Using This Document

Layout and Objectives

Basic Configuration

This section is for anyone setting up their machine for the first time. This has been written with the goal of fairly accurate motion on each controlled axis.

Secondary Configuration

In this section, application- and license-specific setup parameters are addressed. By the end of this section, the machine will move precisely and have the ability to run its cutting tool(s).

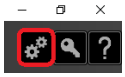
Peripheral Configuration

This section will guide the setup of extra features that enable more safety or added functionality.

Navigation

Using the Configuration Screen

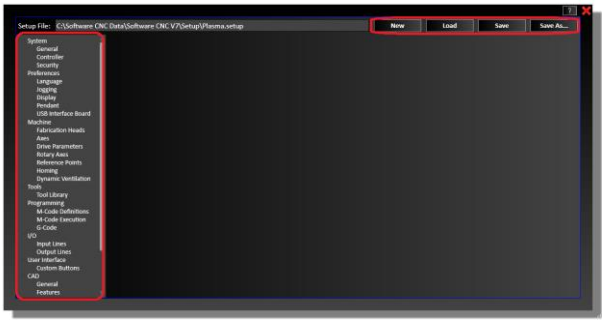
To open the configuration panel, click the 'Double Gear' icon found in the upper-right of the screen:



The File tools are located at the upper right of the panel:

- New – Starts a brand new configuration from factory defaults
- Load – Browse for a previously-saved setup file
- Save – Overwrites the currently open setup file with any changes
- Save As… – Prompts to save the currently open setup file under a different file name

On the left-hand side, the configuration page browser can be used to move between categories:

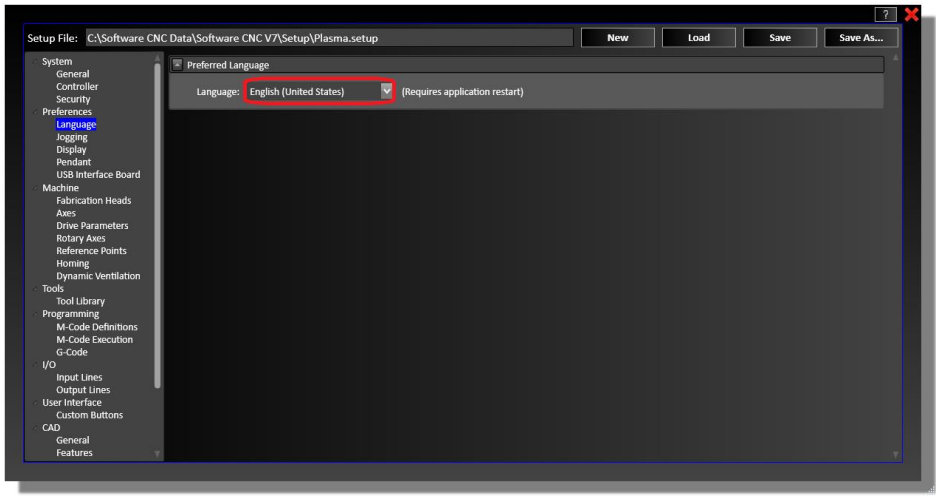


Primary Configuration

Preferences

Preferences…Language

The software comes equipped with multiple languages. Using the dropdown, select which language you prefer:



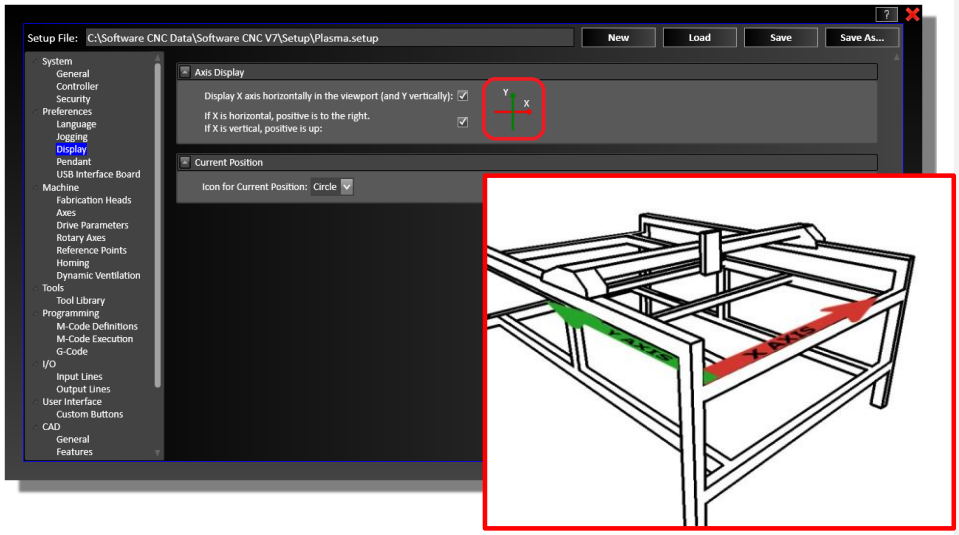
Available languages are:

- English
- Spanish
- Italian
- French
- Portuguese

Please note: if you decide to change the displayed language, you must save the setup file and restart the software for changes to take effect.

Preferences…Display

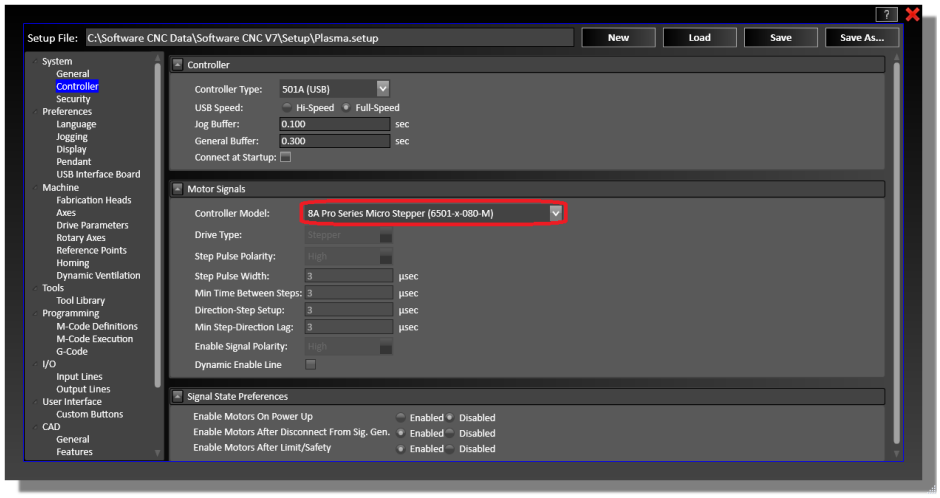
Using the checkboxes on this page, ensure that the axes layout highlighted here matches the orientation of your computer in relation to your machine.

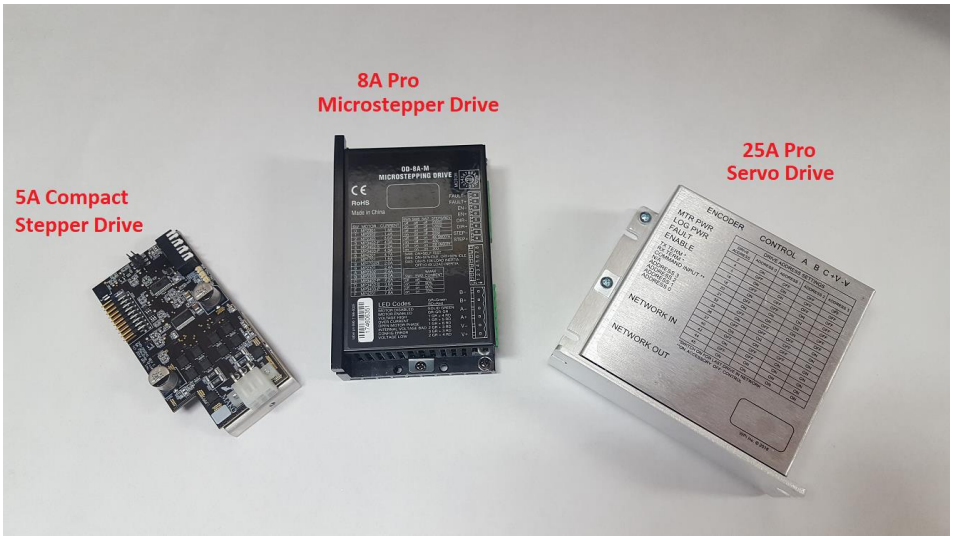


Controller

System…Controller

Using the highlighted dropdown, select the driver model installed on the machine (the model number associated with each driver is shown in parentheses). If you are using third-party drives, select other and manually enter each value.

