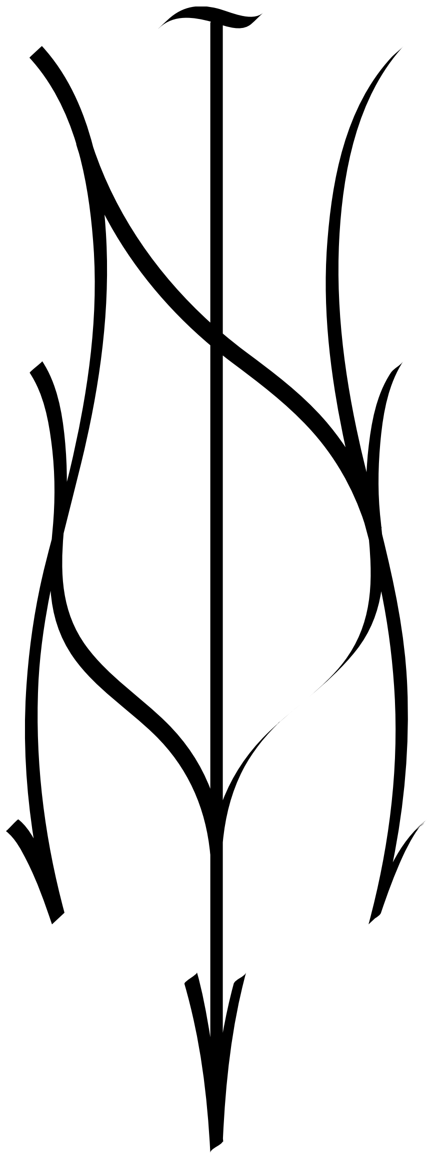
Infernal Noise Machine



flight of harmony

Contents

I.N.M. Features

Important Note:

This is a noise device. Please mentally append "-ish" to all descriptions.

IMP Noise Core:

- Controls
  - Frequency & Range Joysticks
    - Coarse
    - Fine
      - Fine scaling adjustment, relative to Coarse, at maximum Width
        - 1/5 to 1/25
      - Fine scaling adjustment, relative to Coarse, at minimum Width
        - 1/125 to 1/500
  - Domain rotary switch
    - Select frequency band of IMP noise core
    - 1-8, lowest to highest
  - Tone
    - Low-pass filter to remove harshness in higher domains
  - Frequency
    - Width
      - Width of Frequency band affected
    - Frequency CV input attenuator
  - Range
    - Range CV input attenuator
    - Width
      - Width of Range band affected
  - Domain (frequency range groups)
    - 8 switch-selected
- Tone control
  - Variable between low-pass and all-pass
    - Adjustment also varies phase interaction
- Inputs
  - CV, 0 to +5V
    - Over- and under-voltage protection
    - Frequency and Range CV (buffered)
    - Coarse Frequency and Range (Joystick)
    - Fine Frequency and Range (Joystick)
    - Frequency and Range Width (no attenuator)
- Outputs
  - CV, 0 to +5V
    - Coarse Frequency and Range
      - Joystick, buffered, non-breaking
    - Fine Frequency and Range
      - Joystick, buffered, non-breaking
  - Signal, ±5V
    - Noise out

        - ±5V soft-clip limited

Voltage-Controlled Oscillator (VCO):

- Variable base frequency
    - ~0.5Hz to ~140kHZ
    - Temperature compensated
    - 1V/oct tracking
    - CV input:
- Frequency Modulation
    - Selectable modulation source
        - Noise Signal from Imp
        - External signal
    - Variable modulation depth
    - External signal input
    - Level control
- Inputs
    - CV
        - ±12V
        - VCO frequency
    - Ext
        - External modulation source
        - AC-coupled
        - ±5V soft-clip limited
    - Mod CV
        - VCO Modulation Depth
- Outputs, ±5V
    - Square
    - Ramp
    - Saw
    - Triangle
    - Sine

Dual Voltage-Controlled Filter (VCF), one per channel:

- Controls
    - CV
        - Center Frequency CV input attenuator
    - fc
        - Center Frequency
    - Gain
        - Gain level
    - Selector switches (In VCA section)
        - In/Out
            - Have VCF either In or Out of VCF -> VCA signal chain (bypass)
- Inputs
    - fc CV
        - VCF center frequency
        - Buffered

- Ext In
    - External signal input
        - AC-coupled
        - Breaking
- Outputs
  - Ext Out
    - AC-coupled
    - Breaking

Dual Voltage-Controlled Amplifier (VCA), one per channel:

- Controls
  - Level
  - CV
    - VCA output level CV input attenuator
- Inputs
  - CV
    - VCA level
    - Buffered
  - In
    - External signal input
      - Breaking
- Outputs
  - Out
    - Signal out
      - ±5V soft-clip limited
      - Non-breaking
  - All Out
    - Average of VCA1 & VCA2
      - ±5V soft-clip limited
    - Control
      - Volume

Specifications

- Type
  - Paraphonic sound source/Oscillator
  - CV & Signal processor
- Format
  - Eurorack
- Width
  - 48hp / 243mm / 9.6"
- Depth below panel
  - 41mm / 1.625"
- Height above panel
  - 28mm / 1.25"
- Power
  - Current draw
    - +12V: 165mA (nominal)
    - -12V: -130mA (nominal)

- o 16-pin (2x8) Doepfer standard eurorack shrouded header
- o User-selectable +5V supply
  - System bus
  - Onboard regulated supply
- Included
  - o Module
  - o 9” 16-pin to 10-pin & 16-pin power cable
  - o (4) M3x1.5x6 mounting screws
  - o (4) nylon washers

Functional Features

- IMP noise core audio source, generated by the nonlinear heterodyning of a pair of oscillators. The IMP has eight frequency regions (Domains) of operation, from semi-random sub-audio impulses to above audio range, used as the primary frequency modulation (FM) source for the VCO. The output is also available to each signal chain as well as an independent output jack.

  Frequency of oscillation is controlled by Coarse and Fine joysticks with multiple Control Voltage (CV) inputs and other controls. The joysticks have breaking input jacks for controlling external signals, and non-breaking output jacks to allow the signal to be used externally as well as control the IMP.
- Voltage-Controlled Oscillator (VCO) with Square, Ramp, Saw, Triangle, and Sine, waveforms available to each signal chain along with independent output jacks for each waveform. The VCO has two user-selectable ranges:
  - 1 Volt per Octave (1V/Oct) covering ~19Hz to ~44kHz.
  - Low-Frequency Oscillator (LFO) covering ~750Hz down to ~0.0015Hz (~11 minutes per cycle).

The VCO can be modulated by the internal IMP noise core or by external modulation sources, and the modulation amount (depth) of either can be controlled by dial and CV.

- 2 Audio signal chains consisting of a Voltage-Controlled Filter (VCF) (bypassable) and a Voltage-controlled Amplifier (VCA), each with breaking inputs and outputs (I/O). These I/O allow the VCF and VCA to be used independently or as inserts to the signal chain to allow external effects to be added. The two VCA outputs can also be used to provide stereo imaging and effects.

The VCF are Voltage-Controlled Filters. Filter band width and Gain are varied by the Gain control and the filter's Center Frequency is varied by the fc control and can also be voltage-controlled.

- The VCF In/Out bypass switches remove the filters from the signal chain to pass the raw modulated VCO signal to the VCA.
- The VCAs have ±5V "soft-knee" output limiting protection for external modules. Instead of hard clipping, which squares-off the peaks of the signal, the soft-knee performs a gradual limiting of the signal as it approaches ±5V.
- Summed output of VCA 1 & VCA 2 available at the All Out jack, via the Volume control.

Design Features

- Lifetime warranty against defects in assembly
- Components on one side of PCB for easier serviceability
- Modular build to allow simpler repair or replacement of hardware
- All trimming potentiometers accessible without disassembly
- Pin-to-signal identification on PCB silkscreen to aid servicing
- No electrolytic capacitors in signal path or power circuitry

Now that we have gotten this far, please, continue on and RTFM.

What is it?

The Infernal Noise Machine is a <u>sound</u> synthesizer, not a <u>music</u> synthesizer.

It was designed towards the creation of noise, sound effects, and for the general field of sound design. Having said that, the INM can create a full range of "musical" tones and sound, but that was not the primary goal. It can be used completely independently, but is intended for use with external control voltage (CV) sources to affect or modulate various parameters, which is where the INM truly comes alive.

So what can you do with it? Incidental sounds and ambiances, unholy caterwauling, soundscapes from melancholy to manic, even percussion and traditional musical sounds. The Infernal Noise Machine is particularly effective for making drones that evolve with time, with no external sources required. The internal architecture allows for a wide range of self-evolving, beat-frequency style tonal variations over an infinite range of rates. There is really no simple way to describe what the INM can do – you have to find out for yourself. This is a unique device. It requires a bit of time and patience to get a feel for how it works, but it is worth the effort.

The INM does not operate the same way as a traditional synth. The traditional signal path in a synthesizer can be generalized as the following:

oscillator → filter/effects/mixing → output

The oscillator is the "heart", so to speak, and everything else comes further down the line. External modulation sources are used to vary different aspects of the components of the chain, e.g.: oscillator frequency, filter cutoff frequency and resonance, output level, and so on.

