Contents

Section	Title	Page #
1	**Preface ....**	**1**
2	**Getting started, An overview ……..**	
2.1	**Useful links ....**	
2.2	**G100 Description ……..**	
3	**Connections ....**	
3.1	**Primary Electrical Connections ....**	
3.1.1	Incoming	
3.1.2	Outgoing	
3.2	**Ethernet ....**	
3.2.1	Networking	
3.2.1.1	Networking with a router ……..	
3.2.1.2	Networking without a router ……	
3.2.1.3	Troubleshooting ……	
3.2.2	Tips for setting up an IP address ....……..	
3.2.3	Adding a second Network card	
4	**Installing the G100 plug-in ……...**	
5	**Loading the firmware ……...**	
6	**Configuring Mach 3 ……..**	
6.1	**Ports and Pins ……**	
6.1.1	Port Setup ……	
6.1.2	Motor Outputs ……..	
6.1.3	Input Signals ……	
6.1.4	Output Signals ……..	
6.1.5	Encoders/MPG's ……..	
6.1.6	Spindle Setup ……	
6.1.7	Mill Options ……	
6.2	**Motor Tuning ……**	
6.3	**General Config. ……..**	
6.4	**Homing/Limits ……...**	
7	**Inputs and Outputs ……...**	

7.1 **Inputs ……...**
7.1.1 Digital Inputs ……
7.1.2 Analog Inputs ……...
7.1.3 Motor Inputs ……..
7.1.4 MPG Inputs ……..

7.2 **Outputs ……**
7.2.1 Digital outputs ……..
7.2.2 Analog Outputs ……
7.2.3 Motor Outputs ……..

8 **Trouble Shooting ……...**

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.

2. Getting Started, an Overview

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. Inputs and Outputs.

This section covers the common connections you will be using to control your machine.

8. 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.

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 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 1 0V 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.

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 7, Inputs and Outputs**.

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 7, Inputs and Outputs**

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. The crossover cable and adding a second network card will be covered later in section 3.2.3

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 it's 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.

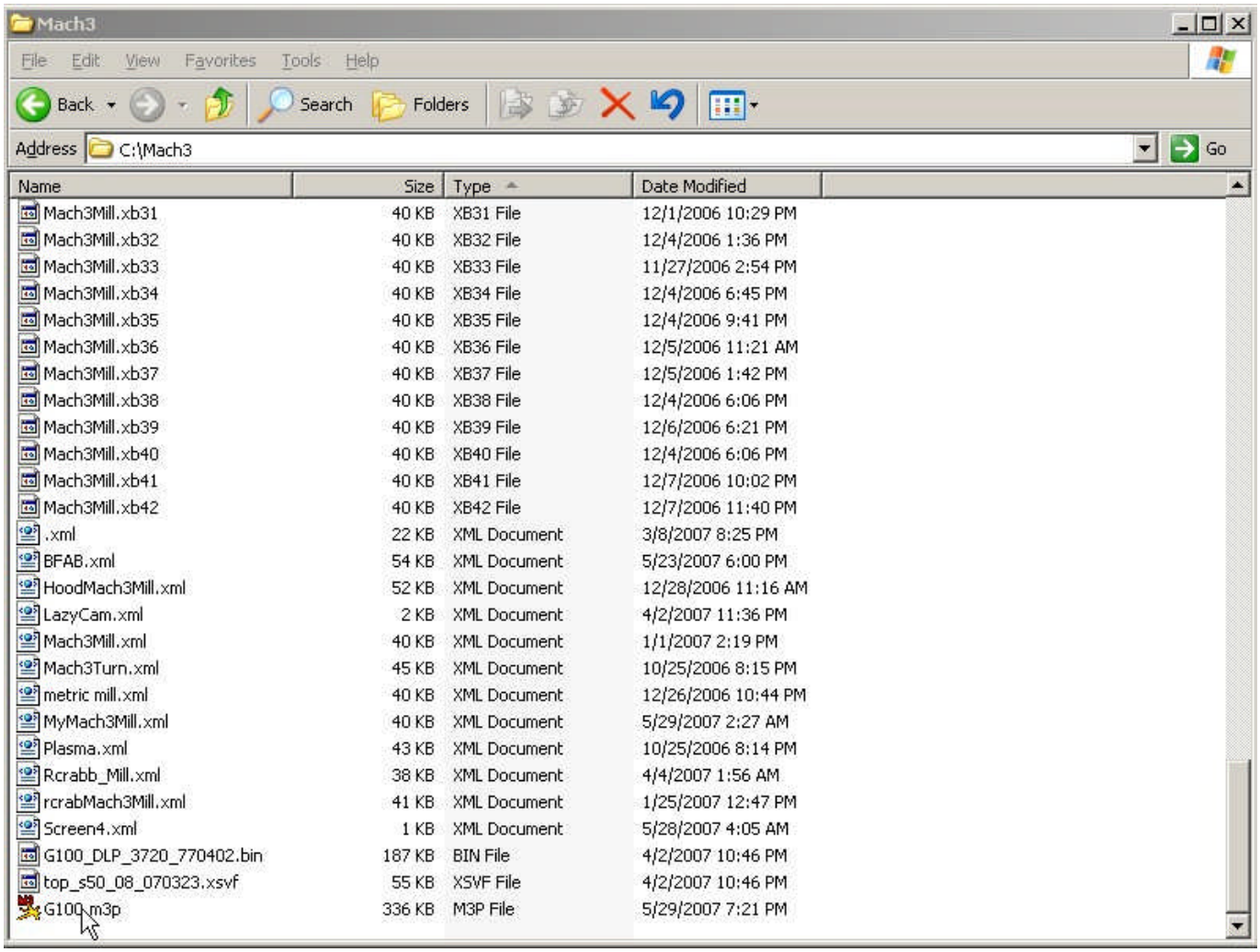
3.2.1.3 Troubleshooting

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 Grex 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 you Mach 3 root folder.
Next, unzip the files that came with the G100 plug-in to your Mach 3 root folder, C:\ Mach3

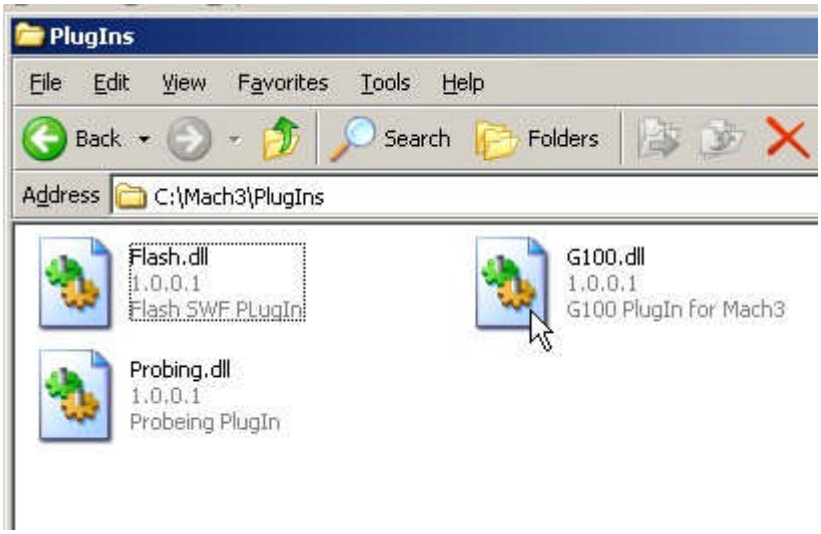
Browse to your Mach 3 root folder and double click on the G100. m3p file.



Name	Size	Type	Date Modified
Mach3Mill.xb31	40 KB	XB31 File	12/1/2006 10:29 PM
Mach3Mill.xb32	40 KB	XB32 File	12/4/2006 1:36 PM
Mach3Mill.xb33	40 KB	XB33 File	11/27/2006 2:54 PM
Mach3Mill.xb34	40 KB	XB34 File	12/4/2006 6:45 PM
Mach3Mill.xb35	40 KB	XB35 File	12/4/2006 9:41 PM
Mach3Mill.xb36	40 KB	XB36 File	12/5/2006 11:21 AM
Mach3Mill.xb37	40 KB	XB37 File	12/5/2006 1:42 PM
Mach3Mill.xb38	40 KB	XB38 File	12/4/2006 6:06 PM
Mach3Mill.xb39	40 KB	XB39 File	12/6/2006 6:21 PM
Mach3Mill.xb40	40 KB	XB40 File	12/4/2006 6:06 PM
Mach3Mill.xb41	40 KB	XB41 File	12/7/2006 10:02 PM
Mach3Mill.xb42	40 KB	XB42 File	12/7/2006 11:40 PM
.xml	22 KB	XML Document	3/8/2007 8:25 PM
BFAB.xml	54 KB	XML Document	5/23/2007 6:00 PM
HoodMach3Mill.xml	52 KB	XML Document	12/28/2006 11:16 AM
LazyCam.xml	2 KB	XML Document	4/2/2007 11:36 PM
Mach3Mill.xml	40 KB	XML Document	1/1/2007 2:19 PM
Mach3Turn.xml	45 KB	XML Document	10/25/2006 8:15 PM
metric mill.xml	40 KB	XML Document	12/26/2006 10:44 PM
MyMach3Mill.xml	40 KB	XML Document	5/29/2007 2:27 AM
Plasma.xml	43 KB	XML Document	10/25/2006 8:14 PM
Rcrabb_Mill.xml	38 KB	XML Document	4/4/2007 1:56 AM
rcrabMach3Mill.xml	41 KB	XML Document	1/25/2007 12:47 PM
Screen4.xml	1 KB	XML Document	5/28/2007 4:05 AM
G100_DLP_3720_770402.bin	187 KB	BIN File	4/2/2007 10:46 PM
top_s50_08_070323.xsvf	55 KB	XSVF File	4/2/2007 10:46 PM
G100.m3p	336 KB	M3P File	5/29/2007 7:21 PM

