



# Laser & Electronics

Manual      MiniContac III

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English, version 4.0

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Part number 112506

## Information on this manual

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It is the duty of the system owner to care for and plan these measures as well as to control their execution. The owner especially has to ensure that

- **the system is only used as directed**
- **the system is only operated in perfect and functional condition. Especially the function of the safety appliances has to be checked regularly**
- **the necessary personal protective equipment for the operating, maintaining and repairing personnel is available and being used**
- **the operating manual is kept legible and complete at the place of operation**
- **this personnel is regularly instructed in matters of work safety and environmental protection and is informed on the operation manual and especially the safety instructions**
- **all safety and warning notes or signs stay on the system and are legible**

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## I. Orientation

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This manual is divided into the following chapters:

1. Introduction
2. Products supplied
3. Safety regulations
4. Description of the machine
5. The Operating
6. Setting up
7. Description of operating procedure
8. Maintenance and servicing
9. Waste disposal
10. Appendix

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## II. Conventions used in this manual

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**Bold text** is used to emphasise important information.

**Illustrations** are numbered. Example: Fig. 5

- › Prompts for actions are identified with an arrow.

*Italic sections* are used to indicate the reactions consequent on an action.

*Words printed in italics* mark proper names

Key inscriptions and menu terms are printed in **BOLD CAPITALS**.

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## III. Notes on the symbols used

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**Danger!** This symbol is used to highlight danger to life or health.



**Caution!** This symbol is used to identify hazards which may cause damage.



**Note:** This symbol is used for notes intended to help you avoid faults in operation or to help you improve your procedures.

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## IV. Target Group

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This manual is written for people with basic knowledge in PCB production, **including the production of multilayer PCBs** for electronics

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## 1.0 Introduction

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Dear Customer

May we congratulate you on your choice of the LPKF *MiniContac III* system for through-hole plating in the laboratory.

This is the simplest system for galvanic through-hole plating to use in terms of the number of baths and production steps that we know of on the market. The process requires no specialist knowledge of chemistry or galvanizing, as the programs that can be selected already contain the optimized process settings.

Nevertheless, as with all galvanizing systems, the instructions in the operating manual must be followed carefully, otherwise there is a significant danger of a bath being damaged to such an extent that it can no longer be used.



**In particular we would like to draw on our experience and bring to your attention the following possible errors:**



- **! MAKE SURE THAT THE AMBIENT TEMPERATURE DURING THE OPERATION IS BETWEEN 18° - 25°C / 64,4° - 77° F (OVERNIGHT, FOR EXAMPLE) !**
- **Pay particular attention to careful rinsing. It is absolutely important that no chemical liquids get from one bath into the other. You must also rinse the circuit board holder carefully after use.**
- **Do not use steel wool or similar to clean circuit boards. Even the tiniest particle of metal is enough to destroy a bath.**
- **Always keep the baths covered, in other words, keep them as clean as humanly possible. This will ensure them a long lifetime.**
- **Ensure that drillings are technically perfect. Please observe the drilling parameters.**
- **Ammonia and chlorine vapours must not be allowed to escape into the room.**
- **An air extraction system can be installed over the machine but there must be no draft created over the baths.**
- **A ventilation system must not be installed over the baths.**
- **We recommend that you receive a basic training from our subject expert. This will provide you with tips and expertise for your entire circuit board production process.**

We are certain that by following these notes and the instructions that follow you will achieve reliable through-hole plating and will be satisfied with the LPKF *MiniContac III* system in all respects.



## 2.0 Products supplied

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The following are supplied with the LPKF *MiniContac III* in addition to the machine itself:

- 2 x Phosphorised copper anodes
- 2 x holders (1 with electric connection, 1 without electric connection)
- covers for the containers
- measuring cylinder
- spray bottle
- wiping spatula
- this manual

### **Not included in the materials supplied:**

- Distilled /Demineralized water (approx 10 l have to be made available)
- Container for disposing of spent chemicals
- Basin for rinsing the circuit boards

## 2.1 Accessories (to be supplied separately)

The chemicals for through-plating are not included but can be ordered separately from LPKF. The stated amount is sufficient for approx. one year of normal throughput.

- 24 l *CLEANER 110*
- 20 l *CLEANER 210*
- 5 l *ACTIVATOR 310*
- 12 l *COPPER PLATER 400*
- 0,25 l *SHINE 400*

Due to the board surfaces processed (see „Through-hole Plating Record“ on page 41) and also due to loss caused by evaporation and spreading it is necessary to fill up the corresponding chemicals after a certain amount of time. The chemicals refill-set designed for this can be supplied separately. Please contact the LPKF AG support department.



**Note: Store the containers with the delivered chemicals for filling them with the corresponding used chemicals.**



**Note: The shelf life of the chemicals is 15 months starting from the date of delivery.**

## 3.0 Safety Regulations

The user must have read this manual, paying particular attention to the safety instructions printed in bold, to ensure safe working with this system.



- **Always wear safety glasses during work!**
- **Never reach into the machine when it is running.**
- **Avoid all contact with the fluids. (If the fluids have contact with the skin or even the eye, immediately rinse thoroughly with water and contact a doctor.)**
- **Never prepare or eat food while operating the machine.**
- **Wash your hands after operating the machine.**
- **Wear suitable protective clothing when filling or draining the machine. (safety glasses and gloves)**
- **Never drink the fluids.**
- **Do not allow any of the fluids to escape when working on the machine.**
- **Always ensure that there is sufficient fluid in the first container (*CLEANER 110*) to prevent the heater system running dry. Risk of fire.**
- **Modifications carried out on the machine by you may jeopardize the safety of the machine and are not covered by the terms of the warranty.**
- **Please note that some materials can produce toxic gasses during processing. Obtain information on this from your materials supplier.**
- **Always work in rooms with ventilation or air extraction. (operation with opened windows). A danger of air pollution caused by operating a Contac-III system could not be established by internal measurements.**
- **Exchange of air 7 times if possible**
- **Please follow the instructions given on the containers and/or separate safety leaflets when using chemicals.**
- **Only use chemicals for the purposes for which they are intended.**
- **Keep your workplace clear.**
- **Observe safety instructions.**

## 4.0 Description of the Machine

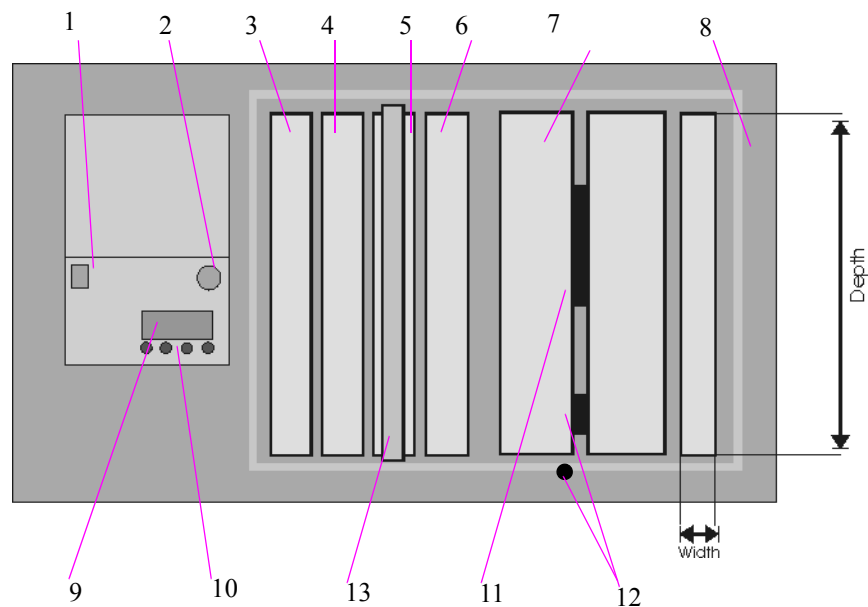
The machine consists of a stable plastic casing and a metal case with working containers for the baths and their associated motion mechanism, the operating unit, the control unit and the circuit board holders.

The operating unit containing the main switch and the control unit is located on the left-hand side (see fig. 4.5 on page 19).

The water inflow and outflow ports are mounted on the left side.

The dimensions of the machine are: approx. 870 mm x 640 mm x 570 mm (W x H x D).

Fig. 1: MiniContac III (seen from the top)



- |                            |   |
|----------------------------|---|
| 1- Power switch            | 8- Container 6 (Sprinkler + drier)                |
| 2- Emergency stop          | 9- Display  |
| 3- Container 1             | 10- Operating buttons                             |
| 4- Container 2 (Sprinkler) | 11- Material holder with electrical connection    |
| 5- Container 3             | 12- Cathode connections                           |
| 6- Container 4             | 13- Material holder without electrical connection |
| 7- Container 5             |   |



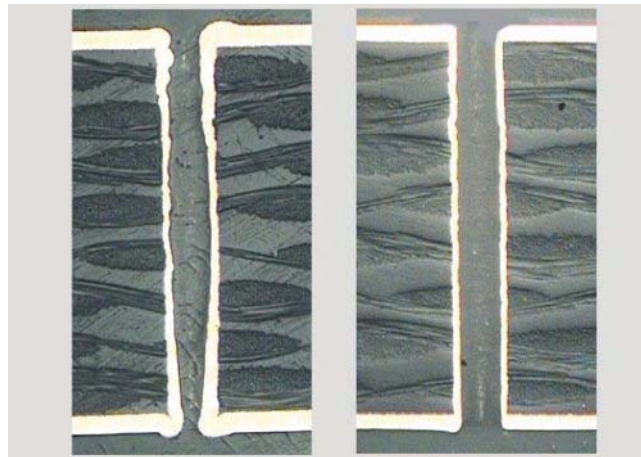
**Caution! Use the material holder with the electrical connection only for the container with *COPPER PLATER*.**

## 4.1 Reverse Pulse Plating

The Reverse Pulse Plating is realized by means of a special LPKF control electronics which monitors the complete through-plating process.

During the standard galvanisation, more material is deposited at the corners of bore holes than within the holes, which is due to the distribution of the flux lines. This formation of a bulge at the edges is called „bone effect“ and occurs especially at a high aspect ratio (see left photo in fig. 2, „Bone effect,“ on page 13).

Fig. 2:Bone effect



During Reverse Pulse Plating the workpiece is shortly anodically poled by applying a reverse pulse. This causes a part of the material to be removed again at the bulges so that generally the copper deposition becomes more constant and the aspect ratio is improved (see right part in fig. 2 on page 13).

