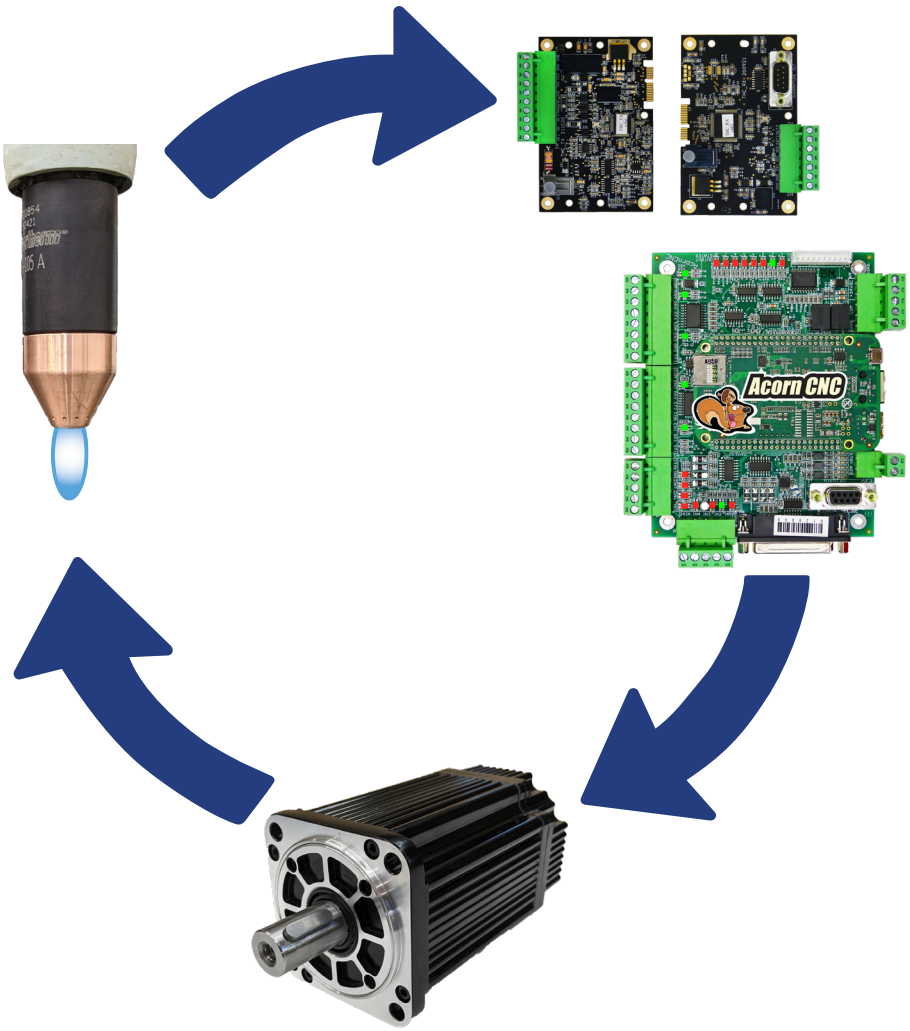
CENTROID™ AcornCNC Plasma

Centroid AcornCNC Plasma Installation Manual

CNC Software version: CNC12 v5.10+
Models: AcornCNC and Centroid THC



Plasma SAFETY WARNINGS

WHEN THE PLASMA UNIT IS OPERATING, HIGH VOLTAGE LEVELS ARE PRESENT THAT ARE LETHAL FOR PEOPLE IF THEY COME INTO CONTACT WITH IT. It's important to always keep in mind that the voltage levels present on a Plasma-equipped machine tool are lethal. Mistakes in wiring can be catastrophic.

Installation of a Plasma CNC controller and THC should be performed only by individuals trained and qualified to do the task. Before completing the installation procedure and working with the equipment, it is required to read and understand the user and installation manuals. It is necessary to be completely sure of and have full understanding of possible dangers, and also be completely assured that installation can be performed in a safe manner. Any schematics or wiring hookup instructions presented on Centroid's website or in the online forums are incomplete educational examples for discussion only. The user or DIY'er is creating his/her own CNC device, which may include dangerous lethal voltages, powerful motors, and resulting dangerous unexpected forceful motion of dangerous cutters and fast-moving heavy machine parts. If you are not qualified to accept all responsibility and/or you do not agree, DO NOT PROCEED and request a refund.

AcornCNC LIMITED WARRANTY

By accepting delivery of or operating this product, you the buyer accept all of the terms of this warranty. If you do not wish to accept the terms of this agreement, immediately call to make arrangements for the return of the product.

Centroid warrants to the original purchaser that any part of its product purchased will be free of defects in workmanship and parts for a period of twelve (12) months from the date of delivery (hereinafter "Warranty Period"). During the Warranty Period, Centroid will, at its option: (1) provide replacement parts necessary to repair the product; (2) replace the product with a comparable product; or (3) refund the amount that the customer paid for the product upon its return. Replacement parts or products will be new or serviceability used, comparable in function and performance to the original part or product, and warranted for the longer of thirty days for the US or the remainder of the warranty period. Any additional purchases or upgrades will not extend this warranty. This product warranty covers normal use only. This product warranty does not cover damage caused during shipment and any damage caused by actions that are beyond Centroid's control, including without limitation: impacts, fluids, fire, flood, wind, earthquake, lightning or similar disaster, war, lockout, epidemic, destruction of production facilities, riot, insurrection, or material unavailability; unauthorized modifications, attachments or peripherals; improper use, environment, installation or electrical supply; improper maintenance; any other misuse, abuse or mishandling. Except for the warranties expressed in this agreement, Centroid disclaims all other warranties, either express or implied, including implied warranties of merchantability or fitness for a particular purpose, other than those warranties implied by and incapable of exclusion, restriction or modification under the applicable law. The term of any implied warranties that cannot be disclaimed are limited to the term of this agreement. Centroid's and customer's maximum liability to the other is limited to the purchase price customer paid for products or services plus interest as allowed under the applicable law. Neither the customer nor Centroid will be liable to the other for property damage, personal injury, loss of use, interruption of business, "down time", customer's time, loss of use of related equipment, lost profits, lost data or other consequential, incidental, punitive or special damages, however caused, whether for breach of warranty, contract, tort (including negligence), absolute or strict liability or otherwise, other than those damages that are incapable of limitation, exclusion or restriction under the applicable law. Acorn CNC is an educational DIY (do-it-yourself) product. Centroid makes no warranties or claims of safety or suitability for any application. Any schematics or wiring hookup instructions presented on Centroid's website or in the online forums are incomplete educational examples for discussion only. The user or DIY'er is creating his/her own CNC device, which may include dangerous voltages, powerful motors, and resulting dangerous unexpected forceful motion of dangerous cutters and fast-moving heavy machine parts.

If you are not qualified to accept all responsibility and/or you do not agree, DO NOT PROCEED and request an RMA# for a full refund.

Overview: Centroid Acorn Plasma CNC controller Setup and Commissioning Steps

Perform these setup tasks in order:

1.) Perform the Acorn Communications Bench Test and then the THC Kit Bench Test. It is imperative to bench test both the Acorn and THC boards (RX and TX) before installing into a cabinet or hooking up to the Plasma Unit.

2.) CNC control wiring and configuration using the Acorn Wizard (see the Acorn Installation Manual for non-plasma related wiring and configuration, such as axis motor drive wiring and setup, overall turns ratio, homing options, etc.): https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/centroid_acorn_install_manual.pdf

If using open-loop stepper motors, it is imperative that the motor, drive, and power supply be matched/balanced with the proper supplied voltage and amps, as well as wired and configured properly. Be sure to follow the guidance found here from GeckoDrive: https://www.geckodrive.com/support/step-motor-basics.html

It is imperative that the mechanical design of the machine operates so that 1.5 to 2.5 turns of the axis motor yields 1" of travel on both the X- and Y-axes. Direct 'Axis Motor to Rack Pinion'-driven machines do not provide the best cutting results. A gear box or belt reduction is highly recommended on rack-driven machines.
Typical gear box ratios used on rack-drive Plasma machines are
5:1 and 3:1.

Ensure Machine design is in the "Plasma Sweet Spot" before proceeding. See Page 10 of this manual for more details.

3.) Review and verify that proper grounding techniques have been followed. See the attached Hypertherm Service bulletin: "Recommended Grounding and Shielding Practices". The guidelines here are critical for plasma machine operation and reducing the possibility of shorting out the THC board.

Triple-check the Plasma Unit CNC Torch Voltage output and related wiring to the TX board. The TX board is designed to read 0-10 VDC, and if any higher voltages are run into the TX board, the board will be destroyed. Measure and test for proper grounding and wiring before firing the Torch for the first time. Improper grounding and wiring can lead to a Plasma arc voltage path to the TX board and destroy it (destroyed TX boards can be replaced by contacting CENTROID support).

4.) Choose the Torch Touch-off method and follow the THC Wiring and Plasma-specific setup information found in this document.

5.) Verify the Torch Touch-off and Breakaway functionality.

6.) Verify basic torch function with the Torch Test Fire button on the VCP.

7.) Load a Materiel Profile using the Centroid Plasma Profile Manager and select a Profile to match the material being used to run the calibration test.

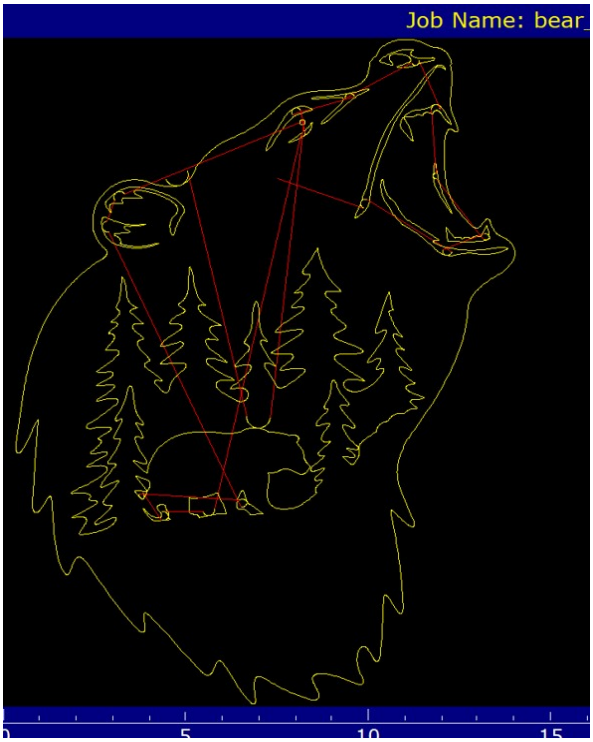
8.) Run the Torch Arc Voltage Calibration macro.

9.) Load and cut the Centroid test plate plasma G-code program to verify operation.

Introduction: Centroid Plasma G-code programs are designed to be used in conjunction with a material profile. A material profile is a set of Plasma CNC values for a particular torch type/amperage and material type and thickness. The G-code program that defines the geometry itself does not contain these values managed by the Profile manager such as pierce height, target voltage, cut height, etc.. This information is provided by the material profile. This method of separating Geometry from Plasma settings provides advantages, such as the ability to quickly change plasma-related settings without having to go back to the CAD/CAM system to generate a new G-code program. It also allows the same G-code program to be run with any material profile. This means one G-code program for any material thickness or type.

Below is an example of a typical Centroid Plasma G-code program
(this G-code was created with SheetCam, the Centroid Plasma sheet cam post processor that is available for download here along with a Fusion 360 post, videos and discussion.
https://centroidcncforum.com/viewtopic.php?f=65&t=7660

```
;Filename: bear_23x23.tap
;Post processor: centroid_plasma_thc_sheetcam.scpost
;Date: 1-21-2022
G20 ;Units: Inches
G90 ; Absolute positioning
M65 ; Loads the profile selected in the Profile Manager
;Operation: Inside Offset, Under Bear, T1: 0.060 Steel Plasma
G0 X10.3078 Y7.1462
M61 ; Performs Torch Touch off and Pierce Cycle
G2 X10.4878 Y7.166 I0.0998 J-0.0801
G1 X10.763 Y6.9451
G1 X10.314 Y6.9368
G3 X10.1121 Y7.1204 I-0.3355 J-0.1661
G3 X10.1095 Y7.1213 I-0.0105 J-0.0276
G3 X10.0053 Y7.1233 I-0.0561 J-0.2024
G3 X10.0012 Y7.1221 I0.0068 J-0.0288
G2 X9.896 Y7.1735 I-0.0291 J0.0739
G1 X9.8954 Y7.1751
G2 X9.8817 Y7.2354 I0.2442 J0.0875
G1 X9.8816 Y7.2362
G2 X9.8802 Y7.2819 I0.2124 J0.0289
G2 X9.9898 Y7.6885 I1.2866 J-0.1287
G2 X10.0437 Y7.7657 I0.2517 J-0.1182
G3 X10.0453 Y7.7675 I-0.021 J0.0208
G2 X10.0986 Y7.7702 I0.0279 J-0.0234
G1 X10.0995 Y7.7694
G2 X10.1288 Y7.7344 I-0.1061 J-0.1184
G1 X10.141 Y7.7133
G3 X10.2179 Y7.4412 I1.6518 J0.3199
G3 X10.2818 Y7.3269 I0.4091 J0.1538
G3 X10.3452 Y7.2803 I0.114 J0.0889
G1 X10.4878 Y7.166
G2 X10.5075 Y6.986 I-0.0801 J-0.0998
M62 ; Performs Torch End Cycle
```



As you can see, the geometry of the plasma cuts consist of G1, G2, and G3's with no feed rate and no Z-values (note: this example program is included with the CNC12 Plasma software installation and can be found by pressing F2 LOAD from the main screen of CNC12).

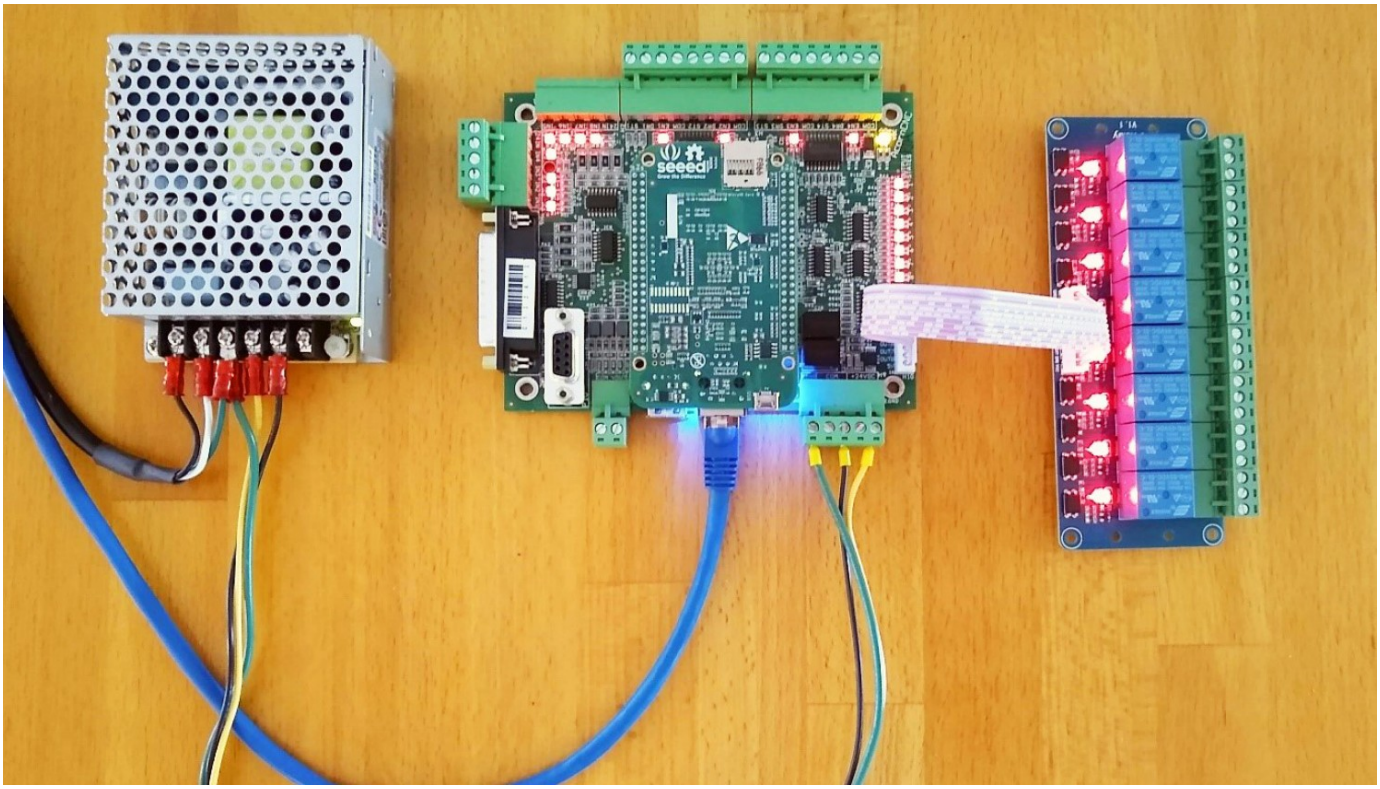
Centroid Acorn Plasma Setup and Configuration

1.) **Acorn Communications Bench Test**. Follow the bench test procedure found here (note the requirements):
https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html

Acorn CNC12 Plasma Software is available for download here:
https://www.centroidcnc.com/centroid_diy/centroid_cnc_software_downloads.html

Please review the requirements and follow the bench test procedure to the letter. Here are highlights that are not to be overlooked:

- CNC PC requirements, especially the SINGLE CORE benchmark requirements (note: this does not mean a single core CPU, which is impossible to find these days anyways). The single core bench mark of 1500 is the performance rating of ONE of the cores of the CPU, NOT the overall score (combined core performance). Laptops are not recommended.
- Use a 1920x1080 display resolution.
- Properly preparing/configuring Windows 10/11 for CNC PC use. It is imperative that the Centroid guidelines are followed. These guidelines can be found here:
https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html
- UPDATE WINDOWS! Centroid CNC software requires the latest .net framework. Make sure that the CNCPC has the latest Windows updates before continuing.



After completing the Acorn Communications Bench Test procedure above.

Perform the RX and TX Bench Test

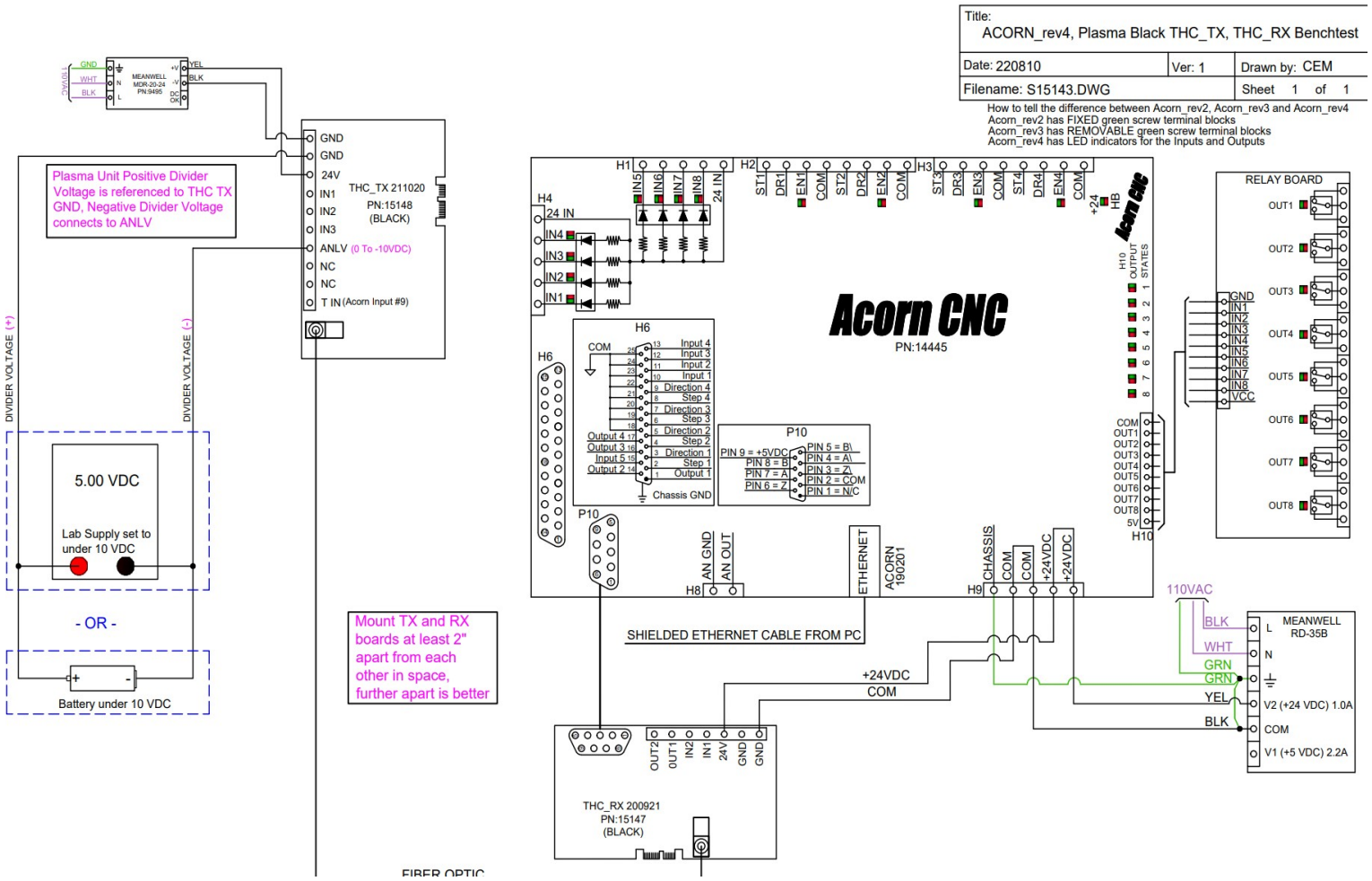
To bench test the Centroid THC with the Acorn controller, hookup the RX and TX according to schematic #S15143.

Do not connect to the Plasma unit at this time.

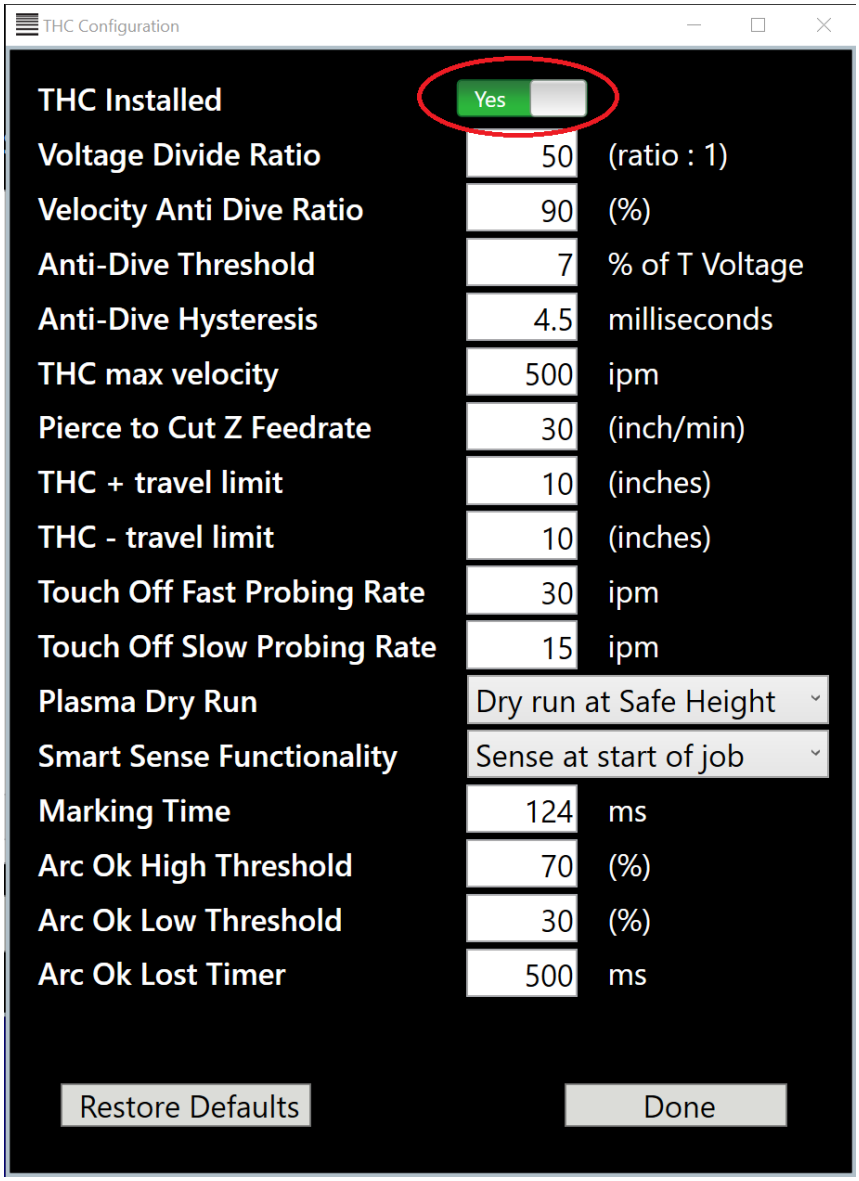
Do not bend the fiber optic cable tighter than a 2” radius, and hold it by the plastic end connectors when installing the cable into the sockets on the RX and TX boards. You will hear a distinct “click” when the fiber is fully seated into socket. Do not pull on the black fiber cable to remove the fiber cable from the socket, instead use the ridge on the plastic connector to pull up on the connector when removing the fiber from the socket on the TX/RX boards.

https://www.centroidcnc.com/dealersupport/schematics/uploads/s15143.r1.pdf

https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php# (type in “Plasma” in the search to see all)



Once the THC boards have been set up in bench test configuration, be sure to set the “THC Installed” selection in the THC configuration menu to “YES”. This is found in the Profile Manager.

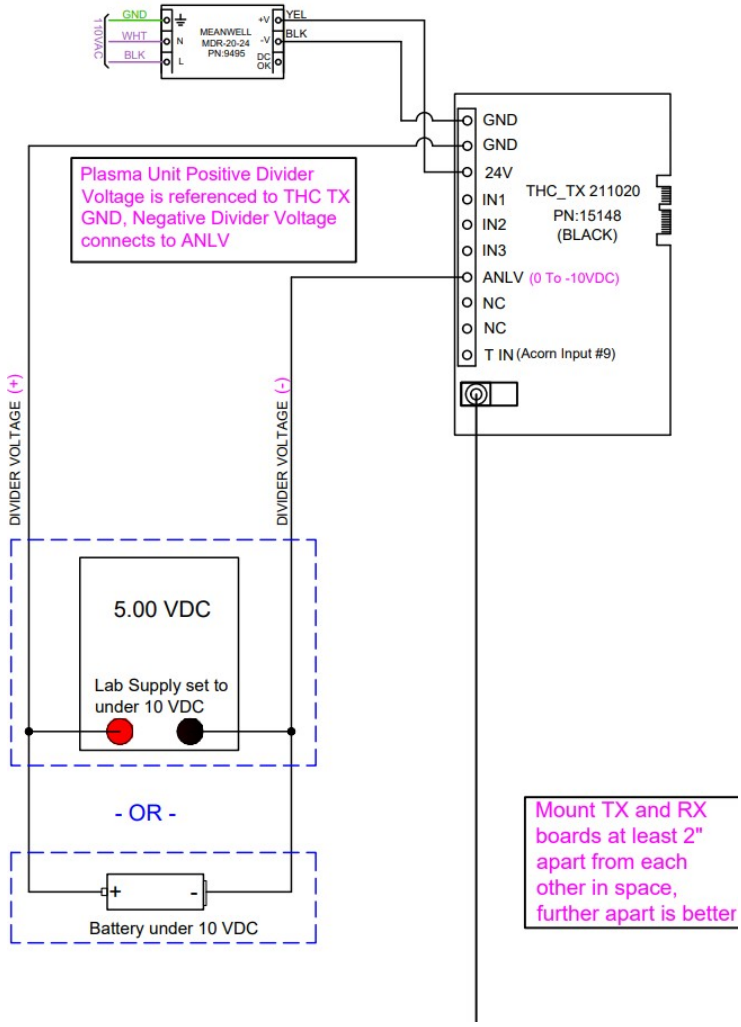


Perform THC RX and TX Voltage Signal Bench Test

- Connect a DC power source, such as a Battery or Lab Supply to the TX board.

Note the color of the THC boards and follow the corresponding schematic.
Early THC boards were GREEN and the current boards are BLACK. They are different, so be sure to use the matching schematic. Use the green schematic for the green board and the black schematic for the black board.
Green THC schematic #'s S15121, S15107,15108,15109, 15114,15123,15124
Black THC schematic #'s S15143,15138,15137,15136

BLACK THC Hook up shown



Verify with a Volt meter that the supplied voltage is actually at the TX board terminals, then run the "THC_Benchtest.cnc" TX to CNC12 Voltage signal communication Test Macro.

1.) Home CNC12 by pressing the Cycle Start button.
2.) Press F2 Load and navigate to "THC_Benchtest.cnc"
3.) Press Cycle Start to run the "THC_Benchtest.cnc" macro
4.) The test macro will report the Voltage that CNC12 is measuring with a message on the screen.

Once the test voltage signal has been verified by the macro, power down and continue with the installation.

2.) Once the bench tests have been performed, it is time to install, setup, and configure the XYZ axes to get basic CNC motion.
See the Acorn Installation manual for non-plasma related wiring and configuration, such as axis motor drive wiring and setup, overall turns ratio, homing options, etc.
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/centroid_acorn_install_manual.pdf

Below are Important details for good Plasma machine performance not to be overlooked:

- When using open-loop stepper motors, it is imperative that the motor, drive, and power supply be matched/balanced and configured properly. Just because it runs does not mean it is configured properly for best performance. Be sure to follow the guidance found here from GeckoDrive:
https://www.geckodrive.com/support/step-motor-basics.html

Better yet, use any of the affordable Closed-loop Stepper or AC Motor/Drive packages now available. There are really not a lot of cost savings in using open-loop steppers any more, and the performance advantages of closed-loop is tremendous in terms of operational time savings and machine performance (better/smoother cuts with less waste/mistakes, not losing steps like an open-loop stepper, etc.).

- The Plasma Machine Gearing 'sweet spot' for mechanical design is so that the machine operates with 1.5 to 2.5 turns of the axis motor yielding 1" of travel for the X- and Y-axes. Direct Axis Motor to Rack Pinion-driven machines do not provide the best cutting results. A gear box or belt reduction is highly recommended on rack-driven machines. Arrange the mechanical parts to be in the 1.5 to 2.5 turns of the motor to be 1" of travel. Typical gear box/ belt reduction ratios used on rack-driven Plasma machines are 5:1 and 3:1. Which one you use will depend on the pinion diameter being used.

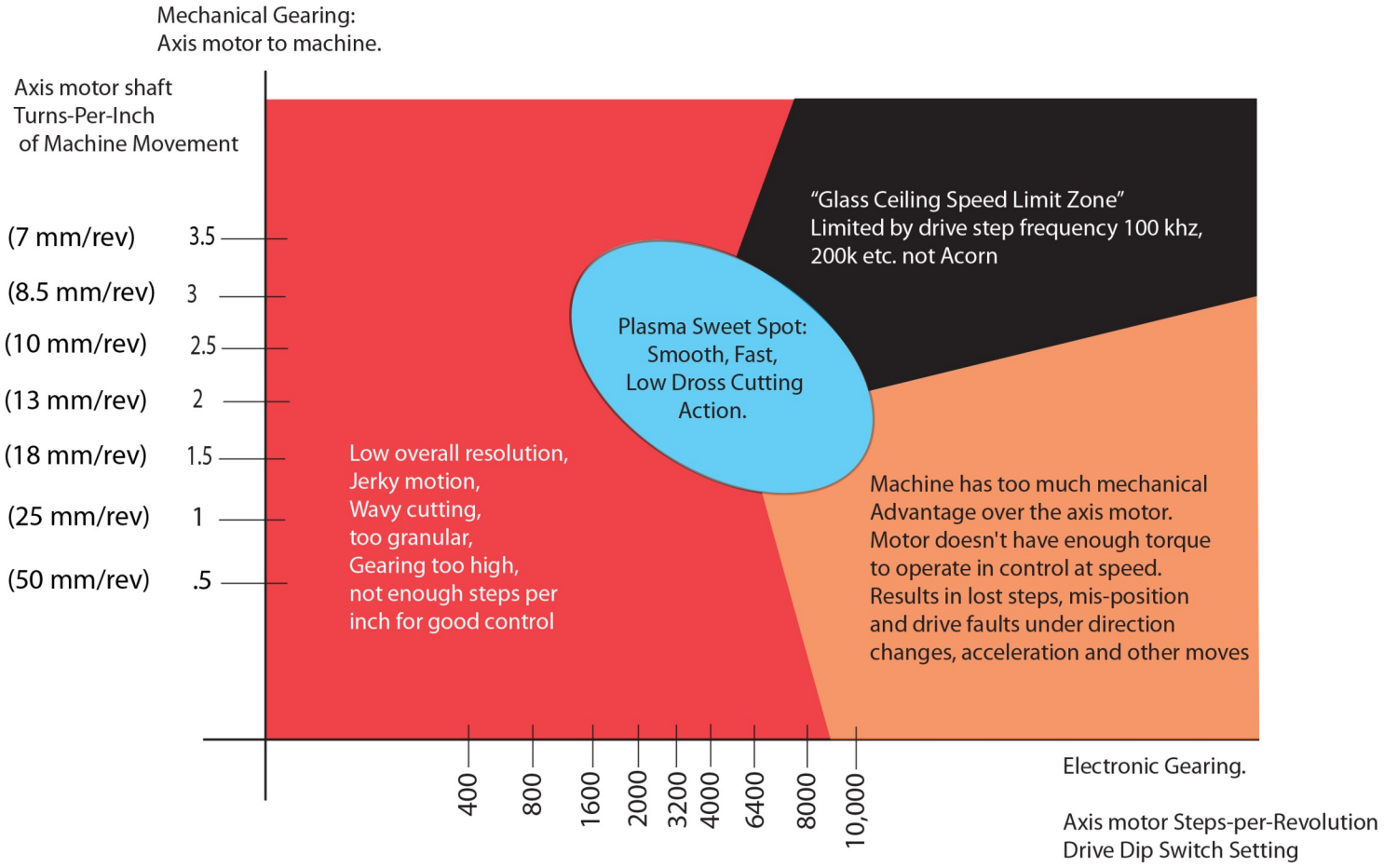
- If you are coming from Mach, LinuxCNC, or any other DIY CNC controllers, be sure to set the Acorn 'steps-per-rev' and 'overall turns ratio' properly. See this post: https://centroidcncforum.com/viewtopic.php?f=63&t=1801 "Steps per Revolution and Overall Turns Ratio, don't do it like Mach did it!"

- The Plasma Table **Z-axis** Overall Turns Ratio is ideal at 2.5 turns per inch. The range for good performance is 2.5 to 5 turns per inch. Note: More reduction results in a slower Z-axis max rate. 2.5 turns per inch is ideal. 5 turns per inch will work (a common metric ballscrew pitch is 5mm, which equals 5.08 turns per inch) and can be used. Just be sure to have a Z-axis motor that has the RPM and power rating to operate the Z-axis at a rate of at least 500 IPM reliably. It is highly recommend to use a Closed-loop motor/drive on the Z-axis of the Plasma machine.

- Axis acceleration/deceleration rates range from .2 to .4 seconds and are typical for good plasma table operation. Lower values (faster) can be used on a properly-built (rigid) and properly-geared (in the sweet spot described above). Start with a value in the .2 to .4 range until you get good cuts, then you can experiment with lower acceleration times after everything else is sorted.

- AC servos on all axis are the best solution. If budget is a consideration, use Closed-loop Stepper Motors as they are the next best thing. In this day and age, it is really not that cost effective to use open-loop stepper motors any more, but if you insist on using them, at least install a Closed-loop Stepper on the Z-axis. An example is this affordable unit: https://www.automationtechnologiesinc.com/products-page/nema34-closed-loop-stepper-motor-system-hybrid-servo-kit/nema-34-hybrid-servo-motor-kl34-8n-1000-rated-torque-1128-oz-in

Plasma machine gearing Sweet Spot for nice cuts and smooth action.



Plasma Machine Mechanical Gearing Sweet Spot - Axis Motor Gearing

1.) **X- and Y-axes** Mechanically build the machine so that one turn of the axis motor yields .75" of travel (19mm) or less. This results in an Overall Turns ratio value in the range of 1.5 to 2.5 turns of the axis motor per inch. All rack and pinion-driven machines will require a belt reduction or gear box reduction to achieve this, typically in the 3:1 to 5:1 reduction range depending on the rack and pinion chosen. Note: Direct driving the rack pinion with the axis motor will result in poor cuts.

Z-axis The overall turns ratio mechanical gearing sweet spot is in the range of 2 to 5 turns-per-inch.

Note: Calibrate and Test that the machine moves 1" when commanded to move 1" on all axes before attempting any plasma cuts!

2.) Axis motors sized and configured properly to move the machine without risking losing steps or stalling at the fast feed rates required for the material that is intended to be cut. Test the machine max rates before cutting any material!

3.) Free and easy axis motion with no sticky spots or other problems. When the axis motor is disconnected, moving the axis back and forth by hand should be smooth, consistent, and easy.

4.) The machine is rigid enough not to shake, flex, move, vibrate, or shutter when moving at typical cutting speeds.

5.) The Gantry should be driven on both sides. This can be achieved with two axis motors being used, one on each side of the gantry paired by either hard wiring or software pairing. Another option is using a single-axis motor, but employing a torque tube drive for the other side.

Electronic Gearing Sweet Spot

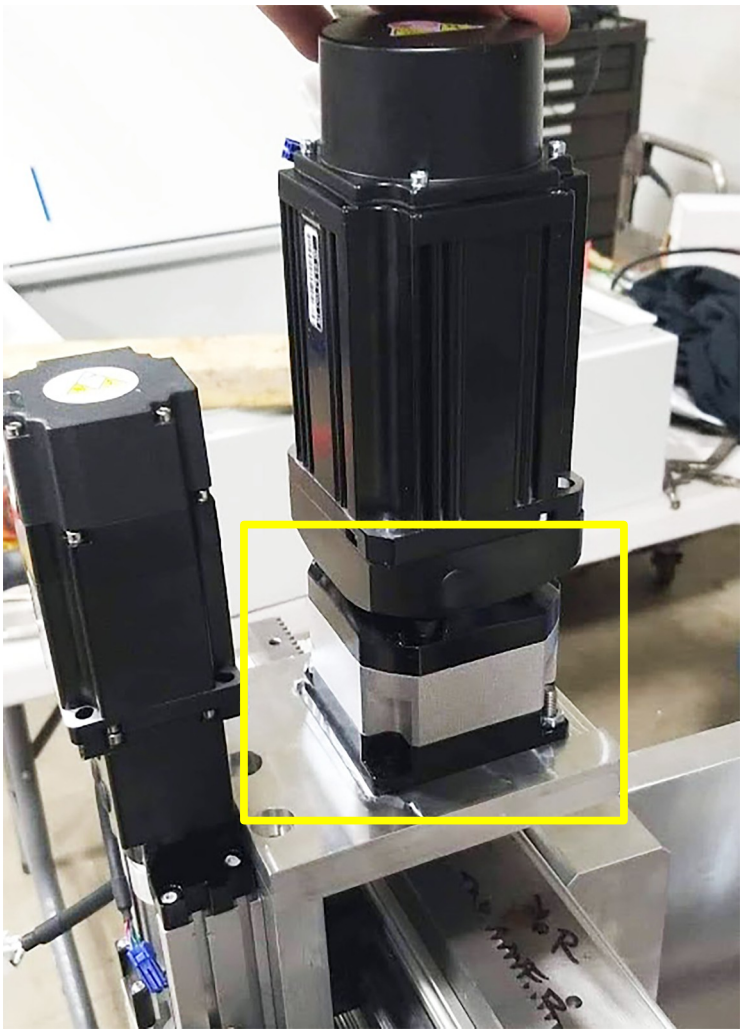
1.) Steps-per-revolution: 3200 is best. Typical values are in the 2000 to 3200 range for stepper motors. Both the Acorn Wizard and Stepper drive should be set to at least 1600 steps-per-revolution. This is the minimum setting. 2000 is a good steps-per-rev value to use. 3200 is best and do not use values below 1600.

2.) Stepper motors are required to have proper matching power supplies (voltage and amps) with AMP settings on the stepper drive so they have the power and control to move the machine at the speeds and acceleration required for plasma cutting. Just because the motor 'works' does not mean that it has been optimized for smoothness and power. No amount of Centroid G-code smoothing will overcome a stepper motor that has too many or not enough voltage and/or amps being pumped into it, or has its phases not wired properly for the voltage of the drive power supply being used. Review https://www.geckodrive.com/support/step-motor-basics.html for more details.

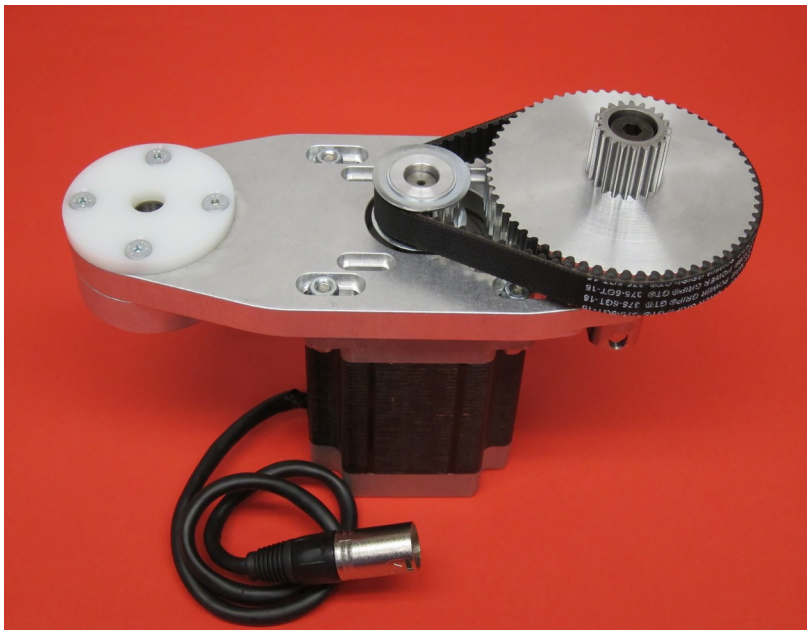
Better yet, avoid all of the hassles associated with open-loop stepper motors, and use modern technology such as AC brushless servo motors (Clearpath, Estun, Delta etc) or Closed-loop Stepper motors (Leadshine, Stepper Online). Closed-loop stepper motors do not have the same torque and control issues that open-loop units do.

3.) Axis acceleration settings: Set the Axis Acell rate within the range of .2 to .4 seconds.

Planetary Gear Box reduction is best



Single Stage Belt Reduction is a minimum viable requirement for a Plasma Machine.



Machine Homing: To home or not to home? There are two philosophies: choose to use a ‘machine home position’ or not. See below for the pros and cons of each of the two main methods:

1.) A machine coordinate system is employed. This method requires that a type of machine homing be used.

2.) No machine coordinate system is used, only a local “temporary” part zero location. This method does not require any sort of machine homing.

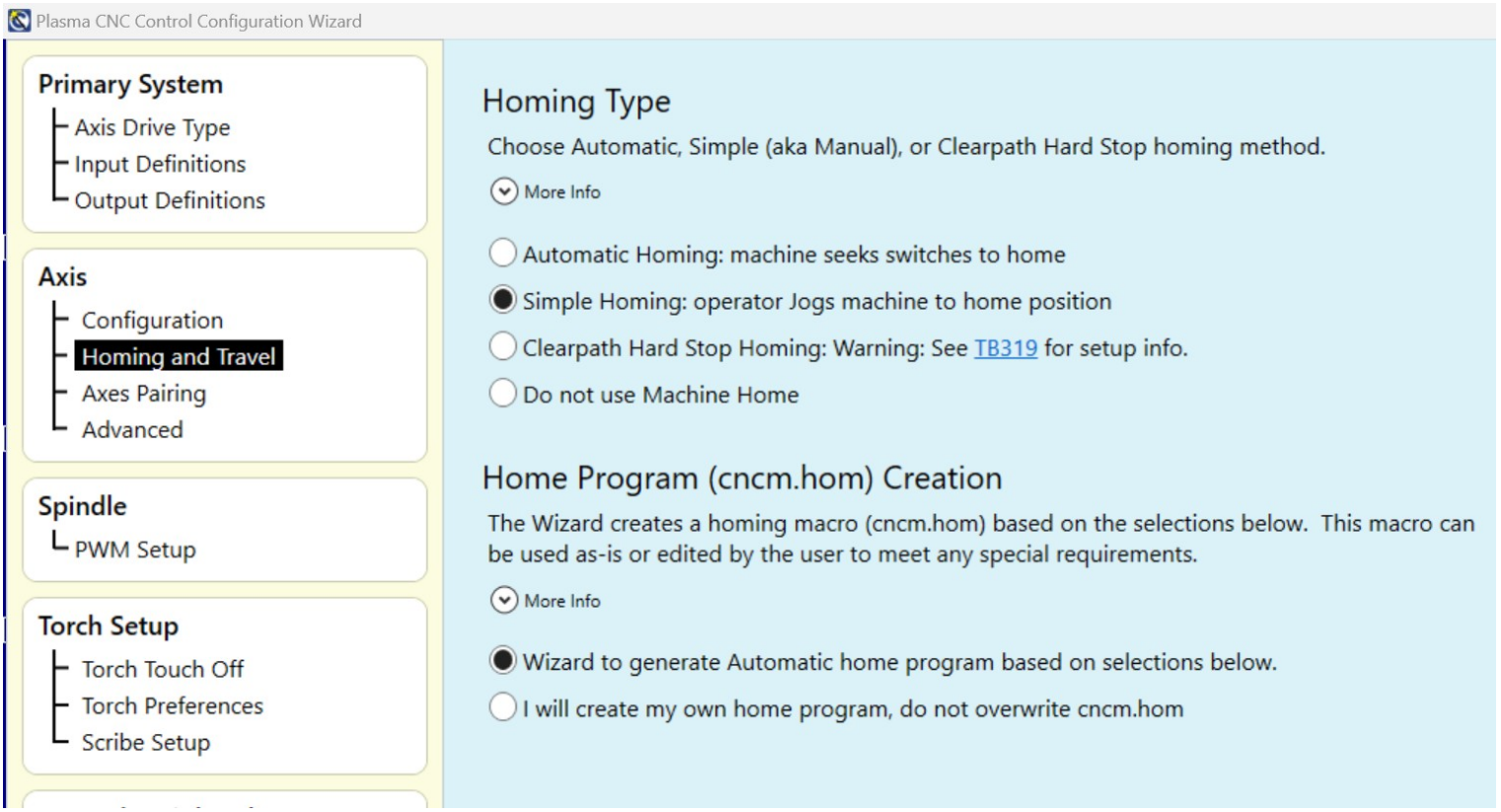
Advantages of #1
- CNC controller will ‘remember’ Part Zero Locations when powered on and off.
- CNC controller can use ‘soft travel limits’ to avoid crashes.
- CNC controller will inform the user before running a job if that job is going to fit within the work envelope based on the part zero location.
- Homing can be automatic using switches or done semi-automatic (the user simply jogs or pushes machine to home position, usually to marks on the machine or urethane hard stops) to set the home position.
- The Reset Home button on the VCP will reset the home position after a loss of steps event when using open-loop steppers.
- Auto-squaring of the Gantry can be used **or** semi-auto squaring (semi-auto = push gantry against hard stops before homing).
- A predefined Torch Tip Change location can be used along with the “Torch Check” button on the VCP.

Cons of #1
- Some view homing as an extra step before the machine can be used to cut a part.
- If the machine is constantly losing steps, having to re-home after loss of steps events when using open-loop steppers is viewed by some to be a painful and unnecessary step when the advantages listed above are not important.
- Some are confused by the use of two coordinate systems: Machine Coordinates and Work Coordinates and how they are used together when using this method.

Advantages of #2
- To some, using only the Work Coordinate System (WCS) is a simpler way of doing things.
- You never have to home the machine.

Cons of #2
- Loss of the advantages of #1. Example 1: if commanded to move 100 inches, even if there is not 100 inches of travel, the machine will do it and crash. Example 2: If the part is too large for the work envelope of the machine, or the part zero location is set at a position where the part will not fit, the machine just runs the part until it crashes, creating wasted material.
- The gantry should be square before power up of the machine, so that paired motors lock the gantry in the square position when powered up. If you forget or if the gantry gets knocked out of square while running, you will have to power cycle the machine to get it square.

Once you have made your decision, select the type of Homing in the Wizard Homing and Travel menu.



TX and RX Board mounting guidelines

- The Centroid THC supports only Plasma Units with divided voltage output. Do not connect to a Torch Voltage signal other than 0-10 VDC.

- The TX board MUST be powered with a separate 24 volt power supply
Follow the Hookup schematics and use the Meanwell 24 volt provided with the Acorn THC kit.
Search “plasma” to see all the Acorn plasma schematics.
https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php#

- Mount the TX board as far away from any other components in the cabinet. One of the TX’s jobs is to isolate any possible Plasma Unit voltage noise, leak, EMI, etc. So if that happens, it does not destroy the RX board, Acorn, or any other components.

- Run any wires from the Plasma Unit, Torch Head, or machine as far apart from any other control-related wires to isolate them from other wires and components.

- The Plasma Unit’s positive divider voltage is referenced to THC TX GND, see the hookup schematic for details.

- The Plasma Unit’s negative divider voltage connects to the THC TX ANLV connection.
(ANLV = Analog Low Voltage 0-10 VDC!)

- Do not bend the fiber optic cable tighter than a 2 inch radius. Do not pull on the black fiber part of the fiber optic cable to remove or insert it into the socket. Hold the Plastic end to insert or remove the fiber from the socket on the TX and RX boards.

- Follow good wiring and ground practices to avoid ground loops. Verify that the Plasma Unit Clamp and TX GND are the same and have a good, low ohm continuity with an ohm meter.

- Critical Grounding information from Hypertherm; Refer to the included Hypertherm Grounding Service bulletin, or visit the link below:
https://www.hypertherm.com/Download?fileId=HYP103900&zip=False

- Critical Machine Grounds: Run a 10 GA ground from z-axis to x-axis to y-axis to the frame, so the slides are not acting as the ground path.

- Using an Ohm meter, double-check that all the grounds are good on the table, and visually inspect connections to verify solid, clean connections of wire and connector to bare metal. Remove paint where the ground leads connect to the table.

- Target Voltage readings are always a problem in plasma, and are mostly caused by bad grounds, no grounds at all, and ungrounded tables (i.e. bad connections from the machine frame ground to the table).

- Do not coil ground leads.

- Do not coil extra CPC cable.