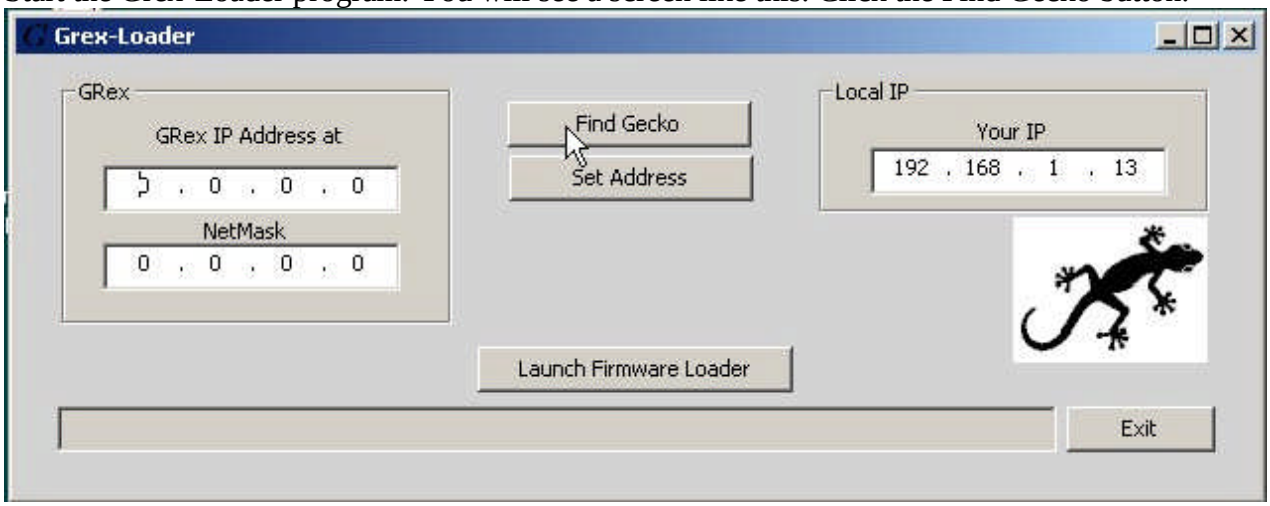
A box should pop up saying that a plug-in has been installed. Click OK.

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.

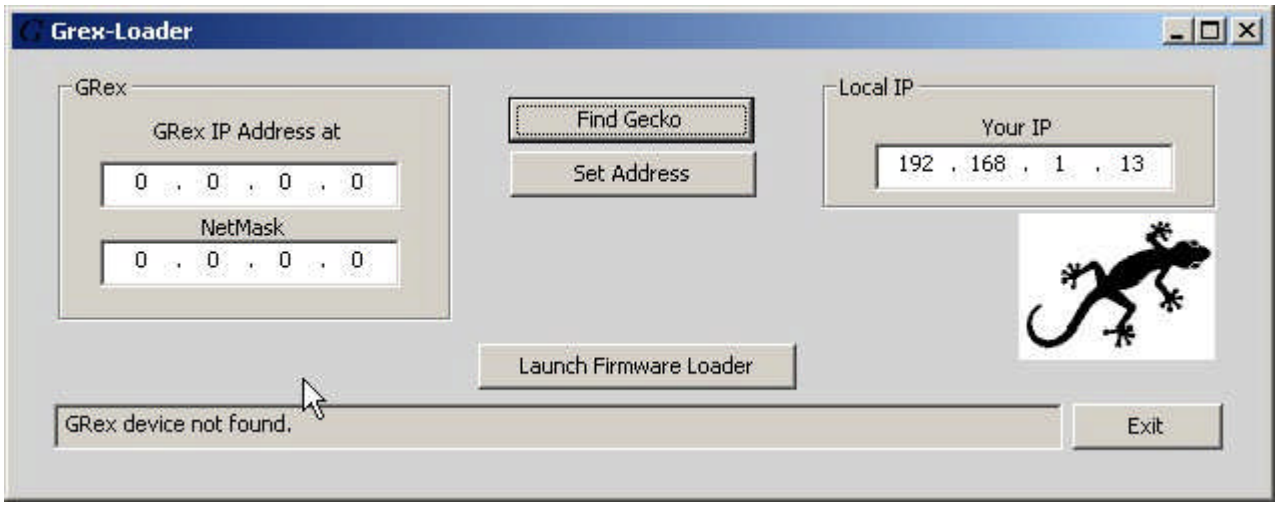


5. Loading the firmware

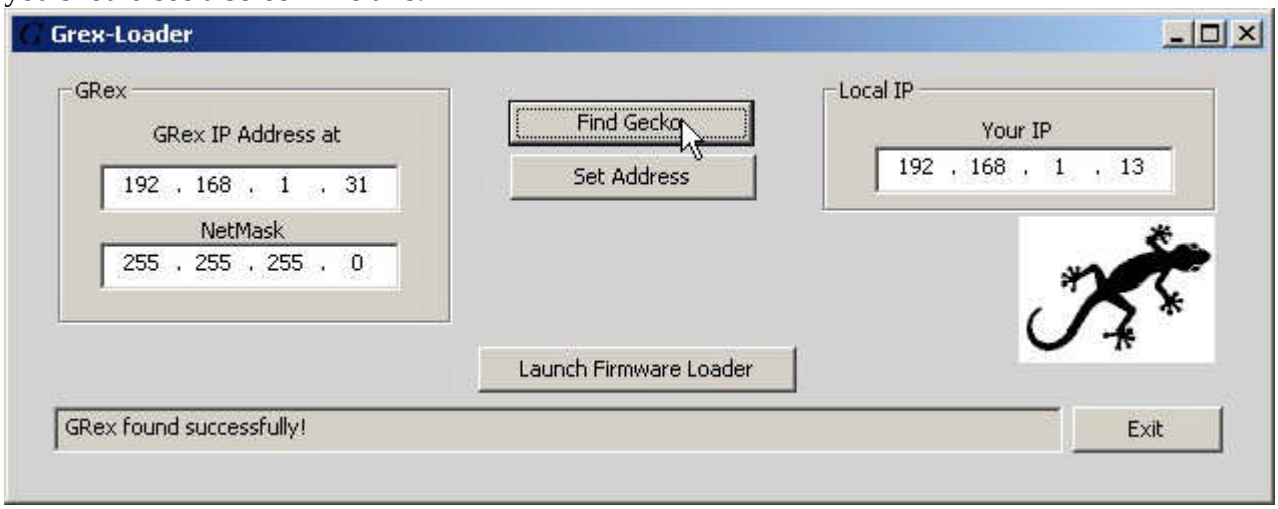
Plug in the power adaptor and the network cable to the G-Rex. Remember to use a crossover cable if you go direct from the PC to the G-Rex.
In your Mach3 folder there is a program named "Grex-Loader.exe" make a shortcut to it and put it on your desktop. Start the Grex-Loader program. You will see a screen like this. Click the Find Gecko button.



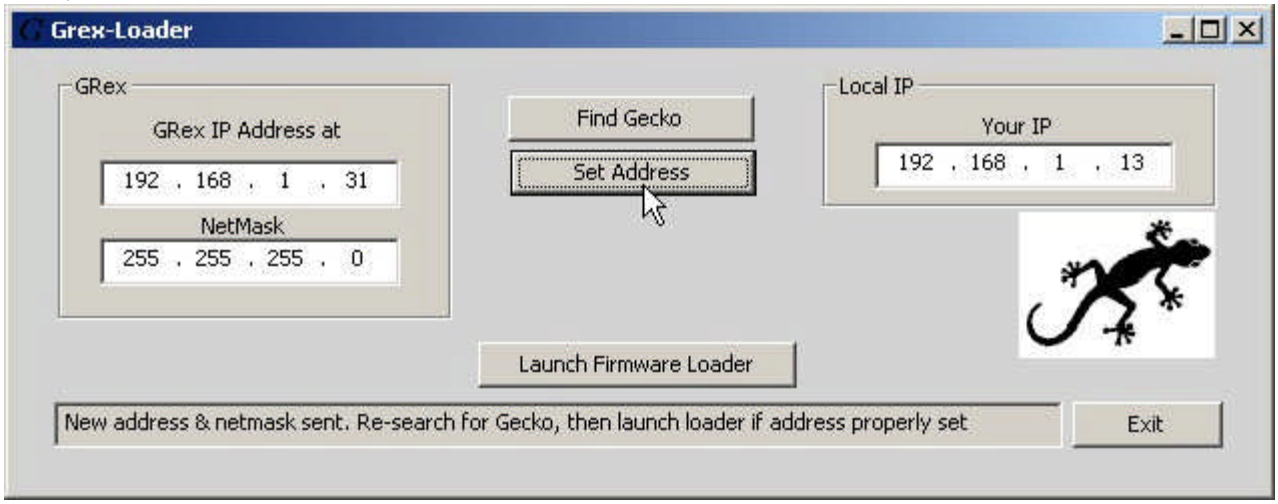
You probably got a screen like this saying, "GRex device not found".