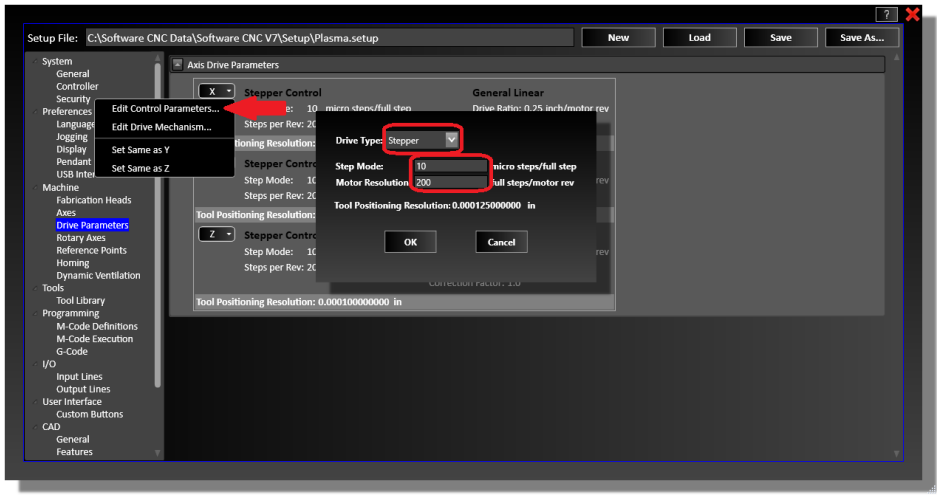




Motion

Machine…Drive Parameters

First, set the control parameters to the default value based on the drive. The control parameters edit screen can be accessed through the relevant axis dropdown:



2.5A/5A Compact Micro Stepper:

- Step Mode: 4 micro steps/full step
- Steps per Rev: 200 full steps/motor rev

8A Pro/Titanium Series Micro Stepper:

- Step Mode: 10 micro steps/full step
- Steps per Rev: 200 full steps/motor rev

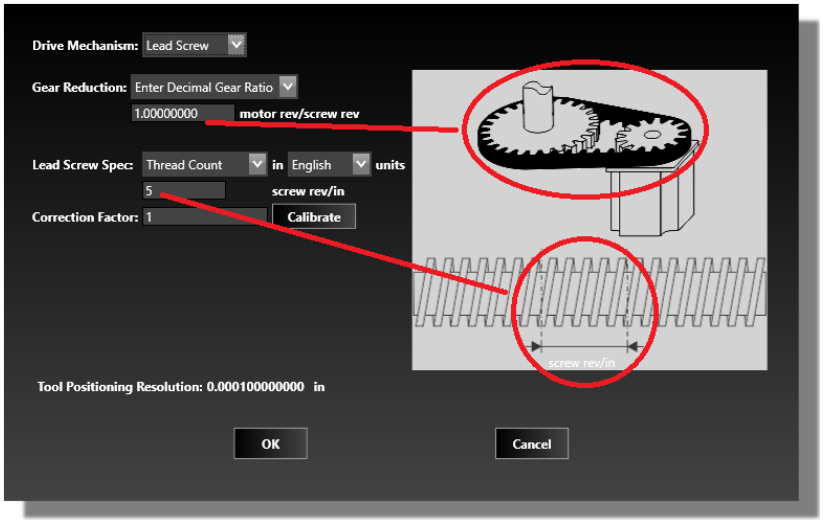
25A Pro/Titanium Series Servo:

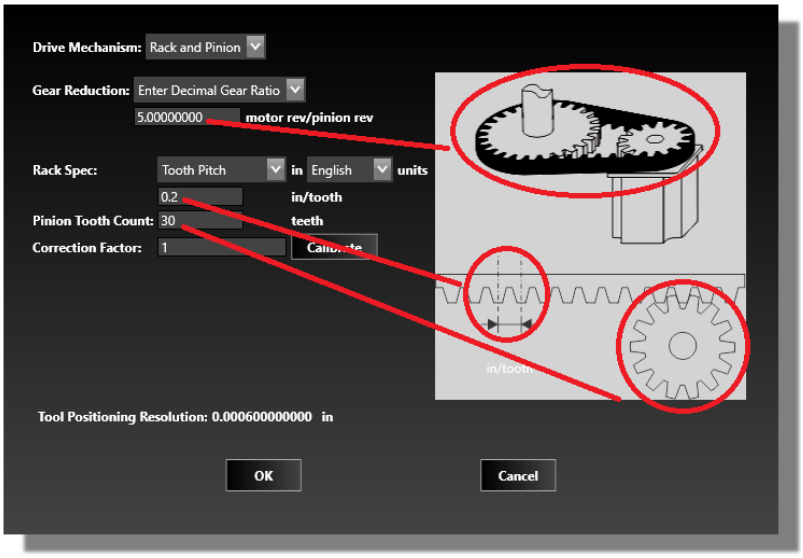
- Encoder Divisor: 5 encoder ticks/SG pulse
- Encoder Resolution: 1000 lines/rev

These values may vary significantly if using third-party drives or motors.

Machine…Drive Parameters (cont.)

Next, select ‘Edit Drive Mechanics…’ from the axis dropdown. This will open the Mechanics Editor window. Here, you will enter the mechanics for the relevant axis. You will need the specifications of each component, either from the manufacturer or by measuring. First, define the type of mechanism on the axis.





Gear Reduction:

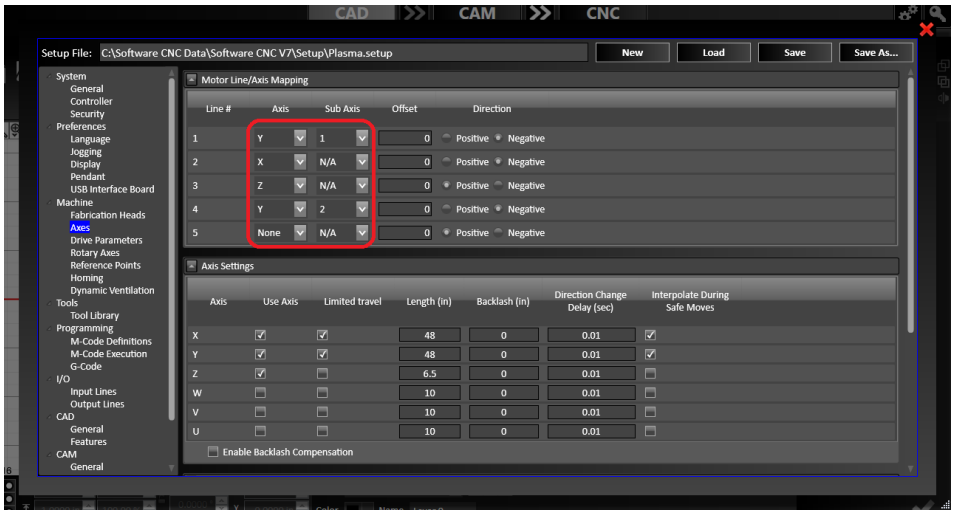
Then, enter in your gearing. If the axis is using belt gearing, you can enter the teeth on each pulley instead of finding the gear ratio. Keep in mind, if the axis has multiple gearing systems (such as both belt gearing as well as a gearbox), you must use the decimal gear ratio of the whole system, found by multiplying each ratio together.

Lead Screw and Rack Specs:

It is easiest to acquire thread or tooth pitch from published specifications, but in the event they are not available, you can measure either the pitch or threads/teeth per inch. If measuring pitch, be sure to measure from the exact same point between threads/teeth. If measuring number per inch, do not count the first one. See the above picture for example.

