StringStudio

USER MANUAL

A|A|S

APPLIED ACOUSTICS SYSTEMS

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Contents

1 Introduction

The *String Studio* is a synthesizer dedicated to the emulation of string instruments. The synthesizer is entirely based on the A|A|S physical modeling technology and uses no sampling nor wave tables. Instead it produces sound by solving, on the fly, mathematical equations modeling the different components involved in string instruments and how they interact. This elaborate synthesis engine responds dynamically to the control signals it receives while you play thereby reproducing the richness and responsiveness of real string instruments.

String Studio features three types of excitators (hammer, pick, and bow) an accurate model of a string, a model of the fret/finger interaction, a damper model and different types of soundboards. The combination of these different elements allows for the reproduction of a wide range of string instruments. *String Studio* is also equipped with a distortion module, filters and a comprehensive output effect stage to add the finishing touch to the sound. Finally, String Studio offers a wide range of performance features, including keyboard modes, portamento, vibrato and legato functions, a programmable pattern arpeggiator, and a complete set of MIDI features for optimal controller integration.

Before discussing the synthesizer in more detail, we would like to take this opportunity to thank you for choosing an A|A|S product. We sincerely hope that this product will bring you inspiration, pleasure and fulfill your creative needs.

1.1 System requirements

The following computer configuration is necessary to run the *String Studio*:

Mac OS :

- Mac OSX 10.2 (Jaguar) or later.
- G4 733 MHz Processor
- 256 MB RAM
- 1024 x 768 or higher screen resolution
- MIDI Keyboard (recommended)
- Ethernet Port
- Quicktime 4.0 or later

Windows :

- Windows 98SE/2000/XP
- PIII 800 MHz
- 128 MB RAM
- 1024 x 768 or higher screen resolution
- DirectX or ASIO supported sound card

- MIDI Keyboard (recommended)

Keep in mind that the computational power required by the *String Studio* depends on the number of voices of polyphony and the sampling rate used. These computer configurations will enable you to play the factory presets with a reasonable number of voices.

1.2 Installation

Mac OS

Insert the *String Studio* program disc into your CD-ROM drive. Open the CD icon once it appears on your desktop. Click on the *String Studio* Install icon and follow the instructions of the installer.

If you purchased this software online, simply double-click on the installer file that you have downloaded and follow the instructions of the installer.

Windows

Insert the *String Studio* program disc into your CD-ROM drive. Launch Explorer to view the content of the CD-ROM and double-click on the installer file to launch the installer.

If you purchased this software online, simply double-click on the installer file that you have downloaded and follow the instructions of the installer.

1.3 Authorization and Registration

During the installation procedure, the authorization page will appear. The *String Studio* uses a proprietary challenge/response copy protection system which requires you to provide some information before using the program. You will need:

- A valid email address
- Your product serial number (on the back of the sleeve of your CD or in your confirmation email for downloads)

A *challenge key* is a long string of capital letters and numbers that is generated uniquely for each machine during the registration process. In other words, for each machine you install this program on you will receive a different challenge key. The *response key* is another unique string of capital letters and numbers generated from the data encrypted in the challenge key.

1.3.1 Unlocking *String Studio* on Windows XP

Step 1: Generating the challenge key

After launching the installer for the first time, a pop-up window will appear asking you to enter your serial number. Type your serial number as it appears on the back of the sleeve of the *String Studio* CD-ROM. If you purchased *String Studio* online, an email with your serial number will have been sent to you at the address which you provided during the purchase process.

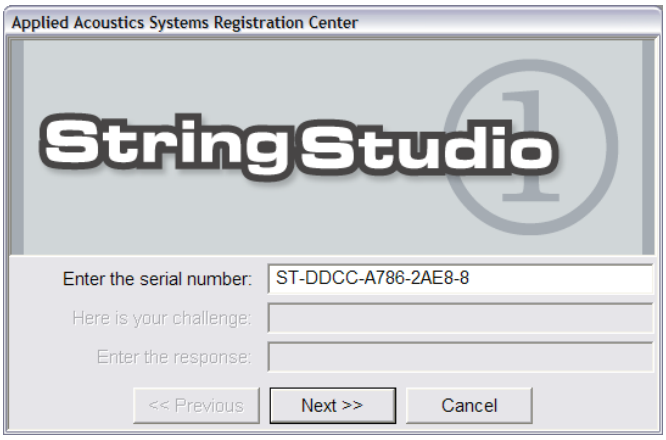


Figure 1: Enter your serial number in the pop-up window.

After entering your serial number, click on the *Next* button and your challenge key will appear automatically in the window.

Figure 2: Challenge key appears automatically after entering the serial number.

Step 2: Generating the Response key and Registering your Product

If your computer is connected to the internet, the installer will automatically launch your web browser and connect you to the unlock page of the A|A|S web server. Your serial number and challenge key will automatically be printed in the form. Enter your email address and click on the *Submit* button.

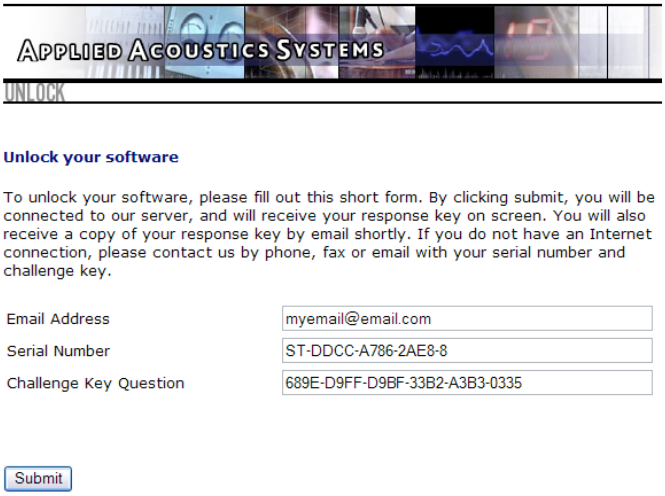


Figure 3: Enter your registration information on the A|A|S webserver.

The next form asks you to provide additional information about yourself including your mailing address and phone number. This information will be used to register your product. Note that only a valid email address is required to register your product. We nevertheless recommend this information be provided to ensure our support team is able to contact you to resolve any future support issues, and notify you of product updates promptly. This information is kept completely confidential. Registration of your product will entitle you to receive support and download updates when available, as well as take advantage of special upgrade prices offered from time to time to registered A|A|S users. Note that this if you already purchased or registered another A|A|S product, the information that you have already supplied under the same email address will appear in the form. Feel free to update this information if it is outdated. Click on the *Submit* button and your response key will appear on-screen.

If your computer is not connected to the internet, take note of your serial number and *challenge key* and proceed to an internet connected computer. Launch your browser and go to the unlock page of the A|A|S website at:

http://www.applied-acoustics.com/unlock.htm

Enter your email address, serial number, and challenge key, and click next. You will then receive your response code on-screen as described above.

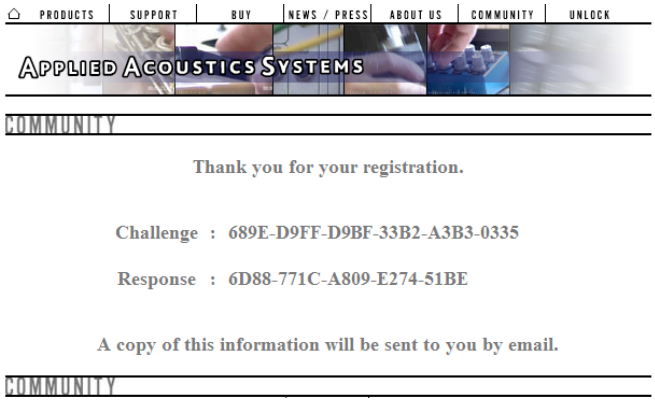


Figure 4: Generation of the response key on the A|A|S server.

Step 3: Completing the unlock process

The *response key* corresponding to your serial number and *challenge key* will be printed in your browser window. In order to complete the unlock process, copy the response key and paste it into the last field of the installer window of *String Studio*. If you obtained your response key from another computer, type the response key by hand in the installer window. Finally, click on the *Finish* button in order to complete the unlock process.

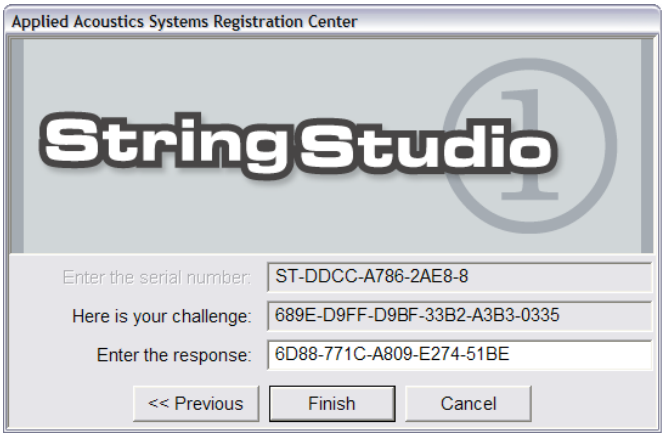


Figure 5: Final step of the unlock process. Enter your response key in the window.

After unlocking *String Studio*, it will be launched. You will not need to re-unlock your software unless:

- You reformat or upgrade your hard drive

- You change or upgrade your operating system
- You uninstall the program

1.3.2 Unlocking *String Studio* on Mac OS

Generating the challenge key Automatically

After launching the installer for the first time, a pop-up window with information on the unlock process will appear. Click on the right arrow to continue.

In the second window, shown in Figure 6, you will be offered to unlock *String Studio* **Automatically** or **Manually**. If your computer **is** connected to the internet, choose **Automatically** and click on the right arrow. If your computer is not connected to the internet, please follow the instructions at the end of this section.

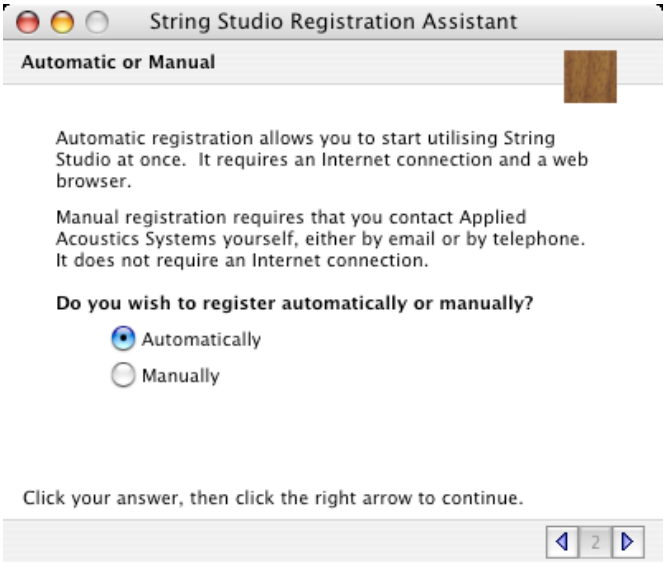


Figure 6: Choose the Automatic unlock mode if your computer is connected to the internet, otherwise choose the manual method.

In the third window, shown in Figure 7, type your email address and click on the right arrow. In the fourth window, see Figure 8, enter your serial number as it appears on the back of the sleeve of the *String Studio* CD-ROM. If you purchased *String Studio* online, an email with your serial number will have been sent to you at the address which you provided during the purchase process. Click on the right arrow.

At this point, the installer will automatically launch your browser and connect you to the registration page of the A|A|S server as shown in Figure 9. You will be asked to provide additional

Figure 7: Enter your email address.

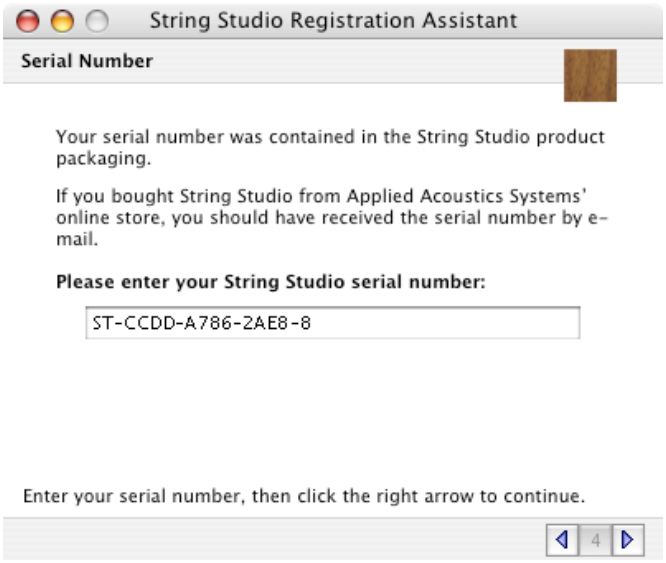


Figure 8: Enter your serial number.

information about yourself including your mailing address and phone number. This information will be used to register your product. Note that only a valid email address is required to register your product. We nevertheless recommend this information be provided to ensure our support

team is able to contact you to resolve any future support issues, and notify you of product updates promptly. This information is kept completely confidential. Registration of your product will entitle you to receive support and download updates when available, as well as take advantage of special upgrade prices offered from time to time to registered A|A|S users. Note that this if you already purchased or registered another A|A|S product, the information that you have already supplied under the same email address will appear in the form. Feel free to update this information if it is outdated. Click on the *Next* button and your challenge key will appear in the window as shown in Figure 10. Copy the *response key* and paste it in the *String Studio* installer window as illustrated in Figure 11. Click on the *Start* button to complete the unlock process.

