

# CNC Production Centre

## User Instructions

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## 0 Introduction

Please read this manual carefully before using the machine. It describes how to operate the CNC drilling machines BUNGARD CCD MTC (manual tool change), ATC (automatic tool change) and CCD/2 (manual tool change, reduced size) and explains how to use the driver software. To distinguish between the three different machine types, some sections or paragraphs of this manual are marked with ATC, MTC or CCD/2.

To run the machine, you need an external computer. Details on computer configuration and set-up can be found in section II 0. We hope that you enjoy using the BUNGARD CCD. Please let us know if we can be of any supplementary technical assistance.

### 0.1 Application

The BUNGARD CCD machines are manufactured by Bungard Elektronik, Rilke Straße 1, 51570 Windeck, Germany and are brought into circulation in foreign countries via local distributors or agents.

The machines are determined for drilling and milling (routing) printed circuit boards and for milling (routing) and engraving aluminium plates. A special application is dosing of pastes or liquids onto panel-shape work-pieces. Any other type of application is permissive only with our consent. The machines may only be operated by qualified operators. Children and animals must be kept off!

The machine may only be operative under normal temperature and humidity conditions, especially only in absence of corrosive or inflammable vapours. At temperatures lower than 10 °C or higher than 30 °C, there may occur the following problems: The spindle might not start running at low temperatures. The stepping motors might run hot or step losses may occur at more than 30 °C in the surrounding air.

The machines are not determined to be connected or combined with other machines. However, they need to be connected to and be controlled by a compatible computer. The driver software is supplied with the machines and is relevant for security.

### 0.2 Operating conditions

#### 0.2.1 Emergency Stop Facilities

The 'ESC' Escape button on the computer stops the spindle and the stepper motors. This is indicated by a red message/icon on the computer screen. The main switch on the control unit or power supply unit cuts the machine from mains supply, but is not suitable for emergency stop: It does not allow programmed spindle lift and quick stop.

#### 0.2.2 Protection against contact with moving parts

There is a round metal tube with a spring included with the spindle. This drill pressure foot shall be mounted to the spindle shaft to prevent incidental contact to the moving tool. It is not possible to entirely envelop the tool, as this would make the drilling and tool change actions impossible. In the case this pressure foot was not placed correctly, the following danger remains:

**WARNING:** Do not touch the tool when the spindle is operational. Prior to any tool change action, wait until the spindle has come to a complete stop.

Under normal operating conditions and with the given work-piece materials, there is no special danger from parts being propelled off the machine. However, special operating conditions or heavy work-pieces may require that the machine is encapsulated. A protection cover is available as an option.

#### 0.2.3 Noise

With the HF-spindle running at full speed and the vacuum cleaner on, the noise pressure level at 1 m distance is 86 db(A). Operators have to wear ear protection.

#### 0.2.4 Dust

It is necessary that the standard vacuum cleaner is always being used during operation on printed circuit boards. The vacuum cleaner must be OFF during and after use of alcohol or other inflammable or explosive liquids (i. e. used for cooling when milling aluminium). Individual operating conditions may require that an extraction unit with higher rating or the optional protective enclosure be installed.

### 0.3 Documentation

Our distributor / reseller in your country is encouraged and in charge of translating the German and / or English manual coming with the machine into your native language. A declaration of EU conformity is appending



## 1 Control unit and mechanics

### 1.1 Power supply

The machine power supply has a wide range AC input. You can run it on any common single phase mains supply. If the power cord supplied with the machine is not suitable for your country, please replace it. In this case it is urgently required that you ensure correct grounding to PE.

**Attention!** You must disconnect the machine from the main supply and wait until DC voltages are low prior to opening the control unit or to pulling cards off from it. We deny any liability if alterations to any mechanical, electric or electronic components of the machine are made. Prior to any manipulation to the control unit, check that the machine has been disconnected from the main supply.

### 1.2 Control unit

MTC, ATC: There is a stand-alone control unit with 3 cable connections to the mechanics unit. There are one cable with 25 pin Sub-D connectors and two cables with 15 pole Sub-D connectors. The connections are unique and cannot be interchanged.



Pict. 1: ATC control unit



Pict. 2: CCD/2 power supply

CCD/2: The control unit is located underneath the mechanics unit, but the power supply comes as a stand-alone box and connects to the machine back by one cable.



Pict. 3: CCD/2 control unit back view



Pict. 4: CCD/2 control unit front view

The control unit on the machine front is linked to one of the computer's serial or USB ports. The USB connection is achieved by a USB to serial converter cable that is included with the machine. This comes with its own software drivers on CD, as explained later. You may use a 1:1 9pole Sub-D cable instead and connect it to any of the computer's free COM ports. The actual port to be used will be detected automatically by software.

The front panels of all control units have some status LEDs with the following meanings: POWER: Supply voltage is present. HOME X, HOME Y, HOME Z: These LEDs give a visual control on the state of the reference switches. They are all lit after a successful reference run. TOOL: On machines with automatic tool change this LED corresponds to the drill break detector and turns on and back off if a drill was found to be OK.

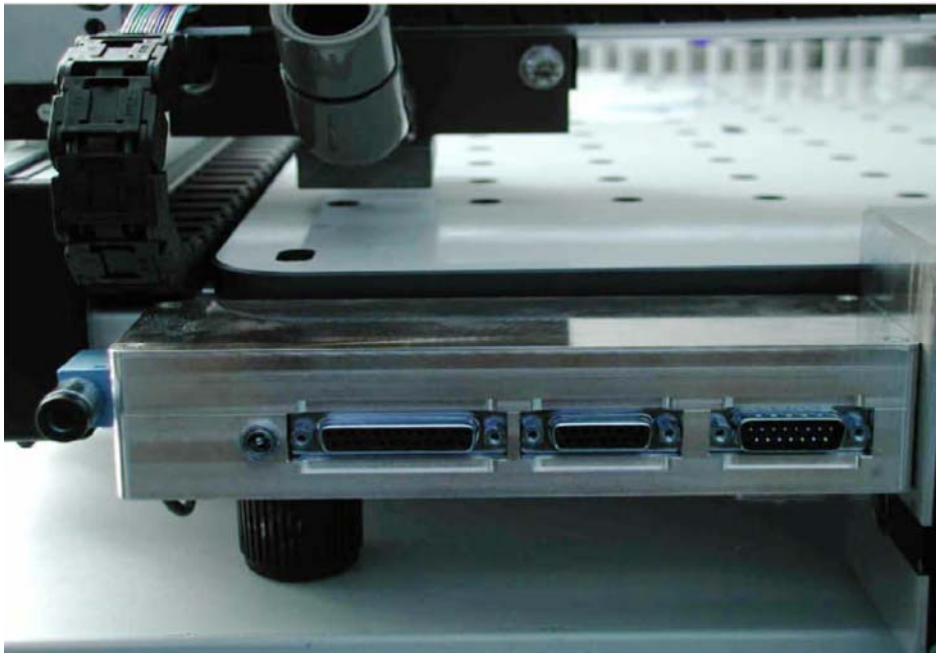
There are no user serviceable parts inside the control units. The potentiometers on the PCBs are factory set. Do not change.

### 1.3 Mechanics Unit

#### 1.3.1 Set up

Put the machine onto a stable, even table and adjust the machine's 4 feet by turning them. A stable desk and a proper setting are important to prevent vibrations etc.

MTC, ATC: Connect the one 25 pole and two 15 pole cables coming from the control unit. They cannot be interchanged.



Pict. 5: ATC/MTC rear view



Pict. 6: Vacuum cleaner switch box

#### 1.3.2 (ATC) Compressed air connection

The machine requires compressed air of at least 5 bar to open and close the spindle chuck. A compressor is not included with the machine, but an air hose is. At the left rear of the machine there is an air valve, as shown on the left side of the above picture. Connect the air hose's free end to that valve. The other end of the hose has a standard connector for compressed air outlets.

#### 1.3.3 Vacuum cleaner

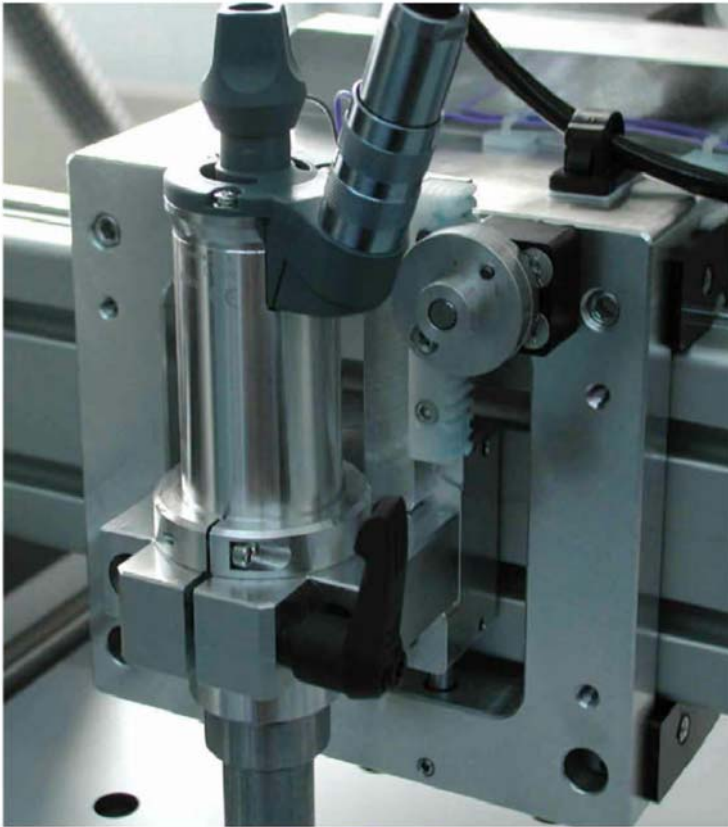
On the rear of all machines, there is one socket for a 3.5 mm audio plug, to be used with the vacuum cleaner switch box (pict.6). This adaptor will turn the vacuum cleaner on and off together with the spindle. It comes in a black plastic housing with AC inlet and outlet for European mains sockets and should be used with the vacuum cleaner that we supply, or i. e. with a liquid cooling pump for aluminium routing. If you connect other devices, power rating must not exceed 500 Watt.

The machine comes with a small vacuum cleaner. After connecting it to the switch box, put it on the table at the rear of the machine and fix the hose to the suction nozzle which is at the left front (MTC, CCD/2) or at the rear (ATC) of the Y axis (grey tube on top end of picture 5). Take care that the hose can freely follow the machines' movement.

The swarf removal may appear to be somewhat poor. This is due to the fact that the shavings are leaving the drill bit at high speed, but not necessarily in the direction of the nozzle. Anyhow, further encapsulation of the tool is not possible.

