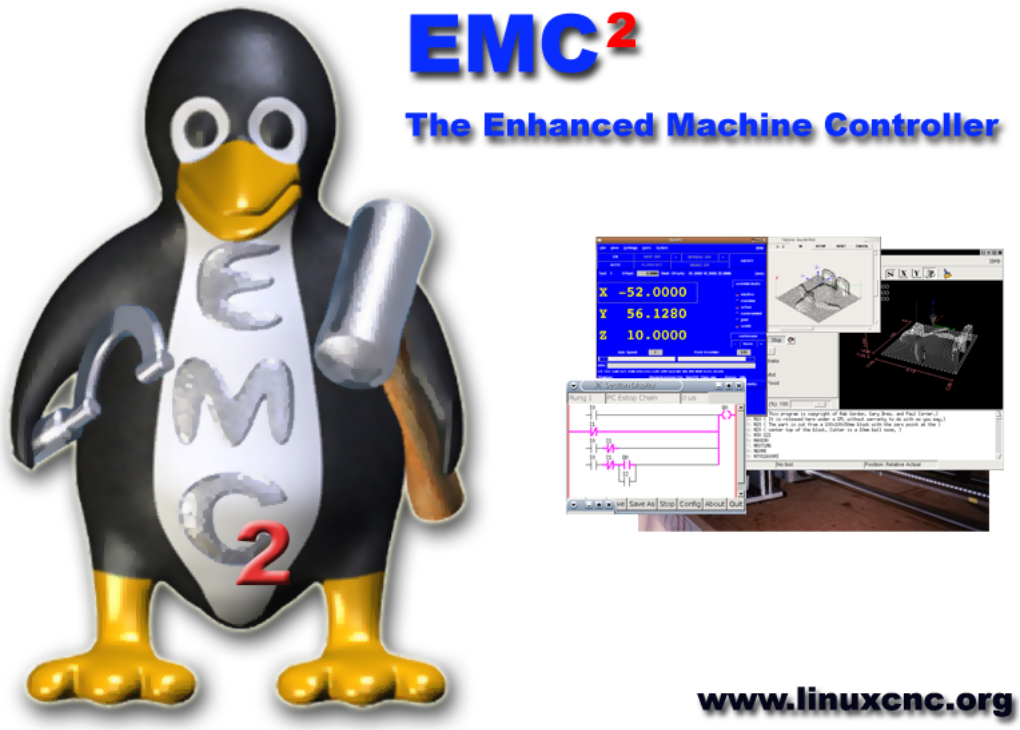
Getting Started Guide V2.2

The EMC Team

November 11, 2008



This handbook is a work in progress. If you are able to help with writing, editing, or graphic preparation please contact any member of the writing team or join and send an email to emc-users@lists.sourceforge.net.

Contents

Chapter 1

Computer

1.1 Minimum Requirements

The minimum system to run EMC2 and Ubuntu may vary depending on the exact usage. Stepper systems in general require faster threads to generate step pulses than servo systems. Using the Live-CD you can test the software before committing a computer. Keep in mind that the Latency Test numbers are more important than the processor speed for software step generation. More information on the Latency Test is in Section (5.5).

Additional information is on the EMC Wiki site:

http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl?Hardware_Requirements

EMC2 and Ubuntu should run reasonably well on a computer with the following minimum hardware specification. These numbers are not the absolute minimum but will give reasonable performance for most stepper systems.

- 700 MHz x86 processor (1.2 GHz x86 processor recommended)
- 384 MB of RAM system memory (512 MB up to 1 GB recommended)
- 8 GB of disk space
- Graphics card capable of 1024x768 resolution
- A network or Internet connection (optional but great for updates)
- A sound card (optional)

1.2 Problematic Hardware

1.2.1 Laptops

Laptops are not generally suited to real time software step generation. Again a Latency Test ran for an extended time will give you the info you need to determine suitability.

1.2.2 Video Cards

If your installation pops up with 800 x 600 screen resolution then most likely Ubuntu does not recognize your video card. On board video many times cause bad real time performance.

Chapter 2

Getting Help

2.1 IRC

IRC stands for Internet Relay Chat. It is a live connection to other EMC users. The EMC IRC channel is #emc on freenode.

The simplest way to get on the IRC is to use the embedded java client on this page:

http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl

Some IRC etiquette:

- Ask specific questions... Avoid "Can someone help me?", "It won't run" type of questions...
- If your really new to all this think a bit about your question before typing it. Make sure you give enough information so someone could solve your question.
- Have some patience when waiting for an answer, sometimes it takes a while to formulate an answer or everyone might be busy working or something.
- Set up your IRC account with your unique name so people will know who you are or if you log on via the java client use the same name every time you log in. This helps people remember who you are and if you have been on before many will remember the past discussions which saves time on both ends.

2.2 Mailing List

An Internet Mailing List is a way to put questions out for everyone on that list to see and answer at their convience. You get better exposure to your questions on a mailing list than on the IRC but answers take longer. In a nutshell you e-mail a message to the list and either get daily digests or individual replys back depending on how you set up your account.

Information about the EMC Users Mailing List is at:

http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl

2.3 EMC Wiki

A Wiki site is a user maintained web site that anyone can edit or add content to.

The user maintained EMC Wiki site contains a wealth of information, procedures, and tips at:

http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl

Chapter 3

Get EMC2

3.1 Normal Download

Download the Live CD from:

http://www.linuxcnc.org/

and follow the Download link.

3.2 Multi-session Download

If the file is too large to download in one session because of a bad or slow Internet connection use **wget** to allow resuming downloads.

3.2.1 Wget Linux

Open a terminal window. In Ubuntu it is Applications/Accessories/Terminal. Note that actual file names may change so you might have to go to http://www.linuxcnc.org/ and follow the Download link to get the actual file name. In most browsers you can right click on the link and select Copy Link Location or similar then paste the link into the terminal window with a right mouse click and select Paste.

