VORTICES

Overview

Vortices is an audio character mixer designed to emulate and accentuate the saturation-compression effects and frequency response of vintage analog consoles and tape machines. Featuring a total of 14 inputs and 7 outputs in a relatively compact 16hp form factor (18hp with VCA CV expander).

Vortices was designed to offer a compact mixing environment with the characteristic sound coloration of vintage analog gear. The frequency response of vintage mixing consoles tends to de-emphasize higher frequencies and produce a rounder tone. I find this to be really nice for reducing harshness from FM'd and digital source material - the response makes them sound smoother and less fatiguing on the ear and imposes an inherent glue and polished sound upon a mix. This type of response also lends itself to feedback patching where higher frequency roll off is desired.

The saturation/compression/limiting aspect is inspired in the vein of post processing a signal from a vintage console into an analog tape machine. Intending to add slight warmth to more extreme saturation-compression. This has a big effect on tonality and tends to push the low-mid range while a built in built in hard limiting function adds hi-mid crunch in the extremes.

Vortices accommodates mono and stereo sources, broken respectively into two mix bus sections, providing separate mix outputs as well as a Master Mix split stereo output and a Master stereo jack output on the back of the module.

The separated outputs and auxiliary inputs are provided to accommodate effect chains, feedback patching and end of chain mixing solutions as well as general sound processing, panning and cross fading applications.

The two mixer sections offer two types of coloration and frequency response. The main Mono Mix channels 1-4 provide a warmer over-driven sound with a more pronounced high frequency reduction and rounder tonality. Higher set gain and input levels pronounce the characteristic saturation-compression effect, thereby beefing up low to mid harmonic content. Inputs will eventually hit a hard peak limiter, providing additional distortion at 12Vpp.

Auxiliary Mono mix inputs bypass the saturation-compression in exchange for the hard peak limiter (12Vpp) with a reduction in high frequency response. They also apply a -3dB pad to help match nominal levels in a total mix.

The direct output for the X-FADE channel 's 2 & 3 at the top of Vortices offers the same saturation-compression without the reduced high frequency response of the MONO MIXER OUTPUTS. (More about the X-FADE breakout described in the Mono Mixer section.)

The main Stereo Mix channels provide a gentler saturation effect and a brighter overall frequency response (when the Stereo Mixer bus Output is utilized). These channels can also be driven harder into their respective peak limiters (12Vpp).

Auxiliary Stereo mix inputs bypass the saturation-compression in exchange for the hard peak limiter (12Vpp). They also apply a -3dB pad to help match nominal levels in a total mix.

The headroom of all final mix outputs is approximately 23Vpp before additional hard clipping of the summed mixes occur.

MONO MIXER DETAIL

AUDIO INPUTS

The Mono Mix bus features 4 main mono inputs, each with a level/saturation control via the mini-pots. Nominal volume level is set between 12-2 O'clock (assuming 10Vpp input) and saturation-compression level can be increased beyond this point.

Inputs 1 & 4 feature manual and voltage control over stereo panorama (PAN).

Inputs 2 & 3 feature manual and voltage controlled cross-fading (X-FADE).

The PAN and X-FADE functions feature unique linear pan/fade laws. Linear laws nominally produce a -6dB dip when the relative control is set to center position. If you are unfamiliar with the decibel scale, this is equal to a gain reduction of 0.5x.

Vortices offers a linear law with only a -1.3dB center dip, equal to a gain reduction of approximately 0.86x, an improvement over what even constant power laws can provide.

That being said, it is possible to achieve saturation/distortion effects based on pan/fade position, where hard panned or faded sources will have slightly higher drive than in center position, without compromising signal volume substantially. Use the mini pots to adjust desired max level of volume and saturation.

There are two additional auxiliary M-AUX 1 and M-AUX 2 mono inputs to the MONO MIXER near the top of Vortices on the left and right sides of the module. These are provided for external sources and sub-mixes as well as possible feedback patch points. These are monophonic; meaning the signal will sum equally onto both the Left and Right MONO MIXER OUTPUTs.

As mentioned previously, a -3dB pad is applied to assist in matching nominal levels of a mix - where it is not expected that every channel level would be set to maximum, and therefore will not dominate over the other inputs.

