X15-250

APOLLO I

QUICK START MANUAL

MachMotion

Specializing in CNC Automation and Motion Control

7/1/14 R0122

This manual covers the setup and configuration of the Apollo I Breakout board connected to the X15-250 control using Mach3.

Formatting Overview:

- Menus, options, icons, fields, and text boxes on the screen will be bold (e.g. the **Help** icon).
- Clickable buttons will be bold and within brackets (e.g. the [**OK**] button).
- Directory names, commands, and examples of editing program files will appear in `Courier New` font

This manual as well as all other MachMotion manuals can be found at www.MachMotion.com

X15-250-A1

R0122

Table of Contents

1 GETTING STARTED

1.1 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

Remove all the contents from the plastic bag.

Next locate the following items:

X15-250-A1 Control
Power Cables
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.

FIGURE 2 POWER CABLES

FIGURE 3 ENVELOPE

1.2 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.

2 STARTING YOUR CONTROL

2.1 Supplying Power

To power your control, 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.

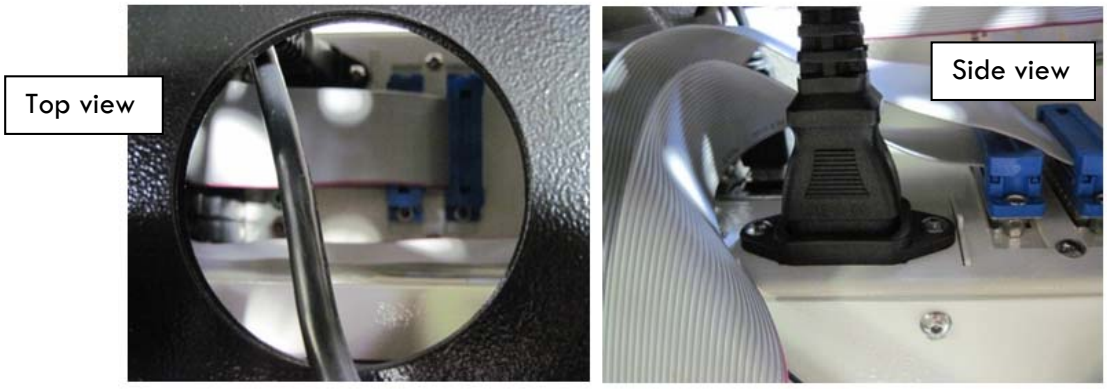


FIGURE 4 POWER CABLE

2.2 Turning on Your Computer

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

FIGURE 5 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.

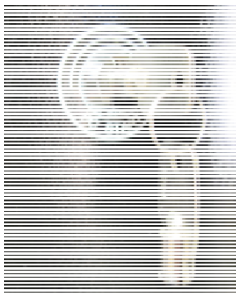


FIGURE 6 PC START

2.3 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:

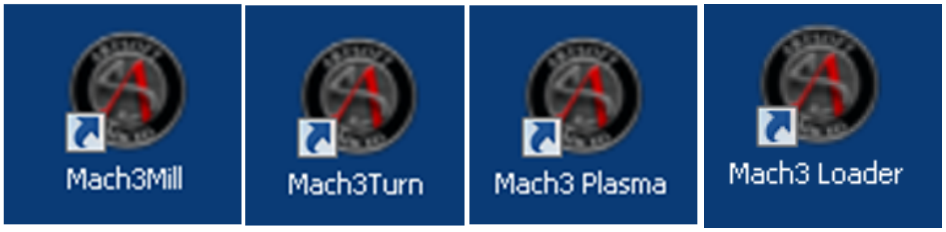


FIGURE 7 PROFILES

FIGURE 8 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:

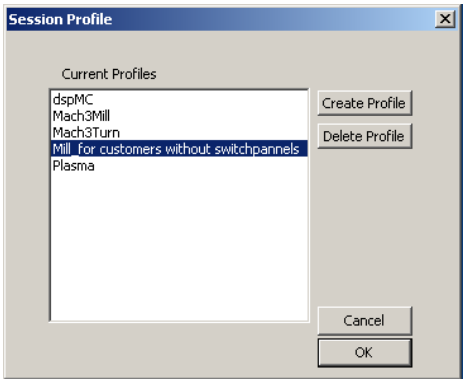


FIGURE 9 LOADER

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.

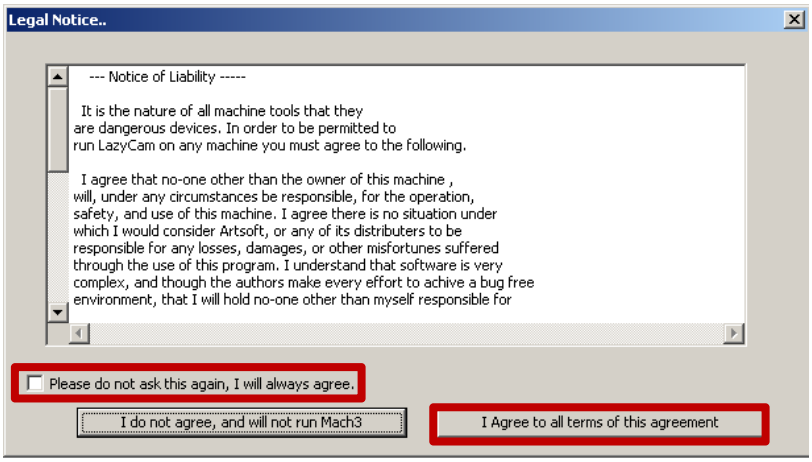


FIGURE 10 LEGAL NOTICE

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 11 MACH3 SOFTWARE

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

FIGURE 122 MACH3 MILL

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

FIGURE 133 RESET

2.4 *Note: For more information on how to run the Mach3 software, please see page 56 on* Documentation

.

3 EXPLORING YOUR CONTROL

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

3.1 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 14 OPERATOR PANEL

WARNING

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).

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

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

FIGURE 15 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 16 below.

FIGURE 16 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.

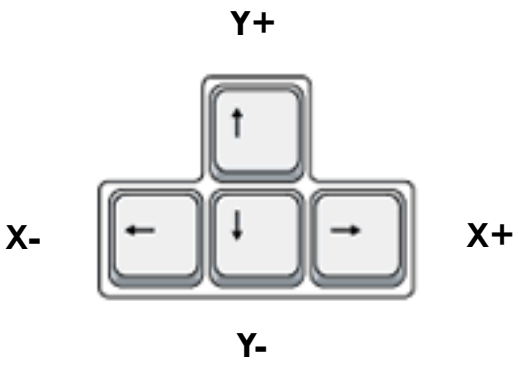


FIGURE 174 JOG KEYS

Note: For information on how to change these shortcut keys or how to create new ones, go to **Error! Reference source not found.***on page* **Error! Bookmark not defined.**.

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 18 FEEDRATE SELECTOR

The green button is a cycle start button which starts a file and the small red button is a feed hold which pauses the file.

.

FIGURE 195 CYCLE START AND FEED HOLD BUTTONS

3.2 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 20 below.

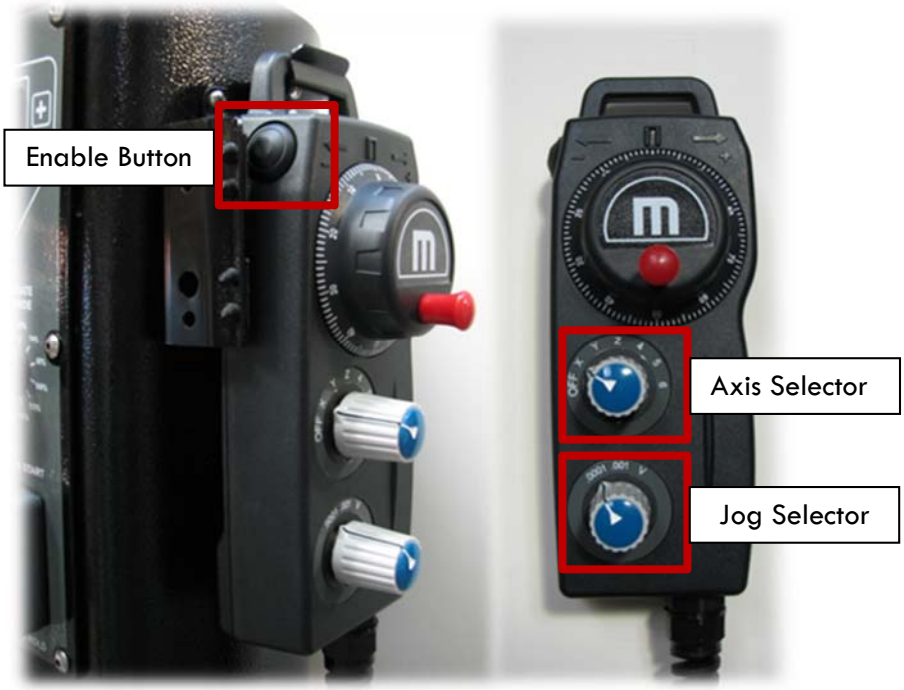


FIGURE 20 PENDANT

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), 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.

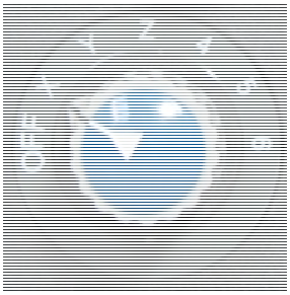


FIGURE 21 AXIS SELECTOR

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 22 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.

3.3 Mouse

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

FIGURE 236 MOUSE

3.4 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 24 KEYBOARD

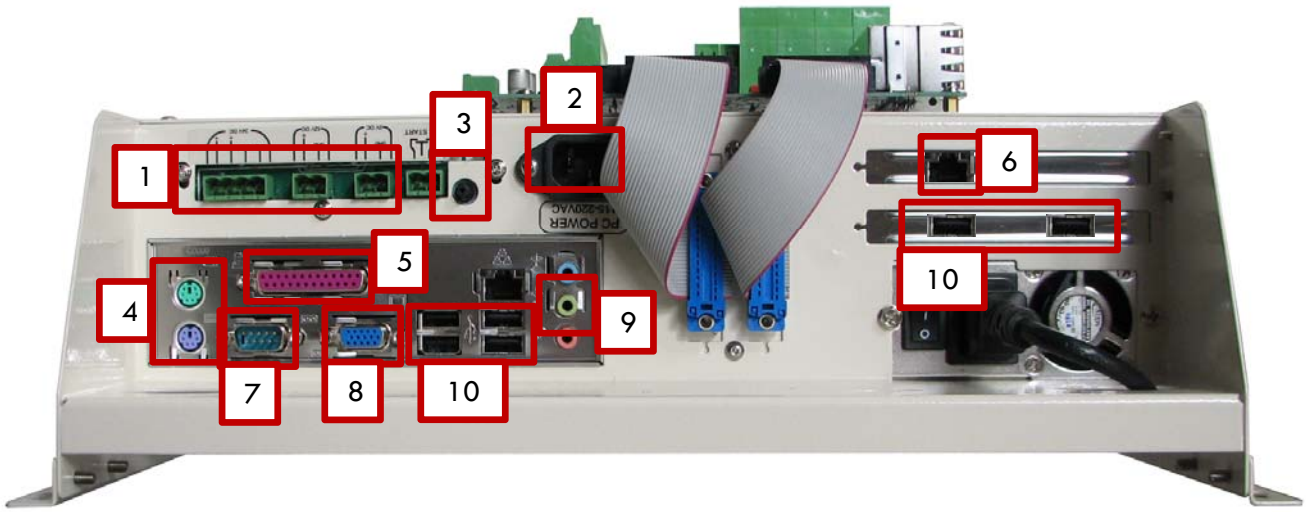
3.5 External USB Port

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 257 USB PORT

3.6 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 Apollo I 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.

4 CONFIGURING YOUR CONTROL

4.1 Removing the Back Panel

To connect your drives and all your I/O, you must begin by removing the back panel of the control. Take out the 10 Phillip screws. Four screws are located on the face of the back panel and six are on the sides.

After removing the cover, you should see the following:

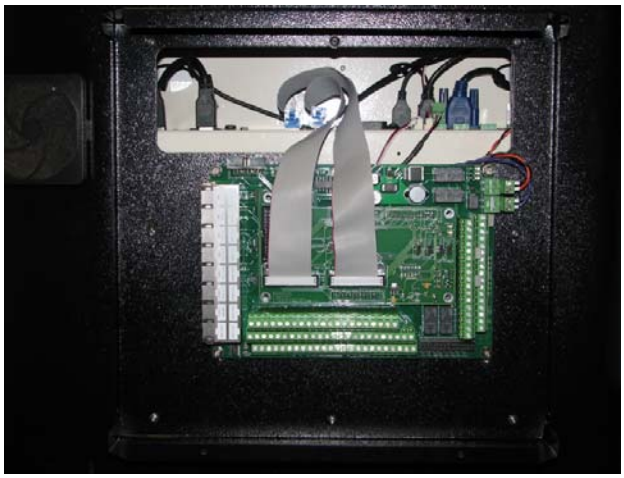


FIGURE 8 BACK PANEL REMOVED

All your drives and external I/O will be wired into the Apollo I Breakout Board shown in the picture below.

