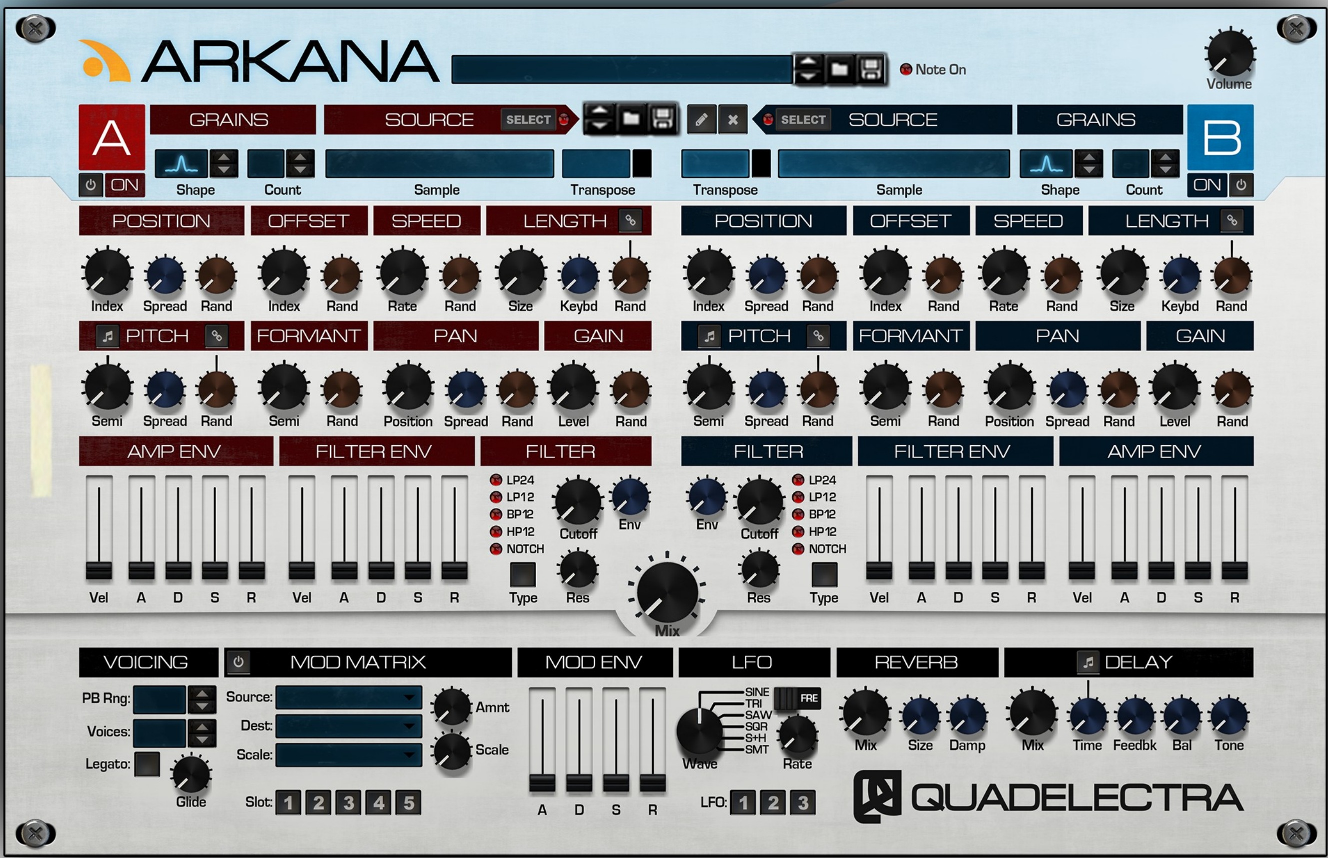
ARKANA

DUAL GENERATOR GRANULAR SYNTHESIZER



OPERATION MANUAL

Version 1.5

QUADELECTRA

Re
Rack Extension

1. Introduction

Welcome to Arkana!

Thank you for your interest in testing and / or purchasing Arkana Granular Synthesizer by Quadelectra. We always put a lot of effort to deliver stable and intuitive devices, but this is our first time to ever build a production quality fully fledged synthesizer.

We sincerely hope that you'll enjoy using Arkana, and that it will become a valuable companion, on your musical adventures.

1.a. Granular Synthesis

As the name suggests Arkana uses a technique called Granular Synthesis to produce sound. Granular synthesis was invented by Iannis Xenakis, who used tape splicing to implement it, almost half a century ago. Yet it was Barry Truax who actualized the technique in real time.

In granular synthesis, a grain emitter, plays back short portions of a sample, and then applies an envelope to the amplitude of each one, to allow smoother transitions. The final product of this process is called a grain – presumably because of the graphical resemblance of its waveform to.. an actual grain.

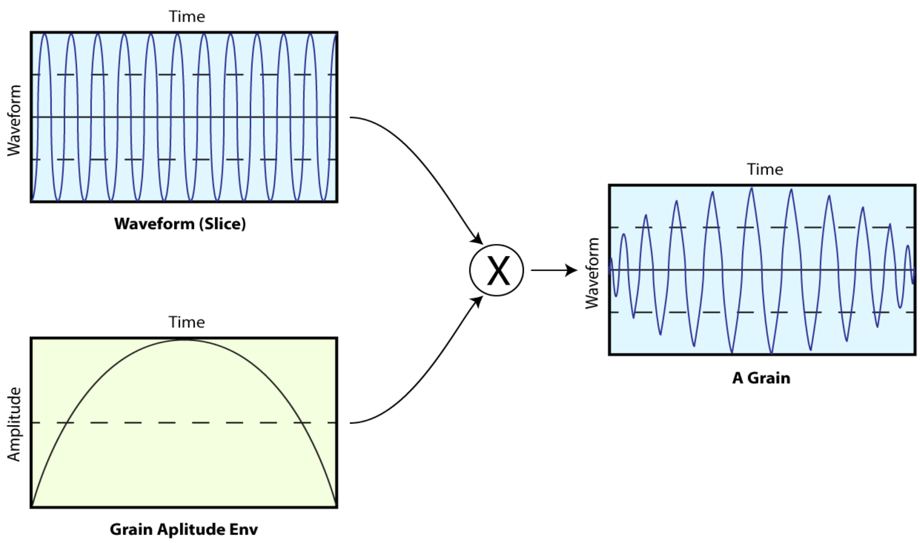


Illustration 1: How a grain is formed.

The process can then be repeated for as long as necessary, and the user of the granular can manipulate several parameters defining not only the circumstances under which the grains will be produced, but also their properties, such as length, pitch, start position on the original sample, evolution from one grain to the next, pan position, volume etc.

1.b. The Sound Of Arkana

Of course Arkana, goes well beyond the above simple concept.

