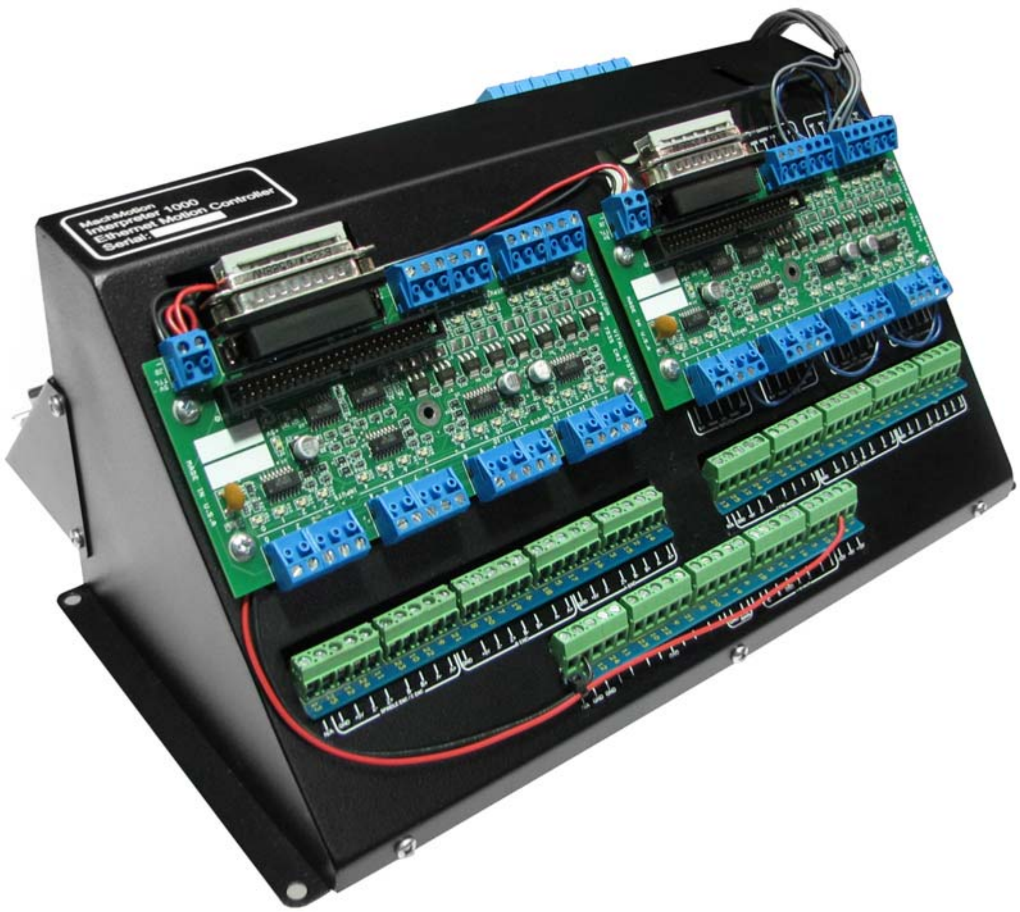
Interpreter 1000

User Guide



Version 2.15
(Updated 06/26/2009)

Newburg, MO USA

For more information please visit the product web page: www.machmotion.com

Contents

1. Overview

1.1 Introduction

The Interpreter 1000 is an Ethernet based controller for motion control, data acquisition, and general PID control system applications. Utilizing the latest Digital Signal Processing (DSP) technology, the Interpreter 1000 offers the highest performance in its class.

Interpreter 1000 board is the perfect solution for a variety of applications involving PC based Motion Control, Storage and Retrieval Systems and Milling / Lathe CNC Machines. Equipped with a rich set of hardware interfaces, it can also be used for wide variety of applications involving PID control, e.g., speed, oven temperature control and so on.

Interpreter 1000 comes with 48 digital I/Os, 8 channel analog inputs of 14-bit resolution, 6 encoder inputs of 32-bit resolution, and 8 channel analog output of 14-bit resolution with +/-10V range. The board has a wide input power supply range, from 10V to 40V DC. It has a RS-232 serial port and TCP/IP based 10/100 Ethernet connectivity.

Interpreter 1000 board comes with GUI software tools to test the hardware, setup PID controller, run motion control commands, and upgrade new firmware. The following gives a brief description of the software tool set:

- Interpreter 1000 AxisWorks – A GUI based software tool to exercise the user's hardware installation. After configuring the I/Os and PID settings, this program can be used to execute motion related commands to verify the installation is setup properly.

- Interpreter 1000 Firmware Upgrade – A GUI based software tool to update the program stored on the Interpreter. New versions of this program can be obtained from MachMotion.

- Windows driver DLLs

Extremely Important Reminder

When operating machines, take extreme precautions. The machines can have enormous power even with a small motor. Never come inside a machine path while powered. Operating machines without necessary precautions can result in lost of limbs or even death.

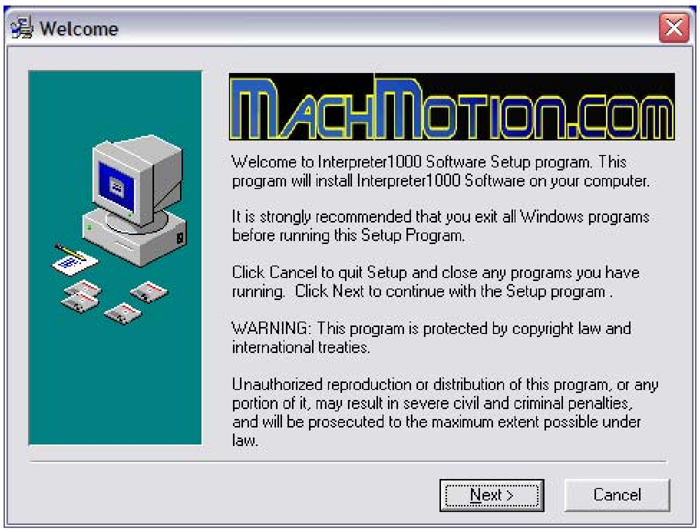
2. Software setup

2.1 Installing the software tools

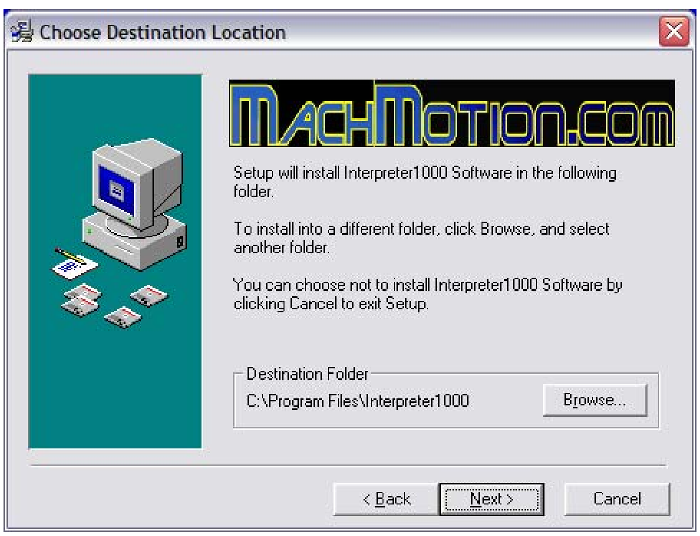
Following are the steps to download and install the setup program.

Download the setup software from http://www.machmotion.com, then click on the link Setup Software. Save the Interpreter_1000 zip file to an appropriate directory. Unzip this file and double click on the setup.exe file.

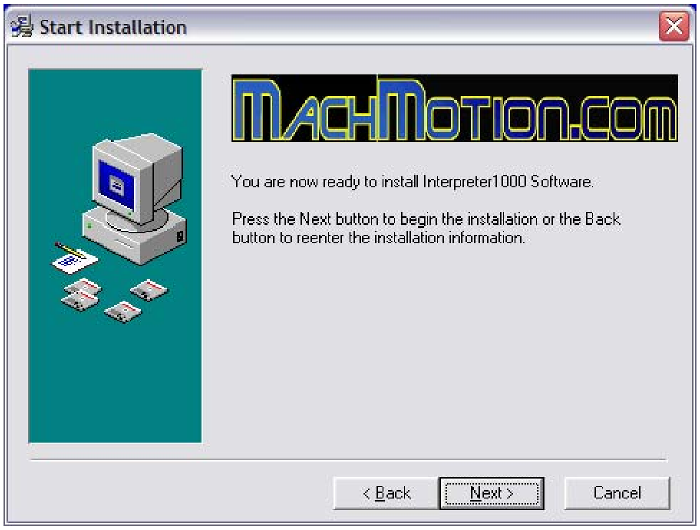
The following Welcome screen appears. Click on next button.

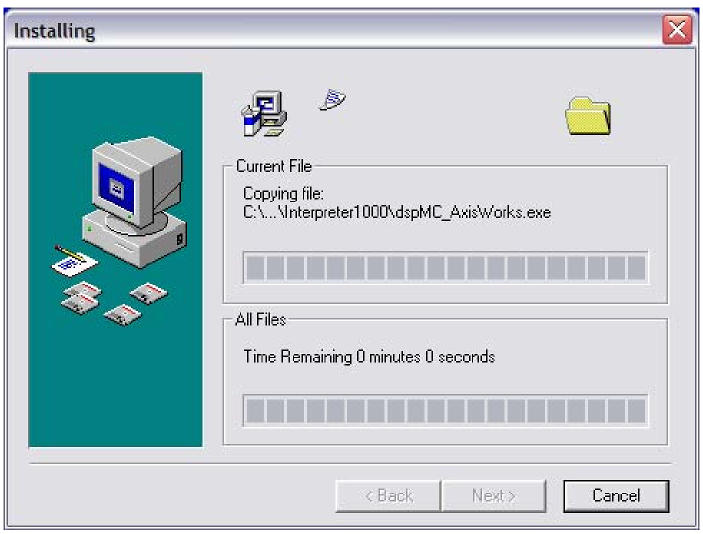


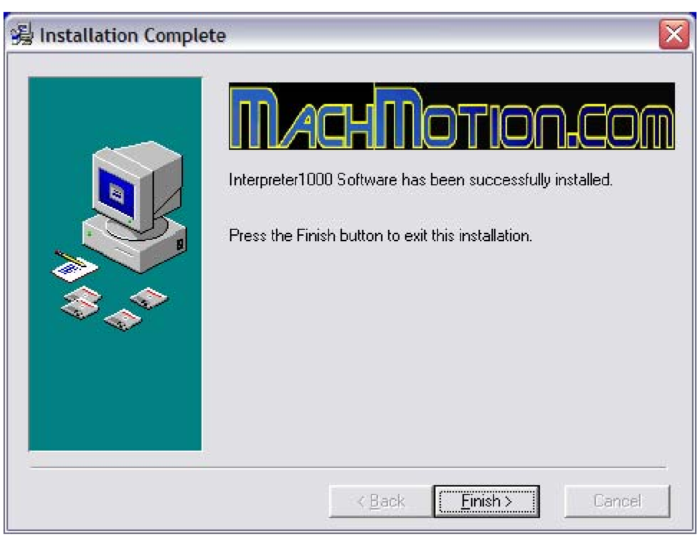
Select the destination of the programs to be installed.



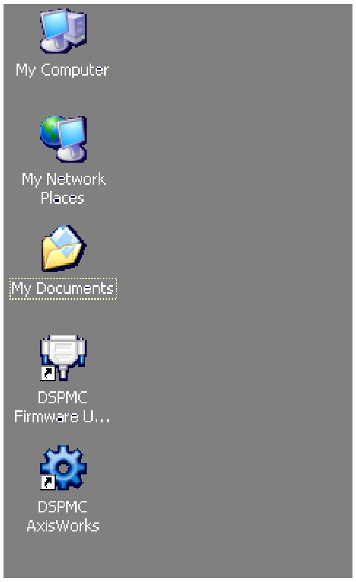
Click on the Next Button to start the installation.


Start Installation
MACHMOTION.COM
You are now ready to install Interpreter1000 Software.
Press the Next button to begin the installation or the Back button to reenter the installation information.
< Back
Next >
Cancel


Installing
Current File
Copying file:
C:\...\Interpreter1000\dspMC_AxisWorks.exe
All Files
Time Remaining 0 minutes 0 seconds
< Back
Next >
Cancel


Installation Complete
MACHMOTION.COM
Interpreter1000 Software has been successfully installed.
Press the Finish button to exit this installation.
< Back
Finish >
Cancel

The installation is complete if you see the above window. Click on ‘Finish’ to exit the setup program. This installation creates two shortcut icons on the desktop, one for the AxisWorks testing program and the other for Firmware upgrade software.



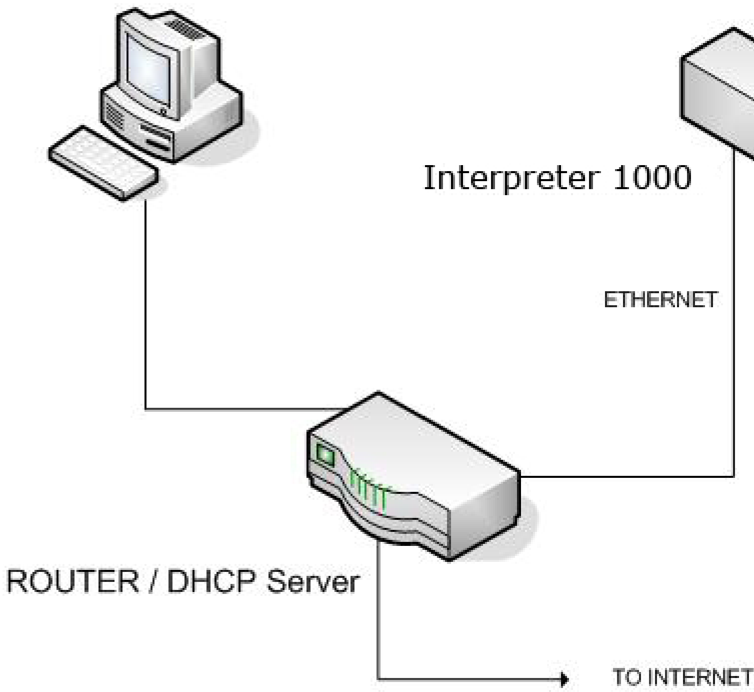
3. Network Connection Setup

You can connect the Interpreter 1000 directly to your PC or connect via an ethernet switch or router. The Interpreter 1000 can use the firmware pre-assigned IP address, ie, 192.168.0.50, or it can get a unique IP address from an external DHCP server on your network. In the latter case, the firmware pre-assigned IP address is ignored.

There are two ways to setup the IP addresses of your PC and the Interpreter 1000.

