



FM AID

Through-zero linear FM

FM AID is a module designed to perform Through-Zero Linear Frequency Modulation (FM) in the analog modular world.

Use any signal as a Carrier or Modulator.

Width: 4HP

Depth: 30mm (3cm, or 1.5 inches)

Power Consumption: +45 /-45 mA at +/-12 Vdc



SPECIFICATIONS

Inputs & Outputs

Carrier Input Level: -5V ... +5V

Note: FM AID also accepts inputs from -1V ... +1V to -12V ... +12V using an onboard trimmer.

Modulator Input Level: Preferably -5V ... +5V

CV Input Level: Preferably -5V ... +5V

Outputs Level: -5V ... +5V

Outputs Impedance: 1kOhm

Module

Width: 4 HP

Depth: 30mm (3cm, or 1.5 inches)

Power

Power Consumption: +45 /-45 mA at +/-12 Vdc

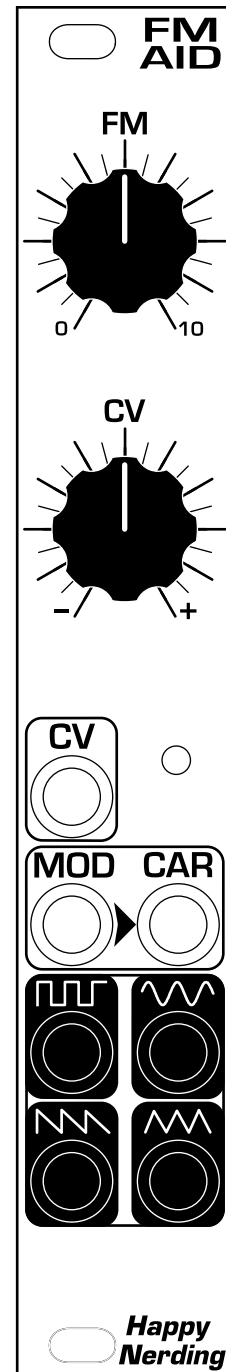
Power Cable: 10 pin-to-16 pin ribbon cable (included).

Note: Factory-assembled modules come with the ribbon cable attached to the male 10 pin PCB mount connector—a standard Eurorack power connector.

Installation Instructions:

1. Confirm that the Eurorack synthesizer system is powered off.
2. Locate 4 HP of space in the Eurorack synthesizer case.
3. Connect the 16 pin side of the ribbon power cable to the 2x8 pin header on the Eurorack power supply, confirming that the red stripe on the power cable is connected to -12V.
5. Mount the FM Aid in the Eurorack synthesizer case.
6. Power the Eurorack synthesizer system on.

Note: This module has reverse polarity protection.

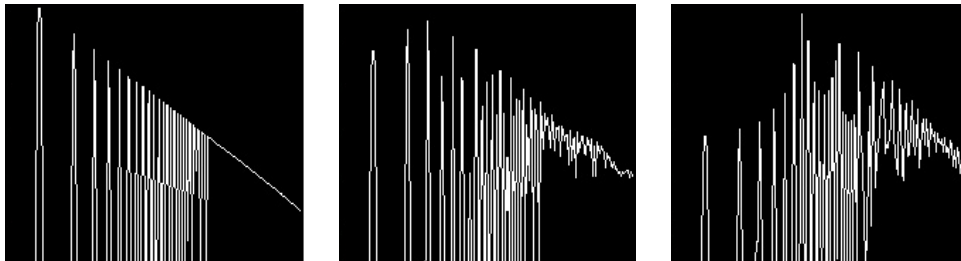


INTRODUCTION

With FM AID, *any* signal 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 and 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: a 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.



