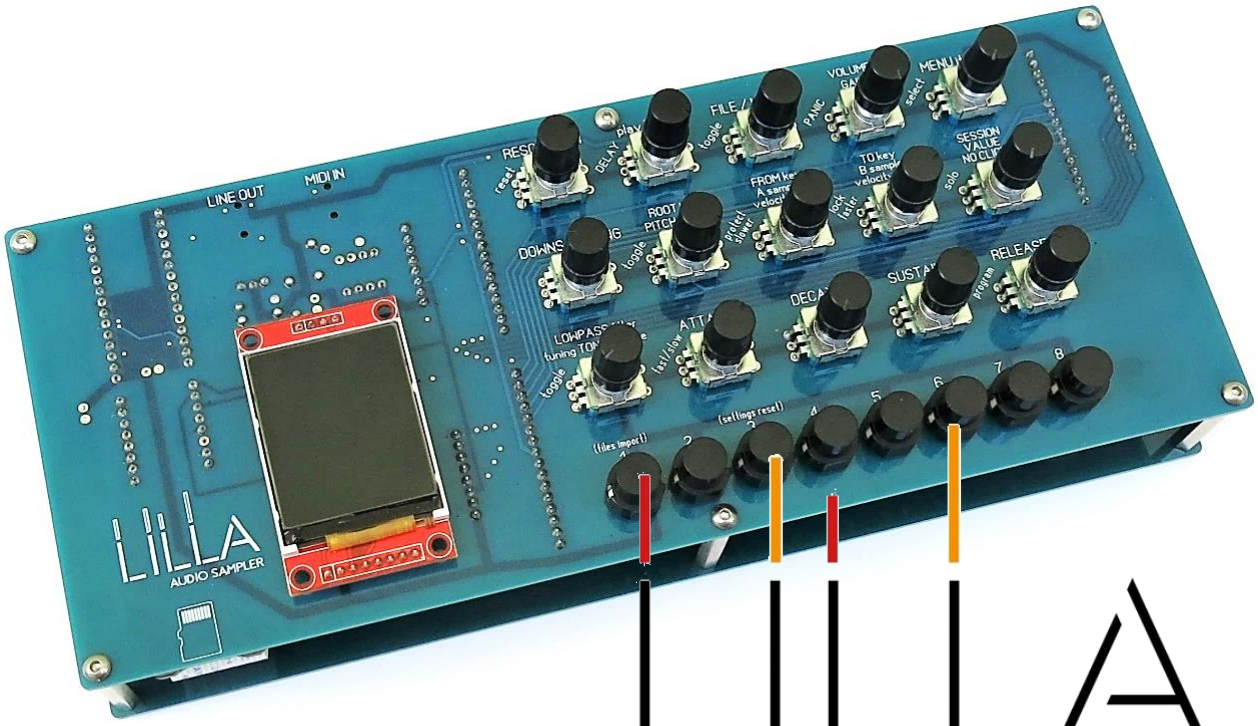


LILLA
AUDIO SAMPLER

User guide

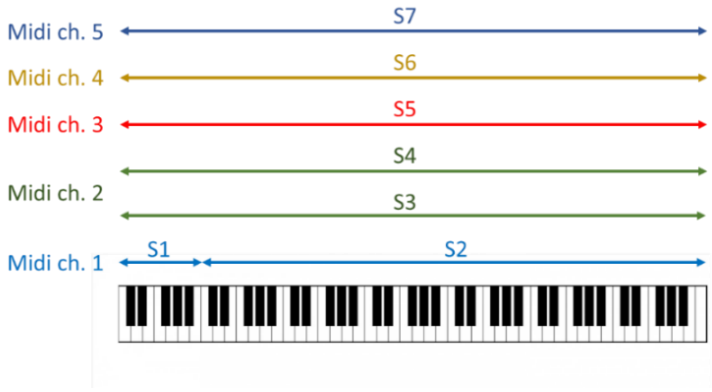
R25 – 21/06/2021
Firmware: 19.24
Hw: LILLA PCB R5 (Teensy 4.1)

Overview

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

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

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

- 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.