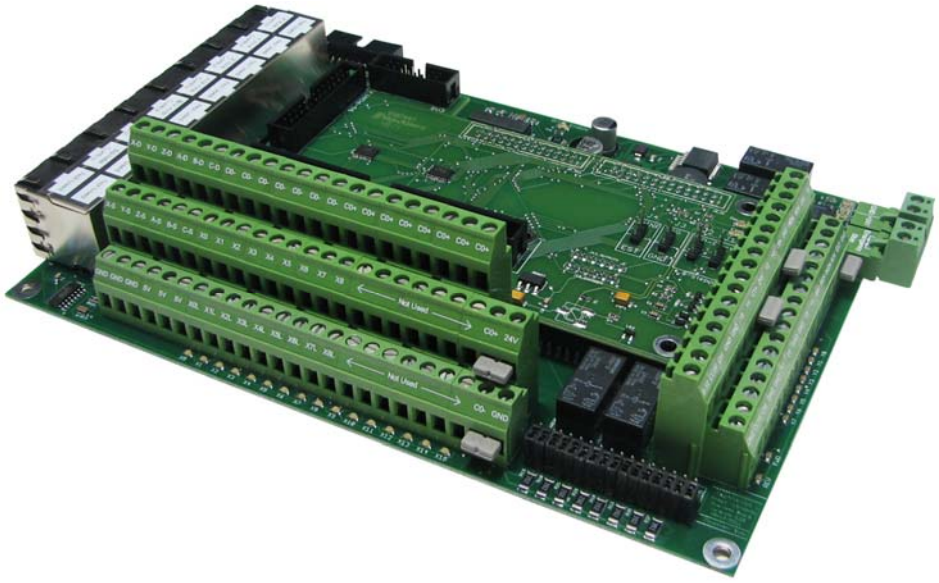


FIGURE 9 APOLLO I BREAKOUT BOARD

Note: For more information about the Apollo I Breakout Board see the Apollo I User's Manual.

4.2 Setting Up Your Axes

Begin by plugging the control cables from your drives into the Apollo I Breakout Board. The Axis Control mod jacks are located on the bottom row of the large mod jack block. See the diagram below.

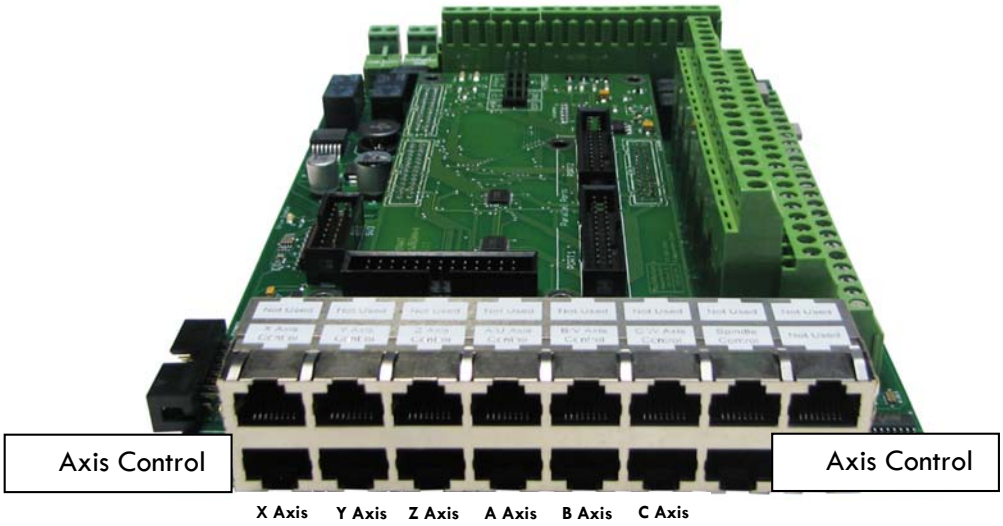
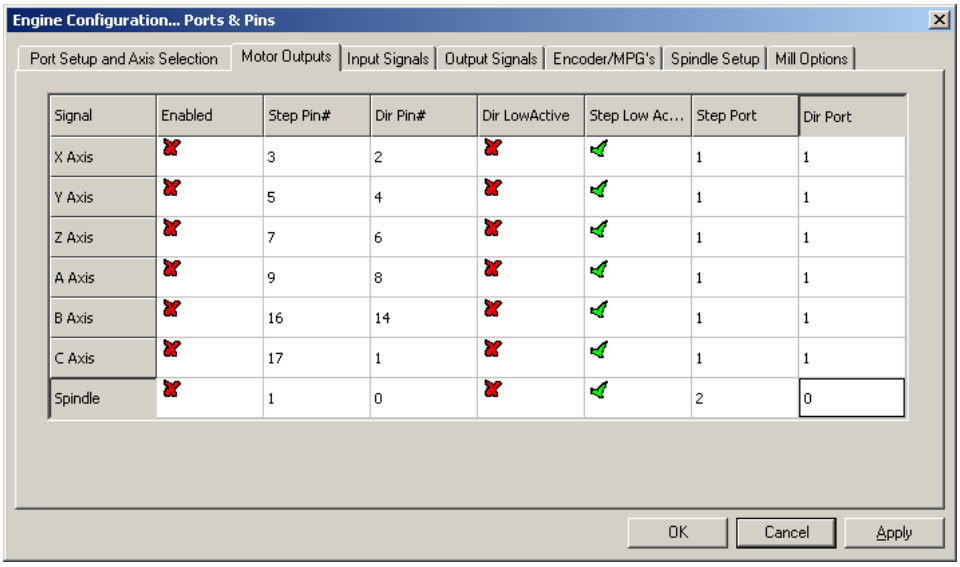


FIGURE 10 DIFFERENTIAL STEP AND DIRECTION MOD JACKS

4.2.1 Enabling Your Axes

After your drives are connected to the Apollo I, open up Mach3, and enable your axes in the following way:

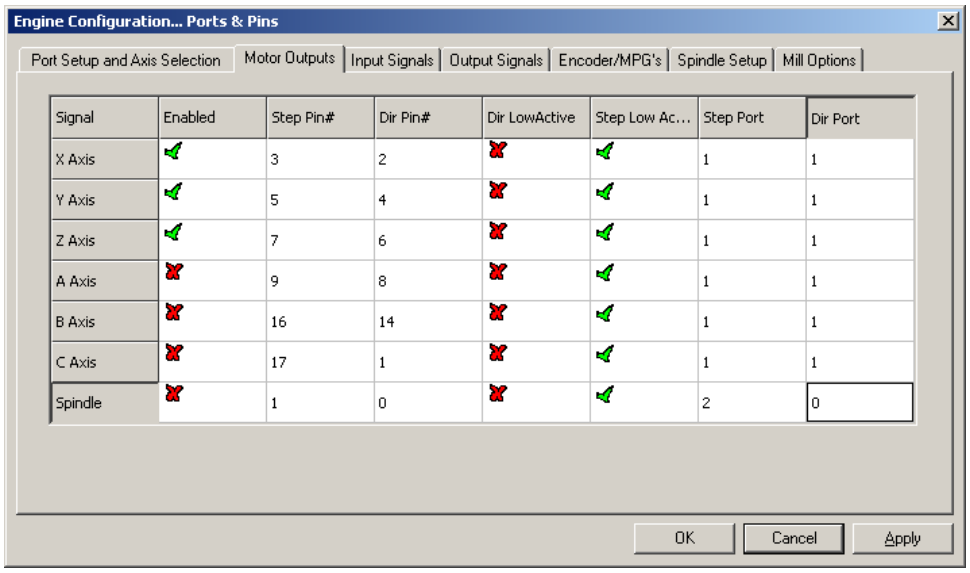
1. On the menu bar, click **Config** and then **Ports and Pins**. A window called *Engine Configuration… Ports and Pins* will pop up. Select the **Motor Outputs** tab and you will see the axis setup as pictured below.



Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac…	Step Port	Dir Port
X Axis	✗	3	2	✗	✓	1	1
Y Axis	✗	5	4	✗	✓	1	1
Z Axis	✗	7	6	✗	✓	1	1
A Axis	✗	9	8	✗	✓	1	1
B Axis	✗	16	14	✗	✓	1	1
C Axis	✗	17	1	✗	✓	1	1
Spindle	✗	1	0	✗	✓	2	0

FIGURE 11 AXIS SETUP

2. 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. **The port and pin numbers must be set up as shown below for anything to work.**



Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac...	Step Port	Dir Port
X Axis	✓	3	2	✗	✓	1	1
Y Axis	✓	5	4	✗	✓	1	1
Z Axis	✓	7	6	✗	✓	1	1
A Axis	✗	9	8	✗	✓	1	1
B Axis	✗	16	14	✗	✓	1	1
C Axis	✗	17	1	✗	✓	1	1
Spindle	✗	1	0	✗	✓	2	0

FIGURE 12 X, Y, AND Z AXES ENABLED

3. Press **Apply** and then **OK**. Now you should be able to jog your motors.

   Just for a reference, you can use the table below to make sure that your axes' ports and pins are configured correctly.

Axis Name	Step Pin #	Dir Pin #	Dir Low	Step Low	Step Port	Dir Port
X	3	2	Red	Green	1	1
Y	5	4	Red	Green	1	1
Z	7	6	Red	Green	1	1
A	9	8	Red	Green	1	1
B	16	14	Red	Green	1	1
C	17	1	Red	Green	1	1
Spindle	1	0	Red	Green	2	0

Table 1 Default Axis Setup

WARNING

You could crash your machine very easily. No limit switches have been set up and your units have not been configured yet.

4.2.2 Calibrating Your Axes

Now you must calibrate your machine. To get your units perfect you must calculate them manually from your machine's specifications. However, you can get them pretty accurate if you use the calibration wizard (Section 4.2.2.2).

4.2.2.1 MANUAL CALIBRATION

You need to calculate how many steps 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
Steppers (10 micro-step)	2000

TABLE 2 MOTOR ENCODER COUNTS

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

1. Calculate your gear reduction using the number of teeth on your pulleys and your gearbox ratio. If your motor is directly driving your axis, then your gear reduction is 1. Otherwise use the formula below.

   Gear Reduction = Screw Teeth / Motor Teeth * Gearbox Ratio

2. Now calculate the distance one motor turn will move your axis by taking the ball screw pitch and dividing it by your gear reduction.

   Distance of One Motor Turn = Ball Screw Pitch / Gear Reduction

3. Next, calculate the number of steps per inch. Find the number of encoder counts for your drive (which can be found on the motor specification sheet or in Table) and divide it by the distance of one motor turn. Next divide it by the drive ratio which is the internal gear inside the drives. This gives you what Mach3 calls your "Steps per."

Motor Type	Drive Ratio
TECO	16
Mitsubishi	125
Steppers (10 micro-step)	1

Table 3 Default Drive Ratios

Steps per = Encoder Counts / Distance of One Motor Turn / Drive Ratio

4. Finally you can calculate your velocity by multiplying your motor's RPM by the distance of one motor turn. This gives you your velocity in inches or millimeters per minute.

   Velocity = RPM * Distance of One Motor Turn

For example, if you are setting up a 3000 RPM TECO motor with a ball screw pitch of 5 TPI (0.2" pitch), ball screw pulley with 36 teeth, and a motor pulley with 18 teeth, calculate your units as follows.

1 Begin by calculating your gear reduction. Take the number of teeth on your screw and divide it by the number of teeth on your motor. In this example the axis has a gear reduction of 2 (36/18).

2 Now calculate the distance one motor turn will move your axis by taking the ball screw pitch and dividing it by your gear reduction. In this example one motor turn will move the axis 0.1 inches (0.2"/2).

3 Next, calculate the number of encoder counts per inch (steps per). Find the number of encoder counts for your drive and divide it by the distance of one motor turn. In this example the steps per inch is 100,000 (10,000/0.1).

4 Finally, you can calculate your velocity by multiplying your motor's RPM by the distance of one motor turn. The velocity in this example is 300 units per minute (0.1*3000).

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.

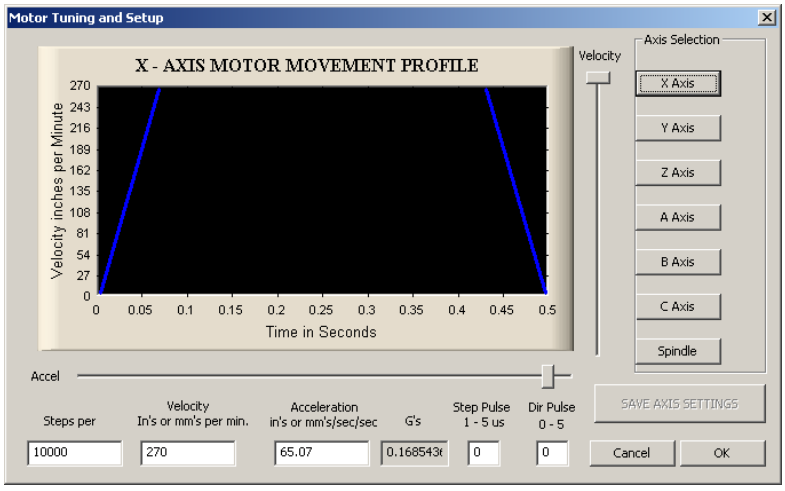


FIGURE 31 MOTOR TUNING AND SETUP

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.

