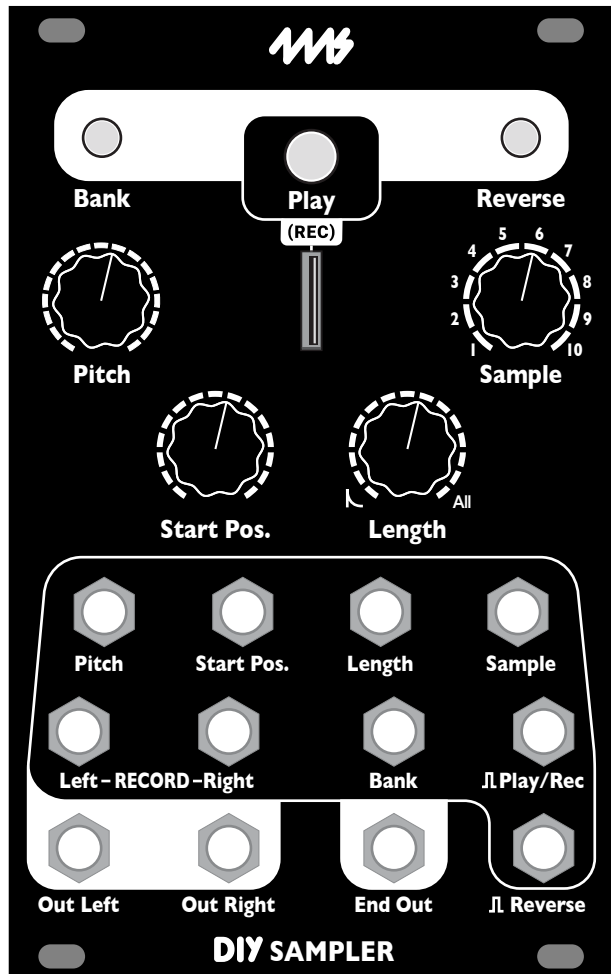# Sampler

4ms Company

User Manual 1.0a – Nov 15, 2023
for firmware v1.0

The **Sampler** is a high fidelity, two-channel stereo audio recorder and playback module. The **Sampler** can record and play back high quality stereo WAV files. A maximum of 600 samples can be loaded at one time from the removable microSD card, in a variety of formats up to 96kHz/32-bit/stereo WAV. All sample parameters (pitch, sample file selection, length, bank, and start position) are CV controllable, and trigger jacks for play/record, and reverse allow for synchronization.

- Stereo playback channels can play any of 600 samples
- Recording creates stereo WAV files directly onto microSD Card for immediate use
- Extremely low noise, high fidelity design
- Plays a variety of WAV files up to 32-bit/96kHz
- Records at 24-bit or 16-bit/48kHz (future firmware will support up to 96kHz)
- Intelligent file system makes loading large sample libraries easy by organizing banks into folders
- CV and controls for 1V/oct tracking, Start Position, Length, Sample selection, Bank, Reverse and Play/Record
- Includes microSD card with Sample Pack and SD Card adaptor

Table of Contents

Setting up your Sampler

1. Remove the Sampler from the box and anti-static bag.
2. Connect the larger end of the power cable to a 16-pin Eurorack power header on your power supply distribution system, with the red stripe towards the -12V. The other end of the power cable is a 10-pin connector which should be connected to the **Sampler** so the red stripe on the power cable is orientated towards the bottom of the module (the bottom is marked by a white stripe and "-12V"). Note: The **Sampler** is reverse-polarity protected, but other modules being incorrectly connected could damage anything on the power bus.
3. **Backup your microSD card before you first power the Sampler on!** We recommend you perform a full backup of the microSD card by using a computer (use the included SD card adaptor if needed). This will be useful if the card ever becomes damaged or you wish to restore the **Sampler** to the original factory settings and samples.
4. Securely screw the **Sampler** to the rails of your case. Power the system on.
5. When the **Sampler** first turns on, it will scan the SD Card for WAV files. The lights will flash purple, yellow, and other colors. When the lights stop flashing and just the Bank light is on, the **Sampler** is ready to play.

Never remove the microSD card when playing or recording!

Overview

- Up to 600 samples loaded at one time (10 samples per bank)
- Includes a microSD card with over 200 samples
- Extremely quiet, low noise and low jitter design
- Firmware can be updated by playing an audio file into the **Sampler**

Playback channel:
- Mono or stereo output through **Out Left** and **Out Right** jacks
- **Play** button/trigger jack: Tapping the button or receiving a trigger starts/re-starts the sample
  - When **Length** is set to "All", the **Play** button starts/stops the sample (set in *System Settings File*, see page 15)
- **Sample** CV/knob: selects a sample from the bank
- **Pitch** CV/knob: playback pitch (-9 to +4 octave range)
  - Tracking: +/- 0.4cents over four octave range (C0–C3)
  - **Pitch** jack can be calibrated to an external keyboard or sequencer
- **Start Pos** CV/knob: position in the sample to begin playback (loop start point)
- **Length** CV/knob: playback time (loop end point)
  - **Length** *knob at max*: entire file is played
  - **Length** *knob 50%-99%:* 200ms - 5s of the sample is played (beginning at the Start Position)
  - **Length** *knob <50%*: Percussive decay envelope is applied to the playback (attack-only envelope if playing Reverse)
  - **Length** *<1%*: Tiny grains are played (can be used to sweep through sample file data manually)
- **Reverse** button/jack: toggles forward/backwards
- **Bank** button/jack: selects channel's bank
  Tip: Hold **Bank** and turn the **Sample** and/or **Length** knob for fast selection of bank
- **Reverse**+**Start Pos** button/knob combo allows for setting volume of each channel independently.
- Maximum file size for playback: 4GB per file (6.2 hours per file at 48kHz/16b/stereo)

Recording channel:
- Recording initiated by button or trigger
- Record into any sample slot in any bank
  - Every recording is saved as a WAV file on the microSD Card
- Recording can be disarmed to prevent accidental recordings
- 48kHz/16-bit or 48kHz/24-bit stereo recording. Future firmware versions will support 96kHz
- "Unlimited" recording time (records continuously until card is full)
  - 256GB card = 16+ days of continuous recording (~400 hours)
  - Long recordings are split into 4GB WAV files

File Organization:
- Includes a high-speed 16GB microSD card, loaded with over 200 samples
- Record new samples directly to banks with the **Record** input jacks
- Load WAV files using a computer and the intuitive bank/color organization system
  - Drag folders of WAV files onto the microSD card, and each folder will become a bank
  - No need to rename WAV files
  - Folders starting with a color name will be loaded into that color bank
    - Example "Blue - Frooty Loops" will load into the Blue bank
  - Sub-folders are ignored, only folders in the root directory are scanned for WAV files
- Works best with "UHS Speed Class 3" cards with this symbol printed on the card: $\lfloor 3 \rfloor$

