



ProtoLaser U4

Basic reference to the detailed
documentation

Order code: 10058056
Version: 3.0

LPKF
Laser & Electronics

Publisher LPKF Laser & Electronics AG
Osteriede 7
30827 Garbsen
Germany
Phone: +49 5131-7095-0
Fax: +49 5131-7095-90
Email: info@lpkf.com

Date of issue 17.12.2021

Copyright © 2021 LPKF AG

This document and its contents in whole and in parts are subject to copyright. The reproduction, translation or duplication of the contents as photocopy or any digital form requires written permission of LPKF Laser & Electronics AG.

Translation of the German original document

General information

This basic reference contains the basic safety instructions and a selection of the information on the system.

The detailed documentation of this system and further documentation for the used software is supplied in PDF format on the data medium.

This document is intended for persons with basic knowledge of installation and operation of software-controlled systems. General knowledge of operational safety as well as basic knowledge of using PCs running Microsoft Windows® are required.


LPKF Laser & Electronics AG (abbreviated to LPKF in the following) reserves the right to make changes in respect to the content of this document. The figures in this document serve as basic understanding and can differ from the actual state of the system/product.

Structure of warning messages and safety notes

The safety notes and warning messages in this document identify hazards and risks and they are created in accordance with ANSI Z535.6-2011 and the standards series ISO 3864.

The warning messages are structured as follows:

- Warning sign (only for injuries)
- Signal word indicating the danger level
- Type and source of the hazard
- Consequences of non-observance
- Measures to avoid the hazard

 + SIGNAL WORD
Type and source of the hazard! Consequences of non-observance. ▶ Measures to avoid the hazard. ▶ Further measure(s) to avoid the hazard.


Warning messages can also be embedded in the format of the surrounding text in order to avoid a *visual disruption* in a sequence. In this case, they are distinguished as follows:


Type and source of the hazard!


Consequences of non-observance.

- ▶ Measure(s) to avoid the hazard.

Warning messages are classified in hazard classes represented by the signal word. In the following, the warning messages are described in accordance to their hazard classes:

 DANGER
<p>Type and source of the hazard!</p> <p>This warning message indicates a hazard of high risk that causes death or serious injury if not avoided.</p> <p>▶ Measure to avoid the hazard.</p>

 WARNING
<p>Type and source of the hazard!</p> <p>This warning message indicates a hazard of medium risk that can cause death or serious injury if not avoided.</p> <p>▶ Measure to avoid the hazard.</p>

 CAUTION
<p>Type and source of the hazard!</p> <p>This warning message indicates a hazard of low risk that can cause minor or moderate injury if not avoided.</p> <p>▶ Measure to avoid the hazard.</p>

NOTICE
<p>Type and source of the hazard!</p> <p>These messages contain information on possible property damage that causes no injury.</p> <p>▶ Measure to avoid the hazard.</p>

Text styles

Various text attributes, spelling, and text structures facilitate reading the document. The text attributes (highlightings) inside this document are defined as follows:

Attribute	Function
<i>italic</i>	highlighting elements of the user interface and of control elements of the system
bold	highlighting important information and keyboard input
Courier New	highlighting file names and file paths
[]	highlighting buttons of software user interfaces
key	highlighting keys

Tasks or procedures that are described in steps are compiled to sequences in this document. A sequence consists of at least three components: objective, step, and result.

Component	Description
■	Indication of an objective. The sequence starts here.
1. 2. 3.	Indication of a sorted list of steps. The specified order must be observed.
□	Indication of an intermediate result that is followed by further steps or the result.
☑	Indication of the result. The sequence is finished.
▶	Indication of a single step.

Additional information

The following symbols are used to indicate additional information:



This note indicates especially useful information.

**Advanced information**

This advanced information indicates special knowledge.



This symbol indicates an intermediate result.



This symbol indicates a final result.

Registered Trademarks

Product and brand names are trademarks of LPKF Laser & Electronics AG, registered among others at the US Patent and Trademark Office: LPKF® and the company logo, # 2,385,062 and # 2,374,780; Solarquipment®, # 3,494,986; ProConduct®, # 3,219,251; Allegro®, # 3,514,950.

Microsoft® and Windows® are brand names or registered trademarks of Microsoft Corporation in the USA and/or other countries. All other trademarks belong to the respective owner.

Customer service

For technical information contact our LPKF Service:

Address LPKF Laser & Electronics AG
Service & Support Rapid Prototyping
Osteriede 7
30827 Garbsen
Germany

Phone + 49 5131 7095-1333

Fax + 49 5131 7095-90

Email support.rp@lpkf.com

Internet <http://www.lpkf.com/en>

In our continuous effort to improve our documentation we are asking you to give us your feedback if you notice any discrepancy when working with the system/product, or if you have any comments or suggestions for improvement.

At the moment of packaging, the system/product has been equipped with the latest software version and with the software and hardware documentation currently valid. By now, new versions of the documentation as well as new software versions might be available.

For all the latest news and updates visit the support area of our homepage:
www.lpkf.com/en/support-services.

Contents

1	Safety	10
1.1	Intended use	10
1.2	Residual risks.....	11
1.3	Basic hazards	12
1.4	Laser safety instructions	14
1.4.1	Laser radiation hazards.....	14
1.4.2	Laser classes	16
1.4.3	Protective measures	17
1.4.4	Actions in case of an injury	19
1.4.5	Laser Safety Instructions.....	19
1.5	Responsibility of the operator	20
1.6	Personnel requirements.....	21
1.7	Personal protective equipment	22
1.8	Safety signs	24
1.9	Safety devices.....	26
1.10	Securing against restart	29
1.11	Actions in case of an emergency.....	30
1.12	Environmental protection	30
2	System description	31
2.1	Technical data.....	31
2.2	Type label	34
2.3	Scope of delivery	35
2.4	EC Declaration of conformity	36
3	Transport and storage	38
3.1	Transport inspection	38
3.2	Packaging	38
3.2.1	Symbols on the packaging.....	39
3.2.2	Unpacking the system.....	40
3.3	Transporting the system	46
3.3.1	Moving the system over short distances	46
3.3.2	Leveling the system	48
3.4	Storage.....	49
4	First startup	50
4.1	Safety	50
4.2	Requirements of the place of installation	51
4.2.1	Climatic conditions	51
4.2.2	Minimum required space.....	51
4.2.3	Workplace of the operating personnel	52
4.2.4	Floor	53
4.2.5	The system's center of gravity	53
4.2.6	Connections provided by the customer.....	54
4.3	Preparations.....	54
4.3.1	Removing the transport locks	55
4.3.2	Filling the coolant	59
4.3.3	Checking the local mains voltage of the chiller	61
4.4	Connecting the system	63
4.4.1	Connecting the stack light.....	63
4.4.2	Connecting the extraction system.....	65
4.4.3	Connecting the compressed-air supply.....	67
4.4.4	Connecting to the network	68
4.4.5	Connecting the screen, keyboard, and mouse	69

4.4.6	Connecting the system to the mains power supply	73
4.5	Switching on the system with the main switch	74
4.6	Switching on the system	74
4.7	Software	75
4.8	Reading the user manual	77
5	Appendix	78
5.1	List of figures	78
5.2	List of tables	79
5.3	Index	80

Scope of this basic reference

Please note that this basic reference does not replace the detailed documentation on the data medium.

Read the detailed documentation before working with the system.

Observe the information, instructions and safety instructions in the detailed documentation to ensure a safe and smooth operation of the system.

Overview of the supplied documentation

The following documentation is supplied in printed form:

Documentation	Description
Basic reference to the detailed documentation	Quick guide for first startup

Table 1: Overview of the printed documentation

The following documentation is stored on the data medium:

Documentation	Description
Basic reference to the detailed documentation	Quick guide for first startup
User manual ProtoLaser U4	Documentation for the ProtoLaser U4
HTML help CircuitPro PL	Documentation of the software CircuitPro PL
How-to guides ProtoLaser U4/S4/R4	Applications, practical tips and basics for the production of double-sided and multi-layer PCBs with the ProtoLaser U4/S4/R4
Unpacking instructions	Instructions for unpacking the system

Table 2: Overview of the documentations on the data medium

1 Safety

The following basic safety instructions help to avoid injuries and property damage. The operator has to ensure that the basic safety instructions are observed and complied with.

Make sure that persons responsible for the system and for its operation as well as persons who work independently on the system have read and understood the detailed documentation.

If any problems occur or you need more information please contact the LPKF Service.

1.1 Intended use

ProtoLaser U4 is a laser system designed for micro material processing and may only be controlled using the system software that is included in the scope of delivery.

The following processing procedures and materials are approved:

Processing procedures

- Structuring laminated substrates
- Separating rigid, flex-rigid, and flexible materials
- Drilling and separating ceramics
- Structuring TCO/ITO
- Cutting LTCC

Materials

- Laminated substrates with a conductive layer of up to 35 µm:
 - FR4
 - RO® type (manufactured by Rogers)
 - RT® type (manufactured by Rogers)
 - TMM® type (manufactured by Rogers)
 - Pyralux® TK (manufactured by DuPont)
 - Pyralux® AP (manufactured by DuPont)
 - TaLamPLUS® (manufactured by Taconic)
 - RF-10® (manufactured by Taconic)
 - CuFLON® (manufactured by Polyflon)
- Polyimide (PI)
- Polyamide (PA)
- Polycarbonate (PC)
- Polycarbonate/Acrylonitrile butadiene styrene (PC/ABS)
- Acrylonitrile butadiene styrene (ABS)
- Polybutylene terephthalate (PBT)
- Glass, borosilicate glass, fused quartz
- Aluminum oxide, LTCC
- Photomasks/Chrome masks, TCO, ITO
- Foils, e.g. brass, copper, aluminum, solder-paste stencil sheets
- Fine polyamide PA2200 (SLS)
- ABS M-30 (FDM smoothed)



In case of doubt contact the LPKF sales department or your local representative to receive more information on alternative materials or processing procedures.

Furthermore, the intended use of the system is ensured by complying with the following points:

Place of installation

- The ambient conditions have to be observed (see page 31).
- The minimum required space of the system has to be observed (see page 51).
- The system may only be used in laboratory environments.



Caution:

The system is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

Service life

- The system is designed for a service life of 10 years used in one-shift operation (8 hours a day, 5 days a week).
- The system has to be maintained within the specified intervals to ensure the service life of the system.

Personnel

- The system has to be operated by personnel who are sufficiently qualified and trained (see page 21).

Processing conditions

- The materials used must not exceed the maximum processing size of the system (see page 32).
- The system has to be operated with an extraction system (see page 33).

Intended use also includes compliance with all information in these instructions.

Improper use

- Using the system with another or modified system software.
- Bridging or bypassing the safety devices.
- Do not use the system for processing easily flammable materials (e.g. paper, wood, etc.), reflective, or highly reflective materials.
- Using the system without the standard cover and covering parts is not allowed.



Do not leave the system unattended during production (e.g. over night)!

1.2 Residual risks

No residual risks have currently been identified, if the intended use as well as all safety regulations are observed. Any identified residual risks and their avoidance are listed in the form of safety instructions starting in chapter 1.3. Non-observance can cause personal injuries and property damage.

1.3 Basic hazards

Always comply with the warning messages listed here and in the individual sections of this documentation to reduce the risks of injuries and property damage and to avoid dangerous situations.

Mechanical hazards

WARNING

Risk of injury by moving components!

Moving components can cause serious injuries e.g. crushing injuries or cuts.

- ▶ Never grasp moving components when the system is operating.
- ▶ Never open any covers when the system is operating.
- ▶ Observe the follow-up time. Before opening the cover, ensure that no component is still moving.

WARNING

Risk of injury by loss of stability!

Loss of stability due to an improper floor or missing locks can cause uncontrollable movement or tilting of the system. This can cause serious injuries.

- ▶ Ensure that the floor is even and has a sufficient load-bearing capacity.
- ▶ Secure the system properly so that it cannot roll away unintentionally.

WARNING

Risk of injuries by pressurized components!

Pressurized components (e.g. compressed-air supply) can move uncontrollably in case of improper handling or in case of a defect and can cause serious injuries.

- ▶ Depressurize the components before working on them. De-energize the residual energies.
- ▶ Always ensure that there is no unintended escape of compressed air.
- ▶ Defective components that are under pressure when operating the system have to be replaced immediately by sufficiently qualified personnel.

Electrical hazards **DANGER****Danger to life by electrical shock!**

Touching energized parts causes a direct danger to life by electrical shock. Damage to the insulation or damaged individual parts can be dangerous to life.

- ▶ Use only the mains cable included in the delivery or a mains cable approved by LPKF.
- ▶ All work on energized components of the system must be performed by a qualified electrician.
- ▶ If the insulation is damaged, switch off the power supply immediately and initiate the repair.
- ▶ De-energize all energized components of the system or equipment, before working with them. Ensure that the system or equipment is de-energized for the whole time of the task.
- ▶ Never bridge or deactivate fuses.
- ▶ Always keep moisture away from energized parts because it can cause a short circuit.

Hazards by materials or substances **WARNING****Health hazard by faulty extraction!**

When processing materials, gases or dusts hazardous to health can be produced.

- ▶ Ensure that the extraction system is switched on and is working properly.
- ▶ Observe the maintenance intervals of the extraction system.
- ▶ Check the connection to the system regularly.

Other hazards **CAUTION****Tripping hazard by hoses and cables!**

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

- ▶ Always ensure that the hoses and cables do not pose a tripping hazard.

1.4 Laser safety instructions

This chapter contains basic information on protection against the hazards of laser radiation. Every user of this laser system must read and understand this chapter before he/she is authorized to work with the system. An annual laser safety instruction delivered by the laser protection officer of the company is required.

1.4.1 Laser radiation hazards

The laser light is very orderly and regular in terms of propagation direction and wavelength. Laser light has a high energy and can travel over wide distances with an almost parallel propagation. The laser power is not dependent on the distance to the target.

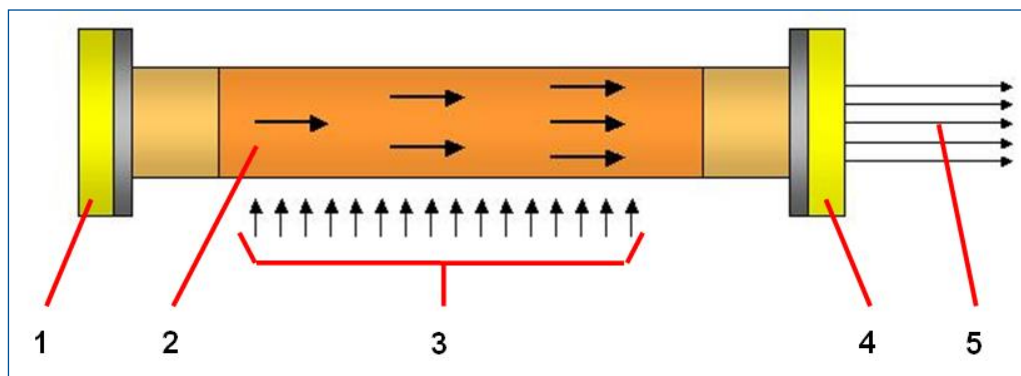


Fig. 1: Functional principle of a laser

- | | |
|-----------------------------|----------------------------|
| 1 Mirror (fully reflective) | 4 Mirror (semitransparent) |
| 2 Laser medium | 5 Laser beam |
| 3 Pump energy | |

Effects on the human eye

In addition to the high energy and the power density, the high focusability of the coherent laser beam is another danger to the human eye. A laser pulse hitting the visual nerve of the eye can cause blindness.

Effects on the human skin

The extent of damage to the human skin is highly related to the wavelength of the laser beam so that the damage can vary between light sunburn, heavy blistering and carbonization of the skin. The impact also depends on the laser power and the duration of irradiation.

Thermal damage

Thermal tissue damage can be classified into reversible and irreversible physical injuries. Reversible tissue injuries are caused by temperatures below 45 °C (113 °F). Tissue dies off (protein coagulation) due to thermal damage at temperatures between 45 °C (113 °F) and 80 °C (176 °F). The water inside the tissue is vaporized at temperatures above 100 °C (212 °F). At temperatures above 150 °C (302 °F) the tissue is carbonized. At temperatures above 300 °C (572 °F) the tissue is evaporated.

