stem modular

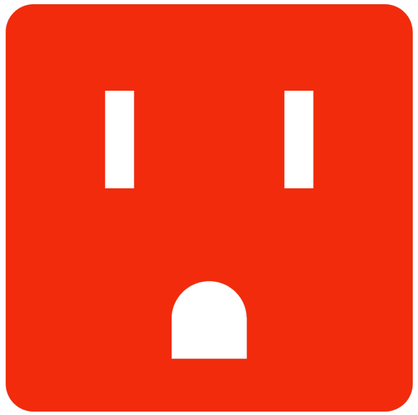
WaveStation Patchbook

Power

The STEM Modular System comes with a 15VDC (center-pin positive) power adapter. Each module is connected inside of the WaveStation to a power bus board using a ribbon cable. If for any reason you need to replace or move any of the modules remember that the red stripe on the ribbon cable should be at the bottom (-12V, consistent with the eurorack standard). If you have any questions about powering the system please reach out to us. Contact information is at the end of this documentation.

Safety

- For your safety and the safety of the equipment, please keep it away from any liquids.
- Always start with headphone volume knobs set less than midway
- If you plan to use the system with other modular gear, make sure that the WaveStation is powered on before patching.



Getting Started

Important terms:
Module - an electronic music building block
Patch - a specific arrangment of modules that is made by connecting inputs and outputs together using patch cables
Frequency - how often a wave repeats - measured in Hertz (Hz)
Amplitude - the height of a wave
Wavelength (λ) - the length of a wave cycle
Control Voltage (CV) - an electrical value that is used to vary parameters of voltage controlled modules
VCO (Voltage Controlled Oscillator) - creates an audio wave - frequency can be controlled by an external voltage source
VCA (Voltage Controlled Amplifier) - sometimes referred to as an analog multiplier because it multiplies the two inputs, and outputs the result - often used as volume control
VCF (Voltage Controlled Filter) - shapes a sound - creates different timbres
LFO (Low Frequency Oscillator) - turns electrical energy into a varying voltage (a wave) that we can't hear but can use as a control voltage source

In the following pages we'll start out with a simple two cable patch and gradually add more. The patches included here are a starting point. Continue exploring by combining them together and experimenting.
Throughout for the tl;dr version look for this text.

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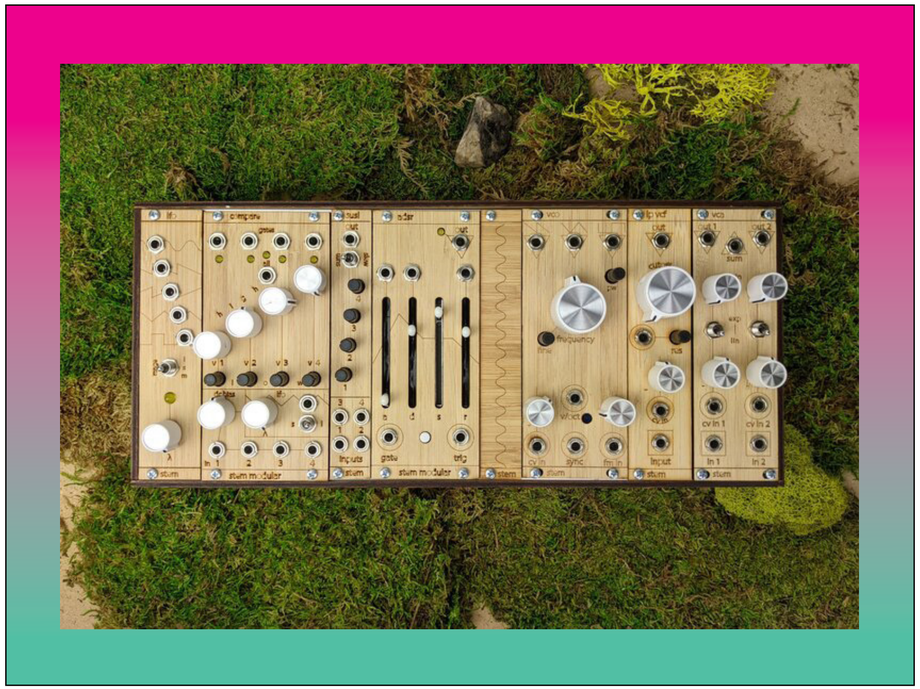
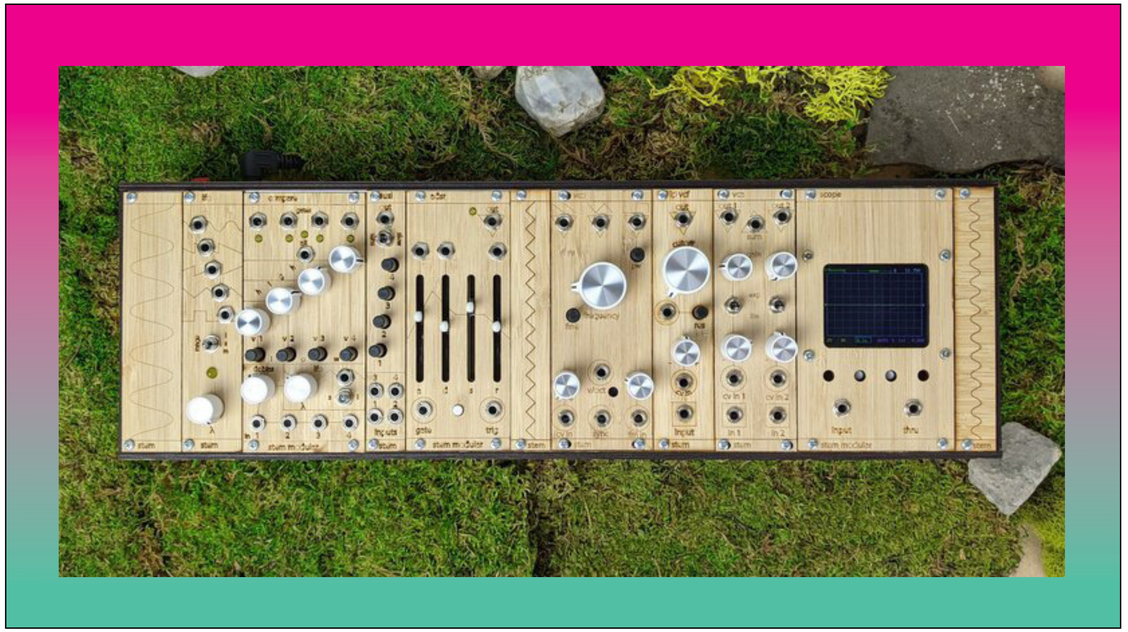
Wave Station Headphone Outputs

There are two versions of the Wave Station - 60hp and 84hp. Both have headphone outputs built into their enclosure. If you are using the 60hp system you will only hear the “sum” output of the VCA, and when using the 84hp system you will hear whatever is connected to the scope input.





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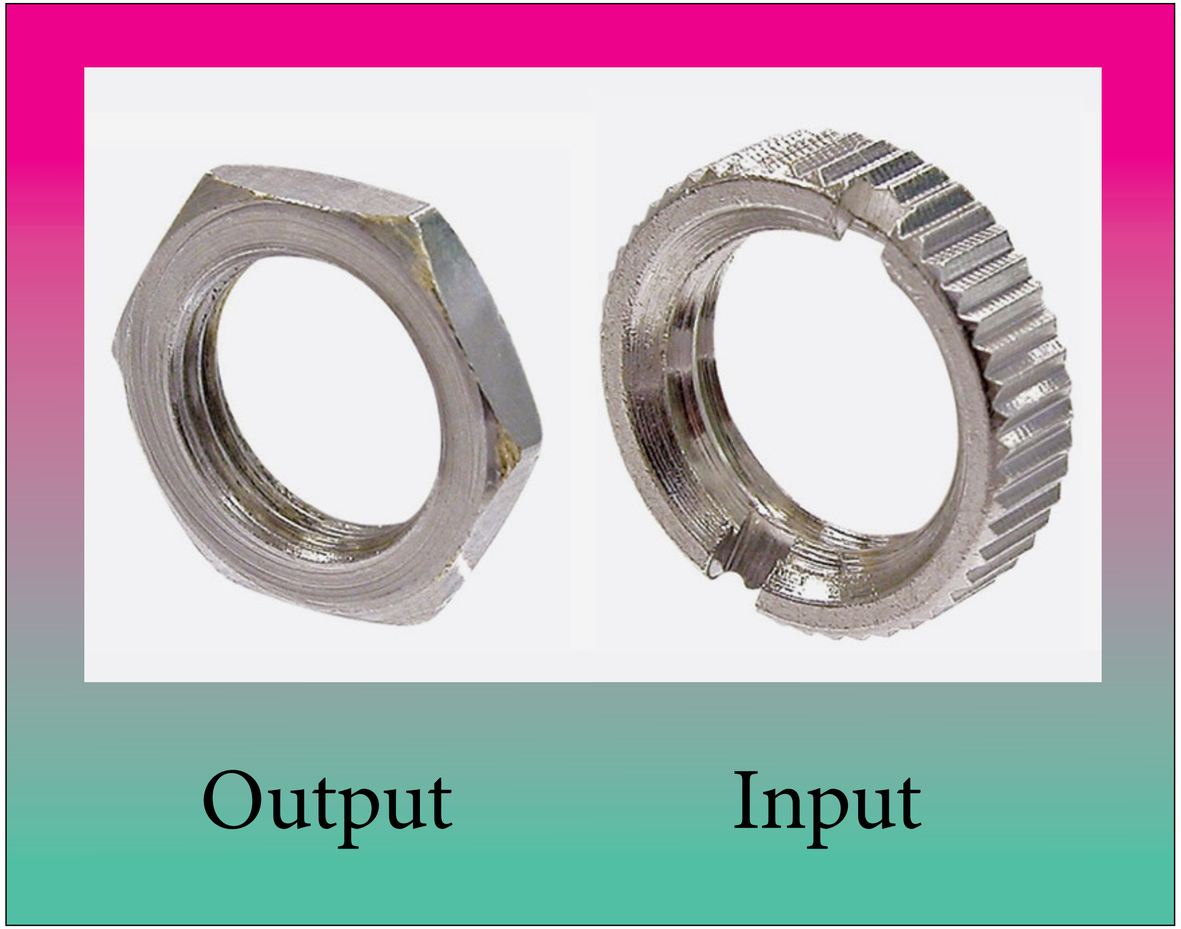
Getting started

1) Outputs have hexagonal jack nuts and inputs have round, knurled nuts.
This is intended to make patching easier for folks that are new to modular synthesizers.