To get the Ubuntu 8.04 Hardy Heron version copy this in the terminal window and press enter:

```
wget -r http://www.linuxcnc.org/hardy/ubuntu-8.04-desktop-emc2-aj07-i386.iso
```

To get the Ubuntu 6.06 Dapper Drake version:

```
wget -r http://www.linuxcnc.org/iso/emc2.2.2-1-ubuntu6.06-desktop-i386.iso
```

To continue a download that has been stopped add the -c option to wget:

```
wget -r -c http://www.linuxcnc.org/hardy/ubuntu-8.04-desktop-emc2-aj07-i386.iso
```

To stop a download use Ctrl-C or close the terminal window.

After the download is complete you will find a new directory called www.linuxcnc.org or something similar. In the subdirectory under the above directory you will find the ISO CD image file. Next is burning the CD.

3.2.2 Wget Windows

The wget program is also available for Windows from

http://gnuwin32.sourceforge.net/packages/wget.htm

Follow the instructions on the web page for downloading and installing the windows version of the wget program.

To run wget open a command prompt window.

In most Windows it is Programs/Accessories/Command Prompt

First you have to change to the directory where wget is installed in.

Typically it is in C:\Program Files\GnuWin32\bin so in the Command Prompt window type:

```
cd C:\Program Files\GnuWin32\bin
```

and the prompt should change to C:\Program Files\GnuWin32>

Type the wget command into the window and press enter as above.

3.3 Burning the CD

EMC2 is distributed as CD image files, called ISOs. To install EMC2, you first need to burn the ISO file onto a CD. You need a working CD/DVD burner and an 80 minute (700 Mb) CD for this. If the CD writing fails, try writing at a slower burn speed

3.3.1 Burn with Linux

Before burning a CD, it is highly recommended that you verify the md5 sum (hash) of the .iso file.

Open a terminal window. In Ubuntu it is Applications/Accessories/Terminal.

Change to the directory where the ISO was downloaded to.

```
cd download_directory
```

The run the md5sum command with the file name you saved.

```
md5sum ubuntu-8.04-desktop-emc2-aj07-i386.iso
```

The md5sum should print out a single line after calculating the hash. On slower computers this might take a minute or two.

```
91c5abb84386091e0ff056e9ebc40fdb ubuntu-8.04-desktop-emc2-aj07-i386.iso
```

Now compare it to the md5sum on the EMC2 download page.

Burning the ISO to a CD

1. Insert a blank CD into your burner. A "CD/DVD Creator" or "Choose Disc Type" window will pop up. Close this, as we will not be using it.
2. Browse to the downloaded ISO image in the file browser.
3. Right click on the ISO image file and choose Write to Disc.
4. Select the write speed. If you are burning a Ubuntu Live CD, it is recommended that you write at the lowest possible speed.
5. Start the burning process.
6. If a choose a file name for the disc image window pops up just pick OK.

3.3.2 Burn with Windows

Before burning a CD, it is highly recommended that you verify the md5 sum (hash) of the .iso file.

Windows does not come with a md5sum program. You will have to download and install one to check the md5sum. More information can be found at:

https://help.ubuntu.com/community/HowToMD5SUM

Burning the ISO to a CD

1. Download and install Infra Recorder, a free and open source image burning program.
2. Insert a blank CD in the drive and select Do nothing or Cancel if an auto-run dialog pops up.
3. Open Infra Recorder, and select the 'Actions' menu, then 'Burn image'.

3.4 Testing EMC2

With the Live CD in the CD/DVD drive shut down the computer then turn the computer back on. This will boot the computer from the Live CD. Once the computer has booted up you can try out EMC2 without installing it. You can not create custom configurations or modify most system settings like screen resolution unless you install EMC2.

To try out EMC2 from the Applications/CNC menu pick EMC2. Then select a sim configuration to try out.

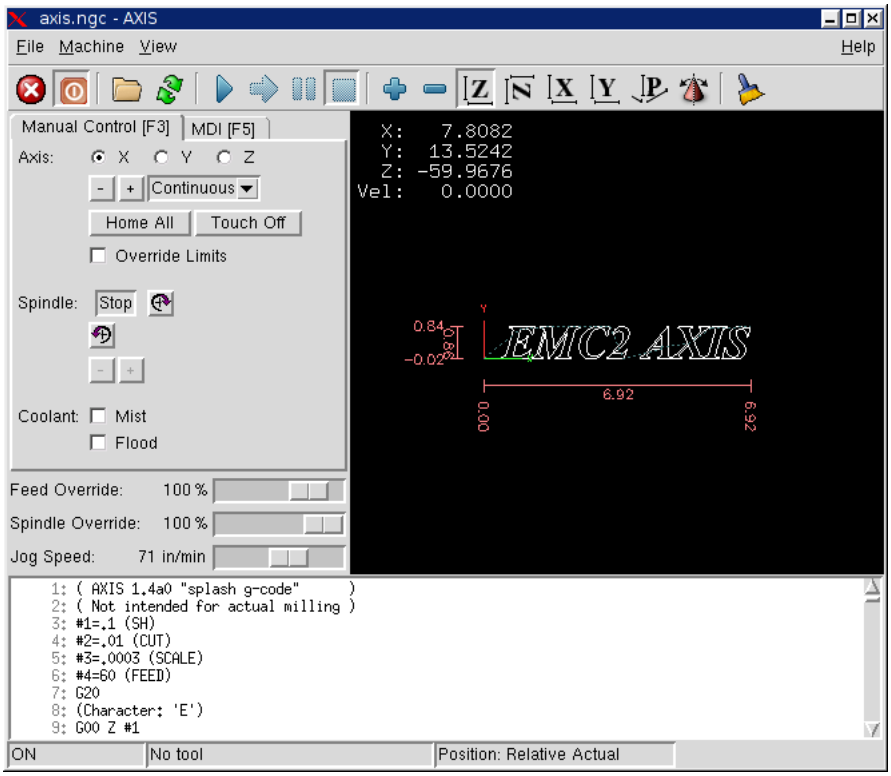
To see if your computer is suitable for software step pulse generation run the Latency Test as outlined in Section (5.5)

3.5 Installing EMC2

If you like what you see, just click the Install icon on the desktop, answer a few questions (your name, timezone, password) and the install completes in a few minutes. Make sure you write down the name you used and the password. Once the install process is complete and you go on line the update manager will pop up and allow you to upgrade to the latest stable version of EMC2.

3.6 AXIS Interface

The AXIS interface is one of the interfaces to choose from. It can be configured to add a Virtual Control Panel to customize the interface to suit your needs. AXIS is the default user interface and is actively being developed.