1. Using a Router with DHCP Server
2. Manually assigning an IP Address to your PC

3.1 Setup IP address using a Router with DHCP Server

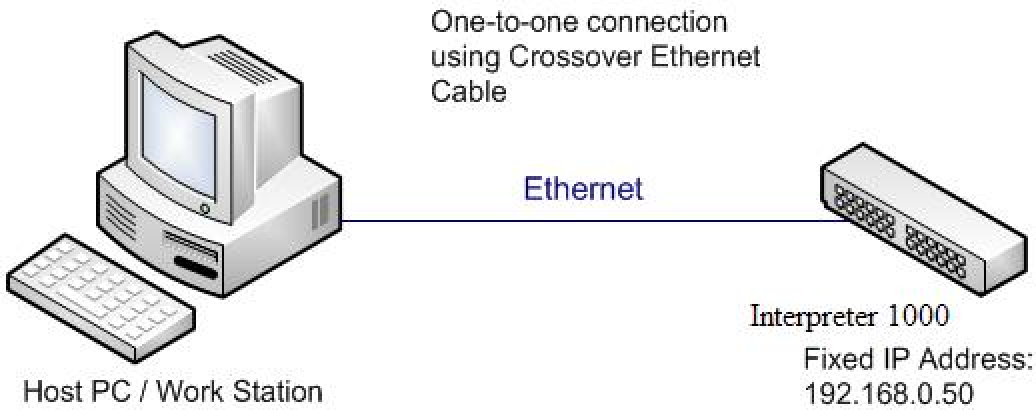


The figure above shows a basic setup using a router on your network. Connect the Ethernet cable from the Ethernet port on the Interpreter 1000 to the DHCP server/Router. Connect another Ethernet cable from the DHCP Server/Router to the PC. The DHCP server dynamically assigns IP address both to the PC as well as to the Interpreter 1000, and therefore completes the network setup without requiring any intervention from the user.

3.2 Manually assigning an IP Address to the PC

When connecting the PC directly to the Interpreter 1000 board, you will need to manually assign an IP address to your PC. The Interpreter 1000 board will use its firmware pre-assigned IP address, i.e., 192.168.0.50, so there is no need to reassign IP address to the board.

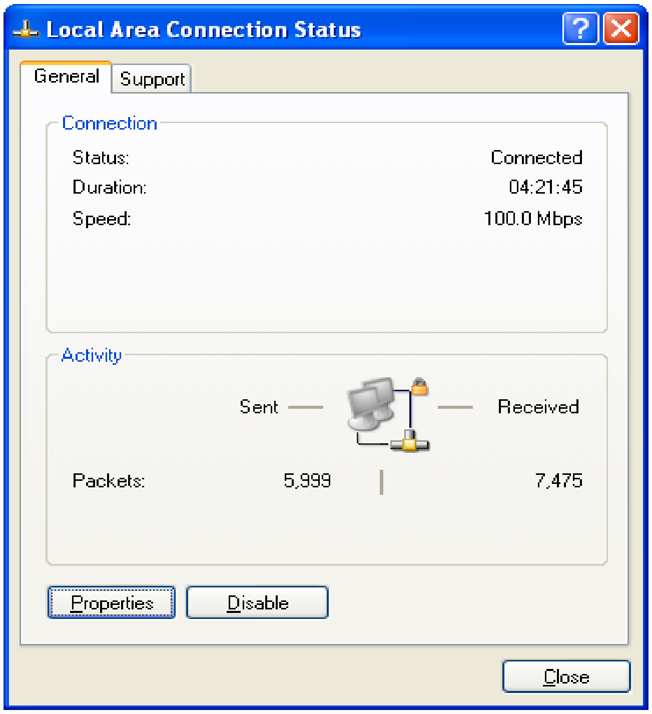
The Ethernet cable is connected to the ethernet port of the Interpreter 1000 board to the PC as shown below:



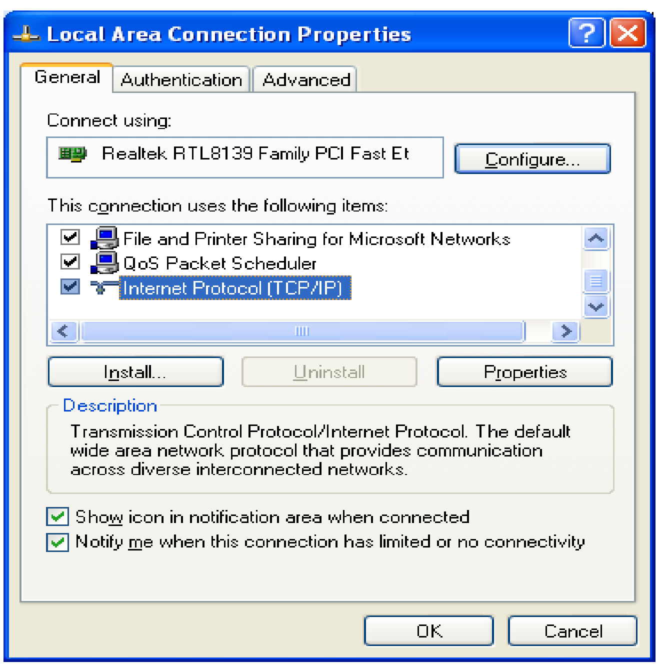
Note: If your network card has auto detection, a crossover cable may not be necessary.
This setup works best when you are using the Interpreter 1000 to control a machine tool. It requires less hardware and wiring.

The PC IP Address can be configured manually in windows XP as follows. For other operating systems, please consult the respective user guides for changing the IP address.

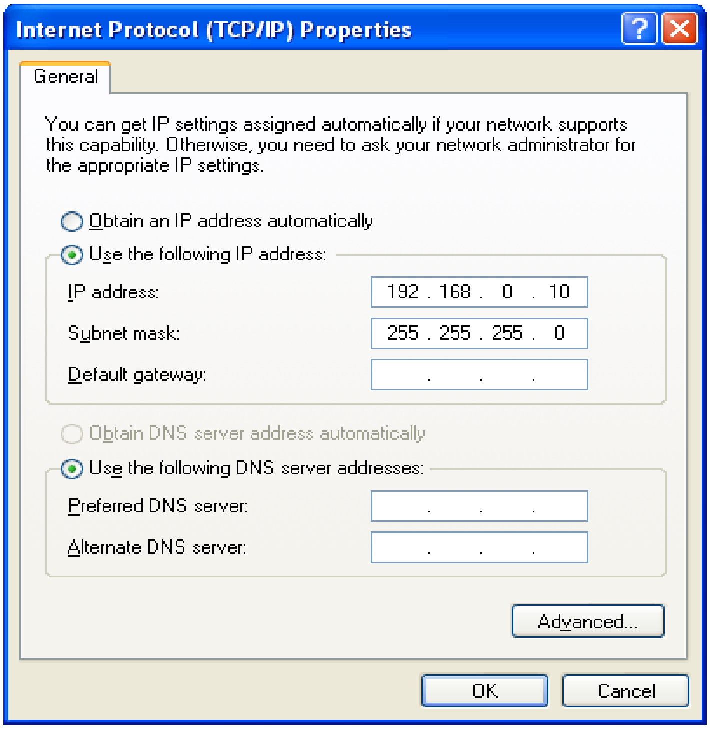
1. Open Windows **Start** menu.
2. Open **Control Panel**.
3. Classic view: Open **Network Connections**
   Category view: Select **Network and Internet Connections**, and then **Network Connections**.
4. Double-click on your active **LAN or Internet connection**.



3. Click on the **Properties** and select the **Internet Protocol (TCP/IP)** Connection in '**General'** Tab

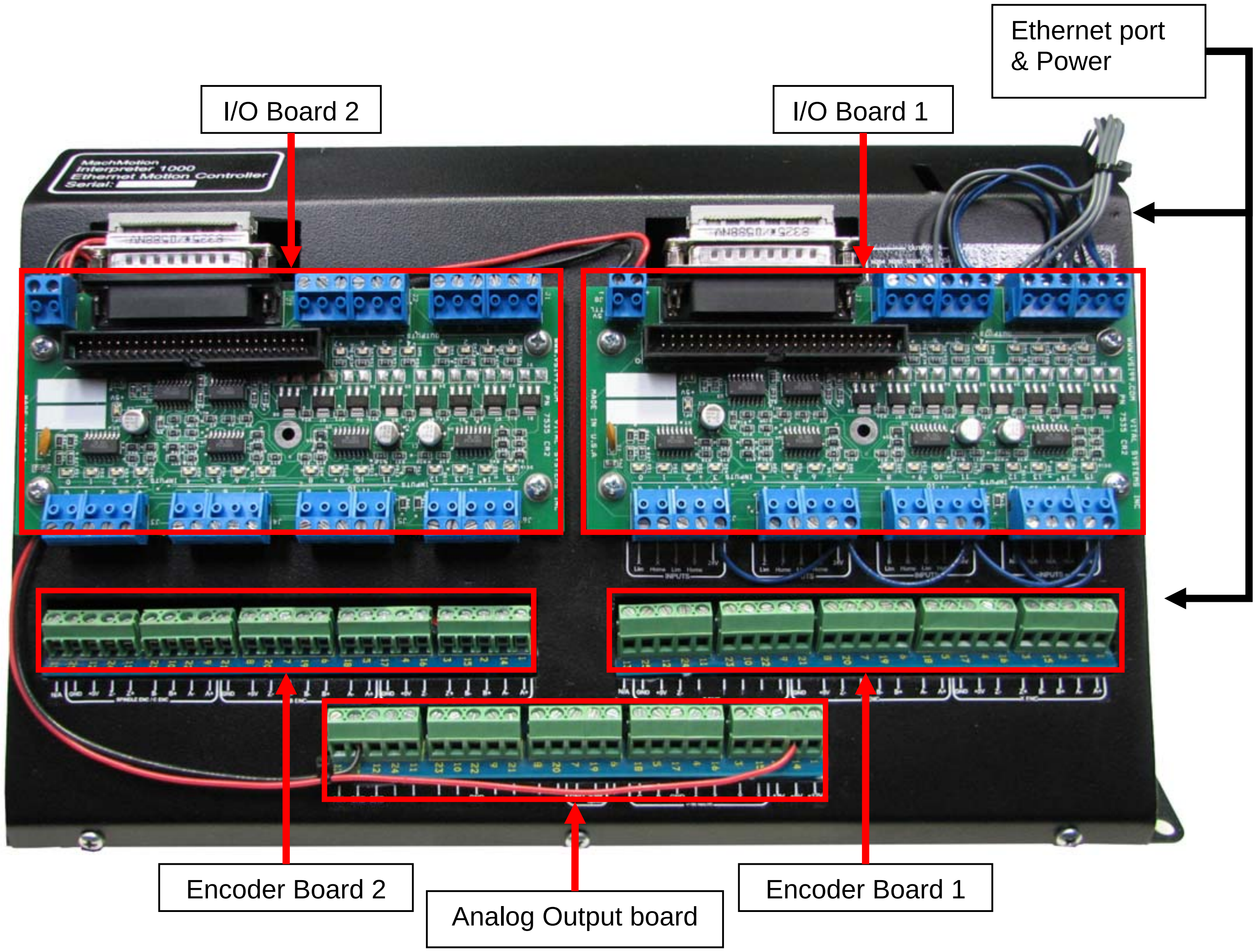


5. Click on the '**Properties**' button and make the settings in your PC similar to the one shown in the figure below.



6. Click **OK** to close each window.
7. Restart your computer.

4. Hardware Interface description



- Ethernet & Power port.
- I/O Board 1 - Digital I/Os, provides 16 inputs (from 0 to 15) and 8 outputs (from 0-7)
- I/O Board 2 - Digital I/Os, provides 16 inputs (from 16 to 31) and 8 outputs (from 8-15)
- Encoder Board 1 - Encoder inputs (for Encoders X, Y and Z).
- Encoder Board 2 - Encoder inputs (for Encoders A, B and C)
- Analog Output Board – Provides DAC output

4.1 Ethernet

Connect to PC directly or via an Ethernet Hub or a switch. The Interpreter 1000 supports 10 MBit and 100 Mbit network speeds. TCP/IP network protocol in UDP mode is used for PC communications.

4.2 Power Port

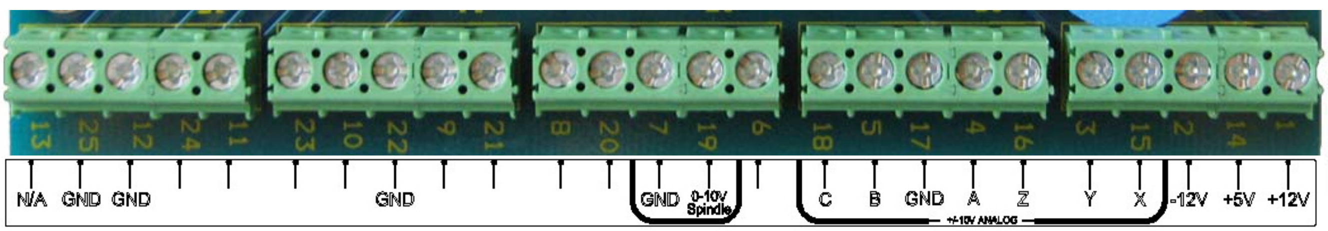
Use a standard PC power cord and connect to 115VAC.

4.3 Analog Output board

All analog outputs for the Analog output board are predefined in Mach3. To activate an Axis in Mach3 go to Config\Ports and Pins\ Motor Outputs tab.

