COSMOTRONIC

VORTEX

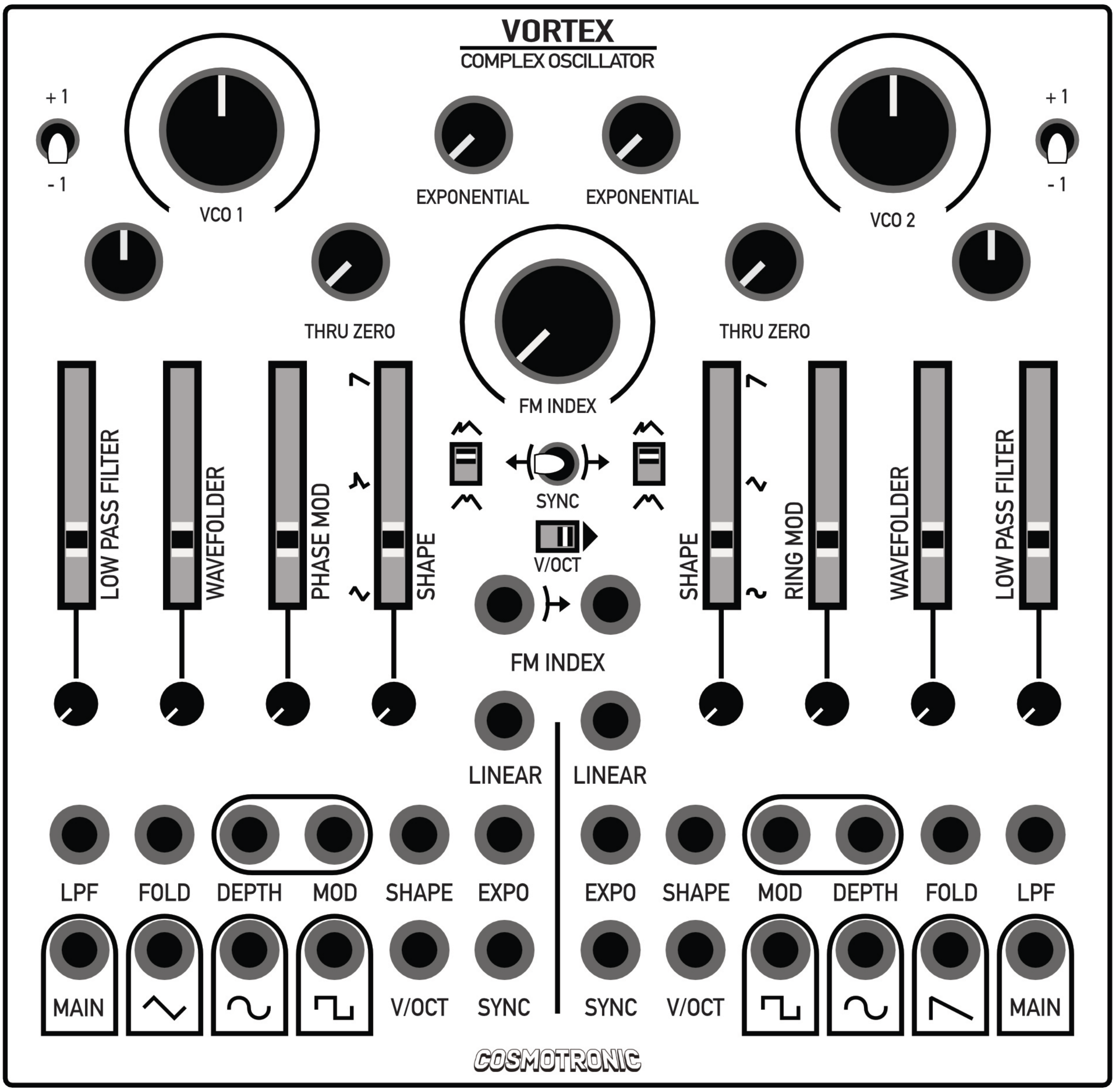
COMPLEX OSCILLATOR

user manual

VORTEX USER MANUAL

by Simon De Rycke / BRiES

Thank you for purchasing VORTEX by Cosmotronic. VORTEX is a versatile analog dual triangle core complex oscillator with a wide frequency range, a lot of timbral shaping options, useful normalizations, CV inputs for every parameter and attenuators to control the amounts of both internal and external modulation.



Contents of the box:
VORTEX
1 ribbon cable
4 black M3 mounting screws
1 Cosmotronic sticker

width:	26HP
depth:	27 mm
current draw:	190 mA +12V
	190 mA -12V
	0 mA 5V

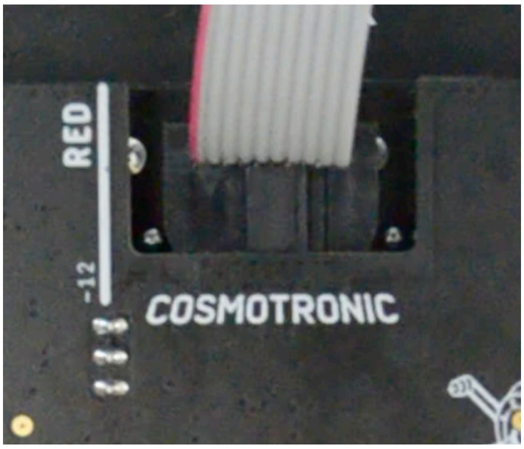
www.cosmotronic.nl - hello@cosmotronic.nl

TABLE OF CONTENTS

CONNECTING VORTEX

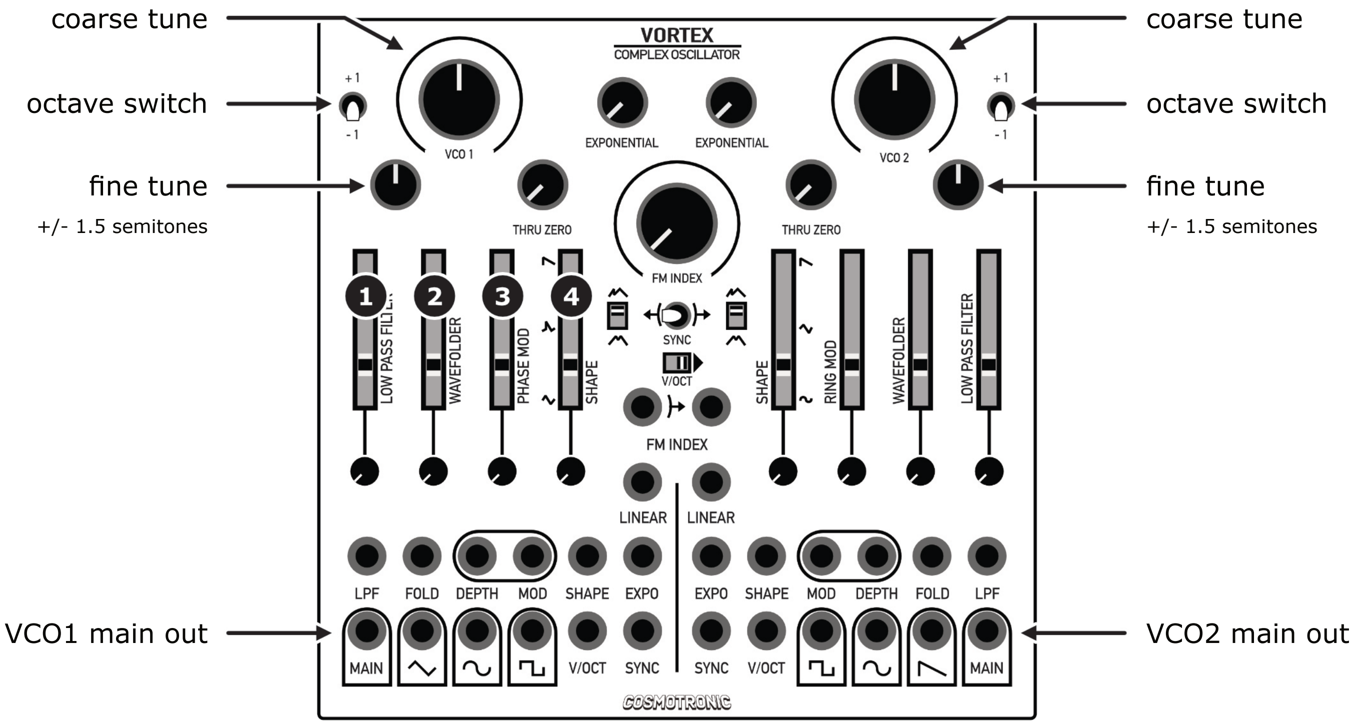
Please take care when connecting VORTEX. VORTEX is reverse voltage protected but the warranty does not cover damage caused by faulty installation of the module. In doubt do not connect the module to your system.

MAKE SURE YOU TURN OFF THE POWER TO YOUR SYSTEM BEFORE CONNECTING VORTEX.



The white line on the back of VORTEX next to the 10 pin header indicates where -12V should be connected. Make sure the red line of the included ribbon cable is on the side indicated by this white line when connecting the ribbon cable. Carefully check where the -12V rail on your system is before connecting the other end of the ribbon cable to a 16 pin power header. The red stripe of the ribbon cable should be on the side of the -12V rail. In most systems ‘red stripe down’ is the standard way to connect the ribbon cable to the bus boards but check the manual of the manufacturer or the labels on the bus boards if there’s any doubt.

FRONT PANEL FEATURES



❶ LOW PASS FILTER (VCO1)

The slider controls the cut-off frequency of the low pass filter of VCO1. You can modulate this frequency using a signal patched into the LPF input jack (normalized to the SINE of VCO2). The input accepts bipolar signals. The knob is an attenuator for this modulation.