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

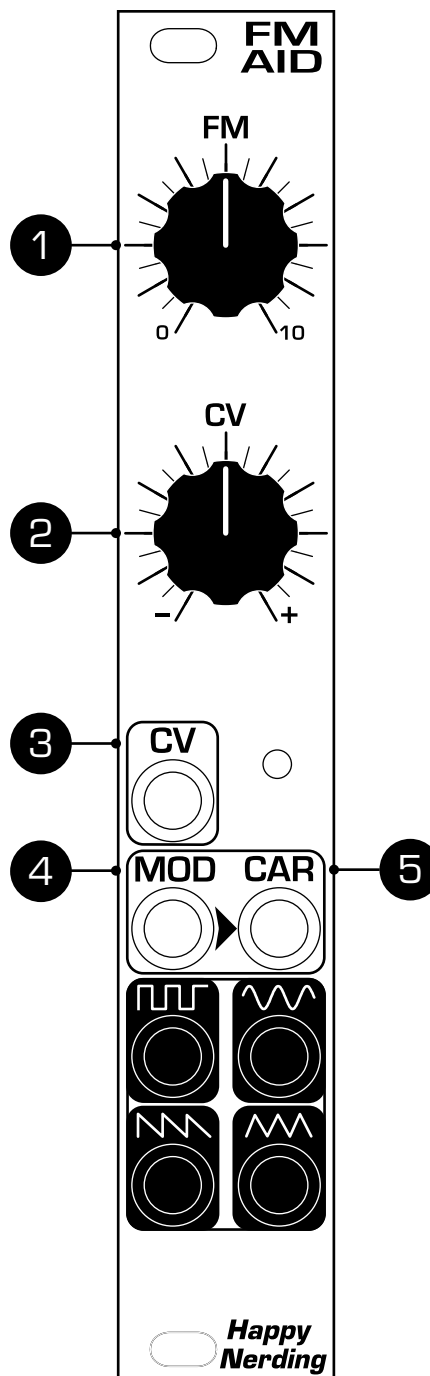
All known FM tricks from digital implementation are also applied. You can endlessly experiment with the Carrier/Modulator frequency ratios, Modulation index (FM knob), Modulator's amplitude shaping (CV knob), feedback FM (output is fed back to the Modulator's input) and many others.

The Carrier input has a 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.



