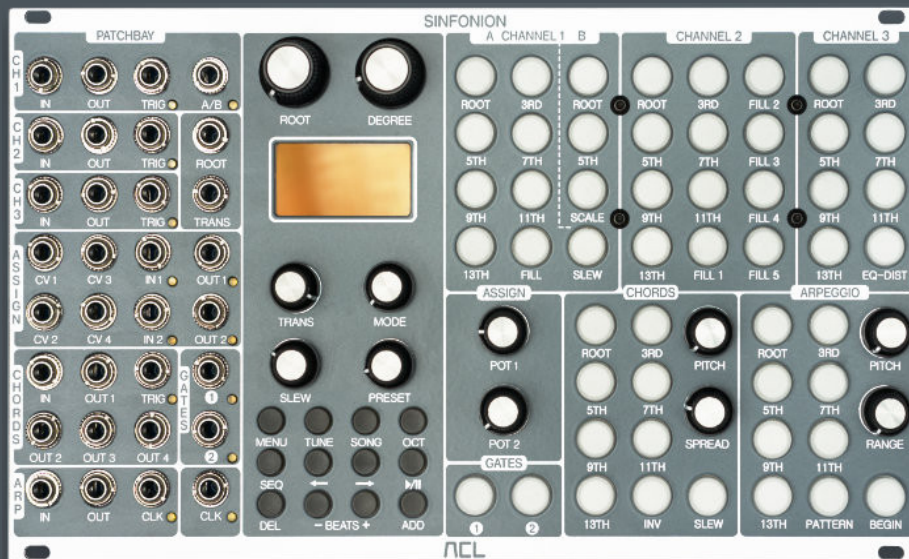# ∏CL

Audiophile Circuits League

Sinfonion

harmonic CV processor

created by Mathias Kettner

User manual for firmware version 1.0

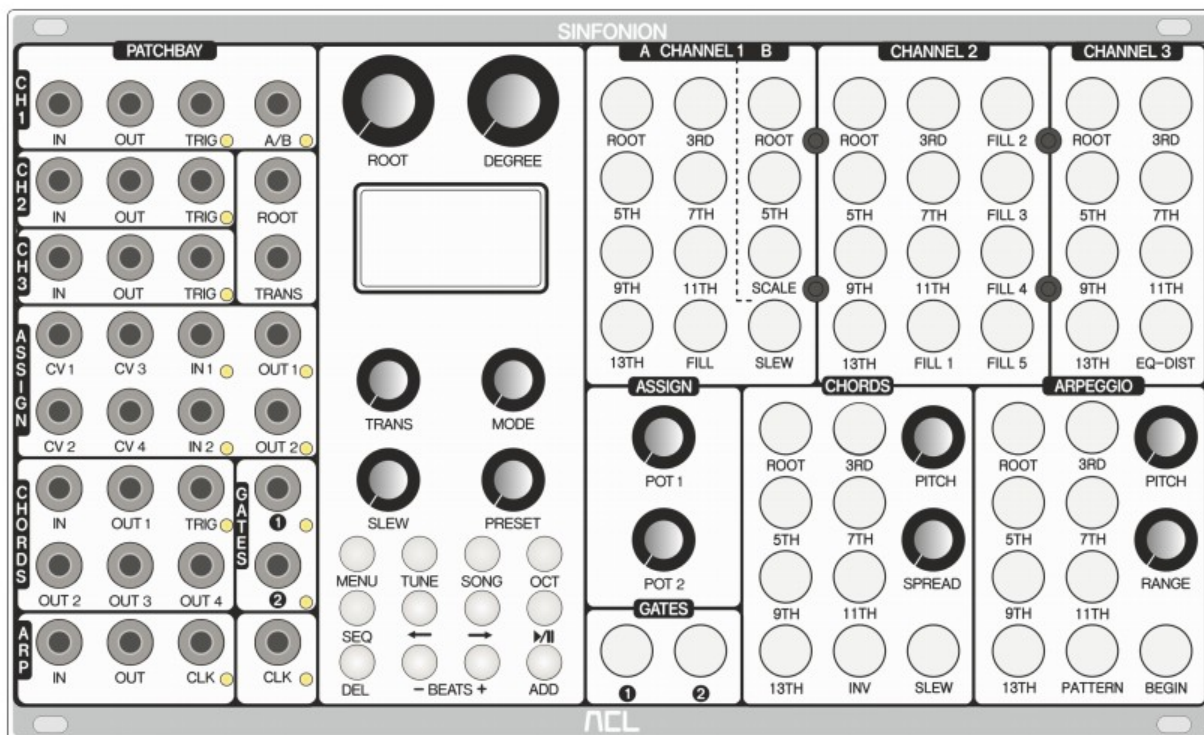Last edited August 6, 2019

Table of Contents

1 Features

Hardware:

- 52 large buttons, 12 small buttons, 12 knobs, 32 jacks
- OLED display with a resolution of 128 x 64 pixels
- 8 pitch outputs, 4 gate outputs, 11 CV inputs, 9 gate inputs
- STM32F446 MCU running at 180 MHz
- 8 highly accurate low jitter 16 bit DACs scaled to an output range from –2 V to +8 V
- 16 highly accurate low jitter 16 bit ADCs covering a range from –10.24 V to +10.24 V
- Expansion port for future expansion modules and for firmware upgrade

Quantizer:

- Three independent quantizer channels
- Selection of allowed notes by using musical intervals using dedicated buttons
- Optional triggered mode
- Dozens of extra functions and settings
- Time for quantization below 1 ms

Chord Generator:

- Four pitch outputs to be used for four voiced chords and other stuff
- Dedicated knobs for pitch and spread
- Buttons for chord inversion and optional slew (portamento)

- Buttons for selecting interval functions for the chord, 98 different voicings

Arpeggiator:

- Eight different basic patterns
- Dedicated knobs for pitch and range
- Buttons for selecting scale notes
- Buttons for selecting the pattern and start note

Chord Progression Sequencer:

- 16 songs with 4 parts each and 32 steps (chord changes) per part
- Chord progression via clock, button, gate or CV
- Sequencing of chord voicings, octave switches and scale note selections

General:

- 88 built in base scales, editable by adding and removing notes
- 7 dedicated CV inputs
- 4 general purpose CV inputs with 28 different assignable functions
- 2 general purpose gate inputs with 20 different assignable functions
- 2 general purpose gate outputs with 14 different assignable functions
- 2 general purpose pots with 28 assignable functions
- Harmonic Link: connect any number of Sinfonions in order to form a distributed "Super Sinfonion"
- Bultin mixing/routing matrix for pitch inputs and outputs
- No load/save necessary - everything is automatically saved
- Any many many more very musical features!

2 Introduction

Welcome to the Sinfonion. Not only is the Sinfonion the most complex and versatile quantizer, chord generator and arpeggiator in Eurorack format, it is also a very musical module and fun to use. It has been designed and programmed by Mathias Kettner and is produced by Audiophile Circuits League in Berlin.

The Sinfonion is designed for those musicians that do not want to be limited to creating "sound sculptures" or rhythmic grooves with their modular instruments but want all their fabulous VCOs and other voices to play together in the most musical and polyphonic way - may it be harmonic or even disharmonic on purpose.

Of course you could use a sequencer or DAW with lots of tracks and program every single note for every single voice. But hey - music is about *playing*, not about programming! The Sinfonion allows you to bring in more randomness and spontaneity while being very "hands on". Its many buttons make it an actual instrument you can *play*.

The key to this all is the combination of three quantizers (called *channels*), one four voiced chord generator and an arpeggiator into *one* module. We call these the five *sections*:

- Channel 1
- Channel 2
- Channel 3
- Arpeggio
- Chords

At any given time all sections share the same musical key and scale (e.g. C minor) — without being actually forced to play the same notes. Channel 1 might be limited to playing the root and 5th note of C minor (C and G), whereas Channel 2 is allowed for all seven notes from the C minor scale. The chord section might play 3rd, 5th, 7th and 9th, which gives a nice and rich texture. Once everything is set up, the built in sequencer of the Sinfonion will bring your patch to life by taking you through simple or complex chord progressions. This will release you from being locked to the ubiquitous minor pentatonic scale.

Here you might say, "*Couldn't I simply do the same by patching together several standalone modules? That's what modular is all about in the first place!*". Believe me: I've tried that. It's not possible. Even if you would invest thousands of euros in quantizers, chord generators, sequencers, precision adders, CV mixers and similar stuff — you would never be able to have them all work together smoothly through even trivial chord changes.

But what if even the Sinfonion with its eight output channels is not enough? You have more voices to play? No problem! With simple patch cables you can link together as many Sinfonions as you like and create a distributed "Super Sinfonion" having 16, 24 or more pitch outputs. You

want to jam with your friends over changing chords? Simply throw a patch cable over, connect your Sinfonions and let the session begin!

3 Installation

This module is mounted like all other Eurorack modules that you probably already have. Connect the 10-pin header of the Sinfonion to your +/-12 volt power header of your bus board with the shipped ribbon cable. The power header of the Sinfonion is shrouded so you cannot plug in the cable incorrectly at the Sinfonion unless you force it. If you use your own ribbon cable then the header might be mounted in the opposite direction, so please double check the orientation.

Most bus boards do not use shrouded headers, so make sure that -12V is at the red marked side of the ribbon cable. Bus boards from other vendors might be shrouded but in opposite direction. Please check the red line!

The +/-12V power circuit on the Sinfonion has two diodes that protect against reverse polarity. If you plug it in reversed by accident, the module will not be powered.

Even more dangerous is putting the 16-pin header in the wrong direction on your bus board. This could result in a short circuit at the 5V of your power supply. Even worse is offsetting the connector by one or two rows of pins. Strange things can happen. Please double check.

And most Importantly: Do not mix up the 10-pin power header with the 14 pin expansion header!

Security Considerations and legal stuff

This is just the user manual. Please ask your vendor or the manufacturer for further information about security, disposal, conformity to laws, certifications, warranty, limitation of the warranty and similar legal crap. Do not do anything with the Sinfonion that could harm your health or your sanity. Do not do anything with the Sinfonion that could use someone else's health or sanity, unless this is an intended side effect of the music that you make with it. And most importantly, do not do anything with the Sinfonion that could harm the Sinfonion's health or sanity. Always handle it gently, since it will soon become the centerpiece of your modular system and losing or damaging it might seriously harm your health or sanity.

4 Quickstart

Though the Sinfonion looks very complex, it's actually very easy to get started with. There are no hidden settings, no "hold this button for 5 seconds and something magic happens" features and no hidden alternative modes. What you see is what you get.

This chapter is a quick introduction for getting things up and running. You might even want to skip the rest of the manual, find out things by experimenting and looking around in the menu and maybe come back later for some details. But for now let's go!

4.1 Set All to Start

First let's bring your module into its "normal" state. This avoids "weird" things from happening during this tutorial:

- Turn the two PITCH knobs of Chords and Arpeggio to 12 o'clock.
- Turn the TRANS knob to 12 o'clock as well.
- Turn all other nine knobs fully to the left (CCW).
- If the SEQ button is lit, press it once in order to turn it off.
- Also turn off MENU, TUNE, SONG and OCT (make them unlit).

Your display should now look like this:

```
C  Chords        Clyd
       CDEF♯GAB
+0                  1
```

4.2 Using the Quantizer

Let's start with the **Channel 2**. Patch the output of an LFO or a manually controlled CV source to the IN jack of Channel 2. Connect the OUT jack of Channel 2 to the pitch input of a VCO or some other synth voice that can track V/Oct. From all the buttons of Channel 2, select ROOT, 3RD, 5TH and 7TH and disable the others.

Setup your voice so that you can hear its sound. When the LFO or your manual input CV goes up and down it should now play C, E, G or B in different octaves. By selecting also 9TH, 11TH and 13TH you complete the lydian C major scale and allow all seven notes of this scale to be played. Play around with the buttons as you like!

The FILL1 ... FILL5 buttons select the five notes that are *not* part of the lydian C major scale. That

way you can play "out", play some blue notes or even switch to chromatic quantization.

Now comes the fun part: With the knob ROOT you can change the key of the scale to any of the twelve possible notes (C, C#, ..., B). And with DEGREE you change the chord quality. ROOT and DEGREE together result in a scale with its notes shown on the display.

This scale defines the meanings of each of the note selection buttons. The mapping is a follows:

- The first scale note is mapped to ROOT
- The second note is mapped to 9TH
- The 3rd is mapped to 3RD
- The 4th is mapped to 11TH
- The 5th is mapped to 5TH
- The 6th is mapped to 13TH
- The 7th is mapped to 7TH

If you do not happen to be an educated jazz musician you will probably wonder why the second note is called 9th and not 2nd. This is a very common form of notation. If you think of chords as thirds stacked upon each other, you will see that this results in root, 3rd, 5th, 7th, 9th, 11th, 13th, 15th, 17th and so on. But since the 15th is the same as the root (just two octaves higher) this sequence stops at 13th.

Channel 1 and 3 work in pretty much the same way but each channel has its specialities. Channel 1 has an A/B switch feature. Just use the A part for the while. The EQ-DIST button on Channel 3 selects an equidistant distribution of the selected notes in the range of 1 Volt. Later I will show details of this feature.

4.3 Playing Chords

Using the Chords section is even simpler: Just connect OUT 1, OUT 2, OUT3 and OUT 4 to the V/Oct input of four VCOs or other voices[1]. With the buttons of the chord section you select the actual chord notes being played. If you select more than four notes, then just the first four are being used. If you select less, then some notes will be doubled to more than one voice. Consider starting here with ROOT, 3RD, 5TH and 7TH.

The IN jack of the chords is optional. The PITCH knob is for manual pitch control and does the same as that input: it selects the overall base pitch of the chord. The RANGE knob selects how dense or wide the spacing of the chord notes are. It may be best to start with the PITCH knob in the center and RANGE totally CCW.

---

1 If you just have three then leave out OUT4.

With INV you can toggle through all possible chord inversions. If the button is not lit, no specific inversion is being selected and the lowest chord note is chosen to match the selected pitch as close as possible.

4.4 The Arpeggiator

Setting up the arpeggiator takes a tiny bit more work. This section differs from the others in that it needs a clock signal. Each time the arpeggiator receives a trigger in its CLOCK jack (just left to the main CLOCK jack) it selects a new note. A most basic patch is like this:

- Patch the OUT of the Arpeggio to the pitch input of a VCO or synth voice.
- Patch some clock or rhythmic trigger to ARP CLK.
- Patch the same clock or trigger signal to the gate of the synth voice.

Select a pattern
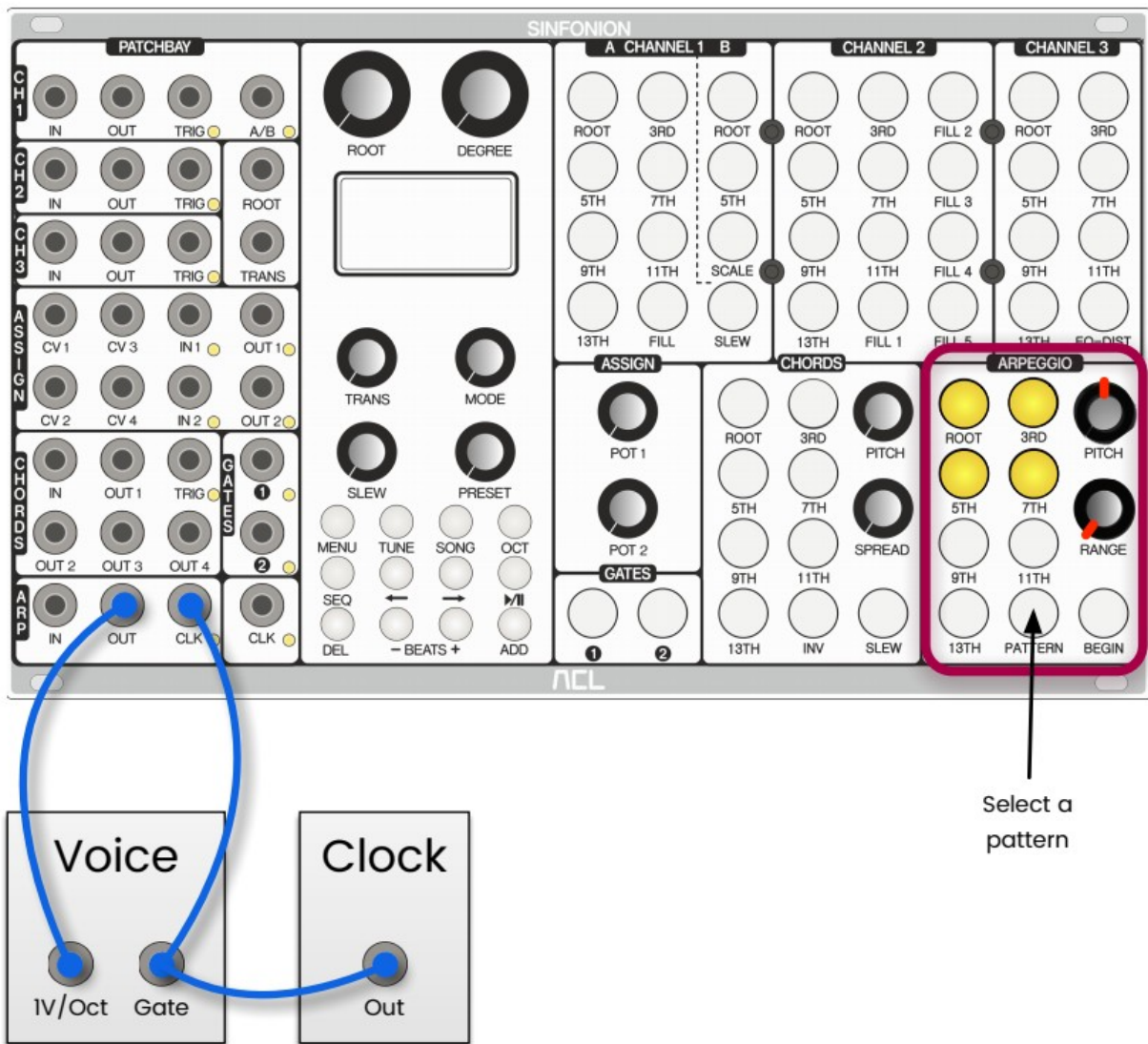
Don't forget to select some of the scale notes to be played with the seven buttons (ROOT, 3RD, 5TH, 7TH, 9TH, 11TH and 13TH) of the Arpeggio section.

