ProtoMat C30 (C30/S)

(3/99)

Manual

English version

LPKF Laser & Electronics AG
Osteriede 7
30827 Garbsen
Germany
Tel.: +49 (0)5131 7095 0
Fax: +49 (0)5131 7095 90
E-mail: lpkf@lpkf.de
Internet: http://www.lpkf.de

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Introduction

The LPKF ProtoMat C30 (C30/S) circuit-board plotter is a system for the production of circuit board prototypes and engraving films, and for engraving aluminium or plastic.

It is essential that you familiarize yourself with the functions of the LPKF *BoardMaster* driver program before using the plotter. You will find a description of the driver program's functionality in the manual for the LPKF *BoardMaster*. The operating interface for the LPKF ProtoMat C30 (C30/S) is a PC.

It is absolutely vital that you read the instructions given in this manual *before* putting the machine into operation, otherwise you will invalidate any warranty claims. The appropriate national warranty provisions apply for machines exported to other countries of the European Community.

LPKF ProtoMat C30 (C30/S) machine ratings

Voltage	200-240 V (or 100-120V)
Power input	150 VA
Speed of plotter spindle	DC motor, 5000 - 32,000/min (variable)
Weight	approximately 24 kg
Drilling performance	78 lifts/min maximum
Resolution (smallest increment)	7.9375 µm (0.3125 mil)
Operating conditions:	
Humidity	60% max.
Temperature	15-25^{0}C

General information

Scope of supply

1. One LPKF ProtoMat C30 (C30/S) machine unit with integrated electronics

2. One null modem cable (LPKF ProtoMat C30 (C30/S) control unit to computer), 9/25-pin AT-adapter

3. One set of accessories (adhesive tape, various Allen keys, 5 alignment pins, tweezers, brush, 7 mm box spanner, two red registration hole strips, syringe containing oil)

4. One mains cable

5. This manual

Optional accessories

The following accessories are available for the LPKF ProtoMat C30 (C30/S):

1. Vacuum system with fine mesh filter.
The fine mesh filter is particularly essential when handling materials containing glass fibre, such as FR4 board material.

2. Noise and dust protective hood

3. LPKF *AutoSwitch.*
Automatic switch for the vacuum system. This option allows the vacuum system to be switched on and off by the plotter spindle.

4. *ZelSpot.*
Illuminates the plotter head.

5. LPKF *AutoContac*
Integrated through-hole plating using a dispenser and a special conductive paste capable of being soldered.

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.

- **Never reach into the machine when it is running.**
- **Caution - the machine changes the traverse speed automatically during the process**.
- **Only change tools when the milling/drilling motor is at a standstill.**
- **Insert the tool into the collet as far as the stop.**
- **Never operate the control PC at the same time as working with the device.**
- **Operators with long hair must wear a hair net.**
- **The equipment's safety can no longer be guaranteed and no claims against the warranty can be accepted if you modify the equipment yourself.**
- **Please note that some materials may produce carcinogenic dust or hazardous gases. Ask your material supplier.**
- **Always work with the vacuum device.**
- **When using chemicals please take note of the safety instruction on the containers or any separate safety sheets delivered with them.**
- **Keep the workstation tidy.**

Air-borne sound

There is a continuous sound pressure level of 71 dBA at the workstation during operation. This value does not include the vacuum unit.

Installation

1. Unpack the LPKF ProtoMat C30 (C30/S) carefully.

Remove the securing bolts.
(see securing bolt 1 in the drawing on the next page)
M5 x 25, 4.5 x 60 screws

2. Now loosen the transport securing devices.

The transport securing devices are located:
To secure the X axis -
(securing device 2) angle brackets on each side of the machine's base plate
M4 x 10 screws
To secure the Y axis -
(securing device 3) on the left-hand side of the plotter head
M4 x 40 screws
To secure the Z axis -
(securing device 4) on the plotter head
M4 x 20 screw

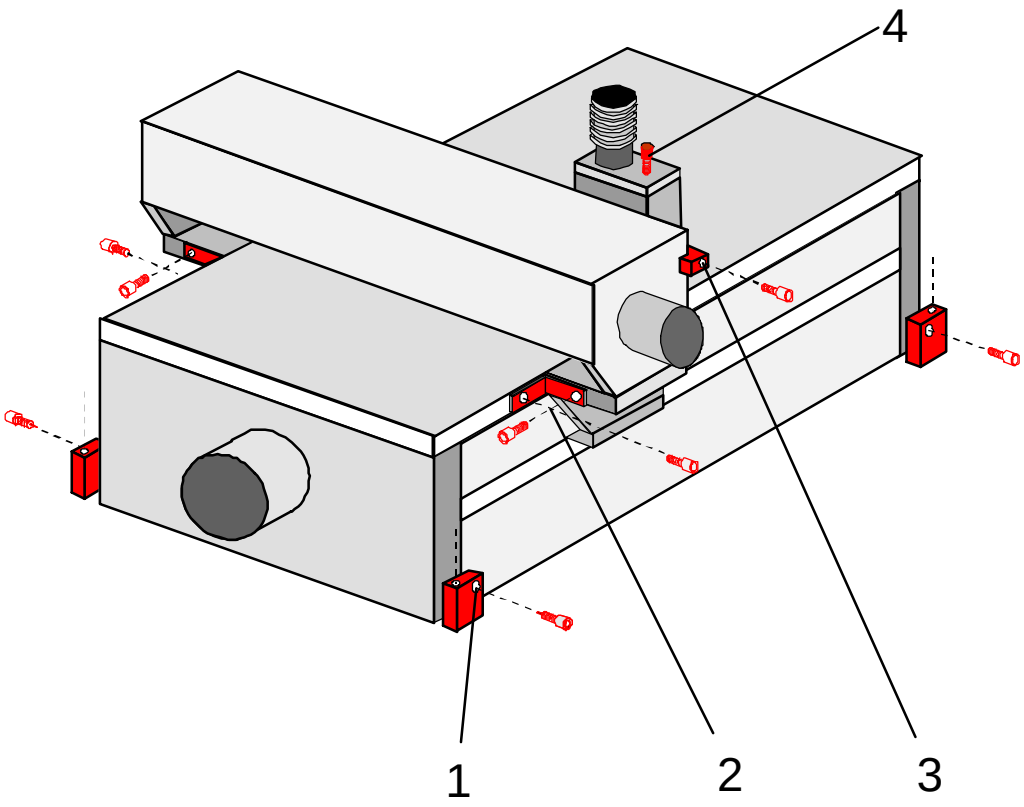
3. Set up the circuit-board plotter so that the cables connecting the electronics unit are free to move.

4. Connect the LPKF ProtoMat C30 (C30/S) to COM1 or COM2 on the computer using the null modem cable.

5. Plug the LPKF ProtoMat C30 (C30/S) control unit into the electricity supply.

6. Fit the vacuum system onto the adaptor
(fits pipe no. 111124 on a Nilfisk industrial vacuum system).

Important: The machine must stand on a flat and firm base in order to work correctly and without malfunctions.



LPKF ProtoMat C30 (C30/S) transport securing devices

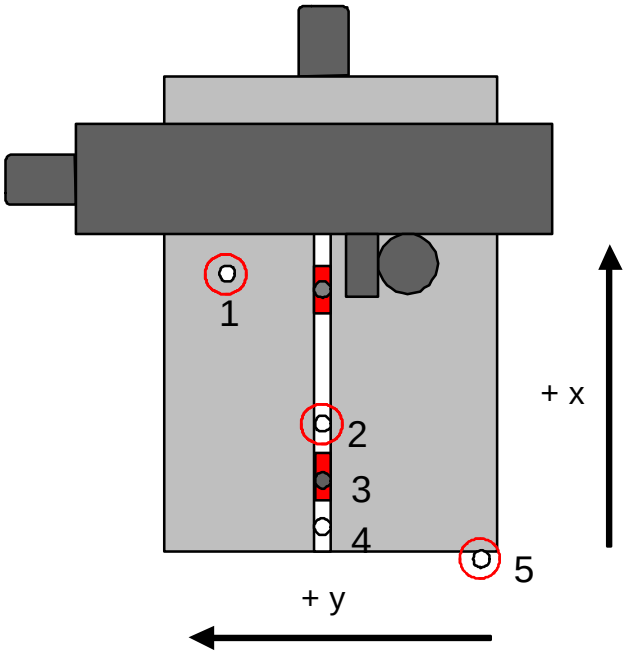
Description of the transport securing devices

1.	Securing device 1	To secure the machine to the transportation base M5 x 25, 4.5 x 60 screws
2.	Securing device 2	To secure the X axis M4 x 10 screws
3.	Securing device 3	To secure the Y axis M4 x 40 screw
4.	Securing device 4	To secure the plotter head M4 x 20 screw

Keep all transport securing devices and reattach them accordingly if the machine is to be shipped again.

The packaging should also be kept and used when the machine is returned for servicing.

Machine orientation



LPKF ProtoMat C30 (C30/S): The X axis has the greater travel

Caution Do no put fingers or any items into the movement range.

Description of the machine's main positions:

1. PAUSE position. The plotter head travels to this point to load or turn the material to be machined.

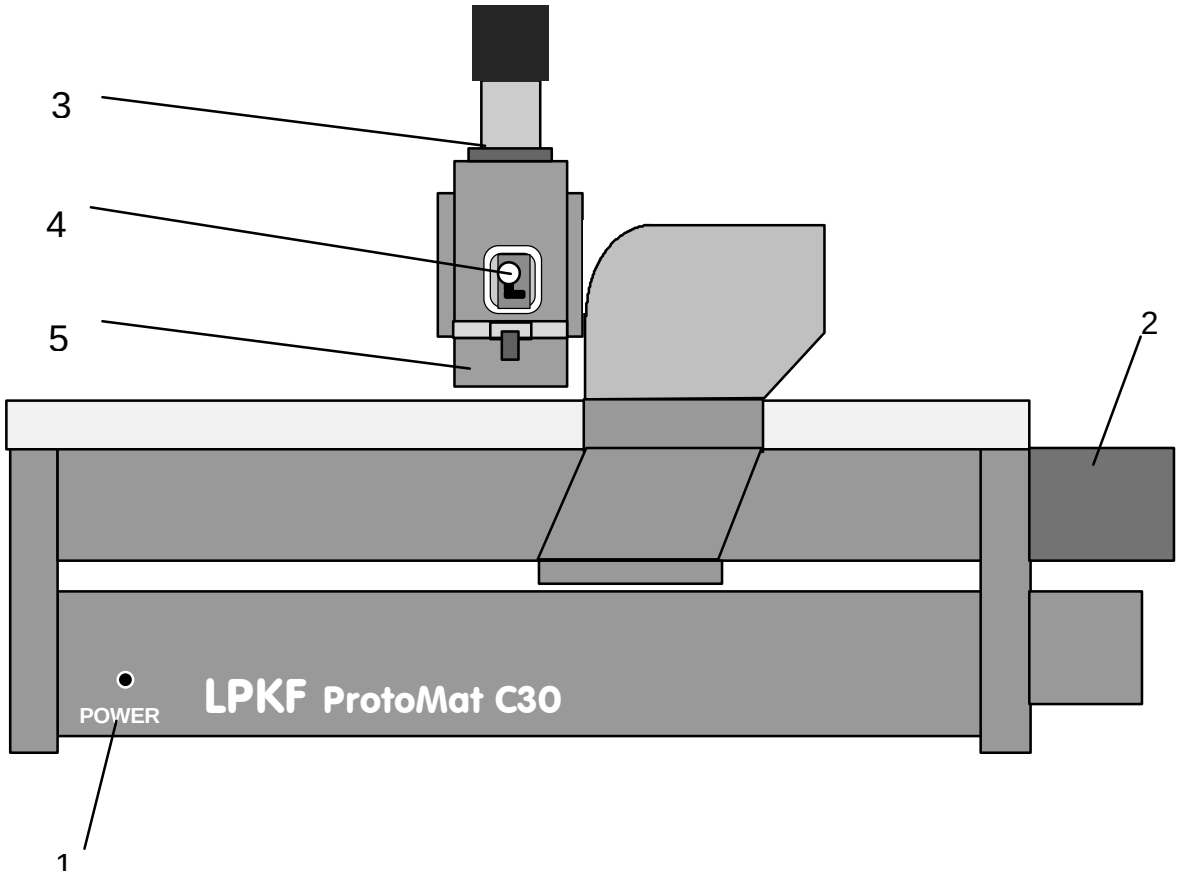
2. HOME position. This is on the plotter's axis of symmetry (registration hole system) and serves as the reference position for the LPKF *BoardMaster*

3. Registration hole slide with hole for alignment pin.

4. Reference pin for the front registration hole strip. The front registration hole slide butts against the stop.

5. Tool change position (zero position).
The tool is changed here.

LPKF ProtoMat C30 (C30/S) displays and connections



Front view of LPKF ProtoMat C30 (C30/S)

Description of the front view:

