



# PANHARMONIUM

Mutating Spectral  
Resynthesizer

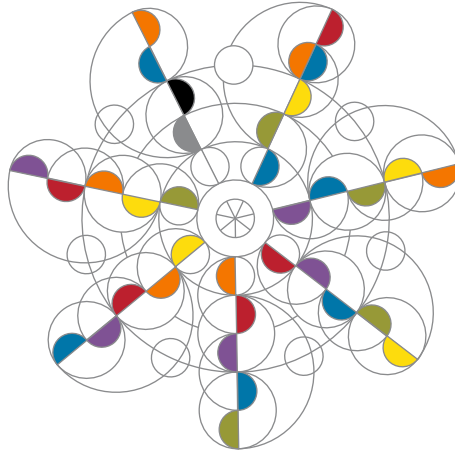
Operation Manual

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# 1. Introduction



Thanks for purchasing the Rossum Electro-Music Panharmonium Mutating Spectral Resynthesizer. This manual will give you the information you need to get the most out of Panharmonium. The manual assumes you already have a basic understanding of synthesis and synthesizers. If you're just starting out, there are a number of good reference and tutorial resources available to get you up to speed. One that we highly recommend is:

## ***Power Tools for Synthesizer Programming***

*(2nd Edition)*

By Jim Aikin

Published by Hal Leonard

HL00131064

Another great source of information is Chris Meyer's Learning Modular:

<https://learningmodular.com>

## **Support**

In the unlikely event that you have a problem with your Panharmonium, tell us about it here:

<http://www.rossum-electro.com/support/support-request-form/>

...and we'll get you sorted out.

If you have any questions, comments, or just want to say "Hi!," you can always get in touch here:

<http://www.rossum-electro.com/about-2/contact-us/>

...and we'll get back to you.

Happy music making!

## 2. Module Installation

As you will have no doubt noticed, the rear of Panharmonium is a circuit board with exposed parts and connections. When handling Panharmonium, it's best that you hold it by the edges of the front panel or circuit board. It's not particularly easy to blow up, but why take chances?

More specifically, the biggest risk (to the extent that there's a risk), is damage by static electricity. Particularly on dry, cold days (or if you've just shuffled across your shag carpet in fuzzy slippers), make a point of touching the metal panel first, before touching any other part of the module.

While all Rossum Electro-Music modules are protected against reverse polarity damage, both to your module and your system, care should still be taken to connect the power cable correctly. (For more detail on our unique protection method, check out Dave's discussion of Circuit Protection in Chapter 15.)

Plug the included 16-pin connector into the header on the rear of the module such that the red stripe on the cable (the -12V side) is on the same end of the header as the "Red Stripe (-12V)" text on the PCB.

Panharmonium requires, at most, 140mA of +12V and 30mA of -12V.

We have included both M3 and M2.5 (for vector rails) mounting screws. Use what fits your system.

If rack rash is of concern to you, use the included nylon washers when mounting Panharmonium in your case.

# 3. Overview



## What is Panharmonium?

Rossum Electro-Music Software Architect Bob Bliss (who also, as it happens, fathered E-mu's famed "EOS" Emulator Operating System) has created Panharmonium, a unique music and sound design tool that

lets you analyze the spectral content of any audio signal and use that analysis to drive a bank of from 1 to 33 oscillators. Depending on various control settings, Panharmonium can accurately recreate the input spectrum in

real time or modify it in a multitude of wildly creative ways. All with an interface whose immediacy encourages performance and interaction.

Panharmonium input can be anything from a single oscillator to an entire mix (including vocals). From dense, swirling pads and drones that evolve with the input's changing spectrum, to clock-syncable spectral arpeggiation, to as-yet unnamed harmonic effects, Panharmonium opens up an entirely new world of sonic possibilities.

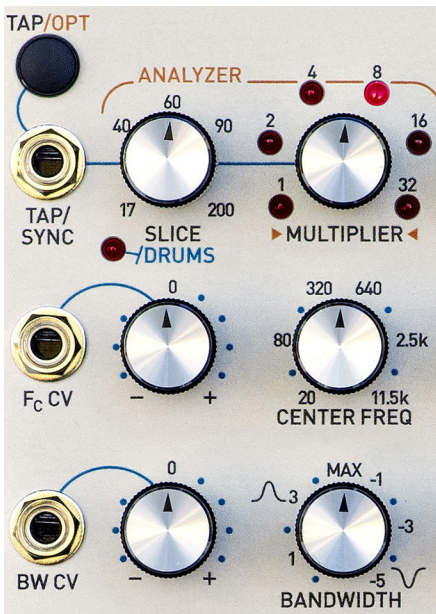
Additionally, Panharmonium can take a snapshot of an instantaneous spectrum and use that as a complex harmonic oscillator, which can then be modified and modulated by all of Panharmonium's other controls.

# 4. Basic Functionality

Before we jump into individual functions in detail, let's take a quick look at Panharmonium's structural organization.

Panharmonium accomplishes its magic through a combination of functional submodules:

## Spectral Analyzer



The **Spectral Analyzer** provides tools for defining the analysis process.

- > The **Slice** parameter sets the rate at which the incoming audio is transformed to spectral data. It can be set by the **Slice** and **Multiplier** controls, the **Tap/Opt** button, or by an external clock signal. Very short slice times result in real-time spectral data, while longer times can create rhythmic spectral patterns.

- > The **Center Freq** and **Bandwidth** controls control the range of frequencies to be analyzed. The **Bandwidth** control allows the selection of narrow to wide pass bands on the left side of the pot and narrow to wide notches on the right side of the pot. The ability to sweep the frequency and modify the bandwidth under CV control opens up a wide range of sonic effects.
- > The **Freeze** button lets you freeze the spectral integrator, sustaining the currently analyzed spectrum.
- > **Freeze Tap Mode** causes a new analysis to be done only upon a **Tap/Opt** button press or receipt of a **Tap/Sync** pulse.

## Spectral Modifiers



These controls allow you to creatively modify the analyzed spectra.

- > The **Voice** parameter lets you select from 1 to 33 oscillators to resynthesize the spectrum.
- > The **Blur** parameter is a spectral lag processor that controls how quickly the spectrum can change. Maximum Blur will freeze the spectrum (equivalent to pressing the **Freeze** button).
- > The **Feedback** control lets you route the resynthesized audio back into the entire processing chain for subtle or dramatic feedback effects. At its max, the output becomes self-sustaining, even if the input is removed.



## Oscillator Bank



The **Oscillator Bank** resynthesizes the analyzed spectra.

- > The **Waveform** parameter selects the oscillators' waveform. In addition to the usual sine, triangle, sawtooth and pulse waveforms, two special crossfading sine and sawtooth waveforms are included.
- > The **Freq** control lets you tune the oscillators over a +/-7 semitone range. The frequency is further controlled by the **1V/Oct** input and the **FM** input and attenuverter.
- > The **Octave** control, not surprisingly, shifts the pitch of the output by octaves.
- > The **Glide** parameter sets the amount of polyphonic glide (i.e., each oscillator has its own glide circuit).
- > The **Mix** control sets the balance between the original input audio and the resynthesized audio.



