

SDS_VCO

User's Manual

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I. Introduction & Connecting Power

Welcome to the SDS_VCO Users Manual! This manual will let you get the most out of your new digital VCO.

This VCO uses variable sample rates to generate tones rather than the customary modern digital method of DSP and a fixed sample rate. This method offers very fast response, analog-like modulating, and a large variety of interesting waveforms, but in a very compact HP and low price. For the Waveforms included with the SDS_VCO see section II.D.

Most VCO's of this size are just that, a VCO. The SDS_VCO has a built-in envelope generator and VCA. This cuts up to 2 other components from your already filled road case, or adds another envelope dimension if used with another VCA. The envelope is responsive as a Gate, or, if selected, a triggered (<100 uS) envelope with Decay based Sustain then Release.

As a bonus, there is also a dimmed LED VU meter, which explains the LED colors, and a CV controlled waveform selector. The LED's are purposely dimmed when in VU meter mode, but can be turned off if desired. CV controlling the waveform, especially with a sequencer, is a way to multiply the VCO into what sounds like several VCO's. There's even an offset control!

The immediate range of the SDS_VCO is 5 Octaves, as the VCO CV input is 0-5 volts, but can be shifted up one octave in settings. There is also a settable offset of A or C at 0 volts. If you have analog control, there is a Quantizer that can be turned on which also obeys the above offsets.

A really fun addition to the SDS_VCO is there are 3 Custom Waveform slots that can be programmed using two knobs as X=time and Y=voltage. Some of the most interesting, dirty, or delicate sounds can be created this way, depending on how you handle the knobs!

If you're not great with the knobs, don't despair! The top Custom Waveform (#15) can be recorded into from an incoming audio sample and then used as with any of the other waveforms.

The best SDS_VCO feature is all of your settings and the Custom waveforms will be remembered on power-down, so once you have them set you may not need to touch them again!

Powering Up:

The SDS_VCO has a standard 16 pin box header to plug into your PSU via ribbon. It is keyed so shouldn't be a problem, but if yours is not keyed, then remember:

Pin 1/Red Stripe plugs in facing upward on the SDS_VCO.

Because of the height of a standard header, the plug may interfere with an adjacent module if that module is deep enough. This can be remedied by using a low profile plug (no retainer) or re-locating the module. That's the fun of 3HP!

I hope you have enjoyed this Introduction and enjoy the SDS_VCO even more!

*SDS

II. Front Panel

This section is a description of the Knobs, Jacks, and LED's on the 3HP panel.

A. CV Inputs

VCO CV:

The top jack marked VCO is the CV input for the frequency the VCO will output at any time, even if used alone.

The useable input range is 0-5 Volts @ 1V/octave, well within the range of any sequencer out there. Voltages beyond this range will be ignored and set the VCO frequency to either extreme.

The voltage can be linear as 1V/Octave to produce any frequency between A2 and Ab7 or C3 and Bb7 depending on the A/C offset settings. The voltage can also be quantized into proper notes if desired. See Section IV. Settings, B. & F. for more on these settings

MOD:

The 2nd from the bottom jack is for Modulation input. Depending on the waveform selected, this may be phase modulation, pulse width modulation, or both.

The voltage range is -5 volts to +5 volts, which gives a phase range of -180° to 0° to +180°, and/or a pulse width range of 0% to 50% to 100%.

This CV input can also be used to select waveforms (offset from Wave knob). The voltage range 0 volts to +5 volts select waveforms 0 to 7, and -5 volts to 0 volts selects waveforms 8 to 15.

A third use for this input is during Wave Record / Clone mode. Audio fed into the MOD input must be at -5V to +5V (10 V swing) modular levels for best recording and interpretation.

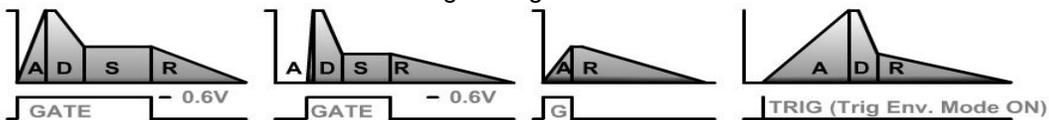


B. T/G Input

The second jack from the top is the trigger/gate input that starts the envelope Attack. If there is nothing patched in, the envelope level will be maximum, thus the audio output constant.