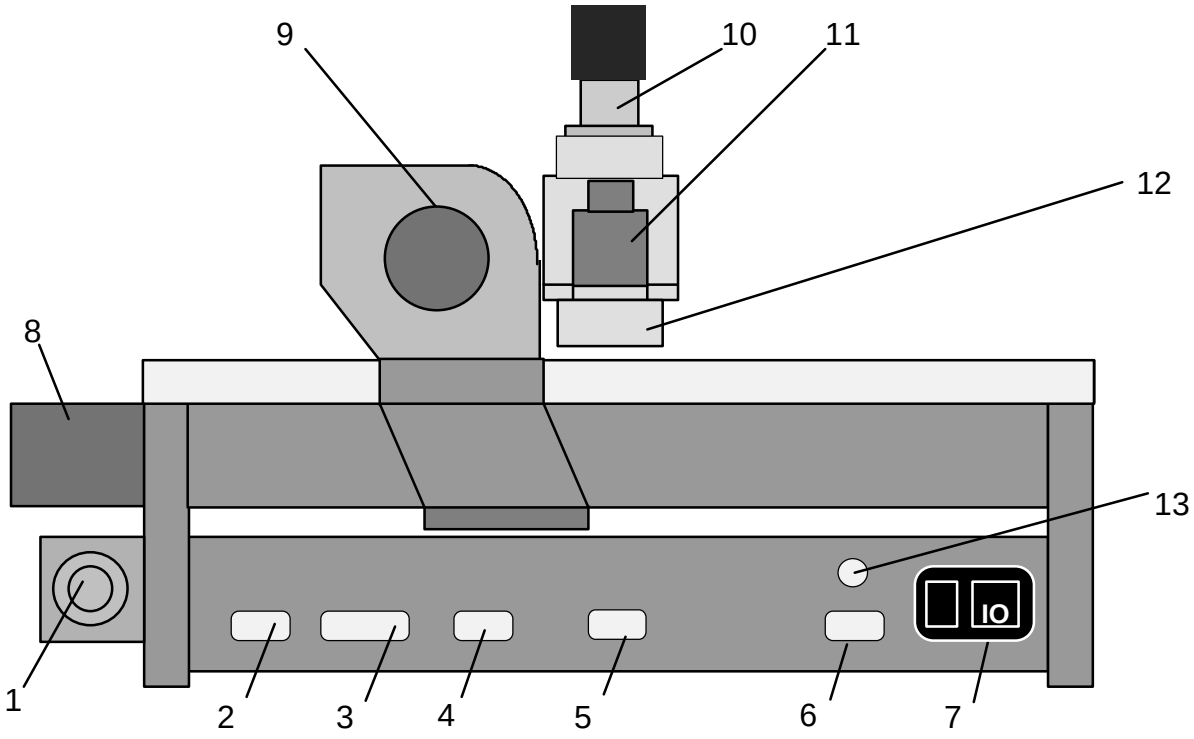
1. Operating indicator for the integrated SMCU machine controller

2. Motor for the longitudinal axis (X axis)

3. Plotter spindle (DC motor)

4. Lever for opening the tool collet (Only ProtoMat C30/S)

5. Working depth limiter



Rear view of the LPKF ProtoMat C30 (C30/S)

Description of the rear:

1. Vacuum system connection

2. Serial port (9-pin) for expansion units

3. Serial port (25-pin) for connection to PC

4. X motor connection

5. Y motor connection

6. Connection for plotter head and options

7. On/Off switch with mains connector and fuses

8. X motor

9. Y motor

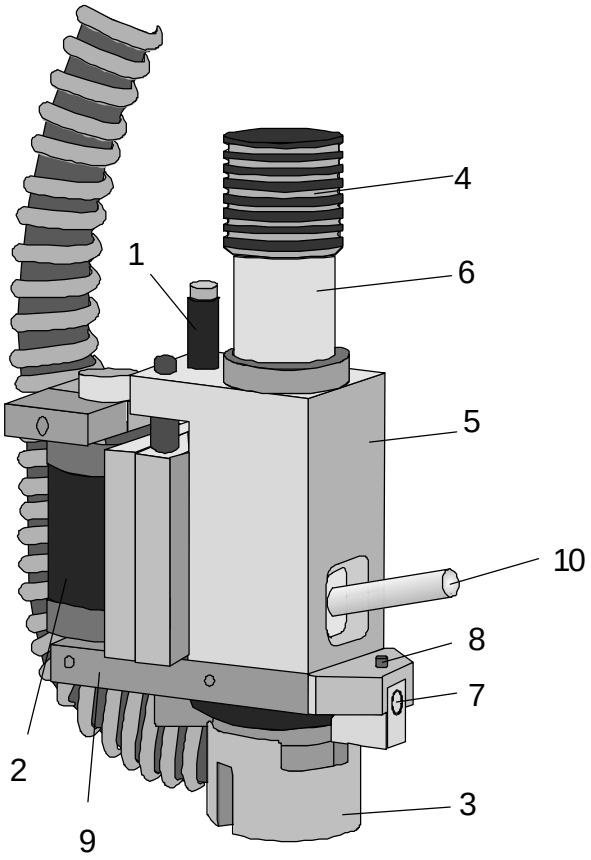
10. Plotter spindle (DC motor)

11. Solenoid actuator

12. Working depth limiter

13. DC motor connection

Functional elements on the plotter head



Front view of plotter head

1. Shock absorber
2. Lifting magnet
3. Working depth limiter
4. Motor cover
5. Mounting flange for the DC motor
6. DC motor
7. Bottom head stop adjustment **(Caution - do not adjust.)**
8. Fixing screw for working depth limiter
9. Plotter head base plate
10. Lever for opening the collet **(Only ProtoMat C30/S)**

Use of LPKF *BoardMaster*

The data required to drive the plotters is generated by postprocessing with LPKF *CircuitCAM* and is stored in a binary LPKF file (LMD format).

BoardMaster now reads these files, decodes the plotter commands and modifies them for the particular machine being driven.

This is necessary as although different machines may perform similar operations, they nevertheless use different command sets.

The LPKF ProtoMat C30 (C30/S) circuit-board plotter is HP-GL compatible, ie the driver generates data in HP-GL format plus some special commands.

Modifications such as enlargement, rotation and duplication etc can be made in LPKF *BordMaster*.

All LPKF circuit-board plotters are controlled through an asynchronous interface (RS232C).

In the case of the LPKF ProtoMat C30 (C30/S), this is set at

9600 Baud, 1 stop bit, 8 data bits, no parity, hardware handshake and ***FIFO off***

in the Windows control panel.

Setup

Before switching on

Caution You must ensure that the voltage set on the machine corresponds with the mains line voltage before switching on. If not, see the section headed Setting the device voltage, electrical fuses.

Remove all objects from the plotter and its traverse range before switching on. Pilot pins must not be projecting from the board material.

Caution Never reach into the machine while it is being switched on.

Never move the plotter head manually. Doing so could damage the electronics.

Switch-on sequence

It is useful, but not essential, to keep to the following switch-on sequence:

1. Computer

2. LPKF ProtoMat C30 (C30/S)

3. Start up the *BoardMaster* program

If, for whatever reason, it should be necessary to switch the machine off and back on, you must switch briefly to the *BoardMaster* Machine Settings... dialog box and quit this with OK. This will send the necessary initialization parameters, such as speed ranges, dwell times, positions and so on to the machine once again.

After switching on

The equipment moves to the x and y limit switches when the machine is switched on. The system first halts in the tool change position. It now waits for commands from *BoardMaster*. Check the following if the equipment does not move when it is switched on:

1. Is the POWER LED lit (only lights after successful initialization)?

2. Are all cables correctly inserted?

3. You may need to check the power supply fuses.

The LPKF ProtoMat C30 (C30/S) operating display

POWER (green): Control unit operating indicator. This only comes on once the system has been initialized) (limit switch reached).

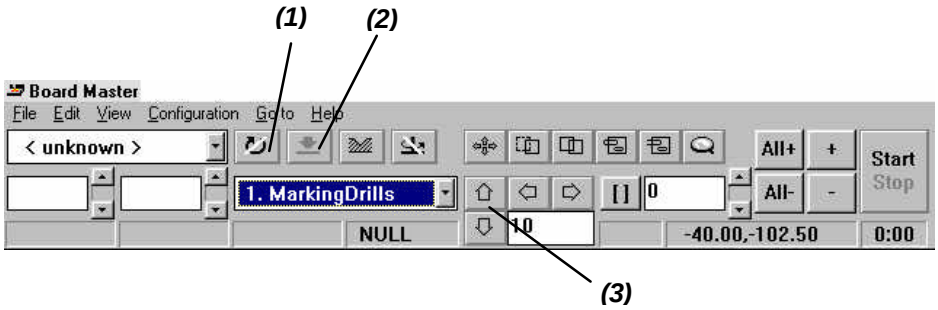
Functional test with LPKF *BoardMaster*

Caution Make sure that no other persons are working on the machine when the first functional test is taking place.

First check that the parameters for the serial port:
9600 baud , 8 data bits, 1 stop bit, no parity bit, hardware handshake and FIFO off.

Also check that the correct interface has been selected in *BoardMaster* under ***Configuration, Interface...*** . Consult the *BoardMaster* Manual if you require assistance.

The remainder of the procedure is carried out using *BoardMaster*:



1. Move the head manually using the cursor keys on the *BoardMaster* toolbar ***(3)***.
2. Switch on the motor. ***(1)*** (The motor runs at low speed during the warm-up phase)
3. Wait for the warm-up phase to complete.
4. Lower/raise the head ***(2)***.
5. Switch off the motor ***(1)***.
6. Check the interface configuration, the connecting cable and the PC interface if the equipment does not move.

Note: The motor cannot be switched off when the machine is in the tool change position.

HOME position and registration hole system

The HOME position must be on the machine's axis of symmetry (registration hole system) for double-sided boards.
Double-sided boards are rotated about this axis of symmetry.

Inaccuracies in the HOME position result in misalignment when double-sided boards are rotated during the machining process.

The HOME position is contained on the configuration diskette supplied as standard. With the *BoardMaster* program and configuration diskette correctly installed, the HOME position corresponds to the setting for the x/y coordinates as measured during the acceptance test.

Note:

The registration hole system can only be guaranteed to be parallel for the current position of the registration hole strips.
The front registration hole slide must be pushed against the pin in the reference groove (reference point).
An additional hole must be drilled for each format in the rear registration hole strip if board material of different sizes is used.
To do this, move from the HOME position towards the rear registration hole strip.
Now move the rear registration hole strip to the required position.
An additional hole is drilled in the slide using a 2.95 mm drill.
The position of the slide for the various holes should recorded or marked on the circuit-board plotter.
This guarantees parallelism for different formats.

You will need to perform a test run on the machine to check the coordinates of the HOME position on new machines and after transporting the system.

The individual steps are described in the next section, "***Checking and correcting the HOME position***".

No further action is required if the preset coordinates are correct. If this is not the case, the corrected coordinates will have to be entered in *BoardMaster*.
See the section entitled "***Programming the HOME position in BoardMaster***".

Checking and correcting the HOME position

The test file NULL-PKT.LMD is supplied with installation program to simplify the procedure for checking the HOME position.

This program drills a hole on one side of the board and then rotates the board before milling a circle in the same place. This allows you to perform a visual check on the position of the HOME point in both axes.

Caution: Bevore beginning you must read the chapters **" Operating the working depth limiter"** and **"Changing a tool (C30)"** as well as **"Changing a tool (C30/S).**

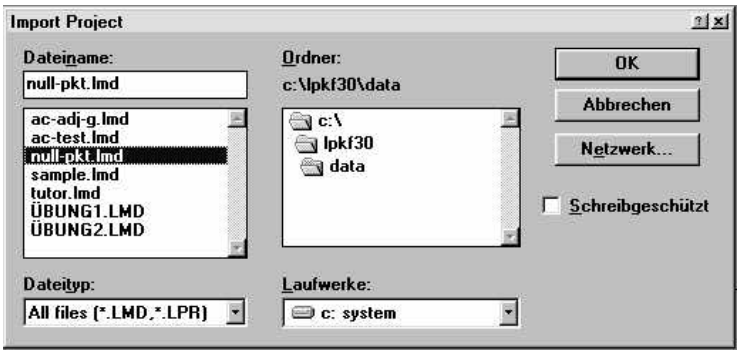
Carry out the following steps:

1. Make registration holes in double-sided board material.

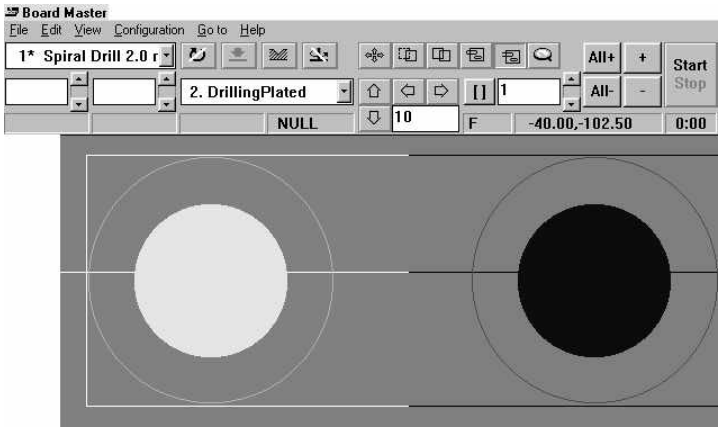
2. Secure the material and drilling backing (2 mm) onto the base plate using the registration hole pins. (see also the section entitled "Securing the board onto the machine bed").

