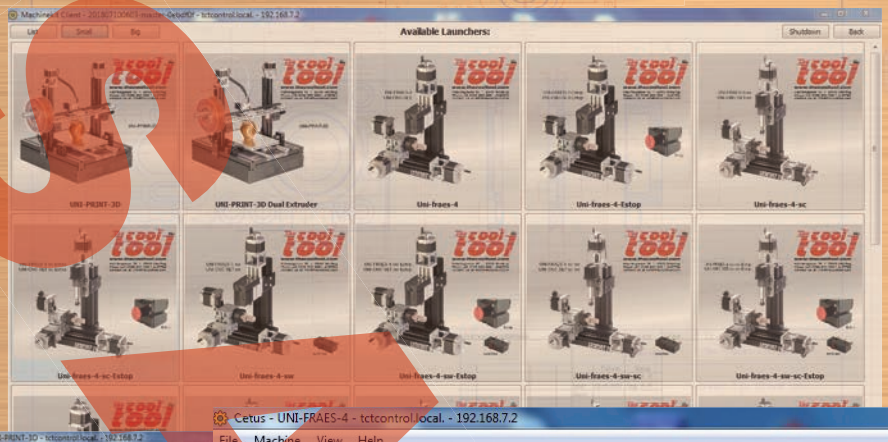
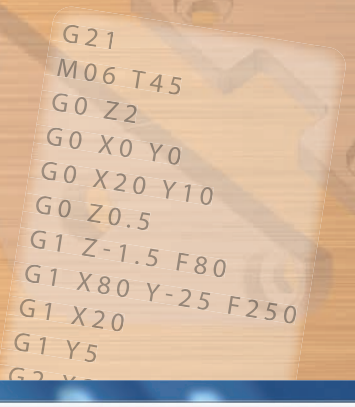
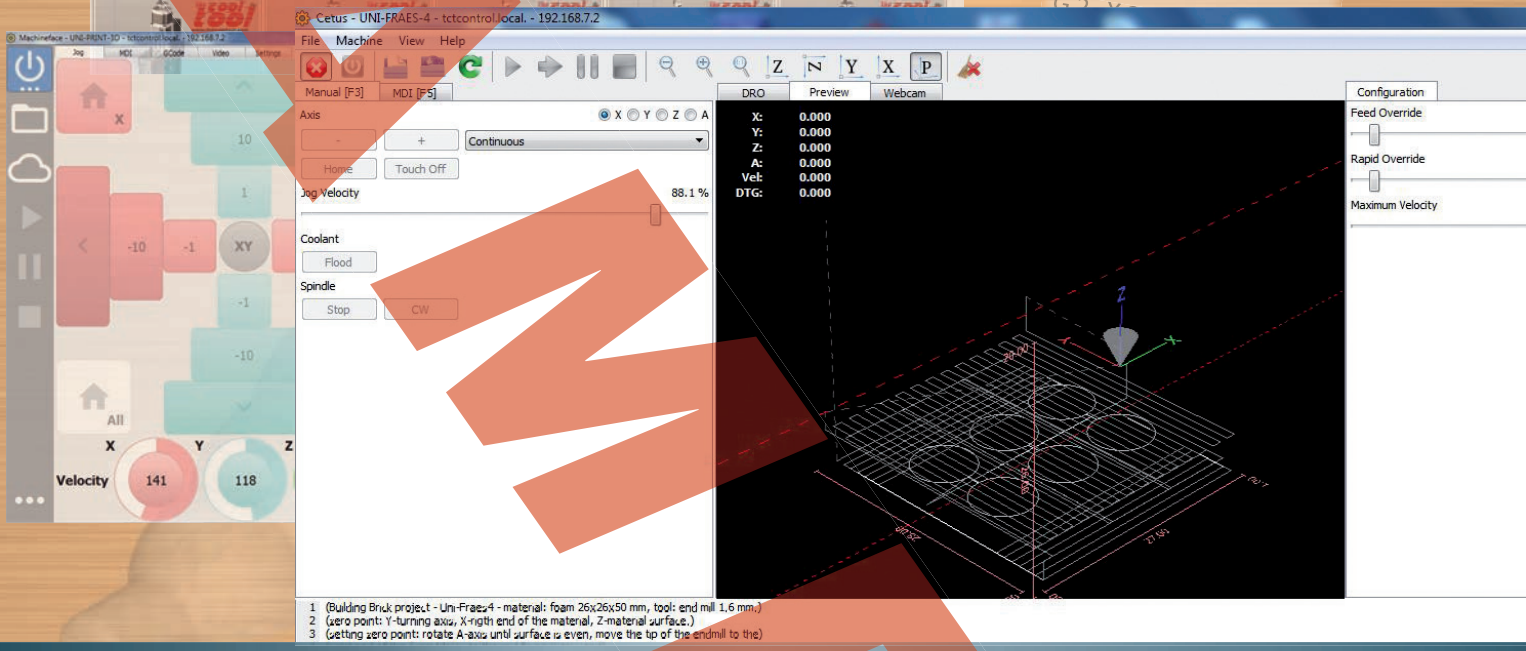
The tool 1981 Education