With the INM, the signal path is a bit different:

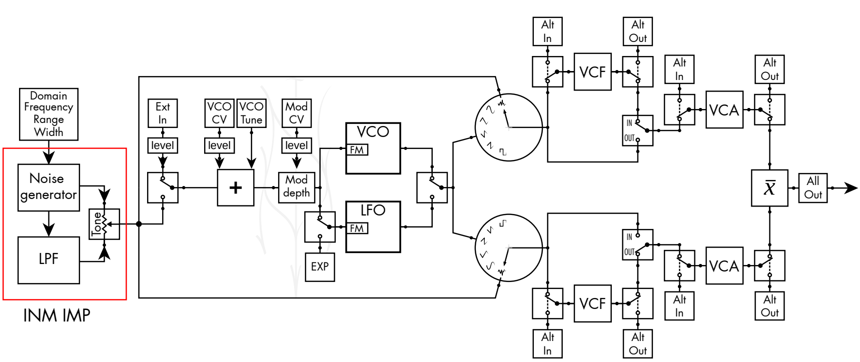


fig. 1, Signal Flow Diagram

The voltage-controlled oscillator (VCO) is <u>not</u> the heart, but an effect. The heart of the INM is the **Imp**, a voltage-controlled noise source. The

VCO is used to "color" the tone of the noise. While the actual signal path is technically the same as traditional synths, with the Imp being used to modulate the frequency of the VCO, the key to proper use of the INM is that the Imp is the core, and the VCO is an effect. The control panel is specifically laid out to enforce this relationship (figure 2).

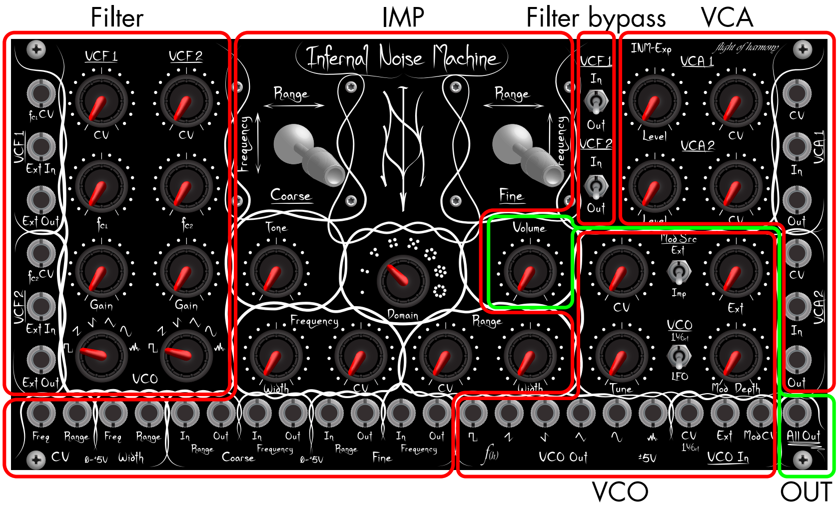


fig. 2, INM-E Panel

You know that part where a manufacturer says their product is new, unique, like nothing you've seen before? This is basically that again, but also a clarification that the Infernal Noise Machine does not work like most sound source modules. To be even more clear:

This thing will piss you off.

It was designed to do new things in new ways, so there is a learning curve. With both the original desktop INM and testers of the INM-E module, some dove in and immediately understood how to use it, while others had weeks of frustration, wondering why they kept getting variations of the same ear-splitting drone (It got its name for a reason). Your prior experience with synths doesn't matter, either. We are even still finding new things that can be done with it. Once it does click with you, however, you'll understand why we are so excited about bringing the INM-E to you.

Controls and Usage

Here is a brief explanation of the controls and their usage, described in the same order as the signal path (see figure 1).

IMP

Domain, Frequency, Range and Width: Technically, all four describe the same Function: what frequency the Imp puts out. The total possible range of the Imp, however, is from subsonic to ultrasonic, and accessed in different ways requiring multiple controls for fine-tuning.

Domain: The first stage of frequency selection. Domain selects one of eight wide bands of the overall range. Domain One is lowest, Eight is highest (in frequency). One is audible popping, Eight is nearly ultrasonic. The Domains 7-8 are where you will find the oddest/most ethereal Noises: static, wind, the impression of voices. It has a lot of what seem to be dead spots, but it is worth the time to wander the Domain and see what can be found.

Frequency: This is the main frequency control within the selected Domain - it sweeps over the entire Domain (depending on Range, see following). The Fine control sweeps up to 1/5 of the size of the band that Coarse does.

Range: This controls how wide of a sweep Frequency covers. Fine control same as with Frequency.

