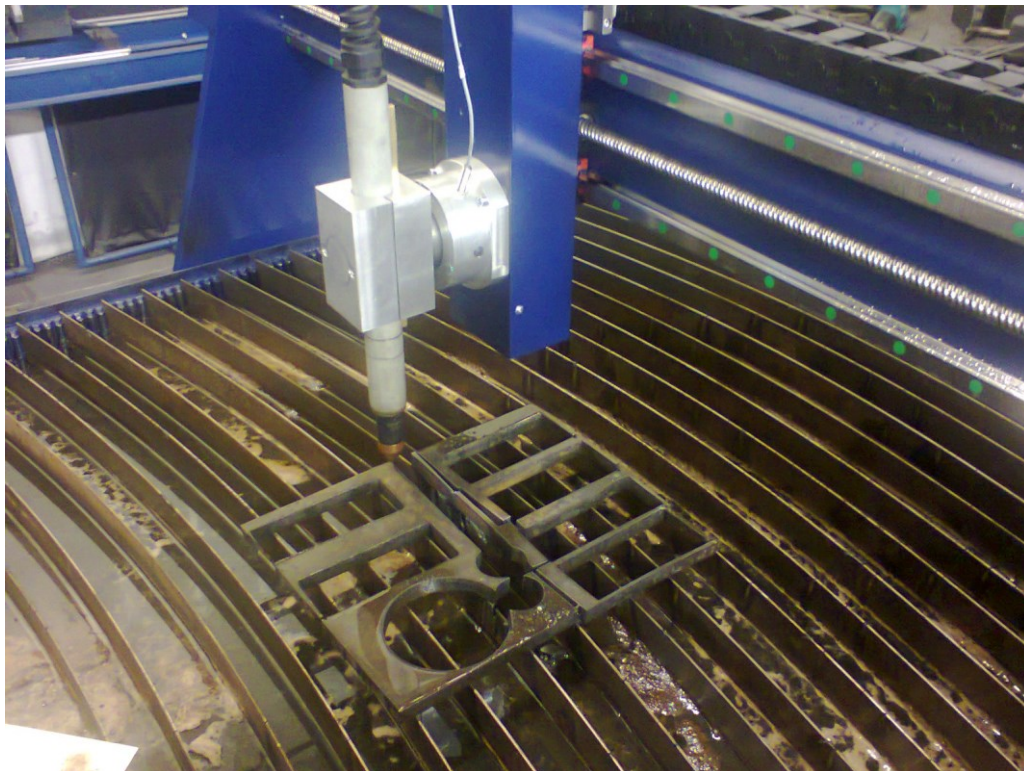




USBCNC PLASMA CONTROL

PLASMA USERMANUAL



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Version	Date	Author	Comment
0.1	15-01-2012	B. Eding	Initial version
0.2	27-06-2012	B. Eding	J1 and J3 on MK2 board where reversed.