### 1.3.4 Mounting the spindle

Referring to picture 7, release the black lever by a 90 degree left turn so that the spindle holder clamp opens. Carefully drop the spindle into the clamp and push it downwards so that the distance flange (aluminium collar) lies firmly on the holder's top. Turn the spindle in a direction so that the cable and the connector housing do not interfere with the Z-axis' movement. Fix the plug to



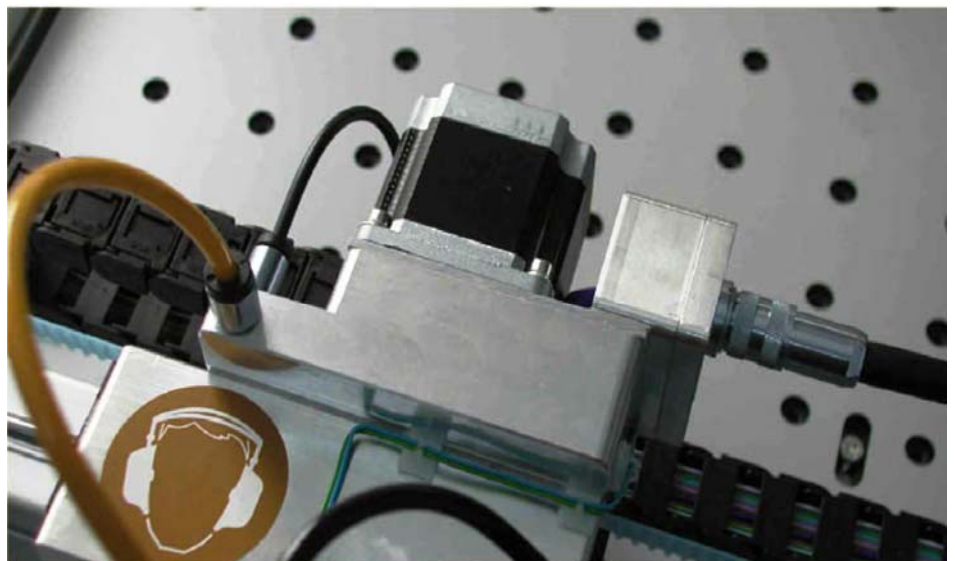
Pict. 7: Spindle

the connector box located to the right of the Z stepping motor (see picture 8) and tighten the plug screw. Turn the lever to close the holder clamp until the spindle is well tightened.

ATC: Use the short piece of air hose coming with the spindle to connect it to the quick mount fitting on top of the Y-axis slider, as on the left part of picture 8. There must be the "test pin" or at least a drill bit in the chuck when the spindle is not in use. Else, damage to the chuck may occur.

**Important:** The distance flange determines the spindle elevation over the table. It is mounted to the spindle at the factory in a way that a drill (with ring is 0.5 mm over the machine table when the Z axis is completely down. You should not change this setting. Otherwise the mechanical position of the Z axis will be different from the one assumed by the driver software. Damage to the machine table may then result.

**Only tools with ring (collar) should be used. The distance from the top edge of the ring to the tool tip is 21 mm.** The spindle distance flange was factory set with respect to that 21 mm active tool length



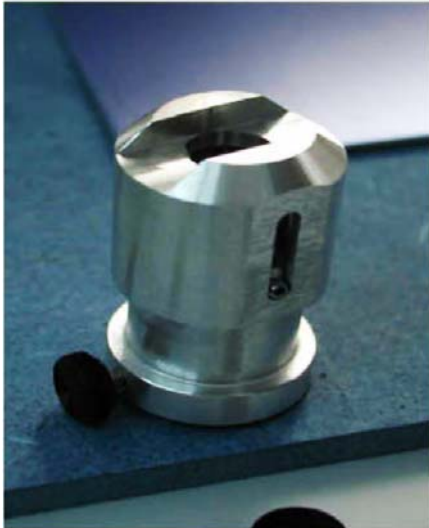
Pict. 8: Spindle connections

### 1.3.5 Spindle accessories

A drill pressure foot and a depth limiter are supplied in the box with the spindle, as well as some cleaning tools for the spindle chuck.

#### 1.3.5.1 Drill pressure foot

The drill pressure foot serves to push the board down before the drill bit hits it. This is particular useful if the board is not flat and plain or if you drill more than one board at once (you can drill stacks of 3 boards of 1.6 mm). Also this pressure foot serves as a protection so that you cannot touch the rotating tool. It is fixed to the spindle shaft by the screw with the black knob.



Pict. 9 Drill pressure foot ...



Pict.10: ... mounted to spindle

ATC: The drill pressure foot can stay on the spindle shaft during automatic tool change. It is though necessary that the slot in the foot faces towards the tool holders, in a position as shown in picture 10.

MTC: The pressure foot must be removed for tool change. After each tool change the drill pressure foot must be put back in place for safety reasons

#### 1.3.5.2. Depth Limiter



Pict.11: Depth limiter ...



Pict.12: ... mounted to spindle

During milling / routing, the depth limiter (DL) achieves a regulation of the Z axis work level in order to compensate for uneven board surfaces. The device is designed to work with tools that we supply, especially those of the G30N type. Note: The DL is not compatible with the cooling devices spray nozzle. If you add a DL to an existing machine, it may interfere with the vacuum cleaner suction nozzle.

We assume that the Z axis is in the upper position, as after a reference run. Keep the HF spindle in the spindle holder and insert a tool. Mount the DL to the lower spindle shaft. Be careful not to touch the tool tip. Shift the device up as far as possible and fix the small screw with the black knob that sits on its upper flange.

The DL has a fine threading and a counter screw. Loosen the counter screw and turn the lower part of the DL in order to adjust the height. Fasten the counter screw to fix the DL height setting. The conical green part of the DL acts as a sensor on the board surface. It can be removed separately and can be turned around so that the opening slot allows to cross over tools sitting in the ATC containers. For machines with manual tool change, the slot should show in the direction of the dust extraction nozzle.

The DL is not used for drilling and routing, so for these applications it should be removed. To do so, do not change the position of the counter screw on the fine thread, but just loosen the black knob and pull the DL off. Again, take care not to touch the tool tip.

To the right top of the Z axis slider, identify the Z axis cog-wheel. It is mounted onto the Z axis shaft together with a double aluminium flange, as shown in picture 7. On the front side of the outer flange, there is a screw connecting the both halves. Remove this screw. You should now be able to lift and lower the Z slider for about 2 mm. For drilling and routing this screw should be always put back in place to eliminate the free flow of the Z slider.

For fine isolation milling, the DL shall be in place. It will follow the board surface and lift or lower the spindle accordingly. In the Tools Menu of RoutePro, the routing depth on the Z axis should be set to 0.1 to 0.5 mm so that there is a minimum possible travel against the spindle's weight load. Please do not set the Z stroke deeper than necessary, because this will cause extensive wear on the DL. For the G30N routers, we recommend a work feed rate of 1 m/min for all axes at 60 000 rpm or proportionally less at lower rpm.

For setting the actual routing depth, the Z axis has to be lowered so far that the sensor touches the board. You can move the Z axis manually or by software when the machine is in the offset mode. The actual routing depth is set relative to the sensor by loosening the counter screw and screwing the lower part of the DL in or out. Always take care that first the sensor and then the router bit touch the board. During set-up, the spindle should be running at low rpm, else the router tip will break. The spindle can be turned on and off from the offset menu.

**Warning: Do not touch the rotating tool!**

### 1.3.6 (ATC) Tool receptacles

On the front end of the machine there is a bar with 16 tool receptacles. They are numbered from 0 to 15. Number 0 always takes the test pin. The drill and router bits go into the remaining 15 round aluminium pieces. A tool can move vertically in this container and a spring will shift it up until the tool ring is stopped by a small flange at the inner top of the receptacle. The positions of the tool containers are known to the software by entries to the configuration file.

Left to the tool position No. 0 there is the drill break detector. The driver software operates the machine in a way that after each drill was used it is checked in this sensor. The LED on the control unit front panel lights up when the drill is detected. This detector also acts as a sensor for too long drills, so that no damage to the machine bed can occur.

### 1.3.7 (MTC) Tool change

To open the spindle chuck, press down the knob on top of the spindle and turn it left. Remove the tool and insert a new one. Press and turn right the knob to close the chuck. To gain better access to the tool, You may lift the spindle but it is not recommended to pull it off entirely. Tool changes during programmed drill operation will lock the stepper motor axes, so that no unwanted malpositioning can occur.



Pict. 13: tool containers

### 1.3.8 Maintenance

It is important that you regularly remove all dust and shavings from the machine. To clean and lubricate the steel shafts, especially those below the aluminium extrusions on the X-axis, use a cloth and some acid-free machine oil. On each end of the linear bearing housings, there are lubricating felt stripes. Regularly apply some oil to them.

The shafts on the Z-axis do not need special lubrication but must also be kept clean.

**Note:** The machine must not be used in corrosive or inflammable atmospheres. If it will not be used for a longer period or prior to transporting it, all steel shafts should be well lubricated.

The drive belts must also be kept clean from dust and shavings but must not be lubricated. The belts are subject to wear. If they show damages like lateral fray-out or deformed teeth they should be replaced.

### 1.3.9 Changing the belts

#### 1.3.9.1 X-axis

Loosen the two screws of the span brace and remove it. Also remove the block with the reversing roller at the end of the X-axis. Move the Y-axis beam to the middle of the X-axis.

Remove the small plate that fixes the belt to the carrier. The two ends of the belt come free. Use some adhesive tape to fix the new belt to the old one. The teeth must be aligned on one side. Pull the old belt out of the gear housing. The new belt will follow the old one. Remove the adhesive tape. Remount the reversing roller, but do not tighten the screw. Keep the new belt on its front end and pull the inner half of it around the reversing roller so that both ends come to lie in front of the belt carrier.

Cut a 3.5 cm long stripe from the old belt. Use this stripe to connect both ends of the belt in a way that their teeth grip into the gaps of the small stripe. If necessary, cut the new belt on one end. The edges should lie face to face on the stripe.

Pull the Y-axis beam back or forth so that the assembly of belt ends and stripe are in position on the beam. Carefully mount the aluminium cover plate and tighten the screws so far that the belt ends can not fall off the carrier. Check if the inner and outer half of the belt are well aligned. To adjust, move the belt ends under the cover plate. Fix the cover plate by well tightening all four screws. Fix the block with the reversing roller. If the belt is too loose, you will have to disassemble, cut one tooth and remount as described above.

