MACHMOTION

Analog Control

Quick Start Manual

7/18/2012

Everything you need to know to get started with your MachMotion X15-250 analog control.

www.MachMotion.com
www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672

Congratulations!

Congratulations on purchasing your MachMotion analog control. All our controls have been designed to be plug and play as much as possible to make it easy for you to install. In this Quick Start Manual we give you all the tools you need to setup your control.

We hope that this installation can be as quick and easy for you as possible. If you have any questions, please do not hesitate to give us a call.

Sincerely,

The MachMotion Team
http://www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672

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Getting Started

Reviewing Your Package

If you have not already, begin by opening up the package containing your control. You should see the following:

Figure 1 CNC Control Package (With Optional Pendant)

Remove all the contents from the plastic bag.

Next locate the following items:

Figure 2 Interpreter 1000

- X15-250 Control
- Interpreter 1000
- 2 Power Cables
- Optional Pendant
- White Envelope

  The envelope contains the keys to turn on your control and backup copies of the software installed on your control. Make sure to store the envelope in a safe location in case something ever goes wrong.

White Envelope

Power Cable

Figure 3 Items

Optional Pendant

Mounting Your Control

If you purchased a mounting arm with your control, begin by assembling it using the Arm Assembly Instructions Manual. The manual can be found on the web at www.machmotion.com under **Support**, then **Documentation**.

However, if you did not receive a mounting arm, begin by mounting the control securely to your machine.

Starting Your Control

Supplying Power

To power your control, begin by taking off the back cover of the control. You need to remove 8 screws.

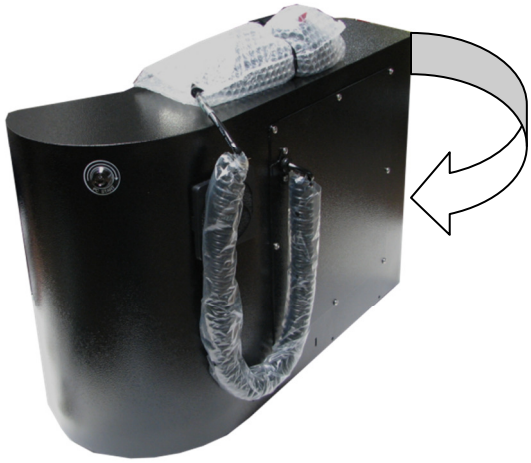


Figure 4 Back Panel

Next plug the black power cable from the control into 115VAC. The other end of the cable should be plugged into the connector inside the hole on the top of the control as shown below.

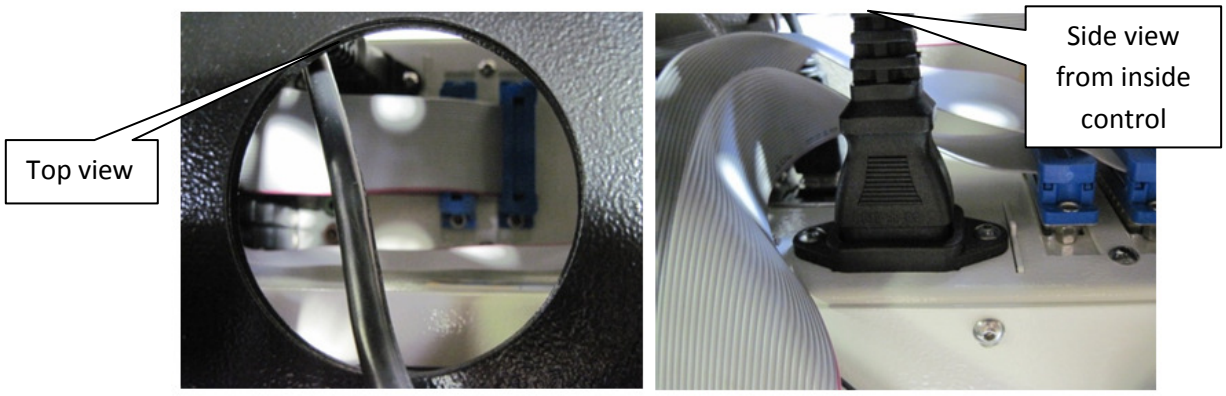
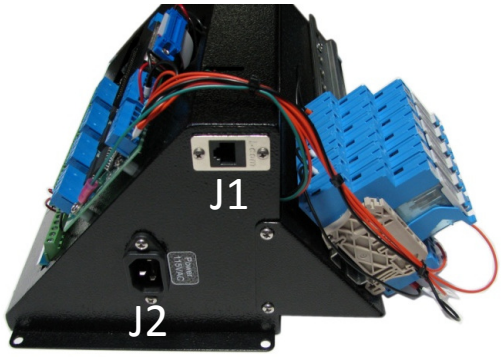


Figure 5 Power Cable

To power the Interpreter 1000, plug the other power cable into J2 on the Interpreter as shown in Figure 6. Plug the other side of the cable into 115VAC.



J1

Connect J1 to the Ethernet cable from the control.

J2

Connect J2 to 115 VAC.

Figure 6 Interpreter Connectors

Connecting Your Interpreter

After removing the back panel you will see a wound up Ethernet cable with a RJ45 connector. Connect the cable to the Interpreter on J1 (Figure 6).

Figure 7 Ethernet Cable

Turning on Your Control

Locate the keys inside the white envelope that came with your control.

Figure 8 Keys

Place one key into the keyhole at the back right hand side of the control as pictured below. Turn on your control by rotating the key and then quickly releasing it.

Figure 9 PC Start

Starting the Mach3 Software

The Mach3 software comes with three profiles, Mach3 Mill, Mach3 Plasma, and Mach3 Turn. Depending on what kind of machine you have, double click on the correct shortcut. Below are pictures of each profile's shortcut:

Figure 11 Profiles

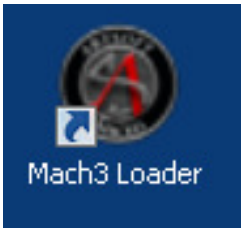


Figure 10 Mach3 Loader

On your desktop you will also find a shortcut for Mach3 Loader. This allows you to load any of the profiles from one location. Double clicking on the Mach3 Loader shortcut opens the following window:

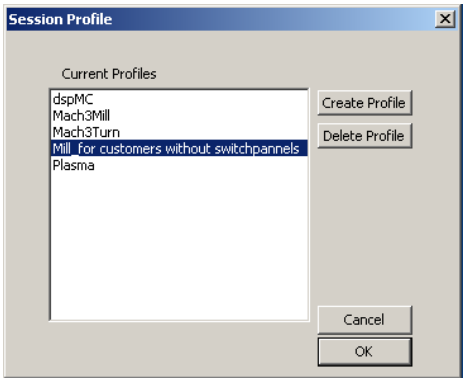


Figure 12 Loader

After double clicking on a profile or opening a profile from the Mach3 Loader, a window will come up asking you to agree to its legal notice.

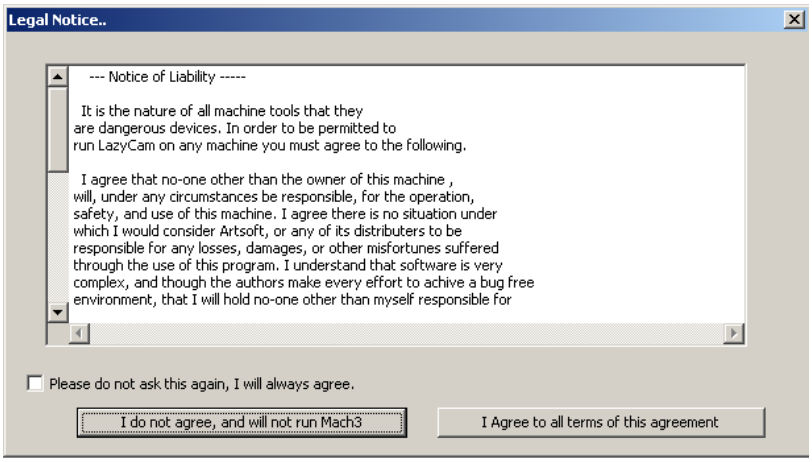


Figure 13 Legal Notice

Read the legal notice and click on the check box "*Please do not ask this again, I will always agree.*" Then press **I agree to all terms of this agreement**.

Next you will see Mach3 loading.

Figure 14 Mach3 Software

If you loaded Mach3Mill and if you had purchased the Ultimate screen set, you will see the following window:

Figure 15 Mach3 Mill

If the Interpreter is powered up and connected to the Ethernet network, the Mach3 status bar should display the following message: "*DSPMC/IP Device Connected.*" If you see an error saying that the device cannot be found, make sure that your Ethernet cable is connected correctly.

Make sure to click the **RESET** button before continuing.

Figure 16 RESET

Note: For more information on how to run the Mach3 software, please see page 85 on Documentation.

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Exploring Your Control

Now with your control up and running, it is time to examine some of its features.

Operator Panel (X15-10-01)

On the right hand side of your control there is the operator panel with jog buttons, selector knobs, and a few buttons. See the picture below:

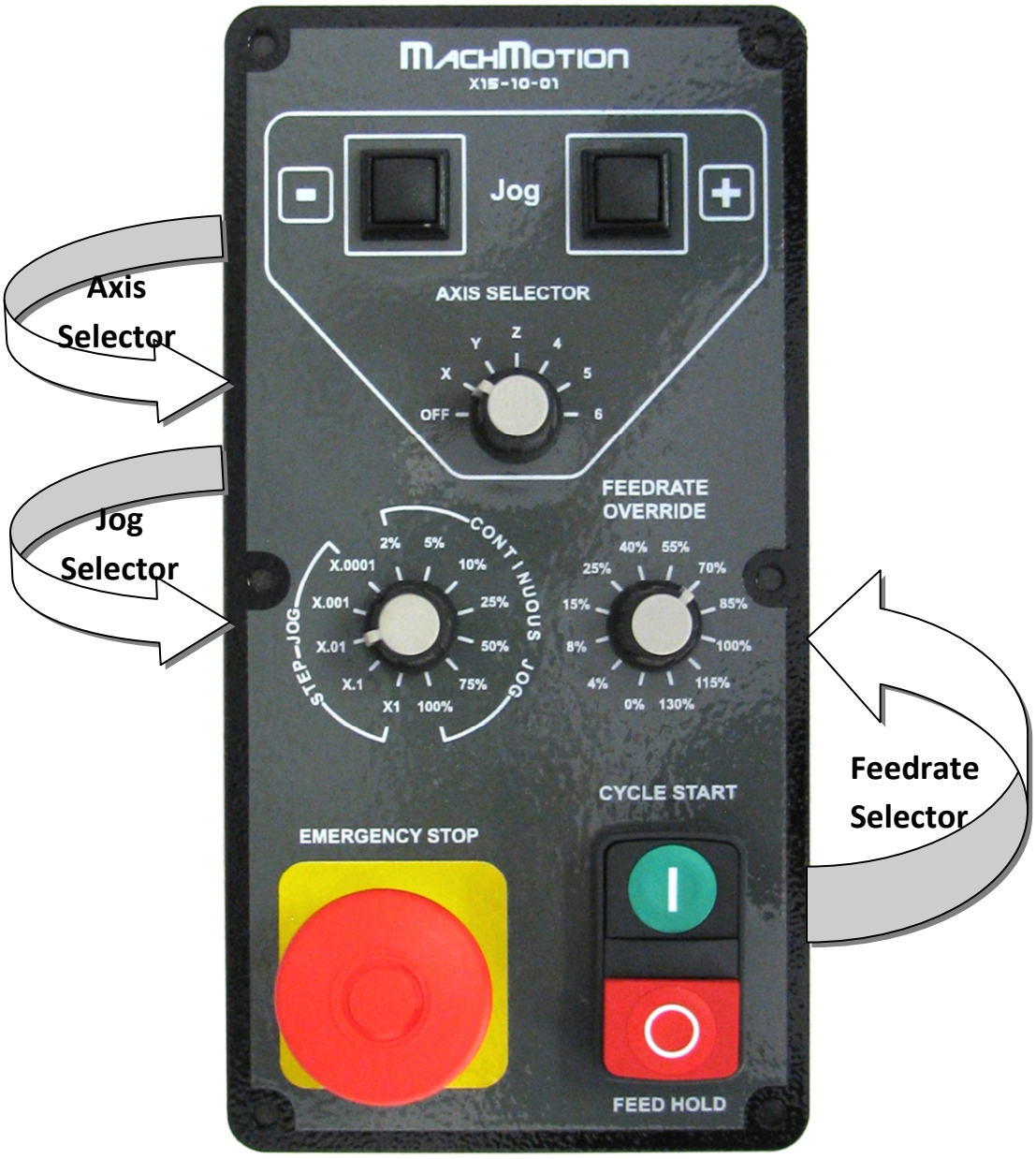


Figure 17 Operator Panel

****

Emergency Stop

In case of an emergency, press the large red Emergency Stop button on the operator panel. All motion will stop immediately. DO NOT PRESS FEED HOLD!

****

You can use the jog buttons to move your axes manually. Use the Axis Selector to select the axis you want to jog. If the Axis Selector is in the off position, the jog buttons are disabled (See Figure 18).

Figure 18 Jog Buttons and Axis Selector

Note: If the jog buttons do not work, make sure that the Axis Selector on the pendant is turned off.

To change the jogging speed or the jog increments adjust the Jog Selector. The selections labeled **Step Jog** allow you to jog a predefined step or increment each time a jog key is pressed. You can jog 1 or 0.0001 of an in/mm at a time by selecting X1 and X.0001 respectively. See Figure 19 below.

Figure 19 Jog Selector

If you want to jog continuously rather than incrementally, turn the Jog Selector over into the **Continuous Jog** section. You can jog your machine at the full jog rate (100%) or slow it down to 2%.

Your machine is setup so that the up and down arrow keys move the Y axis, the left and right keys move the X axis, and the plus and minus keys move the Z axis.

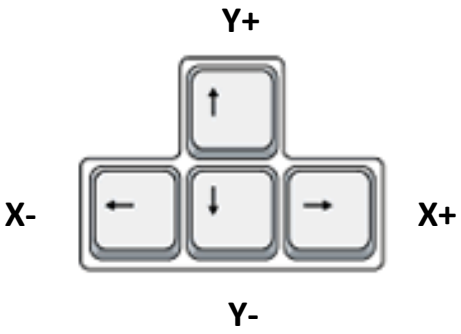


Figure 20 Jog Keys

Note: For information on how to change these shortcut keys or how to create new ones, go to Setting up Hot Keys*on page 76.*

With the Feedrate Selector you can adjust the feedrate override from 0% all the way to 130%. You can use it to slow your machine down while running a program. Also, in step jog mode the speed of the axis is regulated by the Feedrate Selector.

Figure 21 Feedrate Selector

You can start and stop programs by using the green and red buttons on the bottom of your operator panel. The green button is the cycle start button and the small red button is a feed hold. Feed hold does not happen instantaneously. If you need your machine to stop immediately, you must press reset or EStop.

Figure 22 Cycle Start and Feed Hold Buttons

Pendant (X15-20-01)

If your control came with a pendant, read this section. The pendant is mounted on the right side of the control near the operator panel. See Figure 23 below. For information on how to setup your pendant, see *Setting up Your Pendant* on page 64.

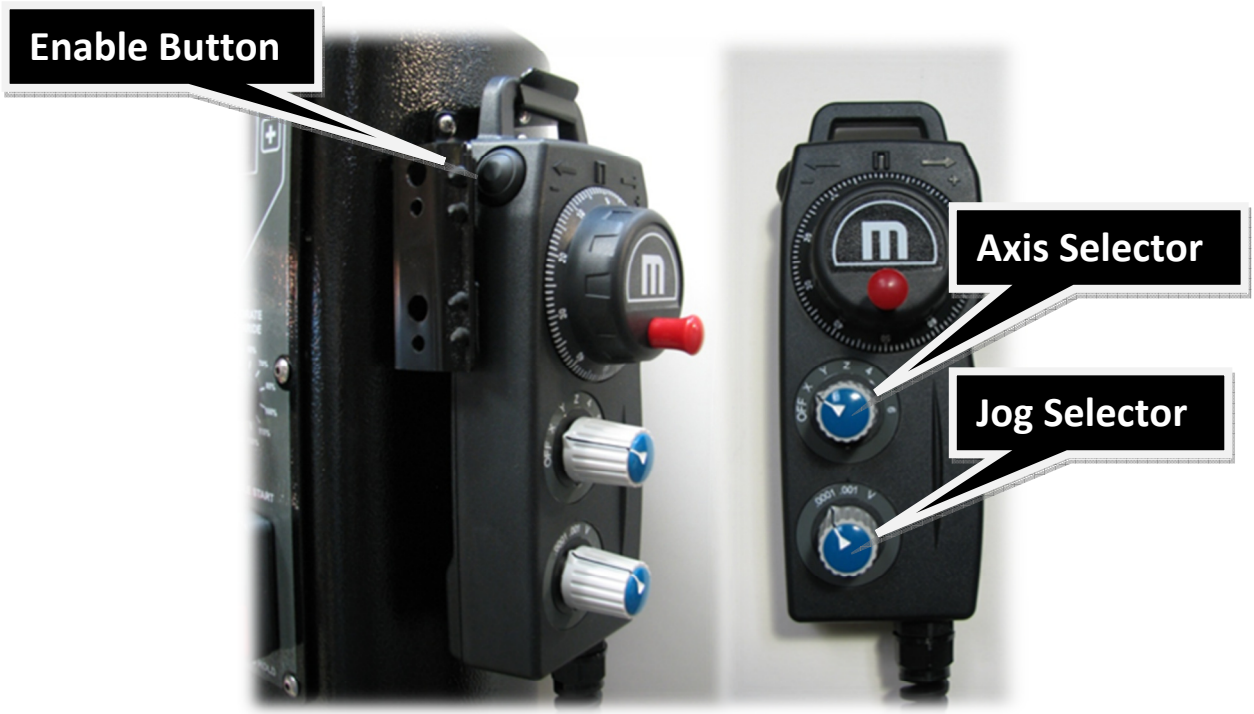


Figure 23 Pendant

To use the pendant you must switch the Axis Selector to the axis you want to jog. The pendant will not work if the Axis Selector is in the **OFF** position. While holding down the enable button (see Figure 23), you can rotate the hand wheel (also called the MPG) and the selected axis will move. Change axes by switching the Axis Selector to a different axis.

Figure 24 Axis Selector

The Jog Selector on the pendant allows us to switch between either 0.0001 or 0.001 inch increments. Each click of the MPG will move the selected increment. However, if the Jog Selector is on **V** then the MPG is in velocity mode. In velocity mode the axis moves as long as the MPG is turning and the speed of the axis is regulated by the speed of the hand wheel. In other words, turning the hand wheel very fast will make your axis move very quickly.

Figure 25 Jog Selector

When you are finished using the pendant, make sure to turn the Axis Selector to **OFF.** Otherwise the operator panel will not allow you to jog.

Mouse

Below the operator panel is a ball mouse. You can use this for navigating around on your control.

Figure 26 Mouse

Keyboard

The keyboard is located at the bottom of the control in a flip-out tray. For security and safety reasons there is a lock hole in the back left hand side of the keyboard tray to prevent the tray from opening. The lock is not supplied with your control.

Figure 27 Keyboard

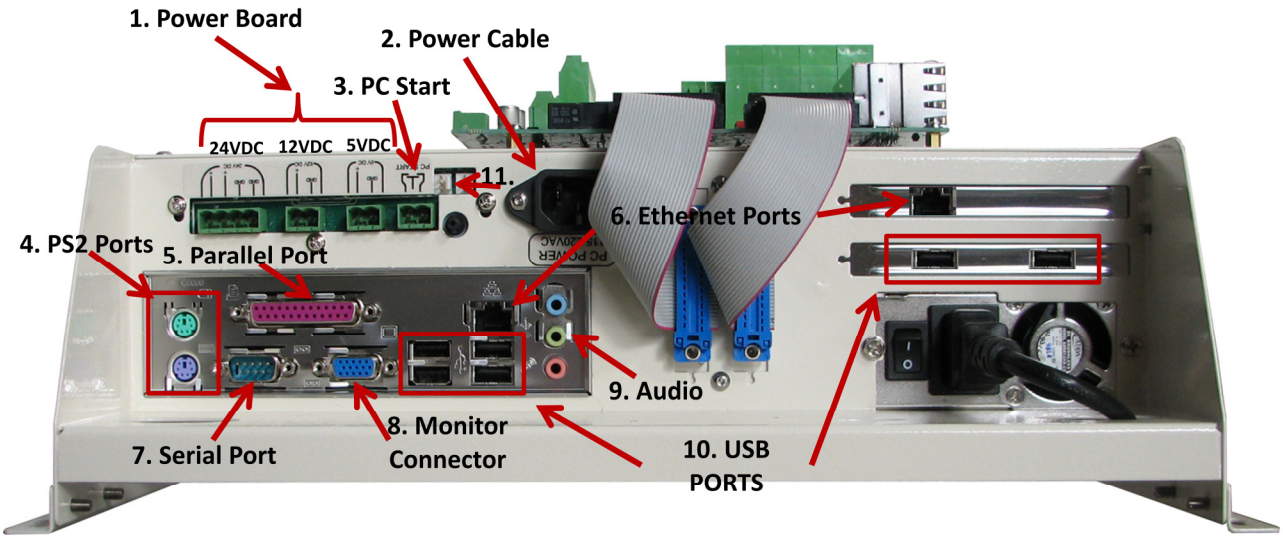
External USB Port

On the right side of the keyboard there is a USB port. Use this for transferring programs, files, or any other data to and from your control.

Figure 28 USB Port

Computer Port Diagram

Below is a diagram of all the different ports on your control with a brief description of each.



