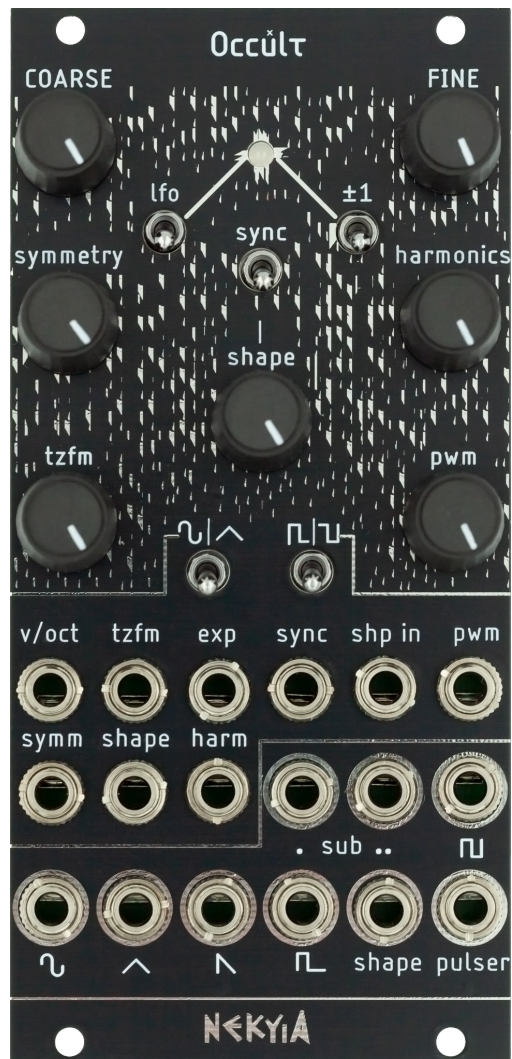


NEKYIA

CIRCUITS

OCCULT

Thru-Zero Waveshaping VCO



User Manual

OVERVIEW

Occult is an analogue TZFM Triangle-core VCO/LFO with a wide frequency range and unique waveshaping capabilities! It features nine simultaneously available wave outputs: Sine, Triangle, Square and Pulse, a PWM Saw, Sub -1 and Sub -2, plus the outputs of Shaper and an interesting Pulser waveshaper circuit. Pulser is a waveshaper inspired by the "double pulser" circuit of Ian Fritz, able to produce exotic, rich sounding waveforms. The Shaper section adds a crossfader which can mix between the normalized Sine wave or any other external input and the Pulser or the inverted Pulser output, further extending the waveshaping possibilities. Apart from an Exponential FM input Occult also includes a TZFM input with an attenuator control, capable of producing more musical and complex FM tones than a typical VCO. Also, a Sync switch allows for both Hard and Soft Sync. The unique waveshaping abilities, CV control for every parameter as well as FM options make Occult a very versatile oscillator for sonic exploration!

Tech Specs:

Depth: 30mm, Skiff Friendly!

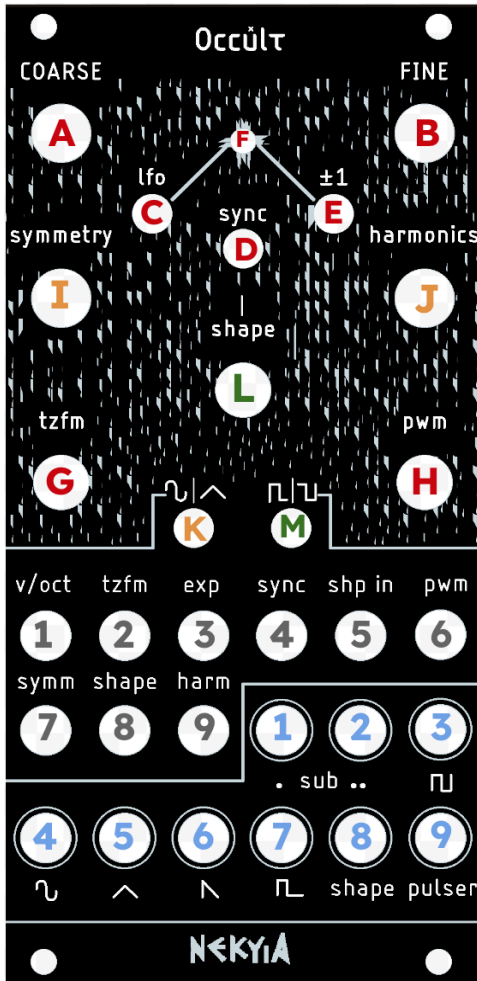
Power: 85mA @+12V / 83mA @-12V

12hp

Installation

Before installing this module disconnect the power from your system! Double check the polarity of the ribbon cable! The red stripe should be aligned with the -12V rail, on both the module (white bold line) and on the bus board.

