Sytrus Synths Creation Manual

From FLStudio 12.3 and onwards

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Foreword

This text is based on the Sytrus Synths Creation manual first published 2008 at this location by Erik McClure:

blackhole12.deviantart.com/art/Sytrus-Synth-Creation-Part-1-75704794

Erik published his manual as JPG images. I tried to find other written tutorials but the manual by Erik worked the best for me, except the images. I tried to read the help by Image-Line but it was too challenging for me as beginner and I could not easily put it on a reading device or print it. Most of the time I came back to Eriks manual.

In early 2013 I chatted with Erik about the manual. He told me that he had given up on converting the manual to PDF. He was all fine with that I would convert the text, after all, his manual was published under Creatives Common v3. In February 2013 the first version of the PDF was published.

In August 2016 Image-Line released FLStudio 12.3 and with it came a new look of Sytrus. I started reworking the text from Erik McClure to match the new version. This time I decided to edit the text as well, considerably:

- The "young language" is removed. No "slapping on", "plunging into" and "crazy".

- The text is not biased anymore. I believe that the reason Erik included opinions about features was because when the subject reached the end of Eriks scope of interest instead of upfront defining the scope the text became biased. My scope is wider and deeper so I further explored and explained these topics.

- I reworked the structure. The different exercises got names so that different parts of the text can refer to earlier exercises. With improved structure it is easier to navigate the text.

- Eriks chapter 5 is deleted. In there he listed his own synths. I did not see any educational value in just listing the settings for synths without any explanation for how something is done or why. All chapters are renumbered and there are new chapters introduced.

If you got this book sent to you but you don't know where it came from then please check out my own server for the latest version of this book on this location: www.malmgren.nl/Sytrus.pdf

I am **not** affiliated with Image-Line other than that I bought a license for FL Studio.

Sytrus Synth Creation

This tutorial covers the creation of synths using the FL studio Sytrus plugin. The version used here is Sytrus from FLStudio 12.3 and onwards.

Presets menu with scrollbar!

When we are creating synths to use in a song, we must keep in mind that a synth is merely the creation and modification of a waveform. It is possible to read the text without doing the exercises but the text is written as if you do, but that is up to you.

Before we begin we need to set up a new project that will help us understand Sytrus. In the main menu bar go to File –> New from template –> Minimal –> Empty and then follow the steps on the next page.

1. In the channel rack click the plus button. Select the Sytrus plugin.
2. Set the channel to output to mixer track one.
3. Open the piano roll and place one note B4 one bar long.
4. Set the Default preset inside Sytrus. In the upper left corner of the Sytrus window you find a drop down menu. Expand Presets and select "Default".
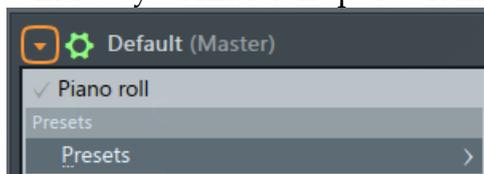
5. Lower the frequency ratio to 1.000. In various synths throughout we will have different values on the frequency ratio.
6. Insert a Wave Candy effect in effect slot 1 of mixer track one. When mixer track one has a green slider button then it is selected, then hover over the effect slots of mixer track one. When the tooltip window displays "FX slot 1 options".
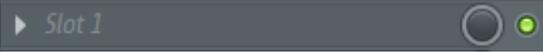
   Left click slot 1 and a menu will be displayed. Select WaveCandy.
7. In the WaveCandy window select the Oscilloscope tab.
8. Set Update to 19 ms.
9. Set Window to 10 ms. A larger window displays more waveform cycles.
10. From here when we play sound, the WaveCandy window will display a graph. That graph is really useful for understanding what is going on in Sytrus.

If you are creating a complex synth and you by accident switch to another preset before you saved it then it will be lost. To avoid this, you can save the entire project and also configure FLStudio to auto save every 5 min. Go to options −> File Settings and set auto save in the backup section, go to the manual for help of finding the backups in case you need them. With a project saved you can just hit Ctrl-S to save your progress on the synth without risking hitting the wrong button or if you forgot to save it is saved for you. All right, we are ready to start investigating Sytrus!
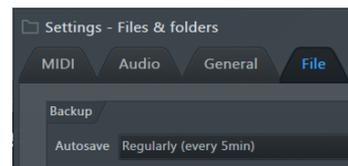
1. Basic waveforms, Chorus

In this chapter we will discuss the basic waveforms that you can see in the operator tabs of Sytrus. We will use our visualization project to experiment with the waveform to see the output in the oscilloscope view of WaveCandy. Set the default preset in Sytrus and let's begin!

Here above you can see a couple of things marked with blue rectangles etc. That are the things we will discuss in the text below.

On the top of Sytrus you will see a row of tabs. Select the tab labeled "OP 1. Use the keyboard at the bottom, play a few notes. You can also use keys on your computer keyboard or (if you have a music keyboard connected you can play a few notes on it). In the upper left corner, you can see a window showing the current waveform

along with a series of sliders that control the shape of the waveform. If you right click the waveform it is possible to select a couple of the basic types.

Sine

This is a simple waveform that often forms the basis of more complex waveforms. Most traditional music instruments generating sounds with help of something vibrating often produce sounds similar to simple sine curves

Saw

The saw waveform is the stuff you often hear with electronic music. If you're looking for something synthy, this is probably the waveform to start with.

Triangle

The triangle is a less used waveform, sort of like a sharper version of the sine wave. Violin and strings sometimes use waveforms derived from this, but the other basic waveforms are usually used in place of the triangle waveform.

Square

The square is often used in hyper sounding synths, and they have a very distinctive sound (as well as a distinctive waveform). You can get some very nice high pitched synths with this form, as well as good bass if you manipulate it correctly.

These are presets selectable by right clicking on the graphical representation of the waveform and selecting them from a drop down list. To really get into creating waveforms we need to start playing around with the sliders.

Bent Saw

This is very often used in FM synthesis (we'll look at that later on in the tutorial), and it is very popular in euro saw synths.

Tempered Square

A sine wave with an extreme amount of tension, this is a softer version of the square synth, with a slightly softer tone to it.

Saw Sine

This is an incredibly useful for string synthesis. With a proper filter, this waveform can create long, flowing notes.

Square Saw

A harsher synth form, this is a very versatile waveform to work with.

Waveform sliders: Shape, Tension, Skew, Sine Shaper, Pre-filter and Noise

There are six waveform sliders.

Shape, SH

The more you raise this slider, the closer the waveform will get to a Square synth. It begins at 0% (A sine wave), passes through 25% (a triangle wave), then 50% (Saw wave), 75% (Square wave), and finally 100% (pulse wave)

Tension, TN

This increases or decreases the severity of the wave. If you drag this down to 0%, you will notice that most of the wave will now be silence, with only the very high points still visible. If you drag this up to 100%, you will notice that almost the entire wave has been pushed to the top or bottom, and that only the very nearly silent portions of the wave still remain that way. If done on a sine wave, pushing the tension to 100% results in something very similar to a square, and if you check the values on the 'Tempered Square' waveform as detailed above, you will notice that is exactly how it was created. The "Bent Saw" was also made this way.

Skew, SK

The best description of this slider is that it squishes the waveform into the center. The "Saw Sine" uses this.

Sine Shaper, SN

The best way to figure out what it does is to try using it on a sine wave. Two additional sine waves will appear in the upper left corner and bottom right corner. This is useful for things like bell synths, usually left at 0%.

Pre-filter, FL

The pre-filter is used to reduce the number of points making up the waveform graph. This technique results in smoother waveforms and is commonly used in organs or woodwinds. In any other synth, it is usually left at 100%.

Noise, NS

The percentage of noise does exactly that - replaces that % of your wave with random noise. At 100%, you will no longer be able to hear your waveform at all, as it will be noise. This is used for wind and air effects, and is used in a synth we will be making later on. This is usually left at 0%.

While you are having fun with the sliders, try pressing some of the buttons that are below the waveform graph. The button on the left cuts the waveform in half, only using the first half.

The middle button inserts a band of silence - use it on the basic wave shapes to see its effect. The button on the right takes the absolute value of the wave, so it will all be above the middle line. On a sine wave, this will result in two small humps, while on a saw wave it will result in something resembling a seesaw. These are not often used, but we will be covering some synths that do use them.

In addition, there are several other parameters and tweaks in this top section of the operator, but for now we will ignore most of them.

We make: Simplicity

Now we will start creating our own new synth preset. It is going to be called Simplicity. In case you changed things here and there you can reset Sytrus by setting the Default preset.

On operator 1 let's set the oscillator to the saw waveform. Now, if we play a note using this waveform, it's going to sound very unrefined, and that's because we need to add some choral effects.

Chorus effect

Now we activate the FX tab and in there we can make changes so that our saw wave

will run through various effects. One really useful effect is Chorus.

The chorus effect is achieved by mixing the sound with one or more delayed, pitch-modulated copies of the sound. The pitch of the added sounds is typically modulated by an LFO, low frequency oscillator.

Chorus is an easy way to add depth and texture to your synth, and it is used in lots and lots of synths.

You can see from the settings, that we have an order of 4 on our choral effect, as well as the default settings for the tabs. Thus the chorus is using 4 copies of the original sound. The order of the chorus can range from 0 (**turning off** the chorus effect entirely, sometimes you want to do that too) to 9. An order of 1 greatly exaggerates the "wahwah" of a chorus effect. As you increase the order, the panning will start to take effect, and the effect is less obvious. Most choral effects are on an order

> Avoid The Extremes
>
> A good rule of thumb in synth creation is to never go to the extremes. The synthesizer is designed to have reasonable limits set on its sliders, but even with those limits, pushing sliders to their absolute extreme is more than likely to result in bleeding ears than a cool synth. This doesn't apply to everything though. Things like mixing and other volume related things are almost always set to 100%

of 4 or 7, sometimes 2 and occasionally 1 (A chorus of 1, however, is difficult to work with, and usually ends up sounding bad. Avoid 1 and 9 if you can).

Before we edit our chorus settings, we need to make some adjustments to our synth output. If you look at the matrix on the right side of the window, you can see that it has rows corresponding to the tabs. 1, 2, 3 etc. for OP 1, OP 2. OP 3, as well as Pan,

FX, Out, and the 3 filters. Ignoring the filters for now, we need to know exactly how FX and Out works. Currently, your synth is routing 100% of its volume directly into the Out channel, with no filter processing whatsoever. We want to change this so that it also puts 100% of its volume into the FX channel. To do this, we click the corresponding dial and move it all the way to the right by dragging our mouse up. In the upper left hand corner of the screen (the tooltip area under the menu) it should say "100%".

Out and FX are the only two ways you can produce sound. Out will produce completely unprocessed sound, and FX will produce sound modified by the effects. We'll look into more FX settings later. For now, hit a note and notice how it is now much richer in tone. You can modify the produced sound by changing the order of the chorus (drag up on the number to increase, down to decrease), and by playing around with the various sliders. Our WaveCandy window displays this:

When increasing the order to 9 then this is the result:
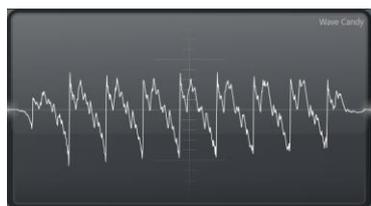
Depth, DP

This does what you would expect it to be - it Increases the depth of the chorus and gives it a fuller texture. This slider sets the amplitude of the pitch oscillation for each copy of the sound. I tend to prefer having this at or near 100% as it produces a fuller voice, but if you're looking for a sharper, more defined voice, try a lower value (near 0%) instead. As always, experimentation is key, and it's hard to make a synth sound bad with this slider.

Speed, SP

This controls the speed of the "wahwah" effect, the flange speed. Putting this slider at 100% is a great way to make your synth sound horrible - Usually this value should be between 65% and 85%, and sometimes between 10% and 20% if you're looking for a really slow choral effect (there are, however, better ways to do that).

Delay, DL

This is the amount of time it takes for the chorus effect to come to full strength. When dealing with plucked or extremely short synths, it is recommended to keep this setting near 0% and probably no higher than 25%. 5% and 10% are good values as it gives the synth a bit of subtle lead in and helps create a refined feel.

Spread, SR

This is how obvious your "wahwah" effect is going to be if you have this at 100% which is what I usually prefer, your choral effect will be spread among the number of copies of the sound. Keep this at 100% if you're looking for a synth that has a constant sound, putting this at 0% produces an immediately identifiable effect.

Cross, CR

This slider determines the arrangement of the sub-voices and how they interact. The effect of this is that a high positive value will result in the synth appearing to come from in front of you. while a high negative value will result in the synth appearing to come from behind you (if you happen to be wearing headphones, at least). Creative use of this effect can help when you're separating instrument locations to avoid blurriness.

Volume, VL

This controls the mix of the choral effect sound and the original sound. When the slider is at 0% it is the same as setting the order to 0 i.e. turning off the effect.
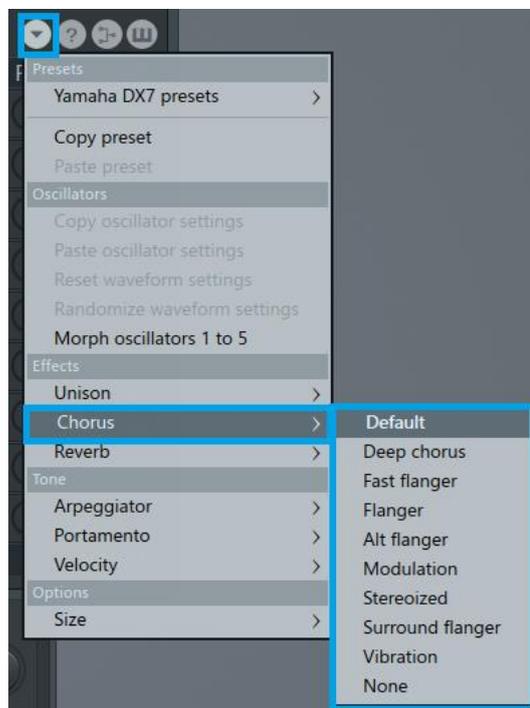
More chorus options

In the options menu there are more options for chorus. These options contain pre-programmed settings of the chorus sliders.

For our synth, set the values to be the something like the image to the left but you can set them to whatever you like. Now we have a cool sounding synth with only a basic saw wave routed through a chorus effect!

Now we're going to reroute the sound through a filter to process it, and then output it through to the chorus effect. To do this, we must reduce OP 1's FX and output percentages to 0%. Put the cursor on the FX and out operator knobs and **click on the mouse wheel to turn off** both of them.
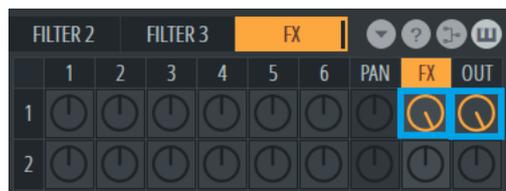
Throughout this manual we will talk about the matrix many times but before we continue I would like to point out that you could also think of Sytrus as a "6xOsc synth". In the picture to the right you can see how to set the knobs for doing just that. In Sytrus it is called operator (and not oscillator) because an operator makes it possible to change so much more than that just the waveform. With this setup you can achieve really many sounds but Sytrus got a lot more power than just mixing 6 oscillators so let's continue with our synthesizer, but first make sure all knobs in the matrix are turned off.
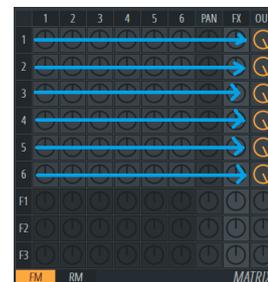
At the row F1 in the column 1 (for operator 1) increase the knob to 100%. Then, if we're going to hear anything, we need to have Filter 1 output to FX and output, again 100% each. To the left you can see how the matrix now should look like. Now the sound from operator 1 is routed through filter one and then through the chorus effect. Now if you play a note, you will notice the range of frequencies has been reduced greatly.

Go to filter 1. This is where you choose the type of filter and tweak its parameters to your liking. Currently, we are using the default Chocolate State Variable filter and its default parameters. The state variable filter is rather complicated, so we're going to choose a different filter for our saw synth. Right click the panel that says "SVF" in it and choose the item labeled "Lime Low Pass" (Alternatively you can just click and drag up until the letters "LP" appear).

A low pass filter is very well described by a graph in Fruity Parametric EQ2. It is configured to let frequencies below the cutoff point to pass through. The cutoff point frequencies can be amplified. That peak is called the resonance effect. When the peek is higher the effect is more pronounced. Chapter 5 talks more about different filters.

The filter icon is exactly the graph here above!

This filter has 3 parameters: Envelope amount, Cutoff frequency and Resonance. We don't care about Envelope amount right now, but we do care about the cutoff frequency. Because this is a low pass, the lower the value on the cutoff frequency knob, the less sound will get through the filter, because you're cutting off the waveform at a lower and lower frequency. On the flipside, if you turn the cutoff frequency all the way up, the filter won't cut off any sound - Try different settings and play different notes to get a feel for it.

