SONIC XV

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Diode Ladder Wave Filter

Thank you for purchasing the AJH Synth Sonic XV Eurorack synthesiser module, which like all AJH Synth products, has been designed and handbuilt in the UK from the very highest quality components. We hope that it will help and inspire you towards creating some great music and sound-scapes!

The Sonic XV Eurorack module is a four pole Diode ladder filter, featuring the circuitry and sound of the Musonics Sonic V synthesiser from the early 1970's. In addition to the regular 24dB Low Pass output we have added a 6dB Low Pass output and a Bandpass output, along with full voltage control and level correction of the resonance on the 24dB output.

Two waveshapers/wavefolders have been added to hugely increase the sonic versatility of this module, firstly there is a six stage diode breakpoint based wavefolder, the output of which can be added to the input signal in any amount from 0 to 100% using a wet/dry mixer control. The drive level of the wavefolder can be manually adjusted with the IN Wave control, or by patching a control or modulation voltage into the IW-CV jack, it can be voltage controlled. There is also a three position bias control switch that allows additional variation to the input waveshaping.

The second waveshaper is connected to the resonance loop of the filter and it adds distortion and waveshaping to the resonance loop signal, again the drive can be adjusted manually or under full voltage control from the RW-CV input. There is a wet/dry mix control so that resonance wave-shaping can be added at any rate between 0 to 100%.

These additions take the diode ladder filter core way beyond it's original function, by using the waveshaping options it becomes a "filter" module that can actually add harmonics to waveforms rather than simply filtering them. With four independant CV inputs very complex filtering and waveshaping sounds are possible that take it far beyond regular diode or transistor ladder filters.

Module width is 14 HP of EuroRack space and it is compatible with standard Euro Rack cases. The height of the panel is 128.5mm, and depth is 24mm, or 34mm with the power cable attached. There are four mounting holes at the corners of the module and we provide 4 of M3 rack fixing screws, along with a Eurorack compatible power cable. Current consumption is 70mA from the +12V supply rail and 55mA from the -12V supply rail.
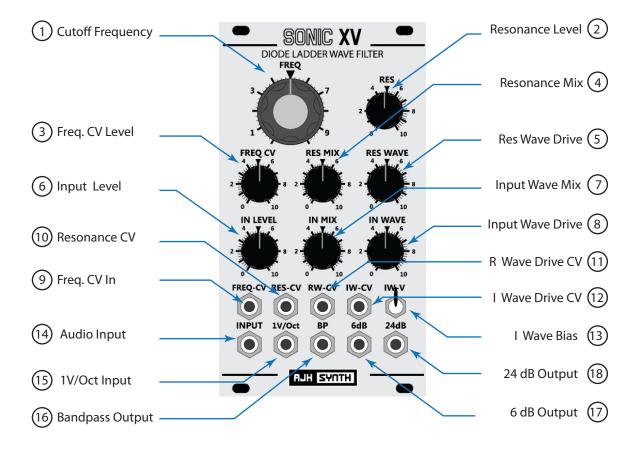
All AJHSynth modules are covered by a one year guarantee against manufacturing defects.

Notes:

It is important that the power supply ribbon cable is connected correctly, see the "Power Cable Orientation" section for more details. Also, we recommend that a high quality, low noise Eurorack power supply is used with this modules, some switched mode PSU's generate high levels of line ripple which may cause undesirable audio noise on the output.

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Controls, Inputs and Outputs

SONIC XV
DIODE LADDER WAVE FILTER

① Cutoff Frequency
② Resonance Level
③ Freq. CV Level
④ Resonance Mix
⑤ Res Wave Drive
⑥ Input Level
⑦ Input Wave Mix
⑧ Input Wave Drive
⑩ Resonance CV
⑪ R Wave Drive CV
⑨ Freq. CV In
⑫ I Wave Drive CV
⑬ I Wave Bias
⑭ Audio Input
⑱ 24 dB Output
⑮ 1V/Oct Input
⑯ Bandpass Output
⑰ 6 dB Output

FREQ • RES • FREQ CV • RES MIX • RES WAVE • IN LEVEL • IN MIX • IN WAVE
FREQ-CV • RES-CV • RW-CV • IW-CV • IW-V
INPUT • 1V/Oct • BP • 6dB • 24dB

AJH SYNTH

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① **Cutoff Frequency:** The Cutoff Frequency control manually varies the cut off frequency of the filter. It is still active when using CV control of frequency, in this case it acts as an offset control.