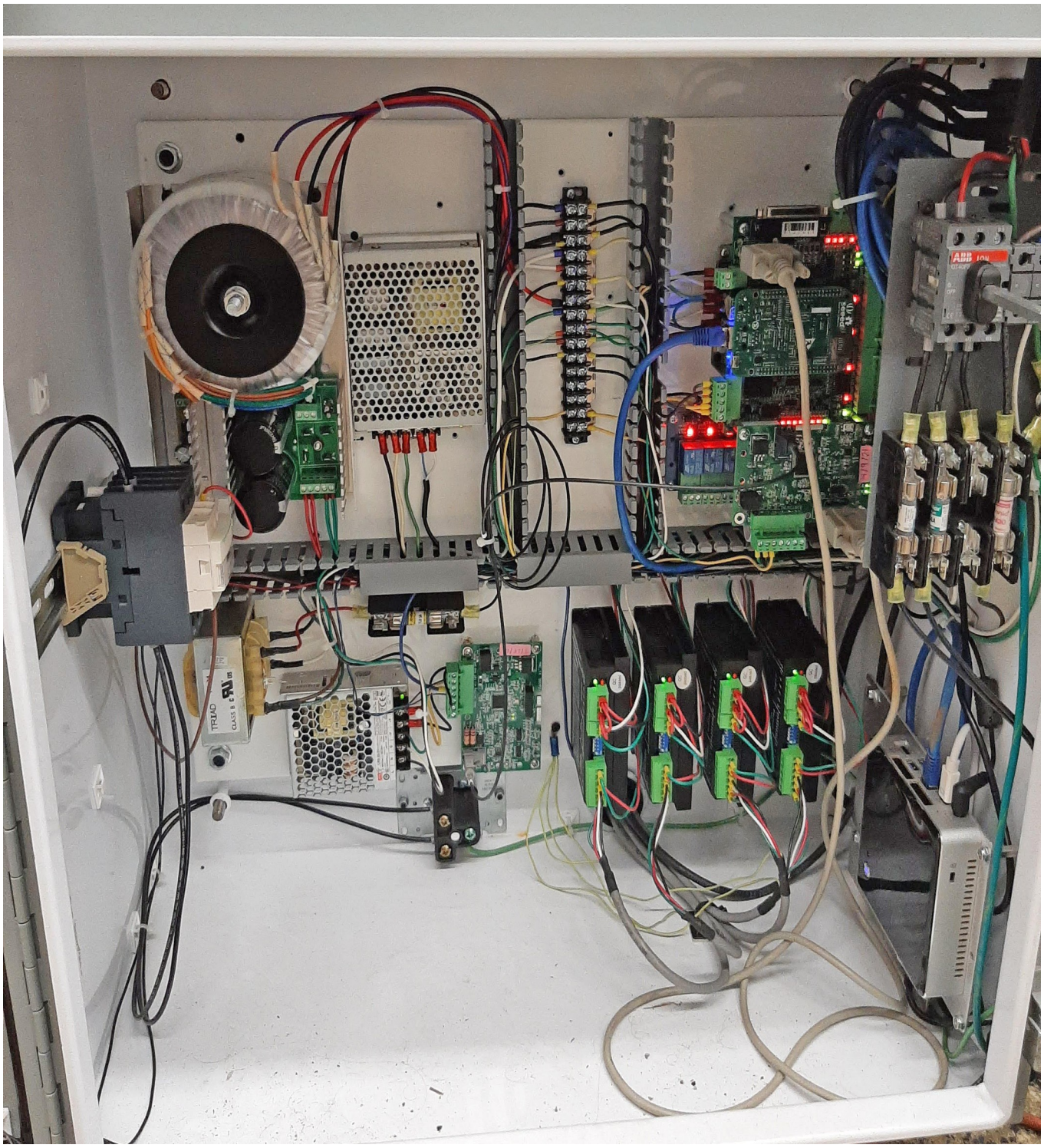
- Use a Hypertherm CPC cable.

- If DIYing CPC cable, then make double sure that the wiring and pins are crimped properly using properly-sized wires. Do not coil this wire.

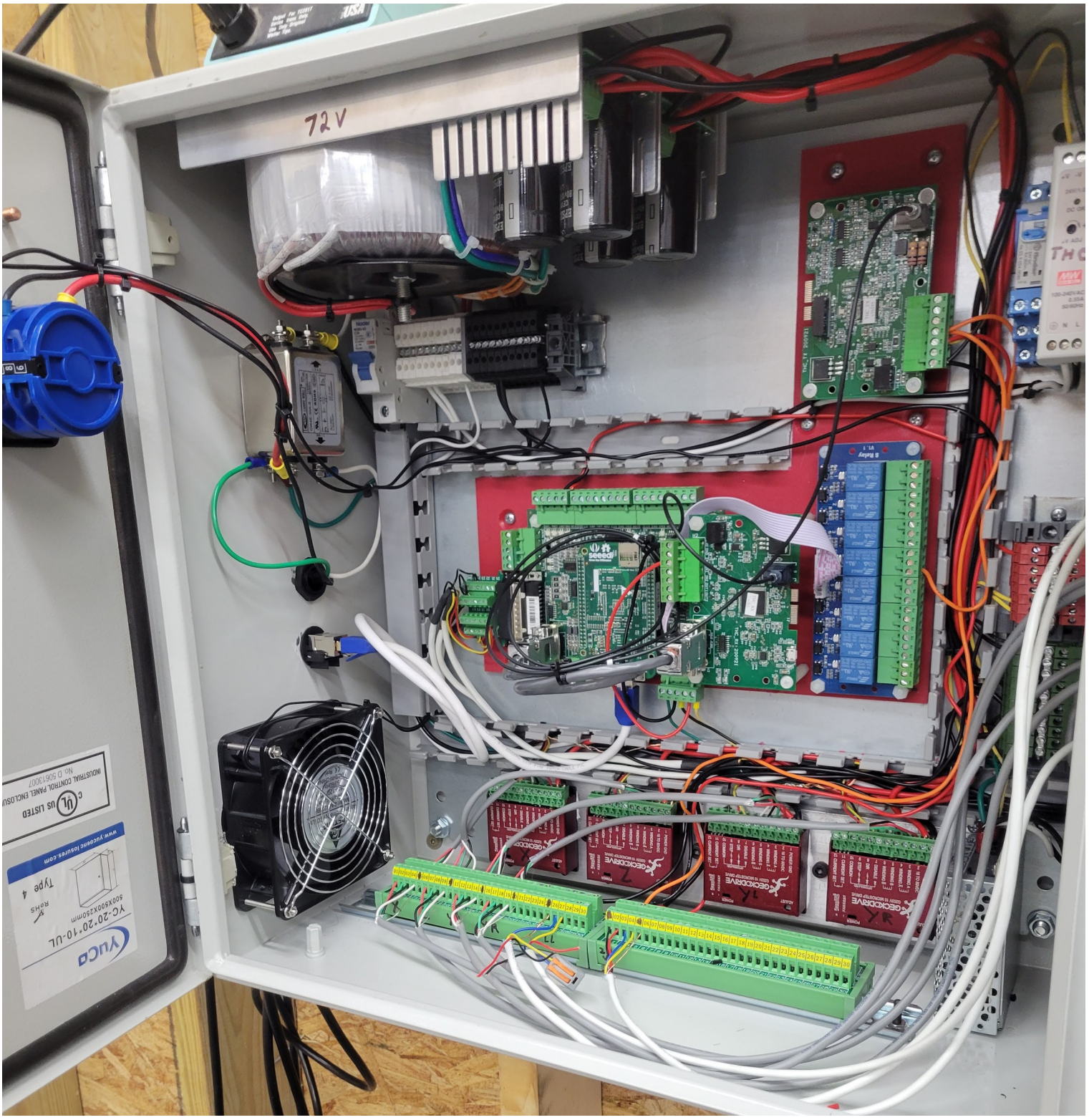
- Run any outside wires that enter the cabinet as far away from any other wires and components as possible.

- A coiled ground to the plate can alter THC voltage readings.

Examples of Centroid Acorn Plasma CNC Control Cabinet Layouts:

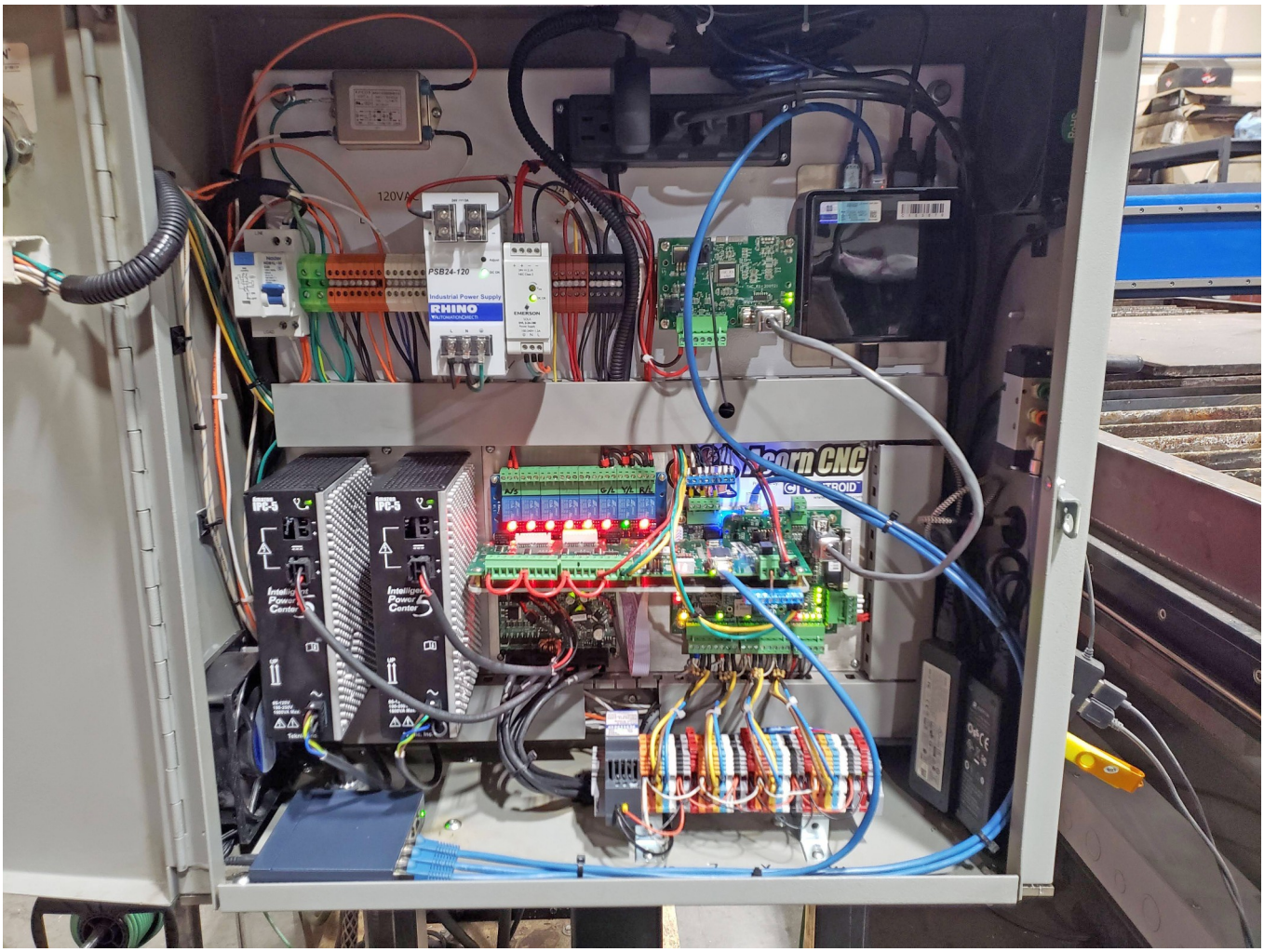


Acorn with Plasma THC RX/TX boards with Leadshine Stepper Drives, Intel NUC, and high-quality Torrid DC axis stepper motor power supply (upper left). Note: The long DB9 serial cable going from RX to Acorn as seen in the image is not recommended. Use the supplied THC kit short DB9 serial cable! Also, it would be good to have the TX board mounted further away from the stepper drives.



Acorn with Plasma THC RX/TX boards with GeckoDrive Stepper Drives, and high-quality Torrid DC axis stepper motor power supply (upper left). Stepper power supply Voltage and Amps are optimized for best stepper motor performance. The TX board is in a good location, but the TX board wires should not be in the wire track with other signal wires!

Acorn with Plasma THC and Clearpath Stepper Killer Axis motors, Intel NUC CNCPC, and Ether1616 I/O expansion board. The TX board is located in another cabinet outside of this cabinet for added noise protection!

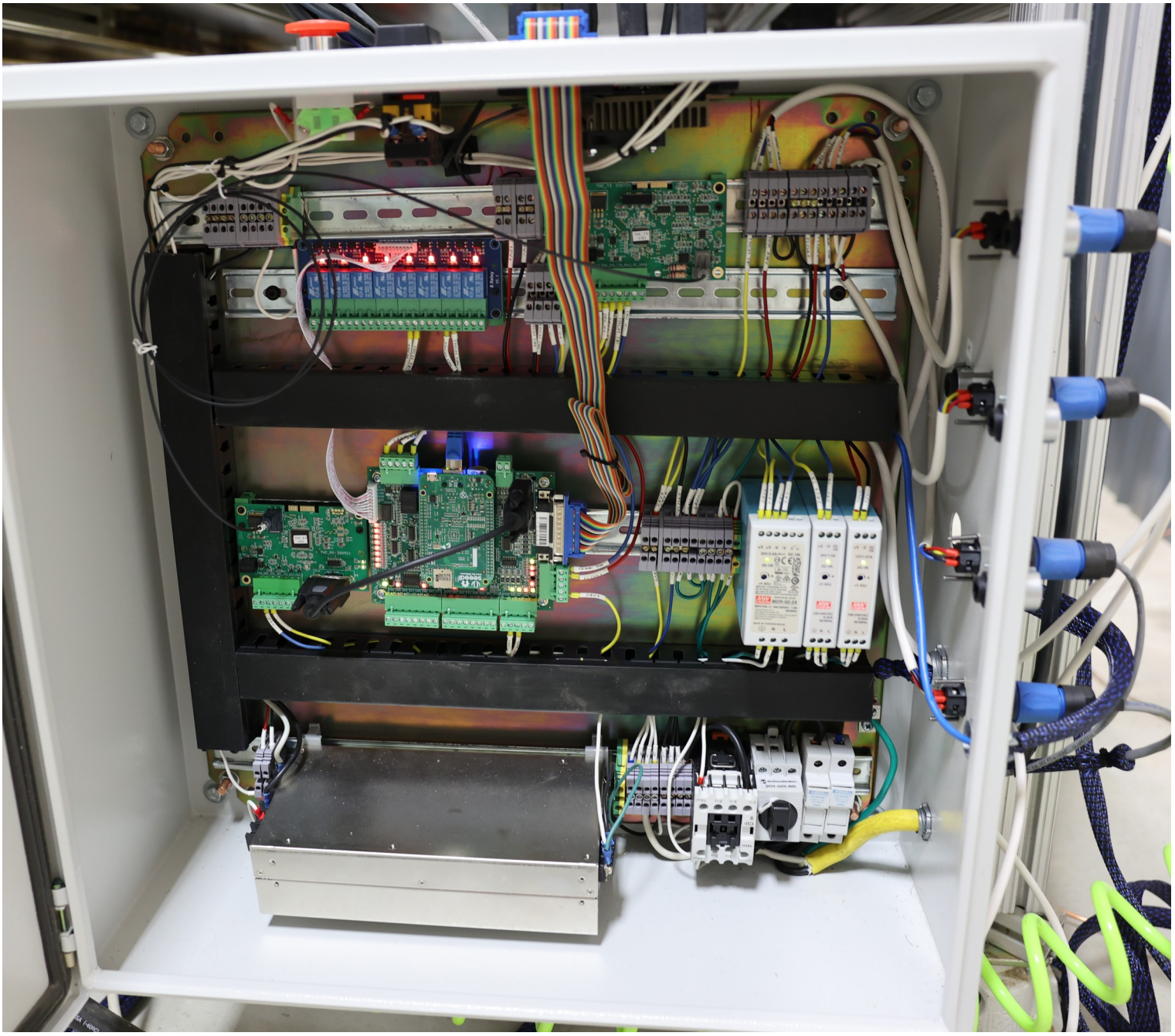


Only the TX to RX Fiber optic cable goes from the outside cabinet containing the TX board into this cabinet, therefore there is no possibility of high voltage signals getting into this cabinet!

Note: The Air solenoid seen on the mid right side should be mounted outside the cabinet and have a snubber (aka quench arc) installed across the solenoid coil (or flyback diode).

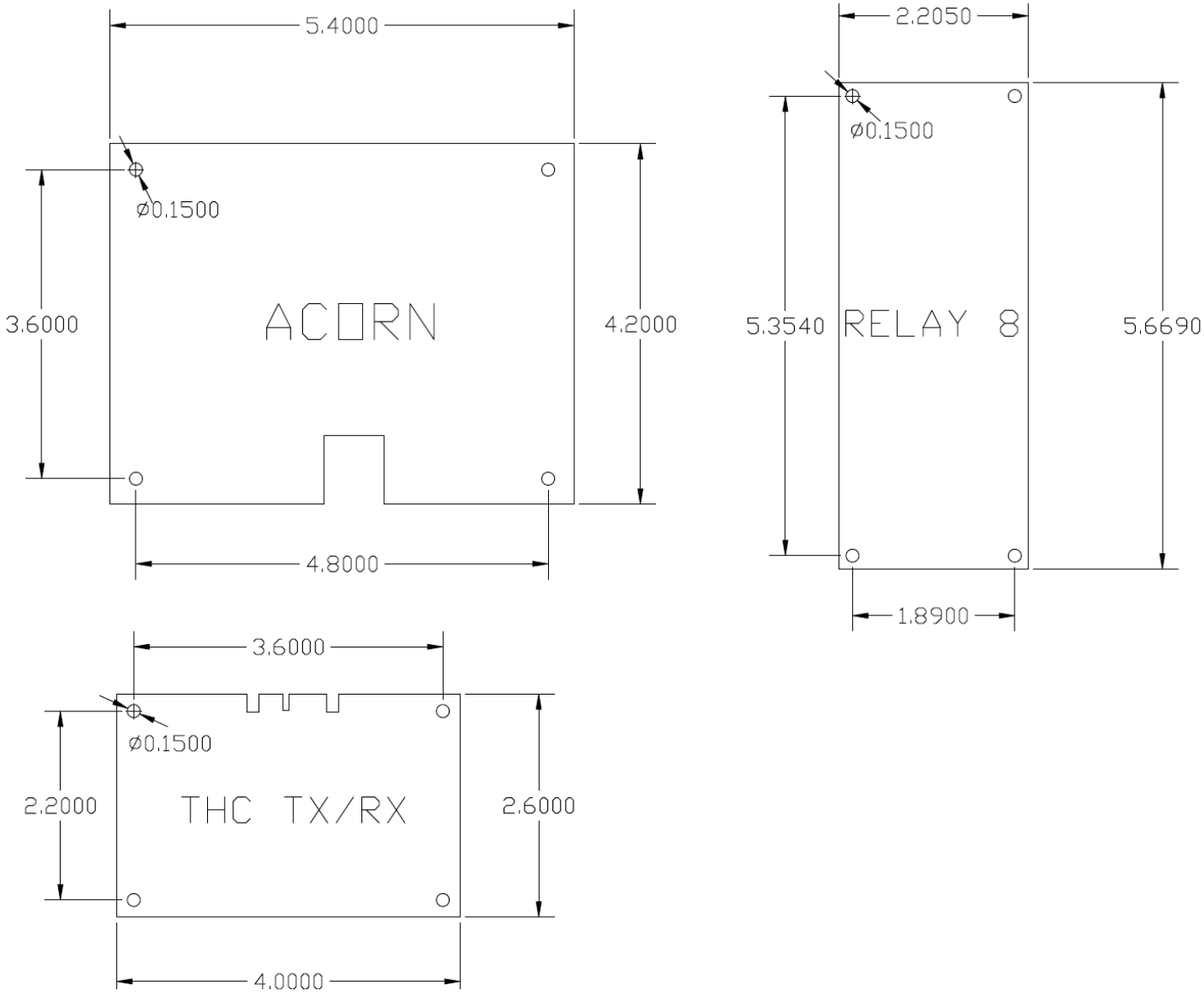
A small cabinet dedicated for the TX board and its cabling is ideal (aka a TX “wart box”). This way the Plasma Unit to TX board connections are isolated from the main CNC control cabinet, and only the Fiber Optic cable enters the main CNC control cabinet. Even better would be to also mount the dedicated 24 VDC power supply in this small TX cabinet.

Acorn with Plasma THC RX/TX boards. The stepper drives are located in another cabinet. The long ribbon cables to those drives are NOT recommended practice.



Keep the step and direction signal cables as short as possible, and use shielded, twisted pair cable for the step and direction signals.

Acorn and TX and RX size and bolt hole locations:

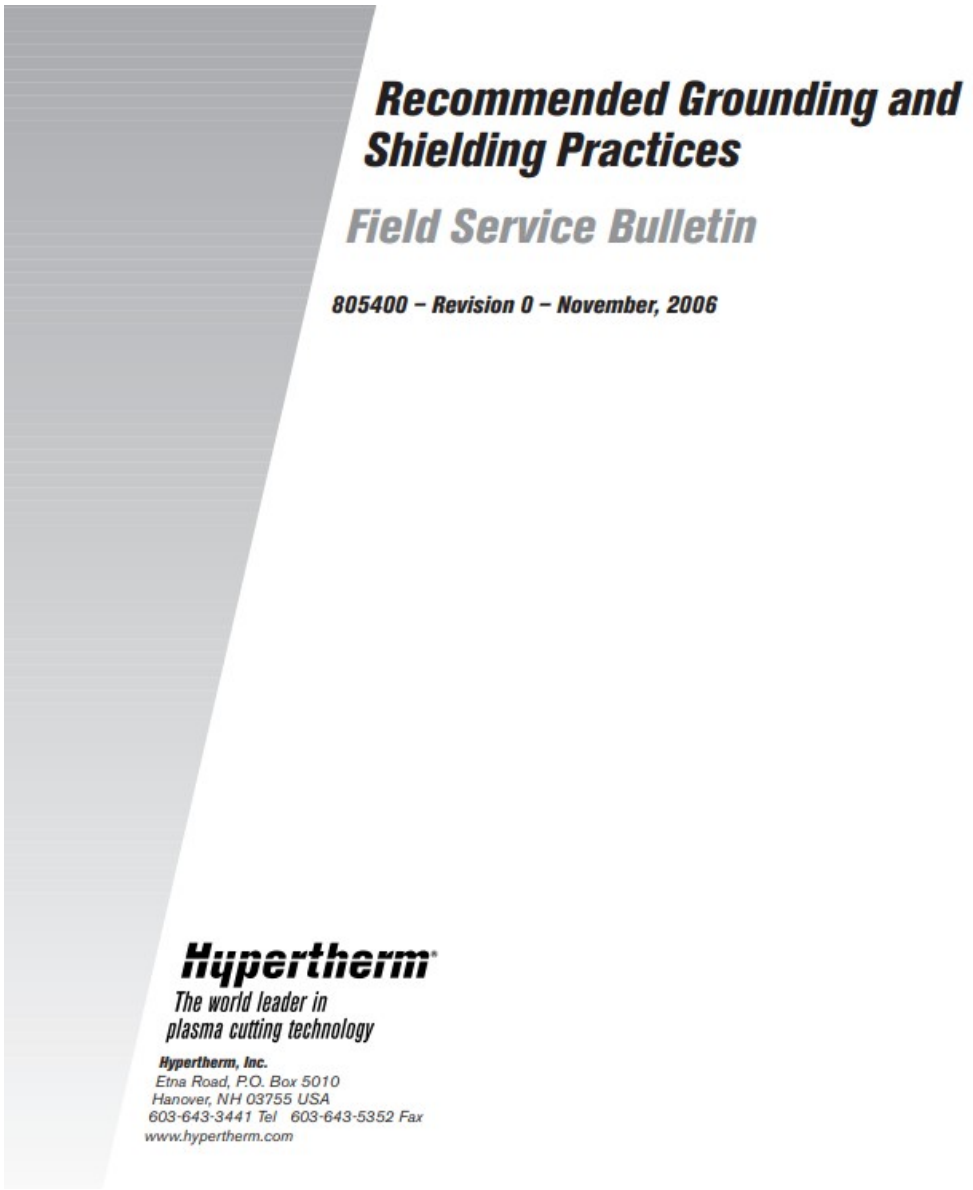


Link to DXF file of image above.
http://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn_tx_rx_dimensions.dxf

Link to solid model download. (.stp)
https://www.centroidcnc.com/centroid_diy/downloads/centroid_solid_models.zip

3.) Review and Verify That Proper Grounding Techniques Have Been Followed.

See the included Hypertherm Service bulletin: “Recommended Grounding and Shielding Practices” at the end of this manual. The guidelines here are critical for plasma machine operation and reducing the possibility of shorting out the THC board.



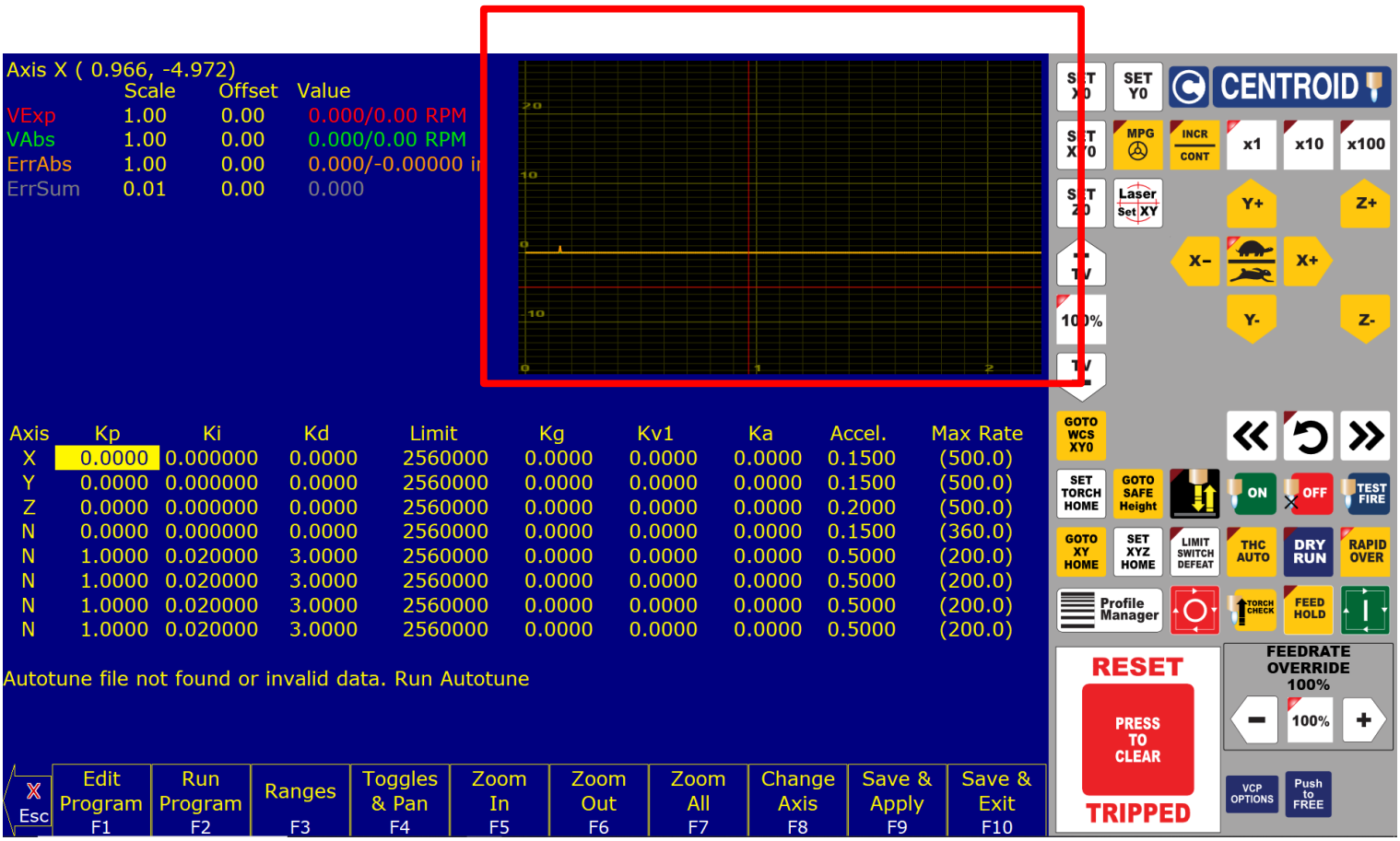
Tools for checking and testing proper grounding and finding stray voltages are using a multi meter and/or oscilloscope. Note that the Centroid THC live scope can be used to “see” stray voltages with the torch NOT running.

To check for stray voltages, make sure the torch is OFF and enter the CNC12 PID config menu.

See the THC voltage live plot by pressing
[F1 Setup menu], [F3 Config], [F4 PID], [F1 PID Config].

Below is a good Live THC voltage scope shot with the torch NOT running. Taken from our in-house Plasma machine.

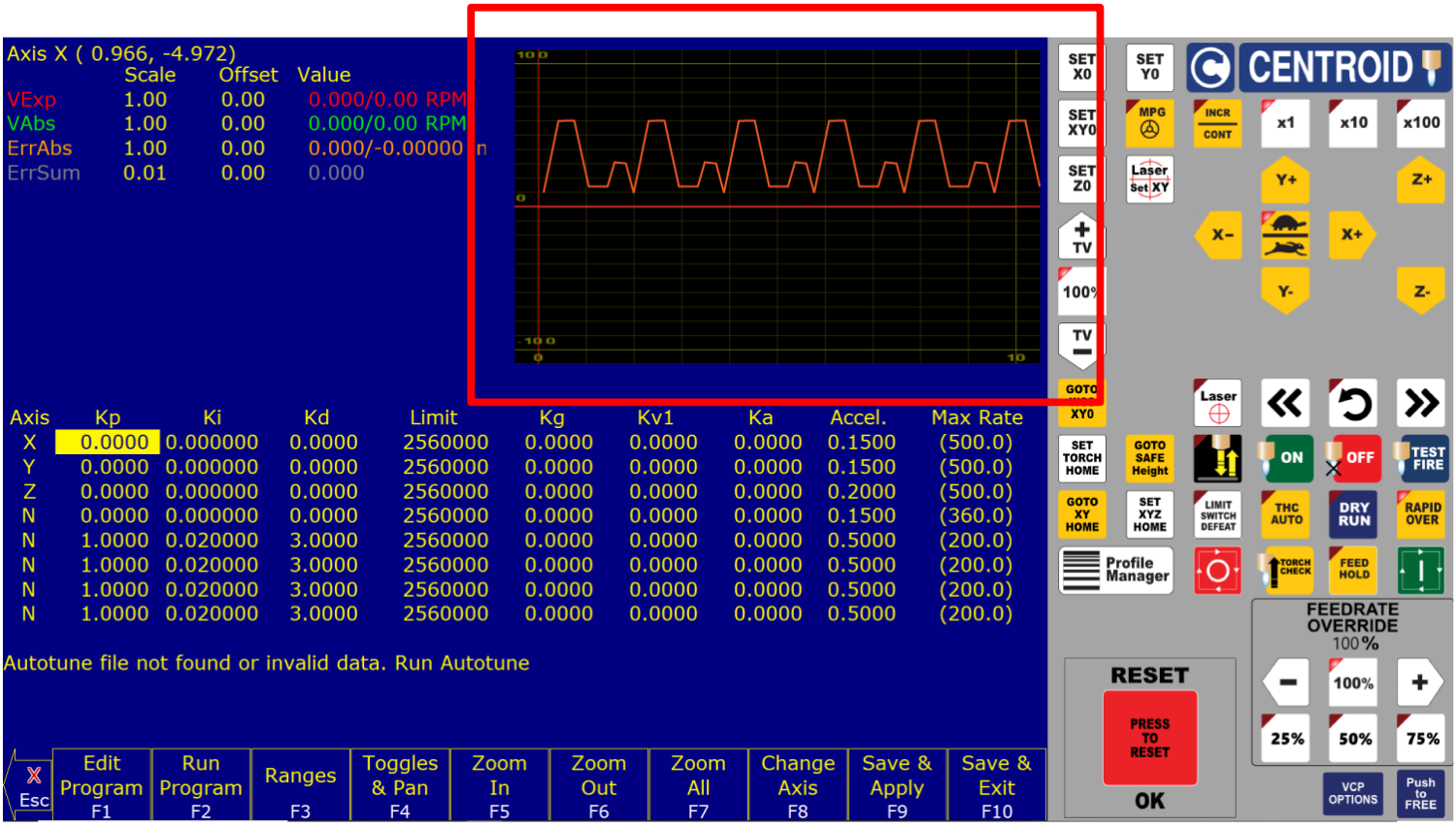
The Live Scope shot displays Volts in “counts”. The counts scale is on the left. 10VDC = 4000 counts



Any orange lines that go above 50 counts is too much stray voltage. Solve grounding issues before proceeding.

Ideal readings are less then 10 counts of stray voltage (as seen in the scope shot above from our in-house system) and can be achieved with a properly-grounded system.

Example of a Bad Scope Shot: Notice the scale on the vertical axis: 0-100 counts.
Orange lines indicate stray floating voltage in the 5-50 count range. This is indicative of grounding and shielding issues present in the electrical cabinet. Do not proceed before solving grounding/shielding issues.



In this scope shot observe the orange line not returning to zero. This is showing that the stray Voltage reading is “Floating” above zero and is an indication of grounding issues. Said another way, the orange line never goes back to zero and floats above it. To zoom in to see this on the control, hover the mouse over the scope and scroll to Zoom in/out. Click and drag with the mouse to adjust view.

4.) Choose Torch Touch-off Method.

Centroid Acorn Plasma software supports several common Torch Touch-off methods.

Method a.) The conductive Torch Tip is used as the sole method of touch-off (a straight connection or stand-alone Ohmic sensor box can be used). See schematic #15107. All Acorn schematics can be found here: https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php#

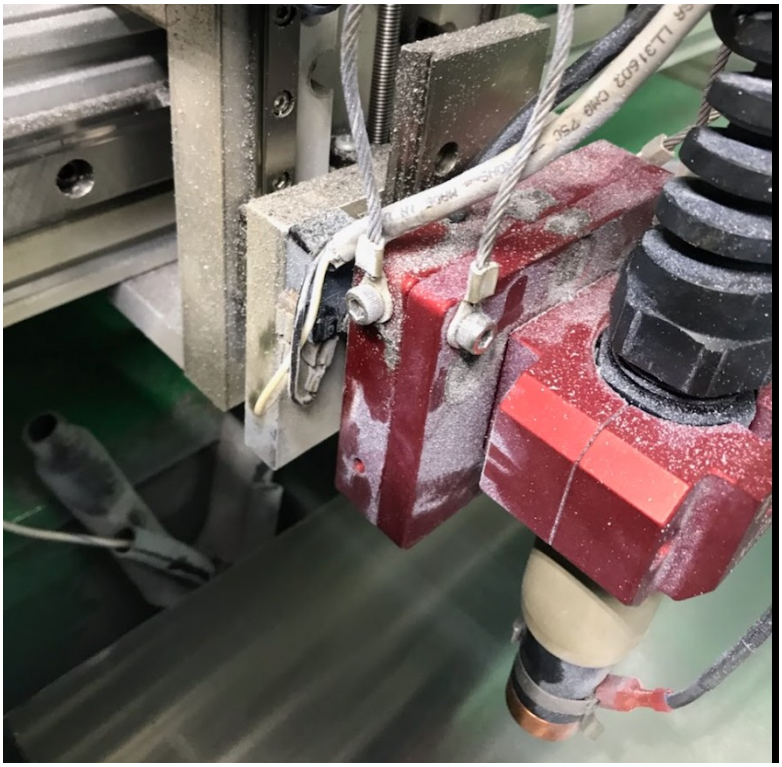
Method b.) A Float Switch is used as the sole method of touch-off. See Schematic #15109.

Method c.) The conductive Torch Tip is used in conjunction with a Float switch. See Schematic #15108.

Torch Mounts: Floating heads, Magnetic breakaway, and Round Mounts are all supported

Magnetic Breakaway Torch Mounts

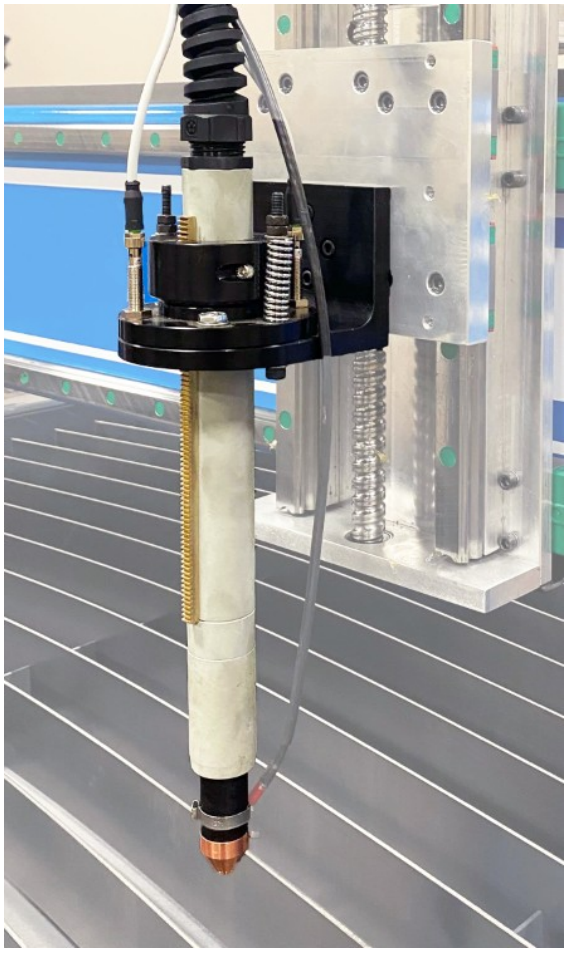
Magnetic Breakaway combined with a sliding head (Floating Head) is a good choice. This setup provides good protection with accurate Floating Head Torch touch-off performance. This torch mount set up can also be used in conjunction with ohmic/conductive touch-off. The photo on the left shows a Magnetic Breakaway mount used with an ohmic/conductive touch-off. The photo on the right shows a magnetic mount with a Floating Head Torch Touch-off.



Magnetic Breakaway with Floating Head Touch-off and Ohmic/Conductive Touch-off

Magnetic Breakaway with Ohmic/Conductive Touch-off

Round Mounts



Round Mounts are basic kinematic seats that lift and pivot in XYZ when the torch touches anything.

Round Mounts come in two flavors:
1.) A Two-sensor Round Mount
and
2.) A Three-sensor Round Mount.

Most Round Mounts can perform two functions: Torch crash protection (Breakaway) and “Float Switch” Torch touch-off sensor.

Round Mounts typically employ Proximity Sensors as the switches. Proximity Sensors also come in several flavors, make sure the round mount has NPN NC proximity switches. The Acorn Plasma system requires NPN NC proximity sensors (PNP will not work).

Round Mounts can be used to act solely as a torch breakaway sensor to let the CNC controller know that the torch has hit something. In this case, all the round mount sensors can be wired in series and connected to the Torch Breakaway input.

Round Mount heads can also be set up so that one of the proximity switches performs the Torch “Float Switch” duties and the others are used as Torch “Breakaway” sensors.

See the example wiring hookup diagram of this in S15136:
https://www.centroidcnc.com/dealersupport/schematics/uploads/S15136.r3.pdf

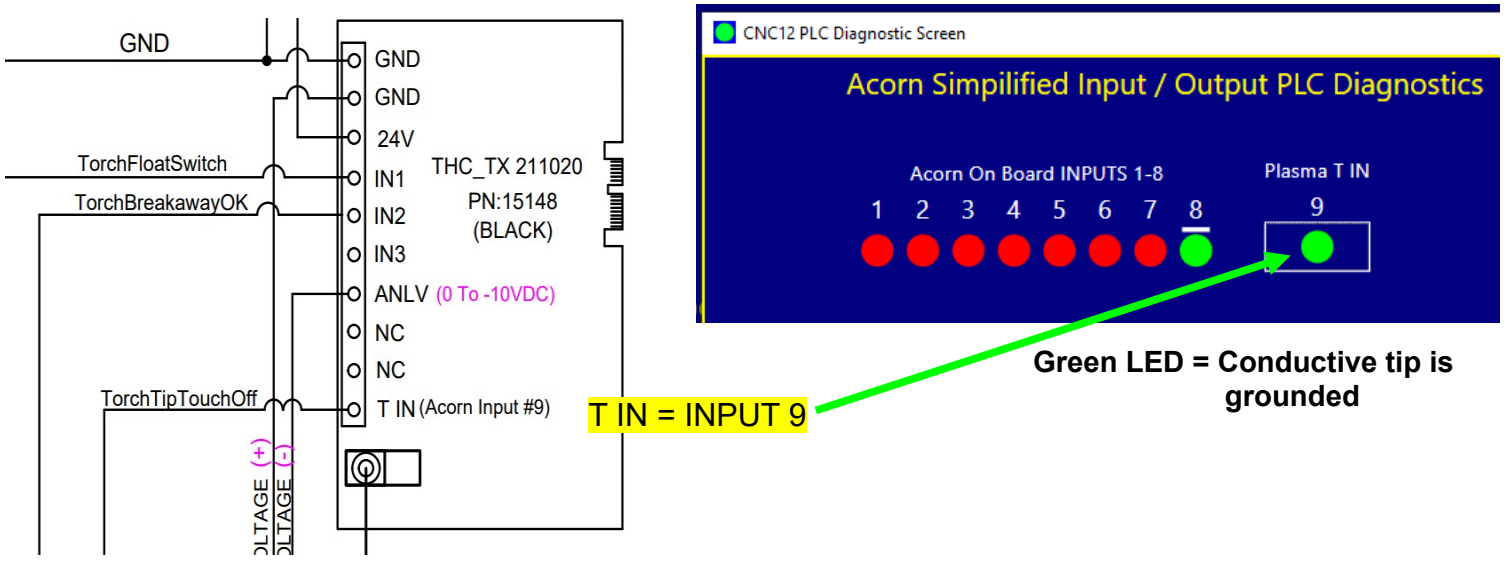
Note: Sometimes getting cheap Made in China round mounts to trigger properly will require a bit of trial and error adjustment, and will sometimes require modifying the unit to get it to perform as intended.

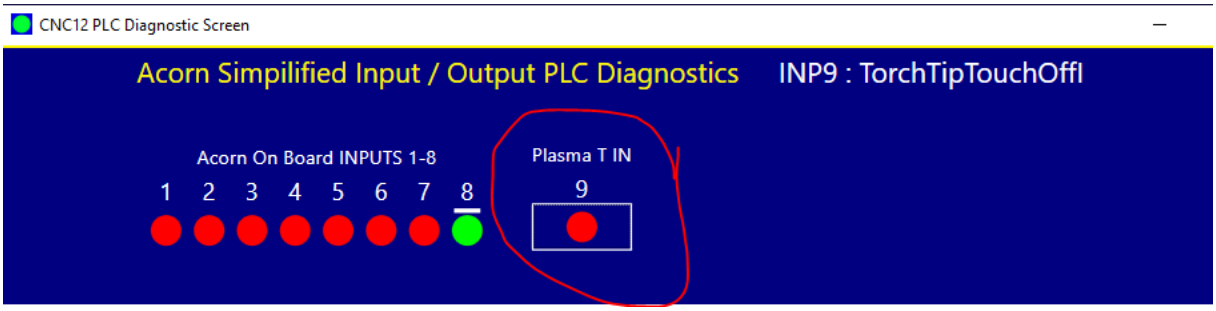
For Round Mounts that have three sensors, often two of them are used as the Breakaway sensors and the third is the Torch Float switch. In this case, simply wire the two breakaway proximity switches in series, as seen in the Round Mount schematics.

Ohmic and Conductive Torch Touch-off.

The “T in” screw terminal on the THC TX board is dedicated for conductive/ohmic touch-off.
By design, the “T in” terminal on the TX board is intended to be used with the Torch Conductive Tip. This conductive torch tip connection can be used with or without a separate stand-alone Ohmic sensor box. By definition, the “T in” connection on the TX board is CNC12/Acorn’s Input 9. There is no need to define an input assignment to Input 9 (you will not see it in the Wizard Input Definitions menu) as Input 9 is only used for conductive Torch Touch-off.

Note the color of your THC boards and follow the corresponding schematic.
Early THC boards were GREEN, current boards are BLACK. They are different, so be sure to use the matching schematic. The green schematic for the green board, and the black schematic for the black board.
Green THC board schematic #’s: S15121, S15107, S15108, S15109, S15114, S15123, and S15124
Black THC board schematic #’s: S15143, S15138, S15137, and S15136





Red LED = Conductive torch tip is not touching anything.
Green LED = Conductive torch tip touched ground.

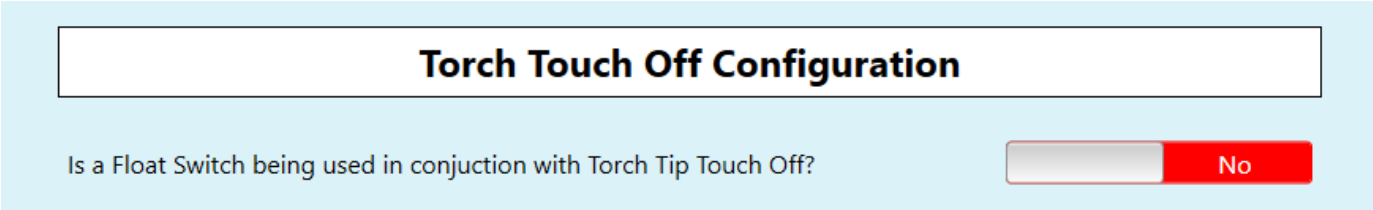
Torch Touch Off Setups

Method a. Conductive Torch Tip is used as the sole method of touch-off:
Wire Conductive Torch Tip according to schematic #S15107

In the Torch Touch-off configuration menu,

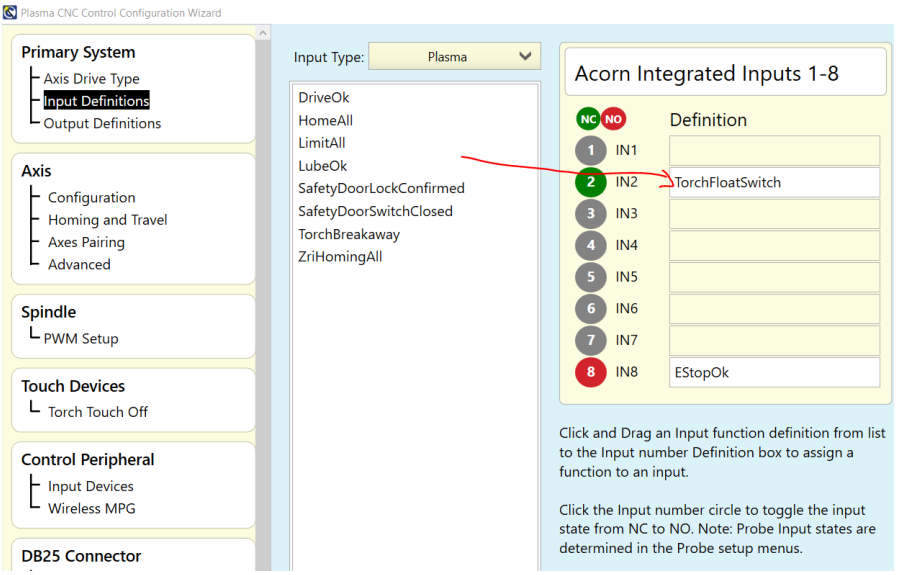
set “Is a Float Switch being used in conjunction with Torch Tip Touch-off?” to “No”

(Note: If set to No, the rest of the configurations and questions in this menu do not apply, so no need to set them. If you do, they are ignored).

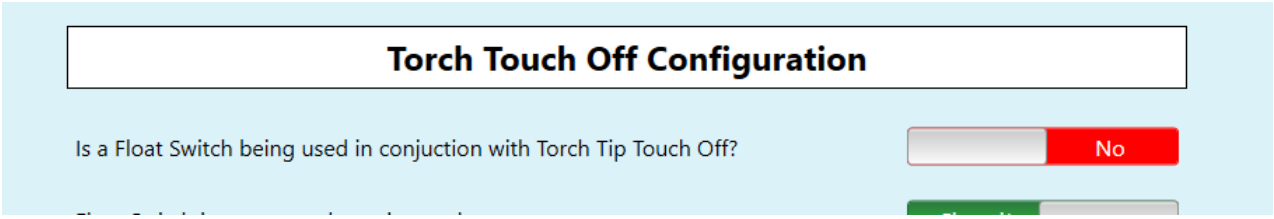


Method b. A Float Switch is used as the sole method of touch-off. See Schematic #15109.

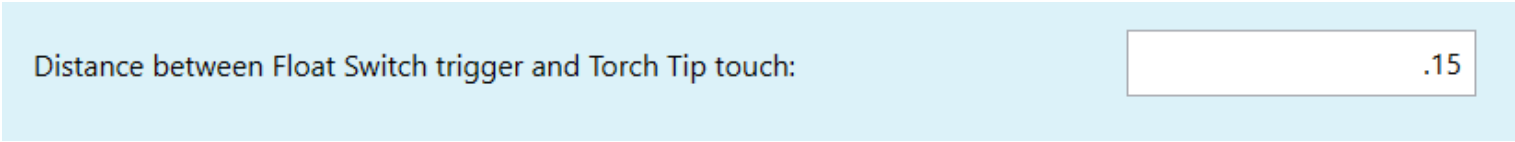
Set the Wizard Torch Float Switch input definition to Input Two.



Then Choose “No” for “Is a Float Switch being used in conjunction with Torch Tip Touch Off?”



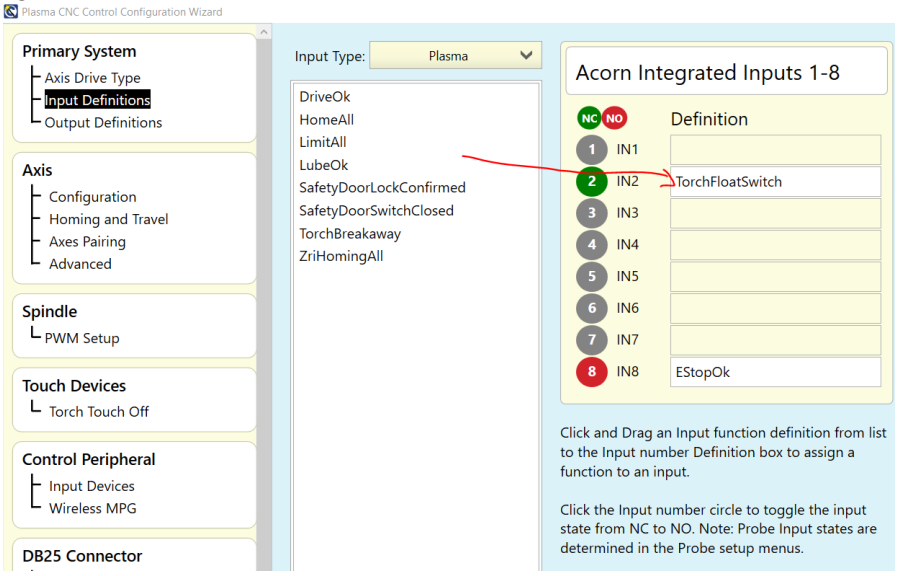
Set the Distance between Float switch trigger and torch tip touch in inches (or mm)



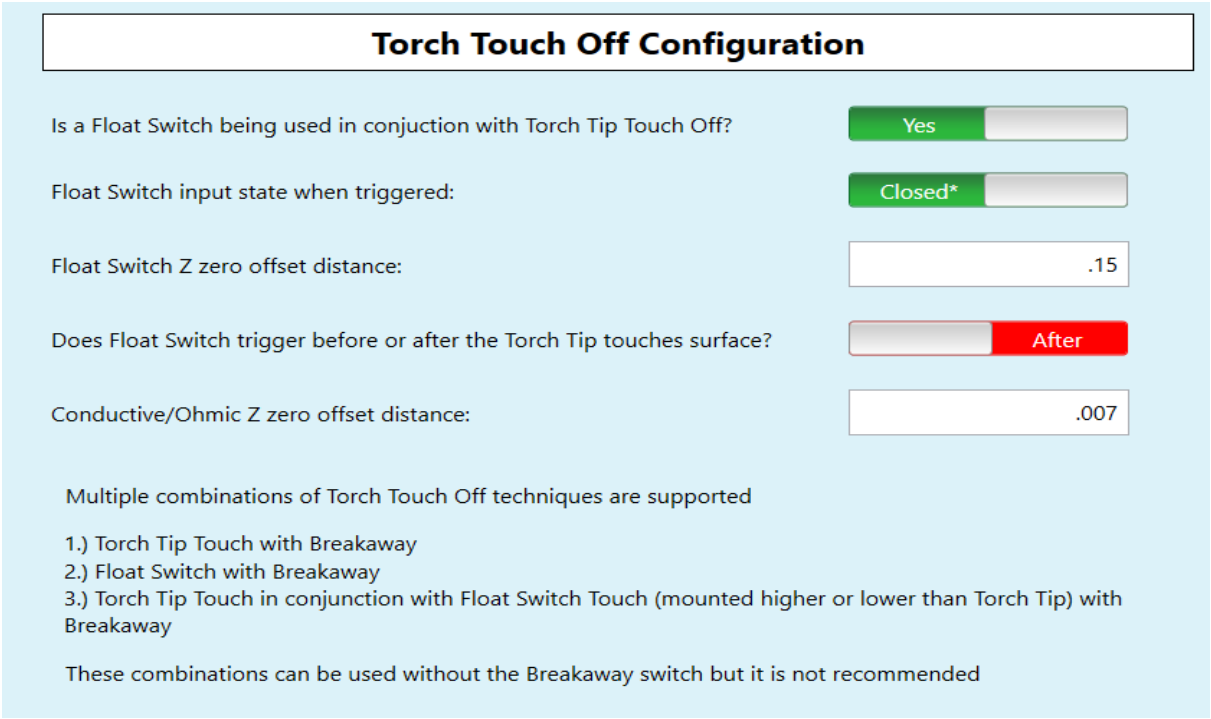
Method c. The conductive Torch Tip is used in conjunction with a Float switch.