Width: Width makes the Fine into Extra Fine. In Domain 1, wide open is best. In Domain 8 the bands of sound are very narrow, so it is best to set the width all the way down to find the hidden sweet spots.

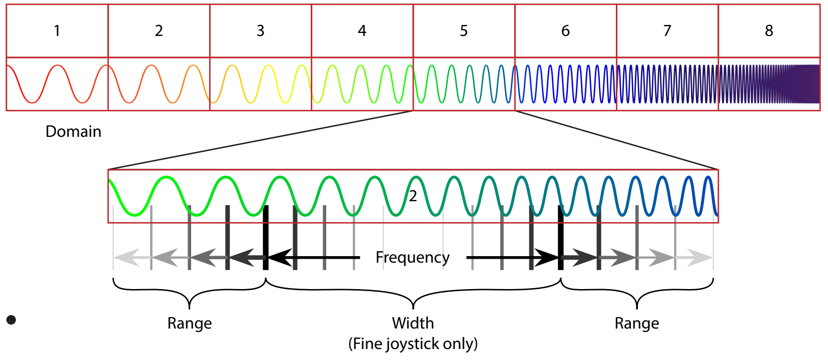


fig. 3, Domain vs. Range vs. Width.

In other words, 1/8th of the possible frequency range is selected by Domain, and the other controls select how much of that Domain the frequency control can sweep across. The Coarse joystick is for a broad sweep over the Domain, the Fine joystick is for finding the perfect "sweet spot", and Width is for when Fine isn't Fine enough.

CV Level: The CV inputs have attenuators to adjust the level of external signals. Fully clockwise is the actual CV level, fully counter-clockwise is full attenuation.

Tone: The Noise generator has two output amplifiers - a buffer and a low-pass filter (LPF), the Tone knob controls the mix/cross fade between these two outputs. The phase relationship between these outputs varies depending on the Noise frequency; sometimes in phase, sometimes 90°, sometimes 180°, and everything in between.

VCO

CV Level: Controls the attenuation of the external CV signal.

VCO Tune: Tuning control to adjust the frequency of the VCO.

Mod Src: Selects which signal is used to modulate the frequency of the VCO. **Int** selects the Imp, **Ext** selects the **Ext In** input. The switch should be to the **Int** position when no external source is connected.

Ext Level: Controls the attenuation of the **Ext In** signal.

Mod Depth: Controls how "deeply" the selected frequency modulation (FM) source affects the VCO. Turn fully clockwise for maximum modulation, fully counter-clockwise for zero modulation.

Main Filter Section:

After the VCO, the signal is routed the filter section, where it is split into two paths to feed into the two VCF.

Input: These switches select one of the available waveforms to send to the filter. The first five are supplied by the VCO - Square, Ramp, Saw, Triangle, and Sine, while the sixth connects the filter input directly to the output of the IMP – think of it as a VCO bypass.

Filter Bypass

Here we take a quick jump up by the VCA section, to the **Bypass VCF1** and **Bypass VCF2** switches. These two switches allow you to bypass the voltage-controlled filters (VCF) and send the selected signal (selected with the **Input** rotary switches) directly to its voltage-controlled amplifier (VCA) with no filtering. Now back to the filters:

Gain: Controls the gain of the filter. Fully counter-clockwise is (almost) full attenuation, fully clockwise is maximum gain. The gain is similar to "depth", but also greatly varies the filter character. Actual quantitative gain is dependent on the input frequency, so it's all over the place.

fc1 & fc2: These should be read as: "center frequency of filter 1 & center frequency of filter 2". These controls are used to change the f_c of the filter, changing what frequency band is emphasized and the overall tone of the signal.

CV Level: Controls the attenuation of the external CV signal. For the VCBPF, the CV varies the center frequency.

VCA section

This is the output section. Each of the two signals is sent to a VCA, and the outputs of the two VCA are summed together and sent to the All Out jack.

Level: The level control for the VCA. Fully clockwise is maximum (±5V), and fully counter-clockwise is full attenuation.

CV Level: Controls the attenuation of the external CV signal, used here to vary the level of the output signal.

Volume control

This is the last stop for the signal on its way to the All Out jack, the volume control. Turn clockwise for full volume, counter-clockwise for full attenuation.

INM-Exp

The INM-Exp is an additional set of five waveform outputs and three frequency controls for the Infernal Noise Machine.

The toggle switch selects how it is controlled: When set to **Exp**, the LFO output is controlled only by the expansion module and is isolated from the main unit, overriding and ignoring the CV+Mod source from the main INM-E. **Tune** controls the frequency, just as the one on the main INM-E, and CV is the level control for the CV input jack.

