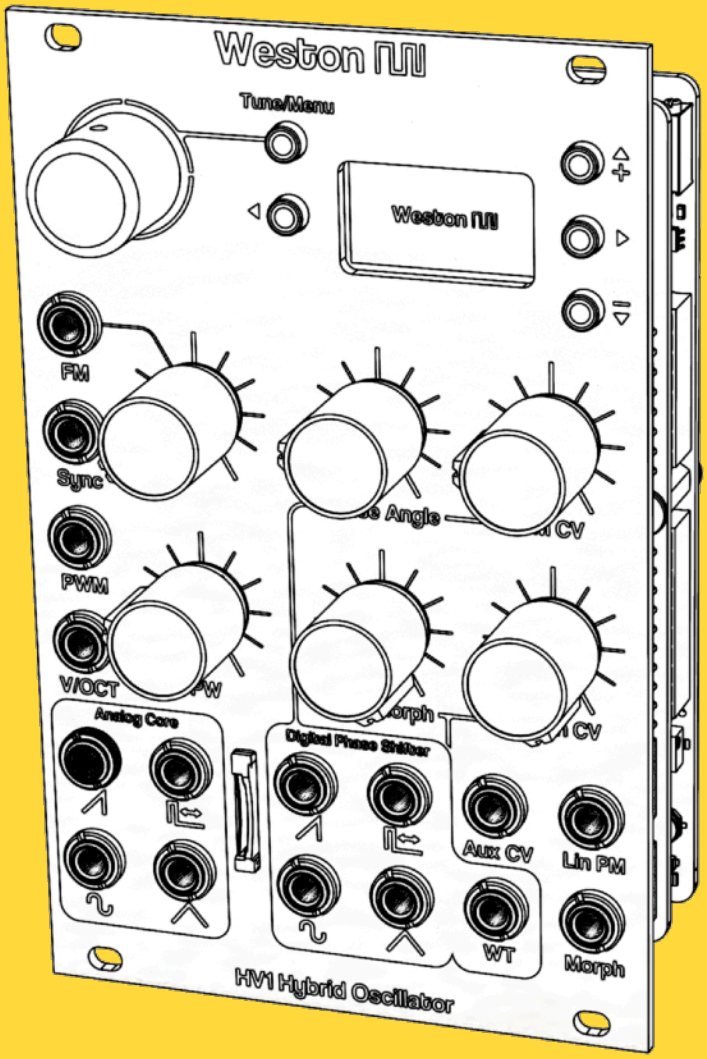
HV1

Hybrid Oscillator

Eurorack Module

User Manual



Weston Precision Audio

Designed In Portland, Oregon

Revision 03 - July 18, 2025

TABLE OF CONTENTS

HV1 Overview

Encoder

A smoothly rotating 360 analog encoder used for adjusting and selecting things.

Tune/Menu Button

Always toggles between tuning screen and menu display modes.

+/- / Up/Down Buttons

Adjusts octave when in tuning display mode and other functions when on menu screens.

FM Input and Attenuator

FM of oscillator core, either thru-zero linear or exponential.

Left/Right Buttons

When in tuning display mode, left button toggles between VCO and LFO range. If in LFO range, right button toggles LFO waveform view.

When in menu display, pages between menu screens.

Sync Input

Sync oscillator core with external signal. Either reversing or resetting type.

Phase Controls

Left knob adjusts phase offset of right waves to left. Right knob is attenuator for PM (Phase Modulation) signal that goes in "Lin PM" jack.

PWM Input/PW Knob

PWM (Pulse Width Modulator) and base PW control for both pulse outputs

Morph Controls

Left knob adjusts morph position of WT output. Right knob is attenuator for Morph CV signal.

Core Outputs

Outputs from oscillator core. 100% Analog.

SD Card Slot

For loading wavetables and updating firmware.

Hybrid Outputs

Outputs from digital phase shifter (triangle & derived waveforms plus WT output)

Aux CV Input

Can be assigned to wavefolding or bitcrushing of right outputs.

DESCRIPTION

HV1 is a VCO (Voltage Controlled Oscillator) Eurorack module that contains the best of both the analog and digital worlds. The oscillator core is an incredibly stable and well-tracking triangle-core analog VCO which outputs triangle, sine, sawtooth, and pulse waveforms. The triangle of the core is passed into a "digital phase shifter" which outputs a phase-shifted wavetable-based triangle which is parsed into sawtooth, sine, and pulse waveforms through traditional analog circuitry. The digital phase information is also mapped to the "WT" (wavetable) output, which can output user wavetables loaded from the SD card on the front of the module.

All waveforms can be modulated with linear through-zero FM and exponential FM, while all the right-side outputs can also be modulated with pure linear phase modulation (PM). This linear PM works like that of PA0, but it has a larger range, spanning +/- 720 degrees.

The Wavetable output supports 16-way cv-controllable morphing, and tables can be loaded in WaveEdit or Serum format.

The digital section of HV1 runs at 16-bit and an extremely brisk 150kHz sampling rate for high fidelity and low aliasing.

Important or helpful bits will be in red.

SPECS

Module Size: 16HP

Depth: 25mm (To back PCB), 33mm (To end of power connector)

VCO Tracking:
At least 8 octaves with +/- 2 cents error

Inputs:
>= 100kOhm Input impedance
CV Inputs: DC Coupled, FM Input: AC/DC Coupled

Power input:
+12V & -12V via standard 10 pin Eurorack connector. Protected against reverse polarity internally and with shrouded connector.