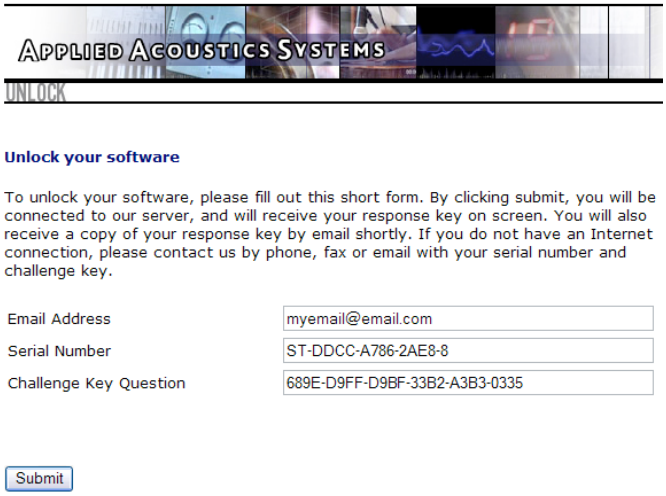


Figure 9: Enter your registration information on the A|A|S webserver.

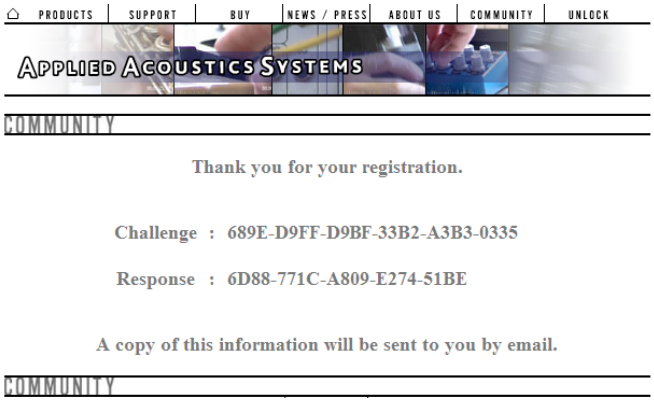


Figure 10: Generation of the response key on the A|A|S server.

Figure 11: Final step of the unlock process. Enter your response key in the window.

Generating the challenge key Manually

If your computer is not connected to the internet, choose **Manually** in the second page displayed by the installer, as shown in Figure 12, and click on the right arrow.

In the third window, the same as in Figure 7, type your email address and click on the right arrow. In the fourth window, please refer to Figure 8, enter your serial number as it appears on the back of the sleeve of the *String Studio* CD-ROM. If you purchased *String Studio* online, an email with your serial number will have been sent to you at the address which you provided during the purchase process. Click on the right arrow and your *challenge key* will be displayed as illustrated in Figure 13. For convenience, click on the *Save Registration Information...* button to save this information in a text file.

Take note of your serial number and *challenge key* and proceed to an internet connected computer. Launch your browser and go to the unlock page of the A|A|S website at:

http://www.applied-acoustics.com/unlock.htm

Enter your email address, serial number, and challenge key, and click next. You will then receive your response code on-screen as shown in Figures 9 and 10.

In order to complete the unlock process, go back to the sixth *String Studio* installer window and type your response key as shown in Figure 11. Finally, click on the arrow button and on then on the *Start* button in order to unlock your synthesizer.

Once the unlock process will have been completed, *String Studio* will be launched. You will not need to re-unlock your software unless:

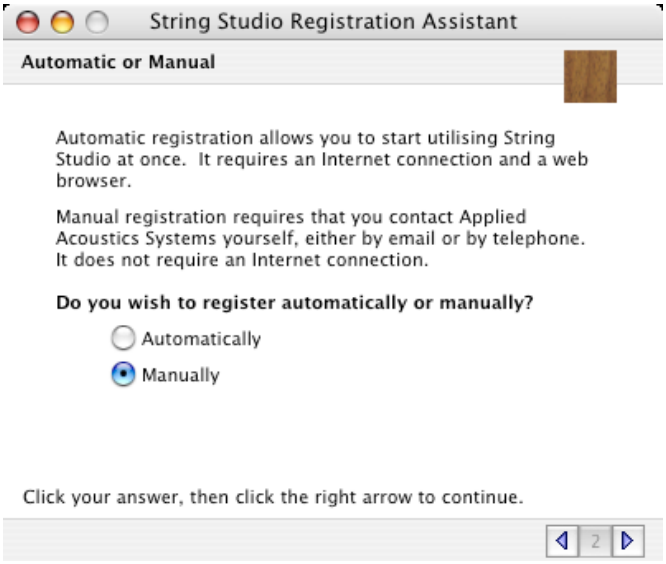


Figure 12: Choose the manual unlock mode if your computer is not connected to the internet.

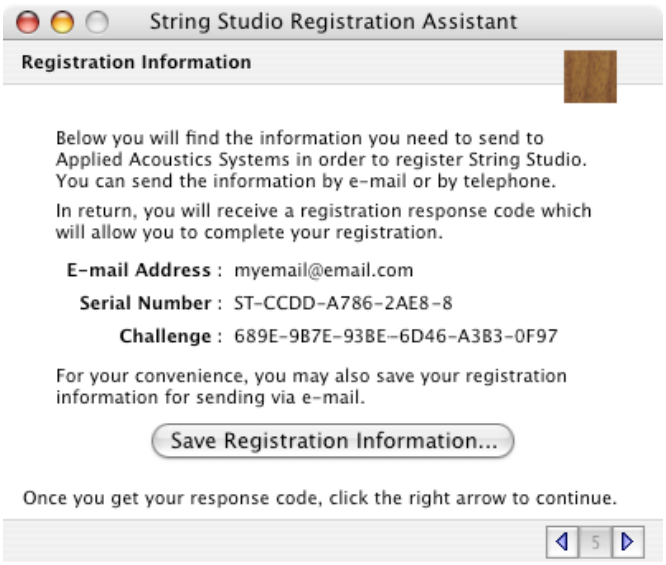


Figure 13: Generation of the challenge key during manual installation.

- You change your computer
- You uninstall the program

1.3.3 Obtaining your response key and registering by fax or over the phone:

Should you not have access to the internet, A|A|S support representatives are available to assist you in the unlock and registration process Monday to Friday, 9am to 6pm EST. You may contact us by phone at:

- North America Toll-free number: 1-888-441-8277
- Outside North America: 1-514-871-8100
- Fax Number: 1-514-845-1875
- Email: support@applied-acoustics.com

1.4 Getting started

The *String Studio* comes with a wide range of factory presets right out of the box which amounts to a huge range of sounds before you have even turned a single knob. As you would expect, the best way of coming to grips with the possibilities *String Studio* offers is simply to go through the presets one at a time. We recommend that you first start using the *String Studio* in standalone mode.

Using *String Studio* in standalone mode

- **Windows** - Double-click on the *String Studio* icon located on your desktop or select *String Studio* from the **Start** > **All Programs** > menu.
- **Mac OS** - Double-click on the *String Studio* icon located in the Applications folder.

Before you start exploring the factory presets, take a moment to set up you audio and MIDI configuration as explained below.

Audio Configuration

This menu allows you to select a port from a list, organized by driver type, of those available on your computer. If you have ASIO drivers available, these should be selected for optimum performance. Multi-channel interfaces will have their outputs listed as stereo pairs.

- **Windows** - Select your sound card port from the list in the **Audio Configuration** dialog from the **Edit** > **Preferences** > **Audio Settings . . .** menu.
- **Mac OS** - Select your audio device from the list in the **Audio Settings** dialog from the **String Studio** > **Preferences** > **Audio Settings . . .** menu.

For more detailed information on audio configuration, sampling rate selection and latency adjustments, please refer to section 6.4.

MIDI Configuration

- **Windows** - Select your MIDI port from the list in the **MIDI Configuration** dialog from the **Edit** > **Preferences** > **MIDI Settings** . . . menu.
- **Mac OS** - Select your MIDI port from the list in the **MIDI Settings** dialog from the *String Studio* > **Preferences** > **...** menu.

For more detailed information on MIDI configuration, MIDI links and MIDI maps, please refer to section 6.2.

Exploring the factory presets

The browser on the left of the *String Studio* interface is similar to the browser your operating system generates to display the contents of your hard disk, or your email program uses to organize your mail and address book. When launching the application for the first time, this "tree view" will include a destination folder for imported presets as well as different folders containing different categories of factory presets. To open a folder, click on the "+" symbol which will reveal the folder content. To load a preset, double-click on a preset icon (blue knob).

The Browser makes it easy to organize presets in whatever manner you choose. To create a new preset folder, click in the browser to select this region of the interface, and choose **New Folder** from the **File** menu. You can now save new presets in this folder or copy or move existing presets to this folder by dragging preset icons from one folder to the other or using the **Copy** and **Paste** commands from the **Edit** menu.

1.4.1 Using MIDI Links

Every parameter on the *String Studio* interface can be linked to an external MIDI controller. To assign a MIDI Link, right-click (control-click on Mac) on a control (knob, button or slider) and a contextual menu will appear. Select **Learn MIDILink** and move a knob or slider on your MIDI controller to activate the link. To deactivate the link, right-click (control-click on Mac) on the control and choose the **Forget MIDILink** command.

1.4.2 Using MIDI program changes

MIDI program changes have been assigned to a selection of factory presets. The factory library can therefore be explored using MIDI program changes.

1.4.3 Using String Studio as a Plug-in

The *String Studio* integrates seamlessly into the industry most popular multi-track recording and sequencing environments as a virtual instrument plug-in. The *String Studio* works as any other plug-in in these environments so we recommend that you refer to your sequencer documentation in case you have problems running the *String Studio* as a plug-in.

1.5 Getting help

A|A|S technical support representatives are on hand from Monday to Friday, 9am to 6pm EST. Whether you have a question on *String Studio*, or need a hand getting it up and running as a plug-in in your favorite sequencer, we are here to help. Contact us by phone, fax, or email at:

- North America Toll Free: 1-888-441-8277
- Worldwide: 1-514-871-8100
- Fax: 1-514-845-1875
- Email: support@applied-acoustics.com

Our online support pages contain downloads of the most recent product updates, and answers to frequently asked questions on all A|A|S products. The support pages are located at:

www.applied-acoustics.com/faq.htm

1.6 Forum and User Library

The A|A|S community site contains the *String Studio* user forum, a place to meet other users and get answers to your questions. The community site also contains an exchange area where you will find presets for your A|A|S products created by other users and where you can make your own creations available to other users.

http://community.applied-acoustics.com/php/community

http://community.applied-acoustics.com/php/forum

1.7 About this manual

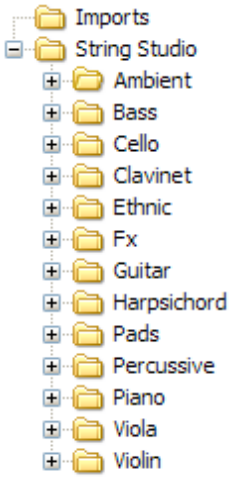
In the next chapter, the use of presets and the browser are described in detail. Chapter 3 describes the general architecture and signal flow of *String Studio*. In Chapter 4, the different modules and controls are reviewed in detail. Chapter 5 describes the different functionalities available from the toolbar while Chapter 6 explains the different functionalities related to Audio and MIDI and their settings. General issues involved in the use of *String Studio* as a plug-in in different host sequencers is covered in Chapter 7. Finally a list of available commands and shortcuts is given in Chapter 8.

Throughout this manual, the following conventions are used:

- Bold characters are used to name modules, commands and menu names.
- Italic characters are used to name controls on the interface.
- Windows and Mac OS keyboard shortcuts are written as Windows shortcut/Mac OS shortcut.

2 Browser and Presets

String Studio comes with several factory presets covering a wide range of sounds. This collection of presets lets you play and familiarize yourself with this synthesizer without having to tweak a single knob. Soon, however, you will be experimenting and creating your own sounds that you will need to archive or exchange with other users. All the operations on presets are conveniently managed with the help of the *String Studio* Browser, similar to those found in most email programs, which uses a hierarchical tree structure and a visually intuitive, drag and drop approach.



2.1 Playing Presets

All the presets are located in the **String Studio** root folder. To explore the different presets available in *String Studio*, click on the "+" icon to the left of the **String Studio** folder, in other words, *expand* this branch of the browser tree, in order to reveal the various preset sub-folders based on different sound categories. Opening the individual sub-folders reveals a set of presets represented by blue knob icons.

