ERKKI KURENNIEMI's INTEGRATED SYNTHESIZER

USER MANUAL OF THE GENERATOR UNIT

Supported by Alfred Kordelin Foundation and
the University of Helsinki Music Research Laboratory.

Suominen, Jari, 1979–
Erkki Kurenniemi's Integrated Synthesizer - User Manual of the Generator Unit

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Corrections may be made to future printings.

Introduction

History

Integrated Synthesizer was designed to be the heart of the Electronic Music Studio of the Department of Musicology, University of Helsinki. It was the first actual instrument Kurenniemi started to build and consisted of three separate units: Generator unit, mixer unit and filter unit. All units consisted several modules. The system never really had a name[1] but in later it has commonly been called Integrated Synthesizer.[2]

Based on University studio receipt archives, the building of the instrument started during summer 1964. Instrument was in operational state in the same fall when the first recordings with the instrument were conducted. New modules were added are removed throughout the lifespan of the system. Today only Generator unit remains close to the state it was after removed from daily use at the end of the 1960s. Mixer unit has been ripped up for parts. The filter unit has totally vanished. Remaining parts of the instrument are still possession of Helsinki University Electronic Music Studio.

Soon after Kurenniemi left University studio, Integrated synthesizer also retired. One reason was most likely, that no one else knew how to use it. This is not a wonder, panels did not have any legends or markings what the knobs and switches actually did, and no documentation to help random user existed.

In 2017 Alfred Kordelin Foundation granted support for restoration of the instrument. Instrument had not been switched on after the end of the 1960s. The restoration project was successful and today the instrument is almost fully operational. In addition to the actual restoration, one of the concrete outcomes of this project is this user manual.

The purpose for this user manual is both to serve those who are able to access actual instrument, but also those who want to dive into the history of electronic instrument design evolution.

This document is reflecting the state of the instrument after maintenance operation was conducted on the instrument in 2018. This document does not completely cover all the features of the instrument. The main focus is in basic usage.

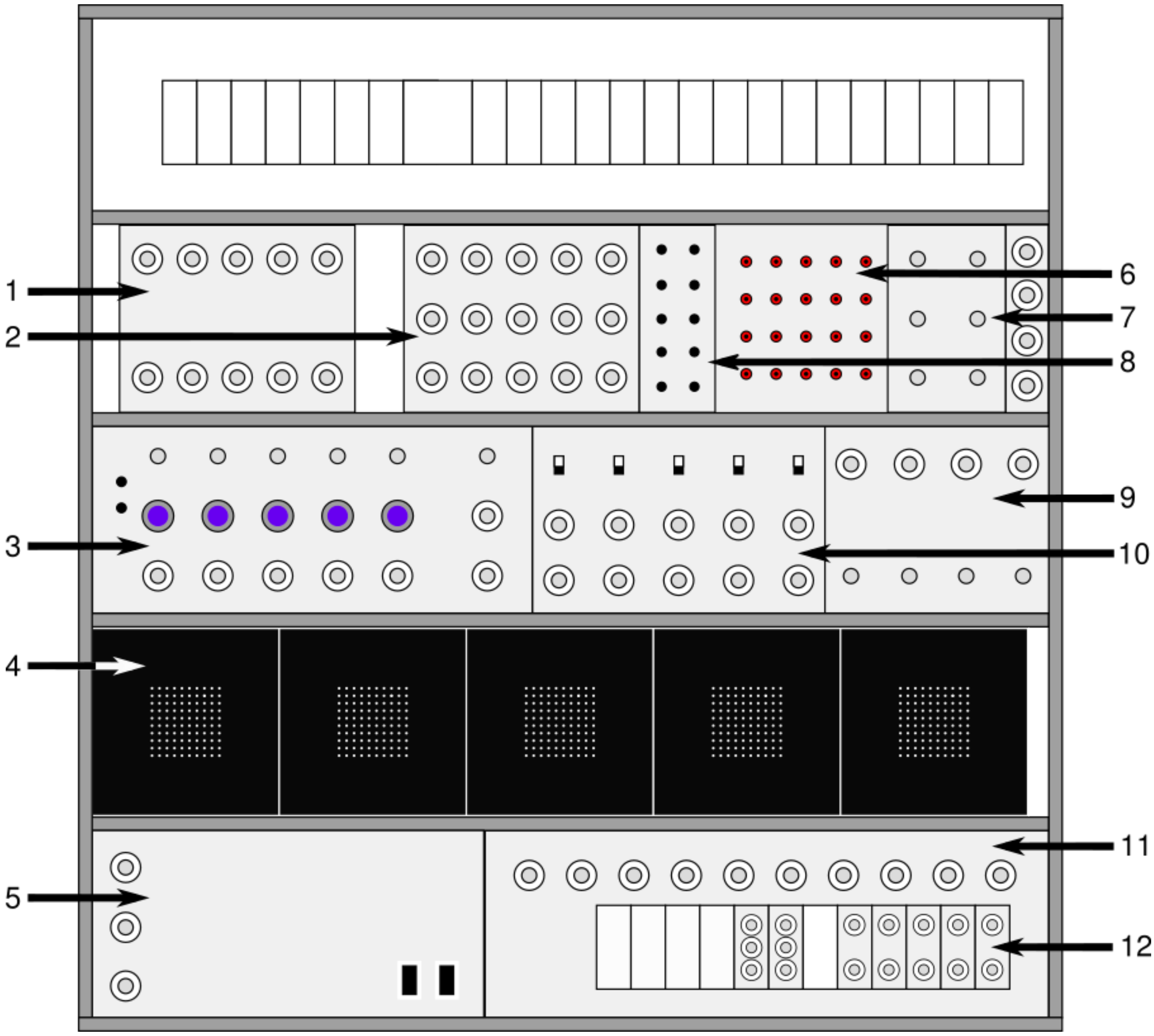
Overview

Generator unit of Erkki Kurenniemi's Integrated Synthesizer is a semi modular system. It has four sound sources: noise generator, quad sine wave generator, cluster generator and harmony

[1] For instance Sähkö-ääni-kone (electric sound machine) or System 1.
[2] For more information: Suominen, Jari 2013. Erkki Kurenniemi's Electronic Music Instruments of the 1960s and 1970s. *Mies tulevaisuudesta*. Kansallisarkisto.

generator. Control voltages are generated by Master Timer sequencer and a low frequency oscillator. Further, system has a set of digital modules that can be patched using patchboards.