Power consumption:
+12V: 125mA
-12V: 45mA

DAC:
2 channels 16-bit / 150kHz

Internal WT Format:
1024 sample

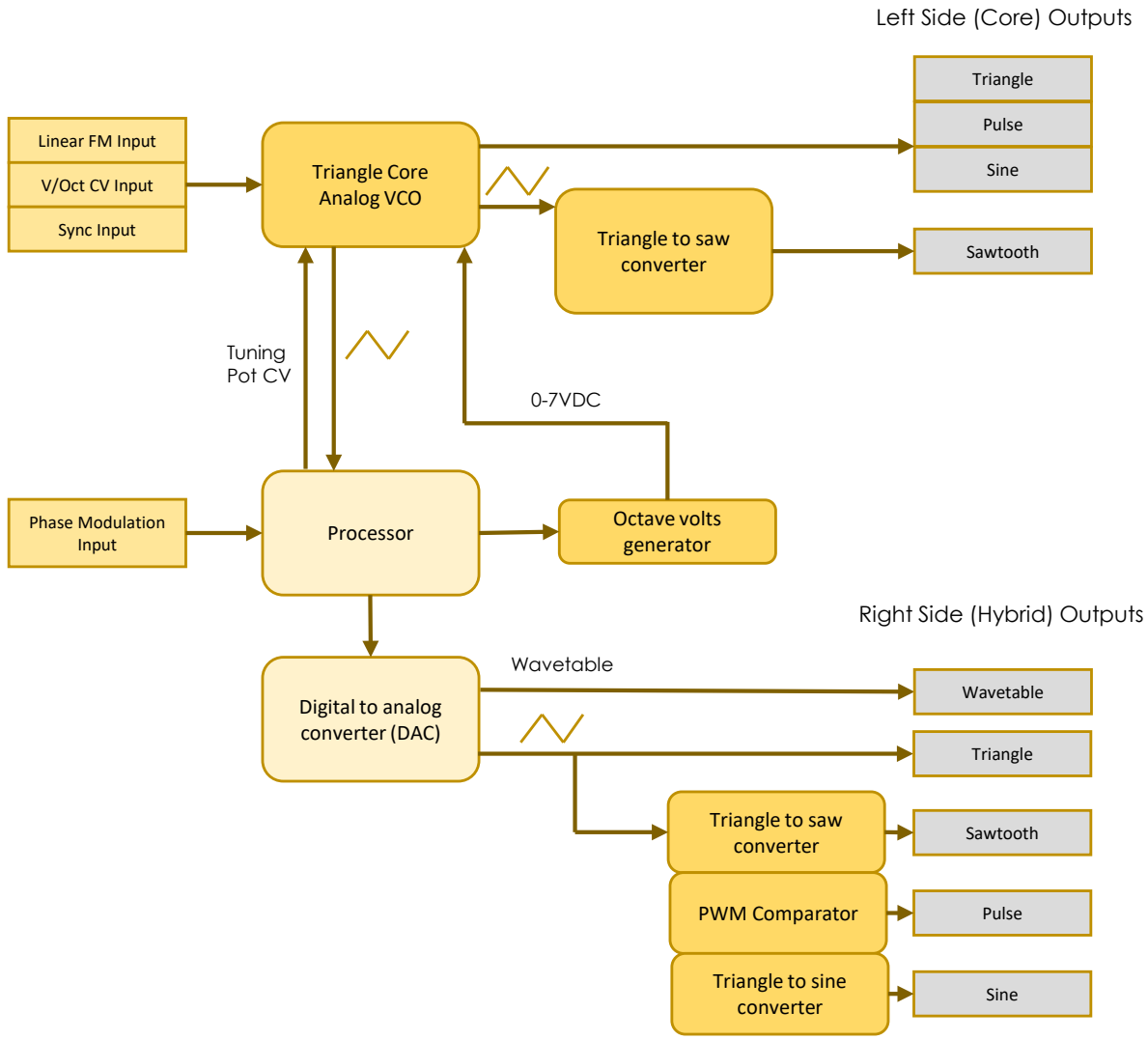
User Wavetable Format:
16-bit WaveEdit (256 sample, 64 bank)
32-bit Serum (2048 sample, bank size depends on file length).
All must have standard WAV file headers to load. 32-bit files should be regular 32-bit, not 32-bit float format.

MAXIMUM LIMITS

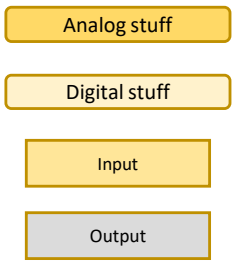
Supply Voltage: +13.5V / -13.5V

All inputs: Up to power supply levels.

HV1 Hybrid Oscillator:
Block Diagram



Key:



USING HV1: GETTING STARTED

After installing and powering up SE1 in your rack, using HV1 is as easy as any oscillator: Just pick an output or 2 and patch a pitch CV into the V/oct input. HV1 comes pre-loaded with wavetables for the WT (Wavetable) output, but if the module is turned on with an empty SD card or no SD card, the WT output will be loaded with a alternating sine/saw/square/tri morph waveform.

USING HV1: HOME SCREEN & MENU/TUNE

HV1 always starts up with the tuning screen which looks like this:

FIG 1: TUNING SCREEN WITH TUNING LOCK ON

Pressing the MENU/TUNE button always toggles between displaying this screen and the menu screens.