❷ WAVEFOLDER (VCO1)

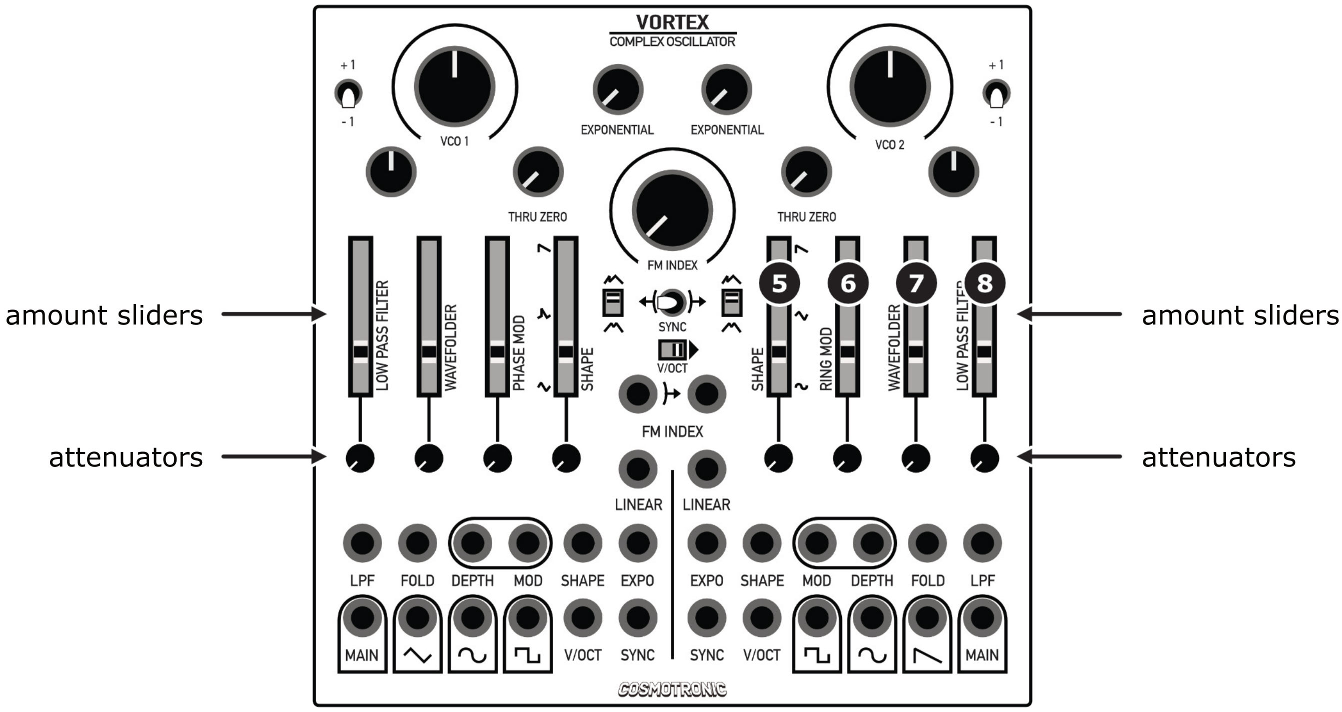
The slider controls the amount of wavefolding of VCO1. You can modulate this amount using a signal patched into the FOLD input jack (normalized to the SINE of VCO2). This input accepts bipolar signals. The knob is an attenuator for this modulation.

❸ PHASE MODULATION (VCO1)

The slider controls how much VCO1 is being phase modulated in other words the DEPTH of the modulation. You can modulate this parameter using a signal patched into the DEPTH input jack (normalized to the SINE of VCO2). The DEPTH input accepts bipolar signals and the knob is an attenuator for this signal. You can use any signal as the modulator by patching it into the MOD input. This input is also normalized to the SINE of VCO2

❹ SHAPE (VCO1)

The slider controls the waveshaper of VCO1. This waveshape is available directly from the TRIANGLE output and also goes into the wavefolder where it is rounded into a sinusoidal shape available at the MAIN output. With the slider at the bottom position the TRIANGLE output is a TRIANGLE wave, and the MAIN output is a SINEWAVE (with FOLD and PHASEMOD sliders in the bottom position). In the middle position both outputs morph into a TRAPEZOID shape and the top position results in a SAW. It’s possible to modulate this parameter using the SHAPE input (normalized to the SINE of VCO2). This input accepts bipolar signals and the knob is an attenuator for the modulator.



❺ SHAPE (VCO2)

The slider controls the waveshaper of VCO2. With the slider at the bottom position the signal coming out of the right MAIN output jack is a DISTORTED SINE wave. In the middle position the MAIN output sends out a TRIANGLE shape and with the slider in the top position the wave is shaped into a SAW. This shaping is continuous and there is no stepping or glitching between waveshapes. You can modulate the shape parameter with a signal patched into the right SHAPE input jack (normalized to the SINE of VCO1). This input accepts bipolar signals. The knob is an attenuator for this signal. You can acces the undistorted waveshapes (after the RING MOD stage) from the SINE output.

❻ RING MODULATION (VCO2)

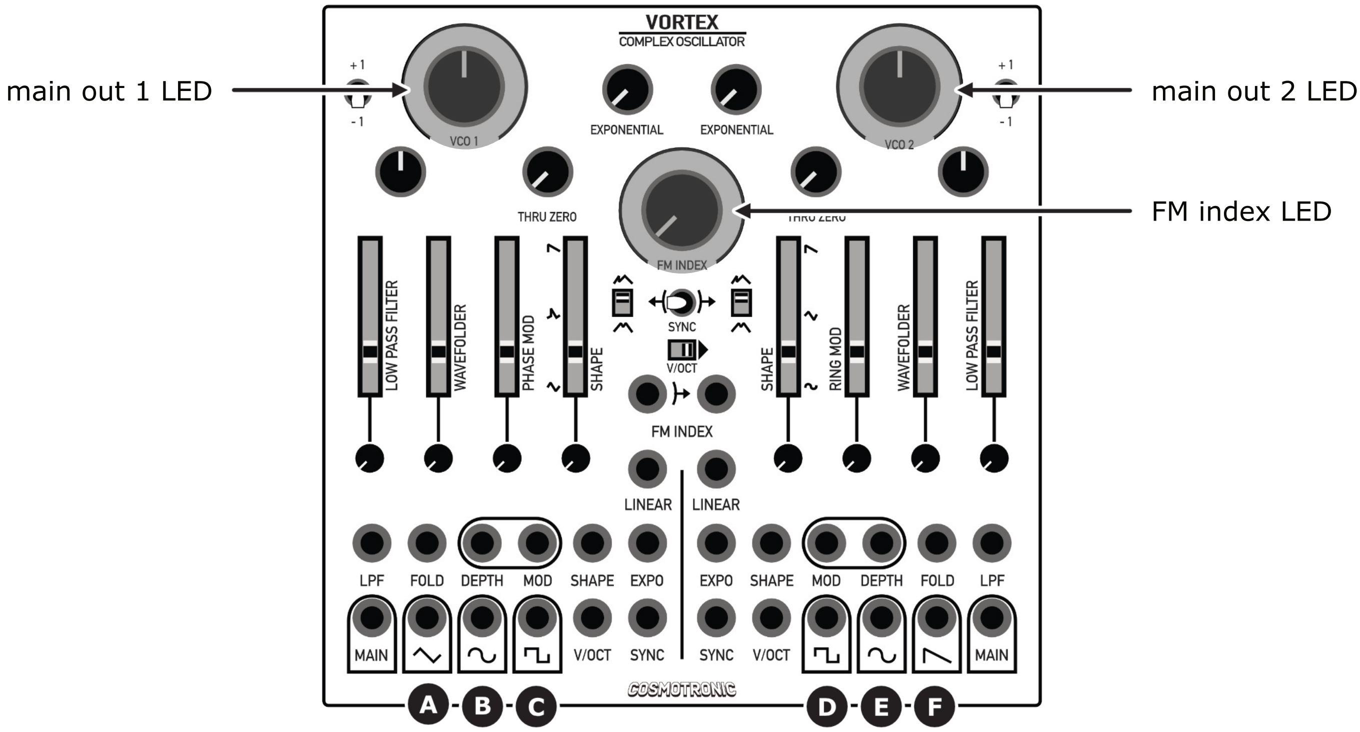
The slider controls how much VCO2 is being ring modulated. You can patch any signal into the MOD input jack (it's normalized to the SINE of VCO1). You can further modulate the amount of ring modulation using a signal patched into the DEPTH input jack (normalized to the SINE of VCO1). The DEPTH input accepts bipolar signals and the knob is an attenuator for this signal.

❼ WAVEFOLDER (VCO2)

The slider controls the amount of wavefolding of VCO2. You can modulate this amount using a signal patched into the FOLD input jack (normalized to the SINE of VCO1). This input accepts bipolar signals. The knob is an attenuator for this modulation.

❽ LOW PASS FILTER (VCO2)

The slider controls the cut-off frequency of the low pass filter of VCO1. You can modulate this frequency using a signal patched into the LPF input jack (normalized to the SINE of VCO2). The input accepts bipolar signals. The knob is an attenuator for this modulation.



Ⓐ VCO1 TRIANGLE OUTPUT

This output is affected by the waveshaper, sync and FM.

Ⓑ VCO1 SINE OUTPUT

This output is affected by the sync settings and FM.

Ⓒ VCO1 SQUARE OUTPUT

This output is affected by the sync settings and FM.