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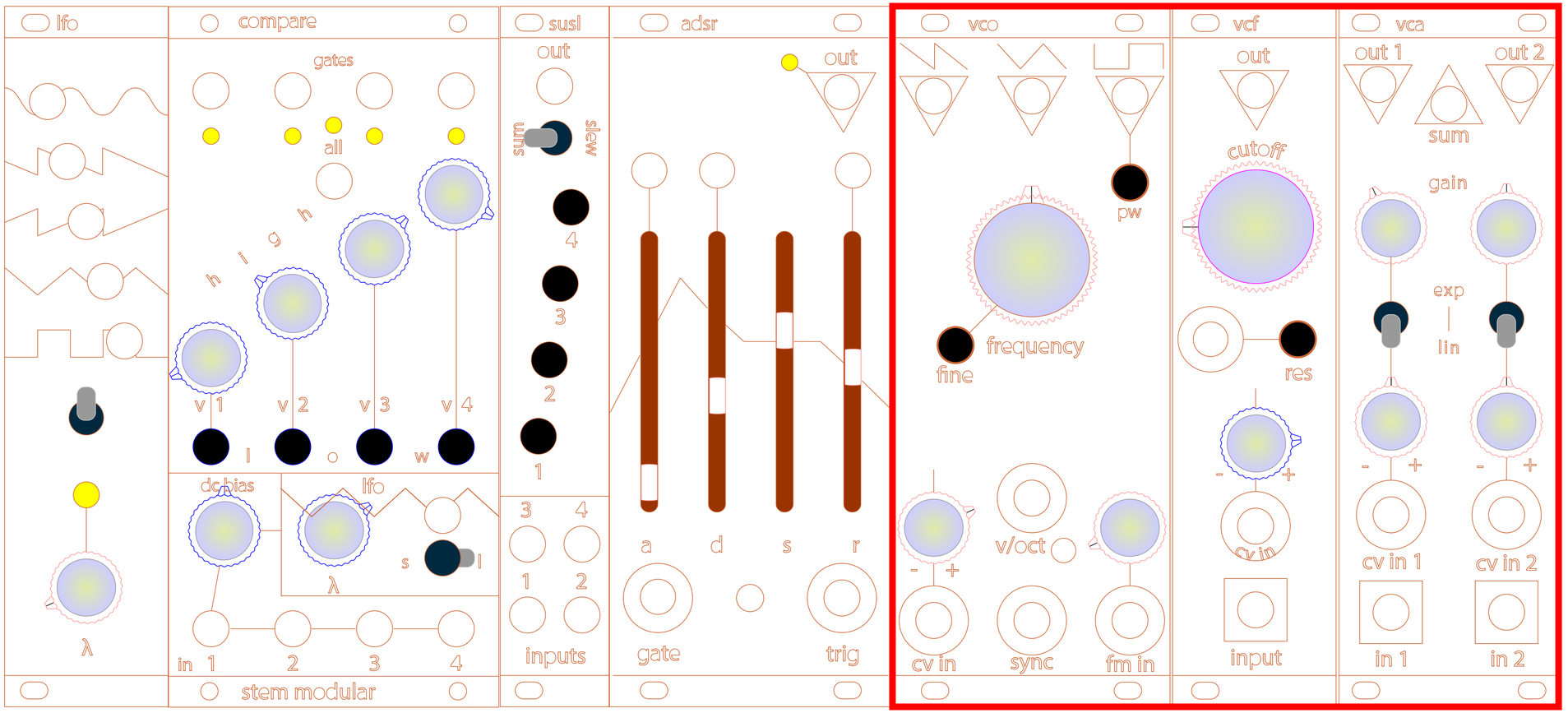
Getting started

2) The three modules on the right side of the system are the audio portion - together they make a simple subtractive synth voice.

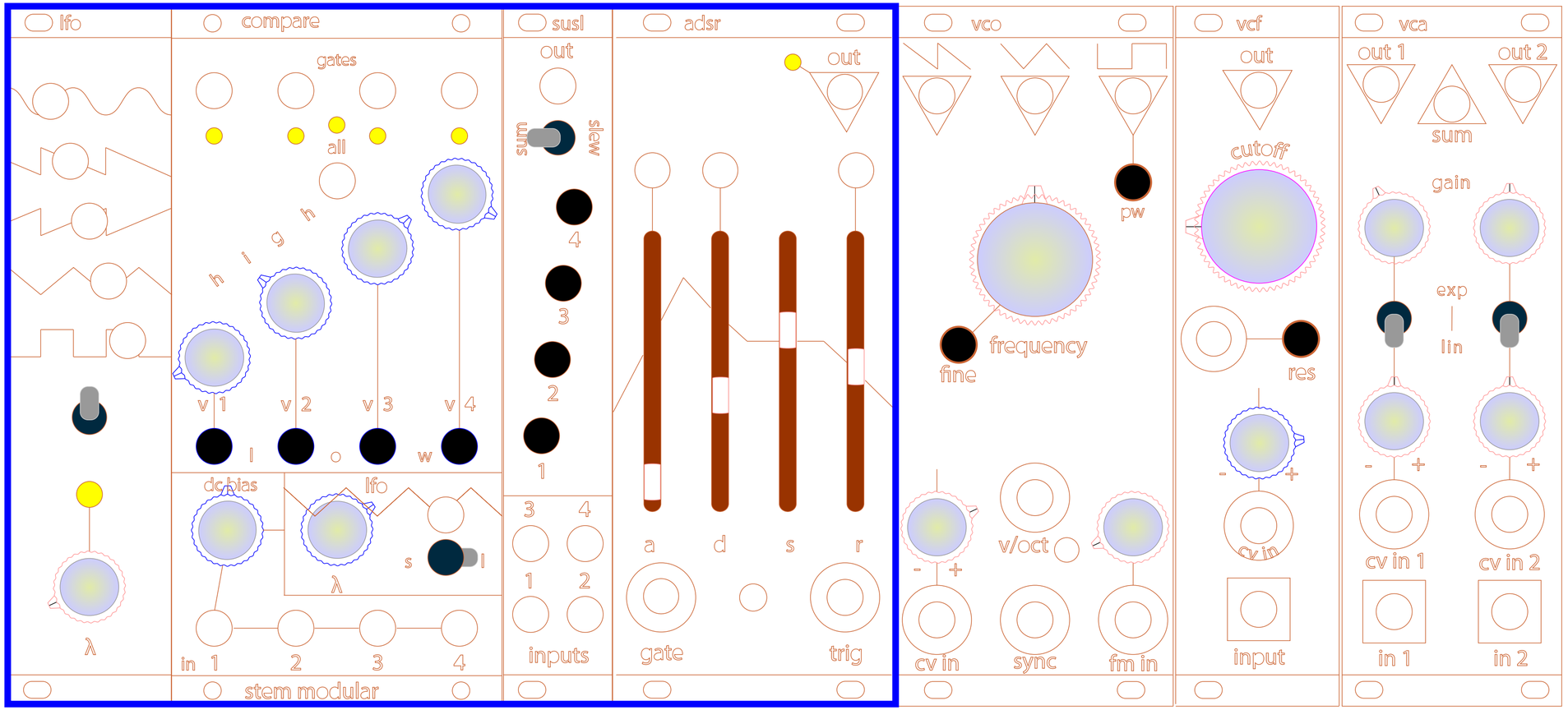
- VCO generates 3 different waveforms and accepts control voltages to change its frequency (pitch)
- LP-VCF shapes the waveforms of the VCO, changing their character by cutting off high frequency harmonics
- VCA changes the amplitude (most often audio volume) of an incoming signal



Getting started

3) The modules on the left generate and manipulate control voltage (CV) signals.

