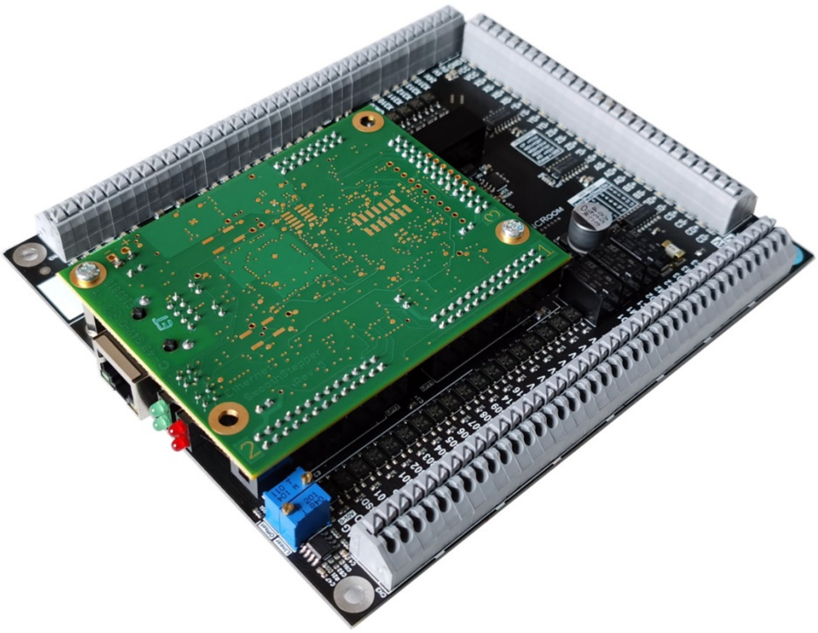
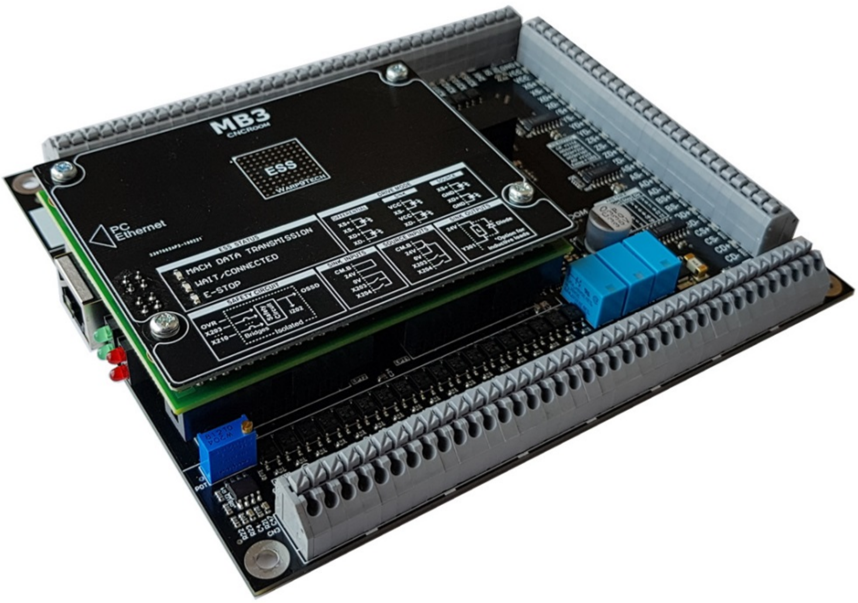
MachBob3 (MB3)

Owner's manual





Doc E20R2 (6/22/2021)
for PCB V1.3, V2.x

Disclaimer

Specifications written in this document are believed to be accurate, but are not guaranteed to be entirely free of error. The information in this manual is subject to change for functional or performance improvements without notice. Please make sure your manual is the latest edition. While the information herein is assumed to be accurate, CNCRoom assumes no responsibility for any errors or omissions. CNCRoom makes and you receive no warranties or conditions, express, implied, statutory or in any communication with you. CNCRoom specifically disclaims any implied warranty of merchantability or fitness for a particular purpose.

Table of Contents

Introduction

It is perhaps well understood that in an industrial environment, personal computers, motion control boards and logic signals can face a large amount of interference from things such as power cables, motors, welding machines, magnetic contactors etc.

We can help to minimize the effects of this interference by having any susceptible electronics enclosed in a metal control cabinet and using the correct safety and best practice techniques, which include, but are not limited to the installation of noise reduction such as an isolated transformer and noise filters.

While these things will help us achieve a better result, using a control board designed for industrial applications can be more important.

MachBob3 (MB3) is designed for industrial application and specifically to work with the Ethernet Smooth Stepper (ESS) which is an excellent motion control board designed to be used with Mach3 and Mach4

Specification and Features

- By using an Ethernet connection, the ESS is far more noise resistant than when using a USB or parallel Port connection and therefore helps to protect the logic signal when the controller and drives are located a large distance from the computer.
- Runs on Mach3 / Mach4 with Windows XP, Win7, Win8 and Windows10 both 32 and 64 bit, on both desktop and notebook computers.
- New! Utilizes All 3 ports of the ESS.
- The Motion Command Signal can be selected between Pulse/Sign, CW/CCW, and Quadrature. Frequency can be selected from 32 kHz to 4 MHz
- New! Differential line driver for motion signals allows for longer wiring with more resistance to interference when compared to TTL open end.
- New! A single 24Vdc Power Supply is needed. There is a 5Vdc isolated and non-isolated dc2dc converter on board, thus saving installation space and wiring.
- New! OSSD (Output Signal Switching Device) outputs and safety circuit are implemented when a peripheral device such as a servo motor drive or a spindle VFD (Variable Frequency Drive) trigger an alarm condition, which causes the Safety Circuit to disengage the OSSD output. This method is used on large CNC machines to cut power from the drives.
- New! status LEDs for all inputs and outputs including motion control signals. Makes it much easier to diagnose and troubleshoot.
- Isolated power and ground between the PC, ESS and I/O, which eliminates crossover noise and ground loop problems.
- Polarity and over voltage protection (in conjunction with a fuse) for the 24Vdc power supply.
- New! “AnaSpeed2”is a 0-10V precise analog output circuit has been implemented. This small circuit island is electrical isolated from the rest of the board, but it forms itself as part of VFD

input circuit which receives PWM signal from ESS by using light. It also has on board isolated DC2DC module which able to supply 0-10V to VFD continuously.

- A charge-pump signal is provided. This helps the user to form a safety interlock condition between controller and devices.
- New! 18 Universal isolated fast inputs on port 1 and 2. They can be used as NPN and PNP inputs, also able handle both 5V and 24V. (see Appendix I MB3 Specifications)
- New! 5 Universal isolated super-fast inputs on port 3. They can be used as NPN and PNP inputs, also able handle both 5V and 24V. (see Appendix I MB3 Specifications)
- 14 NPN isolated output terminals capable of sinking current up to 70mA for each channel and up to 500mA per group.
- New! - 3 onboard relays with both NO/NC contacts and 2 of them can select “Off Delay Time”, which can be used for such application as “Z Drop Protection.”, Please see it on page 32 **[*4]. Off Delay timer**.
- The K3 Relay can be controlled by a charge pump signal. Please see it on page33**, [*7]. K3 Relay pin select**. Showing the appropriate solder bridge for modification.
- New! The Raspberry Pi tall headers are used for firm connection between ESS and MB3 board. This allows ESS to be mounted on MB3 directly without any ribbon cables. This makes the ESS easier to install and reduces the number of contact points, signals trace distance, inductance and resistance between ESS and MB3 board. As a result, all signals are less likely to be affected by noise and distortion.
- Spring terminals for quicker connecting and disconnecting of cables. They are resistant to vibration, so no more screws which have rattled loose and no more forgetting to tighten.

Precaution

- Remember to static discharge before touching any part of ESS/MB3. Ground your body by wearing a grounding strap or frequent touching an earthed metal chassis to release electrostatics.
- Make sure that there is no high voltage leak from your soldering iron when soldering the solder-bridge – the safest way is to unplug your soldering iron from the mains power when it has reached a high enough temperature to melt the solder. High voltage leakage from a cheap soldering iron can potentially damage the integrated circuit (IC) on the MB3 board.
- The MB3 board is **Fragile**, do not drop, as it could badly damage the electronics.
- In certain circumstances, it could be possible for the MB3 board to build up excessive heat if many of the inputs and outputs are active at same time over an extended period. It is therefore advisable to install a good quality cooling fan to ventilate the cabinet.
- 24V, 3A Switching power supply is recommended for powering the MB3 board. In case of accidentally reversal power lead. The switching power supply will stop working. There is no harm to any component of the board. However, the fuse will be blown or even damage to the board if high current switching power supply being used.

Quick Reference

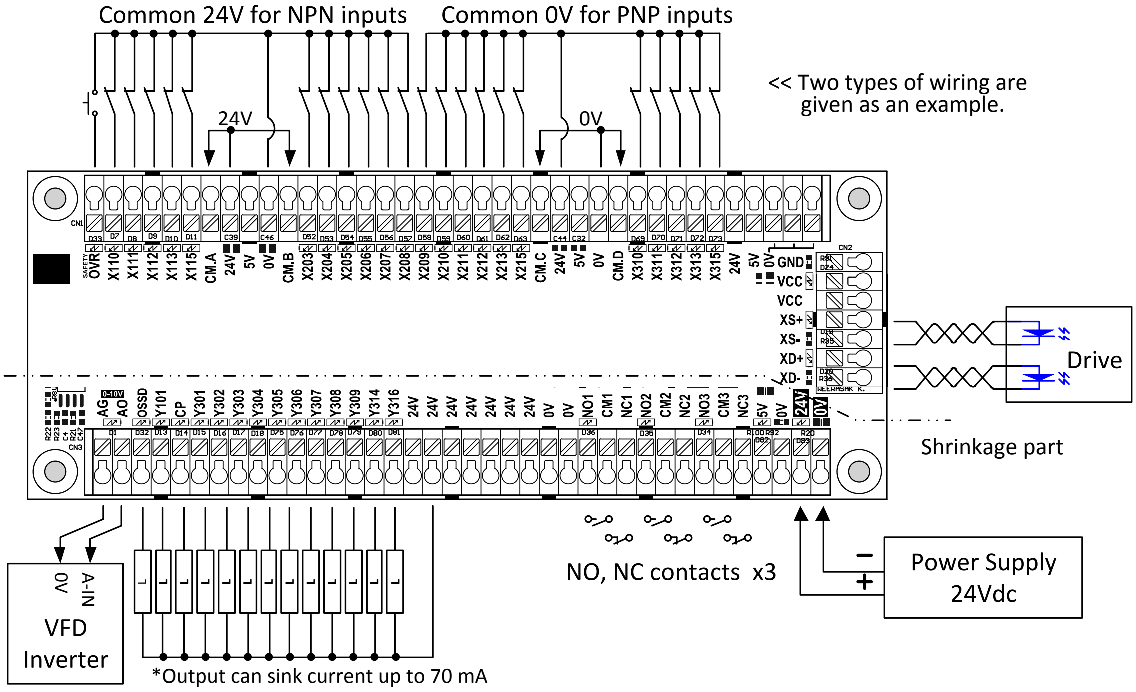


Figure 1, MB3 Overview Connection

Port1 (output)						Port2 (Pins 2-9 as input)						Port3 (Pins 2-9 as output)				
Pin	I/O	Act	Term Name	I/O Type		Pin	I/O	Act	Term Name	I/O Type		Pin	I/O	Act	Term Name	I/O Type
1	O	H	SPD(Spindle)	Sink output		1	O	H	NO1 Relay1	Contact		1	O	H	Y301	Sink output
2	O	L	XS (X Step)	Line driver		2	I	L	OSSD	SafetyFeedBack		2	O	H	Y302	Sink output
3	O	L	XD (X Dir)	Line driver		3	I	L	X203	NPN/PNP input		3	O	H	Y303	Sink output
4	O	L	YS (Y Step)	Line driver		4	I	L	X204	NPN/PNP input		4	O	H	Y304	Sink output
5	O	L	YD (Y Dir)	Line driver		5	I	L	X205	NPN/PNP input		5	O	H	Y305	Sink output
6	O	L	ZS (Z Step)	Line driver		6	I	L	X206	NPN/PNP input		6	O	H	Y306	Sink output
7	O	L	ZD (Z Dir)	Line driver		7	I	L	X207	NPN/PNP input		7	O	H	Y307	Sink output
8	O	L	AS (A Step)	Line driver		8	I	L	X208	NPN/PNP input		8	O	H	Y308	Sink output
9	O	L	AD (A Dir)	Line driver		9	I	L	X209	NPN/PNP input		9	O	H	Y309	Sink output
10	I	L	X110	NPN/PNP input		10	I	L	X210	NPN/PNP input		10	I	L	X310	NPN/PNP input
11	I	L	X111	NPN/PNP input		11	I	L	X211	NPN/PNP input		11	I	L	X311	NPN/PNP input
12	I	L	X112	NPN/PNP input		12	I	L	X212	NPN/PNP input		12	I	L	X312	NPN/PNP input
13	I	L	X113	NPN/PNP input		13	I	L	X213	NPN/PNP input		13	I	L	X313	NPN/PNP input
14	O	H	CP(ChargePump	Sink output		14	O	H	NO2 Relay2	Contact		14	O	H	Y314	Sink output
15	I	L	X115	NPN/PNP input		15	I	L	X215	NPN/PNP input		15	I	L	X315	NPN/PNP input
16	O	L	BS (B Step)	Line driver		16	O	L	CS (C Step)	Line driver		16	O	H	Y316	Sink output
17	O	L	BD (B Dir)	Line driver		17	O	L	CD (C Dir)	Line driver		17	O	H	AO	Analog output
L=Low Active				Analog PWM frequency = 260hz												
H=High Active				NO3 Relay3 can be controlled by Y101, Y317, CP								LPT3 all inputs are high speed inputs.				

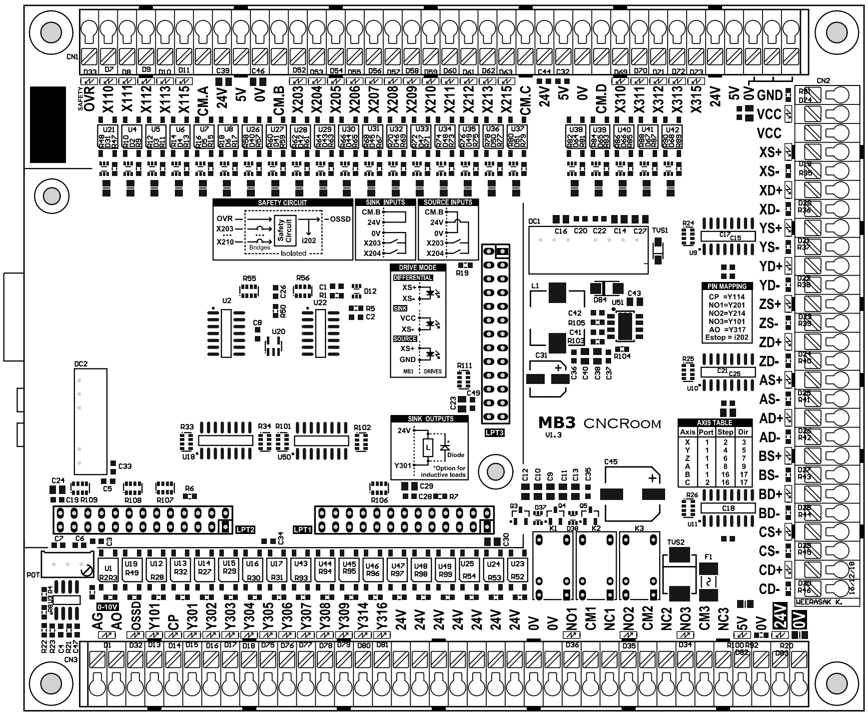
Table 1, Ports n Pins Reference and Active High/Low Tables

Quick Reference is a summary for the experienced users.

Figure 1 is a shrinkage view of MB3 board. It shows the connection of inputs & outputs, power supply, analog output for the VFD and axis signals.

Table 1 is a summary of Ports and Pins and their corresponding reference numbers. All pin numbers preceded by an “X” are inputs and if preceded by a “Y” are outputs. Using X110 as an example. The “X” means it is an input. The first digit “1” is the port number, the last 2 digits “10” is the pin number.

MB3 Layout



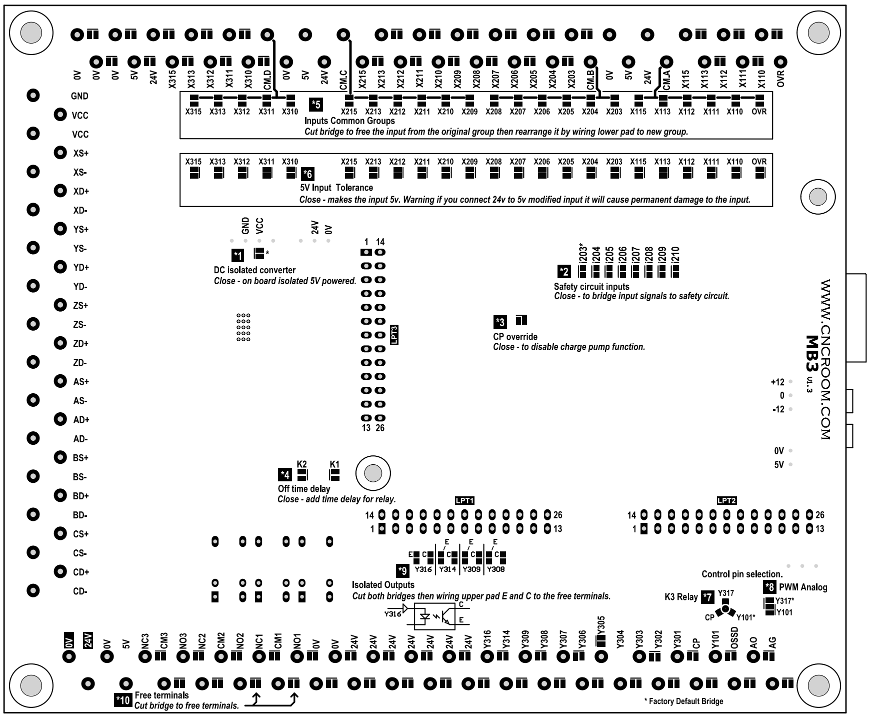
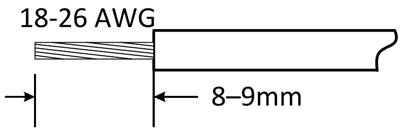


Figure 2, MB3 Board Layout



Input (CN1) – Input terminals, consisting of 23 channels. NPN/PNP, 5/24V selectable.
Axis (CN2) – Axis signal terminals, consisting of 6 axes, which are; X, Y, Z, A, B, C
Output (CN3) – Output terminals, consisting of 14 NPN sink outputs, Analog signal, 3 Relay's NO/NC and an inlet for the 24Vdc power supply
LPT1-3 – Connectors for the ESS
RJ-45 – Communication connector, part of the ESS board

ESS and MB3 piggyback

The ESS receives its 5Vdc power from the MB3 when all three jumpers of ESS are closed, which is the default setting. But you may need to change the jumpers do so before you install. This eliminates the need for an external 5Vdc supply.

The Raspberry Pi tall headers are used for firm connection between ESS and MB3 board. This allows ESS to be mounted on MB3 directly without any ribbon cables. This method will eliminates a number of contact points, distance, inductance and resistance between ESS and MB3 board which allows signals go forth and back faster. Furthermore, this makes both companions look nicer, lower in height.

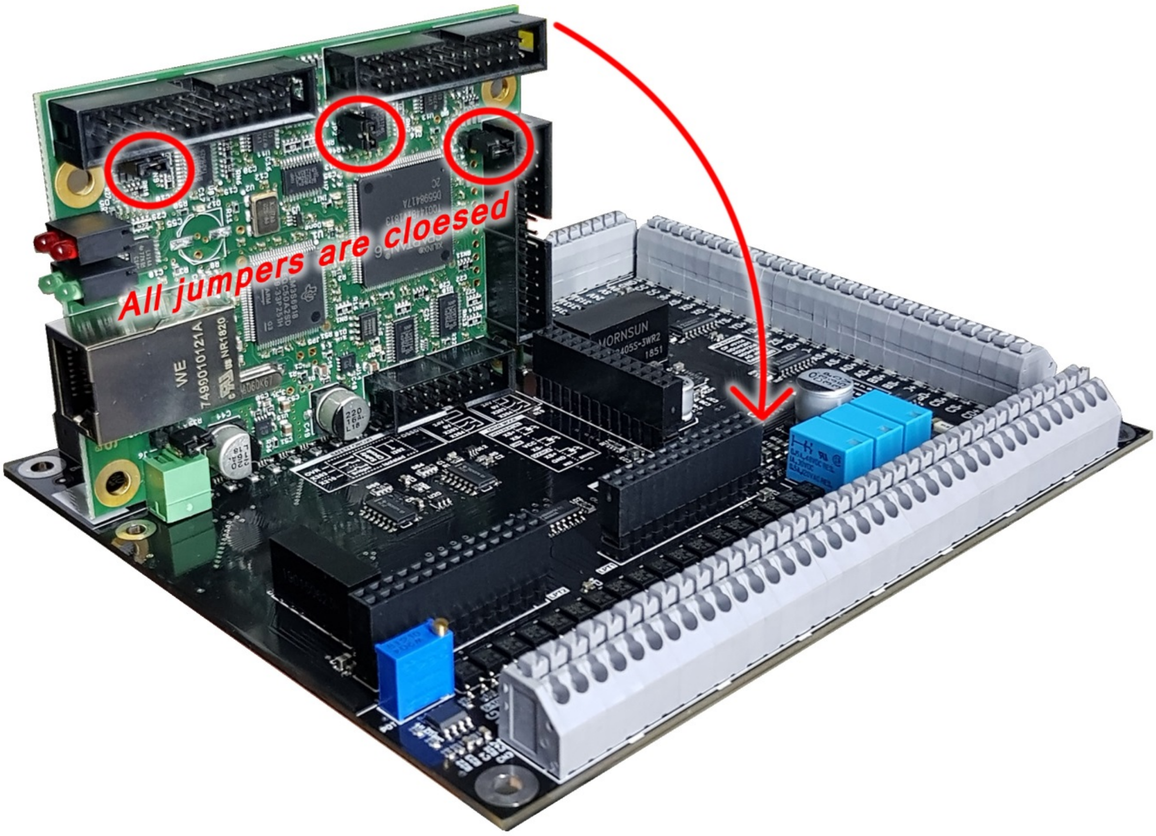


Figure 3, ESS board installation

MB3 Connection Diagram

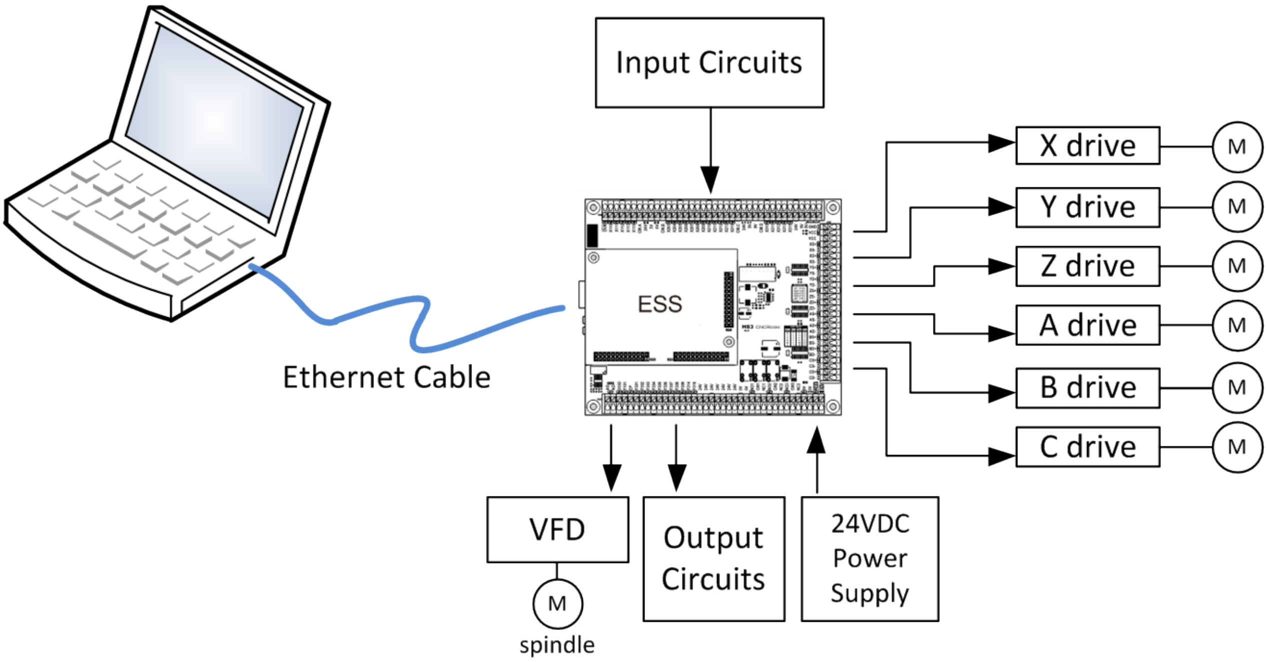


Figure 4, Connection Diagram

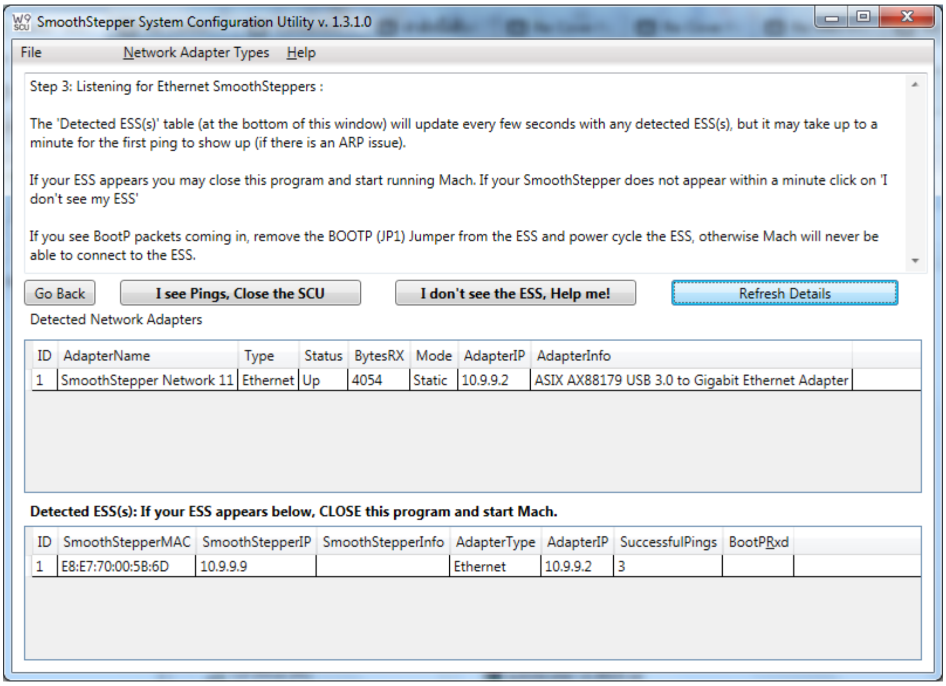


Figure 5, SCU utility successfully connected to the ESS.

The SCU software utility helps the user to configure Windows PC to communicate with ESS easily. Below is the link to SCU tutorial video.

https://www.youtube.com/watch?v=WonXbVGSVio

Hardware

Connecting the ESS to Your PC

Setting up networking for Ethernet device like ESS board is problematic for most beginners. There are lot of tutorial video and guides from Warp9 Tech Design which help the user to achieve this goal easily.

Warp9 Tech Design YouTube channel.

http://www.youtube.com/channel/UCpg3EROtW8xA_KzrFHgn4ZQ/videos

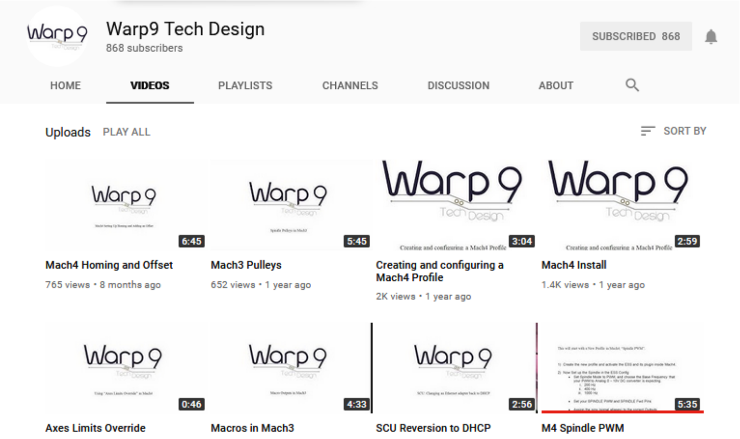


Figure 6, Youtube tutorial video for beginner.

Using the SCU to Fix Windows Firewall Issues

http://www.youtube.com/watch?v=RyRx7naF2rg

ESS Manual Setup

http://www.youtube.com/watch?v=3PahTqFQ05M

The following section has been copied with permission from the Warp9 website at;

http://www.warp9td.com/index.php/documentation/doc-ess#Connecting

The best way to connect your ESS to your PC is to use the Direct Connect method: hook the Ethernet cable directly from your ESS to the network adapter in your PC. This will make trouble shooting easier since there are no switches or routers between the ESS and your PC. (A switch should be fine since it only operates in the lower 3 layers of the TCP/IP stack, but why add extra equipment if you don't need it. A router should be fine if you only have your ESS and PC connected to it, but this will require more work to configure and setup. As a result we highly recommend the direct connection, which is what the SCU [System Configuration Utility] expects.)

If you don't have an Ethernet Adapter on your PC, we recommend using a PCI or PCI Express Ethernet Adapter -OR- a USB 2.0 or USB 3.0 Ethernet Adapter. Quite a few people use these alternatives successfully, including myself.

We STRONGLY discourage using a wireless connection to communicate with your ESS. There can be much more latency or delay involved with wireless communications, along with a much higher risk of dropped packets. The ESS needs a fast, stable, and consistent link to your PC.

Many people use a second Ethernet connection or their wireless connection on the PC so they may easily connect to the internet, which is fine. When not running a machine.