Ⓓ VCO2 SQUARE OUTPUT

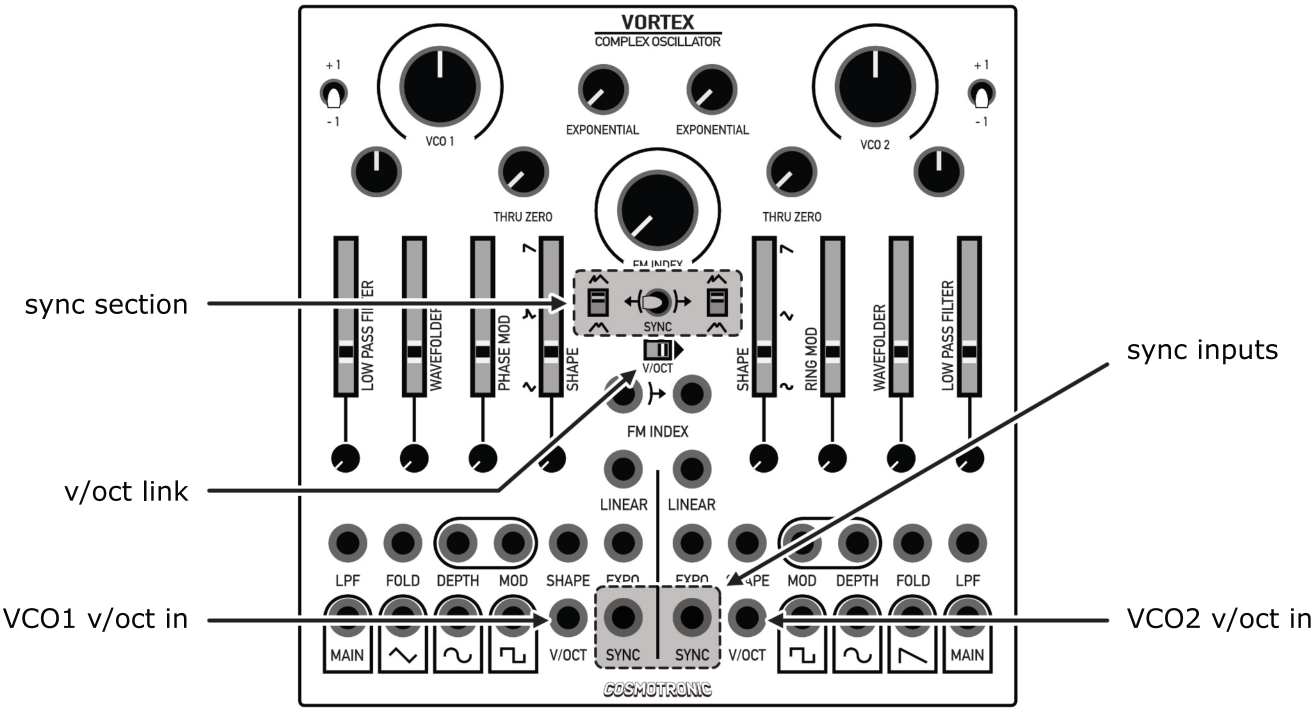
This output is affected by the sync settings and FM.

Ⓔ VCO2 SINE OUTPUT

This output is affected by the waveshaper, ring modulation, sync and FM.

Ⓕ VCO2 SAW OUTPUT

This output is affected by the sync settings and FM.



SYNC SECTION

With the toggle switch in the center position SYNC is disabled. Flipping the toggle switch to the left syncs VCO1 to VCO2. Flipping the toggle switch to the right syncs VCO2 to VCO1. The little switches on either side of the toggle switch let you choose between hard sync (sometimes referred to as 'reset') in the up position and soft sync in the bottom position (sometimes referred to as 'flip').

SYNC INPUTS

You can patch any external VCO (preferably a square or pulse) into the sync inputs of VCO1 and VCO2 to override the internal normalization.

V/OCT inputs

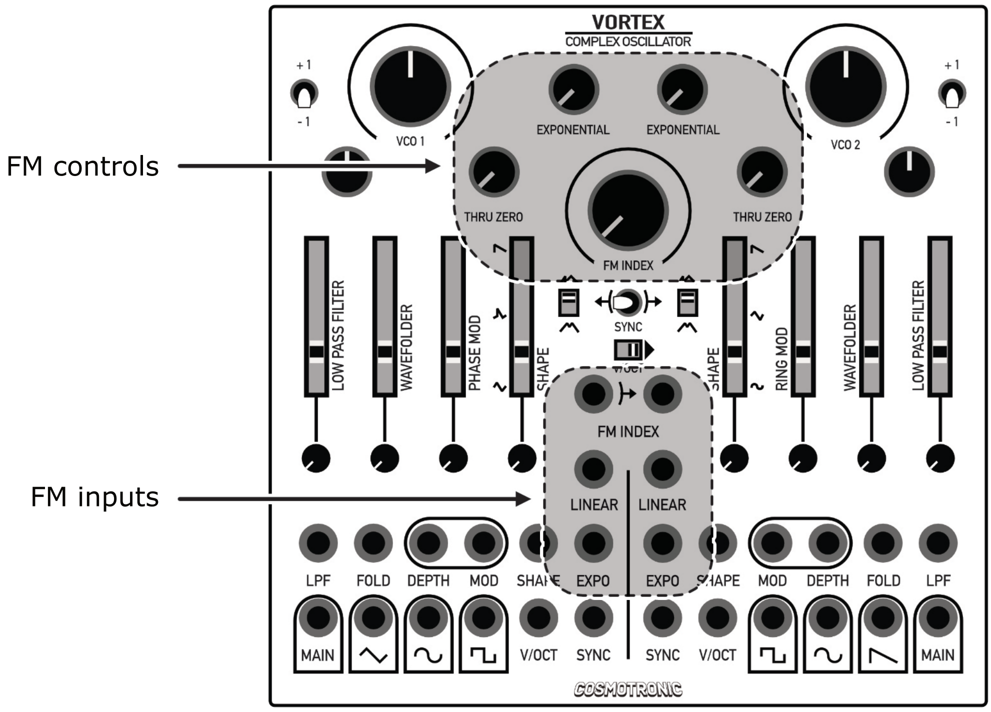
By patching a CV signal into either V/OCT input it's possible to control the pitch of VCO1 and VCO2 seperately (offsetted by the positions of the coarse and fine tune knobs and the octave switch).

The range of both VCO1 and VCO2 is 20Hz to 20kHz. The V/OCT inputs have a high impedance meaning you can use passively multed CV signals without accuracy loss.

V/OCT LINK SWITCH

You can use one V/OCT signal for both VCO1 and VCO2 by flicking the link switch to the right position. This normalizes the V/OCT input of VCO1 to the V/OCT input on VCO2. Keep in mind that the relative pitches of VCO1 and VCO2 remain unchanged.

FRONT PANEL FEATURES



FM CONTROLS

The FM INDEX knob located in the center of the module controls the global amount of both through zero linear frequency modulation and exponential frequency modulation for VCO1 and VCO2.

The left THRU ZERO knob controls the amount of TZFM of VCO1 (attenuated by the FM INDEX knob). The modulator for this TZFM is normalized to the SINE of VCO2. It’s possible to break this normalization by connecting a signal to the LINEAR inputs. The left EXPONENTIAL knob controls the amount of exponential frequency modulation of VCO1 (attenuated by the FM INDEX knob). The modulator for this FM is normalized to the SINE of VCO2. It’s possible to break this normalization by connecting a signal to the EXPO inputs.

VCO2 has the exact same controls (the knobs on the right side). The SINE of VC01 is normalized to the FM inputs.

FM INPUTS

You can patch any bipolar signal into the FM INDEX inputs. The left input controls de global amount of FM for VCO1, the right input controls the global amount of FM for VCO2. The FM INDEX knob acts as an offset for whatever modulation you send into these inputs. These inputs accept bipolar signals.

The FM INDEX input for VCO1 is normalized to the FM INDEX input for VCO2 when you don’t patch anything into the right FM INDEX input (indicated by the arrow).

The LINEAR inputs are inputs for an external modulator for the TZFM. These inputs are AC coupled so it’s best to use a VCO instead of an LFO for the TZFM to behave like it’s intended. The THRU ZERO knobs act as an attenuator for the external modulators. The EXPO inputs are inputs for an external modulator. These inputs are not AC coupled and accept both AC (VCOs) and DC (LFOs, envelopes, ...) signals. The EXPONENTIAL knobs act as an attenuator for the external modulators.

VCO1

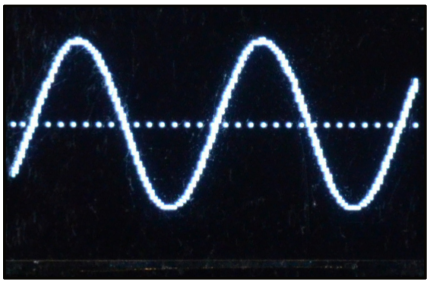
VCO1 is a TRIANGLE core oscillator. The core output is internally shaped to a SQUARE (for syncing VCO2) and a SINE (for modulation of every parameter on VCO2). This shaping happens before the modulation (except for the FM) so the settings of the sliders don't effect these waves. You can listen to the core by auditioning the TRIANGLE output (picture 4) when the SHAPE slider is in the most downward position. The signal flow chart for VCO1 is included in the ADDENDUM section of this user manual.

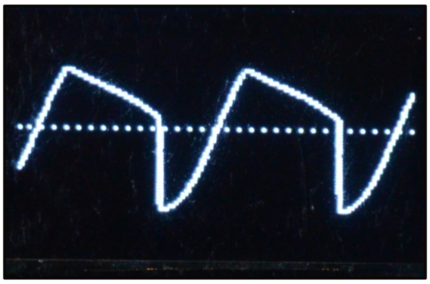
The following sections will only make sense when you listen to the MAIN output of VCO1.