Damage depending on laser beam wavelength

Wavelength (nm)		Spectral range	Eye	Skin
From	To			
180	280	UV-C	Keratitis	Sunburn
280	315	UV-B	Keratitis	Increased pigmentary abnormality
315	400	UV-A	Cataract	Tanning
400	780	Daylight	Retina damage	Burns
780	1400	IR-A	Retina damage, blindness	Burns
1400	3000	IR-B	Cataract or burns of the cornea	Burns
3000	10 ⁶	IR-C	Burns of the cornea or corneal abrasion	Burns

Table 3: Effects of laser radiation**Other laser radiation hazards**

A laser system poses primary and secondary hazards. The primary hazards are due to the laser beam itself. The secondary hazards arise from the laser system or the processing procedure.

Source of danger	Description
Pilot laser (if applicable)	The pilot laser is a compact laser diode or a class 2 HeNe laser. Do not expose your eyes to radiation unnecessarily. The laser radiation is harmless for the skin.

Table 4: Sources of danger

1.4.2 Laser classes

The hazard levels of laser systems are based on the accessible emission limits (AEL) and listed in European Standard EN 60825-1 and the American National Standards ANSI Z136.1 for the Safe Use of Lasers.

Class	Concept	Safety measures
1	The radiation emitted by this laser system is not dangerous.	No specific protective equipment is required.
1M	The radiation emitted by the laser system is eye safe when used without optical instruments. The emitted radiation is not safe when optical instruments are used.	No specific protective equipment is required if the laser system is used without optical instruments.
1C	These laser systems are used for medical purposes only. The radiation emitted by the laser system is not subject to any limitations.	The protection is ensured by technical measures so that the laser can only emit a beam while having contact to skin or tissue. For this, the radiation is reduced to class 1.
2	The laser system is eye safe as a result of normal human aversion responses including the blink reflex.	No specific protective equipment is required.
2M	The light that can penetrate the eye pupil has the value of a class 2 laser. Depending on a divergent or widened beam, it may not be safe when optical instruments are used.	No specific protective equipment is required if the laser system is used without optical instruments.
3R	Exceeds the maximum permissible exposure values. The radiation is max. 5 times higher than the AELs of class 1 or of class 2. The risk is slightly lower than the risk of class 3B.	Dangerous to the human eye, laser safety glasses are recommended.
3B	Looking into the laser beam is dangerous to the eyes. Diffuse reflections are not considered as dangerous. (former class 3 B without class 3 R)	Dangerous to the human eye, laser safety glasses are obligatory.
4	Even diffuse reflections are dangerous to the human eye. There is also a danger of fire and danger to the human skin.	Personal protective equipment is absolutely necessary (laser safety glasses and protective screens)!

Table 5: Laser classes

1.4.3 Protective measures

The operator of a laser system is obliged to take structural and organizational protective measures.

Personal protective measures

The operating personnel must comply with certain protective measures when working on a laser system.

Protective measures	1	1M	1C	2	2M	3R	3B	4
Never look directly into the laser beam neither with nor without laser safety glasses.	x	x	x	x	x	x	x	x
Wear laser safety glasses						x	x	x
Attend a laser safety instruction course once a year							x	x

Table 6: Personal protective measures

Structural protective measures

Depending on the laser class, special protective measures must be taken or be existent.

Protective measures	1	1M	1C	2	2M	3R	3B	4
Walls, ceilings and floors must be built solid and fire proofed. The wall areas must be matte, bright and diffusely reflecting.							x	x
Non-metallic (non-reflecting) installations							x	x
Ambient light must be amply dimensioned and adjustable							x	x
Adequate number of emergency stop buttons, room and door contact switches							x	x
Shielding: high absorption, hardly inflammable							x	x
Specular reflection: avoid any unintended reflections						x	x	x
The laser beam must be limited at the end of its useful path		x	x	x	x	x	x	x
Label the laser area (Warning laser beam) inside the working and traffic area				x	x			
Restrict access to the laser area and label the borders (Warning laser beam)						x	x	x
Operation mode displays and warning lights on all entrance doors of the laser area								x

Table 7: Structural protective measures

Organizational protective measures

Depending on the laser class, special protective measures must be taken.

Protective measures	1	1M	2	2M	3R	3B	4
Inform the Employer's Liability Insurance Association and the industry control office.					x	x	x
A laser safety officer must be appointed in written form.					x	x	x
The borders of the laser area must be defined if the laser area is inside working or traffic areas.			x	x			
The borders of the laser area must be defined.					x	x	x
A remote-controllable locking device must be connected to the room or door electric system.						x	x
The laser system must be equipped with a key switch to securely switch-off the system (key removed).						x	x
The operating personnel must wear laser safety glasses acc. to EN 207.					x	x	x
The operating personnel must wear laser adjustment glasses compliant to EN 208 during adjustment tasks.					x	x	x
The operating personnel must wear protective clothes if necessary (for example protective gloves).					x	x	x
The operating personnel of the laser system must attend a laser safety instruction course.		x	x	x	x	x	x
All insured persons inside the laser area must attend a laser safety instruction course.					x	x	x
Adolescents under 16 years of age are not allowed to enter the laser area. Adolescents between 16 and 18 years of age are only admitted to the laser area if it is instrumental to achieving the educational objective.					x	x	x
Immediate medical care in case of any suspected eye injury.	x	x	x	x	x	x	x

Table 8: Organizational protective measures

1.4.4 Actions in case of an injury

In case of injury or only suspected injury, proceed as follows:

- ▶ The injured person has to consult a dermatologist or eye specialist immediately. Always have the eye fundus examined.
- ▶ Switch off the laser system and secure it against restart.
- ▶ Describe the accident details in a report.
- ▶ Inform the laser protection officer.
- ▶ Inform the supervisor.

1.4.5 Laser Safety Instructions

Observe strictly the following safety instructions for working with laser systems:

- ▶ Only the persons whose presence is required should be present in the laser area.
- ▶ The laser radiation of systems of laser classes 1C, 2, 2M, 3A, 3B and 4 should reach only as far as required for the specific application.
- ▶ Avoid any random reflections when using lasers of class 3 or 4. Keep away, remove or cover any reflecting/glossy objects or surfaces near the laser beam.
- ▶ Any person present in the laser area must be informed immediately when a laser system of class 3 or 4 will be switched on.
- ▶ A laser system is only safe, when no uncontrolled reflected radiation is emitted and access to the laser beam is prevented during operation.
- ▶ Looking directly into the laser beam is forbidden. Even proper laser safety glasses provide only limited protection against direct, specularly reflected or diffusely scattered laser radiation.
- ▶ Use only laser safety glasses that are approved for the specific laser system and are able to absorb the wavelength used.
- ▶ Check the laser safety glasses before every usage. Only undamaged and approved protective glasses (for wavelength and laser class) must be used.
- ▶ Inform the laser protection officer immediately about any damage of the laser system like changes on the protection filter, for example glass cracks, change in color, change in transparency and defects of the carrier.
- ▶ Do not wear any jewelry or other glossy or reflecting objects when operating a laser system.
- ▶ A laser system that is completely shielded with a protective housing is equivalent to laser class 1. If the protective housing is removed, the laser class is increased.

1.5 Responsibility of the operator

Operator

The operator is the person/company who operates the system/product themselves for industrial or commercial purposes, or makes it available to a third party for use and has the product responsibility for the safety of the system operator/user, the personnel in general, and other persons present.

Operator's obligations

The system/product is used in the industrial sector. The operator of the system/product is thus subject to the statutory obligations for occupational health and safety.

In addition to the safety instructions in this document, the safety, accident prevention, and environmental protection regulations must also be observed at the system's/product's place of operation.

The following applies in particular:

- The operator must inform himself about the effective industrial safety regulations and determine additional hazards in a risk assessment that result from the special working conditions at the system's/product's place of operation. The operator has to implement these in the form of operating procedures for the operation of the system/product.
- During the total operating life of the system/product, the operator has to check and ensure that the established operating procedures comply with the current state of the rules and standards and adapt them, if necessary.
- The operator has to define clear-cut responsibilities for installation, operation, trouble-shooting, maintenance, and cleaning.
- The operator has to make sure that all persons who are working with the system/product have read and understood this document. Furthermore, the personnel has to be trained and informed about the dangers on a regular basis.
- The operator has to provide the required personal protective equipment and instruct the personnel to wear it.
- The operator has to instruct the personnel to maintain a clean and tidy workplace. Eating and drinking at the workplace and especially while operating the system/product must not be permitted.

The operator is also responsible to keep the system/product in good working order. Thus, the following applies:

- The operator has to ensure that the maintenance intervals stated in this document are observed.
- The operator has to check all safety devices for proper function and completeness on a regular basis.

1.6 Personnel requirements

WARNING

Accident hazard due to insufficiently qualified personnel!

Insufficiently qualified personnel cannot assess the risks of using the system/product and put themselves and others in danger.

- ▶ Allow only qualified personnel to use the system/product.
- ▶ Keep insufficiently qualified personnel out of the working area.

The different tasks described in this document require different qualifications of the persons who are to perform these tasks.

If no personnel qualifications are listed in the individual chapters of this document, the operating personnel is intended to perform the tasks.

Only persons who can be expected to perform the tasks reliably are authorized to perform the tasks. Persons whose ability to react is impaired e.g. by drugs, alcohol, or medicine, are not authorized.

This document uses the following qualifications for persons for the different tasks.

Qualified electrician

A qualified electrician is able to perform work on electrical systems and to detect and avoid possible dangers on his/her own based on his/her professional training, know-how and experience as well as knowledge of the applicable standards and regulations.

The qualified electrician has been trained for the special field where he/she works and knows the relevant standards and regulations.

Maintenance personnel of the operator

Maintenance personnel are those persons who are designated by the operator to perform simple maintenance tasks (e.g. cleaning the system/product, removing parts from the system/product). The operator has to ensure that the personnel is suited for performing the work.

The maintenance personnel is able to perform his/her work and to detect and avoid possible dangers on his/her own based on his/her professional training, know-how and experience as well as knowledge of the applicable standards and regulations.

The maintenance personnel has been trained for the special field where he/she works and knows the relevant standards and regulations.

Service personnel

Service personnel are persons who are authorized by the manufacturer LPKF for servicing the system/product. These tasks may only be performed by the LPKF Service.

Operating personnel

Operating personnel trained by the operator is able to perform his/her work and to detect and avoid possible dangers on his/her own based on the training performed by the operator, his/her professional training, and his/her know-how and experience.

The operating personnel has been trained by the operator for the special field where he/she works and knows the relevant standards and regulations.

1.7 Personal protective equipment

Personal protective equipment protects against health or safety risks when working with the system.

The individual sections of this manual each point out the personal protective equipment (PPE) that has to be worn during the different tasks of working on the system.

This system is classified as laser class 1 if the cover is closed and it is not necessary to wear laser safety specific PPE during normal operation. If the cover is open (service mode), the system is classified as laser class 4.

Protective equipment for startup and maintenance tasks

- Laser safety glasses with a rating of LB3 for 355 nm, protection class 3
- Respirator half mask according to EN 141/143, protection class P3
- Safety shoes, protection class 1
- Protective gloves, protection class 2
- Safety glasses, protection class 2
- Safety goggles, protection class 2
- Latex lab gloves, protection class 1

Personal protective equipment for working with hazardous substances and chemicals

- Respirator mask with gas filter for organic gases/vapors (boiling point > 65 °C, e.g. EN 14387 type A), protection class P3
 - Safety glasses with side shields (e.g. EN166), protection class 2
 - Chemical-resistant gloves, protection index 6 nitrile rubber (NBR) - 0.4 mm thickness (e.g. EN 374), protection class 3
 - Closed work clothing
- ▶ Always read the safety data sheets before working with hazardous substances and chemicals and always observe the instructions given therein.

Description of the personal protective equipment**Laser safety glasses**

Laser safety glasses protect the eyes against laser radiation for the specified wavelength(s) in the ultraviolet, visible, and infrared spectral range for at least 10 seconds or, in case of pulsed lasers, for at least 100 pulses.

**Safety goggles**

Safety goggles protect the wearer's eyes against chemicals, dust, and splinters. Safety goggles have a seal ring for additional protection.

**Safety glasses with side shields**

Safety glasses with side shields serve for eye protection in case of flying debris and liquid splashes.

**Respirator mask**

Respirator masks protect against hazards from harmful substances in gases, vapors, and particles.

**Safety shoes**

Safety shoes protect the feet against crushing injuries, falling objects and from slipping on slippery surfaces.

**Protective gloves**

Protective gloves protect the hands against friction, abrasions, puncture hazards and deep cuts as well as when touching hot surfaces.

**Chemical-resistant gloves**

Chemical-resistant gloves protect the hands against immediate skin contact with hazardous substances. Refer to the safety data sheet for the required glove material and thickness.

**Protective clothing**

Protective clothing protects the body (except head, hands, and feet) against hazards caused by e.g. heat, cold, and chemicals.

1.8 Safety signs

This chapter lists the safety signs/pictograms that are applied to the system and describes their meaning.

 WARNING
<p>Risk of injury by nonobservance of safety signs!</p> <p>The safety signs on the system instruct you on safe usage of the system. Nonobservance of the safety signs can cause severe injuries.</p> <ul style="list-style-type: none"> ▶ Always observe the safety signs. ▶ Never remove the safety signs. ▶ Stick the safety signs in the language of your country on top of the corresponding safety signs applied on the system. ▶ Apply additional laser safety signs in the language used in your factory. ▶ If a safety sign is no longer legible, clean or replace the safety sign.

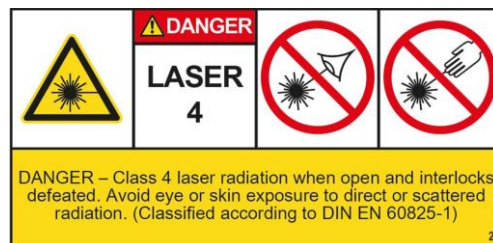


Classification of the laser system acc. to EN 60825-1

This laser system is classified as class 1. The accessible laser radiation is not dangerous.

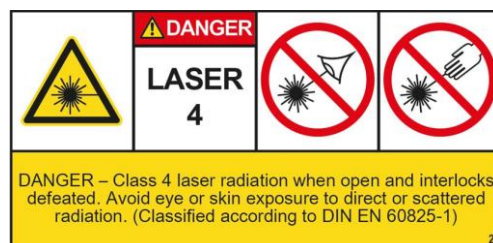
The label is applied at the following position(s):

- at the cover



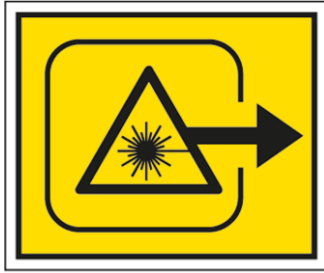
Warning against visible and invisible radiation in case of bypassed safety devices in service mode!

Use your personal protective equipment to avoid damage to health. The laser safety sign is marked with a **2** in the **lower right** corner for better identification.



The label is applied at the following position(s):

- at the cover

**Warning against laser radiation from the laser output aperture!**

In order to avoid serious injuries to your skin or your eyes always comply with the safety instructions while operating the lasers.

The label is applied at the following position(s):

- on the front of the processing head

1.9 Safety devices

This chapter describes the safety devices of the system and how they work.

All system components are connected to the main earthing busbar in the system. The system is connected to the ground potential via the earth wire of the power supply cable.

DANGER

Danger to life by missing safety devices!

Missing or deactivated safety devices when working with the system cause serious or even fatal injuries.

- ▶ Always ensure that all safety devices are functioning properly and are switched on.
- ▶ Ensure that the safety devices are not bridged or manipulated in any other way.

DANGER

Danger to life by uncontrolled restart!

An uncontrolled restart of the system can cause serious injuries or even death.

- ▶ Before restarting the system, ensure that the reason for the emergency stop is eliminated and all safety devices are working properly.
- ▶ Only turn the main switch back to **I** or **ON** if there is no danger anymore.

CAUTION

Risk of injuries by external components!

If you use the main switch (**0** or **OFF**) to switch off the system, only the electrical power supply of the system is disconnected. The supply of the external components (e.g. compressed air, extraction system) is still connected and can cause injuries.

