Apollo III

MANUAL – MACH3

MachMotion

Specializing in CNC Automation and Motion Control

11/10/14 R0124

This manual covers the setup and configuration of the Apollo III motion controller connected to the 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

Apollo III

R0124

Table of Contents

This page intentionally left blank

Part 1:

INSTALLATION & SETUP

WARNING

Improper installation of this motion controller can cause DEATH, INJURY or serious PROPERTY DAMAGE. Do not attempt to install this controller until thoroughly reading and understanding this manual.

1 PART 1: INTRODUCTION

1.1 Overview

The Apollo III is MachMotion's Ethernet motion controller. It uses differential or single-ended step and direction to control up to 6 axes with full encoder feedback (full closed loop). It also has 16 inputs, 8 outputs, excellent position resolution, two MPG inputs, and spindle encoder feedback

1.2 Tool Required

To use the Apollo III, the following items are necessary:

- 24VDC Power Supply
- Emergency Stop Circuit
- Control with Mach3 and Ethernet Port
- Small flat head screw driver

MachMotion CNC controls come with the above items, except the screw driver.

1.3 Reference Diagram

Use the diagram below as a reference throughout the manual.

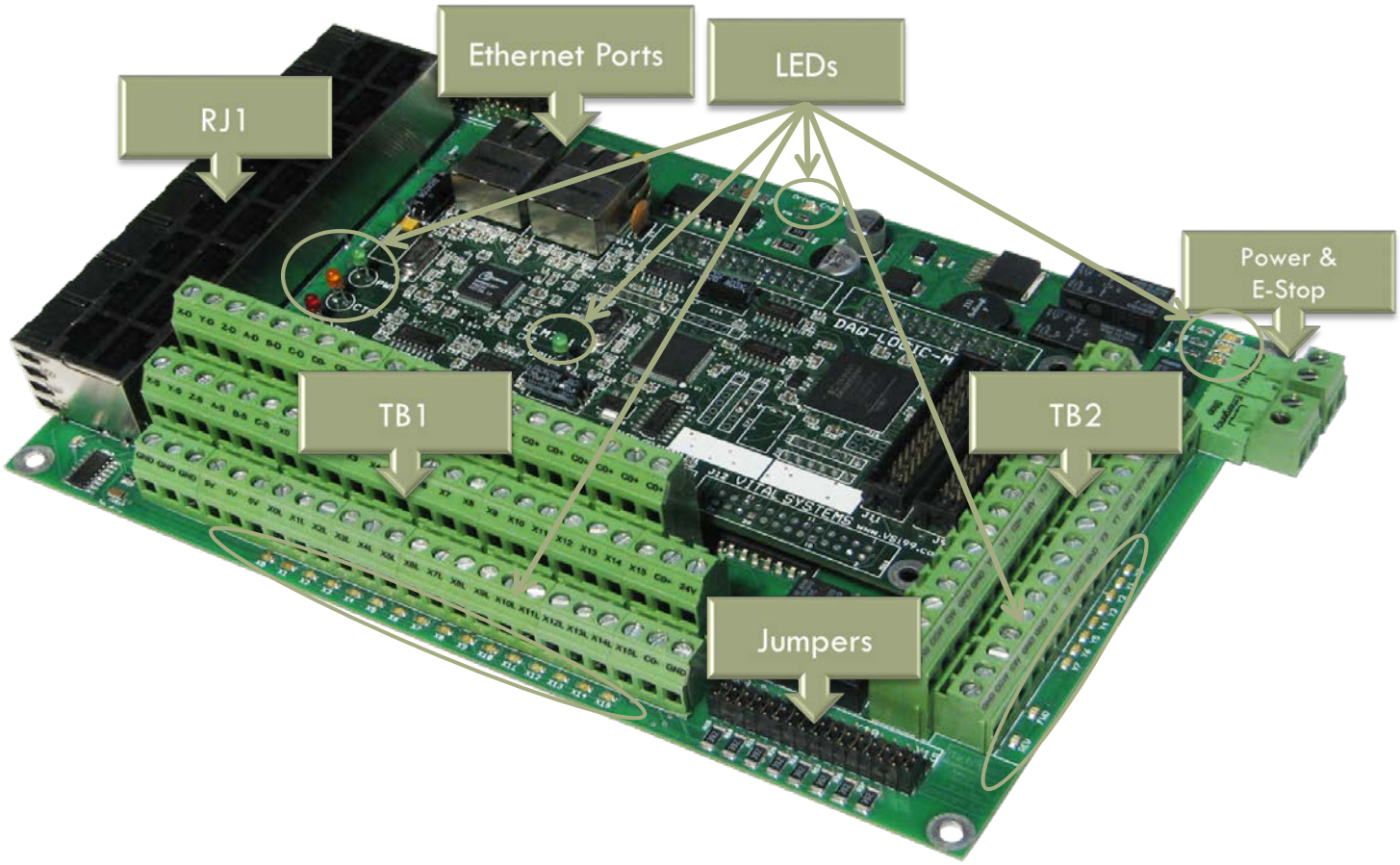


FIGURE 1 APOLLO III OVERVIEW

WARNING

DO NOT connect 115VAC to any part of the Apollo III motion controller. It could cause serious damage to the controller.

1.4 Status LEDs

The Apollo III has four status LEDs that show the status of the controller's processor. The LEDs are located close to the center of the controller. See the figure below.

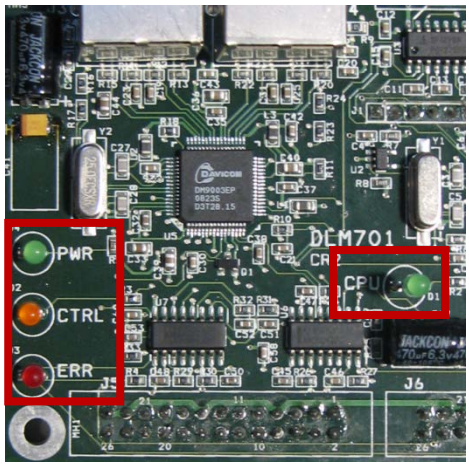


Figure 2 Status LEDs

Color	Label	Function
Green	PWR	Power is supplied to Apollo III
Orange	CTRL	Apollo III has an enable signal from control
Red	ERR	Apollo III has an error
Green	CPU	Apollo III CPU is running (should be flashing when power is supplied)

TABLE 1 - APOLLO III STATUS LEDS

1.5 Specifications

Below are the specifications for the Apollo III motion controller.

Item	Specification
Input Power	24VDC
Max Power Consumption	48W
Axes	6
Step and Direction Axis Control	5V Single Ended and Differential
Connection	RJ45 Connectors and Terminal Blocks
Max Pulse Speed	1.6 MHz
Encoder Feedback	5V Differential
Connection	RJ45 Connectors
Max Frequency	6.25 MHz
Spindle	1
Relay Outputs	Clockwise (CW) and Counterclockwise (CCW)
Analog Signal	0-10VDC
Encoder Feedback	5V Differential
Outputs	8
Voltage	7V-48VDC*
Max Current	250mA**
Commons	2
Inputs	16 (Sinking or Sourcing)
Voltage	2.5V-48VDC
Min Current	2mA
Isolated	Optional
Enable Circuit	2
Hardware Enable	Relay Contacts, 5V Enable, 24V Enable
Drive Enable	Relay Contacts
Emergency Stop Circuit	Normally Closed Connection
Ethernet Port	10/100 MHz
Dimensions	8.32"(L) X 5.75"(W) X 2"(H)
Optimal Temperature Range	32° to 100°F (0° to 38°C)

TABLE 2 - SPECIFICATIONS FOR THE APOLLO III MOTION CONTROLLER

*Only 24V is provided on the motion controller. Any other voltage must be supplied. **Commons must be supplied externally. If the commons are using the Apollo III power supply, each output can only source 125mA.

1.6 Drawing

Below is a drawing of the Apollo III.

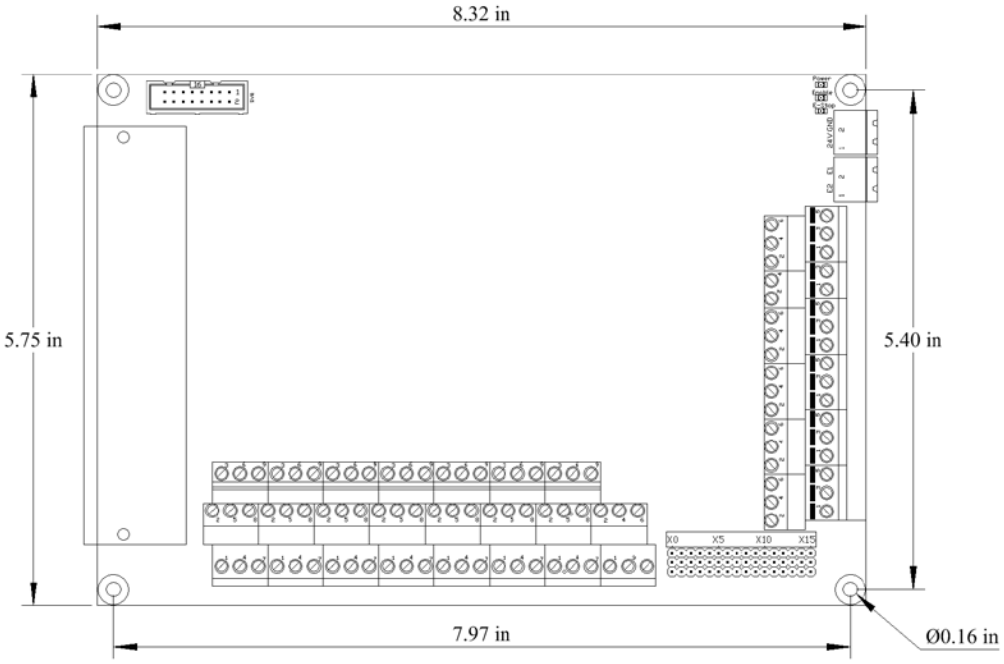


FIGURE 3 - APOLLO III MOUNTING HOLES

The controller can be mounted on any solid surface that will be protected from dust and dirt. Use a minimum of 3/8 inch standoffs to prevent electrical shorts.

Scale drawing of the Apollo III and mounting case are located in Appendices, pages 83 and 85.

Hardware Startup

To power the Apollo III, you must supply 24VDC to the power connection located at the top right of the board as shown below. The top orange LED labeled Power will turn on.

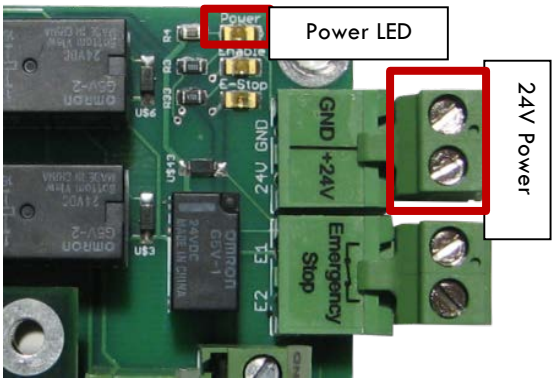


FIGURE 4 24V POWER CONNECTOR

1.7 Software Startup

On the desktop of your control there is a Mach3 shortcut for your machine type. Below are examples of a Mill, Lathe, and Plasma shortcut.

FIGURE 5 PROFILES

There is also a shortcut for Mach3 Loader. This allows any of the profiles to be loaded from one location. Double clicking on the Mach3 Loader shortcut opens the following window:

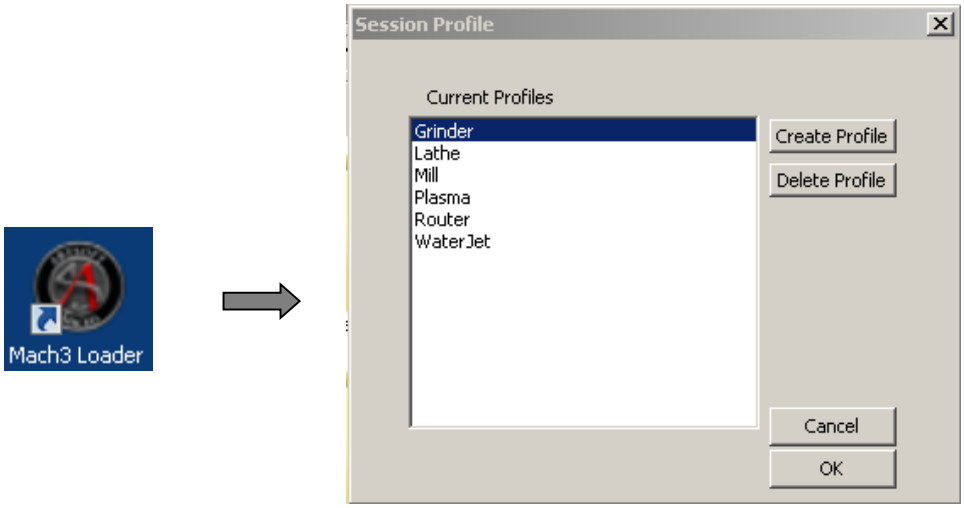


FIGURE 6 LOADER

After double clicking on a profile or opening a profile from Mach3 Loader, a window will come up asking for agreement with the Mach3 *Legal Notice*.

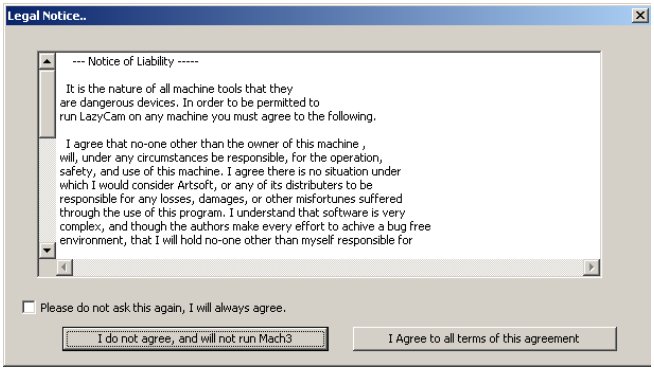


FIGURE 7 LEGAL NOTICE

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**].

When Mach3 loads, clear the [**Reset**] button so it is not flashing. [**Reset**] must be cleared for Mach3 to operate.

2 AXIS SETUP

2.1 Apollo III Cover Removal

All of the drives and external I/O will be wired into the Apollo III. Begin by removing the cover by loosening the four black knobs on the sides.

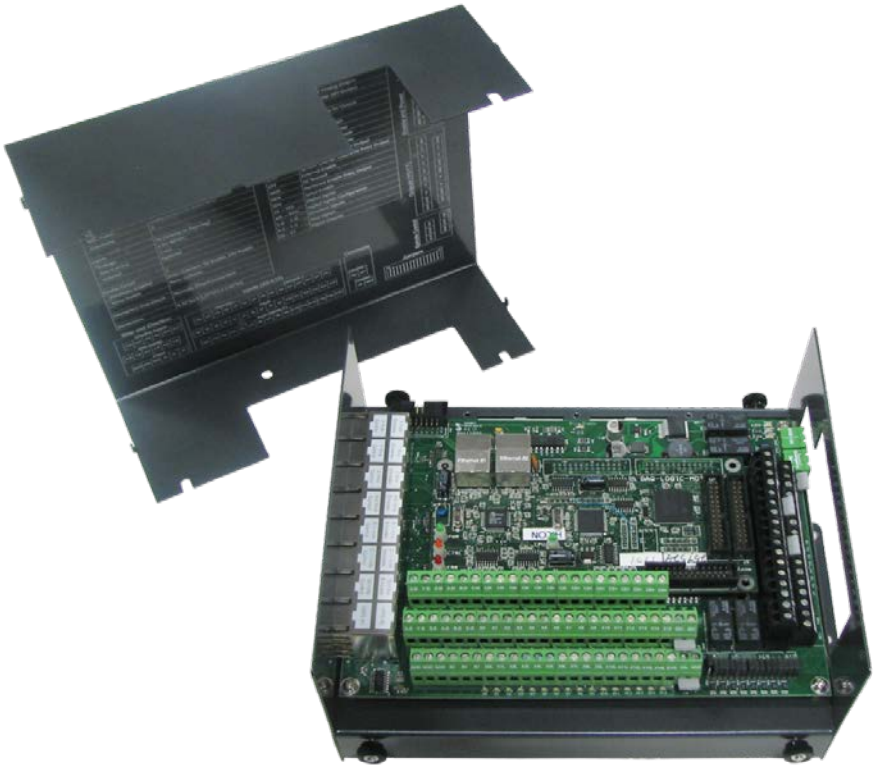


FIGURE 8 APOLLO III COVER REMOVED

Note: For more information about the Apollo III see the Apollo III User's Manual.

Next, plug the drive control and encoder cables into the Apollo III motion controller. The drive control connections are located on the bottom row of the large RJ45 block. The encoder control connections are located on the top row of the large RJ45 block. See the picture below.

FIGURE 9 DIFFERENTIAL STEP AND DIRECTION, AND ENCODER FEEDBACK RJ45 CONNECTIONS

2.2 Enabling Axes

After the drives are connected to the Apollo III, open up Mach3, and enable the axes as follows:

Note: This may already be setup depending on your system.

1. On the menu bar, click **Config->Ports and Pins.**
2. Select the **Motor Outputs** tab to see the axis enable options as pictured below.

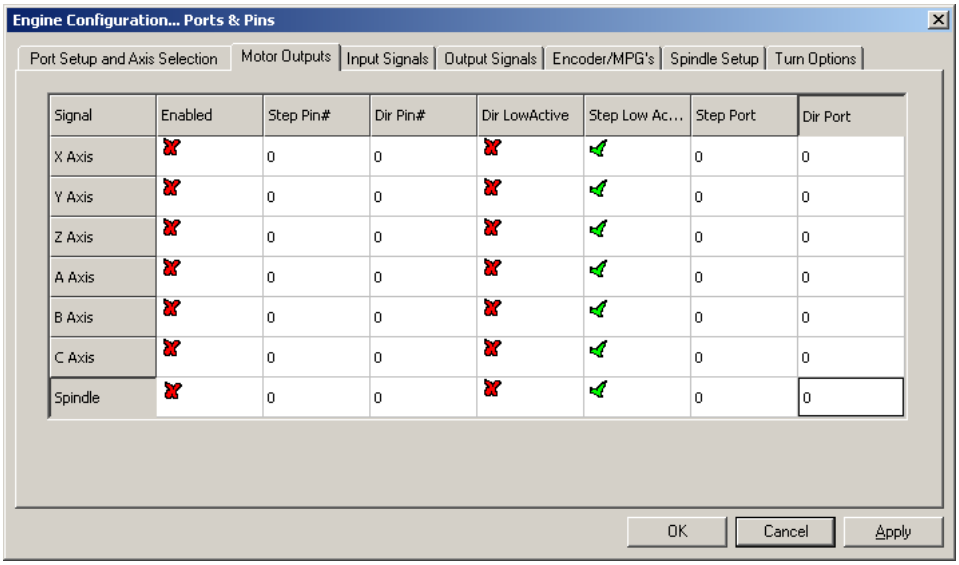


FIGURE 10 AXIS SETUP

3. Enable all the axes that are to be controlled by setting the respective boxes in the **Enabled** column to green checks. In the example below, the X, Y, and Z axes are enabled.

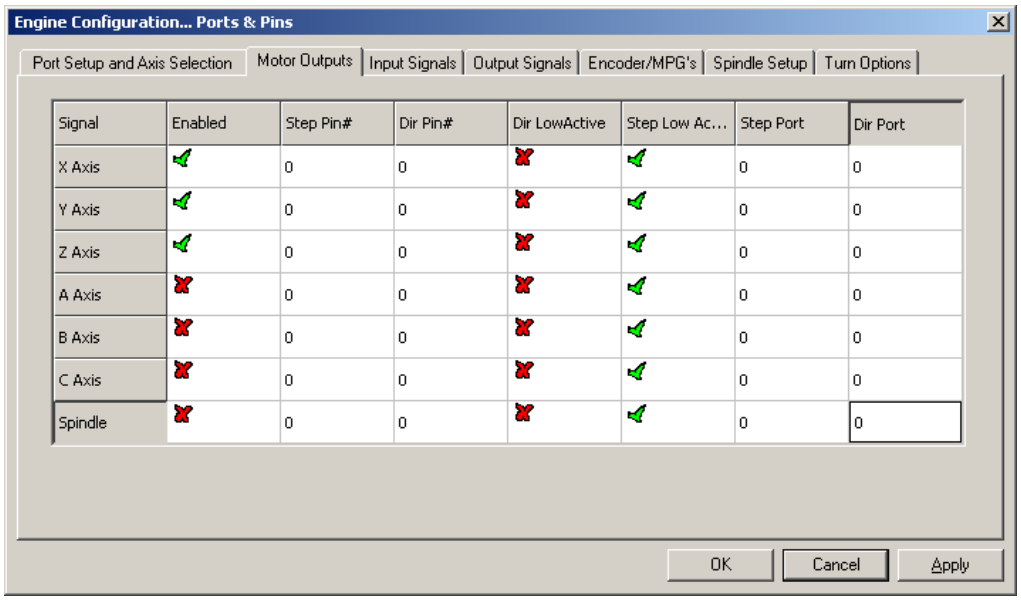


FIGURE 11 X, Y, AND Z AXES ENABLED

4. Press [**OK**] to save any changes and close the window.

The system is now set up for motion.

WARNING

The machine can be crashed very easily. No limit switches have been set up and the units have not been configured yet.

2.3 Axis Calibration

For the machine to move the correct distance, the axes need to be calibrated. To get the units perfect, they must be calculated manually from the machine specifications. However, you can get them extremely close if you use the calibration wizard (see Calibration Wizard on page 18).

2.3.1 Manual Calibration

Complete the following procedure to do the manual calibration:

Note: If the MachMotion plugin is not listed under PlugIn Control, see the Axis Configuration Worksheet to do the calculations by hand or use the calibration wizard on page 18. The worksheet can be found on the MachMotion website under software setup documentation.

Go to **PlugIn Control->MachMotion Plugin.**

1. Select the **Calibration** tab.
2. Select the drive type of the axis being configured.
3. Enter the max motor RPM.
4. Enter the correct drive ratio.