USING SV1: TUNE SCREEN

The tuning screen (shown above in fig. 1) shows the overall oscillator tuning, octave, and phase angle between the left and right outputs. Here's what you can do in this screen:

* Press the encoder to lock/unlock tuning

FIG 2: TUNING SCREEN WITH TUNING ENABLED

* If tuning is unlocked, turn encoder to tune oscillator core.
* Press +/- keys to increase or decrease octave.
* Press and hold encoder for 1 second to toggle between oscillator core tuning and detune of digital outputs relative to analog core. (Details in section XXX).
  * If detune is displayed, press encoder to lock/unlock digital detuning, same as how it works for tuning.

FIG 3: TUNING SCREEN WITH DETUNE DISPLAY

* Press LEFT button to toggle between VCO and LFO range for oscillator core.

* If RANGE is set to LFO, pressing the RIGHT button toggles display of the LFO wave forms. 2 waveforms will display in this view:
  * The output of the core's sine wave with a small square drawn at the current voltage.
  * The output of the WT (wavetable).

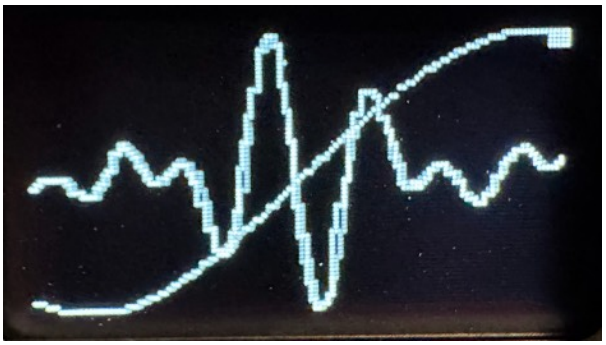


FIG 4: LFO WAVEFORM DISPLAY SCREEN

MENU SCREENS: WAVETABLE VIEW

When toggled to menu display by hitting the MENU/TUNE button, the first screen shown is the wavetable view:

FIG 5: WAVETABLE VIEW

Assuming there is an SD card inserted in HV1 with some valid wavetable files, here is what can be done on this screen:

* Turn the encoder to increment or decrement wavetable banks.
* Press UP or DOWN keys to jump to next WAV file containing wavetable banks.

Wavetable banks are organized as follows on HV1:

* For WaveEdit format files, HV1 assumes each table is 256 samples, and each bank has 64 tables. Since HV1 has a 16-way wavetable morph, each file will show up as FOUR banks. HV1 will interpolate each table from 256-long to the 1024-long HV1 tables while loading.
* For Serum files, HV1 assumes that these are large, finely interpolated banks, with each table having the standard 2048 samples and chooses to interleave and build a 16-table bank based on the length of the file. So for example, if the table was 256 tables long, HV1 would build a bank out of every 256/16 = 16th table, and then downsample each of those 2048-long tables into a 1024-long HV1 table.

***NOTE: It is very common that Serum wavetables have non-standard data written into the file header which can cause HV1 to not load the file. If this is the case, it is recommended to open the WAVE file in an editor such as TwistedWave (Mac) and re-save out the file as a standard 16-bit monophonic wave file so that the header information is compliant and the file can be loaded. Also, make sure any 32-bit files are not 32-bit FLOAT, but just 32-bit (integer).*

MENU SCREENS: OPTIONS VIEW

Pressing the RIGHT key while in the wavetable view will bring up the next menu page: Options:

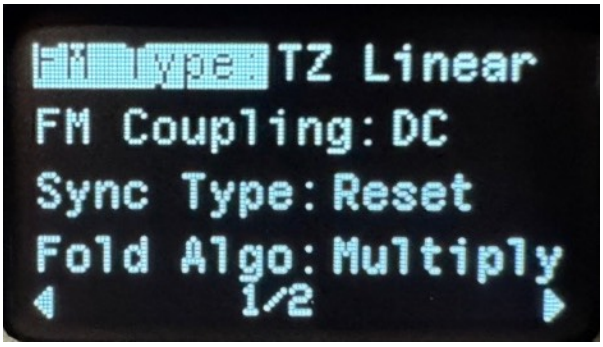


FIG 6: OPTIONS VIEW

In this screen, press UP and DOWN keys to scroll to the active option, and turn the encoder to change the setting. There are 8 options here:

1) Type of FM for the oscillator core: LINEAR TZ or EXPONENTIAL
2) FM Input coupling: AC or DC.
3) Type of sync for the oscillator core: RESET or REVERSE
4) Wave-folding algorithm for digital outputs.
    1) #1 is sinusoidal
    2) #2 is straight multiplication of phase
    3) #3 is triangular
    4) #4 multiplies phase by noise
    5) #5 is low-fi bit-crushed added phase
5) Routing of the "Aux CV" input.
    1) Aux CV routed to wave folding
    2) Aux CV routed to bit-crushing.
    3) Aux CV routed to Wavetable chord.
    4) Aux CV routed to Wavetable cluster.
6) Shifting the octave of the righthand (digital) triangle output up by +1 relative to the VCO core.
7) Shifting the octave of the wavetable output by +1 relative to VCO core.
8) Antialiasing for the WT output on or off*

* Note that when switching banks/files, HV1 takes a few seconds to construct the high-octave antialiased wavetables if WT Antialiasing is turned on.

MENU SCREENS: TUNER VIEW

Pressing the RIGHT key while in the options view will bring up the last menu page: Tuner:

FIG 7: TUNER VIEW

This is a handy tuner which continually measures the pitch of the core oscillator. The closest note is displayed in the center, as well as the cents pitch off from that note as both a number and a bar displayed above the note.

The bottom of the screen shows the current position of the tuning knob within it's total range, and the lower right corner shows the octave selected.

