Phosphor User's Guide

Audio Damage, Inc.
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Audio Unit version implemented using Symbiosis from NuEdge Development.

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Introduction

Phosphor is a polyphonic software synthesizer plug-in modeled on the alphaSyntauri hardware synthesizer. Introduced in 1979, the alphaSyntauri used an Apple][microcomputer as its central processor and user interface. While quite modest by contemporary standards, the alphaSyntauri can create a surprising wealth of sounds easily, thanks to its simple but flexible approach to synthesis.

Rather than mimicking the small number of wave shapes available from the oscillators found in analog synthesizers, the alphaSyntauri's oscillators used tables of numbers—essentially samples of a single cycle of an audio wave. The tables are filled with a process known as *additive synthesis*. The basic idea of additive synthesis is that any sound wave can be created by adding together a large number of sine waves of different frequencies. Each sine wave has a pure sound with no harmonics, but if you add a bunch of them together you can create complex sounds. If you use enough sine waves, and if you control their relative loudness precisely over the duration of a note, you can recreate just about any sound.[1]

Since the alphaSyntauri was limited by the computational power available in its day, it took a relatively simple approach to additive synthesis. Each oscillator's wave shape was created by adding together 16 sine waves, which we'll henceforth refer to as *partials*. The wave shape could not change over the duration of a note, but each oscillator's overall loudness was controlled by a separate envelope generator, and hence the timbre of the note could be varied by mixing the two oscillators dynamically. Phosphor reproduces this system faithfully and adds a couple of tricks of its own.

Phosphor harkens back to a time when high-quality digital synthesis was available only to people with huge budgets or access to academic research facilities, but low-quality digital synthesis was finding its way into the public ear through quarter-munching video games and 8-bit home computers. We hope you enjoy using it as much as we enjoyed building it.

If You Don't Like To Read Manuals

We understand. You just got a shiny new plug-in and you'd really rather play with it than read some dull exposition about it. Go ahead, then—install it, load it up, flip through the presets, move some of the controls around. Phosphor comes with a healthy assortment of built-in presets that will provide instant gratification and keep you amused for quite some time. When you're ready to dig deeper and create your own sounds, a quick read of this manual should help you along.

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[1] For an in-depth explanation of how this works, see http://en.wikipedia.org/wiki/Additive_synthesis

System Requirements

To use Phosphor, you'll need a Steinberg VST-compatible host application which conforms to the VST 2.0 specifications, and a computer capable of running it. For the Audio Unit version of Phosphor, you'll need an application capable of hosting Audio Unit plug-ins, and an Apple computer with an Intel CPU capable of running it.

We support the use of Phosphor under Microsoft Windows XP, Vista, or Windows 7; and Apple OS X version 10.5 or newer.

Installation

Double-click the Phosphor Installer icon, and follow the instructions. During the installation process the installer will ask you to enter your registration code. Your registration code uniquely identifies your purchase, and you will need it if you need to reinstall your plug-in (for example, after upgrading to a new computer). You can retrieve your code from your account at the Audio Damage website if you misplace it. Please don't share your code with your friends. We're delighted if you like our products so much that you want to share them, but please ask your friends to buy their own copy so that we can keep making new products.

On OS X, the installer installs both the AudioUnit and VST versions of Phosphor by default. If you click the Customize button you can choose to not install one of these formats. If you're running a 64-bit version of Windows, you can choose to install either a 32- or 64-bit version of Phosphor, or both. On OS X, both the AudioUnit and VST versions are combination 32/64-bit plug-ins.

To un-install from OS X, simply delete the plug-in from your VST folder, which is usually located at `/Library/Audio/Plug-Ins/VST/`, and your AudioUnits folder, which is located at `/Library/Audio/Plug-Ins/Components/`. To un-install from Windows, delete the file named `Phosphor.dll` from your VST folder(s).

Operation

The following screen shot shows Phosphor's user interface. The controls are described in the following paragraphs.

1. Wavetable Oscillators

Phosphor's core is a pair of audio oscillators, referred to as the Primary and Secondary Oscillators. Each oscillator has its own wave table and hence its own timbre.

