Cynthia

Users manual

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INTRODUCTION

Congratulations with your free edition of Cynthia. As the name implies it is an architectural replica of the old Synthi A by EMS (also known as VCS3).
As the original it is constructed of basic modules connected in a matrix, letting you route sources and control voltages to different destinations. Many module based synths can do that, but Cynthia has one remarkable difference: There is no clear distinction between audio and control voltages as sources. For instance; you can let the output of one audio oscillator control the frequency of another, or use the noise generator to control the filters cut-off frequency.
Even though the synth (just as the original) is monophonic, the flexible routing system will let you create a huge variety of different sounds and effects.
Unless you are familiar with the original Synthi A, I suggest you read this manual carefully, as Cynthia is quite different from the more ordinary synths.
The synth is created with SynthEdit and with the use of Rurik Leffantas Spring Reverb, Andys Patch Pulse and David Haupts Envelope Segment and Soft Dist module. Thanks to these gentlemen for making their great tools available.
Finally I wish to thank HSkovlund from KVR-audio, who kindly provided me with loads of nice presets and gave feedback that inspired me to improve the synth even further.

Installation

The installation process is pretty simple. The zip-file you downloaded contains two files besides this manual: Cynthia.dll and CynthiaFX.dll. Cynthia.dll is a VSTi file (which you should copy to your VSTi folder), while CynthiaFX.dll is a VST file, allowing you to use the synth as an effects plugin. The VST edition will also (in some hosts at least) accept a midi-in, allowing you to use it as a synth as well.

Quick start

Load the synth in your host and load the second patch (Standard Synth). Connections appear as green pins in the matrix, showing how the signal is routed from OSC 1 and 2 to the filter which cut-off frequency is controlled by OSC3. From the filter the signal goes to the envelope shaper which controls the volume. Finally the MIDI freq. will control the frequency of OSC1+2 and the velocity, the output volume.

Bugs and things that aren't right

For reasons unknown to man (or just me at least) the synth has a tendency to go into a "sleep mode". Hitting your MIDI keyboard (or just sending a MIDI signal to it from your host) will activate it again. This is not a problem while you're using Cynthia as a synth (you'll be hammering like crazy on your keyboard then), but if you're using it as an effect you might need to hit the keyboard.

Obviously I'll try to fix this problem in future versions.

1 MODULAR BASED SYNTHESIS

General principle

If you're a complete novice in synthesisers you might want to read through this section first. A classic synthesiser is generally built of 3 types of modules:

- **Sound sources**. These generate an AC voltage with a frequency in the audible range (20-20000 Hz), so when fed to a speaker it would produce a sound. Typical sound sources would be oscillators (OSC1-3 in this synth), noise generators, but also external inputs (input ch. 1 and 2).
- **Control voltage sources**. These produce a AC voltage with a frequency below the audible range or simply a DC voltage. As their name implies they are normally used to control or modify parameters in other modules, like the frequency of an oscillator or a filter. This synth has no clear distinction between sound sources and control voltage sources, but typical control voltages would be produced by the envelope shaper / trapezoid, oscillator 3, control voltage sequencer, the joystick and MIDI-signals (frequency and velocity) received from the host / keyboard.
- **Treatments**. These types of modules can modify the sound produced by the sound sources. Typical modifications would be filtering out certain frequencies (with the filter), thereby altering the temper of the sound or by changing the amplification of the sound over time (with the envelope shaper). Also the delay module, ring modulation and reverb will fall within this category.

Figure 1.1 below shows a simple, but typical example of how a sound is created by combining these modules.