- > **Output Mode/Option** selects between two routings of the input audio and Panharmonium output.

## Assignable CV Inputs



In addition to its dedicated CV Inputs, Panharmonium provides two assignable inputs, **CV1** and **CV2**, that can be assigned to control up to three parameters each. See the subsequent chapters for details.

## Optional Functions

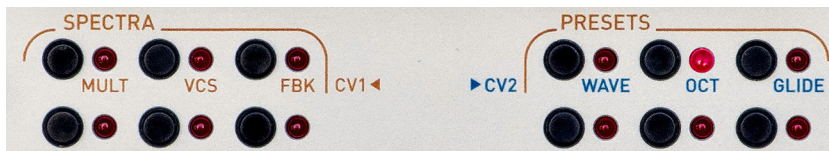
A number of optional functions can be selected by using button combinations.

- > Holding the **Output Mode/Option** button and adjusting the **Slice** control enables **Drums Mode**, which optimizes the spectral analysis for drums and other percussive inputs.
- > Holding the **Output Mode/Option** button and adjusting the **Freq** control enables **Spectral Warping**. In contrast to conventional frequency adjustment, where the harmonic relationships between the spectral elements are preserved, Spectral Warping shifts the harmonic elements individually, producing a variety of clangorous, swarming textures.
- > Holding the **Tap/Opt** button and adjusting the **Freq** control quantizes the resulting frequency adjustments to semitones.



- > Holding the **Freeze** and **Tap/Opt** buttons for 1 second toggles between regular tap mode and **Freeze Tap** mode (see Chapter 6 for details).

## Spectra Memories and Presets



Panharmonium provides memories for 12 user **Spectra** and 12 user **Presets**.

- > The **Spectra** memories let you store up to 12 frozen slices. When selected, a spectrum (up to 33 oscillators wide!) replaces any live input and can have its pitch controlled by the **1V/Oct** input and **FM** controls.
- > A **Preset** is a snapshot of all of the module settings, along with the value of any CVs present at the moment the preset is saved.
- > **Presets** and **Spectra** may be backed up to and restored from WAV files.

## Software Update and Utilities

Panharmonium provides the ability to update its software via WAV files, as well as offering a variety of housekeeping functions. See Chapters 11 and 12 for details.

# 5. Make Some Noise!

If you've already followed along with the Make Some Noise! section of the printed Panharmonium Quick Start Guide included with your module, you can skip this chapter and go directly to the next. However, if you haven't, spending a few minutes here will give you a quick introduction to the function and effects of the basic controls.

The quickest way to hear some of what Panharmonium can do is to check out the Presets and Spectra that come pre-loaded from the factory. Refer to Chapter 13 for details about the intended effect of each Spectrum and Preset and, for the presets, what sort of input each Preset was designed for.

Select a Spectrum or Preset by clicking or double-clicking the desired button in the Spectra or Preset section. To load Preset or Spectrum 1–6, click the appropriate button (1–3 is on the top row of each section, 4–6 on the bottom). The associated LED will light. To select 7–12, double-click the desired button (7–9 on the top row, 10–12 on the bottom). The associated LED will flash. Click the button again to deselect the preset or spectrum.

Once you've selected a Spectrum or Preset, you can "play" Panharmonium via a CV into the 1V/Oct input. Or try modulating some of the other parameters.

If you want to be adventuresome and dive right in:

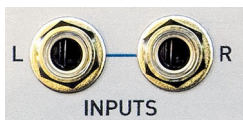
- > Set both the **Center Freq** and **Bandwidth** controls to 12 o'clock.
- > Press the **Output Mode/Option** button until the **L-FX-R** LED is lit. This results in your inputs being passed through to the L & R outputs and the mono output of Panharmonium appearing in both the L & R outputs.

- > Patch some audio into the input(s). (A mono signal patched into the left input will be normalised to the right input.) Inputs can be anything from a single richly harmonic oscillator to an entire mix.
- > Use the **Mix** control to crossfade between the Input audio and Panharmonium's output.
- > Start turning knobs. Seriously. Try things out and see what happens. When a control does something interesting, try modulating it.
- > If you get lost, try reselecting **Preset #1**, which will restore the basic neutral resynthesis settings of all the parameters. It's always a good starting point. (Check Chapter 13 for a list of the individual parameter values.)
- > When you've played for a while, read the rest of this manual. You'll be glad you did.

# 6. The Spectral Analyzer

Panharmonium's **Spectral Analyzer** provides the controls that define how Panharmonium analyzes your input audio to create the data that it uses to drive its **Oscillator Bank**.

## INPUTS



The audio you want Panharmonium to analyze goes here. The input can be one mono stream, a stereo pair, or even two independent mono streams.

**IMPORTANT NOTE:** *Panharmonium is a monophonic processor. If you present it with a stereo input or two mono inputs, those inputs will be internally mixed to mono before being analyzed by Panharmonium. The output of Panharmonium's oscillator bank is always mono.*

**ANOTHER NOTE:** *While a stereo or two mono inputs will be mixed together for the purpose of analysis, in L-FX-R Output Mode (as described in Chapter 8) the two input channels will be passed through independently to the Left and Right outputs.*

**YET ANOTHER NOTE:** *A mono signal patched to the Left Input will be normalised to the Right Input. For more details on patching mono signals, see the Output Mode section in Chapter 8.*

## WHAT IS A SLICE?

A **Slice** is Panharmonium's basic analytical time unit. Panharmonium is constantly analyzing any audio at its inputs. When a slice begins (either as a result of Panharmonium's internal **Slice Clock** or a press of the **Tap/Opt** button or a pulse arriving at the **Tap/Sync** input), Panharmonium transforms the incoming audio into spectral information; it

then uses its most recent spectral analysis to drive its **Oscillator Bank**. That analytical data is used until the beginning of the next slice, at which time it's updated to reflect any change in the the input's spectrum.

Using the **Slice** and **Multiplier** controls, a slice can be as short as 17ms and as long as 6400ms (a little under six and a half seconds). Using the **Freeze** button, **Tap Freeze Mode**, or maximum **Blur** (as described below and in Chapter 7), a slice could potentially last until the heat death of the universe.

Very short slice times result in real-time spectral data, while longer times can create rhythmic spectral patterns.

## SLICE TIME




The **Slice** control sets the basic rate at which the incoming audio is transformed into spectral data. That slice time can be optionally modified by the **Multiplier** control described later in this chapter, as well as

by the **Tap/Opt** button and/or pulses arriving at the **Tap/Sync** input. (We'll discuss the interactions of those options below.)

Using the **Slice** control, slice time can be set from 17ms to 200ms.