‘Machine…Axes’

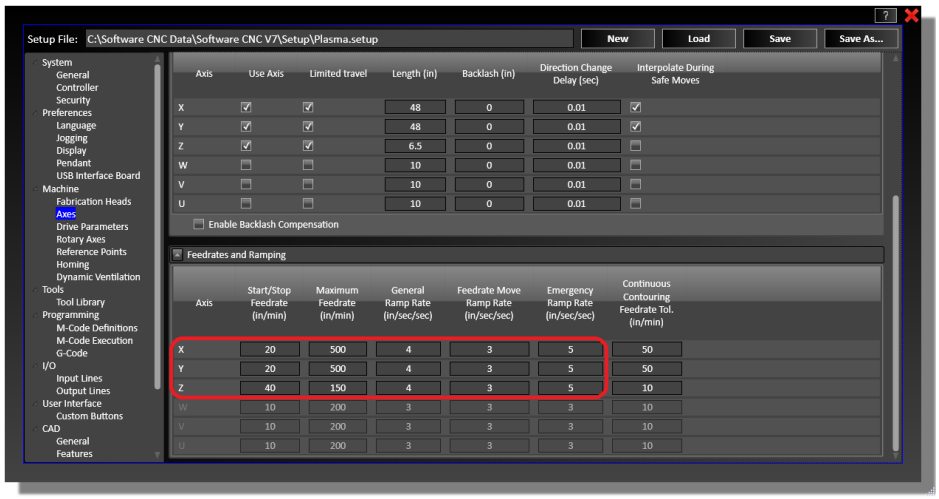
Now, define which axis numbers—that is, which lines the motors are physically plugged into—correspond with which axis letters. If any axis is a dual-driven gantry (i.e, has two motors operating to move in one direction), you must assign different sub-axis numbers to each line driving the same axis. In the example below, the machine’s X-axis motor is plugged into Line 2, the Z-axis into Line 3, one of the dual-driven Y-axis motors into Line 1, and the other into line 4.



Then, ensure that you have the correct direction for each motor. The simplest way to do this is to save the Setup and try to jog each axis. If it moves as expected, the polarity is correct. If not, reopen the Configuration to the ‘Machine…Axes’ page and change the incorrect axes to the other polarity. With a dual-driven axis, make sure that the motors don’t fight each other. If the shafts of both point the same direction, their polarity must be the same. If their shafts point toward each other (or away from each other), one line’s direction will be positive and the other’s will be negative. If setting up a servo system with a slaved drive, set that line’s axis and sub-axis as N/A.

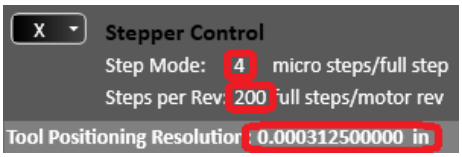
‘Machine…Axes’ (Cont.)

Next, scroll down to the ‘Feedrates/Ramping’ section. These values are dependent on the individual machine, but some conservative starting values are outlined below. You will need to refer to the ‘Machine…Drive Parameters’ section.



Calculating Maximum Feedrate (Stepper):

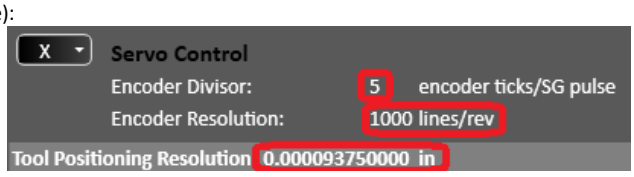
Use the following formula to determine the initial maximum feedrate on each axis:



[Step Mode] x [Steps per Rev] x [Tool Positioning Resolution] x 500 RPM = Maximum Feedrate

Calculating Maximum Feedrate (Servo):

Use the following formula to determine the initial maximum feedrate on each axis (the ‘x4’ is due to servo quadrature):



$$\frac{\text{[Encoder Resolution] x [Tool Positioning Resolution]}}{\text{[Encoder Divisor]}} \text{ x 1000 RPM x 4 = Maximum Feedrate}$$

‘Machine…Axes’ (Cont.)

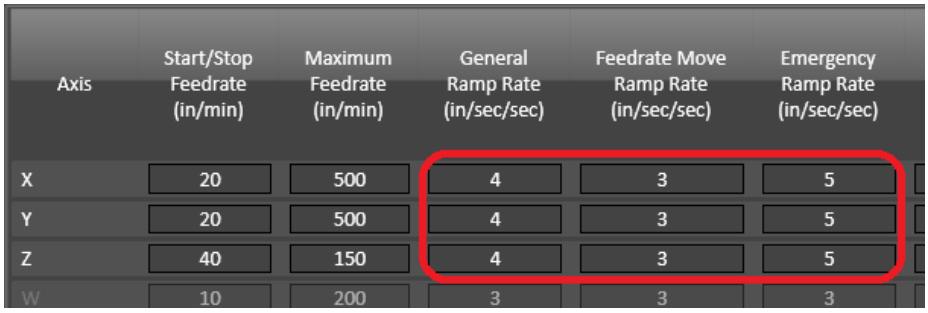
Calculating Start/Stop Feedrate:

To determine the Start/Stop Feedrate on each axis, simply use 5% of the calculated Max Feedrate or:

[Maximum Feedrate] x 0.05 = Start/Stop Feedrate

Ramp Rates:

The ramp (or acceleration) rates will determine the responsiveness of each axis. The higher ramp rate will be more responsive, but will put a greater load on the motor driving each axis. For now, set all General Ramp Rates at 4 in/sec^2, Feedrate Move Ramp Rates at 3 in/sec^2, and Emergency Ramp Rates at 5 in/sec^2.



Axis	Start/Stop Feedrate (in/min)	Maximum Feedrate (in/min)	General Ramp Rate (in/sec/sec)	Feedrate Move Ramp Rate (in/sec/sec)	Emergency Ramp Rate (in/sec/sec)
X	20	500	4	3	5
Y	20	500	4	3	5
Z	40	150	4	3	5
W	10	200	3	3	3

Secondary Configuration

Motion Calibration

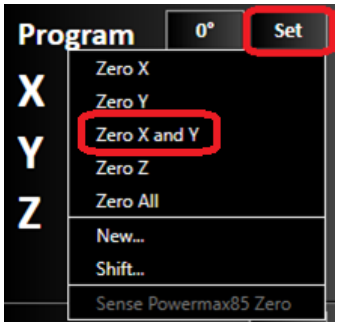
Backlash Compensation

If the machine is using plasma or laser, do not use Backlash Compensation. These type of machines may leave excessive burn marks as the machine dwells during compensation. For other applications, run this procedure on both the X- and Y-axes to determine the amount of backlash on each axis:

1) Jog the axis to the negative of its travel.

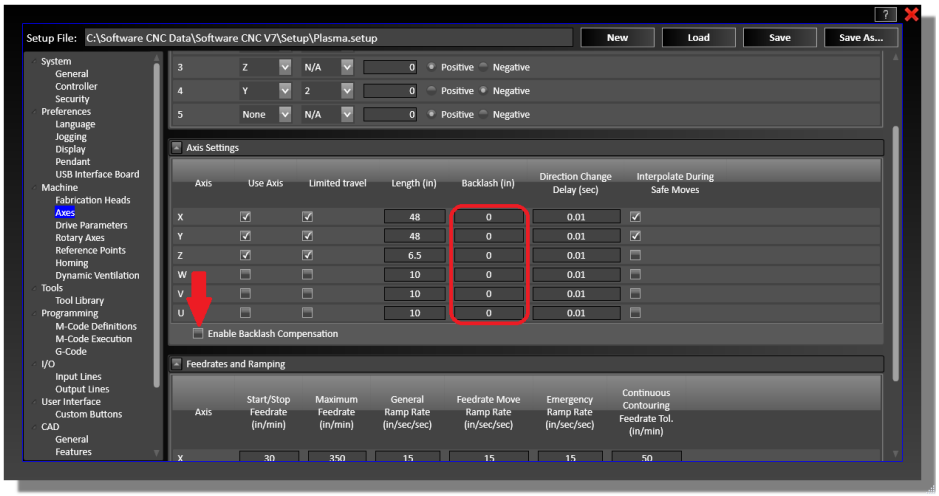
2) Now, use Move to Point mode to travel 1” toward the other end. This can be accessed through the button on the Jog panel.