When set to **INM**, the LFO tracks the CV + Mod signal in the main INM-E as per usual and the INM-Exp knobs and CV jack are disconnected from the system; they do nothing. The LFO works as normal, but with the LFO waveforms additionally available from the INM-Exp jacks. This means the LFO tracks the 1V/octave VCO to some degree, but the LFO is not 1V/oct, so don't expect flawless tracking.

In specific:

fig. 18, INM-EXP LFO Expansion module

With INM-E VCO toggle set to 1V/oct and INM-Exp set to Exp:

- INM-E VCO outputs are 1V/oct rate, tracking CV +Mod source as explained in original description.
- INM-Exp outputs are LFO rate, tracking the INM-Exp Tune + CV jack, no modulation from the main INM.

With INM-E VCO toggle set to 1V/oct and INM-Exp set to INM:

- INM-E VCO outputs are 1V/oct rate, tracking CV +Mod source as explained in original description.
- INM-Exp outputs are LFO rate, tracking CV +Mod source as explained in original description, INM-Exp knobs and CV input are disabled.

With INM-E VCO toggle set to LFO and INM-Exp set to Exp:

- INM-E VCO outputs are LFO rate, tracking the INM-Exp Tune + CV jack, no modulation.
- INM-Exp outputs are LFO rate, tracking the Exp Tune + CV jack, no modulation from the main INM.

With INM-E VCO toggle set to LFO and INM-Exp set to INM:

- INM-E VCO outputs are LFO rate, tracking CV +Mod source as explained in original description.
- INM-Exp outputs are LFO rate, tracking CV +Mod source as explained in original description.

Tips

- *Take your time*. It is easy to get frustrated with the INM. I find the best stuff when I am just noodling around while testing (and end up taking an hour to test one unit because I got lost in the drones or something). I tend to have a harder time when I go in trying to make a cool sound. The INM is built on subtleties and small changes making big differences.
- When modulating the VCO, the greater effect is when the VCO and the Noise frequencies are closer together, i.e., the effect is minimal when the VCO is in the bass range and the Noise Domain is in Eight, but extremely dominant when similar in frequency.
- Saw on one channel + Ramp on the other channel = nothing. They cancel almost completely.

Calibration

Note: Scope display settings are how I do them and are provided for those with little experience. Do it however you want if you are familiar with the equipment

VCA

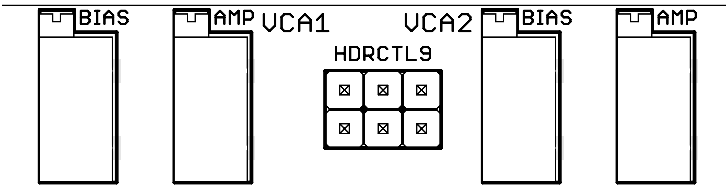


fig. 4, VCA calibration trimmer potentiometers.

Tools required:

- Oscilloscope
- Small flat-bladed screwdriver

Setup:

- Oscilloscope:
  - o Set display to 2.5 Volts per division
  - o Connect oscilloscope to **VCA Out** jack.
- Set related VCF bypass toggle to **Out**.
- Set Channel VCO waveform switch to Square.
- Set VCA **Level** to maximum (full CW[1]).

Procedure:

Observe waveform on oscilloscope display. Adjust to ±5V centered on 0 Volts (fig. 5). **AMP** adjusts amplitude of output, **BIAS** adjusts baseline shift from zero. Repeat for second channel.

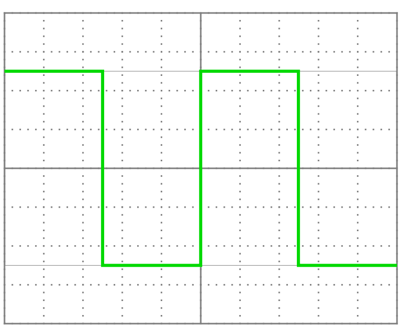


fig. 5, VCA calibration oscilloscope display.

1. CW = ClockWise, CCW = Counter-ClockWise

VCO

1 Volt Per Octave

Note: This is the Infernal Noise Machine, don't ask about tracking or how many octaves, k? If you want a precision VCO with perfect tracking across eighty octaves, you're in the wrong place.

Tools required:

- Small flat-bladed screwdriver
- Frequency meter
- Voltmeter

Reference points:

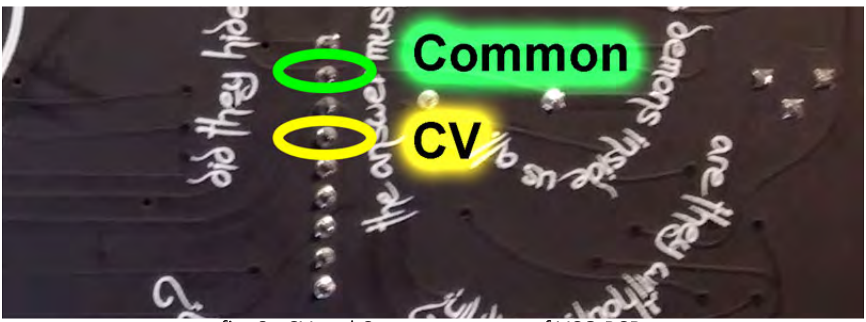


fig. 6, CV and Common on rear of VCO PCB.