+/- keys still adjust the octave up and down just like in the tuning screen while on this screen.

HV1 SOUNDS: MODULATION

HV1 has 2 types of modulation which can vastly vary the timbre of the sound. Firstly, the main VCO core can be modulated via FM (Frequency Modulation). There are 2 types of FM available; Linear Through-Zero, and Exponential (Selection described in the "OPTIONS VIEW" section on page 8). The graphs below show FM via a triangular modulating signal. Yellow wave is the triangle from the core (left) and magenta is the hybrid (right) triangle output.

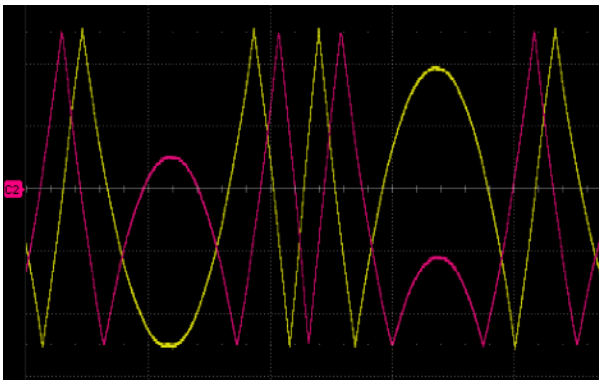


FIG 8: THROUGH ZERO LINEAR FM VIA TRIANGLE

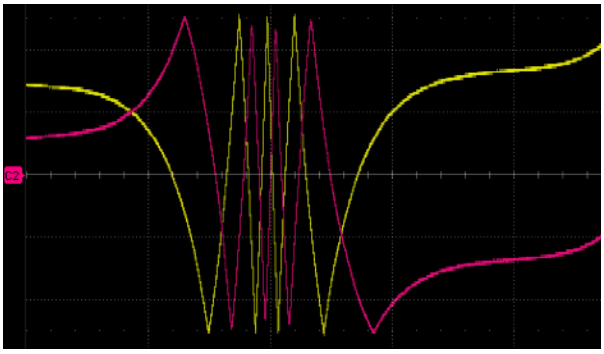


FIG 9: EXPONENTIAL FM VIA TRIANGLE

Besides the fact that these 2 type of modulation sound very different, one will notice that the FM signals affect ALL waveforms, because the oscillator core feeds into the digital phase shifter (see block diagram on page 5).

The other type of modulation available is through-zero PM (Phase Modulation). The "Phase Angle" pot and "Lin PM" input are summed (added) together to modulate the phase of the righthand waves relative to the lefthand waves. Note again that PM only applies to the righthand waves labeled "Digital Phase Shifter". The sound of PM varies a lot depending on the modulating wave. Here are 2 examples:

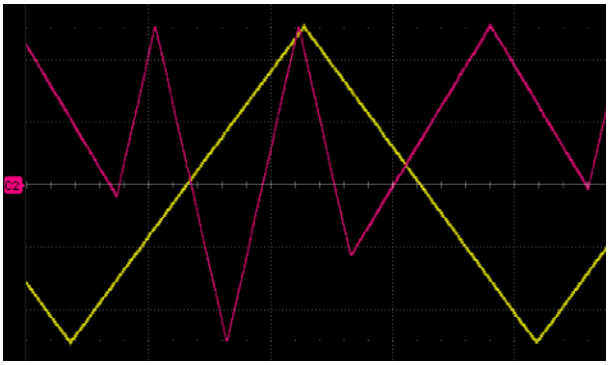


FIG 9: PM WITH TRIANGLE AS MODULATOR

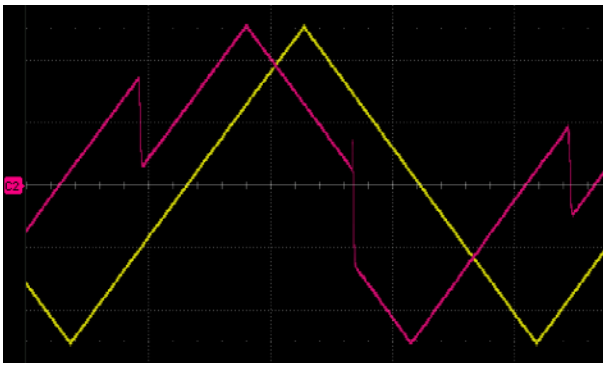


FIG 10: PM WITH SQUARE AS MODULATOR

HV1 SOUNDS: AUX CV ROUTING (FOLD & BITCRUSH)

The “Aux CV” input on HV1 can be routed to several functions: . If Aux CV in is routed to “Fold”, then a CV applied to this input will fold the righthand wave’s phase by an amount proportional to the CV. There are 5 algorithms available and 3 are shown below:

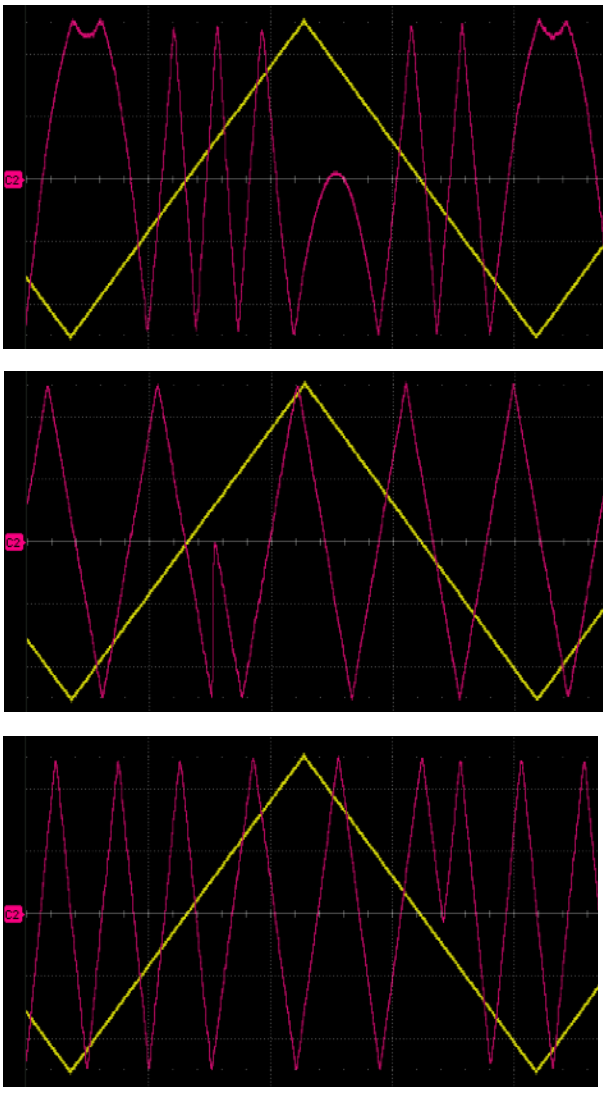


FIG 10/11/12: FOLD ALGO 1, 2, AND 3.
1 IS SINUSOIDAL, 2 IS LINEAR MULTIPLICATION, AND 3 IS TRIANGULAR.

When Aux Cv is set to be routed to “Bitcrush”, the righthand waves will all be bit crushed (bit-reduced) by an amount proportional to the CV. Note that the Aux CV is unipolar and responds to CVs in the range of 0 to 5V.

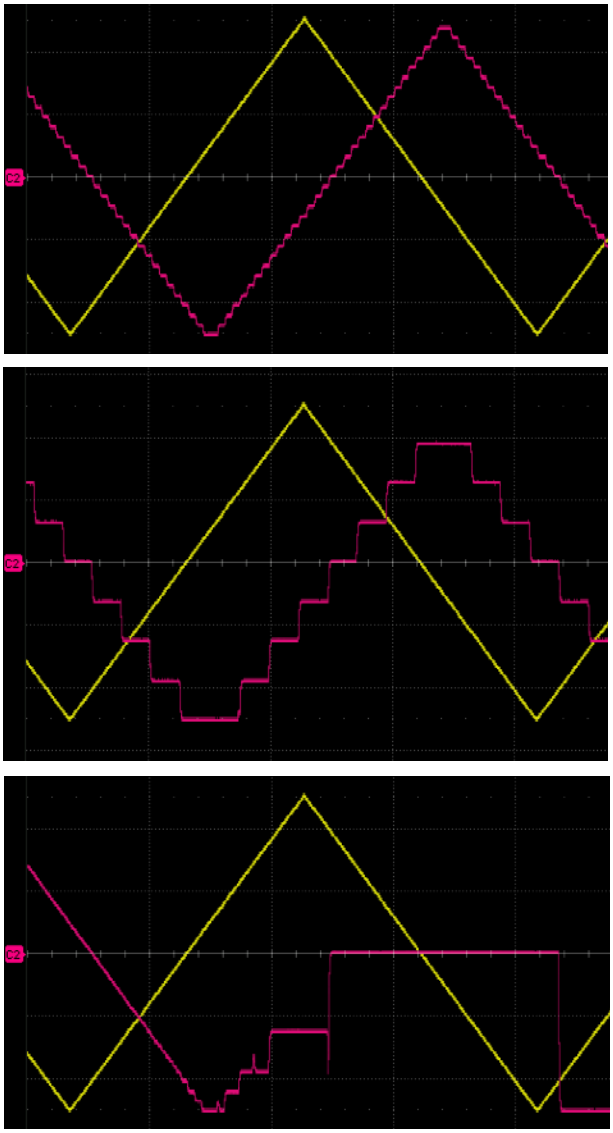


FIG 13/14/15: AUX CV ROUTED TO BITCRUSH;
CV = ~1.5V
CV = ~2.5V
CV = TRIANGULAR WAVE

HV1 SOUNDS: AUX CV ROUTING (WT CHORD & WT CLUSTER)

If Aux CV in is routed to “WT Chord”, the aux CV is quantized to traditional 1V per octave (0.083V) steps, representing 5 octaves on a keyboard. The Wavetable output (Only the WT out, not the phase-shifted triangle) will expand from 1 to 5 oscillators and play a chord which is selected by the quantized CV. Note that not all chords use all 5 oscillators. The chart to the right shows the available chords. Try patching your same pitch CV into the aux CV in chord mode for interesting inspiration.

(WT CHORD & WT CLUSTER)

If Aux CV is routed to “WT Cluster”, HV1 expands the WT output again to 5 oscillators, but the amount of relative detuning of the extra 4 oscillators to the original (the “spread”) is proportionate to the aux CV. 0V means all 5 oscillators are in tune. 5V means the max spread is 1 octave and a 5th (up and down). Try low values of spread on drones for a super thick sound.