PANEL CONTROLS



- A. Controls the pitch of the oscillator.
- B. Fine tune control.
- C. Switching between audio (down) and LFO (up) rates.
- D. Switching between Soft (up) and Hard (down) Sync.
- E. Octave switch selecting +1 octave (up) or -1 octave (down).
- F. Oscillator frequency bipolar LED indicator.
- G. Attenuator that controls the amount of TZFM.
- H. Controls the width of both the Saw and Square wave.

PULSER

- I. Controls the Symmetry of the Pulser.
- J. Controls the amount of Harmonics of the Pulser waveshaper.
- K. Switch for selecting Sine (up) or Triangle (down) wave as the Pulser input.

SHAPER

- L. Crossfades between the Shaper input wave 'shp in' and the Pulser output. Shp in is normalised to Sine wave.
- M. Inverts (down) the Pulser output going in the Shape crossfader circuit.

INPUTS

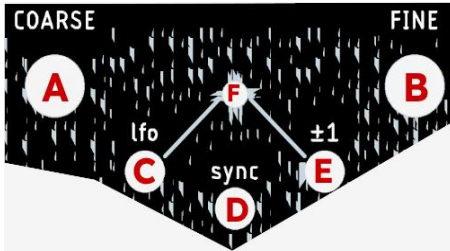
1. Pitch control (1 volt per octave standard).
2. TZFM AC coupled input.
3. Exponential FM input (1 volt per octave standard).
4. Sync input. Depends on the Sync mode switch position.
5. Shape input to be crossfaded with Pulser output wave.
6. PWM CV input. +/- 5V.
7. Symmetry CV input. +/- 5V.
8. Shape crossfader CV input. +/- 5V.
9. Harmonics CV input. +/- 5V.

OUTPUTS

1. Sub 1 outputs 1 octave below the Square wave.
2. Sub 2 outputs 2 octaves below the Square wave.
3. Square wave output.
4. Sine wave output.
5. Triangle wave output.
6. PWM Saw wave output.
7. Pulse wave output.
8. Shaper output.
9. Pulser output. It can exceed 10Vpp on some settings.

Oscillator Core

Pitch Controls



LFO switch (C) determines if Occult will operate as VCO (audio rate) or LFO. In LFO mode (up position) Occult allows for cycles as slow as 20 seconds. In VCO mode it can reach from 20hz to above 20khz.

Bipolar LED (F) that indicates the rate of the oscillator; particularly useful in LFO mode.

Coarse (A) controls the pitch over an approximately 10-octave range, which can be extended using the Octave switch (E).

Fine knob (B) allows finer frequency adjustment over a range of approximately 6 semitones.

V/oct input (1) allows for precise tracking over at least 7 octaves.

Sync

Sync occurs when one oscillator is resetting the phase (restart to a phase of 0 degrees) of a second oscillator. Occult offers two Sync modes through the Sync switch (D) and each results in different timbres. In up position, it produces a Soft Sync and in down position a Hard Sync. Hard rising edge waveforms (e.g Square or Saw) will work best to Sync Occult.

In Hard Sync, Occult will always reset according to the pitch of an external oscillator patched in Sync input (4). In Soft Sync, Occult only resets when it is close to the end of its own wave, meaning it ignores the sync signal unless both Occult and the external oscillator are somewhat close in tune. Therefore, Soft Sync is not accurate for pitch tracking of the external oscillator but it can provide a unique set of timbres.

FM

Frequency modulation synthesis can be achieved when the frequency of a waveform (carrier) is modulated by the frequency of another waveform (modulator). Occult offers both Exponential and Through-zero FM options.

