



FREQ FM

8-BIT GENERATIVE DIGITAL FM SYNTHESIZER

OPERATION MANUAL

HARDWARE REVISION 1.50

FIRMWARE REVISION 1.30

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INTRODUCTION

The Freq FM is an 8-bit digital synthesizer for your desktop featuring dual FM voices paired with a 2-track generative sequencer.

From soul-soothing sine waves to multiverse-shredding modulated distortion, slapping bass lines to soaring arp leads, the Freq FM is a powerhouse of sound design packaged with a melodic and intuitive generative sequencer inspired by the likes of Elektron, Intellijel & Music Thing.

With 2 channels of liquid FM sounds, it plays great by itself or synced with your favourite external gear.

VOICES

- 2 independent FM voices
- 2-operator FM (for old-school Prince of Persia vibes!)
- Multi-mode FM ratios – quantised, free-multiple, independent
- Multiple operator waveforms for carrier & modulator – Sine, Saw, Reverse Saw, Square, Noise, Off
- Attack/Decay modulation envelope per voice
- LFO per voice with multiple waveforms and selectable destination: envelope attack, decay & depth, FM ratio, note length or modulation level

SEQUENCER

- 2/1.5 track polymeric sequencer with up to 16 steps per track (Both tracks use same note sequence but can have different step-counts for poly-metric rhythms)
- Multiple generative algorithms – (semi)random notes, (semi)random runs, arpeggio, drone
- Sequence mutates/evolves at user-defined rate & note-density
- Selectable tonic, octave & scale – Ionian (Major), Minor (Dorian), Pentatonic, Phrygian (GOA!), Octaves, Fifths
- Tap-tempo control
- Sync input & output (Eurorack and Korg Volca compatible)
- 16-step parameter-lock recording of synth parameters (**track 1 only**)

HARDWARE

- Audio output (16KHz 14-bit DAC)
- Sync input / output (0-5V rising-edge)
- Powered by an Arduino Nano V3
- 112mm (w) x 100mm (d) x 40mm (h)
- 7-12V DC or micro USB powered.
- Current draw 65mA @ 12VDC (v1.5 hardware)

QUICK START

VOICE SELECTION

- The Freq FM defaults to Control-All mode with both voices being controlled together
- Press [VOICE] to toggle between controlling voice 1 or 2
- Press [FUNC]+[VOICE] to go back to Control-All mode

SOUND SYNTHESIS

- Adjust attack, decay, envelope depth, amp decay, FM ratio and LFO settings to design your perfect 8-bit FM sounds
- The synthesis engine is quite deep with all controls having 2+ functions – read more for how to change waveforms, detune, octaves and FM modes

SEQUENCER

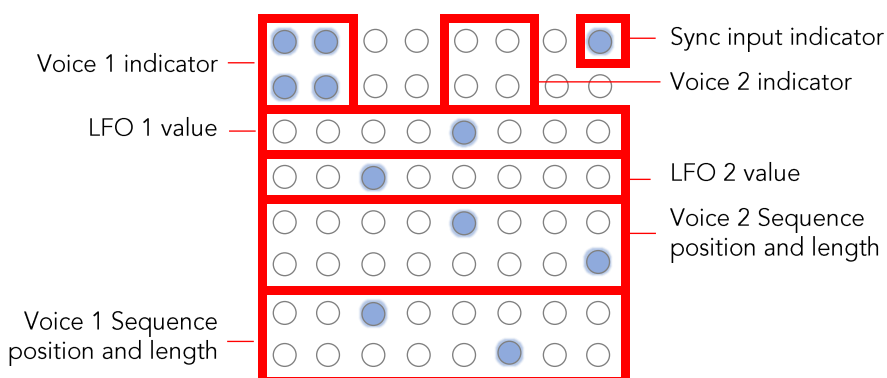
- The Freq FM has a generative sequencer which creates it's own musical patterns
- To set how fast the sequence changes, turn [MUTATION]
- To set how many steps have notes turn [DENSITY]
- To set how many steps are in the sequence (1-16) turn [SEQ LEN]

EXTERNAL/INTERNAL SYNC

- Freq FM has an internal clock which you can sync using the SYNC IN input.
- By default Freq FM is compatible with Volca/Pocket Operator (2 steps per pulse)
- To adjust this setting, hold [FUNC] when the Freq is booting up to enter Global Settings mode (see below for more information)

OPERATIONS MANUAL

DISPLAY



SOUND SYNTHESIS

VOICE SELECTION

- Press [VOICE] to toggle between the two voices
- Press [FUNC]+[VOICE] to toggle Control-All mode to control both voices at once

OCTAVE

- Hold [FUNC] and turn [AMP DECAY] to set the octave for the current voice

MODULATION ENVELOPE

- Use the [ATTACK], [DECAY] and [DEPTH] controls to set the shape and intensity of the modulation envelope

