hamburg-audio

NUKLEAR™

PULSAR TRAIN SYNTHESIZER

version 1.1.2.

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1. Introduction

Thank you for trying or buying hamburg-audio's NUKLEAR™.

NUKLEAR™ is a polyphonic pulsar train synthesizer with step-sequencer and effect section, as well as advanced LFO and envelope routing capabilities.

At the core of NUKLEAR™ are 4 pulsar train generators comparable to oscillators known from classic analog synthesizers. However, pulsar synthesis differs from classic synthesis techniques in many respects. An introduction to pulsar synthesis is given in chapter 2.

The development team of NUKLEAR™ put great effort into developing the synthesis routing capabilities, and state-of-the-art audio algorithms in order to integrate pulsar synthesis into production environments supporting VST2, VST3 or Audio Unit plugin technology. The result is a synthesizer producing a multiverse of previously unheard sounds enriching music production with innovative audio synthesis.

Main features

- Advanced pulsar synthesis with 4 pulsar train generators and up to 16 voices
- 26 pulsar waveforms and 4 pulsar envelope waveforms
- 8 low frequency oscillators
- 8 ADSHR envelope
- Built-in delay effect with sync option
- Built-in distortion effect with 3 distortion types
- 16-step sequencer with 8 programmable patterns for note and multiple parameter modulation control

System requirements

AU or VST capable host software

Minimum:

- Screen resolution of 1024 x 768
- PC: 1 GHz, 256 MB RAM, Windows XP or newer
- Mac (Intel): 1 GHz, 256 MB RAM, Mac OS X 10.5 or newer

Recommended:

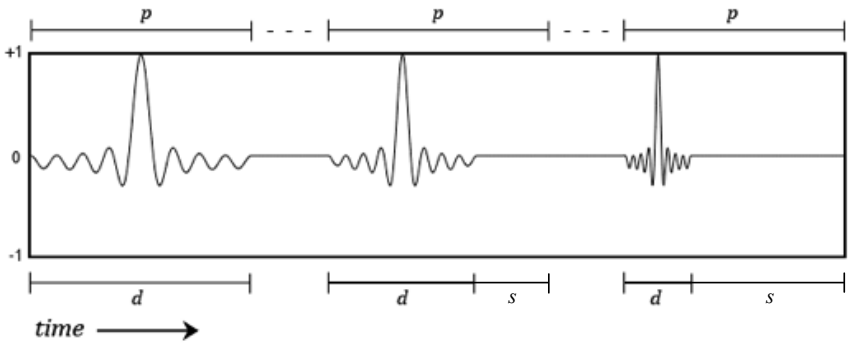
- Screen resolution of 1280 x 960
- PC: 1 GHz, 512 MB RAM, Windows XP or newer
- Mac (Intel): 1 GHz, 512 MB RAM, Mac OS X 10.5 or newer

2. Pulsar Synthesis

Pulsar synthesis is a form of granular synthesis named after spinning neutron stars that emit periodic signals with repitition rates in the range of 0.25 Hz to 642 Hz. Basic pulsar synthesis as described by Curtis Roads generates a monophonic periodic pulsar train controlled by the following parameters:

- fundamental frequency (pulsar frequency): its period *p* consists of the *pulsaret length (duty cycle) d* and the *intergrain time s* (the time between the waveforms).
- duty cycle frequency (formant frequency): determines the length of the waveform (*pulsaret)* within the *pulsar (pulsaret-width d)*.

The pulsaret is characterised by the pulsaret waveform and the pulsaret envelope.



Unlike in conventional Pulse-Width-Modulation (PWM) synthesis, the pulse width control in NUKLEAR™ is an independent parameter, which in some settings may become longer than one period of the fundamental frequency. If this is the case pulsarets are overlapped, i.e. the next pulsaret is emitted before the previous one finished.

In NUKLEAR™ the fundamental frequency f_p is controlled by the MIDI note. The duty cycle frequency f_d, determining the waveform (pulsaret) length, is controlled by the *freq* parameter.

NUKLEAR™'s synthesis engine also offers a pulsar/classic hybrid synthesis, letting the user switch to a classic oscillator, or gradually "mix" the two synthesis techniques.

3. Installation

3.1. Setup

3.1.1. Windows

To start the setup, run the installer by double-clicking the installation program. Separate installers are provided for VST2 and VST3, both for 32bit and 64bit versions of NUKLEAR. The installer will guide you through the installation process. During installation you can choose the destination folder.