Generator unit is an experimental instrument and as such contains partially built and unbuilt sections. The illustration below has functional or otherwise relevant sections of instrument highlighted. Blank sections that contain panel components on actual instrument are not operational (and most of them have never been).



List of the Generator Unit control elements

1. Phase voltages[3]
2. VC Mixer[4]
3. Master Timer[5]
4. Patchboards
5. Low frequency oscillator and digital port latch
6. Mini-banana patch panel
7. Harmony Generator
8. Cluster Generator tuners
9. Quad Sine Wave Oscillator
10. 5-channel Audio Mixer
11. Cluster Generator levels and Wien Bridge / Noise digital output threshold dials
12. ELMA selector rack for audio and voltage control

[3] Master timer control voltage level mixer.
[4] In original documentation Kurenniemi uses VC as in voltage control.
[5] 5-step/bit sequencer.

Getting Started

Setting up Generator Unit for operation it needs to be connected to a power outlet and output amplification system. All sockets and jacks for cables can be found on top side panel.

During 2018 renovation its original power supply was bypassed and replaced with a custom external power supply providing stable +6V, -6V, +18V and -18V voltages with over voltage and short circuit protection. Conveniently original instrument was designed in such a way that this required no modifications for the instrument[6]. As the internal power supply is not in use, external supply needs to be connected to the main unit before power on.

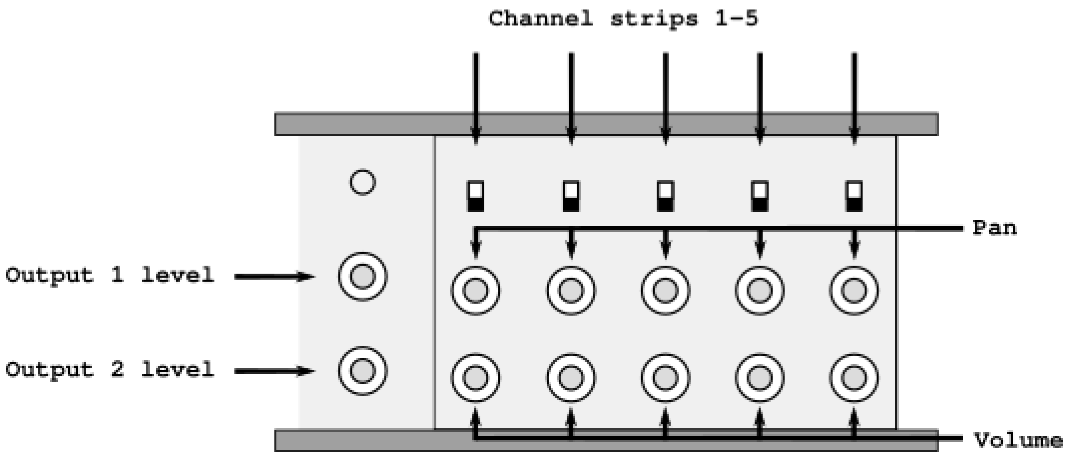
First connect the power cable between the power supply and Generator unit. This cable has XLR plug at the power supply end and both tube socket plug and banana plug at the Generator unit end. It is extremely important that the banana plug providing ground to the system is also connected to the banana jack next to the tube socket. Then proceed to connect euro power cable between the power supply to the mains socket.

Power supply has a security lock for extra security[7]. Turning the key will power Generator Unit on and off. Make sure all four leds on the power supply turn on. Turn power supply off and on again if this fails to happen.

Next to the power cable connections in the Generator unit, three DIN sockets are placed. Two of these are for the main outputs. Third one is for the input and wired to the Harmony generator selector switch panel.

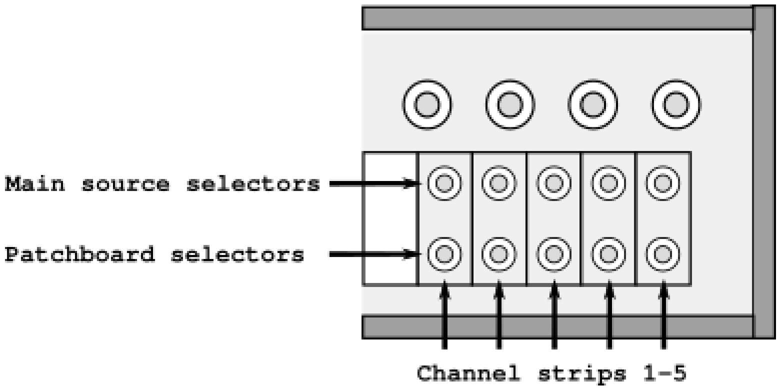
For quick sound check turn all five main source selectors in ELMA selector rack to ‘1’. Make sure all mixer volume knobs are turned fully counterclockwise and all pan knobs are set to ‘5’. Turn main output level knobs to ‘5’ and slightly open all mixers volume knobs.

5-Channel Audio Mixer



[6] Although power switches of the original instrument are no more functional.
[7] *Because crime so bad these days and these bastards try to steal your synthesizers.*

5-channel mixer. Knobs for panning and volume. Level knobs for main outs volume levels are placed on the sequencer panel at the left side of the audio mixer panel. Sound source for each channel is selected with the rotary switches at the ELMA selector rack. Mute switches above the pan knobs have never been operational.