The groups of vertical sliders near the top of Phosphor's windows are called the *partial sliders*. The partial sliders control the level of the partials used to calculate Phosphor's wave tables, and hence control the tone of the oscillators. Each oscillator has its own set of sixteen partial sliders which set the relative amplitudes of each of the sixteen partials. The left-most slider sets the level of the *fundamental*, that is, the lowest-frequency partial, which has the frequency of the note you're playing. The next slider controls a partial whose frequency is twice that of the fundamental (i.e., one octave above the root pitch). The next slider's partial has a frequency of three times that of the fundamental, and so on. A drawing of the resulting wave shape is superimposed over the sliders. As you move a slider, you'll see the wave shape change and hear the tone change.

If you raise only the left-most partial slider, you'll get a single sine wave with a pure tone:

If you raise a couple more sliders to the right, you'll see some wiggle added to that wave, and hear higher harmonics in the sound:

The **CLEAR** and **RAND** buttons above the partials sliders provide a couple of editing shortcuts. Clicking the **CLEAR** button sets all of the sliders to zero. Clicking the **RAND** button sets all of the sliders to zero and then sets about a third of them, chosen at random, to random levels.

If you turn on the Vintage switch ![switch] above the partials sliders on the right, the quality of Phosphor's oscillators is reduced to resemble the alphaSyntauri's hardware. The Vintage switch introduces aliasing and digital grunge which can add some interesting color to Phosphor's tone.

2. Envelope Generators

Phospor employs a pair of envelope generators to shape the volume or loudness of each oscillator over the duration of a note. Since Phosphor's oscillators can create entirely different timbres, using the two envelope generators to vary the relative loudness of each oscillator is one of the keys to producing interesting sound with Phosphor.

Phosphor's envelope generators use the traditional "ADSR" design found in numerous hardware and software synthesizers. Unlike most ADSR envelope generators, Phosphor's EGs let you control the curvature of the Attack, Decay, and Release segments of the envelope.

Phosphor's envelope generators have graphical controls that show you the shape of the envelope. Click and drag the white handles to change the envelope parameters as follows:
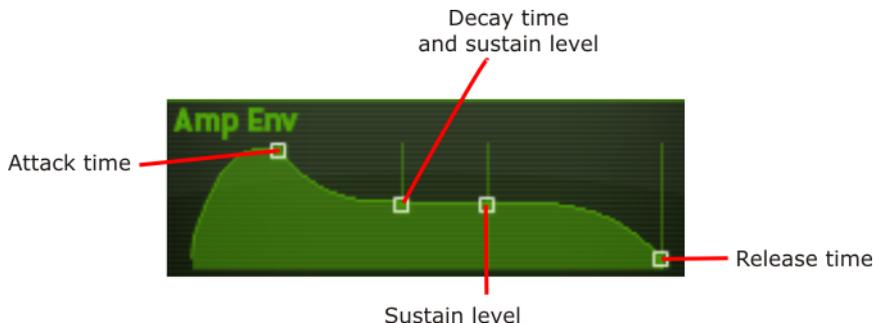
Drag the handles horizontally to change the times; drag the two middle handles vertically to change the sustain level. (The sustain level is the level at which the envelope remains while you hold down a key on your keyboard.)

If you drag vertically between the handles (or to the left of the first handle), you change the curvature of the envelope segment. The alphaSyntauri's envelopes had only linear shape, but Phosphor's adjustable curvature provides a greater variety of envelope shapes.

3. Oscillator Control Sliders

Beneath the envelope generators are groups of sliders which control several parameters for both of the oscillators.

Crossmod

The Crossmod sliders enable the Primary and Secondary oscillators to modulate each other's frequency, creating a much wider range of tones than they create individually. While Yamaha made frequency-modulation (FM) synthesis famous with the DX7, the NED Synclavier combined wavetable and FM synthesis in a manner very similar to Phosphor.

Moving the Primary oscillator's Crossmod slider to the right increases the amount that the Secondary oscillator modulates the Primary oscillator's frequency. This changes the tone produced by the Primary oscillator (and not the Secondary oscillator). In the usual parlance, the Primary oscillator is the *carrier* and the Secondary oscillator is the *modulator*. Generally speaking, as you move the slider to the right, the tone of the Primary oscillator will become brighter and more complex.

It works the other way around for the Secondary oscillator's Crossmod slider: moving it to the right increases the amount that the Primary oscillator modulates the Secondary oscillator, and in this instance we would say that the Secondary oscillator is the carrier and the Primary oscillator is the modulator. Since both oscillators can modulate each other, we call Phosphor's FM scheme cross-modulation.