AUDIO OUTPUTS

There is a direct output for MONO channels 2 & 3 at the top middle of Vortices labeled X-FADE. Patching out here will break these channels out of all the associated MIX outputs (MONO MIX and MASTER MIX.) Therefore, you can either use the cross fading feature separately from the rest of the module or send these channels out for additional processing and back into a Vortices AUX or Stereo Input or into another available Mono input channel for panning, etc.

The MONO MIXER output is split stereo to accommodate channel panorama. The LEFT (**L**) and RIGHT (**R**) MONO MIXER OUTPUTs are located on either side of the X-FADE breakout jack.

PAN & X-FADE CV

CV inputs for PAN and X-FADE point to the associated manual controls for each function with golden arrows. The faded gold boxes visually connect each Mono Input to the respective CV input and manual control. CV inputs expect a symmetrical +/-5V control voltage as standard, however any signal is permitted without damaging these inputs.

QUICK-VIEW: Mono Mixer Bus

Mono Mixer: Audio IN/OUT

A — *Main Monophonic Inputs 1, 2 , 3, 4*

B — *Auxiliary Monophonic Inputs 1 & 2*

C — *Split Stereo (L/R) Direct Output of the MONO MIXER Bus*

D — *Direct X-FADE output for Channels 2 & 3 (Breaks normalization to all Mix Outputs)*

Mono Mixer: Controls

A — *Attenuation, Saturation and Gain*

B — *Channel 1 & 4 Pan Controls*
Golden Arrows pointing from Pan CV Inputs

C — *Channel 2 & 3 X-FADE Control*
Golden Arrows pointing from Fade CV Input

STEREO MIXER DETAIL

AUDIO INPUTS

The Stereo Mix bus features 3 main (L>R normalized) stereo input channels with attenuation and gain. The coloration offers a less pronounced saturation-compression effect compared to the mono mixer. Nominal level control is set around 3 O'clock with additional gain available beyond this point.

A single split stereo (L>R normalized) auxiliary input, located on each respective side of the STEREO MIXER OUTPUT jacks with a -3dB pad is also provided on the Stereo bus to accommodate direct stereo or monophonic sources. Separate mono sources may be used if you would like them to sit directly on the left or right side of the mix. Patching a single mono source into the Left (L) ST-AUX, while the Right (R) ST-AUX is unoccupied will normal the signal to both sides of the stereo mix.

AUDIO OUTPUTS

The STEREO MIXER OUTPUT is located above STEREO channel 2's inputs. As mentioned previously, this output offers a brighter frequency response compared to the MONO and MASTER MIX outputs.

MASTER MIX

The MASTER MIX OUT offers the sum of every audio input on Vortices. Split stereo output are located at the far left and right on the top row. A copy of this signal is also available via a stereo jack on the back of the module. This can be routed to modules that also utilize a similar rear-facing stereo input.

