Plasma CNC Workshop

Outcomes

1. Explain the basics of operating the Plasma CNC machine safely.
2. Demonstrate turning on, jogging, referencing, and running a toolpath on the CNC machine safely.
3. Understand the basics of feeds, speeds, amperage and air pressure.
Work in a 2.5D environment.

The Plasma Table can cut metal from 1mm thick up to 18mm thick with excellent cut quality. It can cut metal up to 35mm thick with less, but still very good, cut quality. Thicker metal requires a slower cut travel speed and a higher setting on the Plasma Source. (18 guage to 1 1/4 inch).

Safety

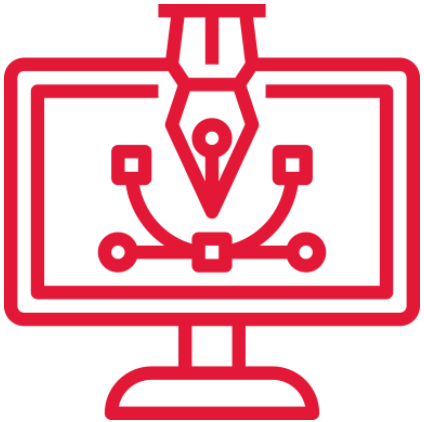
The Plasma Arc is too bright to look at with the naked eye. Use at least Shade 5 UV protection lenses.
The Plasma Arc contains a lot of UV light – the same radiation that causes sunburn. You may want to wear a welding hood.
Warn folks nearby when you are ready to cut so they don't get 'flashed' by the arc.
Newly cut parts, and the material they are cut from will be **HOT** !
Use ventilation. Plasma cutting makes lots of smoke. You can open the garage door on the last bay.
When the plasma starts a piercing cut, molten metal as the penetration starts can be thrown in any direction.

Parts

- A Plasma Source, the LGK-160IGBT, which produces the arc power that turns air into plasma.
- A Transformer that converts local power to the correct voltage for the Plasma Source.
- A Torch Cooler which cools and circulates coolant to the torch to help keep it cool.
- A Plasma Table, 4’ x 8’ with an X and Y axis gantry and a Z axis holding a Plasma Torch.
- A Control Console housing a computer, monitor, mouse, keyboard, USB ports, and other electronics to move the axes and control the Torch.
- A Torch Height Controller in the Control Console.
- The Plasma Source uses compressed air from our air compressor to run through the Torch to make plasma.
- The Torch holder, on the Z axis, uses compressed air to hold the torch in place. Should the torch hit something, the seal is broken, the torch moves, and a loss of pressure signal is sent to the controller.
- The Plasma Table can cut metal from 1mm thick up to 18mm thick with excellent cut quality. It can cut metal up to 35mm thick with less, but still very good, cut quality. Thicker metal requires a slower cut travel speed and a higher setting on the Plasma Source.
- Metal is heavy. Get help moving large or heavy sheets.
- The metal will be **HOT** after cutting. Allow time for it to cool and be cautious when touching cut parts or the metal they were cut from.
- You absolutely must use the ground terminal. Torch will not stay struck without it.

CAD

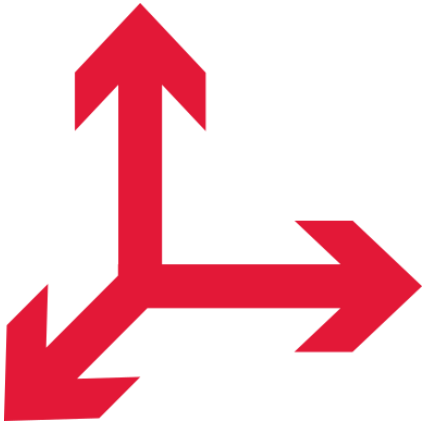
CAD is Computer Aided Design - it’s the software that you use to make/draw/design the thing you want to cut. At its most basic that could be a vector drawing program. If you're doing 2.5D cutting, you can draw in Adobe Illustrator, Corel Draw, Inkscape and others. You can even draw in Vcarve.
Save your design as an .svg file.



CAM

CAM is Computer Aided Manufacturing - is the software you use to generate the Gcode that tells the machine how fast to move and where to move.

Use a CAM program to convert your .svg file into a .gcode file. There are special Plasma Gcode generators and post processors to be used to get the correct Gcode.



GCode

GCode is the line by line instruction code that tells the machine where to start, where to move, and how fast to move. You save your GCode from your preferred CAM software.

