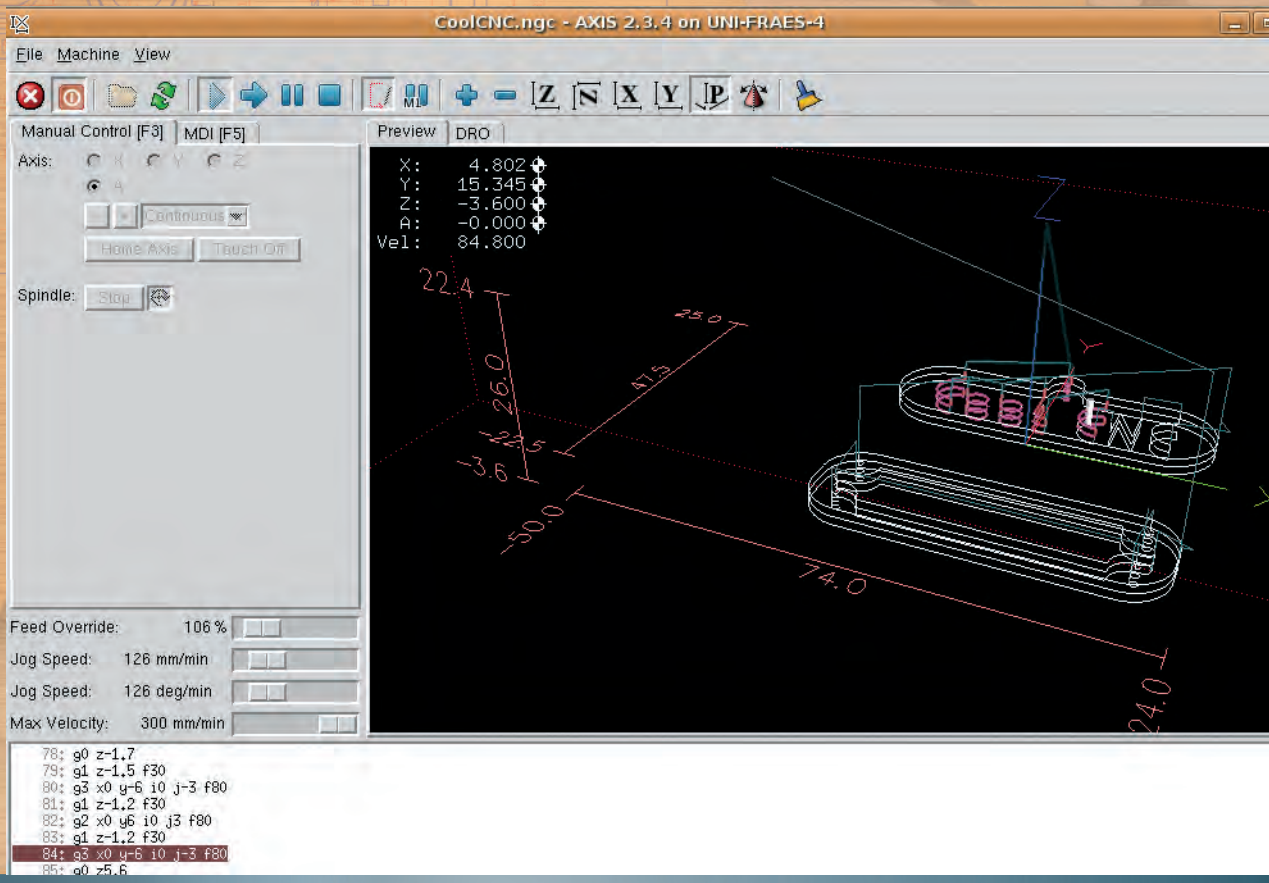
The tool Education



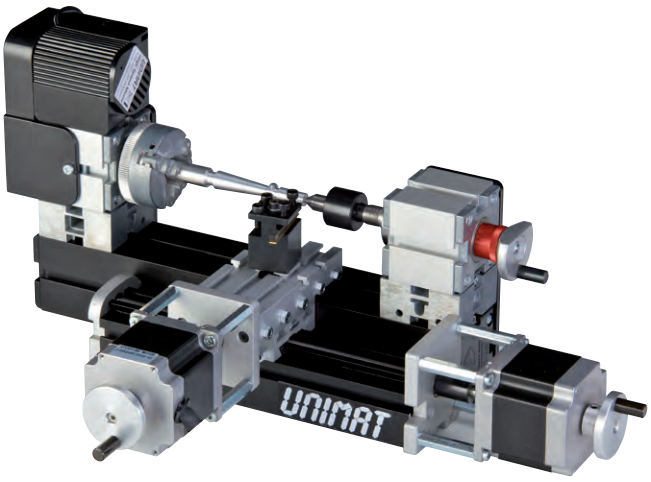
[TVET-CNC-1]

The tool QUALITY PRODUCT MADE IN AUSTRIA

4.0 Unimat in TVET – CNC

Vocational and College Level

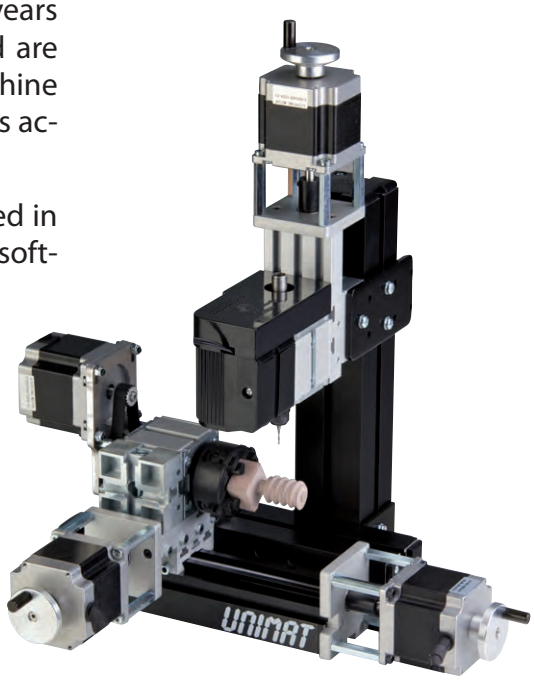
Especially for innovative education in higher grades Unimat CNC is an interesting option. Due to the modular construction an almost infinite number of application possibilities arise. The Unimat CNC slides of the mill and the lathe are equipped with 2 A stepper motors.



Some of the characteristics are:

- Cross Slide: travel 50 mm (extendible: 80 mm)
- Longitudinal Slide: travel 145 mm (extendible: 445 mm)
- Accuracy: max. 0,07 mm
- CNC-Mill – up to 4 axes

Particularly noteworthy is the low costs of this system. Instead of purchasing industrial machines, which eat up the entire budget for years (high entry costs and ongoing expenditures for maintenance) and are not at students' disposal, the Unimat CNC allows for an entire machine park at only a part of the cost. Students can now use these machines actively and autonomously.



The machines are controlled via the free software LinuxCNC included in the bundle CoolCNC Linux. Therefore students can also install the software legally and exercise it at home.

What was designed in a CAD application can be converted into machine code in a CAM application.

LinuxCNC offers a graphical interface as well as sufficient insight into the G-code.

Curriculum example:

Curriculum secondary level II specialized grammar school, engineering, Schleswig Hollstein, Germany. pp. 33.: "Knowledge about automated production facilities … planning and processing of selected components … the emphases must be on automation of production processes as well as on the CAD-CAM combination and quality management. … Processing of parts should be executed and automated. Students should be integrated in this process chain."

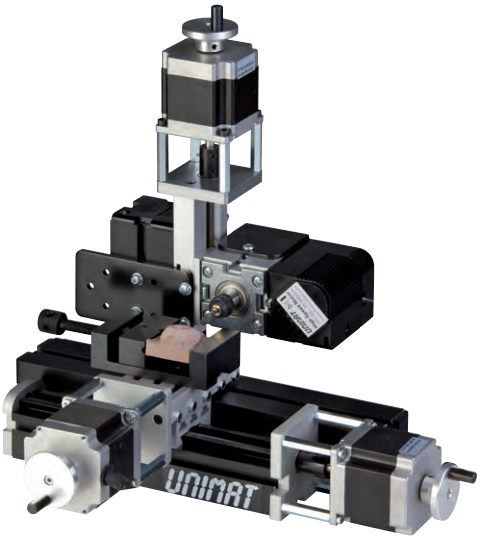
Unimat in TVET – CNC

Opening up new possibilities of using CNC machinery in education

Meanwhile, CNC technology has become an integral part of every solid technical education. The understanding of material, machine and controller code should not only be taught in theory.

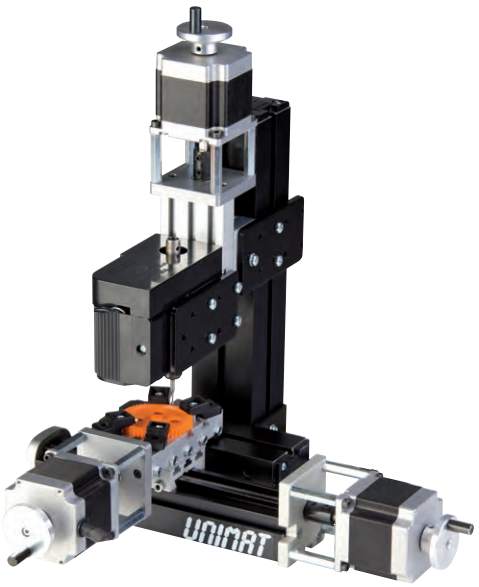
Industrial machines indeed have the advantage in education that students get practical insights, but rarely can a school or a university provide sufficient access to such machines.

The gap between practical and profound training and permanently more restricted budgets, can be bridged with Unimat CNC. Developed for prototyping and model making, this system also provides a lot of advantages for the educational sector.



Autonomous working due to eased access to machinery

Lower costs allow for the acquisition of several devices, many students can work at the same time. Thanks to the high safety, permanent monitoring is not required.

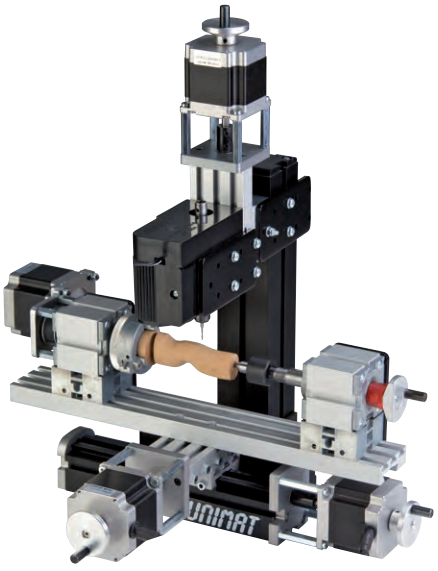


Profound expert knowledge instead of producer specific know-how

Everything learned on these machines can also be applied on big ones. There are no specific details used here that would be invalid on larger projects.

Most easy handling, putting into operation and maintenance

The simple and modular set up enables a fast insight into the functionality of the machine, applying them does not requrie much prior knowledge. Service can be done easily by yourself.



„One only apprehends what one can make himself, and one only conceives, what he can create himself."

Johann Wolfgang von Goethe, free translation

Opening up new possibilities of using CNC machinery in education

- **Use is location-independent**

  Due to the minor weight and size, the machines put in a transport box can be administrated and handled as easily as a video beamer.

- **2 year guarantee period**

  The machines are Austrian quality products with a 2 year guarantee period (wearing parts excluded).

- **Professional controller software without licence fees**

  As controller software you receive the CoolCNC-package. You simply boot the PC from this CD and all applications will start automatically. Only Open Source- applications are being deployed whereby all licence fees omit and even subsequent upgrades will be available for free. It is easy and pays.

CNC-technology can be applied in education easily, cost efficiently and has sufficient possibilities of access. Until now, due to their size and price, students were only able to use industrial machines one at a time and for a few minutes. However, with the Unimat CNC, each group can be assigned a machine and progress with their projects.

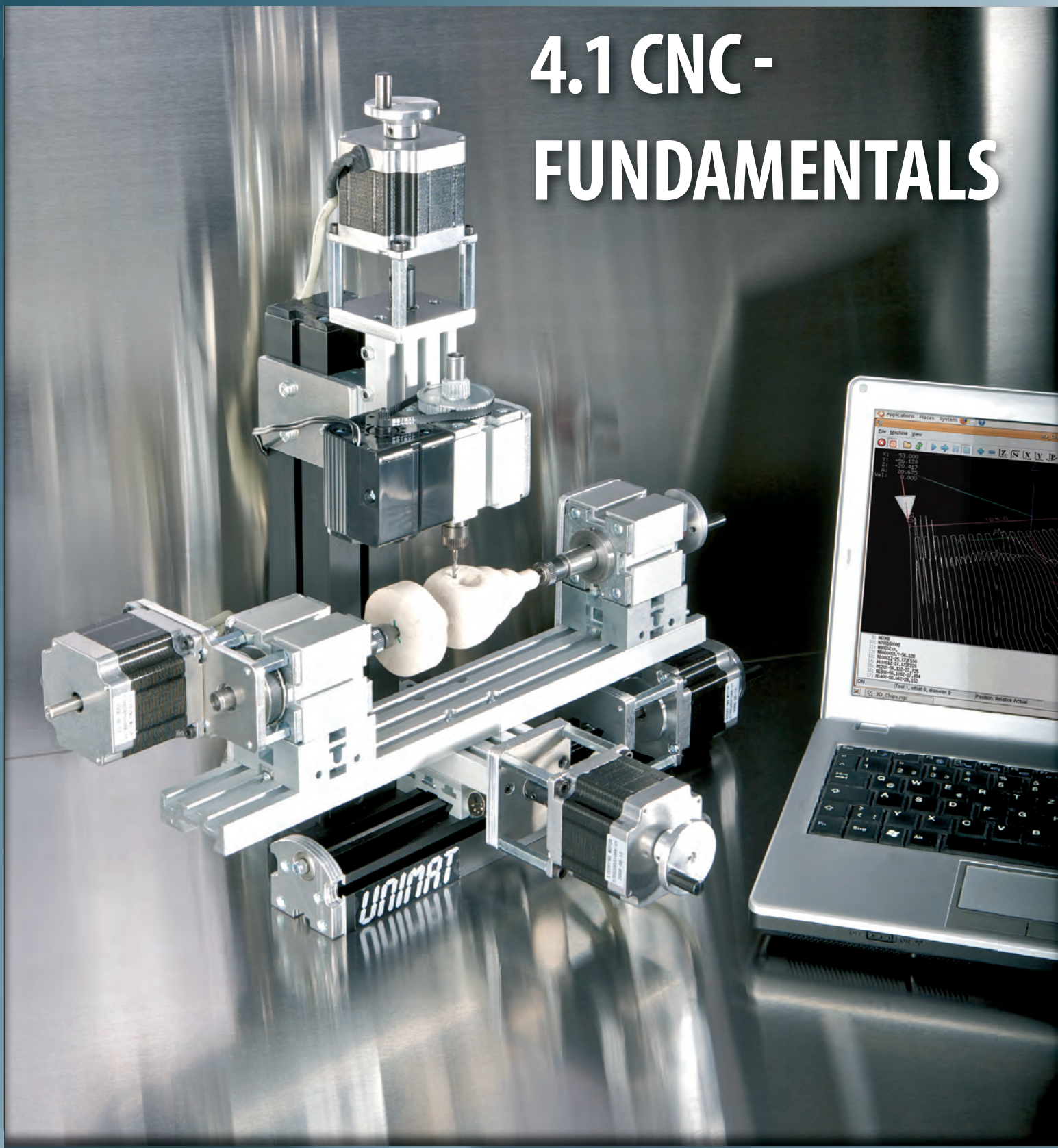
Project: furniture construction

Mag. Radatz, who is in charge of the workshop for interior design at the HTL Moedling, sent us an AutoCAD file, that we easily converted into G-code with the CAM software Deskproto.

A piece of beech wood was clamped and the design „ergonomic handle“ could be processed with the 4-axis CNC mill.

We are always at your disposal for a comprehensive consultation. Simply contact us if you are interested in our machinery!

4.1 CNC - FUNDAMENTALS



The tool 1881 QUALITY PRODUCT MADE IN AUSTRIA

Assets and drawbacks of automation 4.1.1

Assets/Advantages

- Automatic reproducibility
- Productivity increase
- Flexibility of production
- Reduce tool wear (constant conditions)
- Constant manufacturing cycles (Production planning)
- CNC machines can connect with each other (manufacturing systems)
- Great diversity of processing options
- Members can control several machines simultaneously - reduced labor costs
- Complex parts easily duplicate, one-time programming
- Automation improvements via robot integration, Conveyer belts, FMI, etc.

Drawbacks/Disadvantages

- High investment (machine plus work tools)
- CNC specialists for maintenance and running of the machines are required
- Development requirements for planning department(CAD/CAM/CIM)
- Costly individual parts due to programming
- Due to complex systems service providers are necessary for maintenace and service

NC . . . Numerical Control

This type was used on the first numerical controlled machines. The program input was relayed by using punch cards. However it was not possible to change the NC program directly with the machine, so it was necessary to create a new punch card.

CNC ..... Computerized Numerical Control

Here you can change the NC program anytime you want, because you can make the changes on the PC and the PC sends it to the machine. It is also possible to make the changes directly on the user panel of the machine.

For the CoolCNC system, we use the PC as our user panel as well.

DNC ..... Direct Numerical Control

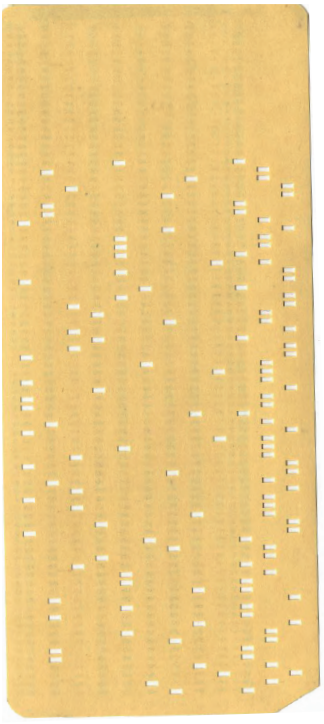
One PC (Server) controls more than one machine at the same time.

Our CoolCNC Linux software is a CNC controller. With some corrections (to the G-Code) it is possible to use it like a „DNC controller“ (for example two turning machines at the same time). But in this case, the visualization on the display is not correct and the G-Code is not according to the norm.

Therefore we only support CNC commands, which are norm conformable (standard rs274ngc).

punch card stamping press

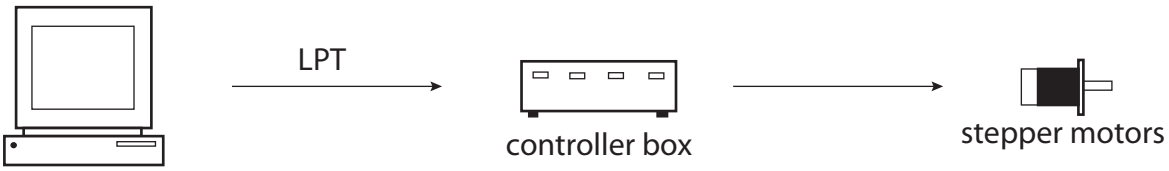
punch card



Set up of CoolCNC Systems

Real Time Linux vs. Windows (not Real Time)

CoolCNC Linux



For Notebooks without LPT:
You can use a PCMCIA or Express Card to Parallel Adapter.
Tested: Delock Art.No.: 61612 and 66220

Functions of PC:

1) User panel (type your own G-Code or open G-Code files)

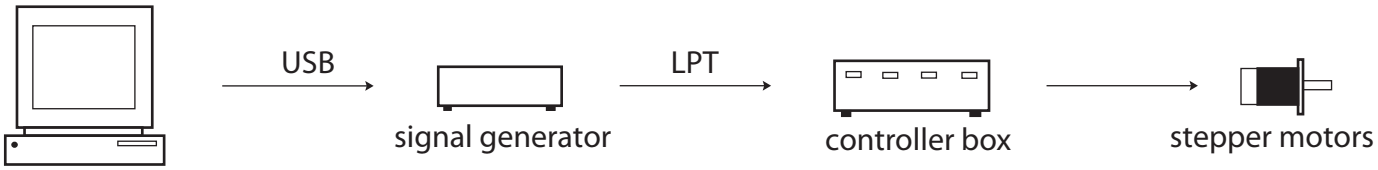
2) „Manual" control of the machine

3) CNC controller (generates the signals for the stepper motors real time)

Function of controller Box:

Amplify the signals from the PC and drive the stepper motors. (partial edit data - 1/2, 1/4, 1/8, ... step)

CoolCNC Windows



Functions of PC:

1) User panel (type your own G-Code or open G-Code files)

2) „Manual" control of the machine

3) CNC controller (generate controller packages – not real time)

Function of signal generator:

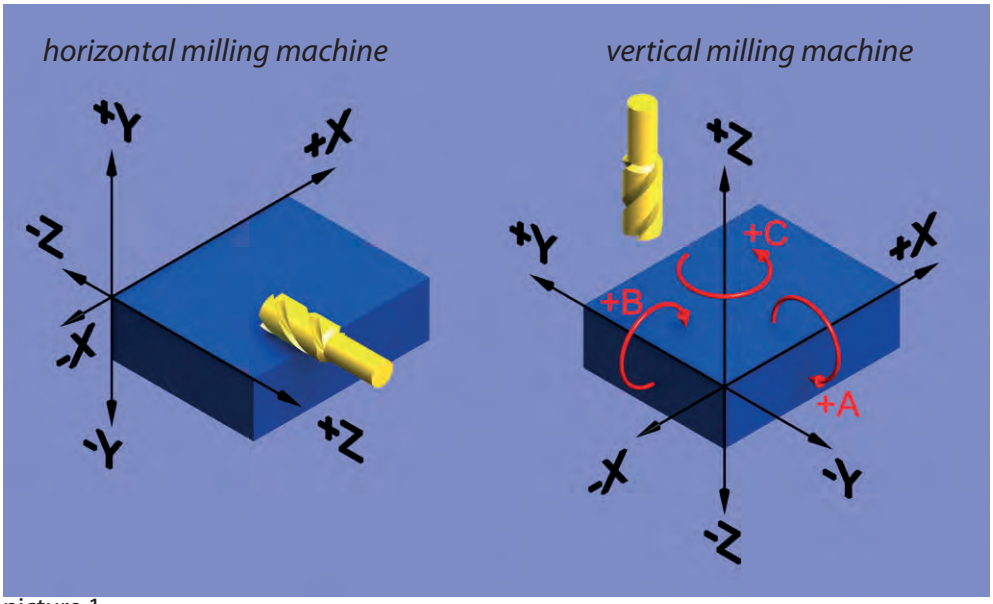
Is converting the information packages from the PC into signals for the stepper motors. The signal generator sends the signals in real time.

Function of controller Box:

Amplify the signals from the PC and drive the stepper motors. (partial edit data - 1/2, 1/4, 1/8, ... step)

Coordinate system for NC machines

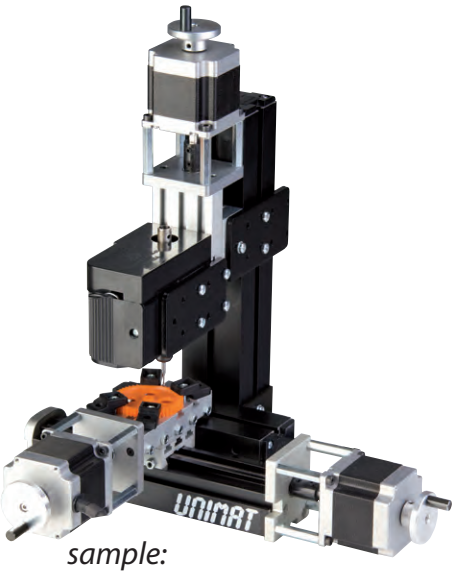
The Cartesian coordinate system refers to the work piece. The axis of the head spindle is Z.
Thereby we get different coordinate systems for Vertical-, Horizontal milling machines and turning machines.
Here you can see the coordinate system of a vertical- and horizontal milling machine.



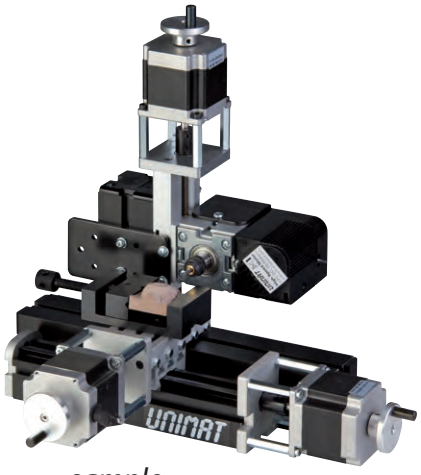
picture 1

If the machine can execute a rotation around an axis, then the name of this rotation axis is A, B or C (pic. 1).
Our 4 axes milling machine can turn the work piece around the x axis, thus the name of this rotation axis is A.

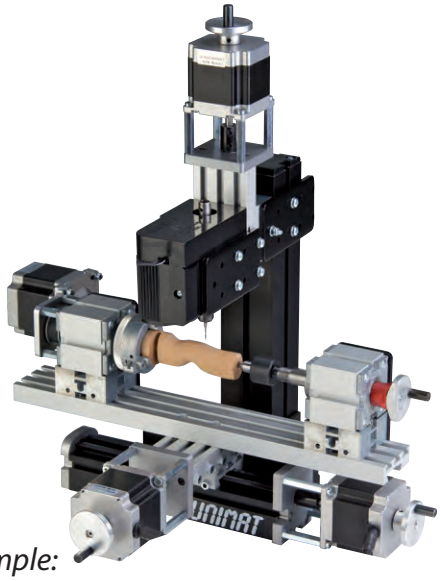
It is important to know that it is following defined G-Code programming -> the work piece is moving. Because of this we can use every norm conformable G-Code on every NC machine – the machine will go to the right direction.



sample:
vertical milling machine



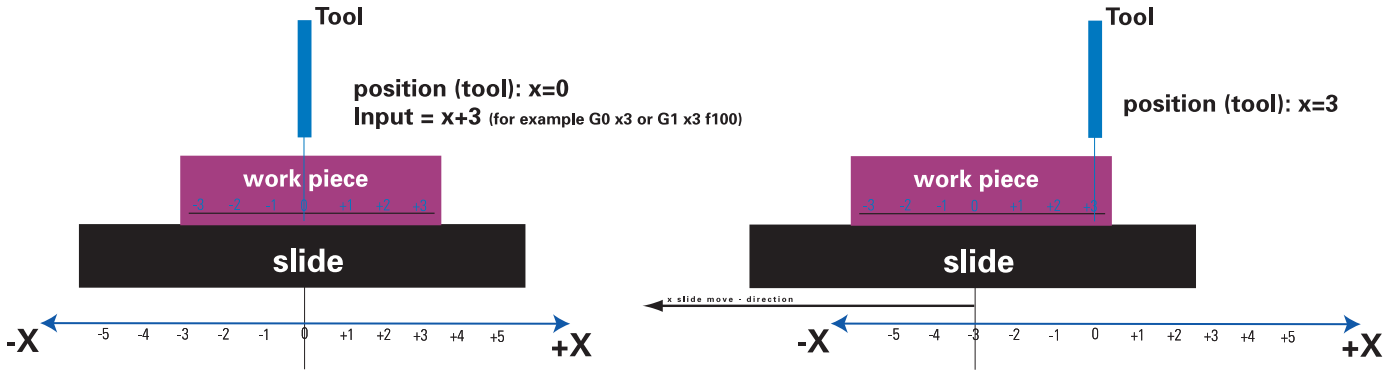
sample:
horizontal milling machine



sample:
vertical milling machine with A -axis

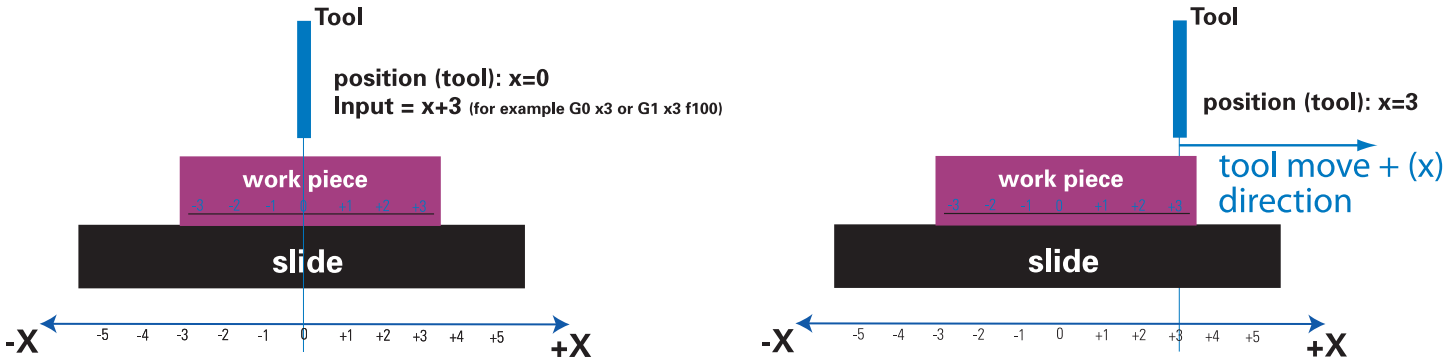
Explanation:

Machines where the work piece is moving (x/y) for example Uni-Fräs-V3 and Uni-Fräs4 – If you want to move the x axis from the zero position to x+3, then the slide goes –3.



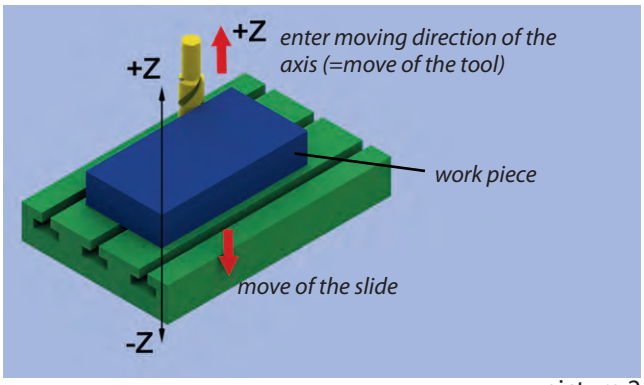
Now the position of the tool is +3 relative to the work piece.

Machines where the tool is moving (like gantry mills) - If you want to move the x axis from the zero position to x+3, then the X slide goes with the tool +3.



Now the position of the tool is +3 relative to the work piece.

If you have a machine where the slide with the work piece is moving in Z direction, the same principle applies (pic. 2).



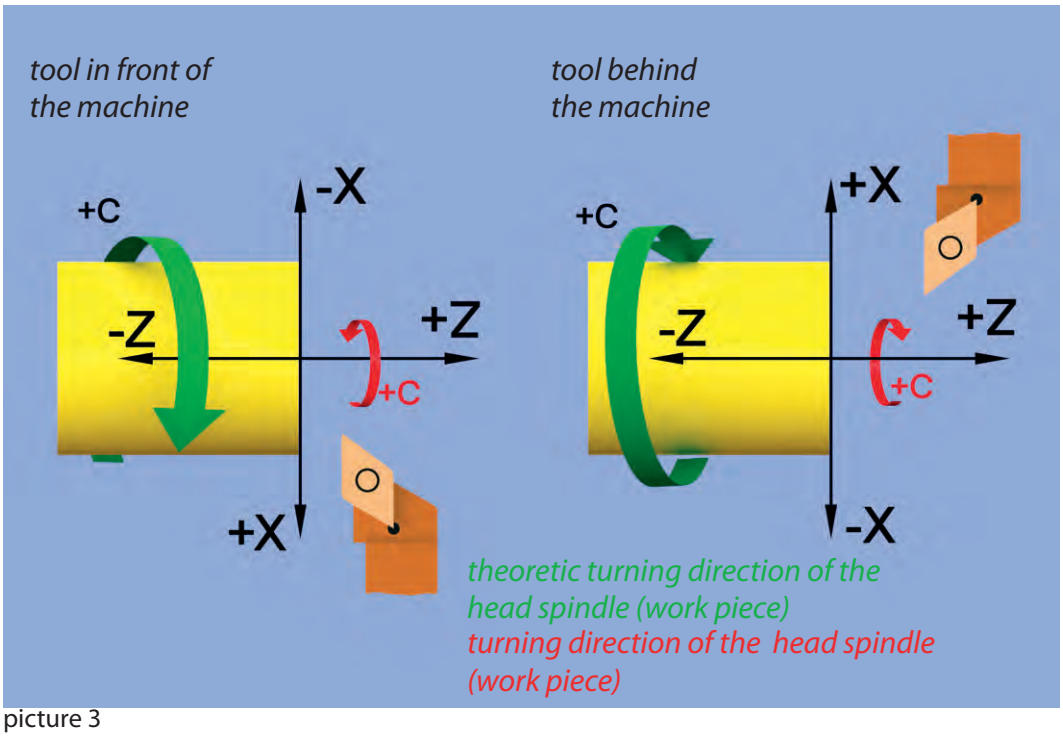
picture 2

If you want to move the Z axis into minus direction (z-5 for example), the slide with the work piece must travel into the plus direction.

Coordinate system turning machines

Turning machines have 3 axes X, Z and C. The C axis is the head spindle (rotation axis).

The Z axis is the linear traveling of the head spindle. This is similar to the milling machines.

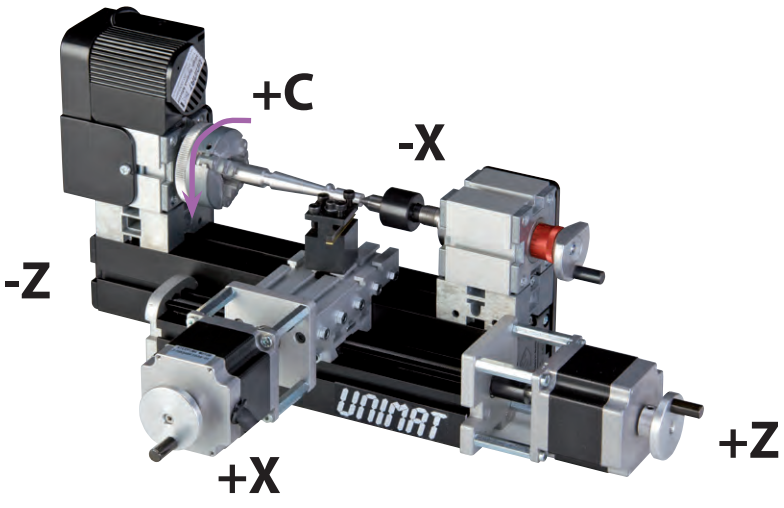


picture 3

All movements into the work piece have a negative direction.

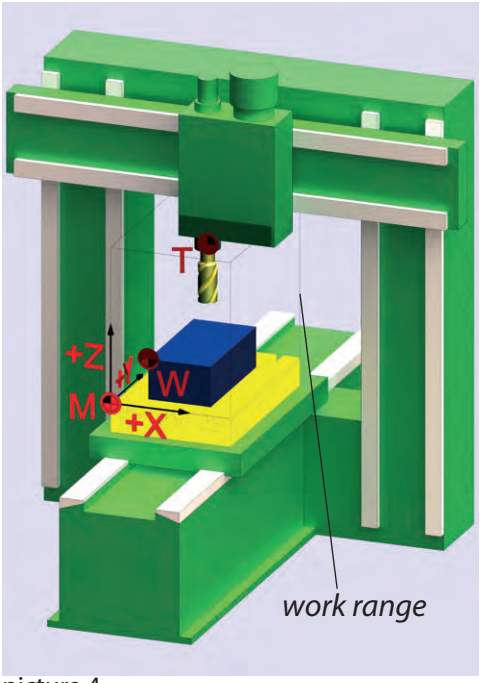
On picture 3 we can see that we have different coordinate systems, depending on whether the tool is positioned in front or behind the work piece.

Our Unimat CNC (Uni-Dreh) turning machine has the following coordinate system. Most of the NC turning machines have the tool behind the machine. Although the Unimat machine has the tool sliding from the front, the G-Code is programmed to the standard command (tool behind the machine)!



Machine zero point (M) (pic. 4):

This point associates the zero positions of all machine axes. It is not possible to change the position of this point. The linear encoder correlates with this point.



picture 4

Reference point (R) (pic. 5):

The reference point and the machine zero point are normally the same point. Only machines (for example a lathe) that cannot travel with the slides to the machine zero point, is the reference point at another position. If you travel with the slides to the reference point, the controller system (software) know the position of the machine's zero point. Many machines have switches for setting the reference point.

Reference point of the tool holder (T) (pic. 5):

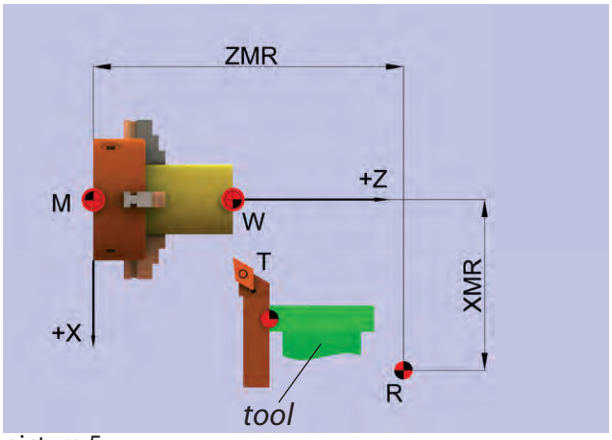
This is the point of intersection of the tool axis and the mounting surface of the tool.

Work piece zero point (W) (pic. 6 and 7):

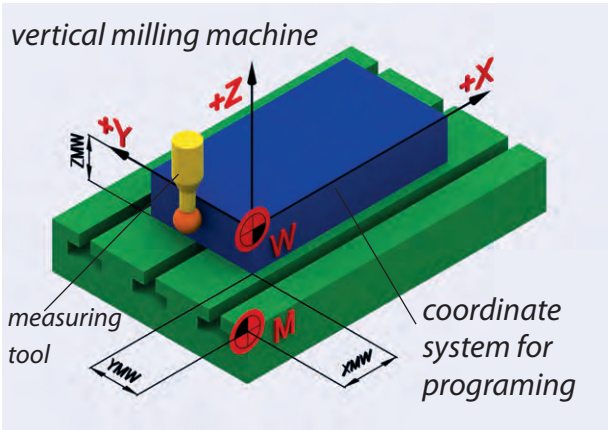
This point is very important. Without a work piece zero point you must make the programming of the design (work piece) set out from the machine zero point. This is not very useful. It is hard to design the program and it is not possible to use the same G-Code (program) on different machines.

Therefore it is state of the art that all coordinates of the work piece (G-Code program) refer to the work piece zero point.