Finally, remount the span bracket and adjust the belt stress. With the Y-Axis beam in the middle of the X-axis range, it should be possible to press the part of the belt to the left or the right of the beam for about 3 mm in the direction of the machine table.

#### 1.3.9.2 Y-axis

Remove the three screws holding the Z-axis stepping motor. Take the motor off from the gear housing and carefully lay it aside. (Be careful not to damage the cable) Change the belt in the same way as explained for the X-axis and then remount the stepping motor. Prior to tightening the 3 screws, adjust the gap of the gear wheels to a minimum by moving the motor back or forth.

**Note:** The reversing rollers can be moved on their axis. Use the blade of a screwdriver to lift or lower their position until the belt runs in the middle of the rollers.

After changing the belts it is likely that the machine needs recalibration. See further below for a description of how to determine the X and Y correction factors.

## 1.4 Fixing the boards

### 1.4.1. Clamp fixing

The machine table has holes each 50 mm. They serve to fix the aluminium and plastic flanges coming with the machine and allow to clamp on all four edges 1 base sheet and 1 to 3 boards of the same size of 1.5 mm. The two flanges near to the machine's zero position determine the board zero position. Use the two big white plastic disks with the 3 eccentric mounting holes to clamp the boards. The small eccentric flanges can be used to align the board(s) in parallel to a main axis. This fixing method is in most cases sufficient for all drilling applications, as well as for fixing a base sheet for isolation milling and contour cut-out routing.



### 1.4.2 Span fixing

You may insert screws into the holes in the machine table. Using stripes of metal or PCB material, this offers you the possibility to fix the plates from on top. This method will apply mainly for engraving aluminium. Disadvantage: the metal stripes lie on top of the plate and may be touched by the spindle.

### 1.4.3. Drilling bare boards

When making double sided PCBs with chemical through hole plating, the first step is to drill the holes. Any photo processing of tracks and pads will follow later.

Use a raw cut piece of copper clad laminate and put it, together with a base sheet of the same size, on the machine table. Align to the X- or Y-axis and fix like described under "clamp fixing"

Alternative: Use a big base sheet and fix it by use of the plastic disks. Put the board to be drilled on top and push it to the machine's zero position. Using adhesive tape, fix the board to the base sheet. Advantage: The fixture position is independent from the board size. The adhesive tape can be drilled through without damage to the drill.

### 1.4.4. Presensitized base material

In the same way as above, pre-sensitized base material still covered with its protection foil may be drilled **prior to exposure**. As to our experience, this gives best results: There is only one positioning operation necessary at exposure time. The drilled image will perfectly fit the etched board structures.

### 1.4.5 Etched PCBs

The board already shows the tracks and pads. The drilling must exactly fit the pads.

When doing the layout, preview 2 or 3 reference holes with an extra tool number and diameter. Use a fresh base sheet and drill these reference holes into it. Press steel pins or rivets into the holes and use this sheet as base sheet later when processing the boards.

Use the OFFSET command to move the machine's zero position to any place on the table. Fix the raw cut bare PCB to this location. Drill the reference holes related to the above used tool. Use the reference holes to position the film artwork. Develop and etch as usual. To drill the board, return to the machine and fix the board to the reference pins of the prepared base sheet.

If the film artwork does not exactly fit the drill coordinates, use the SCALE edit fields to enlarge or reduce the drill image size.

### 1.4.6 Routing

Also for routing a base sheet is strongly recommended! Fix the plate by span or clamp fixing. Pay attention that it lies straight and even.

If, for example, there is a circle to be routed in FR4 material, the inner part of it will most certainly remain where it was on the base sheet. This will of course work only if you use a sharp router and set an appropriate speed.

### 1.4.7 Isolation milling

Use a base sheet that is significantly bigger than the board. Create a drill file with two reference holes. These will later give the mirror axis that we need to turn the board over for isolation milling of the second side. These reference holes should be outside the board image, preferably on the longer side of the board. They need not sit exactly in the middle of the board image. A rough positioning is sufficient as long as there is space enough on top and below so that the board can be flipped along an imaginary mirror line that connects the two holes. In our IsoCAM software there is an automatic function to provide these reference holes.

The base sheet that you use here should be thick enough to allow that the reference pins sit tight and cannot tilt. An MDF plate of 6 mm thickness is a good choice. Instead of steel pins (that always come up to be too long and make collisions) we prefer to use rivets (that have a flat head sitting just on the board surface). These also do not conflict with the depth limiting device as described earlier.

This method of fixation combines two features: The board is held in place safely, also for final cut out routing, and a perfect coincidence of top and bottom layer is achieved due to the fact that mirroring data and flipping the board are done in the same physical position.



## 2 Software

### 2.1 Hard- and Software requirements

The driver software that controls the machine for drilling and routing is called RoutePro 2005, short RP2K5. Together with the manual and some sample files, it comes on a CD and/or floppy disk and can be run on all Windows versions from 98 to XP. The computer should have 1 free USB port or serial port (RS 232). Computer speed is not critical. Software will automatically try to recognize the (virtual) serial port to what the machine is connected. In case of computers with a built-in modem, it is recommended to disable this temporarily.

### 2.2 USB driver

Do not yet connect the machine to the computer, and do not yet start RP2k5. First connect the USB to serial adaptor cable to a free USB port of the computer. This will recognize a new hardware installation and will prompt for a driver disk. At that, please insert the CD that came with the adaptor and follow the instructions on the screen, as for any other standard driver installation. This procedure takes two stages. First it will install a USB device, second it will create a virtual COM: port in your computer. So you will be asked two times to select a driver. Please do not abort the second part of the installation although it looks like the first installation was repeating. Also please note that each time when you connect the adaptor to a different USB port, another request for driver installation may appear again, depending on your computer system.

### 2.3 Software installation

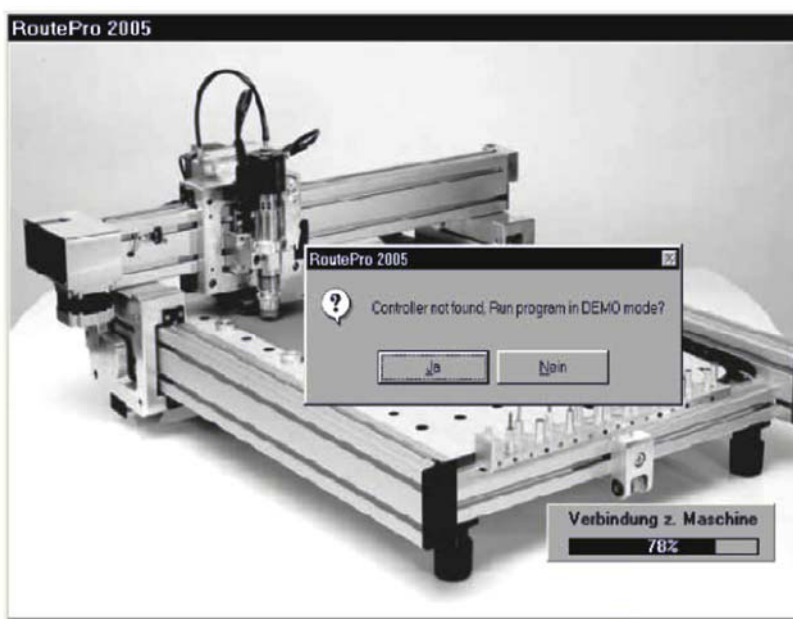
The machine control software comes with a setup program. This setup serves mainly to copy files to a certain destination on your hard disk. There are no entries or changes to your Windows installation or to the registry.

Each delivery is accompanied by either a file or a printed sheet with configuration data that is specific to the individual machine. Configuration data coming as a file on floppy disk need to be copied manually into the directory where you installed the software. If you received a data sheet you are requested to enter data in the menu(s) described on the sheet. The uncomfortable situation where you have to type in data manually is caused by the fact that floppy disks have become rare on new computers and no standard for rewritable other media has yet been established.

In order to synchronize the destination on your hard disk with the default setting inside the configuration of RP2K5, the standard install path is <C:\rp2k5>. If you prefer a different location, you should adapt the path names in the configuration files `routepro.rpc` and `routepro.ini`.

### 2.4 RoutePro 2005

#### 2.4.1 Program Start



Pict. 14: Connecting...

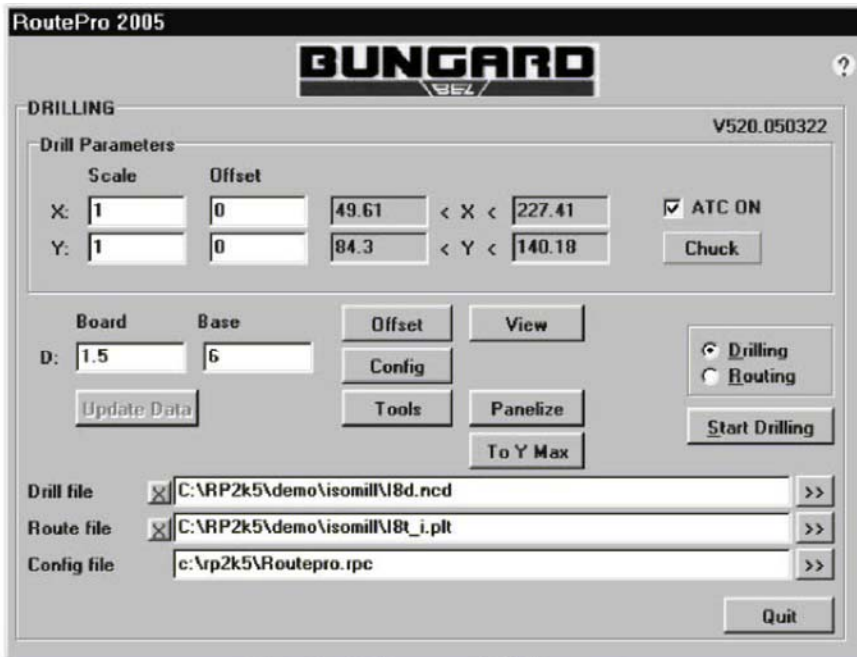
At installation, an icon was created that you should find on your desktop. If this should not be the case, for example due to installation of multiple users on this computer, please use Windows' Explorer, navigate to the (default) <C:\RP2K5> directory and create a shortcut to `Routepro.exe` on your desktop.

Double click on this shortcut icon (or on the program name) to start the software. It will search the computer's physical and virtual serial ports to find the machine controller. In some cases where computers have built-in modems it can happen that these answer instead of the controller, so that the automatic recognition would fail. If this happens, please go to the Windows control panel/system/device manager and disable the modem temporarily.