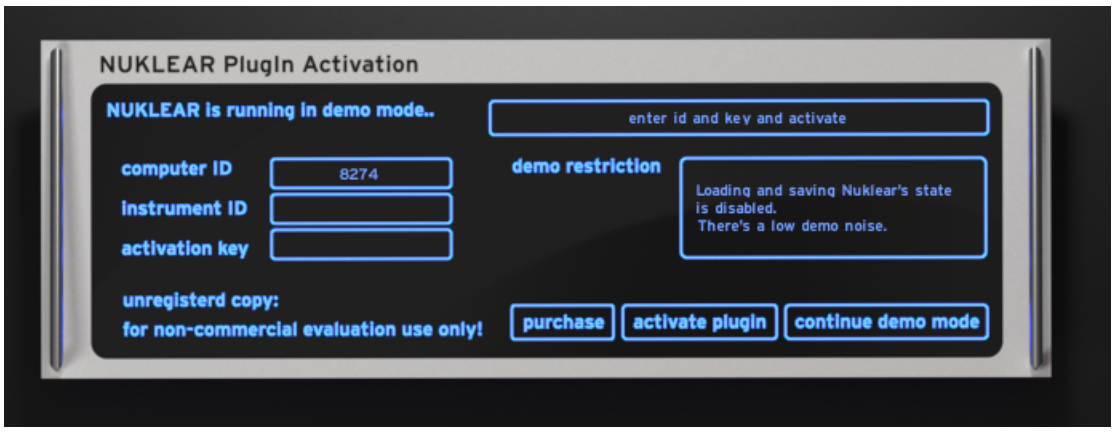
3.1.2. Mac OS

To start the setup, run the installer by double-clicking the installation program. Separate installers are provided for VST2, VST3 and Audio Unit (AU) versions of NUKLEAR: The installer will guide you through the installation process. During installation you can choose the destination folder.

3.2 Program Activation

In order to use all features of NUKLEAR™ the software has to be activated by entering your activation key. Saving presets or the synthesizer's state in within a project is disabled in the demo version. Furthermore a noise signal is played at random times when using an unregistered version. The license for the demo version allows the use of the software for private use only.

The activation page opens when opening the NUKLEAR™ demo version.



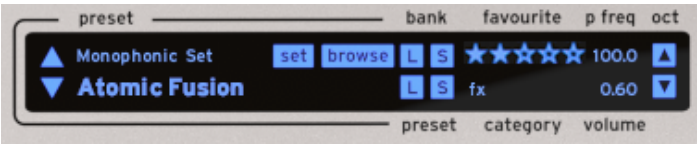
The *purchase* button redirects to hamburg-audio's online shop where you can buy a license. To obtain your personal activation key click the *activate plugin* button or go to http://shop.hamburg-audio.com and navigate to *Request Key*.

4. Reference

The NUKLEAR™ graphical user interface.

The graphical user interface of NUKLEAR™ is divided into several sections, some of which occupy multiple pages. The top left display next to the NUKLEAR™ logo is for plugin settings, preset management and global parameters, such as master volume, global pulsaret frequency and octave control. Routing controls for LFOs, envelopes and control step sequences, as well as the *MIDI learn* function can be found in the display to its right. *Pulsar 1* to *Pulsar 4* control the pulsar trains / oscillators. Furthermore there is a filter section and below a mixer section with controls for gain, panning, and filter settings for the for individual pulsar trains. The *envelope* section shares space with the LFO section. To switch between the pages click on the *envelope* label (or *LFO* label respectively). The lower right section also consists of several pages toggled by clicking on its (top left) label. It contains the effect section (delay, distortion) and the step sequencer.

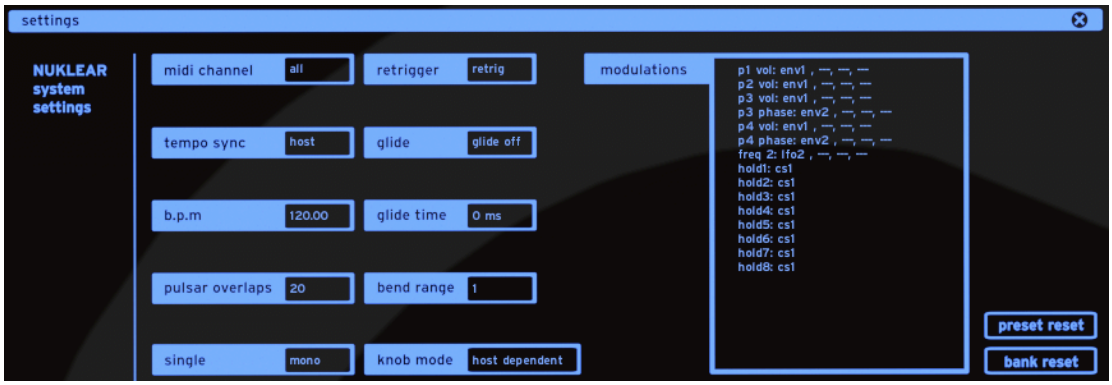
4.1. Global Parameters



On the top left black panel you find the global controls *main volume*, *octave switching* and *pulsaret length* (see chapter 4.3.), as well as controls for loading and storing presets (L/S lower row) and preset banks (L/S upper row). NUKLEAR™ also allows for rating presets by awarding up to 5 stars to a preset. Clicking the preset name field allows for renaming of the preset. To open the preset browser click *browse* to get an overview of the current preset-bank.