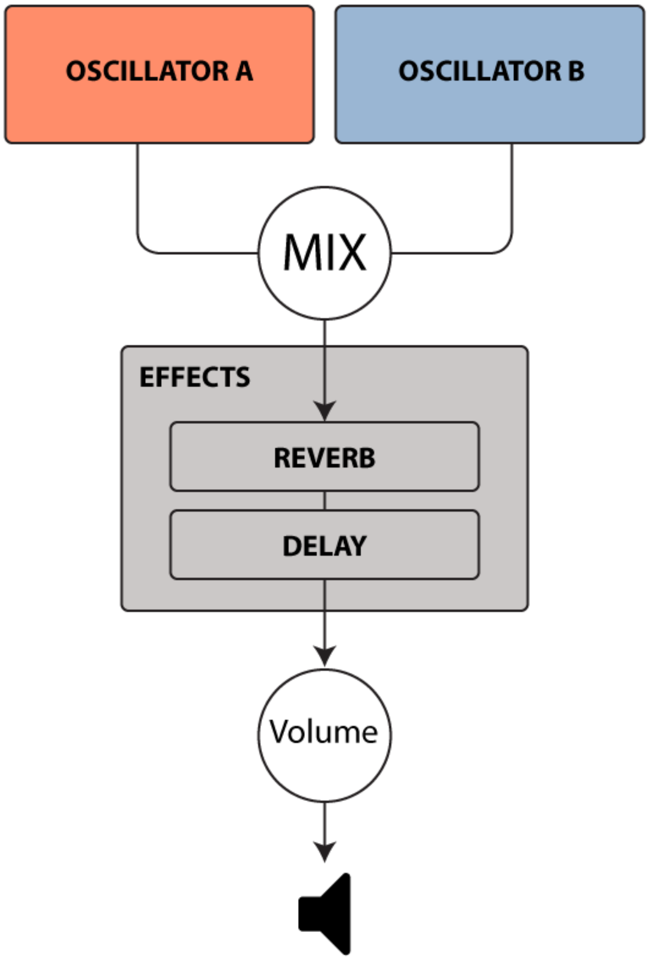


Illustration 2: Arkana concise signal flow diagram

In Arkana each sound is produced using 2 different grain generators. Each generator is capable of handling up to 5 grain emitters. And, what's more, the produced grains are stereophonic, which means that they can cycle grains independently from one another.

You can of course select the number of emitters

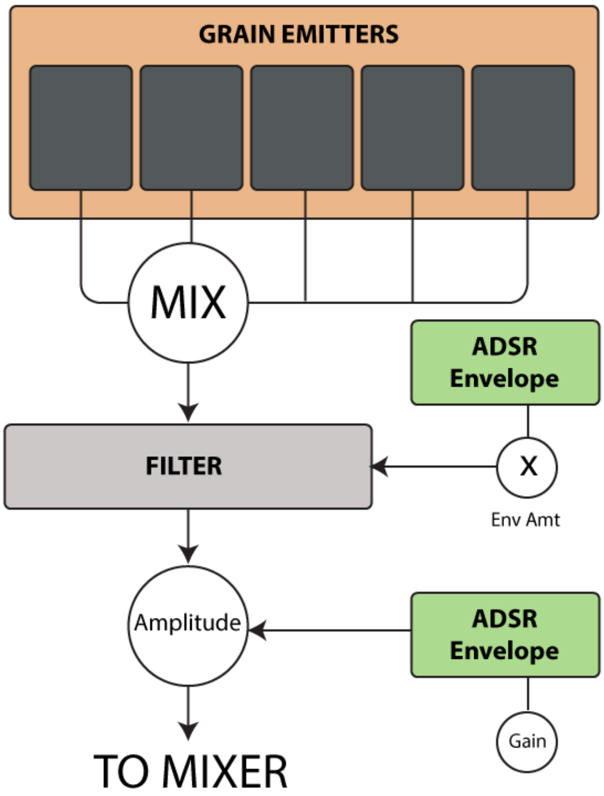


Illustration 3: Arkana Oscillator Diagram

Each of the generators -called oscillators for convenience- has it's own grain emission controls, a dedicated filter, as well as filter and amplitude envelopes.

To further expand the sonic possibilities, Arkana has a 5 Slot Modulation Matrix, as well as a dedicated modulation envelope and 3 LFOs.

To complement all the above, there are also two on board effects. A reverb and a delay unit.

2. The Front Panel

This chapter provides detailed information about the device front panel and basic sound design concepts.

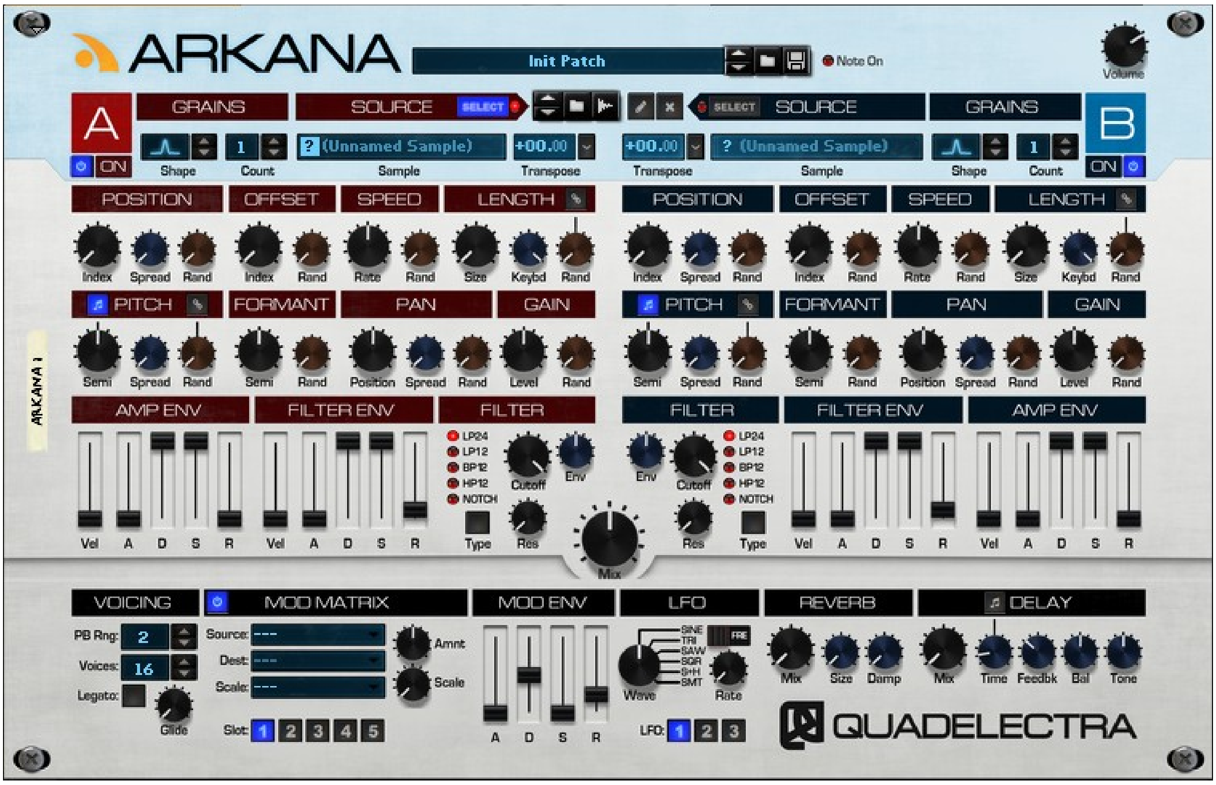


Illustration 4: Arkana synthesizer front panel

The front panel is divided into three main sections:

1. The Upper Section where the patch loader is situated, with the main volume on the right.
2. Oscillators A & B, and the Mix Knob, which occupy most of the front panel mid space. These are the heart of the synthesizer.
3. The Global Settings at the lower section, affecting the entire sound - both Oscillators: These include the Voicing section, the Modulation Matrix and Modulation Sources plus a simple tool set of Effects.

2.a. Oscillators.

Arkana has 2 Oscillators -grain generators actually- per voice. Each generator controls up to 5 grain emitters. Each emitter creates a true stereo grain, which means that the grain consists of two independent mono sub-grains. A stereo sample will be played by assigning each channel to one sub-grain, while a mono sample will be played using the same channel in both sub-grains (dual mono).

What's great about this concept is that things can get very interesting when you start tweaking parameters which affect the two sub-grains independently.

Depending on the characteristic you wish to control, there can be up to 4 different kinds of parameters that you can tweak. Arkana uses a color scheme to indicate each different kind:

- **Constant Value:** The base value of the parameter. This value stays the same between the grain emitters of a generator. These controls are black.
- **Cross Grain (Spreading) or Other Modulation:** Spread occurs when you use more than one grain emitter. The value for that parameter is increased by a given step from one emitter to the other. Spreading controls the size of that step. Spread / Modifier knobs are painted blue.
- **Random:** The parameter introduces a randomness for each grain. Meaning that the result is different whenever the emitter restarts the grain's play cycle. These knobs are colored red.
- **Other parameters:** In special cases such as Length, and Pitch other types of parameters can be present, we will take a closer look at them later in this manual.

All settings can be immediately accessed by the front panel, however changes in some parameters, will not occur in immediately. This is partly due to the nature of the synthesizer's design and the way granular synthesis works. Depending on the parameter actual updates to the sound can occur in three ways:

- **Immediately:** The result is audible as soon as the parameter changes. Example parameters, are the Pitch, Pan and Gain base parameters.
- **Per Grain Play Cycle:** For parameters of this kind, their value is applied only once, every time a new grain play cycle starts, and that value is kept throughout the entire play cycle. Further changes to the parameter within that cycle will not affect the sound, until the next play cycle starts, where the operation is repeated. Most Spread and Randomization parameters fall in this category.
- **Per Note Press:** Finally there are a few parameters which are only calculated once when you press a MIDI key. For example the offset delay between grains, the envelope settings, velocity related calculations etc.

More detailed information about how each parameter is updated, will be given bellow.

Now lets start by examining each generator features.

2.a.1. Grain Shape

This setting deals with the envelope shape that will be used by each generator to shape the amplitude of the produced Grains: Values start from the narrowest window to the broadest. Possible values are:

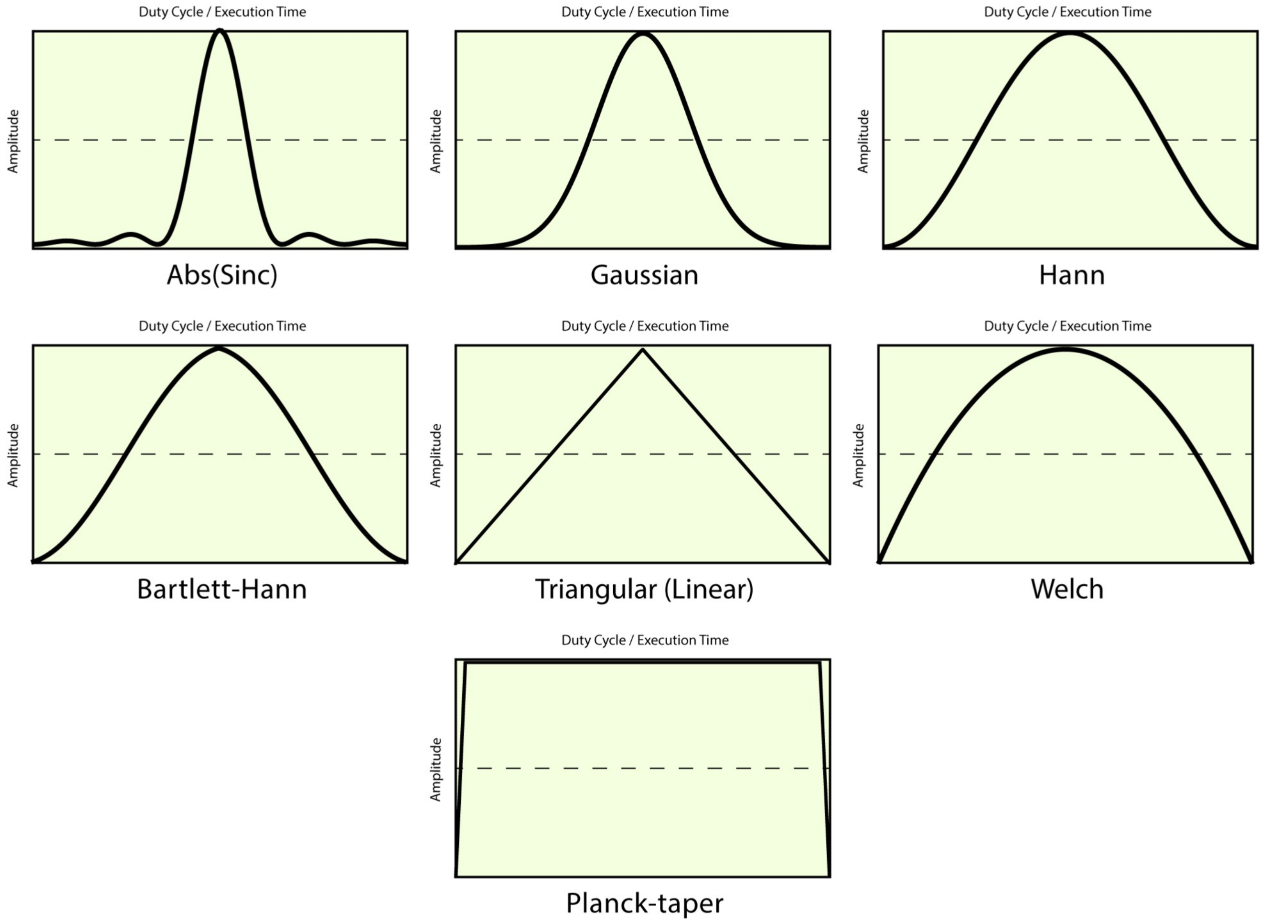


Illustration 5: Arkana grain shapes

- **Abs(sinc):** A sinc window envelope with only absolute (positive) values. The negative values have been flipped, to avoid phase inversion. This provides the narrowest grain effect.
- **Gauss:** A Gaussian window envelope.