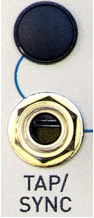
## DRUMS MODE

**Drums Mode** optimizes the spectral analysis for drums and other percussive inputs. To engage Drums Mode, hold the **Output Mode/Option** button and adjust the **Slice** control to its minimum. The **Drums LED** will light to indicate you're in Drums Mode. Simply turn the **Slice** control again (while not holding the **Output Mode/Option button**) to exit Drums Mode. The **Drums LED** will turn off.

 **NOTE:** You're not required to set Drums Mode to the minimum slice value, it can be any value. But assuming your intent is to most accurately analyze a drum or percussion part, there's not much point to selecting anything but the minimum slice time. However, if you're going for some other effect, longer slice times may (or may not) be useful. Just try them and see.


## TAP/OPT & TAP/SYNC


**TAP/OPT** The **Tap/Opt** button and the **Tap/Sync** input each have two basic functions:



> Clicking the **Tap/Opt** button once, or sending one pulse to the **Tap/Sync** input, causes the **Slice Clock** to "resync" (i.e., immediately start a new slice). The clock then continues at its current rate.

> Repeatedly clicking the **Tap/Opt** button or sending multiple pulses to the **Tap/Sync** input establishes a new slice rate for the **Slice Clock** that overrides the **Slice** control setting.

 **AN IMPORTANT NOTE:** The **Tap/Sync** input is designed to be an externally triggered version of the tap tempo function. It is **not** intended as an input for an external clock that explicitly substitutes for the internal clock.

 **ANOTHER NOTE:** If you have used the **Tap/Opt** button or the **Tap/Sync** input to define the slice time and then adjust the **Slice** control, the slice time returns to being controlled by the knob. If you adjust the **Slice** control while continuing to click the **Tap/Opt** button or sending pulses to the **Tap/Sync** input, you may get unusual results (on the other hand, you may get exactly what you want).

To summarize:


Adjust the **Slice** control, and you'll set the internal clock.

Tap the **Tap/Opt** button repeatedly, and you'll set the internal clock.


Pulse the **Tap/Sync** input repeatedly, and you'll set the internal clock.

Don't do any of those things, and the internal clock will run at its current rate.

Do many of those things at once, and they'll wrestle. Last one wins.

 **YET ANOTHER NOTE:** If you inadvertently tap a tempo that's not exactly what you want, wait one second for Panharmonium's internal tap capture window to reset, then start tapping again.


The capture window for the external **Tap/Sync** input is 4.5 seconds to accommodate slow regular clock signals.

 **AND YET ANOTHER NOTE:** When using the **Tap/Opt** button or the **Tap/Sync** input to define the slice time, the function of the **Multiplier** control changes as described below.

## FREEZE TAP MODE

In **Freeze Tap Mode**, clicking the **Tap/Opt** button, or sending a pulse to the **Tap/Sync** input will force the beginning of a new slice and cause that slice to be sustained (frozen) until another click or pulse is received, at which point a new slice will be initiated.

Hold the **Freeze** button and the **Tap/Opt** button for one second to toggle between **Freeze Tap Mode** and regular tap mode. The **Multiplier** LEDs will light steadily to indicate **Freeze Tap Mode**.

 **NOTE:** Although the internal **Slice Clock** will not be initiating new slices in **Freeze Tap Mode**, it will be running and controlling when panel adjustments and CV controls take effect. If it is set at a very slow rate, intermediate changes will not become effective until the beginning of the next period. Also, if you are using a crossfading waveform, the **Slice Clock** will still be controlling the crossfade time.

**ANOTHER NOTE:** If you turn off your system while in Freeze Tap Mode, Panharmonium remembers this and when you next turn it on, it will come back up in FreezeTap Mode. So if you ever turn on your system and find that Panharmonium is not responding to the slice clock, check to see if Freeze Tap Mode is enabled (check the Multiplier LEDs to see if they are on steadily instead of blinking).

## MULTIPLIER



The **Multiplier** control modifies the selected slice time. The LEDs around the knob will light to indicate the current selection and will flash at the resultant rate.

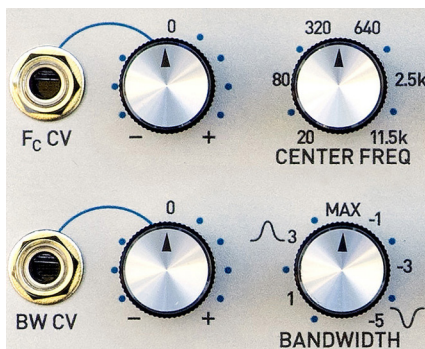
The **Multiplier** control operates in two different ways depending on whether the slice time has been set by the **Slice** control or by the **Tap/Opt** button or the **Tap/Sync** input.

- > When the **Multiplier** control is modifying the slice time as set by the **Slice** control, it only multiplies the slice time. That is, when set at 1, the slice time will be exactly what is set by the **Slice** control. When set at 2, the slice time will be twice that set by the **Slice** control (i.e., the slice rate will be twice as slow), when set at 4, the slice time will be four times that set by the **Slice** control, etc.
- > When the **Multiplier** control is modifying the slice time as set by the **Tap/Opt** button or the **Tap/Sync** input, it can multiply or divide the slice time. When set at 8, the slice time will be exactly what is set by your taps of the **Tap/Opt** button or the pulses arriving at the **Tap/Sync** input. Settings of 4, 2, and 1 successively divide the step duration by 2 (i.e., increase the rate), while 16 and 32 successively multiply the duration by 2 (i.e., decrease the rate).

**A TIP:** When using the **Multiplier** control to modify a slice time set by the **Tap/Opt** button or the **Tap/Sync** input, it may be useful to think in terms of musical note duration. If you tapped quarter notes (relative to your music's tempo), setting **Multiplier** to 4 will cause the slice clock to output at the rate of 8th notes, setting to 2 will output at the rate of 16th notes, setting to 16 will output at the rate of half notes, etc.

The **CV1** input can be assigned to voltage control the **Multiplier** value. See Chapter 9 for details.

## CENTER FREQUENCY AND BANDWIDTH



The **Center Frequency** and **Bandwidth** controls function together to define the frequency range that Panharmonium will analyze. Any part of the input audio's spectrum that falls outside of the defined range will not be used to drive the oscillator bank.


The **Center Frequency** control sets the center frequency of the range of analysis. It can set from 20Hz to 11.5kHz.

The **Fc CV Input** is a control voltage input that is modified by its associated attenuverter and then summed with the value of the **Center Frequency** control to define the effective center frequency.

When the attenuverter knob is set to its "0" position, no control voltage is passed to the parameter. As the knob is turned clockwise from 0, the amplitude of the control voltage increases until, at maximum clockwise rotation, the full amplitude of the signal at the **Fc CV Input** is passed through.