4.2. Settings

Clicking the *set* button opens the settings page with several parameters setting NUKLEAR™*'s* behavior. The assigned modulation sources are shown on the right.



MIDI channel

MIDI input channel selection

Tempo Sync / B.P.M

Sync source selection for the sequencer. *Host* syncs to the host tempo. When *Sync On* is selected the tempo can be specified in beats per minute in the *b.p.m* box.

Pulsar Overlaps

Select the maximum number of overlapping pulsarets for *((formant frequency) < (fundamental frequency))*. When the limit is reached the pulsaret length will be adjusted to fit into the limit. While setting a high number of overlaps further retains the formant structure of the sound at high notes it may lead to sound cancellation in extreme cases. Furthermore, a high number of overlaps increases the CPU load. A blue LED lights up next to a given pulsar-train generator name (e.g. *pulasr* 1) when the maximum number of overlaps for this generator is reached. Range: 0-50, default :20.

Retrigger

Switch between polyphonic and monophonic mode. The monophonic mode can be played *legato* or with retriggering of the envelope at each new *note-on*.

Glide

On/off switch for glide in monophonic mode.

Glide Time

Glide time setting in milliseconds.

Bend Range

Specifies the MIDI pitch bend range in semitones.

Knob Mode

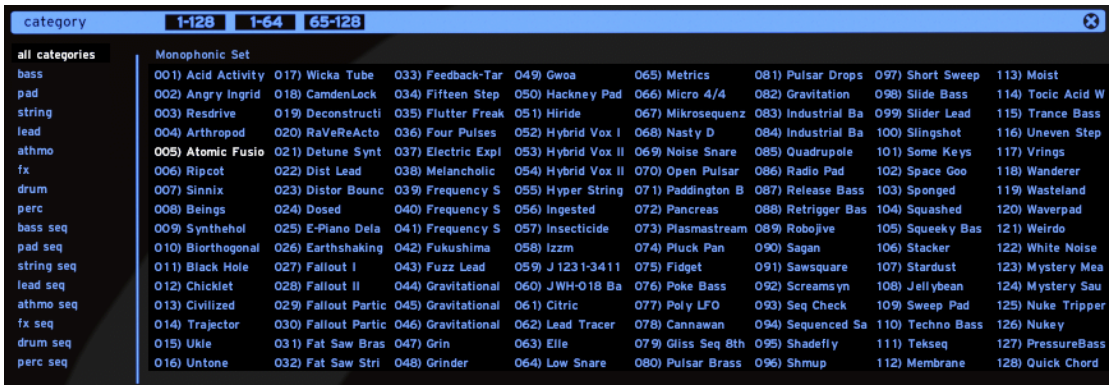
This parameter determines the way the rotary knobs are controlled with the mouse. In linear mode the control knobs are turned with an up/down mouse movement, in the circular setting the movement is circularly around the control knob. In the *host dependent* setting the control mode is set by the host software. In all modes the control knobs can be reset to their default value by clicking on them while holding the *Ctrl* key (Windows) or the command key ⌘ (Mac OS).

Modulation Sources Overview

On the right side the parameters and their modulation sources (if assigned) are displayed.

4.3. Preset Management

NUKLEAR™ uses its own file formats to store presets and preset banks. Up to 128 preset can be stored in one preset bank. To load and save a preset bank click the *L* or *S* button in the first row, the second row loads and saves individual presets. Clicking the *browse* button opens the preset browser.



In the left pane preset categories to be displayed on the right can be selected. The buttons 1-64 / 65-128 switch to the display of the presets of one half of the bank each. Clicking on a preset name loads the selected preset.

It is highly recommended to only use NUKLEAR™'s own file format to load and save presets and preset banks. This concerns the Audio Unit and VST3 standard in particular, since they do not account for preset banks. Using their standard format may lead to undesired results.

4.4. Pulsar Train Generators

Each pulsar train generator produces a pulsar train as described in chapter 2. Additional parameters allow for further manipulation of the train characteristics. The pulsaret is specified by a waveform and an envelope, which together produce the pulsaret waveshape. The left/right arrows on the top right tune the generator in octave steps. A pulsar generator can be muted by clicking on its label on the upper left.

Waveform

Selection of waveform shapes in a pull-down menu

Envelope

Selection of envelope shapes in a pull-down menu

Freq

Duty cycle frequency setting ranging from 40Hz to 8000Hz. This parameter determines the pulsaret length. The actual frequency is also dependent on the global pulsar length setting.

Pulsar

The Pulsar/classic synthesis mixer lets the generator act as a classic oscillator, i.e. the pulsaret length is always the same as the period of the fundamental frequency.

0 – classic oscillator

1 – pulsar train generator

Intermediate settings create a hybrid synthesis changing the relation of the pulsaret length to the fundamental period. The classic mode is especially useful for the addition low frequencies to the spectrum. Waveforms like sawtooth or rectangle in pulsar synthesis may be perceived as intermediate pitch variations when the pulsaret frequency is changed in the overlapping range.