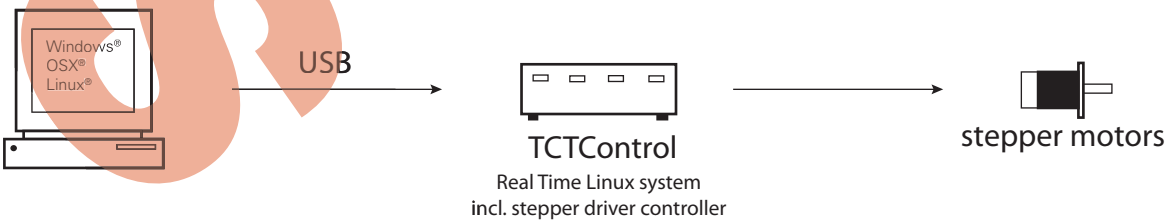
[TVET-CNC-1]

The tool 1981 GmbH est. 1982 QUALITY PRODUCT MADE IN AUSTRIA

The cool tool CNC control systems

TCTControl - CNC machines •
SandyBox - stepper driver controller - CNC machines

TCTControl - [current solution]



Functions of PC:

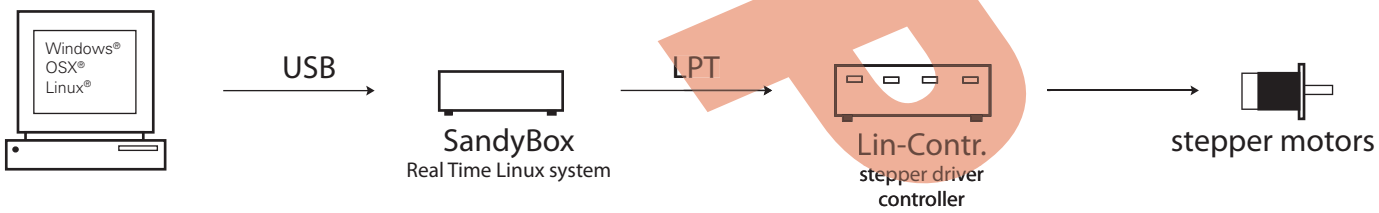
1) User interface (type your own G-Code or open G-Code files)

2) „Manual" control of the machine

TCTControl box:

Control electronics including motion control and pre-installed CNC software
Technical Specifications: Client and drivers included for
Win (7, 8, 10), OSX, Linux
Number of Axes controllable: 4 (upgradeable to 6)
IOs: 6x input for (limit/end) switches, 1x E-stop, 2x relays, 0-10V control signal
Board: 1GHz CPU, 512MB DDR3 RAM, 4GB storage
Power supply: External, 110-240 V, 24 V, 5 A
Connectivity: USB, Ethernet, WiFi (optional)
File types: ISO G-Code RS-274, DIN 66025
Tool path simulation mode: available

SandyBoy - Lin-Contr. - [previous solution]



Functions of PC:

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

2) „Manual" control of the machine

SandyBox:

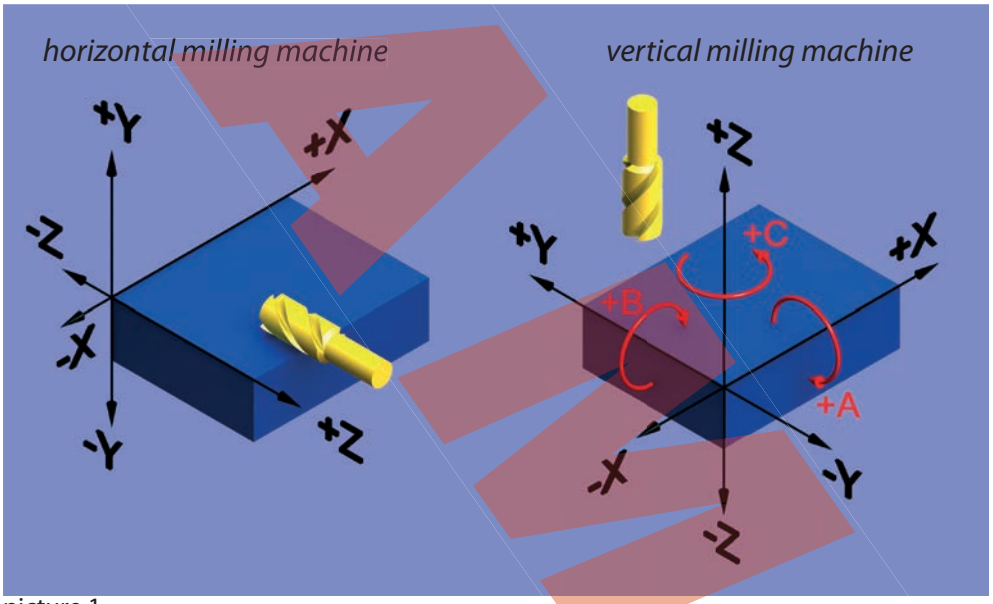
Motion control with pre-installed CNC software, Technical Specifications:
Client and drivers included for Win (7, 8, 10), OSX, Linux
Board: 1GHz CPU, 512MB DDR3 RAM, 4GB storage
Connectivity: USB, Ethernet, WiFi (optional)

Lin-Contr.:

Number of Axes controllable: 3 or 5
IOs: 5x input, 1x relays, 0-10V control signal
Power supply: External, 110-240 V, 24 V, 2 A
File types: ISO G-Code RS-274, DIN 66025
Tool path simulation mode: available