Electrical and Mechanical Specifications

- 16HP Eurorack format module
- 0.98" (25mm) maximum depth
- 10-pin Eurorack power header
- Power consumption (maximums):
  - +12V@145mA; -12V@39mA; +5V rail not used
- Audio **Out** jacks
  - Out : File = -0.1dB max deviation from 20Hz - 10kHz; -3dB @ 20kHz
  - 21V peak-to-peak = full scale
- Audio **RECORD** jacks
  - File : In = max -0.1dB 20Hz-6kHz, -0.9dB @ 6kHz - 20kHz
  - Out : In = max -0.1dB 20Hz-10kHz, -0.7dB @ 15kHz, -3dB @ 20kHz
  - 21V peak-to-peak maximum before clipping
  - Noise (unpatched In jacks): -84.3dB
- **End Out** jack
  - +8V trigger pulse
- **Pitch** CV jack
  - -5V to +5V range, for -5 to +5 octave shift
  - *Note: the Pitch jack combines with Pitch knob and sample file's sample rate, and the resulting pitch shift is limited to -9 octaves down and +4 octaves up*
- CV jacks (**Start Pos CV**, **Sample CV**, **Length CV, Bank CV**)
  - 0 to +5V range
- **Reverse**, **Play** ⊓, **Rec** ⊓ jacks
  - Trigger voltage must be > 1.6V, rising edge is detected
- microSD card slot accessible from front panel

Tutorial 1: Basic Playback

Tap the **PLAY** button to play the currently selected sample in the currently selected bank. Tap it multiple times to re-trigger the sample.
Try it now! Set the channel controls as shown:
- **Pitch** knob to center
- **Start Pos** to 0%
- **Length** to 100%
- Patch the **OUT Left** and **OUT Right** jacks to the left and right channels of your output mixer. (If you only have a mono speaker, just use **OUT Left**).
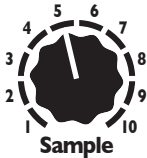
The **Sample** knob selects which sample in the current bank to play. There are 10 slots for samples per bank. Try turning the knob now. Notice that when you turn it to a new slot number (1–10), the **PLAY** button flickers. This indicates you selected a new sample. Hit the **PLAY** button again to play the new sample.

You also can select a sample using the **Sample** CV jack. It accepts voltage from 0V to +5V, so a new sample is selected every 0.5V.

The **Bank** button changes banks. Tap the button to go to the next bank and notice that the **Bank** button's color changes. Each bank contains 10 samples. Go ahead and listen to all the samples in this bank using the **Sample** knob to select a sample and the **PLAY** button to play it. Take a moment to explore a few banks, tapping the **Bank** button to go to the next bank (you can go back a bank by holding **Reverse** while tapping **Bank**). For the next step, we're going to want a sample that will loop nicely, so pick a sample that's at least a couple seconds long.

You also can select a bank using the **Bank** CV jack. It accepts voltage from 0V to 5V, and there are 60 banks, so a new bank is selected every 1/12th of a volt. That means you can select banks by playing a CV keyboard or sequencer into this jack: each semitone (note) from C0 to B5 will be a different bank.

Looping

The **Sampler** is also great for looping samples. Go to a sample that's at least a couple seconds long. Press and hold the **PLAY** button for half a second and the button will turn blue to indicate it's looping (*blue = loop*). You can let go of the **PLAY** button and it'll keep repeating the sample

Pro tip: When looping, if you move the **Sample** knob it'll immediately start playing the new sample (as opposed to when not looping, you have to hit **PLAY** to hear the new sample)

over and over. If at any time you want to stop looping, hold **PLAY** down again for about a second and it'll turn green or yellow to indicate the channel is playing but not looping.

Now let's play with **Pitch**. Turn this knob up to make the sample play back faster and at a higher pitch. Turn it down to play back slower and lower in pitch. The **Pitch** knob has a range of 8 octaves (4 octaves up, 4 octaves down).

The **Pitch** CV jack accepts voltages from -5V to +5V, which is a 10 octave range. The jack is calibrated to 1V/oct, but we recommend calibrating to your own equipment (see *CV Calibration*, page 14).

The total amount of pitch shifting when considering the jack and knob is limited to 9 octaves down and 4 octaves up.

Length *All*

Next, let's try shortening the loop: turn the **Length** knob down a bit. As you turn **Length** down from 100% to 50%, the length/tempo will go from the full sample file length to under a second. From 50% to 0%, the length/tempo gets very short (~250ms down to ~8ms), and a decay envelope is applied to make it percussive.
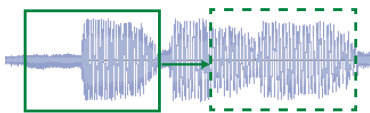
Length

The **Length** CV jack can also be used to change the **Length**. It accepts voltages from 0V to +5V.
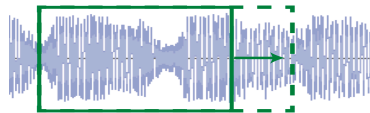
Start Pos.

By now you should see how changing the **Length** moves the end point of the loop. The starting point of the loop is set by the **Start Pos.** Try turning this knob to see how this changes your loop. The knob works by percentage of sample file time: so setting **Start Pos** to 50% will make the sample start from the half-way point. Setting **Start Pos** to 100% doesn't give you much sample left to play, so you'll hear a short blip.
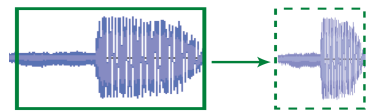
Start Pos.

The **Start Pos.** CV jack can also be used to change the **Start Pos**. It accepts voltages from 0V to +5V.

Start Pos *shifts entire sample window (start and end points)*

Notice that changing **Start Pos** does not change your tempo; it shifts the starting and ending points of the loop together, keeping a constant time. On the other hand, **Length** changes the total time by changing the end position and keeping the starting point constant.

Length *changes end point*

Let's do an experiment and see how **Pitch** and **Length** are related to the tempo of a loop. Set **Length** to 75% and turn **Pitch** to a few different settings while you loop a sample. Do you see how the tempo of the loop changes as you change **Pitch**? It should get shorter as **Pitch** gets higher. Now set **Length** to about 40% and play with **Pitch**. Do you see how the tempo of the loop does **not** change? That's because with **Length** under 50% the playback time is constant (regardless of **Pitch**). With **Length** over 50%, the audio sample data that's played is constant, even though it's stretched or shrunk. So if you set **Start Pos** and **Length** to capture a particular part of a sample (let's say it's a human voice saying the word "hello"), then as long as **Length** is over 50%, it will always play the word "hello" even as you adjust the **Pitch**.

Pitch *stretches window when Length > 50%*

Reverse
The **Sampler** can also play samples backwards. Simply tap the **Reverse** button to toggle reverse or forward playback. The button will be blue when it's in reverse mode, and off when it's in forward mode. In reverse mode, it plays from the ending position towards the starting position. You also can fire a trigger into the **Reverse** jack to toggle forward/backwards play.

Reverse

⎍ **Reverse**

Pro tip: The tempo of a loop can be harnessed by using the **End Out** jack. This jack will fire a trigger whenever the sample loops, restarts, or stops playing. Try patching **End Out** to a clock divider (such as the **RCD** or **QCD**) for a sample-based master clock!

Try this: hit **Reverse** while a long sample is playing forwards. The sound will reverse immediately and start playing backwards towards the start position. You can even keep hitting **Reverse** rapidly to keep a sample "up in the air".
When playing in reverse while **Length** is less than 50%, an attack-only envelope will be applied to the playback (as opposed to the decay-only envelope applied to forward playback with **Length** under 50%)

Tutorial 2: Navigating Banks

In the first tutorial you learned that tapping the **Bank** button moves you to the next bank. What if you went too far and want to go back a bank?
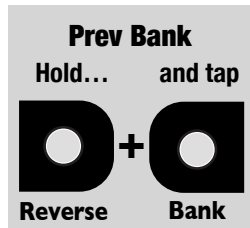
Go to Prev. Bank

To move backwards by one bank, hold down the **Reverse** button while you tap the **Bank** button. Try it now. Watch how when you go past the first bank (solid white), it wraps around to the last bank (green with two blinks in the default **Sampler** sample pack). What do these flashes mean? Let's find out!

