

# Contac S4

## User manual

Publisher	LPKF Laser & Electronics AG Osteriede 7 30827 Garbsen Germany
	Phone: +49 5131-7095-0
	Fax: +49 5131-7095-90
	Email: <a href="mailto:info@lpkf.com">info@lpkf.com</a>
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	Translation of the German original document

## General information

This document contains all information for the intended use of the system/product delivered. 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.

- ▶ Read this document and possibly associated safety data sheets carefully before first start-up and usage of the components.
- ▶ Observe the safety regulations as well as the regulations on operational health and safety and protection of the environment.
- ▶ Use the system/product only in a technically perfect condition.
- ▶ Observe all labels and safety signs on the system/product.
- ▶ Never remove the safety signs and replace or clean them if not readable anymore.
- ▶ Persons who install, operate, uninstall, or maintain our systems/products must not be under the influence of alcohol, other drugs, or medication that impairs the ability to react.
- ▶ Use only approved spare parts and accessories in order to prevent injuries due to unsuitable spare parts and accessories.
- ▶ Observe the technical data and ambient conditions specified in this document.

### Validity

This document is part of the system/product and corresponds to the technical state at the time of publication. This document has always to be present at the system/product and has to be available to the operating personnel without restrictions, in a complete and legible form and at all times. If the operator changes, this document has to be handed over together with the system/product. The operator has to ensure that all safety measures specified in this document are observed.

The operating personnel must have read and understood this document before performing any task. A basic requirement for safe work is observance of all safety notes and steps. This document contains important information about the system/product that have to be observed when installing, first starting up, or maintaining the system/product. Its structure allows trained personnel to perform all tasks.

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.

### 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 hazard class
- 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!

- ▶ 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

##### Type and source of the hazard!

This warning message indicates a hazard of high risk that causes death or serious injury if not avoided.

- ▶ Measure to avoid the hazard.

#### WARNING

##### Type and source of the hazard!

This warning message indicates a hazard of medium risk that can cause death or serious injury if not avoided.

- ▶ Measure to avoid the hazard.

⚠ CAUTION
<b>Type and source of the hazard!</b> This warning message indicates a hazard of low risk that can cause minor or moderate injury if not avoided. ► Measure to avoid the hazard.
NOTICE
<b>Type and source of the hazard!</b> This warning message indicates a hazard that can lead to possible property damage. ► Measure to avoid the hazard.

### Text styles

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

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

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.

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**Limited liability**

All data, notes and instructions in this document have been prepared with consideration to the statutory standards and regulations, the present state of technology, as well as our many years of knowledge and experience.

LPKF accepts no liability for damage due to:

- non-observance of this document
- improper use of the system/product
- employment of personnel that is not sufficiently qualified
- unauthorized modification
- technical changes
- unauthorized manipulation of the safety devices
- use of spare parts that are not approved by LPKF

The actual scope of delivery can deviate from the explanations and presentations given here, due to custom designs, the utilization of additional order options, or due to the most recent technical changes.

The responsibilities agreed in the delivery contract, the General Terms and Conditions as well as the delivery conditions of the manufacturer and the statutory regulations valid at the time of the conclusion of the contract are effective.

### **Warranty**

Please note that the warranty is subject to the current regulations in combination with the current General Terms and Conditions.

All information and instructions in this document have been compiled in observance of current regulations and the current state of the art. Before working with the system/product, this document has to be read carefully. The manufacturer assumes no liability for damage and faults due to non-observance of this document.

LPKF Laser & Electronics AG provides a 12-months warranty if the following conditions are met:

- The warranty starts on delivery.
- The warranty covers defects in material or manufacture. During the warranty period, such defects are remedied without cost by replacement or rework of the defective parts. This service is provided by the LPKF Service.

For further information on wear parts refer to the chapter scope of delivery.

### **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](mailto:support.rp@lpkf.com)

**Internet** [www.lpkf.com](http://www.lpkf.com)

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:  
<http://www.lpkf.com/support>.



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# 1 Safety

This chapter provides an overview of all important safety aspects for protecting persons as well as for a safe and fault-free operation of the system/product. There are further warning messages in the sections of the individual lifecycle stages.

## 1.1 Intended use

The system can be used for through-hole plating of double-sided and multi-layer PCBs and for galvanic strengthening of copper surfaces. When copper build-up is completed the PCBs can be tin-plated. Drilled holes with a diameter of at least 0.2 mm and an aspect ratio of 1:8 can be plated.

Use only the described chemicals approved by LPKF for filling the tanks.

Operate the system only in a well-ventilated room and wear the described protective equipment.

The following protective equipment is required for safe usage of the system:

- Splash goggles
- Protective gloves
- Chemical-resistant gloves

### Improper use

- ▶ Never fill the tanks with other chemicals than the chemicals indicated and approved by LPKF.
- ▶ Do not operate the system with a different or modified software.
- ▶ Only use materials and objects for through-hole plating that are approved by LPKF. Contact the LPKF Service if in doubt.

## 1.2 Residual risks

No residual risks have currently been identified, if the intended use as well as all safety regulations are observed. 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.

### 1.3.1 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.

- ▶ 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.

### 1.3.2 Hazards by materials or substances

#### WARNING

##### **Health hazard by contact with chemicals!**

Contact with the chemicals can cause serious damage to health:

**Inhalation** can irritate/harm nose, throat, and lungs and cause allergic respiratory problems.

**Skin contact** can cause burns, allergies, and hypersensitivity.

**Eye contact** can irritate the eyes and mucous membranes with burning and tears and can cause impaired vision and serious eye damage.

**Ingestion** can cause burns of mucous membranes, throat, esophagus, and stomach and cause gastrointestinal complaints. Stomach pain, diarrhea, and vomiting can also occur.

- ▶ 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.
- ▶ Take off clothes that are contaminated with chemicals immediately.
- ▶ Wash your hands thoroughly after work.
- ▶ Consult a physician in case of complaints after contact with chemicals.

**⚠ CAUTION****Health hazard by inhalation of fumes!**

Inhalation of the fumes produced during tin-plating can cause health damage.

- ▶ Work only in rooms with an air change rate of at least 6/h.

**NOTICE****Damage by inadequate tap water quality!**

An inadequate tap water quality (e.g. due to excessive chlorine content) can degrade the process results.

- ▶ Use distilled water for all process steps in case of inadequate tap water quality

### 1.3.3 Mechanical 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 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.

## 1.5 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.

## **1.6 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.

### **Description of the personal protective equipment**



#### **Splash goggles**

Splash goggles protect the wearer's eyes against chemicals, dust, and splinters.



#### **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 gloves**

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

## 1.7 Safety signs

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

<b>⚠ WARNING</b>	
<b>Risk of injury by nonobservance of safety signs!</b>	
The safety signs on the system instruct you on safe usage of the system. Nonobservance of the safety signs can cause severe injuries.	<ul style="list-style-type: none"><li>▶ Always observe the safety signs.</li><li>▶ Never remove the safety signs.</li><li>▶ If a safety sign is no longer legible, clean or replace the safety sign.</li></ul>

### Safety signs at the housing



**Risk by defective system!**  
Injury or property damage possible.  
Remedy defects of the system  
immediately. Switch off the system  
and disconnect it from the power  
supply.



**Warning! Corrosive chemicals!**  
Wear your personal protective  
equipment.  
Avoid contact with eyes or skin and  
do not inhale fumes.



**Warning! Chemicals hazardous  
to health!**  
Wear your personal protective  
equipment.  
Avoid contact with eyes or skin and  
do not inhale fumes.



**Warning! Environmentally  
hazardous chemicals!**  
A release of the chemical (e.g. by  
improper disposal) can cause  
damage to the environment.



**Warning! Irritant chemicals!**  
Wear your personal protective equipment.  
Avoid contact with eyes or skin and do not inhale fumes.

## 1.8 Safety devices

This chapter describes the safety devices of the system and their function.

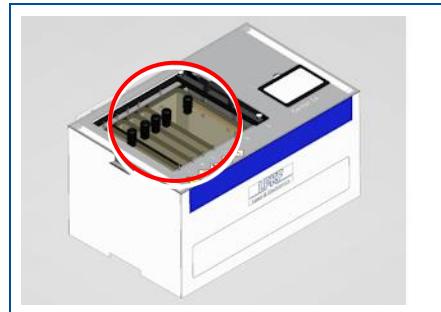


Fig. 1: Tank covers

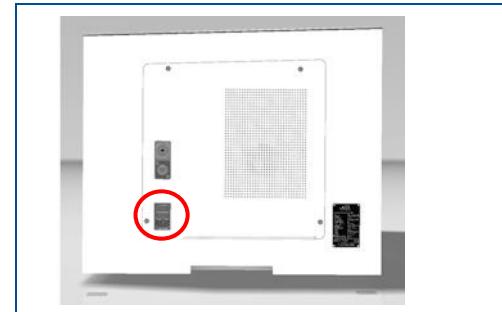


Fig. 2: Fuse

Figure	Description
	The <b>covers</b> (figure 1) protect the operating personnel against inadvertent contact with chemical baths that are not in use. They also reduce evaporation and thus loss of chemicals.
	The <b>fuse</b> (figure 2) prevents damage to the system and injury to the operating personnel caused by overcurrent (e.g. due to a short circuit).  The following fuse is used: <ul style="list-style-type: none"> <li>• Identification: ESKA 522.026</li> <li>• Type: Slow-blow glass fuse</li> <li>• Dimensions: 5 mm x 20 mm</li> <li>• Nominal voltage: 250 V AC</li> <li>• Nominal current: 8 A</li> </ul>

Table 1: Safety devices

## 1.9 Actions in case of an emergency

### Preventive measures

- Always be prepared for fires and accidents!
- Keep first aid equipment (first aid kit, blankets etc.) and fire-fighting equipment functioning properly and close at hand.
- Instruct the personnel on incident reporting, first-aid equipment, and rescue equipment.
- Keep access routes clear for emergency vehicles.

### Response to fire and accidents

- Immediately execute an emergency stop.
- Switch the main switch to 0 (OFF).
- Disconnect the supply of external components as quickly as possible.
- Recover persons from the danger zone if safe to do so.

## 1.10 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.

This system uses several environmentally harmful substances. These may cause long-term adverse effects in the aquatic environment. The substances must not enter surface waters, drains, or soil.

Spent chemicals must not be emptied into the drains, they have to be filled into the containers intended for disposal.

Check which local and national regulations apply and observe these. For recommendations on disposal refer to the safety data sheets. If the regulations differ from the recommendations, observe the regulations.

The following environmentally hazardous substances are used:

- Cleaner 110
- Cleaner 210
- Copper Plater 400
- Electroless Tin Liquid
- ViaCleaner Part 1

The following substances are not classified as environmentally hazardous. It is possible, however, that large quantities or frequent release are harmful to the environment and especially surface waters. Avoid the release of the following substances into the environment:

- Activator 310
- Shine 400
- ViaCleaner Part 2

## 2 Technical data

### General data

Data	Value	Unit
IP Code (IEC 60529)	IP22	–
Service life	10	years

### Climatic conditions

Data	Value	Unit
Temperature range (operation)	20 to 25	°C
Temperature range (storage, transport)	-30 to 60	°C
Max. humidity, non-condensing	90	%

### Electrical data

Data	Value	Unit
Power supply	110/230	V
	50/60	Hz
Output power	750	VA

### Mechanical data

Data	Value	Unit
Dimensions (width x height x depth)	856 x 450 x 540	mm
Weight (without packaging)	without anodes: 60 with anodes: 77	kg

### Process data

Data	Value	Unit
Maximum base material size	230 x 330	mm
Maximum PCB size	200 x 300	mm
Process temperature range	20 to 25 and 55 (tank 1)	°C
Maximum aspect ratio	1:8	–

### 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 emission class	A	-

### 3 Structure and function

This chapter describes the technical structure and the functions of the system.

#### 3.1 Brief description

The Contac S4 is used for through-hole plating of PCBs and for galvanic strengthening of copper surfaces. This creates an electric connection between the different layers of the PCB. The through holes can have a minimum diameter of 0.2 mm (> 8 mil). They are plated using the black-hole process.

The system is suited for processing double-sided and multi-layer PCBs. The process consists of the following six phases:

1. Cleaning the PCB
2. Conditioning th PCB
3. Activating the PCB
4. Active cleaning of the drilled holes
5. Copper-plating the PCB
6. Tin-plating the PCB

The fifth phase uses an air injection to create a more homogeneous copper deposition on the surface of the PCB.