- ▶ Disconnect the supply of all external components immediately.
- ▶ Before working with pressurized components, ensure that these are completely depressurized and de-energized.



Fig. 2: System with safety devices

- 1 Cover with laser protection pane
- 2 Magnet switch of the cover
- 3 Emergency stop button
- 4 Stack light
- 5 Main switch



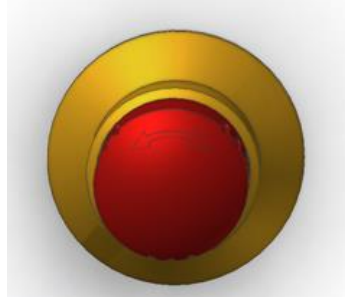
Figure	Description
	<p>The laser protection pane (1) protects against laser radiation.</p>
	<p>The magnet switch (2) protects against opening the cover while the system is in operation. If the cover is opened while the system is operating, the safety circuit is interrupted and the laser is disconnected from the power supply.</p>
	<p>The emergency stop button (3) is located at the front of the system. Pushing this button immediately switches off the laser and stops the motorized axis. This stop is only intended for an emergency.</p>



Figure	Description
	<p>The stack light (4) indicates the system's operating state. The following operating states are displayed with the stack light:</p> <p>Green: Ready for operation The system is ready for operation or already in operation. No fault is present.</p> <p>Orange: Service mode activated Laser class 4 is possible because safety devices have been shut off.</p> <p>Red: Fault Work cannot be continued until the fault is successfully reset in the fault monitor.</p> <p>Blinking red The emergency stop button has been pushed.</p>
	<p>The main switch (5) at the rear of the system switches off or on the mains power supply. But it does not start the system yet. The main switch can be secured against restart with a padlock.</p>

Table 9: Safety devices

Maximum service life of safety-relevant components

Component	Service life in years
Safety relay cover monitoring	8
Laser safety shutter	5
Safety control unit (emergency stop button)	20
Magnet switch of cover	20

Table 10: Service life

1.10 Securing against restart

The system can be secured with a padlock at the main switch. The padlock is not included in the delivery.

DANGER

Danger to life by uncontrolled restart!

An uncontrolled restart of the system can cause serious injuries or even death.

- ▶ Before restarting the system, ensure that the reason for the emergency stop is eliminated and all safety devices are working properly.
- ▶ Only turn the main switch back to **I** or **ON** if there is no danger anymore.

■ Securing against restart

1. Turn the main switch to **0** or **OFF** to disconnect the system from the power supply.
2. Disconnect the supply of all external components.
3. Secure the main switch with a padlock.

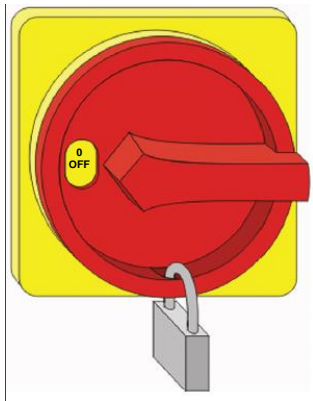


Fig. 3: Securing against restart

4. Keep the key safe.
- The system has been secured against restart.

1.11 Actions in case of an emergency

Preventive measures

- Always be prepared for fire and accidents!
- Keep first aid equipment (first aid kit, blankets etc.) and fire extinguishers in good working order and accessible at all times.
- Familiarize the personnel with accident reporting, first aid and rescue equipment.
- Keep access routes clear for rescue vehicles.

Actions in case of fire and accidents

- Use the emergency stop immediately to stop the system.
- Turn the main switch to **0 (OFF)**.
- Disconnect the supply of external components as soon as possible.
- If there is no risk for your own health rescue people from the danger zone.

Actions in case of a laser accident

- The injured person has to consult a dermatologist or eye specialist immediately. Always have the eye fundus examined.
- Switch off the laser system and secure the laser system against restart.
- Describe the accident details in a report.
- Inform the laser protection officer.
- Inform the supervisor.

1.12 Environmental protection

NOTICE

Environmental hazard by improper handling of substances!

Improper handling of environmentally hazardous substances, especially improper disposal, can cause considerable damage to the environment.

- ▶ Take appropriate measures immediately if environmentally hazardous substances are accidentally discharged into the environment. If you are in doubt, inform the appropriate local authorities about the damage and ask for appropriate measures that have to be taken.

The following environmentally hazardous substances are used:

Lubricants

Lubricants, such as greases and oils, contain toxic substances. They must not be released into the environment. They have to be disposed of by a waste management company.

Cleaning agents

Solvent-containing cleaning agents contain toxic substances. They must not be released into the environment. They have to be disposed of by a waste management company.

Coolant additive EUROLUB Kühlerschutz D-30

Has to be disposed of according to local regulations, e.g. at a suitable disposal site or a suitable incineration plant.

2 System description

The system structures and depanels various circuit board materials with the integrated laser source. The laser source produces ultraviolet radiation with a wavelength of 355 nm.

The system consists of five essential functional units:

- Laser source
- Chiller
- Beam deflection system with lens
- Processing table
- Camera system

2.1 Technical data

General

Data	Value	Unit
IP Code (IEC 60529)	IP20	–
Service life	10	Years
Laser class (EN 60825-1:2014)	1 (production mode)	Class
	4 (service mode)	Class

Climatic conditions

Data	Value	Unit
Temperature range (operation)	22 ± 2 (~71.6 ± 3.6)	°C (°F)
Temperature range (storage, transport)	10 to 40, 0 to 50 (~50 to 104, 32 to 122)	°C (°F)
Max. humidity, non-condensing	< 60	%

Electrical data

Data	Value	Unit
Power supply:		
Voltage	110/230 AC	V
Stability	+10/-15	%
Frequency	50/60	Hz
Input fuse	T16	A
	5 × 20 (~0.2 × 0.8)	mm (in)
	250 AC	V
Nominal power	< 1.5	kVA
Leakage current	< 3.5	mA

Mechanical data

Data	Value	Unit
Dimensions (width × height × depth)	910 × 1650 × 795 (~35.8 × 65.0 × 31.3) (height with opened cover 1765 (~69.5))	mm (in)
Weight (without packaging)	350 (~860)	kg (lbs)
Weight (with packaging)	390 (~772)	kg (lbs)

Load capacity

Data	Value	Unit
Min. distributed load	5.1	kN/m ²
Min. point load on an area of 0.00196 m ²	0.835	kN

Pneumatic data

Data	Value	Unit
Pressure	6	bar
Standard volume flow	185	l/min

Compressed-air purity acc. to ISO 8573-1:2010-04

Data	Value	Unit
Solid particles	1	Class
Water	4	Class
Oil	1	Class

Laser data

Data	Value	Unit
Laser type	Nd:YVO4	–
Laser power	5.7 (50 kHz)	W
Laser wavelength	355	nm
Laser pulse frequency	25 to 300	kHz
Focused laser beam (diameter)	20 ± 2	µm
Axial deviation	/	µm

Process data

Data	Value	Unit
Max. structuring area (x/y/z)	229 × 305 × 10 (~9 × 12 × 0.4) 229 × 305 × 7 (~9 × 12 × 0.28) (laminated substrates)	mm (in)
Max. material size (x/y/z)	239 × 315 × 7 (~9.4 × 12.4 × 0.28)	mm (in)
Mark speed	5.5 (~0.9)	cm ² /min (sq in/min)
Minimum line/space	50/20 (on FR4 18 μm Cu)	μm
Base plate of the processing table (x/y)	268 × 344 (~10.6 × 13.5)	mm (in)
z travel range of the processing table	11 (~0.43)	mm (in)
Accuracy of laser scan area (calibrated)	± 10 (~0.39)	μm (mil)
Positioning accuracy	± 20	μm
Repeatability	± 2.2	μm
Resolution	1.2	μm
Accuracy of camera scan area (calibrated)	/	μm

Emissions

Data	Value	Unit
Sound pressure level LpA (EN ISO 3744)	< 70	dB (A)
Sound power level LwA (EN ISO 3744)	< 70	dB (A)
EMC limit class	A	–

2.2 Type label

The type label is located at the housing of the system. For information on identifying the system and the relevant equipment, specify the system model and the serial number on the type label when you contact the LPKF Service.

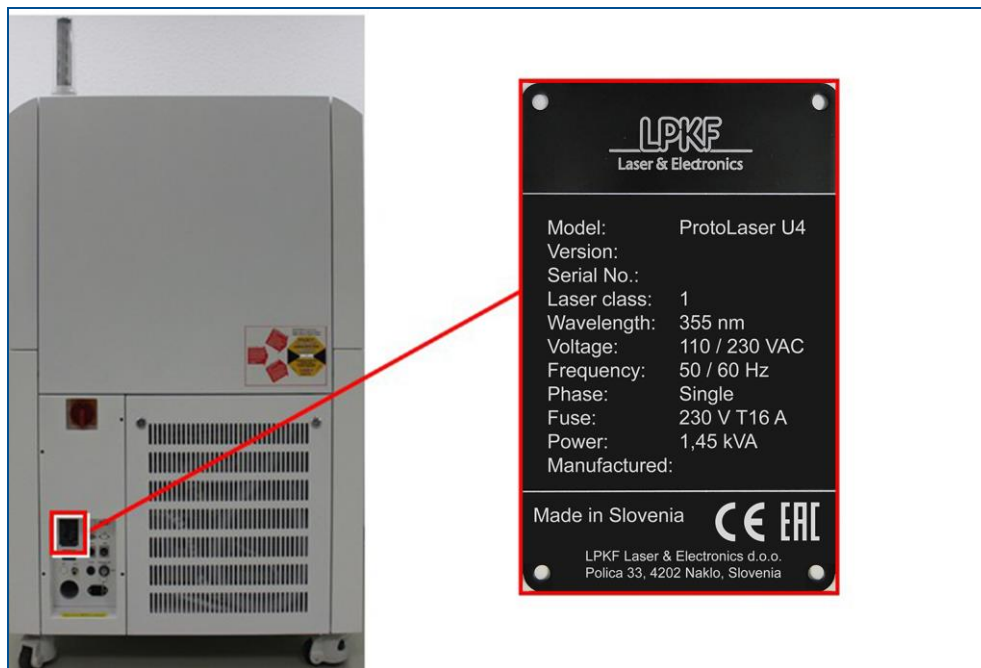


Fig. 4: Type label

Name	Description
Model	System type
Version	Version number
Serial No.	Serial number
Laser class	Laser class
Wavelength	Laser wavelength
Voltage	Operating voltage
Frequency	Line frequency
Phase	Number of phases
Fuse	Fuse protection
Power	Power consumption
Manufactured	Year of manufacture
Made in Slovenia	Country of Origin

Table 11: Type label

2.3 Scope of delivery

ProtoLaser U4

- 2 x Control cabinet keys
- 1 x Screen with mains cable
- 1 x Keyboard
- 1 x Mouse
- 1 x Mains cable 230 V
- 1 x Mains cable 115 V
- 1 x Connection cable for extraction system
- 1 x DisplayPort cable
- 1 x USB cable
- 1 x Stack light
- 1 x Compressed-air tube
- 1 x Plastic container
- 1 x Coolant additive EUROLUB Kühlerschutz D-30
- 1 x Filter kit zero air filter
- 1 x Data medium Documentation
- 1 x Data medium CircuitPro PL
- 1 x Starter kit ProtoLaser
- 1 x Logbook

Data medium Documentation

The data medium contains the following:


- Brochure ProtoLaser U4
- User manual ProtoLaser U4
- Basic reference ProtoLaser U4
- Product catalog Rapid Prototyping
- How-to guides ProtoLaser U4/S4/R4

Data medium CircuitPro PL

The data medium contains the following:

- System software CircuitPro PL
- Product catalog Rapid Prototyping

2.4 EC Declaration of conformity



LPKF
Laser & Electronics

EG-Konformitätserklärung nach Maschinenrichtlinie 2006/42/EG, Anhang II A

Der Hersteller:

LPKF Laser & Electronics d.o.o.
Polica 33
SI-4202 Naklo

erklärt hiermit, das folgendes Produkt

Produktbezeichnung: LPKF ProtoLaser U4
Fabrikat: LPKF Laseranlage

den Bestimmungen der oben gekennzeichneten Richtlinie - einschließlich deren zum Zeitpunkt der Erklärung geltenden Änderungen - entspricht.

Diese Erklärung bezieht sich nur auf den Zustand, in dem das Produkt in Verkehr gebracht wurde. Vom Endnutzer nachträglich angebrachte Teile, oder nachträgliche vorgenommene Veränderungen bleiben unberücksichtigt. Die Erklärung verliert ihre Gültigkeit, wenn das Produkt nachträglich verändert wird.

Folgende nationale oder internationale Normen (oder Teile/Klauseln daraus) und Spezifikationen wurden angewandt:


EN ISO 12100:2010	Sicherheit von Maschinen - Allgemeine Gestaltungsleitsätze - Risikobeurteilung und Risikominderung
EN ISO 13849-1:2015	Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen Teil 1: Allgemeine Gestaltungsleitsätze.
EN 60204-1:2009	Sicherheit von Maschinen - Elektrische Ausrüstung von Maschinen Teil 1: Allgemeine Anforderungen
EN 60825-1:2014	Sicherheit von Laser-Einrichtungen - Teil 1: Klassifizierung von Anlagen, Anforderungen und Benutzer-Richtlinien

Name des Dokumentationsbevollmächtigten: Dr. Drago Kovačič
Adresse des Dokumentationsbevollmächtigten: siehe Adresse des Herstellers

Folgende weitere EU-Richtlinien wurden angewandt:

- EMV-Richtlinie 2014/30/EU
- Niederspannungsrichtlinie 2014/35/EU

Ort: Naklo (Slowenien)
Datum: 24.1.2018


Dr. Boštjan Podobnik
(Geschäftsführer)

CE

Fig. 5: Declaration of conformity (original)

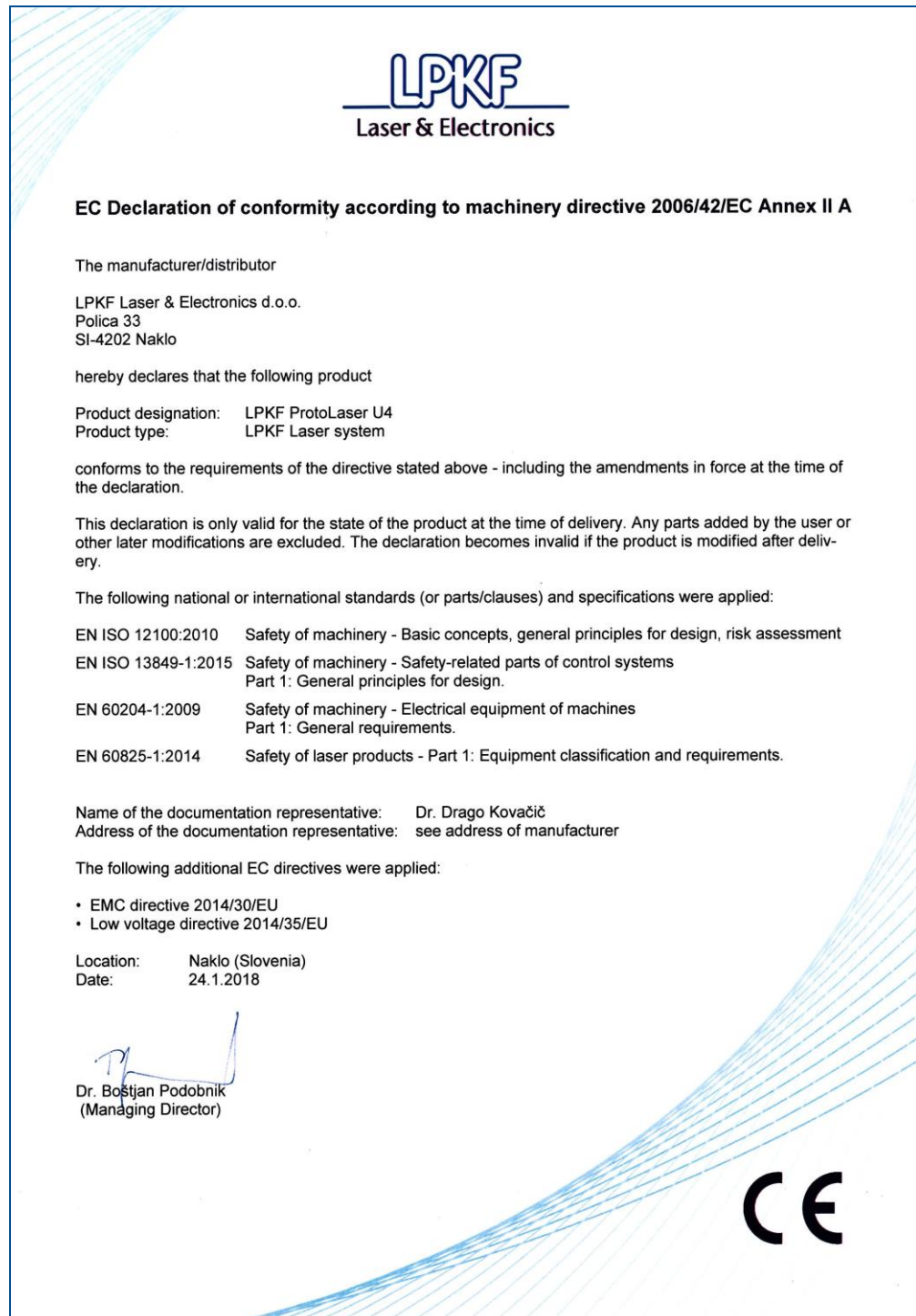


Fig. 6: Declaration of conformity (original)

3 Transport and storage

This chapter contains important information on transport, packaging and storage of the system.