3.7 Updates to EMC2

With the normal install the Update Manager will notify you of updates to EMC2 and Ubuntu when you go on line and allow you to easily upgrade with no Linux knowledge needed. If you want to upgrade to 8.04 from 6.06 a clean install from the Live-CD is needed. It is OK to upgrade EMC when asked to.

Warning: Do not upgrade Ubuntu to a new version as it will prevent EMC from running.

Chapter 4

Stepper Configurations

This section assumes you have done a standard install from the Live CD. After installation it is recommended that you connect the computer to the Internet and wait for the update manager to pop up and get the latest updates for EMC and Ubuntu before continuing. For more complex installations see the Integrators Manual.

4.1 Latency Test

The Latency Test tells you if your hardware might cause a problem when running real time. Some hardware can tie up the processor and cause lateness in responding to requests.

Follow the instructions in section (5.5) to run the latency test.

4.2 Sherline and Xylotex

If you have a Sherline or Xylotex you can skip the following sections and go straight to the Stepper Config Wizard in Section (5). EMC has provided quick setup for the Sherline and Xylotex machines.

4.3 Machine Information

Gather the information about each axis of your machine.

Drive timing is in nano seconds. If your unsure about the timing many popular drives are included in the stepper configuration wizard. Note some newer Gecko drives have different timing than the original one. A list is also on the user maintained EMC wiki site of more drives at:

http:wiki.linuscnc.org

Axis	Drive Type	Step Time ns	Step Space ns	Direction Hold ns	Direction Setup ns
X					
Y					
Z					

4.4 Pinout Information

Gather the information about the connections from your machine to the PC parallel port.

Output Pin	Typical Function	If Different	Input Pin	Typical Function	If Different
1	E-Stop Out		10	Both Limit & Home X	
2	X Step		11	Both Limit & Home Y	
3	X Direction		12	Both Limit & Home Z	
4	Y Step		13	Both Limit & Home A	
5	Y Direction		15	Probe In	
6	Z Step				
7	Z Direction				
8	A Step				
9	A Direction				
14	Spindle CW				
16	Spindle PWM				
17	Amplifier Enable				

Note any pins not used should be set to Unused in the drop down box. These can always be changed later by running Stepconf again.

4.5 Mechanical Information

Gather information on steps and gearing. The result of this is steps per user unit which is used for SCALE in the .ini file.

Axis	Steps/Revolution	Micro steps	Motor Teeth	Leadscrew Teeth	Leadscrew Pitch
X					
Y					
Z					
A					

Steps per revolution is how many steps it takes to turn the stepper one revolution.

Micro steps is how many steps the drive needs to move the stepper one step.

Motor & Leadscrew Teeth is if you have some reduction between the motor and the leadscrew. If not set these to 1.

Leadscrew pitch is how many turns it takes to move your table one user unit. If your setting up in inches then it is turns per inch. If your setting up in millimeters then how many turns per millimeter.

4.6 Configuration Wizard

Run the Stepconf Wizard in chapter (5.1)

4.7 Desktop Shortcut

To create a desktop shortcut after running the Stepconf Wizard. From the CNC menu start EMC2 and pick your new configuration from the list. Check off Create Desktop Shortcut then OK. Now you can run your configuration from the desktop shortcut.

4.8 Modifying

To change something in the basic configuration created by Stepconf Wizard run the wizard again. Select Modify a configuration... Then pick the configuration file .stepconf you wish to modify in the emc2/configs folder. The file headers tell you if the file can be manually edited or not.

Chapter 5

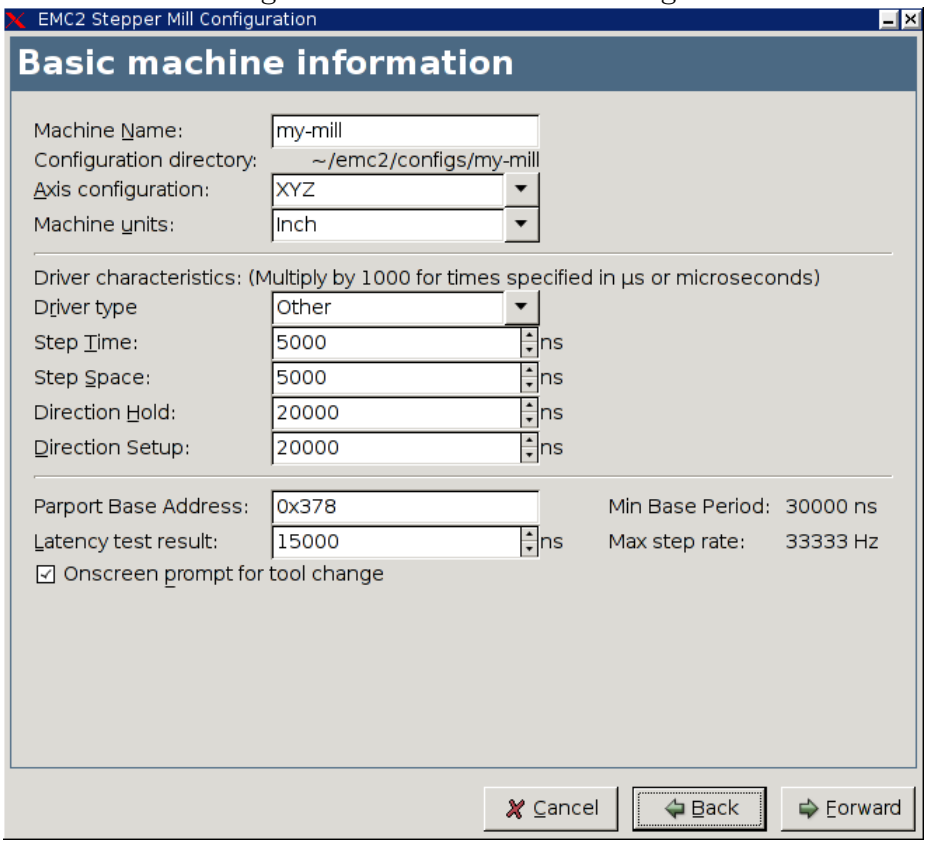
Stepconf Wizard

EMC2 is capable of controlling a wide range of machinery using many different hardware interfaces. Stepconf is a program which generates EMC configuration files for a specific class of CNC machine: those connected to the PC using a standard **parallel port** and controlled with **step & direction** signals. Stepconf is installed when you install EMC2 and is in the CNC menu.