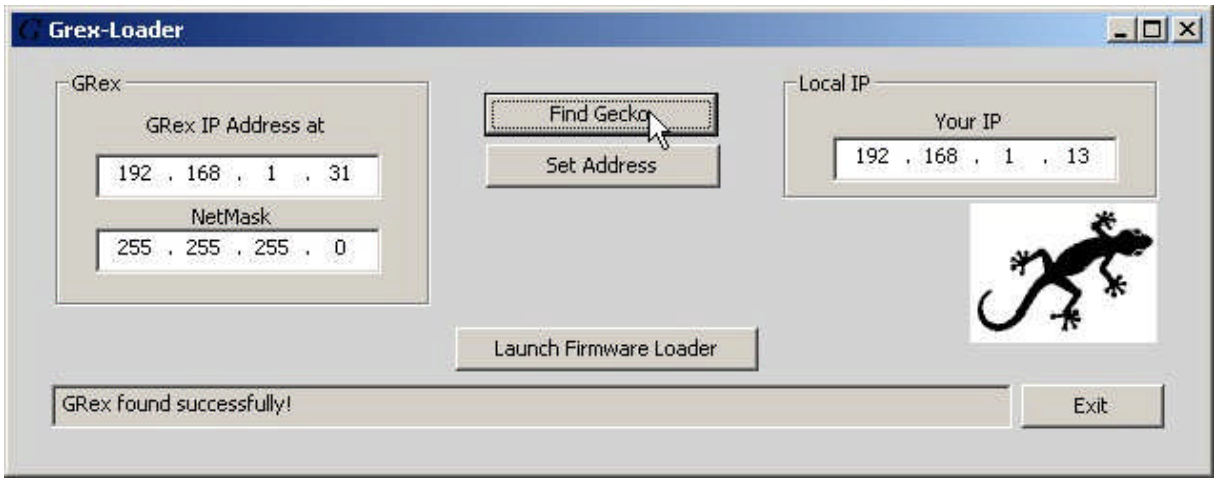
This is because you only have about 10 seconds to find the GRex.
Cycle power to the GRex and click Find Gecko again, about every 2 seconds. On the second or third try you should see a screen like this.



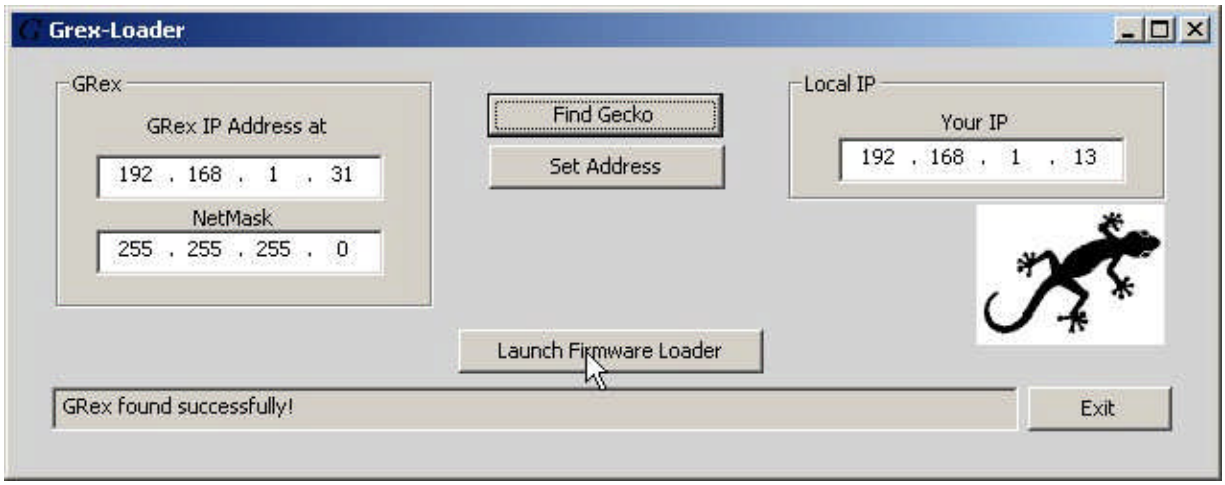
Now, click set address.



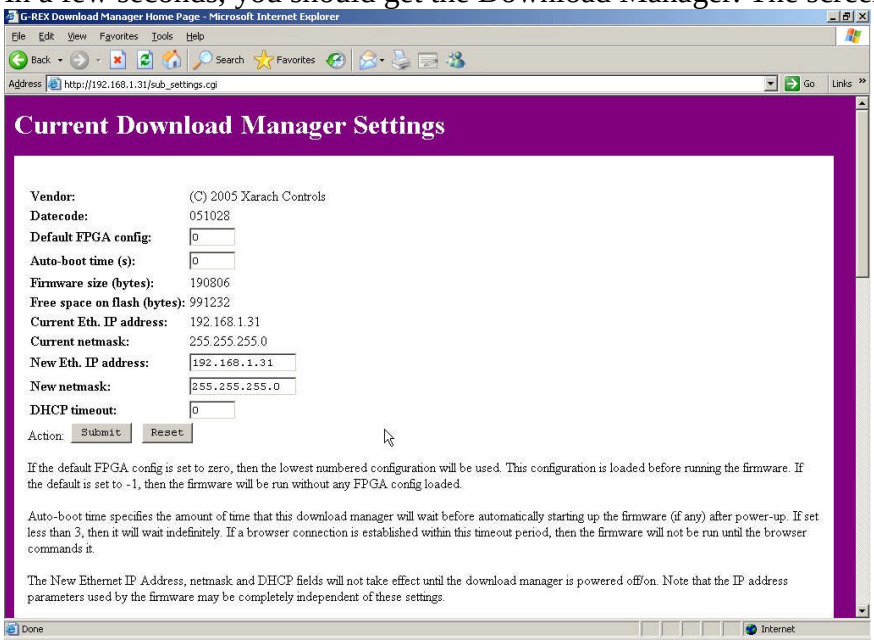
Click Find Gecko button again



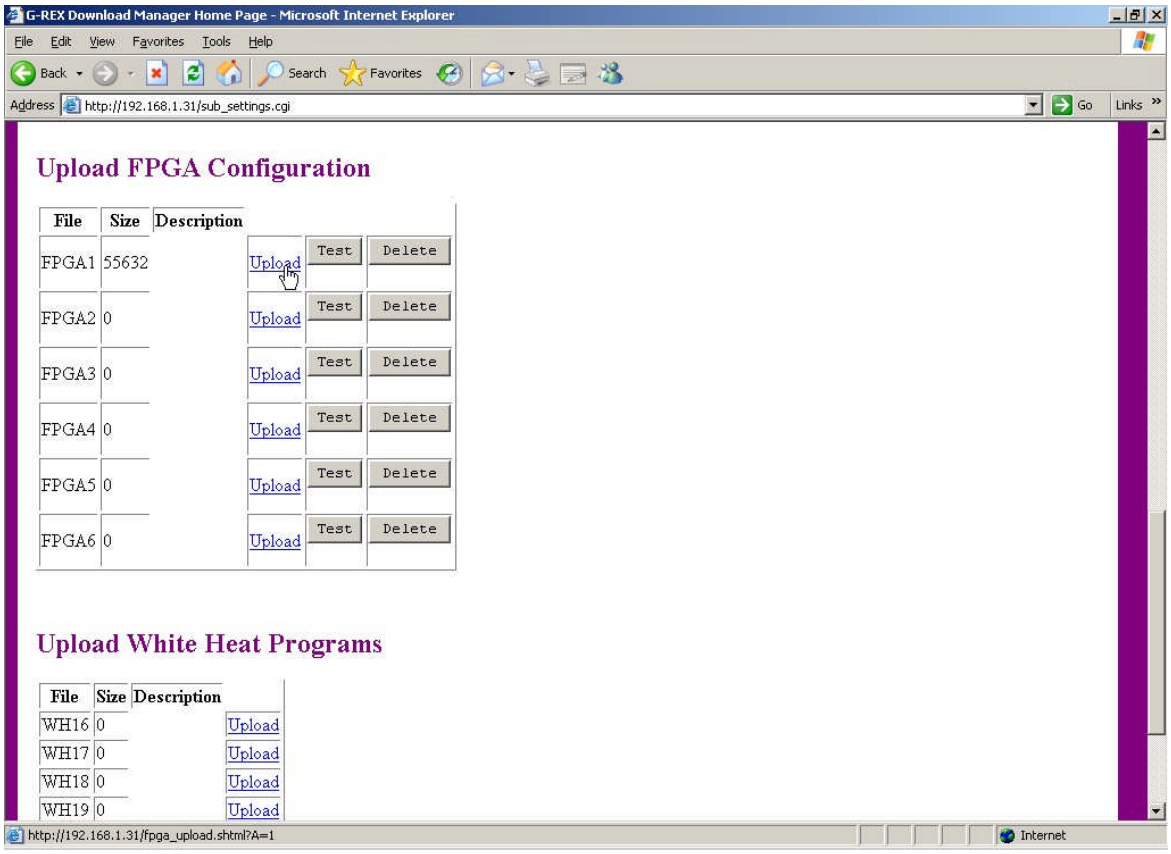
Now click the Launch Firmware Loader Button.