Fig. 3:Standard galvanisation

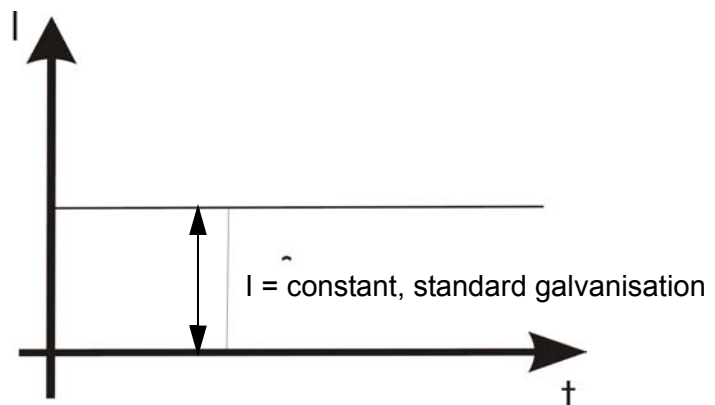
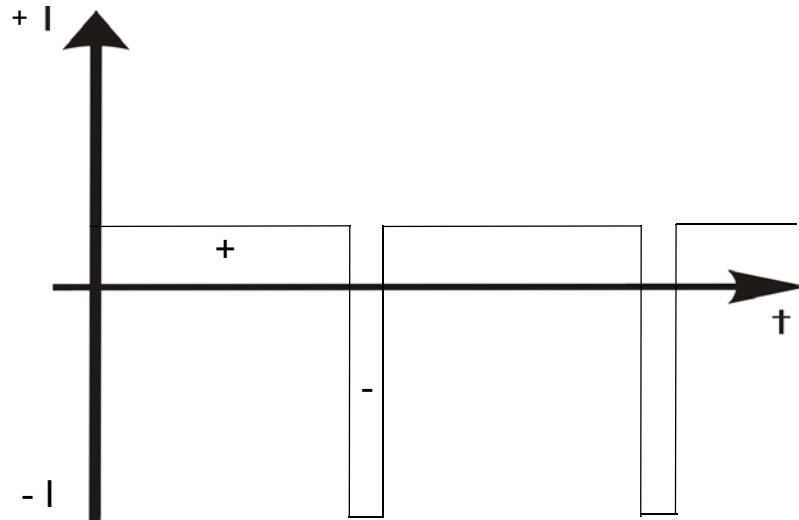


Fig. 4: Galvanisation with reverse pulse plating



## 4.2 Technical surroundings description

For operating the system you will need a freshwater inflow and a sewage effluent. The power supply has to be connected with a fault-current circuit breaker (2V). The user has to provide these connections.

Since water splashes cannot be completely avoided around the system, it is advisable to operate it in surroundings insensitive to water.

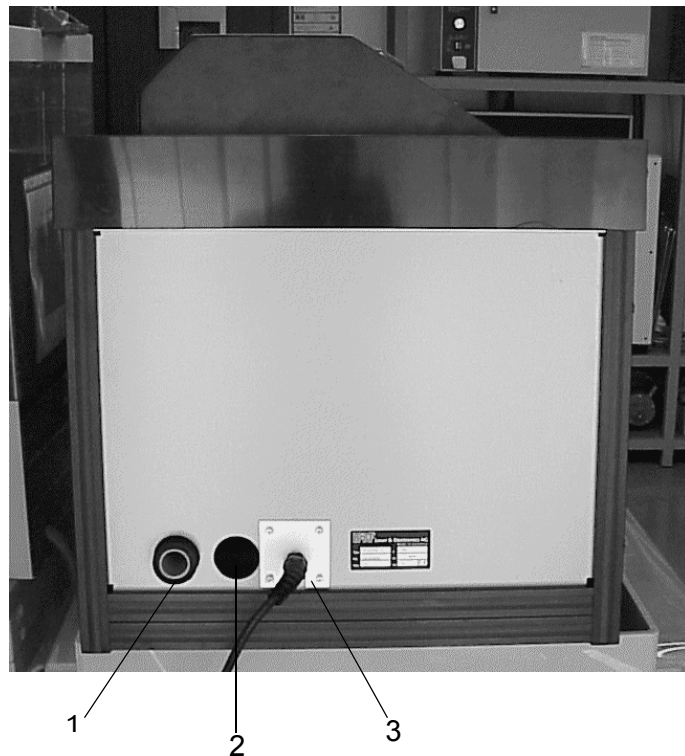
The connections for water inflow and outflow as well as the power supply are on the left side of the systems. You can see the exact location and the connection measures in the drawing (fig. 5 on page 15).

For water supply the system is connected with a water pressure hose (approx. 2 m long, connection thread 3/4 inch, within scope of delivery) to the existing shut-off tap. The maximum permissible water pressure is 3 bar.

The connection of the water wastepipe is done using the DN 40 connection on the left side of the system.

The power supply is connected via an approx. 2 m long 230 V lead.

Fig. 5: MiniContac III



- 1- sewage
- 2- freshwater
- 3- power supply

Water enters by a  $\frac{3}{4}$ " hose and leaves by a DN-40 connection. The drain valves have connection adapters for M" and  $\frac{1}{2}$ " PVC hoses.

### 4.3 Electrical Connections

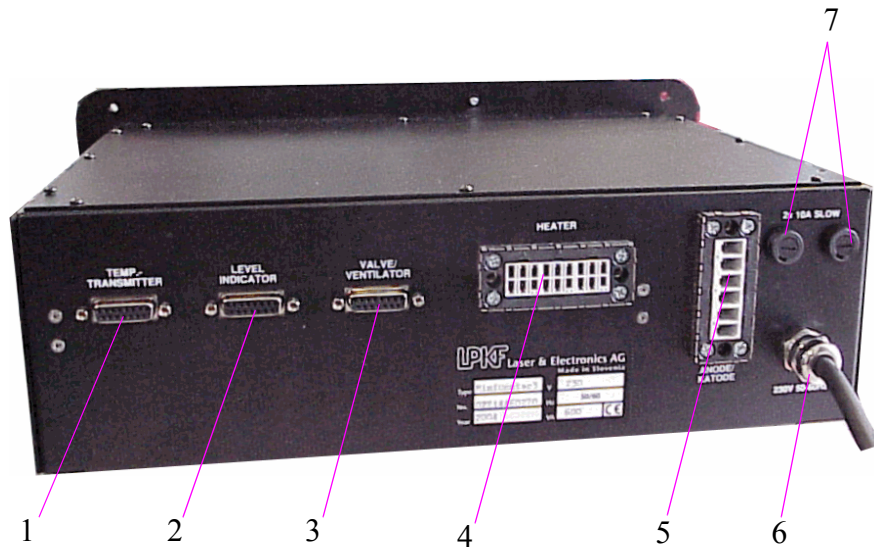
The machine can be run on 230 V / 50-60 Hz / 600 VA.

Switching the operating voltage to 115 V/50-60 Hz/1500 VA must be done **at the manufacturer's site**.

Power is supplied via a power cord with shrouded contacts.

The anodes in container 5 are permanently connected to the rectifier fitted in the control unit via a contact rail while the circuit board holder (circuit board = the cathode) is connected to the cathode connection on the operating unit via the cathode cable.

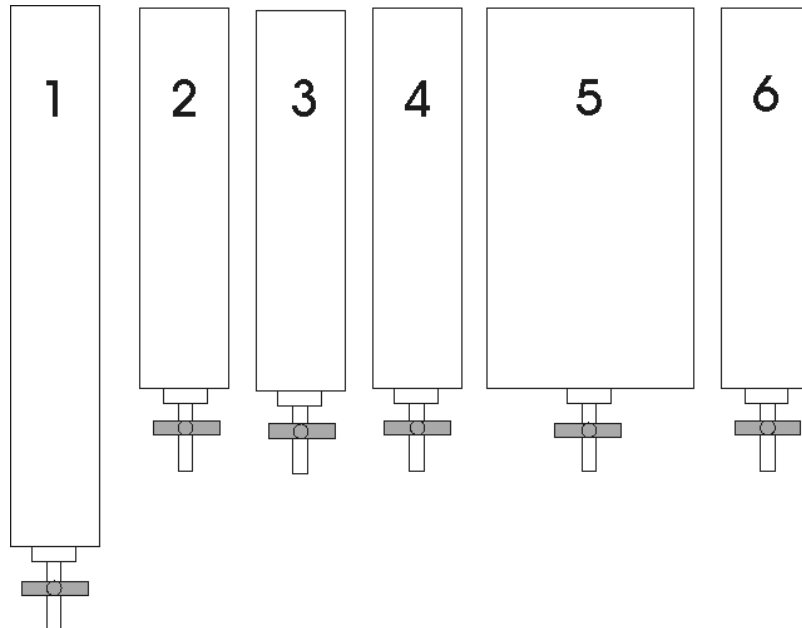
Fig. 6: Electronic



- |                       |                     |
|-----------------------|---------------------|
| 1- Temp. Transmitter  | 5- Anode / cathode  |
| 2- Level Indicator    | 6-230 V 50Hz - 60Hz |
| 3- Valve / Ventilator | 7-2 x 10 A Slow     |
| 4- Heater             |                     |

#### 4.4 Description of the individual containers

Fig. 7: schematic view



- |                   |                           |
|-------------------|---------------------------|
| 1- CLEANER 110    | 4- ACTIVATOR 310          |
| 2- Sprinkler bath | 5- COPPER PLATER 400      |
| 3- CLEANER 210    | 6- Sprinkler bath + drier |



## Container 1

---

### Degreasing and drilling preparation

Solution:	<b>CLEANER 110</b>
Dimensions:	approximately 55 mm x 290 mm x 365 mm (W x H x D)
Volume of reagent:	approximately 5.5 litres
Heating:	approximately 55 °C
Frame motion:	Lift approximately 15 mm
Drainage:	via the outlet valve
Container cover:	yes

## Container 2

---

### Sprinkler rinsing

Dimensions:	approximately 55 mm x 240 mm x 365 mm (W x H x D)
Drainage:	into the drain
Container cover:	yes

Two sprinkler bars in the shape of drilled tubes are fitted on the right and left at the upper edge for rinsing the circuit board.

## Container 3

---

### Preparation

Solution:	<b>CLEANER 210</b>
Dimensions:	approximately 55 mm x 240 mm x 365 mm (W x H x D)
Volume of reagent:	approximately 4.4 litres
Heating:	none
Frame motion:	Lift approximately 15 mm
Drainage:	via the outlet valve
Container cover:	yes

## Container 4

---

### Activation

Solution:	<b>ACTIVATOR 310</b>
Dimensions:	approximately 55 mm x 240 mm x 365 mm (W x H x D)
Volume of reagent:	approximately 4.4 litres
Heating:	no
Frame motion:	Lift approximately 15 mm
Drainage:	via the outlet valve
Container cover:	yes

## Container 5

---

### Copper plating

Solution:	<b>COPPER PLATER 400</b>
Dimensions:	approximately 150 mm x 240 mm x 365 mm (W x H x D)
Volume of reagent:	approximately 11.7 litres
Heating:	none
Frame motion:	Lift approximately 15 mm
Drainage:	via the outlet valve
Container cover:	yes

Two copper rails are fitted in the container to hold the 2 phosphatized copper anodes.