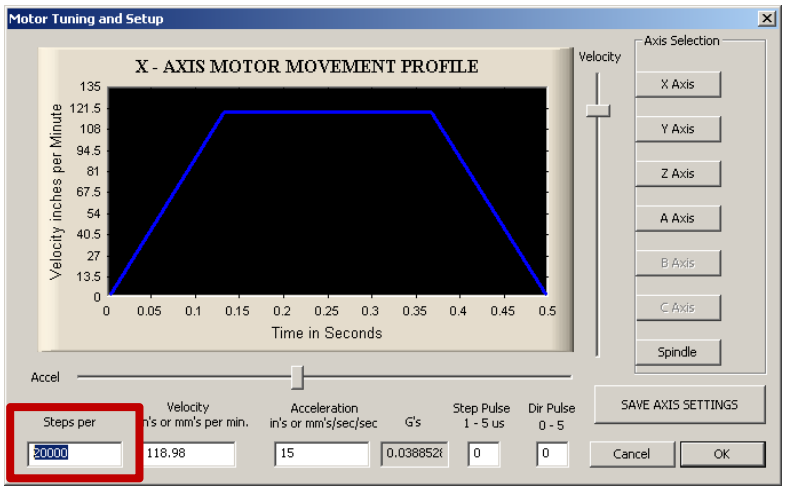


FIGURE 32 STEPS PER IN MOTOR TUNING

Next enter your velocity as shown below.

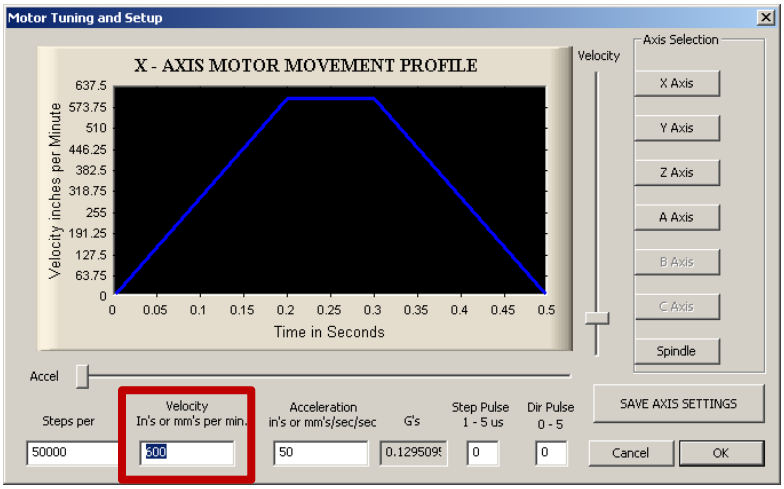


FIGURE 33 VELOCITY IN MOTOR TUNING

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

If your drives are not moving fast enough, you may have to change the internal gear ratio inside your drives. Call MachMotion's tech support team for assistance.

4.2.2.2 CALIBRATION WIZARD

The calibration wizard is located in the **Diagns** screen under the **Mach Settings** tab. Click on the button **Set Steps Per** to begin the wizard. If you do not have the Ultimate screen, then you must go to the **Settings** tab and click on the **Set Steps per Unit** button (right above the **Reset** button).

You will be asked to select an axis and then to enter how far you want the axis to move. After the machine moves, you will need to measure how far it moved and enter it into the wizard. Repeat the wizard for each axis on your machine.

If you want to adjust your velocity, select **Config** on the top menu bar, then **Motor Tuning**. You should see the *Motor Tuning and Setup* window as shown below.

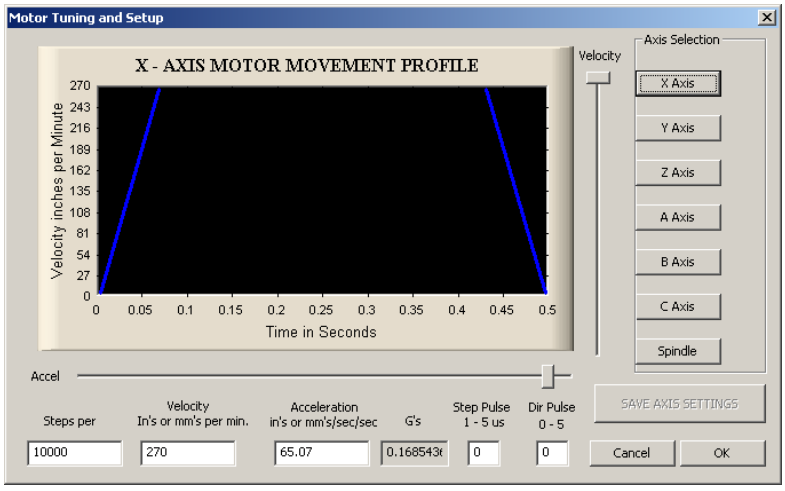


FIGURE 13 MOTOR TUNING AND SETUP

On the right column titled **Axis Selection,** press the button corresponding to the axis you want to set up. The selected axis's parameters will be loaded. Now you can adjust your velocity setting as shown below.

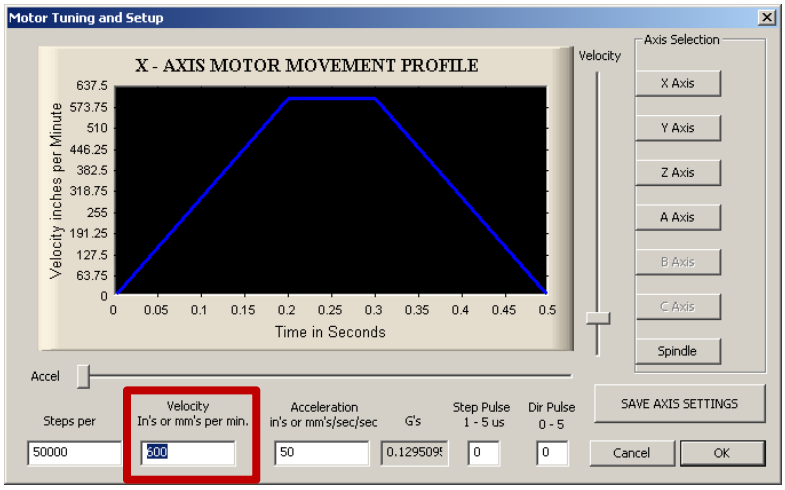


FIGURE 35 VELOCITY IN MOTOR TUNING

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

WARNING

No limits have been set up. You could cause DEATH, INJURY or serious PROPERTY DAMAGE if you are not careful.

4.2.3 Calculating Backlash

The Apollo I 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.

After measuring your backlash, load this value into Mach3. Your backlash value must be in inches or millimeters depending on what units you are using. Click on **Config** and then select **Backlash**. The following window will come up.

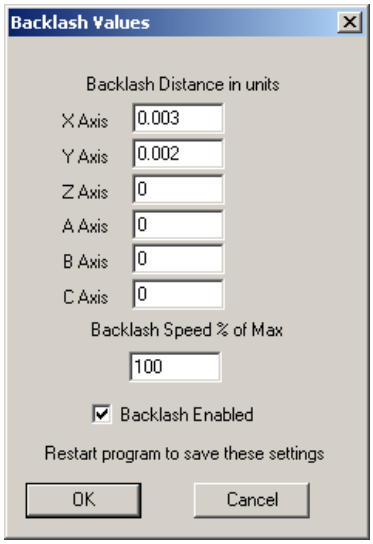


FIGURE 14 BACKLASH

In the figure above, the backlash is set to 0.003" for the X axis and 0.002" for the Y axis. Make sure to check the box **Backlash Enabled** and set the **Backlash Speed** to 100 as shown above.

You can also change the speed that the backlash is applied. Click on **Config**, then select **General Config**. The value **Shuttle Accel** is how fast your backlash will be applied in seconds.

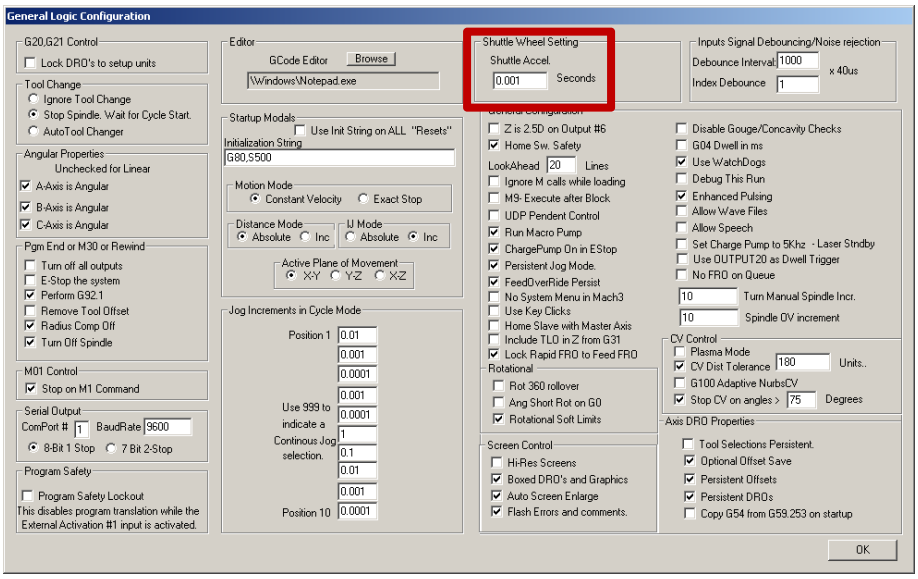


FIGURE 15 SHUTTLE ACCEL

Below is a table of common values.

Drive Type	Seconds
Steppers	1 to 0.1
Servos	0.01 to 0.0001

TABLE 4 BACKLASH TIME

4.2.4 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.**

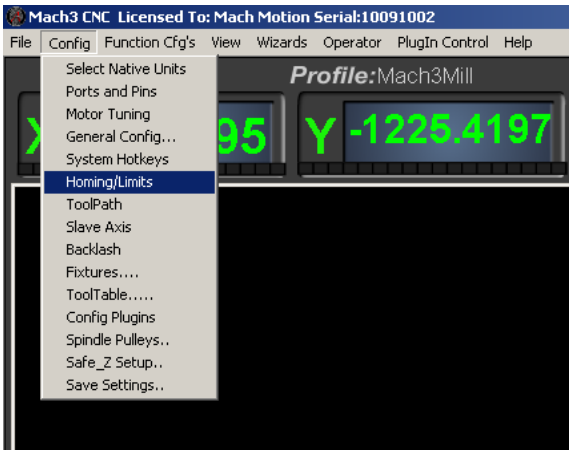


FIGURE 16 HOMING & LIMITS

You will see the following window come up:

FIGURE 17 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.

4.2.5 Slaving an Axis

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

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

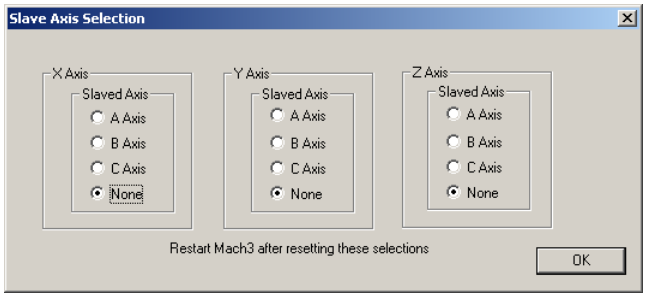


FIGURE 18 SLAVE AXIS SELECTION WINDOW

2. 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.

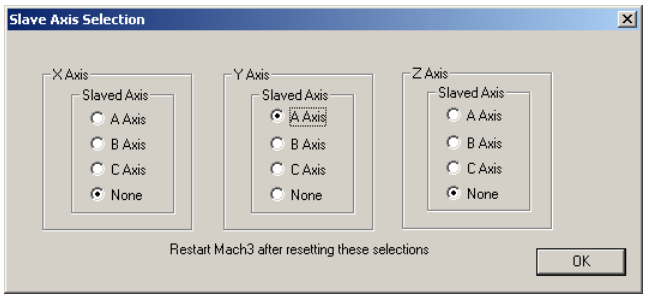


FIGURE 19 A AXIS SLAVED TO Y

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

When Mach3 comes back up, your axis should be slaved correctly.

4.3 Setting up Your Spindle

In this section you will learn how to wire and configure your spindle. The Apollo I spindle control consists of a 0-10V analog signal for spindle speed and two relays (CW and CCW) for spindle direction. Below the spindle terminals there are two LEDs for spindle forward (FWD) and reverse (REV). If these LEDs turn on correctly, then your spindle is set up.

