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1. Preface



Any machine tool is potentially dangerous. Computer controlled machines are potentially more dangerous than manual ones because, for example, a computer is quite prepared to rotate an 8" unbalanced cast iron four-jaw chuck at 3000 rpm, to plunge a panel-fielding router cutter deep into a piece of oak or to mill the clamps holding your work to the table!

This manual tries to give you guidance on safety precautions and techniques but because we do not know the details of your machine or local conditions we can accept no responsibility for the performance of any machine or any damage or injury caused by its use. It is your responsibility to ensure that you understand the implications of what you design and build and to comply with any legislation and codes of practice applicable to your country or state.

If you are in any doubt you must seek guidance from a professionally qualified expert rather than risk injury to yourself or to others.

This document is intended to give details about how to set-up your G100 for the Mach3 system. It assumes that you are familiar with the contents of *Using Mach2Mill* or *Using Mach2Turn* (still in preparation) as appropriate.

You are strongly advised to join the online discussion forum for Mach3. A link to join it is on the *Company* page at <http://www.artsoftcontrols.com/>. You should be aware that, while the forum has many engineers with a vast range of experience as participants, it does not constitute a substitute for a machine tool manufacturer's support network. If your application requires this level of support then you should buy the system from a local distributor or an OEM with a distributor network. In that way you will get the benefits of Mach3 with the possibility of on-site support.

Certain portions of text in this manual are printed "greyed out". They generally describe features found in machine controllers but which are not presently implemented in Mach2. The description of a greyed out feature here is not to be taken as a commitment to implement it at any given time in the future.

Thanks are due to numerous people including the original team who worked at National Institute for Standards and Testing (NIST) on the EMC project and the innumerable users of Mach3 without whose experience, materials and constructive comments this manual could not have been written. Particular thanks are due to Olivier Adler and Brian Barker for their contributions to the development and documentation of Wizards and to Les Newell for his KeyGrabber (which now grabs a lot more than key strokes!).

ArtSoft Corporation is dedicated to continual improvement of its products, so suggestions for enhancements, corrections and clarifications will be gratefully received.

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Every effort has been made to make this manual as complete and as accurate as possible but no warranty or fitness is implied. The information provided is on an "as is" basis. The authors and publisher shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this manual. Use of the manual is covered by the license conditions to which you must agree when installing Mach3 software. Windows XP and Windows 2000 are registered trademarks of Microsoft Corporation. If other trademarks are used in this manual but not acknowledged please notify ArtSoft Corporation so this can be remedied in subsequent editions.

2. Getting Started, an Overview

When working with Mach3's firmware, the G100 communicates through a special binary protocol unlike its geckmotion native firmware. This requires the G100 be flashed with the Mach3 flavour of firmware. All axis can run independently or in coordination with other axis. In this manual we will be going over the steps taken to get your G100 setup and running under the control of Mach 3. It is my intention to be very clear direct, and take the shortest path to reach the desired goal. There is a wealth of information that has been left out of this *G100 Setup Guide* on purpose. I recommend you look over the manual in its entirety and get familiar with it before you begin. **I would also recommend at this point you download and install the latest version of Mach 3. The latest version can be found at <http://www.artsoftcontrols.com/artsoft/downloads/downloads.htm> Also, download the G100 plug-in that can found at <http://www.artsoftcontrols.com/artsoft/plugin.htm> The installation of the G100 plug-in is covered later in section 4.**

This manual covers the following. Section numbers have been listed to avoid confusion.

3. Connections.

This Section will tell you how to get your G100 wired in to the point of being able to power the G100 and communicate thru an Ethernet connection. It does not cover any inputs or outputs

4. Installing the G100 plug-in.

This section covers in detail the downloading and installation process for installing the G100 plug-in.

5. Loading the firmware

This section covers in detail the loading of the firmware.

6. Configuring Mach3.

This section covers in detail the settings you will set from within Mach3. You will open your Mach 3 Profile to get to these settings. Located in the upper left hand corner, Config. tab.

7. Known Issues

This section list known issues.

8. Revisions List

This section list the revisions made to plug ins, firmware, and this manual by date.

9. Trouble Shooting

This section will suggest possible causes of problems and remedies for each. This section will most likely be the one that is most often edited as problems produce and remedies are acquired.

2.1 Useful Links.

Below is a list of links that you may find helpful while in the process of getting your G100 Setup

<http://www.artsoftcontrols.com/> Artsoft's home page

<http://www.artsoftcontrols.com/artsoft/downloads/downloads.htm> Download Mach 3 here.

<http://www.artsoftcontrols.com/artsoft/plugin.htm> Download the G100 plug-in here

<http://www.artsoftcontrols.com/forum/index.php> Artsoft's forum home page

<http://www.artsoftcontrols.com/forum/index.php?board=13.0> Artsoft forum dedicated board to the G100 and Mach3

<http://www.geckodrive.com/index.cfm> Gecko drives home page.

<http://www.geckodrive.com/product.cfm?pid=19> Gecko drives G100 page.

<http://www.netspec.com/helpdesk/wiredoc.html> Network cables link 1.

<http://www.peakelec.co.uk/content/ethernet.html> Network cables link 2

2.2 G100 DESCRIPTION:

The G100 is a 6-axis motion controller. It uses USB or Ethernet communication with a host PC to execute motion control and I/O commands. The axis outputs use a Step/Direction interface to motor drives. Each axis has an associated quadrature encoder input. The G100 also has 22 general purpose inputs, 16 general purpose outputs, 4 analog to digital inputs and 4 digital to analog outputs. Each digital input and output has an LED indicator. **USB is not used with Mach**

The G100 uses an FPGA to generate axis step pulse timing and an 8-bit microcomputer to calculate motion control flow. Communication with the G100 is via text string commands and replies. All axis can run independently or in coordination with other axis. Coordinated axis motion is vector based. The associated axis accelerate, run and decelerate simultaneously while maintaining exact speed ratios.

The G100 uses a unique method of motion control. The FPGA produces step pulse frequencies proportional to 16-bit word. This results 32,767 CW and 32,767 CCW evenly spaced step-pulse frequencies per range. The commanded frequency can only be changed at a fixed rate of 1,024 times per second. The same crystal oscillator time base generates step pulse frequencies and the update rate. The axis position is a running sum of the issued velocities.

The 1,024 updates per second also apply to all inputs and outputs. Inputs, including analog are sampled at that rate and all outputs, including analog are updated at that rate.

G100 HARDWARE FEATURES:

- 1) 8 step-pulse frequency ranges. 65,535 CW and CCW speeds per range. Maximum step-pulse frequency is 4.194304 MHz. Maximum step-pulse jitter is 125 ns. Step and direction outputs are 5V logic, +/-24 mA current drive per output. Step-pulse indicator LED is activity driven; it is lit when output is pulsing.
- 2) 6 quadrature encoder inputs including index channel. Maximum encoder count rate is 1 MHz. Encoder inputs are filtered and have indicator LEDs on each input.
- 3) 16 general-purpose outputs. The outputs are rated at 100mA, 24VDC maximum per output. The outputs are suitable for driving DC relay coils. Each output has an indicator LED which lights when an output is "on".
- 4) 22 general-purpose inputs. The inputs can be activated by SPST switches to ground, by open-collector sensors or by 5V logic levels. The inputs are filtered and protected to +/- 50VDC. Each input has an indicator LED that lights when an input is grounded.
- 5) 4 Digital to analog outputs. Each output is a 0 to 5V (0 to 10V optional) op-amp output and 8-bit resolution.
- 6) 4 Analog to digital inputs. Each input takes a 0 to 5V (0 to 10V optional) input voltage range. The resolution is 8-bit and the input impedance is 2.2K.
- 7) The G100 requires a 12VDC to 24VDC power supply rated at 1.5A. It supplies an internally regulated 5VDC to the terminal block outputs.
- 8) The G100 has both a USB and an Ethernet interface. **USB is not used with Mach**

- 9) The G100 has a 2.5" by 7.375" mounting area footprint and is 1.5" high (63.5mm by 187mm by 38mm). The weight is 10 ounces (284 gm). The enclosure is black anodized aluminum. The G100 has 96 bare-wire type terminal block locations. The terminal blocks have a 3.5mm pitch.

3. Connections

This Section will tell you how to get your G100 wired in to the point of being able to power the G100 and communicate thru an Ethernet connection. It does not cover any inputs, or outputs. **Nor does it cover the USB connection as you should not need it to for use with Mach 3.**

3.1 Primary Electrical Connections.

With the G100 you will have two types of power, the first is the power supplied to the G100. The second is the power the G100 supplies to other devices such as home, limit, and input switches.

3.1.1 Incoming Power.

The G100 requires a 12VDC to 24VDC power supply rated at 1.5A. This can be accomplished in one of two ways. There is a power jack at one end of the G100 for plugging a wall transformer into. This is a center positive (+) connector. The second way is to supply 12VDC to 24VDC + to the terminal marked +24V and a wire connecting the terminal marked GND to ground. Either way supplies an internally regulated 5VDC to the terminal block outputs. Inputs will be covered later in **Section 6.1.4, Inputs Signals.**

3.1.2 Outgoing Power.

At this point we will only point out the fact that the terminals marked +5V is an outgoing power source. **You do not need to supply 5V+ to any of these** as you would with some other breakout boards. Outputs will be covered later in **Section 6.1.5, Output Signals**

3.2 Ethernet.

The G100 uses an Ethernet connection to communicate with Mach 3. It is located in the end opposite of the power connection. As with the incoming power connection, you can establish communication with the G100 one of two ways. One way is to connect it to a standard (straight through) patch cable coming from your network router. The second way is to connect directly to an Ethernet connection on your control PC. **This requires you to use a network crossover cable.**

3.2.1 Networking.

Properly configuring the G100 to communicate with your PC is not difficult, but it does take a little bit of planning. The method of communication for Ethernet is the TCP/IP protocol, which requires each individual device to have a unique IP address. It can be thought of like the postal system – a network is like the post office, and each individual device is a P.O. Box. In order for the mail, in this case packets of information, to be delivered to the correct device, you need to know what address to send it to. On a typical home network, this is commonly done with a router running DHCP, which hands out an IP address from a pre-defined pool to any device requesting one. For a network that does not have a router, or for devices such as the G100 that do not request IP's, then the IP address must be statically assigned. IP addresses can theoretically be any number from 0.0.0.0 to

255.255.255.255, but only small segments of these are allowed for home, or private, use. The segments are: 10.0.0.0 – 10.255.255.255; 172.16.0.0 – 172.16.255.255; and 192.168.0.0 – 192.168.255.255. **It is **very** important that you choose a static IP address for your G100 that falls into one of these ranges.** 99% of most home networks are configured for the 192.168.xxx address block, so the static IP of your G100 should fall into the same 192.168.xxx block (the last number, or octet, of any address is the unique number for the device – the first 3 octets define the network and should be the same). With all of this in mind, it's now time to define a static IP for the G100.

3.2.1.1 Networking with a router

To find out what IP address your computer has, open a Command Prompt and type in the command **ipconfig**. For the sake of example, let's assume that ipconfig shows us an IP address of 192.168.1.100, a Subnet Mask of 255.255.255.0, and a Default Gateway of 192.168.1.1. What this tells us is that the G100 must be assigned an IP address somewhere in the 192.168.1.xxx address block. At this point, it's now important to determine exactly what addresses are available to us, i.e. what addresses are not included in the DHCP pool on the router. Since the router is also typically the default gateway in 99% of circumstances, we open up a web browser and go to 192.168.1.1 to open up the router configuration page. After inspecting our router configuration, let's assume that we determine that the DHCP pool starts at 192.168.1.100 and ends at 192.168.1.150. This tells us that any number, excluding 1 and 100-150, is available to us (assuming that there are no other static IP's on the network). Therefore, we can safely program the G100 to have an IP address of 192.168.1.10, with a Subnet Mask of 255.255.255.0 and a Default Gateway of 192.168.1.1 (copied from ipconfig because the will be the same for every device on the network). At this point, we can talk to the G100 by sending any necessary information to 192.168.1.10.

3.2.1.2 Networking without a router

Networking without a router does not necessarily mean networking without a hub or switch. Whether using a hub, a switch, or connected directly to the G100 through a crossover cable, the important point is that there is no device on the network automatically handing out IP addresses. This means that every device on the network must have a static IP address. To find out what, if any, IP address that your computer has open a Command Prompt and type in the command **ipconfig**. If the command returns an IP of 0.0.0.0 or 169.xxx.xxx.xxx, then there is no address assigned. If another number is returned, such as an IP address of 192.168.1.100, then a static IP has already been assigned. For the sake of argument, let's assume that no valid IP has been assigned, so we need to set one. To do this, go into the Control Panel and open the Network Connections. Depending on the specific configuration of your computer, there may be a few things in there. For a typical computer with 1 network card, there should only be Local Area Connection. Each additional card would be Local Area Connection 2, Local Area Connection 3, etc. Windows 2000 should display the card name (i.e. Intel 10/1000/1000 Gigabit Controller, Marvell Yukon Gigabit Controller, etc) under the connection, Windows XP will show it under Details in the left-hand sidebar of the window. If you have no idea what type/brand of card you're trying to connect to, good old-fashioned trial-and-error still works. Once you have determined which connection you want to configure, right-click on the icon, and choose Properties from the menu that pops

up. On the General tab, highlight *Internet Protocol (TCP/IP)* in the list box, and then click on the Properties button underneath the box. In the property box that opens, *Obtain an IP address automatically* is typically selected, which tells the computer to get its IP address via DHCP. To set the static IP, click the radio button next to *Use the following IP address:*. This should un-grey the box underneath it, allowing you to manual enter an IP. Following the rules above, choose an appropriate IP address, such as 192.168.1.100. The Subnet Mask should always be 255.255.255.0, and the Default Gateway can be left blank. The other boxes at the bottom of the screen, specifying DNS server addresses, can also be left blank. Click Apply and Ok as appropriate until you are back to the desktop. To verify that everything is correct, open up a Command Prompt and type ipconfig again. This time, the IP address that you configured should appear. Now you can safely configure the G100 to have any IP address available on the network, such as 192.168.1.10, with a Subnet Mask of 255.255.255.0. At this point, we can talk to the G100 by sending any necessary information to 192.168.1.10.

3.2.1.3 Troubleshooting

To verify that the G100 and the PC can communicate, a simple **ping** command is all that is required. To use ping, open up a Command Prompt and type in ping followed by the IP address of the G100, i.e. ping 192.168.1.10. If everything is working, the result will be 4 replies. If the message “Request timed out” appears instead of a reply, it means that there is no response. This indicates that the IP address you tried to ping is not correct, or there is a cabling error. If the error message “Destination Network Unreachable” appears instead of a reply, it means that the network of the IP address you’re trying to ping and the IP address your computer is configured for are not the same (i.e. 192.168.1.100 / 192.168.0.10), or the Subnet Mask is configured incorrectly (i.e. 255.255.255.255 instead of 255.255.255.0). This can be fixed by double-checking all numbers. If Windows generates an error message informing you that a duplicate IP exists on the network, this can be rectified by simply following the steps above and changing the PC IP address to something different.

4. Installing the G100 plug-in

The first thing you need to get your G100 running with Mach 3 is a G100 plug-in file that can be downloaded from the Artsoft website. You will have to buy a licenses file to unlock the demo time limit.