- Analog Output range: +/-10 Volts.
- Analog Output Resolution: 14 Bits
- Maximum Output Current Per Output: 20mA

Analog Output Board Pin Assignments:



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

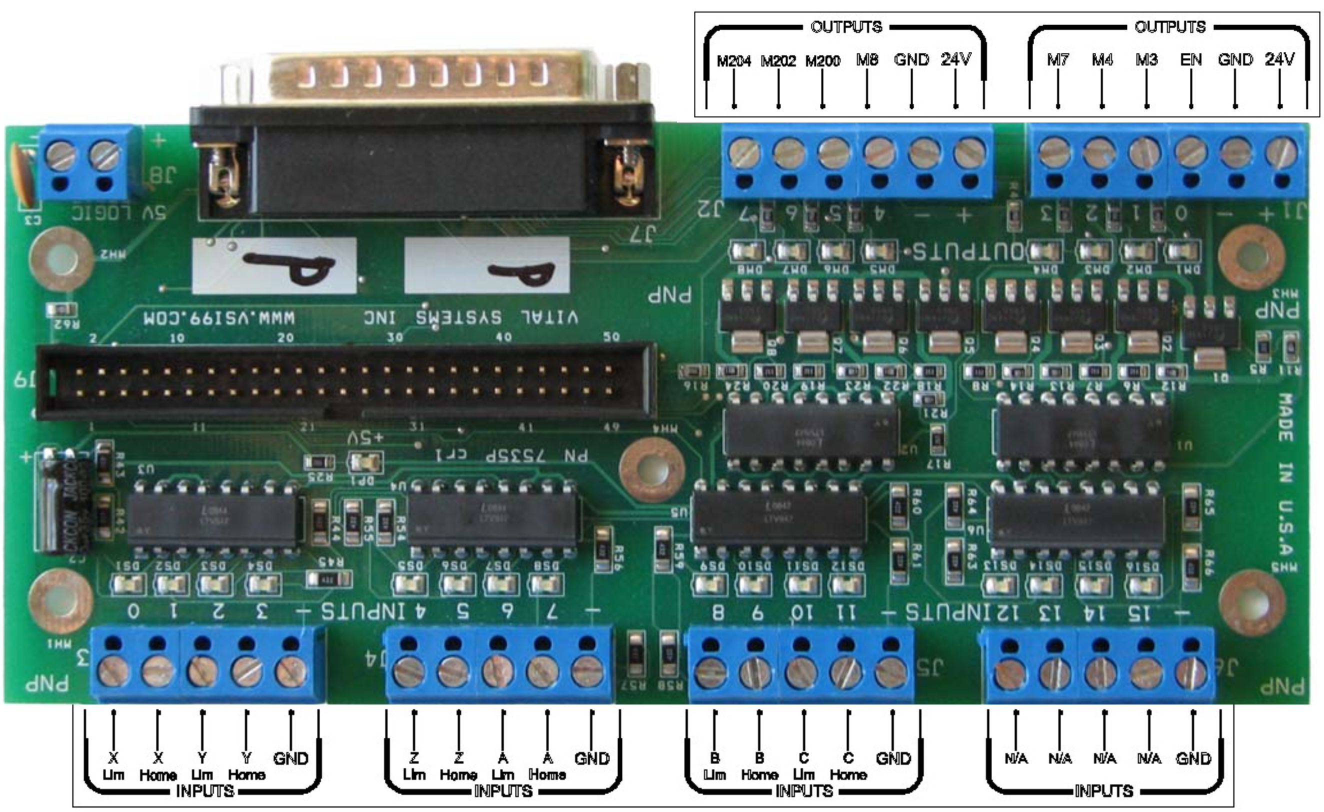
4.4 - I/O Board 1& I/O Board 2

On the Interpreter 1000, there are two Digital I/O boards, providing total of 32 digital inputs and 16 digital outputs. We define the I/O on I/O Board 1 so that it works in Mach3 without any extra setup. For I/O Board 2 the user can define any extra I/O needed and must set it up in Mach3. **The port address in Mach3 for I/O board 1 & 2 is Port 1**

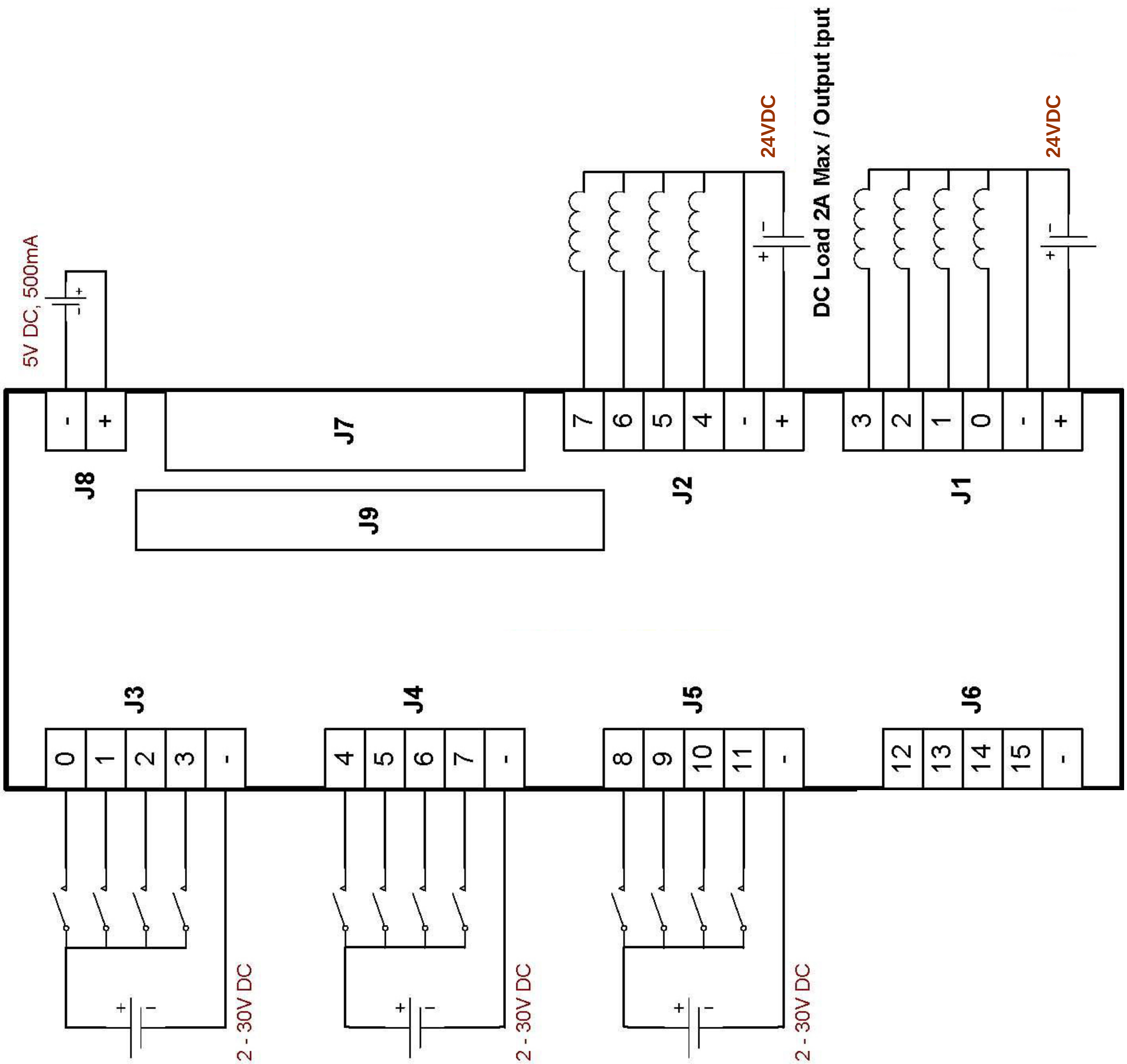
4.4.1 I/O Board 1 Pin Assignments:

I/O Board 1 inputs and outputs are high active (PNP). i.e., apply 12-30VDC to activate an input. All inputs and outputs for I/O Board are pre-defined in Mach3. User can change these settings in Mach3 by going to Config\Ports and Pins\

- PNP Sourcing type Inputs and Outputs
- J1 – J2 Output Connectors are isolated from each other and also from the controller. Load can be any DC type device drawing up to 2Amps current and 24VDC.
- J3 – J5 Input Connectors are isolated from each other and from the controller. Input Voltage range from 12 to 30VDC.
- J6 is reserved for MPG and are accessed though the Opto22 type 50-pin connector (J9)



I/O Board 1 (PNP)



I/O Board 1 (PNP)

Label	Pin #	Mach3 Pin #
24V	+	Output Voltage
GND	-	Output Common
EN	0	Output 0
M3	1	Output 1
M4	2	Output 2
M7	3	Output 3
24V	+	Output Voltage
GND	-	Output Common
M8	4	Output 4
M200	5	Output 5
M202	6	Output 6
M204	7	Output 7

Label	Pin#	Mach3 Pin #
X Lim	0	Input 0
X Home	1	Input 1
Y Lim	2	Input 2
Y Home	3	Input 3
GND	-	Input Voltage Common
Z Lim	4	Input 4
Z Home	5	Input 5
A Lim	6	Input 6
A Home	7	Input 7
GND	-	Input Voltage Common
B Lim	8	Input 8
B Home	9	Input 9
C Lim	10	Input 10
C Home	11	Input 11
GND	-	Input Voltage Common
N/A		Input 12
N/A		Input 13
N/A		Input 14
N/A		Input 15

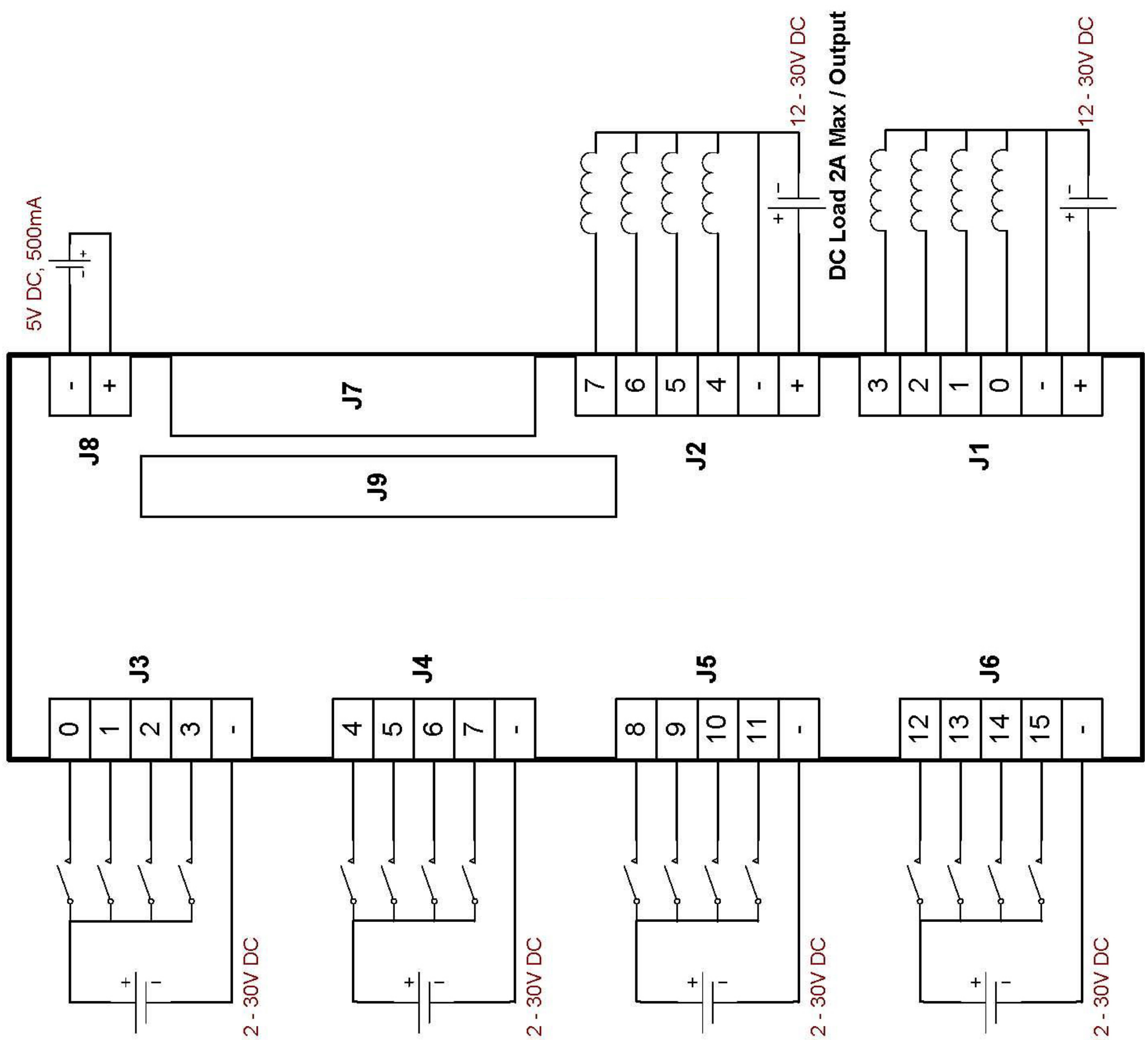
4.4.2 I/O Board 2 Pin Assignments:

I/O Board 2 I/O is extra I/O that the user must define in Mach3. This board is either PNP (inputs and outputs high active) or NPN (inputs and outputs are low active. To read more about how to set up the I/O in Mach3 go to 7.2 Mapping Mach Input Signals to Interpreter 1000 Digital Inputs on Page 34

For Interpreter 1000 with I/O board 2 PNP:

Inputs and outputs are high active (PNP). i.e., apply 12-30VDC to activate an input.

- PNP Sourcing type Inputs and Outputs
- J1 – J2 Output Connectors are isolated from each other and also from the controller. Load can be any DC type device taking up to 2Amps current and 12-30VDC.
- J3 – J6 Input Connectors are isolated from each other and from the controller. Input Voltage range from 12 to 30VDC.



I/O board 2 PNP

All I/O is port 1 in mach3

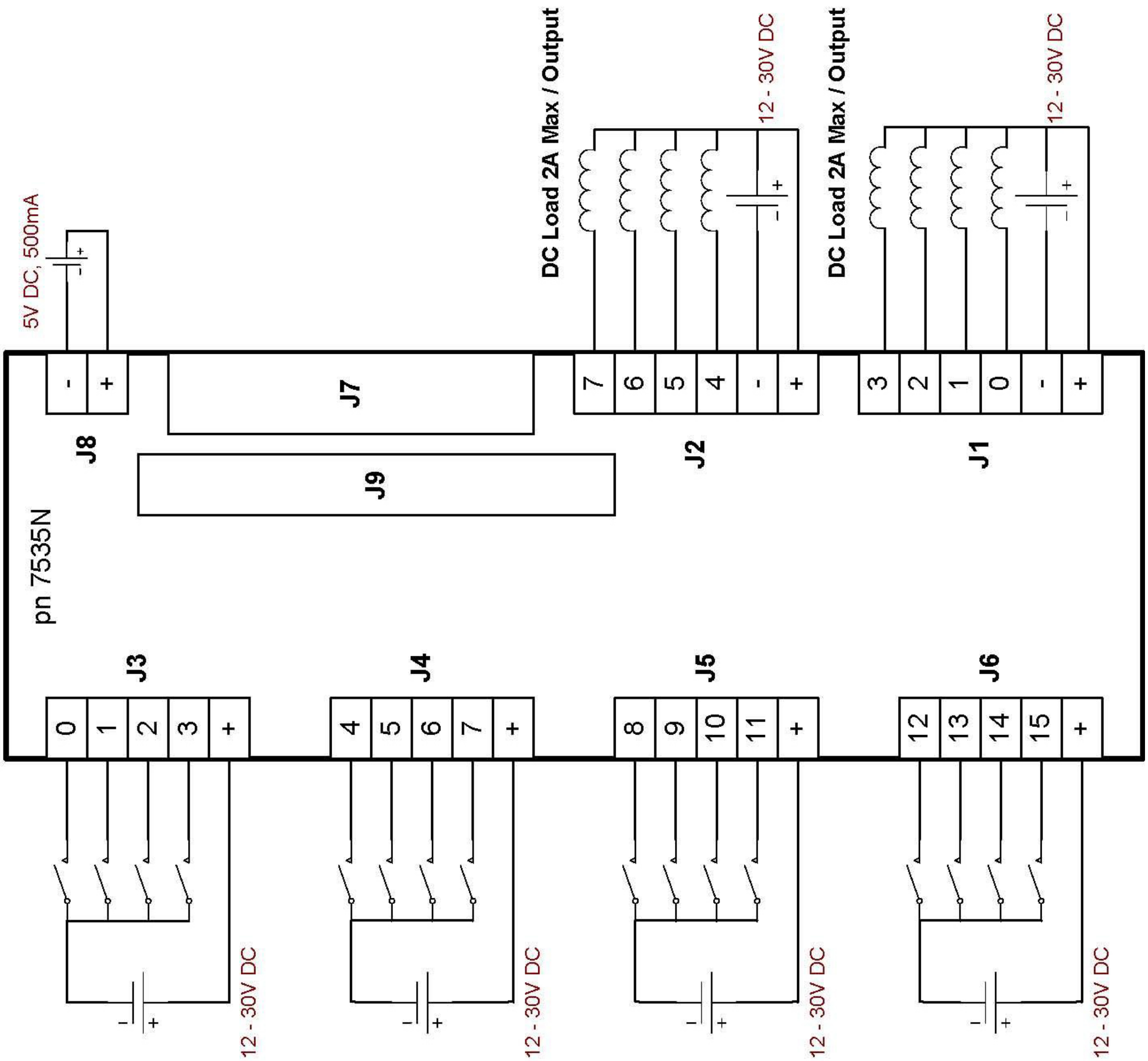
User Defined Outputs	Mach3 Pin #
	+ Output Voltage
	- Output Common
	Output 8
	Output 9
	Output 10
	Output 11
	+ Output Voltage
	- Output Common
	Output 12
	Output 13
	Output 14
	Output 15

User Defined Inputs	Mach3 Pin #
	Input 16
	Input 17
	Input 18
	Input 19
	- Input Voltage Common
	Input 20
	Input 21
	Input 22
	Input 23
	- Input Voltage Common
	Input 24
	Input 25
	Input 26
	Input 27
	- Input Voltage Common
	Input 28
	Input 29
	Input 30
	Input 31

For Interpreter 1000 with I/O board 2 NPN:

Inputs and outputs are low active (NPN). i.e., apply 0VDC (Ground) to activate the input.