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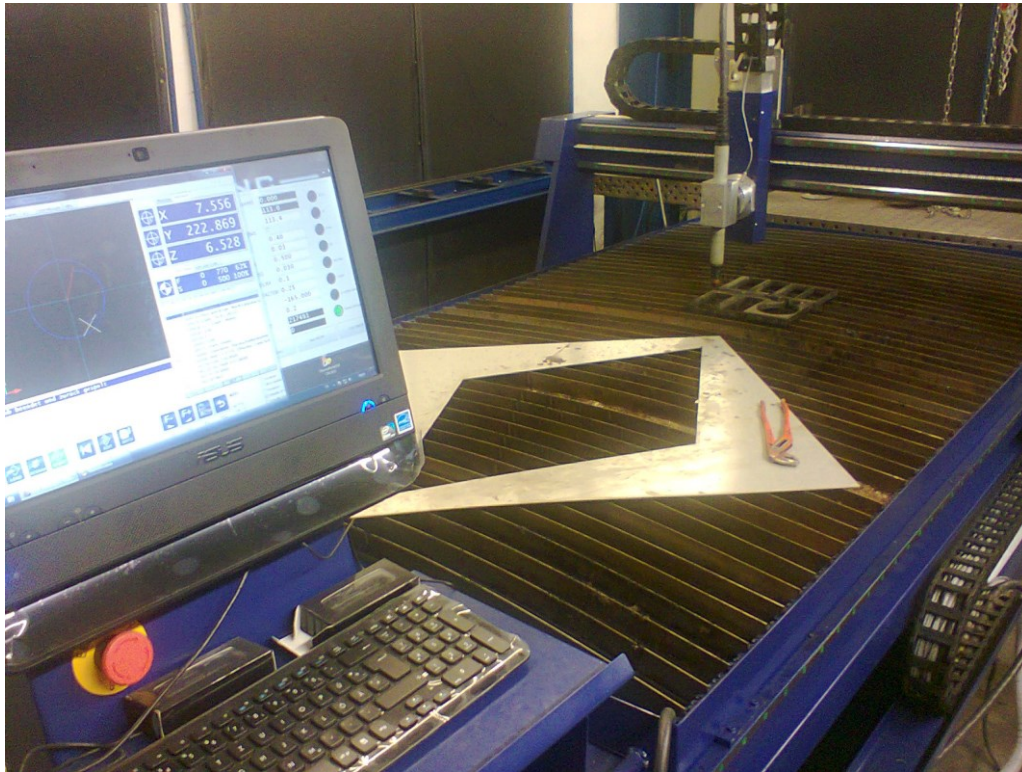
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1 Introduction

1.1 CONTEXT AND SCOPE



<http://www.maschinen-werkzeuge.com/>



Hyperterm powermax 105

1.2 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

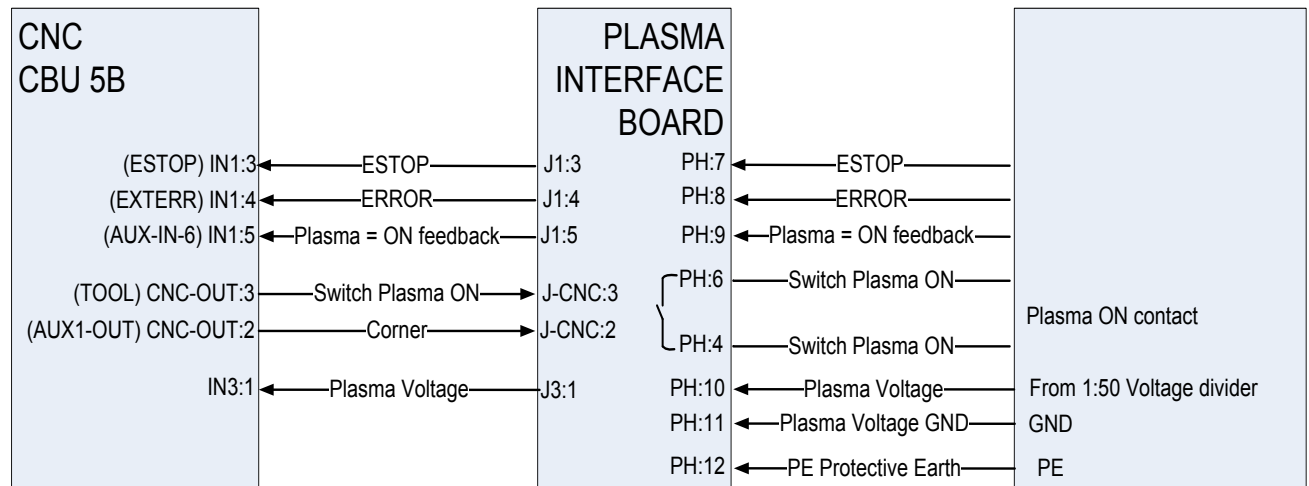
CNC	Computerized Numerical Control
CPU	Central Processor Unit, a PCB board with a Processor on it.
DXF	Drawing Exchange Format) is a CAD data file format developed by Autodesk
FIFO	First In First Out Buffer
HPGL	Hewlet Packard Graphical Language
GUI/UI	Graphical User Interface
INTERPRETER	A software function that is able to read a text file and execute the commands contained therein.
JOBFILE	A <i>job</i> is the text file (G code) that will be executed by the interpreter.
GUI	Graphical User Interface.
PWM	Pulse Width Modulation
G-Code	CNC specific language to control the movements and IO of a milling machine.
LAF	Look Ahead Feed, advanced motion algorithm that ensures minimal machining time.
THC	Torch Height Control