Note	Volts	Chord
C0	0.000	Major
C#0	0.083	Add 4
D0	0.166	Sixth
D#0	0.249	Six Nine
E0	0.332	Major 7th
F0	0.415	Major 9th
F#0	0.498	Major 7 Sharp 11
G0	0.581	Minor
G#0	0.664	Minor Add 4
A0	0.747	Minor Sixth
Bb0	0.830	Minor 7th
B0	0.913	Minor Add 9
C1	0.996	Minor Sixth Add 9
C#1	1.079	Minor 9th
D1	1.162	Minor 11th
D#1	1.245	Minor / Major 7th
E1	1.328	Minor / Major 9th
F1	1.411	Minor / Major 11th
F#1	1.494	Minor 7 Flat 5 (Half Dim)
G1	1.577	Dominant 7th
G#1	1.660	Dominant 9th
A1	1.743	Dominant 11th
Bb1	1.826	Seven Sharp 5
B1	1.909	Seven Flat 5
C2	1.992	Seven Flat 9th
C#2	2.075	Seven Sharp 9th
D2	2.158	Nine Sharp 5
D#2	2.241	Nine Flat 5
E2	2.324	7 Sharp 5 Sharp 9
F2	2.407	7 Sharp 5 Flat 9
F#2	2.490	Flat 5 Sharp 9
G2	2.573	7 Flat 5 Flat 9
G#2	2.656	7 Sharp 11
A2	2.739	Diminished 7th
Bb2	2.822	Augmented

HV1 SOUNDS: WAVETABLE MORPH

The “WT” (wavetable) output of HV1 always loads an array of 16 wavetables into its memory. These 16 wavetables are continuously morphed in an amount proportional to the CV applied. So, 0% CV means 100% of the 1st table is loaded, and 100% CV means that 100% of the 16th table is loaded. The CV from the “Morph” input is summed (added) to the CV from the “Morph” potentiometer.

Very interesting results can be had by slowly modulating the morph CV with an LFO or envelope. However, morph can also be modulated with audio-rate signals all the way up to 20kHz!.

Below is a capture of a triangle LFO (yellow signal) morphing the WT output (magenta signal). The Morph potentiometer is set to 50% so that the CV will morph on both the negative and positive excursions of the input bipolar signal.

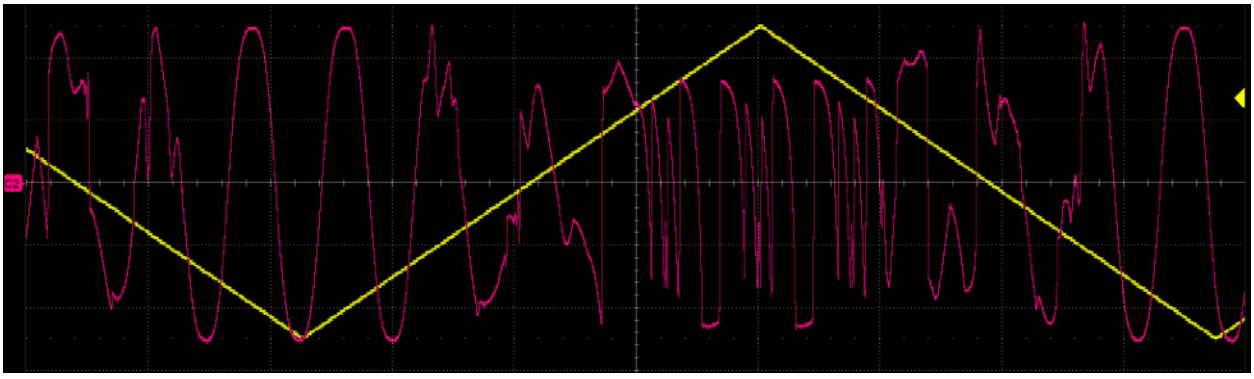


FIG 16: WT MORPH VIA LFO CV

HV1 SOUNDS: DETUNE

Going back to the home screen with the tuning knob and octave/phase angle/ range display, as mentioned on page 6, holding the encoder button down for 1 seconds flips the "knob" display & control from oscillator tuning to digital detune.

FIG 17A: DETUNE DISPLAY (DETUNE OFF)

When digital detune is OFF, the righthand (hybrid) outputs remain phase-locked with the analog VCO and thus at the same frequency. When digital detune is ON, the hybrid outputs phase becomes unlocked form the analog VCO and can be detuned relative to the analog VCO by around +/- one octave.

To toggle detune on and off, simply press the encoder button once when in the detune display as shown above.

Detune allows you to use HV1 like 2 oscillators tuned to a parallel interval like a 5th or 7th, or to slightly detune them for additional phasing effects.

FIG 17B: DETUNE DISPLAY (DETUNE ON)

HV1 SOUNDS: SYNC

HV1's analog oscillator can be sync'd to another oscillator via the "SYNC" input on the front panel. 2 different options can be selected via the options menu (see page 8):

1) RESET: The VCO's integrating capacitor is discharged on each rising pulse of the sync input.
2) RVERSE: The VCO's integrating capacitor reverses the direction of charging on each rising pulse of the sync input.

HV1 SOUNDS: PWM

Finally, HV1 has a PWM input, which modulates the pulse width of both of the pulse inputs. This signal is simply summed with the voltage from the PW (Pulse Width) potentiometer. The range of the PW potentiometer is a little bit past 0% duty cycle and a little bit past 100% duty cycle.

APPENDIX: INSTALLING/ REMOVING THE SD CARD

If you are updating firmware, first turn the module off. If you are simply loading different wavetables, you can "hot swap" the card doing the following:

UNMOUNTING THE SDCARD WHILE HV1 IS ON:

While in the wavetable morph screen, hold the encoder down for 2 seconds and HV1 will attempt to unmount the SD card. The following text should appear (SD CARD NOT MOUNTED). It is now save to remove the card:

FIG 18: SD CARD DISMOUNTED

REMOVING THE SD CAD:

Assuming that either the card has been safely unmounted as described above OR the HV1 is shut down, to remove the SD card, simply put on the edge of the SD card until a slight click is heard and the retention is released. Then let go and the card should push out a few millimeters and be easy to pull out.