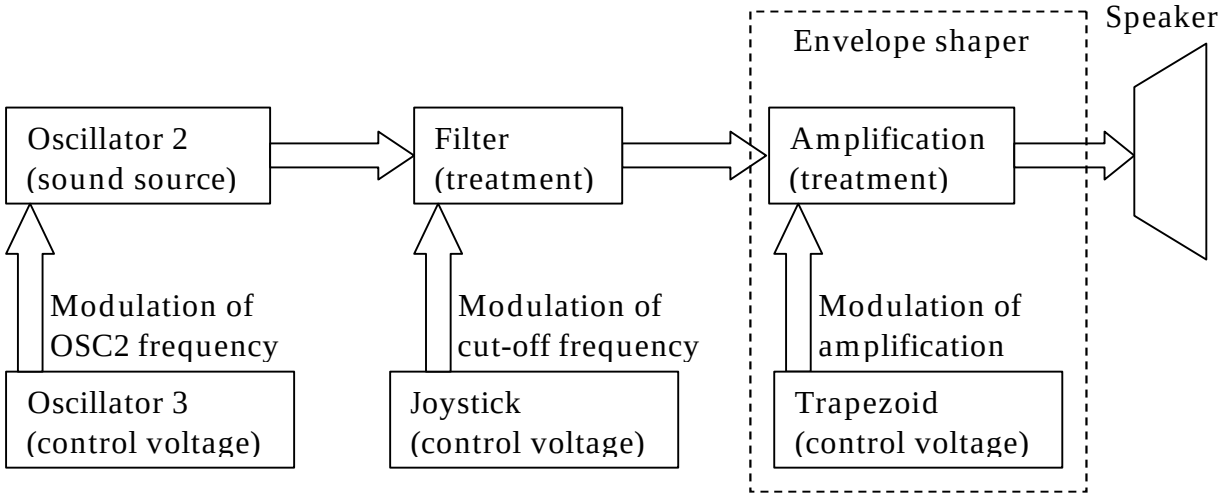
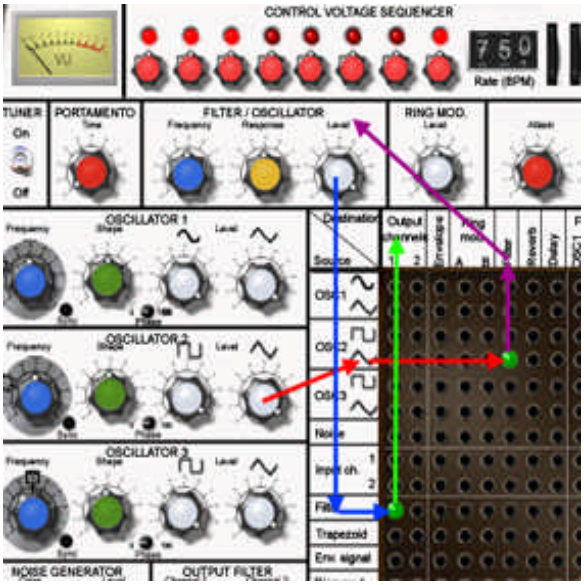


Figure 1.1: A typical connection of modules, where oscillator 3 modifies the frequency of oscillator 2, giving it a vibrato. The sound produced by oscillator 2 is then routed through treatments – first the filter, with its cut-off frequency modified by the joystick and then to the envelope shaper, where the trapezoid voltage controls amplification of the sound, before its send to the speaker.

Connecting modules with a matrix

Before we dive into details about the modules, you should understand the basic concepts of the matrix. Sources (sound sources, control voltages or sounds returned from treatment modules) come from the left arranged in rows. For every pin in the first row you'll have the sine wave from oscillator 1 and so on. Destinations (outputs, sends to treatment modules and modulation inputs for certain modules) are on the top, arranged in columns. So if you want to send the sine output of oscillator 1 to output channel 1 you put a pin in the first hole (upper left corner). A more advanced example is shown in figure 1.2.

Figure 1.2: The triangle waveform produced by OSC2 is routed in to the matrix (→). By putting a pin (green) in the appropriate hole, the signal is routed on to the filter (→). Here it is treated by what ever settings made in the filter and routed back in to the matrix (→). By putting another pin in the first column here, the signal is routed on to output channel 1(→) and should be heard in your speakers.



Any source can be routed to any destination (all though some might not make sense) and a source can easily be routed to more than one destination. Likewise the destinations can take several sources at once. Be aware that it is the sum of the sources that will go to the destination, so with multiple sources to the same destination you might go beyond the range of that module. In that case adjust the level of the individual sources.