Please note: At lower frequencies, this control goes "over centre", with "fully open" at around position 9, it then starts to cut off again as it is further rotated towards 10. With added Freq CV voltage it will go even further "over centre" and cut off more. At higher fundamental frequencies maximum cutoff is at position 10. This behaviour is a quirk of the original Sonic V diode filter core topology and adds character!

② **Resonance Level :** This control manually regulates the amount of internal feedback applied to the filter core. At high levels of feedback (between positions 8 and 10) the filter will self-oscillate and produce a sinewave output without any audio input, however the filter core will only self resonate at higher frequencies (2KHz and above) unless the Resonance Waveshaper is used. When the resonance waveshaping is used the resonance waveform is no longer a sine wave, the exact waveform depends upon the various Resonance control settings.

When self resonating, by applying a control voltage to the 1 V/Oct input, the resonance wave can be played in the same manner as a VCO with a tracking range of 3 - 4 octaves. The CV scaling is not temperature corrected so it may drift with changes in ambient temperature. Please also note that the tracking scale changes if the Resonance Waveshaper is used, by default the scaling is calibrated for waveshaped Resonance.

③ **Freq. CV Level :** Sets the amount of control voltage (between 0% and 100%) which is sent from the cutoff frequency CV Input (9) to the filter cutoff circuitry. It has a greater range than the 1 V/Oct Input so that overmodulation effects are possible.
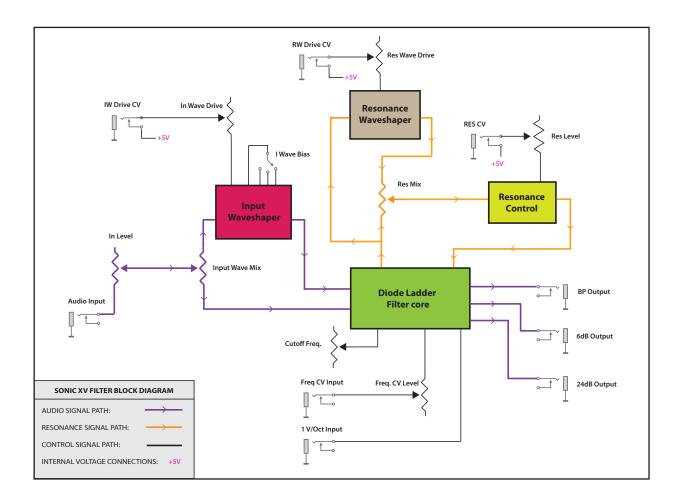
④ **Resonance Mix :** This control is a wet/dry fader that controls the mix of waveshaped resonance signal (from the output of the Resonance Waveshaper) to untreated resonance, and can be varied between 0% to 100%.
With the control set to zero (fully counter clockwise) the Resonance waveshaper is out of circuit and the filter is a regular resonant diode ladder filter. With the control at 10 (100% wet) all of the resonance signal is routed through the Resonance Waveshaper.

Please note: With the RES LEVEL and RES DRIVE controls on 10 (fully clockwise), then modulation of the Resonance waveform will be present with this control between positions 8 to 10. This is intended and can be used to create a theremin type sound - if this is unwanted then the RES MIX control should be slowly rotated counter clockwise until the modulation stops.

(5) Res Wave Drive:

This control sets the drive amount to the Resonance wavefolder, turning the control clockwise increases the drive level. If a control voltage is applied to the R Wave Drive CV Input (11) by plugging in a patch cable, then this control changes function and attenuates the signal passed from the R Wave Drive CV Input to the Resonance waveshaper. It is only effective when the Resonance Waveshaper is in the circuit via the Resonance mix control (4)

(6) Input Level:

This control is an attenuator which sets the signal level from the Audio Input jack (14) to the filter core. It is designed to work with signals at Eurorack modular levels of +/-5V (10v p-p)

(7) Input Wave Mix :

This control is a wet/dry fader that controls the mix of signal from the Input Waveshaper to untreated Input signal. It can be varied between 0% to 100%.
With the control set to zero (fully counter clockwise) the Input waveshaper is out of circuit and the filter is a regular diode ladder filter without any waveshaping of the audio signal. With the control at 10 (100% wet) all of the Input signal is routed through the Input Waveshaper.