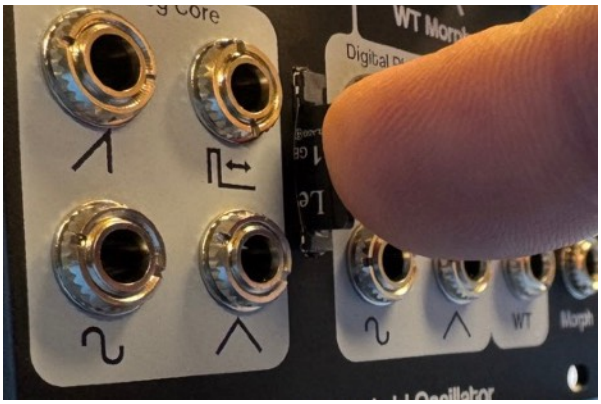


FIG 19: REMOVING THE CARD

INSTALLING THE SD CARD:

To install a card, simply reverse the installation process. Make sure the little notch on the card is facing upward:

FIG 20: INSTALLING THE CARD

...and slide the card in. Then push on the end until the retention latch is actuated.

The card should stick out about 2mm or so when installed.

APPENDIX: INSTALLING/ REMOVING THE SD CARD (continued).

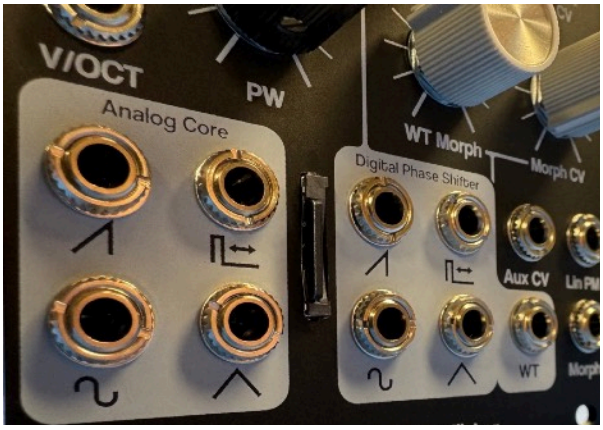


FIG 21: SD CARD INSTALLED

MOUNTING A SD CARD WHILE HV1 IS ON:

If you unmounted a card while HV1 was on, you can mount an installed card the same way. Just hold the encoder for 2 seconds and HV1 will attempt to mount the card and parse the files on it. If all goes well, you'll see the first file on the card loaded up like this:

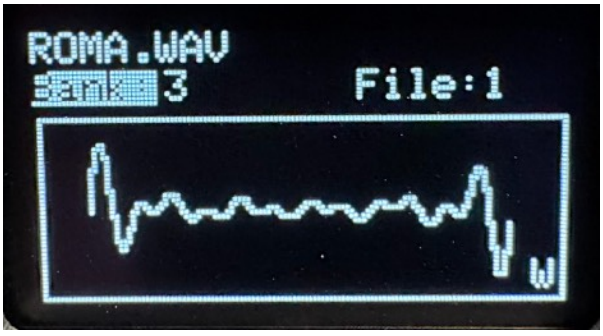


FIG 21: SD CARD SUCCESSFULLY MOUNTED

APPENDIX: FIRMWARE UPDATING

HV1's internal firmware can be updated via the SD card. Before updating, check and see if you already have the newest firmware. The info screen can be accessed by navigating to the TUNER screen and then holding the RIGHT button for 3 seconds:

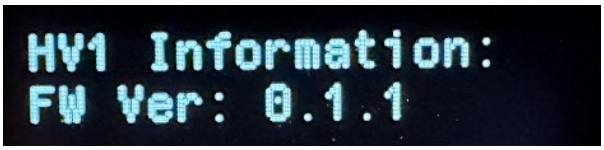


FIG 22: INFO SCREEN

If a newer update is available, follow the steps below:

1) Power down HV1 and remove the SD card. Download the FW update and copy the .BIN file to the root (not in a folder) of the SD card. Make sure your card has only ONE .BIN FW file on it, since the updater cannot parse files and will select the first one it finds for update.
2) Re-insert the SD card and power up HV1 *while holding the RIGHT and DOWN buttons simultaneously*.
3) HV1 will boot to this screen:

FIG 23: FIRMWARE UPDATE SCREEN FIRST SCREEN

Assuming the SD card is inserted and a valid .BIN file is on the card, you will see the screen shown in fig 23.

