

RING SM

User Guide

Ring Modulator - Dual Sub Bass - Mixer

Thank you for purchasing the AJH Synth Ring SM module, which like all AJH Synth Modules, 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 soundscapes! It has the following features:

A Ring Modulator core with a very unique and warm sounding four quadrant multiplier that includes three inputs, X, Y & Z. It is a vintage design based entirely on a discrete transistor core, and includes an extra, resonant Z modulator input. It also has a frequency doubling switch; from a single triangle or sine wave input an octave +1 output is generated.

Two independent Sub Bass generators with very fast tracking, creating -1 Octave and -2 Octaves from the X input. These are not simple square wave subs, they generate shaped waveforms that vary from a trapezoid wave with rounded edges at lower frequencies to sine like waveforms at higher frequencies and are useful up to 1kHz. They have a much lower harmonic content than square wave subs, designed to have more power and sit much better in a mix.

A five input DC coupled mixer based on the discrete transistor CP3 modular design dating back to the early 1970's. The outputs of the ring modulator, X and Y inputs and Sub Bass outputs are routed to the mixer by default – plugging a patch cable into any of the mixer inputs defeats this normalising and allows it to be used as a regular 5 channel mixer for both audio and control voltages.

A clipping / distortion module – input 5 of the mixer is considerably “hotter” than the other four mixer channels and will clip the signal as soon as it hits threshold level. If a DC bias voltage is added the signal is shifted and this allows positive or negative asymmetric clipping of the waveform

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 55mA from the +12V supply rail and 50mA from the -12V supply rail.

All AJH Synth modules are covered by a one year guarantee against manufacturing defects.

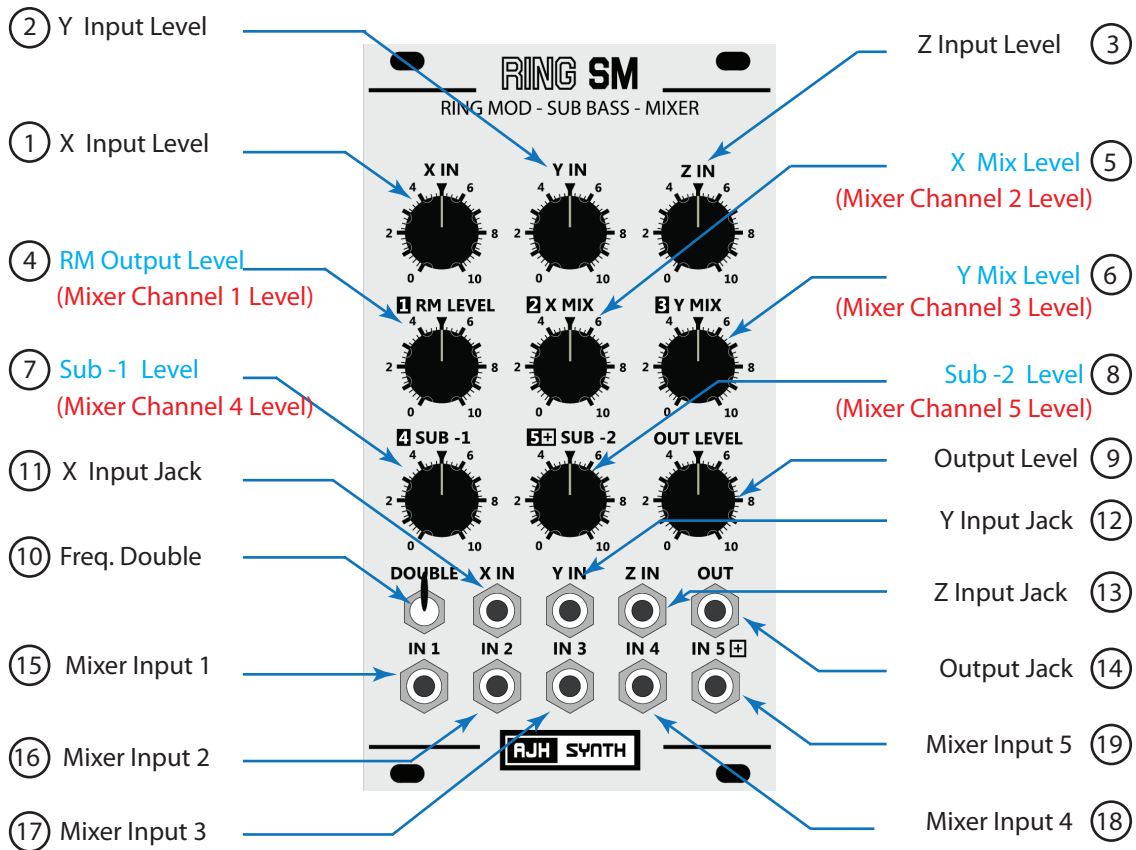
Notes:

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.



www.ajhsynth.com

Controls, Inputs and Outputs



- ① X Input Level : Controls the level of X Input (Carrier) signal from the X Input jack (11) that is sent to the Ring modulator core.
- ② Y Input Level : Controls the level of Y Input (Modulator 1) signal from the Y Input jack (12) that is sent to the Ring modulator core.
- ③ Z Input Level : Controls the level of Z Input (Modulator 2) signal from the Z Input jack (13) that is sent to the Ring modulator core.

This allows a second modulation to be mixed to the Ring Modulator core, it has a slightly more "resonant" character than the Y input and can be used for audio rate or LFO modulation.

- ④ RM Out Level : **This control serves a dual purpose.**
 - 1) Ring Modulator output level - If there is no connection to Mixer Channel 1 (15) then the output of the Ring Modulator is automatically routed (normalised) to Mixer channel 1, and this knob controls the level of Ring Modulator output signal that is fed through the mixer to the Output Level Control (14)
 - 2) Mixer Channel 1 Level - If an audio or control voltage signal is fed into Mixer channel 1 by connecting patch cable jack to Mixer Input 1 (15) then this knob becomes the Input level control for mixer channel 1. In this mode the output of the Ring Modulator is disconnected and not available.

Input level at onset of clipping is +/- 5V (10V p-p) Higher levels of up to +/-10V can be tolerated, however they will be distorted and clipped by the mixer. The mixer is dc coupled, so it can be used to mix control voltages in addition to audio signals.

⑤ X Mix Level:

This control serves a dual purpose.

1) **This sets the X Input Mix through Level** - The signal from the X Input jack (11) is automatically routed (normalised) to Mixer Channel 2 and this knob controls the level of X Input signal that is fed through the mixer to the Output Level Control (14) This allows the original X (Carrier) signal to be mixed with the Ring Modulator and Sub Bass outputs.

Note: The X signal is taken directly from the X In jack socket (11) and the setting of X In Level knob (1) is ignored.

2) **Mixer Channel 2 Level** - If an audio or control voltage signal is fed into Mixer channel 2 by connecting patch cable jack to Mixer Input 2 (16) then this knob becomes the Input level control for mixer channel 2. In this mode the X Mix function is disconnected and not available.

Input level at onset of clipping is +/- 5V (10V p-p) Higher levels of up to +/-10V can be tolerated, however they will be distorted and clipped by the mixer. The mixer is dc coupled, so it can be used to mix control voltages in addition to audio signals.

⑥ Y Mix Level:

This control serves a dual purpose.

1) **This sets the Y Input Mix through Level** - The signal from the Y Input jack (12) is automatically routed (normalised) to Mixer Channel 3 and this knob controls the level of Y Input signal that is fed through the mixer to the Output Level Control (14) This allows the original Y (Modulator) signal to be mixed with the Ring Modulator and Sub Bass outputs.

Note: The Y signal is taken directly from the Y In jack socket (12) and the setting of Y In Level knob (2) is ignored.