- **Hann:** A wider bell shaped envelope.
- **Bartlett-Hann:** Similar to Hann, but with a sharper top.
- **Triangular (Linear):** A linear envelope shaped like a triangle.
- **Welch:** A Welch window which provides the widest smoothing effect.
- **Planck-tapper:** This is the most steep envelope. Suitable when you want to emphasize transients on the sample, sacrificing smoothness between transitions.

Starting from the narrowest to the widest grain envelope, will produce accordingly sounds with thinner to thicker body.

2.a.2. Grain Count

This setting increases or decreases the number of grains that the generator will produce. As mentioned each generator can handle up to 5 grains.

2.a.3. Sample Selection

The LCD next to the grain count controls, display the currently selected sample sound source for this generator. For the time being, RE 2.5 SDK does not support the existence of different controls to load different samples. So one set of sample controls must be used to feed samples to both oscillators.

To encompass this, Arkana provides a set of two selection buttons, one of each oscillator. So in order to load a sample to Oscillator A, for example, you click the “Select” button above the sample name (clicking on the Name LCD of the sample or the LED will also do), and then load, change, drag & drop, edit or delete the sample for that oscillator.

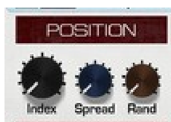
Of course the same applies for Oscillator B.

2.a.4. Transpose

The initial sample transpose / root key. Use this to tune your sound source to the appropriate root frequency.

2.a.5. Position

This section controls the position inside the sample sound where the grain playback will start. All changes occur per grain play cycle.



- **Pos:** Controls the base position value for all grains. The value is expressed as a percentage of the sample's length.

- **Spread:** Controls the position offset between each grain emitter.

- **Rand:** Controls the randomness offset for each grain's position.

2.a.6. Offset

This section inserts a delay between the execution (playback) of each grain emitter only at the first execution, when a key is pressed. The value is expressed by a percentage of the available value range. The maximum delay can be up to 1:GC of the length, where GC is the grain count. So for 2 grains the max offset is ½ of the Length (50%), for 3 grains 1/3 (33.3%) and so on, and so forth.

- **Offset:** This is the base offset value: At the maximum is the ideal setting for a smooth transition between the selected number grain emitters.

- **Rand:** A random value can be applied, to the constant value. This will produce different timing windows between grains, per note press.

2.a.7. Speed

Speed controls the amount of the position that all grain emitters will cover every grain play cycle. The value is expressed as a bipolar percentage (from -200% to +200%). At 0% the emitter will play each grain from the same position, again and again. However a 10% speed will cause the emitter to restart each new grain by advancing its position a 10% of the given length. Consequently at 100% the grain emitter will play the sample at it's normal speed, since each grain will advance it's entire length in position. At 200% the emitter will jump the size of it's length per play cycle, and so on.

Negative values will cause the grain emitter to retreat by a given percentage, which in some cases can cause a similar (but not the same) effect as playng the sample source backwards.

Values for this setting are applied per grain play cycle.

- **Speed:** This knob controls the base speed for all grains.

- **Rand:** The randomize knob introduces a percentage of random variations to the speed between grain play cycles.

2.a.8. Length

This section controls the length (duration) that each grain will play. The length affects many other parameters such as the offset and speed. Yet, the length itself is affected by the transpose, pitch and keyboard note pitch.

- **Len:** The knob affects the base length for all grain emitters. Length value is expressed in period (T) multiplicands. Without pitching and transposition, the period of note C4 (MIDI Key: 60), which is around 3.822ms is considered as the root period. The range of this parameter is from 1xT up to 1000xT. This setting is calculated in real time.

- **Keybd:** A special modifier for the length. You can select the amount that each MIDI key will affect the length period. At 0% length is preserved regardless of which key you press, leaving only the transpose and pitch settings to affect the length value. At 100% however the keyboard affects the length according to the period pressed note.

- **Rand:** This knob adds randomization to the length of each grain.

- **Rand Stereo Link:** Another special feature is the randomization stereo link for the grain length. As mentioned each grain is true stereo, consisting of two sub-grains, one per channel. Enabling the randomization stereo link will cause both sub-grains to use the same setting. While keeping it disabled you allow each sub-grain to cycle independently on its own setting.

2.a.9. Pitch

Pitch has the same effect and coexists with “Transpose”.

Nevertheless while transpose deals with the root key property of the sound source, the Pitch controls deal mostly with the creative aspect of the sound design. Meaning that you'd use them for linear pitch manipulation from here instead.

- **Pitch:** This controls the base value for all grain emitters. The setting is expressed as a float number expressing semitones and cents. The pitch ranges from -24.00 to +24.00 semitones. This setting is applied in real time.

- **Keybd To Pitch Switch:** You can enable or disable the generator ability to respond to pitch changes from the MIDI keyboard, by toggling this switch.

- **Spread:** Spread effect will work when the grain count is larger than one. The knob sets the maximum amount of the effect which ranges from 0% (no effect) to 100% (+24 semitones). The grains will equally share the range from the value of the pitch note, up to the maximum size of this setting.

This means that if you turn the knob to the max, for a total of 2 grain counts, the second emitter will be pitched +2 octaves above the first, while for a total of 3 grain counts the second emitter will be pitch at +1 octave and the third emitter at +2.

The spread setting is calculated per grain play cycle.

- **Rand:** The knob controls the amount of random pitch deviations, that can occur between the grains of the generator. The range is from 0% to 100%. At 0% no effect is produced. At 100% the pitch can vary from -24 to +24 semitones. The setting is calculated per grain play cycle.

- **Rand Stereo Link:** Like in the case of the length randomizer, this switch, when enabled, ensures that both left & right sub-grains will have the same random pitch setting, thus producing a more uniform result.

2.a.10. Formant

When used with short period multipliers on the grain Length, this parameter does what it says, controlling the formants of the sound source. However since this effect is actually produced by playing the sample faster or slower, while preserving the period, longer length multipliers will cause Formant to act as a form of pitch that is applied -in contrast to pitch- only to the sample speed (not the grain's length).