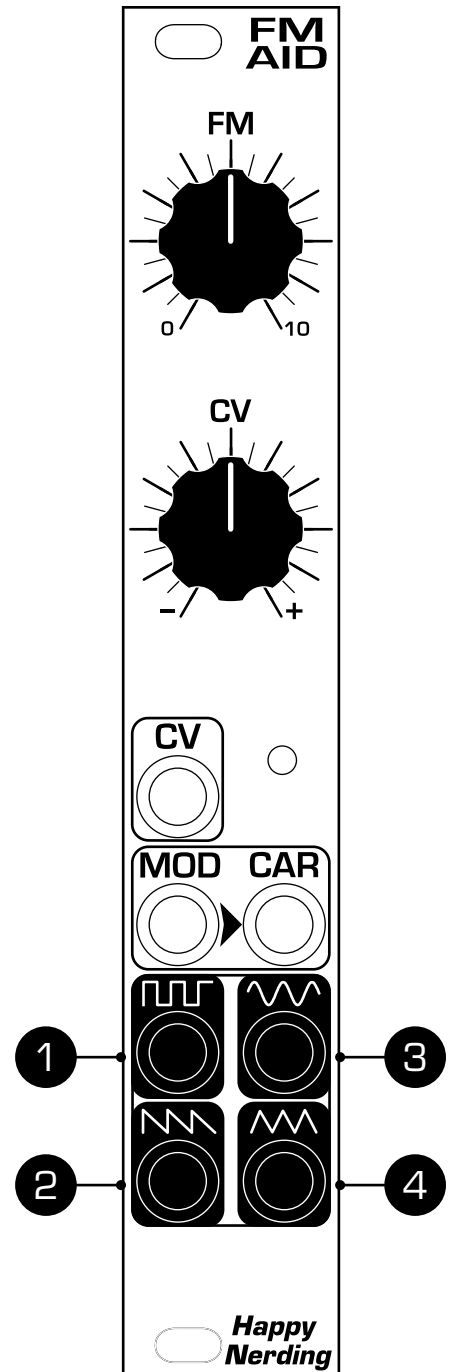
CONTROLS

- 1 FM Knob**
 Sets Frequency Modulation depth, or as it usually called in FM synthesis: modulation index. By increasing the “FM” amount, additional harmonics are shifted proportionally further from the main tone. This increases the sonically perceived brightness and complexity of the sound.
- 2 CV Knob**
 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).
- 3 CV Input**
 Control voltage input for FM depth. Can be either AC or DC. -5V ... +5V input voltage range is welcome.
- 4 MOD Input**
 Modulator—or signal—that modulates the frequency of the Carrier. Any signal, preferably -5V ... +5V (10 V pk-pk), can be used.
- 5 CAR Input**
 Carrier—or input—to be frequency modulated. Any signal, preferably -5V ... +5V (10 V pk-pk), can be used. The sawtooth wave will give the most resemblance to the standard digital FM and will produce the indicated waveforms at the four outputs: sine, triangle, sawtooth and square.



OUTPUTS

- 1 **SQUARE**
Very bright output. Using a saw wave as the Carrier input will result in a square wave.
- 2 **SAWTOOTH**
Very bright output. Using a saw wave as the Carrier input will result in the same saw wave.
- 3 **SINE**
The least bright output. Using a saw wave as the Carrier input will result in a sine wave.
- 4 **TRIANGLE**
A bit brighter than sine output.
Using a saw wave as the Carrier input will result in a triangle wave.



TIPS & TRICKS

Note Velocity

To add extra color to sound, patch velocity voltage to the CV input, which will change the FM depth (index) in relation to the velocity of the notes.

Pitch CV Modulation

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 Modulation

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

Hard-Sync

Try using standard, hard-synced oscillators for the Carrier and Modulator to eliminate the frequency beating, so the produced FM tone will stay static.

Strengthen the Low End

Increasing the FM depth (index) can shift the harmonic peaks higher in frequency, weakening the main tone (first harmonic). To bring back the low end, try any of these methods:

- Lower the octave of the Carrier.
- Lower the pitch of the Modulator.
- Switch the waveform of the Modulator to a sine or a triangle.

Feedback

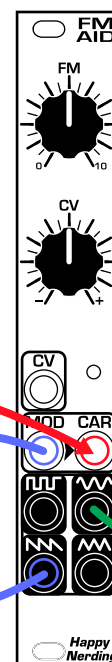
It is known fact, that in digital FM realization, self feedback is used to produce noise at some feedback depth settings. This is due to the limited sample rate in digital realm.

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 "FM" knob range of 6-10 for most of the signals.

Feedback Patching

- CAR input signal
- Self-patch the MOD input
- Output signal



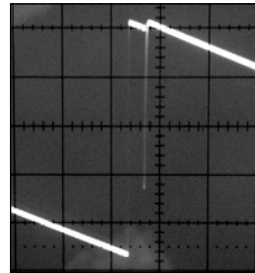
CALIBRATION

There is only one part of the FM AID module which may require the user's adjustments: the onboard trimmer.

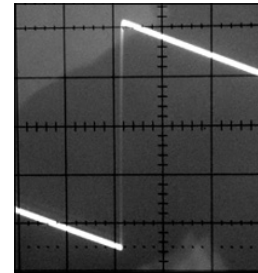
By default FM AID is tuned to be fed with $-5V \dots +5V$ (10 V pk-pk) signals for Carrier. But as all oscillators are not perfectly made to give exactly $-5V \dots +5V$ waveforms, you may have to adjust the trimmer to the setting which gives the least amount of artifacts.

For proper calibration:

With nothing patched to the CV and Modulator inputs, feed the ordinary saw wave into the Carrier jack. Set the "FM" knob fully CCW to the 0 mark. Now monitor the "saw" output



A saw wave with two "teeth"



A proper saw wave

"Two teathed" saw:

Trim CW until the proper saw wave appears.

If the scope shows a proper saw from the beginning, it still may require trimming:

- Trim it CCW until the two teathed artifact starts to appear.
- Then trim it just a bit back for a clear saw picture. Now you are done.

HAPPY NERDING!