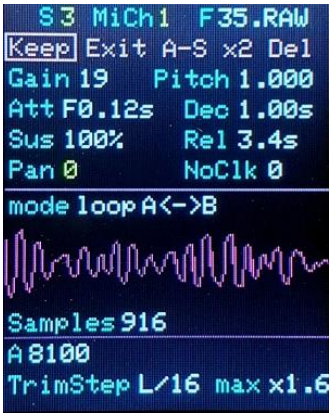
Downward, **MENU item** encoder allows to select and edit Sound's parameters, using
- **ROOT key** encoder;
- **FROM key** encoder;
- **TO key** encoder;
- **GAIN** encoder;
- encoder-integrated **lock** pushbutton;
- encoder-integrated **protect** pushbutton.

The eight lower **Pushbuttons** allow to:

- **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

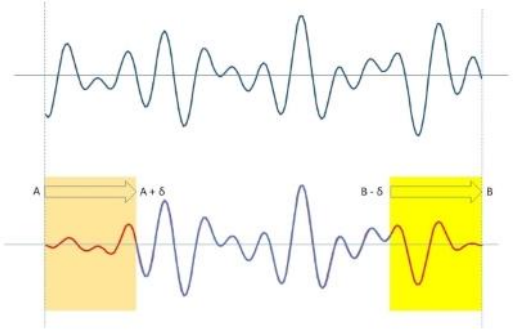
Each **Sound** is made with a slice of a RAW audio file, from **A** sample to **B** sample; **Sound wave** page shows the **A-B** waveform and other parameters described in this section.

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:

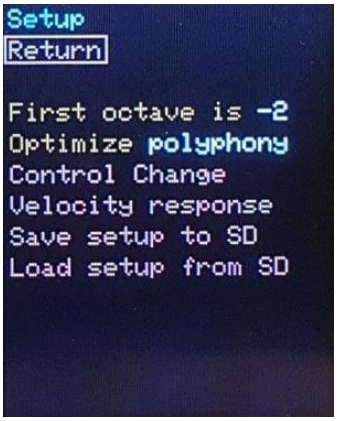
- **A sample**, **B sample** encoders adjust the **A-B** slice to be played, which is also graphically displayed; on display, **Samples** shows the total number of samples in the slice;
- encoder-integrated **slower** and **faster** pushbuttons are used to select the trimming speed/step (**TrimStep** 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";

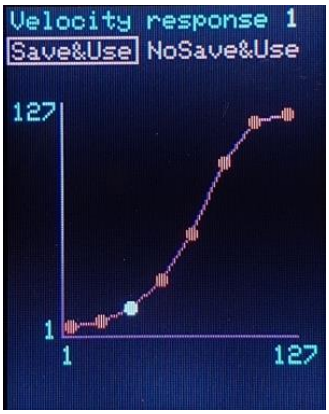


- encoder-integrated **solo** pushbutton applies "solo mode" for this Sound.

	On the lower-right part of d display, **max** (which can be **x1.6**, **x3**, **x24**) shows the maximum pitch allowed for the Sound; this parameter is function of the slice length and the **optimization** (**Optimize**) mode selected in **Settings** page.
	
	MENU item encoder with its integrated **select** pushbutton allows to select:
	• **Exit**: back to **Performance** page discarding all changes made;
	• **Keep**: back to **Performance** page keeping all changes made;
	• **AB**/**AS** : selects the slicing mode:
	  ○ **AB** : **A sample** encoder adjusts **A** sample, **B sample** encoder adjusts **B** sample;
	  ○ **AS** : **A sample** encoder adjusts **A** sample, **B sample** encoder adjusts the number of samples **S**;
	• **Del**: deletes delete the Sound;
	• **x2**: duplicates the Sound; used to add a new Sound to the Session.
	
	By clicking a second time on the same round pushbutton, the **Sound filter** is displayed.
	By clicking on a different pushbutton, the corresponding **Sound Wave** page (if exists in the Session) will be displayed.
	