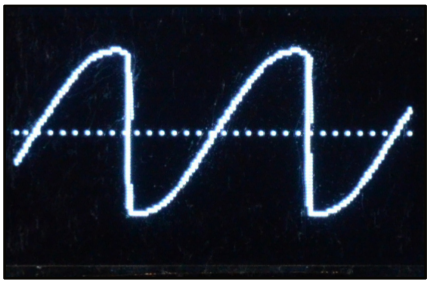
SHAPE

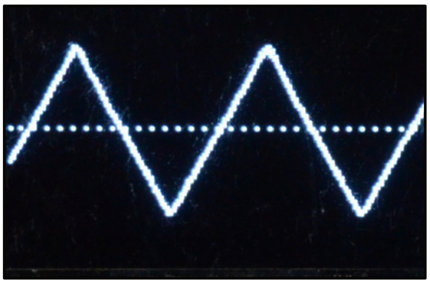
The SHAPE slider controls the waveshaper of VCO1. It continuously shapes the SINE with the slider completely down (picture 1) to a TRAPEZOID (picture 2) when the slider is in the middle position and finally a SAW* (picture 3) with the slider completely up. When auditioning the TRIANGLE output you can also hear the effects of the waveshaper.

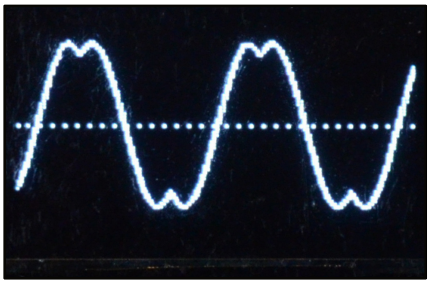
It's possible to modulate the SHAPE parameter using the SINE of VCO2 (normalized). The knob is an attenuator for this modulation. You can override the normalization by patching a signal into the SHAPE input. The slider behaves as an offset for any modulation you send into this input. The knob is an attenuator for the external modulation. The SHAPE input accepts bipolar signals and the maximum range of modulation is achieved (when the SHAPE slider is in the down position) from 0V to 5V. It is however possible to push the waveshape beyond it's expected behaviour. By sending in - 5V when the slider is in the down position the SINE gets a slight dip in the middle (picture 5). This also happens when using bipolar (internal) modulation.


picture 1: sine


picture 2: trapezoid


picture 3: saw


picture 4: triangle core


picture 5: pushing the limits

** The name 'saw' or 'sawtooth' describes a wave that ramps up and then suddenly drops. The term 'ramp' is used when we're talking about a single sawtooth. The inverse wave is simply called 'reverse saw' or 'inverse saw' and describes a wave that ramps down and then abruptly rises.*

WAVEFOLDER

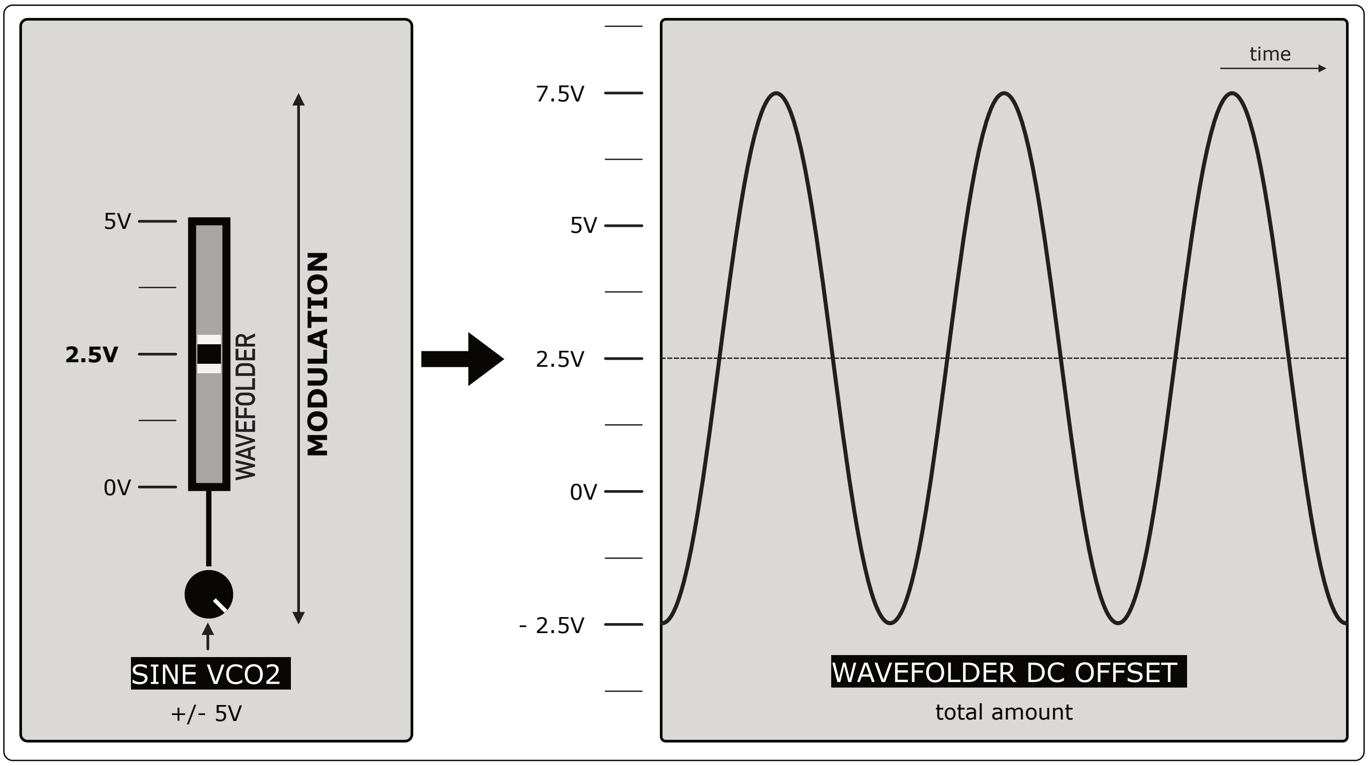
The WAVEFOLDER in VORTEX is based on a design made in 1977 by Barrie Gilbert which was made popular in more recent years by Open Music Labs (*used with permission, many thanks!*). It works by smoothly inverting the polarity of the output with rising input voltages to create oscillations that can be used to shape a triangle or saw into a sinewave. By amplitude modulating the input voltage of this circuit the number of inversions increases and quadruple wavefolding of the output signal is achieved.

The slider of the WAVEFOLDER increases the amount of folds applied to VCO1. At subtle settings (together with some slight filtering) you can use it to shape the SAW into a SINE (more info on this is in the next section about phase modulation). The range of the slider is 0V to 5V of offset.

It's possible to modulate this parameter with the SINE from VCO2 (normalized). The knob is an attenuator for this modulation. You can override this normalization by patching a signal into the FOLD input. This input accepts bipolar signals and the knob is an attenuator for this external modulation.

Maximum modulation is achieved (with the slider completely down) from 0V to 5V. Sending in a negative voltage (with the slider still in the down position) will attenuate the wave completely. This also happens when using the internal modulation when the voltage of the SINE of VCO2 is negative (i.e. during the negative part of the oscillations of the SINE of VCO2). This feature can be (mis)used as a make-shift VCA for VCO1. When no sound is present at the MAIN output the LED under the coarse tuning knob is dimmed completely.

It is possible to achieve higher amounts of wavefolding by sending in higher voltages. Keep in mind that the total amount of wavefolding is controlled by the sum of the DC offset generated by the slider (0V to 5V) and the internal or external modulation (picture 6).



picture 6: modulation ranges

PHASE MODULATION

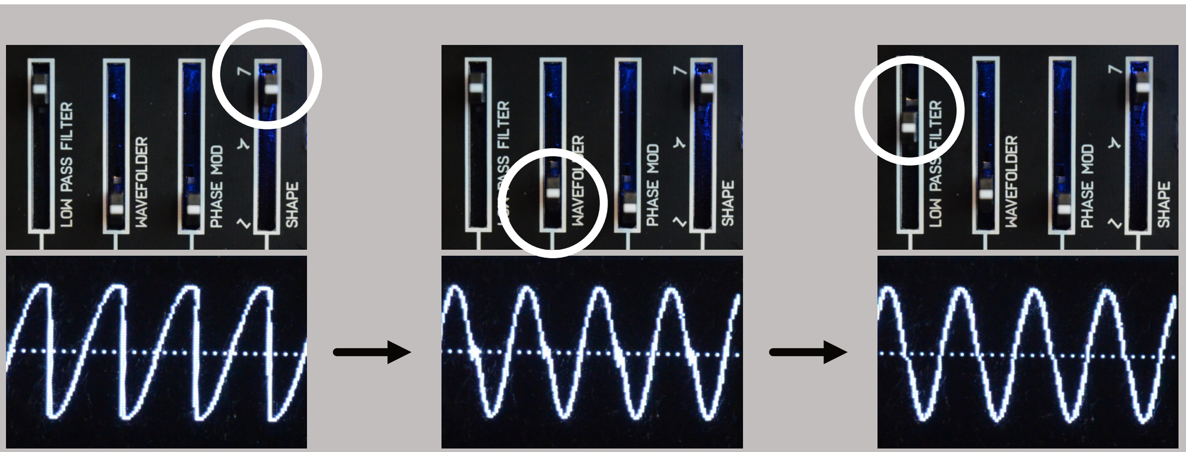
The phase modulation in VORTEX is actually a part of the circuit that also takes care of the wavefolding and waveshaping. It's capable of phase modulation by taking the SAW wave and adding a DC offset. It's only true phase modulation when using the SAW from VCO1 shaped into a SINE wave*. For the other waves (SAW, TRAPEZOID and SINE) it is psuedo phase modulation. Interesting timbres can be achieved by both types of phase modulation with the added benefit of providing a more stable perceivable pitch than for example exponential FM.