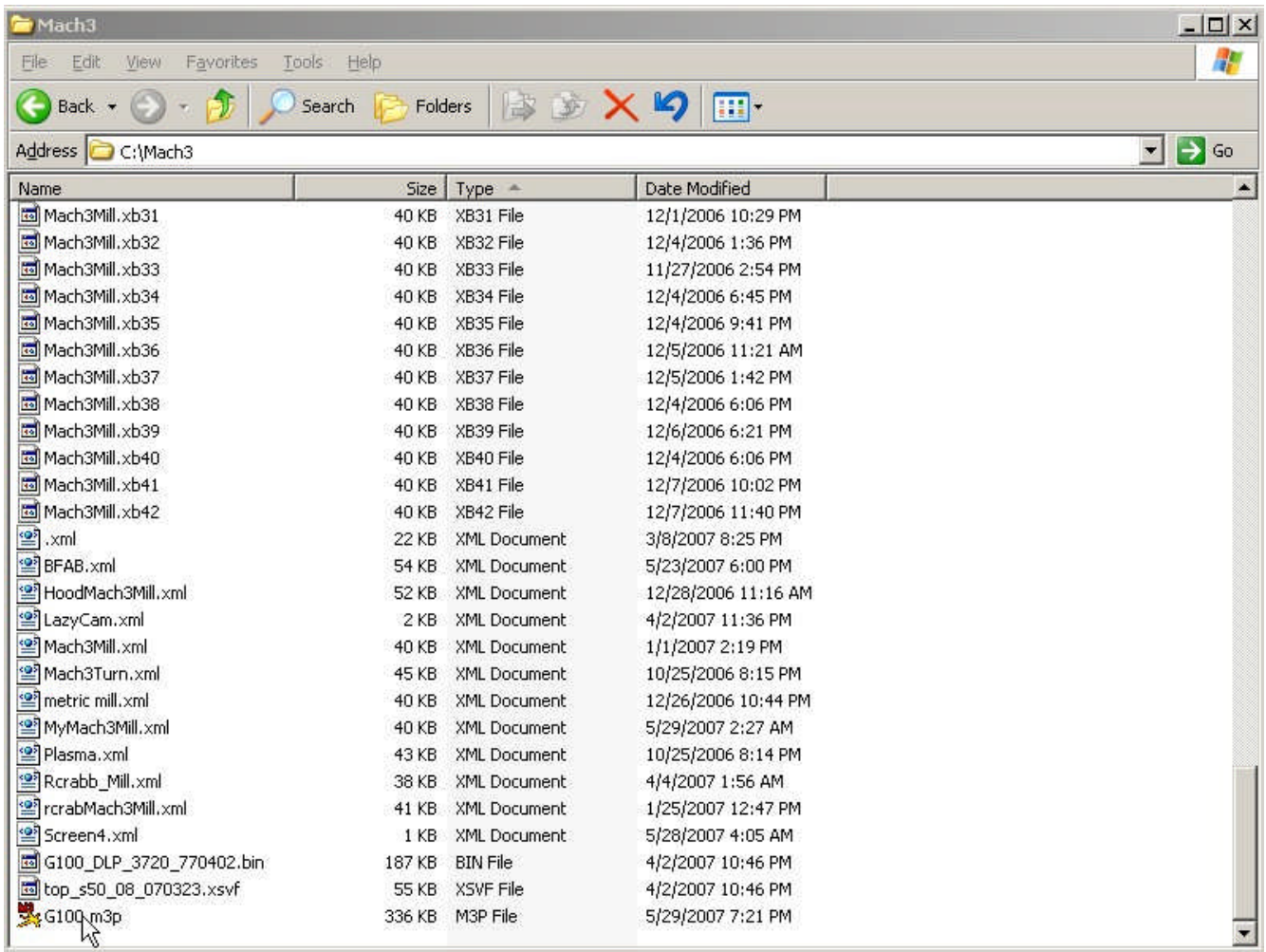
<http://www.artsoftcontrols.com/artsoft/plugin.htm>

When you get your G100 licenses file, copy or drag it into your Mach 3 root folder.

Next, unzip the files that came with the G100 plug-in to your Mach 3 root folder, [C:\Mach3](#)



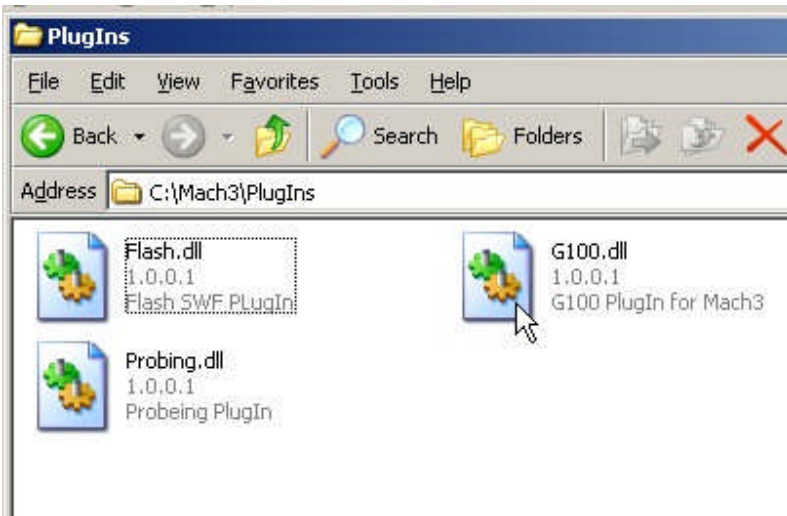
Browse to your Mach 3 root folder and double click on the G100. m3p file.



A box should pop up saying that a plug-in has been installed. Click OK.



You can check to make sure the plug-in was installed by clicking on the plug-ins folder in your Mach 3 root folder. and see that the G100.dll file is there.

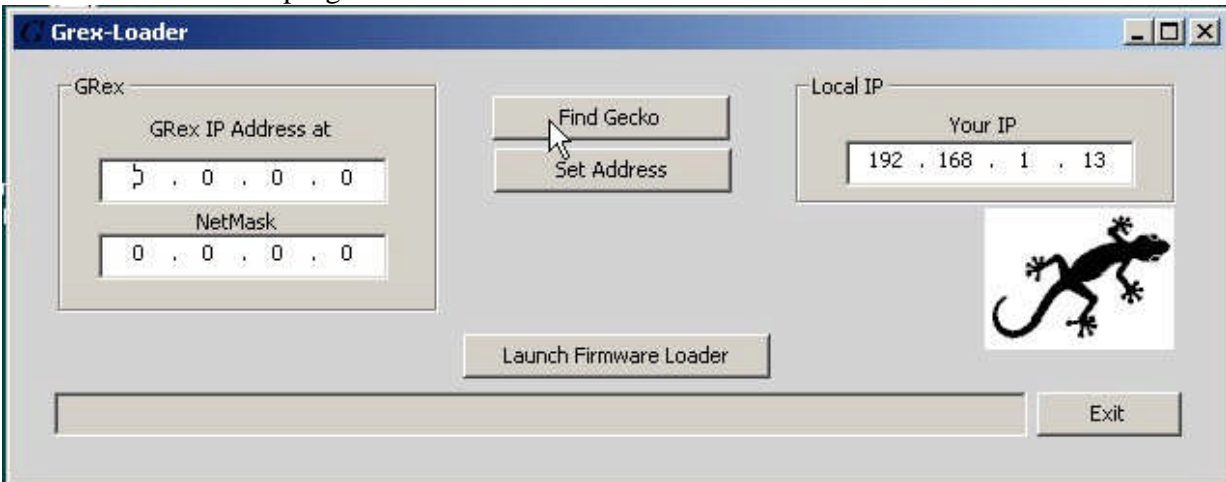


5. Loading the firmware

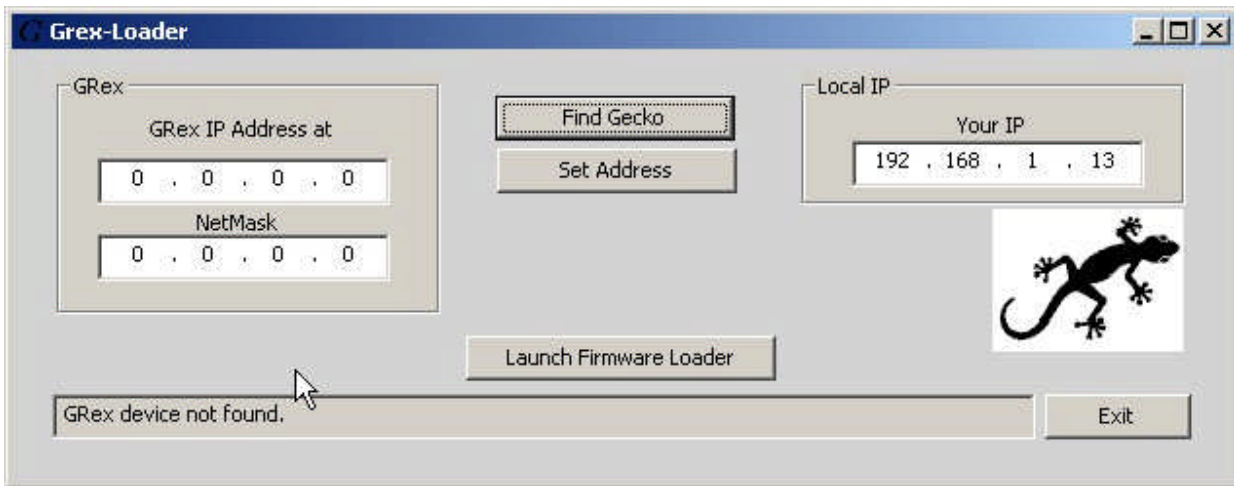
Plug in the power adaptor and the network cable to the G100. Remember to use a crossover cable if you go direct from the PC to the G100.

In your Mach3 folder there is a program named "GreX-Loader.exe" make a shortcut to it and put it on your desktop.

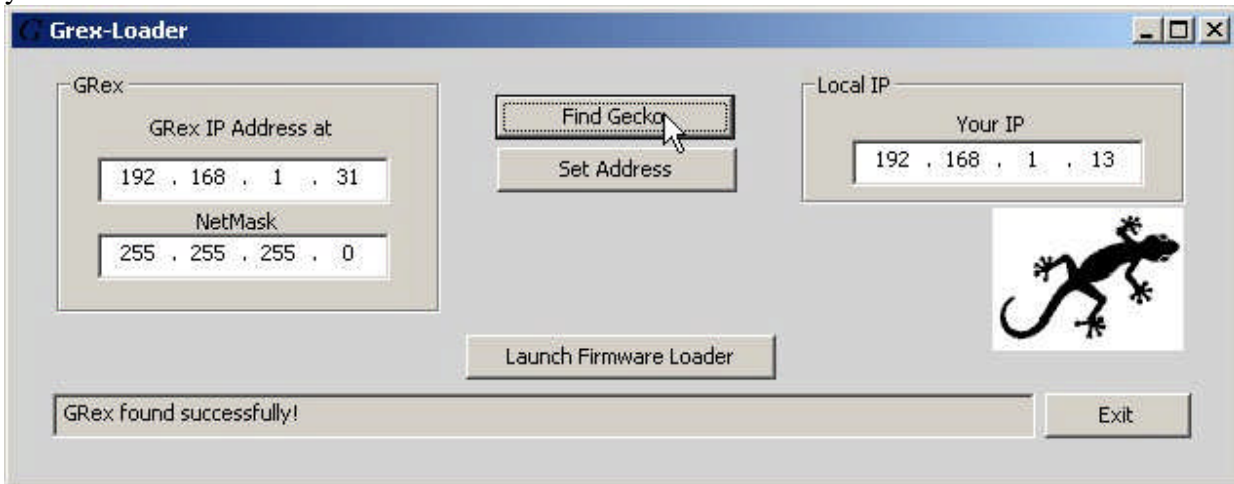
Start the GreX-Loader program. You will see a screen like this. Click the Find Gecko button.



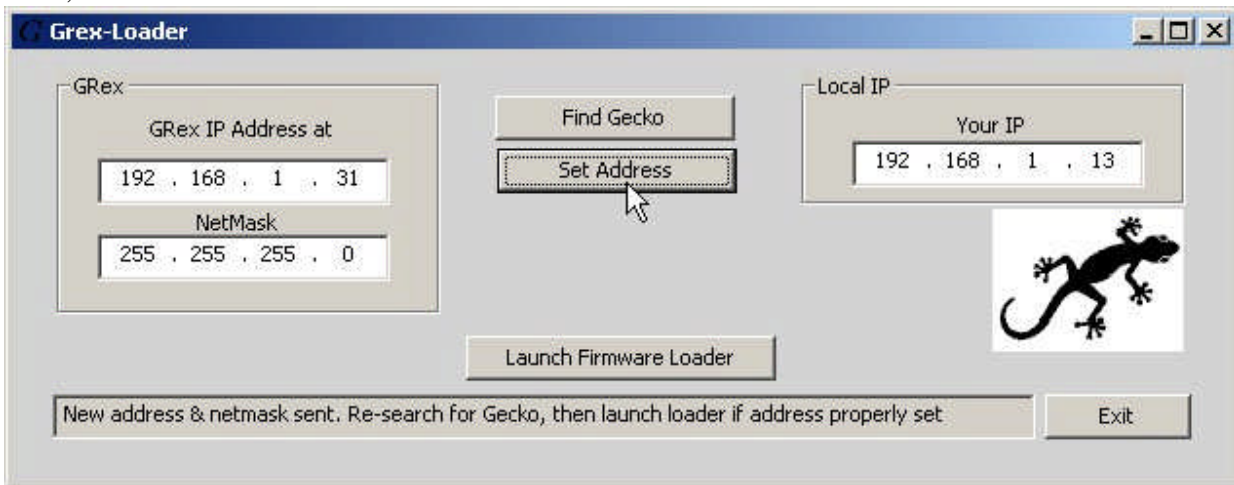
You probably got a screen like this saying, "GRex device not found".



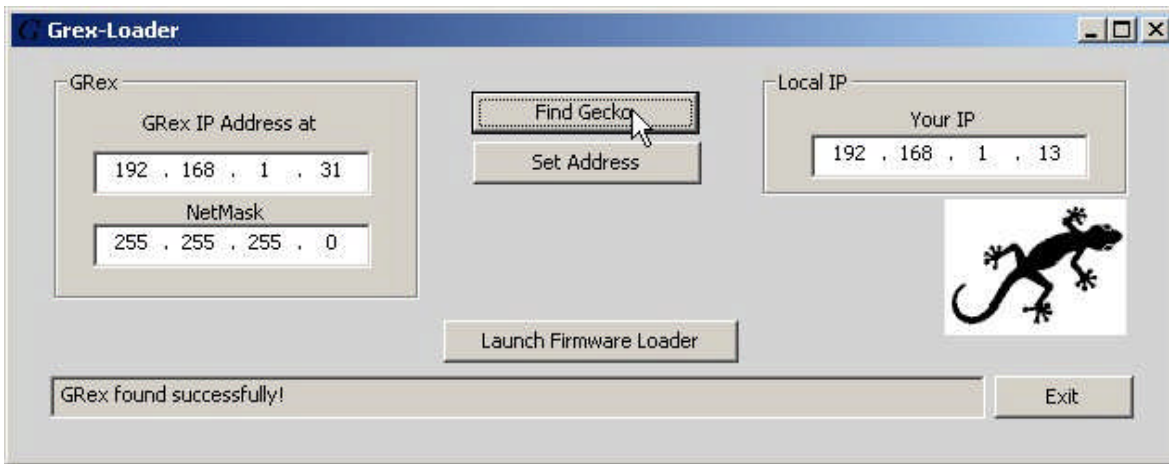
This is because you only have about 10 seconds to find the G-Rex. Cycle power to the G-Rex and click Find Gecko again, about every 2 seconds. On the second or third try you should see a screen like this.



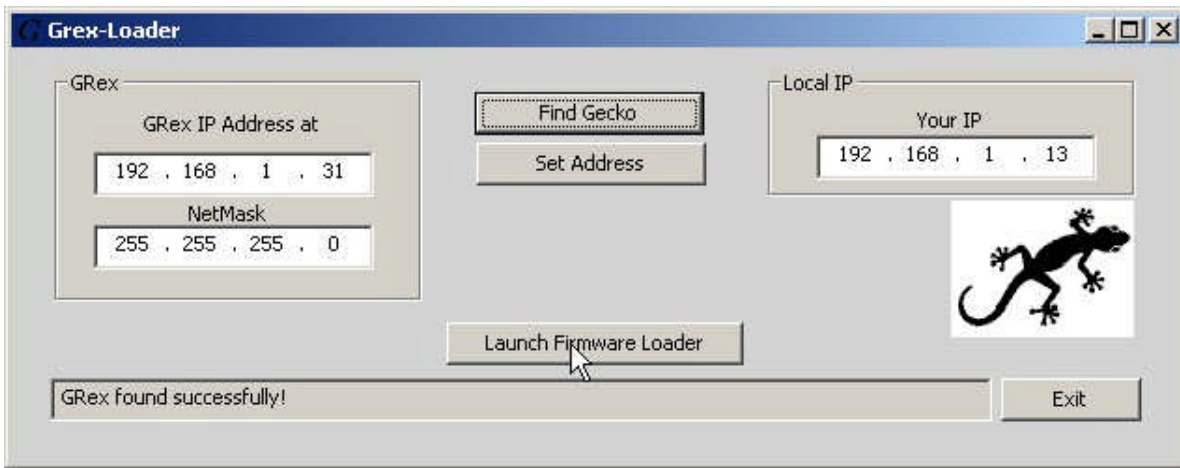
Now, click set address.