As the knob is turned counter-clockwise from 0, the signal at the **Fc CV Input** is inverted (e.g., a CV of +2.5V becomes -2.5V). The farther counterclockwise the knob is turned, the less the attenuation of the inverted signal, until, at maximum counterclockwise rotation, the full amplitude of the inverse of the signal at the **Fc CV Input** is passed through.

The **Bandwidth** control sets the width of the frequency range centered around the selected center frequency and defines whether that analyzed range is bandpass (in which case Panharmonium analyzes the spectrum inside the selected range) or notch (in which case Panharmonium analyzes the spectrum above and below the selected range).


 **NOTE:** Set the **Bandwidth** control to its 12 o'clock (MAX) position to set the widest possible bandwidth. With the control in that position and the **Center Frequency** control also at 12 o'clock, Panharmonium will analyze the entire frequency range from 20Hz to 11.5kHz.

As the **Bandwidth** control is turned counterclockwise from the 12 o'clock position, it sets successively narrower passbands (the marked units are the widths of the passband in octaves).

As the **Bandwidth** control is turned clockwise from the 12 o'clock position, it sets successively wider notches (the marked units are the widths of the notch in octaves).

 **VERY IMPORTANT NOTE:** Depending on the setting of the **Center Frequency** control and how narrow the passband or how wide the notch, it is entirely possible to define an analysis range within which the input audio has no harmonic content at all, in which case Panharmonium will provide no audio output. If your Panharmonium is not making any sound, this is the first thing to check.


The **BW CV** Input is a control voltage input that is modified by its associated attenuverter (as described above) and then summed with the value of the **Bandwidth** control to define the effective bandwidth.


 **A TIP:** Using these controls, you can isolate specific ranges of a mix (e.g., just the bass or vocal) for resynthesis. With the narrowest bandpass, you can actually pick out individual harmonics.

## FREEZE



Pressing the **Freeze** button freezes the spectral analysis, sustaining the current spectrum for as long as the button is depressed.

 **A TIP:** The Freeze function is particularly useful when exploring harmonically interesting audio input for the purpose of saving spectra to memories. Simply keep pressing the button until you get a spectrum you like, and then continue holding it while saving the spectra as described in Chapter 10.

 **NOTE:** It is also possible to freeze the analysis by setting the **Blur** parameter to maximum, either via the **Blur** control or the associated **Blur CV** input.

## SLICE CLOCK OUTPUT



The **Slice Clock Output** provides a trigger at the beginning of each analysis slice. It can be useful to trigger other modules (sequencer clocks or envelopes, for example) in sync with the slice clock.

# 7. The Spectral Modifiers

The controls in the **Spectral Modifiers** section let you creatively modify the analyzed spectra.

## VOICES



The **Voices** control lets you define how many of Panharmonium's oscillators (from 1 to 33) will be used to resynthesize the input.

**NOTE:** While it's tempting to simply turn up **Voices** to 33 all the time, There are many applications that work best with fewer voices. Examples include extracting a bass line from a mix where one voice may do a good job, but additional voices will start bringing in other parts of the mix. The brighter waveforms — saws and pulses — often produce better results with fewer voices.

**ANOTHER NOTE:** The numbers around the **Voices** knob are the specific numbers of voices that are selectable. Intermediate numbers between the displayed labels are not available. So, for example, you can select 6, 8, or 11 voices, but not 7, 9, nor 10.

The **CV1** input can be assigned to voltage control number of **Voices**. See Chapter 9 for details.



## BLUR

The **Blur** parameter is a spectral lag processor that controls how quickly the spectrum can change with each new slice. At its

minimum, spectral changes happen virtually instantly. As the Blur control is rotated clockwise from minimum, spectral changes happen slower and slower until, at maximum, the spectrum freezes (equivalent to holding down the **Freeze** button).



The **Blur CV** input is a control voltage input that is summed with the value of the **Blur** control to define the effective blur value.

**NOTE:** The **Blur CV** input provides a way to freeze the spectrum under CV control. However, keep in mind that the **Blur** parameter must be at its maximum to freeze the spectrum. If the Blur control is set at its minimum, it will take a CV voltage of at least 10V to bring Blur to maximum and freeze the spectrum.



## FEEDBACK

The **Feedback** control lets you route the resynthesized audio back into the entire processing chain for subtle or dramatic feedback effects. At its max, the output becomes self-sustaining, even if you remove the input.

The **CV1** input can be assigned to voltage control the **Feedback** value. See Chapter 9 for details.



# 8. The Oscillator Bank

The **Oscillator Bank** consists of 33 digital oscillators that are used to resynthesize the analyzed spectra.

## WAVEFORM



The **Waveform** control selects the waveform that will be used by the oscillators. In addition to the usual sine, triangle, sawtooth and pulse waveforms, two special

crossfading sine and sawtooth waveforms are included.

When using the normal waveforms, at the beginning of each new slice, each oscillator immediately moves to the frequency assigned to it by the spectral analyzer (unless **Glide** is enabled, in which case it glides to the new frequency).

When using either of the crossfading waveforms, Panharmonium executes a crossfade between the outgoing oscillator pitch (from the previous slice) and the pitch of the new slice. The crossfade time is the duration of the new slice.

**A TIP:** *The easiest way to understand this is to hear it:*

*Pick some input audio with a changing spectrum (a full mix would be good).*

*Set **Slice** to minimum and **Multiplier** to 32.*

*Select the regular Sine waveform and listen to the result.*

*Select the crossfading Sine waveform and listen to the result.*

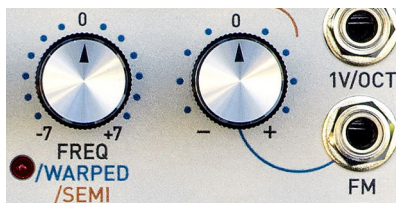
*Slowly turn up the **Slice** time and listen to the result.*

**A NOTE:** *Keep in mind that while crossfade waves and oscillator glide both affect the transition between slices, they are two entirely different effects. With glide, the pitch of each oscillator moves smoothly for one frequency to the next. With crossfade waves, the incoming and outgoing pitches remain constant while their amplitudes are inversely modified. An exception is if Glide is applied to crossfading waveforms, in which case the outgoing pitch remains constant, while the incoming pitch glides toward its target pitch as it fades in towards its target amplitude.*

**ANOTHER NOTE:** *Whether to use a regular or crossfading waveform is entirely a matter of your musical intent. The crossfade waves are great for smooth drones, ambient textures, etc. But when resynthesizing intelligible human speech, the regular waveforms are typically preferable.*

The **CV2** input can be assigned to voltage control the **Waveform** selection. See Chapter 9 for details.

## FREQUENCY



The frequency of Panharmonium's output is controlled by the **Frequency** knob, the **1V/OCT** input and the **FM** input and its associated attenuverter.

