic non-contact working depth limiter compressed air is required. All other functions are available without compressed air.

# Technical Terms

## A

### Activating

A treatment that renders nonconductive material receptive to electroless deposition. Non-preferred synonyms: Seeding, Catalyzing, and Sensitizing.

### Annular Ring

The conductive foil and plating surrounding a hole.

### Aperture

A description of the shape and size of the tool used to create a pad or track. The term comes from the days of vector photoplotters, where film was exposed by shining light through apertures (shaped holes) arrayed around the edge of a disk (or "aperture wheel"). Each aperture corresponded to a different D code in the Gerber data. Today, photoplotters use lasers to expose the film but the term "aperture" persists.

### Aperture List

A list of the shapes and sizes for describing the pads and tracks used to create a layer of a circuit board.

### Artwork

A phototool used to create the different layers during printed circuit board manufacture.

### Artwork Master

An accurately scaled (usually 1:1) pattern which is used to produce the production master.

### Aspect Ratio

The ratio of the circuit board thickness to the smallest hole diameter.

## B

### B-Stage Material

Sheet material impregnated with a resin cured to an intermediate stage (B- stage resin). The preferred term is prepreg.

### Backplanes and Panels

Interconnection panels into or onto which printed circuits, other panels, or integrated circuit packages can be plugged or mounted.

### Bare Board

A finished PCB without added components.

### Barrel

The cylinder formed by plating through a drilled hole.

### Base Laminate or Base Material

The substrate material upon which the conductive pattern is formed. The base material can be rigid or flexible.

### "Bed-of-Nails"

A method of testing printed circuit boards that employs a test fixture mounting an array of contact pins configured so as to engage plated-through holes on the board.

### Blind Via

A via hole that does not pass completely through the printed circuit board. A blind via starts from one side or another.

### Bond Strength

The force per unit area required to separate two adjacent layers of a board by a force perpendicular to the board surface.

## Bridging

A buildup of solder between tracks or pads causing a short circuit.

## Buried Via

A mechanically or laser drilled hole which interconnects internal layers only. It is not electrically connected to any external layer.

## C

### C-Stage

The condition of a resin polymer while in a solid state, with high molecular weight, being insoluble and infusible.

### Center-To-Center Spacing

The nominal distance between the centers of adjacent features or traces on any layer of a printed circuit board.

### Chamfer

A corner which has been rounded or angled to eliminate an otherwise sharp edge.

### Circuit

The interconnection of a number of devices in one or more closed paths to perform a desired electrical or electronic function.

### Circuit Layer

A layer of a printed board containing conductors, including ground and voltage planes.

### Clad or Cladding

A relatively thin layer or sheet of metal foil which is bonded to a laminate core to form the base material for printed circuits.

### Clearance Hole

A hole in the conductive pattern larger than, but concentric with, a hole in the base material of the PCB.

### Coefficient of Expansion, Thermal

A material's fractional change in dimension for a unit of temperature fluctuation.

### Component Hole

A hole used for attachment and electrical connection of component terminations, including pins and wires, to the printed circuit board.

### Component Side

The side of the printed circuit board on which most of the components are mounted.

### Conductive Pattern

The configuration or design of the conductive material on the base laminate. Includes conductors, lands, and through-hole plating.

### Conductor Base Width

The conductor width at the base material's surface plane. See also: Conductor Width

### Conductor-To-Hole Spacing

The distance between the edge of a conductor and the edge of a supported or unsupported hole.

### Conductor Spacing

The distance between tracks on a printed circuit board.

### Conductor Width

The perceivable width of the respective conductor in any random PCB location.

**Controlled Impedance**

The process that gives a circuit the correct impedance value. The design engineer will specify the track impedance required. From this, a suitable manufacturing build will be chosen to the suit track widths and layer spacings on the design to meet the required impedance.

**Copper Foil**

A cathode-quality electrolytic copper used as a conductor for printed circuits. Available in a number of weights (thicknesses); the traditional weights are 1 and 2 ounces per square foot (0.0014 and 0.0028 inches thick).

**Current-Carrying Capacity**

The maximum current which can be carried continuously, under specified conditions, by a conductor without degrading the electrical or mechanical properties of the printed circuit board.

**D****Datum Reference**

A defined point, line, or plane used to locate the pattern or layer for manufacturing, inspection, or for both purposes.

**Deburring**

Process of removing a burr after drilling the board. There are two types of deburring: producing a clean, sharp edge when removing heavy burr; and rounding the edges of holes to prevent build-up during plating.