5.1 Step by Step Instructions

5.1.1 Basic Information

Figure 5.1: Basic Information Page



Machine Name Choose a name for your machine. Use only uppercase letters, lowercase letters, digits, "-" and "_".

Axis Configuration Choose XYZ (Mill), XYZA (4-axis mill) or XZ (Lathe).

Machine Units Choose Inch or mm. All subsequent questions (such as machine travel, leadscrew pitch, etc) will be answered in the chosen units

Driver Characteristics If you have one of the stepper drivers listed in the pull down box, choose it. Otherwise, find the 4 timing values in your driver's data sheet and enter them. If the data sheet gives a value in microseconds, multiply by 1000. For example, enter 4.5us as 4500.

Additional signal conditioning or isolation such as optocouplers and RC filters on break out boards can impose timing constraints of their own, in addition to those of the driver. You may find it necessary to add some time to the drive requirements to allow for this.

Latency Test Result Enter the result of the Latency Test here. To run a latency test see section (5.5)

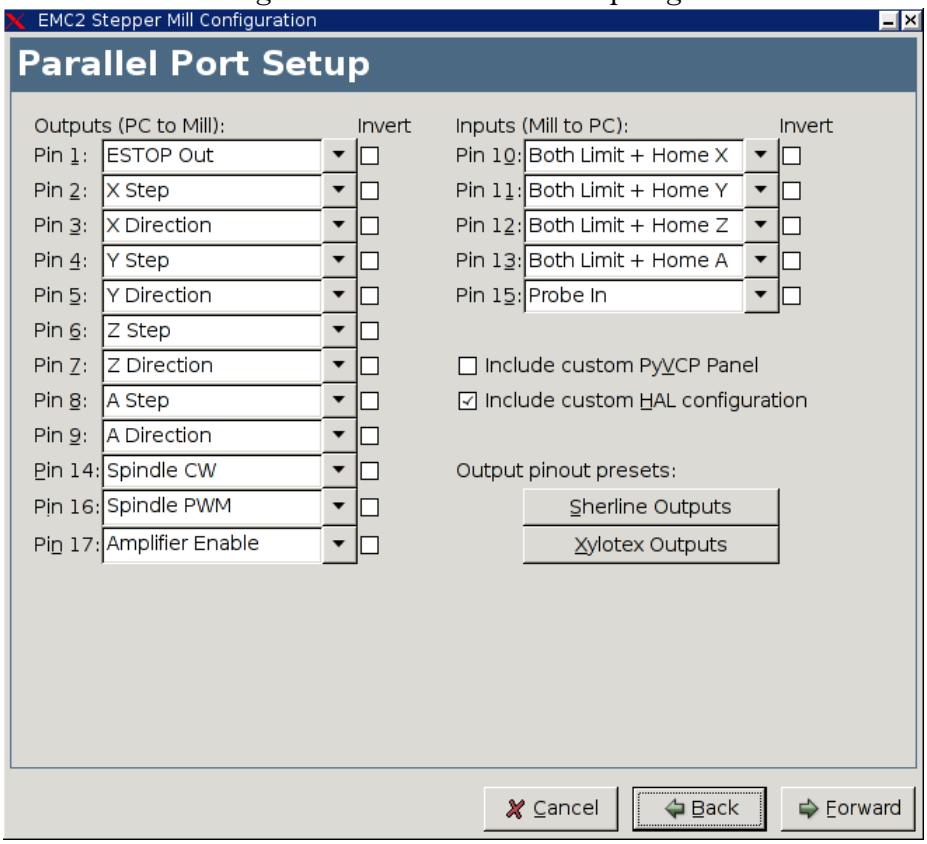
Max Step Rate Stepconf automatically calculates the Max Step Rate based on the driver characteristics entered and the latency test results.

Min Base Period Stepconf automatically determines the Min Base Period based on the driver characteristics entered and latency test result.

Onscreen Prompt For Tool Change If this box is checked, EMC will pause and prompt you to change the tool when **M6** is encountered. Leave this box checked unless you plan to add support for an automatic tool changer in a custom hal file

5.1.2 Parallel Port Setup

Figure 5.2: Parallel Port Setup Page



For each pin, choose the signal which matches your parallel port pin out. Turn on the "invert" check box if the signal is inverted (0V for true/active, 5V for false/inactive).

Output pinout presets Automatically set pins 2 through 9 according to the Sherline standard (Direction on pins 2, 4, 6, 8) or the Xylotex standard (Direction on pins 3, 5, 7, 9).

Inputs and Outputs If the input or output is not used set the option to "Unused".

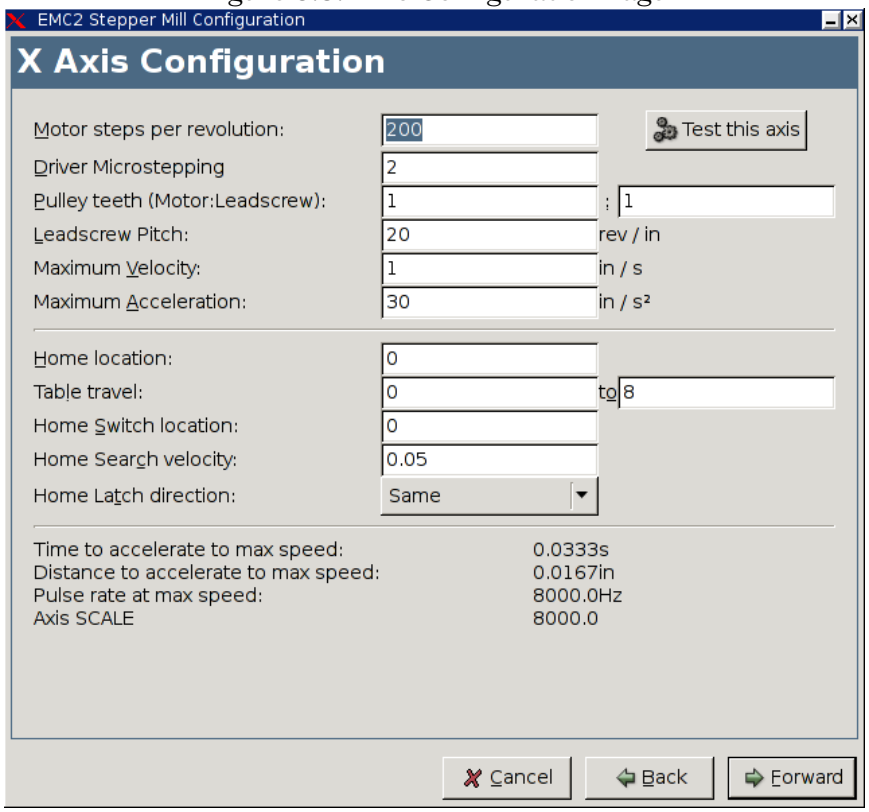
Include custom HAL configuration Allows you to add additional hal customizations in the file `custom.hal` after running Stepconf.