Inputs of the mixer are selected using rotary switches in the ELMA selector rack. Each mixer channel has its own column comprising of a set of two rotary switches. Top one is the main source selector.

Input 9 correspond to patchboard input. Should this be selected, the patchboard column selector rotary switch is used to select intersection used as input in patchboard. Row of the cell is always H, and a shorting pin inserted is necessary for patching. Each mixer channel has been assigned its own fixed patch matrix.

Only a few main sources in addition to the patchboard input (9) are used in the main selector. The complete list is:

- Channel 1:
  - 1: Analog Wien Bridge Oscillator 1
- Channel 2:
  - 0: Cluster Generator
  - 1: Analog Wien Bridge Oscillator 2
- Channel 3:
  - 1: Analog Wien Bridge Oscillator 3
  - 3: Voltage Controlled Attenuator[8]
- Channel 4:
  - 1: Analog Wien Bridge Oscillator 4
  - 3: Harmony Generator (AC)
- Channel 5:
  - 1: Noise (analog)
  - 3: ?[9]

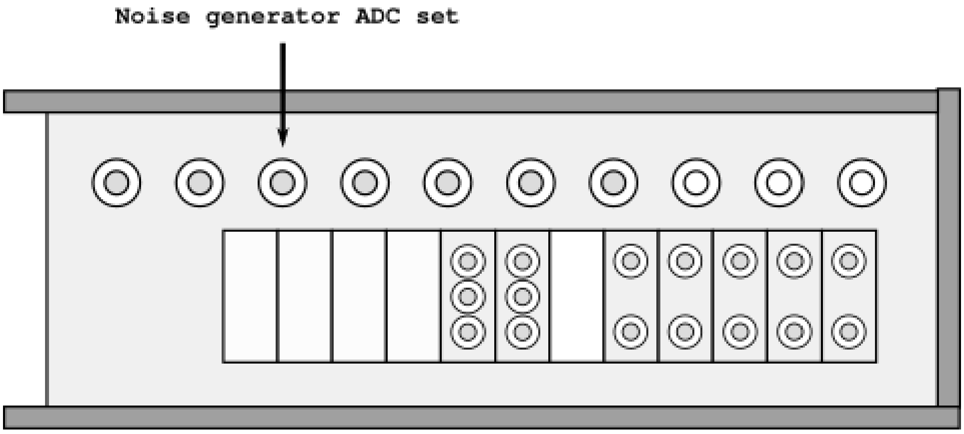
[8] Currently disconnected.
[9] The circuit connected here currently unclear.

Sound generators

Generator unit has four sound sources. Two of the sources, Harmony Generator and Cluster Generator are voltage controlled.

Noise generator

Description: White noise source. Has both analog and digital outputs. Digital output threshold used in ‘AD-conversion’ is set with a knob in lower right panel section (sweet spot just a few degrees).



Outputs:

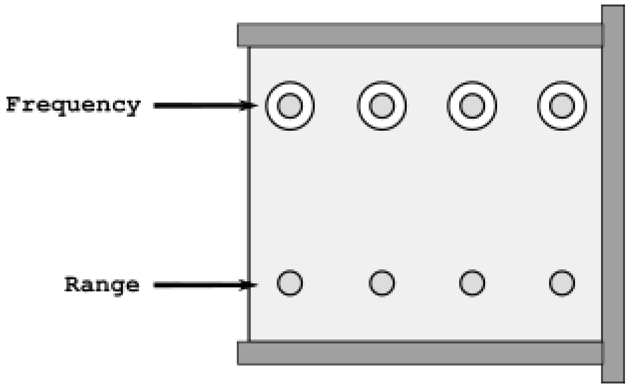
- Analog output connected to the audio main selector switch of the mixer channel 5.
- Digital output goes to the column 0 of the patch matrix 1.

Quad Sine Wave Oscillator

Description: This module is a bank of four Wien Bridge Oscillators, waveform being slightly distorted sine[10]. Oscillators are stable, close to no drift. Oscillators are not voltage controlled.

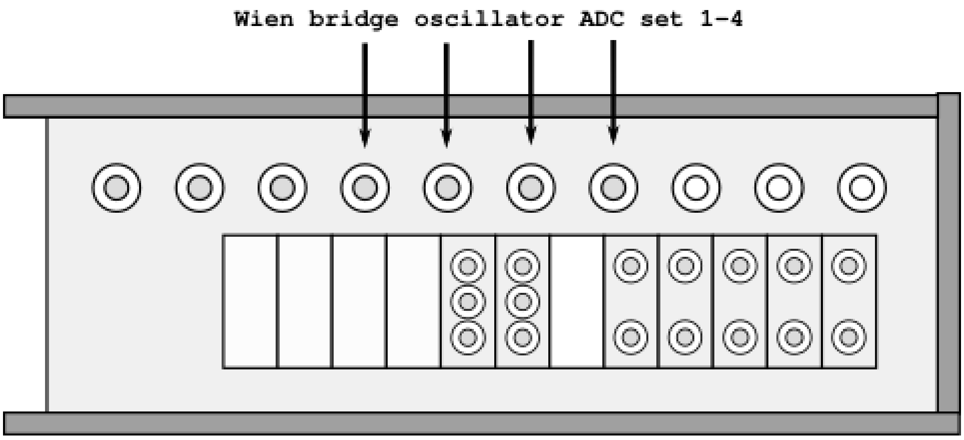
Four analog outputs are connected to the mixer input selector switch. Outputs are also driven through threshold level knobs and the Pulse Shaper NORBIT blocks before landing to the patchboards.

[10] Waveform can be fine tuned and is a compromise between a pure waveform and response of sweeps. More responsive the fine tuning is, closer to square wave the waveform will be. Check renovation documentation for the details.