Phase modulation is a kind of modulation that doesn't affect the core pitch of the oscillator. It merely shifts the waves on the horizontal axis creating a kind of Doppler-effect. At slower MOD rates this sounds like a vibrato but the perceived pitch change is a result of the compression and stretching of the waves, just like when a firetruck passes by. The phase modulation doesn't affect the TRIANGLE core of VCO1 and therefore has also no influence on the SINE and SQUARE outputs that are derived from the core and are used for syncing or modulating VCO2.

The offset used in the circuit is provided by the SINE of VCO2 (when nothing is patched into the MOD input) and attenuated by the PHASE MOD slider which further controls the DEPTH of the phase modulation. It's possible to break the normalization by patching a signal into the MOD input. This input accepts bipolar signals. It's also possible to modulate the DEPTH with the SINE from VCO2 (normalized). The knob is an attenuator for this modulation. You can override this normalization by patching a signal into the DEPTH input. This input accepts bipolar signals and the knob is an attenuator for this external modulation.

The range of pseudo phase modulation is +720° for MOD signals around 2.5V and -540° for MOD signals around -2.5V (with the signal completely unattenuated i.e. with the PHASE MOD slider in the top position). Anything beyond -2.5V to 2.5 V results in silence. The internal normalized modulator (SINE of VCO2) is therefore capable of surpassing the audible phase modulation range but by using the PHASE MOD slider it's possible to attenuate the signal so it stays within the audible range.

Maximum DEPTH modulation is achieved (with the PHASE MOD slider set-up in such a way that the phase modulation stays in the audible range i.e. somewhere in the middle or a little bit higher) from -5V to 5V but this is greatly dependent on the MOD source and PHASE MOD slider settings. It's possible to send higher voltages into the DEPTH input to exceed the range capable with the internal DEPTH modulation but this might result in silence (as explained in the previous paragraph).



** It's possible to do true phase modulation by folding the SAW into a SINE and filtering out the glitch in the wave. The max. range of this phase modulation is ± 360°*

LOW PASS FILTER

The non-resonant LOW PASS FILTER sections of both VCO1 and VCO2 are identical.

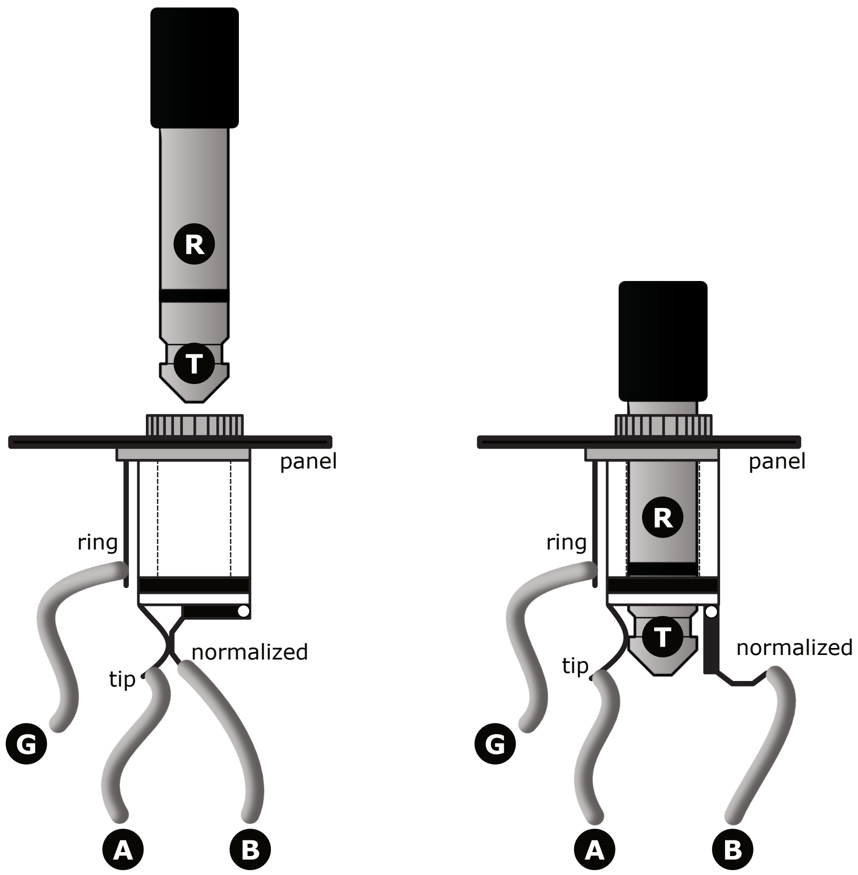
The filters have a 12dB/Oct slope which means that for every octave below the cut-off frequency (set by the LOW PASS FILTER slider) the amplitude of the oscillator drops by 12dB. Setting the slider in the top position keeps the VCO unaffected by the filter and setting it to the down position completely attenuates the signal.

It's possible to modulate the filter frequency with the SINE of VCO2 (normalized*). The knob is an attenuator for this modulation. It's also possible to use an external signal to modulate the filter by patching a signal into the LPF input, breaking the internal normalization. The LPF input accepts bipolar signals and the knob is an attenuator for this external modulation.

The maximum frequency is achieved (with the slider completely down) by sending 5V into the LPF input (don't forget to open the attenuator). This is really useful when patching an envelope into the LPF input as most envelopes will be capable of opening and closing the filter completely.

Although this filter has a really basic feature set it provides for plenty of additional timbral shaping of whatever is coming out of the MAIN output. While the filter is non-resonant it's possible to make throaty AM style sounds by modulating the frequency of the filter with a fast VCO (that's FM of the filter to create AM sounds).

On top of that it's possible to get really interesting timbres by feedback patching the MAIN output back into the LPF input (use a stackcable or a mult for this). There's more detailed information about this in the PATCH EXAMPLES.



** The way most normalized or normalled connections work is by using a little mechanism inside the chassis (female jack) that bends out of the way when a jack is inserted.*

In the simplified diagram to the left A is connected to B when nothing is patched into the input. This is the normalized connection.

When a jack is inserted into the chassis the lug which is connected to B is bent out of the way and by doing so it is disconnected from A. Instead now the tip T of the jack is connected to A.

VCO2

VCO2 is also a TRIANGLE core oscillator. The core output is internally shaped to a SQUARE (for syncing VCO1) and a SINE (for modulating the parameters on VCO1). This shaping happens before the modulation accessible on the front panel so the settings of the sliders don’t effect these (the FM bus does though). The flow chart for VCO2 is in the ADDENDUM section to the back of this user manual.

The following sections will only make sense when you listen to the MAIN output of VCO2.

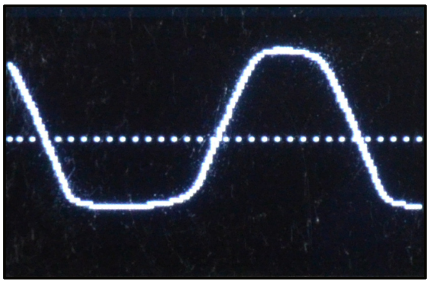
SHAPE

The SHAPE slider controls the waveshaper of VCO2. It continuously shapes the wave from a SINE with the slider completely down (picture 7) to a TRIANGLE (picture 8) when the slider is in the middle position and finally an INVERSE SAW (picture 9) with the slider completely up.

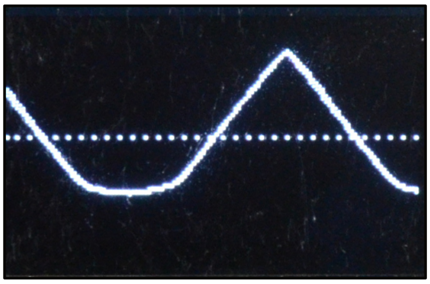
When looking at the pictures from the scope you’ll notice that these waveshapes are a little deformed, this is because of the unique topology of the wavefolder on VCO2 that always adds some distortion, even with the FOLD slider in the down position. The clean waveshapes are available at the dedicated SINE output next to the MAIN output as this output bypasses both the WAVEFOLDER and the LOW PASS FILTER.

It’s possible to modulate the SHAPE parameter using the SINE of VCO1 (normalized). The knob is an attenuator for this modulation. You can override this normalization by patching a signal into the SHAPE input. The slider behaves as an offset for any modulation you send into this input. The knob acts as an attenuator for the external modulation. The SHAPE input accepts bipolar signals and the maximum range of modulation is achieved (when the SHAPE slider is in the down position) from 0V to 5V.

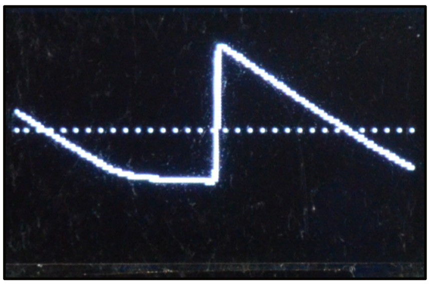
Just as it was the case for the waveshaper of VCO1 it’s possible to push the waveshape of VCO2 beyond it’s expected behaviour. By sending in - 5V when the SHAPE slider is in the down position the SINE from the MAIN output is shaped into a ROUNDED SQUARE (picture 10). This also happens when the normalized modulation (SINE of VCO1) is used. It’s easier to notice if you send in a negative voltage into the V/OCT input of VCO1 to slow it down into LFO rates.