The **Frequency** control lets you smoothly adjust Panharmonium's frequency over a range of +/-7 semitones. Its setting is summed with the **1V/OCT** input and the **FM** input to define the final frequency.

Pressing and holding the **Tap/Opt** button while turning the **Frequency** knob will allow you to adjust the frequency in discrete semitones. Releasing the **Tap/Opt** button will return to continuous adjustment.

The **1V/OCT** CV Input is a calibrated full level control voltage input that is summed with the values of the **Frequency** control and the **FM** input.

The **FM** Input is a control voltage input that is modified by its associated attenuverter and then summed with the value of the **Frequency** control and the **1V/OCT** input.

## SPECTRAL WARPING

Pressing and holding the **Output Mode/Option** button while turning the **Frequency** knob will enable **Spectral Warping**.

With conventional frequency adjustment, the harmonic relationships between a sound's spectral elements are preserved. So, while the pitch changes, each individual harmonic element maintains its relative relationship to the rest of the harmonic elements. As a result, the timbre of the sound remains generally constant as the overall pitch changes.

With **Spectral Warping**, each harmonic element is shifted individually, producing a variety of clangorous, swarming textures.

When the **Output Mode/Option** button is held and the **Frequency** knob is at 12 o'clock, there is no warping. As the knob is turned clockwise, the spectral elements are spread apart, with the low elements being shifted lower and the upper elements being shifted higher.

As the knob is turned counterclockwise, the spectral elements are shifted closer together, until, at the minimum setting, all of the oscillators are forced to the same pitch.

The **Warped LED** will light to indicate that a warp is active. If you release the **Output Mode/Option** button, you will return to

adjusting the conventional frequency, but any selected warp will remain active (and the LED will remain on to indicate this).

To cancel any selected warp, hold the **Output Mode/Option** button and turn the **Frequency** knob to its 12 o'clock position. The **Warped LED** will go out to indicate that the warp is canceled.

## OCTAVE



The **Octave** control transposes Panharmonium's output in octaves from -2 to +3 octaves.

The **CV2** input can be assigned to voltage control the Octave value. See Chapter 9 for details.

## GLIDE



The **Glide** control sets the oscillators' rate of polyphonic glide. (I.e., each oscillator has its own independent glide circuit.)

The **CV2** input can be assigned to voltage control the **Glide** rate. See Chapter 9 for details.

## MIX



The **Mix** control sets the mix balance between the input audio and Panharmonium's resynthesis. As you would expect, at the Dry end of the scale, you will hear only the input audio. At the Wet end, you will hear only the resynthesis.

What actually comes out of the **Left** and **Right Outputs** depends on the setting of the **Output Mode** control described below.



The **Mix CV** input is a control voltage input that is summed with the value of the **Mix** control to define the effective mix.

## OUTPUT MODE



The **Output Mode/Option** button lets you choose between the two available output routings:

**L-FX-R** The left and right input channels are passed through to the left and right outputs. The mono resynthesis output appears at both the left and right outputs (if you are monitoring in stereo, it will appear in the center of the stereo field).

**LR-FX** The left and right input channels are mixed to mono and routed to the left output. The mono resynthesis output appears at the right output.

The associated LEDs light to indicate your choice.

### Stereo Patching

For stereo operation, patch stereo in, and stereo out. The **Mix** control always fades between dry and wet, and affects amplitudes as follows:

In **L-FX-R Mode**, the **Mix** control fades between the input audio passed in true stereo and Panharmonium's processed output panned center, appearing at both output jacks.


In **LR-FX Mode**, the **Mix** control fades between the summed left and right input signals appearing at the left output, and Panharmonium's processed signal appearing at the right output.

### Mono Patching

When processing a mono signal, the suggested patch is to connect your signal to the left input (which is normalised to the right input) and then to monitor the right output. The **Mix** control will then affect the amplitudes at the right output as follows:

In **L-FX-R Mode**, the **Mix** control fades between the input audio and Panharmonium's output.

In **LR-FX Mode**, only Panharmonium's processed output appears at the right output, so the **Mix** control fades between silence and full level — that is, **Mix** becomes a volume control. In this case, the **Mix CV** input can be used like a VCA gain input.

 **NOTE:** *The **Output Mode/Option** selection is remembered at power down and restored the next time you turn your system on. If you turn on your system and aren't hearing what you expect (or not hearing anything), double check the position of the **Mix** control and the selected **Output Mode**.*

# 9. Assigning CV1 and CV2

Panharmonium provides two assignable CV inputs, **CV1** and **CV2**, that can each be assigned to control up to three different parameters as follows:

**CV1:** Multiplier, Voices, and Feedback

**CV2:** Waveform, Octave, and Glide



To assign **CV1** to a target parameter, hold the **Tap/Opt** button and turn one of the **Multiplier**, **Voices**, or **Feedback** knobs. The **CV1** input will be assigned to the selected parameter and any of the other two that were previously selected will be deselected.

When assigning a target as described above or when pressing and holding **Tap/Opt** for at least a second, the top three **Spectra** LEDs will display **CV1** assignments as labeled. If no parameters are currently assigned to **CV1**, the three LEDs will chase to indicate that.

As long as you hold **Tap/Opt** the LEDs will display which (if any) of the parameters are currently assigned to **CV1**. You can toggle their state by pressing their associated buttons. In this way a single CV patched into **CV1** can control up to all three parameters.



Assigning **CV2** to targets is identical to the process described above, except you press the **Output Mode/Option** button to assign **CV2** to **Waveform**, **Octave**, and/or **Glide**. The **Presets** LEDs and buttons will display and set **CV2** assignments.


# 10. Managing Spectra and Presets

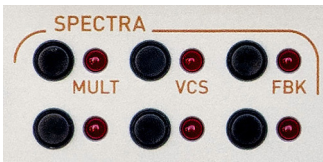
Panharmonium allows you to store 12 **Spectra** and 12 **Presets** in memory for easy recall.



A **Preset** is a snapshot of all of the module settings, along with

the value of any CVs present at the moment the preset is saved. This includes the number of a selected **Spectrum**, if one is selected at the moment the **Preset** is saved. Keep this in mind to help avoid overwriting any spectra used by presets (unless that's what you want).


 **NOTE:** When recalling a preset that was saved with CVs present, the preset will include the effects of those CV values, even if the CVs are no longer patched.



A **Spectrum** is a static snapshot of the harmonic content of the input audio (along

with the current settings of the **Center Frequency** and **Bandwidth** controls) at the moment it is saved. Recalling a saved spectrum replaces any live input and can have its pitch controlled by the **Frequency** control and any CVs at the **1V/OCT** and **FM** inputs.

**Presets** and **Spectra** may be backed up to and restored from WAV files (individually or en masse) as described in Chapter 12.

 **NOTE:** Panharmonium comes from the factory preprogrammed with 12 Presets and 12 Spectra as described in Chapter 13. Our assumption is that once you become familiar with Panharmonium, you'll save your own

creations over them. However, if you think you might want to use some of them in the future, you can simply save some or all of them to WAV archives and reload them as needed. They will also be available for download from our web site.