## Container 6

---

### Sprinkler rinsing + drier

Dimensions:	approximately 55 mm x 240 mm x 365 mm (W x H x D)
Drainage:	into the drain
Container cover:	yes

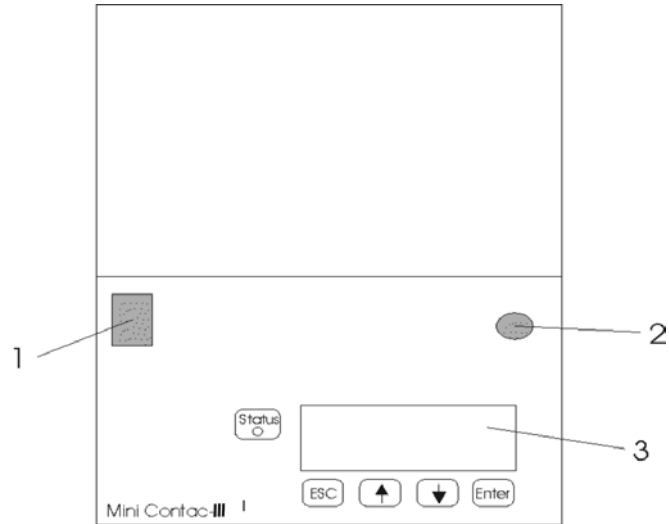
Two sprinkler bars in the shape of drilled tubes are fitted on the right and left at the upper edge for rinsing the circuit board.



**Note: The maximum filling height is marked by a triangular sign in each container.**

## 4.5 The Operating panel

Fig. 8: Main switch





- 1- Main switch
- 2- Emergency Stop
- 3- Display

The following display appears in the indicator when the unit is switched on:

**LPKF AG**  
**MiniContac III**  
**Version 6.1**  
**state: heating up**

*The unit is now in the heating position.*

The following functions can then be carried out with the keys on the press control system:

- |   |  |
|---|--|
| <b>ESC:</b>   | Change-over to the modification mode                         |
|  | Not yet functional   |
|  | Not yet functional   |
| <b>ENTER:</b>   | Change-over to the program selection mode (after heating up) |

## 5.0 The Operating

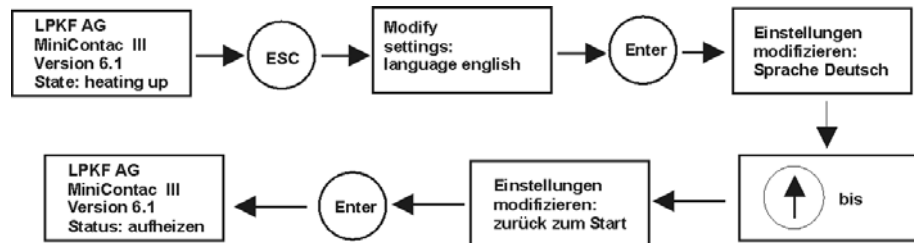
- › Switch on the machine by turning and pulling the emergency stop and pressing the main switch.



*The operating menu of the control system is started.*

The version number of the software currently installed in the control unit appears in the first display.

The software language at the point of delivery is English. You can switch to the German language in the modification menu ( fig. 11 on page 24) at any time (see the following figure).

Fig. 9:





Use the  or  buttons to navigate through the menu items, the **ENTER** button to select a menu item, and the **ESC** button to deselect a menu item and to go up one level.

Use **ENTER** to call up the start menu.

### 5.1 Program selection mode

After the heating phase:

Using the keys  and  you can choose between the following programs:

- Through-plating
- RPP copper plating (see „Reverse Pulse Plating“ on page 13)

- › The selected program is started using the **ENTER** key.

*Then the copper-plating process is started ( see fig. 10 on page 22).*

The modification menu is started using the **ESC** key (see „The Modification menu“ on page 23).

## 5.2 The Process menu

---

The process menu is a pictorial display of the software. It automatically guides the user through the process. There are only a few settings necessary. These settings depend on the circuit board to be processed.

The copper-plating process can be interrupted by pressing the **ESC**-key (see fig. 10 on page 22 in the process menu).

The complete process menu is represented in fig. 10 on page 22.



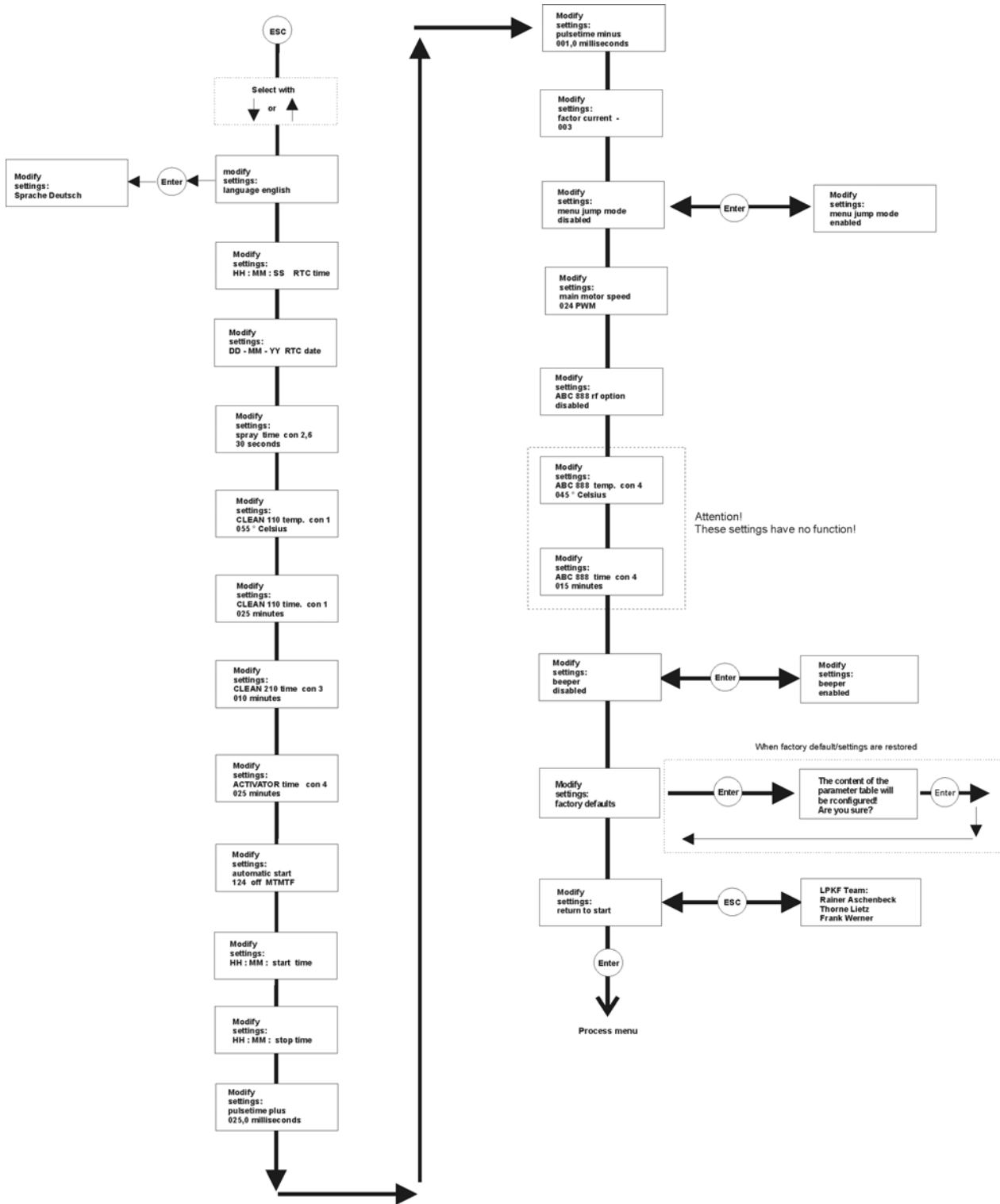
### **5.3 The Modification menu**

---

The modification menu can be used to adjust the parameters for the copper-plating process so that the process can be optimized for each individual plating process.

The complete modification menu is represented in fig. 11 on page 24.

Fig. 11: Modification menu FR 4

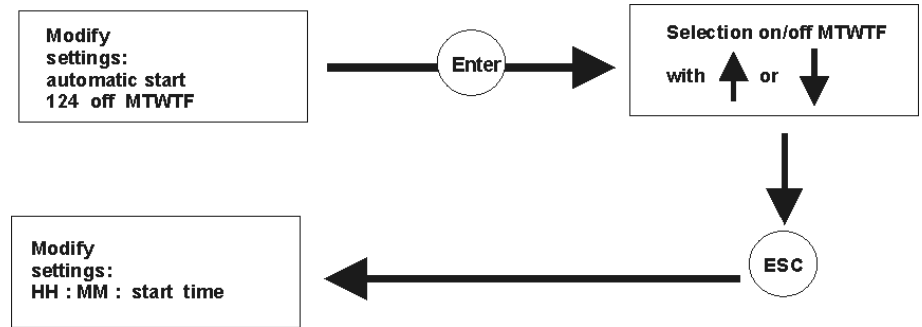




### 5.3.1 Autostart Mode

In order to increase the usable time of the system, the automatic start mode can be switched on and individually adjusted in the modification menu (see following figure).

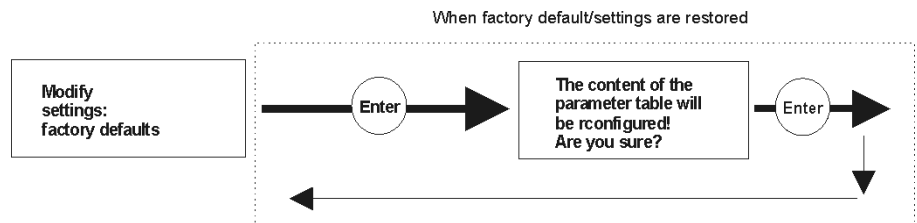
Fig. 12: Autostart Mode



### 5.3.2 Factory or Default Settings

Having made any changes in the modification menu, you can set the system back to defined factory settings at any time (see following figure).

Fig. 13: Factory setting



## 6.0 Setting Up



**Caution! Always make sure that the first bath is sufficiently topped up. Top up with demineralized water if necessary.**

- › Clean any impurities from the copper anodes completely using acetone, then scrub the anodes using scouring powder and water until they are bright and rinse off thoroughly so that no residue is left on the anodes.
- › Hang the anodes into container 5 by means of titanium hooks

**The containers have already been cleaned and rinsed before delivery.** You can immediately pour in the through-hole plating chemicals.

The maximum filling height is marked with a triangular mark in each container.