3. Start up *BoardMaster* and select **LMD OR LPR** from the **FILE, IMPORT** menu.

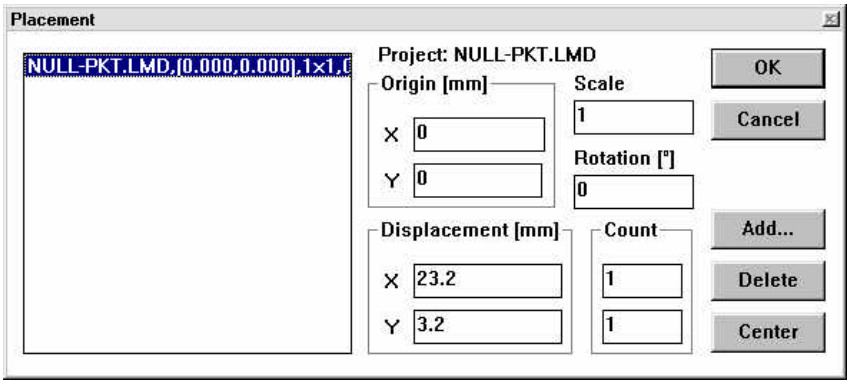
4. Now select the file **NULL-PKT.LMD** and import it by clicking **OK**.



5. Click on  to zoom the display and enclose the detail by clicking and dragging with the left mouse button.



6. Right-click on the project.



The **PLACEMENT** dialog box opens. Specify the position in the **REFERENCE POINT** box as x=0, y=0 and confirm by clicking on

.

7. Select the **DRILLINGPLATED** process from the production phase list box.

8. Click on  and enclose the first hole by clicking and dragging with the left mouse button.

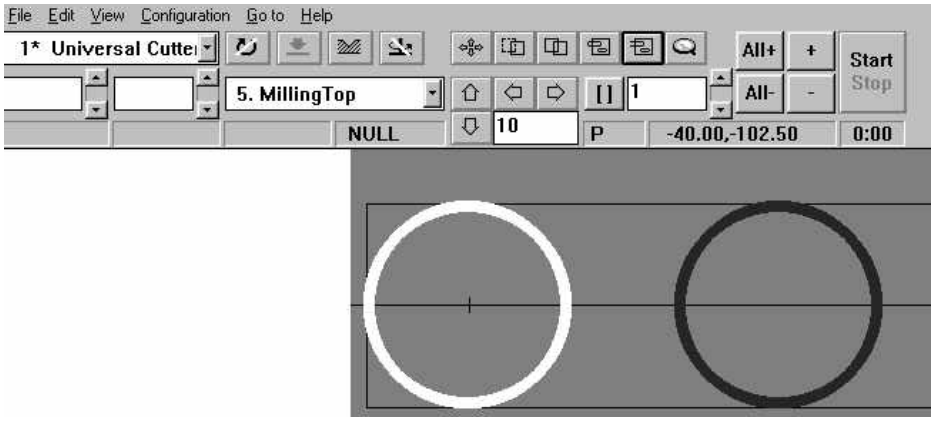
9. Now enable the selected hole for machining by clicking  and 

. The software now prompts you to insert the specified drill. The hole is drilled in the board once you have confirmed that the drill has been inserted.

10. Next move to the PAUSE position and rotate the board about the X axis.

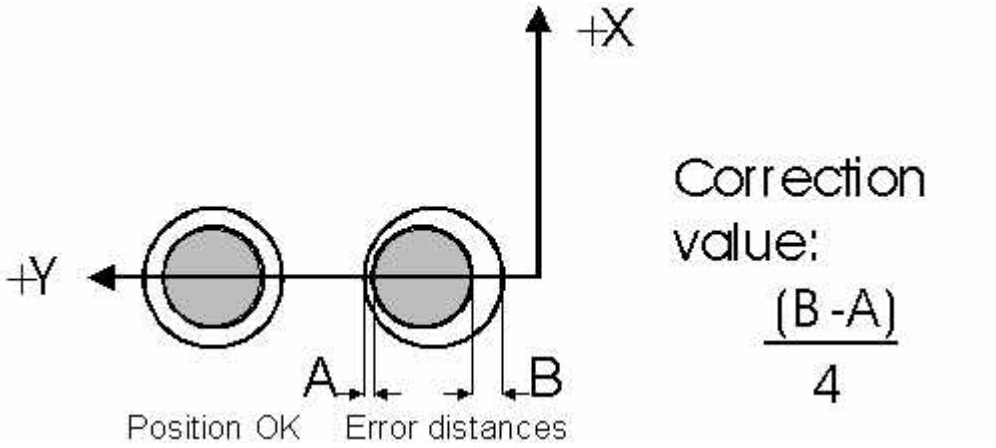
11. Now select the **MILLINGTOP** process from the production phase list box.

12. Click on  once again and enclose the milling track corresponding to the first hole by clicking and dragging with the left mouse button.



13. Now enable the milling track for machining by clicking + and Start Stop.
The software again prompts you to insert the specified tool (see chapter: changing a tool) and mills a circular track once you have confirmed that the specified tool has been inserted. Check the settings, including the milling pass width and the milling depth setting before you start machining.

14. Check visually that the milled channel passes precisely around the centre point of the hole.



15. The HOME position must be corrected if the milled line does not pass exactly through the centre point.
This can be done directly by amending the HOME position in the **MACHINE PARAMETERS** dialog box (see the section entitled ***"Programming the HOME position in LPKF BoardMaster"***).
The correct value can be calculated using the formula given above.
The Y coordinates must always be <u>added</u> to the correction value.

16. The procedure should be repeated as a check after making a correction. It is advisable that you use the second hole and milling track in the test program if the same board is to used to perform the check.

17. **<u>Take a note of the coordinates of the new HOME position.</u>**

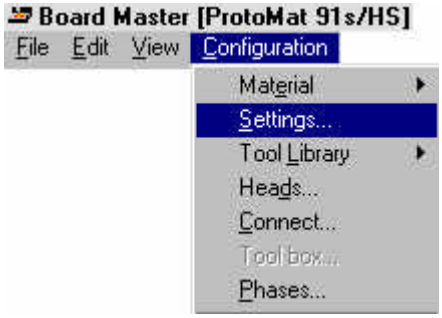
Programing the HOME position in LPKF *BoardMaster*

As previously explained, the HOME position of the LPKF ProtoMat C30 (C30/S) must lie precisely on the machine's axis of symmetry (the registration hole system with the red plastic slides) when you are machining double-sided boards. You must enter a correction if a check as described above shows that the HOME position does not lie on the axis of symmetry.

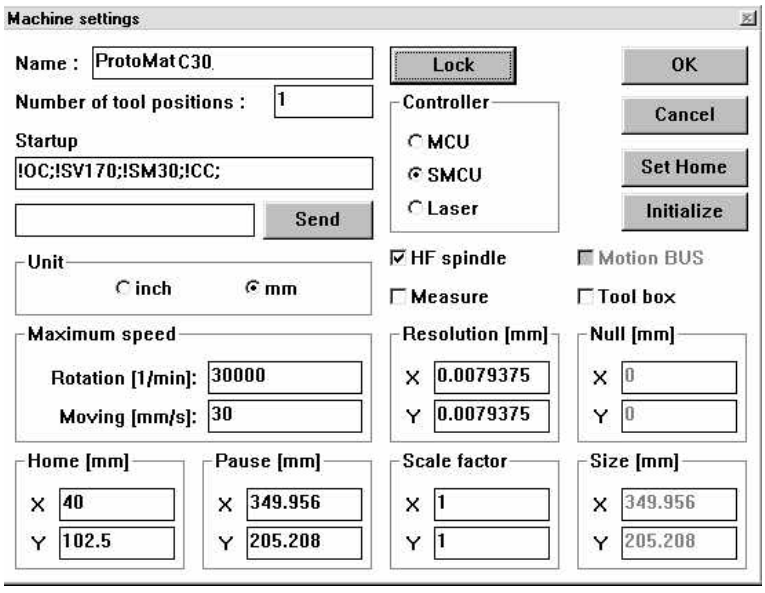
Proceed as follows to do this:

1. Start up *BoardMaster*.

2. Select **CONFIGURATION, SETTINGS** from the menu bar.



3. Click on **UNLOCK** so that you can make entries in this dialog box.

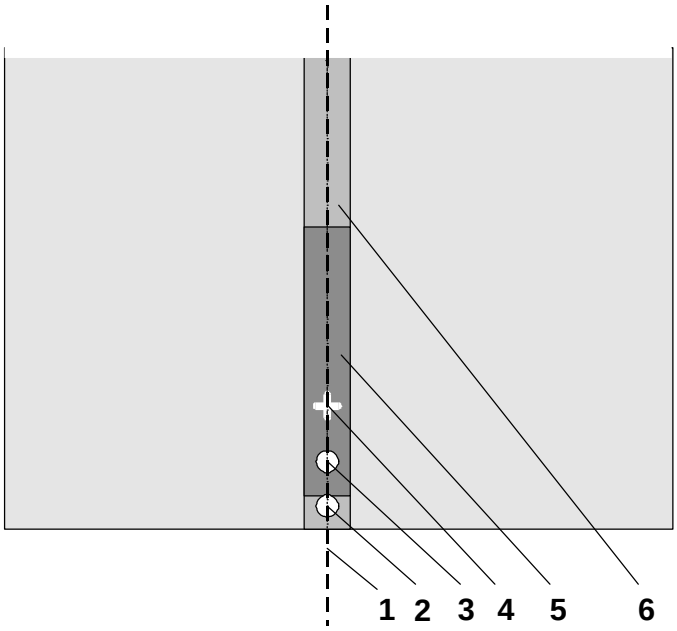


4. If necessary, correct the HOME position coordinates by increased or decreasing the value by the value previously measured.

5. The new values will only be saved when the **MACHINE SETTINGS...** dialog box is closed and you quit *BoardMaster*.

Creating a new registration hole system

The registration holes in the red registration hole strips grow with use over time will no longer be as precise as they originally were.
New holes must be drilled in the strips if this is the case.
The registration hole strips must be replaced if there are too many holes them after some time.



1. Axis of symmetry
2. Reference pin, the stop for the front registration hole strip (5)
3. Front alignment pin
4. HOME position, at least 10 mm from the front alignment pin
5. Registration hole strip
6. Registration hole groove

Front strip of the registration hole system

A new registration hole system is created as follows:

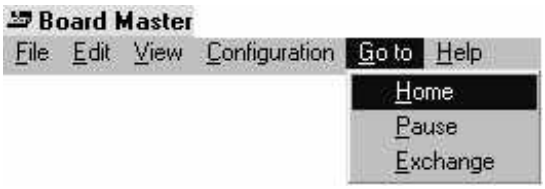
1. First press the two registration hole strips into the machine groove, with the front registration hole strip pushed against the reference pin at the front of the groove. The distance between the two registration hole strips should be approximately the size of the board material in the X axis.

2. Select the tool in *BoardMaster*: "*Spiral Drill Ref 2.95 mm"*

3. Fit the 2.95 mm diameter drill so that the distance between the base plate and the tip of the drill is approximately 0.5 mm.
This is the **only** time a tool is not inserted into the collet as far as it will go.

4. Adjust the working depth limiter to the very top using the knurled screw so that the drill stroke is lengthened.

5. Use **GO TO, HOME**

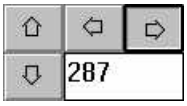


from the *BoardMaster* menu to move the plotter head to the HOME position and then use the arrow buttons to move the head to approximately the centre of the front registration hole strip.

Switch on the motor by clicking  and  (*raise/lower head*) to drill a hole approximately 4 mm deep.
Do not move the position of the plotter head in the Y axis again.

1. Use the arrow buttons in *BoardMaster* to move the plotter head approximately 25 mm in the positive X direction and define this position as the new HOME position:
Open the **MACHINE SETTINGS...** dialog box in *BoardMaster* via **CONFIGURATION, SETTINGS**, select **UNLOCK** and click on the **SET HOME** button. (see also the section entitled *Programming the HOME position in LPKF BoardMaster*)

2. Move along the X axis to the second, rear registration hole strip and drill a hole approximately 4 mm deep there too. It is imperative that you do not move in the Y direction. Select a distance suitable for working with a standard board material. For example, an A4 board is 297 mm, so a registration hole 5 mm from the edge of board gives a distance between the holes of **287** mm.
Simple method:



Enter the value 287 in the **STEP WIDTH** box in *BoardMaster* and then press the arrow button.
The plotter head moves in one 287 mm step to the new position.