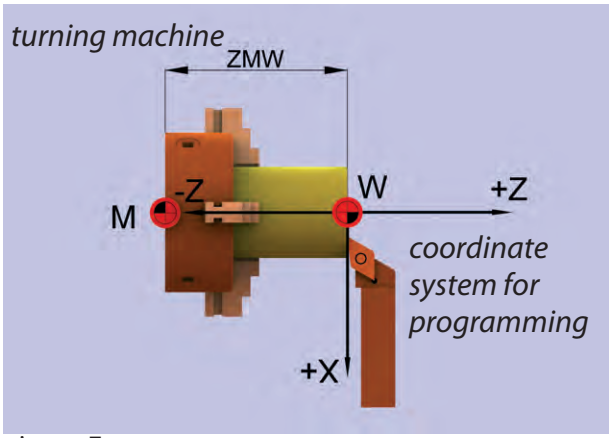
Because of this you can use the same G-Code on different machines.



picture 5



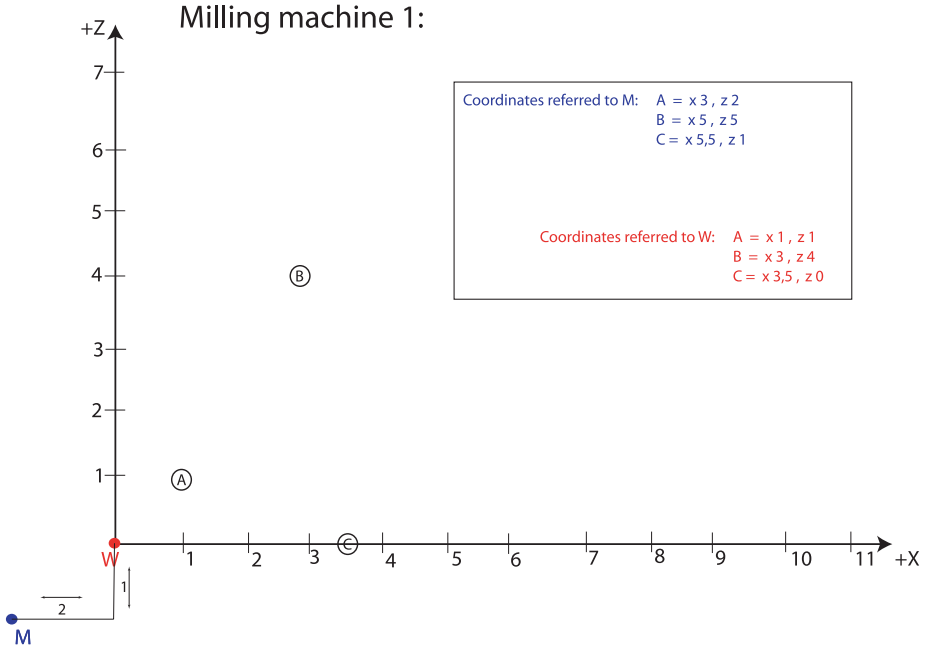
picture 6



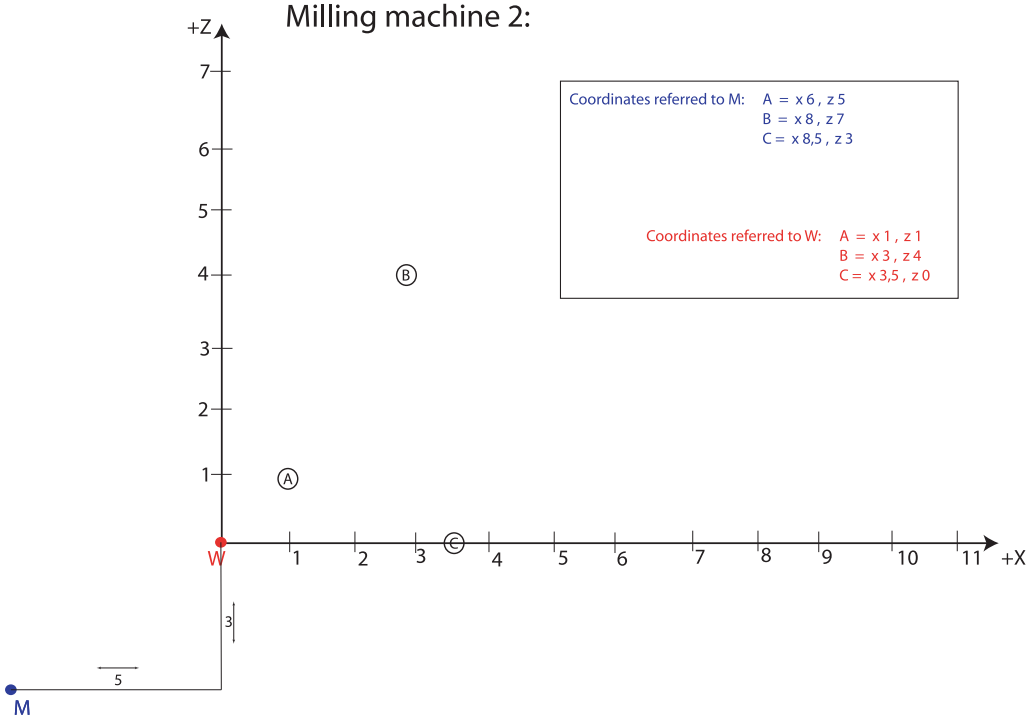
picture 7

Reference points

Milling machine 1:



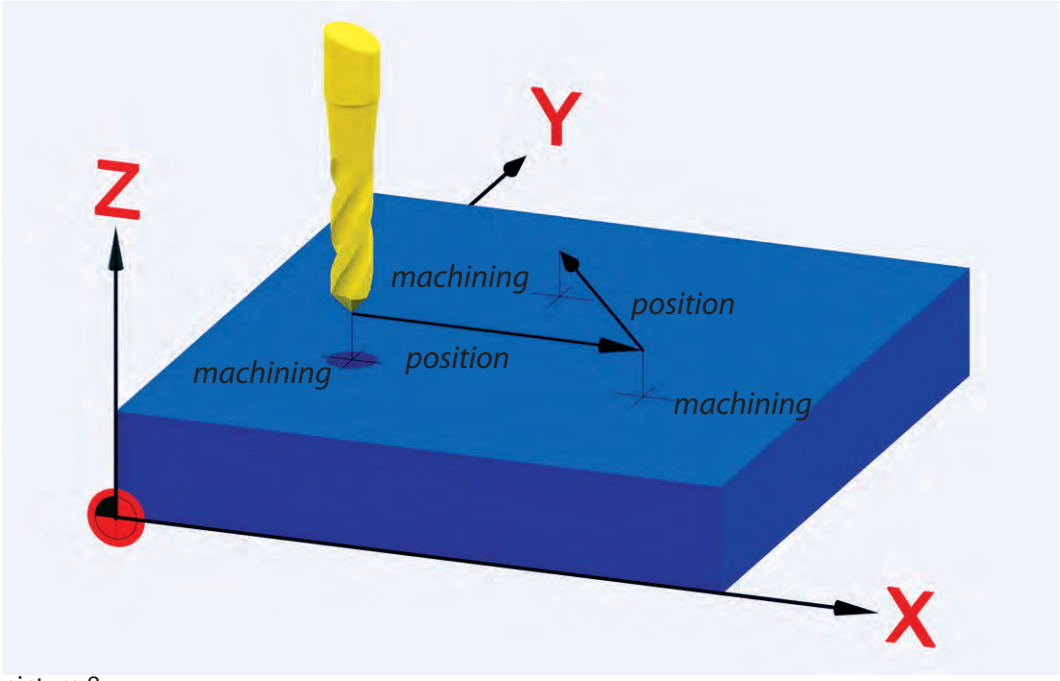
Milling machine 2:



It is possible to use the machine zero point and reference point on the Unimat system, but it would not make much sense. Why: Because of the modularity of the Unimat system (we don't use reference switches).
Every G-Code program (work piece design) is referred to the work piece zero point.
Therefore we must only set the work piece zero point. The position of the work piece zero point referred to the work piece (left corner or center, etc.), is inserted as commanded by the G-Code file. Later we will see some sample files.

Point drive systems

This system is used for drilling-, punching- and spot welding machines. This controller can drive only one or two axes at the same time, from working point to working point (pic. 8). Only the end position (working point) is important, not the route (way).

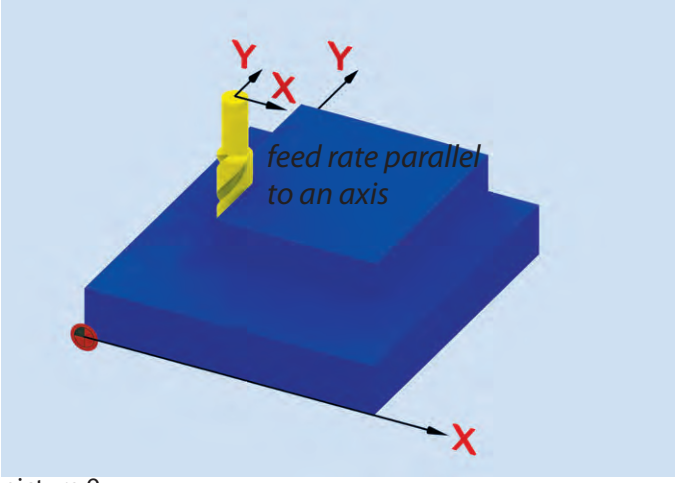


picture 8

The drilling bit goes to point 1, the z-axis goes down and up, then the drilling bit goes to point 2, z-axis goes down and so on, there is no control of the route from point 1 to 2!!!!

Distance drive system:

The machine can only travel parallel to the axis. For example you can make boxes, squares, but not circle or triangles (pic. 9).



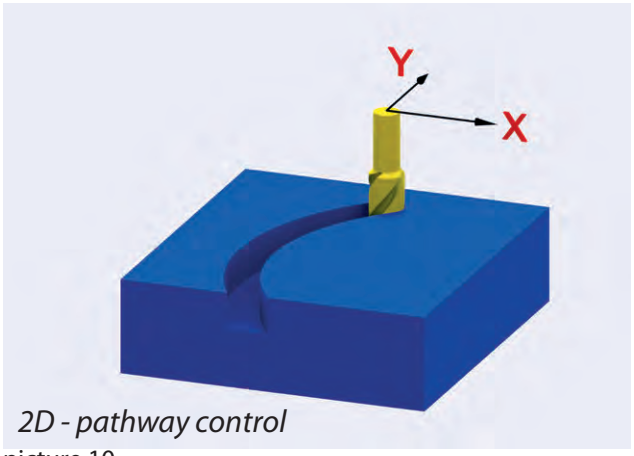
picture 9

Pathway drive system:

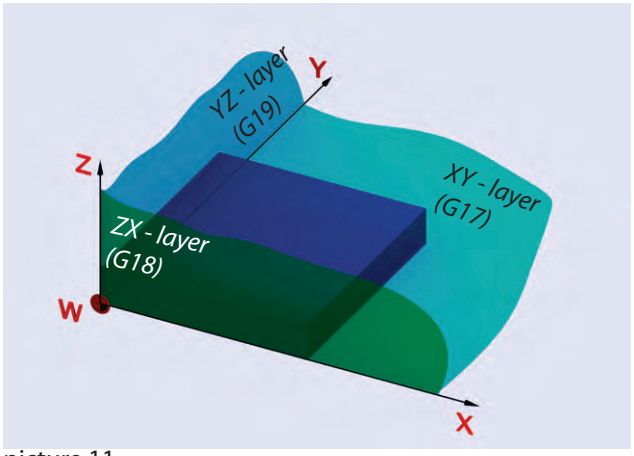
This system can drive 2 or more axes at the same time. The controller interpolates the speed of the axes – the tool follows exactly the programmed path. Here, the path is equally important as the endpoint of the movement.

2D pathway control

2 axis can drive interpolated at the same time. This control system has only 1 layer (X/Y) /pic. 10).



2D - pathway control
picture 10



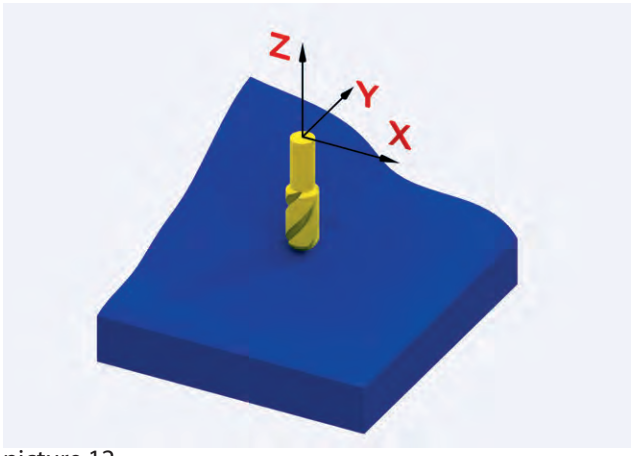
picture 11

2 ½ D pathway control

Here it's the same, 2 axes can drive at the same time, but it is possible to change between 2 or 3 layers (X/Y, Z/X, Y/Z) (pic. 11). You can select the layer with the following G command.

3D pathway control

This control system can drive (interpolates) 3 or more axes at the same time (pic. 12). Most of the modern machine centers have 5 axes.



picture 12

Our CoolCNC software is a 3D pathway control system!
CoolCNC Linux can interpolated up to 8 axes.

a) Manually in any text editor or user interface on a CNC machine.

b) Automatically – use any CAM software to convert the CAD drawing into the NC program

Today the normal way is to generate the G -Code with a CAM software. But it is very important that you understand the G - Code (for debugging, etc.).

Basics:

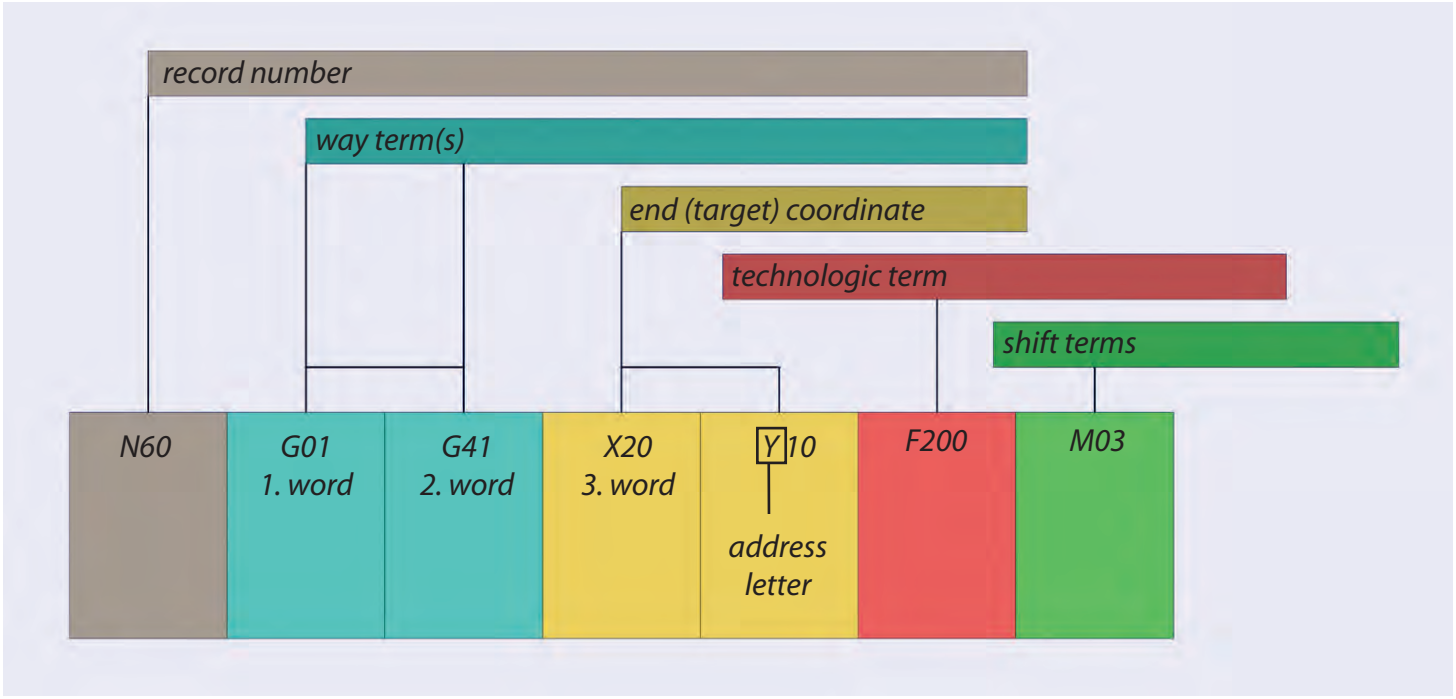
N .... Record number

Gxx .... way terms (linear or circle interpolated and so on)

X, Y, ... geometric terms

F,S,T .... technologic terms (feed rate, speed, tool)

M .... shift terms (motor on/off and so on)



Index of the useable comands in CoolCNC Linux

Code	Description	Parameters
G0	Coordinated Straight Motion Rapid	-
G1	Coordinated Straight Motion Feed Rate	-
G2, G3	Coordinated Helical Motion Feed Rate	I, J, K oder R
G4	Dwell	P
G7, G8	Diameter or Radius Mode	-

Code	Description	Parameters
G10 L1	Set Tool Table Entry	P, R, X, Z
G10 L2	Coordinate System Origin Setting	P, X, Y, Z, A, B, C
G17	XY plane	-
G18	ZX plane	-
G19	YZ plane	-
G20	Inches	-
G21	Millimeter	-
G28	Return To	-
G30	Return To	-
G33	Spindle Synchronized Motion	K
G33.1	Rigid Tapping	K
G38.2 - .5	Probing	-
G40	Cancel Cutter Compensation	-
G41	Cutter Compensation left	-
G42	Cutter Compensation rigth	-
G41.1	Cutter Compensation Transient	D, L
G42.1	Cutter Compensation Transient	D. L
G43	Use Tool Length Offset from Tool Table	H
G49	Cancel Tool Length Offset	I, K
G53	Motion in Machine Coordinate System	-
G54 - G59	Select Coordinate System	-
G59.1 - .3	Select Coordinate System	-
G61	Path Mode	-
G61.1	Path Mode exact stop	-
G64	Continuous Mode with Optional Tolerance	P
G73	Drilling Cycle with Chip Breaking	R, L, Q
G76	Multipass Threading Cycle (Lathe)	P, Z, I, J, R, K, Q, H, L, E
G80	Cancel Motion Modes	
G81	Canned Drilling Cycle	R, L, P
G82 - G89	Other Canned Cycles	R, L, P, Q
G90	Absolut Distance Mode	-
G91	Interpolate Distance Mode	-
G92	Offset Coordinate Systems & Set Parameters	X, Y, Z, A, B, C
G92.1 - .2	Cancel Offsets	-
G92.3	Apply Parameters to Offset Coordinate Systems	-
G93	Feed Modes	-
G94	Feed Modes (mm/min)	-
G95	Feed Modes (mm/U)	-

Code	Description	Parameters
G96	Constant Surface Speed	D, S
G97	RPM Mode	-
G98, G99	Canned Cycle Z Retract Mode	-
F	Feed	-
S	Speed	-
M0	Pause	-
M1	Pause	-
M2	end of program	-
M3	Spindle on clockwise	S
M4	Spindle on counterclockwise	S
M5	Spindle off	-
M6	Change Tool T=Tool Number	T
M7	Mist on	-
M8	Flood on	-
M9	Turn all coolant off	-
M30, M60	Pallet Shuttle	-
M48 - M53	Overrides	P
M61	Set Current Tool Number	Q
M62 - 65	Output Control	P
M66	Input Control	P, E, L, Q
M100 - 199	User Defined M-Codes	P, Q
O	O Codes	-

More details about how to use the codes you can find at www.linuxcnc.org.

G0 / G00

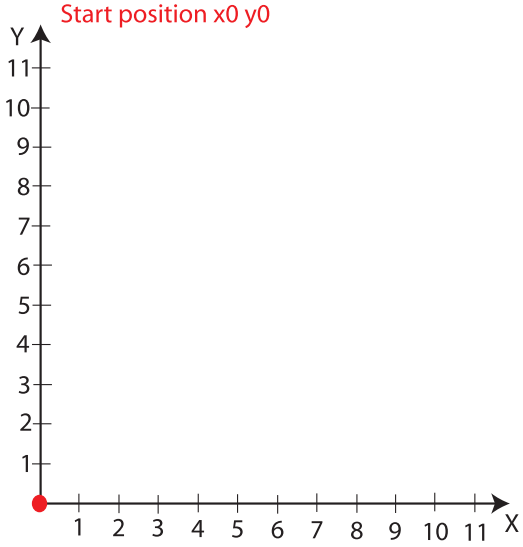
Rapid linear mode – the machine moves at a maximum speed.

G1 / G01:

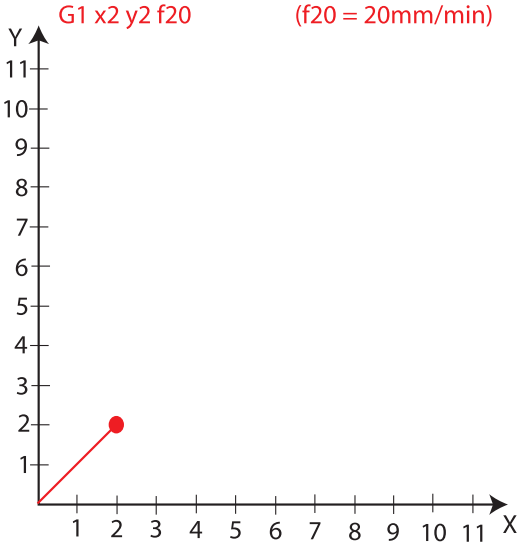
Linear interpolated movement. The speed must be set.

Sample 1:

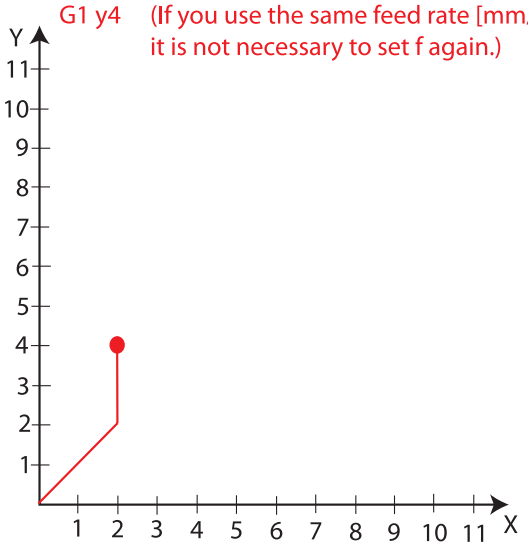
Start position x0 y0



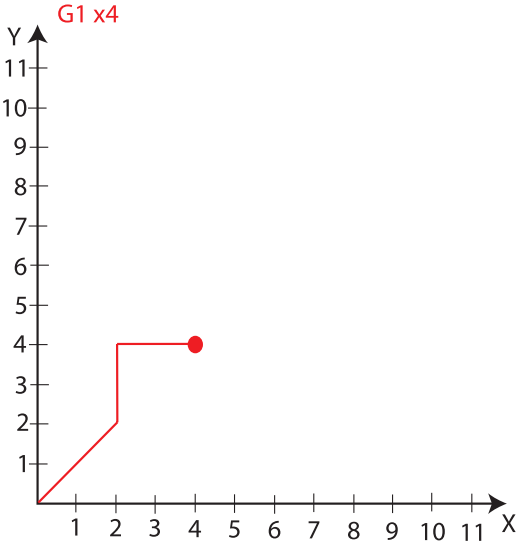
G1 x2 y2 f20 (f20 = 20mm/min)



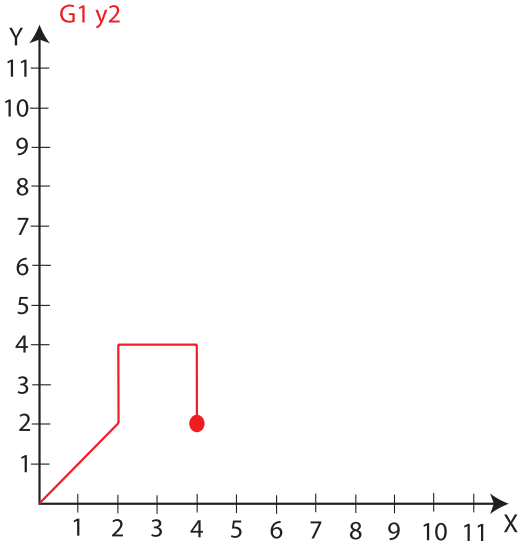
G1 y4 (If you use the same feed rate [mm/min], it is not necessary to set f again.)



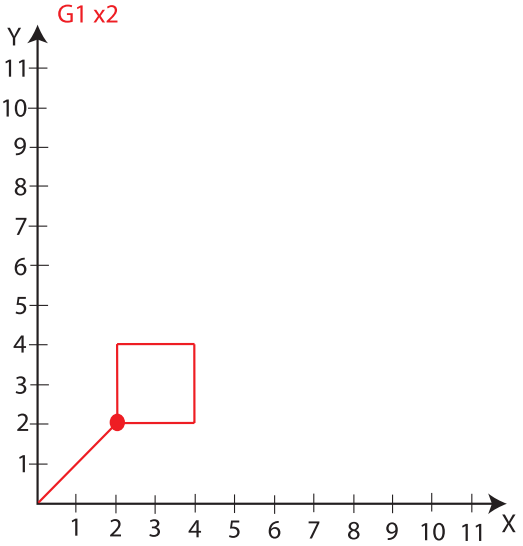
G1 x4



G1 y2

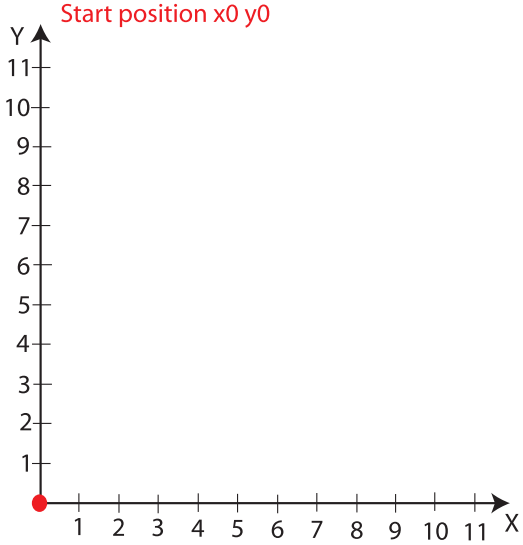


G1 x2

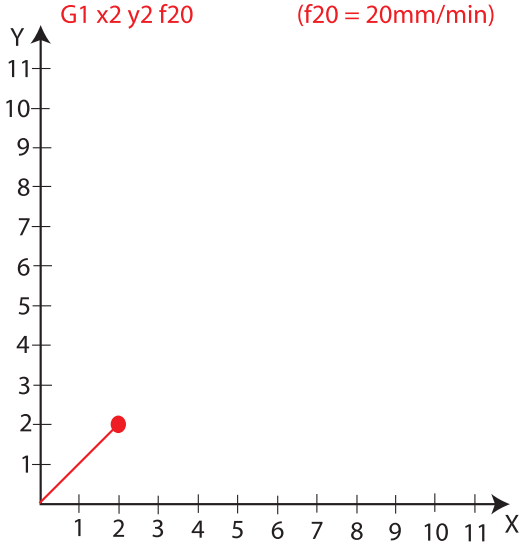


Sample 2:

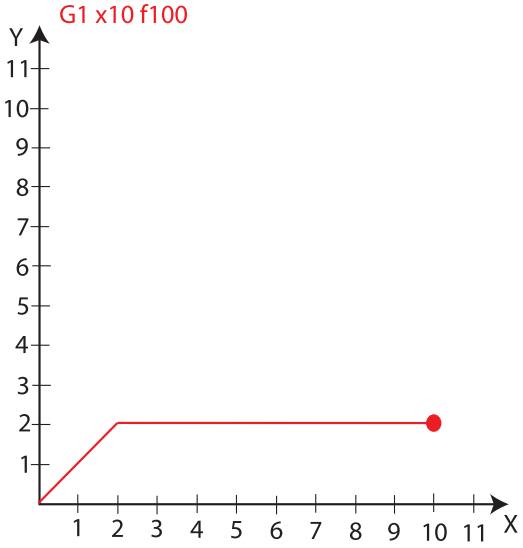
Start position x0 y0



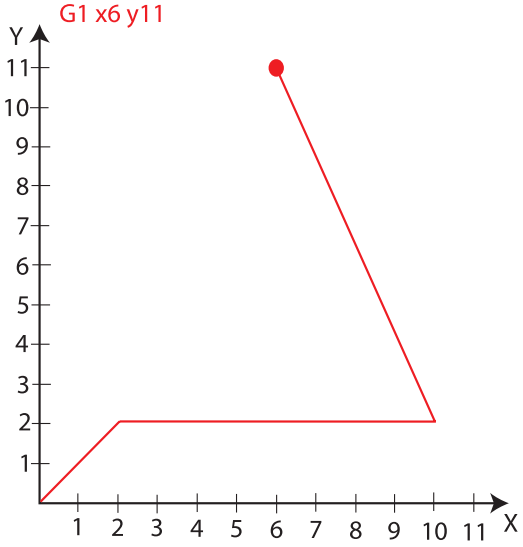
G1 x2 y2 f20 (f20 = 20mm/min)



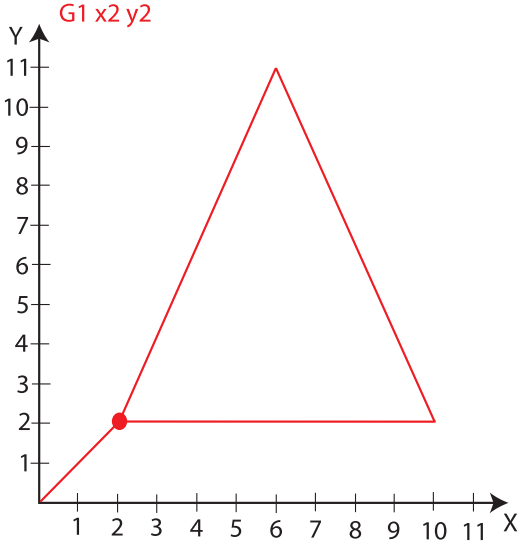
G1 x10 f100



G1 x6 y11



G1 x2 y2



G2 und G3 / G02 und G03

Circle interpolated movement. The speed must be set.

G2/G02 is clockwise circular movement.

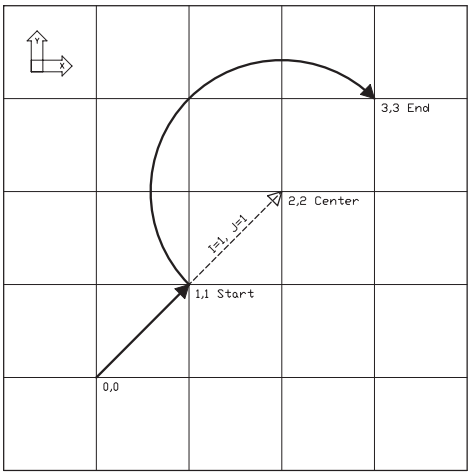
G3/G03 is counter-clockwise circular movement.

The G02 command moves the tool in a clockwise path from the starting point (the current tool position) to the designated ending point in the currently selected plane (see G17-G19). The I , J, and K parameters represent the incremental X, Y, and Z distances (respectively) from the starting point of the arc to the center point of the arc (pic. 1).

Example:

G1 x1 y1 f3
G2 x3 y3 i1 J1

Moves the tool to program coordinates X=1, Y=1 at a feedrate of 3 mm/min. Moves the tool using clockwise circular interpolation to program coordinates X=3, Y=3 with a center point of X=2, Y=2 at a feedrate of 3 mm/min



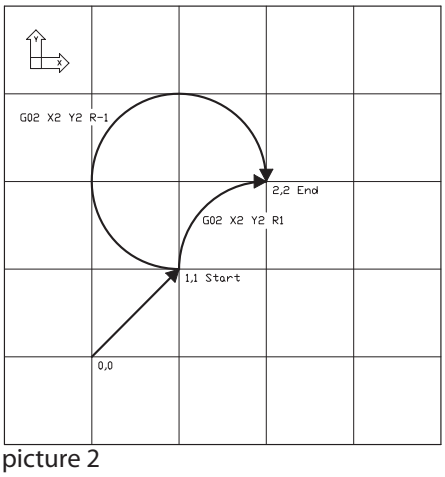
picture 1

An alternative way to specify the distance to the center point is to specify the radius, using the R parameter (pic. 2). This is usually easier than determining the correct I, J and K values. For any given radius, there are usually two possible arcs: one that sweeps an angle less than 180 degrees, and one that sweeps an angle greater than 180 degrees (see diagram below). To specify an angle less than 180 degrees, make R a positive number; to specify an angle greater than 180 degrees, make R a negative number.

G1 x1 y1 f3

G2 x2 y2 r1 (or r-1)

Moves the tool to program coordinates X=1, Y=1 at a feedrate of 3 mm/min. Moves the tool using clockwise circular interpolation to program coordinates X=2, Y=2



picture 2

When using the R word, please note:

• If the arc sweeps a 180 degree angle, it doesn't matter whether R is negative or positive.

• If the ending point is the same as the starting point, CoolCNC will ignore the command, since the center point cannot be determined.

You can use the G02 command to specify a helical move (helical interpolation). During a helical move, the circular motion described above is combined with linear motion that is perpendicular to the plane containing the arc. For example, circular motion in the XY plane is combined with linear motion along the Z axis to form a helix.

To specify helical motion, add an X, Y or Z parameter to the command, wich indicates the ending point of the linear motion. In the following example, a Z parameter has been added to the G02 command for an arc in the XY plane.

G1 x1 y1 z1 f3

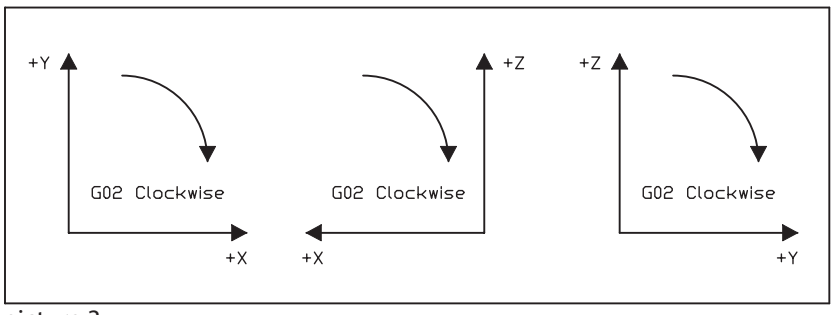
G2 x3 y3 z2 i1 j1

Moves the tool to program coordinates X=1, Y=1, Z=1 at a feedrate of 3 mm/min. Moves the tool using clockwise circular interpolation to program coordinates X=3, Y=3 with a center point of X=2, Y=2, while simultaneously moving the tool in a straight line along the Z axis to Z=2

The accuracy of the helical move, relative to a theoretically perfect helix, is controlled by the Helical Interpolation Accuracy setting on the G-Code panel of the Configuration dialog box (see "G-Code Settings" in the Initial Setup section).

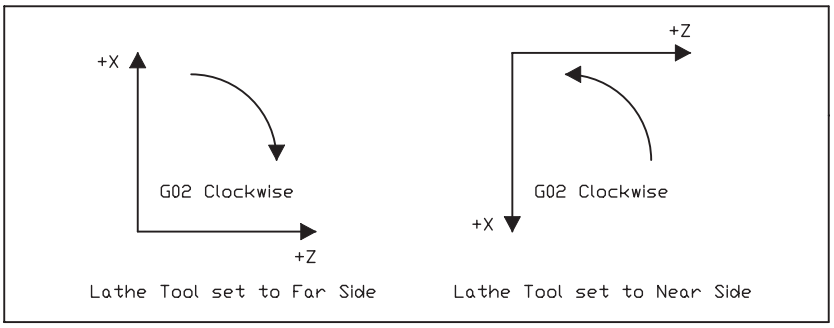
When using G02, there are several things to keep in mind:

• This is a modal command, meaning that all successive moves will be treated as clockwise circular feedrate moves until another modal move command (G00, G01 or G03) occurs.
• The interpretation of the X, Y and Z coordinates depends on the G90/G91 command in effect. The I, J and K values are unaffected by G90/G91.
• The tool will move at the current feedrate set by the last F command.
• Only XY arcs can be cut when G17 is active, only XZ arcs can be cut when G18 is active, and only YZ arcs can be cut when G19 is active. Arcs cannot be specified for the A or W axes.
• The clockwise direction of rotation is as viewed from the positive end of the unused axis (the axis not in the plane of motion). For example, a G02 arc move in the XY plane is clockwise as viewed from the positive end of the Z axis (i.e. from above). The following diagram (pic. 3) illustrates this behavior for all three arc planes:



picture 3

In some cases, a clockwise arc as defined above will be displayed counter clockwise in a viewport. For example, in lathe applications, the Lathe Tool setting (on the Machine Tool panel of the Configuration dialog box) determines whether the X positive direction is up or down in the ZX viewport. When Lathe Tool is set to Near Side, the X positive direction is down and G02 arcs are displayed counter-clockwise on the screen (pic. 4).



picture 4

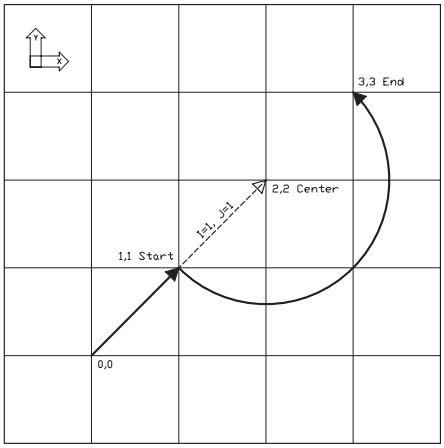
The G03 command is identical to the G02 command, but it moves the tool in a counter-clockwise arc instead of a clockwise arc (pic. 5).

Example:

G1 x1 y1 f3

G3 x3 y3 i1 j1

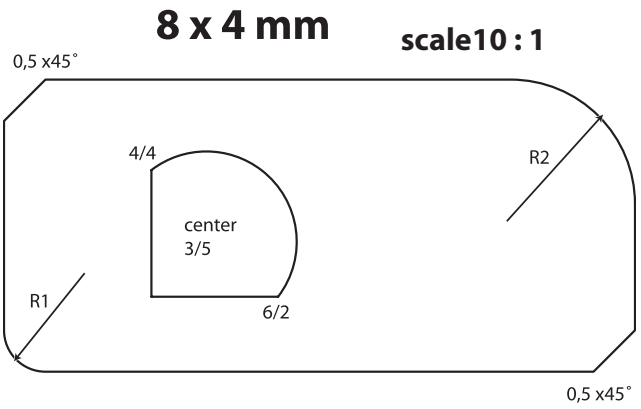
Moves the tool to program coordinates X=1, Y=1 at a feedrate of 3 mm/min. Moves the tool using counter-clockwise circular interpolation to program coordinates X=3, Y=3 with a center point of X=2, Y=2 at a feed rate of 3 mm/min



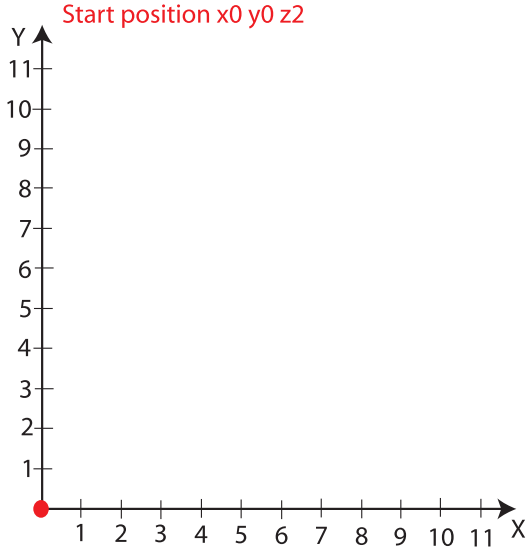
picture 5

Our Cool CNC software can work with I,J,K and also with R (radius)!!!