1. **Power Board**
   Three power supplies (24VDC, 12VDC, & 5VDC) for any application. The 24VDC supply powers the MachMotion IO6 Breakout Board.
2. **Power Cable**
   115VAC-220VAC power for the control.
3. **PC Start**
   To start the control, connect these two pins together with a momentary push button switch.
4. **PS2 Ports**
   These can be used to plug in an older keyboard and mouse.
5. **Parallel Port**
   This can be used for any application.
6. **Ethernet Ports**
   These ports are used to connect to the Interpreter 1000 and to local Ethernet networks.
7. **Serial Port**
   This can be used for any application. However, in many of our systems this is used to communicate with a PLC.
8. **Monitor Connector**
   This is used to connect your control to a monitor with a standard XXX cable.
9. **Audio**
   These are your standard audio outputs.
10. **USB Ports**
    These ports are used for your keyboard, mouse, operator panel, file transfer, and more.
11. **Fan Connectors**
    These connectors supply 12VDC for two small fans.

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Configuring Your Control

Your Motion Controller

The Interpreter 1000 is your Ethernet motion controller. All your standard I/O, encoder inputs, and +-10V analog outputs are wired into it. Most of your time in setting up your control will be working with this controller.

Figure 29 Interpreter 1000

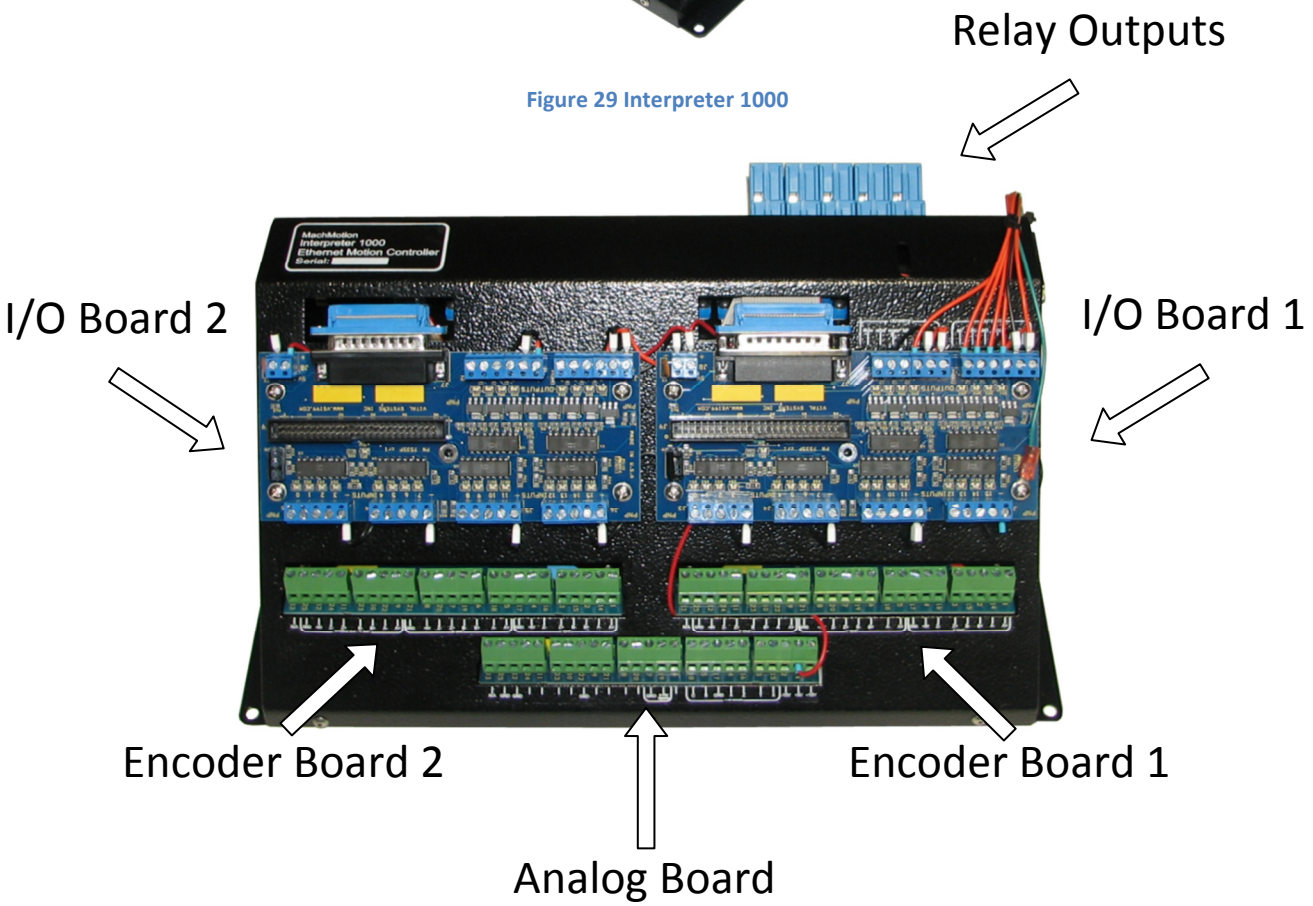


Figure 30 Interpreter Overview

The brain inside the Interpreter is the DSPMC motion controller from Vital Systems. In the remainder of this setup manual, the whole unit is referred to the Interpreter and the computer inside the Interpreter is referred to as the DSPMC.

Monitoring the DSPMC

To monitor the DSPMC, click on **PlugIn Control** on the top menu bar and then select **VITAL DSPMC Status.**

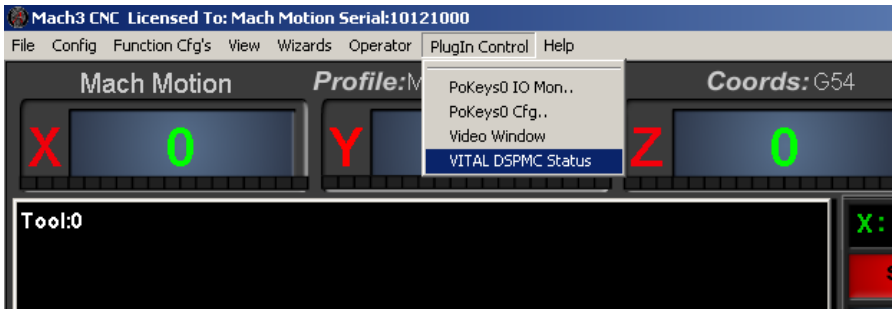


Figure 31 DSPMC Status

If the *dspMC/IP Status* window appears it means that the DSPMC is connected. You can see the current states of the counters, inputs, and outputs.

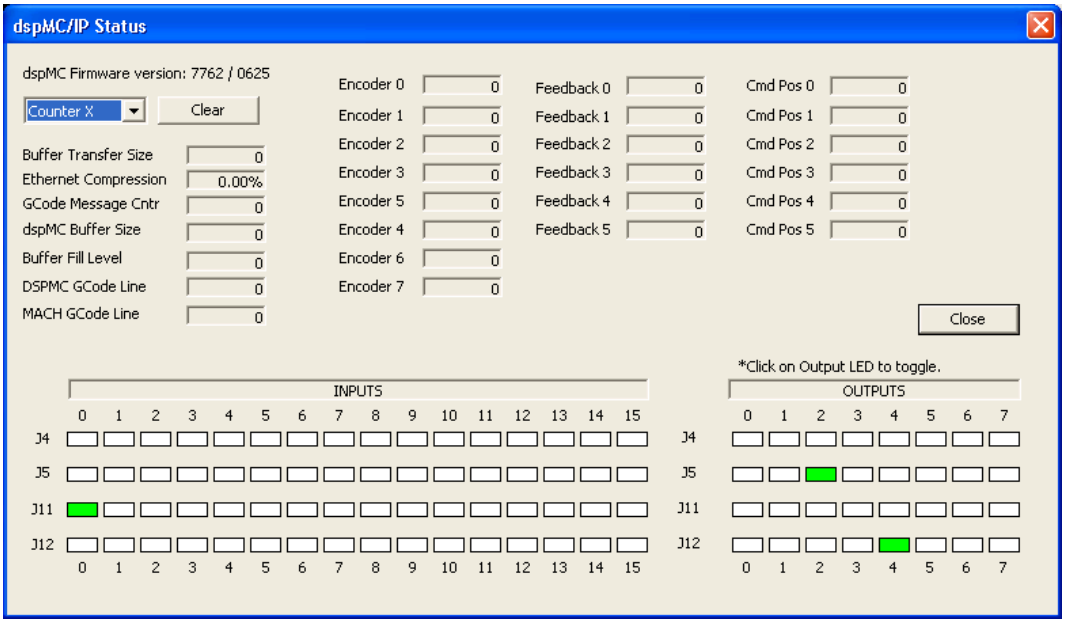


Figure 32 dspMC/IP Status Window

You can toggle the outputs by clicking on the output LEDs. If an output is defined in Ports and Pins, it will controlled by Mach3 and clicking on its LED will not effect. You can leave this window open while running Mach3.

Configuring the DSPMC

To change anything inside the DSPMC, you must open up the DSPMC plugin. Click **Config** on the main menu bar, then **Config PlugIns**. Select the yellow CONFIG button next to the **M3dspMC-DSPMC-PlugIn-xxx-VITAL-** option as shown below.

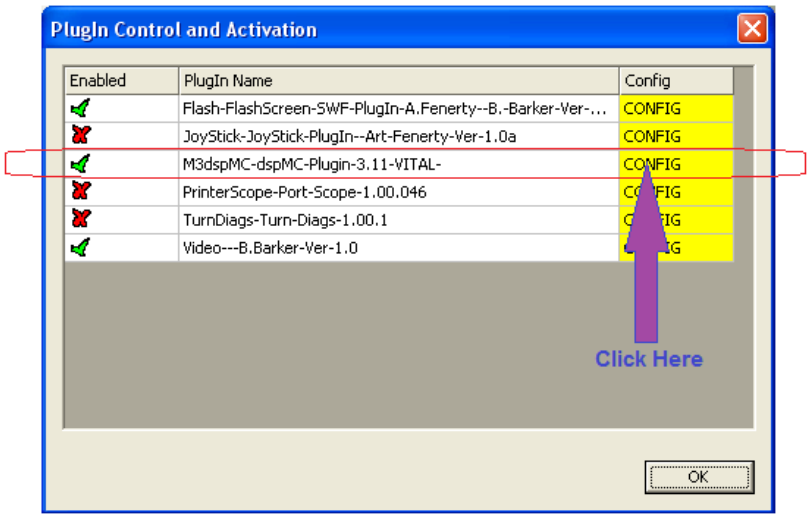


Figure 33 DSPMC PlugIn

Once the DSPMC plugin is launched you can see the following nine tabs:

1. System Tab
2. Axis X(0)
3. Axis Y(1)
4. Axis Z(2)
5. Axis A(3)
6. Axis B(4)
7. Axis C(5)
8. Axis D(6)
9. Axis E(7)

Each axis tab represents an axis to be controlled through the DSPMC. By default, the **System** tab will be selected as shown below.

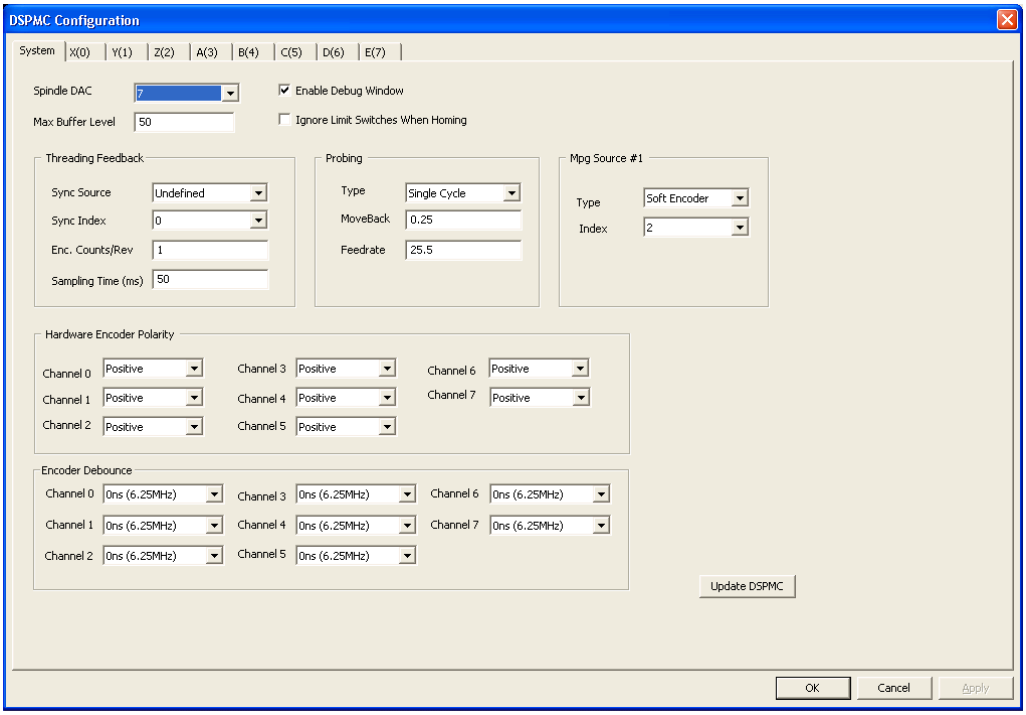


Figure 34 DSPMC Configuration

At any time while inside the plugin, clicking on the **Update DSPMC** button will transmit the settings to the DSPMC controller. Clicking **OK** will also transmit the settings and save them in the selected Mach3 profile (e.g. Mach3Mill, Mach3Turn, etc).

To exit the plugin, press **OK** and then **OK** again on the *PlugIn Control and Activation* window.

Setting up Your Axes

To setup your axes you must wire up your drives, calibrate your axes, setup the Mach3 software, and tune your drives.

Wiring Your Drives

Encoder Feedback

The Interpreter takes TTL (5VDC) differential encoder inputs. Begin by wiring your encoders to the encoder boards on the Interpreter (See Figure 30). Axes X, Y, and Z are all wired into Encoder Board 1 as shown below.

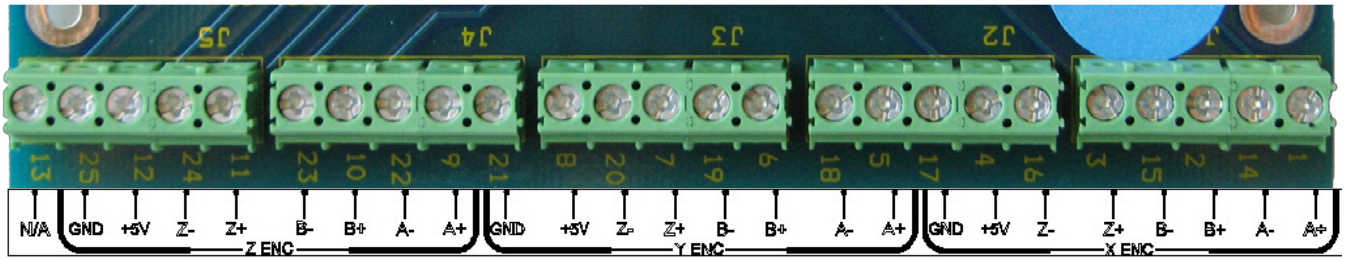


Figure 32 Encoder Board 1

Axes A, B, and C are connected to Encoder Board 2. If you have spindle feedback or an optional pendant, they will also be connected to Encoder Board 2. For more information see Setting up Your Pendant on page 64 or Wiring Spindle Feedback on page 68. The connectors are labeled on the Interpreter as shown below.

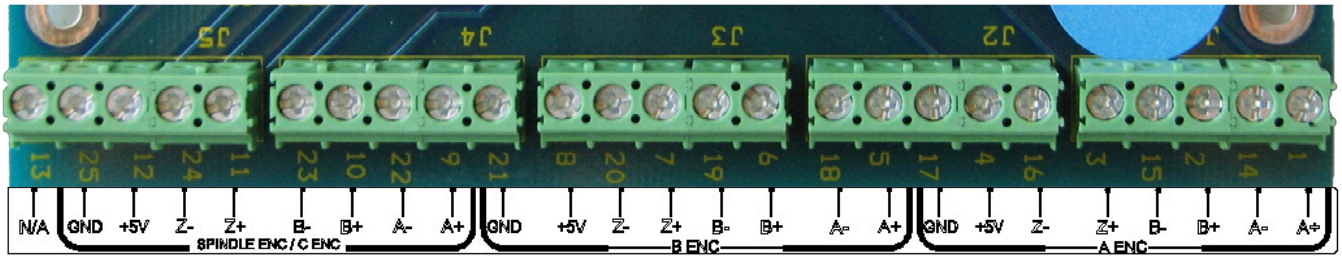


Figure 35 Encoder Board 2

When wiring the encoders make sure to connect all the shields directly to ground. Pins 17, 21, or 25 of the encoder boards are all ground.

Use the tables below as a reference for wiring up your encoders.

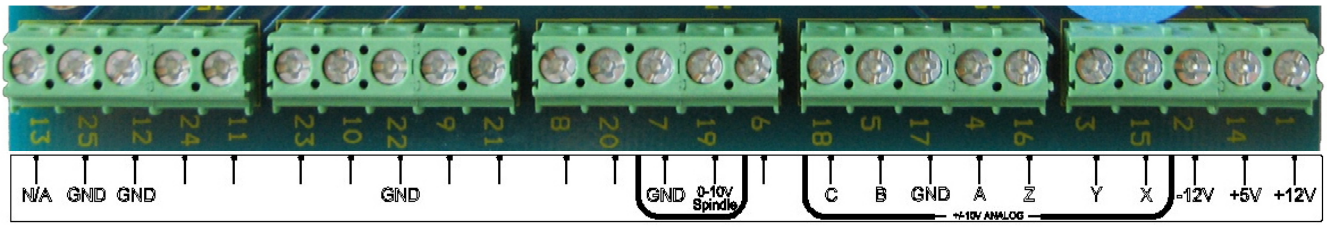
Encoder Board 1			
	Pin#	**Label**	**Function**
X Encoder (Index 0)	1	A+	X Axis A+
	14	A-	X Axis A-
	2	B+	X Axis B+
	15	B-	X Axis B-
	3	Z+	X Axis Z+
	16	Z-	X Axis Z-
	4	+5V	+5V 500mA
	17	GND	Ground
Y Encoder (Index 1)	5	A+	Y Axis A+
	18	A-	Y Axis A-
	6	B+	Y Axis B+
	19	B-	Y Axis B-
	7	Z+	Y Axis Z+
	20	Z-	Y Axis Z-
	8	+5V	+5V 500mA
	21	GND	Ground
Z Encoder (Index 2)	9	A+	Z Axis A+
	22	A-	Z Axis A-
	10	B+	Z Axis B+
	23	B-	Z Axis B-
	11	Z+	Z Axis Z+
	24	Z-	Z Axis Z-
	12	+5V	+5V 500mA
	25	GND	Ground
	13		

Encoder Board 2			
	Pin#	**Label**	**Function**
A Encoder (Index 3)	1	A+	A Axis A+
	14	A-	A Axis A-
	2	B+	A Axis B+
	15	B-	A Axis B-
	3	Z+	A Axis Z+
	16	Z-	A Axis Z-
	4	+5V	+5V 500mA
	17	GND	Ground
B Encoder (Index 4)	5	A+	B Axis A+
	18	A-	B Axis A-
	6	B+	B Axis B+
	19	B-	B Axis B-
	7	Z+	B Axis Z+
	20	Z-	B Axis Z-
	8	+5V	+5V 500mA
	21	GND	Ground
C Encoder or Spindle (Index 5)	9	A+	C Axis A+
	22	A-	C Axis A-
	10	B+	C Axis B+
	23	B-	C Axis B-
	11	Z+	C Axis Z+
	24	Z-	C Axis Z-
	12	+5V	+5V 500mA
	25	GND	Ground
	13		Reserved

Table 1 Encoder Boards

Analog Outputs

The Interpreter's analog outputs are + or – 10V. Connect your analog signals into the Analog Board (see Figure 30).



Again make sure to connect your shields to ground. Use the table below as a reference for your analog outputs.

Analog Board		
Pin#	**Label**	**Function**
1	+12V	+12V, 100mA
14	+5V	+5V, 500mA
2	-12V	-12V, 50mA
15	X	Analog Index 0
3	Y	Analog Index 1
16	Z	Analog Index 2
4	A	Analog Index 3
17	GND	Ground
5	B	Analog Index 4
18	C	Analog Index 5
19	0-10V Spindle	Analog Index 7
7	GND	Ground
12	GND	Ground
25	GND	Ground

Table 2 Analog Board

Enabling Your Axes

After your drives are connected to the Interpreter, enable your axes in the following way:

1. On the menu bar, click **Config** and then **Ports and Pins** as shown below. A window called *Engine Configuration… Ports and Pins* will pop up.