3. Now remove the drilling tool by selecting a different tool in *BoardMaster*.

4. Move the plotter head to the side. Insert two alignment pins in the holes now made in the registration hole strip.
Please check that the pins are positioned securely as any play has a detrimental effect on alignment accuracy.

5. Mark old holes with a felt pen so they cannot be confused with the new ones.

6. Position the previously drilled board material and drilling backing over the alignment pins.
The format of the board material should be selected so that the registration hole strip does not need to be moved more than 10 mm. Moving the registration hole strip more than 10 mm reduces the accuracy of the registration hole system.

7. Now secure the board material in this position with adhesive tape (we recommend Tesakrepp 5250) on all four sides.

Caution	Please note that very sharp tools are involved and that they may become hot. Always work with the vacuum system switched on to avoid injury from swarf..

Tip:	You should select a distance between the registration holes which allows you to work with standard board material. A DIN A4 size board has a side length of 297 mm so holes 5 mm from the edge give a distance between the holes of 287 mm.

Computer-controlled functions of the ProtoMat C30 (C30/S)

Connection to a PC

The LPKF ProtoMat C30 (C30/S) has two serial ports. The first (25-pin) is used for connection to the controlling computer (PC).

The second port (9-pin) is intended for future applications.

The 25-pin interface of the LPKF ProtoMat C30 (C30/S) control unit is connected to a serial port on the computer with the null modem cable supplied.

The RS232 (null modem) cable for the LPKF ProtoMat C30 (C30/S) circuit-board plotter is wired as follows:

25-pin socket PC (COMx)		25-pin socket Circuit-board plotter (SerialPort1)
1		1
2	TXD	3
3	RXD	2
4		5
5		4
7	GND	7
8		20
15.17		24
20		8
24		15.17

The following parameters must be observed:

Baud rate	9600 (default setting, others upon request)
Parity	none
Data bits	8
Stop bit	1
Handshake	hardware
FiFo buffer enabled	no

The LPKF ProtoMat C30 (C30/S) command set

Command structure

The SMCU (*S*ignal *P*rocessor *C*ontrol *U*nit) control unit in the machine interprets the HP-GL commands described below and converts them into defined actions.

The *machine has a resolution of 7.9375µm*.
This differs from the resolution used by standard HP-GL plotters. The use of master commands reduces the output.

The syntax:

Symbol	Meaning
{...}	The contents can be repeated any number of times.
()	The command parameters are contained within these brackets.
[]	The content of these brackets is optional and does not have to be included.

The SMCU expects a separator, which may not be a digit or uppercase letter, between the command parameters. A new command can follow a parameter without a separator. The last character transmitted in a command file must be a semicolon or a line feed character (0A hex.).

Unrecognized commands are ignored by the control unit, but their parameters can lead to unwanted plot absolute or plot relative commands.

HP-GL standard commands

AA (x,y,a{,ß}){;}

Arc Absolute

Draws an arc around the absolute coordinate (x,y) starting from the current position with the arc angle a=[degrees]. It is drawn clockwise where the arc angle a is negative, but otherwise it is drawn anti-clockwise.

AR (x,y,a{,ß}){;}

Arc Relative

Draws an arc around the relative coordinate (x,y) starting from the current position with the arc angle a=[degrees]. It is drawn clockwise where the arc angle a is negative, but otherwise it is drawn anti-clockwise.

CI (r{,ß}){;}

Circle

Draws a complete circle with radius r around the current position. Resolution ß is ignored as the maximum resolution is always used when drawing.

EA (x,y){;}

Edge Rectangle Absolute

Draws a rectangle defined by two corner points diagonally opposite each other. The first corner point is determined by the current position and the second by the absolute coordinate (x,y).

ER (x,y){;}

Edge Rectangle Relative
Draws a rectangle defined by two corner points diagonally opposite each other. The first corner point is determined by the current position and the second by the relative coordinate (x,y).

IN {;}

Initialize
Returns the control unit to the its status after switching on. This restores all default settings.

IW (x0,y0,x1,y1){;}

Input Window
Restricts the XY axis working area to a window with the corner coordinates specified.

OH {;}

Output Hard Clip Limits
The control automatically determines its maximum travel range within the limit switches and sends the coordinates thus determined to the PC as an ASCII string in the form ("W Xmin,Ymin,Zmin,Xmax,Ymax,Zmax <cr>").

OS {;}

Output Status
The control unit sends its status cell to the PC in ASCII hex ("S xxxx <cr>").

PA (x1,y1{,...xn,yn}){;}

Plot Absolute
Draws a line from the current position to the absolute coordinates specified in sequence. The PU and PD commands can be specified as parameters between the coordinate pairs. The PA command word is not necessary if additional coordinate pairs are sent. All coordinate pairs without a command word are taken to relate to the last PA or PR commands sent and are executed accordingly.

PD {;}

Pen Down
Lowers the tool.

PR (x1,y1{,...xn,yn}){;}

Plot Relative
Draws a line from the current position to the relative coordinates specified in sequence. The PU and PD commands can be specified as parameters between the coordinate pairs. The PA command word is not necessary if additional coordinate pairs are sent. All coordinate pairs without a command word are taken to relate to the last PA or PR commands sent and are executed accordingly.

PU {;}

Pen Up
Raises the tool.

VS (v{,n}){;}

Velocity Select
Defines the track speed v=[µm/s] in the XY-plane with the tool lowered and assigns this speed to the tool with number n.

Special commands

All special commands begin with the "!" character and their syntax is otherwise the same as that for HP-GL standard commands.

!AS (a){;}

Acceleration Set

Defines a new acceleration constant a=mm/s^2. The permissible value range is 10 to 50000.

!CC {;}

Close Channel

Terminates any data transfer introduced with the command !OC.

!CM (n){;}

Change Mode

Toggles between the drill (n=0) and the mill working modes (n=1).

!CT (n){;}

Command Counter

Toggles between the echo mode (n=1) and the non-echo mode (n=0). In echo mode, the machine confirms every correctly completed command with the message "C<cr>".

!EM (n){;}

External Motor

Switches the milling/drilling motor on (n=1) or off (n=0)

!ES (n){;}

Enable Stop

Enables (n=1) and locks (n=0) the external stop function. The external stop function is locked immediately after switching on.

!FP {;}

Full Power

Switches the XYZ axis motors to full power.

!HP {;}

Half Power

Switches the XYZ axis motors to half power.

!OC {;}

Open Channel

Opens direct data transmission from the *SerialPort1* serial data channel to the *SerialPort2* serial data channel. All characters received on the *SerialPort1* data channel are sent to the *SerialPort2* data channel until the !CC character string is received.

!ON (a){;}

Output Nominal Position

The control unit sends the nominal position (target position) of the motor axis addressed with parameter a. The following addresses are attributed to the motor axes:
0 = X, Y, Z axis
1 = X axis
2 = Y axis
3 = Z axis

!RD (a){;}

Read Port

Forces a read on the input port with the address a=<0..15>. The data is output as ASCII numbers through the serial port from which the command originated.

!RS (r){;}

Resolution Set

Tells the control unit the machine's step size (r=µm/step). The permissible value range is 1 to 32000.

!TA (x,y,z){;}

Plot Three-D Absolute

Executes out a spatial movement from the current position to the absolute coordinate (x,y,z).

!TD (t1,t2,t3,t4){;}

Time for Drilling

Sets a new drilling time t=[ms].

!TM (t1,t2,t3,t4){;}

Time for Milling

Sets the new milling time t=[ms].

!TR (x,y,z){;}

Plot Three-D Relative

Executes a spatial movement from the current position to the relative coordinate (x,y,z).

!TS (t){;}

Time to Stabilize

Sets a stabilization time t=[ms] between the individual commands.

!TW (t){;}

Time to Wait

The next command is only executed once the waiting time t=[ms] has expired.

!VU (v){;}

Velocity if Pen Up

Defines the track speed v=[µm/s] of the motion in the XY plane when the tool is raised.

!VZ (v){;}

Velocity Z axis

Defines the speed v=[µm/s] of the movement in the Z axis.

!WR (a,d{,m}){;}

Write Port

Writes the data word d to the port with address a=<0..15> with the option of assigning a bit mask.

!ZA (z){;}

Plot Z axis Absolute

Moves the Z axis from the current position to the absolute coordinate (z).

!ZR (z){;}

Plot Z axis Relative

Moves the Z axis from the current position to the absolute coordinate (z).

Special command for the motor controller

The command to open the *SerialPort2* (!OC;) must be processed before communication can take place with the plotter spindle drive motor, after which the *SerialPort2* serial port must be closed again (!CC;)

!RM (r){;}

Revolutions Motor, r=0...32.
Sets the speed (r)*1000 of the DC motor.

Direct commands

Direct commands are special commands which are executed by-passing the command buffer immediately they are interpreted.

!CB{;}

Clear Buffer
Deletes all commands from the command buffer.

!GO{;}

Go On
Clears the stop command and continues command execution.

!RC{;}

Repeat Command
Repeats the most recently executed command.

!ST{;}

Stop
Interrupts the execution of commands once the current command has completed.

The command set implemented is a subset of the HP-GL. Be aware when controlling the device from any other CAD system taht the resolution of the HP-GL commands is substantially smaller than that of normal pen plotters.

The step size is 7.9375 µm/step. (6.35 mm/800 steps).

Tutorial on creating a printed circuit board

It is assumed that the relevant milling data has already been loaded or prepared in *BoardMaster*. The data from the CircuitCAM tutorial can be used, for example.

A further requirement is that the HOME position has been programmed exactly as described above.

Caution : Take care when handling the tools. Danger of cutting. Do not forget to switch on the vacuum system during machining. Bevore beginning you must read the chapters **" Operating the working depth limiter"** and **"Changing a tool (C30)"** as well as **"Changing a tool (C30/S).**

1. Move to the PAUSE position using the *BoardMaster* menu (**GO TO, PAUSE**).

2. Secure the board material with alignment pins as described in the section entitled "Securing the board".

3. Move to the bottom left corner (-x, -y) of the board material using the traverse buttons in *BoardMaster* such that the working depth limiter does not quite come into contact with the adhesive tape.

4. Program this corner in the *BoardMaster* menu **CONFIGURATION, MATERIAL, SET X,Y-MIN** .

5. In the same way, move to the top right corner (+x, +y) of the material and program this under **CONFIGURATION, MATERIAL, SET X,Y MAX**.

6. The material is shown in *BoardMaster* as light grey on the dark grey machine surface.

7. Select **LMD OR LPR** under **FILE, IMPORT** and import the tutorial file **TUTOR.LMD**.
(See also the instructions for importing the file null-pkt.lmd in the section entitled "Checking and correcting the HOME position")

8. Position the view of the board in *BoardMaster* using **EDIT, PLACEMENT** such that all graphical data is located on the material.

Tip: You can open the "**PLACEMENT**" dialog box by right-clicking when the mouse pointer is positioned immediately over the graphical data.

9. Select the first machining phase, **DRILLINGPLATED**.

10. Click on 

to select the drilling data. Selected data is shown lighter.

11. Click on **AUTO-MOTOR-ON**  . (Right motor button in *BoardMaster*).

12. Click on **START** 

.

13. *BoardMaster* requests the tool required for the machining phase and the machine moves to the **TOOL CHANGE** position and automatically switches the motor off.

14. Push down the lever to open the collet and lock it in position by moving it to the right. The tool in the machine can now be removed from the collet using the tweezers supplied.

15. Insert the tool requested as far as it will go and unlock the lever by moving it to the left and then up. The collet is now closed.

16. Confirm the tool change by clicking 

. The motor switches on and the first drilling diameter of the drilling phase is executed.

17. Once the holes of the current diameter have been made, the next tool is requested and changed in the same way.

18. Once the drilling phase has finished, the **MILLINGBOTTOM** milling phase is selected once any galvanic through-hole plating has been carried out.

19. Click on 

to select the milling data. The selected data is shown lighter.

20. Click on the **START** button 

. The plotter head moves to the **TOOL CHANGE** position and prompts for the current tool. Click **STOP FOR ALTERATION AFTER TOOL CHANGE** in the tool combo box to set the milling depth.

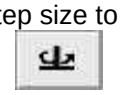
21. Insert the universal milling cutter.

22. Click 

to quit the dialog box.

23. Use the arrow buttons in *BoardMaster* to move to a free position on the board material.

24. Set the step size to 5-10 mm in the **STEP SIZE** box.

Click the  **AUTO-MOTOR-ON** button,

switch on the motor using the  **MOTOR ON/OFF** button,

lower the head by clicking  and move the head using the arrow buttons. Set the milling depth. See also the section entitled "How the mechanical working depth limiter works".

25. Switch off the motor by clicking on **MOTOR ON/OFF**  and switch the motor back on by clicking on the

AUTO-MOTOR-ON  button.

Use the 

button to start the machining.