- *CLEANER 110* in Container 1
- *CLEANER 210* in Container 3
- *ACTIVATOR 310* in Container 4
- *COPPER PLATER 400* in Container 5



**Caution! For the *COPPER PLATER 400* you have to add 2 ml of *SHINE 400* (use the enclosed measuring cup) per liter of bath volume (do this only shortly before putting the bath into operation).**

**Container 4 of the *ACTIVATOR* has to be absolutely dry before filling and should be the last one to be filled.**



**Caution! The filling level depends on the container 5. The chemicals have to be filled in up to a level of approx. 5 mm below the copper bars. The other containers have to be filled to the same level (see triangular marking).**

- › When all baths are filled, you must run a complete procedure with a test board. Then the baths are ready for operation.
- › The chemicals must have been in the *MiniContac III* container for a minimum of 24 hours before commencing through-hole plating.



**Caution! It is imperative that you observe instructions in the safety data sheets for *CLEANER 110*, *CLEANER 210*, *ACTIVATOR 310*, *COPPER PLATER 400* and *SHINE 400*! These must be fixed to the machine so that they are clearly visible.**



**Caution! Use the material holder with the electrical connection only for the container no.5.**

## 7.0 Description of Operating Procedure

Circuit boards must only be drilled with hard-metal drills suitable for drilling board material. They should fall within the drilling parameters which you can obtain from the machine manuals or the tool libraries in *BoardMaster*.

Ideally you should use FR4 with a 5 µm or 9 µm copper coating. This material only needs rinsing to clean the drillings as it is protected by a copper film.

You will need to deburr the circuit board after drilling and brush or scrub the surface with, for example, artificial fleece (not with steel wool) if you are using a board material without a protective film, for example 18/18µm FR4. Rinse the circuit board thoroughly with water, paying particular attention to the drillings.



**Caution! Never blast clean with oil-containing compressed air. Any oil residues could destroy the chemicals or have a negative influence on the quality of the through plating.**



**Caution! Use the material holder with the electrical connection only for the container no.5.**

### 7.1 Through-plating

- › Fix the circuit board in the circuit board holder, then rinse it in **container 2** (spray rinsing). Start the spraying process by pressing **ENTER**.
- › Clamp the circuit board in the holder and send the circuit board into **Container 1** (*CLEANER 110*). The frame motion is switched on by pressing **ENTER** in the programm menu and the holding time is shown beneath this.



**Caution! The circuit board must be rinsed off quickly after it is taken out of the *CLEANER 110* bath to ensure that the degreasing chemicals do not become dry. To do this, move the circuit board up and down during the spraying time.**



**Caution! Please make sure to rinse the board holder, too, to prevent the transfer of chemicals.**

- › Rinse off the circuit board thoroughly in **Container 2** (sprinkler rinsing). Press **ENTER** to start up the sprinkler system.
- › Once the circuit board has been thoroughly rinsed, send it to **Container 3** (*CLEANER 210*) (temperature = approx. 20°C).
- › Then restart by pressing **ENTER**.

- › After a dwell time of approx. 10 minutes, rinse the board in **Container 2**. Now take the board out and intensively spray it completely from both sides including the drill holes using the enclosed spray bottle with demineralized water. This will rinse off harmful tap water components.
- › Now blow off the board with oil-free compressed air. This is to prevent water remaining in the drill holes.

Afterwards dry the board completely with warm air.



**Caution: Do not allow water to get into the *ACTIVATOR* !**



**Note: Stir the *ACTIVATOR* with a glass fibre stick before you put the circuit board into the bath. When the filling level is too low only fill up with *ACTIVATOR 310***

- › Afterwards put into the **Container 4 (*ACTIVATOR 310*)**. Holding time 15-30 minutes, (temperature 20 °C +/- 5° )
- › Then restart by pressing **ENTER**.

The circuit boards need to be moved to rinse out and wet the walls of the drill holes.

*The menu prompts you to dry the circuit board when the holding time expires.*

- › Take out the board.
- › Wipe the ***ACTIVATOR*** off the surface of both sides with the wiping spatula so that the remaining liquid will drop back into **Container 4** (see fig. 14 on page 28).

Fig. 14:



- › Let the circuit board **dry thoroughly on both sides** (e.g. use a hair dryer - temperature < 55°C - or wait for a correspondingly long period of time) and remove excessive activator by carefully tapping the board on a soft support material.

The *ACTIVATOR* can also be dried in the drying cabinet at 55°C (**Caution: Remove the circuit board holder in advance**).



**Make sure that the drillings are free from chemical residues.**

**Caution! Never blast clean with oil-containing compressed air. Any oil residues could destroy the chemicals.**

- › Remove the copper film if you are using FR4 material with copper film.



**Note: When you use base material without a protective film, then pat dry using a fibre-free damp cloth very carefully so as not to wipe the *ACTIVATOR* out of the drillings.**

- › Now set the current level for the copper plating in the configuration menu.


### Modifying settings for time and current

Fig. 15:

Parameter for copper-plating xx.x Ampere (current) xxx Minutes (time)
--

- › Press the **ENTER** key.

*The cursor will go to the number to be changed.*

With the keys  and  you can change the time.

- › Press the **ENTER** key again.

Repeat the process.



**Attention: Please note that you must calculate only the area of the circuit board which is being immersed in the *COPPER PLATER 400* bath.**

**The current level is calculated as follows:**

**Example:**

Surface covered with *COPPER PLATER* :

e.g. 200 mm x 300 mm = 60,000 mm<sup>2</sup> = 600 cm<sup>2</sup> = 6 dm<sup>2</sup>

Surface area = front side plus reverse side =

600 cm<sup>2</sup> x 2 = 1,200 cm<sup>2</sup> = 12 dm<sup>2</sup>

12,0 dm<sup>2</sup> -10% (bis -20%) = 9,6 A - 10,8 A

Current to be set = 10 A



**Note: We recommend to reduce the current by 10-20 % so that the surface of the copper layer becomes more even. To increase the brightness of the deposited copper layer we recommend to increase the current by 30-70% of the calculated value.**

- › Now fix the circuit board in the circuit board holder with electrical connection.
- › The circuit board holder must be connected to the cathode cable (negative) before sending the circuit board to **Container 5**.
- › Only now can you immerse the circuit board immediately into **Container 5** (*COPPER PLATER 400*). Start then by pressing **ENTER**.



**Note: The control unit will display an error if a circuit board has not been immersed in the bath because there will be no current flowing. The *MiniContac III* will be reset to start menu.**



**Note: The circuit board should be removed after 20 minutes and checked to see that all the drillings have been copper plated.**

- › Press **ESC** to interrupt the power supply
- › Press **ESC** again after you have checked the circuit board and put it back in the container. Always keep the cathode cable connected to the holder when doing this. Leave board in the bath for a further 60-90 minutes of plating.

The rules of electrochemistry lead to a fluctuating coating thickness of the separated copper layer. Should you require a lower fluctuation, you can press **ESC** after half the set time which will interrupt the electroplating. Now take the board with the holder out of the bath, turn it upside down and place it into the bath again (wear safety goggles and gloves!). Press **ESC** again and the coating will continue.



**Note: When the filling level is too low, do only refill with *COPPER PLATER 400*, with strong evaporation correct filling level with distilled water.**

Copper will be deposited at a rate of approximately 0.2-0.3 µm per minute depending on the temperature of the bath, the current level, the size of the circuit board and the quality of the chemicals used. Thus approximately 12-18 µm of copper will form in sixty minutes.





**Caution: Please note that the values given for the potential copper thickness are the approximate values that can be deposited using a machine such as the LPKF *MiniContac III* under laboratory conditions.**

You will have to through-hole plate several test circuit boards and use micrographs to determine the actual wall thickness if you need to obtain precise data on the thickness of copper deposited in the drillings. You can begin through-hole plating the circuit boards themselves once you have determined the parameters for the wall thickness you require. We recommend that you use the parameters specified by us to obtain satisfactory through-hole plating.

The galvanisation process can be repeated as often as you choose, and the type of galvanisation (standard or RPP) can be freely selected before each process.

At the end of the galvanisation you are asked **Repeat galvanisation? Yes/No, continue**

› Use the keys  and  to select the desired answer and confirm with **ENTER**.

If you want to repeat galvanisation, the copper plating parameters are again on display.

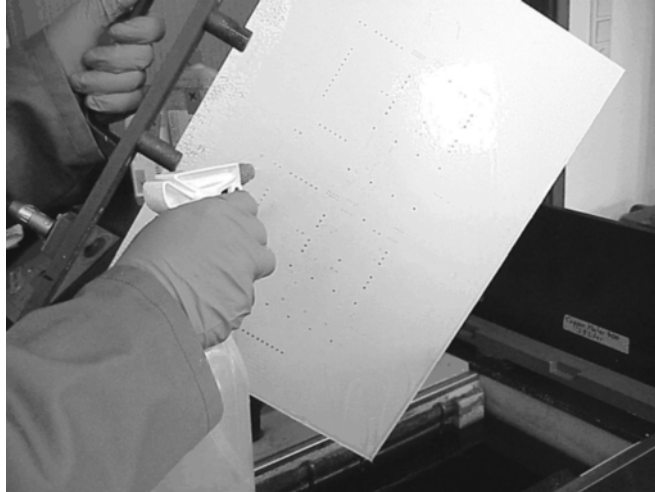
In order to finish the process, proceed as follows.

› Take the circuit board with its holder out of bath 6. Always allow the circuit board to drip off completely over the bath.



**Note: By letting the circuit board drip off over bath 5 (COPPER PLATER 400) you can save chemicals and at the same time act environmentally friendly.**

Fig. 16: Spraying the board



- › Use the supplied spray bottle to spray the circuit board on both sides over bath 5 with distilled or demineralized water (see fig. 16 on page 32).
- › Let this water run back into the *COPPER PLATER 400* bath, as it then compensates for any loss due to spreading of chemicals.
- › Through-hole plating is terminated using **ENTER** and the sprinkler system in **Container 6** is started up.



**Note: The sprinkler system always runs for 30 seconds. It cannot be shut off until this time has elapsed (see „Prolonging of Spray Time“ on page 33).**

- › Move the circuit board up and down in the sprinkler system (**Container 6**) approximately ten times, or rinse the circuit board at least until the flow of water stops.
- › At the end of the spray time dry the board, if possible in warm air. This should be carried out as quickly as possible to prevent oxydation of the copper in the drillings.

The copper plating is now finished.

- › Then press **ENTER**.  
*You are again at the start of the process menu.*

The water used for rinsing is neutral to slightly alkaline and can be disposed of via the normal sewerage system (see „Inspection Report“ on page 44).



**Note: The quality of the surface finish on the circuit board may be poor and the life of the chemicals will be reduced if too high a current is used.**



### 7.1.1 Prolonging of Spray Time

In case the waste water should be more diluted to achieve lower concentrations of the agent than stated in the "Inspection Report 1" on page 42, you can prolong the spray time.