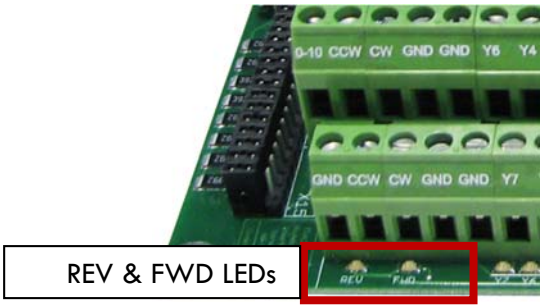


FIGURE 20 SPINDLE LEDS

4.3.1 Wiring Your Spindle

4.3.1.1 VFD FROM MACHMOTION

If you purchased a VFD from MachMotion, setting up your spindle is extremely simple. Just plug the control cable into the Spindle Control mod jack located on the bottom row of the large mod jack block.

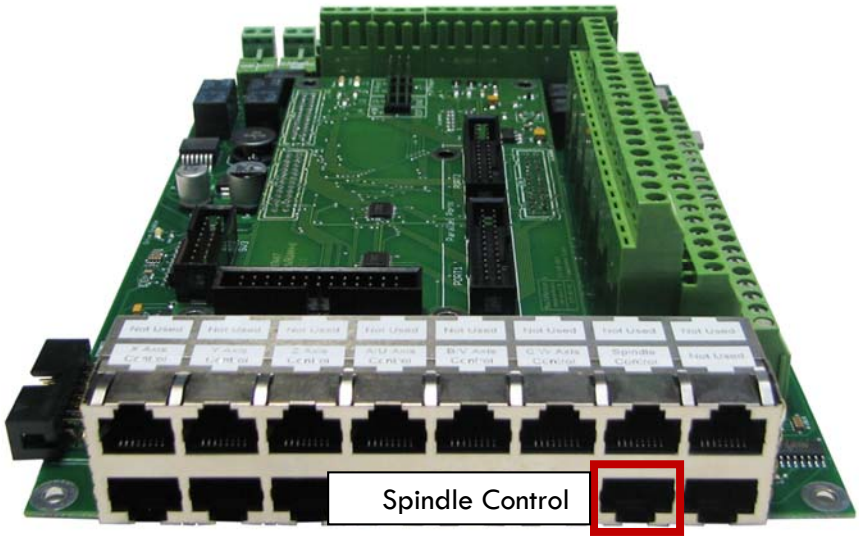


FIGURE 21 SPINDLE CONTROL RJ45 MOD JACK

4.3.1.2 VFD OTHER THAN FROM MACHMOTION

Begin by wiring the CW and CCW connections on the black connector to the common on the VFD. Then wire up analog, analog ground, and forward and reverse into the small green connector. See Figure 22 below.

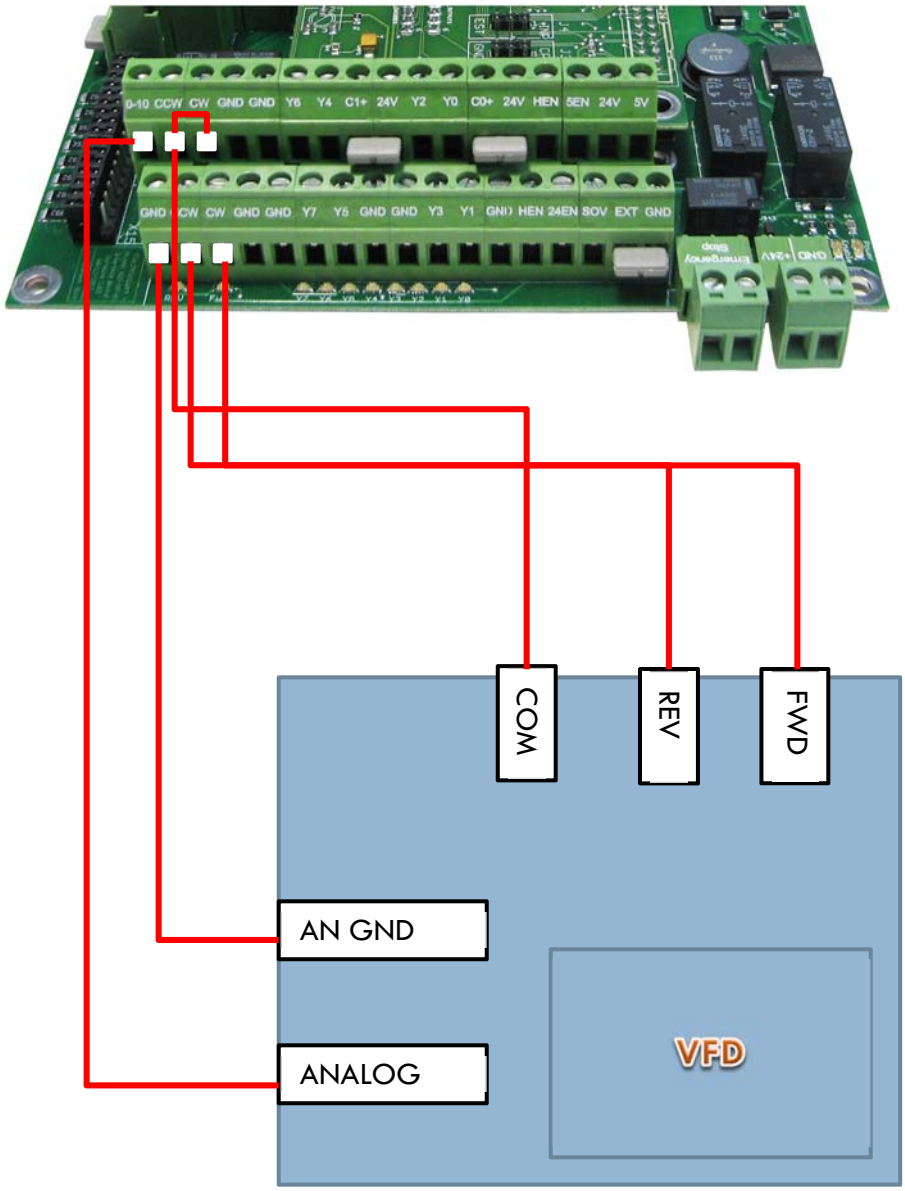


FIGURE 22 VFD NOT FROM MACHMOTION

You can also connect a VFD into the Spindle Control mod jack as shown in Figure 21 on page 28. Make sure to wire up the VFD according to the pinout below.

Function	Analog 0-10VDC	CW Relay	CW Relay	Drive Enable	GND	N/C	CCW Relay	CCW Relay
RJ45 Pins	1	2	3	4	5	6	7	8
Colors	White & Orange	Orange	White & Green	Blue	White & Blue	Green	White & Brown	Brown

TABLE 5 SPINDLE CONTROL RJ45 MOD JACK

4.3.1.3 NO VFD

If you do not have a VFD, wire the spindle into the small green connecter as shown in Figure 23 below. Notice that 24V is wired to the CW and CCW relay contacts on the top row of the green connector.

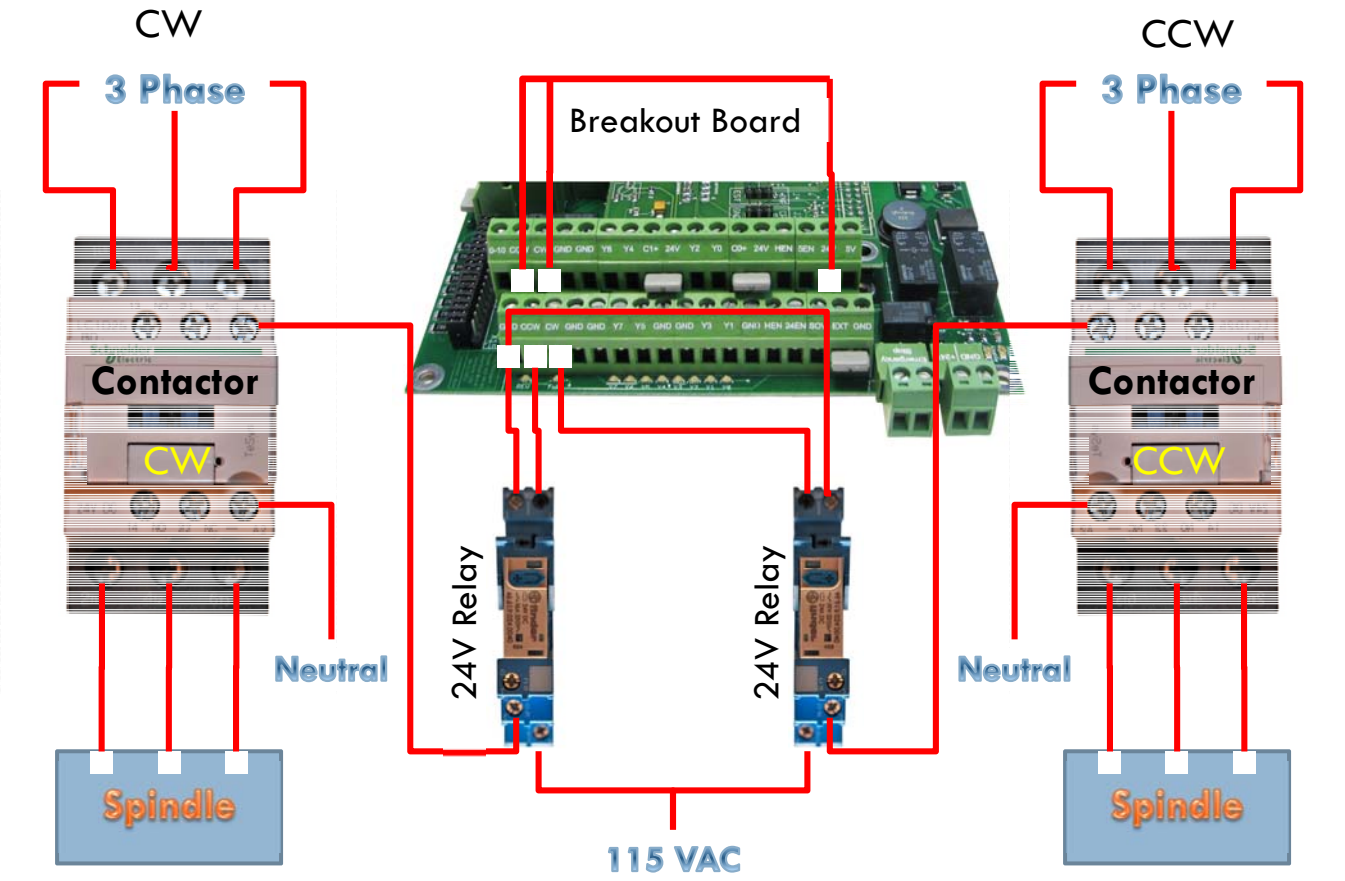


FIGURE 23 SPINDLE

4.3.2 Configuring Your Spindle

Now you are ready to finish setting up the spindle.

4.3.2.1 ENABLING YOUR SPINDLE

Follow the directions below to enable your spindle inside Mach3.

1. 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 port and pin numbers are set up as shown.

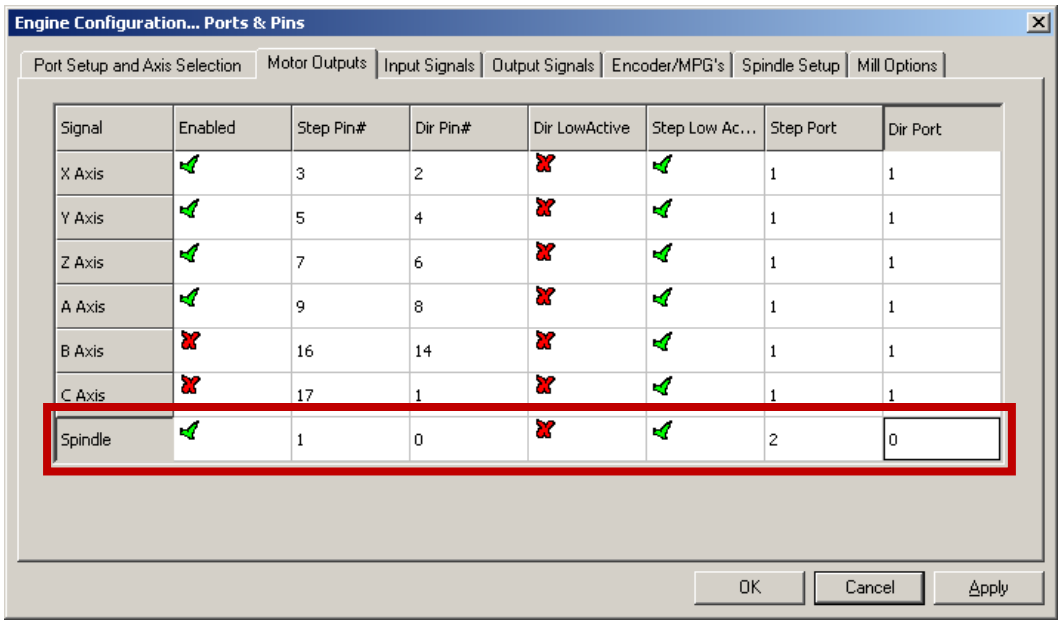


FIGURE 24 SPINDLE SETUP

2. Now click on the **Output Signals** tab. Enable outputs 1 and 2 and set them up to port 2 pin 14 and port 2 pin 16 respectively as shown below. Make sure that the **Active Low** column is set to a red X for both outputs.