When using this input with a gate pulse, the envelope will Attack, Decay, then hang on the Sustain step until the gate falls low again, at which point will step into the Release phase.

When using with a short trigger pulse, the attack must be short or there will be no audio. This can be remedied by setting the "Triggered Envelope" option to on. This is the 4th Green LED from the bottom. See Sect. IV. on entering settings.



C. AD(S)R Controls

The SDS_VCO has 3 (knob) envelope controls:

Attack - the time it takes to reach full envelope, unless cut short by the gate falling low.

Decay - the time and level the envelope will fall to. Fully CCW is the shortest & lowest fall level.

Sustain - The time Gate is held high. The 4th drawing is using with trigger input (See IV. D.)

*Sustain level is partially "decided" by both the Decay and the Release settings and the release time will of course be affected by the Sustain level.

Release - the time it takes to fall back to silence after gate falls low.

These controls are also used in settings selection, wave drawing, and entering settings. Please refer to Section IV. for detailed information on the alternate knob functions.

D. Wave Selection

The bottom knob is used to select one of the 16 waveforms. As this knob is turned, the LED's will indicate selection from off to LED 7 (red at top) then with the Red Left LED on off to LED 7 again. See section III. for waveforms information.

This knob is also used to offset the Mod CV input during CV waveform selection mode. See Section IV. E. for information on this mode.

E. LED's

The SDS_VCO has 8 LED's to indicate primarily waveform selection. While there is no selection in progress, the 7 LED's on the right default to a dimly lit pseudo VU meter indicating the envelope level, thus the relative audio output.

The colors of the 7 LED's follow the VU meter format with the exception of the yellow, which seems a logical transition from green to amber!

The Top left Red LED indicate a +8 condition, so if both Red LED's are on, then waveform #15 is selected. (7+8). Waveforms #0 and #8 are indicated with none of the 7 LED's illuminated.

During CV controlled wave selection mode, the LED's will brightly indicate which waveform is presently selected for a few seconds before returning to the dim VU.

F. Audio Output

The audio output jack is maximum 10 volts peak to peak (+/- 5V) depending on the waveform and of course the envelope. Some waveforms may be less if being modulated at a certain point of phase of course. Most are 8 to 9Vp-p.

The output impedance is 500 ohms so can be shorted or loaded with headphones for monitoring without damaging the module.

III. Waveforms

The SDS_VCO has all of the standard wave forms, i.e.sine, triangle, sawtooths (ramps), square, and PWM Square plus white/pink noise. Then there are some more exotic waveforms and 3 customizable slots for your own waveform that can be drawn in using two of the pots. Waveform #15 can be recorded into (using A pitch is best) via audio input on the Mod CV input!

A. The 13 Waveforms

Waveforms are selected using the bottom "Wave" knob and the LED's indicate selection. The following is a list of all 16 waveforms in the SDS_VCO:

Waveform:	LED:	Description:	Mod CV is:
#0 Sine	None	Standard sine wave (correct)	Phase
#1 Triangle	Green #1	Standard Linear Triangle wave	Phase
#2 Sawtooth Up	Green #2	Standard Linear Ramp Upwards	Phase
#3 Sawtooth Down	Green #3	Standard Linear Ramp Downwards	Phase
#4 Square	Green #4	Standard 50% duty cycle	Phase
#5 PWM Pulse	Yellow	MOD input (or recorded mod) 0%-100%	PWM 0-100%
#6 Noise	Amber	White Noise, Pink with VCO CV variations	Noise Seed
#7 Double Sine	Red	Sine and 2X Sine mix. Opposing MOD.	Phase on both
#8 Sine+Triangle	LRed	MOD crosses sine & triangle waves	Phase on Sine
#9 Sine+Harmonix	LRed+Green #1	Harmonics shifted with MOD CV/mod rec.	Phase on Sine
#10 Sine+PWM*2	LRed+Green #2	MOD phases Sine & mixes PWM *2 level	Phase+PWM
#11 Sine+PWM	LRed+Green #3	Sine wave with a PWM "Spike" that grows as Sine wave is shifted with phase	Phase+PWM
#12 Triangle+Noise	LRed+Green #4	A triangle wave with a thin veil of MOD CV'ed noise on it. Woodwind sounding.	Phase+Noise
#13 Custom 1	LRed+Yellow	Manual entry via knobs to create new	Phase
#14 Custom 2	LRed+Amber	Manual entry via knobs to create new	Phase
#15 Custom 3	LRed+Red	Manual Entry or Record via MOD CV input	Phase