If RP2K5 does not find the machine's control unit it asks if you want to run the program in demo mode. This mode offers all the menus and functions, but does not drive the machine. So this feature is for evaluation and testing. The normal situation is that the machine was recognized. During this start sequence it can be that you hear short noises from the stepper motors come and go.

## 2.4.2 Main menu

The driver software has a tree-like structure. Starting from the main menu, it branches to submenus and dialogues and returns to the main menu. This contains in its upper part on one screen the settings for two modes of program operation, drilling and routing / milling. Toggling the radio buttons on the middle right side of this menu will also change the parameter display.



Pict. 15: Main menu / drilling mode

### 2.4.2.1 Scale

You may here chose a scaling factor separately for the X- and Y-axis. This is to reduce or enlarge the image size or to adapt to other than the predefined coordinate units. Note that different settings for drill and route mode are possible.

### 2.4.2.2 Offset

Enter an offset (in mm) from the X and Y zero position to move the image zero point in positive or negative direction from the machine zero position. Useful for shifting drilling / routing data or to adapt data to shifted board origins. Different settings for Offset in Drill and Rout mode allow to register drill and route data if necessary

### 2.4.2.3 Size display

The four grey fields to the right of the offset fields display the extent of data. The left row shows the min. X and Y values, the right row has the max. values. Both are displayed in mm. The X and Y max. and min. values are independent. So the vector with the max. X position can at the same time be the one with the min. or any else Y position and vice versa. Any offset that you entered is being added to this size display. Sizes that are bigger than the machine table or that are negative show in red, in order to indicate there is a problem. Also when you read a file with the wrong coordinate units it can happen that the file size is bigger than the machine table. An example would be a drill file that was made in 1/10 mil format and that extends to X max. 100 mm. Reading this file in 1 mil format will show a max. X value of 1000 mm. Apart from the digits showing in red colour, it would in this case not be possible to start the drill job.



Pict. 16: Main menu / routing mode

### 2.4.2.4 ATC on / Chuck

On machines with automatic tool change, this checkbox determines if tools are changed automatically or by user intervention. This setting is individual for drilling and routing mode. Manual tool change machines do not show this.

### 2.4.2.5 Board thickness

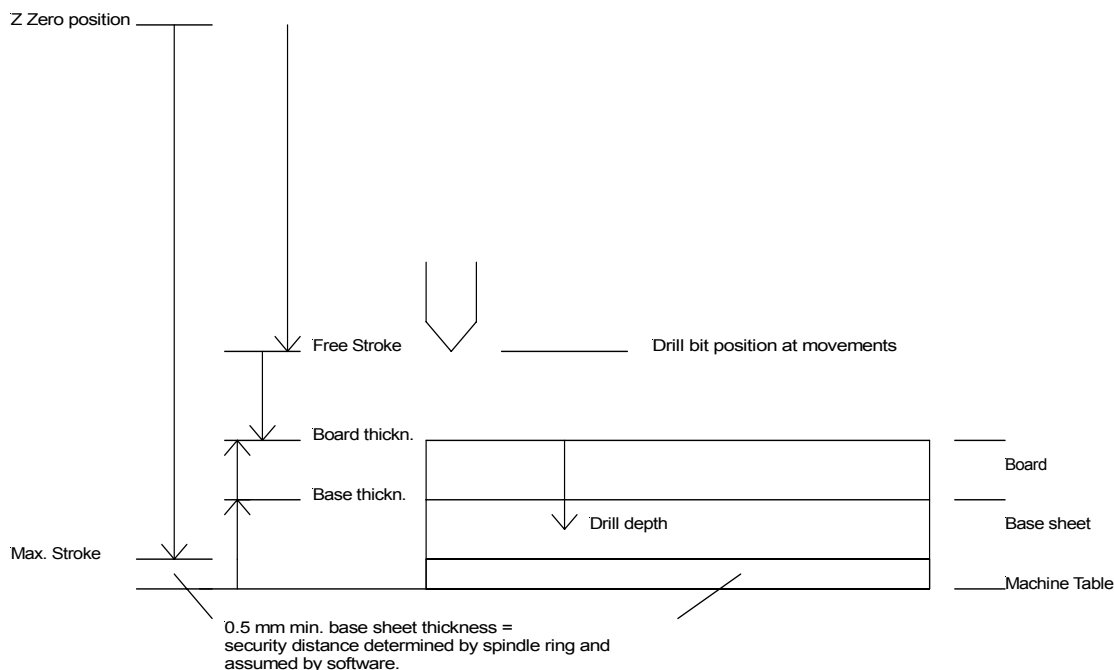
Enter the true thickness in mm of the board to be drilled. This input is necessary for the program to determine the Z-axis movement. It also allows to calculate the stroke length when drilling and to set the flying level of the tool when moving around on the table.

### 2.4.2.6 Base sheet thickness

This determines how much space is between the board and the machine bed. A base sheet is always necessary under each board to be drilled or routed. The conical tip of the tool needs to traverse the entire board and to find space and time to come to a stop inside the base sheet.

The sum of board and base thickness allows the program to determine the exact Z position of the board surface. In conjunction with the tools with ring that we offer, this feature allows to use the Z axis without any further calibration.

See the following picture for a definition of the Z axis positions.



### 2.4.2.7 Loading files

The lower section of this window contains three lines with file names, one each for drilling, routing and for a configuration file. The >> button to the right of each line brings up a standard file select box. After you made your choice there the file will be loaded. The X mark to the left of the drill and route file fields remove the loaded file from memory.

The configuration file contains a set of configuration data. The default file name is routepro.rpc, but you can have several different configurations with different file names. To create a new configuration, just copy and rename an existing configuration file with Windows Explorer. Any change to any menu setting is immediately conserved in this configuration file. This implies that such file must never be write protected, else the software could hang.

When loading a file, the software interprets data and transforms the commands and coordinates into step information. As **routing** data, the following subset of HP/GL commands with their corresponding parameters is accepted: SC, IP, PA, PR, PU, PD, AA, AR, CI, SP. Each command sequence must be terminated with ";". It is allowed to group several commands in one line. Circles and arcs are converted into a chain of vectors with adjustable chord angle.

The **drill** data must be in standard ASCII drill file format, also known as "Excellon" or "Sieb & Meyer" format. Leading zero suppression is allowed, trailing zeros must be present. The driver replaces missing X- or Y-coordinates by the last valid value. The start label "%" must be present. The data section of the file starts after this label, preceding lines are taken as comments. Data blocks must be separated by <CR><LF>. The unit of measurement for both data types can be set in the configuration menu.

### 2.4.3 Tools

After loading a drill or route file, or after pressing the Tools button, the following menu appears.

The outer right column shows which tool codes are being used in the file that was loaded. Reading the numbers top down represents their sequence in the file. This is the case for both drill and route data.

In -HP/GL based- route data, this tool code primarily represents a pen colour, but is being interpreted as a tool. This allows to distinguish different router diameters and allows to take influence on the sequence of milling/routing.

Unfortunately, the tool codes being used in drill files are mostly independent from the physical tool parameters, but merely start counting by one in each file. Only few CAD packages like EAGLE allow to create a fixed relation of tool code and diameter. This is extremely helpful for the machine user, as it allows him to associate the tool directly to its diameter. We recommend that you try to follow this idea and, for example, name a 1.3 mm drill by the name 13. A 0.4 mm drill would then have tool code 04. In the case that this naming convention is not possible with your CAD programme it is necessary to add a tool information file or sheet that describes the relation of tool name and diameter for every drill file that you created. Drill of HP/GL files are human readable and so we suggest you once open one of them with an editor to see how the tool codes are implemented.

#### 2.4.3.1 Drill tool table

The above tool table is for drill tools only. A second, slightly different table for route tools will follow below. The left column of this table counts all possible 99 tools top down. Each line of this table takes the physical parameter settings for the tool with this code.

The first parameter under the column title "Diam" is the tool diameter in mm. The entry under the title "+mm" on the second column takes an additional stroke length (in mm). This value is added to the board thickness to determine the total stroke length. This "add-on stroke" is necessary because the drill bits have to go through the entire board and a bit further to compensate for the conical tip of the drill and to allow good cutting results.

The third column is entitled "Feed". This stands for the penetration speed of this tool on the Z axis in mm/min. The 1/min column sets the spindle rpm. The range is from 30 000 to 60 000 rpm.

Drill diameter, feed rate and rpm are related through the peripheral cutting speed at the tool flute, and this is a value recommended by the tool manufacturer. For example, doubling the spindle rpm means that you should also increase feed to the double, if the diameter stays the same. Or using the double diameter means you should use half the rpm if you do not double the feed rate. The basis for these linear proportion is implemented in a default tool table. This is linked to the main tool menu by the diameter field "Diam". You can open and edit this table when you press the "edit default" button:

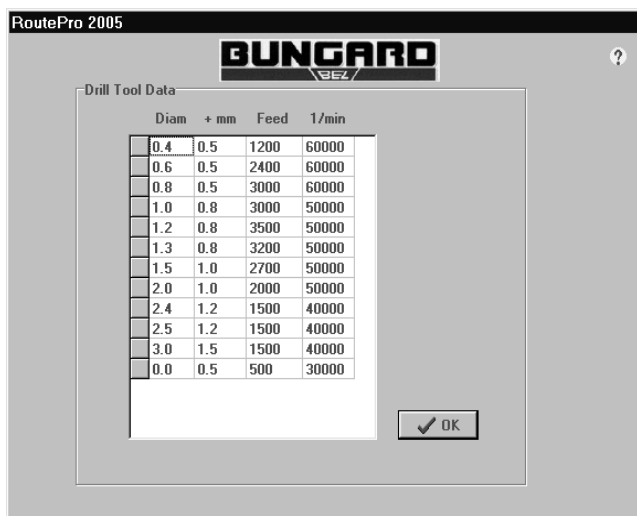
We have prepared a subset of values in this table that are based on a cutting speed of 100 to 150 m/min on the drill circumference, as per the recommendation of our tool supplier. You may change these values at need. To enter a new line, press the INS button, to delete a line, press the DEL button. Quit the menu by pressing OK.

Also in the main tool table you may specify a new diameter that is not in the default list yet, and add all the other physical parameters that you want for this new tool. If you then press the "update" button, this new tool definition will be copied to the default table.

The other way around, if you have all tools for a job in the main table and want to provide the default settings to them, press the "update all" button to transfer the default settings.