- The LFO makes slowly moving waveforms
- Quad Comparitor creates gates - signals that we can use as control voltage or to trigger events
- SuSl is a 4 input mixer - it adds (sums) signals together
- ADSR produces an envelope - a control voltage that we can tweak to create musical movement



Patch #1: Triangle wave with volume control

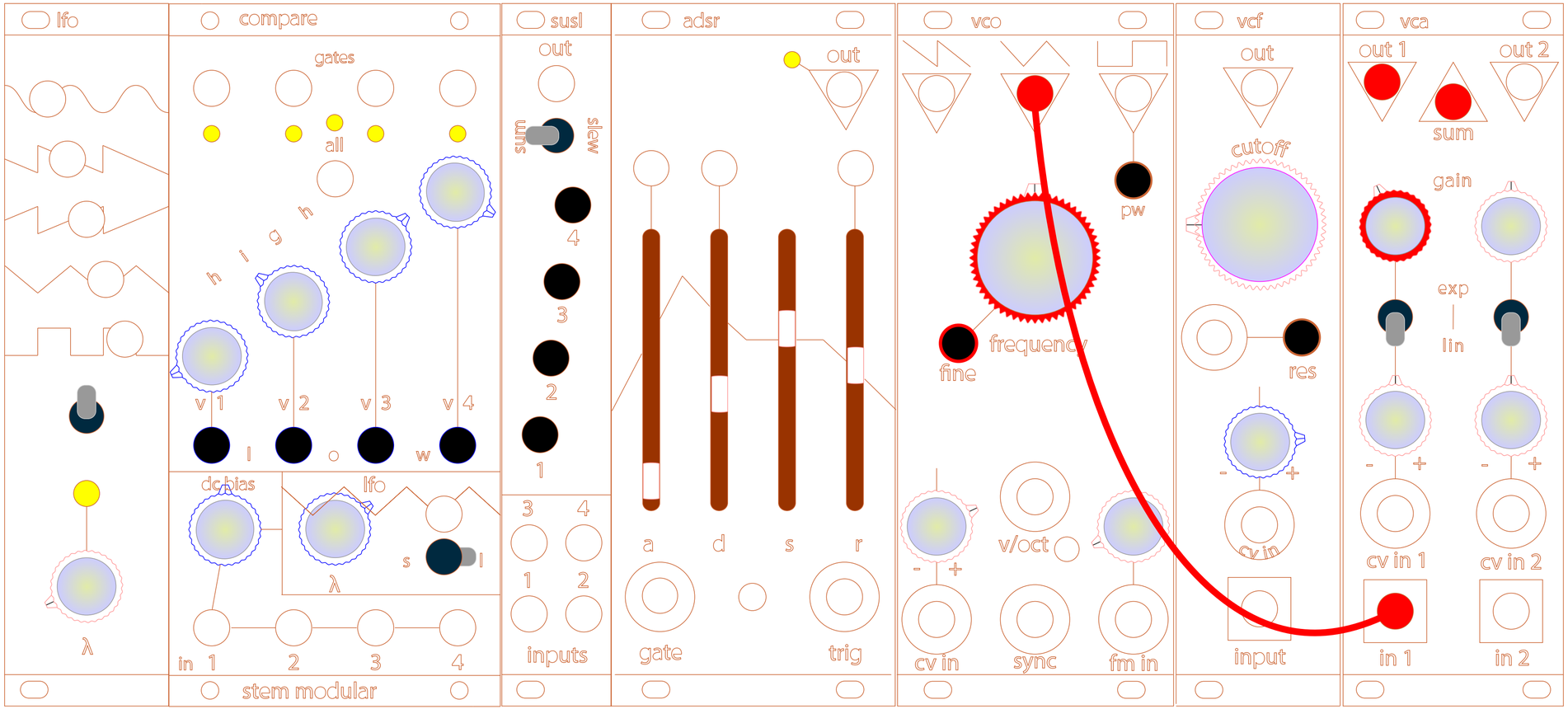
This first patch will get some audio out of the system and introduce the VCO and VCA.
The VCO (Voltage Controlled Oscillator) makes an audio wave and has two controls to adjust frequency. There are three waveform outputs - saw-tooth, triangle, and pulse/square - the knob below the pulse output controls pulse-width ("pw" - how long the wave level is high vs. low).
The VCA (Voltage Controlled Amplifier) is actually two separate VCAs and a "sum" output that mixes the outputs of the two.
Patch the triangle wave output of the VCO to "in 1" of the VCA, and "out 1" or "sum" of the VCA to input of the scope module (not pictured)*.
Now any of the controls listed below (and highlighted in red) will change the frequency (pitch) or volume (amplitude) of the sound wave.

Controls

frequency
fine
pw
gain

Note

"out1" or "sum" can be connected to an amplifier or mixing board, but be careful because the signal is loud!!



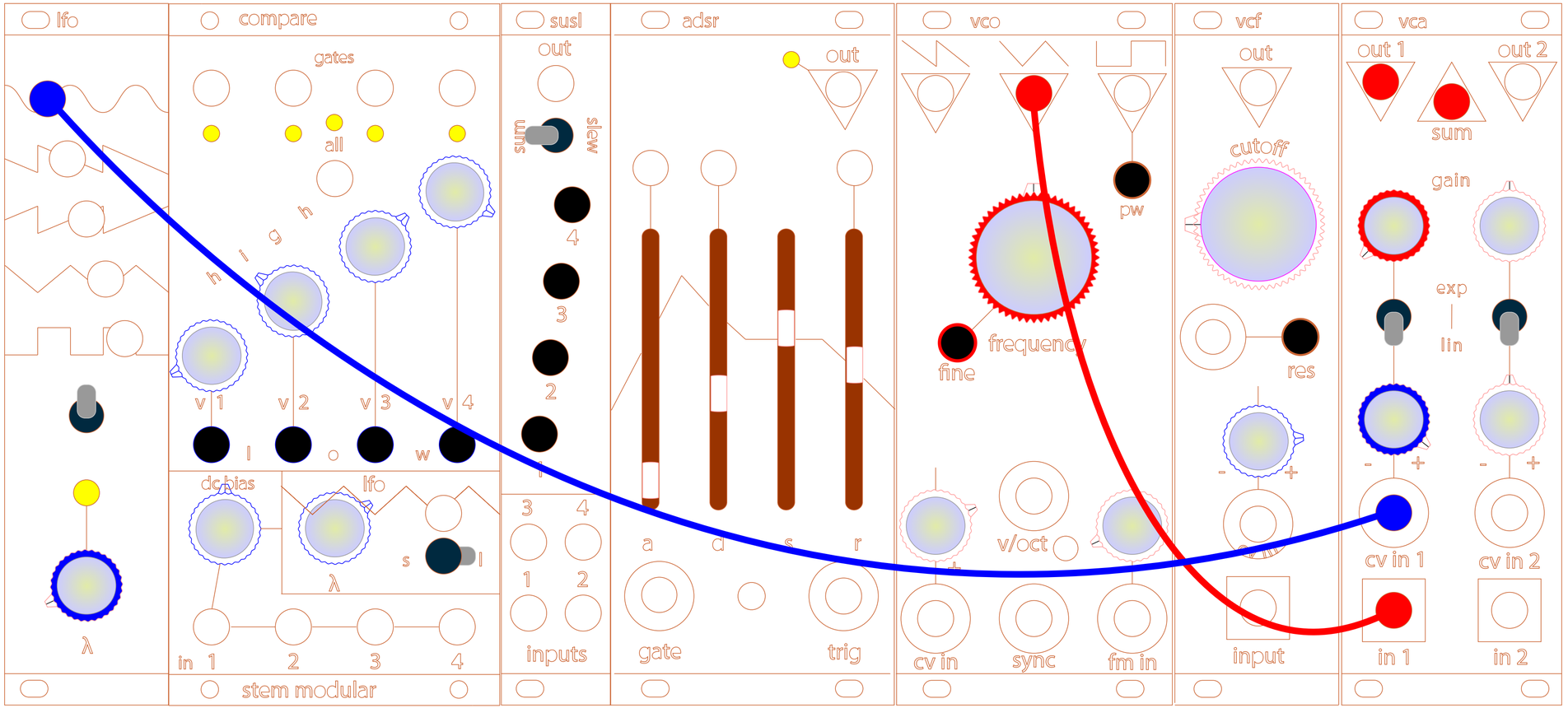
** in 60hp systems "sum" is connected directly to headphones so skip the scope step*

Patch #2: Amplitude Modulation

This second patch adds just one more patch cable - connect an LFO wave to “cv in 1” (the control voltage input of channel 1) of the VCA. Turn the left gain knob counter-clockwise (volume “down”) and the cv knob clockwise (towards the “+” sign, see illustration) - now as the voltage of the LFO wave increases so will the amplitude of the sound wave. Depending on how long or short the wavelength is this will result in a tremolo, wobble, or crescendo effect. Experiment with different LFO waveshapes and speeds. The controls highlighted in red will still give us manual control of frequency and amplitude, but now the controls highlighted in blue will also affect the amplitude through control voltage.

Controls

λ (wavelength)
frequency
fine
pw
gain
cv-
attenutor



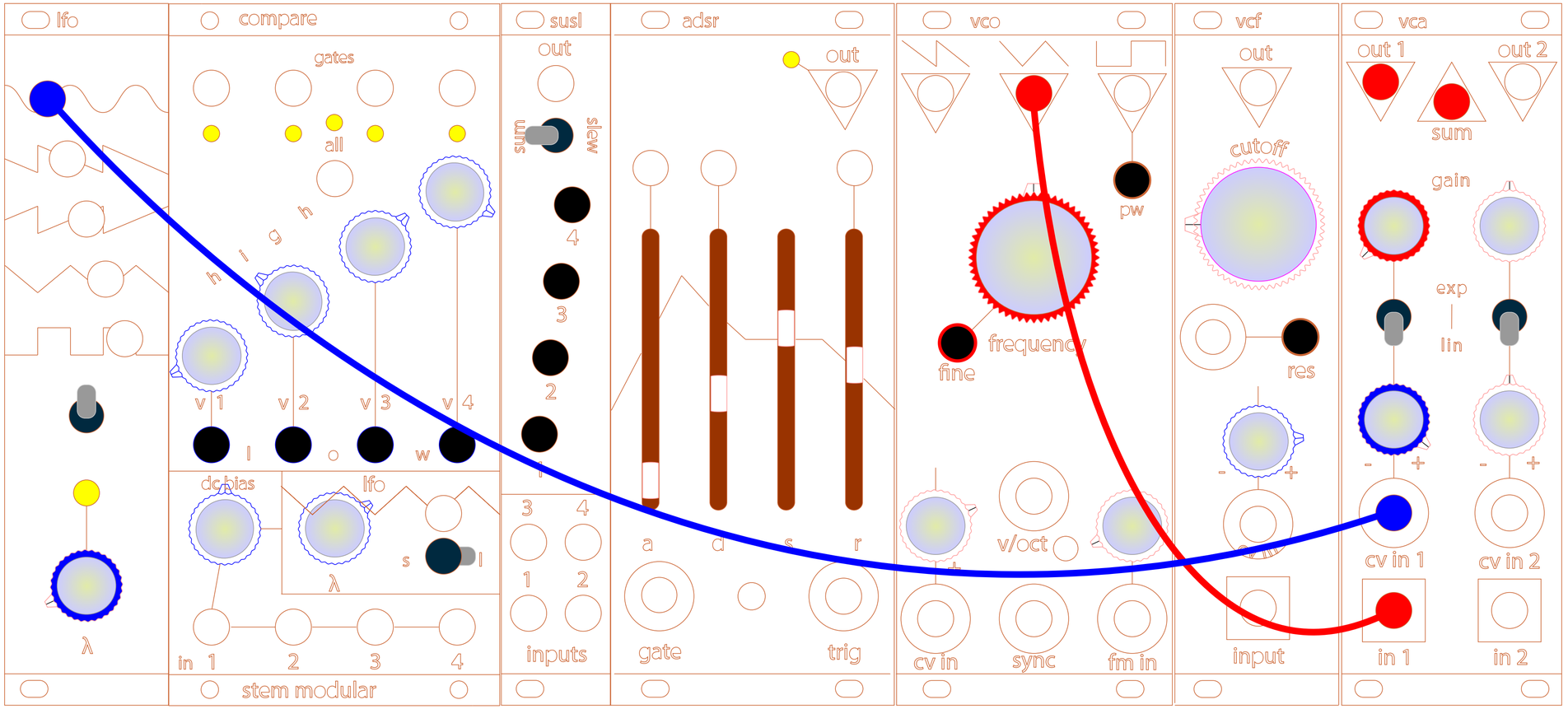
Patch #2: Amplitude Modulation continued