**Design Rules Check**

A computer aided program used to check the manufacturability of the circuit board. The checks include track to track gaps, track to pad gaps, annular ring sizes, track to board edge gaps, acid trap detection, unterminated track checks.

**DFM**

Design For Manufacture.

**Dielectric**

An insulating medium which occupies the region between two conductors.

**Dielectric Constant**

That property of a dielectric that determines the electrostatic energy per unit volume for unit potential grade.

**Digitizing**

Any method of reducing feature locations on a flat plane to digital representation in X-Y coordinates.

**Dimensional Stability**

A measure of dimensional change caused by factors such as temperature, humidity, chemical treatment, age, or stress; usually expressed as units/unit.

**Double-Sided Board**

A printed board with a conductive pattern on both sides, but no inner layers.

**Drill Table**

A description of the drill sizes used to create the circuit board. The drill equivalent of an aperture list.

**E****Edge Connector**

The portion of the PCB used to provide external electrical connection, normally gold plated.

**Electroplating**

The electrodeposition of a metal coating onto a conductive object. The object to be plated is placed in an electrolyte and connected to one terminal of a D/C voltage source. The metal to be deposited is similarly immersed and connected to the other terminal. Ions from the metal provide transfer to metal as they make up the current flow between the electrodes.

**Etching**

The process of removing unwanted metallic substance (bonded to a base) using chemicals, or chemicals and electrolytes.

**F****Fiducial**

A feature of the printed circuit board used to provide a common measurement point for all steps in the assembly process.

**Flash**

A pad. Another term dating from the days of vector photoplotters - tracks were drawn, pads were "flushed". See also pad. "Flash" is also a term used to describe excess material squeezed out between mold pieces during a casting.

**Flux**

A substance used to promote or facilitate fusion, such as a material used to remove oxides from surfaces to be joined by soldering or welding.

**Foil**

A thin sheet of metal, usually copper or aluminum, used as the conductor for printed circuits. The thinner the foil, the lower the required etching time. Thinner foils also permit finer definition and spacing. See Copper Foil.

**FR4**

The standard glass epoxy substrate.

**Fused Coating**

A metallic coating (usually tin or solder alloy) which has been melted and solidified forming a metallurgical bond to the base material.

**G****Gerber Data**

A type of data consisting of graphics commands, usually describing how to draw a picture of a circuit. Intended for directing a photoplotter, it is the most common format for data transfer from PCB CAD systems to the manufacturing process. Gerber data is officially designated as RS-274-D (without embedded aperture codes) and RS-274-X (with embedded aperture codes).

**Ground Plane**

A conductor layer, or portion of a conductor layer, used as a common reference point for circuit returns, shielding, or heat sinking.

**H****HP-GL™**

Hewlett Packard Graphics Language.

**I****Internal Layer or Inner Layer**

A conductive pattern which is contained entirely within a multilayer printed board.

**IR laser**

Laser system working in the infrared range. The LPKF ProtoLaser S uses a laser source with a wavelength of 1064 nm.

## L

### Laminate

A product made by bonding together two or more layers of material.

### Lamination

The process of preparing a laminate; or a multilayer PWB.

### Land

A portion of a conductive pattern usually, but not exclusively, used for the connection and/or attachment of components. Also called Pad, Boss, Terminal area, Blivet, Tab, Spot, or Donut.

### Layer-To-Layer Spacing

The thickness of dielectric material between adjacent layers of conductive circuitry in a multilayer printed circuit board.

### Legend

A format of lettering or symbols on the printed board; e.g. part number, component locations, and patterns.

## M

### Mask

A material applied to enable selective etching, plating, or the application of solder to a printed circuit board.

### Microsectioning

The preparation of a specimen for the microscopic examination of the material to be examined, usually by cutting out a cross-section, followed by encapsulation, polishing, etching, staining, etc.

### Mil

1/1,000th of one inch, or 0.001".

### Minimum Annular Ring

The minimum metal width, at the narrowest point, between the circumference of the hole and the outer circumference of the land. This measurement is made to the drilled hole on internal layers of multilayer printed circuit boards and to the edge of the plating on outside layers of multilayer boards and double-sided boards.

### Minimum Electrical Spacing

The minimum allowable distance between adjacent conductors sufficient to prevent dielectric breakdown, corona, or both, between the conductors at any given voltage and altitude.

### Misregistration

The lack of conformity between two or more patterns or features.