Also important: turn the RANGE knob somewhere, just not fully CCW. With RANGE fully CCW, the arpeggio range would be 0 and you would just get the the same note. As a start, consider selecting a range of exactly one octave.

Now, on each clock signal the arpeggiator selects the next note according to the current pattern. There are eight different patterns that you can walk through with the button PATTERN. The most basic pattern is called "Up". This will step upwards to the next allowed note within the range. If the top of the range is reached it starts again from the lowest allowed note.

With the PITCH knob, you select the pitch of the lowest note of the pattern.

Simply try out different patterns, pitches and ranges.

Hint: modular is not MIDI. It is always interesting to separate the gates from pitch changes. The upper patch is a rudimentary example. Try to use a different gate pattern for the arpeggio clock and for the trigger of your voice. The arpeggiator can be used in the most surprising and creative ways!

4.5 Chord Progression Sequencer
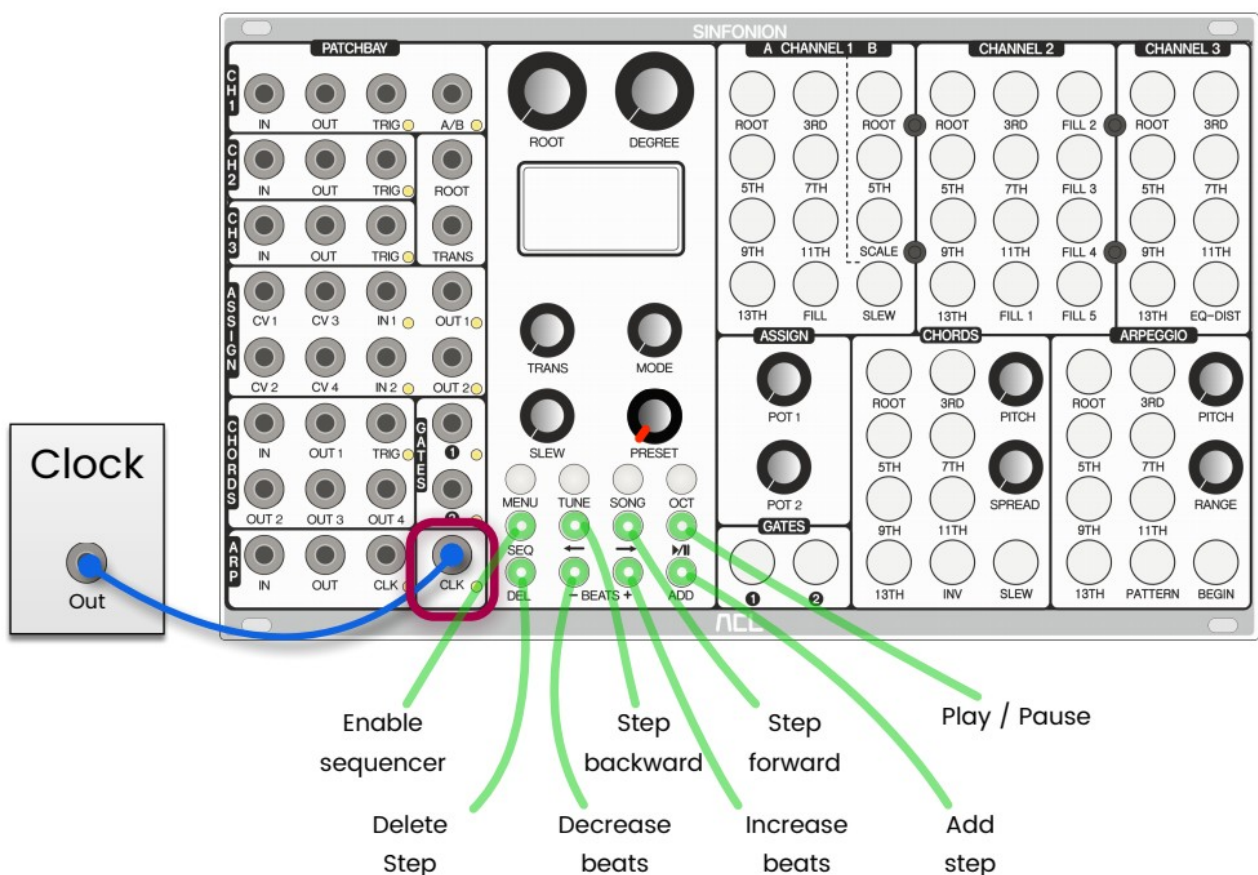
Until now you were in non-sequenced mode. Now let's activate the sequencer:

- Press the SEQ button so that it is illuminated.
- Dial the PRESET knob to the left, thus selecting song part "1A".

If nobody has played around with the Sinfonion so far you should see a song that just consists of one step with the chord C^{maj} which lasts for four beats. The beats are shown as circles, the steps as boxes[2]:

```
C  Chords      Clyd
      CDEF#GAB
+0    ●○○○ ■      1A
```

To edit this step, simply turn the knobs ROOT and DEGREE as you like. Add and remove beats by pressing + and -. The number of beats define the length of the step. Add a new step by pressing ADD. This creates an exact copy of the current step. DEL deletes the current step. When you press DEL while the sequence has just one step then that step is being replaced by the default step of C^{lyd} with four beats. This is because each song must always have at least one step.

At any time you can move between the steps with the buttons labelled ← and →. All quantizer channels, the chords and the arpeggiator will immediately switch over to the new scale. Manual switching is a good choice when you want improvisational freedom, because you can remain in a single chord/scale and switch only when you are ready.

When the sequencer is set to play (by activating ▶/❚❚) then every trigger into the CLK jack advances the sequencer by one beat[3]. When the number of beats of the step is reached it switches to the next step. If this was the last step it starts over from the beginning.

Note: each step does not only define the root note and scale but also the setting of all scale note buttons! Please do not be confused — this is a feature, not a bug! It allows you to make very creative and complex musical progressions. This can also be turned off.

---

2 If your display is different then you can easily erase all settings of song part 1A by pressing DEL a couple of times in a row until you have reached the desired state.

3 In chapter 12 you will learn how to configure the input clock divider so that e.g. just every 16th clock signal is advancing one step.

4.6 Gates

There are two buttons in a box labelled GATES. These correspond to the two jacks GATE 1 and GATE 2. They are very simple: if the button is selected then the gate is high (outputting approximately 5.0V). This gate toggling feature is particularly useful in sequenced mode because the gate states are saved in each sequence step and that way can change over time.
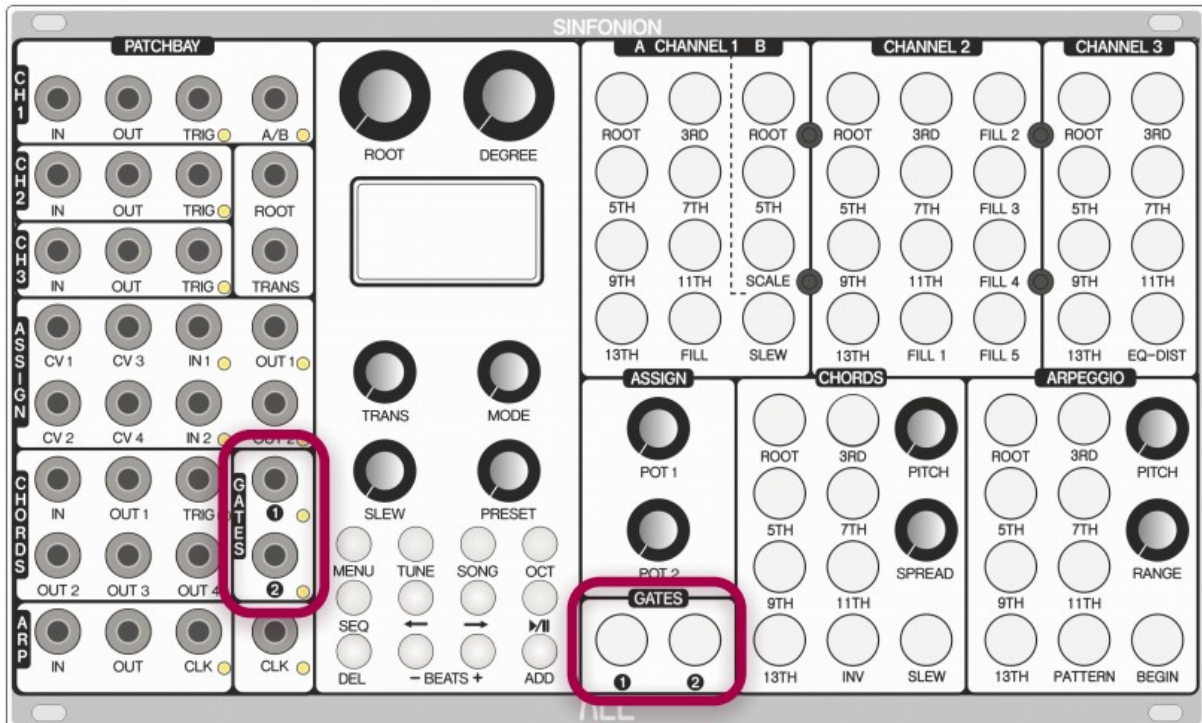
5 General Features

We hope that you liked your first steps with your Sinfonion. Most of its features can be found by experimentation and playing around. There are no hidden things or strange button combinations[4]. Nevertheless in the rest of this manual we will take you through all features of the Sinfonion.

5.1 The Menu

As you might might have guessed, the MENU button opens a configuration menu for many global settings, such as how the general purpose jacks CV 1-4, IN 1/2 and OUT 1/2 should be mapped. While you are in the menu, press ← and → for selecting an item and – BEATS + for changing its value. Everything is saved immediately and permanently. The Sinfonion continues to operate completely normally while you are in the menu so your music can go on.
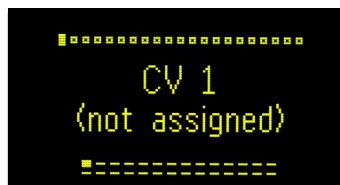
We will not go through all of the possible settings here. It makes more sense to discuss them at the appropriate places in the manual where the general topic of each setting is covered.

5.2 Reset To Defaults

If you have lost track of all your settings and want a fresh start from the beginning you can use the last menu item: "Reset To Defaults". It is also nice when you have lent your Sinfonion to someone else and just got it back[5].

The reset is actually activated by pressing + two times in a row. Please note: You cannot undo

---

4 Well, some "dangerous" things have intentionally been hidden but are explained in this manual.
5 You should never ever do this!

this operation, so use it wisely. The reset will affect:

- all settings that have been done in the menu
- the input and output routing matrix

The reset will **not** delete any of your songs (chord progressions) or button presets.

- the channel configuration such as the octave switches or the bypass feature

5.3 The Display

In non-sequenced mode, the information shown in the display has the following elements:

- Top left: Root note (here "F") and musical mode[6], e.g. "Chords" or "Mel.Minor".
- Top right: chord/scale - either in simplified notation like C^{maj} or in a jazz notation like $E^{\triangle 7aug}$.
- Bottom left: Global transposition in semitones (+0). The transpose knob has a range from -12 (one octave down) to +12 (one octave up).
- Bottom right: Number of the current button preset (here "4"), which ranges from 1 to 16.
- Center: Information about scale, chords or octaves (here "E F G G# A# C D"). You can configure this to show different information (see below).

The display automatically chooses between a notation with sharps or flats based on the number of necessary accidentals. For example, B♭ major is noted with flats because this results in just two accidentals, as opposed to A$^{\#}$ major, where five sharps would be necessary.

In sequenced mode there are two slight changes in the display:

---

6 See chapter 11.2 for what the modes are.

- Bottom right: Here you see the current song number and part (e.g 4A). The sequencer does not use the button presets since every step has its own button preset.

- Bottom center: The number of beats (circles) with the current beat (filled circle), then the number of steps (boxes) with current the step (filled box). If the number of beats is more than 8, a representation like "12/16" is used. The same happens if the number of steps is more than 16.

For the center line there are four possible options displayed. You can change this with the menu option "Display":

There are four possible settings for the display mode:

Scale Tones

This is the default setting. It lists all notes of the current scale. In most cases there are seven notes, but some scales may contain six or eight notes.

The Sinfonion uses American/jazz notation for note names, so a B is the same as an h in German notation. The German b is denoted as B♭.

Scale Structure

Shows the semitone/wholetone structure of the scale. The bullets denote scale tones, and the

tildes denote semitones that are not part of the scale. In the following picture, for example, you can see that the first and last step of the scale are whole tones:

As you can see from the example, a typical major scale begins with two whole tone steps (●~●) and one halftone step (●●). The dominant scale has a minor seven - which means the scale ends with a whole to step until the upper A is reached (●~●).

The nice thing about this representation is that it is completely independent of the root note and also of the traditional note letters like A, B, C and so on. Not everybody immediately knows there is a halftone between E and F whereas between F and G there is a whole tone.

Chord Structure

This setting shows how the chord section distributes and spreads the four selected notes as well as the octave switch of the chord section:
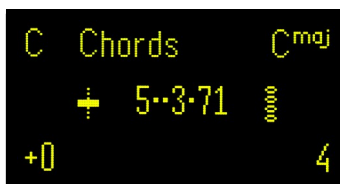
Right in the center, you see a visualization of the chord voicing. The numbers denote the chord tone (1 is root, 3 is 3rd and so on). On the left is the lowest played note - which corresponds to the selected *inversion*. Each dot is one *selected* chord tone that is skipped, either due to the the spread setting or because you have selected more than four chord notes.

Octave Switches

This makes the display show the same information that is normally only been shown on the OCT page (see page 30): the five octave switches for Channel 1, 2, 3, arpeggio and chords.

5.4 Tuning Mode

The TUNE button switches on and off tuning mode:

This mode is very handy for tuning voices that are connected to the Sinfonion. In tuning mode, all eight pitch outputs of the Sinfonion output an exact voltage corresponding to a C. With the buttons ← and → you can move in 1.0V steps from -2.0V (two octaves below a C0) up to 8.0V (C8).

In order to minimize the effect of Volt/octave tracking deviations it is always a good practice to tune oscillators roughly in the same pitch as in which it plays the actual music. The ← and → buttons of the Sinfonion makes this super easy.

Please note that the displayed frequency (e.g. 261.6 Hz for C4) is just a suggestion and based on the convention for an A4 to be 440Hz. You can of course tune to any reference that you like. The Sinfonion just guarantees the precise output of an integer number voltage on all eight pitch outputs.

The precision of the Sinfonion is typically about 1mV or even better. This makes the Sinfonion a perfect voltage reference for calibrating the tracking of VCOs, the outputs of sequencers and so on. 1mV is really good. Even good buffered multiples have typical errors of 1.5mV and more. Beware: Bad ones use a cheap TL074 chip and can be off as far as 10 mV and beyond!

The fast switching between the different voltage levels is extremely handy during the calibration procedure as it allows you to quickly switch back and forth e.g. between 0V and 5V so that you can compare the tunings at these two levels.

Here are some more facts about the tuning mode:

- The tuning mode also honors the octave switches of the individual channels (see page

30). So the displayed voltage is only output at those channels where the octave switch is set to the middle position.

- During tuning mode all CVs that modify pitch and similar features are disabled (transpose, chaotic detune, pitch bend, etc.).

- During tuning mode the OUT function for the arpeggio clock will automatically output arpeggio beats at a fixed rate. If this feature is being used then this triggers the attached voice making it audible for tuning.

- You can map the function "Tuning mode active" to OUT 1/2 and patch something there - e.g. something that suppresses a vibrato or the like.

- A Sinfonion in slave sync mode will *not* automatically go into tuning mode when the master does.

- Tuning mode can even be used in a musical way since it forces all outputs to play a C.

5.5 Button Presets

The largest part of the Sinfonion's front panel is occupied by 52 buttons, each of which belongs to one of the aforementioned sections (Channel 1, 2, 3, Arpeggio, Chords or Gates). Most of the buttons select scale notes for quantizations. Others select things specific to each section.

The 52 buttons altogether form a *preset*. In non-sequenced mode you have 16 button presets. These presets can be switched with the PRESET knob. The current preset number is shown in the bottom right corner of the display. Note: also the current state of the octave switches are part of a button preset.

In sequenced mode every sequence step has its own preset of the 52 buttons and the five octave switches - unless you set the sequencer to "live mode".

Buttons can be off, dim or bright. Those buttons that select scale notes are bright whenever that note is currently being played and dim if it's not played but selected anyway.

The buttons have alternative "pages", which map a different function to each of the buttons. These are:

- The OCT page with the channel options
- The OCT page with the input and output routing matrix
- The SONG page
- The DAC calibration

5.6 Slew

The Sinfonion has a built in slew limiting (also called slide, glide, portamento, etc.) function for

the output pitch. This can create nice glides, just as you would do with an external slew limiter. There is one global time setting for the slew limiting, which you can set with the dedicated SLEW knob.

Slew limiting is enabled on a per-channel base. Channel 1 and the chords have dedicated buttons for this. Furthermore, with the global menu you can assign IN 1/2 to enable slew limiting for Channel 1, 2, 3 or the chords:

```
■■■■■■■□■■■■■■■■■■■■■■■
         In 1
     Chan 2 Slew

---------■---------
```

The slew limiting is enabled as long as there is a high signal in the according IN jack. That way you can create rhythmic slew patterns by means of an external sequencer or other CV generator.

There is also a global menu setting "Slew Curve" that lets you choose between a linear and an exponential slew curve. In linear mode, the time for gliding from one note to another is always exactly the same, regardless of the distance of the notes. The exponential setting works like an analog slew limiter that is based on a capacitor: The farther the distance between the current pitch and the target pitch, the faster the current pitch movement is.

```
■■■■■■■■■■■■■■■■■□■■■■■■■
      Slew Curve
      Exponential

         -■
```

Also, CV 1-4 can be mapped to set the slew time. Set the menu option "CV 1" or "CV 2" to "Slew Time" for this. If you do this, the CV value will multiply or attenuate the value of the slew knob. A CV of +5V will double the slew, +2.5V will keep it unchanged, and 0V deactivates the slew limiting.

