SM042 KOTELNIKOV: User's guide (preliminary version)

Firmware version 1.0

Thank you for purchasing an SSSR Labs module! We wish you a long and fruitful experience with this module. On pages of this manual we will explain how to use the SM042 KOTELNIKOV Wavetable Oscillator.

The KOTELNIKOV module is a voltage controlled digital oscillator for a Eurorack modular synthesizer system. This oscillator produces a tonal sound signal having 7 octaves range (C0–C7) and amplitude range up to +/-5v or more with external amplitude control.

Warning!

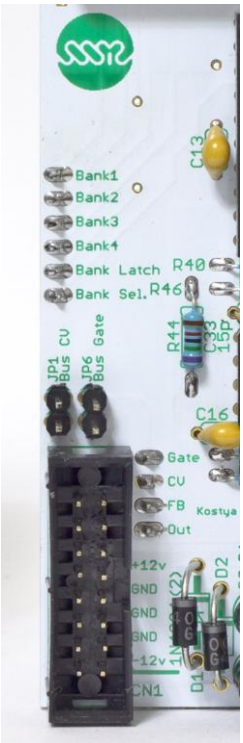
Do not connect the unit to a modular system having 15-volt power lines. This unit was not tested for proper operation with 15-volt systems and there is possibility of overheating and further damaging certain components of the unit.

Do not connect any voltage or current sources that are not intended to be used as musical instrument sound or voltage control outputs to the unit's inputs! Connecting low-impedance current sources such as power sources of any kind can cause immediate destruction of the unit.

Do not connect the audio output of the module to a low-impedance (less than 1 kOhm) load such as headphones, speakers, etc. It can seriously degrade performance of the output driver.

Not observing the above instructions cancels the warranty!

It's recommended to keep an interval of 10 seconds between subsequent power-off and power-on of the system where the unit is installed. A short off-on cycle can sometimes cause wrong pitch tracking. It can be corrected with an off-on cycle with the proper pause.



CONNECTING THE UNIT

The unit is equipped with a 16-lead Eurorack power/control cable. The unit has a keyed power connector that prevents the unit from the power connector being plugged in wrong. However when using a 3rd party power cable or non-keyed power busses, please make sure that the -12v line is physically connected to pins 1-2 (below).

The unit supports Doepfer A-100 CV/Gate bus control (or compatible) within the 0–5v range. To use this feature, the jumpers JP1 Bus CV and JP2 Bus Gate must be installed. In this case module can be controlled via the bus when there is no connectors inserted to V/OCT and GATE inputs. When jacks are inserted, the A-100 bus becomes disconnected. The bus CV line controls the pitch of the instruments within 5 octaves, and the Gate line triggers the Transient Generator.

The oscillator is intended to work in a Eurorack system and its output amplitude can reach 10vpp without using AM or even up to 24vpp when +12v is fed to the **AM** input. However, it can be connected to a line input or to a guitar effect pedal. To do this you must set the **AM** knob to a "9 O'clock" position and adjust it by ear in order to limit the output amplitude down to a safe level.

THE THEORY OF OPERATION

The KOTELNIKOV oscillator plays back previously recorded wave tables represented by digitally stored images of full periods of various kind of sound waves. Each wave table contains 256 8-bit or 12-bit samples. The output sampling rate depends on the sum of voltages on the **V/OCT** and **FM** inputs and also on the settings of the respective knobs (**PITCH**, **FM**, **OCT**). The phase of the currently selected waveform can be manually reset by a trigger on the **SYNC** input.

STANDARD SETTINGS

When you just starting to work with the module, it is recommended to set it like this:

PITCH, **FM**, **WM**, **FILTER**: in the middle position;

AM/AMPLITUDE: fully clockwise;

WAVE: fully counterclockwise;

OCT switch: "0";