26. Then move to the PAUSE position and turn the material if you are machining a double-sided board.

27. Select the **MILLINGTOP** milling phase and machine as described above.

28. If required, select the **CUTTING** milling phase and machine with a contour milling cutter.

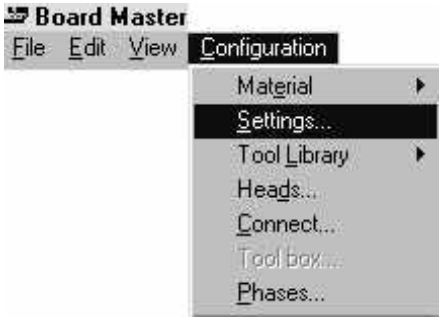
29. Move to the PAUSE position, remove the board and proceed as described in the section entitled "Cleaning the board".

Reprogramming the machine data

You will have to re-enter the PAUSE or HOME position data in the machine settings if the PC operating system crashes and the head no longer moves to these positions.
Proceed as follows:

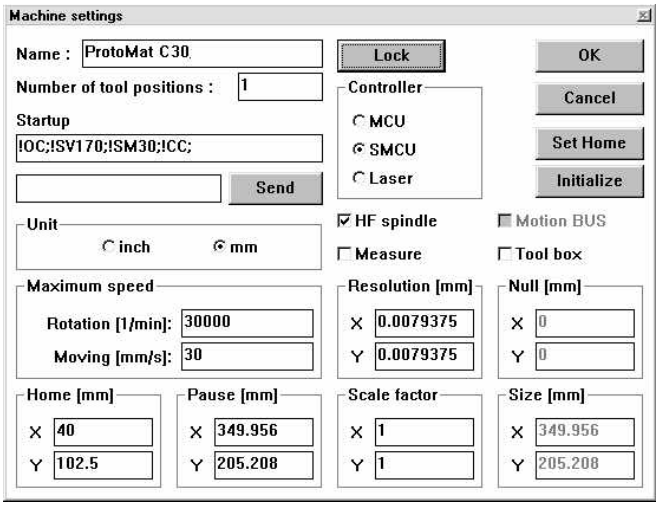
1. Start up *BoardMaster*.

2. Select **CONFIGURATION**, **PARAMETERS** from the menu bar.



1. Click **UNLOCK**.
This activates the **CONTROL**, **SET HOME** and **INITIALIZE** boxes.

2. Click on **INITIALIZE**. The device moves to all four end positions. The device then comes to a halt in the zero position (at the front right). The traverse range thus determined is displayed under **SIZE** and saved by *BoardMaster*.
See the *BoardMaster* Manual for more detailed information.



3. The coordinates for the HOME position are generated automatically.
The X value is set at **0** and the Y value corresponds to half the value specified for Y under **SIZE**.
Now enter the values noted down for the HOME position in the **HOME** box. These values are determined as described in the section entitled "Checking and correcting the HOME position".

The coordinates for the PAUSE position correspond to the values in the **SIZE** box. You can enter any coordinates here.

4. Click

to quit this box.

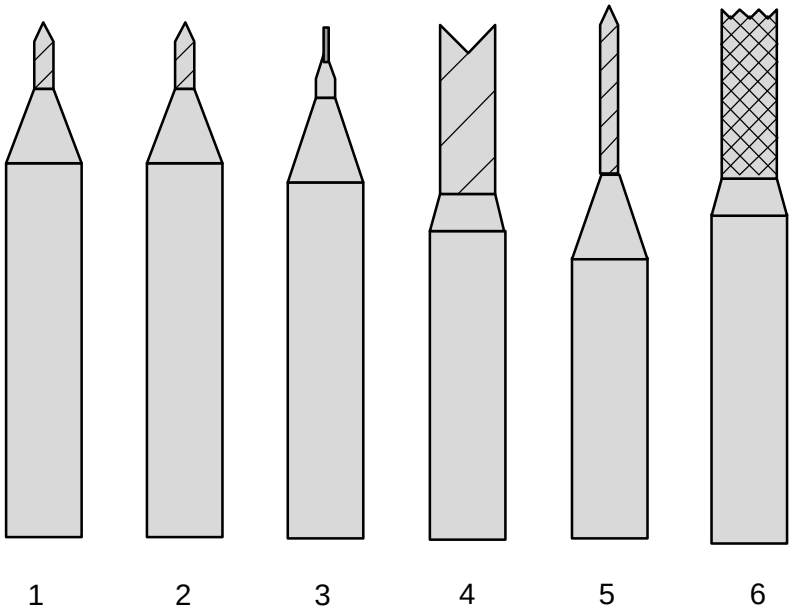
5. *BoardMaster* must be shut down and restarted.

The new values are saved when the **MACHINE SETTINGS...** dialog box is closed and you quit *BoardMaster*.

Tools, material and accessories

Tools

The tools for the **LPKF *ProtoMat C30 (C30/S)*** come in two different lengths.
Tools used to machine the material surface (milling and engraving) are 36 mm long while tools used for drilling or contour milling are 38 mm long.
The following tools are available:



LPKF tools for circuit-board plotter

1. 36 mm long universal LPKF milling cutter and drill for milling isolation channels and for engraving front panels from 0.2 - 0.5 mm (depending on depth set).

2. 36 mm long LPKF micromilling cutter for milling 0.1 to 0.2 mm isolation channels (depending on depth set) with a 17 µm copper cladding on the board material

3. LPKF HF milling cutter for creating 0.25 mm or 0.4 mm wide rectangular section isolation channels.

4. 36 mm long double-chamfered cutter (0.8 mm; 1 mm; 2 mm) for engraving front panels and for engraving wider isolation channels.

5. 38 mm long twist drill of various diameters for drilling in board material.

6. 38 mm long contour milling cutter (1.0 mm; 2.0 mm) for milling out cut-outs in the board material.

Caution Only change tools in the positions defined for this purpose.

The tools must always be inserted in the toolholder as far as the stop, otherwise the working depth will be incorrect.
In certain circumstances, this can even result in damage to the machine base plate.

Tweezers are supplied for tool insertion and removal.

Materials used for machining

In general, all board materials supplied by LPKF can be used for machining. You are free to machine all other materials at your own risk. Please follow the manufacturers' instructions.

Material supplied by LPKF and suitable for machining:

FR3 material:	engraving, drilling, milling
FR4 material :	engraving, drilling, milling
Aluminium:	engraving, milling special alloys only, such as AlCuMg1
Engraving film:	engraving

Other materials upon request.

Caution

Do not allow to the material overheat - lethal gases may be produced.
Carcinogenic dusts may be produced when working with materials containing glass fibres. You should therefore always work with the vacuum system switched on.
Carcinogenic dusts or hazardous gases may be produced when working with unknown materials.
Ask your supplier or the manufacturer before you begin machining.

Procedures for milling and drilling

Securing the board

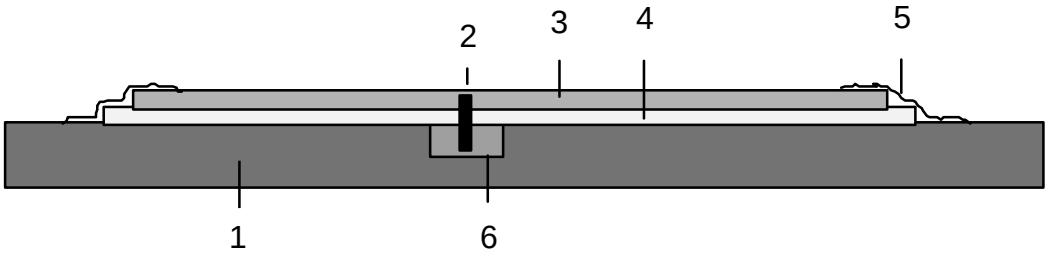
Make 3.0 mm or 3.05 mm diameter congruent registration holes in the board material and drilling backing in the X axis.
This can also be done with any bench drill. Note that the diameter decreases during galvanic through-hole plating.

Tip:	The drilling backing should be drilled to a larger diameter, such as 5 mm to allow for inaccuracies in the registration holes.

Move the plotter head to the PAUSE position. Insert alignment pins in the front and rear registration hole strips.
It is essential that you make sure the front registration hole strip in the machine groove is pushed against the reference pin at the front.

Position the drilled board material and drilling backing over the alignment pins.
The format of the board material should be selected so that the registration hole strip does not need to be moved more than 10 mm. Moving the registration hole strip more than 10 mm reduces the accuracy of the registration hole system.

Now additionally secure the board material in this position on all four sides with adhesive tape (we recommend Tesakrepp 5250).
This prevent the corners of the board bending up.



Securing the board

1. Machine bed (aluminium base plate)
2. 3 mm diameter alignment pins
3. Board material approximately 1.6 mm thick
4. 2 mm thick drilling backing
5. Adhesive tape
6. Registration hole strip

The alignment pins hold the board in position.
They also act as a reference when double-sided boards are rotated.
The adhesive tape holds the board down at the edges. This is particularly important for contour milling.
It is important that no adhesive tape, drilling or milling swarf is left between the individual layers to ensure that the board material lies absolutely flat. Small particles under the board material have an adverse affect on the uniformity of the milling depth.

Caution	Switch on the vacuum system. Bear in mind that the vacuum filter might need be changed.

Operating the working depth limiter

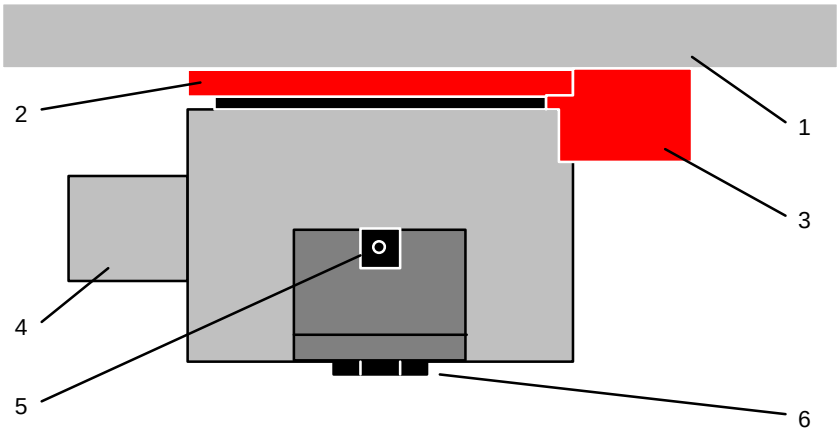
Caution Keep your fingers clear of the machine's traverse range during operation.

It is particularly important that you keep the milling depth constant when milling isolation channels in board materials which tend to be slightly curved. LPKF ProtoMat C30 (C30/S) achieves this using the mechanical working depth limiter.

This has following benefits:

1. The depth limiter rides on the surface of the material. The working depth limiter can follow slightly warped boards.

2. The material is held down within certain limits by the working depth limiter.
   The head is lowered by a solenoid actuator and raised by a spring.



The LPKF ProtoMat C30 (C30/S) working depth limiter

1. Holding plate
2. Knurled nut used to set milling depth
3. Holding block for working depth limiter
4. Suction connector
5. Tool fixing screw (only ProtoMat C30)
6. Feeler ring in the working depth limiter

The milling depth is set by adjusting the knurled nut (2) on the working depth limiter.
Turning the wheel clockwise increases the milling depth and also the milling width in the case of LPKF universal milling cutters due to their conical shape.
Turning the wheel anti-clockwise reduces the milling depth.
The milling depth is altered by approximately 4 µm for each click of the wheel.
Turning the wheel anti-clockwise is easier than turning it clockwise, particularly when the head is lowered.

Changing a tool (C30)

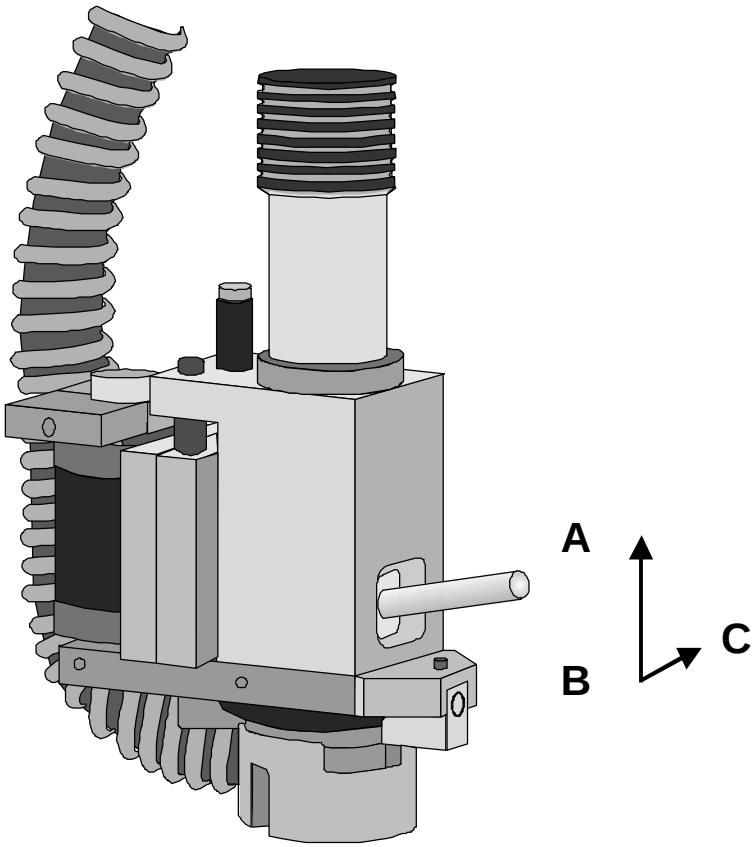
- Remove the tool fixing screw (see picture *working depth limiter*)
- Pull out a possibly available tool with the help of a tweezers from the tool housing.
- Introduce the new tool up to the plot in the tool housing with a tweezers.
- Move and fix the fixing screw.