The matrix of Cynthia has one major difference compared to the original SynthiA as signals can be *inverted* individually in the matrix. That way a positive voltage would become negative and you can subtract signals instead of just adding them. Click the "pin" twice and it will become red, indicating that the signal is inverted.

Warning! As stated previously there's no clear distinction between control and sound sources, but as some of the signals (especially the trapezoid and OSC3 in the low frequency range) would have more characteristic of a DC voltage routing these to the output channels *could* potentially harm your speakers, although most hosts will simply just mute the output if it rises to a potential dangerous level.
Of course I can take no responsibility for that.

2 THE MODULES

Oscillators

These are the main sound sources of the synth. They can produces various waveforms with the frequency being modulated using signals send to the matrix or by each oscillators frequency knob. The controls for OSC1 are shown on Figure 2.1.

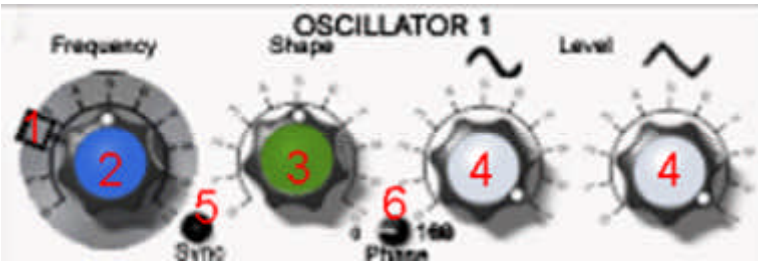


Figure 2.1: The controls for OSC1. Controls for OSC2 and 3 are similar.

Frequency

This module produces a triangle and a sinus shaped wave in the frequency range 0.6 to 16000 Hz. The frequency is controlled by the knobs labelled 1 and 2 in Figure 2.1 above.

The range selector (1) lets you dial in a more narrow range according to the following table:

Range setting	Frequency (Hz)		
	OSC1	OSC2	OSC3
0	0.6	0.6	0.015
1	1.7	1.7	0.043
2	4.1	4.1	0.12
3	11.6	11.6	0.34
4	32.7	32.7	0.98
5	92.5	92.5	2.8
6	261.0	261.0	7.8
7	740.0	740.0	22.0
8	2000.0	2000.0	63.0
9	6000.0	6000.0	177.0
10	16000.0	16000.0	500.0

As seen OSC3 has a much lower frequency range. This makes it useful as a low frequency oscillator (LFO), while it is still capable of going in to the audible range (above 20 Hz).
The blue frequency knob (2) will let you fine tune the frequency within the selected range, which is approximately +/- 0.75 octave.
By assigning a signal to the column labelled OSC1 frequency in the matrix, the frequency of OSC1 can be modified further as any voltage here will be added to the setting on the

OSC. Try this by connecting the host frequency signal to this column and the route the output of OSC1 to the output channels.

Tuning an oscillator

As the frequency can be adjusted freely you might have to tune each oscillator before you start playing. Connect its output to the output channels, and the host pitch to its frequency input in the matrix. Switch on the tuner and press any key on your MIDI keyboard. A sine tone corresponding to the note played on your keyboard is now heard together with the sound produced by the oscillator and you can adjust its frequency until it is in tune with the sine-wave (which is in standard tuning, A = 440 Hz). Obviously you are free to tune the oscillators differently if you need it ;-)

Shape

Harmonics can be added to the wave form by turning the shape knob (3) left or right according. This will alter the shape of the sine/triangle waveform produced by OSC1 as shown in Figure 2.2.