The signals used for cross-modulation originate after the envelope generator but before the Level slider (described below). This means two things: first, since the timbre created by frequency modulation changes with the amplitude of the modulating signal, you can use the envelope generator of the modulator to make the tone of the carrier vary over the duration of the note. Second, you can use the level slider of the modulator to reduce or remove its signal from Phosphor's output so that you hear only the changing tone of the carrier.

Noise

The Noise sliders control the loudness of noise generators whose outputs are mixed together with the signals from the oscillators. The noise generators create white noise—noise with a flat frequency spectrum—and are useful for adding bite to percussive sounds or a bit of grunge to the pure sine waves emanating from the oscillators.

If you click on the VINTAGE switch to the right of the Noise slider, the noise generator reproduces the sound of noise sources found in computer sound generators that were contemporaries of the alphaSyntauri. In this mode, the noise generators have some apparent pitch and will track both the keyboard and pitch-bend wheel as you play. If you've played old video games, you'll recognize the timbre of the noise generator, particularly near the low end of the keyboard.

Pan

The Pan slider controls the stereo placement of the oscillators and noise sources. Moving the Pan slider left and right moves the oscillator's output in the corresponding direction in Phosphor's stereo output.

Level

The Level sliders control the loudness of the oscillators and the noise sources. Moving the slider to the right makes the oscillator's tone and the noise louder, moving them to the left makes them quieter. Note that you won't hear the noise source unless you move the Noise slider at least somewhat to the right also.

Velocity Amount (Amt)

The Velocity Amt sliders allow Phosphor to respond to velocity information from your MIDI controller and/or host sequencer. Moving the Velocity Amt slider to the right increases the influence that velocity has on the loudness of the oscillator, i.e. playing your keyboard harder makes the oscillator louder. If you leave the Velocity Amt slider at the far left, the oscillator's loudness will be the same regardless of how vigorously you pound the keyboard.

Pitch Offset

The Pitch Offset slider, present only on the Secondary Oscillator, raises the frequency of the Secondary oscillator relative to that of the Primary oscillator. This slider has a fairly small range; at its rightmost position, it raises the frequency of the Secondary oscillator by only 10Hz. Raising the frequency of the oscillator has either or both of two effects. If both oscillators are heard at the same time, the Pitch Offset slider will introduce a tremolo-like sound as the two oscillators beat against each other. If any cross-modulation is active, the Pitch Offset slider will make the timbre of the carrier more complex and often somewhat discordant.

4. Low-Frequency Oscillators (LFOs)

Phosphor has two low-frequency oscillators (LFOs) that can be used to change, or modulate, several parameters of the Primary and Secondary Oscillators, and the frequencies of the filters associated with the delays.

The numeric LFO controls determine how fast the output of the LFO varies over time. They operate either in units of frequency (Hertz, or cycles per second), or in metrical units. The LFO's rate can be set from one cycle every 100 seconds (or 0.01 cycles per second, abbreviated 0.01 Hz) to 14 cycles every second (14 Hz). Click on the unit indicators in the upper-right corner of the controls (i.e. the words "Hz" and "sync") to switch between the two modes.

 The **WAVESHAPE** slider and **WAVEFORM** buttons work together to control how the LFO's output varies over time. The **WAVEFORM** buttons let you choose one of four waveforms, with sawtooth, pulse, sinusoidal, and randomly determined shapes. The **WAVESHAPE** slider changes the basic waveform in different ways, depending on which waveform is chosen with the **WAVEFORM** buttons.

- If the sawtooth wave is selected, and the **WAVESHAPE** slider is set to the middle of its range, the output of the LFO rises and falls evenly between its lowest and highest values, creating a symmetric triangular wave. If you move the **WAVESHAPE** slider to the left from its center, the LFO output rises more quickly and falls more slowly. If you move the **WAVESHAPE** slider to the right, the LFO rises more slowly and falls more quickly.

- If the pulse wave is selected, and the **WAVESHAPE** slider is set to the middle of its range, the output of the LFO jumps between its lowest and highest values, staying for an equal period of time at both values. If you move the **WAVESHAPE** slider to the left, the output stays at its highest value for a shorter period of time. If you move the **WAVESHAPE** slider to the right, the output stays at lowest value for a shorter period of time. In engineering terms, the **WAVESHAPE** slider varies the duty cycle of the rectangular wave.