2 Torch Height Control

The torch height to the work piece determines the quality of the cutting process. The material to cut is not even in height. The voltage across the torch during the process is coupled to the height of the torch. The higher the torch, the higher the voltage will be.

Since the torch is coupled to the Z-axis of the CNC machine, the voltage can be kept constant by regulating the height of the torch. This can be done by feeding the (attenuated and isolated) torch voltage to the CNC system. This system will control the height of the Z to keep the voltage constant.

2.1 INTERFACE PLASMA - CNC

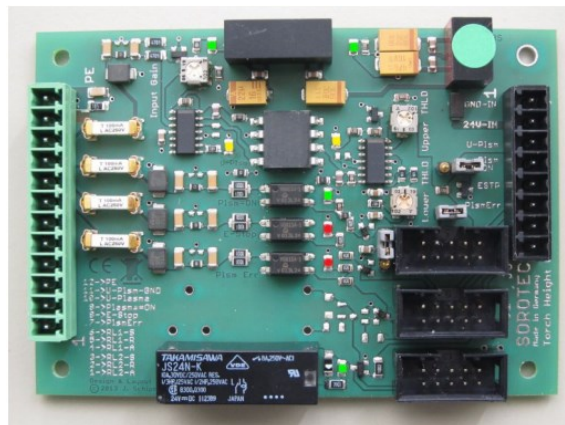


Proto type interface hardware, second version

PE
GND
U-PLASMA
PLASMA=ON
PLASMA ESTOP
PLASMA ERROR

RL1 S
RL1 NC
RL1 NO

RL2 S
RL2 NC
RL2 NO



GND
+24DC

IN3 CPU5B

IN1 CPU5B

CNC-OUT CPU5B

THC control sequence

1. At initial position.
2. Move to start position X,Y,Z=pierce height. (Pierce height is equal to ignition height)
3. Switch plasma on (M3)
4. Delay pierce delay.
5. Move Z down to cutting height.
6. Start contour, after Meas/Control delay activate THC controller.
7. Automatically measure voltage and set as set point if required.
8. At end of contour, switch plasma
9. To Retract height.

3 Plasma UI

3.1 GENERAL SETTINGS FOR PLASMA.

Some items need to be setup in the cnc.ini, use notepad or notepad++ similar program to edit the file.

This is an example of a working setup:

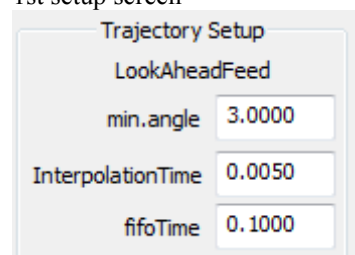
```
[PLASMA]
defaultSetPointVoltage = 135.000000
KPUp = 0.600000
KPDown = 0.600000
KD = 0.050000
deadBand = 0.500000
filterTime = 0.050000
holeDetectVoltage = 25.000000
holeDetectTime = 0.100000
controlDelay = 0.100000
cornerFeedFactor = 0.250000
zMax = 0.000000
zMin = -167.000000
adcOffset = 100.000000
adcMulFactor = 0.200000
plasmaIsOnInputPortID = 0
plasmaIsCornerOutputPortID = 0
plasmaZDownInputPortID = 0
plasmaZUPInputPortID = 0
plasmaAnalogInputPortID = 3
measuredIsSetpoint = 1
```