- NPN Sinking type Inputs and Outputs
- J1 – J2 Output Connectors are isolated from each other and also from the controller. Load can be any DC type device drawing up to 2Amps current and 12-30VDC.
- J3 – J6 Input Connectors are isolated from each other and from the controller. Input Voltage range from 12 to 30VDC.



I/O board 2 NPN

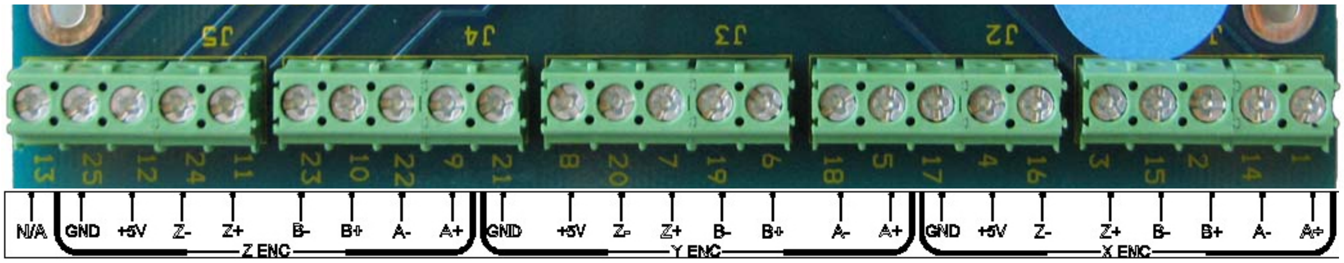
User Defined Outputs	Function
	+ Output Voltage
	- Output Common
	Output 8
	Output 9
	Output 10
	Output 11
	+ Output Voltage
	- Output Common
	Output 12
	Output 13
	Output 14
	Output 15

User Defined Inputs	Function
	Input 16
	Input 17
	Input 18
	Input 19
	+ Input Voltage
	Input 20
	Input 21
	Input 22
	Input 23
	+ Input Voltage
	Input 24
	Input 25
	Input 26
	Input 27
	+ Input Voltage
	Input 28
	Input 29
	Input 30
	Input 31

4.5 Encoder Board 1 Pin Assignments:

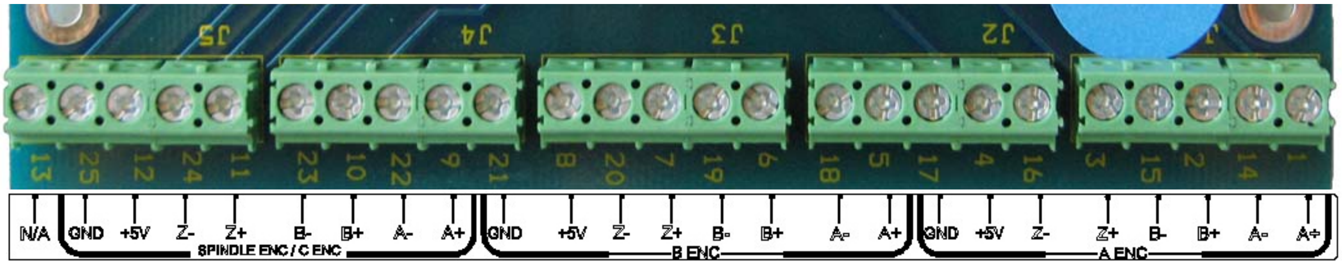
Differential Quadrature Encoders

Encoder Board 1 Pin Assignments:



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

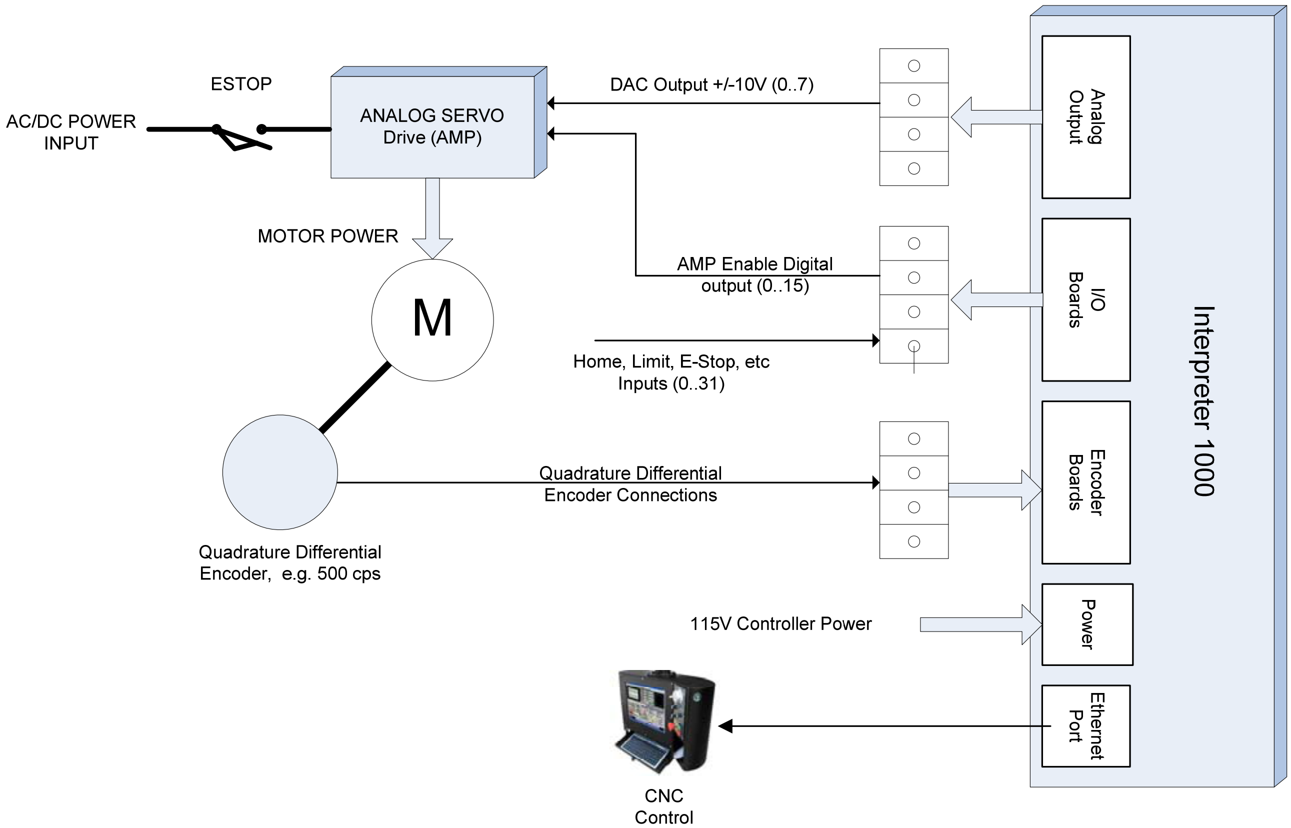
Encoder Board 2 Pin Assignments:



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

5. Hardware Connections

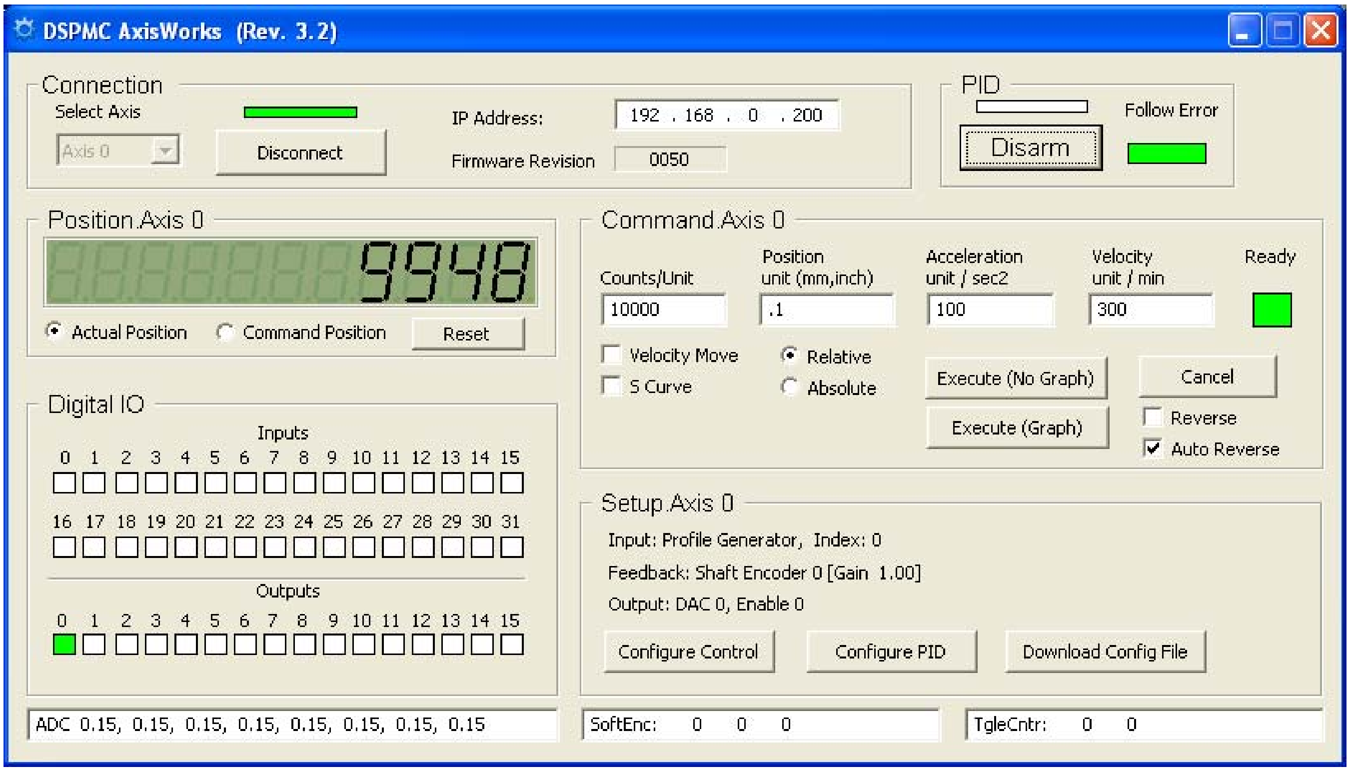
The figure below shows a typical axis setup using the Interpreter 1000



6. AxisWorks Software tool

The AxisWorks software tool allows the user to test the Interpreter 1000 installation. The user can exercise motion and I/O controls easily, without doing any custom programming. The tool lets the user configure the I/O and PID settings. I/O control configuration includes configuring the servo loop Input source and gain, Feedback source, output control and amp-enable output control etc. Once configured, the user can run the motion commands and can also tune the PID controls. PID configuration includes configuring each of the P, I, and D gains as well as set the error limits if any.

Upon double-clicking the Interpreter 1000 AxisWorks icon on the desktop, the initial window would look similar to the following. Each screen item is explained in detail as follows



6.1 User Interface

1 – Connection – Provides details for connecting AxisWorks to the Interpreter 1000.

Before clicking on the 'Connect dspMC' button, check whether the board has been powered on and network setup has been done as explained in *Network Connection Setup*.

Note that the IP Address and Firmware revision fields (which specify the Interpreter 1000's IP address and current loaded firmware revision) are left blank before the connection to the board is made.

A ‘Red’ bar above the ‘Connect dspMC’ button indicates that the connection is not yet made. In order to initiate the connection, select an Axis (out of the 8 Axes from the drop down list). Then click on ‘Connect dspMC’ button, this performs the actual connection to the board. , If connection is successful, the ‘Red’ bar will turn into ‘Green’ color.

2 – PID – Provides control for Arming (enable) and Disarming (disable) of PID loops globally. Also a color bar in red shows if a Following Error is tripped. If green, no error is detected.

3 – Position Axis – Displays actual position and command position for the selected Axis in raw encoder counts.

By selecting ‘Command position’, the display shows the value of the internal variable for the commanded position for the selected axis.

By selecting ‘Actual position’, the display shows the current value of the encoder counter for the selected axis.

Note that the actual position usually slightly deviates from the Command position when PID is enabled.

4 – Command Axis - Executes Move command based on User inputs for selected Axis.

Counts/Unit – Number of encoder counts in one Position Unit (e.g. mm, inches, etc). For example, if your preferred unit of measurement is inches, and if 40000 encoder counts move the axis 1 inch, you will put 40000 in this field. If you are going to work directly in encoder counts, then set this value to 1.

For CNC applications, this is calculated by encoder counts as follows:
Encoder Counts / Inch = Quadrature counts/rev x Gear ratio x leadscrew revs/inch.

For example
Encoder: 2000 Counts / Rev (Actual 500 line encoder)
Gear Ratios: 2
Lead Screw: 5 Revs / Inch

Encoder Counts / Inch = 2000 x 2 x 5 = 20000

Position – Final position or displacement in terms of Position Units, e.g. 1.5, 10.093, etc.

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

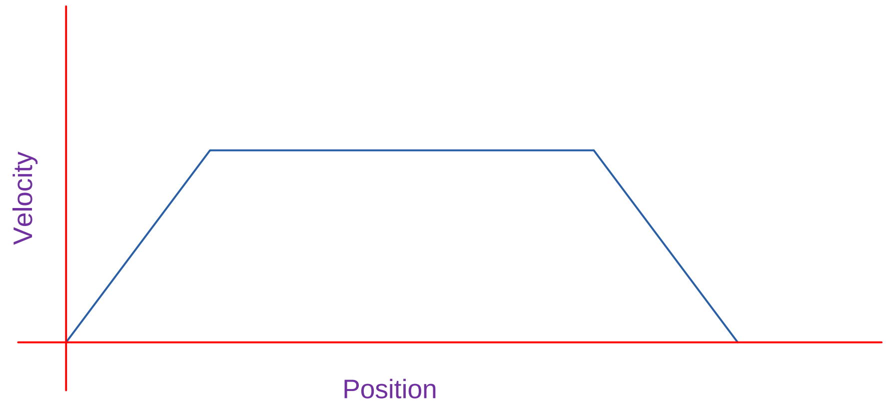
Velocity – Velocity value in terms of Position Units per minute, e.g. inches/minute, mm/mintue etc.

