



LINNAEUS

Thru-Zero State Variable
Filter

Operation Manual

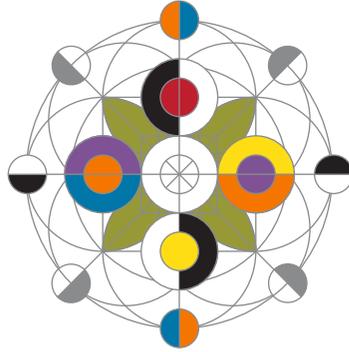
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1. Introduction

Thanks for purchasing (or otherwise acquiring) the Rossum Electro-Music Linnaeus Thru-Zero State Variable Filter. This manual will give you the information you need to get the most out of Linnaeus. 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 Linnaeus, 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 Linnaeus is a circuit board with exposed parts and connections. When handling Linnaeus, 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 10.)

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.

Linnaeus requires, at most, 155mA of +12V and 36mA 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 Linnaeus in your case.

3. Overview

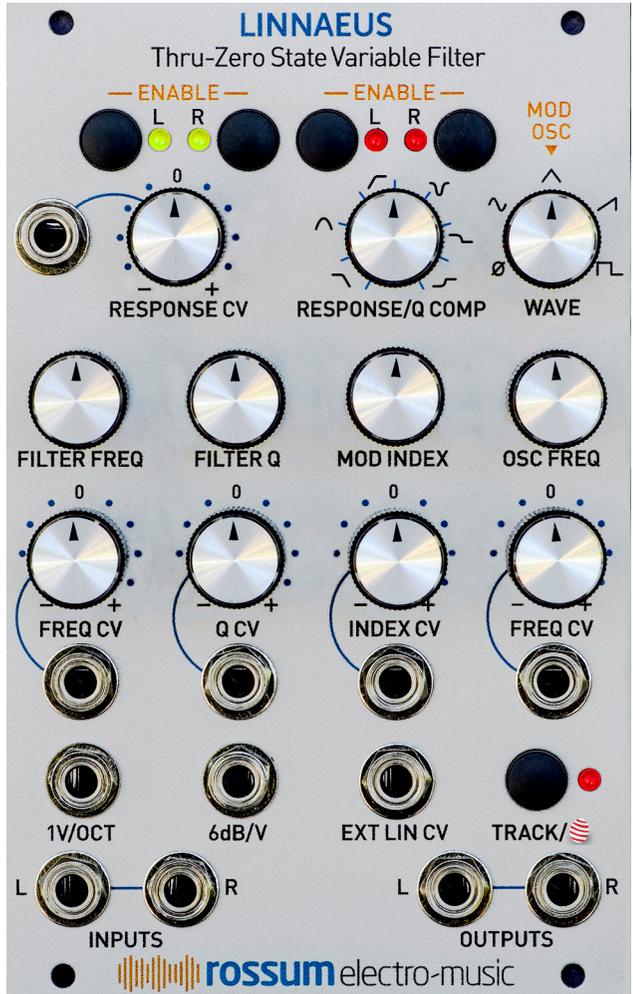
What is Linnaeus?

Following in the tradition of Evolution and Morpheus, Linnaeus represents yet another Dave Rossum innovation in filter technology.

Linnaeus is a stereo state variable filter that provides the unique ability to linearly modulate its resonant frequency through zero into negative frequency, while maintaining stability. With extensive voltage control of nearly every parameter, Linnaeus lets you manipulate the filter's natural response curve in new ways, to create both subtle and dramatic timbral effects. And with a "one-knob-per-parameter" interface, Linnaeus inspires sonic creativity that invites (and rewards) real-time interaction.

Linnaeus's cutoff/resonant frequency is exponentially voltage controllable from subaudio to ultrasonic frequencies, while its resonant gain (Q) is exponentially voltage controllable from 0dB to greater than 60dB.

Linnaeus's channel output response characteristics are independently and continuously variable from Lowpass, through Bandpass, Highpass and Notch, to Low and High Shelving. Voltage control of the response characteristics can be independently selected for each of the two channels.



The linear thru-zero modulation is provided by an integrated modulation oscillator and/or an external linear FM modulation input.