3) Make a mark under the fabrication head’s position. Set the axes coordinates to zero with the ‘Set’ dropdown in the Program Coordinate panel.



4) Once again, travel 1” in the same direction. Then, return to the axis’s zero. Measure the distance between the original mark and the fabrication head’s current position. This is the backlash distance on this axis.

5) Enter this value for the appropriate axis on the “Machine….Axes” page of the configuration. Be sure to enable Backlash Compensation on this page.



6) Repeat for each axis to be measured.

Calibration Factors

To truly fine-tune motion, follow this procedure to determine and correct any error on each axis:

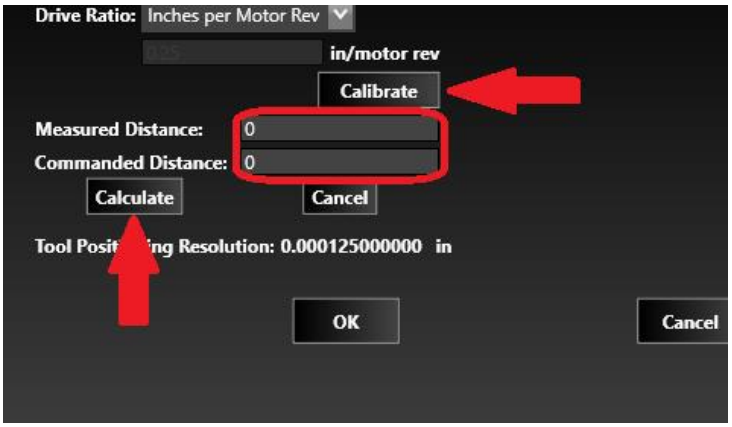
1) Jog the axis to the negative extent of its travel.

2) Mark the machine's current position. Then, use Move to Point mode to move at least 10" (or just short of max travel, if the axis is shorter) toward the other end of the axis.

3) Measure the actual distance physically travelled.

4) Open the configuration and navigate to the "Machine…Drive Parameters" section. Open the "Edit Drive Mechanism…" window for the relevant axis.

5) Click the "Calibrate" button and enter in both the measured and commanded distances. Then, click "Calculate" followed by the "OK" button and save the configuration.



6) This test can be repeated to further fine-tune motion. Bear in mind that a longer distance will yield a more accurate calibration.

Optimizing Feedrates and Ramp Rates

The Feedrates and Ramping section is located at the bottom of the Axes configuration page. Due to variations in the drive mechanisms for each axis, make sure you test the set parameters at several positions along each axis, in both directions.

Start/Stop Feedrate

1) Set a value of 50 ipm for the Start/Stop Feedrate in the Axes section of the configuration for the axis being tested.

2) Now, use Move to Point mode to travel 1". This can be accessed through the button on the Jog panel.

3) If the motor stalls, decrease the Start/Stop Feedrate and repeat the motion. If the motor doesn't stall, increase the parameter and repeat.

4) Continue this process until you find the greatest Start/Stop Feedrate at which stalling does not occur.

5) Return to the Axes screen and enter 70% of the feedrate:

[Greatest Start/Stop Feedrate] x 0.7 = Recommended Start/Stop Feedrate

6) Repeat for each axis.

Maximum Feedrate

1) Return to the Axes screen and verify that your Maximum Feedrate on each axis is set to the value calculated in the Basic Configuration section.

2) Click the Plus button below the Move to Point panel:

Optimizing Feedrates and Ramp Rates (Cont.)

3) Click the Rapid Move checkbox.

4) Use the Move to Point panel to do a longer move of at least a few inches.

5) If the motor stalls, decrease the Maximum Feedrate and repeat the motion. If the motor doesn't stall, increase the parameter and repeat.

6) Continue this process until you find the greatest Maximum Feedrate at which stalling does not occur.

7) Return to the Axes screen and enter 70% of the feedrate:

[Greatest Maximum Feedrate] x 0.7 = Recommended Maximum Feedrate

8) Repeat for each axis.

General and Feedrate Move Ramp Rates

1) Use the Move to Point panel to do a longer move of at least a few inches.

2) If the motor stalls, decrease the General Ramp Rate and repeat the motion. If the motor doesn't stall, increase the parameter and repeat.

3) Continue this process until you find the maximum General Ramp Rate at which stalling does not occur.

4) Return to the Axes screen and enter 70% of the ramp rate:

[Greatest Ramp Rate] x 0.7 = Recommended Ramp Rate

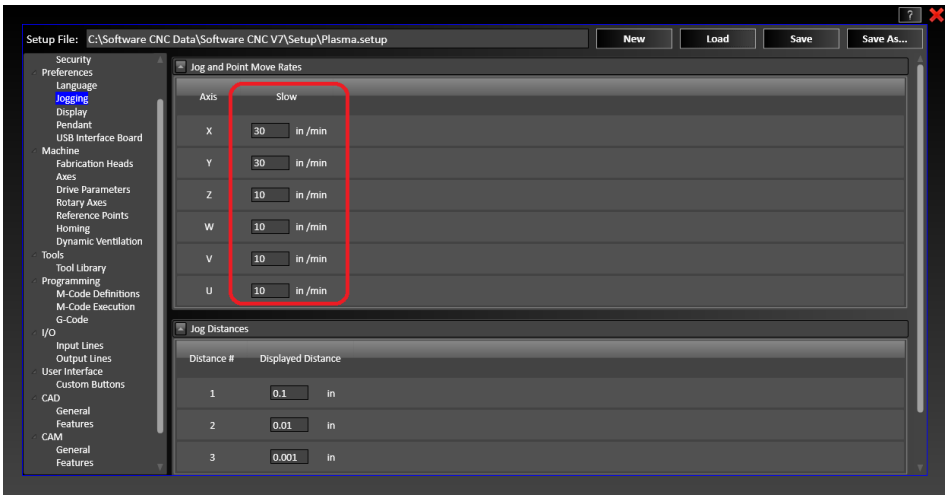
5) Copy this value to the Feedrate Move and Emergency Ramp rates. If you encounter stalls while cutting, reduce only the Feedrate Move Ramp Rate.

6) Repeat for each axis.

Jogging

Minimum Speeds

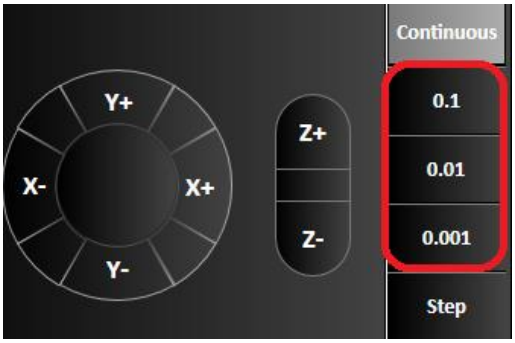
In the “Preferences….Jogging” section of the configuration, you can set the minimum jog and point move speeds for each axis. Choose a speed that is slow enough to position the machine precisely:



These speeds correspond to the left-most position on the speed slider:

Jog Distances

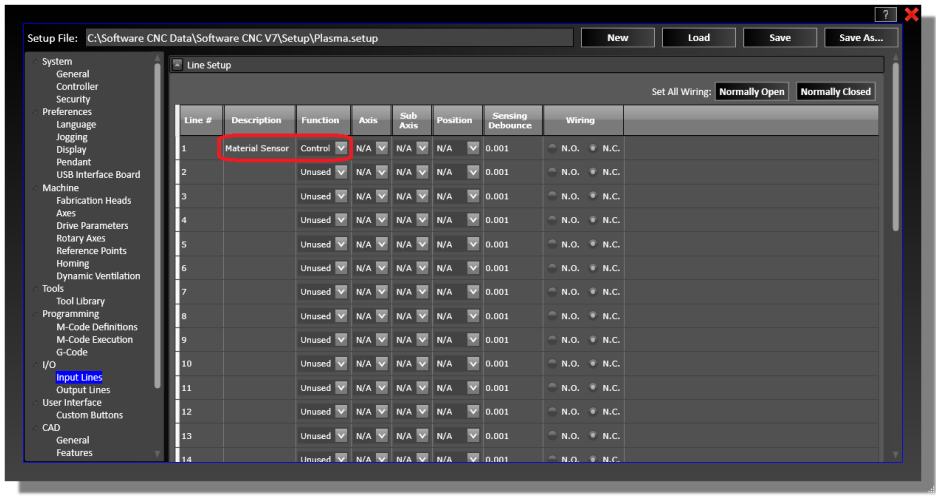
On the same page, you can set discrete jog distances to display on the jog panel:



Inputs

Sensing

Depending on your application, you may be using a material-sensing system, such as an ohmic sensor on a plasma torch. First, open the “I/O….Input Lines” page in the configuration:



Determine which input the sensing mechanism is wired to. If using ohmic sensing through our integrated THC, this will be line 19. Name the sensor in the ‘Description’ column and set it as a ‘Control’ from the ‘Function’ dropdown. If you have multiple modes of sensing, do this for each.