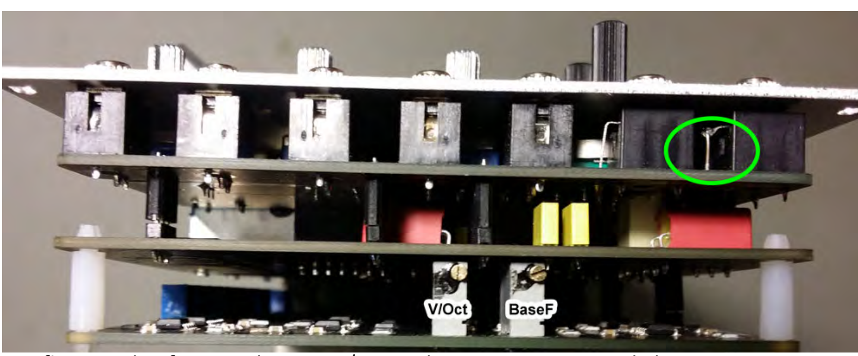


fig. 7, Side of INM-E showing V/Oct and BaseF trimmers, and alternate Common reference point.

Procedure:

- Power up your INM-E and allow it to warm up for about 30 minutes.
- Adjust VCO panel controls:
  - o Set **Tune** to midway.
  - o Set **CV** to minimum (full CCW)
  - o Set **Mod Depth** to minimum (full CCW)

o Set **Ext** to minimum (full CCW)
o Set **VCO** toggle to **1V/Oct**

Calibration

- Adjust the **Tune** knob until voltage at the pin marked "CV" in fig. 7 reads 0.00V.
- Adjust the **BaseF** trimmer (fig. 7) until frequency counter reads 800.0 Hz
- Apply 5.00VDC to **VCO In 1V/Oct CV** input. Turn **CV level** knob full CW.
- Adjust **V/Oct** trimmer (fig. 7) until output is 28.16 kHz
- Repeat the above three steps several times (usually 2-3 more times) until outputs are stable.

Modulation

Modulation of the VCA, both internal and external sources, is done with a dedicated modulation amplifier. The standard calibration is as follows.

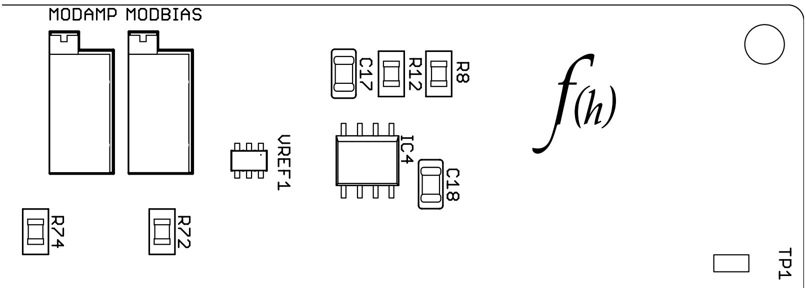


fig. 8, VCO Modulation trimmer potentiometers and TP1 test point.

Tools required:

- Function generator
- 2-channel oscilloscope
- Small flat-bladed screwdriver

Setup:

- Oscilloscope:
  - o Set display to 1V per division
  - o Set vertical mode to chop (display both channels simultaneously)
  - o Verify both channels set to same 0V baseline.
  - o Connect channel 2 to test point TP1.
- Function generator:
  - o Set to ±2V, 1kHz triangle output.
  - o Connect output to oscilloscope channel 1 and to **VCO In Ext** of INM,
- INM:
  - o Set **Mod Src** toggle to **Ext**.
  - o Turn **Ext** Level to maximum CW.

Procedure:

- Observe waveform on oscilloscope display. Adjust until channel 2 waveform is identical to channel 1 (fig. 9). MODAMP adjusts amplitude of output, MODBIAS adjusts baseline shift from zero.

