



FM AID

USER'S GUIDE

MODULE DESCRIPTION

FM AID is a module designed to perform through-zero linear Frequency Modulation (FM) in the analog modular world. Any arbitrary signals can be used as a Carrier and Modulator. The module copies FM in how it is done in digital implementation, but in a completely analog circuit free of digital aliasing artifacts. Digital or software FM oscillators are mainly based on a ramp waveform which is then shaped to other waveforms. This is also represented in the FM AID module: sawtooth signal is expected on the Carrier input to give the indicated sine, triangle, sawtooth and square waveforms on the respective outputs. However the user is not limited to only use sawtooth for the Carrier and any other signal can be plugged giving many complex waveforms at the outputs.

All known FM tricks from digital implementation are also applied – you can endlessly experiment with the Carrier/Modulator frequency ratios, Modulation index (FM knob), Modulator's amplitude shaping (CV knob), feedback FM (output is fed back to the Modulator's input) and many other.

Carrier input has normalised connection to the Modulator's input. This internal routing is disconnected each time a plug is inserted in the Modulator's input. That is a handy option which allows the module to be used with only one signal source – this single signal will act as Carrier and Modulator at the same time. There won't be any frequency differences between Carrier and Modulator in this case, but many interesting wave folding sounds will be available anyway.

SPECIFICATIONS

Carrier input level: -5V ... + 5V (can also accept inputs ranging from [-1V... +1V] to [-12V...+12V] using onboard trimmer)

Modulator input level: preferably -5V ... + 5V

CV input level: preferably -5V ... + 5V

outputs level: -5V ... + 5V

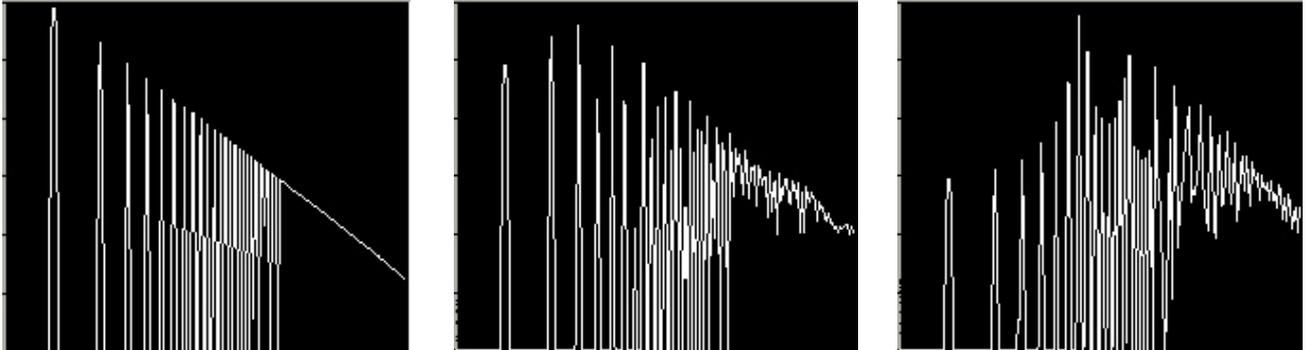
outputs impedance: 1 kOhm

module depth: 3 cm or 1,5 inches

power consumption: +45 /-45 mA at +/-12 Vdc

CONTROLS DESCRIPTION

FM – sets Frequency Modulation depth, or as it usually called in FM synthesis – *modulation index*. By increasing the “FM” amount the user shifts additional harmonics proportionally further from the main tone, so the sonically perceived brightness of the sound and complexity increases too.



FM amounts at 0, 5, 10 dial positions and their respective spectrums.
100 Hz sawtooth wave is used as a Carried and Modulator.

CV – bipolar control with the scale dial from -5 to +5. Any signal applied to the CV input will be internally added to the manually set “FM” amount. So the “CV” knob changes the FM depth (index).

CAR jack – Carrier or input to be frequency modulated. Any signal, preferably $-5V \dots + 5V$ (10 V pk-pk) can be used. Sawtooth wave will give the most resemblance to the standard digital FM and will produce the indicated waveforms at the four shapers outputs – sine, triangle, sawtooth and square.