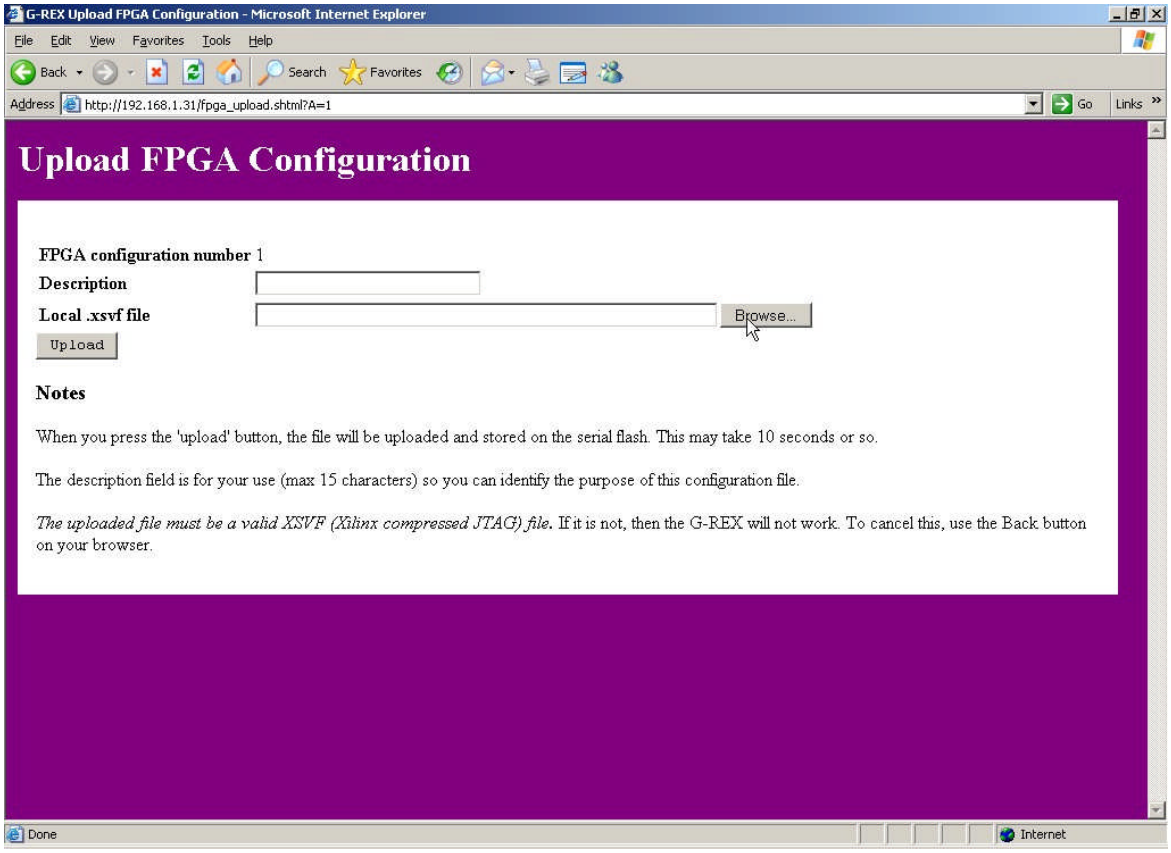
In a few seconds, you should get the Download Manager. The screen should look like this.



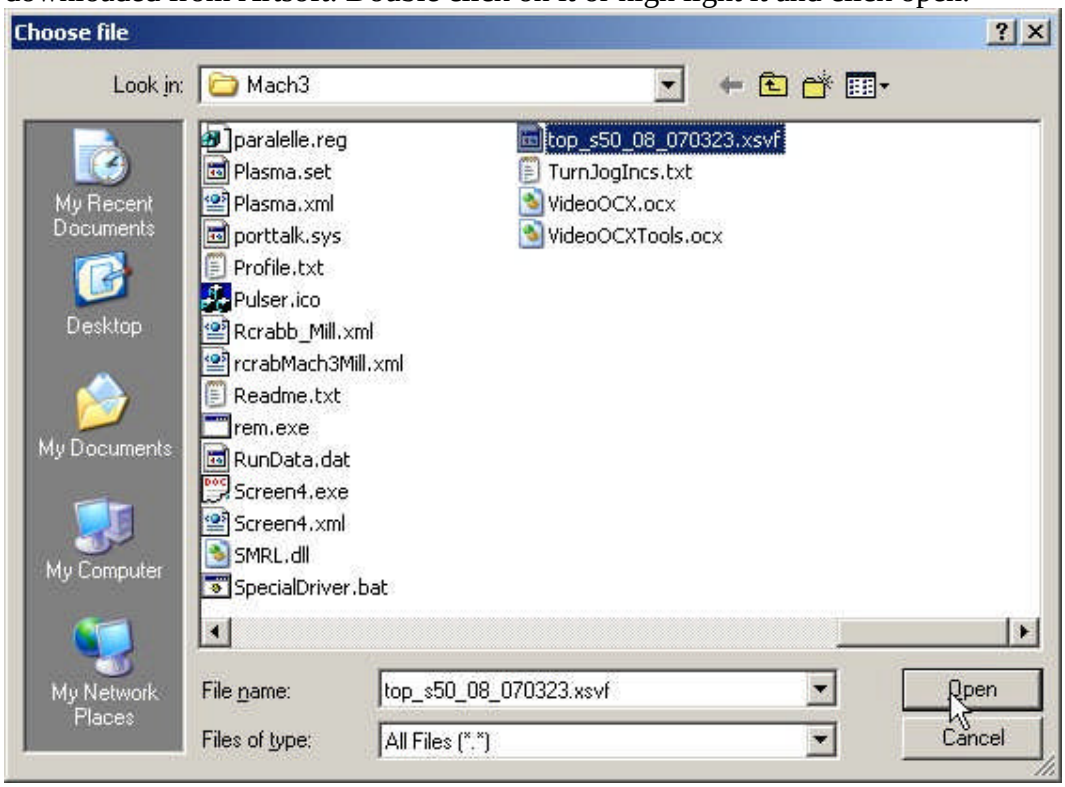
Scroll down to the section Upload FPGA Configuration and click on the “Upload” link



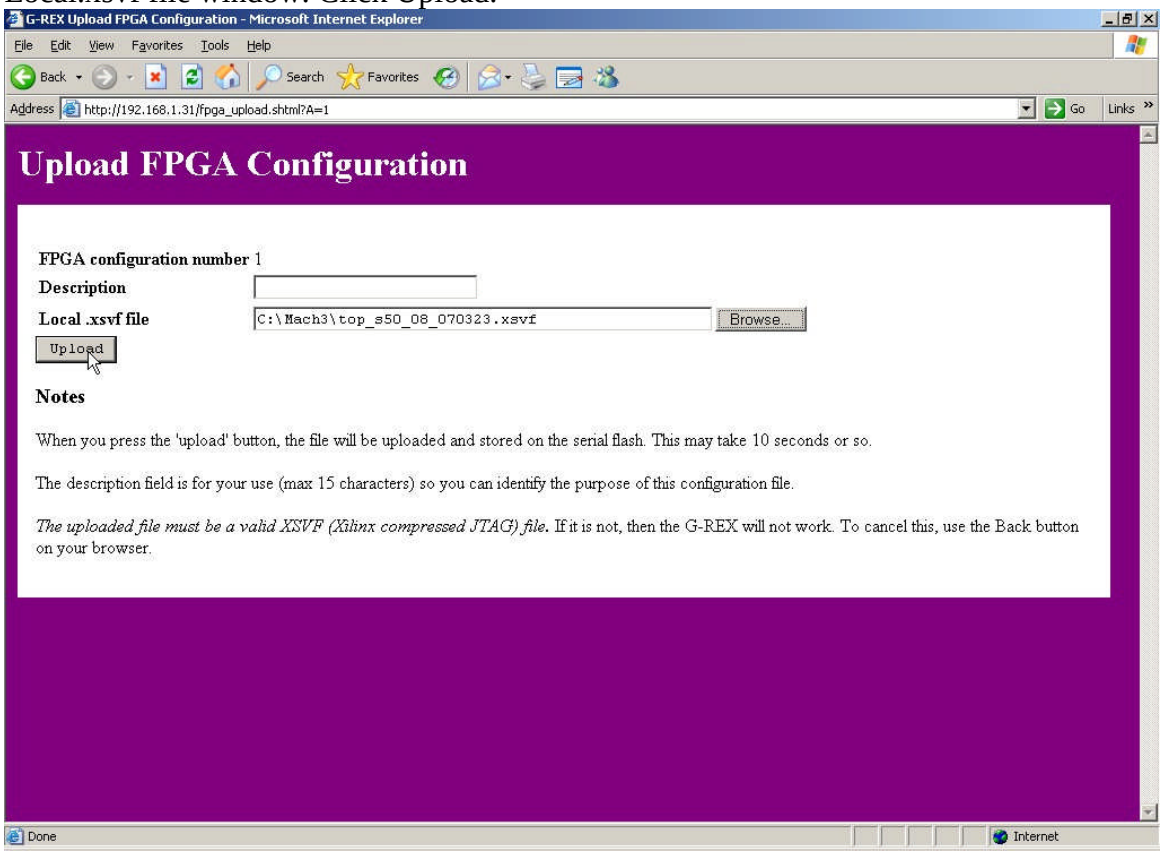
Click the Browse button.