Coordinate systems of NC machines

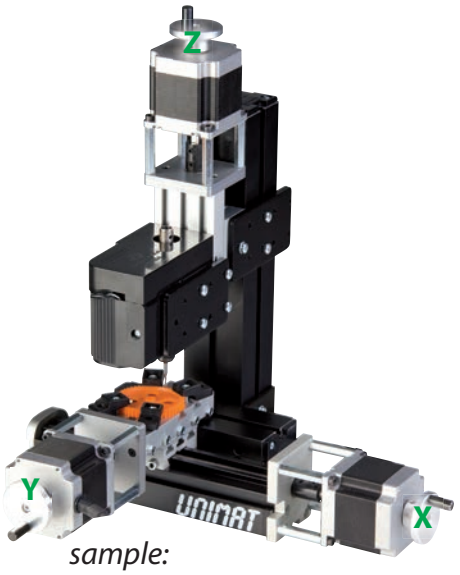
The Cartesian coordinate system refers to the work piece. The axis of the head spindle is Z.
Thereby we get different coordinate systems for Vertical-, Horizontal milling machines and turning machines.
Here you can see the coordinate system of a vertical- and horizontal milling machine.



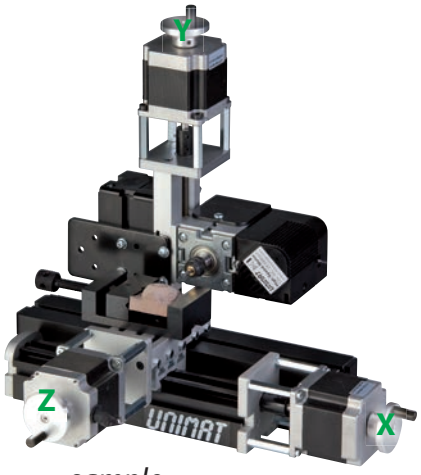
picture 1

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.

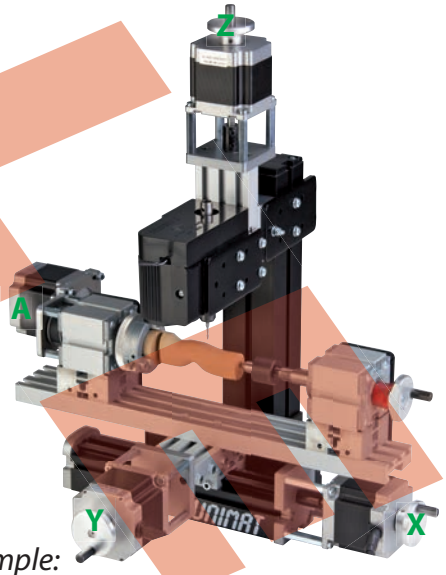
It is important to know that it is following defined G-Code programming -> the work piece is moving. Because of this we can use every norm conformable G-Code on every NC machine – the machine will move to the right direction.



sample:
vertical milling machine



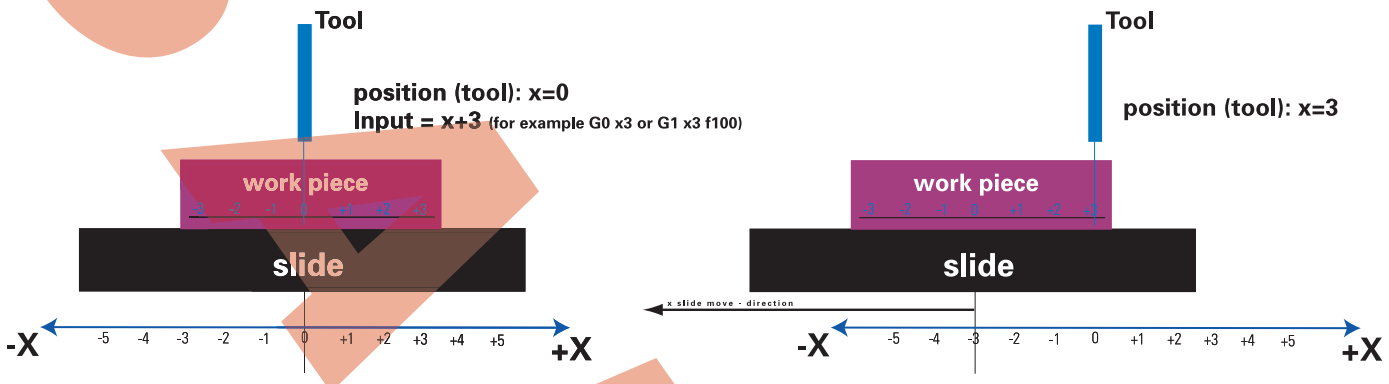
sample:
horizontal milling machine



sample:
vertical milling machine with A -axis

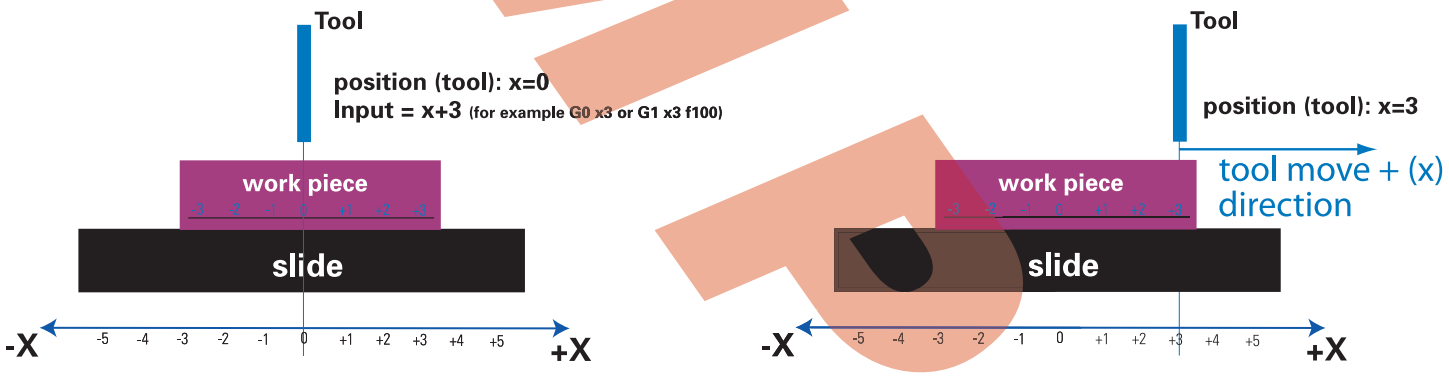
Explanation:

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



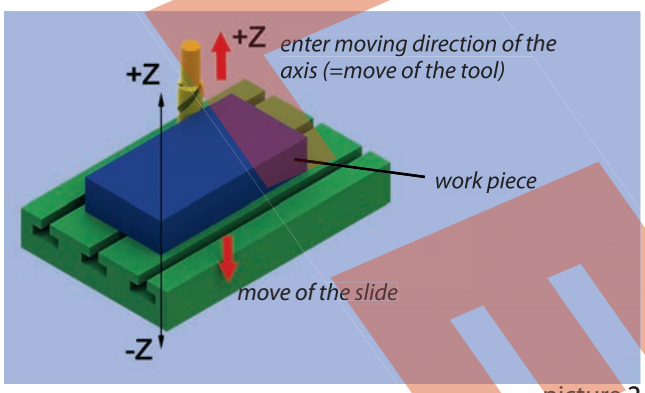
Now the position of the tool is +3 relative to the work piece.

Machines where the tool is moving (gantry mills - like Step490) - 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.

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 (we recommend **Fusion 360** and **Inkscape**).

Basics:

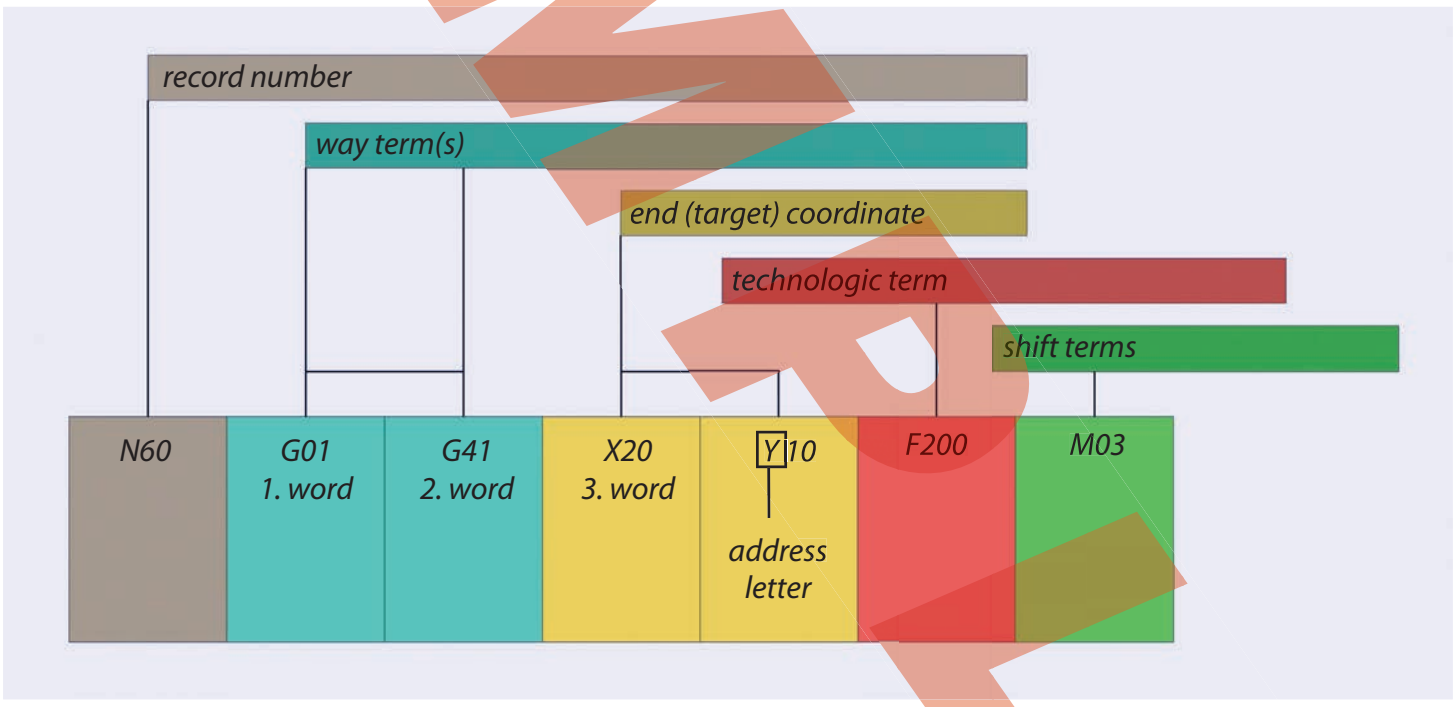
N .... Record number

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)	-

G2 und G3 / G02 und G03

Circle interpolated movement. The feed rate [F] must be set.

G2/G02 is clockwise circular movement.