- If the sine wave is selected, and the **WAVESHAPE** slider is set to the middle of its range, the output of the LFO varies smoothly between its lowest and highest values. The difference between a sine wave and a triangle wave is that the triangle wave abruptly changes direction when it reaches its highest and lowest values; whereas the sine wave gradually slows down, stops, and speeds up again when it changes

directions. Moving the **WAVESHAPE** slider warps and skews the sine wave without creating any sharp corners in its shape. Its effect is far easier to hear than to describe.

- If the random wave is selected, and the **WAVESHAPE** slider is moved all the way to the left, the output of the LFO jumps to a random value, changing at a rate determined by the numeric control. As you move the **WAVESHAPE** slider to the right, the output moves more slowly from one random value to the next.

The diagram on the next page illustrates the different modulation signals generated by different settings of the **WAVEFORM** and **WAVESHAPE** controls.

SAW				
PLS				
SIN				
RND				
Waveshape 0%	Waveshape 25%	Waveshape 50%	Waveshape 75%	Waveshape 100%
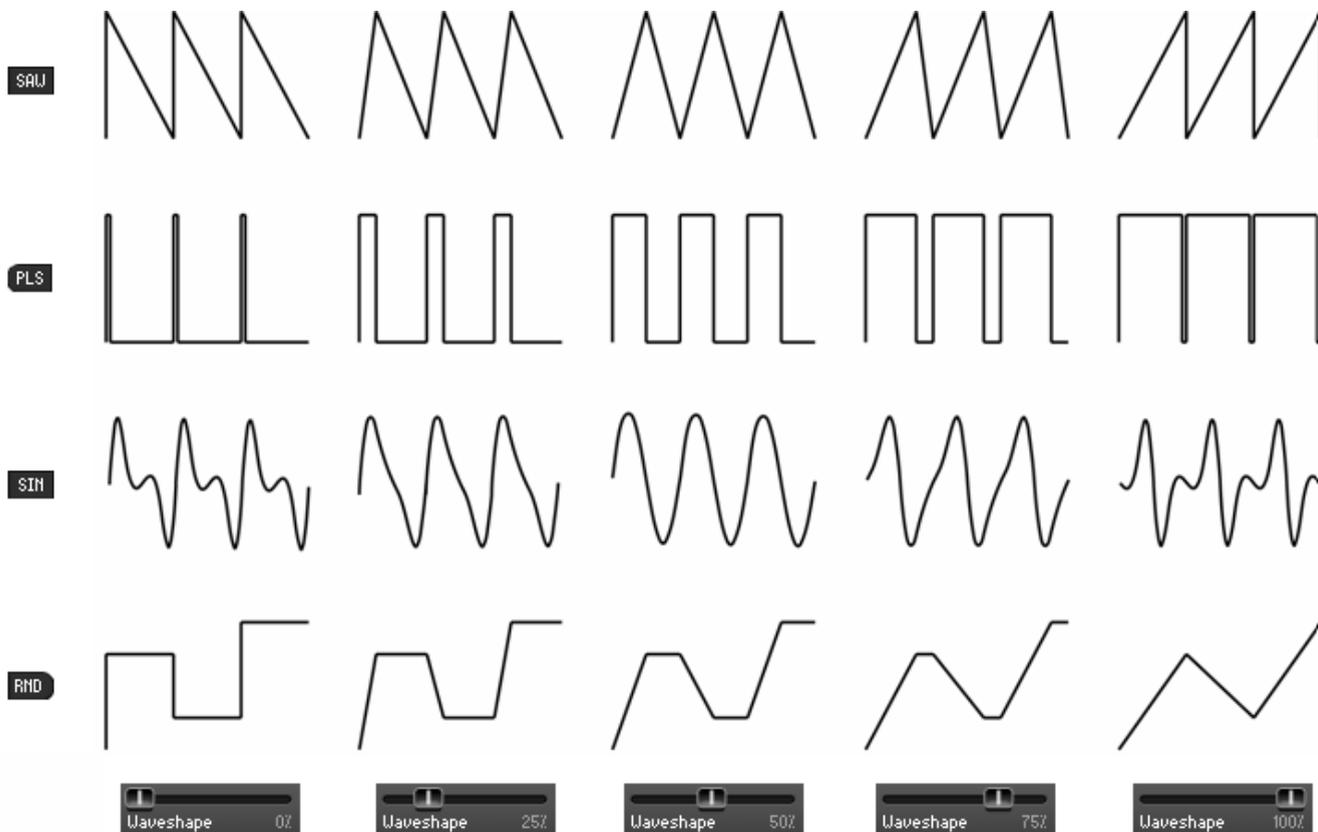
5. Modulation Sliders