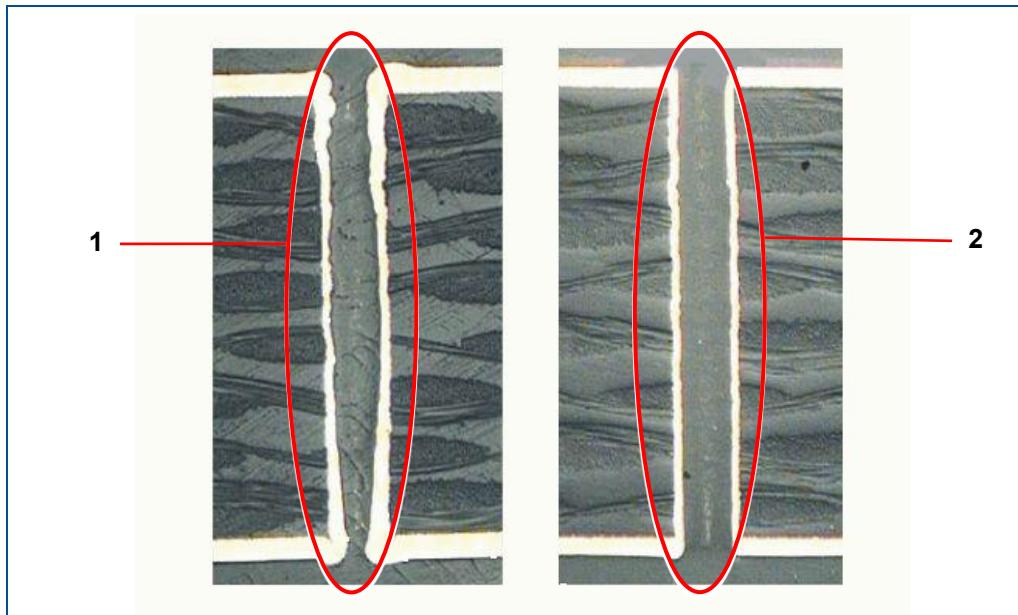
The active cleaning of the drilled holes after applying Activator 310 enabled bonding of the copper to the inner copper layer. This is especially important for plating micro vias and blind vias.

The **tin-plating** option is intended for applying a tin layer on copper surfaces of PCBs. The tin layer is chemically deposited, i.e. without electric current, and is intended to protect the copper surface against corrosion and to improve solderability. This also ensures further processing after a period of storage.

#### Reverse Pulse Plating

**Reverse Pulse Plating** (RPP) is implemented in the special LPKF control circuit that monitors the whole through-plating process.

Conventional electroplating results in increased deposition of material on the rims of the via holes due to the distribution of flux lines. This ridge buildup (dog-bone effect) during metal deposition occurs especially at a large depth-to-diameter ratio of the via holes (see **2** in the following figure).

**Fig. 3: Dog-bone effect**

- 1 With dog-bone effect
- 2 Without dog-bone effect

**Reverse pulse plating** uses short inverted pulses during which the circuit board acts as the anode. This causes parts of the built-up material spikes to be removed so that the overall copper deposition is more uniform (see 1 in the figure above).

The **RPP function** is activated in the copper plating profile as default, but it can be deactivated in the menu *Profiles* for newly created profiles.

It is recommended to use the **RPP function** for PCBs with holes of diameters < 0.4 mm. The **RPP function** is also to be used if a uniform layer thickness and less board margin losses are desired.



The PCB surface is slightly matte after copper plating with **RPP**. If you desire a more glossy surface, start another copper plating cycle with 75% of the original amperage without **RPP** for 15 to 30 minutes.

### 3.2 Scope of delivery

This chapter provides an overview of the system's scope of delivery. For information on optional modules, accessories and extras refer to chapter *Optional modules, accessories, extras* on page 26.

- Contac S4 system
- Contac S4 user manual
- Mains cable (110 V)
- Mains cable (230 V)
- Protective gloves
- Protective goggles
- Squeegee for Activator
- Measuring cylinder
- Skimmer
- 3 x Draining tubes (80 cm)
- 2 x Pipettes

- 2 x Spray bottles
- Screen protector film

### 3.3 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.



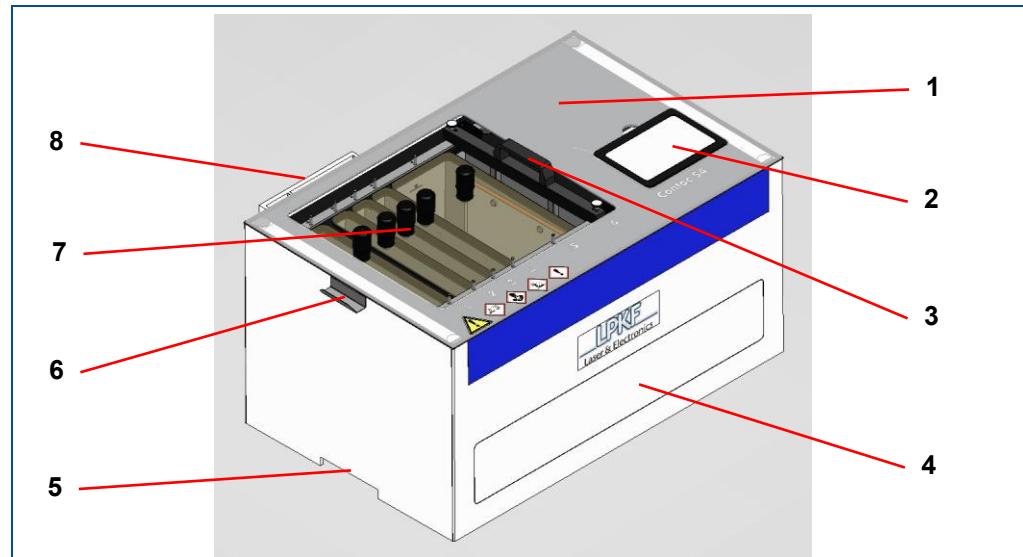
Fig. 4: Type label

Name	Description
Model	System type
Version	Version number
Serial No.	Serial number
Voltage	Operating voltage
Frequency	Line frequency
Phase	Number of phases
Fuse	Fuse protection
Power	Power rating
Manufactured	Year of manufacture
Made in Slovenia	Country of origin

Table 2: Type label

### 3.4 System components

This chapter describes the components of the system. First of all, make yourself familiar with the individual components of the system before starting the operation. Before operating the system, also inform yourself about the important software elements and the different operation modes.



**Fig. 5:** System overview

- |   |                            |   |                          |
|---|----------------------------|---|--------------------------|
| 1 | Glass cover (safety glass) | 5 | Recessed grip            |
| 2 | Touch screen               | 6 | Retainer for PCB holders |
| 3 | PCB holder                 | 7 | Process tanks            |
| 4 | Cover for drain valves     | 8 | Deposit for tank covers  |

#### 3.4.1 Tanks

The system has six tanks for the individual phases of the through-hole plating process. The PCBs can be inserted into the tanks after fastening to the PCB holder. The tanks can be individually covered which prevents excessive evaporation of the chemicals and inadvertent contamination. Contamination of bath 3 can render the **Activator 310** chemical useless and necessitate complete replacement.

Tank 1 is heated to 55 °C at the start of the system if sufficiently filled. A sensor determines the fill level of the tank. If it is too low, an error message is displayed.

Tank 5 is equipped with an air injection that constantly keeps the contained chemical in motion. Thus, a more uniform distribution of the copper components and a more uniform through-hole plating is enabled. This function is activated as soon as the copper plating phase is started.

The chemicals in the tanks can be drained via drain valves inside the system. The drain valves are accessible behind a cover on the front of the system.

The system contains the following tanks:

	<b>Function</b>	<b>Chemical</b>	<b>Capacity</b>	<b>Heated?</b>
Tank 1	Cleaning	Cleaner 110	5 liters	yes, 55 °C
Tank 2	Conditioning	Cleaner 210	5 liters	no
Tank 3	Activation	Activator 310	5 liters	no
Tank 4	Active cleaning	ViaCleaner Part 1 & 2	5 liters	no
Tank 5	Copper plating	Copper Plater 400	15 liters	no
Tank 6	Tinning	Electroless Tin Liquid	5 liters	no

Table 3: Tank overview

### 3.4.2 Touch screen

The system has a touch screen that can be operated with bare fingers or gloves on. The touch screen is chemical-proof.

The touch screen can be adjusted in height so that you can tilt it up or down as necessary.

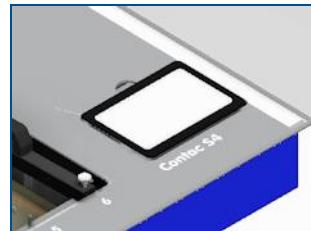


Fig. 6: Touch screen

### 3.4.3 PCB holder

A PCB is fastened to the PCB holder for the through-hole plating process so that they can be inserted into the tanks. The PCB holder can be used for all tanks, no matter whether they use a current or not.

The PCB holder is mounted into a motorized frame that moves the PCB during the process in order to remove potential air bubbles from the PCB.



Fig. 7: PCB holder

### 3.5 Optional modules, accessories, extras

The following consumables are required for filling and using the tanks:

Description	Quantity
Cleaner 110	5 liters
Cleaner 210	5 liters
Activator 310	5 liters
Copper Plater 400	15 liters
Shine 400	0.5 liters
Electroless Tin Liquid	5 liters
ViaCleaner Part 1	5 x 1 l
ViaCleaner Part 2	250 g

Table 4: Consumables

The following items are needed additionally:

- Distilled/De-ionized water
- Containers for disposal of spent chemicals
- Sink for rinsing the PCBs

### 3.6 Connections

The connectors are on the left side of the system:

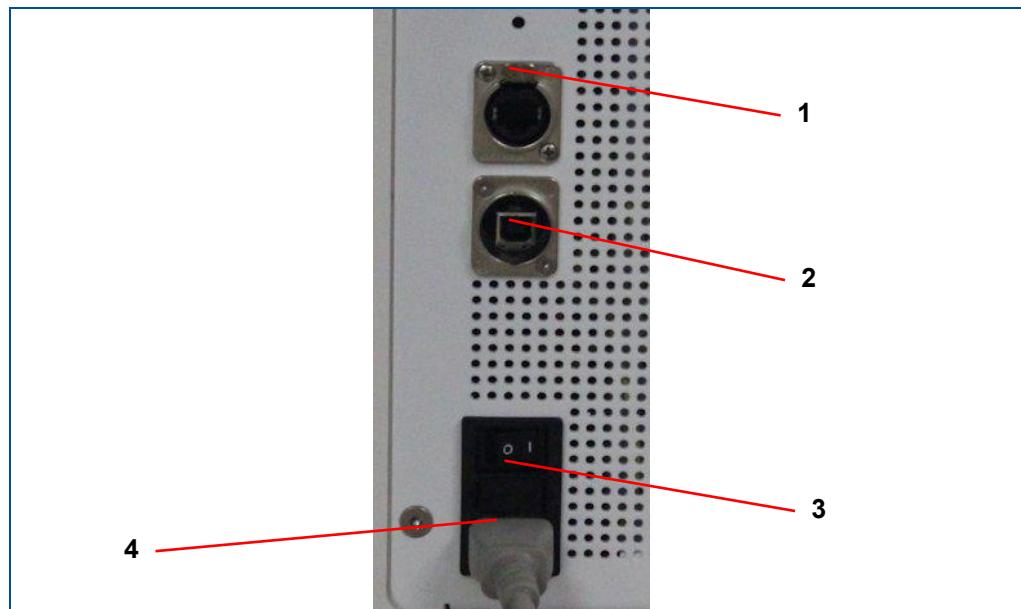


Fig. 8: Connectors

- 1 USB 2.0 socket  
2 Network connector  
3 Main switch  
4 System power inlet

The **network connector** (2) can be used to connect a computer to the system for servicing.

### 3.7 Displays and control elements

This chapter describes the displays and control elements of the system. First of all, make yourself familiar with the individual components of the system before starting the operation.

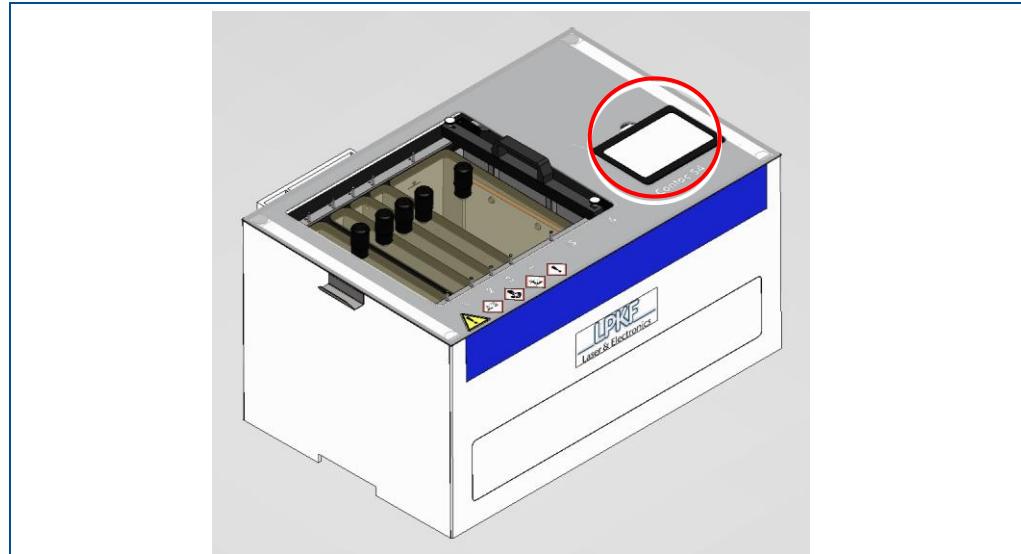


Fig. 9: Touch screen

Figure	Description
	The <b>touch screen</b> is used for operating the system. It reacts to touch with bare fingers or with chemical-resistant gloves.