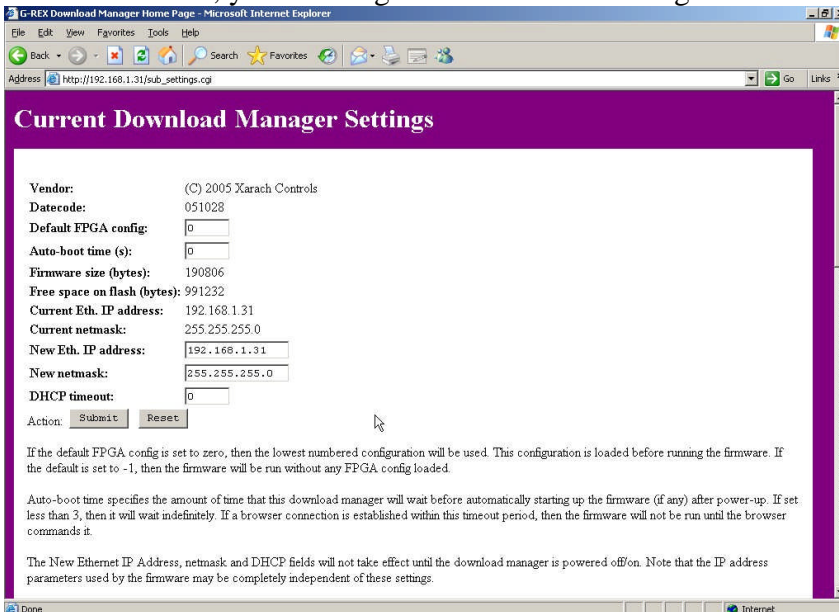
Click Find Gecko button again



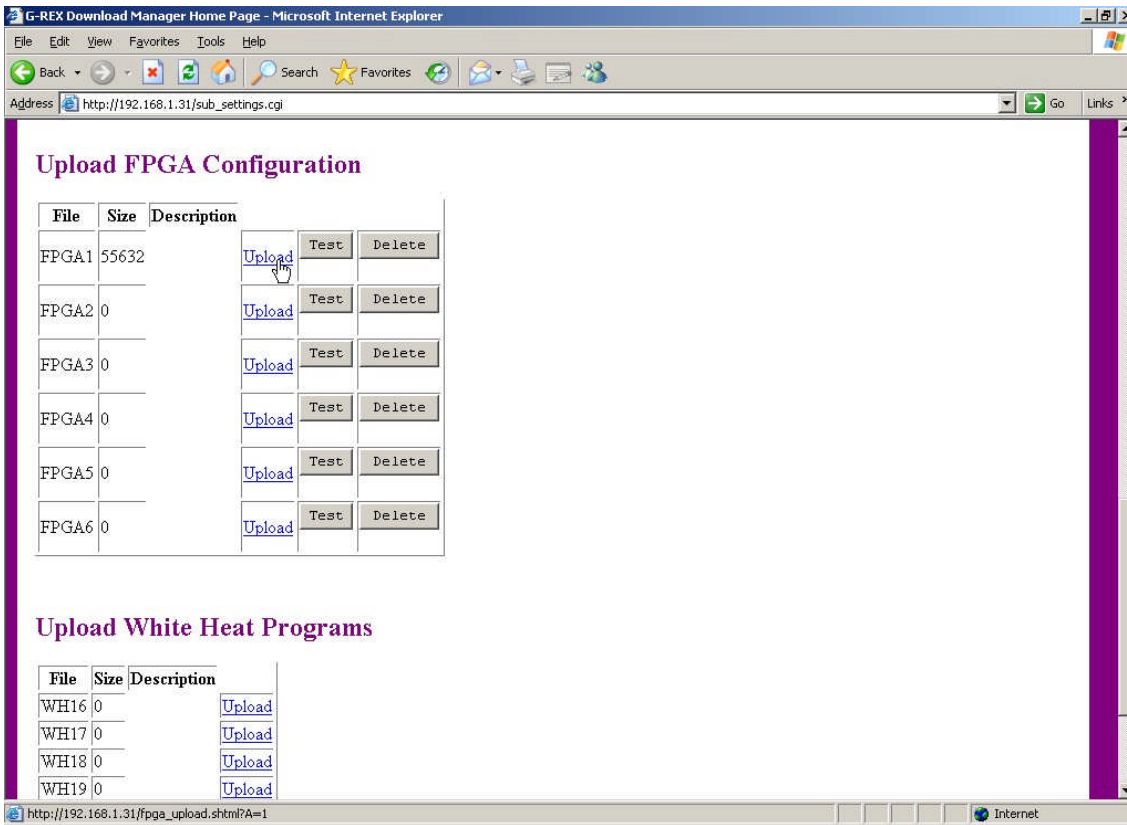
Now click the Launch Firmware Loader Button.



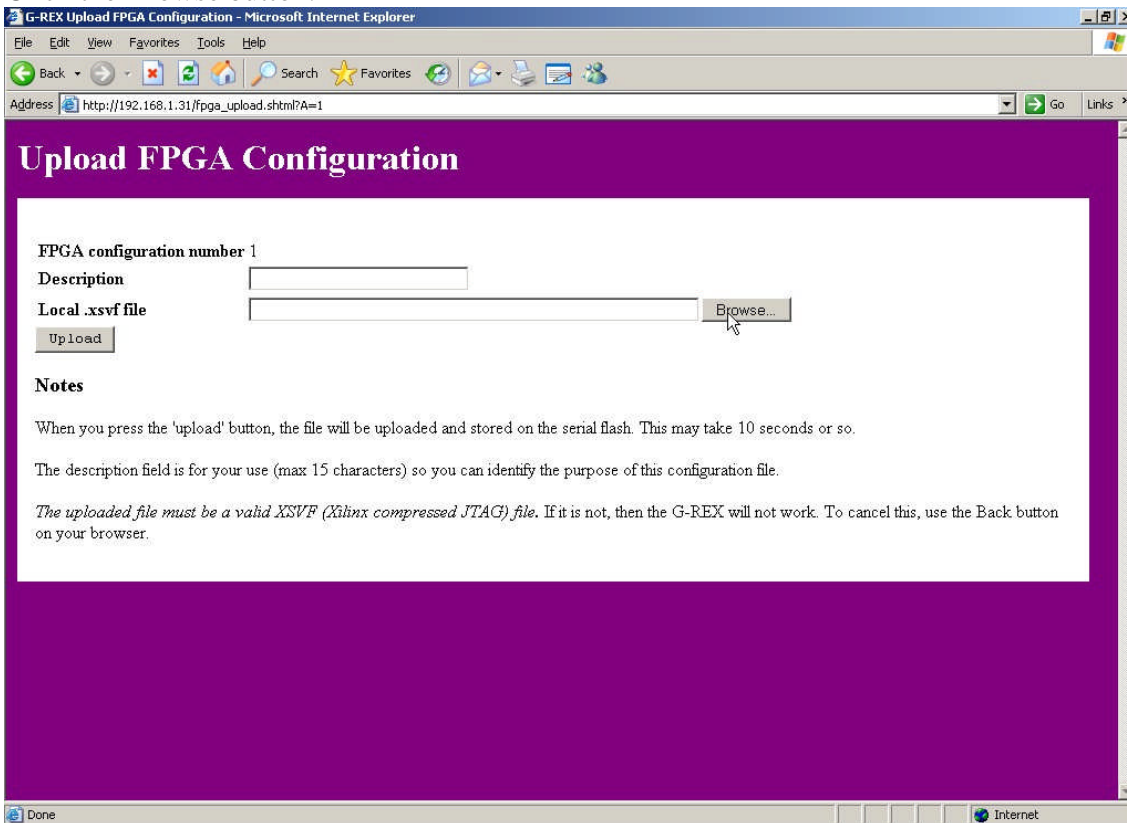
In a few seconds, you should get the Download Manager. The screen should look like this.



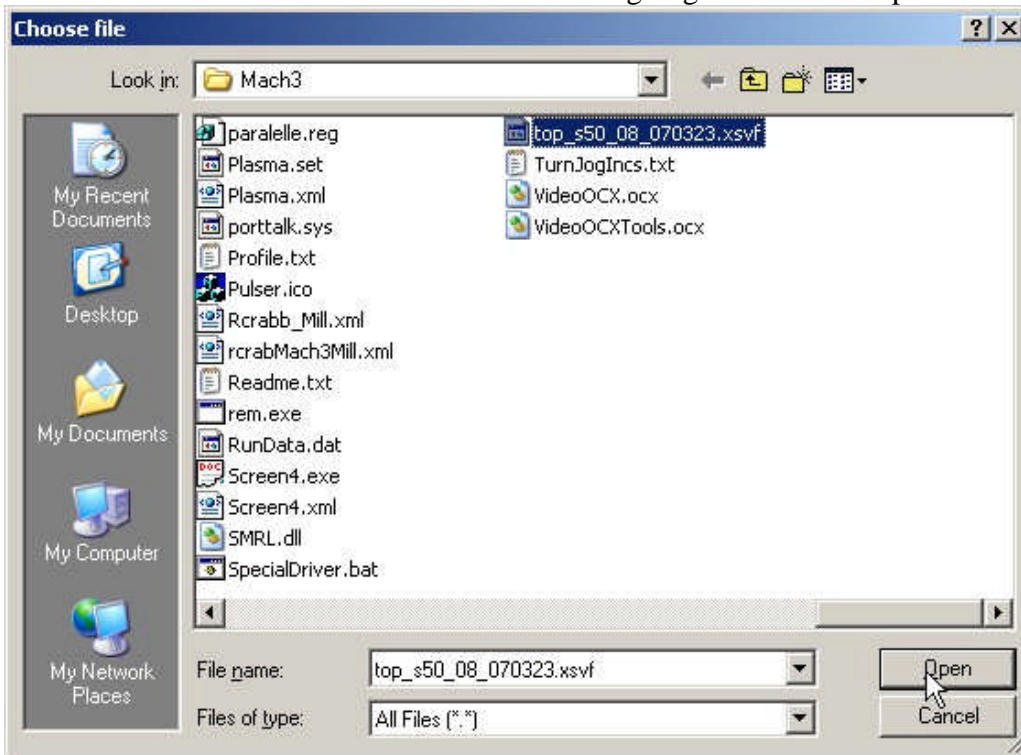
Scroll down to the section Upload FPGA Configuration and click on the "Upload" link



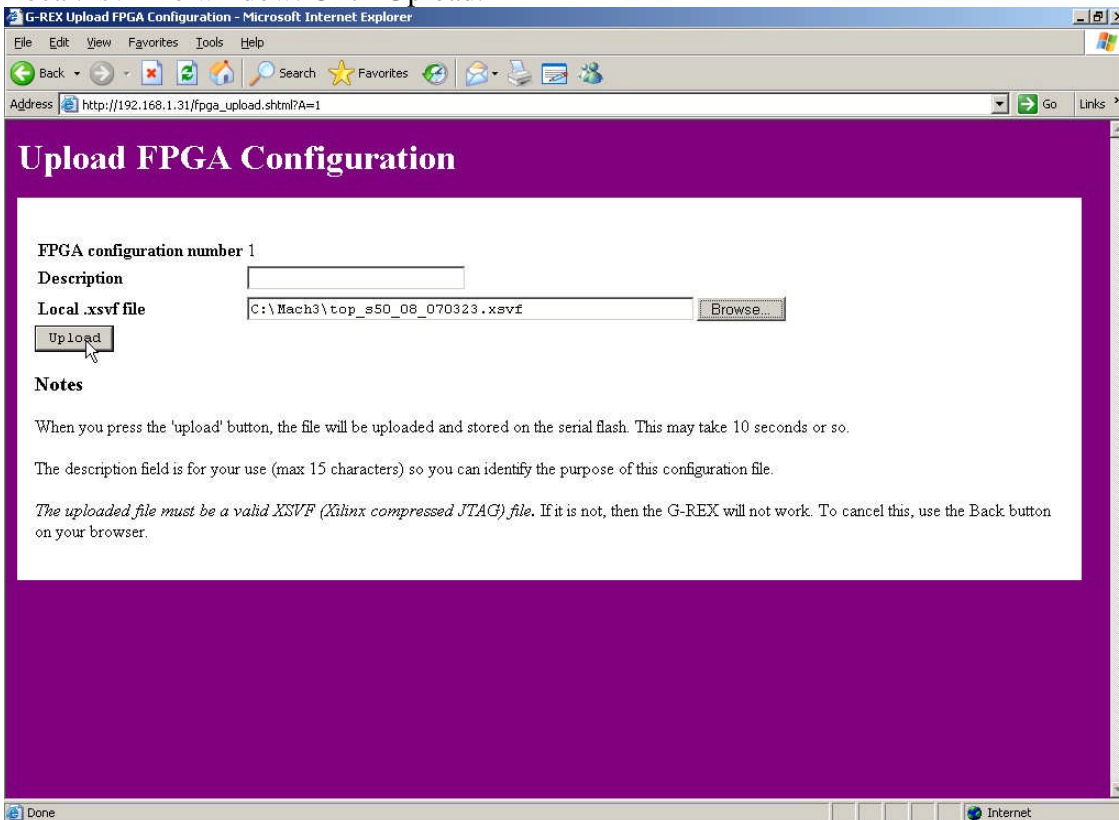
Click the Browse button.



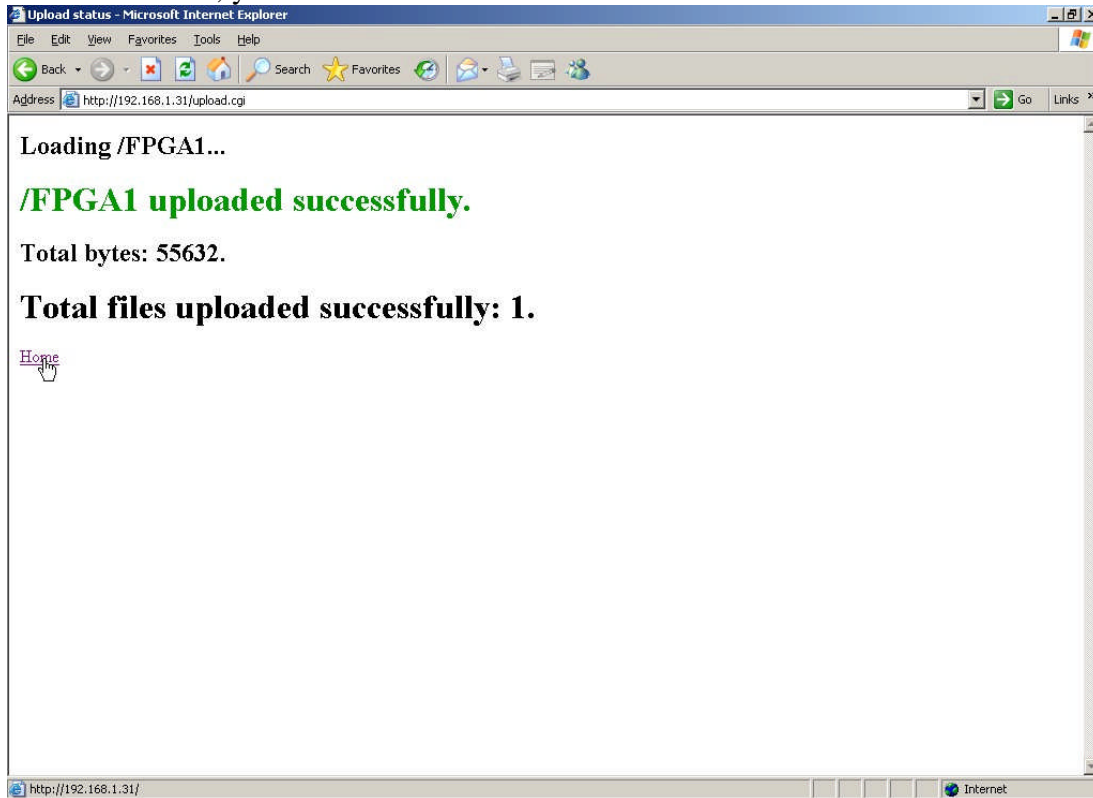
Browse to your Mach 3 root folder. Find the .xsvf file you pasted in from the G100 plug-in zip file you downloaded from Artsoft. Double click on it or high light it and click open.