While you are running Mach and your CNC system, we recommend that you refrain from browsing the internet, gaming or streaming music or videos. This can cause your computer to take too much time away from Mach which could cause lost communications with your ESS (which can ruin your project).

We also recommend that you disable power saving options (monitor sleep and power off timers, hard drive sleep timers, and computer sleep timers); these have been known to cause lost communications with your ESS.

We also recommend that you set Windows Update to notify you that there are updates available instead of automatically installing them on its own.

We also know of cases where antivirus and anti-malware software have caused problems. We recommend that you disable them while you are running Mach, IF your PC is not connected to the internet.

Note that you do not need to assign a static IP address to your computer if you program the ESS to use an address that is in the same subnet as your computer. The subnet is the same if the first 3 groups of numbers in the IP addresses are the same. Quite often Internet routers will assign addresses in the 192.168.0.x or 192.168.1.x ranges. If you wish to use a DHCP server for your computer, you can do that but the ESS still needs to use a static IP address in the same subnet. A direct connection to the ESS is the preferred way to go because there is no question as to whether there is enough bandwidth available to run your machine reliably.

We STRONGLY RECOMMEND THAT YOU DO NOT hook your ESS up to the same Ethernet adapter that you connect to the Internet with. There is no telling how much CPU and Ethernet bandwidth is being used up by other applications or other devices on the network. It is therefore officially discouraged. You are on your own if you wish to mix the Internet with your CNC data. However, if you wish to change the IP address of the ESS, you may do so with the Configurator Utility.

If the remainder of this section confuses you, don't worry. The SCU in the next section will do all of the work for you in just a few mouse clicks! The remainder of this section is just to document what the ESS uses and needs, you may skip to the SCU section.

The ESS comes configured from the factory with a default static IP address of 10.9.9.9 With your ESS at 10.9.9.9, you will need to assign your network adapter to use 10.9.9.2 or another valid and unused address in the subnet. We recommend that you keep the 10.9.9.9 IP address assigned to your ESS, since all of our documentation and videos will use that value. In fact MOST the user keeps this value assigned to their ESS. However, if there is a need to change it, you may do so with the Configurator Utility.

Power Supply

The MB3 needs only a single 24Vdc power supply to operate the board. **Figure 7**, shows power supply input terminals for 0V and 24V. The 24V, 3A power supply is recommended for general usage.

There is a non-isolated step-down switching regulator that converts 24V (18-24Vdc) down to 5V to power most parts of the circuit, including the inputs and outputs.

However, there are also two special isolated DC2DC convertors are used to power the ESS board and AnaSpeed2, 0-10V analog output.

On board there is also a small fuse for protection against over voltage and polarity reversal.

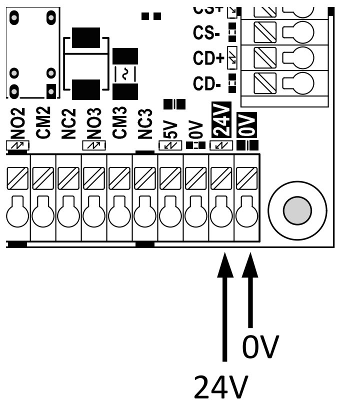


Figure 7, Power supply connection

Axis Connection X, Y, Z, A, B, C

AXIS CN2 terminal supplies motion command for drives.

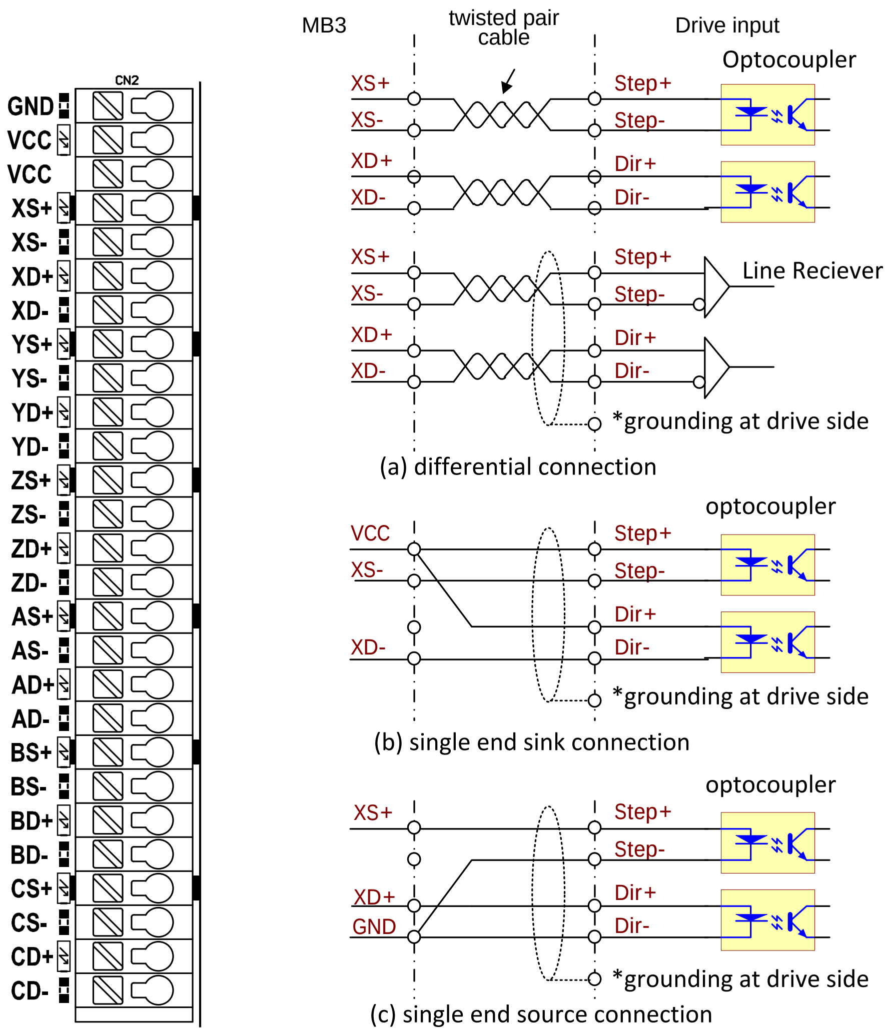


Figure 8, Axis command terminal and various connection modes

There are three different methods of connecting your drives to CN2.
Figure 8 (a) Differential connection has the best noise immunity. It is recommended to use differential mode if possible.

Figure 8 (b) Single end sink connection is used if the exist connection system follows this fashion.

Figure 8 (c) Single end source connection is used if the exist connection system follows this fashion. This connection is similar to computer parallel port.

Inputs

By default, all MB3 inputs are 24V tolerance for industrial sensors and switches. However, sometimes we need to interface with 5V devices, such as MPG and low voltage sensors. On page 33, topic **[*6]. 5V input tolerance** shows the way to makes the MB3 board accepts low voltage. It is recommended to use shielded cable with shield grounded to one side only star configuration. Placing terminals or ground lugs close to the MB3 makes for neater wiring to land shields and 0 or 5/24Vdc. The neater your wiring the easier to work with or add to. You should also consider the whole wiring scheme before wiring as you do not want to continually cross wires as this makes for a rats nest.

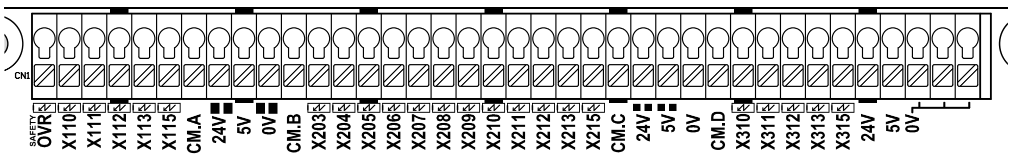


Figure 9, Input terminals

Figure 9 shows 23 input terminals. There are all universal inputs, divided into 4 main groups. Each group has its own common terminal.

CM.A (OVR, X110, X111, X112, X113, X115)
CM.B (X203, X204, X205, X206, X207, X208)
CM.C (X209, X210, X211, X212, X213, X215)
CM.D (X310, X311, X312, X313, X315)

The common pin is used to select NPN or PNP. For example if CM.A connects to 24V, all inputs in this group become NPN type and it waits for 0V to be presented at the X1xx terminal to make input active, the status LED will lights up.
On the other hand, if CM.A connects to 0V, all inputs in this group become PNP and it waits for 24V to be present at X1xx the terminal to make input active, the status LED will light up.

By default all inputs accept 24V, However if 5V input is preferred for particular inputs the user can bridge the solder-bridge underneath of MB3 board.

Input Type

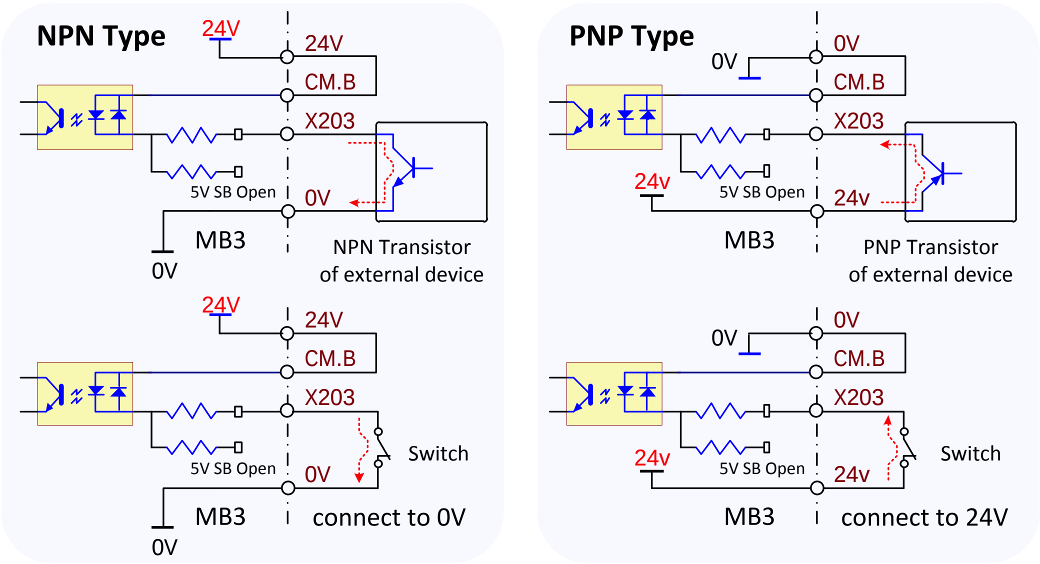


Figure 10, Input Type: NPN/PNP, SINK/SOURCE

The words 'NPN' and 'PNP' of input type come from output transistor of connected device which conducts current from one side to another side. The NPN transistor will sink current from collector to emitter. The PNP transistor will source current from emitter to collector. Sometimes, we hear the words 'sink' and 'source' with NPN and PNP respectively.

Basic input connection with switches

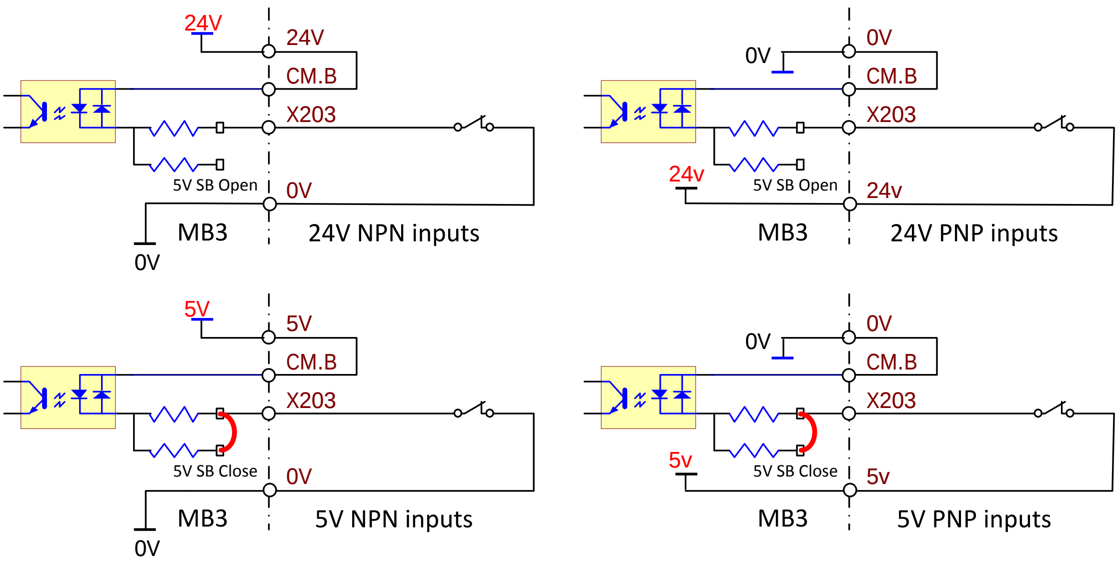


Figure 11, Basic input connections with internal power

Figure 11, shows the 4 different methods to connect a switch with **on board** power supply. On the left side is NPN input type which connects a switch between input X203 and 0V. On the right side is PNP input type which connects a switch between input X203 and power source 24V or 5V.

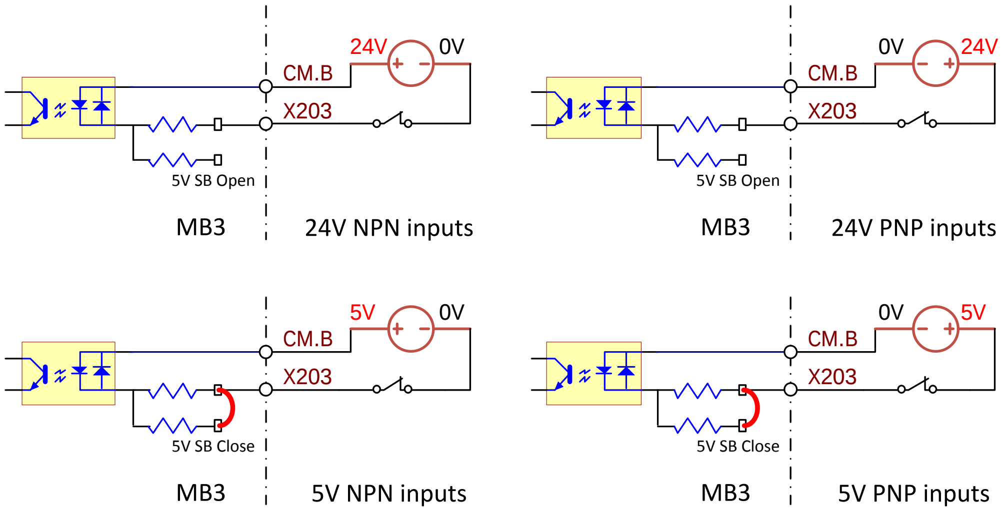


Figure 12, Basic input connections with external power

Figure 12 shows the 4 different methods to connect a switch with **external** power supply. These connections are totally isolated from any part of the MB3 circuit. The external circuits, for instance, could be the fault output of a VFD drive or plasma cutting system, where rough interference noise appears on the device. Totally isolation is a key to help ESS/MB3 avoiding from extreme interference.

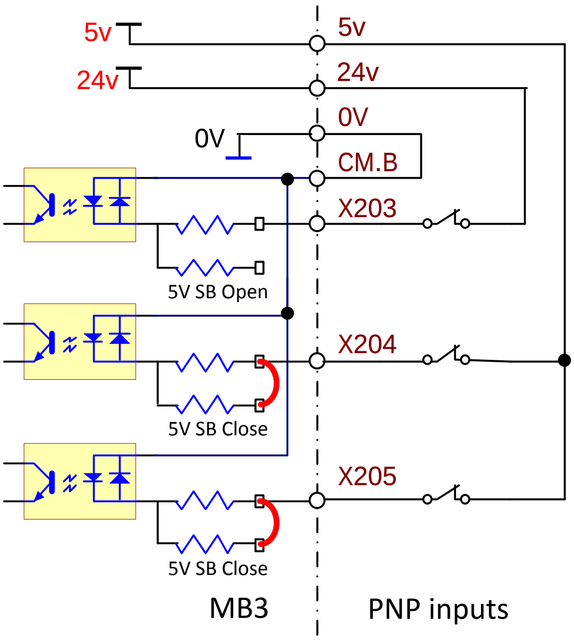


Figure 13, Common 0V or PNP inputting can mix and match between 24V and 5V inputs

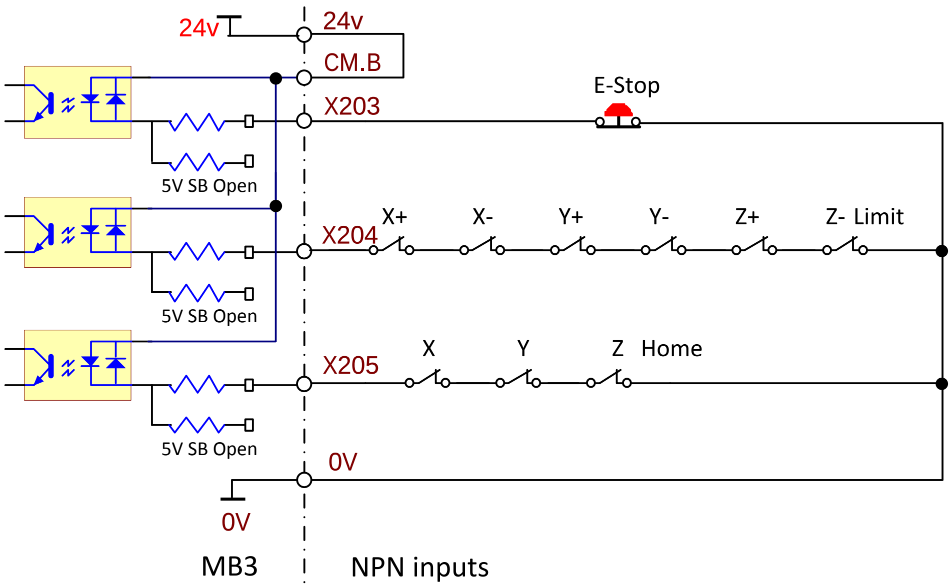


Figure 14, Conventional series connection of LIMIT and HOME switches.

Figure 14 shows the NC contacts are wired in series to form AND logic. This is a conventional method to preserve some inputs for other tasks.

Sensors

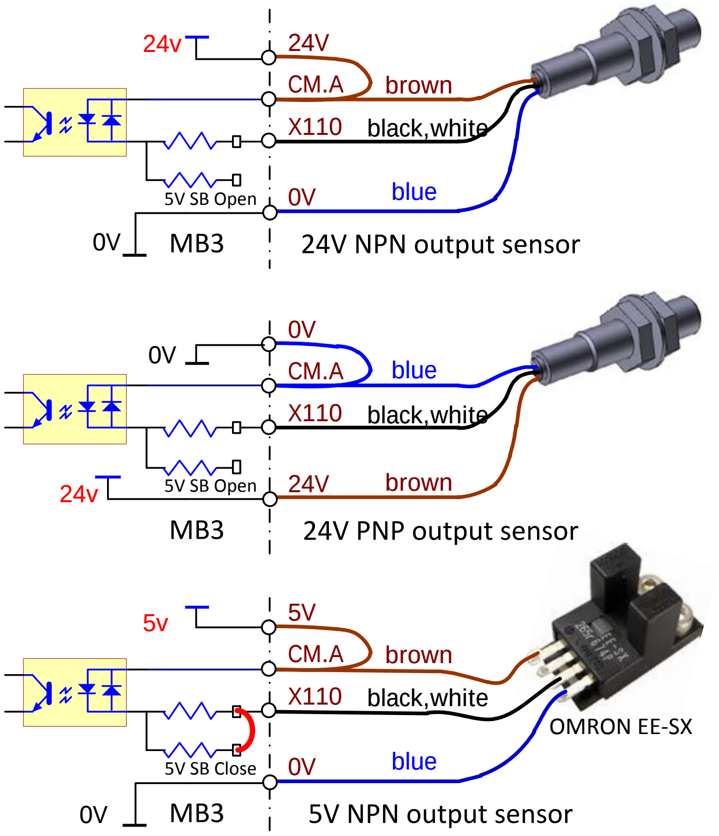


Figure 15, Sensor connections

Figure 15 shows the way to make connection with standard industrial sensors.

MPG / Encoder

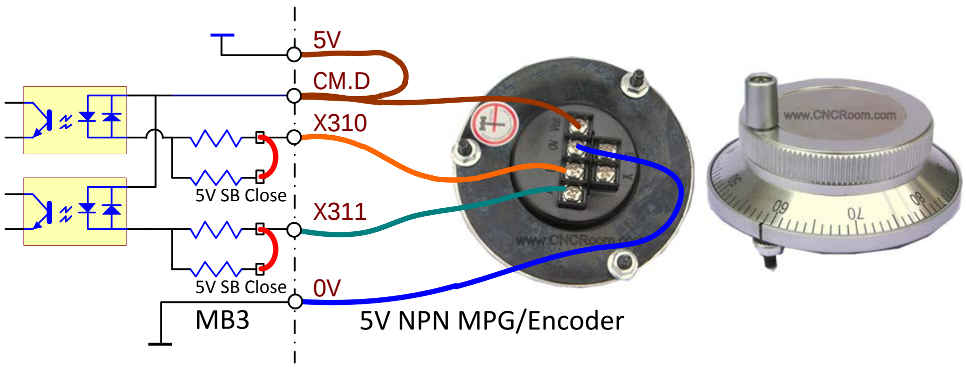


Figure 16, MPG/Encoder connection circuit

MB3 board allows us to make a connection to low voltage devices. In this case, **Figure 16** a 5V MPG device. It is similar to most encoders. Some encoders can do both source and sink. So, it depends on us what input type we want to connect. The **Figure 10**, on page 17 gives you an idea how to approach it.

AC input

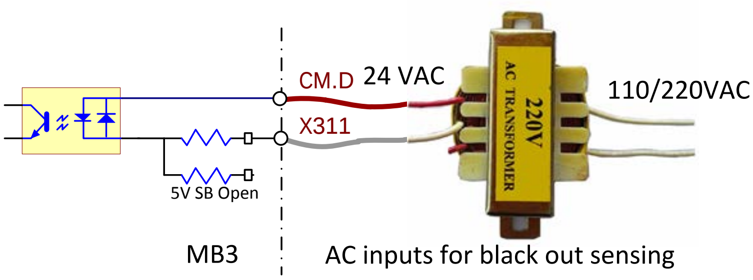


Figure 17, AC source interfacing.

Sometime we would like to make a connection with strange part. **Figure 17** shows how to connect and sense an AC signal. If a brown out or black out happened the controller is able to know beforehand then it commands lock z axis brake before all devices losing power. In this case, some power must be kept in a big capacitor as a backup for controller and drives for few seconds only.

Outputs

Transistor Sink Output

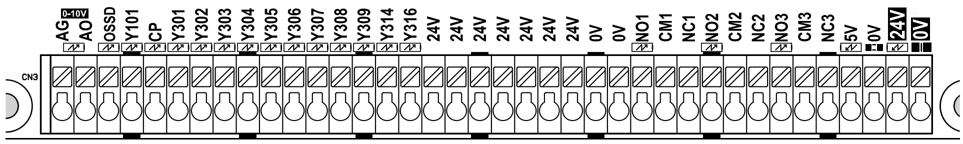


Figure 18, Output terminals

Figure 18 shows 14 output terminals, each output can sink current up to a maximum of 70mA with a total maximum of 500 mA per group of 7 outputs.

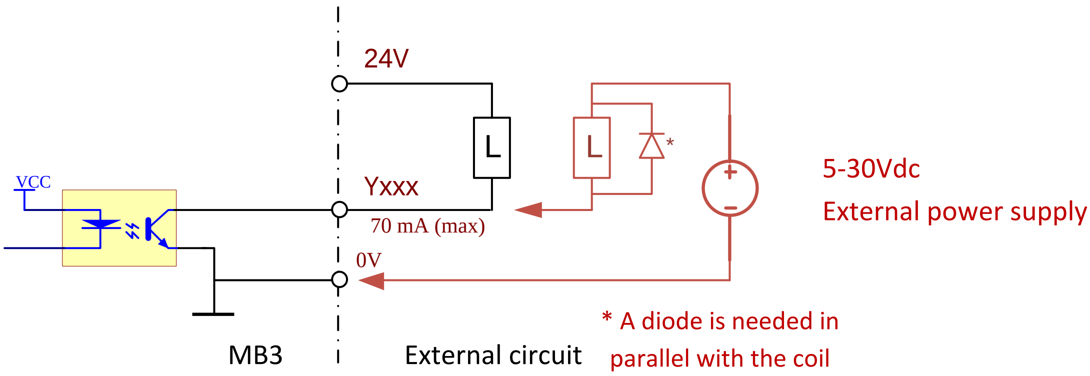


Figure 19, connecting various loads to a “Y” output

Relays

The MB3 comes with three relays; those are K1, K2 and K3. All relays provide NO or NC contacts. The K1, K2 also provides an "OFF Delay" feature. To activate this feature the user needs to follow the instructions as set out on page 32 , topic **[*4]. Off Delay timer**.

These three relays are signal relays and should never be used as power relays. They are intended to convey signals such as forward and reverse to a VFD (Variable Frequency Drive) to control motor rotation of a spindle or similar. They can be used for other purposes as well, and the user needs to map them in Mach accordingly. However, please take care, as the contacts of these relays can carry a maximum current of only 0.5 Amps at 120VAC, or 1 Amp at 24Vdc. The user must use an external relay if the load requirements of the device will exceed the aforementioned current rating.

Charge Pump

Charge pump is pulse frequency signal from Mach3/Mach4 indicating that Mach is present and ready to run. MB3 has special circuit to capture this pulse frequency and output to CP (Charge Pump) terminal. Normally an external relay would be connected to this CP terminal for cutting the power source from any attached loads. However, the user can choose to select K3 as an output for the CP signal. To choose this option, Please see **[*7]. K3 Relay pin select** on page33.

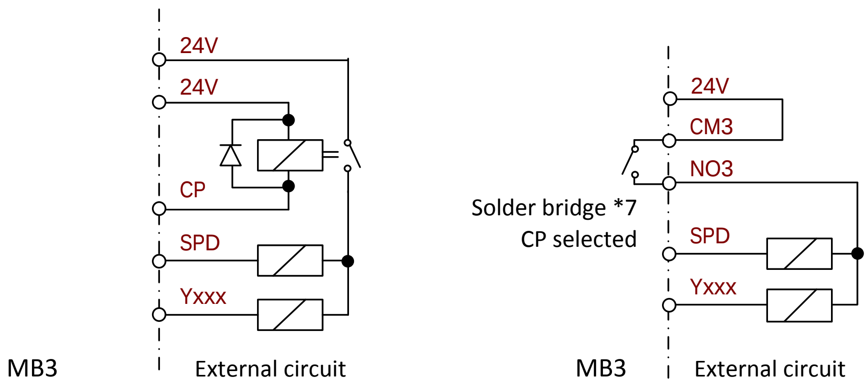


Figure 20, Charge pump interlock with other relays

Analog

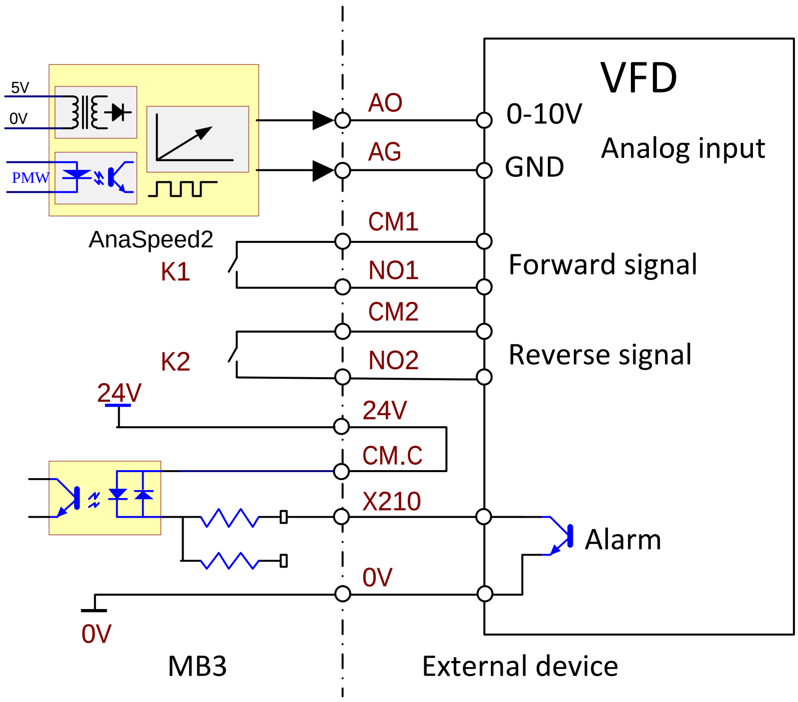


Figure 21, VFD connection

The "AnaSpeed2" circuit converts PWM signal to analog signal 0-10V. Using this analog output with any VFD, the user must program VFD parameters to accept 0-10V.

Normally, a VFD needs a forward command to rotate the motor. Thus, any NO contact of K1, K2 or K3 can be used for this purpose.

Two adjustment POTs (Potentiometers)

There are two multi-turn adjustment POTs (Potentiometers) for the user to make change to analog output.