Changing a tool (C30/S)

The plotter spindle collet on the ProtoMat C30 (C30/S) is operated by a lever which simultaneously disengages the DC motor via a clutch as a spring packet opens the collet.

There must be a tool in the plotter spindle collet whenever the machine is switched on.
It is imperative that the collet is closed. (The collet is closed when the lever is in the “up” position.)

Caution: **Operating the lever when the motor is running could damage the coupling between the motor and the collet. Do not switch on the motor by opened tool clamp or without tool!**



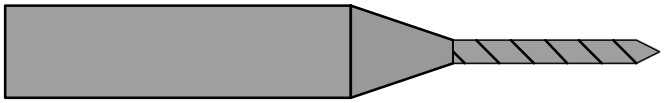
Operating the plotter spindle collet

Position A: Lever in the normal position. The collet is closed.
The motor is connected to the spindle by a clutch.

Position B: The lever must be pushed down to open the collet.
The clutch disengages the motor and a spring pack opens the collet.

Position C: After the lever is pushed down, the open collet is locked open by moving the lever to the right. It is now a simple matter to change the tool using the tweezers supplied.

Drilling



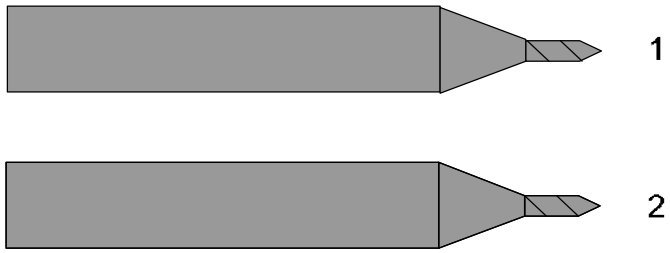
Twist drill

Caution Make sure that the board is secured in position before drilling. Switch on the vacuum system.

The boards must be drilled with drills designed specifically for boards. It is important that the head always lowers at a constant speed. This is ensured by a damper built into the plotter head.
Lowering the head too quickly may result in burring, particularly with holes of small diameter. We therefore recommend that you punch holes with a small diameter before drilling. The **MARKINGDRILLS** phase in *BoardMaster* is intended for this purpose and uses a special universal milling cutter, the "**0.2 MM UNIVERSAL MARKING CUTTER"**.

Only one board can be drilled at a time. It is not possible to stack boards one on top of the other. A drill cover plate is not required.
All drills are 38 mm long.
See the section entitled “Practical tips” for further instructions.

Isolation milling



LPKF Universal (1)and microcutters (2)

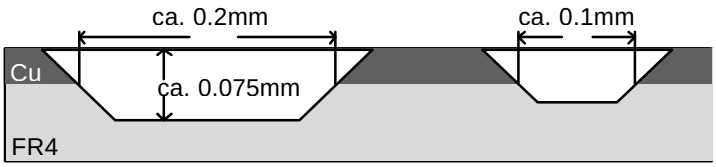
Caution Make sure that the board is positioned securely before milling.
Switch on the vacuum system.

Ensure that the (36 mm long) *LPKF universal milling cutters* being used are sufficiently sharp before you start milling. The milling width is preset in *CircuitCAM* by selecting the isolation track width and the appropriate tool. The preferred milling width is between 0.2 and 0.4 mm.

As a rule, the milling depth must be set as wide (deep) as possible. The tool wears more quickly if only the extreme milling cutter tip (<0.2 mm isolation) is used than with deeper

milling.The LPKF micromilling cutters can be used to create even finer isolation channels but their service life will be only approximately 20% of that of the LPKF universal milling cutters mentioned above.

Caution: Do not confuse micromilling cutters and universal milling cutters. It is only possible to distinguish the two under a microscope.



Milling passes using the LPKF universal, and micro cutters

See the section entitled “Practical tips” for more information.

See the section entitled "Board material" for the advantages and disadvantages of various materials.

The board must be cleaned after machining.
This can be done either in a brush machine or, alternatively, with a manual board cleaner (LPKF accessories). In either case, the board must be rinsed thoroughly with water to remove any copper dust produced by brushing.

After rinsing, the board must be dried thoroughly (air drier) and then protected against oxidation by a soldering varnish.

Contour milling in board material

Contour milling cutters

The traverse speed has to be reduced for contour milling.
This may differ from material to material.
Use only contour milling cutters (38 mm long) designed specifically for this purpose: 1 or 2 mm diameter if possible.

The 1 mm contour milling cutter should only be used for internal cut-outs (smaller internal radius). It breaks relatively easily so set the feed rate to the minimum setting.

The 2 mm contour milling cutter is far more robust and is to be recommended for milling external contours.

Caution All speeds and feed rates prescribed in *BoardMaster* are for FR4 material. You should begin at a lower feed rate when working with other materials.

Caution Please note that some materials, including FR4, may produce carcinogenic dusts (from glass fibres).
You should therefore always work with the vacuum system switched on.
Always use a microfilter.
Some materials (such as Teflon) may produce lethal gases during cutting.

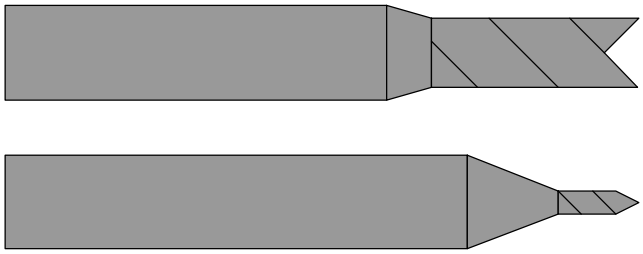
Milling wide isolation channels and rubouts

Double-chamfered cutter

Wide isolation channels and rubout areas (the removal of areas of residual copper) can be created using 36 mm long double-chamfered cutters.
Various diameters (0.8 mm, 1 mm, 2 mm, 3 mm) are available depending on the size of the area of copper residue to be removed.

The milling depth must be set such that the copper is removed with minimal burring. The 3 mm double-chamfered cutter is particularly well suited to milling very wide isolation channels (VDE regulations).

Front plate engraving



Top: Double-chamfered cutter. Bottom: LPKF universal milling cutter

Set the traverse speed as appropriate for the engraving depth and the material when engraving. Use an LPKF universal milling cutter or LPKF double chamfered cutter.

Caution	Switch on the vacuum system, even when engraving.

Milling solder-stop sheets

Create the pads in solder-stop sheets using a ***Unimill 100 Micromill*** with a tool diameter of ***0.15 mm***.
The speed should be set to 20,000 rpm and the advance to 5 mm/s.

Tip:	Set the milling depth using an edge area of the solder-stop sheet which is not used. Use the arrow buttons in *BoardMaster* to mill a 2 x 2 mm square with the motor switched on and check the depth.

Once the milling depth has been set, start the milling procedure using the file prepared by *CircuitCAM*.
At the end of the milling procedure, check that all the pads have been cut out. Start the milling procedure a second time if this is not the case.

Milling layout films

LPKF HF milling cutter

- Layout films can be machined with LPKF HF milling cutters.
- Secure the film base (plexiglas or glass sheet) onto the machine bench with Tesa tape.
- Lay the film material on the base with the coated (matte) side facing upwards.
- Now flatten the film material out firmly flat and on the film support, expelling any air completely.
- Now stick down the film on all four sides with a non-stretching transparent adhesive tape to form an air seal.
  There must not be any air bubbles between the film and the base.
  The milling depth can now be set at the film edge.
  It can be checked by milling a frame around the film area (manual method).
- The traverse speed should be reduced to about 15 mm/second
- Switch on the extractor, but only to half power, so that it extracts "secondary air" on the suction connection or reduce the power on the electronic extractor controller if there is one fitted.
  The film milling program may now be started.
- Film material comes in DIN A3 and A4 formats (special sizes available upon request).

Important:	The film coating is easily scratched and is water soluble, so do not let it come into contact with water.

The film can be recopied with a staining device upon request.
See the section entitled "Practical tips" for more information.

Staining milled films

Duroscal black stain is available for milled negative films which can then be used to make positives.
The fully milled engraving film is stained with Duroscal stain by pouring the liquid onto a SAFIR pad and spreading it evenly over the whole film.
Excess stain must be wiped off with cellulose wadding.
The stained film must be held against the light to check it and to find poorly covered areas so that they can be re-stained.
Now remove the coating immediately. The stain must not be allowed to dry.

Caution	Follow the instructions on the stain container. The stain must not get onto the back of the film as it cannot be removed. The stain is also very difficult to remove from other surfaces (fabrics, skin). Wear an overall and rubber gloves.

Removing the coating

Treat only one film per container when removing coatings to prevent any damage to the second film resulting from contact between its reverse and a surface which is wet from the stain.

Caution Follow the safety instructions on the quick-acting coating remover container.

There are two methods of removing the coating:

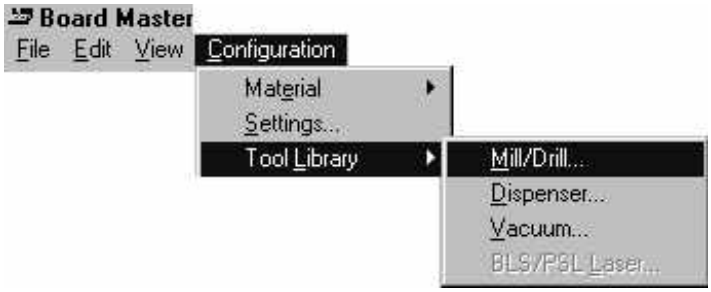
1. Quick coating removal.
Pour the quick-acting coating remover onto the film and immediately wipe the dissolved protective coating with cellulose applying light pressure.
Now dry the film with cellulose wadding, blotting paper or a cloth.

2. Removal with water.
This method involves placing the film in a bowl of hand-hot water (to which a small amount of washing-up liquid has been added).
The protective layer dissolves after about 30 minutes.
Any remaining coating must be removed with a fine hand brush.
This method is more economical and kinder to the environment than the quick-acting method of removal.
The film can be left in the water bath as long as you want.

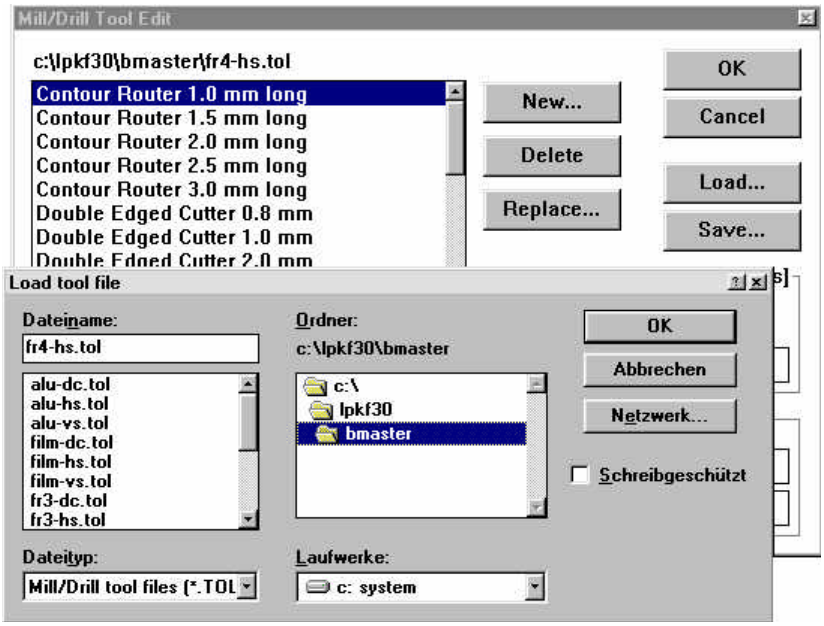
Tool libraries in *BoardMaster*

BoardMaster can be loaded with a previously created library of various tools as an aid to deciding which tool can be used for which materials.

Select the **PLOTTER HEAD** submenu of the **CONFIGURATION, TOOL LIBRARY** menu in *BoardMaster*.