- **Form:** The base value of the parameter is controlled by this knob. Similar to pitch, the range is from -24.00 to +24.00 semitones.

- **Rand:** The knob controls the amount of random formant deviations, that can occur between the grains of the generator. Again, the range is from 0% to 100%, with the maximum setting deviating formants from -24 to +24 semitones. This is also applied per grain play cycle.

2.a.11. Pan

Pan apparently controls the stereo position of each grain.

- **Pan:** The knob that controls the pan position for all grains. This setting is applied in real time.

- **Spread:** This parameter spreads the grain emitters across the stereo panorama. The setting has no effect when a single grain is emitted. However increasing the grain count, will cause the grain emitters to spread evenly across the panorama. The examples bellow show how grain emitters are panned when spread is set to the maximum setting. This setting is applied every grain play cycle.

- **Rand:** This controls the pan position randomization for each grain. The value is calculated every grain play cycle.

Here's an interesting twist though: To pan correctly each grain, we need to adjust the volume of the left and the right channel in correlation to the panorama value. In the randomizer's case, this happens at the start of every grain play cycle.

However as mentioned before each grain consists of two independent sub-grains, one per stereo channel. And in many cases these sub-grains will not act synchronized. To avoid misbehavior, confusion and inconsistencies in such cases Arkana uses the play cycle of the left channel sub-grain as a trigger for applying the pan randomization. The right channel will follow and update immediately even if it hasn't finished its cycle.

2.a.12. Gain

Gain setting reduces or increases the overall level of each generator, by a percentage. The range is between 0% and 200%. At 0% of course the amplitude is zero,

- **Gain:** The knob controls the constant value of the Gain parameter. The parameter is calculated in real time.

- **Rand:** Adds randomization to the gain level, up to the constant value. This setting is calculated per grain cycle.

Like with pan randomization, the gain randomizer calculates a new setting every time the left sub-grain restarts. The right sub-grain will pick up the new value in real time, even if it hasn't finished its cycle.

2.a.13. Amp Envelope

This is a standard ADSR envelope that controls the amplitude of the generator. The envelope settings are calculated once upon the note press event. For the attack slope the maximum execution time is 10 seconds. For decay and release slopes the maximum execution time rises up to 30 seconds.

- **Vel (Velocity Sensitivity):** Controls how much will the velocity of each note affect the amplitude of the generator.

- **A (Attack):** Sets the attack time of the amplitude envelope. (4ms to 10 sec).
- **D (Decay):** Sets the decay time of the amplitude envelope. (4ms to 30 sec).
- **S (Sustain):** A percentage of the overall amplitude of the sound that the note will retain after the decay stage is complete, and before it is released.
- **R (Release):** Sets the release time of the amplitude envelope. (4ms to 30 sec).

2.a.14. Filter Envelope

This controls the ADSR envelope of the filter for the generator. The same rules to the Amplitude Envelope, apply here: Settings are calculated once upon the note press event and slope execution times are identical to the ones of the amplitude envelope.

- **Vel (Velocity Sensitivity):** Controls how much will the velocity affect the intensity of the applied envelope to the filter..
- **A (Attack):** Sets the attack time of the filter envelope. (4ms to 10 sec).
- **D (Decay):** Sets the decay time of the filter envelope. (4ms to 30 sec).
- **S (Sustain):** A percentage of the maximum envelope amount that the note will retain after the decay stage is complete, and before it is released.
- **R (Release):** Sets the release time of the filter envelope. (4ms to 30 sec).

2.a.15. Filter

Each generator has it's own filter, which is a State Variable with an additional -24db Low Pass filter. You can adjust the filter using these parameters:

- **Filter Type:** Selects the type of frequencies that this filter will cut. There are 5 different settings: LP24 (-24db/oct Low Pass), LP12 (-12db/Oct Low Pass), BP12 (-12db/Oct Band Pass), HP12 (-12db/Oct High Pass), NOTCH (Band Reject / Notch).
- **Freq (Cutoff Frequency):** Use this parameter to set the frequency on which the filter will operate.
- **Res (Resonance):** The amount that the peak of the cutoff frequency will

resonate.

- **Env Amt (Envelope Amount):** The setting controls the intensity by which the filter will be affected by the assigned filter envelope. Possible value range is from -100% to +100%. At negative values the envelope is inverted.

2.a.16. Mixing

The results from the two oscillators can be balanced by the “Mix” knob found at the bottom center of their sections, and above the global section below them.

2.b. Voicing

Arkana voicing section gives you control over settings related to play mode, pitch and polyphony.

- **PB Range:** Sets the maximum range for the pitch bend wheel. Values are in semitones and range from -24 to +24. A positive value will cause the pitch to raise when you push the pitch bend wheel up, while a negative value will work the other way around, and drop the pitch on that same movement.

- **Polyphony:** This sets the maximum allowed voices for the device. Exceeding the maximum number of allowed voices will cause Arkana to silent the oldest ones (the notes who where played first) and repurpose them to trigger new notes.

  Note that a voice is still occupied even after you release the MIDI key which owns it, and for as long as it's in the envelope release stage.

- **Legato:** Arkana has two voicing modes. A polyphonic (with newest voice precedence) and a monophonic mode. This switch enabled the Mono / Legato Mode. While in polyphonic mode each new MIDI key press will trigger a new note.

  In mono mode a single note is sustained and continued throughout all MIDI key presses without retriggering, until the last key is released. In case other keys are pressed or released in the meantime, the sound is affected only if the highest pressed MIDI key changes.

  Mono / Legato Mode is suitable for solo instruments such as leads.

- **Glide:** The glide knob controls the portamento time between notes. Higher settings will introduce longer times between transition from the one note to the next. Setting the knob to 0% disables the effect.

2.c. The Modulation Matrix

The Modulation Matrix -we believe- is one of the features you're gonna love on your new Arkana Synthesizer. It allows you to setup internal routing, connecting various parameters as sources to destinations.

There are five available routing slots which you can program. Each slot has five settings:

- **Source:** By clicking this box a pop up appears where you can select a parameter that generates values that will be fed to the modulation route. This can be a modulation source such as the Modulation Envelope or one of the LFOs, an external source connected to one of the five CV inputs, or parameters like the current note's MIDI key and velocity. You can also use parameters like grain index or pan positions.

- **Destination:** Clicking on the destination box a pop up menu appears, from which you can select the parameter that will receive the events of the source.

- **Amt (Amount):** The amount knob defines the magnitude of the modulation from the source to the destination.

- **Scaler:** A Scaler is a second modulation source which is used to dynamically affect the magnitude of the source modulation. An example in which you'd normally use a scaler is, if you wanted to assign a vibrato to the Mod Wheel. In this case you'd use LFO1 for example to modulate the Oscillator A Pitch and then assign the Mod Wheel as a scaler, to control how much of the actual effect will pass throughout the destination.