- › To do this, choose the modification menu and there the menu item **Modify settings, spray time**.



- › Press the **ENTER** key.

Use the  and  key to select the time.



Values from 5 to 60 seconds can be selected. Choose 60 seconds to double the spray time.



**Danger! Do not choose values below the preselected spray time of 30 seconds as the operator may then come in contact with any acid residue on the board. Moreover, due to the danger of water pollution the waste water may then no longer be disposed of in the sewerage.**

### 7.2 Copper plating / RPP copper plating

In the galvanisation menu you can choose between standard copper plating or RPP (reverse pulse plating) copper plating. During standard galvanisation the display shows **COPPER PLATING (+)**, during Reverse Pulse Plating the display shows **COPPER PLATING (+, -)**.

Use the keys  and  to choose the required type of galvanisation.

For RPP, the duration of the pulse in positive and negative direction as well as the factor for current can be set in the modification menu. The current factor can be chosen to be between 1 and 4, default setting is 3. The default settings have proven to give the best through-plating results.

The last value chosen for current remains active, so that it may be necessary to change the current, depending on the size of the circuit board.

## 8.0 Maintenance and Servicing

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### Machine

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The machine itself is maintenance-free.

It is important that you cover up the baths immediately work is completed to prevent contamination.

The machine must be carefully cleaned from time to time and must be kept clean.



**Note: The shelf life of the chemicals is 15 months starting from the date of delivery.**

### Baths

---



**Caution: After each use, the pouring spout must be rinsed with water and demineralised water and then dried.**

Container 1    **Degreasing**    Product: **CLEANER 110**

Cover the container during breaks in working.  
Fluid lost through evaporation can be replaced with distilled or demineralized water. (Change the chemicals after 3 months).



**Note: Avoid unnecessary heating, this will affect the chemical life.**

Container 2 + 6    **Sprinkler rinsing**

Clean limescale deposits from the nozzles at regular intervals.

Container 3    **Preparation**    Product: **CLEANER 210**

Cover the container during breaks in working.  
Fluid lost through evaporation can be replaced with distilled or demineralized water.  
(Change the chemicals after 3 months).

Container 4    **Activation**    Product: **ACTIVATOR 310**

Cover the container during breaks in working.  
The bath is very sensitive and requires careful working procedures.

The tiniest amount of contamination, such as drops of *CLEANER 110*, *CLEANER 210*, *COPPER PLATER 400*, ferrous metal chips, or similar, will eventually cause the bath to fail. It is irrelevant whether the bath is used or not.

The contents of the bath should be thoroughly mixed once a week if the bath is not being used.

Please only put completely dry circuit boards into the *ACTIVATOR* bath. Other liquids like water are not allowed to get into the bath. So please blow off the PCB with oil-free compressed air to guarantee it being free from oil and water. Afterwards dry with warm air (dryer) < 55°C.



**Note: Filling only with ACTIVATOR.**

After taking the PCB out of the *ACTIVATOR* bath, the surplus *ACTIVATOR* liquid has to be wiped off the surface into the bath with the scraper.

Afterwards the drill holes are dried and blown free which is followed by visual control.

Place the circuit board for 20 minutes in a drying cupboard < 55°C before you put it into the *COPPER PLATER* bath.



**Note: After work breaks (longer than one day) thoroughly stir the bath with a glass fibre stick or similar for 2-3 minutes.**

Fluid lost can be topped up with *ACTIVATOR 310*.



**Caution! Do never add water to the *ACTIVATOR* bath otherwise the through-hole plating will be out of order.**

**The bath must be made up anew after a maximum of one year. Make sure that the dispersion is thoroughly mixed when doing this (shake the closed original canister).**



**Caution! Chemicals which have splashed onto the machine should be removed with soft cloths, not with abrasive materials. Otherwise the machine's plastic surface will be roughened, making it harder still to remove the chemicals.**

Container 5    **Copper plating**    Product:    **COPPER  
PLATER 400**

Cover the container during breaks in working.

Filter the chemicals from time to time (preferably using several coffee filter one inside the other).

Empty the bath into a canister to do this. If filtration is done regularly, it is sufficient to filter approx. 20% of the bath.

Do not rinse the black coating off the anodes as it important for their function.

However, you must make sure that particles of the black coating do not break loose and get into the bath.

Any such particles must be filtered out.

Fluid lost should be topped up with *COPPER PLATER 400*. If the ambient air is very dry, use 50% *COPPER PLATER 400* and 50% demineralised water.

If the *COPPER PLATER 400* bath is still working satisfactorily but the copper plate appears dull or coarsely crystalline, this can be corrected by the addition of *SHINE 400*.

The chemical admixture *SHINE 400* is used up in dependence on the throughput. Add 10 ml *SHINE 400* after the display message prompts you.



**Note: The service life of the bath is approximately one year. These figures are only approximate and may vary as the life expectancy is influenced by such factors as careful working procedures and local levels of air pollution. There can therefore be no warranty of the chemicals' function after a certain period.**



**Caution! The machine should be started up again by producing test circuit boards if the baths have been changed or *SHINE 400* has been added.**



**Note: The maximum filling height is marked with a triangular mark in each container.**



**Danger! A danger of air pollution caused by operating a *MiniContac-III* system could not be established by internal measurements, neither by measurements of external technical experts.**

## 9.0 Waste Disposal

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- Do not allow spilt chemicals to enter waterways or the sewerage system.
- The rinsing water generated by working processes can be disposed of via the sewerage system without concern (see the investigation report in the Appendix).
- Never empty chemicals into the drain. Instead drain them into the containers provided for disposal and dispose of them at an authorized chemical processing plant.
- The appropriate method of disposal (neutralization, hazardous waste disposal, chemical-physical treatment) can be found in the safety data sheets provided by the chemical manufacturer.
- You must always check and comply with local and regional regulations governing the on-site and off-site disposal of waste.
- Local and state regulations will always take precedence in the event of any conflict with our recommendations.

## 10.0 Appendix

### 10.1 Error codes and troubleshooting

#### List of errors

- binary value -

Error discription	7	6	5	4	3	2	1	0	Display value (decimal)
Filling level too low	0	0	0	0	0	0	0	1	001
Temp. sensor short circuited	0	0	0	0	0	0	1	0	002
Temp. sensor (open or out of range)	0	0	0	0	0	1	0	0	004
Frame motor supply short circuited	0	0	0	0	1	0	0	0	008
Galvanic voltage interrupted (open)	0	0	0	1	0	0	0	0	016
Galvanic current supply short circuited	0	0	1	0	0	0	0	0	032
Galvanic regulator minimum	0	1	0	0	0	0	0	0	064
Galvanic regulator maximum	1	0	0	0	0	0	0	0	128

There are all combinations of errors between 1 and 255 possible. For example if two errors are occuring together the sum of both errors will be displayed!

Example:

Filling level (1) + Frame motor (8) = Display shows (9)

### 10.2 Technical Data

The *MiniContac III* is a desktop system.

#### Approx. dimensions and connection values:

Width 870 mm  
 Depth 570 mm  
 Height 640 mm

Weight 60 kg

Voltage 230 V  
 Power 600 VA



**AMBIENT TEMPERATURE** 18°-25° C (64,4° F - 77° F)

Max. size of base material: 220 mm x 340 mm  
 Max. size of circuit board: 145 mm x 276 mm

### 10.3 Starting the production steps separately



**Note:** LPKF firmware software version 4.0 or higher required!

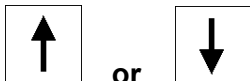


**Attention:** Only experienced users should apply the operating options described in the following. Use of these functions by newcomers will mostly lead to bad process results. If you apply the operating options described in the following, you do so at your own risk. Any liability is excluded.



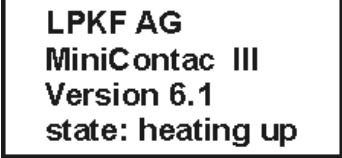
Production steps can only be started separately or be repeated when the jump mode is enabled in the modification menu.





**Attention:** To be able to start individual production steps separately, the indicated operating steps must be executed step by step according to the following table, in order to enable the jump mode and to be able to select the individual production steps by means of the keys



Key/Button	Display on screen
Power on	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>LPKF AG</b>  <b>MiniContac III</b>  <b>Version 6.1</b>  <b>state: heating up</b> </div>
ESC	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>Modify settings.</b>  <b>Language English</b> </div>
	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>Modify settings:</b>  <b>jump mode disabled</b> </div>
Enter	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>Modify settings:</b>  <b>jump mode enabled</b> </div>

Key/Button	Display on screen
	
Enter	
<p>The jump mode is then enabled and the process can be continued or individual production steps can be repeated.</p>	

Use key  to change to the previous menu window.

Use key  to change to the following menu window.

Change to the desired production step





## 10.5 Inspection Report 1

Seite 2/3  
vom 25.10.2004  
Prüfauftrags-Nr. 30514-P2C



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

### Prüfergebnisse

Probenkennzeichnung:	Spülwasser Mini- und Contac II / Mini- und Contac III /			
Labor-Nr.:	3 0514 / 1			
Aussehen:				
Farbe:	farblos			
Trübung:	ohne			
Bodensatz:	ohne			
Geruch:	schwach unspezifisch			
Probemenge:	ca. 750 ml			
PARAMETER	PRÜFVERFAHREN:	PRÜFDATUM:	EINHEIT:	PRÜFERGEBNIS:
pH - Wert	DIN 38404 / 5 a	25.04.03		8,1
Meßtemperatur		25.04.03	°C	14,7
elektrische Leitfähigkeit ber. auf 25 °C	DIN EN 27888 a	29.04.03	µS/cm	816
Chlorid	EN ISO 10304-1 a	10.03.03	mg/l	4,21
Sulfat	EN ISO 10304-1 a	10.03.03	mg/l	10,0
Chrom	EN ISO 11885 a	11.03.03	mg/l	< 0,02
Chrom VI	DIN 38405 / 24 a	11.03.03	mg/l	< 0,03
Kupfer	EN ISO 11885 a	28.04.03	mg/l	0,47
Nickel	EN ISO 11885 a	11.03.03	mg/l	< 0,04
Zink	EN ISO 11885 a	11.03.03	mg/l	0,086
Blei	EN ISO 11885 a	11.03.03	mg/l	< 0,1
Cadmium	EN ISO 11885 a	11.03.03	mg/l	< 0,01
Zinn	EN ISO 11885 a	13.03.03	mg/l	< 0,5
DOC - Gehalt	DIN 38409 / 3/1 a	06.03.03	mg/l	1,39

#### Zeichenerklärung:

u.B. = unter der verfahrensbedingten Bestimmungsgrenze

i.A. = in Anlehnung an

a = Akkreditiertes Verfahren

u = Unterauftrag

Schwermetalle wurden nach Aufschluß mit H<sub>2</sub>O<sub>2</sub> / HNO<sub>3</sub> gemessen