The **DRILLING AND MILLING TOOL PARAMETERS** dialog box opens and you can now **LOAD** a suitable tool library from the directory selected. The tool library directory is called ***c:\lpkf30\bmaster***. Tool libraries have the extension ***.tol***



Board material

Technically speaking, it is possible to machine any board material.

However, phenol resins of lesser quality, such as FR 2, can adversely affect the milling quality

Glass fibre reinforced epoxy material (FR 4 or G 10) can present a health hazard due to the milling dust produced (allergies, risk of cancer).
Tool service life is also substantially reduced.

Caution Never work without the extractor running.

We recommend epoxy material without glass fibre (FR 3). A total thickness of 1.5 mm with a 35 µm copper coating is normally used.

Yielding milling is of the highest quality and a high tool service life, FR 4 has no known drawbacks other than a slightly reduced mechanical load capacity (breakage).

This should not be a significant drawback for prototype boards unless particularly heavy components are to be mounted.

Even finer milling channels can be engraved on 17 µm material at a higher packing density.

A 5 - 17 µm copper thickness is used for galvanically through-hole plated, double-sided boards to prevent an excessively thick copper layer building up following galvanic copper-plating.

Compromises must be taken for 70 µm material when setting the milling depth in that a deeper milling depth results in wider milling passes of 0.3 to 0.6 mm.

Special board materials with a thicker copper layer of up to 300 µm can no longer be machined with the LPKF universal milling cutter.
Contour milling cutters or special tools are needed for these materials.

In these cases, we would ask that you consult us and send sample material so that we can carry out any tests which may be necessary.

A drilling backing is essential for all machining processes on board material.
This allows holes to be drilled through the board without damaging the machine.
The drilling backing can be made simply of bakelized paper and should be 2 mm thick.

Cleaning the board

The finished board must be thoroughly cleaned before components are mounted.
This can be done manually or in a board brushing machine.

Place the board on a flat surface to clean it by hand.
Brush the board with a wet board cleaner (such as the LPKF PAD board cleaner) in the preferred direction of the conductor paths.

The point of brushing is, firstly, to remove the layer of oxidation, and, secondly, to remove any burrs resulting from the use of a blunt tool.

After brushing, the board must be clean of any metal particles.

From now on, the board should only be held by its edges or with gloves.

It is best to rinse off the board under running hot water to remove any brushings from the isolation channels.

Now dry the board with an air drier.

After drying the board coat it on both sides with soldering varnish.

Caution: Never use compressed air to blow out the channels as any oil particles in the air introduced by a faulty oil separator can cause problems later in the manufacturing process.

Practical tips

- Set the milling depth such that ***engraving is too deep*** rather than too shallow. Insufficient depth when engraving increases wear on the milling tool.

- There are a number of reasons why the ***milling width(depth) might be uneven***.

  It is important that the ***machine bed is truly clean***.
  Adhesive tape residue and such like can have a significant adverse affect on the milling depth. Millings between the machine bed, drilling backing and board reduce precision.

  Severely ***distorted materials*** *bend such that the flexure is visible underneath; in this case, secure the edges well with adhesive tape.*
  Another important point for precise milling depth is that millings and drilling chips are ***removed by suction***.

- Hooks can occur between the milling tracks if the incorrect milling sequence is followed, in particular with circles.
  If a circle is to be milled anti-clockwise with a tool which rotates clockwise, ***fine hooks*** can occur between the copper areas if the milling tracks overlap.
  The reason for this is that the cutting speed on the outer edges is reduced. The solution is to select the correct direction of milling.
  In addition, you can select the **REMOVE SPIKES** option on the **STRATEGY** tab in *CircuitCAM* when you set up the isolation job.

- ***Milling burrs*** can be caused by blunt tools or incorrect traverse speeds.

- Deeper settings may be the answer if the structure to be milled allows. Otherwise, change the tool.

- ***Burrs*** arising during contour milling or ***cut edges which are not clean*** are caused either by a blunt tool or an incorrect feed rate.

- With some materials, the ***colour of the milling pass*** gives some indication of the condition of the tool.
  Dark isolation tracks on epoxy materials indicate that the tool is sharp, while lighter tracks indicate a blunt tool.

- ***Drilling burrs*** are caused either because the tool is blunt or the head is being lowered too quickly.

  In the first case, change the tool. In the second case, reduce the tool height over the material.

- ***Drill deflection*** occurs where thin tools which are no longer absolutely sharp are used.
  However, surface structure of the material may also be a factor.
  Drill deflection cannot be avoided even with a sharp tool if, for example, the glass fibre structure of FR4 materials penetrates the copper.
  Drill deflection is very slight for materials with additional, removable copper film (FR4 material with 18 µm or 9 µm copper coating).

Tip:	We recommend that you punch-mark small diameter holes before drilling. The MARKINGDRILLS phase in *BoardMaster* is intended for this purpose and uses a special universal milling cutter, the "0.2 MM UNIVERSAL MARKING CUTTER".

- ***Vitrification of the drilled hole*** occurs where the drill remains in the hole too long after the hole has been made.
  These holes then cause problems for through-hole plating.

  Reduce the drilling times as appropriate.

- ***Drills may break*** where the drilling backing has already been used a number of times.
  The drilling backing should be changed for each new board.
  The drill may break if it comes into contact with the edge of an existing hole in the base.

  Broken tools must be removed from the board and the drilling backing. Very thin drills may also break if the tool is too high above the material.

- ***Milling passes*** created during film milling ***will be uneven*** if there is air still trapped under the film.

  The film may buckle after a while if ***elastic adhesive tape*** is used to secure the film. It is particularly important that the milling backing is flat (LPKF engraving film backing).

- ***Burrs*** will be produced when milling film if either the tool is blunt or milling is too deep.

- ***Uniform misalignment*** between the solder and component sides occurs where the HOME position has not been programmed accurately.

- ***Increasing misalignment in the X axis*** between the solder and component sides occurs where the registration hole system is no longer parallel to the X axis.

  A new registration hole system will have to be drilled.

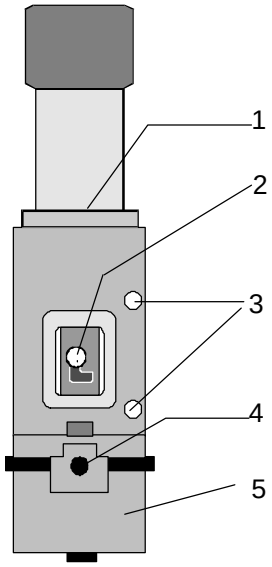
Appendix

Maintenance

Keep spindles clean. In rooms with a high air humidity, wipe down with a lightly oiled cloth from time to time. Keep transport spindles oiled and clean. Do not oil the bearings.

Working depth limiter

Dismantle and clean the working depth limiter at regular intervals. To do this, first switch off the machine. Then proceed as follows:



1. Mark the insertion depth of the spindle **(1)**.

2. Unscrew and remove the collet lever **(2) (ProtoMat C30/S)**.

3. Undo the Allen screws in the holding block **(3)**.

4. The motor can now be lifted out vertically. Gently twist backwards and forwards if necessary.

5. Remove the fixture **(4)**.

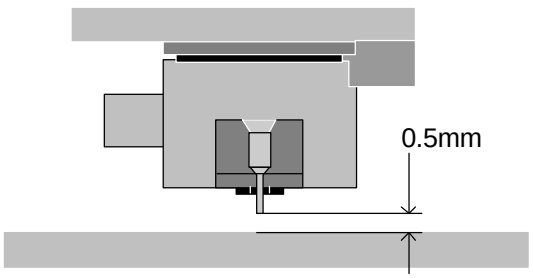
6. The working depth limiter **(5)** can now be removed to the side for cleaning.

7. Clean both parts of the working depth limiter using the brush supplied.

8. After cleaning, the working depth limiter is reassembled in reverse order and the motor is reinserted in the retaining block.

9. Always check that the insertion depth of the spindle is correct before starting up. The distance between the drill tip and machine base plate must be 0.5 mm when the head is lowered.
The machine may not be able to drill through the board if the distance is too great. A larger diameter should be used for the drill because a smaller drill can easily break as it is being adjusted.

10. Finally tighten the screws **(2)** back up and screw the collet lever **(1)** back in **(ProtoMat C30/S).**



(Head lowered)

Check the distance when reassembling the plotter spindle.
The machine may be damaged if the distance is too small when drilling.

Caution Use only graphite to lubricate the working depth limiter.

Lubricating the carriage guide wipers

You must make sure that the carriage guide wipers on the **LPKF *ProtoMat C30 (C30/S)*** are always well lubricated.

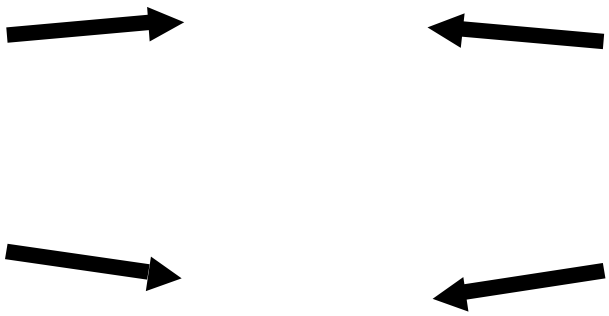
Carriage guide wipers of the Y-axis

Drive the cutting head in the Homeposition, before the Y-axis will be lubricated.

Before the lubrication the Y-axis you must loose the cover located internal hexagon head screws (3mm). After remoting the screws take off the cover.

The positions of the oil insertion opening for the carriage guide wipers of the

Y-axis are marked in the following image with arrows:

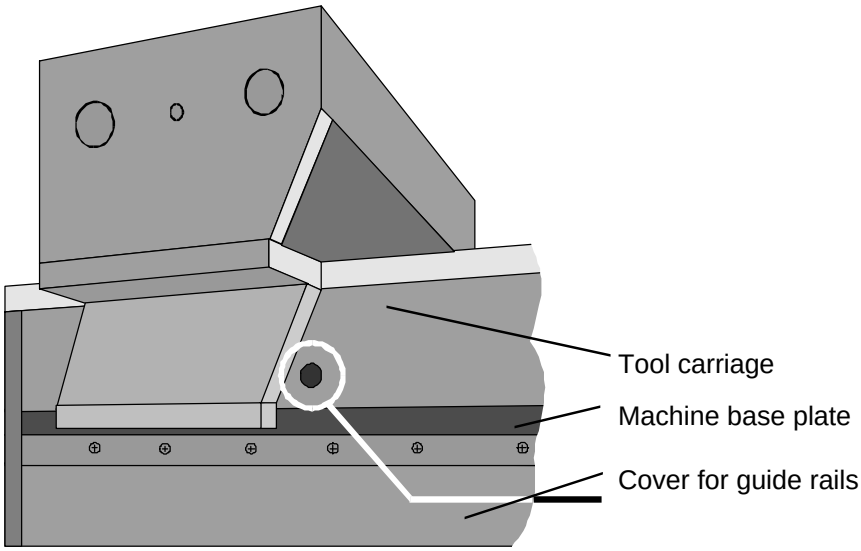


For the lubrication you have to use an **acid-free precision mechanic - oil**!

Stick the dosing neadle (conical grey) on the on-time syringe (delivered with the mashine). In the following image you can see the construction. Now you have to lubricate all four carriage guide wipers of the Y-axis with the help of the one-time syringe (See following image). The prescribed quantity of oil for one carriage guide wiper totals 0,5 ml.

After lubricating the 4 carriage guide wipers you must plug in and mount the cover.

The wipers (4 in total) are located on both sides of the carriage both in front of and behind the guide cheeks.
A hole has been drilled on the left and right of the guide rail cover to allow access these wipers.



Oiling the rear wipers

Supply port

Move the carriage to the **tool change position**.

The supply ports are now behind the guide wall.

Use the syringe to inject oil through the port and into the hole on both sides of the wiper.

Oiling the front wipers

Move the carriage **112 mm to the rear (+X)** of the tool change position.

The supply ports is now located in front of the guide wall and the wipers can be oiled using the syringe.

Caution Wipe any excess oil from the casing as it might corrode the paintwork. Never move the carriage manually. Doing so could cause the output stages of the stepping motors to be damaged by induced voltage.

SerialPort 1 serial connection

The SeralPort1 serial data channel is an RS 232-C standard port with electrical isolation and is used for communication between the control unit and the PC.

The SerialPort1 data transmission rate is programmed using DIL switches 1 and 2.

Switch 1	Switch 2	Baud rate	
OFF	OFF	4800 baud	
ON	OFF	9600 baud	Default setting
OFF	ON	-	
ON	ON	-	

SerialPort1 pinouts:

Pin	Signal	Meaning
2	TXD	Transmit Data
3	RXD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
7	GND-I	Ground (isolated)
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready

All signals are electrically isolated; all contacts not mentioned are not used.

SerialPort2 serial connection

The SerialPort2 data channel is an RS 232-C standard port and can be used for communication between the control unit and another system.

The SerialPort2 data transmission rate is programmed using DIL switches 3 and 4.