## LOADING PRESETS AND SPECTRA


To load Preset or Spectrum 1–6, click the appropriate button (1–3 is on the top row of each section, 4–6 on the bottom). The associated LED will light.

Click the button again to deselect the Preset or Spectrum. The LED will extinguish.

To select Preset or Spectrum 7–12, double-click the desired button (7–9 is on the top row, 10–12 is on the bottom). The associated LED will flash.


Click the button again to deselect the Preset or Spectrum. The LED will extinguish. (It's not necessary to double-click it to deselect, but that will work too.)


 **IMPORTANT NOTE:** When you recall a preset, it's likely that the values of the various parameters will no longer match the physical positions of their corresponding controls. However, adjusting any of the controls (either physically or via a CV) will cause the associated parameter to immediately change to the parameter's new value.

 **ANOTHER NOTE:** When you deselect a preset, Panharmonium reverts to the parameter values of the physical controls, along with the most recent CV assignments for **CV1** and **CV2** and any selected alternate modes (**Drums Mode**, **Spectral Warping**, **Freeze Tap Mode** etc.).

## SAVING PRESETS AND SPECTRA

To save the current Spectrum or Preset to a memory location, click and hold (for Spectrum or Preset 1–6) or double-click and hold (for Spectrum or Preset 7–12) the desired button for three seconds until the associated LED flashes to indicate that it's been saved. ("Double-click and hold" means one short click followed immediately by a second, long held press. Continue holding down the second click until the LED flashes.)

 **NOTE:** *The **Freeze** button can be extremely useful when saving Spectra. If your input audio is not a static tone, press and hold the **Freeze** button repeatedly until you get an interesting spectrum you'd like to save. Then continue holding it while executing the save function.*

 **ANOTHER NOTE:** *To copy a Preset or Spectrum from one button location to another, simply load the source Preset or Spectrum and then immediately save it as described above to the desired new location.*

## INTERACTIONS OF PRESETS AND SPECTRA

To ensure that a recalled spectrum sounds like what you've saved, in addition to the harmonic content itself, the saved spectrum also includes the Center Frequency and Bandwidth values at the moment it is saved (along with the result of any Center Frequency and Bandwidth CVs).

However, Presets also store Center Frequency and Bandwidth values. Consequently, there are occasional circumstances where Panharmonium will need to choose between a Spectrum's Center Frequency and Bandwidth values, a Preset's Center Frequency and Bandwidth values, and the Panharmonium panel's Center Frequency and Bandwidth values.

In these cases, the overriding rule is "**Last one wins.**" Here are the detailed rules:

When selecting a Spectrum, the spectrum's Center Frequency and Bandwidth are loaded into the analyzer and become current and active.

When selecting a Preset that includes a Spectrum, the preset's Center Frequency and Bandwidth are used, and become current.

When re-selecting a Spectrum, the spectrum's Center Frequency and Bandwidth again become active.

At any time, turning the Center Frequency and Bandwidth knobs will cause the knob's setting to become current.


So again, "**Last one wins.**" These small interactions between Presets and Spectra allow for powerful variations without extra controls, but can be somewhat confusing if not understood. Now you know.

Here are some practical scenarios that may help make this clearer:

- > Start with no Spectrum or Preset selected. Center Frequency and Bandwidth controls are live.
- > Select Spectrum 1. You will hear that spectrum with its stored Center Frequency and Bandwidth.
- > Select Preset 1 that was saved using Spectrum 1, but a different Center Frequency and Bandwidth. You still hear Spectrum 1, but now with the preset's Center Frequency and Bandwidth rather than with the saved spectrum's.
- > Deselect Spectrum 1. You will hear either silence (if no live input is patched), or live input.
- > Now re-select Spectrum 1. You will hear the same preset & spectrum, but now with the spectrum's stored Center Frequency and Bandwidth, not the preset's.

> Now deselect Preset 1. Panharmonium remembers that Spectrum 1 was playing when the preset was selected, so keeps Spectrum 1 on, but since deselecting a preset always results in the live panel becoming active, you hear Spectrum 1, but with the live panel's Center Frequency and Bandwidth.

While this may, at first glance, seem complicated, if you think about it, it's actually totally consistent with the "**Last one wins**" rule. It's also moderately likely that you may never even encounter this situation, but if you do, you'll at least know what's going on.

 **A FINAL NOTE:** *If a preset is saved **without** a spectrum selected, when that preset is recalled the current spectrum selection (either on or off) will not change. This allows you to choose a spectrum first, and then recall a preset and overlay it on top while the spectrum continues playing uninterrupted (provided, of course, that preset was saved without a spectrum selected). This "non-interaction" between presets and spectra can also provide powerful variations when understood and used to your advantage.*



# 11. Updating Software

Panharmonium provides the ability to update its operating software via a WAV file.

## Here's how:

1. Turn on your system while holding **Spectra 5 & 6**. The **Multiplier 2, 8, & 32** LEDs will light.
2. Press **Tap/Opt**. The **Multiplier 2, 8, & 32** LEDs will go out, and **Spectra 1** will light to indicate that Panharmonium is waiting for audio.
3. Play the software WAV file into the **1V/OCT** input. We've found that a regular Eurorack patch cord works fine. (See the hints below for successful WAV playback.) **Spectra 2** will light to indicate that audio has been detected. **Spectra 3** will light to indicate that it has recognized the audio as software data. As the file header loads, the **Multiplier LEDs** will act as a VU meter for the incoming audio.
4. Once past the header, the **Multiplier LEDs** will act as a progress indicator. The six LEDs will light in sequence as the data is loaded.
5. At the end of the transfer, **Spectra 4** will light briefly to indicate that all is well. Your module will then reboot automatically.

If instead, all of the **Multiplier** and **Preset** LEDs light, the update was not successful.

This is very rare and almost always because of a playback level that was either too low (most often) or too hot. In that case, click the **Tap/Opt** button, adjust the playback level, and try again.

If it still doesn't work, get in touch via our web site (<http://www.rossum-electro.com/support/support-request-form/>) and we'll help you get it handled.

## Hints for Playing Back WAV Files

The basic requirements for successful WAV file playback for software updates and data transfer is that the file should be played back at the highest possible level without distortion. As long as it doesn't distort, the hotter the better.

We've had good luck playing WAV files directly from a computer (but see the warnings below) as well as smartphones and tablets. In theory, any device that will play a WAV file without distorting the data should work.