- **Scale Amount:** The scale amount adds another layer of magnitude control, over the amount of the effect passed to the destination. Normally you'd set this knob to 100% which will enable the Scaler to use the entire range up to the “Amt” setting. However in more complex situations, that involve automation on the modulation matrix, the Scale Amount can be very handy in order to adjust the amount of a modulation, without committing to the predefined Amount value.

More discussion on the Modulation sources on the next chapter.

2.d. Mod Envelope & LFOs

We've just discussed about the Modulation Matrix, but what about the dedicated modulation sources? These are divided in two kinds:

2.d.1. Mod (Modulation) Envelope

Arkana has a dedicated envelope for modulation purposes. As with the filter and amplitude envelopes the modulation envelope has four stages. However, there is no velocity sensitivity for the modulation envelope:

- **A (Attack):** Sets the attack time of the modulation envelope (4ms to 10 sec).
- **D (Decay):** Sets the decay time of the modulation envelope (4ms to 30 sec).
- **S (Sustain):** A percentage of the maximum envelope amount that the note will retain after the decay stage is complete, and before it is released.
- **R (Release):** Sets the release time of the modulation envelope. (4ms to 30 sec).

2.d.2. LFO (Low Frequency Oscillators)

Arkana also has three independent low frequency oscillators. These can be tempo synced or run free. Modulation from LFO1 and LFO2 is applied globally to all voices. LFO3 is applied per voice, its key synced (ie it resets it's phase to 0 when you hit a key) and you have the ability to modulate its rate using another source in the modulation matrix.

Parameters for each LFO are:

- **Rate:** Sets the rate of the LFO. In regards to the time synchronization setting, the value is expressed as Hz (in free mode) or as time measurements (in synced mode).
- **Sync Switch:** The sync switch changes the LFO timing to either tempo synced, or free.
- **Waveform:** You can select one of the 5 available LFO waveforms:

- Sine: A sinusoidal waveform
- Tri: A triangular waveform
- Saw: A sawtooth (Ramp Up) waveform.
- Square: A pulse / Square waveform.
- Rand: An S+H / Random waveform.
- S.Rand: A random waveform with smooth transitions.

2.e. Effects

Finally Arkana has a small effects section to add *that* final touch to your sounds. The effects have few but simple and effective settings.

2.e.1. Reverb

The reverb unit provides a wide stereo reverberation to the sound. The reverb algorithm is balanced between quality and CPU efficiency,

You can control three different parameters:

- **Mix:** Controls the analogy between the effect and the dry signal. At 0% only the dry signal is heard, while at 100% its the other way around; the wet signal is heard. At 50% both dry and wet signal pass at their maximum level.
- **Size:** Controls the reverberation size. The higher the value the longer will take for the reverb to fade out..
- **Damp:** Controls of course the reverb damping effect. Higher values will cause the high frequencies of the sound to fade quicker than the lower ones.

2.e.2. Delay

Arkana delay unit is a small stereo delay with channel balance and tone controls. You can adjust the following parameters:

- **Mix:** Like in reverb, the knob controls the balance between the effect and the dry signal. At 0% only the dry signal is heard, while at 100% its the other way around; the wet signal is heard. At 50% both dry and the effect signal pass at their maximum level.
- **Time:** Controls the time of the echoes repetition. This parameter can be set in either time units (ms or sec), on in song time measurements such as ¼, ½ of a bar etc.
- **Sync Switch:** The sync switch defines the time units that will be used for the delay effect (see “Time” above)
- **Feedback:** The feedback controls the amount of repetitions, or -if you prefer-

the time it takes for the effect to fade out. Setting this to 100% will cause an eternal feedback loop.

- **Balance:** This knob controls the stereo balance of the delays. The stereo balance changes by inserting a slight delay to either the left or the right channel. This creates a spatial effect to the echo. At 50% both channels are time synced.
- **Tone:** The tone control cuts either the low or the high frequencies of the echoes. At 50% on filtering occurs. However values lower than 50% will cut higher frequencies, and values higher than 50% will cut lower ones.

3. The Back Panel

In this chapter we take a look at the rear panel of the Arkana Granular Synthesizer.

Illustration 6: Arkana rear panel

The panel is divided into four sections:

- **Audio Out:** This section provides the main audio connectivity of the device. Namely a stereo audio output.
- **CV Inputs:** The section provides 5 CV inputs that you can assign to various parameters using the modulation matrix at the front. The acceptable range for all inputs is always bipolar.
- **CV Gate:** The CV / Gate pair for external sequencing.
- **CV Outs:** The CV Outs provides connections to the signals from LFO1 and LFO2. Note that Modulation envelope and LFO3 are instantiated per voice, and cannot be assigned to a single cv output
- **Oversampling:** Arkana also offers the ability to oversample the oscillator playback rate. By default no oversampling is performed. However there might be some cases such as low pitched samples that you wish to use on high pitched sounds, where you might need this feature to avoid aliasing. Note however, that depending on the sample, there still might be some

aliasing even with the best quality.

Oversampling is performed only in the oscillator section. Amp Envelopes, Filters and effects are still processed using the host sampling rate. Also bare in mind that oversampling costs CPU power.

Arkana has 3 different oversampling settings: Eco Mode (x1). Good (x2) and Best (x4).

- **Interpolation:** Finally this option offers 2 kinds of interpolation. Normal and Best. “Normal” is the standard option from the older versions. “Best” is more smooth and produces less artifacts, however it may have a slight toll on the CPU.

4. Considerations

In this chapter we discuss some issues that should be of your concern, in regards to the way Arkana works.

4.a. Grain Synthesis Techniques

In this section we discuss some techniques that you can employ when synthesizing sounds with Arkana.

4.a.a. Coverage

Grain coverage is a technique to smooth out grain playback by enabling the overlapping of grains. It can be implemented by utilizing two or more grain emitters, whose duty starts with a slight offset. Here are some examples:

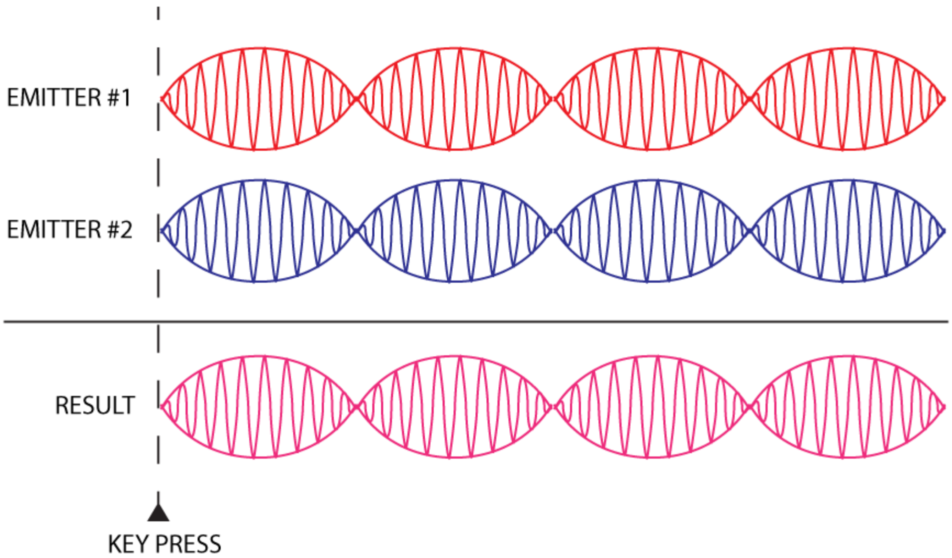


Illustration 7: Two grain streams by two emitters without offset (0%)

Arkana “Offset” parameter serves exactly this functionality. At maximum setting (100%) the grain coverage is up to the maximum effective size which -of course- is determined first and foremost by the grain count.

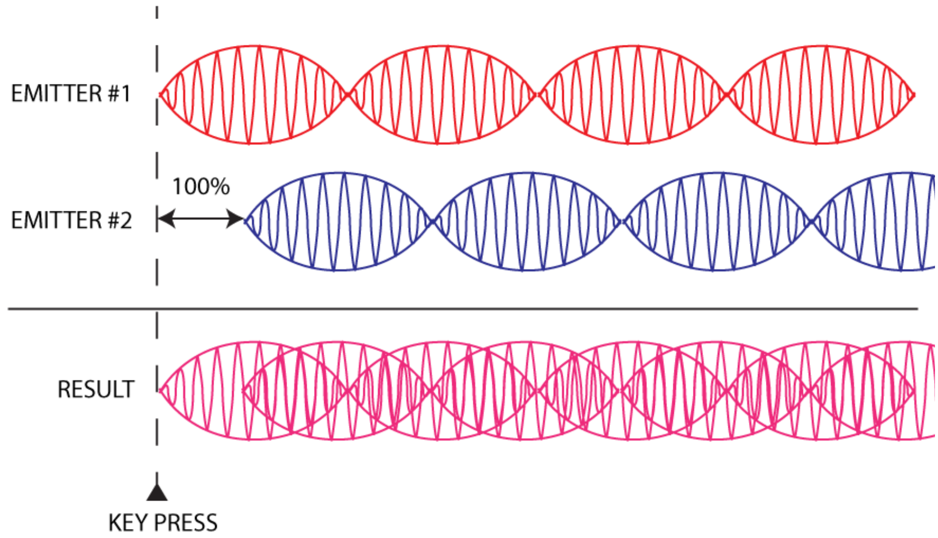


Illustration 8: Two grain streams with the offset set to 100%. Notice the resulting stream. That's grain coverage creating a smoother sound.

4.a.b. Grain Shapes

The available grain shapes, can have a huge impact on the harmonics of the sound when small period multipliers are used. Here are the frequency graphs of a sine sample pitched at C3 with a period T=1, using all available grain shapes.

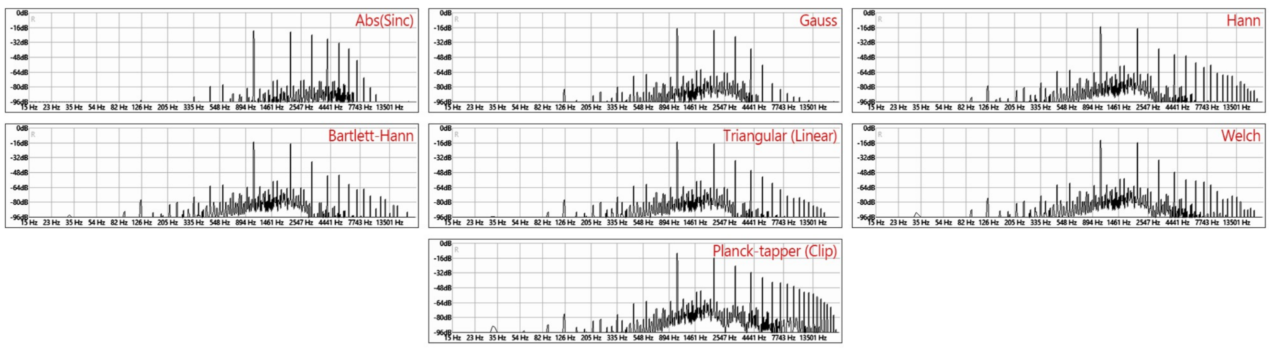


Illustration 9: Grain shapes and their harmonic responses.

Notice that as we advance to the list of grain shapes the body of the sound becomes thicker – more harmonics are added and amplified.

4.b. Cycle Synchronization

Since Arkana uses true stereophonic grains, there are some rules that apply in cases when you need to synchronize their cycles, or -since modulation matrix allows it- use their properties as sources for modulating other parameters.

In general the left channel sub-grain, is the sync / mod source per grain emitter, and consequently the first emitter is the sync / mod source for the oscillator.

Bellow are the synchronization circumstances, and how each one is resolved in particular:

- **Length Stereo Link:** The right channel sub-grain is synchronized to the envelope of the left channel (both channels start synchronized)
- **Pitch Stereo Link:** The right channel sub-grain inherits the pitch of the left channel sub-grain. This DOES NOT affect the grain execution time. You can say that in pitch sync mode, the right channel pitch acts as a formant.
- **Panning:** Panning is set for both grains on every restart of the left channel sub-grain. The right channel is balanced accordingly. Note that depending on your settings this might cause some crackles in case of heavy changes.
- **Gain:** Same rules as with the pan apply here: The left channel sub-grain applies a new value every time it restarts.
- **Modulation Matrix:** In cases when the oscillator pan or position is used as a modulation source, the first emitter's left channel sub-grain values are used.

4.c. Processing Power & Optimization

Athough Arkana's synth engine is optimized to utilize as little processing power as possible, depending on the circumstances, granular synthesis can be very expensive in terms of CPU utilization.

The reason behind that is obvious you do the math:

One voice can utilize up to 2 oscillators. The 2 oscillators control up to 5 grain emitters each, while each emitter controls 2 sub grains (one per channel). So basically hitting a MIDI key in Arkana can utilize up to 2 x 5 x 2 = 20 voices running independently. To this you should add the calculations needed per cycle in every grain, filtering, mod matrix calculations (these are performed per voice too) etc.

Finally if you add oversampling, you increase the demand for processing since the grain playback will chew up 2 or 4 times more CPU power, and two other operations required will be introduced: Bandlimiting and downsampling.