You can use Vcarve with the Makersmiths CNC_Plasma_MSP(inch).pp post processor

Openbuild Cam generator with the Plasma selections

Fusion360 (we think)

Probably other CAM products like OpenCad, SolidWorks, or others

GCode

You will need to be sure that whatever program you use, it must include a pause of about 2 seconds after the torch strike command (M3) to allow the plasma arc to stabilize and pierce your material.

Typical Gcode will look something like”

M3 (turn on torch)

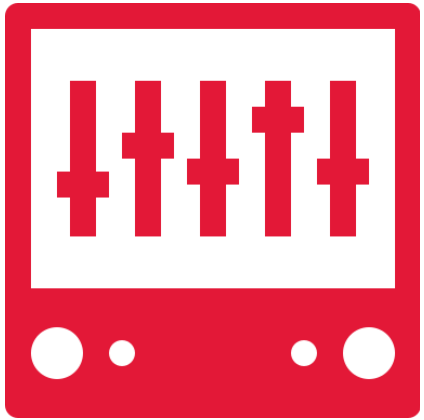
G04 P2.0 (Pause for 2.0 seconds)

Thicker material may require a longer pause, thinner a shorter pause.

Be aware, Mach4 needs a decimal place after the pause time.

Controller

After saving your GCode from your preferred software package, you execute/run that Gcode in Mach4 on the Plasma Table. The function of this is to convert a Gcode line into steps on stepper motors or other control switches.



Feeds

How fast the machine moves:

- Too fast and the Plasma will not cut all the way through.
- Too slow will result in excessive slag on the bottom of your piece, and the torch may go out if it thinks it is cutting air.
- Use 2000mm/min / 80ipm for 1/8 material. Slower for thicker (maybe 1000) and faster for thinner (maybe 2500). Testing is in order to get the best cut quality
- Do not exceed 100 IPM. (the Machine loses steps)

Depth

The Plasma should cut all the way through your metal in one pass.

Torch Consumables

- Torch consumables consist of an inner electrode and a cone.
- Cones with small holes result in a smaller kerf.

Electrode
YK600102
YK600102X

Nozzle
YK600103(3.4)
YK600103(3.0)
YK600103(2.3)
YK600103(2.1)
YK600103(1.8)
YK600103(1.6)

Sparks

- **Fire Hazard !**

- Plasma cutting make lots of sparks of very hot metal.
- Keep a Fire Extinguisher at the ready.

Fixturing

- The Torch should be positioned about 2mm above the surface of your work and should not touch the surface of the work at any time.
- Material must be flat on the table and prevented from moving with clamps or other fixture pieces.
- Very large pieces of metal are probably heavy enough to hold themselves in place.

Toolpath Prep

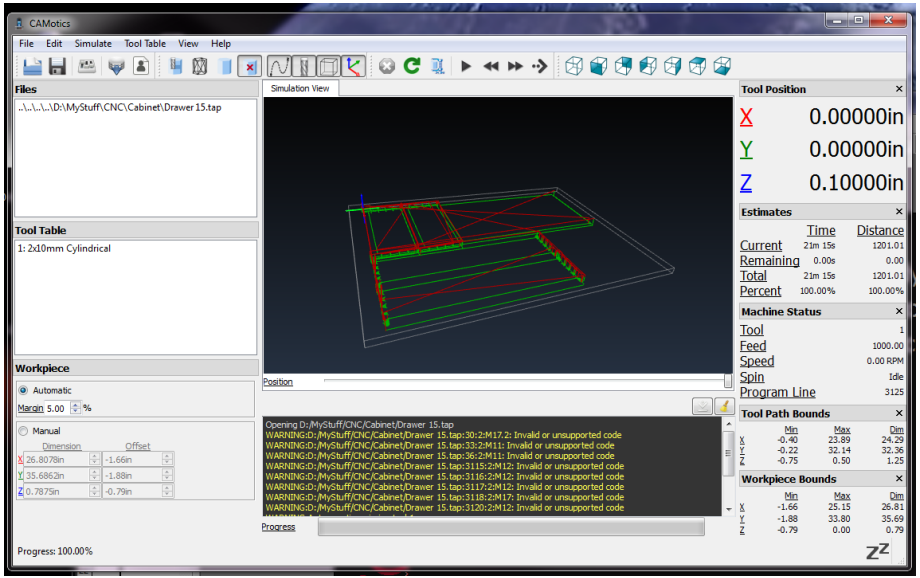
This workshop assumes that you have already saved your Gcode and have used a simulator to '*absolutely confirm*' that you code is solid and only cuts where you want it to.