Include custom PyVCP Panel If selected, the PyVCP control panel `panel.xml` will be displayed on the right-hand side of the main AXIS window. This will not create a PyVCP panel but will create the blank file in the config folder. To create a PyVCP panel see the PyVCP section of the Integrators Manual.

Charge Pump If your driver board requires a charge pump signal simply select Charge Pump from the drop down list for the output pin you wish to connect to your charge pump input. The charge pump output is connected to the base thread by Stepconf. The charge pump output will be about 1/2 of the maximum step rate shown on the Basic Machine Configuration page.

5.1.3 Axis Configuration

Figure 5.3: Axis Configuration Page



Motor Steps Per Revolution The number of full steps per motor revolution. If you know how many degrees the motor is (e.g., 1.2 degree), then divide 360 by the degrees to find the number of steps per motor revolution.

Driver Microstepping The amount of microstepping performed by the driver. Enter "2" for half-stepping.

Pulley Ratio If your machine has pulleys between the motor and leadscrew, enter the ratio here. If not, enter "1:1".

Leadscrew Pitch Enter the pitch of the leadscrew here. If you chose "Inch" units, enter the number of threads per inch here (e.g., enter 8 for 8TPI). If you chose "mm" units, enter the number of millimeters per thread here (e.g., enter 2 for 2mm/rev). If the machine travels in the wrong direction, enter a negative number here instead of a positive number.

Maximum Velocity

Maximum Acceleration The correct values for these items can only be determined through experimentation. See "Finding Velocity and Acceleration" below.

Home Location The position the machine moves to after completing the homing procedure for this axis. For machines without home switches, this is the location the operator manually moves the machine to before pressing the Home button.

Table Travel The range of travel that gcode programs must not exceed. The home location must be inside the Table Travel. In particular, having Home Location exactly equal to one of the Table Travel values is incorrect configuration

Home Switch Location The location at which the home switch trips or releases during the homing process. This item and the two below only appear when Home Switches were chosen in the Parallel Port Pinout.

Home Search Velocity The velocity to use when moving towards the switch. If the switch is near the end of travel, this velocity must be chosen so that the axis can decelerate to a stop before hitting the end of travel. If the switch is only closed for a short range of travel (instead of being closed from its trip point to one end of travel), this velocity must be chosen so that the axis can decelerate to a stop before the switch opens again, and homing must always be started from the same side of the switch.
If the machine moves the wrong direction at the beginning of the homing procedure, negate the value of **Home Search Velocity**.

Home Latch Direction Choose "Same" to have homing back off the switch, then approach it again at a very low speed. The second time the switch closes, the home position is set.
Choose "Opposite" to have homing slowly back off the switch. When the switch opens, the home position is set.

Time to accelerate to max speed

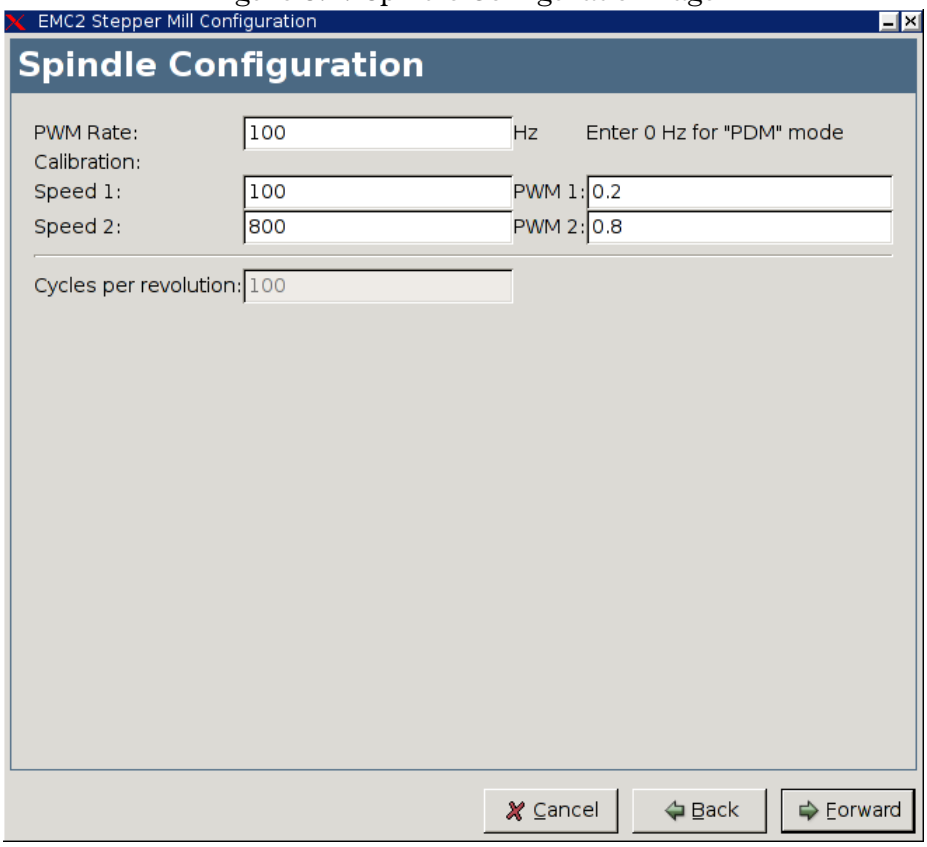
Distance to accelerate to max speed

Pulse rate at max speed Information computed based on the values entered above. The greatest **Pulse rate at max speed** determines the **BASE_PERIOD**, and values above 20000Hz may lead to slow response time or even lockups (the fastest usable pulse rate varies from computer to computer)

Test this axis This will open a window to allow testing for each axis. See section (5.2)

5.1.4 Spindle Configuration

Figure 5.4: Spindle Configuration Page



These options only appear when “Spindle PWM”, “Spindle A” or “Spindle PPR” are chosen in the **Parallel port pinout**.