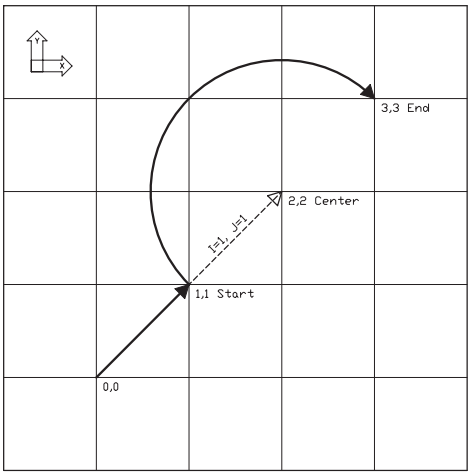
G3/G03 is counter-clockwise circular movement.

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



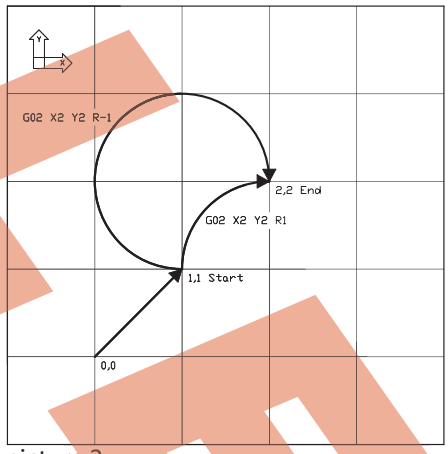
picture 1

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



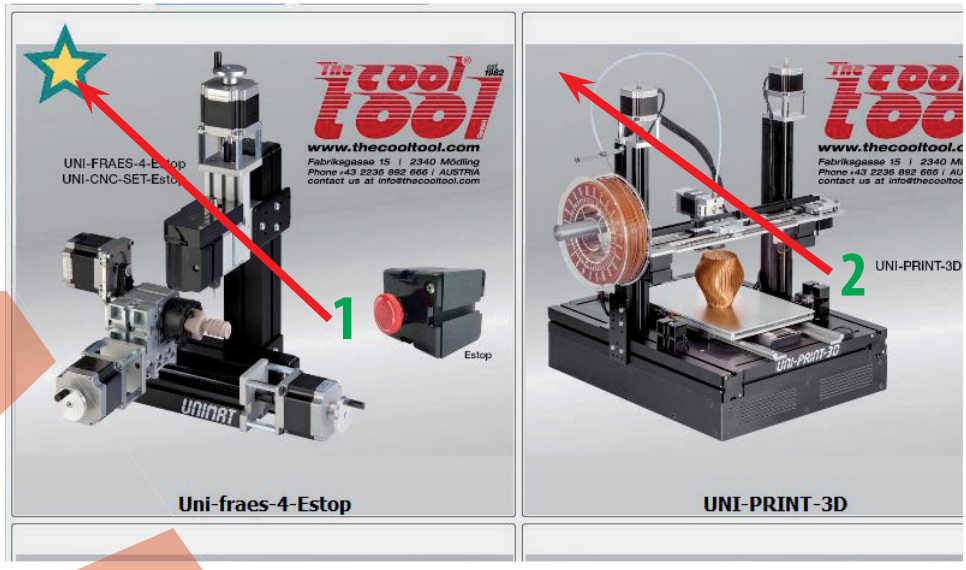
picture 2

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.

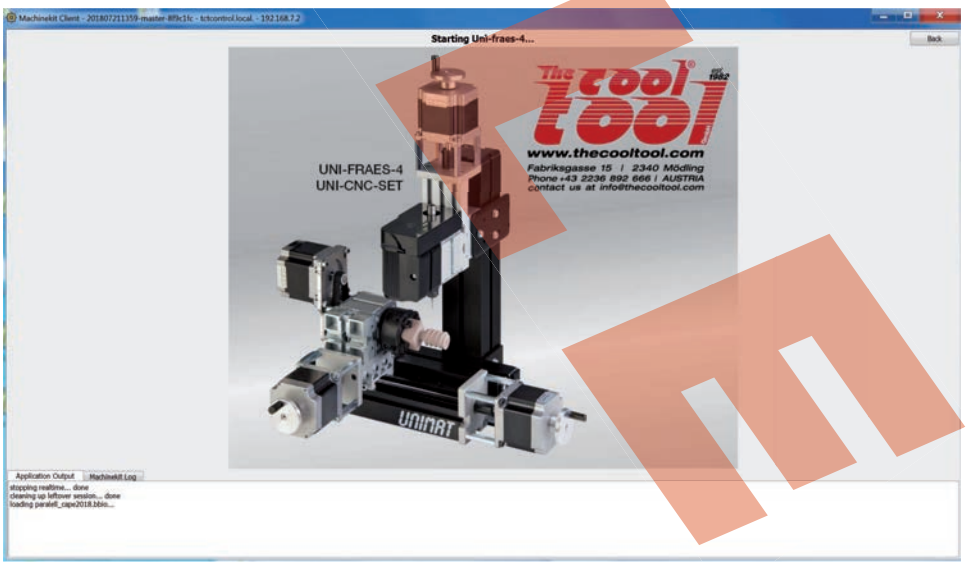
• If the end point is the same as the starting point, CoolCNC will ignore the command, since the center point cannot be determined.

Use the STAR to rank machines up.



To start a machine configuration click on it.

The starting process takes some seconds.