### Mixed Technology

Describes the assembly process of using pin through-hole, surface mount, and other mounting technologies on the same printed circuit board.

### Multilayer Printed Circuit Boards

Printed circuit boards consisting of three or more conducting circuit planes separated by insulating material and bonded together with internal and external connections to each level of the circuitry as required.

## N

### Nick

A cut or notch in a track or pad.

## O

### Open

A loss of electrical continuity caused by a break in a track.

## P

### Pad

The portion of the conductive pattern on printed circuits designated for mounting or attaching components. Also called Land.

### Panel

The base material containing one or more circuit patterns that passes successively through the production sequence and from which printed circuit boards are extracted. See Backplanes and Panels.

### Panel Plating

The plating of the entire surface of a panel (including holes).

### Pattern Plating

Selective plating of a conductive pattern (including holes).

### PCB

Printed Circuit Board

### Photo Plot

A high accuracy laser plotting system. It is used to produce actual size master patterns for printed circuit artwork directly on dimensionally-stable, high contrast silver halide photographic film.

### Photoplotter

A device for generating photographic images by directing a controlled-light beam that directly exposes a light-sensitive material.

### Photoresist

A light sensitive liquid or a film which, when selectively exposed to light, masks off areas of the design that can then be etched away.

### Plated-Through Hole (PTH)

A hole used to form the electrical connections between layers. This is achieved by metalizing the walls of the hole.

### Plating, Electroless

A method of metal deposition employing a chemical reducing agent present in the processing solution. The process is further characterized by the catalytic nature of the surface which enables the metal to be plated to any thickness.

### Plating, Electrolytic

A method of metal deposition employing the work or cathode; the anode the electrolyte, a solution containing dissolved salts of the metal to be plated; and a source of direct current. (See Electroplating)

### Plating Resists

Materials which, when deposited on conductive areas, prevent the plating of the covered areas. Resists are available both as screened-on materials and as dry-film photopolymer resists.

### Plotting

The mechanical conversion of X-Y positional information into a visual pattern, such as artwork.

### Polyimide Resins

High temperature thermoplastics used with glass to produce printed circuit laminates for Multilayer and other circuit applications requiring high temperature performance.

**Prepreg**

Sheet material consisting of the base material impregnated with a synthetic resin, such as epoxy or polyimide, partially cured to the B-stage.

**PWT**

Printed Wiring Technologies

**R****Reflowing**

The melting of an electro-deposit followed by solidification. The surface has the appearance and physical characteristics of being hot-dipped.

**Registration**

The degree of conformity of the position of a pattern, or a portion thereof, with its intended position or with that of any other conductor layer of a board.

**Resist**

Coating material used to mask or to protect selected areas of a pattern from the action of an etchant, solder, or plating. Also see: Dry-Film Resists, Plating Resists and Solder Resists.

**Router**

A machine that cuts away portions of the laminate to leave the desired shape and size of a printed circuit board.

**S****Schematic Diagram**

A drawing which shows, by means of graphic symbols, the electrical connections, components and functions of an electronic circuit.

**Scoring (V-Scoring)**

The panels are precision cut through both sides of the panel to a preset depth. The panels remain rigid for assembly but are ready for breaking into individual circuits.

**Screen Printing**

A process for transferring an image to a surface by forcing suitable media through a stencil screen with a squeegee. Also called Silk Screening.

**Single Sided Board**

A printed circuit board that contains tracks and pads on one side of the board and no plating in the through holes.

**SMT**

Surface Mount Technology

**Solder Leveling**

The process of dipping printed circuit boards into molten solder and leveling the surface with hot air.

**Solder Mask or Resist**

Coatings which mask and insulate portions of a circuit pattern where solder is not desired.

**Solder Side**

On printed circuit boards with components on only one side, the side of the PCB that is opposite to the component side.

**Surface Mounted Technology (SMT)**

The components are mounted on the surface of a circuit board rather than inserting components into plated through holes.

**T****Tester**

A device that checks a PCB for the connectivity of its circuits from the design netlist.

**Thin Foil**

A metal sheet less than 0.0007 inches (1/2 oz) thick or less.

**Tooling Holes**

The general term for non-plated holes placed on a printed circuit board or a panel used for registration and tooling during manufacturing, testing and assembly.

**Track**

An electrical connection between two or more points on a PCB.

**U****UL (Underwriters Laboratory)**

A U.S. safety standard certification organization.