Tool	Diam	+mm	Feed	1/min	Count (1 PCB)	ATC Tab	Holes Drilled	Tools in use
T1	0.4	0.5	1200	60000		1	0	6
T2	0.6	0.5	2400	60000		2	0	20
T3	0.8	0.5	3000	60000		3	0	
T4	1.0	0.8	3000	50000		4	0	
T5	1.2	0.8	3500	50000		5	0	
T6	1.3	0.8	3200	50000	237	6	0	
T7	1.5	1.0	2700	50000		7	0	
T8	2.0	1.0	2000	50000		8	0	
T9	2.4	1.2	1500	40000		9	0	
T10	2.5	1.2	1500	40000		10	0	
T11	3.0	1.5	1500	40000		11	0	
T12	0	0.5	500	30000		12	0	
T13	0	0.5	500	30000		13	0	
T14	0	0.5	500	30000		14	0	

Pict. 18: Drill tool data

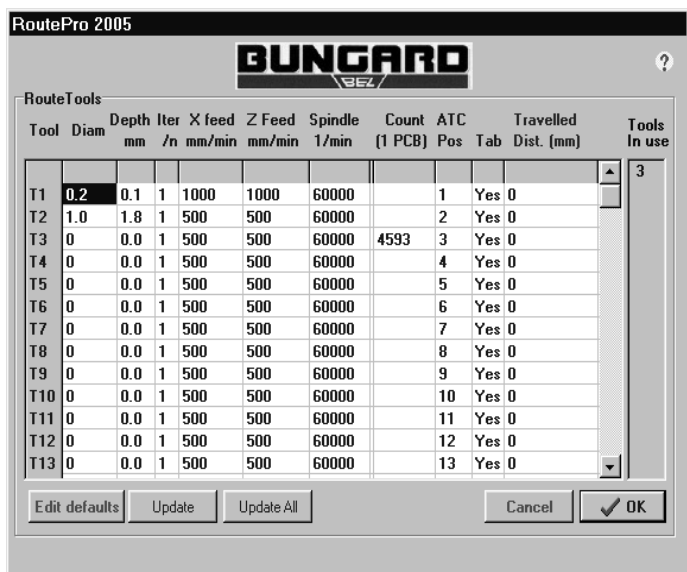


Pict: 19 . Default Drill Tool Table

There are tool tip help texts appearing when you hold the mouse cursor over the buttons. These tool tips explain in short form what the buttons stand for. The other columns in the tool table mostly give information on how often this tool is used in the file, or offer a usage counter, like the column entitled "holes drilled". The "Tab" column informs if a tool uses the standard settings from the default table ("Yes"), if it is not in this table ("No"), or if it is in, but the settings were modified ("Mod").

Anyhow, one important column is left for machines with automatic tool change. This is the one with the title "ATC Pos". Here you can specify the tool container no from which this tool is to be taken. Tool container no. 0 is always reserved for the test pin (that has to sit in the spindle chuck to protect it), but all other numbers from 1 to 15 are possible. **Note:** Correct entries to this column are most important when using the automatic tool change function!

### 2.4.3.2 Route tool table



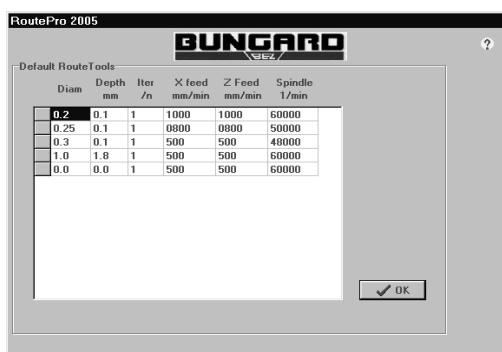
Pict: 20 . Route Tool Table

The main Route tool table looks similar to the drill tool table, but due to the difference in operation, routing requires a few different tool definitions. We do not use an additional stroke here, but we specify the total cutting depth, measured downwards from the board surface.

"Iter /n": Due to enlarged mechanical forces to the router, it may be difficult to process hard or thick boards with a big stroke length. For this reason the driver is capable of routing a vector chain in multiple passes (iterations) with increasing routing depths.

Example: You may want to make an outbreak in a 3 mm aluminium plate. The cutting rate of the router is known to be 1 mm at given settings of routing and spindle speed. You should thus choose 3 iterations.

"X feed mm/min": When drilling, the X and Y traverse speed is at a given constant maximum. Routing requires individual speed settings when the tool is cutting material. This speed is set here. The "Z speed" column takes the corresponding setting for the tool down action. These settings relate to actual routing and milling, but of course traverse speed for positioning is not affected.



Pict: 21/ . Default Route Tool Table

The meaning of the other columns in this menu is the same as for drilling. The travelled distance count summarizes the tool travel path, allowing the user to replace a worn out tool in time.

The default tool table of course has extra entries that reflect the differences in the route tool menu.

#### 2.4.4. Offset

Offset mode allows to manually move the machine axes. This is useful for general testing, but also to determine a new board zero position, if necessary. The "cursor" buttons with the flashes stand for a one-time move in the given direction at a step count as defined in the column Mil/1. The hand up and down buttons stand for a Z axis move. The "Chuck" button is available only for auto tool change machines. On ATC and MTC machines, after starting the spindle by pressing the "Spindle" button, a slider becomes visible that allows to set the spindle rpm.

The table with the "tool", "X Pos" and "Y Pos" columns is to create drill files manually by teaching drill positions. Each time you press the button "add to list", a new drill coordinate will be stored. The new drill file can be stored upon leaving the menu. This Teach-In is of few interest nowadays, and is also not available in routing mode.

The last position information from the offset menu will be transferred to the main menu if you leave this screen by pressing OK. If you press cancel, the position information is neglected. The other way round, if there was a positive offset value stored in the main menu, you will be prompted to maintain or delete it. If you do not delete it, the machine moves to this position before the offset menu comes up.



Pict. 22: Offset mode



Pict. 23: Offset prompt

## 2.4.5. Configuration

There are settings that are unique to every machine. These, as well as some general speed settings and other options, can be found in the configuration menu. This menu is for both drilling and routing.

The first two groups of settings belong to the coordinate units for drilling and routing. All such NC data files use a numeric format with implied decimal point and are based either on metric or imperial / English units. Standard HP/GL assumes 0.025 mm as the basic measuring unit, but there exist also dialects with 1 mil as 1 HP/GL step. In conjunction with other software that we offer, like Isolator or IsoCAM, we recommend to keep the setting on 0.025 mm. Else, you would have to change the measuring unit also in all precedent programs, up to your design tool.

For drilling, the most popular units are 1 mil or 0.1 mil. This corresponds to a "2.3 imperial" or "2.4 imperial" format in terms of what some CAD packages call it. For drill data, no trailing zero suppression is allowed!

Drill sorting can be distinguished in 3 types, where "None" is evident. "X first" and "Y first" describe a chain of meandering vectors, and "Y first" means that the meander is parallel to the X axis. Special sorting is the attempt to implement a solution like for the "travelling salesman" problem, where the shortest way to each target point is being used.

One of the new features of RP2K5 over RP2K is that the step width for the stepper motors can now be set to other than the former 1/2 step mode. For example, 1/8 step now gives us a 6.35  $\mu\text{m}$  step size, as compared to the former 25.4  $\mu\text{m}$ . This requires that the basic step size for 1/1 = 1 entire step is known to the program. This should not be changed as long as the transmission of the machine is fixed and given by the belt drive. Selecting micro-step modes increases precision in terms of finer positioning, but at the same time it reduces the max. possible traverse speed. This speed change is reflected by reduced settings to the XY and Z speed values on the left side of the menu, once you switch from 1/2 step to smaller step rates, say 1/8 step. When you set the step rate back from there to 1/2 step for example, you have to adapt the speed settings manually back to higher values.

Related to the speed settings are the ramps. This word describes an acceleration and deceleration function where the motors speed up and down more or less slowly at the beginning and the end of each vector. The start and end speed of this function is given by the XY and Z Ramp speed setting. We recommend to use a value of 1000 for this in half step mode. The XY and Z Ref speed means the reduced speed that we use to go precisely to the switch point of the reference switches. It is also on 1000 mm/min by default.

Three individual settings to each machine are the X and Y correction factor and the Stroke Z limit. The Z correction factor is given by the gearbox transmission and does not change. The X and Y correction factors are factory set and depend on the belt tension. Changes have influence on positioning precision and should not be made without prior consultation. The Z stroke limit is given by the Z micro-switch. Having the correct setting there is essential for the machine to calculate the correct height over the machine bed and the board. Please ask us for a description of how to measure and set up the right value before changing this setting.

The free stroke setting is explained in the diagram in picture 17. In simple words, this describes the height that the tool has when "flying" over the board while moving to the next position.

The table size distinguishes between the machine types CCD/MTC and ATC and CCD/2. This smaller machine has 325 x 270 mm effective table size, the bigger ones have 495 x 325 mm table size. The value of 555 shown on the picture is useful if you ever need to reach the tool containers in offset mode, for example to check the tool change positions. In all other cases you should keep this setting on 495. For CCD/2 there is no automatic tool change, so there is no reason to change the table size settings.

File extensions for drill and route file may follow the conventions from your CAD. Common values are .DRL, .NCD, .TXT for drill files and .PLT, .HPG, .HGL for HP/GL files.

The spindle delay means a time to wait during acceleration of the spindle, in order to synchronize physical spindle speed up with the time that the program waits before starting to move and drill.

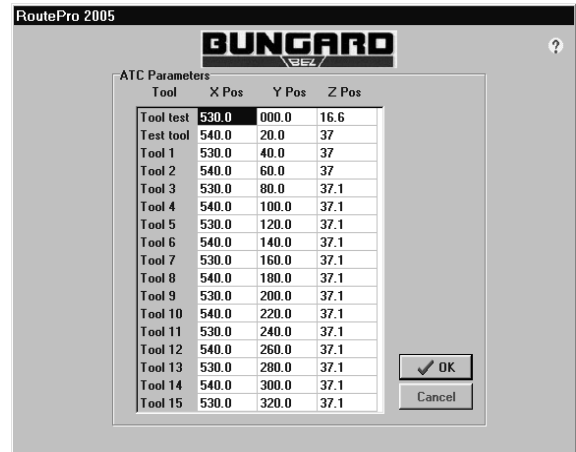
The last entry, the "number of segments" is used when HP/GL arc and circle commands are found in your data files. If these commands do not specify another angle, it determines the degree of segmentation for a full arc.

On the lower left corner, a checkbox enables the ATC functions in the software. If the box is check marked, a button "ATC positions" occurs.