The voltage-controllable modulation oscillator can track the filter's exponential frequency or operate independently. The modulation oscillator's output waveform is continuously variable from Off through Sine, Triangle, and Sawtooth, to Square. The modulation oscillator output is summed with the external linear FM input and input to the modulation index VCA, which controls the linear thru-zero modulation index from zero to 8X. The modulation index is, of course, also voltage controllable.

Linnaeus features include:

- > Ultra-wide frequency range, exponentially voltage-controllable from sub-audio to ultrasonic via precise 1V/OCT and attenuverted CV inputs.
- > Thru-zero linear frequency modulation via an internal modulation oscillator and/or an external linear FM input.
- > Variable linear modulation index, voltage-controllable via an attenuverted CV input.
- > Q (Resonance) exponentially voltage-controllable from 0dB to greater than 60dB via 6dB/V and attenuverted CV inputs.
- > Continuously variable response characteristics independently selectable for each of the two channels via individual Response Enable controls. Characteristics include Lowpass (12dB/oct and 6dB/oct), Bandpass, Highpass (12dB/oct and 6dB/oct), Notch, and Low and High Shelving.
- > Voltage control of response characteristics via an attenuverted CV input. Individual Response CV Enable controls let you independently enable or disable CV control of response for each channel.

- > An integrated modulation oscillator with continuously variable waveform from Off through Sine, Triangle, Sawtooth and Square. Its frequency can be exponentially voltage controlled via an attenuverted CV input.
- > A Track control that lets the modulation oscillator precisely track the filter's exponential frequency.
- > Stereo inputs and outputs. Linnaeus can process a stereo signal or two independent mono signals. While the two channels share the filter's cutoff/resonant frequency, the filter response characteristics can be independently controlled for each channel.
- > Linnaeus, like all Rossum Electro-Music modules, features solid construction, with thick aluminum panels, solid aluminum knobs, and quality components throughout.

What's with the egg?

The Overview above describes Linnaeus as originally conceived and designed by Dave. However, late in the beta testing process, our good friend and tester, Chris Meyer, raised the possibility of alternative behavior that would let Linnaeus function as a self-contained (i.e., no input required) stereo oscillator and/or percussion voice with some really powerful timbral capabilities.

While we were initially hesitant to try to shoehorn the new functions into the existing interface, once Dave had prototyped them, it was clear to us all that they were just too cool not to include. So we've provided them in the form of alternative firmware accessed by pressing and holding the  button.

See Chapter 8 for all the colorful details.

4. Basic Functionality

Before we jump into individual functions in detail, let's take a quick look at Linnaeus's controls.

NOTE: *The control functions described below reflect the main Linnaeus firmware. Check out Chapter 8 for the alternate control functions in Ping Mode.*



FILTER Q (RESONANCE)

Sets the filter's resonance from 0dB to over 60dB.

Q CONTROL INPUTS

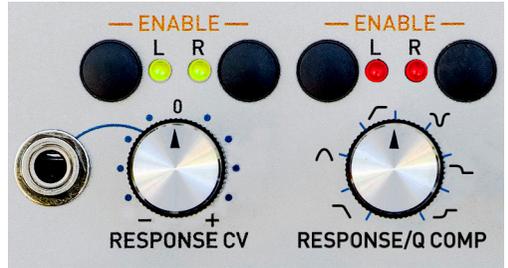
Calibrated 6dB per volt resonance CV input and attenuverted CV input.

FILTER FREQ

Controls the filter's initial cutoff frequency over a range exceeding 20Hz to 20kHz.

FREQUENCY CONTROL INPUTS

Calibrated 1 volt per octave and attenuverted exponential CV inputs.



FILTER RESPONSE/Q COMP

Selects the filter channels' initial response characteristics. The response is continuously variable between Lowpass (12dB/oct and 6dB/oct), Bandpass, Highpass (12dB/oct and 6dB/oct), Notch, and Low and High Shelving and is independently selectable for each of the two channels via the individual Response Enable controls.

When both the Response Enable controls are off, the control sets the amount of level compensation for the current Q.

RESPONSE CV

The attenuverted CV input can be individually enabled for each of the two channels. The Response CV Enable buttons also allow you to select the polarity of the control for each channel.



MOD INDEX (LINEAR MOD INDEX VCA)

Sets the degree to which the internal Modulation Oscillator plus the External Linear CV input affects the filter frequency. The modulation index can be set to values from 0 to 8x.