NOTICE

System damage by improper transport!

Improper transport can cause damage to the system.

- ▶ Transport the system cautiously to the place of installation.
- ▶ Observe the symbols on the packages.
- ▶ Remove the packaging only directly before system installation.

3.1 Transport inspection

Check the delivered goods immediately upon receipt for completeness and for transport damage.

If transport damage is evident or a ShockWatch® indicator or a TiltWatch® indicator has been activated, proceed as follows:

- ▶ Do not accept the delivery or only with reservations.
- ▶ Record the extent of damage on the transport documentation or on the delivery note of the transport company.
- ▶ Use photographs to document the damage.
- ▶ Initiate a complaint.

3.2 Packaging

The packaging is chosen according to the transport conditions.

The packaging is to protect the system from transport damage, corrosion, and other kinds of damage until installation.

- ▶ Keep the packaging in its original form.
- ▶ Only remove the packaging just before installation.

Handling packaging material

- ▶ Dispose of the packaging material according to the current laws and local regulations.

NOTICE

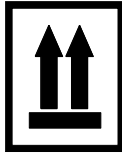
Environmental hazard by wrong disposal of packaging!

Wrong disposal of packaging material can cause environmental hazards.

- ▶ Dispose of the packaging material environmentally friendly.
 - ▶ Observe the local disposal regulations and hire a specialized company for the disposal, if necessary.
- ▶ The system may only be shipped in the original packaging of LPKF. Contact the LPKF Service if you need the packaging.

3.2.1 Symbols on the packaging

Observe the following symbols on the packaging when transporting the system:

**Top**

The arrowheads of the symbol indicate the top side of the package. These always have to point upwards, otherwise, the contents could be damaged.

**Keep dry**

Protect packages against moisture and keep them dry.

**Fragile**

Identifies packages with fragile or sensitive contents. Handle the package with care, do not drop, and do not subject it to shocks.

3.2.2 Unpacking the system

The following describes how to unpack the system. Observe also the unpacking instructions.

⚠ CAUTION

Risk of injury by sharp edges!

When working with the leveling feet, sharp edges of the adjusting lever can cut your hands.

- ▶ Always wear protective gloves.

■ Unpacking the system

1. Remove the screws from the lid.
2. Lift off the lid.

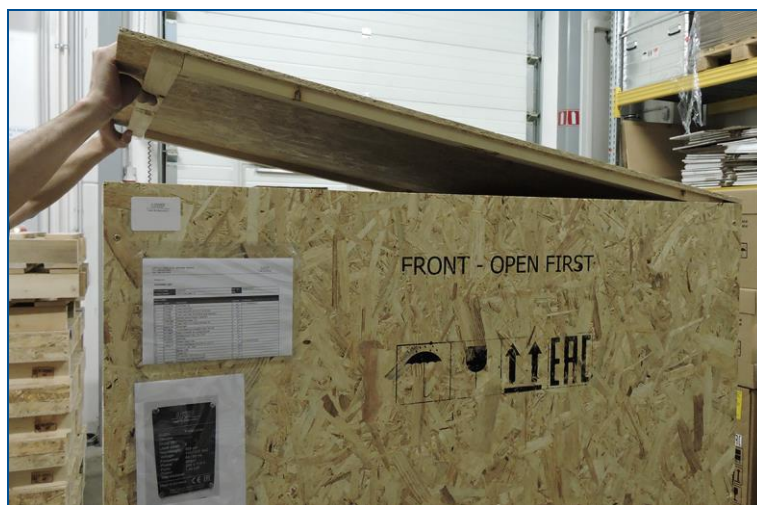


Fig. 7: Lifting off the lid

3. Remove the top padding material.

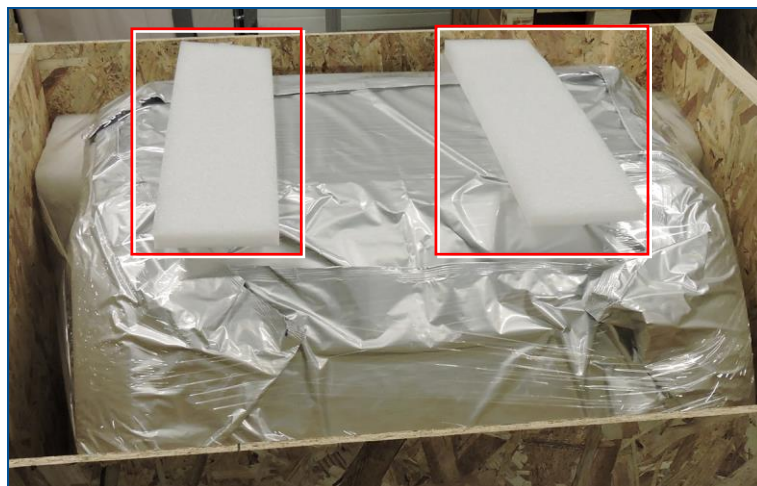


Fig. 8: Top padding material

4. Remove the screws from the front of the packaging.

5. Remove the front.



Fig. 9: Packaging without front

6. Remove the screws from the side and rear panels.
7. Remove the side and rear panels.



Fig. 10: Packaging without panels

8. Cautiously remove the stretch film and the edge protectors.



Fig. 11: Stretch film and edge protectors removed

9. Remove the screws from the two fastening brackets (2) of the front transport support (1) and from the rear transport support (3).



Fig. 12: Front/Rear transport supports

- 1 Front transport support
- 2 Fastening bracket

- 3 Rear transport support

10. Remove the front transport support and the rear transport support.

11. Cut off the welded parts of the foil using scissors.



Fig. 13: Cutting off the welded parts of the foil

12. Remove the foil.



Fig. 14: Foil removed



The transport ramps are on the inside of the front panel.

13. Remove the screws of the transport ramps.



Fig. 15: Transport ramps

14. Put the transport ramps onto the front edge of the box floor.

15. Align the transport ramps with the centers of the caster wheels of the system.



Fig. 16: Placing the transport ramps

16. Screw the transport ramps onto the box floor.



Fig. 17: Fastening the transport ramps

CAUTION! Risk of injury by sharp edges!

When working with the leveling feet, sharp edges of the adjusting lever can cut your hands.

- ▶ Always wear protective gloves.

17. Pull on the ring (3) to pull out the height adjustment lever (2) of the leveling foot.

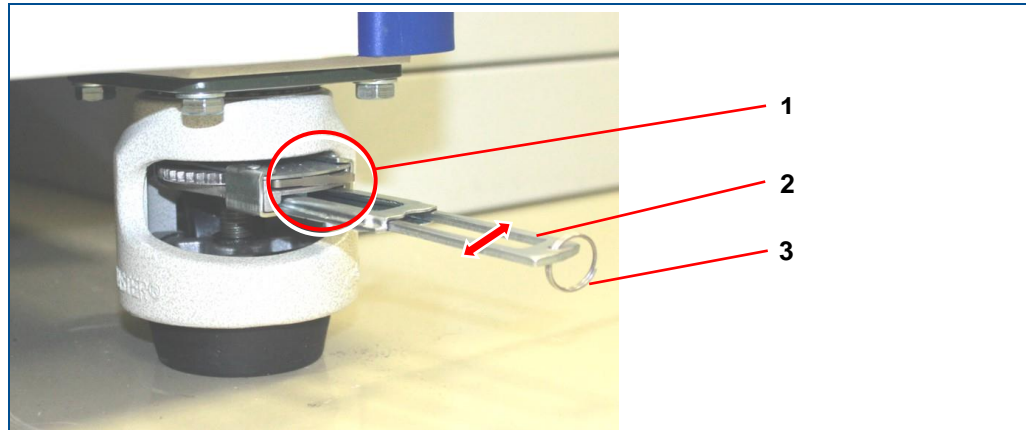


Fig. 18: Leveling foot

- | | | | |
|---|--|---|--|
| 1 | Rocker switch for raising/lowering the leveling foot | 3 | Ring for pulling out the height adjustment lever |
| 2 | Height adjustment lever | | |

18. Push all rocker switches (1) **to the right** to lower the leveling feet and thus lift the system.

19. Adjust all leveling feet using the adjustment levers (2) until the system is lifted off the transport supports.

20. Remove the screws from the four fastening brackets (1) of the side transport supports (2).

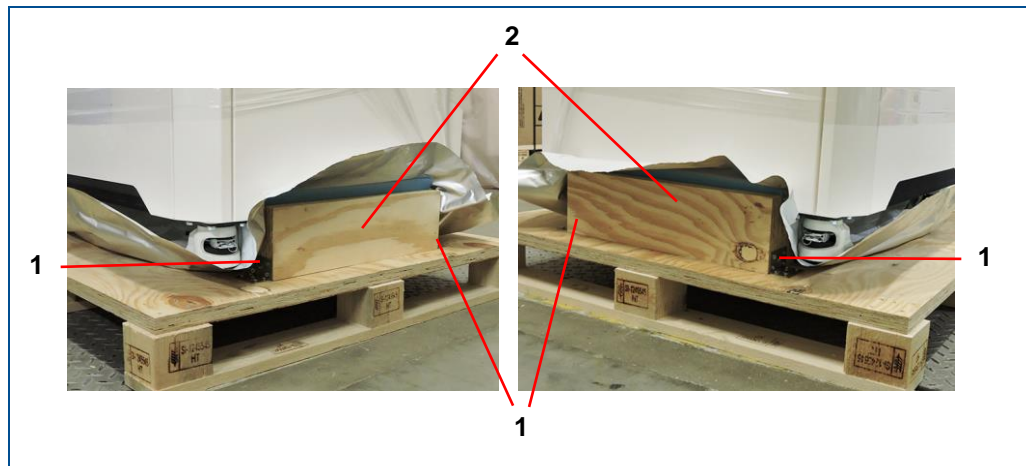


Fig. 19: Side transport supports

- | | | | |
|---|-------------------|---|------------------------|
| 1 | Fastening bracket | 2 | Side transport support |
|---|-------------------|---|------------------------|

21. Remove the side transport supports (2).

22. Push all rocker switches (1) (see figure 18) **to the left** to raise the leveling feet and thus unlock the leveling feet.

23. Adjust all leveling feet using the adjustment levers (3) (see figure 18) until the system stands on all four wheels.

24. Push the adjustment levers (2) (see figure 18) back into their resting positions.

25. Cautiously roll the system from the box floor via the transport ramps.

The system has been unpacked.

3.3 Transporting the system



Before transporting a system, the LPKF Service has to be contacted. The only exception is the transport over short distances (see the following chapter).

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- Wear safety shoes
- Wear protective gloves

Deactivate the system using the main switch at the rear of the system before transport. The cover must remain closed to prevent dirt from entering.

3.3.1 Moving the system over short distances

CAUTION

Risk of injury by sharp edges!

When working with the leveling feet, sharp edges of the adjusting lever can cut your hands.

- ▶ Always wear protective gloves.

NOTICE

Property damage by missing transport lock!

Transporting the system without installed transport locks can cause property damage.

- ▶ Only transport the system with installed transport locks.

The system has four leveling feet with wheels and is thus easy to transport. The system can be transported over short distances (e.g. within a room or a building) using the four leveling feet. To be able to move the system, the locks of the leveling feet have to be loosened first.

■ Loosening the locks of the leveling feet

CAUTION! Risk of injury by sharp edges!

When working with the leveling feet, sharp edges of the adjusting lever can cut your hands.

- ▶ Always wear protective gloves.

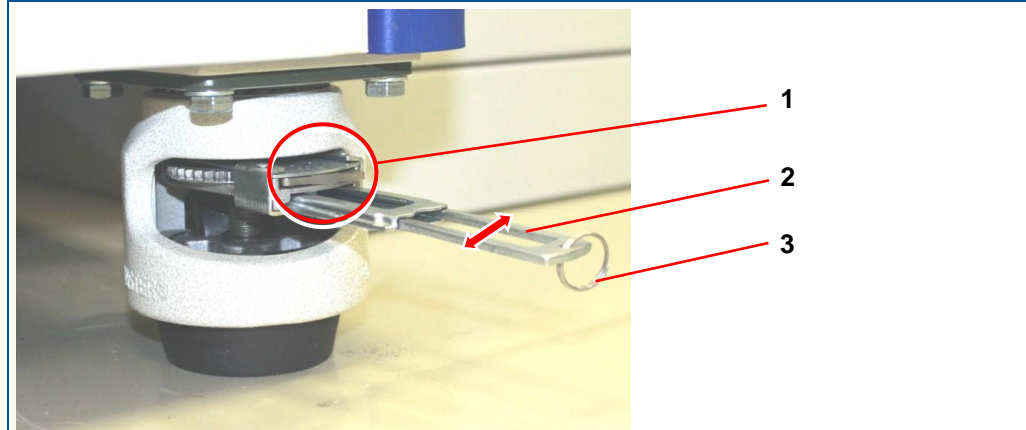


Fig. 20: Leveling foot

- | | |
|--|---|
| <p>1 Reversing lever for adjusting the leveling feet upwards or downwards</p> <p>2 Height adjustment lever</p> | <p>3 Ring for pulling out the adjusting lever.</p> |
|--|---|

1. Pull the ring (**3**) to pull out the height adjustment lever (**2**) of the leveling feet.
2. Adjust the reversing lever (**1**) to the **left** for turning the leveling feet upwards and for loosening their locks.
3. Repeat the steps 1 and 2 for the rest of the leveling feet until the locks are loosened.

- The locks of the leveling feet have been loosened.

■ Moving the system over short distances

1. Switch off the system and ensure that the locks of all leveling feet are disengaged.
2. Disconnect the following connections (see page 63):
 - Mains cable of the system
 - Mains cable of the extraction system
 - Control cable
 - Extraction hose
 - USB cable
 - Network cable
 - DisplayPort cable
 - Compressed-air supply

NOTICE! Property damage by missing transport lock!

Transporting the system without installed transport locks can cause property damage.

- ▶ Only transport the system with installed transport locks.

3. Move the system over a short distance to the desired place.



Carefully reconnect all connections mentioned above to the system before startup. Pay special attention to fastening the extraction hose.

4. Level the system (see page 48).

5. Secure the system at the place of destination with the locks of the leveling feet.

- The system has been moved over a short distance.

3.3.2 Leveling the system

After the final position for the system is determined, the system has to be leveled using the four leveling feet.

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- Processing table is at its center position.