- To load a preset, simply double-click on the preset icon or drag and drop the preset icon from the browser onto the synthesizer interface.
- Switch to the next or previous preset in the hierarchy by clicking on the "+" and "-" sign on the right of the preset name in the left corner of the toolbar at the top of the *String Studio* interface, or by using the "+" and "-" keys of the computer keyboard.
- Select a preset in the Browser by using the up and down arrows from the computer keyboard and click on the *Enter* key of the keyboard.
- You can also load a preset by right-clicking/control-clicking on a preset icon and choosing the **Open Preset** command from the drop-down menu that appears, or by clicking on a preset icon in order to select it, then using the Ctrl-O/Apple-O shortcut.
- It is also possible to load presets using MIDI program changes as described in Section 6.2.
- Switch to the next or previous preset in the hierarchy by clicking on the "+" and "-" sign on the right of the preset name in the left corner of the toolbar at the top of the *String Studio* interface, or by using the "+" and "-" keys of the computer keyboard.

2.2 Editing and Saving Presets

As soon as a preset is modified, the preset icon located just before the preset name in the toolbar changes color, indicating that you must save the preset in order not to lose the changes. Modifications to an existing preset are saved using the **Save Preset** command from the **File** menu or the

Ctrl-S/Apple-S shortcut. Be careful, however, as using this command will overwrite the original preset. In order to create a new preset, use the **Save Preset As** command from the **File** menu and a window will appear asking for a name for the new preset. Once the preset is saved using this command, a new preset icon will appear directly under the *String Studio* folder.

Note that after having modified a preset, *String Studio* will always ask you if you want to save the changes in order not to lose your work. However, this behavior is however not always convenient. To disable this option, select the **General** command under **Preferences** of the **Edit** menu and de-select the **Ask to save preset before opening another** option. By default, *String Studio* will also ask you if you want to save changes to a modified preset before quitting the application. To disable this option, de-select the **Ask to save preset before quitting** option under the same command as mentioned above.

When editing presets and creating new ones, it is very helpful to go back and forth between the different stages of your modifications and adjustments. To move back step by step through every modification that was applied to a preset, use the **Undo** command from the **Edit** menu or the Ctrl-Z/Apple-Z shortcut. Once the **Undo** command has been used, it is also possible to move up again through the modifications by using the **Redo** command from the **Edit** menu or the Ctrl-Y/Apple-Y command. Note that the number of **Undo** levels is unlimited and that this command is effective on any control of the interface but not on the different **Save** commands.

Once a preset has been modified, it is also possible to move back and forth between the current state of the preset and its original state when it was loaded. This is very helpful in order to hear again the original preset after having applied many modifications. To hear the original preset, simply click on the *Compare* button of the toolbar or the **Compare** command from the **Edit** menu. Once this button has been pressed, the original settings of the preset are loaded. Note that in this mode, the graphical interface is frozen and it is therefore not possible to modify the preset. To further modify the preset, click on the *Compare* button again or uncheck the **Compare** command in the **Edit** menu to revert to the modified version of the preset and unfreeze the interface.

2.3 Deleting Presets

To delete a preset, first select it by clicking on its icon in the browser, then use the **Delete** command from the **Edit** menu or the **Del** key from the computer keyboard.

2.4 Documenting Presets

It is possible to document a preset or view related information from the **Edit Preset Information** window. To launch this window, right-click/control-click on a preset icon and choose the **Preset Info** command or use the Ctrl-I/Apple-I shortcut. The **Preset Info** command from the **Edit** menu can also be used after selecting a preset. Information on a preset includes the author's name, copyright notice, date of creation, last modification date and a text description.

2.5 Defining a Default Preset

It is possible to define a default preset that will be loaded automatically when *String Studio* is launched. To define a default preset, select a preset by clicking on its icon in the browser. Then launch the **Edit Preset Information** window as explained in the preceding paragraph and select the **Mark As Default** option. To change the default preset, just repeat the operation on a new preset. If no default preset has been defined, the default values for every module will be loaded when *String Studio* is launched.

2.6 Locating a Preset in the Browser

After navigating through presets, it might be difficult to find the current preset icon in the browser. To rapidly locate the current preset in the browser, use the **Locate** command from the **View** menu or the Ctrl-L/Apple-L shortcut. The **Locate** command will automatically expand the folder containing the currently used preset and select the preset.

2.7 MIDI maps

MIDI maps containing information about MIDI links between the MIDI controllers and the *String Studio* interface can easily be created as will be explained in Section 6.2. MIDI maps are represented in the browser with a MIDI connector icon. MIDI maps are treated exactly the same way as presets in the browser and are saved using the **Save MIDI Links** or **Save MIDI Links As** commands from the **File** menu.

2.8 Exporting and Importing Presets and MIDI maps

The **Import** and **Export** commands, found in the **File** drop down menu, allow one to easily exchange presets and MIDI maps with other *String Studio* users. This feature can also be used to decrease the number of elements in the browser by archiving older or rarely used ones elsewhere, on CD-R, or a second hard disk for example. Files containing *String Studio* presets and MIDI maps are equivalent in size to short text file, making it easy to send presets to other users via email.

To export a folder, a group of folders, presets or MIDI maps within a folder, select the elements to export in the browser and use the **Export** command from the **File** menu. When the **Export** window appears, choose a file name and a destination location on your hard disk. *String Studio* export files will be saved with an "sxf" extension.

Importing presets and MIDI maps is just as easy. Simply click on the **Import** command from the **File** drop down menu, and select the file to import. A new folder will then appear under the **Imports** directory in the browser, containing all of the files contained within the imported package. These can then be dragged and dropped to a new folder, or remain in the Imports directory.

2.9 Customizing the browser

The Browser structure can be customized in various ways. New folders can be created from the **File** drop down menu using the **Create New Folder** command. One can also move presets, MIDI maps, and folders from one place in the browser to another by using the **Copy** and **Paste** commands from the **Edit** drop down menu, or by simply dragging objects from one folder and dropping them into the folder of your choice. Ultimately, how things are organized is left entirely up to you.

The browser can also be hidden from the interface. This can be convenient in order to save screen space. To hide the browser, use the **Hide Browser** command from the **View** menu. To make it reappear, use the **Show Browser** command from the **View** menu.

3 Architecture of *String Studio*

String Studio is a synthesizer built around a **String** module. The graphical interface of the different modules of the synthesizer have been grouped into two panels as shown in Figures 14 and 15. In the first page (Panel A), one can find the modules related to the control of the synthesizer and an output effect stage. The actual synthesis modules appear on the second page (Panel B). One can switch from one view to the other by using the *Panel A* and *Panel B* buttons appearing at the top of the interface.

Figure 14: Control modules and output stage of *String Studio* (Panel A).

The first row of modules of *Panel A* is an output effect stage which includes a multi-effect module, a master clock module, a master level control, and a recorder module. The bottom row of this same panel includes the modules related to performance and the processing of MIDI events including a **Keyboard**, **Arpeggiator**, **Portamento** and **Vibrato** module.

The modules of *Panel B* follow the general geometry of a string instrument which and is composed of 5 main components: the **String**, the **Excitator**, the **Body**, the *Termination* and the **Damper** module.

The individual modules and controls of the user interface will be described in detail in Chapter 4. We will now take a closer look “under the hood” at how the different modules are connected together.

Figure 15: Synthesis modules of *String Studio* (Panel B).

3.1 General Signal Flow

The general architecture of *String Studio* is presented in Figure 16 and follows the functioning of a real string instrument.

It is the vibration from the **String** which constitutes the main sound production mechanism of the instrument. The string is set into motion by the action of an **Excitator** which can be a hammer, a pick or a bow. The frequency of the oscillation is determined by the effective length of the string which is controlled by the finger/fret interaction or **Termination**. A **Damper** can be applied on the strings in order to reduce the decay time of the oscillation. This is the case on a piano, for example, when felt is applied on the strings when the keys and the sustain pedal are released. The vibration from the string is then transmitted to the **Body** of the instrument which can radiate sound efficiently. In some instruments, the string vibration is transmitted directly to the through the bridge. In other instruments, such as the electric guitar, a **Pickup** is used to transmit the string vibration to an amplifier.

In addition to these main modules, a **Filter** module has been included between the **String** and **Body** module in order to expand the sonic possibilities of the instrument. A **Distortion** module, an **EQ** module, and an output effect stage complete the synthesizer as illustrated in the signal flow diagram of Figure 17.

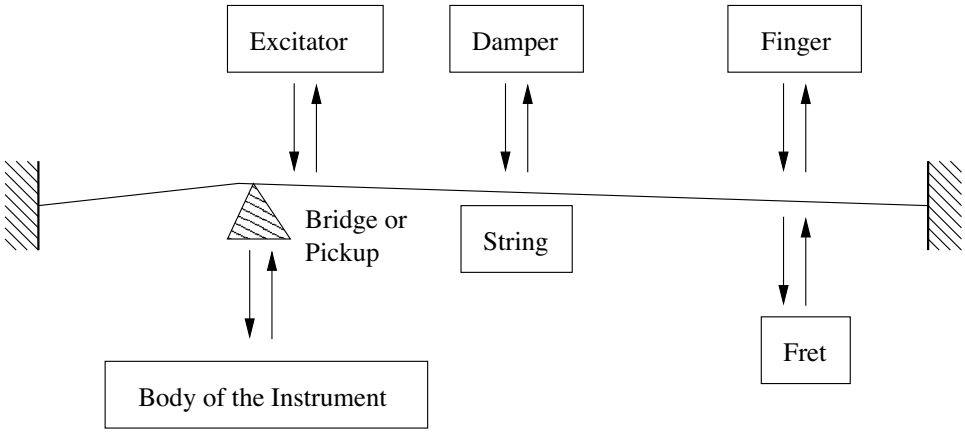


Figure 16: General representation of *String Studio*.

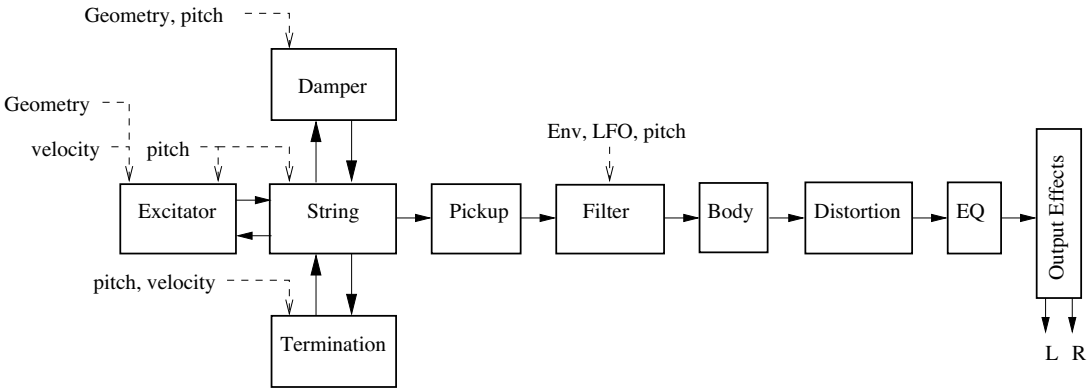


Figure 17: Signal flow of *String Studio*. Modulation signals: dotted lines.

3.2 Modulation Sources

The physical parameters of the **String**, **Excitator**, **Damper**, and **Termination** modules can be modulated with the pitch and velocity signals received from the **Keyboard**. In addition to the pitch signal from the **Keyboard**, the cutoff frequency and resonance (quality factor) of the multi-mode **Filter** module can be modulated with the signal from a low-frequency oscillator **LFO** module and the **Filter Env** envelope generator. Finally, note that the vibrato module from *Panel A* can be considered as an extra pitch modulation source for the **String** module.

3.3 Output Effect

At the end of the signal path, the audio signal from the instrument is sent to the output effect stage for further processing. A **Reverb**, **Delay**, and **Chorus** module are available in this effect stage allowing for a wide range of processing possibilities. Effects can be applied before or after mixing of the signal from each line as will be explained in greater detail in Section 4.18.

4 Parameters

4.1 General Functioning of the Interface

4.1.1 Tweaking Knobs

All the knobs on the interface are selected by clicking on them. Once selected, they can be controlled in different ways depending on the effect you want to achieve.

- For coarse adjustment click-hold on a knob and drag the mouse upwards or downwards to move it clockwise or counter-clockwise.
- For fine adjustment, use the left or down arrow of the computer keyboard to move the knob counterclockwise and the right or up arrow to move it clockwise. The **Page Up** and **Page Down** keys give the same result with slightly faster action.
- To move a control to a given position, place the mouse at this position and Shift-click (Windows) or Option-click (Mac OS). To reach this position slowly, do the same, but use the middle button of the mouse (Windows only).
- Knobs with a green LED above can be moved directly to their center position by clicking on the LED.

Remember that the keyboard shortcuts affect only the most recently selected control. The value of the control currently selected is displayed on the toolbar at the top of the *String Studio* window. The number displayed on the counter is a value corresponding to the setting of the control currently selected. For knobs, the reading is a value between 0 (turned fully to the left) and 127 (turned fully to the right).