For our purposes, we don't want to slice off any sound (yet), so set the cutoff frequency to 100%. For now, a 30% resonance value is good for our filter.

Now that we have our filter set up, let's go back to the FX tab to take a look at some of the other things we can do, the Pan knob on the upper left lets you adjust the center location of the chorus, panning it to the left or the right. I usually avoid panning just one single effect on a synth as it tends to make the synth lopsided. If you programmed for example two effects, then you could pan the two to left and right etc.

In the center, marked Send, it possible to reroute the effect sound to a separate mixer track if that is what you want. This can be useful if you for example create a bass sound but you want the effects of the bass to be mixed differently than the bass itself. For example, you might want to apply ducking on the effect. Ducking is that the sound is lowered in volume to leave room for other sounds in the mix.

On the right hand side, we have a set of 4 tabs - 3 delay banks and a reverb control. Let's start by clicking on the first delay bank D1.

Delay
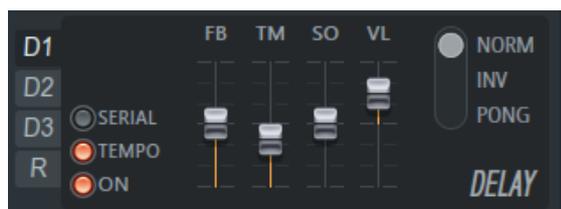
To enable delay effects, click the *On* button and then play a short note. You will notice it now has a delay (or echo) effect, similar to the one produced by the Fruity Delay 2 postprocessor.

The radio buttons on the right hand side toggle what type of delay it is - Normal, meaning the delay will occur on the same side as the instrument, Inverted, meaning the delay will have opposite panning, and Ping Pong, meaning the delay will "bounce" between an inverted and a normal panning state. I have a preference to using Pong for most of my synths as if is a cheap (CPU-wise) and easy way to add depth to a synth.

Above the *On* button there is a led *Tempo* that when enabled makes the time based on the tempo of the entire track.

The four sliders control the parameters of the delay.

Feedback Level, FB

This is the percentage of volume, 0% to 100%, that each successive echo has based from the previous one. The higher this value, the longer the echoes will last, and the slower their progression to being quiet will be. The lower the value, the shorter the time it takes for the echoes to fade away.

Time, TM

This is the number of beats between each delay in milliseconds or in relation to the tempo. Its default setting is 3, but 2, 3, 4 and 6 are all commonly used. A value of 1 will produce a reverb-like effect that may be desirable when you have a lower tempo.

Stereo Offset, SO

This adds a slight delay and a panning offset (either left or right) to the effect: usually used in conjunction with the Pong setting. Max 500 ms left to 500 ms right.

Volume, VL

This controls the volume of the initial delay, -100% to 100%, and is usually set around 50%; setting this to a negative value results in the delay with inverted phase. We will talk more about phase later.

Delay 2 and Delay 3 are the exact same as Delay and allows you to layer on multiple echoing effects. A combination echo of time 3 and time 4 often sounds nice. Now, let's look at the reverb tab.

Reverb

The reverb gives a feeling to the sound as if it is played in a room.
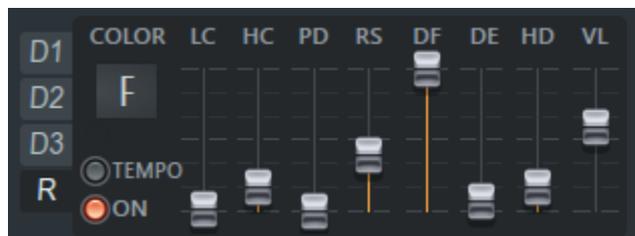
To enable reverb, click the *On* button. To make the time tempo based enable *Tempo*. Above tempo you find the color setting of the reverb, here above set to "F". The color sets the decay time of the bass frequencies. The options are: Warmer (W+), Warm (W), Flat (F), Brighter (B), Bright (B+). A bright room has a low bass response while a warm room has high bass response. A flat coloring has not influence on the bass response. There are eight other parameters to specify the reverb:

- Low Cut, LC. Makes it possible to remove low frequency sound before adding reverb.

- High Cut, HC. Makes it possible to remove high frequencies before adding reverb.

- Pre-delay, PD. The time before the effects starts working. Is specified by the current time mode set by the time button.

- Room Size, RS. Experiment with this!

- Diffusion, DF. Sets how the walls bounce the sound. Hard flat walls or soft irregular walls.

- Decay, DE. Sets the decay time of the reverb, the time it takes to decay the sound to -60 dB.

- High Damping, HD. This sets how much of the sound in the room should be absorbed and muffled by the room. Max value turns this off.

- Wet Volume, VL. Sets how much of the original signal should be mixed with the reverb effect.

There we have it; a simplistic, yet nice sounding saw synth. Next, we will explore the use of envelopes and how they can add lots to a synth, along with some more

complex concepts.

Before we do that we should save this preset. In the upper left corner open the drop down menu.
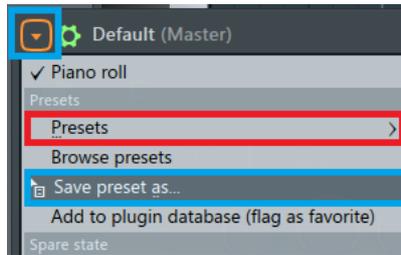
Select "Save preset as…". Give the preset the name "Simplicity". If you by accident hover over the Presets menu-item, then the already available presets are displayed. Then press escape to close that menu and go on with saving the preset. Don't select another preset before you saved this preset!
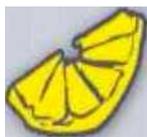
2. Synth creation basics

In this section we will take a look at how to edit envelopes and the basics of synth creation.

We make: Watery Pluck Synth

Open the Default preset. Then select the filter section, we need to adjust our mixing. We want to take the full strength of Operator 1 so we will mix that at 100% while reducing its unfiltered output to 0%. We also want to add about 68% of operator 2, and then take the result of the filter and output it at full volume through both FX and basic output.

Operator 1 and 2 routed to F1 via FX and out.

When mixing two operators to a filter we produce a stronger sound and layering different base waveforms on top of one another creates a layered effect. In this case, since we are only using a base sine wave, adding on an additional sine wave helps strengthen the synth and makes it more noticeable. Now, in the filter, we are going to do something different. Near the letters "SVP there are a series of radio buttons. The one currently highlighted is labeled "x1", and above it there is one labeled "off." Click the "off' radio button - we have now completely disabled the filter. If you are getting clipping problems, simply reduce the volume of the channel. So why are we routing operator signals through it? Because of the mixing - in order to mix operator 1 and operator 2 we have to do it in the filter itself or they will both get individual FX effects and interfere with each other. Now that we've disabled the filter, let's go to the FX tab and adjust our chorus effects.

Chorus Settings

Order 9 | Depth 100% | Speed 80% | Delay 53% | Spread 100% | Cross 0% | Volume 100%.

This synth uses a 9 order chorus for a reason. If you reduce the chorus to 7 you can hear slight aliasing problems. Now that we have our chorus set up, we can play around with our Delay banks. Select the first delay bank and turn it on - we will be using its default settings. Play a short note - we have an echo on our synth now, but it's rather plain. To solve this, open up the second delay bank, enable it, and change its time value to 4:00. Now if you play a short note, the dual echoes enhance each other and create a rich texture.

The two delay banks

Our effects are now set up, and we can get to the real part of this - a pitch envelope. Navigate to the Operator 1 tab, choose the "pitch" tab, and make sure "ENV" is selected.

Here is the envelope editor. While this type of editor also controls LFO, keyboard mapping, etc., the actual editing controls are the

same for all of them. By default, the editor is in Slide mode (Yellow arrow icon). Snap (Green magnet) will snap the points to the grid, and slide slides the rest of the points after the one you selected. Step (Pen) is an alternate mode of editing that can sometimes be useful, but should largely be left alone. Freeze (Snowflake icon) locks all editing.

Starting with a clean slate

The default envelope shape only works for some synths, and you may find yourself deleting it many, many times. To speed up this process, enable "step" editing mode, right click on the right side of the editing window and drag the mouse across to the left side. This will delete all the points except for the origin, giving you a clean slate.

In slide mode when we want to erase right click a point and click "delete" on the popup menu that appears. Do this for all the points, except the first point, which is known as the origin and cannot be deleted.

At the left side below the envelope there is a checkbox you need to set to enable the envelope.

Make sure the pitch is enabled.

Now we will make our first envelope and it will be simple. Add a point to the editor, wherever you want, by right clicking somewhere in the window. A line should now connect the origin with your new point. Left click your new point and move it so that your editor looks something like figure 6.
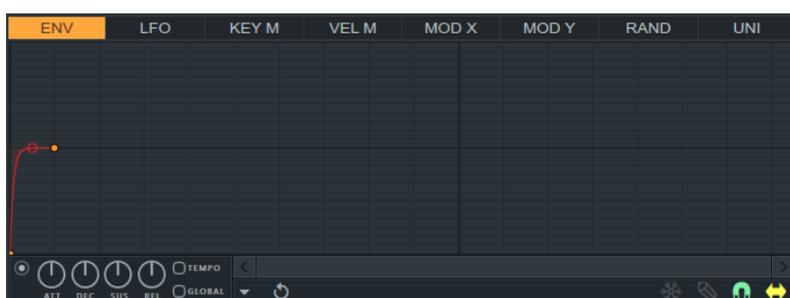

Figure 6: Putting down the first point

Figure 7: Creating the curve

The line connecting the two dots is our entire envelope, and we can adjust the amount of curve it has by clicking the handle in its center and dragging up or down. We want a very extreme curve, so click and drag up as far as you possibly can, until you match figure 7.

There is one last thing to do with the envelope. Near the middle, there are two buttons, "tempo" and "global." I will explain global later, but what we want to do is click the "tempo" button. When you do, the lines in the editor will change, and your point will no longer be aligned to the grid. To fix this, just click and drag your point around so that it snaps to the new grid size.

Why was a new grid size created? If you scroll to the right (Or if you zoom out by moving the scroll wheel down), you will see a highlighted vertical bar on the grid - this represents a measure, and you can probably figure out how the other bars correspond to this in terms of beats. We have set our pitch to last for exactly 1/16th of a measure, so if you adjust the BPM, the effect will get shorter or longer in response.

Enabling Tempo Mode
When you click the tempo button and the envelope hasn't been enabled, it is automatically enabled. Thus, you can save yourself a mouse click by clicking the tempo button instead of the enable button.

> **Using Tempo Mode**
>
> The tempo mode is useful not only for keeping your synth effects in time with the beat, but also for timing the envelopes in general. When tempo mode is enabled, the bars let you know exactly how long your envelope is going to last, 1/4th of a measure, 1/2 of a measure, etc.

Operator settings

Now, we have a few last things to do if we're going to finish off this synth. Navigate back to the OP 1 tab and notice the four toggle buttons on the right side of the waveform sliders.

Center

Sometimes a waveform will, for whatever reason, be biased to the top or bottom of the spectrum, Center will center an operator's waveform so that it stays in the middle of the spectrum. It's usually pretty obvious when a waveform isn't centered, as your oscillator viewing window (by the volume level) will show a waveform that's either really low or really high.

Declick
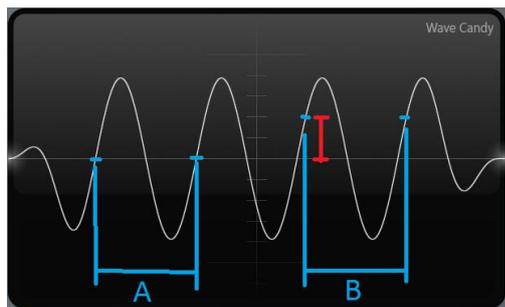
A waveform, such as A in the graph to the left, that start the oscillation from silence, a volume 0% and then from there oscillates, that type of sound is free from any clicking. A waveform such as B starting from a bit into the oscillation, for such sound the beginning may come so abruptly that a clicking sound occurs.

What de-clicking does is that it creates a super-fast increase of volume from 0% to the starting point of the oscillation, marked with red in oscillation B. This quick but yet gradual start of playing the waveform eliminates any clicking.

Band Limit

This band limits the waveform, which helps in aliasing problems; if your wave has extreme amplitudes (or is just loud in general). It doesn't hurt to enable this.

Pluck

This changes the operator synthesis mode to Pluck. We will cover this in chapter 4.

Phase

Often when waveforms have a changed phase, "the starting point of the oscillation", that might result in clicking. Our current synth is clicking right now.

 If you want to change the starting point of a waveform manually then it is the phase button you need to change. The manual, the tooltip window and the forums at Image-Line are all saying that this button changes the starting point of the oscillation. What I found is that the phase button changes the start position for how far into the oscillation Sytrus is playing the oscillation waveform.

If you play a waveform and view it in the WaveCandy oscilloscope then you understand why higher phase values makes the oscillation waveform move to the left, it plays earlier and earlier because the starting point of playing it is further and further into the oscillation. With the official explanation you would think that with higher phase values the oscillation waveform would play later and later and shift to the right.

Next to the Phase knob there is a checkbox (led) that when turned on sync all phases on all operators.

Phase cancellation

When mixing sounds, you will come across a phenomenon called phase cancellation. The phase can be altered manually "manually" with for example the phase knob on the operator tab. Change of phase can also happen as a result of the Unison effect etc.

A regular waveform has a positive and negative value. When we send such sound to a speaker the speaker cone moves out and in. When we mix together two identical waveforms of opposite phase they are cancelling each other.
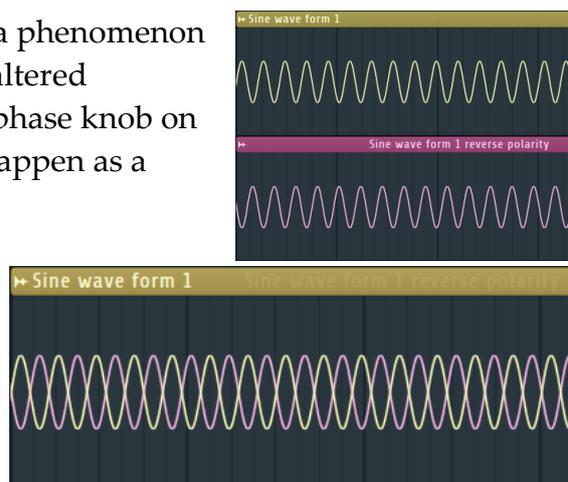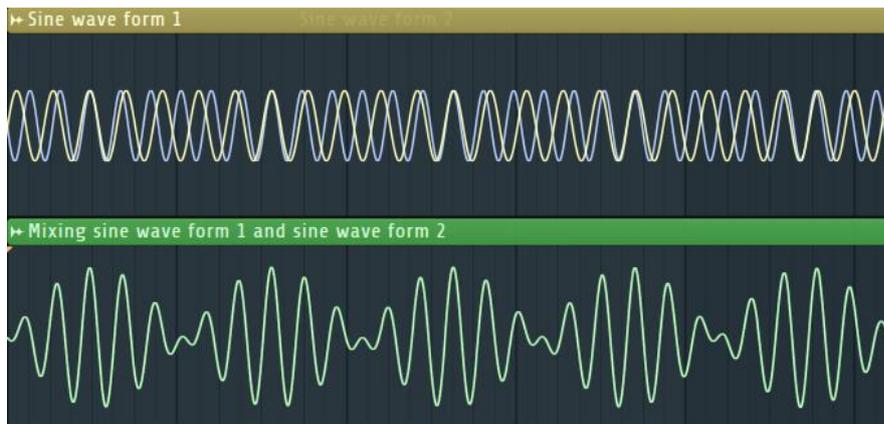
When one sound is going to move the speaker cone out the other sound is doing the exact opposite motion so that the end result is a speaker cone that is not vibrating at all.

Here to the left we are mixing together two waveform. The yellow is sine waveform 1 and the blue is sine waveform 2. When they cancel each other there is almost silence and when they match the sound doubles. The green waveform is the end result of the two. Here the end result is called a rhythmic cancellation.

In modern music this is often used to create something called Reese bass.

Finish the synth

Our waveform is centered already, so we don't need to enable that.