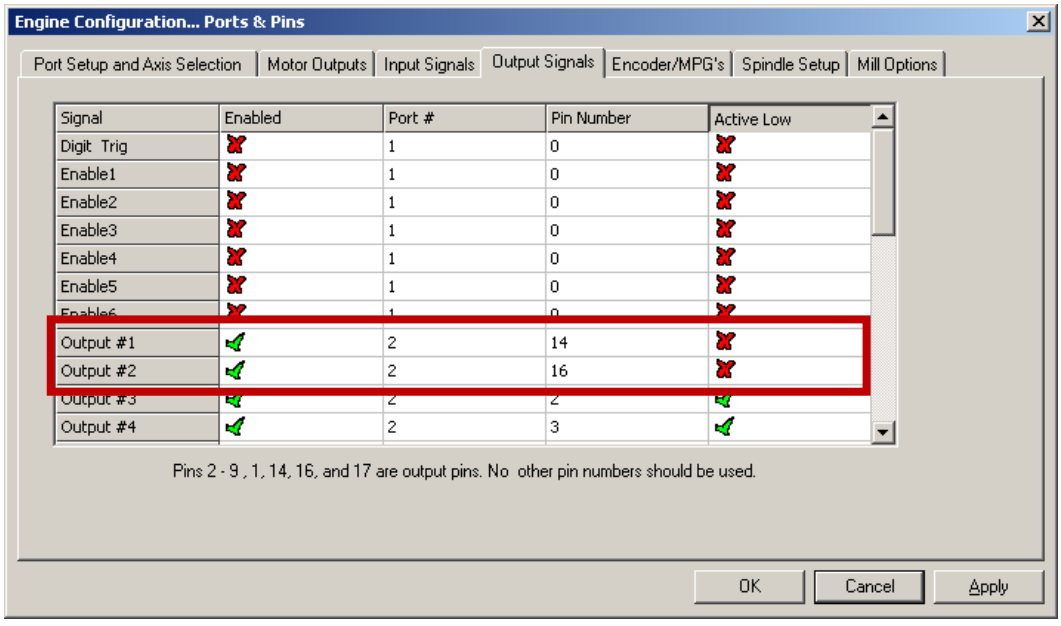


FIGURE 25 SPINDLE OUTPUTS

3. Finally, click on the **Spindle Setup** tab. Make sure the check box **Disable Spindle Relays** is unchecked and that the **Clockwise Output #** is 1 and the **Counterclockwise Output #** is 2. Also, select the check box **PWM Control** and set the **PWM Base Freq.** to 100.

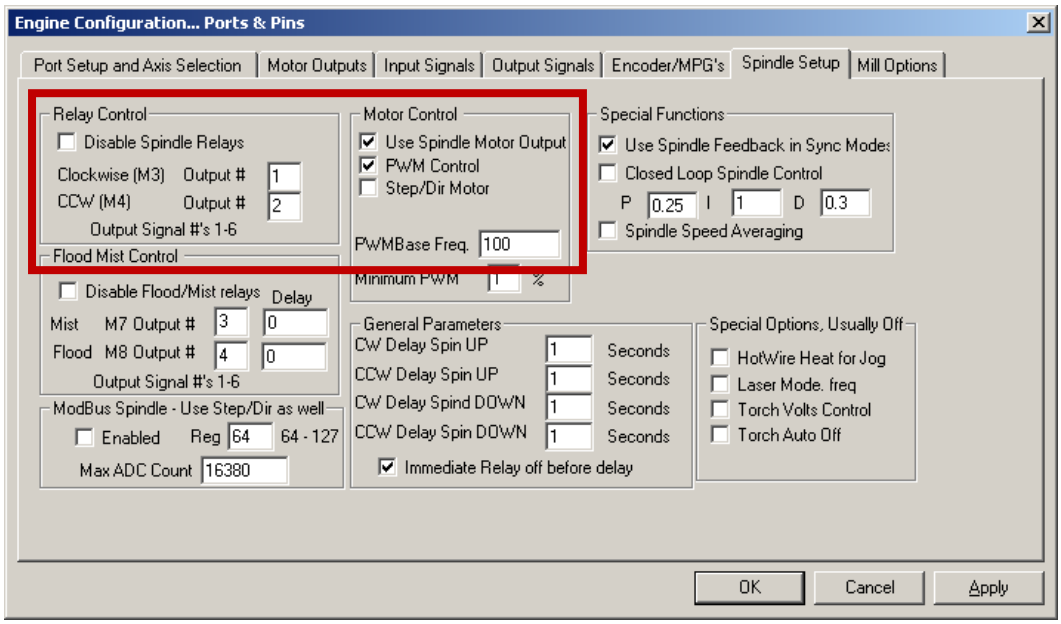


FIGURE 26 SPINDLE SETUP

4. Press **Apply** to save your changes and then **OK**.

Your spindle is now enabled.

4.3.2.2 SETTING UP SPINDLE PULLEYS

For Mach3 to know how to scale the analog voltage output, you must enter in your maximum RPM for the spindle motor. If you have different gears you can set up multiple maximum speeds. Mach3 uses a different pulley for each different speed configuration.

For example, one pulley could be set to 75 to 300 RPM for a low speed (at 300 RPM the control will output 10V). A medium speed pulley could go from 300 to 1200 RPM and high speed pulley could run from 1200 to 2400 RMP.

To change your pulleys, go to **Config -> Spindle Pulleys.** The *Pulley Selection* window will appear as shown in Figure 28.

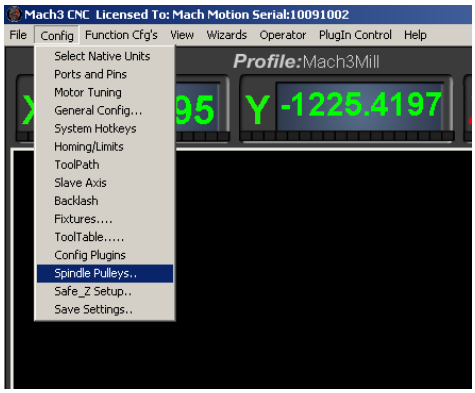


FIGURE 27 SPINDLE PULLEYS

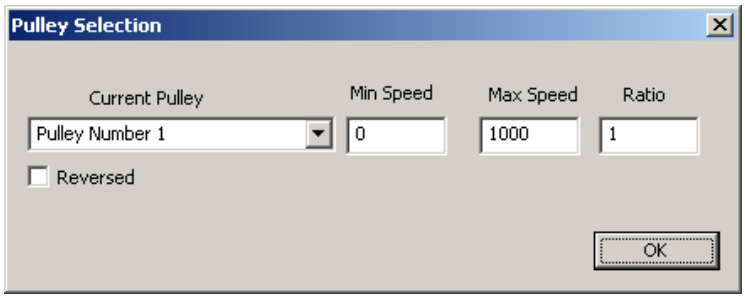


FIGURE 28 PULLEY SPEED SETUP

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**.

Note: Only set up multiple pulleys if your machine has different gears.

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.

4.3.3 Turning on Your Spindle

To turn on you 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 below.

FIGURE 29 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.

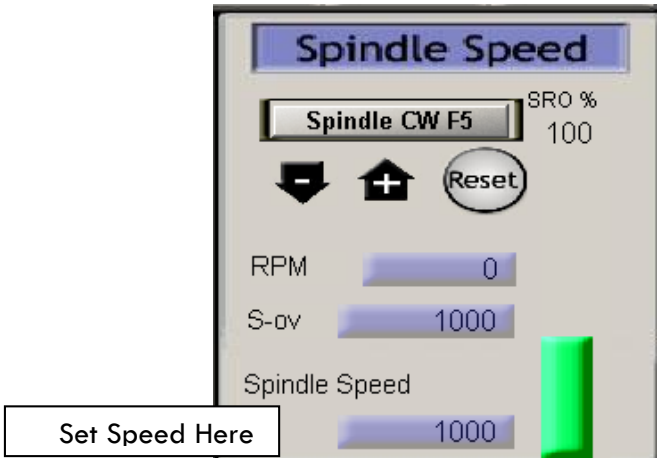


FIGURE 30 SPINDLE SPEED IN RPM

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 31 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.*

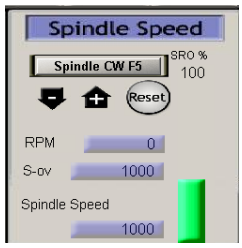


FIGURE 32 SPINDLE SPEED

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

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

TABLE 6 SPINDLE M-CODES

You may also need to change some settings inside your VFD. See the Mitsubishi VFD Installation Guide for more information.

4.3.4 Reversing Direction

To reverse a pulley's direction, go to **Config -> Spindle Pulleys.** Select the pulley that you want to reverse and then check the small box called **Reversed** as shown below.

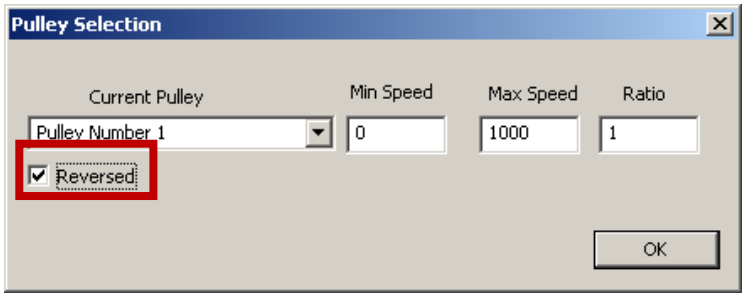


FIGURE 55 REVERSE PULLEY

4.4 Setting Up Your Limits and Homing

The Apollo I Breakout Board has up to 9 inputs that can be used for the limit and home switches. However, if you want to use inputs for other functions also, wire your inputs together in series as shown below.

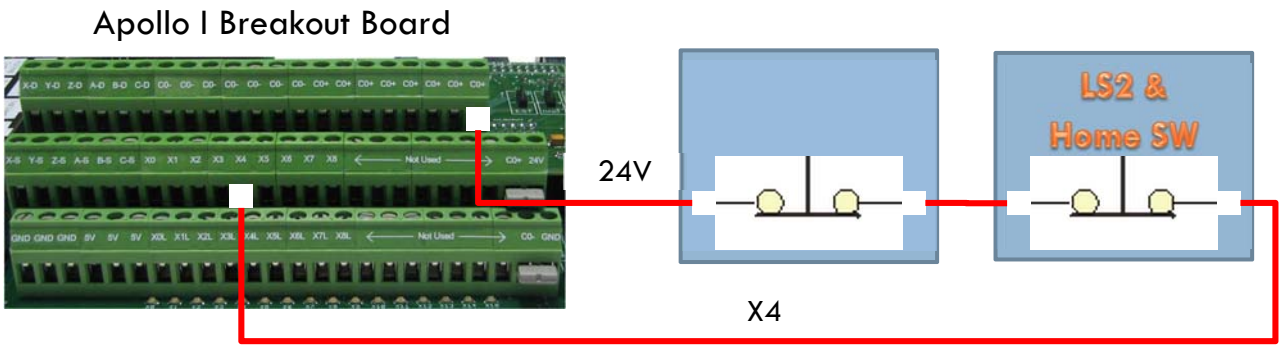


FIGURE 33 LIMIT SWITCHES IN SERIES

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

The standard input allocation is show below.

Axis	Input Number	Axis	Input Number
X	X1	A	X4
Y	X2	B	X5
Z	X3	C	X6

TABLE 7 INPUT PORT AND PIN NUMBERS

To wire up 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 33. Make sure to wire the switches using their normally closed contacts.

3. Wire the remaining side of the first switch to C0+ from the Apollo I Breakout Board. For 24V inputs make sure to jumper C0+ to 24V and C0- to GND on the big green connector as shown below.

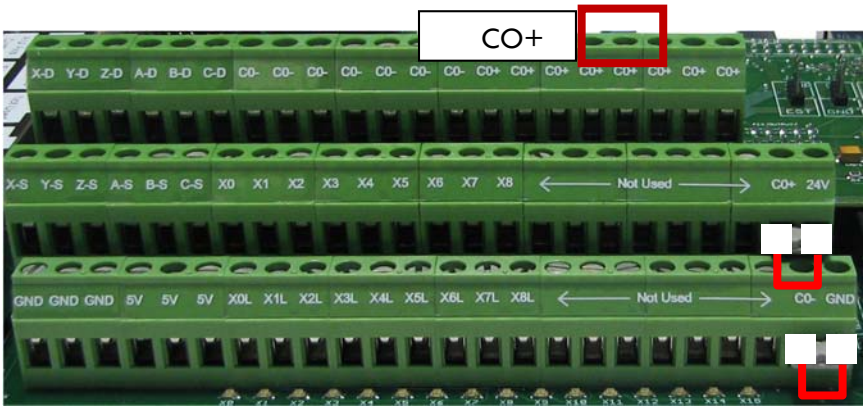


FIGURE 34 24V CONFIGURATION

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

5. On the menu bar at the top of the screen select **Config -> Ports and Pins**.

6. Click on the **Input Signals** tab (See Figure 36).

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. X++ is the forward limit, X—is the backwards limit, and X Home is the homing switch (Figure 36).