Note:
Be careful not to use Acceleration and Velocity values greater than the machine is capable of, or you will cause a “Following Error”. Start slow and work your way up. When you get an error that you can’t tune out, back your settings down to 10% or so.

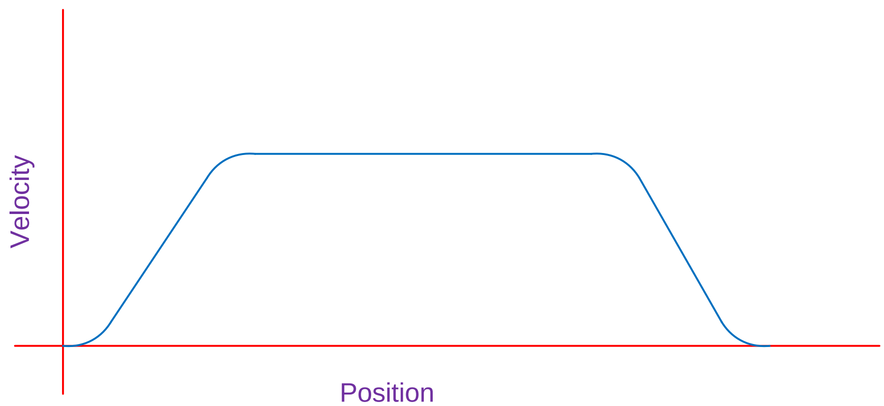
Relative and *Absolute* – These buttons indicate whether the value in the Position field is either the total distance to travel (relative) or the final position (absolute).

Velocity Move – This indicates that the move will not use the position data provided. This is useful when you need to run the axis for long time without worrying about the final position. To stop the axis, click on the cancel button.

S-curve – This indicates that the motion profile will transition smoothly (no sudden change in acceleration). The motion profiles with or without S-Curve option are shown below:



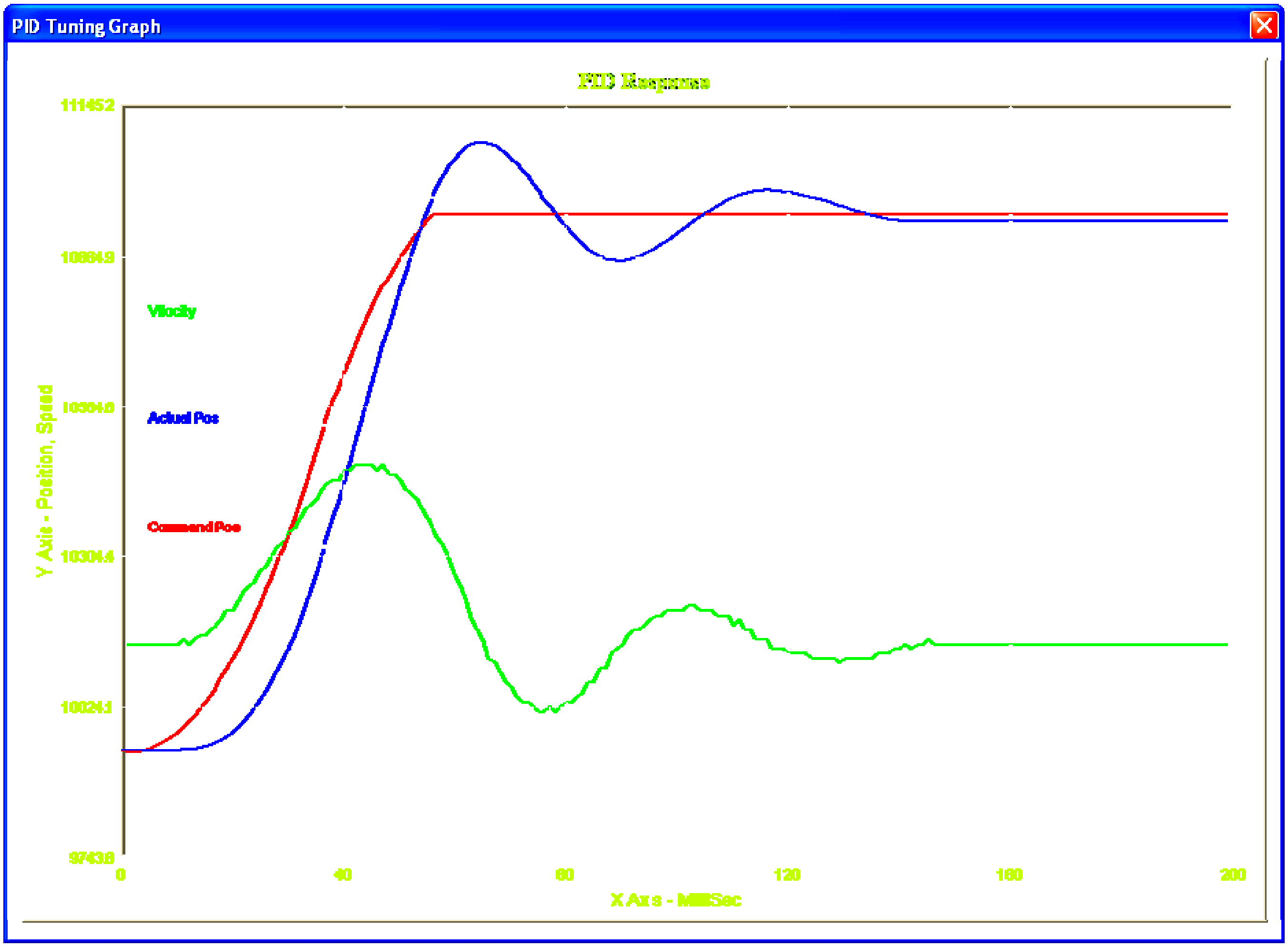
Trapezoidal Motion Profile



S-Curve Motion Profile

Tuning the Interpreter:

Pressing the 'Execute' button (with or without graph) starts the motion. User can press 'Cancel' button to cancel the motion execution anytime during the machine operation. Make sure you have setup the axis properly before moving the axis, as described in the following sections. If Execute with Graph is selected, the Graph window will appear, similar to shown below. The red line shows the commanded position, Blue line shows the actual position, while the Green line shows the actual velocity profile.



5 – Digital I/O – Displays the current states of digital Input and Output pins.

6 – Download Config File – Downloads the user specified configuration file (e.g. dspMC.xml) to the board. Appendix A shows the format of this xml file. You can manually edit this file and re-download the configuration without going thru different windows.

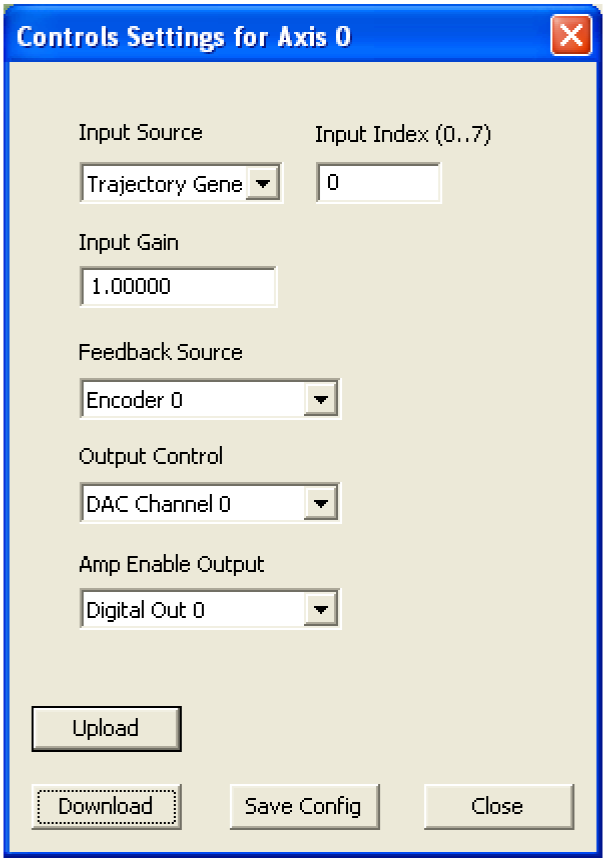
7 – Setup Axis – Setup axis controls (input, feedback, output etc) and PID configuration for the selected axis.

8 – Motion Profile Graphs – Displays actual versus programmed axis motion

The Current configuration values for ‘Input’, ‘Feedback’ and ‘Output’ are displayed for the selected axis. ‘Configure Control’ and ‘Configure PID’ provides dialog windows to the user to add/modify the configuration and PID settings.

6.2 Controls Configuration

The '**Configure Control**' button displays following dialog window:



Input source is the command input to the PID controller for the axis. This can be any one of the following:

- PC Host Software (this configuration is required by some PC software, e.g. Mach3)
- Trajectory Generator
- Any Encoder input
- Any analog input

Important Note:
You must select "Trajectory Generator" as the Input Source when using ***AxisWorks*** to execute motion on Interpreter 1000.

Input Index is the index of the command position source. This number normally matches the axis number. In case for slave axis, it is equal to the master axis number.

Input Gain is the multiplier before the source data is used, e.g. if encoder 0 is the source, the counter value is multiplied by Gain and then used as the input to the PID controller for the selected axis.

Feedback source to the PID controller can be from any Encoder input or any Analog inputs (A/D channel 0-7)

Output control selects the DAC channels (DAC 0-7) that will receive the PID controller output.

Amp Enable Output selects the output pin used to enable the external servo amplifier. User can select any of the 16 digital output pins (Digital out 0-15) as the enable pin for the selected axis.

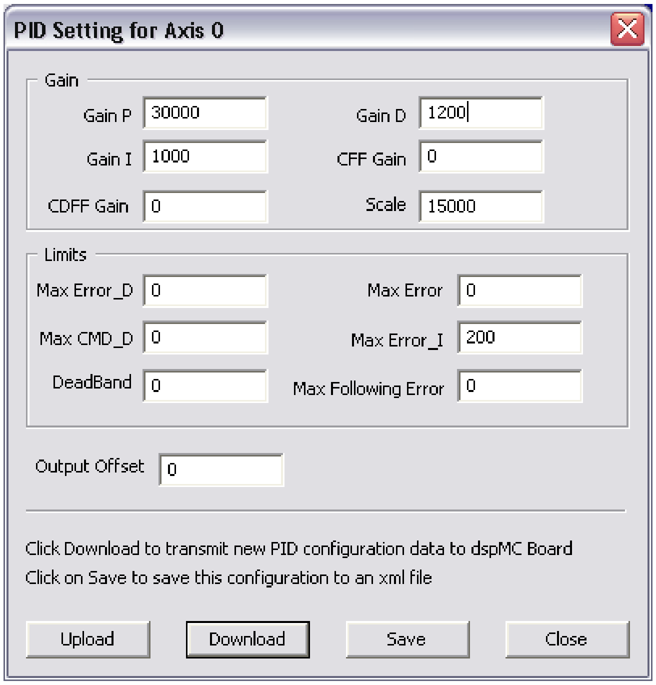
Note that an 'undefined' value is displayed for these fields when not configured.

The ***Upload*** button reads the current values from the Interpreter 1000 board and displays them on this window. If you make a change and like to see the original value you can click on Upload button to get the current programmed values inside the Interpreter 1000.

Clicking the ***'Download'*** button sends the configuration to the Interpreter 1000 board. Note that these configurations are stored on volatile memory inside the board, i.e., the information will need to be re-downloaded when power is cycled on the controller. To avoid re-entering the information, you can also save the configuration to the dspMC.xml file by clicking on the '***Save Config***' button. Once saved, the file can be downloaded to the Interpreter 1000 by clicking on the '***Download Config File***' button on the main window.

6.3 PID Filter Configuration

The ‘**PID Settings**’ button displays the following dialog window:



User can input the P, I, and D coefficients as well as error limits and scale.

Scale is used as a divider for all the setting in the PID gain box. This makes it possible for the software to use smaller manageable numbers and still get the same effect. An example is if you put a gain of 4000 and a scale of 100, it is the same as a scale of 1 and a gain of 400,000.

Don’t be concerned if on the first time you don’t get any motion as the numbers are trial and error. Using P to D ratio of 25 to 1 works real well. If you have no experience, try these numbers:
P = 4000, I = 0, D = 100000, Max following error 1000, Dead-band = 3, Scale = 100 and all others to 0. If your servo drives are tuned real well, Deadband can be set at zero but start at 3 or 5, higher if your servo’s buzz at a standstill.

Command Feed Forward (CFF) gain and Command Differential Feed Forward (CDFF) gain for PID loop control can also be entered here. These are definitely for the more advanced user but will allow for more precise movement.

User can also specify following limits…
Max_error - Maximum error limit,
Max_Error_D - Maximum Derivative Error for Derivate gain,
Max_CMD_D - Maximum Command Error for CDFF gain,
Max_Error_I - Maximum Integral Error for the integral gain,
Deadband – a range of position where the PID is not active

Max Following Error – Maximum deviation allowed between command and actual, above that, the PID controller shuts down and need to be re-enabled manually.

Output Offset - Sets a constant bias to the PID output.

If you changed any field and like to see the current PID settings, click on the '***Upload***' button to read back the data from the controller.

Clicking on '***Download***' sends the PID configuration data to the Interpreter 1000. The new PID configuration can also be saved to an XML file by clicking '***Save***' button. Once saved, there is no need to enter these values every time you run AxisWorks. You can click on the '***Download Config File***' button on the main window to send the configuration to the Interpreter 1000 controller.

7. Mach3 Software Integration

The Mach3 Software is an off-the-shelf Milling and Lathe machine control software. User can download the trail version of the software from www.machsupport.com

The Interpreter 1000 can be integrated with Mach3 to form a high performance machining center. The dspMC Software Tools provide the necessary drivers and configuration files to interface with Mach3 software. If you have installed the software tools as explained in the software installations section, you already have all the necessary drivers.

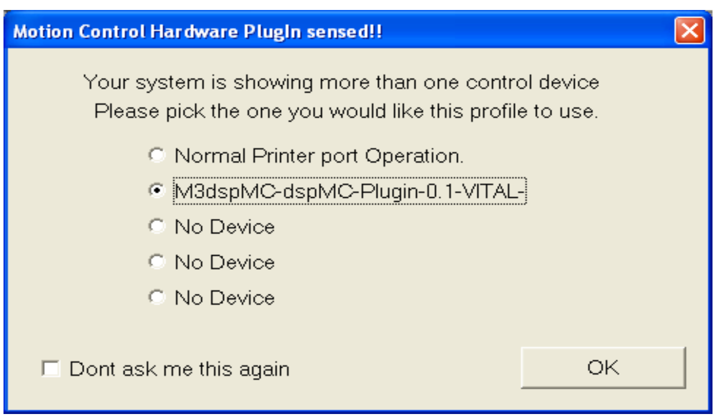
Before using Interpreter 1000 with Mach3, the user should test successful software and hardware installation by using dspMC AxisWorks testing tool as explained in *Testing the installation* chapter.