2) **Mixer Channel 3 Level** - If an audio or control voltage signal is fed into Mixer channel 3 by connecting patch cable jack to Mixer Input 3 (17) then this knob becomes the Input level control for mixer channel 3. In this mode the Y Input through function is disconnected and not available.

Input level at onset of clipping is +/- 5V (10V p-p) Higher levels of up to +/-10V can be tolerated, however they will be distorted and clipped by the mixer. The mixer is dc coupled, so it can be used to mix control voltages in addition to audio signals.

⑦ Sub Bass -1 Level : **This control serves a dual purpose.**

1) **Sub Bass -1 Level** - This controls the level of the shaped sine wave Sub Bass waveform (generated from the X Input) but one octave lower. This Sub Bass waveform is automatically routed (normalised) to Mixer Channel 4 and this knob controls the level of the -1 Octave Sub Bass that is fed through the mixer to the Output Level Control (14)

Note: The waveshape of the Sub -1 output is not related to the wave shape of the X Input, a sine, saw, triangle or square / pulse signal can be applied to the X input and the Sub -1 Waveform will remain a shaped sine wave, one octave lower, in all cases. More complex X input waveforms can be used, however the results may not be as predictable and this can be experimented with for musical effect.

2) **Mixer Channel 4 Level** - If an audio or control voltage signal is fed into Mixer channel 4 by connecting patch cable jack to Mixer Input 4 (18) then this knob becomes the Input level control for mixer channel 4. In this mode the Sub Bass -1 function is disconnected and not available.

Input level at onset of clipping is +/- 5V (10V p-p) Higher levels of up to +/-10V can be tolerated, however they will be distorted and clipped by the mixer. The mixer is dc coupled, so it can be used to mix control voltages in addition to audio signals.

⑧ Sub Bass -2 Level: **This control serves a dual purpose.**

1) **Sub Bass -2 Level** - This controls the level of the shaped sine wave Sub Bass waveform (generated from the X Input) but two octaves lower. This Sub Bass waveform is automatically routed (normalised) to Mixer Channel 5 and this knob controls the level of the -2 Octave Sub Bass that is fed through the mixer to the Output Level Control (14)

Note: The waveshape of the Sub -2 output is not related to the wave shape of the X Input, a sine, saw, triangle or square / pulse signal can be applied to the X input and the Sub -2 Waveform will remain a shaped sine wave, one octave lower, in all cases. More complex X input waveforms can be used, however the results may not be as predictable and this can be experimented with for musical effect.

2) **Mixer Channel 5 Level** - If an audio or control voltage signal is fed into Mixer channel 5 by connecting patch cable jack to Mixer Input 5 (19) then this knob becomes the Input level control for mixer channel 5. In this mode the Sub Bass -2 function is disconnected and not available.

Please note: The 5+ designation on this mixer channel denotes that this input is "hotter" than inputs 1 to 4.

Input level at onset of clipping is +/- 2.5V (5V p-p) Higher levels of up to +/-10V can be tolerated, however they will be distorted and clipped by the mixer. This allows the mixer to be used as a distortion module in addition to a regular DC coupled mixer. The output of the Sub -2 circuit is generated internally at a lower level, so this only applies to external signals applied to Mixer input 5.

⑨ Output level : Sets the overall output level of the module, maximum output is approx +/-6V (12V p-p)

⑩ Freq. Double : This switch selects frequency double mode for the Ring SM. It connects the Carrier and Modulator inputs together, so that only an X input is needed to generate a frequency one octave higher from the Ring Modulator output. For this to work correctly the input signal needs to have a very low harmonic content, sine and triangle work well, other waveforms are acceptable but in this case the frequency doubling feature may not work.

Note: This effect is possible because a four quadrant multiplier (such as that in the Ring SM) produces the sum and difference of the Carrier and Modulator inputs. If the same frequency is applied to both the carrier and modulator, for example lets say 200Hz, then the will be the output the sum (200Hz + 200Hz) and the difference (zero, as both X and Y are the same frequency) So, the output will be 400Hz (+1 Octave), and whatever the input frequency (within reason) the output will always be exactly one octave higher than the input.