Spare parts and auxiliaries

- Precision frame spirit level

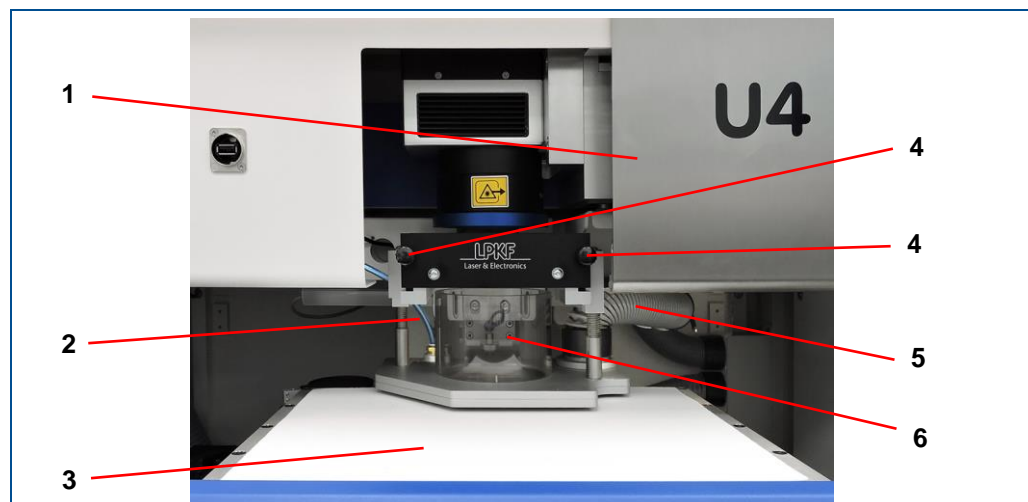


Fig. 21: System with open cover

- | | |
|--|-------------------------|
| 1 Maintenance cover in processing area | 4 Screw extraction hood |
| 2 Compressed-air tube | 5 Extraction hose |
| 3 Sinter plate | 6 Extraction hood |

Leveling the system

1. Open the cover.
2. Open the maintenance door in the processing area (1).
3. Disconnect the compressed-air tube (2) and the extraction hose (5) from the extraction hood (6).
4. Remove the screws (4) of the extraction hood.
5. Pull out the extraction hood towards you.
6. Remove the sinter plate (3) from the processing table.



When opening the system for the first time, an acceptance sample and an information sheet are on the sinter plate.

7. Clean the processing table, if necessary.

CAUTION! Risk of injury by sharp edges!

When working with the leveling feet, sharp edges of the adjusting lever can cut your hands.

▶ Always wear protective gloves.

8. Pull on the ring (see page 47) to pull out the height adjustment lever of the leveling feet.

9. Perform one of the following steps:

- Push the rocker switch **to the right** to **lower** the leveling foot.
- Push the rocker switch **to the left** to **raise** the leveling foot.

10. Level the system with load on all leveling feet in x and y direction using a precision frame spirit level.

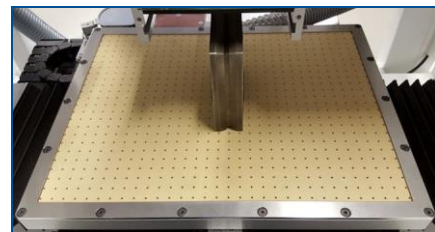
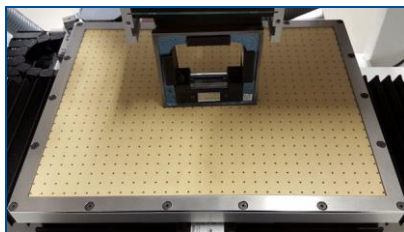


Fig. 22: Precision frame spirit level

11. Push the adjustment levers of all leveling feet back into their resting positions.

12. Reinsert the sinter plate.

13. Reassemble the mentioned components in reverse order.

The system is leveled.

3.4 Storage

▶ Store the system in its original packaging according to the symbols on the packaging.

▶ Store the packages under the following conditions:

- Do not store outdoors.
- Store dry and dust-free.
- Do not expose to aggressive substances.
- Protect against sunlight.
- Storage temperature: 15 °C - 35 °C (59 °F - 95 °F)
- Relative air humidity: 60 % max, non-condensing.
- If storing for more than 3 months, check the general condition of all components and the packaging on a regular basis.

When putting the system out of operation and into storage over a longer period, ensure that the storage room is clean, almost dust-free, and has a sufficient loadbearing capacity.

4 First startup

This chapter contains important information on first startup of the system.

4.1 Safety



LPKF recommends to have the LPKF Service perform the first startup. For further information on an optional training contract or installation contract contact the LPKF Service.

Observe the following safety instructions for the first startup of the system:

WARNING

Accident hazard due to insufficiently qualified personnel!

Insufficiently qualified personnel cannot assess the risks of using the system and put themselves and others in danger.

- ▶ Allow only qualified personnel to use the system.
- ▶ Keep insufficiently qualified personnel out of the working area.

CAUTION

Tripping hazard by hoses and cables!

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

- ▶ Always ensure that the hoses and cables do not pose a tripping hazard.

CAUTION

Health hazard by contact with chemicals!

Direct contact with the chemicals can cause serious damage to health.

- ▶ Always read the safety data sheets before working with chemicals and always observe the instructions given therein.
- ▶ Work in well-ventilated rooms.
- ▶ Wear your personal protective equipment.
- ▶ Avoid direct contact with the chemicals.
- ▶ Wash your hands thoroughly after work.
- ▶ Consult a physician in case of complaints after contact with chemicals.

NOTICE

Property damage by moisture during transport/storage!

When transporting or storing the system, moisture can cause damage to the system.

- ▶ Ensure that there is no moisture in the system.
- ▶ Before first startup of the system wait approx. 24 hours to allow the system to acclimatize.

4.2 Requirements of the place of installation

Check the system for transport damage before the installation is started. The system has to be transported to the desired place of installation. Transport the system in its packaging using a hand pallet truck. The total weight of the system has to be considered! Only when the system is at its place of installation it is leveled.

4.2.1 Climatic conditions

The following climatic conditions have to be ensured for operating the system:

Climatic conditions

Data	Value	Unit
Temperature range (operation)	22 ± 2 (~71.6 ± 3.6)	°C (°F)
Temperature range (storage, transport)	10 to 40, 0 to 50 (~50 to 104, 32 to 122)	°C (°F)
Max. humidity, non-condensing	< 60	%

4.2.2 Minimum required space

System dimensions

- Width 910 mm (~35.8 in)
- Depth 795 mm (~31.3 in)
- Height 1650 mm (~65.0 in)

Minimum required space for operation and maintenance

- Width 2375 mm (~93.5 in)
- Depth 2000 mm (~78.7 in)
- Height 1765 mm (~69.5 in)

An additional space of 750 mm (~29.5 in) is required at the system front to open the maintenance door. Do not block this area because it is a working space for operation and maintenance.

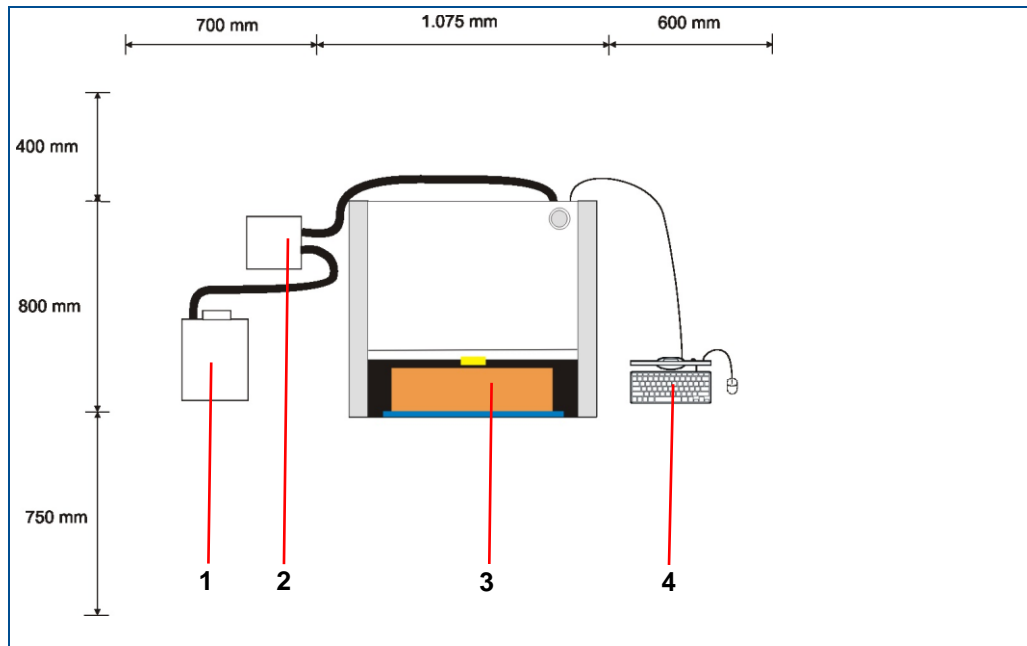


Fig. 23: Minimum required space

- | | | | |
|---|-------------------|---|--|
| 1 | Extraction system | 3 | System |
| 2 | Prefilter unit | 4 | Screen, keyboard, and mouse (recommended position) |

4.2.3 Workplace of the operating personnel

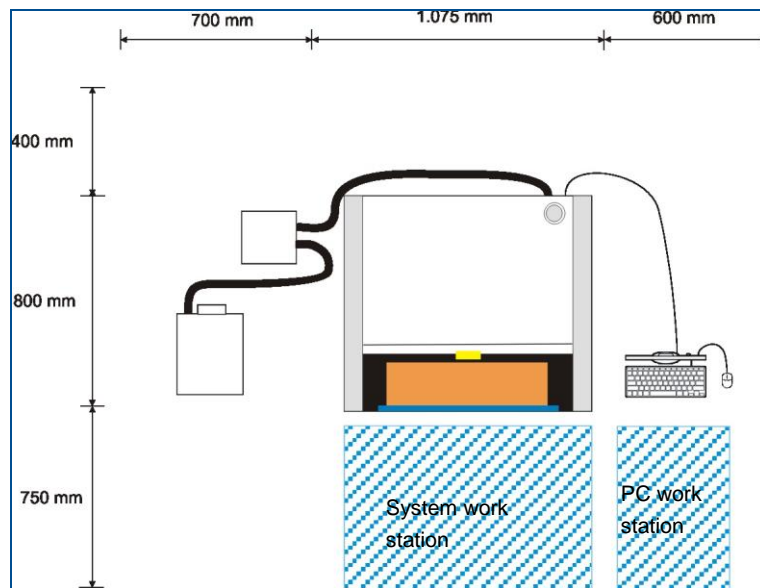


Fig. 24: Workplace of the operating personnel

The system may only be operated by one person. The system is operated according to its intended use at the following work stations:

- System work station
The system work station is used for loading and unloading the system.
- PC work station
The PC work station is used for monitoring the production and for controlling the system.

4.2.4 Floor

The floor has to be level and antistatic, and has to have a sufficient load-bearing capacity for the total weight of the system (350 (~772) kg/lbs).



LPKF recommends using flagstone for the flooring.

Load capacity

Data	Value	Unit
Min. distributed load	5.1	kN/m ²
Min. point load on an area of 0.00196 m ²	0.835	kN

► The system should be installed on a vibration-damped floor.

LPKF will gladly advise you on suitable damping measures such as active and passive vibration-dampers or vibration-damping mats. LPKF assumes no liability for inaccuracies and/or damage due to inadequate vibration damping.

4.2.5 The system's center of gravity

The following figure shows the center of gravity of the system:

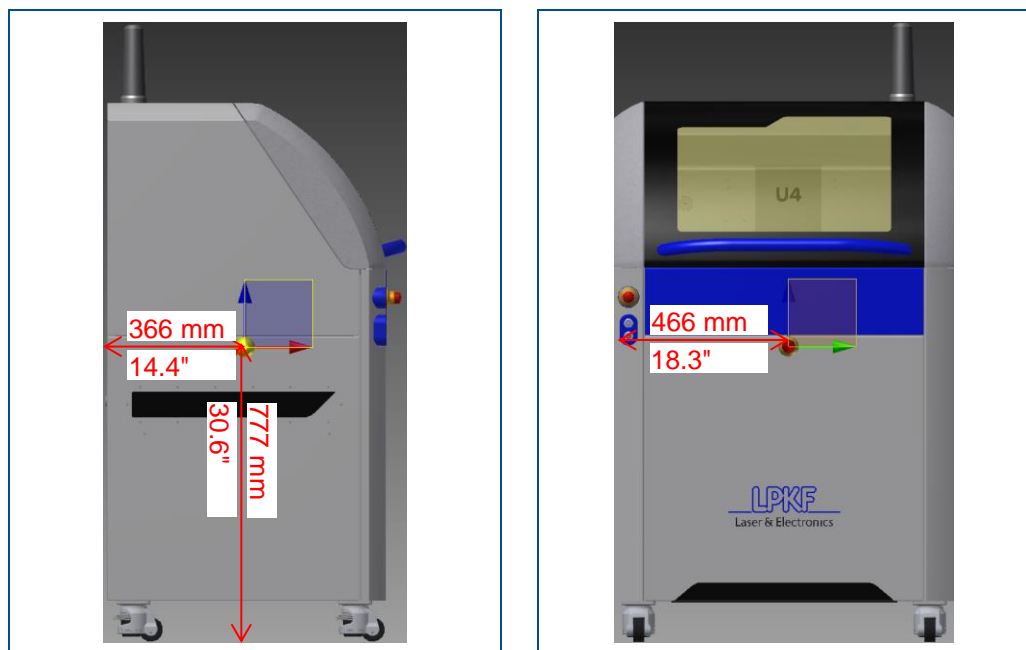


Fig. 25: Center of gravity of the system

4.2.6 Connections provided by the customer

The following connections have to be available for the first startup:

Electrical data

Data	Value	Unit
Power supply:		
Voltage	110/230 AC	V
Stability	+10/-15	%
Frequency	50/60	Hz
Power rating	> 1.5	kW
Electrical connection - socket	CEE 7/3 "Schuko socket"	-

Pneumatic data

Data	Value	Unit
Pressure	6	bar
Standard volume flow	185	l/min

Compressed-air purity acc. to ISO 8573-1:2010-04

Data	Value	Unit
Solid particles	1	Class
Water	4	Class
Oil	1	Class

4.3 Preparations

Before the system is installed, you have to consider and ensure the following:

- A suitable extraction system has to be provided. LPKF recommends the use of the LMD 508 extraction system. This is optionally available at LPKF.
- Provide sufficient space at the place of installation.
- Ensure tidiness and cleanliness at the place of installation.
- Provide the connection materials (hoses, tubes, cables etc.).
- The room has to be clean and almost dust-free.
- Stick the corresponding safety signs in your national language on top of the safety signs that have been applied to the system. Apply the safety signs in the language that is used at the workplace additionally.
- Ensure that the system is leveled (see page 48).
- Remove the transport locks of the system (see page 55).
- Fill the coolant into the chiller (see page 59).
- Check the local mains voltage setting of the chiller (see page 61).

4.3.1 Removing the transport locks

The transport locks have to be removed before the system can be put into operation. The chiller and the processing table are secured with transport locks.

NOTICE

Property damage by missing transport lock!

Transporting the system without installed transport locks can cause property damage.

- ▶ Only transport the system with installed transport locks.

Chiller

The chiller is secured with two transport brackets. The transport brackets are behind the front cover.

■ Removing the transport locks of the chiller

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- Mains cable of the system is not connected.

Spare parts and auxiliaries

- Hex key 5 mm

1. Pull on the lower left edge of the maintenance door to open it.



Fig. 26: Opening the maintenance door

- Remove the screws (**2, 3, 6, 7**) that fasten the transport brackets (**8, 10**) to the base frame.



Put the **screw with rubber stopper (2)** aside, it will be used in one of the next steps.