B. Modulating / PWM'ing Waveforms

The MOD CV input (third jack downward) is multipurpose depending on the settings, but initially defaults to modulate the phase and/or pulse width of a waveform. In the above table the final column describes the way MOD CV input will affect the waveform.

The MOD CV input can alternately control:

- 1) The selection of the 16 waveforms with the WAVE knob added as an offset, or
- 2) The selection of a quantized scale root.
- 3) An offset to Attack Knob
- 4) An offset to Decay Knob

See section [IV. E., F., & H.](#) for more on these alternate modes

C. Creating Custom Waveforms

The top 3 waveforms (#13, #14, & #15) are slots for custom waveforms. Custom waveforms can be created by turning the WAVE (X) and DECay (Y) knobs. Also, Waveform #15 can be created by recording an audio waveform sample present on the MOD input jack.

You will immediately hear the waveform as it is being created. It is saved upon exit.

Manual Entry:

To manually enter a waveform using the DECay and WAVE knobs, use WAVE knob to:

- 1) Select Slot #13 (LRed+Yellow), #14 (LRed+Amber), or #15 (LRed+Red) to create it in.
- 2) Wiggle the ATtack knob until the LED's all flash.
- 3) Turn the ATtack knob CW so the LRed LED stays on. This holds the mode indefinitely.
At this point, knob movements will write a new waveform in the following way:
the DECay knob (Y axis) will select the amplitude at point X
the WAVE knob (X axis) will select from start to end of the waveform
- 4) Slowly move the DECay knob while also moving the WAVE knob to create the waveform
- 5) To skip over an area of Waveform X axis without writing over it, turn ATtack left of center, but no longer than 6 seconds!
- 6) To exit and save the new waveform, turn ATtack left of center and wait 6 seconds.

** Try to start and end the waveform on the same Y axis (easiest at zero, CCW) if you want a softer sounding waveform, as a sharp transition will always sound "sawtoothy".*

*** Writing will occur anytime the X axis (WAVE) is moved at all. The X axis has 128 steps.*

Record a Wave:

To record a sound to Slot #15 (Making it waveform #15), use WAVE knob to:

- 1) Select "Settings/Waveform Record" (Waveform) #7 (Top Red LED on right side)
- 2) Wiggle the ATtack knob until the LED's all flash.
- 3) Turn the ATtack knob CW so the LRed LED stays on. This holds the mode indefinitely.
- 4) Introduce a modular level audio signal into MOD input. (See Audio below)
- 5) Turn ATtack knob CCW, then back CW to record a sample.
This can be repeated until the desired sound is heard.

To replicate a waveform accurately, two rules must be followed:

#1 - The sound should be the note "A" and preferably at or higher than A4

#2 - The sound should be at modular levels, preferably 8-10V P-P

*** Overdriving (>12Vp-p) may cause the module to exit (protection surge) without save*

If you don't care that the waveform duplicates the original, then rule #1 can be bypassed! Any sound, voice, whistling, scratches, or chords can yield some great results! Just remember that the higher frequencies tend to produce a more complex waveform (i.e. a chord)

**Note: All custom waveforms & settings will be remembered for next power-up.*

IV. Wiggle Settings

The SDS_VCO has several settings and modes. To enter settings (or create custom waveforms) select the corresponding LED using the WAVE knob, then wiggle the ATtack knob until the LED's all flash. These settings will be remembered at power down.

For "switch" types of options, i.e. On/Off, dial the ATtack knob right of center to turn it on, or left of center to turn it off. This state is indicated by the lone LRed LED. Setting is saved after the knob hasn't moved for 6 seconds.