4.1.2 Buttons

Buttons are switched *on* or *off* by clicking on them. The value appearing in toolbar and corresponding to a button is 1 when the button is *on* and 0 when it is *off*.

4.1.3 Drop-down menus and Displays

Clicking on a display with a small down-pointing triangle on its right, such as the *Type* control of the **Excitator** module, reveals a drop-down menu with a set of possible settings for the control. Adjustment of the control is obtained by clicking on a selection or using the up and down arrows and the **Enter** key of the computer keyboard.

The other controls represented by a display without a down-pointing arrow, such as the *Tempo* control of the **Clock** module, are adjusted by click-holding on them and dragging the mouse upward or downward. Selection of these controls is possible when the mouse is positioned on the display and a double pointing arrow appears.

4.1.4 Inverting a Signal

The different modulation signals acting on the **String**, **Excitator**, **Body**, **Termination**, and **Filter** modules can easily be inverted by clicking on the small button appearing on the upper right of the corresponding gain knob. The signal is inverted when the button is *on* (LED lit on and value of 1).

4.1.5 Bypassing a Module

The different modules of *String Studio* can be turned *on* or *off* by clicking on the button appearing on the right of the module label. A module is active when the button is in its *on* position or in other words when it is lit and has a value of 1. Note that when a module is **not** activated, calculations associated with this module are not performed, reducing CPU usage.

4.1.6 Resetting a Module and Copying Settings

The modules of String Studio can be reset to their default value by clicking on the down pointing triangle appearing on the left of the module label and selecting the *Default Settings* command.

4.1.7 Modulation Signals

Different parameters can be modulated with signals from the **Keyboard**, **LFO** or **Filter Env** modules. Modulation signals are controlled with gray knobs located below the black knobs corresponding to the modulated parameter. These knobs are in fact gain knobs that are used to multiply the modulation signal by a certain factor. When these knobs are in their leftmost position, the modulation signals are multiplied by zero which has the effect of turning *off* the modulation source. Turning the knobs clockwise increases the gain factor and therefore the influence of the corresponding modulation source. The modulation signal can be inverted by clicking on the LED located on the right at just above the knob.

Each modulation knob can control multiple modulation signals. The source of the modulation signal is selected by clicking on one of the green LEDs located on the right of the line of gray knobs. The sources are labeled *Kbd* (**Keyboard**), *LFO*, and *Env* (**Filter Env**). Each time a new source is selected, the knobs revert to the setting corresponding to this source.

The *Kbd* modulation signal is used to vary the value of a parameter as a function of the pitch of the note played. When the modulation source is turned *off* (knob in its leftmost position), the value of the parameter is constant over the whole range of the keyboard and equal to the value determined by the corresponding parameter knob. Turning the modulation knob clockwise will increase the value of the parameter in the high frequencies while lowering its value for the low notes. This modulation is applied relative to the middle C (C3) which always keeps the value fixed by the parameter knob. For example, choosing a hammer as an excitator, and modulating its stiffness with the pitch signal from the keyboard (*Kbd*) will make the hammer stiffer for high notes and softer for

low notes which is a feature found in many keyboard instruments. Clicking on the inverter LED at the top of the modulation knob inverts this behavior.

4.2 The String Module

In a string instrument most of the sound we hear is radiated from the body of the instrument. The strings themselves radiate just a small amount of sound directly but it is their vibrations that are transmitted to the body of the instrument, through the bridge, where they can be radiated efficiently. It is also the strings that fix the pitch of the sound we hear depending on their effective lengths.

In a real string, the material of the string will affect how it vibrates. For example, a metal string will oscillate for a longer time than a nylon one; its sound will also be brighter. In the **String** module, this behavior is adjusted with the *Damping* and *Decay* knobs. The *Damping* knob is used to set the amount of high frequencies in the string vibration, this amount being increased as the knob is turned clockwise. The decay time of the vibrations is controlled with the help of the *Decay* knob and it is increased by turning the knob clockwise. Both of these parameters can be modulated with the pitch signal received from the keyboard.

In a first approximation, a string can be considered to be harmonic meaning that its partials are located at frequencies equal to multiples of its fundamental frequencies. Real strings, however, are more or less inharmonic depending mostly on the width of the string. This characteristic of strings is adjusted with the *Inharm* knob. When the *Inharm* knob is in its leftmost position, the string will be perfectly harmonic and turning the knob clockwise will increasingly detune the partials toward higher frequencies.

When the *Ratio* LED is on (LED lit and value of 1), the gray knob located below the *Decay* knob is used to adjust the ratio between the decay time of the oscillation of the string when the a note is depressed and when it is released. When the knob is in its leftmost position, both decay times are the same and equal to the decay time determined by the settings of the *Decay* knob. Turning this knob clockwise will decrease the decay time of the note when it is released while keeping the decay time when the key is depressed to its current setting. Note that this control constitutes an easy mean to reproduce the action of dampers on the string. When the **Damper** module is used and the *Rto* knob is turned clockwise, the effect of the both damping mechanisms will add up.

4.3 The Excitator Module

The **String** module can be played using different types of excitators in order to reproduce different types of instruments and playing techniques. The excitator is selected using the *Type* drop-down menu. The choices available are *Plectrum*, *Hammer 1*, *Hammer2* or *Bow*. These different types of excitators share the same front panel but note that the names of the parameters controlled by the different black knobs vary for each excitator. Next we will review the different types in more detail.

4.3.1 Plectrum

The *Plectrum* excitator, illustrated in Figure 18, is used to play instruments such as guitars, harpsichords or basses with a pick. The *Plectrum* can be viewed as an angled object placed under the string and connected to a plate with the help of a spring. The purpose of the plectrum is to impose an initial displacement to the string before it is set into free vibration. As can be understood from figure 18, a vertical motion of the plate (which could be a hand holding the plectrum) will lift the string with the plectrum but will also result in a compression of the spring and an horizontal motion of the plectrum. The string will move with the plectrum until the protrusion *Prot* of the plectrum is equal to the compression of the spring and the string is released. The motion and behavior of the plectrum is controlled by adjusting the different geometrical and mechanical properties of the system.

The *Prot* knob is used to determine the protrusion of the plectrum with respect to the string while the stiffness and damping of the spring is controlled with the help of the *Stiff* and *Damp* knobs. The vertical velocity of the plectrum is adjusted with the *Velocity* knob. Note that the *Prot*, *Stiff*, and *Velocity* controls can be modulated with the pitch of the note played or the velocity signal from the keyboard.

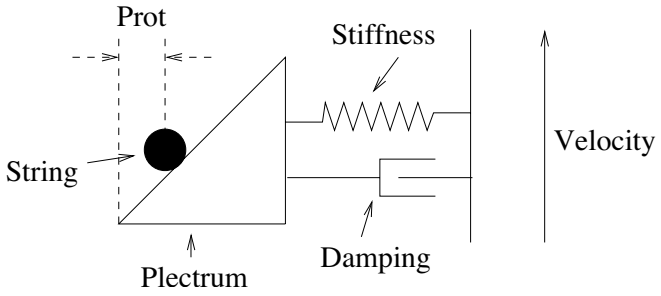


Figure 18: Functioning of the *Plectrum*

4.3.2 Hammer

The *Hammer* is used to play instruments such as the piano or other percussive instruments. With this excitator, the string is set into free vibration following a force impact with the hammer. The hammer can be used in two modes, *Hammer* and *Hammer 2*, as illustrated in Figure 19. In the *Hammer 1* mode, the hammer is located below the string and can only interact once with the string because of the action of gravity which brings it down after it has been raised to hit the string. In the *Hammer 2* mode, the hammer is located above the string and can bounce on the string after the initial impact.

The illustration of 19 shows that the action of the hammer is represented by the motion of a head connected to a mass. The mass of the hammer is adjusted with the *Mass* knob while the stiffness of the head is controlled with the *Stiff* knob. The velocity of the hammer when it hits the string is set with the *velocity* knob. The motion of the hammer can further be characterized by a damping coefficient, adjusted with the *Damp* knob, and controlling the absorption of the impact between the string and the hammer by the hammer. Note that this parameter is not related to the decay time of the string oscillation or the overall sound. On the contrary, the effect of this parameter may sometimes seem counter-intuitive even if it reproduces a physical property of the hammer. For example, increasing the damping of the hammer will make the compression of the spring linking the head to the mass harder and which will shorten the interaction between the hammer and the string but will also make it appear stronger resulting in a louder or longer sound.

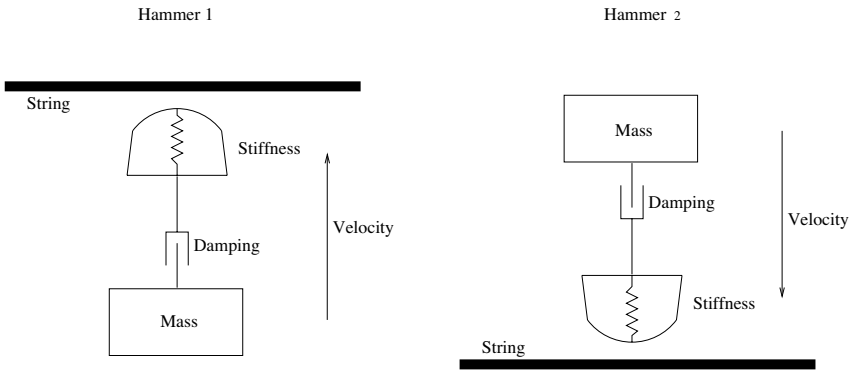


Figure 19: The two *Hammer* modes

4.3.3 Bow

The *Bow* excitator is used to play bowed instruments such as the violin, viola, or cello. The role of the bow is to set the string in self-sustained oscillation. Physically, oscillations of the string are maintained by a regular cycle of stick-slip-stick-slip movements. Due to friction forces between the string and the bow, the string sticks to the bow and follows its motion until the tension forces in the string, due to its own oscillating motion, break it free from the bow. The string is then in its

slip phase and moves in the opposite direction to that of the bow. When the string motion changes direction once more, it sticks to the bow again, moving with the bow until it breaks free and repeats the cycle. Note that the frequency of this stick-slip motion is exactly the same as that of the string oscillation; or, in other words, the pitch of the note played.

The force with which the bow is applied on the string can be adjusted with the *Force* knob, the friction between the bow and the string is set with the *Friction* knob, and the velocity of the bow is controlled with the *Velocity* knob. Note that the *damp* knob is inactive when the *bow* excitator is selected. The tone and behavior of the instrument are the results of a complex relationship between these parameters but some general rules can however be followed. As the force applied by the bow on the string is increased, the tone becomes more scrubby. The friction between the bow and the string usually determines the length of the attack; the greater the friction, the faster the string can be set into motion. Finally, the velocity is related to the amplitude of the sound.

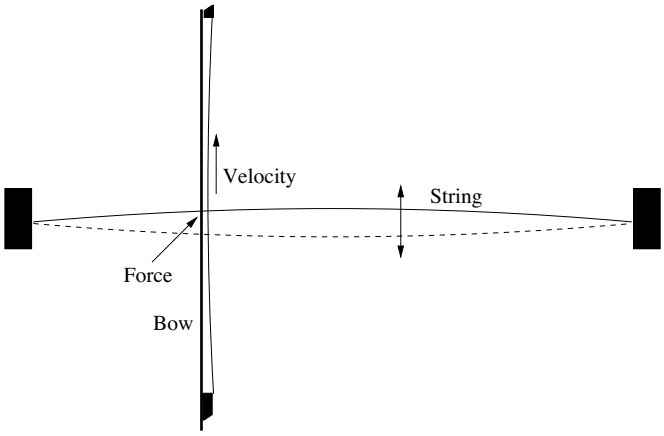


Figure 20: Excitation of a string by a bow

4.4 The Body Module

The role of the body or soundboard of a string instrument is to radiate the vibration energy from the strings. The body also adds a filtering effect to the vibration from the string which depends on its size and shape. In some instruments such as guitars, the body also includes an air cavity which boosts low frequencies.

The *Type* drop-down menu allows one to choose between different body geometries, each of them reproducing the spectral characteristics of the body of different type of instruments. For each type of body one can also determine its size with the help

of the *Size* drop-down menu from *Tiny* to *Huge*. Basically, reducing the size of the **Body**, shifts its frequency response toward higher frequencies while increasing it, results in a shift toward lower frequencies. In addition to its shape and size, the material of the body also influences its radiation and filtering effects. This behavior is adjusted with the *Damp* and *Decay* knobs. The *Damp* knob is used to set the amount of high frequencies in the body vibration, this amount being increased as the knob is turned clockwise. The decay time of the vibrations is controlled with the help of the *Decay* knob; it is increased by turning the knob clockwise.