Figure 22, Analog output adjustment POTs

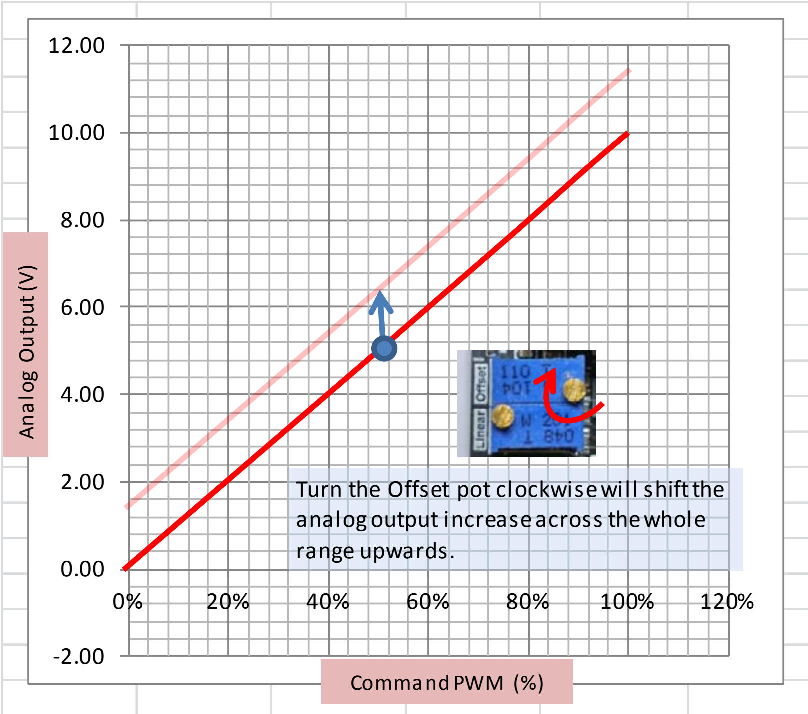


Figure 23, the Offset POT

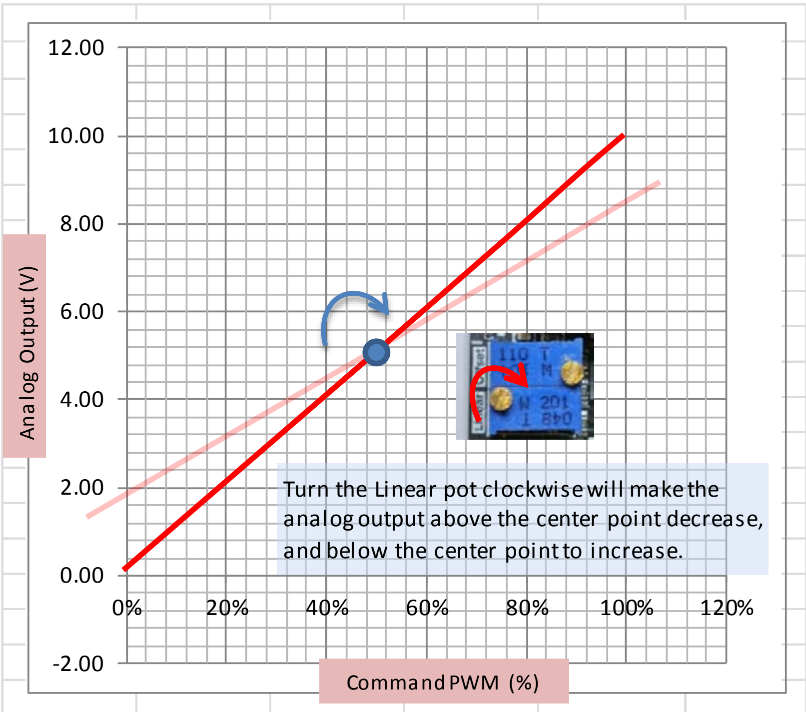


Figure 24, the Linear POT

The first POT called "**Offset**" as shown in **Figure 23** which allows the user to set an offset to analog output. Turning the Offset pot clockwise will shift the analog output increase across the whole range upwards. The output voltage is getting increase. Turning adjustment screw counter-clockwise will shift the whole range of analog output downward; the output voltage is getting decrease.

The second POT was introduced in MB3 version 2.x, called "**Linear**" which allows the user to adjust the linearity of analog output. A good linearity line will be a straight line with a 45 degree slope as shown in **Figure 24**. Turning the adjustment screw clockwise will make the analog output above the center point decrease, and below the center point to increase. On the other hand, turning the adjustment screw counter-clockwise will just make the results opposite.

Standard PWM Setting

The Figure 25 and Figure 26 show standard setting with 10,000 RPM value which is chosen for the tuning purpose. After you have finished tuning process, you may put value back to 18000 RPM or 24000 RPM depend on your spindle specification.

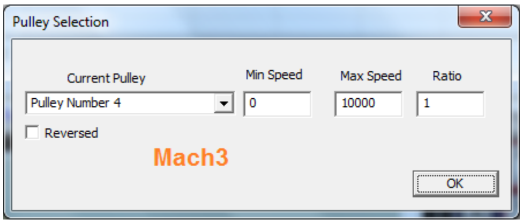


Figure 25, Standard setting in Pulley Max Speed for Mach3

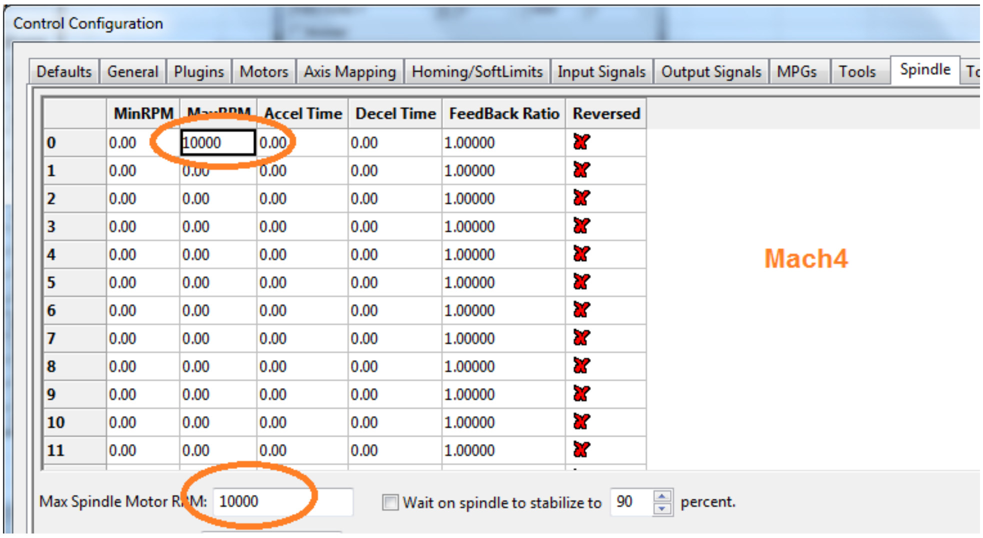


Figure 26, Standard setting in Pulley Max Speed for Mach4

Typical PWM Setup		
Speed Max =10,000		
PWM Freq =100hz		
Cmd	Actual	Err %
0.00	-0.035	-3.50
0.50	0.503	0.60
1.00	1.003	0.30
1.50	1.504	0.27
2.00	2.005	0.25
2.50	2.505	0.20
3.00	3.005	0.17
3.50	3.506	0.17
4.00	4.006	0.15
4.50	4.506	0.13
5.00	5.006	0.12
5.50	5.507	0.13
6.00	6.007	0.12
6.50	6.508	0.12
7.00	7.008	0.11
7.50	7.508	0.11
8.00	8.007	0.09
8.50	8.507	0.08
9.00	9.006	0.07
9.50	9.506	0.06
10.00	9.970	-0.30

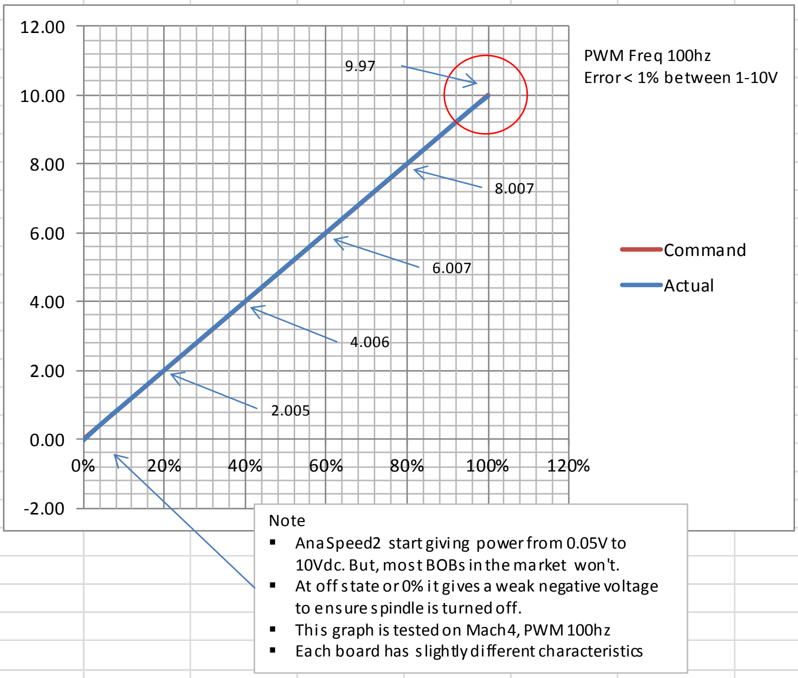


Figure 27, 0-10V Analog output characteristics of standard PWM Setting

Stretching PWM Setting

In the Figure 28, Figure 29 shows stretching technique by adding 1% to max RPM of the standard setting. In this case 10100 is chosen for tuning purpose.

After you have finished tuning process, you may put value of 18180 RPM or 24240 RPM or the value specified by your spindle and add 1% on it.

The advantage of stretching setting over standard setting is that you will get a better linearity across 0-10v from stretching technique. As you can see the value table and the graph between standard and stretching in Figure 27 and Figure 30, especially on the 10v spot.

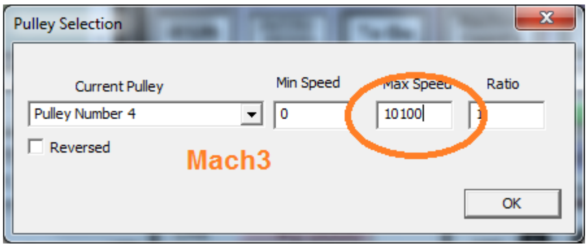


Figure 28, Stretching setting in Pulley Max Speed for Mach3

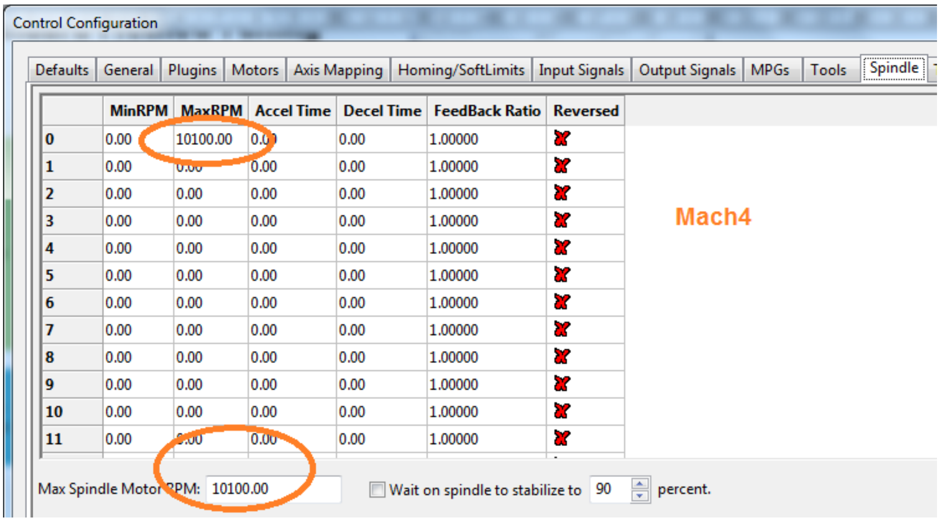


Figure 29, Stretching setting in Pulley Max RPM for Mach4

Adaptive PWM Setup		
Speed Max =10,100		
PWM Freq =100hz		
Cmd	Actual	Err %
0.00	-0.037	-3.65
0.50	0.499	-0.20
1.00	1.000	0.00
1.50	1.500	0.00
2.00	2.001	0.05
2.50	2.501	0.04
3.00	3.002	0.07
3.50	3.502	0.06
4.00	4.003	0.08
4.50	4.503	0.07
5.00	5.004	0.08
5.50	5.504	0.07
6.00	6.005	0.08
6.50	6.505	0.08
7.00	7.005	0.07
7.50	7.505	0.07
8.00	8.005	0.06
8.50	8.505	0.06
9.00	9.004	0.04
9.50	9.504	0.04
10.00	10.002	0.02

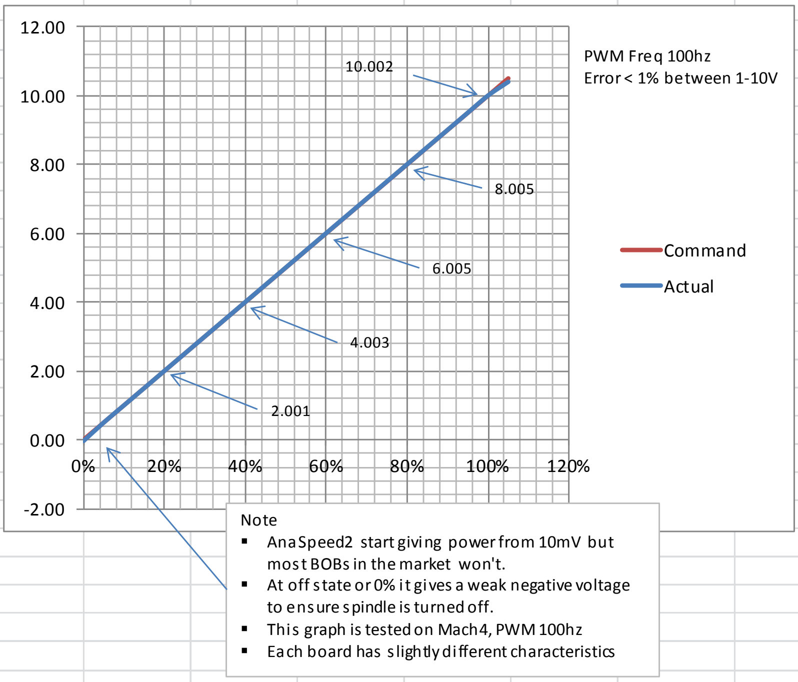


Figure 30, 0-10V Analog output characteristics of Stretching PWM setting

Analog adjustment

Even though the MB3 board has been fully tested and calibrated before shipping. The suitable analog output may be slightly different from the actual need with any VFD. So, analog adjustment is a must.

Practically, we make linearity adjustment by focusing only one point of each zone, upper zone at 9v and lower zone at 1v. We are trying to balance decimal part of both voltage values to be equal, for example 9.025v and 1.025v. The 0.025 add to 9v and 1v.

First, you need to be able to command Mach to generate PWM output by entering the command S9000M3 in the MDI and execute it. This commands Mach software to generate 90% duty cycle of PWM. The LED status on AO terminal will show bright light.

Then entering the command S1000M3 in the MDI and execute it. This commands Mach software to generate 10% duty cycle of PWM. The LED status on AO terminal will show dim light.

At this state you need to connect the leads of volt meter to the AG and AO terminal to monitor analog voltage output, then make an adjustment on the Offset POT and may be together with the Linear POT while commanding S9000M3 and S1000M3 alternatively.

We will try to get a good linearity out of the AO or analog output by only turning the screw on the Linear POT. However, adjustment on the Offset POT also needed that because we need to read decimal part of both upper and lower zone. We need a value just greater than 9.000v and 1.000v for example 9.056 v and 1.049v, by turning the Offset POT which helps us to locate a good fraction number for both 9.0??v and 1.0??v.

The decimal part will tell us how the linearity line leans against 45% standard line. Is it lean forward or backward?

If decimal part of upper zone higher than lower zone, for example 9.056v and 1.049v then you need to turn the Linear POT clockwise.

If decimal part of upper zone smaller than lower zone, for example 9.031v and 1.049v then you need to turn the Linear POT counter-clockwise.

This is a game of balancing of both numbers; you need to make both decimal part of upper and lower to be equal or almost equal.

After satisfying with linearity result, we need to turn adjustment screw on the Offset POT counter-clockwise to decrease output voltage. We are expecting output voltage close to zero such as 9.004 and 1.004 for upper and lower zone respectively.

Now, you are free to check out other values, such as enter S2000M3 for 2v, S7000M3 for 7v and S10000M3 for 10v.

Note.

- It is normal for longer settle time or delay time after switching from high to low duty cycle, such as switch from 9v to 1v
- Please check the link of analog tunning tutorial videos on YouTube and get a MB3-Mach4 PWM Tuning Profile from MB3 product page at https://www.cncroom.com/interface-cards/mb3
- You can conduct an adjustment with the real VFD input load while the device turned on.
- The values 10,000 or 10,100 are chosen for tuning purpose only. After finished tuning, you need to set value back to max speed RPM of your spindle. If you consider using stretching technique then 1% of max speed RPM need to be added. For example the value of 18,000 or 24,000 rpm, the 1% added will be 18,180 and 24,240.

OSSD Output and Safety Circuit

The MB3 has an OSSD (Output Signal Switching Device) output for the user to form a simple safety circuit in their system. When the system is error free, the MB3 energizes the OSSD output and it will de-energize the OSSD output if an error has occurred.

Most drives will give an OK signal or "Servo Ready" or similar, by energizing its appropriate output and connected external devices will receive this status. The MB3 collects all OK signals from various devices through terminal inputs X203 - X210 and then sends out an OK signal to the next device.

However, if there is an error feeding in, MB3 will send out a "Not OK" signal by de-energizing the OSSD output and the external safety circuit will cut power and stop the hazard.

Using a magnetic contactor as an external device is a simple way to disconnect the power supply from the drives or the VFD. The "OVR"(Override) input is provided for temporarily energizing the magnetic contactor, which lets the machine operator recover from the error.

To activate this function, the user needs to select one or more inputs from X203 to X210. Then by creating a solder bridge across the appropriate corresponding solder pads, i203 to i210, which are shown in **Figure 34 on page 32**, the chosen inputs will become part of the safety circuit.

Figure 31 shows the safety circuit block and relevant I/O including, inputs, solder-bridge, and override input and outputs.

Warning. The MB3 utilises only a simple safety circuit. There is no guarantee it will protect against a serious external failure. It is therefore advised that the user **MUST ALWAYS** check the functionality of any external circuit that is connected to the MB3.

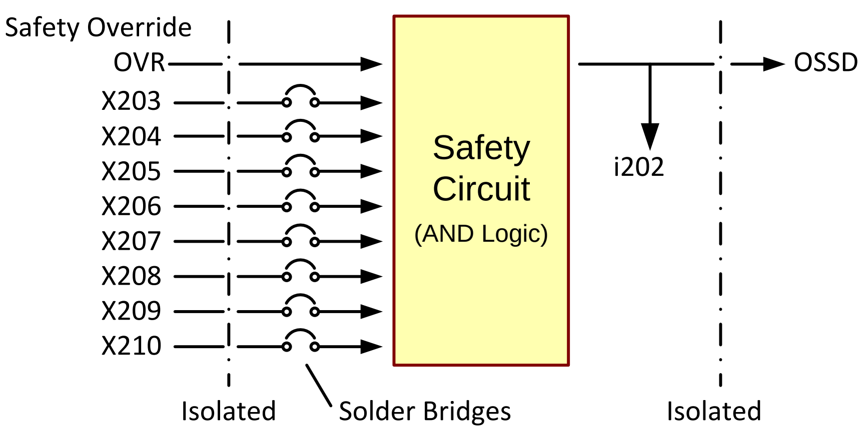


Figure 31, On board safety circuit

Modification

Solder Bridges

The MB3 has a number of places where the user can conduct modifications. Instead of using pin jumpers, solder bridges have been implemented to save cost and space. The user needs to solder or de-solder these bridges to achieve their purpose.

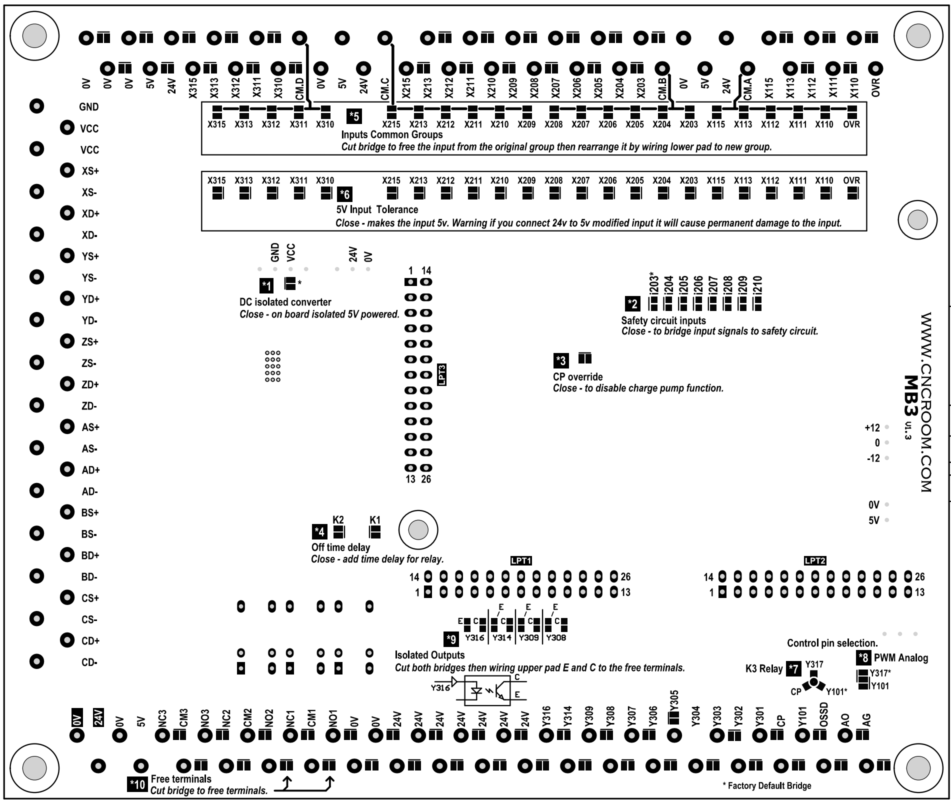


Figure 32, the underneath layout of the MB3

(*Note: the below sub heading numbers, *1 to *10 relate to the printed numbers on the under-side of the MB3 board.)*

[*1]. DC Converter

There is an option to not use the default onboard 5V isolated DC2DC converter. Because this on-board converter can only supply a limited current, in some cases it may be necessary to use an external 5V power supply. The existing bridge has to be de-soldered, and then the user can connect an external 5V power supply to the VCC and GND channel at the Axis CN2 terminal.

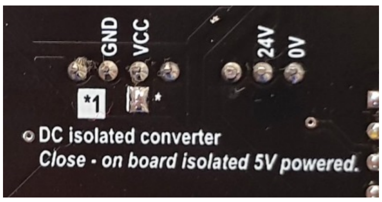


Figure 33, On board 5V DC isolated power for ESS board.

[*2]. Safety Circuit Inputs

Inputs X203 - X210 primarily function are the same as the other normal inputs. However, there is the option to use these inputs as part of the safety circuit by soldering a bridge across one or more pairs of the solder pads, which are shown in the image below. The i203 bridge is already soldered by default.

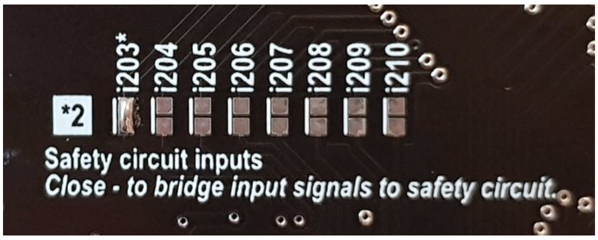


Figure 34, Bridges for safety inputs

[*3]. CP override

This allows the user disable charge pump function. Soldering solder-bridge makes CP signal always on

Figure 35, CP (Charge pump) override solder bridge

[*4]. Off Delay timer

This feature can be used where an "OFF DELAY" is required, such as in "Z-Drop" protection, which allows a mechanical brake to engage before the motor loses its holding torque. This can happen after the control signal or the main power is cut from its drive. Solder the bridge at K1 to enable an off delay of 440 ms, or at K2 for 660 ms.

Figure 36, Off time delay Solder Bridge for K1 and K2

[*5]. Input sub common

By default, inputs are divided into 4 groups. Each group has 5-6 inputs that tied common pin together. As we know, common pin is used to specify input type. Sometimes we have too many inputs for one type and have fewer inputs for another type.

This sub common allows us to rearrange inputs by cutting or isolating common pin apart from the original group then wire it up with another group as our preference. The remains fewer inputs may be used for special purpose such as sensing AC voltage source, sensing touch plate on machine metal table where as high voltage leaking on it, interfacing with MPG device, etc. In short, the sub common is designed for trimming or expanding inputs from the existing group.

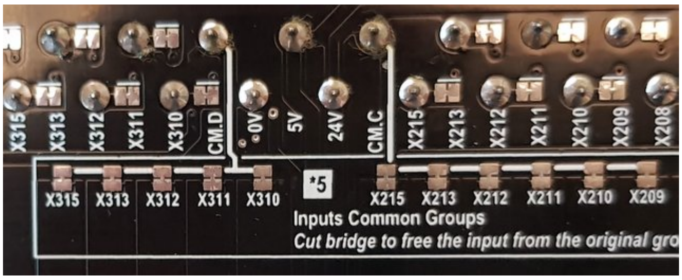


Figure 37, Default sub common pin for each input group

[*6]. 5V input tolerance

By default, all inputs accept 24V power from external devices. However, the user can make these inputs to accept 5V by closing the solder-bridge for each input.

Figure 38, 5V input tolerance solder bridges.

[*7]. K3 Relay pin select

Normally, K3 Relay is associated with output Y101. However, you can select K3 as an output relay of CP (charge pump) signal or Y317. Please be careful of this 3 way bridge selection. Make sure that you bridge only one position at a time.

Figure 39, K3 Pin select solder bridge.

[*8]. Analog pin select

The Pin for PWM (Pulse Width Modulation) Analog lets the users choose between Y101 and Y317. The default setting is Y317. Please be careful of this 2 way bridge selection. Make sure that you bridge only one position at a time.

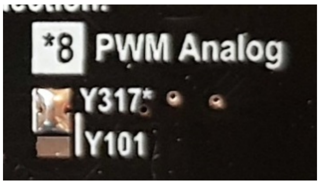


Figure 40, PWM analog output solder bridge

[*9]. Isolated Outputs

Normally, MB3 provides high current transistor outputs. However, these outputs are slow, yet share common ground with other parts of the circuit board. In some circumstances, the user may need faster output or perhaps isolated output to interface with external device such as digital inputs of VFD which high voltage or noise interference running around them. So, isolated output is the best for interfacing with this kind of devices.

There are 4 isolated outputs for the user to access them by cutting and rewiring to free terminal.

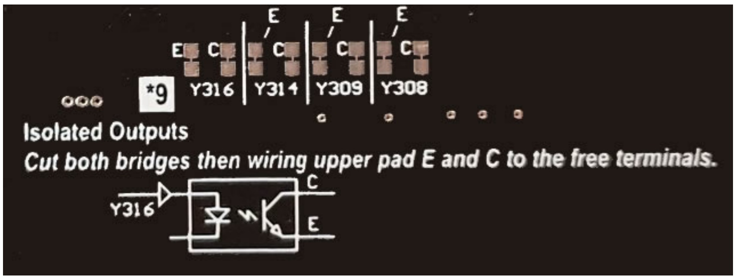


Figure 41, Solder bridges for Isolated transistor outputs

[*10]. Free Terminals

In some circumstances, the user may need a few extra terminals for their work. This can be achieved by cutting or de-soldering one or more of the bridges at the respective terminals. These free terminals are only meant for use with low voltage, nothing over 24V.

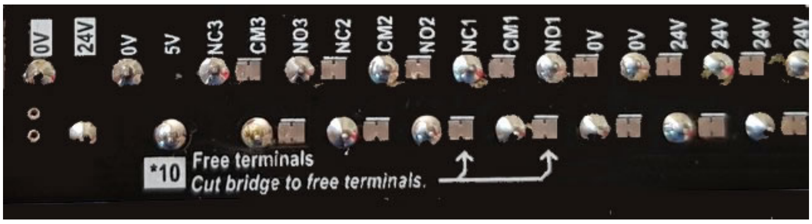


Figure 42, solder bridges at terminal pin

Software

The user can obtain up to date software, plugins and tutorials from the following links.

http://warp9td.com/index.php/sw

http://www.youtube.com/channel/UCpg3EROtW8xA_KzrFHgn4ZQ

The user also can obtain the MB3 pre configuration file from the product link below.

https://www.cncroom.com/interface-cards/mb3

https://www.cncroom.com/interface-cards/ess-mb3

Mach3 Configuration

The user can obtain the pre configuration XML file and copy it to their system. However, there are some values that need to be set to suit individual applications.

After downloading and extracting the pre configuration profile. You will find MB3.xml that needs to be copied and pasted into C:\Mach3 which is shown in picture below. Run Mach3 Loader and choose MB3 profile.