Drive Ratio Apollo III	Drive Type
1	Teco
32	Mitsubishi
64	Yaskawa
1	Stepper

TABLE 2 – DEFAULT DRIVE RATIO VALUES

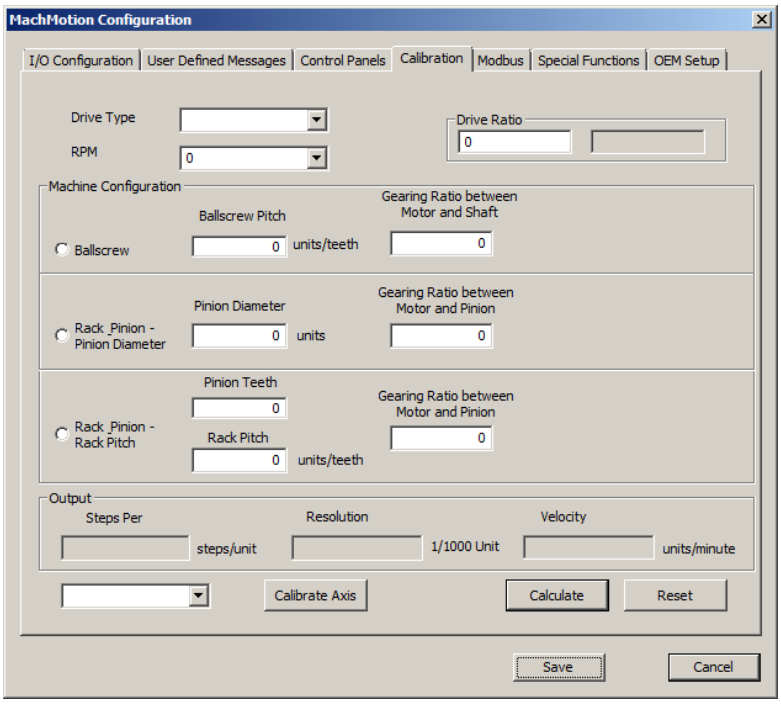


FIGURE 12 - MACHMOTION PLUGIN CALIBRATION CALCULATOR

5. Choose the machine configuration for the axis from the following three options.
   a. **Ball Screw**
      i. Enter the ball screw pitch
      ii. Enter the gearing ratio between the shaft and the motor

   Note: If the system has a pulley ratio and a gear box use this equation to get the total gear ratio:
   [Gear Box Ratio] x [Pulley Ratio] = [Total Gear Ratio]
   Ex: [10:1 Gear Box] x [30 Motor Pulley Teeth/15 Shaft Pulley Teeth] =
   [10] x [30/15] = [20 Total Gear Ratio]

   b. **Rack and Pinion** – Pinion Diameter
      i. Enter pinion diameter
      ii. Enter the gearing ratio between the shaft and the motor
   c. **Rack and Pinion** – Rack Pitch
      i. Enter number of teeth on pinion
      ii. Enter the rack pitch
      iii. Enter the gearing ratio between the shaft and the motor

6. Press the [**Calculate**] button.
7. Select the axis to calibrate.
8. Press the [**Calibrate Axis**] button.

9. Repeat starting at step 3 for each additional axis.
10. Restart Mach3 to save the calibration settings.

2.3.2 Calibration Wizard

Complete the following procedure to use the calibration wizard:

1. Run “M9990” from the MDI line.
2. Select the axis to calibrate.
3. Enter in the distance and federate the axis should move.
4. Measure how far the axis moved.
5. Enter in the distance the axis moved.
6. Allow it to update the Steps Per Unit for that axis if the measurement was correct.
7. Repeat this procedure until the axis is within the required accuracy.

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.

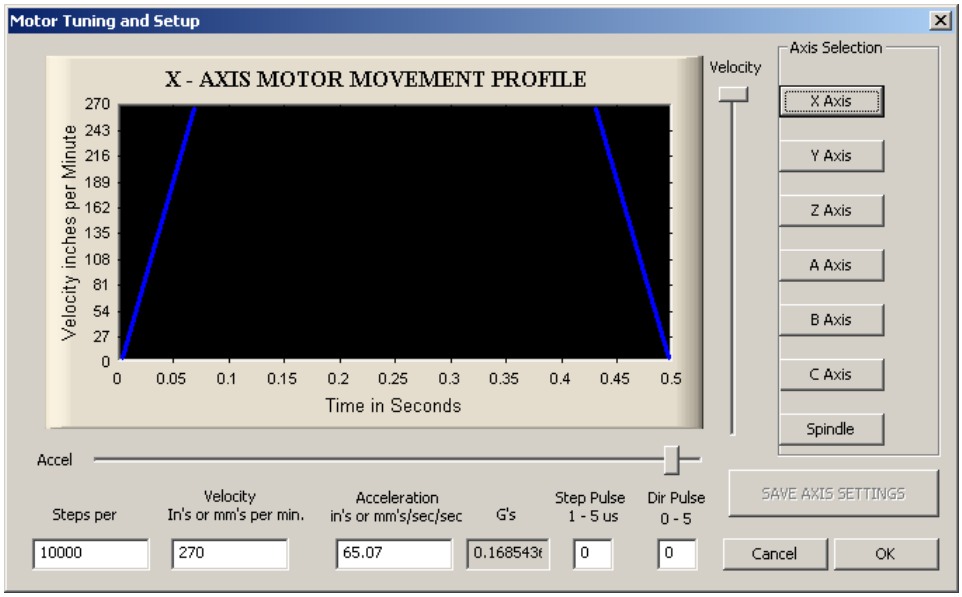


FIGURE 13 MOTOR TUNING AND SETUP

In the 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.

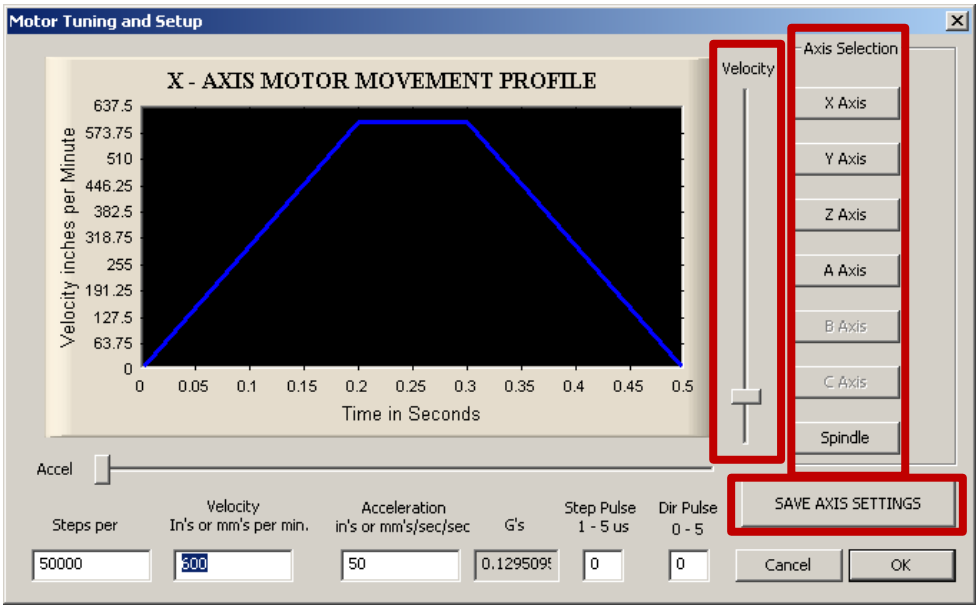


FIGURE 14 VELOCITY IN MOTOR TUNING

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. DEATH, INJURY or serious PROPERTY DAMAGE can occur if the system is not operated carefully.

2.4 Backlash Calculation

The Apollo III has backlash compensation. Use the MDI line to enter G-Code to move the axes. To calculate the machine's backlash, follow the steps below.

1. Move an axis in one direction farther than the maximum possible backlash.
2. Mount a 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. Note how far the dial indicator was off from zero to see the axis's backlash value.
6. On the menu bar go to **Config->Config Plugins** and press the [**CONFIG**] button on the HiCON plugin line.
7. Select the tab corresponding to the desired axis.
8. Enter the backlash distance and speed as described below.

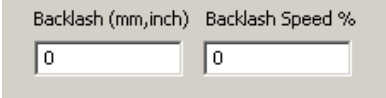


FIGURE 15 BACKLASH COMPENSATION

***Backlash (mm, inch)* –** This field defines the backlash distance in inches or mm. The Apollo III uses this value to calculate virtual load position.
***Backlash Speed* % –** This field adjusts the maximum acceleration that the backlash counts can be applied. The Apollo III takes the max acceleration from the motor tuning and multiplies it by this percentage. Valid values are 10-400 (0.1 to 4 times max acceleration). A common value is 20%.

WARNING
Do not leave the backlash speed zero if you enter in a backlash distance. The Apollo III will not function.

2.5 Reversing Direction

If an axis moves the wrong direction, it can be reversed in the Mach3 software.

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

   The following window will come up:

FIGURE 16 REVERSING DIRECTION

2. Under the **Reversed** column click on the red "X" if the axis needs to be reversed.
3. After making all the changes, press [**OK**].

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

2.6 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.

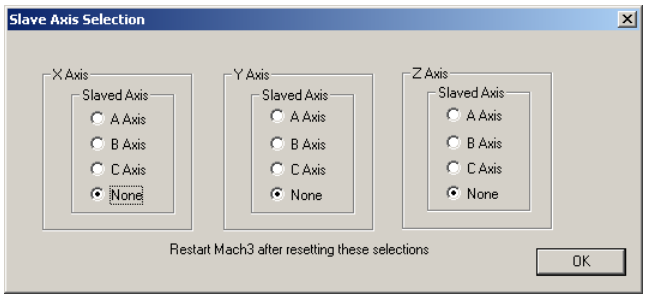


FIGURE 17 SLAVE AXIS SELECTION WINDOW

2. Select the axis to be slaved. The X, Y, and Z aces can have A, B, or C as slaves. For example, the configuration below is used to slave the A axis to the Y axis.

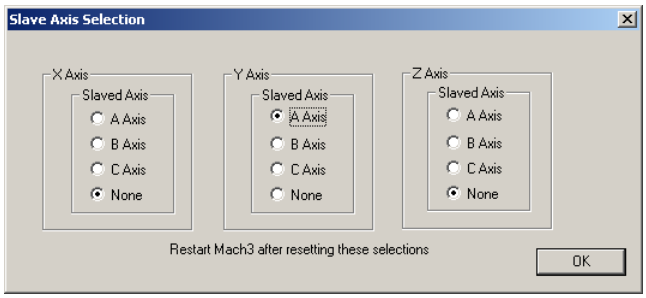


FIGURE 18 A AXIS SLAVED TO Y

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

3 SPINDLE SETUP

This section goes through the wiring and configuration process for spindle integration with Mach3. The Apollo III 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).

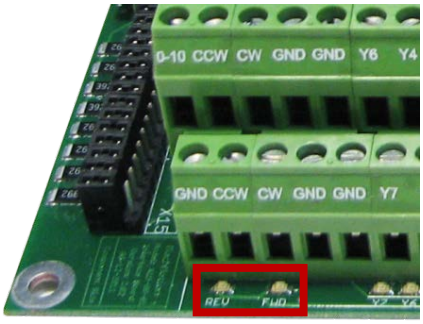


FIGURE 19 SPINDLE LEDS

3.1 Wiring a Spindle

3.1.1 VFD from MachMotion

The process for setting up a VFD from MachMotion is extremely simple. Simply plug the control cable into the Spindle Control RJ45 jack located on the bottom row of the large RJ45 block.

FIGURE 20 SPINDLE CONTROL RJ45 JACK

3.1.2 VFD Other Than from MachMotion

Any VFD can be wired into the Spindle Control RJ45 jack by cutting the end off of a CAT5 cable and wiring the loose ends to the VFD according the following pin out.

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 3 SPINDLE CONTROL RJ45 JACK

3.1.3 No VFD

If the system does not use a VFD to control the spindle, wire the spindle into the small green connecter as shown below. Notice that 24V is wired to the CW and CCW relay contacts on the top row of the green connector.

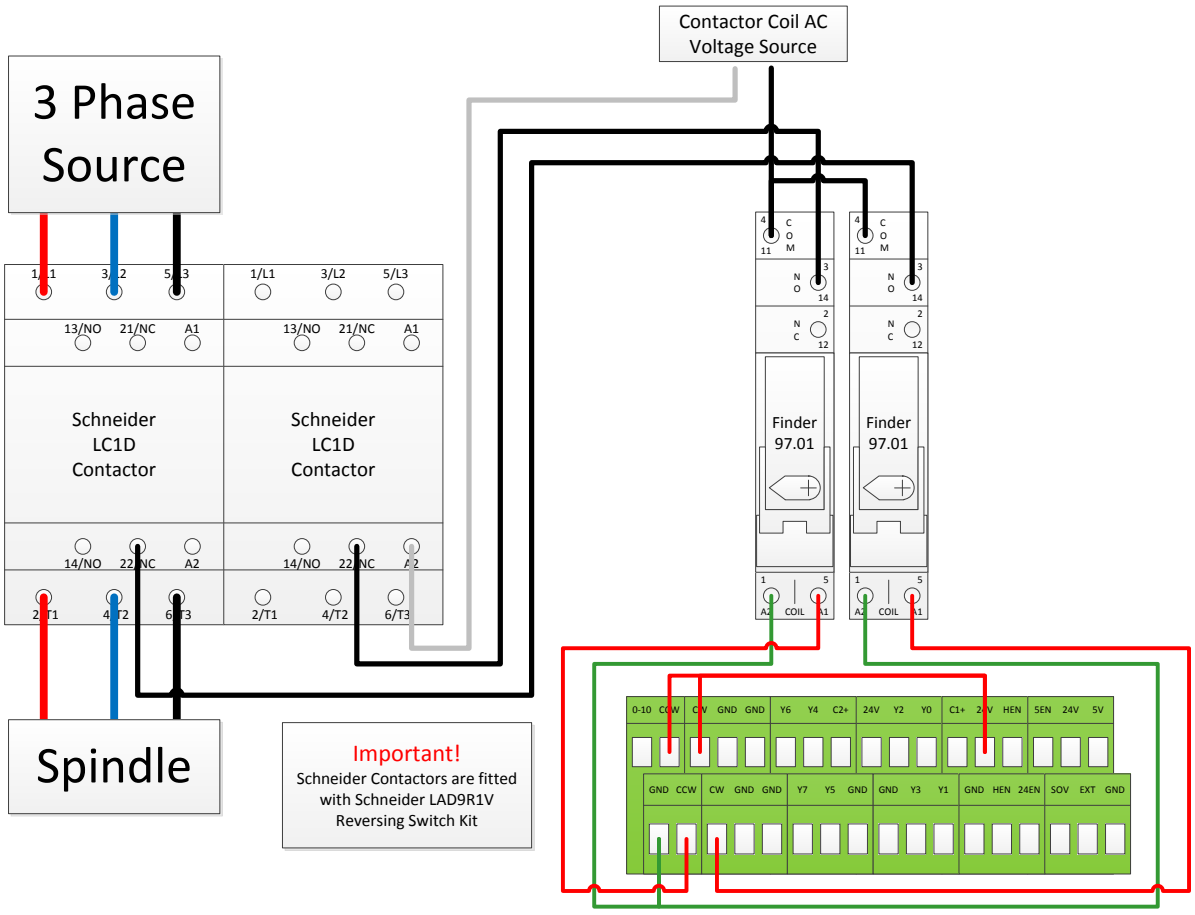


FIGURE 21 NO VFD SPINDLE WIRING

3.2 Spindle Configuration

3.2.1 Spindle Pulley Setup

For Mach3 to know how to scale the analog voltage output, the maximum RPM for the spindle motor must be defined. If the machine has different gears Mach3 can have 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 the pulleys, go to **Config->Spindle Pulleys.** The *Pulley Selection* window will appear as shown in Figure 22.

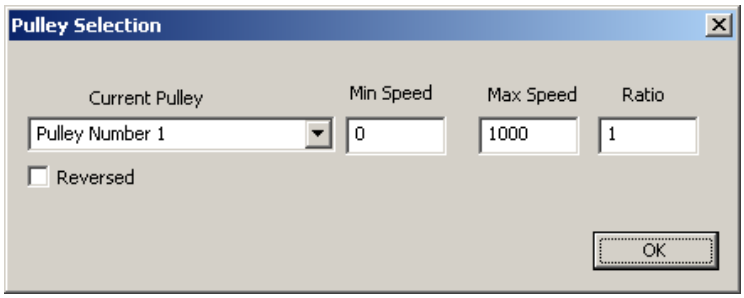


FIGURE 22 PULLEY SPEED SETUP

Use the drop down menu titled **Current Pulley** to select the pulley to be updated. Enter in the maximum and minimum speeds for each pulley. Then select the current pulley and press [**OK**].

Note: Only set up multiple pulleys if the machine has different gears.
Note: If the spindle is turning the wrong direction check the reversed box in the Spindle Pulleys window.

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

3.3 Turning on the Spindle

To control the spindle use the following M-Codes with an S word for spindle RPM in the MDI line (Ex. M3 S2000).

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

TABLE 4 SPINDLE M-CODES

If the spindle is not running correctly at this point some settings may need to change inside the VFD. In this situation reference the VFD manufacturer manual.

Note: See the Mitsubishi VFD Installation Guide for setup information if it was purchased from MachMotion.

3.4 Reversing Direction

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

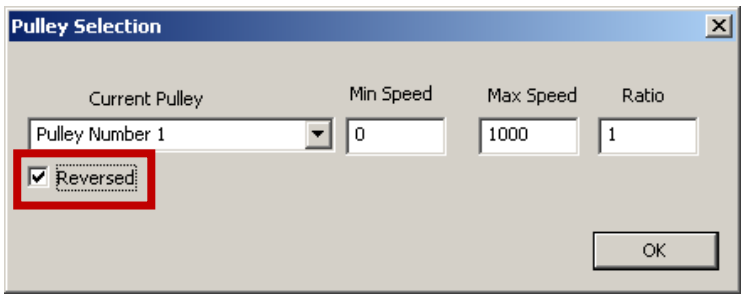


FIGURE 23 REVERSE PULLEY

4 LIMITS AND HOMING SETUP

The Apollo III motion controller has up to 16 inputs that can be used for the limit and home switches. To maximize the number of inputs available for other functions, wire multiple switches in series as shown below.

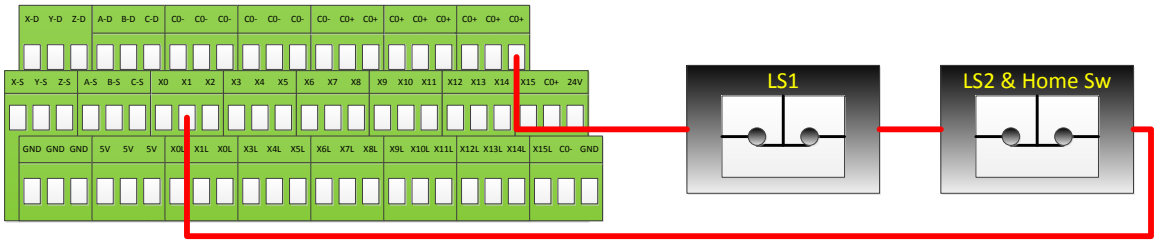


FIGURE 24 LIMIT SWITCHES IN SERIES

Note: For the highest level of safety, wire the limit switches Normally Closed.

The standard limit input allocation is show below.

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

TABLE 5 INPUT PORT AND PIN NUMBERS

To set up and 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 normally closed in series as shown in Figure 24.
3. Wire the remaining side of the first switch to C0+ from the Apollo III motion controller.
4. Wire the remaining side of the limit/home switch into the correct input (see Table 5) depending on which axis is being wired.
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 25).
7. Enable the limit and home switches by clicking the red [**X**] by the signal to make it a green check.

   Note: Each axis has three signals the max travel (X++), the min travel (X--), and the home (X Home). All three must be enabled and set to the correct port and pin address for everything to work correctly using the wiring description above.
8. Set the Port Number and Pin Number to the desired input. All input signals use port 11 and the pin number corresponds to the X number it is wired to (Ex. An input wired into X3 will have a port number of 11 and a pin number of 3).
9. Set up the active low checkbox to a green check.

   *Note: Under the active low column the active state can be changed by clicking on the [**X**] or check mark. If the limit switches are normally open the red X mark should be used. However, this is not recommended as it is not as safe.*

10. When the limit and home switches are completely configured, press [**Apply**] and then [**OK**].

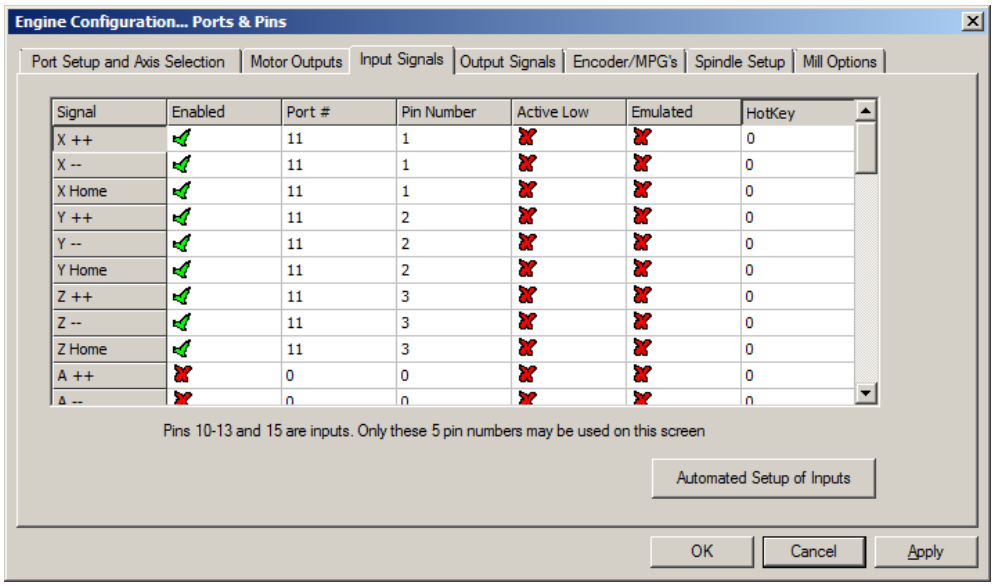


FIGURE 25 INPUT SIGNALS

For example, the configuration above has X, Y, and Z limit and home switches enabled. All of them are wired normally closed. The port and pin for X is port 11 pin 1 (X1) and for Y it is port 11 pin 2 (X2). Notice that all the limit switches and the home switch for an axis have the same port and pin numbers.

4.1 Homing Setup

Now the limit and homing switches are set up correctly it is time to finish setting up homing.

1. Home each axis of the machine individually if possible. Note which axes home in the wrong direction.

   Note: See the system operating manual for individual axis homing instructions.

WARNING

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

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

FIGURE 26 MOTOR HOME/SOFT LIMITS

3. If any of the axes homed in the wrong direction, click on the red X next to the axis on the **Home Neg** column.
4. 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 the machine should now be completely set up. Press the [**Home All**] button again to make sure that everything works correctly.

4.2 Soft Limits Setup

Soft limits are utilized to keep the machine from crashing. If the soft limits are set up correctly, the machine will never be able to hit a physical limit switch unless it is not homed properly. If at any time a command is made for the 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 if the program should continue. To set up the soft limits, follow the procedure outlined below.

1. Jog the machine to the maximum distance from the homing switches.
   Note: Make sure to stay inside the physical limit switches. If the machine is jogged outside of the limit switches, it completely defeats the purpose of soft limits.
2. Record the machine coordinates at the end of the travel.
3. Open the menu bar and click **Config->Homing/Limits** to bring up the *Motor Home/Soft Limits* window will come up (See Figure 26).
4. For each axis enter in the recorded values.
   Note: 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 27 SOFT LIMITS

6. Enable the soft limits (See the Operating Manual for more detail).
   Note: Soft limits prevent the machine from being able to jog outside of the acceptable range. Also when starting a G-Code file it will warn the operator if the file will go outside of the limits. However, if the warning is ignored it will not prevent a G-Code file from overrunning them.

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

5 INPUT SETUP

5.1 Generic Inputs

All 16 inputs on the Apollo III can be used for limit switches, home switches, tool changers, or anything else. To learn how to set up limit switches, go to Setting up Limits and Homing on page 24. As shown below, the inputs are located on the main green terminal block.

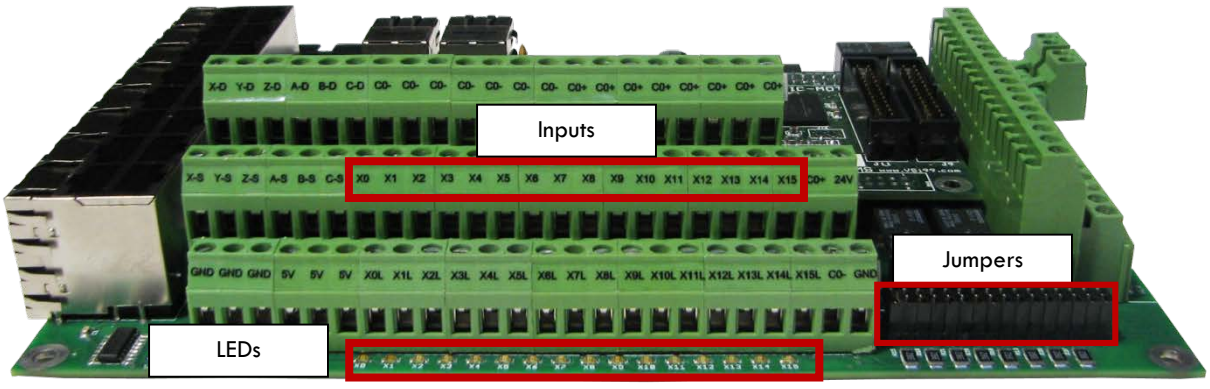


FIGURE 28 INPUTS

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 run from X0, up to X15. 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 III. Each jumper corresponds to an input. For example, the jumper labeled X10 corresponds to the input on TB1 labeled X10 and the LED X10.