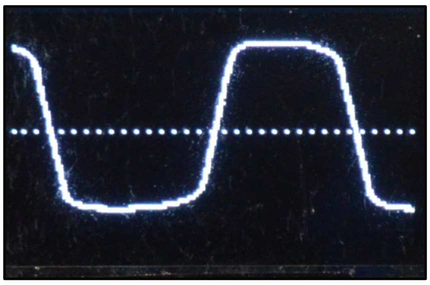
picture 7: sine



picture 8: triangle



picture 9: inverse saw



picture 10: rounded square

RING MODULATION

Ring modulation happens when there’s two bipolar signals that are multiplied in a four-quadrant multiplier. A four-quadrant multiplier could be referred to as a biplolar VCA. Where a regular two quadrant multiplier or VCA (picture 11) attenuates the bipolar input completely when the modulator is in the negative part of its range (resulting in amplitude modulation) a four-quadrant multiplier (picture 12) actually inverts the incoming signal when the ‘modulator’ has a negative voltage.

The resulting sound is an interesting mixture of both sources and as the frequencies of the two VCOs get multiplied sidebands are created. The term sidebands refers to the emergent frequencies of the ring modulated sound. When using two clean sinewaves to ringmodulate each other (in RM there is no distinction between carrier and modulator) the frequency of the sidebands can be easily calculated*.

The SINE of VCO1 (normalized) is added to the ringmodulator by the RING MOD slider. At the bottom position there is no ringmodulation. You can instead use an external VCO (or LFO) by patching it into the MOD input, breaking the normalization. The slider controls the DEPTH of the ring modulation. With the slider in the most upper position full range ringmodulation (without amplitude loss or gain) is achieved with signals from -5V to 5V. You can however send -10V to 10V signals into the MOD input and this actually amplifies the wave, resulting in some saturation or rounding of the shape.

It’s possible to modulate the DEPTH, increasing the sonic options of VORTEX even more. The SINE of VCO1 is normalized to the DEPTH modulation and the knob is an attenuator for this modulation. You can break the normalization by patching a signal into the DEPTH input. This input accepts bipolar signals. The knob is an attenuator for this external modulation. The maximum range of the DEPTH modulation is achieved with signals from -5V to 5V.

X		CARRIER	
	volt	+	-
MODULATOR	+	+	-
	-	0	0

picture 11: two quadrant multiplier

X		OSCILLATOR	
	volt	+	-
OSCILLATOR	+	+	-
	-	-	+

picture 12: four quadrant multiplier

** The frequencies of the sidebands are calculated by adding and subtracting the frequencies of the oscillations that are being multiplied in the four quadrant multiplier.*

When combining a 100Hz and a 300Hz pure sinewave the resulting sidebands will have a frequency of 400Hz (300hz + 100Hz) and 200Hz (300Hz-100Hz). The base frequencies of the original oscillations are lost (unless you ringmodulate two frequencies that are exactly one octave apart from each other).

WAVEFOLDER

The WAVEFOLDER of VCO2 is a unique and completely original circuit. It folds and distorts the SINE, TRIANGLE, INVERSE SAW and everything in between creating subtle rounding of the waves at low settings and rich metallic overtones at more extreme settings (pictures 13, 14 and 15).

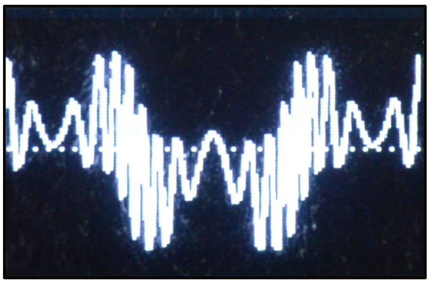
The WAVEFOLDER slider controls the amount of wavefolding. Even at the most downward position this circuit introduces some distortion to the waveshape.

It's possible to use the SINE from VCO1 (normalized) to modulate the amount of wavefolding. The knob is an attenuator for this modulation. The slider acts as an offset. You can override the internal normalization by patching a signal into the FOLD input. This input accepts biploar signals. The knob is an attenuator for this external modulation.

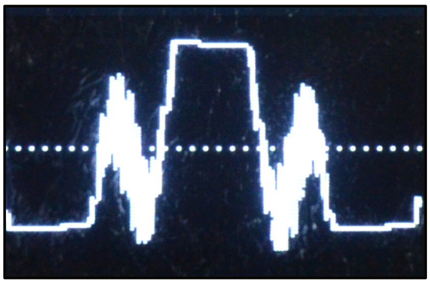
With the slider in the down position the maximum wavefolding is achieved with +5V. Sending in 10V (or maxing out the slider and sending in 5V) will mangle the wave even more (picture 16, 17 and 18). Negative offsets (= sum of the position of the slider and the modulation) completely attenuate the signal resulting in silence. This feature can be (mis)used as a makeshift VCA for VCO2.

LOW PASS FILTER

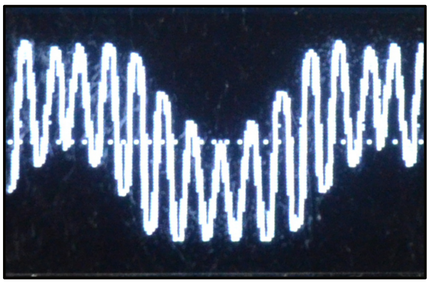
The LOW PASS FILTER in both VCO1 and VCO2 are identical. The SINE from VCO1 is used as a modulator. You can find more information in the section about the LOW PASS FILTER of VCO1.