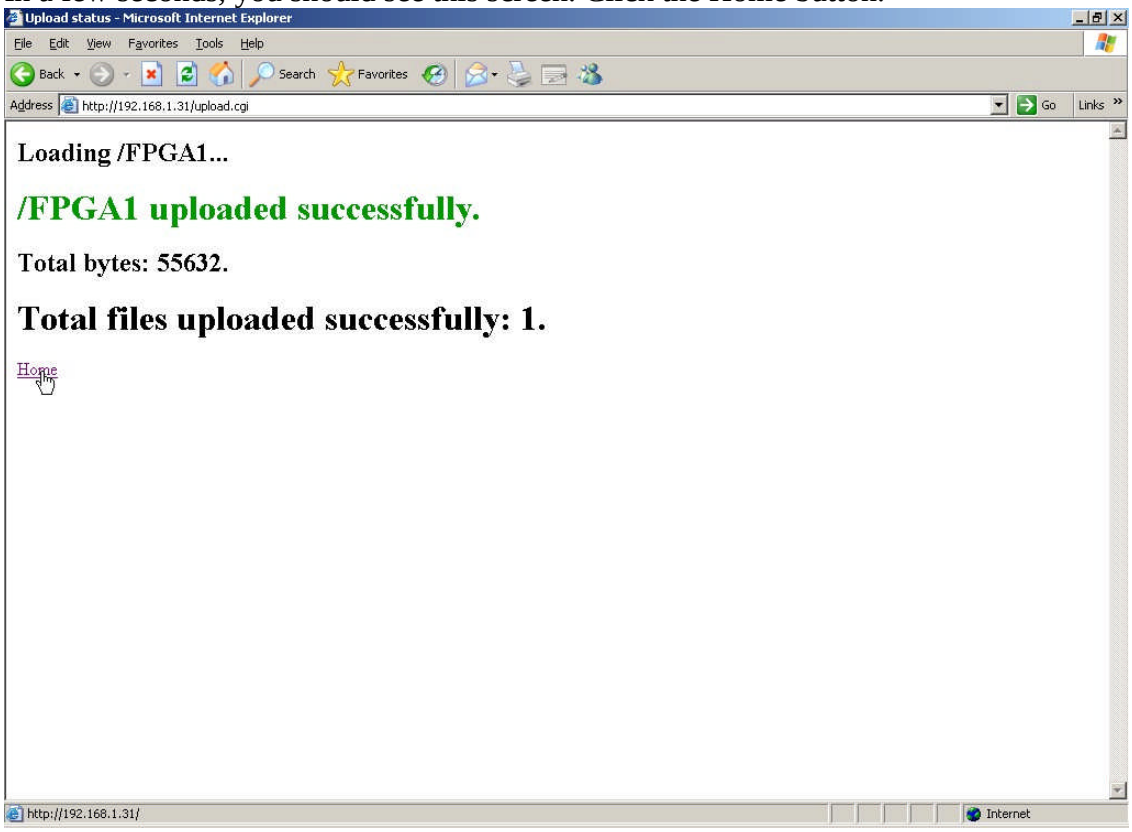
Browse to your Mach 3 root folder. Find the .xsvf file you pasted in from the G100 plug-in zip file you downloaded from Artsoft. Double click on it or high light it and click open.



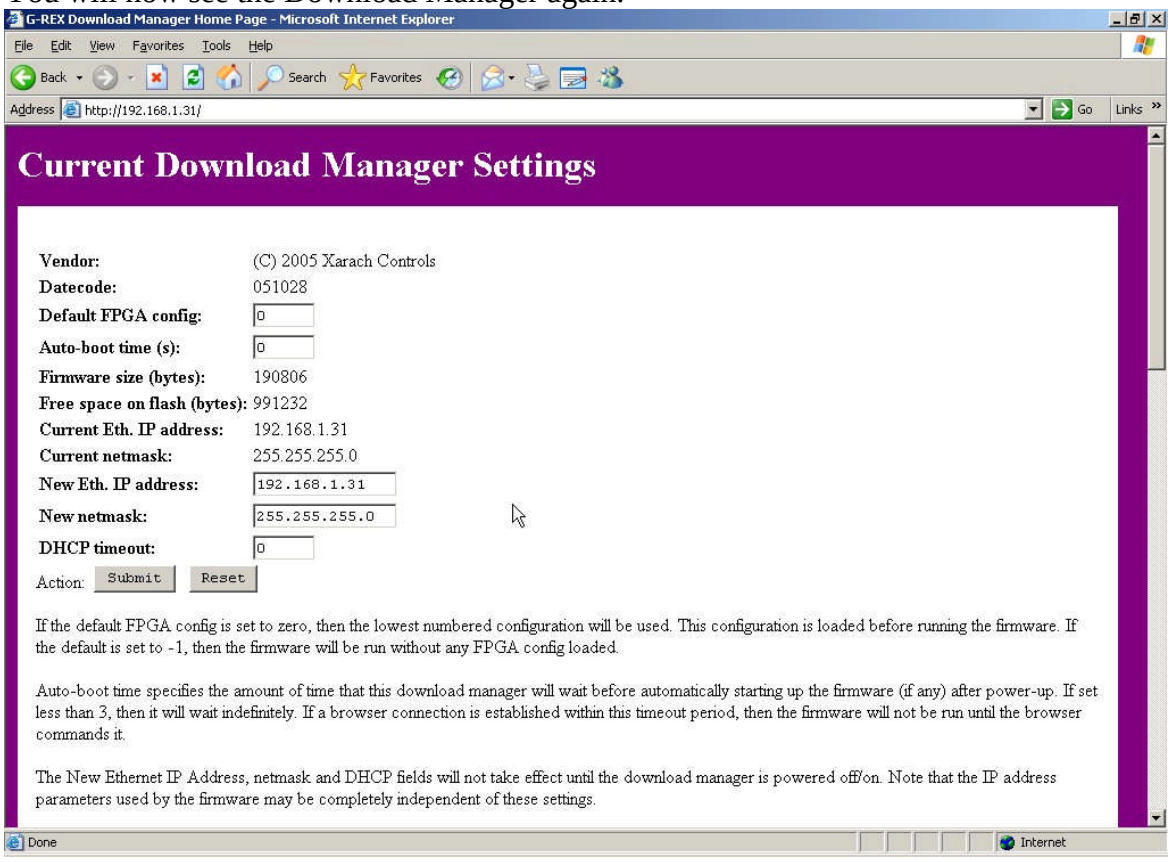
That will take you back to this screen. You will notice the file you selected is now showing in the Local.xsvf file window. Click Upload.