Controls:

- One rotary switch for each oscillator for selecting range:
  - Position 1: ~ 10 - 200Hz
  - Position 2 (up): ~ 160 - 2000Hz
  - Position 3: ~ 1600 - 20000Hz
- One knob for each oscillator for adjusting of the pitch
- In bottom right panel section one knob for each oscillator for setting threshold level for Pulse Shaper PS1 AD-conversion.[11]



Outputs:

- Analog outputs are connected to main source selectors of mixer channels 1-4[12].
- Digital outputs through Pulse Shaper blocks connected to to patchboards 2-5, column 0.

Harmony Generator

Description: This is a bank of four tone generators, each being tuned fundamental ratios away from each other. Internally it consists of one oscillator[13] and 4 parallel divider networks. All

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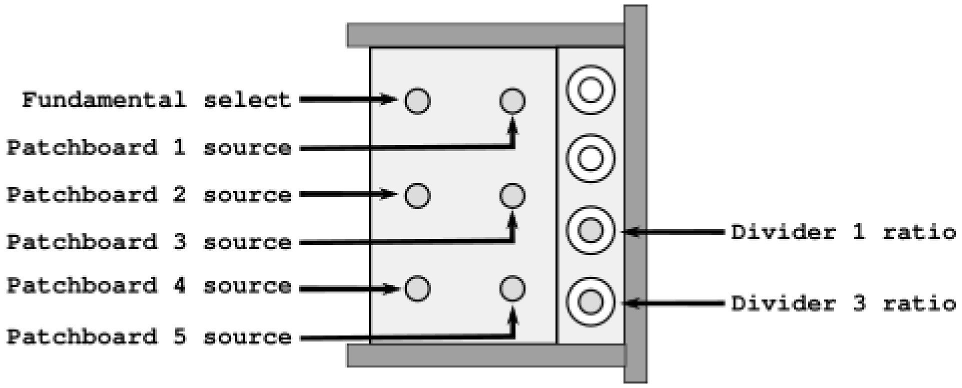
[11] Sweet spot is only a few degrees. The potentiometer dial is set such that it can be found around position 5 on all oscillators and around it sight duty cycle manipulation will occur.
[12] Check Mixer section for details.
[13] Main oscillator might not be oscillating when machine is switched on. To make sure it will oscillate, run -6V signal (for instance from CV mixer) to its input while instrument is switched on. Other option is

five can be controlled, three of these with external CV. It is also possible to feed external signal to the networks.



Controls:

- Knobs:
    - Divider 1 ratio control
    - Divider 3 ratio control
- 6 rotary switch selector panel:
    - Divider network signal source:
        - Position 1 (up): Harmony Generator oscillator
        - Fundamental input DIN connector[14]
        - Position 3: patchboard 1, column 1[15]
    - Patchboard 1 column 1 signal source:
        - Position 3: IOS input DIN connector (digitized)
        - Position 4 (up): Divsum (divider outputs mixed together) (DC) (digitized)
    - Patchboard 2 column 1 signal source:
        - Position 4 (up): Divider 1
    - Patchboard 3 column 1 signal source:
        - Position 4 (up): Divider 2
    - Patchboard 4 column 1 signal source:
        - Position 4 (up): Divider 3
    - Patchboard 5 column 1 signal source:
        - Position 4 (up): Divider 4
- CV input selection switches[16]:
    - Fundamental frequency
    - Divider 2 ratio
    - Divider 4 ratio

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rotate through CV input switch of the oscillator, usually position 6 will start the oscillator. While it would be possible to remove this glitch by modifying the circuit, it would also bring the highest possible frequency down a bit. Current condition is compromise between the glitch and highest frequency.

[14] Requires hot signal to be able to run the network buffer.

[15] This position is obviously intended to be used together with the switch #2 position 3 for level shifting external signal to the digital levels and then to the divider network.

[16] Please revert to Voltage control selectors.

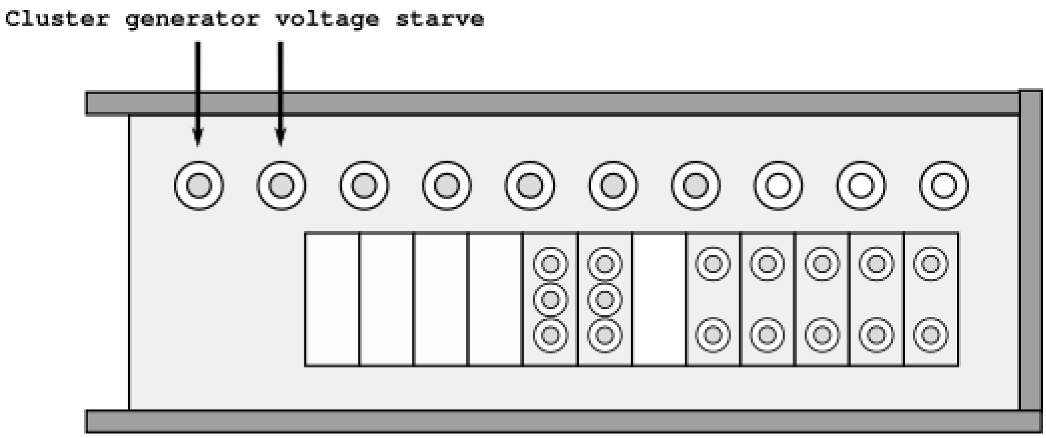
Outputs[17]:

- Mix (AC): Mixer channel 4 main selector input 4
- Mix (DC): Patchboard 1 column 1
- Divider 1: Patchboard 2 column 1
- Divider 2: Patchboard 3 column 1
- Divider 3: Patchboard 4 column 1
- Divider 4: Patchboard 5 column 1

Cluster Generator

Description: This module generates a cluster - a field of harmonic noise. Essentially it is a bank of 10 voltage controlled oscillators, all mixed together. There are two CV inputs available, upper and lower voltage. These are divided down in setup comprising of 10 potentiometers connected in series. The result are ten voltages which always stay in the same order (highest voltage possible voltage from one potentiometer, is the lowest possible on the next one...) However, potentiometers are not placed on the panel in meaningful order, and on the other hand, the ranges of the oscillators are not calibrated, which means that even though 10 CV voltages are always ordered the same way, the pitches of the oscillator may not.