The horizontal sliders on the right side of Phosphor's windows are called modulation sliders. They route signals from the LFOs to the Primary and Secondary Oscillators, and to the filters in the delay lines. Each slider can be thought of as controlling a connection between one of the LFOs and one of the parameters of one of the oscillators. The left-hand column of sliders controls connections between LFO One and the oscillators and filters; the sliders on the right control connections between LFO Two and the oscillators and filters.

The sliders are bidirectional. If left at their center position, no signals from the LFOs reach the corresponding parameter in the oscillators and filters. In general, moving a slider to the right of center causes the LFO to increase the parameter's value and moving it to the left of center causes the LFO to decrease the parameter's value. Simply click and drag on a slider to change its value. If you hold down the CTRL key on your keyboard and click the slider, the slider will return to its center position.

More specifically, the sliders under the headings "LFO to Primary Osc" and "LFO to Secondary Osc" have the following functions:

PITCH – moving the **PITCH** slider to the right causes the LFO to raise the pitch of the oscillator, moving it to the left causes it to lower the pitch. Use the **PITCH** slider to introduce subtle vibrato and trill effects, or not-so-subtle pitch slides and jumps.

PAN – moving the **PAN** slider left or right of center causes the LFO to move the output of the oscillator in the corresponding direction in the stereo field. Note that the LFO's influence is added to the position set by the **PAN** slider in the Oscillator panes. Hence if for instance the Oscillator **PAN** slider is set to the far left, and you move the **PAN** modulation slider to the left, you won't hear any change in the oscillator's position because the LFO can't push it any further to the left.

AMP – moving the **AMP** slider to the right of center causes the LFO to make the Oscillator louder, moving it to the left causes the LFO to make the Oscillator quieter. The effect of the LFO is added to the loudness of the oscillator as set by the **LEVEL** slider in the Oscillator pane.

NOISE - moving the **NOISE** slider to the right of center causes the LFO to make the noise generator louder, moving it to the left causes the LFO to make the Oscillator noise generator. The effect of the LFO is added to the loudness of the noise generator as set by the **NOISE** slider in the Oscillator pane.
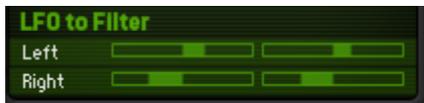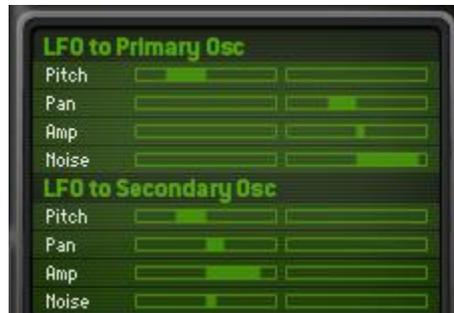
The sliders under the heading "LFO to Filter" connect the LFOs to the filters following the delay lines. The LFOs can modulate (change) the frequencies of the filters. Moving these sliders to the left of center causes the LFOs to decrease the filter frequencies (as if you were dragging the dot in the filter's control to the left), and moving the sliders to the right causes the LFOs to increase the filter frequencies.

Note that the amount that the LFOs control parameters can be affected by the modulation wheel on your MIDI keyboard. See "Keyboard and Master Controls" below for more information.

6. Delay and Filter Controls

Because we at Audio Damage dearly love delay effects, we've added a stereo delay to Phosphor. The output of each oscillator/noise source passes through its own delay. Each delay has a range of 0 to 1999 msec, or approximately two seconds.
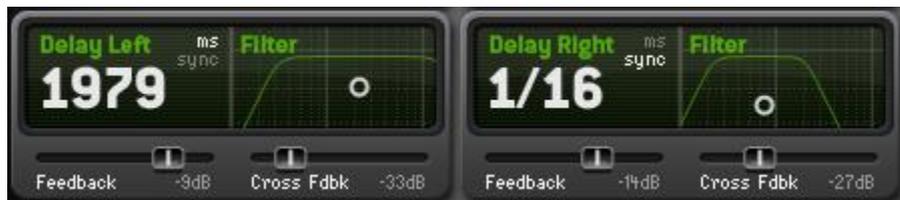
The numeric delay controls operate either in units of time or in metrical units, that is, fractions of a beat. Click on the unit indicators in the upper-right corner of the controls (i.e. the words "ms" and "sync") to switch between the two modes. Click and drag up and down on the numbers to change the delay times. In the "ms" mode, you can drag on individual digits to change the delay time by small or large amounts.