5.1.4.1 Spindle Speed Control

If “Spindle PWM” appears on the pinout, the following information should be entered:

PWM Rate The “carrier frequency” of the PWM signal to the spindle. Enter “0” for PDM mode, which is useful for generating an analog control voltage. Refer to the documentation for your spindle controller for the appropriate value.

Speed 1 and 2, PWM 1 and 2 The generated configuration file uses a simple linear relationship to determine the PWM value for a given RPM value. If the values are not known, they can be determined. For more information see section (5.3)

5.1.4.2 Spindle-synchronized motion (lathe threading)

When the appropriate signals from a spindle encoder are connected to the parallel port, EMC supports lathe threading. These signals are:

Spindle PPR Also called “Index pulse”, this is a pulse that occurs once per revolution of the spindle.

Spindle A This is a pulse that occurs in multiple equally-spaced locations as the spindle turns.

Spindle B (optional) This is a second pulse that occurs, but with an offset from **Spindle A**. The advantages to using both **A** and **B** are increased noise immunity and increased resolution.

If "Spindle A" and "Spindle PPR" appear on the pinout, the following information should be entered:

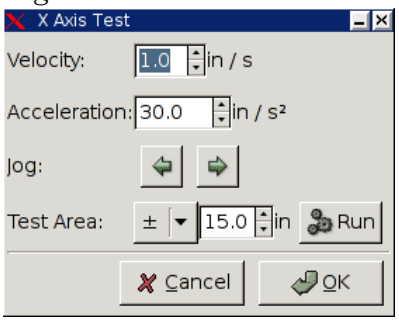
Cycles per revolution The number of cycles of the **Spindle A** signal during one revolution of the spindle

5.1.5 Machine Configuration Complete

Click "Apply" to write the configuration files. Later, you can re-run this program and tweak the settings you entered before.

5.2 Testing Each Axis

Figure 5.5: Axis Test Window



With Stepconf it is easy to try different values for acceleration and velocity. First, enter the correct figures for **Steps per Revolution**, **Microstepping**, **Pulley**, and **Leadscrew**. Then enter a provisional value for **Velocity**. **Next**, click **Test this axis**.

5.2.1 Finding Maximum Velocity

Begin with a low Acceleration (e.g., 2 in/s^2 or 50mm/s^2) and the velocity you hope to attain. Using the buttons provided, jog the axis to near the center of travel. Take care because with a low acceleration value, it can take a surprising distance for the axis to decelerate to a stop.

After gauging the amount of travel available, enter a safe distance in Test Area, keeping in mind that after a stall the motor may next start to move in an unexpected direction. Then click Run. The machine will begin to move back and forth along this axis. In this test, it is important that the combination of Acceleration and Test Area allow the machine to reach the selected Velocity and "cruise" for at least a short distance–the more distance, the better this test is. The formula d=.5*v*v/a gives the minimum distance required reach the specified velocity with the given acceleration. If it is convenient and safe to do so, push the table against the direction of motion to simulate cutting forces. If the machine stalls, reduce the speed and start the test again.

If the machine did not obviously stall, click the "Run" button off. The axis now returns to the position where it started. If the position is incorrect, then the axis stalled or lost steps during the test. Reduce Velocity and start the test again.

If the machine doesn't move, stalls, or loses steps no matter how low you turn Velocity, verify the following:

- Correct step waveform timings
- Correct pinout, including "Invert" on step pins
- Correct, well-shielded cabling
- Physical problems with the motor, motor coupling, leadscrew, etc.

Once you have found a speed at which the axis does not stall or lose steps during this testing procedure, reduce it by 10% and use that as the axis Maximum Velocity.

5.2.2 Finding Maximum Acceleration

With the Maximum Velocity you found in the previous step, enter the acceleration value to test. procedure as above, adjusting the Acceleration value up or down as necessary. In this test, it is important that the combination of Acceleration and Test Area allow the machine to reach the selected Velocity. Once you have found a value at which the axis does not stall or lose steps during this testing procedure, reduce it by 10% and use that as the axis Maximum Acceleration.

5.3 Determining Spindle Calibration

Enter the following values in the Spindle Configuration page:

Speed 1:	**0**	PWM 1:	**0**
Speed 2:	**1000**	PWM 1:	**1**

Finish the remaining steps of the configuration process, then launch EMC with your configuration. Turn the machine on and select the MDI tab. Start the spindle turning by entering: `M3 S100`. Change the spindle speed by entering a different S-number: `S800`. Valid numbers range from 1 to 1000.

For two different S-numbers, measure the actual spindle speed in RPM. Record the S-numbers and actual spindle speeds. Run Stepconf again. For "Speed" enter the measured speed, and for "PWM" enter the S-number divided by 1000.

Because most spindle drivers are somewhat nonlinear in their response curves, it is best to:

- Make sure the two calibration speeds are not too close together in RPM
- Make sure the two calibration speeds are in the range of speeds you will typically use while milling

For instance, if your spindle will go from 0RPM to 8000RPM, but you generally use speeds from 400RPM to 4000RPM, then find the PWM values that give 1600RPM and 2800RPM.

5.4 Axis Travel, Home Location, and Home Switch Location

For each axis, there is a limited range of travel. The physical end of travel is called the **hard stop**.

Before the **hard stop** there is a **limit switch**. If the limit switch is encountered during normal operation, EMC shuts down the motor amplifier. The distance between the **hard stop** and **limit switch** must be long enough to allow an unpowered motor to coast to a stop.