(8) Input Wave Drive:

This control sets the drive amount to the Input wavefolder, turning the control clockwise increases the drive level. If a control voltage is applied to the I Wave Drive CV (12) by plugging in a patch cable, then this control changes function and attenuates the signal passed from the I Wave Drive CV Input to the Input waveshaper. It is only effective when the Input Waveshaper is in the circuit via the Input Wave Mix control (7)

(9) Freq CV In:

Connect an external control voltage to this Input for voltage control of the filter cutoff frequency. The amount of signal passed to the filter core control circuitry can be adjusted with the Freq. CV Level control (3). Acceptable input voltage range is +/- 10V, but the effective input range is +/-5V.

Important Note: Adding Freq. CV when the manual Freq. control is fully open or towards fully open will cause the filter to go "over centre" and start to close down again, and at extreme Freq CV levels the filter may close completely to the point that no output is heard. To correct simply turn the Freq CV control anti-clockwise until this effect is no longer present.

(10) Res. CV In :

Applying a control voltage to this Input will vary the overall Resonance amount applied to the filter core from the output of the Resonance Mix control (4). Acceptable input voltage range is +/- 10V, but only positive voltages between 0 to 5V are effective.

Note: When a patch cable is plugged into this jack socket the function of the Resonance level control (2) changes and it becomes an attenuator for the Resonance CV Input (10)

(11) R Wave Drive In:

This input allows an external control voltage to be used to control the drive of the Resonance waveshaper. Acceptable input voltage range is +/- 10V, but only positive voltages between 0 to 5V are effective.

Notes:
When a patch cable is plugged into this jack socket the function of the Resonance Wave Drive control (5) changes and it becomes an attenuator for level of Resonance Drive CV fed to the Resonance Waveshaper .

Connecting an LFO or Envelope generator to this input allows modulation of the Resonance Wave Drive, and the modulation amount can be controlled with the Res Wave Drive Control (5)

(12) I Wave Drive In :

This input allows an external control voltage to be used to control the drive of the Input waveshaper. Acceptable input voltage range is +/- 10V, but only positive voltages between 0 to 5V are effective.

Notes:
When a patch cable is plugged into this jack socket the function of the Input Wave Drive control (8) changes and it becomes an attenuator for the level of Input Drive CV fed to the Input Waveshaper.

Connecting an LFO or Envelope generator to this input allows modulation of the Input Wave Drive, and the modulation amount can be controlled with the Input Wave Drive Control (8)

(13) I Wave Bias: This switch has three settings, and it adjusts the bias voltage applied internally to the Input Waveshaper, this allows one of three different variations to the waveshaping to be selected. The resultant output waveform from the Input waveshaper is dependant upon the waveform connected to the Audio Input (14)

The Input waveshaper is more effective with waveforms with slow rise or fall times such as sine, triangle and saw waveforms. Complex waveforms can also be used, along with square and pulse waves too, but the effect may be more subtle and / or unpredictable.

(14) Audio Input : The Audio input. The level of signal sent to the filter core and the Input waveshaper from this input is controlled / attenuated by the Input Level control (6). The expected signal level meets the Eurorack standard of +/- 5V (10v p-p)

(15) 1V/Oct Input : A voltage applied to this Input changes the filter cutoff at the rate of 1 volt per octave, or if the filter is in full self oscillation mode (Resonance Level control fully clockwise) it will control the pitch of the self oscillation at this rate.

The CV scaling is not temperature corrected so it may drift with changes in ambient temperature. Please also note that the tracking scale changes if the Resonance waveshaper is used. Fine adjustments of tracking scale can be made with the Scale trimmer, however this should be done by a service technician with the necessary knowledge and equipment.

(16) Bandpass Output: The band pass output from the filter. The output signal level meets the Eurorack standard of +/- 5V (10v p-p), however this is obviously dependant upon the signal input level and setting of the various filter and waveshaper controls.

(17) 6dB Output: The 6dB (one pole) Low Pass output from the filter. The output signal level meets the Eurorack standard of +/- 5V (10v p-p), however this is obviously dependant upon the signal input level and setting of the various filter and waveshaper controls.

(18) 24dB Output: The 24dB (four pole) Low Pass output from the filter. The output signal level meets the Eurorack standard of +/- 5V (10v p-p), however this is obviously dependant upon the signal input level and setting of the various filter and waveshaper controls.

