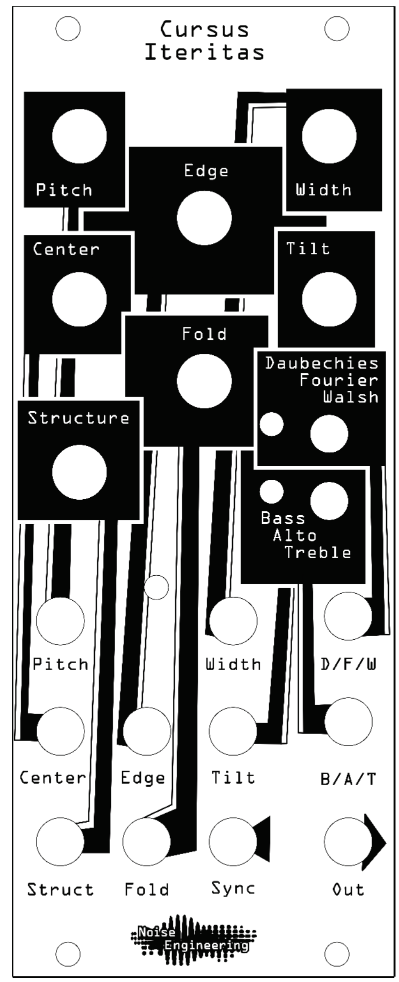
Noise Engineering
Cursus Iteritas

Dynamically generated wavetable oscillator using orthogonal functions.

Type	LFSR VCO
Size	10HP Eurorack
Depth	1.5 Inches
Power	2x8 Eurorack
+12 mA	150 / 80 (if 5v on)
-12 mA	5 / 5
+5 mA	0 / 90 (optional)



Cursus Iteritas is an oscillator that works from a dynamically generated wavetable. It gives the user spectral-like controls over three different modes based on different conceptualizations of frequency: Fourier, which uses sine waves; Daubechies, using wavelets, and Walsh mode, using the Walsh transform. Cursus Iteritas parametrizes a wide variety of sounds, but because the sounds are all based off of orthogonal functions, it has a musical tone structure and can produce an extremely wide variety of harmonic sounds.

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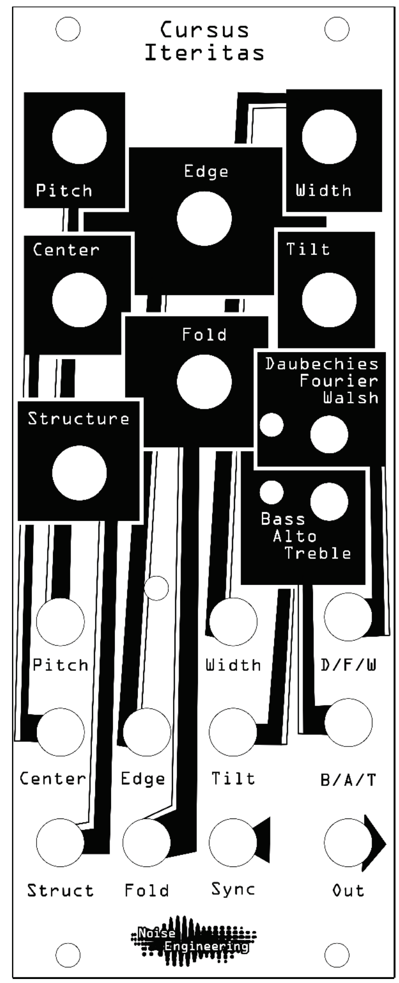
Interface

All knobs on Cursus Iteritas function as offsets for the input jacks. The controls function similar to a bandpass filter; center, width, and tilt allow the filter to be asymmetric.



Pitch
1v/8va pitch control. For more control, see Range below.

Center
selects the center harmonic used to build the wavetable.

Structure
allows selection of harmonics included in the output. In the center position, all harmonics are included. Fully left only even harmonics; fully right, only odd.

Edge
controls the oversampling filter of the wavetable. As this is turned to the right, it will add musical overtones.

Fold
wavefolder. Enough said.

Width
controls how many different harmonics are used to create the wavetable.

Tilt
weights the spread of harmonics. In the middle it is symmetric; at left, lower harmonics are louder while at right, higher harmonics get more volume.

Sync
triggers edge-based oscillator reset

Mode
selects which orthogonal function set is used to produce the wavetable

Range
two-octave offset pitch ranges

Out
audio output - 10vpp

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Patch Tutorial 0 - Introduction

The easiest way to get to know Cursus is to just plug in the output and play with the knobs to get a feel for the sounds it can make.

Patch Tutorial 1 - Gates and LFO

Cursus works very well with any LFO, gate or envelope source the more the better. Patching the outputs of the Numeric repetitor directly into the parameter inputs on Cursus is a great way to generate complex rhythmic tonality variation.

Every LFO source is fun with Cursus. We highly reccomend patching Sinc Iter, Malekko Voltage Block, Malekko AD/LFO, Mannequins Just Friends, Make Noise Wogglebug, and WMD PDO with Cursus.

Tone Generation

Cursus Iteritas generates a spectral description based on knob positions. **Center, Width, Tilt, Structure** determine amplitudes for each harmonic. This description is fed into the inverse transform for the current function set to produce the time-domain wavetable. The wavetable is normalized to reduce amplitude variations across spectral changes.

Oversampling of the wavetable depends on pitch: lower octaves have higher oversampling since the sample rate only varies by a factor of two. The **Edge** control interpolates the oversampling from point sampling to a cubic-spline interpolation (NURBS). As the period of the full length of the wavetable always evenly divides the sample rate, the additional aliasing is largely harmonic in nature. **Fold** controls the signal wavefolding.