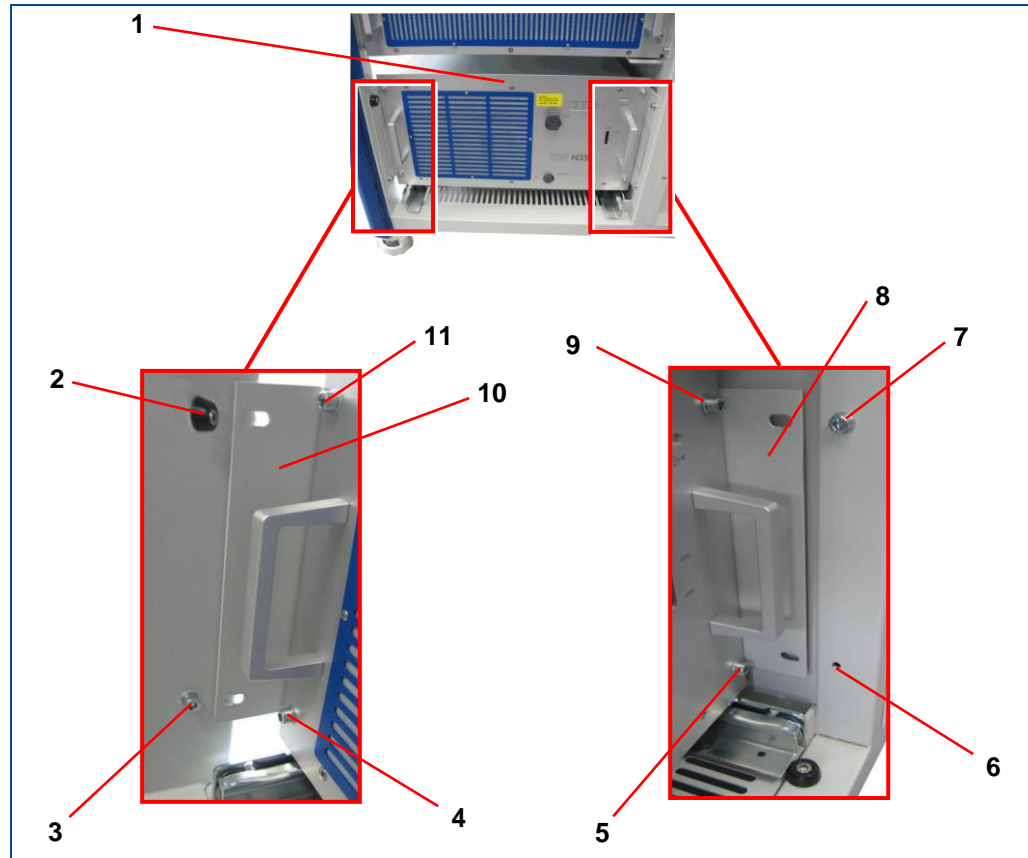


Fig. 27: Transport lock for chiller

- | | |
|--|--|
| 1 Chiller | 7 Screw (fastening transport bracket to base frame) |
| 2 Screw with rubber stopper (fastening transport bracket to base frame) | 8 Transport bracket |
| 3 Screw (fastening transport bracket to base frame) | 9 Screw (fastening transport bracket to chiller) |
| 4 Screw (fastening transport bracket to chiller) | 10 Transport bracket |
| 5 Screw (fastening transport bracket to chiller) | 11 Screw (fastening transport bracket to chiller) |
| 6 Screw (fastening transport bracket to base frame) | |

- Pull out the chiller until the transport brackets protrude from the base frame.
- Remove the screws (**4, 5, 9, 11**) that fasten the transport brackets to the chiller.
- Remove the transport brackets (**8, 10**).

6. Push the chiller into the base frame.



Pushing in the chiller is hampered by a detent at the full extent of the guiding rail.

The chiller can be moved freely.

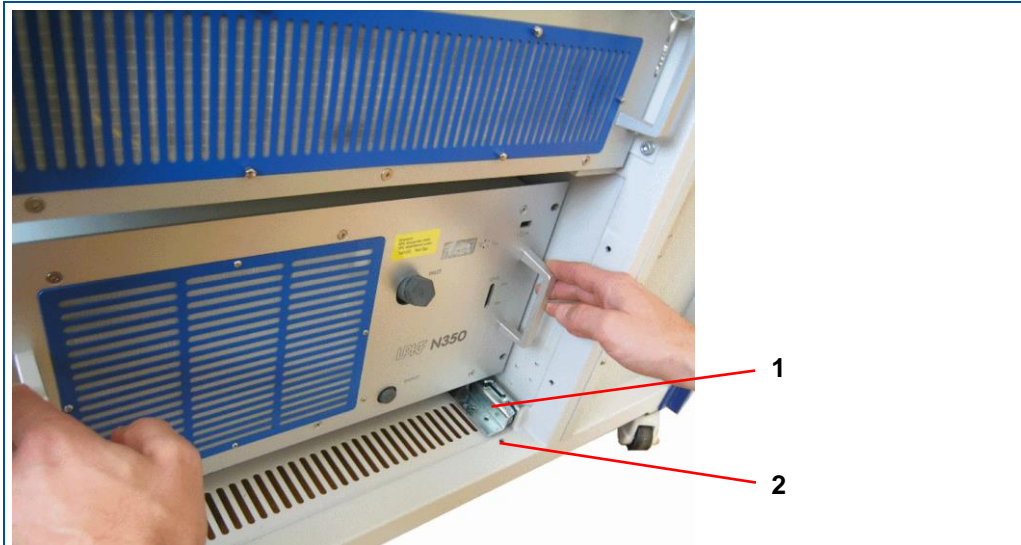


Fig. 28: Chiller

1 Guiding rail

2 Position of the screw with rubber stopper

7. Insert the screw with rubber stopper into the threaded hole in front of the guiding rail and fasten it to secure the chiller.

8. Close the maintenance door.

The transport locks of the chiller have been removed.



Store the transport brackets in a dry place in immediate vicinity of the system. Reinstall the transport brackets for securing the chiller every time the system has to be transported.

Processing table

The processing table is secured with two bolts. The bolts are located beneath the bellows on the left and right side of the x axis.

■ Removing the transport locks of the processing table

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- The mains cable of the system is not connected.
1. Open the cover.
 2. Cautiously push the bellows of the x axis (1) to the side.

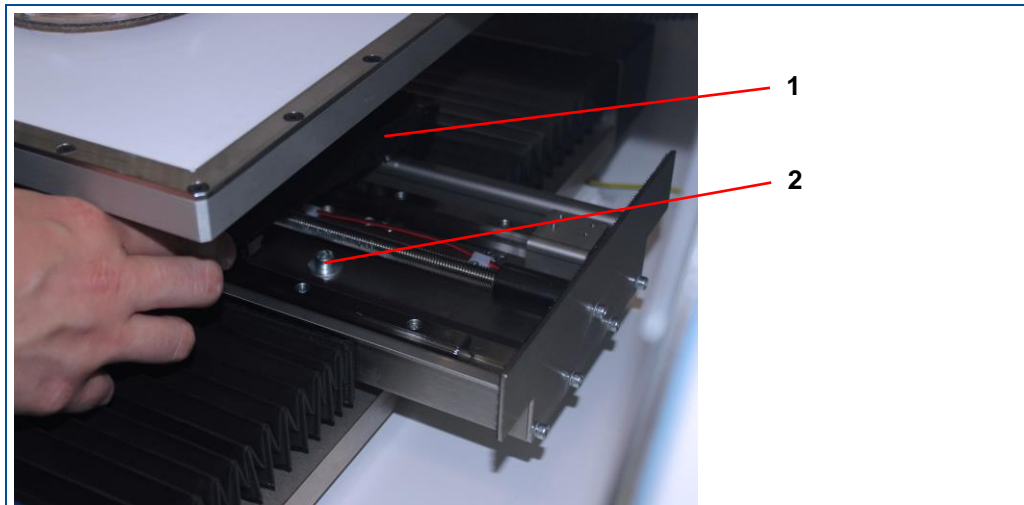


Fig. 29: x axis

1 Bellows of x axis, right side

2 Bolt

3. Pull out the bolt.



Fig. 30: Pulling out the bolt

4. Repeat steps 2 and 3 on the left side of the x axis.
 5. Cover the mounting hole with the bellows.
- The transport locks of the processing table have been removed.



Store the transport brackets in a dry place in immediate vicinity of the system. Reinsert the bolts for securing the processing table every time the system has to be transported.

4.3.2 Filling the coolant

The chiller is located behind the front cover.

The coolant additive (EUROLUB Kühlerschutz D-30) that has been delivered in a separate container has to be mixed with distilled water and filled into the chiller before the system is operated.

The mixing ratio is: 1:6 (EUROLUB Kühlerschutz D-30:distilled water).

■ Pouring in the coolant

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- Wear a respirator mask with gas filter for organic gases/vapors
- Wear safety glasses with side shields
- Wear chemical-resistant gloves
- Wear closed work clothing

Spare parts and auxiliaries

- Jerry can with spout
- EUROLUB Kühlerschutz D-30
- Distilled water

1. Pull on the lower left edge of the maintenance door to open it.



Fig. 31: Opening the maintenance door

2. Remove the cap of the filler neck (1).

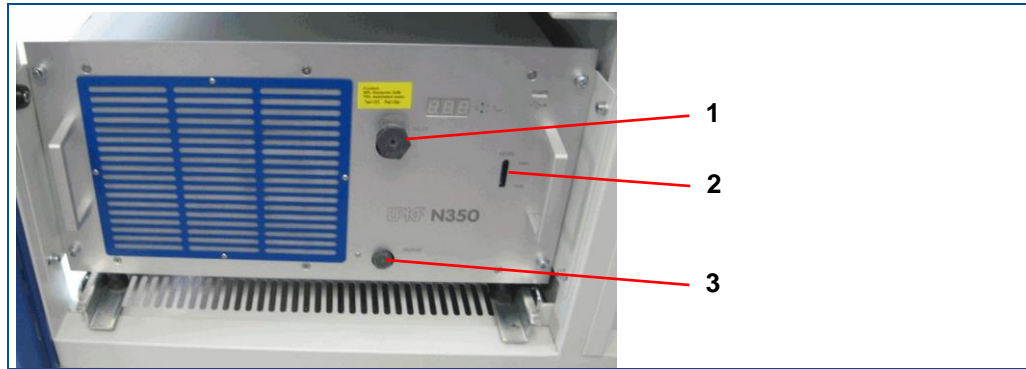


Fig. 32: Chiller

- 1 Filler neck
- 2 Fill level indicator

- 3 Drain valve

CAUTION! Health hazard by contact with chemicals!

Direct contact with the chemicals can cause serious damage to health.

- ▶ Wear your personal protective equipment.

3. Fill the jerry can contained in the delivery with 0.7 l EUROLUB Küblerschutz D-30 and 4.3 l distilled water.
 4. Use the spout to fill the resulting coolant into the filler neck (1).
 5. Fill coolant into the chiller until the fill level indicator (2) displays a maximum fill level.
 6. Screw the cap back onto the filler neck.
 7. Close the maintenance door.
 8. Store unused coolant according to the information in the safety data sheet.
- The coolant has been poured in.

4.3.3 Checking the local mains voltage of the chiller

Ensure that the mains voltage of the chiller is set to the local mains voltage (110 V / 230 V) before connecting the system to the mains power supply.

The chiller is preset to a mains voltage of 230 V on delivery. If your local mains voltage is 110 V, change the local mains voltage setting of the chiller.

NOTICE

Property damage due to incorrectly set mains voltage on the chiller!

An incorrectly set mains voltage can lead to property damage at the chiller.

- ▶ Set the chiller to your local mains voltage.

■ Changing the local mains voltage setting of the chiller

Ensure that the following prerequisites are fulfilled before performing the described tasks:

Prerequisites

- Mains cable of the system is not connected.

Spare parts and auxiliaries

- Control cabinet key
- Flat-bladed screwdriver

1. Insert the control cabinet key into the keyhole of the rear cover.
2. Turn the control cabinet key counter-clockwise by **180°**.

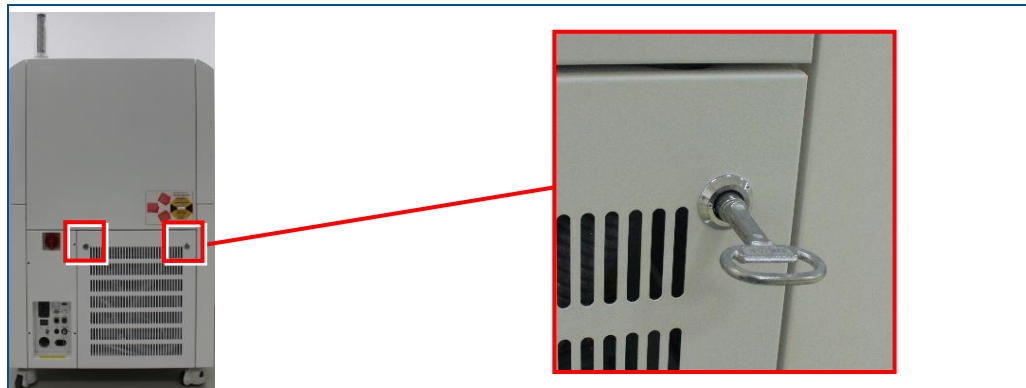


Fig. 33: Rear cover

3. Repeat steps 1 and 2 with the second keyhole of the rear cover.

4. Tilt the rear cover slightly forward and disconnect the grounding cable.



Fig. 34: Grounding cable

5. Lift the rear cover upwards.

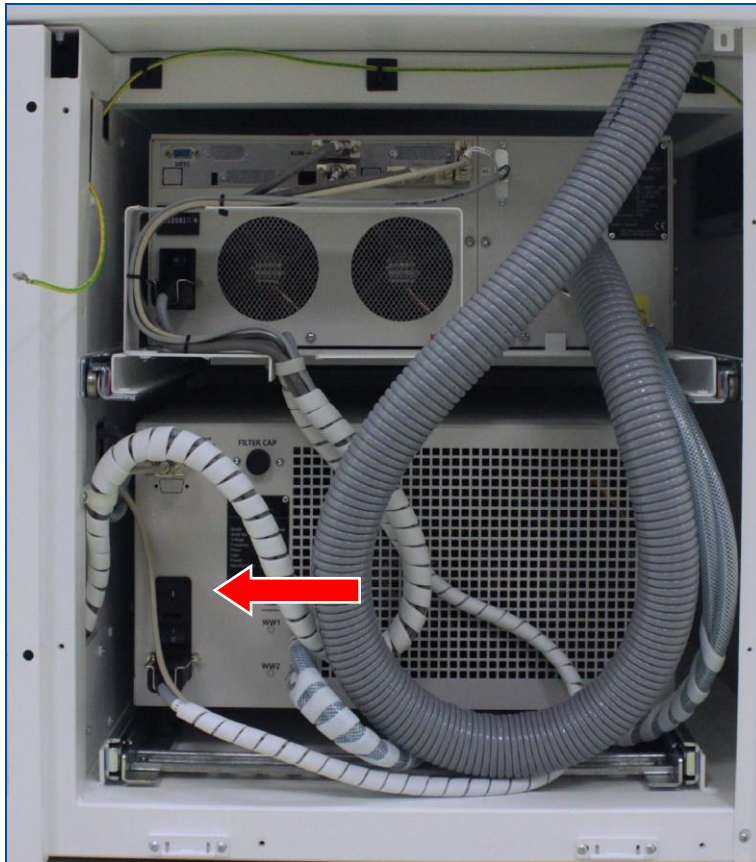


Fig. 35: Line filter of the chiller

6. Pry out the line filter using a flat-bladed screwdriver.
 7. Turn the line filter by **180°** and reinsert it.
 8. Reassemble the mentioned components in reverse order.
- The local mains voltage setting of the chiller has been changed.

4.4 Connecting the system

Once all preparations are concluded, the system is connected in the following order:

- Connecting the stack light
- Connecting the extraction system
- Connecting the compressed-air supply
- Connecting to the network
- Connecting the screen, keyboard, and mouse
- Connecting the system to the mains power supply

4.4.1 Connecting the stack light

Connect the stack light with the system and install it subsequently.