Arkana is SIMD optimized and will run efficiently, by excluding from processing, functionality that is not utilized.

This means that if f.e an oscillator is disabled or its not audible (gain is 0 or mix is turned fully to the other oscillator) will not be processed. The same applies for the effects if their mix level is set to 0%.

4.d. Optimization Techniques

So, about now, would be the right time to discuss optimization techniques when designing patches in regards to both sound quality and CPU efficiency. Here are some points to keep in mind:

4.d.a. Counting Your Grains

Use the grain emitters wisely: You do not need to use all 5 grains in order just to amplify the level of your sample. If that's your case limit grain usage to 1 and increase gain or balance the mix between the oscillators.

The same applies with coverage as explained in section 4.a.a of the manual: Most of the times 2-3 grains are quite enough to sustain a sound portion constantly, depending of course on the grain shape you use.

4.d.b. When To Oversample?

Oversampling is a very useful feature. However, utilizing it always and everywhere ultimately might have no result at all, and cost you excess CPU power for no reason.

The most quick answer to when to use oversampling, is: When you hear aliasing artifacts to your sound. Aliasing is the kind of distortion you usually hear in older FM synthesizers when operators are set to modulate in high frequencies, and it is produced when the higher frequencies (the harmonics) of the sound being played back, exceed the available audio spectrum range.

The available audio spectrum range is from 0Hz up to half the sampling rate of your system: 22.05KHz for 44.1KHz sample rate, 24KHz for 48KHz sample rate and so on. When a harmonic exceeds the upper limit, its "deflected" back (folds back) to the audible spectrum, and you can hear it as lower frequency content.

When this happens, oversampling can minimize or even eliminate this behavior, by extending the audible range internally, when producing the grains at their final pitch, therefore capture exceeding harmonics, then filter out any unwanted frequencies and finally downsample the result to the system playback sample rate,

Bare in mind though that depending on the grain pitch and the harmonic content of the sound there still might be harmonics exceeding the maximum oversampling frequency. In this case you might still get some anti aliasing.

4.d.c. The Right Waveform For The Right Job.

The waveform you use can also have a huge impact on aliasing and thus processing power optimizations. Especially with large grains when triggered by high keys, where large portions of the sample are played at high rates.

The rule of thumb here is to use high pitch waveforms for high pitch intended patches (such as leads, strings, pads etc) and low pitch waveforms for basses, drones and, in general, low pitch intended patches.

Using high pitch waveforms -when sampled to sample rates close the playback sample rate- have already been subjected to the process of band limiting, which otherwise would be performed by the oversampling algorithm. On the other hand, since band limiting, filters out high content from the sound, playing back high pitch sounds on low frequencies, will produce results that sound dull.

5. MIDI CC Chart

CC	Parameter
7	Volume
8	Oscillator Mix
14	LFO #1: Rate
15	LFO #2: Rate
16	LFO #1: Wave
17	LFO #2: Wave
18	LFO #3: Wave
19	LFO #1: Sync
20	LFO #2: Sync
21	LFO #3: Sync
23	LFO #1: Rate Synced
24	LFO #2: Rate Synced
72	Mod Env Release
73	Mod Env Attrack
75	Mod Env Decay
76	LFO #3: Rate
77	LFO #3: Rate Synced
79	Mod Env Sustain
80	Osc A Enabled

CC	Parameter
81	Osc B Enabled
85	Reverb Time
86	Reverb Damping
87	Delay Time
88	Delay Time Sync Switch
89	Delay Synced Time
90	Delay Feedback
91	Reverb Mix
92	Delay Balance
93	Delay Mix
94	Delay Tone
129	Osc A: Length
130	Osc A: Length Keybd Follow
131	Osc A: Length Random
132	Osc A: Length Stereo Link
133	Osc A: Pitch
134	Osc A: Pitch Spread
135	Osc A: Pitch Random
136	Osc A: Pitch Stereo Link
137	Osc A: Keyboard To Pitch
138	Osc A: Speed
139	Osc A: Speed Random

CC	Parameter
140	Osc A: Pan
141	Osc A: Pan Random
142	Osc A: Pan Spread
143	Osc A: Formant
144	Osc A: Formant Random
145	Osc A: Gain
146	Osc A: Gain Random
147	Osc A: Grain Envelope Type
148	Osc A: Grain Count
149	Osc A: Offset
150	Osc A: Offset Random
151	Osc A: Position
152	Osc A: Position Spread
153	Osc A: Position Random
154	Osc A: Filter Type
155	Osc A: Cutoff
156	Osc A: Resonance
157	Osc A: Filter Env Amt
158	Osc A: Filter Env Velocity Sens
159	Osc A: Filter Env Attack
160	Osc A: Filter Env Decay
161	Osc A: Filter Env Sustain

CC	Parameter
162	Osc A: Filter Env Release
163	Osc A: Amp Velocity Sens
164	Osc A: Amp Env Attack
165	Osc A: Amp Env Decay
166	Osc A: Amp Env Sustain
167	Osc A: Amp Env Release
168	Osc B: Length
169	Osc B: Length Keybd Follow
170	Osc B: Length Random
171	Osc B: Length Stereo Link
172	Osc B: Pitch
173	Osc B: Pitch Spread
174	Osc B: Pitch Random
175	Osc B: Pitch Stereo Link
176	Osc B: Keyboard To Pitch
177	Osc B: Speed
178	Osc B: Speed Random
179	Osc B: Pan
180	Osc B: Pan Random
181	Osc B: Pan Spread
182	Osc B: Formant
183	Osc B: Formant Random

CC	Parameter
184	Osc B: Gain
185	Osc B: Gain Random
186	Osc B: Grain Envelope Type
187	Osc B: Grain Count
188	Osc B: Offset
189	Osc B: Offset Random
190	Osc B: Position
191	Osc B: Position Spread
192	Osc B: Position Random
193	Osc B: Filter Type
194	Osc B: Cutoff
195	Osc B: Resonance
196	Osc B: Filter Env Amt
197	Osc B: Filter Env Velocity Sens
198	Osc B: Filter Env Attack
199	Osc B: Filter Env Decay
200	Osc B: Filter Env Sustain
201	Osc B: Filter Env Release
202	Osc B: Amp Velocity Sens
203	Osc B: Amp Env Attack
204	Osc B: Amp Env Decay
205	Osc B: Amp Env Sustain

CC	Parameter
206	Osc B: Amp Env Release
210	Mod Matrix Enabled
211	Matrix Slot #1: Amount
212	Matrix Slot #2: Amount
213	Matrix Slot #3: Amount
214	Matrix Slot #4: Amount
215	Matrix Slot #5: Amount
216	Matrix Slot #1: Scale
217	Matrix Slot #2: Scale
218	Matrix Slot #3: Scale
219	Matrix Slot #4: Scale
220	Matrix Slot #5: Scale

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