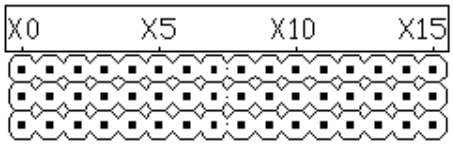


FIGURE 29 INPUT JUMPERS

FIGURE 30 JUMPER POSITIONS

WARNING

Input X0 is configured as drive fault by default. If you have servo drives from MachMotion, DO NOT connect anything to X0. It could damage your drives or Apollo III motion controller.

5.2 Wiring Inputs

5.2.1 Standard 24V Inputs

For a standard 24V input, place the jumper on the bottom two pins. In the example below, all the inputs are set up as standard 24V inputs. Next, connect C0+ to 24V and C0- to GND on TB1 as shown below.

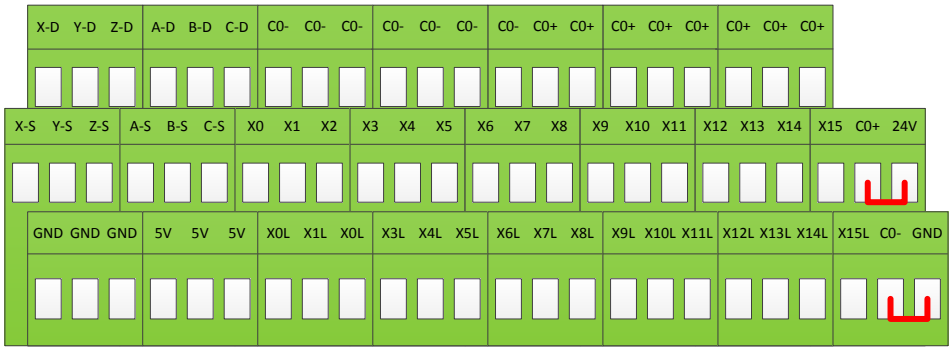


FIGURE 31 24V CONFIGURATION

Then connect the input to the input terminal on the middle row (X1, X2, etc.). See the diagram below.

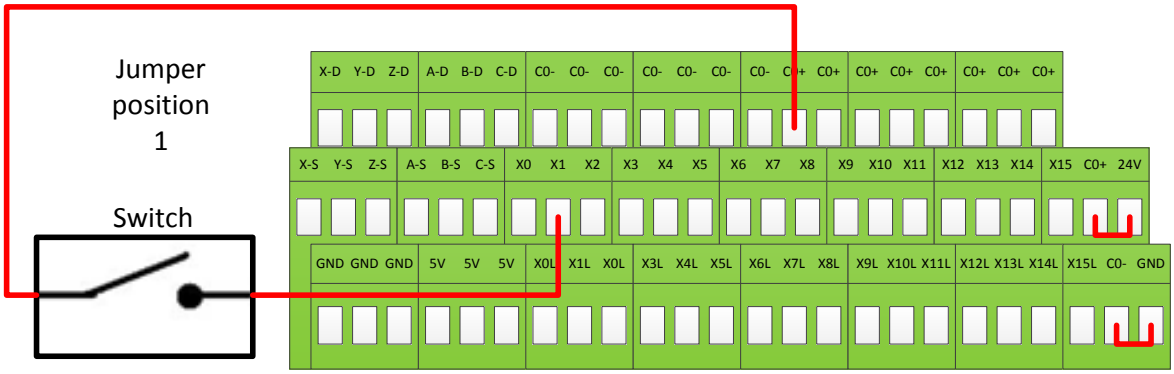


FIGURE 32 STANDARD 24V INPUT

To activate the input, 24V must be supplied 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.

5.2.2 Sinking Inputs (NPN)

For most NPN proxys place the jumper on the top two pins. Then connect the signal into the corresponding input. See the example below.

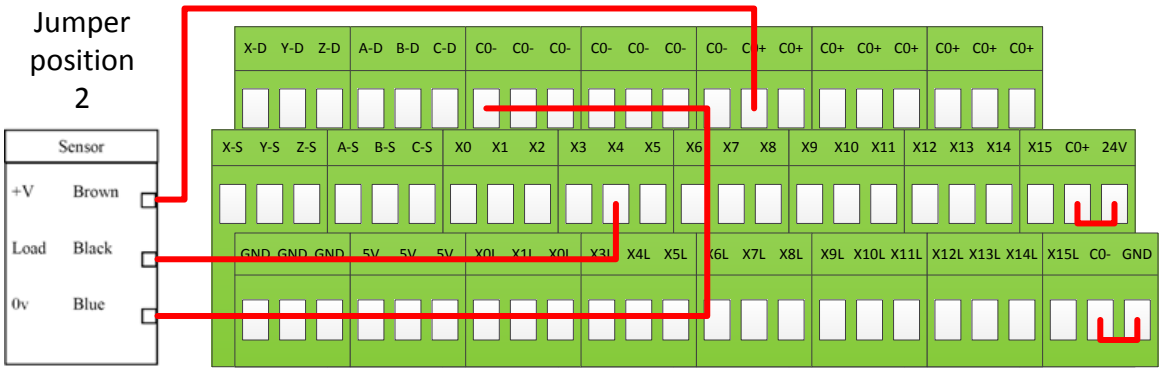


FIGURE 33 STANDARD NPN PROXY

If the proxy has an internal pull-up resistor, depending on its size, it could require the jumper to be completely removed. Use a 3.9k ohm resistor and connect it between XSL and C0+.
Below is an example of a 24V NPN proxy with an internal pull-up resistor. The jumper on the Apollo III must be completely removed for this to work.

FIGURE 34 NPN PROXY WITH INTERNAL PULLUP

5.2.3 Sourcing Inputs (PNP)

For PNP proxies place the jumper on the bottom two pins. Then connect the signal into the corresponding input. See the example below.

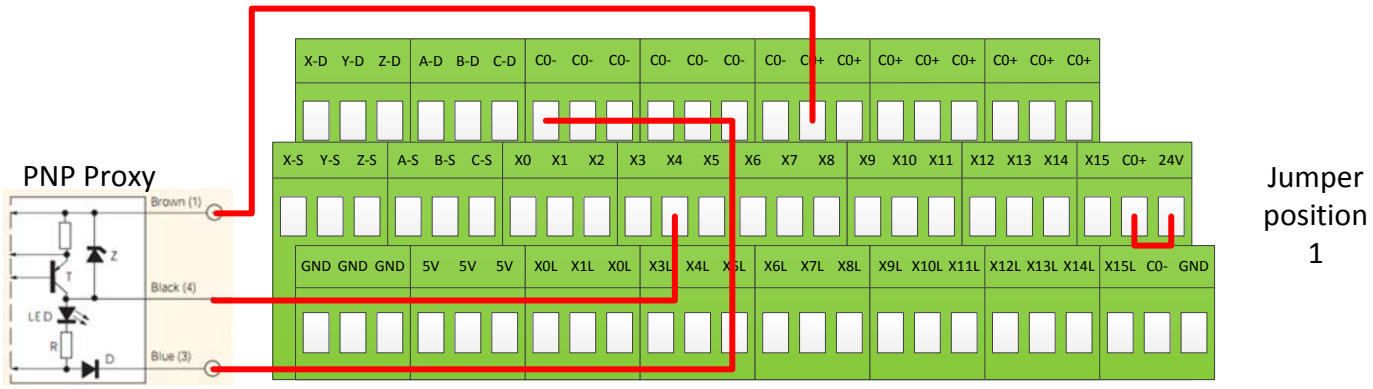


Figure 35 24V Proxy Example

5.3 Configuring Inputs

To configure an input, follow the procedure below.

1. On the menu bar click on **Config->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.

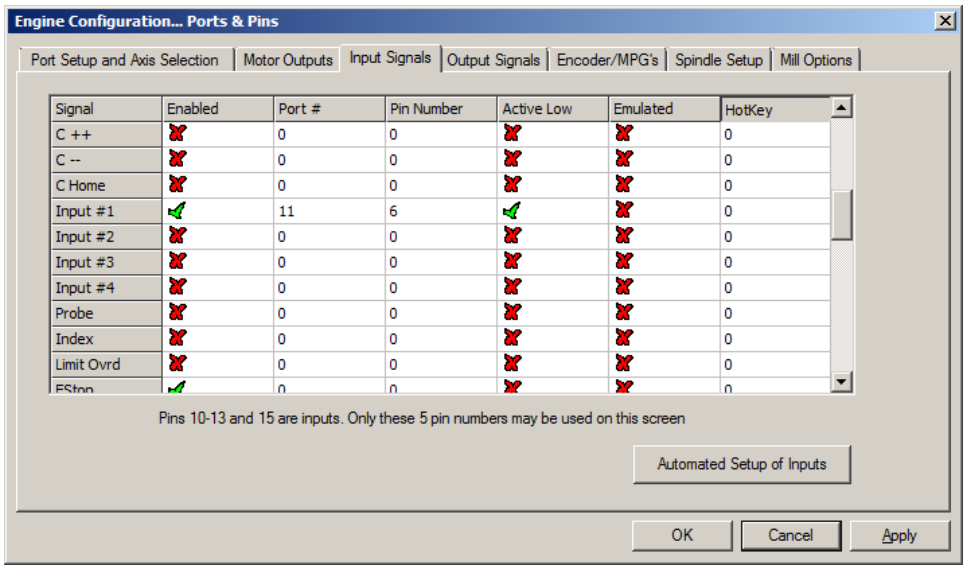


FIGURE 36 INPUT CONFIGURATION

Note: The note below the input signal window is referencing parallel port systems. Ignore this.

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.

   Note: All input port numbers are 11 and the pin numbers correspond to the X number (X4 would be pin 4)
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.

The input is now be set up.

6 OUTPUT SETUP

6.1 Generic Outputs

The Apollo III 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.

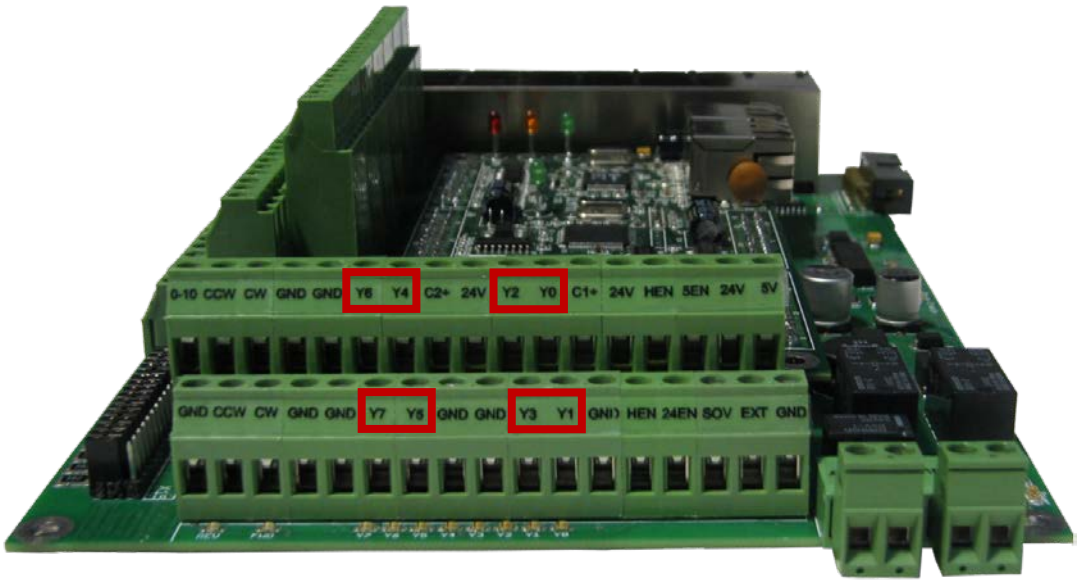


FIGURE 37 OUTPUTS

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.

6.2 Wiring Outputs

There are two separate commons for the outputs. The common C1+ is for outputs Y0-Y3 and C2+ is for Y4-Y7. Each common can take 7-48VDC. If the outputs being used are using the voltage supply from Apollo III, each output can only supply 125mA. However, if they are supplied using a separate voltage source, each output can source up to 250mA.
For standard operation the outputs can have their commons jumpered to 24V on the Apollo III. At that point simply connect the load between the output and GND. See the figure below.

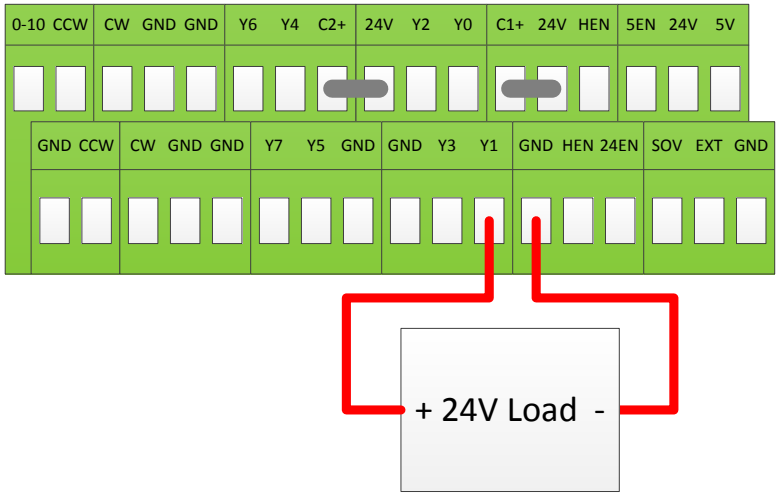


FIGURE 38 STANDARD 24V 125MA OUTPUTS

6.3 Configuring Outputs

To configure an output, follow the procedure below.

1. On the menu bar click on **Config->Ports and Pins**.
2. Select the **Output Signals** tab.
3. Scroll down to the desired output (There are 20 outputs that can be used).

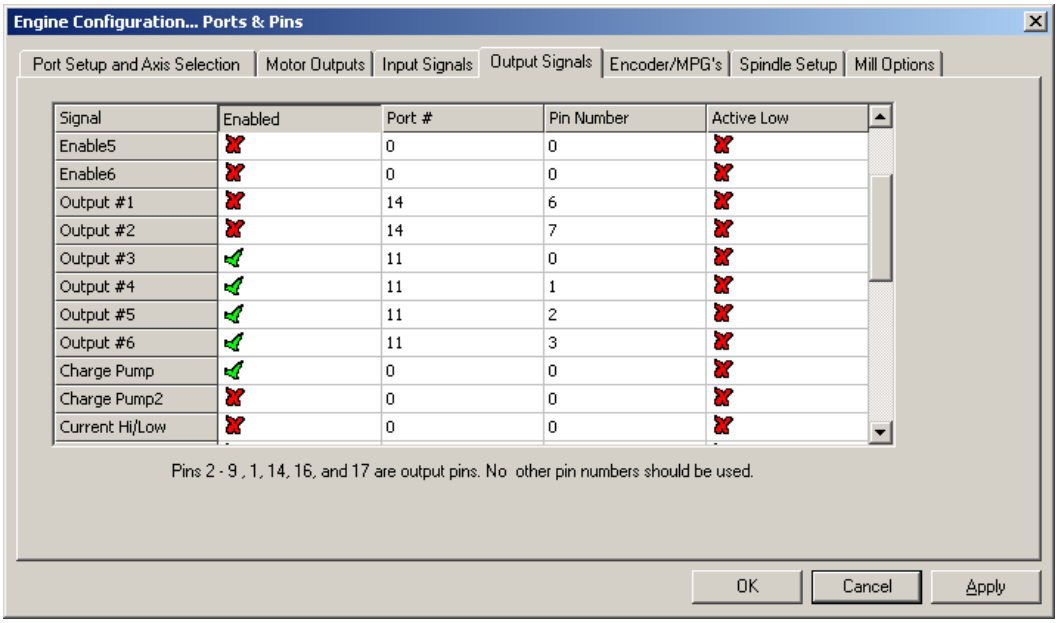


FIGURE 39 OUTPUT CONFIGURATION

Note: The note below the output signal window is referencing parallel port systems. Ignore this.

4. Enable the output by setting the Enabled box to a green check.
5. Set the Port Number to 11 and the Pin Number to the corresponding Y number (Y3 would be pin number 3).
6. Set the Active Low column to a green check for a normally closed signal or red x for normally open.

6.4 Using Outputs

Outputs 5-10 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	Default Output
M200	Output 5 on	Y2
M201	Output 5 off	
M202	Output 6 on	Y3
M203	Output 6 off	
M204	Output 7 on	Y4
M205	Output 7 off	
M206	Output 8 on	Y5
M207	Output 8 off	
M208	Output 9 on	Y6
M209	Output 9 off	
M210	Output 10 on	Y7
M211	Output 10 off	

TABLE 6 M-CODES FOR OUTPUTS

The outputs can also be accessed inside the MachMotion plugin. Read Mist and Flood Control Advanced Options on page 35 for more information on how to use outputs inside the plugin.

6.5 Mist and Flood Control

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

Feature	ON M-Code	OFF M-Code	Preconfigured Output
Mist	M7	M9	Output 3 - Y0
Flood	M8		Output 4 - Y1

TABLE 7 MIST AND FLOOD CONTROL

7 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.

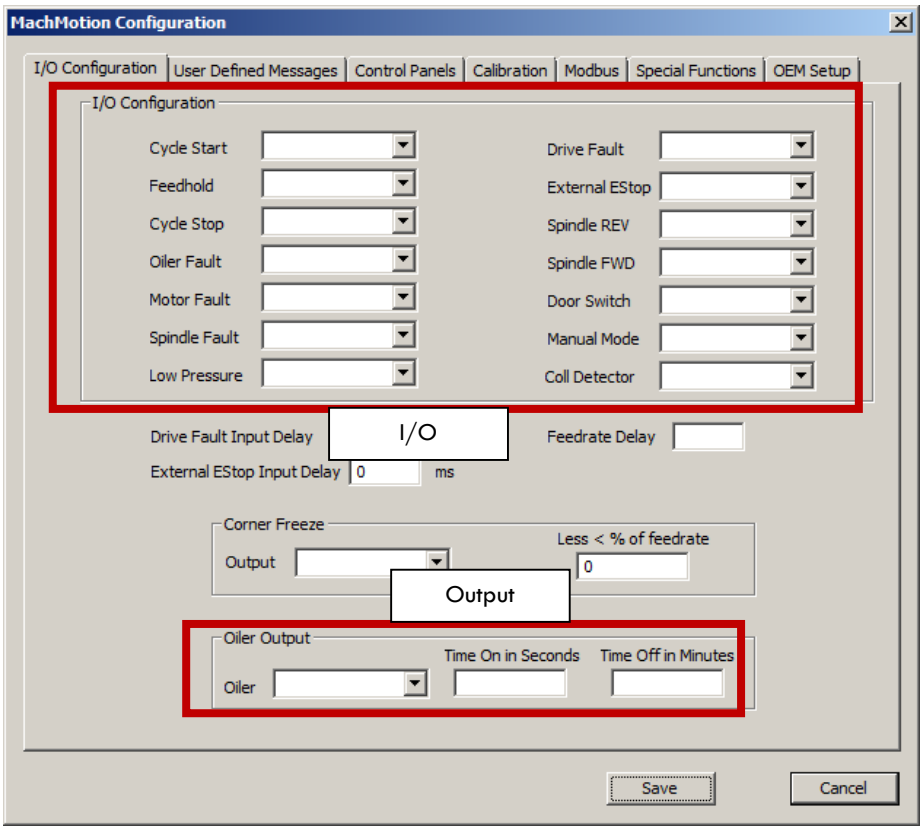


FIGURE 40 - MACHMOTION PLUGIN, IO CONFIGURATION

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.

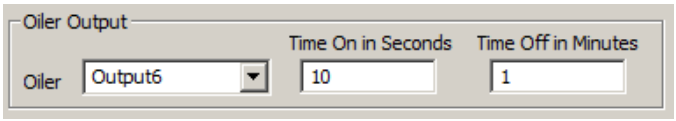


FIGURE 41 OILER

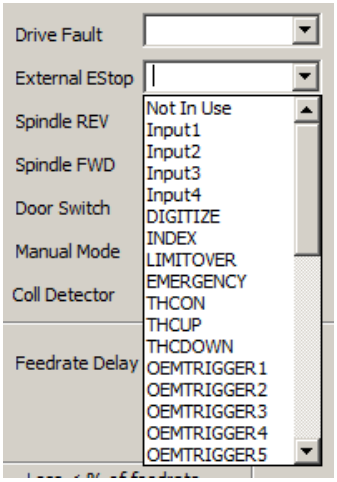


FIGURE 42 CYCLE START

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

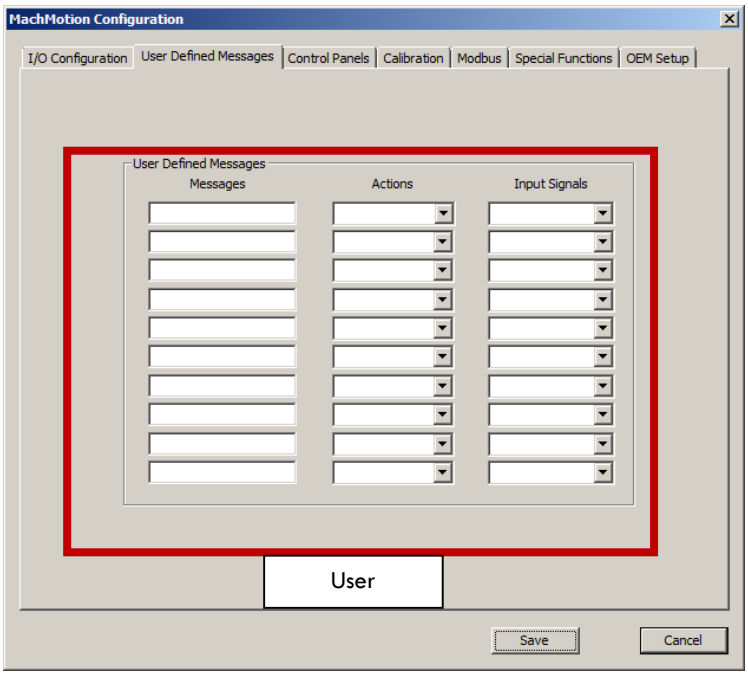


FIGURE 43 - MACHMOTION PLUGIN, USER DEFINED MESSAGES

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.

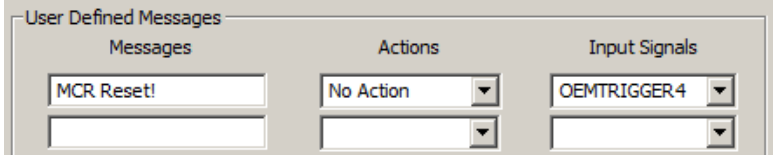


FIGURE 44 USER MESSAGES

This page intentionally left blank

Part 2:

ADVANDED SETUP

8 PART 2: ADVANCED SETUP

8.1 Apollo III Network Connection

The Apollo III can be connected directly to the control or via an Ethernet router. Either of the two Ethernet ports on the Apollo III can be used. The Ethernet ports have a built in Ethernet switch so you can also use them to daisy chain other Ethernet devices together on a local network.