Prev Bank
Hold… and tap
Reverse + **Bank**

Bank Organization

The banks on the **Sampler** are arranged by colors. The colors are arranged somewhat like a rainbow:

| White | Red | Orange | Yellow | Green | Cyan | Blue | Magenta | Lavender | Pearl |
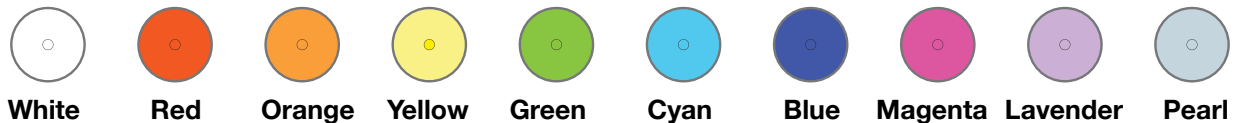
As you tap the **Bank** button, you move through banks in order from White to Pearl. When you reach Pearl, it loops back around to White, but this White is different—it blinks off every second or so. If you keep going, you'll see another White bank that blinks off twice every second. If you're using a new **Sampler** with the default sample pack, the banks are only full up until Green with two flashes (we call this "Green 2 blinks" or "Green-2" for short). After that, it wraps back around to solid White.

As you add samples to your card, you can fill up a maximum of 60 banks. Since there are 10 colors, that means each color can have 0 (solid) to 5 flashes. At 5 flashes, the bank button is flashing almost constantly. Empty banks will be skipped as you cycle through banks with the **Bank** button.
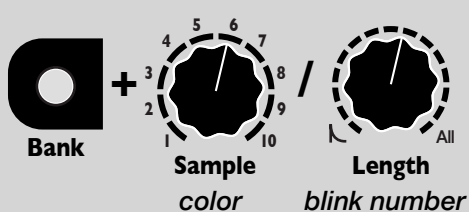
What if you've filled up your banks with samples and you want to go from the solid Red bank to Blue-3 (blue with 3 blinks)?
Well, you could tap the **Bank** button a few dozen times, but there's a faster way.

Starting bank
Solid
1 blink
2 blinks
3 blinks
4 blinks
constant blinking
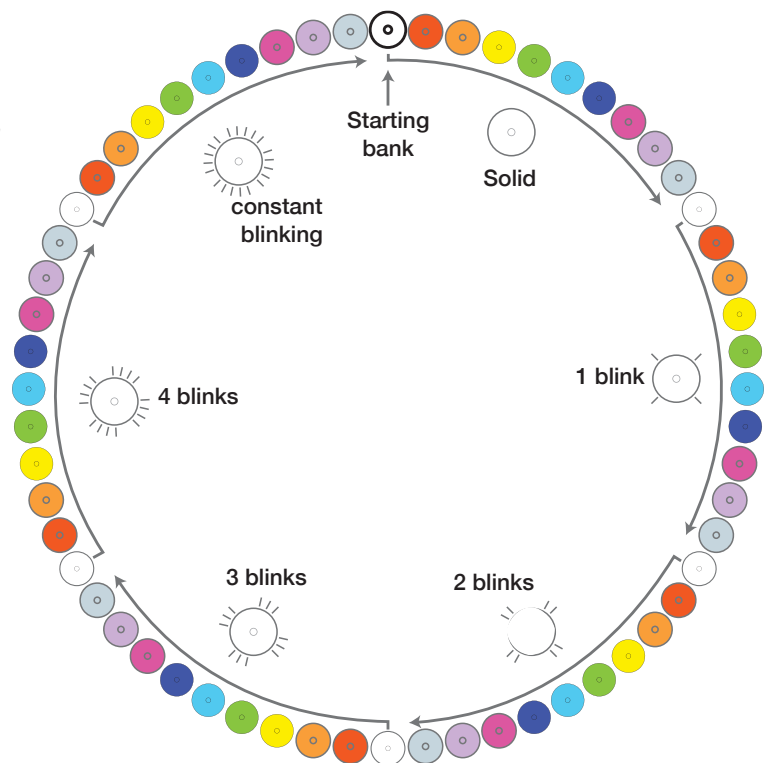
Quick Bank Select

To immediately jump to a specific bank, hold down the **Bank** button while you turn the **Sample** and/or **Length** knobs. The **Sample** knob selects the bank color, and the **Length** knob selects the bank blinks. The bank button will change colors and blinks as you turn the knobs, but the bank won't actually change until you release the **Bank** button.
For example, to go directly to Yellow-2, hold down the **Bank** button and turn the **Sample** knob until the light is yellow. Keeping the **Bank** button down, turn the **Length** knob until the

Go To Any Bank
Hold… and turn… …and/or turn
**Bank** + **Sample** / **Length**
color blink number

left **Bank** button is blinking 2 times. Release the left **Bank** button and it'll jump to Yellow-2. Note that if you turn either knob to select an empty bank, the bank button won't change color or blinks.

The **Bank** CV jack can also be used to select banks. The jack responds to voltage between 0V and 5V, which when using a keyboard, translates to 5 octaves. Since there are 60 notes (semitones) in 5 octaves, and there are 60 possible banks, the jack is essentially mapped such that each note between C0 and C5 selects a different bank.

Note: using *Quick Bank Select* and **Bank** CV simultaneously can sometimes lead you to be on an empty bank. If you find this happening, simply tap the **Bank** button to go to the next bank containing samples.

Channel Playback Volume

Channel Volume

Hold…   **and turn**
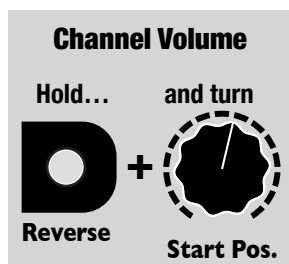
Reverse   **Start Pos.**

Adjust Channel Playback Volume
There's a hidden feature in the **Sampler** that lets you control the playback volume: hold down **Reverse** while you turn the **Start Pos** knob. When you power-on the Sampler, the volume is automatically set to 100%.

The **Reverse** button will not toggle reverse/forward mode when you use this feature. Also, the **Start Pos** won't be adjusted until/unless you move the **Start Pos** knob without the **Reverse** button being down.
The playback volume is not saved after power-down.

Stereo/Mono Mode

Normally a stereo file will play the left channel out of **Out Left** and the right channel out of **Out Right**. However, if you are using a mono signal path in your patch, you may want to use *Mono Mode*. In this mode, the **Sampler** mixes the left and right channels together and sends that to both output jacks. Note that regardless of *Stereo* or *Mono Mode*, if you play a mono file, both jacks will output the mono sample.

Stereo/Mono
Hold one second

Bank   **Play**
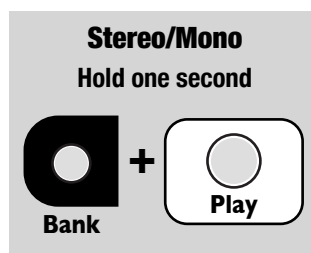
Toggle Stereo/Mono Mode
To toggle between *Stereo* and *Mono Modes*, hold down the **Bank** and **Play** buttons for a second. When entering *Mono* mode, the **Play** button will flash white/blue. When entering *Stereo Mode*, the **Bank** and **Reverse** buttons will flash. You can tell which mode you're in by looking at the color of the **Play** button while playing or looping: in *Mono Mode* it's green and in *Stereo Mode* it's yellow. When looping the button is blue in *Mono Mode* and cyan in *Stereo Mode*.