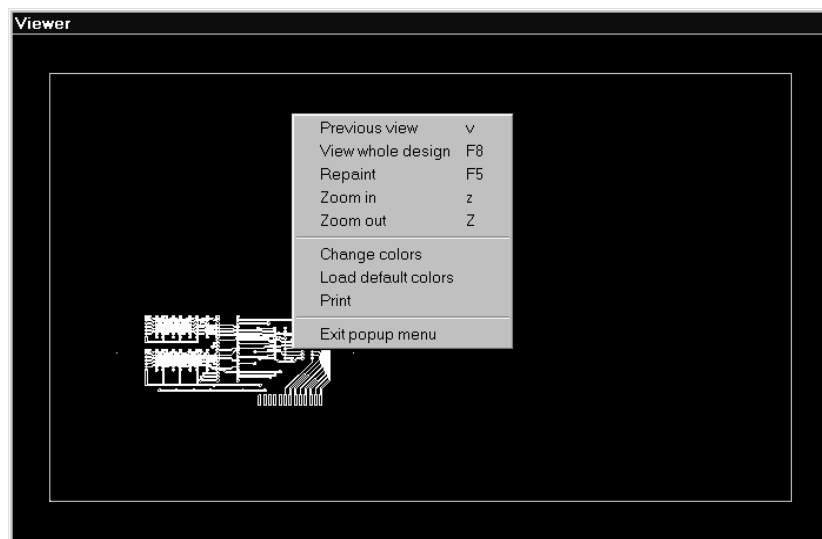
Pressing this button brings you to another screen where you can enter and change the individual position of each tool container in X, Y and Z, as well as the position of the tool test switch. Under normal conditions there is no need to

change these settings. One exception from this rule has to do with the way that broken or too long tools are handled: The tool test switch Z position may require smaller changes in steps of 0.1 mm in the case that your tools are erroneously detected too long or too short. Please contact us for details if ever necessary.

Leaving the config. menu by the cancel button will neglect changes. Pressing OK will bring you back to the main menu, while changes to the configuration are written to the config. file designated in the main menu.



Pict. 25: ATC Positions

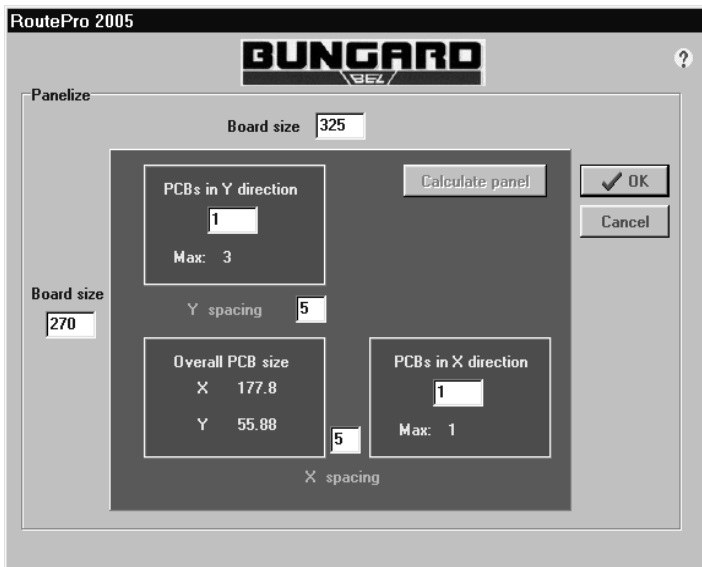


Pict. 26: Viewer

## 2.4.6 Viewer

The "Viewer" button in the main menu opens a second window on the screen. This shows the representation of loaded drill and route data. Under the right mouse button you will find a menu for zooming / panning / repaint. The viewer has no close handle, but it can be resized by dragging the window frame. To close, press the viewer button on the main menu once again.

On the main menu, when the viewer is present, there appears an extra button that allows the additional display of the machine table in the viewer window.



Pict. 3: Panelization

### 2.4.7 Panelize

The "Panelize" button on the main menu opens a windows where you can create multiple copies of a single drill or route file. To do so, just specify the amount of copies in X and Y direction and the gap between them. The max. settings for the board size are given by the machine table size, but can be reduced to what you prefer. When all data are present to execute the panelization, the "calculate panel" button will become active. To finish, exit the menu by OK. To return without change, press "Cancel".

### 2.4.8 To Y max

This serves to run the Y axis out of the way from the zero point to the max. Y elevation. The meaning here is to give better access to the board that is mounted close to the machine zero point. There is no explicit function to return back from Y max, as this will always be the case prior to any other movement, by means of a reference run to the home position.

### 2.4.9 Quit

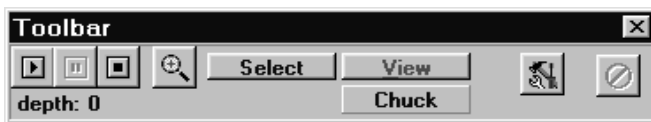
Program execution stops. You are prompted to confirm before the main menu and the viewer windows close. Changes to all menus are written back to the configuration file and will be available upon next program start.

### 2.4.10 Update Data

This button on the left side of the main menu refreshes the screen display of the main menu and of the viewer, for example if you changed the offset values by hand and want to see the resulting position of the image on the screen.

### 2.4.11 Start drilling / milling

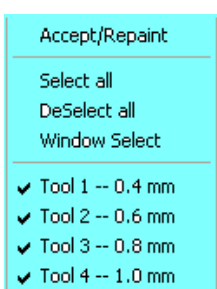
This button is available if you have loaded a file and the dimensions of the drill or route image are within the limits. The following procedure varies, depending if you use automatic tool change or not. The start point is common to all modes:



Picture 28 Tool Bar

After an initial reference run, the so called tool bar comes on the screen. This will stay in a window always on top of the others. It has buttons like on a video player for start, stop and pause. When the machine is running, the button on the right side shows a red stop symbol. This is the emergency stop. Instead of pressing this button, you may at any time press the ESCape key on the keyboard for an immediate stop of the spindle and the stepper motors. Further the tool bar has buttons to control the view size and to open and close the chuck. One button is to check the travel length of the tool that is actually inserted. Tool tip help is available when you put the mouse cursor over a button.

Under the "Select" button, you have different possibilities to influence the drill or route action by choosing all vectors or only those belonging to single tools, or you can select vectors or holes by mouse on the viewer screen.



Pict. 29 Selection

### 2.4.11.1 Automatic tool change

The tool change sequence is like follows:

After pressing the toolbar start button, you are asked if all tools were placed correctly. On confirmation of this, the machine starts moving. The test pin is checked in the drill break detector and is returned to tool change position 0. The spindle is lift with the chuck open, and another test is done in the tool detector to verify if the pin was left. If not, it is likely that there is no compressed air available and the remaining sequence cannot be performed. A message will appear and further execution is stopped. The normal case is that the pin was left in the tool container and the first tool is picked up from its tool holder: The X and Y axes move in U shape from the old to the new tool position. The Z axis goes down to take the drill bit and the chuck closes. Another test is done with this newly picked tool to determine if it has the right length. Either it is too short or too long, it will not be used but put back into the holder. If it has the nominal length of 21 mm (plus/minus a minimum tolerance) spindle will be started and accelerates to the preset rotation speed.

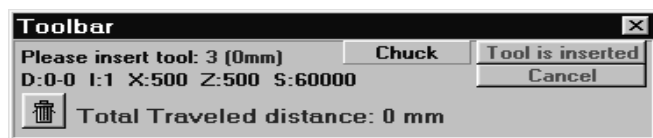


Pict. 30: Tool bar / speeding up

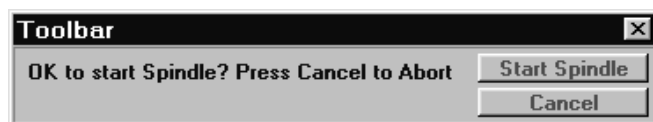
The machine goes to the first hole to be drilled. After drilling all holes assigned to that tool, the spindle stops. The sequence will be repeated for all subsequent tools with the test on too long or too short tools being repeated. At the end of the drill job, the test pin is picked up and a reference run follows. A message box informs about tools found to be too long or too short. Such tools should be checked and replaced, and the drill action must be repeated with a selection of these tools.

### 2.4.11.2 Manual Change

A dialogue showing the actual tool parameters appears. On ATC machines in manual mode, press the chuck button to open the chuck. Insert the tool and confirm it was inserted, or press cancel to stop. On MTC machines change the tool manually as described earlier. At each tool change required, this action has to be repeated. During tool change, the stepper motors are under current so that no unwanted change of position can occur.



Pict. 31: Tool bar / insert tool



Pict. 32: Tool bar / confirm start

The spindle is turned on and off automatically. During the acceleration and brake action the software respects a delay time so that the axis do not move too early.

### 2.4.11.3 Execution

The co-ordinates read from the file will be transformed into steps according to the settings for scaling and offset that you made in the main menu. The progress of drilling or routing is shown on the viewer screen. Holes drilled or vectors milled will change colour. You can at any time stop the machine by pressing the ESC key for a short moment. It may take the time necessary to finish the last drill action before the spindle is stopped and the Z axis lift up.

The HF generator has a spindle overload protection. If overload occurs, the machine will also stop automatically and an alert box comes on the screen that explains the reason of interruption. Spindle overload is a severe exception so that the drill cycle stops at this point. To restart, a new reference run will be necessary and the former selection of holes / vectors will be lost.

During normal execution, the tool change sequence is being repeated for each new tool. After all vectors have been processed a ready message appears and either you return to the main menu or you change the board and immediately restart by the start button on the toolbar.