QUICK-VIEW: Stereo Mix Bus

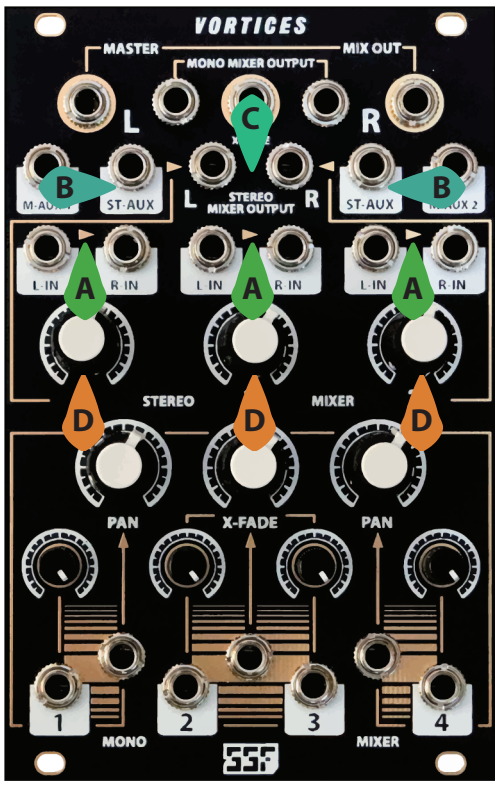
Stereo Mixer: Audio IN/OUT and Controls

A — *Main Stereophonic Inputs 1, 2 , 3 (Left to Right Input Normalization)*

B — *Auxiliary Split Stereo Inputs L & R*

C — *Split Stereo (L/R) Direct Output of the STEREO MIXER Bus*

D — *Attenuation, Saturation and Gain*



AMP BIASING FEATURE

The biasing feature emulates Class-A tube and transistor amplifier tuning. Biasing is a symmetry adjustment that sets the quiescent operating point of a tube or transistor in order to achieve a linear response with least distortion. By increasing the bias (DC offset) a tube/transistor can be pushed into asymmetrical saturation.

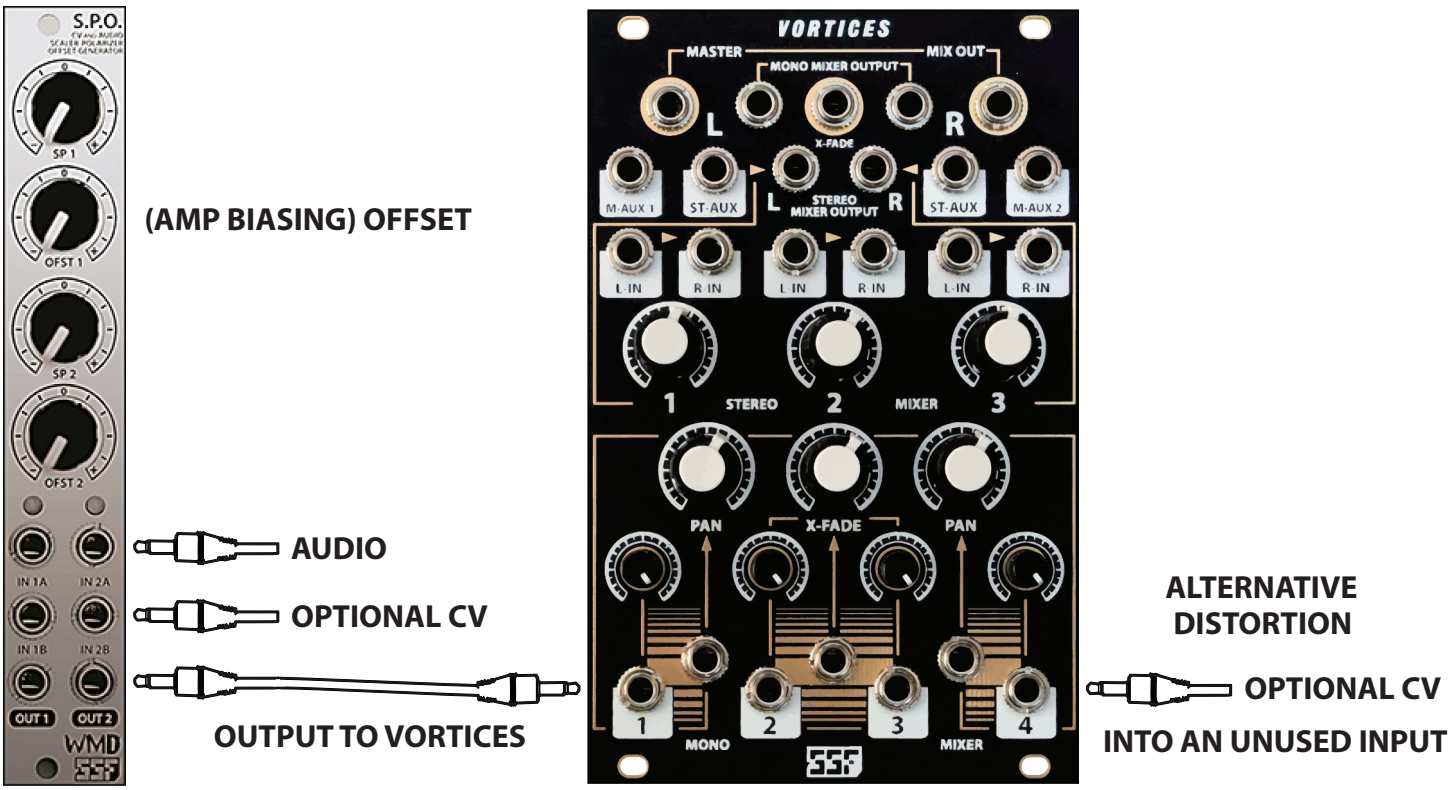
While Vortices already provides enough gain to produce saturation/compression on its own, the output is symmetrical as long as the input signal is also completely symmetrical about 0V. For instance, +/-5V is symmetrical while +6V/-4V is asymmetrical.