FREQUENCY MODULATION RATIO

- Turn [FM RATIO] to control the ratio between the carrier and modulator
- Hold [FUNC] and turn [MODE] to access different multiplier modes for the ratio



Quantised multiple



Un-quantised multiple (high range)



Un-quantised multiple (low range)



Unrelated

- Hold [FUNC] and turn [ATTACK/CARRIER] or [DECAY/MOD] to set the carrier/modulator waveform

LFO

- Turn [LFO DEPTH] to control the intensity of the LFO
- Hold [FUNC] and turn [LFO RATE] to control the speed of the LFO
- Hold [FUNC] and turn [DEPTH/LFO] to change the waveform for the LFO
- Press [LFO ->] to and turn [LFO DEPTH] to control what parameter is affected by the LFO



Mod attack



Mod decay



Carrier Waveform*



Mod envelope depth



Mod ratio



Modulator Waveform*



Amp decay



Base modulation depth



Octave*

*new in v1.30

OPERATIONS MANUAL (CONTINUED...)

SEQUENCER

- Press [START] to start the sequencer running
- Hold [FUNC] while tapping [START] to set the tempo. The Freq FM will average 4 consecutive taps

SYNC WITH OTHER GEAR

- The Freq FM responds to a rising-edge 5V trigger signal received on the SYNC IN jack.
- To control how many steps the sequencer advances:
 - Enter global settings mode by holding [FUNC] when the Freq FM is booting up
 - Turn [SEQ LEN] to adjust. The default value is 2 (U) (Volca compatible)
 - See global settings section below for more information
- Press [REC] to save the settings to EEPROM

MUTATION - HOW FAST THE SEQUENCE CHANGES

- More often: turn [MUTATION] clockwise
- Less often: turn [MUTATION] anticlockwise
- Never: turn [MUTATION] fully anti-clockwise

DENSITY - HOW MANY STEPS HAVE NOTES

- More steps have notes: hold [FUNC] and turn [DENSITY] clockwise
- Less steps have notes: hold [FUNC] and turn [DENSITY] fully clockwise

STEPS - (SETTING IS PER VOICE)

- More steps (up to 16), turn [SEQ LEN] clockwise
- Less steps (down to 1), turn [SQL LEN] anticlockwise

CLOCK DIVISION - (SETTING IS PER VOICE)

- Hold [FUNC] and turn [SEQ LEN] to adjust clock division from /1 to /64

MUSICAL TONIC & SCALE

- To change the scale, press [SCALE]
- To change the tonic, press [FUNC]+[SCALE]

ALGORITHM – HOW THE NOTES ARE GENERATED

- To change the generative algorithm, press [ALGO]

The generative algorithms are at the heart of the Freq FM.

1. Standard mode. Creates single notes in the current scale across multiple octaves, with a slight bias to the tonic note.
2. Arp-run mode. Similar to standard, but creates short 3-note runs in the current scale
3. Drone. Disables the sequencer and puts the modulation envelope into looping mode
4. Scale. Sequence loops through all scale notes with no generative algorithm
5. Call/Response. Same as standard mode, except notes only play every alternate cycle

PARAMETER LOCKING

- Hold [REC] while moving a control to record that movement into the sequence



is displayed when recording mode is activated

- Hold [FUNC]+[REC] while moving a control to delete all recorded parameter locks for that control



is displayed when recording-delete mode is activated

SAVE AND LOAD PATCHES (NEW IN V1.30)

- Hold [REC] and press [START] to load from temporary memory.
- Hold [REC] and double-click [START] to load from permanent memory
- Hold [REC] and press [SCALE] to save to temporary memory
- Hold [REC] and double-click [SCALE] to save to permanent memory

OPERATIONS MANUAL (CONTINUED...)

BUTTON CONTROLS

Button	Primary Function	Alternative Function (hold [FUNC])
[START]	Start or stop the sequencer	Tap tempo
[SCALE]	Select current musical scale 6. Ionian 7. Dorian 8. Minor Pentatonic 9. Phrygian 10. Octave 11. Octave + 5ths	Select tonic through natural notes A - G
[LFO]	Select the destination for the current voice LFO <ul style="list-style-type: none">• Mod Envelope Attack• Mod Envelope Decay• Mod Envelope Depth• Modulation amount• FM Ratio• Note length	Select the generative algorithm used to control the sequencer <ul style="list-style-type: none">12. Standard mode. Creates single notes with a bias to the tonic note13. Arp-run mode. Creates short runs of multiple notes in the scale will be inserted14. Drone. Disables the sequencer and puts the modulation envelope into looping mode15. Scale. Sequence loops through all scale notes with no generative algorithm
[VOICE]	Switch between voice 1 and voice 2 Hold down to adjust other parameters, eg hold [VOICE] and turn [FM RATIO] to adjust voice detuning.	Toggles all-voice control. When active, changes to control values affect both voice 1 and voice 2
[REC]	Hold [REC] while moving a control to record those parameter changes to the sequence	Hold [FUNC]+[REC] while moving a control to delete any recorded parameter changes from the sequence
[FUNC]	Access control's alternative function	n/a

OPERATIONS MANUAL (CONTINUED...)