INDEX CV (MODULATION INDEX CONTROL INPUT)

An attenuverted CV input.

EXT LIN CV

Full-level input that is added to the output of the internal Modulation Oscillator to linearly control the filter's frequency.



MODULATION OSCILLATOR WAVE

Selects the output wave of the internal Modulation Oscillator. Continuously variable from Off through Sine, Triangle, Sawtooth and Square.

MOD OSC FREQ

Controls the Modulation Oscillator's frequency over a range of 20Hz to 20kHz.

FREQ CV (MOD OSC FREQUENCY CV INPUT)

An attenuverted exponential CV input. Maximum range is +/- 1 volt per octave.

TRACK

Press to engage (LED lit) Mod Oscillator Tracking. When engaged, the Mod Oscillator precisely tracks the filter's exponential frequency. Press and hold, or double click, to engage the alternate "Ping

Mode" functionality described in Chapter 8. The LED will flash. Double click toggles Ping Mode on and off.

INPUTS & OUTPUTS



Stereo, DC coupled inputs and outputs. 20V p/p max level. The left input is normalised to the right input.

 **NOTE:** *Linnaeus can process a stereo signal or two independent mono signals. While the two channels share the filter's cutoff/resonant frequency, the filter response characteristics can be independently controlled for each channel.*

5. Make Some Noise!

While we highly encourage you to read this complete manual (you don't want to inadvertently miss out on any capabilities), spending a few minutes here will give you a quick introduction to the function and effects of the basic controls.

Given Linnaeus's complement of knobs and mod inputs, experimentation is the order of the day. To get you started:

Basic Filter Settings

- > Patch some harmonically rich audio into the input(s). If you're using a mono signal, connecting it to the left input will cause it to be normalised to the right input as well — allowing you to experiment with selecting different response characteristics for the two channels.
- > Press the Response CV Enable buttons above the Response CV knob until both LEDs are green. This turns on positive polarity CV Response control for both channels.
- > Press the Response Enable buttons above the Response knob until both LEDs are red. This allows the Response knob to select the response characteristic of both channels.
- > Set the Mod Oscillator Wave parameter to Off.
- > Turn the Response knob fully counterclockwise to select 12dB/oct lowpass.
- > Adjust the Filter Frequency knob and listen to the result.
- > Adjust the Filter Q knob while adjusting the Frequency knob and listen to the result.
- > Use the Response knob to select different response characteristics and repeat the two previous steps.

- > With a stereo or normalised mono input, select a Response characteristic. Then press the Right Response Enable button to turn off its associated LED. Select a different Response characteristic. This new response will be applied to the left input while the right input will remain assigned to the initially selected response. Adjust Frequency and Q and listen to the effect.

Basic Modulation

- > Patch CVs into some or all of the Response CV, 1V/Oct, Freq CV, Q CV, and/or 6dB/V inputs. Adjust attenuverters. Listen to the results.
- > While modulating Response, press the channel Response CV Enable buttons to cycle between positive modulation (green LED), negative modulation (red LED), and no modulation (LED off). Listen to the effect of various combinations.

Thru-Zero Linear Frequency Modulation

There are innumerable possibilities for linear FM patches, but here's one that gives a good introduction to a basic approach.

- > Patch a low frequency (~1Hz) sawtooth into the input.
- > Turn up Q quite high so that you hear ping, ping, ping.
- > Select 12 dB lowpass response and set the Filter Freq to a mellow timbre.
- > Turn up the Mod Index and carefully tune the Mod Oscillators Freq for a pleasing sound (typically a fifth or octave above the filter's resonant frequency).
- > Adjust the Mod Index and listen to the range of timbral variation.

- > Turn on Mod Oscillator Track (if it isn't already on) and adjust filter frequency. The inherent timbre should remain consistent as the pitch of the ringing changes.
- > With the same settings, try different input audio and Q settings and note the results.

Thru-Zero Linear Frequency Modulation Modulation (brought to you by The Department of Redundancy Department)

- > Patch CVs into the Index CV and/or Mod Osc Freq CV inputs. Adjust attenuverters. Listen to the results.
- > Patch a CV (up through audio range) into the External Linear CV input. It will be added to the Mod Oscillator output (unless the Mod Oscillator is set to Off, in which case it will provide the sole modulation). Adjust the various parameters and listen to the results.