Drive Faults

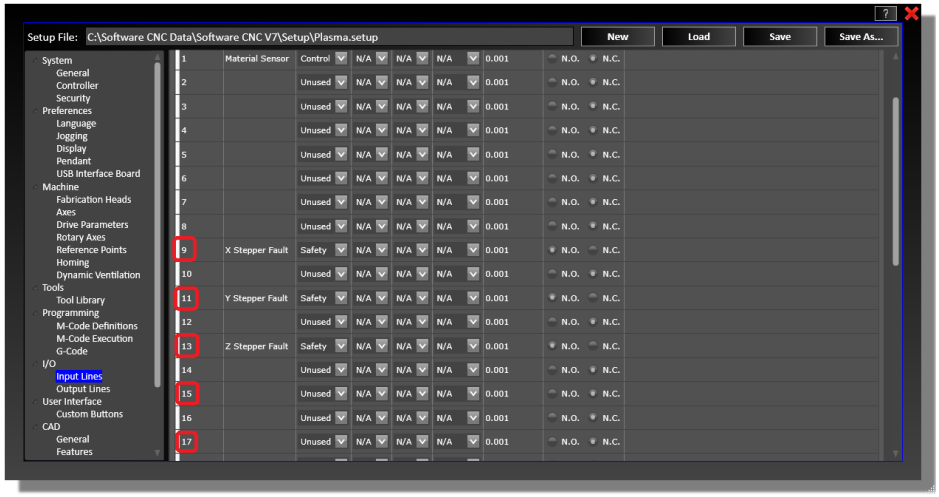
In a Pro or Titanium series controller, setting up input lines as drive faults has two advantages: fault reporting and safety. With fault lines set up, the operator will be notified if a fault occurs and unable to move the machine until the fault is resolved.

Take note of the ‘Motor Line/Axis Mapping’ on the “Machine….Axes” page. Each numbered line corresponds with a different input line for fault reporting.

Motor Line	Input Line
1	9
2	11
3	13
4	15
5	17

Drive Faults (Cont.)

Assign each axis present in your system to one of the input lines using the above chart. Assign the ‘Safety’ function to each line and name them appropriately.



The lines in a stepper system should be configured as Normally Open, or N.O. In a servo system, these fault lines should be set as Normally Closed (N.C.).

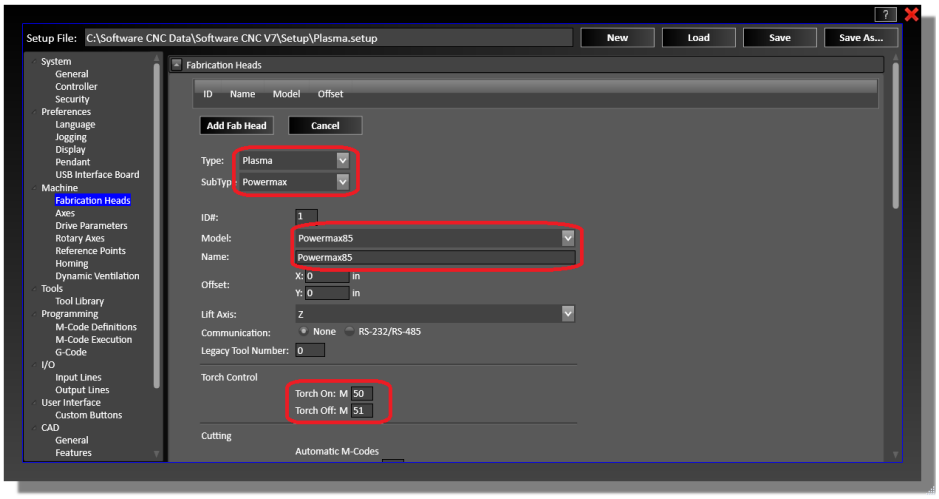
Tool Setup

On/Off M-Codes

First, navigate to the “Programming….M-Code Definitions” page in the configuration. Create an Output Line M-Code by clicking the ‘Add M-Code’ button. Assign an M-Code number to the function and give it an appropriate description. Then, click the Plus button at the end of the line to add an output line control. Use the created dropdown to select the output that the tool is controlled by and set whether the M-Code should enable or disable the selected output.

Creating a Fabrication Head

On the “Machine….Fabrication Heads” page in the configuration, click ‘New Fab Head’. Then, select the type and—if appropriate—the manufacturer and model of tool. Next, enter the On/Off control codes created in the previous step. Once complete, click ‘Add Fab Head’ to finalize.

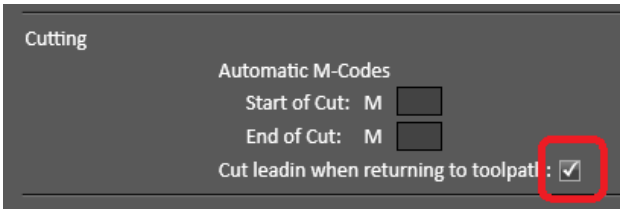


Fabrication Head Options

Return to the “Machine….Fabrication Heads” section of the configuration. Then, click on the fabrication head to edit it.

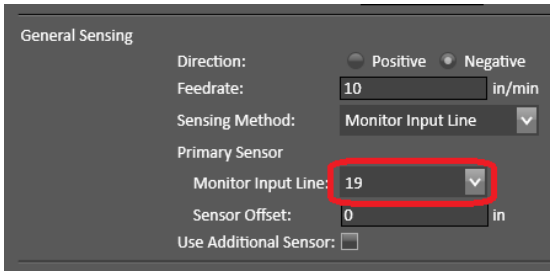
Lead-in on Resume

This Pro-tier option is found in the ‘Cutting’ subsection and aids in mid-program recovery. When this option is enabled, the system will begin cutting at its current position before returning to where it was feedheld. Using this, an operator can jog off the toolpath after a feedhold and create a new lead-in from the current position.



Sensing

In the ‘General Sensing’ subsection, assign the sensing input line under ‘Monitor Input Line’ if you configured one earlier. If there is a delay between contacting the material and activating the sensor, enter a ‘Sensor Offset’. If there are multiple sensors for a single tool, check the ‘Use Additional Sensor’ box and repeat these steps for the secondary sensor. If you plan to use zero-sensing, click the checkbox and enter a distance to retract from the material.



Smart Touch Off

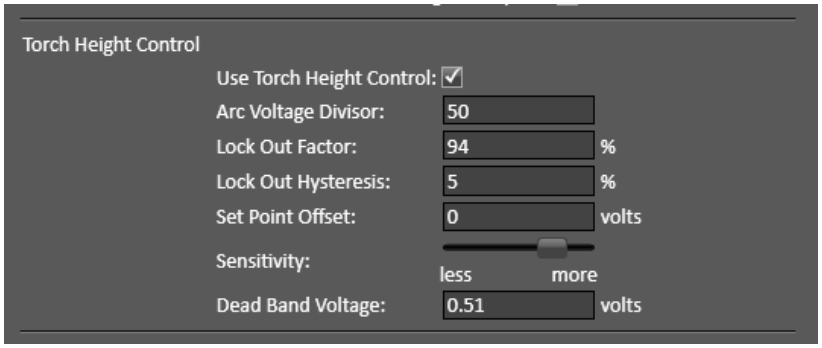
This Pro-tier feature suite allows for advanced touch off behavior. Enable each feature by checking its box.