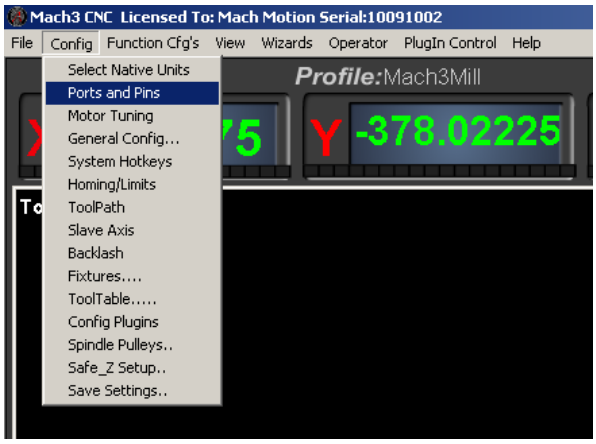


Figure 36 Ports and Pins

2. Select the **Motor Outputs** tab and you will see the axis setup as pictured below.

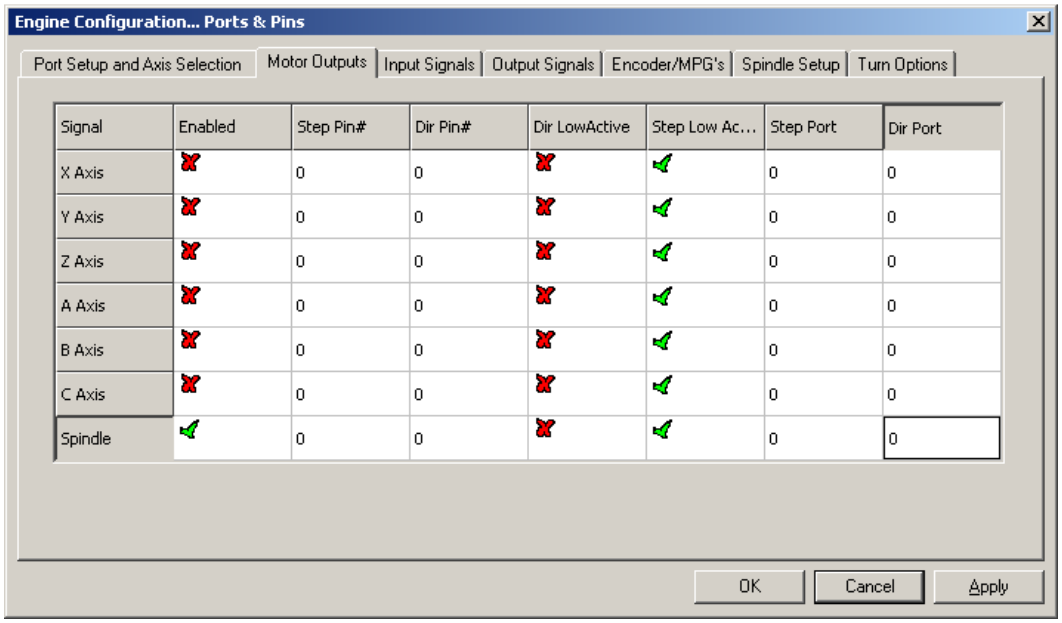


Figure 37 Axis Setup

3. Click on the red "**X**" to enable an axis. If there is a green check mark next to the axis, then the axis is enabled already.

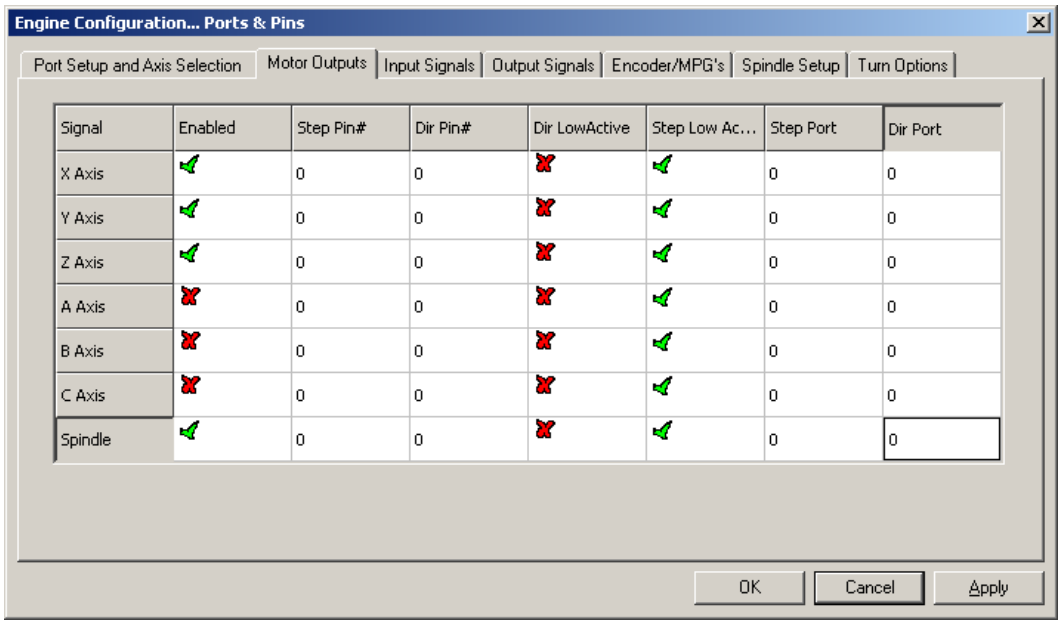


Figure 38 Axes Enabled

4. Press **Apply** and then **OK**. Your axes should now be enabled.

Note that your axes are not setup yet. Do not try to jog your machine at this time.

Calibrating Your Axes

Before you can tune your drives, you must calibrate your machine. You need to calculate how many encoder counts there are per inch and the maximum velocity of your system. If you purchased motors from MachMotion, use the table below as a reference.

Motor Type	Encoder Counts
TECO	10,000
Mitsubishi	131,072

Table 3 Motor Encoder Counts

Calculate the counts per inch and velocity using the steps outlined below.

1. Calculate how far the axis moves with one motor turn. Make sure to include in your calculations both the ball screw or rack and pinion and the gear reduction (such as pulleys).

2. Find the number of encoder steps per inch. Take the number of encoder counts for one full revolution of the motor (which can be found on the motor specification sheet or in Table 3) and divide it by the distance the axis moves in one motor turn (what you calculated above). This gives you what Mach3 calls your “Steps per.”

3. Multiply the distance your machine moves in one motor turn with your motor's rated speed in RPM. This gives you your velocity in inches or millimeters per minute.

Now you are ready to enter these values into the Mach3 software. Select **Config** on the top menu bar, then **Motor Tuning**. You should see the *Motor Tuning and Setup* window as shown below.

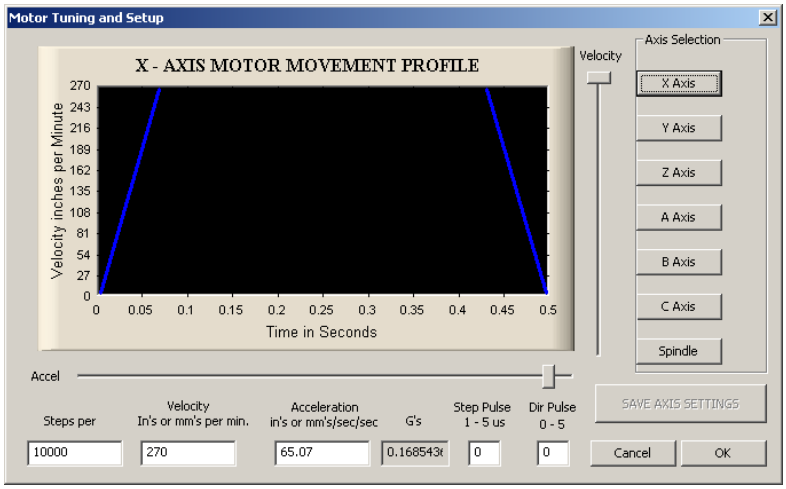


Figure 39 Motor Tuning and Setup

On the right column titled **Axis Selection**, press the button corresponding to the axis you want to setup. The selected axis's parameters will be loaded. Now enter in your new value for **Steps per** as shown below.

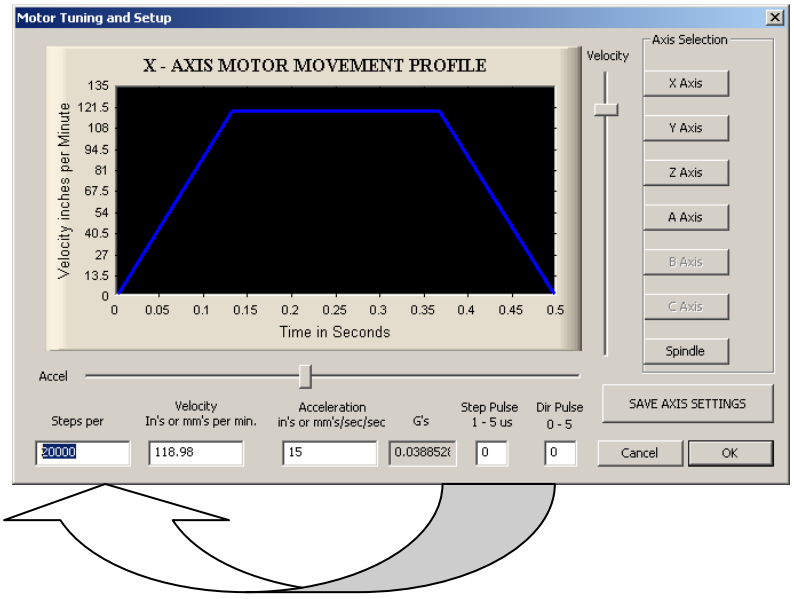


Figure 40 Steps per in Motor Tuning

Next enter your velocity as shown below.

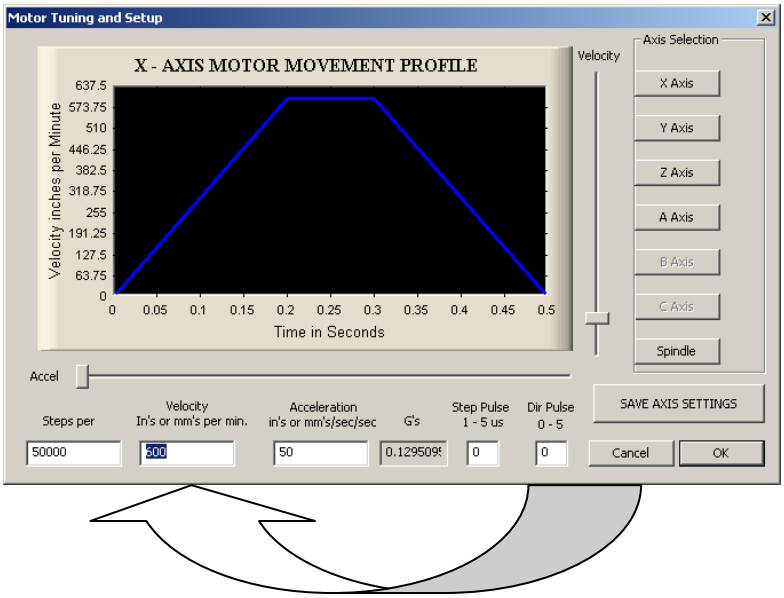


Figure 41 Velocity in Motor Tuning

Press **SAVE AXIS SETTINGS** before clicking on another axis or closing out the *Motor Tuning and Setup* window.

Configuring Your Axes

You must also configure your axes inside the DSPMC. Begin by opening up the plugin as shown in the section *Configuring the DSPMC* on page 25. Select the tab corresponding to the axis you want to configure. Inside the axis tabs there are tuning parameters and control parameters.

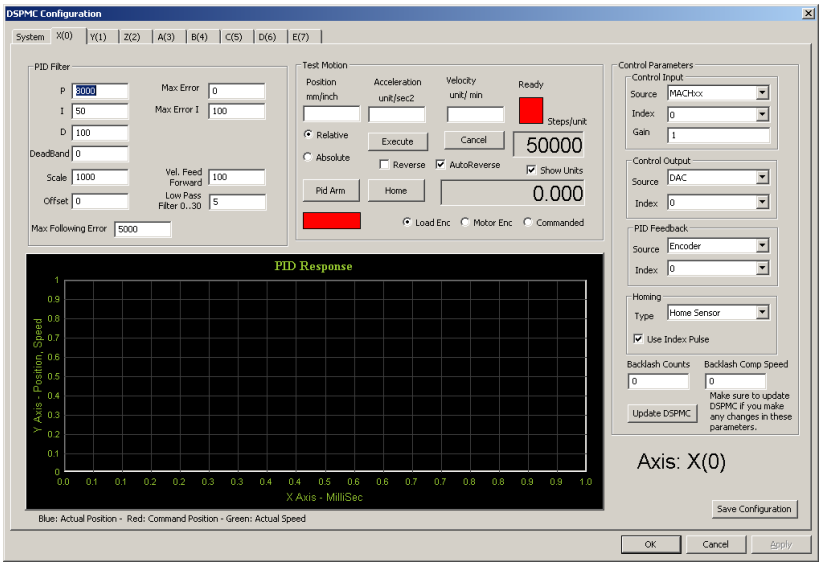


Figure 42 X Axis Configuration

If you purchased your control from MachMotion, the control parameters should be setup for your specific machine. The index and axis numbering start at 0. So for the X axis the index should be 0 for the **Control Input**, **Control Output**, and the **PID Feedback** as shown below. See the tables on the analog and encoder wiring for more information (Table 1 & Table 2).

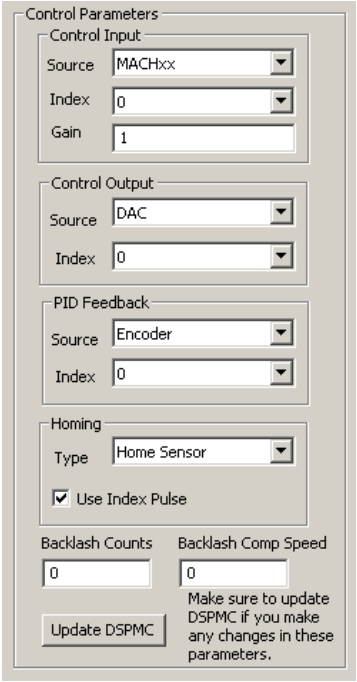


Figure 43 Control Parameters

Note: To setup your machine's backlash, see the section Calculating Backlash *on page 41.*

To update the control parameters, press the **Update DSPMC** button before PID is armed. Clicking on **OK** or the **Save Configuration** buttons saves the entire configuration to the selected Mach3 profile.

If you want more information about the control parameters, please read the section below.

Control Parameters

Control Input Source - Control Input Source defines the input type for the PID filter for a particular axis. This should be set to **MACHxx**. If the axis is not used, it must be disabled by selecting **Undefined**.

Control Input Index **-** Defines the index of the PID input source. Normally this is equal to the axis number (X = 0, Y = 1, Z = 2, etc). For a slave axis, it should be set to the number of the master axis.

Control Input Gain **–** The control input (Commanded) is multiplied by this number before applying to PID filter. Leave this at 1 for most applications.

Control Output Source **-** Control Output Type defines the output for the PID filter for a particular axis. The possible values are:

DAC: Use one of the analog outputs as the PID control output. This setting is needed to drive a Servo amplifier that takes +/-10volt reference inputs.

Stepper: Use one of the dedicated digital output pairs for the Step and Direction signals in stepper drives. **This feature is not currently available**.

Undefined: This setting is used to disable the axis and to ignore the control output index. If the axis is not enabled, then the Control Output Source must be set to **Undefined**.

Control Output Index - Defines the index of the PID Output (e.g. Index 1 is the Y Analog signal or Analog Index 1 Table 2).

PID Feedback Source - PID Feedback Source defines the feedback type for the PID filter for the selected axis. The possible values are:

Encoder: Use one of the differential hardware encoder 0…7 as the PID feedback.

A2D: Use one of the analog inputs as the PID feedback. This allows PID to be used for temperature and process control, in addition to motion control applications.

PID Feedback Index: Configures the index of the PID feedback source.

Homing Type - Defines the homing sequence for each axis. Two types of homing sequences are supported:

Home Sensor (Homing with or without an Index Pulse)
The axis moves in the configured direction until a home sensor is seen. It then moves in the opposite direction at 20% of initial speed until the sensor is not seen. If **Use Index Pulse** is checked, then the axis will continue moving until it finds the index pulse. At this point the home position is defined.

IndexPulseOnly (Use only the Index pulse to Home)
The axis moves in the configured direction to locate the index pulse to home the axis. As soon as the index pulse is detected, it clears the position counter to indicate the home position and stops the axis.

Slaving an Axis

To configure an axis as a slave, follow the steps outlined below.

1. Open up the DSPMC plugin by clicking on **Config**->**Config PlugIns**. Select the yellow CONFIG button next to the **M3dspMC-DSPMC-PlugIn-xxx-VITAL-** option.

2. Click on the axis tab that you want to slave.

3. Set the **Control Input** index equal to the master axis. For example, if the A axis is a slave of Y, set the control input index for A equal to 1 (rather than 3).

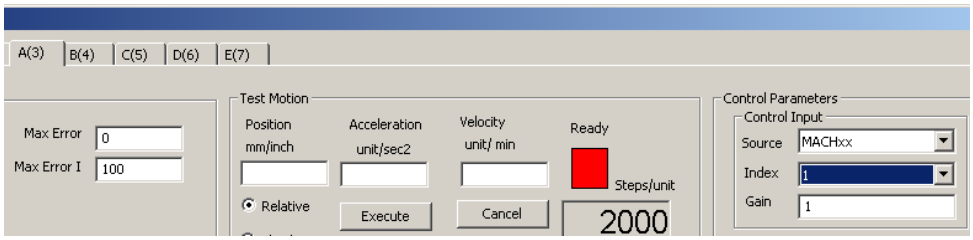


Figure 44 Slave Axis Configuration

4. Press **Update DSPMC** and then pres **OK**.

5. Click on **Config**->**Slave Axis** on the main menu bar. It will display the *Slave Axis Selection* window.

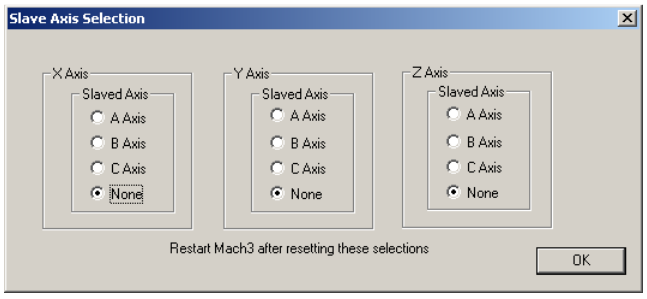


Figure 45 Slave Axis Selection Window

6. Select the axis you want to slave. Under X, Y, and Z you can slave either A, B, or C. For example, the configuration below is used to slave the A axis to the Y axis.

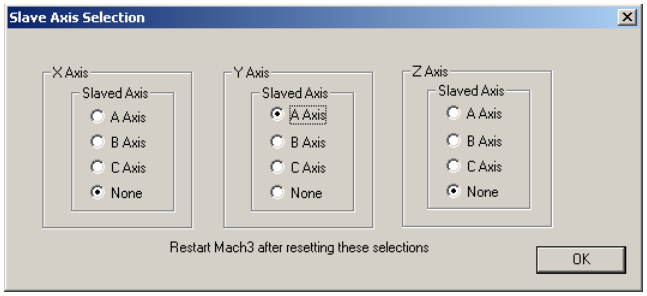


Figure 46 A Axis Slaved to Y

7. Press **OK** and then restart Mach3.

When mach3 comes back up, your axis should be slaved correctly. When tuning, do not run any test motion commands on a slaved axis. Always do test motion commands on the master axis. The slave axis always uses the PID values of the master axis automatically.

Tuning Your Axes

Now you are ready to tune your drives. The DSPMC controller uses the standard PID tuning theory. For more information on other PID terms and general discussion on PID control visit http://en.wikipedia.org/wiki/PID_control.

With the *DSPMC Configuration* window open (See Configuring the DSPMC on page 25), select the tab for the axis you want to tune. To tune your axes, you must be able to execute short moves. Begin by learning how to use the Test Motion module.

Testing Motion

To test your PID values, use the Test Motion module. Utilize the figure below as a reference.

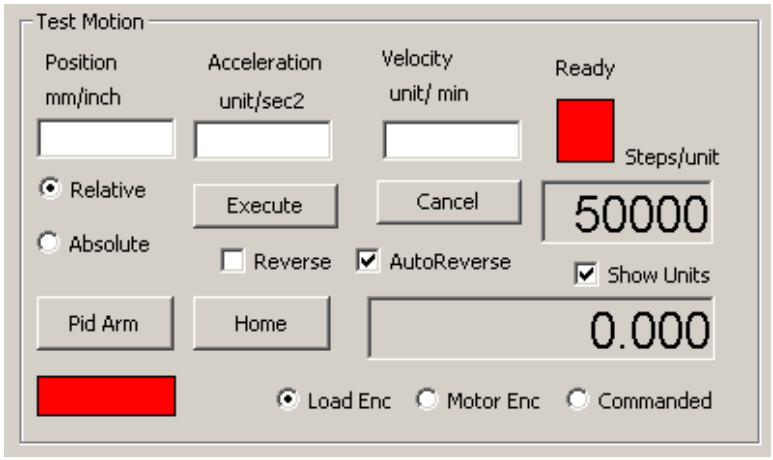


Figure 47 Test Motion

Follow the steps below to test your PID tuning values.

1. Enter in your axis' velocity in units per minute as calculated in the section Calibrating Your Axes on page 31.

Figure 48 Velocity

2. Enter in an extremely high acceleration value for your machine.

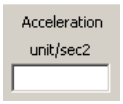


Figure 49 Acceleration

3. Select the Relative or Absolute option. Relative moves the machine X distance from its current position. Absolute moves the machine to the machine coordinate position (distance from home).

4. Enter your distance in the Position user input.

Figure 50 Position

5. Press the button **Pid Arm** to turn on the LED underneath the button. This turns on the servo loop in the DSPMC. When the LED is green, the PID is armed.

   Note: To download a new configuration to the DSPMC, you must disable PID Arm.

6. Press **Execute**. Your axis should move the defined distance.

You can also home the axis by pressing the **Home** button. By selecting the **AutoReverse** check box, you can make the axis reverse the direction automatically for the next motion command and thus avoid the axis going on in one direction during testing. The Ready LED shows if the DSPMC is ready to accept a motion command. If the Ready LED is green, it implies that the DSPMC is ready to accept new motion commands. While executing a motion profile, the Ready LED turns to red and DSPMC cannot accept a new motion command until the current motion sequence is completed or cancelled.

Once the test motion command has completed, you can see how closely the axis followed the commanded motion profile on the PID Response graph. You can tweak the PID parameters and execute the test motion to verify the behavior.