*Tip: if you don't want to start/restart playback when changing modes, press the **Bank** button first before pressing **Play**.*

Tutorial 3: Recording Samples

Record/Play Mode
Hold 2 sec.
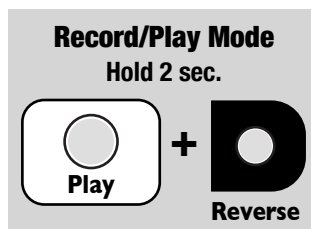
Play   **Reverse**

Enabling Recording
To create a recording, you first have to enter recording mode by holding down the **Play** and **Reverse** buttons for 2 seconds. When in recording mode, the **Play** button will flash red.

Patch the audio you want to record into the **Left** and **Right RECORD** jacks. You should be hearing your input sound coming out the **Out** jacks, but it's not recording yet— just monitoring.

Start/Stop Recording:
Tap button

Play
(REC)

Start/Stop Recording

Tap the **Play** button to begin recording (or fire a trigger into the **Play/Rec** jack). To stop recording, tap the **Play** button again (or fire another trigger). Congratulations! You just made a sample! If you were to put the microSD card into a computer now, you'd see a new WAV file with your sounds on it. But let's try playing it back first. Exit *Record* mode by holding down **Play** and **Reverse** for two seconds. You should see the **Play** button turn off.

Press the **Play** button to play what you just recorded.

Levels: The **Sampler** is made for modular-level signals. For the best quality, use a line-to-modular level converter module. Even a low-cost "input" module such as the **4ms Listen IO** will greatly increase the quality of line-level recordings from a desktop synth, guitar pedal, etc.

Where is my recording?

The sample you recorded is automatically loaded into whatever bank the **Bank** button was displaying and whatever slot the **Sample** knob was pointing to when you *started* recording. So, if you happened to change banks or turn the **Sample** knob while recording, you need to go back in order to play your sample.

Saving new samples into slots

When you record a sample, the WAV file is saved on the microSD card, and the **Sampler** temporarily assigns it to a bank/slot.

The information telling the **Sampler** which sample file is assigned to which slot in the bank is not saved to the microSD card until you save it.

Save Changes
to sample slots and settings

Hold all buttons 3 seconds

Bank + **Play** + **Reverse**

To save the sample bank/slot assignment information, hold down all three buttons for three seconds. When the lights turn white, you can release them. The buttons will go back to their normal colors after the operation is complete.

Why doesn't the **Sampler** just save your sample slot assignment information automatically when you record? The reason is that you might have recorded over a slot that you didn't mean to, or you might not like any of your takes and decide not to keep them.

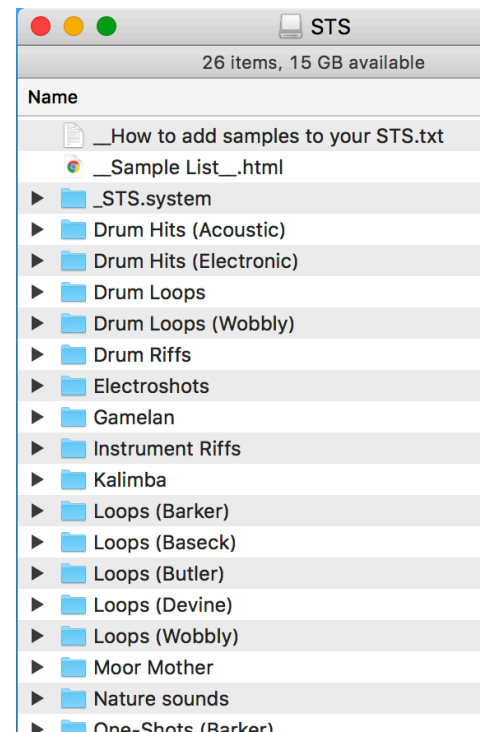## Tutorial 4: Loading Files onto the microSD Card

The **Sampler** has an intelligent and intuitive sample file management system. You can do everything in several different ways, depending on your preferences.

Unlike many other samplers, you never have to rename your files for the **Sampler**. You can simply drag your sample files into folders and the **Sampler** will load them into banks. This makes loading a huge sample library a breeze.

Included with your **Sampler** is an SD Card adaptor that fits any computer with a SD Card slot. If your computer lacks this slot, you need to purchase a microSD to USB adaptor.

First, make sure you're not playing or recording and power down. Remove the microSD card and insert it into the adaptor in your computer. The microSD card should show up as a drive on your computer, similar to what's shown on the right:

Each of these folders contain WAV files. Think of each folder as a bank.

STS
26 items, 15 GB available
Name
__How to add samples to your STS.txt
__Sample List__.html
▶ _STS.system
▶ Drum Hits (Acoustic)
▶ Drum Hits (Electronic)
▶ Drum Loops
▶ Drum Loops (Wobbly)
▶ Drum Riffs
▶ Electroshots
▶ Gamelan
▶ Instrument Riffs
▶ Kalimba
▶ Loops (Barker)
▶ Loops (Baseck)
▶ Loops (Butler)
▶ Loops (Devine)
▶ Loops (Wobbly)
▶ Moor Mother
▶ Nature sounds
▶ One-Shots (Barker)

