HILDA

Complex Oscillator Synth

INTRODUCTION

Hilda is a different kind of monosynth; abrasive, unruly, in your face. The design is designed around a *'complex oscillator'*, one of the concepts borrowed from west-coast synthesis. It starts with a basic waveform, then shapes, modulates and folds it into something else, adding frequencies and side bands on the left and the right.

The result is something that sounds unlike any other traditional synth concept. With a little effort Hilda can sound sweet and polite, but her true character is never too deep below the surface.

Hilda is great for exploring how sounds respond when you prod them with various sonic sticks. It will appeal to musicians who share my fascination with raw sound and the playful, experimental sides of sound design.

In addition to the synthesizer, Hilda provides a basic 16 step sequencer with mutation and randomization features. You can use this sequencer to drive the synth - although Hilda equally shines when you just let her drone and make the sound gyre and gimble without being sequenced.

COMPLEX OSCILLATOR SECTION

The top-left section of the synth is reserved for the complex oscillator. This contains almost half the controls of the signal flow, so you can probably guess that this is the most important part of the instrument.

1. Waveform - morphs the primary oscillator shape from triangle, through square, to sawtooth to give access to different harmonics and timbres as a starting point
2. Frequency - (de)tune the primary oscillator relative to the current/last played note
3. Glide - set the time it takes the oscillator to slide from the last frequency to the next
4. Timbre - Skews the wave shape to change its base timbre. Works best in conjunction with the wavefolder
5. Wavefolder - the famous 'west-coast' waveshaper: it blows up the signal and folds its peaks around, adding a very musical bite to the signal. The effect is strongest when applied to triangle or sawtooth shapes
6. Slope modulation - this lets you apply the slope modulator to the wavefolder
7. LFO modulation - this lets you apply the LFO to the frequency that is sent to the suboscillator ratio. When set to 0 the frequency input into the suboscillator will be static. When > 0 the frequency will fluctuate around the center frequency
8. LFO modulation - applies the LFO to the wave shape selection to make it change harmonics over time
9. Ratio - determines the frequency ratio of the suboscillator in relation to the main oscillator. E.g. When set to 1, the frequency of the subosc will be the same as the main osc. When set to 0.5, the subosc will be exactly one octave lower than the main osc, etc. The ratio applies to the FM, the sub tone, and the cross-ring-mod
10. FM amount - uses the suboscillator to perform frequency modulation on the main oscillator, adding lots of harmonic sidebands to the sound
11. Suboscillator level - this determines how much of the suboscillator tone is mixed in with the main oscillator
12. Cross-ring-mod - this is a combination of a traditional ringmod and a cross modulation. It adds both harmonic and inharmonic sidebands to the signal
13. LFO + Slope mod section - this combines settings for slope mod and LFO mod and applies them to both the FM amount and Xring amount. The LFO and slope are first multiplied and then applied, so they always interact with each other

MIX & PRE-AMP SECTION

14. Noise level - sets the level of *brown noise* that's being mixed in with the oscillator signal. Brown noise has a spectral distribution that is more common in nature than white noise and is generally perceived as more pleasant
15. LFO modulation - applies the LFO to the noise level
16. External input balance - sets the balance between incoming external signals and the internal oscillator + noise levels. ***Note: this only works when Hilda is loaded as an Audio Unit Effect plugin. In instrument/ standalone mode the external input will be silent***
17. Mixer/amplifier - this mixes all inputs (oscillators, noise, external signal) together. Move it counter clockwise to give everything more headroom and get a cleaner signal. Move it beyond 12 o'clock and all signals will be squashed and saturated
18. Bent circuit - this sends the signal through a circuit-bent recorder, adding unpredictable wobble, distortion and detuning

FILTER SECTION

19. Filter type - sets the topology of the filter circuit. The filter is based on an old Oberheim design which lets its 4 poles be configured in unusual ways. There is also a 'bypass' mode which disables the filter
20. Cutoff frequency - effect differs for each selected filter type, but generally it sets the frequency where the filter magic happens
21. Filter drive - overdrives the internal feedback loop, adding bite to the filter's sound
22. Resonance - uses filter feedback to emphasise frequencies around the filter cutoff point
23. LFO + Slope mod section - combines (multiplies) the values of the LFO and slope modulators to dymically change the filter frequency. The current cutoff setting determines the maximum: the cutoff will move between 0 and the cutoff dial's setting.

VCA & LOWPASS GATE SECTION

24. Drone level - determines how much of the signal is sent through the VCA/LPG section and how much is allowed to bypass it completely. Sound that bypasses the VCA/LPG circuit can be heard without triggering a note (unless affected by the Slope Mod [26])
25. LFO mod - applies a tremolo effect on the output of the VCA/LPG circuit
26. Slope mod - allows a (user triggered) rhythmic effect to be applied to the signal that bypasses the VCA/LPG circuit.
27. VCA envelope settings - set the relative times and levels for the VCA or LPG circuits. Decay and release share one setting because they use the same circuitry in the internal 'hardware' design
28. VCA - LPG selector. This switches between a traditional VCA and a west-coast style Lowpass Gate. Read more about Lowpass Gates below
29. Fast mode - switches between short (fast) and long (slow) ADSR times

SPACE SECTION

This circuit is loosely based on an effect chip originally designed for cheap karaoke machines, but these days popular in DIY guitar pedals due to its lo-fi sound character. Its 1-bit oversampling design adds a nice bit of noisy character as echoes decay into aliased artifacts.