5.7 Control Voltages

The Sinfonion has lots of input jacks for control voltages. Some of them are dedicated to a fixed function. The inputs CV 1 through CV 4 are general purpose inputs and can be mapped to one of a large list of functions. Simply go the the MENU, select CV 1, CV 2, CV 3 or CV 4 and choose the function you like.

```
  ▫▮▫▫▫▫▫▫▫▫▫▫▫▫▫▫▫▫▫▫▫
          CV 2
      Chaotic detune

      ≡≡≡≡≡≡▮≡≡≡≡≡≡≡
```
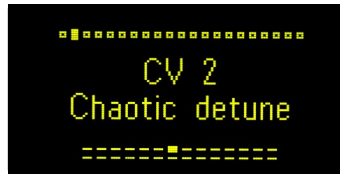
All jacks are normalled to 0.000V internally. Note: if you plug in a cable, this normalization is broken. Now if the other end of this cable is not connected to anything then the input is "floating" and a voltage of approx 2.23V is being read. The reason is that there is no pulldown resistor. This is not a bug but a feature and allows for a very high (i.e. good) input impedance of 1MΩ.

Let's walk through the dedicated CV inputs. Note: all of these are precisely calibrated to *one semitone per selected value*, which is the same as 1/12V. That makes it easy to select items with a sequencer or a CV-keyboard by simply outputting a certain note pitch. Of course you can also use random inputs, LFOs etc.

In order to avoid large voltage spans where the CV input would not be responsive, all CV functions that have a limited number of possible values (e.g. the root note) will wrap around. That way you can use any voltage range from -10.24V to +10.24V for controlling these CV inputs. So for example, the CV for ROOT is *not* limited to a range from 0V to 1V.

The following control voltages are of general interest. This is not a complete list. Further functions are specific to certain sections (e.g. only to Chords) are described in according chapters.

ROOT

Modifies the ROOT note setting. Each 1/12 V changes the root note by one semitone. If you have set the ROOT pot to fully left then this CV will select the exact note that corresponds to the input pitch. For example, if the input pitch is a E0, then E is being selected as root, just as it is the case for E1, E2 and any other E.

Note: setting the root note is **not** the same as transposition.

TRANS

Applies a global transposition of all outputs by the applied input CV, but *quantized to semitones.* Here, nothing wraps around, of course. In order to transpose by 2 octaves, e.g. send +2V. The allowed range is from -10V to +10V.

Most of the CVs do not have a dedicated jack but can be assigned via the menu options "CV 1", "CV 2", "CV 3" or "CV 4". These are:

CV 1-4: Transpose

This CV input is a global transposition just like the dedicated TRANS jack, but *unquantized*. It tracks 1V/Octave very precisely. You can use it for dramatic overall pitch shifts and other funny stuff. Range is -10V to +10V. But as the output pitch jacks are limited to between -2V and +8V, clipping might occur if your transposition is too dramatic.

CV 1-4: Chaotic Note Shuffle

This is a fun CV that shuffles the twelve semitones within each octave. The more voltage you apply the more shuffling happens. The shuffling is applied to all eight outputs. Use this CV for controlled and temporary disharmony.

CV 1-4: Chaotic Detune

Even more chaos: this bipolar CV detunes all eight pitch outputs *independently*. It's a bit like "Transpose" but every output is transposed by a different degree. Half of the outputs are transposed upwards, the other half downwards. You get even more chaos if you do not use a fixed voltage but an LFO. This CV is updated approximately 1000 times per second, so you can modulate the detune with lower audio rates. Try it out!

At 0.0V the there is no detune. At 5.0V, you have maximum detune, and at -5.0V, all voices are detuned by the opposite amount.

During tuning mode the chaotic detune is automatically disabled. It is still applied in the partial bypass mode.

CV 1-4: Harmonic Shift

This is a very musical CV function. It allows a global reduction of harmonic complexity that applies to all channels, chords and the arpeggiator as well. A value of 0V does not change anything, but the higher the CV gets the more interval functions will be reduced. At 5V and higher all sections are being limited to the root note regardless of which buttons are active.

This CV is a good candidate for mapping to an assignable pot. Turning it clockwise will remove more and more harmonic complexity, which can be a nice effect.

The following table shows what happens at certain voltages:

0.0V	normal operation, all intervals allowed
0.7V	FILL1...FILL5 are removed, just scale notes are allowed
1.4V	11th is being removed
2.1V	13th also removed
2.9V	9th removed

3.6V   7th removed, now just root, 3rd and 5th is being played

4.3V   Just root and 5th are active

5.0V   Everything is forced to play the root note

When you apply **negative** voltages to this CV, harmonic functions are being removed in the opposite direction. At -0.7V the root note vanishes, at 1.4V the 5th and so on. This is not quite as useful but leads to interesting results nevertheless.

CV 1-4: Button Preset

This CV selects one of the 16 button presets for you. It's like turning the PRESET knob while you are in *non-sequenced mode.* The CV is bipolar and stepped in 1/12V steps (semitones). It wraps around in both directions every 16 steps.

CV 1-4: Slew Time

Sets the global slew time, just as with the SLEW knob. If you use this CV input, the SLEW pot is turned into an *attenuator*, which means that the knob is multiplied with the CV. So, as long as the CV is at 0.0V the slew is disabled regardless of the knob's position.

CV 1-4: Voltmeter

This CV input turns your Sinfonion into a handy voltmeter with a precision of approximately 1mV[7]. As long as one CV is assigned to this function the display will always show the current voltage:

```
C  Chords        Cmaj

     +2.227 Volts

+0                    4
```
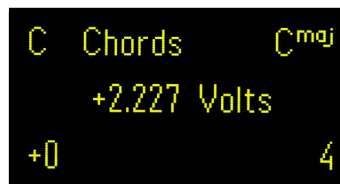
Because of the high precision ADCs, this voltmeter is quite good! Try it out. Check the voltage offset of your buffered multiples. Check the precision of your "precision adders" or your CV sources. And it's really handy for looking around what's going on in your patch.

5.8 Assignable Potentiometers

The Sinfonion provides two assignable knobs POT 1 and POT 2 in the front panel section "ASSIGN".

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7 Remember: the voltage corresponding to one semitone pitch change is <u>83mV</u>!

These can be used to provide direct access all assignable CV functions. This is done with the Menu option POT 1 and POT 2:

Here are some more details:

- Just as some CV functions are bipolar and some unipolar some POT functions have their neutral position in the middle (at 12 o'clock) and others fully counterclockwise.

- If you assign the same function to both a CV jack and a pot at the same time, then the knob turns into an **attenuator** for the CV - and is always unipolar. So turning the knob fully CCW disables the CV, as well as if it is bipolar.

- Even CV functions that already have a dedicated knob (e.g. ROOT) can be assigned to a pot, and will then behave just like the CV. For example, the assigned knob for ROOT will never modify existing sequencer steps, it will just be added when actually quantizing.

- You cannot assign the same function to both knobs.

5.9 Non-tempered Intonations

In western music, the twelve semitones of the chromatic scale are almost always tuned in *equal temperament*. This is very useful since this is the only intonation where all semitone distances are exactly the same — namely a frequency proportion of exactly $2^{1/12}$. That way it is the only temperament that is independent of the key you play in.

It has also a drawback: all intervals except the octave are slightly detuned. A fifth - which should be a frequency proportion of exactly 1.5 - is $2^{7/12}$ in equal temperament. This is a proportion of 1.498. And this small deviation from the 1.500 leads to a slight beating if you play two notes with this interval at the same time.

The Sinfonion offers two alternative temperaments: *just* and *quarter-comma meantone*.

Just intonation

In the Sinfonion you can set the temperament to *just intonation* — also called *pure intonation*. In this mode you get perfect intervals: exactly 2/3 for fifths, 3/4 for fourths and so on. Just

intonation is always related to a specific root note. Because the Sinfonion always knows the current root it can automatically retune all semitones when the root note changes! This is indeed very unique and cannot be done with any other instrument. Select just intonation in the menu option "*Intonation*".

You can select just intonation with the menu option "Intonation".

Quarter-comma meantone

The *Quarter-comma meantone* temperament is a bit of a compromise between tempered and just intonation. This is what Wikipedia says about it:

"*Quarter-comma meantone, or $^1/_4$-comma meantone, was the most common meantone temperament in the sixteenth and seventeenth centuries, and was sometimes used later. In this system the perfect fifth is flattened by one quarter of a syntonic comma, with respect to its just intonation used in Pythagorean tuning (frequency ratio 3:2); the result is 1.5*(80/81)1/4 = 4√5 = about 1.49535 . (The 12th power of that value is 125, whereas 7 octaves is 128.) The purpose is to obtain justly intoned major thirds (with a frequency ratio equal to 5:4). It was described by Pietro Aron in his Toscanello de la Musica of 1523, by saying the major thirds should be tuned to be "sonorous and just, as united as possible."*

You can select quarter-comma meantone intonation with the menu option "Intonation".
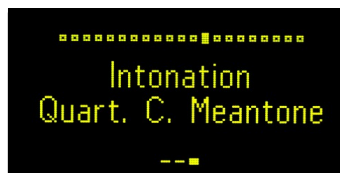
5.10 Factory Reset

If you feel you have garbled things up and want to restart from scratch, there is a feature that resets the Sinfonion to the state in which you have received it. Only the calibration of the DACs is retained.

You can do such a reset at any time by pressing and holding the following five buttons *at the same time*:

1. Channel 3 3RD
2. Channel 3 7TH
3. Channel 3 11TH
4. Channel 3 EQ-DIST
5. Arpeggio BEGIN

Note: There is no such thing as "are your sure?". Pressing these buttons will immediately erase all your songs and reset all global settings and all button presets to their original state and then restart the module. Just the calibration of the DACs remains at it was. You have been warned.

6 Octave Switches & Sections Options

With the button OCT ("Octave") you open and close the section options. Here all of the 52 large buttons are mapped to a different function. It's like a second "page" of buttons. For that reason we also speak of the "OCT page" in this manual.
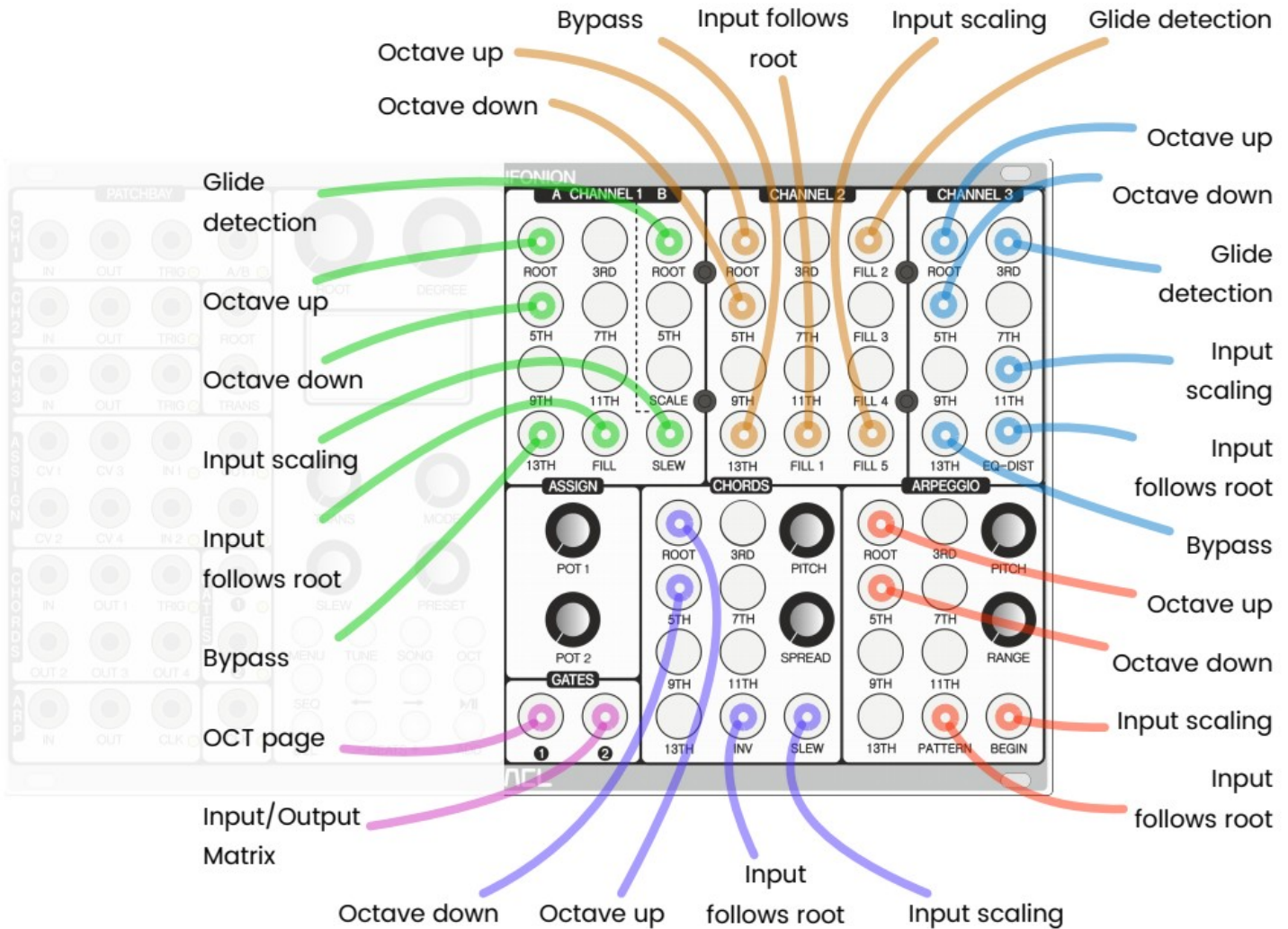
You can let the OCT page stay open as long as you like. The music goes on and everything behaves just as normal - with the exception that each button now has a different purpose. The following image shows the button assignment in the OCT page:

6.1 Octave Switches

The most important feature are the octave switches of Channel 1, 2, 3, chords and arpeggio. In all these five sections the ROOT button switches the pitch *output* of that section up by one octave. 5TH switches one down (in Channel 3 it is the 3RD button).

The total range is +/- 3 Octaves, so there are seven possible settings. While the OCT page is open the display shows the current setting for all five octave switches in the order Channel 1-3, chords and arpeggio:

The illumination of the two buttons indicates the general tendency:

- ROOT is bright and 5TH dim if the octave is at +1, +2 or +3
- both are bright at the neutral position (no octave shift)
- 5TH (Channel 3: 3RD) is bright and ROOT is dim at -1, -2 or -3

The octave switches are part of the current button preset and also of the individual steps in a song.

6.2 Input Follows Root

This feature is available for all five sections and is located on FILL (Channel 1), FILL1 (Channel 2), 13TH (Channel 3), SLEW (chords) and DIR (arpeggio). It toggles between two settings:

- Bright: "IN follows ROOT"
- Dim: "IN is not shifted"

While "IN follows ROOT" is active the input pitch is being shifted by the same musical interval as the distance of the current root from C (in non sequenced mode) or to the root note of the first chord in the song (sequenced mode).

This feature is especially useful if the input is a sequence like a bass pattern or the like. If you change e.g. from C^{min} to F^{maj} then the input will be shifted by a 4th (because F is a 4th away from C). That way the musical line of the pattern will keep as it was - while still being quantized to the correct scale (here from C^{min} to F^{maj}).

If the shift is 7 semitones or more up then it is octaved down instead. So a G^{min} chord would shift **down** by 5 semitones and not up by 7.

6.3 Bypass

Bypassing is a very cool and unique feature, which is not found in any other quantizers. It means that you can effectively turn off quantization and bridge the input directly to the output of a channel. This allows prepared sequences to go through the Sinfonion unchanged. But more than

that! There is a partial bypass mode where transposition, "IN follows ROOT" and other modifications are still active. This opens a whole bunch of new musical possibilities.

The bypass mode is made possible by the high precision ADCs of the Sinfonion, which read the input pitch with a precision of about 1mV. The DACs output the pitch with a precision of another 1mV which adds up to just about 2mV of possible deviation in the worst case. This is in the range of the best buffered multiples and corresponds to about at most 2 cents of detuning[8].

Channel 1, 2 and 3 have a bypass button. It is located at 13TH in the OCT page. The bypass button toggles through three possible settings for that individual channel:

1. Bright: "Normal, Quantize". This is the normal operation

2. Dim: "Bypass + Transpose". This is **soft bypass**. The input voltage is being sent 1:1 to the pitch output but the following modifications are still being applied on its way:

    ◦ octave switches
    ◦ global transposition (via knob or CV)
    ◦ CV function "Chaotic Detune"b
    ◦ CV function "Pitch Bend"
    ◦ "IN follows ROOT"

3. Off: "Bypass". This is a **true bypass**. The input voltage is passed through to OUT without any modifications

6.4 Input Scaling

In the OCT page the buttons SLEW (Channel 1), FILL5 (Channel 2), 11TH (Channel 3), SLEW (chords) and BEGIN (arpeggio) to toggle between four different input scalings, i.e. different ways of how to translate the input voltage into a pitch:

- Bright: "1 Volt / Octave" - the default setting
- Dim: "2 Volts / Octave"
- Dim: "3 Volts / Octave"
- Dim: "5 Volts / Octave"

In the settings 2, 3 and 5V/Oct the input voltage is divided by 2, 3 or 5. This is just like putting an attenuator before the input and is useful if your input pitch is generated by an LFO or a random voltage source. These usually have ranges of at least 0V to 5V or even -5V to 5V, which would correspond to 5 or 10 octaves — way too much.

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8 One semitone corresponds to 83.3 mV.

If your LFO outputs -5 to +5V and you set the input to "5 Volts / Octave" then the resulting pitch is translated into -1V to +1V before quantizing it - a range of just two octaves. This is musically much more useful as 10 octaves than it would be with the standard setting.

Note: the total *input* range of all CV inputs of the Sinfonion is -10.24V to +10.24V. This spans over 20 octaves. In favour of the best possible accuracy the *output* range is limited to the musically interesting range of -2 V to +8 V (10 octaves). We found this asymmetry to be most useful.

6.5 Slew Detection

Channels 1, 2 and 3 support an automatic detection of slews (aka glides, slides or portamento) from the input pitch and can reproduce these glides at the output. This allows you to keep your cool sequencer patterns alive while still being able to requantize them!