For "Selection" types of options, the ATtack knob must be turned to the right to hold from exiting/saving the setting. See section H. on the next page

A. Green #1: +1 Octave

Adds an octave when ATtack knob rests right of center (CW). LRed is on.

** +1 Octave can change some waveforms, i.e. +noise to interact with modulation in a new way!*

B. Green #2: Quantizer Key Offset

Selects the root key offset at VCO CV = 0 volts. Each LED is +1 note, and starts at A, proceeding 15 more semitones to C at the top.

C. Green #3: MOD CV Control of Envelope Decay On/Off

The MOD CV will offset the DeCaY knob for the VCA Envelope. Can be active with D, E, & F.

D. Green #4: MOD CV Control of Envelope Attack On/Off

The MOD CV will partially offset the ATtack knob for the VCA Envelope over a useful range. Can be active with C, E, & F.

E. Yellow #5: MOD CV Selected Waveforms Mode On/Off

The MOD CV input will select waveforms with the WAVE knob acting as an offset.

For 0-5 Volt use, only the first 8 waveforms (#0 to #7) can be selected via CV.

The WAVE knob can offset the CV so access to the upper 8 waveforms is only a matter of centering WAVE knob. Can be active with C, D, & F.

For -5 Volt to +5V use, the entire 16 Waveforms can be selected via CV, -5V starting at #8.

** MOD Source should be removed before selecting other settings during this mode!*

F. Amber #6: MOD CV Selected Quantizer Root Mode On/Off

This enables/Disables MOD input selected quantization scales. When off (default) the Quantization Scale set (see section H.) is valid. When on, the MOD input selects which scale.

0.4166r V/Note Default Unlike 1V/Octave, this offset is 12 Notes over 0V->5V or -5V->0V, or 5:1. This makes it easier to control scales with Mixed LFO's, maths, or manually.

Please keep in mind that and this mode can be active along with MOD CV selected Waveforms (F.) and with C & D (ATtack and DeCaY offsets) all at the same time!

G. Red #7: Wave Recorder / Cloner

This will enter the Recorder mode. Make sure ATtack knob is right of center (CW) to hold the SDS_VCO in this mode while auditioning a new sound. Briefly flip the ATtack knob left of center (LRed LED will go out) then right again to capture a wave. See Section [III. C.](#) for more.

H. Left Red #8: Quantization Scales

This will allow you to select whether quantizing is off or on, and what type of scale as follows:

Quantize Setting	LED(s):	Comments
0-off	None	from 0-5 volts + Quant Root Offset (see B.)
1-all notes	Green #1	12 notes / octave
2- Major	Green #2	3 notes / octave
3- Minor	Green #3	3 notes / octave
4- Major 7	Green #4	4 notes / octave
5- Minor 7	Yellow	4 notes / octave
6- Major 6	Amber	4 notes / octave
7- Minor 9	Red	4 notes / octave - 2 Oct: C Eb G Bb C D Eb G
8- Octaval	LRed	1 notes / octave
9- Blues	LRed+Green #1	5 notes / octave
10- Major 6 / 9 Susp4	LRed+Green #2	4 notes / octave
11- Minor 7 #5	LRed+Green #3	4 notes / octave
12-Aug Susp4	LRed+Green #4	3 notes/octave
13-Minor Pentatonic	LRed+Yellow	5 notes/octave
14-A/C whites	LRed+Amber	7 notes/octave, All of the White notes
15-A/C blacks	LRed+Red	5 notes/octave, All of the Black notes

Quantized notes are great for using not-set CV (LFO's, combinations/math's etc) to generate a string of notes that are in the key of the root. MOD CV can offset the scales (see [F. & B.](#))

I. LRed+Green1: MOD Input Record On/Off

When the MOD input is being used for selecting Waves, Quantizer root keys, ATtack offset, or DeCaY offset, the phase and PWM modulation function can no longer be usable that way. The solution is to modulate your waveforms before entering these *alternate Mod input functions*.