30. Wet/dry level - how much of the signal is sent through the fx
31. Delay time - the duration of the delay line (this is tempo synced)
32. Feedback - the amount of the delayed signal that gets fed back into the delay line.
33. Lowpass filter - a 6dB lowpass filter to reduce the noise and artifacts
34. Output gain level - the volume of the audio coming out of the plugin

MODULATION SOURCES

35. Slope attack/release - The slope is an envelope that is triggered every time a note is played. These dials set the upward and downward curves
36. Slope Cycle - when enabled the slope will retrigger itself indefinitely when it has completed its downward curve (in addition to note triggers)
37. LFO frequency - sets the speed of the LFO from very slow to audio rate
38. LFO mod - this modulates the LFO value with an additional sinewave
39. LFO shape - sets the type of LFO shape
40. Wow - this affects the stability of a dozen parts of the signal flow, causing fluctuations, subtle distortions and other things that make the sound a little bit less static

LIVE PADS (LIVE EFFECTS)

41. Bit stretcher - a formant-like lo-fi distortion
42. Flanger - the effect increases as you move further from the touchpoint
43. Time slowdown - this emulates a temporaray tape slowdown effect
44. Reverser - hold the touchpoint to record, release to play
45. Chopper/repeater - record a short soundslice and repeat it while holding and moving over the touchpoint.

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SEQUENCER

The sequencer can be used to drive the synthesizer. When Hilda is loaded as an Audio Unit plugin, the host needs to be running for the sequencer to also start. In standalone mode the sequencer just needs to be engaged [3] to start running.

1. Note selection knobs - Each knob covers 2 octaves of range. When custom scales are active the selected note may be forced into another note that does fit this scale

2. Velocity knobs - select the velocity for each note. A velocity of 0 means the note won't trigger (i.e. a rest). Double tap a dial to quickly set it to 0

3. Sequencer engage/disengage - use this switch to let the sequencer drive the synth

4. Sequence length - the number of steps in the sequence. This can span partial bars, or multiple bars, depending on the step length (quantize setting [5]).

5. Quantize selection - set the duration of each step (from 1 bar to 1/16th notes)

6. Gate duration of each note (sustain time)

7. Bounce switch - when enabled the playhead of the sequencer will go backwards and forwards across the sequence. When disabled the playhead will run as usual, from left to right and then loop back to the start.

8. Base octave - lets you select which octaves are covered by the sequencer

9. Mutation chance - This dials in the chance that any note that is played will mutate. A mutated note will be taken from another step in the original sequence, resulting in variations in the sequence that still fit with the overall pattern.

10. Mutation permanence - When enabled, any mutations will become part of the pattern, until the sequence is stopped and restarted. As a result the mutations will cause an evolution of the pattern rather than variations. When the host sequencer is stopped, the pattern will be reset to its original state.

VCA VERSUS LPG

A VCA, or voltage controlled amplifier, is a pretty standard part of most synthesizers. It uses an envelope generator and applies it to the amp to make the level of your sounds go up and down over time. Typically it lets you set things like attack and decay rates, sustain level and release rates.

Lowpass Gates (LPG) are much rarer. It is a concept explored extensively in west coast synthesis, by synth pioneers such as Don Buchla. In many ways it is similar to what a VCA does, but achieves it in a different way.

Where a VCA changes the levels of the sound with an amplifier circuit, a LPG uses both an amplifier and a lowpass filter simultaneously. The result is that not only the level of the sound changes, but the 'brightness' of the sound changes accordingly, leading to a timbral effect that mirrors how most physical materials will behave in nature. For example: the more firmly you pluck a string, the more higher frequencies will be added.

The other difference is in how the LPG circuit is designed and the components it uses. Lowpass Gates often use a "Vactrol" to generate their voltage ramps. This uses a light source and a light-sensor, both packed into a light-proof housing so they can only respond to each other. The typical LPG curves come from the way the light and the sensor respond to voltage changes. People typically describe it as "plucky" with a subtle "ringing" at the end of their curve at low voltages.

Hilda simulates this behavior and lets you choose between traditional analog VCA envelope curves and the special curves (and timbral qualities) achieved through an LPG circuit. Since we're operating in the digital domain, I have added the possibility to keep the LPG at a sustain level by letting light levels semi-dimmed at the desired point (physical vactrols typically decay all the way to 0).

COMPLEX OSCILLATOR

Hilda is designed around the concept of the "complex oscillator". In normal synthesizers, such as Moogs, Korgs and Rolands, you'll use subtractive synthesis: starting with raw, frequency-rich waveforms, you use filters to chisel and smoothen out the sound that you're after.