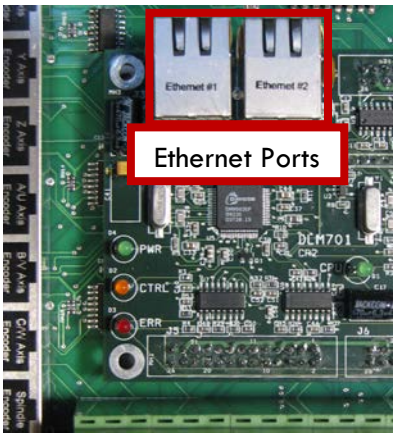


FIGURE 45 ETHERNET CONNECTOR

8.1.1 Direct Connection

To set up the Apollo III to communicate with the control directly, the network configuration needs to be assigned a static IP address. The default static IP configuration is defined below.

Location	IP Address
Apollo III	192.168.0.35
Computer	192.168.0.10

TABLE 8 STATIC IP ADDRESSES

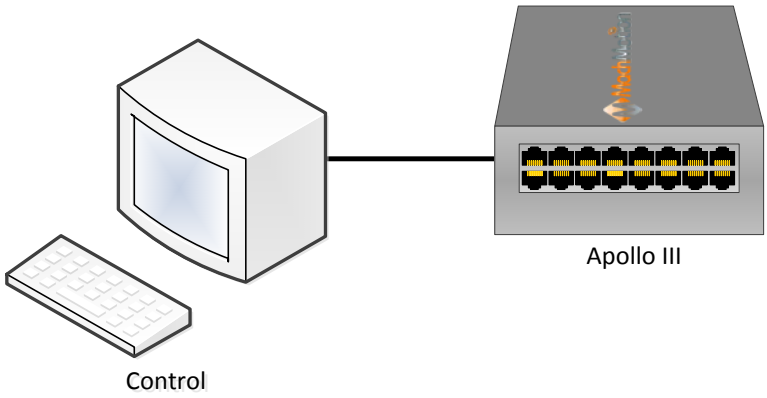


FIGURE 46 DIRECT NETWORK CONFIGURATION

8.1.1.1 CONFIGURING A STATIC IP ADDRESS ON WINDOWS 7

1. Click on the network icon on the system tray.

FIGURE 47 SYSTEM TRAY

2. Click on *Open Network and Sharing Center*.
3. In the top left corner of the *Network and Sharing Center* window click on *Change adapter settings*.
4. Right click on the network port that the Apollo III is connected to and select *Properties*.
5. From the list below double click on *Internet Protocol Version 4*.

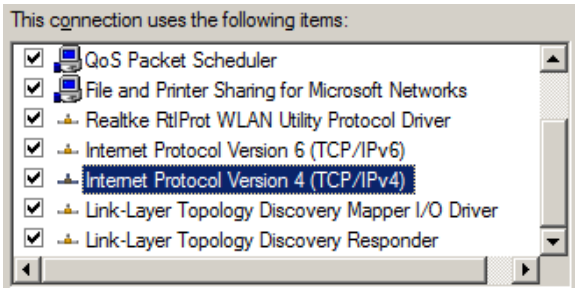


FIGURE 48 LOCAL AREA CONNECTION PROPERTIES

6. Fill out the options as seen below.

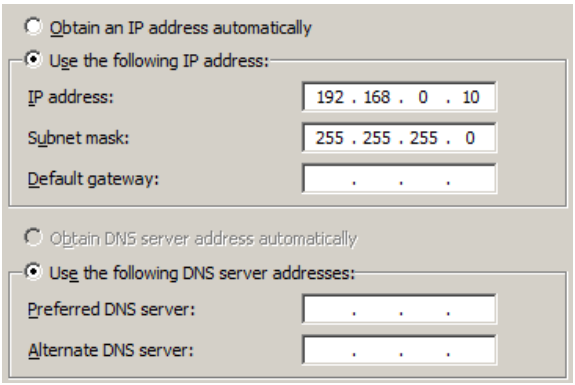


FIGURE 49 IPV4 PROPERTIES

7. Press [**OK**] and close out the rest of the windows.

The control now has the correct static IP address.

8.1.2 Router Connection

When using a network router to connect the Apollo III to the control there is no special network setup required. The router will take care of the IP assignments.

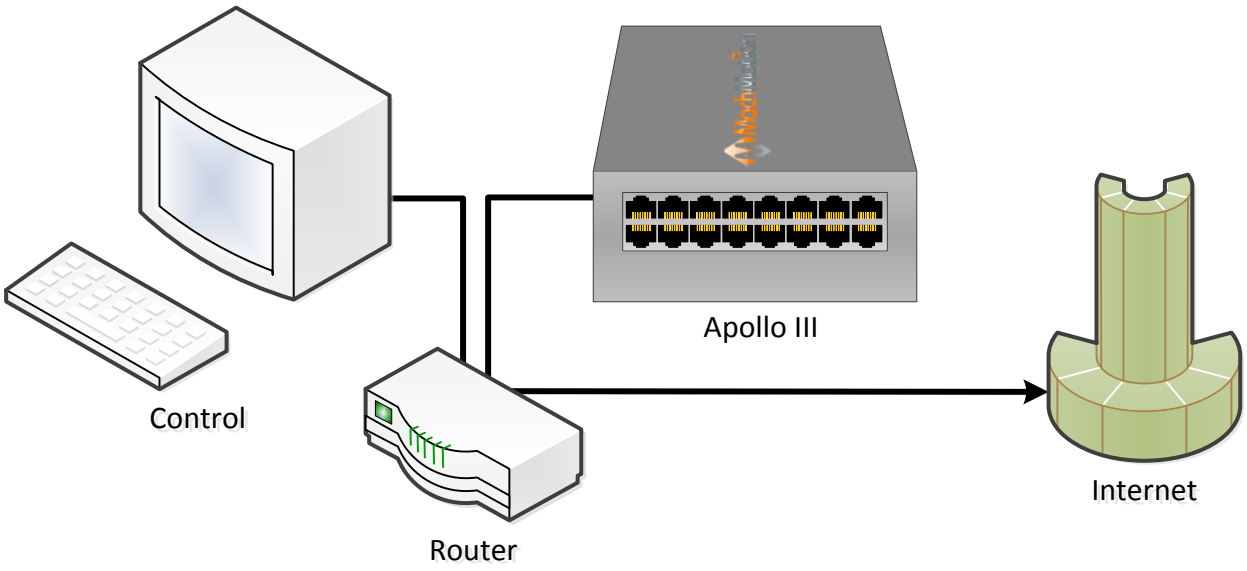


FIGURE 50 NETWORK CONNECTION THROUGH A ROUTER

8.2 Apollo III Software Installation

8.2.1 Installing Apollo III Plugin and Firmware

The plugin and firmware manage the communication and operation of the Apollo III.

Once the files are downloaded on the control, put them in the locations specified below.

File Type	File Name	Location
Plugin	M3HiCON.dll	C:\Mach3\PlugIns
Firmware	HiCONfw-X.XX.bin	C:\Mach3\MotionControllers\Apollo III

TABLE 9 APOLLO III FILES AND LOCATIONS

Note: If the file location for the firmware does not exist, create the folders.

8.2.2 Installing VSI Manager

The VSI manager interfaces with the Apollo III motion controller for updating firmware and managing the connection. To install the manager go to the Downloads page at MachMotion.com. Run the installation program using the default options.

To download the firmware to the Apollo III, follow the procedure below:

1. Open the *VSI Device Manager* program.
2. Click on the [**Scan Network**] button.

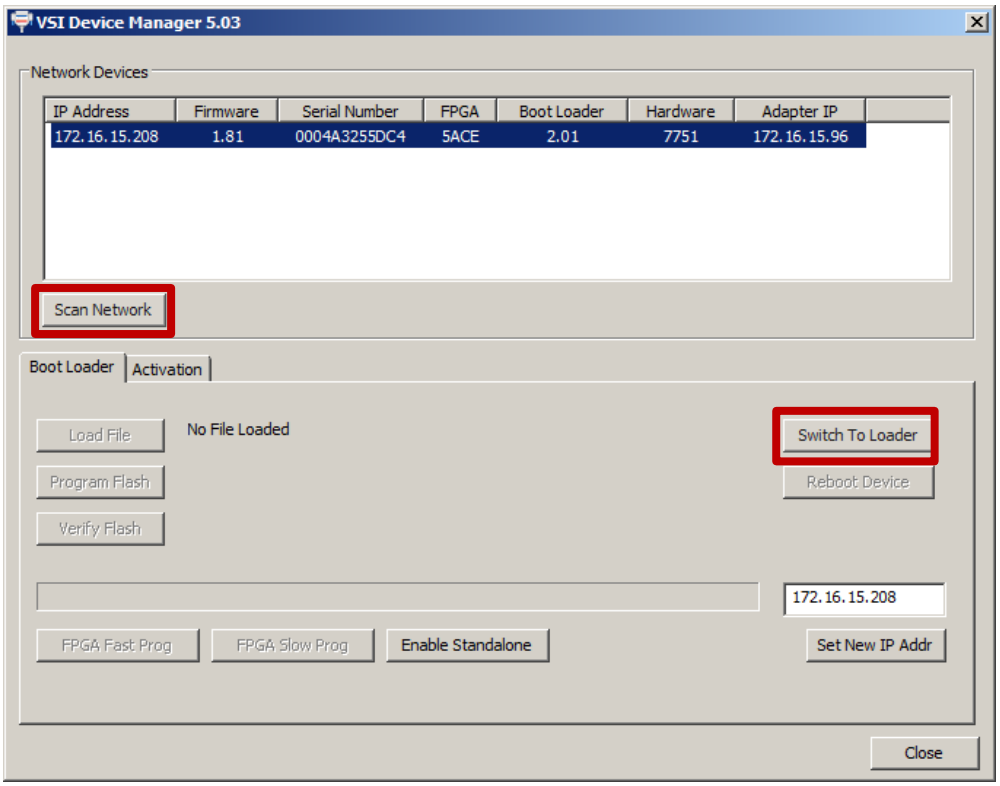


FIGURE 51 VSI DEVICE MANAGER

Note: A device should show up as shown.

3. Select the device and press [**Switch To Loader**].
4. Click through the message windows that pop up and click on [**Load File**].
5. Select the .bin file from the location specified in **Error! Reference source not found.**.
6. Press [**Program Flash**] and wait until it finishes programming.
7. Press [**OK**] when it asks to reboot to launch the new firmware.
8. Close the device manager.

The firmware should now be updated.

WARNING

Install the plugin AND download the firmware to the Apollo III. If the firmware and plugin versions do not match, it could cause serious damage to the machine or cause the Apollo III not to operate at all.

8.3 Mach3 Integration

8.3.1 Mach3 Startup

Open up the Mach3 software, making sure to select the correct profile. Select the M3HiCON plugin as shown below. Make sure to select **Don't ask me this again.**

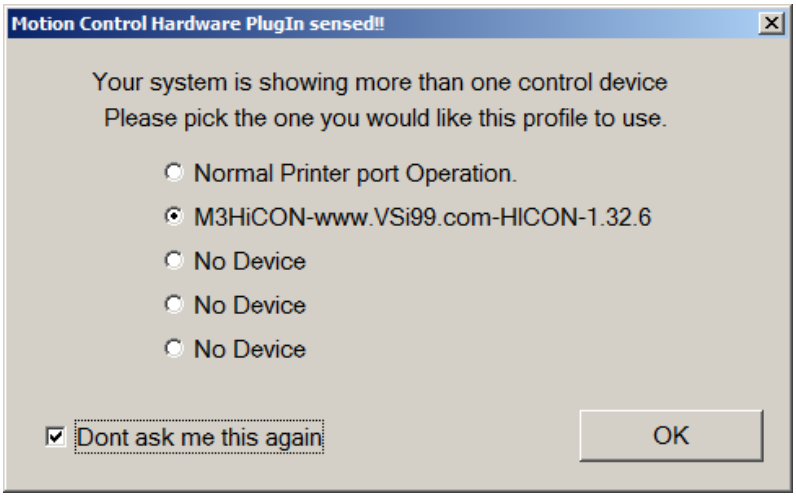


FIGURE 52 DEVICE PLUGIN SELECTION WINDOW

After Mach3 has completely loaded, the status bar at the bottom of the screen should say "**HiCON Online. Plugin: X.XX, Board: XXXX / X.XX, FPGA: XXXX**" where the Xs represent the version numbers. If this message comes up, then everything is connected correctly.

If the status bar in Mach3 says "**HiCON Board Not Found,**" then check the Ethernet cable's connection and the control's IP configuration. If Mach3 continually pops up with errors, make sure that the correct firmware (that matches the current plugin) is downloaded in the Apollo III.

8.4 Apollo III Status Window

To view the status of the Apollo III from inside Mach3, click on **PlugIn Control** on the top menu bar and then select **HiCON Status.**

The *HiCON Status* window shows the current state of the encoders, the inputs, and the outputs.

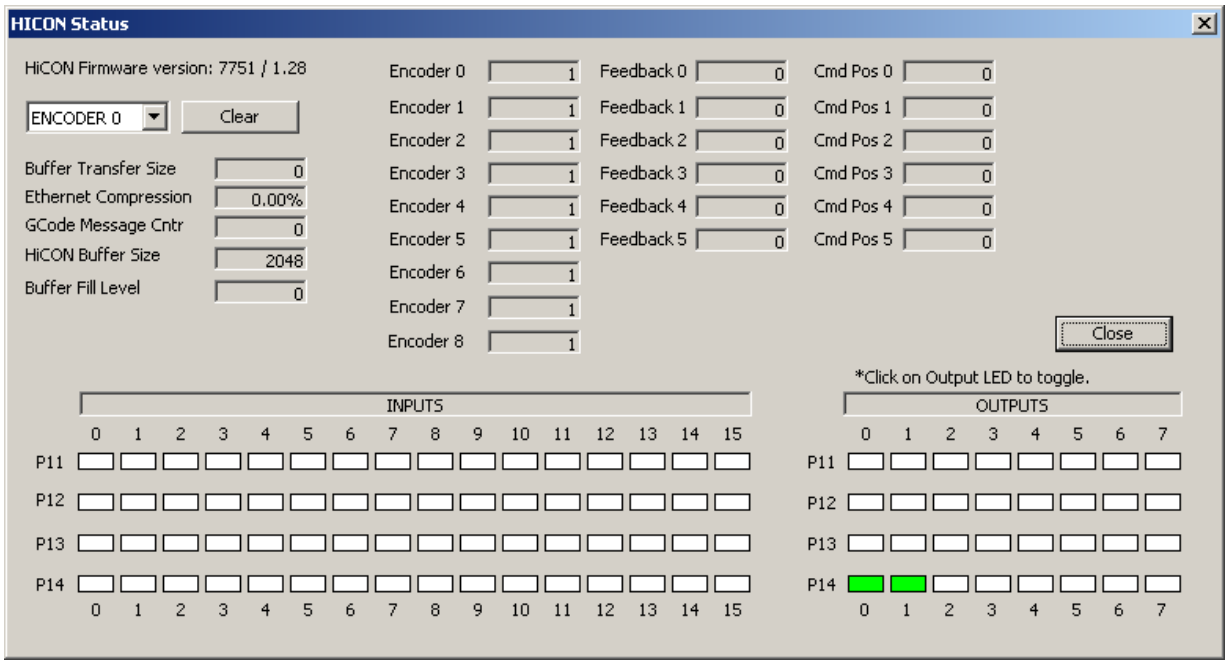


FIGURE 53 HICON STATUS WINDOW

The outputs can be toggled by clicking on the output LEDs. If an output is defined inside Mach3 under **Ports and Pins,** then clicking on the output LED will have no effect. This window can be left open while running Mach3.

The P stands for the port number. So output Y0 is port 11 pin 0 located at P11 column 0.

Note: The HiCON Status window is a great place to check for encoder feedback.

8.5 Apollo III Configuration

To change anything inside the controller, the HiCON plugin must be used. Click **Config** on the main menu bar, then **Config PlugIns**. Select the yellow CONFIG button next to the **M3HiCON-www.VSI99.com-HICON-X.XX** plugin as shown below.

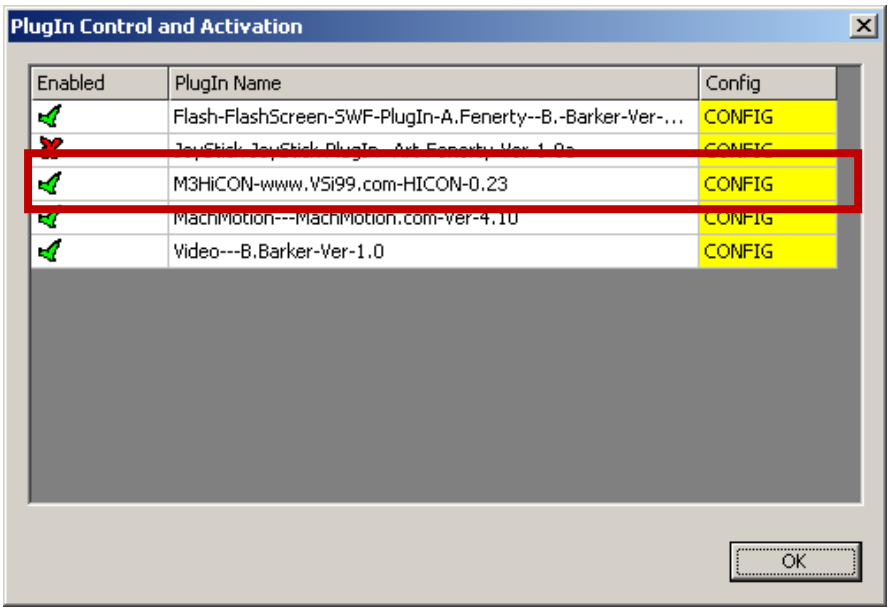


FIGURE 54 HICON PLUGIN

Once the HiCON plugin config is launched, a window with the following seven tabs will appear:

1. System
2. Axis X(0)
3. Axis Y(1)
4. Axis Z(2)
5. Axis A(3)
6. Axis B(4)
7. Axis C(5)

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

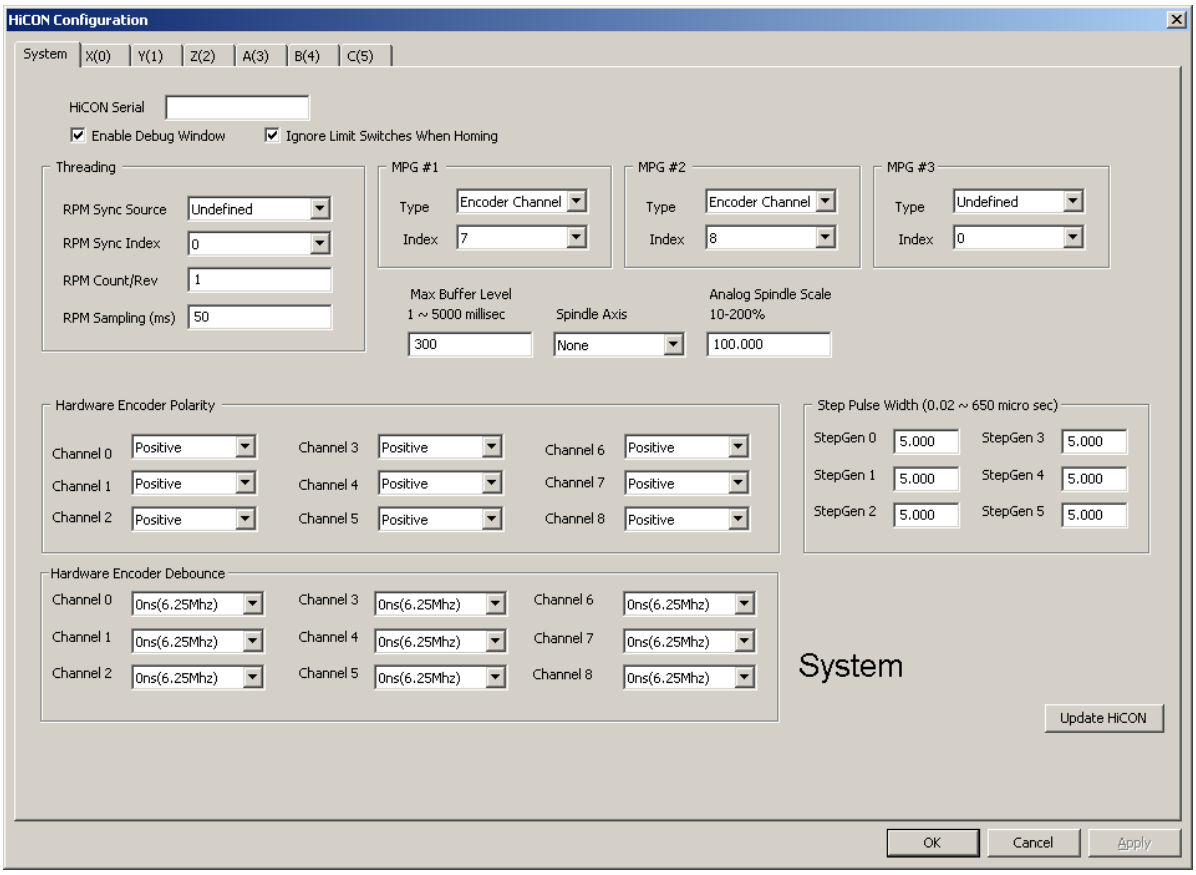


FIGURE 55 HICON CONFIGURATION WINDOW

At any time while inside the plugin, clicking on the [**UPDATE HICON**] button will transmit the settings to the Apollo III motion controller. Clicking [**OK**] will also transmit the settings to the controller 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.

Now, with a brief overview of the Apollo III, it is time to start configuring the controller.

9 ENABLE CIRCUIT

The Apollo III has a hardware enable and a drive enable circuit. However, before they will work, the emergency stop circuit must be set up. Use the table below as a quick reference for the different signals.

Signal / LED	Mach3 Name	Port #	Pin #	Active	Input / Output
Enable	Enable (1 through 6)	14	0	High (Red X)	Output
Drive Enable	Enable (1 through 6)	14	1	High (Red X)	Output
E-Stop	E-Stop	14	5	Low (Green Check)	Input

TABLE 10 ENABLE CIRCUITS

WARNING

Do NOT connect 115VAC to any part of the Apollo III motion controller. It could cause serious damage to the controller.

9.1 Emergency Stop

The emergency stop connector is located right below the power connector on the Apollo III. When the emergency stop terminals are connected together, the red E-Stop LED turns on and the controller can then enable.

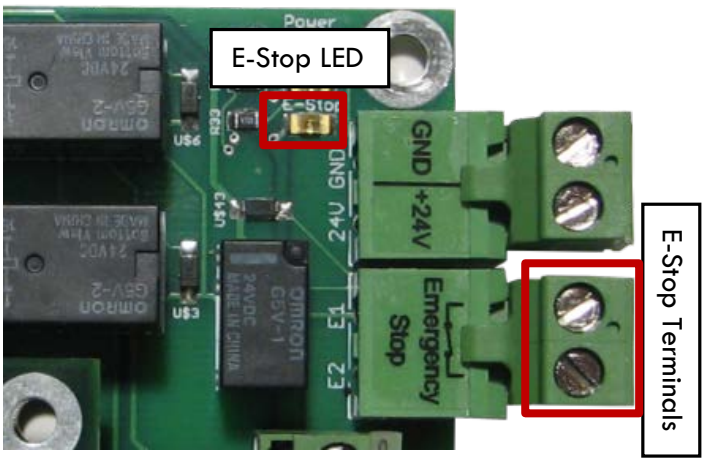


FIGURE 56 EMERGENCY STOP CONNECTION

Note: Nothing will work on the Apollo III motion controller unless the Emergency Stop terminals are connected together!

Emergency stop input is set up inside Mach3 by setting the E-Stop signal to port 14 pin 5. When it is set up correctly, any time the emergency stop terminals are disconnected, Mach3 will be reset.