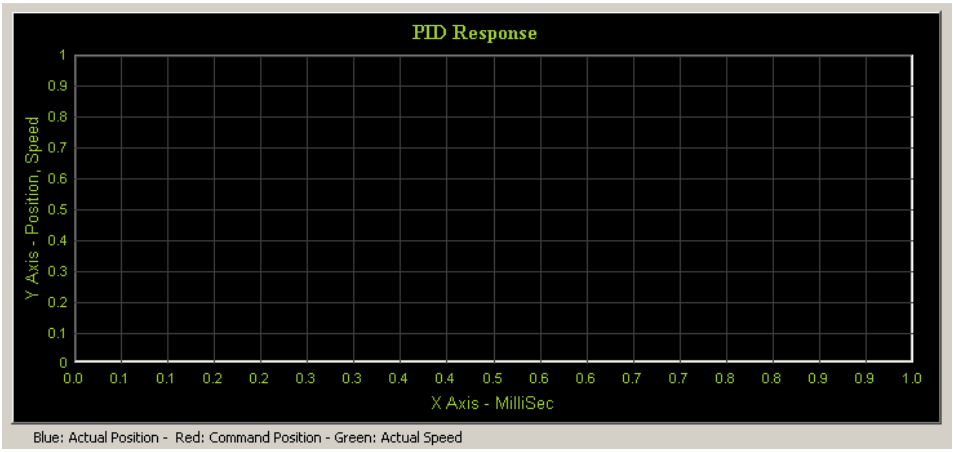


Figure 51 PID Response Graph

Notice that the blue line represents the actual position, the red line shows the command position, and the green line displays the actual speed.

Below is a review of all the test motion parameters. Read this section for more information.

Test Motion Parameters

Position – Test motion final position or displacement in terms of Position Units, e.g. 1.5, 10.093, mm or inches etc.

Acceleration – Test motion acceleration value in terms of Units per second squared, e.g. inches/second^2, mm/sec^2 etc.

Velocity – Test motion velocity value in terms of Units per minute, e.g. inches/minute, mm/minute etc.

Relative* and *Absolute – These check boxes indicate whether the value in the Position field is the distance to travel (relative) or the final position (absolute).

Execute Button – Transmits Execute Motion command to DSPMC. In addition, it also downloads PID Filter parameters before starting the motion. User can press **Cancel** button to cancel the motion execution anytime during the machine operation. Make sure you have downloaded the axis control settings by clicking "Update DSPMC" before clicking on Execute.

New motion command can be launched by Execute button when the Ready LED is green. If the LED turns red after click on the **Execute** button, but you do not observe any motion, then the velocity or acceleration may be too low.

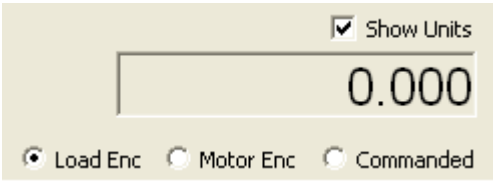
PID Arm Button – By clicking this button, the plugin downloads the PID Filter parameters and arms or disarms the PID. If PID is armed, the LED below this button will turn to green**.** Otherwise it will be red**.**

Home Button – Executes the homing sequence based on selected homing settings.

***Reverse* -** Checking this option will multiply the parameter in the position box with -1 and thus the direction of motion will be reversed.

***Auto Reverse* -** Checking the auto reverse option will toggle the "reverse" option between two consecutive motion commands, thus the user does not have to manually reverse the direction of the motion every time.

Axis Position Display (DRO) – Shows the position of the axis based on the different settings as described below:



Show units - When this option is selected, the data shown will be converted and shown in units (mm, inches etc), otherwise data will be displayed in raw encoder counts.

Commanded position - Displays the value of the internal variable for the commanded position for the selected axis.

Load Encoder - Displays the axis position derived from backlash count and selected feedback encoder.

Motor Encoder – Displays the current value of the axis position derived only from the encoder feedback.

Note that the actual position may slightly deviate from the Commanded position when PID is enabled.

Tuning

The PID parameters are shown in the figure below.

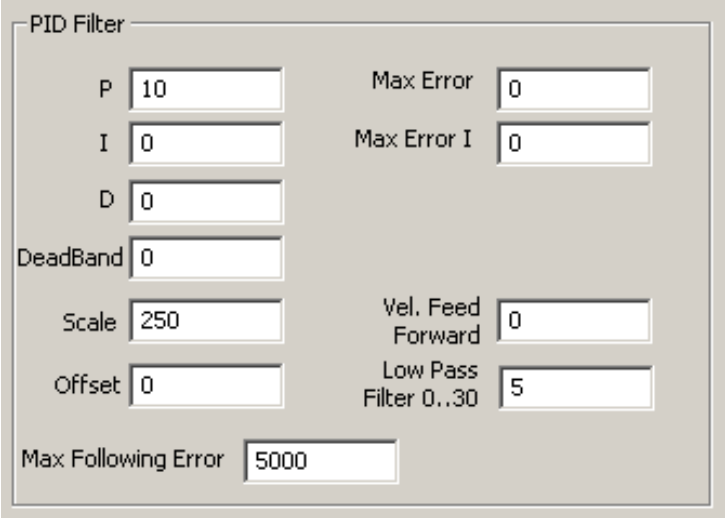


Figure 52 PID Parameters

If you purchased drives and motors from MachMotion, the PID values should already be configured for your drives. Otherwise follow the procedure below to tune your drives.

Note: Your units must be close before you tune your machine. Otherwise your tuning will be changed when you change your units. See Calibrating Your Axes *on page 31.*

1. Set the Scale to 1000, P to 1000, Max Following Error to 5000, and Low Pass Filter to 5. Set all other parameters to zero. See Figure 52 PID Parameters.

2. Execute test motion commands (See Testing Motion on page 37). Move only very small distances such as 0.1-0.2 inches (3-5mm). If no motion is observed, start increasing P until you see motion.

3. If the actual motion is in the opposite direction of command, you will probably get a following error immediately. To correct this change the encoder polarity in the system tab as shown below.

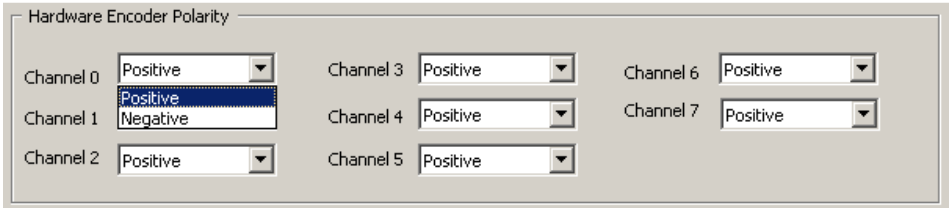


Figure 53 Encoder Polarity

Note: If your PID will not stay armed (the PID Arm LED turns read immediately after pressing ***PID Arm****), then you may also want to change the encoder polarity for that axis.*

4. Examine the graph. Once the actual position actually follows the commanded position, start adding I, Max Error I, D, and VFF terms to fine tune the graph. Ideally, actual graph line should be as close to commanded as possible. When you set the I term greater than 0, make sure Max error I is also non zero, otherwise you will get uncontrolled oscillations. For example, start I with 10 and Max Error I as 50.

In general when tuning, use P to control the power, D to stabilize the system, and I to remove error.

The following section describes the tuning parameters.

Tuning Parameters

Scale is used as a divider for all the settings in the PID gain box. The higher the scale, the lower the output power will be. For example, if you put a gain of 4000 and a scale of 100, it is the same as a gain of 40 with scale of 1. This also helps some gain values to have negligible or more significant effect than others, eg, P 4000, I 10, D 500000, Scale 100. Scale allows strictly whole numbers, instead of decimal values (eg .0043 etc).

Max_error - Maximum error limit. Leave it at 0.

Max_Error_I - Maximum Integral Error for the integral gain. This must be greater than 0 if you put any non zero value in the I term.

Deadband – a range of position around the commanded position where the PID is not active (when armed). For example, if the current command position is 1000 counts, and the Deadband is 10, then the PID will be inactive between counts 990 and 1010.

Max Following Error – Maximum deviation allowed between command and actual. Above that, the PID controller shuts down and needs to be re-enabled manually. If 0, PID will never shutdown which can be extremely dangerous in a run-away motor condition. So always use a positive value in this field. This field can be calculated from the maximum velocity of the axis (e.g. 600 000 count/sec) divided by 1000 gives 600 counts per millisecond. So to achieve 600K count/sec speed, the max following error should be 600 or more. The actual value may be lot more than that based on how tight the PID tuning is and the mechanical characteristics of the axis.

Output Offset - Sets a constant bias to the PID output. This is useful when tuning the Z axis, where the motor has to apply more pressure in one direction than the other.

Low Pass Filter – This field is used to smooth the analog output so that the motors run smoothly with less noise. As the PID runs at 5KHz, a value of 5 will create a nice linearly increasing DAC output at 1KHz. If you put a value of 10, effective PID speed will become 500 Hz.

Calculating Backlash

The DSPMC has backlash compensation. Use the MDI line to enter g-code to move your axes. To calculate your machine's backlash, follow the steps below.

1. Move the axis in one direction farther than the maximum possible backlash.

2. Mount your dial indicator and zero it.

3. Move the axis again in the same direction for a specific distance (it doesn't matter how far).

4. Move the axis backwards the same distance.

5. Calculate how far the dial indicator was off from zero. This is your backlash value.

Calculate the backlash counts by using the formula below:

Backlash Counts = Backlash * Steps per Unit

You can read the current steps per unit by going to **Config**->**Motor Tuning**. Select the axis by clicking on the axis button and the axis parameters will be displayed. The value **Steps per** is the steps per unit used in the formula above. For information on how to calculate your steps per inch see Calibrating Your Axes on page 31.

Now with your backlash counts, it is time to load these values into the DSPMC. Open up the plugin and select the axis you want to update (See *Configuring the DSPMC* on page 25). Under the Control Parameters, enter in your calculated backlash.

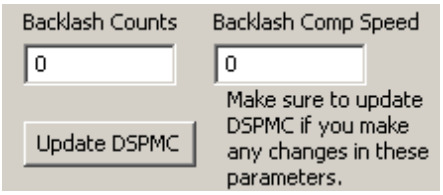


Figure 54 Backlash Compensation

Backlash Count – This field lets you enter backlash in terms of encoder counts. The DSPMC uses this value to calculate virtual load position (mill table).

Backlash Comp Speed – This field let you enter backlash counts to be applied per servo loop at 5KHz. This setting allows you to apply the entire backlash counts over a period of time, instead of a sudden application which may result in damaging oscillations. For example, if backlash count is 500 and comp speed is 10, the entire backlash count will be applied in 500 / 10 * 200microsecond, or 10 milli-seconds. The valid range is 1 to Backlash counts.

Reversing Direction

If an axis moves the wrong direction, you can reverse the direction in the Mach3 software.

1. Navigate to the menu bar and click **Config -> Homing/Limits**.

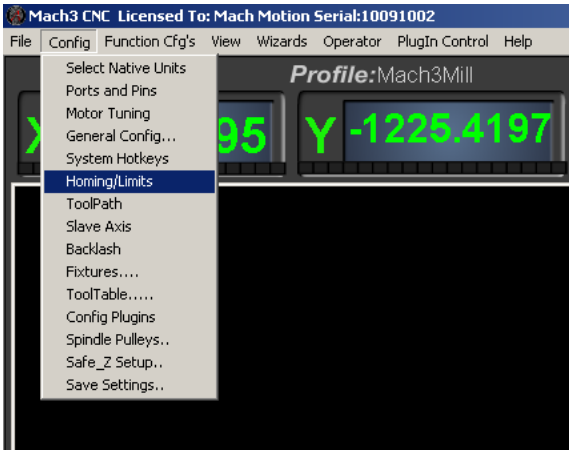


Figure 55 Homing & Limits

You will see the following window come up:

Figure 56 Reversing Direction

2. Under the **Reversed** column click on the red "**X**" if the axis needs to be reversed.

3. After making all your changes, press **OK.**

Your axis will now move the opposite direction than it did before.

Loosing Position

If your machine is moving randomly or appears to be losing position, you may have a noise issue. Begin by making sure that your shields are connected to ground on the Interpreter. Next adjust the encoder debounce value found in the DSPMC plugin under the **Systems** tab.

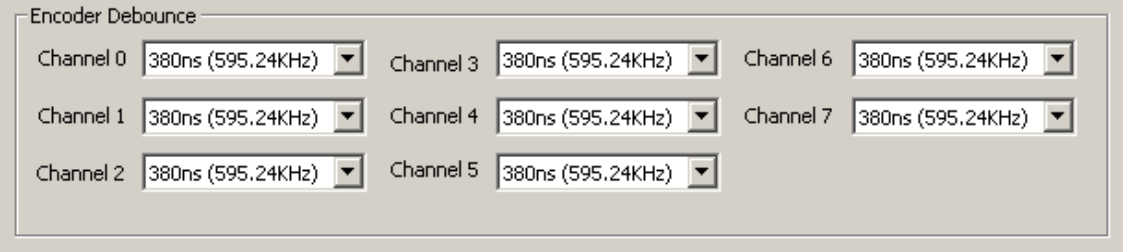


Figure 57 Encoder Debounce

The value of 100ns is normally sufficient, but if your encoder count is still changing by noise, you can try higher debounce values. The higher the value in debounce, the more the maximum frequency of the encoder signal will be reduced. This setting only applies to hardware encoders 0…7.

Setting up Inputs

The Interpreter 1000 has 32 24V inputs. These inputs can be used for limit switches, home switches, tool changers, or anything else. To learn how to configure your limit switches, go to Setting up Your Limits and Homing on page 56. Read the following section to learn how to setup generic inputs. As shown below, the inputs are located on the two I/O boards.

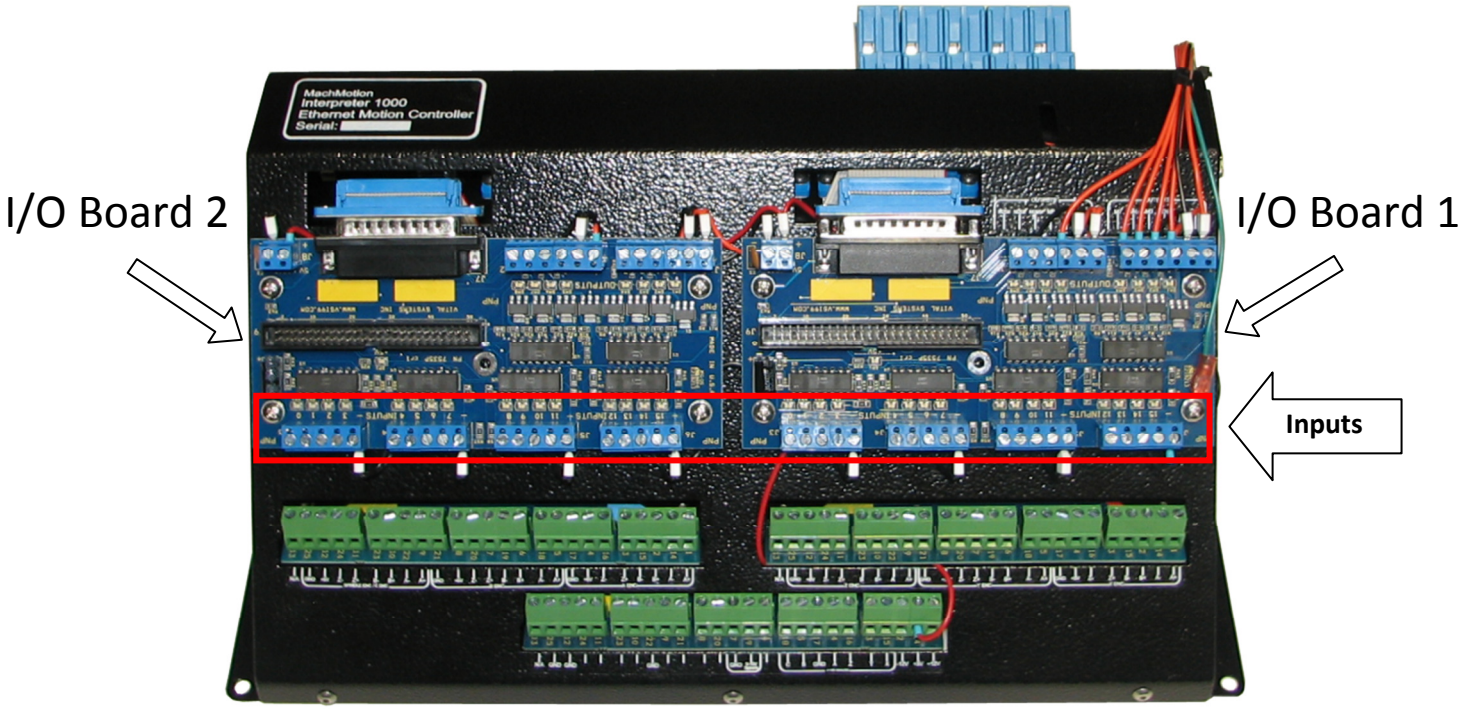


Figure 58 Inputs Overview

LEDs above each input show the current state of the input. If the LED is on, the input is activated. The inputs start counting from 0 on I/O Board 1 and count up to 15. Then on I/O Board 2 the inputs start at 16 and count up to 31. See the picture below.

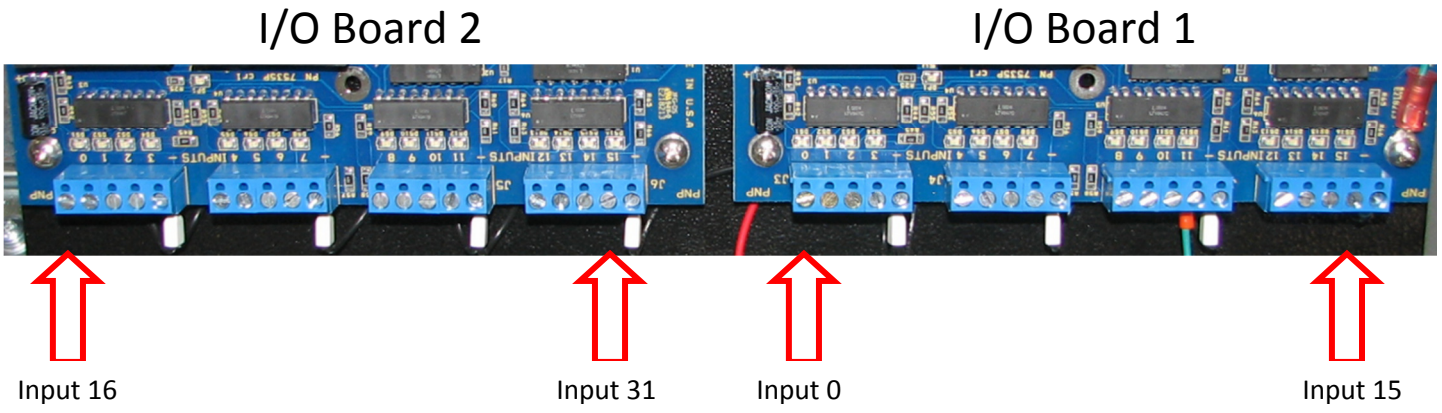


Figure 59 I/O Numbering

Note: All inputs on the Interpreter are accessed in Mach3 with port 1 pin X where X is the input number.

Wiring Your Inputs

The I/O boards on the Interpreter can be PNP or NPN. You can check what kind of board you have by examining the bottom of the board.

Figure 60 PNP I/O Board

To activate a PNP input, you must supply 24V to the input. A floating signal or a ground will not turn on the input.

Figure 61 PNP Input

To activate a NPN input, you must pull the input to ground. A floating signal or a 24V signal will not turn on the output.

Figure 62 NPN Input

Configuring Your Inputs

To configure an input, follow the procedure below.

1. On the menu bar click on **Config,** then **Ports and Pins**.

2. Select the **Input Signals** tab. Scroll down to the desired input. There are 4 inputs and 15 OEM triggers. An OEM trigger acts exactly like an input.

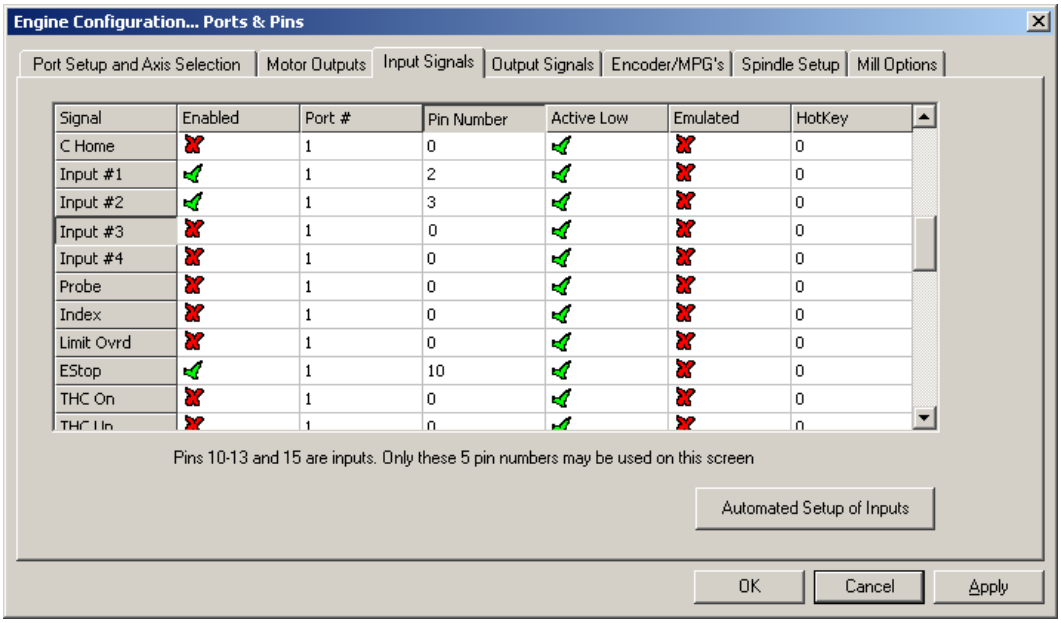


Figure 63 Input Configuration

3. Enable the input by clicking on the red **X**. If the input has a green check mark, it is already enabled.

4. Set the **Port Number** and **Pin Number** to the desired input. Remember all I/O on the Interpreter is addressed using port 1.

5. To change when the input is active, click on the **Active Low** column. A green check mark means that when the input is activated, it will turn on the input in Mach3.

6. Press **Apply** and then **OK**.

Your input should now be setup.