This feature is enabled with the button ROOT at side B (Channel 1), FILL 2 (Channel 2) and 3RD (Channel 3). If you quantize LFOs or random voltages then you probably want to turn it off.

7 The Quantizer in Detail

As we saw at the beginning of the manual each quantizer channel reads an input pitch voltage from to its respective IN jack, quantizes it to a pitch that corresponds to one "allowed" semitone and outputs that at the OUT jack. The allowed semitones are selected from the current scale via the buttons ROOT, 3RD and so on.

Now, let's dig into the many details and functions that the Sinfonion offers - many of which go way beyond anything found in other quantizers. The following flow chart gives you an overview of how the pitch information is flowing from the inputs jack through all internal operations to the output jack. Many of the following features also apply for the Chords and Arpeggio sections:

ACL Sinfonion Version 1
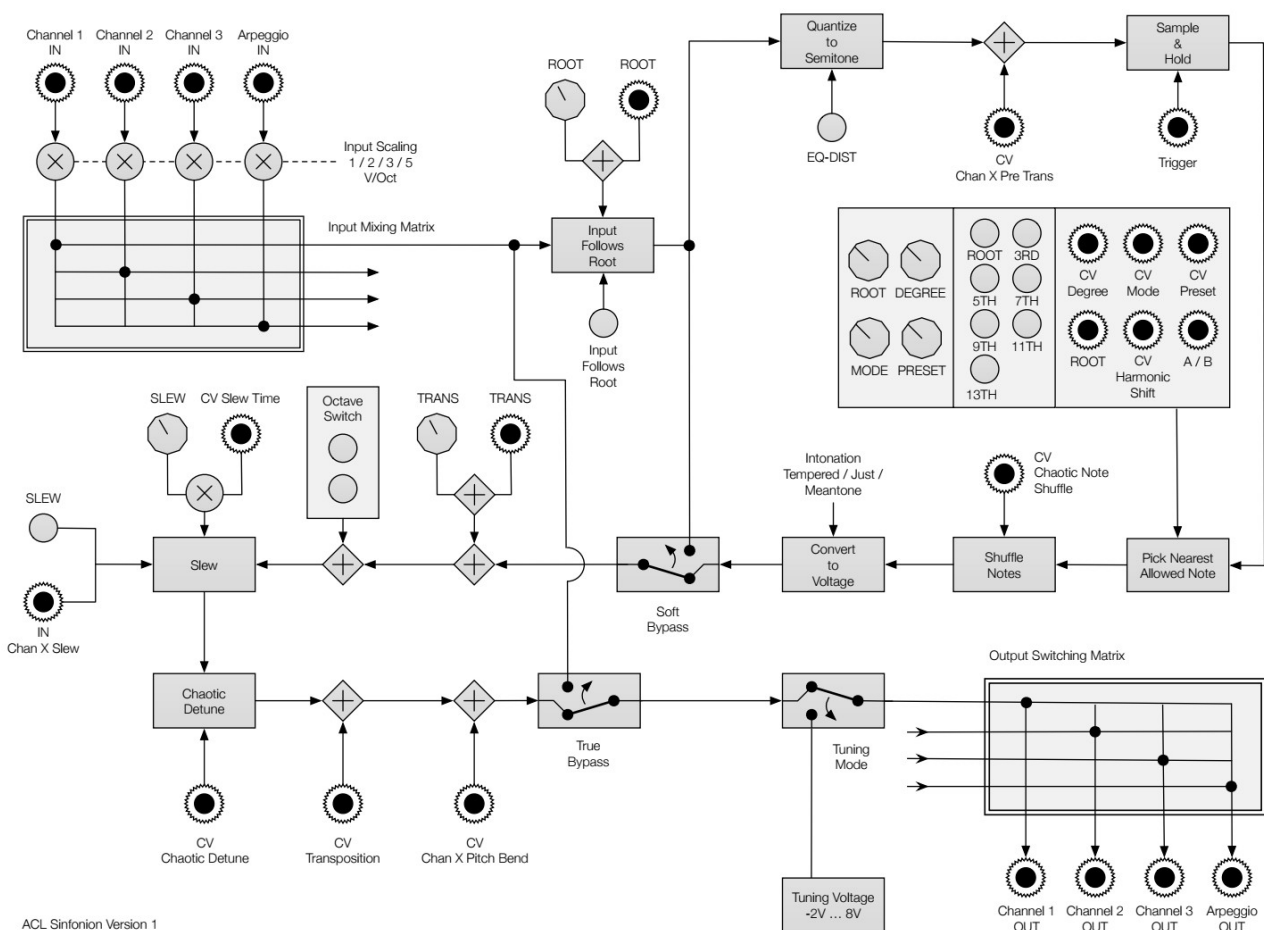
7.1 Input Trigger (Sample & Hold)

Each quantizer channel (and also the Chords section) has an input jack labelled TRIG. This allows you to switch from a continuous quantization to one that is triggered at defined points in time. The Sinfonion automatically detects whether a cable is plugged in. If this is the case, then

quantizing just takes place at the exact time where there is a positive trigger *edge* (the voltage going from 0V to something above 3V). Changes of the input pitch at the IN jack are ignored in all other times. This is like a "sample & hold" for the pitch input.

Triggered operation is useful if the input pitch behaves "chaotic". Good examples are random voltages (even white noise does it) and LFOs.

Please note that changes to the output pitch can still happen though even without any trigger, namely in the following situations:

- If the global transposition (knob or CV) is being changed
- When the CV "Chaotic Detune" changes
- When the CV "Pitch Bend" changes

When the channel is set to bypass then the trigger is ignored and is bypassing all the time.

Sequencers with some latency

If your input pitch is created by a sequencer then you probably do not need a trigger since the input pitch will be correctly timed. If you want to work with a trigger anyway, then please understand that triggers can make things worse here because of timing issues: Most sequencers – especially the digital ones – need a few milliseconds for establishing the correct pitch **after** the gate has been sent. If you use the gate as trigger for the Sinfonion then it will always happily stay behind by one sequencer step!

You can fix this with the global setting "Trigger Time Window". The default setting is "0 ms", which turns the feature off. My experiments have shown that for example for the Cirklon sequencer[9] needs up to 7 ms until the pitch output has reached its target voltage. So setting the trigger time window to 7 ms makes the Sinfonion respect the input pitch not just when the trigger happens but also during a period of 7 ms from that point of time.

Note: The trigger time windows does **not** just delay the trigger by the set time. Instead during

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9 A really great sequencer, thanks to Colin for this :-)

this time window the quantization is done continuously. This avoids unnecessary latency in the pitch output. If the sequencer is reaching the target pitch faster then the correct output pitch will also be set faster.

IN 1/2 Function Quantize Ch1-3

For each channel there is a mappable function for IN 1/2 called "Quantize Ch N". When used a positive signal forces immediate and *continuous* quantisation — other than the trigger jack — which just recognises the positive edges of the signal and just quantized once. This function can be used to "switch off" triggered mode for a while.

Also for the Chords section such an IN function exists: "Quantize Chords".

7.2 Autogates

You can have the Sinfonion automatically create an output trigger signal whenever a channel quantizes to a new semitone. Such triggers are called "Autogate". There is no dedicated jack for this but you can map OUT 1 or OUT 2 to this function.

There is one dedicated automatic gate for Channel 1, 2 and 3, which have their own menu option each:

The duration of such an automatic gate is 10 milliseconds.

Note: using an automatic gate and an input trigger at the same time is no contradiction but in fact very useful! The auto gate will just fire if the output pitch actually changes - not each time the input trigger is being received.

7.3 The FILL Buttons

Channel 1 has a button labelled "FILL". This button selects the remaining five semitones that are **not** part of the current scale. E.g. when you are in C minor, then the FILL button selects D♭, E, G♭, A and B - all of which are not contained in C minor.

This can be used in different musical ways. If you want chromatic quantization then simply enable all buttons including FILL. Just the FILL without any other buttons gives you a pentatonic scale that is completely out of the current scale and creates the maximum disharmony that's

currently possible. You can use this for "dramatic" moments.

Channel 2 has one dedicated button for each of the five semitones that are not part of the scale. This allows full access to all twelve semitones. That way you can use Channel 2 a bit like a "classical" quantizer that offers one button per semitone - just with the important difference that all buttons are related to a certain scale.

The five FILL buttons are not mapped randomly to the five missing notes but are ordered from lower to upper in the following way (examples are for C minor):

- FILL1 ⇒ the alternative 9th (D♭)
- FILL2 ⇒ the alternative 3rd (E)
- FILL3 ⇒ the alternative 4th or 5th (G♭)
- FILL4 ⇒ the alternative 6th (A)
- FILL5 ⇒ the alternative 7th (B)

By "alternative" we mean the according chord function that's *not* contained in the scale. E.g. a minor scale has a minor 3rd, so the alternative 3rd is the major 3rd. So deselecting 3RD and selecting FILL2 will convert major into minor and vice versa!

7.4 Channel 1: A/B-Switch

As you can see from the front panel, Channel 1 is divided into side A and side B. This feature is great for creating musical bass lines from a random input. The idea behind this is that when you want to create a logical bass line you usually play the root note at the beginning of each bar. This is common in many styles of music — even in jazz where harmonies are complex and the bass walks around using nearly all available 12 notes. Playing the root note at regular times lets the listener "lock in" to the current scale and chord.
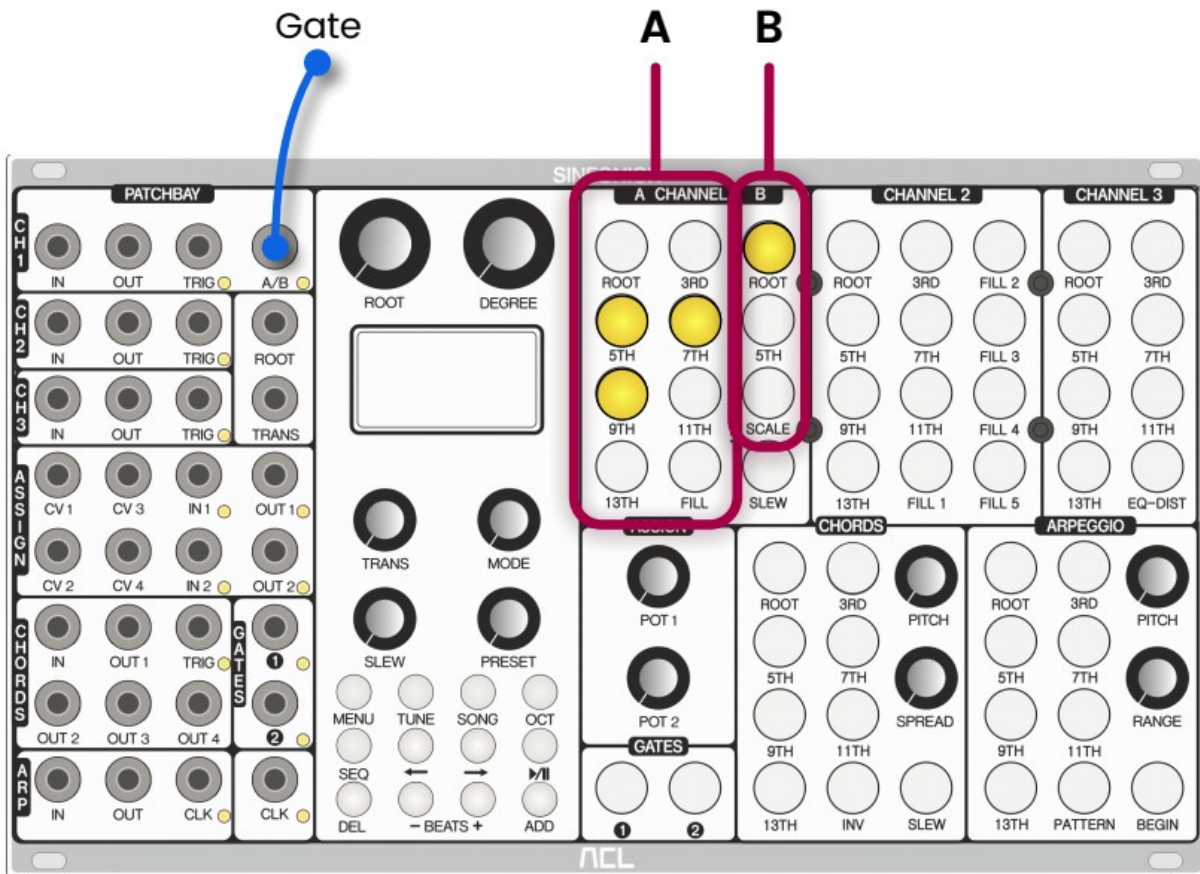
You can try out the A/B feature as follows:

- Feed a (quantized or unquantized) random sequence into IN of Channel 1.

- Patch a steady clock into the CLOCK jack of the sequencer (the right of both CLOCK jacks) and enable the sequencer.

- Create a simple sequence with just one bar and four beats in it

- Now go to the menu and set "Channel 1 A/B" to "each odd beat"
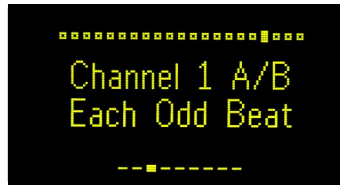
- And now in the A side of Channel 1 select 5TH, 7TH and 9TH, whereas in side B just select ROOT

As the sequencer goes through the four beats, you will now notice that at beat 1 and 3 the root note in the side B is being selected and on 2 and 4 one of the notes in A. That way the Sinfonion enforces a root note on beat 1 and 3.

You can simply try out the difference by deselecting ROOT in B. If nothing is selected on one side then just the other side is being used, so now just A is used. The bass line will immediately sound more random and chaotic.

As you have seen in the menu, there are a whole bunch of different options for when to select A or B. Instead of using the beat, you also can use the clock. The difference between beat and clock is that beats are counted after the sequencer's internal clock divider. If that is e.g. set to 8 then for every 8 clocks there is one beat.

Note 1: The A/B switch via clock or beat also works if the sequencer is disabled. In that case it is assumed that every bar has four beats.

Note 2: When you base the A/B switch on the clock then the current sequencer clock divider setting for the current song is important. If this is set to 1 (which is the default) the clock will *never* go beyond 1! And thus you always stuck to B. I suggest setting it to at least 4. Also in non-sequenced mode you can set a clock divider (with the same menu option). It single purpose is to support the clock based A/B switching.

An alternative to using the clock is the dedicated A/B input jack for Channel 1. Set the menu option "Channel 1 A/B" to "via jack A/B" in order to use this jack. Now whenever this jack reads something above approx. 3 V Channel 1 will switch to B.

7.5 Channel 2 Single Note Mode

Channel 2 is the only channel with direct access to all possible 12 semitones. This brought up the idea to use this channel as a kind of keyboard for playing notes. This is called the "single note mode" and can be enabled with the menu option "Channel 2 Buttons".

When enabled, Channel 2 behaves slightly differently: As soon as you press any of the 12 buttons, all other 11 buttons are immediately turned off. That way you force the quantizer to just quantize to that single note. Of course the input pitch is still being recognized but it is just used for setting the octave.

Now, you can play melodies in a strange way — namely by playing logical scale notes instead of direct pitches. Try it out — this is interesting. Especially if you have the sequencer running and frequent chord changes happen.

When Channel 2 is in "single note mode" then you can use the OUT 1/2 function called "Ch 2 Manual Gate". It is high while you hold a button of Channel 2 and low the rest of the time. That way you can use this channel a bit like a "mini keyboard".

7.6 Channel 3 EQ-DIST: Equidistant Quantizing

Channel 3 offers another quite unique feature, which is very useful if you use random data or LFOs as pitch input. This is best illustrated by an example.

Guess you have enabled ROOT, 5TH and 9TH and patched a random voltage to the IN jack. Then these three notes will not be played the same amount of time! This is because their pitches are quite unevenly distributed within the octave. ROOT and 9TH are close together, 5TH is at larger distance somewhere in the middle.

When EQ-DIST is enabled then the Sinfonion divides the octave of the input pitch into three (or as many as needed) evenly spaced ranges and thus makes sure that all selected notes get their same share of the input range. This makes absolute sense. Try it out!

7.7 CV 1-4: Chan X Pre Trans

There is an assignable CV function for each channel called "Pre Transpose". This allows you to simply add a voltage to the pitch input for that channel. Why would you do that? Couldn't you simply use a mixer module that adds the two voltages before sending them to the Sinfonion? Yes, you could. But "Pre Transpose" is more convenient since it saves you an extra module.

Some musicians use this for combining two sequencers: One for a kind of melody and a second much slower one for shifting the melody up and down a few notes every second bar or so. They send the pitch of the melody sequencer into the IN jack and the pitch of the "modulation"

sequencer in the pre transposition CV.

You also can use one of two the assignable pots for this function for quickly pitching a melody up and down.

Note: This all happens **before** the quantization. So you always stay in the correct musical scale. If unsure please check the flow chart.

7.8 CV 1-4: Chan X Pitch Bend

Just as for the Chords section also for the three quantizer channels there are CVs that allow you a pitch bend of the output pitch. It will modify the pitch by two semitones per 5.0 V. It's main use is creating a vibrato, but as always in modular you will surely find some nice "misuse" of this feature.

Very convenient is the fact that the pitch bend is being disabled during tuning mode.

8 The Arpeggiator

The arpeggiator of the Sinfonion is probably its most surprising section. In the beginning it was designed to play simple patterns like D – F – A – C in a row. This is virtually a chord played sequentially with a single voice, like in ancient computer games. Later, it turned out that many more amazing and unexpected musical things can be done with the arpeggiator. But let's start from the beginning.

In order to use the arpeggiator you need to:

- Patch a voice to its OUT jack.
- Patch a trigger or clock it at its CLOCK jack.

The general CLOCK jack of the sequencer (to the right) is normalled to the Arpeggio, so if you already have patched that then you can reuse it (as long as you do not want a slower, faster or more sophisticated pattern)

Now every time the CLOCK jack receives a trigger signal the arpeggiator selects *the next* note according to the currently selected pattern and outputs that to its OUT. But what does *next* mean exactly?

8.1 Note Selection

Select the allowed scale notes with the buttons ROOT, 3RD, and so on. This is the "material" the arpeggio works on. Note: If you do not select any buttons then just the ROOT note is being selected (just like in all other sections of the Sinfonion).