In addition to cv input network, two potentiometer is used for starving voltages fed to the oscillator circuits.



Controls:

- Ten trimmers for CV ratio for each oscillator in Cluster generator tuner panel
- Collector voltage knob
- Emitter voltage knob
- CV Input Selector switches
    - The upper CV voltage
    - The lower CV voltage

Output:

- Main out connected to the mixer channel 2 main source selector input 0.

[17] Check rotary switch section.

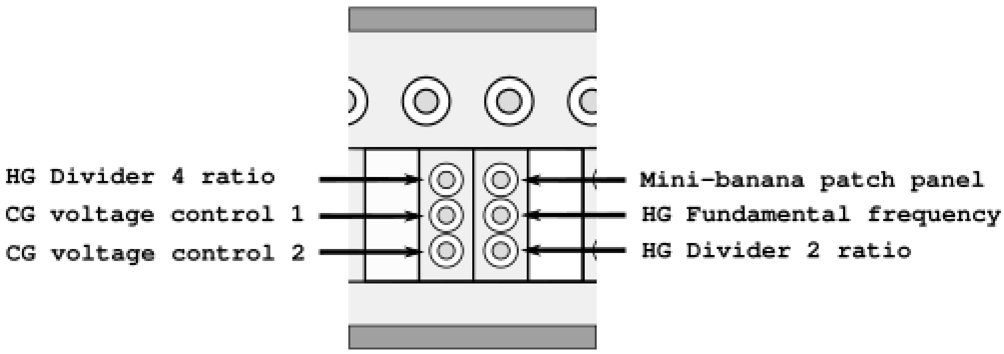
Voltage Control

Voltage Control Selectors

Patching control voltages is done through six rotary switches in the ELMA switching rack at the lower right corner of the instrument. Patching in cv voltages to the sound generators is only possible through these switches. Control voltages can be driven in and out to the sealectro matrices through mini-banana panel inputs and outputs.

Control voltage sources selectable with 10 position rotary switches are the following:

0. VC Mixer 1
1. VC Mixer 2
2. VC Mixer 3
3. Phase voltages 1
4. Phase voltages 2
5. VCO[18]
6. Mini-banana patch panel [3,2]
7. Mini-banana patch panel [3,3]
8. Mini-banana patch panel [3,4]
9. -



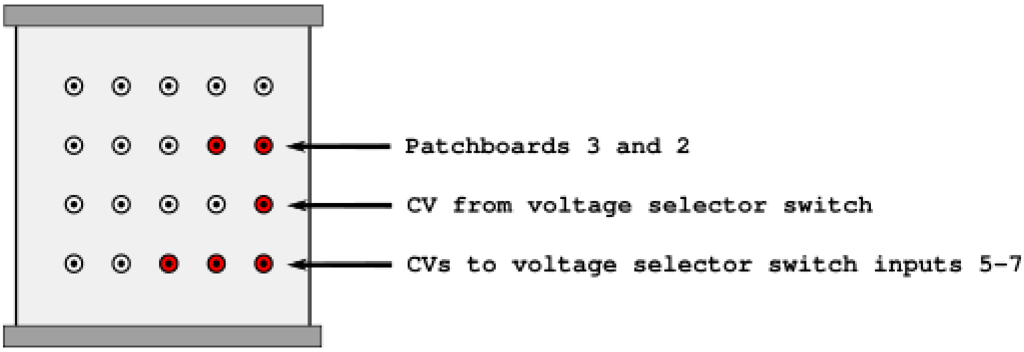
Rotary switches correspond to following voltage control inputs:

- Harmony Generator divider 4 ratio
- Mini-banana patch panel [2,4]
- Cluster Generator voltage control ‘from’[19]
- Harmony Generator fundamental frequency
- Cluster Generator voltage control ‘to’
- Harmony Generator divider 2 ratio

[18] Note that voltage controlled oscillator’s voltage control signal is hardwired to the VC Mixer 2 and therefore does not have its own cv source selector switch.
[19]’From’ and ‘to’ used as whether which one is higher pitch is to be confirmed in the future!

Mini-banana patch panel

Mini-banana patch panel was later[20] addition to the instrument and offers an interface between cv selector and patchboards. Only few banana jacks are actually connected (marked red below). Jacks on the bottom row are used to drive cv to voltage control selector switches.



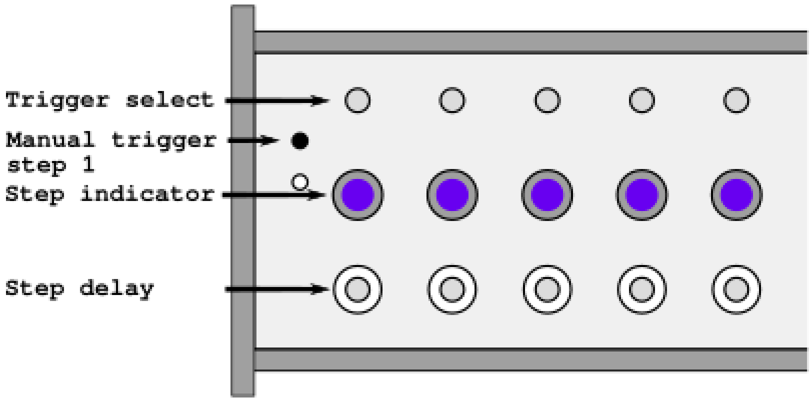
Connections:

- Second row[21]:
  - 4. jack connected to patchboard 3 intersection G3
  - 5. jack connected to patchboard 2 intersection G3
- Third row:
  - 5. jack is cv from voltage control selector switch
- Fourth row:
  - 3. jack is output sent to voltage control selector inputs 5
  - 4. jack is output sent to voltage control selector inputs 6
  - 5. jack is output sent to voltage control selector inputs 7

Master Timer

Description: Master timer is a five step sequencer. It can be run in simple five step sequencer or in a more complex manner allowing polyrhythmic sequences. When used in such matter, multiple steps can be ‘on’ at a time. Each step can also be triggered externally through patch matrices. Each step has a light indicating when step is active.