⑪ X Input Jack: X (Carrier) Input to the Ring Modulator. This signal is also used as the source from which both the Sub -1 and Sub -2 outputs are generated.

Standard Eurorack signal levels of +/- 5V (10V p-p) are expected, however levels of up to +/-10V can be tolerated, but depending upon the setting of the X Input Level control (1) the Ring Modulator output may be distorted and /or clipped.

⑫ Y Input Jack : Y (Modulator 1) Input to the Ring Modulator.

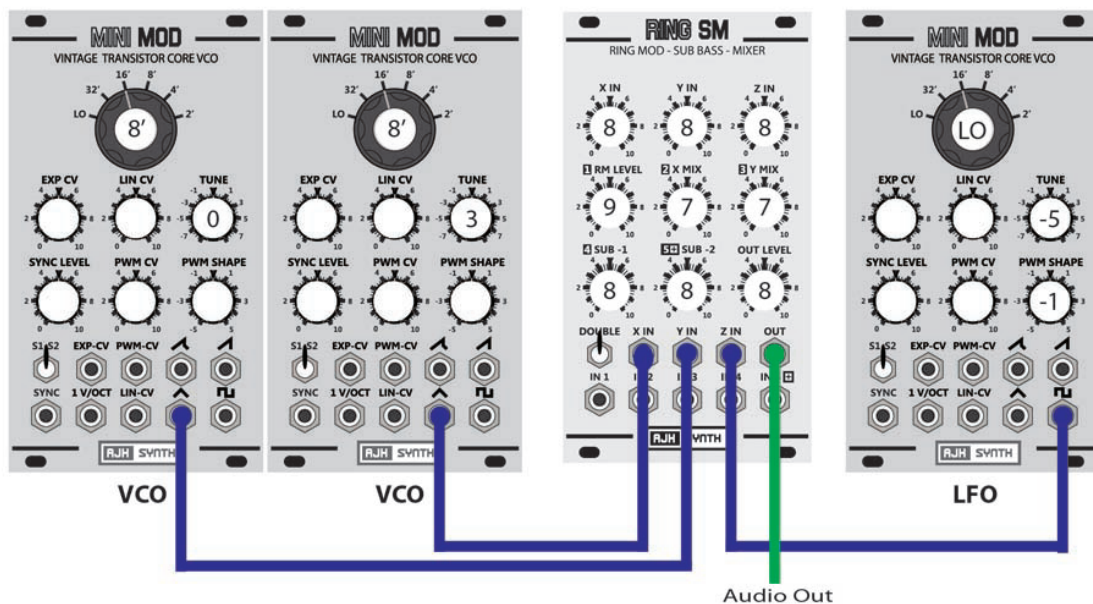
Standard Eurorack signal levels of +/- 5V (10V p-p) are expected, however levels of up to +/-10V can be tolerated, but depending upon the setting of the X Input Level control (1) the Ring Modulator output may be distorted and /or clipped.

- ⑬ Z Input Jack : Z (Modulator 2) Input to the Ring Modulator.

This allows a second modulation to be mixed to the Ring Modulator core, it has a slightly more “resonant” character than the Y input and can be used for audio rate or LFO modulation.

Standard Eurorack signal levels of +/- 5V (10V p-p) are expected, however levels of up to +/-10V can be tolerated, but depending upon the setting of the X Input Level control (1) the Ring Modulator output may be distorted and /or clipped.