Exercise 4

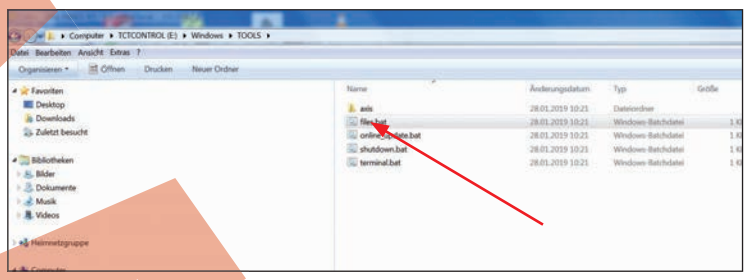
Machine: UNI-FRAES-V3
File: .../examples/exerc4-100-call-a-subroutine-sample.ngc
Raw material: plywood or acrylic, dimensions depending on the selected parameters
Tool: 1.6 mm end mill

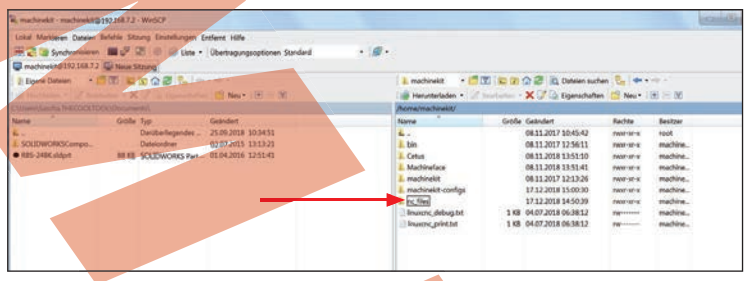
Preparation

•) Start the files.bat file at TCTControl/Windows/TOOLS/

•) When asked for a password use: machinekit

The left part of the „WinSCP“ window is the file system of your PC. The right part is the file system of the TCTControl.

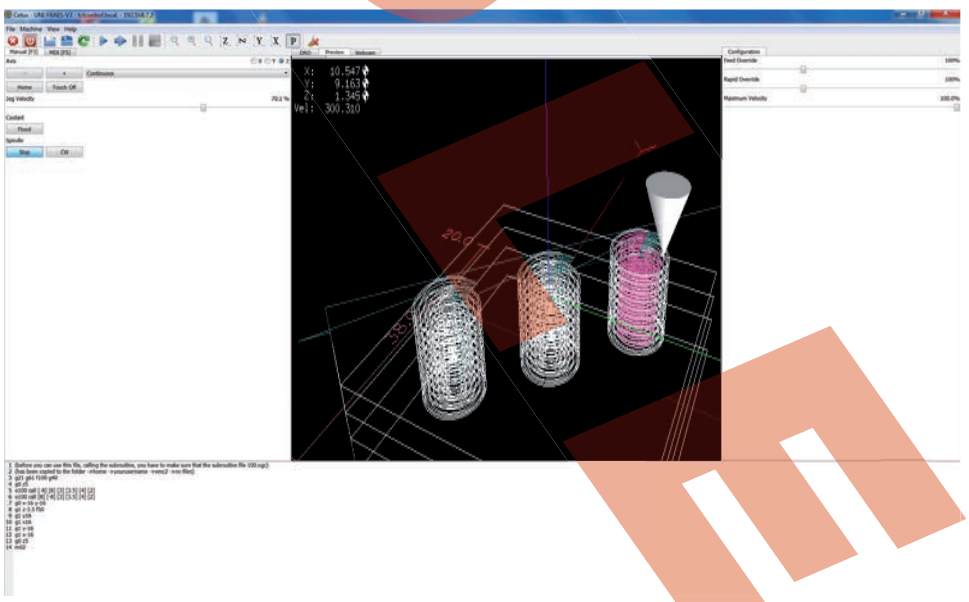




•) Go to nc_files/examples

•) Copy following files to the folder nc_files:
100.ngc
exerc4-100-call-a-subroutine-sample.ngc

•) Open the exerc4-100-call-a-subroutine-sample.ngc file in CETUS

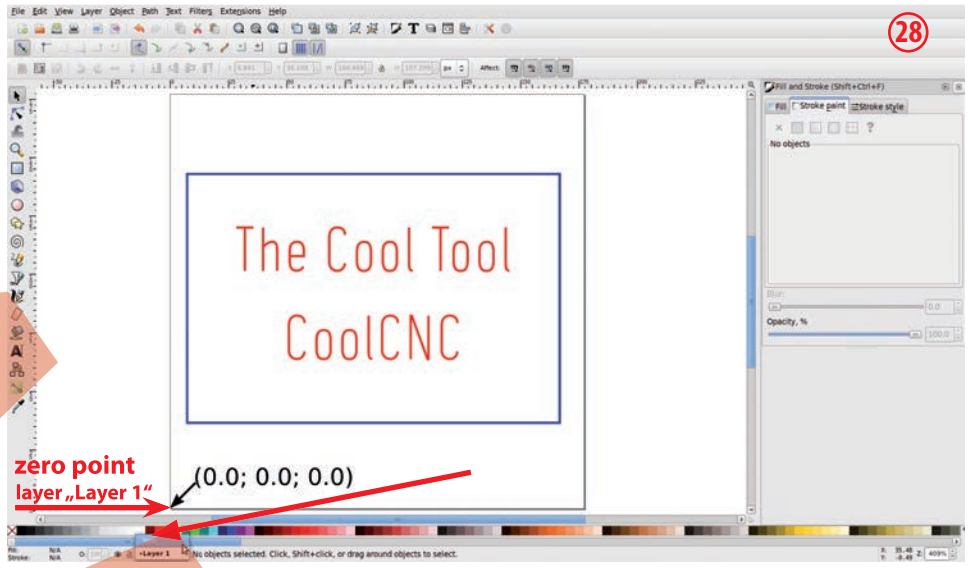


See comments in file exerc4-100-call-a-subroutine-sample.ngc !!!
To learn what the parameters like [-8] [8] [3] [3.5] [4] [2] mean, please read the comments in 100.ngc.