However, here are some caveats:

- > If you are streaming the file directly from the web, be sure that your data rate is sufficient to keep up. If necessary, wait until the file has been completely buffered before starting playback.
- > If you are playing the file from a computer or phone, quit Facebook, your email client, and any other software that produces audio. Any other audio injected into the stream will cause the transfer to fail.
- > If you're using a smartphone, temporarily placing it in Airplane Mode will prevent any incoming call or message notifications from interfering with playback.
- > We have found that Safari on the Mac plays the file in a way that often keeps it from being successfully recognized and decoded. If you are using Safari, we recommend downloading the WAV file to your computer and playing the file from the local copy using Quicktime Player.
- > In fact, if you are having **any** problem streaming the file, downloading the file locally and playing it from there is a good alternative.

> If you do get an unsuccessful transfer (e.g., the level was too low, your computer generated extraneous audio, etc.), you can just correct the problem and try again. However, we've found that rather than just playing the file again from the beginning, it's usually advisable to close the file, reopen it, and then start playback.

# 12. Utilities

Panharmonium offers a variety of utility functions, including the ability to archive and restore saved Spectra and Presets as WAV files.

To access the utility functions, press and hold **Tap/Opt + Freeze + Output Mode/Option** and (while continuing to hold them) one of the **Preset** or **Spectra** buttons.

Here are the details:

## Utilities Accessed via the Preset Buttons

### Button 1: Display software version

Displays the currently installed software version using the **Spectra** and **Presets** LEDs. The **Spectra LED** number is the number before the decimal point and the **Presets LED** number is the number after the decimal point. So, if **Spectra LED #2** is lit and **Presets LED #4** is lit, the installed software would be version 2.4.

**Button 2:** No function.

### Button 3: Compact Flash memory


Causes the internal flash memory to be cleaned up. This happens automatically during normal use, so you typically won't have to worry about it.

### Button 4: Back up all Spectra and Presets to a WAV file

This function allows you to back up all of your stored Spectra and Presets to a WAV file, which can later be restored using Function 5 below.

#### Here's how:

1. Patch the Panharmonium's **Left Output** to the input of your WAV recorder. We've found that a regular Eurorack patch cord works fine.


 **IMPORTANT:** Your recording device must record uncompressed WAV data. Do **not** use an MP3 recorder.


2. Press and hold **Tap/Opt + Freeze + Output Mode/Option** and then the **Preset 4** button. The **Preset 4 LED** will flash. The **Output Mode LR—FX LED** will also flash to indicate that you can press the **Output Mode/Option** button to abort the process if you desire.
3. Press the **Preset 4** button again to proceed. After a second or two, the **Preset 4 LED** will flash rapidly and a tone will appear at the **Left Output** that you can use to adjust the recording level on your WAV recorder.
4. Start recording on your WAV recorder.
5. Press the **Preset 4** button to transmit the data. The LED will light steadily. While loading, the **Multiplier** LEDs will act as a progress indicator. The six LEDs will light in sequence as the data is loaded. (The transfer may take a minute or so, so be patient for that second LED to light.)
6. When the transfer is complete, the LED will flash. Stop your WAV recorder and press the **Preset 4** button again. The LED will go off and you will return to normal operation.

### Button 5: Restore all Spectra and Presets from a WAV file

This function allows you to restore all of your stored Spectra and Presets from a WAV file. This file might be an archive you previously recorded, a file from some other user sharing his or her presets and spectra, or a download from our web site containing the factory example Presets and Spectra (which you may have overwritten but want back).

#### Here's how:


 **NOTE:** Before starting, be sure to check out the "Hints for Playing Back WAV Files" in the previous chapter.

 **ANOTHER NOTE:** *This function will overwrite (i.e., delete) all of the Spectra and Presets in your module. So be careful. You may want to archive your Panharmonium's current contents using Function 4 above before doing this, just in case you change your mind about whether or not you might want them later.*

1. Patch the output of your WAV player to the **CV1** Input. Again, a regular Eurorack patch cord works fine.
2. Press and hold **Tap/Opt + Freeze + Output Mode/Option** and then the **Presets 5** button. The **Presets 5 LED** will flash. The **Output Mode LR-FX LED** will also flash to indicate that you can press the **Output Mode/Option** button to abort the process if you desire.
3. Press the **Presets 5** button again to proceed. After a second or two, the **Presets 5 LED** will double-flash to indicate Panharmonium is waiting for audio.
4. Play the backup WAV file into the **CV1** input. The **Presets 5 LED** will light steadily to indicate audio has been detected. As the file header loads, the **Multiplier LEDs** will act as a VU meter for the incoming audio.
5. Once past the header, the **Multiplier LEDs** will act as a progress indicator. The six LEDs will light in sequence as the data is loaded. (Again, the transfer may take a minute or so, so be patient for that second LED to light.)

If all went well, the **Presets 5 LED** will flash. Click the button to return to normal operation.

If the transfer wasn't successful, the **Presets 5 LED** will flash rapidly and the **Presets** and **Output Mode LEDs** will indicate the error. Press **Presets 5**, adjust your WAV player's level if necessary, and try again. If you continue to have a problem, get in touch via our web site (<http://www.rossum-electro.com/support/support-request-form/>) and we'll get it handled.

 **IMPORTANT NOTE:** *If the transfer wasn't successful (e.g., the received data was corrupt, damaged, or not understood), Panharmonium's current **Spectra** and **Presets** will remain intact, and will not be erased or overwritten.*

### Button 6: Save and restore individual Spectra and Presets to and from WAV files

This function allows you to save and restore individual Spectra and Presets to and from WAV files. It's ideal for exchanging individual content with others or archiving only selected Spectra or Presets.

The actual process of saving and restoring is very similar to the mass archiving and restoring described above.

#### Here's how:


1. Press and hold **Tap/Opt + Freeze + Output Mode/Option** and then the **Presets 6** button. All of the **Spectrum** and **Presets** LEDs will "chase" to remind you which items you can save and/or restore. Press the **Output Mode/Option** button to abort the process if you desire.

#### To archive a Preset or Spectrum:

2. Patch the Panharmonium's **Left Output** to the input of your WAV recorder.
3. Start recording on your WAV recorder.
4. Click (for Spectra or Presets 1–6) or double-click (for Spectra or Presets 7–12) the appropriate button to immediately send the data for that Spectrum or Preset to your WAV recorder.
5. Once the data has been sent, Panharmonium returns to "chase" mode to give you the opportunity to save additional Spectra or Presets.
6. When finished, press the **Output Mode/Option** button to return to normal operation.

## To restore a Preset or Spectrum:

2. Patch the output of your WAV player to the **CV1** Input.
3. Click and hold for three seconds (for Spectra or Presets 1–6) or double-click and hold for three seconds (for Spectra or Presets 7–12) the appropriate button to choose the destination for the restored Spectra or Presets. The button's LED will double-flash to indicate it's waiting for audio.