Read through the following example if the inputs do not make sense. The input shown below is wired into I/O Board 2. As shown on the corner of it, it is a PNP board so 24V must be supplied to turn on the input.

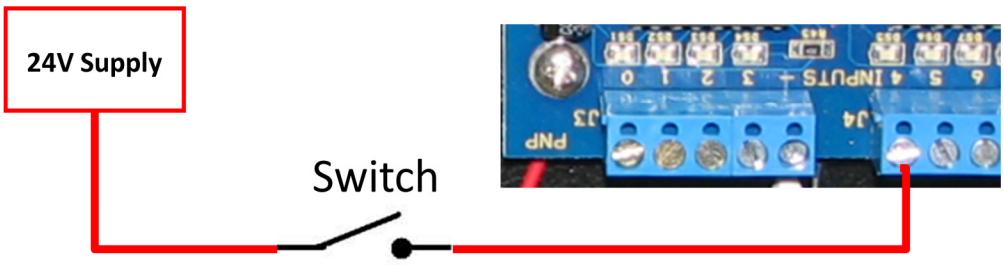


Figure 64 Example Input Wiring

Since this is on I/O Board 2, the inputs start counting at 16. So input 4 is actually input 20 (16 + 4). To use the input inside Mach3, set OEM Trig #1 to port 1, pin 20, active low. Now OEM trigger 1 can be used anywhere inside Mach3 to read input 4 on I/O Board 2.

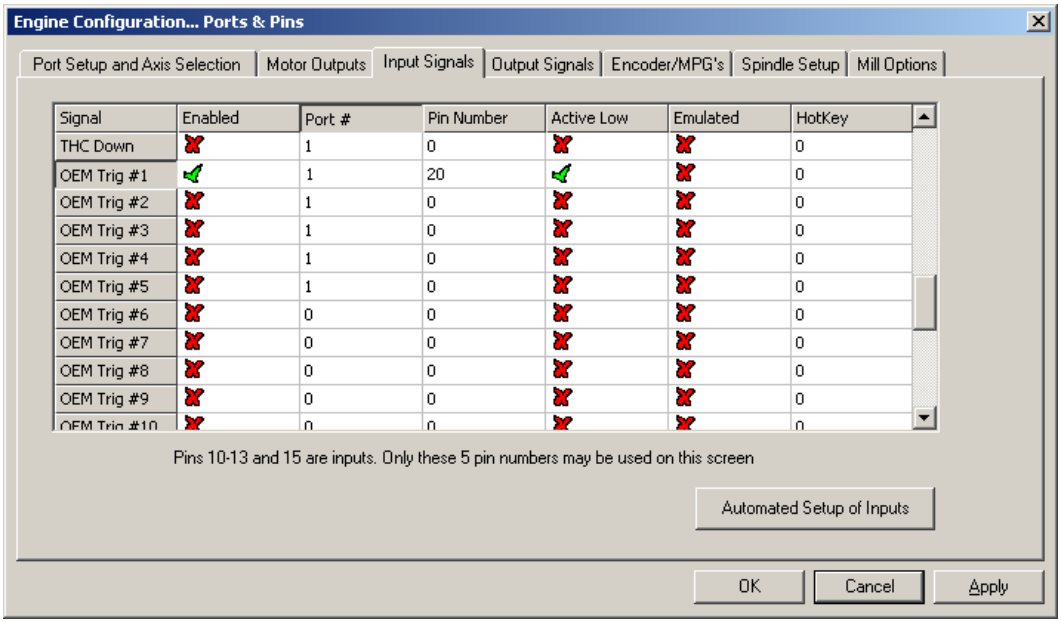


Figure 65 Example Input Configuration

Using Your Inputs

There are a few ways to use generic inputs inside Mach3. First you can read them in a visual basic (VB) script such as a macro. Use the following visual basic statements:

IsActive(INPUTX)
IsActive(OEMTRIGX)

You can also access them inside Brains and inside the MachMotion plugin. Read Advanced Options on page 78 for more information on how to use inputs inside the plugin. Read Setting up Your Limits and Homing on page 56 for information on how to use them as limit and home switches.

Setting up Outputs

The Interpreter 1000 has 16 outputs. The first 5 outputs are relay contacts. The remaining 11 outputs are standard NPN or PNP 24V outputs. The outputs are located on the back of the Interpreter and on the I/O boards.

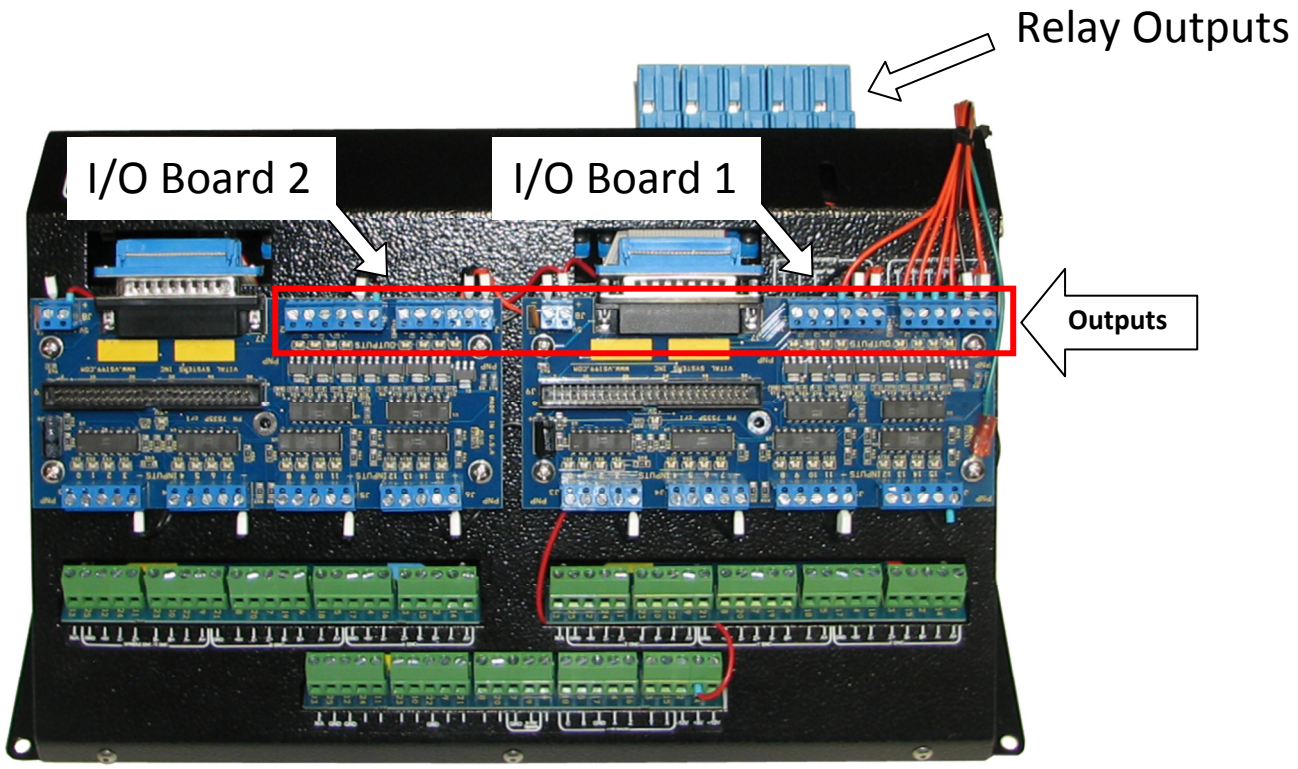
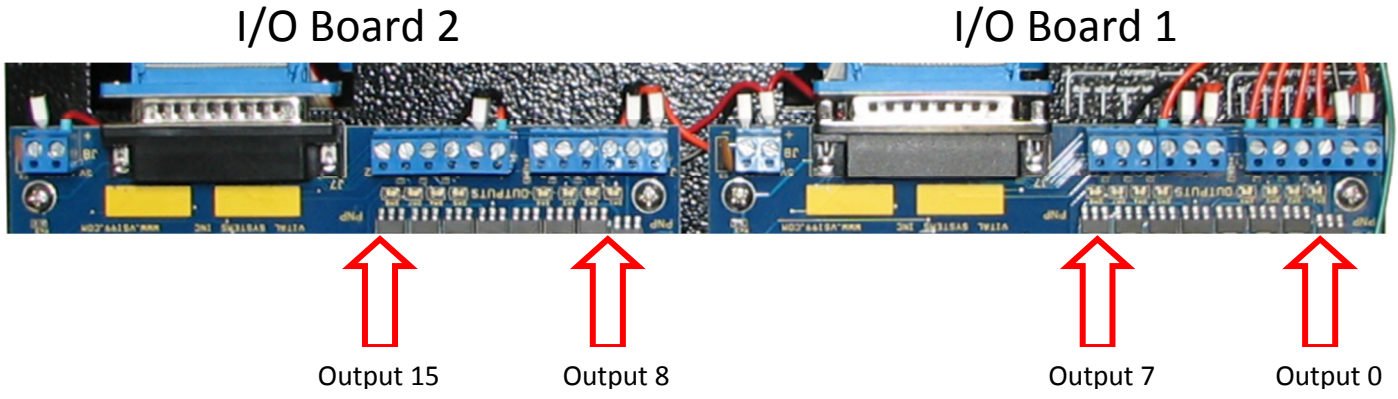


Figure 66 Outputs Overview

LEDs below each output show the current state of the output. If the LED is on, the output is activated. The outputs start counting from 0 on I/O Board 1 and count up to 7. Then on I/O Board 2 the outputs start at 8 and count up to 15. See the picture below.



Note: All outputs on the Interpreter are accessed in Mach3 with port 1 pin X where X is the output number.

Wiring Your Outputs

The I/O boards on the Interpreter can be PNP or NPN. You can determine what kind of board you have by examining the bottom of the I/O Board.

Figure 67 PNP I/O Board

When a PNP output is activated, it sources 24V to the output terminal. When the output is off, the output will float. However, when a NPN output is activated, it sinks to ground. When the output is off, the output line will float.

The 5 relay outputs are shown below. Connect your power signal to the COM terminal and your output signal to the NC (normally closed) or NO (normally open) terminal.

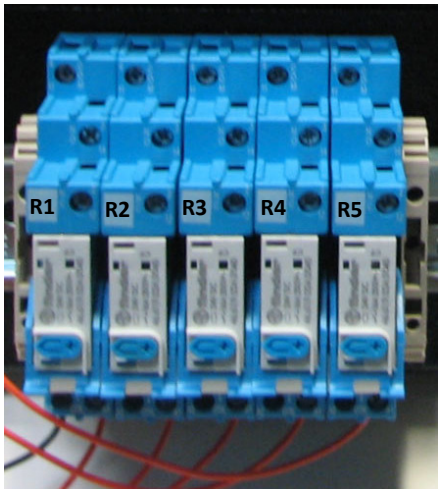


Figure 68 Relay Outputs

The 5 relays are preconfigured as shown in the table below. You can, however, use them for any function.

Relay Name	Function	Turn On Relay	Turn Off Relay
R1	Drive Enable	Reset Off	Reset On
R2	CW Spindle	M3	M5
R3	CCW Spindle	M4	M5
R4	Mist	M7	M9
R5	Flood	M8	M9

Table 4 Relays

Configuring Your Outputs

To configure an output, follow the procedure below.

1. On the menu bar click on **Config,** then **Ports and Pins**.

2. Select the **Output Signals** tab. Scroll down to the desired output. There are 20 outputs that you can use.

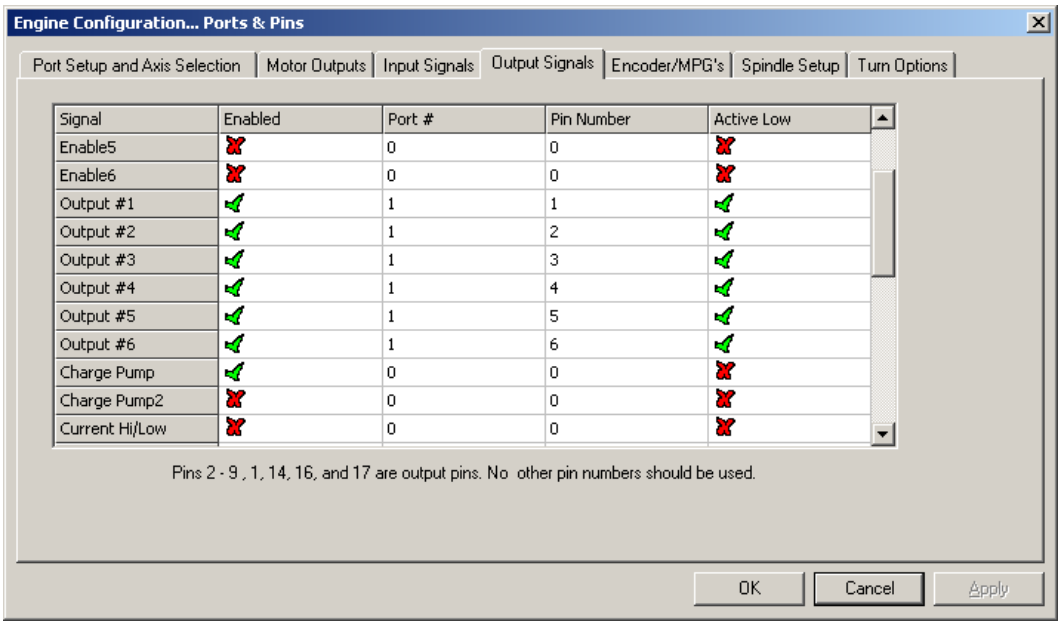


Figure 69 Output Configuration

3. Enable the output by clicking on the red **X**. If the output has a green check mark, it is already enabled.

4. Set the **Port Number** to 1 and the **Pin Number** to the desired output.

5. To setup the relay as normally closed, click on the green check mark under the **Active Low** column and it will turn to a red **X**. Otherwise leave this as a green check mark (normally open contact). If configured with a green check mark, the relay will activate (close) only when the output is on.

6. Press **Apply** and then **OK** to save your settings.

Now your output should be setup.

Using Your Outputs

There are a few ways to control an output inside Mach3. First you can turn them on and off in a visual basic (VB) script such as a macro. Use the following visual basic statements:

ActivateSignal(OutputX)

DeActivateSignal(OutputX)

Also, outputs 5-12 can be controlled with M-Codes. One M-Code turns an output on and the other M-Code turns the output off. Use the table below for a reference.

Custom M-Codes	Functions
M200	Output 5 on
M201	Output 5 off
M202	Output 6 on
M203	Output 6 off
M204	Output 7 on
M205	Output 7 off
M206	Output 8 on
M207	Output 8 off
M208	Output 9 on
M209	Output 9 off
M210	Output 10 on
M211	Output 10 off
M212	Output 11 on
M213	Output 11 off
M214	Output 12 on
M215	Output 12 off

Table 5 Custom M-Codes

You can also access them inside Brains and inside the MachMotion plugin to setup an oiler. Read Advanced Options on page 78 for more information on how to use outputs inside the plugin.

Mist Control

Mist is already preconfigured in Mach3 to be wired into the R4 relay. See the diagram below.

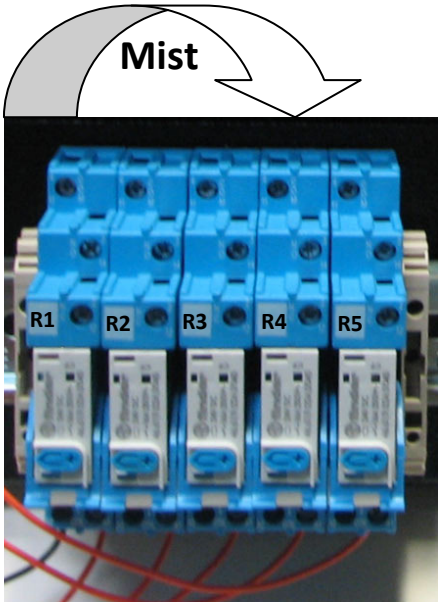


Figure 70 R2 Relay Contact

Follow the steps below to wire up your mist control.

1. Wire up your power signal into the COM terminal. You can use whatever voltage you need, but +24V and +5V are supplied on the Interpreter.

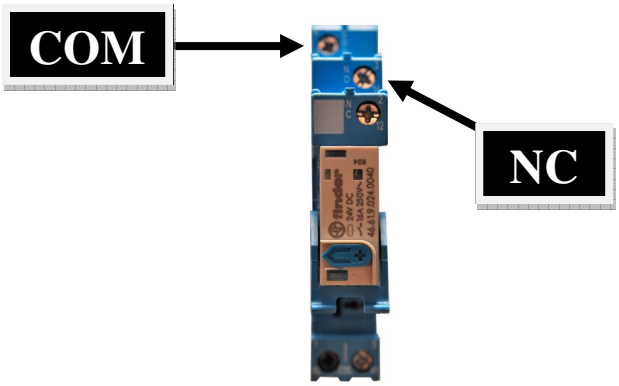


Figure 71 Mist Control

2. Wire up your mist signal into NC terminal on the relay as show above.

To turn on your mist you can use M7 and to turn it off you can use M9. Also, on the Ultimate screen under the **Prog Run-> Advanced** tab, there is a mist button. Toggle it by pressing the button. If the button is green, your mist should be working!

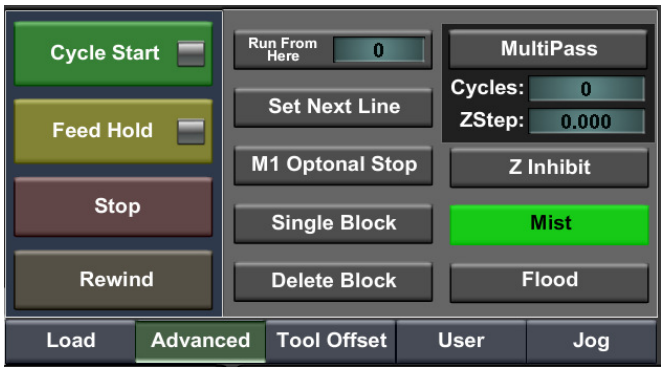


Figure 72 Mist Button

Note: M9 turns off both mist and flood.

Flood Control

Flood is already preconfigured in Mach3 to be wired into the R5 relay. See the diagram below.

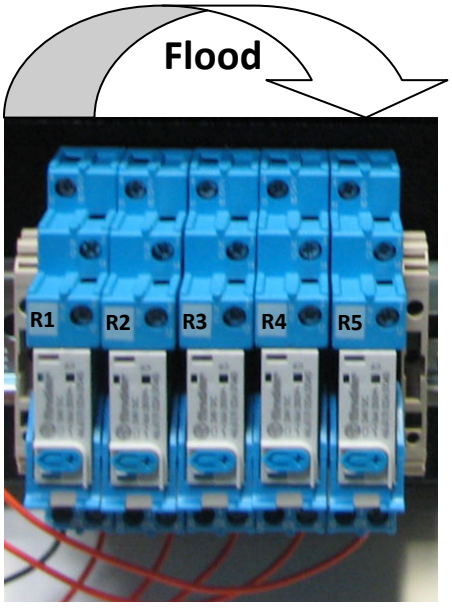


Figure 73 R5 Relay Contact

Follow the steps below to wire up your flood control.

1. Wire up your power signal into the COM terminal. You can use whatever voltage you need, but +24V and +5V are supplied on the Interpreter.

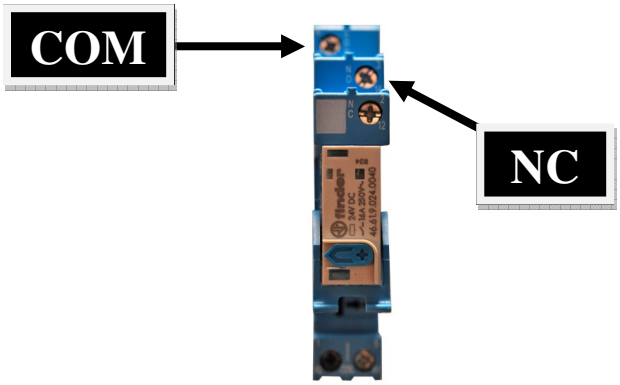


Figure 74 Flood Control

2. Wire up your flood signal into the NC terminal on the relay as show above.

To turn on your flood you can use M8 and to turn it off you can use M9. Also, on the Ultimate screen under the **Prog Run-> Advanced** tab, there is a flood button. Toggle it by pressing the button. If the button is green, your flood should be working!

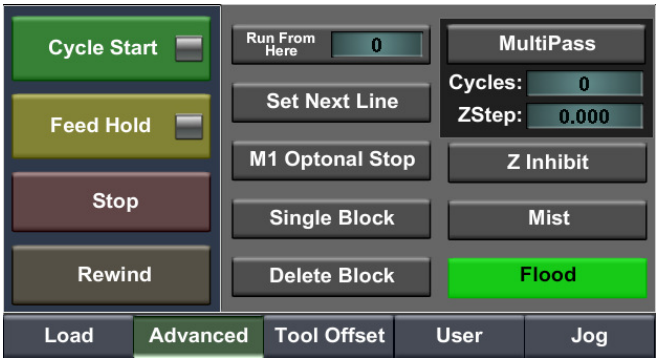


Figure 75 Mist Button

Note: M9 turns off both mist and flood.

Setting up Your Limits and Homing

Any of the 32 inputs on the Interpreter can be configured as limit switches or home switches. The limit switches can be wired together in series to save inputs as shown below. For more information on connecting your inputs to the Interpreter, see Setting up Inputs on page 45.