Create a bank by copying a folder of WAV files

To create a new bank with your own samples, simply drag/copy a folder containing WAV files onto the root level of the **Sampler** microSD card. The WAV files must be directly inside the folder. Folders inside folders (sub-folders) will be ignored by the **Sampler**.
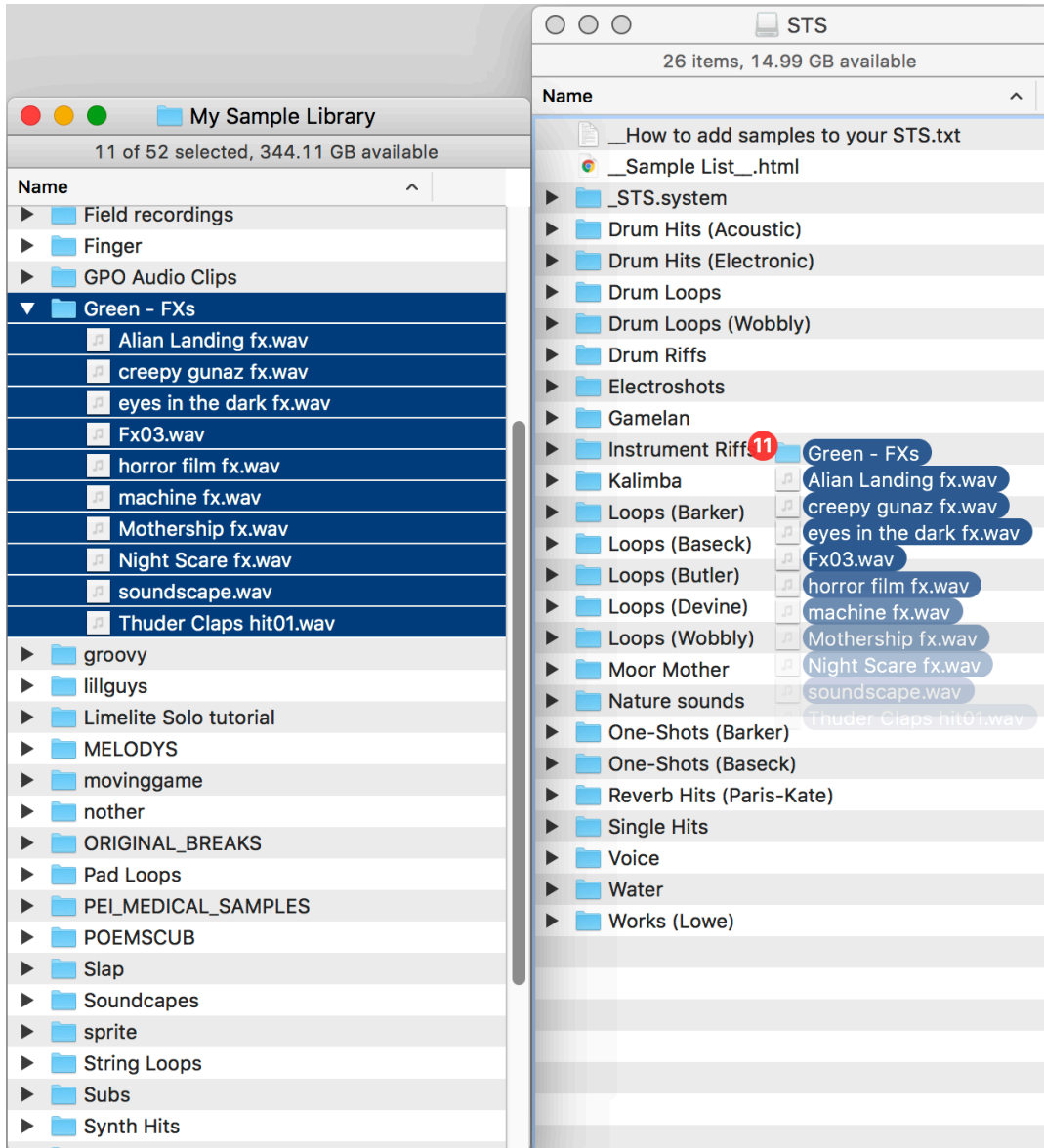
Above: copying a folder of 10 WAV files onto the Sampler microSD card. The folder starts with the word "Green" so it will get loaded into the Green bank. The files will be loaded in alphabetical order into slots 1 – 10.

You can copy as many folders full of WAV files as you like, but only 60 banks can be loaded at once. You could also copy sample(s) to an existing folder if it has less than 10 samples in it.

If you remove a file from a folder, then the **Sampler** won't be able to find that file and will try to find a new file to fill that slot. The first place it will look is the original file's folder. What this means is that if you don't like a particular sample, you can delete the file and replace it with a new file. The **Sampler** won't find the deleted file, and it will load the new file instead. In complex cases, such as when you have banks containing samples spanning multiple folders, the **Sampler** will try to fill the empty slots in each bank by searching in the folder of the lowest-numbered sample's file location.

Folders with color names

If you name the folder starting with a color name from the list on page 7, the folder will automatically be loaded into the bank of that color! Example: "Orange - My Field Recordings" will be loaded into the Orange bank. What if there's already an Orange bank? It'll get bumped to Orange-1 (that's Orange with one blink). And if Orange-1 exists, it'll get bumped to Orange-2, etc…
Here are the valid color names:

White   **Red**   **Orange**   **Yellow**   **Green**   **Cyan**   **Blue**   **Magenta**   **Lavender**   **Pearl**

You can type the color names in ALL CAPS, all lower case, or with Initial Capital Letters. After the color name you can write any ASCII characters. The **Sampler** does not support emojis or unicode ¯_(ツ)_/¯

Automatic loading of new/moved files

When you put the microSD card back into the **Sampler** and power it back up, the **Sampler** will recognize any new folders and will create a new bank for each one. The first 10 WAV files inside that folder (alphabetically) will be loaded into the 10 slots of the bank. If there are more than 10 WAV files in a folder, only 10 will be loaded. Remember, sub-folders are ignored, so only WAV files directly in the folder will be scanned.
Also, missing files will be searched for and/or replaced by new files inside existing folders.

Sample List HTML file

After you've made changes to the microSD card using a computer, the next time you boot the **Sampler** with that card, the module will create a file in the root level of the microSD card called
`__Sample List__.html`

This is a handy quick reference for seeing what files are in what banks and how long each sample is. So if you are ever wondering which samples are assigned to which slots in which banks, open this up and it'll tell you! You might even want to email it to your phone, or print it out so you have it nearby if you want to look something up.

`_STS.system` folder

Inside the `_STS.system` folder is a file called `settings.txt` . This file contains some advanced settings. You can change the settings using a text editor. The syntax is simple and documented at the top of the file.
See the *System Settings File* section on page 15.

If you are a serious hacker familiar with various domain-specific languages, then you may wish to open the sampler_index.dat file. This is a plain-text file containing the path to each of the WAV files and which banks and slots they are assigned to.

It's a good idea to backup the `_STS.system/` folder onto your computer before making changes! While no real damage can occur, the worst case is that all your banks have different colors. Your actual sample files will never be changed.

Example Patches

Sequencing the Sampler

The **Sampler** works well with a standard CV/Gate sequencer.

The Trigger or Gate output of the Sequencer is patched to the **Play/Rec** trigger input of the **Sampler**. This makes the sample fire on each sequencer step. Some sequencers have gate repeat effects, which will make the **Sampler** fire a sample multiple times per step.

The CV output of the sequencer is patched to any of the CV inputs on the **Sampler**. If you want to use the sequencer to control pitch (playing a sample at various pitches), patch into the **Pitch** jack.
If you want a "multi-timbral" effect, patch the CV output into the **Sample** CV jack. Each step of the sequencer can trigger a different sample to play.
If you have a sequencer with 2 or more CV outputs, you can even sequence both pitch and sample selection at once!

You can also select "slices" of a long sample by running the Sequencer into the **Start Pos.** CV jack. Each step of the sequencer can thus play a different slice of the original sample.

Sampler as the clock source: End Out->Clock In
One variation of this patch is to use the **Sampler** itself to clock the sequencer by patching **End Out** to the Sequencer's clock input. Make sure to set the sequencer to run on external clock.
To start the patch, hit **Play** on the **Sampler** once. The **End Out** will fire, thus clocking the sequencer, which starts a sample on the **Sampler**, which fires an **End Out** when it finishes, which advances the sequencer, etc… The **Length** control on the **Sampler** will control the tempo, which will vary with each step if the samples are of different lengths. Try this patch with the Sequencer CV out into the **Sample CV**.

*Note: if the patch seems to run for a moment and then stop, the gate pulse width on the sequencer is probably preventing it from firing new steps. Either reduce PW to triggers or hold **Play** on the **Sampler** for half a second to loop.*

Clock Divided Reverse
Try splitting/mult'ing **End Out** and running it to **Reverse**. Or patch **End Out** into a clock divider and use the divisions to reverse playback every N steps.

Granular Scrubbing

Since the **Sampler** can play fragments of a sample as small as a few milliseconds, it can be used for some basic granular synthesis techniques such as granular scrubbing. This can be used for a variety of sounds, including time-stretching (without changing pitch), and pitch-shifting (without modifying playback time).