West-coast synthesizers on the other hand, use complex oscillators - which start with simple waveforms such as sines and triangles and use wave shaping and FM to make the sounds richer and more complex. This is the essence of a complex oscillator. In Hilda, you can choose your basic waveform and then *complexify* it using the wavefolder, FM, sub-oscillator, cross-ring modulator, etc. Most of these waveshapers can even be modulated over time, either using the LFO or the Slope Generator, to create even more complex harmonics.

PRESET LOADING, SAVING & SHARING

The **save preset** and **load preset** buttons let you retrieve and store presets you've created.

If you want to delete a user created preset, simply swipe left on it - just like you would do in your email app to delete an email. You can only delete user presets. Apple doesn't allow deletion of files inside in the package that was downloaded from the App Store, hence the factory presets are read only.

Press the **export preset** button to quickly share the currently active preset. First you will be prompted for a name for the preset. After you've confirmed the name, you can share your preset to any destination supported by iOS (using the standard share sheet). Typically you can use Airdrop, save on the Files app, or use your Dropbox, iCloud and email, among other options.

If you choose to **export all presets,** it will create a zip-file with all your presets. Once finished, you can save this zip-file to any place you like.

You can re-import any preset by simply opening it with the Hilda app. Single presets have the file extension .hilda. But you can also import zip-files containing multiple presets (such as the backup files exported by Hilda).

Sometimes you need to tap the **refresh** button in the corner of the load dialog for the newly added presets to show up. This button forces the Hilda plugin to scan for newly added presets.

AUDIO UNITS: USING HILDA AS A PLUGIN

When you run the Hilda app, it works like a nice standalone synthesizer. This is nice for some quick jamming on the bus, or creating your own preset collection.

However, to get the most ouf of the app, you want to use it together with other music apps, effects and sequencers. To do this, you need a "plugin host"; an app that brings your virtual studio together and lets you load and combine all your plugins. On iOS the plugin standard is called "Audio Units" (or AUv3 for short). Some popular hosts are: AUM, Cubasis, Garageband, Audiobus, Drambo, Zenbeats or Nanostudio, but there are many others.

Using your audio apps as Audio Unit plugins has several major benefits:

- Combine your music plugins into a virtual studio with instruments, effects, MIDI processors, and easily switch between their UIs

- Use multiple instances of the same instrument

- Instantly recall saved projects without having to load multiple apps in the right order, like we had to in the days of old

- Standardized state-saving of anything you do in your plugins. The states are automatically saved in your host's projects, but you can also easily make your own presets and templates and share them with others.

- Automatic tempo-syncing and standardized MIDI control between all plugins, without having to use proprietary protocols like Ableton Link

- Hi-resolution automation of many synth parameters using AU Parameters

USING HILDA AS AN INSTRUMENT

When loading Hilda as an Audio Unit Instrument, it will become a sound source in your project. In this mode you can control the synth using MIDI and usually you can send its output through a chain of effects and mix it with other instruments loaded into the host.

USING HILDA AS AN AUDIO EFFECT

You can load Hilda as an audio effect in your host's effects section. This gives you all the features of the normal synth mode, but also lets you route external sound through all the filters, amps and effects, using the **"ext" input**.

The EXT knob lets you set the balance between the internal signal and the external input. You can have both go into the pre-amp/mixer, or choose any balance ratio you like.

In effect mode you can't control the synth using MIDI, so you'll have to use the built-in sequencer for control duties in this case.

PLAYING WITH MIDI

When Hilda is loaded as an Auv3 Instrument plugin (i.e. Not in standalone mode or loaded as an effect plugin) you can trigger notes using MIDI.

When you tigger a note, the oscillator frequency will be adjusted relative to the note that was played. E.g. When the oscillator frequency is set to 0.5, Hilda will play an octave lower than you'd expect. The sucoscillator ratio will in turn be calculated based on the oscillator frequency. So if a note sound off, or plays iin uxpected tuning, check your oscillator frequency settings

AUTOMATION: USING AU PARAMETERS

The preferred method for automating synths in Audio Unit plugins is using their native AU Parameter protocol. Most people who use MIDI will be familiar with MIDI CC messages. AU Parameters are the AU equivalent of these with some notable improvements:

- AU Parameters use 32 bit floating point values, where MIDI CC is limited to 7 bit integer values

- AU Paramters are not numbered, but use meaningful names instead, so you don't need a cheat-sheet

- You can have an unlimited number of AU Parameters

Most contemporary iOS hosts give you access to a plugin's AU Parameters and let you MIDI learn them to your own controllers and controller apps.

Additionally, when a host has a timeline with MIDI recording there is a good chance that you can also record any knob movements you do in the app.

USING HILDA AS A MIDI SEQUENCER

If you like the built-in sequencer you can use it to send MIDI OUT to other apps, plugins and even hardware synths, if your host supports routing MIDI from AU plugins (most do).

If you don't need the audio/synth part of Hilda, i.e. you only want to use it for its MIDI capabilities, you can even load it as a AU MIDI plugin. In this case the synth features will be disabled, saving you a lot of CPU power. For this to work, the host needs to support AU MIDI plugins (Apple's *'aumi'* format).

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