Wire the Float Switch to Input #2. See Schematic #S15108

Use the Acorn Plasma Wizard Input definition menu to let CNC12 know which Acorn input is being used for the Float Switch. Click and drag “TorchFloatSwitch” to Input #2.



CNC12 needs to know which switch triggered first, so set the “Before and After” slider to indicate if the Float Switch triggers before the Torch Tip touches the metal or after the Torch Tip touches the metal.



Is a Float Switch being used in conjunction with Torch Tip Touch-off?:

Yes= Both the conductive torch tip and float switch are being used.
No= either a Float or a Conductive is being used just not together.

Float Switch input state when triggered: Does the switch Open or Close when triggered?

Does the Float switch trigger before or after the Torch Tip touches surface?

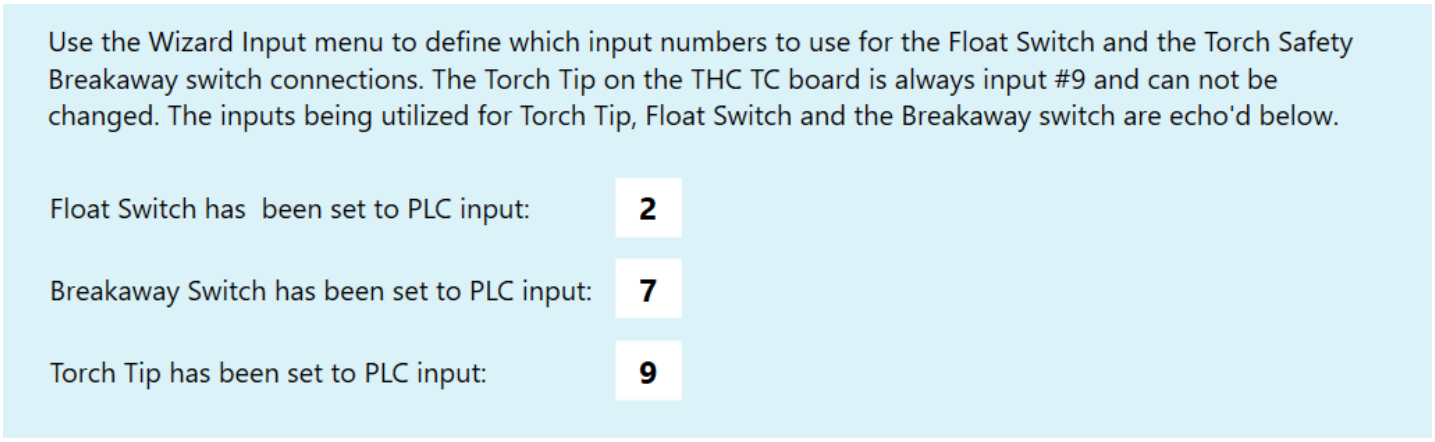
Distance between Float switch trigger and torch tip touch in inches (or mm)

The Acorn Plasma Torch Touch-off menu supports several typical touch-off setups.

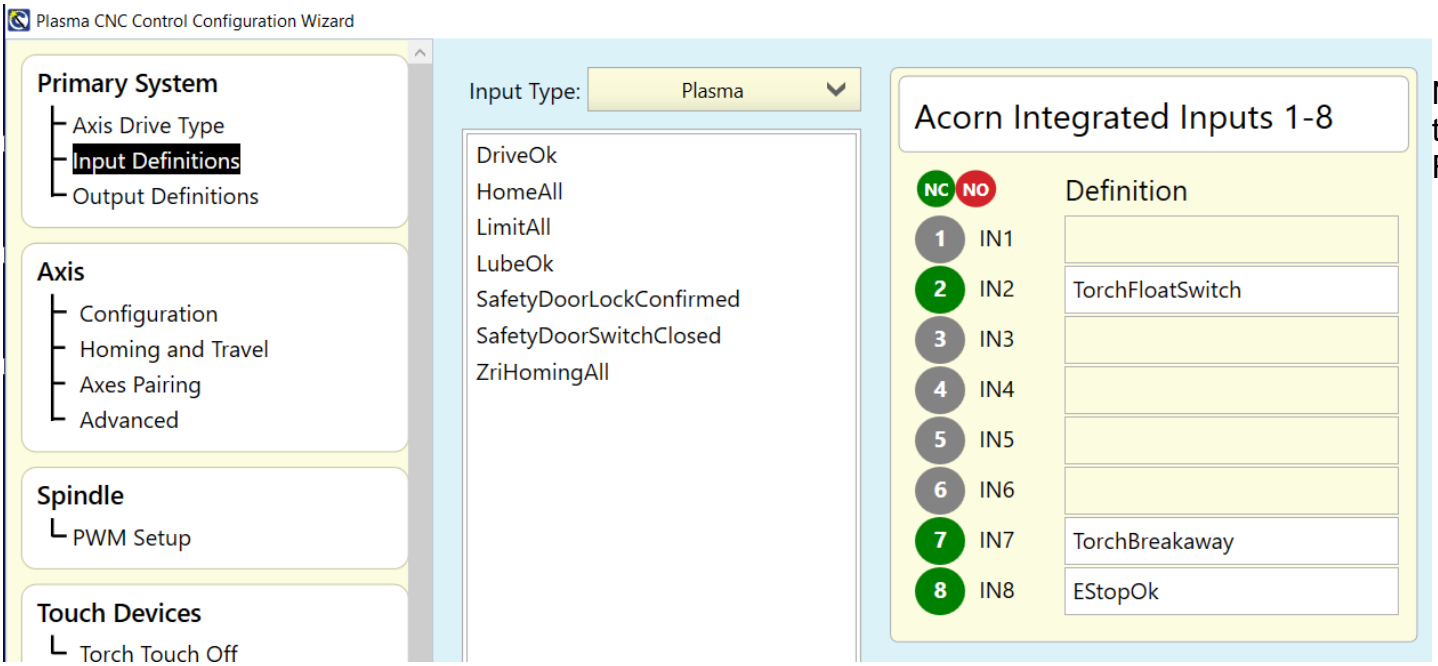
1.) Torch Tip alone
2.) Float Switch alone
3.) Float Switch with Breakaway safety switch
4.) Torch Tip with Breakaway safety switch
5.) Torch Tip with Float Switch and Breakaway safety switch
6.) Torch Tip with Float Switch

The Float switch trigger position can be either above, below or even with the Torch Tip.

Use the Acorn Wizard Input menu to define which input numbers to use for the Float Switch and the Torch Safety Breakaway switch connections. The Torch Tip on the THC TX board is always input #9 and can not be changed. The inputs being utilized for Torch Tip, Float Switch, and the Breakaway switch are echoed below.



Acorn Wizard Input Menu



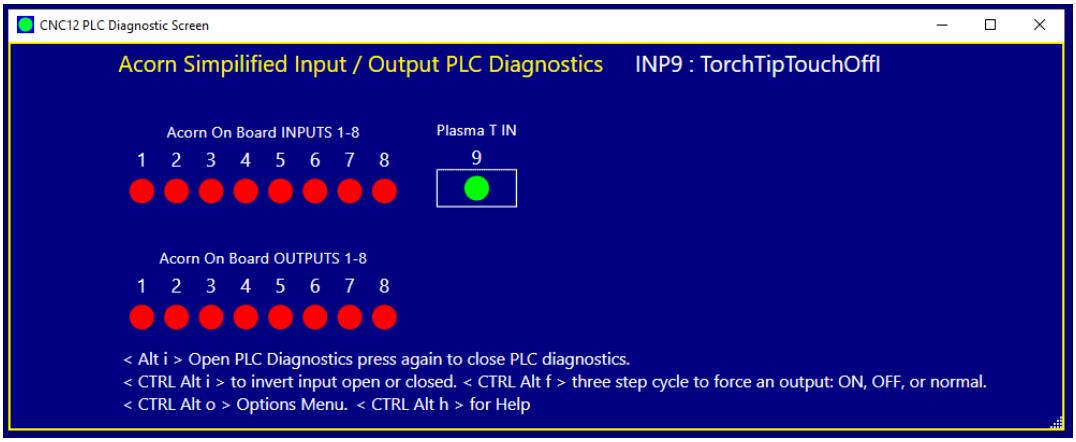
Note: the Float

The “TorchFloatSwitch” input is also monitored by CNC12 when not running a touch-off cycle so that it also acts as a breakaway switch. In other words, if the Float Switch is triggered unexpectedly (while not in a touch-off cycle) CNC12 will stop and issue a Breakaway error message.
THC hookup schematics: https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php|
Click the “Search Files type” button and type in “plasma”.

4.) Verify Torch Touch-off and Breakaway Input Functionality

Before we can use the Torch, we must verify that the Touch-off input and Auto Touch-off cycle are working.

To verify that the wiring and PLC input assignment are working, view the PLC input with the PLC Diagnostic App by pressing the keys <ALT> and <i> at the same time. This menu appears:



Now, with your hands, trigger the Float switch, ground out the Torch Tip, and Trigger the Breakaway Switch. Observe the inputs on the screen. The virtual LED should change color when the switches are triggered. By definition, the Torch conductive tip is “Normally Open”, so the LED will change from Red to Green when the Torch tip is grounded. Typical Float and Breakaway switches are “Normally Closed”, so they change from Green to Red when triggered.

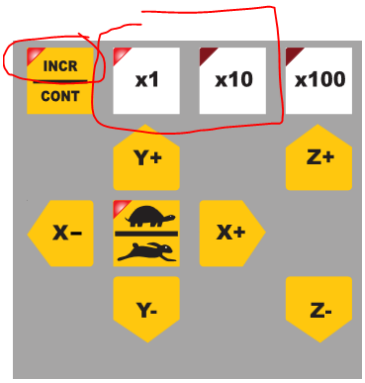
Not only observe the LED changing color, but also verify that the correct input in being activated.
For instance, if we have the Float Switch assigned to Input # 2 in the Wizard, verify that the LED for Input #2 is changing colors when the Float Switch is being triggered by hand.

If using a Float Switch that triggers some distance either before of after the torch tip, you must determine that distance. There are several ways to do this. Here is the method we use:

Float Switch Offset Distance Measurement Method/Procedure

1.) Place a thick flat piece of metal on the machine that will NOT move, bend, or flex.

2.) Slow Jog the Torch Tip down to touch a piece of paper on the metal. Shimmy the paper back and forth and find the point in which the torch tip just touches the piece of paper. Hint: Use Slow Jog once the torch tip gets close to the metal, then switch to “Incremental” “x10” then “x1” to jog the torch tip right onto the paper accurately.



3.) Press “SET Z0” button on the VCP.

4.) Now continue to jog into the metal until the Float switch triggers, stop and observe the position of Z on the DRO. This is the distance that the Z had to move after the torch touched the metal to trigger the Float Switch. Enter this value in the Wizard Torch Touch-off menu for the Float Switch offset distance.

Note: It is a good idea to verify that the Float Switch is triggering consistently at the same location. For a Float Switch to work properly, it must trigger at the same offset distance consistently, so running the test above several times to verify Float Switch consistency is a good idea.

Once verified by hand, test the automatic touch-off cycle with the Torch Touch-off Button on the VCP

Test Run Automatic Touch-off Cycle

With the Hypertherm unit wired as per the Centroid provided Schematics, review the proper grounding practices found at the end of this document and verify the machine grounding is as per the instructions.

Verify that the plasma unit analog voltage output that is connected to the TX board is 0-10 VDC. Anything higher will blow up the TX board when the torch is fired for the first time.

If you haven't done this check, unplug the analog input from the TX board and use a volt meter or oscilloscope to verify that the analog output voltage from the plasma unit is 0-10 VDC when the Torch is ON.

After doing this check,

1.) Place a thick flat piece of metal on the machine that will NOT move or flex
2.) Jog the Torch to approximately 1" above the metal
3.) Press the "TORCH Touch OFF" VCP button to run the automatic touch-off cycle
4.) After the cycle is complete, the Torch will retract to the safe height (specified in the profile being used). Observe the height of the Torch Tip above the metal, is it at the safe height? If so, continue to the next step. If not, most likely the Float Switch Offset distance is not set correctly.
5.) Verify Torch function with a Test Fire
Jog the Torch a good distance above any metal and test fire the torch in the air.
Press the "Torch Test FIRE" button on the VCP and observe the Torch.

The "Torch Test FIRE" button is a momentary button.
Momentary = as long as the button is depressed, the Torch will be on.

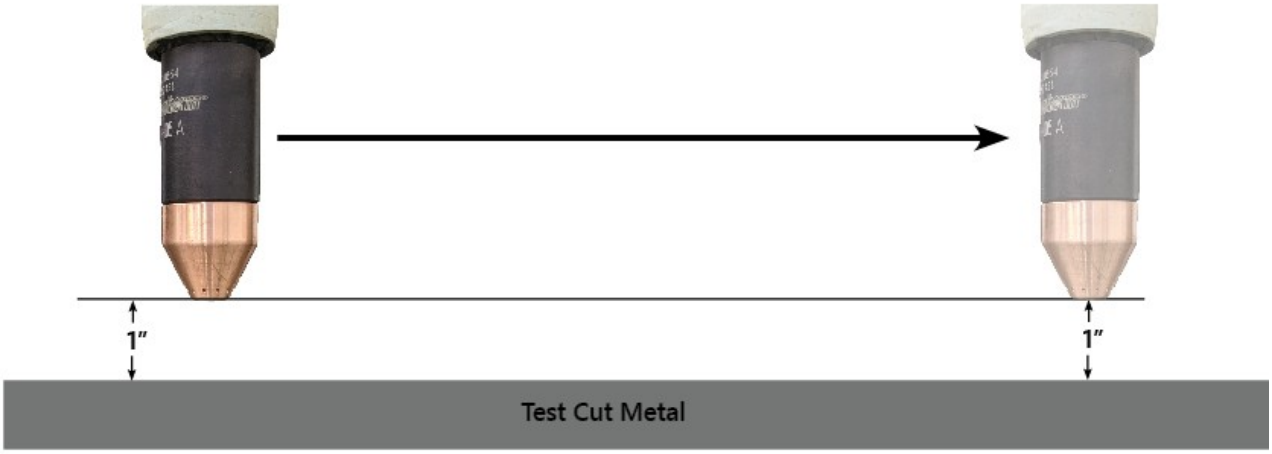
Does the Torch turn on practically instantaneously with the "Torch Test Fire" button? How much delay is observed.

6.) Arc Voltage Calibration Procedure

An initial Arc Voltage Calibration procedure is used to configure the Plasma Torch with the CNC12 Plasma software. This calibration must be performed before using the THC.

Prerequisites: A perfectly flat piece of metal that will not bend, move or warp and is laying parallel to the torch XY movement (NOT on a slope or angle).

To setup the test material parallel to the torch movement, put the test cut metal in the machine, jog the torch back and forth, and make sure that the metal is laying parallel to the torch X Y movement. To do this, jog Z so that the torch is 1” above the metal at one end. Jog X (or Y) to the other end of the metal and verify that the metal is still 1” away from the torch. Do the same thing for both X and Y. It is critical for this test to be conducted with a piece of metal that is flat and not on a slope or angle with no rust, grease, or paint.



Connect the ground clamp directly to the test piece of metal.

Calibration Notes:

- During this calibration test the THC is NOT in use. The Z-axis will stay at the fixed height during the entire test cut.

- It is imperative that the proper material profile be used during this test. A “book” material profile that matches not only the metal type and thickness being cut but also the Plasma Unit Amp settings.

- Use a CLEAN, perfectly flat piece of metal that will not bend, warp, or move and that is laying parallel to the torch XY movement, NOT on a slope or angle. Do not use thin metals for this test.

- If the Z-axis steps-per-rev, overall turns ratio, or acceleration rates are changed AFTER the Torch Calibration, the Torch Calibration must be re-run!

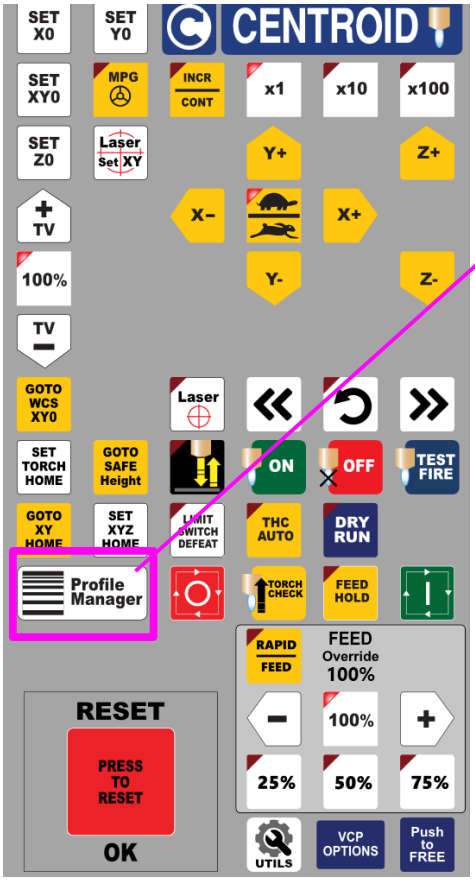
Select a Plasma Cutter Profile Set

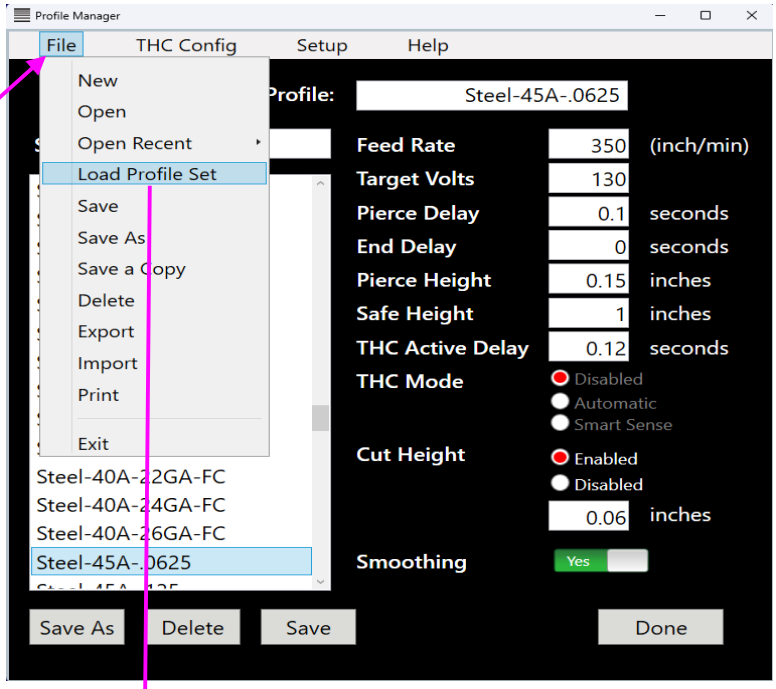
Note: The default profile set is the Hypertherm Powermax85.

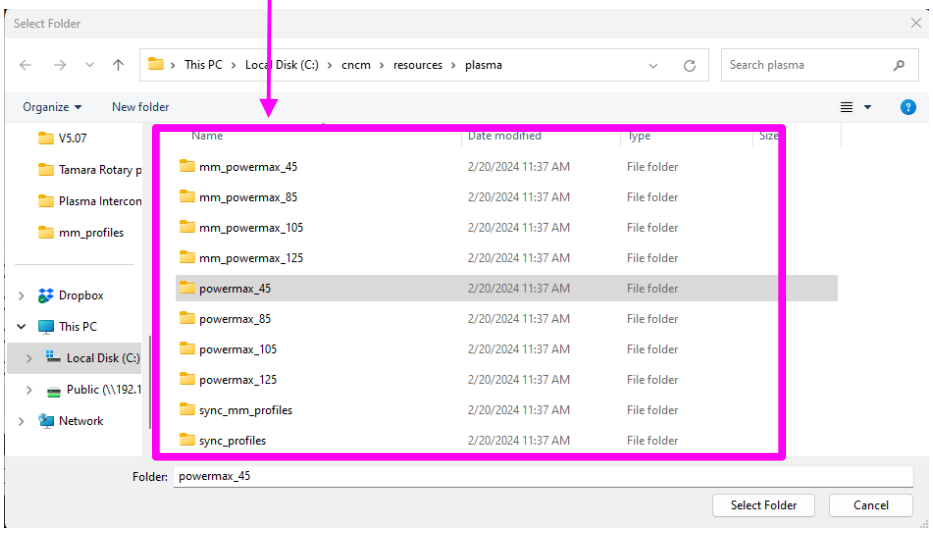
To change to a different profile set, Open the Profile Manager located on the VCP (Virtual Control Panel). Inside the profile manager select “File” at the top left corner.

Select a profile set to load.

If the plasma cutter is not a Hypertherm, Select the Profile set that is similar to the plasma amperage size. For example for a PrimeWeld 60 use the Powermax 65 profile set.

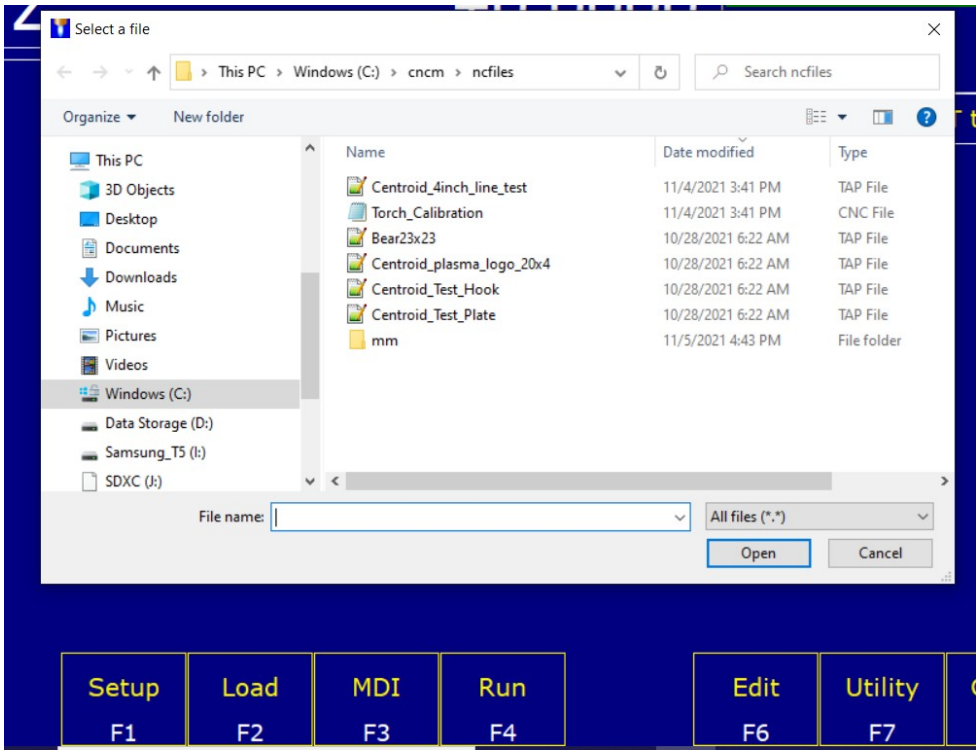




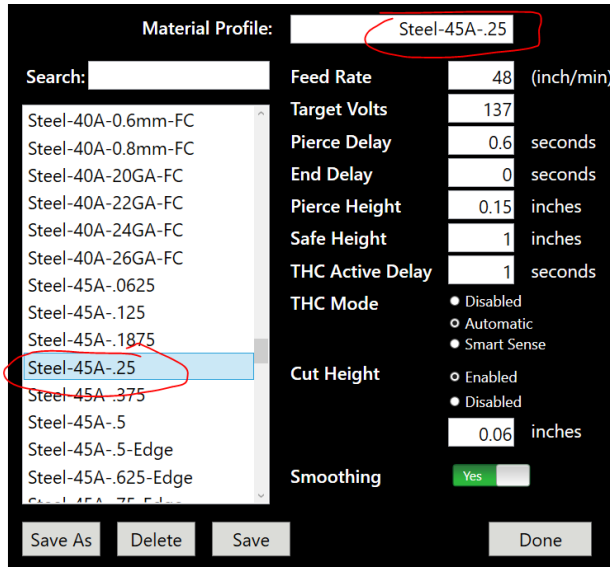


Calibrate Arc Voltage by using the Centroid torch calibration macro: “Torch_Calibration.cnc” located in the c:\cncm\ncfiles directory. This macro steps the user through the calibration process.

1.) Press F2 Load, navigate to the Torch Calibration macro: “Torch_Calibration.cnc”



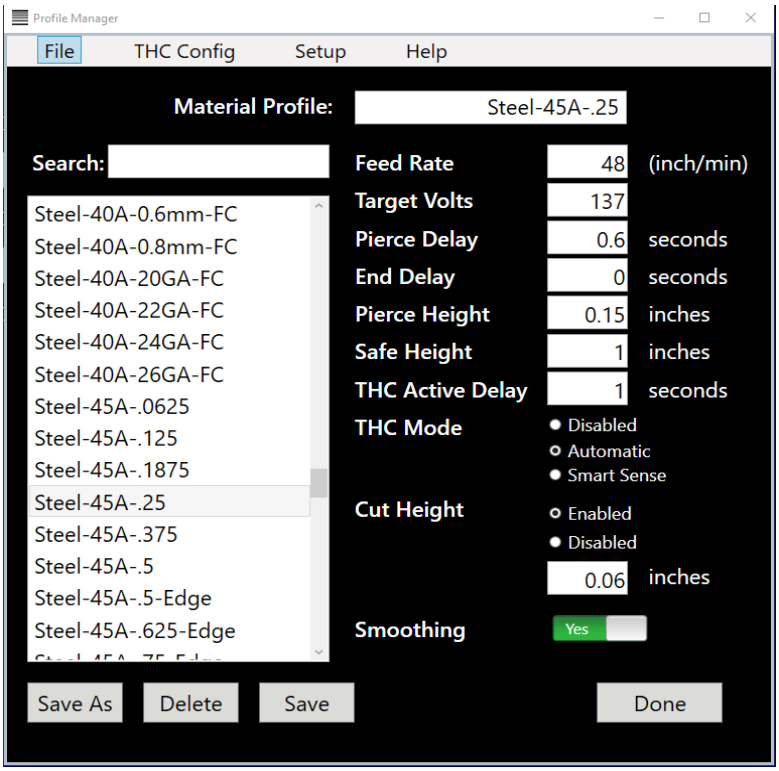
2.) Press the Profile Manager button on the VCP and choose a matching material profile to the test cut material being used and the Plasma Unit Amp settings.



3.) Press cycle start and follow the instructions on the screen

Profile Manager

A set of stock (aka “book”) material profiles are included with the CNC12 Plasma software installation. These profiles appear in the Profile Manager and can be used as is, copied, duplicated. and/or modified by the user using the Profile manager.



Feed Rate: Target XY motion feed rate.

Target Volts: The voltage that the THC will maintain while cutting.

Pierce Delay: Delay of XY motion after pierce command is executed.

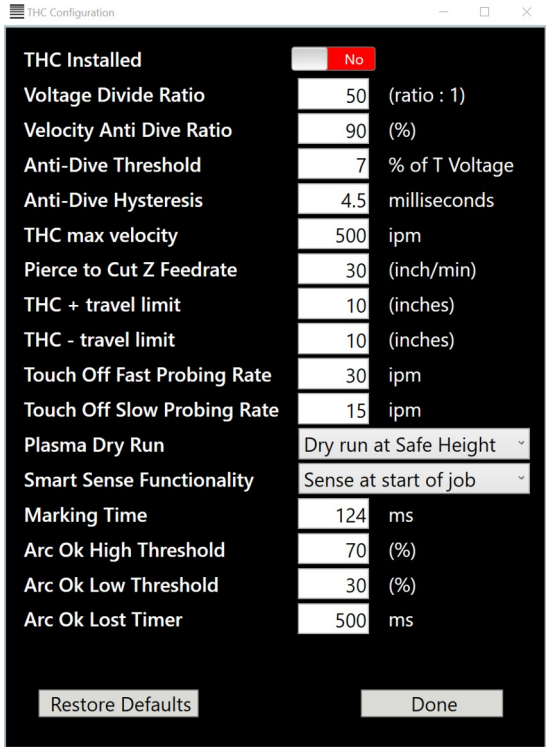
End Delay: Time in seconds the Torch will wait at the end of the cut before moving on to the next cut.

Safe Height: Height in which THC retracts to when done cutting. Safe Height is relative distance to the material surface.

THC Active Delay: Time of XY motion that will be held at cut height with THC OFF.

THC Mode:

- **Disabled** = THC OFF, job will cut at the cut height.
- **Automatic** = THC ON and will follow the parameters in the profile.
- **Smart Sense** = THC ON and will use the recorded voltage during the beginning of the cut, this voltage will override the Target Voltage in the Profile. This Voltage is determined by automatically measuring the actual voltage while cutting at the cut height at the beginning of the cut and will be displayed on the screen during the cut.



Cut Height:
- Enabled = Torch will pierce at Pierce Height, move to Cut Height, then start XY movement
- Disabled = Torch will pierce at Pierce Height, then start XY movement

Smoothing: G-code smoothing feature Yes = ON, NO = OFF. See smoothing section below for more details on smoothing.

Torch and THC Settings

These settings are typically in the “set it and forget it” category. Once the proper values are determined for good cutting results it is not common to be adjusting these values. Default values are shown in the image to the right.

Voltage Divide Ratio: Provided by the Plasma Unit, set this value to match. The voltage divider circuit in the Plasma Unit monitors power supply voltage during cutting. It "divides" the voltage signal and sends a scaled voltage signal to the Acorn THC.

Velocity Anti Dive Ratio is Velocity based Anti Dive control. Velocity based anti-dive will prevent THC motion when the actual X-Y velocity of the machine is less than the specified %. Used to turn off THC automatically when entering tight arcs or turn-arounds.

Anti-Dive Threshold is Voltage based Anti-Dive control. Voltage based anti-dive will prevent THC motion when the actual Voltage of the arc is more than the specified % (the difference between Target Voltage and Actual Voltage).

Anti-Dive Hysteresis is a control value based in time, used to damp the Anti-Dive re-activeness. Larger number = slower reaction.

THC max velocity: The maximum velocity that the Z-axis can move without losing steps. Integrator should test the machine to determine this value. Typically set to 80% of the rate in which the Z-axis will begin to lose steps. In the case of servo controlled systems that can reliably move the Z-axis faster than 500 IPM, use 500 IPM as the max velocity value for the THC.

Pierce to Cut Z Feed Rate: Feed rate to move in Z from the pierce height to the cut height after piercing is finished. Used to prevent flame outs from too quick of Z-axis torch movements after piercing to get to the cut height.

THC – travel limits: Allowable maximum positive and negative distance. This distance limit becomes active whenever the THC is active and is relative to touch off top of work piece Z-value.

Touch Off Fast Probing Rate: The Speed in which the Torch will initially seek the top of the work piece in the automatic Torch Touch-off cycle.

Touch Off Slow Probing Rate: The speed in which the Torch will seek the top of the work piece after initially finding the top of the work piece with the Fast Rate in the automatic Torch Touch-off cycle. If any value greater than 0 the auto touch cycle will first seek the top of the work at fast rate and then retract and use the slow rate to very accurately locate the top of the work piece. If = 0, only the fast rate will be used to touch-off once.

Dry Run Height selection: Choose between Safe Height, Cut Height, or Pierce Height

Smart Sense: Choose how Smart Sense works: 1.) Auto Sense voltage at the start of a job (first cut) and maintain that voltage for the rest of the job. 2.) Auto Sense at the start of every cut and maintain that voltage for the rest of that cut.

Marking Time: Time in milliseconds that the Marking feature will spend at the marking location with the torch on.

Arc Ok High Threshold: Sets the high threshold of what percentage of the target voltage that Arc Ok will look for. This value is closer to the target voltage (70% by default) and indicates when the arc itself has actually started. Default values should function for most Primeweld and Everlast systems.

Arc Ok Low Threshold: Sets the low threshold of what percentage of the target voltage that Arc Ok will look for. This value is set to 30% of the target voltage by default. Default values should function for most Primeweld and Everlast systems.

Arc Ok Lost Timer: This setting is meant to correct for the improper functioning of cheaper cutters. These cutters often have a drop in voltage after the Arc Ok Low Threshold has been reached, before the actual arc has begun. This timer ensures that the Arc Ok waits for the second spike in voltage of the arc starting.

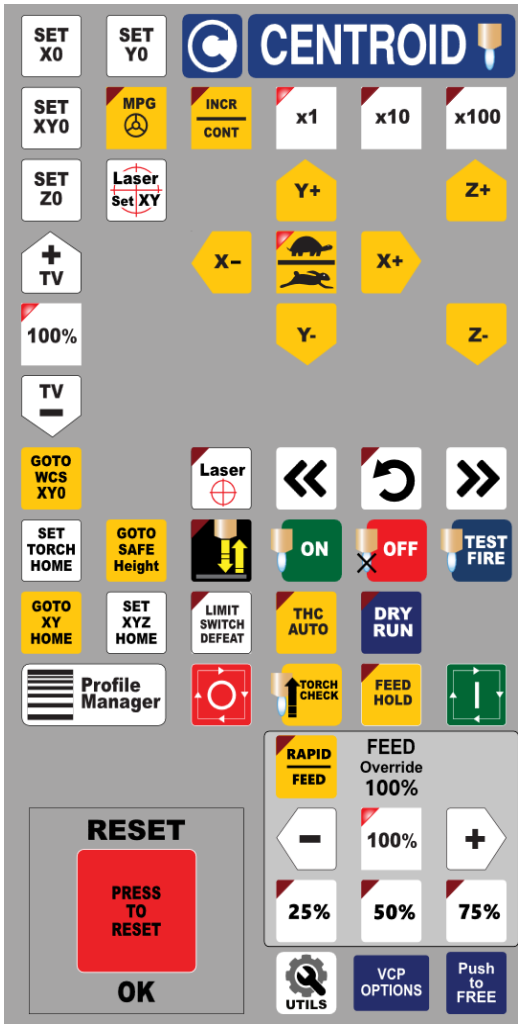
Plasma Virtual Control Panel

A Plasma VCP is provided with the Centroid Acorn CNC12 installation. This VCP can be used as is or modified by the user. More information on how to edit the VCP can be found in the VCP manual here:
https://www.centroidcnc.com/centroid_diy/downloads/centroid_vcp_users_manual.pdf
and the related macro programming guide:
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/centroid_cnc_macro_programming.pdf

Profile Manager: Starts the Material Profile Manager

Cycle Start: Used to start any automatic motion. Such as running a Part G-code program.

Cycle Cancel: Used to stop any automatic motion or cancel out of any operation.



Torch Touch-off: A dry run of the Torch Touch-off Cycle. Used to Test the Torch Touch-off to make sure it is working before running a job. The LED indicates that the Torch is Touching the Metal (lit up when touching), which is useful for debugging the wiring of the Touch-off.

Dry Run: When activated (RED LED ON), the Part program will run without the Torch On. This is used to Dry Run a new program before actually cutting it.

Torch Test Fire: A momentary button that turns on the Torch. This is used to Test Fire the Torch before running a job to make sure that the torch works. As long as the button is held down, the Torch will be on.

Torch ON: Press to turn ON the Torch. Used to manually turn on the torch.

Torch OFF: Press to turn OFF the Torch. Used to manually turn off the torch. Works in conjunction with the Torch ON button.

Torch Check: Press to send the Torch to a Torch Check location. Typically used to check the Torch Tip and change out consumables if necessary. Can be used while running a job or not. Torch Check position is set in the Wizard under the Torch Setup menu and uses the G28 return point. The G28 position is only available for use if the machine is setup with homing other wise Torch Check will prompt the operator to simply jog to the desired position. Pressing Torch Check in the middle of a job will invoke restart mode which allows operator to return to the interruption point after checking the torch and restart at any point.

Limit Switch Defeat: Press to temporarily defeat all limit/home switches which allows user to jog the machine even if a limit/home switch has been tripped. Use with caution as pressing this button will allow the Operator to move the machine further into the direction of the tripped switch. Typically used to clear an accidental switch trip. Once the button is pressed, you have five seconds to jog the machine to clear the switch. The button LED stays on for the five second time period.

THC AUTO: Indicates that the THC is in Auto mode and used to disable AUTO THC

THC Auto LED ON = THC is in Automatic Mode aka Enabled. Meaning the THC will be active when commanded to be active.

THC Auto LED OFF = THC is Disabled. This overrides any commands to turn on the THC.

Pressing THC Auto Button will Toggle the LED and THC Enabled/Disabled.
Pressing this button to turn the LED OFF will override any part program THC commands.

The term "Enable" is used to clarify that “Auto” is simply enabling the THC. It does not necessarily mean the THC is actively tracking, as that is dependent on whether the THC is called for in Job and the related Active Delay Timer

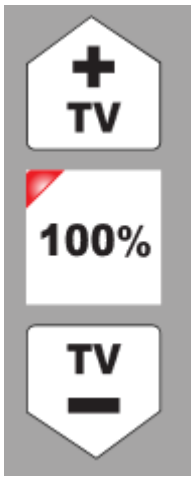
Related Notes:
- Profile Manager menu selection of THC Automatic, or Smart Sense, will Enable the THC and the THC Auto LED turn on at the beginning of the job.

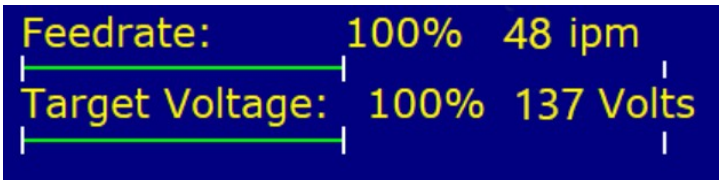
- Profile Manager menu selection of THC Disable, Will turn off the THC Auto LED at beginning of the job.

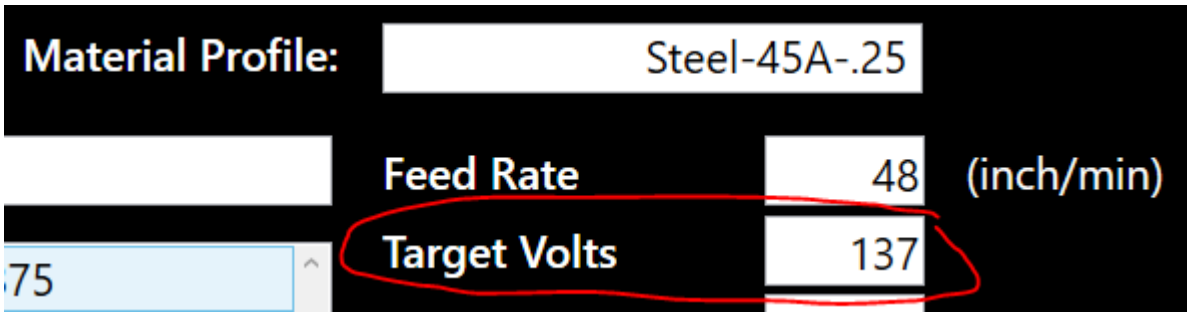
- When using any of the three THC modes: Automatic, Smart Sense and Disabled, the Operator may always press the THC Auto button to Enable or Disable THC at any point.

- When in Disabled and Automatic modes, THC will use the Programmed Voltage in Profile
- When in Smart Sense, THC will use the Smart Sense Voltage Reading.

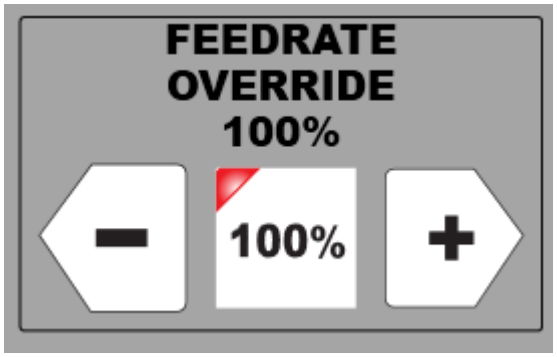
Target Voltage Override: Operator Override controls for adjusting the Target Voltage to be maintained by the THC. Can be used on the Fly (while a job is running). Overrides the Profile Specified by percentage, actual Voltage is displayed on the screen. Press 100% to return to the Profile specified voltage. Works in conjunction with the Wireless MPG wheel.







Feed Rate Override: Operator control to override the programmed feed rate of a job. Works in conjunction with the Wireless MPG wheel which provides a large wheel for easier operator adjustment of the feed rate. Is used to override Jogging Speeds as well as cutting feed rate and Rapid moves (with Rapid Override active) Press the “100%” button to quickly return to the Programmed Feed Rate, effectively removing any override.



Rapid Override: Active when LED is lit. Applies the Feed Rate Override to any Rapid move as well. Effectively allowing the Feed Rate Override amount to apply to all motion. Disable (LED OFF) if it is desired for all Rapid moves to move at the Maximum Rate (set in the setup Wizard in the Axis Configuration menu).

Set Z0: Set Z zero location. Used to set the top of the work piece to zero. Setup Z zero at or very near the first touch-off point of a part program.

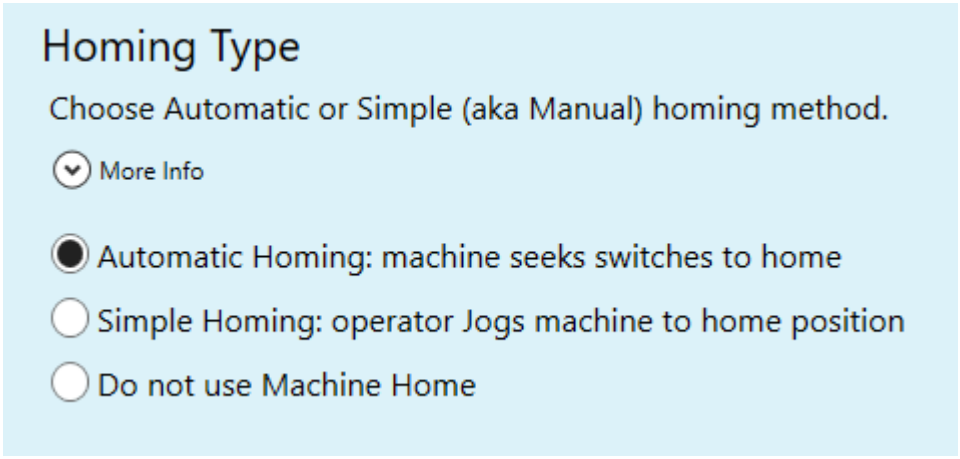
Set XY0: Press this button to set both the X and Y position of the CNC control to match the Part X Y zero location. This zero location matches the XY zero location used in the CAD/CAM system to generate the part G-code. Jog to desired XY zero location on the machine and press Set XY0.

Laser Set XY zero: Used in conjunction with a Laser Cross hair or dot to locate the XY 0 location on the work piece. The offset from the Laser to Torch Center amount is set in the Laser Set XY macro “mfunc53.mac” BEFORE USE. Edit this file with any text editor and enter the offset values for the laser before use. Located in the c:\cncm directory.

SET X0 and SET Y0: Individual buttons for setting X or Y zero locations.

SET Torch HOME: Sets the Z-axis home position. Typically used for when the Z-axis home position needs to be reset due to lost steps on an open-loop stepper system. Torch home typically equals the maximum Z-axis positive position.

Set XYZ HOME: Resets the XYZ MACHINE home position (not to be confused with the Part Zero location). Typically used for when the Machine home position needs to be reset due to lost steps on an open-loop stepper system, such as after a Estop/ESC/Cycle Cancel/Reset event while moving. Pressing this button will: run the Auto homing routine if Automatic homing has been setup, sets Machine Home at the current position if Simple homing has been set up, or sets Machine Home at the current position if no Homing is being used on the machine. Set the homing type in the Wizard Homing and Travel Menu.



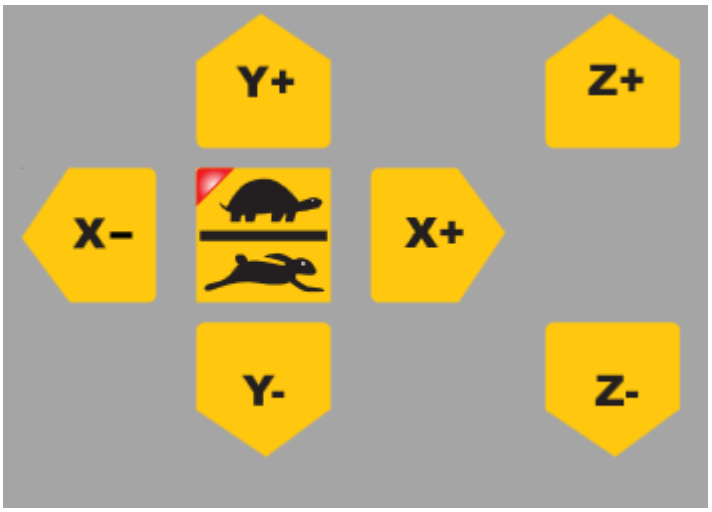
GOTO WCS XY0: Press this button to rapid to the current Work Coordinate System X Y part zero location. Make sure Torch is high enough to clear any obstacles before using this button. This button simply executes macro #55 (mfunc55.mac)

GOTO Safe Height: Press to send the Torch to the Safe Height position specified in the selected Material Profile. Use this only after Part Zero location (top of metal) has been set using the Torch Touch-off button. This button simply executes macro #49 (mfunc49.mac)

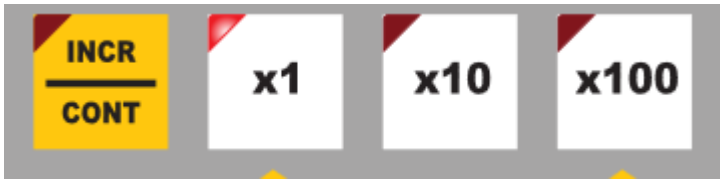
GOTO XYZ HOME: Press to send the Torch to the Machine Home position. (not to be confused with Part zero location) Use this only after a home position has been set. This button simply executes macro #57 (mfunc57.mac)

Operator Axis Jog controls: Momentary buttons. Press to move the machine. Two Modes are available for Jogging: Incremental and Continuous.

LED ON = Slow Jogging Rate
LED OFF = Fast Jogging Rate

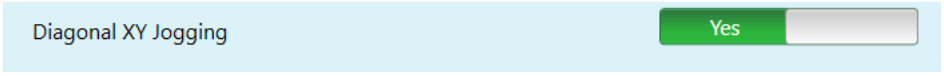


CONT = Continuous jogging mode. LED OFF. Jog button will move the axis as long as the user holds the button down. Ignores the x1, x10, x100 selection. Uses the selected Fast or Slow jogging rate, which is defined in the Wizard Axis Configuration menu.



INCR = Incremental jogging mode. LED ON. Jog buttons will move the specified incremental amount per button press. Holding down the job button does nothing in INCR mode.
X1 = Base Jog increment per button click (set in the Wizard Axis Configuration menu default value is .001”
X10 = Base Jog increment x 10 per button click = .01”
X100 = Base Jog increment x 100 per button click = .1”

Diagonal “”XY” Jogging can be activated in the Wizard under VCP preferences.



Restart Mode:

Restart mode can be invoked by several actions:

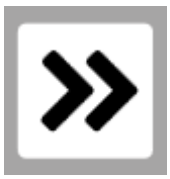
By default, Restart mode is invoked automatically when the job is interrupted. This interruption can be instigated by: a Torch unexpected flame out while cutting, pressing Restart Mode, pressing Feed Hold, pressing Tool Check, or pressing Cycle Cancel while running a job. When restart mode is started, the LED will automatically light up indicating that the backward and forward buttons are active.

Restart mode allows the Operator to move the torch along the path of the part program to “pick up” a restart point using the backward and forward buttons. The Operator-chosen restart point can be anywhere on the part cutting path. The user can also jog off to the side of the part cutting path to add a lead-in line and location for the restart to touch-off and pierce at. To exit restart mode, press Cycle Cancel and the LED will go off to indicate that restart mode is off. The backward/forward buttons will no longer be active.

Restart Mode: Press to toggle Restart Mode on and off.