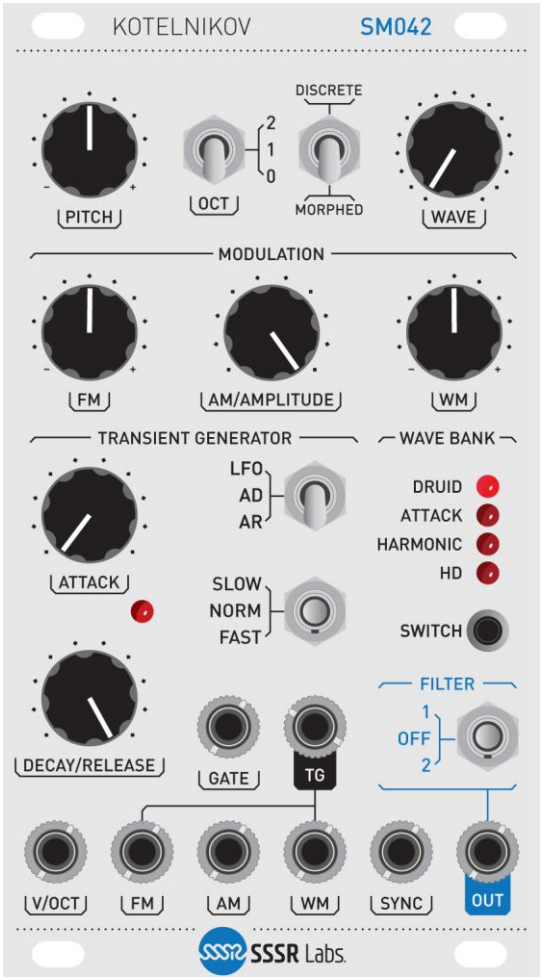
DISCRETE/MORPHED switch: **MORPHED**;

ATTACK: Fully counterclockwise;

DECAY/RELEASE: Fully counterclockwise;

TG mode: **AR**.

In this configuration, the oscillator works with constant volume and generates the first waveform from the selected bank. The timbre of the sound can be smoothly changed with the **WAVE** knob. Pressing the **SWITCH** button changes the current bank. When using KOTELNIKOV as a CV/Gate controlled synthesizer voice, you need to interconnect the **TG** output and the **AM** input with a short patch cable.



THE OSCILLATOR CONTROL

The oscillator has 3 controllable parameters: the frequency, the amplitude and the wave form. Each of these parameters can be changed in various ranges by hand or by a voltage applied to the respective CV inputs.

FREQUENCY CONTROL

The frequency of the oscillator can be exponentially changed: Each +1 volt applied to the **V/OCT** input causes 2 times frequency increase or, in other words, one octave pitch shift. The **PITCH** knob shifts the pitch within about 1 octave. The voltage applied to the **FM** (Frequency Modulation) input gives you an additional exponential frequency control. The **FM** knob of the **MODULATION DEPTH** section allows you to set the degree of the FM in the range of zero to +/-1v/octave. The sum of the voltages is limited by a range of 0-+5v and any exceeding value will be ignored.

The **OCT** switch allows to shift the pitch by one or two octaves. Depending on the position of this switch, the module generates signals within the following ranges of the base harmonic:

- Octave 0: 16.35-523.2 Hz
- Octave 1: 32.7-1046.4 Hz
- Octave 2: 65.4-2092.8 Hz

AMPLITUDE CONTROL

A classic VCO usually does not provide any way of control for its amplitude and requires the presence of a voltage-controlled amplifier in the system. The KOTELNIKOV oscillator allows the user to control its own amplitude over a wide range thanks to the use of a multiplying DAC, which works in the same way as a balanced modulator or 4-quadrant multiplier.

When there's no plug connected to the **AM** (Amplitude Modulation) input, the DAC multiplies a constant value of +5v with the decoded wave data, giving a sound signal with a maximum amplitude of ±5 volts. This voltage can be adjusted with the **AM/AMPLITUDE** knob down to completely muting the signal, which allows the user to connect the module directly to a linear input or perform a mixing of the KOTELNIKOV's output with other sound sources with just a summer using the **AM/AMPLITUDE** knob as a fader.

The amplitude can by changed by a DC or AC voltage on the **AM** input. The range can be up to full ±12v. When this control voltage is only positive, the multiplying DAC works like a linear VCA. When control voltage is bipolar, the multiplying DAC works like a ring modulator giving you additional sonic abilities.