You might be wondering about the positive (+) and negative (-) signs to either side of the knob above the “cv in1” jack. This is known as an attenuverter. When the knob is set to 12 o’clock no signal will affect the module becuase the cv input is completely attenuated. As we turn the knob clockwise the input is less attenuated until 100% of the signal is present. Turning the knob counterclockwise will invert the incoming cv signal.

The LFO wave is actually alternating between positive and negative voltages (bipolar), so inverting the wave might not sound very different. However, when using a unipolar cv signal (only positive voltage) like the ADSR envelope that we will look at in a few pages, clockwise will increase the amplitude and counterclockwise will decrease the amplitude.

Controls

λ (wavelength)
frequency
fine
pw
gain
cv-
attenutor



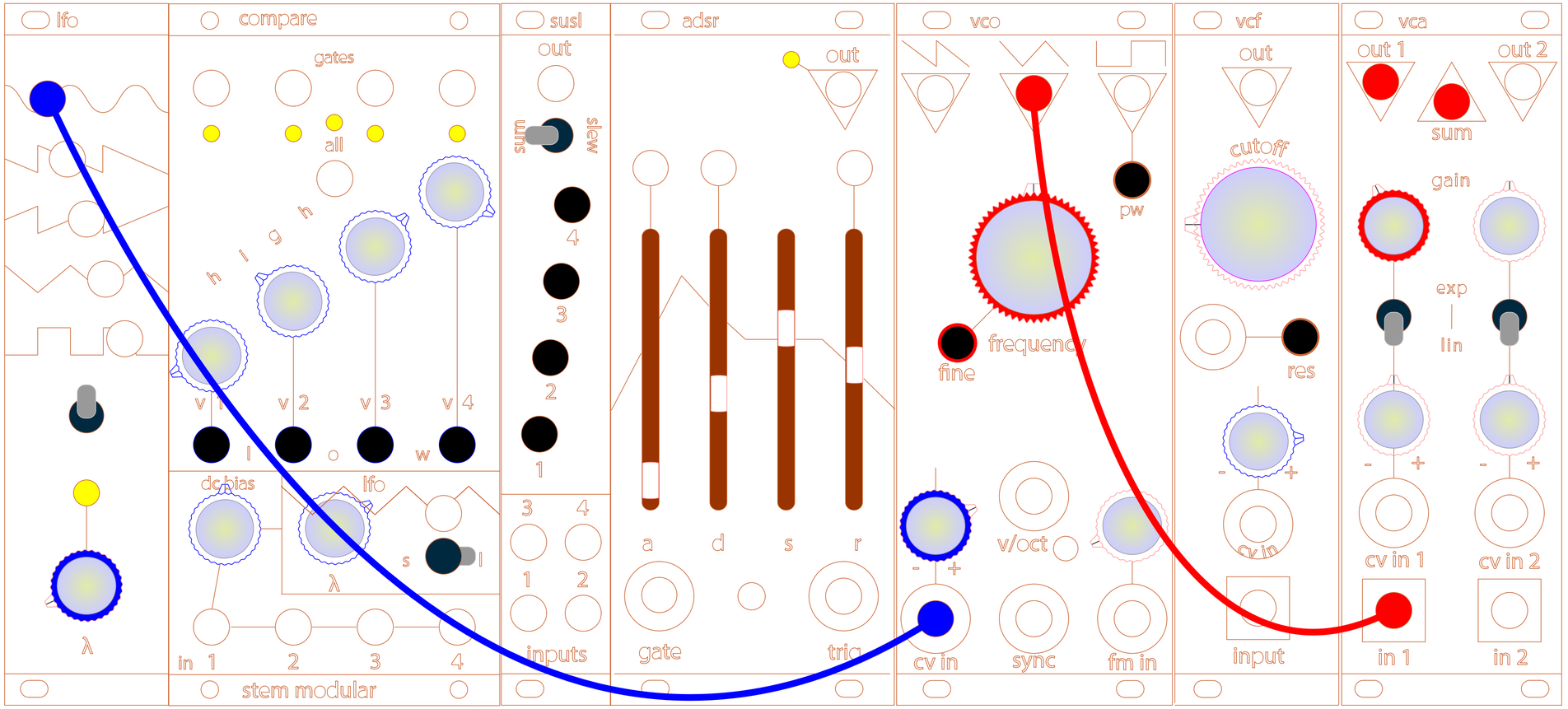
Patch #3: Frequency Modulation

Now with one small change we can modulate the frequency of our sound wave instead of the amplitude.

Connect any waveform from the LFO to the "cv in" of the VCO and you will hear the frequency rise and fall in the pattern of that waveshape (make sure you have turned the VCA gain back up or else you won't hear anything). Again this particular cv control is an attenuverter, so at 12 o'clock we won't hear any change, positive will increase frequency as voltage increases, and negative will decrease frequency as voltage increases. Connect different LFO waves to create different effects.

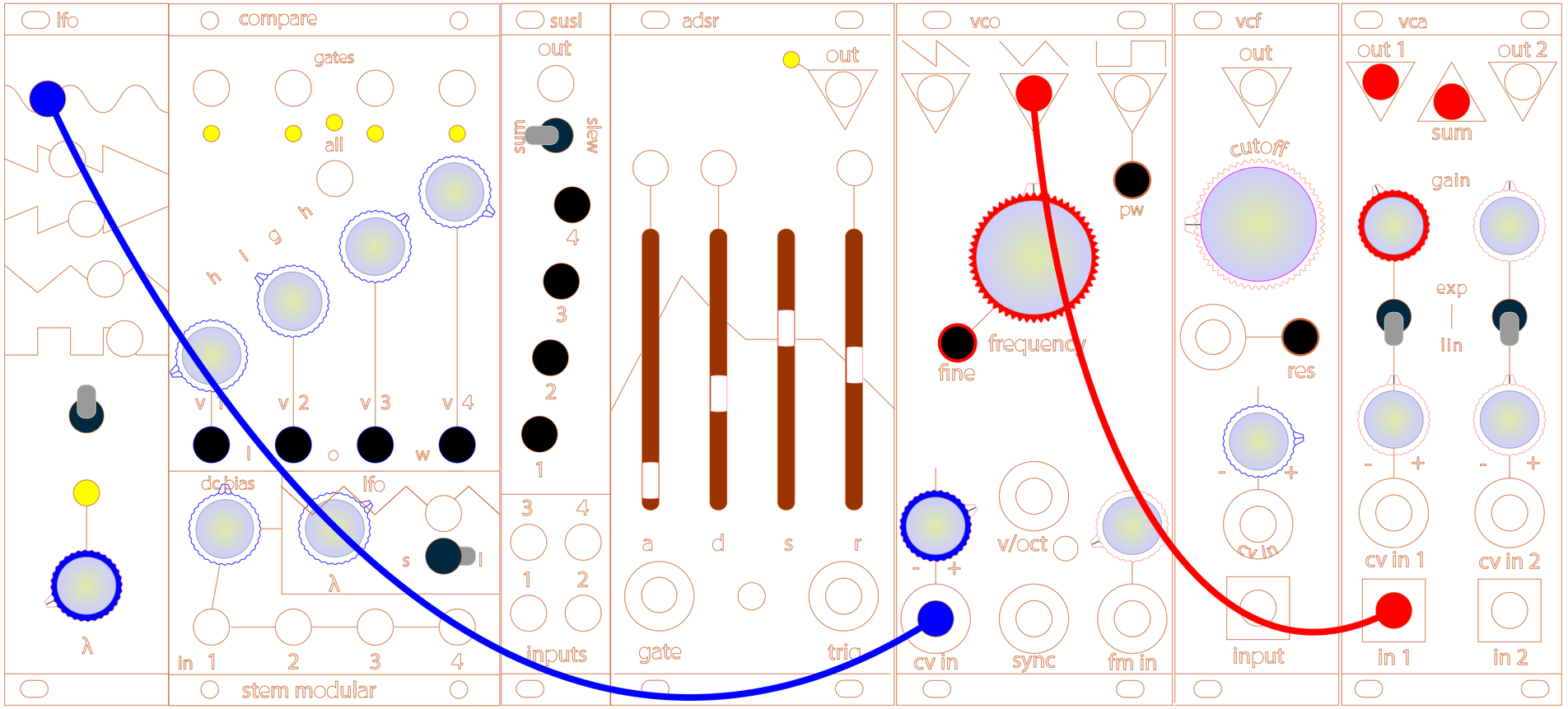
Controls

λ (wavelength)
frequency
fine
pw
cutoff
res
cv-
attenuverter
gain



Patch #3: Frequency Modulation continued - more about the VCO

What about the other VCO inputs? You will notice that in addition to “cv in” there is also a “sync” input, “fm in”, and “v/oct”. While all of these inputs affect the frequency of the oscillator, they do so in different ways. Without getting into too many details (or maths), our ears hear pitches in a way that is not linear, but rather exponential (if this is confusing it might be worth finding a video about octaves and frequencies). Just know that the “v/oct” input is made to work with a keyboard (each octave is spread out over 1 volt), “cv in” is also exponential but not as wide ranging as “v/oct”, “fm in” will change the frequency linearly, and “sync” will try to keep the oscillator in tune when it receives a square wave from another audio oscillator.