Enable the Declick and notice how the initial click is now gone. We're need to enable Band-limit as well. Enable Declick and Band-limit on the second operator as well.
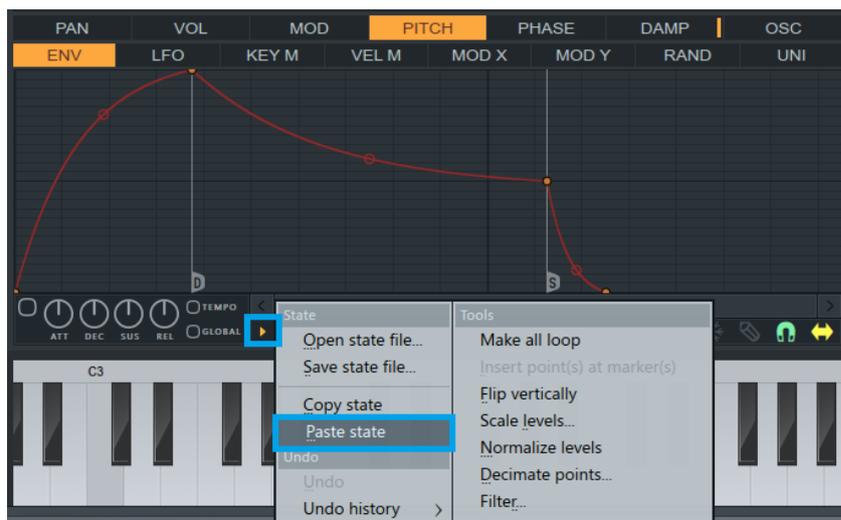
Paste the state after you have copied it from Operator 1

Because we have only made an envelope for operator 1, we will need to make an identical pitch envelope for operator 2. To do this, we click the small arrow button in the middle of the bottom (right next to the Global button), and choose "Copy State." Now turn to operator 2's panel, turn to its pitch tab and click that same little arrow button. Instead of clicking "Copy State," click "Paste State," and we will have successfully copied and pasted the envelope from operator 1 to operator 2 (be sure to enable it).

For the final touch, we are going to go to adjust its frequency ratio for operator 2. Left click and drag down on the big "2.0000" in the window on the right hand side, so that it turns into a "1.0000" and looks like the figure to the right.

Operator 2 is now an octave lower then operator 1, and you can hear that the synth now sounds much deeper.

On the bottom of the main panel you will see a window that has "Patch Name," "Patch Author," and "Patch Description." Highlight the patch name and replace it with your own, then do the same for the author and the description.

Change patch name into Watery Pluck Synth and then save the preset with that same name.

We make: Warp Pluck

Now we're going to return to the synth we created in chapter 1. Open up the preset "Simplicity" and navigate to Filter 1, and make sure the "VOL" tab is highlighted in the panel. It's the exact same envelope shape we saw in the pitch editor for our other synth except in this case, the envelope is modifying the Volume, as we are in the Volume tab. If you went to the "Pan" tab. the envelope there would edit the panning of the filter's output.

So why do we want to edit our instrument's volume with an envelope? Well, we're going to make it "plucked". There is built in pluck feature of Sytrus but we will come back to that later. Here we will make our own pluck effect - to do so delete the default envelope, hit the "tempo" button to simultaneously switch

Figure 13: Give it a good curve!

us to tempo mode and to enable the envelope, then left click and drag the origin point to the top. Once you have done that, add another point approximately 2 beats to the right, on the bottom, and give it a good curve (Figure 13). Now play a note. You will notice that it no longer matters how long you hold down the key - this is because our envelope has no defined areas. The volume is being reduced until the envelope stops, and at that point the volume is at 0 so no matter how long you hold down the note, you will not hear it. Likewise, if you play the note for only a short period of time, because the envelope has not been configured to stop, the envelope continues to function until it reaches its end. If you want to stop it from doing that, right click the point you added and select "Sustain/Loop End." Now when you play a note, it stops when it is supposed to. Raise the point up halfway, and add another point.

Now try playing a short and a long note. Notice how the envelope portion after the sustain loop end point always plays when you release the note, but the portion of the envelope before the sustain loop end point will only play while you are holding down the note. We will discuss this more later; for now, we only need a pluck, so revert your envelope back to Figure 13.

The "S" denotes a sustain loop end point.

Now it's time to have some fun with our filter, click on the tab labeled "CUT". This corresponds to the filter's cutoff frequency knob that you should currently have set to 100%. Likewise, VOL affects volume, PAN affects panning, RES affects the resonance, and LOW/BAND/HIGH does not affect anything because the filter we have chosen does not have those parameters (only the state variable filter does). This time, however, instead of forming an envelope, we are going to use one of the other methods.

Next to the ENV tab you will see a tab labeled LFO. Highlight it, and you will find yourself at the controls of an LFO. An LFO is basically a waveform that is applied to any given attribute on a synth, which loops over and over.
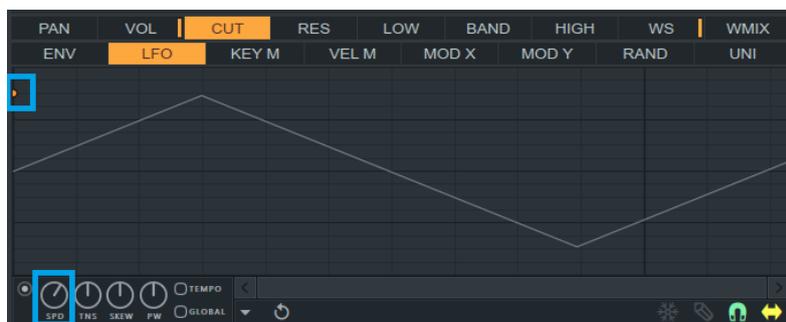
Use the SPD knob to change the LFO

Sytrus allows you to do advanced things with the LFO, but we only really want a

basic one. To get rid of all the points, wipe the slate clean. You will be left with the origin point - notice how in the LFO, it is in the center, not the bottom. This is because the LFO functions in both positive and negative directions. If you raise the origin point **up**, the LFO will begin going positive and increasing the attribute it is linked to (cutoff frequency, in this case), then go down below the line and decrease the attribute it is linked to by the same amount.

For our purposes, we're just going to put the origin **at the bottom** to give the LFO a full range. Once you have done that, click the "tempo" button to both enable the synth

Figure 16. Click the button labeled "Global"

and switch to tempo mode. At the bottom of the LFO editor you will see four knobs. We only really care about the "speed" knob right now, as it determines how fast our LFO wave oscillates. Since we are in tempo mode, Sytrus will automatically snap to tempo-based settings. Set your LFO so that it looks like Figure 16.

Now, play a note. You will notice the cutoff filter is now going down at the start of each note, following the curve of the LFO. However, like an envelope, the LFO is being retriggered each time a note is played. We're going to toggle the "Global" option. Now, if you play many notes, you will notice that instead of being retriggered on each note, the LFO is constantly operative, affecting all the notes at once. It is now a global LFO, and this same concept can apply to looping Envelopes, which we will explore later. To really get a feel for what this LFO is doing, use the new synth on a motif in the piano roll.

You will notice how the LFO is affecting the cutoff ratio based on the tempo time and how it corresponds to the wave. However, the LFO only appears to be affecting the cutoff ratio when it is going down - when it is positive, there is no audible effect, making it seem like its only working half the time. The reason for this is that we've set our cutoff frequency at the highest possible value. When our LFO is in the positive range, it can't increase the cutoff frequency anymore because it's already maxed out. To fix this, reduce the cutoff frequency to 85%.

In chapter 6 we will talk more about the relation between the cutoff frequency and the envelope of for example LFO.

The LFO will now have a more pronounced effect. Actually, its effect will be too pronounced! We can barely hear the synth now! To fix this problem, we must turn to the Envelope knob on our filter.

**ENV 35% |
CUT 85% |
RES 30%.**

The envelope knob is what is controlling the peaks of our LFO and envelope. Currently it is set at 50%, which means our LFO is alternating between subtracting 50% from our cutoff frequency and adding 50%. We can reduce this to 0% or raise it to 100%, but for this synth we want it at around 35%. Now the synth sounds a bit better, but the high part of it seems a bit short, so let's raise our cutoff frequency to 85%. There we go!

We're going to use an envelope to modify our resonance, causing it to peak at the beginning of the note and then falloff to nothing, which should further enforce the plucked nature of the synth. Remember to enable tempo mode before creating the envelope! Now try playing that pattern sequence again. The resonance effect is immediately noticeable.

The resonance envelope.

If we want our synth to be even more obvious, we can utilize the controls at the side of the filter selector: 1x, 2x, 3x, alt 2x, and alt 3x. Click around on them and compare the sounds. Higher values (3x) tend to produce more refined sounding synths by exaggerating the effects of the filter and any envelopes/LFOs you have made.

Flat

The HQ button renders the filter with high quality. You can use it in a draft, or it is usually automatically enabled when you are rendering (that's what the "enable HQ for all plug-ins" setting on the main panel does on export). Flat provides an alternative algorithm for the resonance effect.
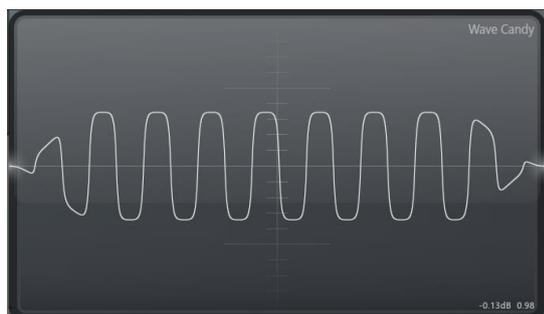
Wave Shaper

As a final exercise, we will look at the controls on the right side of the filter, denoted with the initials "WS." WS stands for Wave Shaper. You can use it to create distortion. Click the *On* button and you will instantly hear a richer, thicker texture on your synth. In the WS panel you see an envelope describing how the input

signal waveform along the horizontal axis is mapped to the output signal waveform on the vertical axis.

An input signal of a sinus curve that looks like this:
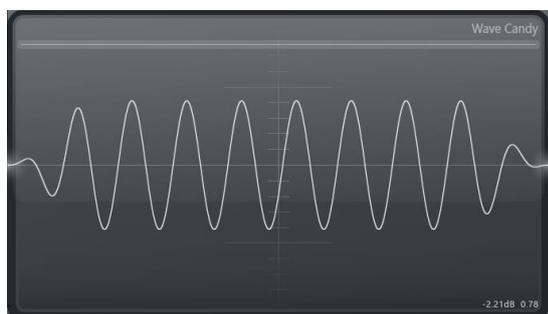
Looke like this when it has been modified by the default wave shape envelope.

To get a feel for how WS functions you could create a curve like the image to the right. It changes the sound into an amplified electric guitar. I'm keeping my wave shaper as a curve dragged all the way down, but you can do whatever you feel like doing.

If you would like the shape to be different between the upper and lower part, then you should enable the plus "unipolar/bipolar mode".
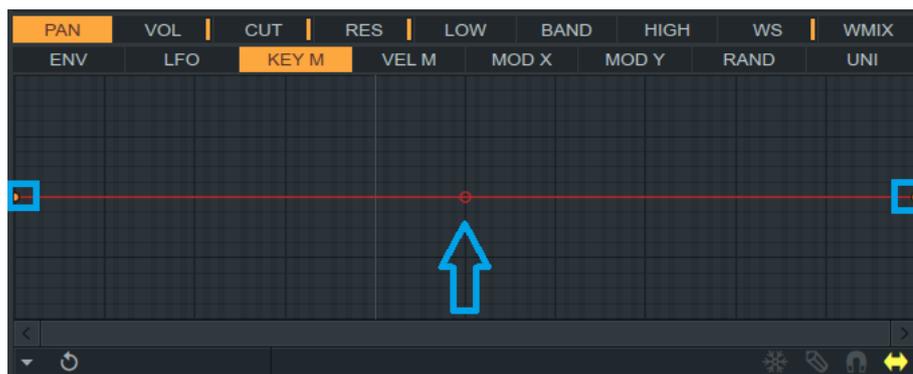
My Amp and Mix Values:

Amp 116% | Mix 66%.

There are two knobs in the WS section, AMP and MIX. AMP controls the amplitude, or strength, of the wave shaping. Mix controls how much of the wave shape mix is used in place of the normal voice. If this is reduced to 50%, half of the sound produced will be from the filter, and the other half will have been processed with the wave shaper.

Key mapping

Go to the PAN tab of filter 1, and as you will recall, the PAN tab controls the panning of the filter's output. Note that it only controls this filter - if we had multiple filters, the other filters would be unaffected by this. Instead of simply creating a pan envelop, however, we're going to use one of the other methods available to us. So far, we've used an Envelope and an LFO. In addition to these, there are KEY M (Key mapping), which allows you to change an attribute based on which key is being pressed. VEL M (Velocity Mapping), which allows you to change an attribute based on the volume of the note played, RAND (Random), which allows you to change an attribute completely randomly, and MOD X, MOD Y, and UNI, which will all be covered later.

If you hover over the grid in the envelope editor and look at the tooltip window you will notice what key the cursor is pointing at. Here the arrow is pointing to C5. Lower the first point to the bottom and raise the second point to the top. Now the lower notes are panned to the left speaker, and the higher notes are panned to the right speaker. If, however, we want to exaggerate this effect, we need to do something special to our curve.

Right click on the second point, and on the drop-down list you will notice several kinds of shapes. Single curve, the one that is selected, is the one we are currently
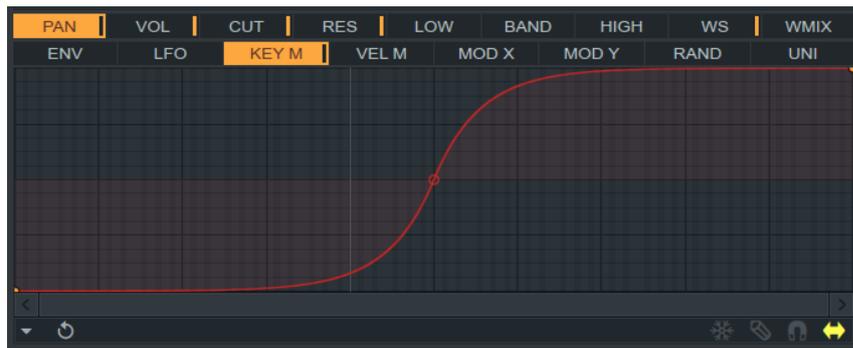
The double curve, dragged down

using. Double curve is the one we want, and the others will be investigated later. Once you have set the curve to a double curve, click the anchor in the middle and drag down. This is a double curve - instead of being a single

curve, it acts as a sinusoidal curve originating on the anchor point. These are very useful for Key mapping and Velocity mapping when you want to exaggerate the effect.

Name your synth (for example Warp Pluck), save it!

3. Main Panel

Master volume, Master LFO and Master Pitch

At the upper left corner of Sytrus you find the main volume, the LFO volume and the master pitch. The master volume makes it possible to increase or decrease the master volume. The master LFO level makes it possible to reduce the volume of LFO globally. Pitch makes it possible to change the pitch. Suppose you set the Default preset of Sytrus to play a C4 in the piano roll and the frequency ratio of operator 1 is set to 1.000 then the tone produced is indeed C4. If you then increase the frequency ratio to 2.000 the tone produced will be one octave higher, a C5. If we then decrease the master pitch with 12 semitones, then although the frequency ratio is still at 2.000 the tone produced will be C4.

Master ADSR lengths

The next part is the global volume envelopes ADSR length setting. ADSR stands for Attack, Decay, Sustain and Release. To try this load the Default preset of Sytrus and go to operator 1, volume envelope. Turn this on. Then go back to the main panel and lower the A slider to the bottom. Now when you play a note you can hear it "turns on" immediately instead of turning on gradually. The other sliders adjust the other parts of the ADSR curve(s).

For the filters the ADSR works the same. For this to work the operator(s) need to be routed through a filter and the volume envelope needs to be turned on for the filters and there need to be an envelope.

Equalizer

The equalizer is useful if you know that your synth needs to change amplification of some frequencies. The equalizer has 3 bands - top, middle and bottom that you can adjust the frequency position of and the bandwidth via the knobs below their sliders. The EQ also has 4 modes - Off, Out+FX, Out, and FX. Out+FX makes the EQ affect both unprocessed and FX output. Out only applies it to unprocessed output and FX only applies it to FX output. Or, you can leave the equalizing to something more precise, such as the Parametric EQ 2.

X/Y Controller

For an in depth explanation of this controller please read chapter 6. The "Smooth" setting of the X/Y controller makes the input smooth. It can be really handy to turn this off if you are playing to create really sharp percussive sounds via automation of the X/Y controller.

Quality
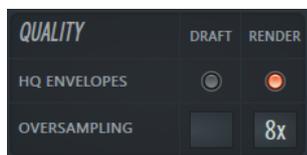
Normally Sytrus is set to work in a draft mode. This setting is good enough to hear what the result will almost be like when rendering. There should under normal circumstances not be necessary to change any of these settings. Perhaps you have a really good computer and high demands to hear exactly what the sound is going to sound like when it has been rendered, then you might want to change the settings here.

Global options
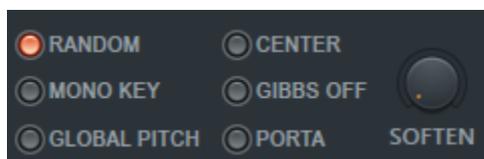
Random

Most synths utilize random things like random noise, and some randomness in unison/choral effects. Turn this off and your synth will be as predictable as the moon.

Mono key

This prevents multiple instances of your synth from playing on the same note. The effect is obvious when you layer multiple notes on top of each other. When mono key is enabled, only one of the notes will play. When mono key is disabled, all of the notes will play.

Soften

This feature adjusts the volume envelope according to the velocity of the key that's being hit, so you can make the fade in of the synth more obvious for quieter notes.