The plasma needs:

1. CPU5B with Ethernet
2. PLASMA INTERFACE with minimal PLASMA on output to the Plasma source and Plasma voltage isolated and transformed to 0-3.3V for the CPU.
3. PC with reliable and fast Ethernet, because we will reduce the life time This improves the dynamic of the THC.
4. CPU firmware **V1.08xx** or higher. (Also for improved dynamics)/

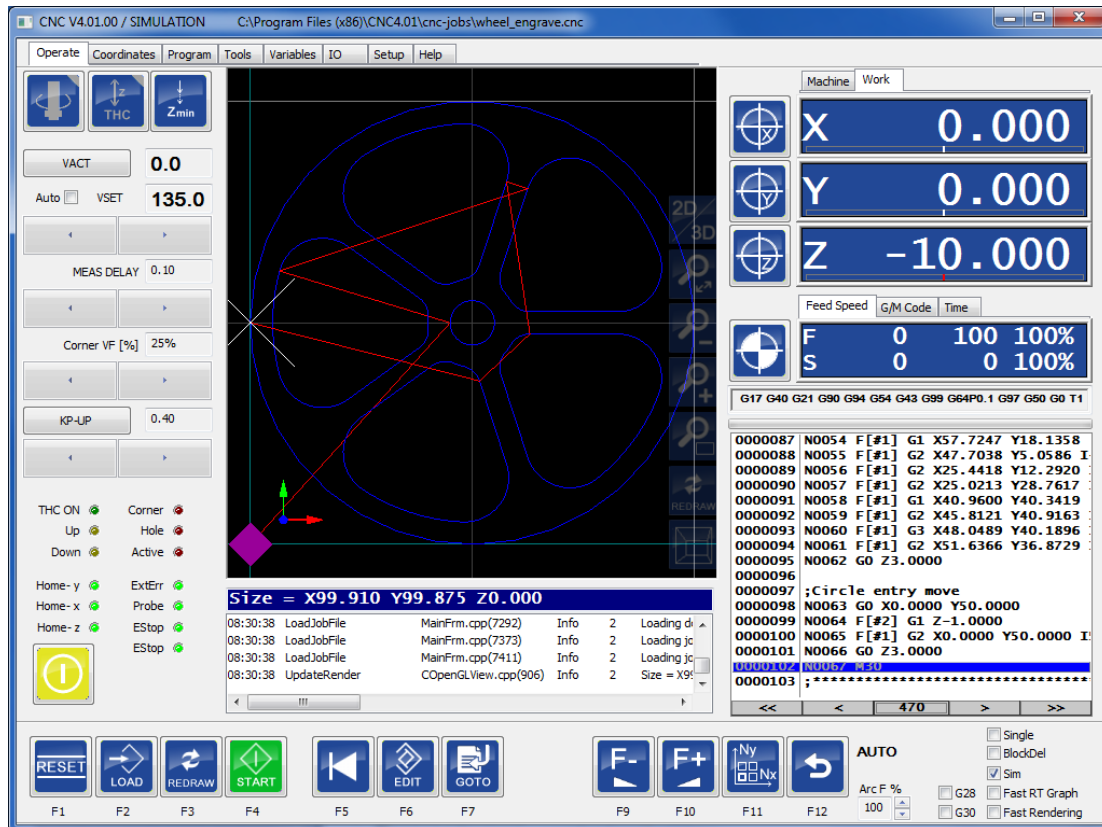
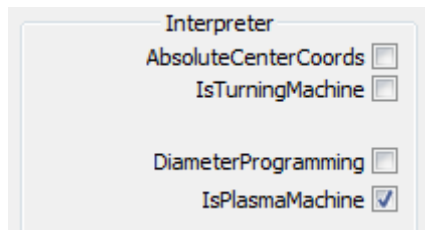
So in the standard setup please set the interpolation Time and fifo Time like this:
(Standard fifo time = 0.2 Second)

1st setup screen



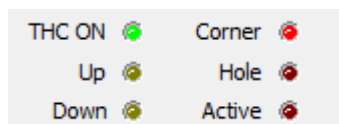
The screenshot shows a software window titled "Trajectory Setup". Inside, there is a section labeled "LookAheadFeed". Below this, there are four input fields with their respective labels: "min.angle" with a value of "3.0000", "InterpolationTime" with a value of "0.0050", and "fifoTime" with a value of "0.1000".