Patch #4: Filtering

Now that we've played with frequency and amplitude, let's add in some filtering. The LP-VCF (Low-Pass Voltage Controlled Filter) changes the character or harmonics of our sound. Simply put, the further counter-clockwise the "cutoff" knob is turn the softer the edges of a sound wave become.

Patch the square wave output of the VCO to the input of the LP-VCF, and the output of the LP-VCF to "in 1" of the VCA (as shown below).

Now in addition to controlling the frequency and amplitude of the sound wave we can also play with the harmonic content (character or timbre) of the sound. When the "cutoff" knob is fully counter-clockwise it's jagged edges will be rounded and it will sound more like a sine wave.

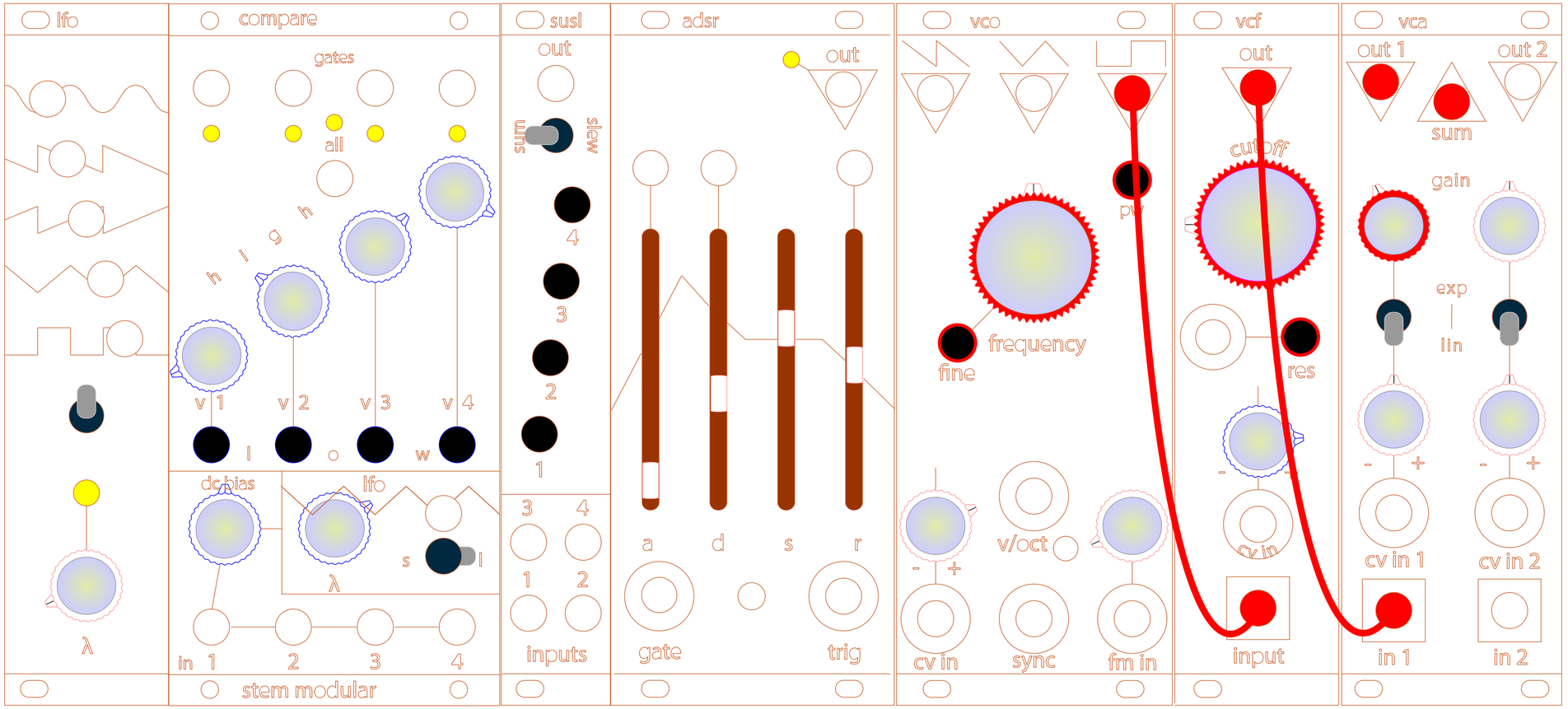
Again the audio controls that we can use to manually control are highlighted in red.

Controls

frequency
fine
pw
cutoff
res
gain

Note

Start off with the "res" control turned all the way counter-clockwise



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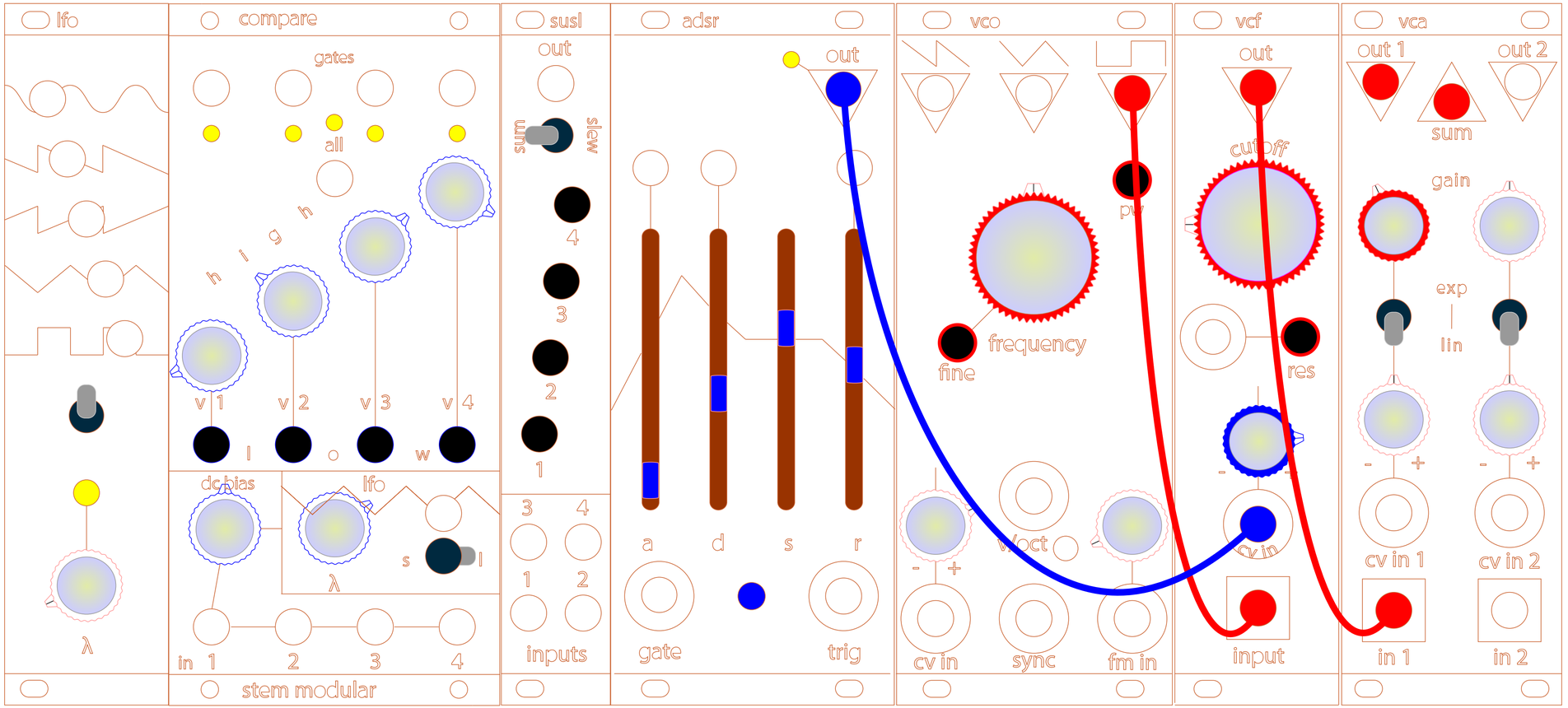
Patch #5: ADSR Envelope

An envelope is kind of what it sounds like - a way to use a control voltage to package up a sound, so to speak. It lets us fine tune the shape of a control voltage signal by giving us control over how fast the voltage rises and falls. ADSR stands for Attack Decay Sustain Release, and these are the four sections of the envelope that we will be controlling (they make up the shape that is on the front of the ADSR module). This shape slopes up to a peak voltage then falls to a sustained voltage level and finally releases back to zero. As we adjust the sliders we change how long or short those sections last - slider down is shortest, up is longest. The LED by the output will give some indication of your shape.

Connect the output of the ADSR to the "cv in" of the LP-VCF and press the envelope button to trigger.