The simplest way to play with granular scrubbing on the **Sampler** is to load a familiar sample: a drum loop or a vocal sample, perhaps. For starters, pick a sample that's between 1 and 10 seconds long.

1. Turn **Start Pos** and **Length** to 0%.
2. Hold **PLAY** to make the **Sampler** loop. You should hear a buzzy tone.
3. Slowly turn the **Start Pos** knob up, and listen how the sample is played (scrubbed). **Start Pos** is essentially sweeping the play head.

4. Now turn **Start Pos** down slowly. The sample should play backwards! Notice that no matter how fast you turn **Start Pos**, the pitch does not change. That is, you can play the sample faster or slower without changing its pitch. This is time-stretching in its most basic form.
5. Now turn **Length** up a tiny bit. Hear how the buzzy overtone changes? **Length** is setting the size of the grains.
6. Let's use an LFO to sweep through the sample so you don't have to do it by hand. Patch a very slow ramp-up LFO into the **Start Pos CV** jack. A **Pingable Envelope Generator,** a **MiniPEG**, or any of the **EnvVCA** family of modules are great for this. The period of the LFO will equal the playback time, so make the LFO's period is several seconds long. Make sure the **Start Pos** knob is back at 0. For full range, the ramp-up LFO should be 0V to +5V. Attenuate or shift as needed: any voltage under 0V or over +5V will make playback "hang". When the LFO is exactly 0V to +5V, you should hear the entire sample being played forwards. Adjust the LFO speed to adjust the playback speed. Also, you can attenuate the LFO and/or adjust the **Start Pos** knob to select certain portions of the sample to playback.
7. Try different LFO wave shapes: ramp-down will play the sample backwards, triangle will play it forwards-backwards, curved waves will play it at variable speeds (constant pitch).
8. Next, let's get rid of that buzzy overtone. Patch a random LFO (or a simple triangle if you don't have a random source) into an attenuator module. Attenuate the signal heavily, down to about +0.5V max. Patch the attenuated random LFO/noise into the **Length CV** jack. Make sure the **Length** knob is turned all the way back down. The overtone should now be randomized enough that it disappears. Adjust the attenuation and/or random speed and/or **Length** knob to suit your taste.
9. To change pitch without changing the playback time, simply adjust the **Pitch** knob (or use the **Pitch** jack). Since the playback time is set by the LFO in **Start Pos CV**, you can freely adjust **Pitch** without changing the timing. Likewise, you can adjust the playback timing without adjusting the **Pitch**.

Random Grains
Scrubbing involves playing the grains in order, but you also can play grains in random order. Patch the random LFO into **Start Pos CV** instead of **Length CV**, and don't attenuate it as much (or at all). Then you can leave **Length CV** unpatched, or patch some other LFO into it to vary the grain sizes.

Clock Sync and Shifting Ping-Pong Loops

Find a sample with rhythmic elements. Hold **Play** to make it loop. Turn down **Length** to between 50% and 90% to make a shorter loop that you like.

Clock Sync:
Run a clock into the **Play** Jack to sync the loop to the clock. If the loop is shorter than the clock, the sample will loop until the next clock.

Shifting Loop:
Patch a very slow LFO into **Start Pos CV**. Each time the loop ends, it'll start in a new position, based on where **Start Pos CV** is *at the moment the sample re-starts.*

Ping-Pong:
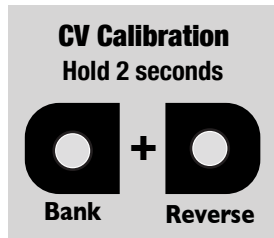Patch **End Out** into **Reverse** to play the loop forward/backwards/forward/backwards

Advanced Features

CV Calibration

CV Calibration
Hold 2 seconds

Bank + **Reverse**

The **Sampler's Pitch** jack is factory-calibrated to respond at 1V/octave. However, there is a lot of variation amongst equipment, so if you want the **Sampler** to be in tune, we highly recommend calibrating the **Pitch** jack to your own equipment. Anytime you patch a different sequencer, keyboard, or controller into the **Pitch** jack (and you will be wanting the tuning to be accurate), you should re-calibrate.

Calibration is quick and easy:
1. Unpatch the **Pitch** jack. It must be unpatched because part of the calibration routine is measuring the "offset" voltage when no CV is being input.
2. Next, hold down **Bank** and **Reverse** for one second. The lights will all turn blue. If they turn red, then you forgot to unpatch the **Pitch** jack.
3. Patch your sequencer, keyboard, or controller into the **Pitch** jack.
4. Play a C2 (2.00V)
5. Press **Play**. The lights will turn magenta. If they turn red and then go back to normal colors, then the voltage read was not close to 2.00V. Verify this voltage and try again. Note that some controllers output 2.00V at C0 or some other octave, so consult your controller's manual or try various octaves.
6. Play a C4 (4.00V)
7. Press **Play**. The lights will turn green and fade back to normal colors. If they turn red, then read the note on step 5 and try again.

If you saw the lights turn green, then your calibration has been saved. The calibration will persist even after power down.

Calibrating CV jack offset
For the other four CV jacks besides **Pitch**, calibration is not normally necessary. However, in exceptional circumstances (using a noisy power supply, for example), you may want to calibrate the offset of these jacks. To do so, unpatch all CV jacks and enter *CV Calibration* mode as described above. Making sure all four CV jacks are unpatched, quickly press and release the **Bank** and **Reverse** buttons at the same time again. These two buttons should flash green and then return to blue, indicating that calibration of these jacks is complete. At this point, you can continue the **Pitch** calibration routine (starting at step 3), or you can press **Play** immediately to exit.

Start-up bank

You can set the default bank to be loaded at start-up by editing the settings.txt file on the SD Card. Look for a section that looks like this:

```
[STARTUP BANK CHANNEL 1]
15
```

Edit the number (15 in the above example, but it might be any number on your unit), setting it to the number value of the bank you want the **Sampler** to start-up in.
For an example, See the *System Settings File* section page 15.

Adjustable Fade Time (Smoother Looping)

The **Sampler** performs a fade at the beginning and end of a sample, and a crossfade when looping. This essentially adds an envelope to the playback. There are two types of envelopes:

- **Fade in/out envelopes**: this is a very short envelope applied to the beginning and end of playback when **Length** is over 50%. It reduces clicks when starting, stopping, or looping, especially when starting or ending in the middle of a sample file.
- **Percussive envelopes**: this is the decay envelope applied to playback when **Length** is less than 50% (if **Reverse** is on, it's an attack envelope). This envelope gives the playback a "percussive" sound.
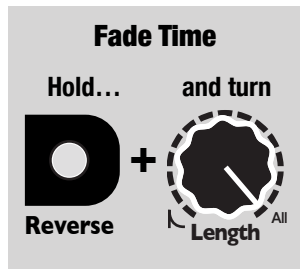
You can adjust the amount of *Fade Time* for the fade in/out envelopes by holding down **Reverse** while turning the **Length** knob. If you turn **Length** all the way down, *Fade Time* will be 0 and envelopes will be disabled. The *Fade Time* will increase as you turn the knob up, until it reaches 39ms when the knob is fully clockwise.

No changes to *Fade Time* will be saved after you power down unless you perform a Save by holding down all three buttons for five seconds (See *Saving New Samples into slots,* page 9).