2nd setup screen



Its about the left panel.

3.2 THE LEDs

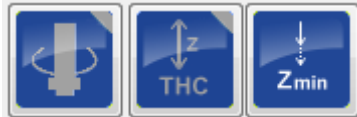


THC ON : LED is ON when THC function is on.
 UP: Z is moving UP
 Down: Z is moving down
 Corner: Corner protect active
 Hole: Hole Detect active
 Active: On when control is active

The THC is active when several conditions are met:

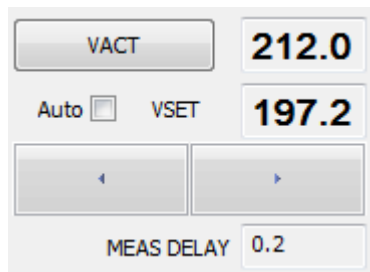
- THC function is switch on
- Spindle (PLASMA) is ON
- Move is G1, G2, G3 without Z
- Corner protect is not active
- Hole detect is not active.

3.3 AT THE TOP WE SEE 3 BUTTONS:



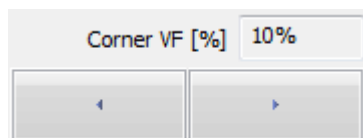
- Spindle ON/OFF (PLASMA) : Switches the plasma ON/OFF
- THC ON/OFF, switches the THC system ON/OFF.
- Define Z min, takes current Z position and define that as minimum for the THC, THC will not go lower. It is displayed also in the Z readout gauge in RED.

3.4 VACT AND VSET:



- VACT button allows to switch the display between the actual plasma voltage or the following error, Vactual - Vset.
- Auto, when switched on a automatics measurement will take place at the beginning off the cutting sequence. After the Mesa Delay time delay, the voltage is measured and set at set point. This is performed once for a job.
- VSET shows the actual Voltage setpoint for the THC controller.
- Meas delay: Sets the delay for automatic measurement and control on. When a cutting move starts, this delay is used before the controller is switched on and the measurement is taken.

3.5 CORNER PROTECTION



The Corner VF setting is needed to prevent the torch from diving down at corners. At corners the actual Feed becomes lower, because of this the Plasma voltage gets higher and the THC will start moving the Z DOWN. This is not wanted. So when the Feed is lower than specified percentage here, the THC control will temporarily be disabled, the Z axis will remain at same height.

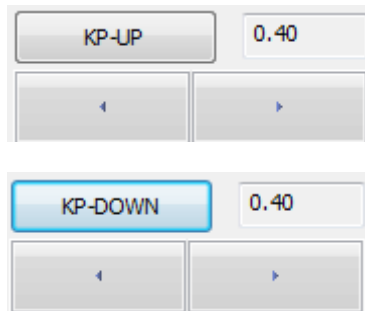
3.6 CONTROLLER PARAMETER SETTINGS

There are a few control parameters, which can be set here, by pressing the button that now showsd KP, next parameter becomes visible to be set.

Default parameters

FIFO TIME	KP	KD	DB	FILTER	HOLE D. V	HOLE D. T
0.2 (standard)	0.3	0.04	0.5	0.05	25	0.1
0.1	0.6	0.02	0.5	0.05	25	0.1

3.6.1 KP



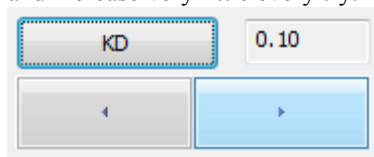
The image shows two identical UI elements for the KP parameter. Each element consists of a button labeled 'KP-UP' or 'KP-DOWN' and a numeric display showing '0.40'. Below the button and display are two arrow buttons, one pointing left and one pointing right.