 If the **SYNC** mode is active, Phosphor uses the current tempo reported by your host to calculate its delay time. In this mode the delay time control sets the delay length in metrical units. The range of values is $1/32^{nd}$ to 1/1 (a whole measure), with dotted and triplet times available. Triplet values are denoted with a "T" after the beat fraction, and dotted values are denoted with a period. For example, "1/8 ." indicates a delay time with a dotted eighth note feel. Phosphor will track tempo changes, saving you from having to adjust its delay time by hand when you change the tempo of your song.

The **FEEDBACK** slider controls the feedback level, that is, the amount of the output signal which is fed from the output of the delay back into its input. Note that the feedback path goes through the filters.

The **CROSS FDBK** slider controls a second feedback path. As you move this slider to the right, some of the signal is fed to the input of the other channel. For example, if you move the right-channel **CROSS FDBK** slider, the right channel output signal is fed back into the input of the left channel. This cross-channel feedback can be used to create delay effects that bounce back and forth.

Phosphor has low-pass and high-pass filters which come after the delay lines in the signal chain. These filters can be adjusted to alter the timbre of the delayed signal. For instance, you can use the low-pass filter to create a "darker" sound, or the high-pass filter to create a "thinner" sound.

The filters are controlled in tandem with the graph-like controls labeled, appropriately enough, **FILTER**. Since the filter controls change the low- and high-pass filters simultaneously the filters act like a band-pass filter with a variable width. Dragging the white circle in the control changes the corner frequencies of both filters. Dragging up and down moves the corner frequencies farther apart and closer together; dragging left and right moves the frequencies in the same direction. As you pull the white dot downwards, the filters move together and allow only a narrow band of frequencies to pass through. You can then move the dot left and right to hear that band move up and down in frequency.

Moving the white dot horizontally changes the filter frequencies in the same direction, moving the frequency pass-band higher and lower

Moving the white dot vertically moves the filter frequencies together and apart, making the frequency pass-band narrower and wider

7. Keyboard and Master Controls

The row of switches and sliders along the bottom of Phosphor's window provide some handy shortcuts for creating new sounds, control Phosphor's response to MIDI keyboards, and setting output levels.

Starting from the left and heading right:

L+R Link

Turning on the L+R Link button cause the controls for the Primary Oscillator and the left delay/filter to affect the corresponding controls for the Secondary Oscillator and the right delay/filter. In other words, if you move a slider on the Primary Oscillator, the corresponding slider for the Secondary Oscillator will move as well. This lets you rapidly adjust parameters both oscillators and delays/filters to the same setting. Note that it doesn't work the other way around: controls for the Secondary Oscillator and right delay/filter do *not* affect their corresponding controls on the left. This lets you set both parameters to the same value with controls on the left, then vary those on the right slightly.

Rand All

Clicking the Rand All button sets most of Phosphor's controls to random positions. Some controls, such as **CROSSMOD**, are not affected because randomizing them tends to not produce useful results. Also, some of the modulation sliders are subjected to only slight amounts of randomization, again with the intent of producing interesting results more often than not. Use the Rand All button to create unexpected starting points for new sounds.

Mod Wheel Destination (Dest)

The **MOD WHEEL DEST** switches control whether the modulation wheel on your MIDI keyboard affects Phosphor's LFO. It has four positions: **OFF**, **LFO1**, **LFO2**, and **1+2**. If set to **LFO1**, the mod wheel controls how much LFO One affects the parameters it is connected to through the modulation sliders. Pushing the wheel forward increases the LFO's effect. If the Mod Wheel Dest switch is set to **LFO2**, the mod wheel controls LFO Two. If it's set to **1+2**, the mod wheel controls both LFOs. If the switch is set to **OFF**—well, hopefully we don't need to explain this to you.