8.2 Input, Pitch and Range

The arpeggio's lowest note is defined by the input pitch at its IN jack plus an offset from the RANGE knob (which goes over four octaves). The lowest note of the arpeggio pattern is that which is just at or above the input pitch. There is also a CV function "Arpeggio Pre Trans" that is also added to the input pitch.

The range knob then selects the *number of semitones* of range from the lowest to the highest output pitch. This is *not* the same as the number of notes to play in that range. For example if you select the range to be one octave and have selected ROOT, 3RD, 5TH and 7TH in a C^{maj} scale and the pitch is set to C2 then the notes C2, E2, G2, B2, C3 are being played in one turn.

The range knob can select up to five octaves of range.

If you set the range to 0 then the arpeggiator behaves almost like a normal quantizer channel as it always selects the note that is closest to the input pitch – just with the exception that it always needs a trigger at CLOCK in order to "read" the input pitch.

8.3 Pattern

The PATTERN button walks through eight possible arpeggio patterns. These patterns are like some fundamental "melodies" and define the order of the notes. The following patterns exist:

- **Up**: Notes are being played from lower to upper until the top of the range is being reached. Then it starts again from the lowest note.
- **Down**: Starts the arpeggio at the top most note and plays downwards.
- **Up/Down**: Goes up first and then note by note down again.
- **Down/Up**: Same but starts at the top of the range and first goes down then up.
- **Baroque**: This is like Up/Down but plays a more sophisticated pattern. It always goes two steps forwards and one step backwards.
- **Octaves**: Like up, but every note is played twice: once normally and once one octave higher. This octaved note can go beyond the selected range.
- **Brownian**[10]: Goes randomly up and down — but just by one note each time.
- **Random**: Randomly chooses any of the allowed notes within the range. It avoids playing the same note twice in a row — because I believe that this sounds silly.

| Arpeggio Mode Up | Arpeggio Mode Down | Arpeggio Mode Up/Down | Arpeggio Mode Down/Up |
| Arpeggio Mode Octaves | Arpeggio Mode Baroque | Arpeggio Mode Random | Arpeggio Mode Brownian |

If you do not like looping through all eight patterns until you find the one you like, there is a shortcut: Press **and hold** the PATTERN button. While you hold it, press any of the remaining eight buttons of the Arpeggio section. Each of the buttons will immediately select one pattern. For example pressing ROOT will select "'Up", 3RD will select "Down" and so on.

8.4 Reset on Chord Change - BEGIN

The BEGIN button walks through several scale notes like ROOT, 3RD, and so on. There is also a

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10 named after Robert Brown who first detected the fluctuating motion of small particles

setting "Next Note".

When set to "Next Note", the button is deactivated and dark. When it is set to any other setting then a kind of automatic reset feature is being activated. The idea behind this is that you can force the arpeggio to restart its pattern from the beginning at defined points of time. This removes randomness and makes it more plannable.

- If your are in sequenced mode the reset happens every time the sequencer switches to the next song step - even if it has the same chord / scale.

- If you are in non-sequenced mode the reset happens every time the chord / scale changes.

By the way: there is also a trigger input function for IN 1/2 called "Arpeggio Reset" that immediately forces a reset of the arpeggio.

When the reset happens the Arpeggio always begins with the interval that is being selected (e.g. 3rd in our example). This holds even if that interval is currently not being selected.

Just like with the pattern, here is a shortcut for immediately selecting a start note, as well: Press **and hold** the BEGIN button. While you hold it, pressing any of the seven interval buttons will select that as the start note. Pressing PATTERN will select "Next" – thus removing the start note selection.

8.5 The Arpeggio Clock and its Divider

What kind of clock signal should you use for your arpeggio? Basically there are two different options:

1. Using a steady clock, e.g. the master clock of your patch
2. Use some cool and interesting rhythm

Both can musically be useful. Just keep in mind that nobody forces you to use the same trigger for both the arpeggio clock *and* the envelope of the voice attached to it! In fact it's much more interesting *not* to do this.

If your arpeggio triggers happen *slower* than that of your voice then the voice will sometimes play the some note twice in a row.

If your arpeggio triggers happen *faster* than that of your voice then sometimes the voice will *skip* notes from the arpeggio's line.

If you decide to run the the arpeggio with a steady clock, however, there is an interesting feature: a built in clock divider / multiplier that internally changes the speed of the actual arpeggio clock before applying it. This is set in the menu option "Arpeggio Clock". The normalz setting is "1/1" which means that no multiplication or division takes place and the incoming clock is used straight away with no change.

There are 16 possible settings, the first of which is "1/4". This means that the incoming clock is divided by four. In other words for every 4 incoming clock triggers just one arpeggio clock trigger is being generated. The last (fastest) one is "4/1", which will create four arpeggio triggers for each incoming trigger — thus multiplying the speed by 4.

In the middle there are funny things such as "3/2". This is a division and multiplication at the same time and doesn't mean anything other than *triplets*: For every *two* incoming clocks *three* arpeggio clocks are fired.

As an alternative to the menu option you can use the assignable CV "Arpeggio Clock". This CV is bipolar and modifies the clock setting on one or the other direction. When you have activated this CV then the display for the setting "Arpeggio Clock" indicates that the values in modified via CV and shows the actual *resulting* value by saying e.g. **(via CV: 3/2)**:

Now, if you try to use the arpeggio clock multiplier, you will soon detect that triggering your actual voice also needs access to the multiplied clock for that to be of any use. In order to do that there is a mappable output function for OUT 1/2 called "Arpeggio Beat". This will output one short trigger for each arpeggio clock - after division or multiplication has taken place. You even can use this as a flexible clock divider without any voice attached to the pitch output. The Sinfonion — the most expensive clock divider in Eurorack! ;-)

One word about the *timing* of the modified clocks: If you use clock *multipliers* or settings like "3/2" then the Sinfonion has to *interpolate* the original clock and create new triggers at points of time where no input clock is being received. This is done by simple time calculations with a precision of approximately 1 ms. But if your input clock is *not* steady this does not work very well. In order to minimize timing problems in such situations the Sinfonion always gives the incoming clock priority over *interpolated* triggers if possible. Let's assume a setting of "3/1": For one input pulse three output pulses are generated. For the first one of these three the actual input signal is

being passed through — even if it is ahead of time. If it is delayed the Sinfonion waits for it and does not create an artificial beat.

8.6 Arpeggio Trigger Delay

When you use a sequencer for feeding the pitch input of the arpeggiator and that sequencer has a delay for establishing the pitch after a gate (as many have) then you probably end up always being one step behind. The menu setting "Arpeggio Trigger Delay" artificially delays the arpeggio trigger in time.

If you suspect your sequencer lags behind when sequencing the pitch of the arpeggio, you can try out this setting and gradually add 1ms at a time until your timing is fixed and you grab the correct note. Selecting higher values will introduce audible delays, however.
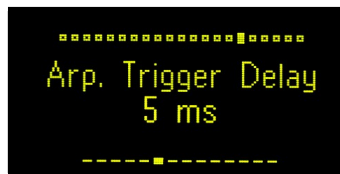
8.7 CV 1-4: Arpeggio Randomize

This CV function for the arpeggiator allows it to randomly suppress arpeggio clocks and sometimes *not* step ahead to the next note. A voltage of 0.0 V or lower completely switches off all arpeggio steps. At 5.0 V or higher the chance is 100%. At 2.5 V there is a 50% chance for an arpeggio clock to actually step ahead the current patterns.

You can use the OUT function "Arpeggio Beat" for getting a trigger every time an actual clock passes through this random gate.

9 The Input & Output Matrices

9.1 The principle

The Input & Output Matrices are something that you wouldn't at all expect in a quantizer, yet it can yield really amazing musical variations with just a fingertip. Implementing the same functionality with external modules would be very cumbersome[11]. What's it about?

With the Matrices, you can juggle around the input and output pitches of channels 1, 2, 3 and the arpeggiator. With just a single button press, melody movements played by one instrument

Input Mixing Matrix

Output Switching Matrix

OCT page   Matrices

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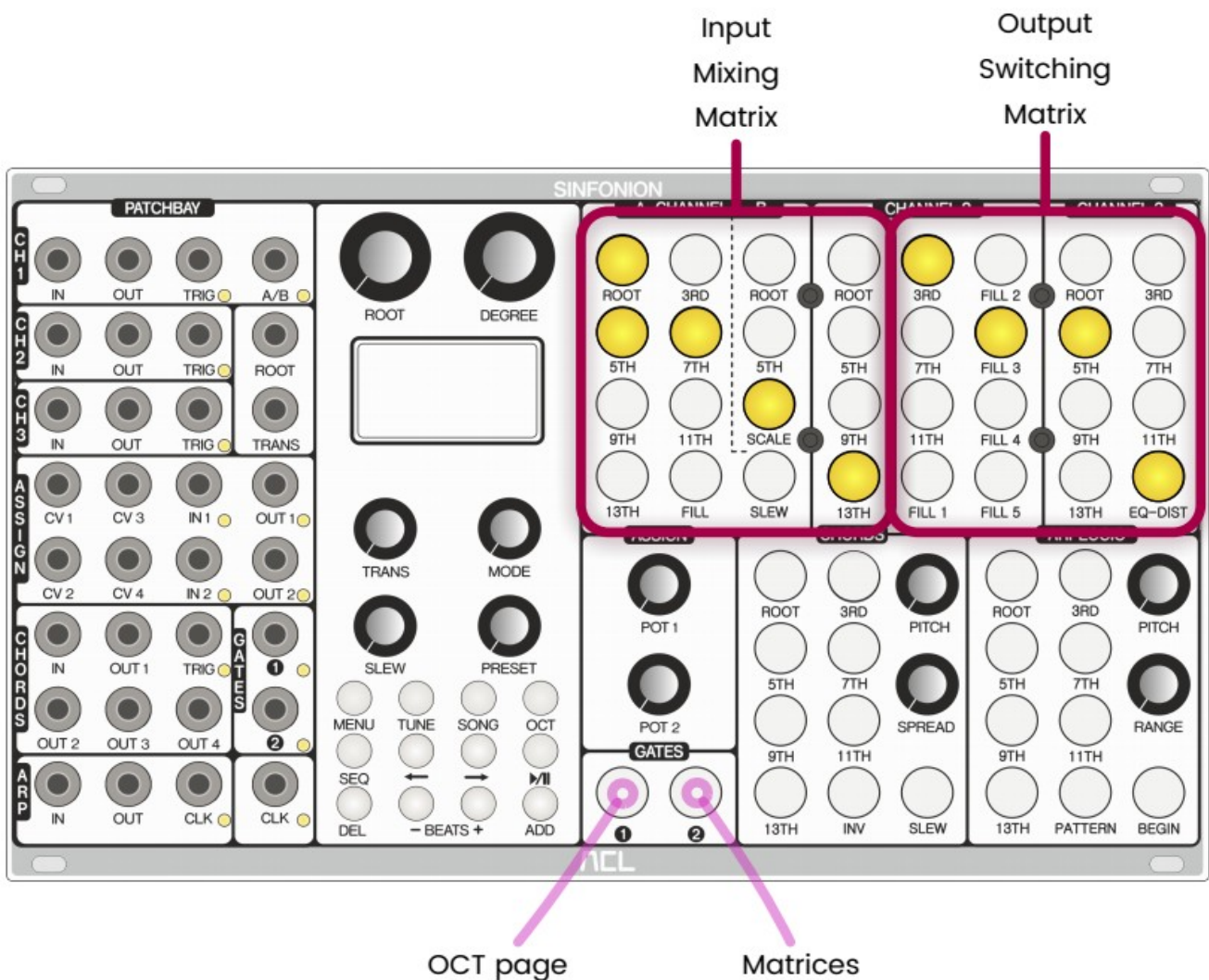
11 Believe me, I've tried it.

suddenly appear in the melody of another voice, voices swap their melodies completely, play unisono and much more. Let's look again at the quantization for chart and see how the input matrix is located at the very beginning and the output matrix at the very end:

The two matrices are:

1. **Input Mixing Matrix**: a 4x4 mixing matrix for the **input** pitches of channel 1, 2, 3 and arpeggio

2. **Output Switching Matrix**: a 4 to 4 matrix for switching the **output** pitches of these sections.

In the default state this looks like this:
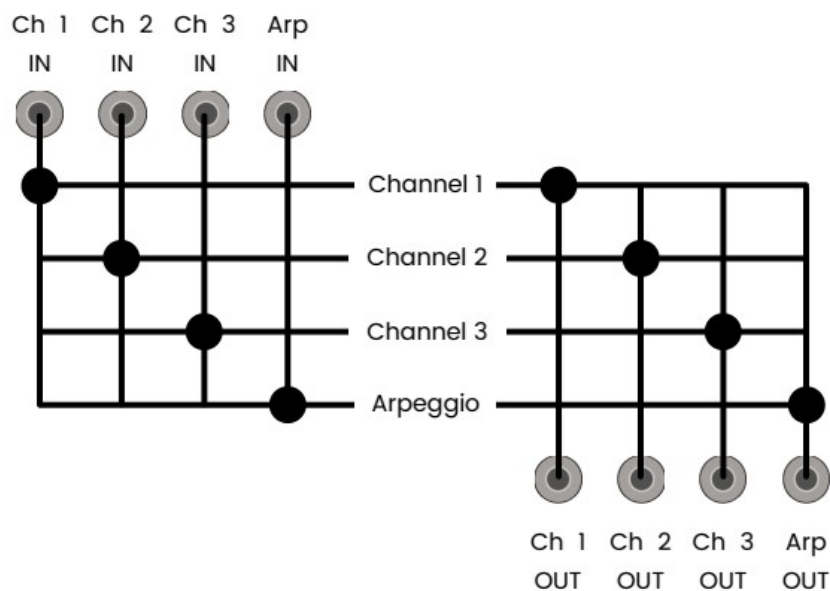
The pitch input of the IN jack of channel 1 is being sent to channel 1, quantized there and output at the OUT jack of channel 1. Not very surprising.

But: changing that routing is where the fun begins. Let's assume you have the following situation:
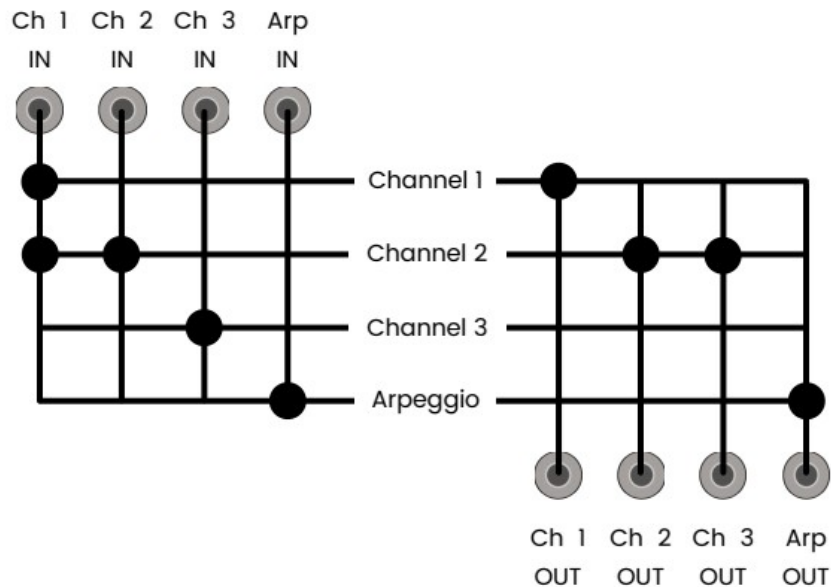
Now let's look at how channel 2 operates here: The pitch that is read at channel 1's IN jack is being **added** to that of Channel 2's IN jack. The resulting input pitch is then quantized through Channel 2. The resulting output pitch of Channel 2 is output not only on Channel 2's OUT jack but also at Channel 3's OUT jack.

How about the other channels? Well, Channel 1 and the Arpeggiator operate as usual and the output of the Channel 3 quantizer is sent **nowhere.**

Note 1: In order to avoid unusably high input pitches, when you mix in several IN jacks to a channel for each channel other than the first **2 octaves are being subtracted** from the result. This means e.g. that C3 + C3 is C4 (and not C6). If no input jack is selected then a pitch of C0 (0 Volt) is assumed.

Note 2: The output matrix really does not mix but only **switch**. Each output jack can only ouput the result of **one** channel. It will not add pitches. Why is that so? Well, because in practice the musical result of a real mixing would not desirable at all (in my opinion). Let's assume you work in a C major scale and add a D3 to an A3. If you compute the according voltages, add them and transfer the result back into a note value the result would be B♭6. This would be out of the scale - besides the fact that it would be ridiculously high. For that reason if you select a new source for an output jack the previous one will automatically be deselected, so that every output jack is connected to exactly one quantizer channel (or the Arpeggiator).

9.2 How to use the Matrices

You can reach the two matrices via the octave page. Bring up this page by pressing OCT. Here you will see that both GATES buttons are illuminated - one dim and one bright. Gate button 1 will be bright if you are in the octave page. Button GATE 2 is bright in the matrix page. Press it to get there. Press button GATE 1 to return to the octave page.

The two matrices are represented by the 8 by 4 area of buttons at the top. The following setting represents our upper example:

While you are in the matrix page, the display shows the state of both matrices in a compressed way. The input mixing matrix is shown as above, the output routings are indicated by just the characters 1, 2, 3 and A (for arpeggio):
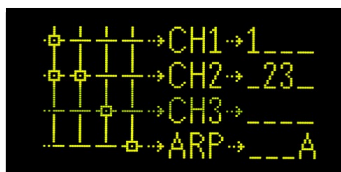
10 The Chord Generator

10.1 General Operation

Four of the eight pitch outputs of the Sinfonion are dedicated to generating chords — or more precisely — to generate the pitch information needed for playing a chord with up to four voices.

In some aspects the chord section behaves like the other three quantizer channels. It has a pitch input jack, a trigger for sampling the input at specific time points, octave buttons and so on. Everything that you have learned about triggers in the quantizer channels 1-3 also is valid for the Chords.

But the main task is creating chords — e.g. synth pads, guitar-like rhythmic patterns or even structures where the four voices have individual rhythms. Most times you won't use the IN jack but simply attach your voices to the pitch outputs and use the PITCH and RANGE knobs to tune in a nicely laid out chord.