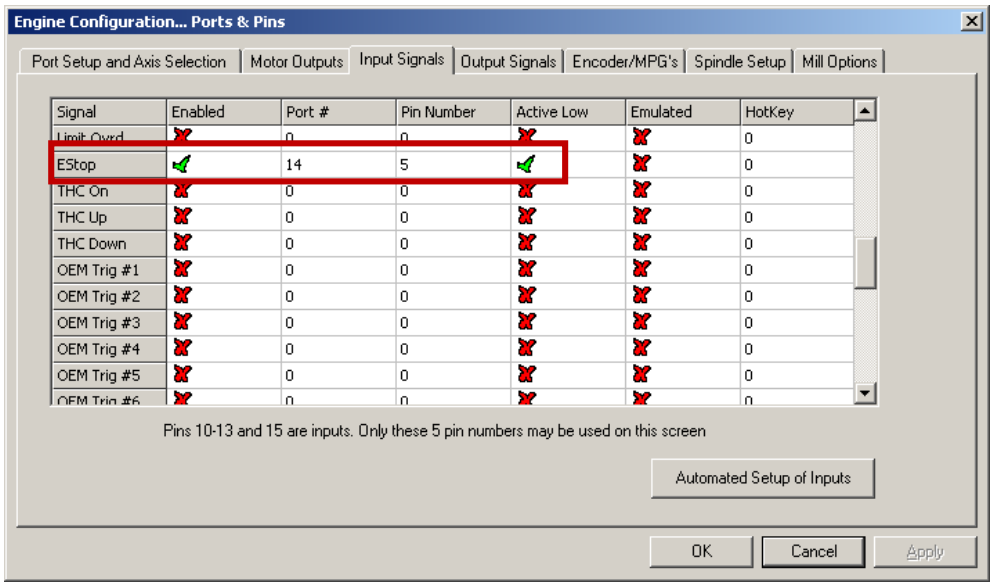


FIGURE 57 MACH3 E-STOP SETUP

9.2 Hardware Enable

The hardware enable is the main enable circuit. It enables all the components on the Apollo III, turns on the 5V enable (5EN) and the 24V enable signals (24EN), and activates the hardware enable relay (HEN). When the hardware enable is set up correctly, it will only activate when there are no emergency conditions. Tripping the emergency circuit or a limit switch will disable the hardware enable. Remember that the emergency stop terminals must be connected for anything to enable.

The 5V and 24V enable signals can be used for any low current applications. The hardware enable relay can be used for higher current applications up to 48V if an external voltage source is provided. The signals are labeled 5EN, 24EN, and HEN on the Apollo III terminal block TB2 as shown below.

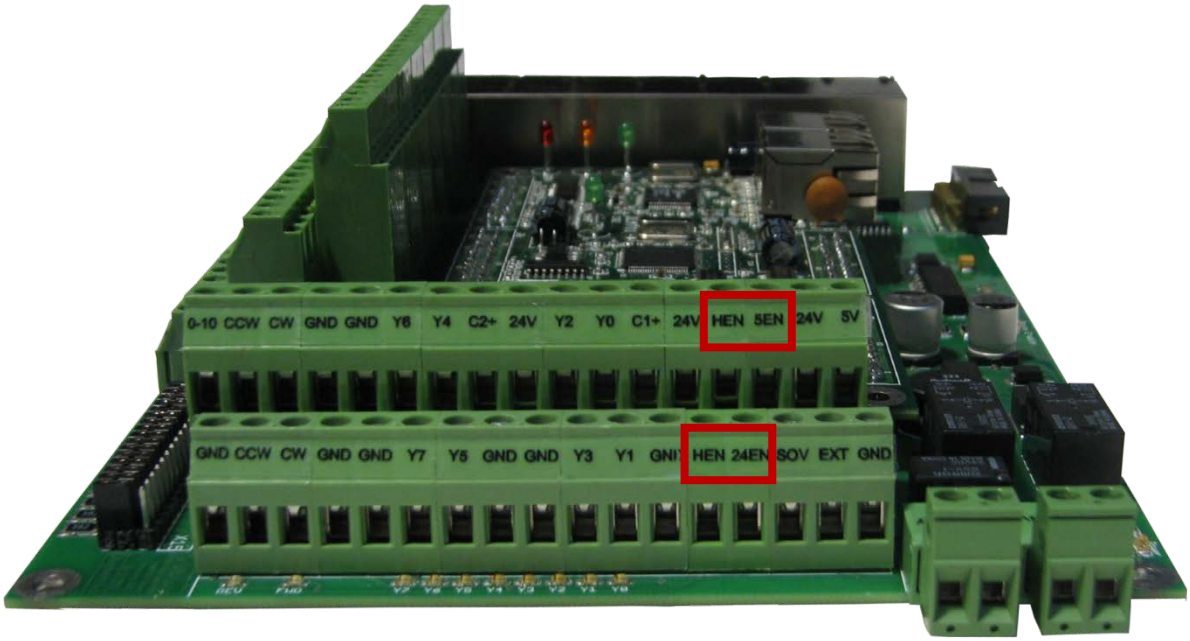


FIGURE 58 HARDWARE ENABLE SIGNALS

View the diagram below for an example of the hardware enable relay wiring.

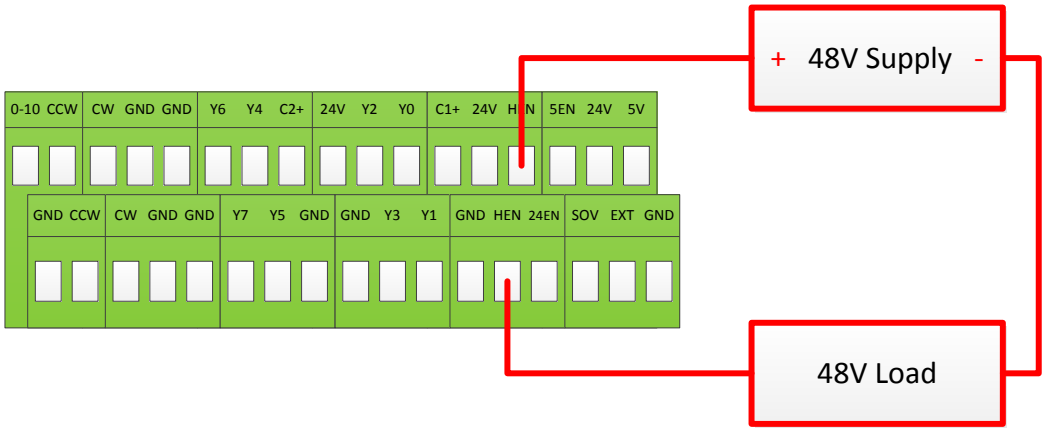


FIGURE 59 HARDWARE ENABLE RELAY EXAMPLE

The green LED (labeled Enable) turns on as soon as the controller detects the enable signal from Mach3. The LED does not mean that the hardware enable circuit is activated. The hardware enable circuit is only activated when the red (E-Stop), orange (Power), and green (Enable) LEDs are on.

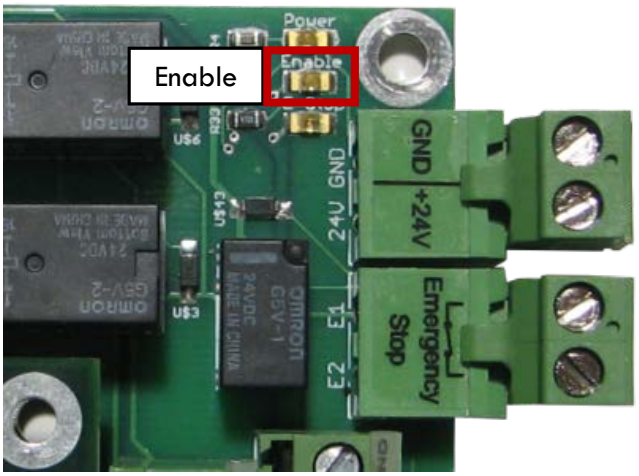


FIGURE 60 HARDWARE ENABLE LED

Hardware enable is set up inside Mach3 by setting one of the Enables to port 14 pin 0. Each enable signal corresponds to an axis (Enable1 = X, Enable2 = Y, etc). Make sure that the axis corresponding to the enable signal used is enabled under the Motor Outputs tab. For example, a lathe with only the X and Z axes enabled should not use the Enable2 (Y axis enable) signal.

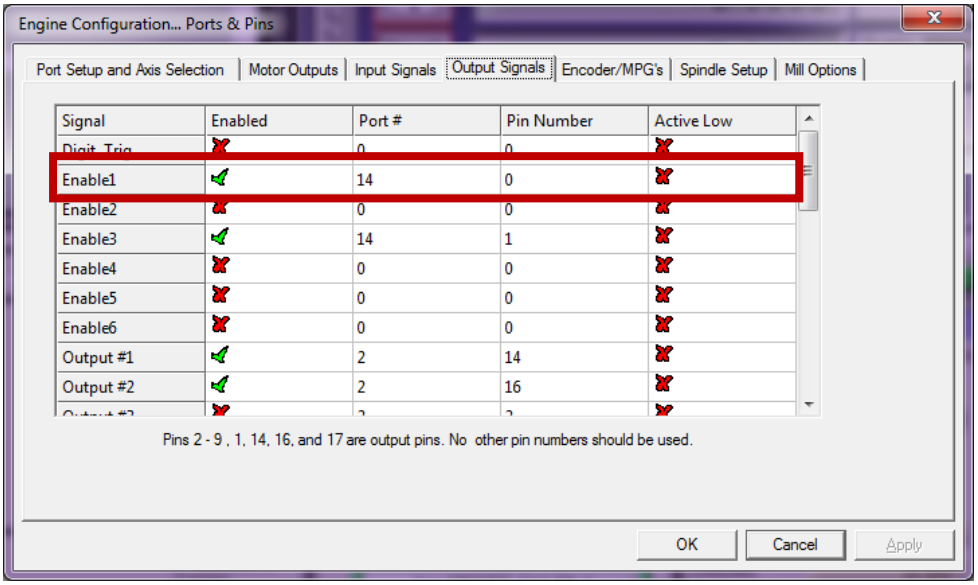


FIGURE 61 MACH3 HARDWARE ENABLE SETUP

9.3 Drive Enable

Drive enable is used to enable all the drives. When activated the drive enable relay connects the external enable (EXT) to the servo enable (SOV) terminals on TB2. The signal SOV runs to each axis control RJ45 jack. EXT can be jumpered to 5V, 24V, GND, or any other DC voltage up to 48V for different enable signals depending on what the servo drives require. Again, remember that the emergency stop terminals must be connected for anything to enable.

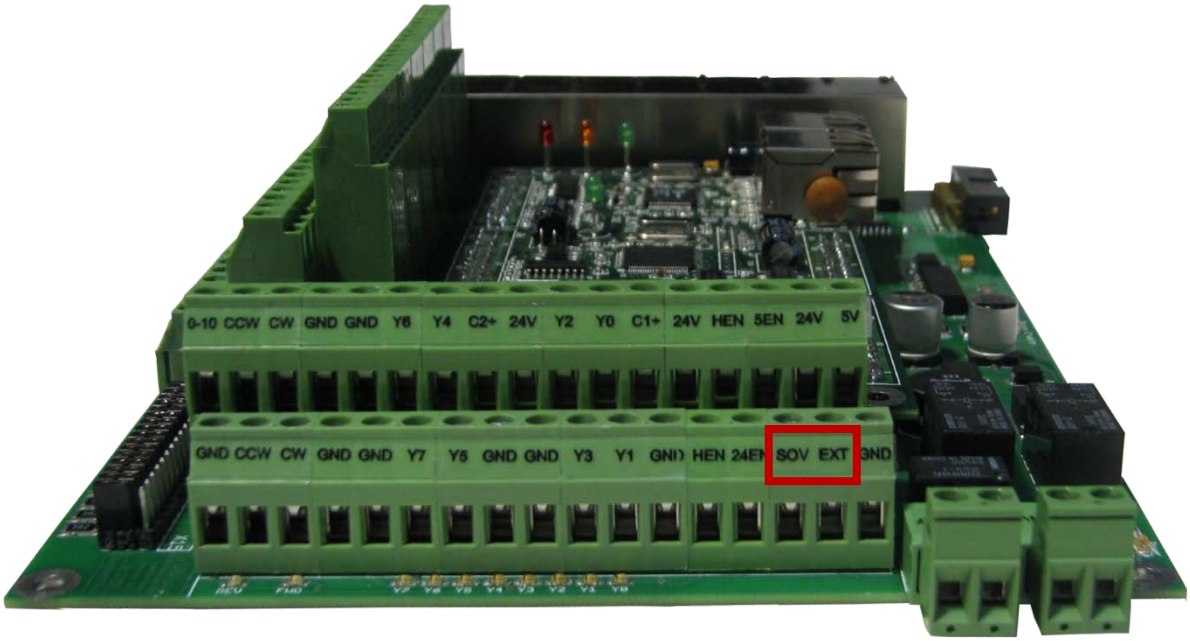


FIGURE 62 DRIVE ENABLE SIGNALS

The Mitsubishi, Yaskawa, and TECO servo drives from MachMotion are all enabled with a ground signal. Therefore EXT and GND are connected together as shown below.

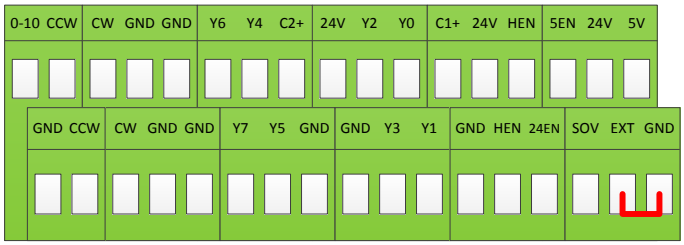


FIGURE 63 DRIVE ENABLE EXAMPLE

The blue LED (labeled Drive Enable) on the top middle of the controller turns on as soon as the drive enable signal from Mach3 is detected. The blue LED does not mean that the drive enable relay is activated. The drive enable relay is only activated when the red (E-Stop), green (Enable), and blue (Drive Enable) LEDs are on.

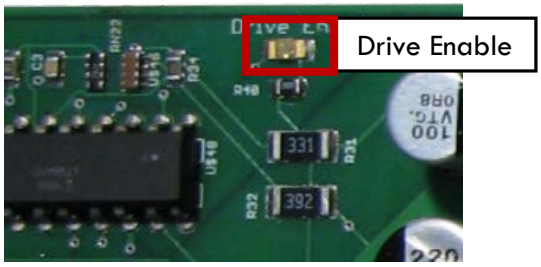


FIGURE 64 DRIVE ENABLE LED

If the system needs to use the drive enable signal without using the axis control cables, just connect the signal directly to SOV.

Drive enable is set up inside Mach3 by setting one of the Enables to port 14 pin 1. Each enable signal corresponds to an axis (Enable1 = X, Enable2 = Y, etc). Make sure that the axis corresponding to the enable signal used is enabled under the Motor Outputs tab. For example, a lathe with only the X and Z axes enabled should not use the Enable2 (Y axis enable) signal.

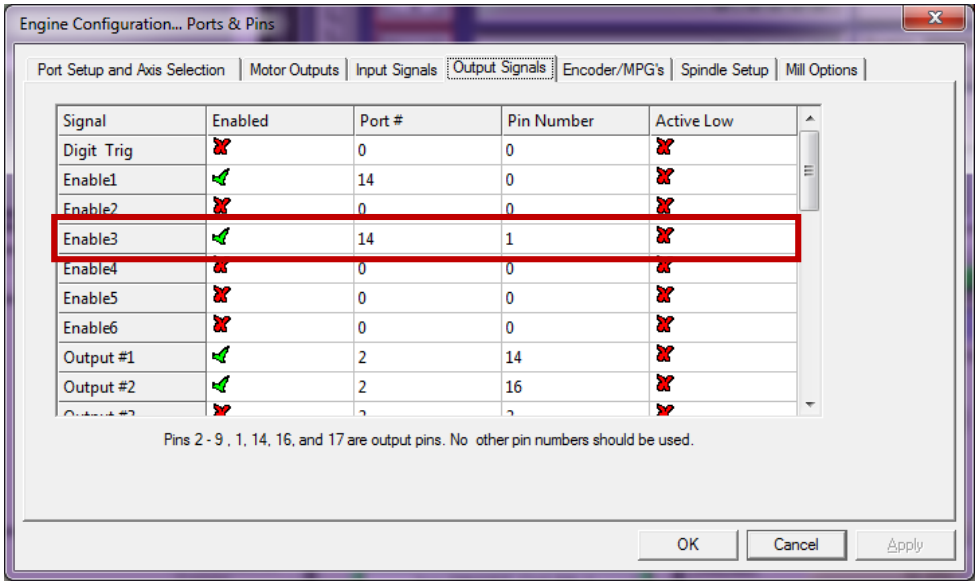


FIGURE 65 MACH3 DRIVE ENABLE SETUP

Now with the enable circuits set up, the next step is to set up the machine axes.

10 AXES

To set up the axes, the drives must be connected to the controller, the Apollo III controller must be configured, and the Mach3 software must be set up as defined below.

10.1 Connecting Drives

The Apollo III motion controller uses step and direction to control the axes. It can use differential or single-ended outputs. For differential outputs there are two signals for step (step + and step -) and two signals for direction (direction + and direction -). For single-ended there is only one signal for both step and direction. All MachMotion products use differential outputs.

10.1.1 Differential Control

Most systems use differential step and direction. The step and direction outputs are located on the bottom row of RJ1, the large RJ45 jack block. See the diagram below.

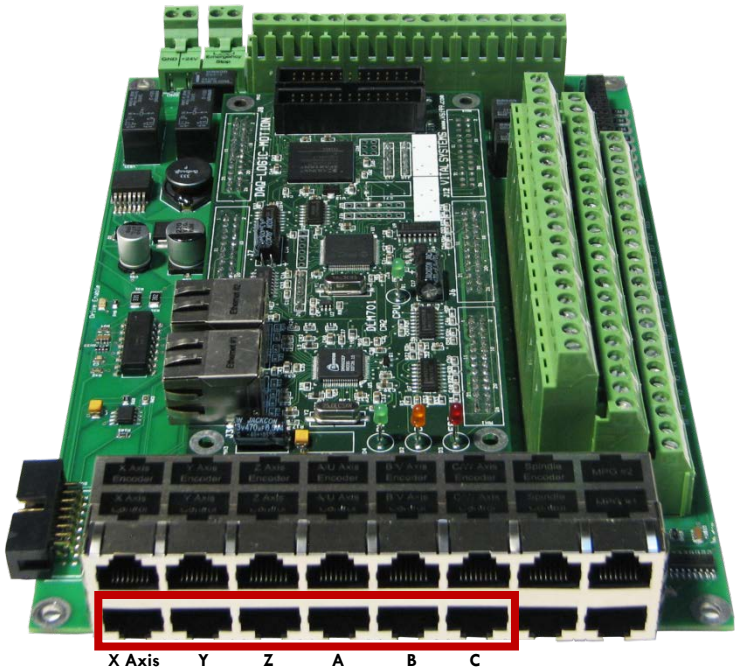


FIGURE 66 DIFFERENTIAL STEP AND DIRECTION RJ45 JACKS

The pinout for the RJ45 jacks is shown below.

Function	Reserved	Drive Error	Direction +	Drive Enable	GND	Direction -	Step +	Step -
RJ45 Pins	1	2	3	4	5	6	7	8
Colors	White & Orange	Orange	White & Green	Blue	White & Blue	Green	White & Brown	Brown

TABLE 11 AXIS CONTROL RJ45 JACK PINOUTS

Any drive from MachMotion can be plugged directly into the axis control RJ45 jacks.

10.1.2 Single-Ended Control

To use single-ended control use the terminals on TB1 (the large green terminal block). The top row is for the direction signals and the middle row is for the step signals. The first letter on each terminal is the axis name and the second letter is the function (D for direction and S for step). See the picture below.

TABLE 9 SINGLED-ENDED STEP AND DIRECTION TERMINALS

With the drives connected it is time to connect the encoder feedback. Skip the next section if the system does not have encoder feedback or if it is not going to be set up at this time.

10.1.3 Encoder Feedback

The encoder feedback inputs are located on the top of RJ1. The encoder signal for each axis is directly above the control signal. See the diagram below.

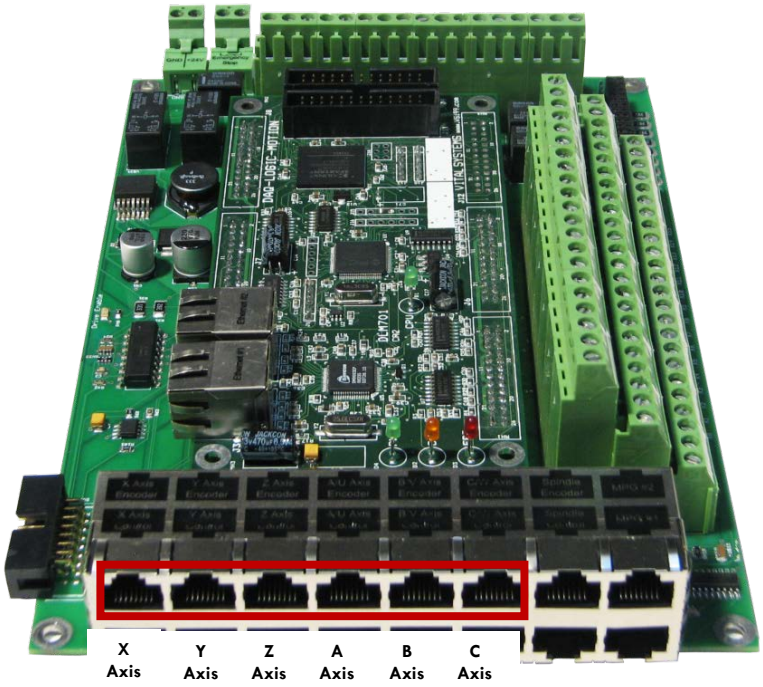


FIGURE 67 ENCODER FEEDBACK RJ45 JACKS

The Apollo III uses a 5V encoder signal. See the pinout below.

Function	A+	A-	B+	5V	GND	B-	I+	I-
RJ45 Pins	1	2	3	4	5	6	7	8
Colors	White & Orange	Orange	White & Green	Blue	White & Blue	Green	White & Brown	Brown

TABLE 12 ENCODER FEEDBACK RJ45 JACK PINOUT

Again any drives purchased from MachMotion can have their encoder feedback plugged directly into the encoder RJ45 jacks.

10.2 Configuring Axes

The axes must also be configured inside the HiCON plugin. Begin by opening up the plugin. Select the tab corresponding to the axis to be configured.

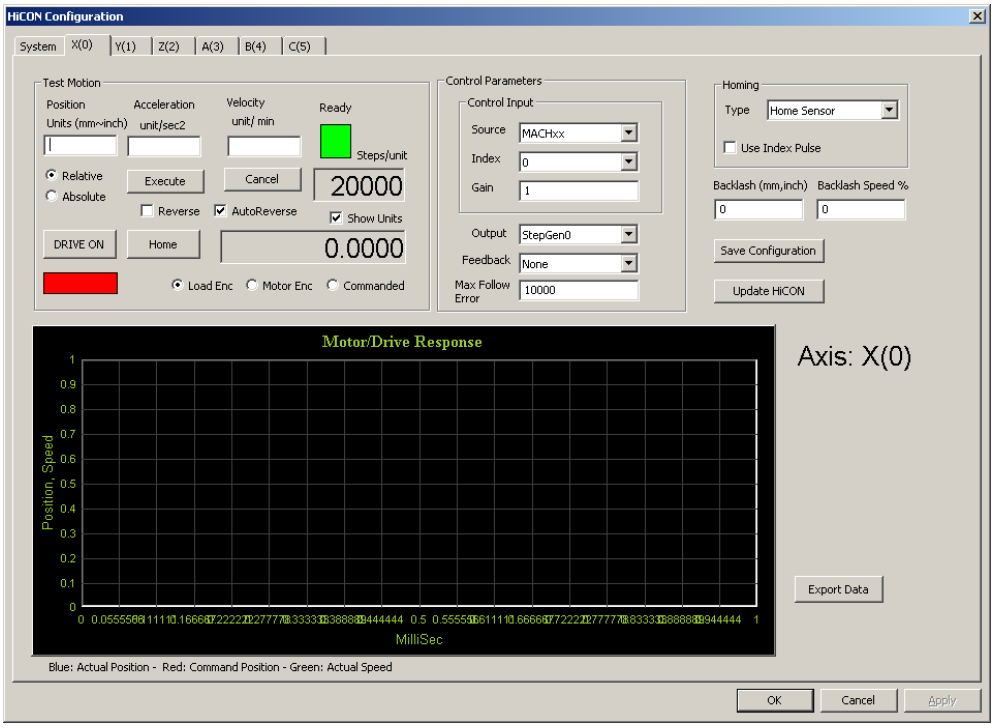


FIGURE 68 X AXIS CONFIGURATION

The control parameters are used to configure the axes. If the Apollo III came with a MachMotion control all of the following parameters will already be set up. For all other systems, the only parameter that should have to change is the Feedback. If the system has encoder feedback, make sure to select the correct encoder under the Feedback drop down bar. The encoder index starts at 0. So for the X axis use Encoder0, for the Y axis Encoder1.