- ⑭ Output Jack : Main Output from the Ring SM Module. Nominally +/- 5V (10v p-p) Eurorack levels, the output level is dependant upon input levels and the setting of the Output Level Control (9).
- ⑮ Mixer Input 1 : Mixer input 1 - Connecting a jack to this input enables mixer channel 1 and disconnects the Ring Modulator output which is normalised through this channel.
- ⑯ Mixer Input 2: Mixer input 2 - Connecting a jack to this input enables mixer channel 2 and disconnects the “X Through” signal which is normalised through this channel.
- ⑰ Mixer Input 3: Mixer input 3 - Connecting a jack to this input enables mixer channel 3 and disconnects the “Y Through” signal which is normalised through this channel.
- ⑱ Mixer Input 4: Mixer input 4 - Connecting a jack to this input enables mixer channel 4 and disconnects the Sub Bass -1 signal which is normalised through this channel.
- ⑲ Mixer Input 5: Mixer input 5 - Connecting a jack to this input enables mixer channel 5 and disconnects the Sub Bass -2 signal which is normalised through this channel. This is the “hot” mixer channel and will distort more easily than channels 1 - 4.



Example patch 1B - “Drone with Heartbeat”

The RING SM four quadrant multiplier core is built around discrete transistors rather than a regular ring modulator integrated circuit chip commonly used in Eurorack modules, this gives a much warmer, more vintage feel as it drifts around a little and this also allows us to use a slightly different topology for the Z modulation input.

All ring modulators work (mathematically) most correctly with sine wave inputs, however triangles work reasonably well too. The output of a Ring Modulator is the sum and difference of the frequencies applied to the X (Carrier) and Y (Modulator) inputs. Other waveforms can of course be used, but with mathematically less predictable results, which is why we like to try them too - feel free to experiment!

The double switch simply connects the X input to the Y input, so that you can get an output from the ring modulator with a single input. This is frequency double mode, and the RM output will be twice the X input frequency (sum plus difference - in this case the sum is 2 times the input frequency and the difference is zero as both signals are the same.

The inputs of the Ring SM are AC coupled, so fixed control voltages will not have any useful effect.

The Z input is very similar in function to an extra Y input (so still gives the regular sum + difference against x input) However, it is more resonant - to illustrate this apply (for example) a 200hz triangle wave to the X input. Then connect an LFO with (around) a 1Hz square wave (pwm) with a 30 to 40% duty cycle to the Y input. You will hear just short clicks - then patch this LFO into the Z input instead, you will hear that the click is now longer in duration and more resonant - this gets more interesting if fed through a BP filter. The X, Y and Z inputs can all be used simultaneously.

Because of the unique combination of (all analogue) Ring Modulator, Dual Sub Bass and Mixer functions the Ring SM can produce some huge sounds, here are a few patch ideas to get you started:

Example 1A - Frequency doubling and Dual Sub bass patch

First, set all controls fully counter clockwise (off). Connect the output to an amplifier suitable for modular synthesiser levels; set the output level (9) to position 7 or 8. Connect a single VCO with a Sine wave or Triangle wave output, again with a sine wave of around 200Hz to The X Input (11). Set the X in Level (1) to around 8, next turn the X Mix control (5) round to 6 or 7 - you should now hear the 200Hz signal at the output.

Now push the double switch down (on) and turn the RM Output level round to 6 or 7 - you should now hear a signal one octave higher (400Hz) mixed with the original signal; temporarily turn down the X Mix control and you will now hear only the doubled frequency from the RM output.

Next, turn the Sub -1 Level Control around to 7 or 8, you should hear a signal an octave lower (100Hz) being added to the mix.

Lastly, turn the Sub -2 Level Control around to 7 or 8 and now an even lower sub bass (50Hz) will be added to the mix.

So we have generated four octave additive synthesis from a single 200Hz sine or triangle wave.....

Example 1B - Adding in some Ring Modulation

Using the above patch, now we will add a second input. First, switch the Double switch (10) to the up position (off). Patch in a second VCO, again with a sine or triangle wave output (initially set to 200Hz) to the Y Input (12). Now Turn the Y Input level (2) control round to 6 or 7, if you have exactly the same frequency for both the X and Y inputs (200Hz) this patch should sound exactly the same as Example 1A, as the ring modulator will be outputting double the frequency.