The output signal from the **Body** module can further be monitored with the *Mix* and *Level* knobs. The *Mix* knob is used to adjust the ratio of direct signal from the *String* module and the signal filtered by the *Body* in the output signal of the **Body** module. In its leftmost position the output signal from the **Body** module will be that from the **String** module only while in its rightmost position, there is no direct signal from the **String** module. When this knob is in its center position, there is equal amounts of direct and filtered signal in the output signal of the **Body** module. Finally, the general level of the output signal from the **Body** module is controlled with the *Level* knob. Note that the level of the output signal can be monitored with the *Signal* LED. This can be helpful when trying to adjust the signal level at the input of the **Distortion** module or the other effect modules. The color of the LED gives a rough indication of the sound level, when it is green the signal from the body is faint, when it is orange the level is in the middle range while when it is red, the signal level is high.

Note that the **Body** module is made inactive or bypassed by selecting the *Off* option in the *Type* control. Even when this option is chosen, the *Level* knob is active which means that the sound level from the *String* can still be monitored by this knob.

4.5 The Damper Module

The **Damper** module is used to attenuate rapidly the vibration of the string. In a piano or harpsichord, this role is played by felts while for the violin or the guitar, the performer's finger is used to damp the string vibrations. Basically, the damper can be viewed as a mass/spring system acting on the string as illustrated in Figure 21. The *Mass* and *Stiff* knobs are used to adjust these parameters, which affect how the damper interacts with the string. These physical parameters can be modulated with the pitch signal from the **Keyboard** and fine-tuned over the whole range of the instrument. The *Velocity* knob is used to adjust the velocity at which the damper is applied and released from the string. This parameter can also be modulated with the pitch signal from the **Keyboard** module. The last parameter of the **Damper** module is controlled with the *Damp* knob and refers to the ability of the damper to absorb energy from the string. Turning this knob clockwise will increase the damping exerted on the string by the damper.

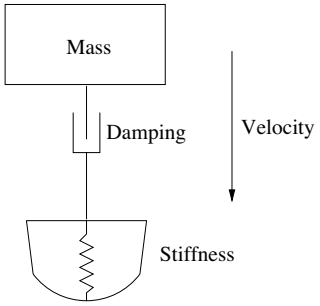


Figure 21: Functioning of the *Damper*

4.6 The Termination Module

This module is used to model the fret/finger/string interaction as illustrated in Figure 22. In a real instrument, this interaction is used to change the effective length of the string and thereby fix the pitch of the note played. The physical parameters of the **Finger** can be varied with both the *Stiff* and *Force* knobs which fix respectively the stiffness of the termination and the force it applies on the string. Note that the *Force* parameter can be modulated by both the pitch and velocity signal from the **Keyboard** module. The termination can further be characterized by the stiffness of the fret on which the string, pushed by the finger, is applied. This parameter is controlled by the *Stiff* knob under the **Fret** label.

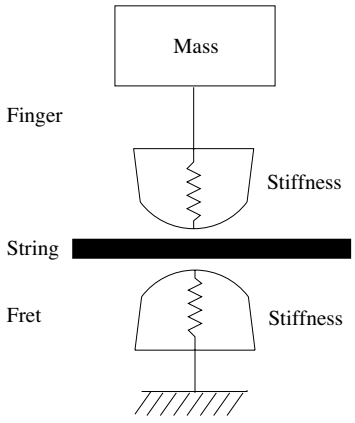


Figure 22: The finger/fret interaction

4.7 The Geometry Module

The **Geometry** module is used to set the location of the point of action of both the excitator and the damper on the string. These positions are adjusted with the *Position* knobs under the *Excitator* and *Damper* labels and can be set to any value between zero (the point of fixation of the string) and half the length of the string (value of 0.5).

When the *Abs* (absolute position) LED is switched *on*, the position of the excitator or the damper is fixed whatever the note played. This would be the case, for example, on a guitar when the player keeps the position of the pick fixed while varying the effective length of the string when changing notes. The actual position is determined with the setting of the *Position* knob applied to the length of a string corresponding to C3 (middle C). Note that when the note played is such that the string length corresponding to this note is shorter than this position, the excitator or the damper will follow the fixation point of the string.

When the *Abs* LED is in its *off* position, the location of the damper or the excitator is changed in order to always correspond to a certain fraction of the length of the string. This fraction of the string length is that determined by the *Position* knob. This type of geometry is found in instruments such as the piano where hammers excite strings at about $1/7$ of their length.

Note that both the excitator and damper position can be modulated with the pitch signal or velocity signal received from the keyboard. The modulation will be relative to the value set by the excitator or damper *Position* knobs.

4.8 The Pickup module

The **Pickup** module reproduces the functioning of magnetic pickups such as found in electric guitars or electric pianos. This type of transducer is sensitive to the motion of a nearby metallic string. When a string vibrates near a pickup, the latter outputs an oscillating signal at the same frequency as that of the string and proportional to the string velocity.

The only parameter to adjust in the **Pickup** module is its position relative to the string which affects the waveform of its output.

Note that usually, the signal from a pickup is sent directly to an external device such as an amplifier. In other words, the body of the instrument does not play any role in the radiation of the sound. In *String Studio*, this behavior is obtained when the **Pickup** module is *on* and both the **Filter** and **Body** modules are switched *off*. When the **Pickup**, the **Filter** and **Body** modules are *on*, the output signal from the **Pickup** is filtered by the **Filter** and **Body** modules. Finally, when the **Pickup** module is switched *off*, the output signal from the **String** is sent directly to the **Filter** and **Body** module.

4.9 The Distortion module

The **Distortion** module implements a simple distortion effect, such as that found in electric guitar distortion pedals for example. Different distortion algorithms, ranging from *mellow* to *metal*, can be selected from the *Type* drop-down menu.

The *Drive* knob is a gain control used to adjust the level of the signal at the input of the **Distortion** module and hence the amount of saturation introduced in the signal. The color of the signal after the distortion algorithm has been applied can be adjusted using the *Tone* knob. In its leftmost position, high frequencies will be attenuated in the signal while in its rightmost position low frequencies will be filtered out from the signal. In its center position, the signal will be left unchanged. Note that this control can be set to its middle position by clicking on the small LED above the knob. Finally, the *Level* knob is used to control the amplitude of the signal at the output of the **Distortion** module.

4.10 The EQ module

The **EQ** module provides equalization over the low, mid, and high frequency bands. This module is located after the *Distortion* module in the signal chain and is composed of a low shelf filter, a bandpass filter, and a high shelf filter in series.

The functioning of the low shelf filter is illustrated in Figure 23. The filter applies a gain factor to frequency components located below a cutoff frequency while leaving those above unchanged. The cutoff frequency of the filter is adjusted using the *Freq* knob and the gain amount is controlled with the *Gain* knob.

The high frequency content of the signal is controlled with a high shelf filter that works in the opposite manner as the low shelf filter as illustrated in Figure 23. The filter will multiply a gain factor to components located above a cutoff frequency while leaving those below unchanged. Again use the *Freq* and *Gain* knobs to adjust the cutoff frequency and gain of the filter.

The mid frequency content of the signal is adjusted using a peak filter as illustrated in Figure 24. The filter applies a gain factor to frequency components in a band located around the cutoff frequency of the filter. The cutoff frequency of the filter is adjusted with the *Freq* knob while the gain coefficient is varied with the *Gain* knob. In addition to these parameters, the width of the frequency band can be adjusted with the *Q* knob.

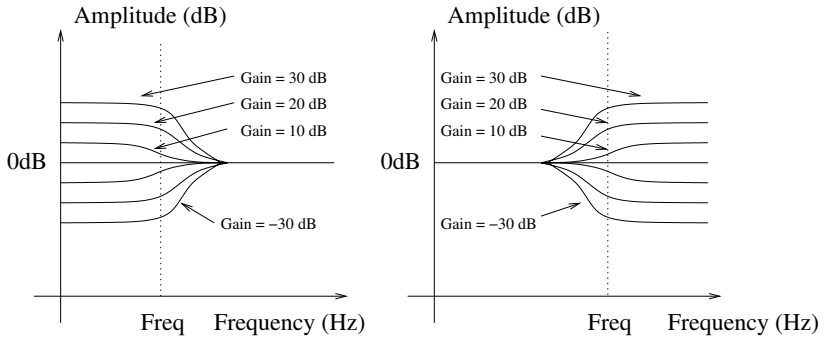


Figure 23: Low and high shelf filters.

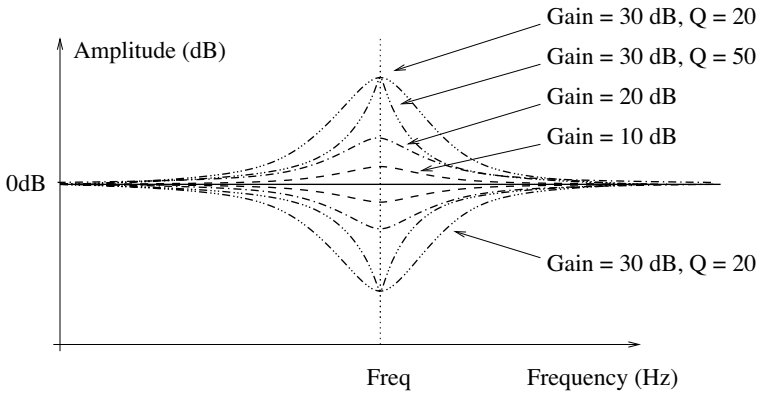


Figure 24: Peak filter.

4.11 The Filter Module

In order to expand the sonic possibilities of *String Studio*, a multi-mode filter has been inserted between the **String** and **Body** modules. This multi-mode filter includes a resonant low-pass, band-pass, high-pass, notch and a formant filter which can be selected using the *Type* drop-down menu. The order of the filter can be adjusted to 2 (-12 dB/oct for low-pass and high-pass and -6 db/oct for band-pass) or 4 (-24 dB/oct for low-pass and high-pass and -12 db/oct for band-pass) with the help of the *Order* drop-down menu. The resonance frequency of the filter is adjusted with the *Cutoff* knob while its Q-factor or resonance is controlled with the *Q* knob. When the formant filter is used, the *Q* knob is used to cycle between the vowels (a, e, i, o, u).

The cutoff frequency and resonance of the filters can be modulated with different modulation sources. The modulation sources include the keyboard pitch signal (*Kbd*) and the output of the **Filter Env**envelope generator (*Env*) and **LFO** modules. Modulation signals with a positive value will increase the cutoff frequency and Q-factor of the filters while a negative value will decrease them. Note that the filter parameters can further be modulated by the velocity signal from the keyboard through the use of the velocity modulation parameter of the **Filter Env** modules.

The modulation knob associated with the cutoff frequency can be adjusted to its center position by clicking on the green LED located above the knob. In this position, the cutoff frequency will exactly follow the pitch of the note played on the keyboard in the case of the *Kbd* modulation, it will vary exactly one octave higher and lower in the case of the LFO modulation and will vary one octave higher or lower depending on the position of the inv switch with the *Env* modulation. Now let's have a closer look at the different filter types available.

4.11.1 Resonant Low-Pass Filter

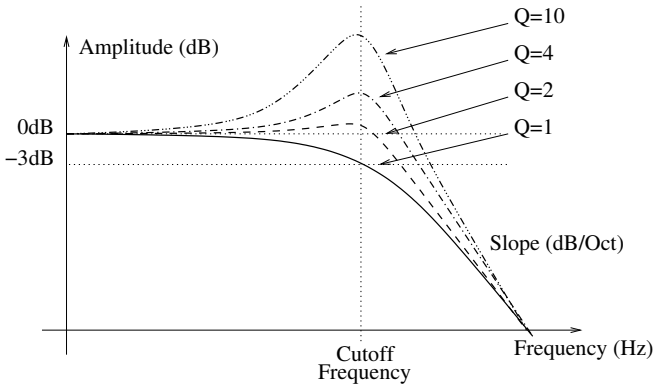


Figure 25: Frequency response of the low-pass filter.

A low-pass filter is used to remove the higher spectral components of the signal while leaving the lower components unchanged. The frequency at which attenuation begins to take effect is called the *cutoff* frequency. In a resonant filter, frequencies located around the cutoff frequency can also be emphasized by an amount called the *quality factor* or *Q-factor* of the filter as illustrated in Figure 25. The higher the Q-factor, the louder and sharper the response of the filter around the cut-off frequency. When the Q-factor is set to 1 (*Q* knob fully turned to the left), there is no emphasis around the cutoff frequency and the attenuation is -3dB at the cutoff frequency. The attenuation for frequencies located above the cut-off frequency depends on the order of the filter which is determined by the *Order* menu, a slope of -12dB/Oct corresponding to a second order filter and a slope of -24dB/Oct to a fourth order filter.

4.11.2 Resonant High-Pass Filter

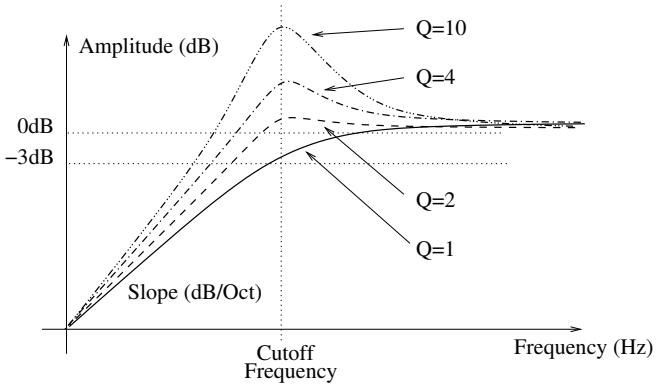


Figure 26: Frequency response of the high-pass filter.