### 3.8 Software

The system is controlled with the pre-installed firmware called EPIC (Electroplating Integrated Control). The firmware assists you during the through-hole plating process by displaying the instructions and the processing time of the current phase or other important information (e.g. the current temperature of tank 1). The firmware also starts certain functions (e.g. air injection) automatically as soon as the corresponding phase is started.

Default profiles are preset for certain materials and processes. Custom profiles that are optimized for your purposes can also be created. You can set the duration of certain phases, the amperage in tank 5 etc. individually in these profiles.

You can also display information on the state of the chemicals and thus determine in time which tank contents have to be replaced.

The system is operated using the touch screen on the top side of the system.

**Fig. 10:** User interface

- |                                  |                              |
|----------------------------------|------------------------------|
| 1 Main menu                      | 4 Special process properties |
| 2 Current process phase and step | 5 Process duration           |
| 3 Active profile                 | 6 Navigation bar             |

## Profiles

The process parameters can be adjusted and stored in the profiles. The parameters are defined for PCBs of specific sizes and should only be used for these sizes to achieve optimum results. Sizes that differ from the defaults can be defined in user-defined profiles.

**Fig. 11:** Profile view

The following parameters can be defined in a profile:

Description	Description
Name	Profile name
Height and width	Dimensions of the PCB (in mm)
Cleaning (tank 1)	Duration (in minutes) and temperature (in °C) of the first process phase
Conditioning (tank 2)	Duration (in minutes) of the second process phase
Activation (tank 3)	Duration (in minutes) of the third process phase
Active cleaning (tank 4)	Duration (in minutes) of the fourth process phase; calculated automatically
Copper-plating (tank 5)	Duration (in minutes) of the fifth process phase and thickness of the deposited copper layer (in µm). The functions <b>RPP</b> and <b>Air</b> can be activated additionally.
Tinning (tank 6)	Duration (in minutes) of the sixth process phase and thickness

Description	Description
	of the deposited tin layer (in µm).
RPP	Reverse pulse plating, see page 21.
Air	Activates the air injection

**Table 5: Profile parameters**

The following profiles are available by default:

No.	Description	Size (in mm)		Tanks (duration in minutes)						RPP	Air
		Height	Width	1	2	3	4	5	6		
1	Copper Plating Profile	305	230	15	5	15	/	90	0	On	On
2	Tin Plating Profile	305	230	0	0	0	/	0	30	Off	Off

**Table 6: Profile overview**

Please note that the duration for tank 4 cannot be set manually. The system calculates the duration automatically based on the temperature of the bath.

You can also create and edit new profiles. For further information refer to page 52.

## 4 Transport and storage

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

### ⚠ CAUTION

#### Risk of injury by crushing during transport!

Body parts can be crushed during transport of the system.

- ▶ Wear your personal protective equipment.
- ▶ Carry the system only at the recessed grips.
- ▶ When setting the system down, ensure that no body parts get pinched or crushed.

### 4.1 Transport inspection

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

If transport damage is evident, 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.
- ▶ Initiate a complaint.

### 4.2 Transporting the system

Ensure the the following requirements are met before performing the steps below:

#### Prerequisites

- Wear safety shoes
- Wear protective gloves
- Work with another person
- System is switched off.

The system weighs 60 kg (without anode plates) and has to be carried by two persons. The system has a recessed grip on both sides for lifting the system.

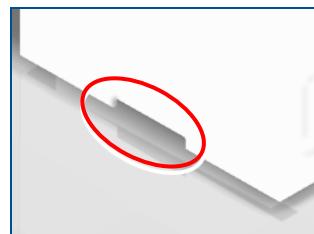


Fig. 12: Recessed grip

#### ■ Transporting the system

1. Ensure that the system is switched off.
2. Remove the mains cable.

3. Lift the system with another person simultaneously at the two recessed grips.
  4. Set the system down at the intended place.
- The system has been transported.

### 4.3 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.

### 4.4 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.

#### 4.4.1 Handling packaging material

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

#### NOTICE

##### Environmental hazard by wrong disposal of packaging!

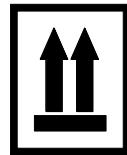
Wrong disposal of packaging material can cause environmental hazards.

- ▶ 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.

#### 4.4.2 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.

## 5 First startup

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

### 5.1 Safety

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.

#### WARNING

##### **Health hazard by contact with chemicals!**

Contact with the chemicals can cause serious damage to health:

**Inhaling** can irritate nose, throat and lungs and can cause allergic respiratory problems.

**Skin contact** can cause chemical burns, allergies, and hypersensitivity.

**Eye contact** can irritate the eyes and mucous membranes with burning and tears and can cause impaired vision and serious eye damage.

**Ingestion** can cause chemical burns of the mucous membranes, throat, esophagus, and stomach and can cause gastrointestinal complaints.

- ▶ Read the provided safety data sheets carefully.
- ▶ Work in well-ventilated rooms.
- ▶ Wear your personal protective equipment.
- ▶ Avoid direct contact with the chemicals.
- ▶ Take off contaminated clothes immediately.
- ▶ Wash your hands thoroughly after work.

#### NOTICE

##### **Property damage due to contaminants on the anodes!**

Contaminants like e.g. finger prints interfere with the copper release of the anodes and cause a particle discharge that contaminates the bath.

- ▶ Touch the copper anodes only with clean protective gloves.

## 5.2 Requirements of the place of installation

Before installing the system, the following requirements of the place of installation have to be ensured.

### 5.2.1 Climatic conditions

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

#### Climatic conditions

Data	Value	Unit
Temperature range (operation)	20 to 25	°C
Temperature range (storage, transport)	-30 to 60	°C
Max. humidity, non-condensing	90	%

### 5.2.2 Minimum required space

#### System dimensions

- Width: 856 mm (~33.7")
- Depth: 562 mm (~22.1")
- Height: 450 mm (~17.7")

#### Minimum space requirements for operation and maintenance

- Width: 956 mm (~37.7")
- Depth: 1562 mm (~61.5")
- Height: 800 mm (~31.5")

A space of approx. 10 cm to the right of the system has to be kept clear for maintenance. In front of the system, at least 1 m of space should be available for operation and movement.

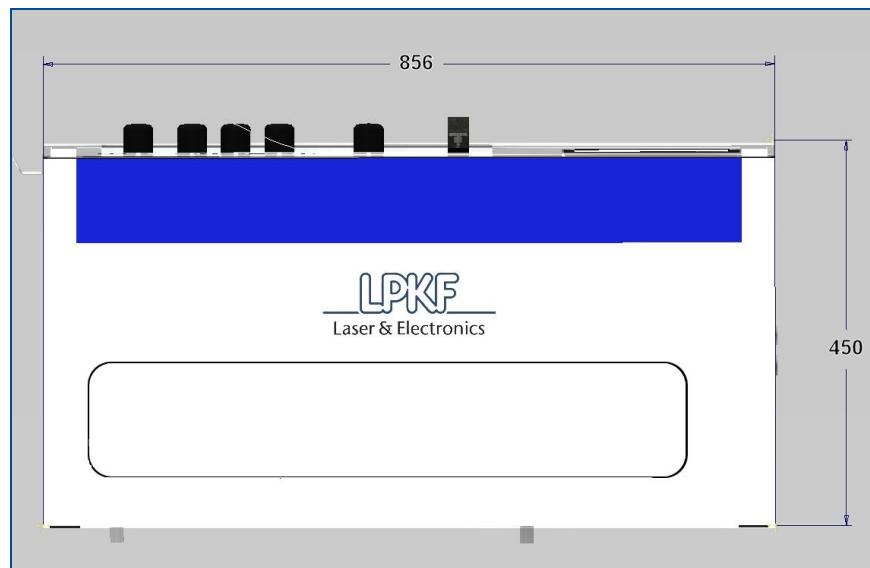


Fig. 13: Minimum space requirements - front view

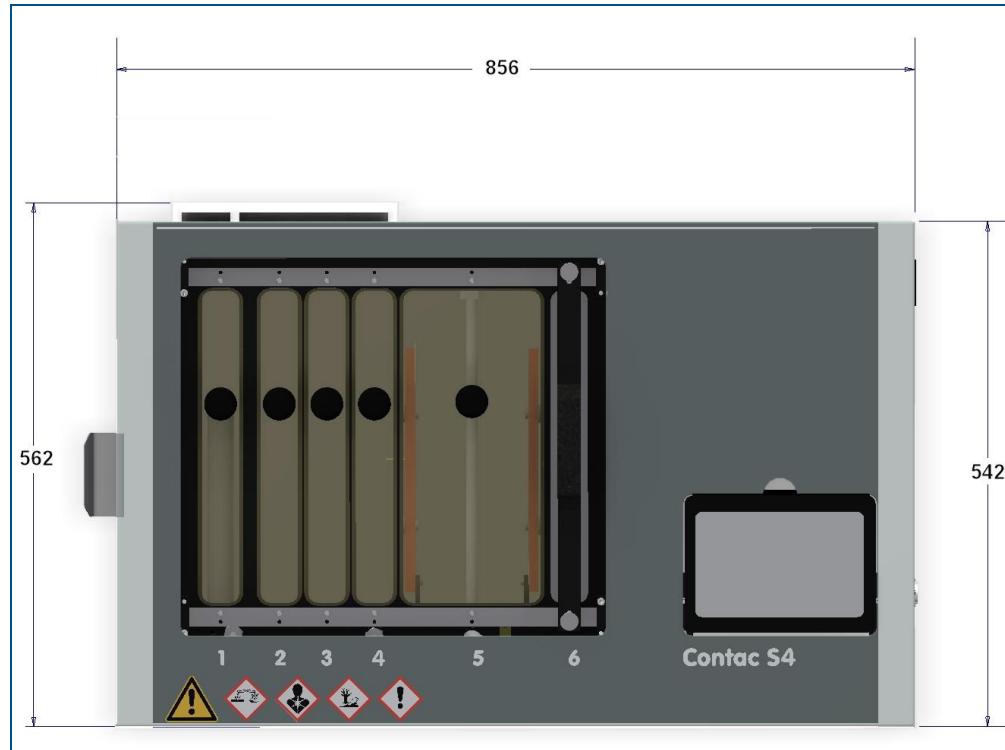


Fig. 14: Minimum space requirements - top view

### 5.2.3 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 (117 kg with filled tanks).

#### **⚠ WARNING**

##### Risk of injury by loss of stability!

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

- ▶ Ensure that the floor has a sufficient load-bearing capacity for the system and is even.

### 5.2.4 Connections provided by the customer

#### Electrical data

Data	Value	Unit
Power supply	110/230	V
	50/60	Hz
Output power	750	VA

### 5.3 Preparations

The copper anodes have to be installed before the system can be put into operation.

#### NOTICE

##### Property damage due to contaminants on the anodes!

Contaminants like e.g. finger prints interfere with the copper release of the anodes and cause a particle discharge that contaminates the bath.

- Touch the copper anodes only with clean protective gloves.

#### ■ Installing the copper anodes

1. Take the copper anodes and the anode bags out of the packaging.
2. Put the anodes into the bags with the holes at the mouths of the bags.



Fig. 15: Copper anode in bag

##### Notice! Damage by falling copper anodes!

- Put padding (e.g. expanded material) into tank 5 before installing the anodes.

3. Hang one copper anode by its two holes onto the gray pins on the left wall of tank 5.



Take care that the small hole at the edge of the anode points to the front of the system and that the anode bag is not jammed between the anode and the pins.

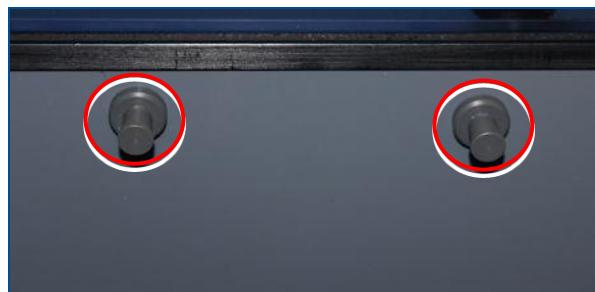


Fig. 16: Gray pins

4. Hang the other copper anode by its two holes onto the gray pins on the right wall of tank 5.

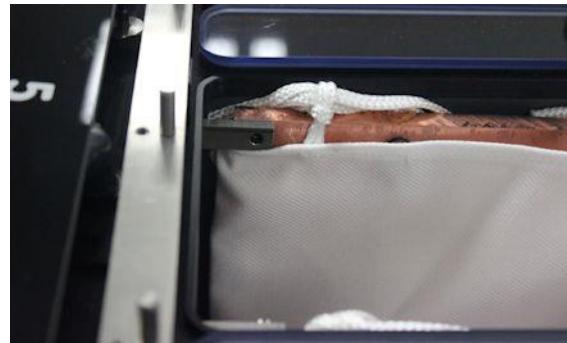


Fig. 17: Installing the copper anodes

5. Fasten a titan bracket to each anode plate using a flat-bladed screwdriver.



Fig. 18: Fastening the titan bracket

- The copper anodes have been installed.