## EG-Konformitätserklärung Declaration of conformity Déclaration de conformité

Wir (Name des Anbieters)  
We (Suppliers Name)  
Nous (Nom du Fournisseur)

Bungard Elektronik GmbH & Co. KG

Anschrift  
Address  
Adresse

Rilke Straße 1  
51570 Windeck  
Germany

erklären in alleiniger Verantwortung, daß die Produkte  
declare under sole responsibility, that the products  
déclarons sous notre seule responsabilité, que les produits

Bezeichnung / Typ  
Name / type  
Nom / type

Bungard CCD / MTC  
Bungard CCD / ATC  
Bungard CCD / 2

mit den Anforderungen der Normen  
fullfil the requirements of the standards  
satisfontent aus exigences des normes

EN 50 081-1, EN 50082-1  
EN 55014, EN 55015  
EN 60204 Teil / Part 1

und den wesentl. Schutzziele der  
and the basic requirements of  
et des exigences de base de la

Richtl. / Directive 89/392 Anh. / App. I

übereinstimmen und damit den Bestimmungen der folgenden EG-Richtlinien entsprechen:  
and therefore correspond to the regulations of the following EU-Directives:  
et, ainsi, correspondent aux règlements des Directives du Conseil:

89/336/EWG, 89/392/EWG, 73/23/EWG

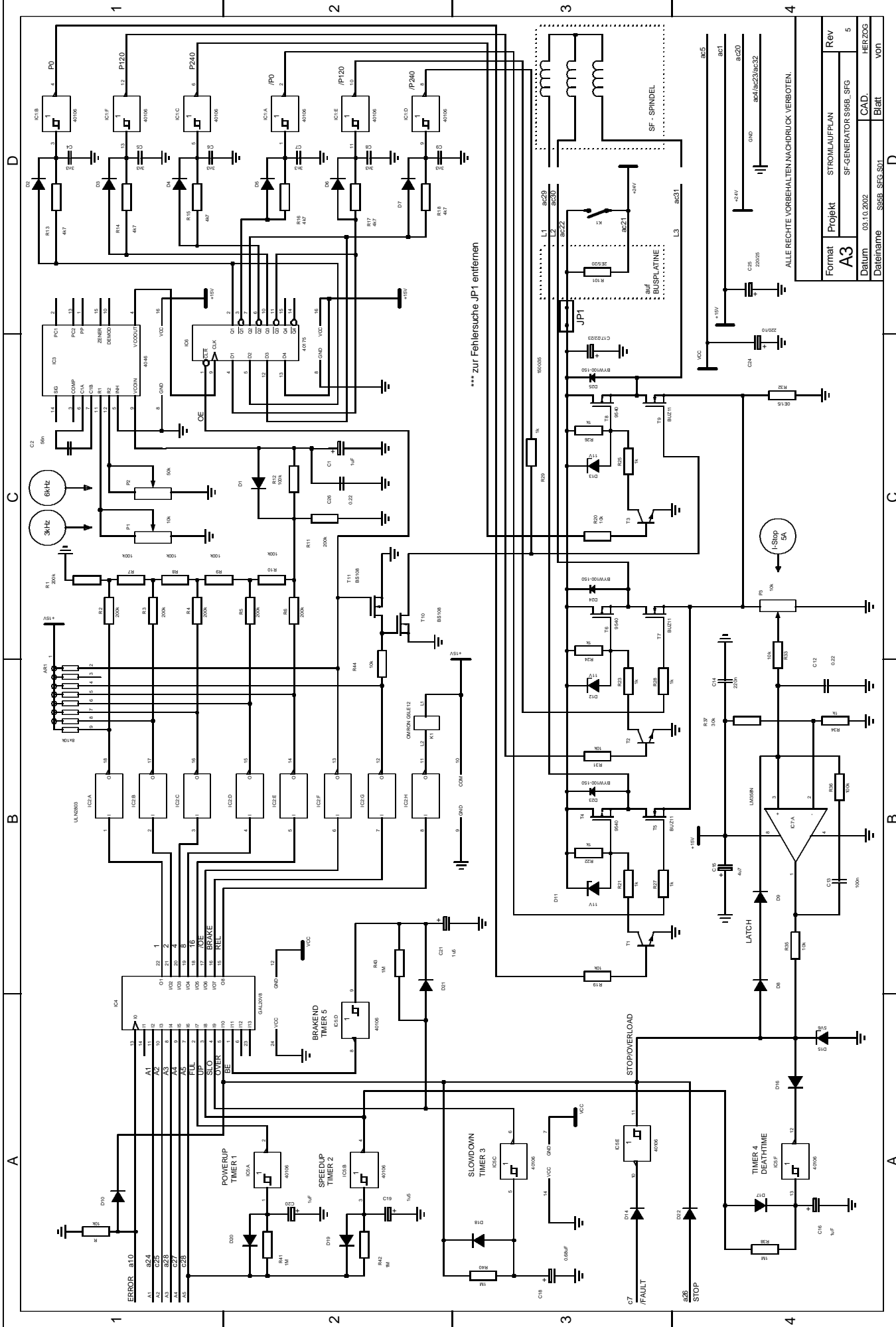
Windeck, 01.04.96

Dietmar Bungard

Ort und Datum der Ausstellung  
Place and Date of Issue  
Lieu et date d'établissement

Name und Unterschrift des Befugten  
Name and signature of authorized person  
Nom et signature de la personne autorisée

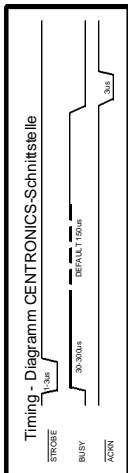
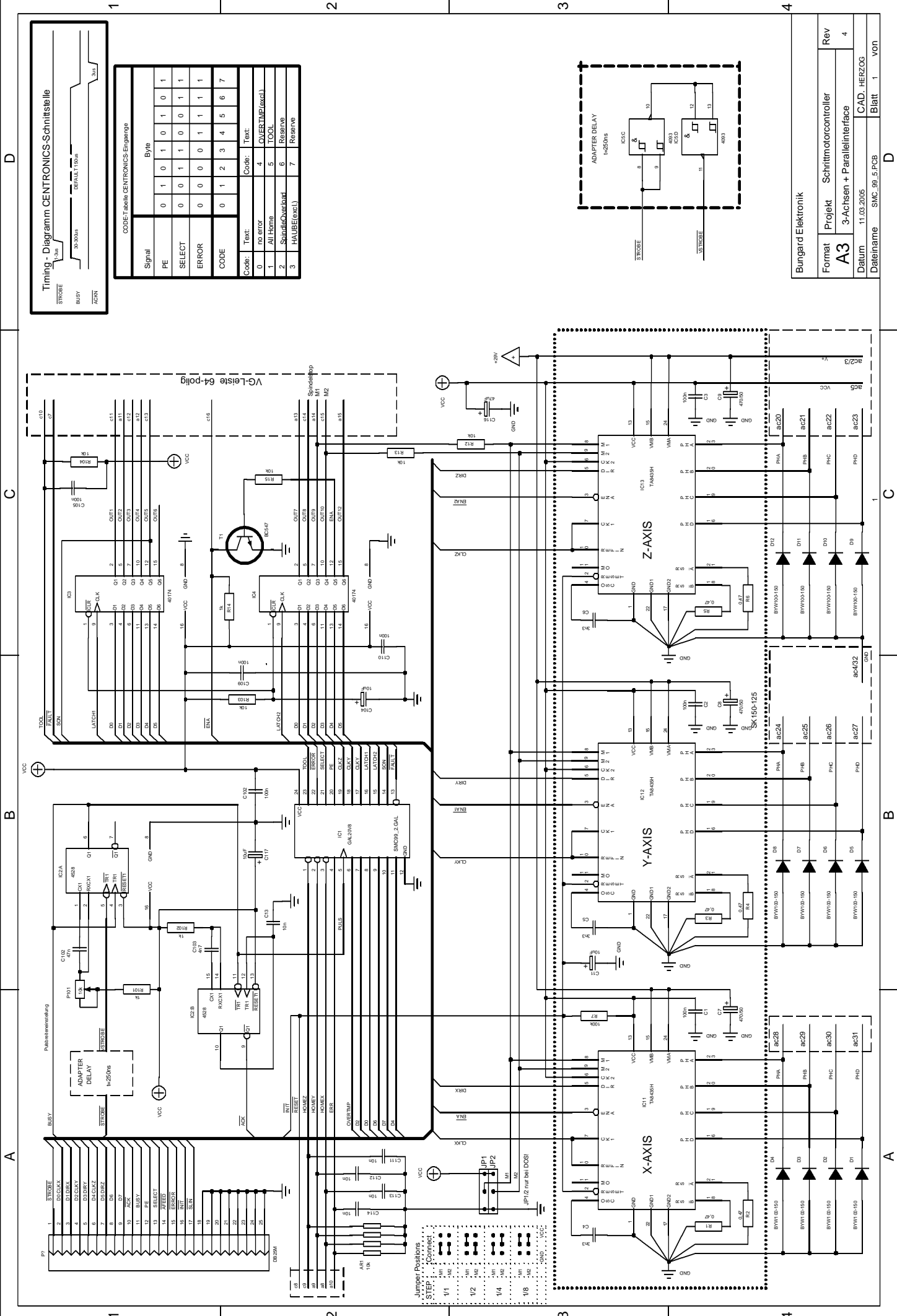
Diese Erklärung entspricht EN 45 014  
This declaration corresponds to EN 45 014  
Cette déclaration correspond à EN 45 014



Format	A3	Projekt	STROMLAUFPLAN	Rev	5
Datum	03.10.2002	SF-GENERATOR	SS9B_SFG	CAD.	HERZOG
Dateiname	SS9B_SFG.S01	Blatt	von		

\*\*\* zur Fehlersuche JP1 entfernen

ALLE RECHTE VORBEHALTEN NACHDRUCK VERBOTTEN.

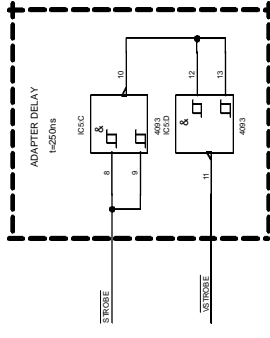


CODESET table CENTRONICS-Empfang

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SELECT	0 0 1 1 0 0 1 1
ERROR	0 0 0 0 1 1 1 1
CODE	0 1 2 3 4 5 6 7