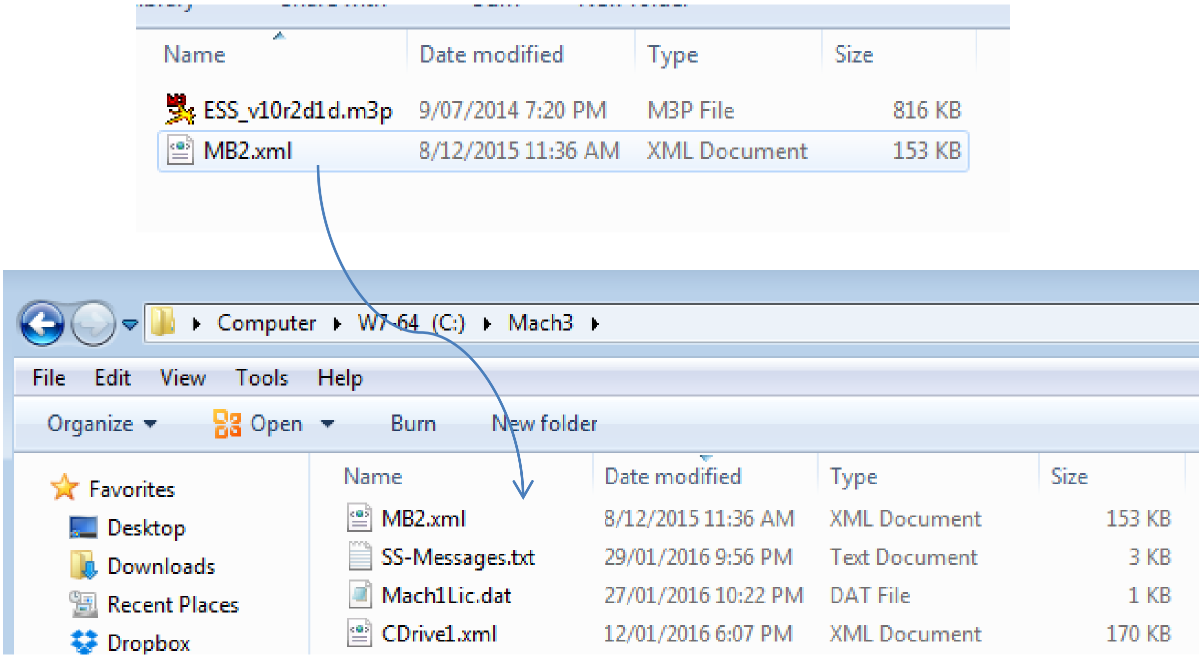


Figure 43, Copy and Paste the MB3 pre-configuration file

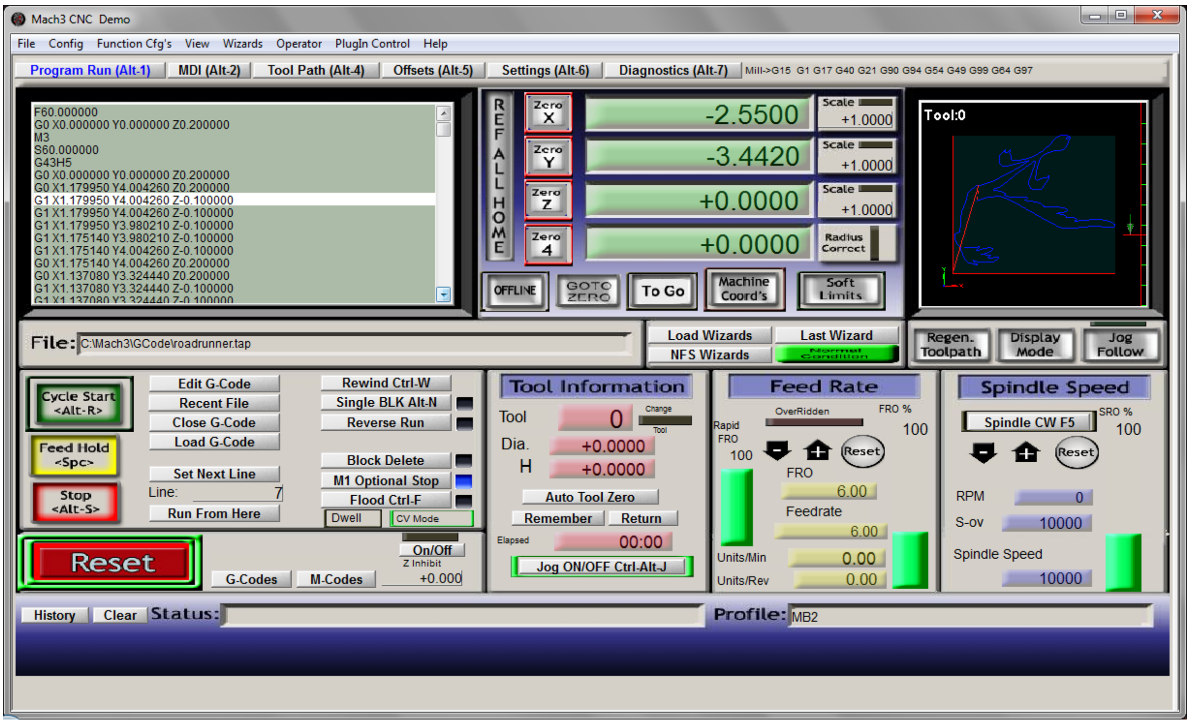


Figure 44, Mach3's first screen

Menu Config > Ports and Pins

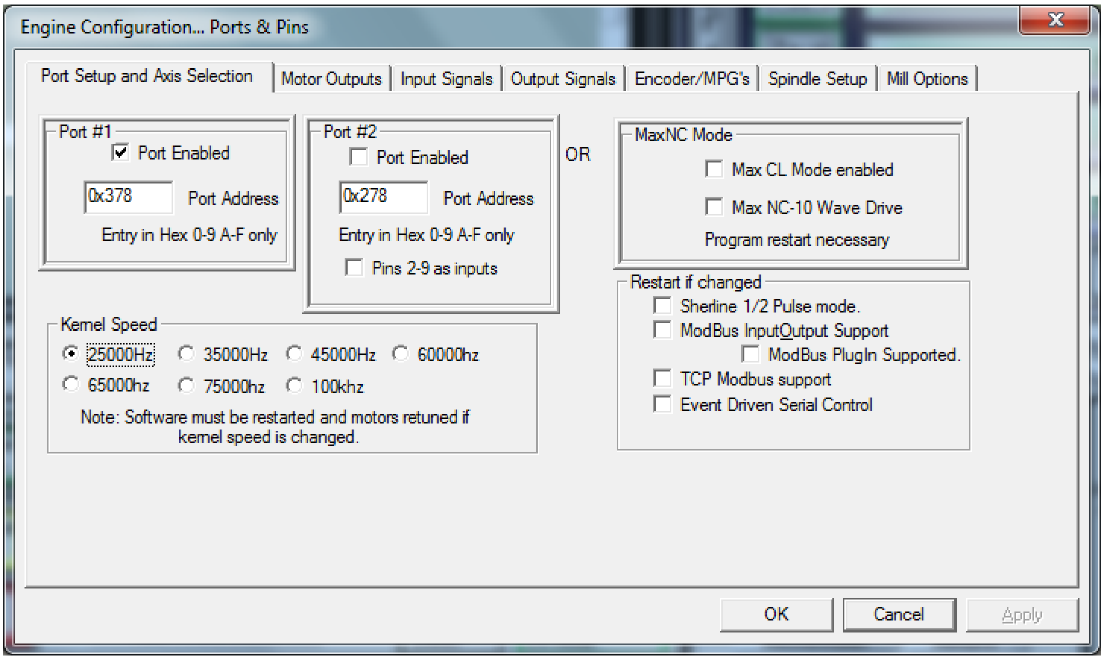
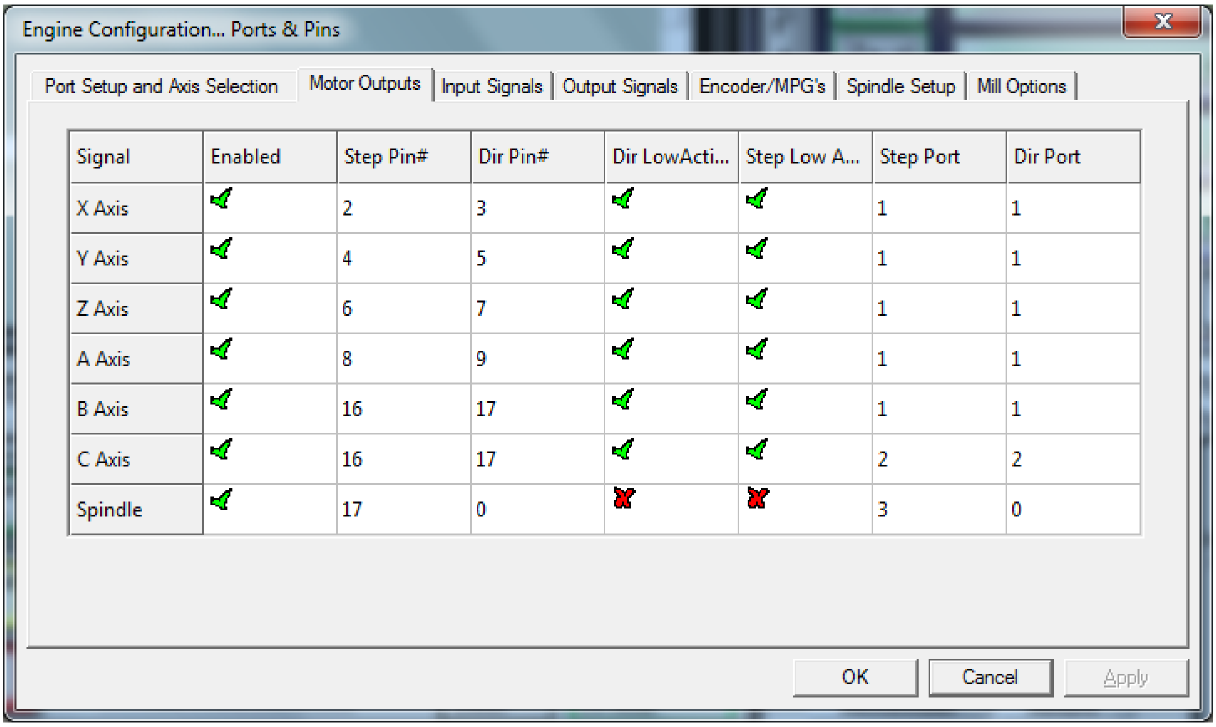


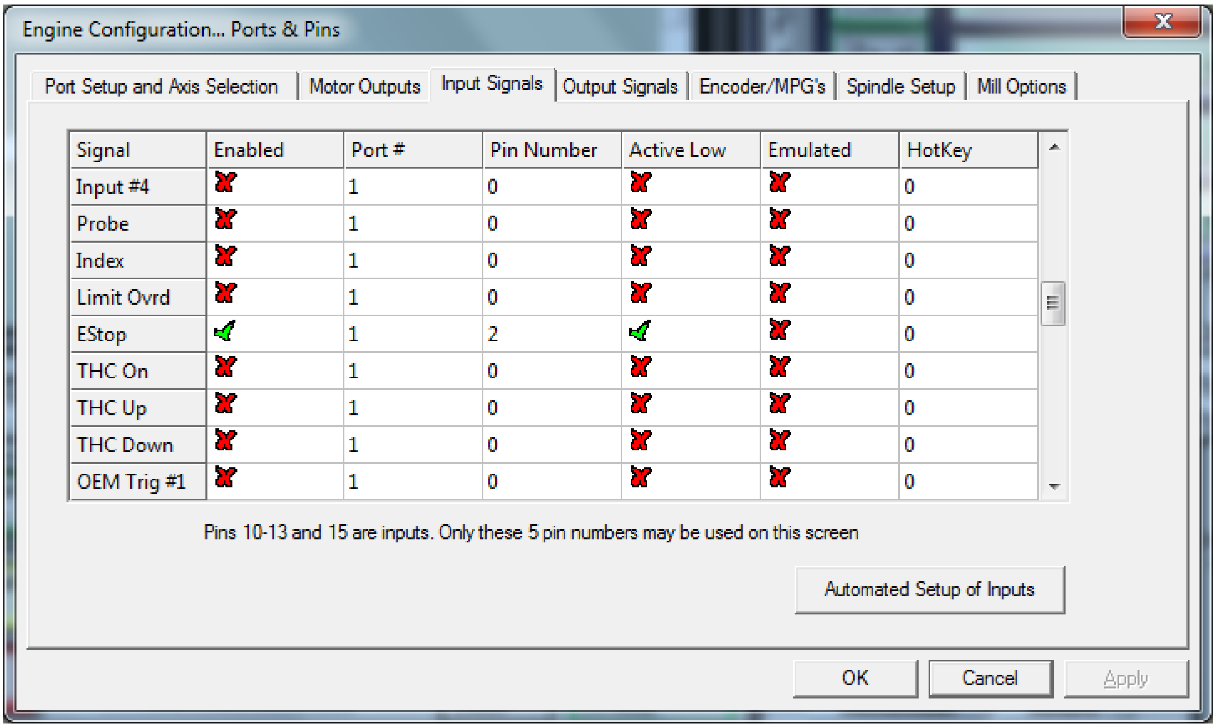
Figure 45, Mach3 Ports and Pins dialog



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

Figure 46, Motor output tab

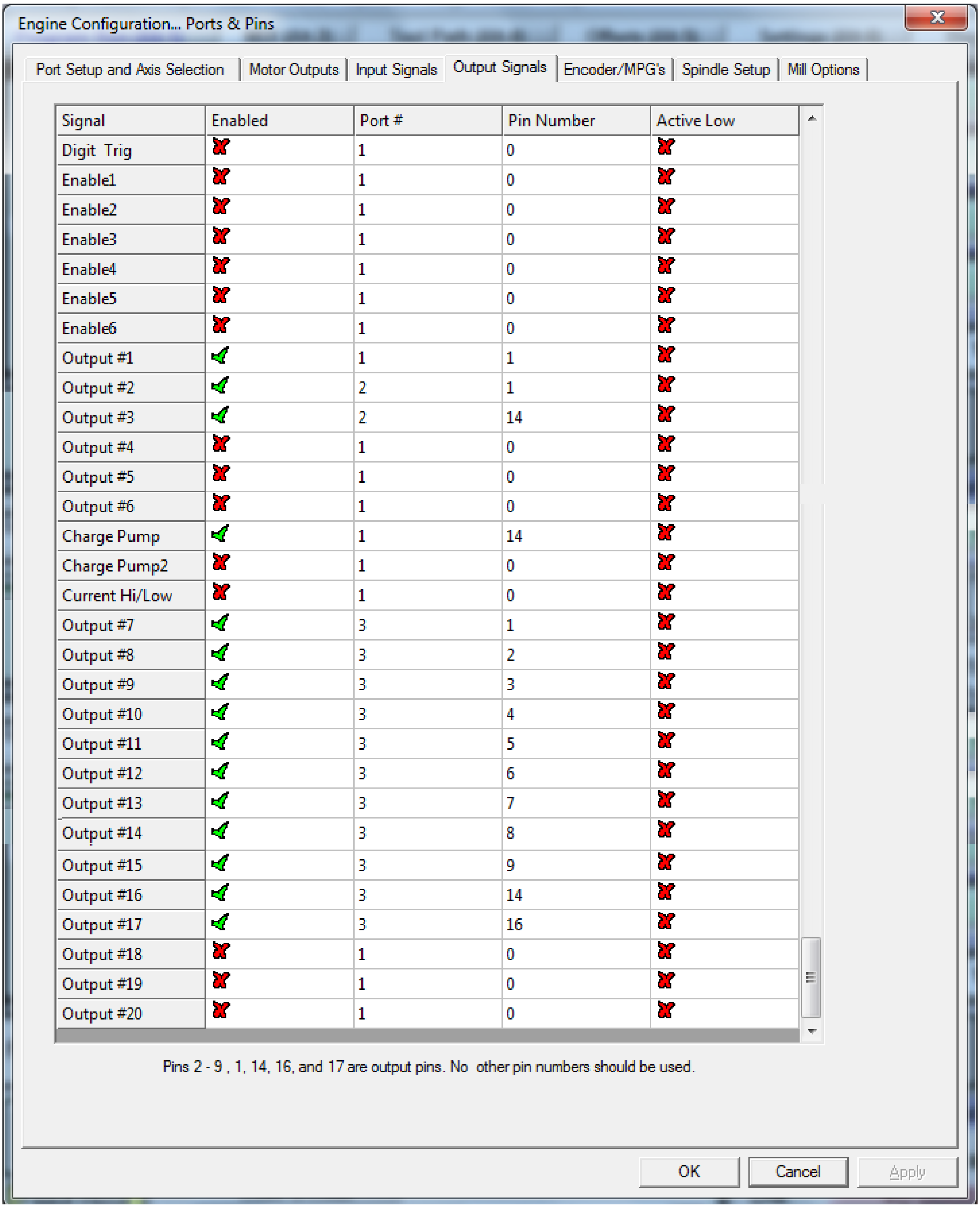
Specify values as shown in the picture.



Signal	Enabled	Port #	Pin Number	Active Low	Emulated	HotKey
Input #4	✗	1	0	✗	✗	0
Probe	✗	1	0	✗	✗	0
Index	✗	1	0	✗	✗	0
Limit Ovrd	✗	1	0	✗	✗	0
EStop	✓	1	2	✓	✗	0
THC On	✗	1	0	✗	✗	0
THC Up	✗	1	0	✗	✗	0
THC Down	✗	1	0	✗	✗	0
OEM Trig #1	✗	1	0	✗	✗	0

Figure 47, Mach3 Input tab

Only Estop signal is configured, but the rest of the inputs the user needs to set suitable values.



Engine Configuration... Ports & Pins

Port Setup and Axis Selection | Motor Outputs | Input Signals | Output Signals | Encoder/MPG's | Spindle Setup | Mill Options

Signal	Enabled	Port #	Pin Number	Active Low
Digit Trig	✗	1	0	✗
Enable1	✗	1	0	✗
Enable2	✗	1	0	✗
Enable3	✗	1	0	✗
Enable4	✗	1	0	✗
Enable5	✗	1	0	✗
Enable6	✗	1	0	✗
Output #1	✓	1	1	✗
Output #2	✓	2	1	✗
Output #3	✓	2	14	✗
Output #4	✗	1	0	✗
Output #5	✗	1	0	✗
Output #6	✗	1	0	✗
Charge Pump	✓	1	14	✗
Charge Pump2	✗	1	0	✗
Current Hi/Low	✗	1	0	✗
Output #7	✓	3	1	✗
Output #8	✓	3	2	✗
Output #9	✓	3	3	✗
Output #10	✓	3	4	✗
Output #11	✓	3	5	✗
Output #12	✓	3	6	✗
Output #13	✓	3	7	✗
Output #14	✓	3	8	✗
Output #15	✓	3	9	✗
Output #16	✓	3	14	✗
Output #17	✓	3	16	✗
Output #18	✗	1	0	✗
Output #19	✗	1	0	✗
Output #20	✗	1	0	✗

Pins 2 - 9 , 1, 14, 16, and 17 are output pins. No other pin numbers should be used.

OK | Cancel | Apply

Figure 48, Mach3 Output tab

The user needs to set suitable values.

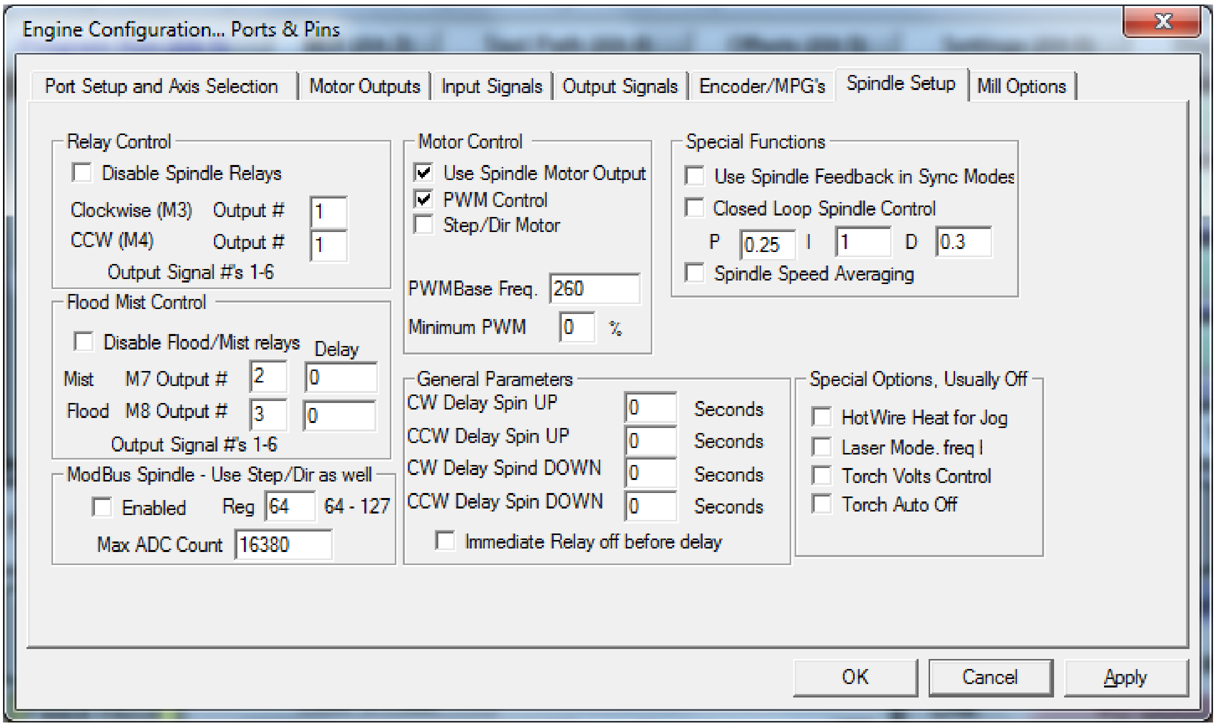


Figure 49, Mach3 Spindle tab

Menu Config > Motor Tuning

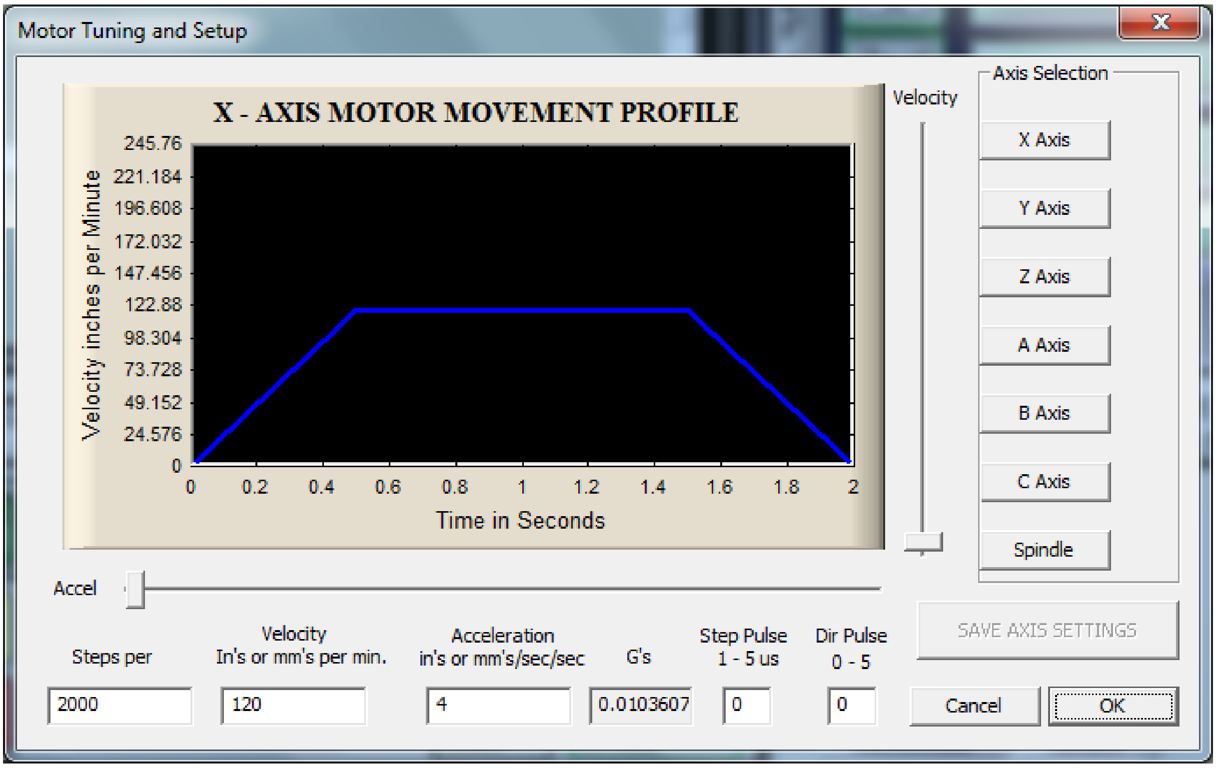


Figure 50, Mach3 Motor tuning dialog

Motor Tuning and Setup for X, Y, Z, A, B and C axis, the user needs to set suitable values.

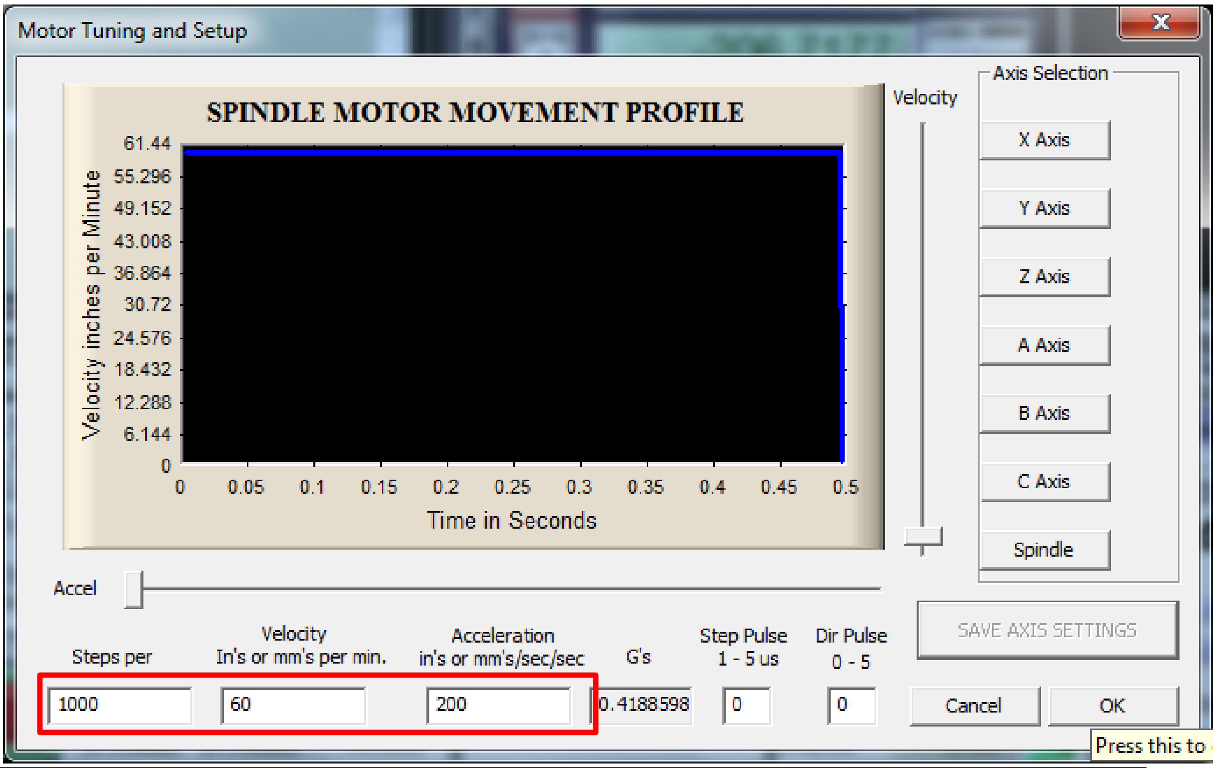


Figure 51, Mach3 Spindle tuning

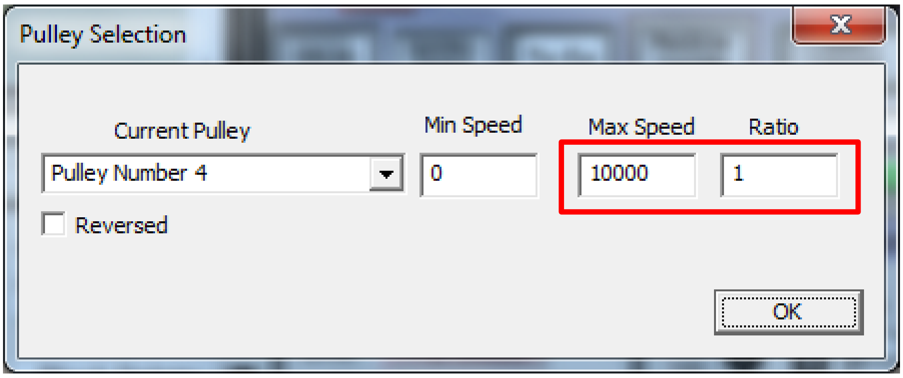


Figure 52, Mach3 Spindle Max speed. 0-10v

Spindle Tuning and Spindle speed need to be set to get analog output 0-10V for entire spindle speed range. The value 10000 rpm is recommended during adjust analog output. But Actual speed will be used instead after finishing setup.