TZFM is a type of Linear FM that can produce deeper and richer timbres. Unlike regular Linear FM where the pitch of the carrier that is being modulated never dips below 0Hz (negative pitch), TZFM can go below zero. This is achieved by reversing the direction of the oscillator when negative frequencies present on the FM input. Instead of running forwards it just starts running backwards resulting in different timbres from regular Linear FM. That also results in a symmetrical FM with a more stable perceivable pitch as the sidebands are centered around the base frequency of the carrier. Mind that at high values of TZFM knob (G) the sound will lose its defined pitch. TZFM input (2) is AC coupled in order to ensure that any DC offset will not destabilize the pitch of the oscillator. In Occult, TZFM is influenced by the Sync switch position. Soft Sync will result in more symmetrical and smooth sounds while Hard Sync will result in more edgy sounds with a more stable perceivable pitch.

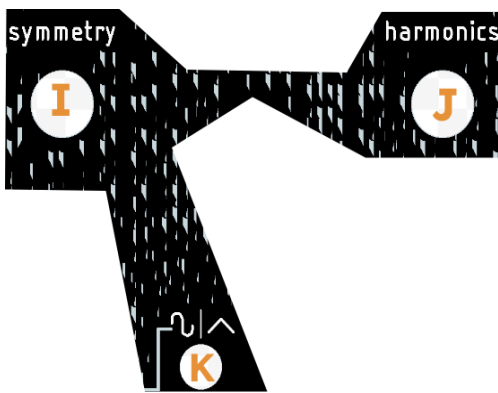
The main difference between Linear and Exponential FM is how they react to incoming voltages. In Exponential FM the frequency of the modulator is changing the perceived pitch that results from the carrier oscillator. Hence, the emerging pitch cannot track chromatically, resulting in a wide range of timbres though and making it ideal for atonal sound effects. Also, unlike the AC coupled TZFM input, Exponential FM input can be used with slow rate voltages e.g LFO in order to create classic vibrato effects.

PWM

Occult offers PWM not only on Pulse wave but also on the Saw wave! PWM knob (H) sets the base pulse width and affects both Pulse and Saw wave outputs. Pulse wave output has a 50% duty cycle (square) when PWM knob (H) is in the middle position. The PWM CV input (6) range is +/- 5V and width can go down to 0% or up to 100% at which point no sound will be produced. Saw wave output has a pure Saw wave when PWM knob (H) is in the zero position. When PWM knob (H) is in the middle position it outputs a double Saw wave which is one octave above the Oscillator's frequency.

Pulser

Pulser is a waveshaper circuit inspired by a circuit called "double pulser" originally developed by Ian Fritz and also presented at Electronotes #72. This unique waveshaper adds odd harmonics to the incoming wave (sine or triangle) by introducing two pulse signals. This is resulting in exotic waveforms with rich overtones that can be continuously varied with control voltages.