The high-pass resonant filter works in exactly the opposite manner as the low-pass resonant filter by removing the frequency component of a signal located below the cutoff frequency while leaving those above the cutoff frequency unchanged. Similarly to the low-pass filter, the *Q-factor* controls the emphasis of frequencies located around the cut-off frequency.

4.11.3 Band-Pass Filter

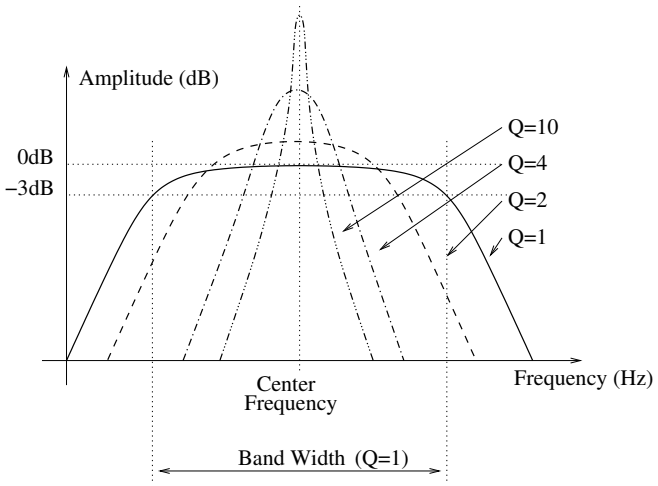


Figure 27: Frequency response of the band-pass filter.

The behavior of a band-pass filter is to let the frequencies in a band located around a center

frequency and to attenuate the frequencies outside of this band as shown in Figure 27. The bandwidth of the band-pass filter is set with the *Q* knob while the center frequency is set with the *Cutoff* knob. The *Order* control sets the order of the filter. This parameter affects the slope of the roll-off on both sides of the center frequency. For a second order filter the slope is -6dB/Oct while for a fourth order filter it is -12dB/Oct.

4.11.4 Notch Filter

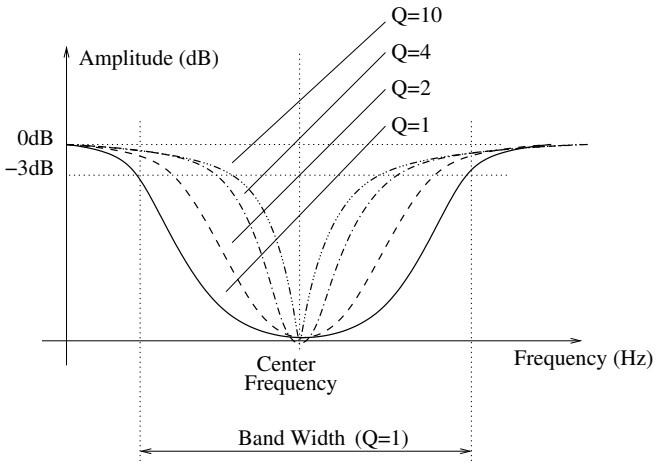


Figure 28: Frequency response of the notch filter.

The notch filter does essentially the opposite of the band-pass filter. It attenuates the frequencies in a band located around the center frequency and leaves those outside of this band unchanged as shown in Figure 28. The *Cutoff* knob is used adjust the center frequency and the *Q* knob sets the bandwidth of the notch. Note that the center frequency is totally removed from the spectrum of the output signal of the filter.

4.11.5 Formant Filter

The formant filter reproduces the filtering effect of the vocal tract in the human voice. By changing the position of the tongue, the opening of the mouth and opening or closing the nasal cavities one can change the filter applied to the glottal signal and thus produce the different vowels. Measurements have shown that this filter can be modeled by three peaking EQ filters corresponding to the three main cavities of the vocal tract as shown in Figure 29 and also known as formants. By moving the parameters of these three filters (frequency, amplitude and Q-factor) one can cycle between all the vowels. The effect of the *Cutoff* knob on the formant filter is to offset all the formants by the same factor and it is used to switch between male voice (left position), female voice (center)

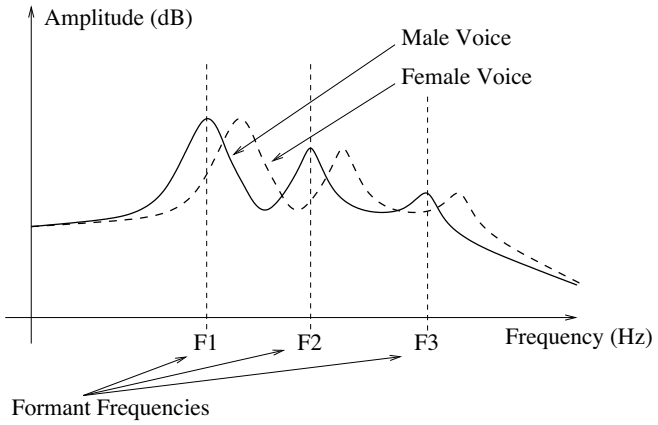


Figure 29: Frequency response of the formant filter.

and child (right position). The *Q* knob is used to cycle between vowels. Note that changing these parameters can be automated by using the different modulation signals.

4.12 The Filter Env Module

The **Filter Env** envelope generator module is based on a standard ADSR (attack, decay, sustain, release) approach including velocity modulation.

The envelope module generates a four-segment envelope: attack, decay, sustain, release. The attack time is adjusted using the *A* knob. The attack time can also be modulated with the velocity signal received from the **Keyboard** in such a way that that the higher the velocity signal the shorter the attack time will be, the intensity of this effect being controlled using the modulation knob below of the *A* knob. When the knob is in its leftmost position, the attack is only determined by the value of the *A* knob, turning the knob clockwise will increase the influence of the velocity signal until the attack time is strictly determined by the inverse of the velocity signal when *V* reaches its maximum value. The decay time is set with the *D* knob. The sustain phase of the envelope generator lasts from the end of the decay phase until the key is released. When the *S* knob is fully turned to the left, the sustain level is zero and there is no sustain phase while fully turned to the right, the sustain level is at maximum and there is no decay phase. Note that the sustain phase can also be modulated with the velocity signal from the keyboard. Finally, when the key is released, the envelope generator toggles to the release phase and the envelope signal decreases from its sustain level to zero in a time set by the *R* knob.

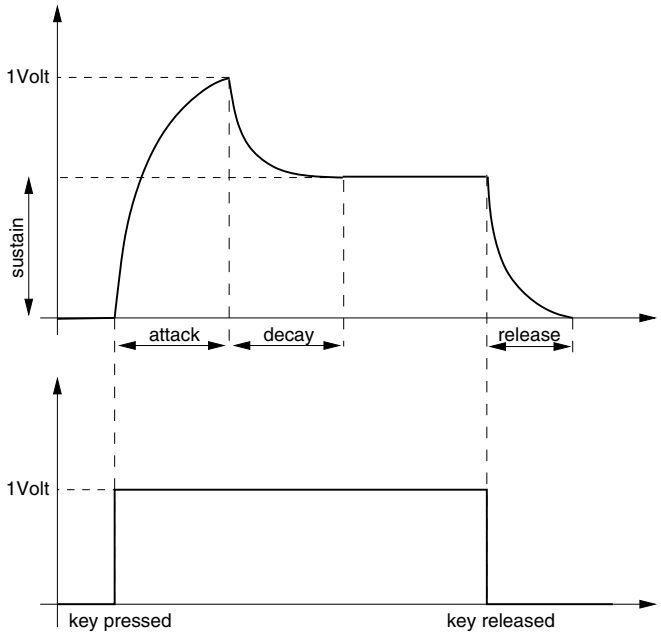


Figure 30: Response curve of an envelope generator

4.13 The LFO Module

The LFO module is used as a modulation source for the **Filter** module. On the **LFO** module, one can adjust the waveform, rate and fade-in behavior.

4.13.1 Wave Shape

The waveform of the **LFO** is selected with the *Shape* drop-down menu. The possible values are *Sine* for sinus, *Tri* for triangular, *Rect* for rectangular and *Rdm1* and *Rdm2* for the two random modes. When the *Shape* control is set to *Rdm1*, the LFO outputs random values at the rate determined by the *Sync* control or the *Rate* knob. In this case, the output value from the LFO remains constant until a new random value is introduced. The *Rdm2* mode reacts almost like the preceding mode except that the **LFO** module ramps up or down between successive random values instead of switching instantly to the new value.

4.13.2 Rate

There are two ways to adjust the rate, or frequency, of the output of the **LFO** module. If the *Sync* control is in its *off* position, the rate is fixed with the *Rate* knob. When the *Sync* control is *on*, the frequency of the oscillator is fixed relative to the frequency (tempo) of the master clock (see 4.18.1) and the value displayed in the *Sync* control. Sync values range from 1/8 of a quarter note (a thirty-second note) to 16 quarter notes (4 whole notes) where the duration of the whole note is determined by the value (in BPM) appearing in the *Tempo* display of the **Clock** module. The **LFO** module can also be synced to a triplet (t) or a dotted note (d). Note that when the *Sync* control is depressed, the *Rate* knob has no effect.

4.13.3 Fade-In

One more feature of the **LFO** module is the possibility to add a fade-in effect to its output signal or in other words to set the amount of time necessary for the amplitude of the **LFO** signal to grow from zero to its maximum value. The duration of this fade-in can be adjusted within the range of 0 to 5 seconds, as determined by the *Fade* knob. Turning this knob fully to the left results in a value of 0 which is equivalent to removing the fade-in effect. The time at which the LFO signal is introduced can even be controlled by adding a delay to the fade in. This parameter can also be set to values varying between 0 and 5 seconds, as determined by the *Delay* knob. Note that this knob is effective even if the *Fade* value is adjusted to zero. In this case, the signal from the **LFO** module will simply be delayed.

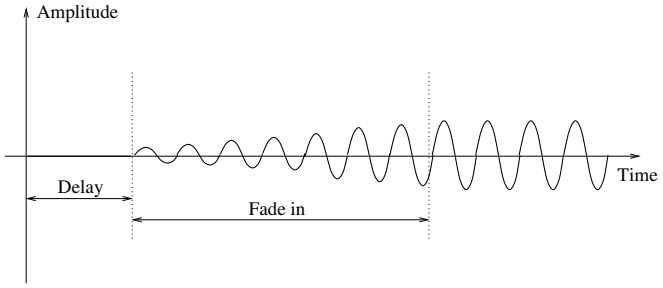


Figure 31: Fade in feature of the LFO.

4.14 The Keyboard Module

The **Keyboard** module controls how the synthesizer voices respond to the events coming from an external MIDI keyboard or from a MIDI sequencer. The first row of controls (*Tuning*, *Oct*, *Semi*) is used to fix the pitch of the keyboard, and transpose the overall keyboard by octaves or semi-tones. The *Stretch* and *Error* knobs, on the bottom row, allow one to stretch the octaves and/or add a random error on each note played. The second line of parameters allows one to turn unison *on* or *off*, select the polyphonic or monophonic mode of operation, and choose the note priority. The first two knobs on the third row, *Detune* and *Decay*, are used to set the detune amount and the time delay respectively between voices of a note when the *Unison* mode is selected.

4.14.1 Tuning

The pitch of A4 (normally 440 Hz) is adjusted, in Hertz, in the *Tuning* display. The pitch can be transposed by -3 to $+3$ octaves and -12 to $+12$ semi-tones by using the *Octave* and *Semi* drop-down menus. Once the tuning of the keyboard has been determined trough the use of these three controls, one can slightly alter it with the *Stretch* and the *Error* knobs. The *Stretch* knob sets the value of a semi-tone. When in the center position, the semi-tone interval corresponds to that of the equal-tempered scale. Turning the knob to the left shrinks the interval while turning it to the right increases it. The main effect of the *Stretch* control is that when it is not in the center position, an interval of one octave will not sound perfectly in tune and therefore beating will be heard when playing perfect octaves. The *Error* knob adds a random error to each note played; the more the knob is turned clockwise, the larger is the error. This will make all the notes play slightly out of tune. Note that the sustain pedal (MIDI controller number 64) is always active on the **Keyboard** module.

4.14.2 Mode and Priority

The keyboard can be monophonic, allowing one to play only one note at a time, or polyphonic, allowing one the play chords. This behavior is adjusted with the *Mode* drop-down menu. The *Priority* control, located on the right of the *Mode* control, sets the behavior of the keyboard when several notes are depressed at the same time in monophonic mode or when the maximum number of polyphonic voices has been reached in polyphonic mode. In monophonic mode, the *Priority* determines which of the lower, last, or higher note has precedence when several notes are played. In polyphonic mode, this control determines which of the lowest, highest, or oldest note is muted in order to replace it with the newest note played once the maximum of polyphonic voices has been reached. Note that since this parameter determines the note priority, the stolen note will be the opposite of what appears in the control display.