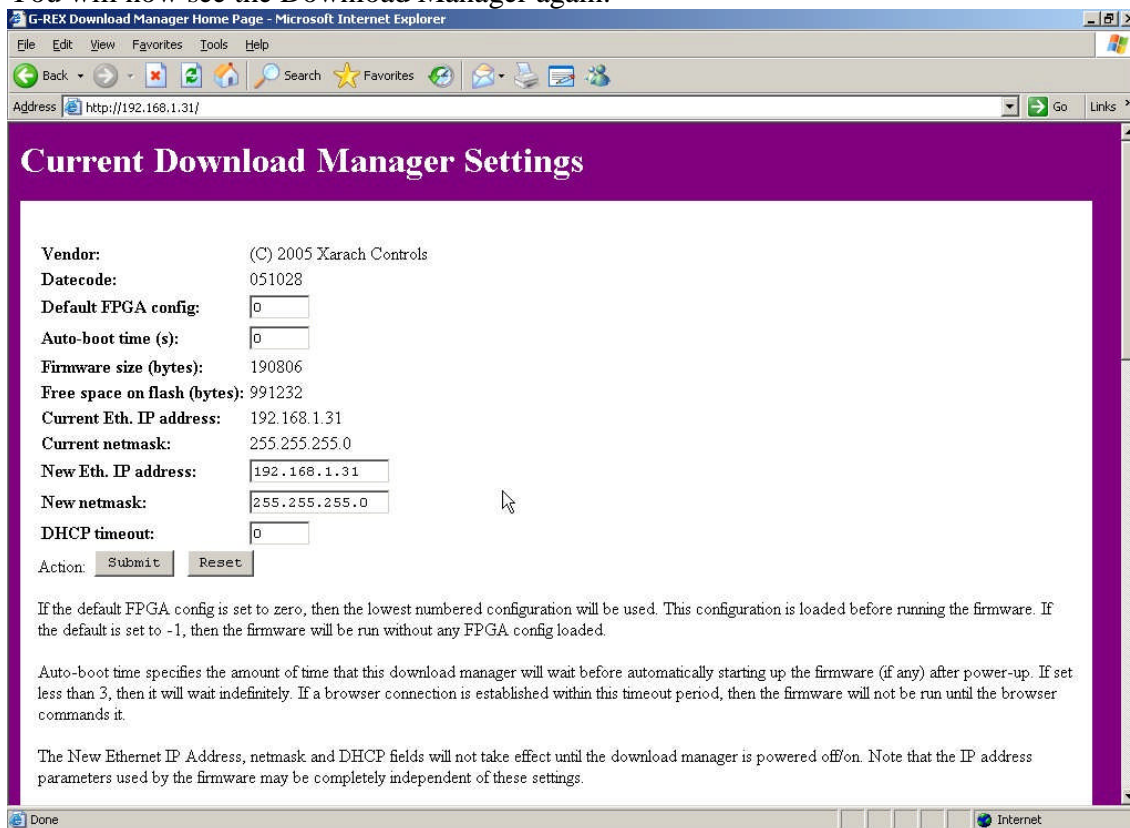
That will take you back to this screen. You will notice the file you selected is now showing in the Local.xsvf file window. Click Upload.



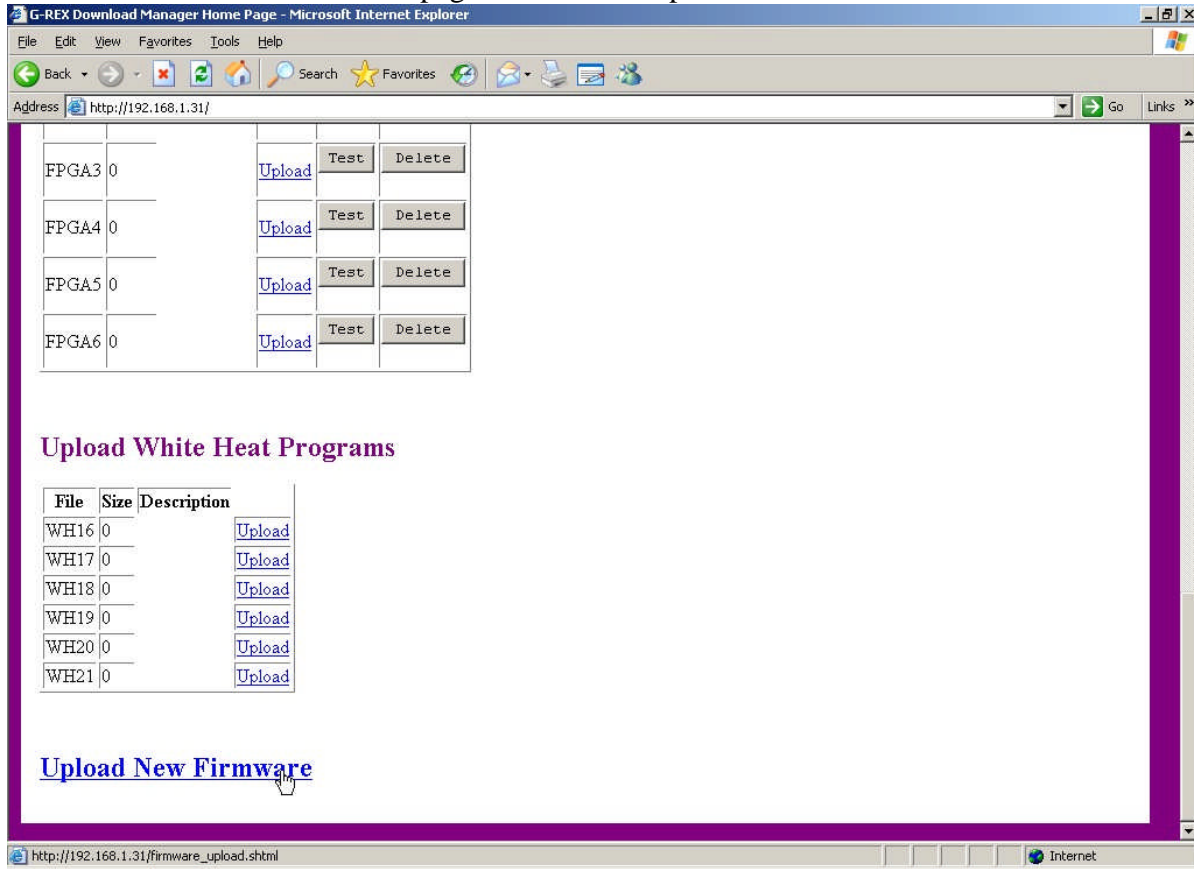
In a few seconds, you should see this screen. Click the Home button.



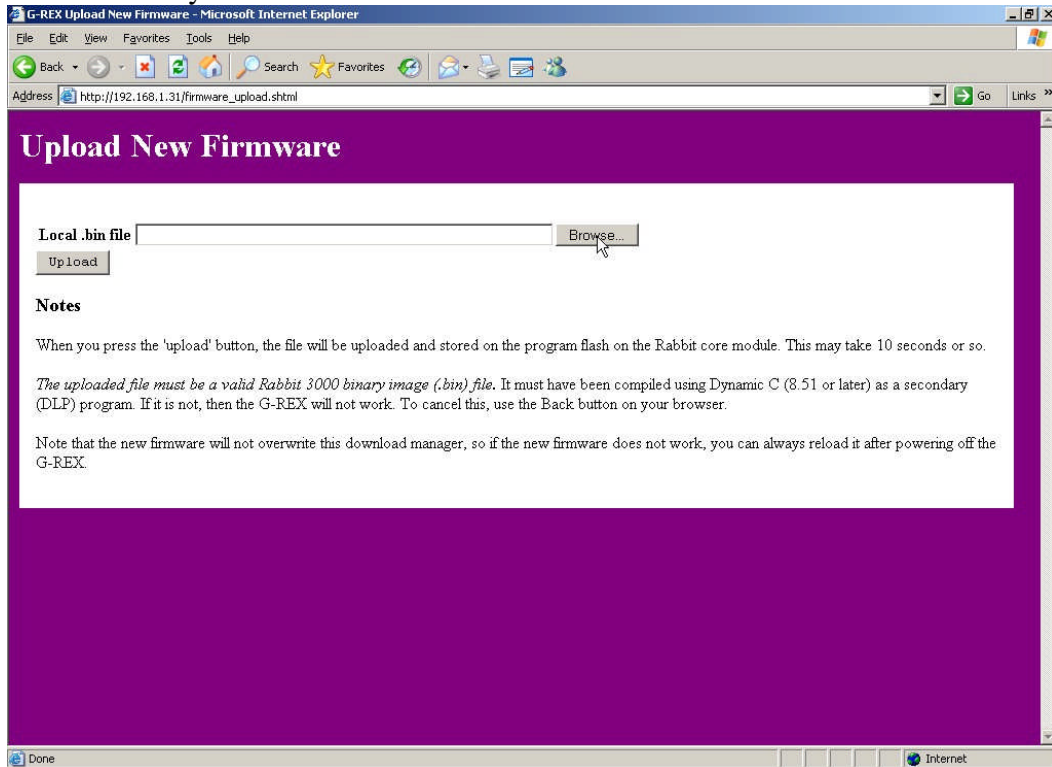
You will now see the Download Manager again.



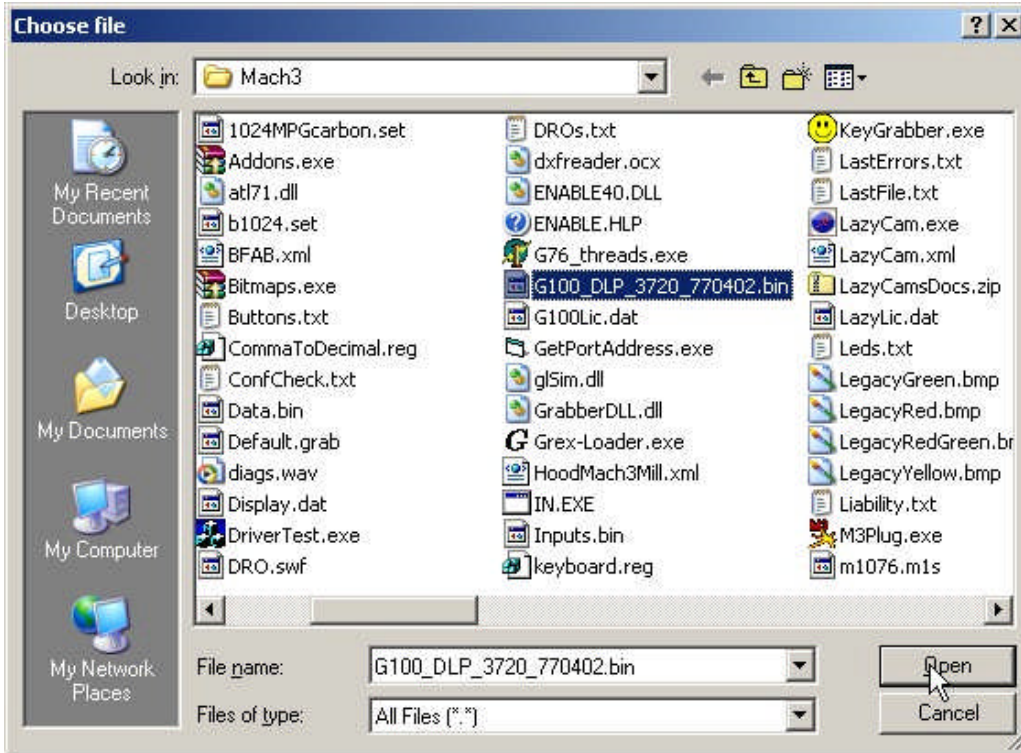
Scroll down to the bottom of the page and click on Upload New Firmware



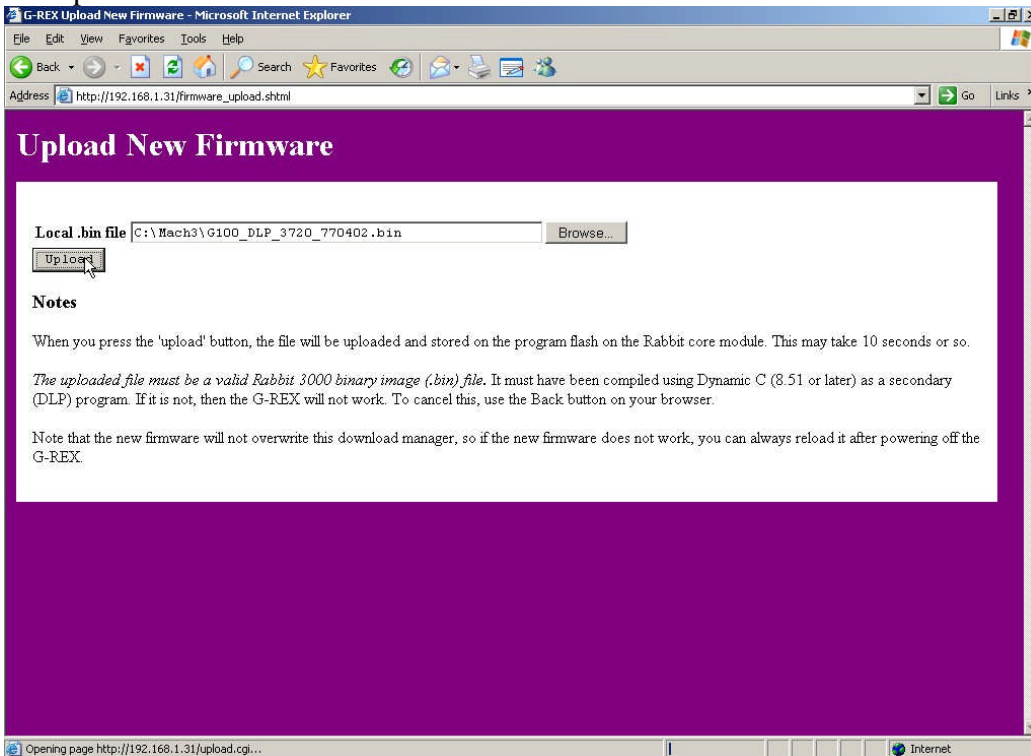
That will take you to this screen. Click the Browse button.