Accessory Configuration

Torch Height Control

Enable THC

Open the “Machine….Fabrication Heads” section of the configuration. Click on the fabrication head to edit its settings. Then, scroll down to the Torch Height Control subsection. Check the ‘Use Torch Height Control’ box and use the default parameters, as shown below:

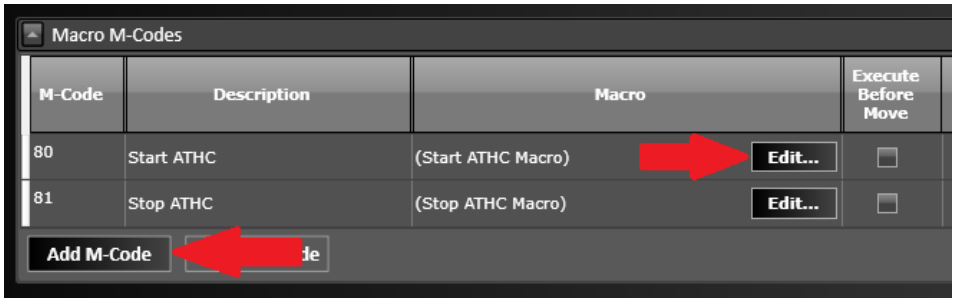


Configure Inputs

Navigate to “I/O….Inputs” in the configuration. Setup input lines 19 and 20 as follows:

Macro M-Codes

Navigate to the “Programming….M-Code Definitions” page. Scroll to the ‘Macro M-Codes’ section. Ensure there is a macro for both ATHC start and stop. By default, these are M80 and M81, respectively.



If you lack one or both of these, click the Add M-Code button to add a line for the macro. Enter the M-Code and name of the macro. Then, click the ‘Edit’ button and enter these default macros:

Start ATHC Macro (M80)

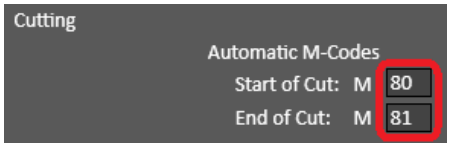
(Start ATHC Macro)
G605 (Move to Initial Height)
M50 (Torch On)
M101 I20 "Failed to detect arc transfer to material." (Wait for Arc Transfer Signal)
G04 X#PierceDelay (Pierce Delay)
G601 (Begin Plasma Cutting)
(M102 I20 S0 (Feed Hold When Loss of Arc)

Stop ATHC Macro (M81)

(Stop ATHC Macro)
G600 (End Plasma Cutting)
(M103 I20 (Disable Feed Hold When Loss of Arc)
M51 (Torch Off)

M-Code Assignment

Open the “Machine…Fabrication Heads” page and click on the fabrication head to edit settings. Find the ‘Cutting’ subsection and enter the two macros into the ‘Automatic M-Codes’ fields.



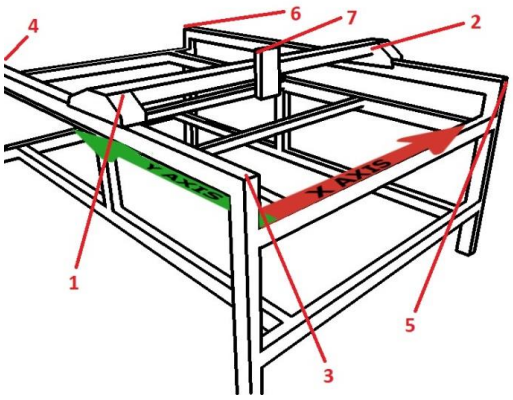
Limits and Homing

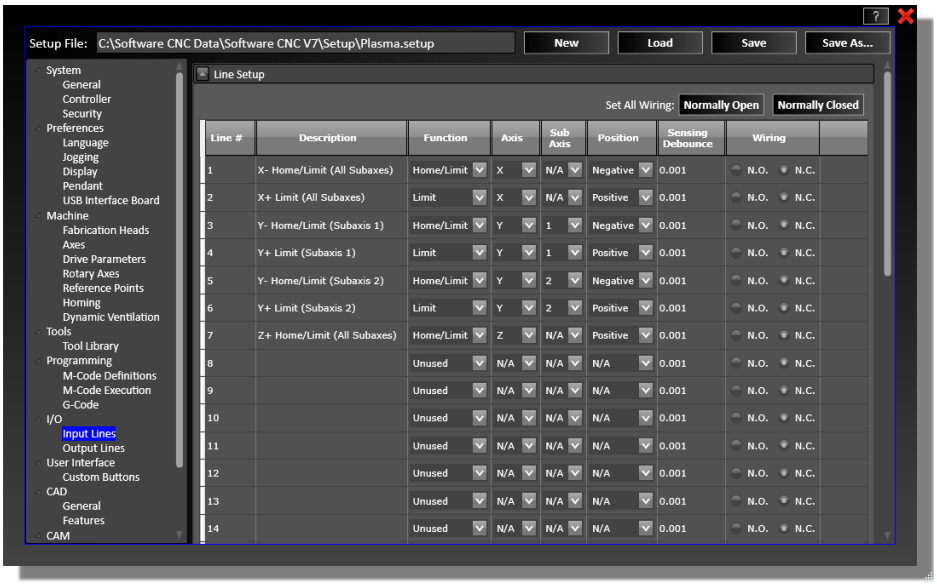
First, determine the axis and position of each switch as well as which input line it is wired to.

Configure Inputs

On the "I/O….Inputs" page, assign the axis, position, and (if applicable) sub-axis to each input in relation to each switch's physical location and wiring. On every axis you intend to home, decide which position you will home to. Set the function of these inputs as 'Home/Limit'. The rest should be set as 'Limit'.

For example, a table with switches wired to the locations shown would be configured like the following page:





Set Up Homing

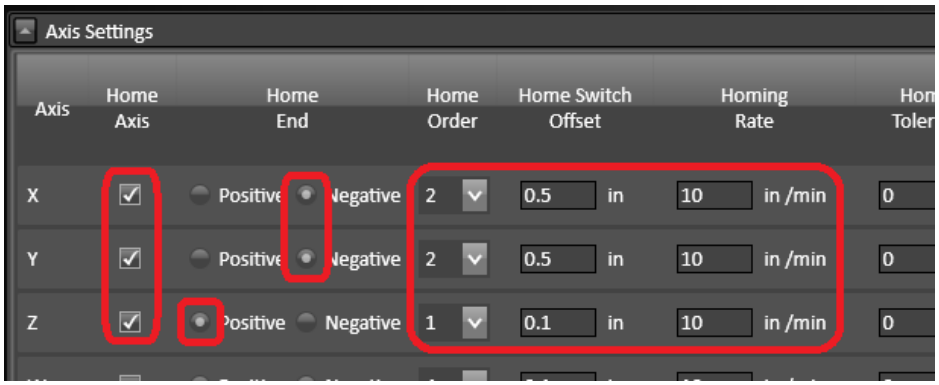
Navigate to the “Machine….Homing” page. Enable homing for each axis you’ve configured a ‘Home/Limit’ switch for. Also, ensure that the ‘Home End’ matches the position of the homing switch.

Home Order

Under this column, select the order in which you wish the axes to seek home. We recommend that this is set up in a way that prevents the machine from moving the tool through the material. Typically, this means homing the Z axis first, followed by X and Y.

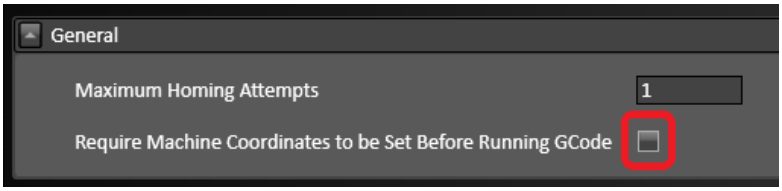
Homing Offset and Rate

The ‘Home Switch Offset’ is the distance the axis will retract after triggering the switch. This is used to create a buffer space between the machine’s maximum travel and the switch. The homing rate is the speed at which the axis will seek the switch. Although this is dependent on the characteristics of the machine, 10 ipm is usually a safe starting point. We do not recommend exceeding 25 ipm.



Require Homing

A commonly used option is ‘Require Machine Coordinates to be Set Before Running GCode”. This will force an operator to home the machine before running any program. It can be enabled at the bottom of the “Machine….Homing” page.