Menu PlugIn Control > Main Config:

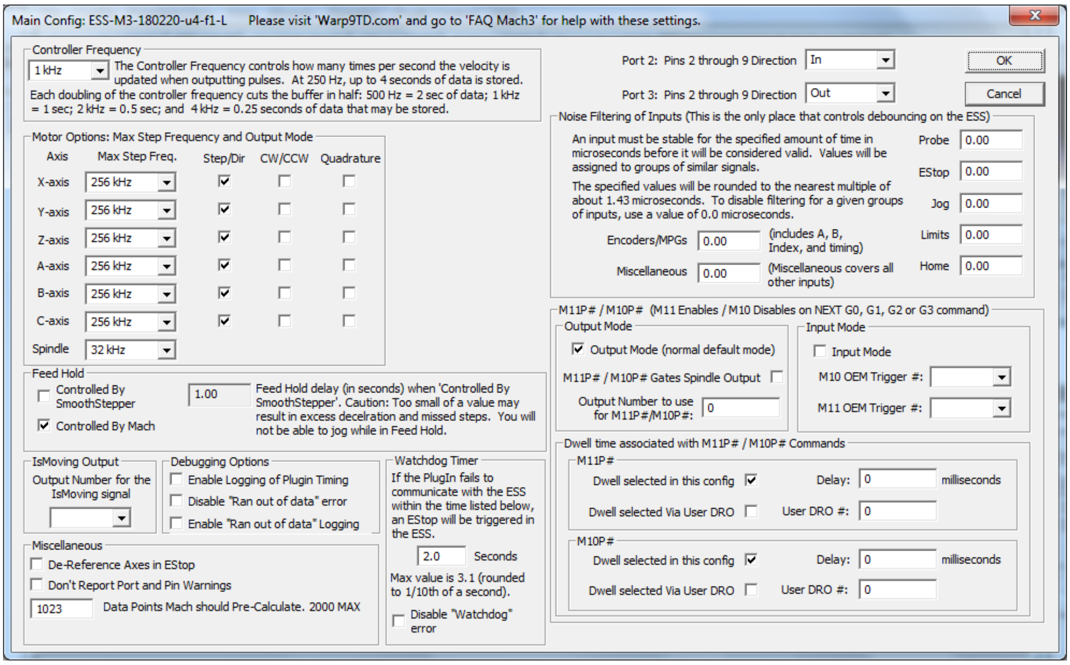


Figure 53, ESS General Configuration

Menu PlugIn Control > Spindle, THC & Laser Config:

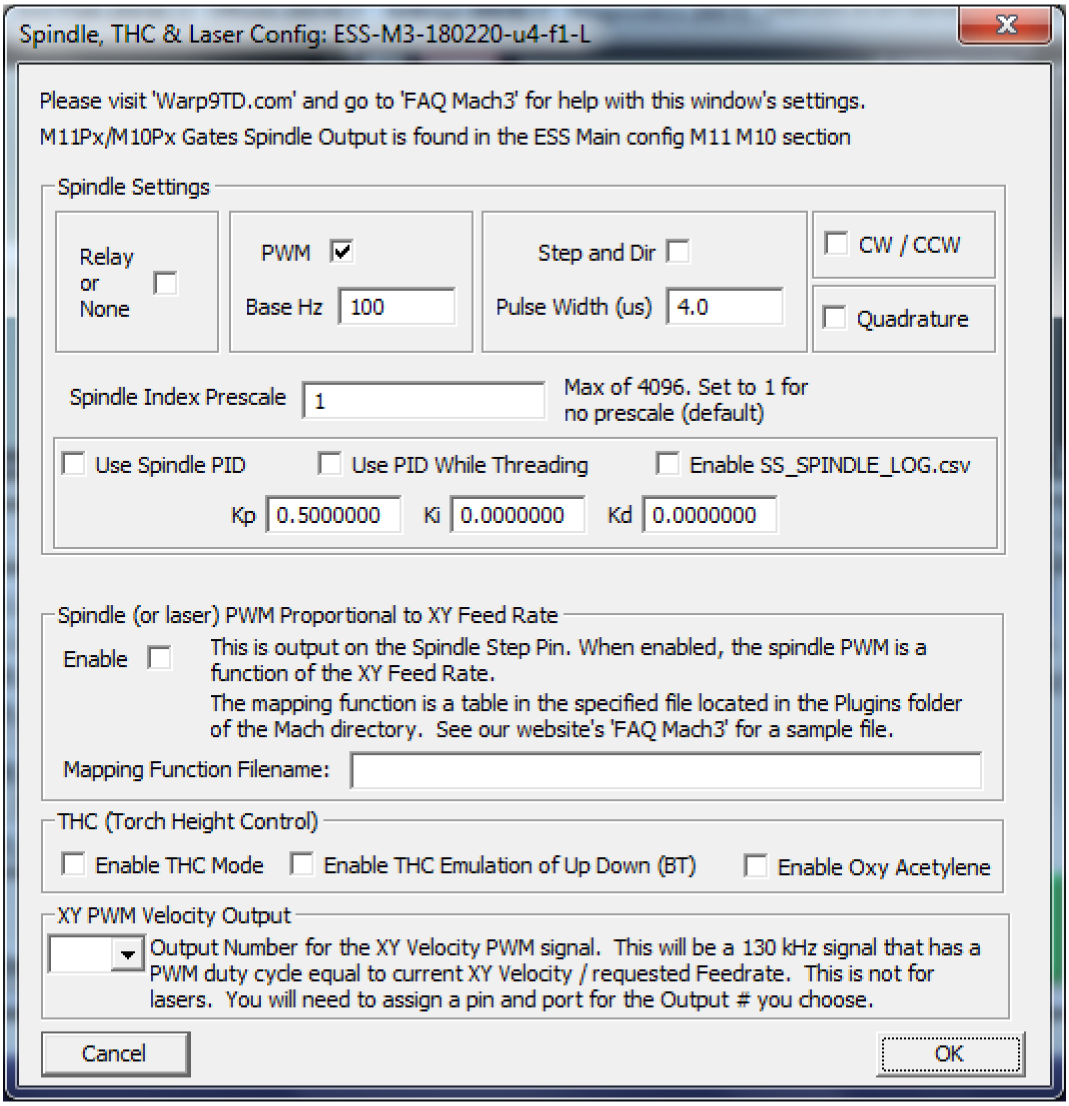


Figure 54, Spindle, THC and Laser Configuration

Mach4 Configuration

The user can obtain the pre configuration profile from the CNCRoom product page. However, there are some values that need to be set to suit the user's individual system.

After downloading and extracting the pre configuration profile. You will find a folder named MB3, copy and paste this folder into C:\Mach4Hobby\Profiles as shown in picture below. Run the “Mach4 loader”, then choose the MB3 profile.

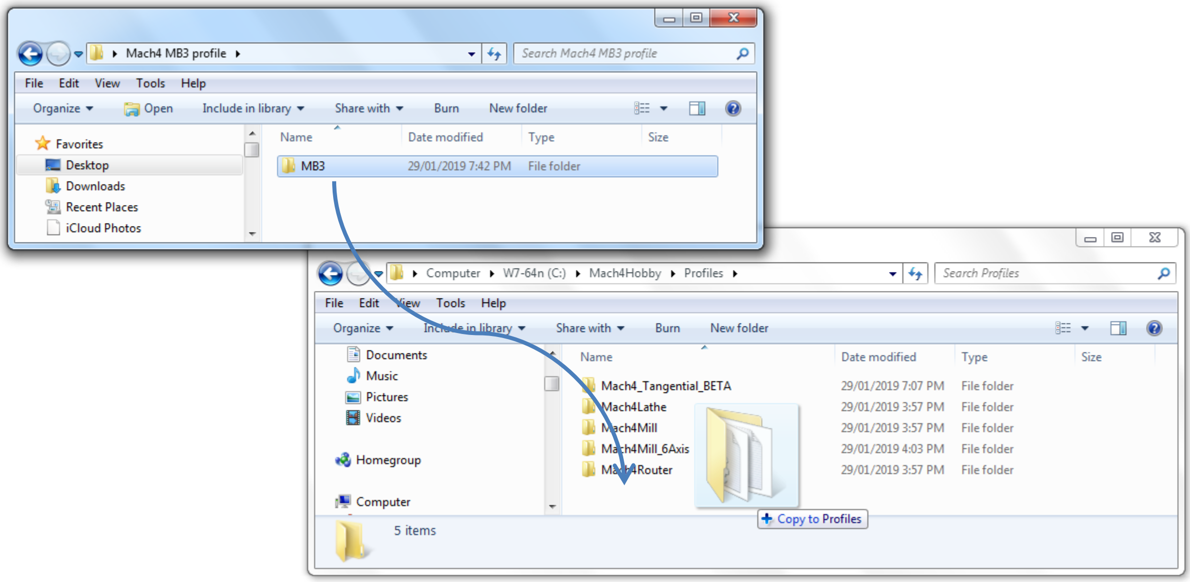


Figure 55, Copy n Paste, or drag n drop the Mach4 pre- configuration file

Setting up the SmoothStepper and Mach4 Software

Please check up to date instruction of Setting up the SmoothStepper and Mach4 Software at Warp9 Tech web page.

https://www.warp9td.com/index.php/gettingstarted/setting-up-the-smoothstepper-and-mach4#SetupInstruction

Setting up new profile

The pictures below show the sequence of making new profile for Mach4.

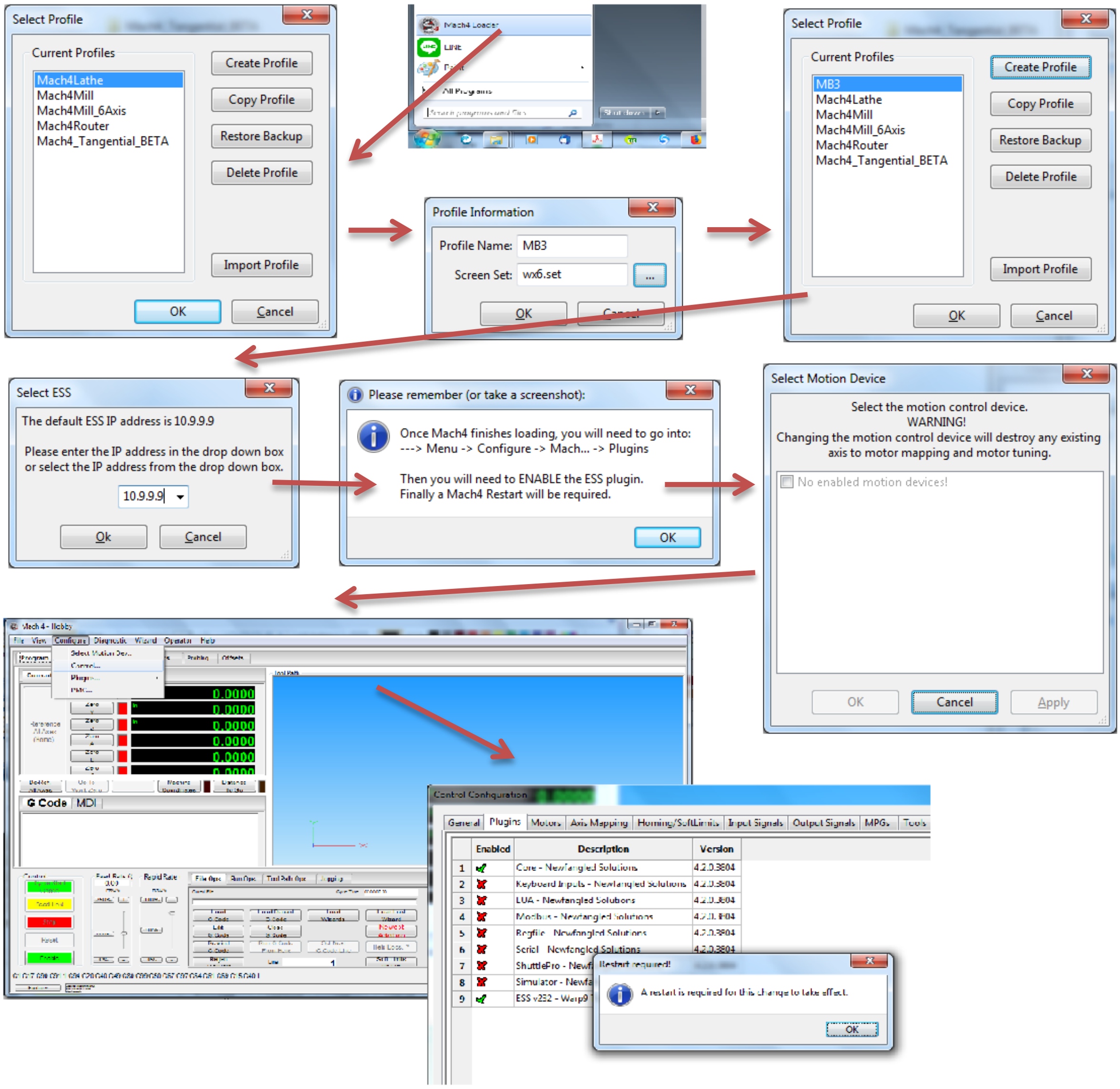


Figure 56, Configure menu and step sequence

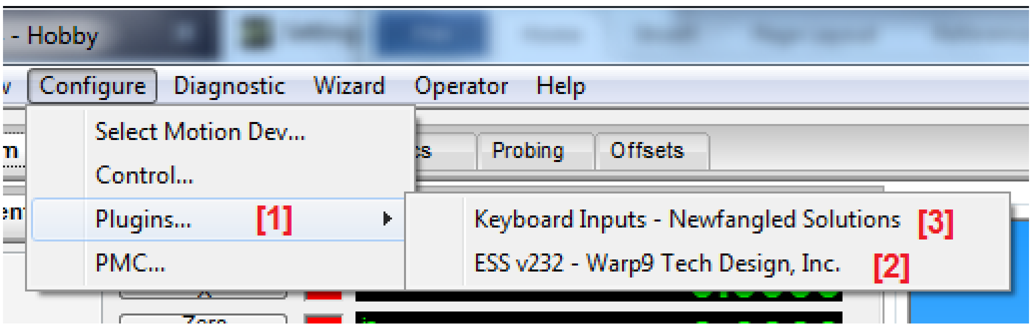


Figure 57, Entry to ESS and Keyboard configuration

Before we can see sub menu [2] and [3], we need enable them in next dialog which shown in **Figure 56,** Configure menu and step sequence

ESS configuration

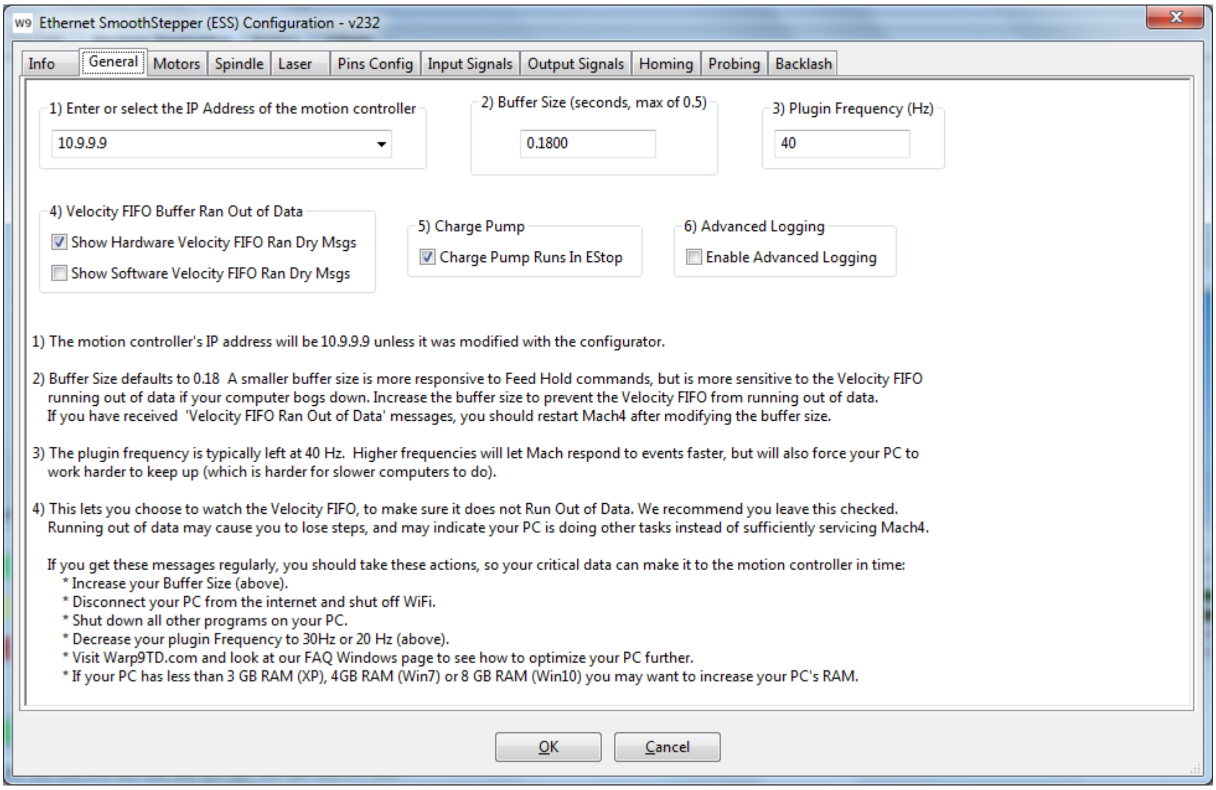


Figure 58, ESS IP address and buffer size

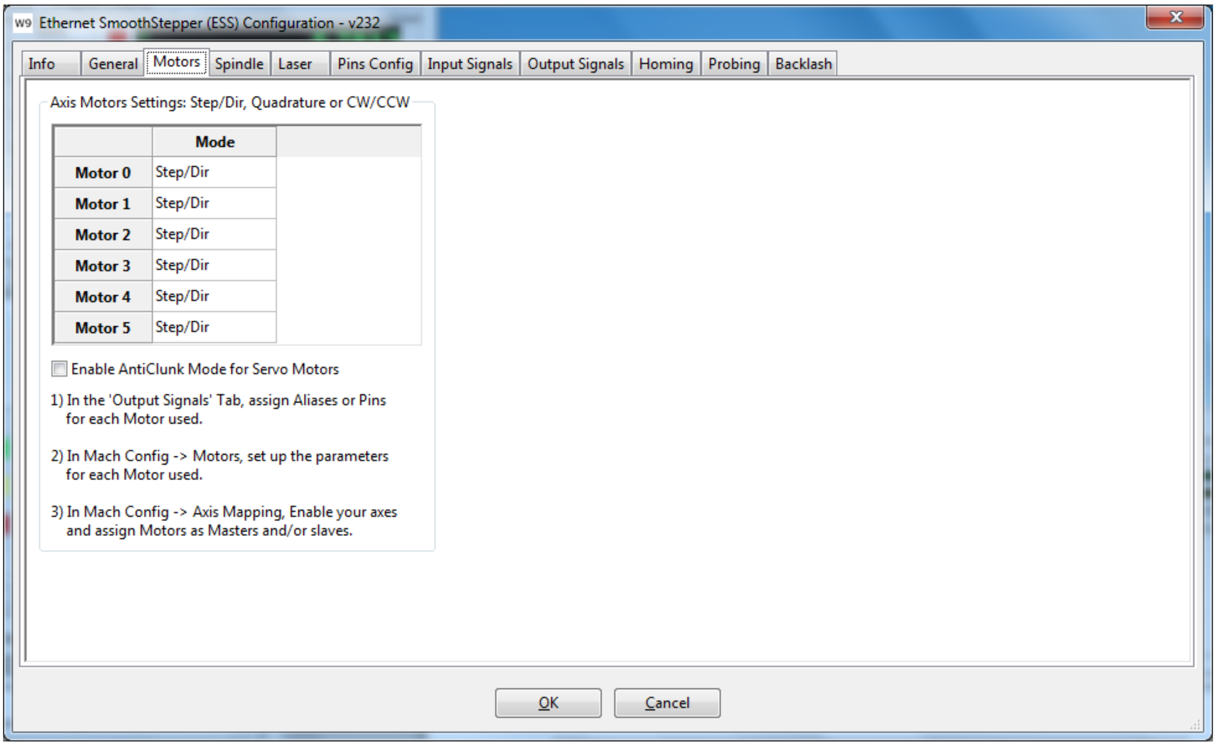


Figure 59, Motor command mode

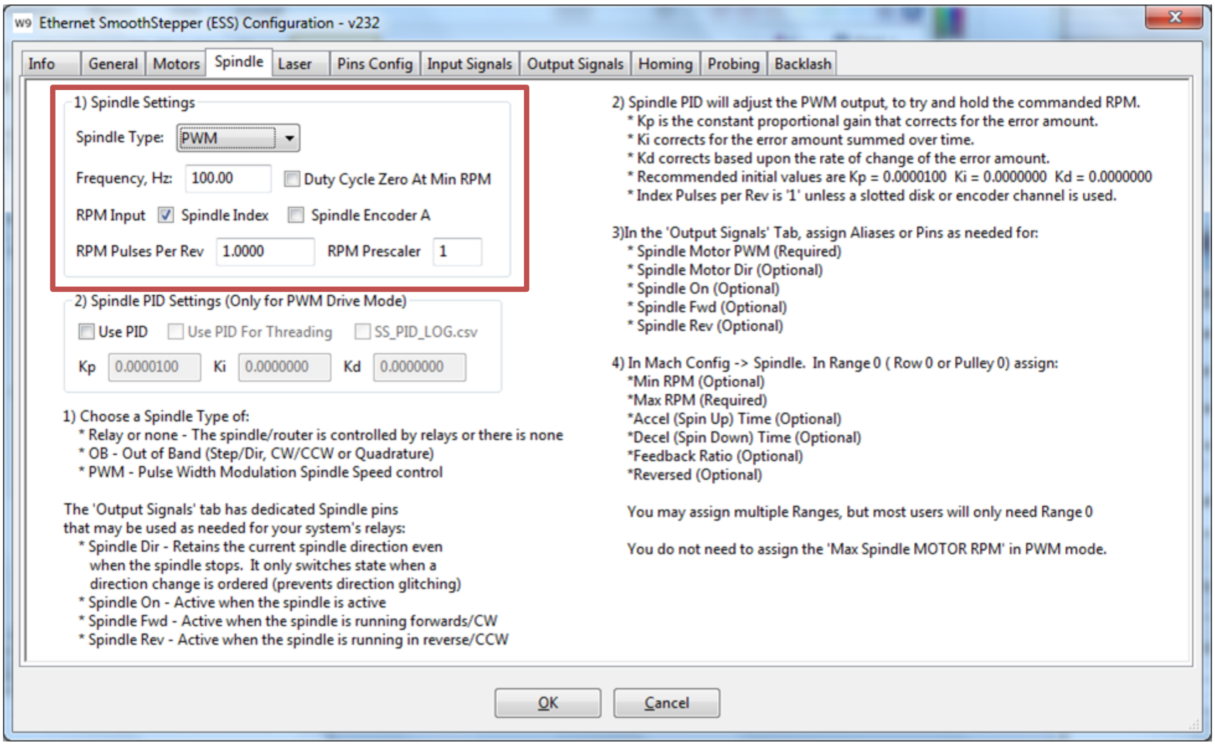
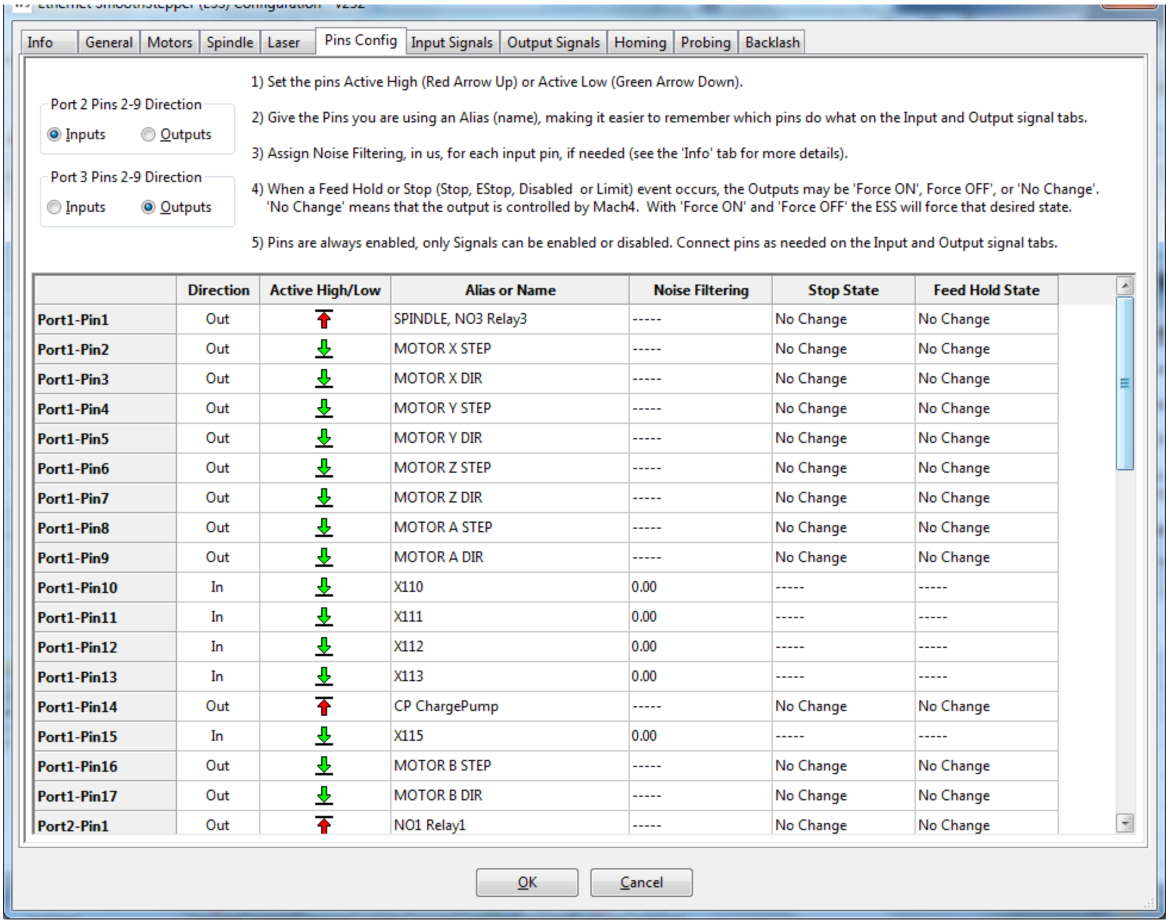
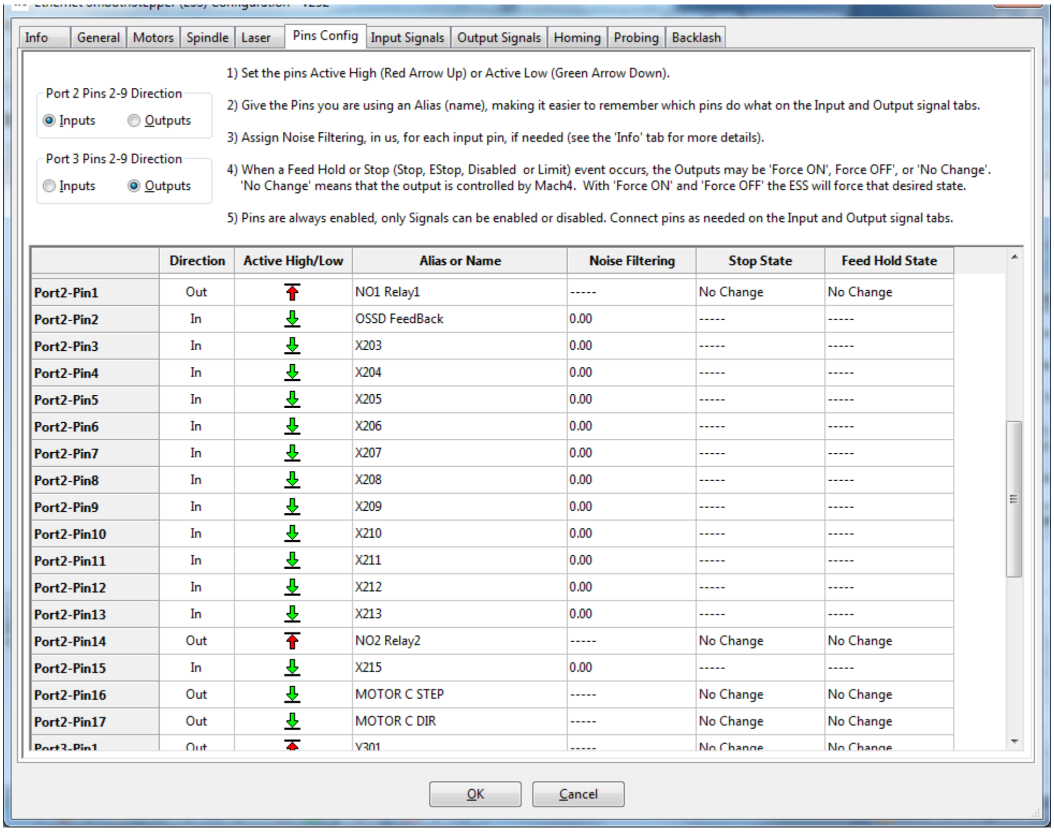


Figure 60, Spindle Setup



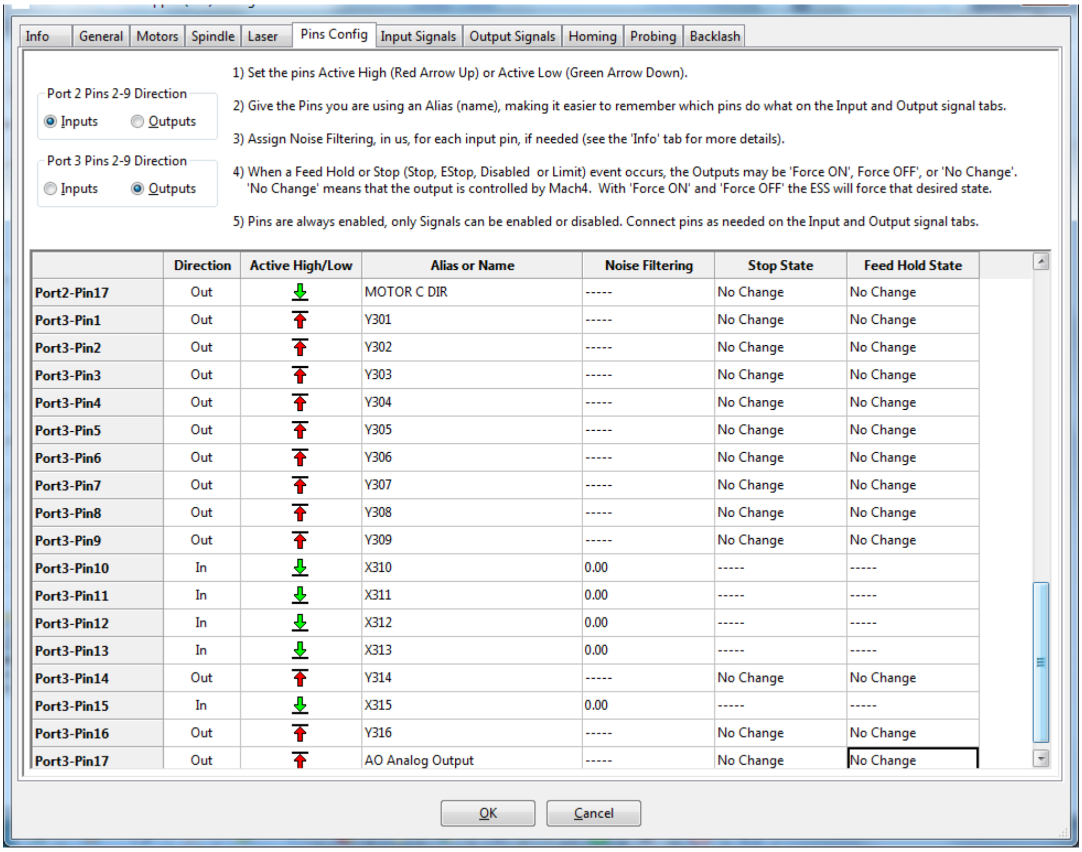
	Direction	Active High/Low	Alias or Name	Noise Filtering	Stop State	Feed Hold State
Port1-Pin1	Out	↑	SPINDLE, NO3 Relay3	-----	No Change	No Change
Port1-Pin2	Out	↓	MOTOR X STEP	-----	No Change	No Change
Port1-Pin3	Out	↓	MOTOR X DIR	-----	No Change	No Change
Port1-Pin4	Out	↓	MOTOR Y STEP	-----	No Change	No Change
Port1-Pin5	Out	↓	MOTOR Y DIR	-----	No Change	No Change
Port1-Pin6	Out	↓	MOTOR Z STEP	-----	No Change	No Change
Port1-Pin7	Out	↓	MOTOR Z DIR	-----	No Change	No Change
Port1-Pin8	Out	↓	MOTOR A STEP	-----	No Change	No Change
Port1-Pin9	Out	↓	MOTOR A DIR	-----	No Change	No Change
Port1-Pin10	In	↓	X110	0.00	-----	-----
Port1-Pin11	In	↓	X111	0.00	-----	-----
Port1-Pin12	In	↓	X112	0.00	-----	-----
Port1-Pin13	In	↓	X113	0.00	-----	-----
Port1-Pin14	Out	↑	CP ChargePump	-----	No Change	No Change
Port1-Pin15	In	↓	X115	0.00	-----	-----
Port1-Pin16	Out	↓	MOTOR B STEP	-----	No Change	No Change
Port1-Pin17	Out	↓	MOTOR B DIR	-----	No Change	No Change
Port2-Pin1	Out	↑	NO1 Relay1	-----	No Change	No Change