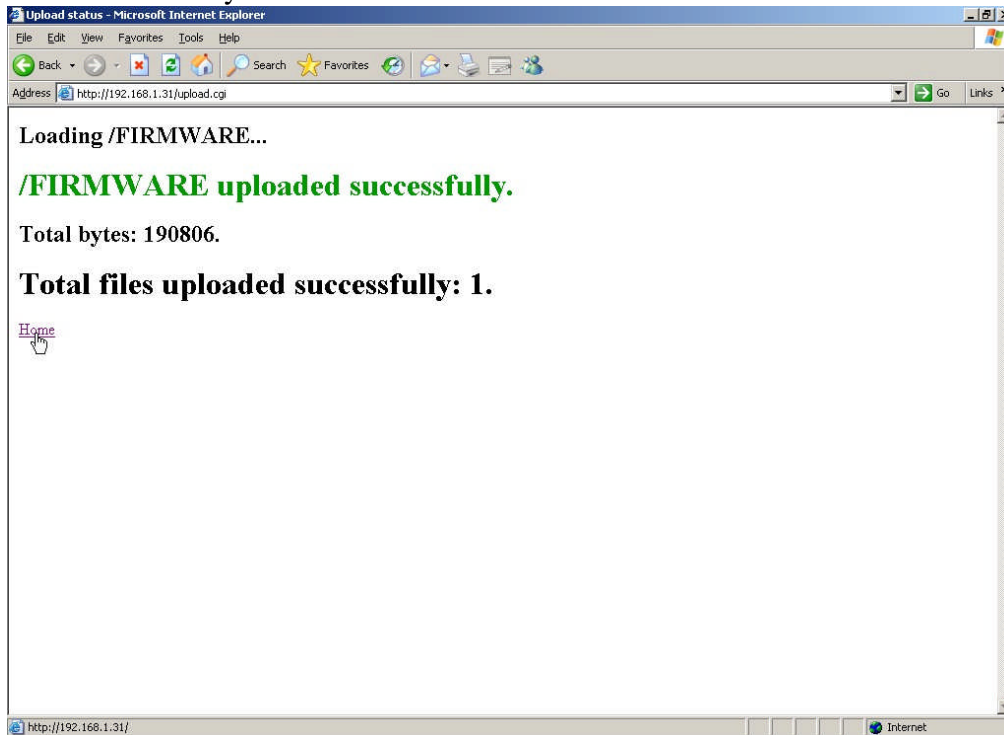
Browse to your Mach 3 root folder and choose the .bin file that came with your G100 plug-in from Artsoft. Double click on it.



That will take you back to this screen. Notice the .bin file now shows in the Local.bin file window. Click the Upload button.



In a few seconds you should see a screen like this. Click the home link.



This brings you back to the Download Manager. Type 10 in the Auto-boot time window and press enter.

Current Download Manager

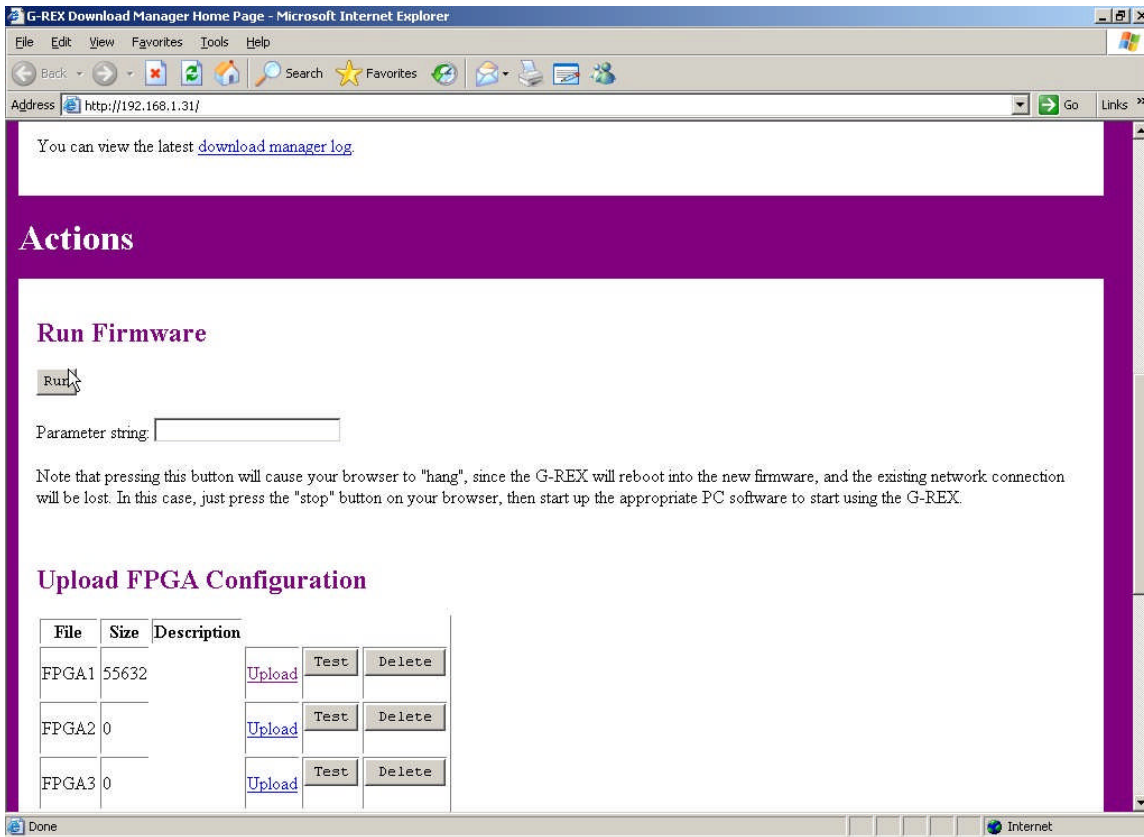
| | |
|------------------------------|--|
| Vendor: | (C) 2005 Xarach Controls |
| Datecode: | 051028 |
| Default FPGA config: | <input type="text" value="0"/> |
| Auto-boot time (s): | <input type="text" value="10"/> |
| Firmware size (bytes): | 190806 |
| Free space on flash (bytes): | 991232 |
| Current Eth. IP address: | 192.168.1.31 |
| Current netmask: | 255.255.255.0 |
| New Eth. IP address: | <input type="text" value="192.168.1.31"/> |
| New netmask: | <input type="text" value="255.255.255.0"/> |
| DHCP timeout: | <input type="text" value="0"/> |
| Action: | <input type="button" value="Submit"/> <input type="button" value="Reset"/> |

Now click the Submit button.

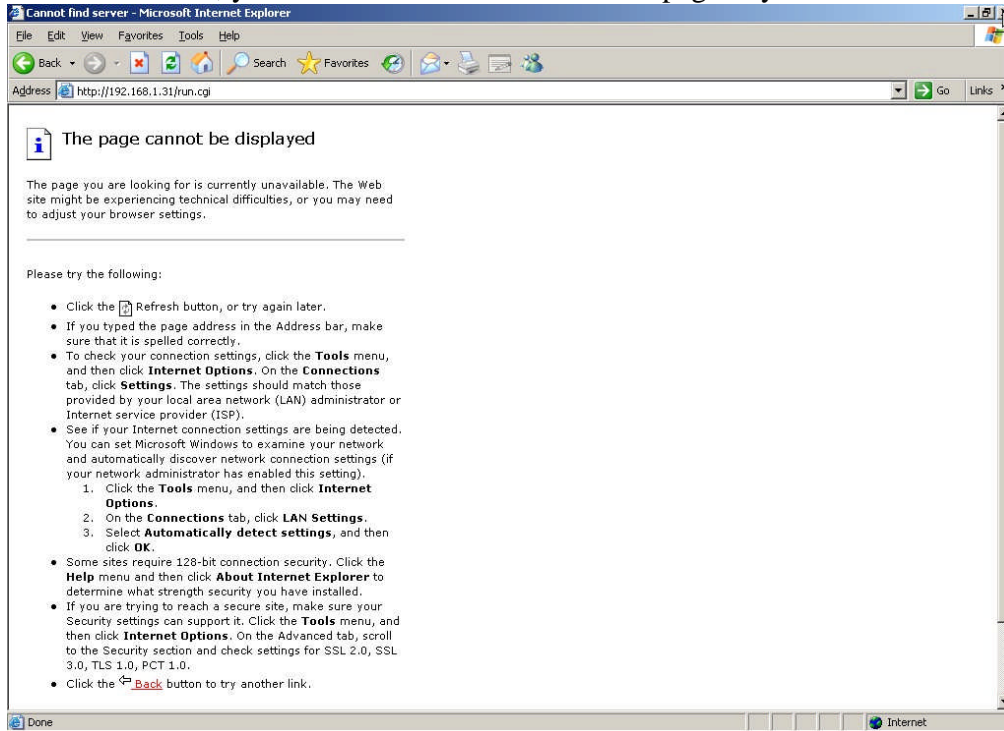
Current Download Manager

Vendor: (C) 2005 Xarach Controls
Datecode: 051028
Default FPGA config:
Auto-boot time (s):
Firmware size (bytes): 190806
Free space on flash (bytes): 991232
Current Eth. IP address: 192.168.1.31
Current netmask: 255.255.255.0
New Eth. IP address:
New netmask:
DHCP timeout:
Action:

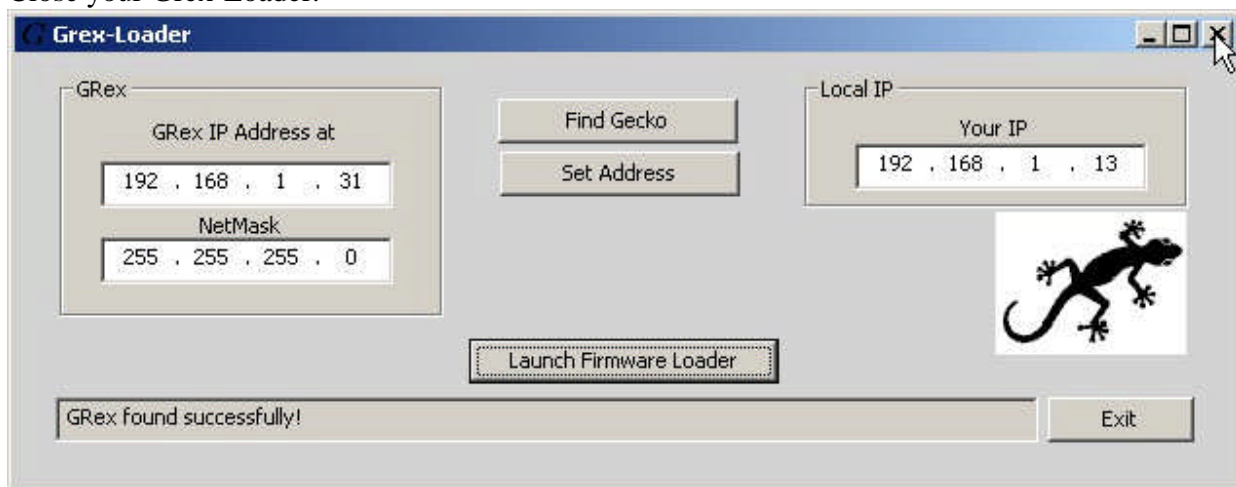
Scroll down to the Actions section and click run under Run Firmware



In a few seconds, you should see a blank or an error page in your browser. Close your browser.



Close your Grex-Loader.



Your firmware is now loaded.

6. Configuring Mach3

In this section we will cover the settings that are set from inside Mach3. These will include Ports and Pins, Motor Tuning, General Config, and Homing/Limits. To get to these open Mach and click on the Config tab at the top.



I will not be going over everything you see here. Most of this has been covered in earlier documents. They can be found at <http://www.artsoftcontrols.com/documentation/> I will only be dealing with the ones that are different for using the G100.

6.1 Ports and Pins

In the Ports and Pins section you will be telling Mach what port you are using to control a pin and what the pins are connected to. I suggest that you make a spread sheet to start with. It should contain all inputs and outputs you will either get information from (these are your inputs) or send information to (these are your outputs). In Ports and Pins, the port is referring to a printer port address. Since the G100 is using an Ethernet connection instead of the printer port, there is no need to set up a printer port. You do however need to always set the port to port 1. **When using a G100 all ports are always set to Port 1.** The pins will vary drastically. The pins are most likely only good for your particular set-up.

6.1.1 G100 Pinout

I have inserted a picture of a G100 below. It shows the relationship of the markings on the G100 and to what pin they coincide with in Mach. For example, look at the left upper corner of the picture. You see the green writing that says Pin 17. It is pointing to the X axis limit pin on the G100. You should wire your home switch for the X axis to this pin. When you set up the pin address in Mach, it will be port 1, pin 17. You also see a screen shot of the analog inputs and out puts viewed in the G100 monitor. What it is telling you is that the pin on the G100 marked Analog out 4 coincides with the top DRO in the analog out section of the monitor.

Input 17 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input 18 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input 19 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input 20 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input 21 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input 22 --- LIM
Step and Dir. to drive --- DIR
Encoder or MPG --- STEP
Encoder index --- +5V
CH-A
CH-B
CH-I
GND

Input power and ground
Only if you choose not to use the plug in connector in the end.

Outputs 1-16

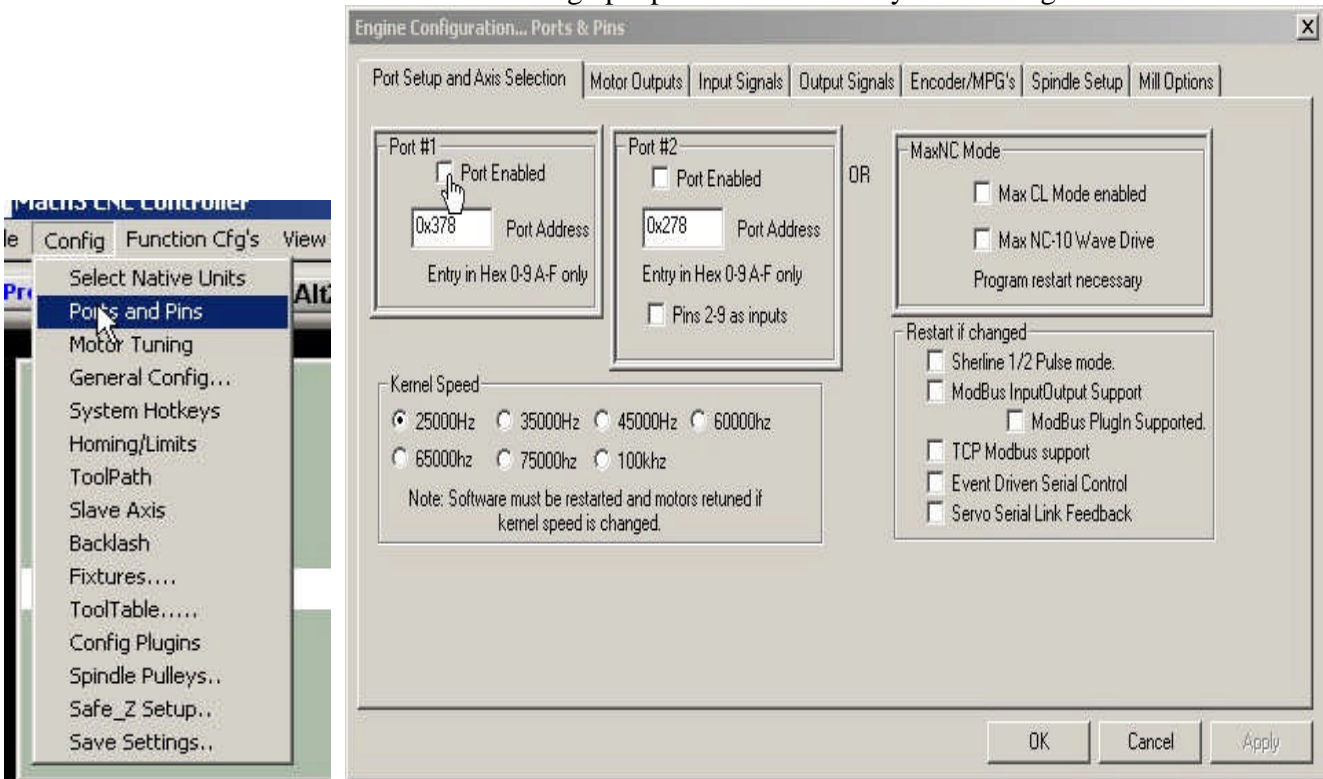
| Analogue Out | Analogue In |
|--------------|-------------|
| 0.00 4 | 4.98 4 |
| 0.00 1 | 0.00 1 |
| 0.00 2 | 0.00 2 |
| 0.00 3 | 0.00 3 |