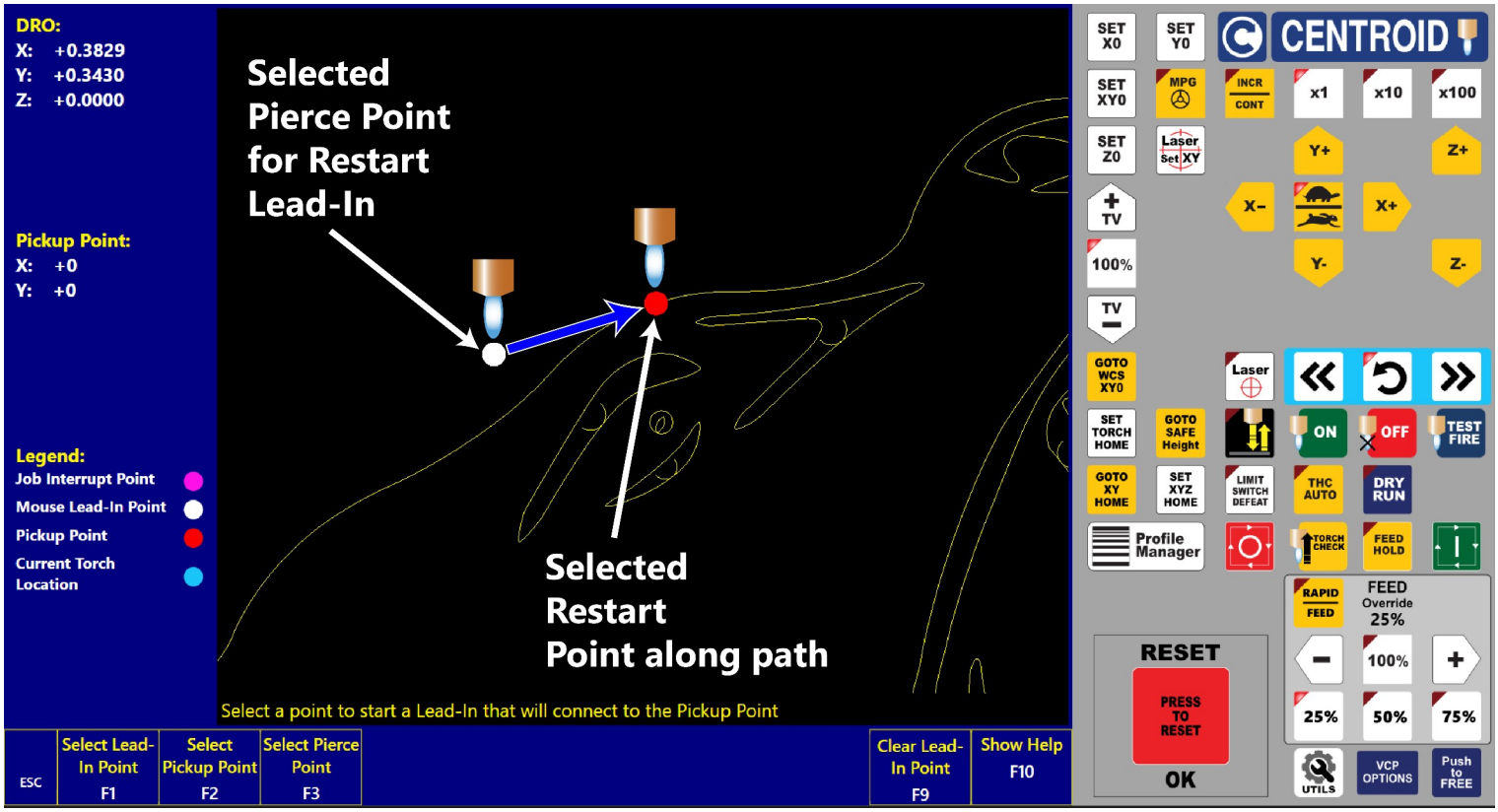
Move Backwards: Press to jog backwards along the part cutting path.

Move Forward: Press to jog forward along the part cutting path.



Plasma Restart Mode Graphical Interface

Plasma restart mode allows the user to restart the Plasma Job at any point along the cut path.
The operator can choose from any one of the existing pierce points programmed into the part
-OR-
Choose any point along the cut path to restart at. When choosing a restart point along the cut path it is practical to create a Lead-in by specifying a Lead-in pierce point that will result in a nice transition back onto the cut path



Screen shot above shows a custom lead-in point (White circle) chosen as a new pierce point to then cut to the ‘pickup’ rejoin the cut path point (Red Circle) of the cut path

F1 Select Lead In Point: A new Place to Pierce to create a new lead in for a restart along the cut path.

F2 Select Pickup Point: A new location to ‘pickup’ (rejoin) the cut path

F3 Select Pierce Point: Choose from any existing Part Program Pierce Point as a restart point.

F9 Clear Lead In Point: Clears the White Lead-in point previously chosen and allows you to pick another lead in pierce point.

Choose a Function key and double click the mouse on the graph to select that point.

Restart Notes:

1.) Restart mode will automatically be evoked when an unexpected collision occurs while running a job. Note: To cancel out of restart mode, press ESC or Cycle Cancel.

2.) If you are running a job and desire to enter Restart Mode, the preferred methods are pressing any one of these buttons: **Restart Mode,** ESC, Cycle Cancel, or Feed Hold. All of these buttons do a controlled stop that does not lose position, unlike E-stop or Reset.

3.) *If E-stop or Reset are pressed during a Job when using OPEN-LOOP stepper motors, the operator should re-home the machine. Start the job with a Dry Run and press Restart Mode to pick back up.

Note: Configured and wired properly, most Hybrid Steppers and AC servos will not lose position during any of these events, so it is usually not necessary to re-home the machine.

4.) Operator Procedure for starting in the middle of a job: Load Job and Set zero's as normal, then:

a. Press Restart Mode
b. Use the Restart mode F1,F2,F3 options to choose a new starting point.
c. Press Cycle Start to start the job.

Feed Hold: Feed Hold decelerates the motion of the current movement to a stop, pausing the job that is currently running. Pressing CYCLE START will continue the movement from the stopped location.

Laser On/Off: Toggles the laser between on and off.

MPG: The MPG is housed in a separate hand-held unit. Press the **MPG** key to set the control jog to respond to the MPG hand wheel (if equipped). When selected, the LED will be on. Select the Jog Increment and desired axis, and slowly turn the wheel. When the LED is not lit, the MPG is disabled and the jog panel is on.

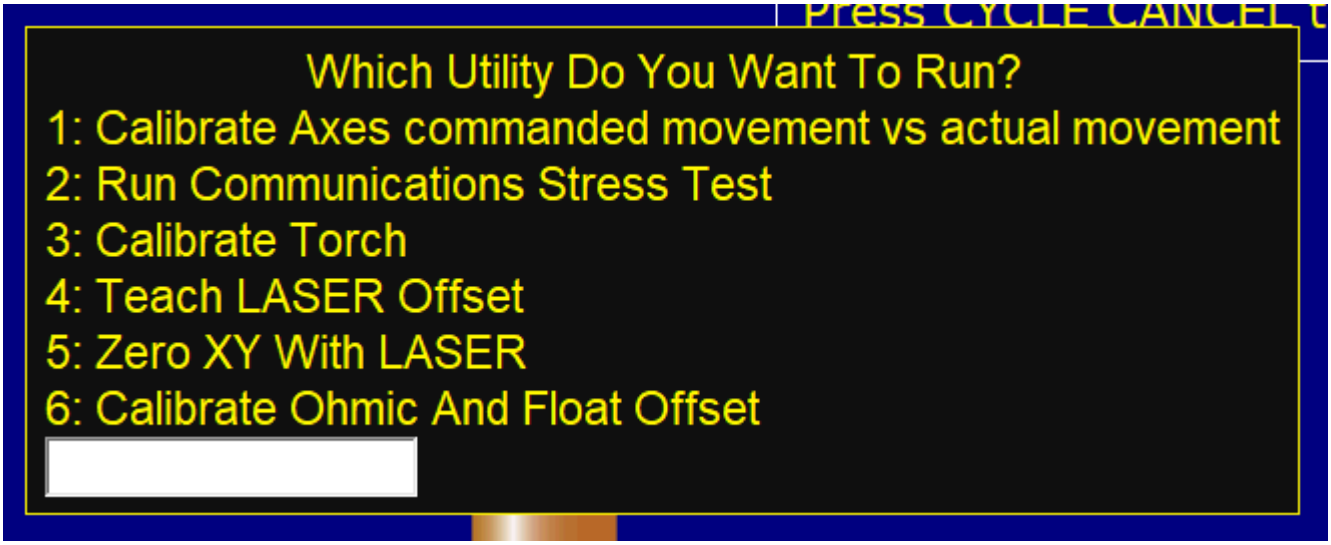
Push to Free: Used to unpin the VCP window, allowing the user to move it around their screen.

Quick Feed Rate Override: Used to quickly change the current feed rate to 25%, 50%, or 75% of the programmed feed rate.

VCP Options: Allows the user to edit VCP settings.

Utils Button

The “Utils” button launches a user editable macro that contains several commonly used setups



1.) “Calibrate Axes Commanded movement vs actual movement” is a macro to help walk the user through setting up the overall turns ratio of an axis so that when the machine is commanded to move 1” it moves 1”. Requirements are that the steps per revolution of the axis drive/motor be set properly before running this macro. This macro will calculate the ‘gear ratio’ of the axis motor to machine.
See these two post for more info.
Gearing for Sweet Spot. https://centroidcncforum.com/viewtopic.php?f=65&t=9149

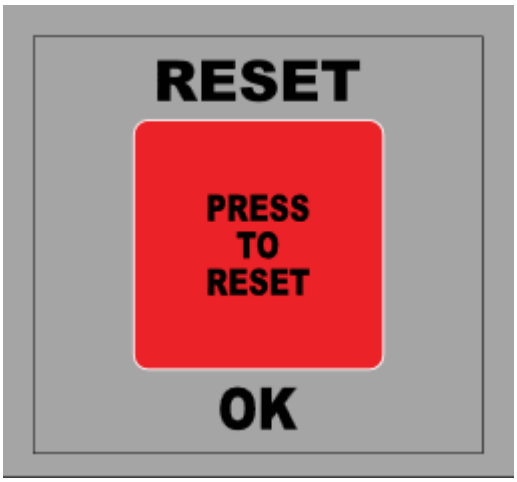
and Steps per revolution. https://centroidcncforum.com/viewtopic.php?f=63&t=1801

2.) “Run Communications Stress Test” This test will verify the communication connection between the PC and the Acorn CNC control board. See this post for more Communications details.
https://centroidcncforum.com/viewtopic.php?f=61&t=1451

3.) “Calibrate Torch” Runs the Torch Calibration macro. Always re-calibrate the torch after any big changes such as a software update or changing Plasma cutters.
4.) Teach Laser Offset. This is the Laser mounting position setup. Done once.
5.) “Zero XY with Laser” (does the same thing as the VCP button “Laser Set XY”
6.) “Calibrate Ohmic and Float Offset” This automates figuring out the offset difference between the ohmic and float switches.

Reset Releases the power to all the axes and cancels the current job immediately upon being pressed.

Reset also resets/clears certain faults if the fault condition has been fixed or cleared.



Auto Repeat notes:

There are two ways to set a job to automatically repeat:

1. Add a M102 at the end of the G-code program. Press Edit and go to end of program and add M102 on the last line, and press save.

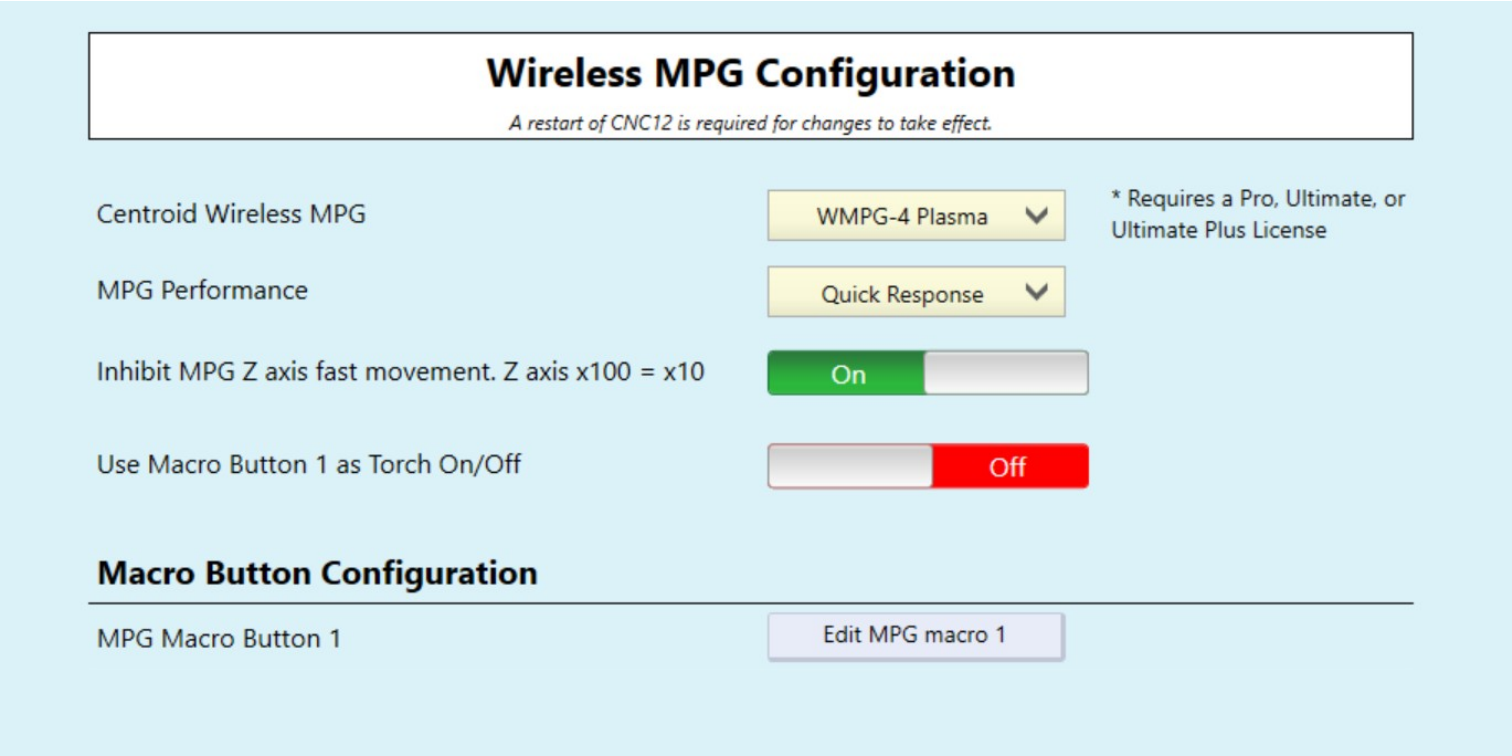
Or

2. Use the Repeat feature found in the Run Menu. Auto repeat can be enabled in the Run Menu. Press F4 Run, then select (F3) to turn Off or On Auto Repeat. ESC to main screen and then press Cycle Start like normal to start the job, that job will now automatically repeat.

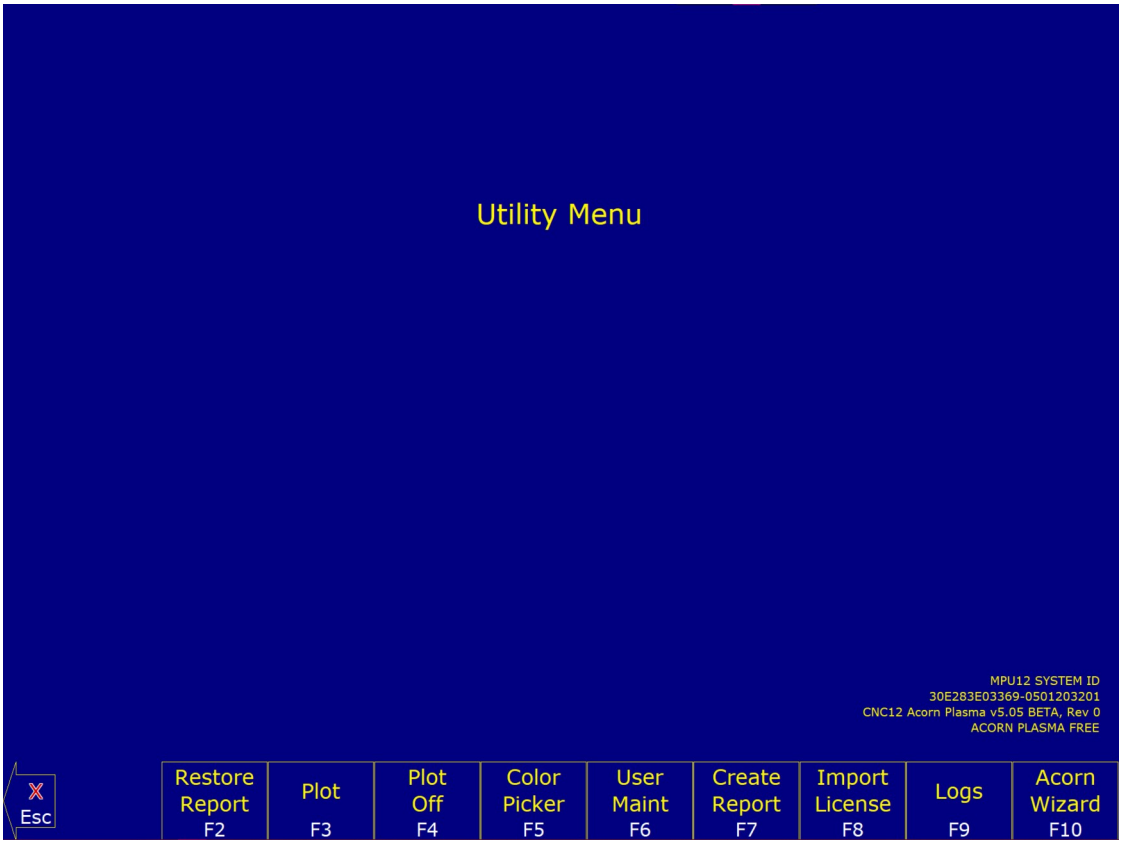
WMPG-4 Plasma Macro Setup

The WMPG-4 Plasma has one programmable macro buttons (M1) that the user can customize to perform a wide variety of tasks. An example of this is setting Macro 1 to toggle the torch on and off for WMPG-4 jog cuts. Shown below is the Wireless MPG Configuration Wizard menu, which enables users to customize their Macro buttons.

Macro 1 can be assigned to be a Torch on/off button with the slider selection or you can create you own set of instructions/commands by editing the MPG Macro for Button 1.


Wireless MPG Configuration
A restart of CNC12 is required for changes to take effect.
Centroid Wireless MPG
WMPG-4 Plasma
* Requires a Pro, Ultimate, or Ultimate Plus License
MPG Performance
Quick Response
Inhibit MPG Z axis fast movement. Z axis x100 = x10
On
Use Macro Button 1 as Torch On/Off
Off
Macro Button Configuration
MPG Macro Button 1
Edit MPG macro 1

CNC12 Utility Menu



F2 – Restore Report: Update your control's configuration with a report.zip file.

F3 – Plot: Opens the menu for the Plot feature. When enabled, this features records data from the last four seconds of every M62 cut. This is typically used for fine-tuning the THC.

F4 – Plot Off/On: Used to toggle the plot feature off and on.

F5 – Color Picker: This menu allows you to change colors from the default Centroid Classic Color Scheme.

F6 – User Maint: Use this menu to access file options, the manual, or machine notes. The file options (**F1 - File Ops**) menu is a way to access files in a DOS format. The manual (**F2 – Manual**) will open a PDF of the CNC12 Plasma manual. Machine Notes (**F3 – Machine Notes**) is a text file that serves as a convenient way to store notes about the machine, control customizations, and other notes. It is stored in the cncm folder.

F7 – Create Report: Generates a backup of system configuration files called report.zip.

F8 – Import License: Allows the user to import paid licenses to unlock additional features in CNC12.

F9 – Logs: Shows the messages and errors that have been logged by the control.

F1 – Errors: Displays the error/message log. Use Page Up, Page Down, Home, and End to view and ESC to exit.

F2 – Stats: Displays counts of errors logged. Use Page Up, Page Down, Home, and End to view and ESC to exit.

F3 – Export: Exports the log to a destination of your choosing.

F10 – Wizard: Opens the CNC control Setup Wizard.

Plasma M-codes

M code	Description	Notes
M3	Fires the torch	Typically not used individually.
M5	Turns off the torch	Typically not used individually.
M35	Enables the THC, M61 contains this M-code	Typically not used individually.
M36	Disables the THC, M62 contains this M-code	Typically not used individually.
M39	Sets the scribe offset, moves the scribe over, and activates/extends the scribe	
M40	Deactivates and retracts the scribe	
M51	Displays the Auto Sense Target Voltage used. 	Displays the SmartSense voltage that is being used. Add an M51 to the G-code program after the first cut using Smart Sense, and the message seen to the left will appear. Use an M51 with MDI to display the last Target Voltage used. Use an M51 with a custom VCP button to display the last Target Voltage used.
M61	Performs the torch touch-off and pierce cycle	mfunc61.mac
M62	Turns off torch and raises to the Safe Height	mfunc62.mac
M64	Marking macro. This macro is used for marking locations without cutting through the metal.	
M65	Loads the cut parameters from the selected Material Profile	
Virtual Control Panel Macros		
M45	VCP Button Macro: Set Work Coordinate XY0	
M46	VCP Button Macro: Set Work Coordinate X0	
M47	VCP Button Macro: Set Work Coordinate Y0	
M48	Torch Touch-off VCP Button Macro.	Edit m48func.mac to retract to the preferred Height. The default is the Safe Height. Variables for the heights are: <CUT_HEIGHT>, <SAFE_HEIGHT>, and <PIERCE_HEIGHT>
M49	VCP Button Macro: Retract to Safe Height	
M50	VCP Button Macro: Set Work Coordinate Z0	
M52	VCP Button Macro: Torch Check	M52 is used when the Torch Check button on the VCP is pressed when NOT actively running a job.
M53	VCP Button Macro: Laser Set XY Position	
M55	VCP Button Macro: Goto Work Coordinate XY0	
M57	VCP Button Macro: GOTO XY HOME	
M58	VCP Button Macro: SET Torch Home Position	
M59	VCP Button Macro: Set XYZ HOME	

System Macros		
Auto Z	c:\cncm\system\auto_z_zero_macro.cnc	Used by M61, a subprogram that controls the touch-off cycle, do not edit this file.
Pierce	c:\cncm\system\piercing_cycle_macro.cnc	Used by M61, a subprogram that controls the piercing cycle, do not edit this file.
Torch Check	c:\cncm\system\torch_check_macro.cnc	This macro is used when the Torch check button on the VCP is pressed while actively running a Job.

Plasma G-codes

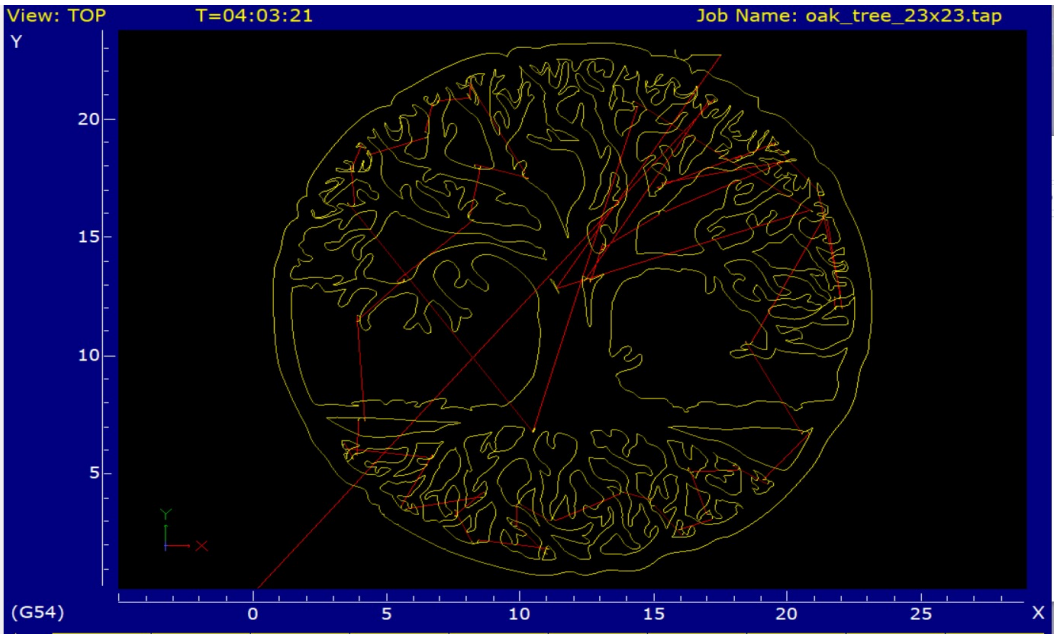
G-codes	Description	Notes
G0	Rapid Position	Rapid moves are used to quickly position the torch above a touch-off point. These moves are done with the Torch OFF.
G1	Straight Line	Cutting Move, point to point line
G2	CW Arc	Cutting Move Arc CW direction
G3	CCW Arc	Cutting Move Arc CCW direction
F	Feed rate. Examples: F100 = 100 ipm or 100 mm/min F<FEEDRATE> = Feed rate specified by the profile manager.	“F” commands in the G-code program are not necessary to run a part. If “F” is not specified in the G-code program, the feed rate for any line defaults to the feed rate in the Material Profile. F commands are modal. F commands added to the G-code program can be used to force a different feed rate than the feed rate set in the Profile manager.
G64 ON	Turns on Smoothing	Uses values from current selected Smoothing Profile
G64 OFF	Turns Off Smoothing	

* Modal = Once the command has been given on one line, all other lines below will use that value until a new value is used.

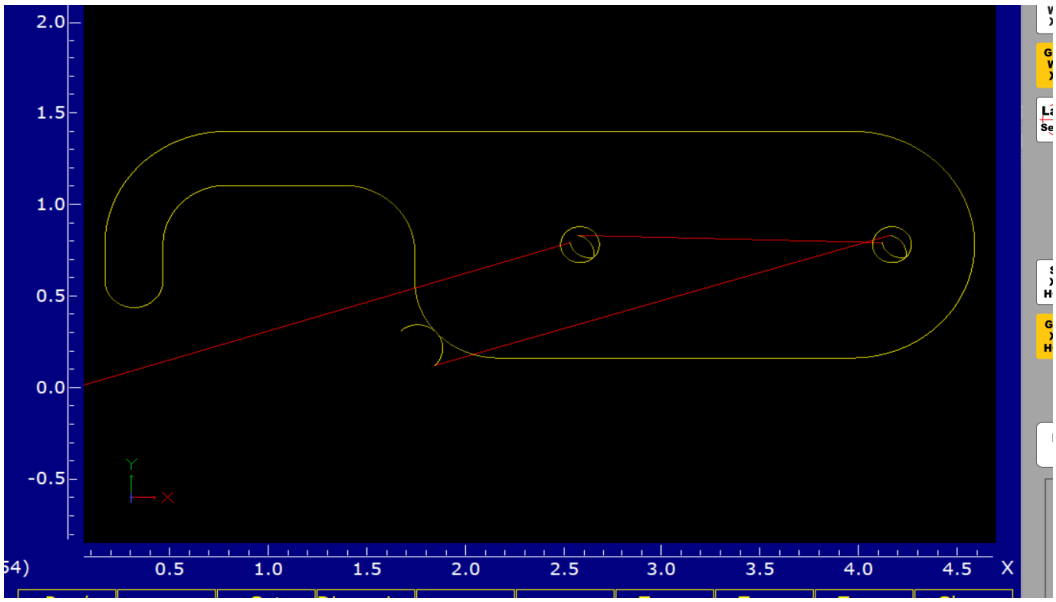
Plasma Smoothing Presets F1 Setup > F8 Smoothing

The Centroid CNC12 G-code smoothing feature will round sharp corners of a G-code program, which produces smooth machine tool motion through any sharp geometry which results in better cuts. Centroid has developed and provided a default a set of Plasma Smoothing Profiles. These default set of values will work well with most typical Plasma G-code programs. There are three Centroid provided plasma smoothing profiles: “Contouring Plasma” which works best with art work, “Precision Plasma” which works best with job shop-type work and “Low Res Smooth” which is designed to Low step per inch resolution Plasma tables.

Examples:
Use F2 “Contouring Plasma” smoothing with jobs like this:



Use F3 “Precision Plasma” smoothing with jobs like this:



Note: Smoothing works amazingly well, BUT only when the machine has been mechanically and electronically designed and configured properly to be in the sweet spot for Plasma use. Smoothing will NOT fix mechanical problems or improper axis motor/drive configuration, tuning, sizing, etc. Smoothing also requires a CNC Computer PC CPU with SINGLE CORE benchmark greater than 1500.

Plasma Machine Setup Sweet Spot for Nice Cuts and Smooth Action With or Without Smoothing

Mechanical Sweet Spot

1.) Overall Turns ratio value in the range of 1 to 2.5 turns of the axis motor per inch of travel. All rack and pinion driven machines will require a belt reduction or gear box to achieve this, typically in the 3:1 to 5:1 range depending on the rack and pinion chosen. Note: Direct driving the pinion with the axis motor results in poor cuts.

2.) Motors sized properly to move the machine without risking losing steps or stalling.

3.) Free and easy axis motion with no sticky spots or other problems. When the axis motor is disconnected, moving the axis back and forth by hand should be smooth, consistent, and easy.

4.) Machine is rigid enough not to shake or flex when moving at typical cutting speeds.

Electronic sweet spot

1.) Steps-per-revolution set in the 1600 to 3200 range for stepper motors. Both the Acorn Wizard and Stepper drive should be set to at least 1600 steps-per-revolution. 2000 is a good steps-per-revolution value to use.

2.) Stepper motors are required to have proper matching power supplies and AMP settings on the stepper drive. Just because the motor works does not mean that it has been optimized for smoothness. No amount of Centroid G-code Smoothing will overcome a stepper motor that has too many amps being pumped into it, or has its phases not wired properly for the voltage of the drive power supply being used. Review https://www.geckodrive.com/support/step-motor-basics.html for details. Better yet, use AC brushless servo motors instead of stepper motors

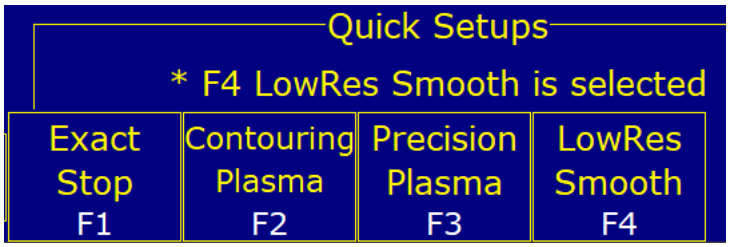
3.) Axis acceleration settings: Set the Axis Acell rate within the range of .15 to .4 seconds. Typical values are .15 to .3 seconds for most Plasma Tables.

4.) Closed Loop Axis motors and drives are recommended on the Z axis of the machine for the best possible THC performance as they respond better to fast position changes much better than open loop steppers. They don't lose steps and have much more torque at higher speeds and can stay on target much better. This is important when cutting thin materials due to the higher cutting feed rates involved. If you must use an open loop stepper on the Z axis, make sure the axis motor and the Z mechanical system are sized properly so that the open loop stepper motor has plenty of mechanical advantage over the mechanical system so it can run the Z axis at the feed rates and acceleration rates required for best performance.

Closed Loop Stepper Motor and Drive, these are affordable and provide great THC performance.

F4: Low Res Smooth is a smoothing preset that performs some black magic for plasma tables that have a less then ideal step per inch resolution. Choose this option when cutting on machines that have been configured with less than 4000 steps per inch. While this is a nice feature it is always best to adjust the machine tool mechanical and electronic gear ratios to be in the sweet spot as outlined above.

F1 Setup > F8 Smoothing



Most users will never have to adjust any of the values below. Simply pick the preset you want in the Smoothing menu (shown above) and go cut parts.

But, in case you were wondering below are the default Centroid Plasma Smoothing Parameter Values found in the parameters menu of CNC12 F1 Setup, F3 Config, F3 Parameter

Parameter #	Contouring Plasma	Precision Plasma	Low Res Smooth	Description
221	2	10	10	NBpts
222	.005 in (.1270 mm)	.002 (.0508 mm)	.002 in (.0508 mm)	Step (in inches)
223	1000	1000	300	Umax
224	0	0	0	Centripetal
225	0	0	1	
226	1	20	20	W
227	95	20	1	Minimum Angle
228	0	0	0	S Curve
230	.5	1	1	Curve Feed Rate Multiplier
231	.25	1	1	Acceleration Multiplier

See Mill Operator Manual pages 332-338 and 222-223 for more information on the Centroid Smoothing menu.

WMPG-4 Plasma

A ‘can’t live without it’ tool for Plasma machine operators, the WMPG-4 facilitates easy live on-the-fly Feed Rate Override control with the large MPG wheel as well as Target Voltage Override in addition to natural control of machine positioning with the MPG wheel as a Jog Wheel.
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/centroid_plasma_WMPG-4.pdf

Take the control to where the work is! A game changing tool, the Centroid Wireless MPG Control Pendant allows the operator to conveniently and precisely set up jobs and tools remotely. No software drivers to install. Plug and Play with Centroid CNC12 CNC software, just plug in the included USB transmitter/receiver and start using it! Plasma WMPG-4 Installation instructions.
Requirements: CNCPC USB port and Plasma Pro License file.

- Use the MPG Wheel to Jog the machine for any kind of positioning.
- Sensitivity of the wheel detents are adjusted by the x1,x10,x100 selector.
- Use the MPG Wheel to control the cutting feed rate on the fly.
- Use the MPG Wheel to control the Target Voltage on the fly.
- 4 axis DRO display
- 4 axis MPG and continuous jogging control
- Robust wireless communication
- No software drivers to install
- Hanger bracket mount w/ magnets
- Smooth motion
- Long range wireless
- Robust CENTROID developed drivers
- Takes 2 AA alkaline batteries, run time approx. 1 month (do not use lithium batteries)
- USB Plug and Play Transmitter / Receiver
- Rubber case protector
- Tactile Feedback domed buttons w/ gold contacts
- High quality 3M Overlay

Cutting Steep Slope Materials

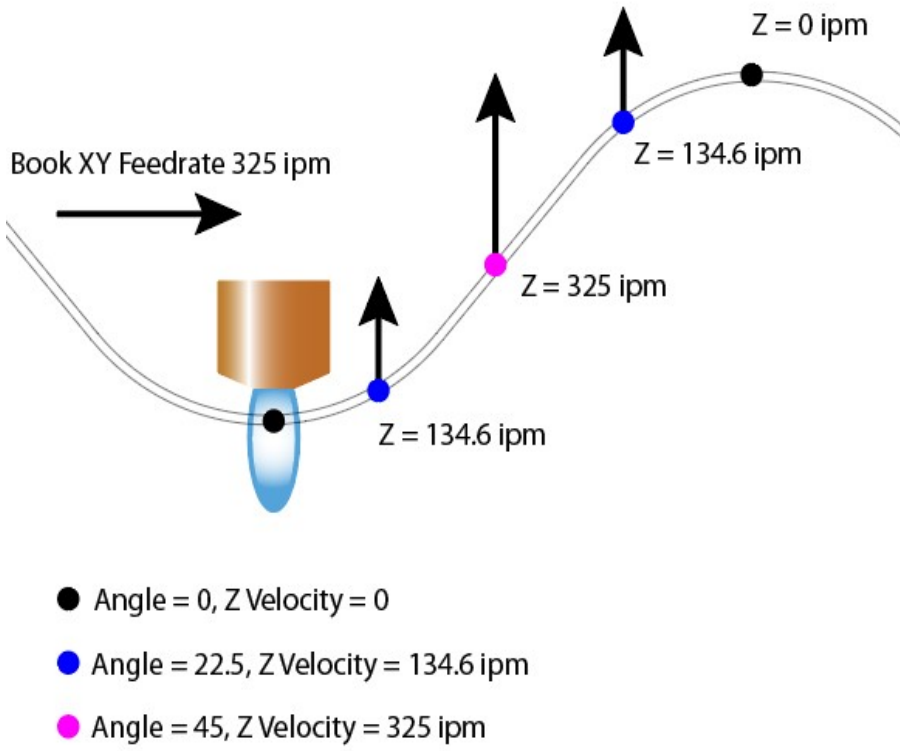
The Centroid default THC configuration values are set for best reliability, best kerf, best edge, low dross and best overall cuts keeping things 'tight' not letting the torch deviate much from the specified Voltage and Velocity. For large sloped jobs the THC configuration values are adjusted.

When cutting corrugated and other high slope jobs the THC operational tolerances can be increased at the expense of cut quality while widening THC responsiveness (forgiveness) to large changes in Z values of the material by allowing wider velocity and voltage changes to occur while the THC is active. Think of the THC configuration as a work envelope for the THC, a set of parameters that the THC is allowed stay active and to work within.

Z axis Max Rate and Axis Acceleration time come into play as well and are required to be set correctly for best performance. When the machine is commissioned, the integrator 'discovers' these values for a given plasma table using a simple trail and error process (commanding simple non THC G-code moves while increasing speeds and acceleration rates until failure). In part, the THC response is governed by these basic axis motion values. Keep in mind instantaneous max rate commands can be requested even over very short moves by the THC algorithm. So its important to have the Z axis Max rate set to the maximum actual reliable rate of the Z axis and along with the Z axis acceleration rate set to a value that isn't too large and isn't too small (too small will "hit" an open loop axis motor so hard it loses steps, too large adds unnecessary delay).

Note: Always re-run the THC configuration program after changing any axis configuration values such as Max Rate, Acceleration, Steps per Revolution, and Overall Turns Ratio as fresh PID values will be calculated during the THC calibration macro process to work with these new settings!

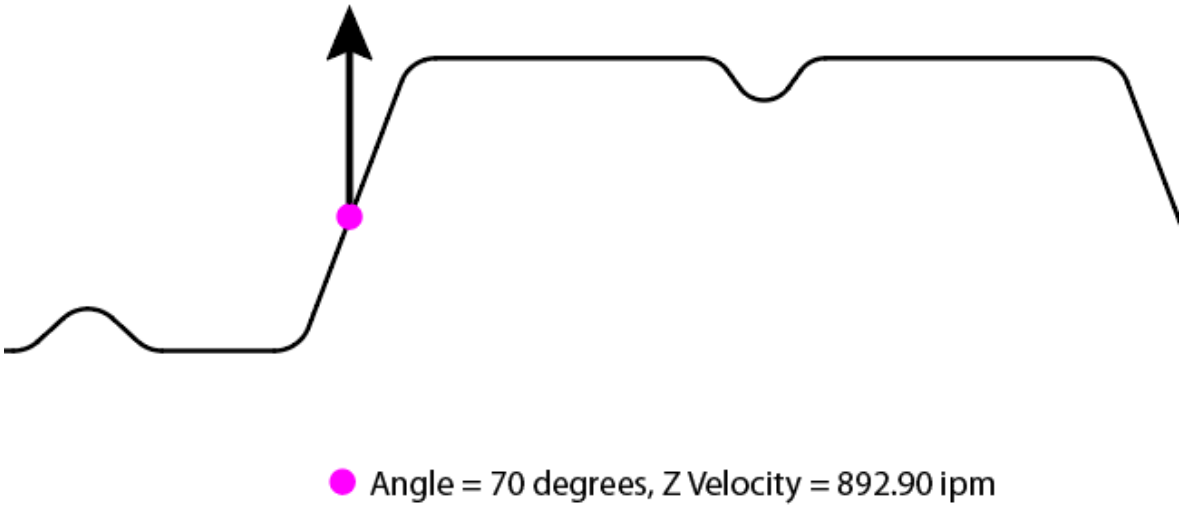
Its interesting to note that the Torch THC Z axis feed rates are a function of the angle of the vertical rise/fall of the material and the XY profile specified feed rate. For instance, on a classic 7/8" sine wave corrugated steel panel the Torch 'book' feed rate for 24 gauge at 40A is 325 inches-per-minute for the XY movement. So that means the Z axis feed rate at mid points along the corrugated rise and fall will be reaching 325 inches per minute to keep up with the XY movement! This occurs at the mid point angle of 45 degrees. Typically steep slope materials are NOT cut at book rates, they are cut at slower speeds as much as half the book values!



For steeper angles greater than 45 degrees, such as those found in modern corrugated roofing profiles, at certain points along the cut the Z-axis will actually be moving faster than the feed rate set for XY axis in the Profile manager!

For example a 70 degree slope with XY torch feed rate set in the profile manager at 325 ipm would require the Z-axis to move at 892.9 inches per minute to keep up with 325 ipm XY motion!

So to have any chance of cutting this type of material the Profile (XY) Feed Rate must be lowered significantly. For example, at XY feed rate of 150 ipm would require the Z-axis to be capable of reliable motion at 412 ipm for this shape!



Recommendations for cutting corrugated/sloped-valley materials.

- Reduce THC config Anti-Dive Velocity Ratio, a good place to start is 80%

- Increase the THC Anti-Dive Threshold (% of Target volts). 15% is a good place to start.

- Cut at lowest amperage settings possible, for example 25 amps or even 15 amps when cutting thin materials.

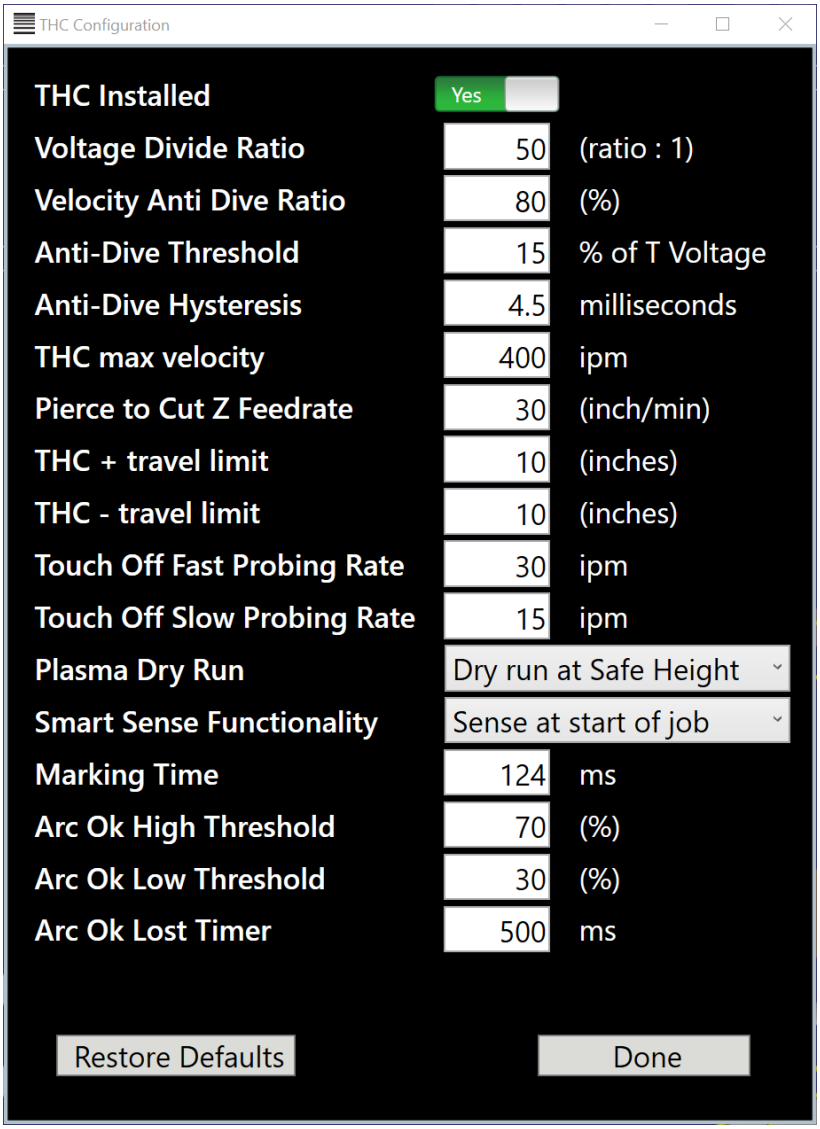
- When running 85 amp cutter use a 45 amp tip. Run at lowest amp setting possible.
  For example cut .25" material at 45 amps with an 85 cutter with 45 tip.

- The more changes in vertical (like corrugated) of a given material, Slow down cut the Material Profile Feed Rate as much as half or more!

- Don't use a regular fine cut nozzle (fine cut requires lower cut height which makes cutting corrugated difficult)

- Use a Hypertherm SYNC torch which operates at a higher cut height for steel and aluminum.

- Always set the THC max velocity to match the reliable max velocity of the Z-axis.

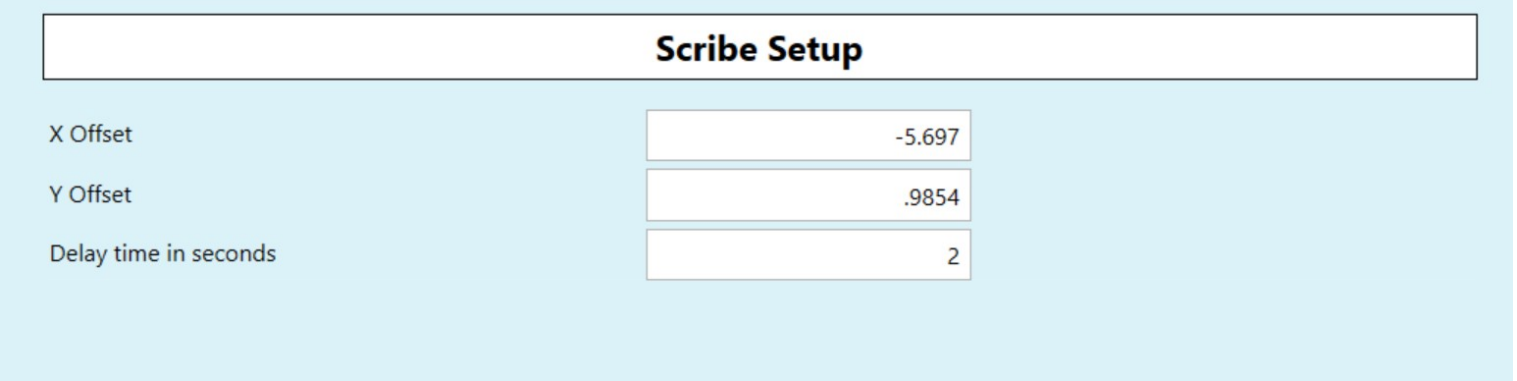


Scribe Setup

The settings for the Scribe feature are set in the Wizard.

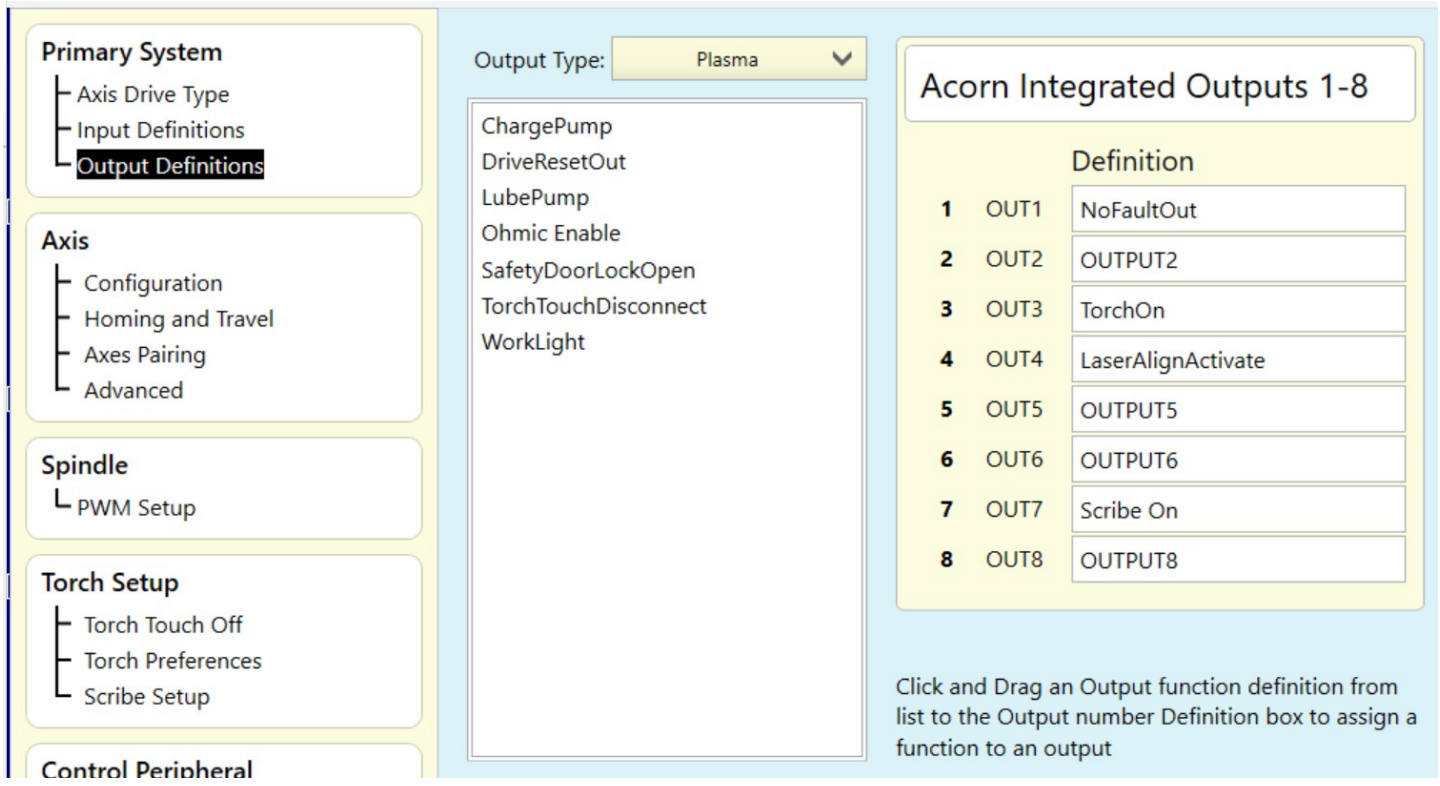
X Offset: The X distance away from the center of the torch.
Y Offset: The Y distance away from the center of the torch.
Delay: The delay between when the scribe is activated and when X/Y motion should start.

Wizard Setup menu for Scribe offset and delay.
Measure the distance from the Center of the Torch to the Center of the scribe and enter those values for the X and Y offset distance.



Scribe Output Definition for Scribe relay.

Drag the “Scribe On” output definition to the output that the Scribe is connected to.

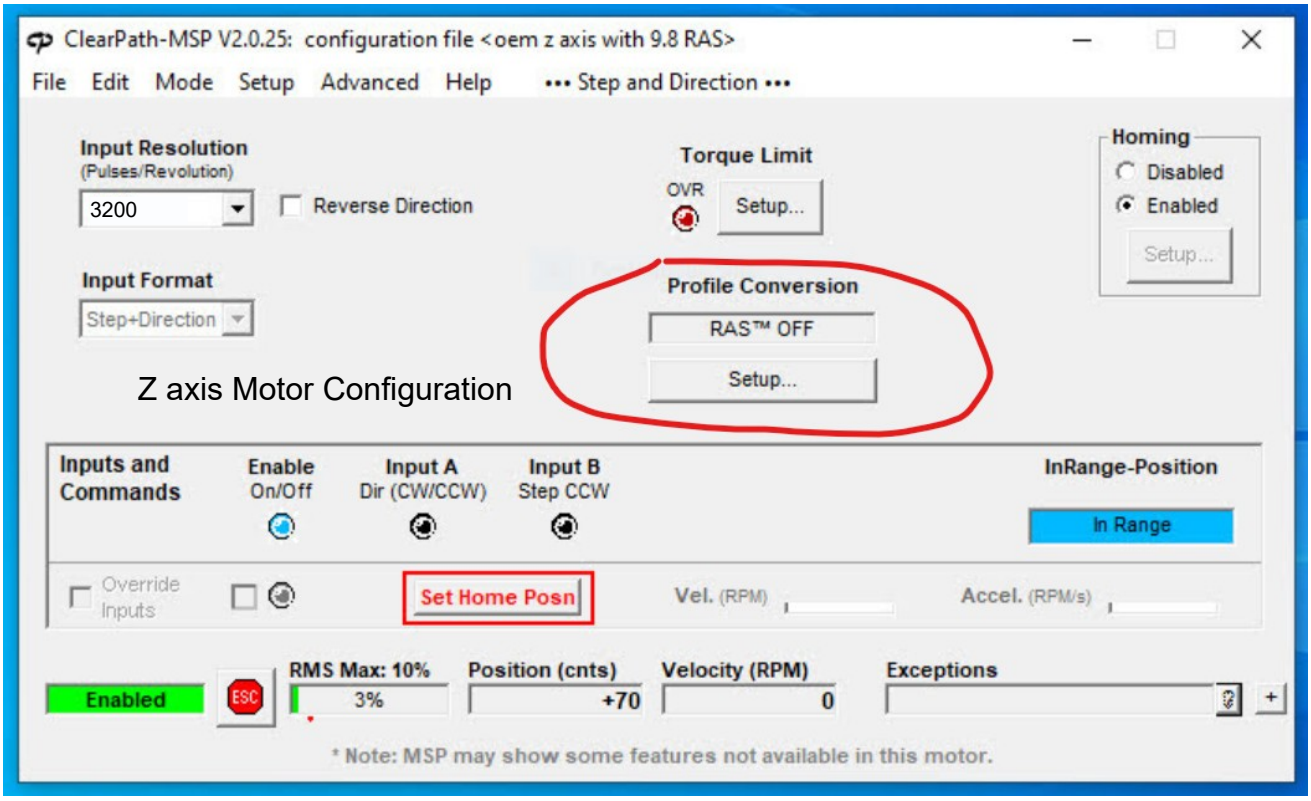


Electronic Gearing Settings for Clearpath Axis Motors

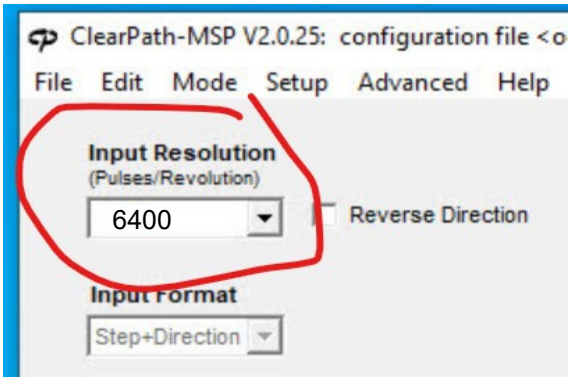
Follow the Centroid recommended wiring and choose the Clearpalth drive type in the Wizard.
More info here.