Patching a CV source into IN allows you to bring more life into the chords and make them move up and down. If you do so check out the different setting for the chord inversion (INV button).

This is how the creation of the chords works:

1. From the chord's IN jack pitch information is being read. If nothing is plugged, 0V is being read (meaning C0).

2. The PITCH knob of the chord section is adding to this input pitch. This knob has a range of four octaves. The resulting pitch is the basis for the *lowest* note of the chord.

3. From all selected scale notes, the first four are picked. If you select less than four some of the notes will be used twice.

4. The selected inversion decides which of these will be used as the lowest note for the chord to be stacked upon.

5. If the spread is not zero, some of the notes (except the lowest) are moved one or more octaves up in order to space them out.

6. The pitches of the four notes are finally modified according to:

    - The octave switch of the chord section
    - The global transposition via pot, jack, TRANS or the optional CV "Transpose"
    - The optional CV "Chaotic Detune"
    - The optional CV "Chaotic Note Shuffle"
    - The optional CV "Pitch Bend"

And now for more details...

10.2 Note Selection (Voicings)

With the buttons, you select which scale notes (ROOT, 3RD, etc.) should be part of the chord. This is really a big difference from other existing chord generators, which are fixed to root, 3rd, 5th and maybe 7th. Every such selection we call a *voicing*.

If you select more than four buttons, then just the first four buttons are being used. The exceeding ones are shown with dim light.

If you select less than four buttons then some notes will be duplicated. So for example you select just ROOT and 5TH, the root note will be played by two of the voices and the 5th by the other two. If you do not select any buttons, then all voices will play the root note. Why? Well, *some* note has to be played. There is no way for a pitch outputs to be *silent*. There is no such thing as *no voltage*.

We suggest that you set the menu option "Display" to "Chord Structure" so you can see what's going on:

Here you can see the layout of the chord. The numbers denote the scale functions, e.g. 9 means 9th and so on. At the left there is the lowest note. Each dot is one selected chord note that is skipped due to the spread.

Note: In some chords/scales the buttons are remapped. For example in C^{sus} the button 3RD selects the 4th and vice versa. That way the vanilla ROOT/3RD/5TH/7TH selection automatically creates a C^{7sus4} chord voicing.

This is also the case for "slash chords". Here 3RD, 5TH and 7TH is always mapped to the three notes of the triad above the slash. 9TH, 11TH and 13TH then fill the missing gaps of the scale. So these chords work best if you simply select ROOT, 3RD, 5TH and 7TH.

My Favourite Chord Voicings

As an inspiration for you here is a small collection of chord voicings that I personally like most:
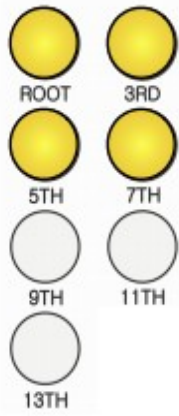
This the default voicing - the classical four voiced chord. Because the 7th is contained you will hear a difference between a C^{maj7} and a C^7. The major 7 in major chords and the minor seven in minor chords sound a bit "lush".
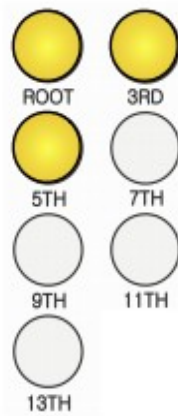
A triad. The 7th is not played but the root note is doubled. This sounds more basic, clear, bright, distinct, but you won't hear the difference between C^{maj7} and C^7.
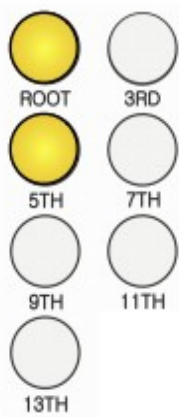
This is even more reduced - just root and 5th. A powerful open sound with no difference between major and minor.
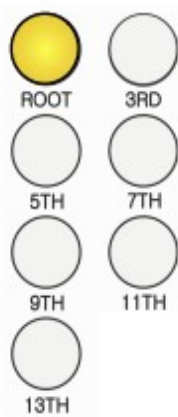
Reduce to the max - just the root note played by all four voices. If you turn up the spread then you can make the four voices play in four different octaves - very fat.
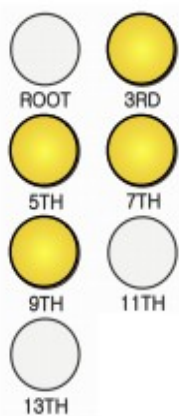
Here we go the opposite way. The root note is being removed. Instead we play the 9th - my favourite interval. This sounds especially nice if the root note is played by a different instrument - prefereably some bass voice. It's a common practice in jazz that the chord instrument omits the root note. Altogether we get a five voiced chord then - which sounds really full and complex.
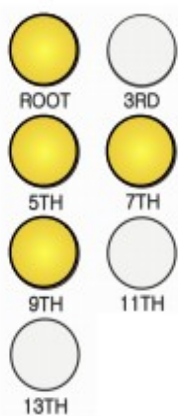
A slight variation where the root is played but the 3rd is omitted. Without the 3rd there is no more distinction between minor and major! This give a cool and open sound with much complexity. Also by adding the 9th we give scales with a ♭9 the chance to show their full character (e.g. C^{hm5} or C^{phr}).
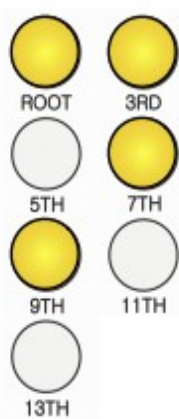
This time we omit the 5th in order to be able to add the 9th. The 5th is the least important note when it comes to the color of a voicing - unless you use one of the rare scales with a dimished 5th.

10.3 Assignment of Notes to Outputs

In order to allow a consistent and tactical patching, there is a fixed mapping of selected notes to the four outputs OUT1, OUT2, OUT3 and OUT4:

- The first selected button is always mapped to OUT1,
- the second button to OUT2,
- the third button to OUT3,
- the fourth button to OUT4.

So if you select ROOT, 5TH, 7TH and 9TH, then OUT1 will also play the root note and OUT4 the 9th. This is independent of the inversion and the spread. This allows you for example to octave down just the root note (by tuning the VCO of that voice one octave lower).

10.4 Inversions

A chord is just a collection of some notes, e.g. C - E - G - B. The inversion of a chord describes the order of these notes. In the "root position" the root note is played as lowest note, the others are stacked upon it. The "first inversion" starts with the 3rd. In our example this would be E - G - B - C, and so on. With the button INV you can either force the inversion to one of the four possible lowest notes or let it run free. When running free the Sinfonion chooses the chord tone as the lowest tone that is closest above the input pitch.

Instead of looping through all five possible inversion settings you can use a shortcut for immediately jumping to one of the settings: Press **and hold** the INV button. Now press:

- ROOT for the 3rd inversion
- 5TH for the 2nd inversion
- 9TH for the 1st inversion

- 13TH for the root position
- any of 3RD, 7TH, 11TH or SLEW for letting the inversion run free

In the mode "slash chords" there is a speciality: the *root* note – if selected – will *always* be laid out as the lowest note – regardless of the selected inversion. This is how slash chord are supposed to sound. Just when ROOT is not selected then the slash chord is missing its "slash" note and thus behaves like any other chord.

10.5 Spread

When it comes to chord voicings, guitar and piano players will know something like "drop 2 voicings" and the like. The Sinfonion does not use this terminology and is not restricted to these classical voicings either. It has a much more general and easy to understand way for laying out chords with more space between the notes.

When the SPREAD knob is fully CCW the spread is set to its minimal value. This means that the chord notes are placed as closely as possible. The more you turn the knob to the right the more space will be placed between the notes. The mechanics behind this tries to space out all four notes as *evenly* as possible. The spread setting basically defines the range between the lowest and highest note in semitones (well, a spread of 0 means a range of one octave, a range of 1 one octave plus one semitone and so on). So first both the lowest and highest notes are being placed at the both ends of the selected range. The remaining two chord notes are then placed as evenly distributed at possible.

This also works nicely with chords that are *not* constructed of root, 3rd, 5th and 7th. It even goes well with strange things like root, 3rd, 7th and 9th, where all notes would be very close without a spread.

Note: Neither the pitch nor the range settings are saved as part of button presets or sequence steps. The setting of the INV button *is*.

10.6 Random Chord Voicings

There is a nice function called "Chords shuffle" that can be mapped to IN 1 or IN 2. Everytime it receives a trigger it shuffles the current selection of the six note buttons[12]. This can bring interesting movement into your patch. You also might want to try putting some random pitch into IN of the chords while using its trigger input for sampling & holding the incoming voltage.

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12 or seven if the SLEW button is mapped to 13TH

10.7 CV 1-4: Chords Pitch Bend

There are several interesting CVs for the Chords section. One is "Chords Pitch Bend". This CV option has originally been created for allowing you to create nice vibratos for your chord section but can be used for other fun stuff as well, of course. The scaling is just two semitones per 5.0 V of input voltage. It is bidirectional, so −5.0 V transposes all chord outputs down by two semitones and +5.0 V transposes two semitones up. So for a nice vibrato patch an LFO through an external attenuator and then into the CV jack.

The nice thing: during tuning mode the pitch bend bend is automatically disabled so you can precisely tune your oscillators.

Also there is another nice feature for this: There is a MENU option called "Pitch Bend Delay". If you enable this then the bend is faded in after each chord change! If used with the LFO this creates a nice *delayed* vibrato. There are four possible settings: None, short, medium and long, which corresponds to a delay of 0, .5, 1 and 2 seconds.

10.8 CV 1-4: Chords Spread

The spreading of the chords - which is usually done with the "Spread" knob - can be automated via CV. The Spread knob does not get useless in the case but turns into a "maximum spread" knob. It works like this:

When using the CV then with the spread knob you select the maximum spread to be allowed by the CV. The CV itself then controls the percentage of this maximum that is being used, which 0V or negative voltages mean 0% and 5.0V or higher voltages mean 100%. So if you select e.g. a maximum spread of 18 semitones a CV of 2.5V will create a spread of 9 semitones. So the knob actually behaves like an attenuator for the spread CV.

10.9 CV 1-4: Chords Voicing

The chord voicing — i.e. the selection of intervals that make up the chord — can also be CV controlled. This is especially powerful if being used with a sequencer since it allows you to create something similar to a four voiced melody — with just one CV. But also random CVs can yield interesting results.

A voicing is a selection of up to four out of seven possible scale notes. If you do a bit of

mathematics (or simple dump counting) you end up with 98 possible voicings. These are

- 35 voicings with four notes
- 35 voicings with three notes
- 21 voicings with two notes
- 7 voicings with one note

In order to allow a precise control with an external sequencer all these 98 voicings are mapped to semitones (i.e. 1/12V steps). At 0V the current voicing is untouched and the Sinfonion behaves like without CV - you select the voicings by pressing buttons. Negative CVs are converted into positive ones, e.g. -2V behaves exactly like +2V. This makes using LFOs as modulation sources more easy.

Please note that selecting a voicing by applying a non-zero CV is just like pressing the buttons. If you are in sequenced mode this will actually *modify* your current sequence steps. Is this a bug or a feature? Well, this probably depends on your taste. I've decided it to do it that way because it is more easy to understand then having "hidden, invisible" voicings that are currently overlayed or shadowed by a CV.

Here is a complete table of all voicings. We assume that C0 is 0V, C1 is 1V, D1 is 1.167V and so on:

Table of all chord voicings

Nr.	Note	Voltage	Voicing	Nr.	Note	Voltage	Voicing	Nr.	Note	Voltage	Voicing
0	C0	0.000V	don't change	1	D♭0	0.083V	1/3/5/7	2	D0	0.167V	1/3/5/9
3	E♭0	0.250V	1/3/5/11	4	E0	0.333V	1/3/5/13	5	F0	0.417V	1/3/7/9
6	G♭0	0.500V	1/3/7/11	7	G0	0.583V	1/3/7/13	8	A♭0	0.667V	1/3/9/11
9	A0	0.750V	1/3/9/13	10	B♭0	0.833V	1/3/11/13	11	B0	0.917V	1/5/7/9
12	C1	1.000V	1/5/7/11	13	D♭1	1.083V	1/5/7/13	14	D1	1.167V	1/5/9/11
15	E♭1	1.250V	1/5/9/13	16	E1	1.333V	1/5/11/13	17	F1	1.417V	1/7/9/11
18	G♭1	1.500V	1/7/9/13	19	G1	1.583V	1/7/11/13	20	A♭1	1.667V	1/9/11/13
21	A1	1.750V	3/5/7/9	22	B♭1	1.833V	3/5/7/11	23	B1	1.917V	3/5/7/13
24	C2	2.000V	3/5/9/11	25	D♭2	2.083V	3/5/9/13	26	D2	2.167V	3/5/11/13
27	E♭2	2.250V	3/7/9/11	28	E2	2.333V	3/7/9/13	29	F2	2.417V	3/7/11/13
30	G♭2	2.500V	3/9/11/13	31	G2	2.583V	5/7/9/11	32	A♭2	2.667V	5/7/9/13
33	A2	2.750V	5/7/11/13	34	B♭2	2.833V	5/9/11/13	35	B2	2.917V	7/9/11/13
36	C3	3.000V	1/3/5	37	D♭3	3.083V	1/3/7	38	D3	3.167V	1/3/9
39	E♭3	3.250V	1/3/11	40	E3	3.333V	1/3/13	41	F3	3.417V	1/5/7
42	G♭3	3.500V	1/5/9	43	G3	3.583V	1/5/11	44	A♭3	3.667V	1/5/13
45	A3	3.750V	1/7/9	46	B♭3	3.833V	1/7/11	47	B3	3.917V	1/7/13
48	C4	4.000V	1/9/11	49	D♭4	4.083V	1/9/13	50	D4	4.167V	1/11/13
51	E♭4	4.250V	3/5/7	52	E4	4.333V	3/5/9	53	F4	4.417V	3/5/11
54	G♭4	4.500V	3/5/13	55	G4	4.583V	3/7/9	56	A♭4	4.667V	3/7/11
57	A4	4.750V	3/7/13	58	B♭4	4.833V	3/9/11	59	B4	4.917V	3/9/13
60	C5	5.000V	3/11/13	61	D♭5	5.083V	5/7/9	62	D5	5.167V	5/7/11
63	E♭5	5.250V	5/7/13	64	E5	5.333V	5/9/11	65	F5	5.417V	5/9/13
66	G♭5	5.500V	5/11/13	67	G5	5.583V	7/9/11	68	A♭5	5.667V	7/9/13
69	A5	5.750V	7/11/13	70	B♭5	5.833V	9/11/13	71	B5	5.917V	1/3
72	C6	6.000V	1/5	73	D♭6	6.083V	1/7	74	D6	6.167V	1/9
75	E♭6	6.250V	1/11	76	E6	6.333V	1/13	77	F6	6.417V	3/5
78	G♭6	6.500V	3/7	79	G6	6.583V	3/9	80	A♭6	6.667V	3/11
81	A6	6.750V	3/13	82	B♭6	6.833V	5/7	83	B6	6.917V	5/9
84	C7	7.000V	5/11	85	D♭7	7.083V	5/13	86	D7	7.167V	7/9
87	E♭7	7.250V	7/11	88	E7	7.333V	7/13	89	F7	7.417V	9/11
90	G♭7	7.500V	9/13	91	G7	7.583V	11/13	92	A♭7	7.667V	1
93	A7	7.750V	3	94	B♭7	7.833V	5	95	B7	7.917V	7
96	C8	8.000V	9	97	D♭8	8.083V	11	98	D8	8.167V	13

11 Scales and Modes

11.1 Scales vs. Chords

The Sinfonion is all about chords and scales. The Sinfonion's harmonic system is derived from jazz, and so chords and scales are essentially the same. As an example let's look at a C major scale:'

<p style="text-align:center">C D E F G A B C</p>

You get this scale if you select the ROOT note "C", the MODE "Chords" and the DEGREE "C^{maj}". Now let's highlight every second note:

<p style="text-align:center">**C** D **E** F **G** A **B** C</p>

The first three (root, 3rd and 5th) are C-E-G - a C major triad. If you go one step further to B (7TH) then you get a four voiced C^{maj7} chord. Jazz musicians like to extend this even further by simply continuing this pattern:

<p style="text-align:center">**C** D **E** F **G** A **B** C **D** E **F** G **A**</p>

The next three notes are D (9th), F (11th) and A (13th). This results in a C$^{maj7/9/11/13}$ chord: C-E-G-B-D-F-A. Because this sounds quite strange most times you would omit some of the notes when actually playing this on a piano or synth. But as you can see in this example a scale can be viewed as a seven voiced chord. So chords and scales are essentially the same.

This is also the reason why the Sinfonion has no such thing as "custom scales". This concept is not necessary. Simply choose a scale that matches your scale as closely as possible and remove notes (by not selecting some of the seven scale notes) or add notes (with the FILL buttons).

11.2 The Mode

In the short introduction you have already seen the knobs ROOT and DEGREE. There is a third knob for selecting the actual scale: MODE. The name mode is derived from the concept of a musical *mode,* like major or minor. You also can regard each mode as a collection of up to 12 different scales. These are the modes of the Sinfonion:

Chords

When you are used to "classical" quantizers, please note the Sinfonion has a very different concept of a "scale". In other quantizers a scale is just a subset of the 12 possible semitones. So for these the scale C D E F G A B C (C^{maj}) is really the same as D E F G A B C D (D dorian minor). For the Sinfonion this is not the case at all, since the buttons ROOT, 3RD and so on will be

mapped to completely different notes!

A collection of the most common scales used in popular music. Most times this is the only mode that you will need. The notation of the chords is simplified in this mode and differs from all other modes. The scales of this mode are ordered in a musical way - starting with major chords. I will use C as the root note in the following explanations:

C^{lyd}: Major chord/scale with a #11. The scale is called lydian - just like the scale that you get if you start at F on a piano and go up all the white keys.

C^{maj}: Major chord with ionian scale - this is the classical major scale - the pillar of all children songs.

C^7: Dominant chord with mixolydian scale (minor 7). You get a G^7 scale when you go all white keys from G to G on a piano. This scale is also the base tonality of blues.