Global pitch

These makes operator 1's pitch envelopes affect the entire synth (yes, the entire

synth, no exceptions).

Center

This centers the waveform, similar to the center option on an operator, except for the total output of the synth.

Gibbs off

This is a method to get rid of the Gibbs phenomenon when oversampling is set to something lower than 2x. Above 2x this should not be necessary.

Porta

This feature is explained in chapter 11.

Unison

Next we will talk about the Unison effect. Unison is an effect created by generating several copies of the synth and then introducing differences between each sub voice. This is similar to how Chorus works. What is the difference between the Unison and the Chorus effect?

- Unison essentially lets the synth play all the sub voices at the same time and then insert differences in phase and pitch (etc) to make the overall sound bigger together. Unison applies the effects based on the original sound.

- Chorus works by taking an audio signal that is pitch shifted, panned and delayed etc and then sent on to the next step of modification up until the order of the effect one after another. Finally, the signal is mixed with the dry signal. The LFO controls the pitch shift.

Unison is turned off when set to 1.

Now we will experiment with Unison by clicking the box next to its sliders, marked with a blue rectangle, and dragging up until the number 2 appears, as shown in figure 11.
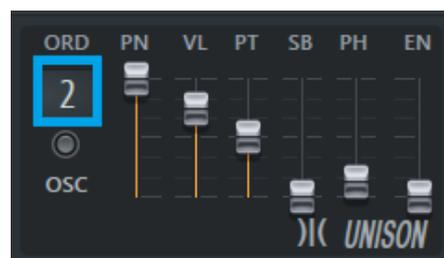
Figure 11: Setting up Unison

Panning, PN

This controls the panning variation between the sub voices. At 100%, the full stereo spectrum will be utilized. At 50% the maximum panning will only be at 50%, At 0%, there is no panning done at all. Be mindful that you will be completely unable to do panning effects when this is set at 100%. If you want your instrument to go from one speaker to another, set this very low, or consider not using Unison at all.

Volume, VL

This controls the volume level variation between the sub voices.

Pitch, PT

This is the pitch variations on the individual sub voices. With too much of pitch variation the synth will sound detuned.

Sub-level, SB

This generates an additional set of instrument sub voices at an octave lower than the current one, and mixes them according to the percentage. If this is at 50%, 50% of the sound produced will be one octave lower than normal, and 50% will be generated on the normal octave. Note that usage of this doubles the CPU usage but for bass sounds it is really nice!

Phase, PH

This is the phase variation put on the sub voices, and is used to widen the sound. Like the starting phase dial, the sounds produced by different values of this depend completely on the synth in question, so experiment with it.

Envelope Variation, EV

When you have a volume envelope set up (or any other envelope, for that matter), this is how much the envelope points are scattered. An interesting effect of this when using a pluck volume envelope is that higher values tend to exaggerate the pluck effect. We talk about the real pluck effect in chapter 4.

Play around with these settings until you've found one that you like. Remember that Unison is your friend - it can very quickly make a synth sound cool. Unison makes almost anything sound cool. Seriously!

Unison visualized
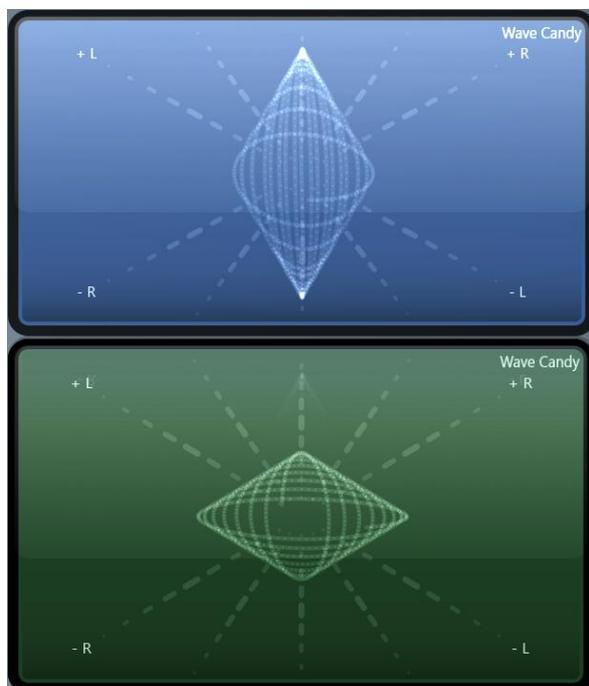
I failed many times to understand how Unison works. That is why I decided to recreate Unison without using Unison. Then I would match my sound with that produced with real Unison and if I could get the two to look the same in a graph and sound the same then I would have proven to myself that I had understood Unison! Perhaps if you read how I did this you can better understand Unison as well. If you already got it then you can skip this and jump to the next section.

As you can see in the graph I succeeded!

For this experiment I start with a new fresh empty project of FLStudio, after I first saved my current work obviously. To channel one I added a Sytrus that I would use for the real Unison. For channel two and three I added a Sytrus each for simulating Unison of order two. In the mixer for track two and three I redirected the sound to mixer track four **only**. In the effect slot of mixer track four I added a WaveCandy that I made blue. That is the upper graph here above.

Real Unison, the lower green graph

In mixer track one I added a WaveCandy at effect slot one. That WaveCandy became green, the lower graph here above.

In Sytrus one I loaded the Default preset. In the main tab I made Unison into these settings as you see here to the right. Pan was 100% | Volume 0% | Pitch 86% | Sub level 0% | Phase 100% | Envelope Variation 0%. This is an admittedly simple kind of Unison effect. If renders really well in the WaveCandy though.

The lower WaveCandy graph was set to the following settings as you can see to the left. What we are seeing is two sub voices panned left and right, that gives the stereo spread. We can see that the phase is not in sync between the two sub voices because otherwise we had only got a line. We can see the two sub voices are out of pitch and that makes the shape wobbling from a flat oval to a tall oval.

Unison created with two Sytrus, the blue upper graph

Can we make this with two Sytrus synths and why two? That is because the order of the real Unison was two. To emulate that we need two Sytrus synths to emulate two sub voices.

For Sytrus two I set panning to minus 40%. Frequency ratio to 2.0374.

For Sytrus three I set panning to 40%. Frequency ratio to 1.9000 and phase to 34.

These two Sytrus synths now works like two sub voices of Unison. They are panning right and left. They are detuned to each other and they start at different phases of the oscillation cycle – the phase.

The Unison settings that you can change in the main panel are all evenly spread among the sub voices. It is also possible to spread the effects unevenly but that is something we are going to discuss in the section about Unison mapping.

Main Menu

Since we're on the chapter about the main panel, let's talk about the Sytrus Main Menu. Here you can copy/paste an entire preset or an oscillator, as well as randomizing and resetting waveforms. You can also morph oscillators 1 through 5.

What this does is best demonstrated. Create a new Default synth, change operator 1 to a saw synth and operator 6 to a Square synth. Click on "Morph Oscillators 1 through 5" and you will notice that oscillators 2-5 are now intermediate steps necessary to transform operator 1 into operator 6.

There are also convenient presets for Unison in the main menu.
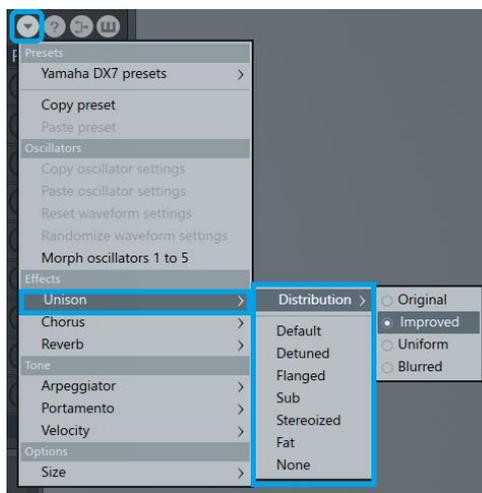
The preset information panel

On the main panel you also find a window with information about the preset. If you share a preset with someone else, it is helpful if you give a brief explanation about the preset in the information panel.
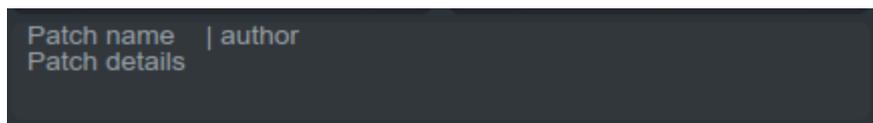
4. Synthesis

It's time to go back to Operators and really dig into some waveform synthesis. If you look at the bottom of the matrix, you will notice two buttons, "FM" which stands for Frequency Modulation. "RM" stands for Ring Modulation and it modulates volume. This is more a modulation of the type "what you see is what you get". We talk about RM at the end of this chapter.

Frequency Modulation

With FM we are automating the pitch of an oscillator with help of another oscillator. The angle of the slope of the controlling waveform tells how fast the controlled waveform is going to play. A horizontal angle on the controlling waveform gives no change in speed. When the controlling waveform has an upwards angle the speed is increasing on the controlled waveform oscillation and when the angle of the controlling waveform oscillation is pointing downwards the speed is decreasing. The steeper the curve the faster.

Decreasing with what? When both waveforms have a frequency ratio specified then the change in speed is relative.

We will make sounds that perhaps don't sounds so well but they make it easy to see what is happens with the waveforms. I made blue arrows in my images of the matrix, there is the target the controlled waveform and the origin of the arrows are the controlling waveform.

Suppose we change operator one and two to these two waveforms here below. Then we frequency modulate from 2 to 1 by 100%. Please note that operator two has a starting phase of 18%.
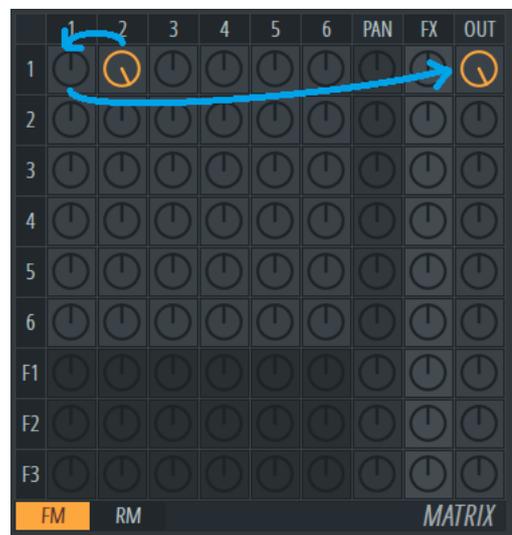
The resulting waveform looks like this.

Operator two is the controlling operator. Operator one is the controlled operator. The form of operator one is that it starts by going up to 100% and then it slides down to minus 100% and then nothing happens for the rest of the cycle. This is the base waveform. Then we are controlling the base waveform with operator two.

Operator two starts with a horisontal curve for a really long time. It is only at the end of the cycle that something happens. If we had not changed the phase then all the action of the controlling waveform had taken place immediately next to the beginning of the start of operator one. By changing the phase moved the controlling waveform backwards slightly so that the action of the controlling waveform takes place in the middle of the horisontal part of the controlled

With this trick we can see what the frequency modulation is doing. The controlling waveform first has an upgoing slope. It goes so fast in fact that the entire operator one waveform cycle is played. Then the controlling waveform goes down again so now the controlled waveform comes back but this time revesed. Then we head up and finally down.

Reversing the waveforms will not produce the same result.

Here is an example of sending operator one to two by 18% and from two to out. The curve produced by these settings produce the graph on the next page.
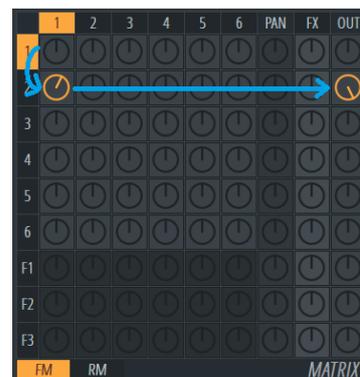
It is as if the waveform of operator one is rippling up the surface of the waveform produced by operator two. The possibilities are endless. It is of-course so that 18% is not so much. It is barely noticeble.

We could also send the two waveforms separatly to out. That produces almost the same curve but more evenly shaped. The uneven result of the previous curve is because the controlling operator has a slight curve so the control speed is not constant.
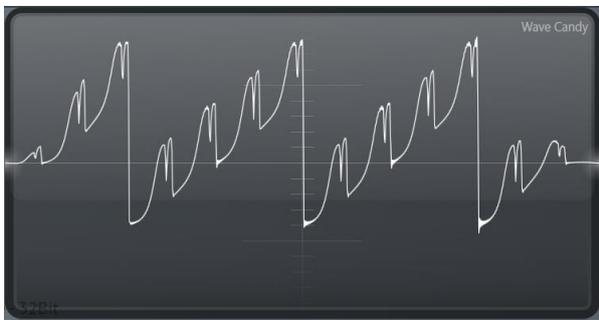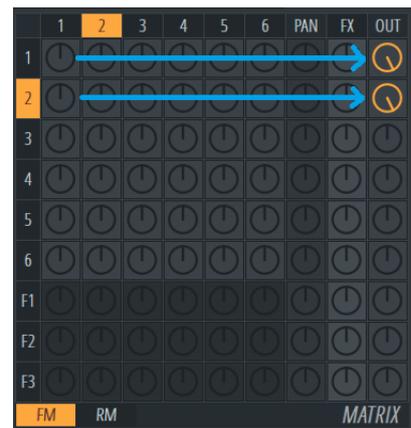

This is what you would call a 2xOsc synth.

When we send operator 1 to 2 by -18% then this curve is produced. See how the shape of operator one is reversed.
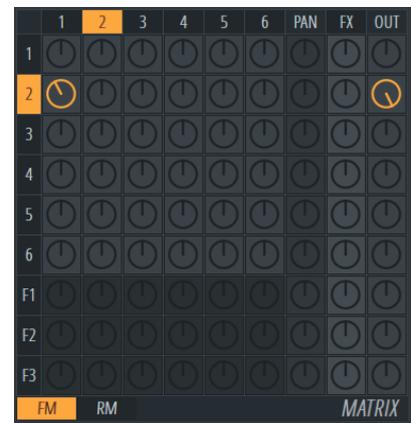
Ring Modulation

Ring Modulation makes it possible to modulate the volume. It is called ring modulation because the original hardware that produced this kind of sound is shaped as a ring.
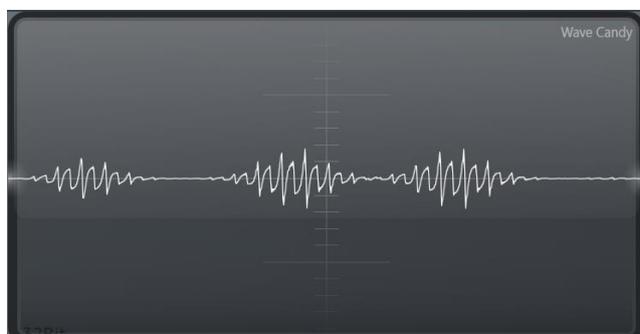
We can illustrate this by making a sound with operator two with a high frequency.
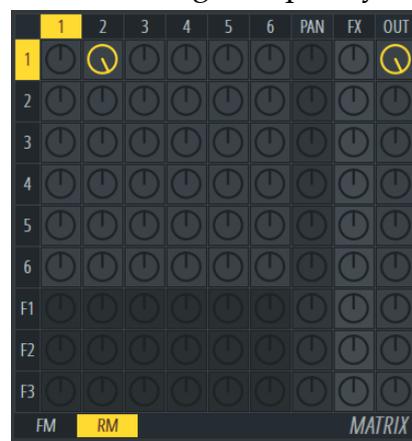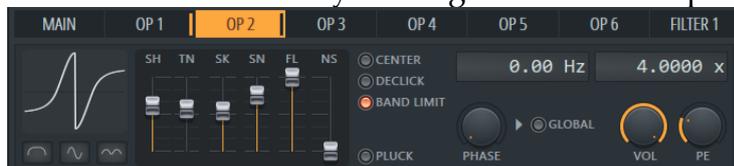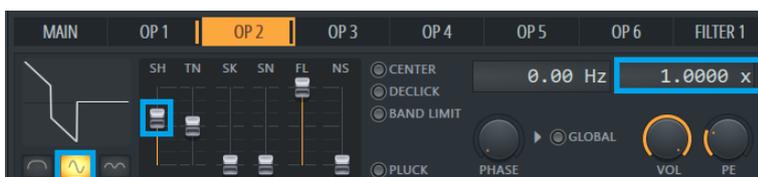

Then operator one is a rather slow frequency.
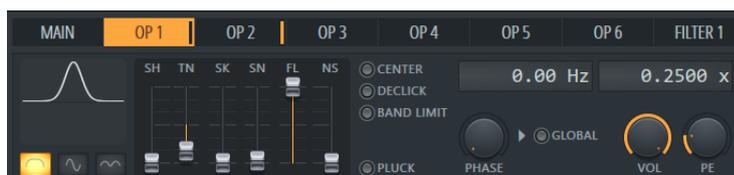
When operator two is sent to one then this is the result.