WAVE FORM CONTROL

80 wave forms of the KOTELNIKOV module are organized in 4 banks:

DRUID: 16 wave forms of the Electric Druid VCDO. 8-bit.

ATTACK: 16 wave forms with interleaved alternating brightness. 8-bit.

HARMONIC: Subsequently arranged harmonic signals. The first wave form represents a sine wave having the base frequency, and subsequent wave forms represent harmonics respective to the 1st one, from 2nd to 16th. 8-bit

HD: 32 wave forms, which imitates sounds of analogue oscillators, reed instruments and a human voice. 12-bit.

Within the current bank, the wave form can be selected with the **WAVE** knob or a voltage applied to the **WM** (Waveform Modulation) input. The depth of the wave form modulation can be attenuverted with the **WM** knob in the **MODULATION DEPTH** section. The internal range of the waveform select input is 5v. This range is divided into 16 bands, 0.3125v each, which corresponds to the index of the wave form in the current bank. The **Morphed/Discrete** switch defines the mode of the wave form selection. When it's set to **Discrete**, the **WAVE** knob starts to work as a virtual rotary switch and CV works also as an analog selection code: you can select only pure wave forms exactly as they are stored in memory. When the switch is set to **Morphed**, morphing (a cross-fade) between each two adjacent wave forms is applied giving a continuous range of timbres.

The **HD** bank differs from the others: It has twice as large a set of wave forms: 32 - and morphing is not possible in this bank. The width of each voltage band is 156mV.

Modulation of any of these parameters in the audio range of frequencies allows you to create unusual and bright sounds, which are very different in comparison with the on-board sound set. The best performance can be reached when the modulation frequency has a constant relation to the pitch. This allows you to enter the field of FM-synthesis.

THE TRANSIENT GENERATOR

The on-board Transient Generator represents an analog transient function generator with controlled direction. The signal of this generator goes to the **TG** output. It can operate in three modes:

AR: An attack-release envelope generator.

AD: An attack-decay envelope generator.

LFO: A low-frequency generator.

The operating mode can be selected with the **AR/AD/LFO** switch.

All three modes share the same time settings: The relative rate of the upward voltage change is defined with the **ATTACK** knob position, and the same for the downward voltage change is defined with the

DECAY/RELEASE knob position. The ratio is 1:1000. Also, the range may be shifted with the range switch: SLOW/NORMAL/FAST. The ratio of these ranges are 1:33:1000.

The TRIG input is a +5v logical input for the trigger signal. This trigger is set when there's a logical "one" or +5v, and it is reset when there's zero volts.

In the AR mode, TG is normally standby while trigger is reset. When trigger is set, the Attack stage begins and voltage on the TG out rises up to a maximum of +5v. When the trigger is reset, the TG immediately turns to the Release stage and the output voltage falls down to 0 volts. Direction can be changed at any moment, so the level on the TRIG input in this mode controls direction.

In the AD mode, TG is also normally in standby while trigger is reset and the Attack stage begins on the rising edge of the logical signal on the TRIG input. The difference in this mode is that the attack stage always proceeds to its end until the voltage reaches its maximum of +5v. Then TG immediately turns to the Decay stage and the voltage falls until it drops to zero. If a new rising edge is present at the TRIG input while the decay is not yet over, the signal will start to rise from that point.

In the LFO mode, TG operates automatically, changing its direction once it reaches the end point, such that it represents a unipolar low-frequency triangle/sawtooth oscillator with a range of about 0.1—30000 Hz. The angle of the sawtooth depends on the ratio between the settings of the ATTACK and DECAY/RELEASE knobs. As in the AD mode, setting the trigger (rising edge) during the falling stage immediately toggles the rising stage, so we get a retriggerable LFO.

The Transient generator is internally connected with the WM and FM inputs; in other words, they are normalled to the TG.

THE SYNC INPUT

Each wave form of the KOTELNIKOV module has a particular start point: a zero-phase. You can reset the playback right to this point with the SYNC input. It operates similarly to a Hard Sync input on an analogue oscillator. The playback starts from the very beginning when the signal on the SYNC input crosses the +0.7v point.