[20] The exact time it was introduced is not clear, but in 1968 it was in place.
[21] Can be used both for input and output.



Controls[22]*:*

- Each step has a knob for setting step delay time for each step.
- Each step has a rotary switch for selecting trigger source for the step. The first step differs from other steps.
    - Step 1 trigger select options:
        1. No trigger
        2. Patchboard 1 D5
        3. Step 2
        4. Step 3
        5. Step 4
        6. Step 5
    - Rotary switch options for the remaining steps:
        1. No trigger
        2. Previous step
        3. Patchboard 2-5 D5
- Top button on the left side of the panel triggers the first step of the sequencer. Pressing is necessary for starting the sequence.

Inputs:

- Patchboard intersection D5 of the corresponding patch matrix (step #1 to patch matrix #1 and so on).

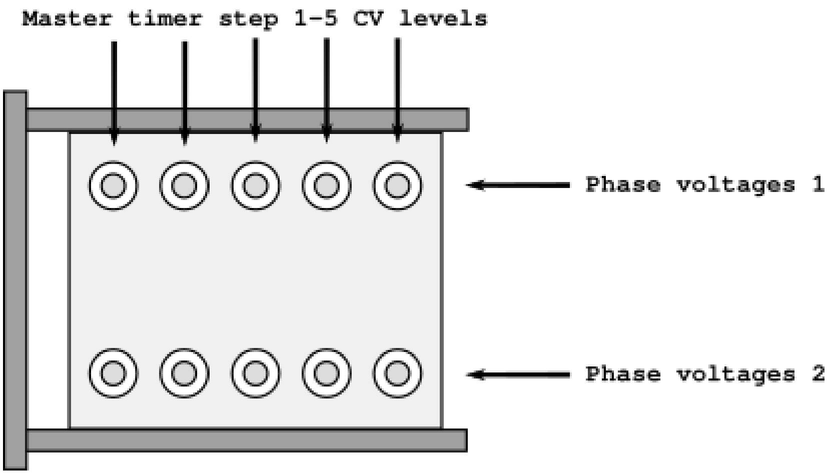
Outputs:

- Each step has been hardwired to matching step on Phase voltage mixer.
- Trigger signals (inverted and non-inverted) for each step wired to the patch matrices.

[22] Two knobs on the right side of the panel are part of the 5-Channel Audio Mixer. The rotary switch above them is not in use.

Phase Voltages[23]

Phase mixer is a dual CV source with two separate sections. Each section has a set of five knobs, each associated with one step of the Master timer for setting CV value. Output will hold CVs of active Master Timer steps mixed together.



Controls:

- For both sections a knob for each step of Master timer, five per section.

Inputs:

- Master Timer active steps hardwired to corresponding knobs.

Outputs:

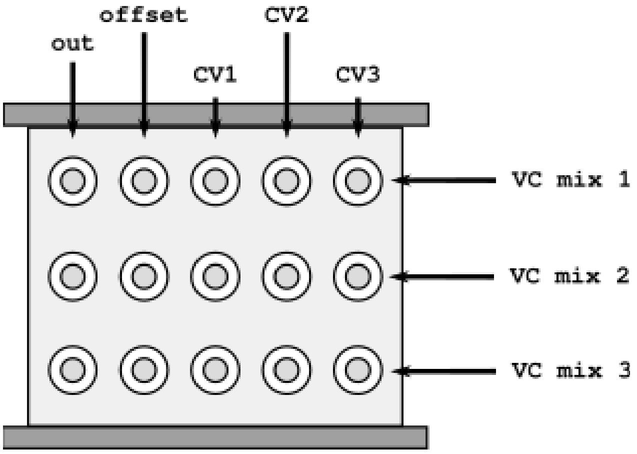
- One CV voltage per section, both hardwired to VC selector switches and VCMIX.

VCMIX

Description: Bank of three independent CV mixers, one row of knobs in the panel for each. Knobs are used to mix three CV sources and offset voltage together. Two of the CV voltages are patched in from patch matrix and third is the output from Phase voltages.

Each mixer section has their own selection of CV sources. Mixing is done with passive electronics network and does not follow conventional logic[24]. Each knob adjusts balance between cv sources in the mixing network, not amplitude. Output balance between submix of three CVs on the right and offset voltage is adjusted with the first knob on the row. Outputs are connected to the VC source selectors sources 0, 1 and 2.

[23] ‘Vaihejännitteet’ in original documentation.
[24] This is either intentional or simply faulty design.