## 10.6 Translation of Inspection Report 1

page 2/3  
of June 18, 2003  
Test order No. 30514- P2C



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

### Test Results

Sample identification.:	<b>flushing water</b>			
Laboratory No.:	<b>Mini- and Contac II / Mini- and Contac III</b>			
	<b>3 0514 / 1</b>			
<b>Appearance:</b>				
colour:	colourless			
turbidity:	none			
sediments:	none			
smell:	weakly non-specific			
sample quantity:	0,75 ltr			
PARAMETER	TEST METHOD	TEST DATE	UNIT	TEST RESULT
pH - value	DIN 38404 / 5	April 25, 2003		<b>8,1</b>
measurement temperature		April 25, 2003	°C	<b>14,7</b>
electric conductivity calculated at 25° C	DIN EN 27888	April 29, 2003	µS / cm	<b>816</b>
chloride	EN ISO 10304-1	a March 10, 2003	mg / ltr	<b>4,21</b>
sulphate	EN ISO 10304-1	a March 10, 2003	mg / ltr	<b>10,0</b>
chromium	EN ISO 11885	a March 11, 2003	mg / ltr	<b>&lt; 0,02</b>
chromium IV	DIN 38405	a March 11, 2003	mg / ltr	<b>&lt; 0,03</b>
copper	EN ISO 11885	a April 28, 2003	mg / ltr	<b>0,47</b>
nickel	EN ISO 11885	a March 11, 2003	mg / ltr	<b>&lt; 0,04</b>
zinc	EN ISO 11885	a March 11, 2003	mg / ltr	<b>0,086</b>
lead	EN ISO 11885	a March 11, 2003	mg / ltr	<b>&lt; 0,1</b>
cadmium	EN ISO 11885	a March 11, 2003	mg / ltr	<b>&lt; 0,01</b>
tin	EN ISO 11885	a March 13, 2003	mg / ltr	<b>&lt; 0,5</b>
DOC contents	DIN 38409 / 3 / 1	a March 06, 2003	mg / ltr	<b>1,39</b>

Note:

a = accredited method

The samples were analysed after H<sub>2</sub>O<sub>2</sub> / HNO<sub>3</sub> digestion

## 10.7 Inspection Report

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Seite 3/3  
vom 25.10.2004  
Prüfauftrags-Nr. 3 0514-P2C



CHEMISCHES LABOR  
DR. WIRTS+PARTNER  
SACHVERSTÄNDIGEN GMBH

### **Zusammenfassende gutachterliche Stellungnahme zum Prüfbericht Auftrags- Nr. 3 0514-P2C**

Die Auftraggeberin vertreibt Kontaktierungsanlagen.

Bei dem Betrieb dieser Kontaktierungsanlage Mini- und Contac II / Mini- und Contac III fällt Wasser zur Entsorgung an.

Zur Klärung, ob das anfallende Spülwasser in die öffentliche Abwasser- Kanalisation eingeleitet werden kann, wurde dem hiesigen Labor eine Abwasserprobe übergeben.

Das Untersuchungsprogramm wurde auf allgemeine Parameter, Säurereste und Schwermetalle abgestellt.

Die im einzelnen erhaltenen Meßergebnisse sind vorstehend aufgeführt.

Die Spülwasserprobe war farblos und klar war. Der pH- Wert lag im neutralen Bereich und die elektrischen Leitfähigkeit war gering. Alle weiteren geprüften Parameter lagen in einer für Abwasser normalen Größenordnung.

Unter Bezug auf die ATV- DVWK- Regelwert A115 „Einleiten von nicht häuslichem Abwasser in eine öffentliche Abwasseranlage“ entsprach das Spülwasser den Abwasser- Anforderungen.

Nach Vorlage dieses Prüfberichtes erteilt die zuständige Behörde die Genehmigung zur Einleitung in den Regen- oder Schmutzwasserkanal.

## 10.8 Translation of Inspection Report

page 3/3  
of June 18, 2003  
Test order No. 30514- P2C



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

### Summarised expert comments re. Test Report Order No.3 O514-P2C

The Principal is distributor of a contacting plant.

The operation of this contacting plant Mini- and Contac II / Mini- and Contac III Mini involves the accrual of water which is to be disposed of.

To clarify whether this accruing flushing water can be discharged into the public sewage system, a wastewater sample was handed to the undersigning laboratory.

The analysis programme was aimed at general parameters, residual acids and heavy metals.

The measuring results obtained in detail are itemized hereabove.

The flushing water sample was colourless and clear. The pH-value was in the neutral range and the electric conductivity was low. All the other parameters tested were in a magnitude normal for wastewater.

The flushing water sample met the sewage water requirements, with reference to ATV-DVWK-Regelwert A 115 "Einleiten von nicht häuslichem Abwasser in eine öffentliche Abwasseranlage" (discharge of non-domestic wastewater into a public sewage plant).

On presentation of this Test Report, the authority in charge will grant approval to this discharge into the public rainwater system or drainage system.

## 10.9 Inspection Report 2

Seite 2/2  
vom 03.07.2003  
Prüfauftrags-Nr. 31490-P1C



CHEMISCHES LABOR  
DR. WIRTS + PARTNER  
SACHVERSTÄNDIGEN GMBH

### Prüfergebnisse

Probenkennzeichnung:	Trinkwasser			
Labor-Nr.:	3 1 490 / 1			
Aussehen:				
Farbe:	farblos			
Trübung:	ohne			
Bodensatz:	ohne			
Geruch:	schwach unspezifisch			
Probemenge:	ca. 1000 ml			
PARAMETER	PRÜFVERFAHREN:	PRÜFDATUM:	EINHEIT:	PRÜFERGEBNIS:
pH - Wert	DIN 38404 / 5 a	01.07.2003	°C	8,0
Meßtemperatur				14,6
elektrische Leitfähigkeit ber. auf 25 °C	DIN EN 27888 a		µS/cm	852
Kupfer	EN ISO 11885 a	01.07.2003	mg/l	0,023

Zeichenerklärung:

u.B. = unter der verfahrensbedingten Bestimmungsgrenze  
i.A. = in Anlehnung an  
a = Akkreditiertes Verfahren  
u = Unterauftrag

## 10.10 Translation of Inspection Report 2

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



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

### Test Results

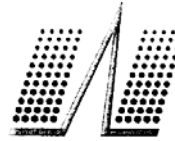
Sample identification:	drinking water			
Laboratory No.:	3 1490 / 1			
Appearance:	colourless			
colour:	none			
turbidity:	none			
sediments:	none			
smell:	weakly non-specific			
sample quantity:	1,0 ltr			
PARAMETER	TEST METHOD	TEST DATE	UNIT	TEST RESULT
pH - value	DIN 38404 / 5 a	July 1, 2003	°C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

**Note:**

a = accredited method

## 10.11 Inspection Report 3

Seite 2/4  
vom 08.06.2000  
Auftrags-Nr. 0 1218-P2C



CHEMISCHES LABOR  
DR. WIRTS+PARTNER  
SACHVERSTÄNDIGEN GMBH

Probenkennzeichnung:	Cleaner 110, Probe 1			
Labor-Nr.:	0 1218/ 1			
Aussehen: Farbe: Trübung: Bodensatz: Geruch:	farblos klar ohne schwach, unspezifisch			
Folgende Ergebnisse beziehen sich auf die homogenisierte Wasserprobe incl. Bodensatz				
PARAMETER	PRÜFMETHODE:	ANALYSEN-DATUM:	EINHEIT:	PRÜFERGEBNIS:
pH - Wert	DIN 38404/ 5	24.05.00		9,4
Meßtemperatur		24.05.00	°C	13,9
elektrische Leitfähigkeit ber. auf 25 °C	DIN 38404/ 8	24.05.00	µS/cm	57,4
Chrom, gesamt	DIN 38406/ 22	30.05.00	mg/l	< 0,02
Chrom VI	DIN 38405/ 24	30.05.00	mg/l	< 0,03
Kupfer	DIN 38406/ 22	30.05.00	mg/l	0,028
Nickel	DIN 38406/ 22	30.05.00	mg/l	< 0,04
Zink	DIN 38406/ 22	30.05.00	mg/l	< 0,02
Blei	DIN 38406/ 22	30.05.00	mg/l	< 0,1
Cadmium	DIN 38406/ 22	30.05.00	mg/l	< 0,01
Quecksilber	DIN 38406 / 12	07.06.00	mg/l	< 0,0005
Arsen	Graphitrohr-AAS	05.06.00	mg/l	< 0,005
AOX - Gehalt	DIN 38409/ 14	31.05.00	mg/l	< 0,010
TOC - Gehalt	DIN 38409/ 3/1	29.05.00	mg/l	2,42
Mineralöl-Kohlenwasserstoffe	DIN 38409/ 18	26.05.00	mg/l	< 1,6

Zeichenerklärung:

u.B. = unter der verfahrensbedingten Bestimmungsgrenze  
i. A. = in Anlehnung an  
( Die 16 PAK - Einzelsubstanzen sind nachstehend aufgeführt. )



## 10.12 Translation of Inspection Report 3

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of June 8, 2000  
order No. 0 1218-P2C



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

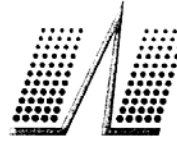
<b>sample identification:</b>	Cleaner 110, sample 1			
<b>laboratory No.</b>	0 1218/ 1			
<b>appearance</b> <b>colour</b> <b>turbidity:</b> <b>sediment:</b> <b>smell:</b>	colourless none without slightly non-specific			
<b>The results itemized herebelow are relating to the homogenized water sample incl. sediment.</b>				
<b>PARAMETER</b>	<b>TEST METHOD</b>	<b>ANALYSIS DAY</b>	<b>UNIT</b>	<b>TEST RESULT</b>
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
<b>AOX - content</b>	DIN 38409/ 14	31.05.00	mg/l	< 0,010
<b>TOC - content</b>	DIN 38409/ 3/1	29.05.00	mg/l	2,42
<b>mineral oil hydrocarbons</b>	DIN 38409/ 18	26.05.00	mg/l	< 1,6

Zeichenerklärung:

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

## 10.13 Inspection Report 4

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vom 08.06.2000  
Auftrags-Nr. 0 1218-P2C