THE FILTER

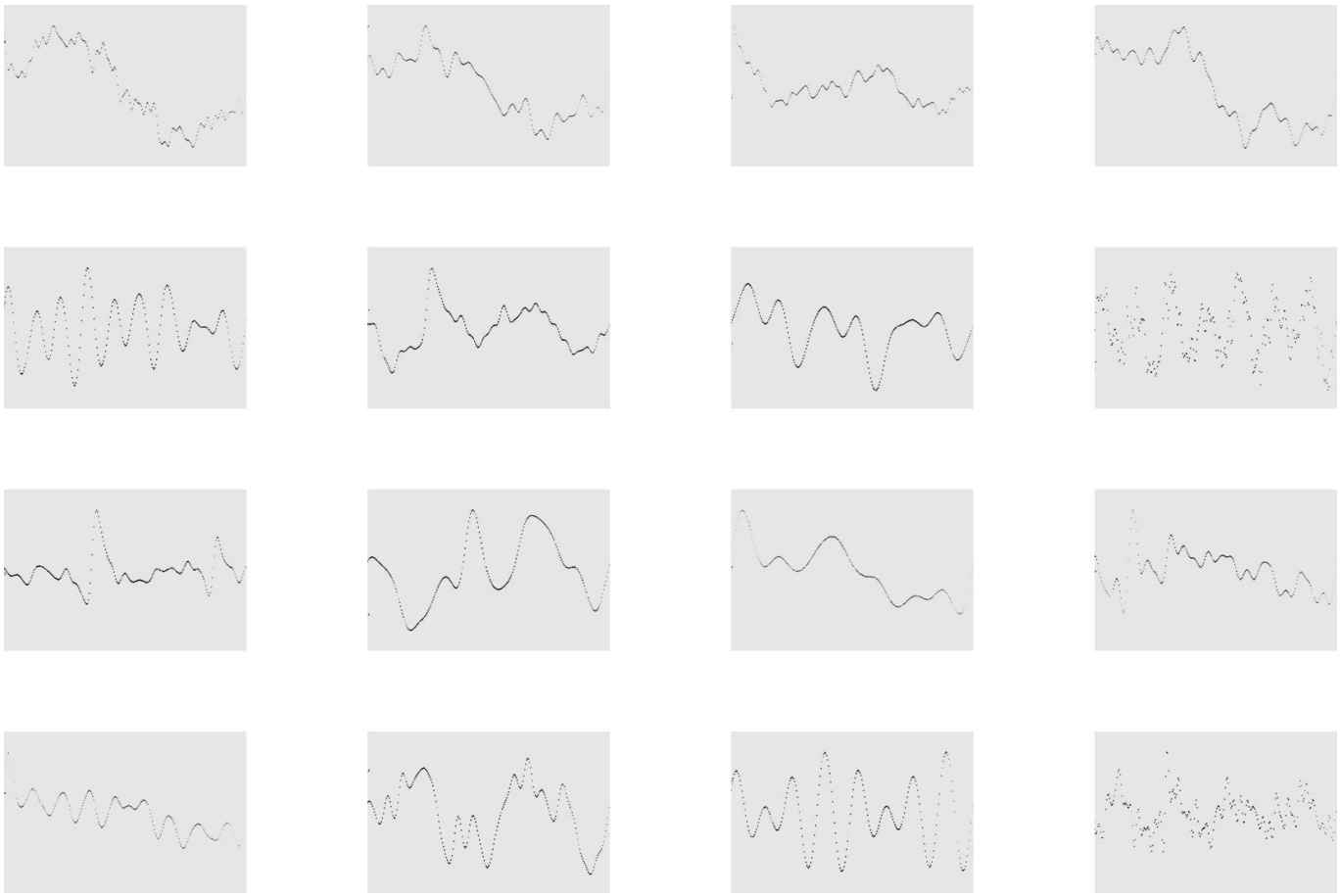
For the user's convenience there is a simple passive low-pass filter. Its operation mode can be selected with the FILTER switch.

In mode «1» the filter slightly suppresses the staircase in the output signal.