Now gradually change the frequency of VCO 2, you will hear the classic ring modulator sweeping sound - Now turn the Y MIX Control (6) around to 6 or 7 and you will hear the output signal of VCO appear in the mix too. By playing with the various signal levels and VCO frequencies some massive drone sounds can be created - or by routing the signal through a VCA and Envelope Generator some very useful percussion sounds can be generated too.

Turn down the levels on the Sub -1, Sub -2 and X Mix controls and the RM output will be much more obvious.

Lastly, try adding a third VCO to the Z Input for some more complex modulation, or try an LFO set to give a Square pulse with about 30 to 40% duty cycle and 1 to 2 Hz tempo, some nice resonant "pings" can be added to the ring modulator sounds.

The output can obviously be further processed by vcf's, vca's and contour generators - this is modular synthesis and there is a wealth of possibilities only limited by your imagination!

Sub Bass Modules:

The Sub Bass waveforms for both Sub -1 and Sub -2 are generated from the waveform that is applied to the X Input. They are very fast tracking, usually locking on within one cycle, but they do depend upon the waveshape of the signal used (which is connected to the X input). Waveforms with higher harmonic content or noise can confuse the tracking, but this can be used for musical effect as seen in some of the demonstration videos. The Sub Bass waveforms are "shaped" sine waves and the actual waveshape varies with frequency, at higher frequencies they have a very low harmonic content, similar to a sine wave - but as they get lower in frequency they morph into a rounded trapezoid shape with a slightly higher harmonic content - this is deliberate as at lower frequencies they are a little fuller and fatter than a perfect sine wave, and really fatten up the bottom end of a mix, whereas at 100Hz and above they gradually transform into a more sine like waveform so they don't muddy up the mix in what can often be a busier part of the audio spectrum. They do fall off in level at higher frequencies, but are still working at 1kHz, which is quite high for a sub bass!!

Discrete Transistor Mixer:

The mixer is DC coupled and non-inverting, so can be used to process control voltages in addition to audio signals.

Unity gain on a single mixer stage occurs with the output knob set to 10 and the channel input knob set to 9, (or 8 on channel 5) turning the input knob round to 10 takes the mixer into clipping even with a single input - so obviously adding in more inputs requires either the channel knobs to be turned down or lots of clipping (which we quite like!) It won't break with everything set to 10, it just gets a bit angry :-)

Please note: When using the mixer, always ensure that the level controls for any channels which are not in use are turned down to zero; this will prevent any unwanted bleed through of noise from the Ring mod and Sub Bass sections. The Sub Bass generators will produce random sound even without any waveform applied to the X Input, so their level control knobs should be kept at zero unless they are in use.

Using the Mixer as a Distortion Module:

The mixer section has a "Hot" Channel - Input 5 on the mixer is marked as 5+, this is to show that it is "hotter" than the other four inputs and so more readily distorted / clipped, turning the Mixer Channel 5 control and the Output Level control fully clockwise will give considerable clipping on a single +/-5V audio signal. The distortion will be (fairly) symmetrical, hard clipping.

The output of Sub -2 is lower to compensate for this, so levels of the two subs are the same at the mixer output for the same setting on their level controls.

Exploring asymmetric distortion with the Mixer:

As the discrete transistor mixer core is DC coupled, applying a positive or negative DC bias voltage to any of the mixer channels will cause this offset to be added to the waveform. It will therefore shift the waveform up or down from zero by the corresponding voltage, so positive or negative asymmetric clipping can be achieved as the signal tries to swing above the headroom threshold of the mixer. Figs 1 & 2 below show the effect of both positive and negative bias voltages on a sine wave input- trace 1 (yellow) is the input to Mixer Channel 1 and trace 2 (green) is the Mixer output.