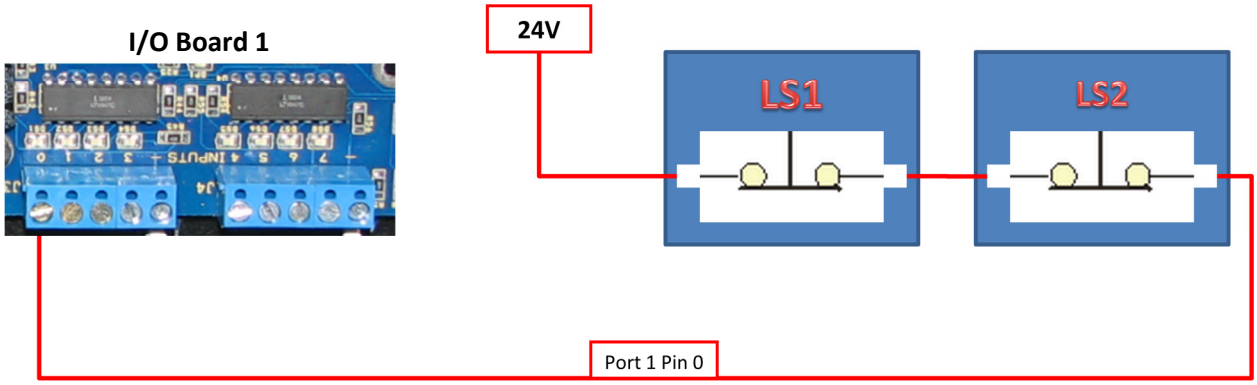


Figure 76 Limit Switches in Series

*Note: Make sure to wire your limit switches **Normally Closed**.*

Although any input can be setup for any function, below is the standard configuration for the inputs.

Limit & Home Switches		
Signal	**Input #**	**Port #**
X Limits	0	1
X Home	1	1
Y Limits	2	1
Y Home	3	1
Z Limits	4	1
Z Home	5	1
A Limits	6	1
A Home	7	1
B Limits	8	1
B Home	9	1
C Limits	10	1
C Home	11	1

Table 6 Limit Switch Inputs

To wire 24V limit/home switches, follow the steps outlined below.

1. Pick two limit switches closest to the end of the axis' maximum and minimum travel.

2. Wire the two switches together in series as shown in Figure 76. Make sure to wire the switches using their normally closed contacts.

3. Wire the remaining side of the first switch to 24V (for a PNP I/O board) or to ground (for a NPN I/O board). To use an external 24V power supply, just make sure that the grounds are common.

4. Wire the remaining side of the limit/home switch into the correct input depending on which axis you are wiring (see Table 6).

5. On the menu bar at the top of the screen select **Config -> Ports and Pins** (see Figure 36).

6. Click on the **Input Signals** tab (see Figure 78).

7. Enable your limit and home switches by clicking the red "**X**" by the signal. The input is enabled when there is a green check mark on the enable column. X++ is the forward limit, X—is the back limit, and X Home is the homing switch (Figure 78).

   For example, to enable the Y forward limit switch, click on the red "**X**" in the first column on the Y++ row. The "**X**" will change to a green check mark showing that the limit is enabled. You can also scroll down to view more input signals.

8. Check to make sure your port and pin number for that signal are correct. All inputs on the Interpreter use port 1. The first column to the right of the Enabled column is the port number and the next column is the pin number.

Figure 77 Limit Switches Ports and Pins Configuration

9. Setup the active state. Under the active low column you can change the active state by clicking on the "**X**" or check mark. For normally open, the green check mark should be used. Accordingly, for normally closed switches, the red "**X**" should be selected. If your limits are wired as shown in Figure 76 then this column should have the red "**X**".

10. When you are finished setting up your limit and home switches, press **Apply** and then **OK**.

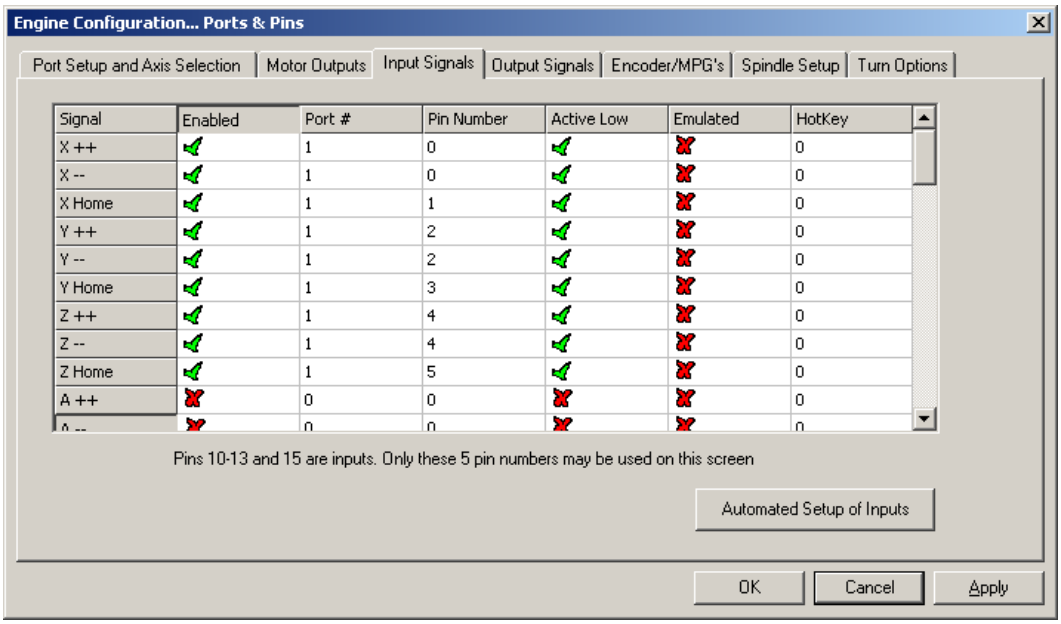


Figure 78 Input Signals

For example, the configuration above has X, Y, and Z limit and home switches enabled. The limit switches are wired normally closed and in series. The X forward and reverse limit switches are connected to port 1 pin 0 (Input 0 on I/O Board 1). The X home switch is wired into port 1 pin 1 (Input 1 on the I/O Board 1). Notice that the axes' forward and reverse limit switches (X++ and X--) both use the same port and pin number.

Setting up Homing

Now your limit and homing switches are setup correctly. It is time to finish setting up homing.

1. On the sub menu click the **Ref Home** button as shown below.

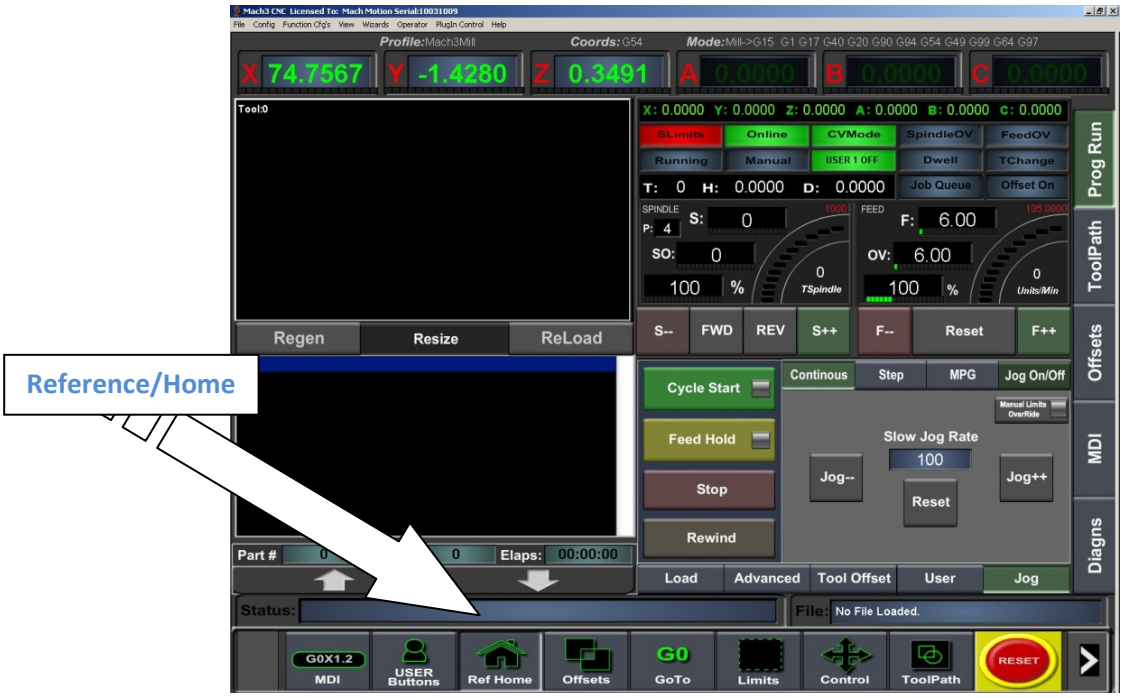


Figure 79 Home Machine

2. Home your machine. You can either select **Ref Home** which will reference all the axes at once or you can individually reference each axis. Notice which axes home in the wrong direction.

Figure 80 Reference Buttons

****

Warning

If your limit switches are not setup correctly or if an axis moves in the opposite direction of the home switch, you could crash your machine. Make sure to keep your hand on the Emergency Stop button the first time you home your machine.

****

When an axis is homed, the label (X, Y, Z, etc) at the top of the **Prog Run** screen will turn green.

3. Open to the menu bar and click **Config -> Homing/Limits** (Figure 55). The *Motor Home/Soft Limits* window will come up as shown below.

Figure 81 Motor Home/Soft Limits

4. If any of the axes homed in the wrong direction, click on the red "**X**" next to the axis.

5. Set the speed of the axis by changing the percentage under the **Speed %** column.

6. To set a homing offset, enter a value into the **Home Off** column. When the homing switch is triggered, this value will become the machine coordinate for the home position.

Homing on your machine should now be completely set up. Press the **Ref Home** button again to make sure that everything works correctly.

Setting up Your Soft Limits

Soft limits are utilized to keep your machine from crashing. If the soft limits are setup correctly, you will never be able to hit a physical limit switch on your machine unless the machine is not homed properly. If at any time you command your machine to move outside of the soft limits (while they are enabled), an error will appear in the status line or a window will pop up asking you if you want to continue. To setup the soft limits, follow the procedure outlined below.

1. Jog your machine to the maximum distance from your homing switches. Make sure to stay inside your physical limit switches. If you jog outside of your limit switches, you completely defeat the purpose of soft limits.

Figure 82 Offsets Screen

2. Navigate to the **Offsets** screen as shown above. Record the exact position for each axis as shown by the *Machine Coordinates* arrow (See Figure 82).

   Note: If you don't have the Ultimate Screen, just view the machine coordinates on the Diagnostics page.

3. Open the menu bar and click **Config -> Homing/Limits** (Figure 55). The Motor Home/Soft Limits window will come up (See Figure 81).

4. For each axis enter in your recorded values. If the value is positive, place it into the Soft Max limit and set the Soft Min limit to zero. Otherwise, with a negative value, set the Soft Max to zero and the Soft Min to the recorded value.

5. Press **OK**

Figure 83 Soft Limits

In the figure above the X axis soft limits go from 26.45 to 0, the Y axis from 16.75 to 0, and the Z axis from 0 to negative 3.65. If at any time the machine attempts to move past these limits, there will be an error. Also the X & Z axes are reversed.

6. Go to the **Offsets** page and click on the **Soft Limit** button. The button will turn green, showing that the soft limits have been enabled. See Figure 84 below. Now when you are jogging or running a G-code file, your machine will stop when it hits a soft limit.

Figure 84 Soft Limits on MachMotion Screen

*Note: If you don't have the MachMotion Ultimate Screen, click on the **Soft Limits** button on the main screen. The LED behind the button will turn on.*

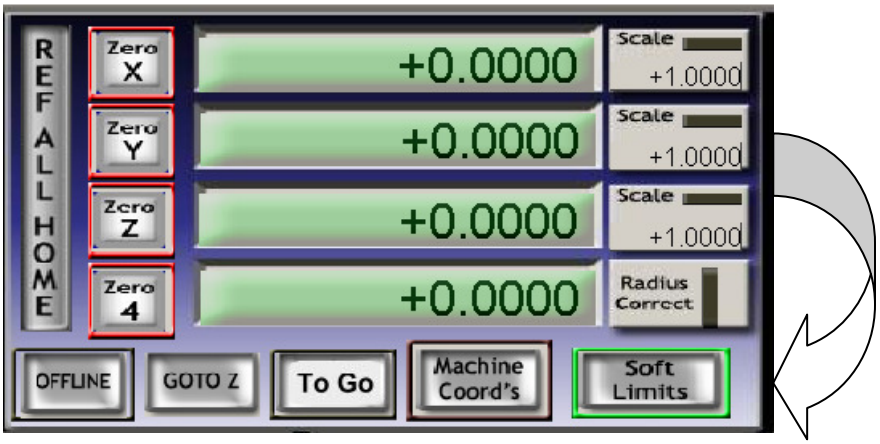


Figure 85 Soft Limits Old Screen Set

Test your soft limits by jogging your axes in all directions. As long as your machine is homed, you should never be able to hit a hard limit switch.

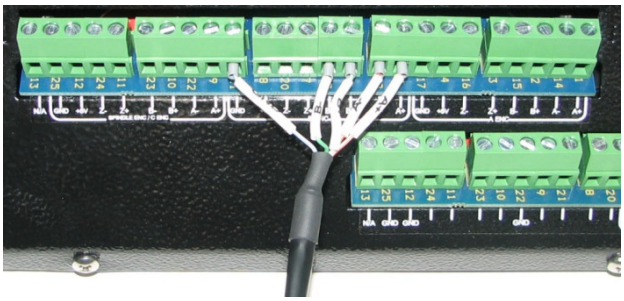
Setting up Your Pendant

If your control came with the optional pendant, please follow the instructions in this section to setup your pendant.

1. Find the pendant cable in the back of your control.

Figure 86 Pendant Cable

2. Connect the pendant cable to the Interpreter. Any unused encoder input will work. However, if you are not using a 5th axis, use the B encoder to connect your pendant as shown below.



Label	Color
A+	Orange/White
A-	Orange
B+	Green/White
B-	Green
GND	Blue/White

Figure 87 Pendant Wiring

3. Open the DSPMC plug by navigating to **Config->Config PlugIns**. Select the yellow CONFIG button next to the **M3dspMC-DSPMC-PlugIn-xxx-VITAL-** option. The *DSPMC Configuration* window will come up.

4. Under the **MPG Source #1** on the main System tab, select the type **Hard Encoder**. See Figure 88.

5. Enter in the index according to the table below. For example, the B axis should use index 4.

X Axis	0
Y Axis	1
Z Axis	2
A Axis	3
B Axis	4
C Axis	5

Table 7 Axis Index

See the picture below of the MPG configuration.

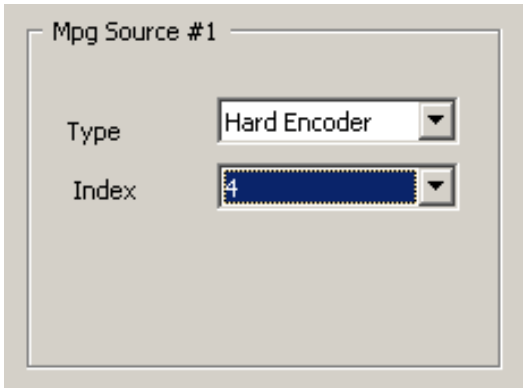


Figure 88 Pendant Configuration

6. Press **Update DSPMC** and then **OK**.

7. Open up **Config**->**Ports and Pins** and go to the **Encoder/MPG's** tab.

8. Make sure that the MPG #1 is enabled. Set the **Counts/Units** to 4 as shown below.

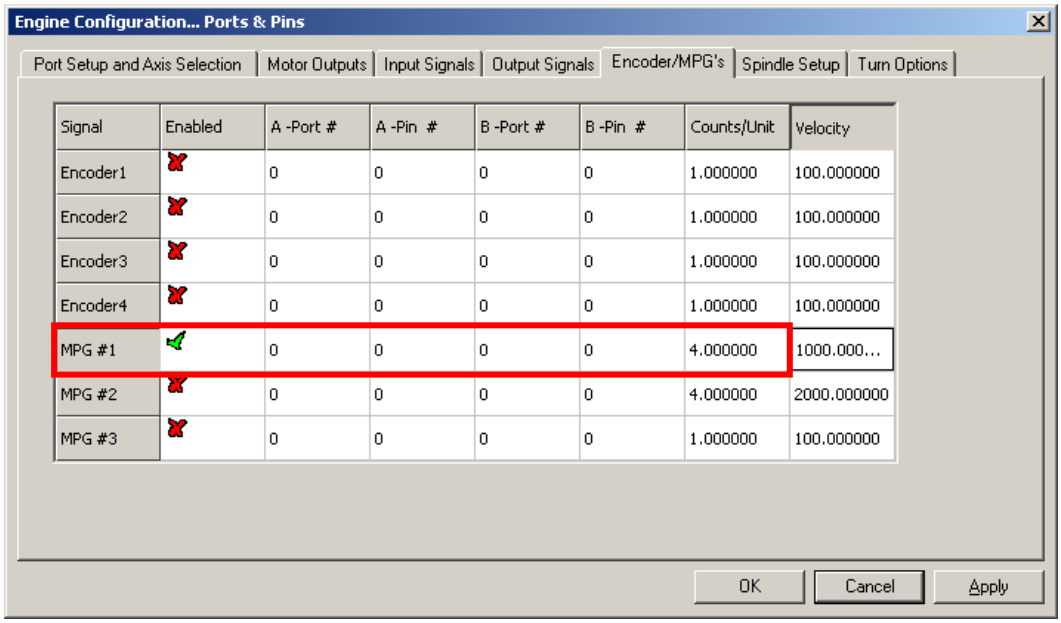


Figure 89 MPG 1 Enabled

9. Press **Apply** and then **OK**.

Following the instructions in the section Pendant (X15-20-01) on page 18 to test your pendant. Everything should be setup correctly.

Setting up Your Spindle

In this section you will learn how to wire and configure your spindle. Begin by enabling your spindle. Select **Config**->**Ports and Pins** and then click on the **Motor Outputs** tab. Enable the spindle by clicking on the red "X". If there is a green check mark next to the spindle, then it is already enabled. Make sure that the active low columns have a green check mark in them as shown below.

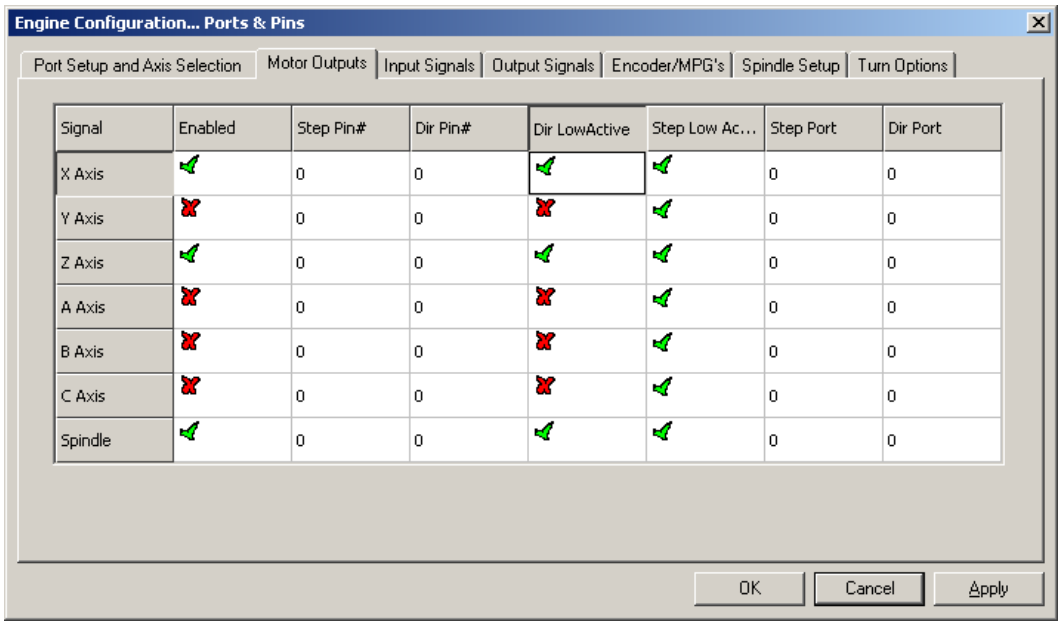


Figure 90 Spindle Setup

Press **Apply** and then **OK**. Your spindle is now enabled.

Wiring Spindle Control

The Interpreter can be used to control a spindle drive (VFD) or it can control a spindle motor directly.

Spindle Drive

Wire up your spindle drive or VFD using the steps below.

1. Connect the commons (COM) of R2 and R3 to the common on the VFD.
2. Connect the forward (FWD) signal to R2 and the reverse (REV) signal to R3.
3. Connect the GND signal to the analog ground and the analog input to the 0-10V analog output on the Analog Board.

See the diagram below.