 **NOTE:** *The above suggestions apply to the normal firmware. For the alternate Ping Mode, see Chapter 8.*

6. Main Filter Settings

At its core, Linnaeus is a superb state variable filter. In this chapter, we'll look at the main filter and modulation settings. In the following chapter, we'll look at its unique thru-zero modulation functions.

INPUTS



Linnaeus's two independent inputs are DC coupled (so you can process CVs) and will accept a

maximum level of 20V p/p.

The left input is normalised to the right input. Plugging a single input into the left input is functionally equivalent to multhing the input and plugging it into both the left and right input.

 **NOTE:** *Linnaeus can process a stereo signal or two independent mono signals. While the two channels share the filter's cutoff/resonant frequency, the filter response characteristics can be independently controlled for each channel.*

FILTER FREQ



This control lets you set the filter's initial frequency over a range of 20Hz to 20kHz.

FREQ CV



The **Freq CV** input is an exponential control voltage input that is modified by its associated attenuverter and then summed with the value of the **Filter Freq** control and the **1V/OCT** input to determine the final frequency.

When the attenuverter knob is set to its "0" position, no control voltage is passed to Linnaeus. 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 **Freq CV** input is passed through and results in a nominal 1V/Oct response.

As the knob is turned counter-clockwise from 0, the signal at the **Freq 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 **Freq CV** input is passed through, also at a nominal 1V/Oct response.

1V/OCT CV



The **1V/OCT CV** Input is a calibrated full level exponential control voltage input that is summed with the values of the **Filter Freq** control and the **Freq CV** input to determine the final frequency.

FILTER Q (RESONANCE)



This control lets you set the filter's initial resonance from 0dB to over 60dB.

Q CV



The **Q CV** input is an exponential control voltage input that is modified by its associated attenuverter and then summed with the value of the **Filter Q** control and the **6dB/V** input to determine the final resonance.

The attenuverter functions as described above. Its extreme clockwise and counterclockwise settings provide a nominal response of $2x/V$. A change in CV of one volt will result in either doubling or halving the resonance.

6dB/V



The **6dB/V CV Input** is a calibrated full level exponential control voltage input that is summed with the values of the **Filter Q** control and the **Q CV** input to determine the final Q value. As a change

of 6dB results in doubling or halving the resonance, each volt at this input will double or halve it.

RESPONSE/Q COMP



When one or both of the **Response Enable** LEDs are on, this control lets you select the initial filter response characteristic for one or both of the two channels.

The response for each channel is

continuously variable between (in clockwise order from fully counterclockwise) 12dB/oct lowpass, 6dB/oct lowpass, bandpass, 12dB/oct highpass, 6dB/oct highpass, notch, low shelving, and high shelving.

The response is independently selectable for each of the two channels via the individual **Enable** controls described below.

NOTE: While the control has blue tick marks surrounding it (implying discreet settings), the response actually transitions smoothly and continuously from one response to another. The pure bandpass and notch responses are found at their specific tick marks, but the rest of the response indicators indicate a range of lowpass, highpass and shelving responses.

RESPONSE ENABLE

The **Response Enable** buttons and associated LEDs let you set which of the two channels (or both) will respond to changes of the **Response** control.

Repeatedly pressing a channel button will toggle between enabled (LED on) and disabled (LED off).

When a channel is enabled, adjusting the **Response** control will set the response of that channel.

When a channel is disabled, the channel maintains the most recently selected response and will ignore changes to the **Response** control.

In practice, this lets you set each channel to a different response. So, for example, if you want to set the left channel to lowpass and the right to notch:

- > Press the **Left Response Enable** button until the left channel is enabled (LED on). (At this point, it doesn't matter if the right is enabled or not).
- > Use the **Response** control to select the lowpass response of your choice.
- > Press the **Left Response Enable** button to disable the left channel (LED off). It will now maintain the selected lowpass response.
- > Press the **Right Response Enable** button until the right channel is enabled (LED on).
- > Use the **Response** control to select notch.

When both **Response Enable** controls are off, the control sets the amount of level compensation for the current Q, as described next.