Gcode Simulators:

CAMotics

Vcarve

Others



Important!!!

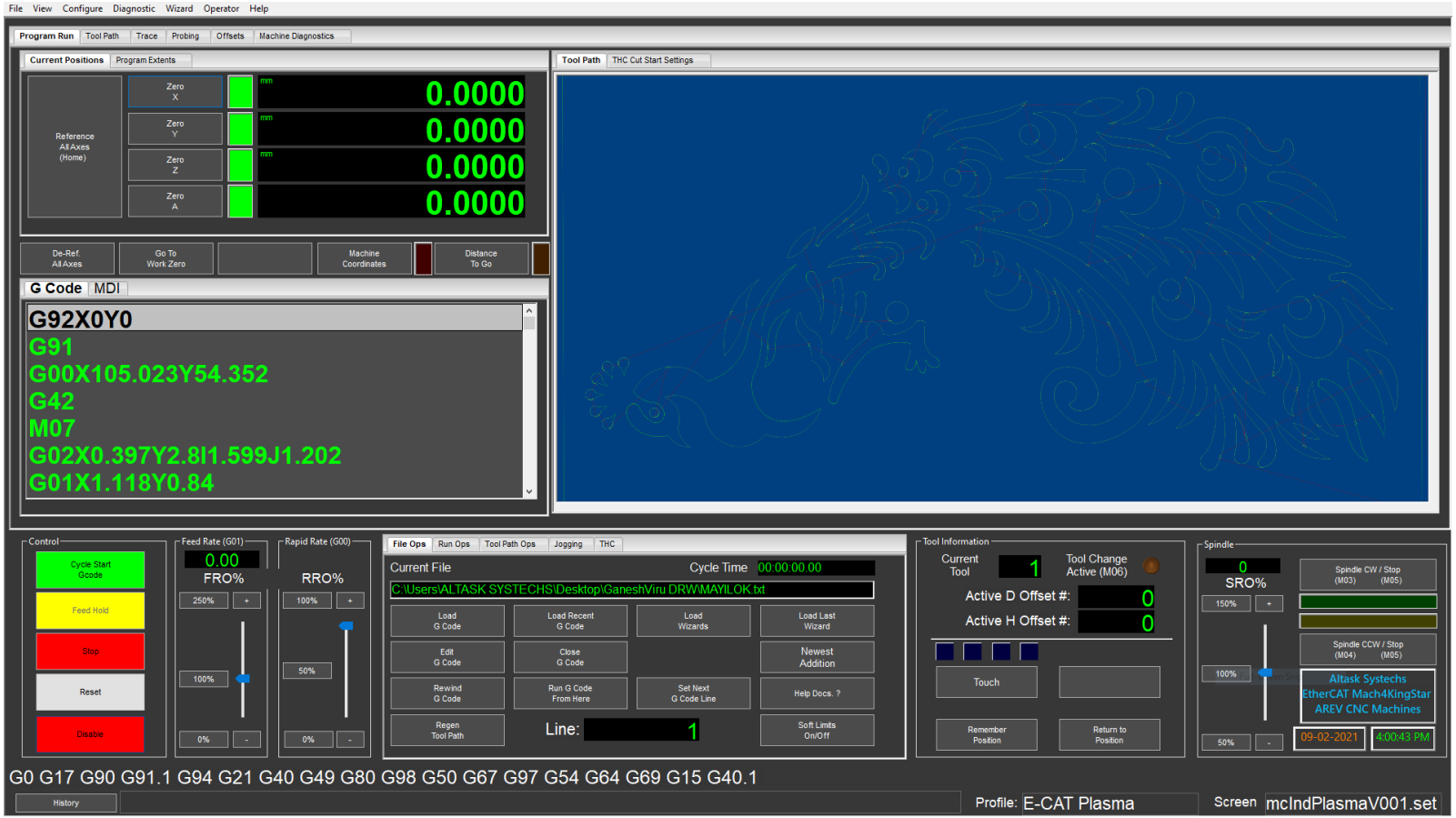
You need to be with the machine while it's cutting and be ready to stop the machine if something goes wrong.
Always have quick access to the Emergency Stop button..
Double check that the Torch height is high enough to clear any clamps or fixture pieces. Make sure your toolpaths aren't going to accidentally cut your clamps or fixture locating pieces.
The material support rails in the bed are sacrificial and can be replaced with they get worn.
Be careful of anything you put on the bed that you don't want cut or knocked over.