We make: BagpipeSynth

Now we will start create something that not only looks interesting but also sounds useful. We will call this synth "BagpipeSynth". Load the default preset.

Let's set operator 1's shape to 100% - we don't need to change anything else. Notice that a raw waveform rarely sounds good.

Open up operator 2 and set Shape to about 60% and turn on the even button that looks like a little sine wave. Go to the Frequency Ratio of operator 2 and change it to 1.0000.

Then, go to the matrix, and modulate operator 2 to 1 with 5%, as shown in the figure to the right.

The base waveform in operator 1 is being modified by the waveform in operator 2, in this case, by 5%. This, in essence, mixes the waveforms


Mixing waveforms of op1 and op2
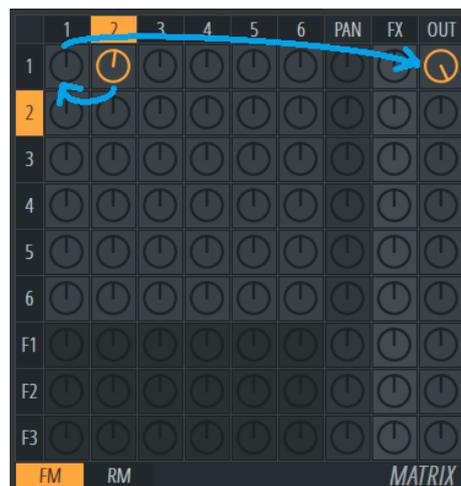
together to form a single, new waveform. If you mixed together a saw and a square, for example, you would get a wave that looked a little like a saw and a little like a square. Because operator 2 has a frequency ratio of 2.0000 and operator 1 has a frequency ratio of 1.0000, operator two is only about half as long as operator one, which makes it about an octave higher. Change the frequency ratio of operator 2 to match operator 1. Now operator 2 has the same frequency ratio as 1 and is on the same octave. For more fun, let's enable the "Even" button on the waveform for operator 2 as silence, its functional part is actually about an octave higher, but its only modulating half of operator 1's waveform. That means that for the silent part of operator 2, operator 1 has no change in its waveform. For the preset that we create in this section we want operator 2 at a frequency ratio of 1.0000 and operator 1 at 2.0000.
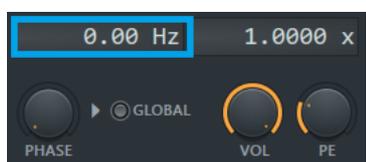
The window, marked with blue, to the left of the frequency ratio is the frequency offset, and you can use it to make very minor changes to the wave frequency: this is useful for low frequency modulation or minor tweaks to the wave frequency, but we'll just ignore it for now. Below the frequency ratio there are two dials. One is the volume, which controls the amplitude of the wave, and the other is the pitch envelope amount. I suggest leaving the pitch envelope amount well-enough alone. The volume however just reduces how loud the wave is.

My Unison Settings

Order 2 | Panning 100% | Volume 100% | Pitch 25% | Sub-level 27% | Phase 70% | Envelope Variation 0%.

Now that we've played around with Unison, let's put in some Choral effects. Choral effects are a very easy way to make your synth sound good, because, like unison, they'll make almost anything that's got a decent base waveform sound good. Just increase the FX output for operator 1 to 100%.

Use That Chorus!

Chorus is excellent. Use it unless you're looking for a very distinctive tone on your synth. If you are just looking for a nice sounding synth, Chorus will give it to you. Use Chorus.

My Chorus Settings

Order 5 | Depth 30% | Speed 80% | Delay 0% | Spread 100% | Cross -100% | Volume 100%.

My Reverb Settings

Color Brighter | Low-cut 45 Hz | High-cut Off | Pre-delay 75 ms | Room size 76 | Diffusion 100 | Decay 2.7 seconds | High Damping 7.4 kHz | Volume 38%.

To give our synth some depth, turn on Reverb and Delay. Delay makes almost anything sound better - however, there is the danger of making your synth blurred or cluttering up your song, so keep that in mind. For my delay bank, I'm using the default settings, but I made a custom reverb setting. What we created here perhaps could be called a futuristic bagpipe? Save this preset as "BagpipeSynth".
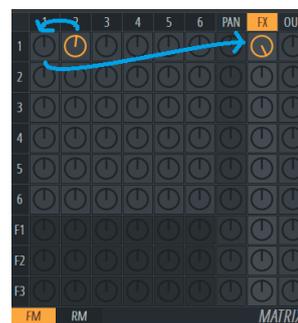
Only FX Output

Sine Harmonics

Please load the BagpipeSynth preset if not already loaded. Enable the OSC sub tab marked with a blue rectangle. This panel displays vertical bands. I changed the width of the scrollbar so that my vertical bands are zoomed in. The upper part of the first band is entirely set. Look at the tooltip while hovering over the bands. The first band says "Harmonic 1 magnitude 100%". When you hover with the cursor below the dashed line at the first band then the tooltip says "Harmonic 1 phase: 0%".

There are in total 255 of these bands. Each band describes a sinus curve harmonic. Its magnitude and its phase, the starting time into the cycle. When hovering over the bands you also notice at the right side of the tooltip window that the octaves are indicated. The octaves are also given by darker bands.

When mixing together more sine curves with various phase in clever ways it is possible to create any waveform imaginable. This is key sentences that you could easily miss but I would like to point out that if you missed the previous sentence then you could read it again, and again. Thanks.

You can manipulate the bands to change the sounds. It is as if the waveform window has a "predefined curves mode" making it possible to manipulate the curve with the bands. Then when


selecting "Convert shape to sine harmonics" the sliders are reset and the sine harmonics window is then displaying the underlying sine harmonics that builds the sound.

When the waveform is converted to sine harmonics the graph corresponds really well with how the sound also looks like in WaveCandy in the spectrum mode. See here below even though the sound is also mixed with another operator and the effects.

Before we start with creating the next synth we will look at how the sine harmonics of a saw waveform corresponds to the WaveCandy spectrum graph when playing it.
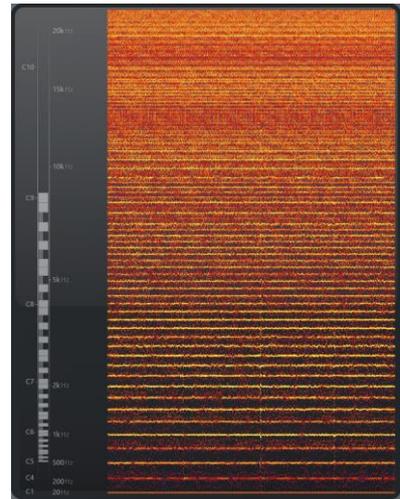
Load the Default preset. Set operator one to a saw waveform. Right click and select "Convert to sine harmonics".

The bands with the lowest frequency is to the left in the osc window. Band 1 has a magnitude of 100% amplitude. Then gradually the magnitude for band two and so on is getting lower and lower. The spectrum diagram shows the lowest frequences at the bottom. They have the highest amplitude displayed with bright yellow. As the amplitude gets lower the higher frequencies gets more an more red until they are purple at the top of the diagram. You can also see a vertical line and that is because there is a little clicking going on at the beginning of each bar.
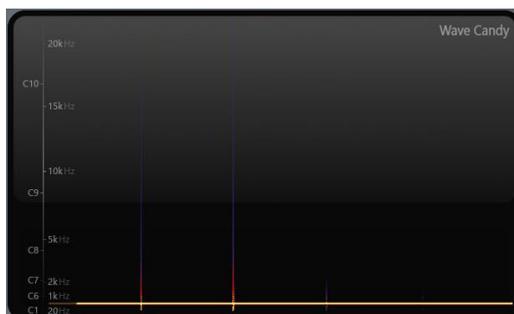
Here is the same analysis done with a sine wave.

As you can see the sine harmonics of a sine wave converts to one band and when listening to it the frequency spectrum light up one line with yellow.

We make: Three bands saw

Now we will create a new synth based on a saw wave. We will call this synth "three bands saw". Load the Default preset into Sytrus. Set the waveform of operator 1 to a saw wave. Then set harmonic of band 1 to 100%, harmonic of band 2 to 75% and finally harmonic of band 4 to 51%.

Now we have a very rich saw synth. Eliminate Operator 1 's output and route Operator 1 into the first filter, choose a Lime Low Pass filter and set the cutoff frequency to 100%, and the resonance to 60%, then give filter 1 both FX and basic output.

Now we're going to switch to the FX tab and remove the chorus by setting its order to 0, then enabling a default delay bank plus default reverb. Then we add a bit of unison, the parameters I used are shown below.

My Unison Settings

Order 2 | Panning 100% | Volume 100% | Pitch ~ 34% | Sub-level 0% | Phase ~ 50% | Envelope Variation 0%.

By not using chorus, but using unison, we have produced a very distinct sound, one that can sound pretty cool in the correct circumstances.

> **Sustained Synths**
>
> Plucked synths or synths that do not last very long are relatively easy to make. Delay and reverb can make almost anything that's very short sound good. Things start getting trickier when you want a synth that can be played for long periods of time, in which case harsh waveforms (like the saw and square) need to have filters and choral effects to soften their impact.

Now we can save this synth and name the preset "Three bands saw".

We make: Smooth that curve

The next synth that we will create will be called "Smooth that curve". Open a new Default preset, navigate to Operator 1's oscillator editor, then click and drag your left mouse button so you get a curve that looks like here to the right. Be sure to zoom out by clicking and dragging down on the scrollbar at the bottom right corner.

This may look like a complicated wave that won't sound good, but the Oscillator Editor has a feature that will help us out. In the bottom left corner there is a button called "Smooth". Click this repeatedly with your mouse and watch as the curve you drew with your mouse is magically smoothed out. After you've smoothed it, reset the first bar to 100% and play a few notes. Because the harmonics are set in a smoothed curve, the resulting wave is relatively pleasant to listen to, and relatively pleasant is all we need to make it sound good.
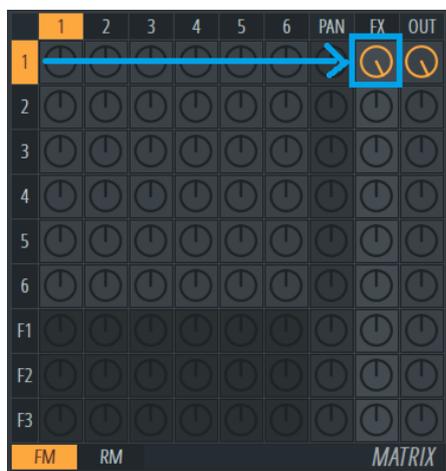
Add some chorus to that, and you will notice that unlike our simpler waves, this thickened wave has a lot more depth, and an increased "fullness" to it. By using the oscillator to create full sounds like this, they come in very handy when dealing with drawn string synths, background synths, or other synths that need what is called a "rich spectrum". Noise can also provide this rich spectrum, as is demonstrated by the Pluck mode. Before we look at pluck mode, feel free to play around with that synth - add some reverb, some echo, try out the unison, and in general just have fun with it. I'll leave it to you to come up with a motif to entertain yourself with. Save that synth though, because we're going to come back to it later and filter it. I will refer to it as "Smooth that curve".
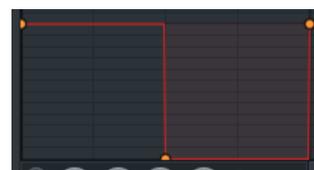
## *Pitch Envelope Automation. We make: RockBagpipeSynth*

It is possible to change a synth into a primitive sequence synth with the pitch envelope. Load for example "BagpipeSynth". Go to Operator 1's pitch value ENV panel and wipe it clean after enabling tempo mode.Then move the origin to the center of the window and create a new point 2 as shown to the left.


Next, right click on the point and choose "Hold." This should give you something that looks like the image to the left. The hold shape, as you can see, is a square, and is useful when you need to suddenly switch from one value to another value without sliding. Right click on a third point at the the position 001:002:000 at 0% on level with the origin and 1 beat away so you get something that looks like the image to the right.
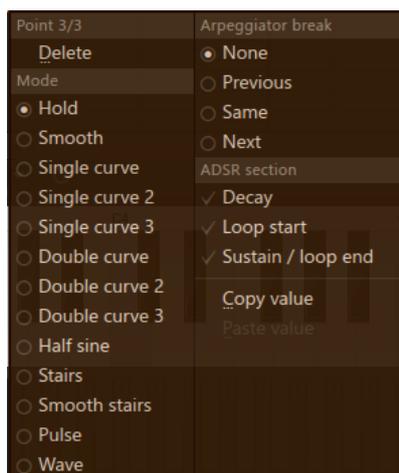
There are 13 curve shapes in total. The hold curve is the only of the curve modes that comes without a tension control in the middle. All the other curve modes will make it possible to change the shape of the curve by holding down the mouse on the tension control and then dragging up or down.
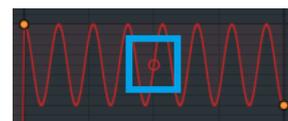

Most of the time this system works intuitively and it is fun to play with. The thing that can be tricky at times is to find the tension control at the center of Pulse and Wave when they are so dense that the red little circle is obscured by all the curve lines. Just keep searching, the point is in there somewhere. When you found it the cursor changes to an up down arrow and then it is time to press the mouse button and drag.

In addition to the delete command there are 3 loop related commands. Loop start, Sustain/Loop End, and Decay. Decay does not actually change anything - it is only a

marker to tell Sytrus where the decay of an envelope begins. Loop Start marks the beginning of a loop, and Sustain/Loop End marks the end of a loop. When the envelope reaches Sustain/Loop End, provided that the note is still being sustained, it will return to the Loop Start point, and continue looping until the note is released.

Once the note is released, any envelope that is located after the Sustain/Loop End point will play. Let's create a loop by setting our second point as the end loop point and our origin as the loop beginning, see image to the right.
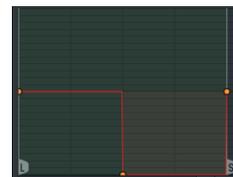
Now, play and hold a note. It rocks back and forth from an octave below. Just like our loop specified (the pitch screen, by default, moves the instrument up to 12 semitones up and 12 semitones down, or an octave up and an octave down).

Our pitch envelope rocks the synth back and forth while it's on the long, sustained note, preventing it from sounding repetitive.

In the menu you also notice arpeggio breaks. We will talk about these in chaptor 10. You can save this synth as "RockBagpipeSynth".

> Loop Point Behavior
>
> It is worth mentioning that the behavior of the end loop point is different if there is no loop start point. If there is no loop start point, the envelope will simply freeze at the end loop point until it is released. Once it is released, any envelope after the end loop point is played. If you do not specify an end loop point at all, however, the envelope will keep on playing no matter what happens!

We make: Noise pluck

Pluck Mode

Now, let's set the Default preset again for creation of a new synth and open the oscillator of operator 1. This time, we're going to do something that normally would not be recommended. Randomly click around the bars like in the image here to the right.

Totally random sine harmonics.

Go ahead and turn on pluck mode for operator 1 and play a note. If you have something that looks like my wave, it will probably sound like a bell of sorts. It will also sound nice - which is rather unexpected with our ad-hoc oscillator editing. That is because the Pluck mode is dependent on only one thing - the richness of the harmonics. You will notice that while in pluck mode you cannot modulate the operator with any other operator. Keep this in mind before using it. Now, let's try something else. While the oscillator editor lets us create rich harmonics, random noise works too. Increase the noise slider for operator 1 up to 100% and play a few notes.

It sounds like a guitar! Well, that's what plucked mode is used for - plucked strings. This is very useful for synthesizing things like banjos, guitars, and whatnot, but it's almost impossible to use for anything that's sustained. In the case of noise, since we have random noise set at 100%, no matter what we do to our waveform (you can go ahead and erase it completely if you want), it will produce the exact same tone. To get unique tones, take a base waveform and then add on about 50-70% noise, which will give you both a unique sound and a good, rich pluck. Chorus works on plucked things too. Set operator 1's FX output to 100% to hear it. It sounds a bit weird because of the choral effect, but there is a little trick we can do to create a cool effect.

Chorus Settings
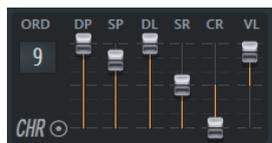
Order 9 | Depth 100% | Speed 80% | Delay 100% | Spread 50% | Cross -100% | Volume 80%.

Strings are very susceptible to chorus delay, depth, and spread. The effect usually only works well with a very high order, but it can sound cool even if it's a bit CPU-hungry. You can produce a wide range of effects using only chorus and pluck. Try adding on a bit of echo too; though this doesn't sound quite as good as if the synth had a filter on to take off some of its sharpness. Save this preset as "Noice pluck".

Oscillator

The Oscillator has a few more interesting tricks you that you get access to via the menu next to the global checkbox.

With this menu you can export waveforms and load waveforms.

You can also record sounds with Edison and select a section of the recorded sound and drag this to the waveform window with the drag button in Edison, see the image to the right.