In many places in the signal path, there are soft clipping stages to mimic analog-style clipping to give more warmth and complexity to the sounds generated.

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Variable Sample Rate

Cursus Iteritas uses a sample rate that is a multiple of the fundamental (lowest) oscillator frequency. This moves alias power that is a multiple of the fundamental to be mapped to a multiple of this tone, therefore making the aliasing align with the harmonics of the tone. This works well for settings with a strong harmonic structure (spread fully CW or fully CCW) and adds unique aliasing character for other tones.

Calibration of Tuning

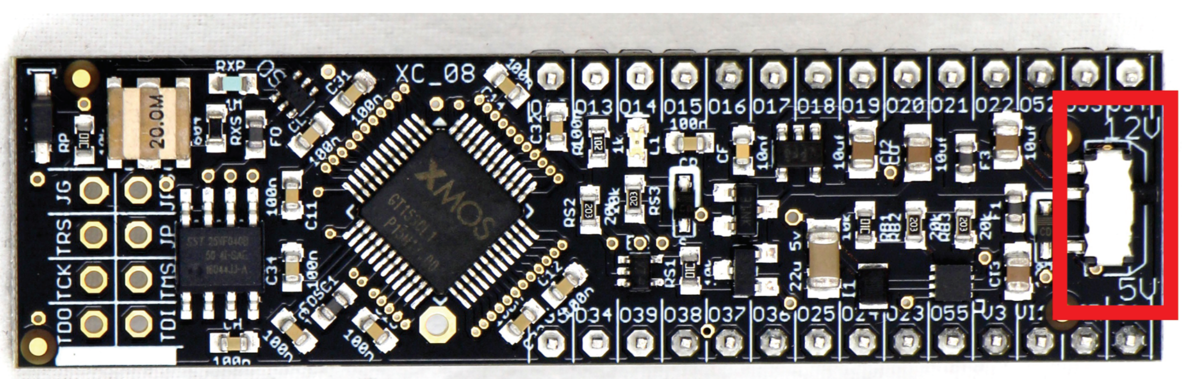
Cursus comes pre-calibrated but over time it may change and need a touch up.

Pitch calibration is controlled by an linear resistor-divider network. To calibrate the tuning, attach a volt meter (preferably 4+ digit) to the test points TPCV and TPGND on the rear panel and adjust the trim pot.

The voltage measured should be 5/16 (.3125) times the input voltage applied to the CV input. A reasonable way to tune the scale is to use an adjustable voltage source to generate 4 volts then adjust the tuning trim until the test points read 1.2500V. Cursus Iteritas can also be tuned using a reference supply capable of generating a 1 volt difference and using a stroboscope such as the Peterson 490 to tune to an octave interval. This is method is preferred to the meter-only method.

Voltage Supply

Cursus Iteritas can run its processor on the 5V eurorack power rail to reduce noise and load on the 12V bus. Gently push the switch tab in the direction of the desired rail to use.



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Genesis and Design Notes

This module started many years ago when Scott Jager and Yasi Perera turned me onto Walsh functions.

The big question was how to reduce the large number of variables (32 harmonic volumes for a 32 band Walsh synthesizer) into a reasonable control set. Bandpass filter-like controls seemed to be a good solution and there already exist similar controls in the various existant Harmonic Oscillators. A software prototype was written that proved that a sequency bandpass control scheme was usable. The then project went to sleep for a couple years as other modules took priority.

When I started working on it again I wanted it to have three modes much like our other current modules so I went searching for other orthogonal function sets that could fit in the same control scheme.

The Fourier Series was an obvious second set of orthogonal functions to use which perfectly mapped to the bandpass-like controls.

Modern mathematics have given us an ocean of orthogonal function sets in wavelets so that seemed another good place to look. The Daubechies 4 wavelet fit the bill being easy to compute and having an interesting—and somewhat sawtooth-like—waveform. The controls were a little less natural since this wavelet has more time precision and more frequency redundancy. With some work however it worked out quite naturally.

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Special Thanks

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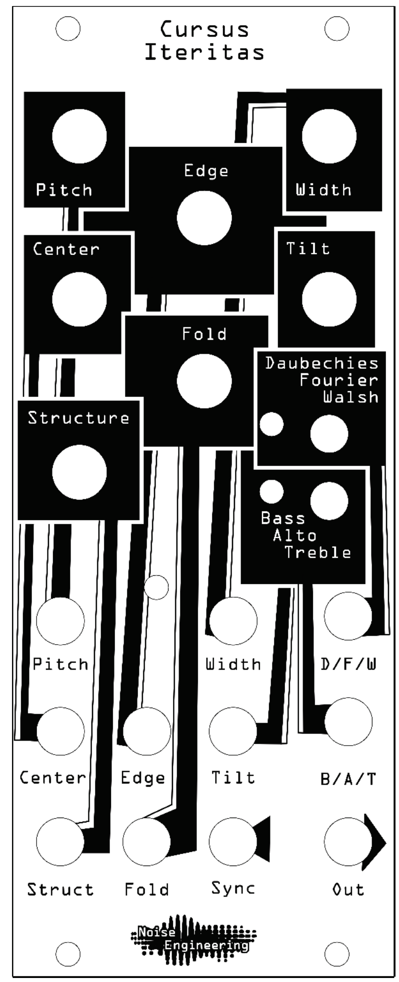

References

Hutchins Jr, Bernard A. "Experimental electronic music devices employing Walsh functions." Journal of the Audio Engineering Society 21.8 (1973): 640-645.

Brown, Owen. A Digital Waveform Synthesizer Using Walsh Functions. Diss. 1971.

Rozenberg, Maurice. "Microcomputer-controlled sound processing using Walsh Functions." Computer Music Journal (1979): 42-47.