 **IMPORTANT NOTE:** *When individual Spectra or Presets are archived, their button location is not saved with them. This allows you to load a saved Spectrum or Preset into any button location you prefer.*

4. Play the audio.
5. The LED lights steadily to indicate audio detected. As the file header loads, the **Multiplier LEDs** will act as a VU meter for the incoming audio.
6. Once past the header, the **Multiplier LEDs** will act as a progress indicator. The six LEDs will light in sequence as the data is loaded.
7. If the transfer is successful, the selected LED will go off and the Panharmonium will return to "chase" mode ready for additional transfer actions. When finished, press the **Output Mode/Option** button to rerun to normal operation.
8. If the transfer wasn't successful, the selected LED will flash rapidly and the **Preset** and **Output Mode LEDs** will indicate the error. Press selected button, adjust your WAV player's level if necessary, and try again. If you continue to have a problem, get in touch via our web site (<http://www.rossum-electro.com/support/support-request-form/>) and we'll get it handled.

## Utilities Accessed via the Spectra Buttons

These functions are intended for calibration and test during the manufacturing process, and as such, it's highly unlikely you'll ever need to interact with them. But here they are for reference.

**Button 1: Calibrate 0V**

**Button 2: Calibrate 4V  
(a.k.a. Calibrate 1V/Oct)\***

**Button 3: Calibrate the DAC**

**Button 4: Manufacturing Test (hold for 1 second to enter)**

**Button 5: No Function**

**Button 6: No Function**

*\* If you want to calibrate to the Buchla 1.2V/Oct standard, you can do that by using 4.8V instead of 4V here.*

Unless you like living dangerously (or we have instructed you to do something here as part of diagnosing a problem), you would be best advised not to fool around with these. Seriously.

# 13. Factory Presets and Spectra

To help you get started, we and some of our friends and beta testers have created some presets and spectra for you to play around with.

## PRESETS

While the presets are briefly described below, keep in mind that with Panharmonium, the sound of presets is as much a result of the input audio as it is the setting of parameters. So we can't really predict exactly what they are going to sound like for you. In any case, check them out, play around with the various parameters, and see (and hear) what happens.

### Preset 1: Default

Basic resynthesis settings. A neutral starting point for new presets. If you get ever lost, come back here. In fact, it's worth becoming familiar with these settings. Check the end of this chapter for the specific parameter values.

### Preset 2: Crazy Piccolo Guy

Use a complete mix as an input. Generates a highpitched synth solo.

### Preset 3: Psycho Feedback Organ

Generates stacked organ tones.

### Preset 4: Tinkle Bells

Adds very high harmonic chatter to the input. Again, good with full mixes.

### Preset 5: Glidey Sine Quartet

Four sine waves with a rhythmic element defined by a slow slice time. Use tap tempo to sync it to a rhythm track or other existing music.

### Preset 6: Cylons

Locked frequency bands make robots. To use this preset, it helps to first freeze the input on a spectrum you like, or select a stored spectrum, then select the Cylons preset, then unfreeze, and then use live input. You'll see!

### Preset 7: Lunar Reverb

A simple Panharmonium ambience patch. Good with pretty much everything.

### Preset 8: String Verb

A long release medium density string patch, at unity pitch. Use this to add string-like sounds to music that doesn't have any. Or anything else.

### Preset 9: Crazy Swarm

A mad sound effect using full feedback. Tomorrow may know...

### Preset 10: Brass Attack

Adds some punchy horn-like sounds, transposed up an octave, mixed in with the input audio. Try a mix.

### Preset 11: Warp 1

A basic frequency shifter patch with a slow rhythmic slice time. Best with input audio with lots of harmonic content.

### Preset 12: Dearth Of Fifths

Max feedback recirculating through the circle of fifths. Use with anything. Or with nothing, all by itself.

## SPECTRA

The spectra are static harmonic structures captured from various audio sources. They are intended to be used as complex oscillators. All of Panharmonium's various parameters can be used to modify and bring dynamic variation to them. In particular, **Waveform**, **Center Frequency** and **Bandwidth** can have dramatic effects on their timbres.

### Spectrum 1: A Saw

A sampled sawtooth wave on "A" for use as a simple oscillator. Try it with the sawtooth waveform for fatness.

### Spectrum 2: A Chord

A sampled "A Major" chord. Use Waveform, Center Frequency and Bandwidth to achieve variations.

### Spectrum 3: E Saw

A sampled sawtooth waves on "E" for use as a simple oscillator. Again, try it with the sawtooth waveform for fatness.

### Spectrum 4: Am7

An "A minor 7th" chord captured from a music track.

### Spectrum 5: G

A "G Major" chord captured from a music track.

### Spectrum 6: Dsus

A "Dsus" chord captured from a music track.

### Spectrum 7: Peff Wave 1

The first of three complex waves captured from a Buchla synthesizer by our good friend Kurt Kurasaki. Tweak the **Center Frequency** and **Bandwidth** controls for variations.

### Spectrum 8: Peff Wave 2

Another from Kurt.

### Spectrum 9: Peff Wave 3

And another .

### Spectrum 10: Reek Wave 1

Dense wave from our pal Reek Havok. Again, tweak the **Center Frequency** and **Bandwidth** for variations.

### Spectrum 11: Reek Wave 2

Another from Reek.

### Spectrum 12: Most Famous Chord

Presented without comment...

## DEFAULT "NEUTRAL" SETTINGS

As mentioned above, **Preset 1** provides a neutral starting point for new presets. You may find these settings useful in your own programming:

### SPECTRAL ANALYZER

Slice Time: 50ms

Multiplier: 1X

Center Frequency: 480Hz (12 o'clock)

Bandwidth: MAX (12 o'clock)

### SPECTRAL MODIFIERS

Voices: 33

Blur: 0

Feedback: 0

### OSCILLATOR BANK

Waveform: Sine Xfade

Frequency: 0 (12 o'clock)

Octave: 0

Glide: 0

Mix: 10 (Full Wet)



# 14. From Dave's Lab

## Circuit Protection

Eurorack suffers from the problem of power connector reversal. When 10 pin connectors are used, mis-insertion results in a swap of +12V and -12 V, and protection is easily accomplished using various techniques such as series diodes.

But more systems are providing the +5V supply and thus use the full 16 pin connector. When this is reversed, a diode-protected module is still safe, but the six connected ground pins in the module will short together the system's +5V and +12V supplies, potentially damaging the power supply and any modules that use +5V.

To prevent this, Rossum Electro-Music modules deviate from the standard Eurorack power connector by leaving power connector pins 9 and 10 open, rather than connecting them to ground. When plugged in backwards, this leaves the system +12V supply disconnected. Since ground is still supplied by four pins as well the chassis and any patch cords connected to the module, the dropping of these two pins has no measurable effect on circuit performance, but it means that if a Rossum Electro module is accidentally plugged in backwards, no stress is placed on the +5V supply or modules that use it.

# 15. Acknowledgements

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Kirk Southwell  
Ben "DivKid" Wilson

And, it goes without saying (but, as we always do, we'll say it anyway), our families for understanding all the late nights and weekends spent not having fun (or doing chores) with them.

The following software may be included in this product:

KISS FFT

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