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

Probenkennzeichnung:	Cleaner 210, Probe 2			
Labor-Nr.:	0 1218/ 2			
Aussehen:				
Farbe:	farblos			
Trübung:	klar			
Bodensatz:	ohne			
Geruch:	schwach, unspezifisch			
Folgende Ergebnisse beziehen sich auf die homogenisierte Wasserprobe incl. Bodensatz				
PARAMETER	PRÜFMETHODE:	ANALYSEN-DATUM:	EINHEIT:	PRÜFERGEBNIS:
pH - Wert	DIN 38404/ 5	24.05.00		8,2
Meßtemperatur		24.05.00	°C	13,1
elektrische Leitfähigkeit ber. auf 25 °C	DIN 38404/ 8	24.05.00	µS/cm	28,2
Chrom, gesamt	DIN 38406/ 22	30.05.00	mg/l	< 0,02
Chrom VI	DIN 38405/ 24	30.05.00	mg/l	< 0,03
Kupfer	DIN 38406/ 22	30.05.00	mg/l	0,106
Nickel	DIN 38406/ 22	30.05.00	mg/l	< 0,04
Zink	DIN 38406/ 22	30.05.00	mg/l	< 0,02
Blei	DIN 38406/ 22	30.05.00	mg/l	< 0,1
Cadmium	DIN 38406/ 22	30.05.00	mg/l	< 0,01
Quecksilber	DIN 38406 / 12	07.06.00	mg/l	< 0,0005
Arsen	Graphitrohr-AAS	05.06.00	mg/l	< 0,005
AOX - Gehalt	DIN 38409/ 14	31.05.00	mg/l	< 0,010
TOC - Gehalt	DIN 38409/ 3/1	29.05.00	mg/l	7,65
Mineralöl-Kohlenwasserstoffe	DIN 38409/ 18	26.05.00	mg/l	< 1,6

Zeichenerklärung:

u.B. = unter der verfahrensbedingten Bestimmungsgrenze  
i. A. = in Anlehnung an  
( Die 16 PAK - Einzelsubstanzen sind nachstehend aufgeführt. )

## 10.14 Translation of Inspection Report 4

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of June 8, 2000  
order No. 0 1218-P2C



CHEMISCHES LABOR  
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SACHVERSTÄNDIGEN GMBH

sample identification:	Cleaner 210, sample 2			
laboratory No.	0 1218/ 2			
appearance colour turbidity: sediment: smell:	colourless none without slightly non-specific			
The results itemized herebelow are relating to the homogenized water sample incl. sediment.				
PARAMETER	TEST METHOD	ANALYSIS DAY	UNIT	TEST RESULT
pH value	DIN 38404/ 5	24.05.00		8,2
measuring temperature		24.05.00	°C	13,1
electric conductivity at 25°C	DIN 38404/ 8	24.05.00	µS/cm	28,2
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	0,106
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	7,65
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

## 10.15 Inspection Report

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vom 08.06.2000  
Auftrags-Nr. 0 1218-P2C



CHEMISCHES LABOR  
DR. WIRTS + PARTNER  
SACHVERSTÄNDIGEN GMBH

### Gutachterliche Stellungnahme zum Prüfbericht, Auftrags-Nr. 0 1218-P1C

Bei dem Betrieb einer Kontaktierungsanlage der Auftraggeberin fällt Waschwasser zur Entsorgung bzw. Verwertung an.

Zur Klärung, ob das Waschwasser in eine öffentliche Abwasserkanalisation eingeleitet werden kann, wurden dem hiesigen Labor zwei Proben zur chemischen Untersuchung übergeben.

Die Proben wurden neben allgemeinen Parametern auf Schwermetalle und organische Summenparameter geprüft.

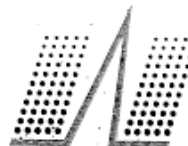
Die im einzelnen erhaltenen Meßergebnisse sind vorstehend aufgeführt.

Bei Auswertung der Meßergebnisse war festzustellen, daß die Waschwasserproben, Labor-Nr. 0 1218/ 1 und 2 (Cleaner 110 und 210), einen leicht alkalischen pH-Wert aufwiesen. Die Schwermetallübersichtsuntersuchung ergab jeweils nur geringe, unkritische Gehalte. Auch die geprüften organischen Summenparameter wiesen nur geringe Werte auf.

Unter Bezug auf das ATV-Regelwerk, Arbeitsblatt A 115 "Einleiten von nicht häuslichem Abwasser in eine öffentliche Abwasseranlage" entsprachen die Proben, Labor-Nr. 0 1218/ 1+2 (Cleaner 110 und 210), den Abwasseranforderungen, so daß eine Einleitung in eine öffentliche Abwasserkanalisation möglich wäre.

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order No. 0 1218-P2C



CHEMISCHES LABOR  
DR. WIRTS+PARTNER  
SACHVERSTÄNDIGEN GMBH

### Expert comments re.: Test Report, Order No. 0 1218-P1C

On operation of a Contact Bed Plant of Mandator's, wash water is produced which is either put to waste disposal, or is utilised.

To clarify whether the wash water can be introduced into a Public Sewerage System, two samples were handed over for chemical analysis to the undersigning laboratory.

The samples were analysed – further to general parameters – for heavy metals and for organic summation parameters.

The measuring results obtained in detail are itemised hereabove.

The evaluation of the measuring results proved that the wash water samples, Labor No. 0 1218/ 1 and /2 (Cleaner 110 and 210) had a slightly alkaline pH value. The heavy metals general analysis brought, in each case, no more than slightly non critical contents. The organic summation parameters showed, on examination, no more than slight values.

With reference to the ATV-Regelwerk, Arbeitsblatt A 115 "Einleiten von nicht häuslichem Abwasser in eine öffentliche Abwasseranlage" ( Discharge from nodomestic sewage in a public sewage plant) , the samples, Labor-No. 0 1218/ 1+2 (Cleaner 110 and 210) met the waste water requirements, so that an introduction into a Public Sewerage System might be possible.

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vom 26.01.2004  
Auftrags-Nr. 03 0687-GA



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

### Arbeitsbereiche und Messergebnisse

Betrieb:	LPKF Laser & Electronics AG, Garbsen
Arbeitsbereich:	Galvanik
Datum:	18.11.2003

Arbeitsbereich / Messpunkt	Stoffe	Datum	Uhrzeit	Dauer (min)	Art der Probe	Faktor für verkürzte Exposition	Konzentration (mg/m <sup>3</sup> )	Stoffindex I	
Nr.   Bezeichnung									
1	<i>galvanische</i>	Formaldehyd (Gesamtprozess)	18.11.03	10.47	120	o / W	k=1	0,013	0,02
	<i>Durchkontaktierung</i>	Formaldehyd (saures Cu-Bad)	18.11.03	12.50	30	o / W	k=1	0,018	0,03
2	<b>Contac-III</b>	Schwefeldioxid (Gesamtprozess)	18.11.03	10.47	120	o / W	k=1	< 0,4	< 0,31
		Schwefeldioxid (saures Cu-Bad)	18.11.03	12.50	30	(K *)		< 1,3 *)	
3		Schwefelsäure (Gesamtprozess)	18.11.03	10.47	120	o / W	k=1	< 0,05	< 0,5
		Schwefelsäure (saures Cu-Bad)	18.11.03	12.50	30	(K *)		< 0,2 *)	
4		Kohlenstoffdioxid	18.11.03	10.47	145	o / W	k=1	741 ppm	0,15

#### Erläuterungen:

p = personenbezogen  
o = ortsfest  
S = Schichtmittelwert  
K = Kurzzeitwert  
W = Worst-case-Betrachtung

\*) die zur Zeit verfügbaren Analysenverfahren sind aufgrund geringer Nachweisempfindlichkeit bei kurzen Messdauern nicht oder nur bedingt zur Kontrolle des Kurzzeitwertes geeignet

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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/m <sup>3</sup> )	Substance index I
No	Designation								
1	galvanic	Formaldehyde (total process)	18.11.03	10.47	120	o / W	k=1	0,013	0,02
	plating through	Formaldehyde (sour Cu bath)	18.11.03	12.50	30	o / W	k=1	0,018	0,03
2	<b>Contac-III</b>	Sulfur dioxide (total process)	18.11.03	10.47	120	o / W	k=1	< 0,4	< 0,31
		Sulfur dioxide (sour Cu bath)	18.11.03	12.50	30	(K *)		< 1,3 *)	
3		Sulfuric acid (total process)	18.11.03	10.47	120	o / W	k=1	< 0,05	< 0,5
		Sulfuric acid (sour Cu bath)	18.11.03	12.50	30	(K *)		< 0,2 *)	
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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CHEMISCHES LABOR  
DR. WIRTS+PARTNER  
SACHVERSTÄNDIGEN GMBH

### Befund

#### **"Arbeitsbereich Galvanik - galvanische Durchkontaktierungsanlage Contac-III":**

Die **Grenzwerte** für Formaldehyd, Schwefeldioxid, Schwefelsäure und Kohlenstoffdioxid sind auch unter dem Aspekt einer Worst-case-Betrachtung (konstante Exposition über eine Schichtdauer von 8 Stunden) eingehalten. Üblicherweise beträgt der tatsächliche Aufenthalt an der Anlage etwa 2-3 Stunden pro Schicht. Es ergeben sich folgende Stoffindizes:

Stoff	Stoffindex bei 8-stündiger Exposition	Stoffindex bei 3-stündiger Exposition
Formaldehyd	0,02	< 0,01
Schwefeldioxid	< 0,3	< 0,13
Schwefelsäure	< 0,5	< 0,19
Kohlenstoffdioxid	0,15	(0,06)

Eine Aufsummierung der Stoffindizes wurde aus folgenden Gründen nicht vorgenommen:

Für Schwefeldioxid und Schwefelsäure sind die Grenzwerte erst kürzlich gesenkt worden. Aufgrund nicht ausreichender Empfindlichkeit liegen die Bestimmungsgrenzen der verfügbaren Analysenverfahren bei rd. ein Drittel bzw. der Hälfte des Grenzwertes, so dass eine "einfache" Aufsummierung der Stoffindizes zu einer verfälschten Betrachtung der tatsächlichen Situation führen würde. Eine Analyse des Produktionsablaufs und eine genauere Betrachtung der verwendeten Chemikalienbäder zeigt jedoch, dass unter vorschriftsmäßig eingehaltenen Produktionsbedingungen mit keiner erhöhten Gefahrstoffemission zu rechnen ist. Der Messwert für Kohlenstoffdioxid lag mit 0,074 Volumenprozent deutlich unter dem Innenraumrichtwert von 0,15 Volumenprozent (DIN 1946, Teil 2) und weist auf einen gut belüfteten Raum.

#### **Kurzzeitwerte**

Die Kontrolle der Kurzzeitwerte von Schwefeldioxid und Schwefelsäure gestalten sich etwas schwieriger. Grund ist die kürzlich vorgenommene Absenkung der Grenzwerte, wobei zur exakten Überprüfung des 15-Minuten-Intervalls zur Zeit keine ausreichend empfindlichen Messverfahren zur Verfügung stehen.