This document assumes that user is familiar with the usage of Mach3 software. This chapter describes the mapping of Mach3 internal software signals to the Interpreter 1000 connectors.

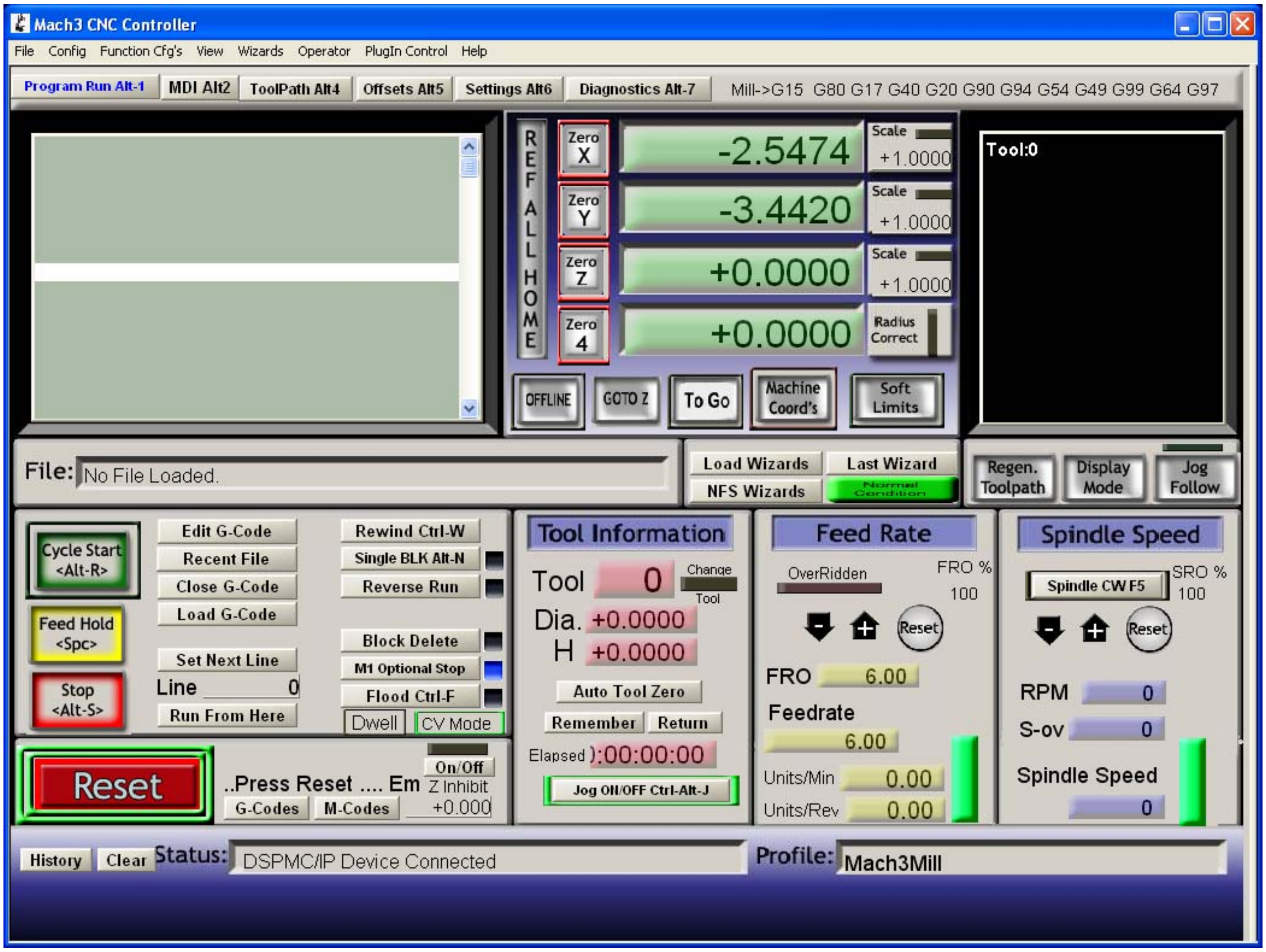
The general Mach3 software operation remains mostly the same when using dspMC plugin.

7.1 Starting Mach3 with the Interpreter 1000

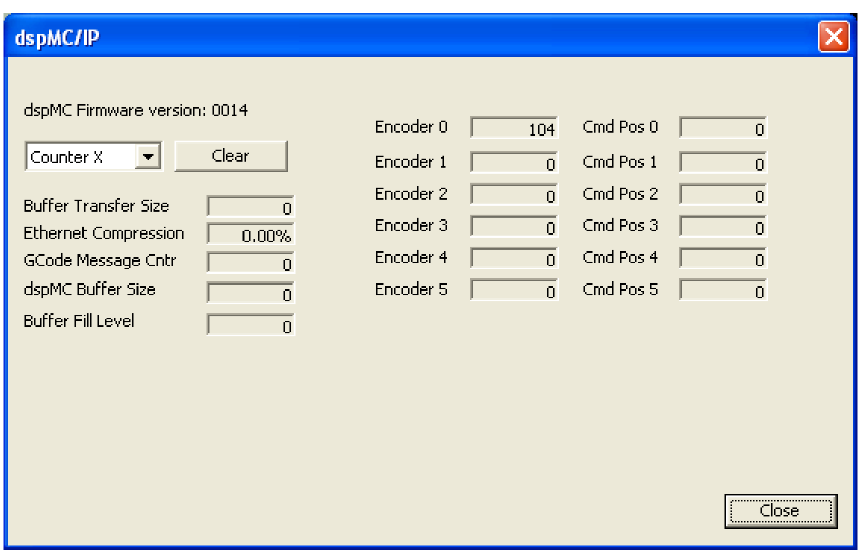
To launch Mach3 with dspMC plugin, double-click on the Mach3Mill software icon on the desktop. It shows the following dialog box with the option to select M3dspMC plugin. Make sure this plugin is selected and click ‘OK’.



Make sure the Interpreter 1000 is powered up and connected to the Ethernet network. The Mach3 software shows up as follows with a message ‘dspMC/IP Device Connected’ in the Status bar.



Click on the Menu item ‘PlugIn Control’, and then click on the item ‘..dspMC/IP Window” which displays the following screen indicating that the Interpreter 1000 is connected with current states of counter and other stats. User can leave this window open while running Mach3.



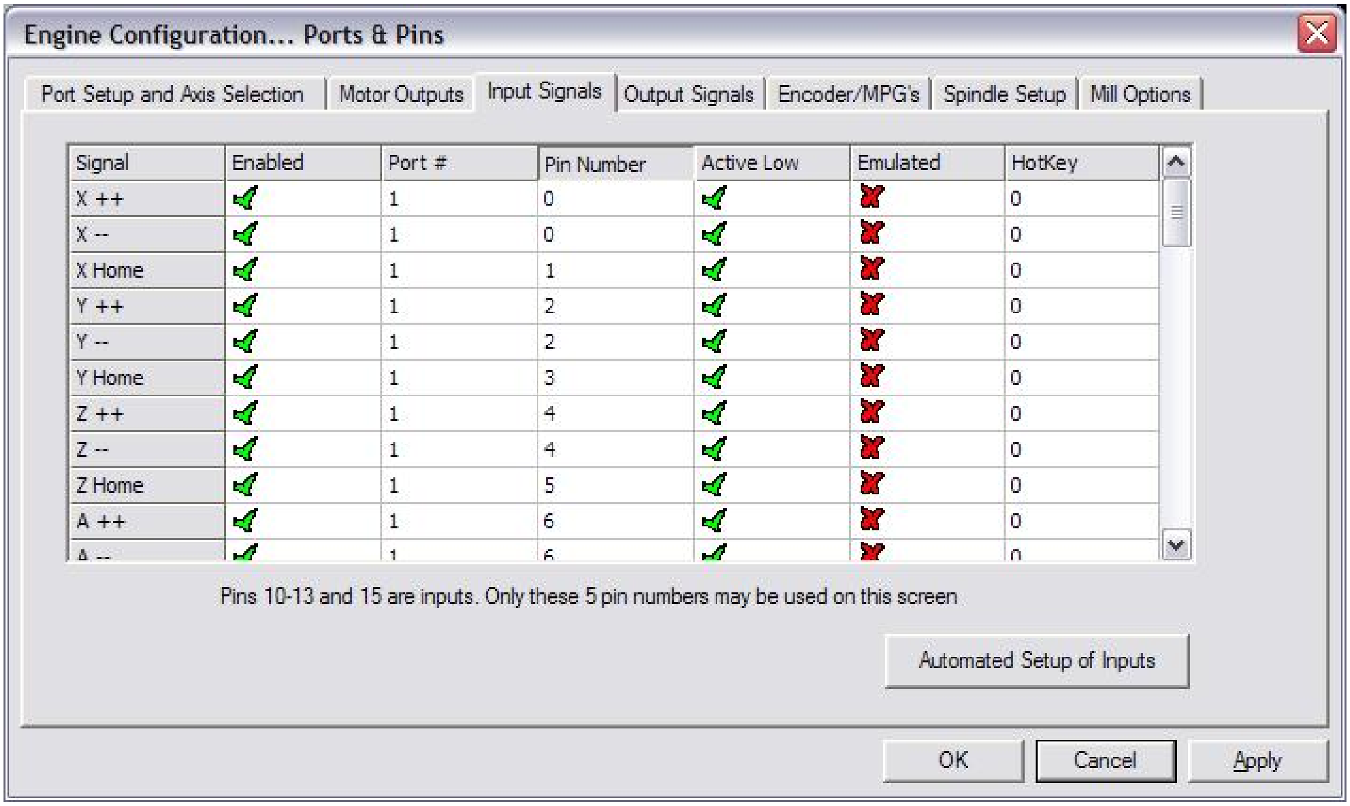
This screen is mostly used for diagnostics, but the user can also clear the Encoder counters, if required.

7.2 Mapping Mach Input Signals to Interpreter 1000 Digital Inputs

The following table shows the mapping from Mach3 input pin numbers to the digital inputs available on the Interpreter 1000 I/O Boards.

Mach3 *Input* ports and pins		I/O Boards 1 & 2 pin assignments	
Port #	**Pin Number**	**Label**	**Board #1**
1	0	X Lim	0
1	1	X Home	1
1	2	Y Lim	2
1	3	Y Home	3
1	4	Z Lim	4
1	5	Z Home	5
1	6	A Lim	6
1	7	A Home	7
1	8	B Lim	8
1	9	B Home	9
1	10	C Lim	10
1	11	C Home	11
1	12	Reserved	12
1	13	Reserved	13
1	14	Reserved	14
1	15	Reserved	15
			Board #2
1	16		0
1	17		1
1	18		2
1	19		3
1	20		4
1	21		5
1	22		6
1	23		7
1	24		8
1	25		9
1	26		10
1	27		11
1	28		12
1	29		13
1	30		14
1	31		15

If using any of the Mach3 input signals, make sure the pins are ‘Enabled’ and set ‘Active Low’ as shown in the example figure below.



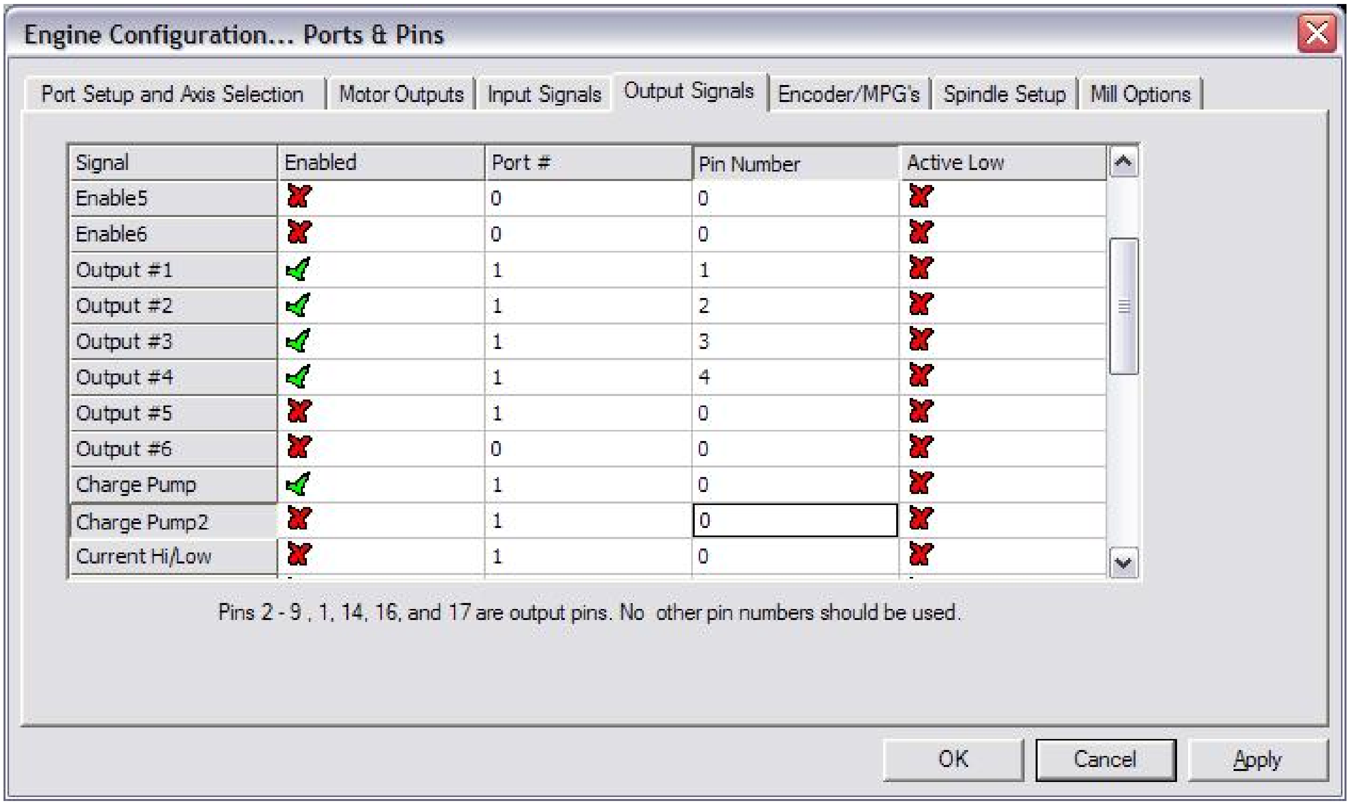
Ignore the line printed on the above window about pins 10-13 and 15. This does not apply to Interpreter 1000 based system.

7.3 Mapping Mach3 output pins to Interpreter 1000 Digital Outputs

The following table shows the mapping from Mach3 output pin numbers to the digital outputs available on the Interpreter 1000 I/O Boards.