Safety Features

As an Input

For all systems, an emergency stop (E-Stop) can be wired as an input. This includes collision-detection systems. On the "I/O….Input Lines" page, simply set the 'Function' of the device's input as 'Safety'.

As an Accessory

For Pro Series controllers equipped with a 10-pin Accessory port, an E-Stop can be installed without the use of an input. This should be a normally closed circuit across pins 1 and 2 on that connector. If the system contains a servo power board, make sure switch 6 on the board is in the 'On' position. If it instead uses the stepper power board, jumper JP102 should be removed. Additionally, systems containing a servo power board can be set to wait for a reset signal after being E-Stopped. This reset switch should be a normally open, momentary switch wired to pins 9 and 10. Switch 1 on the power board must be in the 'On' position to enable this function.

Laser Pointer

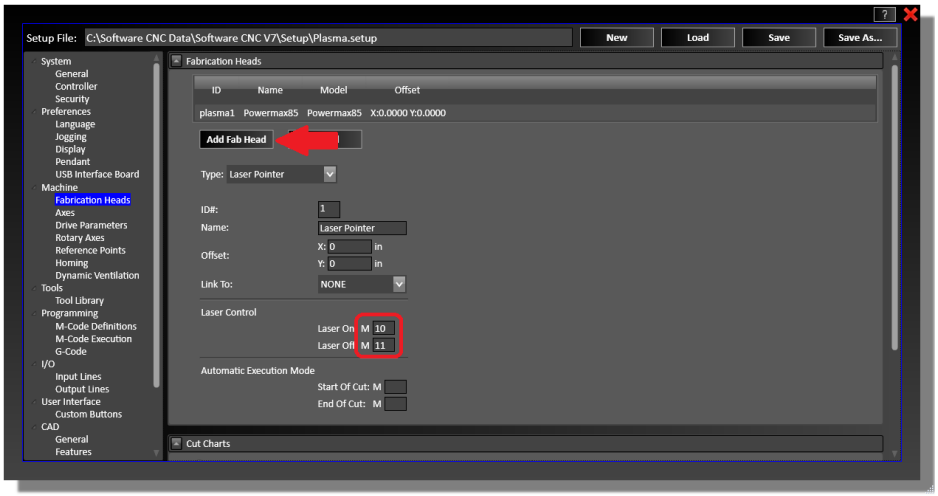
On/Off M-Codes

First, navigate to the “Programming….M-Code Definitions” page in the configuration. Create an Output Line M-Code by clicking the ‘Add M-Code’ button. Assign an M-Code number to the function and give it an appropriate description. Then, click the Plus button at the end of the line to add an output line control. Use the created dropdown to select the output that the laser pointer is controlled by and set

whether the M-Code should enable or disable the selected output.

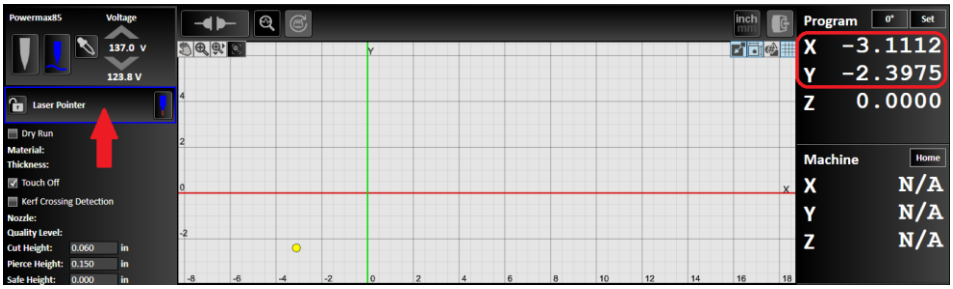
Creating a Fabrication Head

On the “Machine….Fabrication Heads” page in the configuration, click ‘New Fab Head’. Then, select Laser Pointer as the type. Next, enter the On/Off control codes created in the previous step. Once complete, click ‘Add Fab Head’ to finalize.

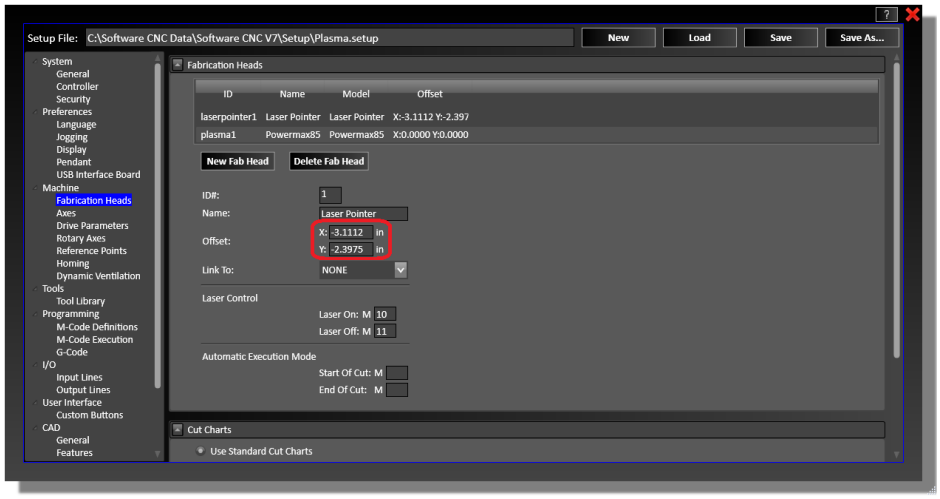


Determine the Offset

Next, find the distance between the primary tool and the laser pointer. The easiest way to make this measurement is to use the software's coordinate readout. First, load the smallest tool available into the machine. Put a piece of scrap material in the work area and jog the primary tool into position above it. Zero the X and Y coordinates and then make a mark or cut in the scrap at this position. Now, turn on the laser pointer and move it to the cut.



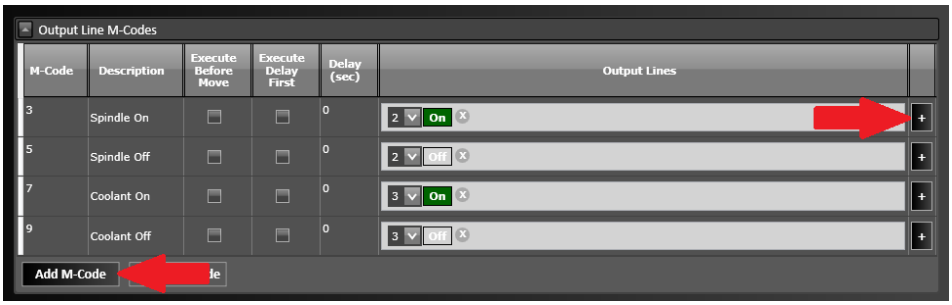
Return to the "Machine….Fabrication Heads" page in the configuration and click on the Laser Pointer tool to edit its parameters. Enter the current position in 'Offset' and save the configuration. You then should see the DRO return to X and Y zero.



Dual-Channel Relay

On/Off M-Codes

First, navigate to the “Programming….M-Code Definitions” page in the configuration. Create an Output Line M-Code by clicking the ‘Add M-Code’ button. Assign an M-Code number to the function and give it an appropriate description. Then, click the Plus button at the end of the line to add an output line control. Use the created dropdown to select the output that the device is controlled by and set whether the M-Code should enable or disable the selected output.



For one, two, or three relay boxes, the output lines are wired by default as:

Box # and Channel	Output
1-A	2
1-B	3
2-A	4
2-B	5
3-A	6
3-B	7

When four relays are connected, the default wiring becomes:

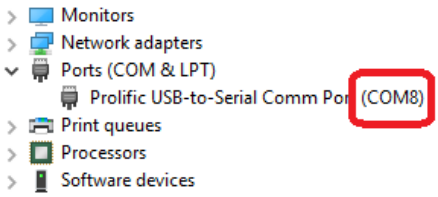
Box # and Channel	Output
1-A	1
1-B	2
2-A	3
2-B	4
3-A	5
3-B	6
4-A	7
4-B	8

Servo Communications

To interface with the drives in a Pro series servo controller, you will need to use the ServoWare software and a USB to serial adapter connected to the DB-9 COM port on the rear of the controller. In a Titanium series, this software and the adapter are preinstalled.