Controls

attack (a)
decay (d)
sustain (s)
release (r)
cutoff
res
cv-
attenuverter
gain



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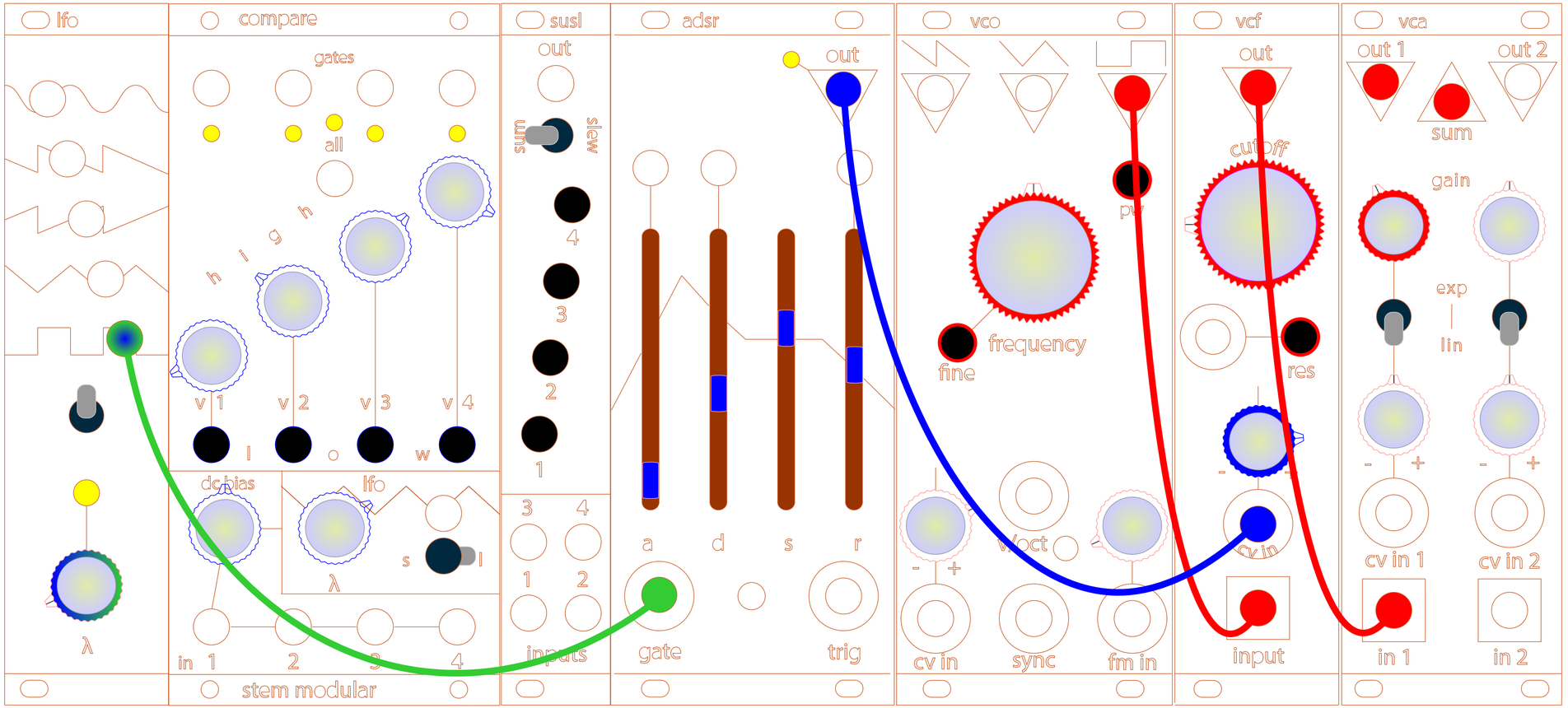
Patch #6: Gates

In the last patch we used the button on the ADSR to trigger the envelope shape. But just like we are able to use control voltages to move knobs in ways that our fingers couldn't, we can use a different kind of control voltage called a gate to play the envelope in a robotically precise way. A gate is a pulse - either a low or high voltage. When the voltage is low we say the gate is off, and when it is high we say the gate is on. The LFO square wave can be used as a repeating gate; its LED flashing on when the gate level is high. Connect the square wave of the LFO to the "gate" jack of the ADSR and everytime the voltage is high the ADSR envelope will go through its steps.

And what about "trig"? That jack will reset the envelope when a gate is also present and can create trill effects. Trig only works when gate is on.

Controls

λ (wavelength)
attack (a)
decay (d)
sustain (s)
release (r)
frequency
fine
pw
cutoff
res
gain



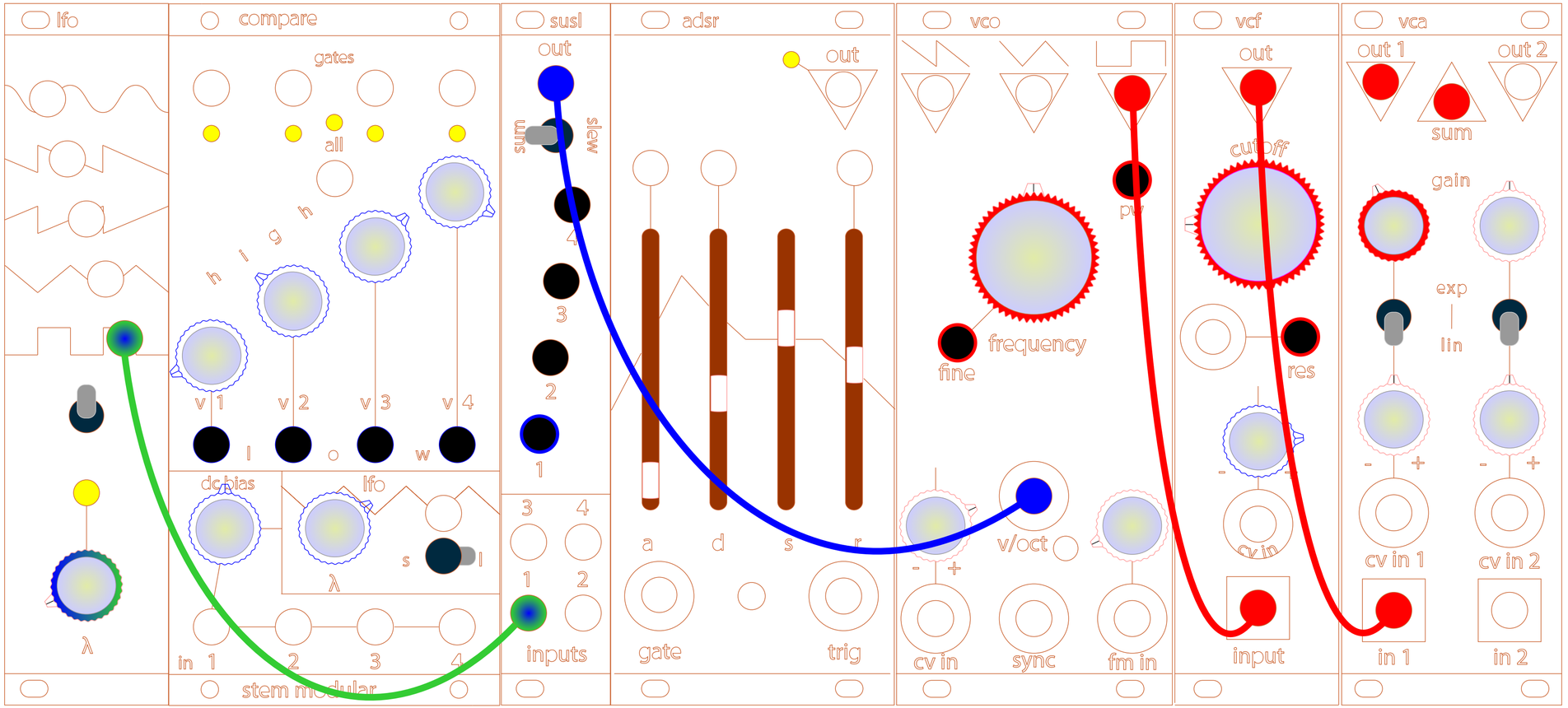
Patch #7: Mixing and attenuation

The Sum & Slew (“susl”) module is a mixer that adds (sums) 4 inputs together into one output. Each input has a corresponding attenuator knob that is used to adjust how much signal is summed. When the black knob is turned counter-clockwise it will be fully resisting (attenuating) the incoming signal, and when it is fully clockwise it will apply zero resistance.

Connect the square wave of the LFO to input 1 of the “susl” module, then connect the output of the “susl” module to the “v/oct” input of the VCO. With input 1 knob turned counter-clockwise you won’t hear any changes to the pitch, but as you turn it clockwise you will hear the pitch change with the high and low levels of the square wave.