C^{sus}: Dominant chord with suspended 4 and mixolydian scale. Note: this is the same scale as for C^7 but the mapping of the buttons 3RD and 11TH are swapped. So if you have selected a chord voicing of ROOT, 3RD, 5TH and 7TH you will essentially get ROOT, 4TH, 5TH, 7TH - which is exactly the C^{7sus4} chord.

C^{alt}: C^7 chord with ♭9 and altered scale. This scale is one of the seven scales of the melodic minor mode and has a strange and interesting sound - especially as a dominant for a minor tonica. This scale is mainly used in Jazz but I've added it here as an inspiration for everyone because it sounds so cool ;-)

C^{hm5}: C^7 chord based on a harmonic minor scale starting from the 5th. This is one of my favourite scale and sounds very "spanish". It is also known as "Spanish Gypsy Scale", "Phrygian Dominant Scale" or "Spanish Phrygian Scale"). You can use it as a dominant for a minor scale or even "stand alone" - without any further chord changes.

C^{dor}: Minor seventh chord with major 13th ($6^{th)}$) (dorian scale). This is not the usual minor scale but one with a raised 13th. This scale is by far the most commonly used minor scale in Jazz and an absolute winner if you play "modal", i.e. without any chord changes. The major 13th sound much more interesting and "spicy" then that minor 13. Try it out!

C^{min}: Minor chord with plain old natural minor scale (aeolian, using ♭13). This is the most common minor scale in non-jazz music.

C^{hm}: Harmonic minor scale. This scale is like natural minor but with a major 7th and has a one-and-a-halftone step between the ♭6th and the 7th. Great sound. C^{hm} and G^{hm5} share the same seven notes.

C^{phr}: Phrygian minor scale. This is like natural minor but with $\flat9$ and sounds darker. You get a E phrygian scale if you play the white keys from E to E.

C^{dim}: Diminished chord and diminished scale. This scale consists of 8 notes. Here the 13TH button selects *two* notes. The diminished scale starts with a whole tone and the repeats halftone and whole tone steps.

C^{aug}: Dominant seventh chord with #5 and the augmented scale, which consists of just whole tone steps. This scale has only six notes! The 13TH button is unused in this scale. The FILL button from Channel 1 now includes 6 missing notes - not five.

Chords2

This is a second collection of chords/scales, which are less common, but all the more interesting! These are:

$C^{7\#11}$: This major scale belongs to the melodic minor/altered scale and is very popular amongst jazz musicians. It's the mixolydian scale but with a raised 4th. Very airy with just a nice amount of strangeness.

$C^{7\flat13}$: The melodic minor scale from the 5th. This time we lower the 6th in mixolydian.

$C^{sus4\flat9}$: This is just like C^{sus4} - a mixolydian scale where 3rd and 4th have been swapped. But here we lower the 9th, which gives a strange and more dark and aggressive sound.

$C^{7\#9}$: I'm not completely sure if this chord symbol is ideal but I could not think of anything more appropriate: what it means is a scale with eight notes called the "halftone whole tone scale". Sometimes it is also called "octatonic scale". It means that the scale starts with a halftone and then alternates between whole tone and halftone. It contains both the lowered and raised 9th. This means that if you select the 9th then you actually select two notes at the same time: the $\flat9$ and the #9! Note: this is essentially the same scale as the diminished scale (C^{dim}), but that one starts with a whole tone.

$C-^{\triangle7}$: A melodic minor scale, which means that it has both a raised 6th and a major 7th. This is a nice alternative to the natural minor scale (aeolian).

$C^{\triangle7\#5\#11}$: This looks strange but is actually the melodic minor scale played from the 3rd. The chord is a major 7 chord with a raised 5th! Try it out!

$C-^{7\flat5}$: A plain locrian scale, which is the same as a bog-standard major scale played from the 7th. In common chord minor progressions this scale is on the 2nd and leads to the 5th.

Slashch.

So called "slash chords". These are constructed by putting a triad above a root note. The Sinfonion just features slash chords where the root note is not contained in the triad, because those are just inversions for normal chords.

As an example for a slash chord take a D major triad over a C root note. This is denoted as D/C - hence the name. The chord is made out of C, D, F# and A. You might notice that this is just an inversion of D^7. Something similar holds for all of the slash chords in this mode. But there is a subtle difference for the chord generator: Regardless of which chord inversion you select with the INV button - the root note will always stay the lowest note, just the triad is being inverted!

Major

This mode is a compilation of all seven chords of a full major cadence plus five additional chords, which are also useful. Here you will see that the root note of the chord changes when you change the degree. For example if you are in C major the 5th is G and the canonical chord for that is G^7. So G^7 is being used and not C^7. That way if your song stays in one key you just need to play with DEGREE and can have the root note unchanged.

This is especially interesting when using the assignable CV DEGREE for selecting the degree. It is best to set the DEGREE knob fully CCW in this case. Each 12th Volt of input voltage (which corresponds to one semitone) selects on degree. And if you set the root note to C, the input "pitch" exactly matches the base note of the selected scale degree. For example if you send the CV for the note G (regardless in which octave), always the chord/scale G^7 is being selected. If you send a CV for a note that is not part of the scale then you get one of five scales that are based on other notes. For example sending a $C^#$ in C major then you will get a $C^#$ lydian major scale.

Minor

This mode is very similar to "Major" but this time it's a full natural minor cadence - again with five extra scales based on the non-scale notes.

Mel.Minor

Alle seven degrees of a full cadence in melodic minor. Note that this mode does not use ionian scales but altered scales. The first chord is C minor with a major 7th and a major 6th. One of my favourite scales!

Har.Minor

This is a cadence with all seven chords / scales that are derived from harmonic minor. This

scale has one whole-and-a-halftone step. Especially the G[7b9] scale in this mode is popular and is also called the "spanish scale" or "phrygian dominant scale". It has a very specific and well known sound and is a nice change from the omnipresent minor pentatonic. In the mode Chords you find this scale with the suffix hm5.

Har.Major

The harmonic *major* scale is a major scale with a ♭6 and one whole-and-a-halftone step. Rarely used, strange sound, interesting. Again the mode consists of the seven chords derived from that scale.

Db.H.Maj

Even stranger is the double *harmonic major* scale with *two* one-and-a-whole-tone steps.

11.3 Display modes for scales

As we have seen in this chapter, each of the chords in all these modes are basically just names for scales made of 7 (in rare cases 6 or 8) notes. If you are curious which these are then set the menu option "Display" to "Scale Tones" and you will see:

There is also a display mode called "Scale Structure":

In that mode just the intervals between the notes are being shown. Each bullet denotes a scale note, the small tildes show semitones that are not part of the scale.

12 The Chord Progression Sequencer

12.1 Basic Principle

Just in order to avoid confusion: the built in sequencer of the Sinfonion only sequences *chords,* not melodies or rhythms. For that reason we sometimes call it a *chord progression sequencer.* The sequencer automatically switches from chord to chord just as when you play music from a lead sheet. This is a completely new concept in Eurorack, and it is really simple.

The Sinfonion stores 16 songs (numbered from 1 to 16). Each song consists of four parts (A, B, C and D). Each part can have up to 32 steps (chord changes). This makes a maximum of 2048 song steps in total.

You activate the sequencer by pressing SEQ. The PRESET knob now turns into a song selection knob and lets you choose between the 16 songs. If the PRESET knob is totally CCW then you start in song 1 and part A:

If your Sinfonion is new (or reset to its default state) this song part consists of just one step. Every song step has of the following settings:

- A root note, degree and mode (resulting in a chord/scale).

- The number of *beats*. The default is 4. The maximum number of beats in a step is 128. You can think of steps as quarter notes and in most cases you will have something like 4 or 8 beats.

- A setting of all of the 52 large buttons - including things like the arpeggio pattern (DIR) and the chord inversion (INV).

- The current setting of the octave switches of all five sections.

All songs in your Sinfonion that you have never touched consist of exactly one step with the scale C^{lyd} (lydian major) in the "Chords" mode with four beats.

12.2 Editing

Editing a song is very simple. You always edit the current step. Use ← and → to manually switch

back and forth. It's a good idea to pause the sequencer while you are editing (with the button ▶|
∎∎).

- You can change the number of beats with the buttons + and -. The minimum number of beats is 1 of course. For sequences over 32 beats the buttons will jump in larger steps forward (for your convenience but at the cost of not being able to create a step with 117 beats).

- You can change root, degree and mode by simply turning the according knobs. Since the knobs are pots not encoders you cannot turn the knob endlessly. But otherwise they behave like an encoder. This new concept avoids the nasty need to "pick up" knobs. It just takes some time to get used to the fact that the actual values are not always at the same position as the knobs.

- You change the setting of the buttons by simply pressing them.

- You can change the octave switches by going to the OCT page.

- You can add a new step by pressing "ADD". This will create a copy of the current step and automatically moves one step forward so that you can directly edit the new step.

- You delete the current step by pressing "DEL". This will also move you forward to the next step. Pressing DEL when there is just one step will delete the step but immediately create a new step with the default settings of four beats, C^{maj} and buttons in default position. This is done because there cannot be an empty song part.

Note:

- All changes are immediately saved. There is no save button. If you turn off your modular then nothing is lost. The Sinfonion keeps perfect track of all settings. This is how analog modules behave - no loss of settings when you power off your system. We believe that this is a good style for digital modules, too.

  This can lead to confusion if you change something while the sequencer is running.

12.3 Clocking the Sequencer

The sequencer has no built in clock. Why? For most "normal" sequencers it is indeed convenient if they are able to produce a master clock of their own. But when using the Sinfonion as chord sequencer you will for sure have some other clock or sequencer in your modular setup anyway that has the role of the master clock.

Patch that master clock (or some LFO if you don't have any) into the CLOCK jack. Please do not mix this up with the CLOCK jack of the Arpeggiator - that also has a clock input. In fact the sequencer clock is normalized to the Arpeggiator clock so the later one can share the master

clock easily.

Now each clock signal will move the sequencer ahead by one *beat* (beats are the small circles). When all beats of the current step are traversed the song will advance to the next step and a chord change happens.

If you do this in a real patch you will probably come up with the problem that the master clock is too fast. Let's for example assume that it will run at 16th notes. If you want a step to be four quarters long then you would need to configure it to have 64 steps, which is a bit clumsy.

Therefore the Sinfonion has a built in clock divider for the sequencer clock. It is configured with the menu option "Clock Divider". You can divide the input clock by 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 16, 24, 32, 48 or 64.

Please note that this setting is saved **per song part**! So it is *not* a global setting. For this reason the current song part that this setting applies to is shown in the display:

Having different settings for different song parts is quite useful in some advanced situations:

- Songs with metrics different from 4/4, e.g. a groove where one bar consist of 12 beats instead of 16.

- Songs where you want chord changes to happen at strange times so you need a finer control over the timing of the chord changes.

Please do not forget to set the clock divider correctly for every song part that you use.

12.4 The SONG Page (Song Parts, Step Access)

The sequencer has its own additional button page, which very much behaves like the OCT page. Pressing SONG will bring you to the SONG page or close it if it was open. While in this page all 52 buttons have a different meaning as the following diagram shows:

Jump to song step

Enter SONG page   Jump to song part   Live mode
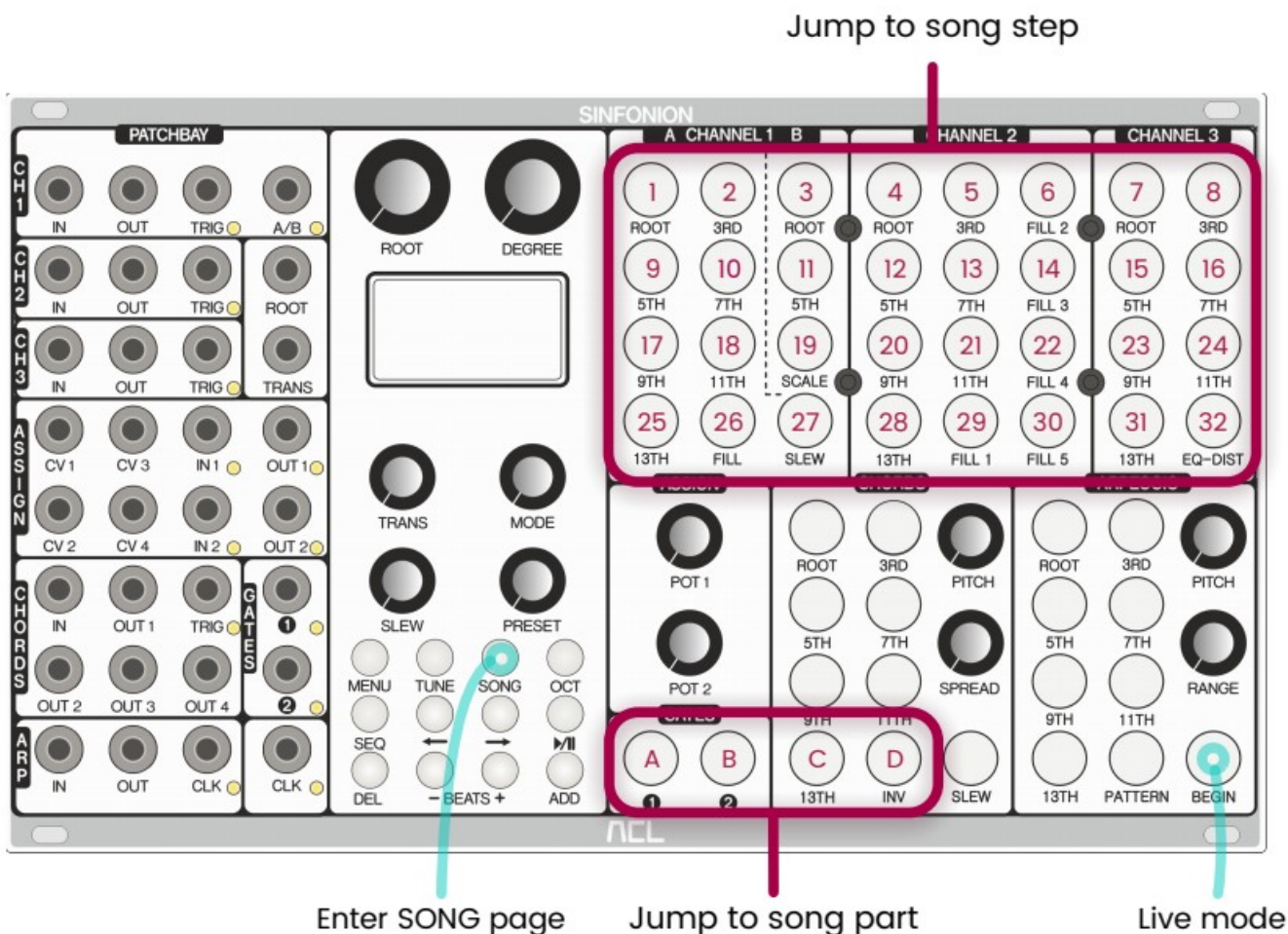
You can open the SONG page only when the sequencer is activated. Otherwise the button is inactive.

Jumping to a Song Step

The field of 4x8 buttons at the left (the buttons of Channel 1, 2 and 3) are showing all song steps – in four rows with eight steps each. The first song step is at ROOT of Channel 1, the second at 3RD and so on.

1.   Dim lit buttons show existing song steps.
2.   The bright buttons show the *current* song step.
3.   If the song has less than 32 steps then the exceeding buttons are inactive.

Pressing a dim lit button will jump directly to that step of the song. This works if the sequencer is running or stopped. It's a nice feature in a live performance. You can use the sequencer in stopped mode and consider a song just as a collection of cool chords and scales and jump to as you like.

Note: In order to make timing more easy for you the manual switching to a new step is quantized by beats! That way, you always have a precise clocking, even if you press at a random time. The chord - however - changes immediately, even before the next beat begins.

Changing a Song Part

Each song has four parts: A, B, C and D. When you power up the Sinfonion or switch the song then you start always in part A. Each of the parts has up to 32 song steps.

While the SONG page is open the topmost four buttons of the Chords section are representing the song parts A (ROOT), B (3RD), C (5TH) and D (7TH). With these you can go directly to each song part. In order to make your life simpler the transition is not done immediately but the current part is finished first and then the new part is started with precise timing. Let's assume you want to switch to part B. It's like this:

- If you press the button 3RD of Chords (meaning part B) once then it will start to blink. As soon as the sequencer has reached the end of the current song it will switch over to part B - exactly in time.

- If you press B for a second time it will *immediately* jump to that part.

Live Mode

As we have already explained in sequenced mode any change to one of the 52 buttons is immediately saved to the current step. This also means that when the sequencer goes to the next step your changes will disappear and the button settings of the next step appear.

When you want to improvise live with the buttons this can be very annoying. In order to cure that there is a button mode called "Buttons + Octaves are live" as opposed to "are sequenced".

This button is located on the SONG page. It is the SYNC button of the Arpeggio section. It is a global setting that is toggled by each button press. This button is dim in normal mode and bright in live mode.

Note: This setting is not saved in the song but is a global setting and of course automatically saved for you next session.

12.5 IN 1/2 Functions for the Sequencer

There are several useful input triggers for the sequencer, which can be mapped to IN 1/2:

Song Reset

Map "Seq. Song Reset" to IN 1/2 for an external reset of the sequencer. Any positive edge seen here will reset the sequencer to the first step and first beat and also *jump to song part A*. Note: in order to avoid timing glitches any clock signal that comes within 5 ms of the reset trigger is ignored. This helps in situations where the trigger for the clock and the reset are off by a 1 ms or so. If the clock is just a bit ahead of the reset trigger then nothing serious goes wrong since the reset will set the clock counter to 1 anyway. But a clock that is just a bit too late would immediately set the clock counter to 2 – and that way the chord change would happen just one tick too soon from there on.

Note: When the sequencer is paused this input trigger is ignored.

Part Reset

The "Seq. Part Reset" is just the same as "Song Reset", but does not switch to part A but stays in the current part.

Step Forward

The trigger "Seq. Step Forward" is just like pressing →. It moves one step forward. The main difference to the CLOCK jack is that the sequencer clock divider is skipped here.

Note: when you activate this IN function then a trigger in the CLOCK jack does **not** forward the sequencer anymore! This is an important feature, because the sequencer clock is useful for other things as well, like the A/B switching feature.

Step Backward

Just the same as forward, but goes back one step. Wraps around to the last step as if it was already the first. Note: When going backward the current beat is set to 1, not to the last beat of the step.