Mach3 *Output* ports and pins		**Label**	**Breakout board pin assignments**
Port #	**Pin Number**		**Board #1**
1	0	EN	0
1	1	M3	1
1	2	M4	2
1	3	M7	3
1	4	M8	4
1	5	M200	5
1	6	M202	6
1	7	M204	7
			Board #2
1	8		0
1	9		1
1	10		2
1	11		3
1	12		4
1	13		5
1	14		6
1	15		7

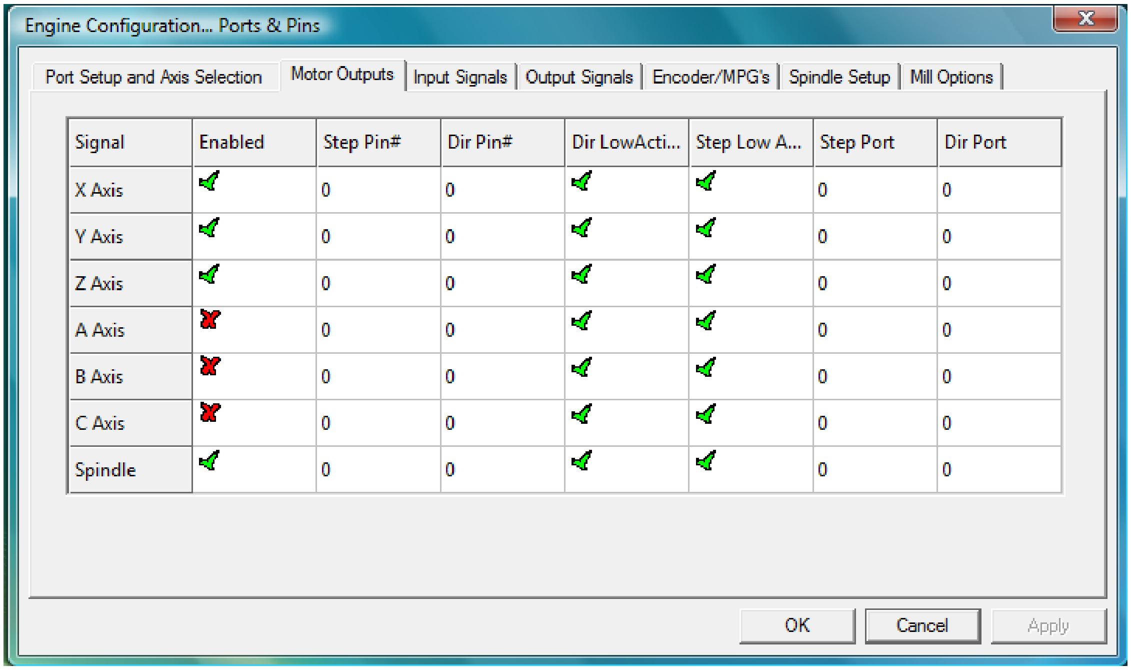
As with the input configuration, if using any of the Mach3 output signals, make sure the pins are ‘Enabled’ and set ‘Active Low’ as shown in the example figure below.



Ignore the line printed on the above window about pins 2-9,1,14.... This does not apply to Interpreter 1000 based system.

7.4 Motor outputs.

On the Motor Ouputs tab, enable the ones that you will be using, and set to active low. Leave the Step Pin # , Dir Pin# , Step Port, and the Dir Port set to 0.



Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActi...	Step Low A...	Step Port	Dir Port
X Axis	✓	0	0	✓	✓	0	0
Y Axis	✓	0	0	✓	✓	0	0
Z Axis	✓	0	0	✓	✓	0	0
A Axis	✗	0	0	✓	✓	0	0
B Axis	✗	0	0	✓	✓	0	0
C Axis	✗	0	0	✓	✓	0	0
Spindle	✓	0	0	✓	✓	0	0

7.5 Spindle Setup.

When using a VFD or other motor controlling device that uses 0-10v control the following steps are needed.

Make sure the spindle enable is checked and is set to active low.

Go to the Config tab and then spindle pulleys. Current pulley 1. For this example, set min speed to 0 and max speed to 100. Set Ratio 10. This will give a 0v output to the spindle at S0 (min speed) and a 10v at S100 (max speed).

This setting is great for testing. Without the VFD/Drive hooked up you can test your output with a digital volt meter to make sure you are getting 0-10volts for 0 to max speed.
When it all works then put in min 0 and max gets set to the max speed of your machine, eg, 5000. This will allow you to program S in the G-code in actual rpm, ie 0 … 5000.

7.6 Downloading the PID configuration

The *dspMC.xml* file contains the PID and system configuration data. This file is usually stored in C:\Mach3 folder. The user can modify this file for tuning the PID loop. To download new set of PID configuration onto the dspMC board, click on 'PlugIn Control' and select 'Download Config File' item.

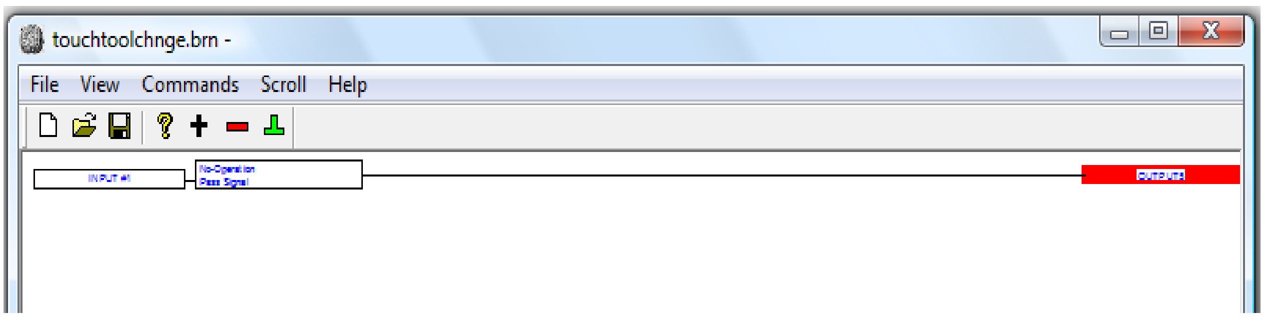
Note that the download is possible only when the Mach3 software is in ESTOP mode ('Emergency Mode Active…' message is displayed continuously when in ESTOP mode).

For more information on the *dspMC.xml* configuration file, please refer to *Appendix A*

7.7 Getting beyond the basic input/output with Mach3.

When you are done with limit switches and other basic I/O you will probably want to have several switches on you control panel next to the e-stop such as feed hold, stop, g-Code rewind and other things. To get this added functionality you will need to learn how to write brains in Mach3. Brains are used to get access to all of the extra I/O and to work tool changers and just about anything you can think of.

Here is an example of a basic brain to map input 1 to output 5.



Connect a wire between input 1 and output 5 under the ports and pins tab of Mach3.
After a few tries you will gain confidence and understanding.

For more information: go to www.machsupport.com and then to the video section and look for Brains.

7.8 Axis Homing and Direction

In the Config menu, select Homing/Limits. You will see the following window.

Motor Home/SoftLimits

Entries are in setup units.

Axis	Reversed	Soft Max	Soft Min	Slow Zone	Home Off.	Home Neg	Auto Zero	Speed %
X	✓	100.00	-100.00	1.00	1	✗	✓	20
Y	✗	100.00	-100.00	1.00	1	✓	✓	20
Z	✓	100.00	-100.00	1.00	.5	✗	✓	20
A	✗	100.00	-100.00	1.00	0.0000	✗	✓	20
B	✗	100.00	-100.00	1.00	0.0000	✗	✓	20
C	✗	100.00	-100.00	1.00	0.0000	✗	✓	20

G28 home location coordinates

X	0	A	0
Y	0	B	0
Z	0	C	0

OK

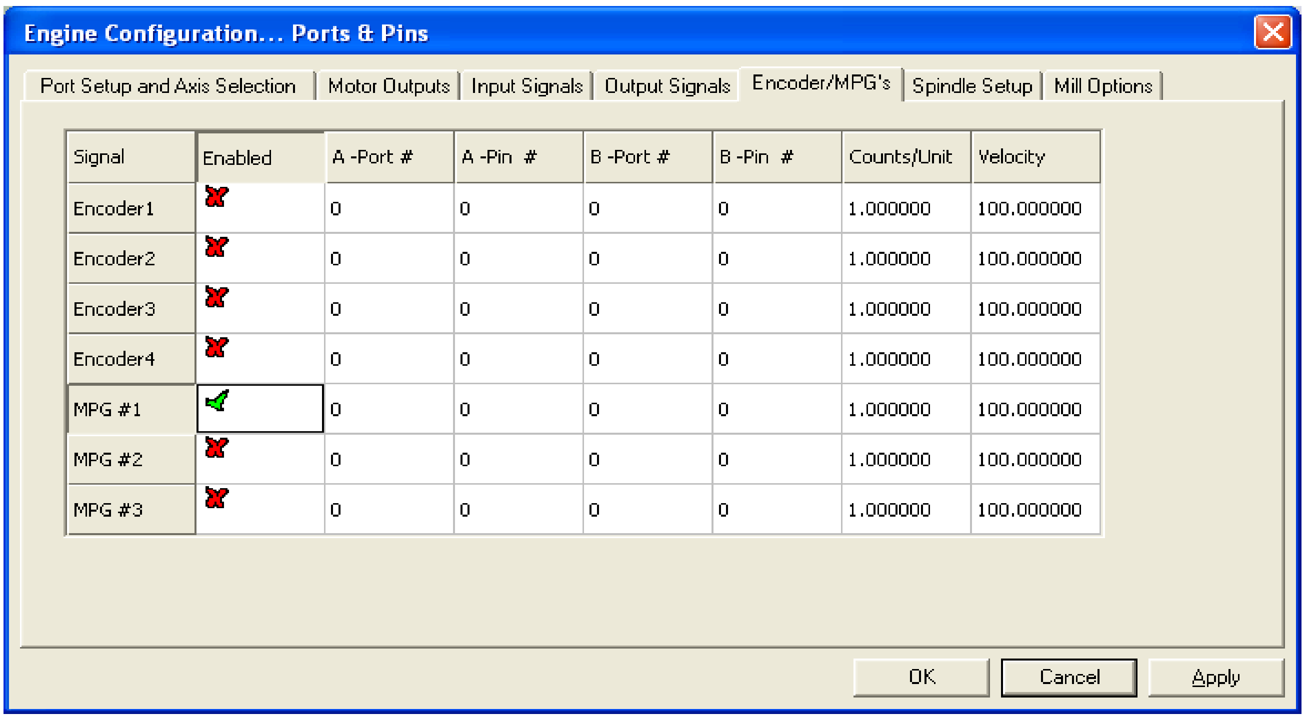
To change the axis direction, click on the Reversed column for the axis you want to change the direction. A green check mark indicates the direction is now reversed.

Homing Offset lets you move the axis to a predefined position after homing is complete. Home Neg, changes the default homing direction.

The Interpreter 1000 offers a number of different homing types for each axis. Please review section A.15 Homing to select the correct homing sequence.

7.9 Manual Pulse Generation - MPG

Interpreter 1000 allows using a quadrature encoder as a MPG source. The encoder can be connected to the dedicated encoder inputs on Encoder Board 1 or Encoder Board 2 (HardEncoder), as well as to the I/O boards digital inputs (SoftEncoder). In the dspmc.xml file you specify the correct MPG source.



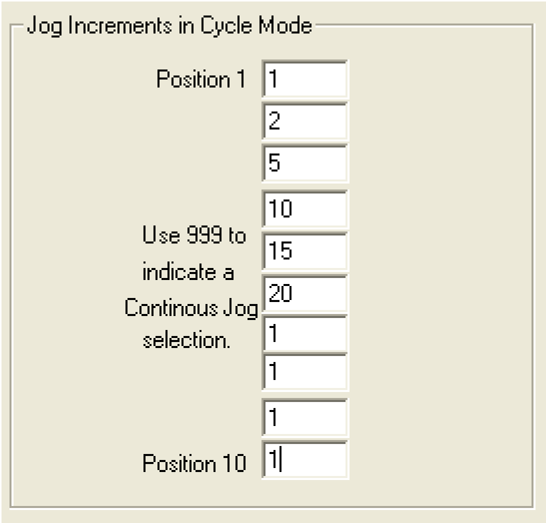
Signal	Enabled	A -Port #	A -Pin #	B -Port #	B -Pin #	Counts/Unit	Velocity
Encoder1	✗	0	0	0	0	1.000000	100.000000
Encoder2	✗	0	0	0	0	1.000000	100.000000
Encoder3	✗	0	0	0	0	1.000000	100.000000
Encoder4	✗	0	0	0	0	1.000000	100.000000
MPG #1	✓	0	0	0	0	1.000000	100.000000
MPG #2	✗	0	0	0	0	1.000000	100.000000
MPG #3	✗	0	0	0	0	1.000000	100.000000

To turn on the MPG feature, make sure MPG #1 is checked green as shown above in the Ports and Pins window. The rest of the fields in this window are not used.

The SoftEncoder are available on digital inputs of connector I/O Board 1 & 2. The pin assignments are as follows:

SoftEncoder 0 : I/O Board 1 A = J6 Pin 12, B = J6 Pin 13
SoftEncoder 1 : I/O Board 1 A = J6 Pin 14, B = J6 Pin 15
SoftEncoder 2 : I/O Board 2 A = J3 Pin 0, B = J3 Pin 1

You set the encoder multiplier in the General Config setting as shown below. You can use your own multiplier values in this window.



See section A.16 MPG Settings – MpgSource1 for the xml file settings for MPG.

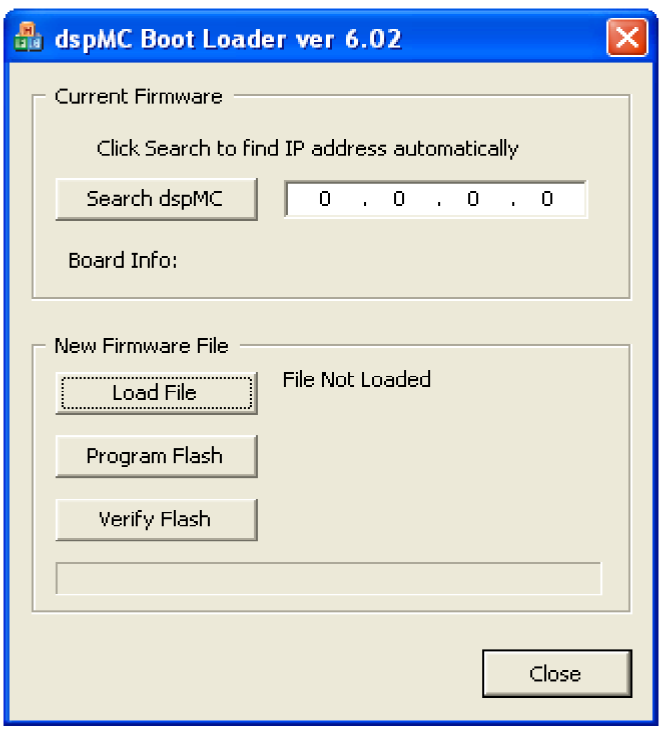
8. Interpreter 1000 Software Upgrade Tool

The Boot Loader software tool for Interpreter 1000 is used to re-program (Flash) the board software (Firmware). The latest Firmware file is available from the factory on request. The file is sent in compressed zip format, so you will need to unzip the file and extract the binary file before programming.

NOTE: Before programming the Firmware, please close all programs that are communicating with the DSPMC board. This includes programs running on other computers that are connected to the DSPMC board over Ethernet.

The following steps describe the procedure to upgrade the firmware.