Before the **limit switch** there is a **soft limit**. This is a limit enforced in software after homing. If a MDI command, or gcode program would pass the soft limit, it is not executed. If a jog would pass the soft limit, it is terminated at the soft limit.

The **home switch** can be placed anywhere within the travel (between hard stops). As long as external hardware does not deactivate the motor amplifiers with the limit switch is reached, one of the limit switches can be used as a home switch.

The **zero position** is the location on the axis that is 0 in the machine coordinate system. Usually the **zero position** will be within the **soft limits**. On lathes, constant surface speed mode requires that machine **X=0** correspond to the center of spindle rotation when no tool offset is in effect.

The **home position** is the location within travel that the axis will be moved to at the end of the homing sequence. This value must be within the **soft limits**. In particular, the **home position** should never be exactly equal to a **soft limit**.

5.4.1 Operating without Limit Switches

A machine can be operated without limit switches. In this case, only the **soft limits** stop the machine from reaching the **hard stop**. **Soft limits** only operate after the machine has been homed. Since there is no switch, the machine must be moved by eye to the home position before pressing the “Home” or “Home All” button.

5.4.2 Operating without Home Switches

A machine can be operated without home switches. If the machine has limit switches, but no home switches, it is best to use a limit switch as the home switch (e.g., choose **Minimum Limit + Home X** in the pinout). If the machine has no limit switches, or the limit switches cannot be used as home switches for another reason, then the machine must be homed “by eye”. Homing by eye is not as repeatable as homing to switches, but it still allows the **soft limits** to be useful.

5.5 Latency Test

Generating step pulses in software has one very big advantage - it’s free. Just about every PC has a parallel port that is capable of outputting step pulses that are generated by the software. However, software step pulses also have some disadvantages:

- limited maximum step rate
- jitter in the generated pulses
- loads the CPU

Latency is how long it takes the PC to stop what it is doing and respond to an external request. In our case, the request is the periodic "heartbeat" that serves as a timing reference for the step pulses. The lower the latency, the faster you can run the heartbeat, and the faster and smoother the step pulses will be.

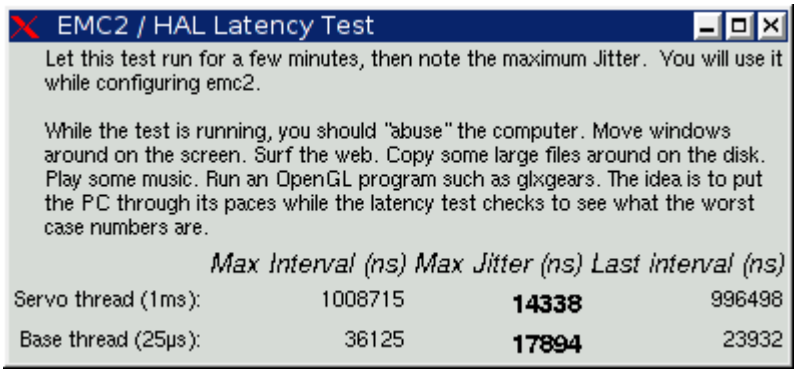
Latency is far more important than CPU speed. A lowly Pentium II that responds to interrupts within 10 microseconds each and every time can give better results than the latest and fastest P4 Hyperthreading beast.

The CPU isn’t the only factor in determining latency. Motherboards, video cards, USB ports, and a number of other things can hurt the latency. The best way to find out what you are dealing with is to run the HAL latency test.

To run the test, from Applications/Accessories/Terminal (Ubuntu) open a shell and run the following command:

```
latency-test
```

You should see something like this:



While the test is running, you should "abuse" the computer. Move windows around on the screen. Surf the web. Copy some large files around on the disk. Play some music. Run an OpenGL program such as glxgears. The idea is to put the PC through its paces while the latency test checks to see what the worst case numbers are.

Do not run EMC2 or Stepconf while the latency test is running.

The important numbers are the “max jitter”. In the example above, that is 17894 nanoseconds, or 17.9 microseconds. Record this number, and enter it in Stepconf when it is requested.

In the example above, latency-test only ran for a few seconds. You should run the test for at least several minutes; sometimes the worst case latency doesn’t happen very often, or only happens when you do some particular action. For instance, one Intel motherboard worked pretty well most of the time, but every 64 seconds it had a very bad 300uS latency. Fortunately that was fixable.

For the latest information on fixing SMI issues goto:

"Fixing SMI Issues" http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl?FixingSMIIssues

So, what do the results mean? If your Max Jitter number is less than about 15-20 microseconds (15000-20000 nanoseconds), the computer should give very nice results with software stepping. If the max latency is more like 30-50 microseconds, you can still get good results, but your maximum step rate might be a little disappointing, especially if you use microstepping or have very fine pitch leadscrews. If the numbers are 100uS or more (100,000 nanoseconds), then the PC is not a good candidate for software stepping. Numbers over 1 millisecond (1,000,000 nanoseconds) mean the PC is not a good candidate for EMC, regardless of whether you use software stepping or not.

Note that if you get high numbers, there may be ways to improve them. Another PC had very bad latency (several milliseconds) when using the onboard video. But a $5 used Matrox video card solved the problem - EMC does not require bleeding edge hardware.

5.6 Home and Limit Switch wiring options

The ideal wiring for external switches would be one input per switch. However, the PC parallel port only offers a total of 5 inputs, while there are as many as 9 switches on a 3-axis machine. Instead, multiple switches are wired together in various ways so that a smaller number of inputs are required.

The figures below show the general idea of wiring multiple switches to a single input pin. In each case, when one switch is actuated, the value seen on INPUT goes from logic HIGH to LOW. However, EMC expects a TRUE value when a switch is closed, so the corresponding “Invert” box must be checked on the pinout configuration page.