These numbers coincide with the numbers on the G100

Inputs 1-16

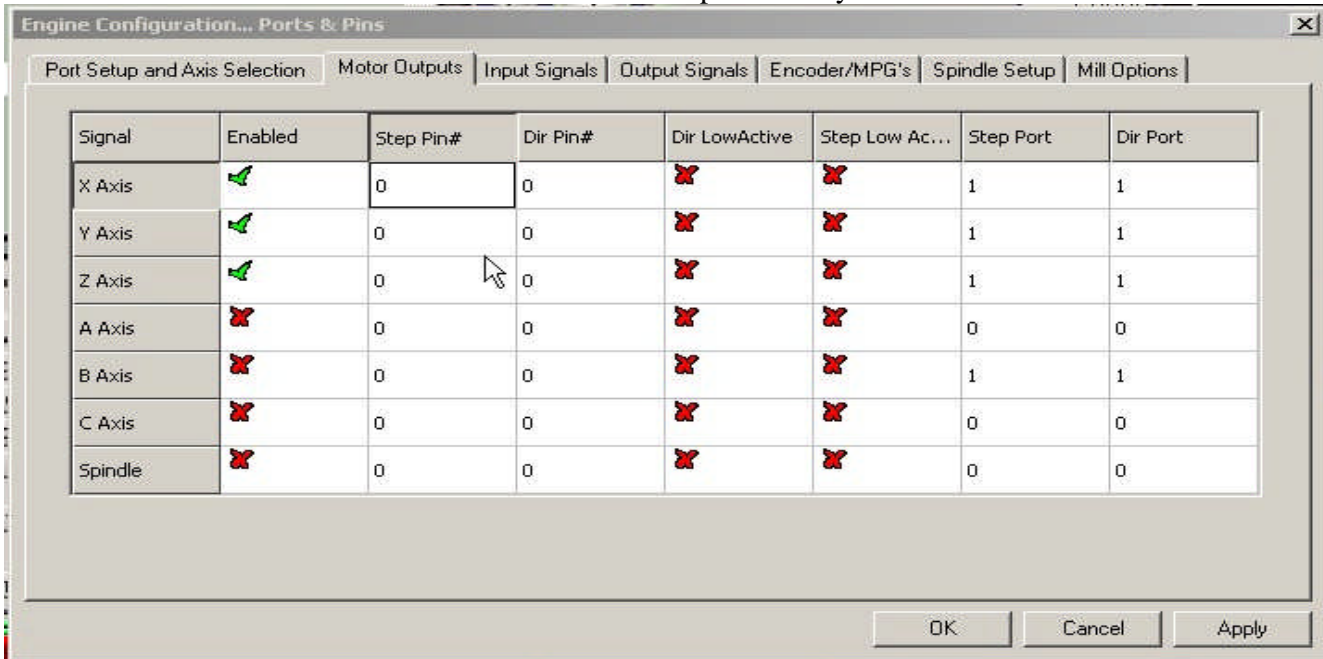
6.1.2 Port Setup

In the pictures below, you see that I have no ports enabled. This is because the G100 uses an Ethernet connection. Setting up a port is not necessary when using the G100.



6.1.3 Motor Outputs

In this section you only need to enable the motors and set the port address for all step and direction pins to port 1. You can set all pin numbers to 0 if you like, it doesn't have an effect on the G100 as they are hard coded. If you send a command to an axis, the pins labeled for that axis on the G100 will respond if they are enabled.

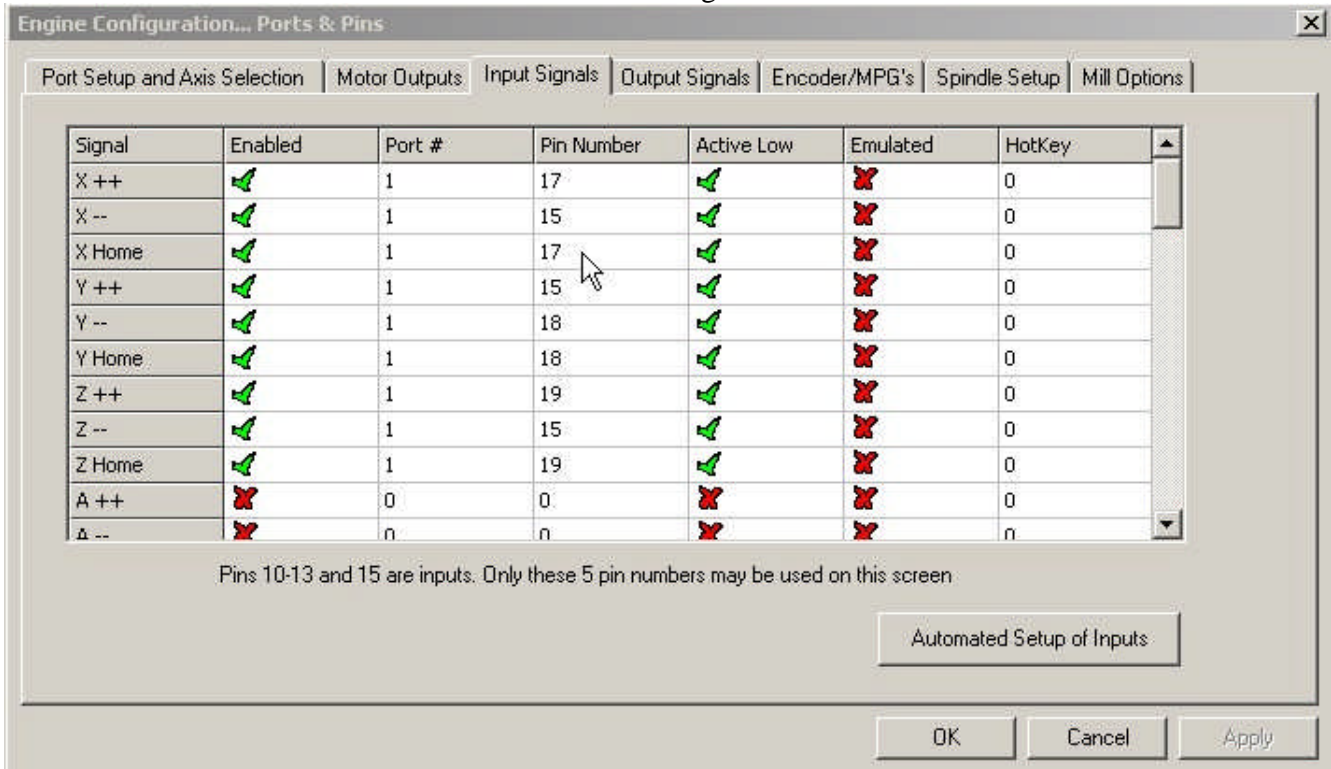


6.1.4 Input Signals

Inputs are signals that are sending information to Mach. There are several types of input signals the G100 and Mach can use to perform many functions. I will try to cover the following in this section. Digital, Analog, Encoder, and MPG (Manual Pulse Generator).

6.1.4.1 Digital Inputs

Digital inputs are just a signal. They are either on or off. A digital input is recognized by a drastic change in voltage. The G100 is sourcing 5 volts to the digital input pins. To send a signal to Mach through the G100, simply ground the 5 volts coming from that pin. This “sinks” the voltage to ground lowering it to 0 to make the necessary change in voltage to be recognized as active, in this case “active low”. In the picture below, you see that I have pins 17, 18, and 19 in two positions each. These are my home switches during the homing routine and my limit switches when not in homing.



6.1.4.2 Analog Inputs

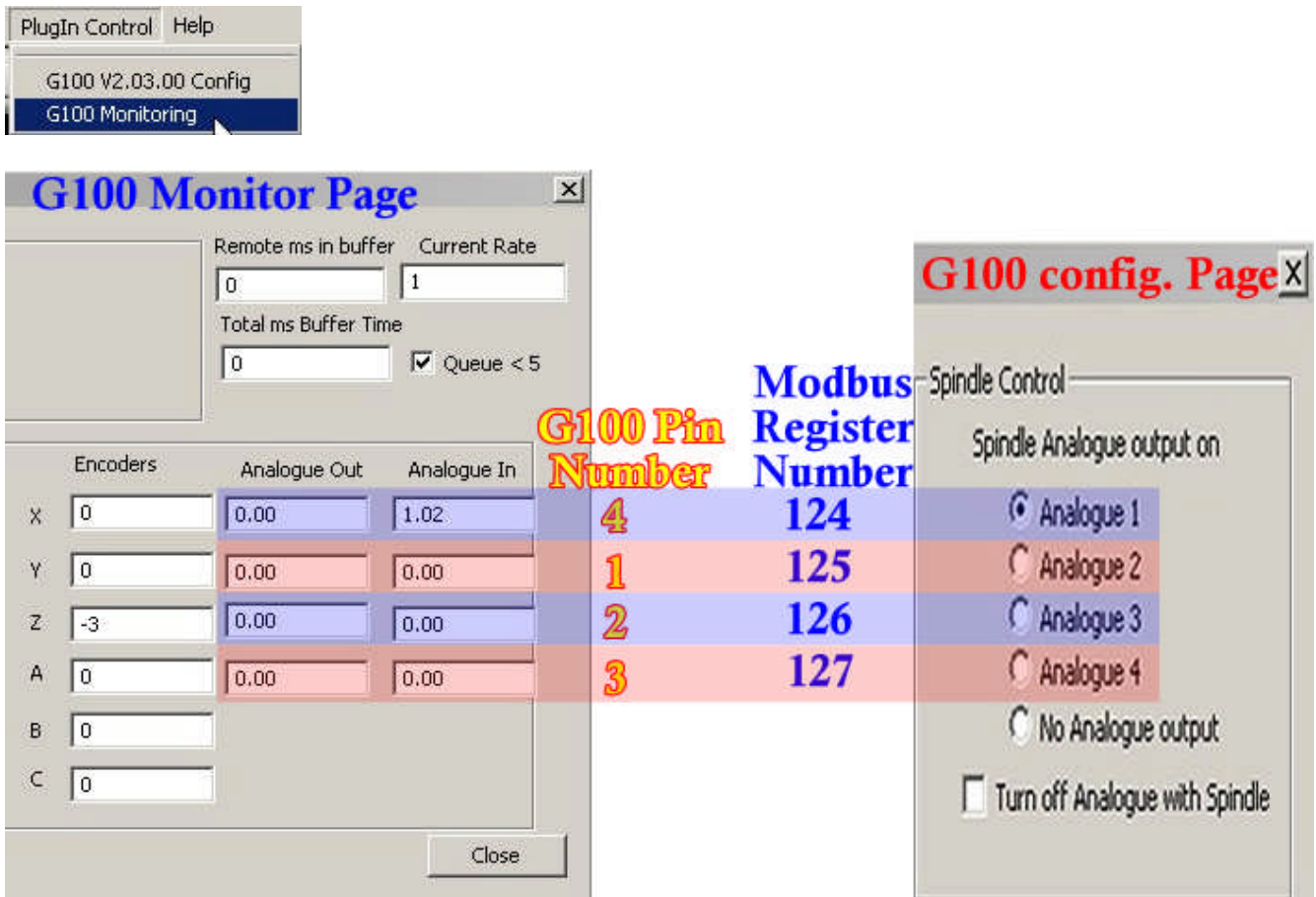
Analog inputs are varying voltage signals. They can perform a broad range of functions depending on the voltage they are being supplied with. One of the greatest things about them is that you can use one analog input to perform multiple functions. They work very well for a number of things but my favorites are FRO (feed rate override) and SRO (spin rate override). To get full use of analogs, you will most likely need to create or edit your macro pump. If you need help with the macro pumps, this is a good place to look.

<http://www.artsoftcontrols.com/forum/index.php?board=29.0> I hope that in the very near future you will be able to use the Brains in Mach as well. Here is a link to an intro video on brains.

<http://www.artsoftcontrols.com/Videos/Mach3%20Video%20Selections/Mach3%20Video%20Selections.html> I have attached an example macro pump that I use for my FRO.

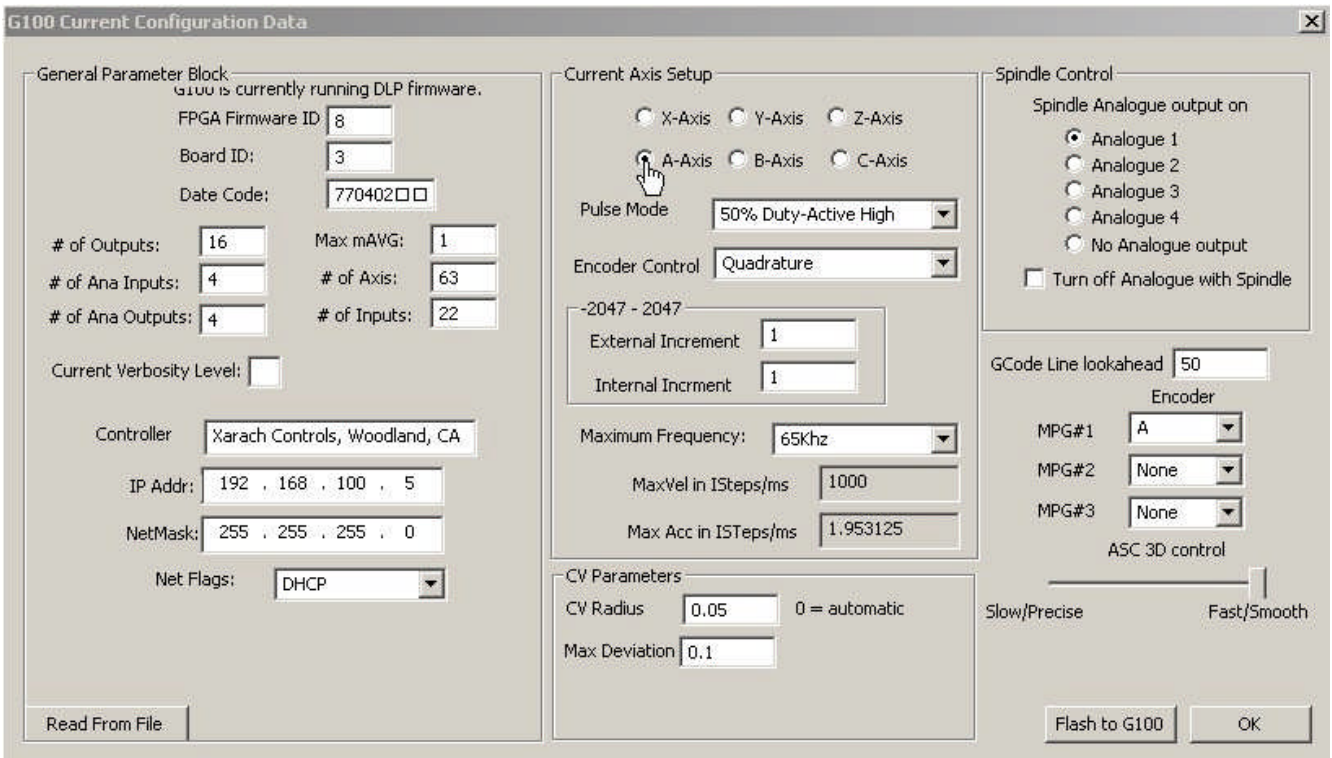
```
'macropump.m1s MyGreX
FeedOVPot=GetInput(124)
FeedPercent=(FeedOVPot/32768)
FeedOver=(300*FeedPercent)
SetOEMDRO(821,FeedOver)
FeedOver=10+(190*FeedPercent)
```

To use the analogs in a macro pump you will need to know their modbus register numbers. I have attached a picture to help explain. You can go to the G100 monitoring and config pages by clicking on the PlugIn Control tab at the top of Mach.