RESPONSE CV



The **Response CV** input is a control voltage input that is modified by its associated attenuverter and then summed with the value of the **Response**

control to determine the final response.

RESPONSE CV ENABLE

The **Response CV Enable** buttons and associated LEDs let you select which of the two channels (or both) will respond to voltages at the Response CV input.

Repeatedly pressing a channel button will cycle between disabled (LED off), enabled with positive polarity (green LED), or enabled with negative polarity (red LED).

In practice, this lets you:

- > Modulate both channels in the same direction
- > Modulate both channels in opposite directions
- > Modulate one channel, but not the other
- > Modulate neither channel

 **A TIP:** With a stereo input, try setting both channels to the same response and setting the **Response CV Enables** to opposite polarities. Patch a slow sine or triangle into the **Response CV** input and listen to the resulting timbral effect as the two channels briefly share responses as the CV passes through 0 volts and then vary in opposite directions as the CV moves above and below 0. Try adjusting the filter frequency and initial response.

Q COMPENSATION



When both **Response Enable** controls are off, the **Response/Q Comp** control sets the amount of level compensation for the current Q.

Linnaeus is capable of providing an extremely high level of resonance. As previously mentioned, its maximum resonance is in excess of 60dB, compared to the maximum resonance of 24dB before self-oscillation of our Evolution ladder filter.

 **NOTE:** Unlike Evolution, Linnaeus (as is typical for state variable filters) will never enter self-oscillation.

As a result, setting the filter frequency to the fundamental or first few harmonics of an input signal and cranking up the Q will often result in overdrive distortion. Now, while Linnaeus offers really tasty soft clipping distortion, that may not always be what you want. For those cases, we have **Q Compensation**.

Q Compensation lets you set the amount of level attenuation applied to the input as a result of the current resonance. The higher the resonance, the more the level attenuation. The **Response/Q Comp** control lets you select the ratio between increases in Q and input attenuation.

As examples:

- > With the control fully counterclockwise, there will be no Q compensation. Increasing Q will have no effect on input level.
- > Setting the knob at about 11:00 o'clock results in what we have found to be a reasonable default value. Increasing Q results in a moderate amount of attenuation. This is the value that is set at the factory for new Linnaeuses.
- > Setting the knob fully clockwise results in maximum compensation and will tame most high Q settings.

 **NOTE:** *If, when you turn off both **Enable** controls, the **Response/Q Comp** knob is at a position that does not correspond to the current **Q Compensation** setting (as will often be the case if you've been using the control to select **Response**), the **Q Compensation** setting will not immediately jump to the setting associated with the knob position. However, once you turn the knob, the setting will then move to reflect the knob's position.*

 **ANOTHER NOTE:** *The same behavior described above also applies to the situation where the **Response** knob has been disabled for a channel and then later re-enabled. The **Response** setting will not jump to a new value until the knob is slightly moved.*

 **IMPORTANT NOTE: Q Compensation** *is not only for completely eliminating distortion. If some distortion is what you want, **Q Compensation** provides a method to dial in just how much of that distortion you'd like. As such, it can operate as a powerful creative control.*

7. Linear Frequency Modulation

As we said in the previous chapter, Linnaeus is, at its core, a superb state variable filter. But its thru-zero linear FM capability truly sets it apart in the world of modular (or, in fact, any) filters. It opens up exciting new timbral possibilities that are simply not attainable with exponential modulation.

It's beyond the scope of this manual to provide an in-depth discussion of exponential versus linear versus thru-zero linear FM, but for those interested, Chris Meyer (as part of his Learning Modular series) offers clear explanations, along with audio examples, here:

<https://learningmodular.com/understanding-the-differences-between-exponential-linear-and-through-zero-fm/>

Of course, Chris's explanation focuses on oscillators, since when he wrote it, there were no thru-zero linear FM filters, but it still does a great job of making the differences easily understandable.

NOTE: In addition to its **External Linear CV** input, Linnaeus also provides the ability to linearly modulate its frequency via its internal **Modulation Oscillator**. Using this oscillator, you have access to an extremely wide range of timbres without the need of patching an external CV. (Of course, adding in an external CV further expands the possibilities.)