F Tune

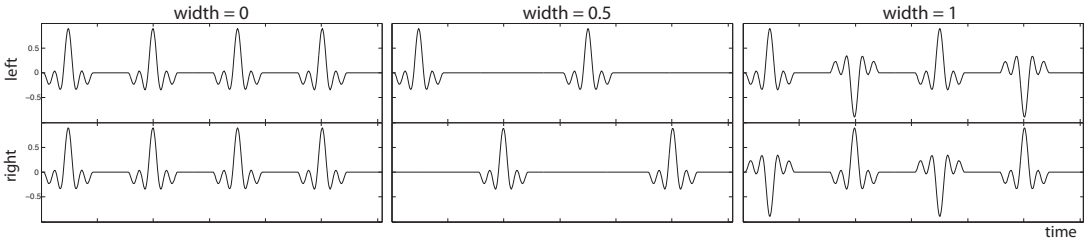
Fine tune. Range: -1 to 1 semitones.

Tune

Range: -12 to 12 semitones.

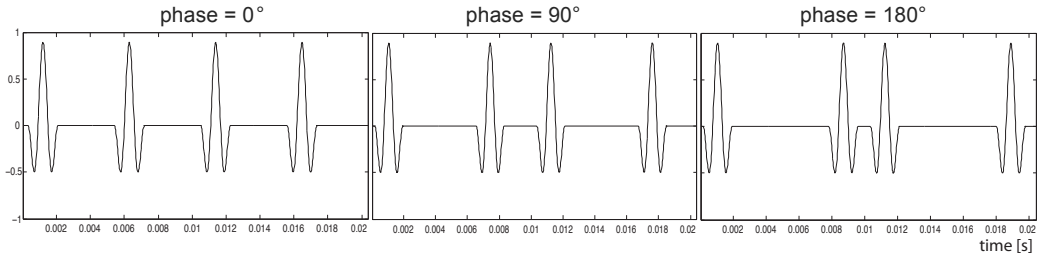
Width

Sets the amount of alternation of pulsars between the stereo channels. At *0* every pulsar plays on both channels, at center position the pulsars alternate between the channels. At *1* the alternating pulses are mirrored negatively onto the other channel. Note that at *width=1* the phase shift between the left and right channel is 180°, which needs to be taken into account when mastering music for vinyl.



Phase

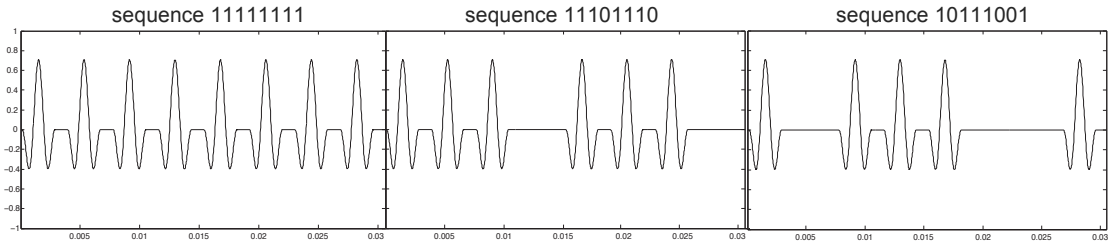
Shifts the phase of every second pulsar within the fundamental cycle in a range from 0 to 360°. At 360° the second pulsar is delayed to coincide with the following one.



Micro-Sequencer

The micro-sequencer can alter the pulsar train by masking (omitting) pulsars according to a specified sequence. The top row of triangles determines the length of the sequence loop, and the lower row activates and deactivates pulsars. In the example in the screenshot above the

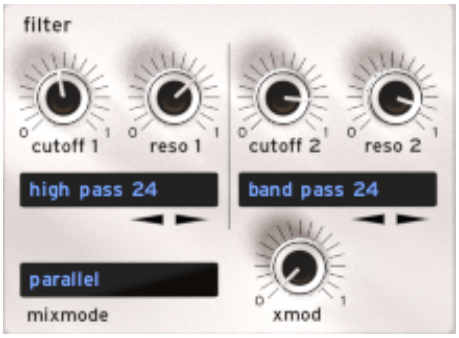
sequence length is 4 pulsars, in which one pulsar is omitted. This particular setting introduces sub-harmonics at ¼ of the fundamental frequency.



Copy Settings

By clicking the symbol on the left above the envelope display, the settings of the pulsar train generator are copied to the clipboard. Clicking the same symbol in another generator pastes the settings. When active, the copy-function can be deactivated by a second click on the same copy-buton.

4.5. Filter



The filter section provides a selection of filters (low pass, band pass, high pass, 12/24dB). Two filters can be applied in parallel or serial mode (*mixmode*). In parallel mode the parameter *xmod* changes the filter outputs from addition to multiplication (ring modulation).

4.6. Mixer

The mixer section controls the volume, panning and filter settings for the individual pulsar trains. Note, that a pulsar train can be muted independently from the *mix* parameter by clicking on the label of the respective pulsar train generator (see section 4.4.).