Sample 3:

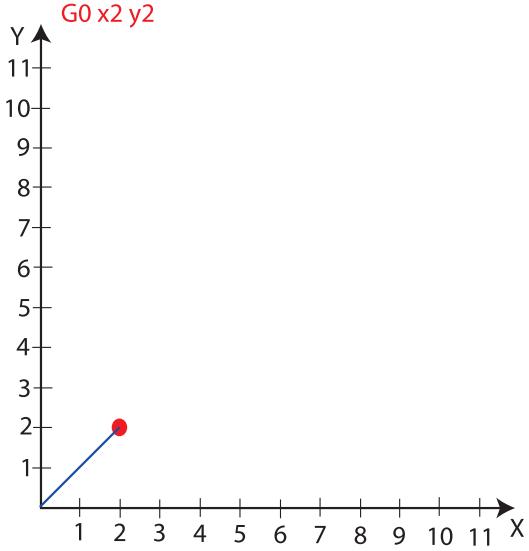


Start position x0 y0 z2

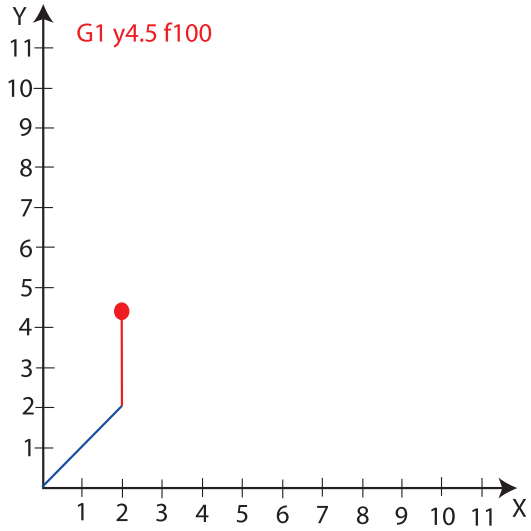


G1 z-1 f20 (the z axis move from z2 to z-1, with 20mm/min)

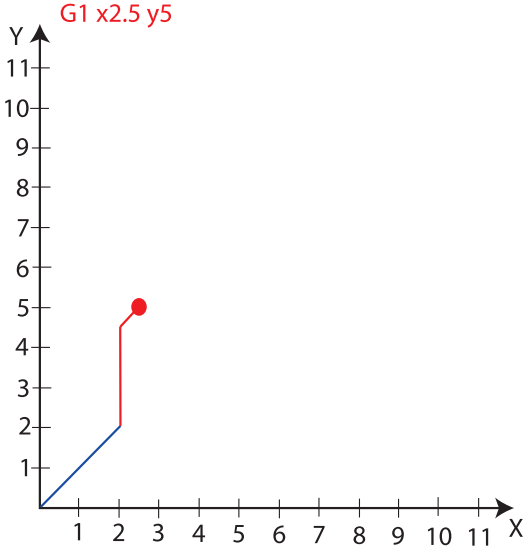
G0 x2 y2



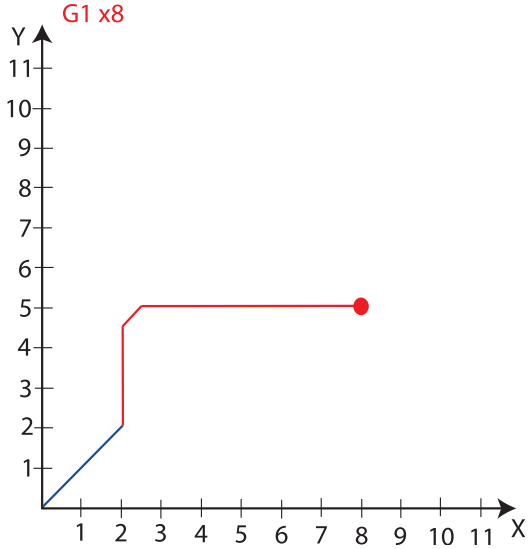
G1 y4.5 f100

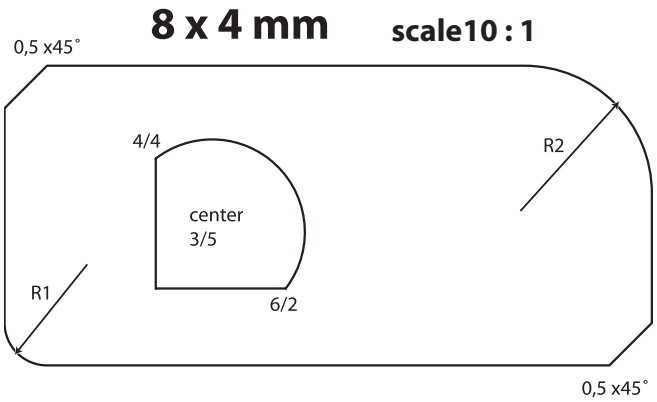


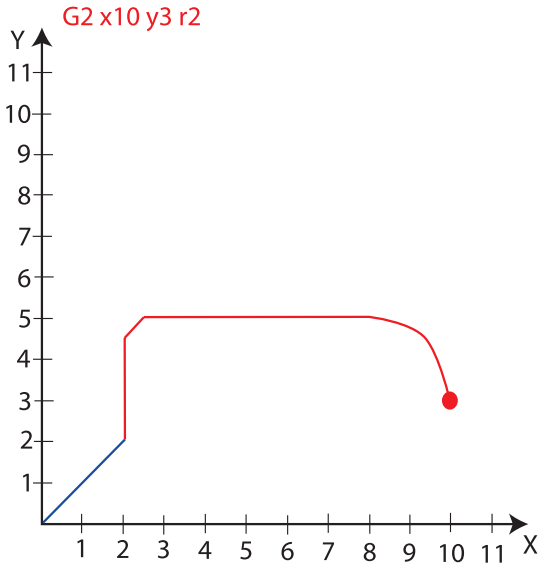
G1 x2.5 y5

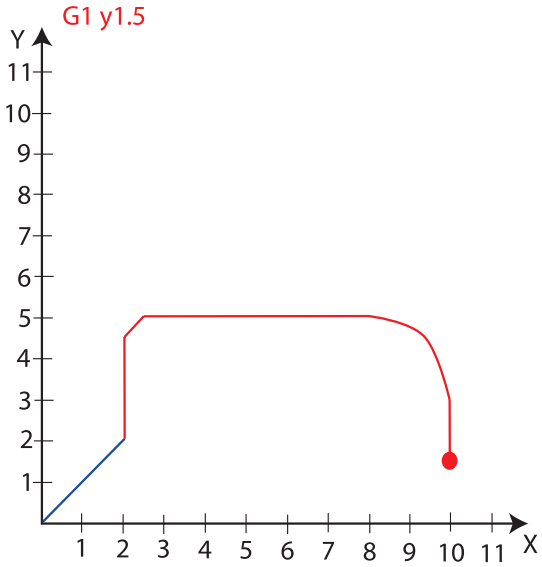


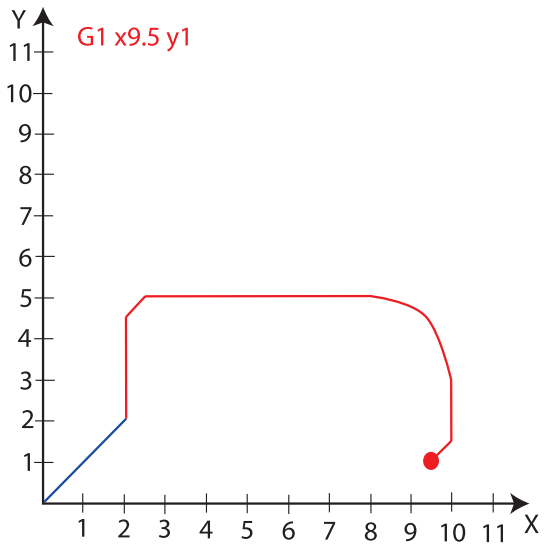
G1 x8

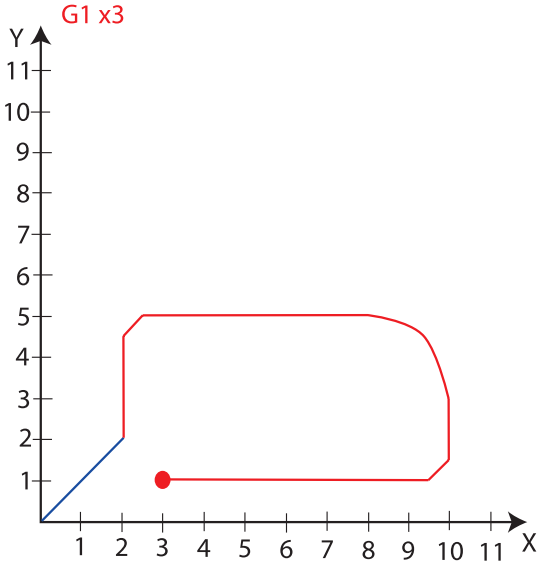


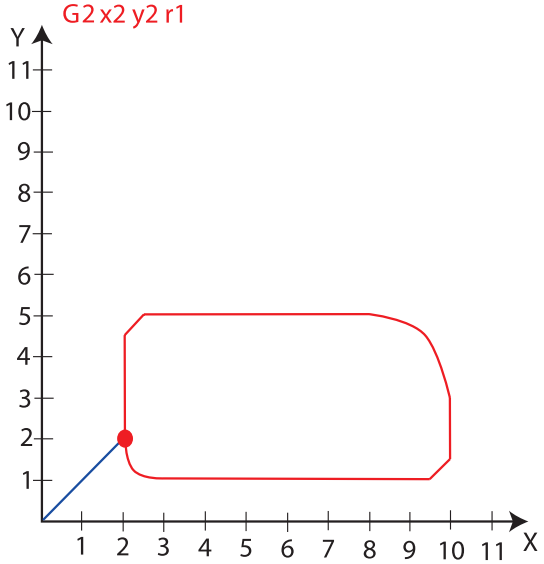

8 x 4 mm
scale10 : 1
0,5 x45°
4/4
center
3/5
6/2
R1
R2
0,5 x45°

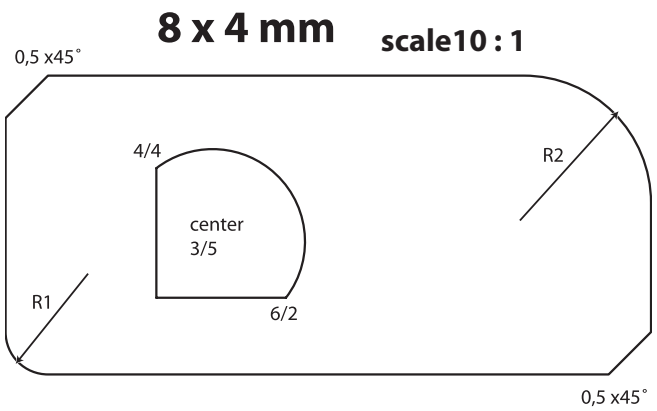

G2 x10 y3 r2
Y
X


G1 y1.5
Y
X


G1 x9.5 y1
Y
X

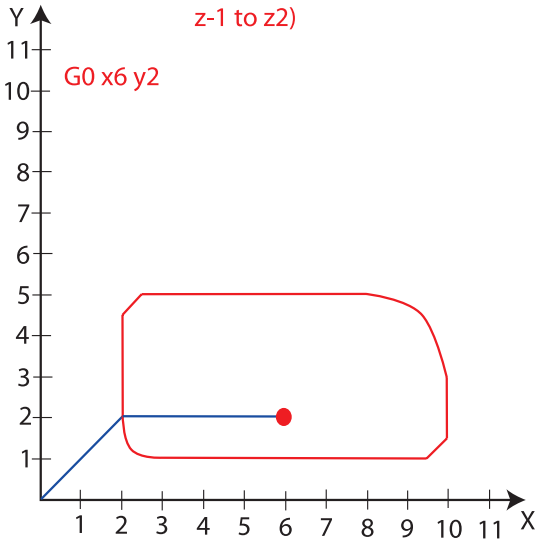

G1 x3
Y
X


G2 x2 y2 r1
Y
X



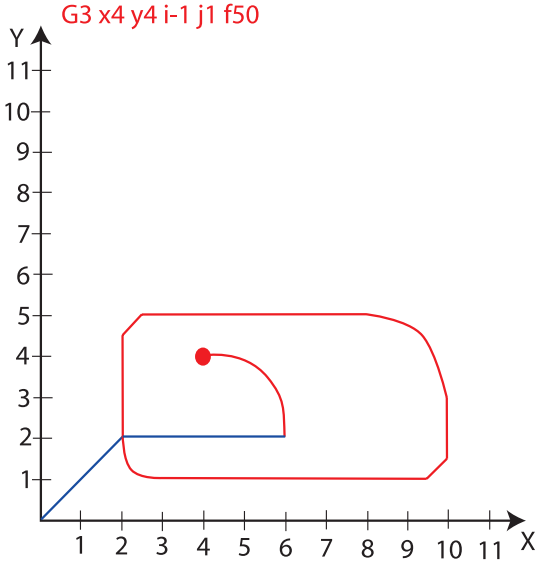
G0 z2 (z axis goes in rapid mode from z-1 to z2)

G0 x6 y2

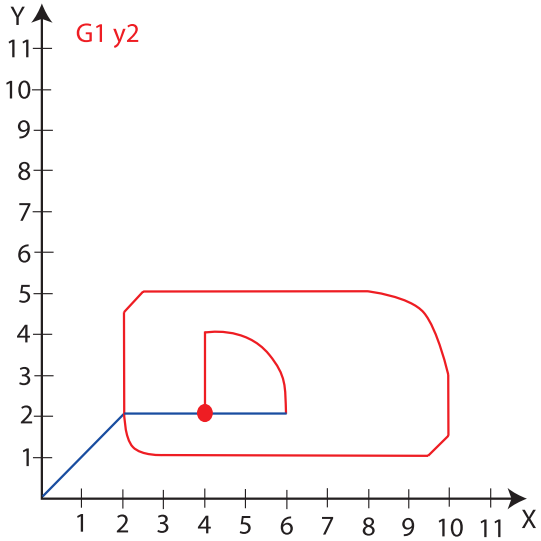


G1 z-1 f20 (z move from z2 to z-1 with 20mm/min)

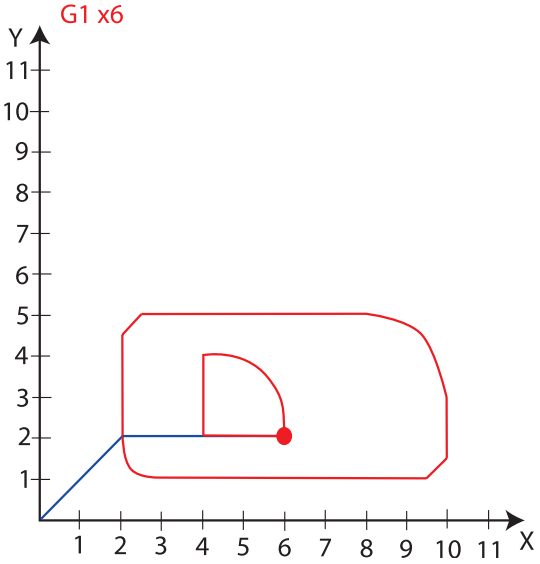
G3 x4 y4 i-1 j1 f50



G1 y2

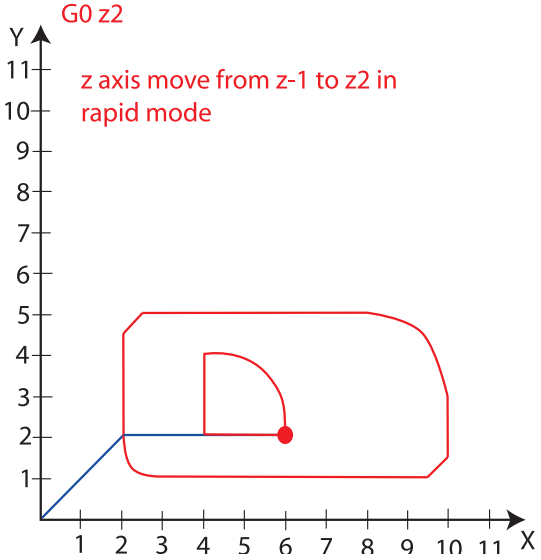


G1 x6

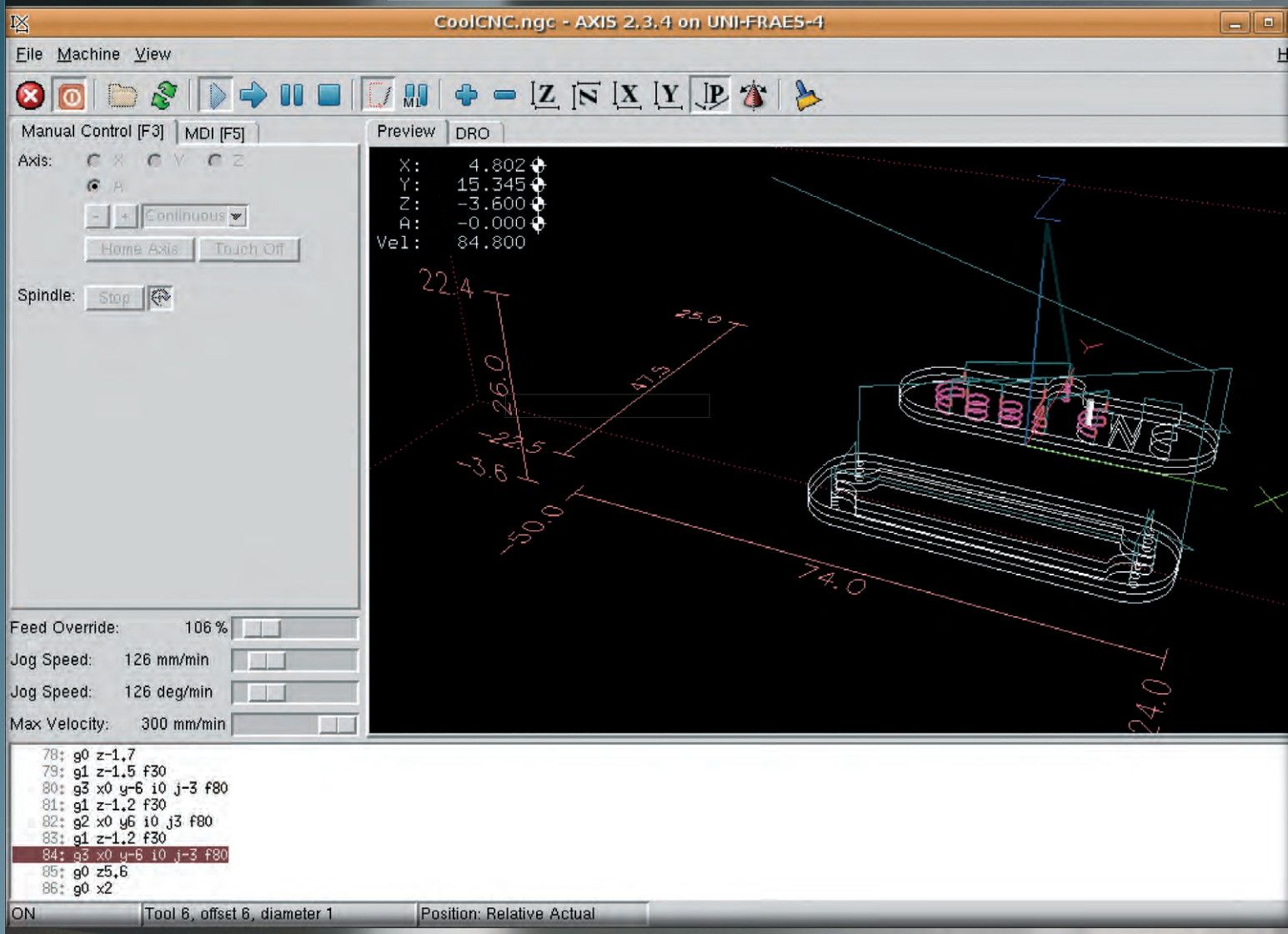


G0 z2

z axis move from z-1 to z2 in rapid mode



4.2 CoolCNC® LINUX (LinuxCNC®)



The tool® QUALITY PRODUCT MADE IN AUSTRIA

General

Our CoolCNC Linux® Package is based on a specially designed 5 axes step motor controller and control software. We use the Open Source Software LinuxCNC® which runs under the Ubuntu® Linux and expands to the Rtai® Kernel. As a graphical interface, it also serves under the GNU GPL software axis. LinuxCNC® generally supports the conventional G-code standard RS-274.

The Axis® Interface is now available in different languages, and is continuously being translated into many more: de, en, es, fi, fr, hu, it, ja, pl, ru, sk, sr, sv, zh (cn, hk, tw)

To facilitate the installation, we suggest the Live CD with the complete system. However it can also be downloaded as images from our homepage. It is possible to use our system through the Live CD without installing it on the computer!

Included in our complete CoolCNC Linux package is an industrial PC, coordinated by the System. The pre-installed operating system leads to a Plug and Play solution. Incl. Open Source CAD/CAM applications (Inkscape,)Heeks

If you are not using the pre-installed PC, please find important information for installation on the following pages.

System Requirements

In principle, the system can be installed on every „i386“ based computer (pay attention to the minimum requirements). However, to control a machine, the following requirements must be met:

1) Low latency of the PC (Processors)

2) Parallel interface (LPT)

Even if these two points are not met, installation will still be possible. However the process can only be simulated on the screen.

- Pentium III® or higher (Pay attention to the latency)
- min. 512 MB RAM
- min. 2,1 GB free space on HDD
- Parallel interface or free slot for interface
- Notebook-LPT, PCMCIA, or Express Card Slot for interface card
- CD or DVD drive

Before installing

The following basic options are available:

1) No installation on HDD
Booting from the Live CD – working with the System – all changes will be lost when restarted.

2) Test after install
Booting from the Live CD – working (testing) with the System – start the installation over the installation icons on the desktop.

3) Installing with the start menu
Booting from the Live CD – start installation in the first menu (before the actual boot process).

4) Install LinuxCNC® on a pre-installed Ubuntu® System
Since this seldom happens, we will not go into detail about it. For more information, go to www.linuxcnc.org

The system can also be installed in addition to an already-installed operating system. This follows a so-called dual-boot system. For a dual-boot system, a minimum of 2.1 GB free space on the HDD is necessary.

Before setting up a dual-boot system, run a backup first.

In a Bios setup, your computer's function „Booting from CD or DVD" must be activated.

For questions, contact your system administrator.

Installation

Here the approach of „Testing then Installing" is described.

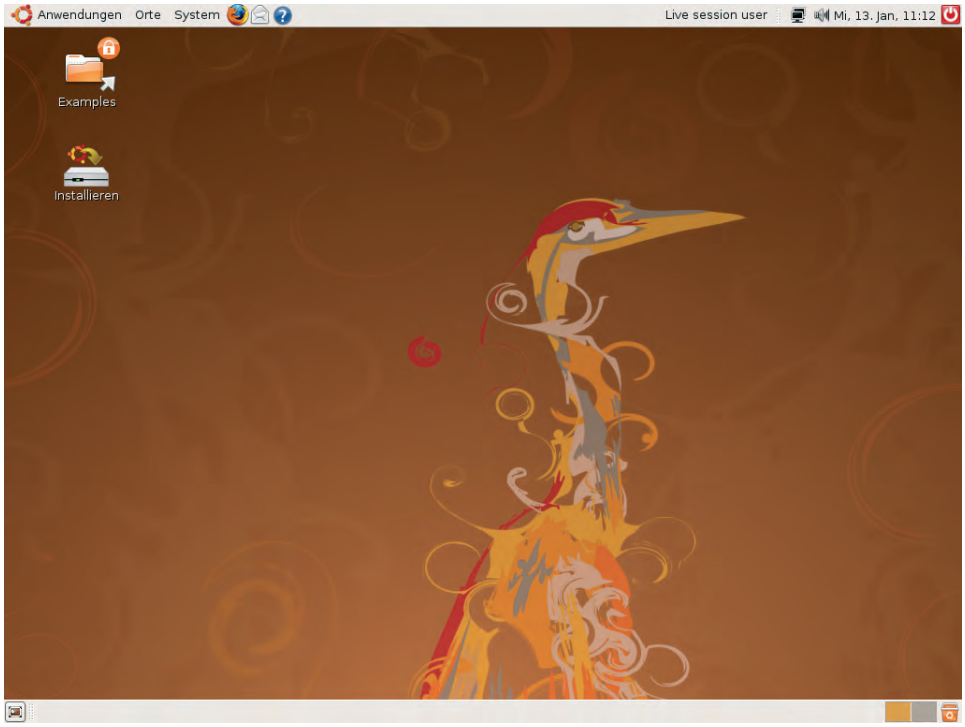
- Place the Live CD (CoolCNC) in the CD or DVD drive
- Turn on the computer
- After a few seconds you will see a window in which you can choose which language you would like to work in
- In the next menu, choose „Try Ubuntu (Computer…)"
- Ubuntu will start. This may take a few minutes, depending on the computer

If the language selection window did not show up after the computer started, check the following:

- Is the Bios „Start from CD" activated? Make sure your PC started from the optical drive
- By the new Live CD's, „Live DVD's" must be considered. Therefore, a DVD drive will be necessary. Otherwise, downloading the Live CD images and burning your own Live CD (blank CD) is possible as well

• After the Ubuntu starts, you will be able to see the installation icons on your desktop. Now you can use the system.

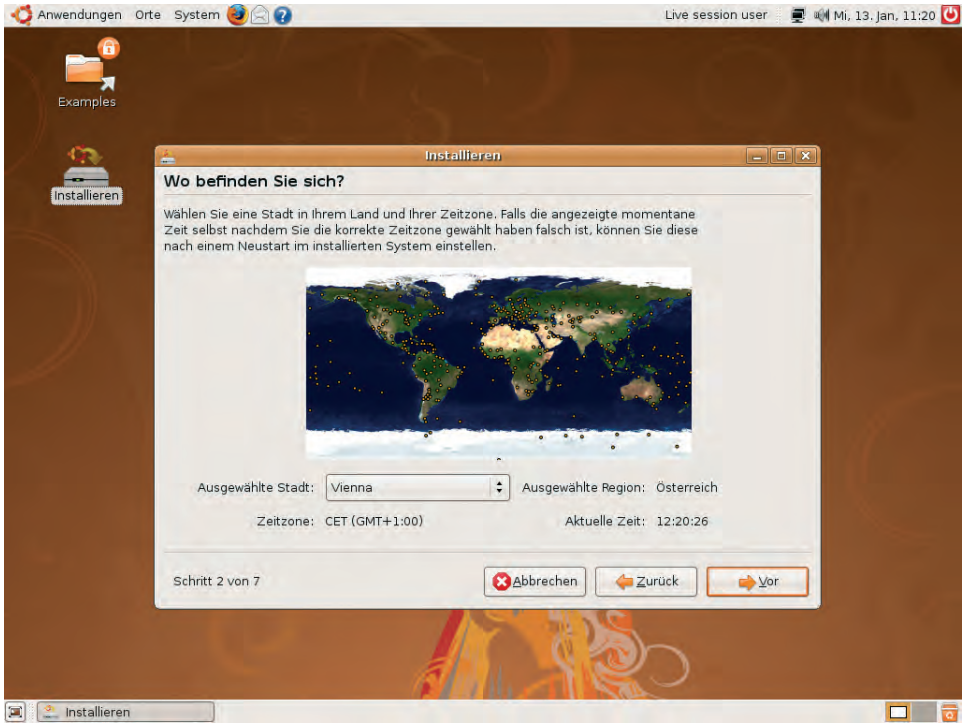
More specific information can be found under „Working with axis 4.2.2."



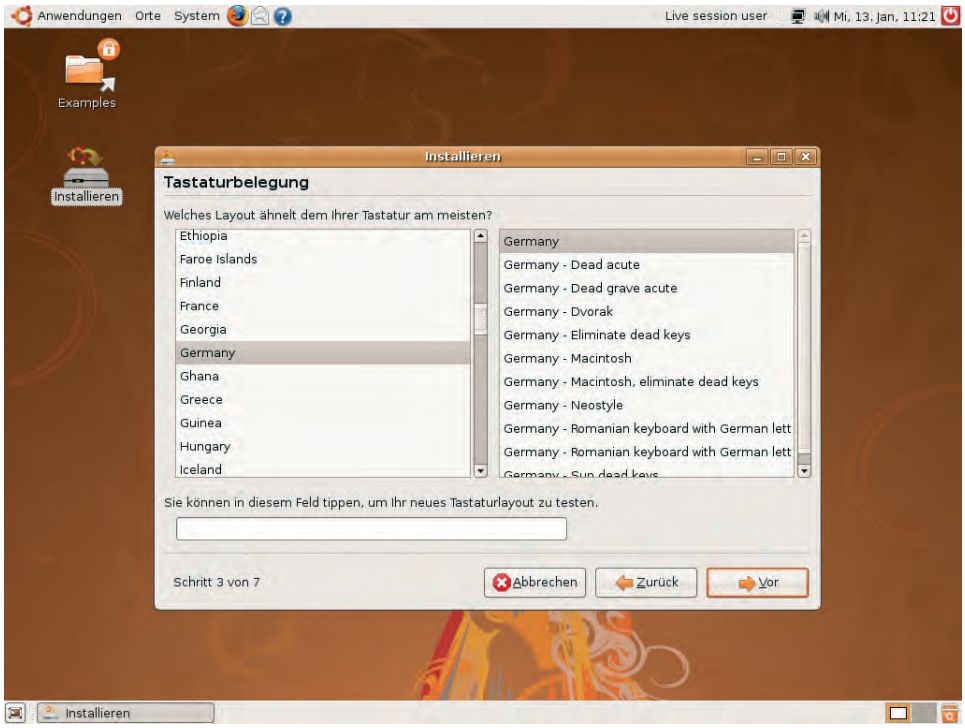
Double click the installation icon and select „install" to start setup.

• Choose a language and click "continue".

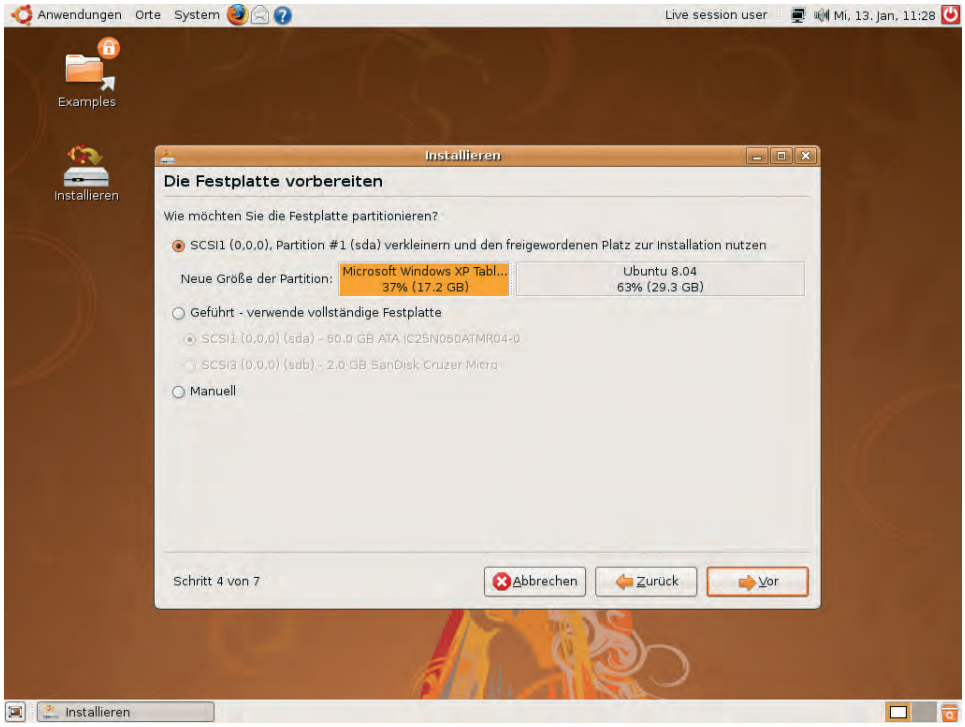
• Select the correct time zone and click "continue".



• Choose the preferred keyboard layout and click "continue".



• There are, depending on the disc configuration and other parameters such as dual-boot system, many different possibilities. Described below are the two most common ones.



a) Empty hard drive (not a dual-boot system): select the „Guided – use entire disc“ menu item. Any preexisting data on this disc will be lost.

b) Dual-boot system

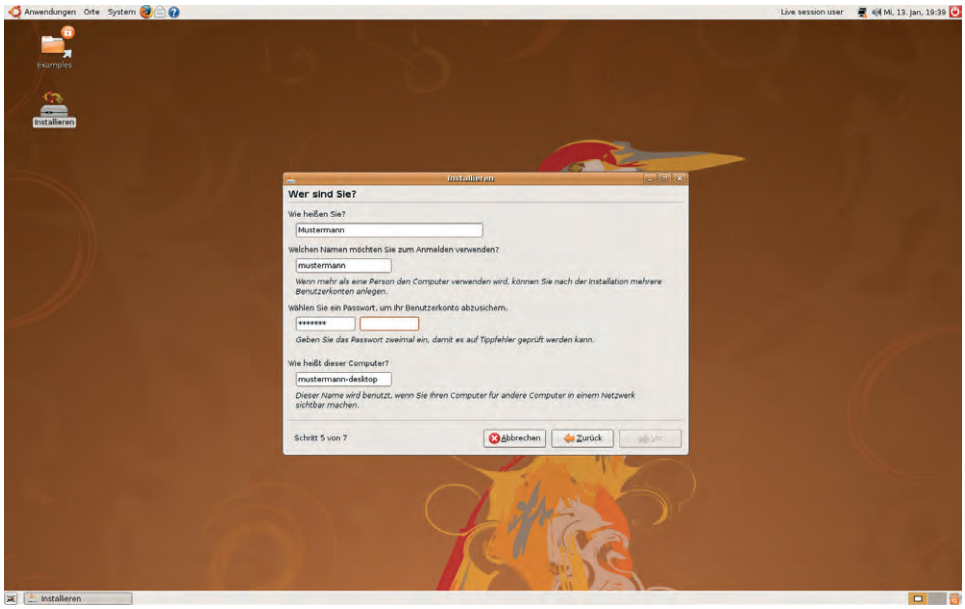
b.1) The hard drive has a partition: select the function „reduce ... and use free space to install.“ The existing partition will be displayed in orange. The shaded area corresponds to the free space. In between is a gray bar rule, using this bar you can set the desired size.

b.2) The hard drive has more partitions: select one of the free partitions for the installation, and follow the directions.

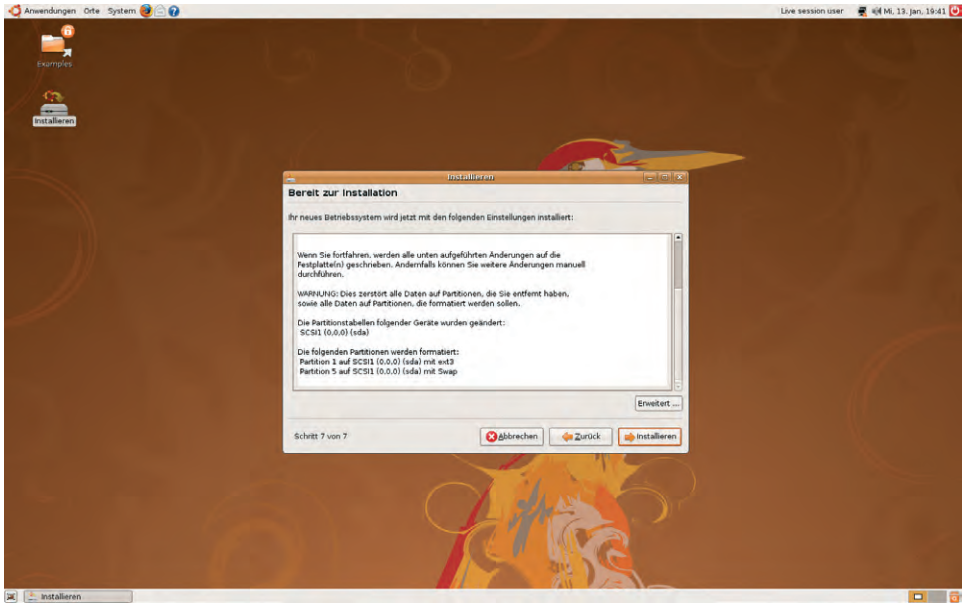
Then click continue.

If you are not sure, please ask your system administrator!

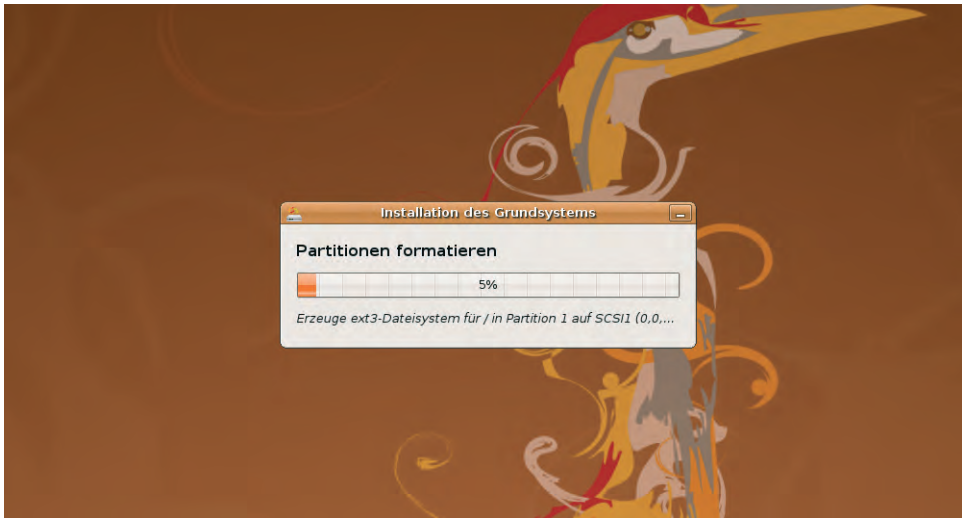
• Type in your name, username (CoolCNC) and password (an individual computer name can also be assigned), then click continue.



• Now you can review your preferences before installing. If satisfied, click „install“ otherwise click „back“.



• The installation will now begin. Installation speed will depend on your computer.

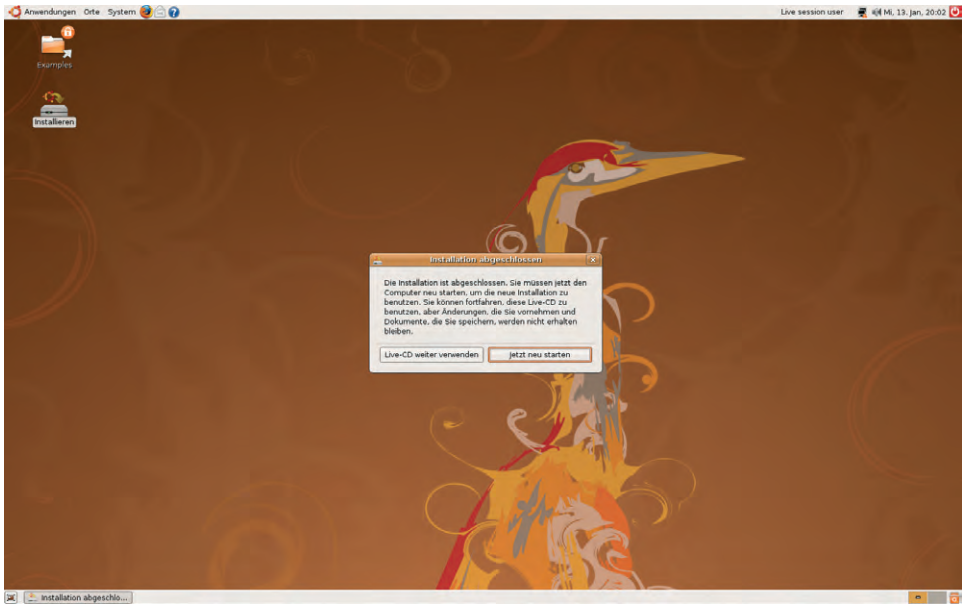


• After installation, restart your computer by clicking „restart.“

Ubuntu will end. You will then be asked to remove the CD. Now click enter.