   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. Set the **Port Number** and **Pin Number** to the desired input. Use the table below to set up your ports and pins.

Input Number	Port Number	Pin Number
X0	1	10
X1	1	11
X2	1	12
X3	1	13
X4	1	15
X5	2	10
X6	2	11
X7	2	12
X8	2	13

TABLE 8 INPUT PORT AND PIN NUMBERS

The first column to the right of the Enabled column is the Port Number, and the next column is the Pin Number. For example, in the figure below, Y-- is set up for input X2.

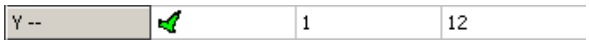


FIGURE 35 LIMIT SWITCHES PORTS AND PINS CONFIGURATION

9. Set up 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 33 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**.

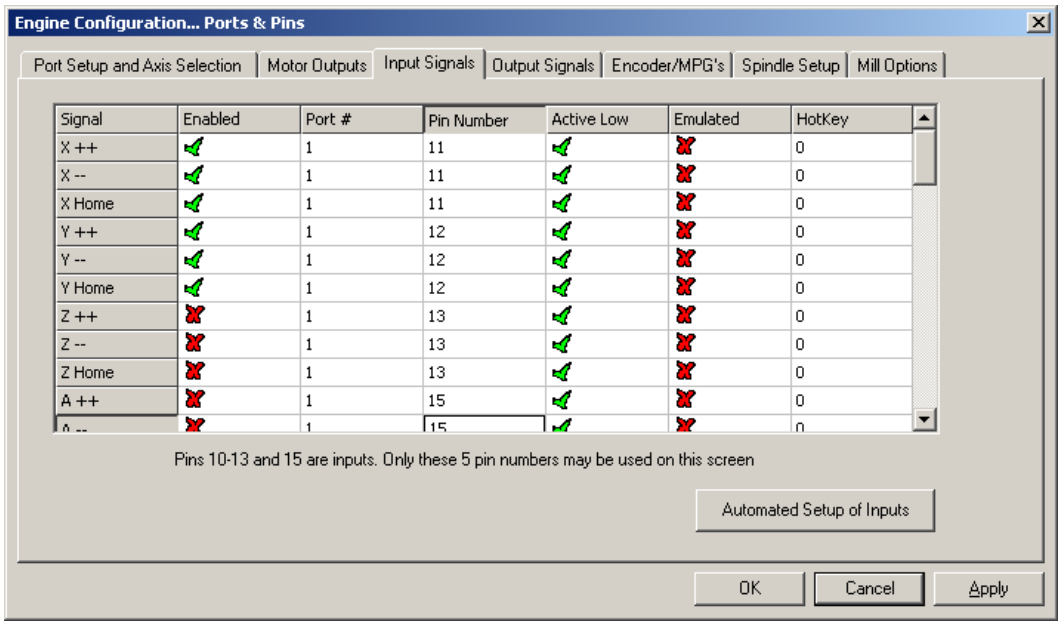


FIGURE 36 INPUT SIGNALS

For example, the configuration above only has X and Y limit and home switches enabled. All of them are wired normally closed. The port and pin for X is port 1 pin 11 (X1) and for Y it is port 1 pin 12 (X2). Notice that all the limit switches and the home switch for an axis have the same port and pin numbers.

4.4.1 Setting up Homing

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

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

FIGURE 37 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 38 REFERENCE BUTTONS

WARNING

If your limit switches are not set up 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.** The *Motor Home/Soft Limits* window will come up as shown below.

FIGURE 39 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. Press **OK** to close the *Motor Home/Soft Limits* window.

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

4.4.2 Setting up Your Soft Limits

Soft limits are utilized to keep your machine from crashing. If the soft limits are set up 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 set up 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 40 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 40).

   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**. The Motor Home/Soft Limits window will come up (See Figure 39).

   *Note: DO NOT try to edit your soft limits in the **Offsets** screen. You must use the Motor Home/Soft Limits window.*

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 41 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 -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. This enables the soft limits. See Figure 42 below. Now when you are jogging or running a G-code file, your machine will stop when it hits a soft limit.

FIGURE 42 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 43 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.

4.5 Setting Up Inputs

4.5.1 Generic Inputs

The Apollo I has 9 configurable inputs. These inputs can be used for limit switches, home switches, tool changers, or anything else. To learn how to set up your limit switches, go to Setting up Your Limits and Homing on page 35. As shown below, the inputs are located on the main green terminal block.

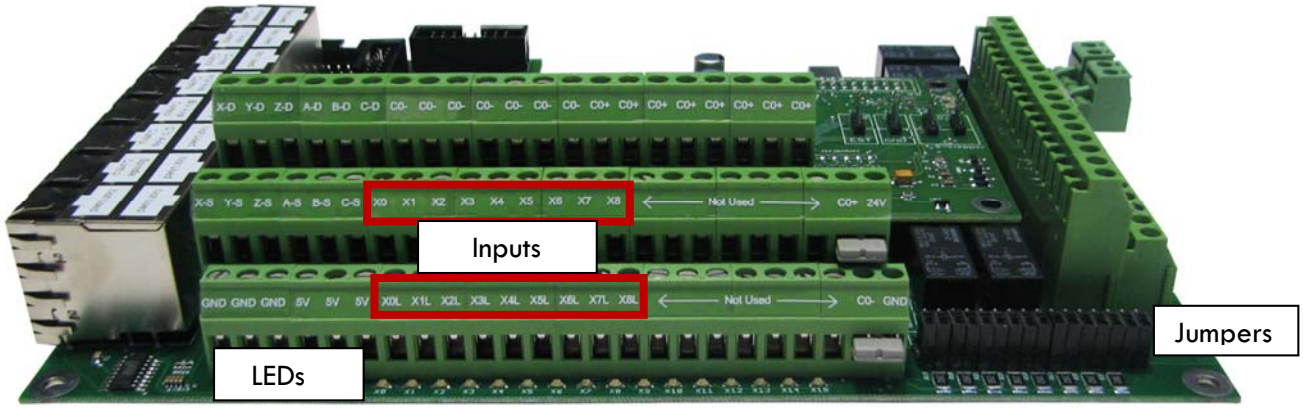


FIGURE 44 INPUTS

Note: Some of the input terminals and jumpers are not used for the Apollo I.

Each input has an LED that shows the current state of the input. Both the LED and input are labeled with the input name. The inputs start counting from X0 and up to X8. If the LED is on, then the input is activated.

Different configurations can be selected for each input by using the jumpers near the bottom right of Apollo I. For more information see the Apollo I User's Manual.

Input X0 is the standard drive fault input. The signal is run to each drive through the control cable. For a standard system, the jumper for X0 is connected to the top two pins and a pull up resistor is connected from X0L to C0+. Do not use input X0 if it has anything connected to it when you receive it from the factory.

4.5.1.1 WIRING YOUR INPUTS

For 24V inputs, make sure the jumpers are on the bottom row as shown below.

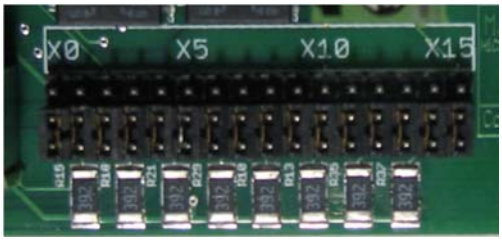


FIGURE 45 JUMPER CONFIGURATION

Next, make sure C0+ is connected to 24V and C0- is connected to GND as shown in Figure 34 on page 37. With the jumpers configured correctly, you are ready to wire in your input.

Connect your input to the input terminal on the middle row (X0, X1, etc). See the diagram below.

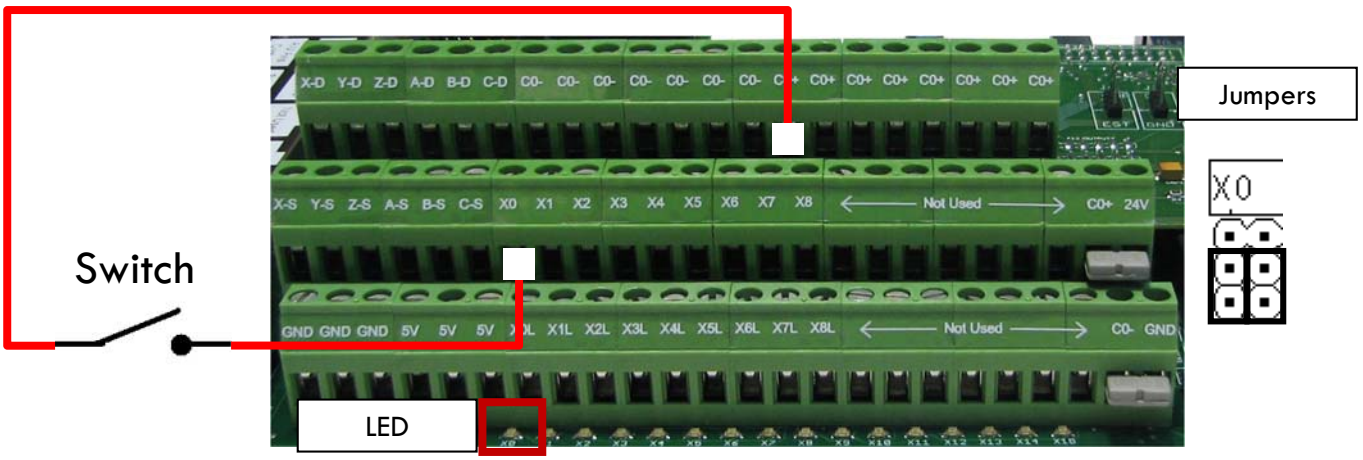


FIGURE 46 STANDARD 24V INPUT

To activate the input, you must supply 24V to the input. A floating signal or a ground will not turn on the input. The LED corresponding to the input will turn on brightly when the input is activated.

4.5.1.2 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.

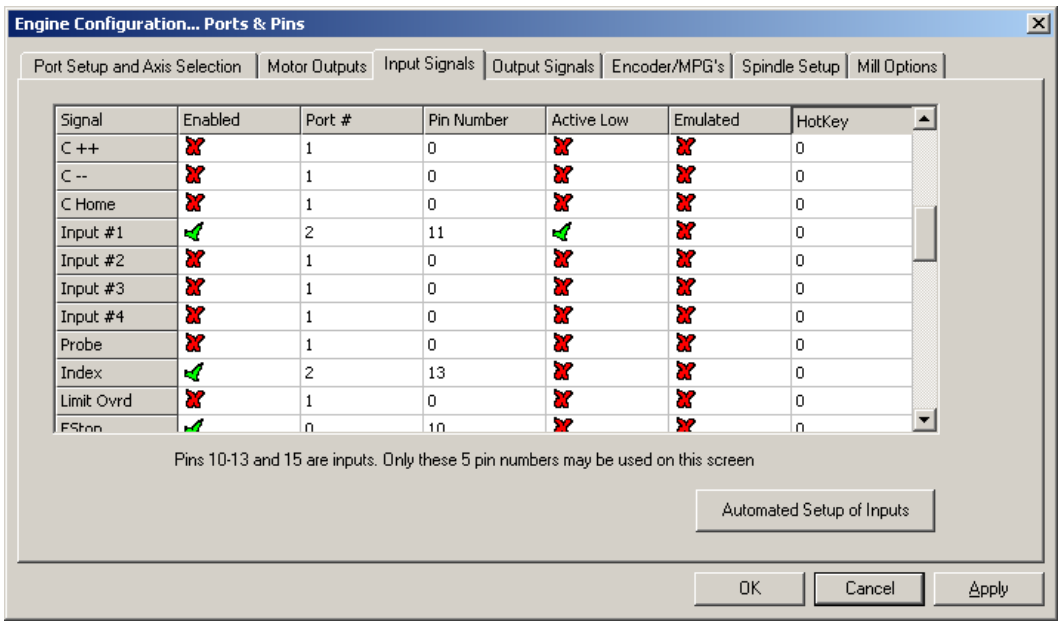


FIGURE 47 INPUT CONFIGURATION

3. Enable the input by clicking on the red **X**. If it is a green check mark, it is already enabled.
4. Set the **Port Number** and **Pin Number** to the desired input. Use Table on page 37 for a reference.
5. To change when the input is active, click on the **Active Low** column. A green check mark means that the input is active low and a red X means that the input is active high.

Your input should now be set up.