You can also use the menu to lock various harmonic channels. The "Lock Harmonic" menu option gives you 5 different ways of locking harmonic channels - you can lock all the channels, the even channels, the odd channels, any inactive (unused) channels, or you can invert whatever is currently being locked. This is useful for editing when you need to edit only the even or only the odd channels, or don't want to accidentally activate a harmonic channel while editing.

There are a number of other handy editing functions on the menu, and most are self-explanatory (just experiment with them a little). The Gibbs phenomenon is, well, the only thing you need to know is that it makes synths sound bad so the attenuate/remove Gibbs phenomenon options are extremely handy if your synth isn't sounding too good and you're not entirely sure why. Unfortunately, these options can also ruin your waveform, so keep that in mind.

5. Filter types

Let's explore the various filters that Sytrus has to offer. While the State Variable filter can do almost anything, sometimes a simpler filter is best. The following list can be accessed by right clicking the filter panel.

Here below I made screenshots from the Parametric EQ 2 to illustrate graphically what some of the filters are doing.

The available filters

Chocolate State Variable, SVF

The only filter with the LOW, BAND, and HIGH values, this filter can mimic almost any other filter, as well as everything in between.

Lime High Pass, HP

A simple high pass filter, removing off all the frequencies below the cutoff amount. The peek is the resonance effect.

Vanilla Low Pass, LP2

Another low pass filter, with a slightly different algorithm. Also here the peak is the resonance.

Vanilla Band Pass, BP

A band pass filter, where the resonance controls the bandwidth of the frequencies. A band pass filter, instead of chopping off all the frequencies above or below a certain amount, takes all of the frequencies surrounding the cutoff amount and removes the rest, depending on the resonance value, thus acting as a "middle" frequency filter.

Vanilla Notch, NOT

This is the inverse of a band pass, removing all of the frequencies near the cutoff amount and leaving the rest.

Vanilla High Pass, HP2

Another high pass filter, with a slightly different algorithm.

Vanilla All Pass, AP

The vanilla all pass filter let all frequencies pass through, but changes the phase relationship among various frequencies. It does this by varying its phase shift as a function of frequency. Okay, this here is a guess because the documentation says nothing about this.

Vanilla Low Shelf, LS

Similar to a low pass filter, except with a gain parameter allowing you to exaggerate the filter output.

Vanilla Peaking, PK

The peaking filter is capable of mimicking both the band and notch pass filters. This filter is entirely dependent on the "Gain" parameter as it takes the frequency cutoff amount and "peaks" it based on the Gain parameter, with a bandwidth size again determined by the resonance. This allows you to take a certain frequency band and exaggerate or eliminate it.

Vanilla High Shelf, HS

Similar to a low pass filter, except with a gain parameter allowing you to exaggerate the filter output.

Mango Low Pass, LP3

This is a low pass filter with a "drive" component, allowing you to achieve an effect similar to a very harsh wave shaper.

Cherry Phaser, PHS

This is a phaser filter that lets you adjust the properties of the phaser through the cutoff amount and the resonance.

All filters got an ENV value. This sets how efficient the cutoff is above the cutoff point. It is possible to arrange the ENV value so that the filter is leaking frequencies above the cutoff point.

Filters are a huge part of making synths, especially realistic synths. Because realistic synths are almost always based of a sine wave, they depend entirely on FM modulation and filters to create their sound. The reason realistic synths are always sine-based is because real-life instruments are always sine based. Trust me; the waveform produced by a violin is not going to look like a saw tooth wave. You can also use the knob in the upper right hand corner to feed the output of one filter into the next, allowing you to apply up to 3 filters to the same signal (alternatively, you can apply 3 filters to 3 different signals and have them all output at once).

6. X/Y Controller

Sytrus has a very handy function on the main page, an X/Y controller. These X and Y values are completely customizable and can control whatever aspect of your synth that you'd like to map to them. This controller has the caption "Modulation" and that is fine as such but we already got all sorts of modulation going on in Sytrus so if you don't mind I call it X/Y controller.
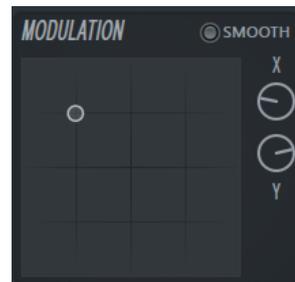
The X/Y controller on the Main panel has a relative influence on the knob it is mapped to. If you for example has the CUT knob set to 50% then the X/Y controller is operating relative to that. In the CUT MOD X window of a filter there you can see that horizontally you have the position of the X controller (or Y if you are using MOD Y).

The exact position that X or Y is currently set to in the main panel is given by a white line. If you go to the main panel and change the X/Y controller, then the white line has moved accordingly when you come back. The input X or Y value horizontally is translated to a value vertically via an envelope. If you look carefully in for example the CUT MODX window, then you can see that when you hover over it with the mouse the tooltip says that the value goes from −100% to +100% vertically. The outcome delta value is added or subtracted to the current position of for example CUT to produce the end result of CUT. In the graph here above when X is set to one quarter then delta is negative 50% (Marked with red) and when X is set to 3 quarters then the output is positive 50% (Marked with green).

With another envelope, for example, when CUT is in 50% and the envelope goes from -100% to +100% then the entire range of the X/Y controller will influence the CUT value. If CUT is set to 0% then only the positive range will influence the end result of the CUT value.

This principle of a knob representing a function in a filter and the possibility to add or subtract via the X/Y controller applies to a number of screens: Keyboard Mapping (KEY M), Velocity Mapping (VEL M), Modulation Mapping X (MOD X), Modulation

Mapping Y (MOD Y) etc. If you start to look around where you notice the -100 to +100 range, there the same principle applies. When the range is 0 to 100 there the influence is absolute, Operator MOD – MOD X for example.

Next we will test this in practice so we are going to return to one of our older synths "Smooth that curve".

Let's reroute operator 1 of so that it goes through filter 1 with the settings shown to the right.

The state variable filter SVF is a filter that can act as many different kinds of filters, because it not only has a cutoff frequency and resonance, but also low, band and high pass. By manipulating the low, band and high pass parameters, you can change what kind of filter it is, and thus change what the cutoff frequency actually does. The low pass can be thought of as cutting off the lower frequencies, the band pass as cutting out the middle frequencies, and the high pass as cutting out the high frequencies. However, the band pass changes its behavior as the high pass changes, so be aware of that.

In our filter, we have the following settings: SVF x3 (HQ) | ENV 50% | CUT 50% | RES 50% | Low 100% | Band 100% | High 0% | WS On | WSamp 150% | WSMix 66%. We preserve the low and middle portions of the frequency but eliminate all the high frequencies, essentially creating a kind of combo low pass and band pass filter. The wave shaper gives us a nice, unique tone to our synth, and becomes instrumental later on when we warp it.

Let's map the cutoff ratio to the X axis. To do this, go into cut, and then MOD X, and you will see an envelope. The far left of the envelope represents the far left of the X axis, and vice versa.

Modulation panel

Manipulate the envelope so it looks like Figure 3. Now, head back to the main screen of Sytrus and look at the Modulation panel. You can either click or drag around the target point, or you can use the X axis knob located on the right side of the panel. Both will change the filter, and you can achieve a cool sounding effect by dragging the X value from the left to the right.
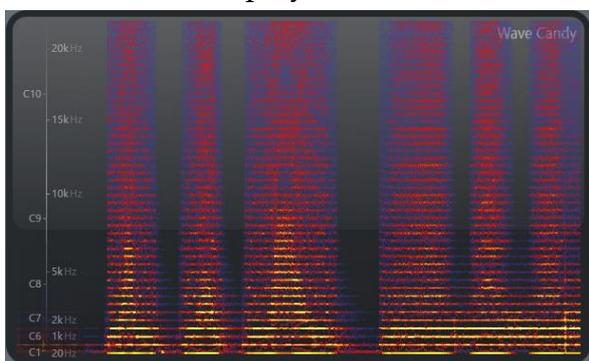

Figure 3: Mapping the X axis to the CUT value

Figure 5: Mapping the WMIX value to the Y axis

Next, let's map something to the Y axis. Since we're using a state variable filter, we can now utilize the LOW, BAND, and HIGH panels, and map any of them to the Y axis just like we did with CUT. Or, we can also map the WMIX value to the Y axis so that the amount of wave shaping effect is given by the Y axis. Let's try that (Figure 5). Observe in the WaveCandy spectrum graph how the sound looks like while manipulating the modulation.

Here to the left I played one note and dragged the x axis from left to the right three times. Then keeping x in the middle I dragged y axis from top to bottom a couple of times. The WMIX value corresponds to the MIX dial in the wave shaper, but it has a different design than CUT, RES and PAN. The setting of WMIX/ LOW/ BAND/ HIGH all use a method similar to VOL, that is, they only reduce, they do not increase. When Y is maxed out, the WMIX value will be 66% because that is its current value. When it is bottomed out, the value will be 0%. Therefore, when mapping these values to the X and Y axis, we have to set them to their highest possible values, not their optimal ones, and then manually choose the best setting with the modulation panel.

Since we mapped X and Y to the CUT and WMIX values, respectively, we can switch to any filter we like and still have valid mappings, since all filters have cutoff and the wave shaper is independent of the filters.

7. Unison Mapping

In regular Unison all modifications to the sounds are spread evenly among all sub voices. With Unison mapping it is possible to specify special cases for the effects for each sub voice. Here we will continue to work on the "Smooth that curve" preset we worked on in the previous section. Before experimenting with Unison I turned off Chorus in the FX tab so that I could better listen to how Unison mapping works.

The unison mapping feature depends on the number of sub voices being used (order) for the Unison effect as it is specified in the main panel. Before we change the Unison mapping it is best to set order and then leave it because changing it will clear the custom Unison mapping envelopes.

Each operator and all three filters and the effects tab all got their own Unison Mapping tabs. The Unison mapping tabs of the operators influence the production of the effect for each sub voice. Then if you send your sound to a filter and the effect then it is possible to specify specific filter or effect parameters for each sub voice.
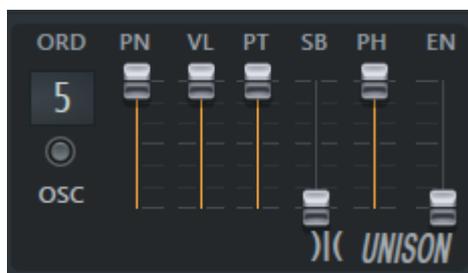
If we in the main panel specify 5 sub voices, then that creates sort of five different "channels" that can have their own filters and effects applied to them when going through Sytrus on the way to out. Here we will work with Panning PN, Volume VL, Pitch PT and Phase PH.

In operator one the sound is created. In the picture to the right I marked the "poles" representing each sub voice of Unison with thick vertical lines. The thin horizontal line represents the "home pitch" of the synth. When placing a voice below the home pitch that voice is lowered an amount given by the PE value at the right. In my graph I made sub voice

1 and 5 bass voices. The third is unchanged. Voice 2 and 4 are slightly higher. I cannot say this sound fantastic but it serves the purpose of explaining Unison mapping.
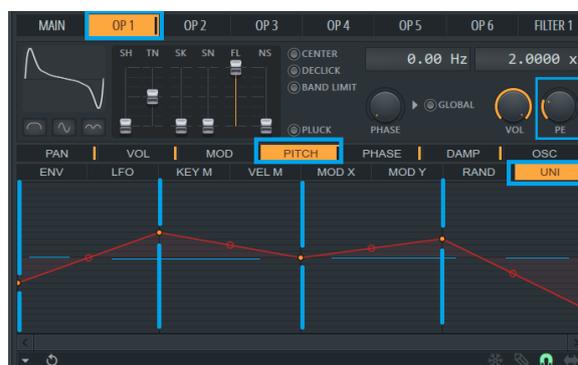
With the panning panel I distributed the voices in the room. The bass voices, one and five are placed to the left and to the right. Voice 3 in the center.

The volume is set so that the two bass sounds has slightly lower volume. The center sound has the highest volume. While working with these settings it was convenient to give only one sub voice a volume to figure out what it was doing and then one by one listen to the different sub voices.

Phase was distributed among the different sub voices.

In Filter one I gave the first, third and fifth sub voice different CUT off values.

Finally, I modified the volume of the effects so that the first sub voice got less volume compared to the center and the right side got much less effects.

As you can see with Unison you get a number Sytrus synths next to each other and the mapping makes it possible to influence how these synths are related. The Unison MOD panel is a great example of this. The envelopes here control how much the waveform is modulated at different percent's. Most of the time we don't change operator one's mod knob because that is operator one modifying itself. However, if we were specifying Unison mappings for operator two then we could individually per voice tell how much per sub voice operator two should modulate operator one. Now you can save the "Smooth that curve" preset.

Pluck mode damp

The DAMP parameter is exclusive to pluck mode, and it controls how much the pluck is damped. This curve is set for all instruments by default, and for traditional plucks is best left alone. However, should you want to adjust it, you can.

We make: Super Saw

Time to make a new synth. This preset will be named "Super Saw". Actually this synth will be made without any modulation. At first we will repeat many of the things we already learned and then at the end of this section we will get to pitch envelope automation. We will make a super saw synth with phase cancellation in mind.

Open up a new Default preset in Sytrus. On the main tab the only thing we will be changing is Unison. Set it to order 9 | Panning 100% | Volume 75% | Pitch 92% | Sub Level 0% | Phase 84% | Variation 25%. Essentially this gives us nine sub voices of Sytrus.
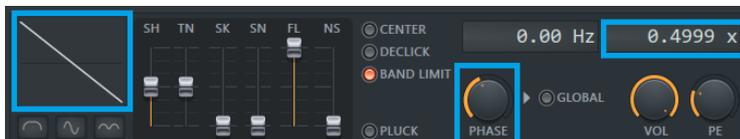
We set all operators to saw waves. That gives us plenty of sine harmonics.
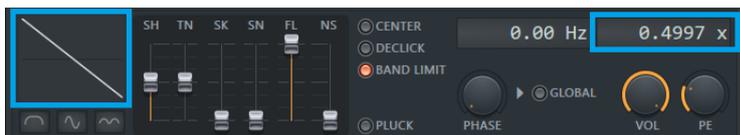
For operator 1 we set frequency ratio to 0.4997 and phase to 0%.

For operator 2 we set frequency ratio to 0.4998 and the phase is set to 22%.
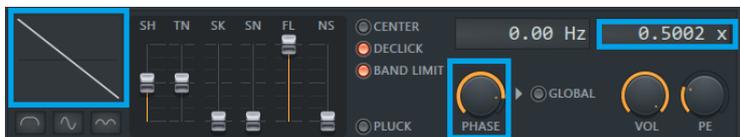

For operator 3 we set the frequency ratio to 0.4999 and the phase is set to 42%.

For operator 4 we set the frequency ratio to 0.5000 and phase is set to 50%

For operator 5 we set the Frequency ratio to 0.5001 and phase is set to 68%.

For operator 6 we set the frequency ratio to 0.5002 and the phase is set to 85%

So for every sub voice of Unison we have 6 operators playing at various frequencies and phases.

These operators we program as you can see to the right. There is no need to be precise on the knobs.

Unfortunately, we don't have 6 filters so here we bring together two operators to use one filter. For the sake of it we mix them with opposite phase just because I could.

Now let's talk about the filters. There came a lot of high frequencies from the operators so to manage that I set all filters to low pass filters.
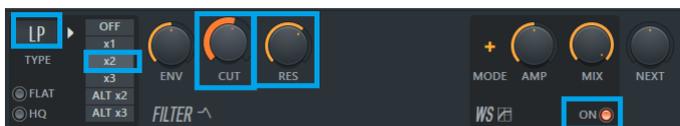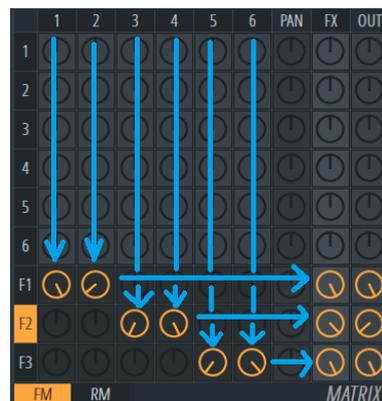
Turn on LowPass x2. Set Cut to 50% and Res to 60%.

Turn on LowPass x2. Set Cut to 40% and Res to 50%.

Turn on LowPass x2. Set Cut to 30% and Res to 30%.

Change to the WS tab and increase the wave shape envelope a bit on all filters.

Chorus settings: Order 7 | Depth 19% | Speed 24% | Delay 33% | Spread 100% | Cross 0% | Volume 100%

Reverb settings: On | Warmer W+ | Rewerb Lowcut Off | Rewerb Highcut 11kHz | Predelay 140ms | Roomsize 40 | Roomsize diffusion 100 | Reverb decay 1sec | Reverb High Damping 4.0kHz | Reverb wet volume 20%

Now let's give the synth the name "Super Saw".

There is another plugin by Image-Line that can make better Super Saw synths and that is Harmor because it can randomize the initial phase but that is an entirely different story.