Controls

λ (wavelength)
attenuator 1
frequency
fine
pw
cutoff
res
gain

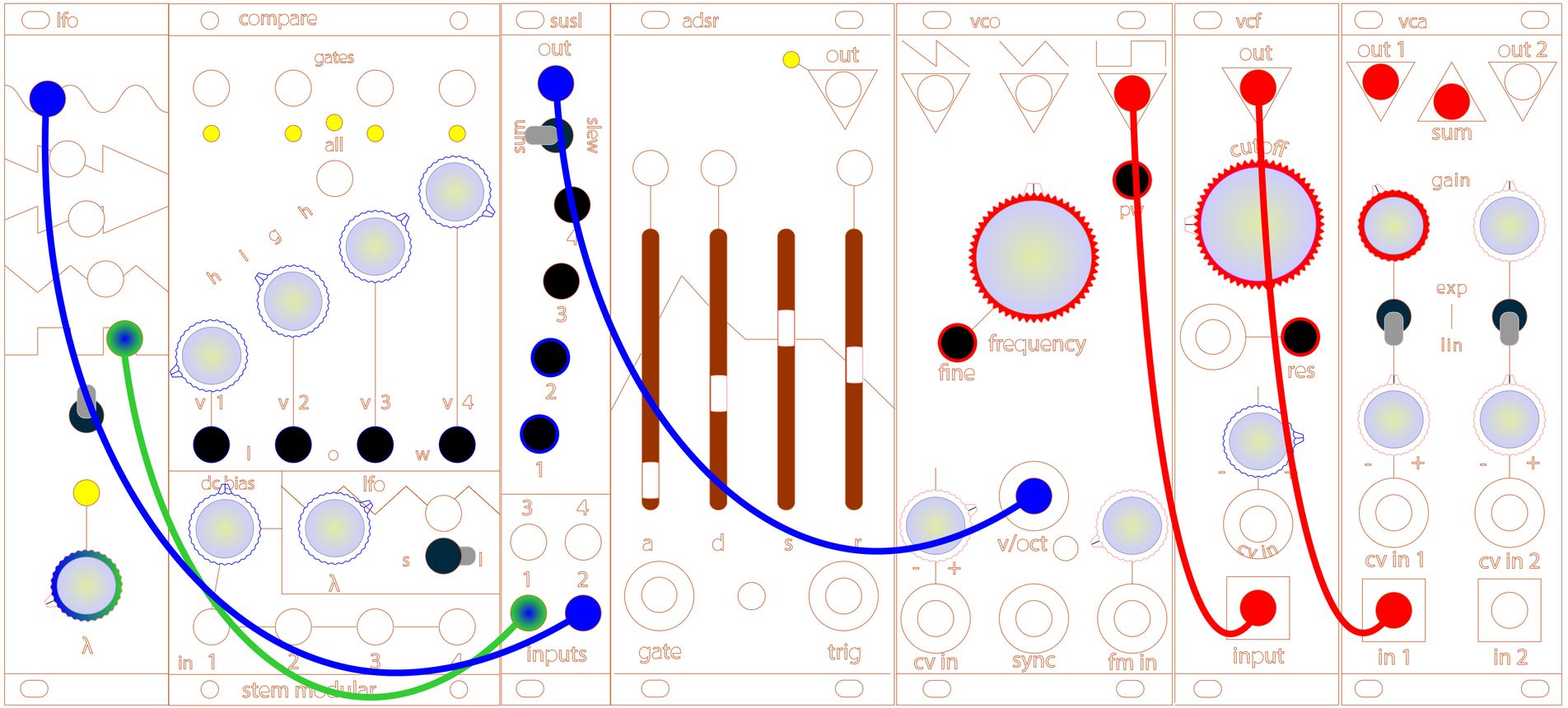


Patch #7: Mixing and attenuation continued

Add more LFO waves to the other susl inputs and experiment with different attenuation levels. Send the output of the mixer through the scope to see how the voltage levels change as you play with the attenuation.

Controls

λ (wavelength)
attenuator 1+2
frequency
fine
pw
cutoff
res
gain



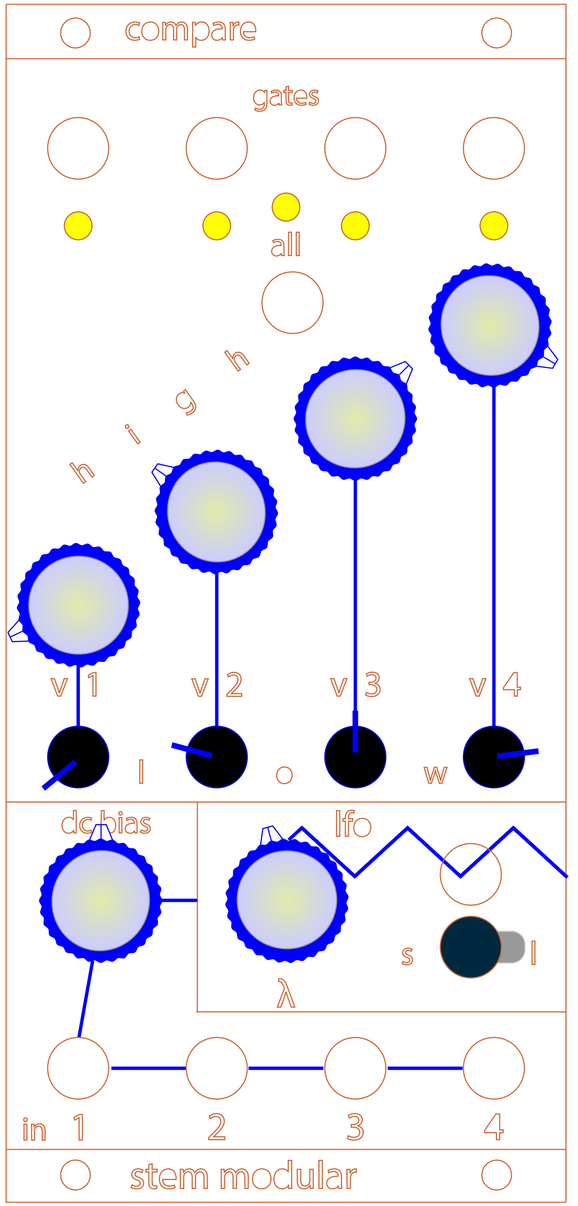
Patch #8: Comparator sequence

The compare module is great for creating patterns. You may have noticed the LEDs blinking - they are used to help us see when gate outputs are high (in this case 10V). When there are no cables plugged into this module the triangle oscillator will be connected (internally) to input 1 and then normalled* to the other inputs as well (1>2>3>4, see below).

There are four window comparators and we can set the window using the "high" and "low" controls. Whenever the wave is between those voltage levels the LED will light up and the output will be 10V (otherwise it is 0V).

With knobs set as seen here the oscillator will cause gate outputs to turn on in a pattern that scans back and forth. If instead we set all of the high and low knobs the same, the LEDs would all flash at the same time. The important thing to remember is that the "low" knob should always be set lower (more counter-clockwise) than the "high" knob. The oscillator knob will change the rate of scanning and "dc bias" will weight the scan to the right or left.

The best way to understand it is to play, so on to the patches.



* "normalled" means that the jacks are connected together behind-the-scenes. For this module that means the jacks are connected 1>2>3>4, so whatever goes into 1 will also go to 2, 3, and 4. However, if we plug another signal into input 2 it breaks the chain and the pattern will look like 1|2>3>4 , where inputs 1 and 2 are different but 3 and 4 follow 2. Experiment with it to experience how it works.

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Patch #8: Comparator sequence continued

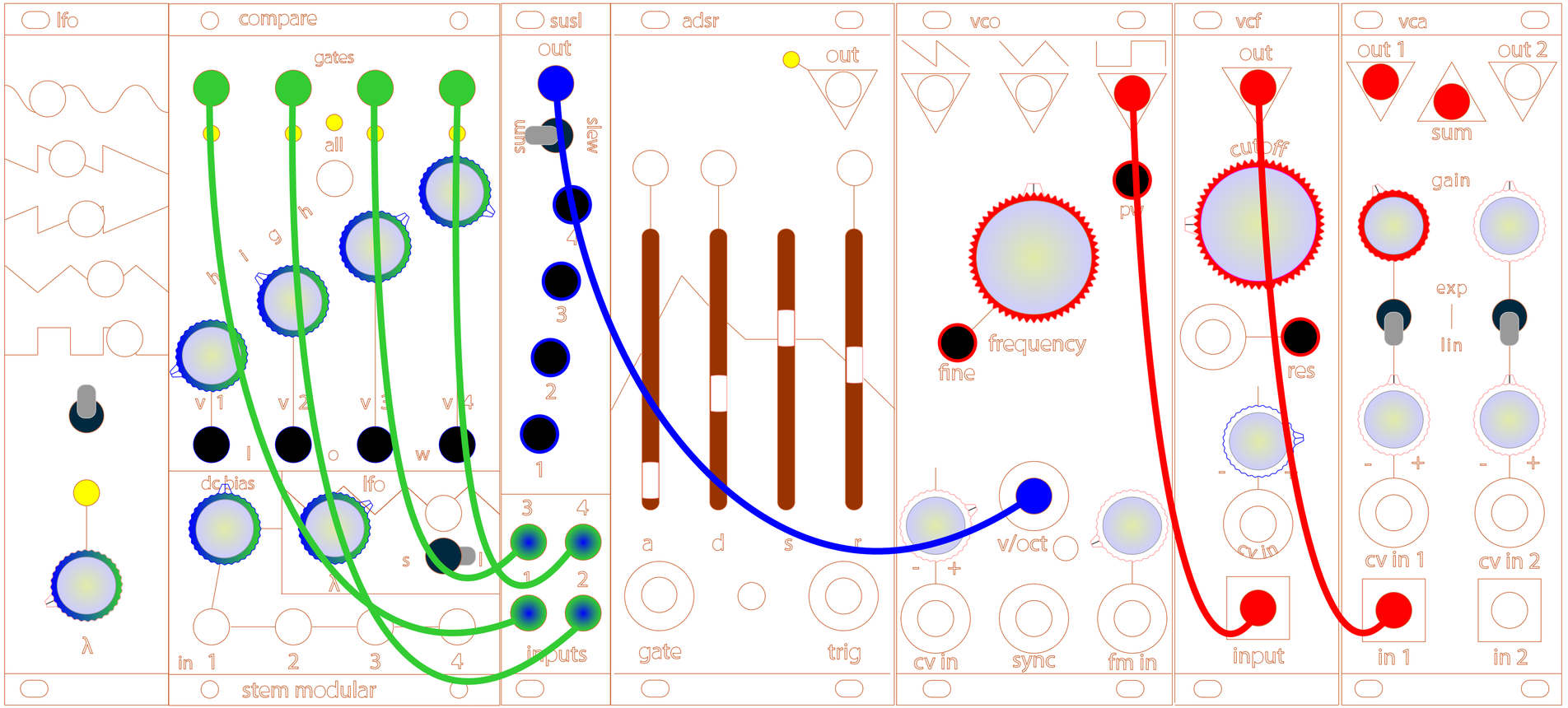
With the compare module set as shown on the previous page we can create a sequence of control voltages to get different notes from the VCO.