The tonality of symmetrical saturation/compression exhibits a dominance of 3rd order (ODD) harmonics. However, if one half of a waveform saturates more than the opposite half, in an asymmetrical manner, this produces an increased level of 2nd order (EVEN) harmonics.

Vortices can produce asymmetrical saturation/compression when the input source is biased (offset) with a positive or negative DC voltage. This is accomplished by using an external CV processor or mixer with a voltage offset adjustment or externally summing an audio source with an envelope or LFO (for a time varying effect), before patching into one of Vortices' inputs.

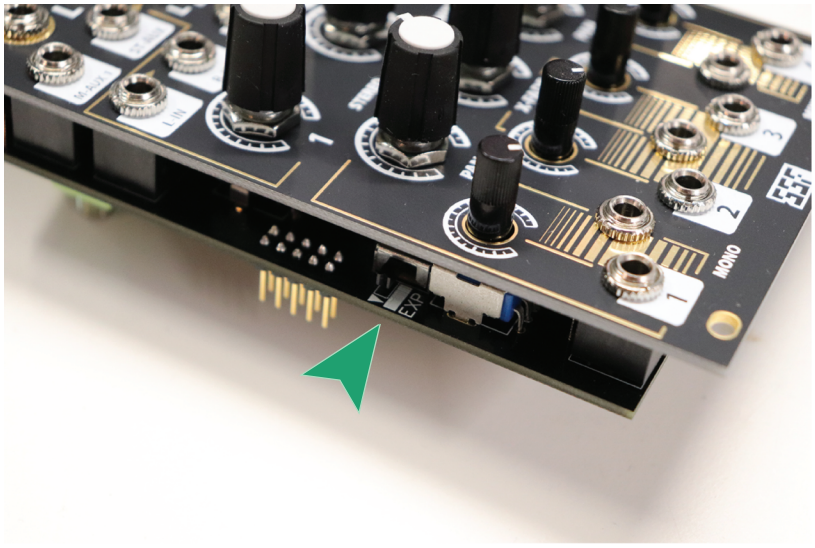
If you do not have a free external mixer with or without an offset adjustment, an alternative tonal structure can be achieved by patching an envelope or LFO into an unused channel of the same mix bus on Vortices. In this case, the signal is clipped by the internal hard limiter and produces crunchier asymmetrical distortion effects.

In all amp biasing cases, the total output symmetry remains unaffected and therefore every channel can be biased without pushing the summed mixer outputs beyond the maximum headroom of ~23Vpp.



V-CV EXPANDER

Vortices CV expander adds voltage control of the signal levels for the 3 stereo and 4 mono main inputs.



★ The switch located near the expansion header, between the panel and PCB must be set in the EXP position when the expander is connected.

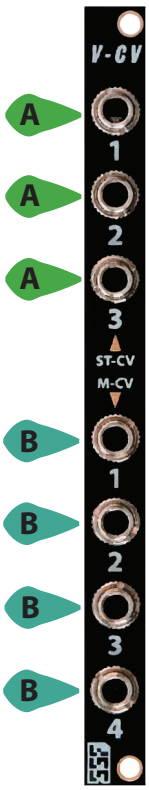
The supplied 10pin cable must be connected in the same orientation on Vortices and V-CV. Red stripe down.

With V-CV connected the functioning of Vortices remains the same. Once a Control signal is patched, the respective channel attenuator adjusts the level of the incoming CV, allowing level and saturation to be automated. The CV source should be near 10V for full scale behavior.

QUICK-VIEW: V-CV Expander

A *Stereo Mixer CV Inputs*

B *Mono Mixer CV Inputs*



DESIGN PHILOSPHY

In this section I will describe my intentions and inspiration for creating Vortices. Particularly in respect to my choice of layout and features and influences from artists and my own experience in using modular synthesizers.