## 5.4 Connecting the system

The following tasks have to be executed to start up the system.

- Filling the tanks
  - Filling tank 1 (Cleaning)
  - Filling tank 2 (Conditioning)
  - Filling tank 4 (Active cleaning)
  - Filling tank 5 (Copper plating)
  - Filling Tank 6 (Tinning)
  - Filling Tank 3 (Activation)
- Connecting the system to the power supply
- Initializing the system



The tanks have been cleaned and rinsed before delivery, thus the chemicals can be filled without delay.

### ■ Filling tank 1

1. Remove the cover of tank 1 and put it into the holder slot.
2. Fill tank 1 with **Cleaner 110** up to the mark.



Ensure that tank 1 is always sufficiently filled. Replace evaporation losses with **Cleaner 110**, use distilled or de-ionized water only if necessary.

3. Place the cover back onto tank 1.

Tank 1 has been filled.

### **■ Filling tank 2**

1. Remove the cover of tank 2 and put it into the holder slot.
2. Fill tank 2 with **Cleaner 210** up to the mark.
3. Place the cover back onto tank 2.

Tank 2 has been filled.

### **■ Filling tank 4**

1. Remove the cover of tank 4 and put it into the holder slot.
2. Fill **ViaCleaner Part 1** (four bottles 1l each) into the 5l jerry can included in the delivery.
3. Fill **ViaCleaner Part 2** into the 5l jerry can.
4. Mix the ViaCleaner solution thoroughly.
5. Attach the spout to the jerry can's muzzle.
6. Fill the ViaCleaner solution into tank 4.
7. Place the cover back onto tank 4.

Tank 4 has been filled.

### **■ Filling tank 5**

1. Remove the cover of tank 5 and put it into the holder slot.
2. Fill tank 5 with **Copper Plater 400** up to the mark.
3. Add 50 ml of **Shine 400** to tank 5.
4. Put the floating balls into tank 5.
5. Place the cover back onto tank 5.

Tank 5 has been filled.

### **■ Filling tank 6**

1. Remove the cover of tank 6 and put it into the holder slot.
2. Fill tank 6 with **Electroless Tin** up to the mark.
3. Place the cover back onto tank 6.

Tank 6 has been filled.



Tank 3 should be filled last to avoid malfunction of the chemical caused by inadvertent splashes.

### **■ Filling tank 3**

1. Remove the cover of tank 3 and put it into the holder slot.
2. Shake the jerry can filled with **Activator 310** for approximately one minute.



The Activator liquid is very sensitive and can easily become unusable. Tank 3 has to be absolutely dry before filling in **Activator 310**.

3. Fill tank 3 with **Activator 310** up to the mark.
  4. Place the cover back onto tank 3.
- Tank 3 has been filled.



It is recommended to store the containers for later disposal of the chemicals.

### ■ Connecting the system to the power supply

1. Check whether the main switch is switched to 0 and switch it to this position if not.



Fig. 19: Power supply

2. Plug the mains cable into the appliance inlet.



Fig. 20: Mains cable plugged into appliance inlet

3. Plug the mains cable into the wall socket.



Fig. 21: Mains cable plugged into wall socket

- The system has been connected to the power supply.

The system has to be initialized after connecting and filling. This requires a PCB that subsequently, however, cannot be processed any further. Thus, you should use a dummy PCB that is not intended for further processing.



### Initialization

The initialization of the copper anodes takes 240 minutes. Initialization creates a thin homogeneous phosphorus layer that helps creating shiny copper layers. Insufficient initialization can cause matte and inhomogeneous copper layers to be built during the first process runs.

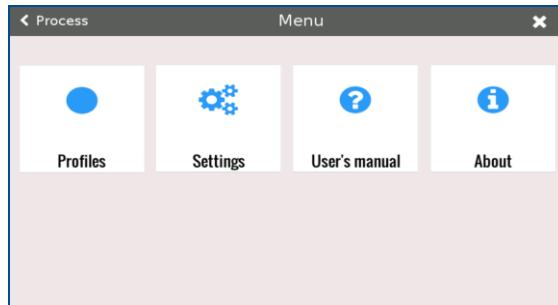
### ■ Initializing the system

1. Switch the main switch on the right side of the system to I (On).



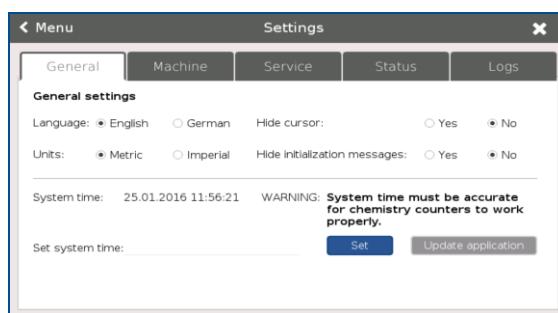
**Fig. 22:** Main switch On

- Tank 1 is heated.
- 2. Follow the instructions on the touch screen.
- The processing view is displayed.
- 3. Tap on
- The main menu is displayed.



**Fig. 23:** Main menu

4. Tap on [Settings].
- The settings are displayed.



**Fig. 24:** Settings

5. Select the tab Service.
6. In the line *Anode exchange* tap on [Service].
7. Fasten the dummy PCB to the PCB holder.

8. Rinse the dummy PCB with water.
  9. Insert the dummy PCB into tank 5.
  10. Tap on .
  - The displayed processing time is counted down.
  11. Wait until the time has elapsed.
  12. Remove the dummy PCB from the tank.
  13. Let the dummy PCB drip off into tank 5.
  14. Rinse the dummy PCB with water.
  15. Dispose of the dummy PCB according to regulations.
- The system has been initialized.

## 6 Operating the system

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

### 6.1 Safety

#### **WARNING**

##### **Health hazard by contact with chemicals!**

Contact with the chemicals can cause serious damage to health:

**Inhaling** can irritate nose, throat and lungs and can cause allergic respiratory problems.

**Skin contact** can cause chemical burns, allergies, and hypersensitivity.

**Eye contact** can irritate the eyes and mucous membranes with burning and tears and can cause impaired vision and serious eye damage.

**Ingestion** can cause chemical burns of the mucous membranes, throat, esophagus, and stomach and can cause gastrointestinal complaints.

- ▶ Read the provided safety data sheets carefully.
- ▶ Work in well-ventilated rooms.
- ▶ Wear your personal protective equipment.
- ▶ Avoid direct contact with the chemicals.
- ▶ Take off contaminated clothes immediately.
- ▶ Wash your hands thoroughly after work.

#### **CAUTION**

##### **Health hazard by inhalation of fumes!**

Inhalation of the fumes produced during tin-plating can cause health damage.

- ▶ Work only in rooms with an air change rate of at least 6/h.

#### **NOTICE**

##### **Property damage due to missing cover!**

A cover missing on a tank can cause the bath to be not ready for use or to become completely unusable (by evaporation or contamination).

- ▶ Cover the tanks that are not in use with the provided covers.

#### **NOTICE**

##### **Property damage by contamination of the activation bath!**

The activation bath is very sensitive to contaminants and can become unusable if even slightly contaminated.

- ▶ Avoid any contamination of the activation bath.
- ▶ Always cover the activation tank when not in use.
- ▶ Never compensate evaporation losses with water. Replenish with Activator 310 up to the mark.

## 6.2 Preparations for use

Before working with the system check the following settings and conditions:

- Ensure that the room temperature is between 20 and 25 °C.
- Check the fill level of tank 1.
- Check whether copper sulphate crystals have formed in tank 5 put the crystals back into the bath if present.
- Place a spray bottle filled with distilled or de-ionized water next to the system.

## 6.3 Typical production process

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

- Process preparation
- Process sequence



During the through-hole plating process, all required steps are prompted and described by messages on the screen.

### 6.3.1 Process preparation

Proceed as follows to switch off the system:

#### ■ Switching on the system

1. Switch the main switch on the right side of the system to I (On).



Fig. 25: Main switch On

Tank 1 is heated.

2. Follow the instructions on the touch screen.

- The process view is displayed.

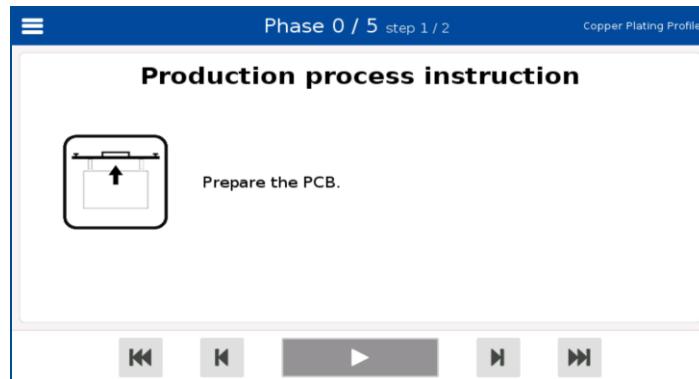


Fig. 26: Process view

- The system has been switched on.

Before starting the through-hole plating of the PCB, you should select the correct profile. This defines which steps you will execute and how long the PCB will dwell in the tanks. For information on creating and editing profiles refer to page 52.

### ■ Selecting a profile

1. Tap on .
- The menu is opened.

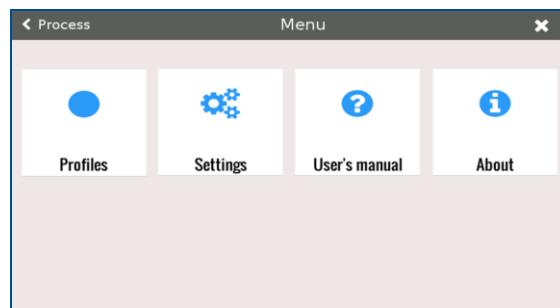


Fig. 27: Main menu

2. Tap on [Profiles].
- The profile overview is displayed:

#		Profile name	Actions	
1		Copper Plating Profile	  	
2		Tin Plating Profile	  	

Fig. 28: Profiles overview

3. Tap on [Select] of the desired profile.
- Select the profile *Copper Plating Profile* for the process described in the following.
- The process view is displayed with the selected profile.
- The profile has been selected.

### 6.3.2 Process sequence

This chapter describes the process of copper plating a PCB with subsequent tin plating.

- Starting the process
- Preparing the PCB
- Cleaning the PCB
- Conditioning the PCB
- Activating the PCB
- Active cleaning of the drilled holes
- Copper-plating the PCB
- Tin-plating the PCB
- Switching off the system

#### ■ Starting the process

1. Open the process view.

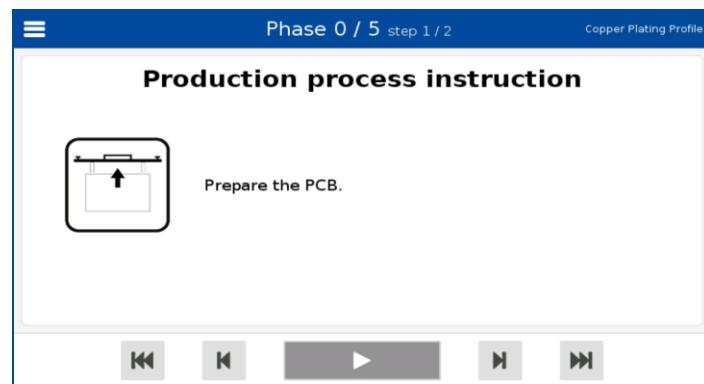


Fig. 29: Process view

- The first step is displayed.  
 The process is started.

#### ■ Preparing the PCB

1. Loosen the two screws on the side so far that the PCB can be inserted into the PCB holder.



Fig. 30: Screws on side

2. Insert the PCB into the PCB holder in such a way that it is aligned to the middle.
3. Tighten the screws on the side until the PCB is safely fastened.
4. Rinse the PCB with water.

You can use clean tap water instead of distilled or de-ionized water.