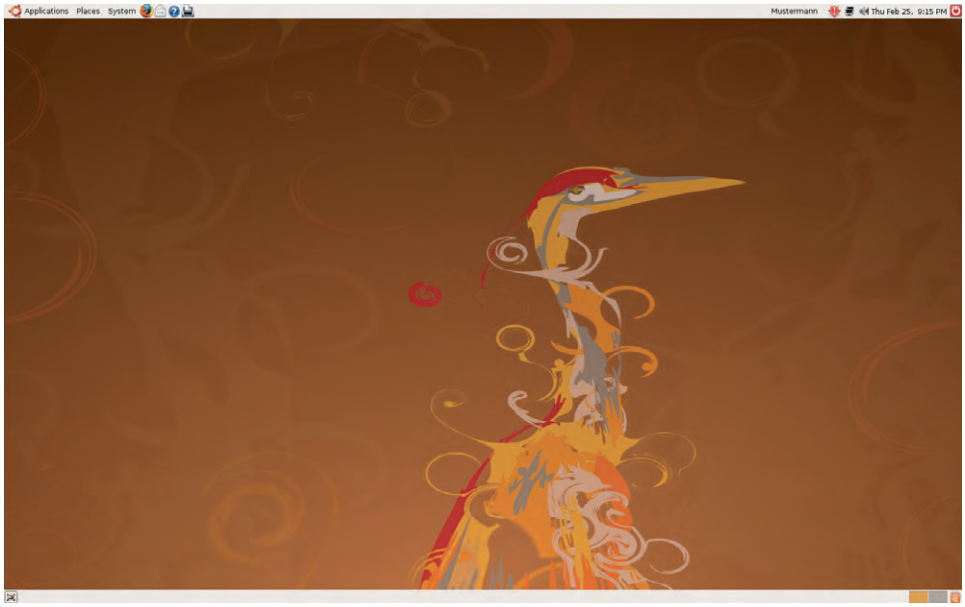
The next time you start your PC, the boot manager will be displayed on dual boot systems, where you can choose which operating system to run on.

After the boot, sign on with your username and password.



Once you have logged in, you will see the desktop. So you can regularly be updated on both LinuxCNC and Ubuntu, you will need an internet connection. Below is explained how to change network settings.

The desktop will not be displayed fully in the next few images. Instead, only the essential parts will be shown.

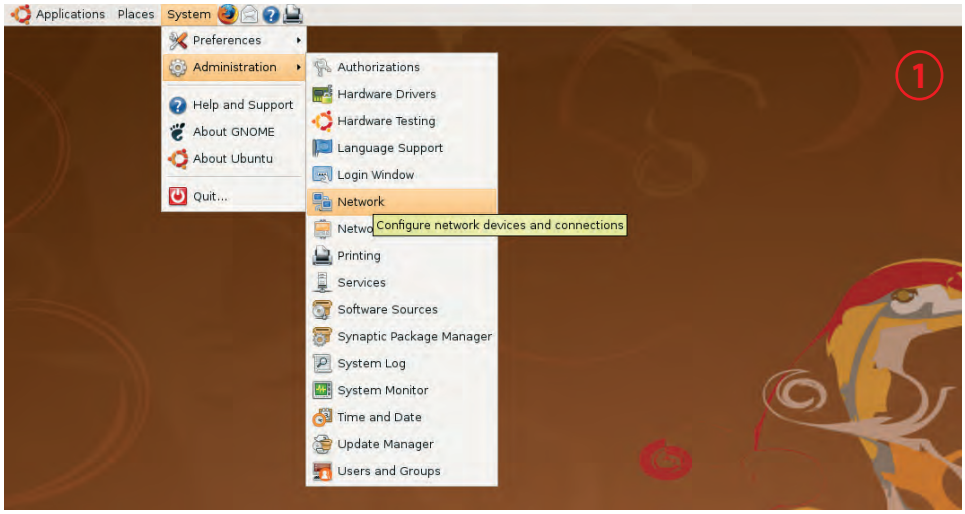


Network Connection

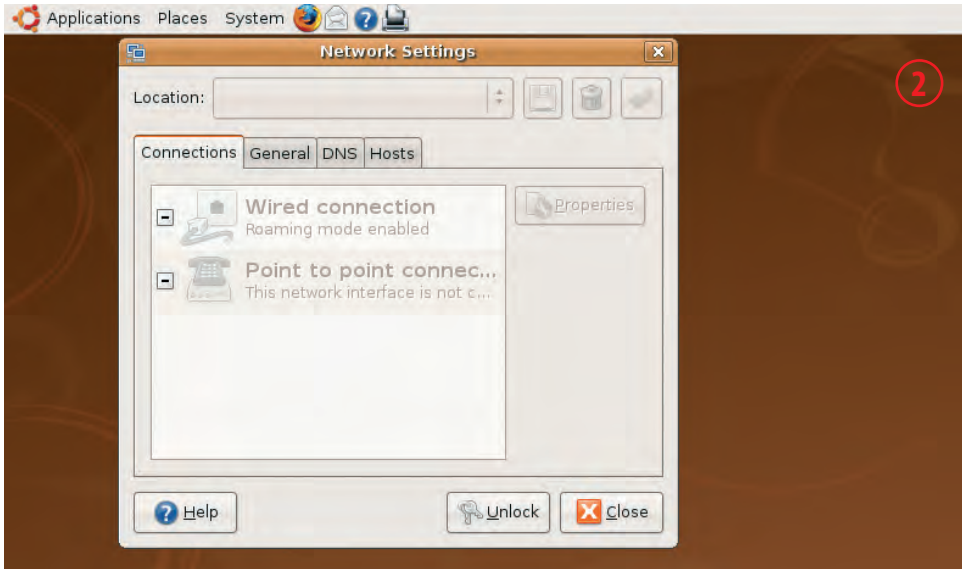
Described here are some possible network settings to explain the procedure.

For necessary settings on your computer, ask your network administrator or provider!

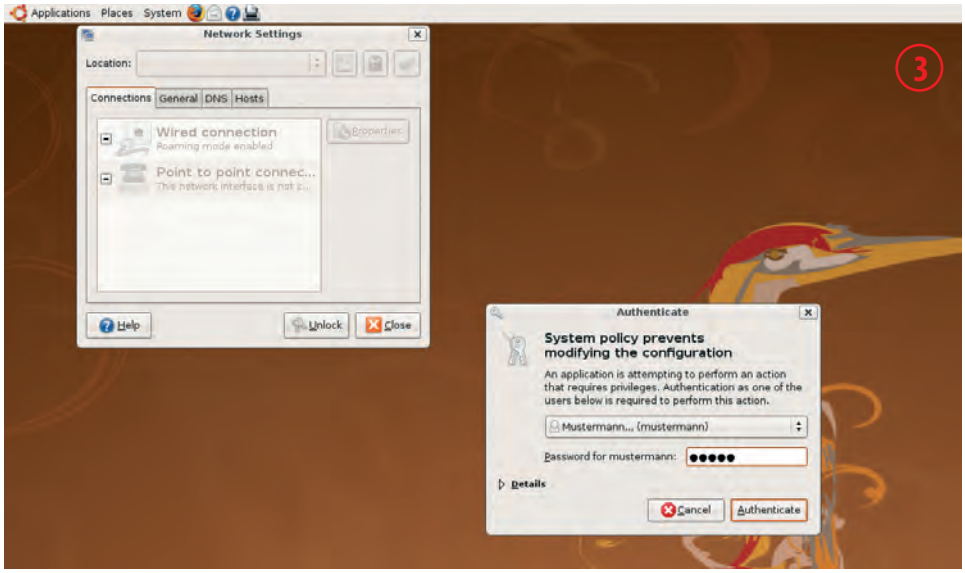
1) Open the network settings



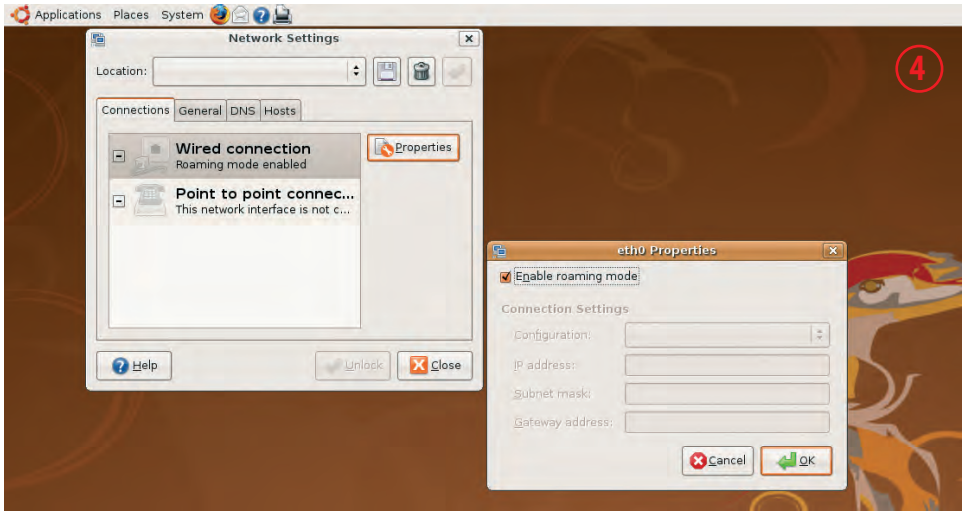
2) Click „unlock“



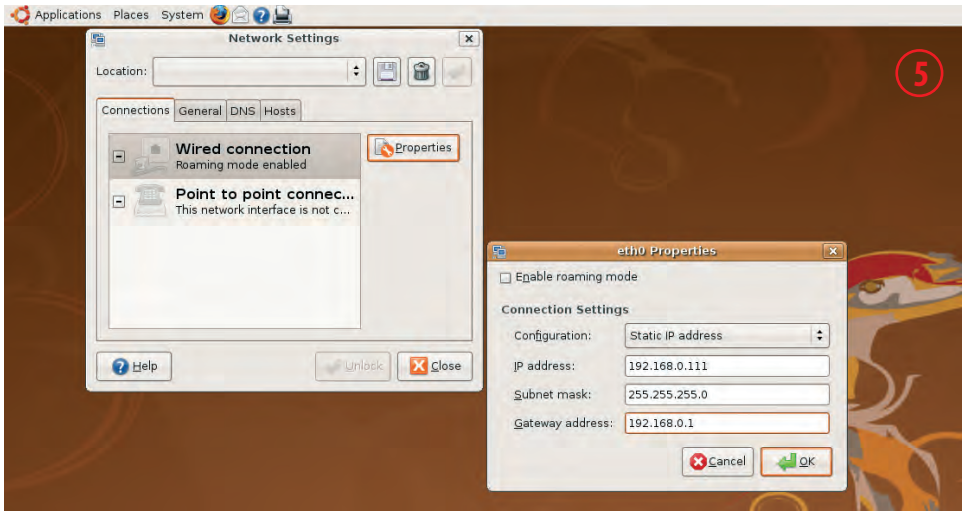
3) Type in password and click „authenticate“



4) In the left window highlight the network card, then click „Properties.“ Now open the properties window of the network card, remove the check and enable „roaming mode“.

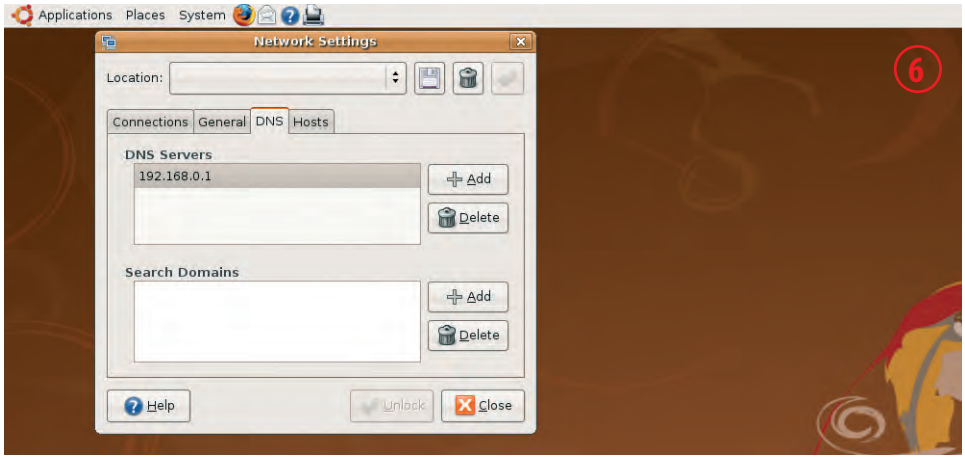


5) Select your „configuration“ and enter your specific parameters. Then close the window by clicking „OK“.



6) Cick on the „DNS“ tab. On the right, click „Add“ on the window „DNS server.“

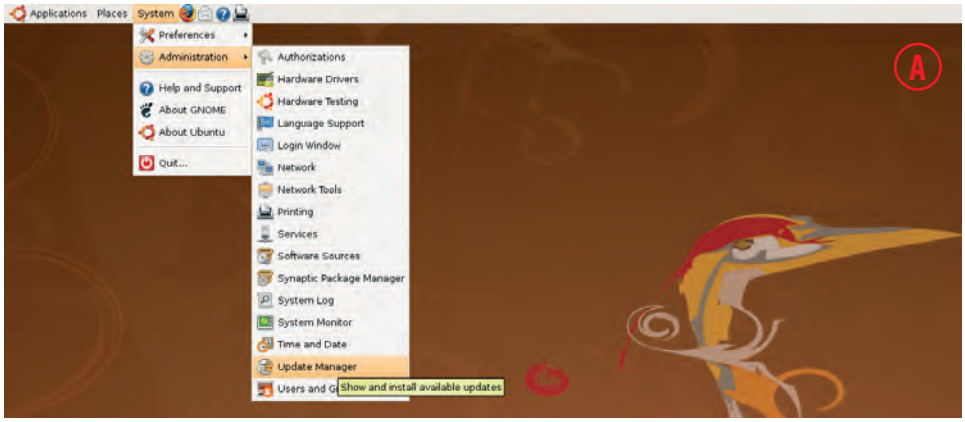
Now enter the IP address of the DNS server and press „Enter.“ Close the window.



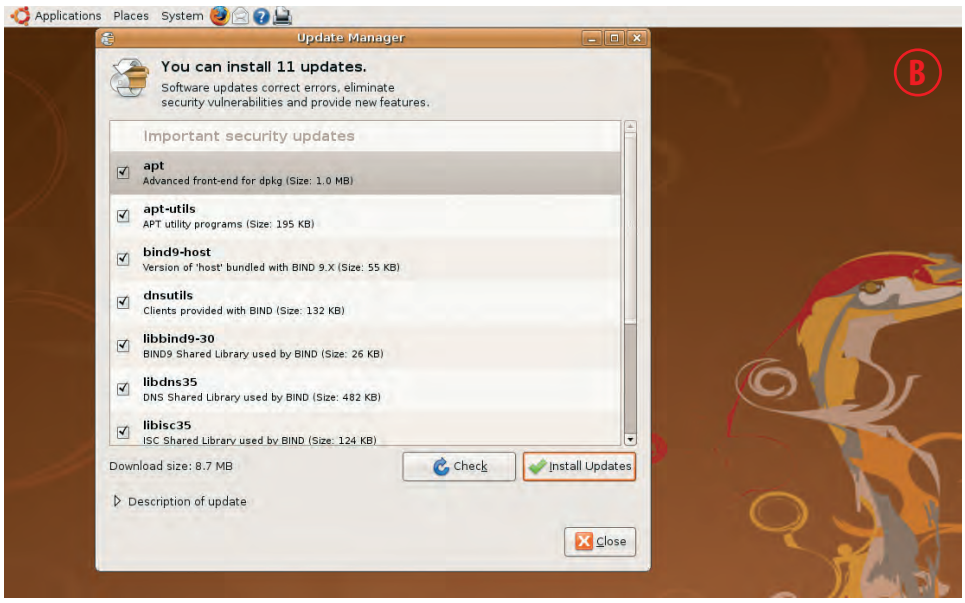
Updates

Ubuntu® automatically checks for updates through existing internet connections. However, manually starting the update management is also possible and is described below. The updates also include Ubuntu®, LinuxCNC® and Axis®.

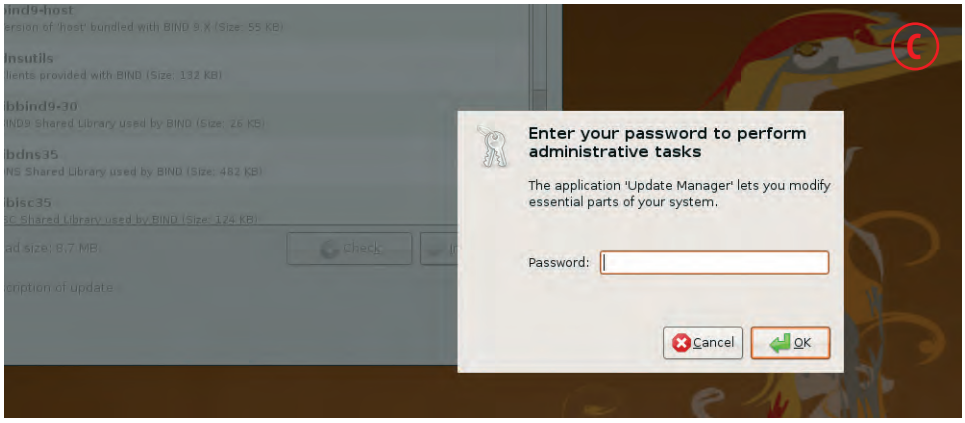
A) Open „Update management“.



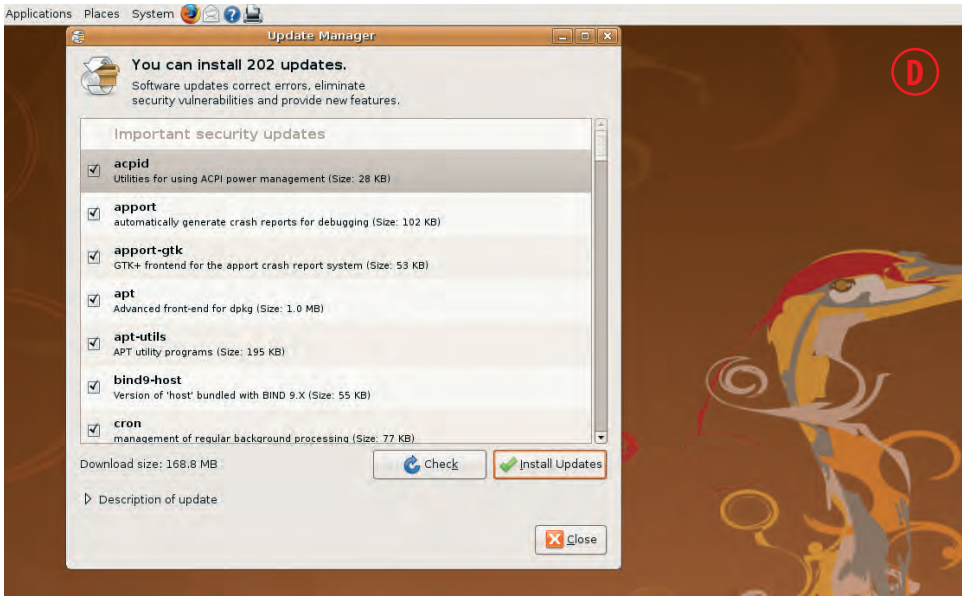
B) A list of updates will appear. To ensure that the list is updated, click on „Check“.

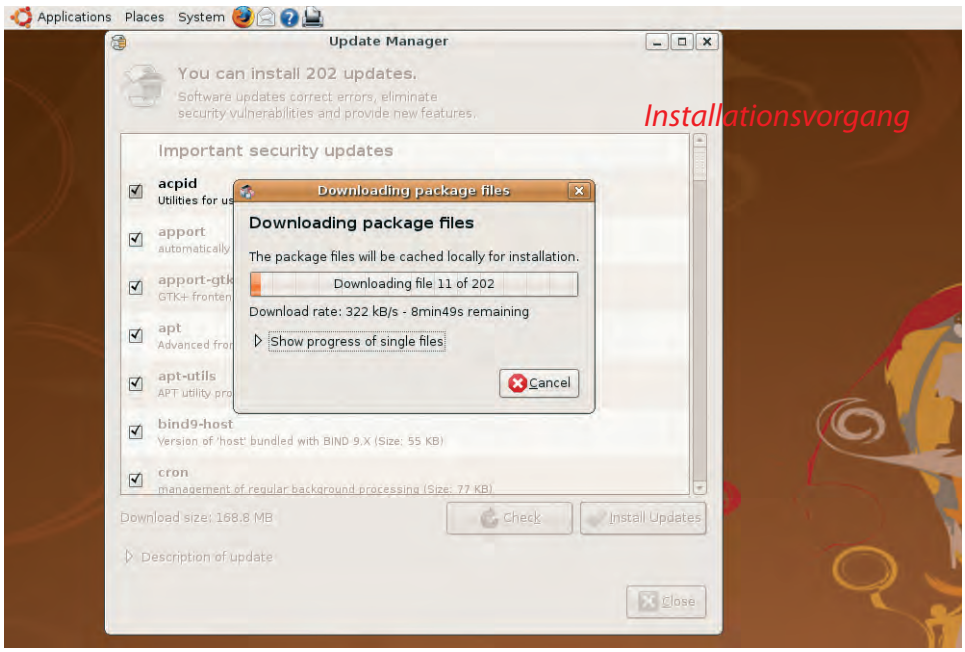


C) Type in your password and press "ok" and the list will begin to update.



D) You will see the full list. To install the suggested updates, click „install updates." After the installations, you may close the update management window.



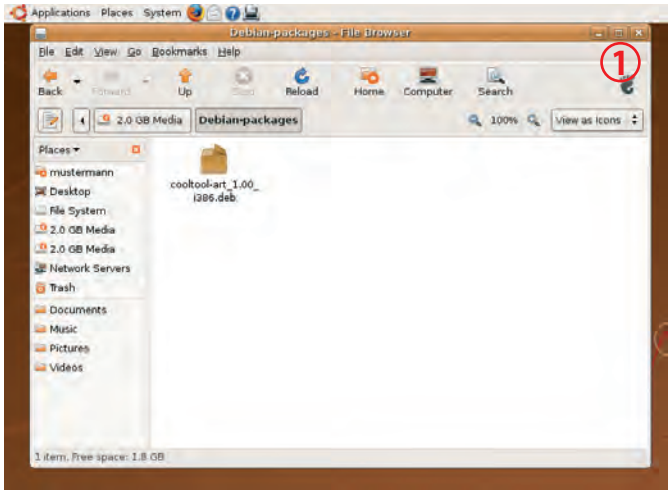


CoolCNC desktop wallpapers

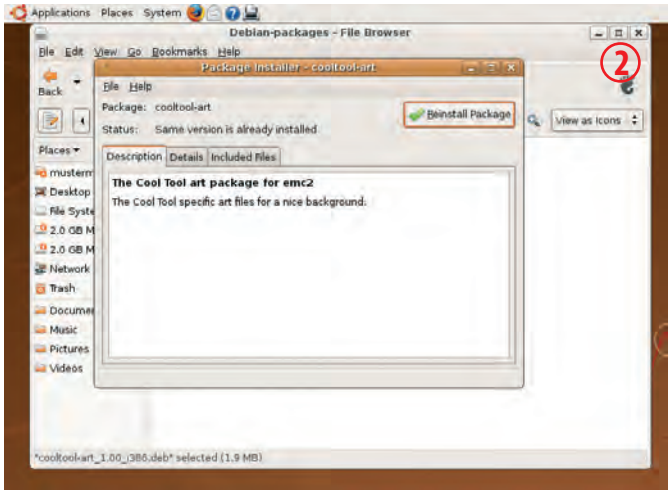
The installation of the CoolCNC desktop wallpaper is optional. On the supplied USB key are the „Debian-packages.“ Open it.

1) Double click on „cooltool-art_1.00_i386.dep“

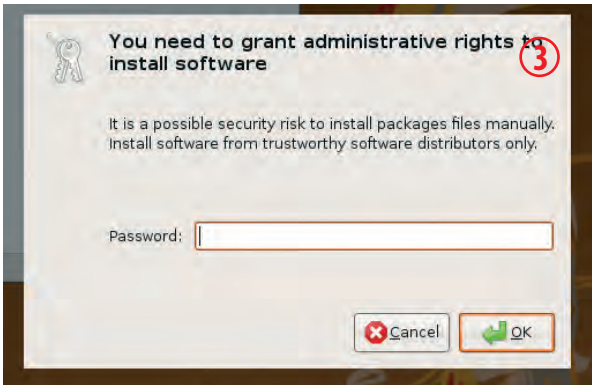
The files can also be downloaded from our homepage.



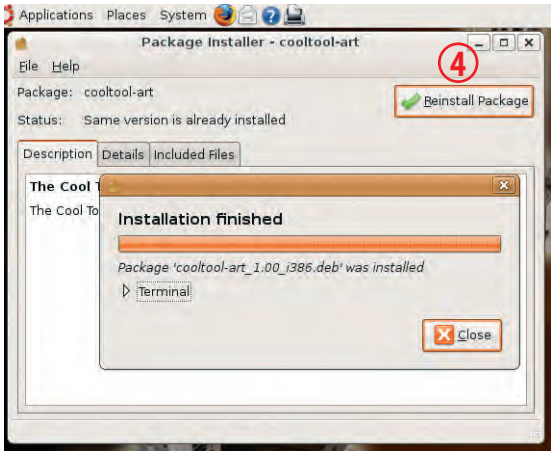
2) Click on „Reinstall package“.



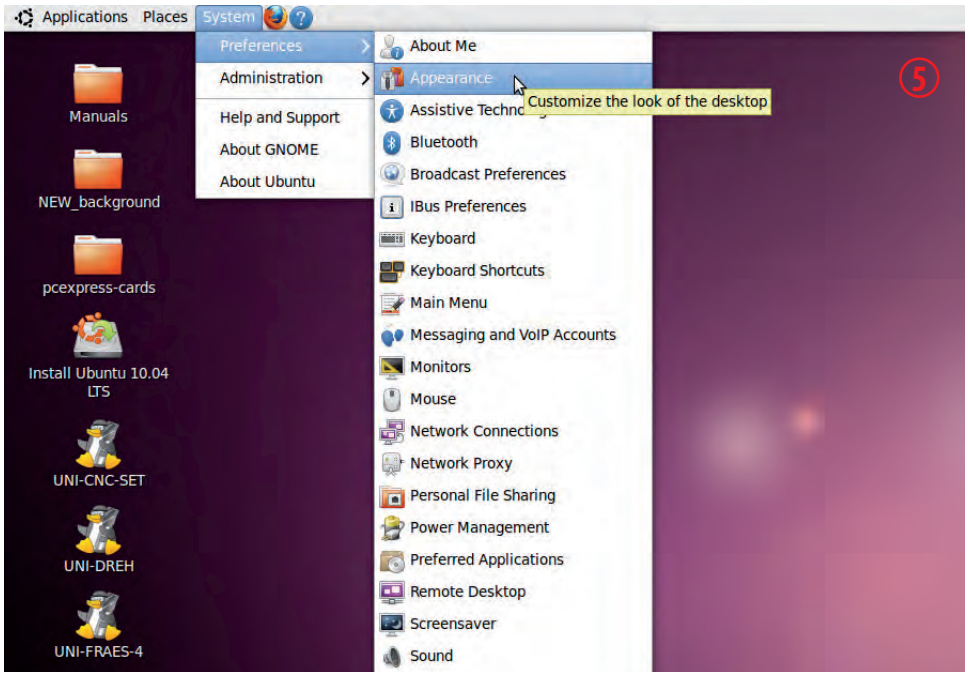
3) Type in your password. Installation will begin.



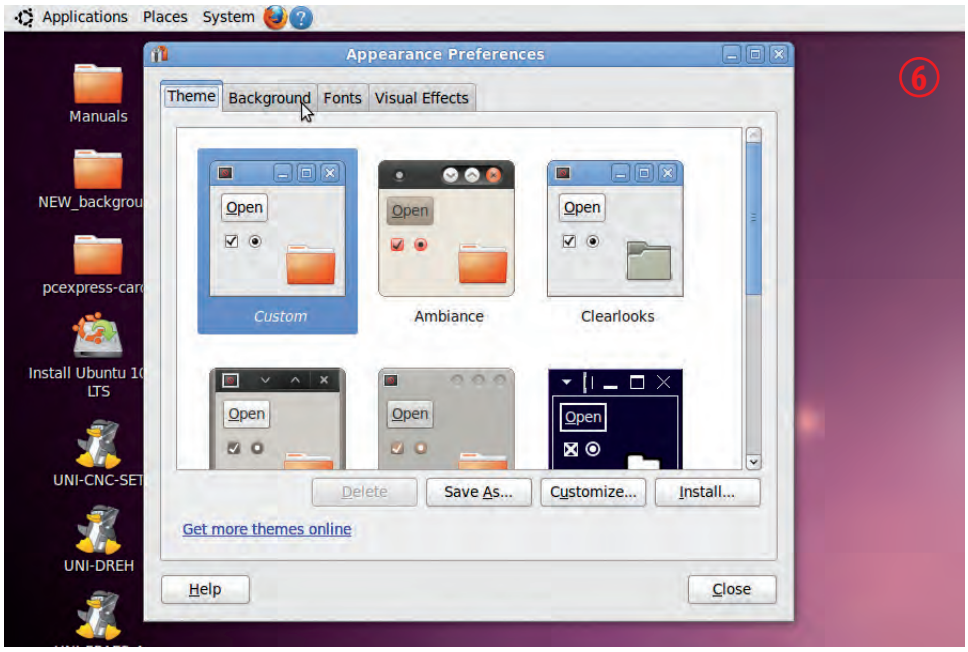
4) Click on „close". Then close the „Package installer" too.



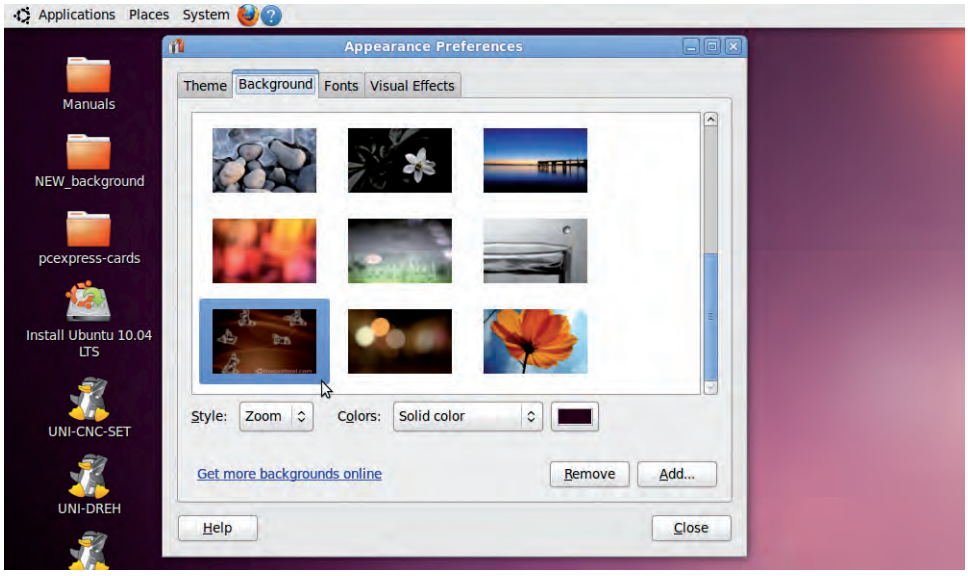
5) open "Appearance"



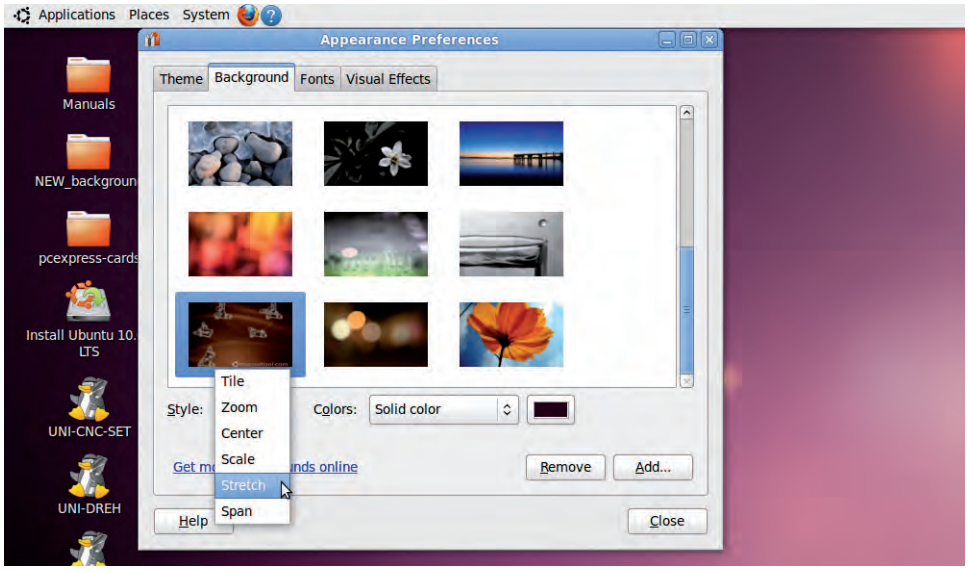
6) go to "Background"



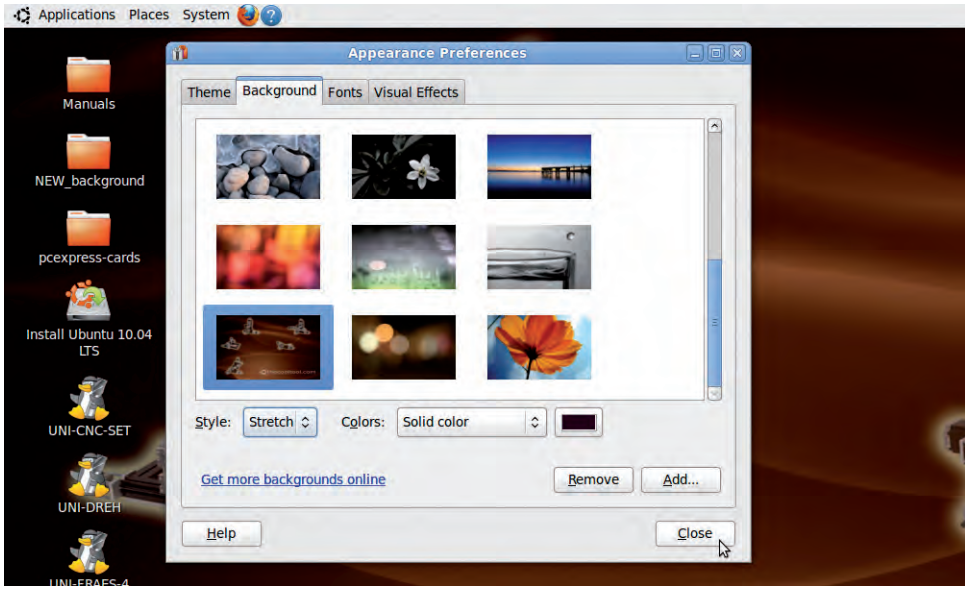
7) select the new "CoolTool" background



8) select "Stretch"



9) close the window



General advice on how to handle the Step motor control box

The CoolCNC® Step motor control boxes come in a 3 and 5 axes option. Both versions come with step motor outputs: 1x LPT-input, 1x Relay output, 1x 5V Ouput, 1x 24V output, 5x Signal input (i.e. for limit switches), 1x PWM Ouput signal and 1x Power supply connector (AC adapter included in delivery).

Note the following points:

1) If the control box is connected to the PC, then they both must be turned off.

2) Never plug or unplug the step motors during operation. The box must be turned off. This applies to all other inputs and outputs of cables from the box.

3) Use the box in a dry environment. The ambient temperature should be between -10 and +35 degree Celsius (14 and 95 degrees Fahrenheit).

4) Only use the step motors supplied by us.

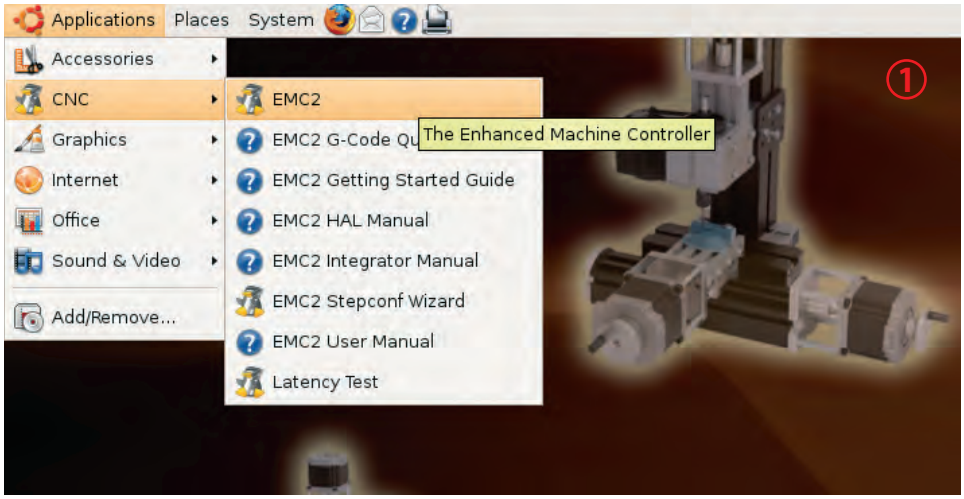
5) Turn on the box only after the control software LinuxCNC® (Axis®) has been started.