While the maximum *Fade Time* you can set by holding down **Reverse** and turning **Length** is 39ms, you can actually set *Fade Time* to be longer than this by editing the settings.txt file and entering a value up to 255 (corresponding to 255ms). See the *System Settings File* section below.

Percussive envelope time is set by the **Length** knob and CV, not by *Fade Time*. However, percussive envelopes will be turned off whenever *Fade Time* is 0.

Keep in mind that when *Fade Time* is set to 0, playback may click and pop. This is not normally a desired setting. However, turning off envelopes is often preferred when doing "Granular" patches (see page 12), or when playing CV sample files (.wav files with clocks/gates, sequencer CV, or slow LFOs, etc).

System Settings File

On the SD Card there is a file called settings.txt, which lives in the _STS.system folder. If you are familiar with editing settings files and wish to change how your **Sampler** operates, you may edit this file with a plain text editor. The file is meant to compatible with the 4ms **Stereo Triggered Sampler**, so not all options are available for the **Sampler** (for instance, nothing regarding channel 2 is meaningful on the **Sampler**).

After editing the file, save it as plain text. If you try to save it as RTF or as a docx or anything that contains formatting, HTML, markup, or anything other than ASCII characters, the **Sampler** will not load the file and will restore default settings.

[STEREO MODE]
Possible values: `stereo, mono`
Default value: `stereo`
Selects *Stereo* or *Mono Mode* on startup. See *Stereo/Mono Mode* section, page 8

[RECORD SAMPLE BITS]
Possible values: 16, 24
Default value: 16
Sets the bit depth for recording.

[RECORD SAMPLE RATE]
Not used on the **Sampler** (future firmware version will support it)

[AUTO STOP ON SAMPLE CHANGE]
Possible values: `Yes`, `No`, `Looping Only`
Default value: `Yes`
`Yes:` changing to a new sample always stops/restarts playback
`No:` changing to a new sample never interrupts playback
`Looping Only:` changing to a new sample restarts playback only when looping

[PLAY BUTTON STOPS WITH LENGTH AT FULL]
Possible values: `Yes`, `No`
Default value: `Yes`
Yes: **Play** buttons act as start/re-start, unless **Length** is at 100%, then they act as start/stop
No: **Play** buttons always act as start/re-start sample

[QUANTIZE CHANNEL 1 1V/OCT JACK]
Possible values: `Yes`, `No`
Default value: `No`
Whether or not the **Pitch** CV jack is quantized to semitones

[QUANTIZE CHANNEL 2 1V/OCT JACK]
Not used on the **Sampler**

[SHORT SAMPLE PERCUSSIVE ENVELOPE]
Not used on the **Sampler.** Percussive envelopes can be disabled by setting FADE TIME to 0.

[CROSSFADE SAMPLE END POINTS]
Not used on the **Sampler.** Crossfading can be disabled by settings FADE TIME to 0 (see below).

[STARTUP BANK CHANNEL 1]
Possible values: any number from 0 to 59, specifying which bank to jump to when powering up.
The ones digit of the bank number equals color of the bank, with 0 = White, 1 = Red, … 9 = Pearl.
The tens digit of the bank number equals the number of blinks (ranging from 0 to 5).
Therefore 3 means Yellow (no blinks), and 41 means Red-4 (four blinks).

[STARTUP BANK CHANNEL 2]
Not used on **Sampler**

[TRIG DELAY]
Possible values: any whole number between 1 and 20, which sets the trigger delay in milliseconds.
Default: 8 (which is 8ms).
This is the amount of delay automatically added after a trigger is received on the **Play/Rec** trigger jack, before the **Pitch** CV and **Start Pos** CV jacks are read and the sample is played. This delay allows the **Sampler** to work with sequencers and keyboards which output a gate before the CV stabilizes at a voltage.

[FADE TIME]
Possible values: any number between 0 and 255 which translates to a fade time in milliseconds. The value of 0 means no crossfading will happen.
Default: 24 (which is 24ms).
See the section *Adjustable Fade Time* on page 15 for an explanation of this feature.
This value can also be controlled on the **Sampler** by holding **Reverse** and turning **Length**.

[AUTO INCREMENT REC SLOT ON TRIG]
Not used on the **Sampler** (future firmware version will support it).

Variable Trigger Delay / Latency

You can enable a Trigger Delay for the **Play Trig** jack. This adds a 1–20ms delay after a trigger is received on the **Play Trig** jack. This feature is useful to compensate for slew/lag when using a CV sequencer with the **Sample** CV and/or **Pitch** CV jacks. The **Sampler** will read the voltages on the **Sample** CV and **Pitch** CV jacks after the Trigger Delay period, and then it will start playback. Adding this extra delay allows for the voltage to "settle".

To set the Trigger Delay, edit the settings.txt file and change the number in this section:

```
[TRIG DELAY]
8
```

If you wish to have the least amount of latency, set this to "1". If you wish to have the maximum amount of compatibility with all sequencers, set this to "8" or above. The default value is "8".

Pro tip: If you play a sample and then move the **Start Pos** more than +/-3 seconds, the sample file data starting at the new **Start Pos** will have to be loaded into the cache again.

A bit of technical explanation regarding latency: Each sample slot has its own ultra-fast RAM cache that's about 3 seconds. Once the samples in the bank have been loaded into the cache, you can trigger any of the 10 samples in a bank with very low latency. The only limitation is that only the first 3 seconds of a sample file are loaded into the cache (the 3 seconds start at the **Start Pos** position). The process of loading into the cache typically adds 5ms to the latency, on the *very first time* a sample is played after changing banks. After the sample has been played once, the latency will be 0.7ms for all future times.

Color Adjustment Mode

You can fine-tune the colors of the buttons and save the adjustment values in non-volatile memory. Normally this is done at the factory, but you may wish to make adjustments if you have multiple **Sampler** modules and want the **Bank** button colors to match exactly between modules.

1. Power off. Make sure a valid SD Card is inserted.
2. Hold down the **Play** and **Reverse** buttons and power on.
3. When the **Play** button starts flashing, release the buttons.
4. Press **Play** repeatedly until each of the three buttons has turned red, green, and then blue. Then, press **Play** three more times as each button turns white. In total, you will have pressed **Play** 13 times.
5. At this point, **Play** will be solid green (not flashing). Press and hold it for five seconds to enter *Color Adjustment Mode*. The button will turn off and then after five seconds it will turn back on. Release the button.
6. Turn the **Sample** knob all the way down.
7. Tap the **Bank** button. This selects it to be calibrated.
8. Turn the **Pitch**, **Start Pos**, and **Length** knobs to adjust the red, green, and blue amounts, respectively. When a knob is centered, no adjustment is made. Turning it to the right of center increases that relative amount of that hue. Turning it to the left of center decreases the relative amount of that hue.
9. Adjust the knobs until the color looks good.
10. Turn the **Sample** knob to each position 1 - 10 to cycle through all 10 bank colors. Verify the **Bank** button's bank colors look good. If not, adjust the **Pitch**, **Start Pos**, and **Length** knobs.
11. When you're happy with the colors, you can optionally tap **Play** and/or **Reverse** to calibrate their colors. Note that only the green and blue can be calibrated for these two buttons.
12. To save changes, hold down **Play** for four seconds until it turns green. On the other hand, if you wish to cancel, hold down **Reverse** for four seconds.
13. Power off.