Mix

Volume

Pan

Constant power pan

F Dest:

Filter pan (left = filter 1, mid = both filters, right = filter 2)

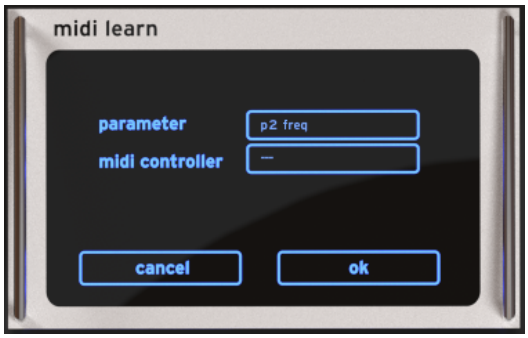
4.7. LFO, Envelope and MIDI Controller Assignment

Clicking the label of a parameter will select it. A blue colored control knob indicates the selection and its name appears in the top right black panel in the *parameter* column.

In the columns *source 1* and *source 2*, the modulation source can be selected from a pull-down menu opened by clicking in the first row. The LFO/Envelope settings section below the panel will automatically displays the controls for the selected modulation source. In addition to LFOs and envelopes, values sent from the sequencer can also be used by selecting one of C1 to C8.

The modulation sources among each other in the column will be multiplied, while the two sources act in parallel. The modulation amplitude is selected in the *amt* column. LFOs can also be modulated by other LFOs. When selecting *keytrk* (keytrack) as modulation source the modulation depth is dependent on the note pitch. The left circle in the row below assigns the modulation wheel, the right circle the note velocity to the assigned LFO/Envelope amplitude. If no modulation source is selected the modulation wheel or note velocity directly modulates the parameter.

MIDI controllers can be freely assigned to a parameter via *MIDI learn*. Clicking on the circle in the lower right corner opens a dialog displaying the selected parameter.



The next MIDI controller received by NUKLEAR™ will be displayed and assigned to the selected parameter. Click *OK* to confirm or *CANCEL* to close the window without changes.

4.8. LFO and Envelope Parameters

NUKLEAR™ uses the same section for the LFO and envelope controls. By clicking on the label (*lfo 1* in the image) the display switches between the LFO and envelopes page. There are 8 LFOs and envelopes to choose from, which can be selected by clicking on one of the black circles on the top right. The blue LED indicates that the selected modulation source has been assigned. Moving the mouse over the LED highlights all visible parameters assigned to the modulation source.

4.8.1. LFO Settings

Freq

LFO frequency

Attack

Amplitude attack time. This is the time it takes for the LFO to reach its maximum amplitude.

Offset

Time setting to delay the start of the LFO

Phase

Sets the initial phase of the LFO

Sync

When activated the LFO frequency is synced to the master tempo according to the setting in the *time/bars* display. In sync mode the frequency is selected in the menu above the *bars* label.

Retrigger

When activated a MIDI note-on command retriggers the LFO including attack, offset and phase.

LFO Type

Pull-down menu for the selection of LFO waveforms.

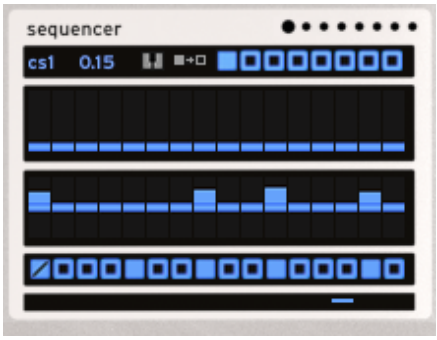
Time/Bars

Timing settings in fractions of bars for LFO sync mode.

4.8.2. Envelope Settings

The envelopes are ADSHR envelopes with the addition of a hold parameter. Furthermore the attack, decay, sustain and release, slopes can be modified via the three controls in the bottom row. The slope shape is exponential on the left (*0*) and can be gradually changed to linear by turning the control to the right *(1*).

4.9. The Step Sequencer



The step sequencer can play a maximum of 8 different patterns, selected by the boxes on the upper right.

In polyphonic mode the sequencer acts purely as a control sequencer, hence the note sequence row is grayed out. The control sequences send up to 16 values per bar that are freely assignable to any parameter. In monophonic mode the note sequencer is active and triggers up to 16 notes per bar.

The lower row of bars sets the note pitch. The upper row sends controller data to be assigned to parameters as modulation sources *C1* to *C8*. The bar height determines the value. The vertical bars represent the maximum of 16 steps per pattern. Each step is controlled according to the symbol in the box below. As opposed to the other step types the *return* function also applies in polyphonic mode.

 trigger off

 trigger on

 slide

 hold

 return: limits the amount of steps in a pattern by marking the end of a sequencer loop. If for instance the 5th step is marked with *return*, the sequencer plays in 5/4. If no loop marker is set the full 16-step sequence is played. This parameter does not alter the duration of the pattern.

A mouse click while holding down the Alt-key copies the step type to all other steps of the pattern (function dependent on host software). A right click sets the step directly to *off*.

There are several additional functions for editing a sequence:

Value Interpolation

The parameter in the upper left corner determines the interpolation time between values in the controller value sequence. At setting *0* note changes are immediate, at *1* the note pitch slides over one note length.

Modulation Source 

The upper row in the pattern acts as one of eight modulation sources (*C1* to *C8*) according to this setting. It is selected by clicking either on the name directly or by the round buttons on the upper right.

Copy Pattern 

To copy one pattern to another click the *copy* symbol next to the pattern selection at the top of the sequencer. The selected pattern will be copied to the pattern selected next.

ALT-Key

By holding the ALT-key a bar is set directly to a value. Normally the value is set by clicking on a bar and holding the mouse button while moving the mouse up or down.

Right-Click

Right-clicking on a step in the sequencer sets all bars to the value of the selected step.

Pattern Selection via MIDI 

By clicking on the keyboard symbol in the top row the MIDI keys for the selection of patterns can be assigned. The parameter has three states displayed in the top right black panel. After

activating *learn* the first MIDI note played will be assigned to selecting pattern 1. The seven next higher notes are assigned to the other patterns. The other states are *on* and *off.*

C1 to *C8* can also be assigned to parameters of an envelope on the upper right black panel (see chapter 4.8.). A parameter of an envelope is selected by clicking on its name (e.g. 'attack') instead of the control knob itself.

Note: In order to use the sequencer for note patterns, the synthesizer has to be set to *monophonic* mode. To control the envelope parameters (attack, hold, etc.) for a note in the sequence, assign an envelope to a volume control, and one of the CS controllers to the respective envelope parameter. The control sequence can also be applied to polyphonic sound independently from the note pattern.

4.10. Effects

NUKLEAR™ comes with an effect section consisting of a *stereo delay* and *distortion* effect. The effect can be turned on by clicking on the upper right button *on*.

4.10.1. Delay Effect

The delay effect has three states: *on*, *off* and *global off*. *Global off* allows switching presets with bypassed delay effect.

Time

Delay time setting

Feedback

Delay feedback amount

Width

Stereo amount

Mix

Dry/wet mix

Low Cut

Filter cutoff frequency for the attenuation of low frequencies of the input signal

High Cut

Filter cutoff frequency for the attenuation of high frequencies of the input signal

Low Damp

Filter cutoff frequency for the attenuation of low frequencies of the delayed signal

Hi Damp

Filter cutoff frequency for the attenuation of high frequencies of the delayed signal

4.10.2. Distortion

Drive Type

Selection of distortion type *soft*, *medium* or *hard*

Pre Filter

When activated, the signal is distorted prior to the application of the filters.

Drive

Drive amount

Gain

Distortion Gain

Lo Damp

Low frequency dampening amount for the distorted signal

Hi Damp

High frequency dampening amount for the distorted signal

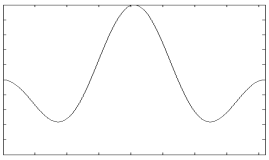
Mix

Dry/wet mix

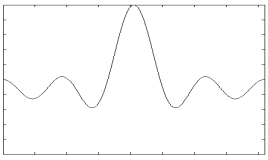
5. Pulsaret Waveforms & Envelopes

Along with the classic waveforms sawtooth (saw), square (rect), triangle, sine, and needle, NUKLEAR™ offers a selection of additional pulsar waveforms shown below. Furthermore, white and pink noise can be selected.

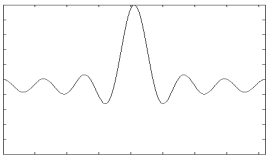
Note: only the width parameter has an effect on the sound when selecting a noise waveform without a pulsaret envelope, as it is not emitted in pulsars but as a constant stream. However, selecting noise in combination with a pulsaret envelope produces a pulsar train.



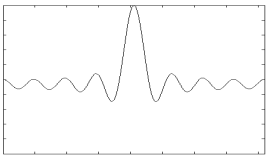
bp1: bandlimited pulse 1



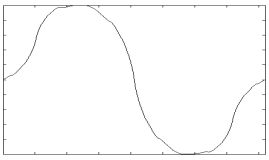
bp2: bandlimited pulse 2



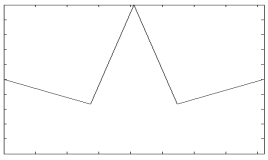
bp3: bandlimited pulse 3



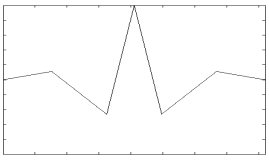
bp4: bandlimited pulse 4



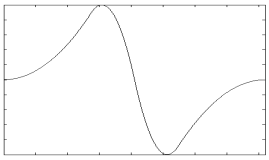
bior1.3d: based on biorthogonal decomposition wavelet 1.3



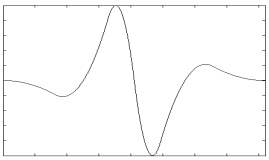
bior2.2r: based on biorthogonal reconstruction wavelet 2.2



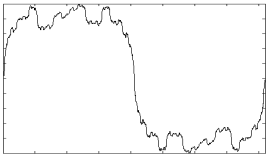
bior2.6r: based based on biorthogonal reconstruction wavelet 2.6



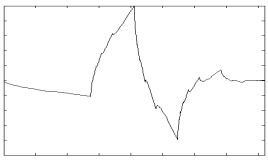
bior3.1r: based on biorthogonal reconstruction wavelet 3.1



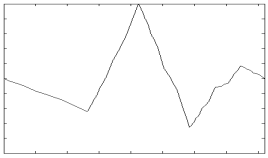
bior3.3r: based on biorthogonal reconstruction wavelet 3.3



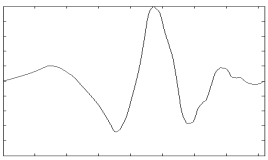
bior3.5d: based on biorthogonal decomposition wavelet 3.5



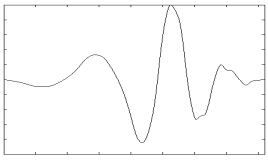
db2: based on Daubechies 2 wavelet



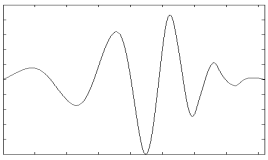
db3: based on Daubechies 3 wavelet



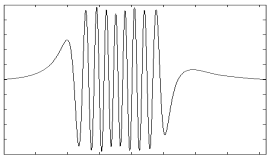
db4: based on Daubechies 4 wavelet



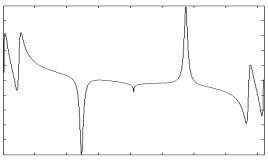
db5: based on Daubechies 5 wavelet



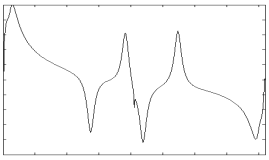
db8: based on Daubechies 8 wavelet



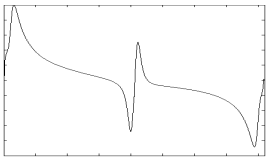
grav: gravitational wave



xw1: experimental waveform 1

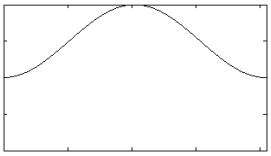


xw2: experimental waveform 2

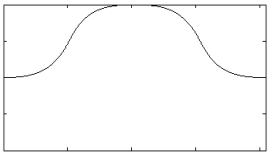


xw3: experimental waveform 3

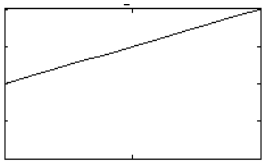
The waveforms can be used in combination with the following envelopes functions:



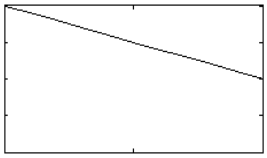
hann: hann window



hann1: hann window 2



saw up: linear attack



saw down: linear decay

6. Pulsar Train Parameters Explained

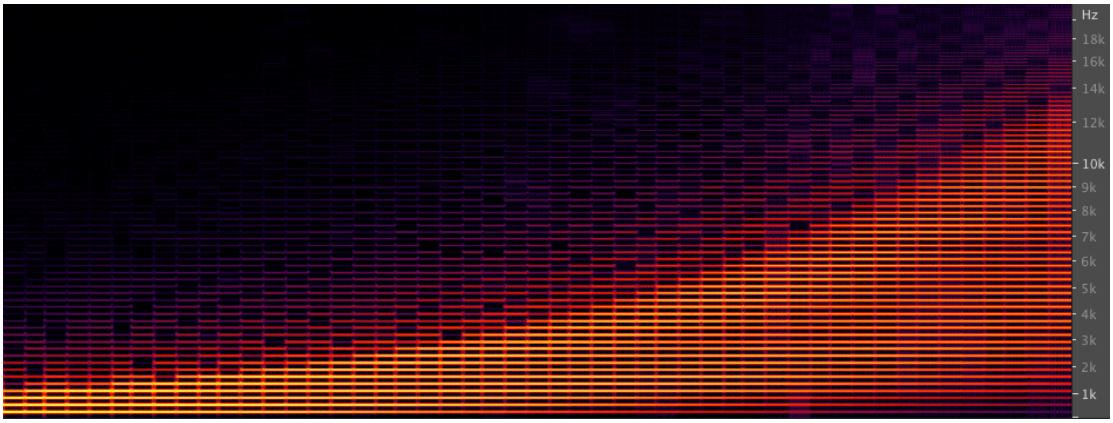
This section gives some advice on sound design with NUKLEAR™ and describes the way the parameters affect the produced sound. An overview of the parameters is given in section 4.4.