8. Reshape the sound

In this chapter we will practice many of the things we already learned. There are a few new things such as using the equalizer. For the rest we will deepen the knowledge we already got and put it into practice.

We make: OneOnOne

The idea with this synth is that will modulate operator 1 with itself. Then from there we will do different things to shape the sound at different keys, etc.

Open up the default preset. On operator 1 you lower the frequency ratio to 1.0000. Change the modulation grid so that operator 1 is modulating itself by 100%.
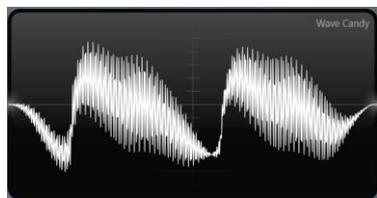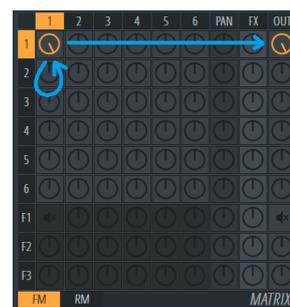
What do we get when modulating a sine waveform with itself? You can see that to the left. What does that mean when an operator is operating itself? The controlling waveform shape speed up the controlled waveform shape, when the slope points upwards, as we are used to, but the controlling and the controlled shape looks the same. However, if we make operator one and **two** to both be sine waveforms of 1.000 frequency ratio then we do not get the same effect as making operator 1 operate on itself so we can make the conclusion that the controlled waveform and the controlling waveform is in fact the same so that the operator is really operating itself while calculating the waveform. When the original sine waveform points upwards the result is a that the oscillation is speeding up. The base shape of what is speeding up is always going to be a sine waveform. At some point the original waveform will slow down and so will the generated waveform.
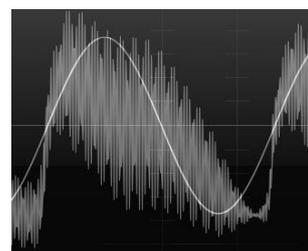
It appears as if the pure sine wave is the only wave that can be modulated with itself 100% and producing something useful. The result is something similar to a soft saw wave.

Make sure operator 1 has no output, and then mix 100% of operator 1 with filter 1. Next it's on to the filter. Use the following setting for filter 1, plus a traditional pluck volume envelope, see to the left: SVF x2 | ENV 50% | CUT 17% | RES 100% | Low 0% | Band 0% | High 100% | WS Off. Instead of outputting Filter 1 to FX and output, we're going to use the Next knob to route 100% of Filter 1's output to Filter 2.

Filter 2 should have the following settings: SVF xl | ENV 50% | CUT 93% | RES 10% | Low 100% | Band 45% | High 20% | WS Off.

Chorus and Delay Settings

Order 6 | Depth 60% | Speed 80% | Delay 20% | Spread 100% | Cross 0% | Volume 100%.

Turn on the default Delay 1 bank, change it to 4:00 time, and try to play some notes. It's sounding a bit harsh to me, so I think we should put on a bit of unison. Before we do though, let's go to the main panel and pitch the synth up 12 semitones.

Unison Settings
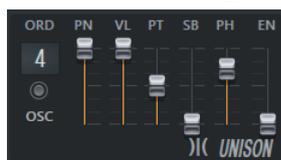
Order 4 | Panning 100% | Volume 100% | Pitch 50% | Sub-level 0% | Phase 73% | Envelope 0%.

There are a number of
problems with our current
synth. Currently there are
some high pitch sounds
generated. We can see these
if we play notes with
WaveCandy in spectrum
mode. Here I point to the
lowest key of the on screen
keyboard and dragged with

the mouse to the highest notes. The higher we come the more really high frequencies
are emerging.
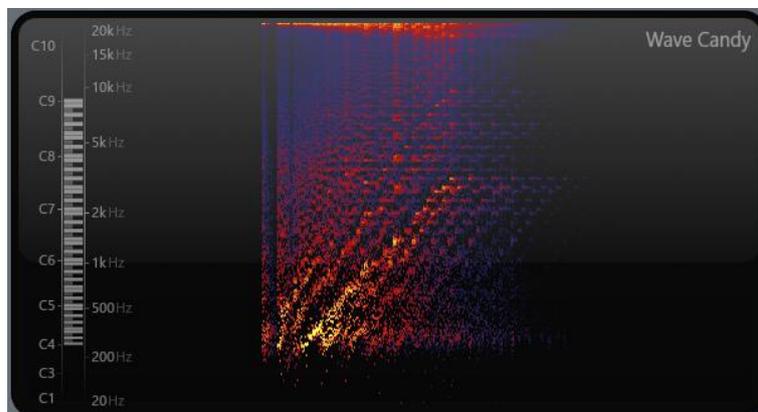
We can fix this in several ways. For example, turning on the 3 band equalizer on the
main panel. It is worth noting that you can switch between low shelf, peeking and
high shelf modes for each band. The icon above the third band is the icon for low
shelf. You need to know that because the tooltip will not tell you that. Another thing
you need to know is that even though you set the equalizer to filter the sounds there
will always "leak" a bit anyway. This is not a blocking kind of band type. I set
frequency to 15000Hz and the width to 0.06. If this was not a Sytrus tutorial I had
suggested, you would use Parametric EQ 2 and block off the high frequencies.

To reduce high frequencies, we can also use key mapping to adjust our cutoff
frequency of filter 2. The origin at 62% and point 2 at 0%. Like so.
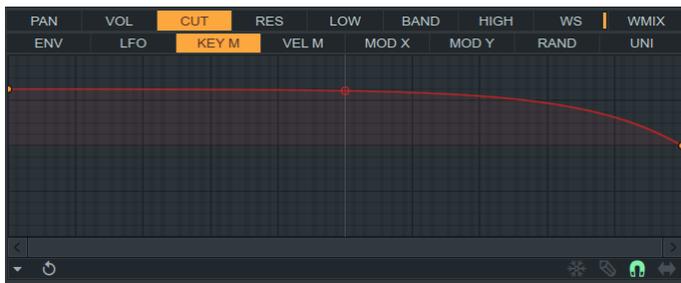
Copy the state of Cut – Key M and paste it into Res – Key M as well. Now the high frequencies are less pronounced. There were still plenty of high frequencies but I noticed that if I lowered the high band on filter 1 then things improved to acceptable levels.

That's one problem solved, but our middle notes have too many low frequencies on them. To solve this problem, we'll go to filter 1's cutoff frequency key mapping, and put in an envelope like in the image to the left. Now our synth is relatively stable and sounds pretty good.

There is still more we can do, however. Let's try mapping the X-axis modulation to the frequency modulation of Operator 1. To do this, simply create an envelope like the one you see in the figure to the right, in OP1 MOD x-axis
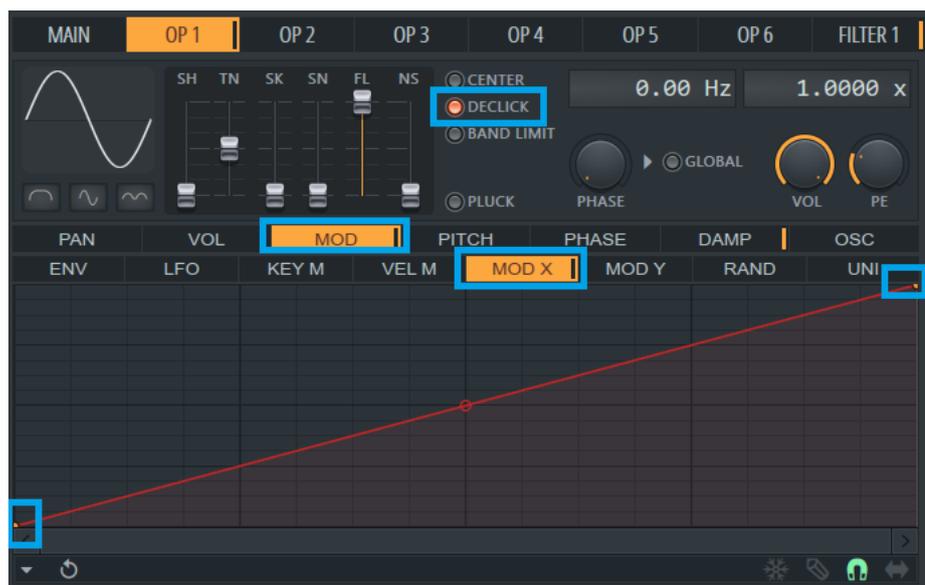
mapping. Since this is a full power mapping (ranges from 100% - 0% only), you will hear the modulation reduced to 50% after you create the envelope, because by default the X axis modulation is set to the center. Go to the synth main page and reduce the X axis modulation to 0%. Now we have a sort of dreamy pluck sound, with massive clicking problems. To fix those annoying clicks, go to Operator 1 and

turn on Declick. Much better! As you can see, the X/Y controller can completely change a synth's tone. But we're not done yet!

Go to operator 2, turn on Band limit, and reduce its frequency ratio to 0.5000 and change its starting phase to 50%. Now modulate operator 1 with operator 2 by 100%. Provided you kept the X-axis modulation at 0, you shouldn't hear much of a difference, but gradually move the x-axis modulation up and a stark change will become evident in the synth. Unfortunately, this change doesn't sound good for very long - by the time you've reached 50% on the x-axis, the synth starts to break down. Operator 2 simply can't be modulating operator 1 at full power and still sound good.

How can we fix this? If we reduce the volume of Operator 2, we can reduce its influence on operator 1, therefore preserving the sound of the synth. We will need to inversely map operator 2's volume with the x-axis modulation, see below.

Move the x-axis around and you will be rewarded with a synth that can sound like 4. The power of mapping modulation points and adjusting the volume of operators that are modulating other operators cannot be emphasized enough. Now lower notes take on the properties of a smoother synth and higher notes take on the properties of a harsher one. All this, and we haven't even mapped the Y-axis modulation to anything yet! Just remember that if you aren't modulating an operator with anything, the modulation attribute will have no effect.

Our synth is now finished, so give it a name OneOnOne, explain what the X-axis does (I would explain it as "changes the voice of the synth"), and whatever you made the Y axis do, if anything. Before you save it, you might want to enable the "Gibbs Off' option - this should help with those slight pitch warbles happening on the really high notes. Another button near the "Gibbs Off' option is an option called "Global Pitch." This is useful if you want to change the pitch of all the operators all at once - by enabling it, the pitch envelope in operator 1 acts on the entire synth instead of just operator 1. However, we don't use pitch envelopes in this synth, so enabling this option wouldn't change anything.

9. Sequence

In this chapter we will focus on programming a sequence of "actions" into the synth.

We make: TutSeqOne

Sequence synths can be made really complex so they incorporate rhythm, bass line, lead synth sound etc. Your fantasy is the limit.

The sequence synth we will be making is going to rock back and forth between the tonic and subtonic chords with a variety of instruments playing different patterns.

We start by setting the Default preset. We will create our first voice, which is going to be on Operator 1. Right-click OP1's waveform and choose a Saw waveform, then lower its frequency ratio to 1.000. Route 100% of it into only Filter 1, and then change filter 1 to the following: LP x3 | ENV 50% | CUT 100% | RES 34%, then stick in a volume envelope as shown above.

This voice is going to serve as our long, sustained background voice. Sustained voices usually need some sort of volume variation if they are to sound good.

Always try to put in volume envelopes to make the instruments either fade in and out or simply pluck, otherwise you'll muck up the output. We could have also stuck this volume envelope in the operator itself, but we didn't. It really doesn't make a difference for this synth.

Operator 2 is where things start to get interesting. To begin, build a waveform with the following settings: Shape 0% | Tension 30% | Skew 58% | Sine Shaper 40% | Prefilter 100% | Noise 0%. Next, open the tab pitch – env and enable tempo. Add a pitch envelope according to the image here above. This pitch envelope defines the melody in our synth; notice how it goes from the tonic to the subtonic. The entire envelope is set to tempo and to loop every measure (since it is one measure long). We must keep that in mind while building the rest of our sequence synth.

Speaking of which, our first operator isn't switching chords halfway through the measure.

We fix it by applying a pitch filter to operator one as here above. Switch to operator one, Pitch – Envelope. Turn on Tempo and make the curve as displayed here above.

Now that we've fixed that, we need to do something about the fact that operator 2 is sustained. We don't want it to be sustained, so we're going to add a looping volume envelope. Because each pitch change (or note change) occurs every 2 steps, hence logically we should make our volume envelope 2 steps in length as well.

Turn on tempo and then make the envelope as shown here above. Mix 100% of operator 2 to Filter 2 then output 84% of Filter 1 to FX, 52% of filter 1 to Out. -68% of filter 2 to FX, and 100% of Filter 2 to Out. Try the synth.

Before this is going to sound good, we need to setup the second filter: SVF xl | ENV 50% | CUT 50% | RES 50% | LOW 50% | BAND 100% | HIGH 85%.

Now, it's starting to shape up, but we really need another layer so open up Operator 3 and right click and set it to a saw. Set the frequency ratio to 1.000 then mix 100% of Operator 3 into filter 3 and route filter 3 to FX and out.

Open tab pitch – env and turn on tempo. Add a pitch envelope according to the figure here above.
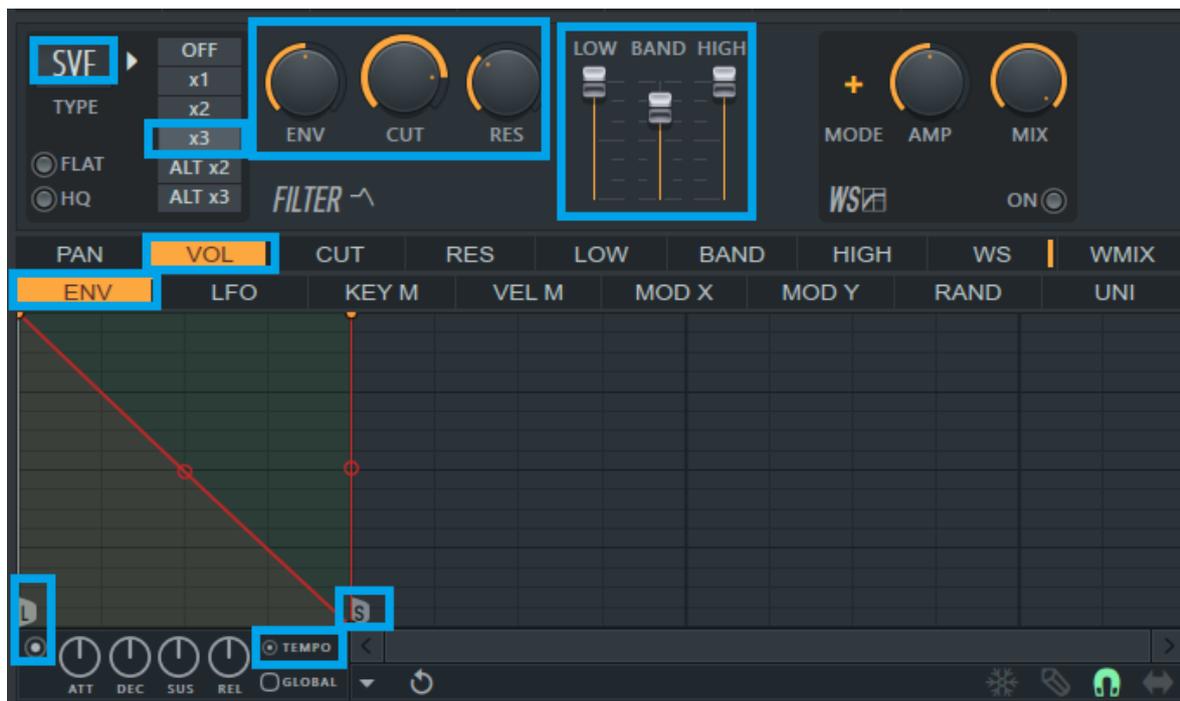
Set up filter 3 with the following settings: SVF x3 | ENV 50% | CUT 83% | RES 33% | LOW 100% | BAND 77% | HIGH 100%. Also apply a volume envelope, as shown here above.

Notice how the volume envelopes are always engineered to line up with the pitch envelopes. You can also make volume envelopes that trigger multiple notes without changing the pitch, but remember to keep the entire synth in tempo time and to line everything up by snapping in a sequence synth, it is crucial that every part of the synth sync perfectly with the others.

Our synth is nearing completion, but we have a few more things to do. First, let's improve our FX effects a bit by adding this chorus, and a bit of reverb.

Reverb

Reverb color B | Low cut 183 Hz | High cut Off | Predelay 41 ms | Room Size 100 | Diffusion 100 | Decay Time 1.3 sec | High Damping 2.6 kHz | Volume 32%.

Chorus Settings

Order 6 | Depth 89% | Speed 60% | Delay 30% | Spread 100% | Cross -34% | Volume 100%.

This synth isn't going to have any delay echo effects on it. Instead we go to the main page and turn on unison. This time, however, we're going to enable oscillator-only unison, which applies the unison affect to the oscillators without applying it to the entire synth. This gives us a really cool effect, especially with how our sequence synth is set up.