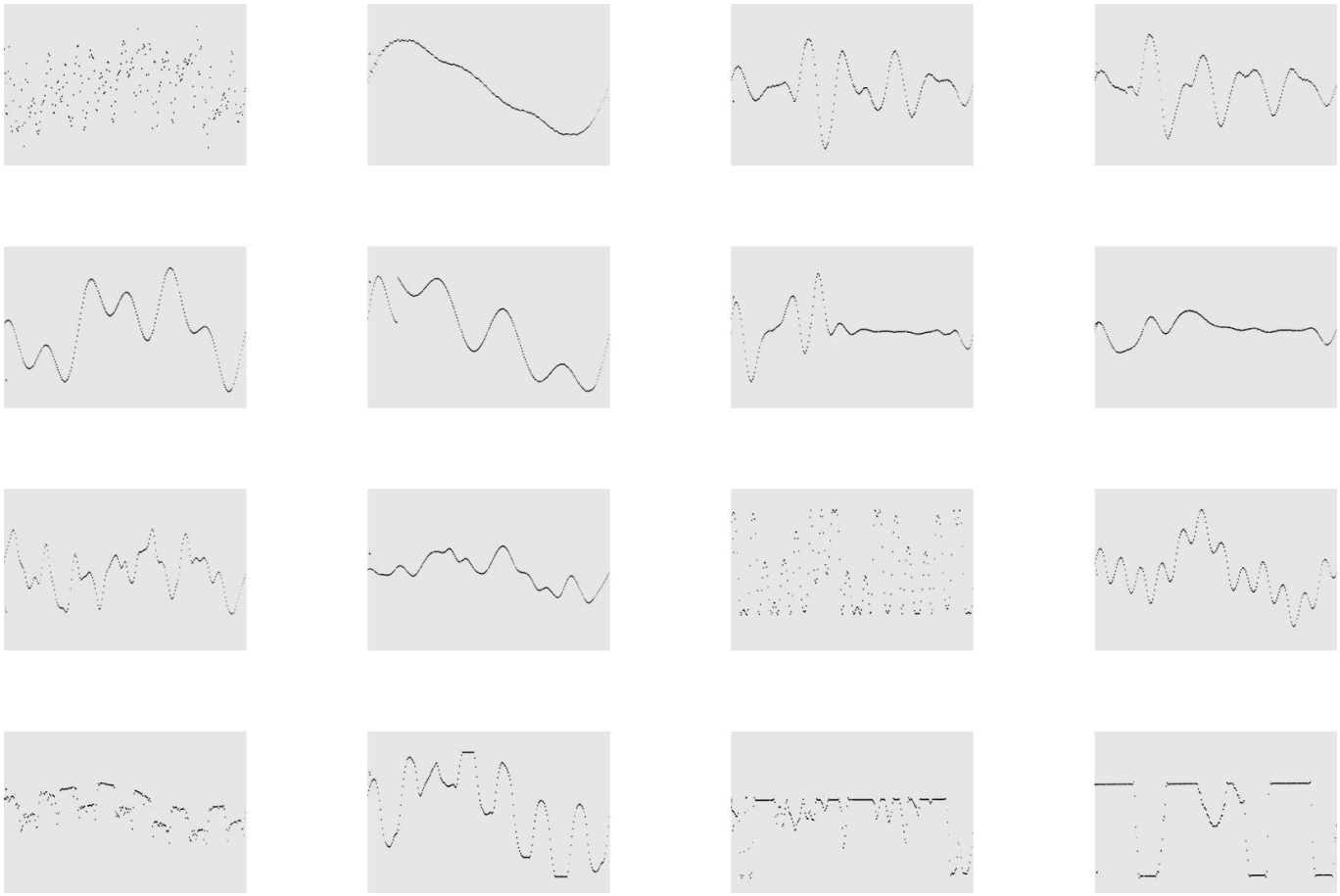
In mode «2» the filter damps high frequencies.

In mode «OFF» the filter is in bypass and output signal is raw and bright.