5. Tap on [OK].
- The process time and the temperature of the bath in tank 1 are displayed.

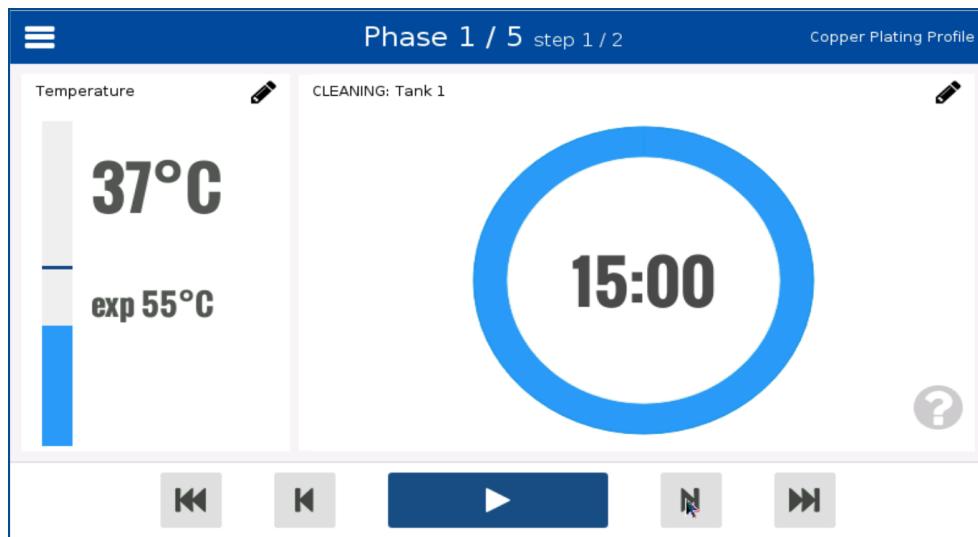


Fig. 31: Process time and bath temperature

- The PCB has been prepared.



Contaminants at the inside of the PCB holder can impair copper plating. Clean these surfaces with a coarse sponge and water if necessary.

## ■ Cleaning the PCB

1. Wait until the temperature display shows 50 °C.
2. Remove the cover of tank 1 and put it into the holder slot.



Fig. 32: Holder slots for the covers

3. Insert the PCB into tank 1 so that the pins on the tank's edge fit into the openings of the PCB holder.
4. Lift the front end of the PCB holder for approx. 3 cm and knock it several times (8 to 10 times) on the frame before setting it down again.
5. Fasten the PCB holder by hand-tightening the knurled screws.



Fig. 33: Knurled screw

6. Wait until the temperature display shows 50 °C again.
  7. Tap on .
  - The processing time is counted down.
  8. Wait until the time has elapsed.
  - The next task is displayed.
  9. Loosen the knurled screws of the PCB holder.
  10. Remove the PCB from the tank.
  11. Place the cover back onto tank 1.
  12. Rinse the PCB with water.
- The PCB has been cleaned.

## ■ Conditioning the PCB

1. Remove the cover of tank 2 and put it into the holder slot.
2. Insert the PCB into tank 2 so that the pins on the tank's edge fit into the openings of the PCB holder.
3. Fasten the PCB holder by hand-tightening the knurled screws.
4. Tap on .
- The processing time is counted down.
5. Wait until the time has elapsed.
6. Loosen the knurled screws of the PCB holder.
7. Remove the PCB from the tank.
8. Place the cover back onto tank 2.
9. Rinse the PCB with water.
10. Using the provided spray bottle (filled with de-ionized water), spray the PCB on both sides to remove remaining tap water from the drilled holes.

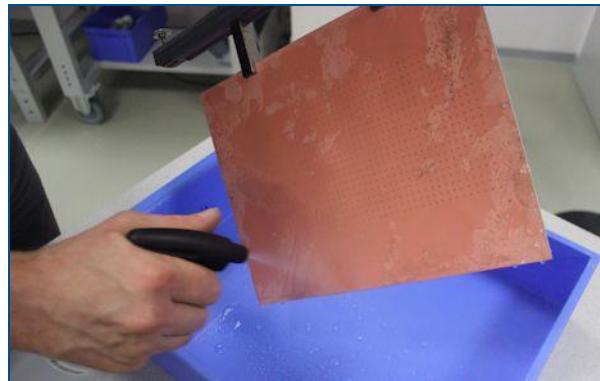


Fig. 34: Spraying the PCB

11. Remove the de-ionized water by knocking on the PCB above a sink.

You can also dry the drilled holes using oil-free compressed air.

- The PCB has been conditioned.



The following task describes how to remove excess Activator liquid by knocking. If you have a vacuum table and a nonwoven filter mat, you can use these as a clean alternative to knocking for removing the excess Activator liquid. For information on this method refer to page 54.

### ■ Activating the PCB

1. Remove the cover of tank 3 and put it into the holder slot.
2. Insert the PCB into tank 3 so that the pins on the tank's edge fit into the openings of the PCB holder.
3. Fasten the PCB holder by hand-tightening the knurled screws.
4. Tap on .
  - The processing time is counted down.
5. Wait until the time has elapsed.
6. Loosen the knurled screws of the PCB holder.
7. Remove the PCB from the tank.
8. Swipe the Activator liquid from both sides of the PCB using the squeegee and let the liquid drip back into tank 3.



Fig. 35: Swiping the Activator liquid

9. Knock on the almost dry PCB above the tank to remove excess Activator liquid from small drilled holes.
10. Place the cover back onto tank 3.

11. Remove the PCB holder.
  12. Dry the PCB in a drying cabinet at **50 °C** for **10 minutes**.
  13. If you are using FR4 material with extra copper foil, remove the foil after drying.
  14. Fasten the PCB to the PCB holder.
- The PCB has been activated.

### ■ Active cleaning of the drilled holes

1. Remove the cover of tank 4 and put it into the holder slot.
  2. Insert the PCB into tank 4 so that the pins on the tank's edge fit into the openings of the PCB holder.
  3. Lift the front end of the PCB holder for approx. 3 cm and knock it several times (8 to 10 times) on the frame before setting it down again.
  4. Fasten the PCB holder by hand-tightening the knurled screws.
  5. Tap on .

The processing time is counted down.

  6. Wait until the time has elapsed.
  7. Loosen the knurled screws of the PCB holder.
  8. Remove the PCB from the tank.
  9. Place the cover back onto tank 4.
  10. Rinse the PCB with water.
- The drilled holes have been cleaned.

### ■ Copper-plating the PCB

1. Remove the cover of tank 5 and put it into the holder slot.
2. Insert the PCB into tank 5 so that the pins on the tank's edge fit into the openings of the PCB holder.
3. Lift the front end of the PCB holder for approx. 3 cm and knock it several times (8-10 times) on the frame before setting it down again.
4. Fasten the PCB holder using the knurled screws.

**Notice! Damage by excessive waiting period!**  
**► Start the process immediately after inserting the PCB into tank 5.**

5. Tap on .

The displayed processing time is counted down.

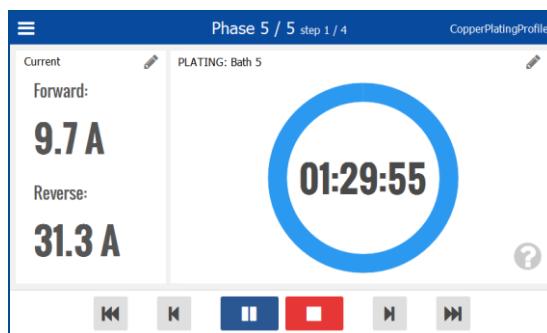



Fig. 36: Process view of copper plating

6. Wait until the time has elapsed.
  7. Loosen the knurled screws of the PCB holder.
  8. Remove the PCB from the tank.
  9. Let the PCB drip off into tank 5.
  10. Using the spray bottle, spray the PCB slightly on both sides above tank 5 and let the water drip into the tank.  
The de-ionized water can be used to compensate evaporation losses.
  11. Rinse the PCB with water.
  12. Dry the PCB as quick as possible with warm air (e.g. using a hair-dryer).  
Dry the PCB as quick as possible to avoid oxidation of the copper.
- The PCB can now be processed further (e.g. using a ProtoMat system).
- The PCB has been copper-plated.



### Tin-plating the PCB

Tin-plating of the PCB is optional, but it can be advantageous for further processing because the tin-plated PCB is protected against corrosion and can be soldered more easily.

The following PCBs can be tin-plated:

- Unprocessed PCBs
- Through-plated but not milled PCBs
- PCBs milled with an LPKF ProtoMat and through-plated

### ■ Tin-plating the PCB

1. Change to the **Tin Plating Profile** (see page 44).
2. Open the process view by tapping on

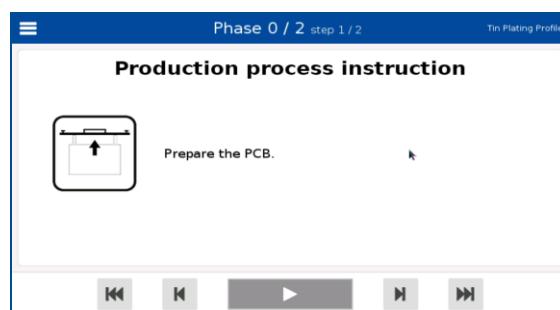
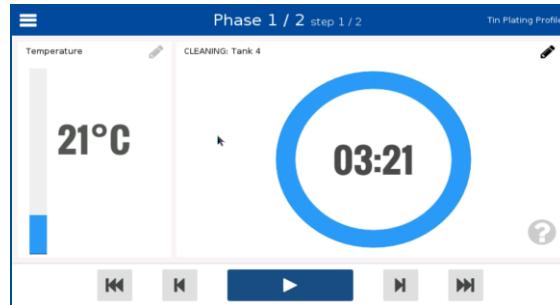


Fig. 37: Process view

3. Tap on
4. Rinse the PCB with water.
5. Brush and polish the PCB gently with a non-woven pad or a PCB brushing machine.  
Clean the holes as well to remove possible chips and burrs.
6. Fasten the PCB to the PCB holder if not yet done.
7. Remove the cover of tank 4 and put it into the holder slot.

8. Insert the PCB into tank 4 so that the pins on the tank's edge fit into the openings of the PCB holder.
9. Lift the front end of the PCB holder for approx. 3 cm and knock it several times (8 to 10 times) on the frame before setting it down again.
10. Fasten the PCB holder by hand-tightening the knurled screws.



**Fig. 38:** Tin-plating the PCB

11. Tap on .
- The processing time is counted down.
12. Wait until the time has elapsed.
13. Loosen the knurled screws of the PCB holder.
14. Remove the PCB from the tank.
15. Place the cover back onto tank 4.
16. Rinse the PCB with water.
17. Stir the contents of tank 6 with a fiberglass rod to avoid sedimentation of the chemicals.
18. Insert the PCB into tank 6 so that the pins on the tank's edge fit into the openings of the PCB holder.
19. Fasten the PCB holder by hand-tightening the knurled screws.
20. Tap on .
- The processing time is counted down.



The maximum layer thickness of the deposited tin layer is approx. 1 µm. The preset process duration of 30 minutes should be sufficient to achieve this layer thickness.

21. Loosen the knurled screws of the PCB holder.
  22. Remove the PCB from the tank.
  23. Rinse the PCB for at least 30 seconds.
  24. Rinse the PCB with warm water.
  25. Dry the PCB as quick as possible with warm air (e.g. using a hair-dryer).
  26. Remove the PCB holder.
- The PCB has been tin-plated.

## **Switching off the system**

1. Ensure that no PCB is in any of the tanks.
2. Check that all covers are on the tank and cover the tanks if necessary.
3. Switch the main switch to **0** (Off).



Fig. 39: Main switch off

- The touch screen is switched off and tank 1 is no longer heated.
- The system has been switched off.

## 6.4 Special tasks

This chapter describes rarely used tasks that may facilitate working with your system.  
The following steps are performed:

- Creating a new profile
- Editing a profile
- Preparing the vacuum table
- Activating the PCB (using a vacuum table)

### ■ Creating a new profile

1. Tap on
- The following view is displayed:

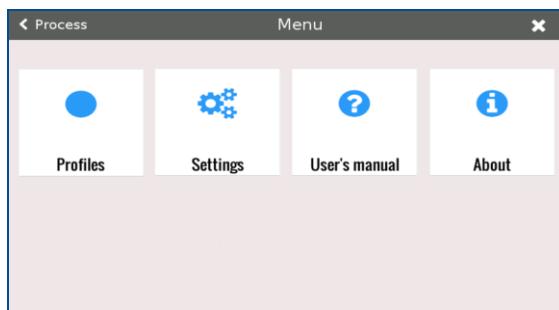


Fig. 40: Main menu

2. Tap on [Profiles].
- The following view is displayed:



**Fig. 41:** Profiles overview

3. Tap on next to an existing profile.
- The following view is displayed:

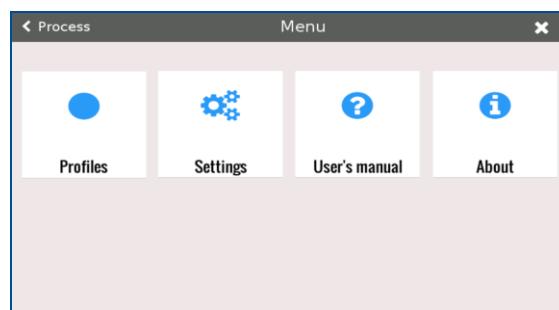


**Fig. 42:** Creating a new profile

4. Enter the name for the profile.
  5. Enter the dimensions of the PCB.  
Use the profile only for PCBs having the entered dimensions. These are used for calculating the amperage.
  6. Enter the other parameters.
  7. Tap on [Save].
- A new profile has been created.