The controls of the pulse train generators are best understood when playing one oscillator and comparing monophonic pulse trains first played at very low fundamental frequencies followed frequencies in the higher range. In order to do that you may open the preset 'Manual', which can be found in the factory bank, preset number 25. Note that the octave settings both globally and for the individual generator are set to their minima in order to be able to play notes with fundamental frequencies in the subharmonic range down to under 1Hz.

When playing a low note you will hear separate pulsars emitted at a slow rate making the individual pulsars clearly distinguishable.

freq:

Move the *freq* parameter and you will notice the change in timbre of the pulsarets. This parameter contracts and stretches the pulsaret waveform. At lower frequency settings the waveform is pitched down, making it longer and shifting the spectrum to lower frequencies. Higher settings contract the waveform resulting in a spectrum with higher frequencies. Sonically this produces an effect reminding of a band pass filter.



Spectral effect of the pulsaret frequency (*freq*) from low to high at a constant fundamental frequency.

width:

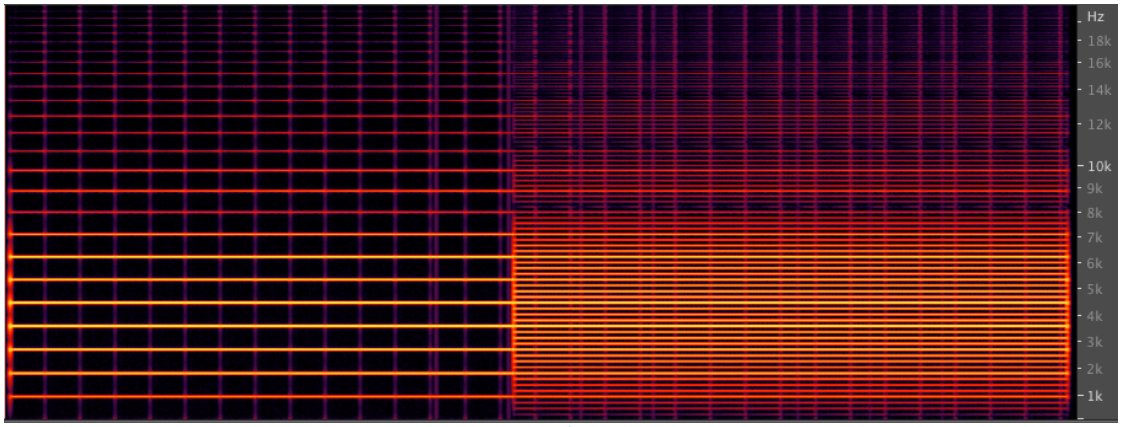
Now slowly turn up the width parameter to its middle position. The pulsars are now alternating between left and right. The middle position lets the pulsars alternate between hard left and hard right. At higher notes this results in a stereo widening of the sound and introduces frequencies one octave lower. This is due to amplitude modulation taking place. At medium width on each of the channels the pulsar train is essentially played at half the original frequency with a phase shift of 180° between them. At *width* settings above the middle position the alternating pulses are mirrored negatively onto the other channel (see image in chapter 4.4).

phase:

To examine the *phase* parameter, first set *width* back to zero so that a monophonic stream of pulsars is played, just as in the beginning of this example. When turning up the phase parameter every other pulse is delayed. The delay time is given in degrees of the fundamental period. At its maximum setting every other pulse conincides with the next one. This can also be observed when playing notes in the subharmonic region, so that the individual pulses are acustically distinguishable.

microsequencer:

The microsequencer's effect can be also be observed by playing subharmonic notes. Set the length of a loop in the upper row of triangles, and the sequence in the lower row. You should hear a sequence where pulsars are muted at each black (deactivated) triangle in the lower row within the loop. The screenshot of the pulsar generator in chapter 4.4. the sequence has a length of 4 pulsars with one of the four pulsars masked. A spectrogram of a note where the microsequencer is activated with this setting given below.



Spectral effect of the microsequencer: masking every 4th pulsar introduces harmonics at ¼ of the fundamental frequency. The Microsequencer is acrivated half way through the signal.

Pulsar generators as oscillators:

To compensate for the lack of low frequencies of pure pulsar synthesis in many settings we introduced the *pulsar* parameter which makes it possible to turn the pulsar train generator in to a virtual analog oscillator, however with the additional controls of *width*, *phase* and microsequencing. However, by setting *width* and *phase* to 0, deactivating the microsequencer, and selecting for instance the sawtooth waveform, it acts just like a classic sawtooth oscillator (the classic oscillator can be described here as a pulsar train generator where the pulsaret frequency is always equal to the fundamental frequency). Using this *pulsar* setting in at least one of the four pulse train generators can be very useful for the design of the lower frequency spectrum of a sound, especially in combination with a low pass filter.

Curtis Roads' original 2001 article on pulsar synthesis from the Journal of the Audio Engineering Society can be found online:

http://clang.mat.ucsb.edu/articles_files/SoundCompwithPulsars.pdf


ATOMKRAFT ?
NEIN DANKE