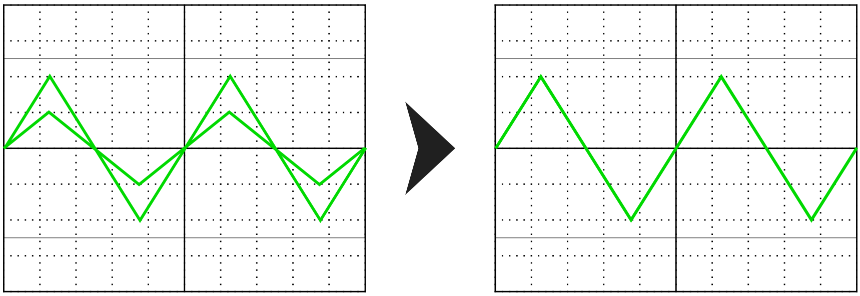


fig. 9, VCO modulation amplifier calibration oscilloscope display.

Waveshaping

VCO

Note: The VCO is a fairly standard ramp oscillator, with the Triangle created from manipulation of the ramp, which leaves some artifacts. The Sine is derived by distortion of the Triangle, so it contains some of these artifacts as well.

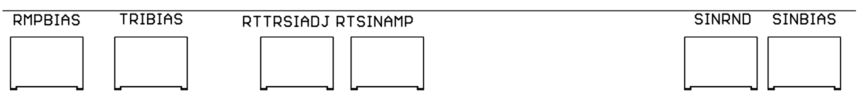


fig. 10, VCO waveshaping trimmer potentiometers

Tools required:

- Oscilloscope
- Small screwdriver

Setup:

- Oscilloscope:
  - o Set display to 2.5 Volts per division
- Set **VCO** toggle to **VCO**
- Set **Mod Depth** to minimum (CCW)
- Set **Tune** to midway.

Procedure:

Use the **VCO Out** jacks to calibrate each waveform in turn.

- **Square**
  - o Nothing to change here, please move along.
- **Ramp - RMPBIAS**
  - o Adjust **RMPBIAS** (fig. 10) until signal is vertically centered on 0 Volts (fig. 11)

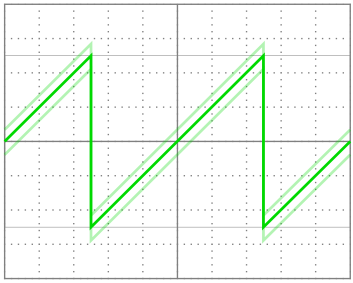


fig. 11, Ramp Bias adjustment display.

- **Saw — RMPBIAS**
  - Saw is just an inverted ramp, you've done enough already.
    - No, really, ignore any offset variance, *it's fine*.
- **Triangle — TRIBIAS, TRSIADJ**
  - **TRIBIAS** is identical in function to **RMPBIAS**. Adjust to correct waveform offset.
  - TRSIADJ controls the conversion of the ramp into a triangle, adjust this until the display shows an equilateral triangle-ish shape (fig. 12).
    - No, I'm *not* getting bored with writing this manual *at all*.

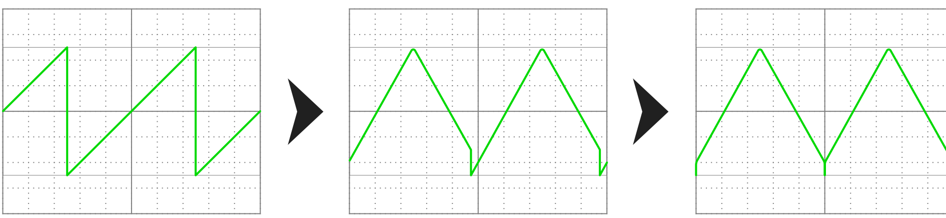


fig. 12, Effect of adjusting the TRSIADJ trimmer potentiometer

- **Sine — TRSIADJ**, **SINAMP**, **SINRND**, **SINBIAS**
  - Ready for fun? The sine is derived by nonlinear distortion of the triangle and has four trimpots that affect its shape. Sine is also the only one that has an amplitude adjustment. Because I'm nice like that.
    - I mean, really, the damn thing has enough trimpots already, doesn't it?
  - **TRSIADJ** affects both triangle and sine. Adjust to correct any unevenness at the bottom of the waveform, but it will also affect the triangle. Find a suitable medium.
  - **SINBIAS** is *not* the same as the other bias adjustments — the uppy-downy thing — it is the bias on the distortion applied to the triangle relative to the zero Volt baseline. Adjust this until the top and bottom of the sine are balanced (fig. 13).
  - Confession: the labels for **SINAMP** and **SINRND** are swapped. Ignore what the words mean please. You have to adjust the two of them together anyway, so it's not that big of a deal. Following this:
    - **SINRND** controls the amplitude (height) of the sine. Adjust this until the sine is roughly ±5V
    - **SINAMP** controls the roundness of the sine (fig. 14). Adjust this next until the shape resembles a sine wave.
    - If, for some reason, you really borked[2] your sine wave or are just having

2. Really screwed up.

fun screwing around, you may have to go back and forth between **SINRND** and **SINAMP** to get the shape right.