	The following command, described in **Performance** page, can also be used:
	• **DELAY**
	• **PANIC**
	• **RESOLUTION**
	• **DOWNSAMPLING**
	• **LOW-PASS FILTER/TUNING TONE**

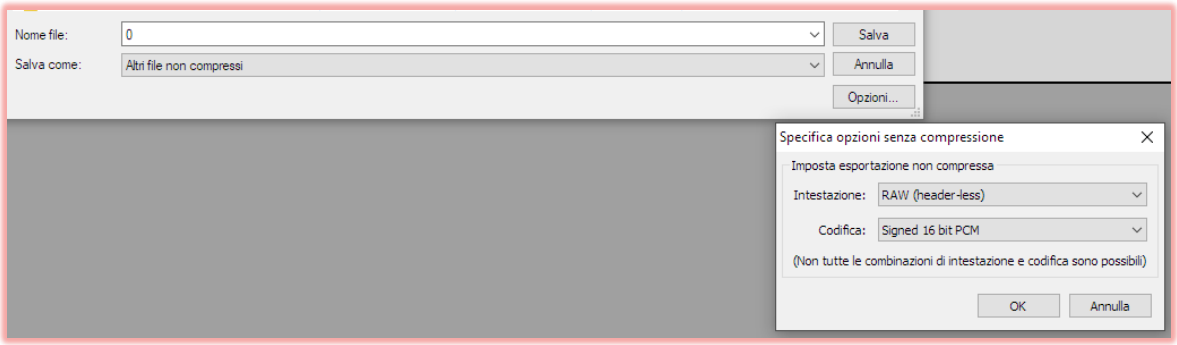
	**Sound filter page** Each **Sound** has its **virtual multimode VCF**, whose cut-off frequency can be modulated (**Modulation**) around a central value (**F-pivot**); modulation can be chosen among: • **Rising** curve; • **Falling** curve; • **Sinus** LFO; • **AT-Sinus**: midi After Touch Channel message + sinus LFO. **MENU item** encoder and **VALUE** encoder allow to select and adjust: • **Filter**: used (**Y**), not used (**N**); • **Type**: type of filter (**Lowpass**, **Highpass**, **Bandpass**, **Notch)**; • **F-pivot**: central cut-off frequency of the filter; • **Resonance**: filter's Q-factor; • **Modulation**: **none**, **Rising**, **Falling**, **Sinus**, **AT-Sinus**; • **Index**: modulation index; • **F/T**: shows a **frequency** if modulation is Sinus, AT-Sinus; shows **time** in other cases. By clicking a second time on the same round pushbutton, the **Performance** is displayed. By clicking on a different pushbutton, the **Sound wave** of the corresponding Sound (if exists in the Session) will be displayed. The following commands, described in **Sound wave** page, can also be used: • **FILE** • **GAIN** • **PITCH**

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

	• **Load setup from SD**: clicking on **select**, all settings (Sessions, Sounds, Control Change configs, etc.) will be deleted and replaced with **/LILLASET/LILLA.TXT** settings file; By choosing **Return** and clicking on **select** the **Performance** page will be shown.
	**Control Change page** This page allows to define (in **autolearning** also) a set of Control Change commands (CC) used to change Sound's gain and the general Lowpass cut-frequency. All CC values can be set by using the **MENU item** encoder and **VALUE** encoder. By choosing **Return** and clicking on **select** all settings on this page will be saved and the **Setup** page will be displayed.
	**Velocity response page** LILLA stores n.2 **Velocity in/ Velocity out** response curves. This page allows to edit these curves: • set the response curve to be used by using the **VALUE** encoder; • Adjust the curve by using **velocity IN** and **velocity OUT** encoders. By using the **MENU item** encoder and its integrated **select** pushbutton: • **Use**: use this curve; • **Save&use**: saves modifies and use this curve; • **NoSave&use**: deletes all modifies and use this curve; then the **Setup** page will be shown.
	**MIDI monitor page** This tool displays the last incoming midi message.