Teknic Clearpath motors provide fast, smooth, powerful motion and work well with the Acorn CNC controller. These are a good choice for a plasma machine. There are two main models of the Clearpath stepper killer motors. A common Clearpath purchase for a plasma machine is the lower-resolution, less-expensive Clearpath model which runs at a native 800 steps-per-revolution. If you can spring for a few more bucks, we highly recommend purchasing the higher-resolution model, which provides 6400 steps-per-revolution.

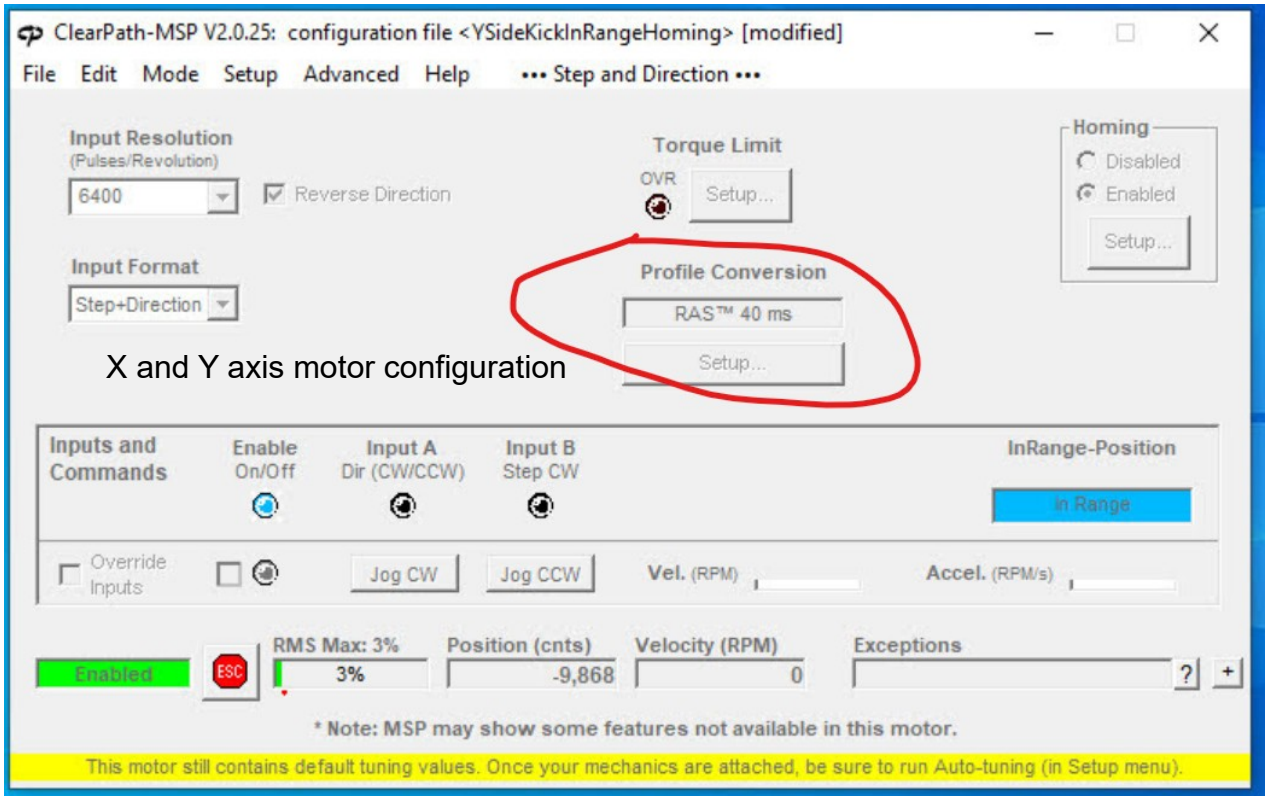
Clearpath has its own smoothing algorithm (called RAS) built into the motor drive firmware. This works very well for XY motion, but for the Z-(THC) axis this feature must be disabled in the Clearpath MSP software on the **Z-axis motor setup,** shown below:



Note: Even for the 800 steps-per-revolution model Clearpath motor, set the **Input Resolution** to 6400, and be sure set the Acorn Wizard Axis Configuration to 6400 to match.



A typical Clearpath RAS setting for the X- and Y-axes of a Plasma table = 40 ms



Also interesting to note is that the Clearpath motors can be setup for Auto-homing and Squaring (hardware-paired or software-paired). See TB #319 for more information: https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/319.pdf

Advice for Troubleshooting

Critical Grounding information from Hypertherm. Refer to the included Hypertherm Grounding Service bulletin, or visit the link below:
https://www.hypertherm.com/Download?fileId=HYP103900&zip=False

- Critical Machine Grounds: Run a 10 GA ground from the z-axis to the x-axis to the y-axis to the frame, so the slides are not acting as the ground path.

- Using an Ohm meter, double-check that all the grounds are good on the table and visually inspect connections. Verify solid, clean connections of wire and connector to bare metal. Remove paint where the ground leads connect to the table.

- Target Voltage readings are always problems in plasma, and are mostly caused by bad grounds, no grounds at all, and un-grounded tables (i.e. bad connections from machine frame ground to table).

- Do not coil ground leads.

- Do not coil extra CPC cable.

- Use a Hypertherm CPC cable.

- If DIYing a CPC cable, then make double sure that the wiring and pins are crimped properly and you are using properly-sized wires. Do not coil these wires.

- Run any outside wires that enter the cabinet as far away from any other wires and components as possible.

- A coiled ground to the plate can alter THC voltage readings.

Target Voltage Issues Caused by Nozzle Problems:

- Check the nozzle and shield. A bad pierce can ruin a nozzle in one pierce, causing the voltage to be off.

- Make sure to use the correct amp nozzle for the amp setting being used.

Installation Instructions for Updating Acorn CNC12 Plasma to a Newer Version of the Software

1.) Open the Wizard and Press ‘CTRL and P’ keys at the same time this will automatically make a PDF of screen shots of all the current Wizard settings. Save to the desktop or thumb drive. This creates a visual record of the current Wizard settings (store copies of the report and screenshots in a safe place, even on another computer as an extra precaution). If ‘CTRL and P’ is not available (older versions of CNC12 before v5.xx) You can also manually create screen shots with the Windows “Snipping Tool” which is very handy for this. To find this program, type “snip” in the Windows search bar.

2.) Download and unzip the CNC12 zip file:
EXTRACT the zip file, open the extracted folder, and have the Acorn up and running with a heartbeat. Double-click on setup.exe and follow the instructions to install CNC12. A Windows notification may appear: Click “More Info”, then click “Run Anyway” to continue.

3.) With the Acorn up and running with a heartbeat, double-click on the CNC12 Plasma Icon to start CNC12. CNC12 will update the firmware on the Acorn BBG. Follow the instructions on the screen.

4.) Install the Acorn License file from the Acorn Utility menu “Options” button.

5.) Open the Wizard and re-enter the information and settings from the screenshots made in Step 1, press “Write settings to CNC control”, and follow the instructions on the screen.

<u>Now Follow the Plasma Setup Steps in the Beginning of this Manual, Starting with Step 4:</u>

4.) Verify Torch Touch-off and Breakaway functionality.

5.) Verify basic torch function with the Torch Test Fire button on the VCP.

6.) Load a Profile using the Centroid Profile Manager to select a Profile to match the material to test cut with.

7.) Run the Arc Voltage Calibration macro. See critical details to get this right in the corresponding section of this manual.

8.) Load and cut the Centroid test plate plasma G-code program to verify operation.

Note: Currently the “Restore Report” feature should only be used on the same version of CNC12 software. Do not use the “Restore Report” feature when updating from one version of CNC12 to another.

Appendix

Plasma CNC12 Parameters

Parameter #	Description	Notes
5	Determines whether or not to use torch_check_macro.cnc after hitting torch check when running a job	Set by Acorn Plasma Wizard (Use G28 Torch Check Position)
19	Sets Macro 1 on the WMPG to act as Torch On/Off	Set by Acorn Plasma Wizard
511	THC Target Voltage (Counts)	Set by Profile Manager
512	THC Maximum Offset Acceleration (Steps / Interrupt)	Set by Profile Manager THC settings
513	THC Maximum Offset Velocity (Steps / Interrupt)	Set by Profile Manager THC settings
514	THC Maximum Offset (Steps)	Set by Profile Manager THC settings
515	THC Minimum Offset (Steps)	Set by Profile Manager THC settings
516	THC Voltage Error Level	Set by Profile Manager THC settings
517	THC Voltage Max Consecutive Errors	Set by Profile Manager THC settings
518	Plasma Voltage Divider Ratio	Set by Profile Manager THC settings
519	THC Active Delay (ms)	Set by Profile Manager
520	THC Velocity Anti-Dive Percentage	Set by Profile Manager THC settings
521	Feed Rate (Steps / Interrupt)	Set by Profile Manager
522	ArcOK Voltage Threshold (Counts)	Set by Profile Manager THC settings
523	THC Mode Setting	Set by Profile Manager
524	Float Switch used with TorchTip Setting	Set by Acorn Plasma Wizard
525	THC Voltage Factor	Set by Torch Calibration Macro
526	Pierce-Cut Z Feed Rate (Units / min)	Set by Profile Manager THC settings
527	Kp Value for THC	Set by Torch Calibration Macro
528	Ki Value for THC	Set by Torch Calibration Macro
529	Kd Value for THC	Set by Torch Calibration Macro
530	Integral Limit for THC	Set by Torch Calibration Macro
531	Torch ohmic/conductive touch distance offset value	Set by Acorn Plasma Wizard
532	Anti-flicker for Target Voltage Display. Takes an average over a number of samples. The default value is 5. The higher the sample number, the more averaging is applied to the display voltage. This has nothing to do with the THC target voltage, the purpose of this parameter is to simply display and easy to read value.	Default value is 5. 5 real time samples are added together and divided by 5 and that is the Voltage that is displayed. Base sample rate is 4000 times per second.

Plasma Resources.

Centroid Plasma CNC Tech Support Forum:
https://centroidcncforum.com/viewforum.php?f=65

Beginners Guide to CNC Plasma Cutting:
https://www.plasmaspider.com/viewforum.php?f=202

Plasma Spider Forum Resources

Clean & Dry Compressed Air - Very Important

Consumable Condition - What to Look for & When to Replace

Rigidly Mount & Square Your Torch

Cutting Height - It's a BIG deal

Cutting Direction - CW or CCW and When

Tips for Cutting Circles

Pierce Height, Cut Height, Height Control Explained

Reducing Pierce Divots or Marks

Appendix A:

Recommended Grounding and Shielding Practices

Field Service Bulletin

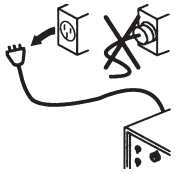
805400 – Revision 0 – November, 2006

Hypertherm®

The world leader in plasma cutting technology

Hypertherm, Inc.
Etna Road, P.O. Box 5010
Hanover, NH 03755 USA
603-643-3441 Tel 603-643-5352 Fax
www.hypertherm.com


WARNING
ELECTRIC SHOCK CAN KILL



Disconnect electrical power before performing any maintenance. All work requiring the removal of the power supply cover must be performed by a qualified technician.

See *Section 1* of the plasma system instruction manual for more safety precautions.

Introduction

This document describes the grounding and shielding necessary to protect a plasma cutting system installation against radio frequency interference (RFI) and electromagnetic interference (EMI) noise. It addresses the 3 grounding systems described below. There is diagram on page 5 for reference.

Note: These procedures and practices are not known to succeed in every case to eliminate RFI/EMI noise issues. The practices listed here have been used on many installations with excellent results, and we recommend that these practices be a routine part of the installation process. The actual methods used to implement these practices may vary from system to system but should remain as consistent as possible across the product line.

Types of grounding

A. The safety (PE) or service ground is shown in green on the diagram on page 5. This is the grounding system that applies to the incoming line voltage. It prevents a shock hazard to any personnel from any of the equipment, or the work table. It includes the service ground coming into the plasma power supply and other systems such as the CNC controller and the motor drivers, as well as the supplemental ground rod connected to the work table. In the plasma circuits, the ground is carried from the plasma power supply chassis to the chassis of each separate console through the interconnecting cables.

B. The DC power or cutting current ground is shown in red on the diagram on page 5. This is the grounding system that completes the path of the cutting current from the torch back to the power supply. It requires that the positive lead from the power supply be firmly connected to the work table ground bus with a properly sized cable. It also requires that the slats make good contact with the table and the workpiece.

C. RFI and EMI grounding and shielding is shown in blue on the diagram on page 5. This is the grounding system that limits the amount of electrical “noise” emitted by the plasma and motor drive systems. It also limits the amount of “noise” that is received by the CNC and other control and measurement circuits. This grounding/shielding process is the main target of this document.

Steps to take

1. Unless noted, use only AWG #6 (16 mm^2) welding cable (Hypertherm part no. 047040) for the EMI ground cables shown on the diagram (blue).

2. The cutting table is used for the common, or star, EMI ground point and should have threaded studs welded to the table with a copper bus bar mounted on them. A separate bus bar(s) should be mounted on the gantry as close to the drive motor(s) as possible. If there are drive motors at each end of the gantry, run a separate EMI ground wire from the far drive motor to the gantry bus bar. The gantry bus bar should have a separate heavy EMI ground wire (AWG #4 part no. 047031) to the table bus bar. The EMI ground wires for the torch lifter and the RHF box must each run separately to the table ground bus.

3. A ground rod that meets all applicable local and national electrical codes must be installed within 6m (20 feet) of the table. This is a PE ground and should be connected to the ground bus on the cutting table with AWG #6 green/yellow grounding wire (Hypertherm part number 047121) or equivalent. All PE grounds are shown on the diagram in green.

4. For the most effective shielding, use the Hypertherm CNC interface cables for I/O signals, serial communication signals, power supply-to-power supply multi-drop connections, and interconnections between all parts of the Hypertherm system.

5. All hardware used in the ground system must be brass or copper. The only exception is that the studs welded to the table for mounting the ground bus can be steel. Under no circumstances should aluminum or steel hardware be used.

6. AC power, PE, and service grounds must be connected to all equipment according to local and national codes.

7. The positive, negative, and pilot arc leads should be bundled together for as long a distance as possible. The torch lead, work lead and the pilot arc (nozzle) leads may only be run parallel to other wires or cables if they are separated by at least 150 mm (6"). If possible, run power and signal wires in separate cable tracks.

8. The ignition console should be mounted as close as possible to the torch, and must have a separate ground wire to the bus bar on the cutting table.

9. Each Hypertherm component, as well as any other CNC or motor-drive cabinet or enclosure, must have a separate ground cable to the common (star) point on the table. This includes the ignition console, even if it is bolted to the power supply or to the cutting machine.

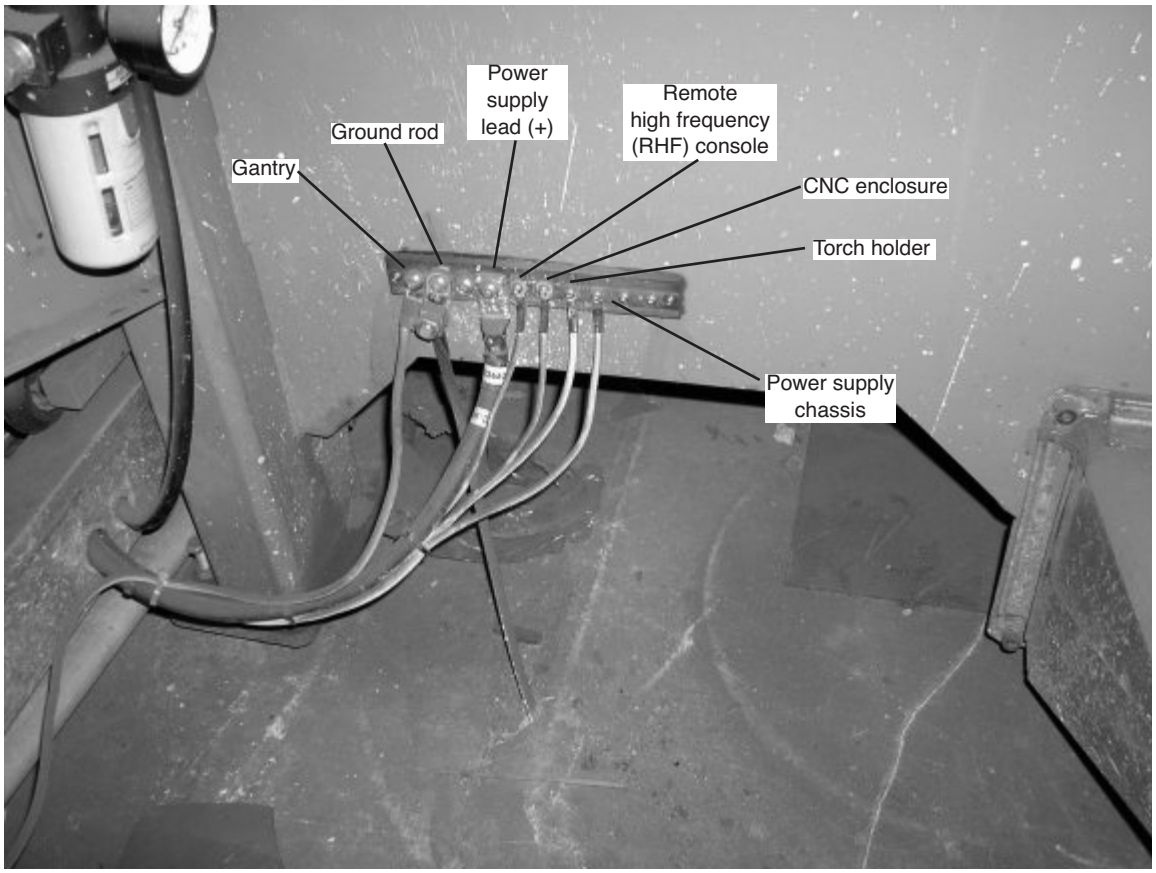
10. The metal braided shield on the torch leads must be connected firmly to the ignition console and to the torch. It must be electrically insulated from any metal and from any contact with the floor or building.

11. The torch holder and the torch break-away mechanism – the part mounted to the lifter, not the part mounted on the torch– must be connected to the stationary part of the lifter with copper braid at least 12.7 mm (1/2") wide. A separate wire must run from the lifter to the bus bar on the gantry. The valve assembly should also have a separate connection to the gantry bus bar.

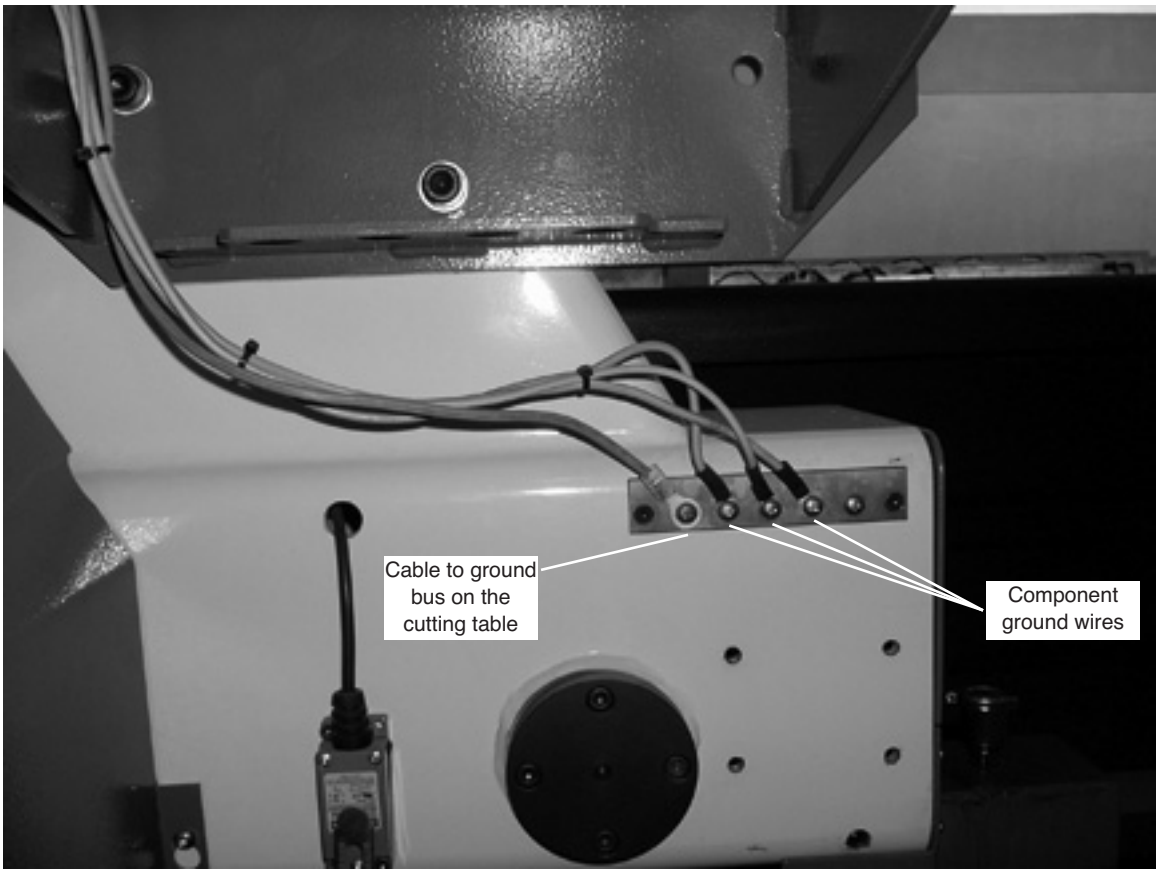
12. If the gantry runs on rails that are not welded to the table, then the rails need to be connected with a ground wire from each end of both rails to the table. This need not go to the common (star) point, but could take the shortest path to the table.

13. If the OEM is installing a voltage divider to process arc voltage for use in the control system, the voltage divider board should be mounted as close as possible to the point where the arc voltage is sampled. One acceptable location is in the plasma power supply. If the Hypertherm voltage divider board is used, the output signal is isolated from all other circuits. The processed signal should be run in twisted, shielded cable (Belden type 1800F or equivalent). The cable used must have a braided shield, not a foil shield. The shield should be connected to the chassis of the power supply and left unconnected at the other end.

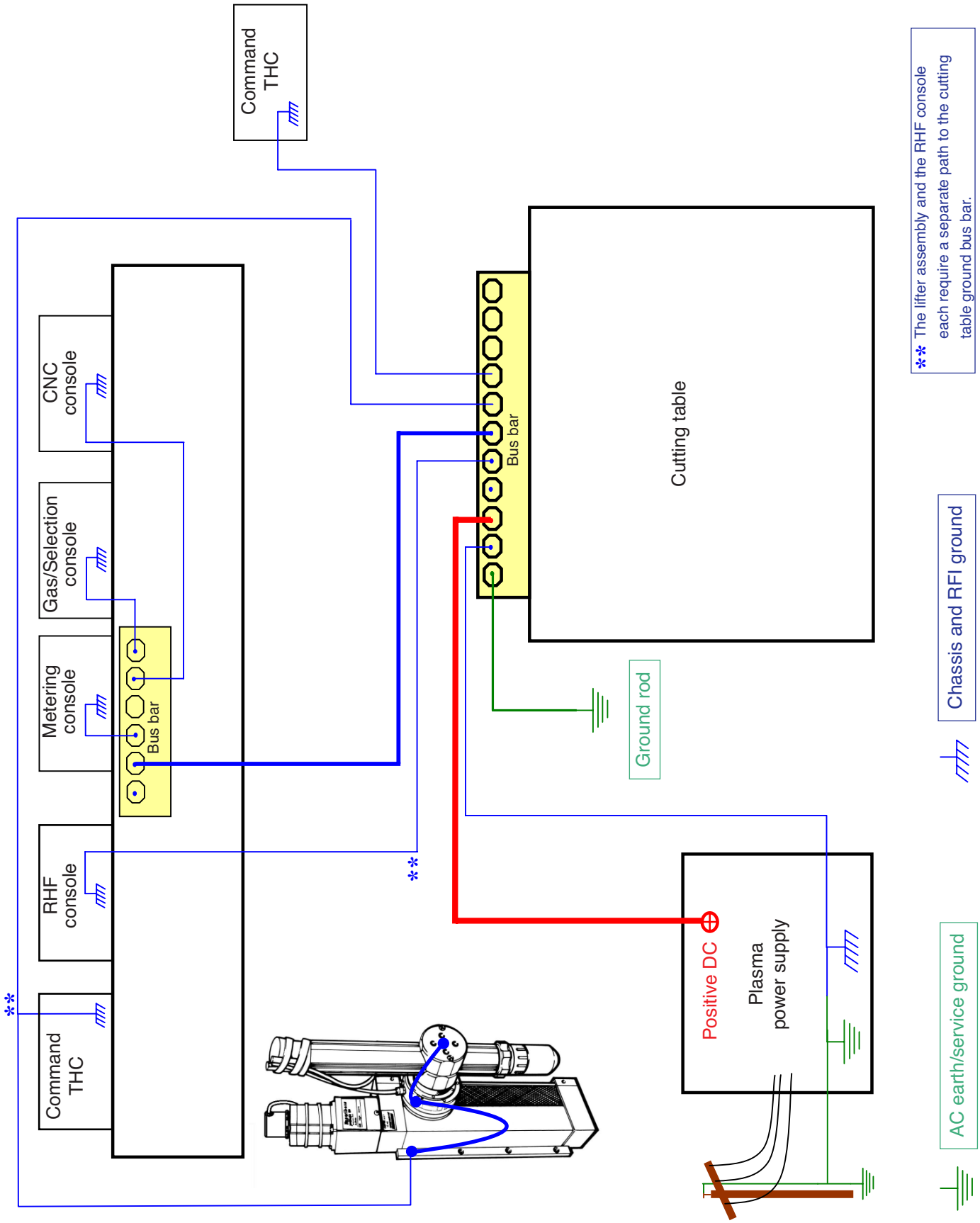
14. All other signals (analog, digital, serial, encoder) should run in twisted pairs inside a shielded cable. Connectors on these cables should have a metal housing and the shield, not the drain, should be connected to the metal housing of the connectors at each end of the cable. Never run the shield or the drain through the connector on any of the pins.



Example of a good cutting table ground bus. The picture above shows the connection from the gantry ground bus, the connection from the ground rod, the power supply positive lead, the RHF console, the CNC enclosure, the torch holder, and the power supply chassis.



Example of a good gantry ground bus. It is bolted to the gantry, close to the motor. All of the individual ground wires from the components mounted on the gantry go to the bus except those from the RHF module and the torch holder. A single heavy cable then goes from the gantry ground bus to the ground bus bolted to the table.


Command THC
CNC console
Gas/Selection console
Metering console
RHF console
Command THC
Bus bar
Bus bar
Cutting table
Ground rod
Positive DC
Plasma power supply
** The lifter assembly and the RHF console each require a separate path to the cutting table ground bus bar.
Chassis and RFI ground
AC earth/service ground

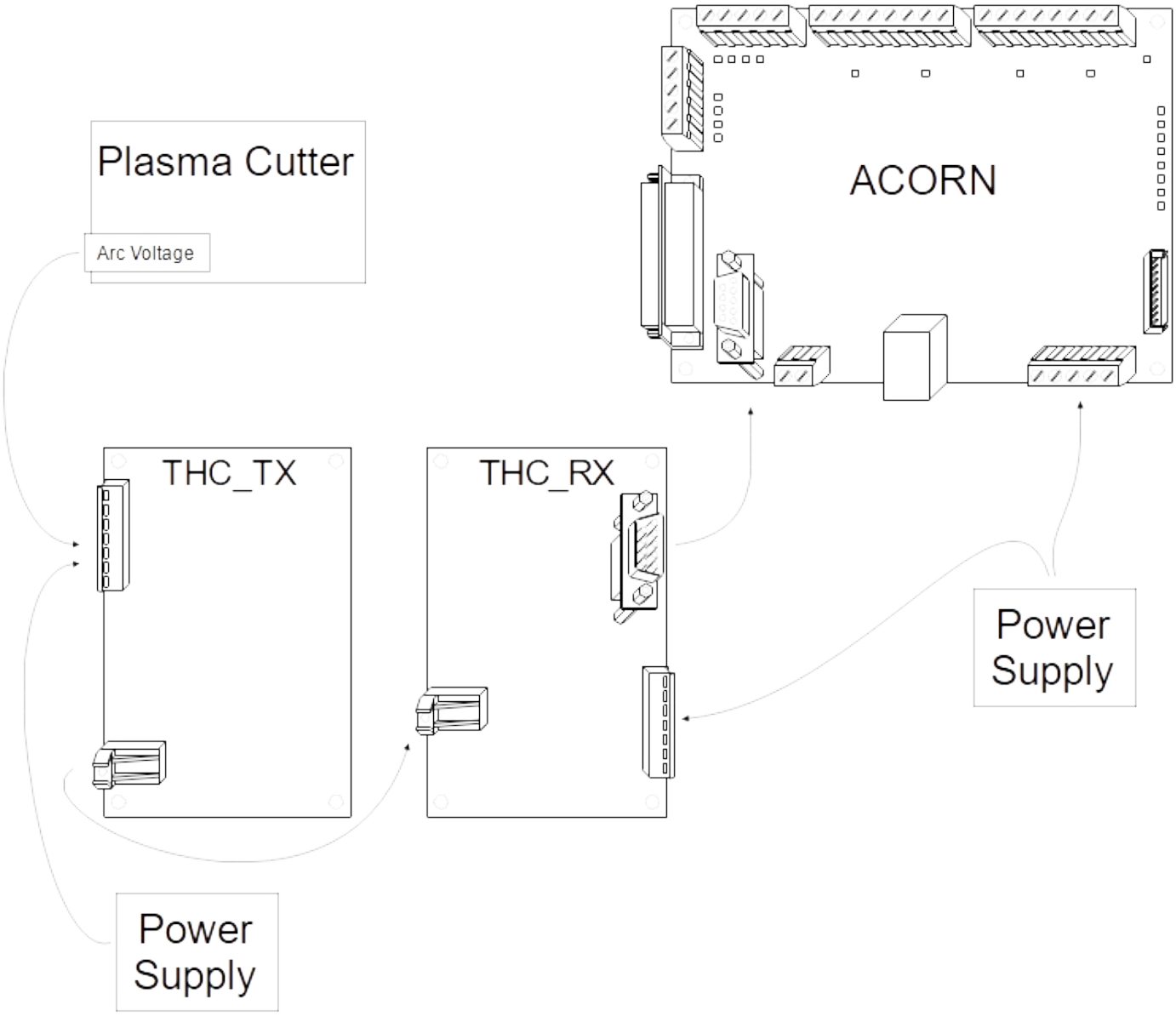
Appendix B: THC_RX and THC_TX Specifications

For THC_RX 200921 and THC_TX 210721
11/2/2021

Overview

The THC_RX and THC_TX circuit board set is a torch height control (THC) interface. THC_TX transmits plasma voltage readings through an optical fiber to THC_RX. THC_RX transmits the voltage reading to a compatible control, such as ACORN, through a specialized encoder interface. The fiber interface isolates plasma cutter electrical noise from the rest of the control system for reliable operation.

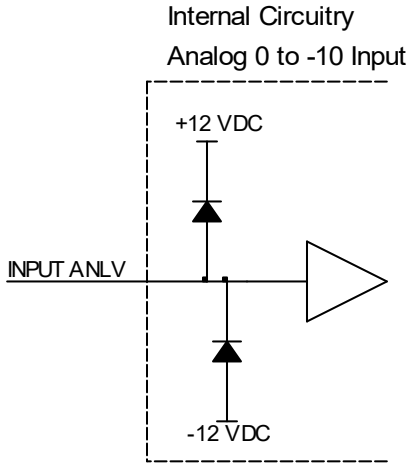
Function:	Torch Height Control Interface
Control Interface:	Encoder style quadrature interface
Dimensions (W*D*H):	4 * 2.6 * 0.75 inches (each device)

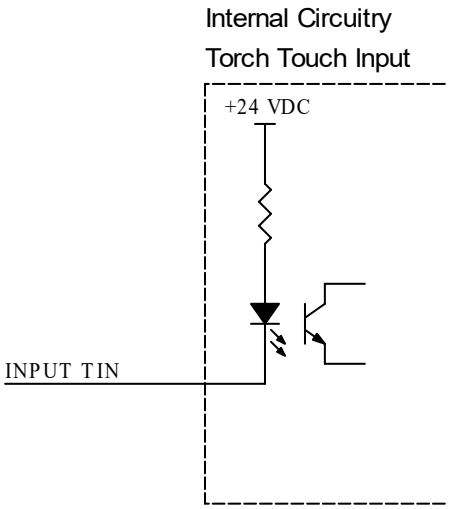

Plasma Cutter
Arc Voltage
ACORN
THC_TX
THC_RX
Power Supply
Power Supply

THC_TX Features

THC_TX has connections for arc voltage measurement and torch to part touch detect. The analog arc voltage may be supplied as 0 to -10V connected to the ANLV terminal. The plasma cutter must have a divided arc voltage output to get 0 to -10V input. Typically, the divider ratio is 50:1 or 40:1. The analog inputs measure voltage that is negative with respect to THC_TX and work table ground.

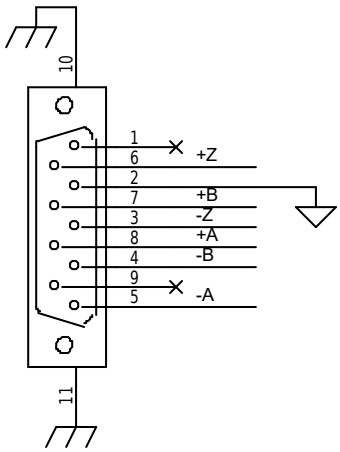
The touch detect input is activated when the TIN terminal is connected to THC_TX and work table ground.

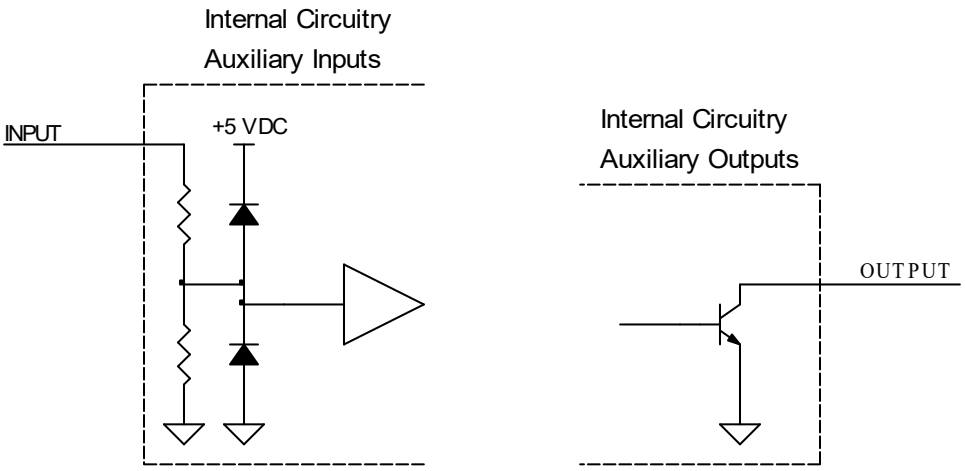




THC_RX Features

THC_RX drives encoder-like signals to a compatible control's encoder input. A straight-through cable connects THC_RX H3 to a Centroid control's DE9 encoder connector. Auxiliary inputs and outputs are available on THC_RX for future expansion.





THC_RX Specifications

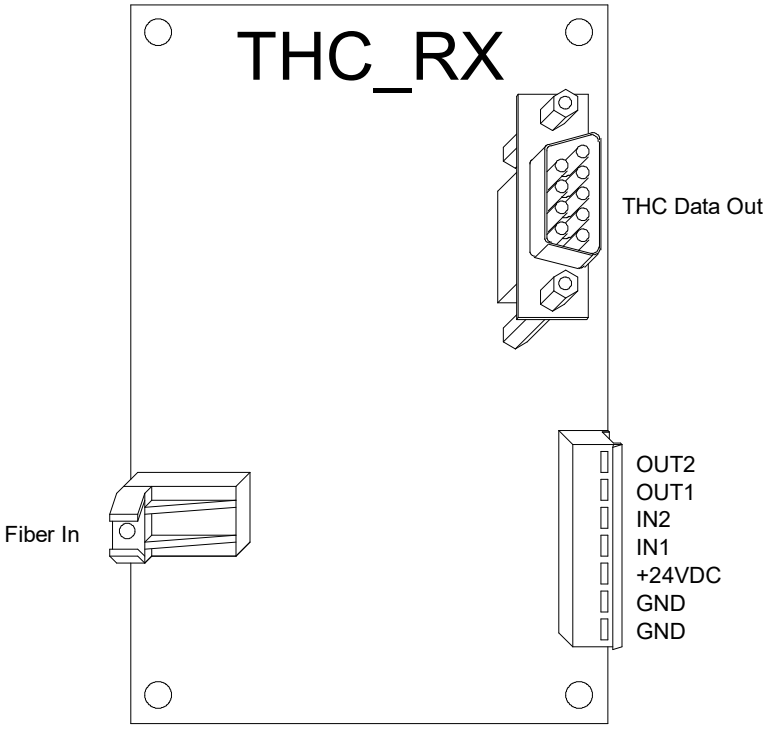
Characteristic	Min.	Typ.	Max.	Unit
24 Volt Supply Current	0.1	-	-	A
24 Volt Supply Voltage (Vsupply)	22	-	26	VDC
IN1, IN2 Input On Voltage	-	>3.2	Vsupply	VDC
IN1, IN2 Input Off Voltage	0	<1.0	-	VDC
IN1, IN2 Input Operating current	-	4	5	mA
OUT1, OUT2 Output Voltage*	0	-	26	VDC
OUT1, OUT2 Output Current	-	12	50	mA
Size: 4.0 * 2.6 * 0.7 (W*D*H)				Inches

.
*OUT1, OUT2 open drain, voltage describes allowable external pull up

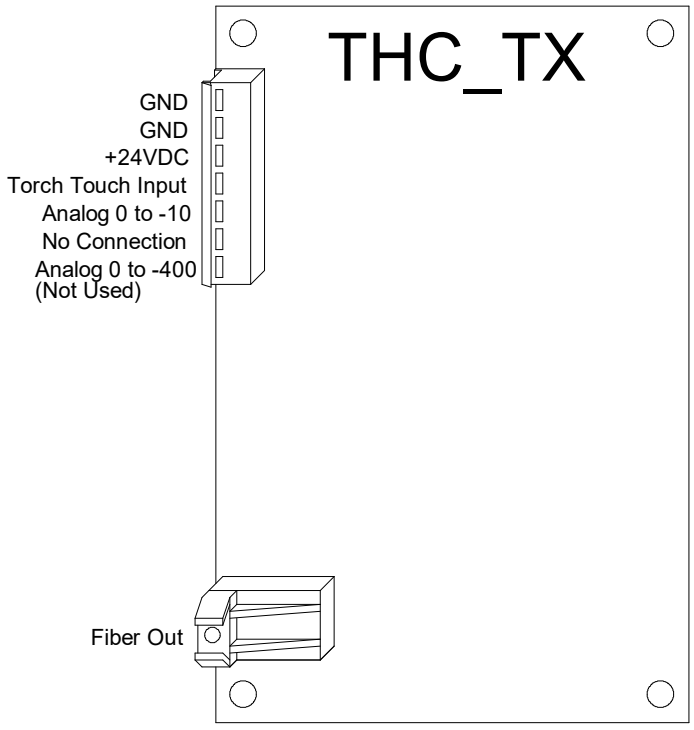
THC_TX Specifications

Characteristic	Min.	Typ.	Max.	Unit
24 Volt Supply Current	0.1	-	-	A
24 Volt Supply Voltage (Vsupply)	22	-	26	VDC
Part Touch Input Voltage	-	Vsupply	-	VDC
Part Touch Input On Voltage	-	< 4	-	VDC
Part Touch Input Operating current	10	12	17	mA
ANLV Analog Input Voltage	-10	-	0	VDC
ANLV Analog Input Current	-	5	-	nA
Analog Input Resolution	-	12	-	bits
Size: 4.0 * 2.6 * 0.7 (W*D*H)				Inches

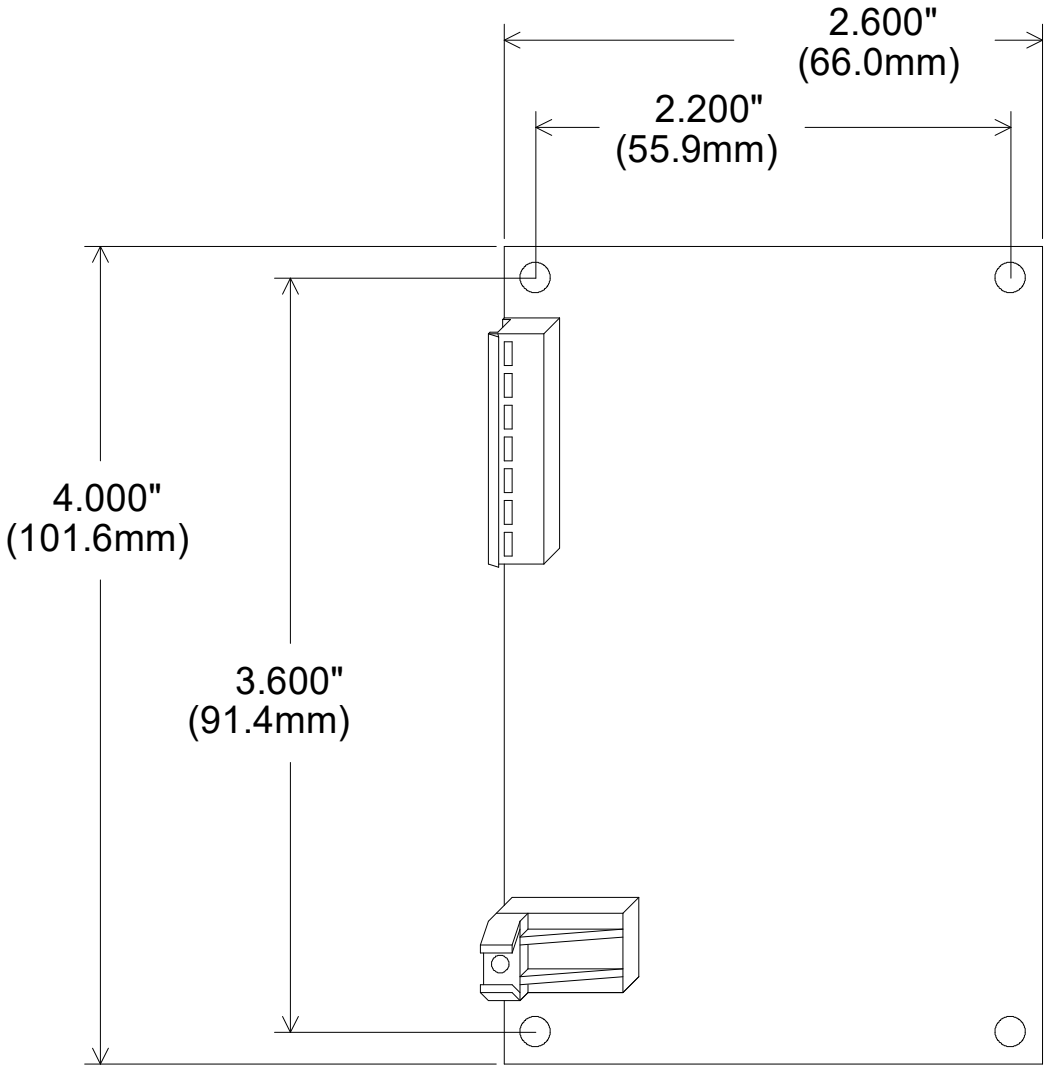
THC_RX Connections

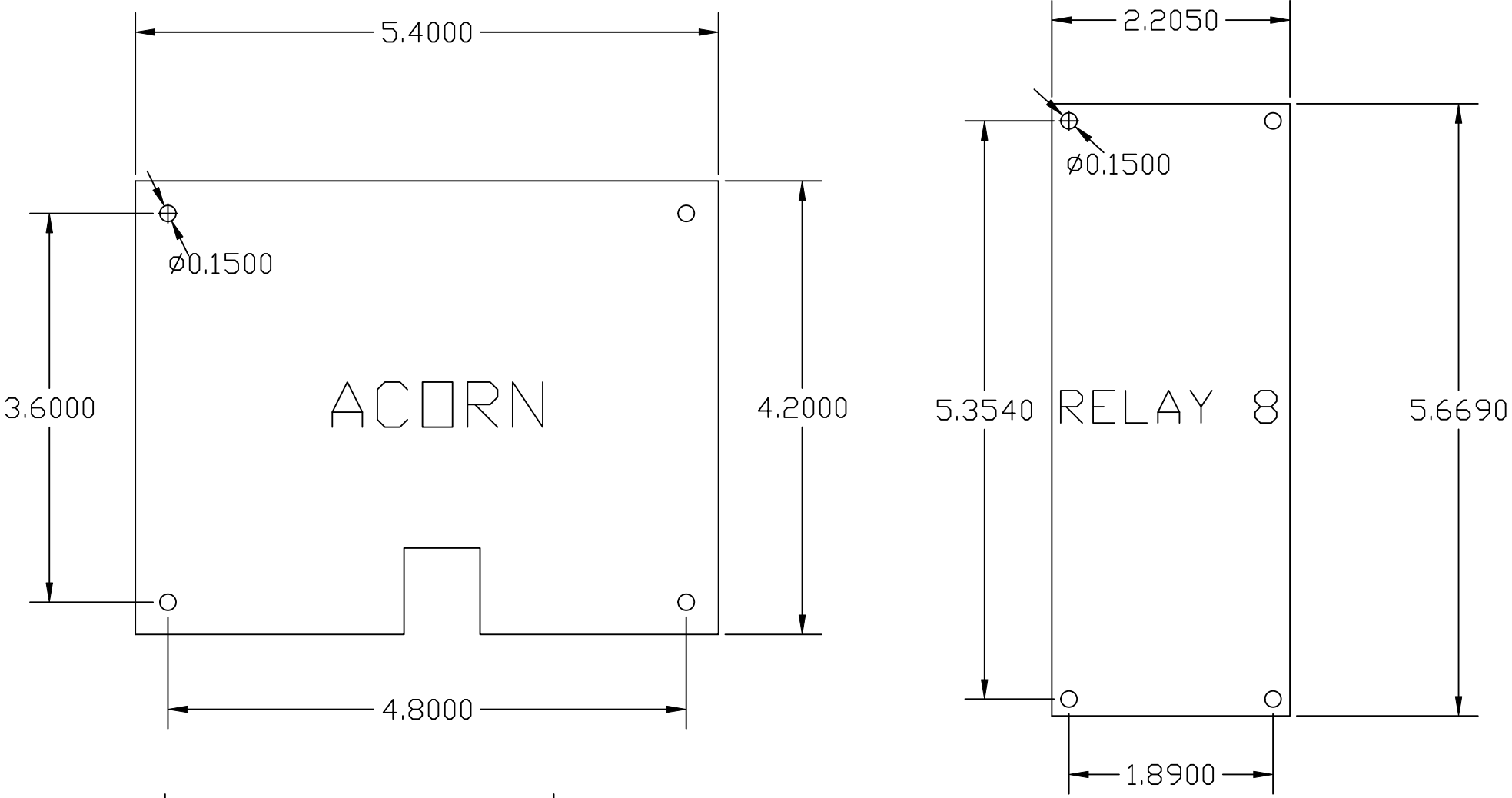


THC_TX Connections

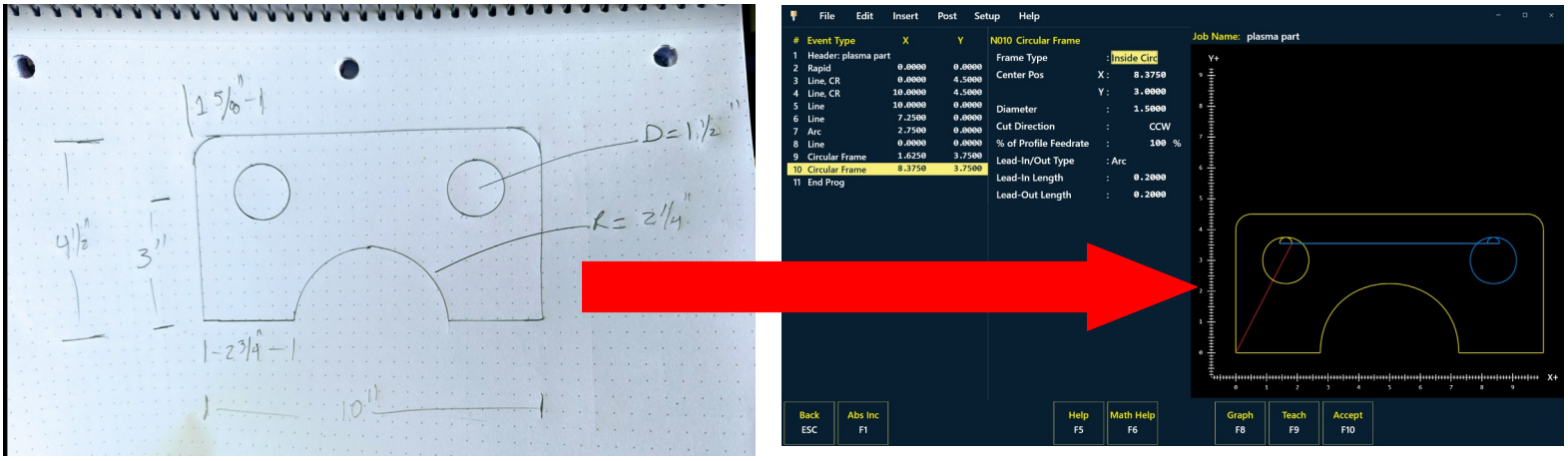


THC_RX and THC_TX Mounting Dimensions
(Same footprint for both)




5.4000
Ø0.1500
3.6000
ACORN
4.2000
4.8000
2.2050
Ø0.1500
5.3540
RELAY 8
5.6690
1.8900
3.6000
Ø0.1500
2.2000
THC TX/RX
2.6000
4.0000

Plasma Intercon quickly creates Plasma Part Programs with minimal fuss.
“Intercon” stands for “Interactive Conversational” programming.
Intercon conversational programming prompts the operator for basic part geometry and draws the part for you.
Intercon allow you to go from Print-to-Part with no other CAD/CAM system needed.
Plasma Intercon is a standard feature included with the Centroid Plasma CNC12 installer.
Press F5 CAM (computer aided machininig) from the main menu of Plasma CNC12 to start Plasma Intercon.