Inputs and Controls:

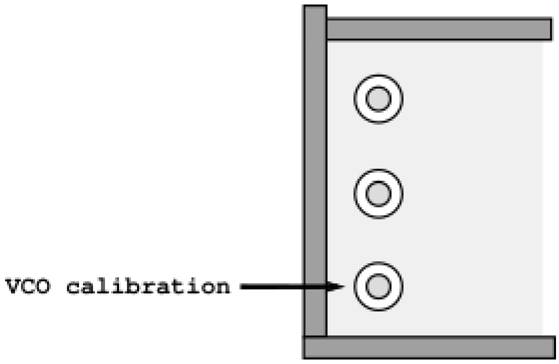
- VC mix 1 (top row)
    1. knob: sets balance between offset knob and the CV mix of knobs 3, 4 and 5.
    2. knob: offset voltage [-6V,0V]
    3. knob: CV1: intersection H3 on patchboard 1
    4. knob: CV2: phase voltage 1
    5. knob: CV3: intersection H0 on patchboard 1
- VC mix 2 (middle row)
    1. knob: sets balance between offset knob and the CV mix of knobs 3, 4 and 5.
    2. knob: offset voltage [-6V,0V]
    3. knob: CV1: intersection H4 on patchboard 1
    4. knob: CV2: phase voltage 1
    5. knob: CV3: intersection H0 on patchboard 2
- VC mix 3 (bottom row)
    1. knob: sets balance between offset knob and the CV mix of knobs 3, 4 and 5.
    2. knob: offset voltage [-6V,0V]
    3. knob: CV1: intersection H5 on patchboard 1
    4. knob: CV2: phase voltage 2
    5. knob: CV3: intersection H0 on patchboard 3

Outputs:

- All three VC mixes are connected to VC selector switches.
- VC mix 2 also connected to CV input of VCO.

VCO

Voltage controlled low frequency oscillator, possibly the oldest module of the instrument. The circuit is a simple PNP-based relaxation oscillator. As such the oscillation is quite unstable and picky about how it is calibrated in relation to the incoming cv. Adjusting the amplitude is not possible.



Controls:

- Knob for calibrating the oscillation threshold (sweet spot is somewhere around 5). This also adjusts the frequency in some degree.

Inputs:

- CV input for setting up the frequency hardwired to VC mix 2 output.

Output:

- Position 5 of the VC selectors.
- Double Rakovich 2 CV in

Digital Control

Generator unit contains a set of one of the earliest integrated circuits, digital NORBIT 1-series logic gates[25]. Digital signal levels used on this logic family are -6V (1) and 0V (0). Gates don't have any actual interface, just a set of inputs and outputs. Patching signal into gates is done through five 10 x 10 patchboards.

Patchboards

Patchboard section of the generator consists of five 10 x 10 Sealectroboards[26]. The main arrangement of each five patchboards are similar, but the inputs and outputs differ slightly. Each patchboard is also associated with individual 5-channel mixer channel and patchboard selector switch in ELMA switching rack.

Patchboards from same company were also used on EMS VCS3 synthesizer.[27] Patchboards on EMS synthesizers are a bit different from the ones used on the generator unit. Both boards are a multiple pole devices consisting of two contact decks. In EMS patchboards, on input deck all intersections on the same row are connected. Similarly on output deck, all intersections on

[25] Wikipedia 2019. NORBIT. https://en.wikipedia.org/wiki/NORBIT. Checked 31.12.2019.
[26] *Sealectroboard - the advanced system for programming and switching*. Sealectro Corporation.
[27] Kurenniemi had generator unit mostly finished in 1964 while EMS released VCS3 in 1969 and while it is obvious that Kurenniemi could not be influenced by EMS's product, most likely EMS was not aware of Kurenniemi's instrument either.

same column are connected. Placing pin on a single intersection will connect one row on input deck to one row on output deck.

The arrangement of the patchboards on Generator Unit differs from EMS patchboards: On input deck the intersections on the same column are connected. Further, on output deck the intersections are not connected to any other intersection, but act as individual outputs. 10 x 10 patchboard has then potentially 100 outputs. Inserting pin on occupied intersection will connect the input deck column to output deck intersection which may or may not be occupied. While all columns are connected to output of selected modules, only fraction of intersections on Generator Unit patchboards are occupied.

The main logic in the patchboards is that the outputs of NORBIT blocks (or other signal sources) are connected to the ten columns of one patchboard. Selected intersections are connected to the inputs of modules and placing a shorting pin in one of them will patch the signal from output to input. From a single output, signal can be connected to multiple inputs.

The exception is the lowest row of the patchboards, where the intersections are wired to the outputs as well. Placing a shorting pin there would connect two outputs, which would potentially damage the system. Generator Unit should be equipped with a selection of patch cables for breaking signal out from these intersections.

Two different types of patch cables are used in Generator Unit patchboards. First type will connect input deck intersection to output deck intersection. Second type will connect output deck intersection to output deck intersection. The plugs on the cables are color coded to separate which deck they will make contact.

In this document, columns are indexed starting from 0 to be coherent with dials of patchboard column selector knobs. Rows are labeled with letters from A-J.

Patchboard cheat sheet

Input deck (columns)

0. Pulse Shaper out
    - 0.1. Noise through ADC knob
    - 0.2. Sine oscillator 1 through ADC knob
    - 0.3. Sine oscillator 2 through ADC knob
    - 0.4. Sine oscillator 3 through ADC knob
    - 0.5. Sine oscillator 4 through ADC knob
1. Pulse Shaper out
    - 1.1. Harmony Generator Divsum
    - 1.2. Harmony Generator divider 1
    - 1.3. Harmony Generator divider 2
    - 1.4. Harmony Generator divider 3
    - 1.5. Harmony Generator divider 4
2. FF3 1 out
3. FF3 2 out

4. FF3 3 out
5. FF3 4 out
6. Gate 1 out
7. Gate 2 out
8. FF1 out
9. Master Timer trigger
   9.1. Master Timer step 1 trigger out
   9.2. Master Timer step 2 trigger out
   9.3. Master Timer step 3 trigger out
   9.4. Master Timer step 4 trigger out
   9.5. Master Timer step 5 trigger out

Output deck:

A1	FF3 1 trigger input 1 (R)
A2	FF3 2 trigger input 1 (R)
A3	FF3 3 trigger input 1 (R)
A4	FF3 4 trigger input 1 (R)
B1	FF3 1 trigger input 2 (S)
B2	FF3 2 trigger input 2 (S)
B3	FF3 3 trigger input 2 (S)
B4	FF3 4 trigger input 2 (S)
C3	FF3 1 external trigger input K
C4	FF3 2 external trigger input K
C5	FF3 3 external trigger input K
C6	FF3 4 external trigger input K
D5	Master timer trigger input
E0	Gate 1 input G1
E1	Gate 1 input G2
E2	Gate 1 input G3
E3	Gate 1 input G4
E4	Gate 1 input G5
E5	Gate 1 input G6
E8	Gate 1 input G7
F0	Gate 2 input G1
F1	Gate 2 input G2
F2	Gate 2 input G3
F3	Gate 2 input G4
F4	Gate 2 input G5
F5	Gate 2 input G6
F9	Gate 2 input G7
G3	Mini-banana panel row 2 (only patchboards 2 and 3)[28]
H0	VC mix 1-3 cv 1 input (only patchboards 1-3)
H3	VC mix 1 cv 3 input (only patchboard 1)
H4	VC mix 2 cv 3 input (only patchboard 1)

[28] Can be input or output depending on how signal has been patched in mini-banana panel.

H5	VC mix 3 cv 3 input (only patchboard 1)
I0	5-channel mixer patchboard selector position 0
I1	5-channel mixer patchboard selector position 1
I2	5-channel mixer patchboard selector position 2
I3	5-channel mixer patchboard selector position 3
I4	5-channel mixer patchboard selector position 4
I5	5-channel mixer patchboard selector position 5
I6	5-channel mixer patchboard selector position 6
I7	5-channel mixer patchboard selector position 7
I8	5-channel mixer patchboard selector position 8
I9	5-channel mixer patchboard selector position 9
J2	*FF3 1 inverted* ***output***
J3	*FF3 2 inverted* ***output***
J4	*FF3 3 inverted* ***output***
J5	*FF3 4 inverted* ***output***
J6	*Ground* ***output***
J8	*FF1 inverted* ***output***
J9	*Master timer step*[29] *inverted* ***output***

Note: Don't use shorting pins on row J as all intersections are wired to outputs of modules!

NORBIT circuit blocks

Pulse Shaper PS1

In Generator Unit, Pulse Shapers are used to convert analog waveforms to -6V logic levels. Inputs of all ten PS1 circuit blocks in the system are hardwired to one of the following outputs: noise generator, sine wave oscillator 1-4 and harmony generator outputs (divsum + divider outputs 1-4). Outputs are wired to patchboard columns 0 and 1.

Flip-flop FF3

Generator unit includes four FF3 SR type flip-flops in every patchboard. Inputs for FF3 flip-flops are placed in columns 1-6 in patchboards. Outputs are wired to columns 2-5.

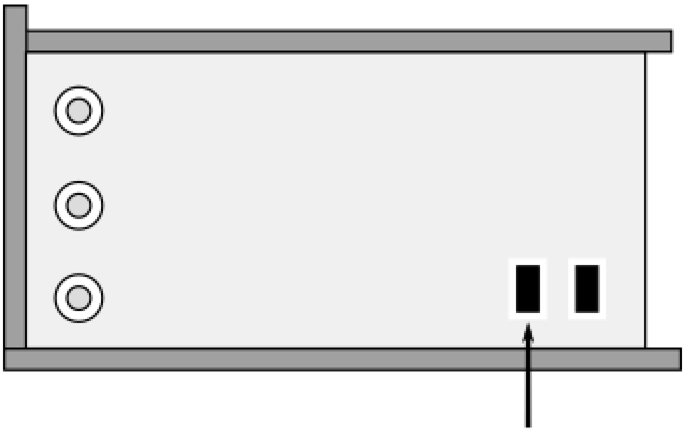
Inputs:

- Trigger input 1 S (set)
- Trigger input 2 R (reset)
- External trigger input K
- DC input 2 (reset) in all blocks wired to toggle switch in bottom right panel

Outputs:

- Main output Q
- Inverted main output ¬Q

[29] Step matching the patchboard number. Signal in column 9 inverted.



Most common application for these blocks in Generator unit is frequency division. When signal is driven to both S and R inputs, the output will toggle, which results into a tone one octave down from original. All four FF3s in one patchboard can be simply chained with shorting pins inserted to all outputs on rows A and B. This will give a total of five octaves range of same tone.

Flip-flop FF1

Each patchboard has one FF1 SR type flip-flop. Only reset DC is wired, similarly as FF3 gates, to the toggle switch in bottom right panel. The output Q is after power on either 0 or 1 and after use of the switch, it will stay at 0 until power down.

Input:
- Reset DC input in all blocks wired to toggle switch in bottom right panel

Output:
- Direct output Q
- Inverted output ¬Q

The purpose of this block seems to be providing constant 1 and 0 voltages to patchboards. However the block would be much more useful if its state would be toggleable.

Cascaded Twin OR 23P1 / Twin AND 23A1 Gate

Each patchboard has two identical gates comprising of four cascaded NORBIT blocks: two three input AND gates and one three input OR gate. As these blocks hold passive circuit network, they are buffered with 2IA2 twin inverted amplifiers[30].

Inputs:

G1: W1 input AND (gate 1)[31]
G2: W2 input AND (gate 1)
G3: W3 input AND (gate 1)
G4: W4 input AND (gate 2)

[30] Signal run through both inverting gates to keep the phase as it was.
[31] Unconnected AND gate inputs default as 1

G5: W5 input AND (gate 2)
G6: W6 input AND (gate 2)
G7: W3 (or W6) input OR gate[32]

Output:

- Direct output Q

Logic formula this gate implements is:
$(G1 \land G2 \land G3) \lor (G4 \land G5 \land G6) \lor G7$
As AND gate inputs default to 1 unconnected while OR gate input defaults as 0, the formula may be reduced if only some of the inputs are connected. For instance if only G3 and G4 are connected, the formula can be written as:
$G3 \lor G4$

[32] Unconnected OR gate input default as 0