The default parameters are shown below:

Parameter Name	Value
Source	MACHxx
Index	N*
Gain	1
Output	StepGenN*
Feedback	EncoderN*
Max Follow Error	10000

TABLE 13 CONTROL PARAMETERS

*N is the axis number with 0 being X, 1 being Y, 2 being Z, etc.

To update the control parameters, press the UPDATE HICON button. Clicking on OK or the SAVE CONFIGURATION buttons saves the entire configuration to the selected Mach3 profile.

The axes should now be set up enough to jog the machine.

WARNING

The machine has not been calibrated so it could jog at extremely high speeds and move erroneous distances. Also, no limits have been set up so DEATH, INJURY or serious PROPERTY DAMAGE could result if extreme caution is not used.

If more information is desired about the control parameters, please read the section below.

10.2.1 Control Parameters

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

Index – Index defines the index of the controller source. This is equal to the axis number (X = 0, Y = 1, Z = 2, etc).

Gain – The control input (commanded) is multiplied by this number. Leave this at 1 for most applications.

Output – Output defines the output for the controller for a particular axis. The possible values are:

StepGenX: This setting uses step and direction as the output. X refers to the axis number.

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

Feedback – Feedback defines the feedback type for the controller for the selected axis. The possible values are:

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

None: Use this if the system is not going to use encoder feedback.

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.

Max Follow Error – Defines the number of steps between the commanded position and the actual position (from the encoder feedback) before an emergency condition is triggered. This value is only applicable if the system is using encoder feedback.

10.3 Testing Motion

The test motion module is only useful if encoder feedback is being used. For most applications this will never be needed. However, this can be used to optimize the system acceleration and velocity. It allows the following error of the machine to be viewed during commanded movements. Utilize the figure below as a reference.

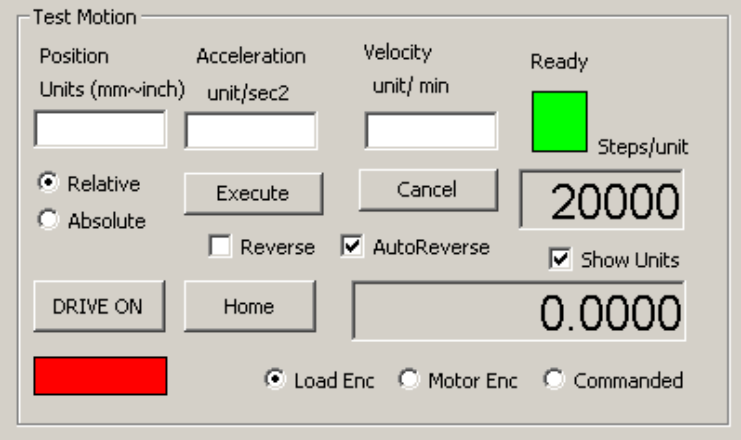


FIGURE 69 TEST MOTION

Follow the steps below to test motion.

1. Enter in the desired axis velocity in units per minute
2. Enter in the desired acceleration value for the machine
3. Select the **Relative** or **Absolute** option

Note: Relative moves the machine X distance from its current position. Absolute moves the machine to the machine coordinate position (distance from home). Relative is generally recommended.

4. Enter the distance in the Position user input.
5. Press the button DRIVE ON to turn on the LED beneath the button. This enables the drives. When the LED is green, the drives are enabled.

   Note: To download a new configuration to the Apollo III, DRIVE ON must be disabled.

6. Press EXECUTE to command the movement

The axis can also be homed by pressing the HOME button. Make sure that homing is set up in Mach3 before using this function.

By selecting the **AutoReverse** check box, the system can make the axis reverse direction automatically for the next motion command and thus avoid the axis continuing on in one direction during testing. The Ready LED shows if the Apollo III is ready to accept a motion command. If the Ready LED is green, it implies that the controller is ready to accept new motion commands. While executing a motion profile, the Ready LED turns to red and Apollo III cannot accept a new motion command until the current motion sequence is completed or cancelled.

Once the test motion command has completed, the accuracy of the commanded motion profile can be seen on the on the Motor/Drive Response graph. The acceleration and velocity can be optimized to get the machine's following error to a minimum.

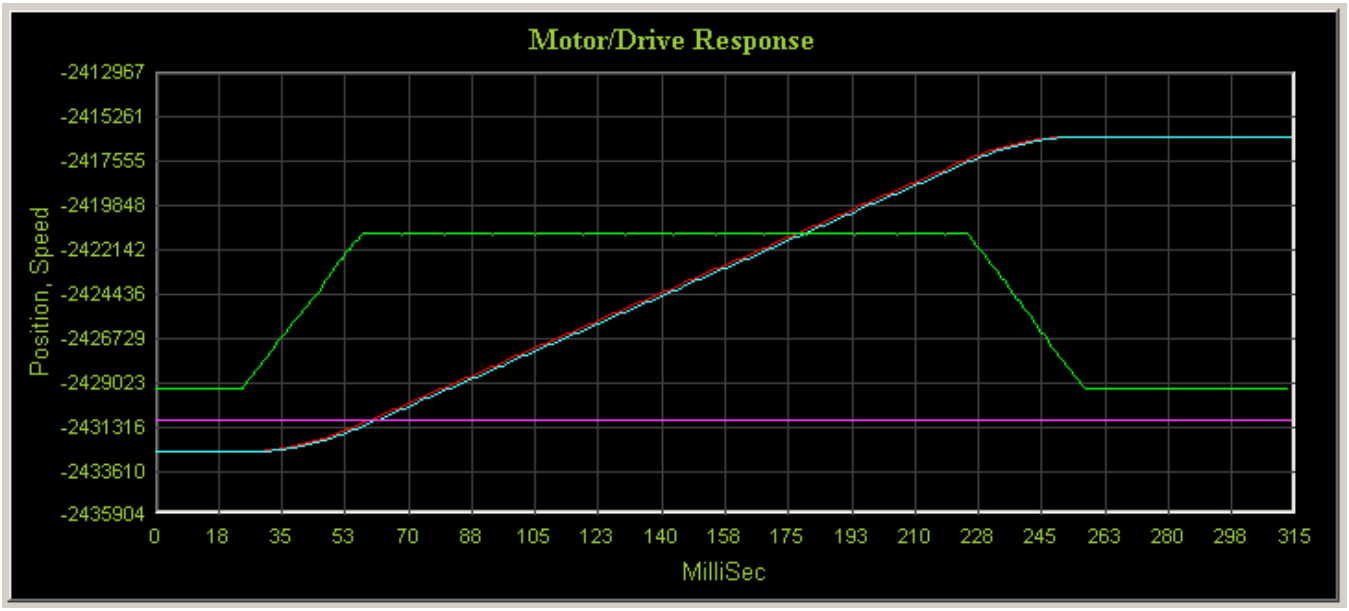


FIGURE 70 MOTOR/DRIVE RESPONSE GRAPH

The blue line represents the actual position, the red line shows the commanded position, and the green line displays the actual speed. Therefore the distance between the blue line and the red line is the following error.

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

10.3.1 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 Apollo III. In addition, it also downloads control parameters before starting the motion. User can press the CANCEL button to cancel the motion execution anytime during the machine operation. Make sure that the axis control settings have been downloaded by clicking UPDATE HICON before clicking on EXECUTE. Motion commands can be run by pressing the EXECUTE button when the Ready LED is green.

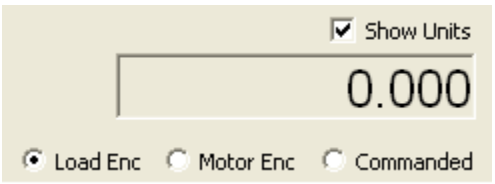
DRIVE ON Button – By clicking this button, the plugin downloads the parameters and enables the drives. If DRIVE ON is active, the LED below this button will turn to green. Otherwise it will be red.

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.

10.4 Backlash Compensation

The Apollo III has backlash compensation. Each axis tab in the HiCON plugin has the fields below for controlling the compensation amount and speed.

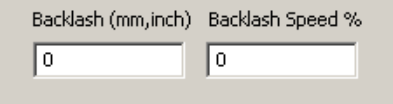


FIGURE 71 BACKLASH COMPENSATION

Backlash (mm,inch) – This field defines the backlash distance in inches or mm. The Apollo III uses this value to calculate virtual load position.

Backlash Speed % – This field adjusts the maximum acceleration that the backlash counts can be applied. The Apollo III takes the max acceleration from the motor tuning and multiplies it by this percentage. Valid values are 10-400 (0.1 to 4 times max acceleration).

WARNING

Do not use the native backlash compensation in Mach3. The backlash compensation in the HiCON plugin is the master and the Mach3 settings are ignored.

10.5 Reversing Direction

If an axis moves the wrong direction, it can be reversed in the Mach3 software.

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

   The following window will come up:

FIGURE 72 REVERSING DIRECTION

5. Under the **Reversed** column click on the red "X" if the axis needs to be reversed
6. After making all the changes, press OK
7. On the menu bar go to **Config->Config Plugins** and press the CONFIG button on the HiCON plugin line
8. Change the Encoder Polarity all axes reversed above from **Positive** to **Negative** or vice versa

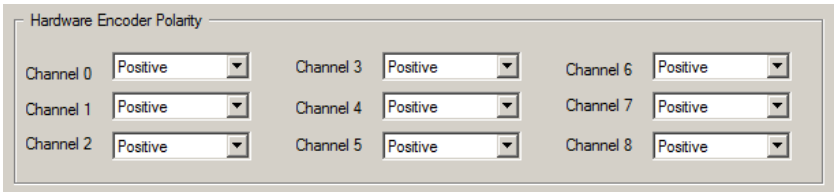


FIGURE 73 - ENCODER POLARITY

The axis will now move the opposite direction than it did before. If the polarity is not changed a following error will occur every time that axis is commanded to move.

10.6 Slaving an Axis

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

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

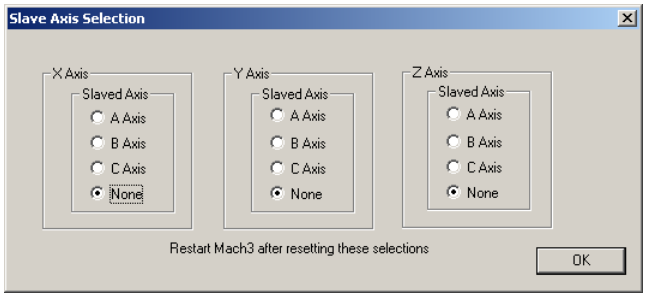


FIGURE 74 SLAVE AXIS SELECTION WINDOW

5. Select the axis to be slaved. The X, Y, and Z aces can have A, B, or C as slaves. For example, the configuration below is used to slave the A axis to the Y axis

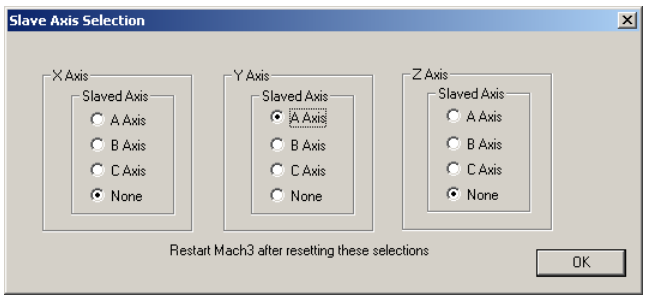


FIGURE 75 A AXIS SLAVED TO Y

6. Press OK and then restart Mach3
7. On the menu bar go to **Config->Config Plugins** and press the CONFIG button on the HiCON plugin line
8. Go to the tab for the slave axis and set the Index drop down to match the number of the master axis (Ex. To slave A to X set Index on the A tab to 0)

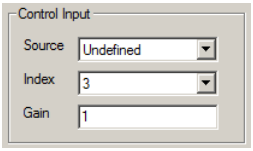


FIGURE 76 - CONTROL INPUT

9. Press the [**Save Config**] button just to the lower right of the Control Input box

*Note: Make sure to press the [**Save Configuration**] button after making any setting changes in the HiCON plugin.*

11 SPINDLE

This section goes through the wiring and configuration process for spindle integration with Mach3. The Apollo III 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 the spindle is set up.

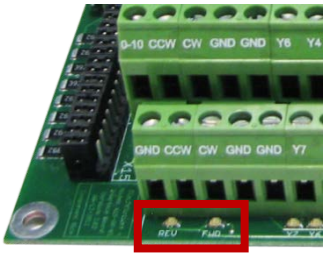


FIGURE 77 SPINDLE LEDS

11.1 Wiring a Spindle

11.1.1 VFD

Any VFD can be wired into the Spindle Control RJ45 jack by cutting the end off of a CAT5 cable and wiring the loose ends to the VFD according the following pin out.

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 14 SPINDLE CONTROL RJ45 JACK

11.1.2 VFD from MachMotion

The process for setting up a VFD from MachMotion is extremely simple. Simply plug the control cable into the Spindle Control RJ45 jack located on the bottom row of the large RJ45 jack block.

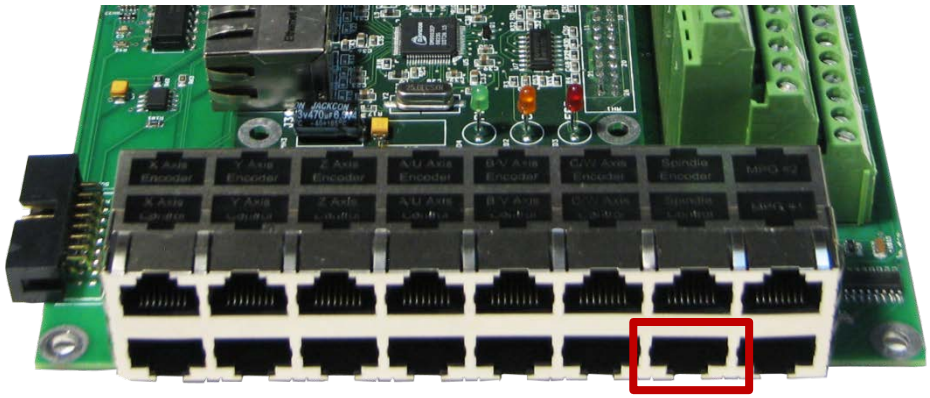


FIGURE 78 SPINDLE CONTROL RJ45 JACK

11.1.3 No VFD

If the system does not use a VFD to control the spindle, wire the spindle into the small green connecter as shown below. Notice that 24V is wired to the CW and CCW relay contacts on the top row of the green connector.

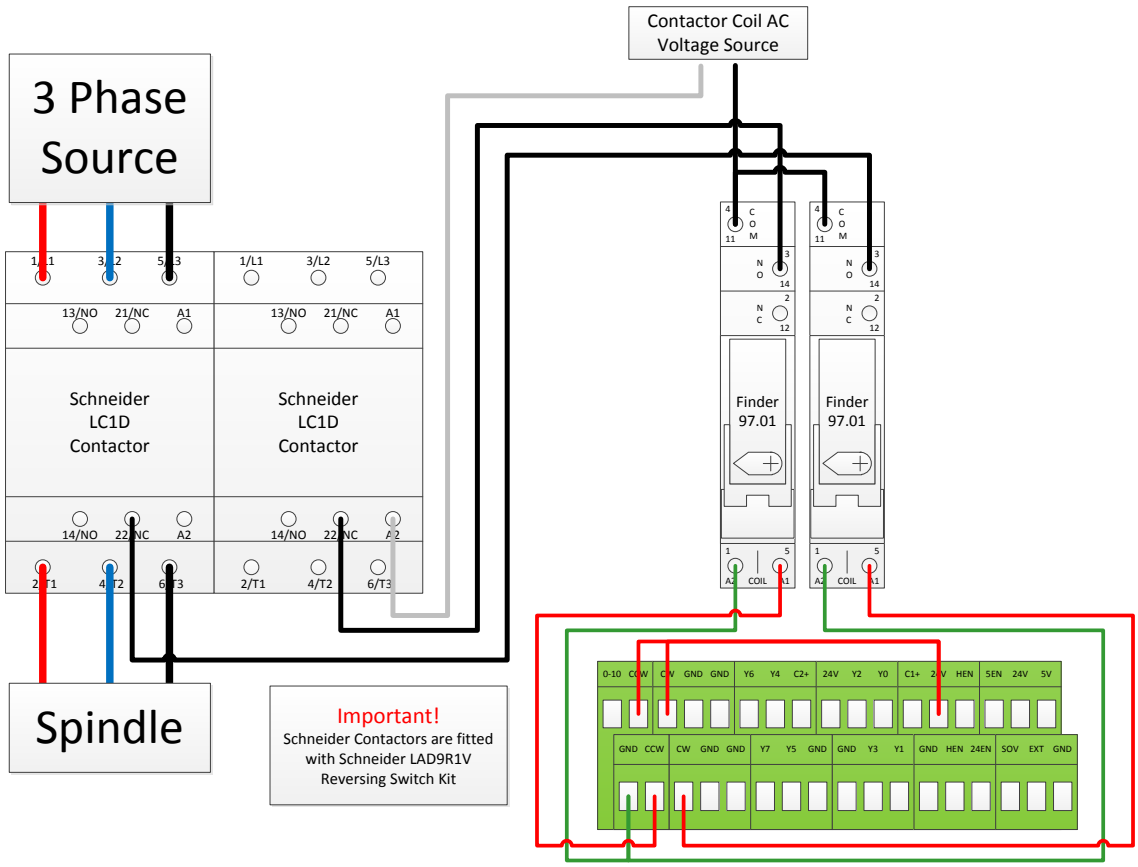


FIGURE 79 SPINDLE

11.1.4 Spindle Feedback

The Apollo III takes a 5V encoder signal as spindle feedback. Connect it into the top row of RJ1 as shown below.

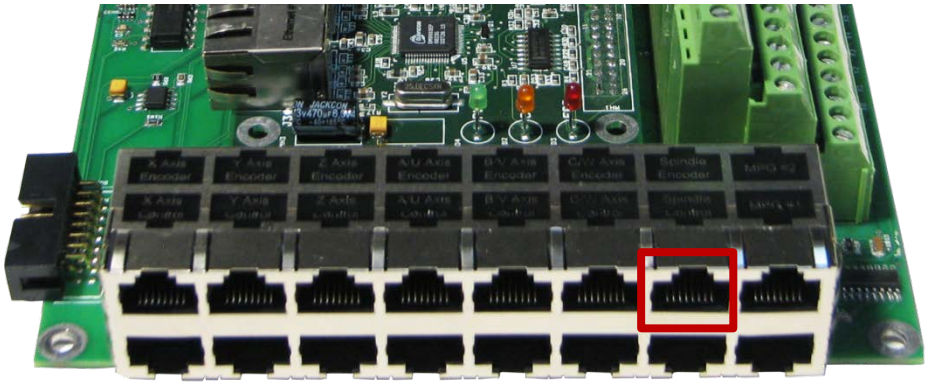


FIGURE 80 SPINDLE FEEDBACK RJ45 JACK

The pin out for the spindle feedback RJ45 jack is shown below.

Function	A+	A-	B+	5V	GND	B-	I+	I-
RJ45 Pins	1	2	3	4	5	6	7	8
Colors	White & Orange	Orange	White & Green	Blue	White & Blue	Green	White & Brown	Brown

TABLE 15 SPINDLE FEEDBACK RJ45 JACK

11.2 Configuring the Spindle

11.2.1 Enabling the Spindle

Follow the directions below to enable the spindle inside Mach3.

1. Select **Config->Ports and Pins** and then click on the **Motor Outputs** tab
2. Enable all the spindle by setting the spindle box in the column titled Enable to a green check

All the port and pin numbers should be set to 0.

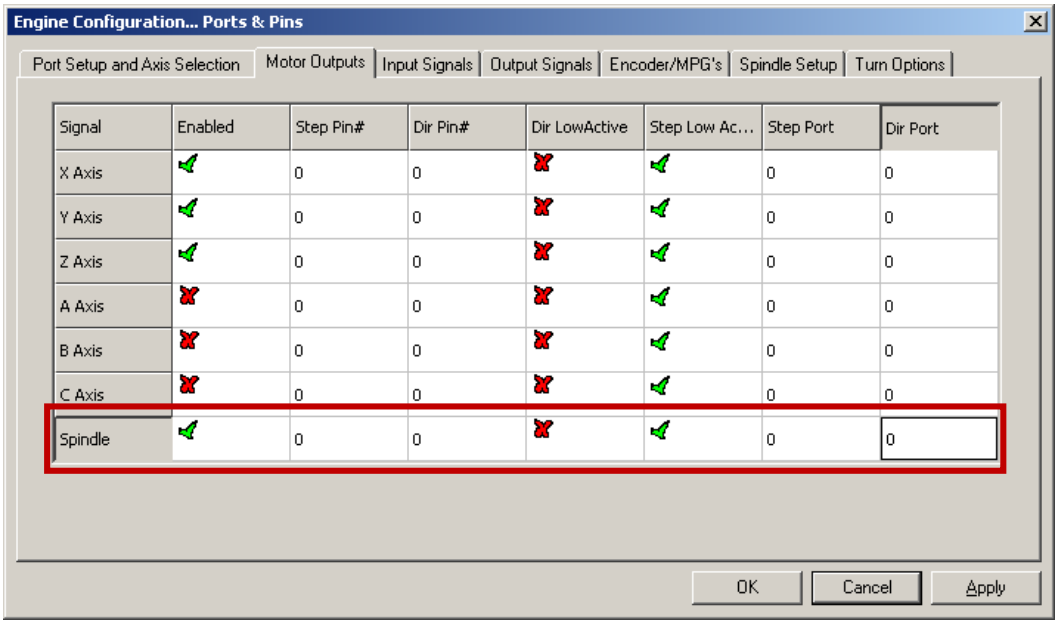


FIGURE 81 SPINDLE SETUP

3. Now click on the **Output Signals** tab
4. Enable outputs 1 and 2 and set them up to port 14 pin 6 and port 14 pin 7 respectively as shown below. Make sure that the **Active Low** column is set to a red "X" for both outputs.