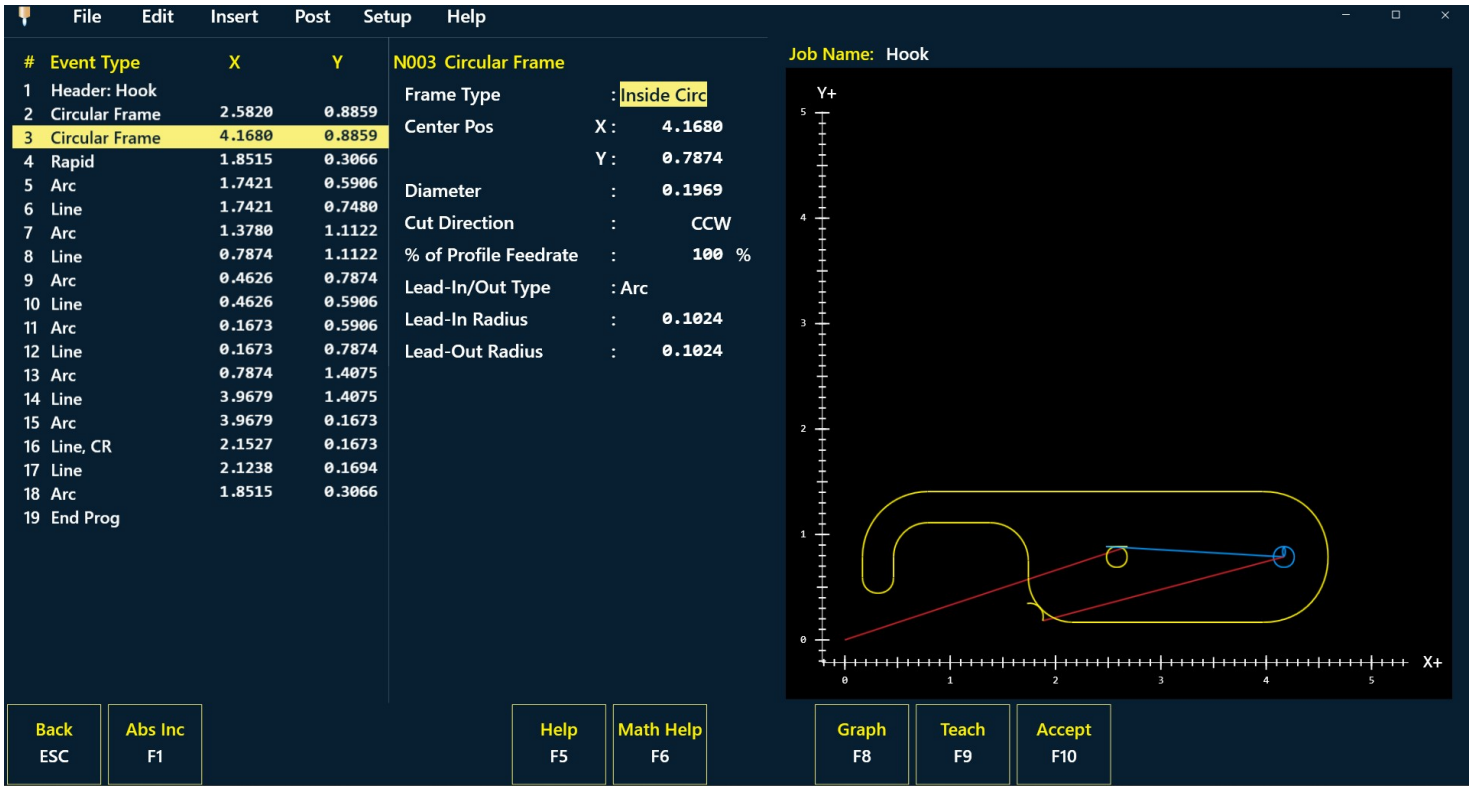
Print to Part in minutes with no CAD/CAM

Highlights and Features of Plasma Intercon

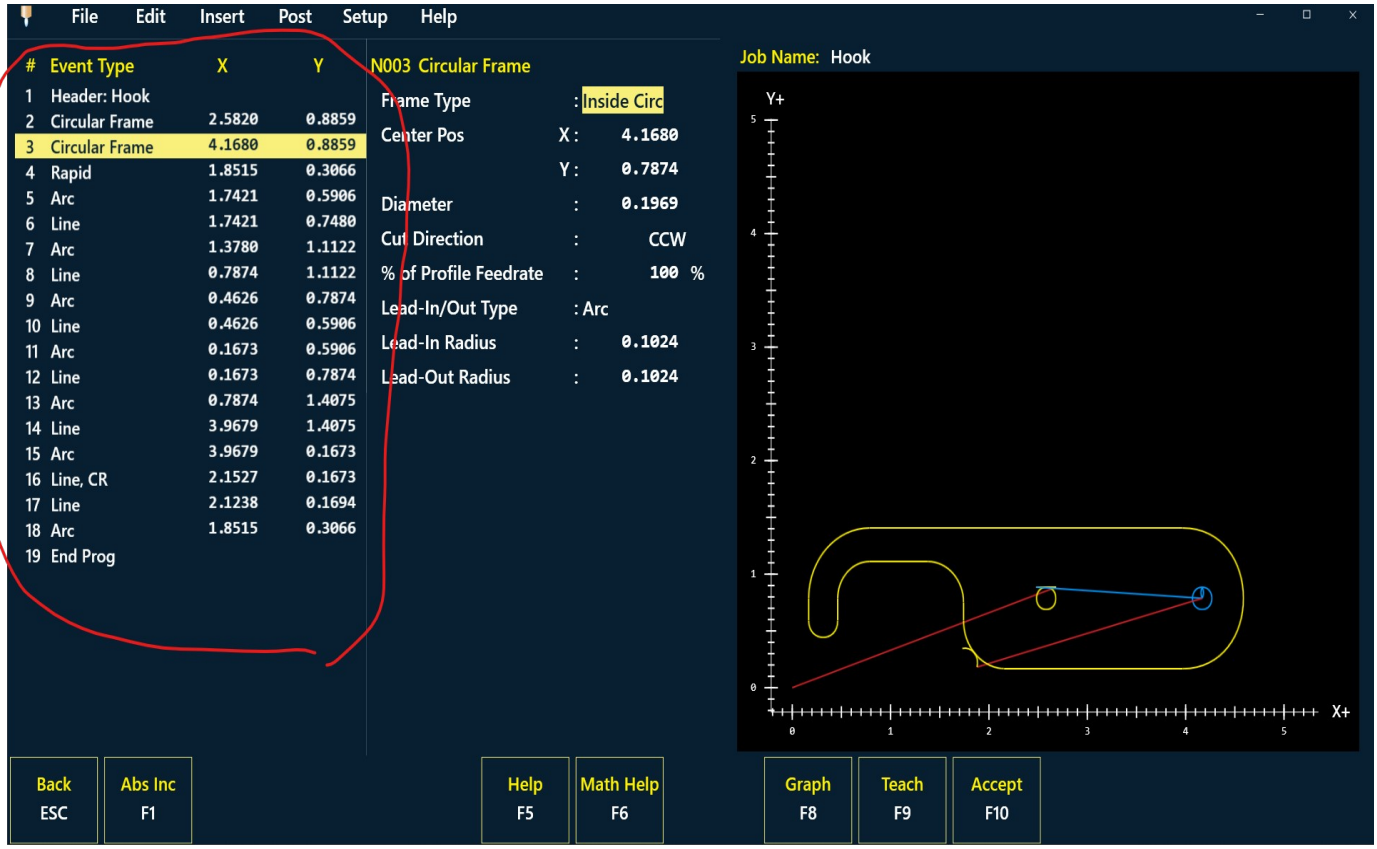
- No other CAD or CAM programs are necessary to create part programs with Plasma Intercon.
- Intercon prompts you for the part information.
- No CAD file is required to create parts with Plasma Intercon (however, DXF and SVG Import are features of Plasma Intercon if you wish to use a CAD drawing).
- Teach Mode (aka, tracing or manual digitizing). Trace the part or template or full size drawing using Intercon and the machine itself, The traced program is also easy to tweak and modifiy. Teach Mode is Cross Hair Laser compatible.
- Auto Lead-in and Lead-out types: Arc, Tangent Line, Perpendicular Line, and None
- Auto Kerf compensation. Left, Right, Center (on the line).
- Cut Direction control
- Auto Radiusing (connect radius)
- “Canned” Cycles. Rectangular Frames, Circular Frames, Lines, Arcs
- Auto Marking
- Repeat, Mirror, Rotate
- Nesting
- DXF and SVG import
- Use Line Angle and Lenght or Endpoints
- Adjust cut speed based on percentage of Material Profile Feedrate (commonly used for small circle speed control)
- Math Help Geometry Solver

In addition to running Plasma Intercon on the Plasma Machine computer an offline version is also availble and runs on a Windows 10/11 PC with the Intercon USB key so you can program plasma parts in the comfort of your office.

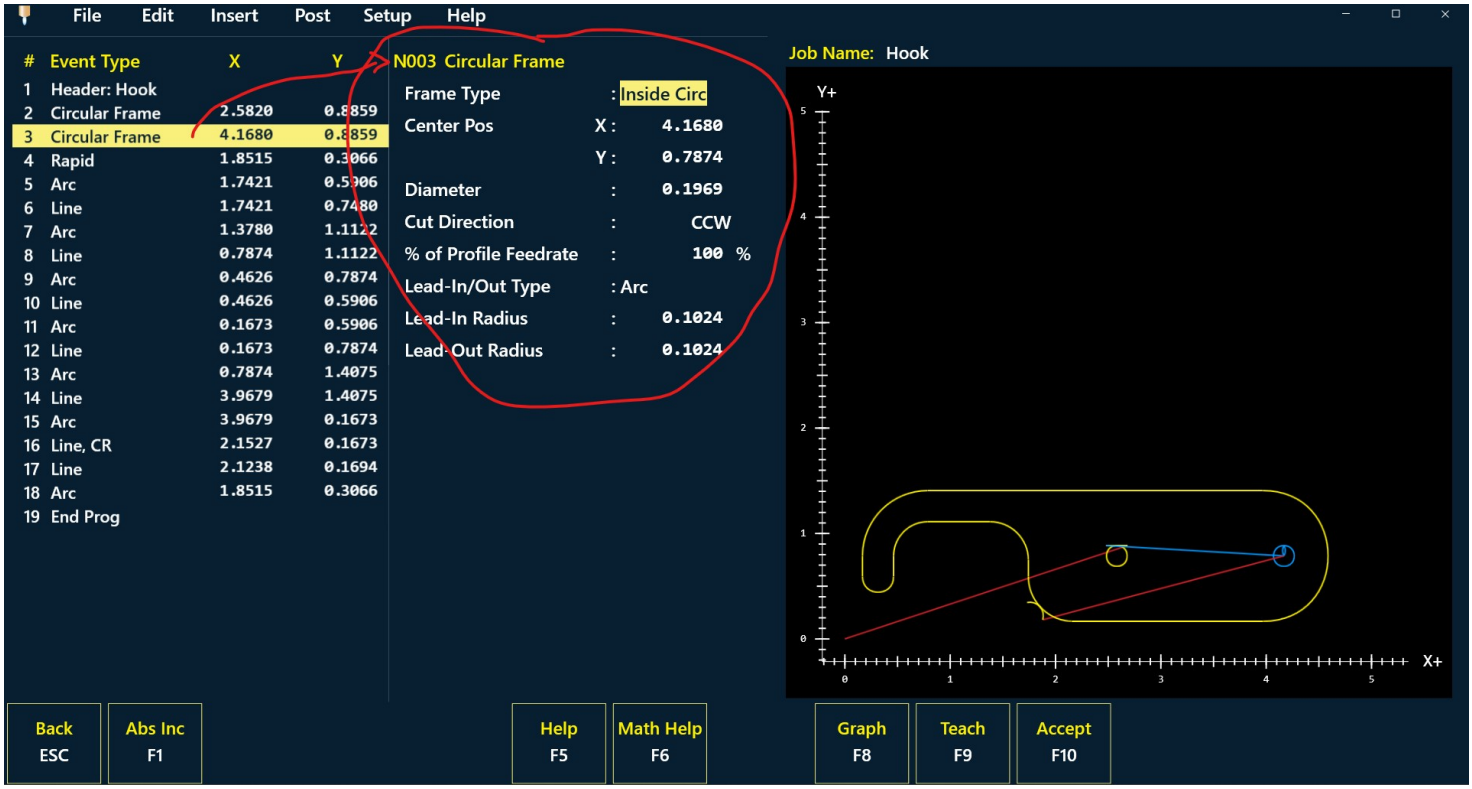
When starting Plasma Intecon for the first time it will automatically load a sample part program called “Hook”



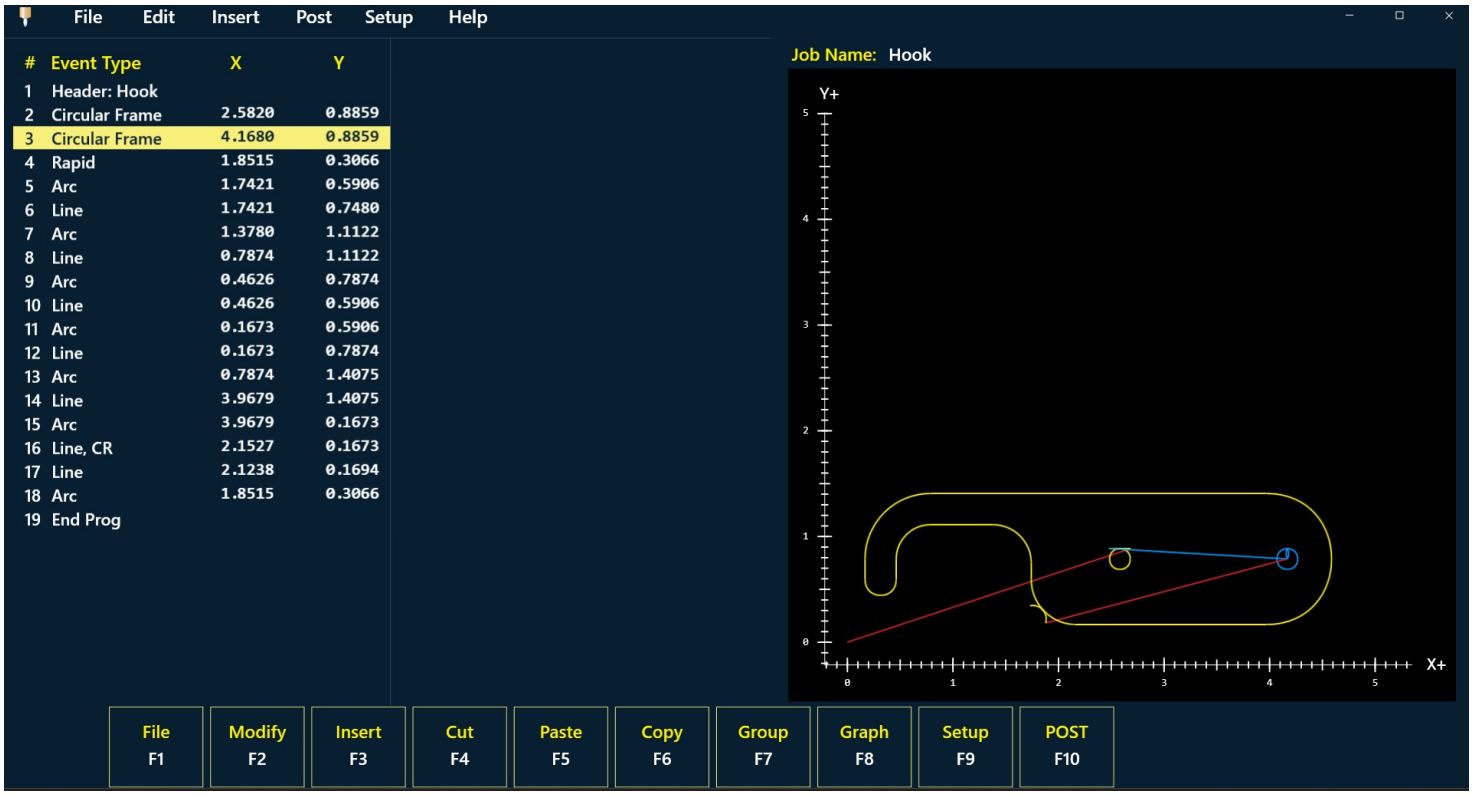
The major events of the Hook part program are seen on the left window. These are the lines, arcs and circular frames that make up the program.



Double click to see or edit the information contained within an event. Or move the cursor with the arrow keys to highlight any event and press enter to edit it.



Once finished editing the event information. Press/Click F10 Accept the Event back into the program.



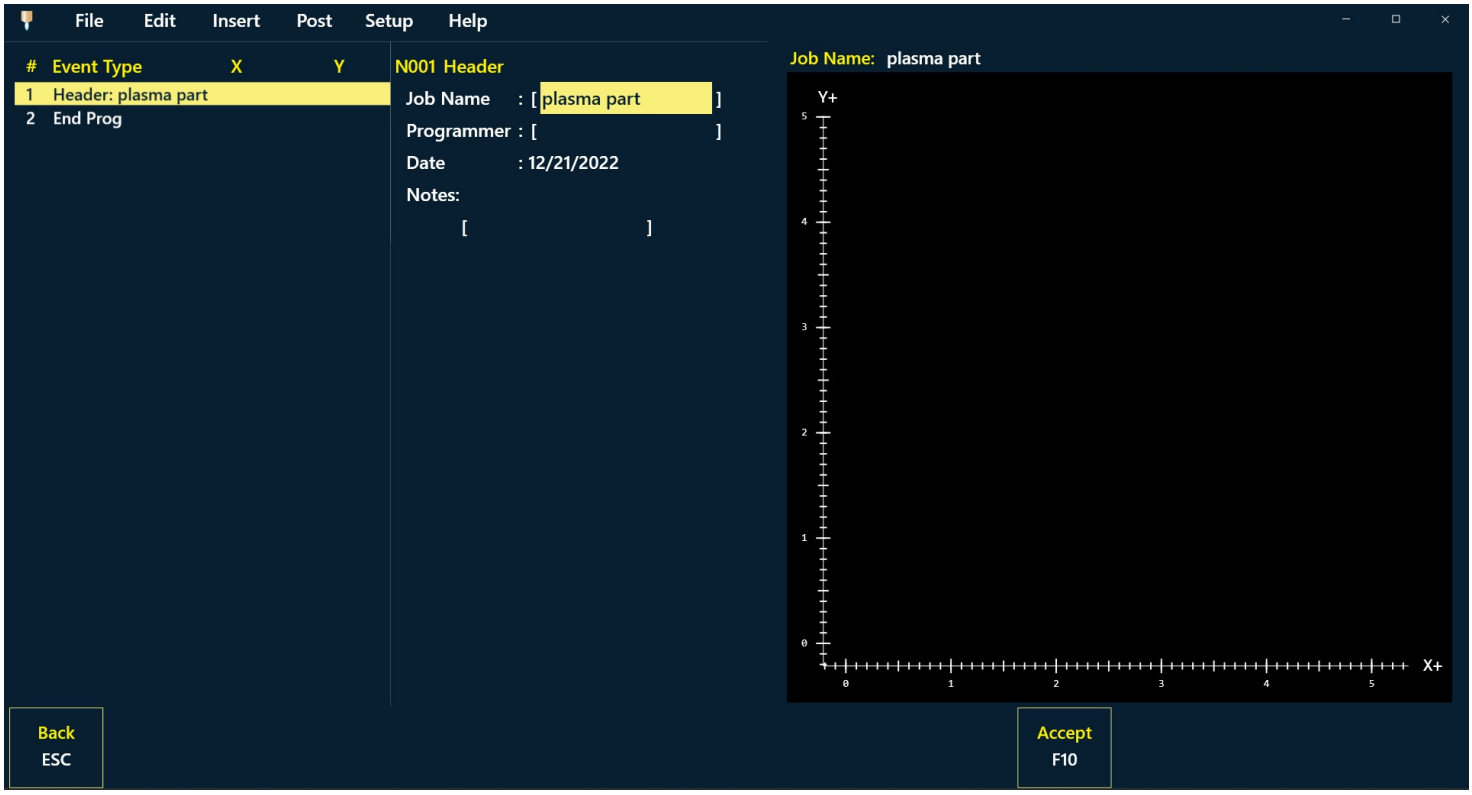
Press F10 Post to create the Part Program. (the Plasma G code program). This part G-code program will have the same name but with a new extension. “Hook.CNC” and is saved in the G code folder of CNC12 (c:\cncm\ncfiles)

Plasma part program G-code is human readable, if you are curious you can look at the Plasma Generated G code program with any Text editor (we recommend Notepad ++).
Below is the “Hook.CNC” G-code part program automatically generated by Plasma Intercon. This G-code part program is ready to cut!

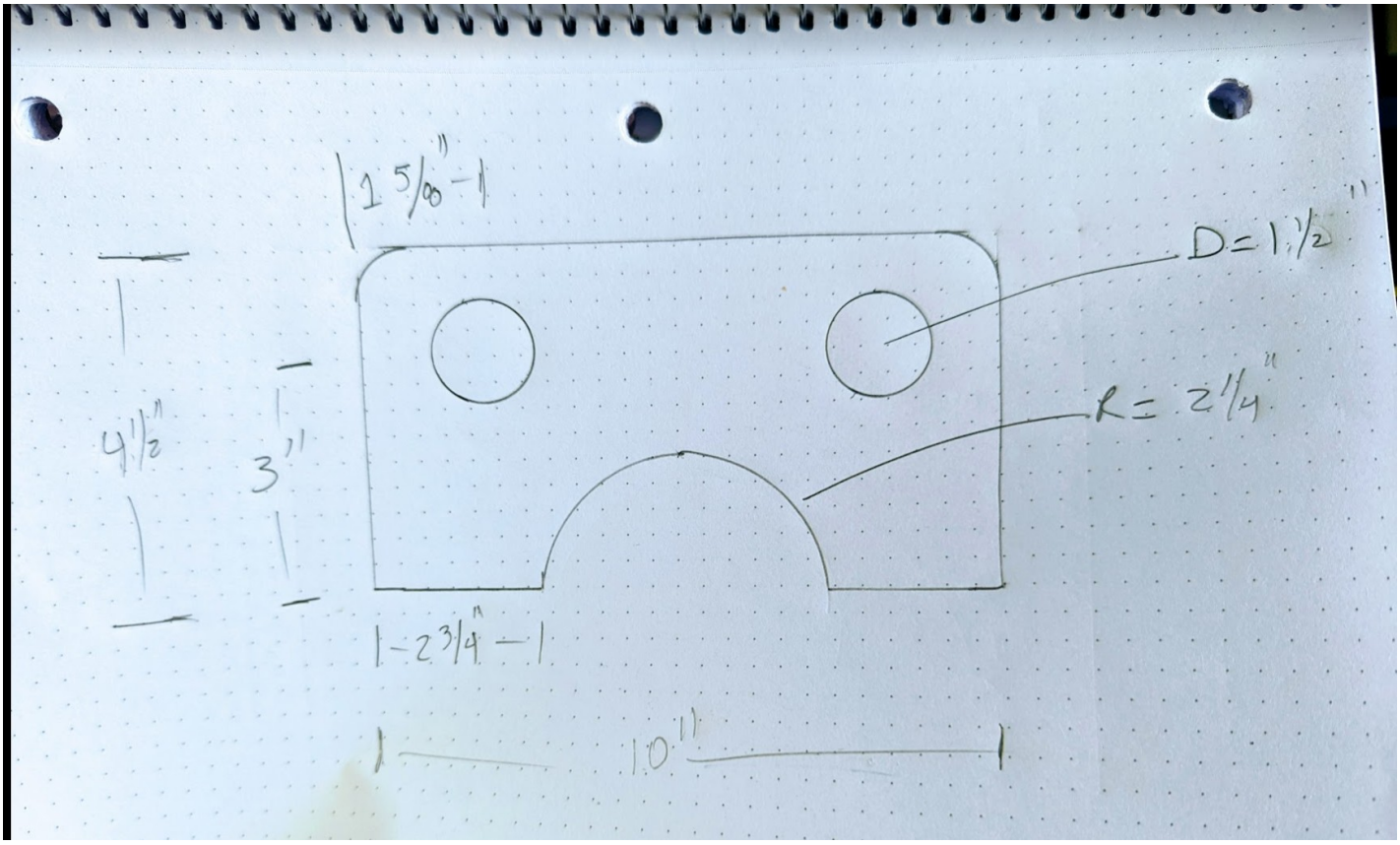
```
N0001
G17 ; Setup for XY plane
G20 ; inch measurements
G90 ; absolute positioning
M65
; --- Inside Circ Frame ---
N0002
G0 X2.6844 Y0.85585
M61
G1 X2.582 Y0.85585
G3 X2.582 Y0.85585 I0 J-0.06845
X2.4796 Y0.85585
M62
; --- Inside Circ Frame ---
N0003
G0 X4.168 Y0.7874
M61
G3 X4.168 Y0.85585 I-0.06379976 J0.034225
G3 X4.168 Y0.85585 I0 J-0.06845
G3 X4.168 Y0.7874 I0.06379976 J-0.034225
M62
; --- Rapid Traverse ---
N0004
G0 X1.878390323 Y0.18145644
; --- Arc CW ---
N0005
M61
G3 X1.8515 Y0.3066 I-0.121822663 J0.039284077
G2 X1.7421 Y0.5906 I0.3139 J0.2839
; --- Line ---
N0006
G1 X1.7421 Y0.748
; --- Arc CCW ---
N0007
G3 X1.378 Y1.1122 I-0.3642 J0
; --- Line ---
N0008
G1 X0.7874 Y1.1122
; --- Arc CCW ---
N0009
G3 X0.4626 Y0.7874 I0 J-0.3248
; --- Line ---
N0010
```

```
G1 X0.4626 Y0.5906
; --- Arc CW ---
N0011
G2 X0.1673 Y0.5906 I-0.1477 J0
; --- Line ---
N0012
G1 X0.1673 Y0.7874
; --- Arc CW ---
N0013
G2 X0.7874 Y1.4075 I0.6201 J0
; --- Line ---
N0014
G1 X3.9679 Y1.4075
; --- Arc CW ---
N0015
G2 X3.9679 Y0.1673 I0 J-0.6201
; --- Line ---
N0016
G1 X2.153770388 Y0.1673
G2 X2.151632427 Y0.167377575 I0 J0.0295
; --- Line ---
N0017
G1 X2.1238 Y0.1694
; --- Arc CW ---
N0018
G2 X1.8515 Y0.3066 I0.0415 J0.4211
G3 X1.729671111 Y0.345864766 I-0.09491873 J-0.085874529
M62
; --- End of Program ---
N0019
M30
```

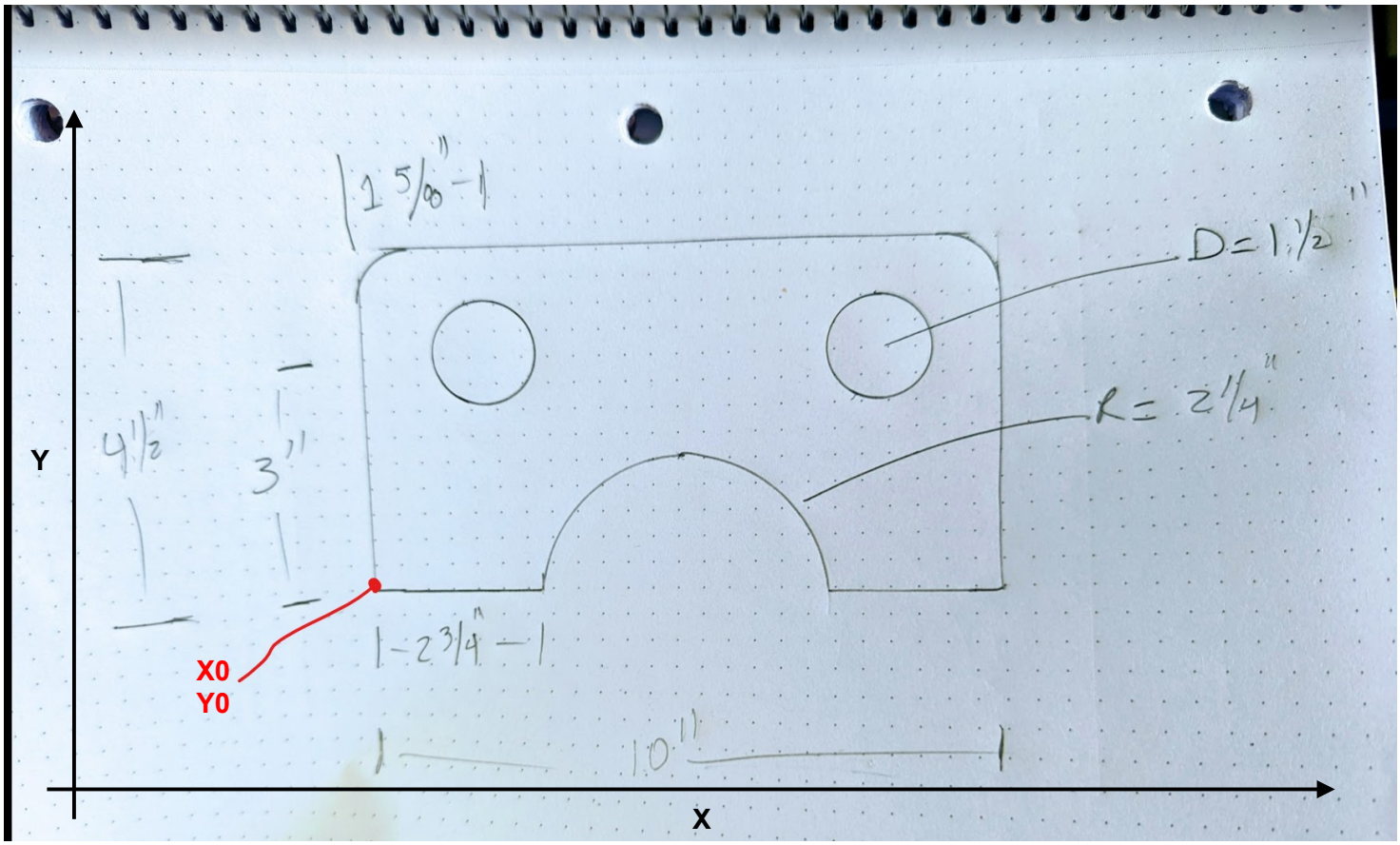
To Create a New Plasma Part program Press/Click File-> New, Type in a name for the new program, enter job name and optional programmer and notes and press F10



In this tutorial we will create this part using Plasma Intercon



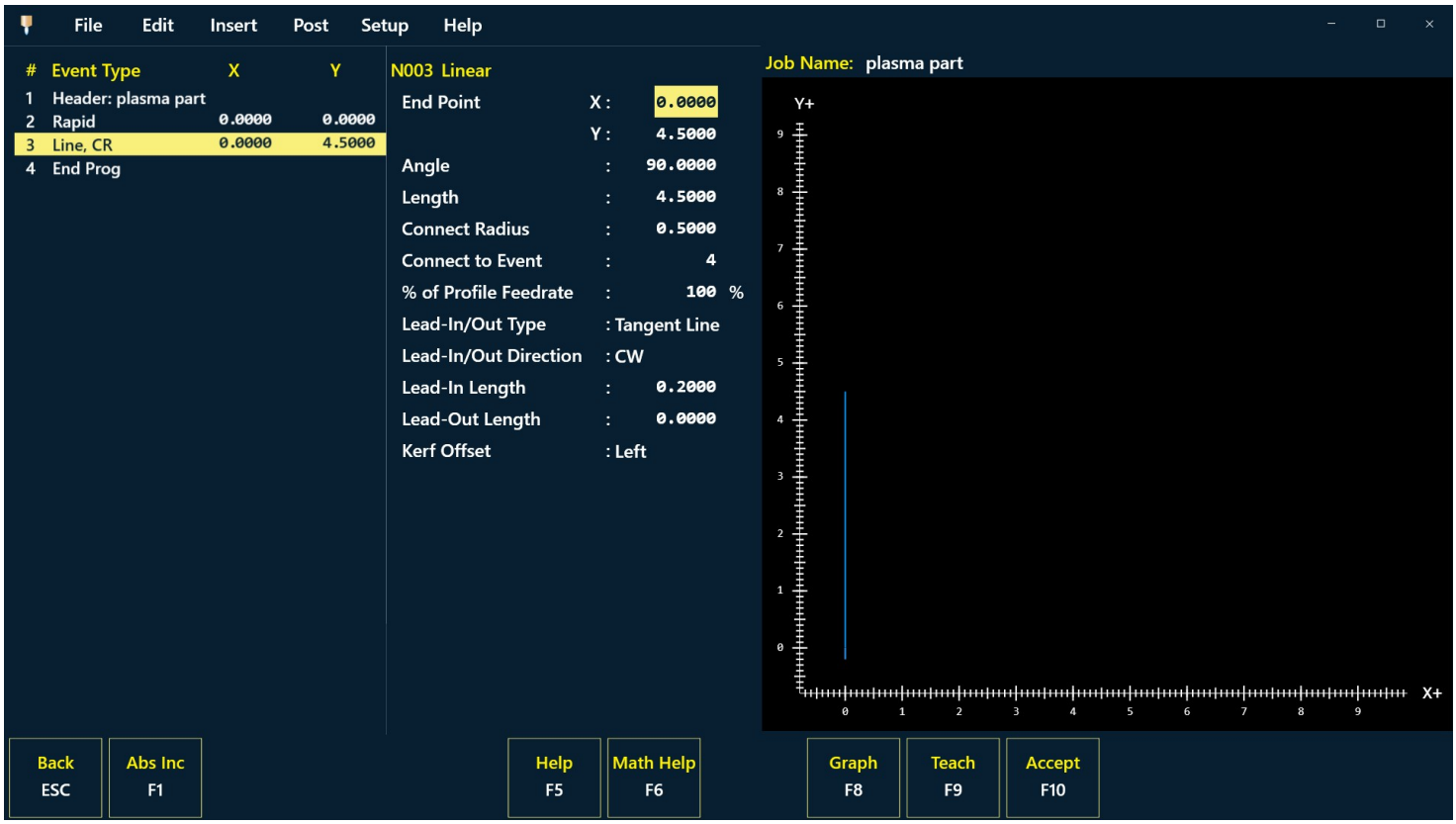
To start, always decide where you want to call the Part Zero position.
I have chosen the lower left hand corner.



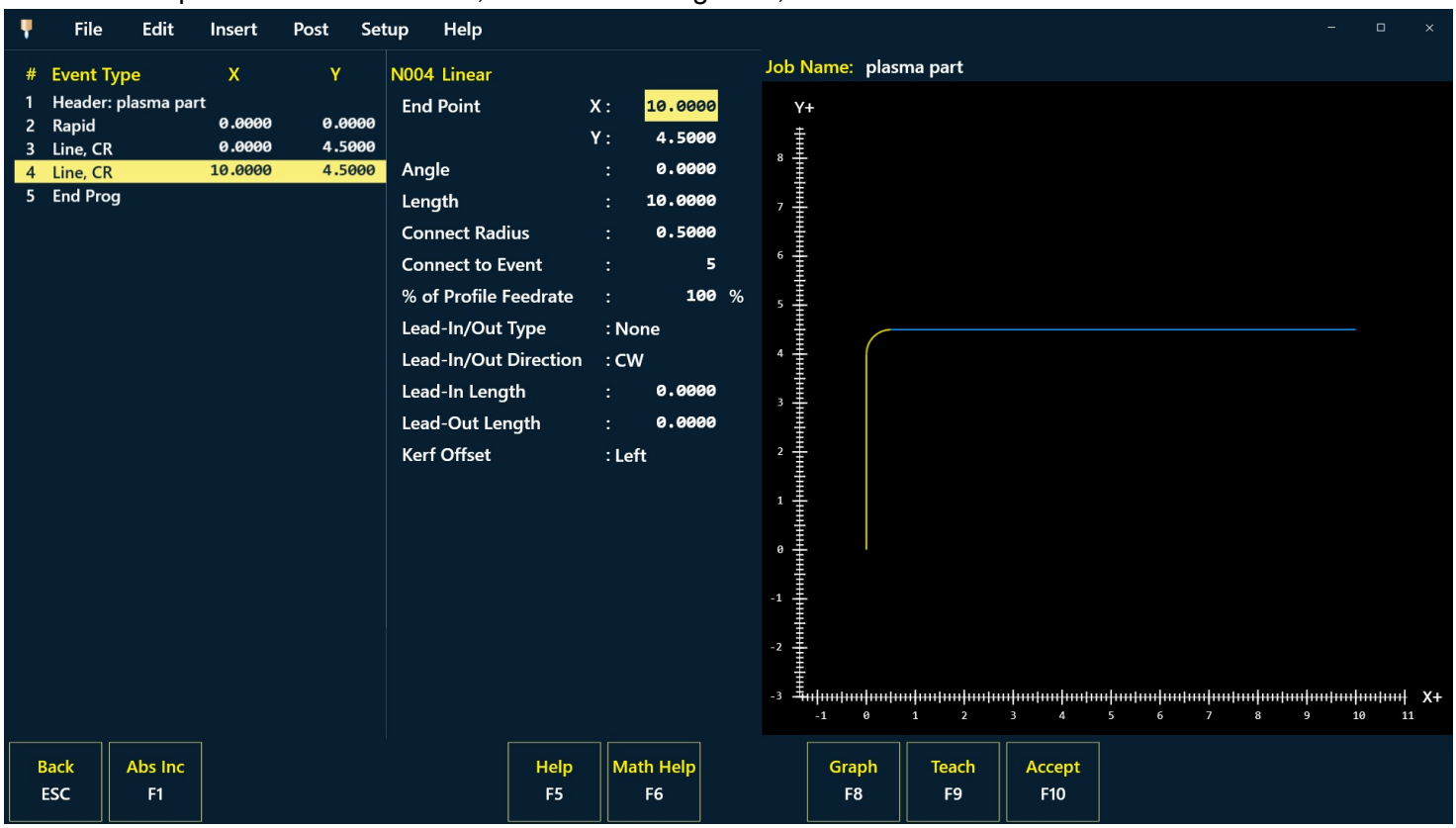
The first Torch move to create this part will be a rapid position move to the starting point of where I want to begin cutting, I have chosen to start cutting at X0,Y0.
To insert the rapid to the starting point at X0Y0 position, select F1 Rapid and press F10 to Accept.

Next select F2 Line.
Enter the end point of the first line, from the drawing: X0, Y4.5.

Press F10 to Accept the line into event #3.

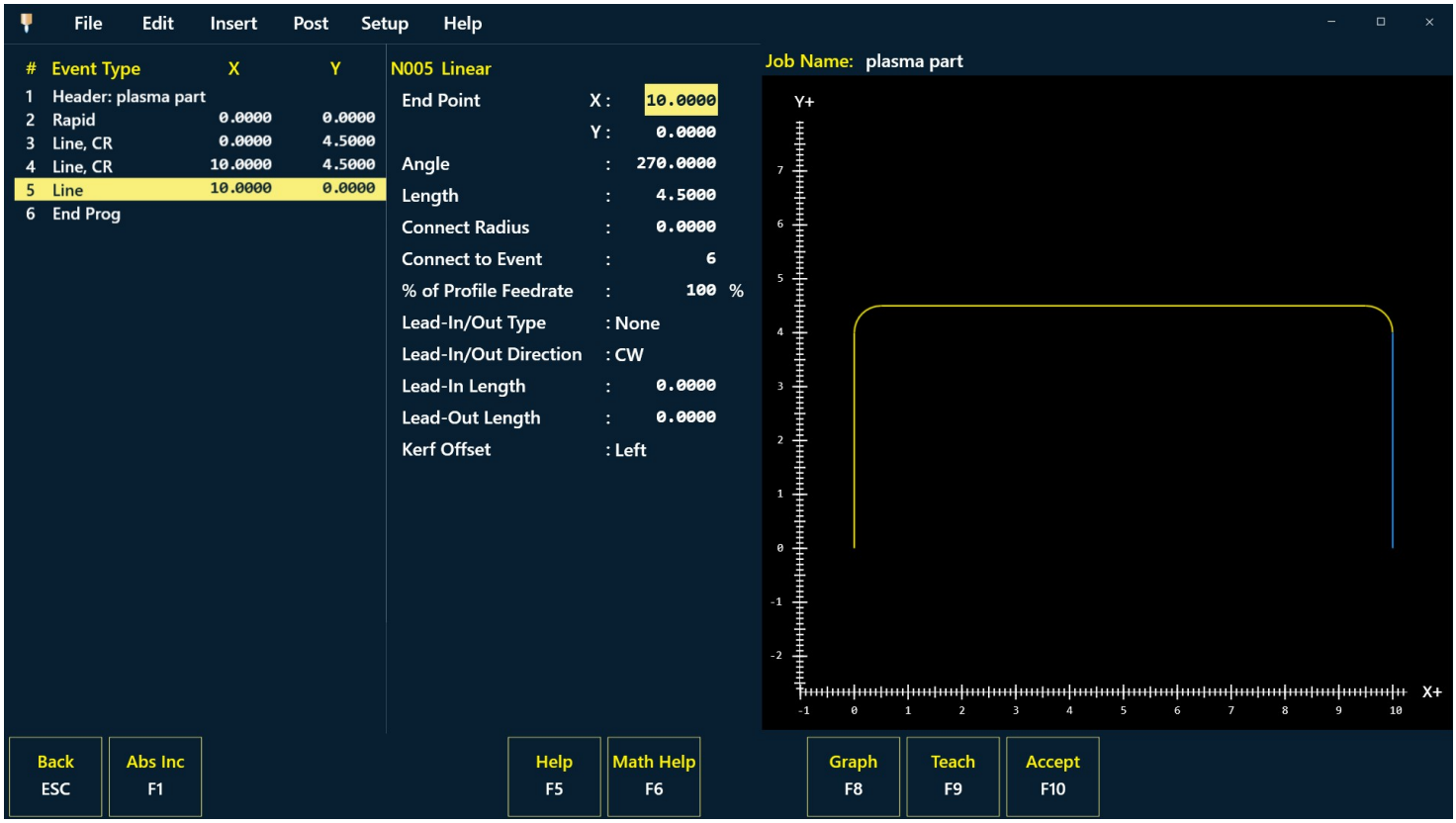


Press F2 Line to create the second line.
Enter the endpoint of the second line, from the drawing: X10, Y4.5.

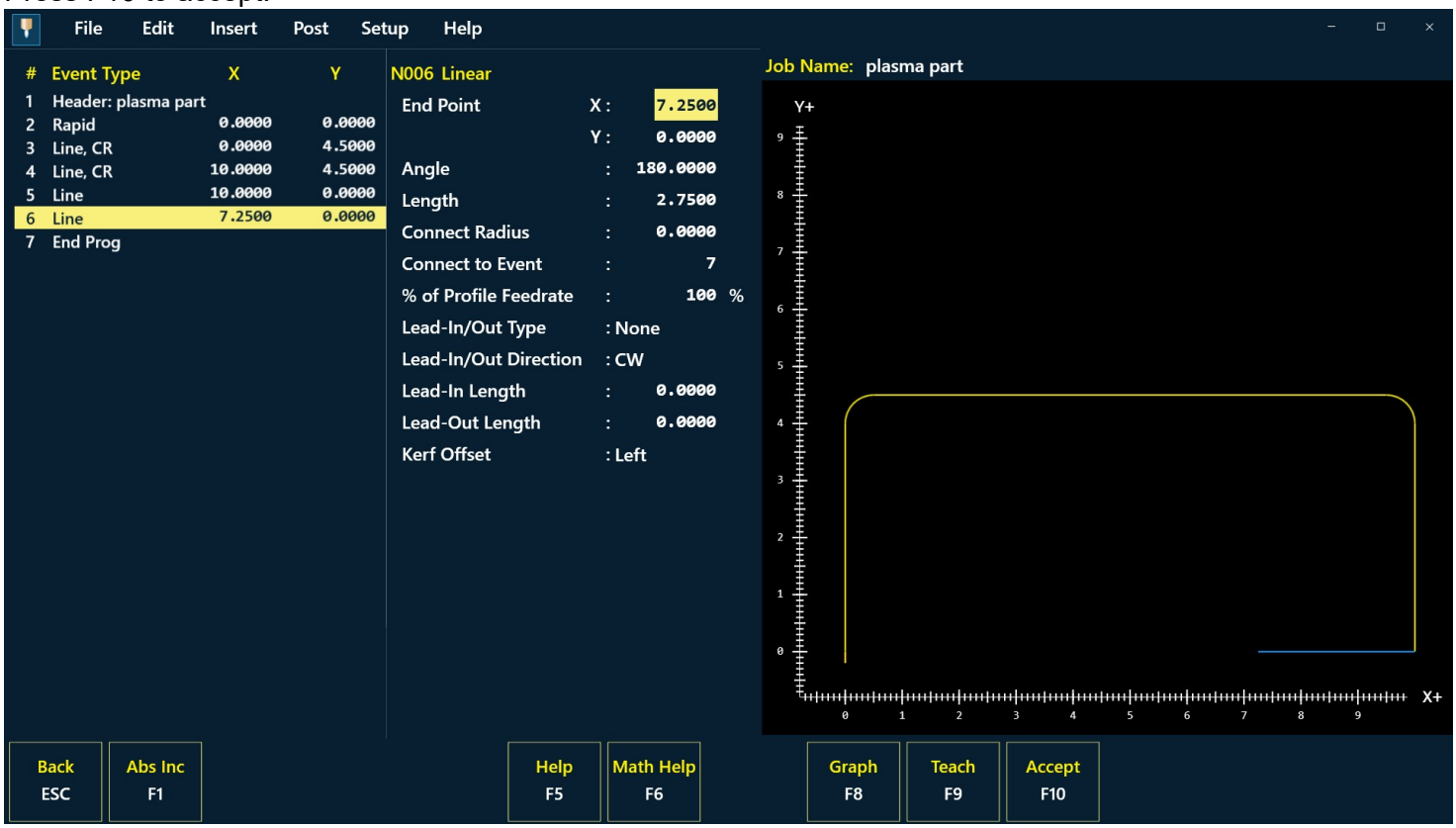


Notice Intercon automatically added a .5” radius between the two lines. This feature is called “Connect Radius”. Adjust the connect raduis to the amount desired or set to zero to deactivate it.

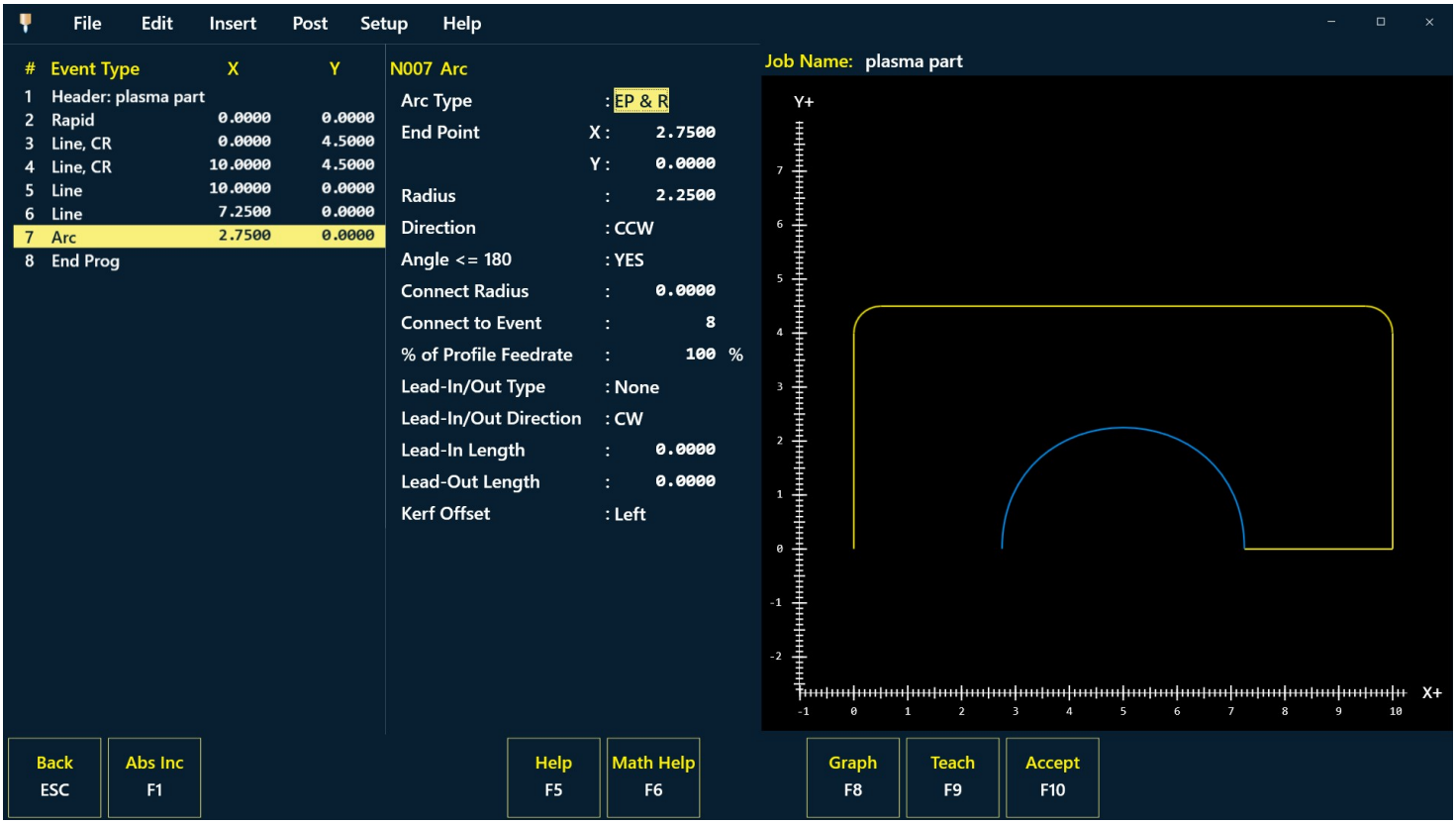
Press F2 Line to create the third line.
Enter the endpoint of the third line, from the drawing: X10, Y0.
On this line set connect radius = 0 since there is a square corner on the next connecting line.
Press F10 to accept.