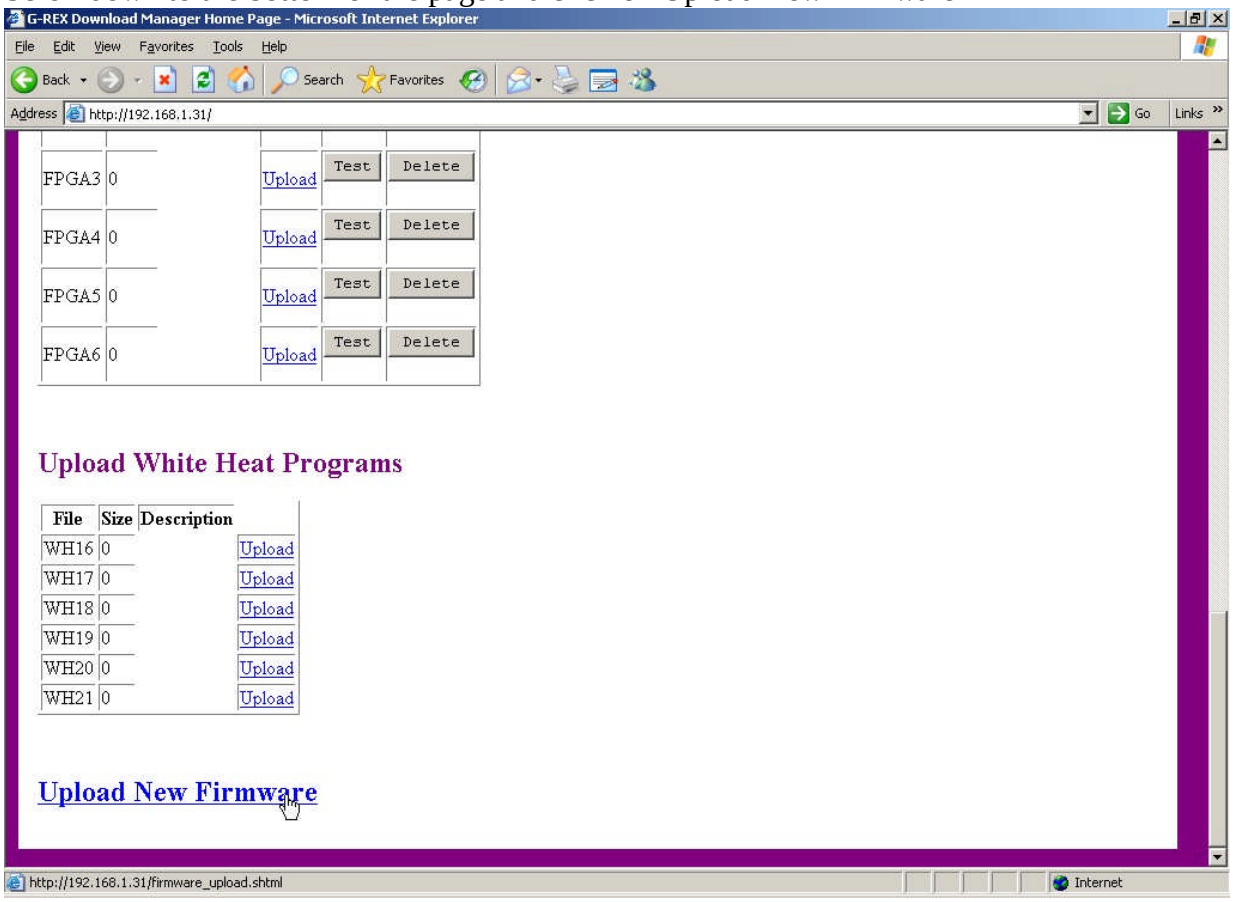
In a few seconds, you should see this screen. Click the Home button.



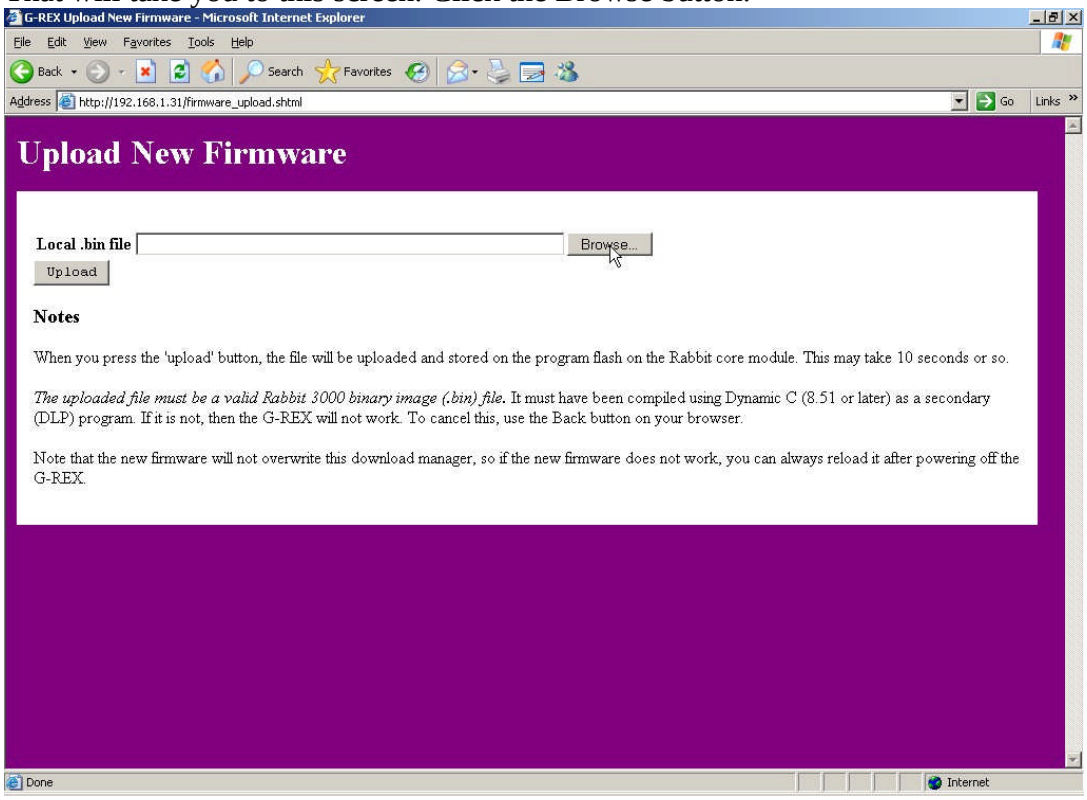
You will now see the Download Manager again.



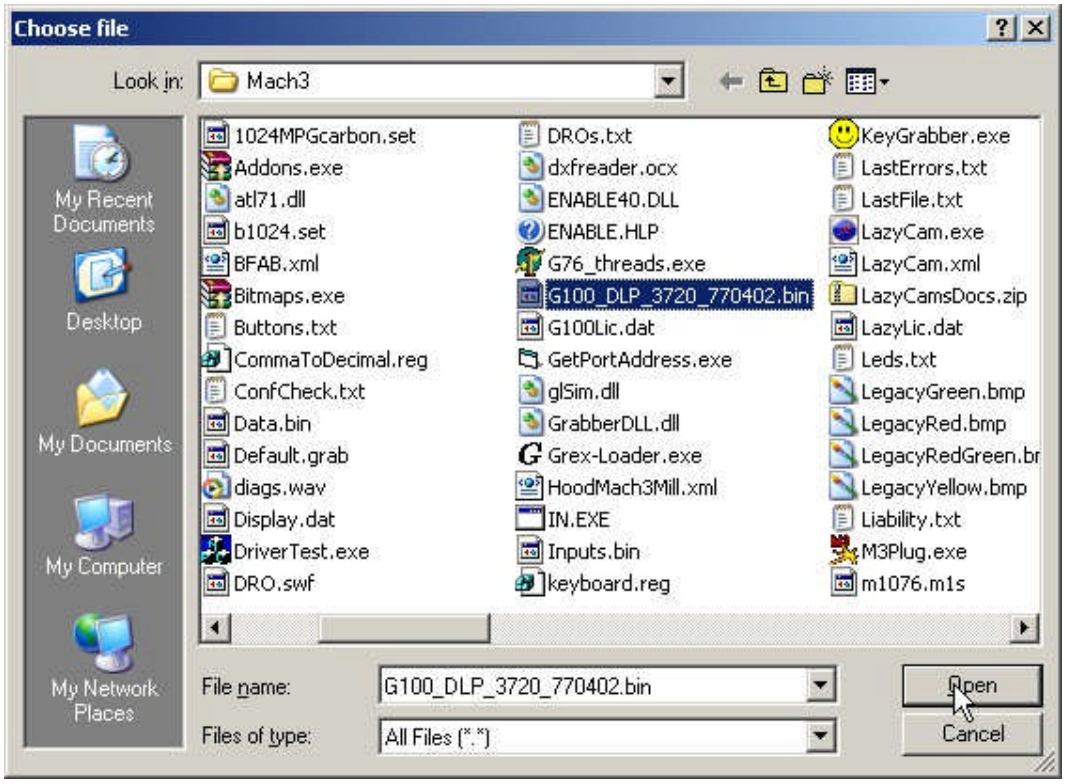
Scroll down to the bottom of the page and click on Upload New Firmware



