d16 group
AUDIO SOFTWARE

LUSH-101

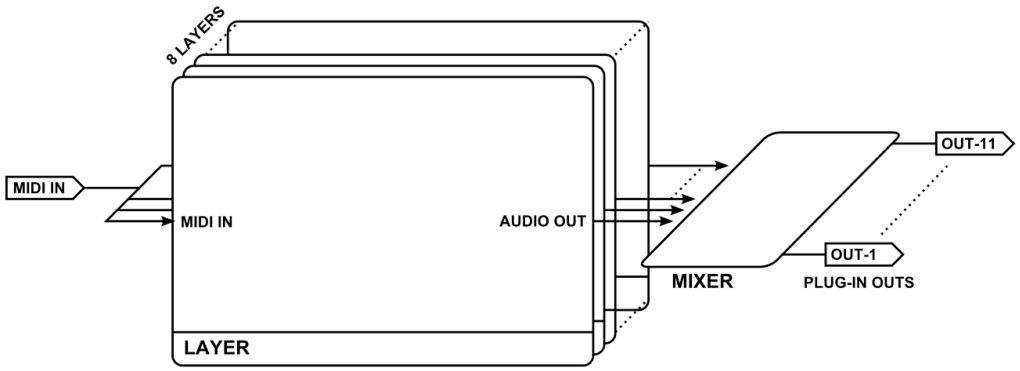
Multitimbral Polyphonic Synthesizer

User Manual

Overview

LuSH-101 is a polyphonic subtractive synthesizer. Its structure is based on “layers” (**LuSH-101** has 8 of them). In fact, each **Layer** is an independent synthesizer with its own parameters and own polyphony. Each of the layers can listen to different **MIDI** channel and respond to a different keyboard zone. In consequence, the synthesizer may work as multi-timbral instrument, in which each **Layer** is controlled by a different **MIDI** channel. It is also possible to conveniently make keyboard splits, where **Layers** listen to the same **MIDI** channel, by responding to disjunctive keyboard zones. You can also create complex sound textures by overlapping **Layers** (listening to the same **MIDI** channel and responding to the same keyboard zone).

LuSH-101 allows for convenient mixing of Layers within a specially designed for this purpose **Mixer** (built into the **LuSH-101**), in which we can make a final touch to a sound through parametric equalizers, compressors (one per each channel) and 3 send effects (built-in the **Mixer**). Each of the tracks corresponding to one **Layer** or each of 3 available FX tracks corresponding to 3 send effects can be sent to any of 11 available outputs.

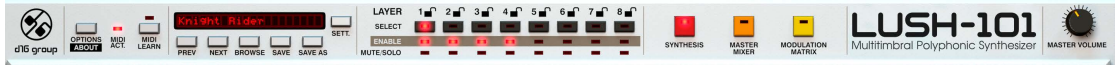


General signal flow

The GUI of plug-in looks as follows:

Graphical user interface

At the top of GUI there is a bar called **Control** section:



Control section

Below the bar we can see a part of GUI, which is responsible for editing a single **Layer** (this is the default view, after opening the **LuSH-101** in a host application).

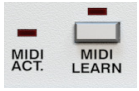
Synthesis view containing layer's parameters

In the **Control** section we can distinguish the following groups of controls:

- **Options** button, which enables access to an **Options** panel. The entire global configuration is performed from there.

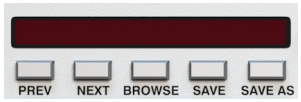
Options (about) button

- **MIDI** section contains a **Midi act**. LED indicating any activity from the MIDI port and the **Midi Learn** button which enables the **Midi Learn** mode.



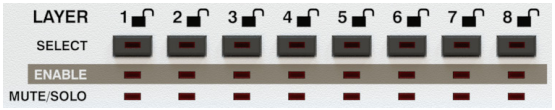
Midi section

- **Preset management** section (for **Global presets** – preset types are described later)



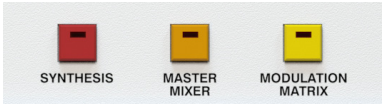
Preset management section for global presets

- Three rows of buttons to select a **Layer** for editing (first row - **Select**), turning the **Layer** on/off (second row - **Enable**) and / or muting / soloing the **Layer** (third row - **Mute** / **Solo**). Above, there is a row of **Padlocks** for locking individual **Layers**, thus preventing overwriting selected **Layers** parameters when the **Global Preset** is loaded.



Layer selector

- Buttons for switching the GUI's **View**:



View (tab) selector

  - **Synthesis** – Editing selected **Layer**'s sound parameters.
  - **Master mixer** – Mixing and combining the sound from all **Layers** together.
  - **Modulation matrix** – Editing selected **Layer**'s modulation matrix.
- **Master volume** knob - controlling overall volume of the output sound coming from the LuSH-101

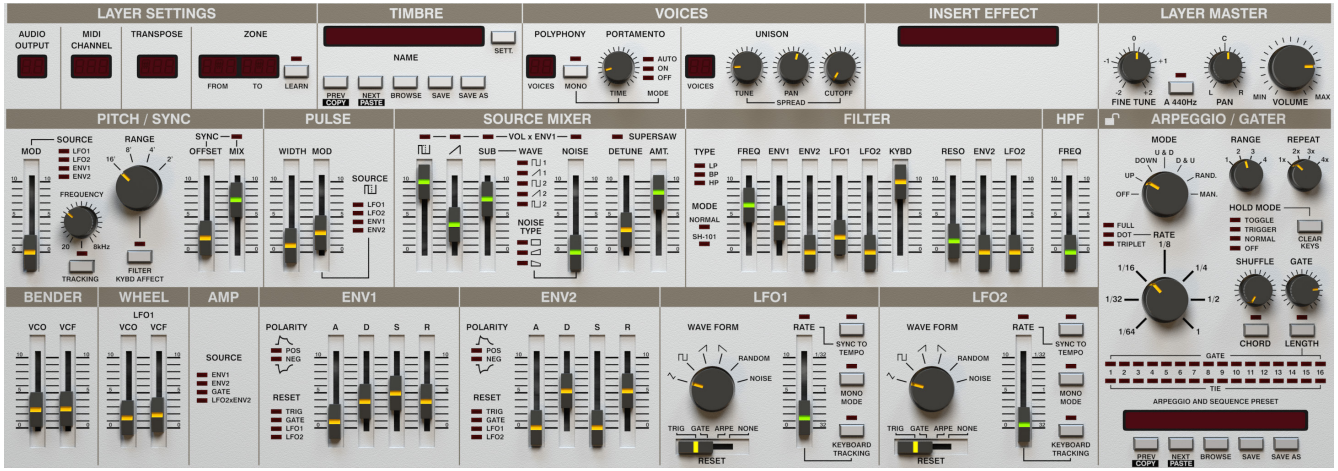
Master volume knob

Layer

We access **Layer** parameters by clicking the **Synthesis** button in the **Control** section:

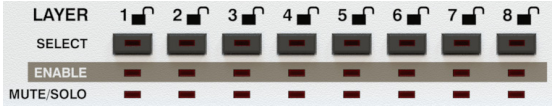
View (tab) selector

They are displayed in the main part of GUI:



Synthesis view containing layer's parameters

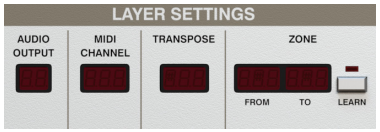
We can select, which **Layer** (from the 8 available) we want to edit using **Layer** select buttons in the **Control** section:



Layer selector

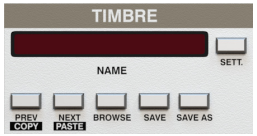
In a single **Layer** we can distinguish the following groups of controls:

- **Layer settings**:



Layer settings

- **Timbre preset** browser:



Timbre browser

- **Voices** (polyphony management):

Voices section

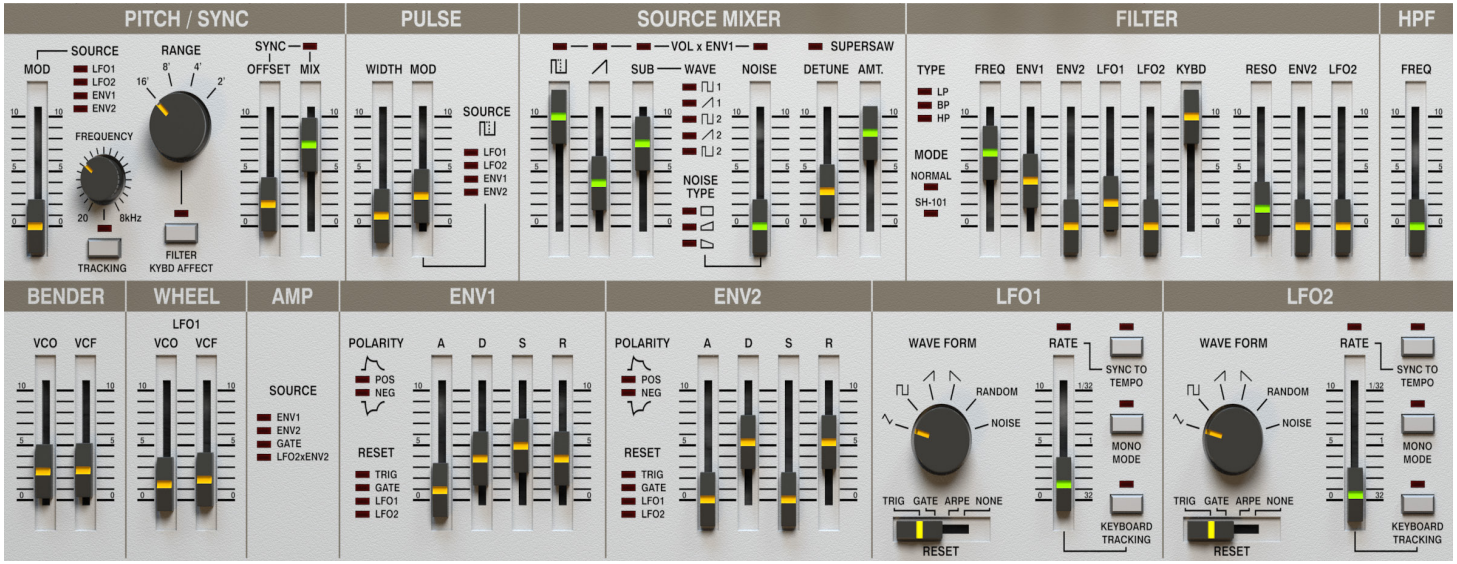
- **Insert effect**:

Insert effect section

- **Layer master**:

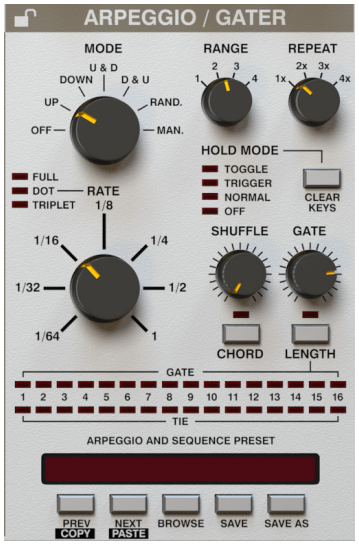
Layer master

- Set of sound parameters:



Layer's sound parameters

- **Arpeggio** / **Gater** – set of parameters controlling **Layer Arpeggiator**



Layer's sound parameters

Layer settings

Parameters from **Layer settings**, **Voices section**, **Layer Master** are stored per each layer independently.

Layer control parameters

We can distinguish:

- **Audio output**

Layer's audio output

It is the number of the plug-in output (**1-11**), to which the signal from the **Layer** will be sent to. In **LuSH-101** we have **11** stereo outputs to our disposal. We edit the number by dragging the LED display with the mouse. Practically, each LED display-like control shown on a GUI is draggable (editable this way).

Note: this parameter is NOT stored within the preset of any kind, it is stored within the host application project only!

- **MIDI channel**

Layer's midi channel

A **MIDI channel** on which the **Layer** is listening out (**1-16**) or **All** (Omni). If **All** is set, then the **Layer** listens out on all channels on a MIDI port redirected to a LuSH-101.

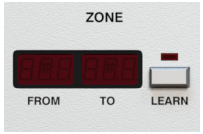
Note: this parameter is NOT stored within the preset of any kind, it is stored within the host application project only!

- **Transpose**

Layer's transpose

Layer's transposition in the range of -**24** to +**24** halftones.

- **Zone**



Layer's zone

Apart from the MIDI channel, we can also set a keyboard **Zone**, to which the **Layer** will be responding, by creating a split, if keyboard zones are disjunctive and **Layers** listen to the same MIDI channel. The keyboard **Zone** is defined by two notes, and contains all the notes between those two. The lower note defines the beginning (**From**) and the higher note defines the end of the **Zone** (**To**).

Additionally we can use the **Learn** function to define a **Zone** directly from the MIDI keyboard:

1. Press **Learn** button.
2. The plug-in is now waiting for two MIDI Note messages, by listening to all MIDI channels (ignoring **Channel** number setting from **Layer**).
3. When you press two keys (at once or one by one) on your MIDI keyboard, the plug-in will automatically set the beginning and the end of a **Zone** (**From** and **To** LED displays) taking the lower note as the beginning and the higher note as the end.

- **Voices** - Polyphony settings:

Voices - polyphony settings

In this section we can edit **Polyphony** and **Portamento** settings for the **Layer**:

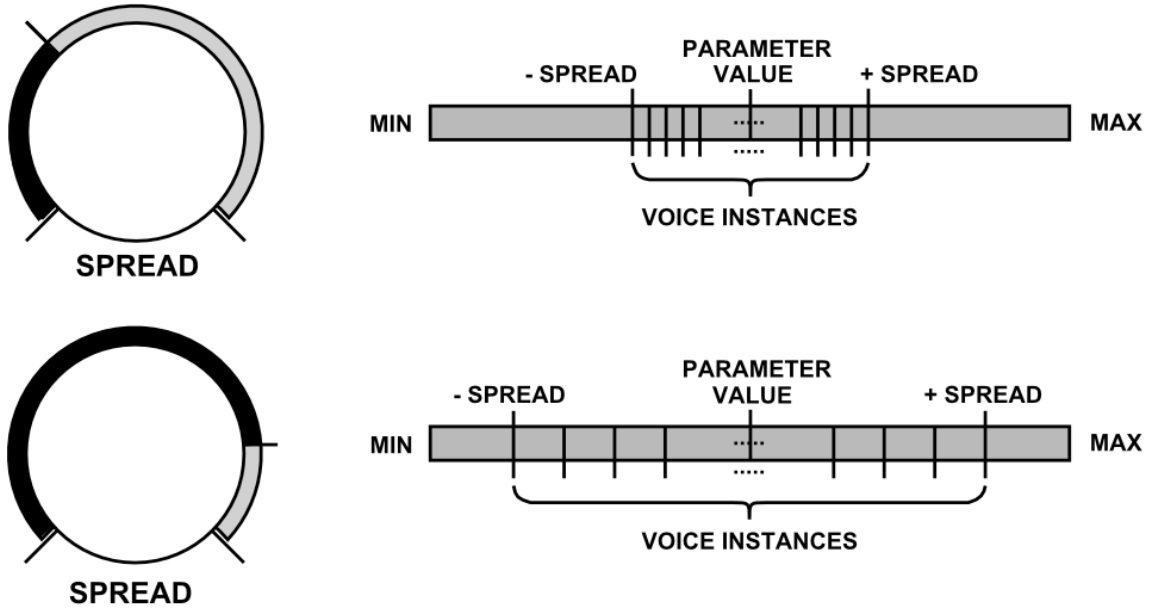
- **Voices** – It is the total number of voices of **Polyphony** for **Layer** (up to **32** voices). If the number of voices is equal to **1** then implicitly the **Mono** mode is set and other controls in this section start to work.
- **Mono** – This button turns on/off the **Mono** mode. If the number of voices of **Polyphony** is greater than **1**, then we may use this switch to overturn the **Mono** mode on. In this situation the **Polyphony** is automatically reduced to one voice.
- **Mode** – This controls the **Portamento** mode and works only in the **Mono** mode and it has three values:
  - **Off** – **Portamento** is off.
  - **On** – **Portamento** is always on (for overlapping and non-overlapping MIDI notes).
  - **Auto** – **Portamento** works only for overlapping MIDI notes.
- **Time** – It is the time of smooth pitch transition between two successively incoming notes.

Unison:

Voices - unison settings

Unison mode allows to play a single note with a few voices of **Polyphony** at the time, in which each voice is slightly changed (its **Tune**, **Panorama** or/and filter's **Cutoff**). By default, **Unison** mode is turned off (value of **Voices** shows **1**). Increasing Voices LED display in **Unison** section turns on **Unison**, and **Spread** knobs become active.

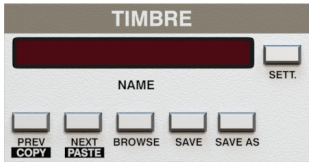
- **Tune** – The strength of detune voices in **Unison**.
- **Pan** – The spread of **Panorama** of voices in **Unison.**
- **Cutoff** – The strength of filter **Cutoff** spread among the voices of **Unison**.



Unison spread

We need to remember that **Unison** mode “steals” **Polyphony**, e.g. when we set **Unison** to **2**, we will not be able to set the polyphony greater than **16**, because it would exceed **32** voices in total (**Unison** voices * **Polyphony**).

Timbre preset management section:



Timbre browser

Presets in **LuSH-101** can be created and stored on a few levels of hierarchy (for particular groups of parameters only or for all of them), which defines a preset type. For a single **Layer** or for a combination of all 8 **Layers** with additional parameters specific for a combination (like parameters of the **Mixer**). Presets prepared for a single **Layer** are called **Timbres** and presets made for a combination of **Layers** are called **Global presets**.

In **Timbre preset management** section we have the following controls:

- **Timbre name** – The text box containing the name of currently loaded **Timbre** preset.
- **Prev** / **Next** – Those two buttons are used for linear navigation through the banks of **Timbres**.
- **Browse** – This button opens the **Timbre** preset browser.
- **Save** / **Save as** – Storing a current **Timbre** preset.
- **Sett** - Open the **Layers**' settings panel.

You will find a detailed description of **Preset management** and **Timbre management** in the chapter **Preset management**.

Prev / **Next** buttons used whileholding **CTRL** button (**Apple CMD** on **MacOS**) allow to **Copy / Paste Layer**'s parameters:

- **Prev + CTRL** - Copies parameters from currently selected **Layer** into a buffer.
- **Next + CTRL** - Pastes parameters from buffer onto selected **Layer**.

Synthesis

LuSH-101 is a subtractive synthesizer and the control of the signal flow used here does not differ substantially from most of compact hardware or software synthesizers on the market. It encompasses all the elements and components widely used in modern synthesizers.