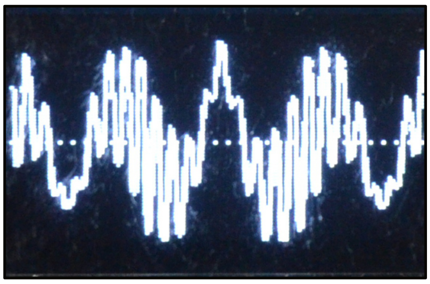
picture 13: folded sine



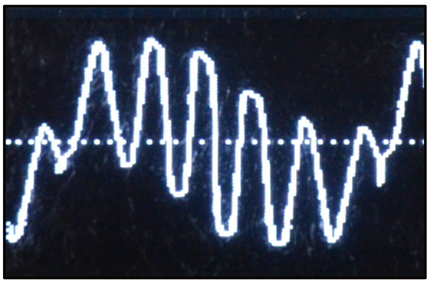
picture 16: mangled sine



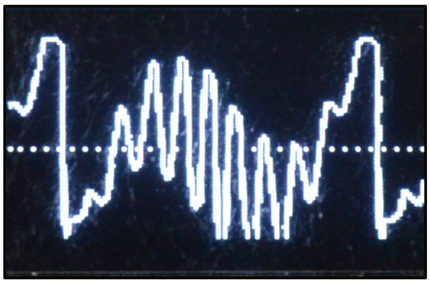
picture 14: folded triangle



picture 17: mangled triangle



picture 15: folded inverse saw

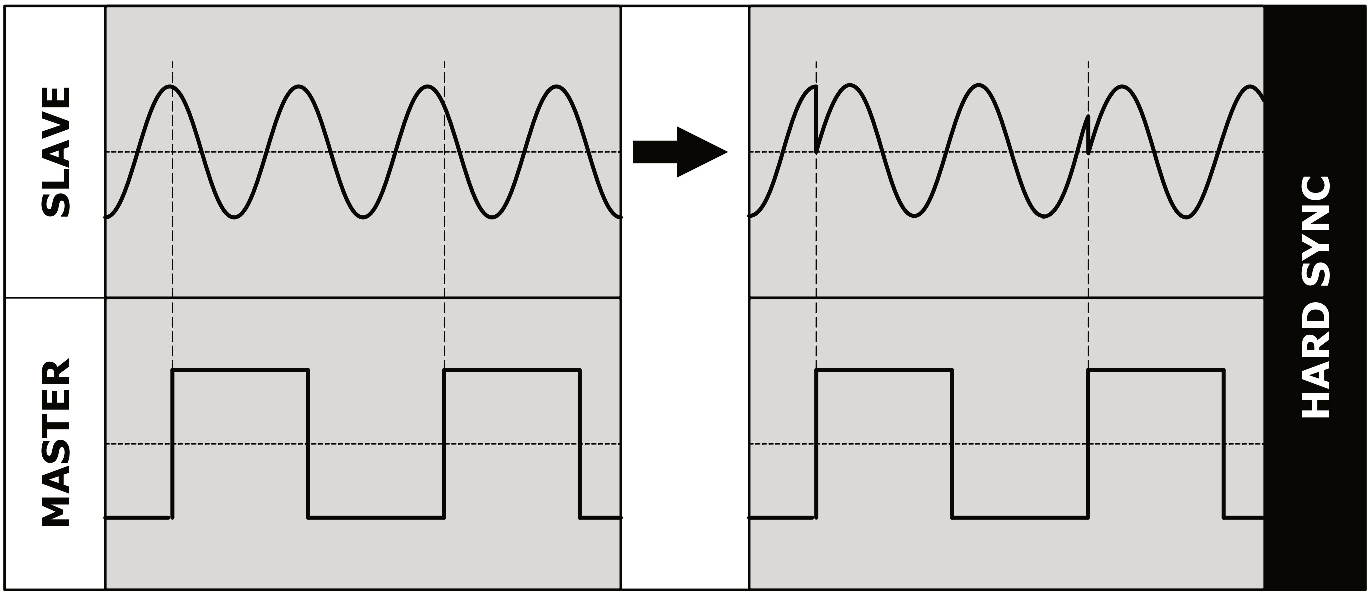


picture 18: mangled inv. saw

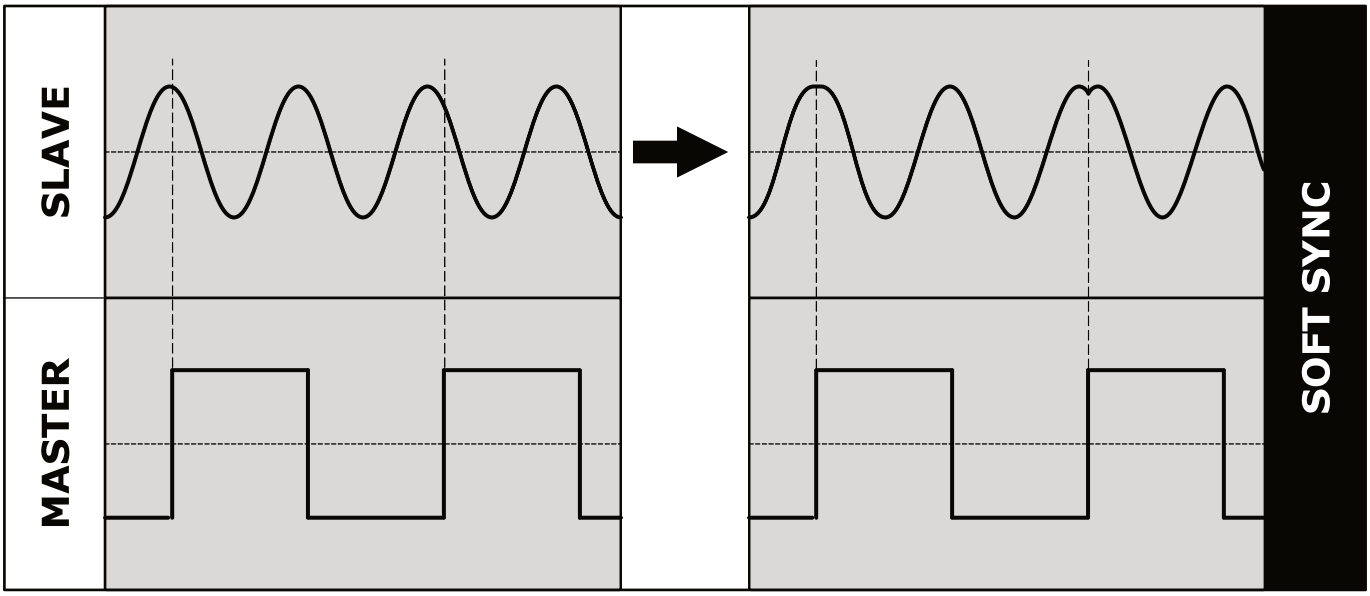
SYNC

SYNC refers to syncing the phases of two oscillators together. By syncing a VCO (slave) to another one (master) the slave oscillator is forced to restart its cycle every time the master oscillator does. The reset or hard sync happens when there's a clear rising edge on the master VCO (picture 19). There's another type of sync called soft sync or flip that doesn't reset the phase of the slave oscillator to the start, rather it causes the oscillator to switch from the falling edge to the rising edge (or vice versa) whenever there's a rising edge on the master VCO (picture 20). Soft sync has a different sonic quality and is able to produce some octave-switching effects when changing the relative pitch of the master and slave oscillators.

Using SYNC can be a method to make sure that two slightly detuned oscillators produce the exact same pitch without much timbral change to the slave oscillator. When detuning the slaved oscillator a considerable amount (in reference to the master oscillator) this will result in a very distinctive timbre. Most oscillators that have a SYNC input expect a SQUARE VCO to act as the master but VORTEX accepts most waveshapes as long as the amplitude of the signals is high enough.



picture 19: hard sync / reset



picture 20: soft sync / flip

SYNC TOGGLE SWITCH

VORTEX uses normalized connections to make setting up a SYNC sound really easy and quick without the need to patch any cables. For this it uses the SQUARE waves that are derived from the TRIANGLE core oscillators, this way the SQUARE outputs are not influenced by the wavefolders, phase modulation, ring modulation, shape modulation and filters. They are however influenced by the V/Oct inputs and the FM and SYNC settings. These SQUARE outputs that are derived from the cores of both VCO1 and VCO2 are available directly on the front panel from the SQUARE outputs.

The toggle switch at the center of VORTEX disables sync when it's in the middle position. When the toggle switch is in the right position VCO1 acts as a master for VCO2 (and defines the pitch of the output signal) and when the toggle is in the left position VCO2 is the master oscillator controlling the pitch. The white arrows next to the toggle switch indicate the slaved oscillator. It's as if you're patching in a cable from the master to the slave oscillator.

The pitch and timbre of the master oscillator are not influenced by the SYNC settings at all.

HARD SYNC / SOFT SYNC

The little switches on either side of the SYNC toggle switch set the type of oscillator SYNC. In the top position it produces HARD SYNC (indicated by hard synced triangle icon) and in the bottom position it switches to SOFT SYNC (indicated by the soft synced triangle icon). This switch also works when using external SYNC signals.

SYNC INPUTS

The SYNC inputs for VCO1 and VCO2 make it possible to SYNC either or both oscillators to an external VCO (or to the outputs of VORTEX itself). When nothing is patched into these inputs the SYNC input of VCO2 is normalized to the SQUARE wave from VCO1 (and normalized to the output of the TOGGLE SWITCH) and accordingly the SYNC input for VCO1 is normalized to the SQUARE wave of VCO2 (and normalized to the output of the TOGGLE SWITCH). Connecting a signal to the SYNC input on either side breaks the normalization for that side and by doing so the TOGGLE SWITCH is bypassed as well.

The signal you patch into these inputs is preferably a SQUARE oscillator, but it's possible to use different waveforms as well. As long as the amplitude of the signal you send in is high enough, it will produce SYNC tones for the slaved oscillator, although the behaviour might be somewhat unpredictable with certain VCOs when using non-SQUARE waveshapes.

USE MORE SYNC

SYNC is a really powerful tool expecially when used together with frequency modulation, phase modulation, ring modulation, shape modulation, filter modulation, ... It helps to force the modulated oscillator to have a more clear pitch or frequency while still retaining a rich modulated sound. It's even possible to create some kind of pulse width animation when modulating the frequency of the slave oscillator while it's being synced. There's more detailed information about this in the PATCH EXAMPLES.

FREQUENCY MODULATION

VORTEX offers several ways to modulate the frequency of both VCO1 and VCO2. Not only do the V/Oct inputs accept bipolar signals, there's a lot of additional sonic mayhem to be explored by using through zero linear FM and exponential FM, either with the internally normalized connections or with external modulation sources. The flow chart for the FM bus is in the ADDENDUM section.

THROUGH ZERO FREQUENCY MODULATION / TZFM

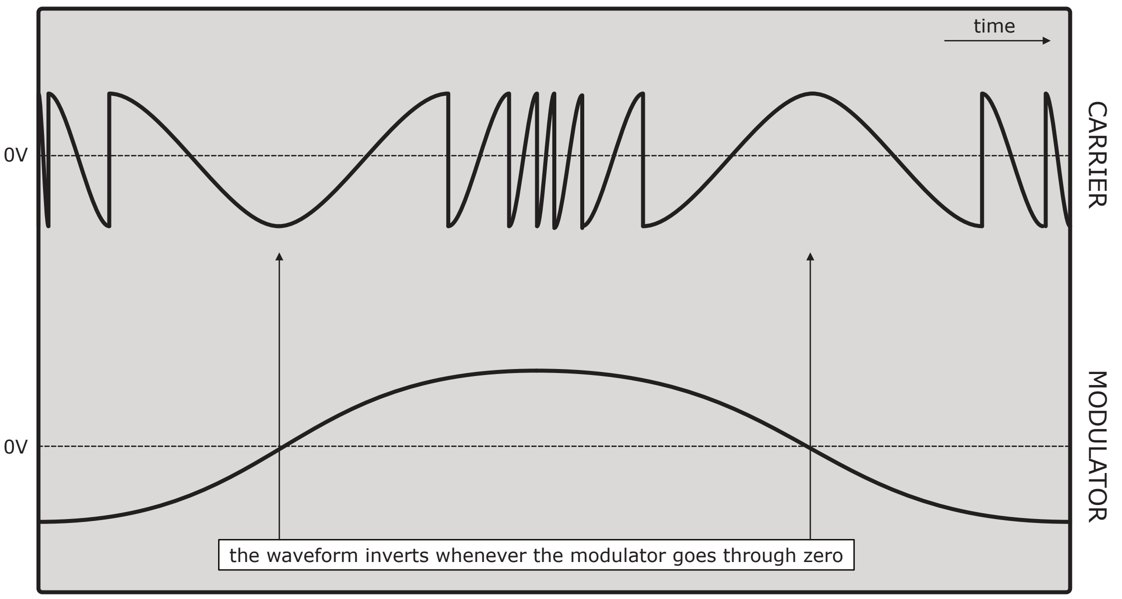
Unlike in regular linear FM where the oscillator that's being modulated (called the carrier) is never able to go below 0Hz (at which point the oscillator wouldn't oscillate at all), with TZFM it actually can go below zero.

Instead of running forwards it just starts running backwards and this results in the waveshape being inverted whenever the modulator pushes the absolute frequency of the carrier below zero (picture 21). Aside from a difference in timbre from regular FM it also has the advantage of being a symmetrical type of frequency modulation and this results in a more stable perceivable pitch as the sidebands are centered around the base frequency of the carrier. At high amounts of TZFM (controlled by the FM INDEX) the resulting sound will lose it's clear pitch though.

Both VCO1 and VCO2 have a knob for setting the maximum amount of TZFM labeled THRU ZERO. The big knob in the center labeled FM INDEX controls the global amount of frequency modulation (this also applies to the exponential FM of both VCO 1 and VCO 2). The modulator for VCO1 is normalized to the SINE from VCO2 and vice versa. It is however possible to use a different signal to modulate the frequency by patching any VCO into the LINEAR input jack. These inputs accept bipolar signals.