The SDS_VCO records a reasonable facsimile of the incoming modulation and remembers the last 3.3 seconds before entering into the alternate mode. There are of course limitations as the sample rate is only 330 Hz, and coarse modulating waveforms are "smoothed" to avoid internal "ringing".

**** The modulating signal must be present before entering into any of these alternates as only the last 3.3 seconds is saved. This modulation is saved to permanent memory for power-up recall.**

The waveforms may sound slightly different under internal modulation, but this can be a good thing! Also the modulation is "joined" to loop smoothly, so if your cycle > 3.3 seconds it may not.

Select Left Red LED + lowest Green, then wiggle ATtack to enter settings. ATtack knob right (CW) of center turns this feature on, left (CCW) of center turns it off. Wait 6 seconds to exit/save.

J. LRed+Green2: VU Meter On/Off

Selects whether VU meter becomes active after last WAVE tweak. Default is On. (ATtack CW)

K. LRed+Green3: Triggered Envelope On/Off

When On, a short trigger will act as a gate for the DELay setting. The Attack part of the envelope will play in it's entirety no matter what length it is, whereas with this mode off, a trigger might make no sound at all. The sustain length cannot be controlled by a trigger or gate when this is on.

L. *LRed+G4*: MIDI Channel Select (Optional)

If you chose to have the CV to MIDI add-on installed, congrats! You now have a CV to MIDI note converter! You don't have to use the VCO as a VCO, it could be used to control any MIDI synth, V-Drums, or send notes to a DAW without even hearing the VCO output. The following section describes simple MIDI operation and configuring a MIDI channel to it.

By default the MIDI Channel is set to Channel 1. This can be changed by selecting Left Red LED + Green LED # 4 (option 12) and wiggling on the ATtack knob to enter settings as usual. Select a MIDI channel from 1 to 8 using the ATtack and the 8 LED's.

To select a MIDI Channel from 9-15, (drums are on channel 10 in any GM MIDI synth for example) just continue turning the ATtack knob past center and add 8 (indicated by LRed LED) to the displayed LED on the right side.

To set to MIDI Channel 16, turn ATtack fully left so no LED's are lighted. This layout (1-15, then 16 is all off) is so the LED numbers align with MIDI Channel numbers.

* Note: Some form of Quantization scale must be ON for MIDI notes to be sent (i.e. "All Notes")

What is sent via MIDI?

Any time there is a Trigger/Gate on the T/G input, a MIDI note will be sent on the set MIDI Channel. This mimics precisely the "notes" being played by the SDS_VCO, and responds to Gate length as Note-On, Note-Off messages.

* If in Trigger Envelope mode, the VCO's output will carry through the envelope, while the MIDI notes are turned off immediately when the trigger falls.

** If the MOD input is

a) *not* being used for Scales Root offset or Wave Selection, and

b) DeCaY is set to be offset by MOD CV input,

then MOD CV controls the Velocity of MIDI notes on positive side only. Min. velocity is 14%, but defaults to 80% when not being controlled by the MOD input.

The Note range is 5 octaves from MIDI Note 33 (A-2) @ 0 Volts to MIDI Note 93 (Ab-7) @ 5V. If +1 Octave is on, all of these notes are shifted up by 12 Notes.

As this feature is just a small add-on, it is limited to sending notes only during quantization. If Quantization is set to zero (no quantization) then only 1 note will be sent.

How do I install the MIDI board?

If you purchased the MIDI board separately, you will need to install it, but there's no need to do a Firmware update for this feature to work, just plug and play.

Included with the MIDI board is a small plastic snap-in stand-off which aligns when the 3 pins are aligned with the header on the larger vertical board. Simply align and carefully press it into place. Do not force it sideways. Carefully align with the hole once the 3 pins are just sitting on top of the header. Make sure the 3.5mm plug is low enough before finally soldering the pins.

What is the 3.5mm plug's wiring configuration?

A MIDI patch cord (Panel mount or in-line 5-Pin MIDI Jack) is included, but if you want to wire your own, here's the configuration to a female MIDI jack:

Note that a stereo jack must be used with this jack, a mono plug may cause damage to the safety resistor if a mono plug is plugged in while the unit is powered up for a prolonged period...