4.14.3 Unison

The unison mode allows one to stack voices, in other words, play two or four voices for each note played on the keyboard. This mode creates the impression that several instruments are playing the same note together, adding depth to the sound.

Each voice can be slightly detuned relative to the others by moving the *Detune* knob clockwise. Furthermore, voices can be desynchronized by adding a small time lag between their triggering with the *Delay* knob. This delay is nil when the knob is in its leftmost position and increased by turning it clockwise.

4.15 The Portamento Module

The portamento effect is used to make the pitch slide between notes rather than changing immediately from note to note. The *Time* knob sets the amount of time it will take for the pitch to slide over one octave. The *Mode* drop-down menu enables one to choose between the *Constant* or *Proportional* mode. When in *Constant* mode, the time necessary for the pitch to slide from one note to another will always be the same regardless of the interval between the notes. When set to proportional, the slide time will be proportional to the width of the interval between the two notes. When the portamento is on, the slide effect occurs between every note.

Clicking on the *Legato* button will switch the module into legato mode and the sliding between two notes will only occur if the second note is played before the first one is released. When a note is played staccato, or in other words if a key is released before the next one is depressed, there will be no portamento effect. Note that even though the portamento effect is available when the **Keyboard** module is in polyphonic mode, it is mostly dedicated to monophonic playing. In polyphonic mode, the sames rules will apply to individual voices and the overall result will be less predictable.

4.16 The Vibrato Module

The vibrato effect is equivalent to a periodic low frequency pitch modulation. This effect is generally obtained by using an LFO to modulate the pitch signal of a signal generator. In *String Studio*, a dedicated module is provided for this effect.

The *Rate* knob sets the frequency of the vibrato effect from 0.5 Hz to 5 Hz. The *Amount* knob sets the depth of the effect, or in other words the amplitude of the frequency variations. In its leftmost position, there is no vibrato and turning the knob clockwise increases the amount of pitch variation. The *MW* gain knob is used to determine the effect of the keyboard modulation wheel on the depth of the vibrato. When this knob is fully turned to the left, the modulation wheel has no effect but

when it is turned clockwise the depth of the vibrato will increase when the modulation wheel is used. The increase is always relative to the position of the *Amount* knob and will be greater as the *Mod* knob is turned clockwise.

The vibrato can be adjusted not to start at the beginning of a note but with a little lag. This lag is set by the *Delay* knob. The *Fade* knob allows you to set the amount of time taken by the amplitude of the vibrato effect to grow from zero to the amount set by the *Amount* knob.

The last parameter is used to add liveness to the sound. When several musicians play together, they do not necessarily start their vibrato exactly at the same time, speed and amplitude. The *Error* knob is used to produce this effect by adding an error to the *Rate*, *Amount*, *Delay* and *Fade* parameters of the vibrato of each polyphonic voice. As the *Error* knob is turned clockwise, the larger will be the difference between the vibrato effect applied to each voice. In its leftmost position there is no added error and all the voices are played with exactly the same vibrato effect.

4.17 The Arpeggiator Module

The **Arpeggiator** module allows one to play sequentially all the notes that are played on the keyboard. In other words, arpeggios are played rather than chords. The modules allows one to produce a wide range of arpeggios and rhythmic patterns and to sync the effects to the tempo of an external sequencer.

4.17.1 Arpeggio Patterns

The arpeggio pattern is set by the combination of the value of the *Range*, *Span* and *Order* controls. The *Range* control is used to select the number of octaves across which the pattern will be repeated. When the range is set to 0, there is no transposition and only the notes currently depressed on the keyboard are played. If set to a value between 1 and 4 (its maximum value), the notes played are transposed and played sequentially, over a range of one or more octaves depending on the value of the *Range* parameter. The direction of the transposition is set with the *Span* drop-down menu. This parameter can be adjusted to *Low* for downwards transposition, to *High* for upwards transposition or *Wide* for transposing both upwards and downwards. Finally, the *Order* control sets the order in which the notes are played, therefore determining the arpeggio pattern. When set to *Forward*, the notes are played from the lowest to the highest. When set to *Backward* the notes will be played from the highest to the lowest. In the two last modes, *Rock and Roll exclusive* and *Rock and Roll inclusive*, the note will be played forward from the lowest to the highest and then backward from the highest down to the lowest. When using the *RnR exclusive* mode, the highest and the lowest notes will not be repeated when switching direction but in RnR inclusive mode these notes will be repeated.

4.17.2 Rhythmic Patterns

The rhythmic pattern is shown on the *Pattern* display. Different rhythmic presets are available through the utility menu. Notes will be played as the 16-step display is scanned and the corresponding step is selected (green button on). The little arrow on the top of the display is used to fix looping points from which the rhythmic pattern will start being played again from the beginning. Note that when a preset pattern is edited and then the **Save Preset** command from the **File** menu is used, the modified pattern will be saved and reloaded when the corresponding preset is later selected.

4.17.3 Rate and Synchronization

The rate at which the arpeggiator pattern is scanned is set by the *Rate* knob or can be synced to the master clock of the *Clock* module. The *Rate* knob will only be effective when the *Sync* control is set to *Off*. When the *Sync* control in *on*, the rate is fixed relative to the frequency (tempo) of the master clock (see 4.18.1) and the value displayed in the *Sync* control. Sync values range from 1/8 of a quarter note (a thirty-second note) to 16 quarter notes (4 whole notes) where the duration of the whole note is determined by the value (in BPM) appearing in the *Tempo* display of the **Clock** module. This effect can also be synced to a triplet (t) or a dotted note (d).

4.17.4 Latch mode

The **Arpeggiator** module is toggled in latch mode by clicking the *Latch* button to the *on* position. In this mode, the **Arpeggiator** will keep playing its pattern when the notes on the keyboard are released and until a new chord is played.

4.18 The Output Effect Section

The output effect stage is located at the top row of *Panel A* of *String Studio*. This effect stage allows one to add effects to the sound and record performances on the fly as wave or aiff files and to synchronize different modules with a host sequencer.

4.18.1 The Clock Module

This module is used to control the tempo of the different effects of the output section as well as that of the **LFO** and **Arpeggiator** modules. The *Source* drop down menu is used to determine if the sync signal comes from an external source or from the internal clock of the module. The *Tempo* display indicates the value of the tempo in BPM (beats per minute). When *String Studio* is used as a plug-in in a host sequencer and the *Ext* source is chosen, the clock signal will be that sent by the host sequencer while in standalone mode the clock will be the one received on the MIDI channel selected in the toolbar.

When the *Int* source is chosen, the tempo is determined by the value of *Tempo* display. The tempo can also be changed by clicking repeatedly on the *Tap* pad of the *Tempo* display which will update the value of the tempo in the *Tempo* display.

Note that the settings of the **Clock** module are saved with presets. In order for the **Clock** module to remain in a specific state even when loading new presets, click on the *Lock* icon at the top of the module.

4.18.2 The Chorus Module

This module implements both a chorus and a flange effect consists of four variable delay lines in parallel with a cross-feedback matrix between the lines. A wide range of effects is obtained by modulating the length of the lines and varying the amount of cross-feedback.

The *Chorus* drop down menu is used to choose between different chorus and flanger algorithms. The effect can be synchronized to the **Clock** module with the *Sync* drop-down menu. Sync values range from 1/8 of a quarter note (a thirty-second note) to 16 quarter notes (4 whole notes) where the duration of the whole note is determined by the value (in BPM) appearing in the *Tempo* display of the **Clock** module. The effect can also be synced to a triplet (t) or dotted note (d).

The different chorus algorithms can be controlled with the three knobs appearing at the bottom of the module. The *Mix* knob is used to adjust the ratio of “dry” and “wet” in the output signal of the module. When the knob is adjusted in the left position, only the original or “dry” signal is sent to the output while in the right position only the processed or “wet” signal is sent to the output. In its center position there will be equal amounts of “dry” and “wet” signal in the output signal. The *Depth* knob is used to adjust the amount of variation of length in the delay lines which controls the amplitude of the effect while the *Rate* knob is used to fix the frequency of the modulation.

4.18.3 The Delay Module

This module is a standard ping pong delay which is used to generate echo. It is based on two delay lines each including a low-pass filter. The effect is obtained by feeding back the signal at the end of each delay line into the input of the other line with an attenuation coefficient. The result is a signal traveling from one channel to the other, each time attenuated and filtered in the high frequencies due to the gain factor and the presence of the low-pass filter.

The *Delay* drop down menu is used to choose between different delay algorithms. The effect can be synchronized to the **Clock** module with the *Sync* drop-down menu. Sync values range from 1/8 of a quarter note (a thirty-second note) to 16 quarter notes (4 whole notes) where the duration of the whole note is determined by the value (in BPM) appearing in the *Tempo* display of the **Clock** module. The effect can also be synced to a triplet (t) or dotted note (d).

The different delay algorithms can be controlled with the three knobs appearing at the bottom of the module. The *Mix* knob is used to adjust the ratio of "dry" and "wet" in the output signal of the module. When the knob is adjusted in the left position, only the original or "dry" signal is sent to the output while in the right position only the processed or "wet" signal is sent to the output. In its center position there is equal amounts of "dry" and "wet" signal in the output signal. The *Depth* knob is used to adjust the amount of signal re-injected from the output of a line into the other one while the *Rate* knob controls the length of the delay lines and therefore the delay between echoes.

4.18.4 The Reverb module

The **Reverb** module is used to recreate the effect of reflections of sound on the walls of a room or hall. These reflections add space to the sound and make it warmer, deeper, as well as more realistic since we always listen to instruments in a room and thus with a room effect.

The *Reverb* drop down menu is used to choose between different reverb algorithms representing different types of rooms or halls. Each algorithm can be adjusted with the knobs located at the bottom of the module. The *Mix* knob is used to set the relative amount of "dry" and "wet" signal which is related to the proximity of the sound source. The *Decay* is used to control the reverberation time of the room. In a real room, the reverberation time is not constant across the whole frequency range because the walls of the hall are generally more absorbent at high frequencies which results in a shorter reverberation time for these frequencies. This effect is controlled with the *Color* knob which sets the reverberation time of high frequencies relatively to the value of the *Decay* knob.

Note that the settings of the different modules of the output stage are saved with presets. In order for the effects to remain with the same settings even when loading new presets, click on the *Lock* icon at the top of the module.

4.18.5 Topology

The three effects of the output section can be used in four different configurations as shown in Figure 32 and where the **Chorus**, **Delay** and **Reverb** modules are labeled **A**, **B**, and **C** respectively.

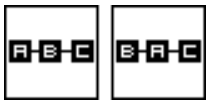


Figure 32: The four topologies in which the effects can be applied after the **Amp** module of the two module rows; **A** = **Chorus** module, **B** = **Delay** module and **C** = **Reverb** module.

In the first configuration, the **Chorus** module is first applied, then the **Delay** and finally the **Reverb** module. In the second configuration, the signal is first processed by the **Delay**, then by the **Chorus** and the **Reverb** module.

Note that each of the effects can be muted by selecting the *Bypass* preset in its respective algorithm selection drop down menu.

4.18.6 The Output Module

This module is used to monitor levels of the left and right channels. It is located at the of *Panel A* and *Panel B*. The overall level is adjusted with the *Level* knob. The best dynamic range is obtained when the level meters are around 0 dB for loud sounds.

4.18.7 The Recorder Module

This module is used to record the output of *String Studio* to a stereo 16-bit wave or aiff file. The *File* display, is used to choose the name and location of the destination file. One should always use this before starting a recording. The *Rec* and *Stop* buttons are used to start or stop the recording. On Windows systems the sampling rate will match that of the **Audio Settings** of the **Preferences** command of the **Edit** menu. On Mac systems, the specific settings are determined by QuickTime.

5 Toolbar

The toolbar at the top of the *String Studio* interface allows you to monitor important information related to your current set-up.

5.1 Preset Display

Displays the name of the currently opened preset. The + and − buttons on the right of the preset name, or alternatively the + and − keys on the computer keyboard, are used to navigate upwards and downwards in the preset hierarchy as found in the browser. When a preset is modified, the preset icon to the left of the preset name will change color in order to indicate that saving is necessary in order not to loose the changes that have been applied.

5.2 MIDI map

Displays the name of the currently opened MIDI map. For more information on MIDI maps, please refer to Section 6.2.

5.3 Polyphony Combo Box

Displays the number of voices of polyphony (2 to 32). The number of voices can be adjusted with the drop down menu from the combo box.

5.4 MIDI Channel combo box

Displays the current MIDI channel on which *String Studio* is receiving MIDI information. The channel can be adjusted with the drop down menu from the combo box.

5.5 Value Display

Displays the value of the currently selected control on the interface. The values range from 0 to 127 for knobs and 0 or 1 for buttons depending on whether they are in their *on* or *off* position.

5.6 CPU meter

Percentage of the total CPU resources currently used by *String Studio*.