Keep in mind that the LINEAR inputs are AC coupled and only signals with a frequency of approximately 1.2 Hz and more result in TZFM (in other words: you can't use static voltages or slow LFOs for TZFM on VORTEX as these are filtered out by a hi-pass filter). The reason for this is to make sure any DC offset in the modulator doesn't destabilize the pitch of VORTEX.

In linear FM (through zero or regular) every volt you add to the input adds a certain amount of cycles to the frequency of the oscillator. How many depends on the callibration and the settings. On some systems linear FM is used for pitch tracking and this is referred to as Hz/V tracking.



picture 21: through zero frequency modulation

EXPONENTIAL FREQUENCY MODULATION

The main difference between linear frequency modulation and exponential frequency modulation is how it reacts to incoming voltages. In exponential FM every volt you add to the FM input causes the frequency of the oscillator to be multiplied by a certain integer. V/Oct tracking is exponential in nature and every volt added will result in a pitch one octave higher or twice the original frequency. Adding 2V will cause the pitch to go up 2 octaves (four times the original frequency).

Using exponential FM provides a wide range of timbres when using a VCO as a modulator. It's also ideal for patching in an LFO as a modulator to create a gentle (or extreme) vibrato.

Both VCO1 and VCO2 have a knob labeled EXPONENTIAL for setting the maximum amount of exponential FM. The knob labeled FM INDEX controls the global amount of frequency modulation (this setting also applies to the linear FM of both VCO 1 and VCO 2). The modulator for VCO1 is normalized to the SINE from VCO2 and vice versa. It is possible to use a different signal as a modulator by patching any VCO into the input jacks labeled EXPO. These inputs accept bipolar signals and accept both DC (static or slow moving CV) signals and AC (fast alternating CV) signals.

It's possible to get a decent (but not perfect) pitch tracking on the EXPO inputs by maxing out the FM INDEX knob and settings the EXPONENTIAL knob to approximately 3 o'clock. This can be used to act as a 'quick and dirty' way to transpose any pitch sequence patched into the regular V/Oct inputs.

FM INDEX

The big knob in the center of VORTEX controls the global amount of FM for VCO1 and VCO2 for both linear and exponential frequency modulation. Turning it to the right increases the amounts of FM and this is indicated by the LED light surrounding the knob shifting from blue to orange.

It's possible to modulate the global amount of FM by connecting a signal to the FM INDEX inputs. These inputs accept bipolar signals. The left FM INDEX input is normalized to the right one (indicated by the arrow) so when a modulator is connected to the FM INDEX input of VCO1 this will also modulate the FM INDEX of the right VCO. Of course it's also possible to connect different modulators to either input. The FM INDEX knob acts as an offset for both inputs (meaning that any signal you send into the inputs will be added or subtracted from the DC voltage generated by the position of the knob which opens the VCA for the FM bus).

TUNING TRIMPOT

If you remove VORTEX from your rack you'll notice two little trimmers. These are trimpots for changing the root frequency of VCO1 and VCO2 seperately.

You could for example tune VORTEX to C0 (with the COARSE knobs completely CCW) to be able to return to a stable pitch quickly whenever you knock either VCO out of tune by accident. This could be useful when performing for an audience or in any kind of live situation.

Take care when adjusting this trimpot. Stop turning it immediately when there's a 'clicking' sound.

PATCH EXAMPLES

WAVEFOLD MAKESHIFT VCA

Sending a negative voltage into the wavefolder on either VCO results in silence. This feature can be used as a VCA. Slightly offsetting any envelope with a negative voltage and using this envelope to modulate the wavefolder is all you need to do to achieve this. Using the same envelope to modulate the LOW PASS FILTER creates a classic subtractive synthesis voice or a low pass gate emulation.

Alternatively you can use the internally normalized modulation, an external LFO or a VCO to create AM sounds by using them to modulate the wavefolder. As the modulation goes into its negative range the wavefolder will temporarily create silence.

Amplitude modulation greatly resembles ring modulation but on top of the sidebands the pitch of the carrier is also present at the output. This is the main difference between AM and RM.

PULSE WIDTH ANIMATION

Syncing VCO1 to VCO2 (sync switch to the left) while modulating the frequency on VCO1 can result in some PWM-style sounds coming from the SQUARE output.

Keep in mind that the SQUARE and SINE output on VCO1 are not affected by the low pass filter, the wavefolder, the phase modulation nor the shape parameter.

This also works for VCO2.

FILTER FEEDBACK

Self-patching the MAIN OUT of VCO1 back into the LPF input (through a VCA) can produce some interesting octave switching effects when VCO1 is slaved to VCO2 (sync switch to the left).

Using different outputs from VCO1 to patch back into the LPF leads to interesting sounds as well.

This also works for VCO2.

EXOTIC SHAPES

Patching any of the outputs back into any of the inputs is always a useful experiment.

The first picture is an example where the SINE output of VCO1 is patched into the PHASE MOD input.

The second picture is an example of self-patching the SQUARE output into the FOLD input.

Try combining sync with self-patching or use different outputs from VCO2 to modulate the parameters on VCO1 (or vice versa).

Don't forget to audition all the outputs to hear what the effects are.

There's really no limit to this. Experimentation is the key to unlocking many exotic waveforms and interesting timbres.

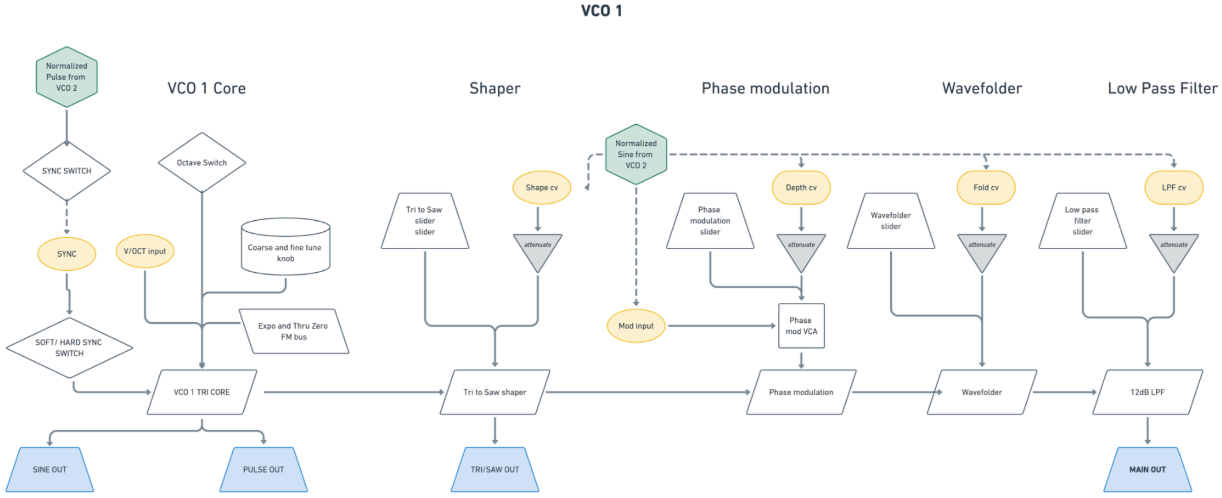
NOISE PATCH

When patching the SQUARE output into the LINEAR FM input it's possible to create colored noise coming from the MAIN output.

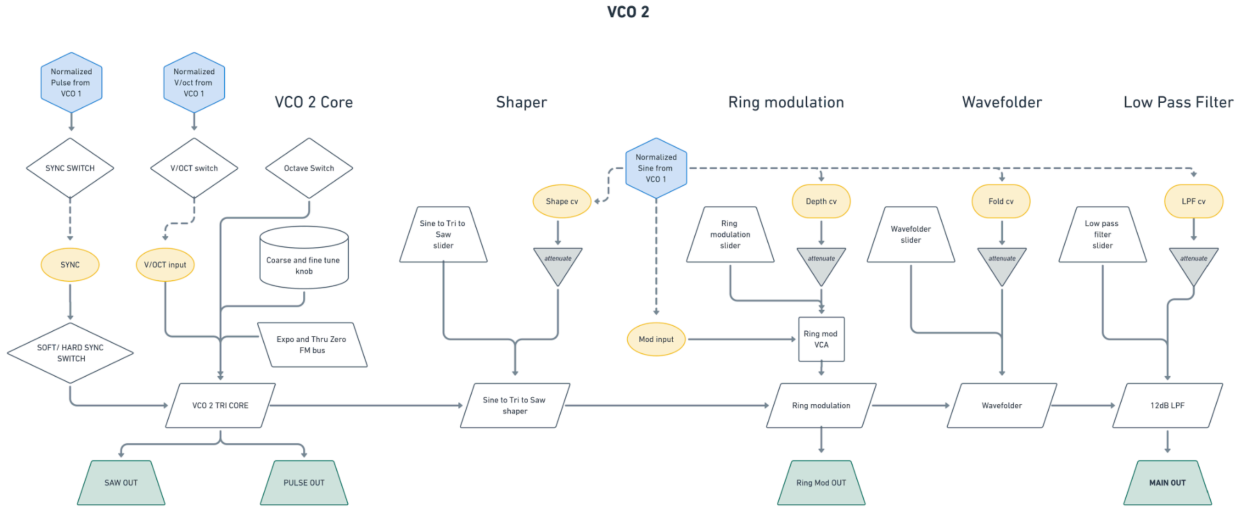
Experiment with the pitch and FM INDEX to get different variations of noise (red, pink, white, ...). Remember that the FM settings influence the TRIANGLE core so the SINE used to modulate either VCO will be shaped into noise as well.

ADDENDUM

VCO1 FLOWCHART



VCO2 FLOWCHART



FM BUS FLOWCHART