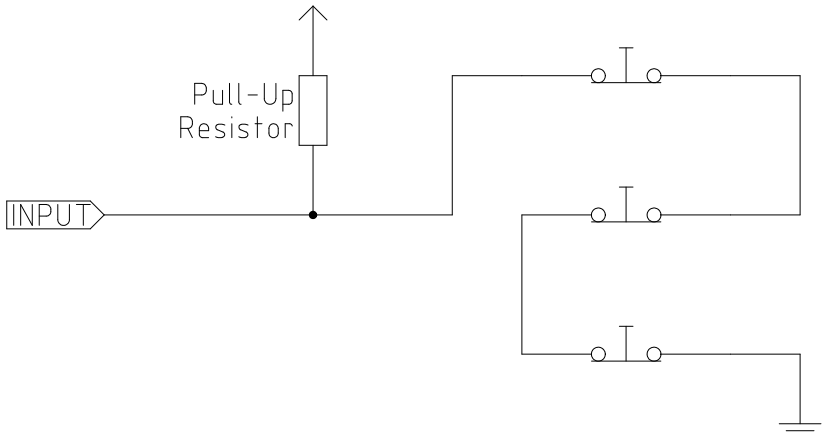


Figure 5.6: Wiring Normally Closed switches in series (simplified diagram)

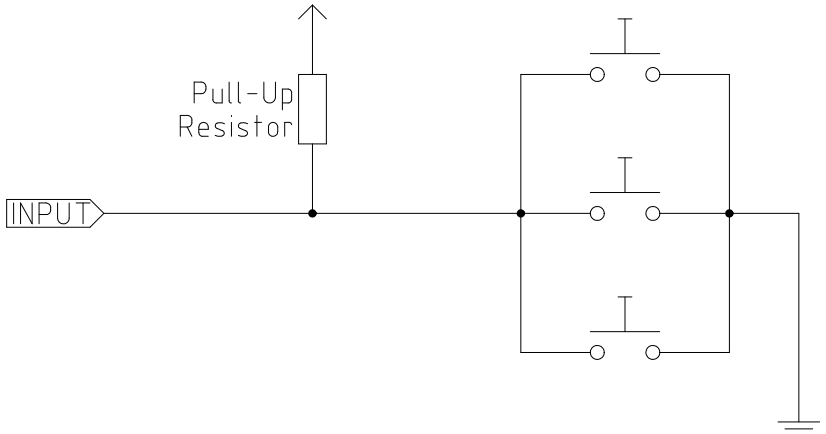


Figure 5.7: Wiring Normally Open switches in parallel (simplified diagram)

The following combinations of switches are permitted in Stepconf:

- Combine home switches for all axes
- Combine limit switches for all axes
- Combine both limit switches for one axis
- Combine both limit switches and the home switch for one axis
- Combine one limit switch and the home switch for one axis

The last two combinations are also appropriate when a “home to limit” is used.

Chapter 6

Linux FAQ

These are some basic Linux commands and techniques for new to Linux users. More complete information can be found on the web or by using the man pages.

6.1 Automatic Login

When you install EMC2 with the Ubuntu LiveCD the default is to have to log in each time you turn the computer on. To enable automatic login go to System/Administration/Login Window. If it is a fresh install the Login Window might take a second or three to pop up. You will have to have your password that you used for the install to gain acess to the Login Window Preferences window. In the Security tab check off Enable Automatic Login and pick a user name from the list (that would be you).

6.2 Man Pages

Man pages are automatically generated manual pages in most cases. Man pages are usually available for most programs and commands in Linux.

To view a man page open up a terminal window by going to Applications, Accessories, Terminal. For example if you wanted to find out something about the find command in the terminal window type:

```
man find
```

Use the Page Up and Page Down keys to view the man page and the Q key to quit viewing.

6.3 List Modules

Sometimes when troubleshooting you need to get a list of modules that are loaded. In a terminal window type:

```
lsmod
```

If you want to send the output from lsmod to a text file in a terminal window type:

```
lsmod > mymod.txt
```

The resulting text file will be located in the home directory if you did not change directories when you opened up the terminal window and it will be named mymod.txt or what ever you named it.

6.4 Editing a Root File

When you open the file browser and you see the Owner of the file is root you must do extra steps to edit that file. Editing some root files can have bad results. Be careful when editing root files. You can open and view most root files normally but they will open in "read only" mode.

6.4.1 The Command Line Way

Open up Applications, Accessories, Terminal.

In the terminal window type:

```
sudo gedit
```

Open the file with File, Open then edit

6.4.2 The GUI Way

1. Right click on the desktop and select Create Launcher
2. Type a name in like sudo edit
3. Type **gksudo "gnome-open %u"** as the command and save the launcher to your desktop
4. Drag a file onto your launcher to open and edit

6.5 Terminal Commands

6.5.1 Working Directory

To find out the path to the present working directory in the terminal window type:

```
pwd
```

6.5.2 Changing Directories

To move up one level in the terminal window type:

```
cd ..
```

To move up two levels in the terminal window type:

```
cd ../..
```

To move down to the emc2/configs subdirectory in the terminal window type:

```
cd emc2/configs
```

6.5.3 Listing files in a directory

To view a list of all the files and subdirectories in the terminal window type:

```
dir
```

or

```
ls
```

6.5.4 Finding a File

The find command can be a bit confusing to a new Linux user. The basic syntax is:

```
find starting-directory parameters actions
```

For example to find all the .ini files in your EMC2 directory you first need to use the pwd command to find out the directory. Open a new terminal window and type:

```
pwd
```

might return the following result

```
/home/joe
```

With this information put the command together like this:

```
find /home/joe/emc2 -name *.ini -print
```

The -name is the name of the file your looking for and the -print tells it to print out the result to the terminal window. The *.ini tells find to return all files that have the .ini extension.

To find all the files in the directory named and all the subdirectories under that add the -L option to the find command like this:

```
find -L /home/joe/emc2 -name *.ini -print
```

6.5.5 Searching for Text

```
grep -i -r 'text to search for' *
```

To find all the files that contain the 'text to search for' in the current directory and all the subdirectories below the current while ignoring the case. The -i is for ignore case and the -r is for recursive (include all subdirectories in the search). The * is a wild card for search all files.

6.6 Hardware Problems

6.6.1 Hardware Info

To find out what hardware is connected to your motherboard in a terminal window type:

```
lspci -v
```

6.6.2 Monitor Resolution

During installation Ubuntu attempts to detect the monitor settings. If this fails you are left with a generic monitor with a maximum resolution of 800x600.

Instructions for fixing this are located here:

https://help.ubuntu.com/community/FixVideoResolutionHowto

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Appendix A

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