Referencing

Do not Home the machine. This machine does not have a Home position.

The work X-zero and Y-Zero is set manually.

Mach4


File View Configure Diagnostic Wizard Operator Help
Program Run Tool Path Trace Probing Offsets Machine Diagnostics
Current Positions Program Extents
Reference All Axes (Home)
Zero X
Zero Y
Zero Z
Zero A
0.0000
0.0000
0.0000
0.0000
De-Ref. All Axes
Go To Work Zero
Machine Coordinates
Distance To Go
G Code MDI
G92X0Y0
G91
G00X105.023Y54.352
G42
M07
G02X0.397Y2.8I1.599J1.202
G01X1.118Y0.84
Tool Path THC Cut Start Settings
Control
Cycle Start Gcode
Feed Hold
Stop
Reset
Disable
Feed Rate (G01)
0.00
FRO%
Rapid Rate (G00)
RRO%
File Ops Run Ops Tool Path Ops Jogging THC
Current File
Cycle Time 00:00:00.00
C:\Users\ALTASK SYSTECHS\Desktop\GaneshViru DRW\MAYILOK.txt
Load G Code
Load Recent G Code
Load Wizards
Load Last Wizard
Edit G Code
Close G Code
Newest Addition
Rewind G Code
Run G Code From Here
Set Next G Code Line
Help Docs. ?
Regen Tool Path
Line: 1
Soft Limits On/Off
Tool Information
Current Tool 1
Tool Change Active (M06)
Active D Offset #: 0
Active H Offset #: 0
Touch
Remember Position
Return to Position
Spindle
SRO%
Spindle CW / Stop (M03) (M05)
Spindle CCW / Stop (M04) (M05)
Altask Systechs
EtherCAT Mach4KingStar
AREV CNC Machines
09-02-2021
4:00:43 PM
G0 G17 G90 G91.1 G94 G21 G40 G49 G80 G98 G50 G67 G97 G54 G64 G69 G15 G40.1
History
Profile: E-CAT Plasma
Screen mcIndPlasmaV001.set

Jogging

In Mach4 select the Jogging tab, lower right window, 4th tab, says Jogging.

Move the Torch to where you want your X-zero Y-zero to be by using the X and Y jogging buttons.
X - moves the torch to the left.
X + moves the torch to the right.
Y – moves the gantry toward the front of the table
Y + moves the gantry toward the back of the table

Starting up

Plug in the Air Dryer in the Woodshop
Start the Compressor
You may have to reset the compressor overload switch. Press down the Red button. You may also have to push the blue button on the Compressor power box.

In the back bay.
Turn on the main power box. You will hear a fan start running in the transformer in the corner.

Turn on the air valve.
Note the pressures for the Torch Holder and the Plasma Source Supply
60 PSI Orange Plasma Air **35 PSI Grey Torch Holder**

As soon as you turn on the Air, you will hear a hissing noise from the torch holder. The torch holder uses air pressure to hold the torch in the fixture. You will need to pull (gently) twist, and otherwise adjust the torch until the holder seals and the air leakage stops

Starting up

Turn on the Torch Cooler.

Turn on the Plasma Source.

The Control Console uses 2 power supplies. A 220 VAC supply and a 110 VAC Supply. Both of these come from power cables plugged into wall outlets. Make sure both are plugged in.
Turn on the small red switch on the lower left side of the Control Console.
Press the Green power button on the upper right corner of the Control Console
Button will latch down. A light below the Emergency Stop button will come on.
Power on the computer if it does not automatically start by pressing the power button.

Double click the Mach4 Plasma Icon at the top center of the screen once the system boots.

Starting up

Mach4
Do not Home the machine. This machine does not have a Home position. The work X-zero and Y-Zero is set manually.

Enable the Machine
Enable the machine by clicking the Enable button in the lower left-hand corner.

Positioning your blank on the machine.
Place your material in a convenient place on the bed of the machine. The material must lay absolutely flat. Use clamps as necessary. Put clamps in places where the torch will not run into them.

Attach the Ground Connection to your material in a place that will not be cut, or be in the way of the Torch path. It is a magnetic connection. Turn the knob clockwise to engage the magnet. Counter-clockwise to release. Shiny spots make good ground connections.

Starting up

Move the Torch to where you want your X-zero Y-zero to be by using the X and Y jogging buttons.