Figure 61, Pins Config and Alias Names



	Direction	Active High/Low	Alias or Name	Noise Filtering	Stop State	Feed Hold State
Port2-Pin1	Out	Up	NO1 Relay1	-----	No Change	No Change
Port2-Pin2	In	Down	OSSD FeedBack	0.00	-----	-----
Port2-Pin3	In	Down	X203	0.00	-----	-----
Port2-Pin4	In	Down	X204	0.00	-----	-----
Port2-Pin5	In	Down	X205	0.00	-----	-----
Port2-Pin6	In	Down	X206	0.00	-----	-----
Port2-Pin7	In	Down	X207	0.00	-----	-----
Port2-Pin8	In	Down	X208	0.00	-----	-----
Port2-Pin9	In	Down	X209	0.00	-----	-----
Port2-Pin10	In	Down	X210	0.00	-----	-----
Port2-Pin11	In	Down	X211	0.00	-----	-----
Port2-Pin12	In	Down	X212	0.00	-----	-----
Port2-Pin13	In	Down	X213	0.00	-----	-----
Port2-Pin14	Out	Up	NO2 Relay2	-----	No Change	No Change
Port2-Pin15	In	Down	X215	0.00	-----	-----
Port2-Pin16	Out	Down	MOTOR C STEP	-----	No Change	No Change
Port2-Pin17	Out	Down	MOTOR C DIR	-----	No Change	No Change
Port3-Pin1	Out	Up	Y301	-----	No Change	No Change

Figure 62, Pins Config and Alias Names (continue 1)



	Direction	Active High/Low	Alias or Name	Noise Filtering	Stop State	Feed Hold State
Port2-Pin17	Out	Down	MOTOR C DIR	-----	No Change	No Change
Port3-Pin1	Out	Up	Y301	-----	No Change	No Change
Port3-Pin2	Out	Up	Y302	-----	No Change	No Change
Port3-Pin3	Out	Up	Y303	-----	No Change	No Change
Port3-Pin4	Out	Up	Y304	-----	No Change	No Change
Port3-Pin5	Out	Up	Y305	-----	No Change	No Change
Port3-Pin6	Out	Up	Y306	-----	No Change	No Change
Port3-Pin7	Out	Up	Y307	-----	No Change	No Change
Port3-Pin8	Out	Up	Y308	-----	No Change	No Change
Port3-Pin9	Out	Up	Y309	-----	No Change	No Change
Port3-Pin10	In	Down	X310	0.00	-----	-----
Port3-Pin11	In	Down	X311	0.00	-----	-----
Port3-Pin12	In	Down	X312	0.00	-----	-----
Port3-Pin13	In	Down	X313	0.00	-----	-----
Port3-Pin14	Out	Up	Y314	-----	No Change	No Change
Port3-Pin15	In	Down	X315	0.00	-----	-----
Port3-Pin16	Out	Up	Y316	-----	No Change	No Change
Port3-Pin17	Out	Up	AO Analog Output	-----	No Change	No Change

Figure 63, Pin Alias Names (continue 2)

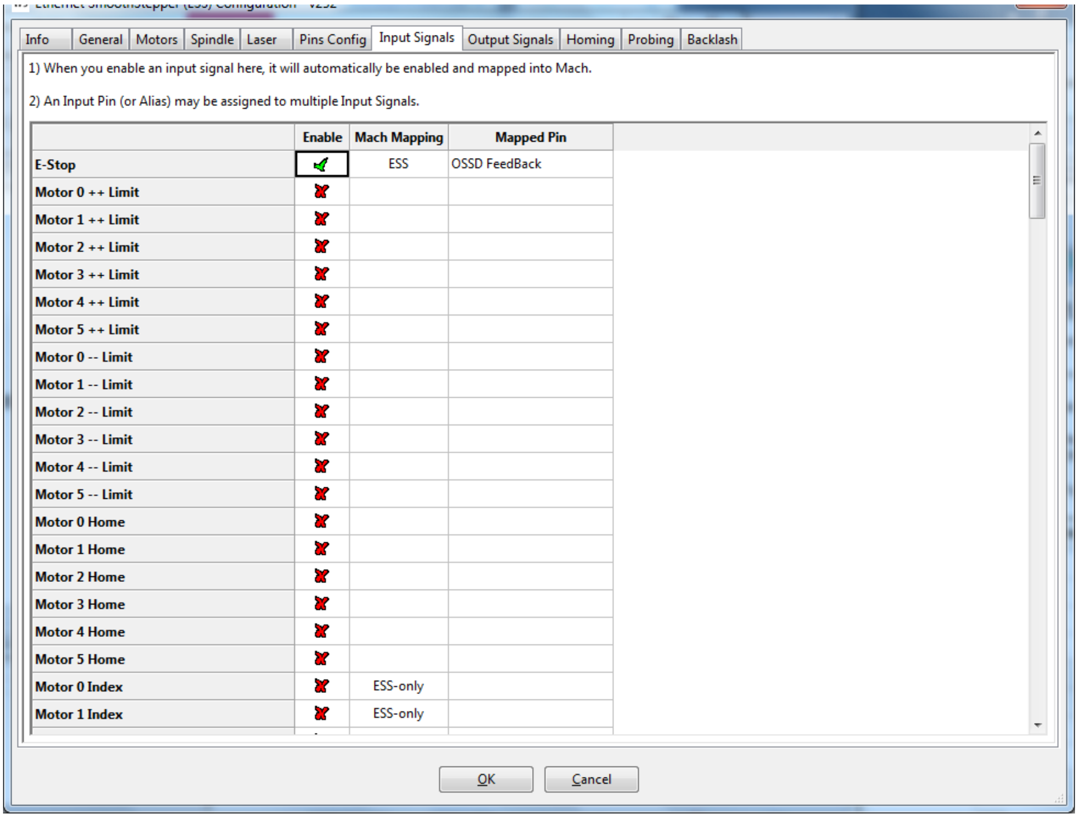
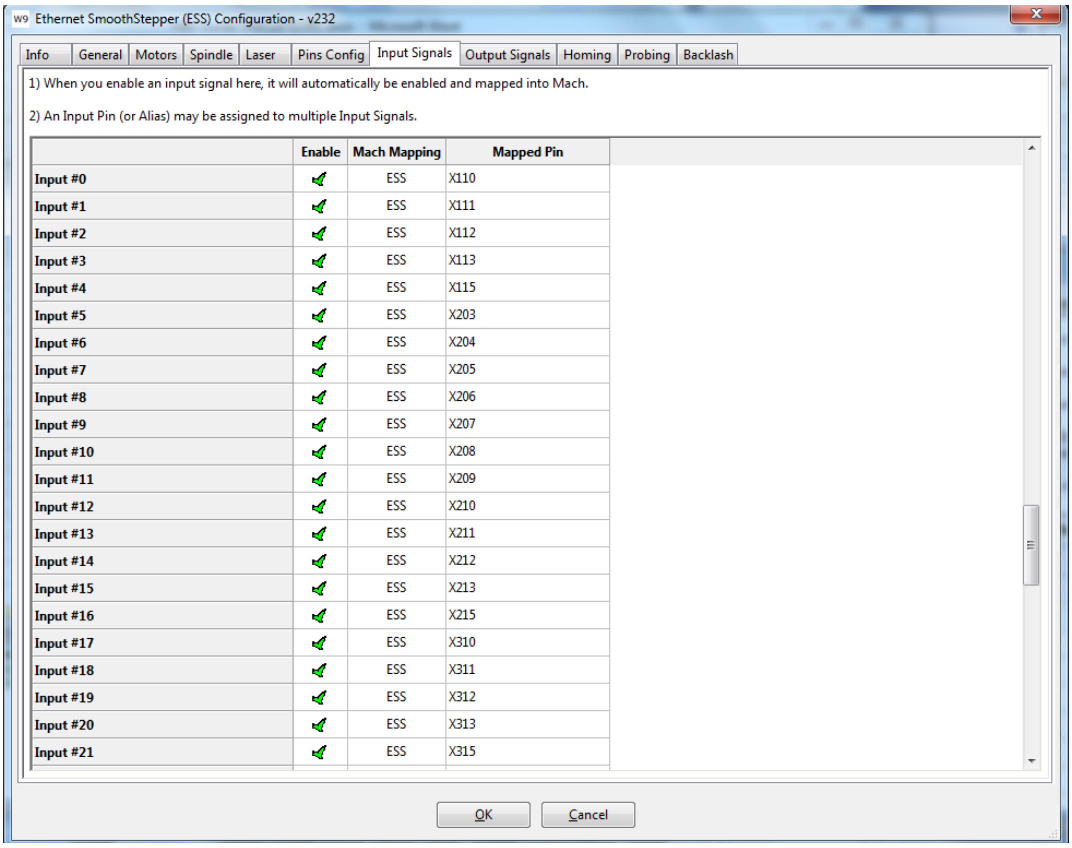
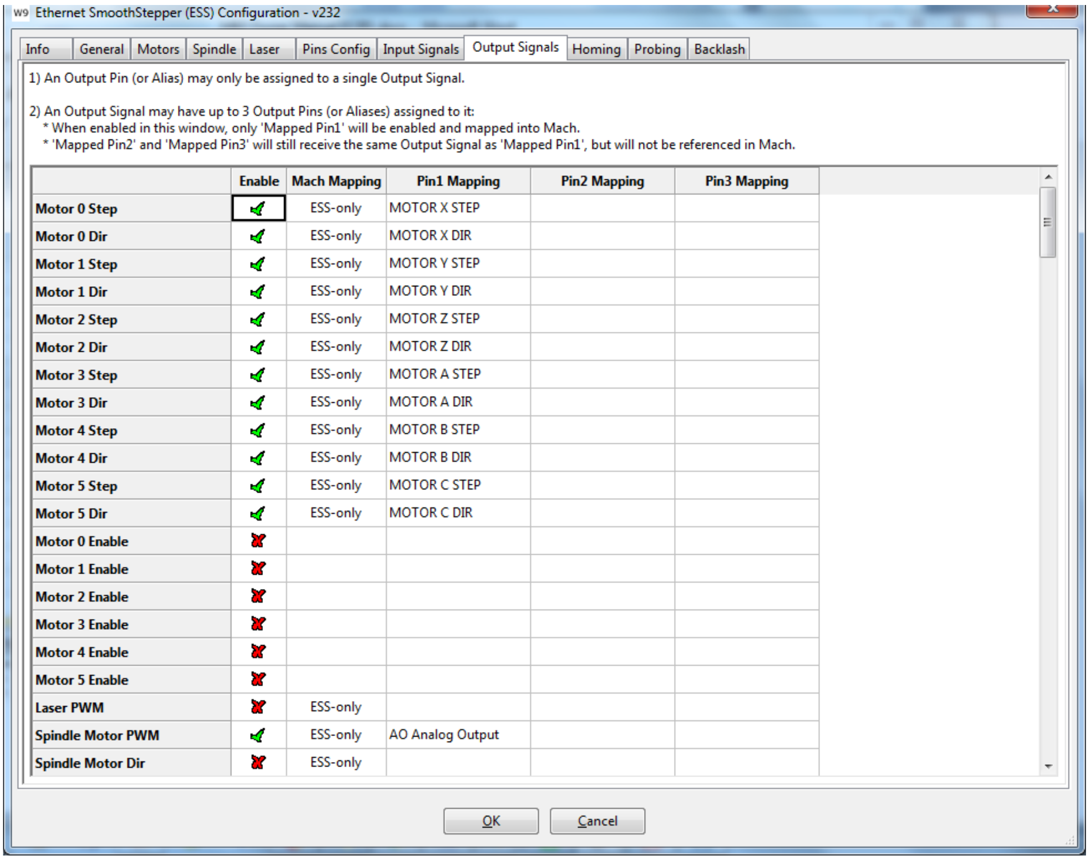


Figure 64, Input Signals Mapping



	Enable	Mach Mapping	Mapped Pin
Input #0	✓	ESS	X110
Input #1	✓	ESS	X111
Input #2	✓	ESS	X112
Input #3	✓	ESS	X113
Input #4	✓	ESS	X115
Input #5	✓	ESS	X203
Input #6	✓	ESS	X204
Input #7	✓	ESS	X205
Input #8	✓	ESS	X206
Input #9	✓	ESS	X207
Input #10	✓	ESS	X208
Input #11	✓	ESS	X209
Input #12	✓	ESS	X210
Input #13	✓	ESS	X211
Input #14	✓	ESS	X212
Input #15	✓	ESS	X213
Input #16	✓	ESS	X215
Input #17	✓	ESS	X310
Input #18	✓	ESS	X311
Input #19	✓	ESS	X312
Input #20	✓	ESS	X313
Input #21	✓	ESS	X315

Figure 65, Input Signals Mapping (continue 1)



	Enable	Mach Mapping	Pin1 Mapping	Pin2 Mapping	Pin3 Mapping
Motor 0 Step	✓	ESS-only	MOTOR X STEP		
Motor 0 Dir	✓	ESS-only	MOTOR X DIR		
Motor 1 Step	✓	ESS-only	MOTOR Y STEP		
Motor 1 Dir	✓	ESS-only	MOTOR Y DIR		
Motor 2 Step	✓	ESS-only	MOTOR Z STEP		
Motor 2 Dir	✓	ESS-only	MOTOR Z DIR		
Motor 3 Step	✓	ESS-only	MOTOR A STEP		
Motor 3 Dir	✓	ESS-only	MOTOR A DIR		
Motor 4 Step	✓	ESS-only	MOTOR B STEP		
Motor 4 Dir	✓	ESS-only	MOTOR B DIR		
Motor 5 Step	✓	ESS-only	MOTOR C STEP		
Motor 5 Dir	✓	ESS-only	MOTOR C DIR		
Motor 0 Enable	✗				
Motor 1 Enable	✗				
Motor 2 Enable	✗				
Motor 3 Enable	✗				
Motor 4 Enable	✗				
Motor 5 Enable	✗				
Laser PWM	✗	ESS-only			
Spindle Motor PWM	✓	ESS-only	AO Analog Output		
Spindle Motor Dir	✗	ESS-only			

Figure 66, Output Signals Mapping

The user must set each output active correctly otherwise that output will stay on constantly.

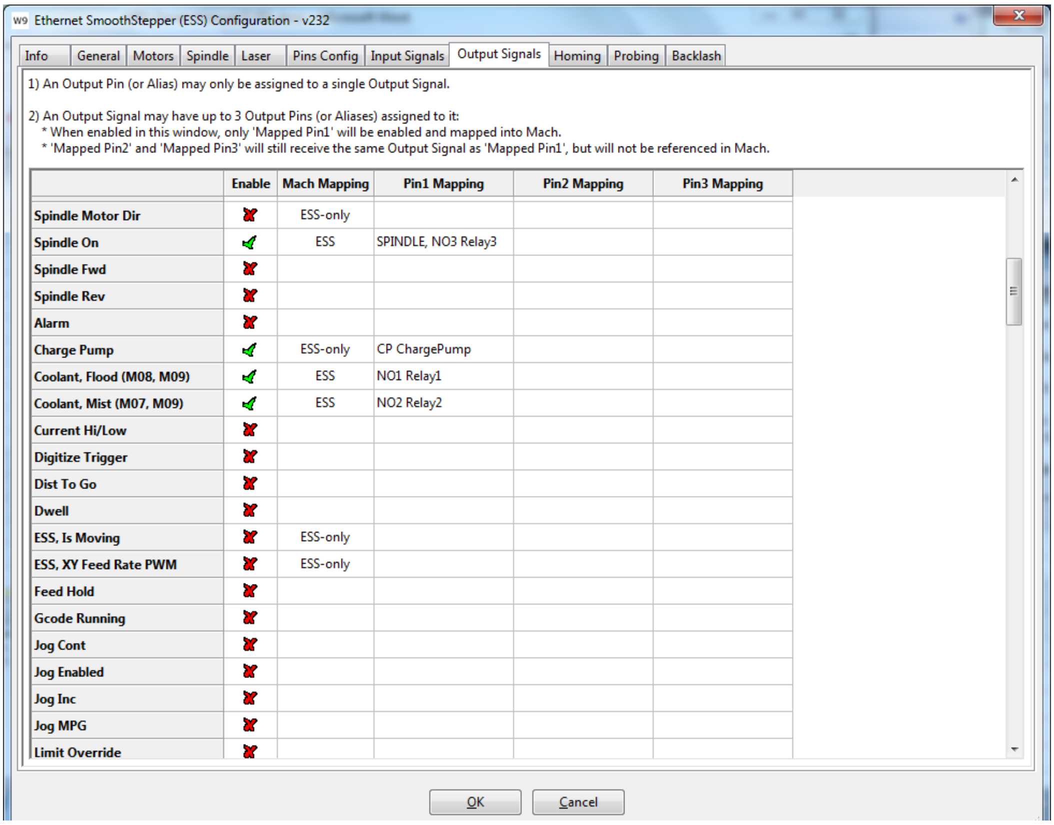


Figure 67, Output Signals Mapping (continue 1)

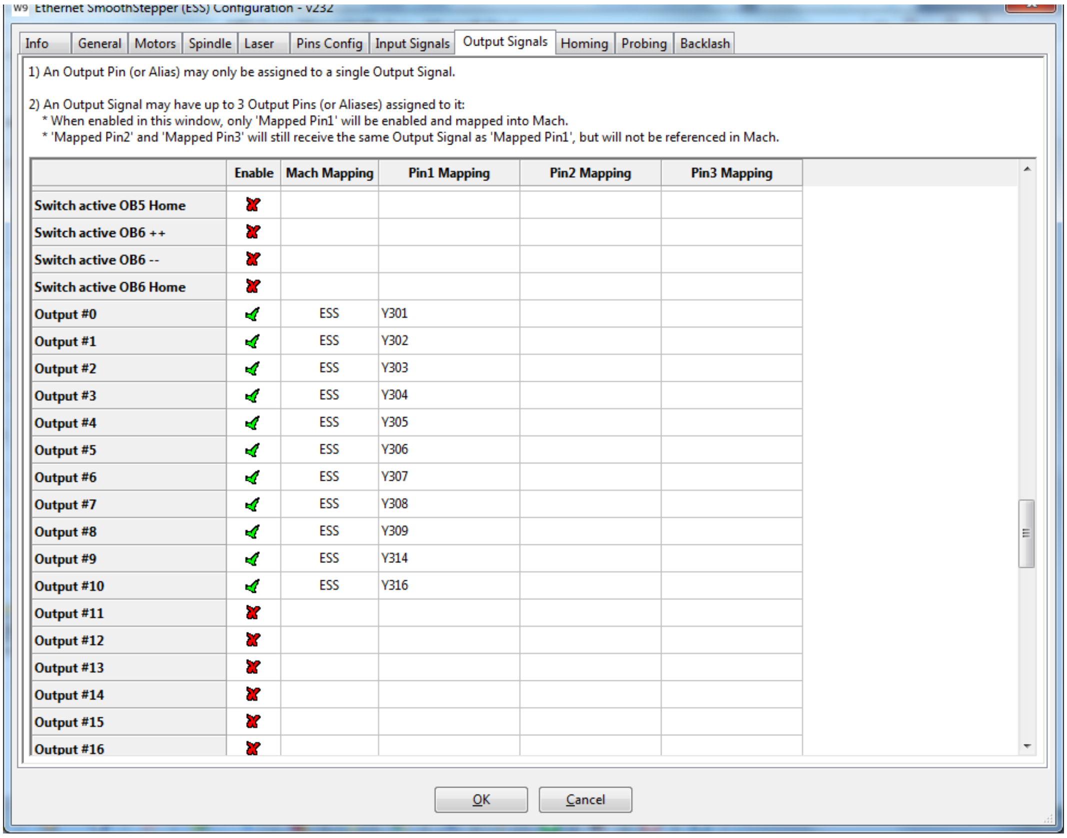


Figure 68, Output Signals Mapping (continue 2)