Material



Fig. 36: Stack light

■ Connecting the stack light

1. Connect the cable of the system with the connector of the stack light:

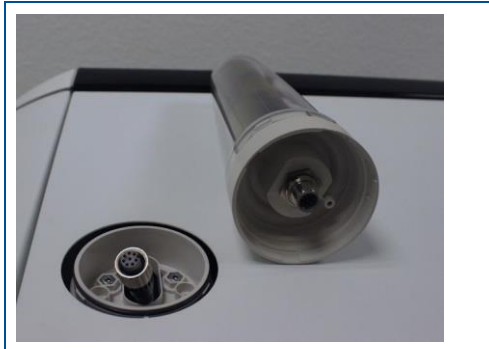


Fig. 37: Connecting the cable

2. Insert the stack light into the socket.
The markings of the stack light and of the socket must match up.

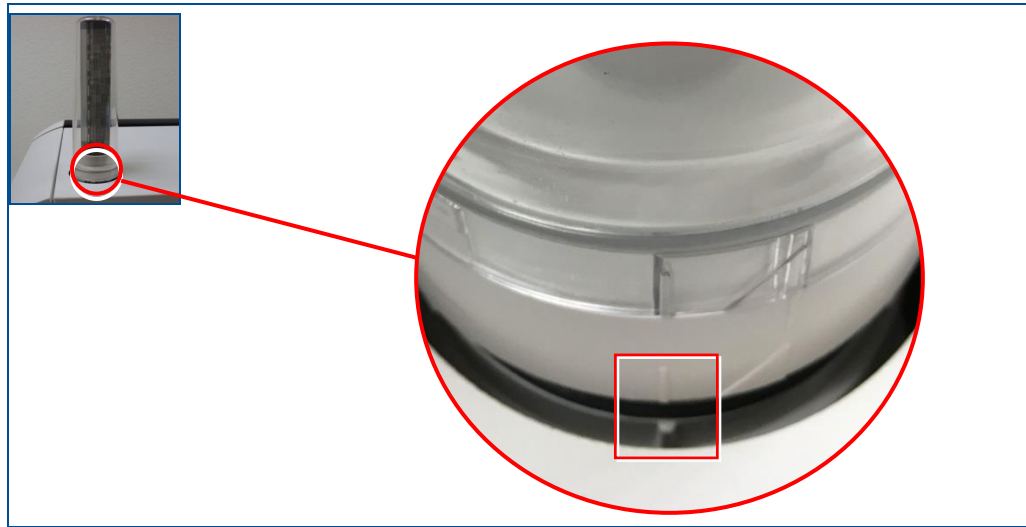


Fig. 38: Stack light markings

3. Fasten the stack light by turning it clockwise.

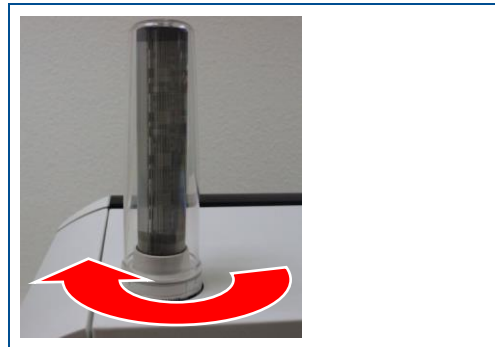


Fig. 39: Turning the stack light

- The stack light has been connected.

4.4.2 Connecting the extraction system

The extraction system is an optional accessory that can be ordered from LPKF. The following shows the required steps for connecting the LMD 508 and the prefilter unit:

Material

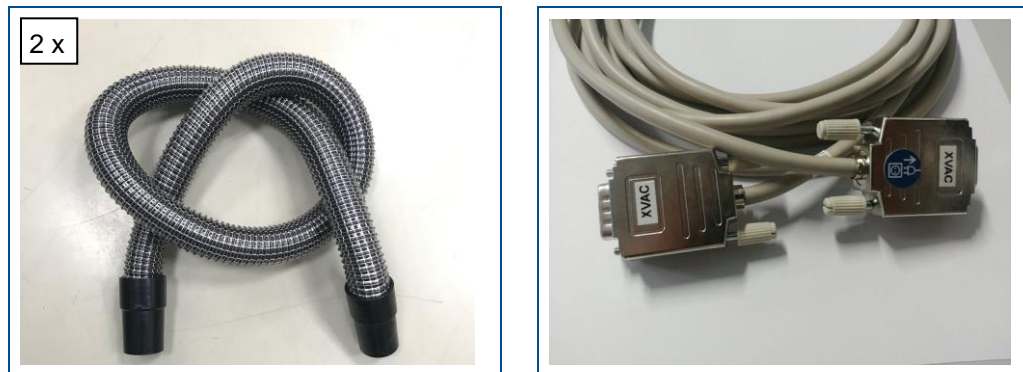


Fig. 40: Extraction hose and 9-pin D-sub connectors (male/female)

■ Connecting the extraction system

CAUTION! Tripping hazard due to hoses and cables!

Hoses and cables are connected to the system. If the hoses and cables are laid inappropriately, they pose a tripping hazard for the operating personnel.

- ▶ Always ensure that the hoses and cables do not pose a tripping hazard.

1. Connect the extraction hose of the extraction system with the prefilter unit.

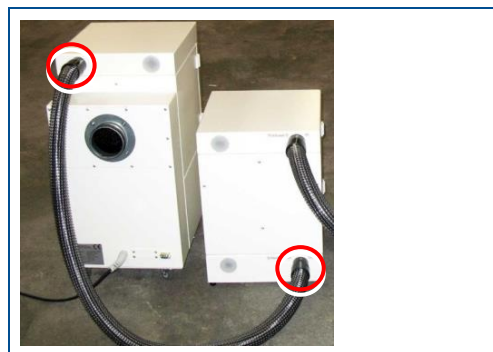


Fig. 41: Extraction system with prefilter unit

2. Connect the extraction hose of the prefilter unit with the system.



Fig. 42: Connector for the extraction system

3. Connect the (female) 9-pin D-sub connector with the system.



Fig. 43: Connector for the control cable

4. Connect the (male) 9-pin D-sub connector with the system.



Fig. 44: Connector for the control cable

5. Connect the air outlet nozzle with your air outlet nozzle.



Fig. 45: Air outlet nozzle

6. Connect the extraction system to the mains power supply.



Fig. 46: Wall socket

- The extraction system has been connected.



LPKF recommends to set the rotation speed of the extraction system to 70 %. Adjust the follow-up time of the extraction system according to your requirements. For further information refer to the user manual of the extraction system.

4.4.3 Connecting the compressed-air supply

The system is connected to the compressed-air supply via a pneumatic tube.

Material



Fig. 47: Pneumatic tube

■ Connecting the compressed-air supply

CAUTION! Tripping hazard by hoses and cables!

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

► Always ensure that the hoses and cables do not pose a tripping hazard.

1. Connect the pneumatic tube with the compressed-air connector (coupling for 8 mm (0.315") outer tube diameter) of the system.



Fig. 48: Connector for compressed-air tube

2. Connect the pneumatic tube with the compressed-air supply (maximum pressure: 6 bar).

The compressed-air supply has been connected.

4.4.4 Connecting to the network

The system is connected to the network via a network cable.

Material



Fig. 49: Network cable

■ Connecting the network cable

CAUTION! Tripping hazard by hoses and cables!

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

- ▶ Always ensure that the hoses and cables do not pose a tripping hazard.

1. Connect the network cable to the system.



Fig. 50: Connecting the network cable

2. Connect the network cable to your network.



Fig. 51: Network connector

- The network cable has been connected.

4.4.5 Connecting the screen, keyboard, and mouse

The screen is connected to the system via a DisplayPort cable and a USB cable type A/B. The keyboard and mouse are connected to the screen via a USB cable.

Material

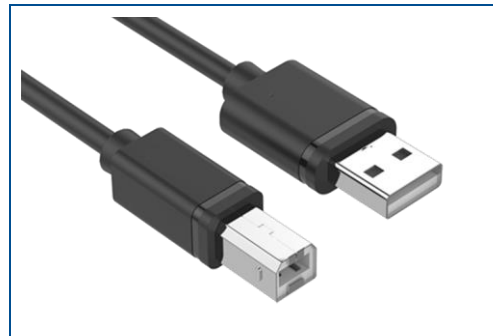


Fig. 52: DisplayPort to HDMI cable and USB A to USB B cable

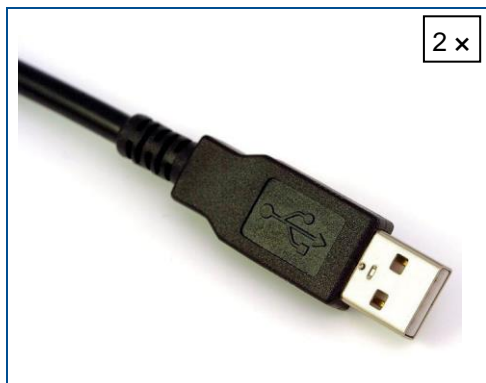


Fig. 53: USB A cable of the keyboard/mouse and mains cable

■ Connecting the screen, keyboard, and mouse

CAUTION! Tripping hazard by hoses and cables!

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

- ▶ Always ensure that the hoses and cables do not pose a tripping hazard.