Zero all the axes (X, Y, and Z) when you have moved the torch to your desired X and Y zero location.
The green numbers just to the right of the buttons should all go to 0.0000

Adjust the Height of Torch Nozzle above work.
2mm to 5mm (max). Closer is better as long as the Torch does not contact the work. The Torch Height is adjusted using the Torch Up and Torch Down switch. Start with the Torch tip 2mm above your work.

Move the Auto/Manual switch to Auto.
(Do not press the Zero Test button. The Arc Strike button will not do anything.)

Starting up

Adjust the Torch Height Controller if necessary
Use these numbers as a starting point. SetArc should be about 30. Bigger numbers for thicker materials. It is set using the Height knob. Sensitivity should be about 20. It is set using the Sensitivity knob.
During the cut, the ARC number will show the arc voltage.

Load your Gcode
In Mach4, File – Load Gcode – Your file name
(Your Gcode file should have the file type extension, .tap, .nc, or .gcode)

When you are ready to cut, (Torch should be at your work X and Y zero and the Torch height should be set.

Click the Cycle Start Gcode button.

You can stop the machine by clicking the Stop button.
When stopped, you can send the torch back to X-zero Y-zero by clicking the Go To Work Zero button. You can restart your job by clicking the Reset button and then the Cycle Start Gcode button.

Troubleshooting

If the Torch strikes and then goes out:

- Check the ground clamp is attached and making good contact.
- Check the Torch Height. Too high and the torch will automatically shut down.
- The pause time in your Gcode is too long.

If the Torch does not strike.

- Check lights on the front of the Plasma Source.
- Check the nozzle, they can get welded shut if the nozzle touches your work

During Job

Stay with the machine.
Be ready to hit the Emergency Stop Button (Estop) if necessary.
Listen to the sound of the machine - you'll get used to the sound it should make depending on the material you are cutting.
Speed slider may be used to adjust the travel speed.
The sound of air leaking means that the Torch has come loose. Stop the job to resolve.
Once you have a little bit of experience, you will learn what power, travel speed, and air pressure work best for various materials.

Recovery

Recovering from Estop

Rotate the Estop switch to release it.
Reset your Tools, X, Y, zero’s and the Torch height.
Enable the machine
Reset the Gcode
Restart your program.

Recovery

Recovering from Stop

Resolve the issue.

Depending on the problem, reset your X, Y, zero’s

Reset your Gcode

Restart your program

Recovery

Hitting a Limit Switch

There are no limit switches on this machine.

If you reach the end of travel in any of the axes, the machine will vibrate while trying to continue motion.

Click stop, move your work to a more suitable location (check your Gcode to be sure it is not exceeding the bounds of the machine) and restart

Going Wrong

1. Hit a clamp, screw, or other object you didn't mean to cut - Stop the machine, re-reference the machine, Reset and start over
2. Too much power. You can adjust the Plasm Torch Power Source Amperage on the fly.
3. Too little power. Increase the Amperage on the Plasma Torch Power Source.
4. Torch does not strike. Click Stop, Reset, and start again.
5. Torch does not stay struck. Check the torch height (might be too much) and confirm the ground clamp is in place.
6. Toolpath not cutting in the right place. Reset X and Y zero.

After Job

Wait The metal will be **HOT** after cutting. Allow time for it to cool and be cautious when touching cut parts or the metal they were cut from.

Use pliers to move hot metal pieces.

After Job

Turn off the Torch Cooler
Turn off the Plasma Source
Turn off the air valve
Turn off the main power box
Turn off the control cabinet by rotating the green power button
Exit Mach4
Shut down Windows
Turn off the red switch on the lower left hand side of the control cabinet.

Materials

Do and Do Not Cut List

DO cut

Metal. 1mm to 35mm thick

18 gauge to 1¼ inch thick.

Cut with Care

Aluminum up to ½ inch thick.

Other conductive Metals

Tests will be required to determine power, pressure and cut speed.

DO NOT CUT

Any non-conductive material

Other Tips

If something goes wrong, try not to move your piece or change X,Y, zero

You can do repeatable cuts by putting your material in exactly the same place each time, or leaving enough room for error

A good fixture will help with repeatability and consistency.

Mach4 and the Torch Height Controller have lots of adjustments. Experimentation will likely be necessary to find settings for the best cut quality.

Consider using a registration mark to confirm X Y Zero

Mach4 ‘run Gcode from line number’ functionality works quite well.