Unison Settings
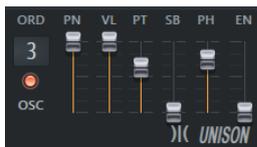
Order 3 | Panning 100% | Volume 100% | Pitch 64% | Sublevel 0% | Phase 74% | Envelope 0%.

Now it's time to add the final operator to our synth; a square-based one. Open the tab for Operator 4 and input the following parameters for its waveform: Shape 50% | Tension 80% | Skew 0% | Sine Shaper 0% | Pre filter 100% | Noise 0%. Make sure you enable Band Limit as well. Then go to tab pitch – envelope of operator 1 and copy that envelope. Go back to operator 4 and its pitch – envelope tab and paste it there. It should now look like the image here to the right.
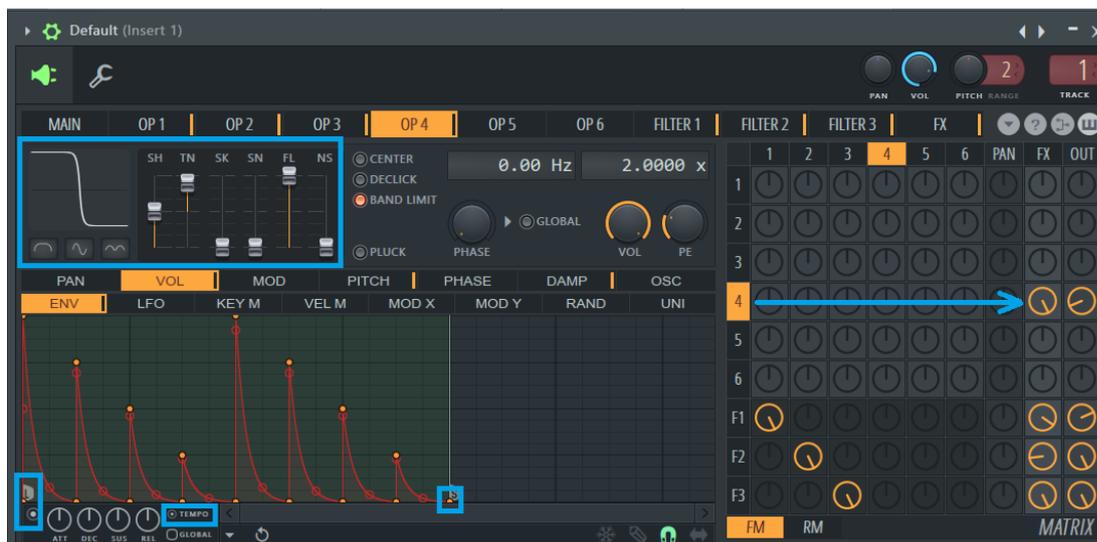
Create the volume envelope as here above.

This envelope does not correspond with the pitch changes, but it is synced with the beats. This creates an echo effect where one note is played, echoed, and then another note is played on the subtonic and echoed. Route operator 4 to FX 100% and -70% of it to Out.

Now we will program the X/Y controller for this synth. Because this is a sequence synth, we're going to map MOD X and MOD Y to multiple attributes.

Filter 1 Cut – Mod x:

Filter 1 Res – Mod y:

Filter 2 Band – Mod y:

Filter 3 Band – Mod y:

There we go, our synth is complete! Now, like any finished synth, we should give it a name, explain what the X/Y modulation does, adjust our X/Y modulation to the optimum value, and save it as a preset.

I decided to call this synth "TutSeqOne; Mod X adjusts the cutoff frequency; Mod Y adjusts the middle strength."

Congratulations! You have made your first sequence synth. Feel free to edit this one, either by taking out its chord change, adding in additional variation, or changing its melody.

10. Arpeggiator

It is a really easy task for a computer to reproduce premade patterns, such as arpeggios, also called arps. A lot of music are featuring arpeggios. Normally arpeggio is notes of a chord played in a specific pattern. Sytrus's method of making arps is fairly unconventional.

Before we get into this I would like to point out that you can let FLStudio create arpeggios for you from within the piano roll window as well. The benefit with that method is that you can see how the arpeggios turn out. With the arpeggio feature built into Sytrus that is slightly less obvious. That said, the built in method that Sytrus provides makes it possible to "package" the arpeggio effect into a preset that you apply as a building block in your music whereas the piano roll method rebuilds your notes in the piano roll to create the arpeggio. Either method has it pros and cons. There are differences in the workflow but the end result is the same.
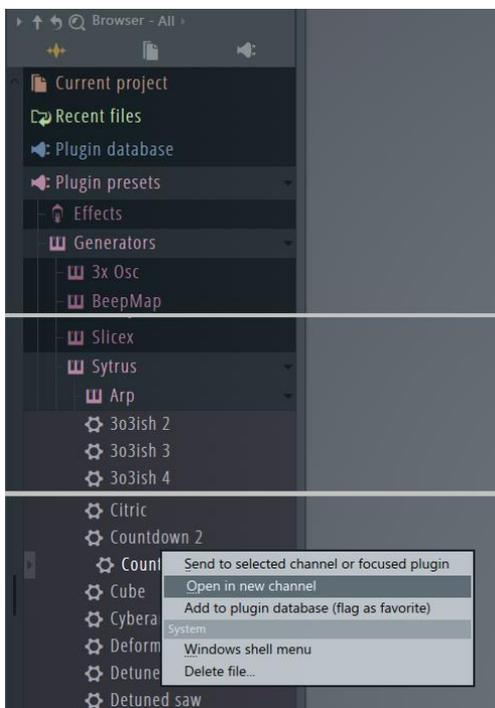
To demonstrate how and what an arpeggiator is we will have a look at Countdown. In the browser panel of FLStudio navigate to Plugin presets –> Generators –> Sytrus –> Arp and load up the "Countdown" preset in a new channel. Play a single note - it sounds just like a regular sequence synth.

However, if you open up the piano roll and input a chord sequence like the one you see here above. This synth is doing something very different.

The Countdown synth is hopping around the notes you gave in the piano roll instead of playing them all at once – this is due to the arpeggiation. Why is it doing this? To find out, we need to look at Countdown's Operator 1 Volume Envelope.

 At what time are things happening inside the window to the right? The tooltip just gives some numbers divided by colon so what are these numbers? They are Bar:Beat:Tick. The tick is specifid by the general settings of the project. Go to the main menu and open Options –> Project general settings.
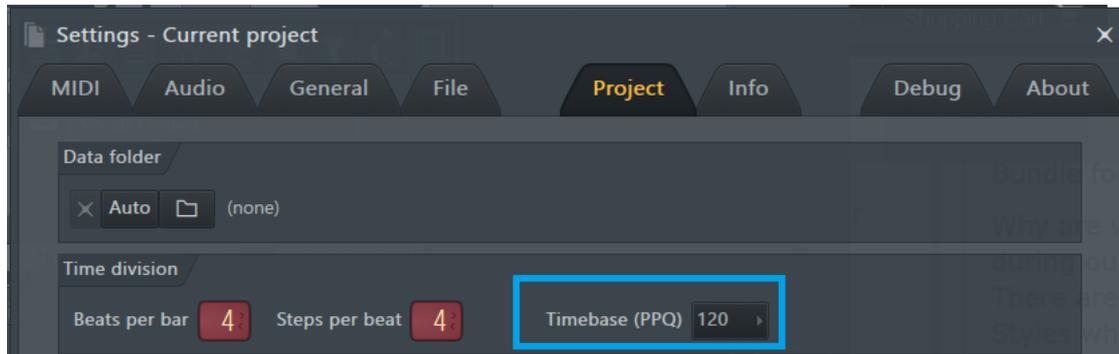
The setting at Timebase (PPQ) gives how many ticks per beat there is in the project. If you set yours to 120 then there are 120 ticks per beat.
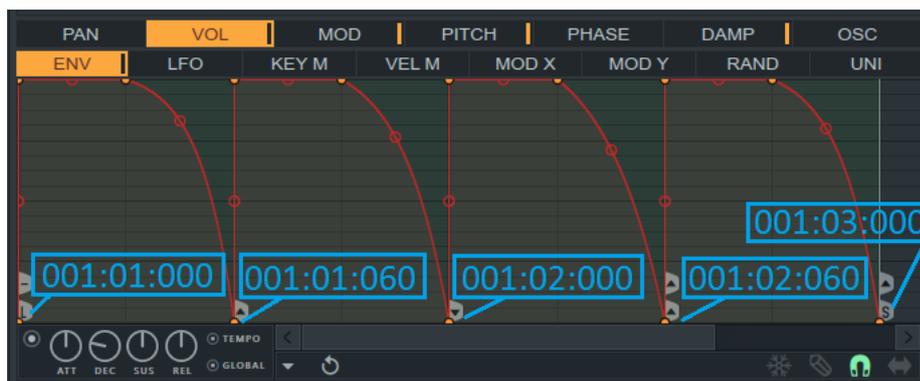
 When you are hovering over the notes in the piano roll and look at the tooltip we do not necessary get the time represented with "B:B:T" but with "B:S:T" Bar-Step-Tick. To be able to understanding the arpeggiator we need to set the song position panel to Bar–Beat–Tick as well. Right click the song position panel and set the options like the image here to the left.

This volume envelope may look like a normal one, but notice the arrows at the bottom of the peaks. These are arpeggiator instructions. The little "up" arrows cause the synth to move to the next highest note in the given triad, the little "down" arrows cause the synth to move down to the next lowest note in the given triad, and the "dash" symbol that you see by the sustain loop start point tells the arpeggiator to stay on the current note in the triad. When the arpeggiator goes below the given notes, it will loop back to the top, and vice versa.

You could take what I said here for granted but would it not be nice to plot out the notes, or better even. Let FLStudio tell us what notes it is producing? This is possible. We can let Edison tell us what notes we are using. There is a little catch though because the Edison tool is having a bit of trouble to distinguish the notes from the Countdown preset so we will make things easier for Edison.

Open the Pitch Envelope window. Turn off this envelope. You do this with the little radio button at the bottom left corner of the envelope window. Also turn off the Mod Envelope. Then go to FX and turn off Delay1. We removed much of groove like this but is it easier to analyze.

Now open the channel rack window. Set the Countdown preset of Sytrus to go to mixer track one. Also if you have other channels using mixer track


one, then you can mute these too.
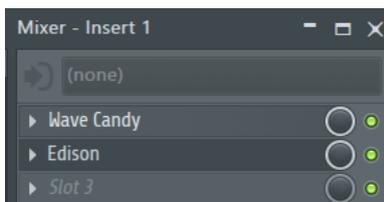
Add an Edison to the effect slot of mixer track one. Edison is not a regular effect but just like WaveCandy can pick up the sounds and do
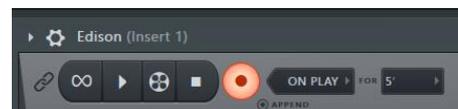
something with them, display graphs etc, can Edison record things. In the "When/What to record" window you set "On Play". Then you press the "Record" button. Nothing happens – until you press the play button . Then Edison will start recording what is played in mixer track one. When the piano roll come to the end of the four bars it will jump to the beginning again. That position is marked as a "Song jump" in Edison. At that point you can stop playing and also press stop Recording in Edison. The first section of the recorded "song" is what we are interested in. Double click the Song jump and press delete. If you have more song jumps, then you can repeat this procedure until you have one bar left.

At the bottom of the Edison window you find a little triangle with a menu. In that

menu select View –> Time format –> Bar : Beat : Tick. Theoretically Edison would now line up the time representation nicely but it looks like a bug in the time representation. Anyway we got an almost perfect Sytrus compatible time format. Next select Regions –> Detect pitch regions. After some lining up of the windows I could create this view of the first bar of the tune.
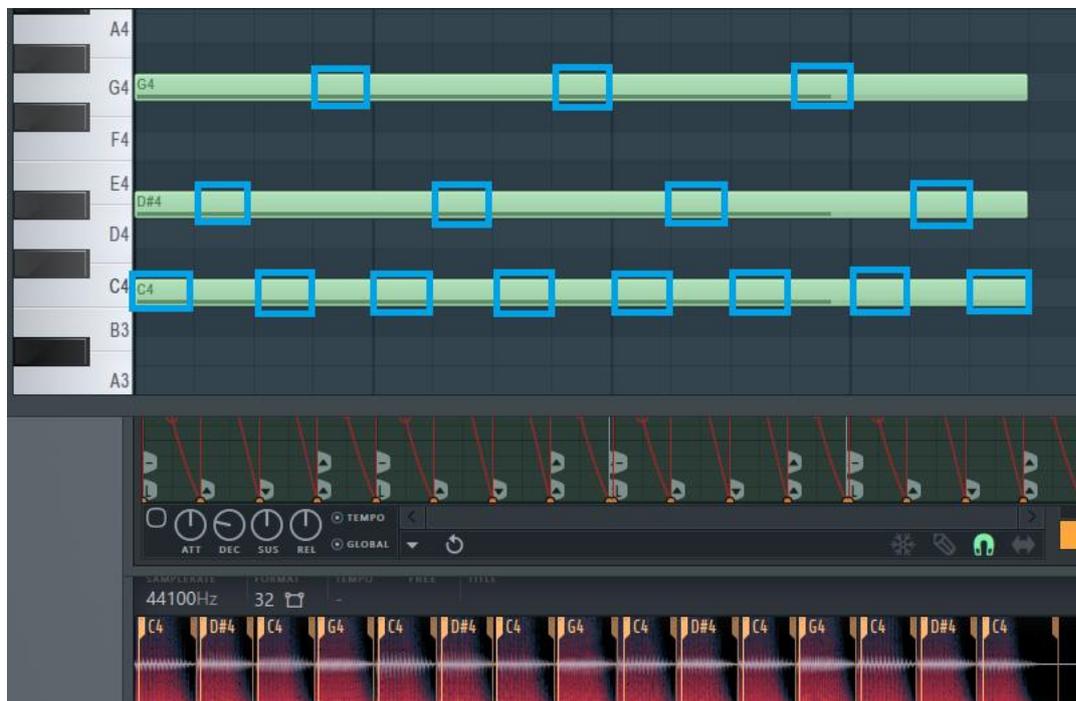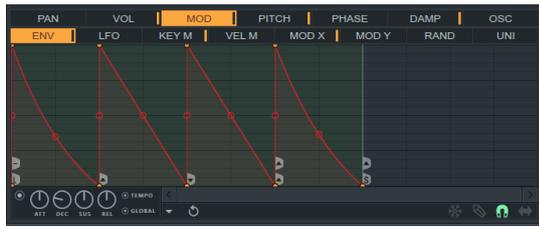

This way FLStudio explains the arpeggio for us!

If you right click one of the points and hover over "Arpeggiator Break" in the drop-down list, you can see that either Previous, Same, or Next has been chosen for that point.

Let's restore the Countdown preset to its original. This synth is made up of 3 envelopes - Volume, Modulation, and Pitch, plus effects.

The Modulation Envelope

The modulation envelope is a pluck-based envelope that causes the synth to have a plucky feel to it. Modulation envelopes can often be used when a synth needs a plucky sound to it. You may also notice that the modulation envelope has arpeggiator breaks on it as well. This is not recommended, as it is completely pointless. If you remove these redundant arpeggiator breaks, the synth will sound exactly the same. Because almost all arp synths will be using a volume envelope to create multiple notes, it's a matter of common sense to put the arp breaks on the volume envelope. Usually it is the volume envelope of the Operator, but they can also go to the filters.

The pitch envelope on Countdown is interesting. At first glance, it looks like it could never work - going up 3 semitones? But if you take a closer look, you will notice that the Pitch envelope knob has been turned all the way up to +4800 cents. This is four times the default amount of +1200, which means that while

The Pitch Envelope

the default had 24 semitones from top to bottom, this pitch envelope has 96. Likewise, even though an octave in the default pitch envelope is 12 grid steps, because the range has been multiplied by 4, the number of grid steps has been divided by 4. 12 divided by 4 = 3. 3 steps, one octave. So what our pitch envelope here is really doing is going up and down approximately 4 octaves. That is all this synth is doing; running around the octaves with an arpeggiator.

11.Portamento

Portamento is an effect that when a note is played, it is automatically pitch shifted from whatever the previous note was. This effect blends the notes together and is often used in bass line saw synths. How to get this to work however, is a bit more complicated.

To try this set the Defaut preset. Turn on Portamento by clicking the "porta" button on the main panel. Next, we need to go to the pitch envelope of the first operator. and create an envelope that looks like figure to the right.

There are two things we need in this envelope, a decay point and a sustain loop end point. You cannot assign those to the same point, so we basically have a trailing portion of our pitch envelope. The portamento effect only cares about the distance between the origin and the decay point. Unfortunately, we can hear portamento a little too clearly when we're going down almost an octave. We can solve this by sticking in silent notes that trigger the portamento silently, thus ensuring that the portamento effect has nothing to pitch bend when the note is hit.

There are other ways in FLStudio to program portamento. I think it is fair to say that portamento implemented from the piano roll or from within Harmor provide better portamento options, but that is another story.

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