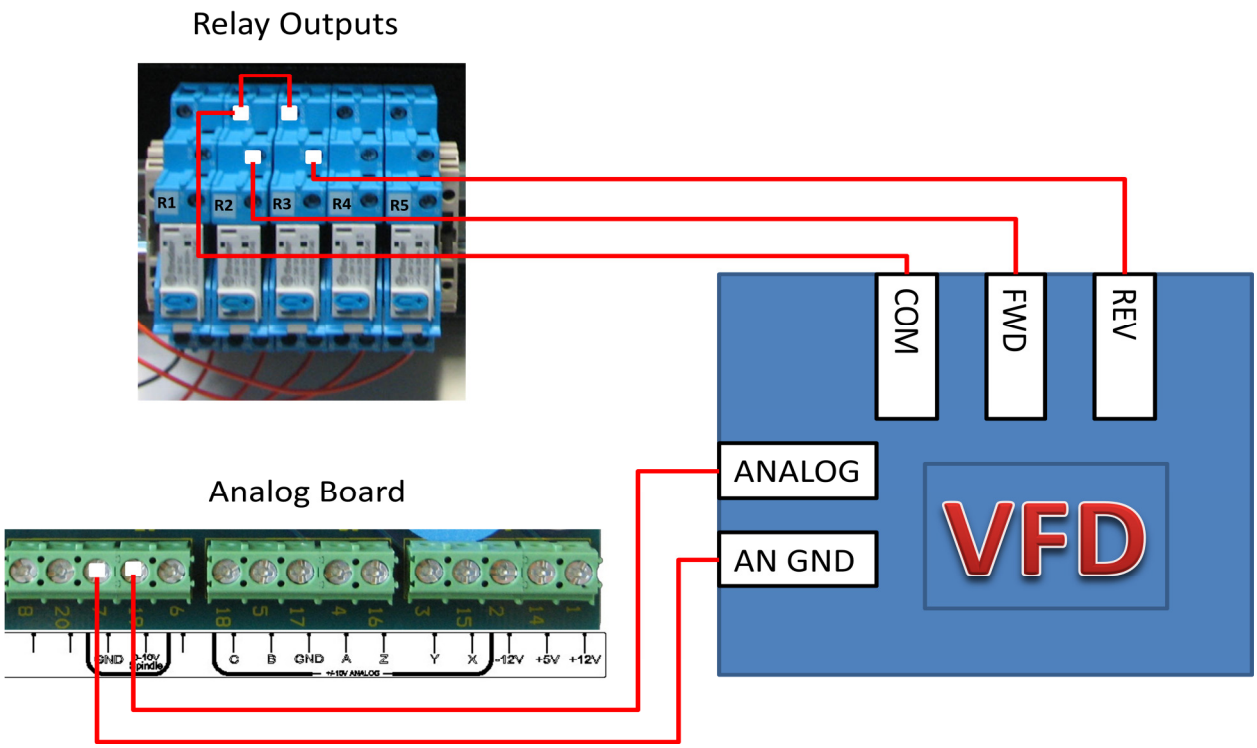


Figure 91 VFD Schematic

Spindle Motor Only

If you do not have a VFD, wire the spindle just into the relays on the back of the Interpreter. Connect 115VAC into the commons (COM) on the relay and connect the other side of the relay (NC) into the contactor.

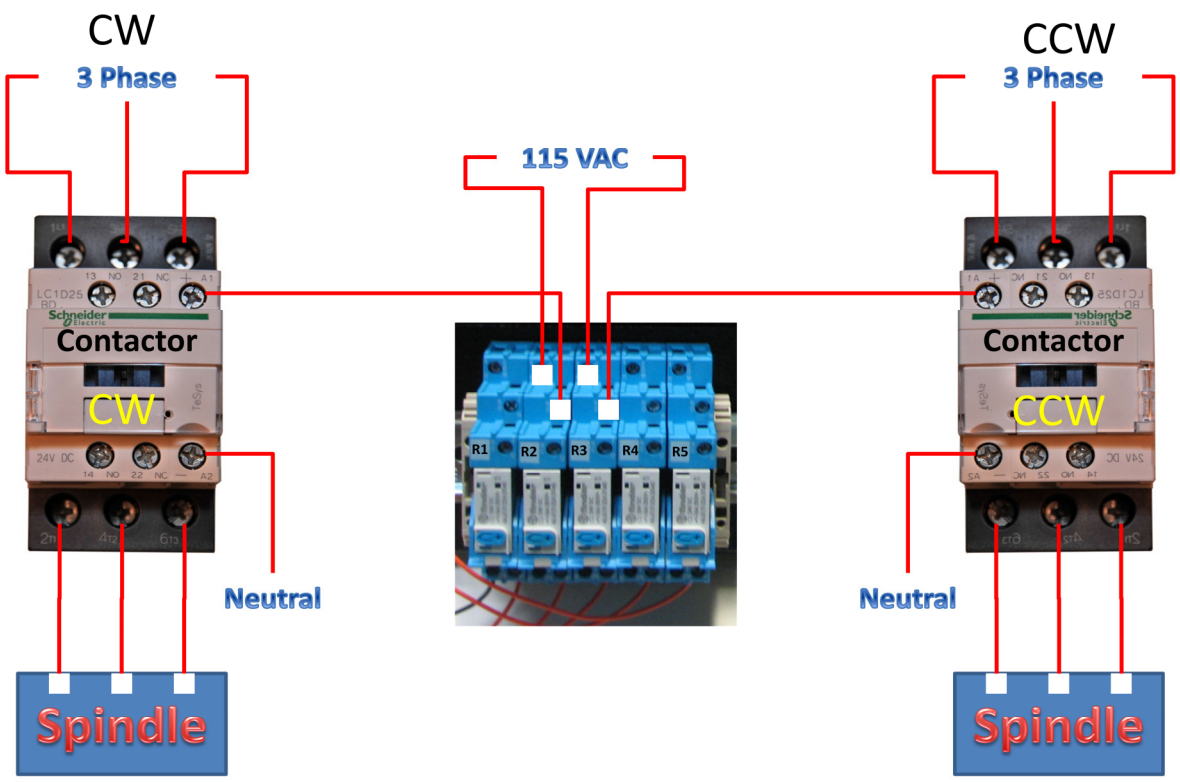


Figure 92 Spindle Motor

Wiring Spindle Feedback

If your spindle has encoder feedback, wire it into the Spindle Enc or C axis encoder position.

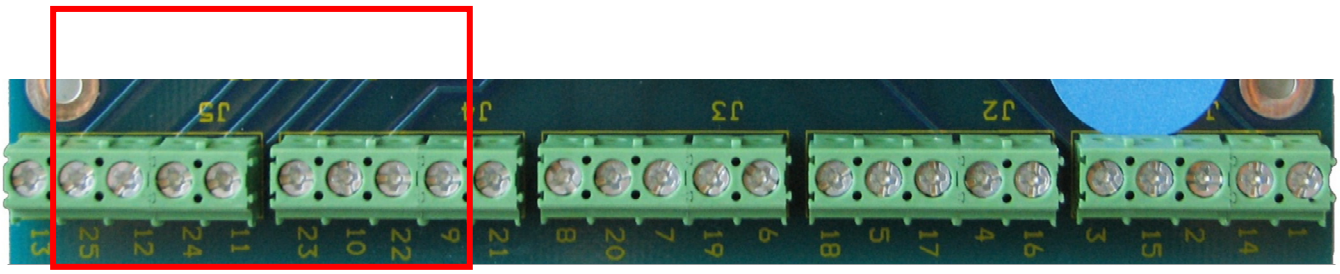


Figure 93 Encoder Board 2

Note: Spindle feedback is only needed if you will be threading.

Use the table below for connecting the spindle feedback.

Encoder Board 2			
	Pin#	**Label**	**Function**
Spindle Encoder	9	A+	Spindle A+
	22	A-	Spindle A-
	10	B+	Spindle B+
	23	B-	Spindle B-
	11	Z+	Spindle Z+
	24	Z-	Spindle Z-
	12	+5V	+5V 500mA
	25	GND	Ground
	13		Not Used

Table 8 Spindle Encoder

Setting up the DSPMC

Open the DSPMC plugin by navigating to **Config**->**Config PlugIns**. Select the yellow CONFIG button next to the **M3dspMC-DSPMC-PlugIn-xxx-VITAL-** option. The *DSPMC Configuration* window will come up.

On the **Systems** tab set the **Spindle DAC** to 7 as shown below.

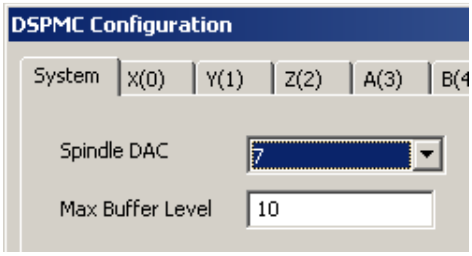


Figure 94 Spindle DAC

If your spindle has encoder feedback, setup the **Threading Feedback** section. Set the **Sync Source** to Hard Encoder, the **Sync Index** to 5, and the **Enc. Counts/Rev** to the number of encoder pulses per revolution. See the screen shot below.

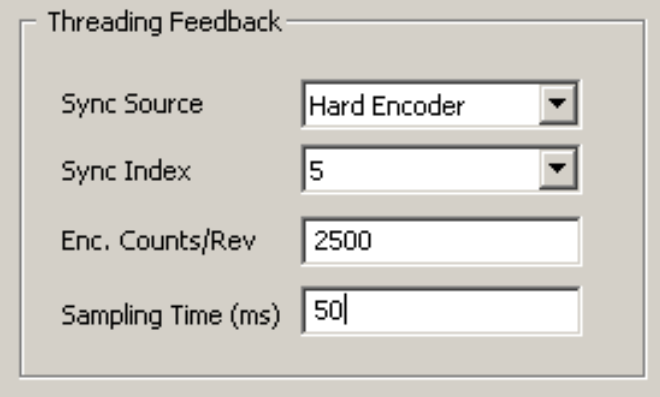


Figure 95 Spindle Feedback Settings

Now you are ready to set a pulley speed and then test your spindle.

Setting up Pulleys

The Mach3 software has many different pulleys for different gears on your spindle. If you are using a VFD, choose a separate pulley for low, medium, and high speeds. You can use as many pulleys as you want. When the spindle is running at the maximum speed, then there should be 10VDC on the analog spindle output. At the pulley's minimum speed, there should be 0VDC on the spindle output.

For example, pulley one could be set to 75 to 300 RPM for low speed. The medium could go from 300 to 1200 RPM and high speed could be from 1200 to 2400 RMP.

To setup the spindle speed or to change pulleys, go to **Config -> Spindle Pulleys.** The *Pulley Selection* window will appear as shown in Figure 97.

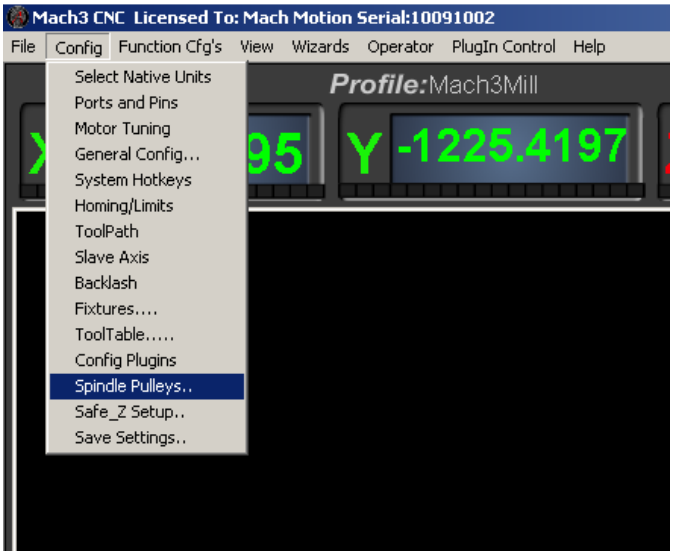


Figure 96 Spindle Pulleys

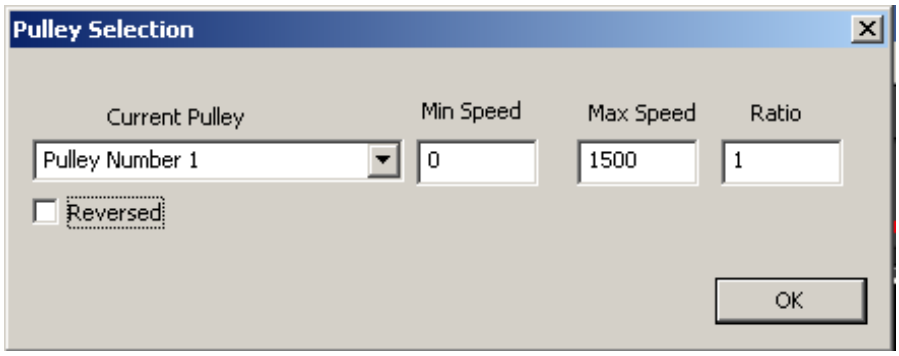


Figure 97 Pulley Speed Setup

Use the drop down menu titled **Current Pulley** to select the pulley you want to update. Enter in your maximum and minimum speeds for each pulley. Then select the pulley you want to load and press **OK**.

You can also change pulleys by using M41-M45. The macros can be used to just change pulleys in Mach3 or you could use them to automatically change gears on your machine. Outputs 12-16 are configured to shift between gears 1 and 5. To shift your machine into neutral, run M40. Open up the macros with the VB Script Editor for more details.

Turning on Your Spindle

To turn on your spindle, begin by setting a spindle speed. Navigate to **Prog Run** and click on the Spindle **S:** user input. Enter your speed and press **Send** as shown in Figure 98.

Figure 98 Setting up Spindle Speed

Note: If you don't have the MachMotion screen set, spindle speed can be changed right on the main screen of the Mill profile. Click on the user input, enter a new number, and then press enter.

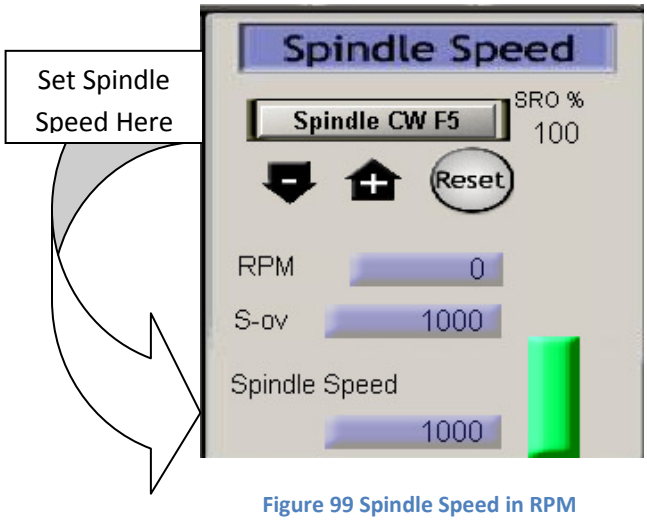


Figure 99 Spindle Speed in RPM

Control the spindle by pressing the **FWD** and **REV** buttons. The button will turn red when you press it once. Pressing the button again turns the spindle back off.

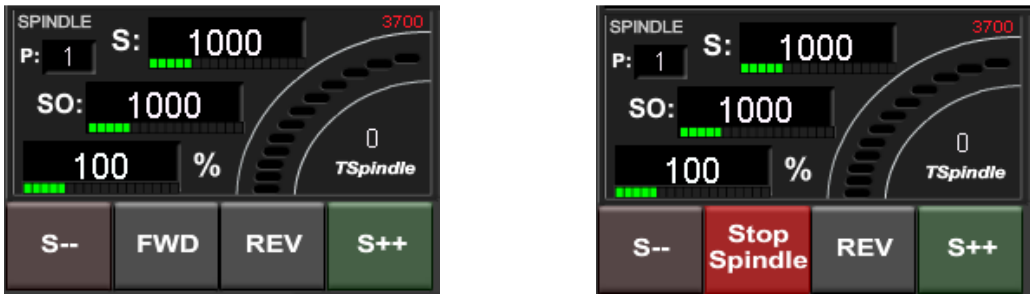


Figure 100 Spindle Buttons

*Note: If you don't have the MachMotion screen set, turn on the spindle by pressing the button **Spindle CW F5**. When the button is flashing, the spindle should be on.*

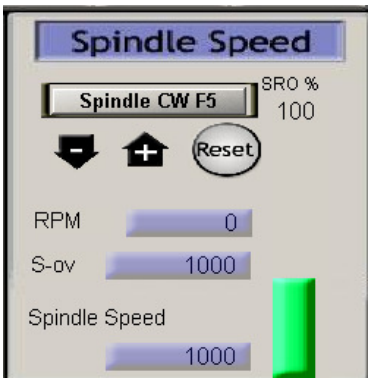


Figure 101 Spindle Speed

You can also control the spindle by using M-codes. As a reference use the table below.

M-Code	Function
M3	Clockwise
M4	Counter/Clockwise
M5	Stop

Table 9 Spindle M-Codes

Setting up Probing

There are two different probing methods.

Single Cycle is the standard method where the axis moves forward until the probe input is triggered. The position is captured and then the axis ramps down to a stop.

Dual Cycle, on the other hand, is more accurate. It begins with a probing move (called coarse move). As soon as the probe input is triggered, the axis ramps down to a stop and backs off the distance specified in the **MoveBack** parameter. The axis then starts the second move, called the fine move. The direction is same as the coarse move. The feedrate for the fine move is defined by the parameter **Feedrate.**

For both methods the machine coordinates are saved in parameters 2000 – 2005 (X is stored in 2000 and C is stored in 2005).

To setup probing, follow the procedure below.

1. Setup your probe input. Open *Engine Configuration… Ports & Pins* by clicking on **Config**->**Ports and Pins**. Click on the **Input Signals** tab. Setup the port and pin numbers for the Probe input as shown below. You can use any input.

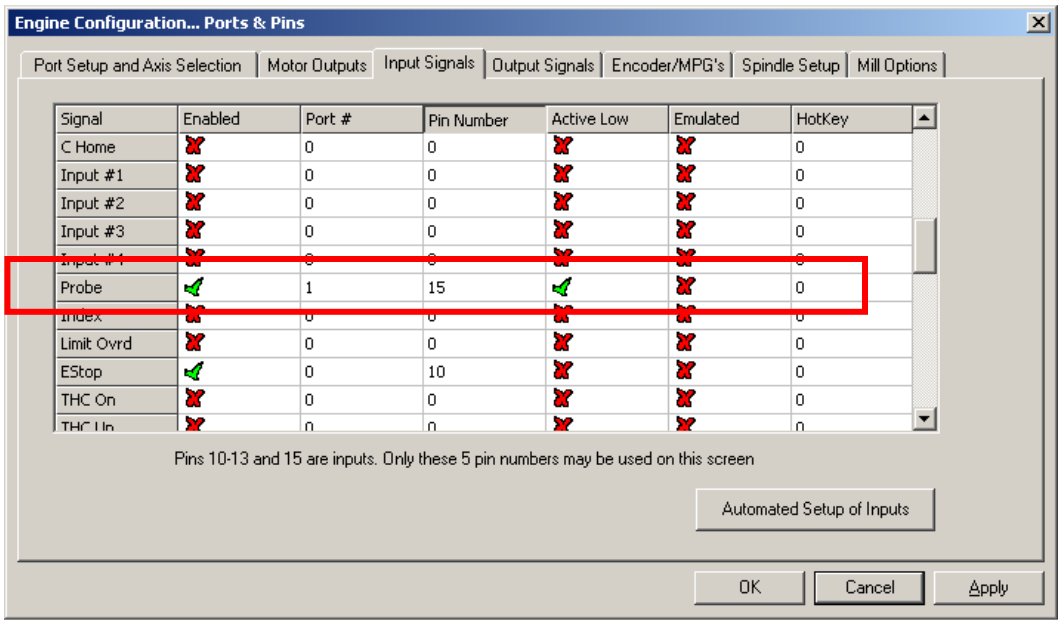


Figure 102 Probe Input

Make sure to press **Apply** before leaving the *Engine Configuration… Ports & Pins* window.

2. Select your probing method. With the *DSPMC Configuration* window open (See Configuring the DSPMC on page 25), select the **Systems** tab. Under the probing section, select Single Cycle or Dual Cycle.

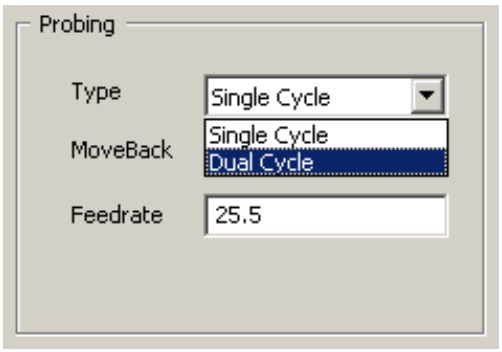


Figure 103 Probing Method

3. If you are using the Dual Cycle method, enter in the **MoveBack** and **Feedrate** values.

Make sure to save the parameters to the DSPMC. Your probing should now be set up.

Setting up Hot Keys

The Mach3 software allows you to configure keys on your keyboard as shortcuts for jogging different axes. Follow the steps below to setup your jog keys.

1. On the menu bar at the top of the screen select **Config -> System HotKeys.** The *System HotKeys Setup* window will appear.

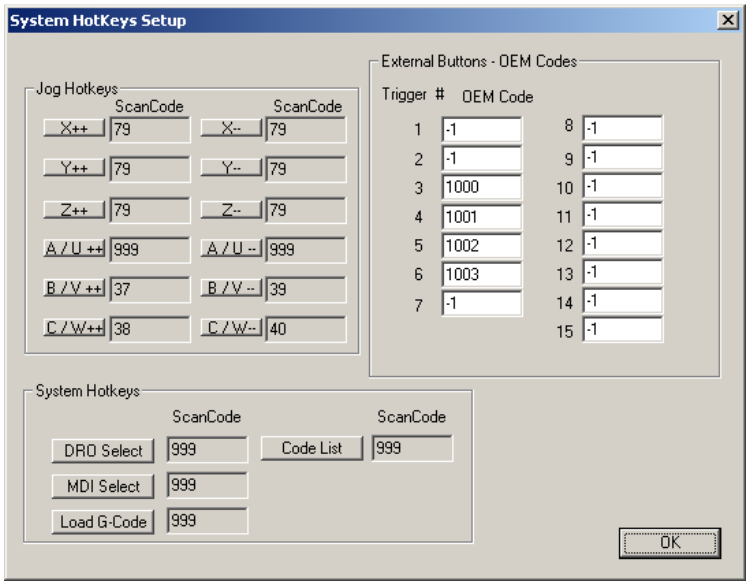


Figure 104 System HotKeys

2. Click on the axis you want to configure. The X++ is the forward X axis button and the X—is the reverse button. A small window will pop up.

Figure 105 Set HotKey

3. Press whatever key you want to control that function and the little window will disappear and load the value of that key into the *System HotKeys Setup* window.