Note: The colors of the buttons will not match each other, and this is normal and to be expected. Do not try to adjust the colors of a button to match another button on the same **Sampler** module. The

only legitimate purpose for this mode is to match colors between two *different* modules or to make minor adjustments in relative brightness between buttons on the same module.

Rebuilding the Index File

The **Sampler** keeps track of the name of the sample file assigned to each bank/slot in a file called sample_index.dat (aka "the index file"), located in the _Sampler.system folder. If you wish to revert the Sampler to the factory organization, there is a factory original file located in a folder within the system folder, follow the instructions in the "How To" text file in that folder.
If you wish to clear all file organization, you can simply delete the index file (back it up first, please!).

Updating Firmware (Audio Bootloader)

You can update the **Sampler** firmware by playing a special audio file into the **Record** jack. When new firmware versions are released, the firmware audio files can be downloaded at
https://4mscompany.com/sampler

1. To enter bootloader mode, power off the **Sampler** and connect a computer or smart phone audio output to the **Left Record** jack. Either a stereo or mono cable is fine. Connect the **Out Right** jack to an amp/speakers so you can listen.

2. **Set the computer/phone's volume to 50%**. You may need to adjust it up or down if this is too loud or quiet (see step 6). Unlike other 4ms modules, the **Sampler's** bootloader is designed to work with consumer line-level signal (a peak-to-peak voltage of a little under 1V is ideal, or -10dbV). Turn off all audio notifications that might interrupt playback.

3. Depress the **Bank** and **Reverse** buttons while powering on the **Sampler**. When you see either button blink, release the buttons.

4. If the **Reverse** and **Play** buttons are blinking red, press the **Play** button. **Play** will start blinking slowly (twice per second) to indicate the module is now ready to receive firmware.

5. Begin playing the file. Immediately you should see **Bank** turn on and **Play** and **Reverse** start flashing blue, white, cyan, and/or purple. Do not interrupt the process!

6. The color of the **Bank** button tells you if the audio is too loud or quiet. Green is the ideal volume. Cyan, blue, or off indicates the audio is too quiet. Yellow or red indicates it's too loud.

7. If there's an error, **Play** and **Reverse** will blink red rapidly. The **Bank** button will continue to indicate the audio level, so this is a good time to verify the level is ideal and adjust the output level as needed. Verify the cable is not loose, all sounds/vibrate/notifications are off, and that you have downloaded the audio file completely (avoid streaming or playing from the browser). Stop the audio file, reset it back to the start, and tap the **Play** button to reset. The **Play** button should blink slowly. Play the file from the beginning again.

8. If the file loads successfully, **Play** and **Reverse** will blink in a rainbow pattern. Press **Play** start.

The open-source licensed source files (in C++, for compiling with arm-none-eabi-gcc) can be found at https://www.github.com/4ms/sampler

What version is my Sampler?

To view the firmware version, power on the **Sampler** with an SD Card installed. When startup is complete (all lights stop blinking), remove the SD Card and insert it into a computer. Open the file named "__Sample List__.html". The firmware version is written at the top of the file.

## microSD Card Specifications

- We include the ideal type of card to use with the **Sampler**. If you need to buy an additional card, we highly recommend that you purchase the same class of card. The **Sampler** works best with a UHS Speed Class 3 card (also known as U3, which is the fastest of the UHS-I type cards).
    - Look for this symbol printed on the card:
- Example card: *SanDisk Extreme microSDHC UHS-1 Card* (advertised as "Read up to 60MB/sec, Write up to 40MB/sec")
- If "UHS Speed Class 3" is not available, a "Class 10" card is acceptable (booting will be slower, and there may be more latency when playing 96kHz/32-bit/stereo files at high Pitch settings)
- A Class 10 card will be slower than a UHS Class 3 card. A class 6 or class 4 will be even slower than the class 10. If you are not using the **Sampler** to record long samples, and you only playback 44.1kHz/16bit samples, then even the slowest microSD Card available will work fine. However, we still recommend purchasing a high-quality microSD Card, as cheaper cards are not as reliable and may result in loss of your data.
- See https://www.sdcard.org/developers/overview/speed_class/ for a discussion on micro SD Card speeds and labeling
- **Never remove the microSD card while the Sampler is playing or recording**.

How to prepare a new microSD Card

- Purchase a UHS Class 3 card (see above)
- Format the card as ExFAT (preferred) or FAT32 (acceptable). See screenshot (right) for how to set MacOS standard "Disk Utility" program.
- Verify all sample files are valid WAV files (see file format specifications below)
- Put your WAV files into folders to organize them into banks (preferably 10 WAV files per folder)
    - Each new folder found will represent a bank. You can name the folders beginning with the name of a color (such as "Yellow-field recordings") to force that folder to load into a particular color bank.
    - Sample files must be located directly in the root directory, or in a folder. Folders inside folders (sub-folders) are never scanned by the **Sampler**.
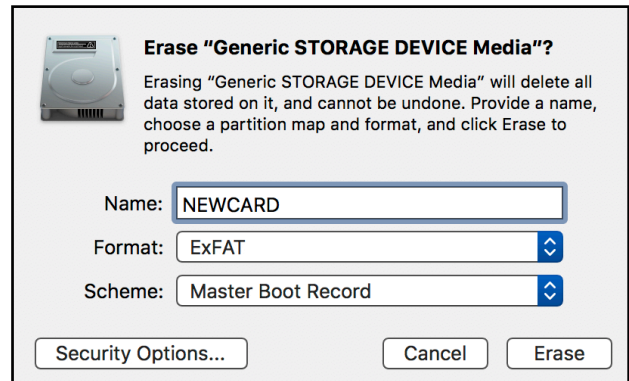
File Formats

The **Sampler** recognizes the vast majority of WAV files. Verify that your files meet the following criteria (all others will be ignored):
- **Format**: WAVE
- **Bit depth**: 32-bit float; 16, 24, 32-bit signed; 8-bit unsigned
- **Channels**: Stereo or Mono
- **Sampling rate**: 8kHz to 96kHz
- **File name**: Must end in .wav or .WAV
- **Folders**: files must be in a root-level folder (sub-folders are ignored)
- **Limitation on file names:** The maximum file name plus full path cannot be more than 80 characters. File names that are longer in 80 characters (including the ".wav", the folder name, plus a "/" for the separator) will be ignored.

Chart of Special Button Features

Playback:

Looping
Hold 0.5 sec.

Stereo/Mono
Hold one second
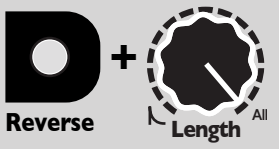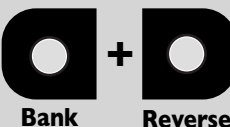
Channel Volume
Hold… and turn

Reverse + Start Pos.

Navigating Banks:

Next Bank
Bank

Prev Bank
Hold… and tap
Reverse + Bank

Go To Any Bank
Hold… and turn… …and/or turn
Bank + Sample / Length
color *blink number*

Recording:

Record/Play Mode
Hold 2 sec.
Play + Reverse

Start/Stop Recording
Play (REC)

Settings:

Fade Time
Hold… and turn
Reverse + Length All

Save Changes
to sample slots and fade time
Hold all buttons 3 seconds
Bank + Play + Reverse

CV Calibration
Hold 2 seconds
Bank + Reverse

Bootloader:

Bootloader Mode
Hold while powering on
Play + Reverse