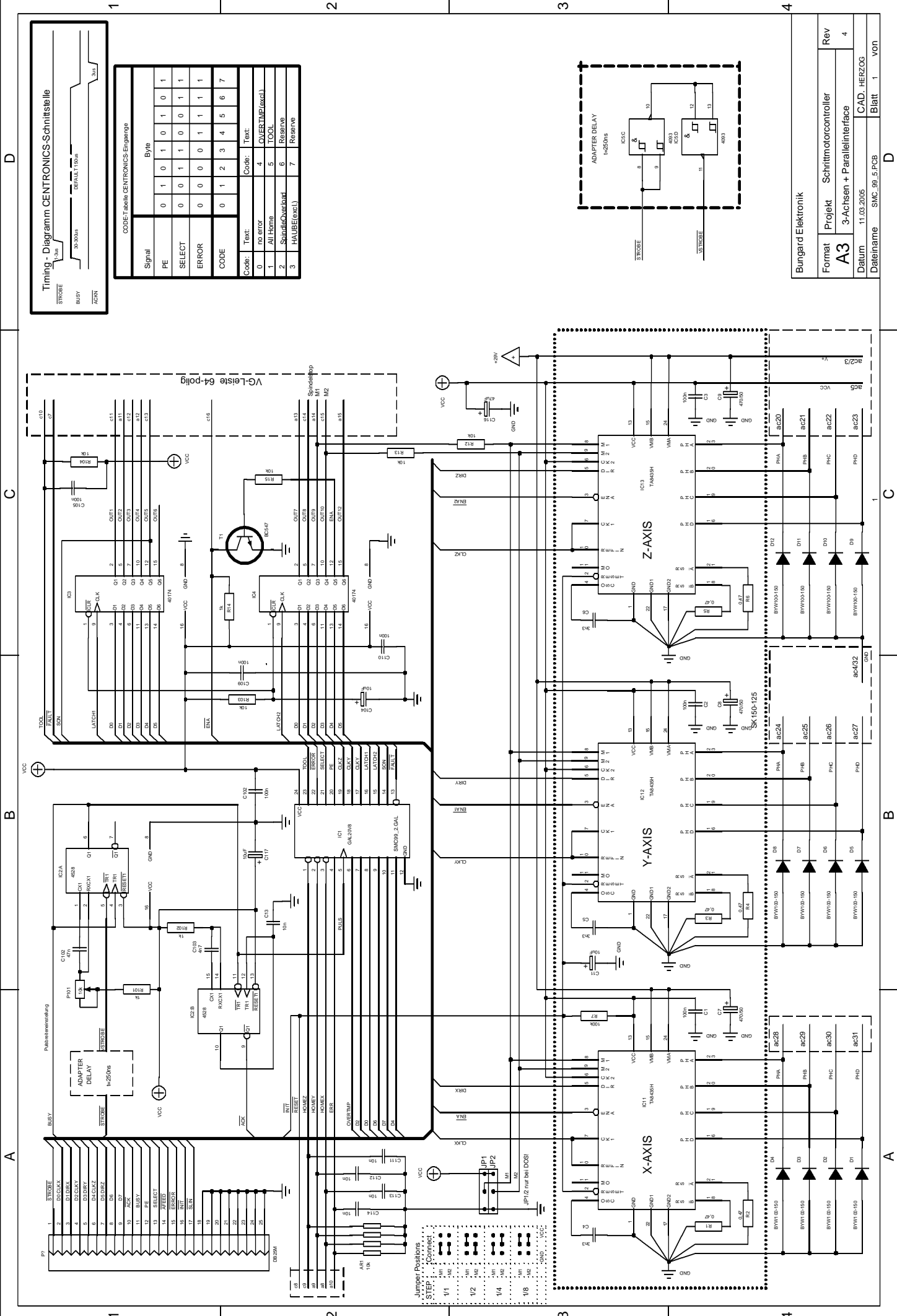
Code:	Text:
0	no error
1	All Home
2	Spindel/Carriage
3	HAUBE(external)
4	OVERTEMP(excl.)
5	TOOL
6	Reserve
7	Reserve

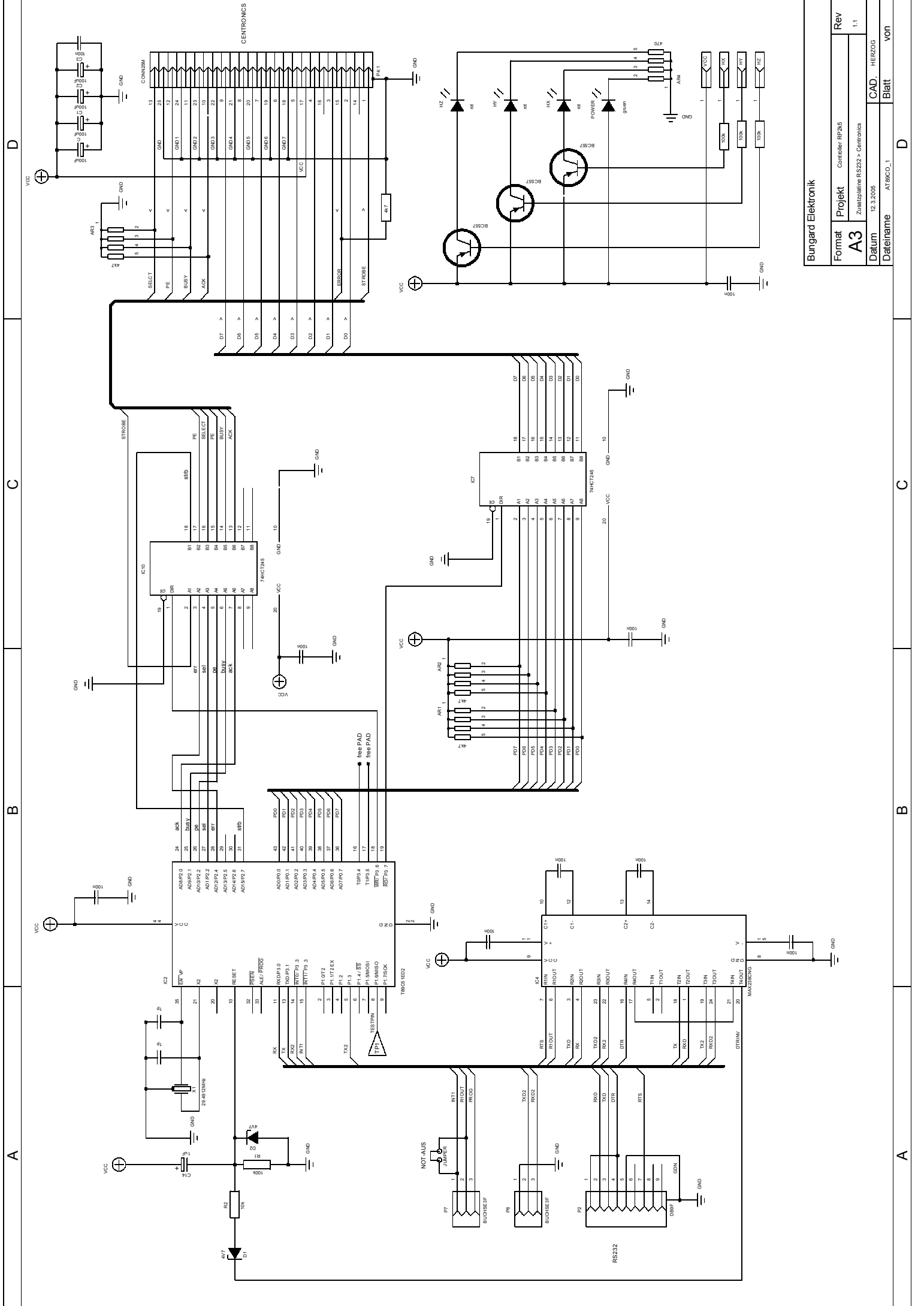


Bungard Elektronik

Format	Projekt	Schrittmotorcontroller	Rev
A3	3-Achsen + Parallelinterface		4

Datum: 11.03.2005  
 Dateiname: SMC\_99\_5.PCB  
 CAD: HERZOG  
 Blatt: 1 von

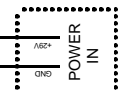
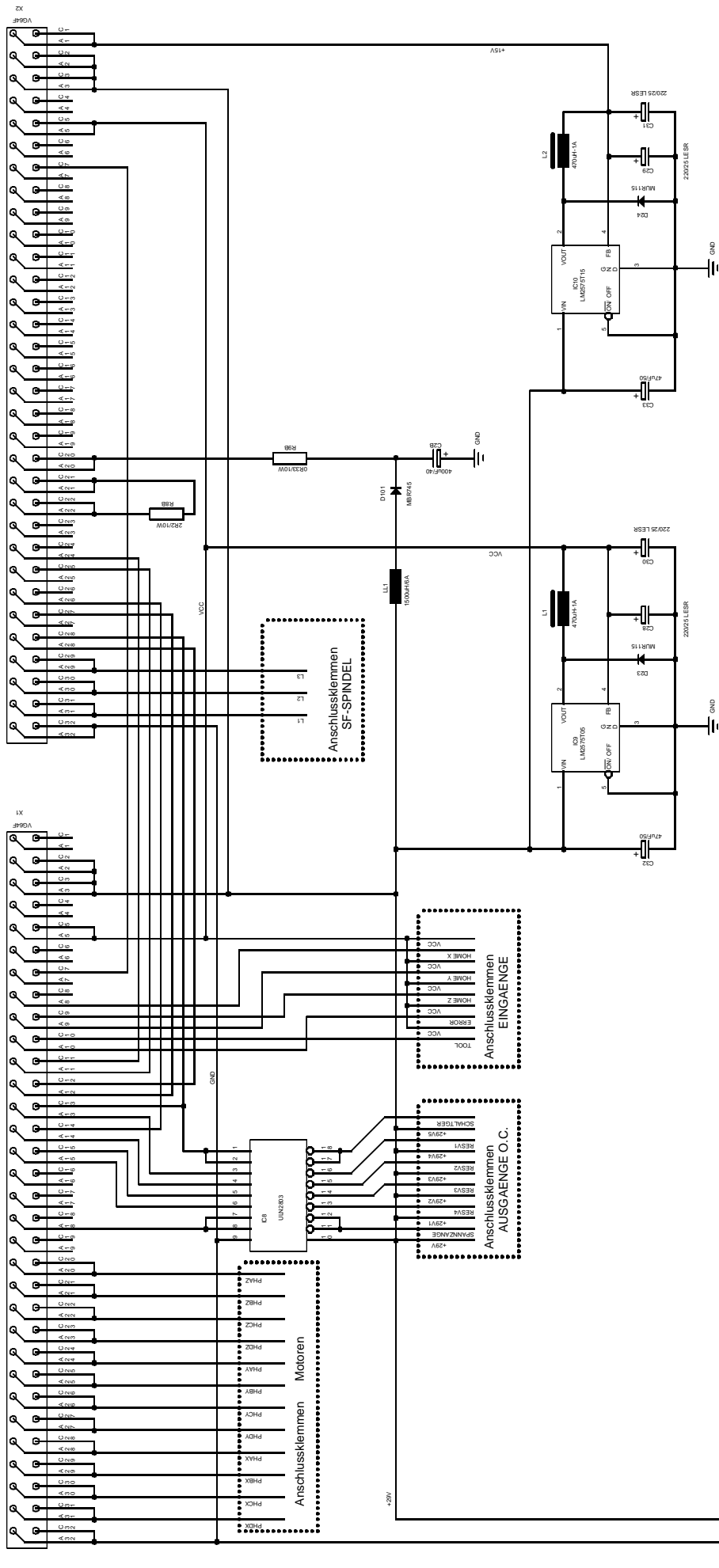




A B C D

1 2 3 4

Bungard Elektronik	
Format	Projekt
A3	Controller RP265
Datum	Zusatztabelle RS232 > Centronics
12.3.2005	1.1
Dateiname	CAD_HERZOG
AT86CO_1	Blatt
	von



Format	A3	Projekt	Schrittmotorcontroller	Rev	2
Datum	27.07.2000	Anschluplatine/Stromversorgung		CAD	HERZOGS
Dateiname	SMC_99_4.PCB	Blatt	2	von	

A

B

C

D