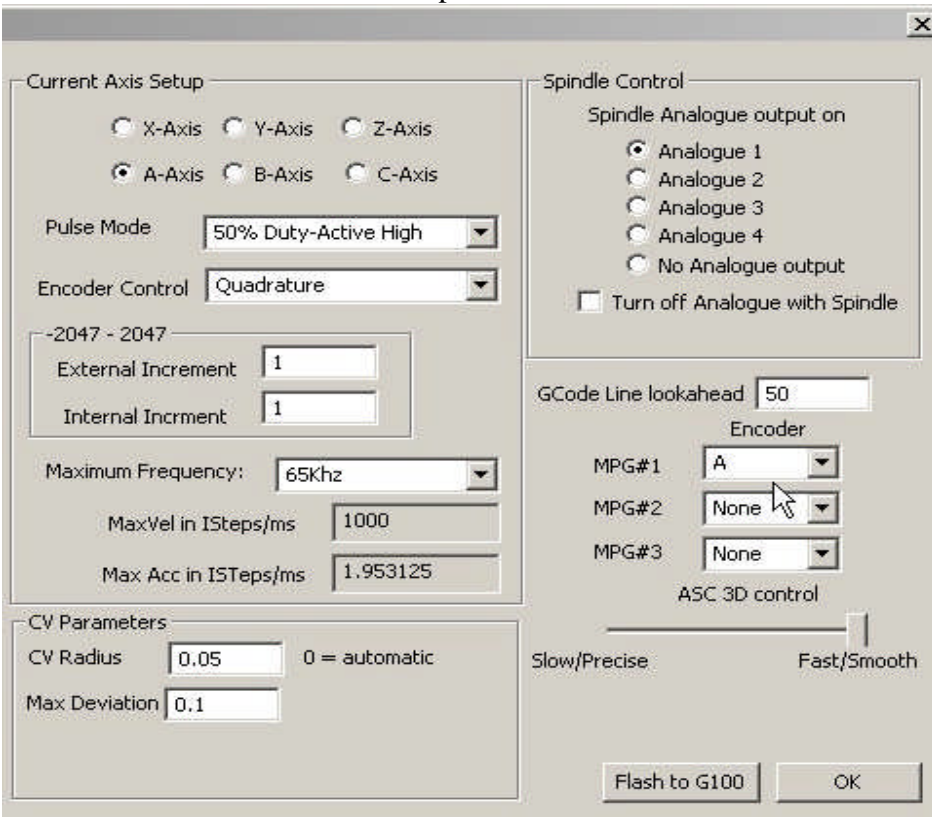


6.1.4.3 Encoder/MPG Inputs

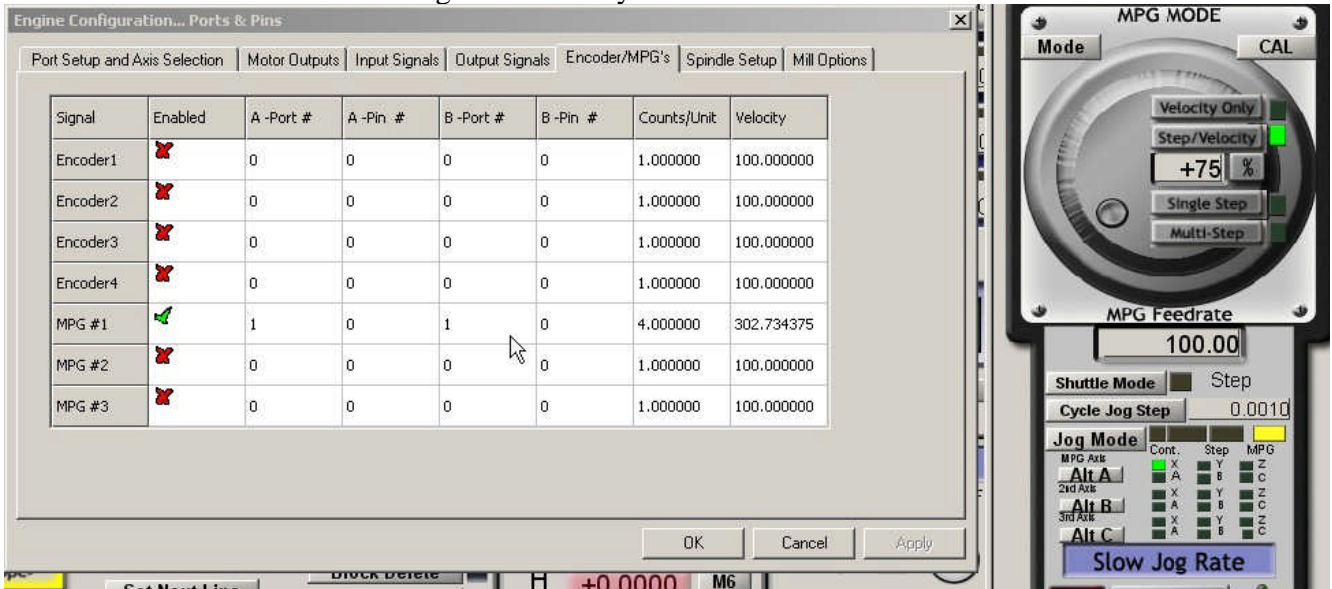
Encoders and MPGs (Manual Pulse Generators) use the same pins on the G100. For each of the six axis labeled on the G100 you have the following pins for encoders and MPGs. They are CH-A (channel A), CH-B (channel B). You may use the CH-I (index) for your encoders. You can also pick up the 5 volts and ground from the pins marked as such for each axis. Here is an example of how to set up a MPG for use through the G100.



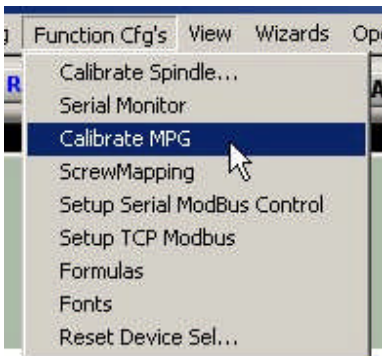
In the Current Axis Setup section, you see that I have selected the A-Axis to wire the MPG to. I have CH-A and CH-B on the MPG wired to the pins CH-A and CH-B for the A-Axis. I have also chosen my Pulse Mode and Encoder Control type from the drop down menus.



Once this is done, you need to flash the G100 for these settings to take effect. In the picture below, you see that MPG #1 is enabled, the ports are set to port 1 and the pins are set to 0. On the right side you see the MPG page (press your tab key to open and close the MPG page). It is set to Step/Velocity Mode, Cycle Jog Step is set to .001 and the X-axis is selected. You will have to play with your mode selection to get the results you desire.



At this point you should go to Function Cfg's at the top of Mach and choose calibrate MPGs. Follow the instructions and you should be able to tune your MPG with no problems.



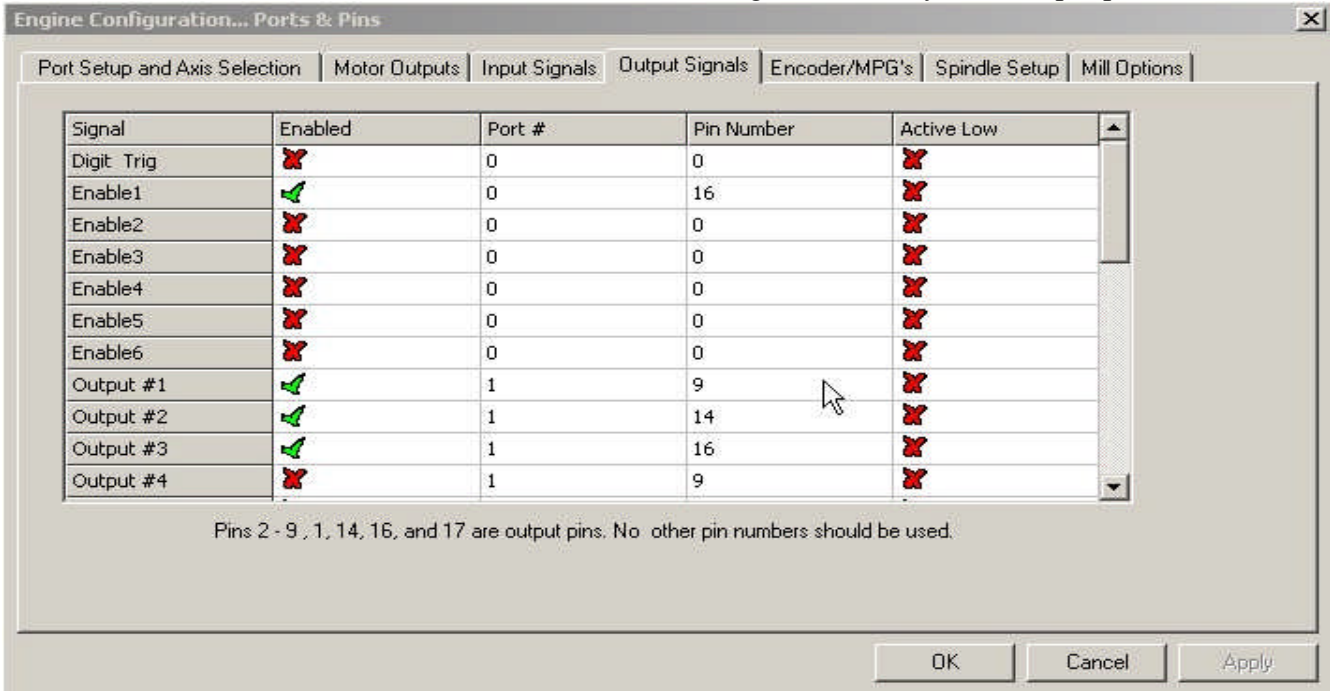
6.1.5 Output Signals

Outputs are signals that are being sent from Mach. There are two types of output signals the G100 and Mach can use to perform many functions. I will try to cover these in this section, Digital (this includes Motor Outputs) and Analog.

6.1.5.1 Digital Outputs

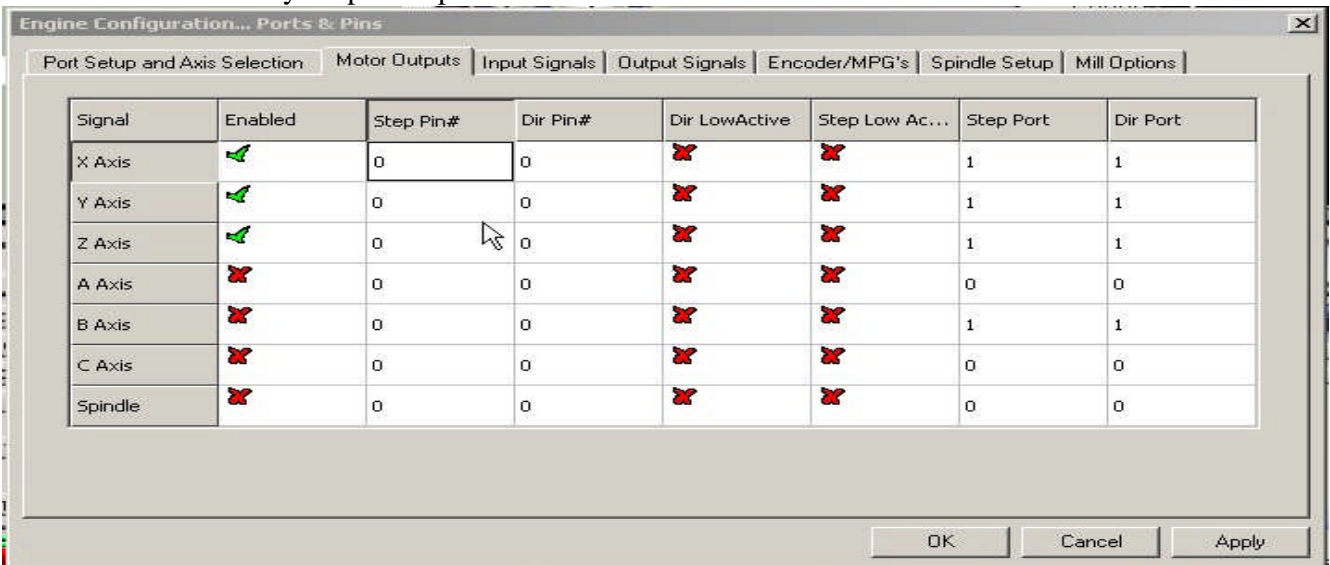
Digital outputs are just a signal. They are either on or off. Motor Outputs may pulse at a very high frequency but they are still either on or off. A digital output is recognized by a drastic change in voltage. The G100 sends 5 volts out to the device being controlled. The digital outputs are labeled 1-16 on the G100. The Dir and Step pins for each Axis on the G100 are also digital outputs. A good example of

using a digital output would be controlling a relay that turns a coolant pump on and off. You would wire the control voltage for the relay to an output pin on the G100.



6.1.5.2 Motor Outputs

Motor Outputs are digital signals that can be pulsed at very high speeds. They are marked on the G100 as DIR (Direction) and Step. They will be wired to your drives. The direction pin tells your drive one of two things, you are traveling in a forward or reverse direction. The only time their status changes, is when you send a command to change direction. It will be high for forward and low for reverse or vice versa. The Step pin is simply sending a signal to the drive telling it to produce one step. The rate the pulses are sent at is dictated by the rate (speed) you are commanding through Mach. When setting up your Motor Outputs, there is no need to worry about pin numbers. As with all other settings for pins on the G100, set your port to port 1 and enable the axis.

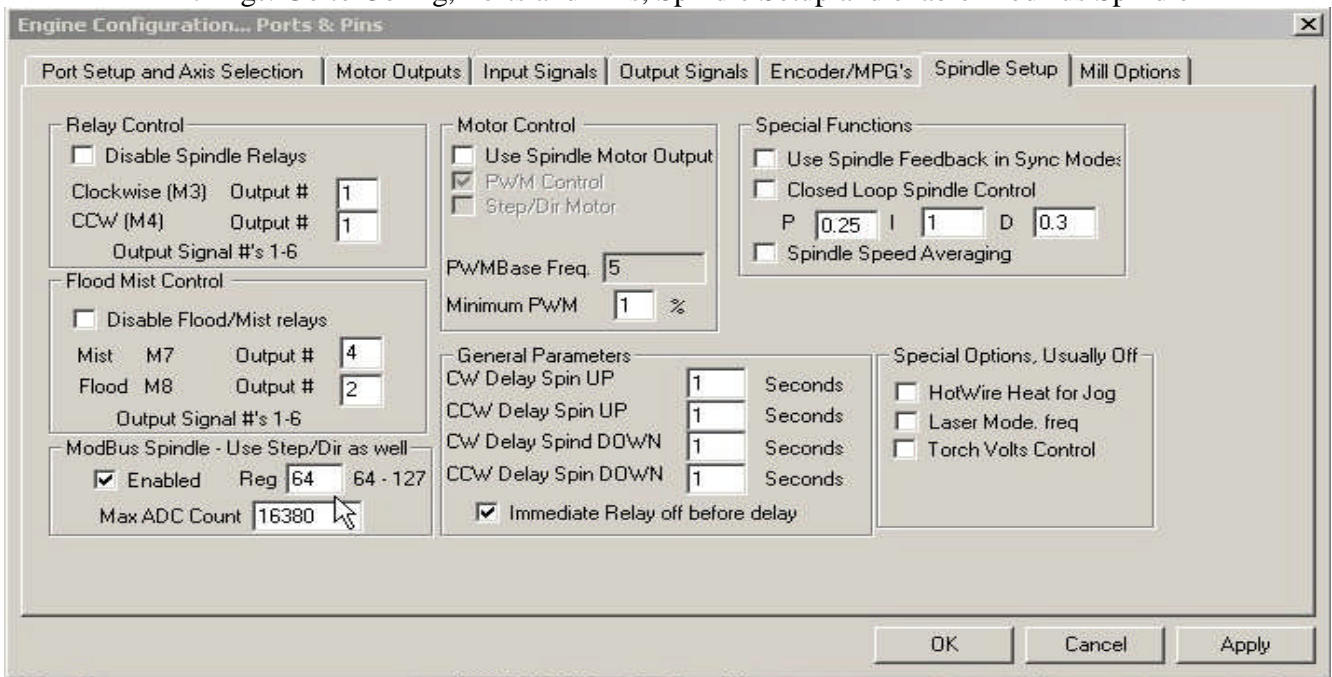


6.1.5.3 Analog Outputs

Analog outputs are varying voltage signals. A good example of a device using an analog output from Mach is a VFD (Variable Frequency Drive) At present, an analog output for a VFD is very simple to set up. This is covered in the very next section. Other analog outputs will need to be controlled using the macropump. For more information on the Analogs and macropumps, refer back to section 6.1.4.2, Analog Inputs