Mod jack – Modulator or signal which modulates the frequency of the Carrier. Any signal, preferably $-5V \dots + 5V$ (10 V pk-pk) can be used.

CV jack – control voltage input for FM depth. Can be either AC or DC. $-5V \dots + 5V$ input voltage range is welcome.

The main difference between analog FM implementation of this FM AID module and general software FM.

Digital FM uses integrated modulator's signal to modulate carrier, but FM AID does not change the modulator's signal.

So in digital implementation:

- square wave modulator equals to triangle wave modulator in FM AID
- triangle wave modulator equals to sine wave modulator in FM AID

Integration of the modulator's signal in software realization usually gives less bright FM tones than FM AID module.

SINE jack – the least bright output. For the case of saw Carrier the result will be sine waveform.

TRIANGLE jack – a bit brighter than sine output. For the case of saw Carrier the result will be triangle waveform.

SAWTOOTH jack – very bright output. For the case of saw Carrier the result will be the same saw waveform.

SQUARE jack – very bright output. For the case of saw Carrier the result will be square waveform.

POWER INPUT – male 10 pin PCB mount connector - a standard Eurorack power connector. To be plugged to a regulated +12Vdc and -12Vdc PSU only when the power supply is OFF. Mind the proper positioning on the pins.

USEFUL TIPS AND TRICKS

By routing Velocity voltage into CV input you can change the FM depth (index) in relation to the notes velocity, that adds extra changes to the sound.

Pitch CV can be used to vary the FM depth (index) amount for different pitches. Positive CV setting will raise the FM depth (index) for every higher pitched note. Negative CV setting will allow to decrease the FM depth (index) for higher pitched notes.

Audio rate signals can be plugged to CV input as well – just try it and you will like it.

Don't forget to try to use for the Carrier and Modulator standard hard synced oscillators to eliminate the frequency beating, so the produced FM tone will stay static.

With the increase the FM depth (index) the harmonics peak shifts higher in frequency and the main tone (first harmonic) weakens, so you may lower the Carrier octave to bring back the low end power. Lowering the pitch of the Modulator or switching it to sine or triangle waveforms will give more low end too.

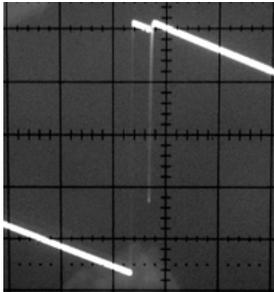
It is known fact, that in digital FM realization, self feedback is used to produce noise at some feedback depth settings. This is due to the limited sample rate in digital realm.

Of course there is no such restriction for analog implementation of FM AID module. But there is still limited reset time of standard analog waveforms, so it is possible to resemble the digital noise generation too. It is done by sending any of the four outputs to the Modulator's input making a feedback path. Each of the four shapers will give different noise flavors, thus try them all. Depending on the reset time of the Carrier signal this noise generation setting will vary, but it will be somewhere in the range of 6-10 "FM" mark for most of the signals.

CALIBRATION

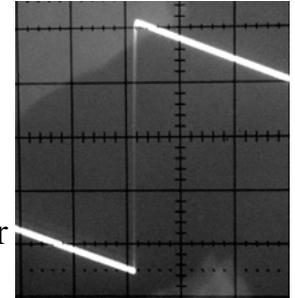
There is only one part of the FM AID module which may require the user's adjustments – onboard trimmer. By default FM AID is tuned to be fed with $-5V \dots +5V$ (10 V pk-pk) signals for Carrier. But as all oscillators are not perfectly made to give exactly $-5V \dots +5V$ waveforms, you may have to adjust the trimmer to the setting which gives the least amount of artifacts.

For proper calibration feed the ordinary saw wave into the Carrier jack. Nothing should be plugged into the CV and Modulator inputs. Set “FM” knob fully CCW to 0 mark. Now monitor the “saw” output.



Two teathed saw – to be trimmed CW until the proper saw wave will appear.

If the scope shows proper saw from the beginning it is still may require trimming – trim it CCW until the two teathed artifact will start to appear and then trim it just a bit back for clear saw picture. Now you are done.



If you will have questions regarding the calibration – please contact hnerding@gmail.com

HAPPY NERDING!