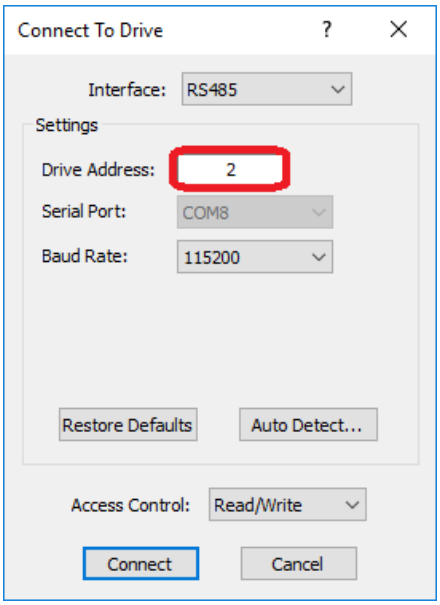
COM Port

To identify the correct port to use, open the Windows Device Manager and expand the 'Ports (COM & LPT)' category. Identify the device and make a note of its COM port.



Connecting to Drives

To interact with a drive, open the ServoWare software and click the 'Connect' button. This will display the 'Connect To Drive' screen. Here, select the COM port you found earlier from the 'Serial Port' dropdown. Then, enter the 'Drive Address'. Addresses correspond to the axis:



Axis #	Address
1	2
2	4
3	5
4	16
5	18

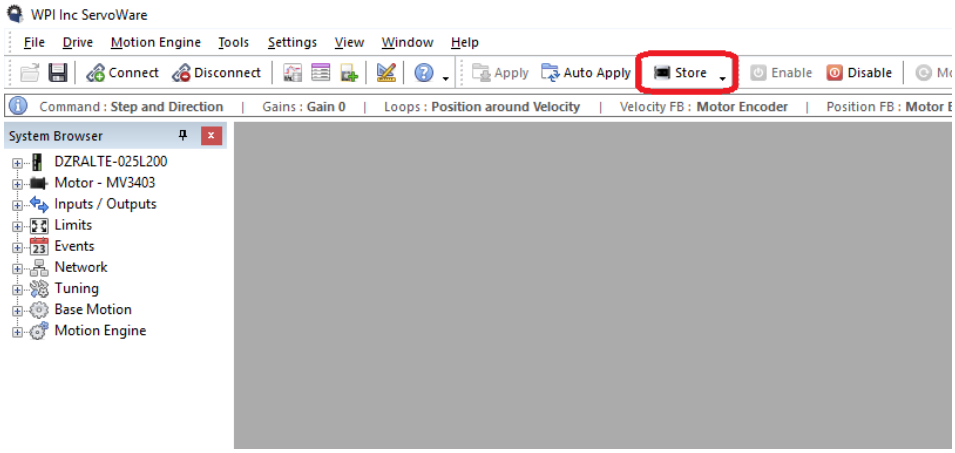
Default Tuning

Preset tuning files for each motor can be found (by default) in:

C:\Users\Public\Documents\ServoWare 7.4\My Projects\Sample Projects

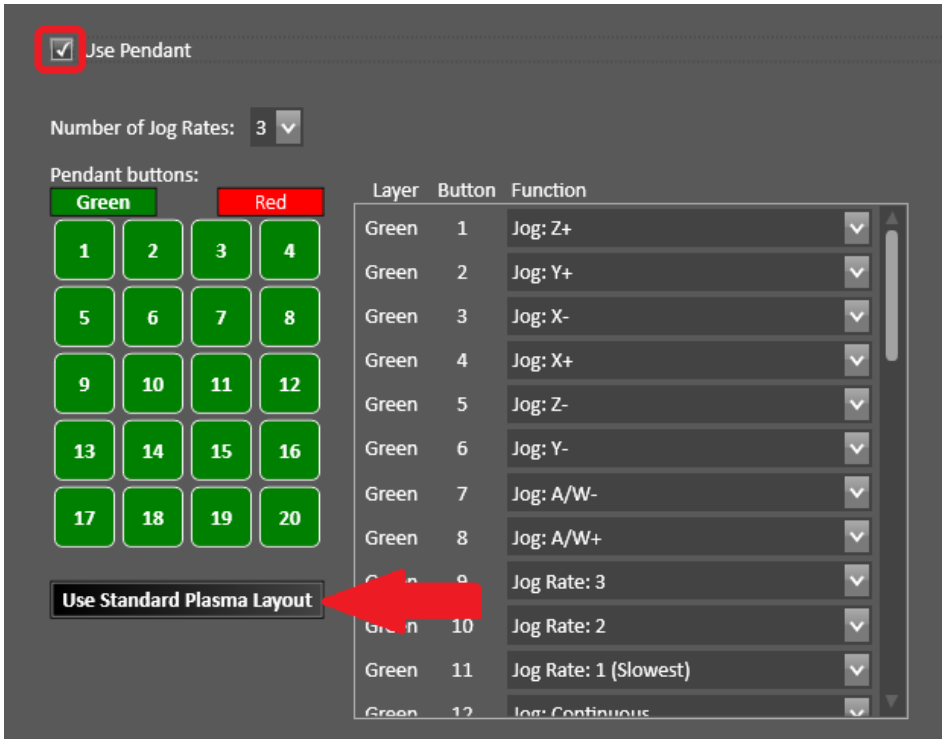
Saving Changes

To save changes to the drive's memory, click the 'Store' button.



Control Pendant

To set up the pendant, open the configuration to “Preferences….Pendant”. Here, you can enable use of the pendant and assign functions to each of the keys. Click the ‘Use Standard Plasma Layout’ button to load the default function set. These can be changed using the dropdowns at the right.



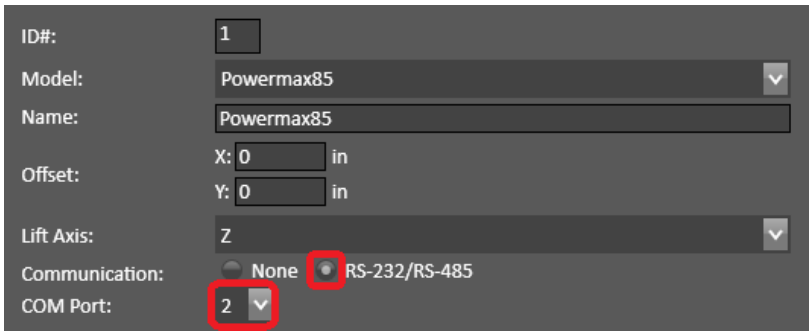
Plasma Communications

COM Port

To identify the correct port to use, open the Windows Device Manager and expand the 'Ports (COM & LPT)' category. Identify the device and make a note of its COM port.

Port Assignment

Open the "Machine…Fabrication Heads" page and click on the fabrication head to edit settings. Change the 'Communications' from 'None' to 'RS-232/RS-485'. Then, using the dropdown, select the COM port identified previously.



Oxy Fuel

Process Flow Definition

Because the actual operation of an oxy fuel torch can vary greatly from machine-to-machine, it is important to establish which elements of the cut process will be handled within the controls. For each action to be handled automatically, identify the output that toggles the action and decide on both an 'On' and 'Off' M-Code.

For example, one process may look like:

Manually ignite -> Move to position -> Low-preheat delay -> *Enable high-preheat* -> High-preheat delay…

… *Disable high-preheat* -> *Enable cut gas* -> Pierce delay -> Execute Cut -> *Disable cut gas* -> Purge delay

Each italicized step represents an automatic action that requires an output toggled by an M-Code. This may be assigned as:

Action	M-Code	Output	State
Enable high-preheat	52	1	On
Disable high-preheat	53	1	Off
Enable cut gas	54	2	On
Disable cut gas	55	2	Off

On/Off M-Codes

Now, navigate to the "Programming….M-Code Definitions" page in the configuration. Create an Output Line M-Code by clicking the 'Add M-Code' button. Using the process flow defined earlier, create Output M-Codes for each automated action. Click the Plus button at the end of the line to add an output line control. Use the created dropdown to select the output that the action is controlled by and set whether the M-Code should enable or disable the selected output.