Experiment with different parameters.

https://inkscape.org

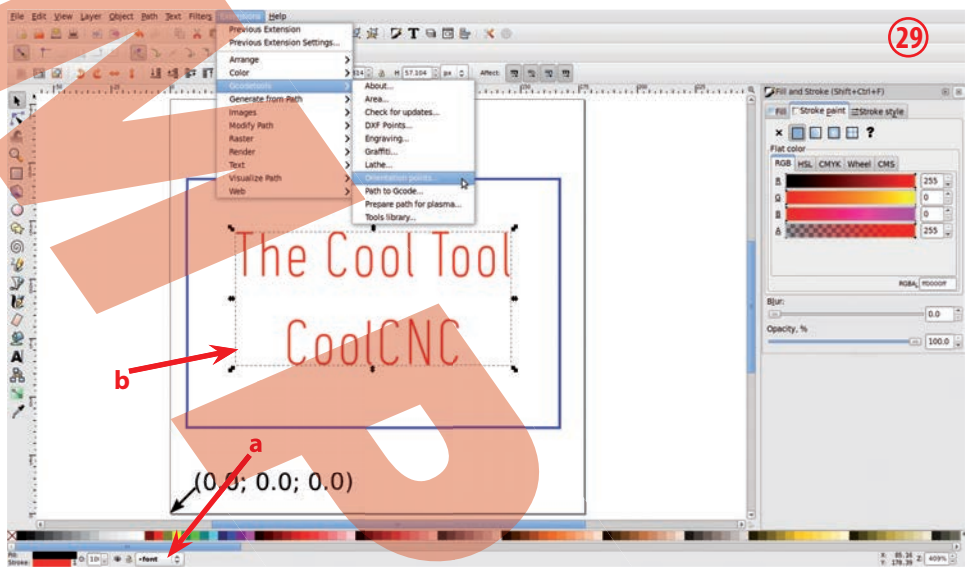
28) select the layer "font"



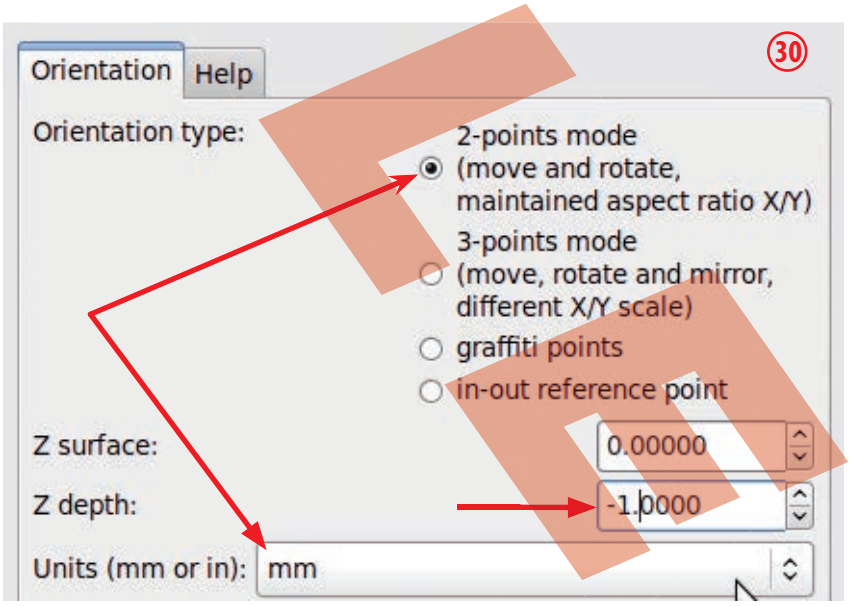
29) Orientation points
(zero point for the red text)

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



General advice on how to handle the TCTControl box

The TCTControl boxes are available in 4 or 6 axes option. Both versions come with stepper motor outputs and: 1x USB client, 1x USB host, 1x 10/100 ethernet, 1x E-stop input, 6x Signal input (i.e. for limit switches), 1x spindel control ouput, 2x relais output, 1x UniPrint3D port and 1x Power supply connector (AC adapter included in delivery).

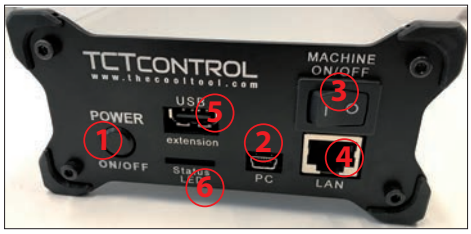
Note the following:

1) Never plug or unplug the step motors during operation.
The "MACHINE" [3] must be switched off first. This also applies to all other inputs and outputs on the rear panel.

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

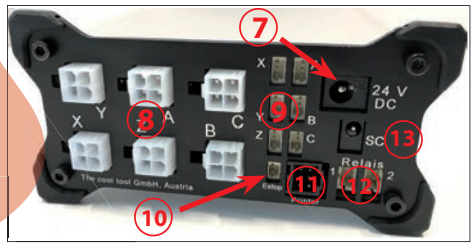
3) Only use the step motors supplied by us.