Fig. 1 - Asymmetric Distortion of a +/-5V Sine wave

Mixer input 1: +/- 5V Sine wave at 400Hz
Mixer input 2: +5V DC fixed voltage



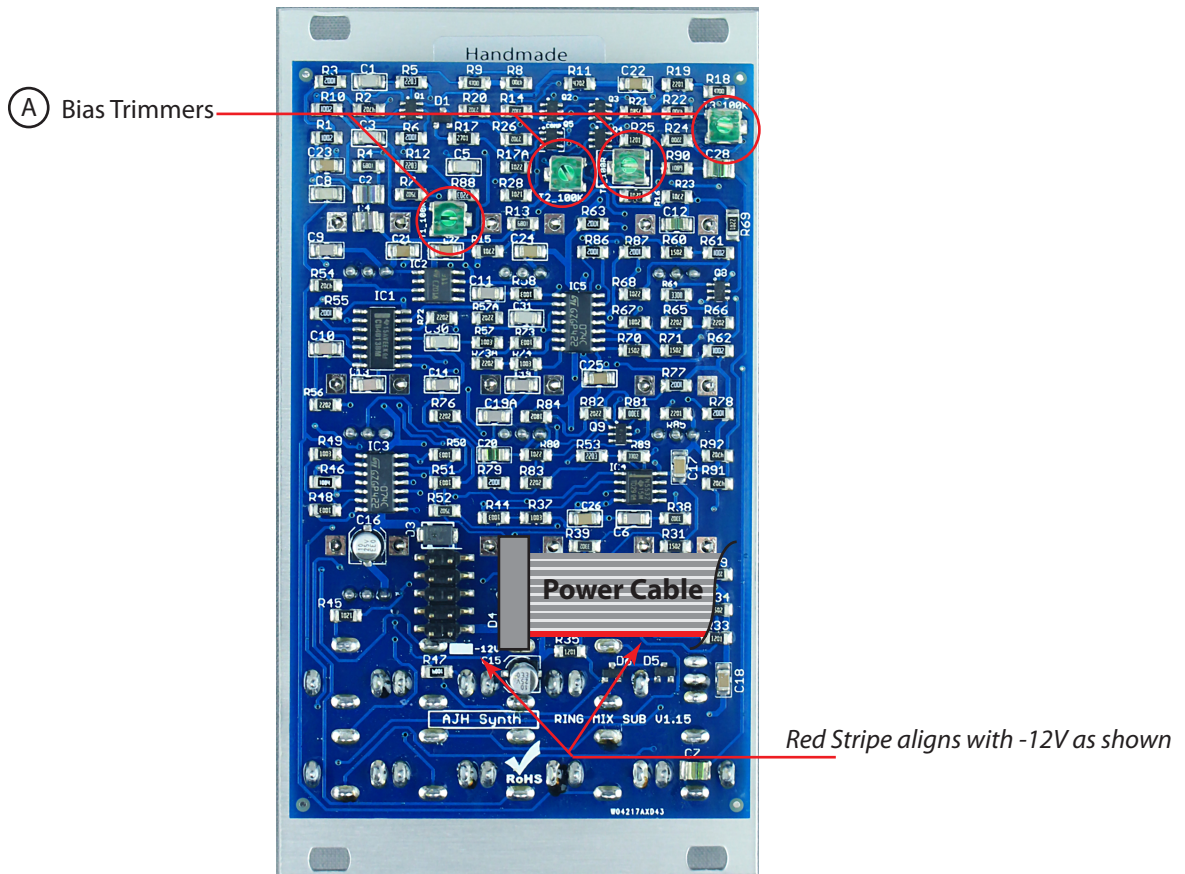
Fig. 2 - Asymmetric Distortion of a +/-5V Sine wave

Mixer input 1: +/- 5V Sine wave at 400Hz
Mixer input 2: -5V DC fixed voltage

Power Cable connection

Note:

This information is given for completeness, the Ring SM is calibrated after manufacture and under normal circumstances should not require any user adjustment.



- (A) Bias Trimmers : **FOR MANUFACTURER ADJUSTMENT ONLY.** These four trimmers are for adjustment of the ring modulator core. Specialist test and measurement equipment is required to correctly set these trimmers, so they are sealed after factory calibration and user adjustment should not be attempted.

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