## ■ Editing a profile

1. Tap on .
- The main menu is displayed:



**Fig. 43:** Main menu

2. Select [Profiles].

- The profile overview is displayed:



Fig. 44: Profile overview

3. Tap on  next to the profile to be edited.

The default profiles cannot be edited. The  icon cannot be selected for these profiles.

- The profile view is displayed:



Fig. 45: Profile view

4. Edit the parameters of the profile.
  5. Confirm your entries by tapping on [Save].
- The profile has been edited.

## ■ Preparing the vacuum table

1. Connect the extraction hose of an extraction system to the vacuum table.
2. Fasten a new nonwoven mat onto the vacuum table if necessary.

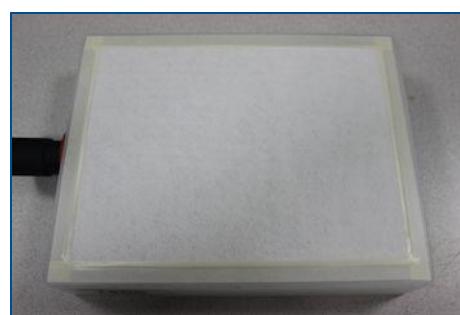


Fig. 46: Vacuum table with nonwoven mat

- The vacuum table has been prepared.

### ■ Activating the PCB (using a vacuum table)

You can also remove excessive Activator 310 using a vacuum table instead of the knock method (see page 48). This is simpler and cleaner but requires a vacuum table and a nonwoven filter mat.

1. Remove the cover of tank 3 and put it into the holder slot.
2. Insert the PCB into tank 3 so that the pins on the tank's edge fit into the openings of the PCB holder.
3. Fasten the PCB holder using the knurled screws.
4. Tap on .
- The displayed processing time is counted down.
5. Wait until the time has elapsed.
6. Loosen the knurled screws of the PCB holder.
7. Remove the PCB from the tank.
8. Swipe the Activator liquid from both sides of the PCB using the provided squeegee and let the liquid drip back into tank 3.



If you are through-hole plating a PCB without extra copper foil, you have to use a squeegee with rubber blade to remove the Activator liquid. You can thus swipe the liquid from the PCB without removing it from the drilled holes.

9. Place the PCB onto the vacuum table.

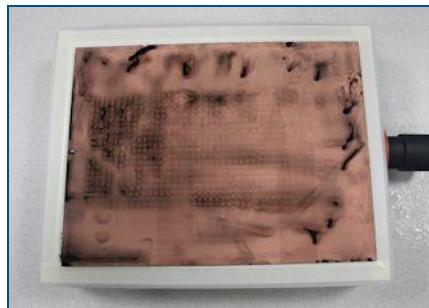


Fig. 47: Vacuum table with PCB

10. Start the extraction system and wait for approx. 30 seconds.
11. Switch off the extraction system.
12. Turn the PCB over.
13. Start the extraction system and wait for approx. 30 seconds.
14. Switch off the extraction system.
- The excess Activator liquid has been removed.
15. Remove the PCB from the vacuum table.
16. Place the cover back onto tank 3.
17. Remove the PCB holder.
18. Dry the PCB in a drying cabinet at 50 °C for 10 minutes.
19. If you are using FR4 material with extra copper foil, remove the foil after drying.
20. Fasten the PCB to the PCB holder.
- The PCB has been activated.

Once the PCB has been activated you can proceed to the phase for active cleaning of the drill holes on page 49.

## 7 Maintenance

This chapter contains important information on the maintenance of the system.

Proper maintenance and proper handling of the supply components, in this case the extraction system, are basic requirements for flawless functioning of the system.

Maintenance has to be performed and documented regularly according the instructions of the manufacturer.

The system is designed for a service life of 5 years of one-shift operation (10 hours per day). The given maintenance intervals are valid for one-shift operation in a 5-day work week.

### 7.1 Safety

Follow the safety instructions below for your own protection and for the protection of other persons in the vicinity of the maintenance work. The maintenance personnel must ensure that the described prerequisites for the planned maintenance tasks are fulfilled and they must observe the special warning messages for the individual maintenance tasks.

#### WARNING

##### **Health hazard by contact with chemicals!**

Contact with the chemicals can cause serious damage to health:

**Inhaling** can irritate nose, throat and lungs and can cause allergic respiratory problems.

**Skin contact** can cause chemical burns, allergies, and hypersensitivity.

**Eye contact** can irritate the eyes and mucous membranes with burning and tears and can cause impaired vision and serious eye damage.

**Ingestion** can cause chemical burns of the mucous membranes, throat, esophagus, and stomach and can cause gastrointestinal complaints.

- ▶ Read the provided safety data sheets carefully.
- ▶ Work in well-ventilated rooms.
- ▶ Wear your personal protective equipment.
- ▶ Avoid direct contact with the chemicals.
- ▶ Take off contaminated clothes immediately.
- ▶ Wash your hands thoroughly after work.

#### **NOTICE**

##### **Property damage by contamination of the activation bath!**

The activation bath is very sensitive to contaminants and can become unusable if even slightly contaminated.

- ▶ Avoid any contamination of the activation bath.
- ▶ Always cover the activation tank when not in use.
- ▶ Never compensate evaporation losses with water. Replenish with Activator 310 up to the mark.

## 7.2 Maintenance schedule

The following table lists the maintenance tasks that are to be performed by personnel trained for these tasks.

**Maintenance schedule for the maintenance personnel of the operator**

Component/ Assembly	Interval	Task to be performed	Remark
System	Daily to weekly	Clean the system.	Use a sponge and water to clean the housing.
PCB holder	If necessary	Remove the copper layer	Hang the PCB holder (without PCB) into tank 4 for several hours.
Tank 3 (Activation)	After non-usage (≥ 1 day)	Stir contents with glass fiber rod for 2 to 3 minutes.	Any foam created by stirring has to dissolve before using the bath.
Tank 6 (Tin plating)	When bath is spent	Replenish Electroless Tin Liquid	The bath is spent after 8 to 10 PCBs of A4 form factor. See page 61.
Tank 5 (copper plating)	Weekly	Check visually for copper sulphate crystals.	Put crystals back into tank 5.
Tank 5 (Copper plating)	After 100 ampere hours	Add Shine 400	See page 61.
Tank 5 (Copper plating)	Every 3 weeks	Filter tank 5.	See page 59.
Tank 1 (Cleaning)	Every 3 months or in case of significant color change	Replace Cleaner 110.	Empty the tank completely and refill.
Tank 2 (Conditioning)	Every 3 months or in case of significant color change	Replace Cleaner 210.	Empty the tank completely and refill.
Tank 3 (Activation)	Yearly or after malfunction of the bath.	Replace Activator 310.	Empty the tank completely and refill.
Tank 5 (Copper plating)	Yearly	Replace Copper Plater 400.	Empty the tank completely and refill.
Tank 6 (Tin plating)	Yearly	Replace Electroless Tin Liquid.	Empty the tank completely and refill.
Tank 6 (Tin plating)	For times of prolonged non-usage	Fill the bath into a nonmetal jerry can.	This prevents oxidization of the bath.

**Table 7: Maintenance schedule for the maintenance personnel of the operator**

### 7.3 Maintenance tasks for the maintenance personnel of the operator

This chapter describes in detail the individual maintenance tasks that the maintenance personnel of the operating company may perform.

#### ■ Draining a tank

##### Prerequisites

- Bath 1 has cooled down (before draining tank 1)
- The floating balls have been removed (before emptying tank 5)
- 1. Remove the cover from the front of the system.

##### Spare parts and auxiliary supplies

- Tube
- Jerry can



Fig. 48: Cover for drain valves

2. Attach the tube to the relevant drain valve.

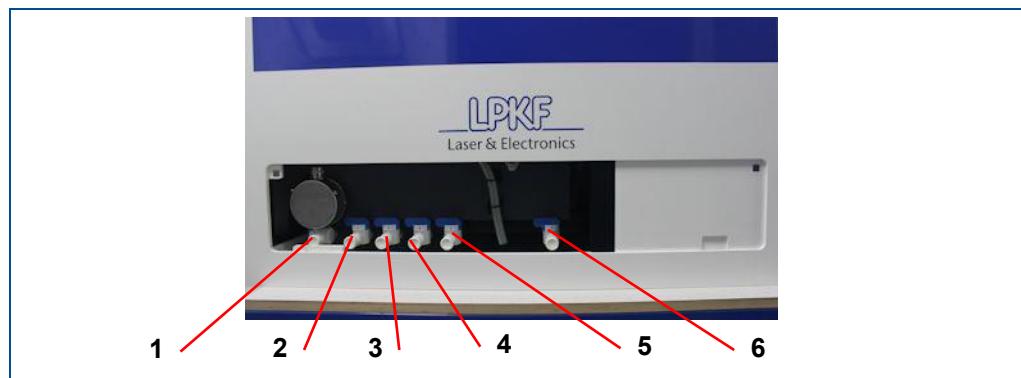


Fig. 49: Drain valves

- |   |                        |   |  |
|---|------------------------|---|--|
| 1 | Tank 1 (Cleaner 110)   | 4 | Tank 4 (ViaCleaner Part 1 & 2)         |
| 2 | Tank 2 (Cleaner 210)   | 5 | Tank 5 (Copper Plater 400 & Shine 400) |
| 3 | Tank 3 (Activator 310) | 6 | Tank 6 (Electroless Tin Liquid)        |

3. Insert the other end of the tube into a jerry can.



Use the original jerry can if the chemical was delivered in a jerry can.

4. Turn the lever of the valve to the front.



Fig. 50: Turning the lever of the valve

- The contents of the tank drains into the jerry can.
- 5. Wait until the liquid has drained completely.
- 6. Turn the lever of the valve to the right.
- 7. Push on the ring of the valve and pull out the tube.



Fig. 51: Ring on drain valve

- 8. Repeat the steps 2 to 7 for all tanks you want to drain.
  - 9. Fasten the cover to the front of the system.
- The tank has been drained.

## ■ Filtering Copper Plater 400

### Prerequisites

- Visible suspended particles or contaminants in tank 5

### Spare parts and auxiliary supplies

- Jerry can
- Tube
- Fuel filter (alternatively several coffee filters or a folded filter paper)
- Copper Plater 400
- De-ionized water

1. Remove the cover from the front of the system.
2. Attach the tube to the drain valve of tank 5.
3. Attach the fuel filter at the other end of the tube.
4. Insert the end of the tube into a jerry can.



**Fig. 52:** Filtering Copper Plater 400

5. Turn the lever of the valve to the front.
- The contents of the tank drains into the jerry can.
6. Wait until approx. 5 liters of the tank's content have drained.



It is sufficient to filter this partial amount because the contaminants accumulate at the bottom of the tank and are already flushed out with this amount. If suspended particles or contaminants occur at the surface of the tank, the whole contents of the tank have to be filtered.

7. Close the valve.



Instead of using a fuel filter you can also use several stacked coffee filters or a folded filter paper.

8. Pour the filtered liquid back into tank 5.
9. Fill up tank 5 with **Cleaner 400** up to the mark.
10. Moisten a cloth with de-ionized water.
11. Wipe the rim of the tank with the cloth.
12. Place the cover back onto tank 5.
13. Tap on
14. Tap on [Settings].
15. Select the tab Service.

Settings				
General	Machine	Service	Status	Logs
Anode replacement	25.01.2016	Time left:	90 days	
Cleaner 110	09.12.2015	Time left:	43 days	
Cleaner 210	09.12.2015	Time left:	43 days	
Activator 310	05.10.2015	Time left:	253 days	
ViaCleaner Solution	418065 mm2	Area left:	75%	
Copper-plating filter	25.01.2016	Time left:	90 days	
Copper plater 400	25.01.2016	Time left:	365 days	
SHINE 400	0 Ah	Charge left:	100%	
Tin plating	278710 mm2	Area left:	75%	

**Fig. 53:** Service menu

16. In the line **Copper plating filter** tap on [Reset].
- The remaining time is reset.
- Copper Plater 400 has been filtered.

## ■ Add Shine 400

### Prerequisites

- 100 ampere hours have been used since the last replenishment

### Spare parts and auxiliary supplies

- Shine 400
- Dummy board

1. Finish the current plating process with all pending steps.
  2. In the line **Shine 400** tap on [Service].
  3. Add 5 ml of **Shine 400** to tank 5.
  4. Re-initialize the system with a dummy board (9" x 12"). Use the following parameters:
    - Tank 1: 15 minutes
    - Tank 2: 5 minutes
    - Tank 5: 90 minutes at 10 A; **RPP off**
- The remaining time is reset.
- Shine 400 has been added.

## ■ Replenish Electroless Tin Liquid

### Prerequisites

- Tin-plating bath is spent.

### Spare parts and auxiliary supplies

- Electroless Tin Liquid (5 liters)
- Jerry can (non-metal)
- Tube
- De-ionized water

1. Remove the cover from the front of the system.
2. Attach the tube to the valve of tank 6.



Fig. 54: Drain valve of tank 6

3. Insert the other end of the tube into a clean, dry non-metal jerry can.
4. Turn the lever of the valve to the front.
- The contents of the tank drains into the jerry can.
5. Wait until the liquid has drained completely.
6. Close the valve.
7. Push on the ring of the valve and pull out the tube.