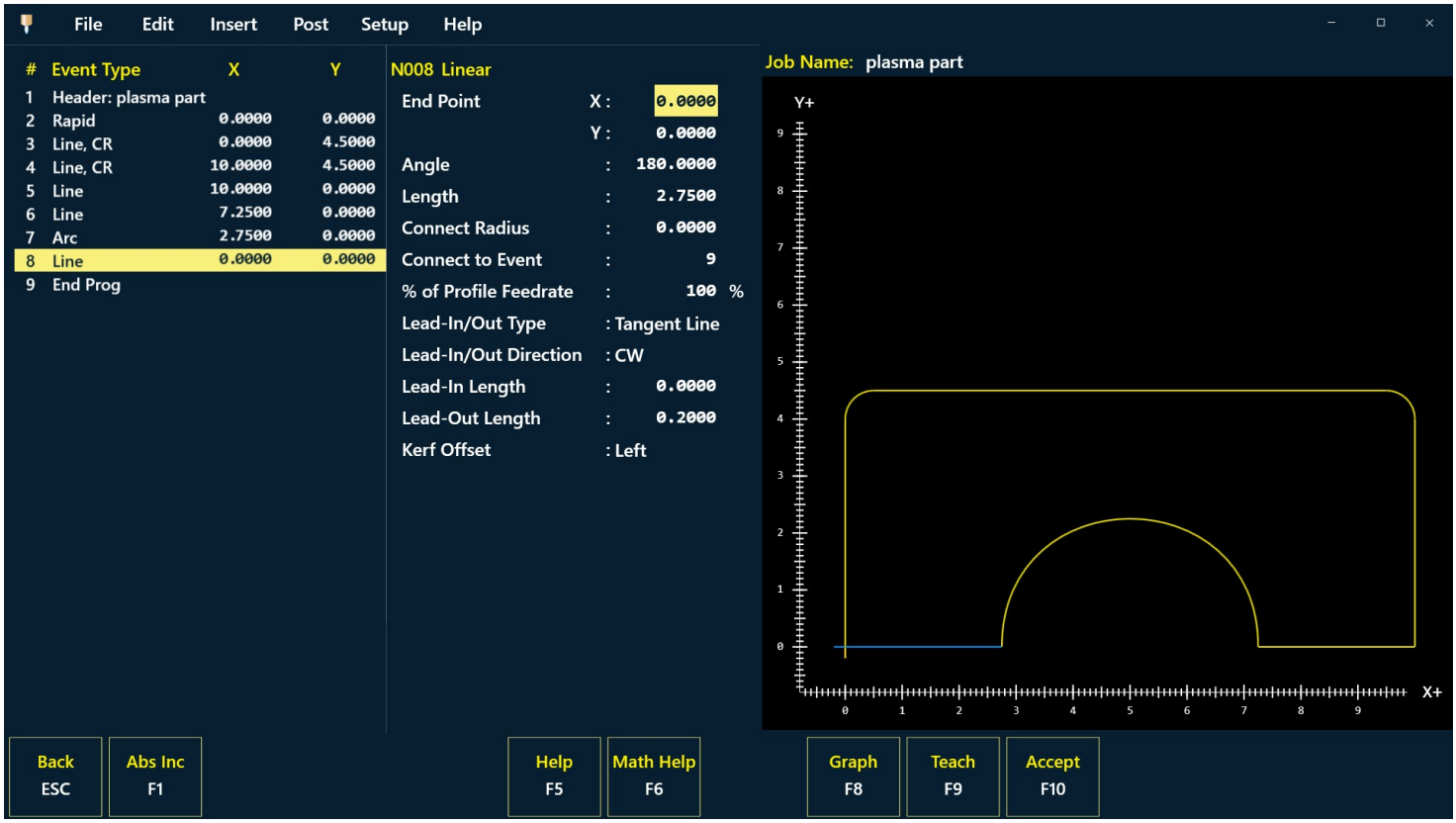
Press F2 Line to create the forth line.
Enter the endpoint of the third line, from the drawing: X7.25, Y0.
Press F10 to accept.



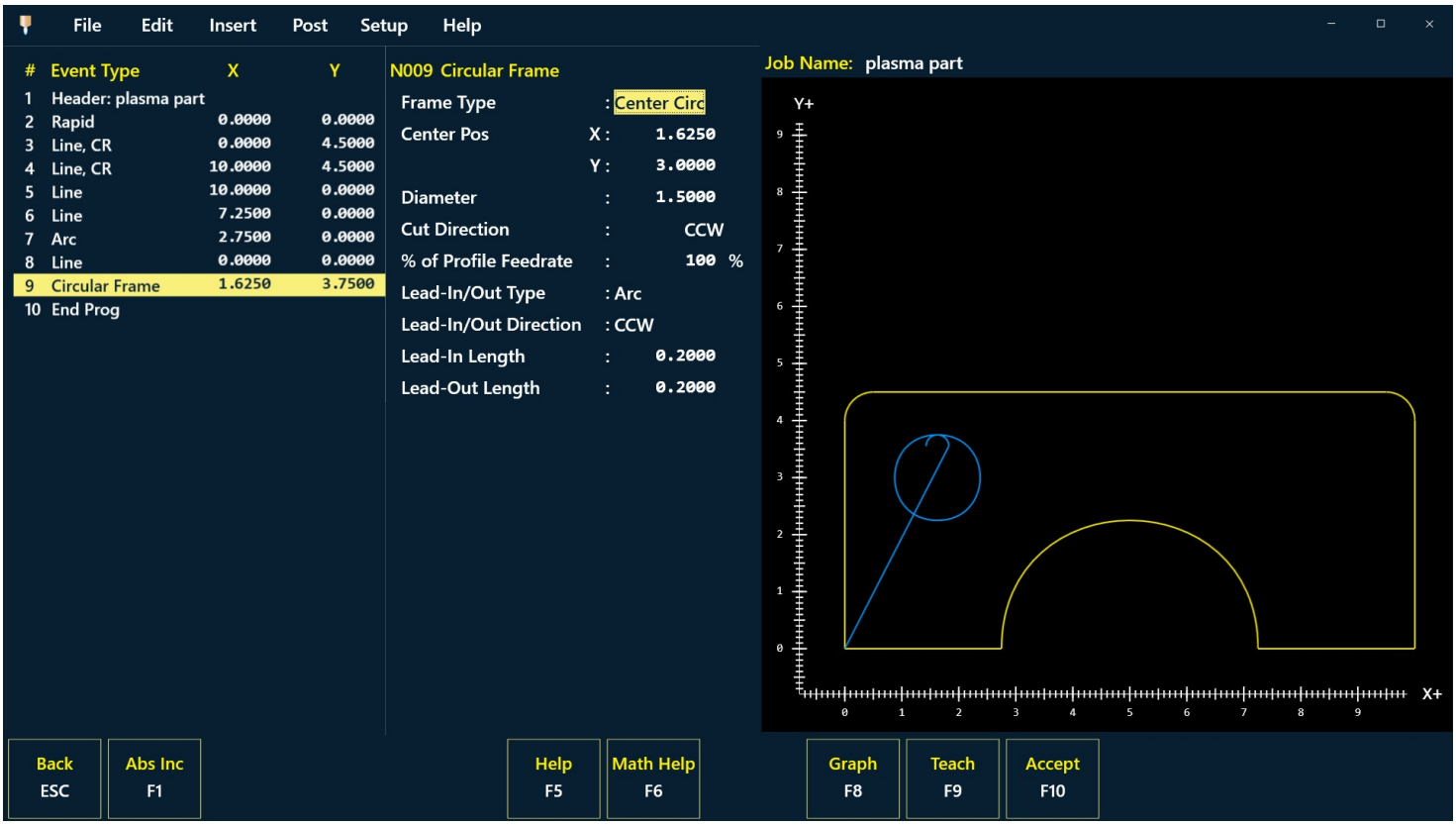
Now lets create the arc.
Press F3.
And choose the Arc Type: “End Point & Radius”.
Enter the Arc Enpoint X2.75, Y0 and the Radius 2.25.
Set Arc direction to Counter Clock Wise. Press F10 to Accept.



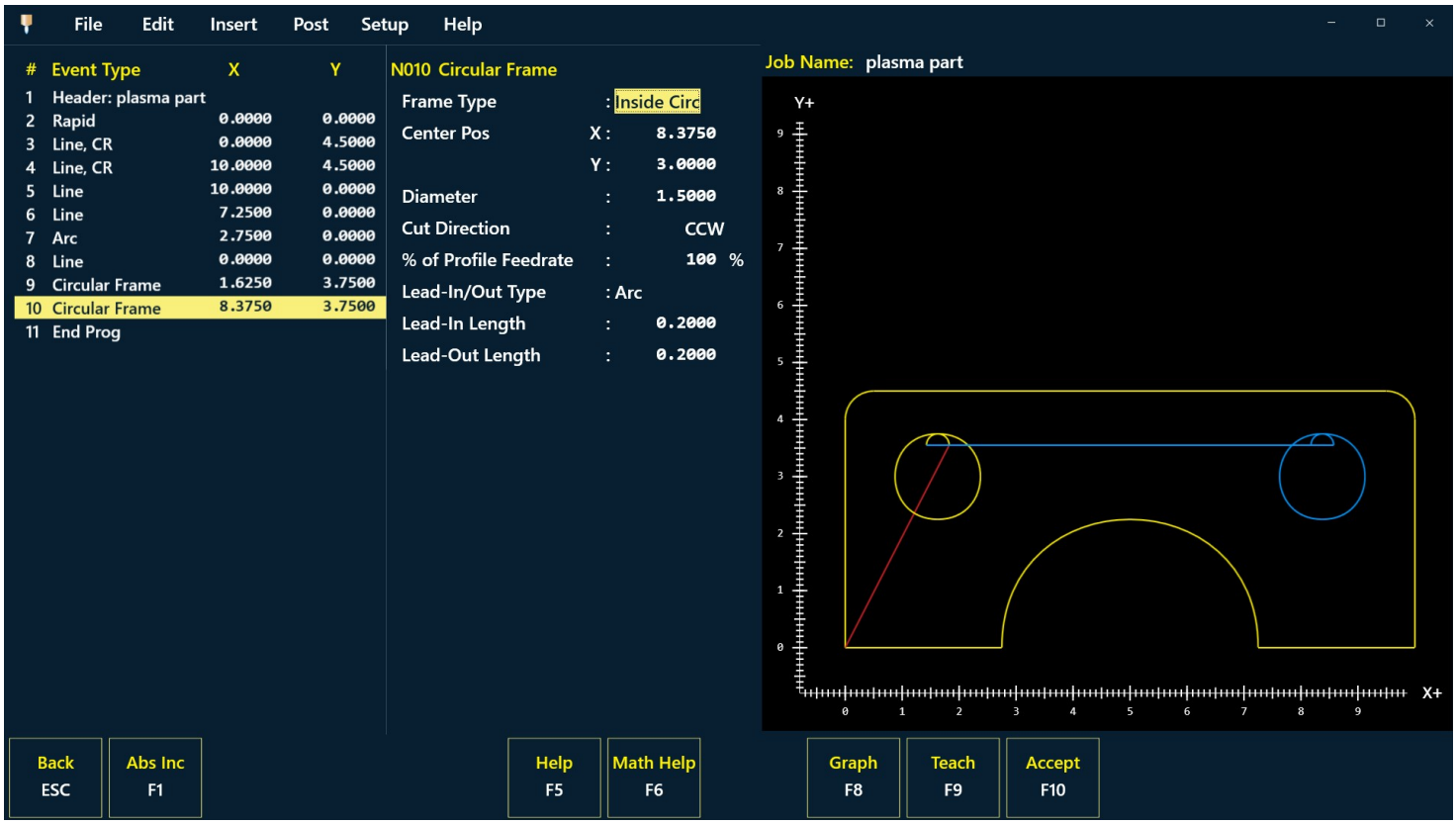
Press F2 Line to creat the fifth line.
Enter the endpoint of the third line, from the drawing: X0, Y0.
Set Lead Out Lenght to .2 and
Press F10 to accept.



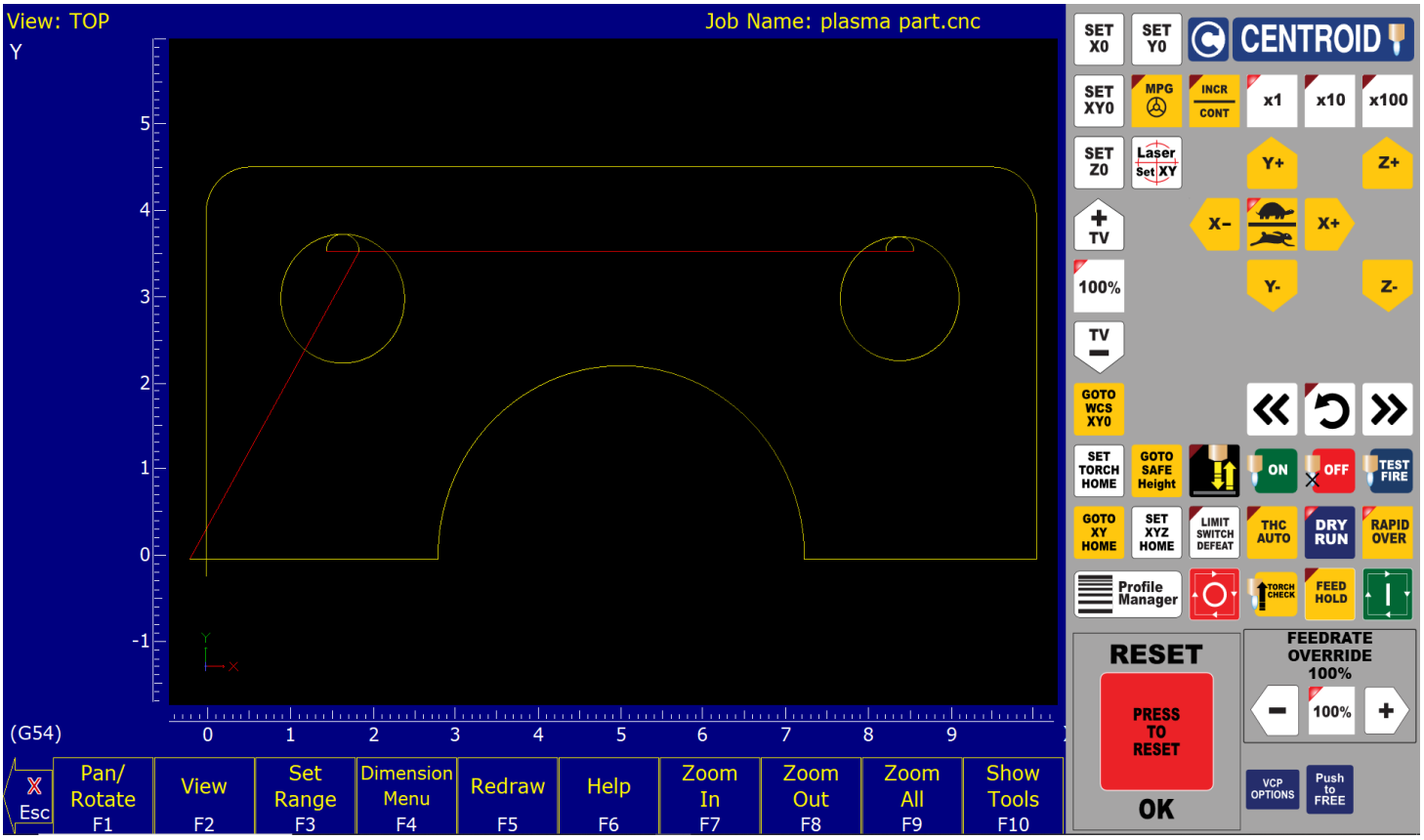
Press F4 Circular frame.
Enter the center point of the circular frame from the print: X1.625, Y3.
Set cut direction to CCW.
Press F10 to Accept.



Press F4 Circular frame.
From the print, to find the center point of this circle I subtracted the first circles X distance from 0 from the know width of the part which is 10inches. That gave me a X center position of 8.375 inches.
The Y Center position is the same as the first circle at 3 inches. X8.375, Y 3.000.
Press F10 to Accept.



Press F10 Post to create the G-code Part Program and it will automatically load the job in CNC12, select the Material profile and it is ready to run. Notice the Lead in and Lead out moves have automatically been added by Intercon. These lenght values are adjustable.



Plasma Intercon Function Keys and Menus: F1 - File

Back (ESC): Return to the previous menu.

New (F1): Create a new job. This will open a menu prompting for a file name. Once a file name has been entered, press ENTER or click F10 – Accept. The header event will automatically be opened to its edit menu. The following screen will display:

Job Name: The name of the current intercon program. This is the name the cnc file will bear upon post.

Programmer: The creator of the current intercon program.

Date: The date created. This is automatically filled with the current date in Month/Day/Year format.

Notes: Any notes relevant to the program.

Load (F2): Opens a Windows file directory prompting to find a Plasma Intercon (.icp) job file. Upon hitting "Open," it will load the events of the selected file.

Save (F3): Saves the current Plasma Intercon job. If the file does not exist, it will open a prompt to name the new .icp file. Otherwise, the current job overwrites the existing file with the same name.

Save As (F4): Similar to "Save," but will always open a dialog to create a new .icp file.

Export DXF (F5): Convert the events of the current job to a .dxf file and saves the .dxf file in a similar manner to the "Save As" option above.

F2 - Modify

Modify will open the appropriate menu for the highlighted event from the primary Event List, including all information available about that event. Changing information these fields will change the highlighted event upon clicking **F10 - Accept**

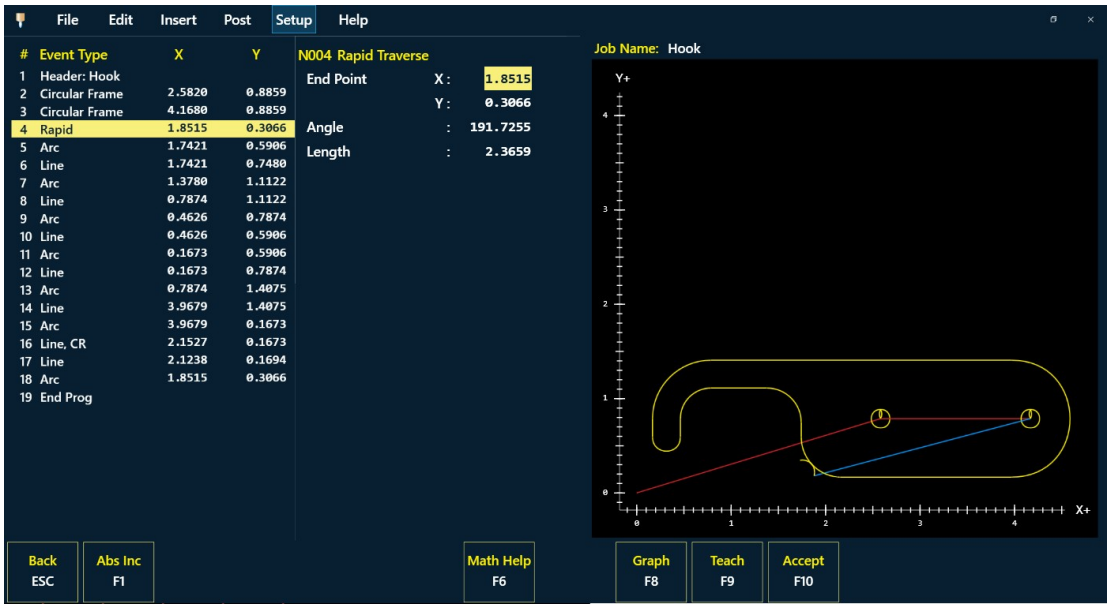
F3 - Insert

This will open a placeholder where a new event will be added and open a list of event options to insert. If the "Header" event is selected when "Insert" is selected, the event will be inserted directly below the Header; otherwise it will insert above the selected event.

NOTE: All buttons within the Event menus (Rapid, Line, Arc, etc) where users can toggle through a list of options can be toggled using the SPACEBAR.

Back (ESC): Pressing the **(ESC)** button will drop the placeholder and close the Insert submenu, returning to the "main" option list.

Rapid (F1): When selecting **F1 - Rapid** from the Insert Menu, the following screen is displayed:

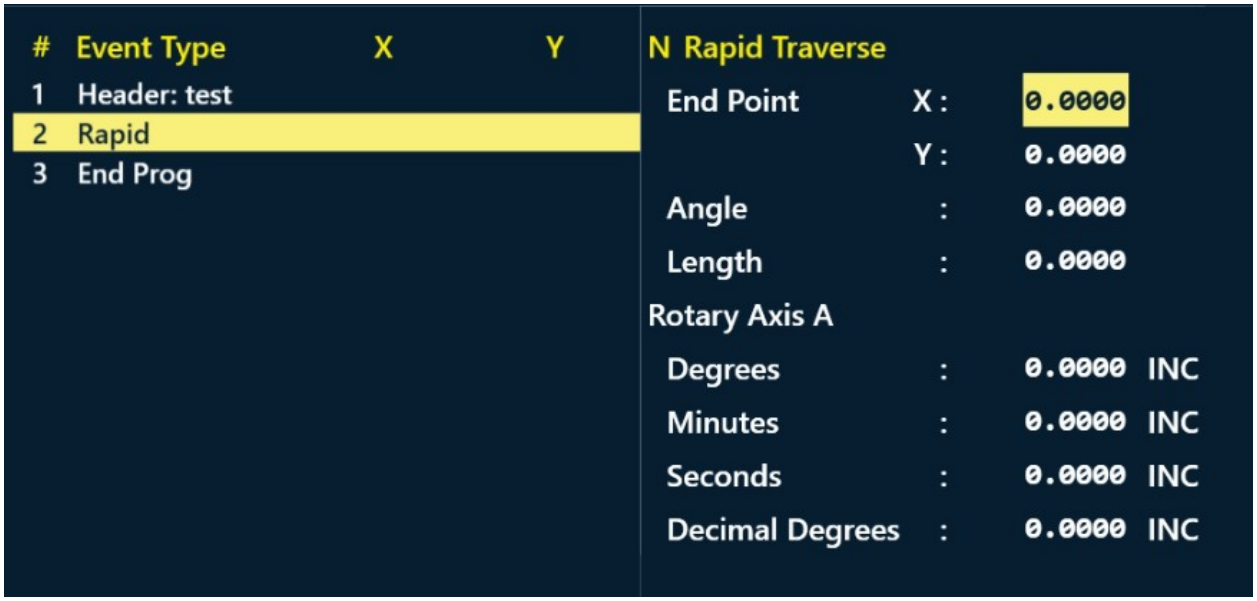


End: When the rapid traverse screen is first accessed, the cursor will highlight the first field, End X. This is the X coordinate of where the torch will be after the rapid traverse has been completed. Similarly, Y represents the coordinate of the torch after the rapid traverse is completed. The angle and length fields will be computed automatically if the end point of the move has been entered.

Angle: The destination may also be specified in terms of a counterclockwise angle from the three o'clock position. When combined with a length for the current move, the corresponding X and Y coordinates for the destination will be calculated and placed in the correct fields.

Length: The length of the rapid traversal. When combined with the angle of the current move, the corresponding X and Y coordinates for the destination will be calculated and placed in the correct fields.

If the option **Rotary 4th Axis** under the **F9 - Preferences Setup Menu** is selected, there will be additional options in the Rapid menu. All options under Rotary are set to Incremental mode by default.



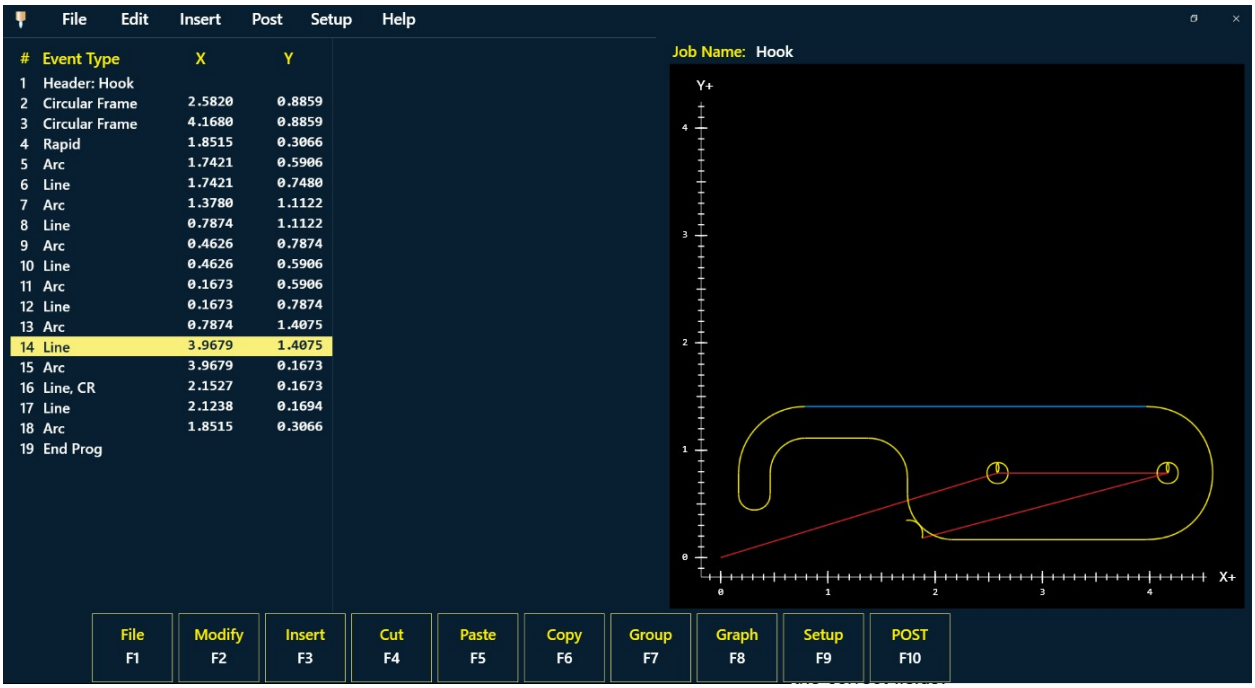
Degrees: The number of degrees to move the rotary axis. This value can be positive or negative and movement of the rotary axis will depend on the orientation of the axis.

Minutes: The number of minutes to move the rotary axis. Values for this field are between 0 and 59.

Seconds: The number of seconds to move the rotary axis. Values for this field are between 0 and 59.

Decimal Degrees: This is another method of entering the number of degrees. If the movement of the rotary axis is entered with the fields listed above, the value of this field will be calculated automatically. If the movement of the rotary axis is entered with this field or changes are made to it, then the degrees, minutes, and seconds will be calculated or changed automatically. Values for this field can be positive or negative.

Line (F2):
When selecting **F2 - Line** from the Insert Menu, the following screen is displayed:



End: When the linear plasma screen is first accessed, the cursor will highlight the first field, End X. This is the X coordinate of where the torch will be after the linear move has been completed. Similarly, Y represents the coordinate of the torch after the linear move is completed. The angle and length fields will be computed automatically if the end point of the move has been entered.

Angle: The destination may also be specified in terms of a counterclockwise angle from the three o'clock position. When combined with a length for the current move, the corresponding X and Y coordinates for the destination will be calculated and placed in the correct fields.

Length: The length of the linear move. When combined with the angle of the current move, the corresponding X and Y coordinates for the destination will be calculated and placed in the correct fields.

Connect Radius: If two linear move operations are being performed and a rounded 'corner' between them is desired instead of a sharp peak, the radius of the 'corner' may be entered and Intercon will insert an arc between the linear move operations. This connect radius also works for blending a line into an arc operation.

Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

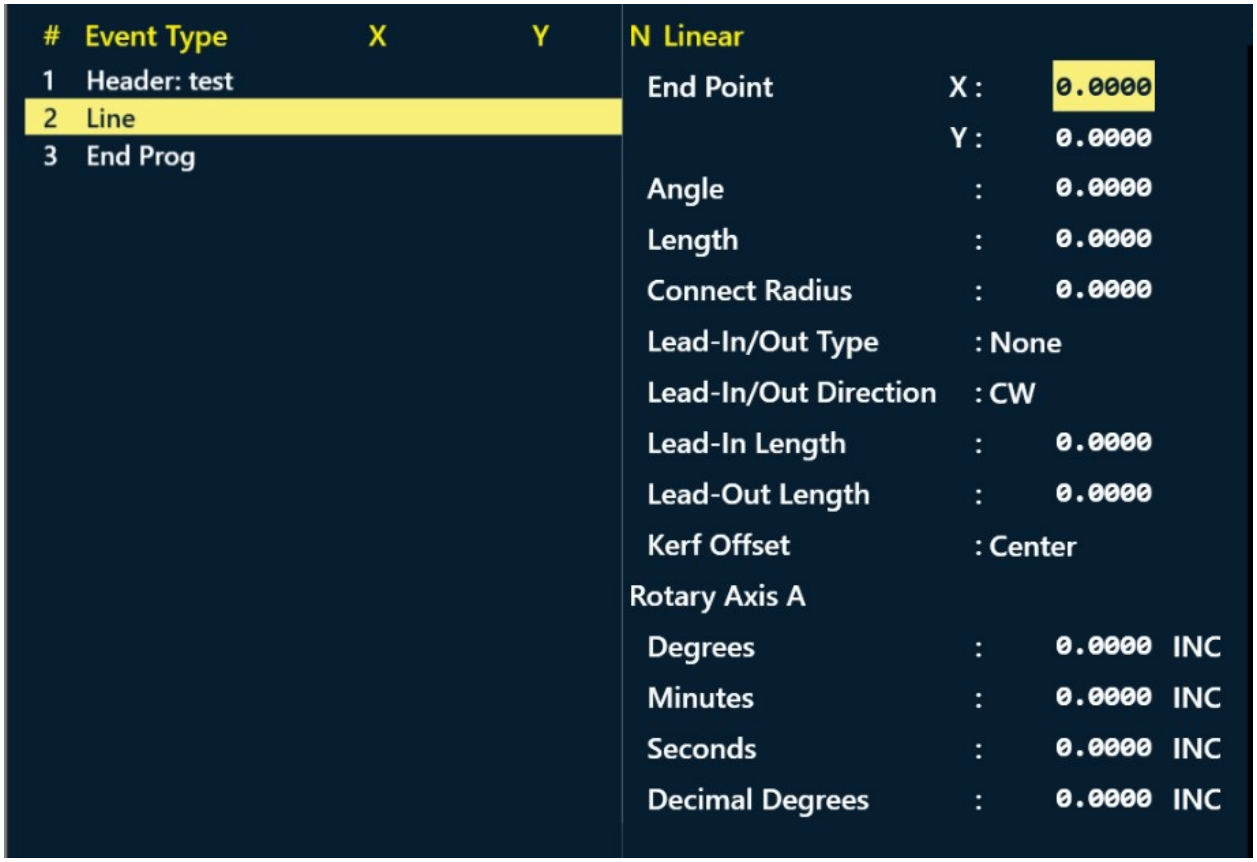
Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Kerf Offset: The side of the line that the torch will be offset to. Options are Center, Left or Right. Press **SPACE** to toggle between them.

If the option **Rotary 4th Axis** under the **F9 - Preferences Setup Menu** is selected, there will be additional options in the Line menu. All options under Rotary are set to Incremental mode by default.



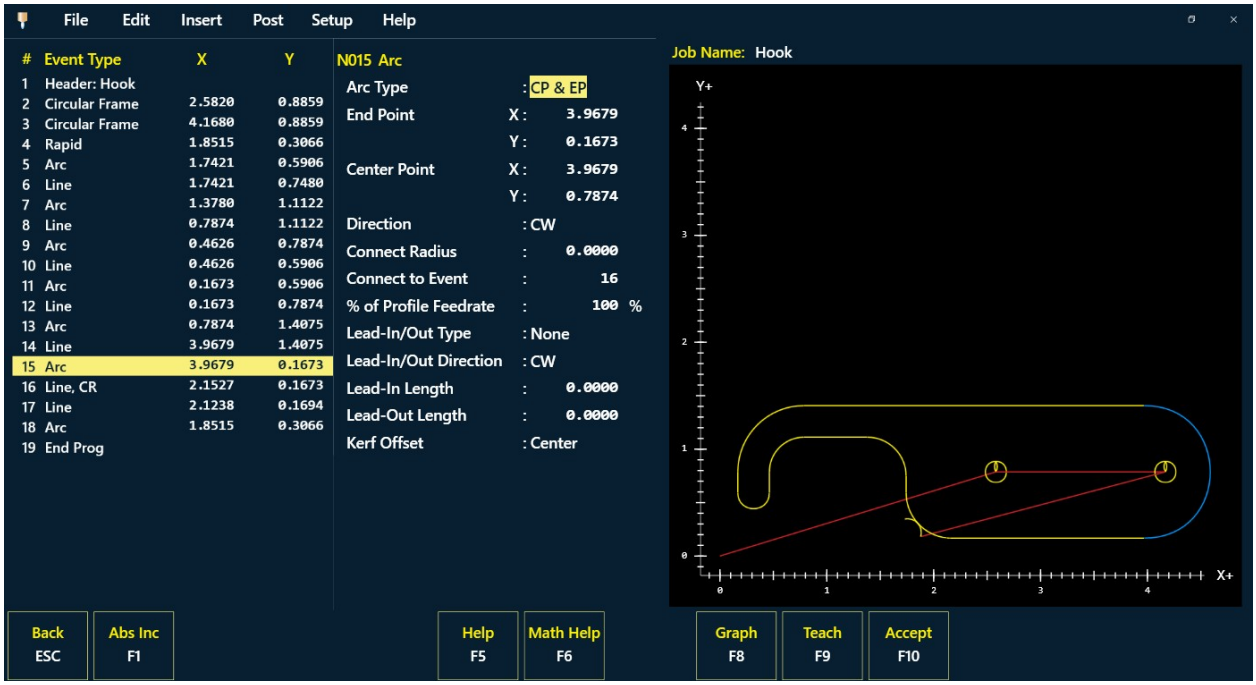
Degrees: The number of degrees to move the rotary axis. This value can be positive or negative and movement of the rotary axis will depend on the orientation of the axis.

Minutes: The number of minutes to move the rotary axis. Values for this field are between 0 and 59.

Seconds: The number of seconds to move the rotary axis. Values for this field are between 0 and 59.

Decimal Degrees: This is another method of entering the number of degrees. If the movement of the rotary axis is entered with the fields listed above, the value of this field will be calculated automatically. If the movement of the rotary axis is entered with this field or changes are made to it, then the degrees, minutes, and seconds will be calculated or changed automatically. Values for this field can be positive or negative.

Arc (F3):
When selecting **F3 - Arc** from the Insert Menu, the following screen is displayed:



Arc Type: There are four ways to specify an Arc: using an endpoint and a radius (EP&R), using a center point and an angle (CP&A), using a center point and an endpoint (CP&EP), or using a midpoint and an endpoint (3-Point). The Three Point arc is designed to be used in conjunction with Teach Mode. When specifying a particular kind of arc, certain fields will not be able to be modfied. For example, an endpoint and a radius is being specified, the mid point, center point and angle fields will not be able to be modified. This is because Intercon calculates the correct values for these fields. Press **SPACE** to toggle between them.

Mid: The X and Y coordinates of a point on the arc path somewhere between the start point and end point of the arc. This field can only be modified when specifying a Three Point arc.

End: The X and Y coordinates of where the torch will be once the arc move is complete. This field cannot be modified if specifying a center point and angle (CP&A) arc.

Center: This is the X and Y position of the center of the arc. This field cannot be modified if specifying an end point and radius (EP&R) arc or a Three Point arc.

Angle: Number of degrees through which the torch will travel. This value must lie between 0 and 360 degrees. This field can only be modified if specifying a center point and angle (CP&A) arc.

Radius: Distance from the center of the arc to its edge. This value must be greater than 0. This field can only be modified if specifying an end point and radius (EP&R) arc.

Direction: Determines whether the arc moves clockwise (CW) or counterclockwise (CCW). Press **SPACE** to toggle between them.

Angle <= 180: For end point and radius (EP&R) arcs, this field determines whether the arc is less than (YES) or greater than (NO) 180 degrees.

Connect Radius: This field works like the Linear Move connect radius. It allows for the blending of an arc into the next line or arc operation.

Connect to Event: Defines Which Event the connecting radius will merge with. Used for connecting the end of a cut with the beginning of a cut.

% of Profile Feedrate: Applies a specific Percentage of the profile feedrate that is applied to the event. For example a tight Arc or circle is comonly ran at a slower feedrate of 60% of the Profile Feedrate.

Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

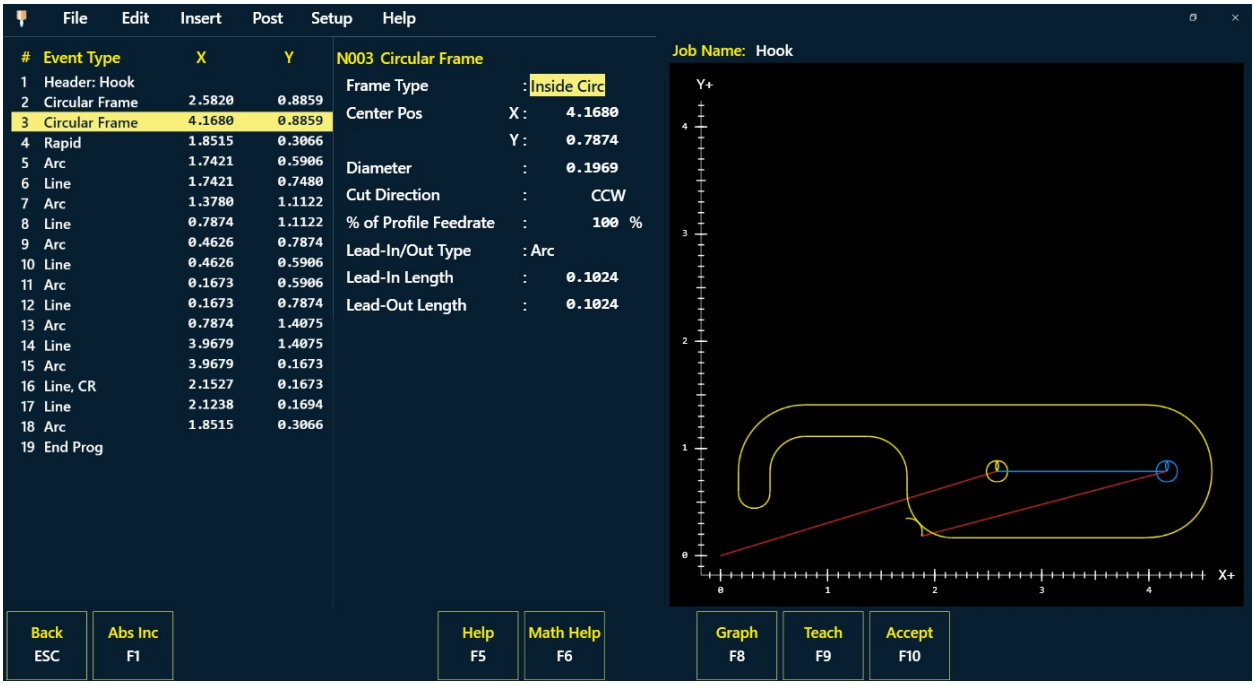
Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Kerf Offset: The side of the arc that the torch will be offset to. Options are Center, Left or Right. Press **SPACE** to toggle between them.

Circle (F4):
When selecting **F4 - Circle** from the Insert Menu, the following screen is displayed:



Frame Type: Selects Center Circle, Outside Circle, Inside Circle, and Marking Circle. Press **SPACE** to toggle between them.

Center: X and Y coordinates of the center of the circle

Diameter: Diameter of the circle

Cut Direction: Direction of the cut. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them.

% of Profile Feedrate: Applies a specific Percentage of the profile feedrate that is applied to the event. For example a tight Arc or circle is comonly ran at a slower feedrate of 60% of the Profile Feedrate.

Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: This option is only available for the frame type Center Circle. Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

NOTE: If the lead-in or lead-out length is less than or equal to the value of “Lead-In/Out From Center On Circle <=” setting in the preferences setting menu, the lead-in or lead-out will start or end at the center of the circle frame.

Rect. (F5):
When selecting **F5 - Rect** from the Insert Menu, the following screen is displayed:

Frame Type: Selects Center Rect, Outside Rect, Inside Rect, and Marking Rect. Press **SPACE** to toggle between them.

Position Type: Defines what location the rectangular frame is defined from. Selects Center, Upper Left, Upper Right, Lower Right, and Lower Left. Press **SPACE** to toggle between them.

Center Pos: X and Y coordinates of the center of the rectangle. **NOTE:** Only available for position type Center.

Corner Pos: X and Y coordinates of the corner of the rectangle specified by position type. **NOTE:** Not available for position type Center.

Length: X-axis dimension of the rectangle.

Width: Y-axis dimension of the rectangle.

Corner Radius: Radius of curvature of the corners.

Cut Direction: Direction of the cut. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them.

% of Profile Feedrate: Applies a specific Percentage of the profile feedrate that is applied to the event. For example a tight Arc or circle is comonly ran at a slower feedrate of 60% of the Profile Feedrate.

Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: This option is only available for the frame type Center Rect. Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Repeat (F6):
When selecting **F6 - Repeat** from the Insert Menu, the following screen is displayed:

Group Start Event: The event number of the group event to be repeated. This is an optional way to define a group of events to repeat. This will automatically populate the Start Event and End Event fields.

Start Event: The event number of the first event to be repeated.

End Event: The event number of the last event to be repeated.

Increment (X): The amount to move in the X direction before creating the next copy.

Increment (Y): The amount to move in the Y direction before creating the next copy.

Rotary Increment (A): The amount to rotate the rotary axis. **NOTE:** This field is only available if Rotary Axis is enabled in the setup menu.

Number of Copies: The number of copies to be created.

Remove Original: Removes the events that define the repeat. Press **SPACE** to toggle between NO and YES.

Skip List: Specifies which copy/copies to skip.

Mirror (F7):
When selecting **F7 - Mirror** from the Insert Menu, the following screen is displayed:

Group Start Event: The event number of the group event to be mirrored. This is an optional way to define a group of events to repeat. This will automatically populate the Start Event and End Event fields.

Start Event: The event number of the first event to be mirrored.

End Event: The event number of the last event to be mirrored.

Mirror Line: Selects between Horizontal, Vertical, and Other. Press **SPACE** to toggle between them

X Offset: The X value at which the mirror line is created. **NOTE:** Not available for horizontal mirror line.

Y Offset: The Y value at which the mirror line is created. **NOTE:** Not available for vertical mirror line

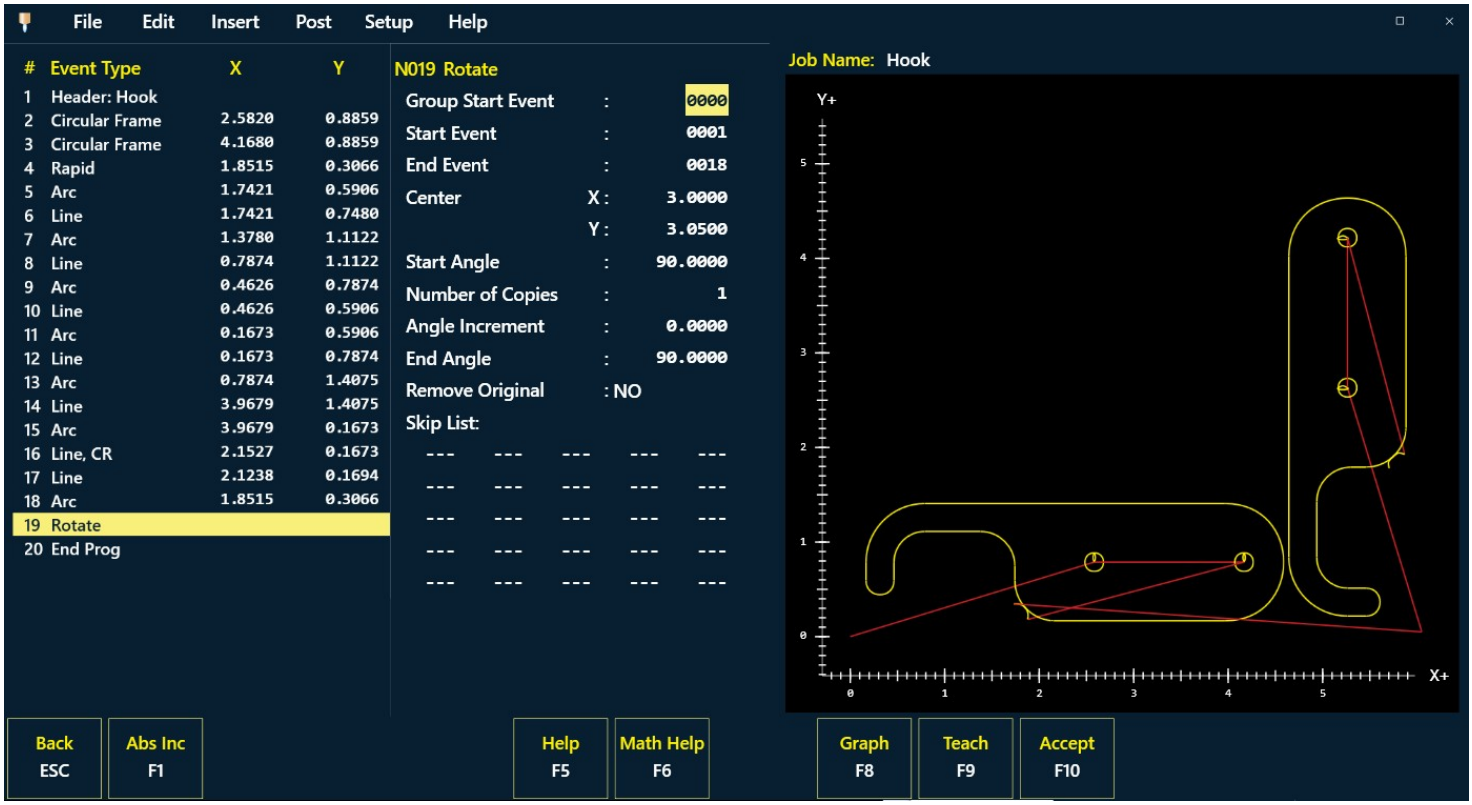
Angle: The angle of the line that passes through the point given by the X and Y offset. **NOTE:** Only available for other mirror line.

Remove Original: Removes the events that define the mirror. Press **SPACE** to toggle between NO and YES.

Keep Same Cut Direction: Maintains the same CW or CCW direction of the original events. Press **SPACE** to toggle between NO and YES.

Rotate (F8):

When selecting **F8 - Rotate** from the Insert Menu, the following screen is displayed:



Group Start Event: The event number of the group event to be rotated. This is an optional way to define a group of events to repeat. This will automatically populate the Start Event and End Event fields.

Start Event: The event number of the first event to be rotated.

End Event: The event number of the last event to be rotated.

Center: The X and Y coordinates of the center of rotation.

Start Angle: The angle in degrees that the first copy should start at.

Number of Copies: The number of copies to be created.

Angle Increment: The amount of degrees between each copy

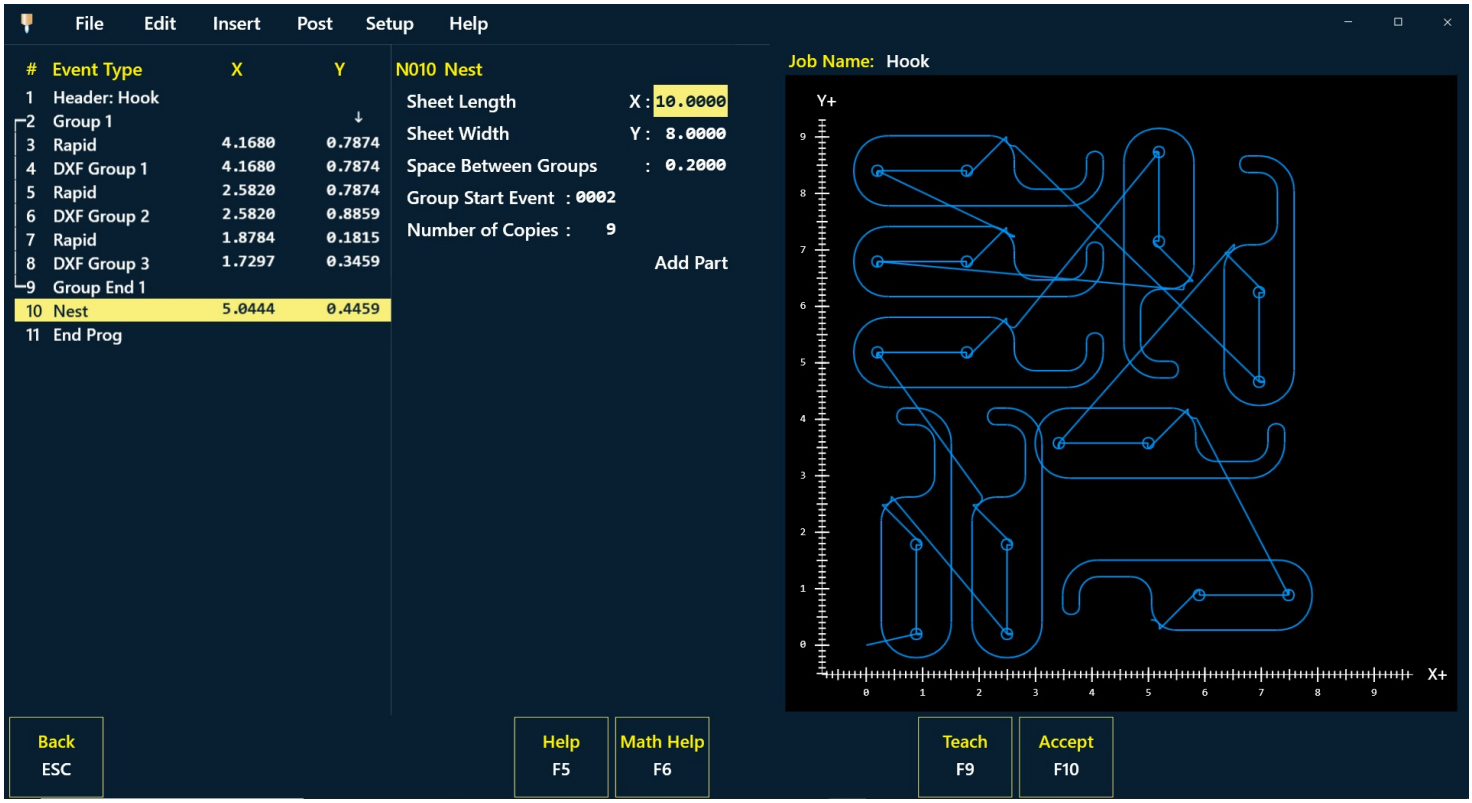
End Angle: The angle in degrees that the final copy should start at.

Remove Original: Removes the events that define the rotate. Press **SPACE** to toggle between NO and YES.

Skip List: Specifies which copy/copies to skip.

Nest (F9):

When selecting **F9 - Nest** from the Insert Menu, the following screen is displayed:



Sheet Length: The amount of material in the X direction.

Sheet Width: The amount of material in the Y direction.

Group Start Event: The event number of the group you would like to nest.

Number of Copies: The number of copies of the group you would like to include.

Add Part: Press **SPACE** or click on this button to add another pair of Group Start Event and Number of Copies. This allows more than one part to be nested together.

Modifying and accepting the Nest event multiple times will alter how the parts are nested. If the first rendition of the nest is undersiable, simply modify and accept the event to achieve a better result.

DXF (F10):
SVG (F11):
When selecting **F10 - DXF** or **F11 - SVG** from the Insert Menu, a windows file dialog is displayed prompting to select a dxf or svg file, respectively. Once selected, click **Open**. This will import the file as a group of grouped contours. The grouped contours are named with the file type, either DXF or SVG, along with its group number.

Before importing a DXF or SVG it is good practice to review the vector file. Just because a vector file looks ok on the screen doesn't mean it is ready or good to cut.

Common DXF and SVG pitfalls are:

- Duplicate Lines and Arcs. These are lines and arcs that are identical and drawn on top of each other. They do not show up when looking at the cad file in a cad system but if they are there Plasma Intercon will see them and try and use them. Solution: Most all CAD systems have a "Delete Duplicate" function which cleans up the cad drawing by deleting any duplicate entities (lines and arcs).

- Endpoint over-run or gaps: Lines or Arcs don't end at the same start point of the next line. This could be a gap or over-run. Solution: Most CAD systems and drawing program have tools to automatically join line and arcs endpoints so they start and end on the same point. Clean up the CAD file in this way before importing into Plasma Intercon for the best results. Plasma Intercon has a Vector gap tolerence setting as well. Plasma Intercon will automaticlly join vector endpoints that are within this distance tolerence setting.

- Hidden Lines and arcs. Lines and Arcs that may not show up in the CAD program may be because of color or a line thickness of zero. Will show up in Plasma Intercon. Solution: Make all lines and arcs the same color and thickness.

- Hidden layers, multiple layers. Sometimes hidden layers or multiple layers will cause an issue. Put all geometry (lines and arcs) on one Layer and delete all other layers.