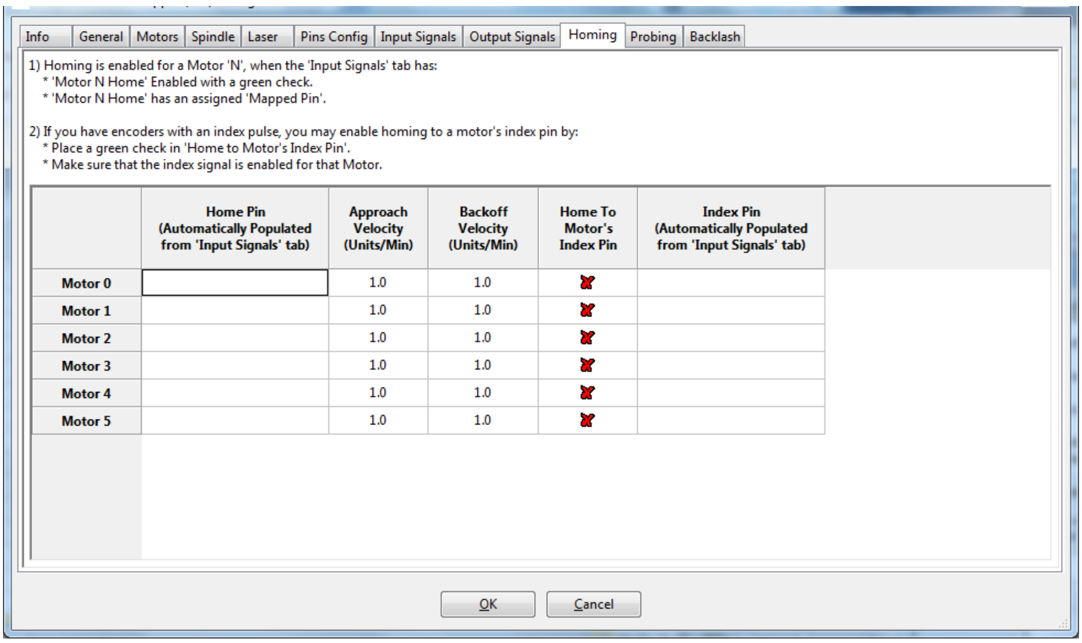


Figure 69, Homing, depends on the user's choice

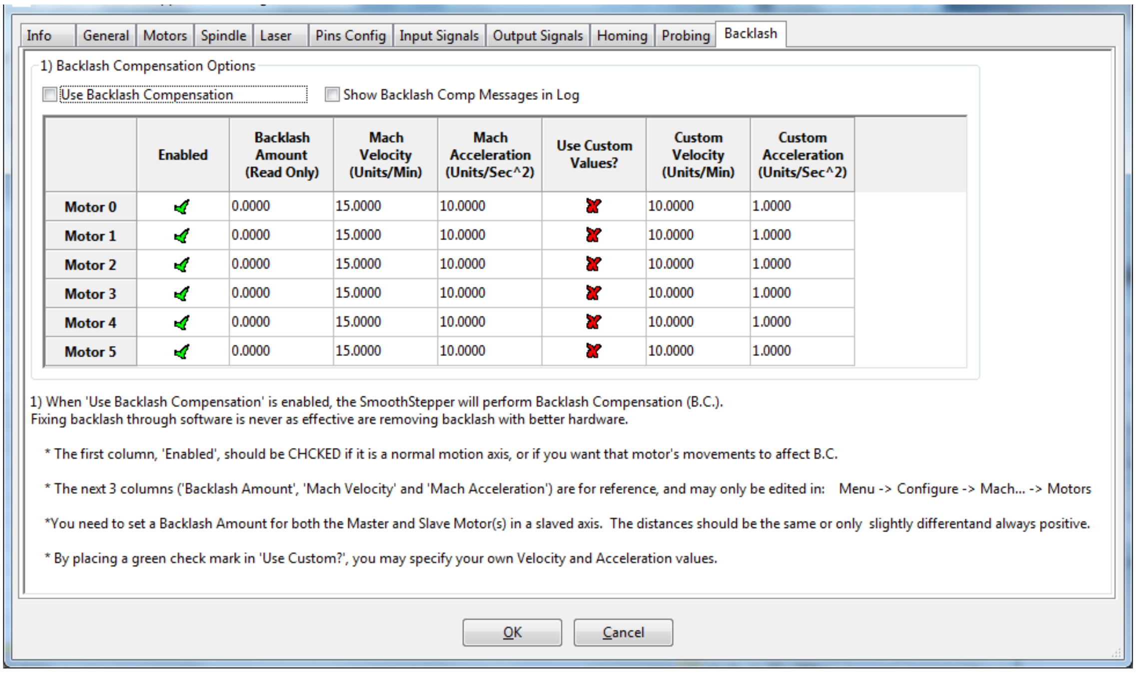


Figure 70, Backlash, all default value

Mach4 own configuration

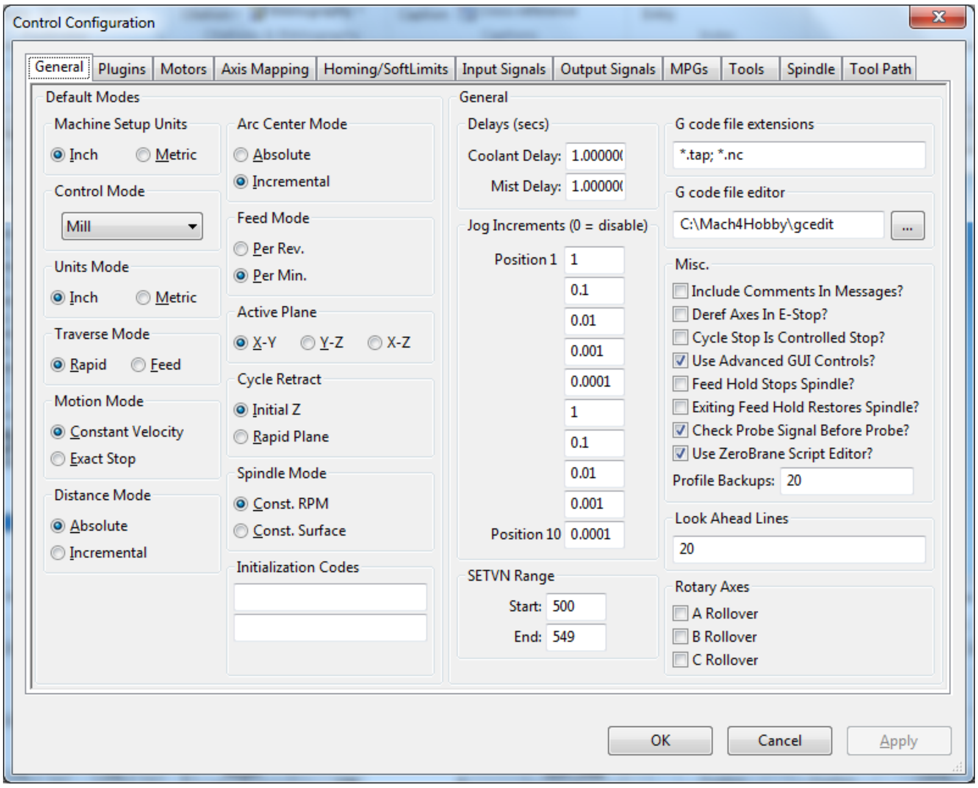


Figure 71, Mach4 General Configuration

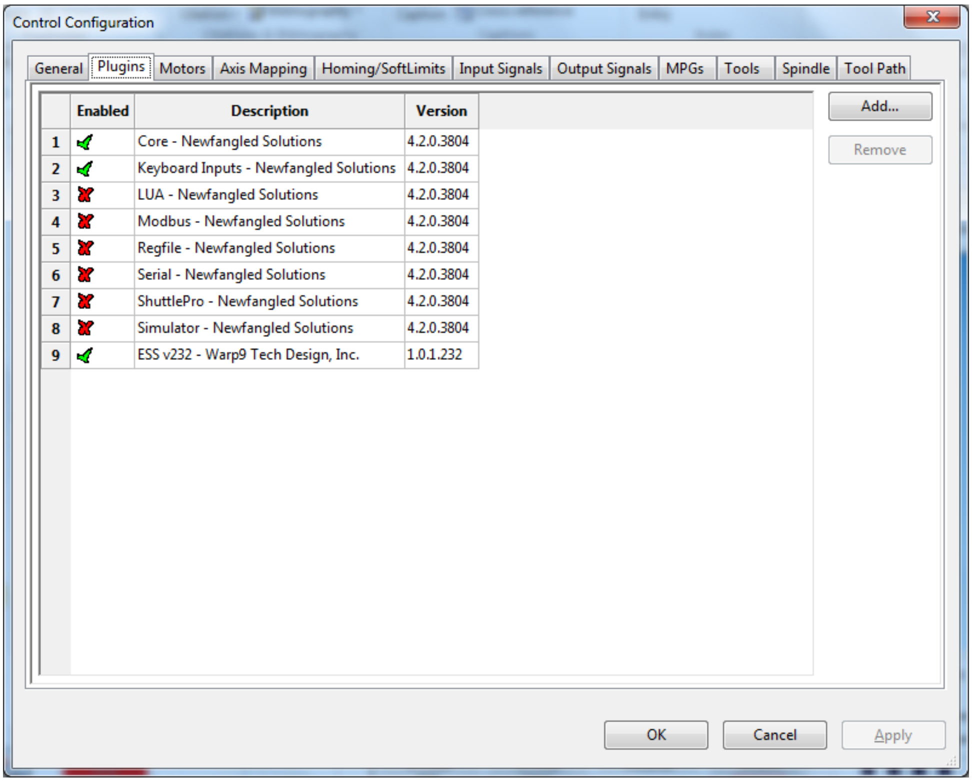


Figure 72, Mach4 Plugins enabled

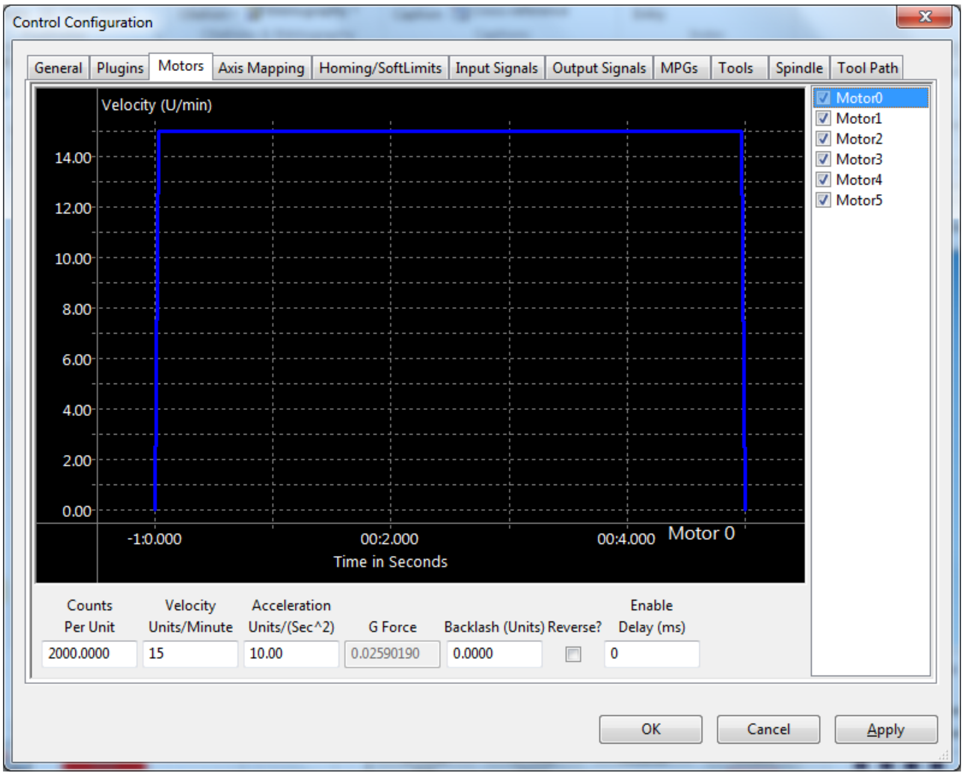
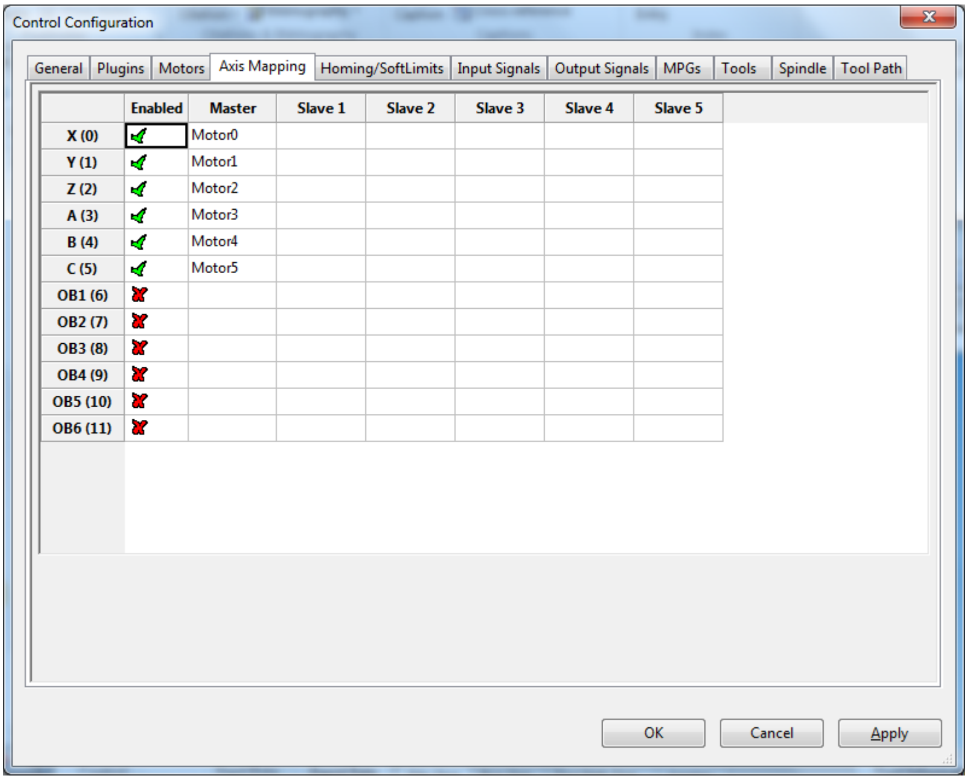
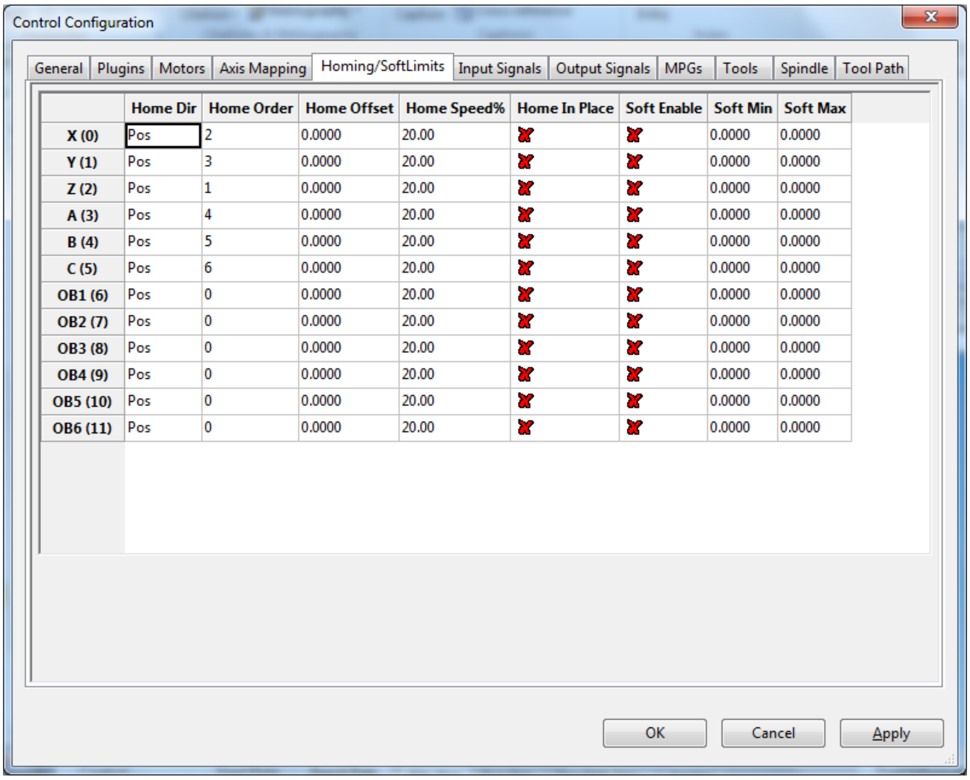


Figure 73, Mach4 Motors profiles



	Enabled	Master	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
X (0)	✓	Motor0					
Y (1)	✓	Motor1					
Z (2)	✓	Motor2					
A (3)	✓	Motor3					
B (4)	✓	Motor4					
C (5)	✓	Motor5					
OB1 (6)	✗						
OB2 (7)	✗						
OB3 (8)	✗						
OB4 (9)	✗						
OB5 (10)	✗						
OB6 (11)	✗						

Figure 74, Mach4 Axis Mapping



	Home Dir	Home Order	Home Offset	Home Speed%	Home In Place	Soft Enable	Soft Min	Soft Max
X (0)	Pos	2	0.0000	20.00	✗	✗	0.0000	0.0000
Y (1)	Pos	3	0.0000	20.00	✗	✗	0.0000	0.0000
Z (2)	Pos	1	0.0000	20.00	✗	✗	0.0000	0.0000
A (3)	Pos	4	0.0000	20.00	✗	✗	0.0000	0.0000
B (4)	Pos	5	0.0000	20.00	✗	✗	0.0000	0.0000
C (5)	Pos	6	0.0000	20.00	✗	✗	0.0000	0.0000
OB1 (6)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000
OB2 (7)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000
OB3 (8)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000
OB4 (9)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000
OB5 (10)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000
OB6 (11)	Pos	0	0.0000	20.00	✗	✗	0.0000	0.0000

Figure 75, Mach4 Homing and Soft Limits

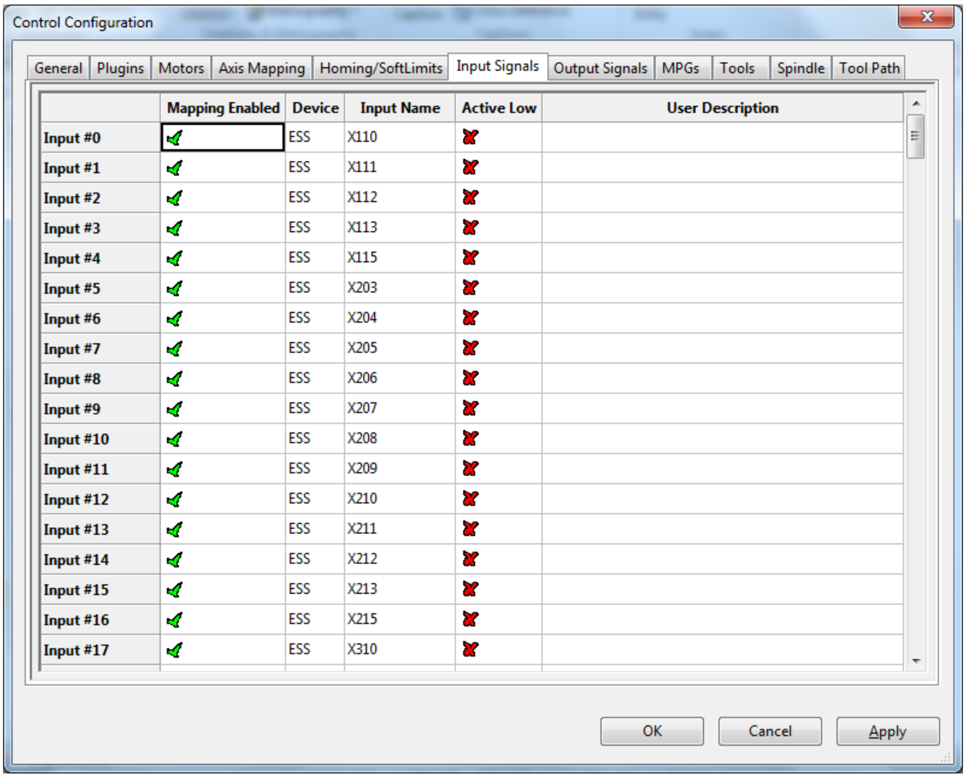
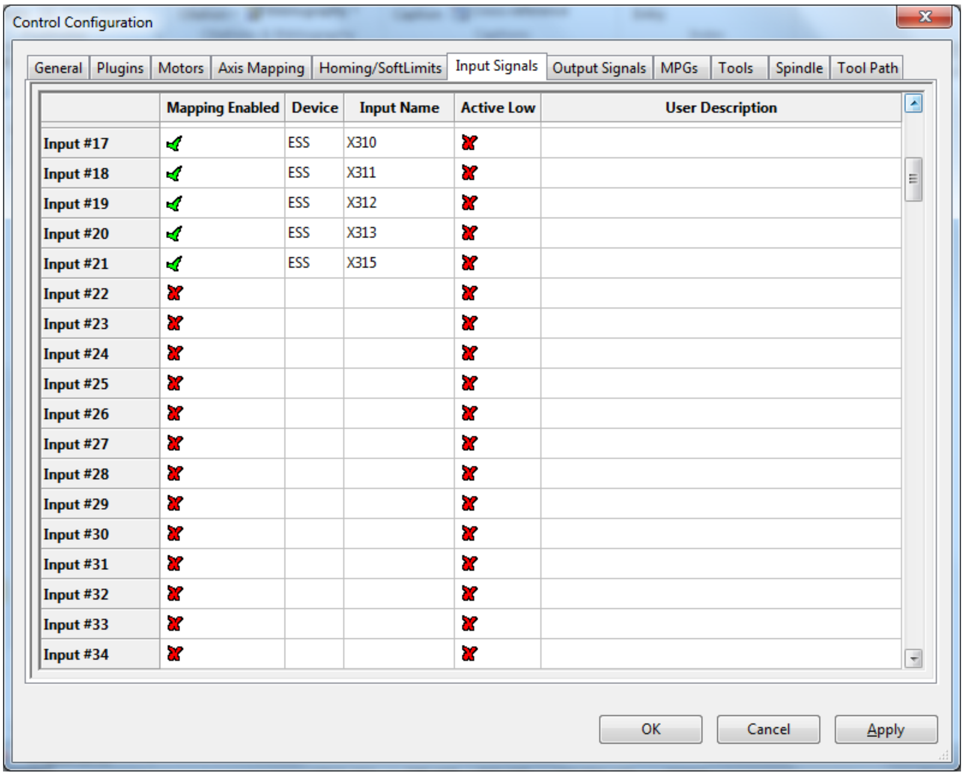
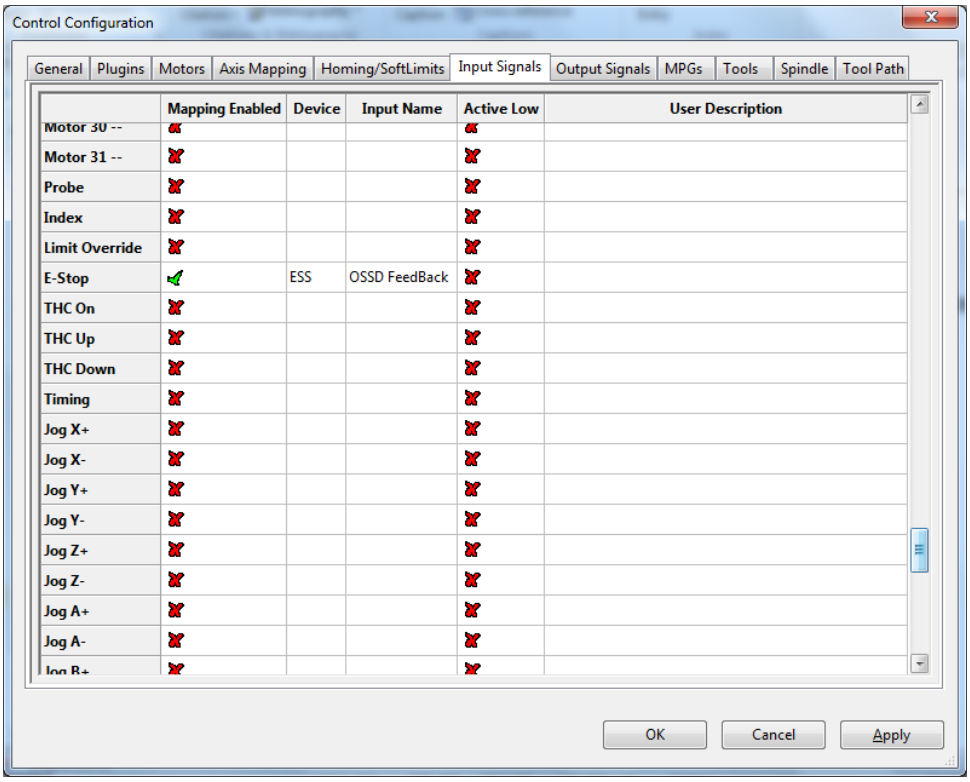


Figure 76, Mach4 Input Signals



	Mapping Enabled	Device	Input Name	Active Low	User Description
Input #17	✓	ESS	X310	✗	
Input #18	✓	ESS	X311	✗	
Input #19	✓	ESS	X312	✗	
Input #20	✓	ESS	X313	✗	
Input #21	✓	ESS	X315	✗	
Input #22	✗			✗	
Input #23	✗			✗	
Input #24	✗			✗	
Input #25	✗			✗	
Input #26	✗			✗	
Input #27	✗			✗	
Input #28	✗			✗	
Input #29	✗			✗	
Input #30	✗			✗	
Input #31	✗			✗	
Input #32	✗			✗	
Input #33	✗			✗	
Input #34	✗			✗	

Figure 77, Mach4 Input Signals (continue 1)



	Mapping Enabled	Device	Input Name	Active Low	User Description
Motor 30 --	✗			✗	
Motor 31 --	✗			✗	
Probe	✗			✗	
Index	✗			✗	
Limit Override	✗			✗	
E-Stop	✓	ESS	OSSD FeedBack	✗	
THC On	✗			✗	
THC Up	✗			✗	
THC Down	✗			✗	
Timing	✗			✗	
Jog X+	✗			✗	
Jog X-	✗			✗	
Jog Y+	✗			✗	
Jog Y-	✗			✗	
Jog Z+	✗			✗	
Jog Z-	✗			✗	
Jog A+	✗			✗	
Jog A-	✗			✗	
Jog B+	✗			✗	

Figure 78, Mach4 Input Signals (continue 2)

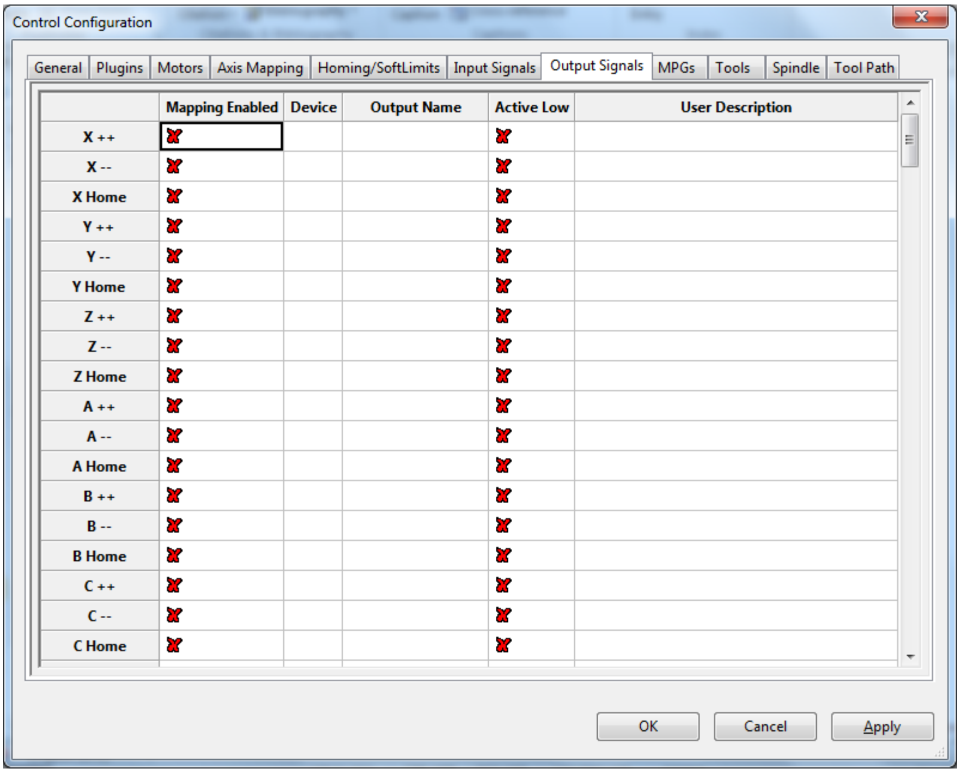


Figure 79, Mach4 Output Signals

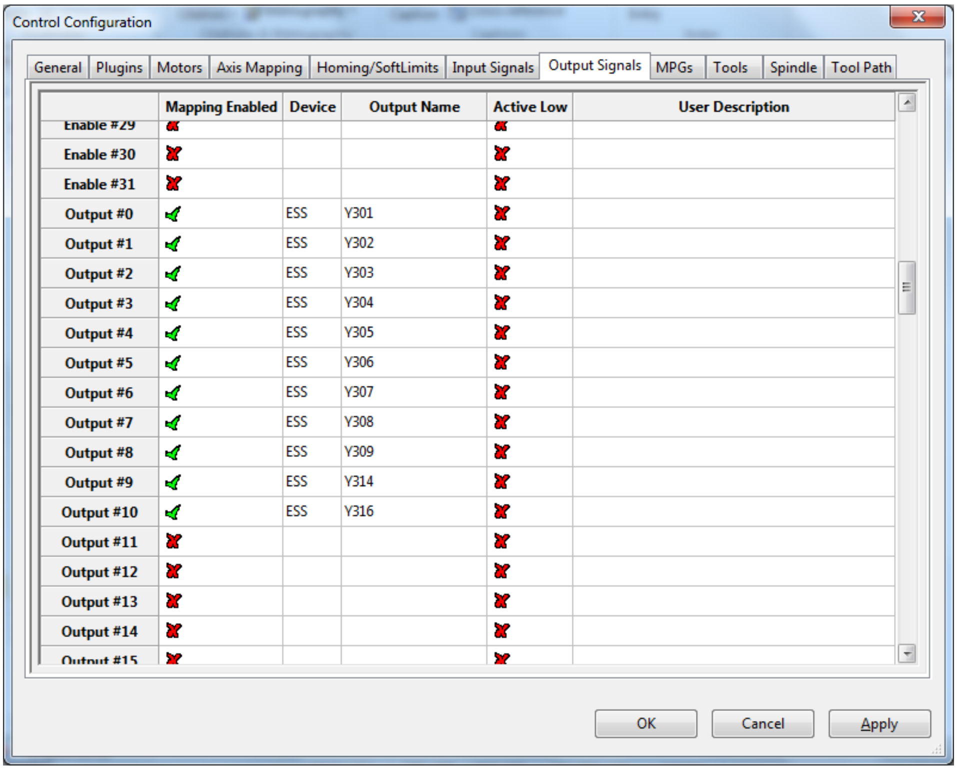


Figure 80, Mach4 Output Signals (continue 1)

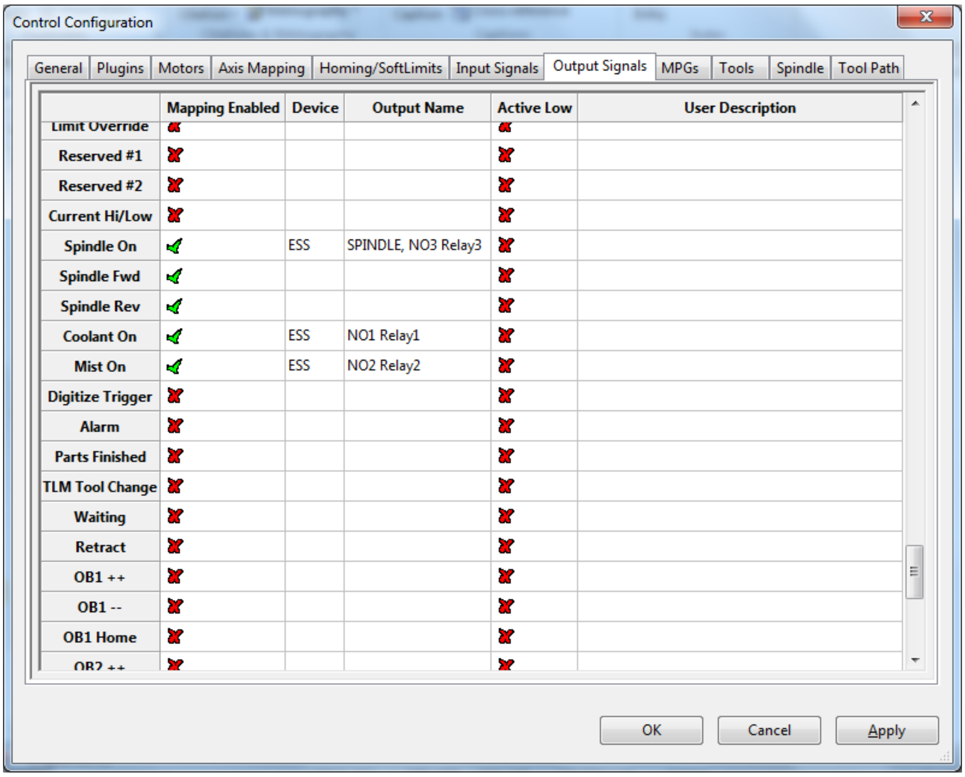


Figure 81, Mach4 Output Signals (continue 2)

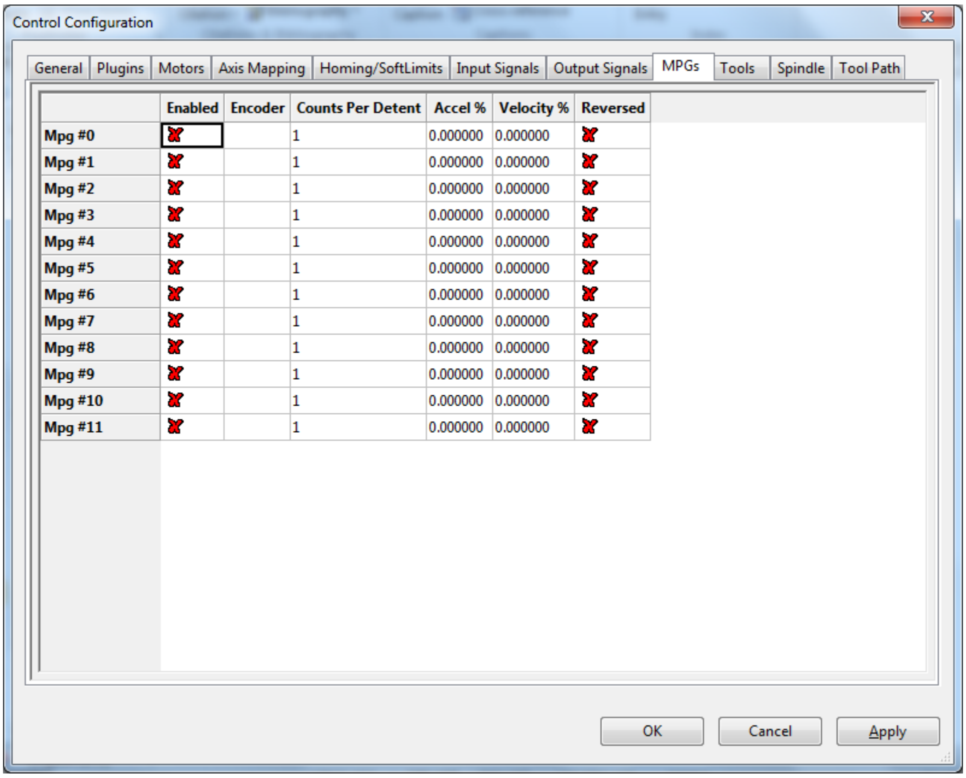


Figure 82, Mach4 MPGs

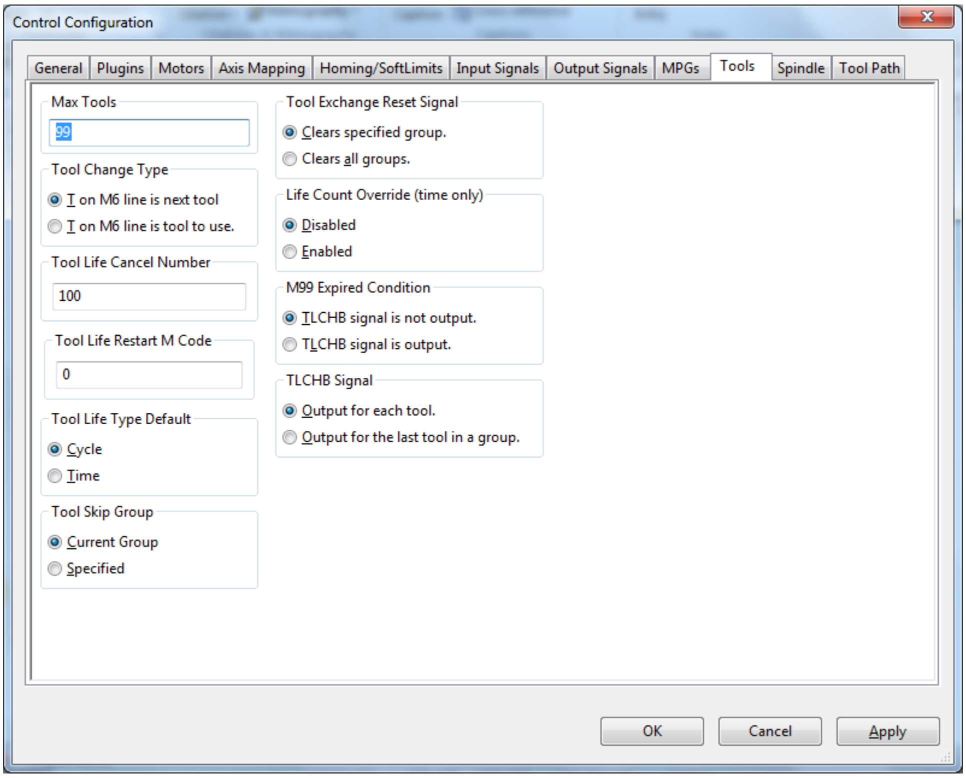


Figure 83, Tools

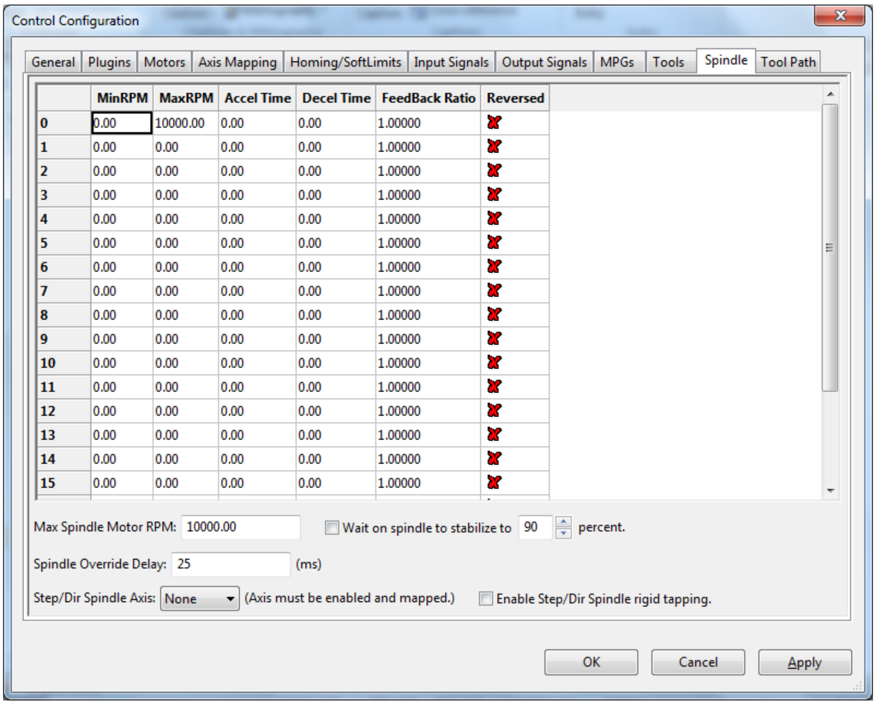


Figure 84, Mach4 Spindle

The value in MaxRPM column for each range or gear number 0-15 is referenced to 10V. In this case, 10000 RPM is preferred for analog output tuning. Since it reflects to 0-10V while we enter speed command in MDI such as S10000 for 10V, S6000 for 6V, S3500 for 3.5V. The below is formula for 0-10V.