Fig. 55: Ring on drain valve

8. Attach the cover to the front of the system.
9. Remove the cover of tank 6 and put it into the holder slot.
10. Fill tank 6 with new **Electroless Tin Liquid** up to the mark.
11. Place the cover back onto tank 6.
12. Tap on .
13. Tap on [Settings].
14. Select the tab Service.

Einstellungen				
Allgemein	Maschine	Service	Status	Logs
Anodenwechsel	25.01.2016	Zeit verbleibend: 90 Tage		
Cleaner 110	09.12.2015	Zeit verbleibend: 43 Tage		
Cleaner 210	09.12.2015	Zeit verbleibend: 43 Tage		
Activator 310	05.10.2015	Zeit verbleibend: 253 Tage		
ViaCleaner Lösung	418065 mm <sup>2</sup>	Fläche verbleibend: 75%		
Kupferbad filtern	25.01.2016	Zeit verbleibend: 90 Tage		
Copper Plater 400	25.01.2016	Zeit verbleibend: 365 Tage		
Shine 400	0 Ah	Menge verbleibend: 100%		
Verzinnung	278710 mm <sup>2</sup>	Fläche verbleibend: 75%		

Fig. 56: Service menu

15. In the line *Tin plating* tap on [Reset].
  - The remaining time is reset.
  - Electroless Tin Liquid has been replenished.

## 8 Troubleshooting

This chapter contains an overview of possible faults and measures for troubleshooting.

If faults occur that cannot be eliminated by the following messages contact the LPKF Service.

### 8.1 Fault display

Errors and pending maintenance tasks are displayed as messages on the user interface.

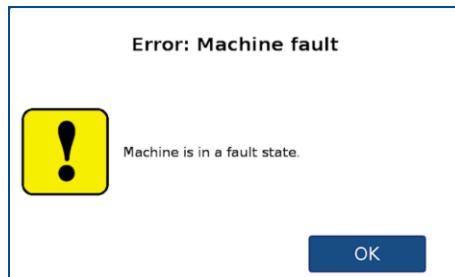


Fig. 57: Error message

Remedy the displayed error and acknowledge the message by tapping on [OK]. If you have any questions contact the LPKF Service.

### 8.2 Fault table

The following table contains possible faults and proposals how to clear them.

Fault	Possible cause Note	Remedy
Bath 1 remains at room temperature	Immersion heaters or fuse for heaters are defective.	Switch off the system and contact the LPKF Service.
Active cleaning liquid does not turn blue.	ViaCleaner Part 1 and Part 2 are not properly mixed.	Drain the active cleaning liquid into a 5l canister and add ViaCleaner Part 2. Mix the solution thoroughly and pour back into the tank.
		Dispose of the current active cleaning liquid. Fill ViaCleaner Part 1 and 2 into the 5l canister, Mix the solution thoroughly and pour into the tank.
Copper particles on the surface of the PCB	Copper particles are dispersed in the plating bath (tank 5).	Drain tank 5 completely and clean it, filter the bath (see page 59).
System cannot be switched on.	No connection to power supply.	Check the mains plug.
	Internal defect	Switch off the system and contact the LPKF Service.

Table 8: Troubleshooting

## 9 Disassembly and disposal

This chapter describes the disassembly and the disposal of the system.

The following tasks may only be performed by the **maintenance personnel of the operator**.

### 9.1 Safety

#### **WARNING**

##### **Health hazard by contact with chemicals!**

Contact with the chemicals can cause serious damage to health:

**Inhaling** can irritate nose, throat and lungs and can cause allergic respiratory problems.

**Skin contact** can cause chemical burns, allergies, and hypersensitivity.

**Eye contact** can irritate the eyes and mucous membranes with burning and tears and can cause impaired vision and serious eye damage.

**Ingestion** can cause chemical burns of the mucous membranes, throat, esophagus, and stomach and can cause gastrointestinal complaints.

- ▶ Read the provided safety data sheets carefully.
- ▶ Work in well-ventilated rooms.
- ▶ Wear your personal protective equipment.
- ▶ Avoid direct contact with the chemicals.
- ▶ Take off contaminated clothes immediately.
- ▶ Wash your hands thoroughly after work.

#### **NOTICE**

##### **Environmental hazard by improper disposal of the system!**

Improper disposal of the system can cause hazards to the environment.

- ▶ Dispose of the system properly or contact the LPKF Service.

### 9.2 Preparations

The system has to be prepared as follows before disassembly and disposal:

- Switch off the system.
- Disconnect the system from the power supply.
- Wait until bath 1 has cooled down.

### 9.3 Disposing of the system

The system is disassembled as follows:

#### ■ Uninstalling the system

1. Drain the tanks separately (see page 58).

Use the original containers of the chemicals if on hand except for **Electroless Tin Liquid**. Use a clean, dry, and non-metal canister for **Electroless Tin Liquid**.

2. Rinse the tanks thoroughly.
3. Rinse tank 3 with distilled water or de-ionized water once more.
4. Remove the anodes with the anode bags from tank 5.
5. Remove the anodes from the anode bags.
6. Rinse the anodes and anode bags.
7. Brush the anodes with a plastic brush until shiny.
8. Dry the anodes and anode bags.

The anodes and anode bags may have to be replaced, depending on their condition.

9. Dry the tanks.

The system has been uninstalled.

## 10 Appendix

This chapter contains navigation elements of the document.

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### 10.3 EC Declaration of conformity

**LPKF**  
Laser & Electronics

**EC Declaration of conformity according to machinery directive 2006/42/EC Annex II A**

The manufacturer/distributor: LPKF Laser & Electronics d.o.o.  
Polica 33  
SI-4202 Naklo, Slovenija

hereby declares that the following product  
Product designation: Contac S4  
Product type: Through-hole Plating System

conforms to the requirements of the directive stated above - including the amendments in force at the time of the declaration.

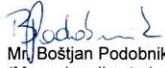
This declaration is only valid for the state of the product at the time of delivery. Any parts added by the user or other later modifications are excluded. The declaration becomes invalid if the product is modified after delivery.

The following harmonized standards were applied:  
EN ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction  
EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements.  
EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

The following additional EC directives were applied:  
EMC directive 2004/108/EC  
Low voltage directive 2006/95/EC

The party authorised to compile the technical file: Matjaž Samarin

Location: Naklo (Slovenia)  
Date: 8.4.2016

  
Mr. Boštjan Podobnik  
(Managing director)

  
Mr. Zeike Wolfgang  
(Managing director)

**CE**

Fig. 58: EC Declaration of conformity

## 10.4 Analysis results

### 10.4.1 Analysis results 1

 <p><b>CHEMISCHES LABOR DR. WIRTS + PARTNER SACHVERSTÄNDIGEN GMBH</b></p> <p><b>Analyses, Expertise, Consulting</b>            Chemisches Labor Dr. Wirts + Partner            Sachverständigen GmbH            Rutenbergstr. 59            D-30559 Hannover            Phone: +49 (0)511 950798-0            Fax: +49 (0)511 950798-29            E-Mail: Kontakt@Wirts.de            Internet: www.Wirts.de</p> <p>  <b>DAkkS</b>            Deutsche            Akkreditierungsstelle            D-PL-14001-01-00</p>	
<p><b>Test report</b></p> <p><b>Test Order No.:</b> 31204136 C      <b>Date:</b> 18.07.2012 / Froböse  <b>Page:</b> 1/2</p> <p><b>Customer:</b> LPKF Laser &amp; Electronics AG            Osteriede 7            30827 Garbsen</p> <p><b>Order received on:</b> 25.06.2012</p> <p><b>Order placement:</b> In writing by customer</p> <p><b>Project:</b> Rinse water, Vendor No.: 71204</p> <p><b>Test task definition:</b> Examination of rinse wastewater parameters in regard to discharging</p> <p><b>Sample No.:</b> P12004235</p> <p><b>Sample drawn:</b> On 20.06.2012 by customer</p> <p><b>Sample delivery:</b> On 22.06.2012 by parcel service</p>	
<p>Responsible for the test report</p> <p><i>A. S. Rütten, M.Sc.</i></p>	<p>Geologist Bruno Rütten, M.Sc.</p> <p><i>A. S. Rütten</i></p>
<p>The test results refer solely to the samples tested. Any reproduction or publication as a whole or in parts is allowed only with an authorization in writing issued by 'Chemisches Labor Dr. Wirts + Partner Sachverständigen GmbH'.</p> <p>The test lab is accredited according to DIN EN ISO/IEC 17025:2005 for the test procedures employed. The accredited test procedures comply with the management agreement OFD/BAM for legacy waste deposit investigation on German federal real estate. Authorized for analysis of officially taken confirmatory samples according to §43 LFGB.</p> <p>Chemisches Labor Dr. Wirts + Partner Sachverständigen GmbH      Geschäftsführer: Dr. C. Wirts            Hannoversche Volksbank BLZ 251 900 01 Kto.-Nr 00 129 984 00      BIC VOHA DE 2H IBAN DE63 2519 0001 0012 9984 00      Amtsgericht Hannover HRB 54361            US-Nr DE184011600 St-Nr 11 25 217 21217</p>	

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 Date: 18.07.2012  
 Test Order No. 31204136



CHEMISCHES LABOR  
 DR. WIRTS + PARTNER  
 SACHVERSTÄNDIGEN GMBH

SAMPLE NO.:	P12004235		
Parameter	Test procedure	Unit	Test result
pH value	DIN 38404, 5	a	7.90
Measuring temperature		°C	19.6
Electric conductivity	DIN EN 27888	µS/cm	776
Aluminium	EN ISO 11885	mg/l	0.32
Copper	EN ISO 11885	mg/l	0.40
Tin	EN ISO 17294/2	mg/l	1.6
Zinc	EN ISO 11885	mg/l	0.08
Iron	EN ISO 11885	mg/l	0.18
Manganese	EN ISO 11885	mg/l	0.10
Sulphur total	EN ISO 11885	mg/l	57.7
Sulphate, computed from sulphur content	EN ISO 11885	mg/l	173
DOC content	DIN EN 1484 (1997)	mg/l	6.36

Legend:

u.B. = below the procedure dependent determination limit  
 i.A. = based on  
 a = accredited test method  
 u = subcontracted  
 n.a. = not quantifiable

Assessment regarding the Test Order No. 31204136 C:

The customer markets chemical tin plating baths for tin-coating of printed circuit boards. In the process, rinse water is generated which has to be treated or discharged. A sample of used rinse water has been submitted to our lab for chemical examination. The examination goal is to decide whether the used rinse water produced in the chemical plating process can be discharged into the public sewerage system.

The examination plan included general parameters, heavy metals and DOC (Dissolved Organic Carbon).

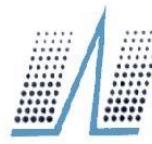
Individual examination results are summarized in the table above.

pH value of the colourless, clear water sample was in the neutral range, with normal electrolyte load. The screening for heavy metals has shown only inconspicuous concentrations. The organic load of the waste water, expressed as DOC, was very low.

Taking into account the collection of rules and standards ATV-A115 "Discharge of non-domestic waste water in a public sewerage system", the waste water sample analyzed in our lab complied with waste water requirements. Therefore, rinse water generated in the plating process can be discharged into the public sewerage system.