ROTARY CONTROLS

Rotary Control	Primary Function	Alternative Function (hold [FUNC])
[MUTATION]	Control the likelihood that the sequence will change over time	Control the density of the sequence, i.e. how likely is a step to play a note
[SEQ LEN]	Control the length of the sequence for the currently selected voice	Control the number of steps the sequencer will advance per sync pulse (1 – 4)
[AMP DECAY]	Control the length of each note. In drone mode , this controls the carrier frequency of the voice	Controls the base octave of the currently selected voice
[LFO DEPTH]	Control the depth of the LFO for the currently selected voice	Control the rate of the LFO for the currently selected voice
[FM RATIO]	Control the FM ratio (ratio of modulator frequency to carrier frequency) for the currently selected voice	Control the FM ratio mode for the currently selected voice. <ul style="list-style-type: none">• Quantised multiple• Unquantised multiple (high range)• Unquantised multiple (low range)• Free (modulator unrelated to carrier) Hold [VOICE] to adjust voice detune.
[ATTACK]	Control the modulation envelope attack time for the currently selected voice	Select the carrier waveform for the current voice
[DECAY]	Control the modulation envelope decay time for the currently selected voice	Select the modulation waveform for the current voice
[DEPTH]	Control the modulation envelope depth for the currently selected voice	Select the LFO waveform for the current voice

GLOBAL SETTINGS

Hold [FUNC] for 3 seconds while the Freq FM is booting up to access the system settings.

When in Global Settings mode, press [REC] to save the current settings to EEPROM. These settings will then be loaded each time the Freq FM boots up.

Rotary Control	Primary Function	
[MUTATION]	Display brightness	Adjust display brightness from 1-15.
[SEQ LEN]	Sync Mode	 1 step per sync pulse. Internal clock disabled .
	Applies to sync input and output signals	 1 step per sync pulse. Internal clock enabled.
		 2 steps per sync pulse (eg volca). Internal clock enabled.
		 4 steps per sync pulse. Internal clock enabled.

SPECIFICATIONS

VOICE ARCHITECTURE

Voice 1		Voice 2	
Carrier	8-bit digital oscillator	Carrier	8-bit digital oscillator
Octave	0 - 6	Octave	0 - 6
Waveform	Sine, triangle, distorted-tri, square, pseudorandom, white-noise, off	Waveform	Sine, triangle, distorted-tri, square, pseudorandom, white-noise, off
Amp Decay	Note length ~4ms – ~16s	Amp Decay	Note length ~4ms – ~16s
Modulator	8-bit digital oscillator	Modulator	8-bit digital oscillator
FM Ratio		FM Ratio	
FM Mode	quantised, high multiple, low multiple, fixed	FM Mode	quantised, high multiple, low multiple, fixed
Waveform	Sine, triangle, distorted-tri, square, reverse saw, off	Waveform	Sine, triangle, distorted-tri, square, reverse saw, off
Mod Envelope		Mod Envelope	
Depth		Depth	
Attack time		Attack time	
Decay time		Decay time	
LFO		LFO	
Depth		Depth	
Rate		Rate	
Waveform	Sine, triangle, distorted-tri, square, reverse saw, pseudorandom, white noise, off	Waveform	Sine, triangle, distorted-tri, square, reverse saw, pseudorandom, white noise, off
Parameter locks		-	
Per step* parameter locks			
Note length			
LFO depth			
FM ratio			
Mod envelope attack, decay and depth			
* controls voice 1 but step based on track with longest sequence length			

SEQUENCER ARCHITECTURE

Track 1	Track 2
Sequence length	Sequence length
Current step	Current step
Note length	Note length
Clock Division	Clock Division
Sequence notes	
Sequence mutation rate	
Sequence note density	
Steps per sync pulse	

SPECIFICATIONS (CONTINUED...)

TECHNICAL SPECIFICATIONS

SPECIFICATIONS	
Synthesis	2-operator FM 8-bit digital oscillators
Polyphony	2 bi-timbral voices
Sequencer	16 step polymetric sequencer
Modulation	Attack/decay envelope per channel Multi-waveform LFO per channel Parameter locking per step (voice 1 only)
I/O	Audio out Sync in / out Power 9-12v USB (power and firmware update) Eurorack power (with modification)
External sync	Sync in & out 0-5v sync pulse 1 or 2 steps per pulse
Signal output	14-bit 16384Hz DAC Mono output
Microprocessor	Arduino Nano V3 (ATMEGA328P)
Power supply	Micro USB 9-12VDC 2.1mm Positive tip Can be adapted for +12V eurorack power
Display	8 x 8 LED matrix
Power consumption	65mA @ 12VDC (v1.5 hardware)
Dimensions	111mm (w) (~22HP) x 100mm (d) x 40mm (h)