MOD INDEX



The **Mod Index** is a linear control that sets the initial value of the internal **Linear Mod Index VCA** that defines the degree to which the sum of the output of the internal

Modulation Oscillator and the **External Linear CV** input affects the filter frequency.

The mod index range is from 0–8x.

INDEX CV



The **Index CV** input is a control voltage input that is modified by its associated attenuverter and then summed with the value of the **Mod Index** control to determine the final modulation index.

A TIP: Modulating the modulation index is a powerful tool for creating dynamic timbral variation. Experiment with both LFO range and audio rate modulation sources, as well as a variety of modulation waveforms.

EXTERNAL LINEAR CV INPUT



This is a full-level input that is added to the output of the internal Modulation Oscillator to linearly control the filter's frequency. It will accept a maximum level of 20V p/p.

MOD OSCILLATOR WAVE



This control selects the output wave of the internal **Mod Oscillator**. It is continuously variable from Off through Sine, Triangle, Sawtooth and Square. As you move the control from Off to Sine, the sine wave will smoothly fade in. As you continue turning the knob, the output will smoothly morph between the adjacent waves.

OSC FREQ



This control lets you set the **Modulation Oscillator's** initial frequency over a range of 20Hz to 20kHz.

A TIP: *If you don't press **Track** on Linnaeus, but have the **Mod Osc** patched through its frequency attenuverter to track the incoming signal, and now vary the filter frequency, you will also get interesting effects. Try it!*

FREQ CV



The **Freq CV** input is an exponential control voltage input that is modified by its associated attenuverter and then summed with the value of the **Osc Freq** control to determine the final **Mod Oscillator** frequency.

With the attenuverter in the full clockwise or counterclockwise positions, the modulation response is a nominal 1V/Oct.

TRACK



Press this button to engage **Mod Oscillator** tracking. When engaged, the associated LED will be lit and the **Mod Oscillator** will precisely track the filter's exponential frequency.

A TIP: *If whatever is supplying your input audio has a 1V/Oct frequency input, try using the same frequency control CV into both the input's and Linnaeus's 1V/Oct inputs. Enable **Track** and iteratively adjust Linnaeus's frequency and the Mod Oscillator's frequency for the timbre of your choice. You can now use the frequency control CV to drive the frequency of both the input and Linnaeus in parallel while maintaining your chosen timbre.*

NOTE: *Although we won't be discussing the alternate Ping Mode until the next chapter, it's probably worth noting here (in case you accidentally do it) that pressing and holding, or double clicking, the **Track** button will activate Ping Mode. The LED will flash to indicate this. Double click the button to toggle Ping Mode on and off.*

8. Ping Mode

As mentioned back in Chapter 3, late in the beta testing process, our good friend and tester, Chris Meyer, suggested some alternative behavior that would let Linnaeus function as a self-contained (i.e., no input required) stereo oscillator and/or percussion voice with some really powerful timbral capabilities.

Once we realized how cool that was, our main dilemma was how to integrate the new functions into an existing interface that had not been designed with them in mind. We eventually decided that providing them as a built-in “alternate firmware” was least disruptive to the core interface.



And thus was born the Track/  button!

 **NOTE:** *We realize that the interface described below is not as elegant as it would be in a module we designed specifically for this functionality, but we're pretty sure that you'll find the creative possibilities that it opens up are more than worth it.*

So what is Ping Mode?

Ping Mode is an optional functional mode for Linnaeus that allows it to be used as a sound source (oscillator) without the need for any signal at its audio inputs. It takes advantage of the fact that at high Q levels, “pinging” the filter with a sharply rising waveform will cause the filter to ring at its resonant frequency. The higher the Q, the longer the filter rings. If the filter is pinged at audio rate (or at least often enough that the sequential ringing overlaps), the filter will generate a continuous signal, essentially becoming an oscillator.

Of course, you could patch this manually using the main Linnaeus functionality and a number of additional modules, but by integrating a dedicated internal “ping” oscillator, and providing some very useful internal patching options, a variety of creative timbral capabilities are provided without the need for complex external patching.

When in Ping Mode, a dedicated internal sawtooth oscillator is applied to the Left and/or Right channel. Alternatively, you can set one or both channels to “manual” ping mode. In manual ping mode, pressing the **Left** or **Right Response CV Enable** buttons will trigger a pulse to the corresponding input, as will triggers or gates (or, in fact, any audio) patched to the corresponding audio input(s).