The center ring is hot (max 200mA @ 5V), while the tip is signal, and the inner ring is ground.

The center ring will connect to a MIDI DIN-5F (Female) jack at pin 5.

The Tip will connect to the MIDI DIN-5F (Female) jack at pin 4.

The Ground will connect to the MIDI DIN-5F (Female) jack at pin 2.

*Please note that DIN-5 plugs pin order (with curve up) 1, 4, 2, 5, 3

** A male plug will need pins 4 & 5 swapped as it's facing opposite!

M. No LED's: Firmware Update Loader / Default Reset

Wiggling while all LED's are off (Wave pot fully CCW) will cause a master reset after 10 seconds as indicated by the LED's forming a shrinking bar.

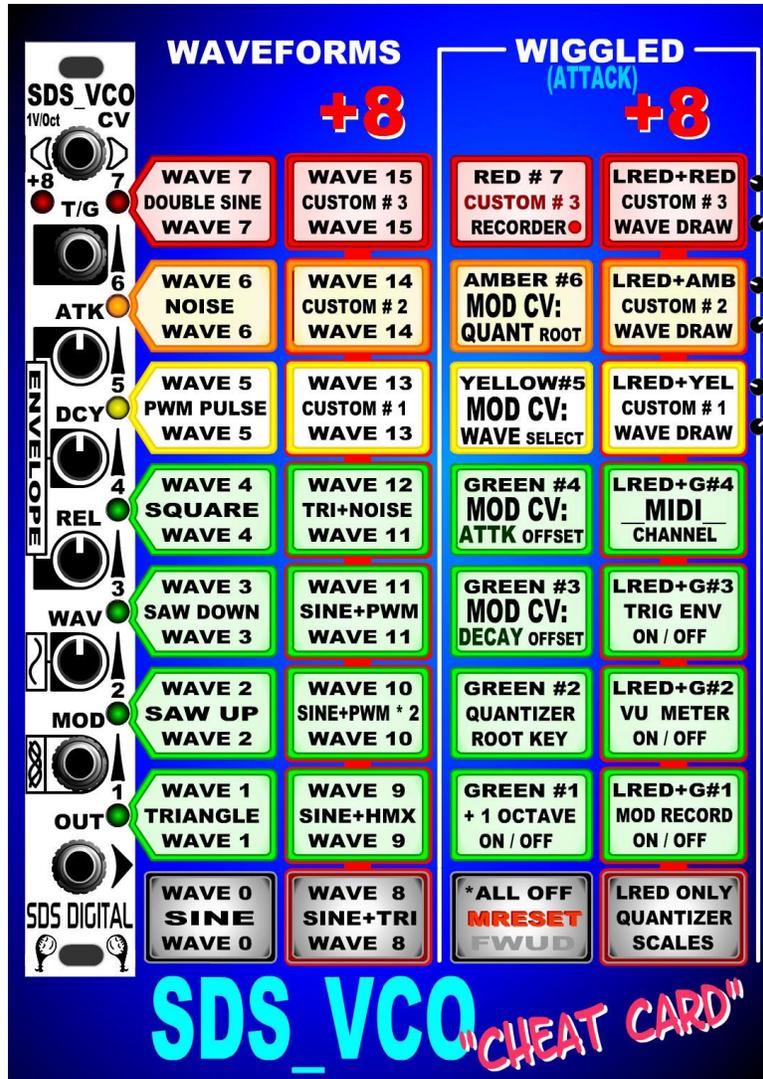
once the bar is gone, all wiggle settings will be restored to factory values but Custom Waveforms and any recorded modulation will remain, even though Mod recorder will be off.

Also, this function can be used to load Firmware via an mp3 file from your phone, mp3 player, notebook etc. See FWUD instructions on the download page for more, if FWUD is required.

****Note: To do a master reset, make sure nothing is plugged into the VCO CV jack**

****Note: Make sure the module has been powered for at least 12 seconds before entering this.**

Cheat Card



Firmware Updates, Support: <http://www.freshnelly.com/sdsvco/sdsvco.htm>

View some videos on the SDS_VCO at [youtube.com/freshnelly](https://www.youtube.com/freshnelly)