1 ... main switches
2 ... socked power supply
3 ... relay output
4 ... input PC (LTP)
5 ... 5 and 24 V output, 5x signal input

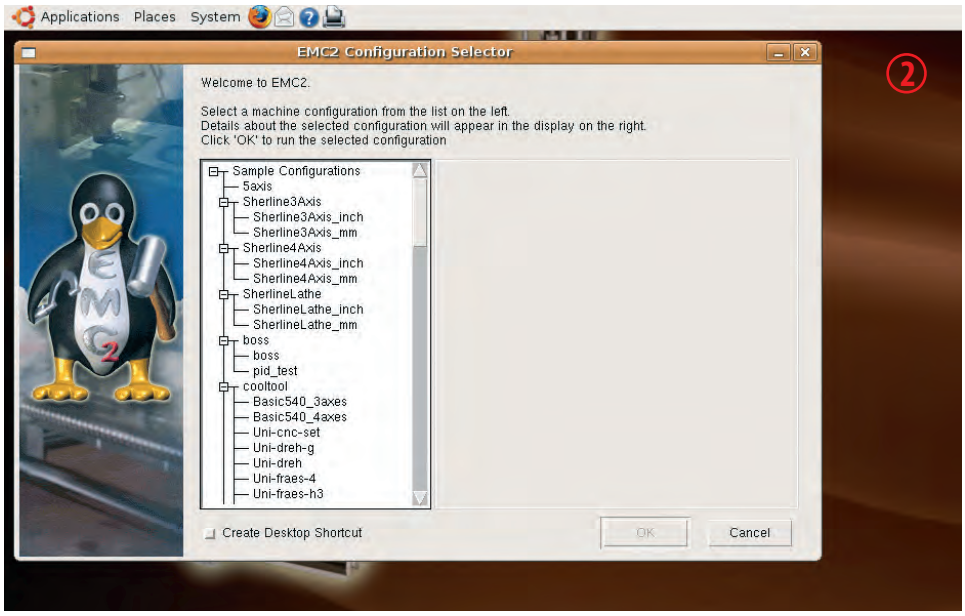
6 ... PWM output (drive)
7 - 9 ... step motor output (X, Y, Z)
Only for 5 axes controller:
10 ... step motor output *A - axis*
11 ... step motor output *B or C - axis*

Bootstrap by LinuxCNC®

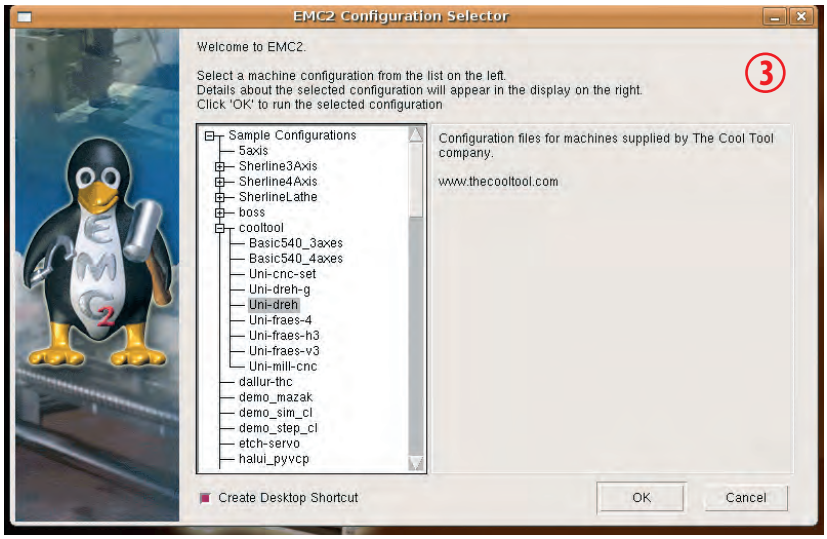
1) Click on the desktop icon „LinuxCNC," a selection window will open.



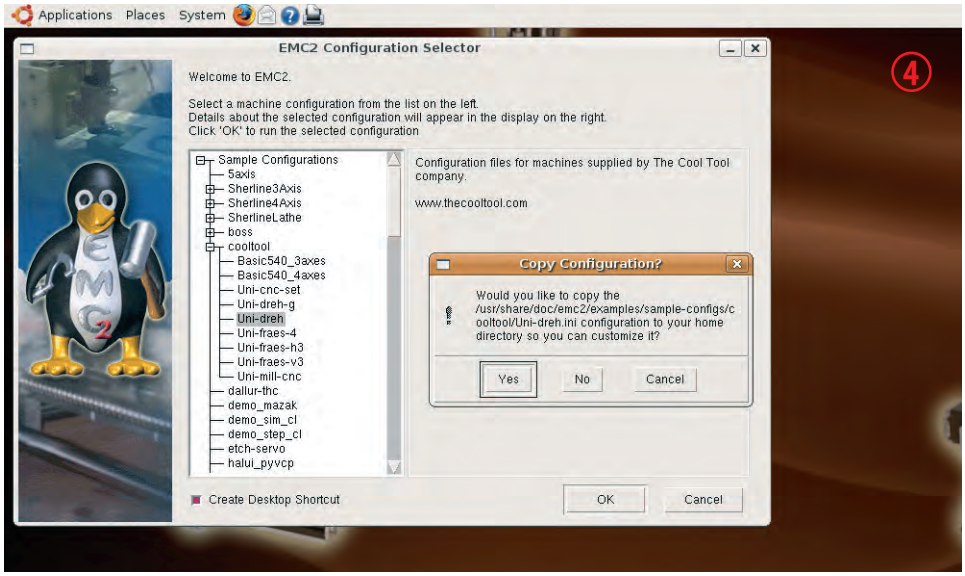
2) Under „Example Configurations," all pre-installed machine configurations are listed.



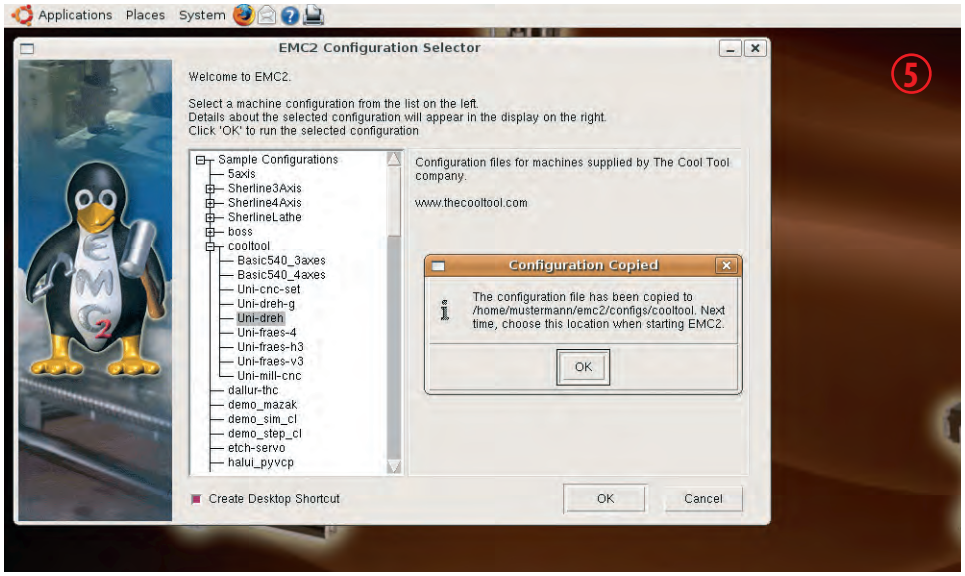
3) Go to the file „cooltool" and highlight the desired Unimat CNC Machine. To create a desktop shortcut, activate the function „create desktop shortcut," and click „ok".



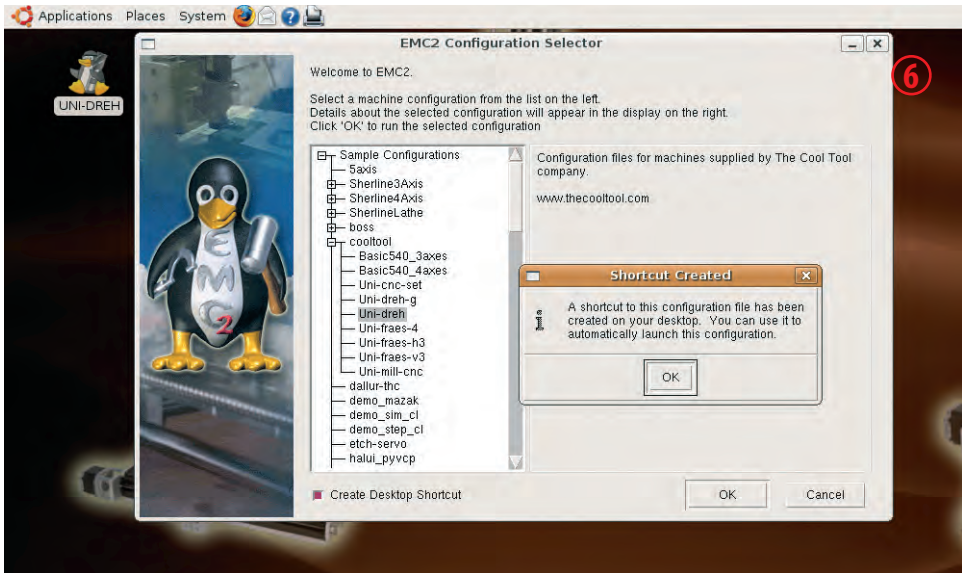
4) When asked if the configurations should be copied, click „yes“.



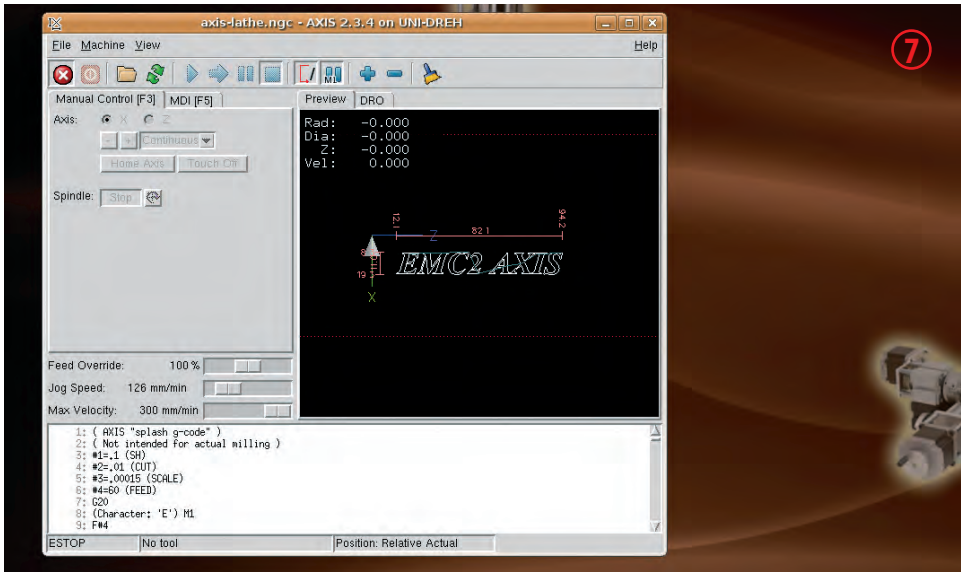
5) You will see a confirmation that states that the data has been copied (Only the subfolders will be copied, in this case the folder „cooltool“). Click „ok“.



6) You will now be able to see the desktop shortcut. Close the confirmation window by clicking „ok“.



7) After the LinuxCNC® starts, look at the Axis® user interface. Quit the program for now.

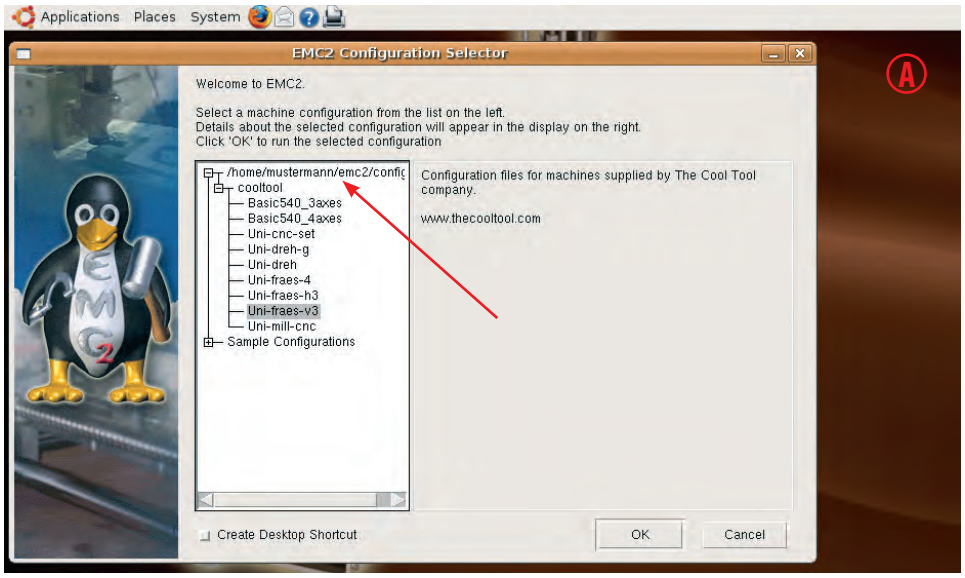


Restart LinuxCNC®

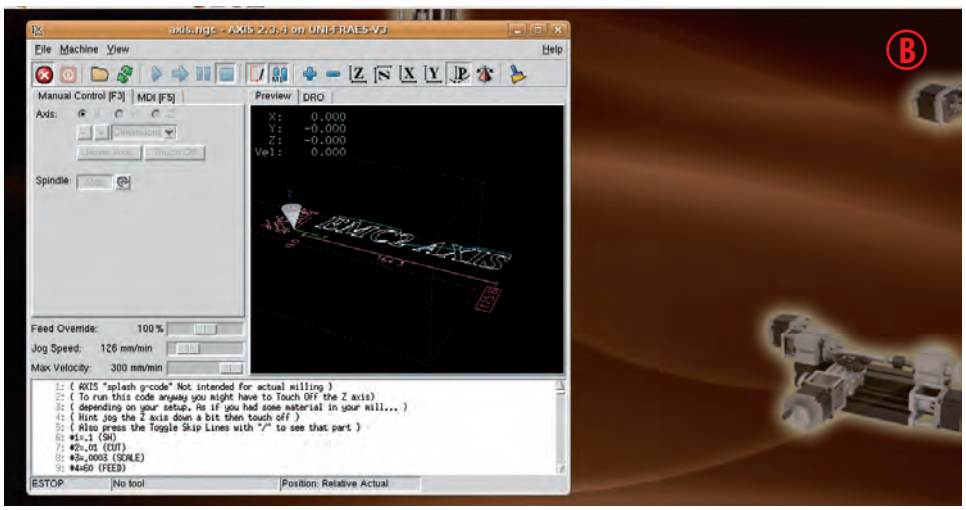
Variant 1: Double click on the desktop shortcut; the user interface of the specific machine will start immediately.

Variant 2: Start the LinuxCNC® as stated above in item 1. It will reopen the option window (A).

Here you will see your own configuration file. Start the machine configurations only from this file or from the desktop shortcut!

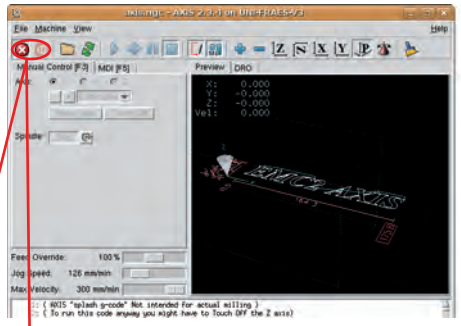


(B) ..... Axis® user interface of Unimat CNC Vertical milling

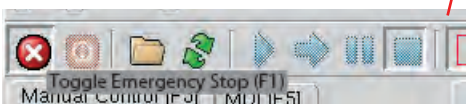


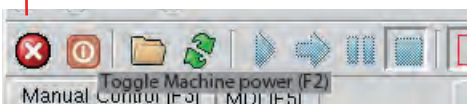
Description of Axis® user interface

The appearance of the interface can be altered with the machine configuration data. Below the „UNI-FRAES-V3“ configuration is described. Make sure that the step motor control is turned off or not connected to the PC. Now start the „UNI-FRAES-V3“ machine configuration.

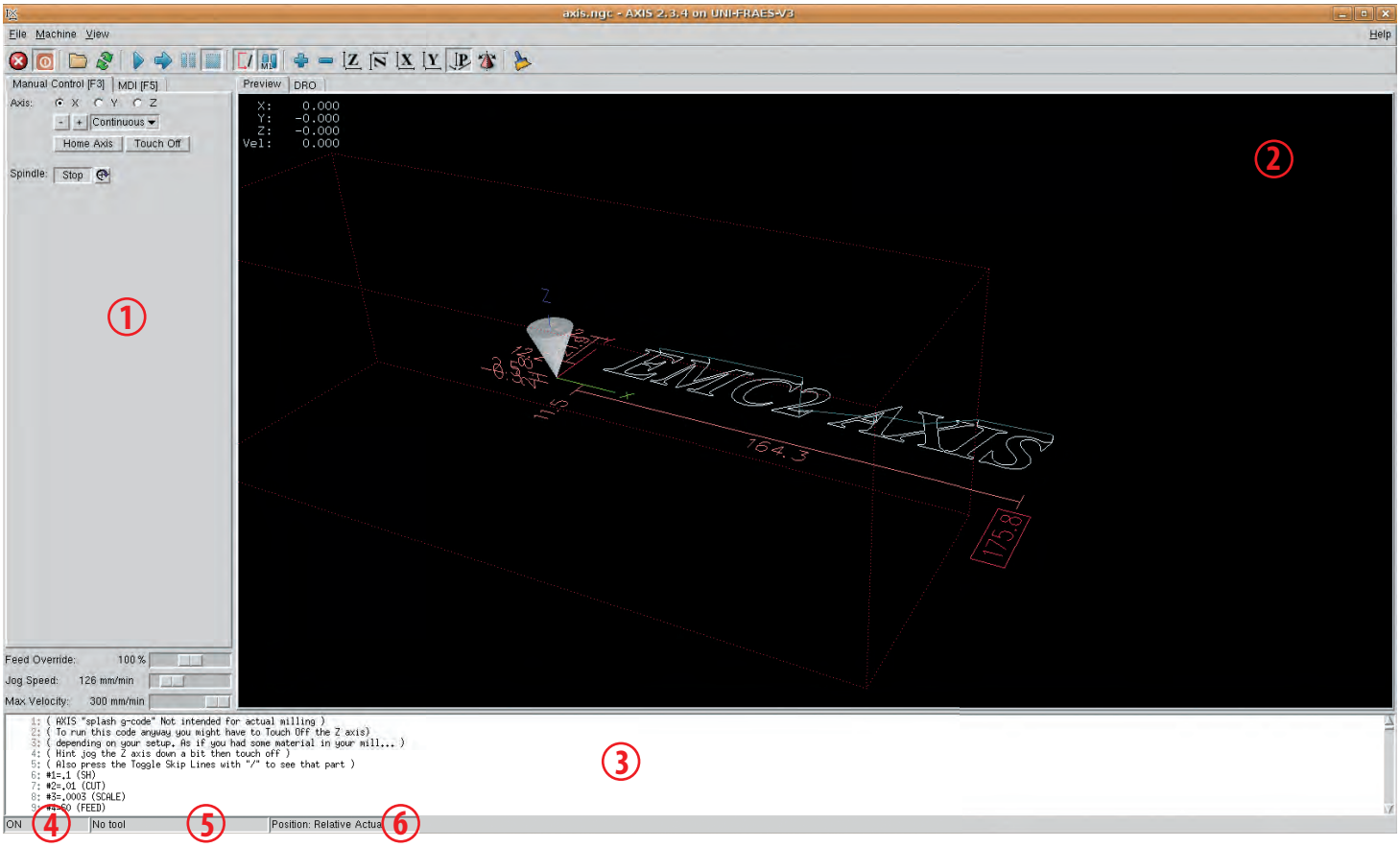


To access all the functions, you must turn on the machine. To do so, either click on the symbol on the right or press „F1“ and then „F2“.





Now the previously inactive icons are also active.

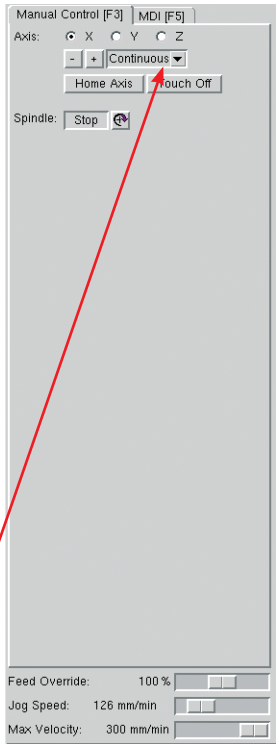


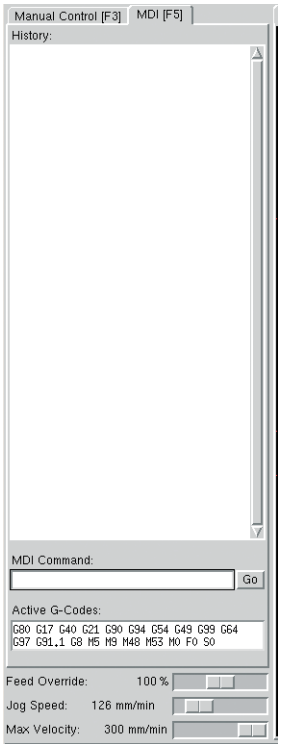
Icon List

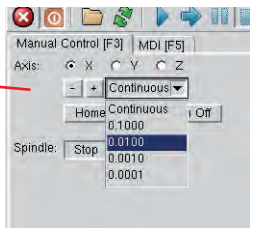
- *open (G-Code)*
- *Update, reload Data (G-Code)*
- *Perform actual Data (G-Code)*
- *executes only the next line (G-Code)*
- *Processing interval*
- *Processing Stop*
- *Rows that start with / are ignored (G-Code)*
- *M1 command on/ignore*
- *enlarges presentation in the preview*
- *lessen presentation in the preview*
- *option to view preview*
- *turning preview in preferred angle*
- *deletes recorded travel in the preview*

1) Manual Range

This range of interface serves to manually control the machine. It is composed of two tabs, the „Manual Control“ and the „MDI“.







Manual Control

Axes: The activated axes can be moved with the „+“ and „-“ icons (above the “Home” icon). Either the axes travel continuously or by a specific value (0.1: 0.01; and so on). For the axis to travel continuously keep pressing down on the icon. The machine can also travel using the keyboard: left and right arrow keys - x axis, up and down arrow keys - y axis, page up and down - z axis. Other key shortcuts can be found under „Help“ located on the top right of the Axis window.

Home axis: Sets the reference point for the active axis (actual position set to zero). Machines with reference switches trigger the home icon and will drive the machine to the reference switches.

Touch off: Here the distance between the actual position and the zero point of the active axis can be determined. This is very useful for lathes. More information can be found in chapter 4.3. Uni-Dreh.

Spindle: The main spindle can be turned on or off. However, this is only possible if it is connected to a relay box or to a special spindle motor through the PWM output.

Feed override: With this control the feed rate can be increased or decreased. This value has implications on the G-code data as well as on the manual rates.

Feedrate: Adjustment of the travel speed for the manual procedure.

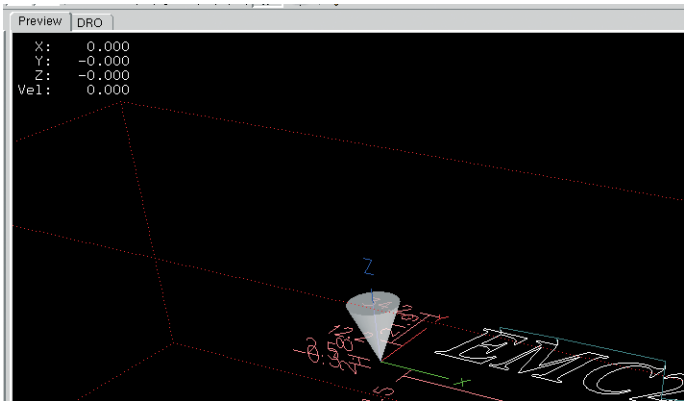
Maximum feedrate: This value determines the maximum travel speed of the linear axes (X,Y,Z).

MDI

Here the individual commands (in G-code form) can be entered. For example, setting the machine to a specific position.

2) Coordinates field

In this section, the actual position of the machine can be read. It consists of two tabs, „Preview“ and „DRO“.



Preview

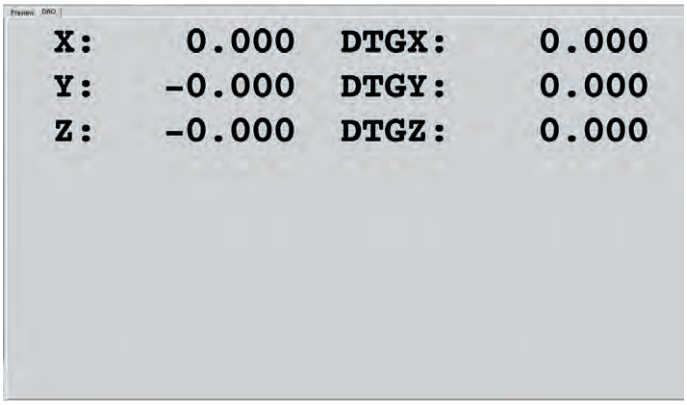
The following values can be read:

• Actual position of each axis

• Referenced and not referenced axes. If an axis is referenced, then there is a mark next to the coordinate value.

• Current speed – (if more axes travel, the speed of the fastest one is displayed).

• „Preview“ of the work piece – not the work piece, but the programmed tool path is presented. Furthermore, each movement of the machine is drawn out and presented (i.e. manual pathways in yellow).

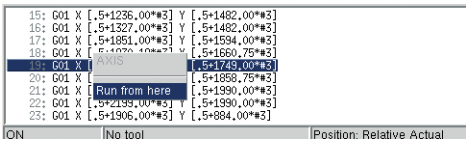


DRO

In this tab, only the coordinates of the axes are shown. Each axis is assigned a „DTG“ display („Distance to go“). This value shows the distance the axis still needs to cover until it reaches its endpoint.

3) NC program window

Here the current G-code is displayed. When something is being processed, the row corresponding to it is highlighted. It is possible to highlight it with a right click and start the process from the selected line.



4) Machine status

Shows the machine status – machine on/off, emergency on

5) Work tool

Shows the activated work tool. For this, the specifications of the tool bit have to be inserted in the tool table. See examples in chapter 4.3. Projects for 3-axis Unimat CNC.

6) Position

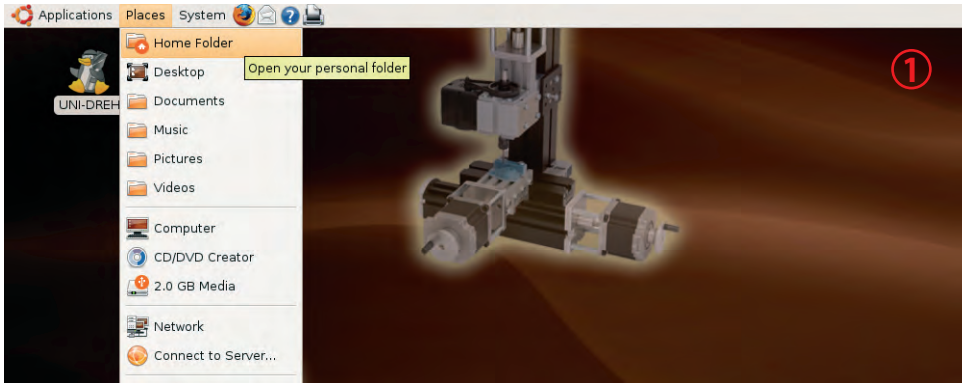
Shows the current software mode.

Files and Storage locations

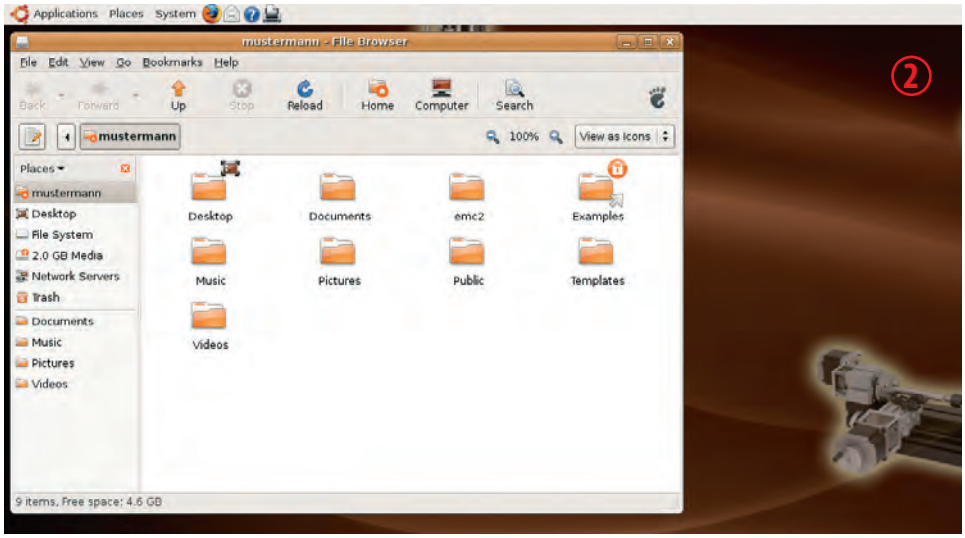
All relevant files are in the file „LinuxCNC," which is in the user's „Personal Folder." In our case, it is in the folder: /home/mustermann/

Opening the Personal folders:

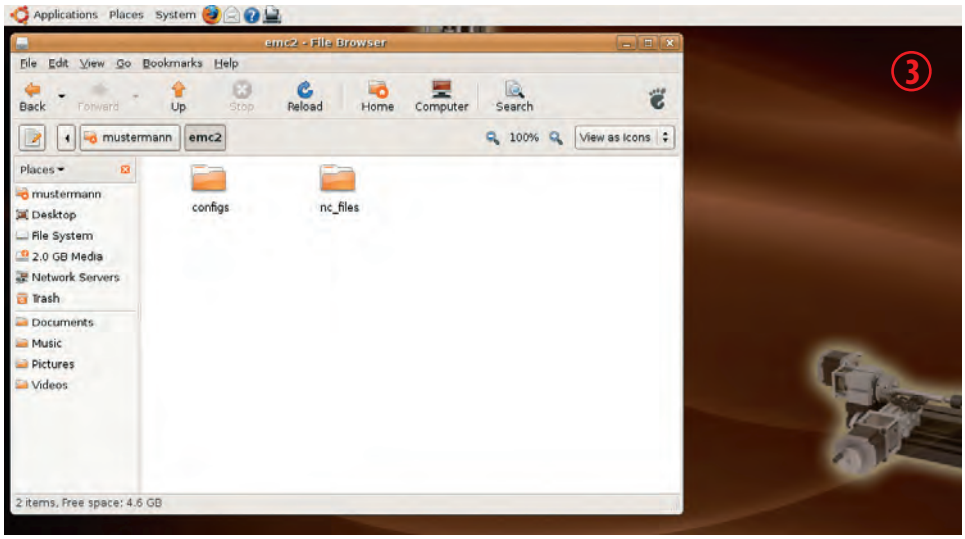
1) Click on „Locations" then „Personal Folder"



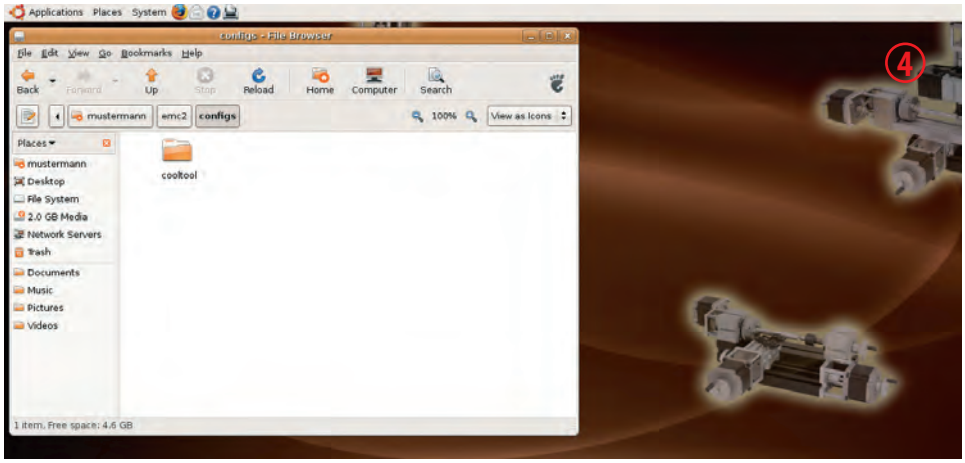
2) You will now see the „LinuxCNC" file. Double click to open.



3) Double click on „configs".



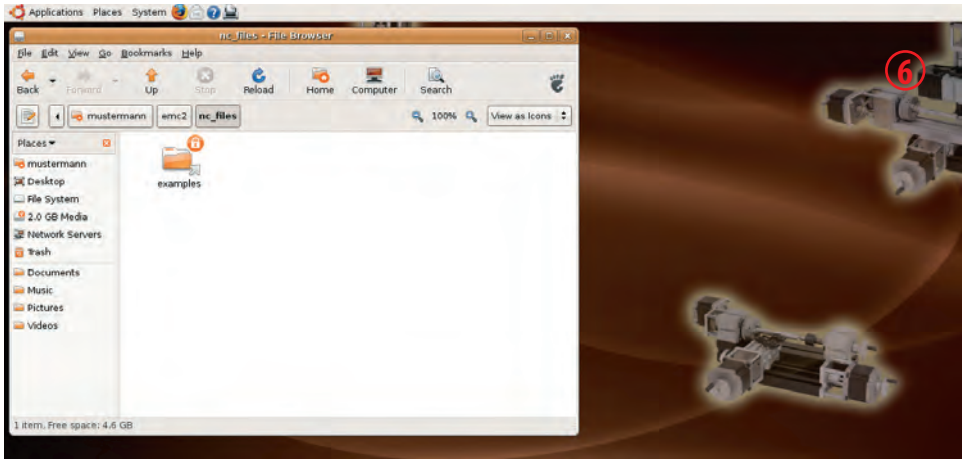
4) Double click on „cooltool“.



5) Now you will see all the configuration data. The machine configuration data (--.ini) can be opened and edited here (see „Changing the step motor turning direction“)..

6) Click on the „back“ button until you see the files „configs“ and „nc_files“ (step3). Now open the file „nc_files.“ You should store all your NC-data (G-code) in this folder. It is very important when working with sub-G-Code programs, because LinuxCNC will be searching for them here.

For example data, there is a link labeled „examples“.



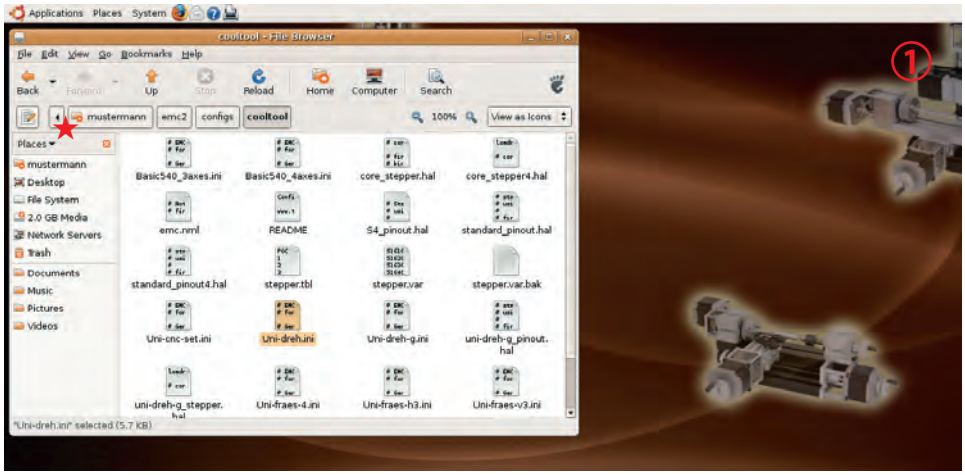
Changing the step motor turning direction

The machine configuration data (--,ini) are coordinated with the Unimat CNC machines, that the slides move according to standards (see The Coordinate System from NC controlled machines 4.1.4).

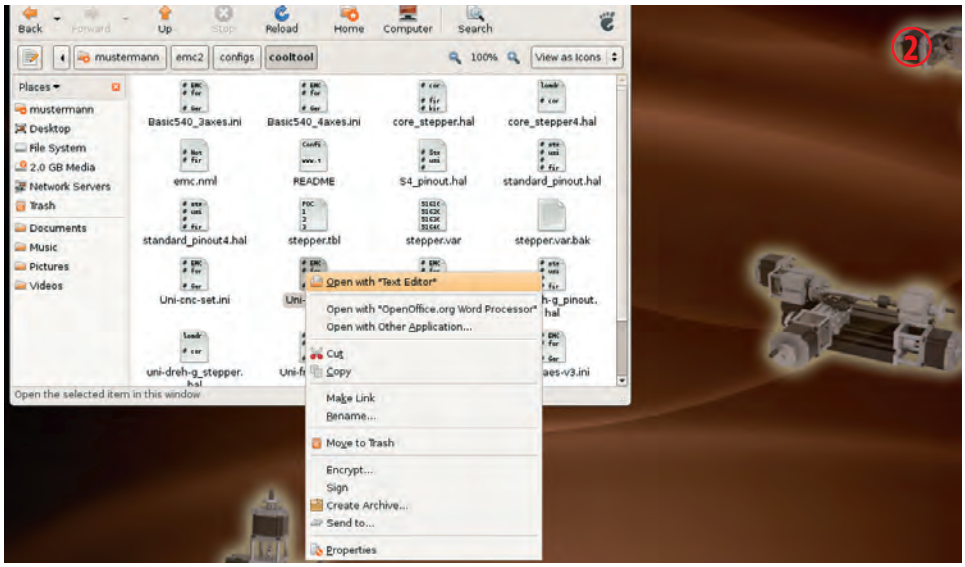
It is possible that the step motor's polarity is set backwards (the slide moves exactly in the opposite direction).

Therefore, the movement direction should be checked after the assembly of each machine. The moving direction of an axis can be changed as follows:

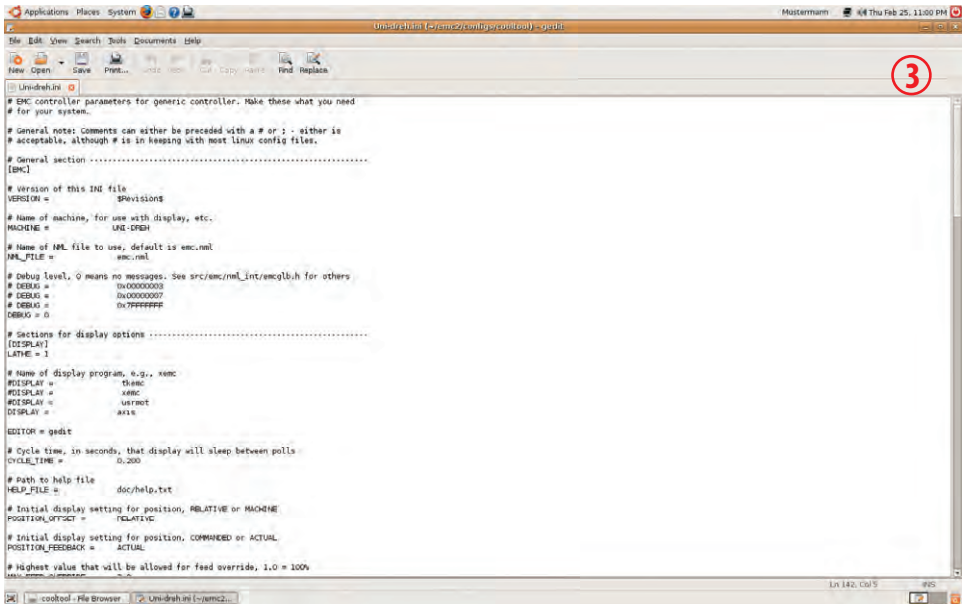
1) Open the configuration folder (see „Files and Storage locations“), in this case, the „cooltool“ folder (/home/mustermann/LinuxCNC/configs/cooltool). Search for the appropriate machine configuration data and right click it (i.e. Unidreh.ini).