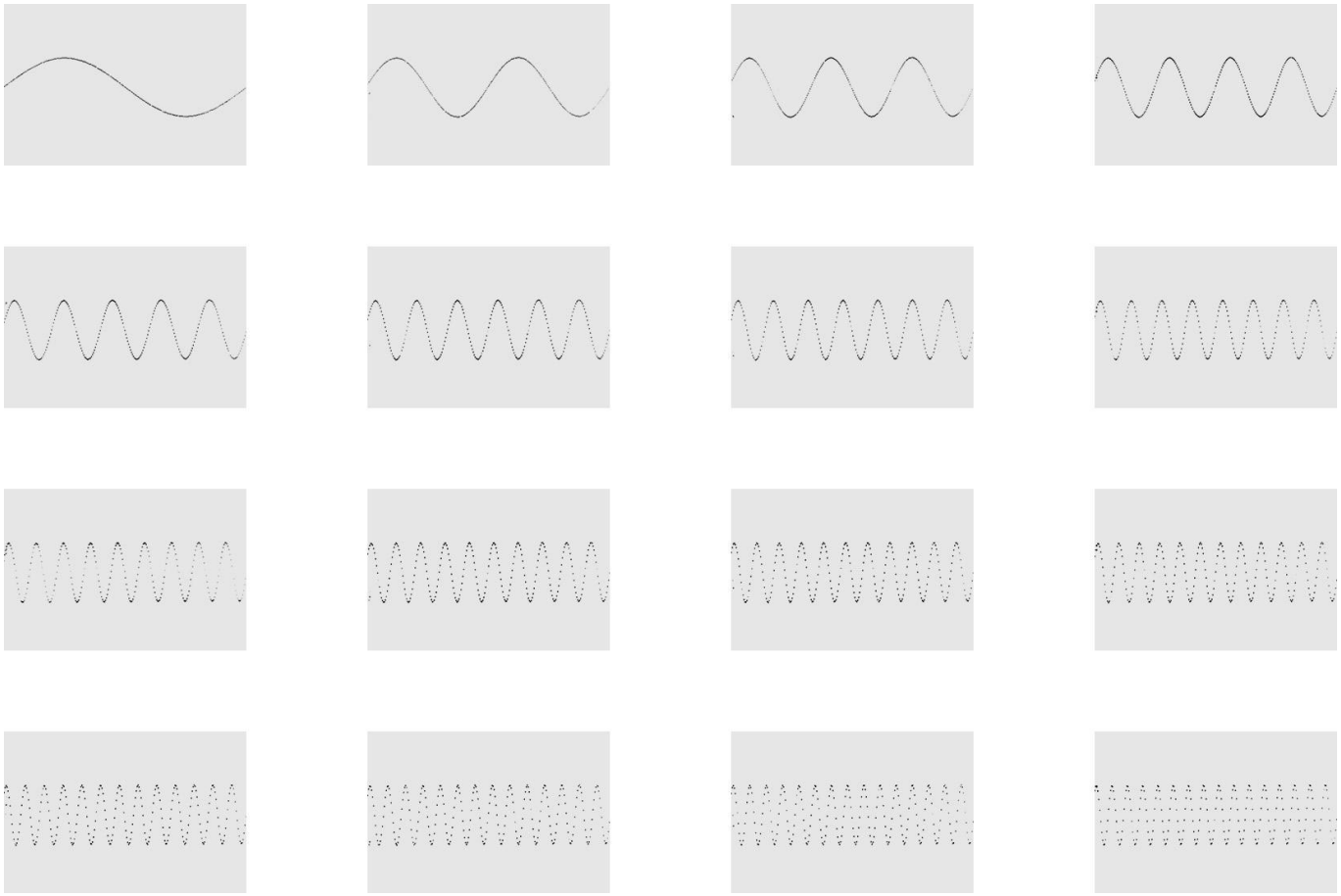
DRUID Bank Wave Forms



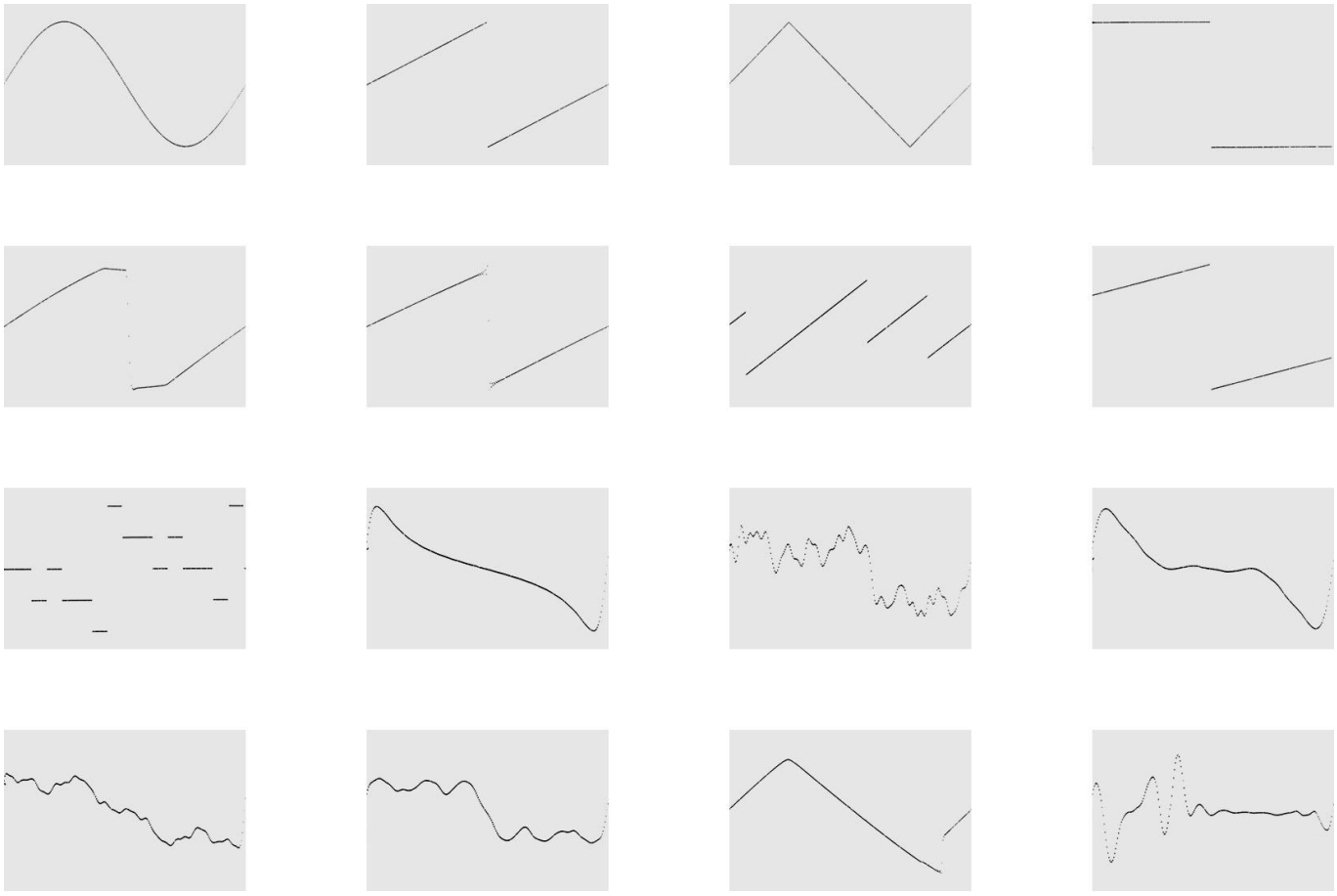
ATTACK Bank Wave Forms



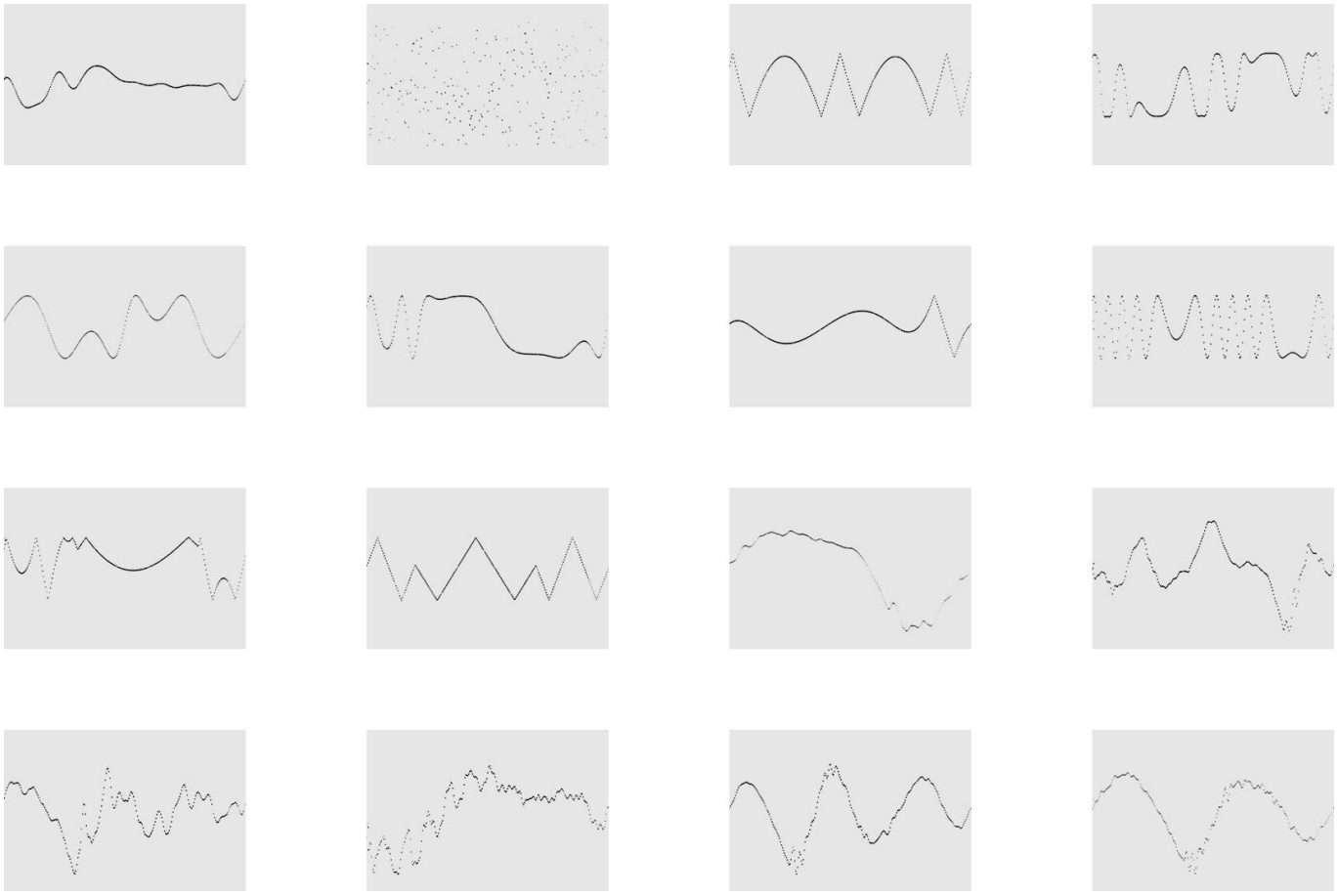
HARMONIC Bank Wave Forms



HD Bank Wave Forms (1–16)



HD Bank Wave Forms (17–32)



Technical specifications

Pitch: 7 octaves range (C0-C7), 6 cents resolution

DAC: 12-bit, variable sampling rate: 4.2–133.3kHz

Wave tables: 3x16 8-bit tables, 32 12-bit tables.256 samples each.

Control ADC: 10-bit/6kHz

Module width: 14hp

Depth behind the panel: 40mm

Physical dimensions: 71x129x60mm

Weight: 230g

Rightholders information

The Doepfer trademark belongs to Dieter Doepfer and Doepfer Musikelektronik GmbH .

The copyright on the firmware and electrical circuit of the SSSR Labs KOTELNIKOV module and also the SSSR Labs trade mark belongs to Dmitry Shtatnov. http://modularsynth.ru/.

The copyright for the wave content of the DRUID bank belongs to Tom "Electric Druid" Wiltshire. http://electricdruid.net/. Used with permission.