Connect the gate outputs of Compare to SuSl inputs 1-4 and SuSl out to v/oct input of the VCO. Use the knobs of the SuSl mixer to attenuate the gate inputs, varying their voltage level to produce different frequencies from the VCO. Make sure the switch on the comparator is to the right (l = long and will create sequences, s= short and will create audio).

Now the controls on the comparitor will change the speed and pattern of the sequence of notes and the mixer controls will change the voltage level (in this case the note/frequency that we hear).

Controls

high/low
dc bias
λ (wavelength)
attenuator 1-4
frequency
fine
pw
cutoff
res
gain



Patch #8: Comparator sequence continued

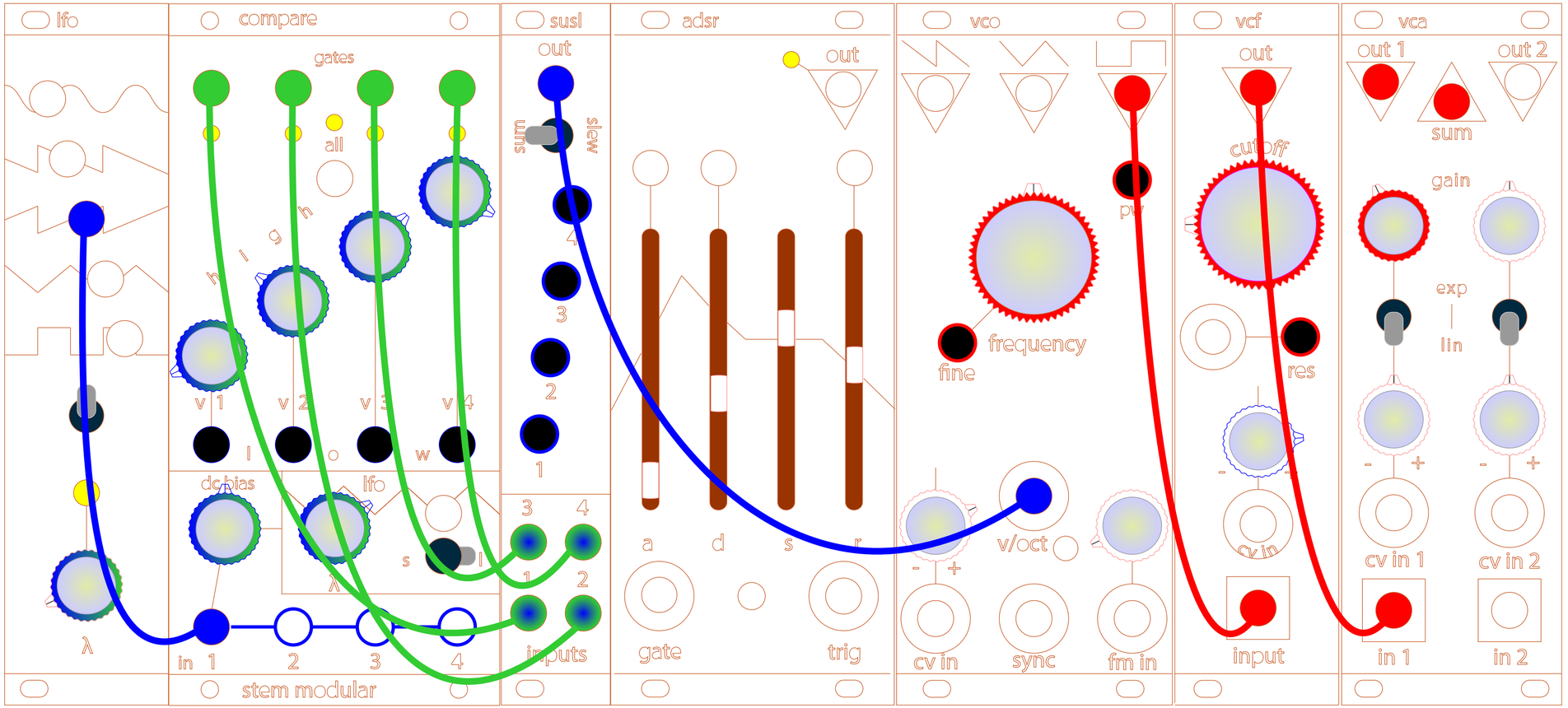
Now let's change this patch ever so slightly and explore a little more of what comparators can do.

Connect the ramp wave (see picture) of the LFO to input 1 of the compare module.

Now the comparators pattern will change from scanning back and forth to moving from 1 to 4 and immediately back to 1. If we look at the shape of the ramp wave versus the triangle we can see how the voltage changes in a different pattern, so this makes sense. Also notice that now the LFO knob controls the speed of the compare sequence. By inserting a cable into input 1's jack we interrupted the internal oscillator connection.

Controls

high/low
dc bias
λ (wavelength)
attenuator 1-4
frequency
fine
pw
cutoff
res
gain



Patch #8: Comparator sequence continued

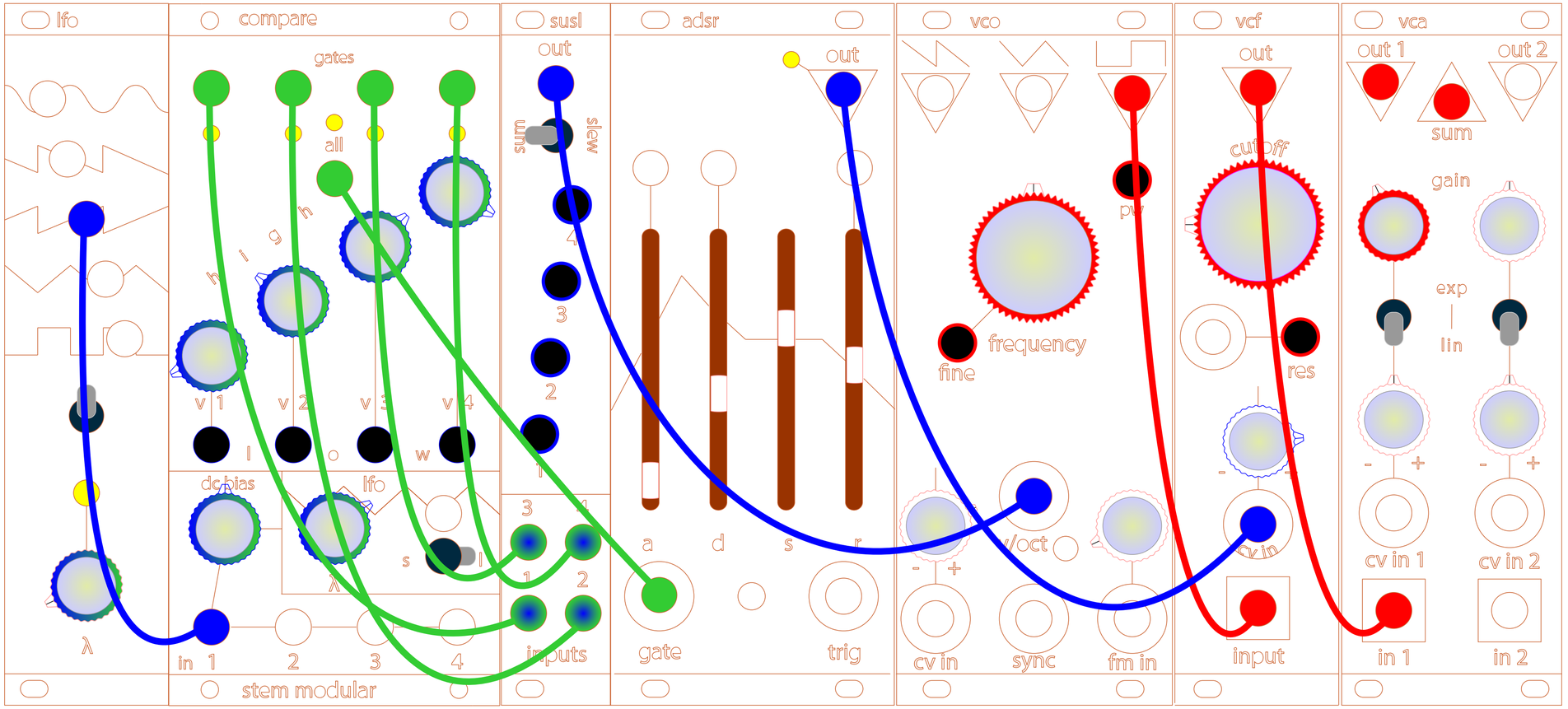
Let's keep going with this patch. Now we're going to add ADSR for even more fun. We'll use the "all" output of the compare module to trigger the gate. If we tweak the comparator windows just so, there will be a voltage drop between each step of the comparator sequence. Every time a new gate happens the ADSR will get triggered and it will sound even more like notes are being played by an instrument.

Connect "all" output of the compare module to the gate input of the ADSR module and the "out" of the ADSR to "cv in" of the LP-VCF.

With patch cables and controls set as seen below you will hear notes that sound like they are being plucked.

Controls

high/low
dc bias
λ (wavelength)
attenuator 1-4
frequency
fine
pw
cutoff
res
gain



For more info about the system and how it's used visit

http://www.stemmodular.com

Check out the videos on our YouTube Channel

... and follow us @STEMModular on all of the social medias.

Feel free to reach out if you have any questions!

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