Poly Mode

The Poly Mode switches determine how Phosphor responds when you play more than one note at a time on your MIDI keyboard. It has three positions:

> Poly – in this mode, Phosphor responds polyphonically, like a piano and most digital synthesizers. Play several keys on your keyboard, and you'll hear several notes.

> Mono – in this mode, Phosphor plays only one note at a time. If you hold down a key on your keyboard, and press another key, Phosphor will not play a new note, but will change its pitch to that of the new key. In this mode, the envelope generators are not restarted when you play additional keys.

> Retrig – this is the same as Mono mode, but the envelope generators are retriggered every time you press a key.

Portamento

The Portamento slider creates a sliding effect when the mono or retrig modes are active. If you hold down a key and press another key, Phosphor's pitch will slide to the second note at a rate determined by the sliders. The further you move the slider to the right, the longer it takes Phosphor to slide from one note to the next. The Portamento slider has no effect if Poly mode is active.

Delay Mix

The Delay Mix slider controls the relative loudness of Phospor's raw output and the output from the delays and filters. If you set the slider to the far left, you won't hear the delayed/filtered signal at all. If you set it to the far right, you'll hear only the delayed/filtered signal. If you set it in the middle, you'll hear equal amounts of both.

Output

The Output slider controls Phosphor's overall loudness. Phosphor's signal can vary fairly widely depending on how many partials you use and whether cross-modulation is employed; use this slider to compensate. Moving towards the right makes Phosphor's output louder.

MIDI Controllers

Phosphor responds to MIDI continuous controller messages. You can use hardware MIDI controllers, such as MIDI slider boxes or the knobs found on some MIDI keyboards, to adjust Phosphor's parameters other than the partials sliders.

Phosphor has a simple "MIDI Learn" mode for assigning its onscreen controls to MIDI controllers. To assign a control to a MIDI controller:

1. Hold down the SHIFT and CTRL keys on your PC's keyboard, or SHIFT and CMD keys if you're using a Mac, and click once on the control. A white box will be drawn around the control to indicate that it is ready to learn which MIDI controller it will be assigned to.

2. Move the MIDI controller to send a continuous controller message—turn the knob, press the button, move the slider, whatever is appropriate.

3. The white square will disappear. Now the control will move when you manipulate the MIDI controller.

When assigning a MIDI controller to Phosphor's XY controls (the FM and Timbre voice controls as well as the Filter/Feedback control), the XY control will move horizontally in response to the MIDI controller. Hold down the OPTION key on your Mac keyboard, or the ALT key on a PC keyboard, to assign a MIDI controller to move the XY control vertically. You can also use the option or alt key to assign a controller to the peak level of the Pitch EG and the release curvature of the Amp EG.

Phosphor waits until it has received two consecutive continuous controller messages with the same controller number before it makes an assignment. This filters out extraneous data sent by some MIDI controllers. If you are assigning a button or switch on a MIDI controller, you may have to press or move the switch twice before Phosphor recognizes the controller and assigns it to the desired knob.

- To assign a different MIDI controller to a control, repeat the same procedure using a different controller.

- To cancel MIDI Learn mode without assigning a controller, hold down the SHIFT and CTRL keys (SHIFT and CMD keys on a Mac) and click in any empty area in Phosphor's window (i.e., don't click on another control). The white box will disappear.

- To remove a MIDI controller assignment from a control, SHIFT and CTRL keys, (SHIFT and CMD keys on a Mac) click on the control once so that the white box appears, then click again on the same control.

Phosphor's MIDI controller assignments apply to all presets and instances of Phosphor, in all host applications that you use. The MIDI assignments are stored in a special file on your hard drive. The contents of this file are read when Phosphor is loaded by your host. If you have two or more instances of Phosphor in use at once, any MIDI assignments you make will not be propagated to the other instances until the next time that your host loads the plug-ins.

Automation

Most of Phosphor's parameters other than the partials sliders can be automated using your host's automation features. Consult your host's documentation for information on how to use these features.

Presets

Phosphor comes with a selection of 80 presets, organized in the following categories: pads, lead synthesizer, bass, keyboards, and special effects.

And Finally…

Thanks again for purchasing Phosphor. We make every effort to ensure your satisfaction with our products, and want you to be happy with your purchase. Please write to support@audiodamage.com if you have any questions or comments.