Part Forward

Switches to the beginning of the next song part in the order A, B, C, D, A, B, C, D, etc. Note: this trigger signal is quantized to the beat. If your trigger just happens before a beat clock then it will be ignored – so the step will not be short by one beat.

Part Backward

Switches to the beginning of the previous song part.

12.6 CV 1-4 Functions for the Sequencer

There are also a couple of mappable CV functions dealing with the sequencer:

Song

Selects one of the 16 songs while you are in sequenced mode - just like turning the PRESET knob. The CV is bipolar and stepped in 1/12V steps (semitones). It wraps around in both directions every 16 steps.

Song Part 1V/Part

Selects one out of the four song parts A, B, C and D. For you convenience this is *not* in semitones but in *octaves.* This means you have 1 Volt per song part. This CV has one speciality: If you apply 0V then no song part is selected and the current part is unchanged!

The scheme is:

- 0 V → keep current part
- 1 V → switch to part A
- 2 V → switch to part B
- 3 V → switch to part C
- 4 V → switch to part C

If you send voltages in between then they are rounded to the next full voltage (0.501 V .. 1.499 V is being interpreted as 1 V, etc.)

Song + Part

This CV combines the selection of the song and the part and allows you to switch to any of the 64 song parts immediately. Parts are addressed in 1/12V steps in order to be sequenced conveniently by simply outputting pitches. The scheme is:

- 0V (usually C0) → keep current song / part
- 0.083V (usually D♭0) → song 1 part A
- 0.167V (usually D0) → song 1 part B
- 0.250V (usually E♭0) → song 1 part C
- 0.333V (usually E0) → song 1 part D
- 0.417V (usually F0) → song 2 part A
- ... and so on

Sequence Step

Selects the current step from the sequence. Steps are mapped to semitones (1/12V) with the usual wrap around in both directions.

Note: This CV is only effective while the sequencer is **stopped**.

12.7 OUT 1/2 Functions for the Sequencer

For optimal integration into your patch the Sinfonion also offers some output triggers for certain sequencer events. All these triggers have a fixed duration of 10 ms.

Sequencer Clock

Replicates the incoming clock of the sequencer, but with a fixed gate length of 10 ms. This is useful if two Sinfonion's are linked so that the slave Sinfonion can output the master clock. There is a short latency of about 1 ms.

Sequencer Beat

Outputs the sequencer clock but after the clock dividers. This means that for every beat (small circle in the display) one trigger is being output.

Song Step

Outputs a trigger whenever it is switched forward or backward.

Song Reset

Outputs a trigger whenever the song part wraps around (restarts from step one) or is being reset externally.

12.8 Freeze Mode

The Freeze Mode is the only "hidden" feature in the Sinfonion[13]. By hidden I mean requiring some button combination that is not immediately obvious. "Freeze" is a feature that supports you when playing live. The idea behind it is that you get a chance to dial in certain chords, sequences and other stuff without that becoming immediately audible.

---

13 Well, other then the calibration function and the factory reset, which has been hidden in order to save you from accidentally losing data.

The freeze mode is activated by double clicking the button ▶|❚❚. During freeze mode this button blinks. The current chord/scale is now frozen, no further chord progression is done. Any change of the knobs ROOT, DEGREE and MODE will just affect the display — not the played music. The same holds for the selected large buttons and the octave switches. Note: all other knobs stay active!

Now you can select another sequence, edit a sequence, switch song parts and so on. As soon as you leave the freeze mode (by pressing the ▶|❚❚ button again) the currently selected situation become immediately live and the sequencer starts play mode.

13 Syncing Two or More Sinfonions

Do you want to jam with your friends that also have Sinfonions? And like in a band you want all musicians to play in a common key and scale all the time? Or do you want to create a large patch with two or more Sinfonions controlling *lots* of voices?

This is indeed possible with the "Sync" feature. It allows you to link two or more Sinfonions forming "one large Sinfonion". This is very easy and does not even need any special ribbon cables nor even unmounting the module. Just a simple patch cable will do! Here is the recipe:

1. Choose one Sinfonion as the "master". If will be authoritative as to which chord/scale is currently being played.

2. Edit the menu option **OUT 1** and set it to "Sync Master" (Note: OUT 2 does not support this, it really has to be OUT 1):

3. All other Sinfonions will be called "Slaves". Set the option **IN 1** to "Sync Slave" at these:

4. Now patch the OUT 1 of the master to the IN 1 of the slaves. If you have more than one slave then simply use a buffered or unbuffered multiple. Of course the Sinfonions can be housed in different racks. We tested cable lengths of 6 m. But probably much longer cables are possible if you are using good shielded cables.

That's it! The display of the slave now shows that it is configured as slave and that the sync is active:

```
F  Chords        Falt
   F F# A G# C# B D#
+0  Sync: alive    1
```

If the flow of data from the master to the slave is unstable or broken for any reason then the display immediately shows **Sync: dead.**

The slave now follows all harmonic changes of the master. In details this works as follows:

- The slave receives the current settings of ROOT, DEGREE, MODE and TRANS from the master. This also includes modifications that are done via the according CVs on the master. Also the CV "Chaotic Detune" is synced from the master to the slave.

- On the slave the knobs ROOT, DEGREE, MODE and TRANS become inactive.

- On the slave the *CVs* for these still remain active and can

  create a deviation on the slave (thus forcing the slave to play in a *different* scale as the master).

- On the slave the sequencer is disabled. It is not needed. Because the master defines the chord progressions.

- The slave receives the information about the sequencer clock and reset information from the master. This can be used for outputting these at OUT 1/2 and for the A/B-switch of Channel 1.

- The communication is a serial protocol running at 115200 bits per second. One sync cycle lasts about 0.35 ms (so there are approximately 3000 updates per second).

If for any reason the sync between the master and the slave breaks then the slave freezes at its last chord - unless you remove the mapping of IN 1 and change it to anything other then "Sync Slave".

As the link from the master to the slave is a one-way connection you can attach an arbitrary number of slaves to the master - really! You can do a mega jam with all you friends. Everyone links his Sinfonion to that one of the "harmonic band master" and so all can play together. You even can fetch the master clock over this link by mapping OUT 1/2 to "Sequencer Clock" on the slaves.

If you do so, please post a nice video of you session :-)

14 Calibration of the Pitch Outputs

14.1 General Introduction

Control voltages for pitches need to be very precise — especially in a polyphonic setup. That is because just 83 mV correspond to one semitone and the half of this — 41mV — is just between to semitones and thus the worst detune possible. Voltage offsets of more then 1-2mV are audible, especially if you play several notes at the same or a related pitch (e.g. like in a chord) at the same time.

Therefore the Sinfonion is equipped with eight high precision digital/analog converters with a resolution of 16 bits. High precision operational amplifiers are used for buffering and scaling DAC outputs to a range of a just a bit more than -2 V to +8 V (10 octaves).

Because even high-end analog electronic components always have small deviations from the optimum, some calibration is necessary in order to reach the most precision. The DACs of the Sinfonion are carefully calibrated by the manufacturer in order to exactly match one Volt per octave. The calibration is done via software and saved in the onboard flash of the MCU of each individual Sinfonion.

If for any reason you have lost this calibration or want to refine it then here is the procedure. Please note that for a good calibration you need a good voltmeter. The thing from the hardware store for $25 is probably not the best choice. Neither is using a VCO in combination with a a tuning device or the like. The Sinfonion will be less than 1mV off if well calibrated — over a range of 10 octaves.

For this reason the calibration mode is hidden in order to avoid you accidentally changing the original factory calibration. Because this is different in every individual Sinfonion there is no way to restore it once you have changed it, so please be careful. You have been warned.

14.2 Procedure

You start calibration by pressing and holding at once the following three buttons:

- TUNE
- ←
- 3RD of Channel 1 side A

The display should now show this:

```
Calibrate          0V
    14997 Channel 1
```

Note: all changes you do are immediately saved! You leave the calibration by pressing MENU. The calibration is done by setting the internal DAC values that correspond to 0V and to 5V for each of the eight output channels[14]. You have thus to edit 16 of these numbers for a complete calibration. At any time you either calibrate 0V or 5V. You can toggle between these two by pressing TUNE. Here is a complete overview over all relevant buttons in calibration mode:
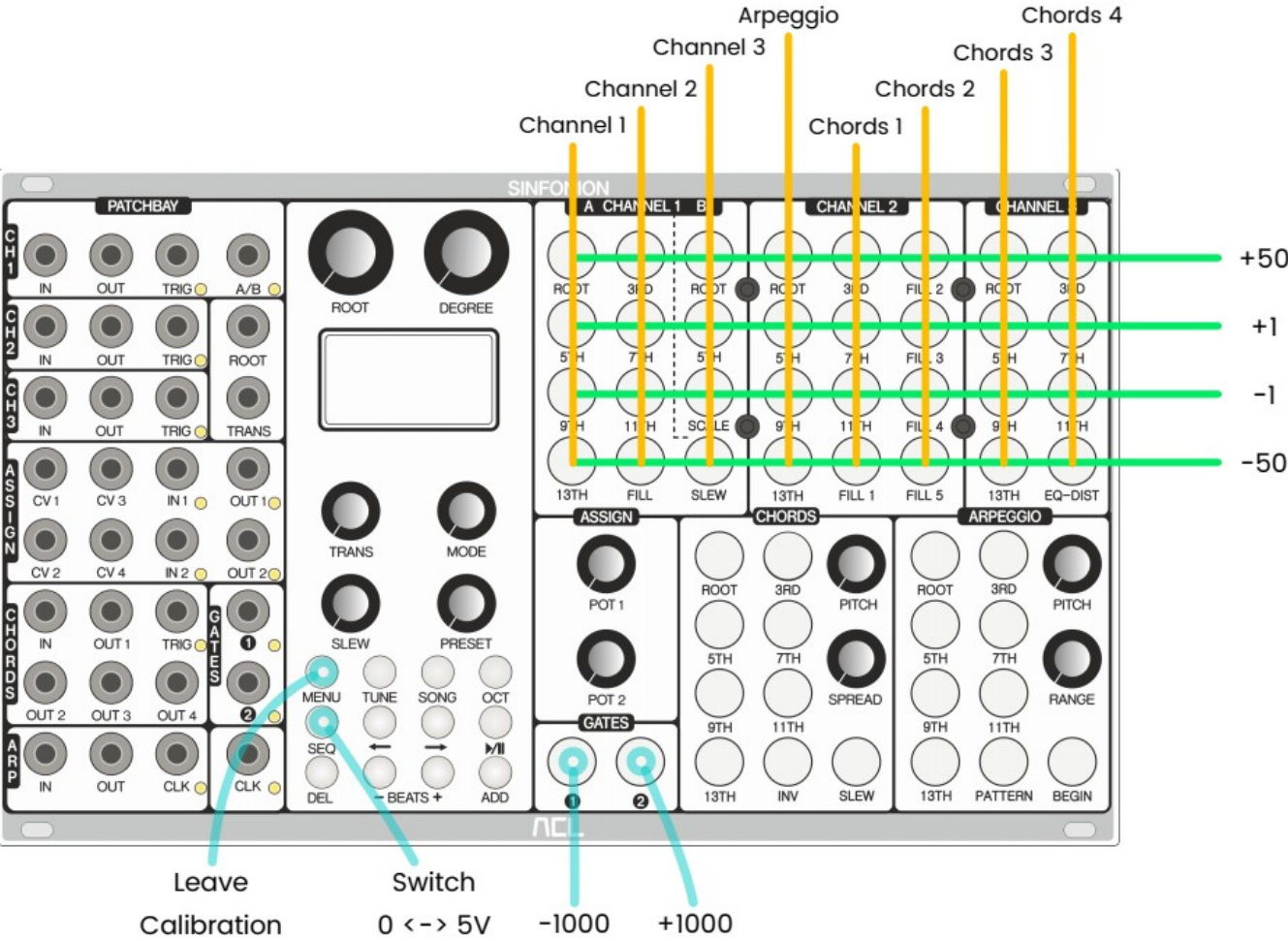
The 8x4 button field at the top gives direct access to the calibration value for all eight outputs. Each column of four buttons corresponds with one output and will modify the DAC value by +50, +1, –1 or –50. The order of the channels is Channel 1, 2, 3, Arpeggio and then the four channels of the Chords section. If you have a long way to travel (which would be surprising!) then button Gate 1 is –1000 and Gate 2 is +1000 for the section **that has been edited most recently**:

Here is the proposed procedure for calibrating the Sinfonion:

1. Power everything up and wait a couple of minutes until everything is warmed up[15].

2. Connect a *precision* voltmeter to the OUT jack of Channel 1.

3. Enter calibration mode by pressing TUNE, ← and Channel 1 3RD (side A) at the same time.

4. The voltmeter should now show approximately 0.000 V. Use the first column of the 8x4 button area for changing the DAC value so that your voltmeter best matches 0.000 V.

5. Press TUNE in order to switch to 5 V. The voltmeter should now show approximately 5.000 V.

6. Calibrate this as best as you can with the first button column again.

7. Now connect your voltmeter to OUT of Channel 2 and do everything over again. If you like you can now start with 5 V and then do 0 V later. This saves you one button click.

8. Do the same for Channel 3 (3rd column), arpeggio (4th column) and the four outputs of the Chords section (columns 5 to 8).

9. Press MENU for leaving the calibration mode.

By the way: since a well calibrated Sinfonion is very precise and the tuning mode allows you to easily switch in 1 Volt steps from –2.0V to +8.0V it is a very handy tool for calibrating VCOs!

14.3 The ADCs

The ADCs do not need to be calibrated. They have a precision from approx 1 mV right from the chip manufacturer and are directly wired to the jacks. There are no discrete parts such as resistors or op amps that would introduce deviations.
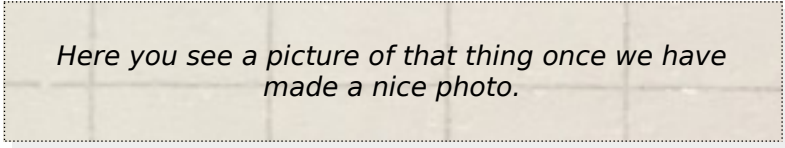
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15 Well, the Sinfonion really has a very good temperature stability and this should not be necessary. But warming up always gives a good feeling…

15 Firmware Upgrade

15.1 Upgrade procedure

As time goes by and more and more people use the Sinfonion new ideas are born and software bugs are probably going to be found and fixed. The result are new versions of the Sinfonion firmware, which you can find and download at audiophilecircuitsleage.com.

The easiest way to upgrade your module to a new firmware is with a special small expansion dongle, which you can purchase from your local dealer for a small charge, once it is deliverable. This dongle can be mounted on the expansion port at the back of the module and holds a small reader for micro SD cards.

Here you see a picture of that thing once we have made a nice photo.

Here is the procedure for the upgrade:

1. Download a new firmware image from audiophilecircuitsleage.com to your PC. The name of the file should be something like **sinfonion-combo-1.7.bin**. You must use a file with a **.bin** extension. .hex will not work! It also won't work without the **-combo-** in the name.

2. **Rename** that file **exactly** to `aclsinf1.fw`. Note: the name ends with fw – without a dot. The dot is just here for sake of grammar. If you do not choose the right name then the upgrader won't recognize the file and keep using the old firmware.

3. Copy that file to the micro SD card that has been shipped with the expansion dongle. Copy it into the main directory of the card. Keep the name `aclsinf1.fw`. You might need an SD to micro SD adapter. If you have lost your micro SD card, you can use your own. But please make sure that you card supports SDHC.

4. Unmount the Sinfonion from your rack. Do **not** power it yet.

5. Mount the expansion dongle – that one with the SD card reader – to the 14 pin expansion port of the Sinfonion. Please make sure that you really use the 14 pin expansion header – not the 10 pin power header! Mount it the right way: honor the notch at the side of the socket. If you have mounted it correctly then later the small **green** LED will indicate that it is powered once the Sinfonion has power.

6. Insert the micro SD card into the reader on the dongle. There are two ways. Only one is

correct. The card must completely vanish in the reader.

7. Connect the Sinfonion with the power cable to the rack in a way that you still can see the red and blue LED at the back of the dongle. Make sure that the back of the Sinfonion does not touch any metal!

8. Power on your rack (and thus the Sinfonion). If everything works fine then the blue LED should blink exactly **three** times, and then the Sinfonion starts with the new firmware! This takes just about 3-5 seconds. You can read the version number at the start screen for a couple of seconds.

9. Power off your rack again and remove the dongle. Finished!

15.2 Error codes

If everything goes well, the **blue** LED on the dongle flashes three times in a row. There are lots of things that could possibly go wrong – however. If something goes wrong, please try to fix the reason and try again. Here is the list of all LED blink codes.

- **B** – The blue LED flashes
- **R** – The red LED flashes
- **BR** – both LEDs flash at the same time

Please note that in most error cases that procedure stops and the LED code is repeated over and over. I you want to abort the firmware upgrade then power off the Sinfonion and remove the dongle before starting it again.

Code	Stop	What happened
B	no	No micro SD card has been inserted. Or the one inserted is not supported.
B B	no	The SD card has been found and could be read. But no file with the name `aclsinf1.fw` has been found in its main directory.
B B B	no	The firmware has successfully been programmed (upgraded).
R R R	yes	The SD card has been found but no (valid) filesystem has been found. The filesystem must be of type FAT.
R R B	yes	The filesystem on the SD card is somehow corrupted or not a valid FAT filesystem.
R BR R	yes	The file `aclsinf1.fw` has been found but is too small. It should typically have a size betwenn 190K and 256K.
R BR B	yes	The file `aclsinf1.fw` has been found but is too big.
R BR R B	yes	The file `aclsinf1.fw` has been found but it's contents are invalid.
R BR R R	yes	The contents of the file could not completely be read from the micro SD card.

Code	Stop	What happened
R BR B R	yes	The was a read error when reading from the card.
R B BR B	yes	The flash on the MCU of the Sinfonion could not be erased. Please try again.
R B BR R	yes	The firmware could not be written to the flash memory. Please try again.
R B BR BR	yes	There is no firmware that can be started. Please try again with a new firmware.

As long as none of the last three errors happened (those starting with R B BR) your Sinfonion is still OK and keeps using the old firmware. If you encouter any of those last errors, please try again. If you do not succeed please contact your dealer.