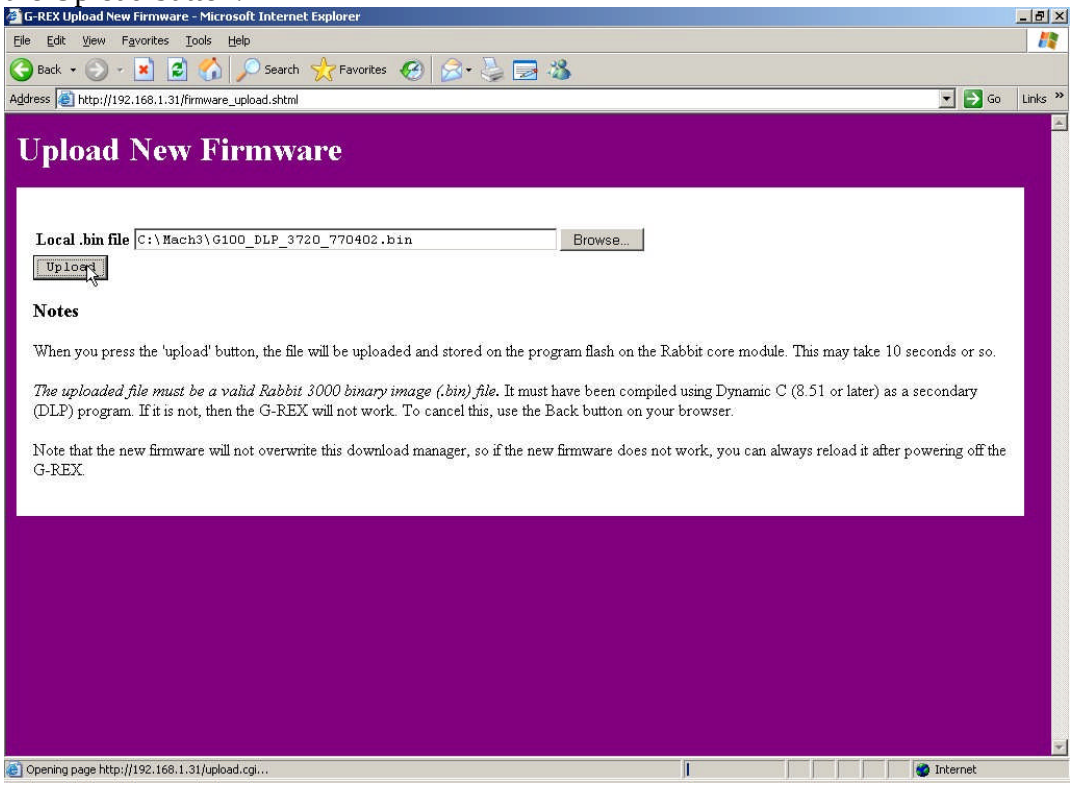
That will take you to this screen. Click the Browse button.



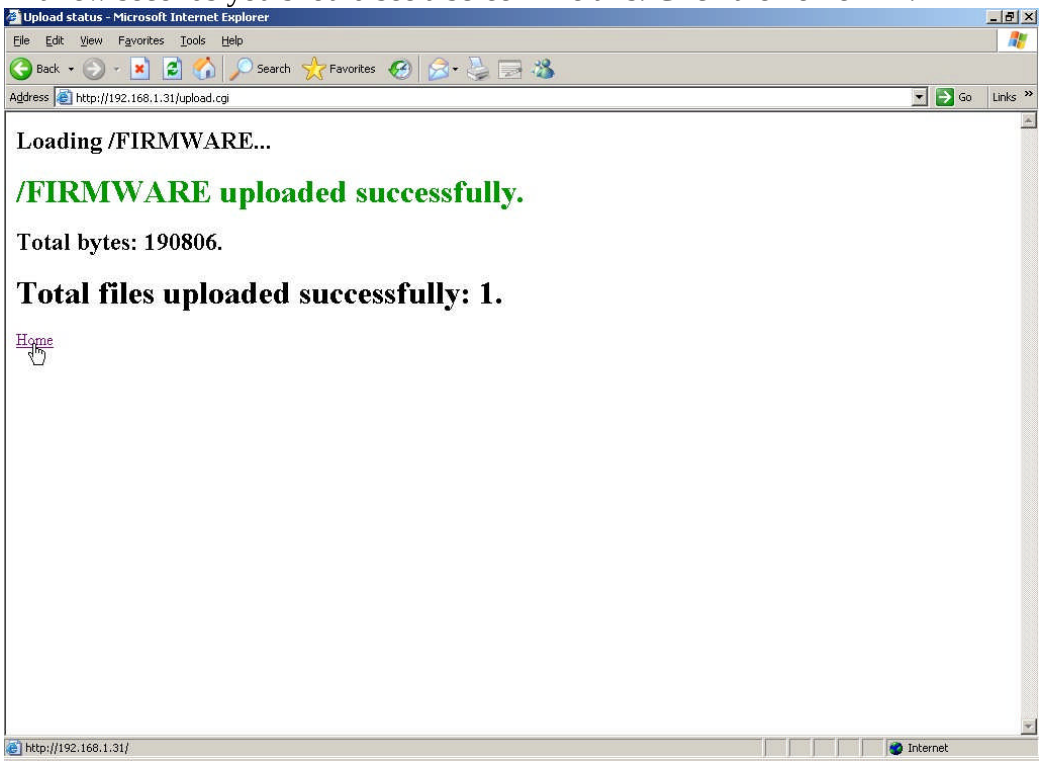
Browse to your Mach 3 root folder and choose the .bin file that came with your G100 plug-in from Artsoft. Double click on it.



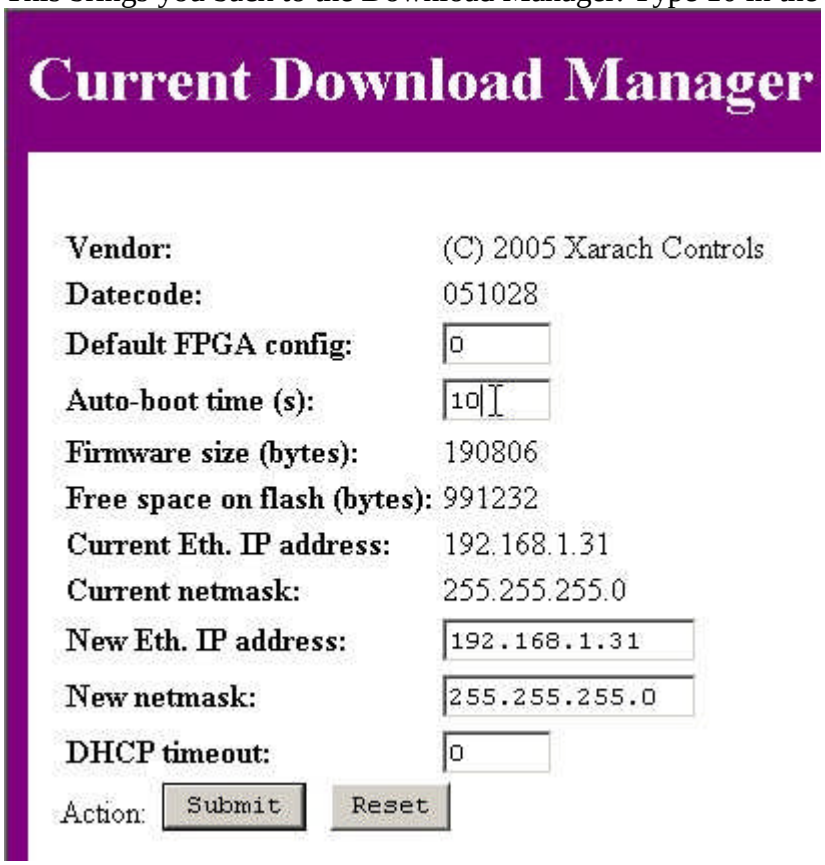
That will take you back to this screen. Notice the .bin file now shows in the Local.bin file window. Click the Upload button.



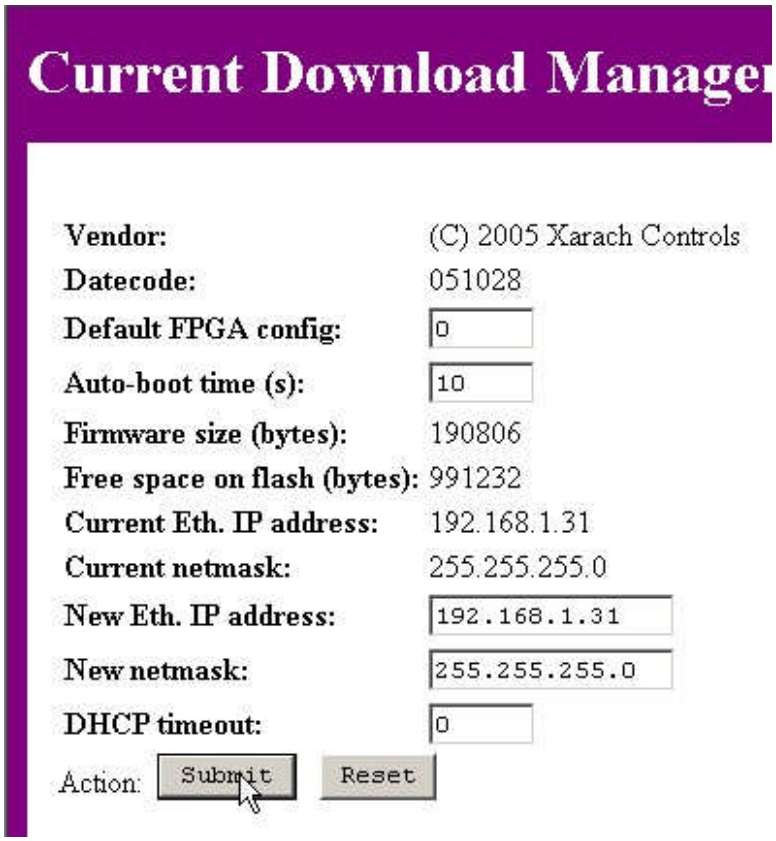
In a few seconds you should see a screen like this. Click the home link.