4.5.1.3 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 51 for more information on how to use inputs inside the plugin.

4.6 Setting Up Outputs

4.6.1 Generic Outputs

The Apollo I has 8 logic outputs that can be used for any low current application. They are located on the small green terminal block as shown below.

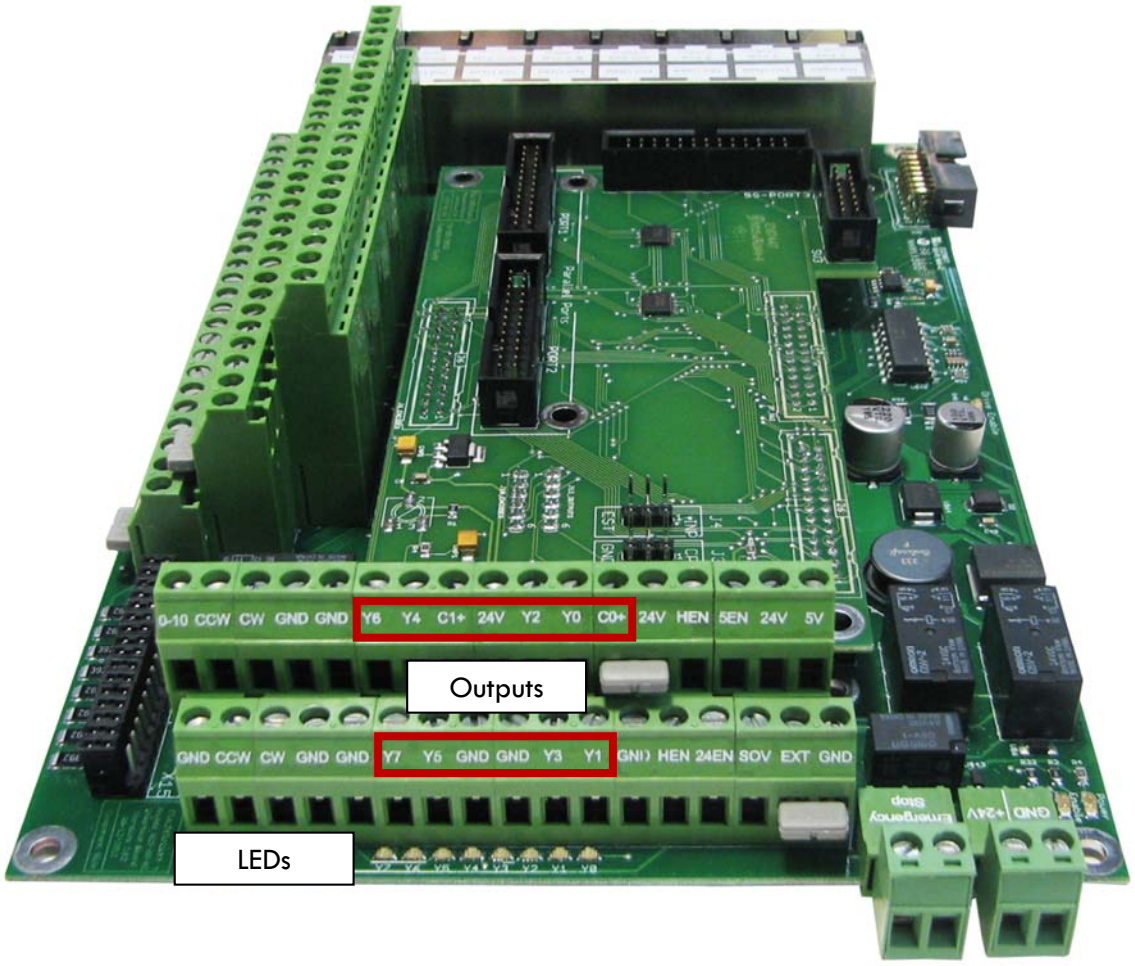


FIGURE 48 OUTPUTS

Each output has an LED that shows its current state. The outputs and LEDs are labeled Y0 through Y7. If the LED is on, the output is activated.

4.6.1.1 WIRING YOUR OUTPUTS

There are two separate commons for the outputs. The common C1+ is for outputs Y0-Y3 and C1+ is for Y4-Y7. Each common can take 7-48VDC. If you are using the voltage supply from Apollo I, each output can only supply 125mA. However, if you supply your own voltage source, each output can source up to 250mA.

For standard operation you can jumper the commons to 24V on the Apollo I. Then connect your signal to the output. See the figure below.

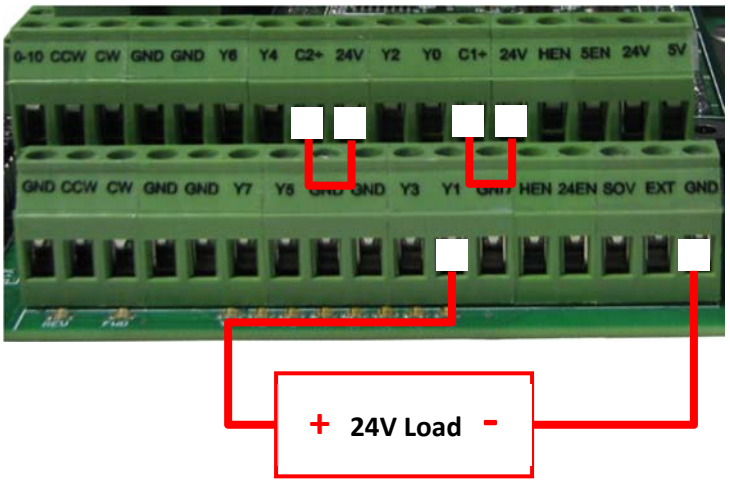


FIGURE 49 STANDARD 24V 125MA OUTPUTS

4.6.1.2 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.

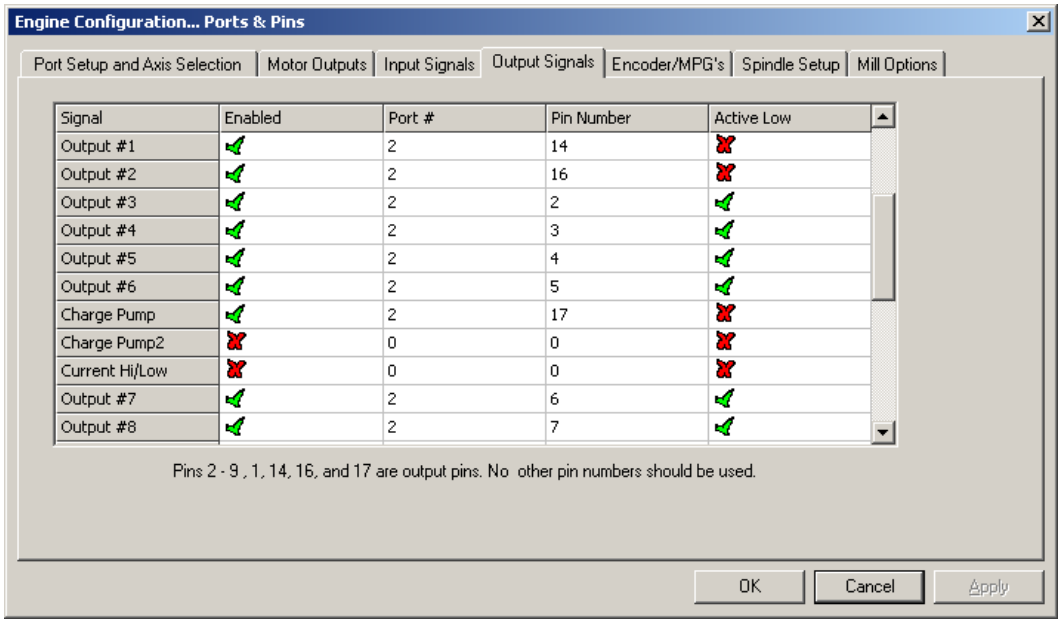


FIGURE 50 OUTPUT CONFIGURATION

3. Enable the output by clicking on the red **X.** If it is a green check mark, it is already enabled.
4. Set the **Port Number** to 2 and the **Pin Number** to the desired output. See the table below for more details.
5.

Output	Port Number	Pin Number
Y0	2	2
Y1	2	3
Y2	2	4
Y3	2	5
Y4	2	6
Y5	2	7
Y6	2	8
Y7	2	9

TABLE 9 OUTPUT PORT AND PIN NUMBERS

6. Finally, to set up an output as normally on, click on the green check mark under the **Active Low** column to turn it into a red X. Otherwise leave this as a green check mark.

Now your output should be set up.

4.6.1.3 USING YOUR OUTPUTS

There are a few ways to control an output. 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 1 M-CODES FOR OUTPUTS

You can also access them inside Brains and inside the MachMotion plugin. Read Advanced Options on page 51 for more information on how to use outputs inside the plugin.

4.6.2 Mist Control

Mist is already preconfigured in Mach3 to be wired into Y0 on the small green connector.

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!

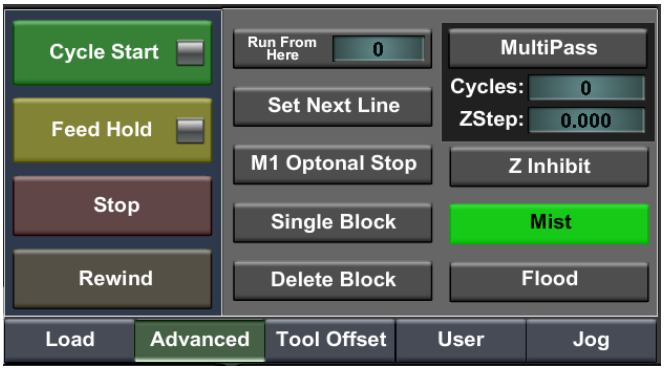


FIGURE 51 MIST BUTTON

Note: M9 turns off both mist and flood.

4.6.3 Flood Control

Flood is already preconfigured in Mach3 to be wired into the Y1 on the little green connector.

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!

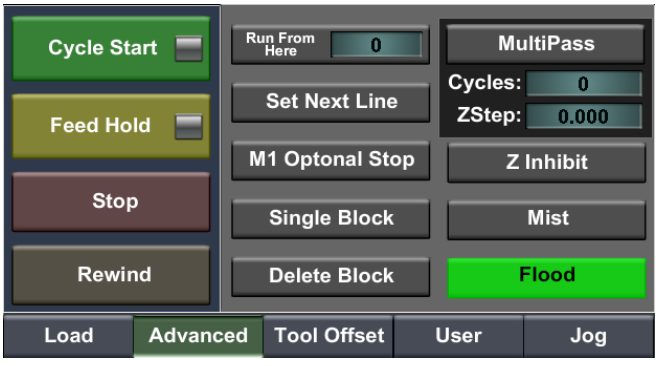


FIGURE 52 MIST BUTTON

Note: M9 turns off both mist and flood.

4.7 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 set up 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.

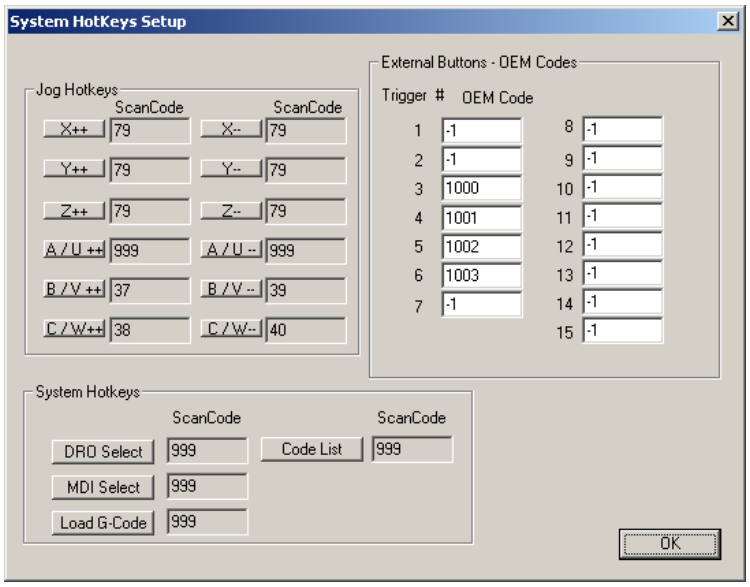


FIGURE 53 SYSTEM HOTKEYS

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 54 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.**

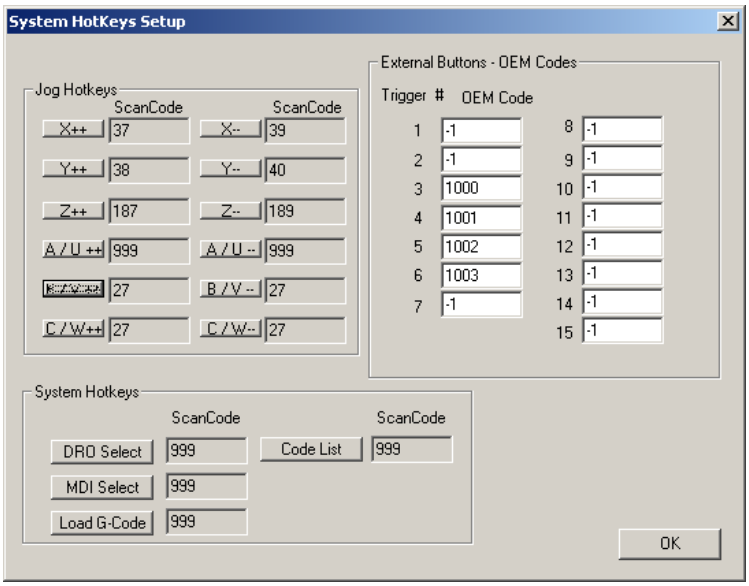


FIGURE 78 HOTKEYS EXAMPLE

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

4.8 Advanced Options

A number of advanced features can be accessed and configured in the MachMotion plugin such as periodic oiler control and custom user messages. Begin by going to **PlugIn Control->MachMotion Config** to open the MachMotion plugin.