#### *Schwefeldioxid:*

Aufgrund der Gleichartigkeit des Prozesses konnte hier ein "verlängertes" 30-Minuten-Intervall für die Messung herangezogen werden. Der Überschreitungsfaktor ist "1", d.h. die Konzentration soll zu keinem Zeitpunkt höher sein als der Grenzwert. Der Messwert lag unter der Bestimmungsgrenze von 1,3 mg/m<sup>3</sup> (Grenzwert 1,3 mg/m<sup>3</sup>). Damit ist der *Kurzzeitwert* als sicher *eingehalten* zu betrachten.



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*Schwefelsäure:*

Auch hier konnte aufgrund des konstant gleichartig verlaufenden Prozesses ein 30-Minuten-Intervall für die Messung herangezogen werden. Der Überschreitungsfaktor ist auch hier "1". Der Messwert lag unter der Bestimmungsgrenze von 0,2 mg/m<sup>3</sup> (Grenzwert 0,1 mg/m<sup>3</sup>).

Während der Benutzung des "sauren Cu-Bades" gab es keinerlei Hinweise auf eine Veränderung der Badstabilität. Auch eine geruchliche Belastung der Luft oder Reizwirkungen wurden nicht festgestellt. Somit ist auch hier von einer Einhaltung des Kurzzeitwertes auszugehen.

*Bei vorschriftgemäßem Betreiben der Anlage sind die Grenzwerte für die oben genannten Stoffe gut eingehalten.*

*Eine Betrachtung der Randbedingungen für die Kurzzeitwerte ergibt, dass unter üblichen Betriebsbedingungen auch diese gut eingehalten werden können.*

K.-D. Willaschek-Jühne  
- Dipl. Chemiker -

Anlagen:

- Fotodokumentation
- Prüfbericht 32636-P1A
- Prüfbericht 32726-P1A
- Probenahmeprotokolle
- Messprotokoll - CO<sub>2</sub>-Messung und Klimadaten  
(Kontinuierliche Messung: testo 445 mit CO<sub>2</sub>-Fühler und Dreifachsonde (°C; %rF; m/s))

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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/m<sup>3</sup> (limit value 1.3 mg/m<sup>3</sup>). With that

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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 32726-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))

## 10.21 Inspetion Report



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

Dr. Wirts + Partner GmbH · Rutenbergstr. 59 · D-30559 Hannover

LPKF Laser & Electronics AG  
 Osteriede 7  
 30827 Garbsen

### Analytik, Gutachten, Beratung

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 Internet: [www.Wirts.de](http://www.Wirts.de)

Ihr Zeichen: ---	Unser Zeichen: 05 0269-GWJ	Ihr Gesprächspartner: Hr. Willaschek-Jühne	Datum: 26.05.2005
Betrifft: Galvanische Durchkontaktiersysteme LPKF MiniContac S und MiniContac III hier: Gefahrstoffbelastung in der Luft am Arbeitsplatz			

### Bestätigung

Wir haben in unserem Gutachten 03 0687-GA vom 26.01.2004 über die Ergebnisse der Untersuchungen der Gefahrstoffbelastung in der Luft im Arbeitsbereich des Laborgalvaniksystems LPKF Contac III zur galvanischen Durchkontaktierung von Leiterplatten berichtet. Hier konnte bescheinigt werden, dass bei vorschriftsgemäßem Betreiben der Anlage die Grenzwerte für Formaldehyd, Schwefeldioxid, Schwefelsäure und Kohlenstoffdioxid gut eingehalten sind.

Wir wurden nun gebeten, zu prüfen, in wie weit die in unserem Gutachten ermittelten Daten auch auf die neuen, deutlich kleiner dimensionierten Geräte LPKF MiniContac S und LPKF MiniContac III zur galvanischen Durchkontaktierung von Leiterplatten übertragbar sind.

Hierzu wurden uns für die Systeme LPKF MiniContac S und LPKF MiniContac III die technischen Daten, Angaben über die Dimensionierung der Anlagen, sowie die Beschreibung der Arbeitsabläufe übermittelt.

Eine Überprüfung dieser Daten zeigte, dass die verwendeten Chemikalienbäder in ihrer Zusammensetzung identisch mit den messtechnisch überprüften Bädern der Laborgalvanikanlage LPKF Contac III sind. Gleichzeitig sind die Behälter kleiner dimensioniert, d.h. die Volumina und insbesondere auch die Badoberflächen sind kleiner, beim System LPKF MiniContac S sogar deutlich kleiner als bei dem System LPKF Contac III. Da auch die Verarbeitungstemperaturen der Chemikalienbäder und weitere Verarbeitungsparameter der elektrochemischen Prozesse identisch sind, kann davon ausgegangen werden, dass die Emissionen von Gefahrstoffen eher noch geringer - auf keinen Fall aber höher - ausfallen, wie in dem messtechnisch überprüften System LPKF Contac III.

Damit können wir bescheinigen, dass beim vorschriftsgemäßen Betrieb der Systeme LPKF MiniContac S und MiniContac III ebenfalls von einer Einhaltung der Arbeitsplatzgrenzwerte auszugehen ist.



K.-D. Willaschek-Jühne  
 - Dipl. Chemiker -



Das Prüflaboratorium ist nach DIN EN ISO/IEC 17025 durch die DACH Deutsche Akkreditierungsstelle Chemie GmbH  
 prüfunsakreditiert. Die akkreditierten Verfahren entsprechen der Verwaltungsvereinbarung OFD/BAM zur Altlastener-  
 kundung auf Bundesliegenschaften. Zulassung zur Untersuchung amtlich zurückgelassener Proben nach §42 LMBG.



Chemisches Labor Dr. Wirts + Partner Sachverständigen GmbH      Geschäftsführer: Dr. H.-D. Wirts    Dr. C. Wirts      Amtsgericht Hannover HRB 54381  
 Hannoversche Volksbank BLZ 251 900 01    Kto.-Nr 00 129 984 00    BIC VOHA DE 2H    IBAN DE63 2519 0001 0012 9984 00    USt-IdNr DE164011600    St-Nr 11 25 217 21217

## 10.22 Translation of Inspection Report



CHEMISCHES LABOR  
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SACHVERSTÄNDIGEN GMBH

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Your ref.	Our ref.	Person to contact	Date
---	05 0269-GWJ	K.-D. Willaschek-Jühne	26 May 2005

### Certification

In our survey 03 0687-GA dated 26<sup>th</sup> January 2004 we reported about the results of our examinations regarding the pollution with hazardous substances in the work area of the galvanic system LPKF Contac III for galvanic through-plating of circuit boards. It could be confirmed that if the system is operated according to regulations the limit values for formaldehyde, sulfur dioxide, sulfuric acid, and carbon dioxide are well complied with.

We were asked to check to what extent the data determined in our test report can be applied to the new and significantly smaller system LPKF MiniContac S and MiniContac III for galvanic through-plating of circuit boards.

To do this, we were given the technical data, details about the dimensions of the systems as well as the description of the working procedures for the systems LPKF MiniContac S and LPKF MiniContac III.

An examination of this data showed that the chemicals baths that are used are identical to those of the baths of the galvanic system LPKF Contac III that were tested by us. At the same time the containers are smaller in size, i.e. the volumes and the surface areas of the baths are smaller, even significantly smaller for the LPKF MiniContac S, than those of the system LPKF Contac III.

As the processing temperatures of the chemical baths as well as other processing parameters of the electrochemical processes are identical, it can safely be assumed that the emission of hazardous substances is likely to be lower, but in no case higher than that of the metrologically tested system LPKF Contac III.

Thus we can certify that if the LPKF MiniContac S and LPKF MiniContac III are used according to regulations the limit values for workplace concentrations are complied with.

K.-D. Willaschek-Jühne



Das Prüflaboratorium ist nach DIN EN ISO/IEC 17025 durch die DACH Deutsche Akkreditierungsstelle Chemie GmbH präferenzakkreditiert. Die akkreditierten Verfahren entsprechen der Verwaltungsvereinbarung OFD/BAM zur Altlastenrekundung auf Bundesliegenschaften. Zulassung zur Untersuchung amtlich zurückgelassener Proben nach §42 LMBG.



Akkreditiertes Prüflaboratorium  
Register-Nr.: AKS-P-20310-EU  
Staatliche Akkreditierungsstelle Hannover

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Hannoversche Volksbank BLZ 251 900 01 Kto.-Nr 05 129 964 00

Geschäftsführer Dr. H.-D. Wirts Dr. G. Wirts  
BIC VOHA DE 2H IBAN DE63 2519 0001 0012 9984 00

Amtsgericht Hannover HRB 54381  
USt-IdNr DE164011600 St-Nr 11 25 217 21217

## 10.23 Declaration of Conformity (German)

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1. Hersteller der mit LPKF „*MiniContac III*“ bezeichneten Maschine ist die Firma:

LPKF  
Laser & Electronics AG  
Osteriede 7

D-30827 Garbsen

2. Bei der mit LPKF *MiniContac III* bezeichneten Maschine handelt es sich um eine Durchkontaktierungsanlage, die zum Erstellen von Durchkontaktierungen in Mehrlagenleiterplatten (Multilayern) geeignet ist. Die Seriennummer der vorstehenden Maschine ist 1F.....(siehe linke, untere Seitenwand). Weitere Angaben zur LPKF *MiniContac III* sind dem beiliegenden Handbuch zu entnehmen.
3. Die LPKF *MiniContac III* entspricht den Bestimmungen der EG-Maschinenrichtlinie 93 / 44 vom 14. Juni 93 (siehe auch Anhang I der Richtlinie).
4. Bei der Erstellung der LPKF *MiniContac III* fanden auch bestehende DIN- Vorschriften Anwendung.
5. Bevollmächtigter Unterzeichner dieser Erklärung ist

Herr Bernd Hackmann  
Vorstand LPKF AG  
Osteriede 7

D-30827 Garbsen



Bernd Hackmann

## 10.24 Declaration of Conformity

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1. Manufacturer of the machine designated LPKF *MiniContac III* is company:

LPKF  
Laser & Electronics AG  
Osteriede 7  
D-30827 Garbsen  
Germany

2. The machine designated as LPKF LPKF *MiniContac III* is a through-plating system, suitable for the production of through-hole platings in multilayer circuit boards. The series number of the above-mentioned machine is 1T..... (see bottom of left machine side). Further details of the LPKF LPKF *MiniContac III* can be seen in the enclosed manual.
3. The LPKF LPKF *MiniContac III* corresponds to the provisions of the EC recommendation 93/44 dated June 14, 1993 ( see also Appendix of the recommendation).
4. Existing DIN regulations have also been applied for the production of the LPKF *MiniContac III* .
- 5 Authorized to sign this declaration is

Mr. Bernd Hackmann  
Board of Directors LPKF  
Osteriede 7  
D-30827 Garbsen/Germany



Bernd Hackmann

## **10.25 Safety Data Sheet**

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*CLEANER 110*

*CLEANER 210*

*ACTIVATOR 310*

*COPPER PLATER 400*

*SHINE 400*