Making RAW audio files using Audacity

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

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

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

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

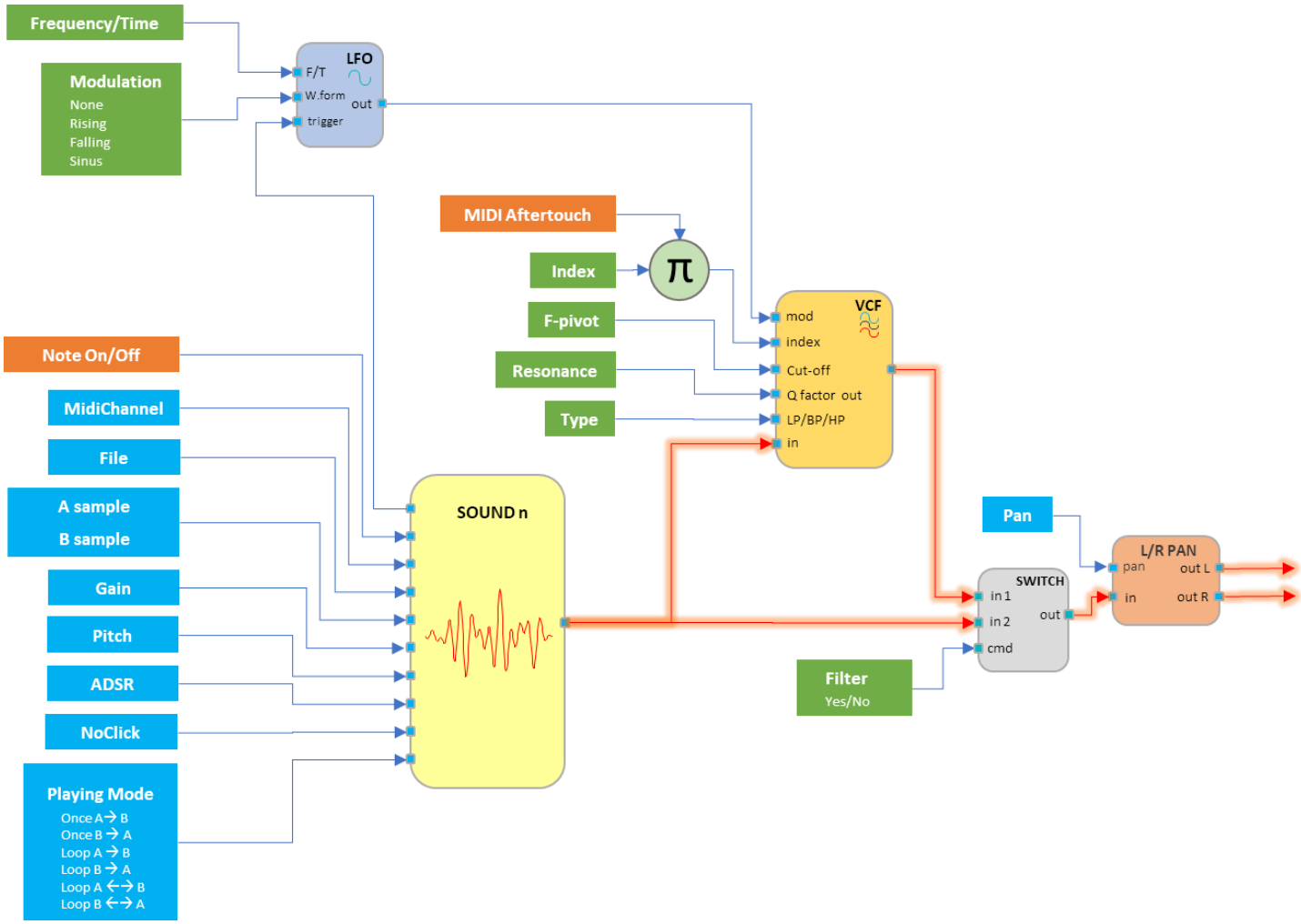
The updated user guide and firmware can be downloaded from:
github.com/SandroGrassia/LILLA_audio_sampler.

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);
3) download the last firmware file **Lilla_Arduino_T41_xxxxxxx.hex** (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 wiring diagram



Delay/Reverb wiring

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