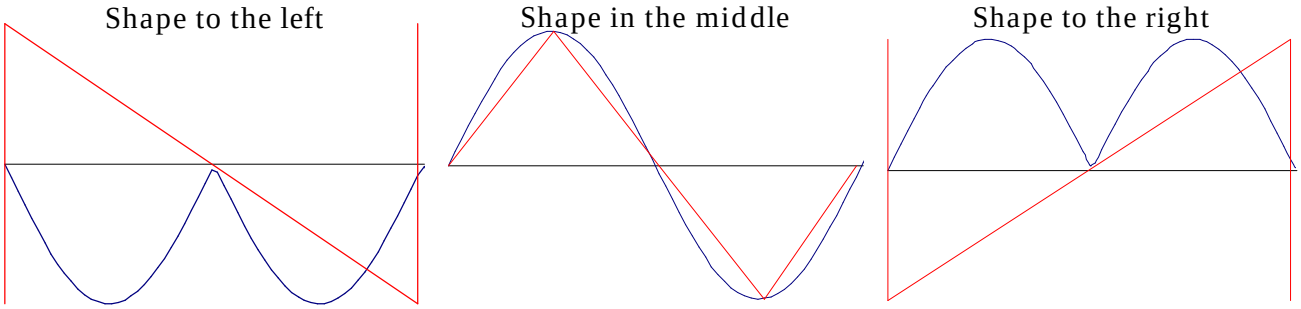


Figure 2.2: The effect of the shape knob on the sine and triangle waveform in oscillator 1.

OSC2 and 3 can produce a triangle and square wave, which also can be modified with their shape knob according to Figure 2.3 below.

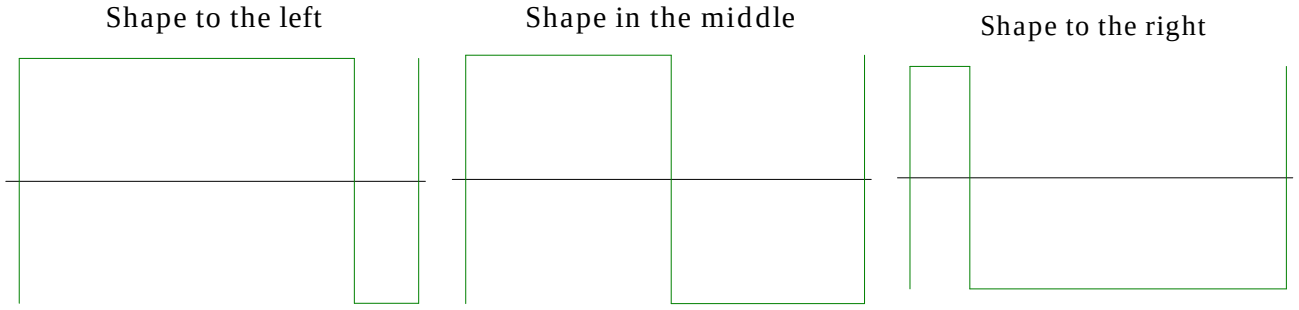


Figure 2.3: The effect of the shape knob on the square waveform in oscillator 2. The effect on the triangle waveform is identical to the one in oscillator 1.

In between these 3 positions of the shape knob the triangle wave-form will be more complex, giving loads of nasty harmonics.

Levels
The level knobs (4) let you control the amount of triangle and sine/square wave signal send to the matrix the corresponding rows.

Syncing and phase modulating
Each oscillator has a sync button (labelled 5 in Figure 2.2). Activating this will synchronise the waveform to the gate-signal received from the host/keyboard. That way the waveform will always start a 0 volts/0 degrees rather than at a random point, when the synth is triggered. However, to achieve the classic old school sound you might want to disable the sync function, allowing the oscillators to run freely. The phase of each oscillator can also be modified with the phase knob (6). This will shift the phase up to 180 degrees.

Noise generator

The noise generator produces white noise, which is passed through a filter letting you change the colour of the noise with the colour knob. Turning the colour knob all left will give you a more dark sounding noise (brown noise), with mainly low frequencies, while turning the knob right will give a brighter noise (white noise). The level send to the matrix is controlled by the level knob.

Input channels

Within the routing system of your host any audio signal can be assigned to these two inputs, allowing you to either modify the audio signal or use it as a control voltage.