- You're not going to get a perfect sine wave, by the way. Noise Machine, remember?

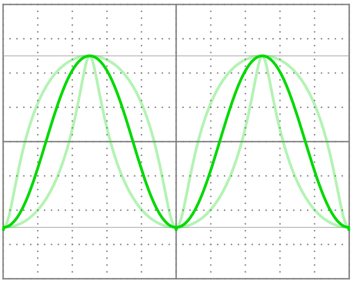


fig. 13, SINBIAS trimmer potentiometer adjustment.

fig. 14, SINAMP trimmer potentiometer adjustment.

LFO

Note: The LFO is a basic triangle oscillator, with all other waveforms derived by distorting the original triangle and its attendant timing square wave.

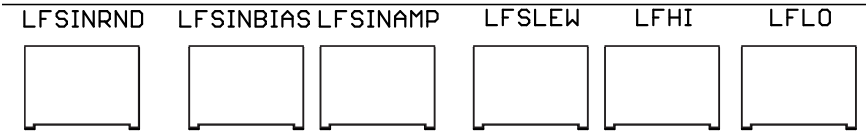


fig. 15, LFO trimmer potentiometers.

Tools required:

- Oscilloscope
- Small screwdriver

Setup:

- Oscilloscope:
  - o Set display to 2.5 Volts per division
- Set **VCO** toggle to **LFO**
- Set **Mod Depth** to minimum (CCW)
- Set **Tune** to 3/4 CW to full CW.
  - Enough to have several cycles visible in the display.

Procedure:

Use the **VCO Out** jacks to calibrate each waveform in turn.

- **Square**
  - o Sorry, you're S.O.L.[3] here too. Carry on.
- **Ramp** — **LFSLEW**, **LFHI**, **LFLO**
  - o The ramp is derived from the triangle by the annoyingly fiddly process of inverting and level-shifting the triangle and attempting to get the two images to line up. This can be very sensitive to component variances, hence the multitude of trimmer potentiometers.
  - o **LFSLEW** Don't touch this, please. Leave the pretty blue sticker alone. It is there just in case it was needed, but it ended up not being needed. It's on you to fix if you touch it; it adjusts the slopes of the two halves of the ramp (fig. 16).

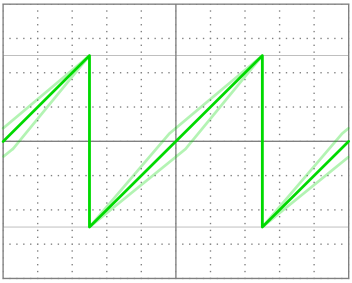


fig. 16, LFSLEW trimmer potentiometer adjustment.

  - o **LFHI**, **LFLO** these adjust the heights of the two halves relative to the zero Volt baseline. If you touch one, you will likely need to touch the other. These are annoying to deal with and must be adjusted carefully. **LFHI** adjust the position of the upper half, **LFLO** the other half. If these need adjustment, I start with **LFHI**, bringing it near the 0V line, then adjust **LFLO** to bring the bottom up. Both halves shift when adjusting each trimmer so, when you are close to both being on the line, alternate between both trimmers using the smallest changes possible.

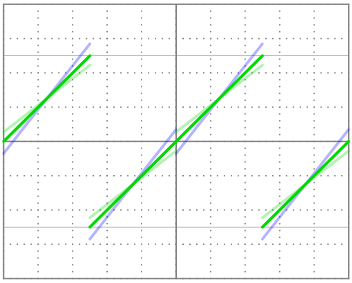


fig. 17, LFHI, LFLO trimmer potentiometer adjustment.

- **Triangle**
  - o IT'S FINE DAMMIT[4].

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3. Shit Out of Luck
4. This is the correct spelling, by the way. The "n" disappears when "damn" and "it" are contracted together.

- **Sine — LFSINRND, LFSINBIAS, LFSINAMP**
  - Same as for VCO sine on page 19 above
    - Yes, even the mixed-up labeling, thank you.

Thanks

Eternal thanks and appreciation to E.T., I.I., and C.L. for all the help in getting this thing going. Every bit of this ordeal was helpful!

Extra thanks again to HeWhoWantsJeans for putting up with my autistic ass all these years and supporting me through everything.

A huge shoutout to everyone who joined in in the Kickstarter and helped make this product launch a reality. The INM-E would not be here without your trust and support.

~flight

Guarantee

All f(h) products are guaranteed against defects in manufacturing and workmanship for the lifetime of the product. Please contact me via email at: support@flightofharmony.com

Stuff

Comments, suggestions, complaints to: flight@flightofharmony.com

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Published: March, 2021

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