RW Drive CV
+5V
Res Wave Drive

IW Drive CV
In Wave Drive
+5V

RES CV
+5V
Res Level

Resonance Waveshaper

I Wave Bias

Res Mix

Resonance Control

Input Waveshaper

In Level

Input Wave Mix

Audio Input

Diode Ladder Filter core

BP Output

6dB Output

24dB Output

Cutoff Freq.

Freq CV Input
Freq. CV Level

1 V/Oct Input

SONIC XV FILTER BLOCK DIAGRAM

AUDIO SIGNAL PATH:

RESONANCE SIGNAL PATH:

CONTROL SIGNAL PATH:

INTERNAL VOLTAGE CONNECTIONS: +5V

Getting Started:

The Sonic XV filter can be easily used without any waveshaping by simply rotating the IN MIX and RES MIX controls to zero (fully anticlockwise) In this configuration the Sonic XV filter performs as a regular resonant VCF, with 24dB Low pass, 6dB Low pass and Band Pass outputs.

Important note: The Resonace waveshaper is only effective if resonance is added to the sound with the RES control (2) If this control is off or at a low position then no resonance waveshaping will be heard as it is only effective on the resonance loop, it does not effect the main signal path through the filter.

In use:

Example 1 - Using the Sonic XV as a regular VCF:

Firstly, set the following controls to zero (fully anticlockwise): RES LEVEL, RES MIX, RES WAVE, IN MIX, IN WAVE, FREQ CV, IN LEVEL.

Set the FREQ CV control (1) fully clockwise (10)

1) Connect the module to a Eurorack compatible power supply, taking care to orient the power header the correct way around. Now connect a waveform with some harmonic content (for example a sawtooth wave of a frequency between 100Hz to 500Hz) to the INPUT (14), the signal level should be around +/-5V (10V p-p). Connect the 24dB output (18) to an amplifier suitable for modular synthesiser output levels.

2) Now, gradually rotate the IN LEVEL clockwise to position 10 - you should now hear the sawtooth waveform from the amplifier. Next, gradually rotate the FREQ CV control (3) anti clockwise, you should hear the classic sound of a low pass filter sweep. Now try rotating the RES control (2) clockwise. In combination with the FREQ CV control a range of filtered and resonant sounds can be obtained. Now try connecting the amplifier to the 6bB and then the BP Outputs to see how these different filter slopes shape the sound.

3) So, we have explored static filtering, next we will try adding voltage control. Connect a CV signal (+/-5V signal level or 0 to+5V level) from an LFO or envelope generator to the FREQ-CV Jack (9) - now gradually turn the FREQ CV Level control (3) clockwise - the filter frequency will be modulated by this control voltage and the FREQ CV Level control determmines the amount of modulation sent to the filter core. Try also adding a control voltage to the Res CV Input (10); in this case a control voltage of 0 to +5 volts is effective, +/- 5V modulation can be used but all below zero voltages will be ignored.

Example 2 - Exploring waveshaping:

The input waveshaper is most effective on waveforms with slower rise and fall times times, such as triangle waves and sine waves (yes - it is possible to add harmonics to sine waves that can be later filtered! This is certainly not possible with a regular low pass filter) It does also work with more complex waveforms and waveforms with fast rise and fall times, however the results may vary from subtle to interesting or even extreme depending upon the source waveform.

1) So , first set up the patch detailed in Example 1, section 1 above, but replace the source waveform with a triangle wave instead of the previous sawtooth wave. Try different settings for the the FREQ and RES controls, you will notice that the sound is much duller with the triangle wave, this is because it has much lower levels of harmonics.

2) Now, rotate the IN MIX control to position 5 (12 o'clock position), then try rotating the IN WAVE Drive control (8) - you will now hear extra harmonics added to the output sound as the waveshaper processes the original Triangle wave. At this position we have approximately 50/50 wet to dry mix of the original triangle wave and the output of the wave-shaper.

3) Try different positions of the Input Wave Bias switch (12), it creates three variations of waveshaping.

So, we have explored static input wave shaping, lets now try voltage control of waveshape drive:

4) Connect the output of an LFO or a gated envelope generator to the IW-CV input jack (12) The function of the IN WAVE drive control changes when a patch cable is inserted into the IW-CV socket, instead of having a sweep function it now attenuates the level of the control voltage applied to the IW-CV input.