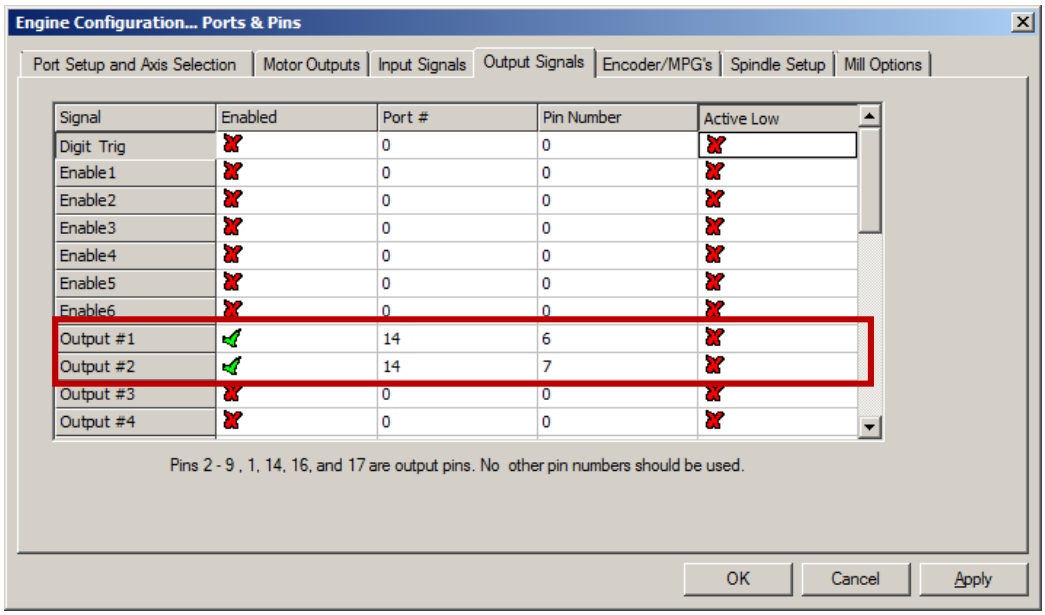


FIGURE 82 SPINDLE OUTPUTS

5. Finally, click on the **Spindle Setup** tab.

Description	Setting
Disable Spindle Relays	Unchecked
Clockwise (M3) Output #	1
CCW (M4) Output #	2
Use Spindle Motor	Checked
PWM Control	Checked
Step/Dir Motor	Unchecked
PWM Base Freq.	100
Minimum PWM	1

TABLE 16 SPINDLE SETTINGS

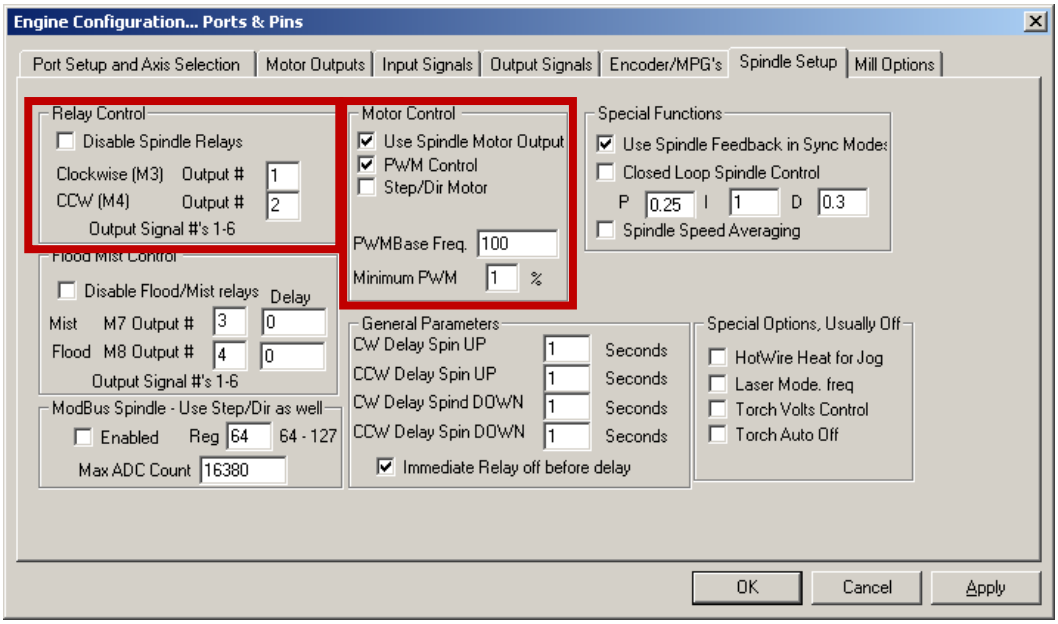


FIGURE 83 SPINDLE SETUP

6. Press APPLY to save the changes and then OK.

The spindle is now enabled.

11.2.2 Spindle Pulley Setup

For Mach3 to know how to scale the analog voltage output, the maximum RPM for the spindle motor must be defined. If the machine has different gears Mach3 can have 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 RPM.

To change the pulleys, go to **Config->Spindle Pulleys.** The *Pulley Selection* window will appear as shown in Figure 22.

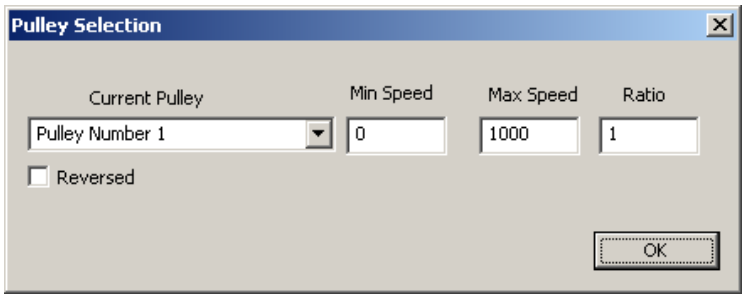


FIGURE 84 PULLEY SPEED SETUP

Use the drop down menu titled **Current Pulley** to select the pulley to be updated. Enter in the maximum and minimum speeds for each pulley. Then select the current pulley and press OK.

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

Note: If the spindle is turning the wrong direction check the reversed box in the Spindle Pulleys window

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

11.2.3 Analog Calibration

On the **Systems** tab the spindle voltage can be adjusted by changing the percentage (10-200%). Most systems will not require this value to be changed. However, if the voltage is not close enough, the percentage adjustment can be calculated with the following formula:

Analog Spindle Scale % = Commanded Voltage/Actual Voltage*100

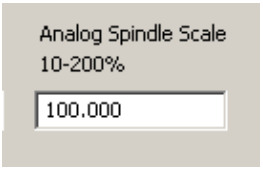


FIGURE 85 SPINDLE DAC

11.2.4 RPM Feedback

If the spindle has encoder feedback, set up the **Threading** section. Set the **RPM Sync** to Hard Encoder, the **RPM Sync Index** to 6, and the **RPM** to the number of encoder pulses per revolution.

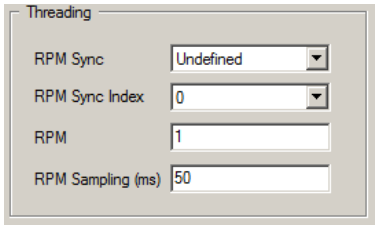


FIGURE 86 SPINDLE FEEDBACK SETTINGS

11.2.5 Servo Spindle Setup

To use a servo axis as a spindle the HiCON plugin will need to be configured as follows:

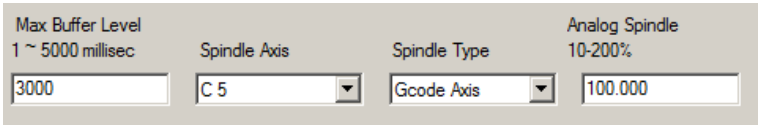


FIGURE 87 SERVO SPINDLE SETTINGS

Set the **Spindle Axis** drop down to the axis the servo spindle is connected to and set the **Spindle Type** to *Gcode Axis*.

11.2.6 Turning on the Spindle

In addition to the screen controls the spindle can also be controlled using M-codes. Use the table below as a reference.

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

TABLE 17 SPINDLE M-CODES

12 MPGS

The Apollo III has two 5V MPG encoder inputs. They are located on RJ1 as shown below.

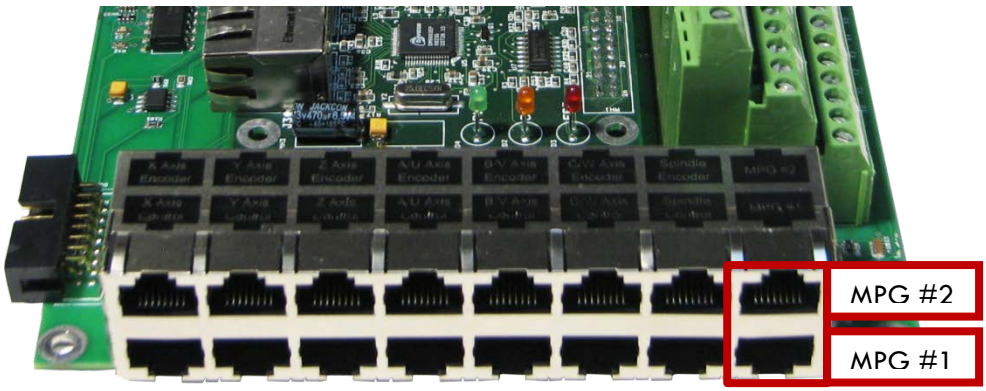


FIGURE 88 MPG RJ45 JACKS

Below is the pinout for the MPGs:

Function	A+	A-	B+	5V	GND	B-	N/C	N/C
RJ45 Pins	1	2	3	4	5	6	7	8
Colors	White & Orange	Orange	White & Green	Blue	White & Blue	Green	White & Brown	Brown

TABLE 18 MPG RJ45 JACKS

To configure the MPGs open up the HiCON plugin as shown in **Error! Reference source not found.** on page **Error! Bookmark not defined.**. Under the **System** tab set the MPG type to **Encoder Channel**. The **Index** should be set to 7 for MPG 1 and 8 for MPG 2 as shown below.

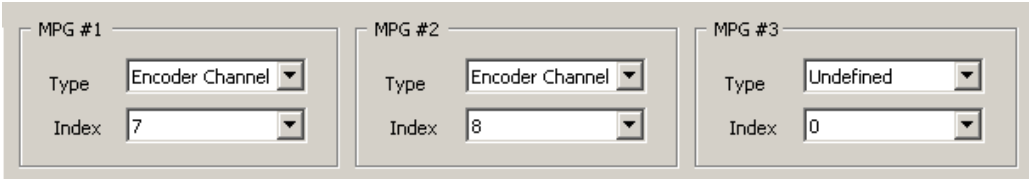


FIGURE 89 MPG PLUGIN SETUP

Next, set up the Mach3 software.

1. Open up **Config->Ports and Pins** and go to the **Encoder/MPG's** tab.
2. Enable one of the MPGs by clicking on the red X under the Enabled column. If it has a green check mark then it is already enabled.

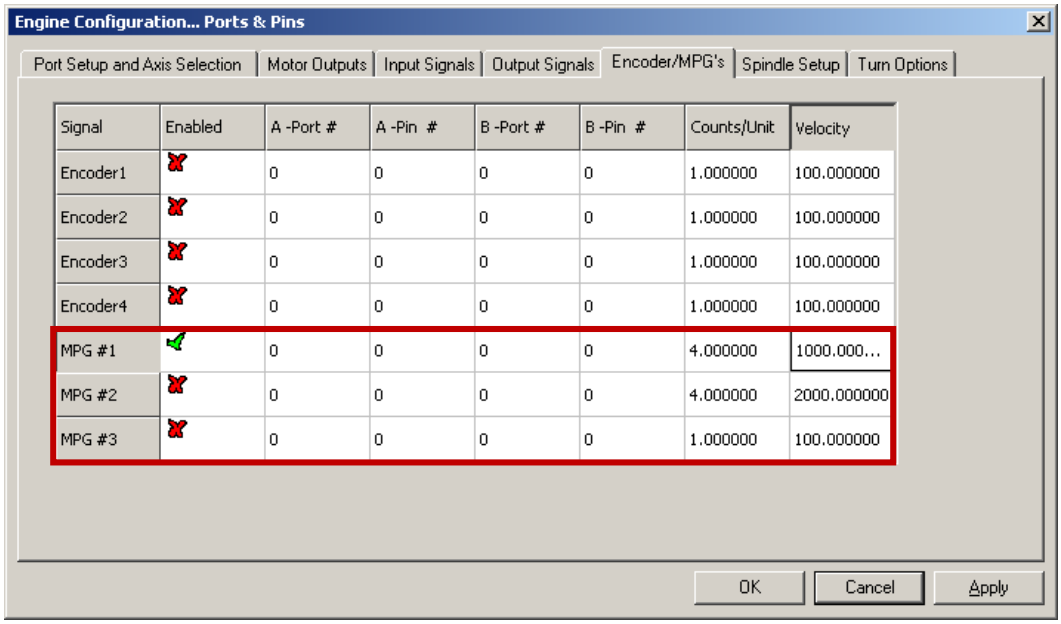


FIGURE 90 MPG 1 ENABLED

3. Set the **Counts/Unit** to the number of counts per click. On most MPGs this is 4.
4. Press APPLY and then OK.

The MPG is now set up.

13 INPUTS

The Apollo III has 16 configurable inputs. These inputs can be used for limit switches, home switches, tool changers, or anything else. As shown below, the inputs are located on the main green terminal block, TB1.

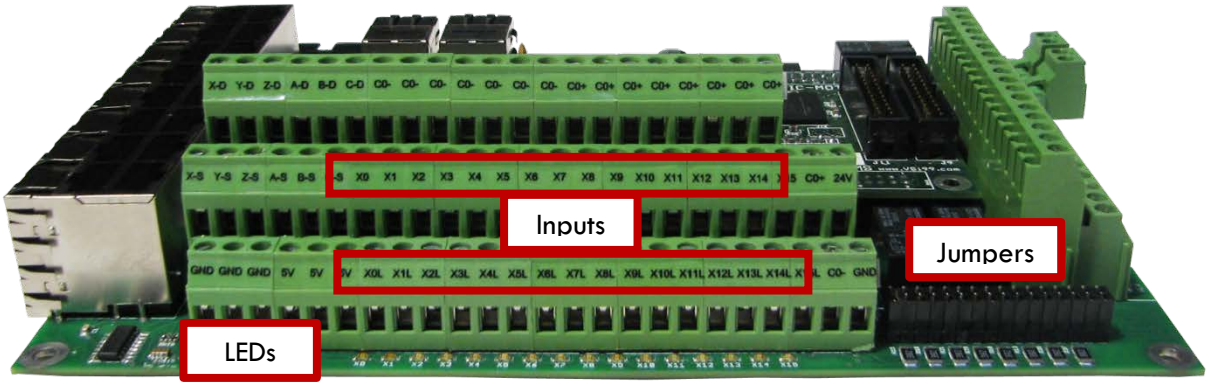


FIGURE 91 INPUTS

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 X15. 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 III. The jumpers start counting from the left at X0 and increment up to X15. Each jumper corresponds to an input. For example, the jumper labeled X10 corresponds to the input on TB1 labeled X10 and the LED X10.

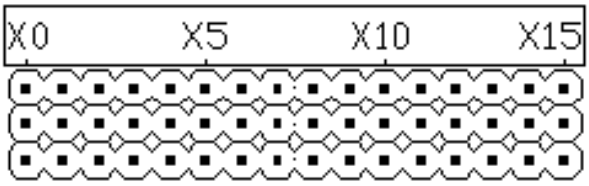


FIGURE 92 INPUT JUMPERS

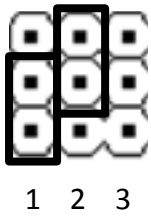


FIGURE 93 JUMPER POSITIONS

WARNING

Input X0 is configured as drive fault by default. If you servo drives from MachMotion, DO NOT connect anything to X0. It could damage your drives or Apollo III motion controller.

13.1 Wiring Inputs

13.1.1 Standard 24V Inputs

For a standard 24V input, place the jumper on the bottom two pins. Next, connect C0+ to 24V and C0- to GND on TB1 as shown below.

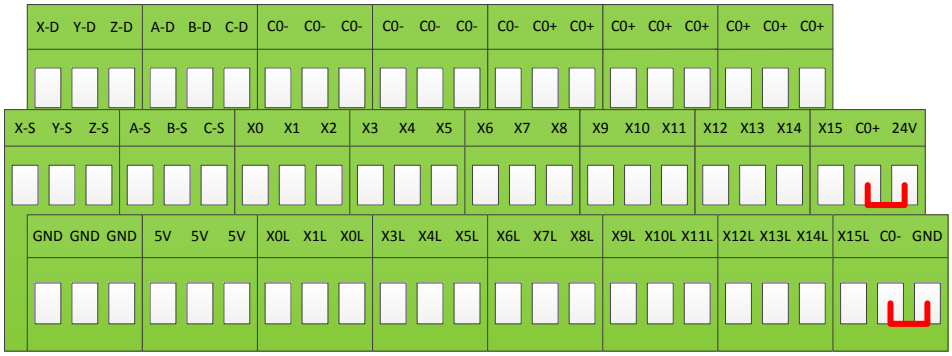


FIGURE 94 - 24V CONFIGURATION

Then connect the input to the input terminal on the middle row (X1, X2, etc.). See the diagram below.

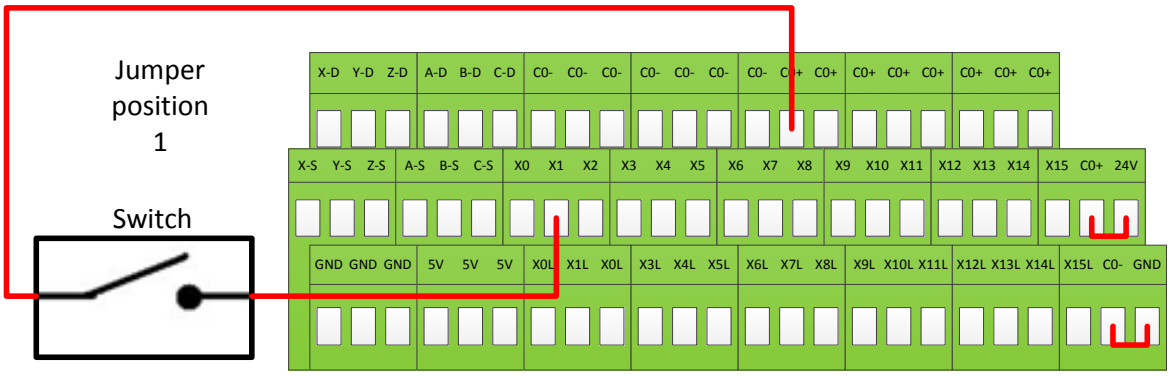


FIGURE 95 STANDARD 24V INPUT

To activate the input, 24V must be supplied 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.

13.1.2 High Voltage Sourcing Inputs (PNP)

For 9-48V inputs, supply the positive voltage to the C0+ terminal and connect ground to C0-. Set the jumper for the input to the bottom two terminals. Then connect the signal into the corresponding input.

For example, the Apollo III shown below is set up for 30V. Notice that input X4 is connected to a switch.

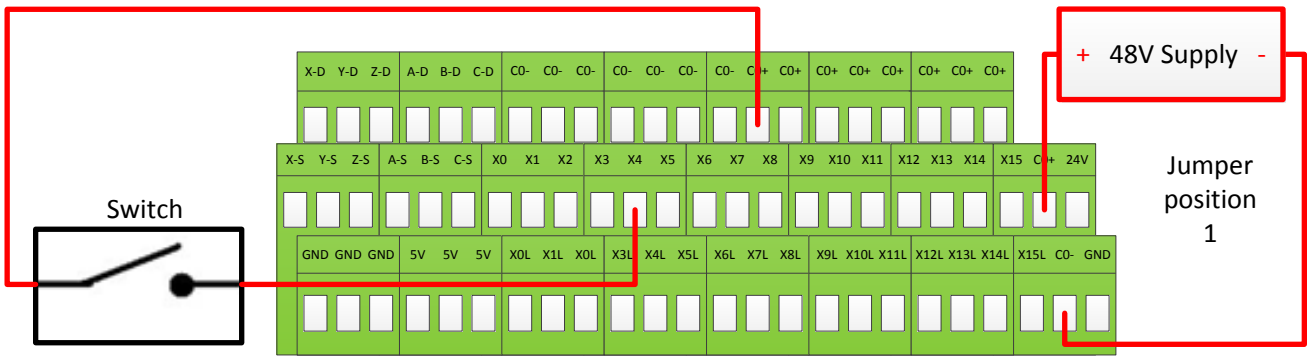


FIGURE 96 - HIGH VOLTAGE SOURCING INPUTS

Note: All the inputs use the same common.

Below is another example with a 12V PNP proxy sensor.

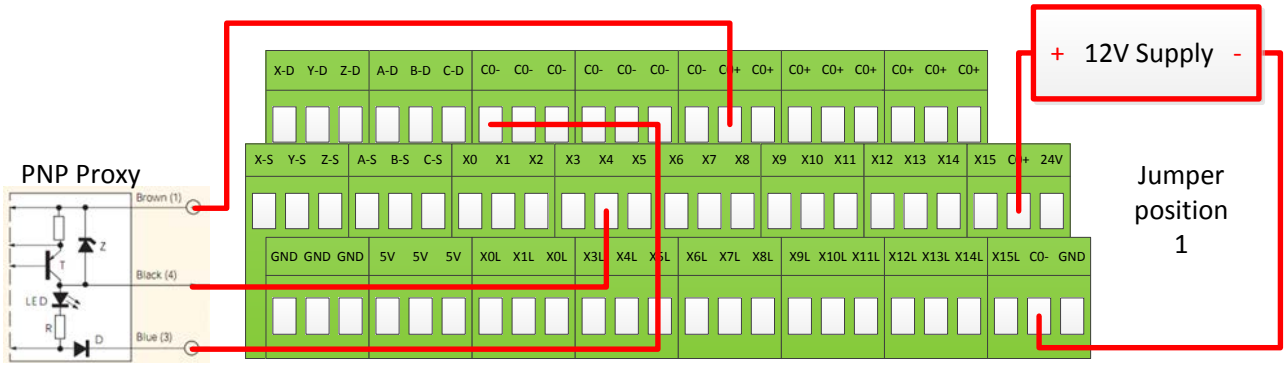


FIGURE 97 - 12V PROXY EXAMPLE

13.1.3 Low Voltage Sourcing Inputs (PNP)

For 2.5-10V inputs, connect the positive voltage to the C0+ terminal and ground to C0-. Completely remove the jumper corresponding to the input and connect XNL (where N represents the input number) to GND. Then connect the signal to the corresponding input.

Assuming that the jumper for X5 has been removed, the example below shows how to wire in a 5V toggle switch.

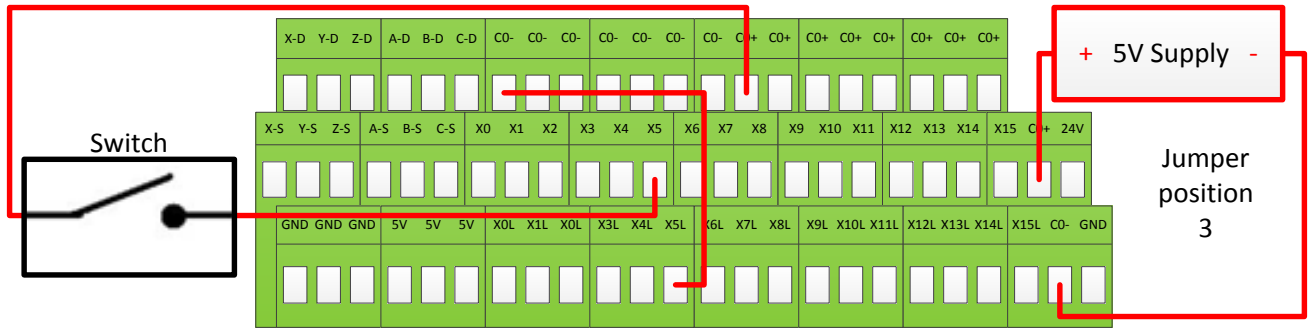


FIGURE 98 - 5V TOGGLE SWITCH EXAMPLE

Note: The 5V supply could come from TB2 on the Apollo III.

13.1.4 Sinking Inputs (NPN)

For most NPN proxies place the jumper on the top two pins. Then connect the signal into the corresponding input. See the example below.