1. Double Click the 'Interpreter 1000 Firmware Upgrade' icon that was installed during software installation. The following window appears:



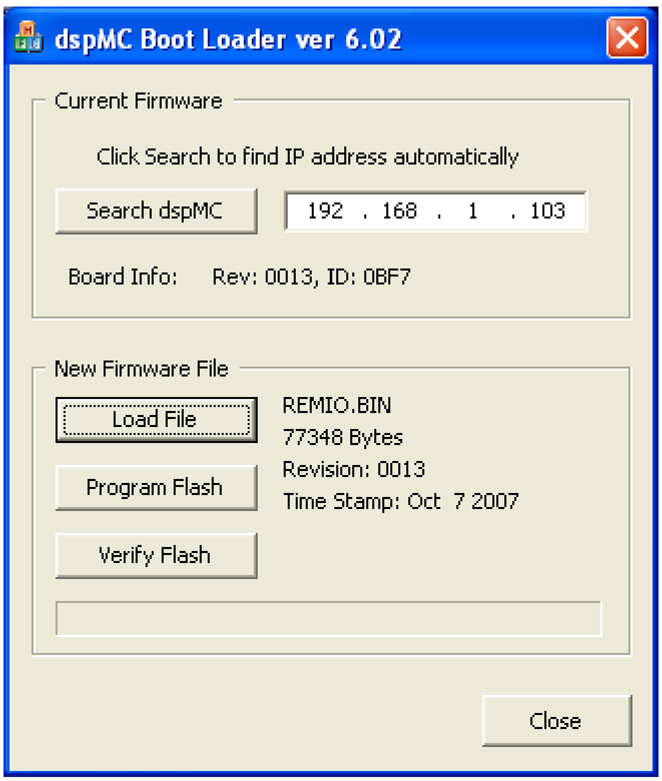
2. Click on the Search dspMC button to setup the connection.

This window shows that the connection is correctly established. Click OK. If the connection cannot be established, please refer to Network Connection Setup chapter to setup communications with the device.

Once connected, the main window shows the current board information, ie, the firmware revision and the board serial ID. If the firmware file you received from factory has the same revision number, then you do not need to re-program the board.

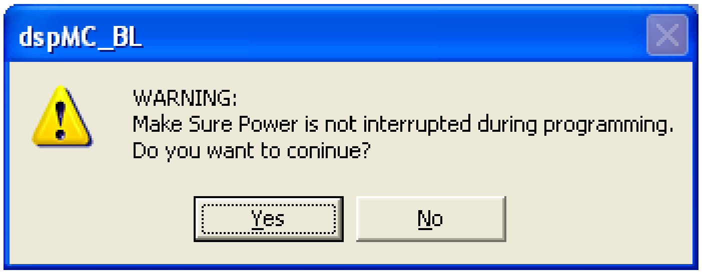
3. Click on the Load File button and search for the firmware (.bin) file that you received from factory.

Once the file is selected, a sample would look like this:

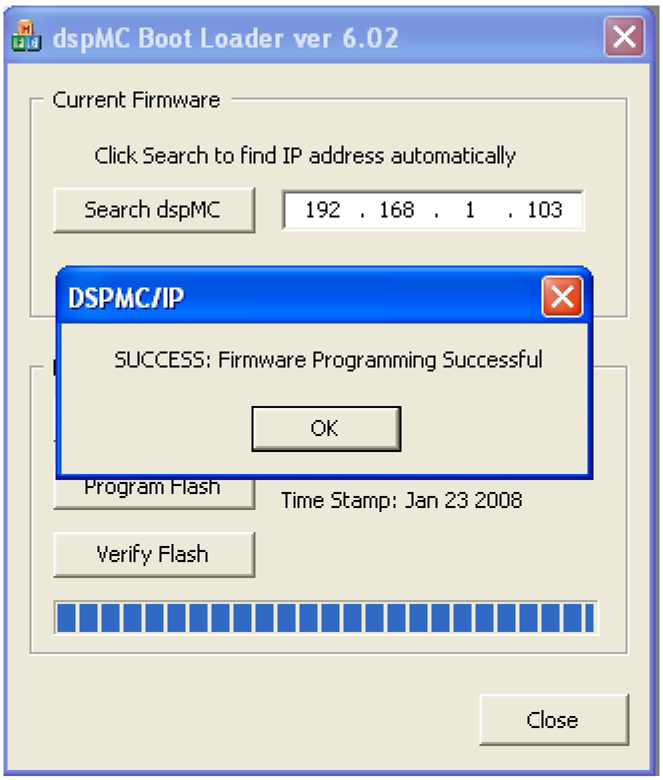


The version number and time-stamp of the firmware file you opened is shown on the main window. Please make sure this the correct version you intend to flash.

4. Click on the Program Flash Button. Please make sure that the board power supply does not get interrupted during this process. Click on the yes button to start. If you are not sure, click 'No' and provide a stable power supply before you try programming again.



Once you click 'Yes', the software will start programming the board. The progress bar will show the programming progress. After the programming is done, the software will verify if the programming is successful. A 'SUCCESS' message is displayed if firmware programming and verification is successful as shown below.



If an error is detected, it will show the location of the first data mismatch. You can try programming again by clicking on Program Flash Button to correct the error.

Note:

Note: If an error is detected during programming or verification, you can retry programming as many times as you like, as long as you do not turn off power to the Interpreter 1000. Once the board power is turned off, it will try to load the new firmware the next time you power up.

After a successful programming and verification, the Interpreter 1000 board must be restarted to execute the newly loaded program. This can be accomplished by turning off the power, and then turning back on again after 5 seconds.

Appendix A – dspMC.xml Format

XML format of Interpreter 1000 configuration is shown below. Only axis 0 is shown. All other axes follow the same format. At the end of the listing, detailed description if each parameter is described.

```
<?xml version="1.0" encoding="utf-8"?>
<!-- This file represents configuration database for dspMC Motion Controller -->
<Mach3Config>

	<Spindle>
		<DAC>7</DAC>
	</Spindle>

	<MaxBufferLevel> 50 </MaxBufferLevel>   <!-- upto 100% for 4096 points/axis -->

	<BackLash>				<!-- Raw Encoder Counts -->
		<Counts_x> 0 </Counts_x>
		<Counts_y> 0 </Counts_y>
		<Counts_z> 0 </Counts_z>
		<Counts_a> 0 </Counts_a>
		<Counts_b> 0 </Counts_b>
		<Counts_c> 0 </Counts_c>
	</BackLash>

	<RPM>
		<CountsPerRev_x> 2000 </CountsPerRev_x>
		<CountsPerRev_y> 2000 </CountsPerRev_y>
		<CountsPerRev_z> 2000 </CountsPerRev_z>
		<CountsPerRev_a> 2000 </CountsPerRev_a>
		<CountsPerRev_b> 2000 </CountsPerRev_b>
		<CountsPerRev_c> 2000 </CountsPerRev_c>
	</RPM>

	<MpgSource1>
		<Type>HardEncoder</Type> <!—SoftEncoder or HardEncoder-->
		<Index>2</Index>
	</MpgSource1>

</Mach3Config>

<dspMCConfig>
	<Axis0>
		<PID_Filter>
			<P>30000</P>
			<I>1000</I>
			<D>0</D>
			<!-- Feed Forward Command Gain -->
			<ffcGain>0</ffcGain>
			<!-- Feed Forward Command Derivative Gain -->
			<ffcdGain>0</ffcdGain>
			<!-- Max Limit on Error (Command - Feedback) -->
			<MaxError>0</MaxError>
			<!-- Max Limit on Integral Error -->
			<MaxError_I>200</MaxError_I>
```

```
                <!-- Max Limit on Differential Error -->
                <MaxError_D>0</MaxError_D>
                <!-- Max Limit on Following Error -->
                <MaxError_F>0</MaxError_F>
                <!-- Range of Error where PID Loop does not respond -->
                <Deadband>0</Deadband>
                <!-- Max Limit on Command Derivative -->
                <MaxCmd_D>0</MaxCmd_D>
                <!-- Divisor for PID Calculation -->
                <Scale>15000</Scale>
                <!-- Constant to be added after PID calculation and scalling -->
                <Offset>0</Offset>
            </PID_Filter>
            <ControlInput>
                <!-- Source: TrajectoryPlanner, CommandPosition, Counter, A2D -->
                <Source>CommandPosition</Source>
                <Index>0</Index>
                <Gain>1.000000</Gain>
            </ControlInput>
            <!-- Feedback: Counter, A2D -->
            <PID_Feedback>
                <Source>Counter</Source>
                <Index>0</Index>
                <Gain>1.000000</Gain>
            </PID_Feedback>
            <ControlOutput>
                <!-- Output: DAC, Stepper -->
                <Type>DAC</Type>
                <Index>0</Index>
            </ControlOutput>
            <AmpEnable>
                <!-- Bit Index 0=undefined, 1..16 bit number - 1 -->
                <Index>0</Index>
            </AmpEnable>

            <Homing>

                <Type> HomeSensor </Type>     <!-- Options: HomeSensor, IndexPulseOnly -->

                <UseIndexPulse>1</UseIndexPulse>
                        <!-- Options: 1 = use index pulse, 0 = donot use index pulse -->
            </Homing>

        </Axis0>…..
```

Description of XML parameters:

A.1 Spindle DAC

The Spindle DAC configuration selects the analog output (DAC) for the spindle speed control. The DAC output voltage varies from 0 to +10volts. Any Analog output position can be selected from 0 to 7. Make sure the selected DAC output number is not used anywhere else in the dspmc.xml file. If it is used, then enter **“Undefined”** in the ***ControlOutput Type*** section.

The following section defines DAC output 6 for spindle.

```
<Spindle>
    <DAC>6</DAC>
</Spindle>
```

A.2 MaxBufferLevel

This section defines how much command position buffering will be done inside the Interpreter 1000 controller. The total size of the buffer is 4096 points per axis. These points are consumed by the Interpreter 1000 at 1 KHZ. To get faster response time on federate changes, you may select a lower value, but the side effect is that if the PC software slows down and cannot sustain the motion data rate to the Interpreter 1000, then the motion could be jerky.

The valid rage for this section is 1…100 percent.

eg,
MaxBufferLevel> 50 </MaxBufferLevel>

A.3 BackLash

The following example shows how to calculate backlash counts for x axis:

Example Backlash = 0.010" on x axis
Encoder = 4000 counts per revolution (1000 count encoder)
Lead Screw = 10 revolution per inch

You have 40000 counts per inch and backlash in encoder counts will be 40000 x 0.010 = 400

Therefore in the dspmc.xml you will enter 400 as follows:

```
<BackLash>
   <Counts_x> 400 </Counts_x>
</BackLash>
```

A.4 RPM

The RPM is calculated using encoder A and B signals. For Mach3, the RPM data is saved in UserDROs index 10 thru 15 for 6 axis.

The CountsPerRev_x value specifies the encoder counts per rev x 4. For example for a 500 count encoder you enter 2000.

```
<RPM>
        <CountsPerRev_x> 2000 </CountsPerRev_x>
        <CountsPerRev_y> 4000 </CountsPerRev_y>
</RPM>
```

A.5 PID Filter

These values define the co-efficient of PID filters for each axis. See Section 6.2 PID Filter Configuration for definition of these parameters. The PID filter is run at 5KHz for each axis.

More information on PID control is available at http://en.wikipedia.org/wiki/PID_control.

A.6 ControlInput Source

ControlInput Source defines the input type (or set-point) for the PID filter for a particular axis. The possible values are:

CommandPosition: This setting is used for PC applications that generate command position itself, e.g. Mach3. The Interpreter 1000 makes the axis follow these command positions. The command position data is provided to Interpreter 1000 at a rate of 1KHz for each axis.

TrajectoryPlanner: The Interpreter 1000 controller also has built in trajectory generator (or planner) for each axis. This allows motion profiles to be generated automatically, based on user provided distance, accel, and velocity settings.

Counter: Use a shaft encoder counter as the PID input.

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

A.7 ControlInput Index

Defines the index of the PID input source. Normally this is equal to the axis number. For slave application, this defines the data index of the master.

A.8 ControlInput Gain

Defines the multiplier before applying the data to the PID input. E.g. if Analog Input 0 is the source, analog input 0 value is first multiplied by the Gain and then used in the PID calculation.

A.9 PID Feedback Source

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

Counter: Use a shaft encoder counter as the PID feedback.

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

A.10 PID Feedback Index

Defines the index of the PID feedback source.

A.11 PID Feedback Gain

Defines the multiplier before applying the data to the PID feedback. E.g. if Encoder Counter 0 is the feedback source, Encoder Counter 0 value is first multiplied by the Gain and then used in the PID calculation.

A.12 ControlOutput Type

ControlOutput Type defines the output for the PID filter for a particular axis. The possible values are:

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

Stepper: Use one of the dedicated digital output pairs for the Step and Direction signals used in stepper drives.

Undefined: This setting is used when the axis is disabled and the index is used on some other axis. For example, if DAC 6 is used for Spindle speed and DAC 6 is also used as ControlOuput for the axis, but the axis is not part of the system, then the user must define the ControlOutput type as undefined. If the axis is part of the system, then some other index should be used for Spindle or axis output.

A.13 ControlOutput Index

Defines the index of the PID Output type.

A.14 AmpEnable Index

Defines the index of the digital output to be used as the enable signal for the output servo amplifier or drive. Valid range is 0 thru 16. A value of 0 means no output is used as Enable signal for this axis. Value of 1..16 means digital output 0 .. 15.

A.15 Homing

This section defines homing sequence for each axis. Two types of homing sequence are supported:

- **HomeSensor** (homing with or without Index Pulse)
- **IndexPulseOnly** (Use only the Index pulse to Home)

For *HomeSensor* method, the axis moves in configured direction until home sensor is found. It then moves in the opposite direction for configured length. If *UseIndexPulse* is set to 1, after finding the home sensor, the axis moves in opposite direction to locate the index pulse and then continue moving for the configured length.

For *IndexPulseOnly*, the axis moves in the configured direction to locate the index pulse to home the axis. It then moves in the opposite direction for the configured length.

A.16 MPG Settings – MpgSource1

This section defines MPG (Manual Pulse Generation) Quadrature encoder source. Both Differential and Single Ended Encoder types are supported. Differential encoder can be hooked up to any of the six encoder channel available on connectors J6 and J7. These encoders are defined as ***HardEncoder*** in the xml file. Single Ended encoders (defined as ***SoftEncoder***) can be hooked up to the Digital Inputs available on Connector J5.

The pin assignments for available SoftEncoder are as follows:

SoftEncoder 0 : A+ On J5 Pin 6,
B+ On J5 Pin 19
SoftEncoder 1 : A+ On J5 Pin 7
B+ On J5 Pin 20
SoftEncoder 2 : A+ On J5 Pin 8
B+ On J5 Pin 21

Example 1: Connect a differential encoder for MPG on Encoder Channel 5 (J7)

```
<MpgSource1>
        <Type> HardEncoder </Type>
        <Index>5</Index>
</MpgSource1>
```

Example 2: Connect a single-ended encoder for MPG on J5 Digital Inputs, pin 7 and 20.

```
<MpgSource1>
        <Type> SoftEncoder </Type>
        <Index>1</Index>
</MpgSource1>
```

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