1. Connect the DisplayPort to HDMI cable to the system.

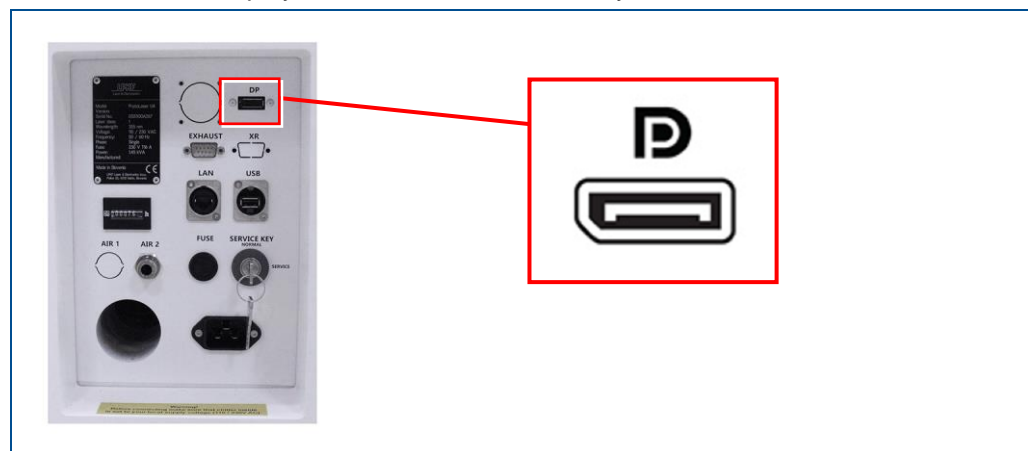


Fig. 54: DisplayPort connector

2. Connect the DisplayPort to HDMI cable to the screen.

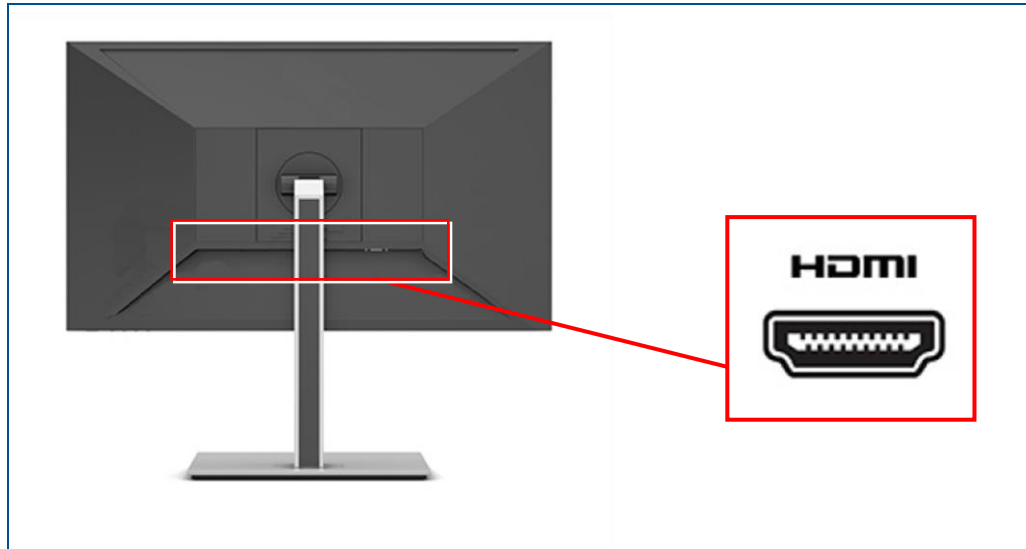


Fig. 55: HDMI connector

3. Connect the USB A to USB B cable to the system.

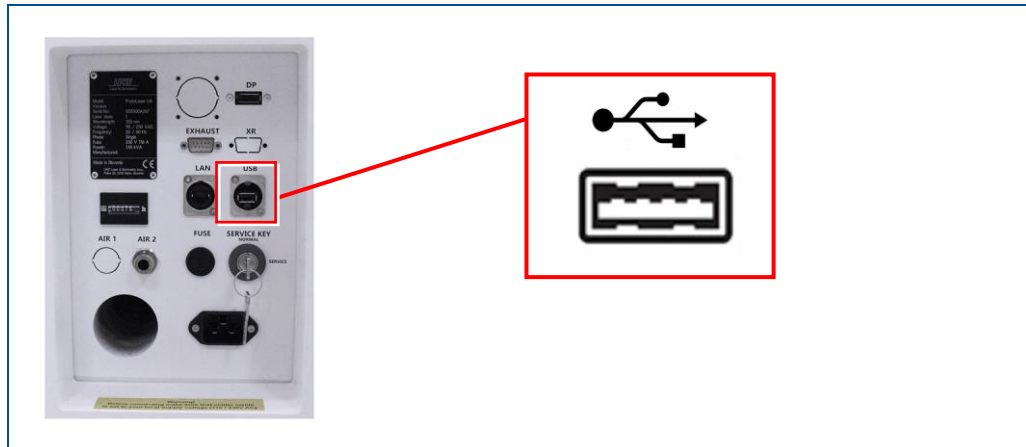


Fig. 56: USB A port

4. Connect the USB A to USB B cable to the screen.

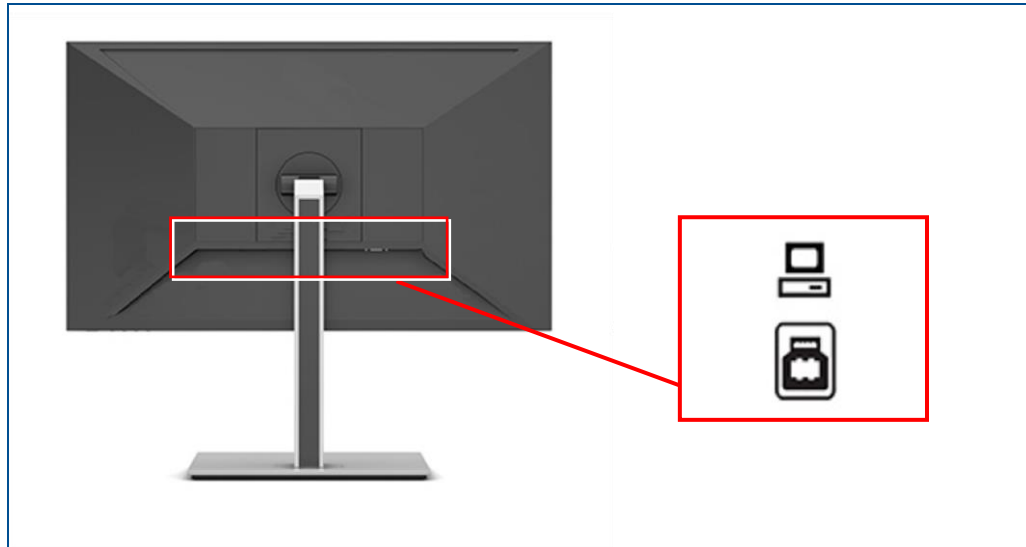


Fig. 57: USB B port

5. Connect the USB cable (type A plug) of the keyboard and the mouse to the screen.

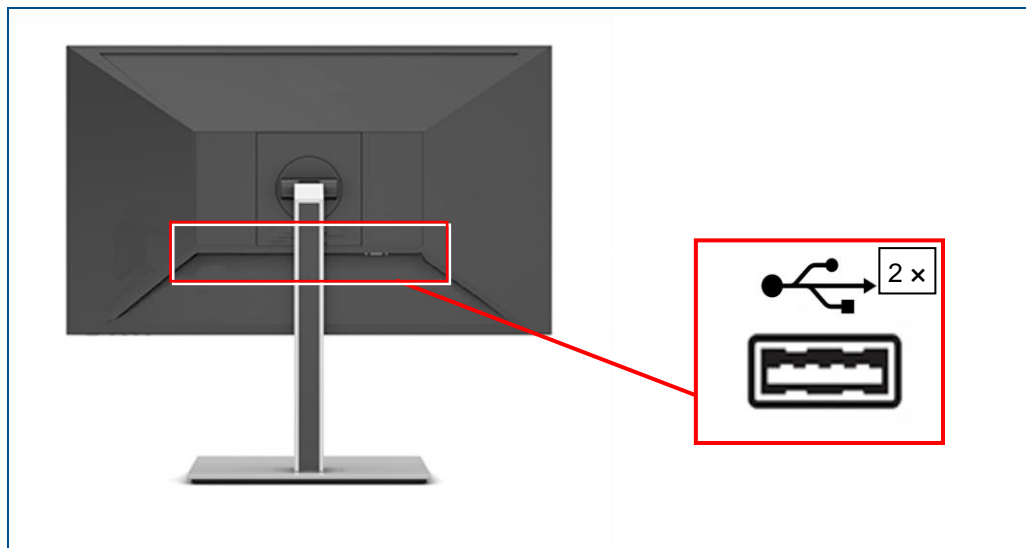


Fig. 58: USB A ports

6. Connect the mains cable to the screen.

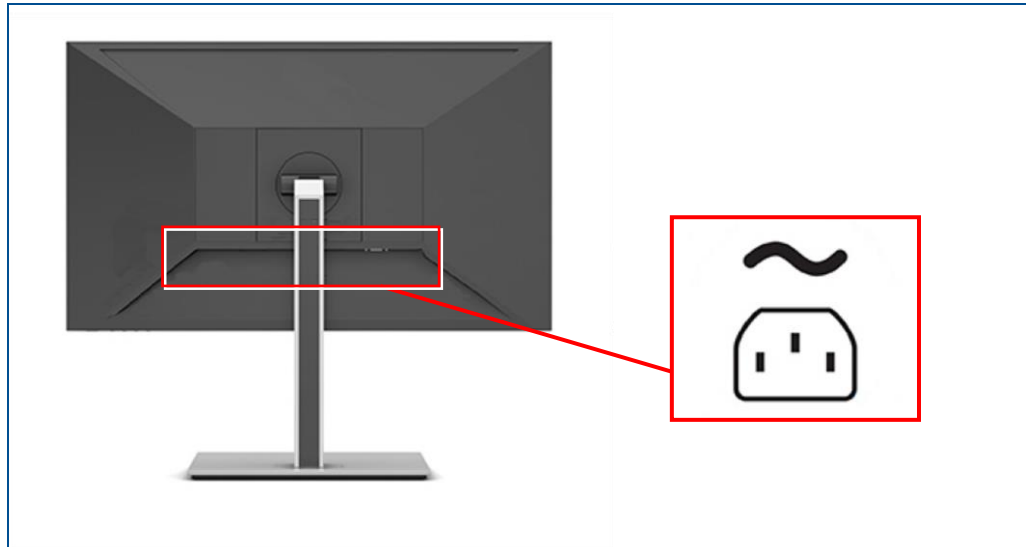


Fig. 59: Connector for mains cable

7. Plug the mains cable into the wall socket.



Fig. 60: Mains cable

The screen, keyboard, and mouse are connected.

4.4.6 Connecting the system to the mains power supply

The system is connected to the mains power supply using a mains cable.

Material



Fig. 61: Mains cable

■ Connecting the mains cable

CAUTION! Tripping hazard by hoses and cables!

Hoses and cables are routed to the system. If the hoses and cables are laid inappropriately they pose a tripping hazard for the operating personnel.

► Always ensure that the hoses and cables do not pose a tripping hazard.

1. Connect the mains cable to the system.



Fig. 62: Connector for mains cable

2. Plug the mains cable into the wall socket.



Fig. 63: Wall socket

The mains cable has been connected.

4.5 Switching on the system with the main switch

The main switch of the system switches on or off the mains power supply.

■ Switching on the system with the main switch

1. Turn the main switch at the rear of the system to position *ON*.



Fig. 64: Main switch set to *ON*

- The mains power supply of the system is switched on.

4.6 Switching on the system

The on/off switch of the system switches the system on or off.

■ Switching on the system

1. Press the on/off switch at the system front.

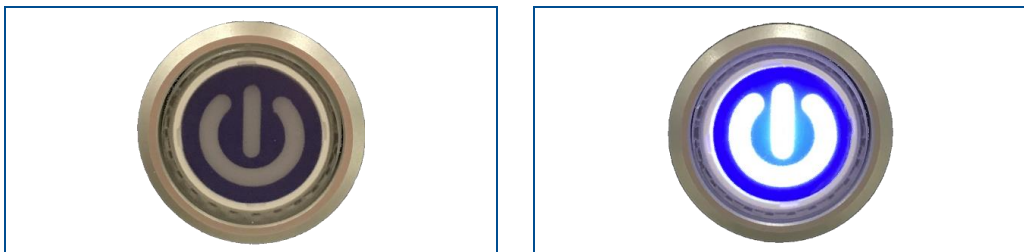


Fig. 65: On/Off switch

- The system is switched on. The PC boots automatically.
The on/off switch is illuminated.
- The system has been switched on.

4.7 Software

The system is operated with the preinstalled system software CircuitPro PL. The system software is used for preparing the layout data and for controlling the system.



For detailed information on operating the system software press **F1** to invoke the help function.

System requirements CircuitPro PL

The following table lists the recommended system configuration for working with CircuitPro PL:

Component	System configuration
CPU	Dual Core 2.6 GHz LPKF discourages the use of the following CPU because it causes problems: <ul style="list-style-type: none"> Intel Xeon
RAM	16 GB
Memory requirements	2 GB
Graphics card	With 1 GB dedicated memory (non-shared memory) LPKF discourages the use of the following graphics card because it causes problems: <ul style="list-style-type: none"> Intel 82945G
Screen resolution	1680 × 1050 pixels
Operating system	Windows 10 (64bit)

Table 12: Recommended system configuration CircuitPro PL

The following table lists the minimum system configuration for working with CircuitPro PL:

Component	System configuration
CPU	2 GHz LPKF discourages the use of the following CPU because it causes problems: <ul style="list-style-type: none"> Intel Xeon
RAM	4 GB
Memory requirements	2 GB
Graphics card	With 128 MB dedicated memory (non-shared memory) LPKF discourages the use of the following graphics card because it causes problems: <ul style="list-style-type: none"> Intel 82945G
Screen resolution	1280 × 768 pixels
Supported operating systems	Windows 10 (64bit)

Table 13: Minimum system configuration CircuitPro PL

■ **Starting the system software**

- ▶ Double-click on the following symbol to start the system software CircuitPro PL.



Fig. 66: Desktop icon CircuitPro PL

- CircuitPro PL is started and the user guidance step *New* is displayed:

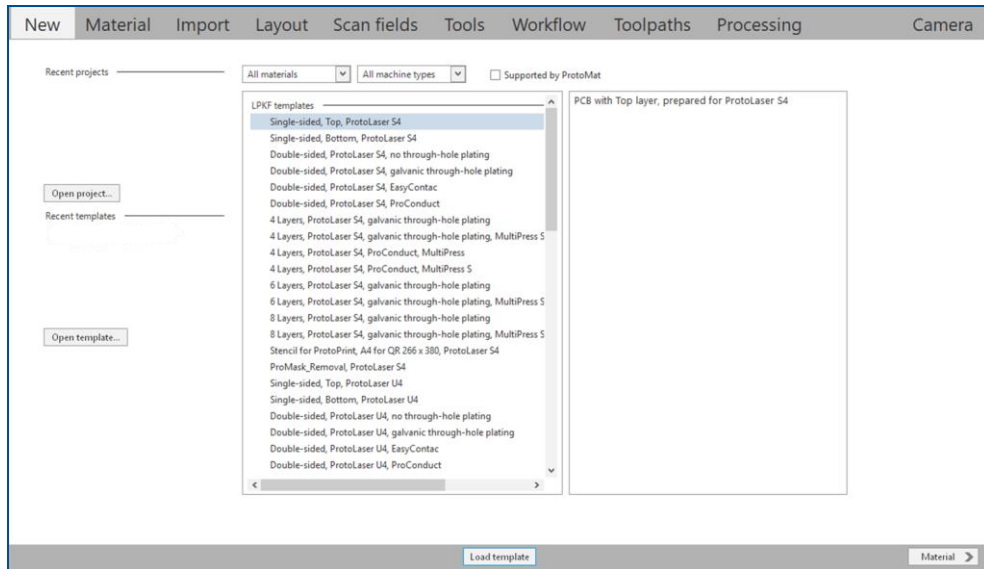

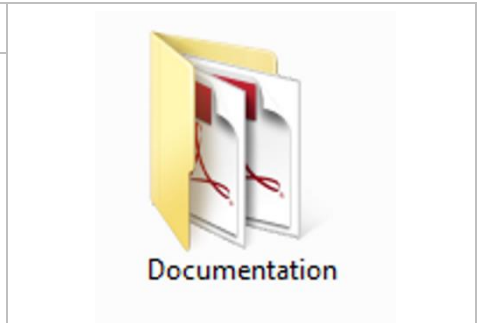
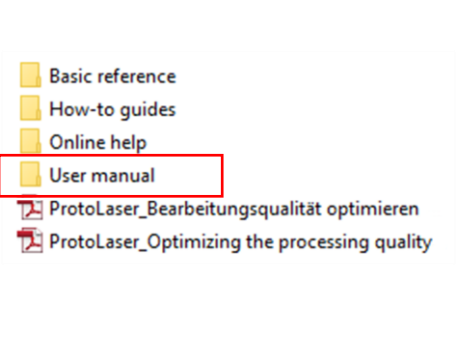
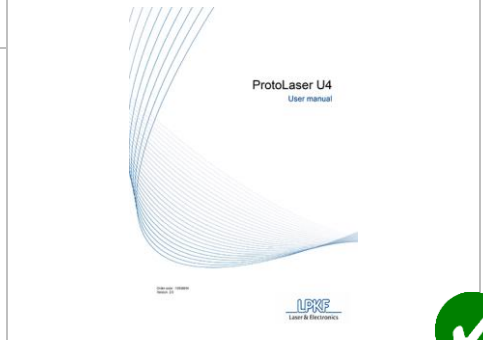


Fig. 67: User guidance step *New*

- The system software has been started.

4.8 Reading the user manual

Once the system is started, read the documentations that are located on the desktop of the PC. Alternatively, you can find the documentations on the data medium included in the delivery. The system software has already been installed on your system.

1		2	
3	 <ul style="list-style-type: none"> Basic reference How-to guides Online help User manual ProtoLaser_Bearbeitungsqualität optimieren ProtoLaser_Optimizing the processing quality 	4	

5 Appendix

This chapter contains navigation elements of the document.

5.1 List of figures

Fig. 1:	Functional principle of a laser.....	14
Fig. 2:	System with safety devices	27
Fig. 3:	Securing against restart	29
Fig. 4:	Type label	34
Fig. 5:	Declaration of conformity (original).....	36
Fig. 6:	Declaration of conformity (original).....	37
Fig. 7:	Lifting off the lid	40
Fig. 8:	Top padding material.....	40
Fig. 9:	Packaging without front	41
Fig. 10:	Packaging without panels.....	41
Fig. 11:	Stretch film and edge protectors removed	42
Fig. 12:	Front/Rear transport supports	42
Fig. 13:	Cutting off the welded parts of the foil	43
Fig. 14:	Foil removed.....	43
Fig. 15:	Transport ramps	44
Fig. 16:	Placing the transport ramps	44
Fig. 17:	Fastening the transport ramps	44
Fig. 18:	Leveling foot	45
Fig. 19:	Side transport supports	45
Fig. 20:	Leveling foot	47
Fig. 21:	System with open cover	48
Fig. 22:	Precision frame spirit level	49
Fig. 23:	Minimum required space	52
Fig. 24:	Workplace of the operating personnel.....	52
Fig. 25:	Center of gravity of the system.....	53
Fig. 26:	Opening the maintenance door	55
Fig. 27:	Transport lock for chiller	56
Fig. 28:	Chiller	57
Fig. 29:	x axis	58
Fig. 30:	Pulling out the bolt.....	58
Fig. 31:	Opening the maintenance door	59
Fig. 32:	Chiller	60
Fig. 33:	Rear cover	61
Fig. 34:	Grounding cable	62
Fig. 35:	Line filter of the chiller	62
Fig. 36:	Stack light	63
Fig. 37:	Connecting the cable.....	63
Fig. 38:	Stack light markings	64
Fig. 39:	Turning the stack light	64
Fig. 40:	Extraction hose and 9-pin D-sub connectors (male/female)	65
Fig. 41:	Extraction system with prefilter unit.....	65
Fig. 42:	Connector for the extraction system.....	65
Fig. 43:	Connector for the control cable	66
Fig. 44:	Connector for the control cable	66
Fig. 45:	Air outlet nozzle	66
Fig. 46:	Wall socket	66
Fig. 47:	Pneumatic tube.....	67
Fig. 48:	Connector for compressed-air tube.....	67
Fig. 49:	Network cable.....	68
Fig. 50:	Connecting the network cable	68
Fig. 51:	Network connector.....	68

Fig. 52:	DisplayPort to HDMI cable and USB A to USB B cable	69
Fig. 53:	USB A cable of the keyboard/mouse and mains cable	69
Fig. 54:	DisplayPort connector	69
Fig. 55:	HDMI connector.....	70
Fig. 56:	USB A port.....	70
Fig. 57:	USB B port.....	71
Fig. 58:	USB A ports.....	71
Fig. 59:	Connector for mains cable	72
Fig. 60:	Mains cable	72
Fig. 61:	Mains cable	73
Fig. 62:	Connector for mains cable	73
Fig. 63:	Wall socket	73
Fig. 64:	Main switch set to <i>I ON</i>	74
Fig. 65:	On/Off switch.....	74
Fig. 66:	Desktop icon CircuitPro PL	76
Fig. 67:	User guidance step <i>New</i>	76

5.2 List of tables

Table 1:	Overview of the printed documentation	9
Table 2:	Overview of the documentations on the data medium	9
Table 3:	Effects of laser radiation	15
Table 4:	Sources of danger	15
Table 5:	Laser classes.....	16
Table 6:	Personal protective measures	17
Table 7:	Structural protective measures.....	17
Table 8:	Organizational protective measures	18
Table 9:	Safety devices	28
Table 10:	Service life	28
Table 11:	Type label	34
Table 12:	Recommended system configuration CircuitPro PL.....	75
Table 13:	Minimum system configuration CircuitPro PL	75

5.3 Index

C

cataract	16
chemical-resistant gloves	24
cleaning agents	30
climatic conditions	32, 52
compressed-air purity	33, 55
connecting the extraction system	65
coolant additive	30
customer service	5

D

duration of irradiation	15
-------------------------------	----

E

electrical data	32, 54
emissions	34
EUROLUB Kühlerschutz D-30	30

F

first startup	51
---------------------	----

H

hazards	
laser radiation	15

K

keratitis	16
-----------------	----

L

laser beam	15
laser class	32
laser classes	17
laser data	33
laser protection officer	15
laser radiation	15
laser radiation hazards	15
laser safety glasses	17, 19, 23
laser safety instructions	15
leveling the system	49
list of figures	79
list of tables	80
load capacity	33, 54
LPKF Service	5
lubricants	30

M

mark speed	33
materials	11
max. structuring area	33
mechanical data	32
mixing ratio	59
moving the system over short distances	47

O

operating personnel	23
operating states	28

P

packaging	
symbols on the packaging	40
unpacking the system	40
pneumatic data	33, 55
process data	33
processing procedures	11
processing table	58
protective clothing	24
protective equipment	17
protective gloves	24
protective measures	18

Q

qualified electrician	22
-----------------------------	----

R

requirements of the place of installation	52
climatic conditions	52
connections provided by the customer	54
floor	54
minimum required space	52
the system's center of gravity	54
respirator mask	24

S

safety devices	27
safety glasses with side shields	24
safety goggles	23
safety shoes	24
safety signs	25
service personnel	22
stack light	28
system	
switching on	75

T

tissue damage	15
tissue dies off	15
transport locks	
removing	55
transporting the system	47

W

wavelength	15
------------------	----