4) Turn on "MACHINE" only after the control software machinekit® (Cetus/machineface®) has been started. To simulate projects on the screen turn off "MACHINE".



1 ... boot/shut down button (software part)
2 ... connection to the PC (USB)
3 ... ON/OFF (stepper motor driver part)
The stepper motor drivers part is independent from the software part and must be switched on/off separately.
4 ... network connection
5 ... USB port to connect WLan adapter, flash drives, ...
6 ... status LEDs:

Blue LED shine
TCTControl software part is running
Blue and red LED shine
CNC application is running
software status -> machine power on
(ON/OFF button without function)



7 .... power connector (24 V / 5 A adapter)
8 .... machine axes (stepper motor)
9 .... input eg. reference switches
10 ... E-stop (art.no. 164 425 CNC)
11 ... *connection to UniPrint3D*
12 ... *relais outputs 1 + 2 (signal 24 V)*
13 ... *spindle control output (0 - 10 V)*

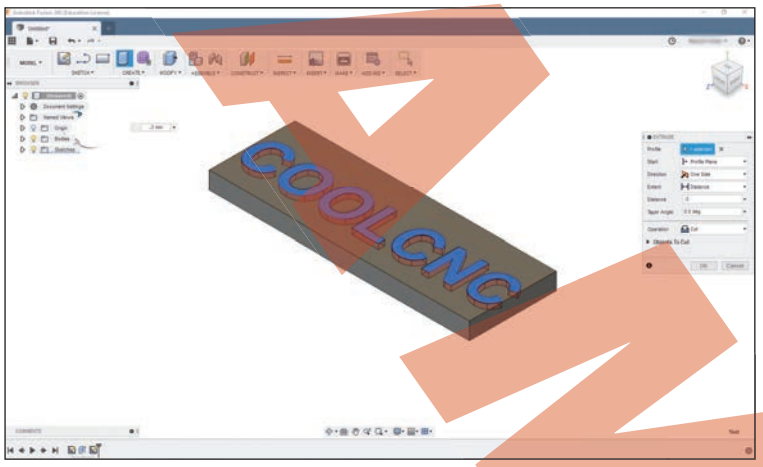
Working with Autodesk® Fusion 360®

https://www.autodesk.com/products/fusion-360/students-teachers-educators

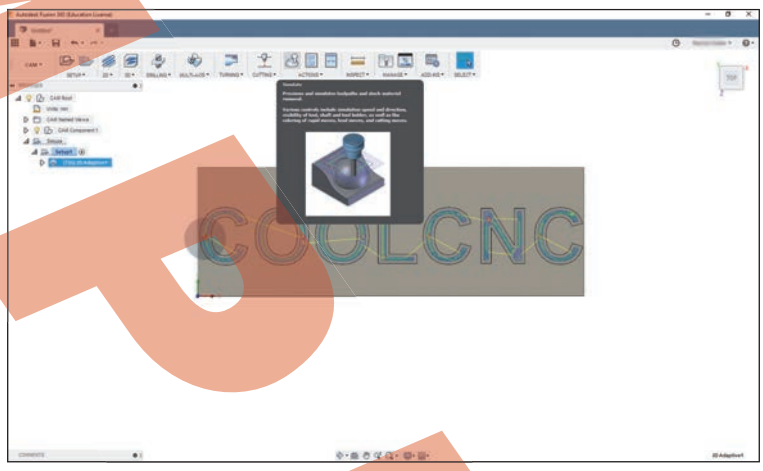
Fusion 360 is a professional 3D CAD/CAM software for which AUTODESK offers free licenses for education.

Advanced designs, 2.5D drawings or 3D models can be constructed, the CAM functionality allows for generating G-code files.

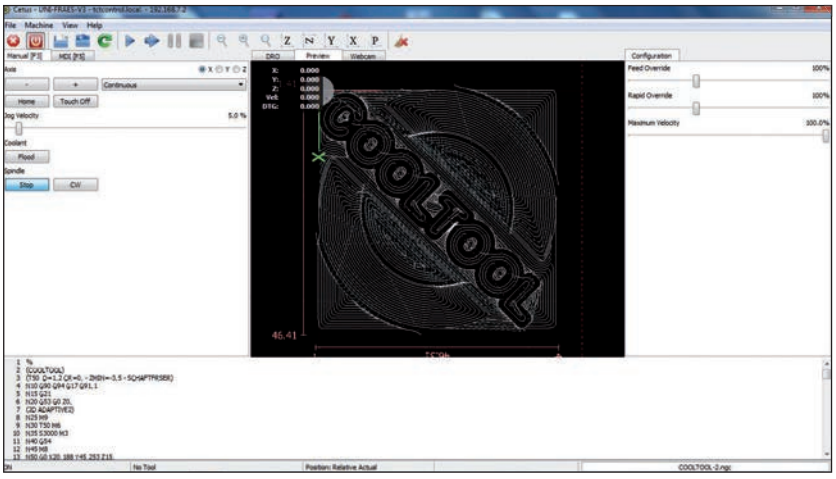
Suitable post-processors and tool-tables make it compatible to the Machinekit CNC software.



Fusion 360 - CAD
(design process)



Fusion 360 - CAM
(set machining parameters)



Cetus - machinekit
(loaded G-Code)

Autodesk® Inventor® can also be used.