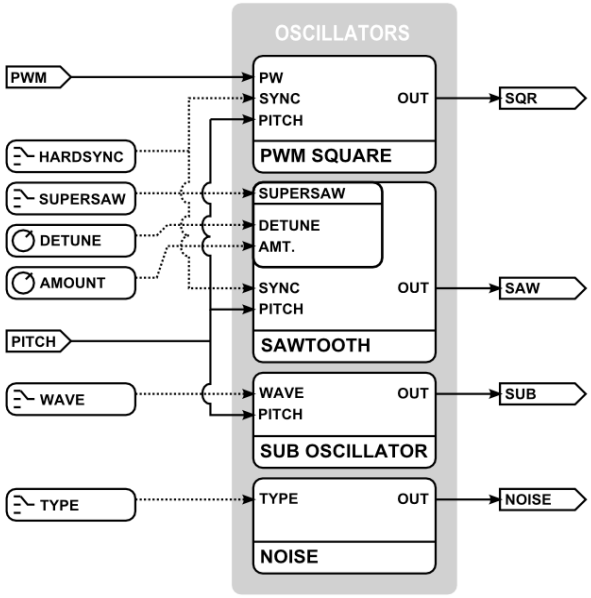
Oscillators - VCO

LuSH-101 has four oscillators:

- **Square** with adjustable pulse width and **HardSync** option,
- **Sawtooth** with **HardSync** and **SuperSaw** options,

  Note: Supersaw oscillator operates on mixing few sawtooth waveforms, each slightly detuned.

- **Suboscillator** with 5 different waveforms to select from:
  - **Square** with 50 / 50 pulse width, one octave below base frequency,
  - **Sawtooth**, one octave below base frequency,
  - **Square** with 50 / 50 pulse width, two octaves below base frequency,
  - **Sawtooth**, two octaves below base frequency,
  - **Square** with 25 / 75 pulse width, two octaves below base frequency,
- **Noise** generator with three different colors to select from:
  - White,
  - Pink,
  - Brown.



Vco diagram

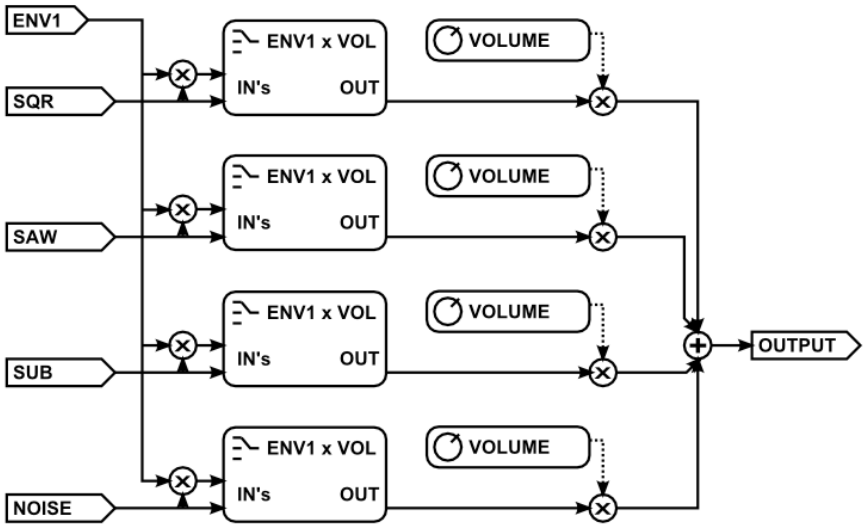
Oscillators can be mixed together in proportions set by sliders placed in the **Source mixer** section:

Synthesis - source mixer

Starting from the left side, sliders in this section are responsible for:

- **Volume** of **Square** oscillator with adjustable pulse width.
- **Volume** of **Sawtooth** oscillator.
- **Volume** of **Suboscillator**.
- **Volume** of **Noise** generator.

LEDs (**VOL x ENV1**) above the **SQR**, **SAW**, **SUB** and **Noise** sliders allow independent (for each oscillator) modulation of amplitude using **ENV1** (first envelope).



Oscillator's independent amplitude modulation by ENV1

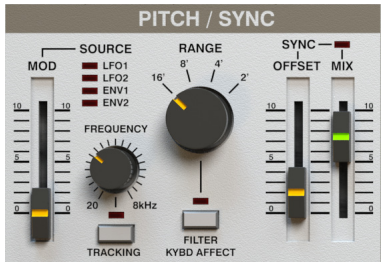
There are also two groups of radio buttons in the **Source Mixer** section:

- **Wave** – That chooses one of the five available waveforms for the suboscillator
- **Noise type** – Responsible for selecting a noise type for the noise oscillator

Noise type and waveform radio groups

HardSync

Usually **HardSync** requires two oscillators. One of them restarts the period of the second one. **Master** – which has constant frequency based only on note's frequency, **Slave** – which has frequency based on note frequency varied by additional modulation sources (like **envelope** or **LFO**). Master restarts **Slave**'s period. In **LuSH-101 HardSync** is possible, because it uses implicitly the second hidden oscillator for **PWM Square** generator and **Sawtooth** generator. **HardSync** can be controlled and activated in **Pitch / Sync** section on GUI (two last sliders on the right and the LED above them).



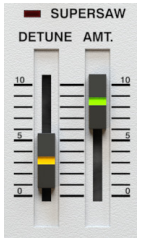
Pitch / sync section

- **Sync** – **HardSync** activation and deactivation
- **Offset** – Frequency offset of the slave oscillator
- **Mix** – This is a cross-fade between **Slave** oscillator and the mixed **50** / **50 Slave** and **Master** oscillators.

When **HardSync** is enabled the pitch modulation (**Mod** fader in **Pitch** / **Sync** section) affects the **Slave**'s oscillator frequency only.

Supersaw

Two last sliders in the **Source Mixer** section and the **LED** above them are responsible for controlling the **SuperSaw** mode for the **Sawtooth** oscillator.



Supersaw parameters

Supersaw LED activates and deactivates that mode, and parameters:

- **Amt.** - Amount, the effect strength, the bigger the value is, the more saw oscillators are added.
- **Detune** – This is the detune value between additional saw oscillators.

Note: Please note that SuperSaw and HardSync cannot work at once. If you turn on HardSync mode, SuperSaw will be automatically disabled.

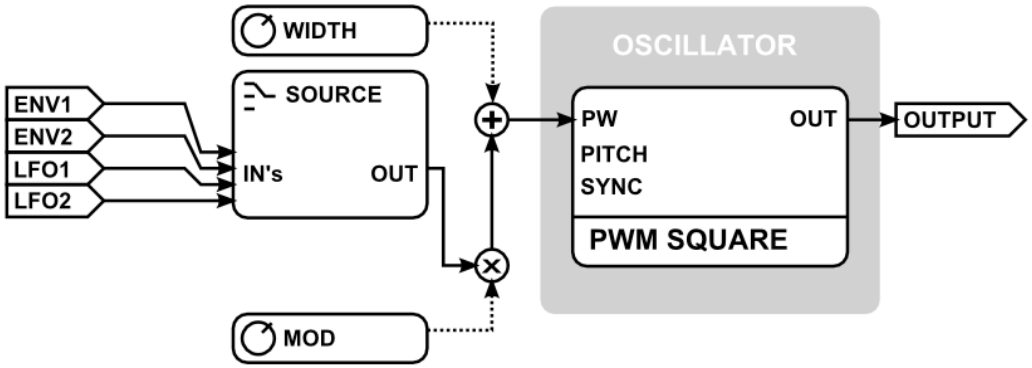
Supersaw works alternatively to **Sawtooth** oscillator, therefore, the amplitude of **Supersaw** is controlled by **Sawtooth's volume** fader in the **Source Mixer** section.

Synthesis - source mixer

Pulse Width Modulation – PWM

The three parameters in **Pulse** section are responsible for controlling the pulse width of the first oscillator in the **Source Mixer** section:

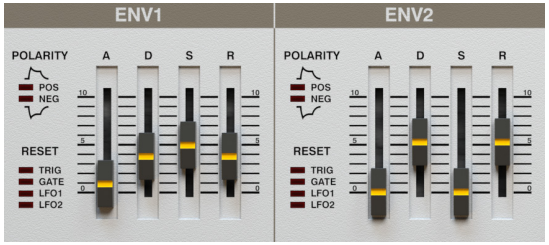
- **Width** – **Pulse width** of square wave.
- **Mod** – Amount of pulse width modulation by a modulation source.
- **Source** - Selection of modulation source: **LFO1**, **LFO2**, **ENV1**, **ENV2**



PWM diagram

Envelope generators

Envelopes can be used for controlling the signal amplitude, filters, sound pitch or pulse width. We have two generators to our disposal in the **Layer**. Their controls on GUI are located in sections: **ENV1** and **ENV2**.



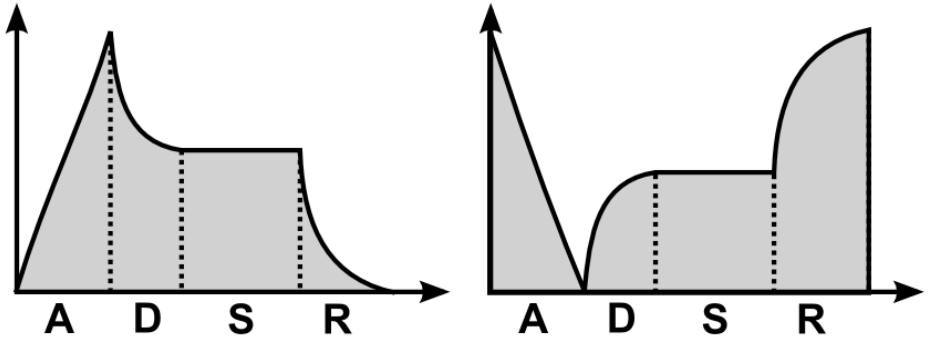
Synthesis - envelopes

These are classic **ADRS** generators with four parameters:

- **A** – Attack time.
- **D** – Decay time.
- **S** – Sustain level.
- **R** – Release time

There are two additional parameters:

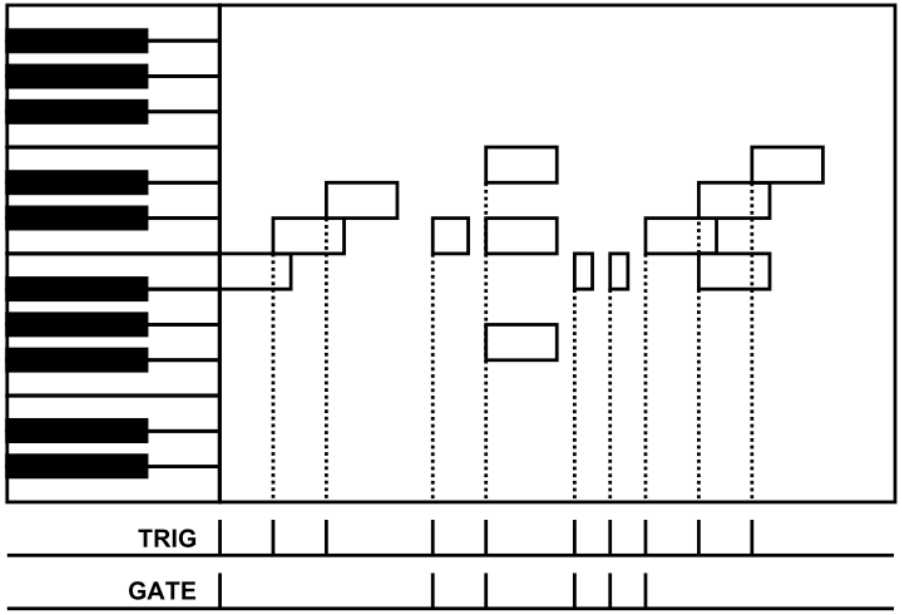
- **Polarity** – **Positive** / **Negative**:



Positive and negative envelope

Depending on a chosen **Polarity**, the envelopes are straight or inverted.

- **Trigger** – This parameter decides when the **Envelope** is triggered. We have the following values to choose from:
  - **Trig** – Each incoming to **LuSH-101** note re-triggers an **Envelope**.
  - **Gate** – The note re-triggers **Envelope** if any other note is not played at the moment. Therefore, the trigger is not generated for overlapping notes.



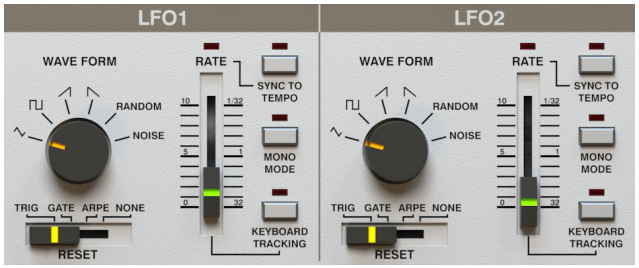
Retriggering an envelope

Trig and **Gate** behave differently only in **Mono** mode, in **Poly** mode there is no difference between **Trig** or **Gate**.

- **LFO1** - Envelope is re-triggered when new period of **LFO1** starts.
- **LFO2** - Envelope is re-triggered when new period of **LFO2** starts.

Low Frequency Oscillators - LFO

In the **Layer** there are two multipurpose low frequency oscillators, which parameters are located in sections **LFO1** and **LFO2** on GUI:



Synthesis - LFOs

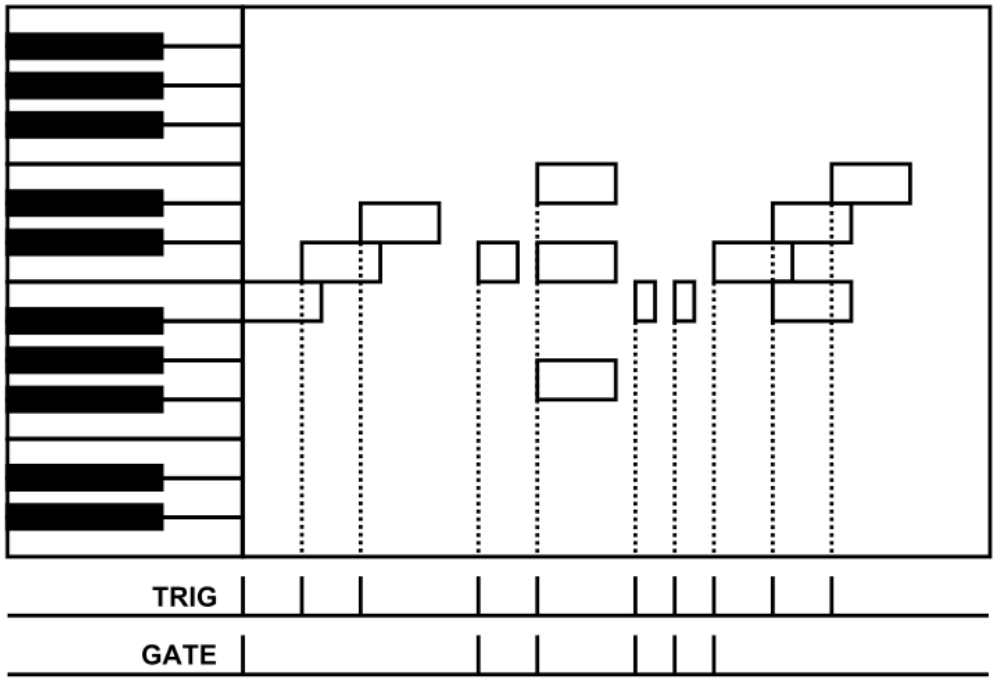
Both **LFO**s can be used for controlling sound pitch, filter parameters, pulse width or sound amplitude.

There are two basic parameters for **LFO**:

- **Waveform** –We can choose one of six available waveforms:
  - **Triangle**.
  - **Square.**
  - **Sawtooth** ascending.
  - **Sawtooth** descending.
  - **Random**.
  - **Noise**.
- **Rate** – Defines the frequency of the **LFO**. There is an exception, namely **Noise** waveform, which is a white noise and the **Rate** knob doesn't affect it.

Further parameters controlling the **LFO** work mode:

- **Reset** –decides under what conditions theLFO is reset (it is set on the beginning of its period). We have 4 possibilities:
  - **Trig** – Each new incoming note resets the **LFO**.
  - **Gate** - Incoming note resets the **LFO** if any other note is not currently played (pressed on the keyboard).



Retriggering an envelope

In **Poly** mode it does not matter if we choose **Trig** or **Gate**, because in both cases the **LFO** is reset for every incoming note.

- **Arpe** - This works only when the **Arpeggiator** is active. The **LFO** is reset when the **Arpeggiator** starts generating a sequence, i.e. when we release all the keys on the MIDI keyboard and press them (or one of them) again.
- **None** – the **LFO** is never reset.

- **Sync to tempo** – This switch is responsible for the **LFO**'s synchronization with the tempo. By default, the **LFO** is internally timed (Sync if off). When we turn on Sync, the frequency of the LFO will depend on the tempo set in a host application and the **Rate** will be a discrete parameter which defines a time scale (as notation values): 32, 16, 8, 4, 2, 1 bars, 1/2 , 1/4 , 1/8 , 1/16 and 1/32
- **Keyboard Tracking** – When turned on, the frequency of the note affects the **LFO** frequency. With this feature we can achieve a simple FM synthesis (modulating a frequency of **VCO** with **LFO**).
- **Mono mode** – Turned off by default. In **Poly** mode with **Mono** switched on, all voices in the Layer have synchronized **LFO**s together in a phase, giving an impression of a single **LFO** controlling all voices at once.

Filters

LuSH-101 has two serially connected filters.

- The second one is a multi-mode resonant filter (**Lo-pass**, **Band-pass** and **Hi-pass**)
- The first one is a **Hi-pass** filter with a characteristic **RC** analogue filter.

In **HPF** section we have only one parameter which controls the first of those two filters (**Hi-pass**):

- **Freq** – cutoff frequency of the **Hi-pass** filter.

Synthesis - high pass filter

In **VCF** section we have access to parameters that control multi-mode resonant filter:

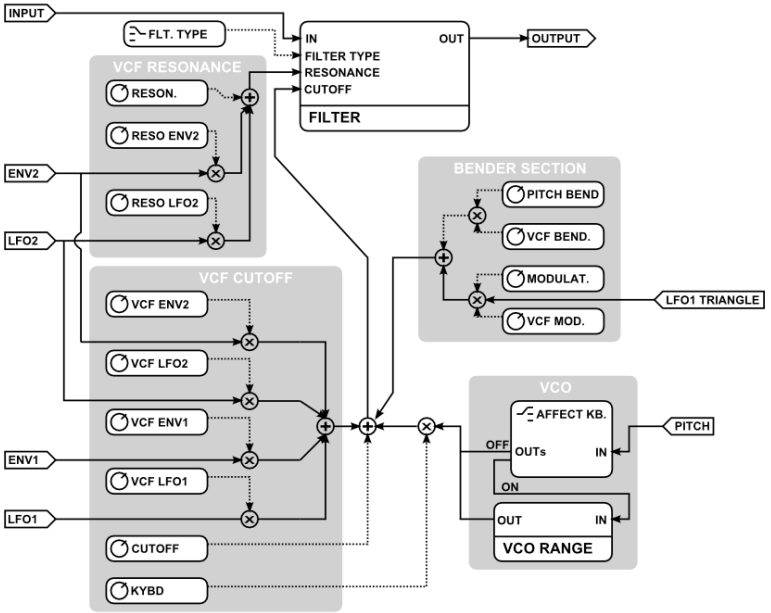
Synthesis - VCF filter section

From the left respectively:

- **Type** – We have three available filter types to select from:
  - **LP** – lo-pass,
  - **BP** – band-pass,
  - **HP** - hi-pass
- **Mode** - There are two selectable filter modes:
  - **Normal** - The overall peak volume of the filter output is constant across the **Cutoff** frequency and **Resonance** domain and the filter itself is softer in comparison to SH-101 variant.
  - **SH-101** - More unstable and analogue like with faithful emulation of self-oscillations appearing in SH-101.
- **Freq** – Filter cutoff frequency.
- **ENV1** – Sets a depth of modulation of the cutoff frequency by **Envelope1**.
- **ENV2** – Sets a depth of modulation of the cutoff frequency by **Envelope2**.
- **LFO1** – Sets a depth of modulation of the cutoff frequency by **LFO1**.
- **LFO2** – Sets a depth of modulation of the cutoff frequency by **LFO2**.

- **Kybd** – Keyboard tracking; applying **VCO** frequency on cutoff frequency of the filter. The **Kybd** parameter controls the amount of this effect. When the **Kybd** is set to min., the cutoff frequency remains unchanged in relation to **VCO** frequency causing higher notes to be duller with low pass filter turned on. When the **Kybd** is set to max., the cutoff frequency is perfectly tuned with **VCO** - the filter is set to exactly track the pitch; the brightness of the sound will stay the same throughout the keyboard range.
- **Reso** – Filter resonance.
- **ENV2** – Sets a depth of modulation of the resonance by **Envelope2**.
- **LFO2**– Sets a depth of modulation of the resonance by **LFO2**.

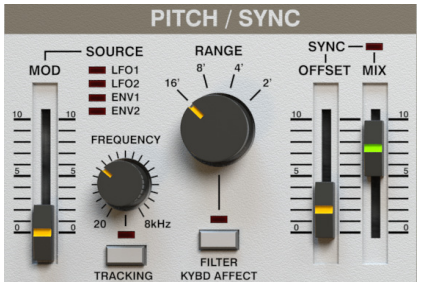
The diagram below presents the manner in which parameters from the **VCF** section, **Bender**, **Wheel** sections and the **VCO** section affect the filter:



Vcf diagram

Oscillator's frequency control

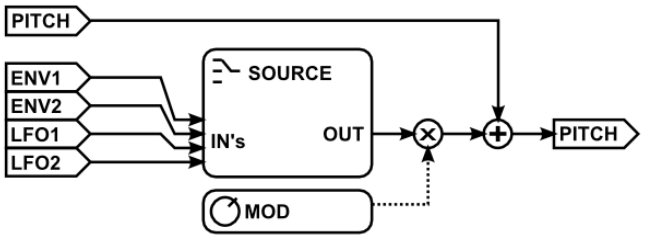
In the **Pitch** / **Sync** section on GUI we have a set of parameters which control the influence of the envelopes or **LFO**s on the frequency of oscillator in the **Source Mixer** section.



Pitch / sync section

The first two parameters (starting from left) control the amount of modulation of envelopes or **LFO**s on the oscillator frequency:

- **Mod** – The depth of modulation of the applied modulation source on a frequency.
- **Source** – Selection of the source of the pitch modulation: **LFO1**, **LFO2**, **ENV1** or **ENV2**.

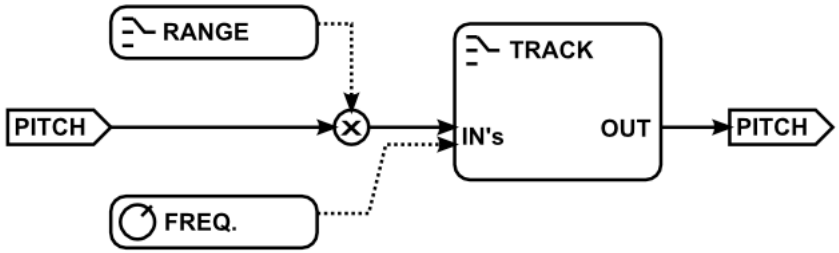


Vco modulation

With **HardSync** mode turned on, modulation is applied on **Slave** oscillators only for **Square** and **Sawtooth** waveforms.

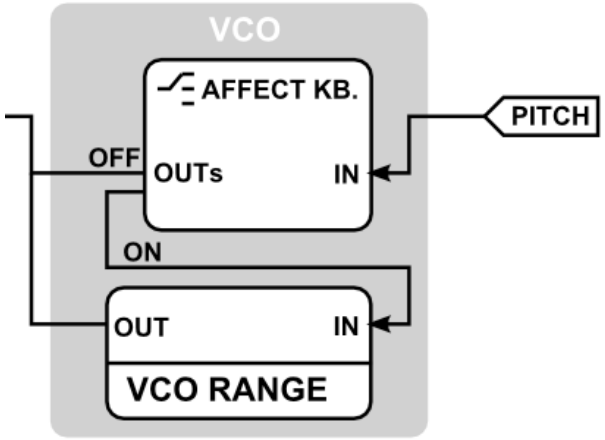
Next three parameters control sound pitch andits influence on the filter's frequency:

- **Range** – Pitch transposition by whole octaves:
  - 16' – Pitch non-transposed.
  - 8' – Pitch transposed by +1 octave.
  - 4' – Pitch transposed by +2 octaves.
  - 2' – Pitch transposed by +3 octaves.
  - **Tracking** – Turned on by default. When tracking is turned on, the pitch of incoming midi notes is taken into account when a sound is generated. If we turn off the **Tracking**, the pitch of incoming midi notes is ignored by **LuSH-101** and the frequency is constant (controlled by **Frequency** parameter described below). In consequence, no matter what key we press on the keyboard, the sound will have exactly the same frequency.
  - **Frequency** – It is the absolute frequency of **VCO** (from 20 Hz to 8 kHz), this parameter works only when **Tracking** is turned off (described above).



Vco frequency tracking diagram

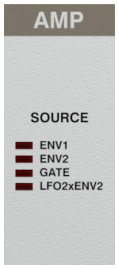
  - **Tracking Kybd. Affect** – When Keyboard Affect is turned on, both parameters, **Range** and **Frequency** (when **Tracking** is turned off), are taken into account by filter keyboard tracking.



Vcf keyboard range affect

Amplifier - VCA

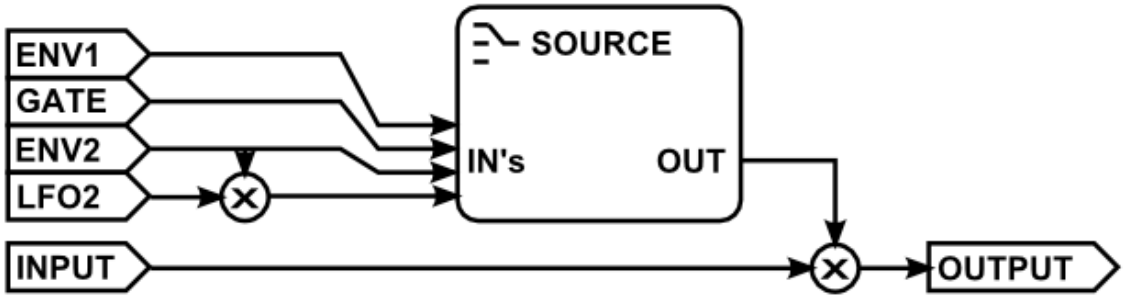
In this section (**VCA**) we have only one switch, which allows to select the generator of amplitude.



Synthesis - amp section

- **Source** – The switch responsible for selecting the generator:
  - **ENV1** – Sound amplitude is controlled by the **ENV1**.
  - **ENV2** – Sound amplitude is controlled by the **ENV2**.

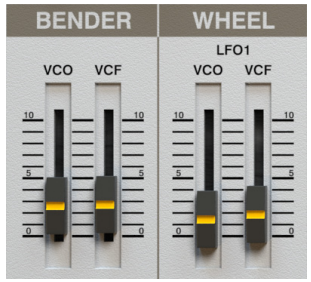
- **Gate** – Sound amplitude is controlled by the **Gate** signal, i.e. incoming MIDI Note On message generates positive slope (sound amplitude has maximum value) and MIDI Note Off message generates negative slope (sound amplitude is zero).
- **LFO2 x ENV2** – The sound amplitude is controlled by the product of **LFO2**'s and **ENV2**'s outputs.



Vca amplitude modulation

Wheel and Bender modulation

These two sections allow instant changing of the effect of modulation wheel or/and bender on the filter's or/and oscillator's frequencies.



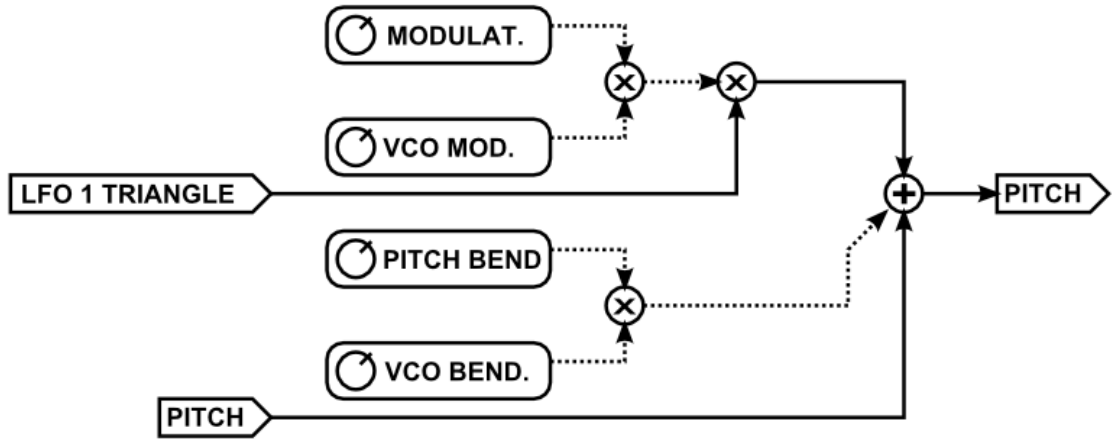
Synthesis - wheel and bender sections

- **Wheel** – Allows controlling, through the modulation wheel, the depth of effect of **LFO1** on the oscillator frequency or/and filter cutoff frequency. We have the following parameters:
  - **VCO** – The depth of modulation of the oscillator's frequency by **LFO1**'s output – gives a vibratto effect controlled by the modulation wheel.
  - **VCF** – The depth of modulation of the filter frequency by **LFO1**'s output.

Note: Please note that the waveform of the LFO1 output for the wheel section is always triangular. The waveform parameter in LFO1 section is ignored here.

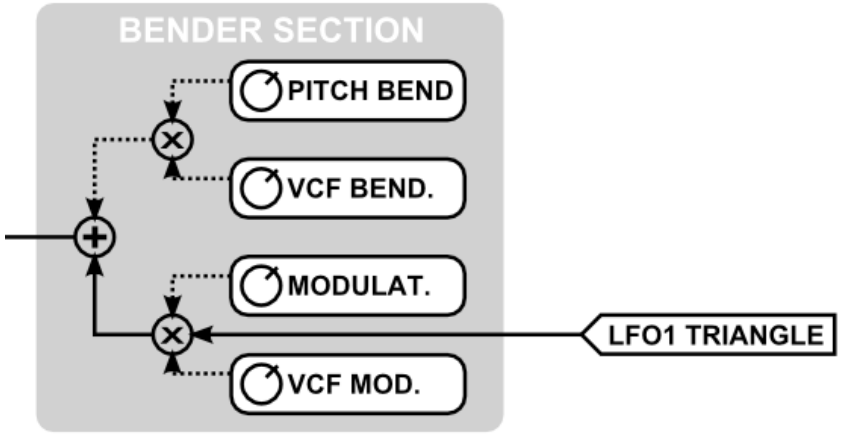
- **Bender** – Allows using the pitch bender to control oscillator's frequency or/and filter cutoff frequency. There are two parameters:
  - **VCO** – The range the bender affects the oscillator's frequency.
  - **VCF** – The range the bender affects the filter cutoff frequency.

The diagram below presents the manner in which **VCO** parameters in **Bender** and **Wheel** sections influence the oscillator frequency:



Wheel and bender affecting vco

The way the **VCF** parameters in **Bender** and **Wheel** sections affect the filter cutoff frequency:



Bender and wheel in vcf section

Master section

There are three available parameters:

- **Fine tune** – It is a precise (fine) tuning of oscillators in the **Layer**.
- **Pan** – Layer panorama.
- **Volume** – Layer output volume.

The **A440hz** button generates a test signal – sine wave with *440 Hz* frequency (middle A key).

Insert effects

A single insert effect can be used per **Layer**:

Insert effect section

We are able to select one of the available FX algorithms:

- **Chorus**
- **Flanger**
- **String Ensemble**
- **Phaser**
- **Vowel Filter**
- **Distortion**
- **Decimator**
- **Tremolo**

Or just turn off the insert effect (**for Layer**) – **no effect**. In this situation the Layer output will be directly sent to the synthesizer **Mixer** without processing.

To choose the effect you need, pull down the combo box in the **Insert effect** section and select one algorithm you are willing to use. Each of the insert effects has its own set of parameters to control.

Chorus

Insert effect - chorus

- **Speed** – **LFO** speed. We have three fixed values:
  - **Slow**
  - **Fast**
  - **Mid**
- **Mode** – Chorus mode.
  - **Thin** – Single delay line.
  - **Fat** – Double delay line.
- **Stereo** – Stereo phase shift between **LFO** controlling delay lines for left and right channels.
- D**ry / Wet** – Proportions between processed and unprocessed sound.

Flanger

Insert effect - flanger

- **Depth** – Depth of flanger effect.
- **Rate** – LFO frequency.
- **Feedback** – Flanger feedback.
- **Invert** – Inverting flanger feedback.
- **Dry / wet** – Proportions between processed and unprocessed sound.

String ensemble

This is a combination of chorus and phaser effects.

Insert effect - string ensemble

- **String mode** – Chorus work mode:
  - **Light** – Subtle flow of **LFO**s controlling delay lines.
  - **Heavy** – Higher frequency and depth of **LFO**s.
- **Stereo** – Stereo phase shift between the channels.
- **Phaser** – Turning on/off the Phaser in String ensemble.
- **Rate** – Frequency of the Phaser **LFO**.
- **Color** – Color variant of the Phaser effect.

Phaser

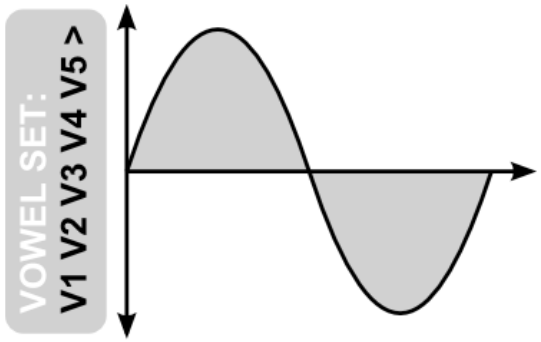
Insert effect - phaser

- **Speed** – LFO frequency.
- **LFO swtich** – The way of controlling the phaser. By default, the Phase is controlled by a single **LFO** (**Sng. position**) or by two **LFO**s (**Dbl. Position**), however, the second **LFO** has constant fixed frequency and lesser amplitude.
- **Stereo** – Stereo phase shift between the channels.
- **Feedback** – Phaser feedback.

Vowel filter

Insert effect - vowel

- **Reso** – Resonance.
- **Rate** – Frequency of the **LFO** controlling **Vowel filter**.
- **Depth** – Depth of the **LFO** controlling **Vowel filter**.
- **Vowel set select** – Controls the position of the Vowel filter in a Vowels list, the **LFO** oscillates around this position.



Vowel set

Above the fader we see a Vowels' list, which can be modified by the user. The list is composed of five elements. Each of them can be modified by a mouse click (left button goes forward, right button goes backward). We have one vowel of five available to choose from: A, E, I, O, U.

- **Vocal** – Button, that pulls down the list, from which we may select one of available vocal timbres.

Distortion

Insert effect - distortion

- **Dynamics** – Amount of compression before distortion. The higher the value of this parameter, the higher the compression is (lesser dynamics of signal).
- **Preamp** – Signal amplification before going through the clipper.
- **Threshold** – Threshold value for the clipper.
- **Shape** – Clipping curvature.

Decimator

Insert effect - decimator

- **Preamp** - Input signal amplification before it is degraded, the parameter's range is in [0 ..48 dB].
- **AA Filter** - Turning on and off the Antialias low-pass filter, which cutoff frequency is linked with a decimation frequency (**Frequency** knob).
- **Frequency** - Decimation frequency [0 .. 44 kHz].
- **Quantize** - Quantization with a given number of bits [1..15], if the knob is set to off position, the input signal is not quantized and only the decimation is performed.

Tremolo

Insert effect - tremolo

- **Rate** - The rate oftremolo effect.
- **Depth**–The rate of tremolo effect.
- **Waveform** - Tremolo's LFO waveform (Sinus or **Triangle**).
- **Stereo spread**– It is a tremolo LFO stereo phase shift between **Left** and **Right** channels (range: [0 ..180 degrees]).

Arpeggiator

LuSH-101 has a very advanced **Arpeggiator** section. Just like the other modules in the **Layer**, this one also works in an independent way for each **Layer**. This means that for every **Layer** the **Arpeggiator** can be activated or not. The **Arpeggiator** section is located on the right side of Synth view.

Arpeggiator (gater) section

Here, we can distinguish the following parameters:

- **Mode** – The Arpeggiator's work mode (run mode):
  - **Off** – Arpeggiator turned off.
  - **Up** – Upward sequencing.
  - **Down** – Downward sequencing.
  - **U&D** – Upwards and downwards, beginning from upright.
  - **U&D** – Downwards and upwards, beginning from downright.

  - **Random** – Random order sequencing.
  - **Manual** – Sequencing accordingly with the order of pressed keys on the MIDI keyboard.
- **Range** – Arpeggiator range expressed in octaves.
- **Repeat** – Number of repetitions of the Arpeggiator sequence in each octave.
- **Rate** – Rhythmical value of a single step in the Arpeggiator sequence: 1 bar, 1/2 , 1/4 , 1/8 , 1/16 , 1/32 and 1/64

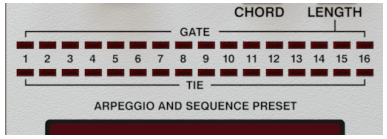
  Additionally with the help of three LEDs: **Full** / **Dot** / **Tri**, working in radio mode, we can modify the rhythmical value of the **Rate** parameter:

  - **Full** – Full note.
  - **Dot** – Dotted note.
  - **Tri** – Triplet.
- **Shuffle** – Shuffle strength for generated sequence.
- **Gate** – Note length for a single step in a generated sequence. If the **Gate** is set to 100%, notes generated in an Arpeggiator sequence will be overlapping each other (Legato)
- **Chord** – When turned off, the **Arpeggiator** behaves regularly (it generates monophonical sequence accordingly with other settings), but if it is turned on, the **Arpeggiator** acts as a gater. Pressing the Chord on the MIDI keyboard will cause the **Arpeggiator** to play all sounds at once in a single step. Please note, that to use the **Chord** mode, you need to set an adequate polyphony to make it work.
- **Hold mode** – Typical **Hold** mode causes the **Arpeggiator** sequence to constantly play, despite the fact the MIDI keys are no longer held on the keyboard. Successively pressed keys will be added to the **Arpeggiator** sequence, in other words, incoming MIDI Note off messages are ignored. In **LuSH-101** we have a few **Hold** modes to select from:
  - **Off** – Hold is inactive.
  - **Normal** – Hold mode works regularly (as described above).

- **Trigger** – When keys are pressed on the keyboard, the notes corresponding to them are added to a sequence. When we press and hold, for example, two keys, they are added to a sequence, even if we release one of them, two notes are still in queue (playing). Even if we release all pressed keys, the sequence will be still playing, however when at this point we press any notes again on the MIDI keyboard, the notes previously played are removed from the sequence, and the new ones pressed will be added to sequence immediately.
- **Toggle** – In this mode the MIDI keyboard works in Toggle mode; pressing one key adds a corresponding note to the **Arpeggiator**'s sequence, pressing the same key once again removes the note from the sequence.

- **Clear keys** – irrespective of the chosen **Hold** mode, using this button will remove all the notes from the **Arpeggiator** sequence, which were earlier added with Hold mode. Using **Clear** keys button while holding **CTRL** performs the action for all **Layers** in **LuSH-101**.

In the bottom part of **Arpeggio** / **Gate** section there are two rows of **LED**s. Each column accords with a single step of the **Arpeggiator** sequence – although that single complete cycle of the **Arpeggiator** can be much longer, because of **Range** and **Repeat** values or/and the number of keys pressed on the MIDI keyboard simultaneously.

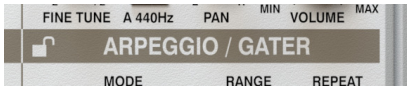


Arpeggiator (gater) section

16 LEDs correspond to 16 steps. When the 16th step is reached, the **Arpeggiator** goes back to the 1st step. LEDs work in toggle mode, and therefore:

- The first row (**Gate**) displays whether the step is played or not. If LED is set, the step is played. If LED is unset, then the pause is generated and the note that should appear in this place is omitted.
- The second row (**Tie**) is used for tying the notes together. If the LED is set, the step corresponding to that LED is tied together with the next step. Setting the adjacent LEDs will tie all the notes into a single longer one.

There is also a **Padlock** icon in the upper left corner of the **Arpeggiator** section:



Apreggiator's padlock

It is used for locking all parameters within the **Layer's Arpeggiator**, thus preventing overwriting their values when the **Timbre** preset or **Global Preset** is loaded. To read the details go to **Preset Management** chapter.

Examples

Let's assume the following values of the Arpeggiator's parameters:

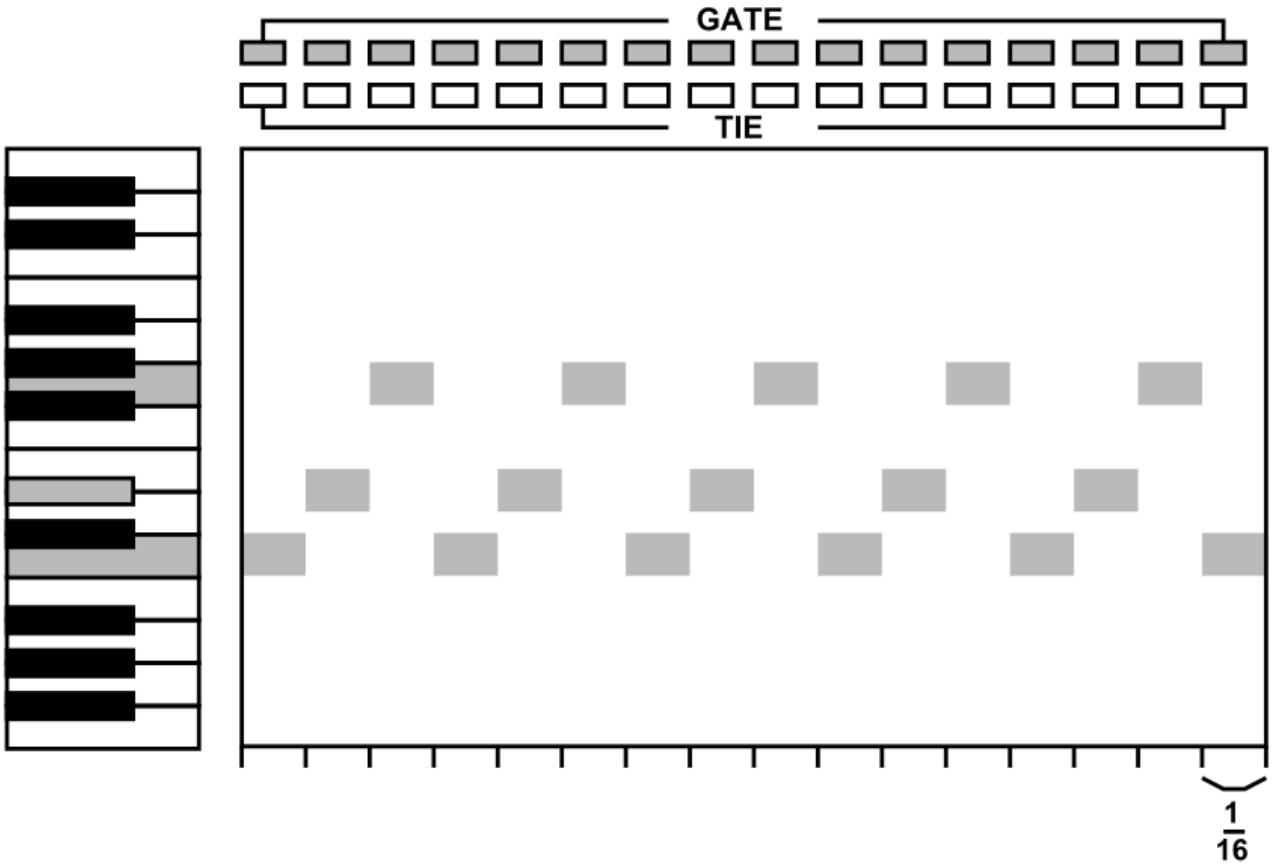
Range = **1 oct**

Mode = **up**

Repeat = **1x**

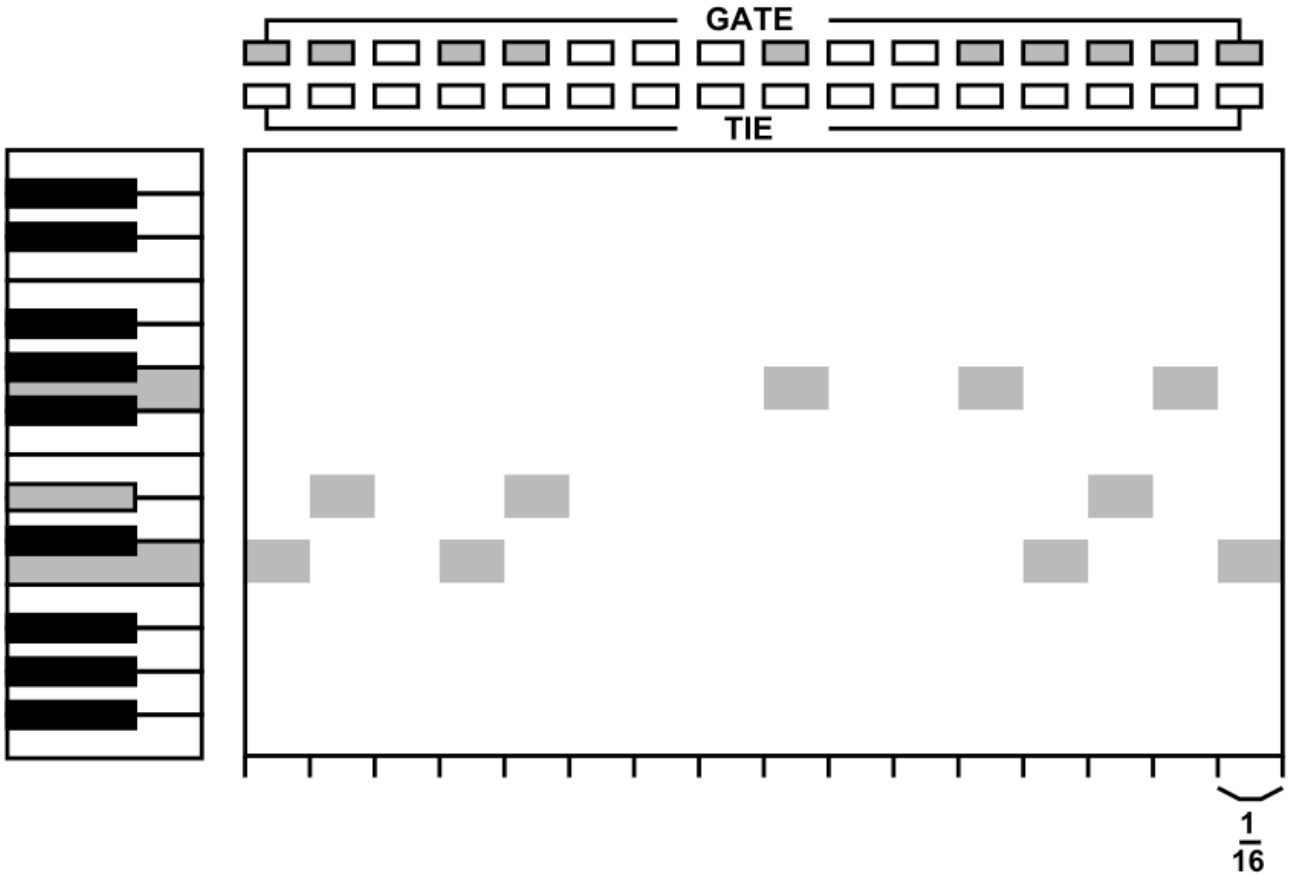
Rate = **1/16 (full)**

To get a regularly sounding Arpeggiator we have to set all the LEDs in the Gate row, and disable all the LEDs in Tie row. For C-min chord pressed on the MIDI keyboard the sequence will look as follows:



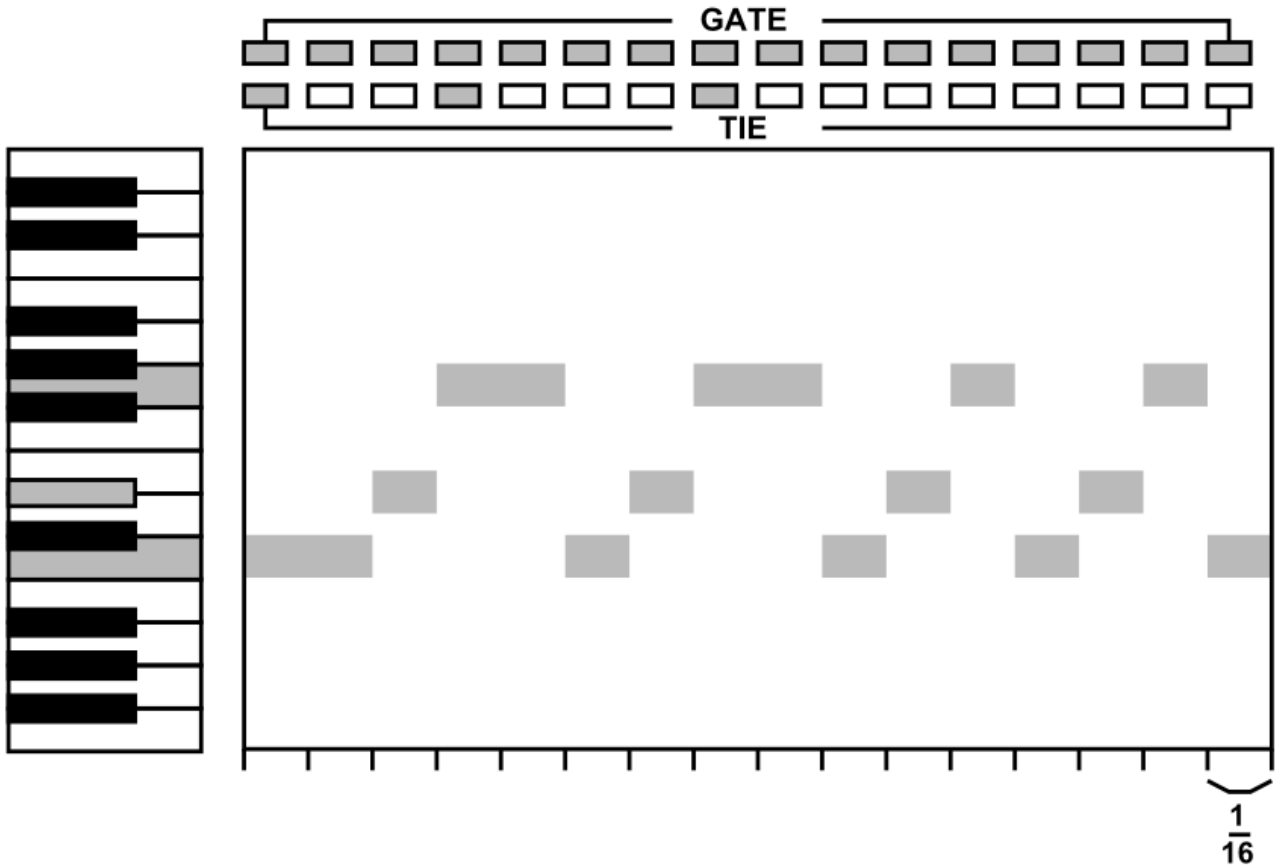
Arpeggiator - example 1

We can slightly modify the **Gate** row and as a result get the following sequence:



Arpeggiator - example 2

If we instead slightly modify the **Tie** row, we will receive this sequence:

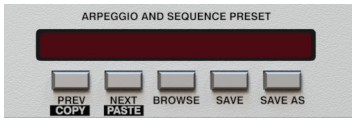


Arpeggiator - example 3

Obviously, the maximal length is **16** steps, but you may decrease it:

1. Press the **Length** button in the **Arpeggio** / **Gater** section.
2. Click on any LED in the **Gate** row making it the last step in a sequence. This is how the length is set.
3. Press the **Length** button again.

At the bottom of the **Arpeggio** / **Gate** section there is a preset management system for the **Arpeggiator**. You can store your own settings for this section or load earlier prepared ones.



Arpeggiator - Preset Management

In this section we have the following controls:

- The text box containing the name of the currently loaded **Arpe preset**.
- **Prev** / **Next** – These two buttons are used for linear navigation through the banks of **Arpe presets**.
- **Browse** – This button opens the **Arpe preset browser.**
- **Save** / **Save as** – Storing a current **Arpe preset**.

Prev / **Next** buttons used while holding **CTRL** button (**Apple CMD** on **MacOS**) allow to **Copy** / **Paste Arpeggiator** parameters:

- **Prev + CTRL** - Copies Arpe parameters from the currently selected **Layer** into a buffer.
- **Next + CTRL** - Pastes parameters from a buffer onto the current **Layer Arpeggiator**.

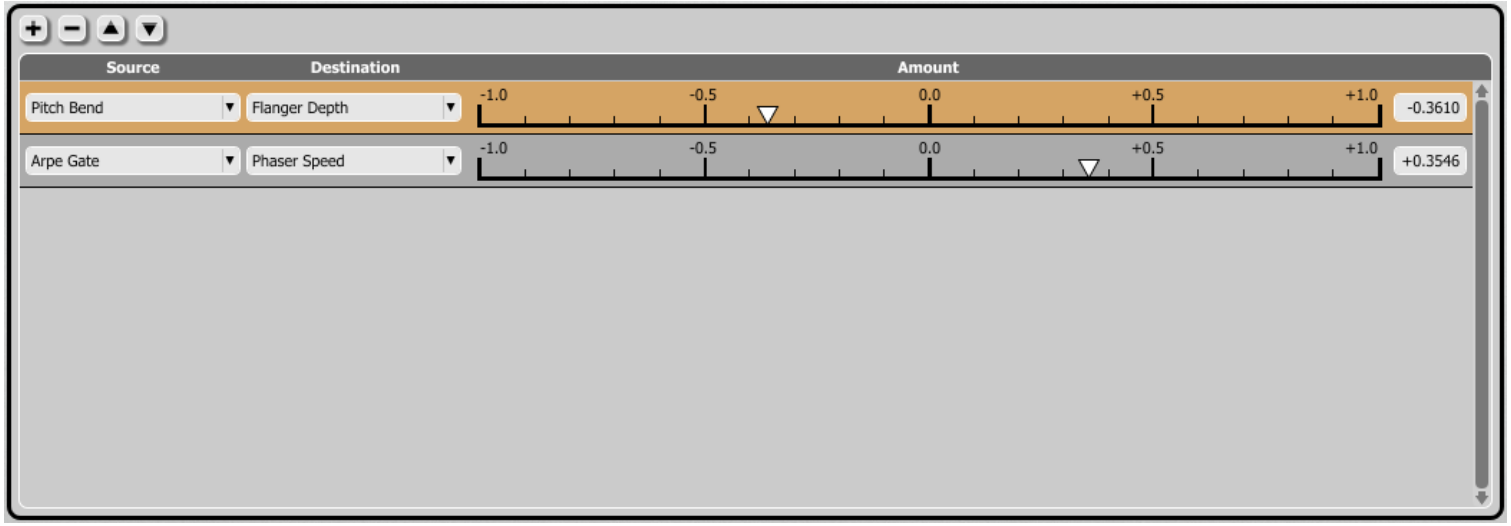
Modulation Matrix

Modulation Matrix is a tool which increases the expressivity of the sound by allowing the user to alter **Layer** sound parameters values using MIDI events. Each **Layer** in LuSH-101 contains its own and completely independent from others **Modulation Matrix**.

To edit the **Modulation Matrix** you need to click the **Modulation Matrix** button in the **Select View** section.

Select view section

After doing so, you will see the **Modulation Matrix** view in the front panel of **LuSH-101**:

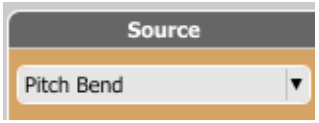


Modulation matrix

As you can see the **Control** section in the top part of GUI is still visible and accessible, making it possible to switch between the Layers and editing the **Modulation Matrix** for each of them without the necessity of leaving the **Modulation Matrix** view.

Modulation Matrix in **LuSH-101** is displayed in a tabular form, in which the following columns can be distinguished:

- **Source** - Input controller responsible for modifying the destination parameter:

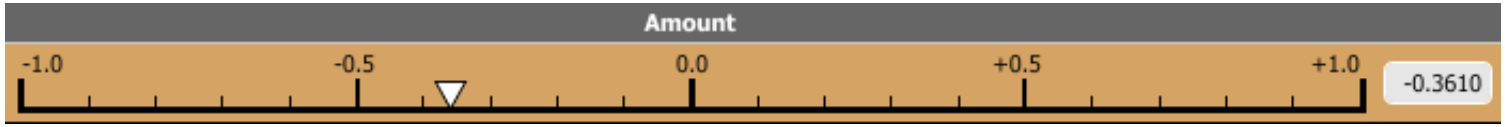


Modulation Matrix - Source

- **Destination** - Destination parameter, which is supposed to be modified:

Modulation Matrix - Destination

- **Amount** - A slider which controls the influence of the **Source** on a **Destination**.



Modulation Matrix - Amount fader

Operating the **Modulation Matrix** is based on a formula:

New Destination parameter's value = Destination parameter + Source controller * Amount

Where:

- **Destination** and **Source** have values (in most cases) in the range of [0..1],
- **Amount** has values within the [-1..1] range

By using the combo box in the Source column you can select one of the following input controllers:

- **Modulation** - Midi CC #01 (range [0..1]),

- **Expression** - Midi CC #11 (range [0..1]),
- **Pitch Bend** - Midi Pitch Bender (range [-1 .. 1]),
- **Velocity** - Midi Note velocity (range [0..1]),
- **Pitch** - Values (range [0..1]) of **Pitch Tracking** (see the **Timbre settings** chapter) assigned to each and every MIDI note,
- **Channel Pressure** - MIDI Channel Aftertouch (range [0..1]),
- **Sustain** - Midi CC #64 / Sustain pedal (gets one of two values; {0,1})
- **Arpe Gate** - Gate step sequence from **Layer's Arpeggiator** (sequence has two-state steps and because of that sequence, each step can have one of two values; {0,1})
- **Arpe Tie** - Tie step sequence from **Layer's Arpeggiator** (sequence has two-state steps and because of that sequence, each step can have one of two values; {0,1})

By using the combo box in the **Destination** column we can select one from almost all available sound parameters of the **Layer**.

In the **Modulation Matrix** a single controller (**Source**) can modify a few sound parameters (**Destinations**) at the same time when few rows with same **Source** are added. Also a few controllers (**Sources**) can modify a single parameter when a few rows with identical **Destination** are added.

*Note: It should be remembered that in the case of selecting **Velocity** or **Pitch** as a **Source** in the **Modulation Matrix**, there will be no access to all parameters in the **Destination** column, because both, **Velocity** and **Pitch**, are source controllers working per voice, and some of the parameters affect all **Layer** voices (e.g.Insert effects parameters). To those kind ofparameters **Velocity** and **Pitch** sources cannot be assigned.*

On left upper corner of the **Modulation Matrix** there are four buttons devoted to basic editing actions:

 - Adding a new row to a **Modulation Matrix**,

 - Removing a selected row from a **Modulation Matrix**,

- Moving up a selected row,
- Moving down a selected row

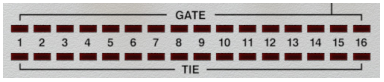
A row can be selected by a mouse-click on any of its controls, (selected row becomes highlighted).

Voice Volume - A special destination parameter

In the **Destination** column we have a specific parameter available which can be selected, namely **Voice Volume** (in a **Source Mixer** node). This parameter has no equivalent in any of the GUI parameters. It controls the volume of a single voice generated by the synthesizer. Using it as the **Destination** in the **Modulation Matrix** enables achieving typical volume dynamics. This parameter works according to a slightly different formula than other **Destinations** in the **Modulation Matrix**. When the **Amount** value is set to 0, the **Voice Volume** is not modified at all (lack of volume dynamics). In case of setting the **Amount** to **1**, the MIDI note **Velocity** affects the **Voice Volume** to full extend (maximum **Volume** dynamics) in accordance witha principle: The greater the **Velocity** of a MIDI note, the louder the sound is generated. But if we set the **Amount** to **-1**, then the note **Velocity** is inversely proportional to the sound volume (**Voice Volume**); the greater the velocity value of a MIDI note, the quieter the sound is generated.

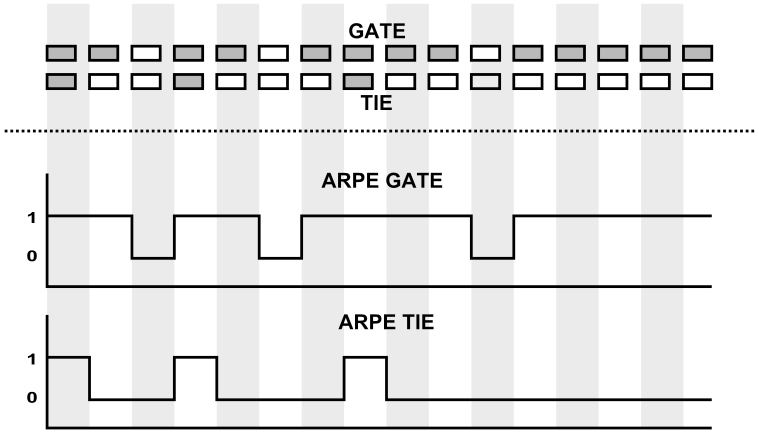
Arpe Gate, Arpe Tie - special modulation sources

In regard to **Sources** in the **Modulation Matrix**, most of them are just external MIDI events that come in from an active port redirected to the **LuSH-101**. The **Arpe Gate** and the **Arpe Tie** are two exceptions of that rule, because they are both generated internally by the **Layer Arpeggiator**. Moreover, these are not continuous parameters, but binary sequences generated by the **Arpeggiator** based on the states of **Gate** and **Ties** steps. If the step is set, then the generated value is **1**, otherwise **0**.



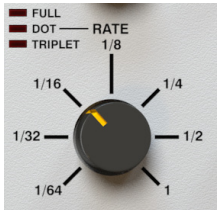
Tie and gate step values

This is an exemplary setting of **Arpeggiator Tie** and **Gate** rows and corresponding to them sequences of **Arpe Gate** and **Arpe Tie Sources** in the **Modulation Matrix**:



Modulation matrix - arpe output example

*Note: **Arpe Gate** and **Arpe Tie Sources** work even if the **Layer Arpeggiator** is turned off (**Apre Mode** parameter set to off). Regardless of whether the **Arpeggiator** is turned on or off the tempo of the generated sequence is controlled by the **Rate** knob (**Arpeggiator** section).*



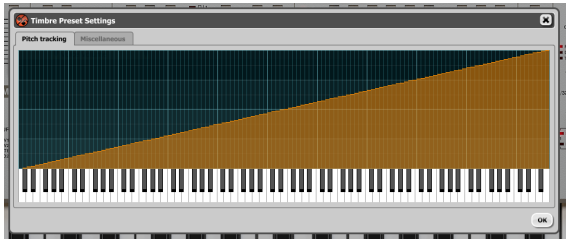
Arpeggiator - Rate knob

Timbre Preset Settings

Timbre Preset Settings panel contains configuration settings specific for a single **Layer** / **Timbre**, that do not necessarily have to be at hand when you edit a sound. To open the**Timbre Preset Settings** panel use **Sett** button in the **Timbre** section in **Synthesis** view.

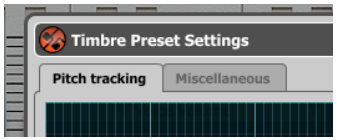
Timbre browser

After pressing the button, the panel will appear:



Timbre Preset Settings

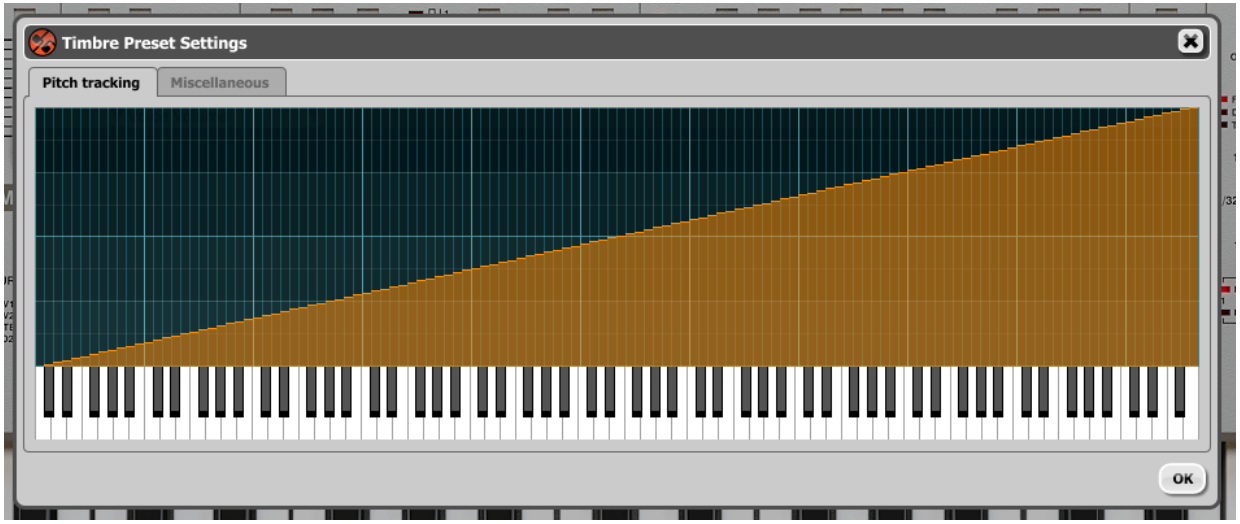
In the panel there are two tabs available:



Timbre preset settings - Tabs

- **Pitch tracking**
- **Miscellaneous**

Pitch tracking tab

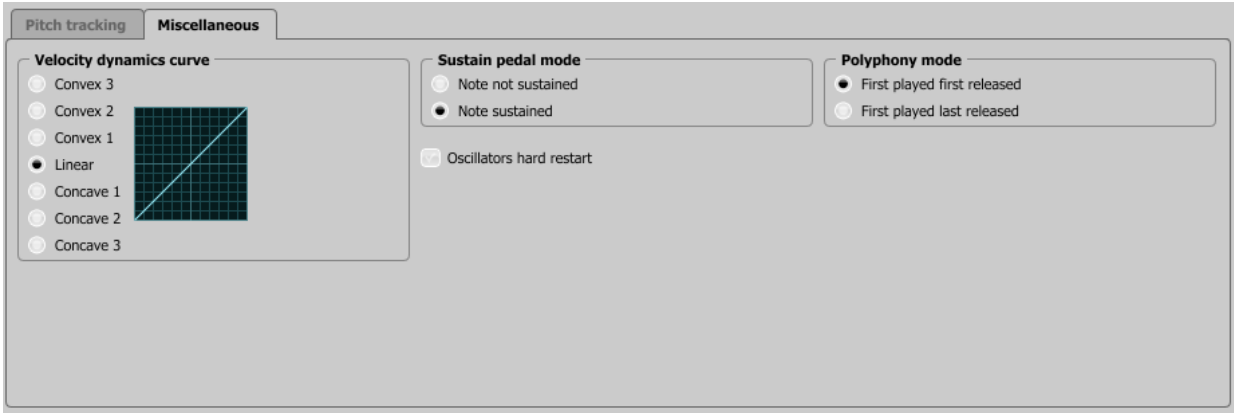


Timbre preset settings - Pitch tracking tab

There is a graph situated in the Pitch tracking tab, which allows to assign a certain value in the range of [1..100] to each MIDI note coming into the Layer. This set of values is used in the **Modulation Matrix** as a **Source: Pitch.** Depending on a MIDI note received by LuSH-101 a corresponding value is returned as a **Pitch** (rescaled to the range [0..1]) in the **Modulation Matrix.** Editing the **Pitch** tracking values can be performed in two ways:

- **Freehand drawing**, using the mouse while holding the left button.
- **Linearly interpolated drawing**, using and clicking the right button. The first click starts a line, successive click starts another line at the end of the first one, and so on. If you are done, just finish with a left mouse click.

Miscellaneous tab



Timbre preset settings – Miscellaneous tab

In this tab, the following options are available:

- **Velocity dynamics curve** - Allows to select between seven different dynamic curves, the one selected is taken into account in **Modulation Matrix** (**Velocity**).
  - **Convex 3**
  - **Convex 2**
  - **Convex 1**
  - **Linear**
  - **Concave 1**
  - **Concave 2**
  - **Concave 3**

  Linear is the default one.

- **Sustain pedal mode** - Sustain pedal apart from its basic task of sustaining the played notes, can be also used as a **Source** in the **Modulation Matrix**. Therefore we might want to disable sustaining the notes by the pedal, to limit its usage to the **Modulation Matrix** only. It is possible to perform this action using this option. There are two variants we can select from:
  - **Note not sustained** - Sustain pedal does not sustaining notes and works in the **Modulation Matrix** only.
  - **Note sustained** - (default value) Sustain pedal fulfils its basic function and sustaining notes when we press it and at the same time it can be used as a **Source** for the **Modulation Matrix**.
- **Polyphony mode** - Polyphony for the **Layer** is limited by a set of voices / generators, that are allocated to the individual MIDI notes played on the keyboard. If polyphony is too small then during the playback of complex keyboard phrases, sounds, which were triggered earlier by MIDI notes and are still playing, need to be stopped by successively and continuously incoming new MIDI notes (because of the limited polyphony). This concerns mainly sounds with longer release times. In **LuSH-101** we can choose how notes should be distributed among available voices of polyphony (the order in which voices should be assigned to incoming notes and later released). There are two modes built-in:
  - **First played first released** - (default value) This way is analogous to a queue, in which a first assigned voice to a note (considering the timeline) will be also the first one released - Method inspired by **Korg's** analogue synthesizers.
  - **First played last released** - Voices management is done in a way similar to a stack, where the last assigned voice to a note (considering the timeline) will be also the first one released - This method was inspired by **Roland's** analogue synthesizers.
- **Oscillators Hard Restart** - The option is turned off by default. In case of its activation the oscillators phase (VCO) of a given layer is reset each time a new note is being played. The **Legato** (overlapping notes) for the monophonic mode is an exception, in which the incoming of a new note does not erase the oscillator phase, even with the **Oscillators Hard Restart** option activated.

All settings from the **Timbre Preset Settings** panel are stored along with the **Timbre** / **Layer** preset.

Mixer

In **LuSH-101** we have 8 independent **Layers**, each of them is actually an independent synthesizer with its own set of parameters, completely separated from the others. You can combine and mix the sound from all the **Layers** together on the **Master mixer** view.

Select view section

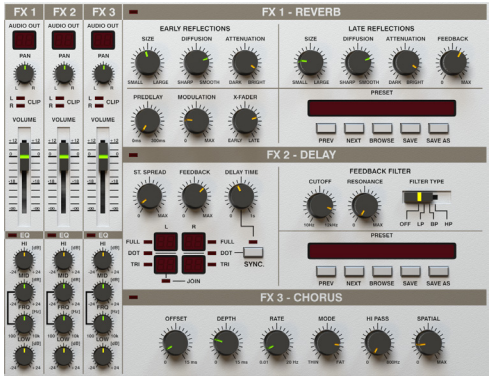
After clicking the **Master mixer** button, the **Mixer** view appears on the front panel of **LuSH-101**.

Mixer view

First 8 channel strips representthe synthesizer **Layers**:

Mixer - layers' channel strips

Three succeeding channel strips are the **FX** channels with three **FX** algorithms permanently assigned to them (one per each):

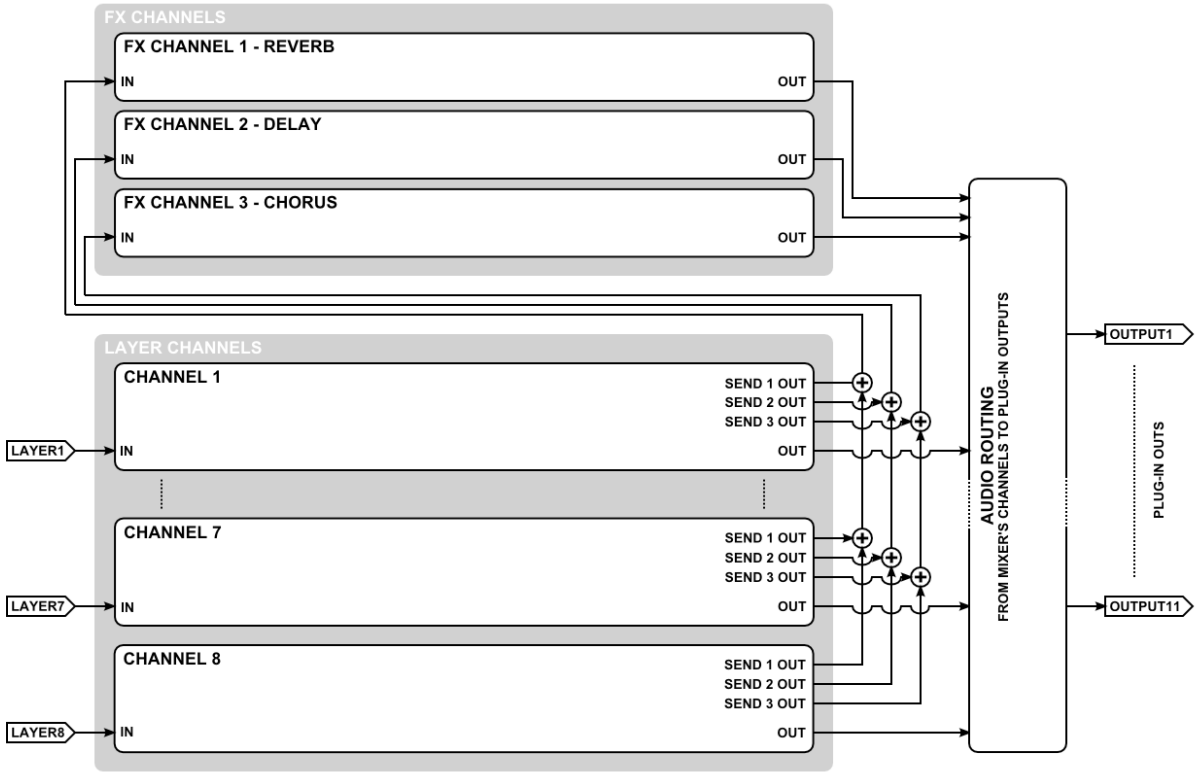


Mixer - send effects and FX channels strips

- **FX1** – Reverb is assigned to **FX1** channel,
- **FX2** – Delay is assigned to **FX2** channel,
- **FX3** – Chorus is assigned to **FX3** channel,

Each of those send effects has its own set of parameters, and in respect to the complexity (number of parameters) of the **Reverb** and **Delay** effects , they have their own preset management system.

Each channel (**Layer** or **FX**) can be routed to one of the eleven available plug-in outputs.



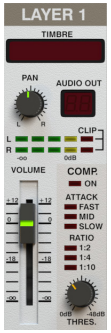
Signal flow through a mixer

Layer channel strip

Before the signal outgoing from a Layer is mixed with signals from other **Layers**, it passes through a channel strip.

Mixer - layer's channel strip

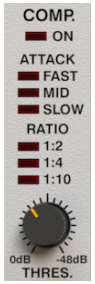
Starting from the top of the channel strip we can distinguish the following controls:



Mixer - layer's channel strip - top section

- **Timbre** – This text box displays the name of the loaded timbre and allows to change the **Timbre**'s name by clicking on it.
- **Pan** – **Panorama**, this control corresponds to a **Pan** knob, which is placed in the **Layer** master section in the **Layer** tab.
- **Audio out** – Plug-in Audio output, which the **Layer**'s outgoing signal is routed after processing to in a channel strip. This is conjugated with Audio output in **Layer** settings section in the **Layer** tab.
- **Volume** – This slider controls the output volume ofthe channel strip.

Next to the **Volume** fader there is the **Compressor** section, which is basically an insert effect in the channel strip.



Mixer - layer's channel strip - compressor

- **On** – LED that turns on/off the compression.
- **Attack** – The radio group of three LEDs that select one of the three available fixed envelopes:
  - **Fast** – Fast attack, slow release.
  - **Mid** – Medium attack, medium release.
  - **Slow** – Slow attack, fast release.
- **Ratio** – The radio group of three LEDs which select one of three available fixed compression ratios:
  - **1:2**
  - **1:4**

- **1:10**
- **Thres**. - Compressor threshold.

Below there is a simple parametric equalizer, the **EQ** section:

Mixer - layer's channel strip - eq

- **Hi** – Hi-shelf gain from -24db to +24db for frequencies >= 8khz.
- **Mid frq**. – Center frequency of the peak for middle frequencies from 100hz to 10khz.
- **Mid** – Gain value for a peak for middle frequencies from -24db to +24db.
- **Low** – Low-shelf gain from -24db to +24db for frequencies <=100hz.

The Pre.Comp. switch controls the sequence of processing by the Compressor and **EQ** sections. If **Pre.Comp**. is:

- **On** – the signal is first processed by the compressor and then its output is processed by the **EQ**.
- **Off** – the signal is first processed by the **EQ** and then its output is processed by the **Compressor**.

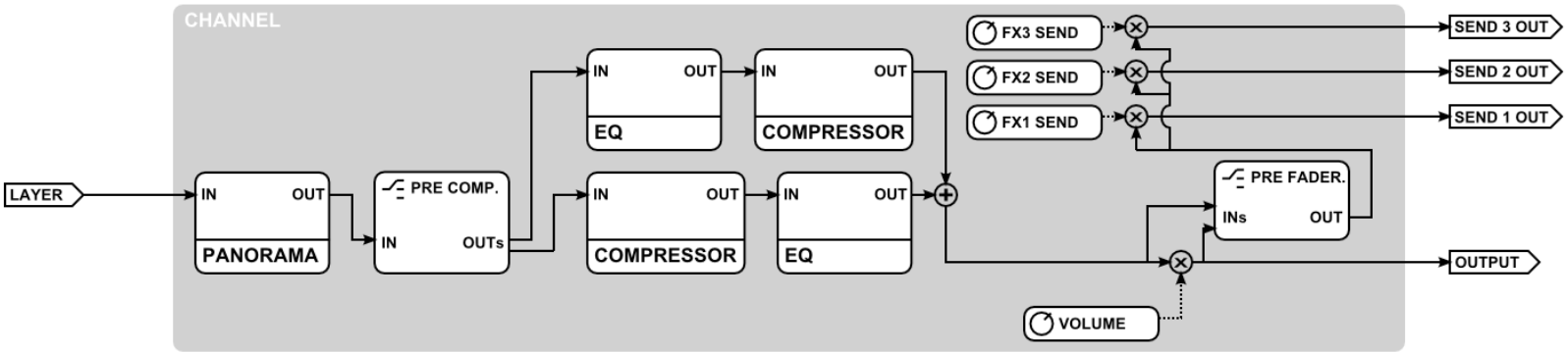
In **Send** section we have three parameters which control the amount of signal. After processing by a channel strip (but before the fader) the signal is sent to **FX channels**.

Mixer - layer's channel strip - send section

- **FX1** – Is a send value for **FX1** Channel.
- **FX2** – Is a send value for **FX2** Channel.
- **FX3** – Is a send value for **FX3** Channel.

The Pre fad. (Pre fader) switch, which controls whether the signal is sent to **FX** Channels, takes the **Volume** fader into account.

The diagram below depicts the signal flow through a channel strip:



Signal flow through a layer's channel strip

FX Channel strip

The part of the signal, controlled by **FX** knobs (in **Send** sections of **Layer** channel strips), from each **Layer** is sent to the **FX Channel**. The input of the **FX Channel** is a sum of all the parts from all **Layers**. Each of the **FX Channels** is assigned to one effect algorithm (**Reverb**, **Delay** or **Chorus**) and then it is further processed.

Mixer - FX Channel strip

The **FX Channel**, apart from having an assigned effect algorithm, contains few other elements affecting the sound.

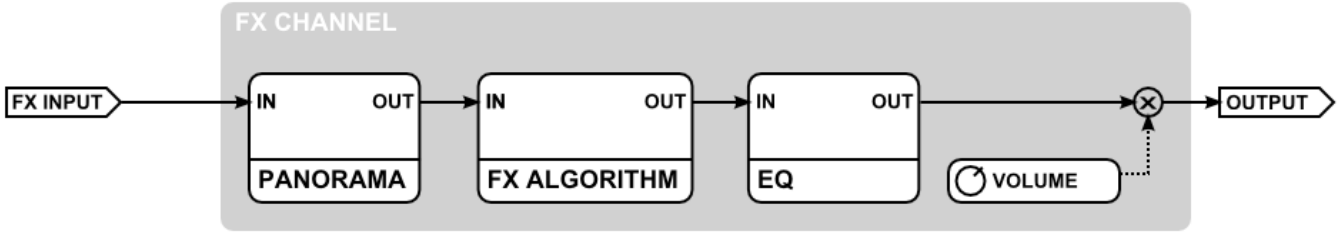
Mixer - FX Channel strip - top section

- **Audio out** – It is the plug-in output number towhich the output signal from the **FX Channel** will be routed to (1-11).
- **Pan** – Panorama.
- **Volume** – Fader that controls the amplitude of the **FX Channel** output signal.

The **EQ** section controls a simple parametric equalizer of the **FX Channel**, and it contains the following parameters:

Mixer - FX Channel strip - eq section

- **Hi** – Hi-shelf gain from -24db to +24db for frequencies >= 8khz.
- **Mid frq**. - Center frequency of the peak for middle frequencies from 100hz to 10khz.
- **Mid** – Gain value for a peak for middle frequencies from -24db to +24db.
- **Low** – Low-shelf gain from -24db to +24db for frequencies <=100hz.



Signal flow through a FX Channel strip

FX algorithms

In **LuSH-101** mixer we have three different fx algorithms assigned permanently to particular **FX Channels**.

Reverb

Reverb is assigned to the **FX1 Channel**, its parameters are located in **FX 1 – Reverb** section on GUI:

Mixer - FX 1 - Reverb section

Here we can distinguish the following groups of parameters:

- **Early reflections:**
  - **Size** – Size of the room for early reflections only.
  - **Diffusion** - It is the reflecting surface's ability to spread the echo out. If this parameter is set to **Sharp**, the reflecting surface is perfectly flat and does not distort the reflected wave. In the case of setting this value to **Smooth**, the reflecting surface distorts wave and spread out into different directions.
  - **Attenuation** - This parameter changes the characteristic of the wall's surface, its dumping properties.
- **Late reflections:**
  - **Size** - Size of the room for late reflections only.
  - **Diffusion**.
  - **Attenuation**.
  - **Feedback** - Controls how much of wave energy is consumed every reflection. The smaller the value the more energy is consumed in every reflection, meaning the feedback is weaker.
- **Three other parameters:**
  - **Predelay** - Delay between dry signal and reverberation.
  - **Modulation** - It isa parameter, which controls the delay lines disturbance.
  - **X-Fader**– Cross-fade between early reflections output and late reflections output.

LED in the Reverb's top bar works in toggle mode and is responsible for turning on and off the effect:

FX 1 - Reverb - Top bar

Since Reverb contains quite a big number of parameters, there is also a **Preset management** section, in which we can do the preset management for a Reverb:

- The text box containing the name of currently loaded Reverb preset.
- **Prev / Next** – These two buttons are used for linear navigation through the bank of Reverb presets.
- **Browse** – This button opens a browser with Reverb presets.
- **Save / Save as** – Storing a current setting as a preset.

Delay

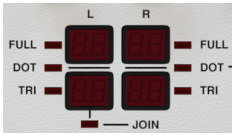
The Delay effect is assigned to the **FX2 Channel** and it is controlled from a **FX2 – Delay** section on GUI:

Mixer - FX 2 - Delay section

This Delay algorithm allows a synchronization of its delay lines with host tempo and resonance filter in a feedback loop.

The following parameters control the Delay:

- **Sync.** – Turning on/off the synchronization with the host application. When it is off, the delay time is set by a **Delay time** knob, otherwise we set a time based on delay using the four LED displays (arranged in two columns).
- **Delay Time** – It is the delay time in milliseconds. This control works only when **Sync.** is turned off (non tempo synchronized delay).
- **L / R** – In a tempo synchronization mode (**Sync.** Turned on), the delay is set by note values (relative duration). We can set these values separately for left and right channels:



FX Delay - tempo based delay time

For left and right channels (L, R) there are two LED displays per each (arranged vertically and separated by a straight line). The numbers on the top are numerators; on the bottom - denominator. The entire fraction represents a note value, which is a delay time between the taps. The denominator is a rhythmic scale (e.g. 16 means it's a 16th note), the numerator is a multiplier, and so 3/16 for example is a duration time of the three 16th notes each:

3/16ths delay time

- **Full / Dot / Tri** – Those three radio LEDs select between three rhythmical modifiers (for left and right channel independently):
    - **Full** – Full note.
    - **Dot** – Dotted note.
    - **Tri** – Triplet note.

Example: On the left channel we set a delay value for 5/16 , on the right channel for 3/16. Additionally for the right channel we select a Dot modifier. These are the resultant delays:

FX Delay - example 1

- **Join** – This LED works only when **Sync.** is on. If **Join** is turned on, it means the delay lines for the right and left channel are joined together and we set a delay time globally for both of them by setting a delay time for the left channel only (L column).

- **St.Spread** – Stereo spread is a linear (additional) delay between the left and right channel. Therefore, if:
  - **Sync. Is Off** – When the Delay effect is not synchronized with a host application, the maximal delay between the left and right channel is 50% of the Delay time knob value.
  - **Sync. Is On** – When the Delay effect is synchronized with a host application, the maximal delay value between left and right channel is a half of the rhythmical value set in a L column.
- **Feedback** – Feedback value of the Delay effect.

The filter in a feedback loop is controlled by following parameters:

- **Cuttoff** – Cutoff frequency.
- **Resonance**.
- **Filter Type** – **OFF** (no filter), **Lp** (Low-pass filter), **Bp** (Band-pass filter), **Hp** (High-pass filter).

LED in the Delay's top bar works in toggle mode and is responsible for turning on and off the effect:

FX 2 - Delay - Top bar

The preset section allows for managing the presets for the Delay effect:

- The text box containing the name of the currently loaded Delay's preset.
- **Prev / Next** – These two buttons are used for linear navigation through the bank of Delay's presets.
- **Browse** – This button opens a browser for Delay presets.
- **Save / Save as** – Storing a current setting as a preset.

Chorus

Chorus is an effect permanently assigned to the **FX3** Channel, controlled from the **FX3 – Chorus** section on GUI:

Mixer - FX 3 - Chorus section

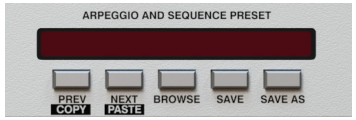
- **Rate** – Controls LFO frequency [0.01 Hz .. 20 Hz]. The LFO waveform is triangular.
- **Depth** - Amplitude of LFO oscillations expressed in milliseconds.
- **Offset**– It is an offset between dry signal and the minimum of the LFO oscillations expressed in milliseconds
- **Mode** – It isthe volume of the output from the second delay line. It makes the sound more fat.
- **Stereo** – This is a stereo phase offset of the LFO controlling the delay line.
- **HiPass** – It is a high-pass filter cutoff frequency. It filters an output signal from the Chorus.

LED in a Chorus' top bar works in toggle mode and is responsible for turning on and off the effect:

FX 3 - Chorus - Top bar

Global preset settings

This panel contains settings specific for the **Global Preset** that are not necessarily at hand when you edit a sound. To open the **Global Preset Settings** panel you need to use **Sett.** button in the **Global preset management** section on GUI:



Arpeggiator - Preset Management

This window will appear:

Global Preset Settings window

Arpeggio Sync Mode

If we use the **Arpeggiator** on more than one **Layer**, **Arpeggio Sync Mode** defines a way of communication / synchronization of the **Arpeggiators** across the **Layers**. Timers which tick **Arpeggiators** in **Layers** can work either independently, or they can be joined together according to specified criteria. If the timers of two or more **Arpeggiators** are joined together, the **Arpeggiator** triggered as the first one (Master), generates a master timing signal simultaneously with generating its sequence of notes., which all the other **Arpeggiators** will also be synchronized with. In other words, **Arpeggiators** triggered subsequently (Slave) will be generating a note sequence(s) quantized / synchronized with a timing signal generated by the **Master Arpeggiator. Arpeggio Sync Mode** defines a criterion by which **Arpeggiator**s in **Layers** are grouped together. Within a single group the **Arpeggiator** triggered as the first one become the **Master**. We can select one of the criteria:

- **Each independent** - All **Arpeggiators** work completely independently and noneof them affectsthe others.
- **All together** - All 8 **Arpeggiators** (from all **8 Layers**) are grouped together; when one of them is triggered as the first, the other **Arpeggiators** will be adjusting their timers to the first one.
- **Common midi channel** - **Arpeggiators** set on the same MIDI channel (Layer settings) are grouped together. The **Arpeggiator** triggered as the first one synchronizes other **Arpeggiators** in a group.

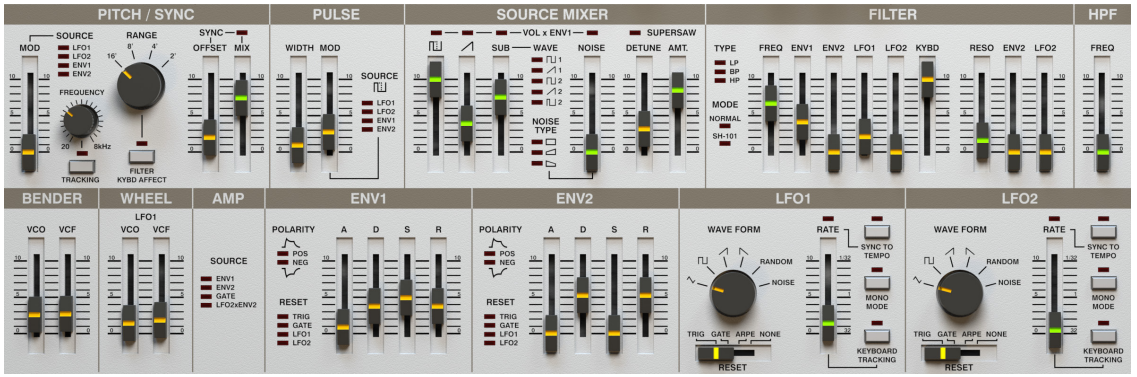
  Arpeggiators in **Layers** are grouped by **Layers** MIDI channels. Any two **Arpeggiators** in **Layers** that are listening out on the same MIDI channel are grouped together and one of them can be a **Master**. Alternatively, any two **Arpeggiators** in **Layers** listening out on different MIDI channels will be in separate groups.

Preset Management

Presets structure

The presets structure in **LuSH-101** is hierarchically organized, there are five kinds of presets, which store different groups of parameters.

- **Layer preset** – In **LuSH-101** it is called a **Timbre**. Within this type of preset the following parameters are stored:
  - Parameters from the **Voices** section.
  - **Insert effect** type and **insert effect** parameters.
  - All parameters from **Layer master** section.
  - All parameters from **Synthesis** section including oscillators, envelopes and LFOs settings.

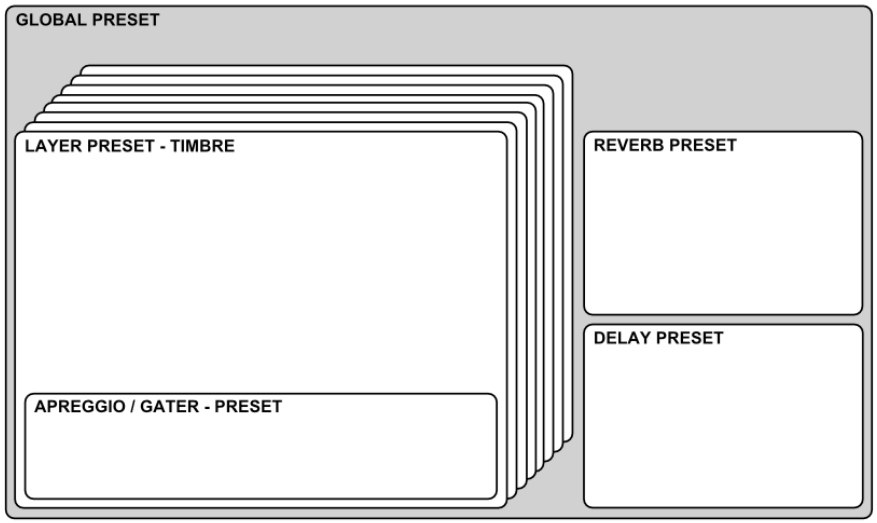


Layer's sound parameters

- **Modulation Matrix**
- **Arpeggio** / **Gater** section settings.
- **Timbre** settings.

- **Arpeggiator preset** – **Arpeggio** / **Gater** section settings.
- **Reverb preset** – Reverb settings in Mixer tab, **FX 1 – Reverb** section.
- **Delay preset** – Delay settings in Mixer tab, **FX 2 – Delay** section.
- **Global preset** – also simply called **Preset**, which stores the state of the whole synthesizer including:
  - All layers (see the **Layer preset**).
  - Mixer settings and send effects,
  - Transpositions and keyboard zones (from **Layer settings** section) for all **Layers**.
  - Master volume.
  - Preset settings.

In general, global **Preset** aggregates presets for all **Layers** (**Timbres**) + **Delay** preset + **Reverb** preset + additional parameters.



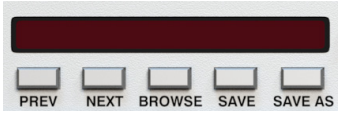
Global preset structure

Preset storage

All kinds of presets are stored on a disk in a particular location, which makes the process of management smooth and allows to easily exchange presets between users. When you insert a plug-in to a host application, before the window opens, some initial actions are performed. Among those, LuSH-101 scans the location in which presets are stored on the hard disk and projects this location into the tree (hierarchical) structure, which corresponds to a structure of folders and files:

- Single files are projected as presets and the file name is the preset name.
- A folder is projected as a group of presets, which is presented in the **Preset Browser** as a group (node). It is allowed to nest the structure of groups and single presets into another group etc.

In the **Preset** section (regardless of global, timbre or others), we can always distinguish a few common controls:



Preset management section

- The text box containing the name of the currently loaded preset.
- **Prev** / **Next** – These two buttons are used for linear navigation through the bank of presets.
- **Browse** – This button opens **Preset browser**.
- **Save** / **Save as** – Storing a current settings as a preset (overwriting / as new one).

For storing presetsthe standard OS dialogue windows are always used.

Note: All kinds of presets are stored accordingly to a human-readable XML standard. There is no need to edit presets manually, however, they can be opened and edited in any text / XML editor.

By default, presets are kept on the hard drive:

- for MacOS – the folder "~/Library/Application Support/D16 Group/LuSH-101/Arpe"
- for Windows – the folder "c:\Users\[user_name]\AppData\Roaming\D16 Group\LuSH-101"

Following files types are recognized by LuSH-101:

- *.shprst* - Global Preset,
- *.shtmbr* - Timbre (Layer) Preset,
- *.shfx1* - Reverb effect's Preset
- *.shfx2* - Delay effect's Preset
- *.sharpe* - Arpeggiator's Preset

Padlocks

Padlock is a functionality, which makes locking a certain set of parameters when the preset is loaded possible; values of the locked parameters will not be altered. There are two kinds of **Padlocks** in **LuSH-101** considering the range of effect:

- **Layer Padlock** - Single **Layer Padlock** covers all **Layer** parameters (including the **Arpeggiator** in a particular **Layer**), locks them only during loading **Global Presets**. This kind of **Padlock** will not work if we try to load a **Timbre Presets** or **Arpeggiator Presets** instead.

Layers' padlocks

To activate **Padlocks** for selected **Layers** click on a **Padlock** icon (in the **Control** section) corresponding to **Layers** you want to lock. **Padlock** icons work in toggle mode.

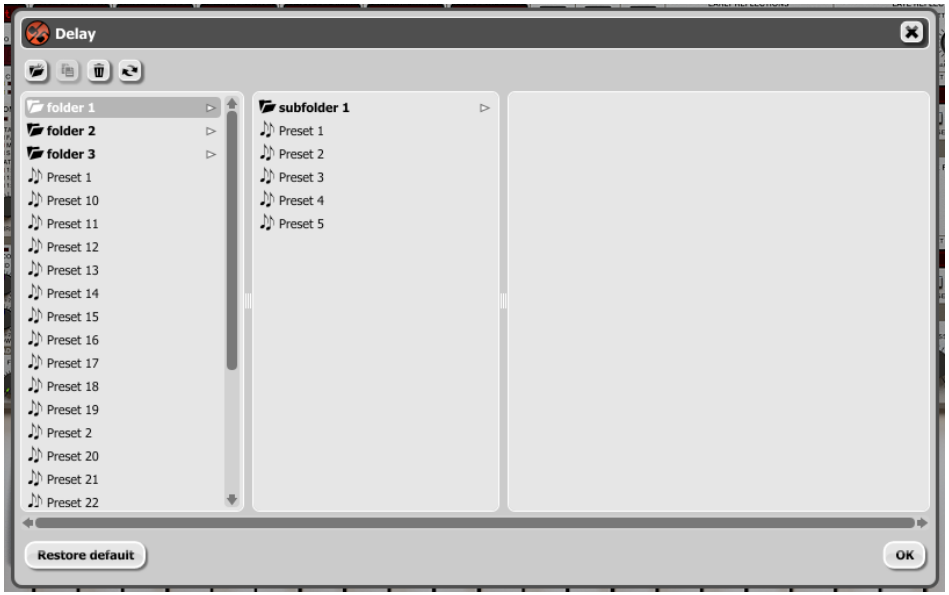
- **Arpe Padlock** - This kind of **Padlock** covers all **Arpeggiator** parameters in a single **Layer** and locks them during loading **Timbre Presets** or **Global Preset**, but it will not work on **Arpeggiator Presets**.

Apreggiator's padlock

To activate the **Arpe Padlock** use the padlock icon in the **Arpeggiator**'s top bar.

Preset Browser

As it was mentioned in the previous chapter, presets in LuSH-101 are stored as files on the hard drive. Therefore, the **Preset Browser** reflects the file structure of a location on the disk where presets are actually kept.



Preset Browser

The hierarchy of the file structure on the disk is represented by columns (each column is a single level in the directory tree), in which the leftmost column is the highest level in the file structure (**Preset** root folder), and subsequent columns, going to the right, represent successive levels of the directory tree. Each column may contain two kinds of items:

- **Folder** - Which name is emphasized with bold font and an arrow on the right.

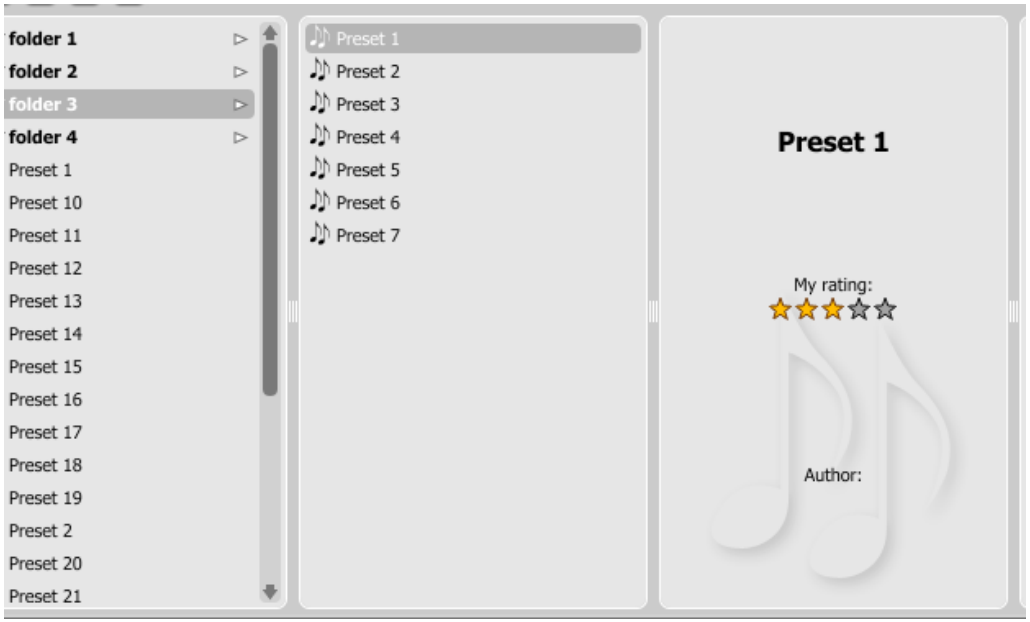
Preset Browser - Folder

- **Preset file**

Preset Browser - Preset

Clicking the **Folder** selects it, and its content (subfolders and files) is displayed in the adjacent column to the right. If the folder we selected contains any subfolders, analogically you can perform the same action on and on, until reaching the deepest level of the directory tree. All columns starting from the left side will correspond to successive levels of the directory tree.

Clicking the **Preset file** selects and loads the preset, and also displays information about the preset in the column directly on the right side:



Preset Browser - Preset description

It contains information like: **Preset** name, **Author** and **Rating**. We can change the **Rating** according to our recognition by giving it 1 to 5 stars (by mouse clicking on one of the stars). The author's name is assigned automatically to all newly created and saved presets based on information given by user in a **Preset** tab in **Configuration** panel.

Double-clicking the item (**Folder** or **Preset file**) toggles edit mode,which allows to rename the file.

We can select (for removing or copying):

- A Single item by clicking it.
- Group of items:
  - By selecting the first one and adding new elements by selecting them while holding CTRL key (Apple CMD na MacOS)

- By selecting a range of items; click the first one (to mark the beginning) and then click the last one while holding CTRL key (to mark an end).

Selected item(s) can be moved to any subfolder using the drag'n'drop method. It is also possible to move a selected **Preset** / **Folder** or group level up in the directory tree using the drag'n'drop method, if we drop the selected item(s) onto the column on the right.

There are several buttons in the top bar of the **Preset Browser**. The buttons can be used to perform additional actions:

Preset Browser - Top Bar buttons

- Creating a new **Folder** in the current location.
- Creating a duplicate of a selected **Preset file** (this option does not work on **Folders** and groups of items)
- Deleting a selected item or group of items.
- Refreshing the columns content in the **Preset browser**. It is necessary in the situation when **LuSH-101** is loaded and the content of the hard drive (in the location where **Preset files** are kept) has changed.

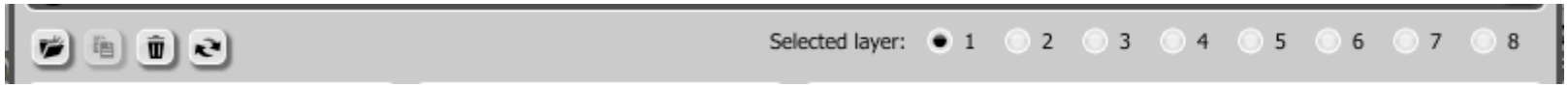
Using **Restore default** button at the bottom part of the **Preset Browser** causes overwriting the current **Layer** sound parameters with initial values.

Preset Browser - Bottom Bar

The **Ok** button on the right or **Close** button in the upper right corner closes the **Preset Browser**.

Arpeggiator Preset Browser

The previous chapter focused on describing general features of the **Preset Browser**, namely its simplest possible variant, which appears in the case of browsing the **Presets for Delay** or **Reverb effects** in the **Mixer**. The **Preset Browser** for **Layer Arpeggiator** is slightly more advanced (level up in complexity), enriched with additional functionality.



Preset Browser - Select Layer radio group

There is a radio group called Select layer in the upper bar of the **Preset Browser**. It allows to select a **Layer**, for which the **Arpeggiator preset** will be loaded (without the necessity of leaving the **Arpeggiator Preset Brower** window to change an active **Layer**).

Timbre Preset Browser

The **Timbre Preset Browser** has exactly the same functionality as the **Arpeggiator Preset Browser**, but with one extra functionality added:

Preset Browser - Arpe Padlock

On the right side of the upper bar there is an **Arpe Padlock**, which allows to lock the **Arpeggiator** parameters. If we try to load the **Timbre Preset** with **Arpe Padlock** turned on, the **Arpeggiator** parameters will remain unchanged. Therefore, this function performs exactly the same action as the **Padlock** on GUI:

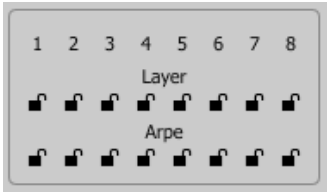
Apreggiator's padlock

We do not have to leave the **Timbre Preset Browser** to toggle it.

Global Preset Browser

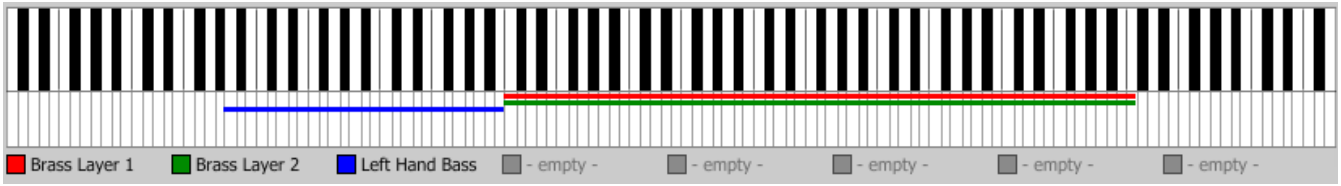
The Global Preset Browser offers two additional functionalities:

- It is possible to toggle all **Padlocks** from one location (including **Timbre Padlocks** and **Arpe Padlocks** for all **Layers**):



Global Preset Browser - Padlocks

- In the bottom part of the **Global Preset Browser** a visual music keyboard is located which shows the distribution of zones across the MIDI keyboard.



Global Preset Browser - Zones' Layout

Below the keyboard **Timbre** names for all the **Layers** are shown and if an enabled MIDI port is redirected to **LuSH-101** this control indicates their activity in response to MIDI notes.

Configuration

The **Configuration** panel in LuSH-101 allows us to change the general settings of the plug-in. Use the **Options** button on GUI to load it:

Options (about) button

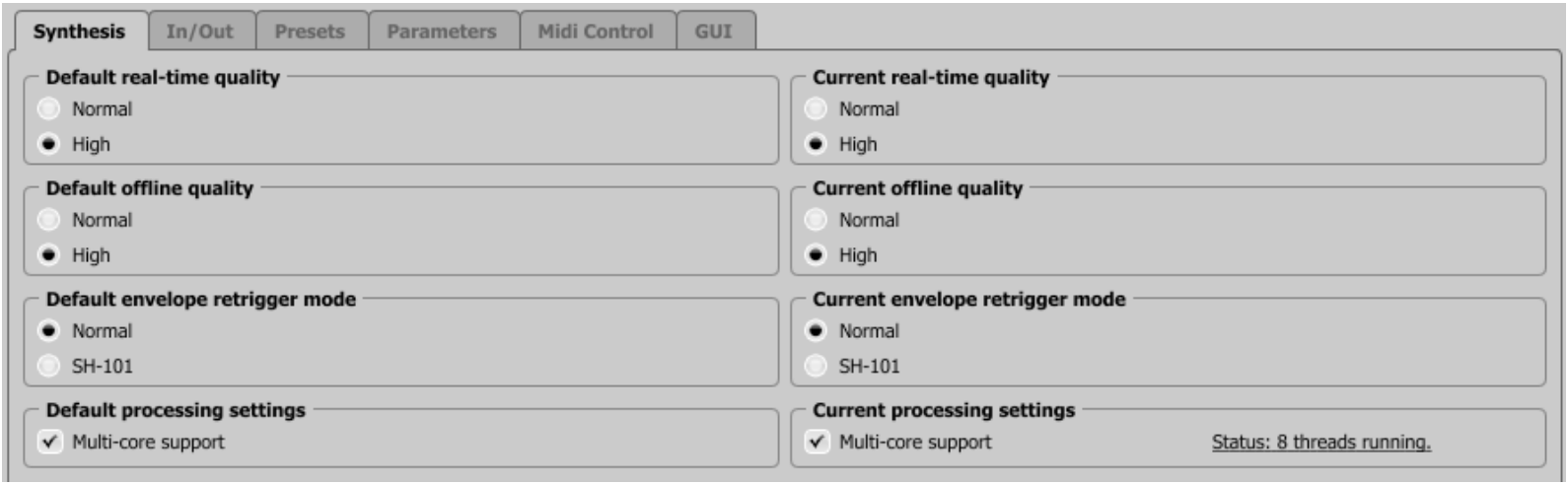
In the **Configuration** panel the following tabs are available:

Configuration Panel - Tabs

- **Synthesis** – Global processing settings.
- **In** / **Out** – Configuring default MIDI channels and Audio outputs.
- **Presets** – Global actions on preset files.
- **Parameters** – Configuring automatable parameters within the host application.
- **Midi Control** – Configuring MIDI communication with plug-in.
- **GUI** – Plug-in graphical user interface options.

Synthesis tab

This tab is used to control the processing settings and the quality of the sound generated by the synthesizer:



Options - Synthesis Tab

Current Quality (real-time and offline)

Allows to select the current quality for **real-time** or **offline**. We can choose from two available grades:

- **Normal**
- **High**

High quality chosen, requires more CPU resources. Changing the **Current Quality** instantly affects the generated sound. Keep in mind that the tone of a sound can be slightly different when we change this setting.

Current Quality is stored within the host project file.

Default Quality

Every time a **LuSH-101** is loaded in the host application (new instance is created) the **Default Quality** value is used for a **Current Quality** setting. **Default Quality** is stored within a configuration file of **LuSH-101**. This file is saved at the moment of unloading any of active plug-in instances from the host application.

Current envelope retrigger mode

Allows to switch the envelope retrigger mode within polyphony = 1 voice (monophony) and within the set envelope reset mode on Trig.

- **Normal** – When by using the MIDI keyboard we trigger sounds and hold them, then in every new MIDI note the envelope is reset despite the fact that the earlier pressed notes were held. This is characteristic for the **Trig** reset mode. Remember, when polyphony = 1 voice, only one note is always played from all the note notes pressed on the keyboard. When we release the key responsible for playing the note, one of the earlier pressed notes will be played. However, when we choose Normal mode (default for the **Default Envelope Retrigger** mode), releasing a button does not result in resetting the envelope.
- **SH-101** – This envelope retrigger mode was inspired by the manner in which the envelope was working in SH-101 synthesizer and it differs from Normal mode in one aspect. When successively releasing the pressed keys on the MDI keyboard, not only does the played note change, but the envelope is also reset if it is switched to **Trig** reset mode.

Default envelope retrigger mode

Every time a LuSH-101 is loaded in host application (new instance is created) the **Default envelope retrigger mode's** value is used for a **Current envelope retrigger mode** setting. **Default envelope retrigger mode** is stored within a configuration file of the LuSH-101. This file is saved in a moment of unloading any of active plug-in instances from the host application.

Current processing settings

Options - Current processing settings

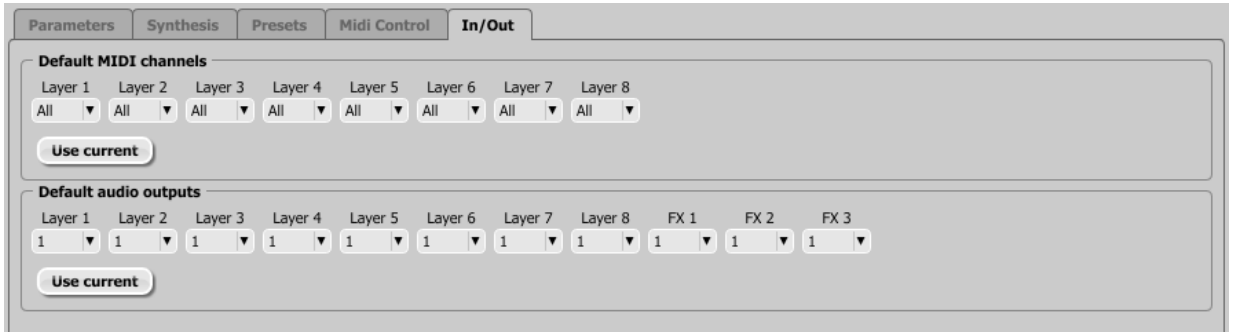
According to the specification, a plug-in generates or processes the sound in a one-track manner and it is the host application which activates the plug-in in a separate thread. Plug-ins with a large demand for the processor resources can significantly use it up. LuSH-101 allows to activate multi-core support, which creates processing threads by generating the sound with the use of many processor cores available in the system. The selection of the **Multi-core support** option in the **Current processing settings** section activates the multi-thread processing in the plug-in and causes an even spread of the load on the available processor cores and decreases the general processor's use.
A multi-core processor is a necessary prerequisite for using this option, otherwise the processor's load may even increase. **Status** informs about the number of available cores in the system, including virtual cores, when the **Multi-core support** option is active.

Default processing settings

Every time a LuSH-101 is loaded in the host application (new instance is created) the **Default processing setting** is used for a **Current processing setting**. **Default processing setting** is stored within a configuration file of **LuSH-101**. This file is saved at the moment of unloading any of active plug-in instances from the host application.

In / Out tab

Allows to modify the default MIDI input channels and / or Audio outputs routing.



Options - In, Out tab

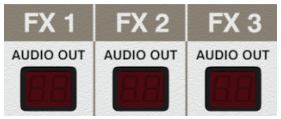
From this location it is possible to change the default MIDI channel for any **Layer**:

Layer's midi channel

default **Audio** output for any **Layer**:

Layer's audio output

or default **Audio** output for any of the three available effect channels:

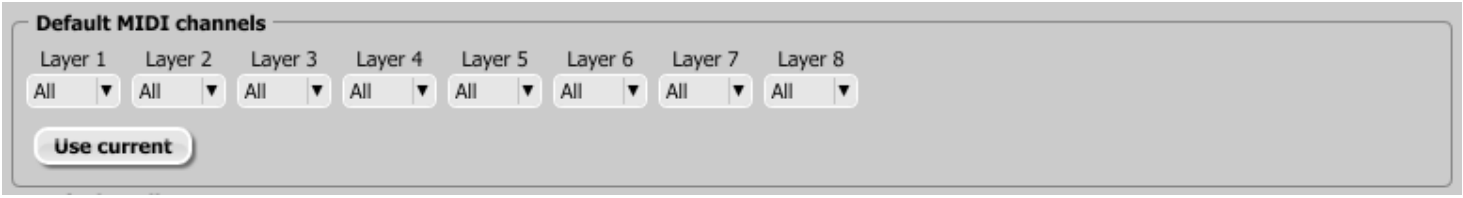


Mixer - FX Channels audio outputs

Values set in the **In / Out** tab are stored within the LuSH-101 configuration file every time the plug-in is unloaded from the host application and recalled when a new instance is created.

Default MIDI channels

This section allows to define the set of default MIDI channels for all **Layers**:



Default MIDI channel section

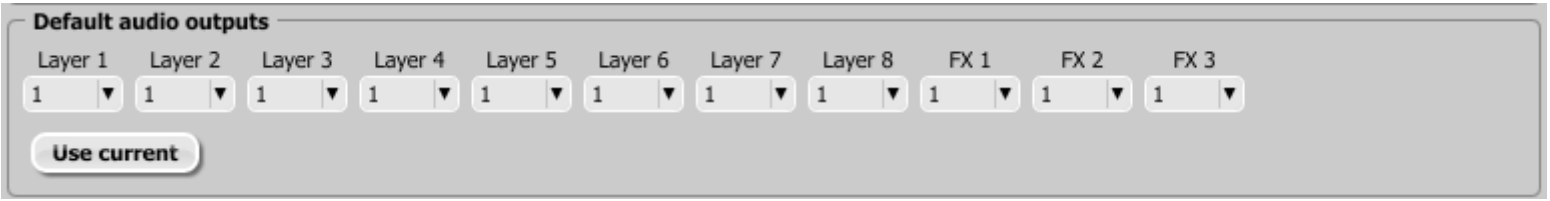
By selecting a value using combo boxes for each **Layer**, we can select a channel from 1 to 16 or **All**, which turns the **Layer** into a mode in which it responds to MIDI messages from all 16 MIDI channels at once.

Pressing the **Use Current** button takes all current MIDI channels set on **Layers** and makes them the default ones.

Layer's midi channel

Default audio outputs

This section allows to configure the set of default **Audio** outputs (from 8 **Layers** + 3 from FX channels on **Mixer**):



Default audio output section

The choice is made using combo boxes. Each of them allows to assign a default **Audio** output (1-11) to a **Layer** or **FX** channel.

Use current button copies current **Audio** outputs configuration (from **Layers** and **Mixer**) and makes it the default one.

Presets tab

In the Presets tab, we have an access to functions allowing certain global actions on preset file.

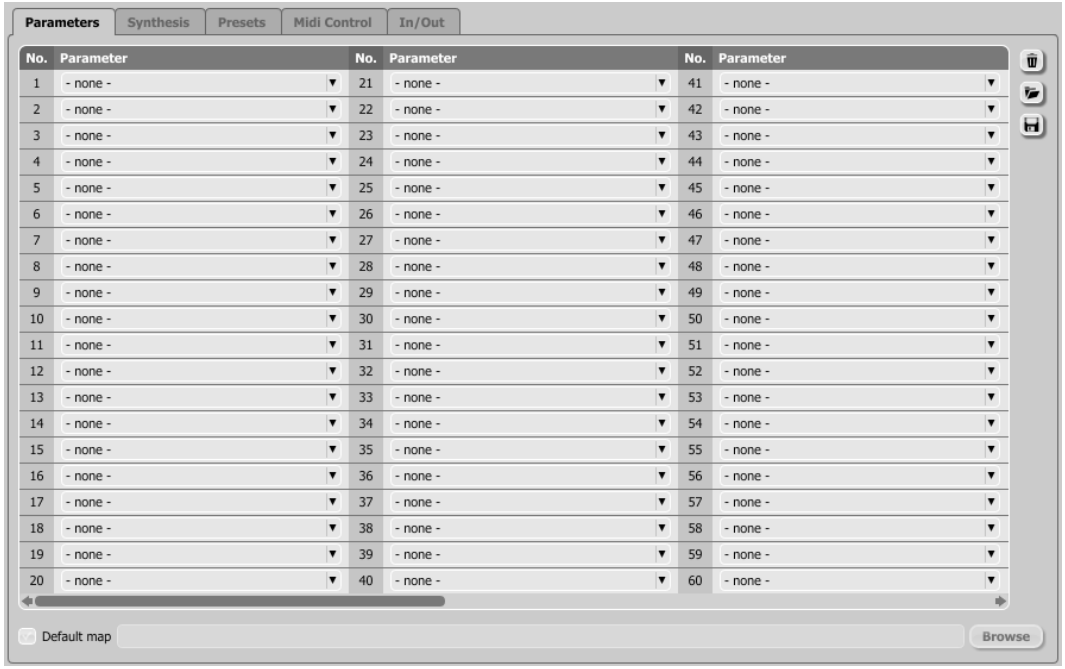
Every preset in LuSH-101 apart from storing the values of sound parameters, stores also certain additional information i.e. author's name or rating. The **Author** box in the **Presets** tab, describes the author's name which is going to be saved within every new instance of the preset. Double-click and edit the box, confirm with enter button to change the value of the box. Any new instance of the preset (**Global**, **Timbre** or one of the send effects) is going to encompass information from that box.

Update presets button updates information about the author in every new instance of the preset created by the user. Other presets, e.g. default presets, presets of other authors, will not be modified.

The **Presets directory** value below the **Author** box displays the path to the present bank on the hard drive.

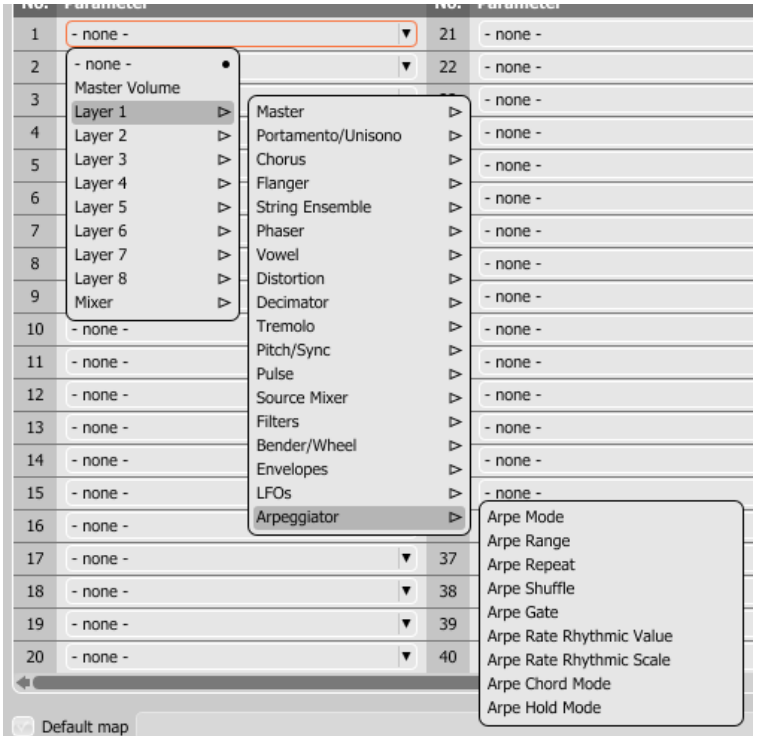
Parameters tab

Due to the fact that the number of sound parameters in LuSH-101 synthesizer is counted in thousands, and the parameters automation assured by the host application accordingly with VST/AU technologies allows to use max. 128 automatable parameters, we can map/assign the chosen internal parameters of the synthesizer on 128 automatable (from the host level) general usage parameters in the **Parameters** tab.



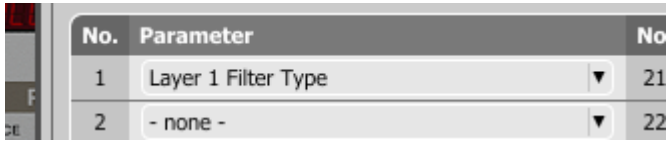
Options - Parameters tab

The parameter map is represented in the form of table, in which the column No. is the number of the general usage automatable parameter and the column **Parameter** is the internal parameter of the synthesizer. Each line assigns an internal parameter to an automatable parameter. We assign an internal parameter using the combo box in the **Parameter** column.



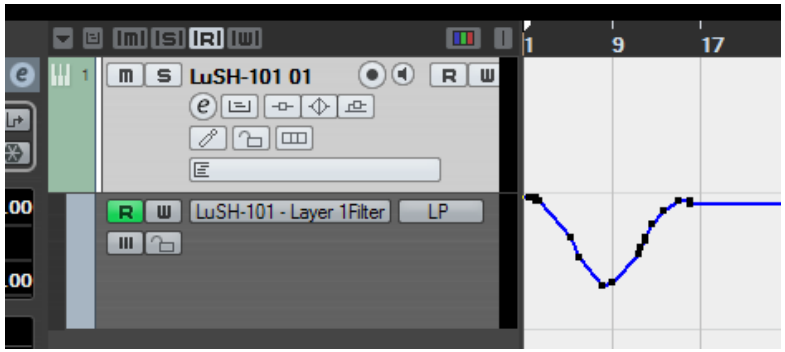
Host parameter assignment

For example, when we assign the general usage parameter No.1 to the internal synthesis parameter **Layer 1** -> **Filters** -> **Filter Type** (filter type for the first layer).



Parameters tab - Parameter mapping

Then we can automate the chosen parameter from the host application level.



Cubase - Layer 1 Filter Type automation

Assignment List Management

On the right side of parameter assignment list there are editorial function buttons available:

- clearing the entire assignment list.
- loading the assignment list from a file (.shhpmap)
- saving the assignment list to a file (.shhpmap)

Note: Assignment list files are compatible with XML format and can be viewed and edited in any text editor.

Default Parameters map

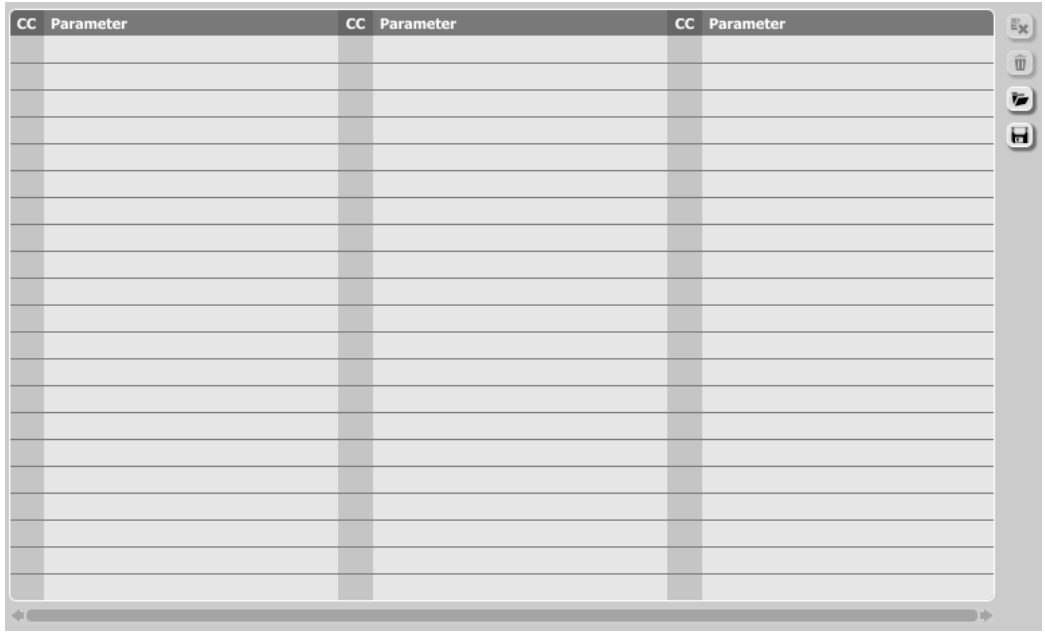
Selecting a default Parameters map:

1. Check the **Default Map** checkbox, which activates the **Browse** button on the right.
2. Click the Browse and select a file with saved **Parameters** map.

After selecting a **Parameters** map the text box on the left from the **Browse** button shows the path to the active map file. A default **Parameters** map is loaded each time when the plug-ins is loaded.

Midi Control tab

LuSH-101 can assign its controls (on GUI) to any MIDI CC (Midi Control Change) event, allowing the control of the plug-in to use external hardware or software controller.



MIDI CC Assignements table and functional buttons

Controls included in the tab:

- **Midi learn mode** - Checkbox which activates **Midi learn** mode.
- **List of active MIDI CC assignments** - containing pairs consisting of MIDI CC number and the name of the plug-in parameter.
- **Default Map** - Checkbox which activates a default MIDI CC map. When the map is activated it will be loaded with creating a new instance of the plug-in.

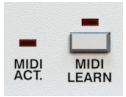
Midi learn

Assigning a LuSH-101' control to the MIDI controller requires:

1. Checking the **Midi Learn mode** checkbox in the **Midi Control** tab:

Midi Control tab - Midi Learn mode checkbox

or pressing the **Midi Learn** button in the **Control** section on GUI:



Control Section - Midi Learn

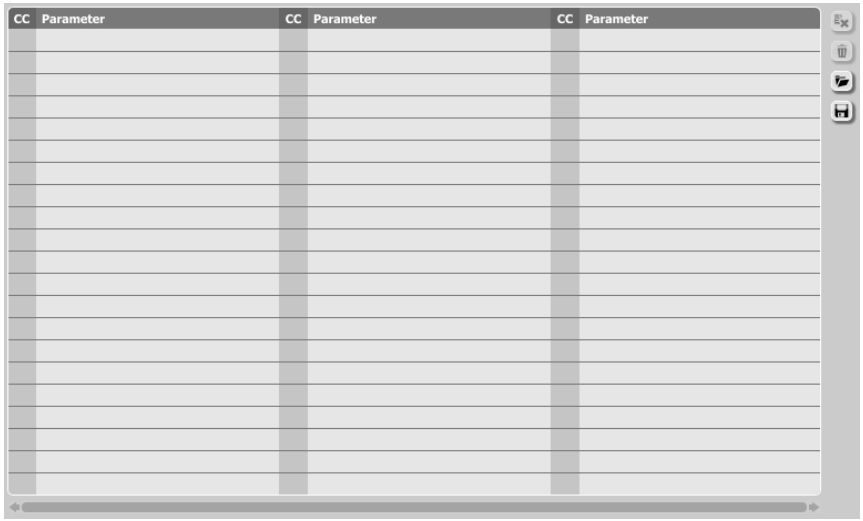
2. In the status bar in the bottom section of GUI a message should appear *"waiting for a controller or parameter movement ..."*:

Status bar

In this mode the plug-in waits for any change in the parameter's value (movement of any control on GUI) and for a movement of any MIDI CC control on the external MIDI controller, which operates on an active MIDI input channel directed to LuSH-101. The order of these actions is irrelevant.

During the above-mentioned actions, the status bar informs about the currently changing values of controls and provides their names.

When a link is established between MIDI CC and the sound parameter, a line is added to the list of MIDI CC assignments.



MIDI CC Assignements table and functional buttons

When a link is established for a controller, it is possible to repeat the operation for next MIDI CC and parameter pairs. Subsequent links will be created and added to the list.

3. When all the needed links are created, uncheck the **Midi Learn Mode** checkbox or press again the **Midi Learn** button on GUI in the **Control** section.

In order to create new links, it is possible to reactivate the **Midi Learn** mode at any time.

The links are always sorted in an ascending manner in relation to the CC column (according to the MIDI CC code).

Unlinking and MIDI link management

On the right side of the link list there are four function buttons located:

Function buttons

- Removes a selected link; selectingany link from the list and clicking on it highlights the selected link. Pressing this button removes the selected link.
- Removes all MIDI CC links.
- Loads a MIDI map from file (.shccmap – LuSH-101 MIDI CC Map).
- Saves all links in the list to a MIDI map file.

Note: MIDI map files are saved in XML format, which enables their edition in any text editor

Default MIDI map

Selecting a default MIDI map:

Setting a default MIDI Map

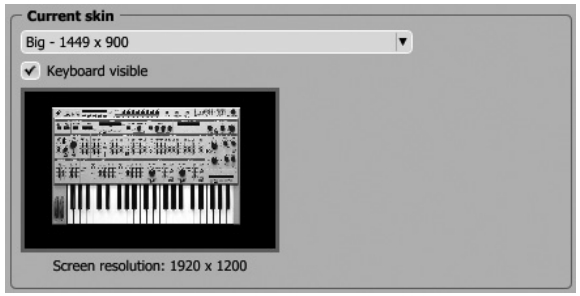
1. Check the **Default Map** checkbox, which activates the **Browse** button on the right.
2. Click the **Browse** button and select a file with a saved MIDI map.

After selecting a MIDI map the text box on the left from the Browse button shows the path to the active map file.
A default MIDI map is loaded each time when the plug-in is loaded.

GUI tab

The GUI tab includes the user interface settings options.

Current skin



GUI tab - Current Skin Section

By using the controls from the **Current Skin** section it is possible to change the window size of the current plug-in instance. The change is performed with the use of the combo box in the upper part of the section, in which two options are available:

- **Big – 1449 x 900** pixels
- **Small –1086 x 675** pixels

Situated below, the **Keyboard visible** checkbox allows to hide the music keyboard, which saves more space on the screen.

The view at the bottom of the **Current Skin** section displays the graphic representation of the performed changes, enabling their comparison with the current system screen resolution.

Default skin

Every time a LuSH-101 is loaded in the host application (new instance is created) the **Default Skin** is used for a **Current Skin** setting. **Default Skin** is stored within a configuration file of **LuSH-101**. This file is saved at the moment of unloading any of active plug-in instances from the host application.

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Contents