Voltage = (Requested RPM / MaxRPM) * 10

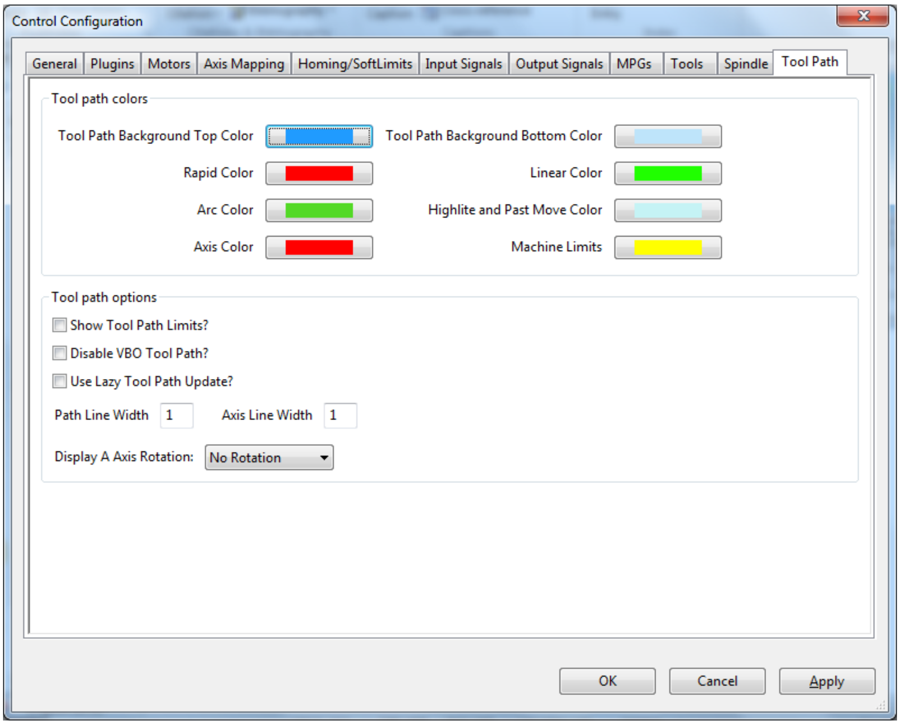


Figure 85, Mach4 Tool Path Colors

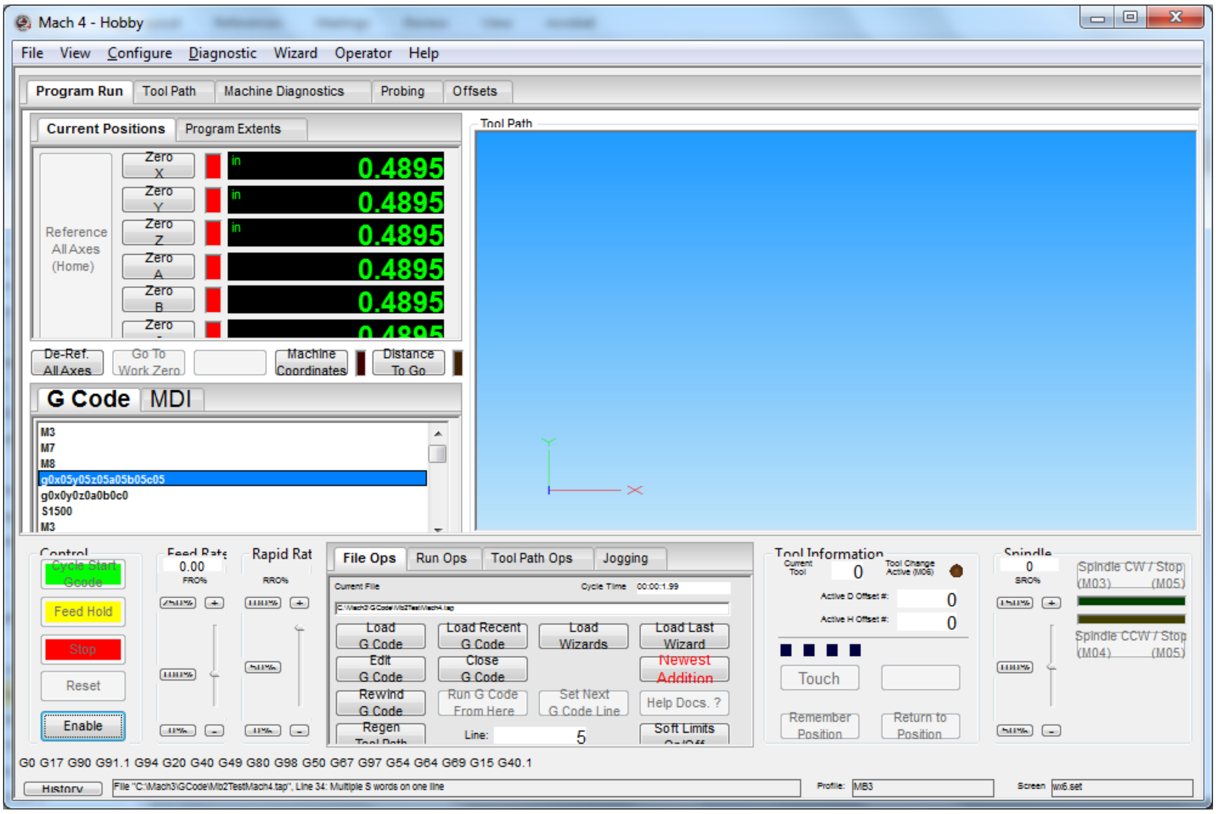
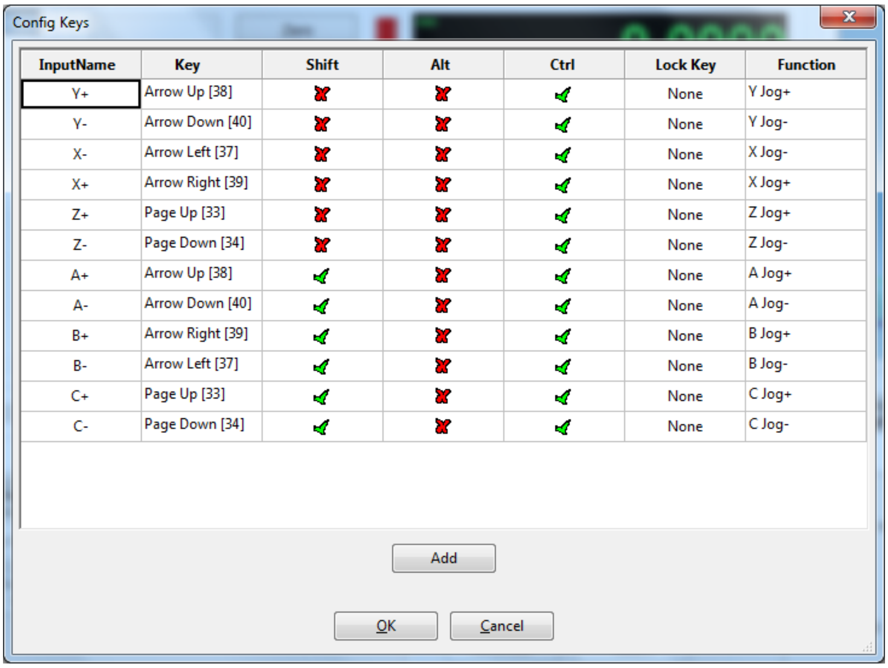


Figure 86, Mach4's first screen

Mach4 Keyboard config



InputName	Key	Shift	Alt	Ctrl	Lock Key	Function
Y+	Arrow Up [38]	✗	✗	✓	None	Y Jog+
Y-	Arrow Down [40]	✗	✗	✓	None	Y Jog-
X-	Arrow Left [37]	✗	✗	✓	None	X Jog-
X+	Arrow Right [39]	✗	✗	✓	None	X Jog+
Z+	Page Up [33]	✗	✗	✓	None	Z Jog+
Z-	Page Down [34]	✗	✗	✓	None	Z Jog-
A+	Arrow Up [38]	✓	✗	✓	None	A Jog+
A-	Arrow Down [40]	✓	✗	✓	None	A Jog-
B+	Arrow Right [39]	✓	✗	✓	None	B Jog+
B-	Arrow Left [37]	✓	✗	✓	None	B Jog-
C+	Page Up [33]	✓	✗	✓	None	C Jog+
C-	Page Down [34]	✓	✗	✓	None	C Jog-

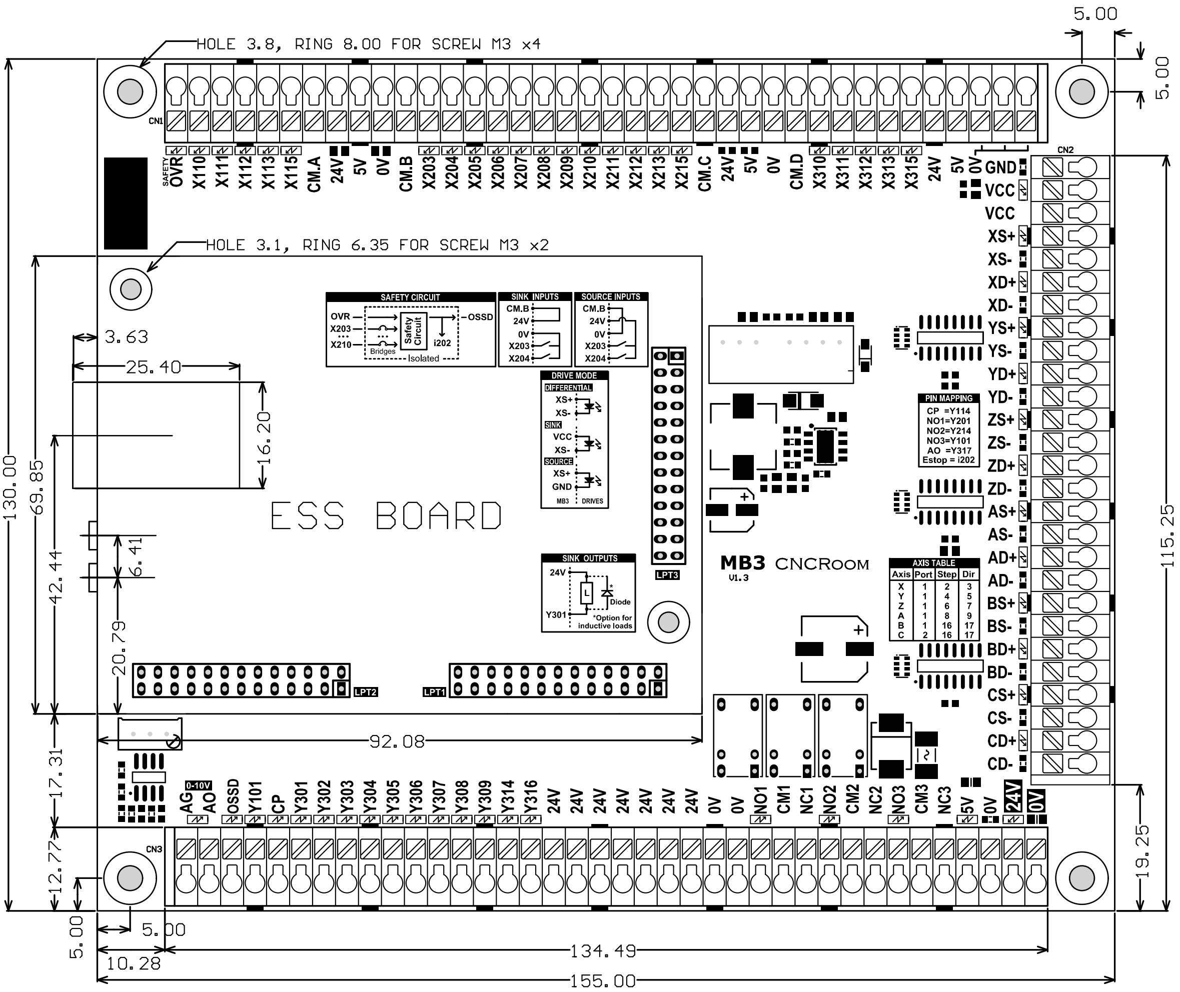
Figure 87, Mach4 Keyboard Mapping

Appendix I MB3 Specifications

Dimensions	130 x 155 mm (height x width)
Supply voltage	24V (18-28Vdc), 500mA
Supply voltage ripple	≤ 5%
Transistor Outputs Yxxx	NPN, Sink 5-24Vdc, 70mA Max
Relay contact ON1, ON2, ON3	0.5A 120Vac, 1A 24Vdc
Analog output AO	0-10V (Error ±1.2% between 1-10V)*
Inputs type	NPN/PNP
Inputs voltage level	5/24Vdc
Inputs response X1xx, X2xx	14.37khz / 69.58us / 862,200 index rpm*
Inputs response X3xx	28.5khz / 35.08us / 1,710,000 index rpm*
Ambient operating temperature	0-40°C

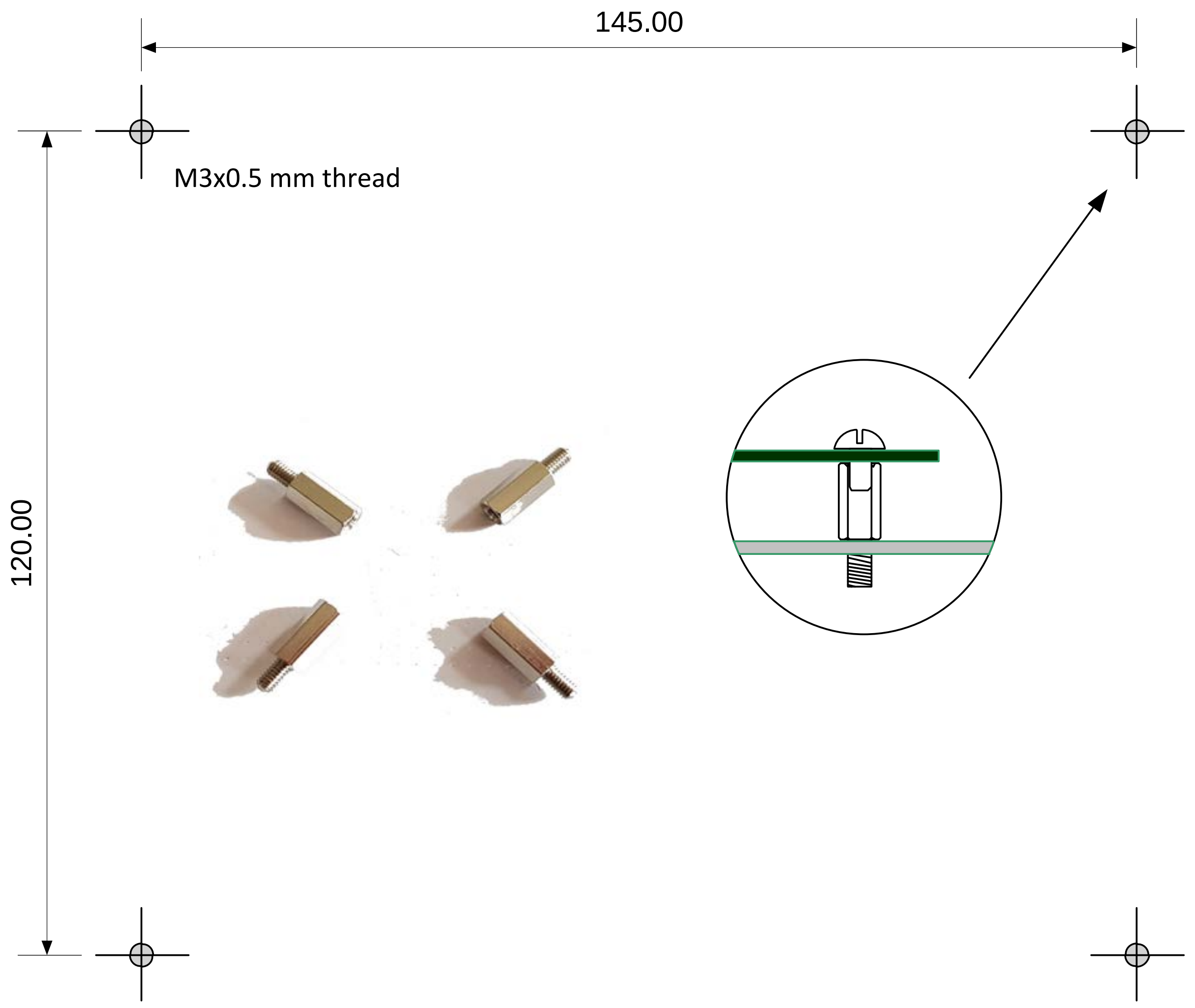
*Tested on Mach4

Appendix II MB3 Board Dimensions



Unit is mm.

Standoffs installation on back panel


145.00
120.00
M3x0.5 mm thread

Appendix III Safety circuit options

The circuits shown below are only examples and adhere to no particular country's safety standard. Please always seek professional advice from a qualified electrician or electrical engineer in your country of residence before implementing any circuit that is presented in this manual. CNCRoom cannot be held responsible for any adverse outcome, which came about as a result of copying anything from this manual.

Safety Circuit 1

Safety circuit 1 is simple but effective. It has fewer components and less wiring and relies mainly on good and consistent function of the computer and electronic components to disengage the drive's power through a "servo on" signal or similar.

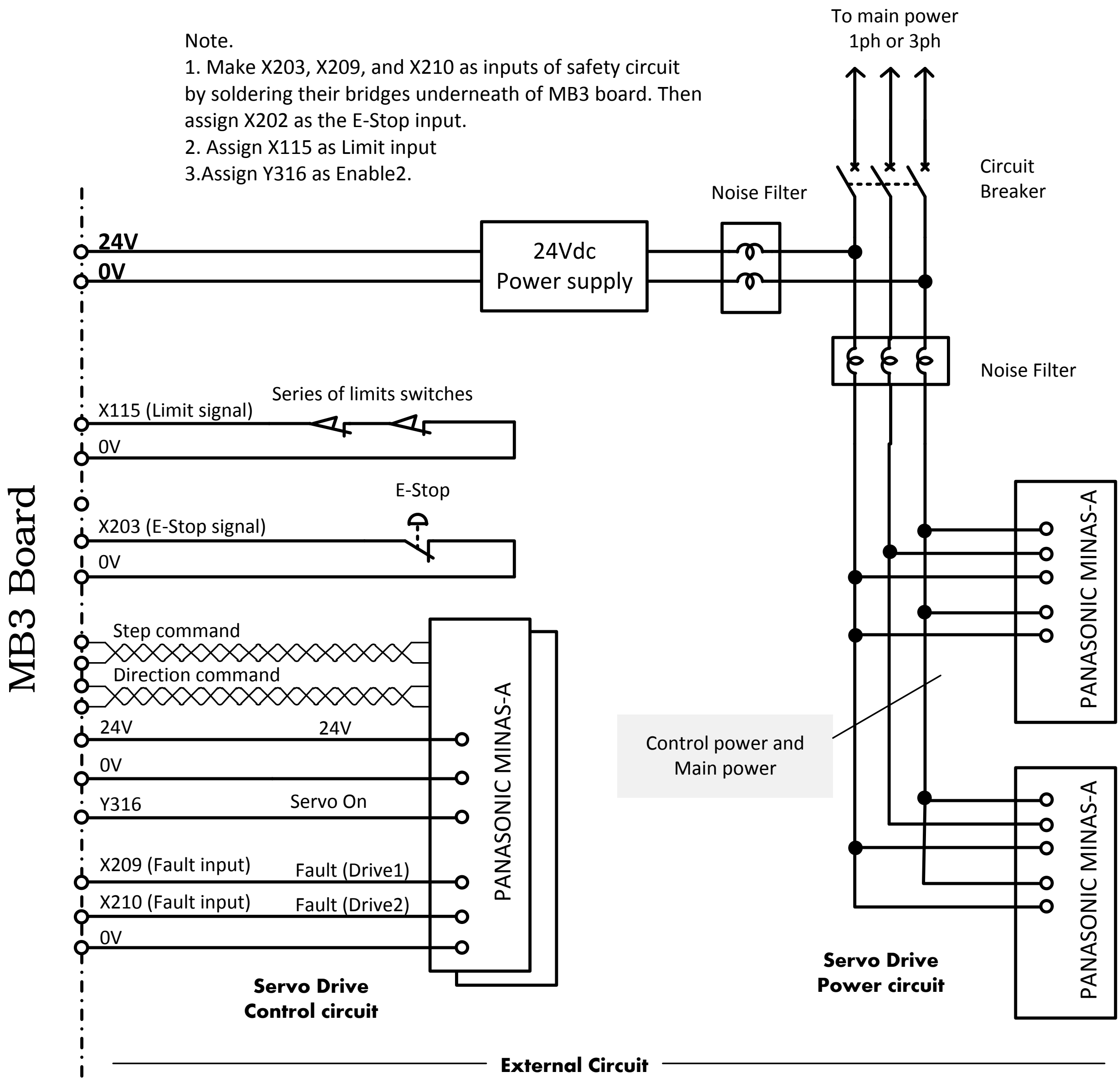


Figure 88, Safety Circuit 1

Safety Circuit 2

Safety circuit 2 is more for the user who prefers not to rely on electronics for safety and would prefer the option of disengaging power from the drives or hazardous devices by the use of unintelligent components, such as limit switches, the Estop button or a magnetic contactor.

In a situation where a motor runs out of control, being caused either by electromagnetic interference or even human error, a well-designed system should be able to halt the machine by the use of limit switches alone or by hitting the Estop button.

However, in normal circumstance, the MB3 with an external circuit and connection to a computer should work well together. In some drive connections you may need to implement the use of timer relays to handle an "Under Voltage" error.

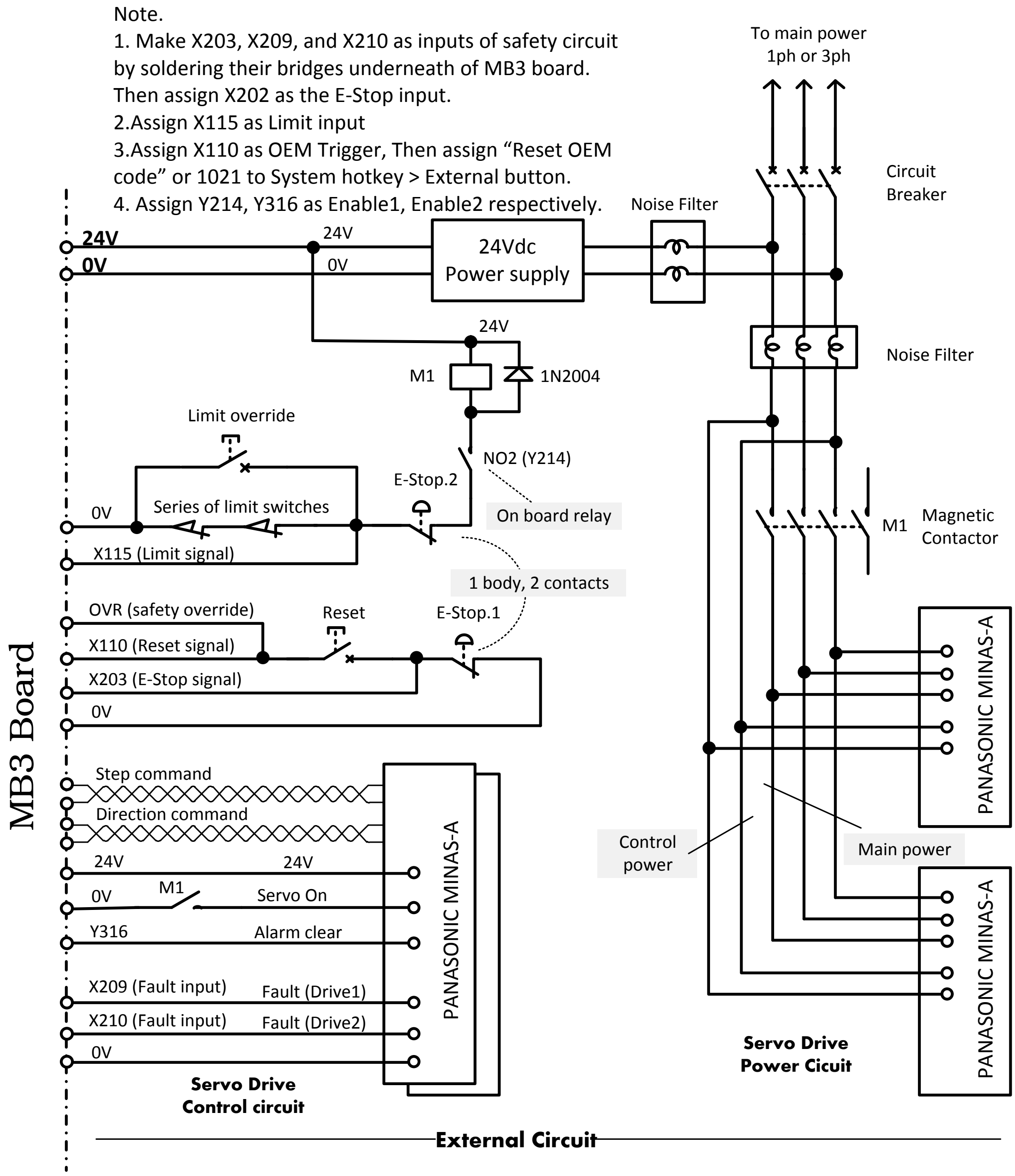


Figure 89, Safety Circuit 2

Safety Circuit 3

Since the MB3 board supports an “Off-Delay” function for relay K1 and K2, it allows the user to create a timing sequence for devices that need to power up or power down independently at different times.

In this circuit an AC line monitor for recognising a “Power-Out” or “Black-Out” condition has also been introduced. This circuit will halt the machine in an orderly fashion before it loses power completely. A UPS is needed to power AC drives for few seconds after the power has failed. For DC drives a lower cost, slow charging capacitor is all that is necessary.

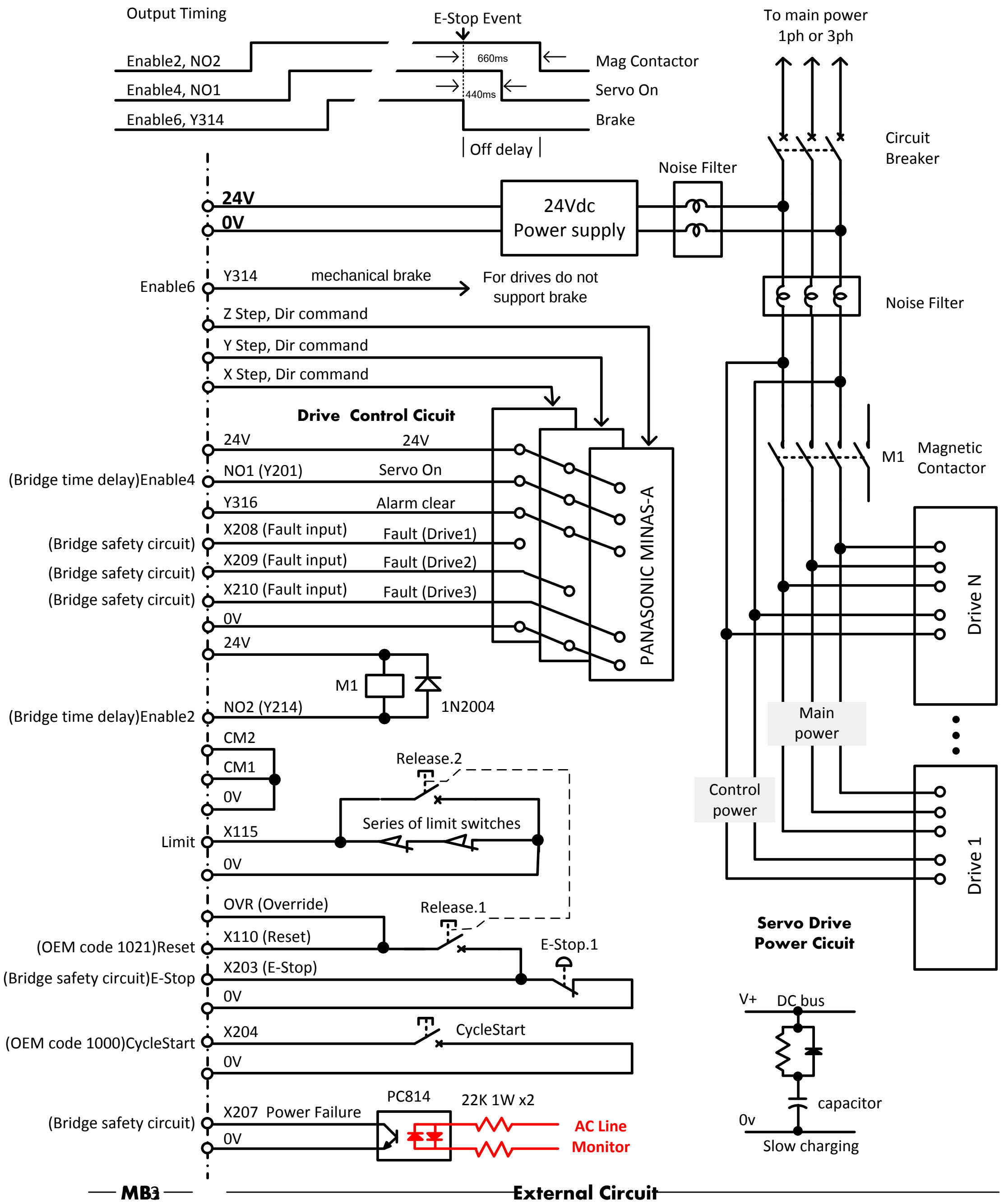


Figure 90, Safety Circuit 3

Appendix IV Figure and Table references

Figures

Figure Number Page
Number

Table

Document Revision Log

Doc E20R2: reported by Christophe LE DU (19/06/21) where CM.A should be CM.B in figure 11.