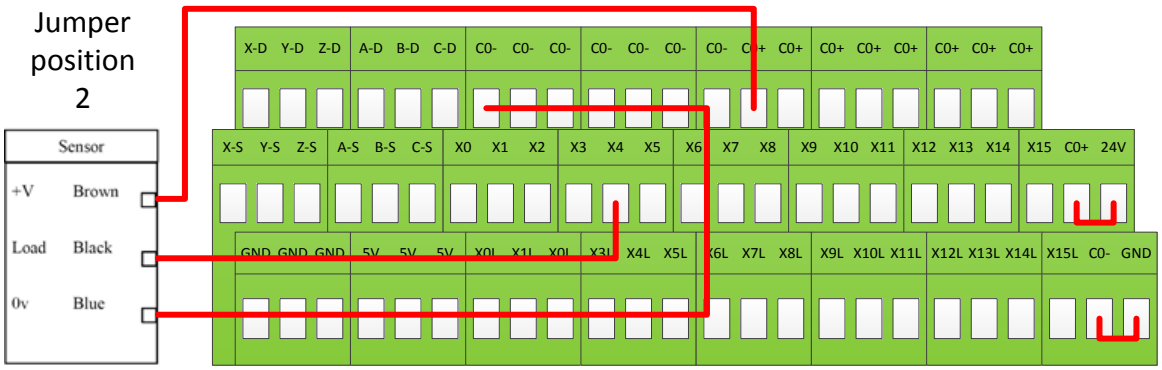


FIGURE 99 STANDARD NPN PROXY

If the proxy has an internal pull-up resistor, depending on its size, it could require the jumper to be completely removed. Use a 3.9k ohm resistor and connect it between XSL and C0+.

Below is an example of a 24V NPN proxy with an internal pull-up resistor. The jumper on the Apollo III must be completely removed for this to work.

FIGURE 100 NPN PROXY WITH INTERNAL PULLUP

13.1.5 Isolated Inputs

To isolate inputs, supply an external power supply to C0- (GND) and C0+ (positive voltage supply). Do not power the C0+ with more than 48V. All the other wiring configurations (PNP, NPN, etc) are the same whether or not the inputs are isolated. In the example below the inputs are isolated using a separate 5V power supply.

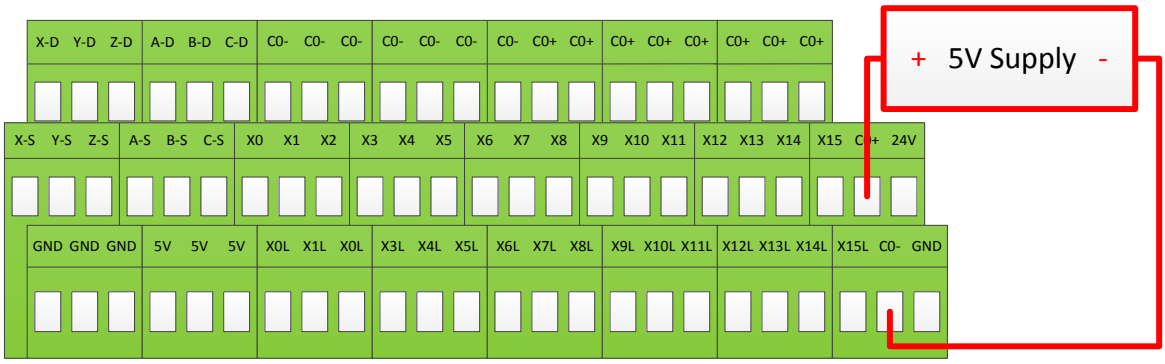


FIGURE 101 - 5V ISOLATED POWER SUPPLY

13.2 Configuring Inputs

To configure an input in Mach3, follow the procedure below.

6. On the menu bar click on **Config->Ports and Pins**.
7. 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.

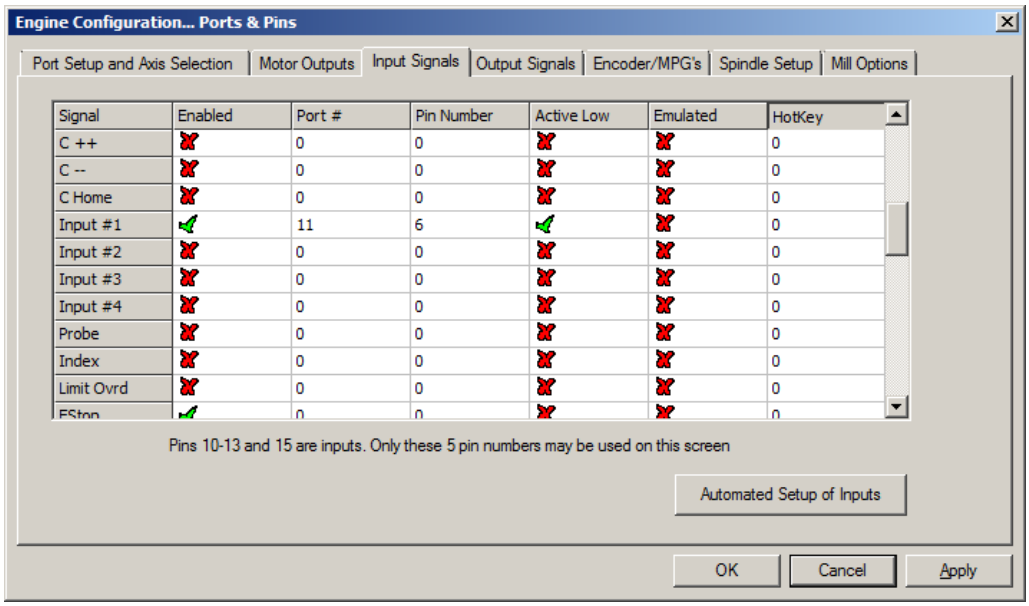


FIGURE 102 INPUT CONFIGURATION

8. Enable the input by clicking on the red "X". If it is a green check mark, it is already enabled.
9. Set the **Port Number** and **Pin Number** to the desired input

   Note: All input port numbers are 11 and the pin numbers correspond to the X number (X4 would be pin 4)
10. 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.

The input is now be set up.

14 OUTPUTS

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

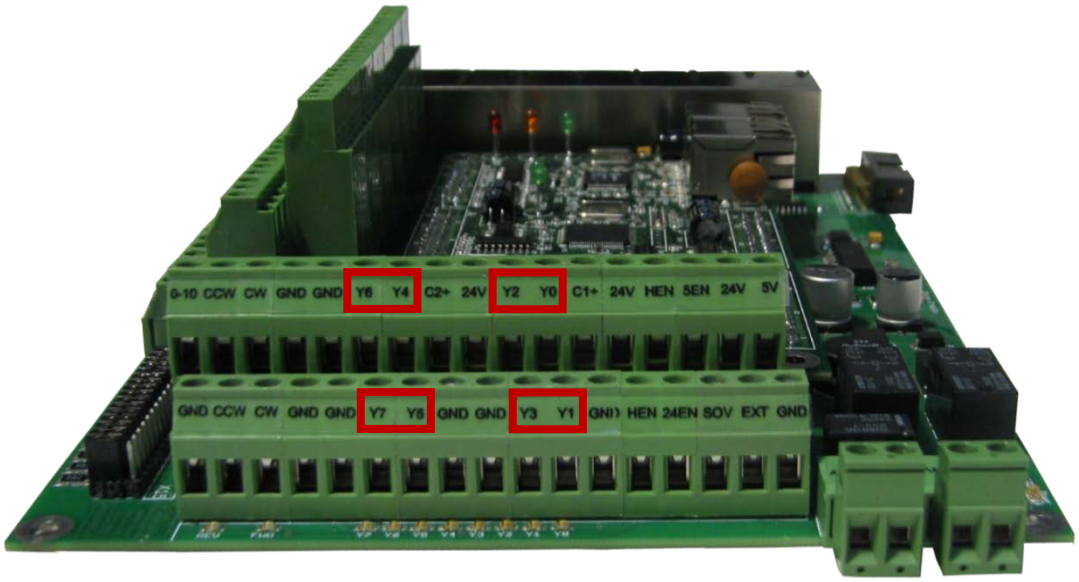


FIGURE 103 OUTPUTS

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.

14.1 Wiring Outputs

There are two separate commons for the outputs. The common C1+ is for outputs Y0-Y3 and C2+ is for Y4-Y7. Each common can take 7-48VDC. If the outputs being used are using the voltage supply from Apollo III, each output can only supply 125mA. However, if they are supplied using a separate voltage source, each output can source up to 250mA.

For standard operation the outputs can have their commons jumpered to 24V on the Apollo III. At that point simply connect the load to the output and GND. See the figure below.

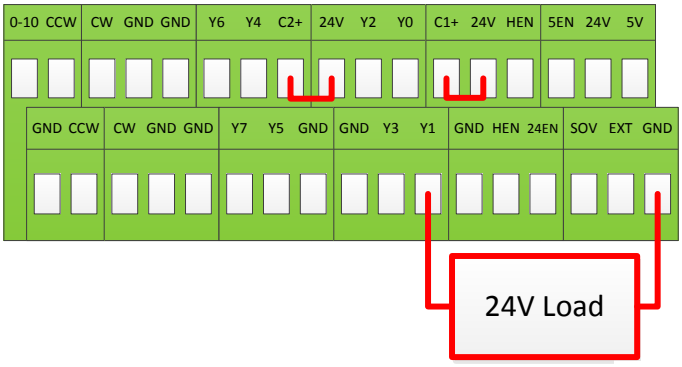


FIGURE 104 STANDARD 24V 125MA OUTPUTS

In the example below, a 10V and 48V supply are used to power the two commons. In this example Y0-Y3 are 48V outputs and Y4-Y7 are 10V outputs.

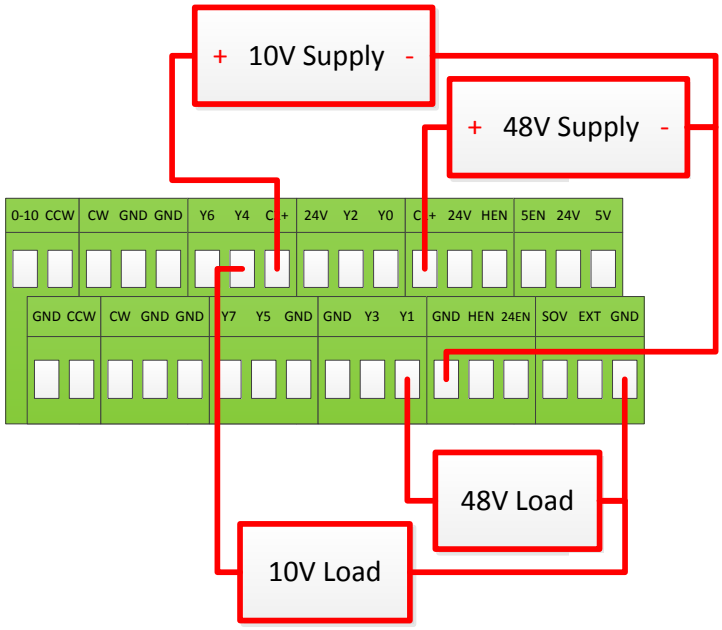


FIGURE 105 CUSTOM 250MA OUTPUTS

14.2 Configuring Outputs

To configure an output, follow the procedure below.

7. On the menu bar click on **Config->Ports and Pins.**
8. Select the **Output Signals** tab.
9. Scroll down to the desired output (There are 20 outputs that can be used).

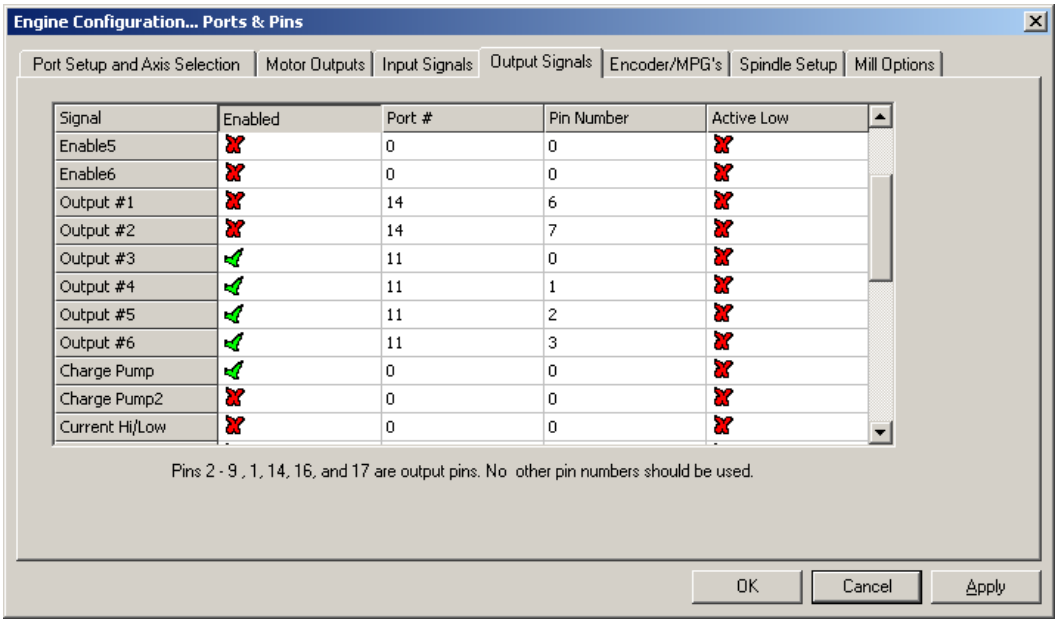


FIGURE 106 OUTPUT CONFIGURATION

10. Enable the output by setting the Enabled box to a green check.
11. Set the **Port Number** to 11 and the **Pin Number** to the corresponding Y number (Y3 would be pin number 3).
12. Set the Active Low column to a green check for a normally closed signal or red x for normally open.

14.3 Using Outputs

Outputs 5-10 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	Default Output
M200	Output 5 on	Y2
M201	Output 5 off	
M202	Output 6 on	Y3
M203	Output 6 off	
M204	Output 7 on	Y4
M205	Output 7 off	
M206	Output 8 on	Y5
M207	Output 8 off	
M208	Output 9 on	Y6
M209	Output 9 off	
M210	Output 10 on	Y7
M211	Output 10 off	

TABLE 19 M-CODES FOR OUTPUTS

15 APPENDICES

15.1 Default Factory Settings

These are not the settings required for the system to function correctly. These are the settings as they come from the factory before the setup process described above is completed.

15.1.1 Default Motor Outputs

Signal	Enabled	Step Pin#	Dir Pin#	Dir Low Active	Step Low Active	Step Port	Dir Port
X Axis	X*	0	0	X	✓	0	0
Y Axis	X*	0	0	X	✓	0	0
Z Axis	X*	0	0	X	✓	0	0
A Axis	X*	0	0	X	✓	0	0
B Axis	X*	0	0	X	✓	0	0
C Axis	X*	0	0	X	✓	0	0
Spindle	✓	0	0	X	✓	0	0

Table 20 – Default Motor Outputs

*These will be enabled if drives and motors for these axes were purchased with the control.

15.1.2 Default Input Signals

Signal	Enabled	Port #	Pin Number	Active Low	Emulated	HotKey
X++	X	11	1	X	X	0
X--	X	11	1	X	X	0
X Home	X	11	1	X	X	0
Y++	X	11	2	X	X	0
Y--	X	11	2	X	X	0
Y Home	X	11	2	X	X	0
Z++	X	11	3	X	X	0
Z--	X	11	3	X	X	0
Z Home	X	11	3	X	X	0
A++	X	11	4	X	X	0
A--	X	11	4	X	X	0
A Home	X	11	4	X	X	0
B++	X	11	5	X	X	0
B--	X	11	5	X	X	0
B Home	X	11	5	X	X	0
C++	X	11	6	X	X	0

C--	X	11	6	X	X	0
C Home	X	11	6	X	X	0
Estop	✓	14	5	✓	X	0
OEM Trig #1	✓	11	0	X	X	0

Table 21 – Default Inputs Signals

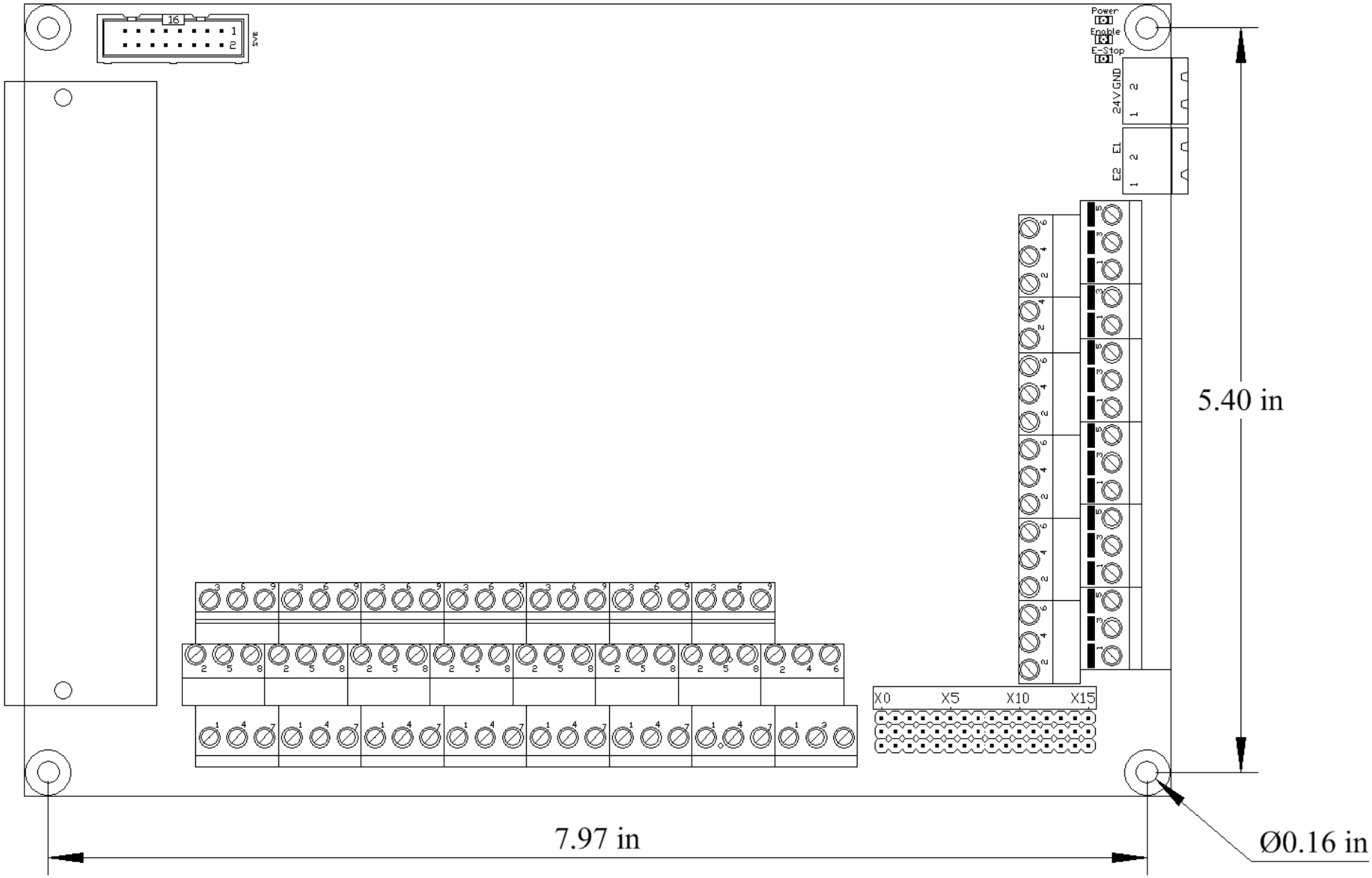
15.1.3 Default Output Signals

Signal	Enabled	Port #	Pin Number	Active Low
Digit Trig	X	0	0	X
Enable1	✓	14	0	X
Enable3	✓	14	1	X
Output #1	✓	14	6	X
Output #2	✓	14	7	X
Output #3	✓	11	0	X
Output #4	✓	11	1	X
Output #5	✓	11	2	X
Output #6	✓	11	3	X
Output #7	✓	11	4	X
Output #8	✓	11	5	X
Output #9	✓	11	6	X
Output #10	✓	11	7	X

Table 22 – Default Outputs

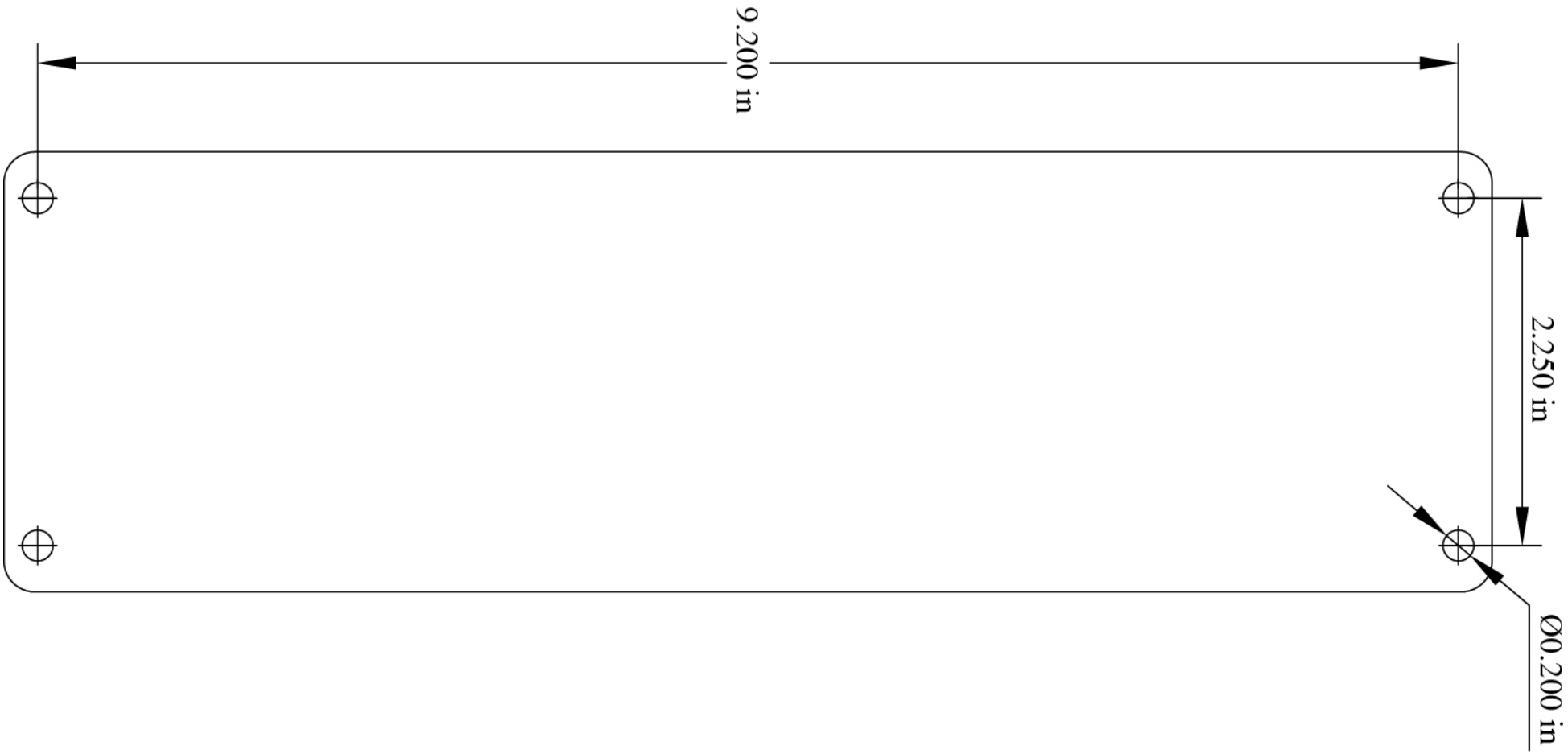
This page intentionally left blank

15.2 Apollo III Drawing



This page intentionally left blank

15.3 Apollo III Case Mount Drawing



This page intentionally left blank

16 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.

16.1 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