2) The selection window will open. Choose „open with >>Texteditor<<.“ If this option is not available, choose „open with other application“ and select in the following window “Texteditor”.



3) You will now see the machine configuration data in Texteditor. Scroll down to „Axes section“.



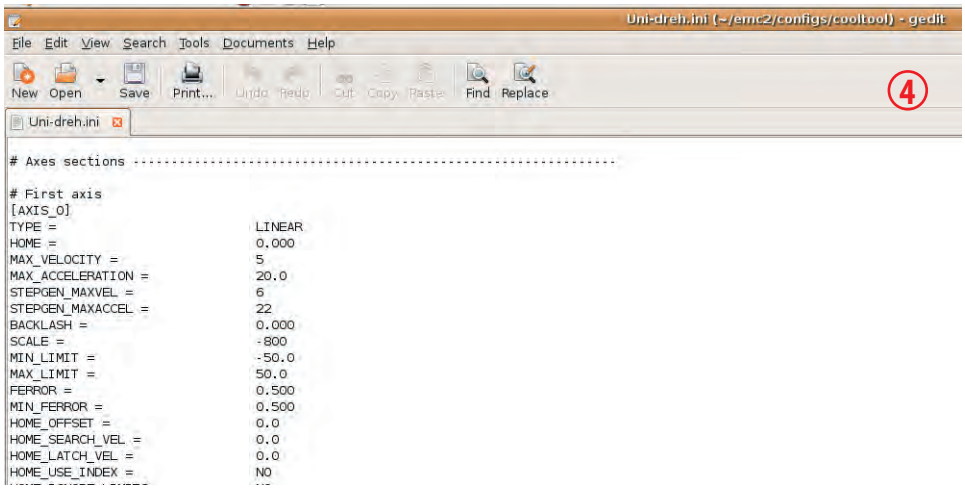
4) In this section, the axes parameters are defined (i.e. maximum travel, feed, step motor's rotation direction, etc.).

"#First axis" = X-axis

"#Secound axis" = Y-axis

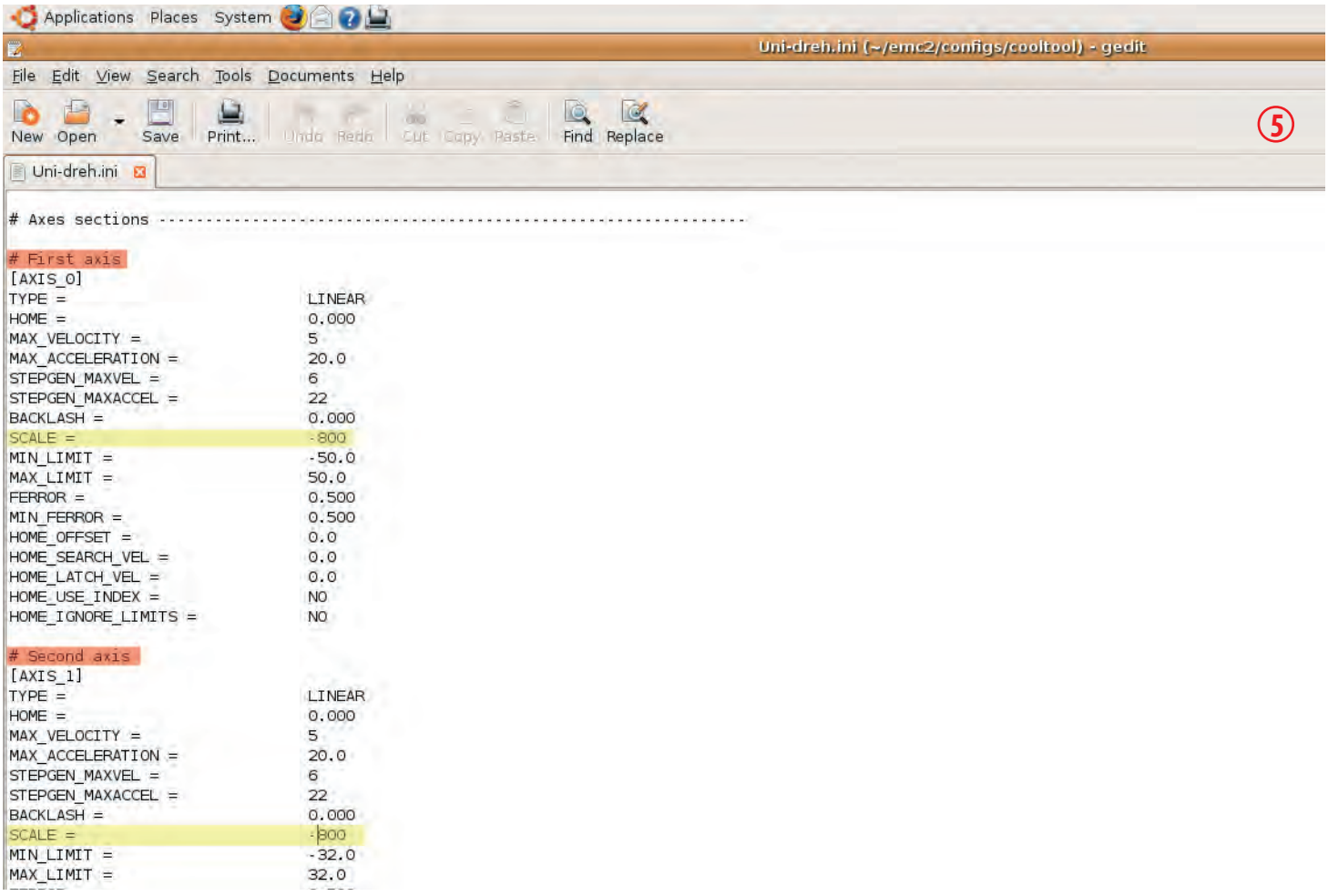
"#Third axis" = Z-axis

and so on



5) „1st axis" represents the x-axis. „2nd axis" represents the y-axis, and so on.

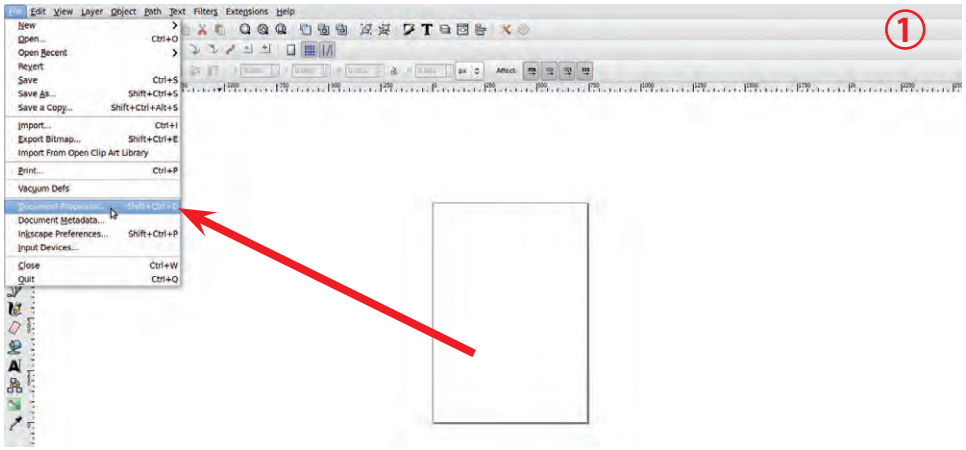
For every axis, you will find the „SCALE" parameter, defining the step motor's/controller's step resolution (one rotation with the motor requires 800 steps/piece steps). In the case of spindles with 1 mm thread pitch meets one rotation 1 mm feed (1 mm = Scale 800). For spindles with 2 mm thread pitch we got a scale value of 400 (1 mm feed are 400 piece steps of the stepper motor). The sign of this value determines the rotation direction (polarity) of the step motor. To change the rotation direction, invert the sign of the corresponding axis (800 to -800 and vice versa).



Sample 1 - engraving into acrylic

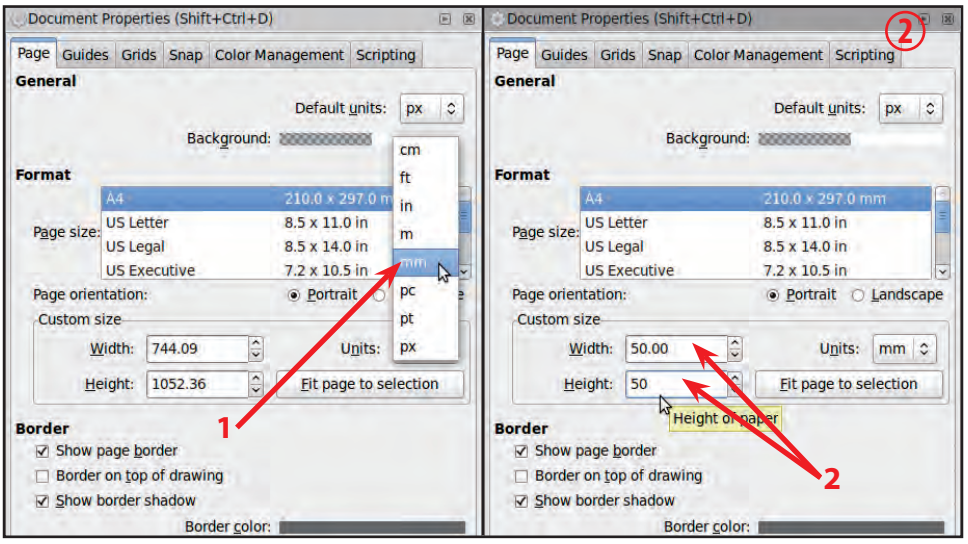
raw material: acrylic plate ~ 50 x 50 x 3 mm
tool: end mill ø1.0 mm
optional: end mill ø1.6 mm

1) open "Inkscape®" then click on "File" --> "Document Properties...".

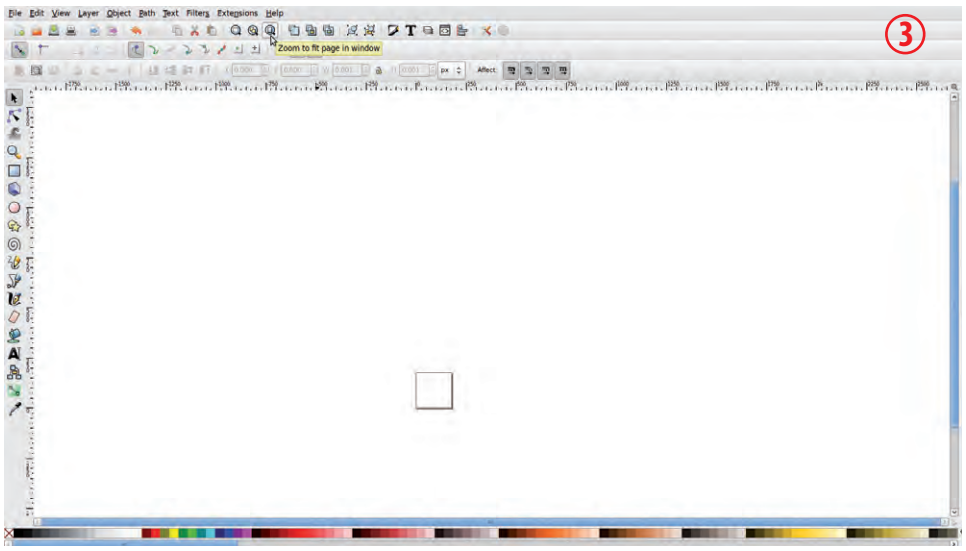


2) select at "Custom size" --> "Units" --> "mm".

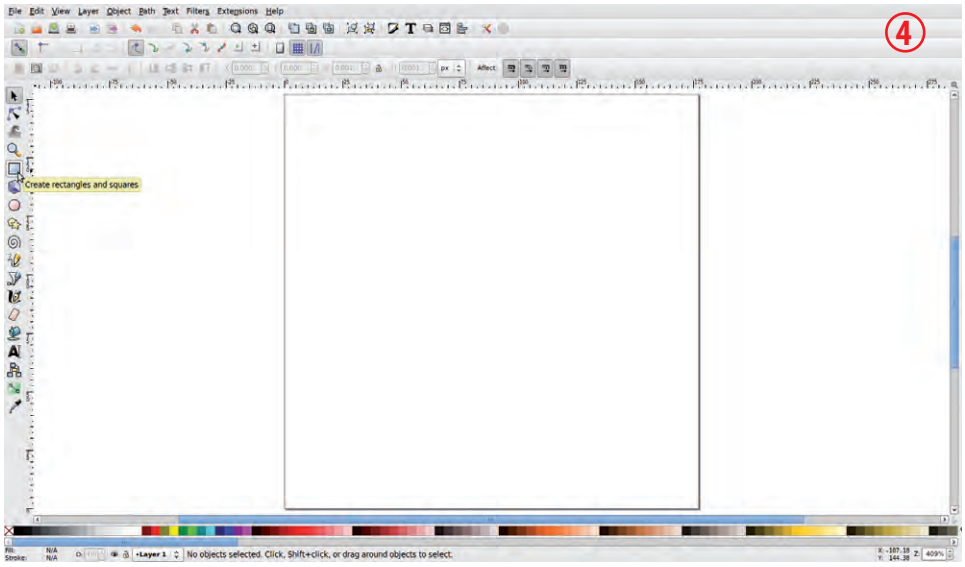
enter for both "Width" and "Height" 50 after that close the window.



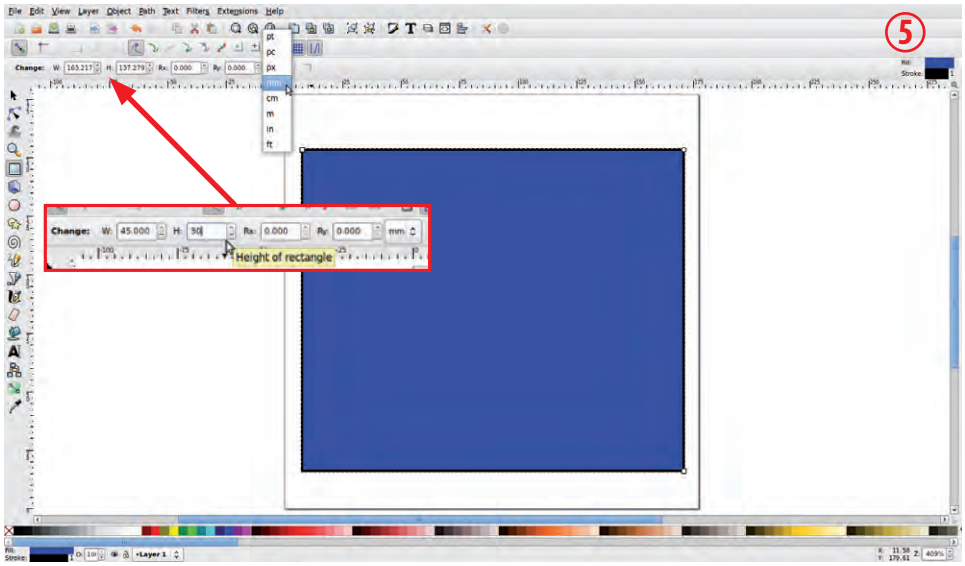
3) click on the magnifier icon "Zoom to fit page in window".



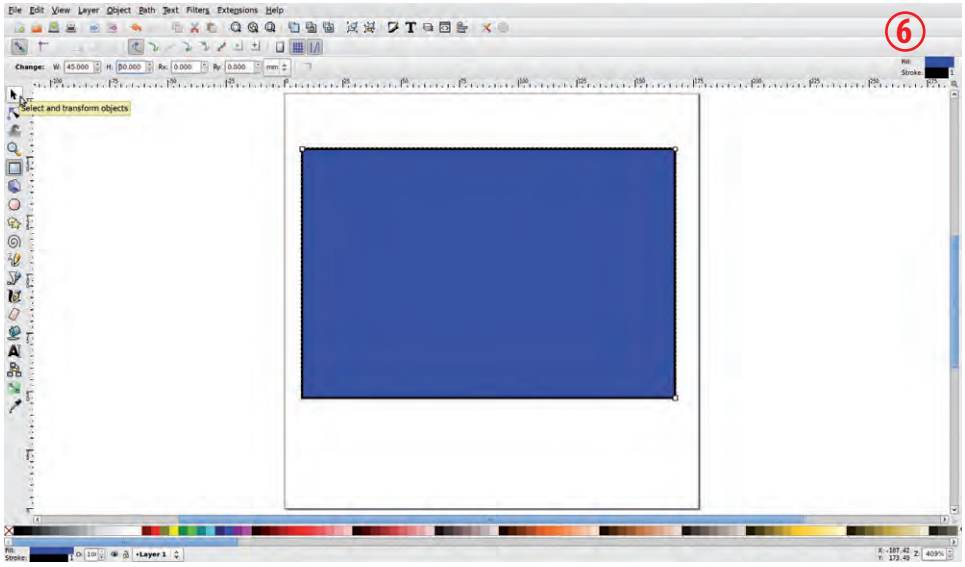
4) click on the square icon "Create rectangles and squares".



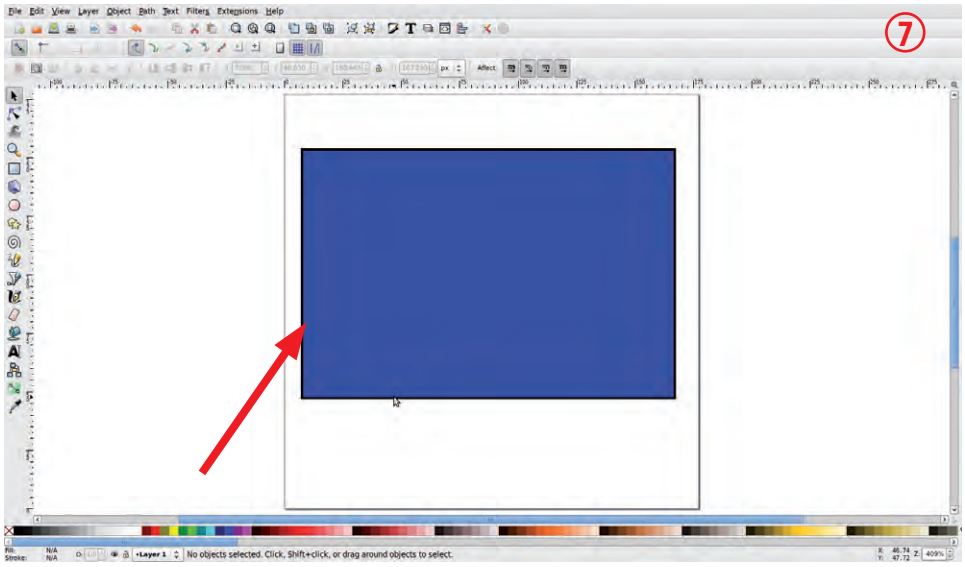
5) at "Change" select "mm" then enter for "W" (width) 45 and for "H" (height) 30.



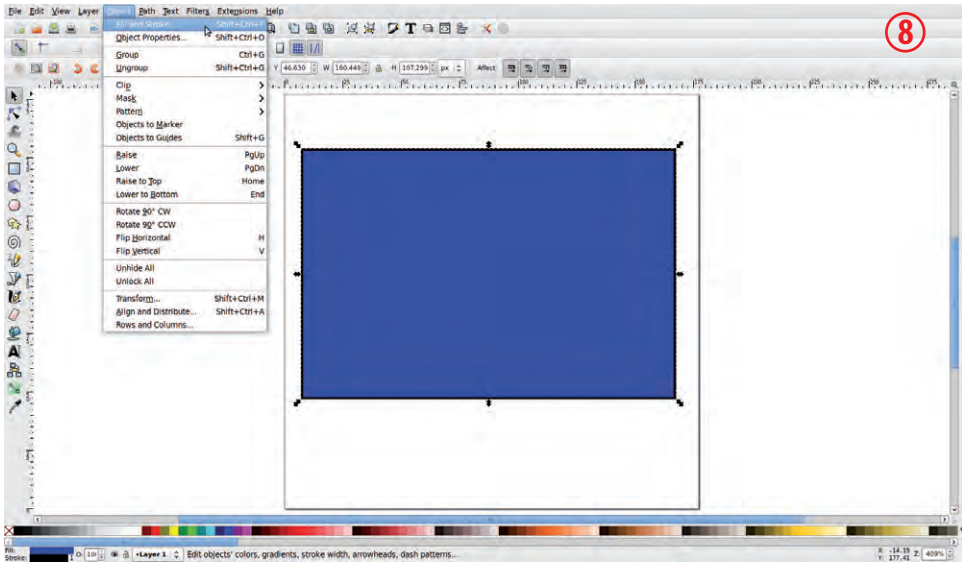
6) click on the arrow "Select and transform objects".



7) select the rectangle (click on it).

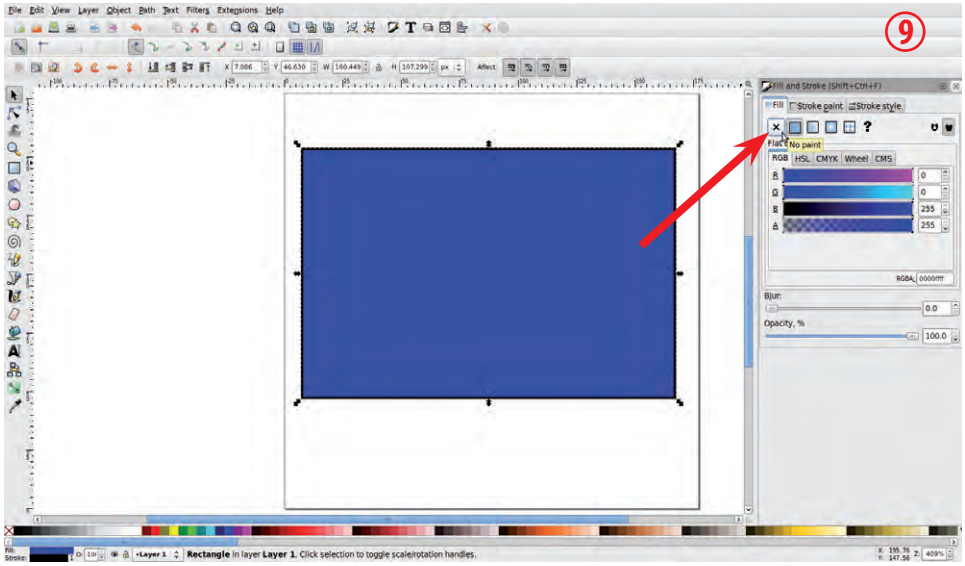


8) Now that the rectangle is marked click on "Object" --> "Fill and Stroke".



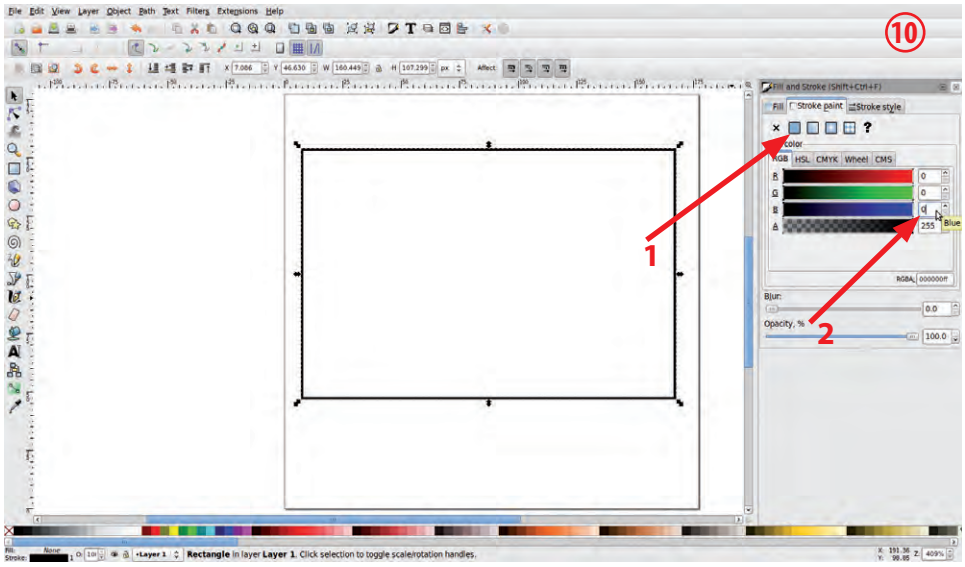
9) in the window "Fill and Stroke" select "Fill" and click on "X" (No paint).

Attention:
The rectangle must be selected (marked).



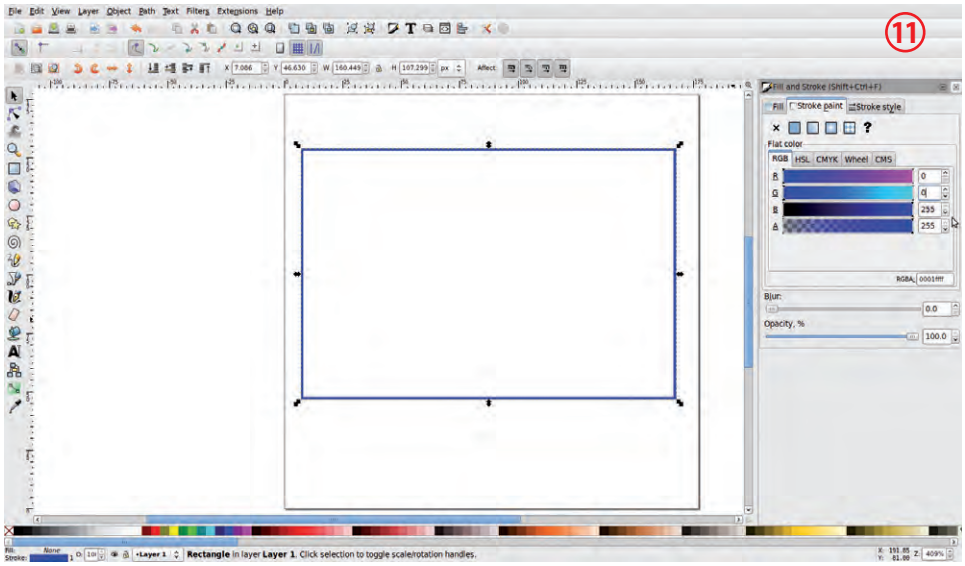
10) switch to "Stroke paint" and click on "Flat color" (1), then click "Blue" (2).

Attention:
The rectangle must be selected (marked).



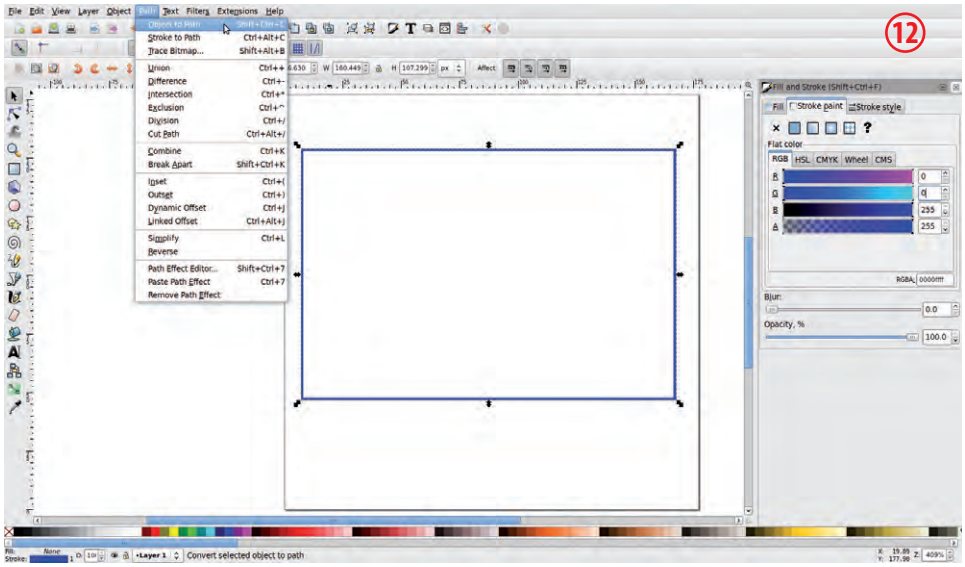
11) write "255" and press "Enter". The contour color of the rectangle is now blue.

Attention:
The rectangle must be selected (marked).



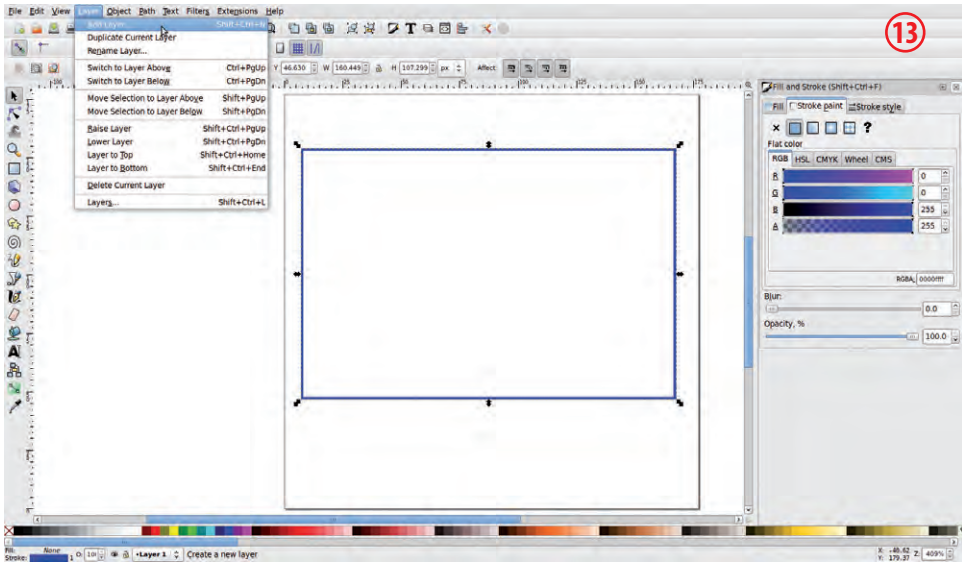
12) click on "Path" --> "Object to Path" (vector). Now the rectangle is a vector graphic.

Attention:
The rectangle must be selected (marked).

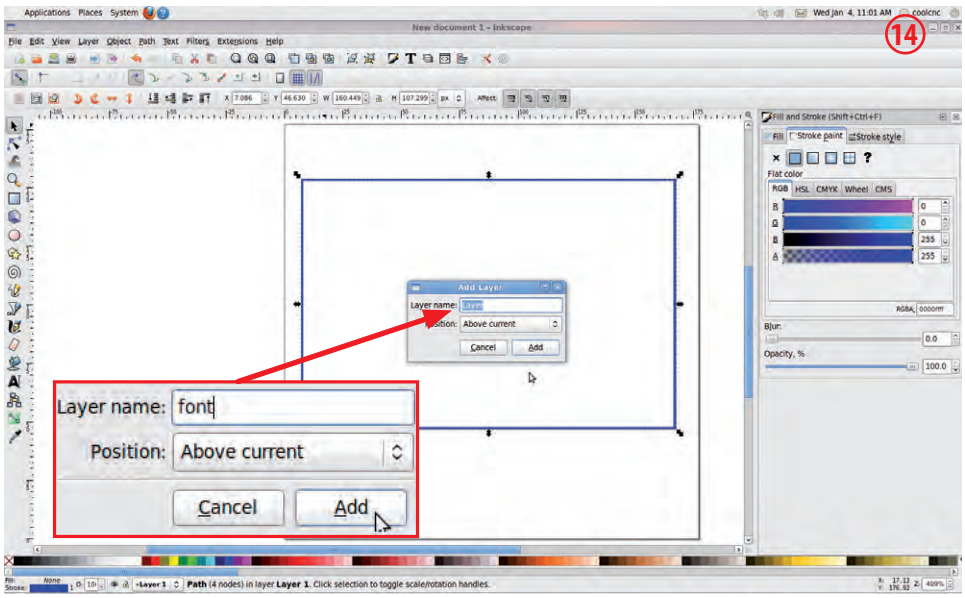


Create a new layer for the labeling:

13) click on “Layer” --> “Add Layer”.

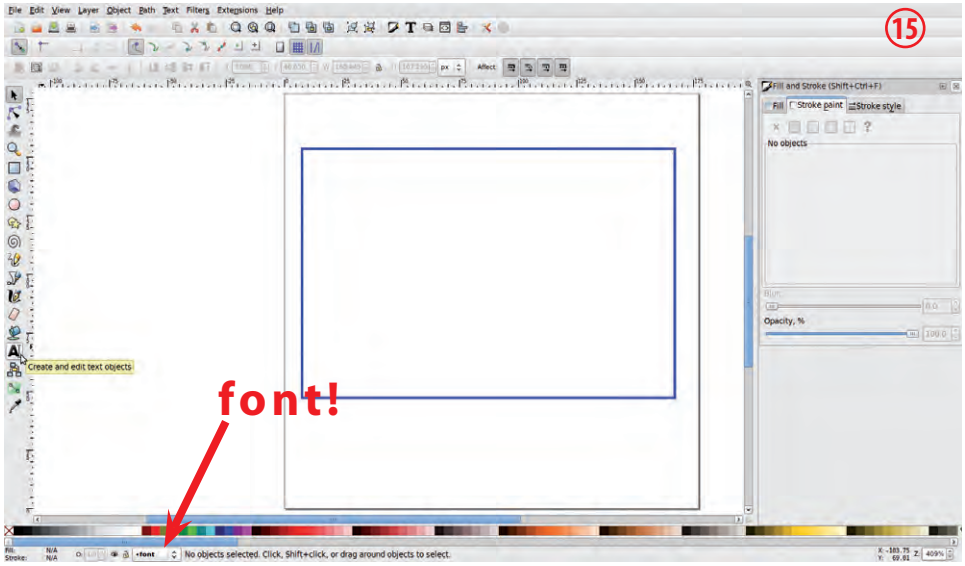


14) enter following name for the layer “font”, then click on “Add”.



15) click on “A” icon “Create and edit text objects”.

Attention:
Layer “font” must be activated.

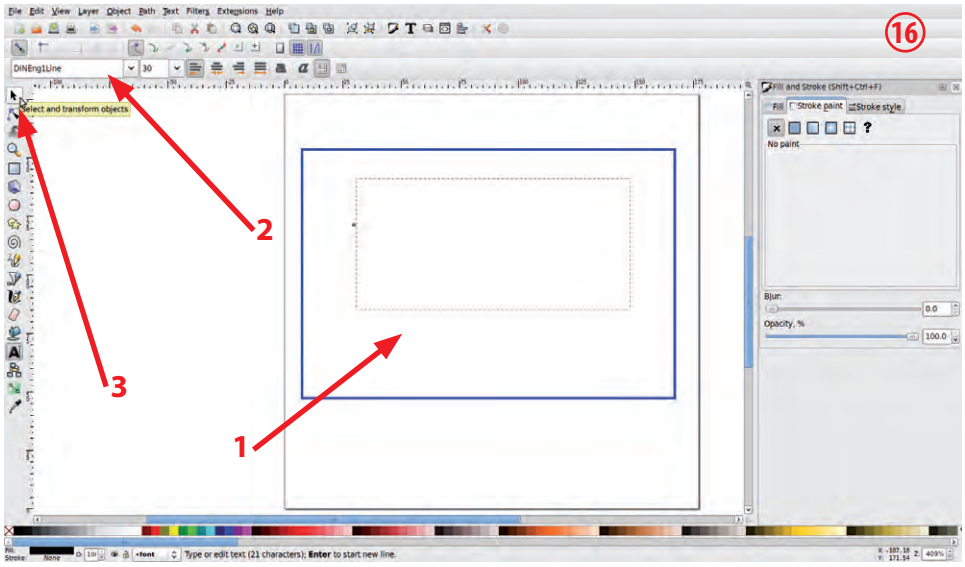


16) click into the blue rectangle, then select a (Single Line Fonts) - for example "DINEng1Line". Write your text - for example:

The Cool Tool

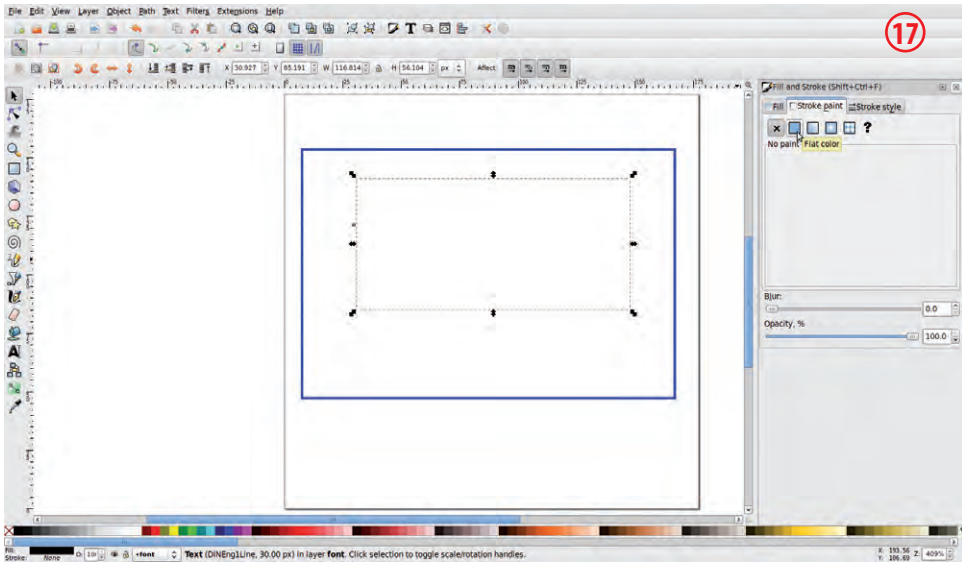
CoolCNC

After that click on the arrow icon "Select and transform objects".

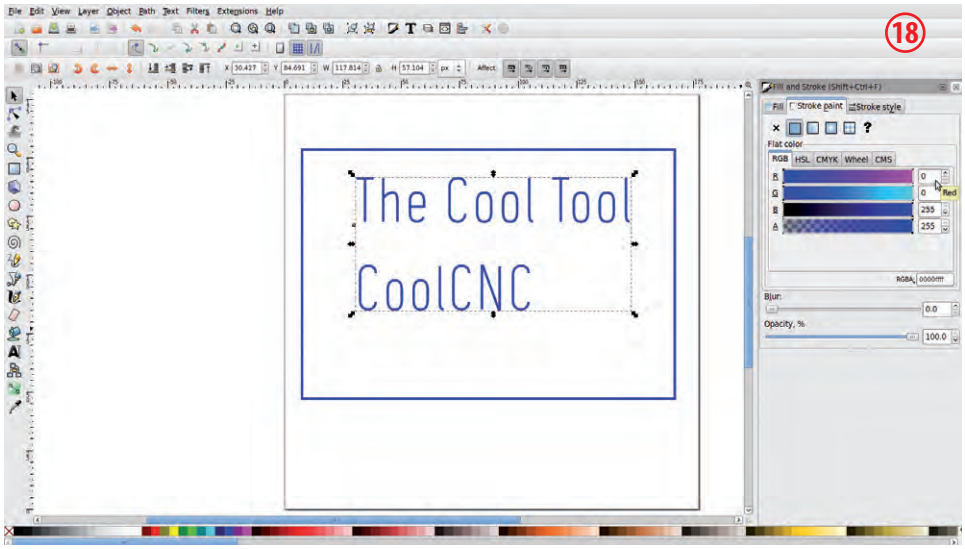


17) click on "Stroke paint" --> "Flat color".

Attention:
The text field must be activated (marked).