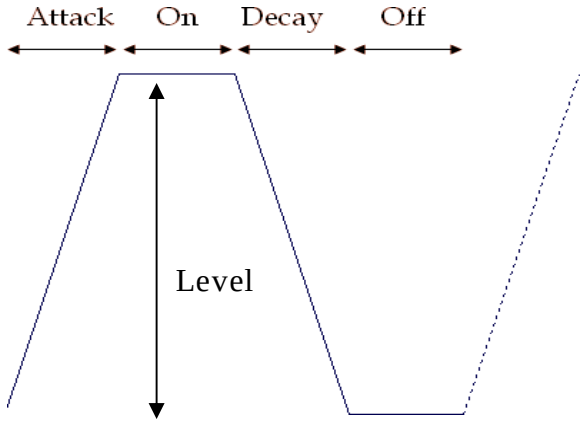
Filter/Oscillator

Signals assigned to the Filter column of the matrix will be summed and send to the filter. With the response knob in the low range (approximately until 4-5) the filter functions as a regular low pass filter with the frequency knob controlling the cut-off frequency. As the response knob is turned clockwise the filter characteristic approaches a band-pass filter and after 7 the filter will start resonating, producing a sine wave with a frequency set by the frequency knob. The level knob controls the amount of filtered signal that returned the matrix.
The frequency can also be modulated by assigning sources to the filter frequency column in the matrix.

Envelope shaper

The triggering of the envelope shaper is controlled by the common gate signal (explained below). It produces a control voltage as shown in Figure 2.4. Please note that this envelope generator is different from the ordinary ADSR envelope.
As in a regular synth there is an attack phase, where the signal rises to the level determined by the level knob. The “On” knob then determines the time period at which the signal stays at this level and the “Decay” knob the time it takes for the signal to return to 0 volts. The fourth knob, labelled “Off”, is quite unique, as it allows you to re-trigger the envelope generator again automatically when the cycle is complete!

Figure 2.4: The voltage produced by the envelope shaper. The length of attack, on (sustain), decay and off times can be control by the corresponding knobs.
Attack time: 2 ms to 1 second.
On time: 0 to 2.5 seconds.
Decay time: 3 ms to 15 seconds.
Off time: 10 ms to 5 seconds.



As this self-triggering behaviour can be unwanted, you can over-ride it by turning the "Off" knob all the way to "manual".

By assigning a signal to the column labelled Decay in the matrix the decay time can be modulated. Have a look at the patch labelled "Bounce" to hear the effect of this.

Gate signal
The common gate signal is a DC control voltage that will go high (10 V) upon either of the following events:

- A MIDI note on signal is received from the host or keyboard
- The trigger button is pressed
- For each step in the build in sequencer when its on
- At the end of the envelope shaper cycle if its set to re-trigger

Upon patch change the gate signal and output is muted for 2-3 seconds after a patch change. This is done to prevent unwanted triggering of the new patch if a gate signal is coming from the envelop shaper.

Envelope controlled amplification
The control voltage produced by the envelope shaper controls an amplifier so the amplitude of any signal send to the Envelope column will be adjusted as shown on Figure 2.5 and returned into the matrix at the row labelled Env. signal.