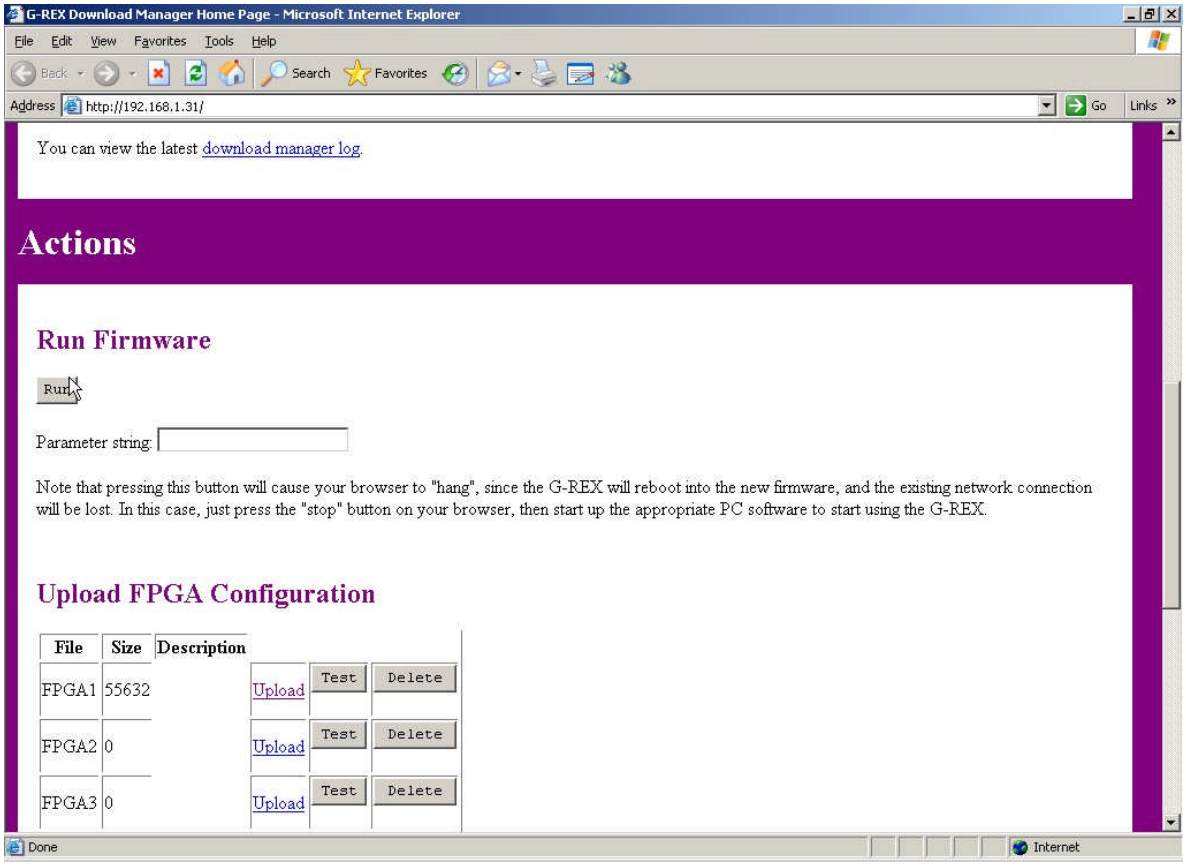
This brings you back to the Download Manager. Type 10 in the Auto-boot time window and press enter.



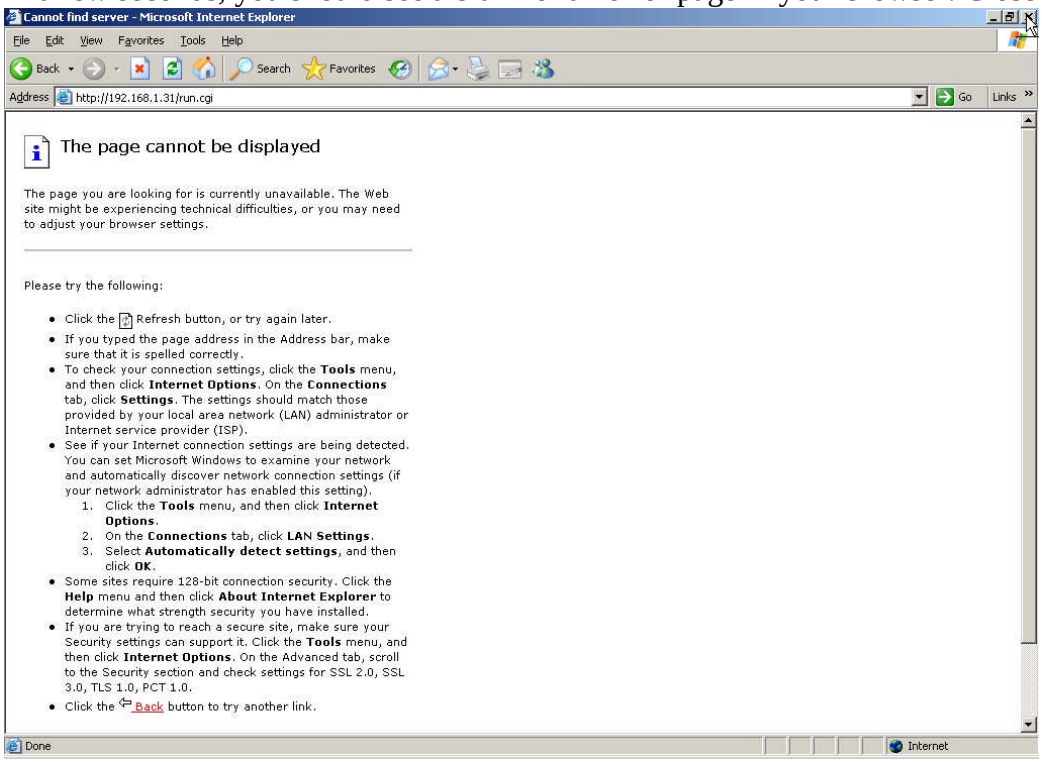
Now click the Submit button.



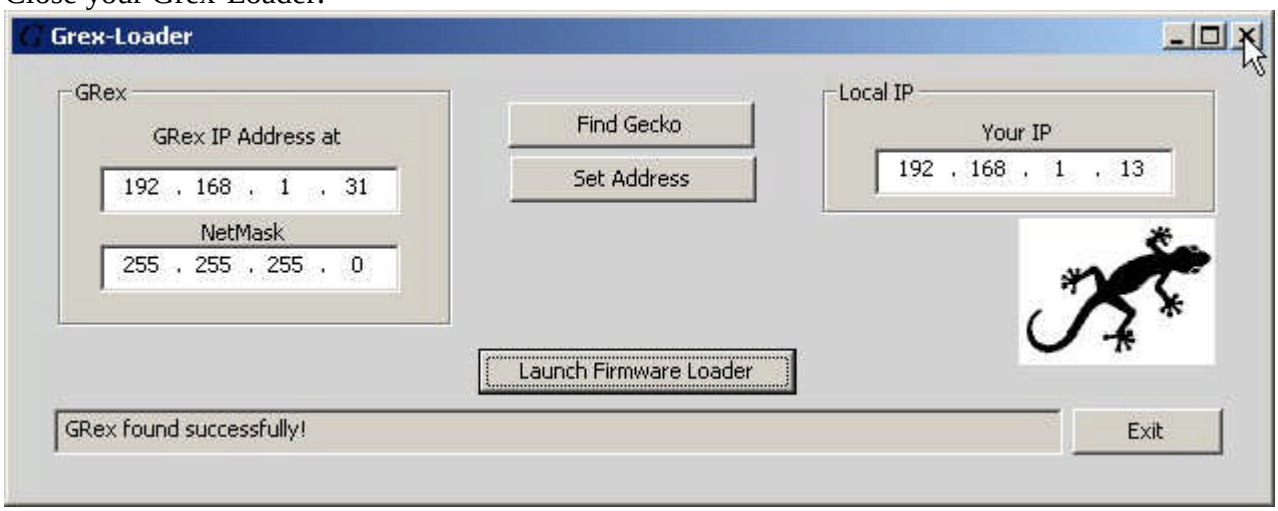
Scroll down to the Actions section and click run under Run Firmware



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 Homeing/Limits.