### 10.4.2 Analysis results 2

page 2/2  
of July 29, 2003  
Test order No. 31490-P2C



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SACHVERSTÄNDIGEN GMBH

#### Test Results

Sample identification:	drinking water			
Laboratory No.:	3 1490 / 1			
Appearance: colour: turbidity: sediments: smell: sample quantity:	colourless none none weakly non-specific 1,0 ltr			
PARAMETER	TEST METHOD	TEST DATE	UNIT	TEST RESULT
pH - value measurement temperature electric conductivity calculated at 25 °C	DIN 38404 / 5 a DIN EN 27888 a	July 1, 2003 July 1, 2003	°C µS/cm	8,0 14,6 852
copper	EN ISO 11885 a	July 1, 2003	mg/ltr	0,023

Note:

a = accredited method

### 10.4.3 Analysis results 3

page 2/4  
of June 8, 2000  
order No. 0 1218-P2C



CHEMISCHES LABOR  
DR. WIRTS + PARTNER  
SACHVERSTÄNDIGEN GMBH

sample identification:	Cleaner 110, sample 1			
laboratory No.	0 1218/ 1			
appearance				
colour	colourless			
turbidity:	none			
sediment:	without			
smell:	slightly non-specific			
<b>The results itemized herebelow are relating to the homogenized water sample incl. sediment.</b>				
PARAMETER	TEST METHOD	ANALYSIS DAY	UNIT	TEST RESULT
pH value	DIN 38404/ 5	24.05.00		9.4
measuring temperature		24.05.00	°C	13.9
electric conductivity at 25°C	DIN 38404/ 8	24.05.00	µS/cm	57.4
chromium, total	DIN 38406/ 22	30.05.00	mg/l	< 0.02
chromium VI	DIN 38405/ 24	30.05.00	mg/l	< 0.03
copper	DIN 38406/ 22	30.05.00	mg/l	0.028
nickel	DIN 38406/ 22	30.05.00	mg/l	< 0.04
zinc	DIN 38406/ 22	30.05.00	mg/l	< 0.02
lead	DIN 38406/ 22	30.05.00	mg/l	< 0.1
cadmium	DIN 38406/ 22	30.05.00	mg/l	< 0.01
mercury	DIN 38406 / 12	07.06.00	mg/l	< 0.0005
arsenic	Graphitrohr-AAS	05.06.00	mg/l	< 0.005
AOX - content	DIN 38409/ 14	31.05.00	mg/l	< 0.010
TOC - content	DIN 38409/ 3/1	29.05.00	mg/l	2.42
mineral oil hydrocarbons	DIN 38409/ 18	26.05.00	mg/l	< 1.6

**Zeichenerklärung:**  
u.B. = below determinability limit set by analysis process  
i. A. = leaning on

page of order No.	3/4 June 8, 2000 0 1218-P2C		CHEMISCHES LABOR <b>DR. WIRTS + PARTNER</b> SACHVERSTÄNDIGEN GMBH	
sample identification:	Cleaner 210, sample 2			
laboratory No.	0 1218/ 2			
appearance colour turbidity: sediment:	colourless none without			
smell:	slightly non-specific			
<b>The results itemized herebelow are relating to the homogenized water sample incl. sediment.</b>				
PARAMETER	TEST METHOD	ANALYSIS DAY	UNIT	TEST RESULT
pH value measuring temperature electric conductivity at 25°C	DIN 38404/ 5 DIN 38404/ 8	24.05.00 24.05.00 24.05.00	°C µS/cm	8.2 13.1 28.2
chromium, total chromium VI copper nickel zinc lead cadmium mercury arsenic	DIN 38406/ 22 DIN 38405/ 24 DIN 38406/ 22 DIN 38406/ 22 DIN 38406/ 22 DIN 38406/ 22 DIN 38406/ 22 DIN 38406 / 12 Graphitrohr-AAS	30.05.00 30.05.00 30.05.00 30.05.00 30.05.00 30.05.00 30.05.00 07.06.00 05.06.00	mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l	< 0.02 < 0.03 0.106 < 0.04 < 0.02 < 0.1 < 0.01 < 0.0005 < 0.005
AOX - content	DIN 38409/ 14	31.05.00	mg/l	< 0.010
TOC - content	DIN 38409/ 3/1	29.05.00	mg/l	7.65
mineral oil hydrocarbons	DIN 38409/ 18	26.05.00	mg/l	< 1.6
<b>Zeichenerklärung:</b> u.B. = below determinability limit set by analysis process I. A. = leaning on				

#### 10.4.4 Analysis results 4

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of Jan. 26, 2004  
Order No. 03 0687-GA



CHEMISCHES LABOR  
**DR. WIRTS + PARTNER**  
SACHVERSTÄNDIGEN GMBH

##### Operating areas and measurement results

works:	LPKF Laser & Electronics AG, Garbsen
operating ranges:	Galvanics
date:	18.11.2003

Working area / measuring point		Substances	Date	Time	Duration (min)	Sampling mode	Factor for shortened exposure	Concentration (mg/m³)	Substance index I
No.	Designation								
1	<i>galvanic plating through</i>	Formaldehyde (total process) Formaldehyde (sour Cu bath)	18.11.03 18.11.03	10.47 12.50	120 30	o / W o / W	k=1 k=1	0,013 0,018	0,02 0,03
2	<i>Contac-III</i>	Sulfur dioxide (total process) Sulfur dioxide (sour Cu bath)	18.11.03 18.11.03	10.47 12.50	120 30	o / W (K *)	k=1 k=1	< 0,4 < 1,3 (*)	< 0,31
3		Sulfuric acid (total process) Sulfuric acid (sour Cu bath)	18.11.03 18.11.03	10.47 12.50	120 30	o / W (K *)	k=1 k=1	< 0,05 < 0,2 (*)	< 0,5
4		carbon dioxide	18.11.03	10.47	145	o / W	k=1	741 ppm	0,15

##### Explanations:

p = relative to a person  
o = stationary  
S = average shift value  
K = short time exposure value  
W = worst case viewing

\*) the analysis methods available at the present time are, by reason of their rather slight detectability response at brief measuring durations, not or only restrictedly suitable for the control of the short time value

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of Jan. 26, 2004  
Order No. 03 0687-GA



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- **sulfur dioxide**
- **carbon dioxide**
- On the principals' request, the parameter list was completed by **formaldehyde**, because the chemical bath in Container 6 is holding formaldehyde in minor percentages.

### Findings

"Operating range Galvanics - galvanic plating-through plant Contac III"

The Limit values for formaldehyde, sulfur dioxide, sulfuric acid and carbon dioxide are retained, too, under the worst case aspect (constant exposure through an eight hour shift duration). Usually, the actual dwell period at the plant will amount to approx. 2 - 3 hours per shift. The following substance indices will result:

Substance	substance index at 8-hour exposure	substance index at 3-hour exposure
Formaldehyde	0,02	< 0,01
Sulfur dioxide	< 0,3	< 0,13
Sulfuric acid	< 0,5	< 0,19
Carbon dioxide	0,15	(0,06)

The substance indices were not summed-up for the following reasons:

Only a short while ago, the limit values for sulfur dioxide and sulfuric acid were lowered. By reason of insufficient sensitivity, the limits of quantitation of the analysis methods available are at around one third respectively one half of the limit value, so that a "simple" summing-up of the substance indices would lead to an adulterated picture of the real and actual situation. An analysis of the production process and a closer observation of the chemical baths used does show, however - production conditions being adhered to strictly - an increased emission of hazardous substances will not have to be taken into account.

The measured value for carbon dioxide was, with a 0.074 volume percentage, distinctly below the indoor standard value of 0.15 volume percent (DIN 1946, Part 2), and does indicate a well-ventilated room.

#### **Short time values**

The control of the short time values of sulfur dioxide and sulfuric acid is involving some more difficulties; by reason of the lowering made, a short time ago, of the limit values so that - for an exact checking of the 15-minute interval - at present there are not available measuring procedures which would be sufficiently sensitive.

#### **Sulfur dioxide:**

The process homogeneity allowed, in this instance, the use of a "lengthened" 30-minute interval for the measurement. The excess factor is "1", i.e., the concentration shall not, at any time, be higher than the limit value. The measured value was below the limit of quantitation of 1.3 mg/m³ (limit value 1.3 mg/m³). With that

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SACHVERSTÄNDIGEN GMBH

the short time value is to be regarded as certainly respected.

*Sulfuric acid:*

Here, too, by reason of the process taking its constantly homogeneous course a 30-minute interval could be used for the measurement. The excess factor here too is "1". The measured value was below the limit of quantitation of 0.2 mg/m<sup>3</sup> (limit value 0.1 mg/m<sup>3</sup>).

Whilst the "sour Cu bath" was being used, there were no indications of an alteration of the bath stability. Neither were there ascertained any smell load in the air nor any irritating influences. Thus there is to be assumed here, too, an adherence to the short time value.

*If the plant is operated according to prescription, the limit values for the a.m. substances will be well adhered to.*

*An observation of the marginal conditions for the short time values shows that these, under usual operating conditions, can also be well kept.*

K.-D. Willaschek-Jühne  
- Diploma Chemist -

**Enclosures:**

- Photo documentation
- Test Report 32636-P1A
- Test Report 32728-P1A
- Sampling protocols
- Measuring protocol - CO<sub>2</sub> measurement and climate data (continuous measuring: testo 445 with CO<sub>2</sub> sensor and triple probe (°C; %rF; m/s)

### 10.4.5 Analysis results 5

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 Date 03.03.2016  
 Order No. 2160063GWJ



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 SACHVERSTÄNDIGEN GMBH

#### 4.1 Table – Summary of measurement results

Sample	Area	Parameter	Measured value [mg/m³]	Limit [mg/m³]
2160063/2	RP Development Lab, workplace LPKF Contac S4	Tin(II) chloride (expressed as tin)	0.001	OEL 8 mg/m³
2160063/1		Thiourea	< 0.0003	OEL --- DNEL 0,2 mg/m³ Limit Finland, Latvia 0,5 mg/m³ (8 hours mean)

## 5 Findings

### 5.1 Tin(II) chloride

The occupational exposure limit (OEL) as specified in TRGS 900 (Technical Rules for Hazardous Materials) lies currently at 8 mg/m³. The occupational exposure limit (OEL) refers to the contents of elemental tin. There is no excess exposure factor.

The measured workplace concentration lies at 0,001 mg/m³. Based on available information, this measurement result can be seen as representative for the complete working shift duration and is so low that the limit concentration for the examined parameter (tin(II) chloride) can be assumed as permanently safely complied with as long as the operation conditions will not change.

### 5.2 Thiourea

Concerning thiourea, there exists a well-founded suspicion in regard of its carcinogenic potential. Correspondingly, no occupational exposure limit (OEL) has been defined.

For evaluation, the DNEL value (Derived No-Effect Level) can be employed. The DNEL value lies at 0.2 mg/m³. The occupational exposure limit valid in Finland and Latvia, 0,5 mg/m³, can also be used for comparison.

The measured workplace concentration lies below the determination limit of 0,0003 mg/m³. Based on available information, this measurement result can be seen as representative for the complete working shift duration and is so low that the DNEL value for the examined parameter (thiourea) can be assumed as permanently safely complied with as long as the operation conditions will not change.

Appropriate technical or personal safety measures must be scrupulously observed.

K.-D. Willaschek-Jühne

- Certified Chemist -

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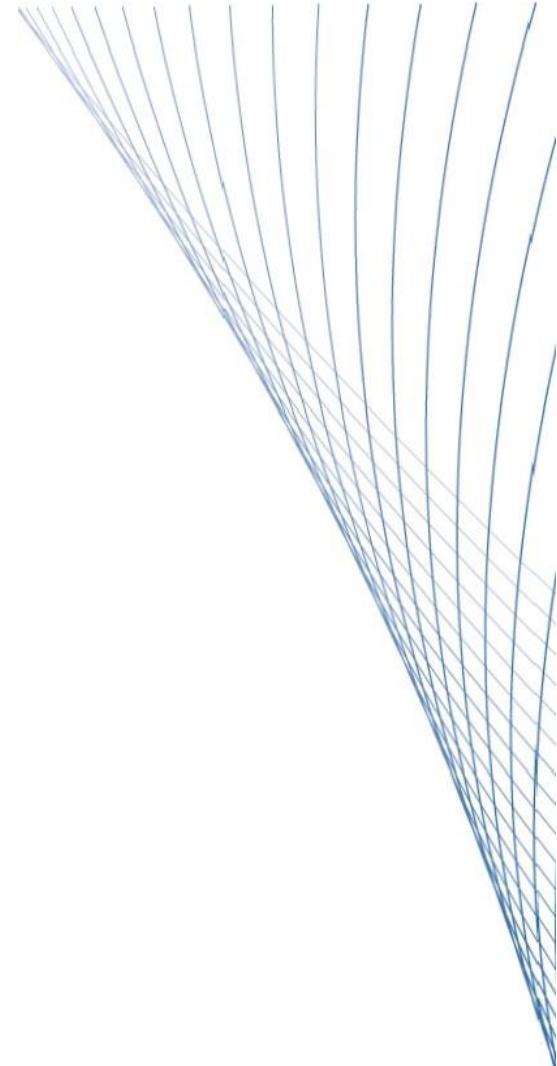
## 6 Sampling protocols

Sample No.	2160063/1
Examined parameter	Thiourea
Sampling device	Sampling pump, SG 4000, GSA // GGP
Collecting medium	Glass fibre filter MN 85/90 BF, binder free, diameter 37 mm
Sampling location	RP Development Lab, workplace LPKF Contac S4
Date	23.02.2016
Start of sampling	10.44 a.m.
Sampling duration	200 min
Intake rate	3.5 L/min
Sample air volume	700 L (related to 20°C and 1013 hPa)
Sampling conditions	simulated production conditions

Sample No.	2160063/2
Examined parameter	Tin(II) chloride as elemental tin
Sampling device	Sampling pump, SG 4000, GSA // GGP
Collecting medium	Cellulose ester membrane filter (Metrcel GN-4), Pw 0,8 µm, diameter 37 mm
Sampling location	RP Development Lab, workplace LPKF Contac S4
Date	23.02.2016
Start of sampling	10.44 a.m.
Sampling duration	210 min
Intake rate	3.5 L/min
Sample air volume	735 L (related to 20°C and 1013 hPa)
Sampling conditions	simulated production conditions

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LPKF Laser & Electronics AG  
Osteriede 7  
30827 Garbsen  
Deutschland

Telefon +49 5131 7095-0  
Telefax +49 5131 7095-90

[www.lpkf.com](http://www.lpkf.com)