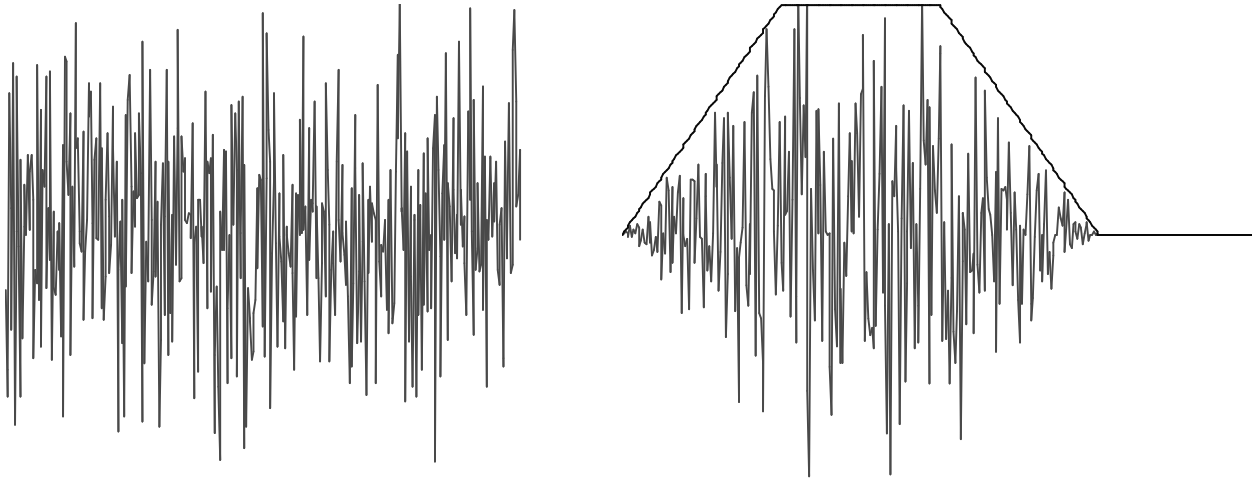


Figure 2.5: A signal before and after being shaped by the envelop shaper signal.

Trapezoid

The control voltage produced by the envelope shaper is duplicated and send to the trapezoid module where it can be modified further by adjusting its level or adding/subtracting a DC voltage (the Bias knob). Further more the signal can be inverted using the invert function in the matrix (click the pin twice till it turns red). The effect of inversion, biasing and level on the trapezoid signal is shown in Figure 2.6.

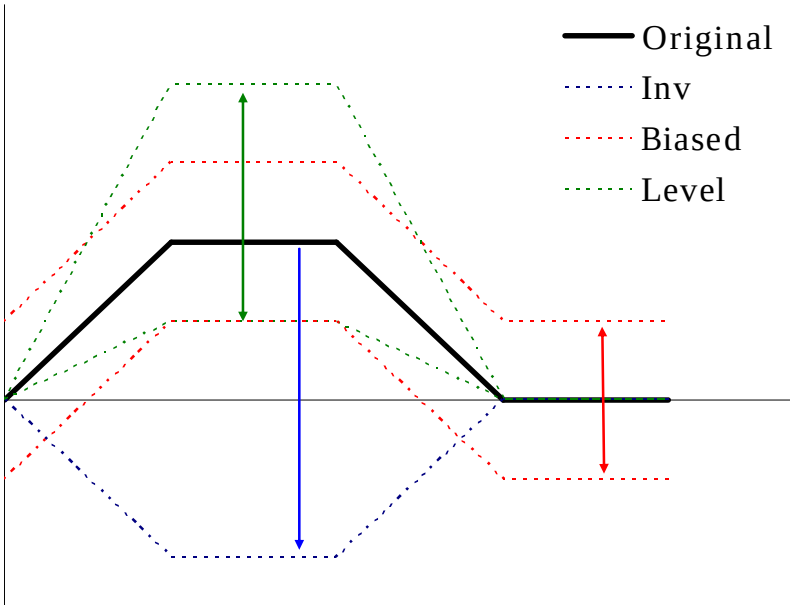


Figure 2.6: The effect of inversion, biasing and level adjustment on the trapezoid signal.

The produced control voltage is then sent to the matrix on the Trapezoid row. As the envelope generator (and thereby trapezoid) can re-trigger it self it can actually also work as a low frequency range oscillator.

Ring modulator

The ring modulator takes two inputs (A and B). The inputs control the level of each other as they are multiplied. This means that if one input is 0 (or nothing is routed to it), nothing will be present on the output. It can be used for classic ring modulation (two sound

sources are multiplied giving a bell-like ringing sound), or to apply an envelope to a signal (amplitude modulation), or to scale a signal by a fixed amount. The level knob adjusts the level of output returned to the matrix.

Reverberation

Reverb is added to the signal assigned to the Reverb column. The module simulates a spring reverb and lets you choose between two different sizes of springs; the short one producing a brighter and shorter reverb than the long one. The Feedback knob controls the length of the reverb and the Mix knob controls the ratio between wet and dry signal on the output sent to the row labelled Reverb.