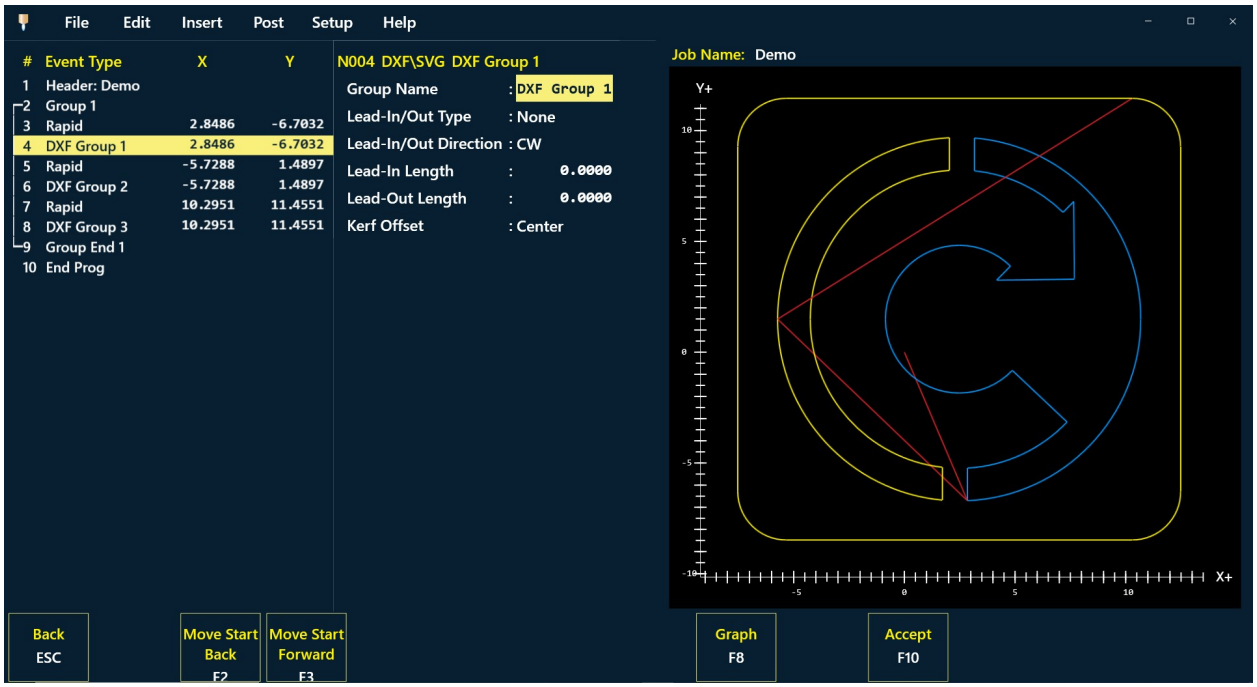
- Fonts don't work. When creating text in the CAD system most systems will use any of the Windows installed fonts so you can easily size and place the text you want. Solution: The last step before saving the CAD file in preparation for importation into Plasma Intercon is to convert all text into lines and arcs in the CAD system. Typically in the CAD system there is a feature called "Convert (fonts) to Outlines" or in Qcad is called "Explode"

- To many nodes. A common problem with art related SVG's and DXF's is the vectors that make up the art are very very short vectors (for example .001" long lines) sometimes there are thousands and thousands of 'nodes' (aka endpoints) this is commonly a result of scanning and using CAD tools to convert a photo (bitmap image .bmp, .jpg, .png, etc) to vectors. Centroid CNC12 is very good at running a short vector plasma part program at smooth speeds when using its "Plasma Smoothing" feature. That being said it is always good practice to not have super short vectors. There are diminishing returns involved, having super short vectors is unnessary and at some point will start to

degrade the cut performance. Good rule of thumb is to not have any vectors shorter than .01”. When tracing a bitmap with software tools don’t just crank up the resolution as that will create a file with very short vectors. Only increase the tracing resolution settings to the point that a satisfactory trace is made. If you are working with a tracing DXF/SVG file created by someone else and you are not the one tracing it you can still optomize it as most CAD systems and Art programs (inkscape and illustrator) have optomization tools that will reduce the number of lines and arcs that make up the file by fitting longer lines and acrs through all the short vectors that closely matches the geometry.

- Drawing is using fill or width parameters. CAD file looks fine in the CAD/Graphics program but looks complely different in Plasma Intercon. Commonly found in graphics programs are fill and vector width values that are used to define a shape. Solution: Use the tools in the CAD/Graphics program to export/save as only vectors. In illustrator use “Convert to Outlines” to convert shapes to lines and arcs.

Once a DXF is imported, Click or enter a group to modify it. The group contours will display in blue:



Group Name: This names the group in the event list.

Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

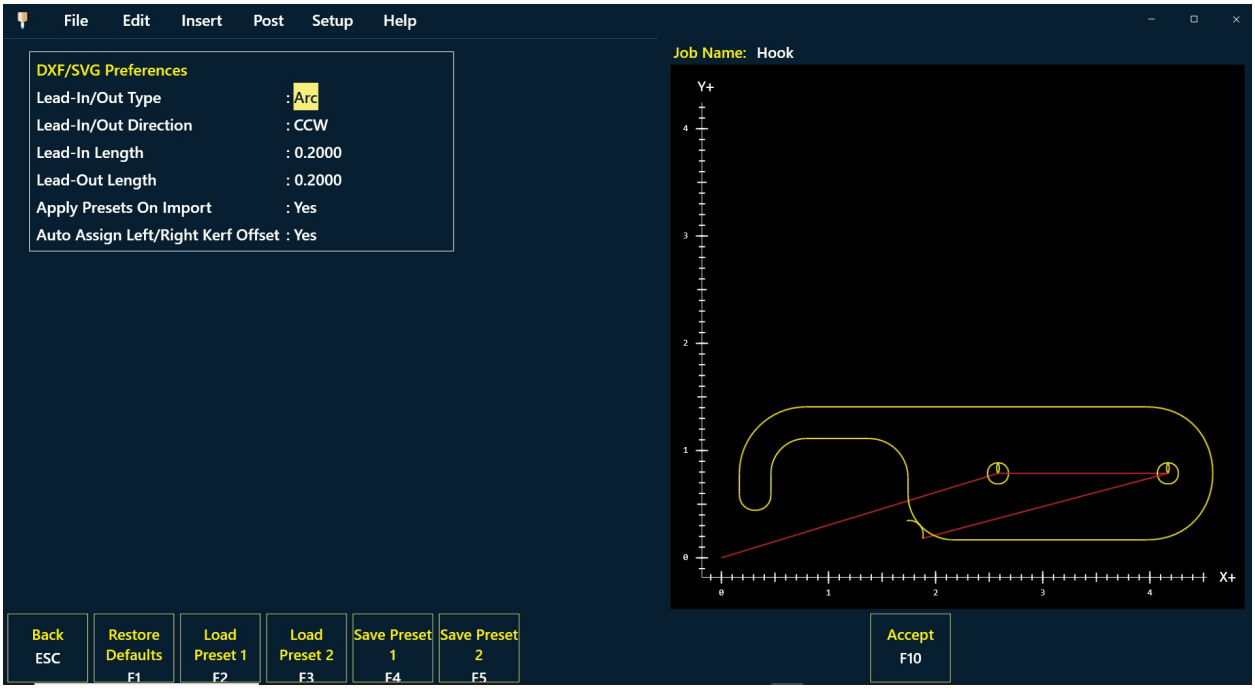
Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Kerf Offset: The side of the contour cut that the torch will be offset to. Options are Center, Left or Right. Press **SPACE** to toggle between them.

If the start location is not ideal, using **F2 - Move Start Back** or **F3 - Move Start Forward** will move the start of the contour back or forward in the cut, respectively. The start will move to the end of the previous/next event within the grouped contour.

Post (F12): Intercon will generate a G code file that will run on a CNC controlled plasma cutter and save this new file to a folder called ncfiles. This functionality is also found as F10 POST on the “main” menu.

DXF/SVG Preferences (Setup): DXF/SVG Preferences is presets that can be applied to a DXF or SVG to save time. When applied inside and outside cuts will be automatically determind.



Lead-In/Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line. Press **SPACE** to toggle between them.

Lead-In/Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW). Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Apply Prests On Imports: Auto Applies presets to any DXF/SVF when imported.

Auto Assign Left/Right Kerf Offset: Automatically determins wether the cut is an outside or inside cut and Applies the expected inside or outside kerf offset for the corelated cut direction.

F4 - Cut

The selected event(s) are copied to Intercon's clipboard and removed from their current position in the event list.

F5 - Paste

The last event(s) in Intercon's clipboard are removed from the clipboard and inserted above the selected position (if "Header" event is selected, inserts below).

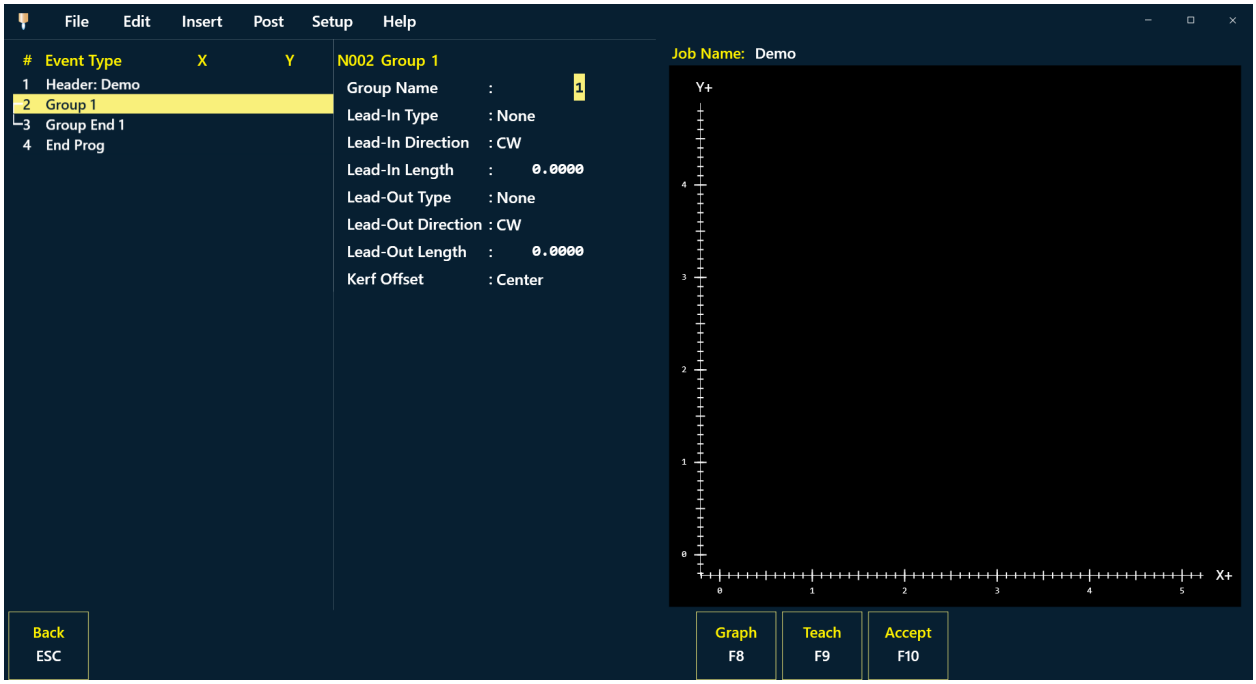
F6 - Copy

Add the selected event(s) to Intercon's clipboard to Paste elsewhere. Unlike "Cut," the event(s) that are selected stay in their current position.

F7 - Group

If the Header or End Program is selected, this will insert an empty group at the top or bottom of the event list, respectively. Otherwise, any events selected will be grouped together.

After inserting a group, this screen will be displayed:



Group Name: This names the group in the event list. This will also show up in the posted file if comments are enabled.

Lead-In Type: Selects None, Arc, Tangent Line, and Perpendicular Line for the first non-rapid event in the group. Press **SPACE** to toggle between them.

Lead-In Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW) for

the first non-rapid event in the group. Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-In Length: Length of the lead-in. Length of 0 will result in no lead-in.

Lead-Out Type: Selects None, Arc, Tangent Line, and Perpendicular Line for the last non-rapid event in the group. Press **SPACE** to toggle between them.

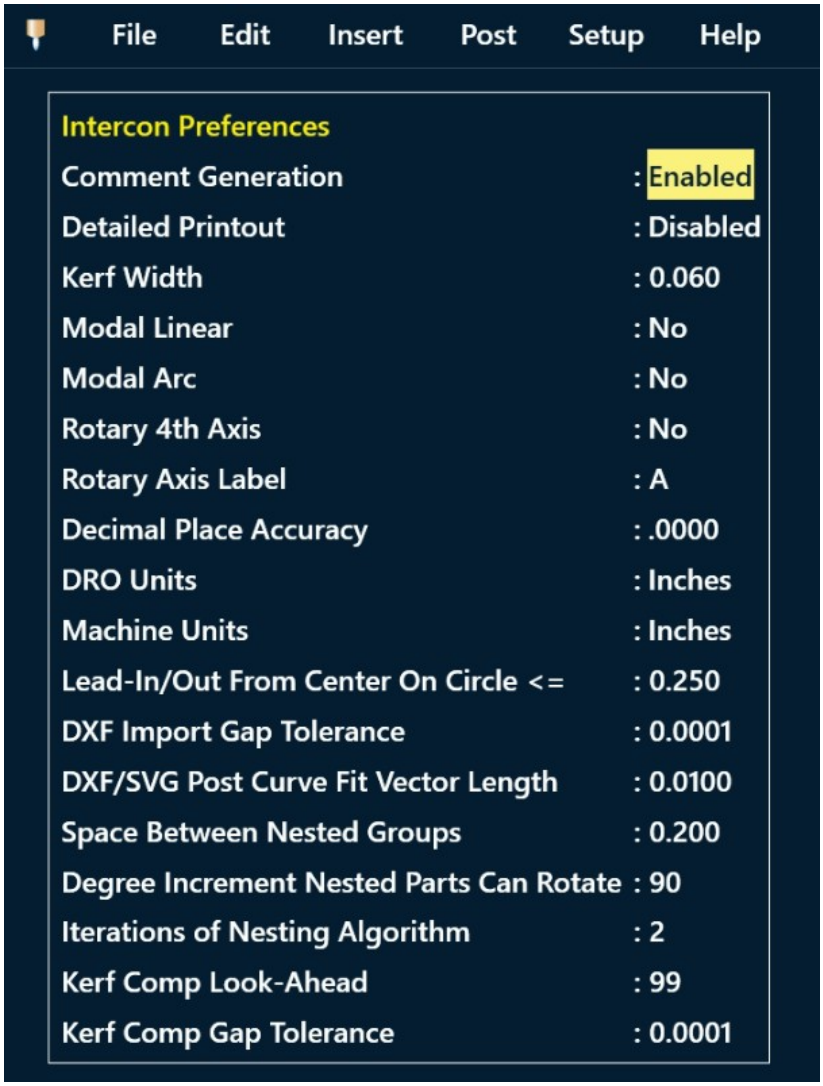
Lead-Out Direction: Direction of Lead-In/Out. Either Clockwise (CW) or Counter-Clockwise (CCW) for the last non-rapid event in the group. Press **SPACE** to toggle between them. **NOTE**: Does not affect lead-in/out type Tangent Line.

Lead-Out Length: Length of lead-out. Length of 0 will result in no lead-out.

Kerf Offset: The side of the arc that the torch will be offset to. Options are Center, Left or Right. Press **SPACE** to toggle between them.

NOTE: Groups can not be placed inside of groups.

F9 - Preferences Setup Menu



Comment Generation: Intercon will generate helpful comments throughout the G codes to facilitate easier operator understanding when reading or editing Intercon generated G code. Choose “Enable” to include these comments. “Disable” turns off these comments.

Detailed Printout: Determines whether the “Print” functionality only prints a list of events and their end points (“Disabled”) or if all information about each of those events is printed (“Enabled”).

Kerf Width: “Kerf” is the term in the world of Plasma Cutters for the width of the cut the torch will make. Different torch tips have different widths. Intercon asks for the width of your torch’s kerf for the sake of being able to compensate for that when creating G code files.

Modal Linear: Intercon can tell if the event before what you’re Inserting was a Line and brings forward information from that event when you add another event of the same type. “Enable” to allow this information to be pulled forward. “Disable” to turn this feature off.

Modal Arc: Intercon can tell if the event before what you’re Inserting was an Arc and brings forward

information from that event when you add another event of the same type. “Enable” to allow this information to be pulled forward. “Disable” to turn this feature off.

Rotary 4th Axis: This option specifies whether or not 4th axis movement fields appear in Linear and Rapid moves and whether or not the Intercon program will post 4th axis movement.

Rotary Axis Label: This option specifies what letter will signify the 4th axis of movement.

Decimal Place Accuracy: This option will decide how many digits to the right of the decimal point Intercon displays in Digital ReadOuts (DROs). Options range from “0.00” to “0.0000.” **Note:** Values will always be rounded down at the Decimal Accuracy chosen for displaying information (ie. ⅛ or 0.125 would become 0.12 when option “0.00” is selected). However, the full value of the information is still maintained for Intercon’s calculations (ie. it will still calculate and operate with the value 0.125 even though it’s only displaying 0.12 on screen).

DRO Units: Short for Digital ReadOut Units. All measurements in Intercon will be displayed in the chosen option. If “Inches” is selected, all user generated events and graphics will be shown in inches. The same is true of the “Millimeters” option. **Note:** DXF and SVG files will automatically be translated by Intercon to the chosen Machine Units option regardless of what measurement system it was originally created in.

Machine Units: This option is for the measurement units (“Inches” or “Millimeters”) that your plasma cutter machine is set up to use. This is separate from DRO Units because Intercon can translate programs written in one unit type and convert it to the other for your convenience when you post your G code file.

Lead-In/Out From Center on Circle <= : Intercon checks the diameter of a Circle Frame when you Accept it. If the diameter is as small as this number or smaller, any lead-in or lead-out on the inside of that event will be overridden and start/end at the center of the circle instead.

DXF Import Gap Tolerance: Not all events in an imported DXF may touch. For example, there may be a very small gap between the end of one line (let’s say it ends at the point (24.9999, 3)) and the beginning of another (25, 3). This setting allows you to tell Intercon how large of a gap you want to treat as being continuous before they are considered distant enough to be separate.

DXF/SVG Post Curve Fit Vector Length: Intercon cleverly looks at curves and splines from DXF and SVG files and breaks them up into many small lines to recreate them inside of Intercon. This option controls how long those small lines are. The closer this value is to 0, the more exact the import will be; but this comes with a speed cost for Posting G codes. **Note:** This option will always be a decimal number between 0 and 1 DRO Units.

Space Between Nested Groups: This setting allows you to control the minimal amount of space between nested parts. For best results, we recommend using a value here that is larger than your torch’s Kerf Width.

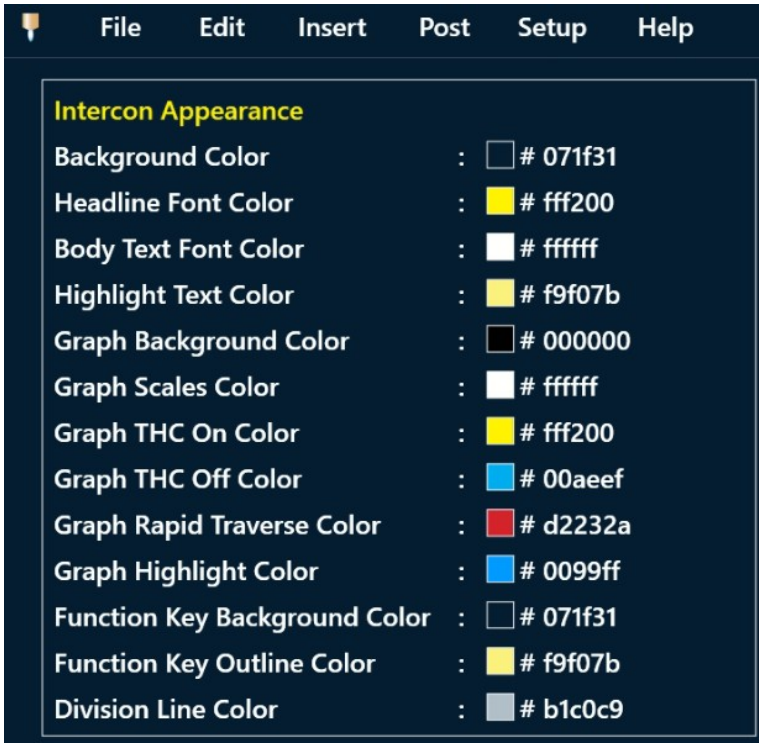
Degree Increment Nested Parts Can Rotate: When nesting a part, this setting allows you to decide how many degrees each part can be rotated to make a successful nest. Value will always be between 0 and 360 degrees. Any value outside of this range will be automatically recalculated until the value falls within this range.

Iterations of Nesting Algorithm: How many times Intercon's nesting function will run to try to find the best way to nest the parts for space use. More iterations will likely result in higher efficiency in material use, but will run slower. The developers behind Intercon suggest using between 2 and 5 iterations.

Kerf Comp Look-Ahead: To find which events are supposed to intersect with each other, Intercon looks at a certain number of events and subevents beyond each event. This setting allows you to decide how far ahead you want Intercon to look before it decides an event does not intersect with any others. Kerf Comp Look-Ahead should always be at least 1 and a whole number.

Kerf Comp Gap Tolerance: Not all events in a part after compensating for kerf width may touch. For example, there may be a very small gap between the end of one line (let's say it ends at the point (24.9999, 3)) and the beginning of another (25, 3). This setting allows you to tell Intercon how large of a gap you want to treat as being continuous before they are considered distant enough to be separate. This value will always be between 0.1 and 0.0001 DRO Units.

Appearance Setup Menu



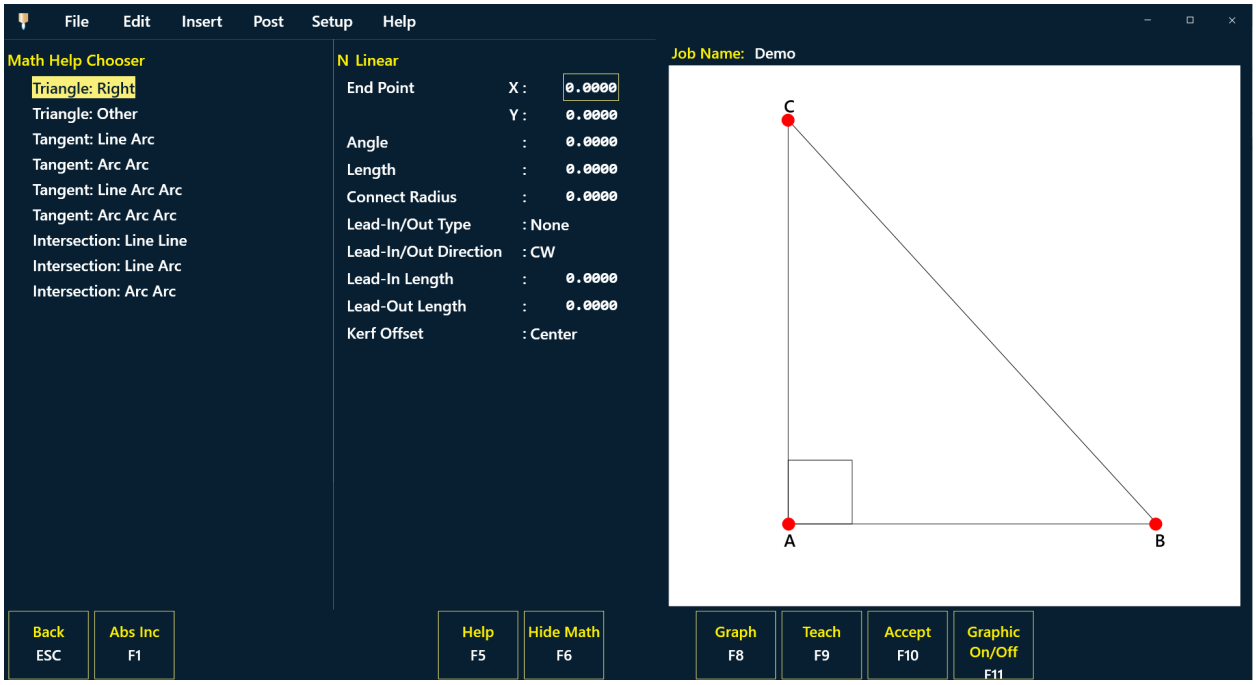
These options are all 6-letter or number hex code strings representing a color. If you click on the color swatch square directly to the left of the hex code, it opens a dialog box with a color picker. Additionally, you may enter RGB values in this dialog box to get the corresponding hex code.

F10 - Post

Intercon will generate a G code file that will run on a CNC controlled plasma cutter and save this new file to a folder called ncfiles. This functionality is also found as option F12 Post under the “Insert” menu.

Math Help

Intercon provides a math assistance function to solve the trigonometric problems common in part drawings. To enter Math Help, press **F6 - Math Help** from almost any Edit Operation screen. When Math Help is invoked, the following screen appears which shows all available solvers:



The figures on the right are a graphical representation of the highlighted solver on the left. Pressing the **ENTER** key will display another menu that has various fields particular to the type of problem that is being solved. The graphic below displays the Right Triangle Calculator menu. The options that are available on the function keys are the same for every type of math help solver and perform the following operations:

F1 - Prev Soln (Previous Solution)
F2 - Next Soln (Next Solution) The **Prev Soln** and **Next Soln** options will cycle backward and forward, respectively, through the available solution sets for math solvers that may have multiple solutions. A status line near the bottom left of the screen appears once a valid solution has been found. The solution status line indicates the total number of solutions and the solution number that is currently represented by the graphic display on the right. For example, in an Arc Tangent ARcs math help, the display solution status may be "**-** Solution 1 of 8 -". In this case, the **Prev Soln** and **Next Soln** can be used to cycle through all eight of the solutions.

F3 - Clear All The **Clear All** option removes all solutions. It sets all fields for a particular solver to **UNKNOWN**

F4 - Prev Solver
F5 - Next Solver The **Prev Solver** and **Next Solver** options cycle backward and forward, respectively, through the various math help solvers. These options are shortcuts which have the same effect as pressing **EXC** to reach the main math help menu, navigating to the previous or next math help option, and then pressing **ENTER**

F6 - Hide Math The **Hide Math** option exits math help mode and returns the event list. Pressing **Math Help** will invoke Math Help again.

F7 - Copy <<
F8 - Copy >> The **Copy <<** option will move the value from the selected edit operation field into the selected math help menu field and the **Copy >>** option will move the value from the selected math help menu into the selected edit operation field.

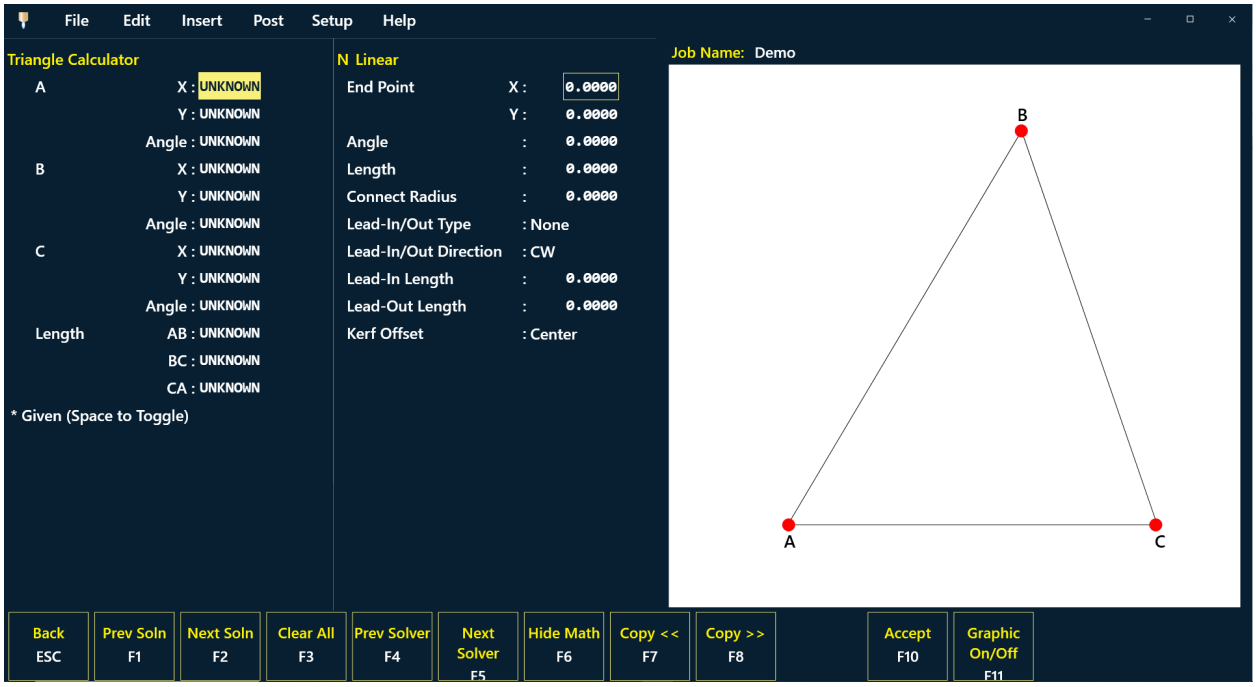
F10 - Accept The **Accept** option will accept the values entered for the current event.

F11 - Graphic On/Off The **Graphic On/Off** option will toggle the graphical representation of the math help menu on the display

Arrow Keys - Select fields
The **LEFT** and **RIGHT** arrow keys are used to navigate between the math menu and the edit menu. The **UP** and **DOWN** arrow keys are used to navigate within a menu. To choose fields for the "Copy" option, use the **UP** and **DOWN** arrow keys to highlight the desired field in the menu and use the **LEFT** or **RIGHT** arrow keys to switch menus.

Other features common to all Math Help operations
In some math help operations, there will be an asterisk '*' character that appears immediately to the right of a field. This character marks the field as a "given" field, which means that the value of this field will be held constant in the process of solving the math equations.

Triangle: Right
Triangle: Other



The screen will show **UNKNOWN** if the value of each parameter is not known. Math Help waits for known values to be entered, where:

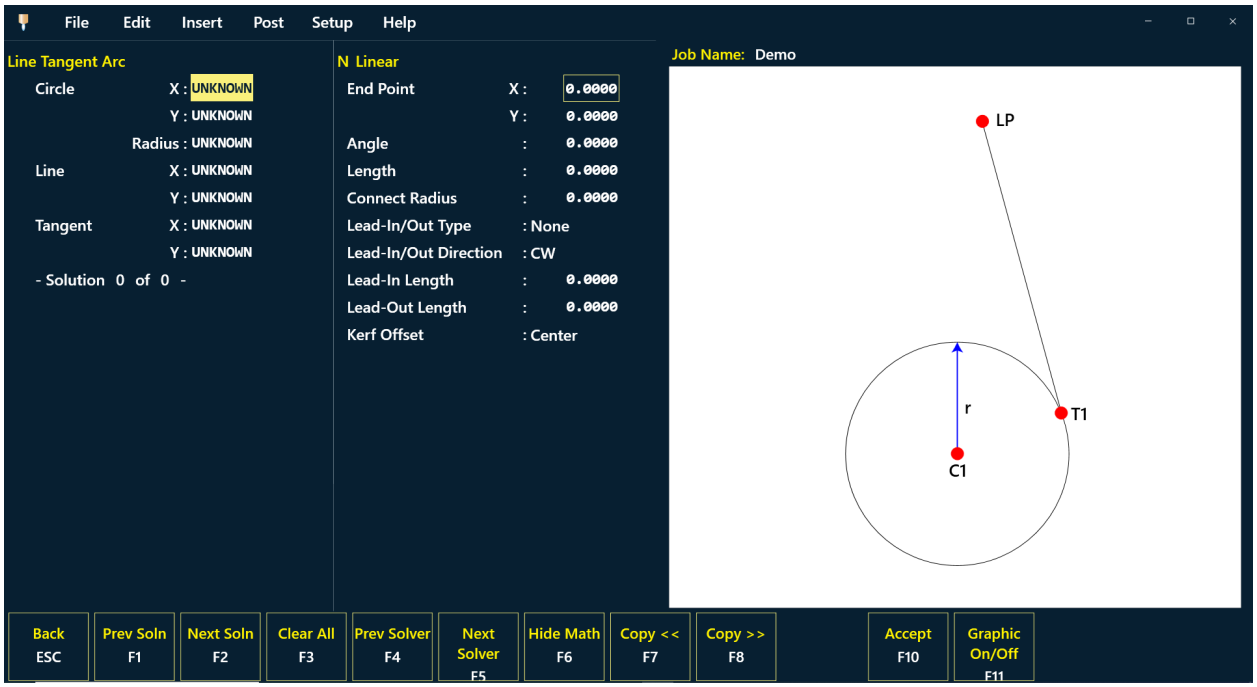
Point a, b, or c is the coordinate value for each corner of the triangle.

Angle A, B, or C is the angle at each point of the triangle.

Length is the value of the distance between the points indicated.

Continue adding all the known parameters. Select parameters using the arrow keys. When Math Help solves the remaining unknown values, the screen will display them.

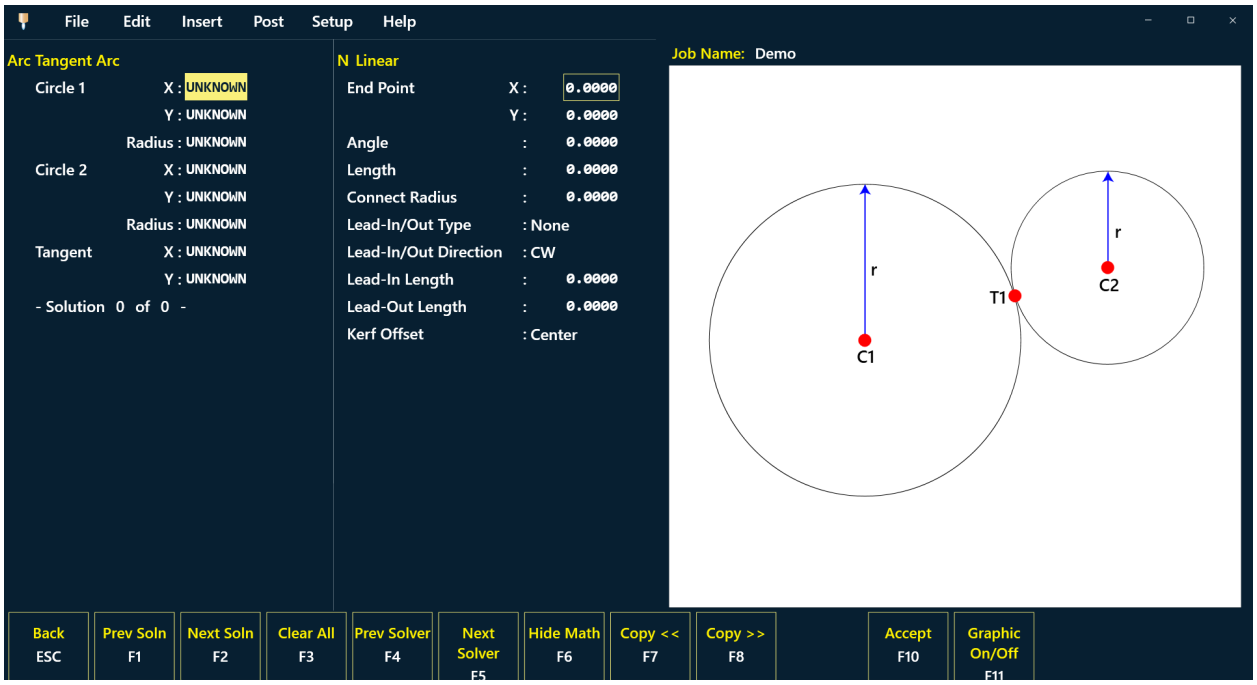
Tangent: Line Arc



Given the center (C1), the radius of an arc, and 1 point (LP) on a line, find the lines tangent to the arc (defined by the tangent point(T1)).

You must enter the X and Y coordinates for the circle's center point, the circle's radius, and the X and Y coordinates for a point on the line.

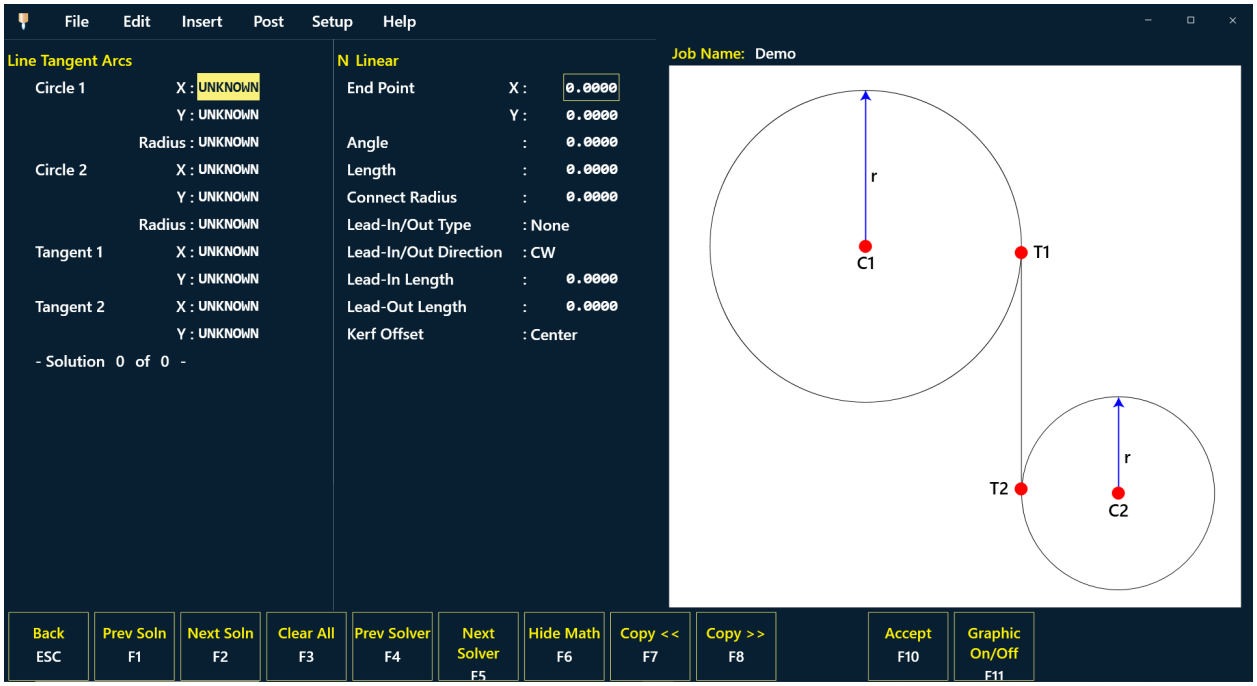
Tangent: Arc Arc



Given the center points (C! And C2) and radii (R1 and R2) of two arcs, find the point (T1) at which they are tangent.

You must enter the X and Y coordinates for the first circle's center point, the radius of the first circle, the X and Y coordinates for the second circle's center point, and the second circle's radius.

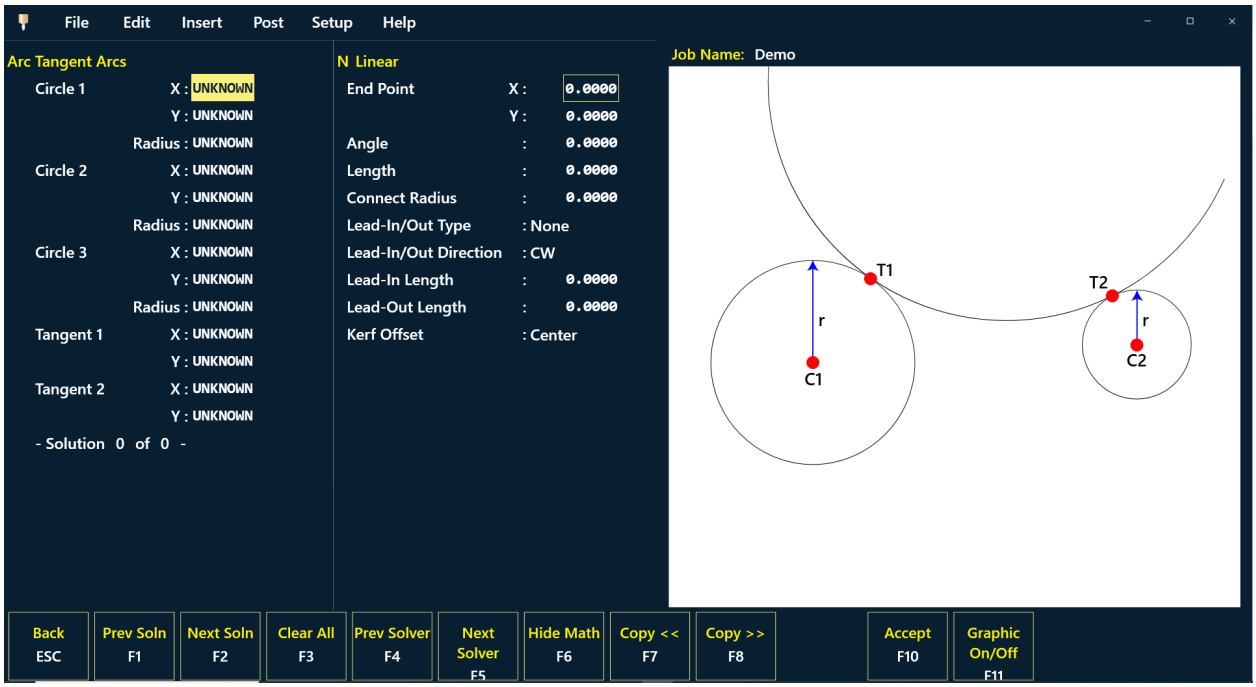
Tangent: Line Arc Arc



Given the center points (C1 and C2) and raddi (R1 and R2) of two arcs, find the lines (defined by T1-T2) tangent to both arcs.

You must enter the X and Y coordinates for the first circle's center point, the radius of the first circle, the X and Y coordinates for the second circle's center point, and the second circle's radius.

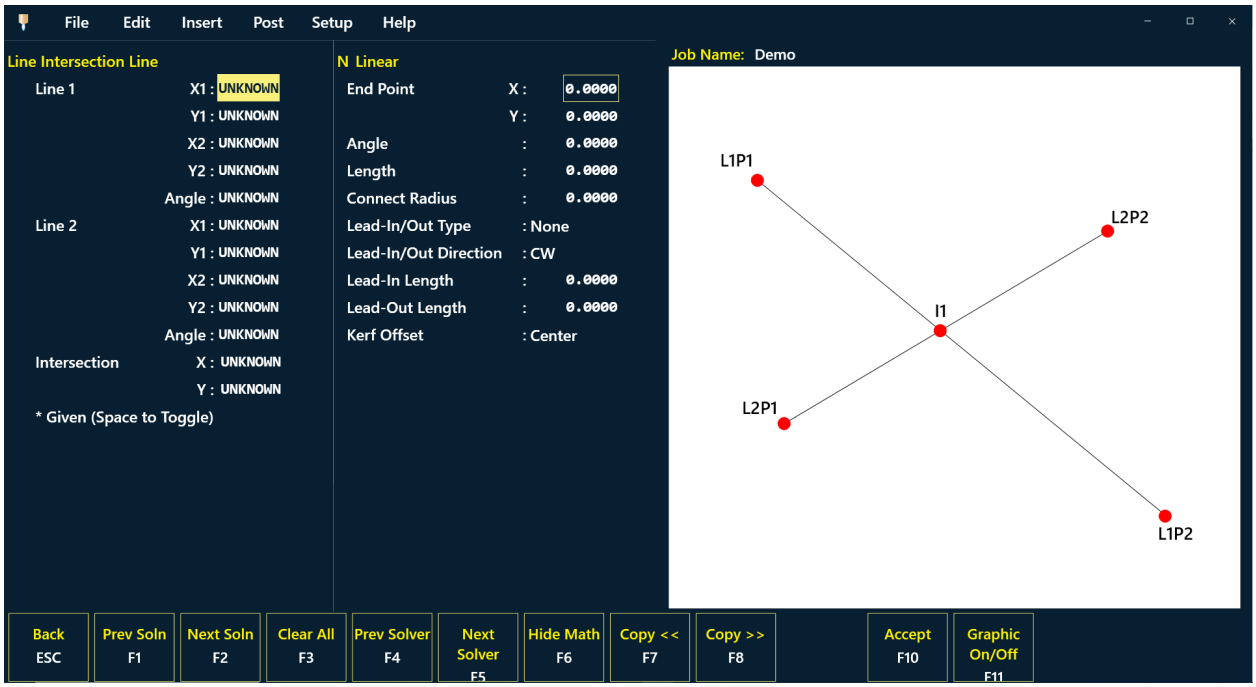
Tangent: Arc Arc Arc



Given the center points (C1 and C2) and radii (R1 and R2) of two arcs and the radius of a third arc, find the center point of the third arc and the tangent points (T1 and T2).

You must enter the radius of the tangent arc, the X and Y coordinates for the first circle's center point, the radius of the first circle, the X and Y coordinates for the second circle's center point, and the second circle's radius.

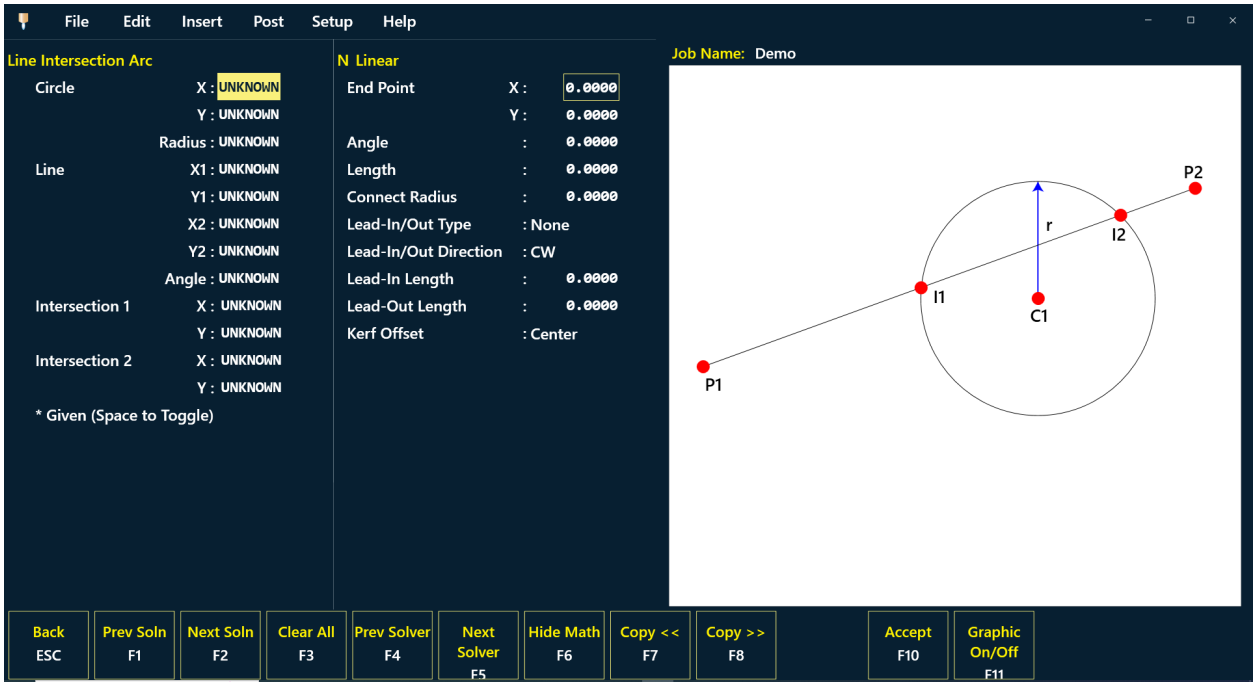
Intersection: Line Line



You must enter the X and Y coordinates for 1 point on each line, and also one of the following:

- The X and Y coordinates for a second point
- The X coordinate for a second point and the angle from horizontal
- The Y coordinate for a second point and the angle from horizontal
- The angle from horizontal only

Intersection: Line Arc

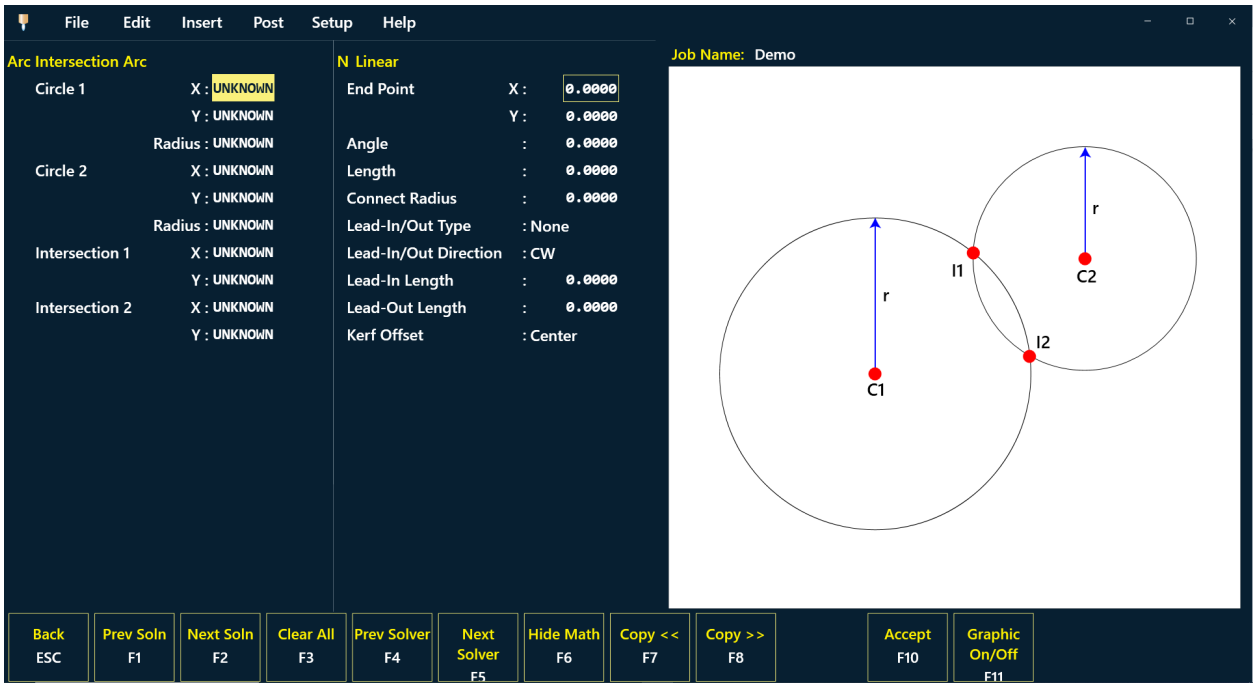


Given the center (C1) and Radius (R) of an arc, 1 point (P1) and either a second point (P2) or one coordinate (P2 X or Y) and the angle from horizontal, find the intersection point(s) (I1 and I2).

You must enter the X and Y coordinates for the circle's center point, the circle's radius, the X and Y coordinates for one point on the line, and one of the following:

- The X and Y coordinates of a second point on the line
- The X coordinate of a second point and the angle from horizontal
- The Y coordinate of a second point and the angle from horizontal

Intersection: Arc Arc



Given the center points (C1 and C2) and the radii (R1 and R2) of two arcs, find the intersection point(s) (I1 and I2) of the arcs.

You must enter the X and Y coordinates for the first circle's center point, the radius of the first circle, the X and Y coordinates for the second circle's center point, and the second circle's radius.