5.7 MIDI LED

The red MIDI LED toggles when a MIDI signal is received by the *String Studio*. This is very useful to see if *String Studio* is receiving MIDI signal from your keyboard or other controllers. If the LED does not blink when you play your keyboard, check your connections and the transmit/receive channels you are using or the MIDI settings of *String Studio* as explained in Section 6.2.

6 Audio and MIDI Settings

This chapter explains how to select the audio and MIDI devices used by *String Studio* as well as how to create and edit MIDI links and MIDI maps. When referring to commands that are different on Windows and Mac OS systems, the commands are listed in the following order: Windows command/Mac OS command.

6.1 Audio Device Settings

To select the audio device used by *String Studio*:

- Go to the **Edit** menu, choose **Preferences** and then **Audio Settings**. On Mac OS, the same command is under the **String Studio** menu. A list of the audio devices installed on your computer will appear in the **Audio Configuration** window.
- Click on the audio device you wish to use and click on the **OK** button.

6.2 MIDI Settings

6.2.1 Selecting a MIDI Device

To select the MIDI device used by *String Studio*:

- Go to the **Edit** menu, choose **Preferences** and then **MIDI Settings**. On Mac OS, the same command is under the **String Studio** menu. A list of the MIDI devices installed on your computer will appear in the **MIDI Configuration** window.
- Select the MIDI device you want to use and click on the **OK** button.

6.2.2 Creating MIDI Links

Every control on the *String Studio* interface can be manipulated by an external MIDI controller. In most cases this is much more convenient than using the mouse, especially if you want to move many controllers at once. For example, you can map the motion of a knob on the interface to a real knob on a knob box or to the modulation wheel from your keyboard. As you use the specified MIDI controllers, you will see the controls move on the *String Studio* interface just as if you had used the mouse.

To assign a MIDI link to a controller:

- On the interface, right-click/Control-click on a control (knob, button), a contextual menu appears. Select **Learn MIDILink**.

- Move a knob or slider on your MIDI controller (this can be a keyboard, a knob box, or any device that sends MIDI). This will link the control of the *String Studio* to the MIDI controller you just moved.

MIDI links can also be created in the MIDI Links window which is launched by choosing the **Edit MIDILinks** command from the **Edit** menu or by right-clicking/Control-click on any control and choosing the **Edit MIDILinks** command.

- Click on **New** to create a new MIDI link.
- The MIDI controller number specified in the **Controller** textbox is set by default to a value of 1. This is the MIDI controller number corresponding to the modulation wheel. If you want to assign a new controller to the knob, specify the number here.
- You can also assign a different MIDI channel to the controller in the **Channel** textbox. By default this value will be set to channel 1.

6.2.3 Editing MIDI Links

MIDI links can be edited in the MIDI Links window, which lists all the currently available MIDI links.

- To edit the MIDI link, right-click/Control-click again on the control and choose **Edit MIDILinks** to open the MIDI links window. You can also use the **Edit MIDILinks** command from the **Edit** menu.
- Click on the MIDI link you wish to modify and then on the **Edit** button to launch the **EDIT MIDI Link** window.
- Choose the parameter controlled by the current MIDI link from the **Parameter** drop-down menu which lists all the parameters of the current module.
- Specify the MIDI controller number and MIDI channel of the physical controller you wish to link to the parameter in the corresponding textboxes.
- You can also adjust the **Minimum Value** and **Maximum Value** of the controller, which are used to limit the range of MIDI controllers. The **Minimum Value** field determines the position on the *String Studio* control which corresponds to the minimum value sent by the MIDI controller; the **Maximum Value** determines the position which corresponds to the maximum value sent by the MIDI controller. A value of 0 corresponds to the *String Studio* control minimum position (left position for a knob) and a value of 1 to the *String Studio* control maximum position (right position for a knob).
- Note that the range of a knob can be inverted by setting the value of **Maximum Value** to a smaller value than that of **Minimum Value**. This can be useful, for example, if you want to control the cutoff and the resonance of a filter with the same knob but you want the resonance to increase as the cutoff decreases.

- Click on the **OK** button and the link appears in the list of controllers linked to the control.
- Click on the **OK** button again to confirm the change and to leave the MIDI Links window.
- Note that the **Minimum Value** and **Maximum Value** of a MIDI link can also be set by right/control clicking on the corresponding control and selecting the **Set MidiLink Minimum Value** or **Set MidiLink Maximum Value** command. The value corresponding to the control position will then be saved as the minimum or maximum value of the MIDI link.

6.2.4 Deleting MIDI Links

- To remove a MIDI link, right-click/Control-click again on the control and choose **Forget MIDILinks**.
- MIDI links can also be removed from the MIDI Links window by clicking on the MIDI link to be removed to select it, then by clicking on the **Remove** button and the **OK** button to confirm the change.

6.2.5 Creating a MIDI Map

A set of MIDI links can be saved into a MIDI map by using the **Save MIDI Links As** from the **File** menu. Different MIDI maps corresponding to different MIDI controllers can thereby be saved for *String Studio*. A MIDI map can be loaded by double clicking on the corresponding MIDI connector icon that appears in the browser when a MIDI map is saved. Furthermore a MIDI map can be loaded automatically when an instrument is launched.

- To assign a default MIDI map, **right-click/Ctrl-click** on the MIDI map icon and choose the **MIDI Link Info** command. In the **Edit Information Window**, select the **Mark As Default** option.

6.2.6 Creating the MIDI Program Change Map

MIDI program changes can be used to switch between presets while playing. To associate a program change to a preset:

- Choose **Edit Program Changes** from the **Edit** menu.
- The browser view and the list of presets appears to the left of the **Program Changes** window, while the program change table appears to the right. The **Program Changes** table lists the program numbers (from 1 to 128) and their corresponding presets.
- To associate a preset to a given program change, click on the preset icon in the browser and drag-and-drop it on the selected line of the program change table.
- To unassign a program change, right-click/Ctrl-click on the preset name to the right of the **Program Changes** window and click on **unassign**.

6.3 Audio Control Panel

To launch the audio configuration panel, choose **Audio Control Panel** under **Preferences** of the **Edit** menu on Windows or the **String Studio** menu on Mac OS systems.

This panel allows you to select the bit depth sample rate (22.05, 44.1, 48, or 96 kHz) and buffer size, which affects how quickly *String Studio* responds to the control information it receives. The smaller the buffer size, the shorter the latency, and vice versa. Note that the content of the dialog depends on the driver selected in the **Audio Settings** menu.

Some sound cards provide their own ASIO control panel, in which case the above information will differ from card to card. Some sound cards also require that you close all programs before making changes to the buffer size or sampling rate. If you discover this is the case with your sound card, please refer to the manufacturer's documentation for details on configuring it for optimum performance. Most sound card manufacturers also update their drivers regularly. It is strongly recommended that you visit your sound card manufacturer's website regularly to ensure you are using the most up to date drivers and support software.

6.4 Latency Settings

The latency is the time delay between the moment you send a control signal to your computer (for example when you hit a key on your MIDI keyboard) and the moment when you hear the effect. Roughly, the latency will be equal to the duration of the buffers used by the application and the sound card to play audio and MIDI. To calculate the total time required to play a buffer, just divide the number of samples per buffer by the sampling frequency. For example, 256 samples played at 48 kHz represent a time of 5.3 ms. Doubling the number of samples and keeping the sampling frequency constant will double this time while changing the sampling frequency to 96 kHz and keeping the buffer size constant will reduce the latency to 2.7 ms.

It is of course desirable to have as little latency as possible. *String Studio* however requires a certain amount of time to be able to calculate sound samples in a continuous manner. This time depends on the power of your computer, the preset played, the sampling rate, and the number of voices of polyphony used. Note that it will literally take twice as much CPU power to process audio at a sampling rate of 96 kHz as it would to process the same data at 48 kHz, simply because you need to calculate twice as many samples in the same amount of time.

Depending on your machine you should choose, for a given sampling frequency, the smallest buffer size that allows you to keep real-time for a reasonable number of voices of polyphony. To adjust these parameters:

- Launch the **Audio Control Panel**
- Choose the sampling frequency and the audio format (16, 24, 32 bits)
- Adjust the buffer size

In order to optimize the resources allocated to the calculation of audio by *String Studio*, it is possible to decrease the ratio of resources devoted to the calculation of graphics for the interface in favor of audio related calculations. To adjust this ratio, choose the **General** command under **Preferences** in the **Edit** menu on Windows or String Studio menu on Mac OS and adjust the *Performance* slider to the desired value between **better audio performance** and **smoother graphics**.

7 Using the String Studio as a Plug-In

String Studio is available in VST, DXi, AudioUnit and RTAS (for Mac OS only) formats and integrates seamlessly into the industry most popular multi-track recording and sequencing environments as a virtual instrument plug-in. The plug-in versions will work exactly the same way as the standalone version, except for the audio, MIDI, and latency configurations that will be taken care of by the host sequencer. Furthermore *String Studio* works as any other plug-in in these environments so we recommend that you refer to your sequencer documentation in case you have problems running *String Studio* as a plug-in. We review here some general points to keep in mind when using a plug-in version of *String Studio*.

7.1 Window Size

The size of the *String Studio* window is fixed as in the standalone version. It is possible, however, to gain some space on the screen by using the **Hide Browser** command from the **View** menu in order to hide the browser.

7.2 Synchronization to the Host Sequencer

To synchronize *String Studio* with the clock of a host sequencer, select the **External Source** option in the **Source** drop down menu of the **Clock** module and make sure that the *Sync* control of the **Effects**, **LFO** and **Arpeggiator** modules are set to their *On* position.

7.3 Audio and MIDI parameters

When *String Studio* is used as a plug-in, the audio and MIDI ports, sampling rate, buffer size, and audio format are determined by the host sequencer.

7.4 Automation

String Studio supports automation functions of host sequencers. Automation can usually be done by using MIDI links and recording MIDI events, or by recording the motion of controls on the interface.

7.5 Multiple Instances

Multiple instances of *String Studio* can be launched simultaneously in a host sequencer.

7.6 Saving Projects

When saving a project in a host sequencer, information on the position of all the controls on the interface, the MIDI links, and the preset name are saved. Note that if the preset was modified after it was loaded, the original version of the preset is not overwritten.

7.7 MIDI channel

Make sure that the MIDI controller, sequencer and *String Studio* all use the same MIDI channel.

7.8 MIDI program change

MIDI program changes are supported in the plug-in versions of *String Studio*. Note that with the VST format, the list of program changes is available in the host program's VST program list and the **Edit Program Changes** command is not available.

7.9 Performance

Using a plug-in in a host sequencer requires CPU processing for both applications. The load on the CPU is even higher when multiple instances of a plug-in or numerous different plug-ins are used. To decrease CPU usage, remember that you can use the **freeze** of **bounce to track** functions of the host sequencer in order to render to audio the part played by a plug-in instead of recalculating it every time it is played.

8 Quick reference to commands and shortcuts

File Menu

Command	Windows	Mac OS	Description
New Folder...		Apple+Shift+N	New Folder in the Browser
Open Preset	Ctrl+O	Apple+Option+O	Open the selected preset
Save Preset	Ctrl+S	Apple+S	Save the current preset
Save Preset As...			Save the current preset under a new name
Save MIDI Links	Ctrl+Shift+S	Apple+Shift+S	Save the current MIDI links
Save MIDI Links As...			Save the current MIDI links under a new name
Import...			Import a .axf file
Export...			Export a .axf file
Exit (Quit on Mac)			Quit the application

Edit Menu

Command	Windows	Mac OS	Description
Undo	Ctrl+Z	Apple+Z	Undo last command
Redo	Ctrl+Y	Apple+Shift+Z	Redo last command
Cut	Ctrl+X	Apple+X	Cut selected item
Copy	Ctrl+C	Apple+C	Copy selected item
Paste	Ctrl+V	Apple+V	Paste
Delete	Del		Delete selected item
Select All	Ctrl+A	Apple+A	Select all items
Get Info…	Ctrl-I	Apple+I	Edit information about a selected item (browser)
Compare			Compare modified preset with original settings
Learn MIDILink			Enter MIDI link learn mode (player)
Forget MIDILink			Drop a MIDI link (player)
Set MIDILink Minimun Value			Limit the value of a MIDI link to a minimum value
Set MIDILink Minimun Value			Limit the value of a MIDI link to a maximum value
Edit MIDIlinks			Display the Edit MIDI links window to view or edit MIDI links of the current patch
Edit Program Change…			Associate presets with MIDI program changes

Edit/Preferences Menu on Windows, String Studio/Preferences on Mac OS

Command	Windows	Mac OS	Description
General			Display the Edit General Preferences window
Audio Settings			Display the Audio Settings window
MIDI Settings			Display the MIDI Settings window
Audio Control Panel			Display the Latency Settings window

View Menu

Command	Windows	Mac OS	Description
Show/Hide Browser		Apple-B	Show/Hide the browser panel
Locate	Ctrl-L	Apple-L	Locate the current preset in the browser and select it

Help Menu

Command	Windows	Mac OS	Description
Manual	F1		Display the user manual
About String Studio			Display the About String Studio window

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