This gives a quick overview of the Input Waveshaper - For the Resonance waveshaping try the same example above but this time leave the IN MIX control in the Dry (0) position and try the effect on the sound of the RES MIX and RES WAVE controls.

For Voltage Controlled Resonance Waveshaping, connect the output of an LFO, gated envelope generator or other modulation source to the RW-CV input jack (12), this gives voltage control of the Resonance Waveshaping Drive.

The overall resonance level increases as the REX MIX control is rotated clockwise, so you may need to "back off" the RES LEVEL control (2) to compensate for this.

Note: The resonance waveshaping is considerably less wide ranging than the input waveshaping and can have quite a narrow "sweet spot", this is because any waveshaping applied to the resonance loop passes through the filter and in the process can have most of the harmonics removed, depending upon the filter cutoff frequency. The main benefit of the resonance waveshaper is to bring the lower threshold of filter self resonance down from 2khz to below 200hz.
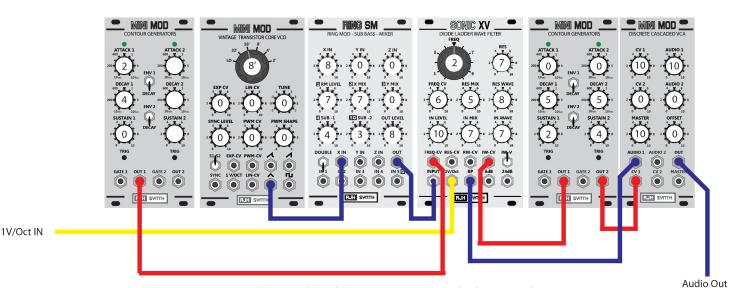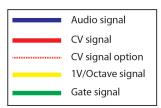
Patch example:

Below is a visual example of a patch combining several AJH Synth modules. This is to give an idea of how to connect everything together, in this case we are applying external CV's from thwo separate Envelope Generators to modulate both the Cuttoff frequency and the Drive if the Input waveshaper. As an audio source we are using just a single triangle wave from the VCO, but then feeding this signal through the RING SM module to generate a mix of +1 Octave, triangle and two sub basses to really fatten up the sound.

Obviously other Eurorack compatible modules can be substitued for the VCO's, VCA, Envelopes and mixers shown.

PATCH NAME: Metallic Growl

COMMENTS: Single Triangle wave into Ring SM and Sonic XV - BP filtered and Waves Patch
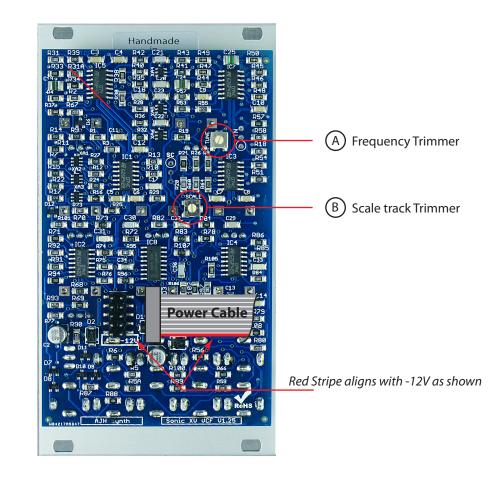

1V/Oct IN

Audio Out

Note: 1V/Oct for VCO and Gate for Contour Generators are taken from Eurorack Bus
If Bus is not used then connect Gate 1 of both Contour Generators to gate via a multi,
and connect 1V/Oct of VCO and Sonic XV to 1V/Oct signal with second multi

——	Audio signal
——	CV signal
·····	CV signal option
——	1V/Octave signal
——	Gate signal

Adjustment, Calibration and Power Cable connection

(A) Frequency Trimmer

(B) Scale track Trimmer

Red Stripe aligns with -12V as shown

(A) Frequency Trimmer :   **FOR MANUFACTURER ADJUSTMENT ONLY**. This trimmer sets the effective range of the Cutoff fFequency Control (1)

(B) Scale Trimmer :   **FOR MANUFACTURER ADJUSTMENT ONLY**. This trimmer is used to set the tracking scale to exactly 1V/Octave. Different adjustment is necessary for waveshaped and non-waveshaped resonance - the default setting is for 1 V/Oct tracking with full waveshaping selected, as this has a much larger and more useful audio range than non-waveshaped resonance.

If you need any help using this module or have any technical questions please feel free to contact us at support@ajhsynth.com