Delay

Delays whatever signal that is assigned to the Delay column and return the delayed signal in Delay row. The seconds / milliseconds switch lets you choose between delay times in range of 0-10 seconds and 0-0.1 seconds respectively. The level of delayed signal returned to the matrix is controlled by the level knob. By making a connection between the delay return and send you can produce multiple delays and adjust the amount of feedback with the level knob.

Output channels/Speakers

Any signal assigned to Output column will be send to the output module. This module lets you change the level, filter and pan each of the two output channels before they are send to the synth's output. The level of each channel can also be modified by assigning a signal to the two columns on the far right.
If the level of the signal in the output channels is high enough a slight distortion / clipping will occur.
Output channels are muted for 2-3 seconds during patch changes.
The synth has 4 output channels in your host. Output 1-2 are direct outputs, while 3-4 simulates the more canny sound from the build in speakers of the original SynthiA ☺

Joystick

The joystick located next to the matrix produces two DC voltages – one for each dimension (X and Y). These can be used as control voltages and are sent to the matrix on the rows labelled "Stick". The range of each dimension can be adjusted individually by the Range knobs next to the matrix. Next to the joystick you'll find a trigger button[1] that will trigger the envelope shaper.

[1] This one is also usefull to wake up the synth if it "falls a sleep".

Sequencer

In addition to the modules in the original SynthiA I have included a very simple, yet useful 8 note sequencer as shown in Figure 2.8.

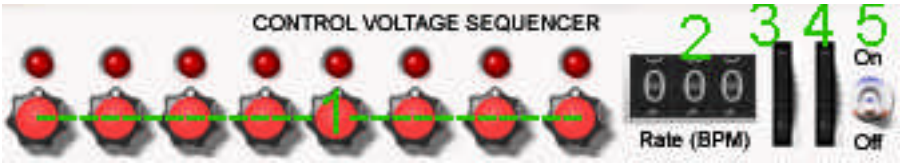


Figure 2.8: The sequencer module with 8 knobs for adjusting each of the 8 control voltages produced, and controls for adjusting the playback rate.

This will repeatedly produce a series of 8 control voltages in the range -1V to +1V (divided in steps of 1/12V, so one step would correspond to a semitone) and a gate signal. The voltage of each step is adjusted by the knobs (1), with the central position corresponding to 0 V.

The rate at which the sequence is played is indicated by the counter (2) and adjusted by the wheels next to it (3 and 4). A rough adjustment is made with (3) and more delicate fine tuning with (4).

The rate is given in beats per minute, so in order to make the sequencer play quarter notes in a 60 BPM song you'll need to set the rate to 60 BPM. Like wise set it to 120 BPM if you want 8th in a 60 BPM song and so forth. Maximum rate is 999 BPM… which is pretty fast!

The on/off switch (5) will determine if the gate signal is routed on to trigger the envelope generator or not. Even though this switch is off, the sequencer will still produce its sequence of control voltages and route them to the matrix. This is useful if you want the sequencer to control the filter frequency or something else.

To turn the sequencer completely off, adjust the rate to 0 BPM.

For more advanced sequences (notes at different length or velocity) your host would be a more obvious choice.

Host/MIDI controlling

The MIDI signal produced by the host or MIDI keyboard is converted to pitch (1 volt/octave) and velocity control voltages and sent to the matrix on its bottom rows.

This allows you to control the frequency produced by an oscillator with the keyboard or the output level with the velocity signal. However other and more interesting effects can be achieved by letting these voltages control other modules (i.e. assigning the velocity to OSC frequencies, filter frequency or as one of the inputs of the ring modulator).

The portamento time knob will produce a continuous gliding frequency control voltage between two notes.

Apart from that every knob can be assigned to any MIDI controller message at will, depending on your host.

3 TROUBLESHOOTING

Here you'll find causes to some of the typical problems you might encounter.