Users often question why module manufactures choose to make certain design choices. I personally have struggled with striking a balance between choosing the size and feature set when I design Eurorack modules. When it comes to mixers I have always found it challenging to make choices based on the somewhat standard requirements and the rack space they ultimately take up for a relatively basic function. Vortices was designed to capture a list of the most basic needs of a mixer as well as offer extra use features while taking up a small amount of rack space. These requirements included the ability to pan both manually and via voltage control, the ability to cross-fade two sources and to accommodate both stereo and mono sources including extra inputs. Additionally, I found that I always wanted a way to use a mixer in more of a modular fashion through the ability to separate the mono and stereo sections to use them as sends while having the option to use either as the main mix output.

The second half of the design equation stems from the fact that while extremely useful, mixers are also a somewhat boring necessity. This is where the character aspect comes into play. Some are familiar with my love of the analog philosophy and inspiration from the pro audio world. The use of vintage audio consoles and analog tape for the "magic" they can impose on a mix or instrument is now a widely known phenomenon. Although some have gone to great lengths to attain these machines for exorbitant prices, the effect is far from snake oil. Here is a great article from Sound on Sound for further reading about how and why vintage analog equipment exhibits this effect in music production.

Vortices was designed with intentional gain staging and high frequency tone shaping to both mimic and accentuate the effects of over-driving and biasing vintage audio equipment involving tube and transistor circuitry as well as the saturation-compression effects of magnetic tape in order to highlight the benefits that these devices are so well sought after for. The ability of vintage analog equipment to glue a mix without the need for compression while adding subtle to more apparent harmonic content is not restricted to pro audio and fits in quite well in the modular synthesis environment. Furthermore, the response of these devices lend heavily on the more modern techniques of feedback that have been popularized by artists such as Empyset and are gaining ground in the experimental modular synthesis microcosm. You can find a discussion of Emptyset's feedback techniques from the Eurorack community here.

Inspired by the characteristics of both vintage analog mixing consoles and magnetic tape machines, the concept is realized in a simulated signal chain where we have a virtual console as our input section, which is then fed into a tape machine for final mixdown. Every channel exhibits a simulated headroom. You can think of them as console/tape inputs that are nearing the headroom limits of those devices and therefore ready to be pushed into saturation and clipping. This effect mimics the physical limits of these vintage devices. Both the Mono and Stereo channels max headroom is approximately 12Vpp. This limit is post input level control and can be tailored to almost any input level to remain clean if desired. However, we intend that you do push these limits when desired.

The headroom limits are met with a hard-peak limiter, not unlike the simple safety limiting devices employed in vintage gear. Here you will find another level of distortion with a crunchier hard clipping effect in contrast to the more general, softer saturation compression akin to over-driven analog tape. You will find it much rarer to hit the headroom limit in typical use unless intentionally overloading the input or applying one of the CV offset techniques described in the Amp Biasing section. So, you can think of Vortices as a mini vintage studio, a feedback hub or simply as an effect or tone shaping device.
Although we have focused on the above vintage characteristics, we have opted to skip any emulation of low fidelity effects from these devices and continue to employ the use of pro audio grade components throughout.

If you have read some of the above references or are already familiar with the specifics of these saturation and frequency response characteristics in use, we now point out that the mono and stereo sections of Vortices exhibit alternative severity of these effects. The intention behind this choice is inherent in modules that one may be using with Vortices. For instance, it has been described earlier in the manual that the mono and master output sections offer a more intense effect on frequency response, while the stereo output offers a brighter response in this regard. It has also been noted that the stereo section's saturation effect is more subtle.

The intention here is that you would use the mono section to add varying levels of saturation, add panning and cross-fading – then patch from the Mono Mix Output to stereo effects such as delays, reverb or resonators. Since these effects do tend to be stereo and can also tend to be darker in tone, the stereo section is meant to accommodate these aspects while still adding a bit or warmth and roundness to the overall response. This is a case where you would choose to use the Stereo Mix Output as your main mix out. In general, the stereo section and output may be used for sources in which you do not need to add as much saturation or distortion or would like that particular input to have a stronger high frequency presence.