4) Press + to start the update. First the application block of flash memory will be briefly erased and this will be displayed:

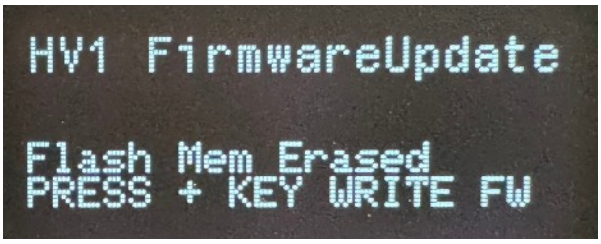
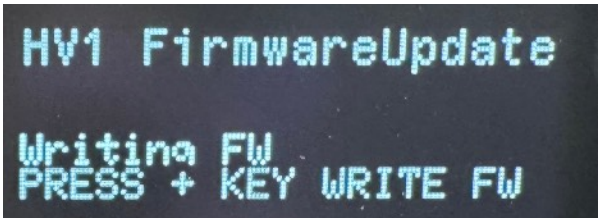


FIG 24: FW UPDATE, FLASH MEM SUCCESSFULLY ERASED

5) Press + again to write the BIN file to flash memory. This will be displayed:



Briefly, and then this:

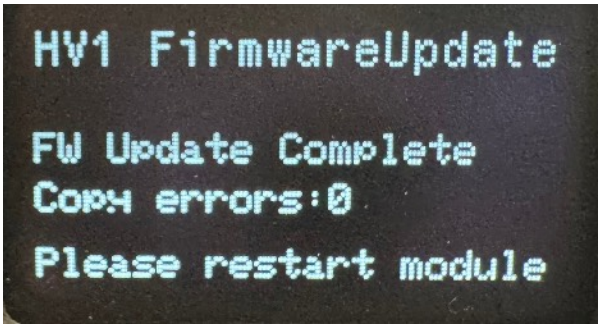


FIG 25/26: FW UPDATING COPYING FW

6) The firmware update is now complete. You should see the screen shown in figure 26. Assuming the

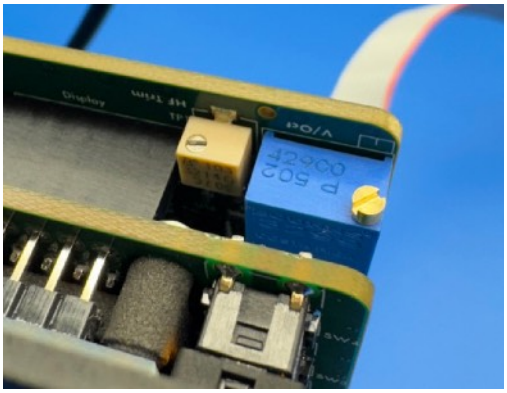
update went OK, “FW Update Complete” and “Copy Errors: 0” should be displayed.

7) Simply power down the module and restart it as normal, without holding any keys down, and HV1 should boot with the newly updated firmware. You can check the version the same way you did in the beginning by going to the tuner and holding the RIGHT key for 3 seconds.

APPENDIX: CALIBRATIONS

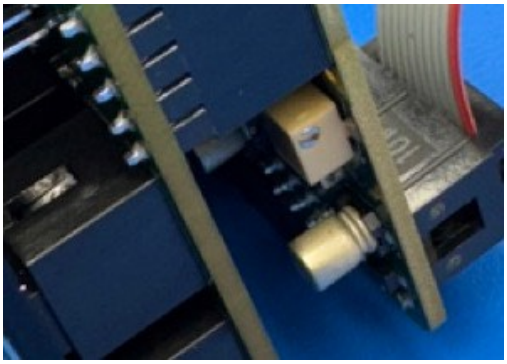
In normal use, HV1 shouldn't need to be calibrated, but if for some reason something needs to be adjusted, this section explains the available options. Some are adjusted physically/ mechanically, and some in software. Starting with the physical trimmer pots:

VCO Volts/Octave and HF Trim:



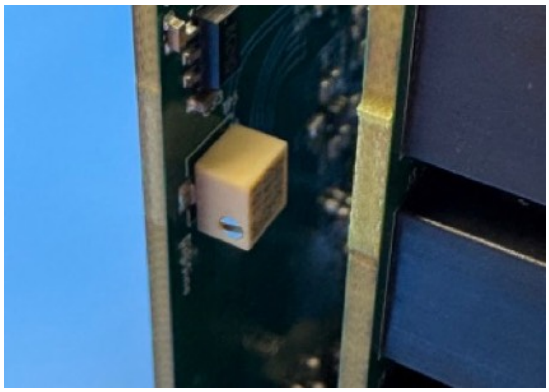
Located on the upper right corner of the rear of the module are the V/oct and HF trim. These adjust the scale and high-frequency response of the analog VCO. A 1.5mm flat screwdriver is needed to adjust the HF trim, and a 2.0mm for the V/octave.

Octave Voltage Trim:



This trimmer, located on the right side of the rear of the module is for adjusting the scale of the octave voltage. Only adjust this after ensuring the VCO V/oct scale is perfectly adjusted.

Right Sine Trim:



This trimmer, located on the left side of the rear of the module adjusts the shape of the sine on the digital (righthand) output. Adjust by ear or by using a frequency analyzer. This normally will not ever need to be adjusted.

APPENDIX: CALIBRATIONS (DIGITAL)

Tuning offset and phase offset trim:
When on the main tuning screen, holding the +/UP button for 3 seconds will enter a calibration mode and a "C" will show in the upper left as shown:

The numbers at the bottom left are the values of tuning offset and phase offset, respectively (shown here as 267 and 2000).

Pressing + or - will adjust the tuning offset. If, for example you had tuning set to 0 and your "C" was 5 cents off, you can use this adjustment to set it perfect.

Pressing LEFT or RIGHT will adjust the phase 0 offset. Monitoring the left and right triangles on an oscilloscope, turn the phase potentiometer to full counter-clockwise. The 2 triangles should be coincident (on top of each other). If not, press LEFT and RIGHT until they are. When finished, simply hold +/UP for 3 seconds until the "C" disappears. The tuning offset and phase offset will be saved to internal non-volatile memory.

REVISION HISTORY

03: Added explanations of new Aux CV routing options in FW 0.2.0.
02: FW update procedure erroneously referenced fig 19 but should be 23.
01: Initial release.