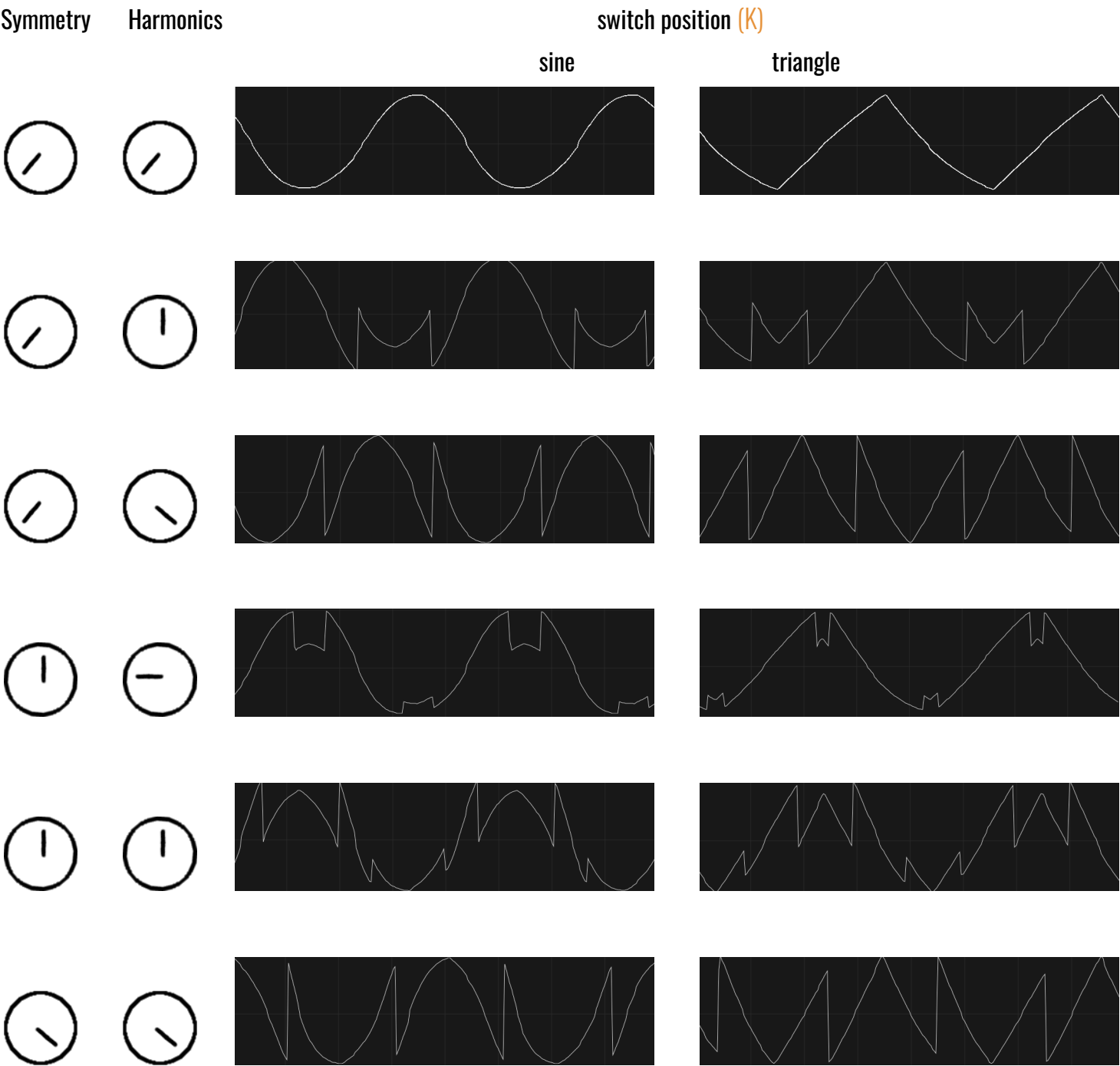
Symmetry knob (I) controls the pulse widths of the produced pulses, essentially increasing or decreasing the thresholds of the comparators. Symmetry can be modulated through Symm CV input (7).

Harmonics knob (J) mixes symmetrically placed positive and negative pulses extracted from the input signal (sine or triangle) itself using two comparator circuits and then mixed back to the original signal while simultaneously

controlling the mix level. Harmonics can be modulated through Harm CV input (9).

Wave switch (K) is switching between a Sine wave (up position) and a Triangle wave (down position) as the Pulser input.