4. Repeat this process until all your buttons are configured. Press **OK.**

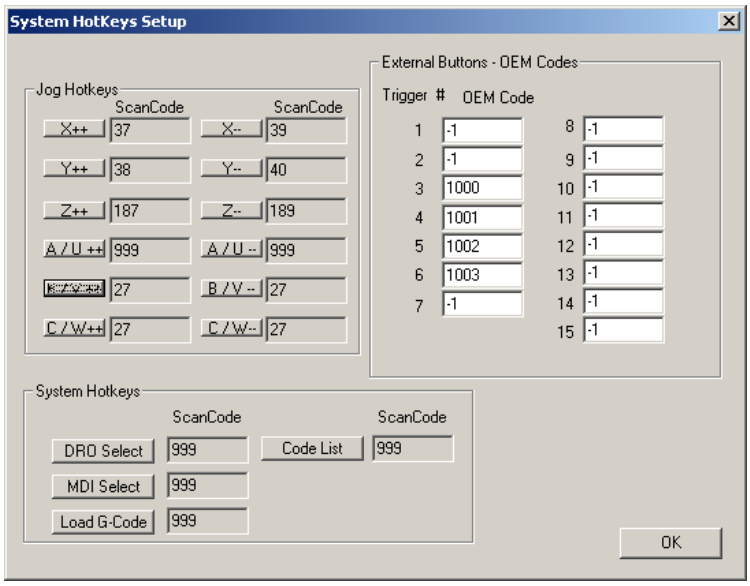


Figure 106 HotKeys Example

For example in Figure 106 the right and left arrow keys control the X axis and the up and down arrow keys control the Y axis.

Advanced Options

Under the system configuration window you can setup external inputs, an oiler, and user messages. Begin by clicking **Config** on the menu bar. Then select **Config PlugIns**. The *PlugIn Control and Activation* window will appear. On the farthest right column, click on the yellow **CONFIG** button of the MachMotion plugin as shown below.

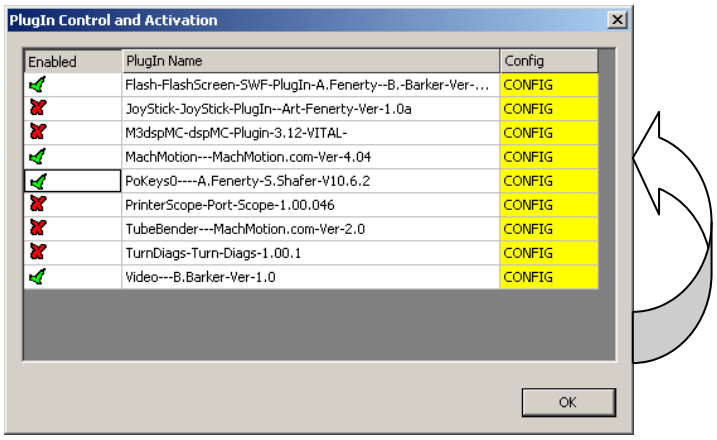


Figure 107 Plugin Control

A new window called *Configure ModIO and Mach3* will appear. Select the **System Configuration** button.

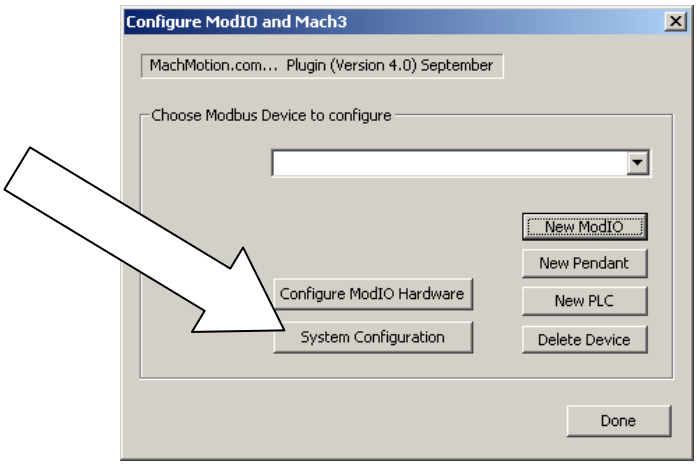


Figure 108 Configure ModIO and Mach3

Now you should see the *System Configuration* window as shown below.

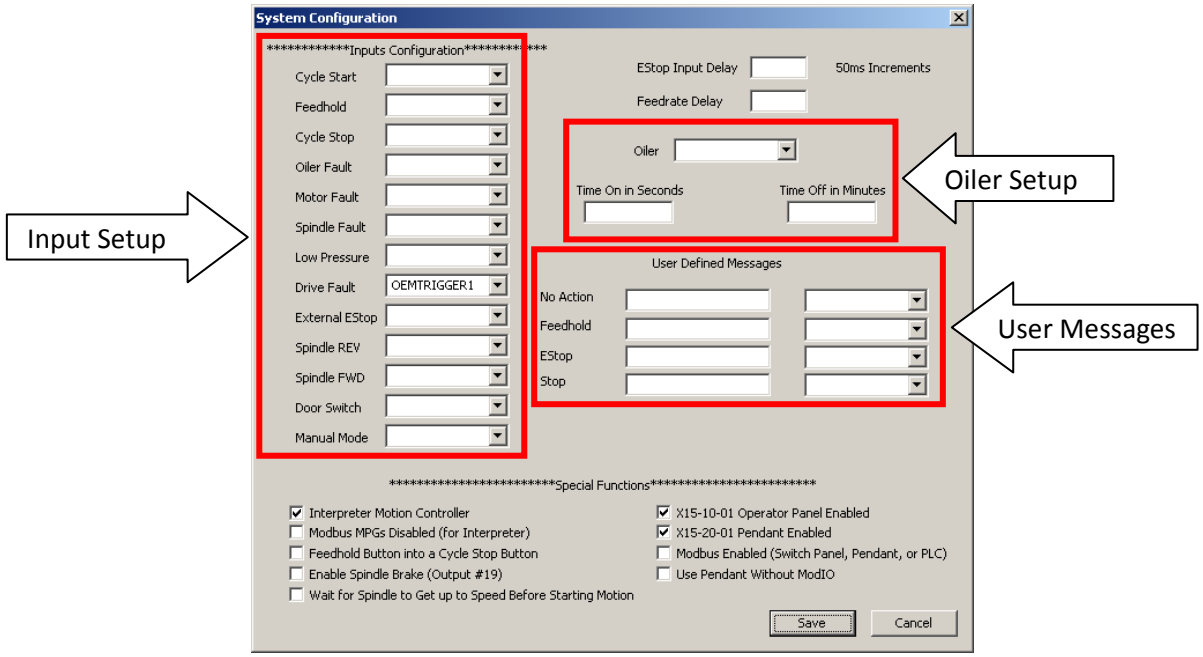


Figure 109 System Configuration

You should only ever touch the input configuration, the oiler setup, and the user defined messages. The special functions are used to setup your control at the factory. Please do not change these settings.

The Input Setup section allows you to have an input turn on a function. The functions are listed in the left side such as Cycle Start, Feedhold, Cycle Stop, etc. The input in the drop down menu turns on the corresponding function. In the figure above, OEM trigger 1 (OEMTRIGGER1) turns on the drive fault.

For example, to setup an external EStop, configure a normal input in ports and pins (See Setting up Inputs). Let's assume we setup Input 4. Then use the drop down menu in the System Configuration window to select the input as shown below.

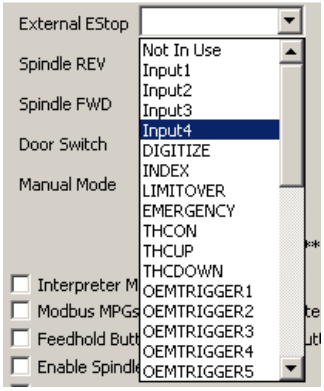


Figure 110 External Estop

Now whenever Input4 is active, EStop will be flagged.

You can configure the User Messages to have a custom messages displayed. Each input will do a specific function (estop, feedhold, stop) and write to the status bar except the No Action option. The No Action just displays the message on the status bar whenever the input is active. In the example below, when OEM trigger 4 is activated, the message "**MCR Reset!!**" will be displayed on the status bar.

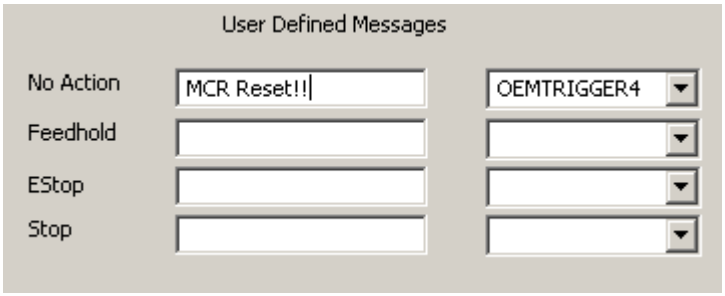


Figure 111 User Messages

You may also need to setup an oiler. Just define an output, set the time you want the oiler on, and the time you want it off. In the example below the oiler is attached to output 6. It is turned on for 10 seconds every 1 minute. The spindle has to be one for the oiler to turn on.

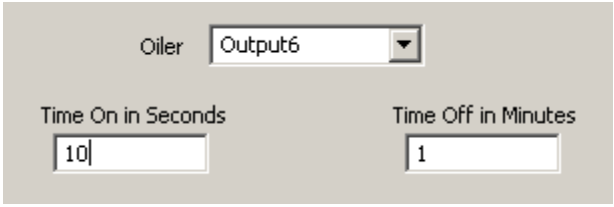


Figure 112 Oiler

Shutting Down the Control

To power down your control, follow the steps outlined below.

1. Shut down the Mach3 software by clicking the exit button at the top right of the control. A window will pop up asking you if you are sure you want to end the session.

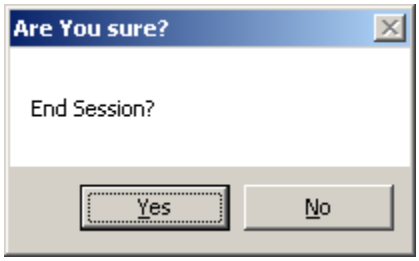


Figure 113 End Session

2. Click **Yes**. If another window pops up and asks you if you want to save the fixture, click **Yes**.

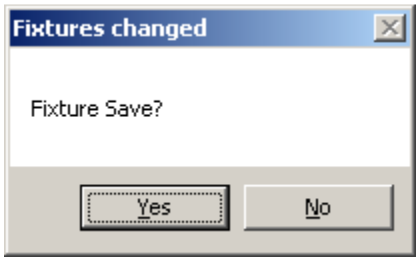


Figure 114 Fixture Save

3. Rotate and release the key on the back right hand side of the control. You can also click on the **Start** menu and then press **Shut Down**. The Mach Motion control will turn off.

Note: Do not turn the key until the control's software has completely shut down. Also, do not remove the power of the machine until the control is completely off.

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Reviewing Your Control Installation

To verify that your CNC control is completely setup, please review the checklist below.

- € Push in the large red Emergency Stop button on the operator of your control.
  - Does it EStop Mach3 and disable all your axes? If not, see check the wiring of your EStop circuit.
- € Jog all axes in both directions (Use the operator panel or the arrow keys on your keyboard).
  - Does each axis move at a reasonable speed? If not, try adjusting the velocity in the motor tuning (See page 31).
  - Is the motion in each axis smooth? If not, try adjusting the acceleration in the motor tuning (See page 31).
  - Does each axis move in the correct direction (i.e. does the control DRO correspond with the axis direction)? If not, change the axis's direction (See page 42).
- € Command each axis to move one inch (MDI G91 G01 and then X1, Y1, Z1, etc).
  - Did it move the exact distance? If not, calibrate your machine (See page 31).
- € Make sure you have no backlash.
  - Follow the sequence below for each axis:
    - Move the axis in one direction farther than the maximum possible backlash.
    - Mount your dial indicator and zero it.
    - Move the axis again in the same direction for a specific distance (it doesn't matter how far).
    - Move the axis backwards the same distance.
  - Did the machine move back to zero? If not, check your backlash compensation (See page 41).
- € Turn the spindle on CW and CCW (if you have wired your spindle to run both directions) by commanding M3 and then M4 in the MDI line.
  - Did the spindle move both directions? If not, check your spindle setup (See page 66).
- € Command different spindle speeds (MDI S100, S500, S1000, etc with the spindle running).
  - Does the spindle move the correct RPM? If not, calibrate your spindle (See page 70).
- € Press Home All or Reference All.
  - Does each axis hit its home switch and back off of it? If not, setup homing (See page 59).
- € Slowly jog each axis to the positive and then negative limits of its travel.
  - Do the soft limits stop each axis from hitting a hard stop or a limit switch? If not, setup your soft limits (See page 61).
- € Trigger each limit switch (manually or by turning off the soft limits and jogging slowly into the limit).
  - Does it EStop Mach3? If not, setup your limit switches or check your wiring (See page 56).
- € Test your Flood, Mist, and any other outputs you are using on this control.
  - Do they work correctly? If not, setup your outputs and check your wiring (See pages 53 and 54).
- € Run a G-Code file.
  - Does it run correctly?

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Finding Information for Your Control

Documentation

For further reference you can view all our other manuals under our **Manuals** folder on your desktop.

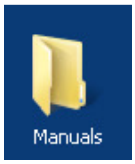


Figure 115 Manuals

Below is a list of our manuals and a brief note on what they are about. The label in parentheses is the folder the manuals are located under on your computer. For example, **"(Using Mach3)"** is a sub-folder in the Manuals folder. You can find all our latest manuals plus other information online at www.machmotion.com .

There are also wiring diagrams located in the Manuals folder under the sub-folder Wiring Diagrams.

For even more manuals and documentation besides what is on your computer and on our website, see More Information on page 87.

For setting up your control:

Arm Assembly Instructions

Leads you through a simple step by step procedure to assemble your mounting arm.

Ultimate Screen Installation

Step by step guide to install the Ultimate Screen.

DSPMC Manual

More information on the actual computer inside the Interpreter 1000.

For learning how to use the Mach3 software (Using Mach3):

Mach3 Install Config

Gives a general overview of how to setup and use the Mach3 software. If you are unfamiliar with Mach3 this would be a fantastic resource.

Mach3Mill

Using Mach3Mill A user's guide to installation, configuration and operation

Gives pretty much everything you need to know about the mill software. Much of the configuration is already complete, but you can still learn a lot about the power of Mach3.

Using3Turn

Using Mach3Turn A user's guide to installation, configuration and operation

Gives pretty much everything you need to know about the turn software. Much of the configuration is already complete, but you can still learn a lot about the power of Mach3.

Tool Setup Guide

Shows how to set up your machine's tooling.

M-Codes

For a list of M-codes, visit our website www.machmotion.com and select the CNC Info tab.

G-Codes

For a list of G-codes, visit our website www.machmotion.com and select the CNC Info tab.

For customizing/programming your control (Programming):

Mach3 V3 Programmer Reference

Presents all the different VB commands that you can use in Mach3 and lists all the LEDs and DROs for programming.

Cypress VB Language Manual

Gives a detailed explanation of visual basic and windows.

Ultimate Screen Customization

Shows some ways to customize the Ultimate Screen provided by MachMotion.

For your servo drives (Servo Drives):

Mitsubshi Quickstart

TECO Quickstart

For your stepper drives(Stepper Drives):

Stepper Drive Setup Guide 1.0.1

For interfacing with a PLC(PLC):

Programmable Logic Controllers

If you need to interface with a PLC, this manual tells you everything you need to know.

Setting Up Your Tool Changer

Leads you through a step by step process to set up a PLC tool changer.

D0-06 Volume 1 & D0-06 Volume 2

Shows how to program the D0-06 PLCs.

More Information

Below are many other resources to help you learn everything you need to know about Mach3. They cover everything from programming in VB to setting up homing and offsets in your machine.

For the Mach3 Software Documentation:

- A host of videos on how to use and even configure the Mach3 software are found at http://www.machsupport.com/videos.php. Click on the **Artsoft Video Tutorials** for even more videos.
- For manuals and information on the Mach3 software visit http://www.machsupport.com/documentation.php .
- The Mach3 Wiki (http://www.machsupport.com/MachCustomizeWiki/index.php?title=Main_Page) also offers a lot of support for configuring mach3.

For Screen Information:

- For MachMotion's Ultimate Screen, tutorial videos can be found on www.machmotion.com under **Support** and then **Ultimate Screen Support Videos**.

- For customizing without the Ultimate Screen, you can download the Mach3 screen editor at http://www.kd-dietz.de/index_eng.htm. Go to the Mach Screen Videos for information on how to use the editor under the Downloads tab from the same website.

Finding a Post Processor

For a list of post processors for the Mach software visit http://www.machsupport.com/posts.php. If your CAM package is not listed, contact your CAM producer and ask for a Mach post processor. If they do not have a Mach-specific post processor, a standard Fanuc post should work fine for most applications.

If you are using BobCAD-CAM, go to the following website. Download the post processor specific for your machine type.

http://www.bobcadsupport.com/posts/index.php?start=/kunden/homepages/17/d229444852/htdocs/bobcadsupport/posts/BobCAD_V22_Mill_Posts/Mach&parent=/kunden/homepages/17/d229444852/htdocs/bobcadsupport/posts

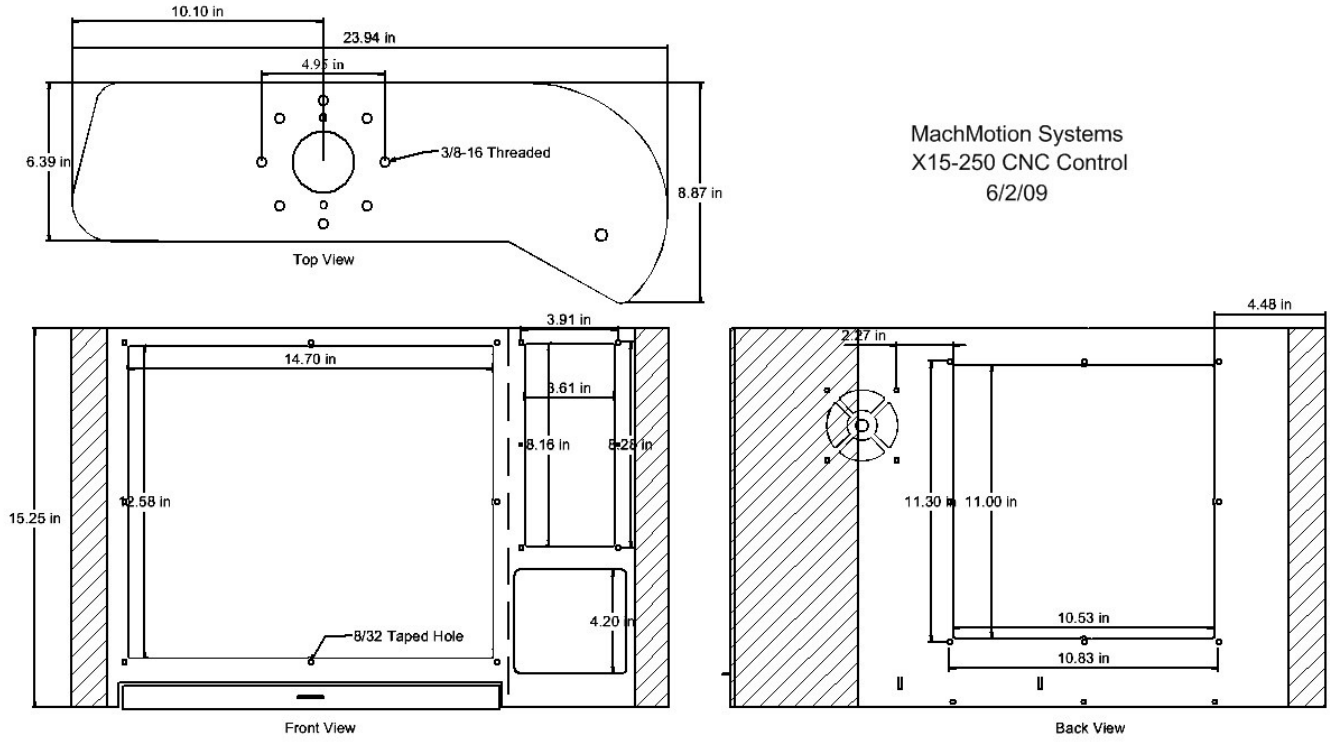
Note: NoATC means No Automatic Tool Changer.

Specification

Below is the specification for a standard X15-250 analog control.

Item	Specification
Power Source	AC 115VAC – 220VAC 50/60 Hz
Max Power Consumption	350W
Computer	X15-110 PC
Operating System	Windows 7
Processor	Intel® Pentium® Dual-Core 2.6GHz
RAM	1 GB
I/O Ports	
PS/2 Keyboard & PS/2 Mouse	1
VGA Port	1
Serial Port	1
Parallel Ports	3
Ethernet LAN (RJ45) Port	2
USB Ports	6 (2 Available)
6 Channel Audio I/O	1
Monitor	17” Color LCD
Keyboard	Retractable
Power Supply	5VDC, 12VDC, & 24VDC
CNC Control Software	Mach3
Axes	X, Y, Z, A, B, C
Enclosure	
Dimensions	24"(W) X 15.5"(H) X 6.5"(D)
Material	18 Gauge Steel, Powder Coated
Operator Interface	
Operator Panel	Jog Buttons, Selector Switches, Emergency Stop, Cycle Start, & Cycle Stop Buttons
Optional Pendant	Hand-wheel & Selector Switches
Motion & I/O Interface	Interpreter 1000
Inputs	32 NPN or PNP
Outputs	16 (5 Relay, 11 24VDC NPN or PNP)

Below is the X15-250 CNC Control drawing.



Warranty Information

MachMotion warrants all products to be free from manufacturer defects for a period of one year from the date of purchase. Products which prove to be defective under normal conditions and proper use during the warranty period will be replaced without charge. For warranty service, send the defective product to MachMotion, 14518 County Road 7240, Newburg, MO 65550. If the defect is found to be caused by improper use, then this warranty does not apply. Otherwise the product will be repaired or exchanged and shipped to the address located on the Product Return\Repair Form. MachMotion will cover the return UPS ground shipping for the replaced/repaired product. When a product or part is exchanged, any replacement item becomes your property and the replaced item becomes MachMotion's property.

Congratulations on completing the user's manual for your analog control! We hope that you have found this manual very helpful.

Please let us know if you have any questions.

Sincerely,

The Mach Motion Team
http://www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672