6.1.6 Spindle Setup

To set up your spindle to be controlled by an analog output you should only have to do 2 things. Go to Config, Ports and Pins, Spindle Setup and enable ModBus Spindle



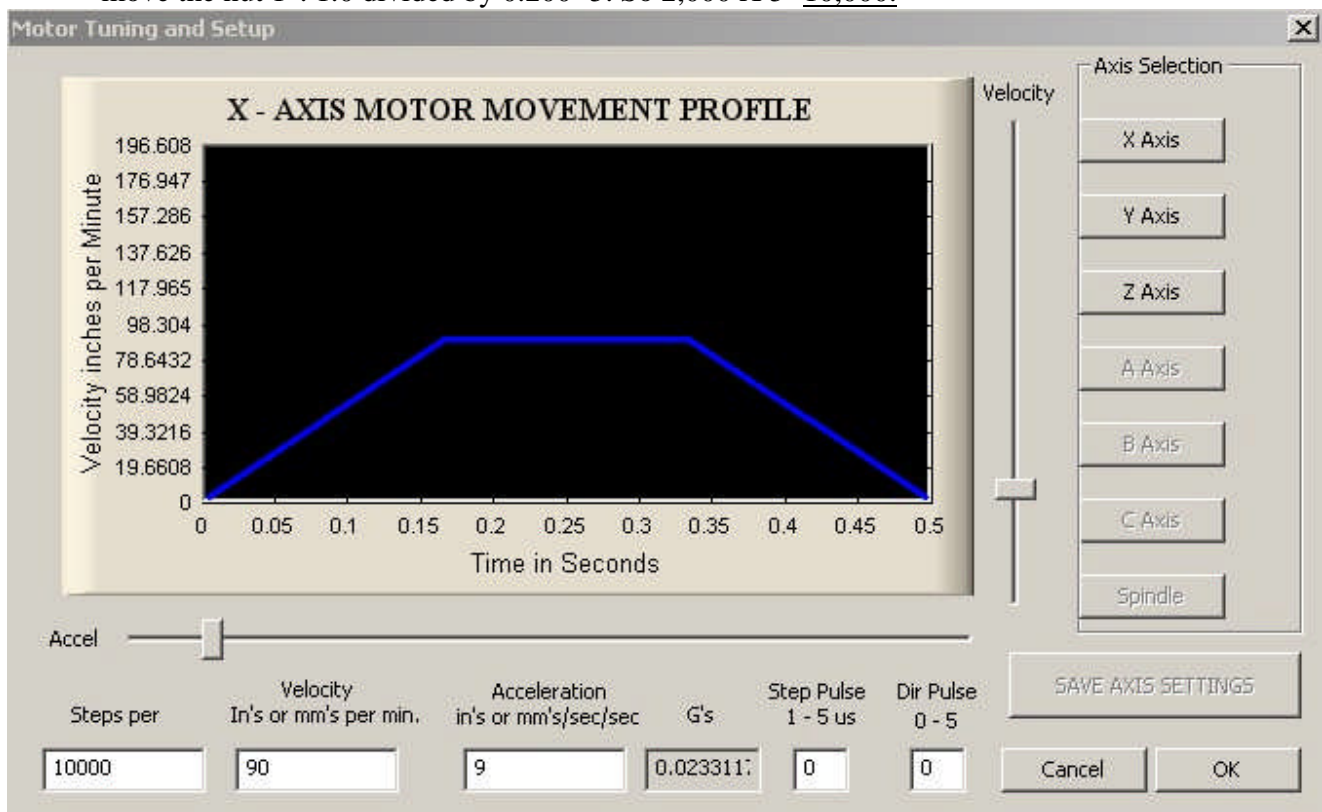
Next, go to Plugin Control and choose which analog output you want to use for your spindle control. Study the picture below to decide which analog output you have wired it to.

| G100 Pin Number | Modbus Register Number |
|-----------------|------------------------|
| 4 | 124 |
| 1 | 125 |
| 2 | 126 |
| 3 | 127 |

Flash the G100 and exit.

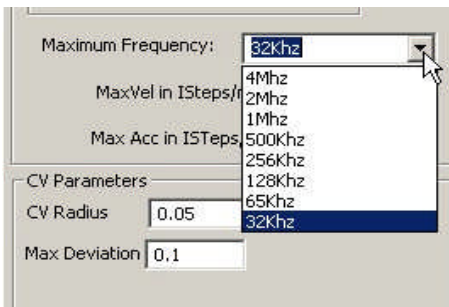
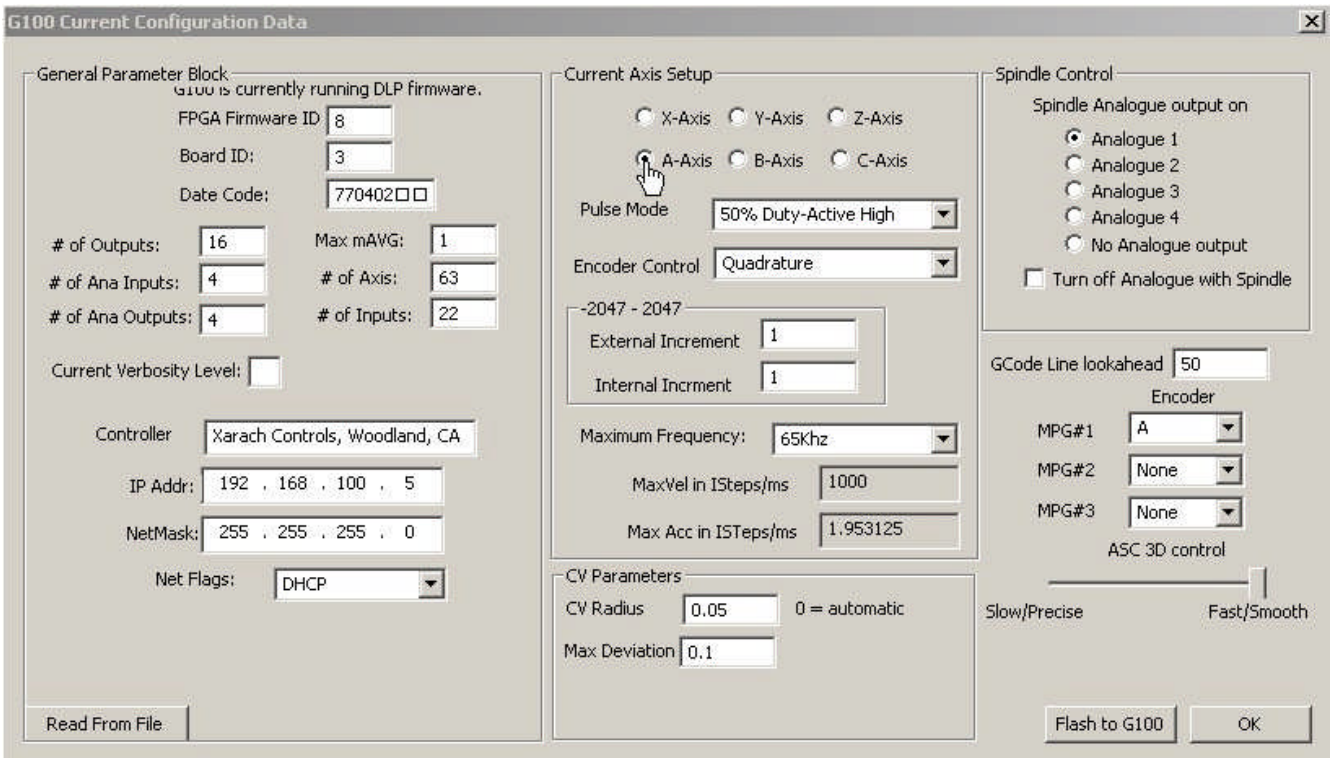
6.2 Motor tuning

The settings you will be dealing with in Motor Tuning are the same as with any other hardware with a few exceptions. You will generally be able to tune for higher acceleration rates and the step and direction pulse length will be 0. **One of the key features of the G100 is that you can send step pulses at 4 MHz.** This is especially good for those running a large number of steps per at high speeds. Lets look at steps per for a minute. Here is how you do the math. I will give you mine as an example. What we need to know is how many pulses from Mach will it take to move the machine 1 of your units? (inch or mm) Mine is in inches. 1 inch = 10,000 pulses on mine. This is how I came up with the number. My steppers have 200 pulses per revolution. (360 degrees divided by 1.8 degrees = 200) Micro stepping = 10. So $200 \times 10 = 2,000$ Motor to screw gearing is 1-1. So $2,000 \times 1 = 2,000$ Screw lead is .200 of an inch. My screw will have to turn 5 rounds to move the nut 1". 1.0 divided by $0.200 = 5$. So $2,000 \times 5 = 10,000$.



Now that we know our Steps per, we can do the math to find out what frequency range we will need to set the G100 to. I want to be able to travel at 100 IPM (inches per minute). Steps per = $10,000 * 100$ (IPM) = $1,000,000 / 60$ (Seconds in a minute) = $16,666 / 1,000 = 16.666$ KHz. This means that I will need to set the G100 to the next higher Maximum Frequency. 32 KHz is good for this set up. If I needed a pulse rate of exactly 32 KHz I would choose the 65 KHz mode.

In the 2 pictures below, you see that I have selected an axis and chosen a Maximum Frequency. At this point, I need to flash the G100. **This has to be done for each axis on your machine.** If you have a 4 axis machine, you will need to do this 4 times



6.3 General Config.

All settings in General Config. will be the same as with any other hardware. At one point the setting "G100 Adaptive NurbsCV" effected the performance of the G100. The setting has not been removed form the page yet but its code has. It will be removed all together at some point in the future.

General Logic Configuration

| | | | |
|---|---|--|---|
| G20,G21 Control <input type="checkbox"/> Lock DRO's to setup units | Editor GCode Editor <input type="button" value="Browse"/> <input type="text" value="\\Windows\notepad.exe"/> | Shuttle Wheel Setting Shuttle Accel. <input type="text" value="0.0041"/> Seconds | Inputs Signal Debouncing/Noise rejection Debounce Interval: <input type="text" value="1000"/> x 40us Index Debounce: <input type="text" value="1000"/> |
| Tool Change <input checked="" type="radio"/> Ignore Tool Change <input type="radio"/> Stop Spindle. Wait for Cycle Start. <input type="radio"/> Auto Tool Changer | Startup Modals <input type="checkbox"/> Use Init String on ALL "Resets" Initialization String <input type="text" value="G80"/> | General Configuration <input type="checkbox"/> Z is 2.5D on Output #6 <input checked="" type="checkbox"/> Home Sw. Safety LookAhead <input type="text" value="50"/> Lines <input type="checkbox"/> UDP Pendent Control <input type="checkbox"/> Run Macro Pump <input type="checkbox"/> ChargePump On in EStop <input checked="" type="checkbox"/> Persistent Jog Mode. <input checked="" type="checkbox"/> FeedOverride Persist <input type="checkbox"/> No System Menu in Mach3 <input checked="" type="checkbox"/> Use Key Clicks <input type="checkbox"/> Home Slave with Master Axis <input type="checkbox"/> Include TLD in Z from G31 | |
| Angular Properties Unchecked for Linear <input checked="" type="checkbox"/> A-Axis is Angular <input checked="" type="checkbox"/> B-Axis is Angular <input checked="" type="checkbox"/> C-Axis is Angular | Motion Mode <input type="radio"/> Constant Velocity <input checked="" type="radio"/> Exact Stop Distance Mode <input checked="" type="radio"/> Absolute <input type="radio"/> Inc IJ Mode <input type="radio"/> Absolute <input checked="" type="radio"/> Inc Active Plane of Movement <input checked="" type="radio"/> X-Y <input type="radio"/> Y-Z <input type="radio"/> X-Z | <input checked="" type="checkbox"/> Disable Gouge/Concavity Checks <input type="checkbox"/> G04 Dwell in ms <input checked="" type="checkbox"/> Use WatchDogs <input type="checkbox"/> Debug This Run <input checked="" type="checkbox"/> Enhanced Pulsing <input type="checkbox"/> Allow Wave Files <input type="checkbox"/> Allow Speech <input type="checkbox"/> Set Charge Pump to 5Khz for Laser standy level <input checked="" type="checkbox"/> No FRD on Queue <input type="text" value="100"/> Turn Manual Spindle Incr. <input type="text" value="10"/> Spindle OV increment | |
| Pgm End or M30 or Rewind <input type="checkbox"/> Turn off all outputs <input type="checkbox"/> E-Stop the system <input checked="" type="checkbox"/> Perform G92.1 <input type="checkbox"/> Remove Tool Offset <input checked="" type="checkbox"/> Radius Comp Off <input checked="" type="checkbox"/> Turn Off Spindle | Jog Increments in Cycle Mode Position 1 <input type="text" value="1"/> <input type="text" value="0.1"/> <input type="text" value="0.01"/> <input type="text" value="0.001"/> <input type="text" value="0.0001"/> Use 999 to indicate a Continuous Jog selection. <input type="text" value="1"/> <input type="text" value="0.1"/> <input type="text" value="0.01"/> <input type="text" value="0.001"/> <input type="text" value="0.0001"/> Position 10 <input type="text" value="0.0001"/> | Rotational <input type="checkbox"/> Rot 360 rollover <input type="checkbox"/> Ang Short Rot on G0 <input checked="" type="checkbox"/> Rotational Soft Limits | |
| M01 Control <input checked="" type="checkbox"/> Stop on M1 Command | Screen Control <input checked="" type="checkbox"/> Hi-Res Screens <input checked="" type="checkbox"/> Boxed DRO's and Graphics <input checked="" type="checkbox"/> Auto Screen Enlarge <input checked="" type="checkbox"/> Flash Errors and comments. | | |
| Serial Output ComPort # <input type="text" value="1"/> BaudRate <input type="text" value="9600"/> <input checked="" type="radio"/> 8-Bit 1 Stop <input type="radio"/> 7 Bit 2-Stop | CV Control <input type="checkbox"/> Plasma Mode <input type="checkbox"/> CV Dist Tolerance <input type="text" value="180"/> Units.. <input checked="" type="checkbox"/> G100 Adaptive NurbsCV <input checked="" type="checkbox"/> Stop CV on angles > <input type="text" value="0"/> Degrees | | |
| Program Safety <input type="checkbox"/> Program Safety Lockout This disables program translation while the External Activation #1 input is activated. | Axis DRO Properties: <input type="checkbox"/> Tool Selections Persistent. <input checked="" type="checkbox"/> Optional Offset Save <input checked="" type="checkbox"/> Persistent Offsets <input checked="" type="checkbox"/> Persistent DROs <input checked="" type="checkbox"/> Copy G54 from G59.253 on startup | | |

6.4 Homing / Limits

Homing and Limits are set as with any other hardware. The first column on the left that you're allowed to change is Reversed. This dictates which way your axis will move when given a + or - command. The second column is Soft Max. This is how close your soft limits will allow your axis to get to its home switch before coming to a complete stop. The next column is Soft Min. This is how far your soft limits will allow your axis to travel before coming to a complete stop. The next column is Slow Zone. This is the distance from your Soft Max and Soft Min point that the soft limits start slowing your axis preparing to come to a complete stop. The next column is Home Off. You can enter a value here if you would like for your axis to go a certain distance from the home switch after it sees it when you give it a ref home command. The next column is Home Neg (Home Negative). If you check this box it will home the axis in the negative direction rather than the positive. The next column is Auto Zero. When this is checked for an axis it will zero your DRO once it has finished homing that axis. The next column is Speed %. This sets the speed at which your machine will travel during the homing routine. It is a percentage of your Max Velocity.



7. Known Issues

- 9/19/07 Probing is not working.
- 9/19/07 You must ref. all axis home before limits work as they should.
- 9/19/07 FRO does not work as it should.

8. Revisions List

- 9/19/07 First release of the G100 Setup Guide.
- 9/20/07 Fixed a few typos and added a little to the motor tuning section.

9. Trouble Shooting

10. Special Thanks

Special thanks to:

Art Fenerty

Brian Barker

Candace

Chad

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Graham Waterworth

Hood

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Ynneb

Zealous

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