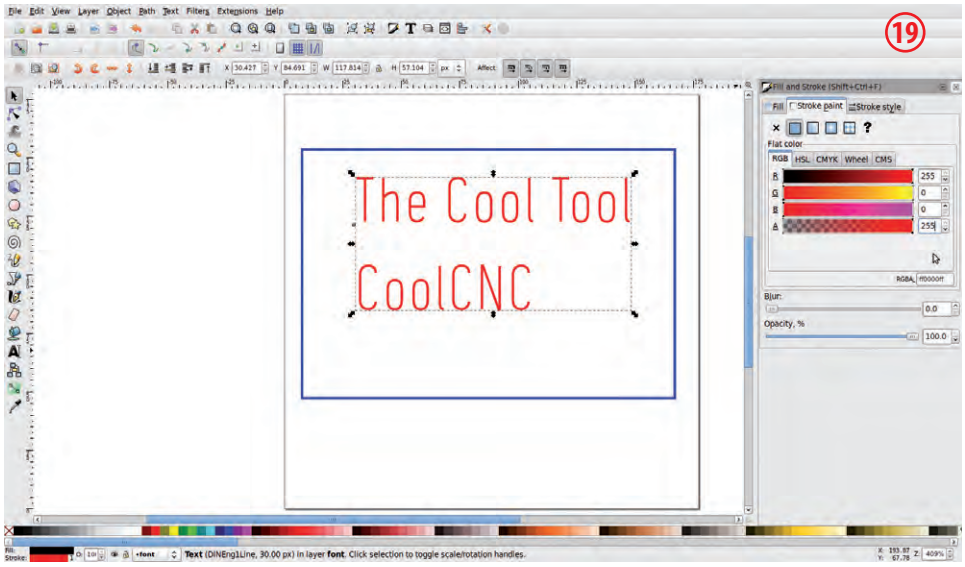


18) click on "red"



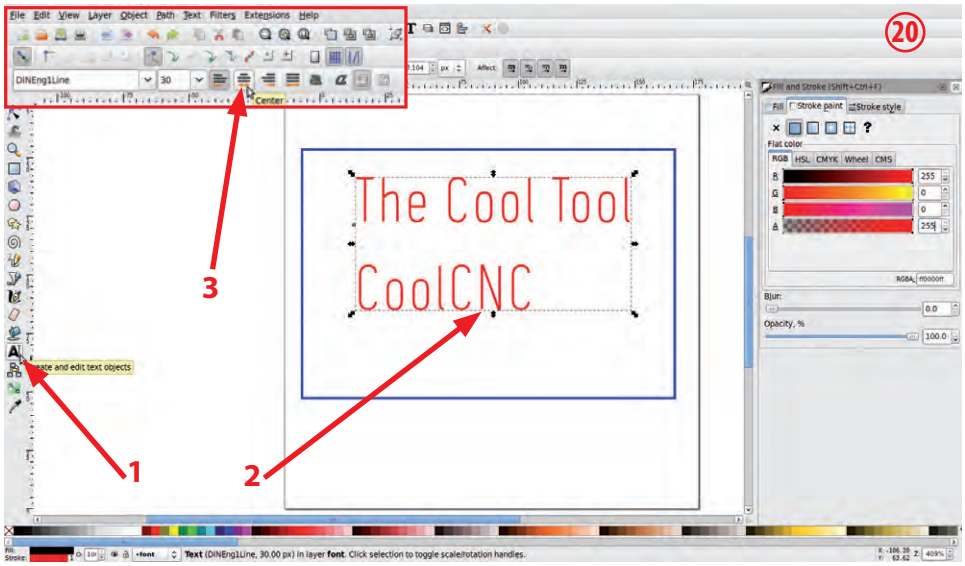
19) enter "255" then click on "blue" and change value to "0" and press "Enter".

Attention:
The text field must be activated (marked).

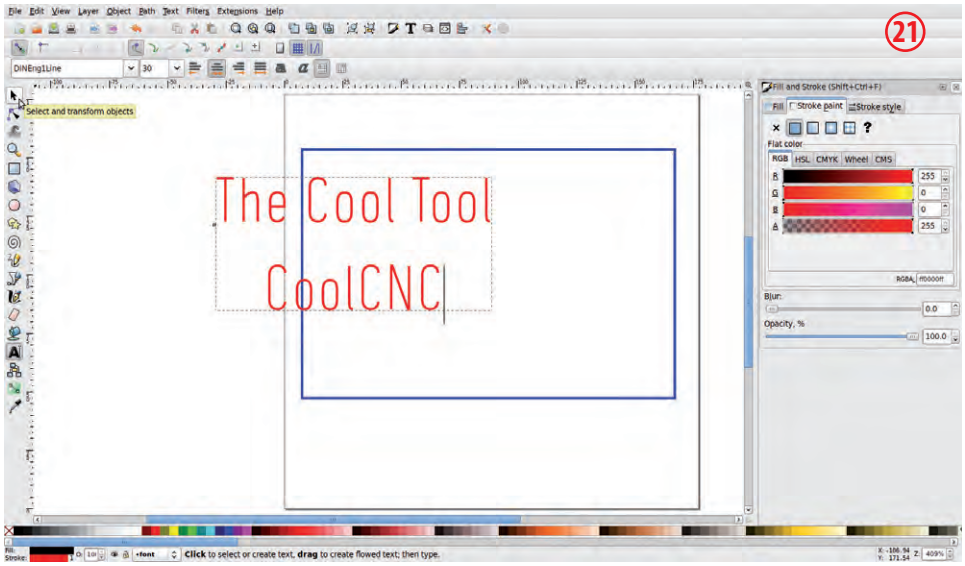


20) click on "A" icon "Create and edit text objects", then click into the text field (The Cool Tool ....).

After that click on "Center".

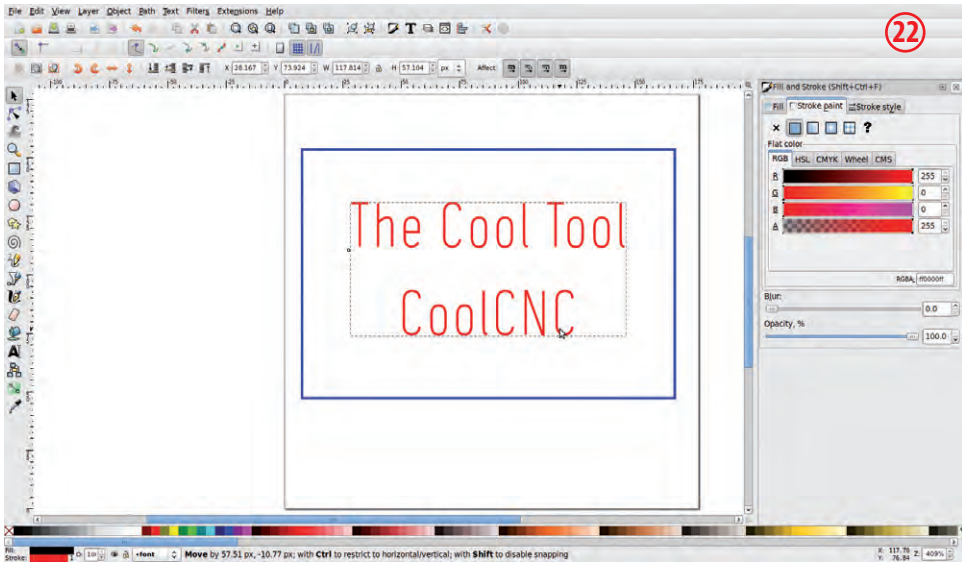


21) click on the arrow icon "Select and transform objects".



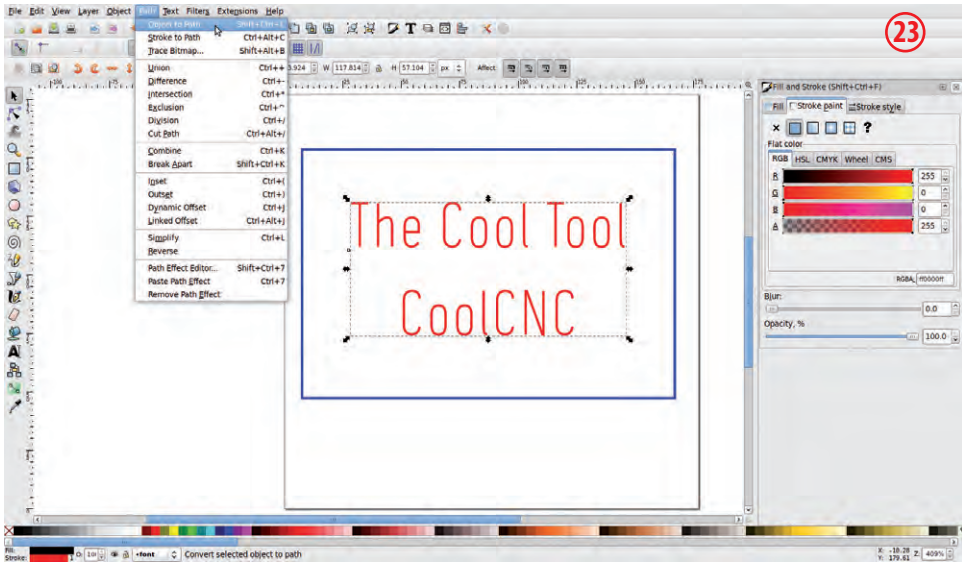
22) select the text field and place it in the middle of the blue rectangle.

Attention:
Please take care that the blue rectangle is at the center of the raw material. If it is not at the center, select the blue rectangle and the text field and place it again.



23) click on "Path" --> "Object to Path" (vector). Now the font is converted to a vector graphic.

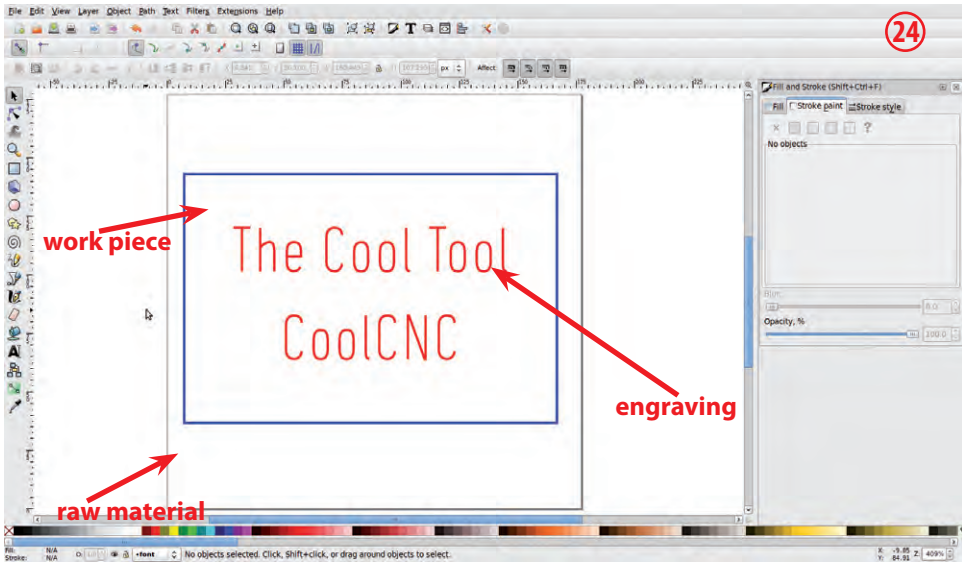
Attention:
The text field must be activated (marked).



24) Why two layers?
For each cutting depth you need a separate layer. Here we have two different depths:

1) red text: 1.0 mm (engraving)

2) blue rectangle: 4.5 mm
(raw material 4.0 mm - acrylic)

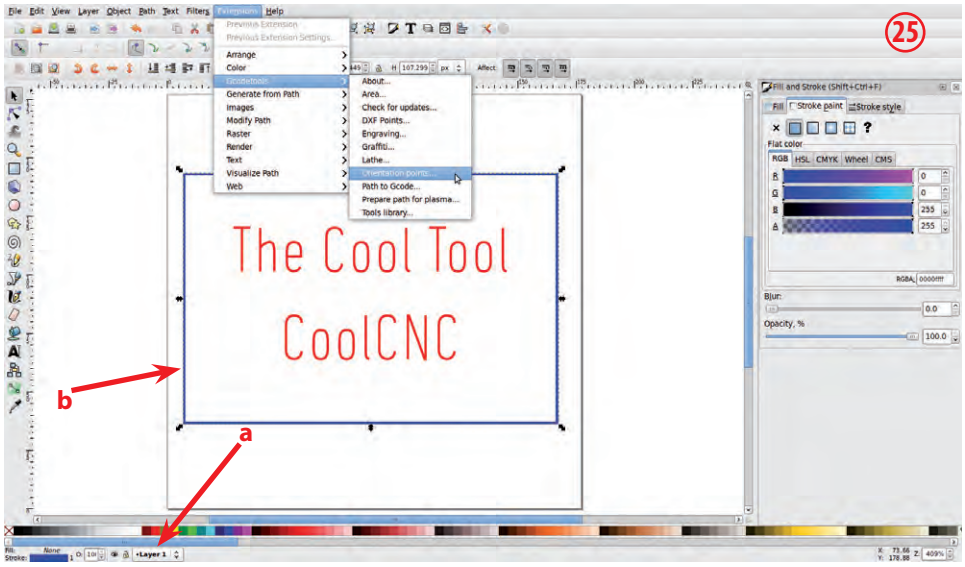


Gcode Tools®

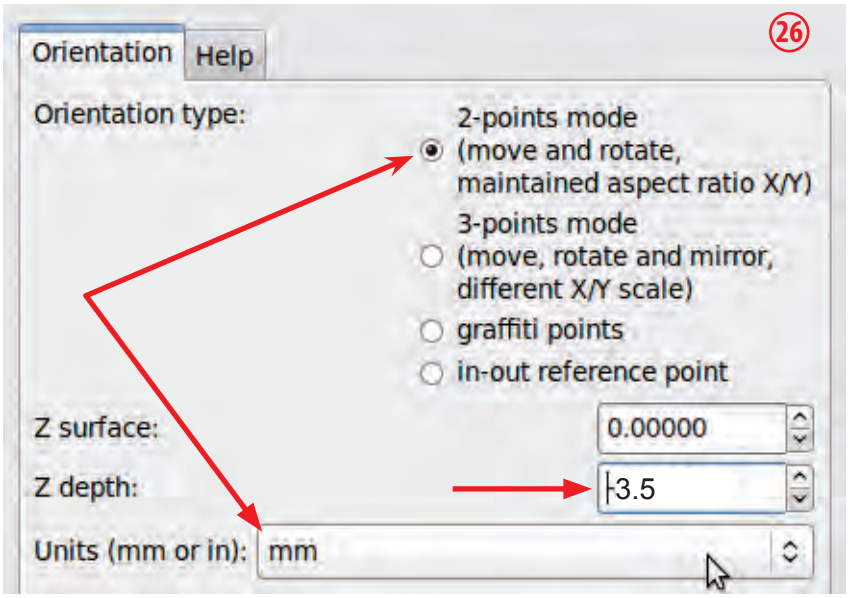
25) Orientation points
(zero point for the blue rectangle)

click on "Extensions" --> "Gcodetools" --> "Orientation points ..."

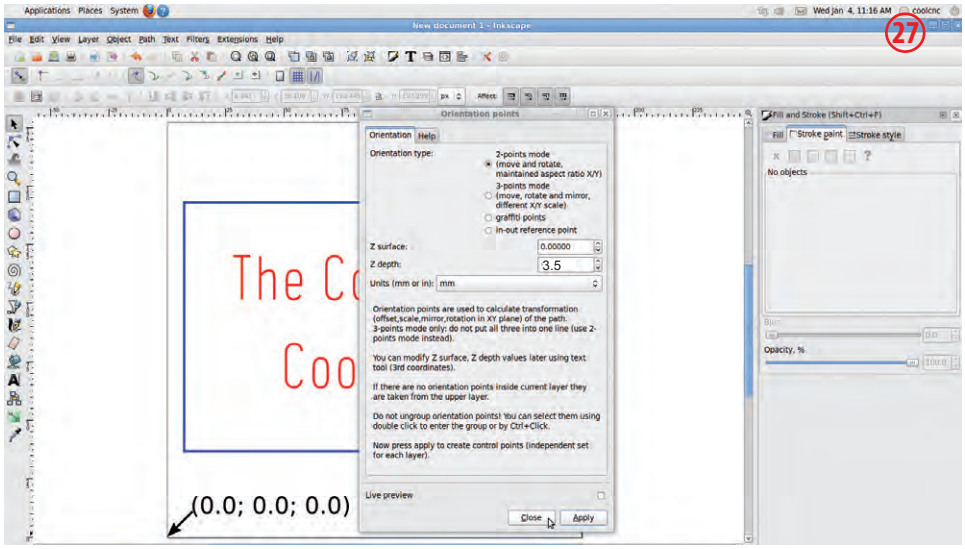
Attention:
a) layer "Layer 1" must be activated.
b) blue rectangle must be selected.



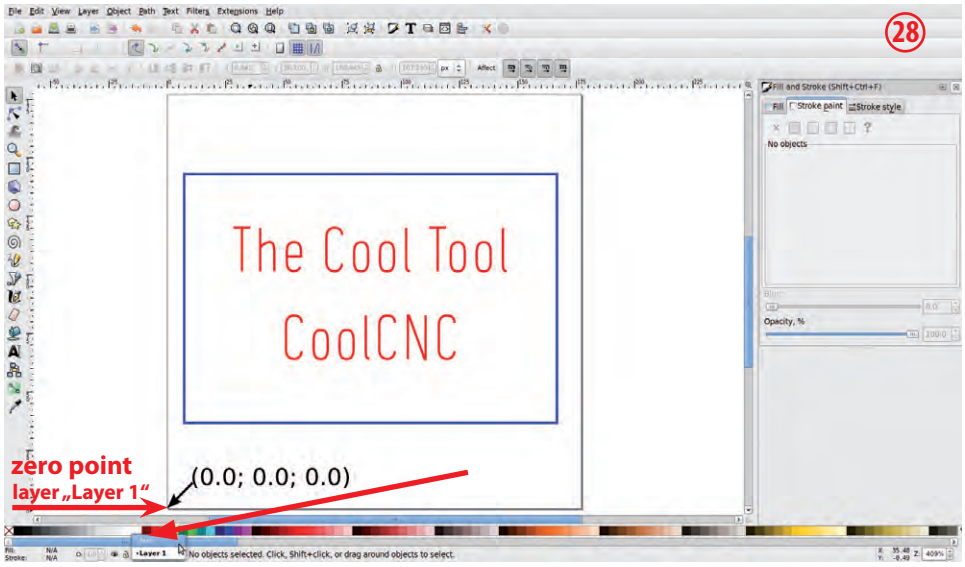
26) select "2-points mode" and "mm". enter at "z depth" "-3.5".
Attention:
"z surface" remains "0.0".



27) click on "Apply" and then "Close"



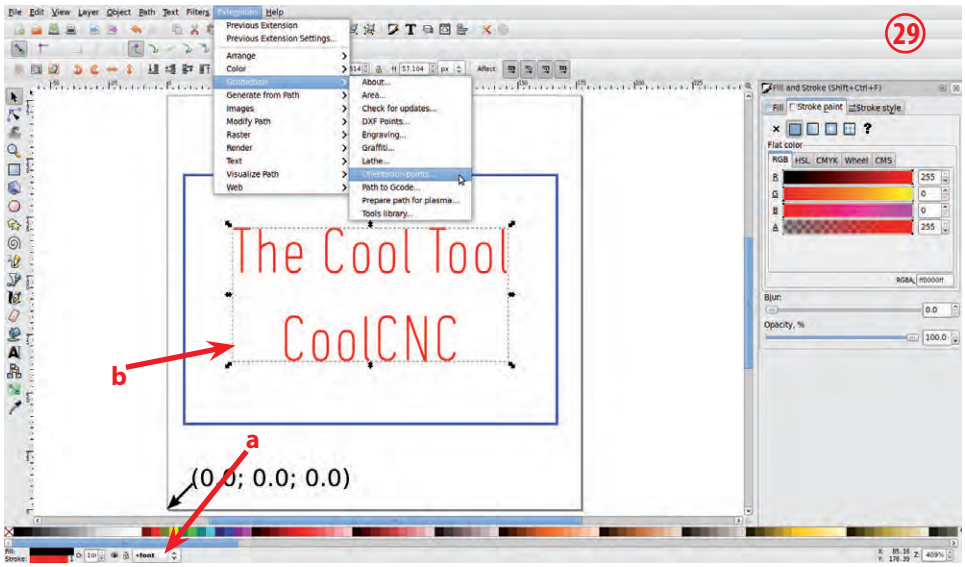
28) select the layer "font"



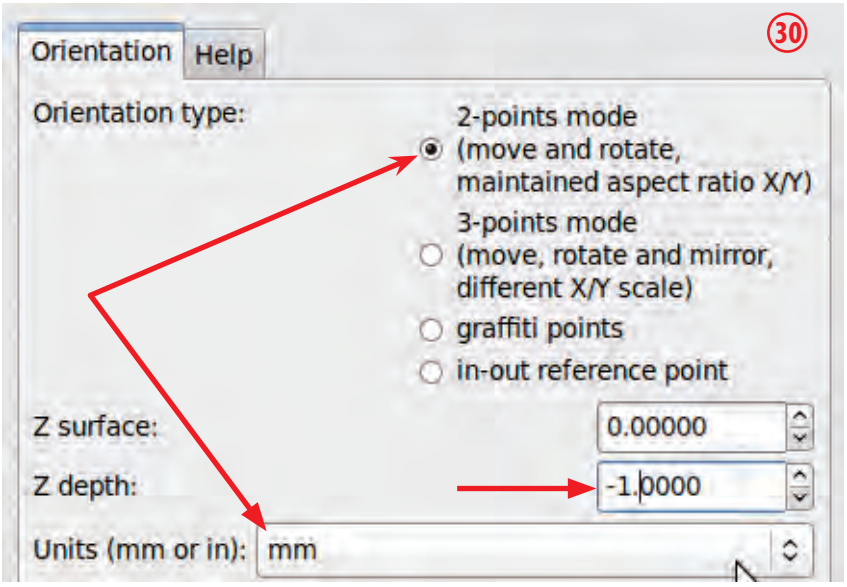
29) Orientation points
(zero point for the red text)

click on "Extensions" --> "Gco-detools" --> "Orientation points ..."

Attention:
a) layer "font" must be activated.
b) red text must be selected.

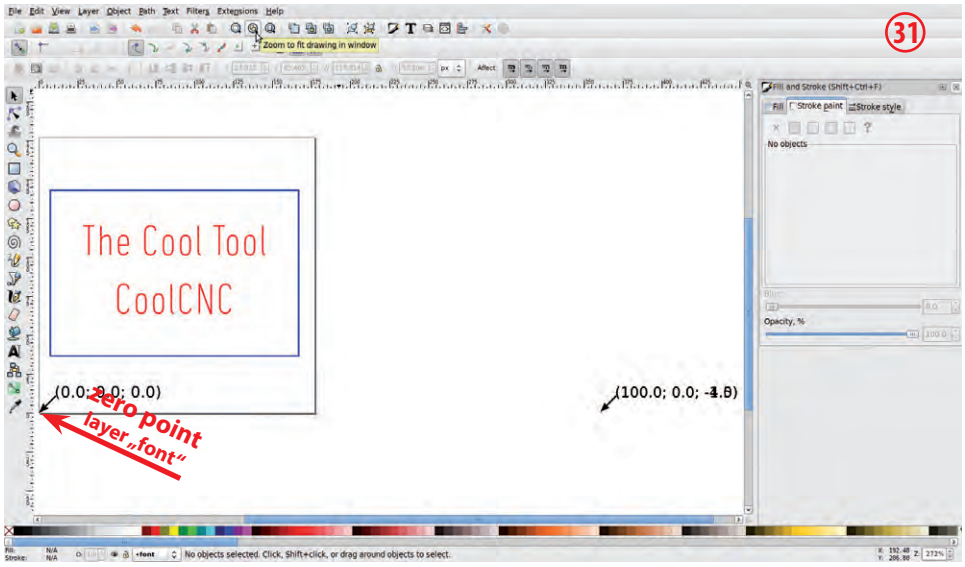


30) select "2-points mode" and "mm". enter at "z depth" "-1.0".
Attention:
"z surface" remains "0.0".

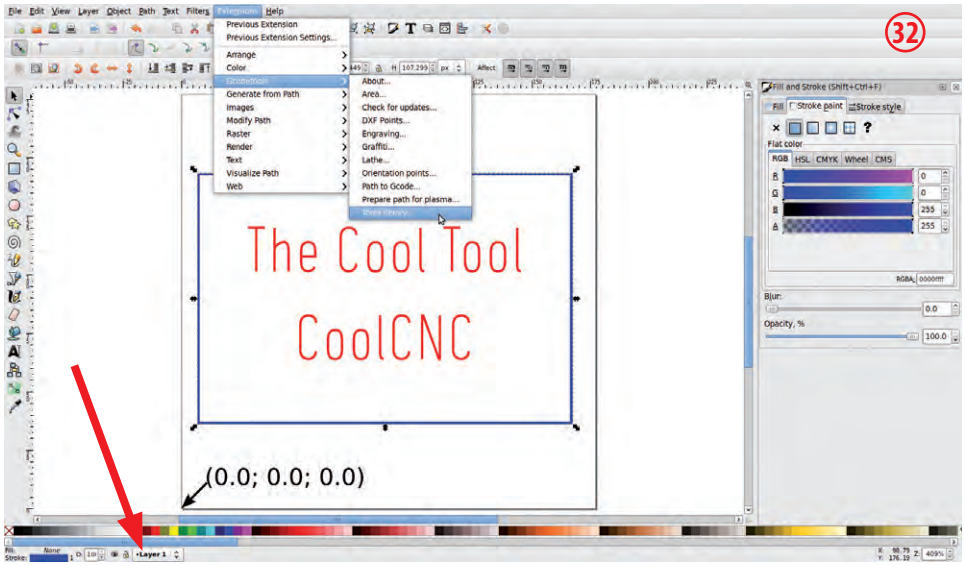


31) The position of the zero point for layer "Layer 1" and layer "font" is the same (congruent).

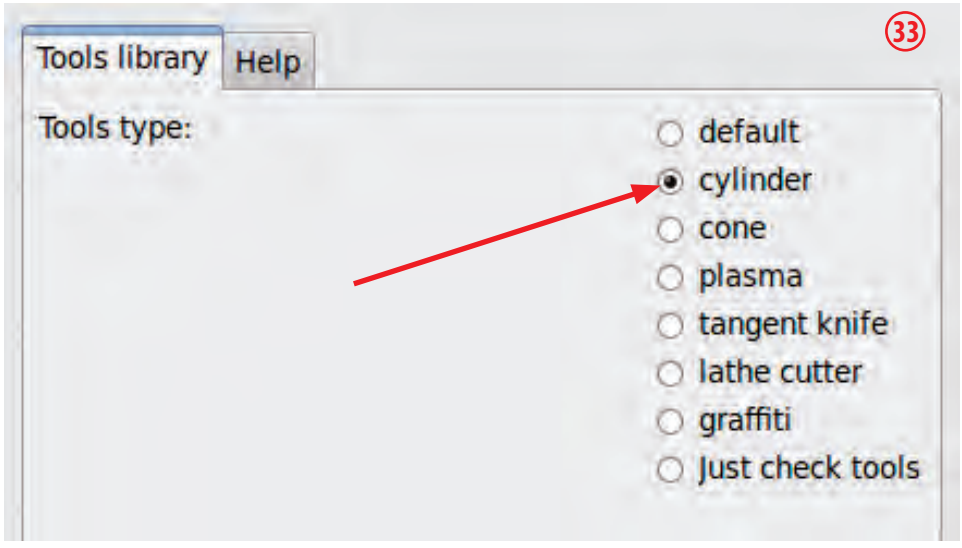
Attention:
Do not move this point!



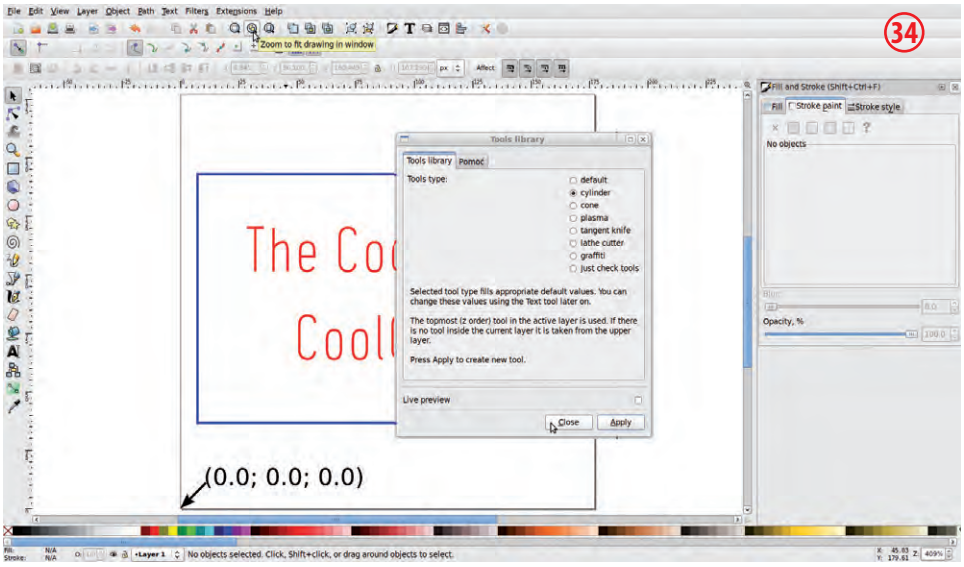
32) Tools library
activate "Layer 1" and select the blue rectangle (marked), then click on "Extensions" --> "Gcodetools" --> "Tools library"



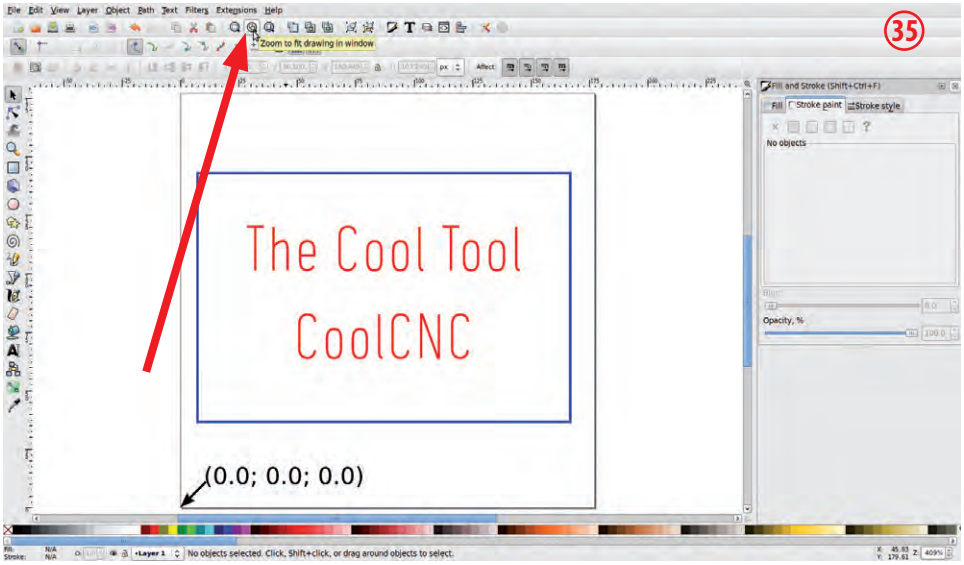
33) select "cylinder"



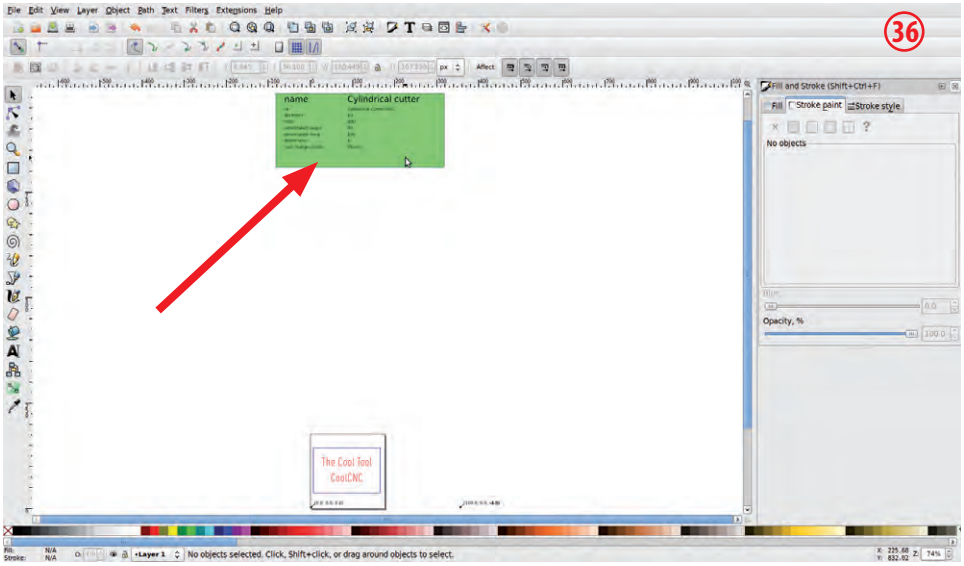
4) click on "Apply" then close the window - click on "Close"



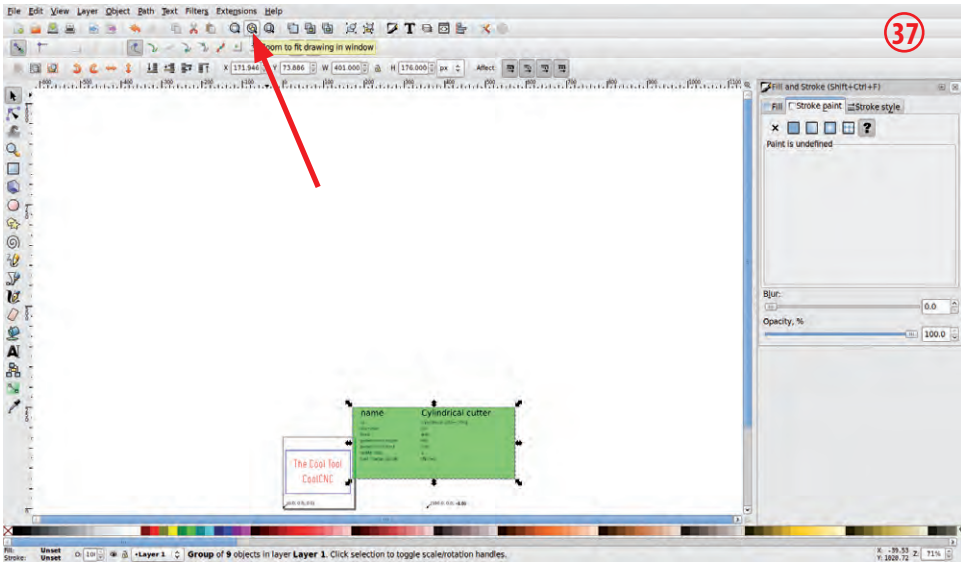
2) click on the magnifier icon "Zoom to fit drawing in window"



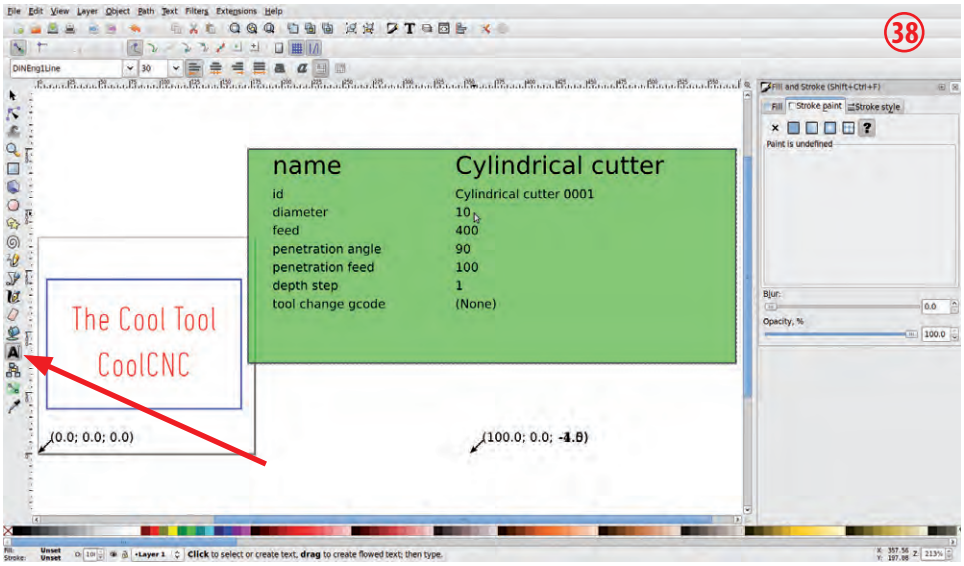
36) now you can see the "Tool window" for "Layer 1".



37) place the "Tool window" near the blue rectangle, then click on the magnifier icon (Zoom to fit drawing in window).