Ping Mode is typically used by choosing a setup (see below), then tuning the **Mod Oscillator** and **Wave** to create an interesting timbre, which can then be modulated by the Modulation Index and more subtly by the filter Response.

Enabling Ping Mode

Pressing and holding, or double clicking, the **Track/**  button will activate Ping Mode. The LED will flash to indicate this. Double-clicking the button will toggle Ping Mode on and off.

 **NOTE:** *In Ping Mode, the **Track LED** will still indicate whether or not **Mod Oscillator Tracking** is engaged. If tracking is not engaged, the LED will flash on with a brief red flash.*

If tracking is engaged, the LED will be red and will flash off briefly.

Ping Mode Setup

Pressing and holding the **Track/**  button will allow you to view and adjust the various Ping Mode setup options. While the button is held, you can control the frequency of the Ping Sawtooth Oscillator, whether it tracks the Filter Frequency or the Mod Oscillator Frequency, whether it is applied to the Left or Right Channel, or both, and whether a channel will be pinged by the Ping Oscillator, a manual button press or external input, or nothing.

Viewing Setup Options

 **NOTE:** *In the following instructions, be sure to carefully differentiate between the **Response CV Enable** buttons and LEDs (above the **Response CV** knob) and the **Response Enable** buttons and LEDs (above the **Response** knob). As the only differences are the "CV," it can be easy to get mixed up, which can have disconcerting results.*

While the **Track/**  button is held:

The **Left** and **Right Response CV Enable** LEDs will indicate which channels will receive a ping:

- > If the LED is off, the channel will not be pinged.
- > If the LED is green, the channel will be continually pinged by the internal Ping Oscillator and the Ping Oscillator will track the Filter Frequency.
- > If the LED is red, the channel will be continually pinged by the internal Ping Oscillator and the Ping Oscillator will track the Mod Oscillator Frequency.

 **NOTE:** *While in red/green Internal Ping Mode, the audio inputs also remain active, and any signals present there are added to the pings.*

- > If the LED is blinking yellow, it can be manually pinged by pressing the associated **Response CV Enable** button.

 **NOTE:** *While in manual Ping Mode, triggers or gates (or, in fact, any audio) patched to the corresponding audio input(s) will also generate pings.*

Adjusting Setup Options

While the **Track/**  button is held, the top row of **Response Enable** buttons control the Ping setup as follows:

- > Pressing the **Left Response Enable** button causes the Ping Oscillator to track the filter frequency. The **Response CV Enable** LED of any channel set to Internal ping will light green.
- > Pressing the **Right Response Enable** button causes the Ping Oscillator to track the **Mod Oscillator** frequency. The **Response CV Enable** LED of any channel set to Internal ping will light red.
- > Pressing the **Left Response CV Enable** button determines, cyclically, the ping source of the left channel: Off, Ping Oscillator, or Manual/External.
- > Pressing the **Right Response CV Enable** button determines, cyclically, the ping source of the right channel: Off, Ping Oscillator, or Manual/External.

 **NOTE:** *You cannot turn both channels off simultaneously. If one channel is set to off, pressing the button of the other channel will cycle only through internal and manual ping. To turn both channels off simultaneously, exit Ping Mode.*

- > Adjusting the **Mod Oscillator Wave** knob will select the Ping Oscillator frequency ratio. The available frequencies are fractional integer ratios of the selected frequency source (i.e., filter frequency or Mod Oscillator frequency). The ratios range from 1/32 to 1. The default ratio is 1/4 (i.e., the Ping Oscillator will run at 1/4 the frequency of its selected frequency source).

 **NOTE:** If you have selected the **Mod Oscillator** as the Ping Oscillator frequency source, and Mod Oscillator **Track** is enabled, adjusting the Mod Oscillator frequency will, as expected, change the frequency of the Ping Oscillator. However, changing the filter frequency will also change the frequency of the Ping Oscillator, as it will change the Mod Oscillator frequency which will, in turn, change the Ping Oscillator frequency. If you do not want the filter frequency to affect the Ping Oscillator, be sure **Track** is off.

 **ANOTHER NOTE:** Once a ping setup has been programmed, it will be remembered the next time Ping Mode is activated, even through a power cycle.