Switch 3	Switch 4	Baud rate	
OFF	OFF	4800 baud	
ON	OFF	9600 baud	Default setting
OFF	ON	-	
ON	ON	-	

SerialPort2 pinouts

PIN	Signal	Meaning
3	TXD	Transmit Data
2	RXD	Receive Data
7	RTS	Request to Send
8	CTS	Clear to Send
5	GND	Ground

Any pin not mentioned is not used.

Connecting the stepping motors

The stepping motors are connected on each axis using a 15-pin SUB-D connector.
If a limit switch is actuated, any further axis movement *towards* the limit switch is immediately blocked.
The position of the sockets is described in the section entitled "LPKF ProtoMat 91S displays and connections".

Caution Never confuse the cable for the stepping motor and the plotter head.

Connecting the plotter head

The plotter head is connected to the control unit with a 15-pin socket.
The position of the socket is described in the section entitled "LPKF ProtoMat 91S displays and connections".
A further 5-pin cable supplies the plotter spindle.

Caution Never confuse the cable for the stepping motor and the plotter head.

EPROMs

The software for the control unit is held on two EPROMs.
The LPKF ProtoMat C30 (C30/S) must be partially dismantled if the EPROMs need to be replaced.

Proceed as described under "Removing the electronics unit".

Use only an PLCC pliers to remove the EPROMs as otherwise the mounting contacts might be damaged.

Support the board from below when inserting new EPROMs to avoid bending the board.

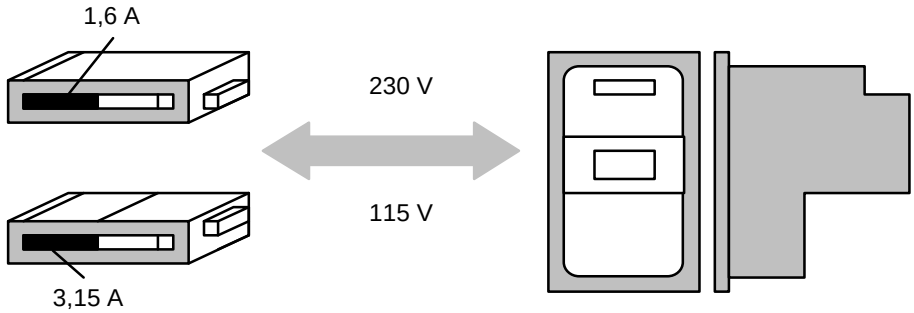
Take care that the orientation of the EPROMs is correct.

Switching the device voltage, electrical fuses

Caution Make sure that the mains connector is removed before working on the fuses or opening the device.

The primary and secondary voltages on the LPKF ProtoMat C30 (C30/S) are fused.
The mains (primary) fuses are in the control unit power connection and can be accessed from the outside.

Caution Make sure that *both* fuses are replaced when switching to another line voltage.
Both fuses must have the *same* rating.



Setting the voltage and fuses

The secondary fuses are inside the control unit.
The control unit must be removed from the mechanism before replacing the fuses. Proceed as described under "Removing the electronics unit".

Removing the electronics unit

The control unit must be isolated from the mechanism.

First move the plotter head to the TOOL CHANGE position if the plotter head is still attached. Now use the arrow buttons to move the crossbar to the centre of the machine base plate.

The head must not be in either the TOOL CHANGE or HOME position and the limit switches must have been cleared.

Switch off the circuit board plotter and disconnect the device from the mains by removing the mains connector.

Position of screws for removing the electronics unit from the mechanism of an LPKF ProtoMat C30 (C30/S)

Undo the electric connections between the mechanism and the control unit.

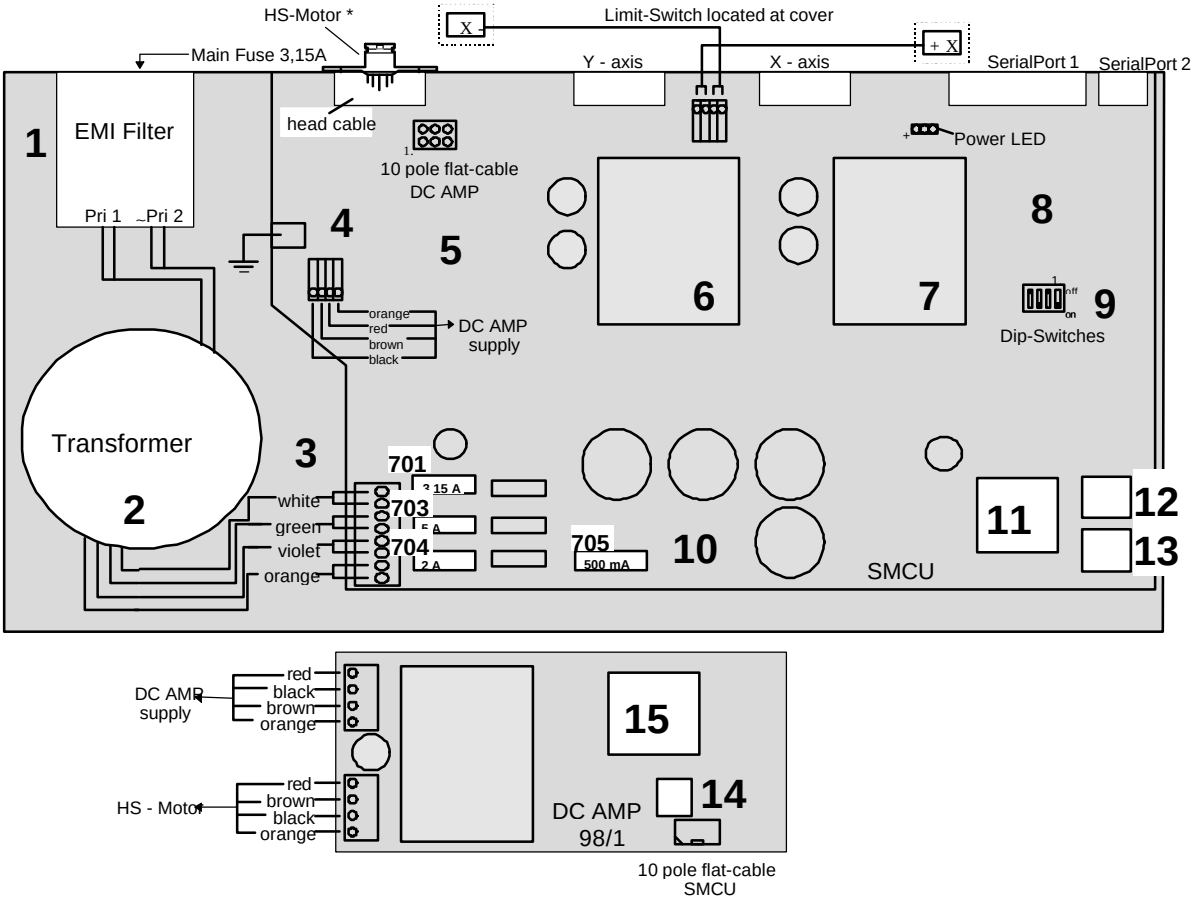
Tilt the circuit-board plotter towards the head.

Undo feet 1, 2, 3, 4 and the Allen screws 5, 6 on the underside of the machine.

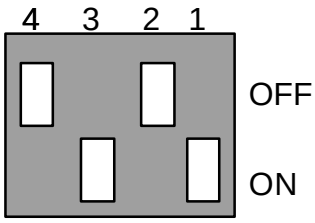
Remove the cover with the limit switches.

The control unit has now been released.

Caution Check that the machine is disconnected from the mains by removing the mains connector.



View of the LPKF ProtoMat C30 (C30/S) circuit board



DIL switches for setting the baud rate **(9)**
(with default setting)

1. Mains filter
2. Transformer
3. Transformer connection
4. Plotter head power pack
5. Z axis power pack (bare)
6. Y axis power pack
7. X axis power pack
8. Processor section
9. DIL switches for setting the baud rate (in default setting)
10. PSUs
11. Processor
12. EPROM L
13. EPROM H
14. EPROM for motor output stage (electronics under the cover)
15. Processor for motor output stage (electronics under the cover)

701-705 Various fuses (see below)

The secondary circuits are protected by microfuses as follows:

Fuse	Type	Circuit
F701	3.15 A	Power output phases
F703	5.00 A	+24 V at I/O-interface
F704	2.00 A	+5V and VREF
F705	0.50 A	RS 232 C/SerialPort1

The units are reassembled in the opposite order to that described above for disassembly.

Caution Never confuse the cable for the stepping motor and the plotter head.

Always check that head and motor cables are connected correctly before switching on.

The fuses for the primary circuit are in the power switch, which also contains the mains filter and the power selector (i.e. 230 V/115 V).

Medium time-lag fuses must be used:

230V fused with 1.6A

115V fused with 3.15A

Table of available tools

Tools marked with an asterisk (*) are available for the LPKF ProtoMat C30 (C30/S).

Name	Diameter	Length		Delivery time
	in mm	36 mm	38 mm	S = stock part
Universal milling cutter	0.2 - 0.4	*		S
Micromill	0.1 - 0.2	*		S
RF cutter (Milling layout films)	0.25	*		S
Contour milling cutters	1.0		*	S
	2.0		*	S
	3.0		*	S
Double chamfered cutters	0.8	*		S
	1.0	*		S
	2.0	*		S
	3.0	*		S
Drills	0.3		*	S
	0.4		*	S
	0.5		*	S
	0.6		*	S
	0.7		*	S
	0.8		*	S
	0.9		*	S
	1.0		*	S
	1.1		*	S
	1.2		*	S
	1.3		*	S
	1.4		*	S
	1.5		*	S
	1.6		*	S
	1.7		*	S
	1.8		*	S
	1.9		*	S
	2.0		*	S
	2.1		*	S
	2.2		*	S
	2.3		*	S
	2.4		*	S
	2.5		*	S
	2.6		*	S
	2.7		*	S
	2.8		*	S
	2.9		*	S
	2.95		*	
	3.0		*	S

Concluding remarks

The European Community Machinery Directive 93/44 dated 14 June 1993 has been used as a basis for this manual.

Where reference has not been made to the EC Directive in any section, we hereby refer the reader to the relevant paragraphs of the Directive and any claims concerning completeness and liability are excluded.

Furthermore, we hereby draw attention to all remaining risks unknown to the manufacturer which might occur due to incorrect use of the machine.

LPKF shall not be held responsible for damage resulting from use of the LPKF ProtoMat C30 (C30/S).

This also applies where reference has been made to such damage.

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Konformitätserklärung für LPKF ProtoMat C30 (C30/S)

1. Hersteller der mit LPKF ProtoMat C30 (C30/S) bezeichneten Maschine ist die Firma:

LPKF
Laser & Electronics AG
Osteriede 7
D-30827 Garbsen

2. Bei der mit LPKF ProtoMat C30 (C30/S) bezeichneten Maschine handelt es sich um einen Fräsbohrplotter, der zum Erstellen von Leiterplattenprototypen und Gravurfilmen, sowie zum Gravieren von Aluminium oder Kunststoff geeignet ist. Die Seriennummer der vorstehenden Maschine ist 1F.....(siehe auch Bodenplatte). Weitere Angaben zur LPKF ProtoMat C30 (C30/S) sind dem beiliegenden Handbuch zu entnehmen.

3. Die LPKF ProtoMat C30 (C30/S) entspricht den Bestimmungen der EG-Maschinenrichtlinie 93 / 68 vom 22. Juli 93, der EG-Niederspannungsrichtlinie (73 / 23 / EWG) und der EG-Richtlinie EMV (89 / 336 / EWG).

4. Die LPKF ProtoMat C30 (C30/S) ist nach dem Stand der Technik und nach den anerkannten sicherheitstechnischen Regeln gebaut worden. Bei der Erstellung 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

Declaration of conformity for the LPKF ProtoMat C30 (C30/S)

1. The manufacturer of the machine identified as the LPKF ProtoMat C30 (C30/S) is:

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

2. The machine identified as LPKF ProtoMat 91S is a circuit-board plotter, suitable for the production of circuit board prototypes and engraving films, as well as for the engraving of aluminium or plastic. The series number of the above-mentioned machine is 1F.....(see also base plate).
Further information on the LPKF ProtoMat C30 (C30/S) can be obtained from the Manual enclosed.

3. The LPKF ProtoMat C30 (C30/S) complies with the requirements of the of EC Machinery Directive 93/68 dated 22 July 1993, the EC Low Voltage Directive (73/23/EEC) and EC EMC Directive (89/336/EEC).

4. The LPKF ProtoMat C30 (C30/S) has been manufactured in accordance with the state of the art and in accordance with recognised rules of safety. Existing DIN specifications have also been applied in the manufacture of the LPKF ProtoMat C30 (C30/S).

5. Authorized signatory to this declaration:

Mr. Bernd Hackmann
Managing director LPKF AG
Osteriede 7
D-30827 Garbsen, Germany

Bernd Hackmann