**UV (Ultraviolet)**

Ultraviolet radiation is electromagnetic waves with short wave length which can be used for curing polymers. Ultrasonic waves can also be used to clean PCBs in special cleaning equipment.

**UV laser**

Laser system working in the ultraviolet range. These wavelengths are easily absorbed by numerous materials.

**V****Via or Via Hole**

A plated-through hole used to connect individual layers of a circuit board. These holes are generally the smallest as no components are inserted in them.

**ViaCleaner**

A special bath that removes activator coatings from copper surfaces in microvias prior to galvanic via plating.

**W****WYSIWYG**

What You See Is What You Get. This term describes a computer interface that reflects an actual physical object, as opposed to a more symbolic representation. For example, early word processing programs produced a final printed output that was very different than what appeared on the editing screen, but later programs appeared on the editing screen exactly as they were expected to print

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# Indicia

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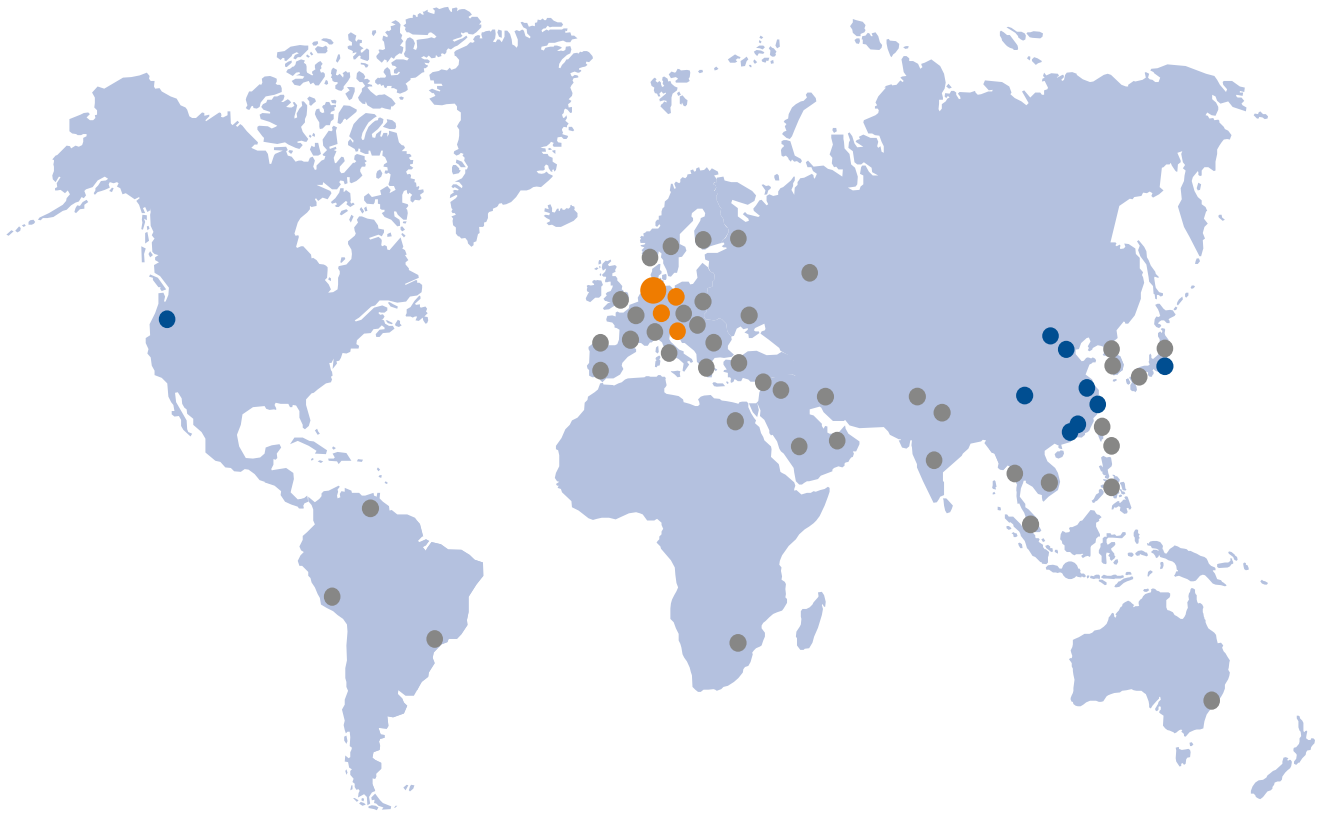
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