Problem	Cause	Solution
I get a stuttering or distorted sound	The CPU usage might be too high. On a +4200 AMD dual core typical CPU usage is about 5%, but at a slower system or with complex routing this might be the reason.	Make sure you're using ASIO drivers (ASIO4ALL is very nice). Increase the buffer size. Try to make a less complex routing (fewer modules). Avoid using the reverb as this is most heavy on the CPU. Upgrade your hardware ☹
	The output level is too high.	Check the meters – if they go in to the red, you'll have to reduce the level (white knob) of the module that's distorting.
	The "off time" on the envelope shaper is not set to manual. This will give a retriggering of the envelope cycle, which at very low settings can make a stuttering sound.	Turn "off time" all the way to max/manual.
My band is complaining about that I'm out of tune	The oscillators you're using are not in tune… or you're playing wrong ;-)	You'll have to tune the oscillators manually – either to another instrument or by using the build in tuner. The range selector should be around 2-3 for OSC1 and 2 to be in tune.
The input channels doesn't seem to work	Your host will only route audio to VST's and not VSTi	Use the VST version of Cynthia (CynthiaFX) instead.
	Nothing is routed to the input channel from your host.	Check the routing of your host. As this differs from host to host, you'll have to figure it out your self, though I can provide some basic support on Reaper.

	Cynthia fell a sleep	This happens from time to time, when a module doesn't receive a MIDI input. Hit the trigger button / keyboard and it might work
The note is not sustained	If the "on time" of the envelope shaper is not set to manual, each note will only be sustained a given time.	Set the "on time" to manual (all the way to max).
I can't hear anything?!?!	No or wrong connections in the matrix	Check if you made the right connections. Try to route an oscillator directly to the output channel
	Levels are set too low	Check all the way through the signal chain if the level of every module in use is set to an appropriate level.
	The oscillators' frequency is set too low or high.	Set the range of the given oscillator to ~5 without anything else routed to its frequency input in the matrix.
	Outputs are muted for a few seconds during patch changes.	Wait a while ;-)
The pitch doesn't change when I play the keyboard	The oscillator in use doesn't receive a MIDI signal.	Make sure your MIDI keyboard is connected and "host pitch" is routed to the oscillator frequency in the matrix.
The program (or my host) crashes	Multiple instances of Cynthia on a multicore system. This is caused by a bug in Synthedit, and will be fixed some glory day	If you need more than one instance make a copy of the .dll file and rename it to Cynthia2.dll
	You are trying to load old presets from previous versions (Putney 2)	Unfortunately you'll have to remake the preset manually.

Other problems? Mail me at cynthia@ninecows.dk or ask in a forum like KVR-audio. And… if I start getting spam on that email account I'll close it!

4 SOME FINAL THOUGHTS

When the SynthiA/VCS3 originally was made, it was intended to be just as much an educational/scientific, though expensive toy as an instrument. Therefore it is *not* a plug-and-play synth (go find a Roland if you need that).
You can make some amazing and unexpected sounds with Cynthia, but it will take a while to get used to the playing her. You might want to read a bit about modular synths and basic subtractive synthesis before you start, as Cynthia has a rather steep learning curve.
Several famous bands have been using the original synth (The Who, Pink Floyd, Jean Michel Jarre and many more), but back then they also had EMS technicians in the studio to assist them…! So don't give up – once you got the hang of how the routing works and what the different modules are capable of, you'll enjoy it and hopefully reach for Cynthia whenever you need an old school sound or some weird effects.

Be creative – happy playing!

Copyright and all that

I never made this synth with the intention of making money. I did it for fun and thought that I could just as well share the fun with others. You're free to use the synth as much as you like – also on records that you want to sell, but please don't sell the software it self – either alone or as a part of a software package. It's my creation and as long as I'm not making money selling it, neither should you. Please respect this.

This synth also contains modules created by third party and you might want to check their policies on copyright too!

Feel free to give a copy of it to friends, but make sure to refer to my webpage: www.ninecows.dk/cynthia as this is the place to go for support and updates or if you want to contribute with presets or ideas for improvement.

The software is provided "as is" and with no guaranties. If it for some reason should cause any loss of equipment (damaged speakers), hearing or data … well too bad. It should be pretty stable and safe to use, but you're using it on your own risk.