The high frequency response and intensity of saturation achievable from the mono section offers additional uses specific to modular synthesis. For instance, we are all familiar with frequency and amplitude modulation for producing more complex sounds. These basic techniques are widely utilized for creating sideband frequencies beyond the fundamental that standard VCO waveforms can produce. Unfortunately, they can also create grittier overtones in the higher harmonic region and can sound harsh and piercing.

The Mono Mixer channels can smooth FM'd material and round out the edginess of sharp transients. Because our ears will perceive higher frequencies in this manner, and signal sources do not generally have built in frequency compensation in this part of the audio band, the only way to tame the imbalance would traditionally be to use a filter. While a simple solution, it may not be practical to use up a VCF for such a simple function. Vortices offers a way to accomplish this automatically in a mix. Another similar and common situation occurs when using digital sources. There are many very good sounding digital modules but even the great ones can sound sterile or exhibit some aliasing. Both the frequency response and saturation can be used to smooth and add analog warmth to these sources.

While on the subject of high frequencies, it is also important to have a handle on this part of the audio spectrum in a feedback application. Vortices lends itself to even simple self-feedback patching without the need for additional modules to tame the high end. High end frequencies will start to feedback much more easily than lower ones. It becomes more difficult to manage a feedback patch when the high end is constantly on the brink of oscillation. You can choose a number of feedback topologies that focus on either the mono or stereo mixers with mindfulness of your chosen source material and how frequencies and external modules may affect your patch.

The Amp Biasing Feature mentioned earlier in the manual may be familiar to an engineer or tech in the audio world, but unknown to many synth users. This is an essential aspect of any discrete amplifier and a feature exploited by the technical counterparts of many famous artists as well as savvy audio engineers who desired to perfect or modify a device to attain 'that sound'.

We have touched on this feature in the Amp Biasing section where we described biasing as a necessary feature of calibrating a tube or transistor amplifier to work correctly, in order to produce a clean and linear response. Vortices' implementation of this feature is 100% on the level of exploitation of the harmonic effects it can produce. If you do not chose to offset the input signal before patching into Vortices, and your signal is symmetrical about ground (Zero Volts), then the effect is simply the same as a properly biased amplifier, with the exception that you can increase the drive to overdrive the input into heavier saturation and clipping. When pushed into this region, the top and bottom halves of the input signal both have to potential to exhibit the same effect on the input waveform (symmetrical distortion.)

When a signal distorts symmetrically, additional Odd Order harmonics are produced, specifically third order up from the fundamental frequency dominates, with the successive 5th, 7th harmonics appearing in reduced amplitude. Odd Harmonics are known to have enharmonic qualities. One example of this would be a square wave, which consists of a summation of only odd-order frequencies. See the Fourier Analysis section of this wiki article if you are unfamiliar with this concept. We also see this happening on an oscilloscope when we add a lot of gain to a sine or triangle waveform – as we add gain the signal begins to clip and look more and more like a square wave. We also hear the additional odd harmonics produced as the signal becomes increasingly square shaped.

But we digress, the alternative to this symmetrical distortion and production of enharmonic overtones is to have the ability to asymmetrically distort a signal in order to enlist a dominance of Even Order, more musical sounding 2nd, 4th and 6th harmonic overtones. This is where some of the intentional or rather sometimes unintentional parameters of vintage audio imparts the magical effects we have exploited. So, by adding a DC offset to an input signal, we can emulate the ability to produce sweeter and more musical sounding harmonics when distortion is applied. This effect comes without the disadvantage of allowing this offset to either physically offset the input signal within the mix, or sum into the final output of the mix itself. This means that any signal that has a bias offset applied will always physically remain symmetrical about ground, while the asymmetrical clipping effects remain intact.

Thank you for choosing to include Vortices in your modular system. It is my hope that this section offered you some insight into the design intention and has inspired you to use Vortices creatively and sparked some ideas for you to experiment with. Thank you for your support.

Technical

Vortices:

Power Consumption: +110mA, -105mA

Width: 16hp

Depth: 26mm

V-CV:

Power Consumption: +0mA, -0mA

Width: 2hp

Depth: 23mm