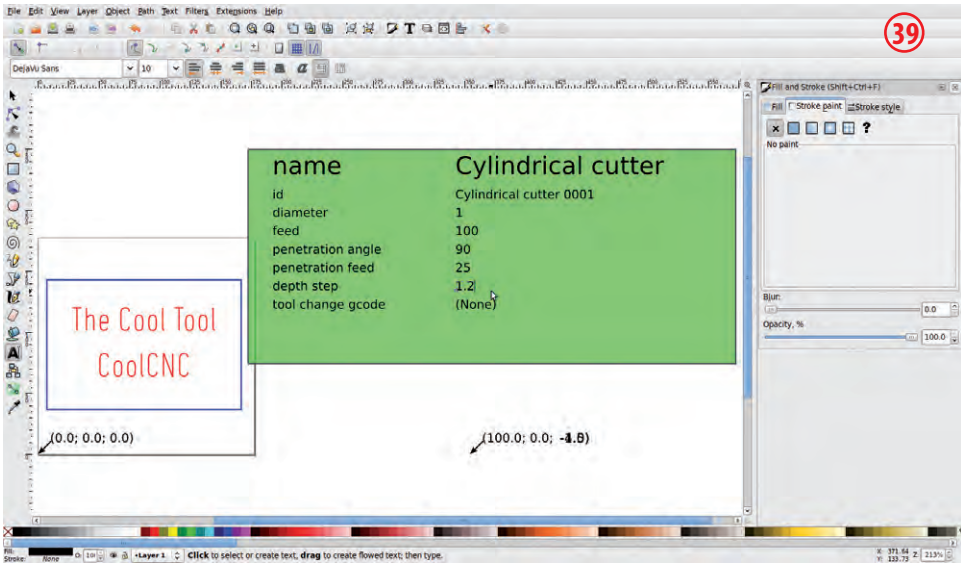


38) click on the "A" icon (Create and edit text objects)

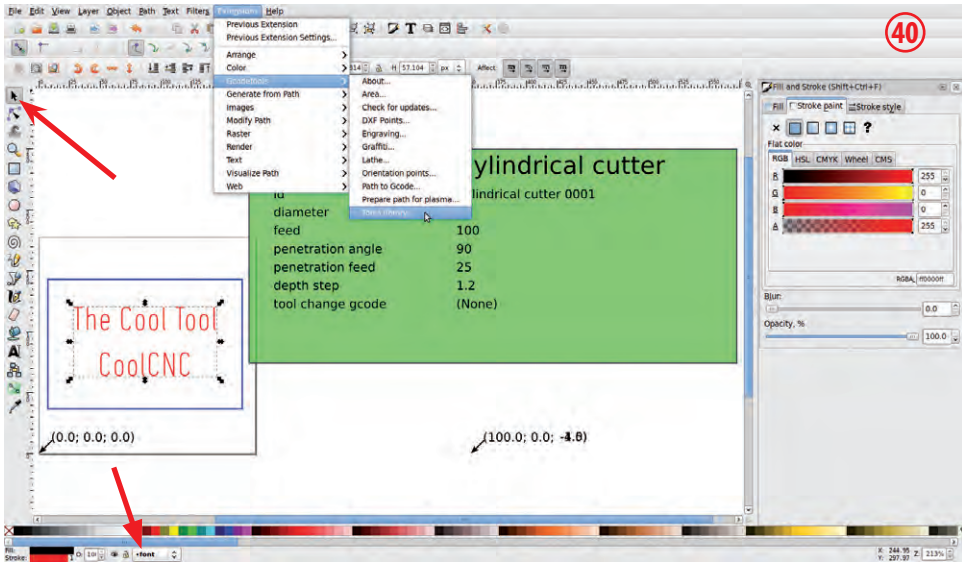


39) edit the following parameters in the "tool window:

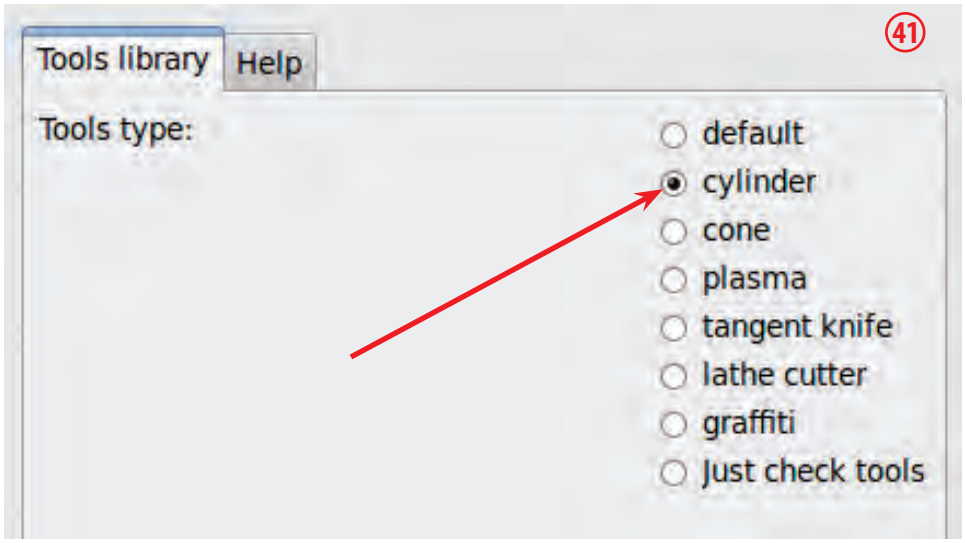
diameter = 1
feed = 100
penetration feed = 25
depth step = 1.2



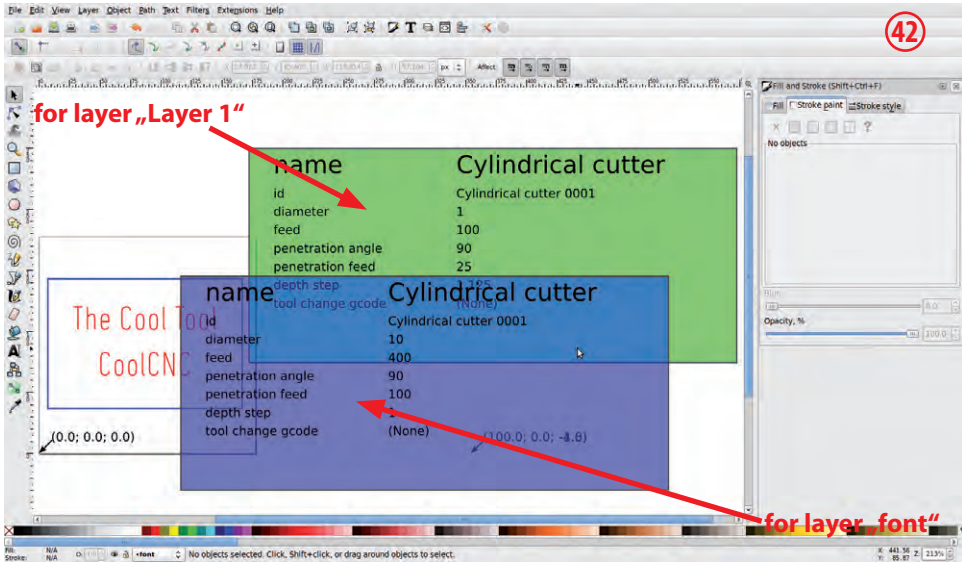
40) activate layer "font" and select the red text (marked), then click on "Extensions" --> "Gcodetools" --> "Tools library"



41) select "cylinder" and click on "Apply" then close the window - click on "Close".

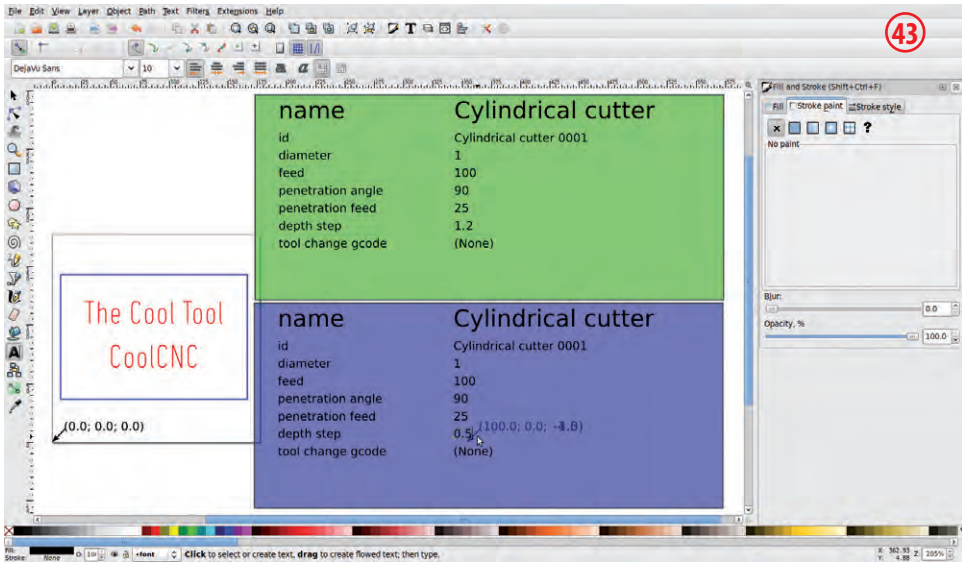


42) the new "Tool window" (window for layer "font") is magenta.

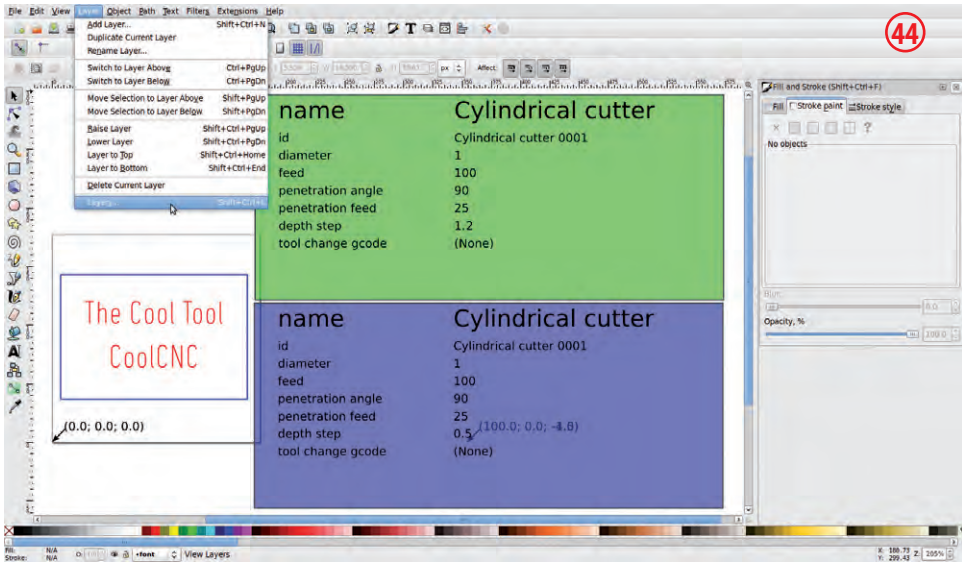


43) click on the "A" icon (Create and edit text objects) and edit following parameters:

diameter = 1
feed = 100
penetration feed = 25
depth step = 0.5

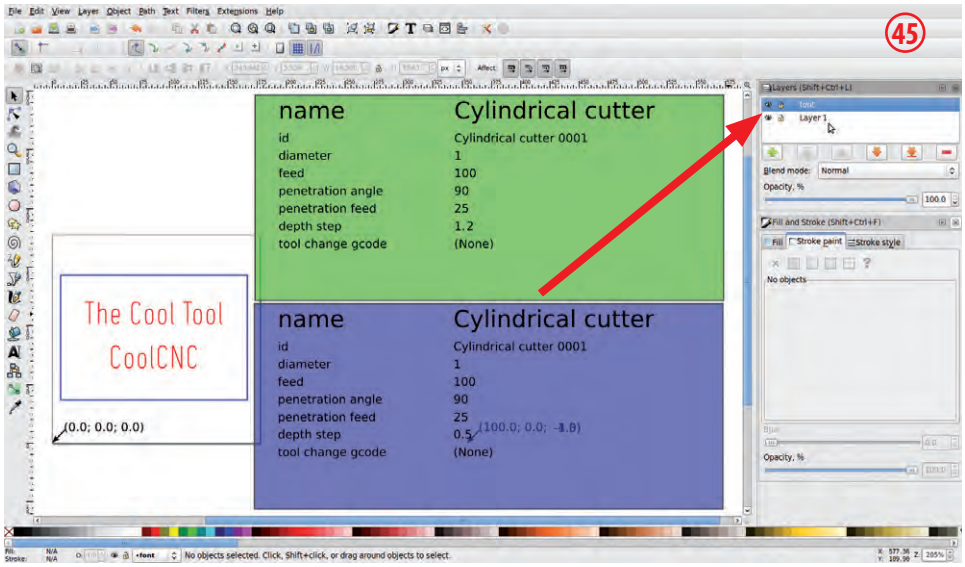


44) check the order of the layers. click on "Layer" --> "Layers ...".

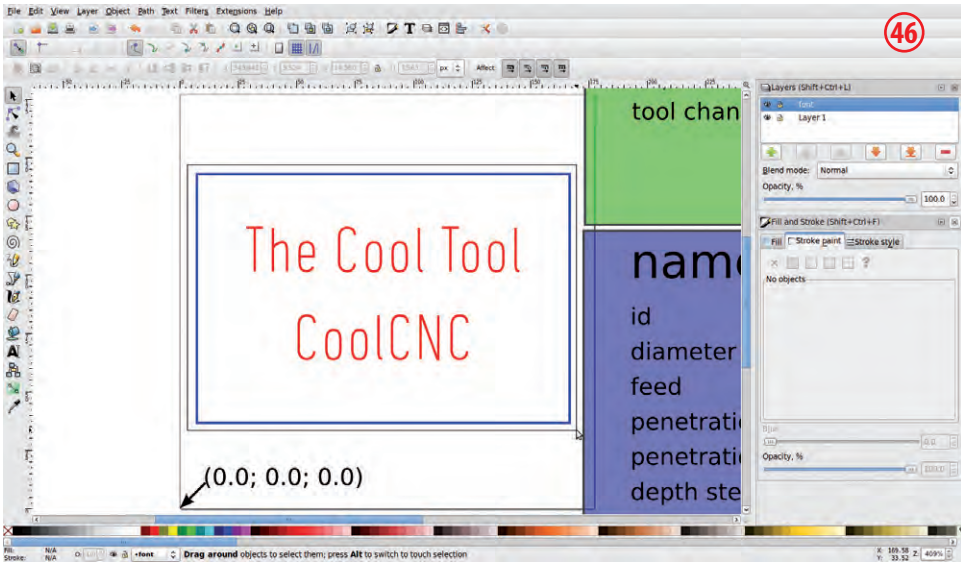


45) correct order: 1) font
2) Layer 1

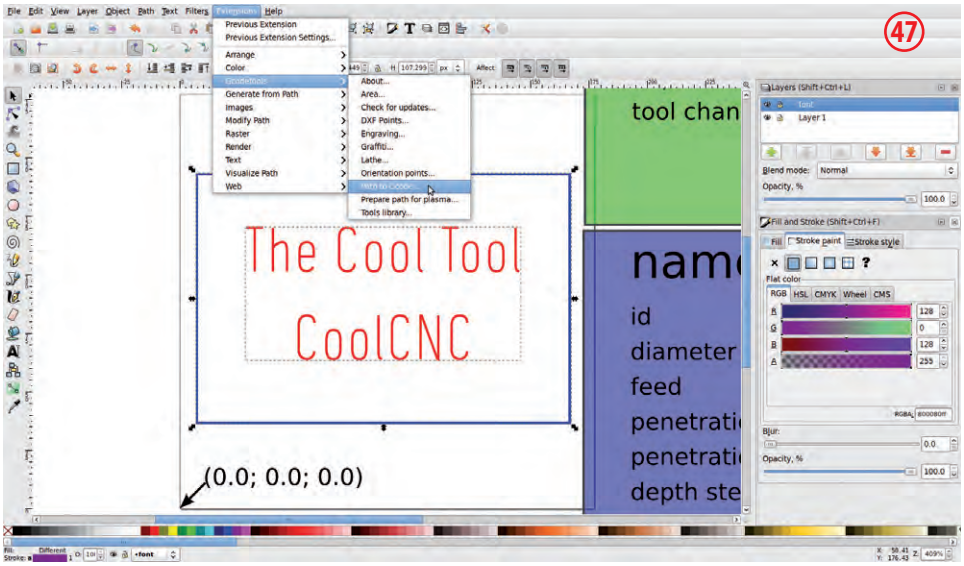
If the order isn't correct, you can change the order. Select one of the two layers and then move it (with the arrows) up or down.



46) click on the arrow icon "Select and transform objects", then select the engraving (red text) and the work piece (blue rectangle).



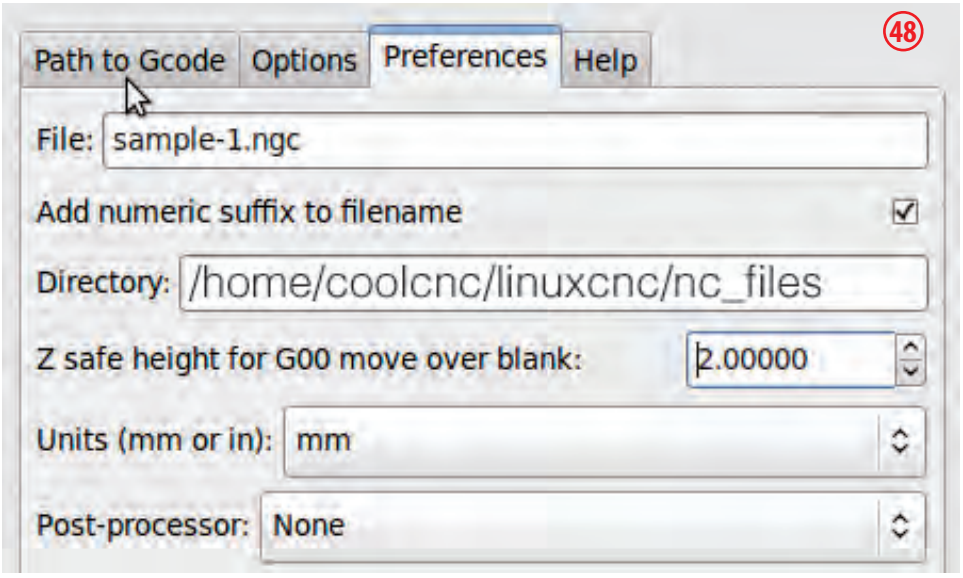
47) click on "Extensions" --> "Gcodetools" --> "Path to Gcode ...".



48) click on "Preferences" and enter following parameters:

File: **sample-1.ngc**
Add numeric..... **"activate"** ☑
Directory: **/home/coolcnc/linuxcnc/nc_files**
("coolcnc" = username)
Z safe height **2.00**
Units **mm**
Post-processor **None**

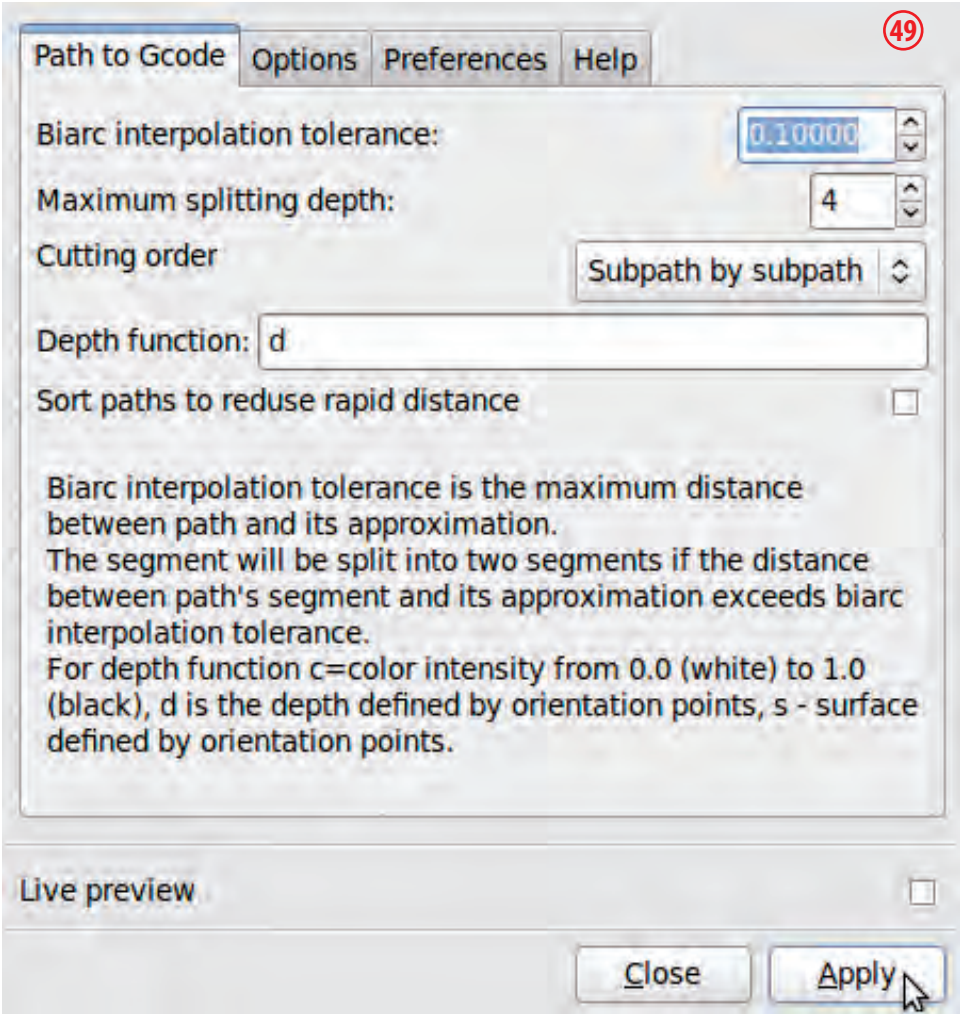
click on "Path to Gcode"!



49) check the parameters:

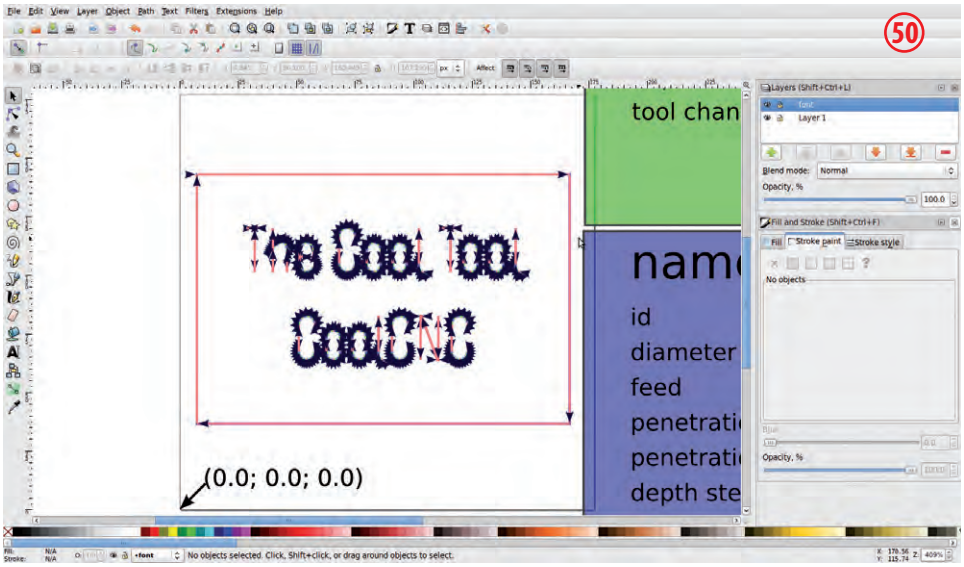
Biarc inter..... **0.100**
Maximum splitting **4**
Cutting order
subpath by subpath
Depth funktion: **d**

click on "Apply" and then close the window- click on "Close"!



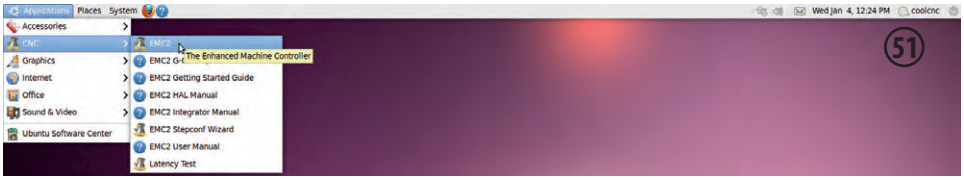
50) finished!

Now you can save the Inkscape file (click on "File" --> "Save") , after that you can close Inkscape®.

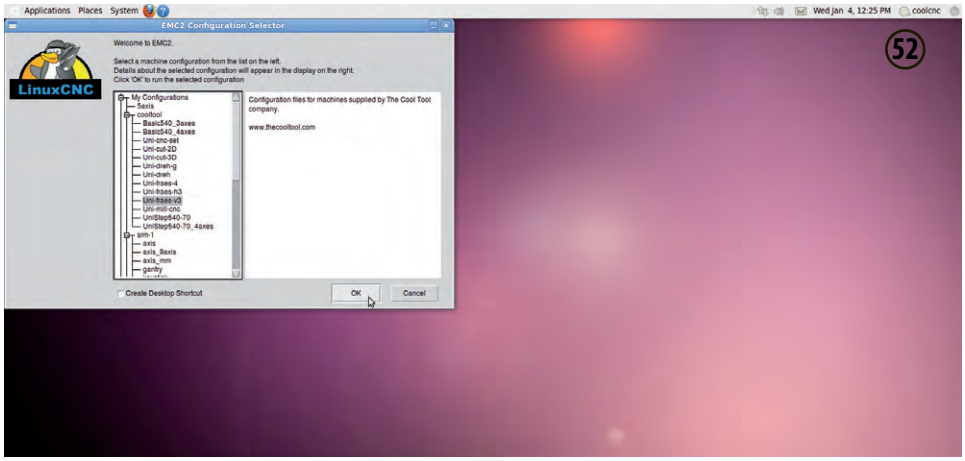


51) start LinuxCNC®

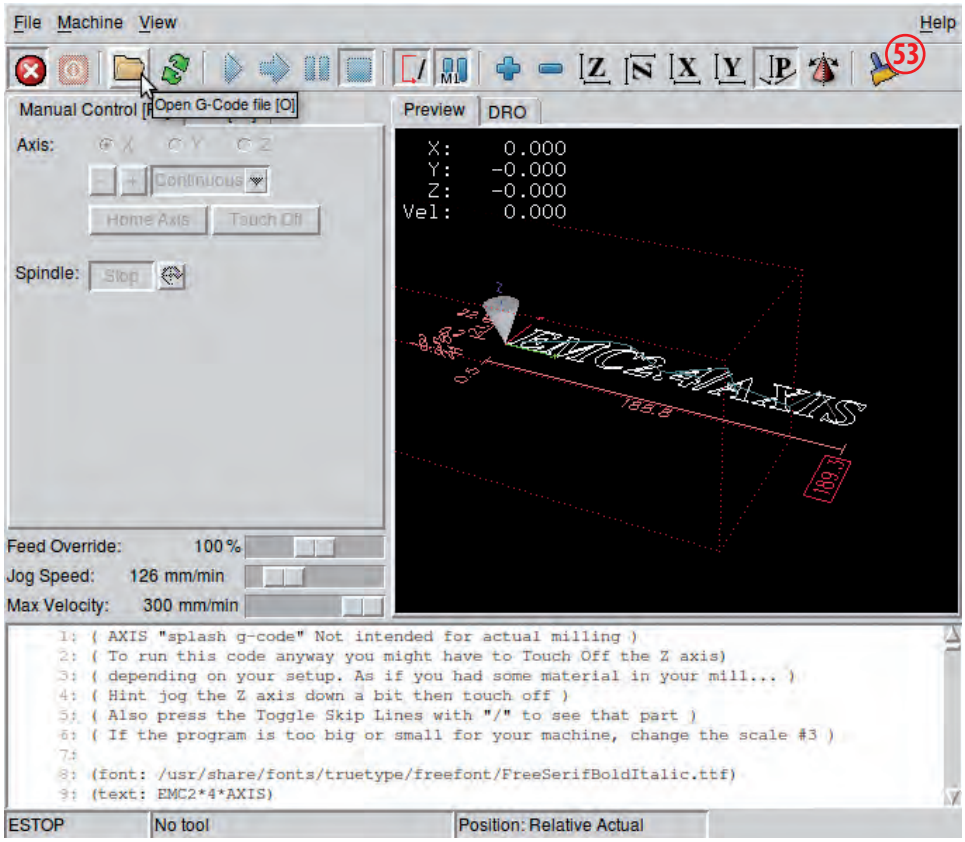
click on "Applications" --> "CNC" --> "LinuxCNC".



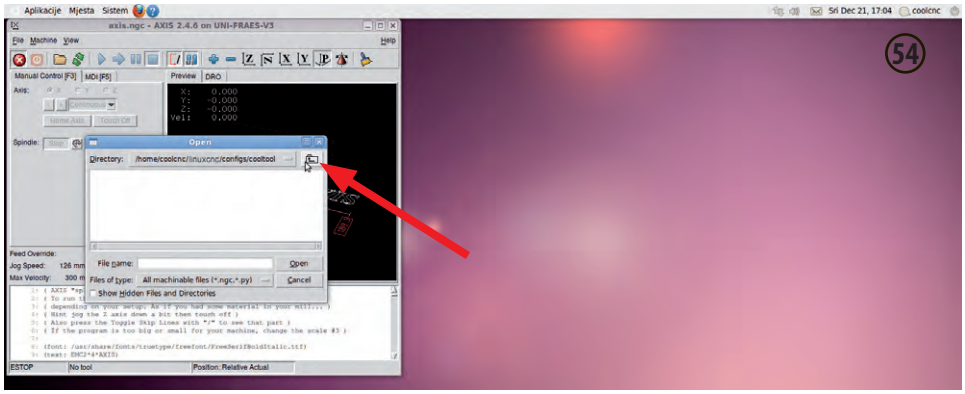
52) select "UNI-FRAES-V3" and click "OK"



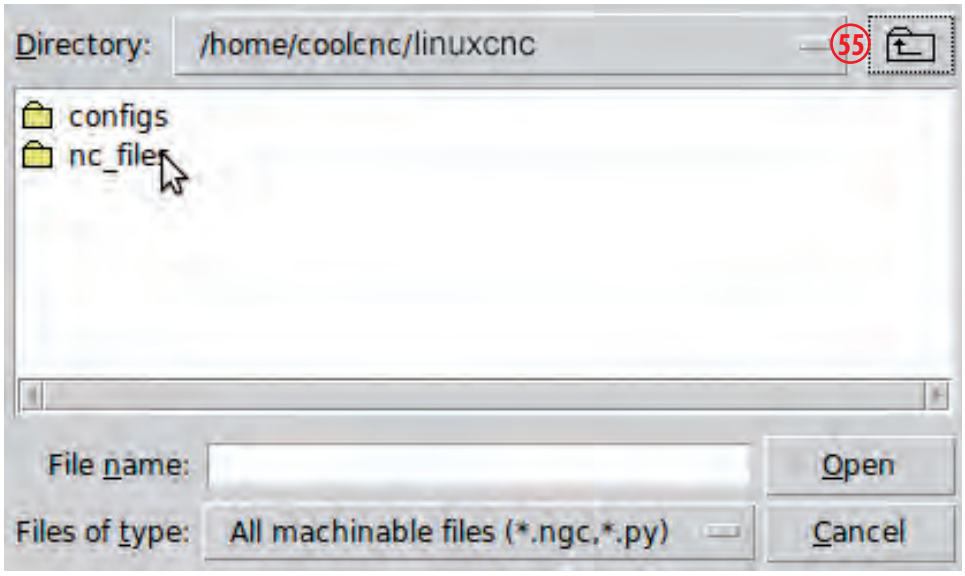
53) click on "Open G-Code file".



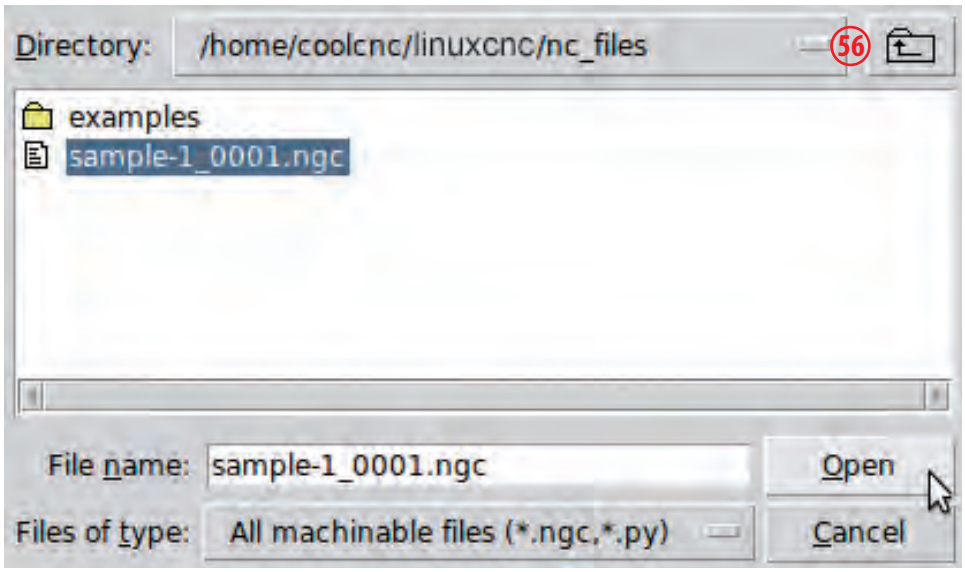
54) click two times on the icon (one directory up).



55) double click on "nc_files".



56) select "sample-1_0001.ngc" and click "Open".



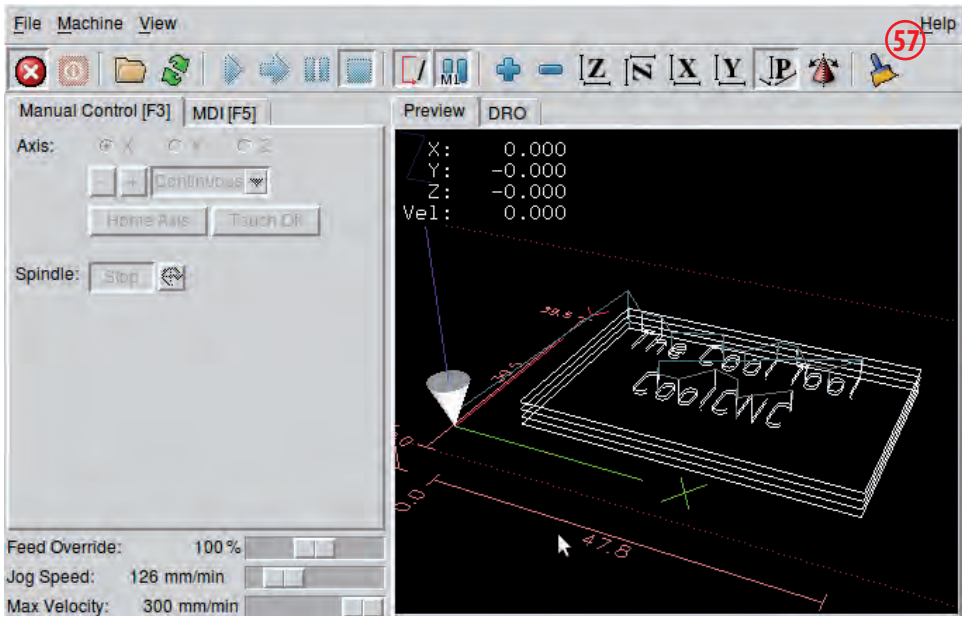
57) simulation:

Attention: The controller (Lin-Contr) must be turned off.

click on "Machine" --> "Toggle Emergency Stop" or "F1" and then "Machine" --> Toggle Machine Power" or "F2".

select "X" and click on "Home Axis" - make the same for "Axis" Y and Z.

click on the icon "Begin executing current file"

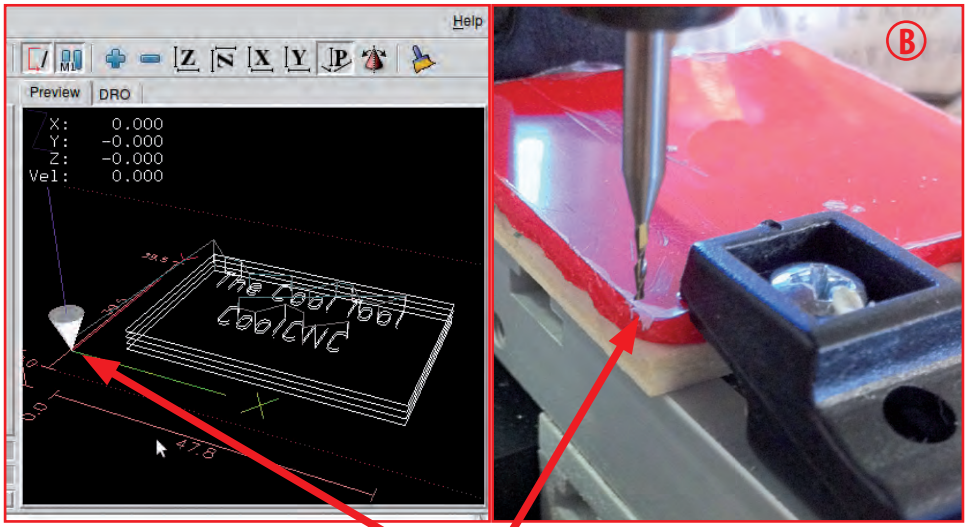


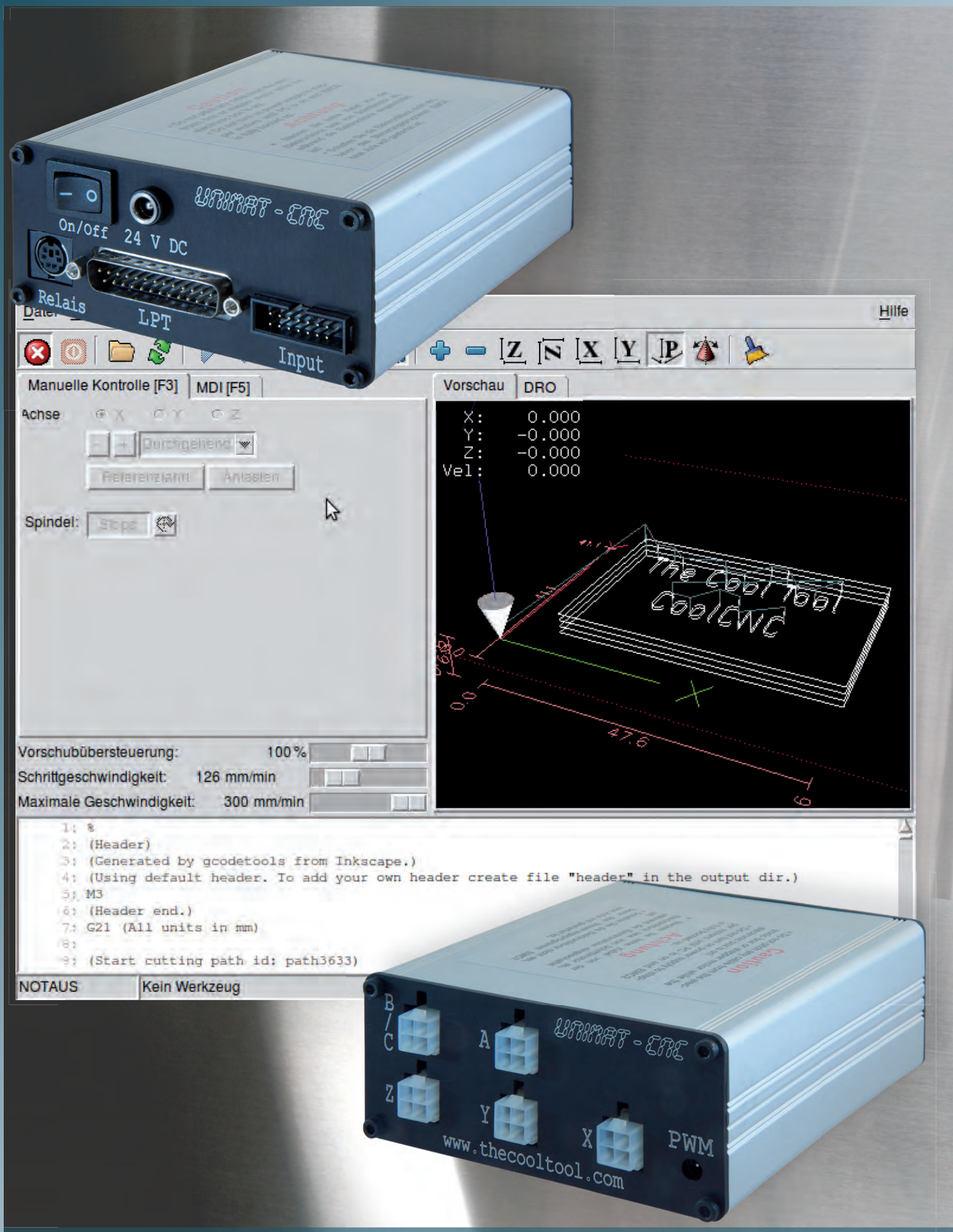
Sample 1 - milling

A) mount the raw material on the machine.

3x slot nut (U46)
3x M4x12 (U69)
3x clamping jaw (U49)
1x plywood 4 mm
1x acrylic 4 mm

B) zero point for the Z axis is the material surface (acrylic).





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