Standard the KP parameter is shown, this controls the THC control speed. When too low, the Z axis will follow too slow. When too high, the Z axis will start oscillating.

There are 2 KP values, one for moving UP and one for moving down. We have made this because experience learns that the behavior of the system is different moving up or down.

3.6.2 KD

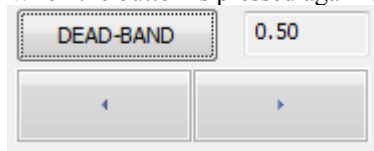
When the button shown KP is pressed we will see KD, this is the differential K factor for the control loop. It makes the dynamic better, but it easily makes the control loop oscillate. Start with low values and increase very little every try.



The image shows a UI element for the KD parameter. It features a button labeled 'KD' with a dashed border, a numeric display showing '0.10', and two arrow buttons below it. The right arrow button is highlighted in blue.

3.6.3 DEADBAND

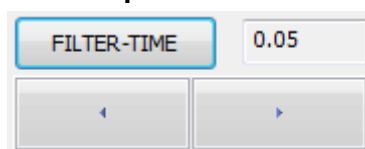
When the button is pressed again we see the DEADBAND parameter.



The image shows a UI element for the DEADBAND parameter. It features a button labeled 'DEAD-BAND' with a dashed border, a numeric display showing '0.50', and two arrow buttons below it.

When VACT-VSET is lower than this value, the controller does nothing, it prevents limit cycling, going up down continuously when not needed.

3.6.4 Spike filter



The image shows a UI element for the FILTER-TIME parameter. It features a button labeled 'FILTER-TIME' with a blue border, a numeric display showing '0.05', and two arrow buttons below it.

Next parameter is FILTER-TIME

This is the time of our spike filter, spikes are filtered as well sudden voltage increases when going over a part where there is already cut.

Suppose we are moving with F3000, and our cutting width is 2 mm.

F3000 = 50 mm/sec or 2 millimeter takes 0.04 sec. The filter time should be bigger than 0.04 to filter this spike away. Be Aware, the filter influences the control speed negatively.

3.6.5 Hole Detect

When we go over a hole or when we pass the end of the plate, then the plasma voltage will suddenly rise a lot. When we would do nothing the controller will make the Z move downwards, fast and cause collision. To prevent this we have the hole detection that needs 2 parameters.

The image shows two UI elements for parameter adjustment. The top element is for 'HOLE-DET-V' with a value of '25.00'. It has a label box on the left and a numeric input box on the right, with left and right arrow buttons below them. The bottom element is for 'HOLE-DET-T' with a value of '0.10'. It also has a label box on the left and a numeric input box on the right, with left and right arrow buttons below them. The 'HOLE-DET-T' label box is highlighted with a blue dashed border.

When the voltage difference $V_{act} - V_{set}$ is more than the HOLE-DETECT-VOLTAGE and longer than the HOLE-DETECT-TIME, the controller will stop controlling.

3.6.6 Tracing

For test purpose an extra parameter is added, LOG AN INPUT VAL, this value can be 0 or 1. When set to 1, the values of the analog value are logged to a file for investigating. The file is made in the CNC4.01 director and has this format: ANALOG-MM-DD-YYYY-HH-MM-SS.txt.

The tracing performs its function during 1 run, then it is switched off automatically, so you need to switch it on again for every run you want to use it.

It can be easily shown with GNUPLOT, like this.

Start GNUPLOT:

In the console type e.g.

```
gnuplot> cd c:\program files\cnc4.01
```

```
gnuplot> 'ANALOG-32-1-2013--21-3-32.txt' u 1:2 w l
```

It means to plot the data in the file of Column 1 as X and Column 2 as Y with lines connected.

This is the result of random changing the analog input: