

# User guide

**R25 – 21/06/2021**

Firmware: 19.24

Hw: LILLA PCB R5 (Teensy 4.1)

## Overview

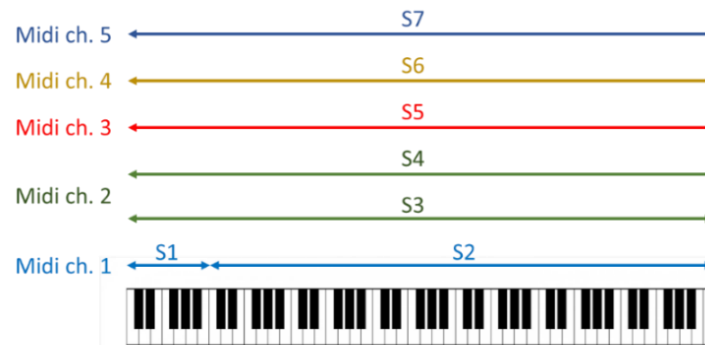
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**LILLA** is a polyphonic (**16 voices**) multitimbral and multi-midi audio sampler, based on **Teensy 4.1**. LILLA stores audio files (**16 bit, 44.1kHz**) in a flash memory (**32MB**), and plays them applying various playing mode, adding an ADSR envelope, changing length and pitch; LILLA allows the sound editing (e.g. slicing) during the performance without interruption, includes virtual multimode VCF, LFO, Delay/Reverb modules together with Resolution and Downsampling effects; LILLA supports midi Pitch-bend, Vibrato and After Touch, also can adopt any midi Control-Change to adjust inner parameters. Up to **8 parts** (Sounds) can be used in the performance, with multi-layered distribution and also multi-midi control; the internal memory can store 25 presets (Sessions) and 90 Sounds.

## Sessions and Sounds

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A **Session** includes up to **8 Sounds**; each Sound is associated to a single midi channel, and mapped on a portion of the keyboard.



LILLA allows to store up to **25 Sessions** and **90 Sounds**; export/import on micro SD card can be used to manage more Sessions/Sounds.

## Audio files

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LILLA plays **mono** audio files in **RAW** (header-less) **format, 16bit** signed PCM, Little-endian, **44100Hz**, named with a number followed by the **RAW** extension: 0.RAW, 1.RAW, etc. The RAW files can be created using a common audio editor (example: Audacity). LILLA imports audio files using a micro SD card, and stores them in a **32MB** flash memory area.

## Input/Output

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- USB micro (power supply, programming)
- 3.5mm stereo jack **MIDI IN**
- 3.5mm stereo jack **LINE OUT**
- **micro SD** slot

On Teensy Audio Board there is another 3.5mm stereo jack output: it's a headphone output. ***WARNING: when LILLA is powered by your computer, DO NOT connect this headphone output to the computer's audio-IN/audio-board, Audio Board may be damaged.***

## Pages, commands and use


### Performance page

This page shows the running Session, which is a set of 1 to 8 Sounds.

On top, the page shows:

- Ses**: Session's number;
- Vol**: master volume;
- LpF**: general Lowpass filter's cut-frequency;
- Res**: general Resolution affect value (bits);
- DownS**: general Downsampling effect value (Hz).

The table in the middle of the page shows the Sounds and some of their parameters:

- S**: number of the Sound in the Session; it can be followed by:
  -  (locked): a *locked* Sound may not be affected/modified by Resolution, Downsampling effects, midi Pitch-bend;
  - P** (protected) : a *protected* Sound cannot be stopped by other Sounds;
- RoK**: Root Key, the key playing the audio file with original pitch;
- From- To**: Sound's range on the keyboard;
- G**: Sound's relative gain.

(Note: all other Sound's attributes are shown on **Sound wave** and **Sound filter** pages)

These are the active commands:

- VOLUME** encoder adjusts master volume;
- encoder-integrated **PANIC** pushbutton immediately stops all sounds;
- SESSION** encoder selects the Session;
- RESOLUTION** encoder adjusts Resolution (from 16bits down to 1bit);
- DOWNSAMPLING** encoder adjusts Downsampling (from 44.1KHz down to 344Hz);
- encoder-integrated **reset** pushbutton sets Resolution to 16bit and Downsampling to 44.1KHz;
- encoder-integrated **toggle** pushbutton toggles between:
  - LOWPASS filter**: 12dB/oct general Low-pass filter cut-frequency;
  - tuning TONE volume** encoder: Tuning-tone volume;
- encoder-integrated **DELAY** pushbutton switches to **Delay** page.

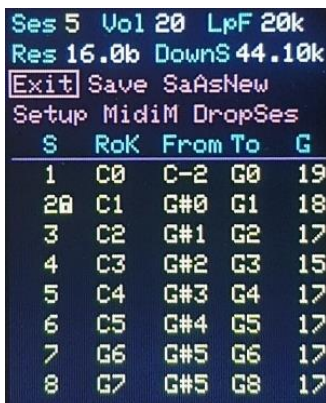
**MENU item** encoder with its integrated **select** pushbutton allows to select:

- SaAsNew**: Save-as-New creates a new Session with running settings;
- Save**: saves all changes made;
- Setup**: switches to **Setup** page;
- MidiM**: switches to **Midi Monitor** page;
- DropSes**: drops this Session (Note: if this is the only Session, cannot be deleted);
- Exit**: drops all changes made to the Session.

Downward, **MENU item** encoder allows to select and edit Sound's parameters, using

- ROOT key** encoder;
- FROM key** encoder;
- TO key** encoder;
- GAIN** encoder;
- encoder-integrated **lock** pushbutton;
- encoder-integrated **protect** pushbutton.

The eight lower **Pushbuttons** allow to:



Ses 5	Vol 20	LpF 20k
Res 16.0b	DownS 44.10k	
[Exit] Save SaAsNew		
Setup MidiM DropSes		
S	RoK	From To G
1	C0	C-2 G0 19
2	C1	G#0 G1 18
3	C2	G#1 G2 17
4	C3	G#2 G3 15
5	C4	G#3 G4 17
6	C5	G#4 G5 17
7	G6	G#5 G6 17
8	G7	G#5 G8 17

- **first click:** switches to **Sound wave** page, which shows Sound's waveform and other Sound's properties;
- **second click:** switches to **Sound Filter** page, which shows Sound's dedicated multimode VCFs and LFOs parameters;
- **third click:** returns to **Performance** page.

#### LED

Notice that each time a Sound is played, on the left end of the display an LED goes on; color is **GREEN** if **Tuning tone** is OFF, otherwise color is **RED**.

#### Sound wave page

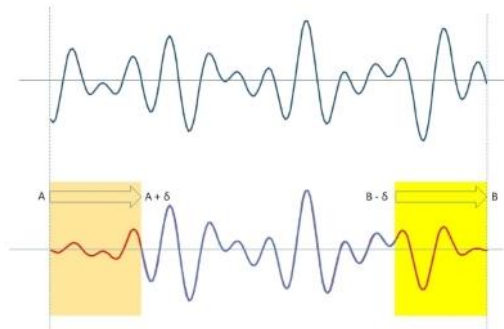
Each **Sound** is made with a slice of a RAW audio file, from **A** sample to **B** sample; **Sound wave** page shows the **A-B** waveform and other parameters described in this section.

These are the active commands:

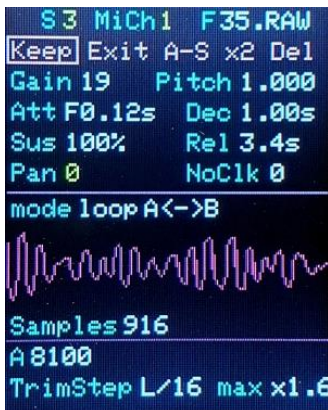
- **FILE/MIDI CHANNEL** encoder allows to select the RAW audio file (**F**) or MIDI channel (**MiCh**); the encoder-integrated **toggle** pushbutton toggles between one or the other functionality;
- **GAIN** encoder adjusts Sound relative **Gain** value;
- **PITCH/PAN** encoder adjusts Sound fine-**Pitch** or L/R **Pan**; the encoder-integrated **toggle** pushbutton toggles between one or the other functionality;
- encoder **ATTACK**, **DECAY**, **SUSTAIN**, **RELEASE** encoders adjust ADSR values (**Att**, **Dec**, **Sus**, **Rel** on display);
- encoder-integrated **fast/slow** pushbutton select the shape of **Attack** curve;
- **play MODE** encoder allows to select the play-mode (**mode**): **once A→B**, **once B→A**, **loop A→B**, **loop B→A**, **loop A↔B**, **loop B↔A**;

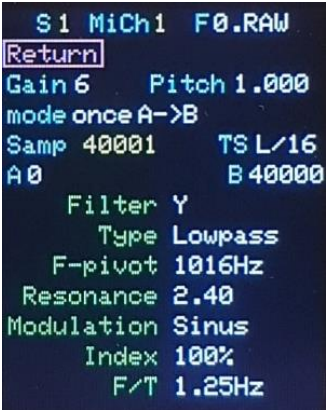
The following commands are related to file trimming/adjusting:

- **A sample**, **B sample** encoders adjust the **A-B** slice to be played, which is also graphically displayed; on display, **Samples** shows the total number of samples in the slice;
- encoder-integrated **slower** and **faster** pushbuttons are used to select the trimming speed/step (**TrimStep** on display); the displayed value can be:
  - a simple number **1**, **10**, **100**, **1K**, **10K**;
  - **10s**, **100s** : **A** point gradually slides using **A sample** encoder;
  - **L/16**: trimming step is **Samples/16**;
- **NOCLICK** encoder adjusts a **cross-fade mix** window involving a certain number (**NoClk**) of samples, on both extremes of the slice; this feature is active with modes **loop A→B**, **loop B→A** and allows to cancel/reduce the loop "click";


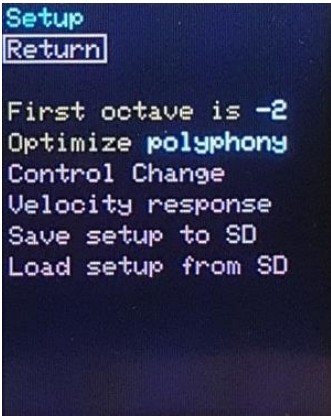





- encoder-integrated **solo** pushbutton applies "solo mode" for this Sound.



	<p>On the lower-right part of d display, <b>max</b> (which can be <b>x1.6</b>, <b>x3</b>, <b>x24</b>) shows the maximum pitch allowed for the Sound; this parameter is function of the slice length and the <b>optimization</b> (<b>Optimize</b>) mode selected in <b>Settings</b> page.</p> <p><b>MENU item</b> encoder with its integrated <b>select</b> pushbutton allows to select:</p> <ul style="list-style-type: none"> <li>• <b>Exit</b>: back to <b>Performance</b> page discarding all changes made;</li> <li>• <b>Keep</b>: back to <b>Performance</b> page keeping all changes made;</li> <li>• <b>AB/AS</b> : selects the slicing mode: <ul style="list-style-type: none"> <li>◦ <b>AB</b> : <b>A sample</b> encoder adjusts <b>A</b> sample, <b>B sample</b> encoder adjusts <b>B</b> sample;</li> <li>◦ <b>AS</b> : <b>A sample</b> encoder adjusts <b>A</b> sample, <b>B sample</b> encoder adjusts the number of samples <b>S</b>;</li> </ul> </li> <li>• <b>Del</b>: deletes delete the Sound;</li> <li>• <b>x2</b>: duplicates the Sound; used to add a new Sound to the Session.</li> </ul> <p>By clicking a second time on the same round pushbutton, the <b>Sound filter</b> is displayed.</p> <p>By clicking on a different pushbutton, the corresponding <b>Sound Wave</b> page (if exists in the Session) will be displayed.</p> <p>The following command, described in <b>Performance</b> page, can also be used:</p> <ul style="list-style-type: none"> <li>• <b>DELAY</b></li> <li>• <b>PANIC</b></li> <li>• <b>RESOLUTION</b></li> <li>• <b>DOWNSAMPLING</b></li> <li>• <b>LOW-PASS FILTER/TUNING TONE</b></li> </ul>
	<p><b>Sound filter</b> page</p> <p>Each <b>Sound</b> has its <b>virtual multimode VCF</b>, whose cut-off frequency can be modulated (<b>Modulation</b>) around a central value (<b>F-pivot</b>); modulation can be chosen among:</p> <ul style="list-style-type: none"> <li>• <b>Rising</b> curve;</li> <li>• <b>Falling</b> curve;</li> <li>• <b>Sinus</b> LFO;</li> <li>• <b>AT-Sinus</b>: midi After Touch Channel message + sinus LFO.</li> </ul> <p><b>MENU item</b> encoder and <b>VALUE</b> encoder allow to select and adjust:</p> <ul style="list-style-type: none"> <li>• <b>Filter</b>: used (<b>Y</b>), not used (<b>N</b>);</li> <li>• <b>Type</b>: type of filter (<b>Lowpass</b>, <b>Highpass</b>, <b>Bandpass</b>, <b>Notch</b>);</li> <li>• <b>F-pivot</b>: central cut-off frequency of the filter;</li> <li>• <b>Resonance</b>: filter's Q-factor;</li> <li>• <b>Modulation</b>: <b>none</b>, <b>Rising</b>, <b>Falling</b>, <b>Sinus</b>, <b>AT-Sinus</b>;</li> <li>• <b>Index</b>: modulation index;</li> <li>• <b>F/T</b>: shows a <b>frequency</b> if modulation is Sinus, AT-Sinus; shows <b>time</b> in other cases.</li> </ul> <p>By clicking a second time on the same round pushbutton, the <b>Performance</b> is displayed.</p> <p>By clicking on a different pushbutton, the <b>Sound wave</b> of the corresponding Sound (if exists in the Session) will be displayed.</p> <p>The following commands, described in <b>Sound wave</b> page, can also be used:</p> <ul style="list-style-type: none"> <li>• <b>FILE</b></li> <li>• <b>GAIN</b></li> <li>• <b>PITCH</b></li> </ul>



	<ul style="list-style-type: none"> <li>• <b>play MODE</b></li> <li>• <b>A sample</b></li> <li>• <b>B sample</b></li> </ul> <p>The following commands, described in <b>Performance</b> page, can also be used:</p> <ul style="list-style-type: none"> <li>• <b>DELAY</b></li> <li>• <b>PANIC</b></li> <li>• <b>RESOLUTION</b></li> <li>• <b>DOWNSAMPLING</b></li> <li>• <b>LOW-PASS FILTER/TUNING TONE</b></li> </ul>
	<p><b>Delay</b> page</p> <p>LILLA has a couple of <b>delay/reverb</b> blocks, one per output channel; each Sound can separately be routed to the couple of delay/reverb; the delay value (expressed in samples) can be modulated by a couple (one per delay) of sinus LFOs, or by the same incoming audio signal.</p> <p>The 1 to 8 lower <b>Pushbuttons</b> allow to route (<b>Y</b>) or not (<b>N</b>) a Sound to the delay effect.</p> <p>On this page, the display shows the following parameters which can be modified using <b>MENU item</b> encoder (item selection) and <b>VALUE</b> encoder (value adjusting):</p> <ul style="list-style-type: none"> <li>• <b>Wet</b>: amount of delayed signal sent to a feedback mixer;</li> <li>• <b>Delay</b>: delay value in samples; from 0 up to 5800 sample (131ms);</li> <li>• <b>D(L-R)</b>: delay values delta, between left delay-block and right delay-block;</li> <li>• <b>Mod</b>: delay modulation signal: <b>none</b>, <b>sinus</b> (LFO), (incoming) <b>signal</b>;</li> <li>• <b>Index</b>: modulation depth;</li> <li>• <b>Freq</b>: rate of the <b>sinus LFO</b> modulation;</li> <li>• <b>F(L-R)</b>: delta rate between left LFO and right LFO.</li> </ul> <p>By clicking either the encoder-integrated pushbutton <b>DELAY</b> or the encoder-integrated <b>select</b> pushbutton, the <b>Performance</b> page will be displayed.</p>
	<p><b>Setup</b> page</p> <p>This page allows to set parameters and do some actions by using the <b>MENU item</b> encoder, the encoder-integrated <b>select</b> pushbutton, and <b>VALUE</b> encoder:</p> <ul style="list-style-type: none"> <li>• <b>First octave is</b>: this number is the octave corresponding to note-numbers 0-11; value can be chosen among <b>-2, -1, 0</b>;</li> <li>• <b>Optimize</b>: describes LILLA's behave for Sounds with a sound-slice longer than 675 samples (15ms):       <ol style="list-style-type: none"> <li>1. <b>polyphony</b>: LILLA will allow up to <b>16 voices</b> for these Sounds, and will allow a maximum pitch <b>1.6</b> (8 semitones beyond the Root Key);</li> <li>2. <b>extension</b>: LILLA will allow up to <b>12 voices</b> to these Sounds, with a maximum pitch <b>3.0</b> (19 semitones beyond the Root Key); when Sounds use a sound-slice shorter than 675 samples, LILLA allows <b>16 voices</b> and a maximum pitch <b>24.0</b>;</li> </ol> </li> <li>• <b>Control Change</b>: clicking on <b>select</b> the <b>Control Change</b> page is shown;</li> <li>• <b>Velocity Response</b>: clicking on <b>select</b> the <b>Velocity Response</b> page is shown;</li> <li>• <b>Save setup to SD</b>: clicking on <b>select</b>, all settings (Sessions, Sounds, Control Change configs, etc.) will be saved in <b>/LILLASET/LILLAOLD.TXT</b> file in micro SD card;</li> </ul>

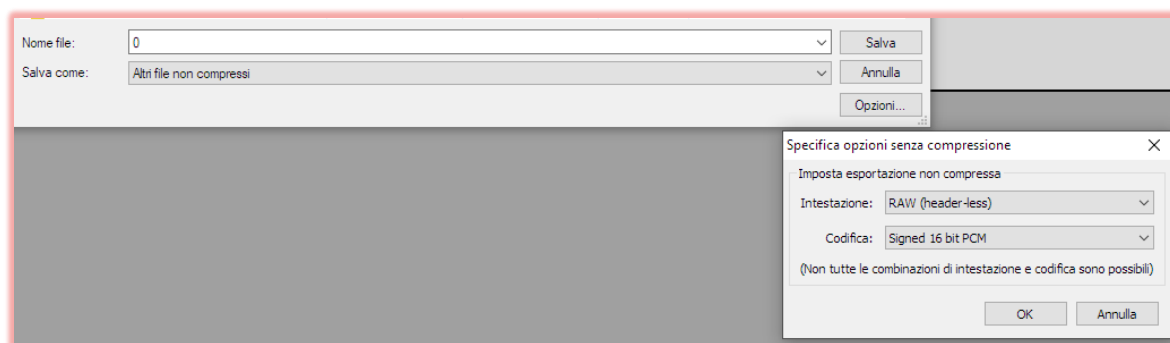
	<ul style="list-style-type: none"> <li><b>Load setup from SD:</b> clicking on <b>select</b>, all settings (Sessions, Sounds, Control Change configs, etc.) will be deleted and replaced with <b>/LILLASET/LILLA.TXT</b> settings file;</li> </ul> <p>By choosing <b>Return</b> and clicking on <b>select</b> the <b>Performance</b> page will be shown.</p>
	<p><b>Control Change</b> page</p> <p>This page allows to define (in <b>autolearning</b> also) a set of Control Change commands (CC) used to change Sound's gain and the general Lowpass cut-frequency.</p> <p>All CC values can be set by using the <b>MENU item</b> encoder and <b>VALUE</b> encoder.</p> <p>By choosing <b>Return</b> and clicking on <b>select</b> all settings on this page will be saved and the <b>Setup</b> page will be displayed.</p>
	<p><b>Velocity response</b> page</p> <p>LILLA stores n.2 <b>Velocity in/ Velocity out</b> response curves. This page allows to edit these curves:</p> <ul style="list-style-type: none"> <li>set the response curve to be used by using the <b>VALUE</b> encoder;</li> <li>Adjust the curve by using <b>velocity IN</b> and <b>velocity OUT</b> encoders.</li> </ul> <p>By using the <b>MENU item</b> encoder and its integrated <b>select</b> pushbutton:</p> <ul style="list-style-type: none"> <li><b>Use:</b> use this curve;</li> <li><b>Save&amp;use:</b> saves modifies and use this curve;</li> <li><b>NoSave&amp;use:</b> deletes all modifies and use this curve;</li> </ul> <p>then the <b>Setup</b> page will be shown.</p>
	<p><b>MIDI monitor</b> page</p> <p>This tool displays the last incoming midi message.</p>

## Making RAW audio files using Audacity

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LILLA requires headerless, mono, 16bit, 44100Hz RAW files, named from **0.RAW** up to **255.RAW**.

Using Audacity, a mono 44100Hz file can be exported into RAW: from menu "**File**", choose "**Audio Export...**" then "**Other uncompressed files**" and in "**Options**" choose **Header: "RAW (header-less)"** e **Coding: "Signed 16 bit PCM"**.



## How to import RAW files

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1. Format **FAT-32** a micro SD card;
2. in the root directory, create the folder **\LILLARAW**;
3. copy and paste the RAW files in this folder; the sum of RAW files must not exceed **32MB**; it's recommended to provide a file **0.RAW** lasting at least 1 sec, it will be useful if/when a **settings reset** will be done;
4. power-on LILLA while keeping the **(files import)** pushbutton down, until the cover page is displayed.

Notice: by copying RAW files from micro SD card, all RAW files stored in LILLA will be DELETED and replaced with the files copied.

## Setups/settings save and import

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All setups and settings (excluded the RAW files) can be saved/imported by using the micro SD card, from **Setup** page. This functionality can also be useful in order to create an archive of setups.

## Settings reset

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LILLA can be reset, deleting all Sessions/Sounds; to do this power-on LILLA while keeping the **(settings reset)** pushbutton down until the **Performance** page is displayed; all existing Sessions and Sounds will be deleted, **Session 0** will be created with a single Sound using file 0.RAW.



# How to update the firmware

The updated user guide and firmware can be downloaded from:

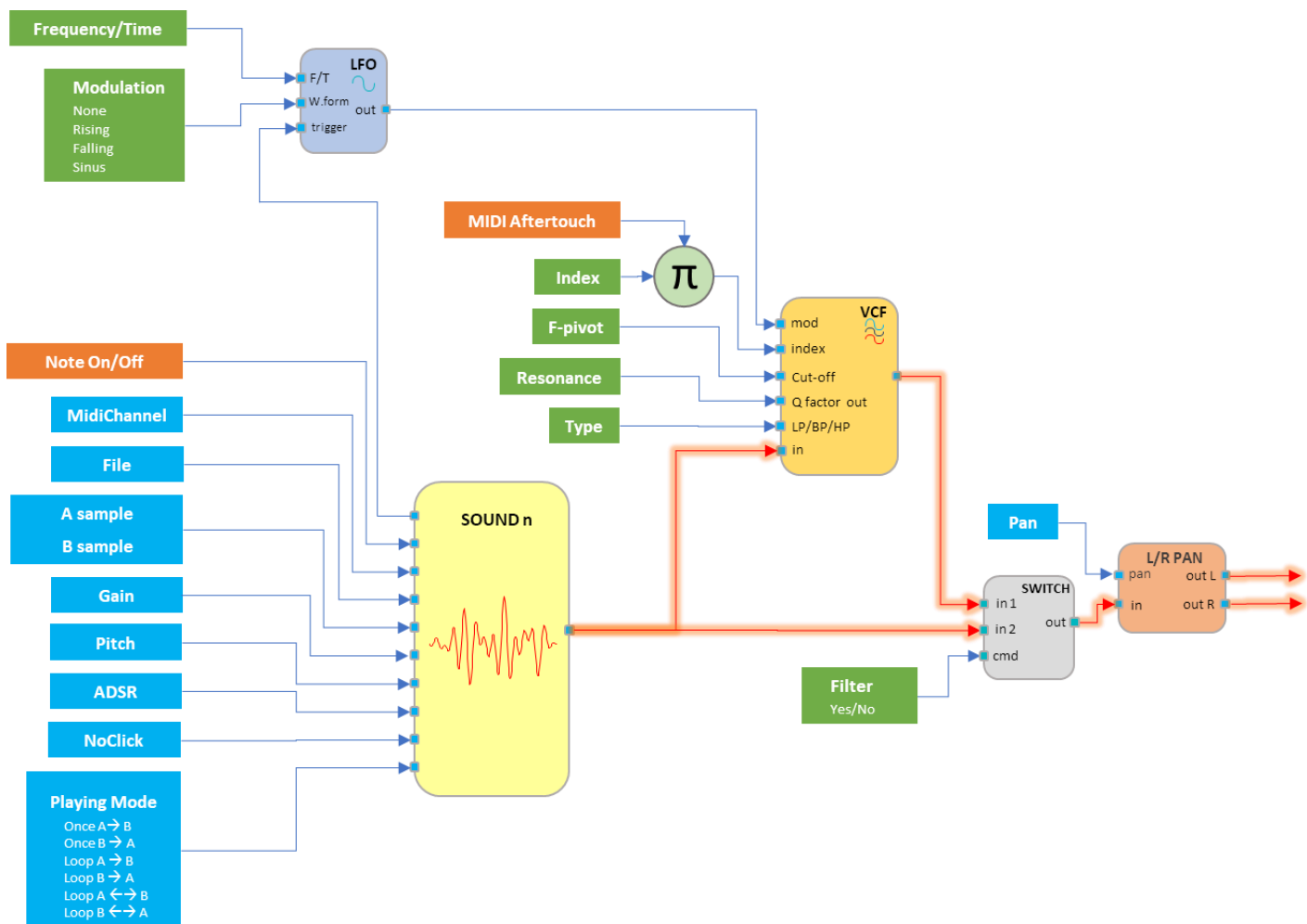
**[github.com/SandroGrassia/LILLA\\_audio\\_sampler](https://github.com/SandroGrassia/LILLA_audio_sampler).**

Updating firmware requires a computer with the recommended versions of **Arduino IDE** and **Teensyduino** installed:

- 1) download and install Arduino IDE (<https://www.arduino.cc/en/software>);
- 2) download and install Teensyduino ([https://www.pjrc.com/teensy/td\\_download.html](https://www.pjrc.com/teensy/td_download.html));
- 3) download the last firmware file **Lilla\_Arduino\_T41\_xxxxxxx.hex** ([github.com/SandroGrassia/LILLA\\_audio\\_sampler](https://github.com/SandroGrassia/LILLA_audio_sampler))
- 4) connect LILLA to the computer, using a data-transfer capable USB cable;
- 5) run Teensyduino (file name is **teensy.exe** and path is: \Arduino\hardware\tools\teensy.exe), select **File** → **Open Hex File** and choose the firmware file;
- 6) on Teensyduino, click the round icon "**Auto**" which becomes bright green;
- 7) on LILLA, click on the encoder-integrated **program** pushbutton: Teensyduino will upload the new firmware.

## Sound filter wiring

The following schematic shows the Sound-associated multimodal filter interconnections



## Delay/Reverb wiring

The following schematic shows the couple of general Delays and general Low-pass filters