Pulser Waveform Examples



Shaper

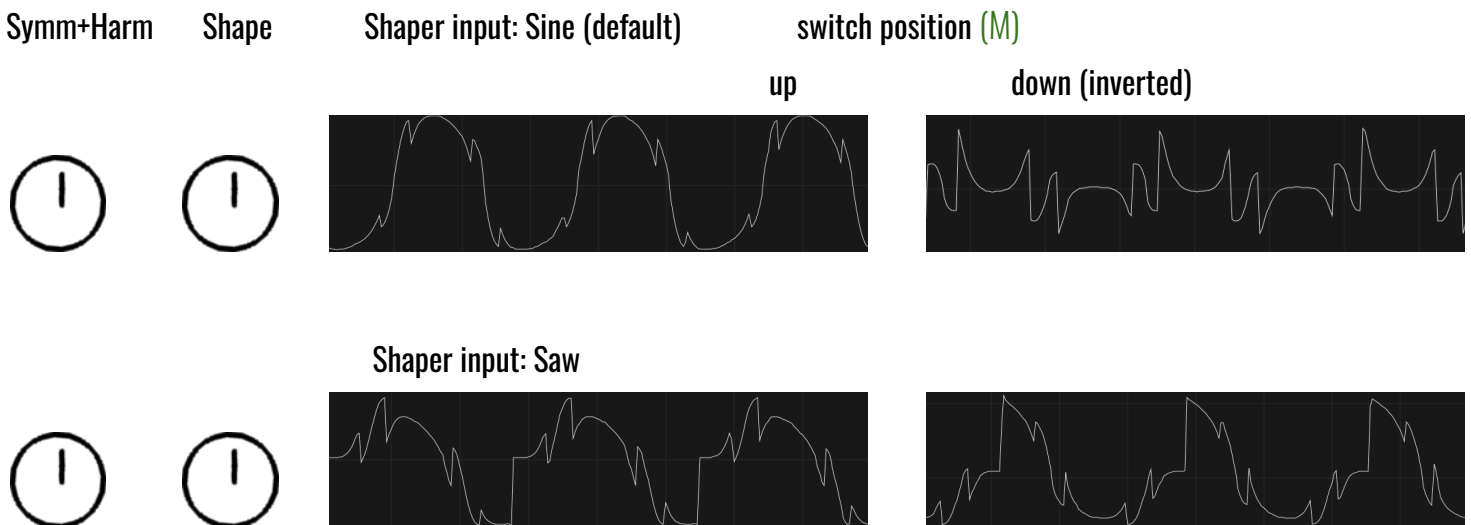


Shaper is essentially a CV controlled crossfader which can smoothly fade between two signals, allowing for a wide combination of waveshapes. The balance between the two signals can be adjusted with Shape knob (L) or with modulation applied to the Shape CV input (8).

Sine wave is normalized as one of the crossfader input signals. Therefore, by setting Shape knob (L) in zero position it will output a Sine wave on the Shape output (8). This Sine wave will be slightly saturated though offering a warmer Sine wave of a different character compared to the pure Sine wave appeared on the Sine wave output (4). Normalization of the Sine wave can break by patching a signal to the Shaper input {shp in (5)} so as any other Occult's wave or even an external oscillator can be used as one of the crossfader inputs.

The second input of the crossfader is always connected to the Pulser output. When switch (M) is in down position, Pulser output is inverted resulting in different waveform possibilities which further expand Occult's timbral shaping options!

Shaper Waveform Examples



Tips & Tricks

- A classic patch of TZFM: monitor the Sine output (4) and patch a Sine wave from another VCO to the TZFM input (2) and turn up the TZFM knob (G). As the amount is increased you will hear the creation of harmonics, reaching a point where the frequency crosses 0Hz and reverses direction. You can patch the Modulator signal through a VCA before reaching TZFM input (2) and modulate the VCA with an envelope to achieve dynamically controlled complex timbres. You can achieve more extreme harmonics by monitoring the rest of waveforms or even the Pulser out. In this case it will be also interesting to patch this out through a Low Pass Gate to create complex percussive sounds with rich harmonics.
- Sine waves are generally a good starting point as carrier and modulator signals for FM synthesis purposes as they do not have extra harmonics like saw and square waves do which can result in more harsh sounding FM. Musically pleasant results will be achieved when the modulator signal has a lower frequency than the carrier base frequency. However, rules are made to be broken:)
- Experimentation on self-patching is highly recommended for further timbre exploration! For example you can patch the Sub 1 or 2 output into the Harmonics or Symmetry CV input. Patching pure waveform outputs in TZFM input can create interesting harmonics. Also, trying different waveforms through Shape crossfader (shp in) will offer unlimited options.
- Syncing Occult with another VCO while modulating the frequency of Occult can result in interesting sync-like sounds. Try both Hard and Soft Sync as each can result in very different timbres. You will be amazed with the textures you will achieve on Soft Sync while monitoring Pulser output!
- Occult can also be a very versatile LFO, able to create a huge range of waveforms. Apart from that it can also deliver rhythmical ratios on the outputs when used as LFO within a patch (e.g trigger envelopes or drum sounds). For example, Sub1 out has half the rate ($/2$) of the base frequency, Sub 2 a quarter ($/4$) while Double Saw out (Saw out when PWM knob in middle position) has twice the rate ($\times 2$).



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