Ping Mode Operation

All of the above describes the behavior while the **Track**/ button is held down.

Releasing the **Track**/ button returns the LEDs and controls to their usual functions, with the following exceptions:

- > If a channel is in Manual Ping Mode, its **Response CV Enable** button will trigger a manual Ping on that channel rather than toggling the **Response CV** assignment. To show this state, the associated **Response CV Enable** LED will blink yellow superimposed on the color of the current **Response CV Enable** assignment.

 **NOTE:** Since you can't change the **Response CV Enable** assignment of a channel assigned to Manual Ping Mode while in Ping Mode, it's easy simply to exit Ping Mode, use the **Response CV Enable** button to change the assignment, and then re-enable Ping Mode.

- > Any signal at the input of a channel assigned to Manual/External Ping Mode will be converted to triggers which will ping the filter.

 **A TIP:** Patch the output of a gate or trigger sequencer to the input of a channel in Manual/External Ping Mode to use Linnaeus as an FM percussion synth voice. With this setup:

- > **Filter Frequency** controls tuning.
- > **Q** controls decay.
- > **Mod Index + Mod Oscillator Frequency + Mod Oscillator Wave** control modulation, and therefore, timbre.

As Chris Meyer pointed out in our discussions of this, "If someone loves 'Buchla Bongos,' here they are in one module."

 **ANOTHER TIP:** We have found it easier to dial in tones in Internal Ping Mode if the Ping Oscillator is set to track the Mod Oscillator rather than filter frequency. When ping rate tracks the filter frequency, it can be tricky to dial in Mod Oscillator Frequency settings that are in tune or otherwise consonant. Settings are more forgiving when ping rate tracks the Mod Oscillator, so we would suggest that as a starting point when first experimenting with Internal Ping Mode.

 **YET ANOTHER TIP:** In Manual/External Ping Mode using an external audio rate signal, the relationship between filter frequency and the external signal source's tuning is very important. Once you get them aligned to where, for example, filter frequency is tuned to a harmonic of the external signal source, the amplitude goes way up and it's more viable as an oscillator. To maintain this consistent timbre, control the frequencies of both the external signal source and Linnaeus with the same full level CV.

9. Updating Software

Linnaeus can update its operating software using a WAV file.

The latest version of software will always be available on the Downloads tab of the Linnaeus web page:

<http://www.rossum-electro.com/products/linnaeus/>

Checking your Software Version

To display the software version currently in your Linnaeus, press and hold the **Right Response Enable** button. After about 2 seconds, the top 4 LEDs will display the software version in binary. Of course, you don't have to actually read binary, just compare the LED pattern to the latest listed on the web page. If they match, you're up to date. If there's a later version on the web page, update your Linnaeus as described below.

How to Update

1. Turn on your system while holding down the **Left Response CV Enable** button and the **Left Response Enable** button. All the LEDs across the top will light red, and the **Track** LED will go off.
2. Press the **Track** button to proceed. After a second or two, the **Left Response CV Enable** LED will light red.
3. Patch your WAV player into the **Ext Lin CV** input. We've found that a regular Eurorack patch cord works fine. (See the hints below for successful WAV playback.)
4. Begin playing the WAV file. The **Left Response CV Enable** LED will act as a VU meter. Red is too low, yellow marginal, green is good. If necessary, adjust the playback level of your WAV player and try again.

5. Once past the header (usually very quickly), the sync mark will be found, which will turn the **Left Response CV Enable** LED to yellow. At this point, the **Right Response CV Enable LED** will display the file loading progress, beginning off, turning red 1/4 of the way through, yellow half way through, and green when 75% through.
6. When the load is complete, both the **Left** and **Right Response CV Enable** LEDs will turn green. Press **Track** to reboot using the new software.
7. If an error occurs, both the **Left** and **Right Response CV Enable** LEDs will turn red. An error code is displayed on the other LEDs. Note the LED pattern in case you need to get in touch with us about the problem. Errors are extremely rare and are usually a matter of a problem with the playback level of the file, in which case simply adjust the level and press TRACK to 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 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 (although it's almost impossible these days to prevent the OS from occasionally trying to alert you to something). 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 your saved download 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.

10. 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.

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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.

