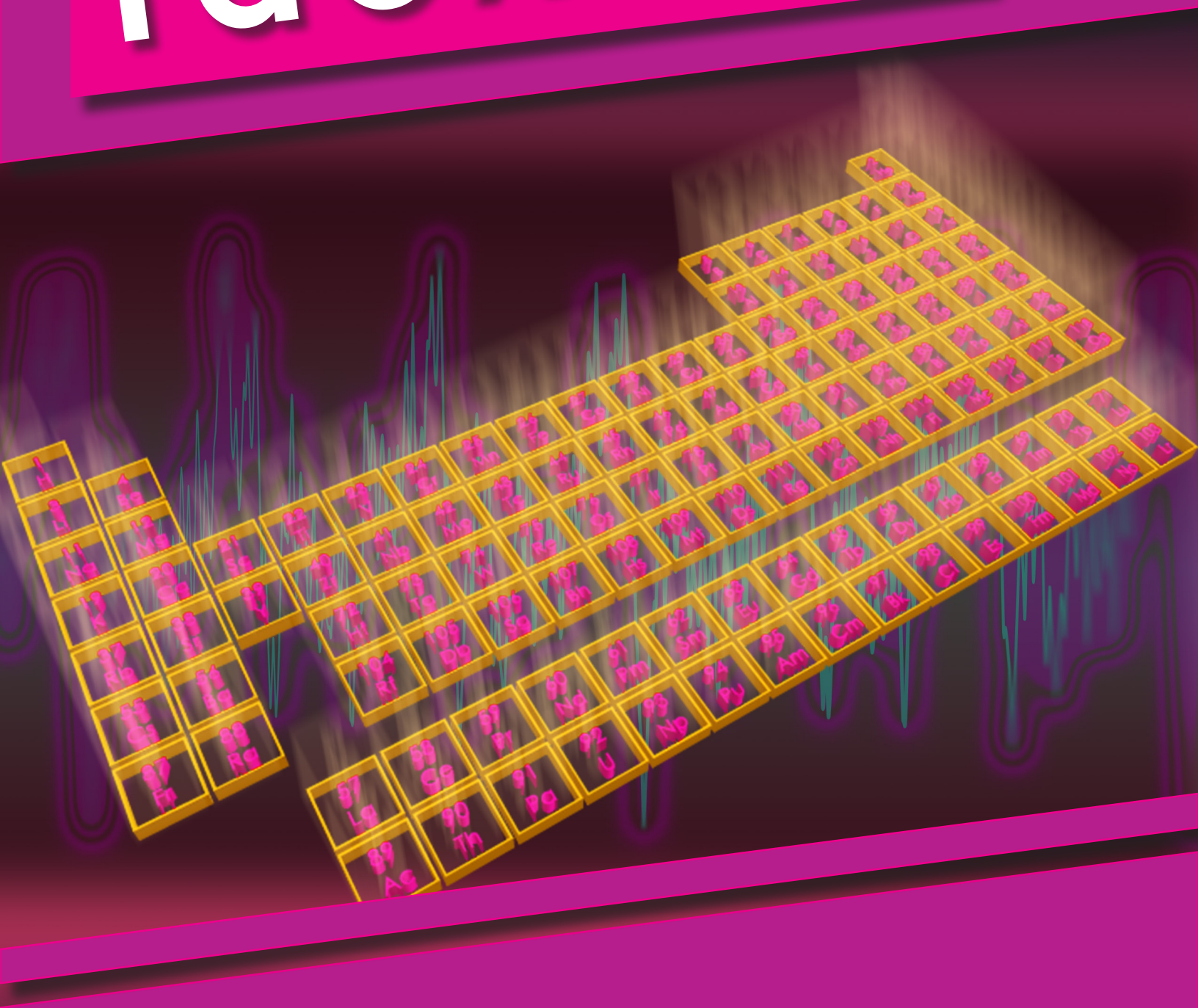
Таблица



Tablitsa Wavetable Synthesizer

User's Manual

v0.1.1.0 *(beta)*

Contents

Quick-Start Guide

Features

- 118 wavetables with adjustable timbre
- Phase and ring modulation
- Unison voice controls
- Two filters, each with three models
- Polyphonic (voice) effects
- Master effects
- Three envelopes, two LFOs, and a sequencer
- Velocity, keytrack, and random (key-trigger) modulation

How do I...?

Change the wavetable
Click and drag one of the highlighted cells on the Periodic Table to a new element.

Apply modulation
Center-click the dial for the parameter you would like to modulate. The dial will become highlighted, and the vertical *Depth* sliders in each modulator's panel will become linked to that control. When these are adjusted, arcs representing the modulation depth appear on the active control.

Use the phase and ring modulators
Use the dropdown panel in the *Osc Modulators* panel to select which modulator's parameters are adjusted by the toggle buttons below and the dials to the right. Use the toggle buttons to turn modulation on or off for each oscillator. The *Pitch* dial controls the modulation oscillator's frequency *in semitones as an offset of the current note*, while the *Amount* dial controls the amplitude of the modulation oscillator.

Apply effects
Use the table control to navigate to the Voice or Master Effects panel. The numbered toggle switch on the right side of the panel controls the effect slot which is currently being edited, and the dropdown list on the left controls the effect currently inserted into that slot.

Interacting with controls

The current wavetables can be changed by clicking and dragging the highlighted cells on the **Periodic Table** to new a new element.

Knobs and sliders can be adjusted either by clicking and dragging or by scrolling. Hold shift to enable finer control. Center-click to activate a knob's parameter for modulation. Double-clicking a control resets it to its default value.

In the standalone application, the virtual **MIDI keyboard** keyboard responds to computer keyboard input. The middle row of letter characters on the computer's keyboard (keys 'A' to the colon/semicolon on an American QWERTY keyboard) begin at (note) C and correspond to the white keys of a piano; the row above corresponds to the black keys within that octave. The keys 'Z' and 'X' (US QWERTY keyboard) move the current playable notes down or up one octave, respectively.

Overview

What is this?

Tablitsa (transliteration of Russian *таблица*, meaning "table" as in "periodic table" or "wavetable") is a wavetable synthesizer, meaning it produces sound by reading precomputed values from a "table" of audio samples, i.e. a buffer stored in memory. The synthesis parameters of each oscillator are associated (somewhat arbitrarily) with various chemical properties such as charge, mass, and energy state. The wavetables themselves follow a similar pattern to the periodic table itself: every group (column) on on the Periodic Table has a characteristic function family associated with it, which outputs an amplitude for a given harmonic index, essentially producing Fourier Coefficients for each component sinusoid of a wavetable. The exact harmonic-amplitude curve is also determined by the period (row), such that the function morphs slightly from the top of the periodic table to the bottom.

The Lanthanides and Actinides (bottom two rows on the table, depicted separately from the rest) follow a slightly different system. The Lanthanide wavetables have harmonic amplitudes determined by the Fourier transform of various samples of audio, rather than by a mathematical expression. The Actinides' harmonic-amplitude curves all follow an exponential decay curve, but with a good deal of randomness added.

Each element's wavetabe contains at least two waveforms, each with the same harmonic-amplitude curve, but with different *harmonic content*. More specifically, the waveforms contain different *in*harmonic frequencies, i.e. frequencies not an integer multiple of the fundamental. The wavetables have as many waveforms with different inharmonic frequency contents as their corresponding elements have oxidation states which occur in nature, and the precise inharmonic frequencies are determined by those oxidaiton states. For example, carbon is found in nature in oxidation states between -4 and +4, so it has ninewavetables, each with a different set of inharmonic frequencies added to its harmonic content. Although the Noble Gasses in reality only have one oxidation state, their wavetables consist of two waveforms.

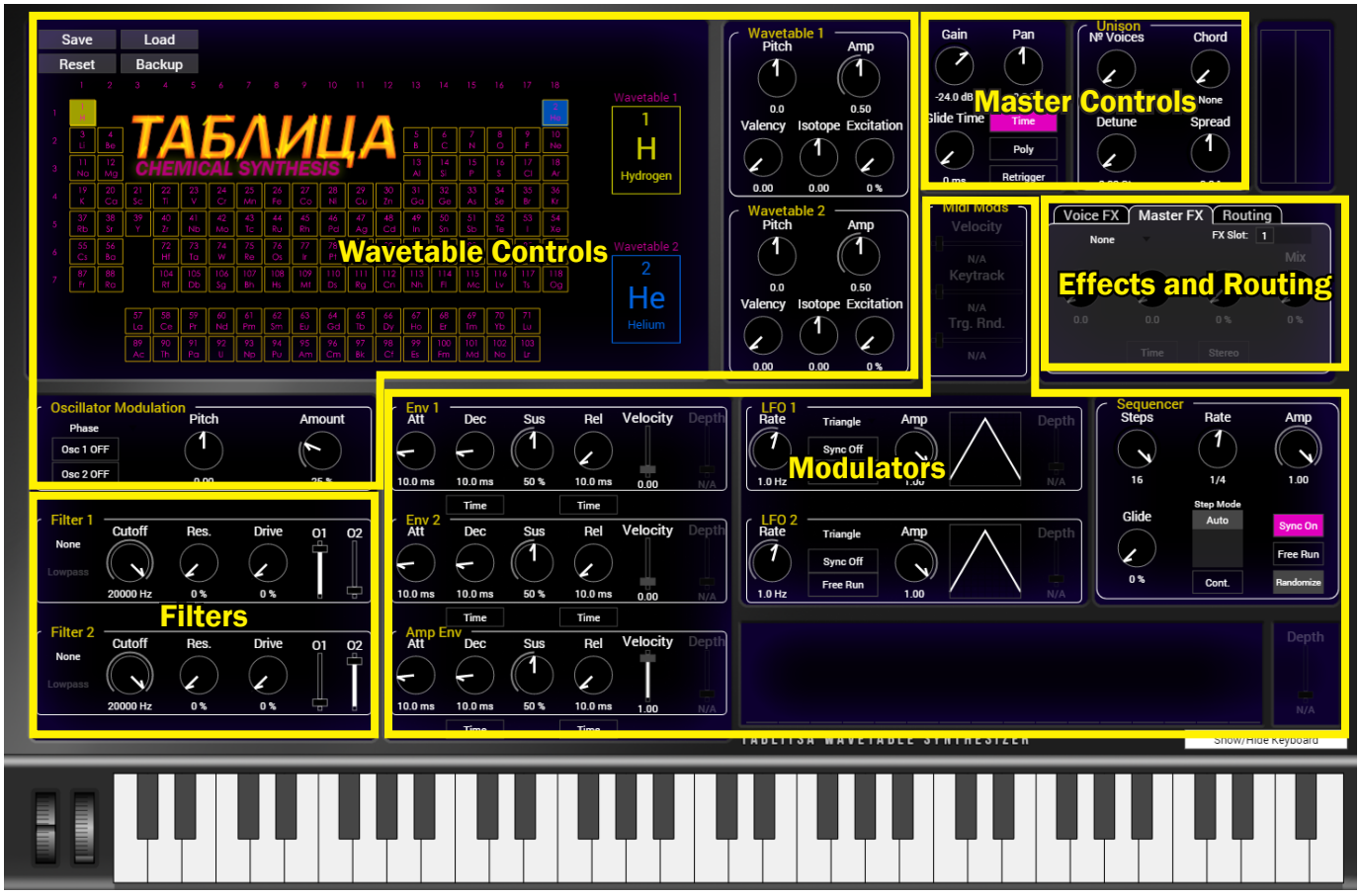
The *Valency* knob controls the position in the wavetable between oxidation-state waveforms. Moving this knob causes the oscillator to sweep through the timbres available in an element's wavetable, i.e. the inharmonic frequencies which it contains according to its oxidation states. The waveforms are

ordered from the lowest to highest oxidation states (mapped to the normalized values of 0 to 1 on the dial), so for elements with only positive oxidation states (most metals, in the center of the table), the purely-harmonic waveform (oxidation state 0) is the leftmost dial position, while for elements with negative oxidation states, the purely-harmonic waveform is located somewhere in the middle or on the right.

The *Isotope* knob controls the phase-bend: setting it to a negative value causes more samples to be read from the left side (beginning) of the wavetable, while positive values correspond to reading more samples from the right side of the table. The *Excitation* knob controls the formant of the oscillator output, i.e. a local peak in the frequency amplitude spectrum above the fundamental.

The default wavetables, Hydrogen and Helium, respectively contain a sawtooth and a square wave in their zero oxidation states.

Interface



Workflow

With Tablitsa, you have at your disposal two wavetable oscillators with 118 wavetables, two filters, and effects which are applied polyphonically (to each voice, with modulation) or monophonically (to the master output signal). The parameters *Valency*, *Isotope*, and *Excitation*, as well as the phase and ring modulators, control the periodic waveform generated by the oscillator. All post-oscillator processing—filters and effects—occurs sequentially on the signal routed to each unit. The send level of each oscillator signal to each filter is adjustable, as are the sends from the unfiltered oscillator outputs to the voice effects, and the mix between the unfiltered oscillator outputs and the voice effect outputs to be send to the mater effects.

To design a sound, begin by selecting wavetables by clicking and dragging the highlighted cells on the Periodic Table interface. Adjust the oscillator parameters to determine each oscillator's characteristic waveform. Phase and ring modulation can be applied to the oscillator via the panel underneath the Periodic Table and on the left side of the window. The voicing controls in the top right of the window determine how many voices are triggered per MIDI Key-Down event and how these voices are distributed in pitch and within the stereo space. The oscillator outputs are next processed by the filters. Select the model of filter (Two-Pole State-Variable Filter, Moog Ladder Filter, or Comb Filter) via the first dropdown list and the mode of the filter (e.g. highpass, lowpass, bandpass) via the second. Next, up to three sequential Voice Effects—processing applied to each MIDI-controlled voice individually, before all their signals are summed—can be applied. The numbered switch at the right of the effects panel indicates the current effects slot, and the dropdown list on the left indicates the effect applied to that slot. In the routing panel, the filter-bypass send from each oscillator to the voice effect rack can be set. To bypass a filter entirely, set the oscillator sends *to the filters* to zero. Finally, up to three sequential master effects can be added.

All controls which affect each voice individually may have their values modulated. The modulation depth (the send of a modulator's signal to a synthesis parameter) is adjusted by the vertical slider in each modulator's panel. The parameter whose modulation is currently being edited is selected by center-clicking (or ctrl/cmd-clicking) the parameter's knob, causing the knob to become highlighted. Knobs whose parameters can be modulated are identifiable by a slightly lighter track color than that of those whose parameters do not accept modulation.

Controls and Synthesis Guide

Global and Voice Controls

Gain controls the output amplitude, which is the last bit of processing applied to the synthesizer's output. *Pan* is modulatable on a per-voice basis—despite being grouped with the global/master controls—so each voice can have its own pan envelope.

Polyphonicity can be set via the toggle button which reads *Poly* or *Mono*. As with all toggle buttons in Tablitsa, the currently-displayed text determines which mode is currently active. Polyphonic mode provides sixteen simultaneous voices (counting unison voices), which monophonic mode allows only

one voice to be active at a time (not counting unison voices).

The *Retrigger/Legato* button determines whether envelopes (and LFOs, if they are set to *Reset*) return to their initial phases when a new note is pressed while another note is being held down (in either polyphonic or monophonic mode).

Glide controls the portamento/glissando, i.e. the time it takes the pitch to change when a note is pressed while another is still sustained. This operates on a per-voice basis, so in polyphonic mode, the pitch will glide from the last MIDI pitch played by that voice, which is not necessarily that of the last-pressed note. The *Rate/Time* switch controls whether the glide speed (in semitones per second) is constant regardless of the distance to be traveled, or whether the time required to glide from one pitch to another is independent of the difference between the pitches. Portamento operates on MIDI note-on pitch, and so it is applied before and independently of the pitch shift of the oscillator, and any MIDI-controlled pitch bending.

The Unison Voice panel allows you to control how many voices are triggered when you play a note, and how these voices are distributed in pitch and stereo space. *Detune* controls the total spread of pitches above and below the oscillator pitch, while *Spread* controls the range of panning angles, with negative values corresponding to an inversion of the signal. When multiple voices are played in unison, the first voice's pitch and pan are in the center of the ranges, the second and third voices' at each end of the ranges, and any further voices are distributed throughout the ranges. The *Chord* dial allows you to select a specific pitch distribution. Voices are assigned to notes in seventh chords in the order *tonic-dominant-mediant-leading tone*.

Oscillators

The difference between oscillator parameters and all downstream parameters is that the oscillator parameters determine *how audio data is read* from the wavetables to produce an audio signal, while downstream processing units are effects which modify an incoming audio signal. The output of each oscillator can be set separately from that of the other oscillator to the filters and to the voice effects.

Pitch controls the offset of the oscillator's frequency from the MIDI note input, in semitones. The pitch may be shifted two octaves in either direction. *Amp* controls the volume.

Valency controls the wavetable position, amounting to the inharmonic content of the frequency spectrum. *Isotope* controls the pitch bend within the wavetable as a mapping function between the current phase (which increases linearly each sample) and the phase in the wavetable from which samples are read. This is a non-linear process which introduces new harmonic content not present in the wavetable into the output. *Excitation* adjusts the formant, which does not introduce new harmonic content, but changes the relative amplitudes of certain harmonics. The values of this dial change with pitch, with 0 corresponding to a formant (harmonic frequency with the highest amplitude) equal to the fundamental of the current note and 1 corresponding to a formant equal to the fundamental of the highest MIDI note (G#9).

Phase and Ring Modulation

Both phase and ring modulation involve using an audible-frequency sine wave to modulate some aspect of the oscillator. Phase modulation is applied *during* the process of reading samples from the wave table, modulating the phase in the current waveform from which samples are read. Ring modulation is applied *to* the modulator output and is simply the same as amplitude modulation—this amounts to multiplying the oscillator output by the ring modulation signal. ("Ring" is a historical term and refers to the appearance of analog circuits used to generate this effect.) Each modulator's pitch offset (*Pitch*) and amplitude (*Amount*) can be controlled independently of the other, but these parameters are the same for each wavetable oscillator. However, the pitch offset is based on the *oscillator* pitch, which is potentially different for each oscillator and voice, as opposed to the MIDI note pitch. The dropdown list on the left of the panel controls which modulator's parameters are currently linked to the controls (but does not itself affect the output), and the toggle buttons below determine whether or not the selected modulator is applied to the given oscillator.

Filters

For each filter, there are three available models: the classic two-pole (-24dB/Octave stopband slope) state-variable resonant filter (SVF), an emulation of the Moog MS-20 ladder filter, and a comb filter. The *Cutoff* parameter is not keytracked. For SVF and Moog Ladder Filter, *Drive* controls the gain prior to passing the input signal through a non-linear function. The comb filter has adjustable *Feedforward* and *Feedback* coefficients and delay time (the feedforward and feedback delay ratio is constant).

The SVF and Moog Ladder Filter each have several modes, selectable through the lower dropdown list. The Moog Ladder Filter has two sets of modes, the first consisting of two-pole filters, and the second of four-pole filters.

The sends of each oscillator to each filter can be controlled by the sliders on the right side of each filter panel. Note that setting the send of an oscillator to zero sends zero-amplitude inputs to the filter, while setting the filter itself to *None* causes any sent inputs to be passed through without modification. Therefore, sending 100% of an oscillator's output to a filter *and* sending 100% to the filter bypass (directly to the voice effects) doubles the signal amplitude.

Voice Effects

Voice effects are applied to the individual signals from the filters and oscillators of each MIDI-controlled voice, so MIDI-gate modulation can be applied to the effect parameters. The filter outputs are combined and sent to the voice effects, and the unfiltered oscillator signals can be individually added to the effect input via the routing panel. The effects are applied cummulatively in the order of the effect slots.

Details of each effect are provided below.

Sample and Hold

This fixes the output signal for the interval specified by *Rate* at the value of the input signal at the beginning of that interval. *Decay* specifies amount by which the output signal "drifts" towards the current input—zero decay holds the output perfectly flat within resampling intervals. *Noise* introduces white noise into the output. *Mix* controls the dry and wet signal simultaneously (e.g. a value of 60% corresponds to 60% wet and 40% dry).

Texturizer

The Texturizer is an allpass ladder filter with nonlinear resonance. *Cutoff* controls the cutoff frequency of the allpass ladder, while the remaining parameters control various properties of the resonance. The behavior is not entirely predictable, but the general effect is to provide a "metallic" quality to the signal.

Distortion

The distortion effect applies a soft-clipping function to a signal amplified according to *Gain*. *Fuzz* introduces random noise into the signal by rapidly modulating the cutoff of a second-order allpass filter, and *Color* controls the cutoff of a bandpass filter used to enhance a particular region of the input signal's frequency spectrum.

Super Ring

The Super Ring effect achieves similar spectral results to ring (amplitude) modulation, but through a different method. Instead of multiplying the input signal by another oscillating signal, the input is passed through an allpass ladder filter whose cutoff is modulated by a sinusoidal signal with a frequency offset from the current MIDI note frequency by the amount specified by *Pitch* and a given *Phase* offset. *Mod Depth* controls the range of filter cutoff values over which modulation is applied.

Master Effects

The output of the voice effects is summed with the oscillator voice effect bypass signals and sent to the master effects, which are also applied cummulatively in the order of the effect slots.

Delay

Left and *Right* control the delay of each stereo channel, both of which have the same *Feedback* level. The toggle buttons below the dials allow you to specify the delay times in milliseconds or in beats, and to adjust the channel delay times independently (*Stereo*) or to lock them to each other (*Mono*). *Mix* specifies the wet mix level only—i.e. the volume of the delayed signal, which is added to the input.

EQ

The three-band equalizer consists of three shelving filters with adjustable levels and mid-band frequency selection.

Reverbs

Two reverb effects are provided. *Reverb 1* is a classic cascade-style reverb consisting of stereo delay lines and allpass filters. *Reverb 2* is a more complex algorithm and produces a slightly less metallic sound. The reverb parameter controls are tuned to ranges subjectively deemed most useful, so the values displayed by the dials are fairly arbitrary. *Mix* specifies wet mix only—the amount of reverb signal to add to the input.

Modulation

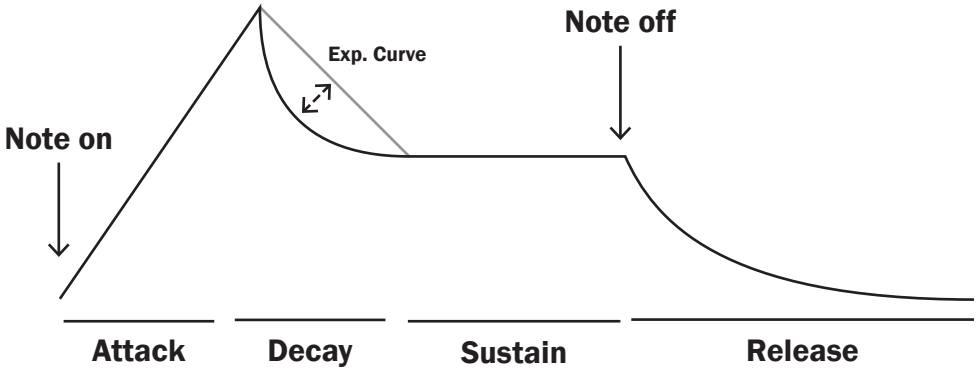
Basics

Modulation changes the value of a parameter over time. A modulator may be either gated, when it is linked to a single voice and restarts when a note is triggered, or ungated, in which case it runs independently of MIDI voicing. The low-frequency oscillators (LFOs) and the sequencer (which is itself a special type of LFO) may be independently switched between gated and ungated modes by toggling their button whose text reads *Restart* in gated mode and *Free-Run* in ungated mode. In ungated mode, a single modulator controls all voices, meaning that all modulation from that modulator unit will be in-phase.

To apply modulation to a parameter, center-click or control-click the knob which controls that parameter. The knob will become highlighted and the parameter will become "linked" to the modulation depth control sliders at the right end of each modulator's control panel. The modulation depth represents the proportion of the parameter's total range (independent of the current "baseline" value; i.e., the value of the knob) which is modulated over. Modulation is additive, which is to say the final modulation signal is the sum of the current values of all modulators times their respective modulation depths for the given parameter. Note also that modulation is not scaled to the amount of headroom between the current parameter value and its minimum or maximum value, so if the total modulation overshoots the maximum or minimum, the parameter's value will be clipped at the maximum or minimum for as long as the modulation signal is out of the range.

Envelopes

There are three envelopes in *Tablitsa*, the third of which obligatorily controls the master amplitude of each voice. Gating of the envelopes is controlled for all three simultaneously via the *Retrigger/Legato* toggle button in the master controls panel. In *Retrigger* mode, each voice has its own envelopes, which restart when a note is pressed. In *Legato* mode, envelopes are shared between voices and will not retrigger of a new note is pressed while at least one other note is still sutained. Envelopes follow a typical ADSR (attack-decay-sustain-release) model with linear attack and exponential decay and release stages, as shown below:



The expontential decay and release curves can produce a very sharp or percussive effect, as most of the modulation occurs at the beginning of the stage. As this is not always desired, the exponentiality of the curve can be adjusted. The toggle switches underneath the *Decay* and *Release* time knobs allow you to switch between adjusting time and adjusting the curve shape. In *Curve* edit mode, a value of 100% corresponds to a purely exponential curve, while a value of 0% corresponds to a purely linear curve. Intermediate values result in linear interpolation between the two curves. The *Attack* curve is always linear.

The *Velocity* slider between the stage-time knobs and the modulation depth slider controls how much the envelope velocity *and* time are influenced by MIDI velocity. Increasing the velocity modulation will cause the envelope to progress slower than the indicated time values at lower velocity values and its depth to be shallower. This is useful for mimicking the articulation of real musical instruments.

The *Sustain* level of envelopes is a modulatable parameter.

LFOs

Low-frequency oscillators (LFOs) provide modulation through a continuous periodic signal. The frequency of the LFO is controlled by the *Rate* knob, either continuously in units of Hertz (cycles per second) or in discrete steps locked to the current tempo of the digital audio workstation project in the VST3 version of *Tablitsa* (the tempo is 120bpm in the standalone app). Tempo sync is controlled by the *Sync Off/On* toggle button to the right of the *Rate* knob. In Hertz mode (tempo sync off), the LFO frequency is modulatable, but not in tempo sync mode.

The amplitude of the LFO can also be controlled by the corresonding knob. This essentially has the same effect as the modulation depth, but it is modulatable. It may also be useful for attaining finer control, e.g. for generating a few cents of pitch modulation for vibrato.

The drop-down list above the toggle buttons allows you to select the LFO waveform, which is displayed to the right of the amplitude knob. By clicking and dragging on the display control, you can adjust the initial phase of the LFO.

Sequencer

The sequencer functions virtually the same as the LFO, and indeed much of the underlying code is identical. In this light, however, it is important to note that for the sequencer, the rate value indicates the amount of time spent on each individual step, not the time required to complete a full cycle. Because the number of steps per cycle is adjustable, this approach ensures that the time per step remains constant, independent of the number of steps per cycle. It is also advantageous in tempo sync mode, as each step is held for the note value indicated on the rate dial. (For example, if the rate dial is set to 1/4, then each step is held for one quarter note.)

The value for each step can be set simply by clicking and dragging on the sequencer interface in the bottom-right of the application interface. The *Rate* and *Amp* dials, as well as the tempo sync and gating toggle buttons, function analogously to those in the LFO panels. *Steps* controls the number of steps per cycle. *Glide* controls the time required to transition linearly from one step's value to the next, as a percentage of the step time.

A unique feature of the sequencer is the *Step Mode* control. In *Auto* mode, the sequencer progresses monotonically through its step, like and LFO with an irregular waveform. In *Gate* mode, the *Rate* control is ignored, and the sequencer steps forward every time a note is pressed. *Trigger* mode has the opposite effect: the sequencer progresses normally and retriggers the currently-held MIDI note each time it steps forward. *Trigger* mode currently only functions when the synthesizer is in monophonic mode.

MIDI Modulators

MIDI modulators provide modulation values based on current MIDI note data. *Velocity* corresponds, of course, to MIDI velocity and is based on keypress pressure on MIDI controllers which support it. *Keytrack* is a linear function of MIDI pitch, spanning the range from 0.00 to 1.00 for the 128 MIDI notes. (Keytrack range is currently not adjustable but probably will be in future versions.) *Random Trigger* ("Trg. Rnd.") produces a random value between 0.00 and 1.00 at each MIDI note-on event.

Under the Hood

This section will contain an explanation of the wavetable format and resampling algorithm in the full release version. Thank you for beta-testing Tablitsa!