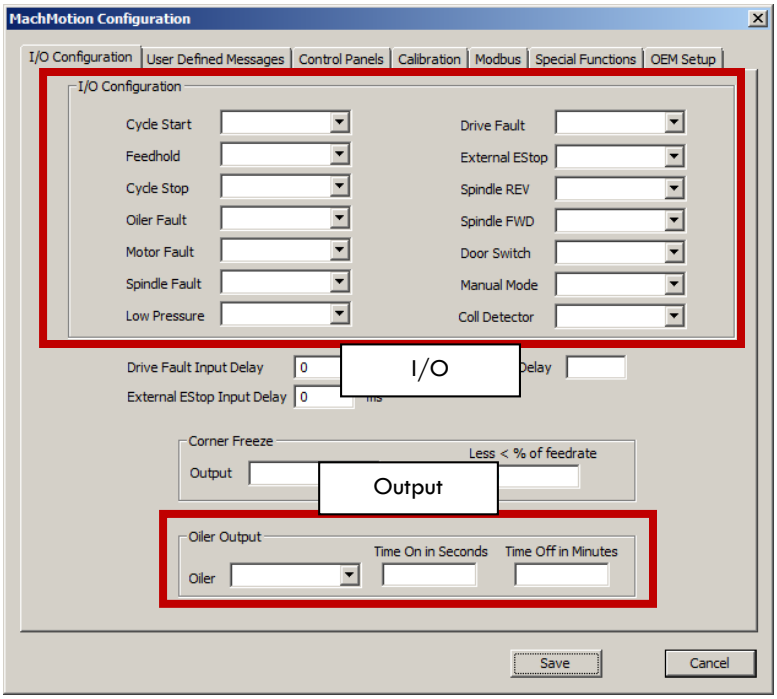


FIGURE 79 - MACHMOTION PLUGIN, IO CONFIGURATION

In general, only change values and settings in the red boxes shown above. The rest of the options are used to set up the control at the factory. Please do not change these settings.

The I/O Configuration section allows an input to turn on a function. 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 set up an external E-Stop, configure a normal input in ports and pins (See Setting up Inputs). Let's assume we set up Input 4. Then use the drop down menu in the System Configuration window to select the input as shown below.

The system may also require an oiler. Just define an output, set the time run time of the oiler, and the time between cycles. 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 on for the oiler to turn on.

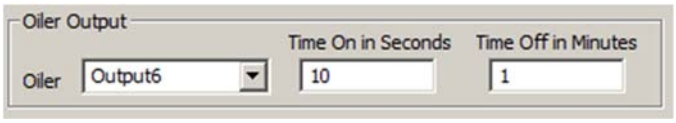


FIGURE 80 OILER

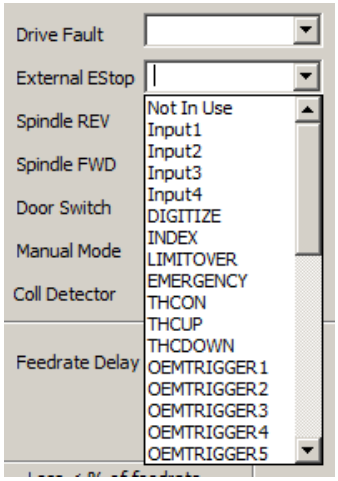


FIGURE 81 CYCLE START

Now whenever Input4 is active, E-Stop will be flagged.

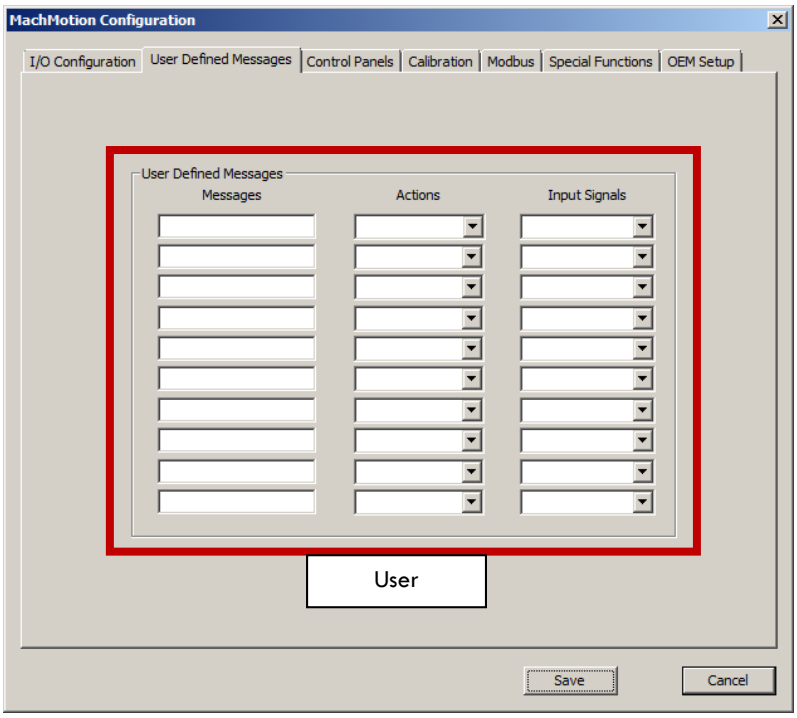


FIGURE 82 - MACHMOTION PLUGIN, USER DEFINED MESSAGES

The User Messages can be configured to have custom messages displayed. Each input will do a specific function (E-Stop, feed hold, 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.

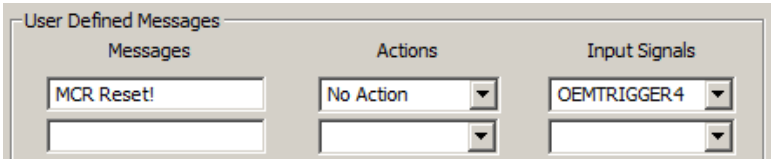


FIGURE 83 USER MESSAGES

5 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.

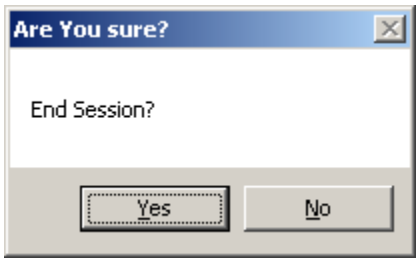


FIGURE 84 END SESSION

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

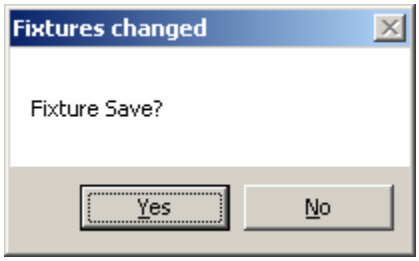


FIGURE 85 FIXTURE SAVE

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.

6 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, 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.
  - Is the motion in each axis smooth? If not, try adjusting the acceleration in the motor tuning.
  - 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 25).
- ☐ 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 20).
- ☐ 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 24).
- ☐ 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 27).
- ☐ 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 32).
- ☐ Press Home All or Reference All.
  - Does each axis hit its home switch and back off of it? If not, setup homing (See page 39).
- ☐ 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 40).
- ☐ 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 36).
- ☐ 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 49).
- ☐ Run a G-Code file.
  - Does it run correctly?

7 FINDING INFORMATION FOR YOUR CONTROL

7.1 Documentation

For more information you can view many more manuals under the **Manuals** folder on your desktop.

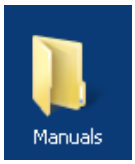


FIGURE 86 MANUALS

You can find all our latest manuals plus other information online at www.machmotion.com .

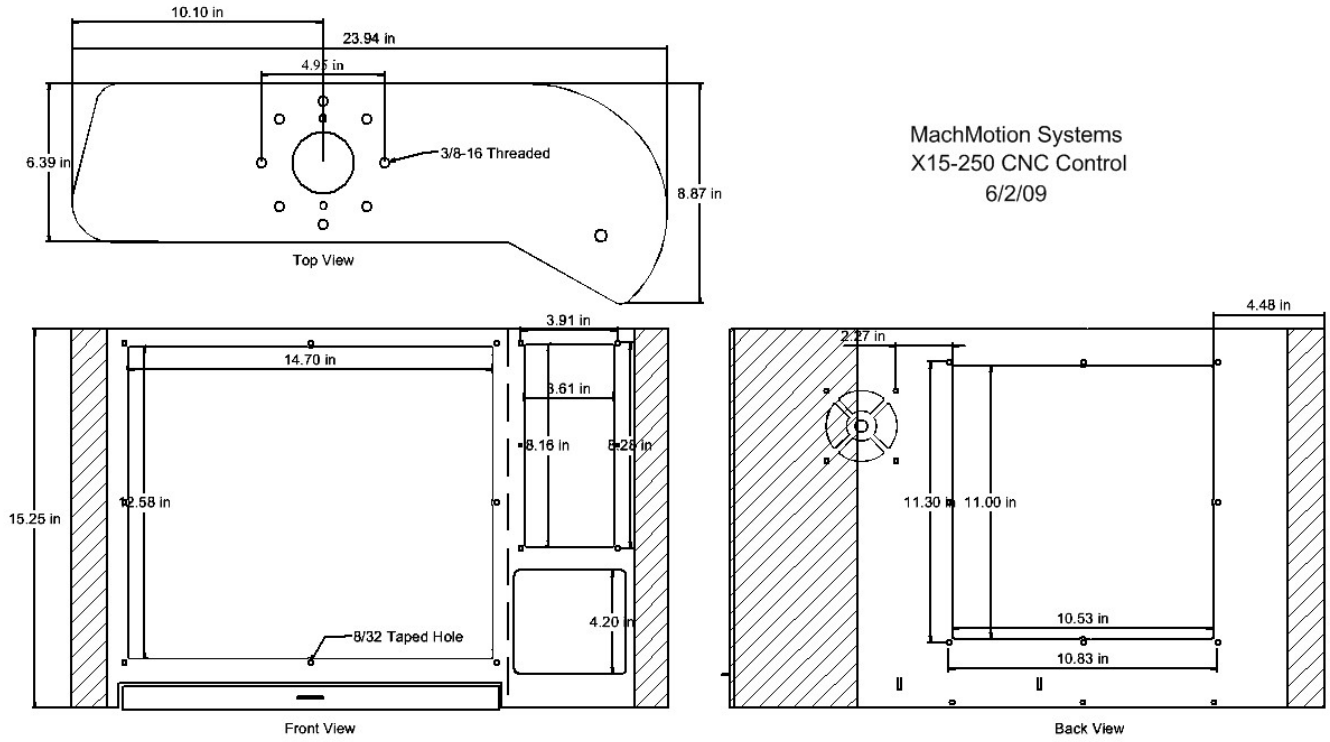
8 SPECIFICATION

Below is the specification for a standard X15-250-A1 CNC 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	1
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,
Optional Pendant	Hand-wheel & Selector Switches
Motion & I/O Interface	Apollo I Breakout Board

Table 10

Below is the X15-250-A1 CNC Control drawing.



9 APPENDIX

9.1 Warranty Information

MachMotion guarantees 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 repaired or exchanged free of charge. For warranty service the customer must contact MachMotion for an RMA number and then return the defective product to MachMotion. If a product is sent to MachMotion without an RMA number, the product may be misdirected or delayed. When a product or part is exchanged, any replacement item becomes the customer's property and the replaced item becomes MachMotion's property.

If the defect is found to be caused by improper use or installation, the warranty is void. Otherwise the product will be repaired or exchanged and returned to the address located on the Product Return/Repair Form.

MachMotion will cover ground shipping cost for the replacement/repaired product being returned to the customer. MachMotion does offer expedited shipping at the customer's expense.

If a replacement product is needed quickly, a replacement can be sent immediately. In this case the customer will be charged for the replacement part at the time of the order and be refunded that charge when the defective component is returned to MachMotion, assuming the defective item falls under the warranty guidelines. MachMotion will issue a refund within two work weeks after receiving the faulty component.

9.2 Additional Resources

Additional manuals and resources can be found at MachMotion.com

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