VECTOR

Operator's Manual

CONTENTS

1   INTRODUCTION

Welcome to Vector, an experimental exploratory hardware synthesizer combining elements of several synthesis methods into a very special expressive blend.

The operator's manual is organized as follows:

- **Quick start guide** shows how to go from zero to sound in a short time while showing the major features.

- **Overview** describes the control elements of Vector.

- **Sound engine** contains detailed description of all Vector's features and main concepts (such as the Orbiter or Corners) as well as the principles of the sound synthesis method.

- **Configuration** shows available settings and presets.

- **Specifications** documents MIDI implementation or available connections.

Note:

Vector is still evolving which means this manual is being updated accordingly. Please check docs.beetlecrab.audio/vector for newer versions.

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2   QUICK START GUIDE

The quick start guide will lead you from zero to sound and show some of the most important features of Vector. For a comprehensive description of the machine and its sound synthesis engine, see the Overview section.

1. First, make sure the hardware is set up properly:

   - Connect a MIDI controller to the USB or MIDI IN jack.

   - Connect headphones to the Phones jack.

   - Connect the provided power supply and turn on Vector.

2. After Vector starts up, it shows the **Orbiter screen** ☽ – it is called after the blue orb which moves along a certain trajectory. Make sure the **Control** switch is in the Auto position.

3. Hit the **Focus** button twice. The blue orb moves to the first (top left) Corner.

4. Play a note and experiment with the five knobs just below the display which control the Corner parameters (**Overtone Gen 1 and 2**, **Overtone Blend**, **Filter Cutoff** and **Filter Resonance**).

5. Hit Focus again to move to the next Corner and create a different sound by playing a note. Each Corner has its own set of parameters.

6. Hold the Focus button to exit the focus mode. Notice the blue orb is moving along the trajectory again. Now, when you play a note, all four Corners are playing simultaneously and their mix is determined by the position of the green orb. Explore the periodic modulation.

7. The trajectory can be moved on the touchscreen or warped on the **Warp Pad**. Try the different shapes and speeds.

8. Next, try the **Arpeggiator**. Make sure the **Active** switch in the Arpeggiator section is turned on and that the **Feed Direction** switch is set to **Arp** or **Both** and slowly blinking. If it is not, enable the **Feed button**.

9. Play a chord to trigger the arpeggiator. You can transpose octaves of the individual steps in the top part of the **Effects screen** ⦀. You can also use the **Octave Walk** ⊞ to enable octave randomization.

10. Try the **Delay**. Set the **Feed Direction** switch to **Delay** or **Both** and the **Delay** knob in the Mixer section to approximately 50%. Play with the **Delay Time** and **Delay Feedback** on the **Effects screen** ⦀.

11. Play with **Chorus** and **Reverb** in a similar fashion (except the Feed Direction has no effect here).

12. Move to the **Presets screen** ▤ and try another preset from the **System presets** collection to explore more sound possibilities!

3   OVERVIEW

Vector is a digital desktop synthesizer based around the Orbiter. Four separate sound generators (Corners), each with a separate blend and filter stages, are mixed together based on the Orbiter position in a 2D space and the final mix is then processed by various Effects. The Corners are triggered either by notes sent from an external MIDI controller or from an internal Arpeggiator.

Vector's control elements consist of a 7" capacitive touchscreen display, 25 click-less rotary encoders, 7 toggle switches, and 4 buttons with status LEDs, all grouped into various sections on the Front panel.

Furthermore, the display is divided into a few screens:

- ☽ **Orbiter Screen**, the main screen with Orbiter,
- ⋕ **Effects Screen**, a "secondary" screen with Effects controls,
- 🕮 **Presets Screen**, which allows system and user Presets to be loaded and stored,
- ⋮⋮ **Routing Screen**, with per-preset Routing of selected MIDI parameters, and
- ⚙ **Settings Screen** with Global settings (MIDI etc.).

Orbiter screen is the main screen which appears on power-up and allows access to the "secondary" Effects screen. The Presets and Routing screens are accessible from the Effects screen while the Settings screen is accessible from the Routing screen.

3.1 Front panel

The control elements on the front panel are grouped into multiple sections: Input (1), Envelope (2), Mixer (3), Feed and Arpeggiator (4), and Sync (5).

This section covers the front panel elements in detail.
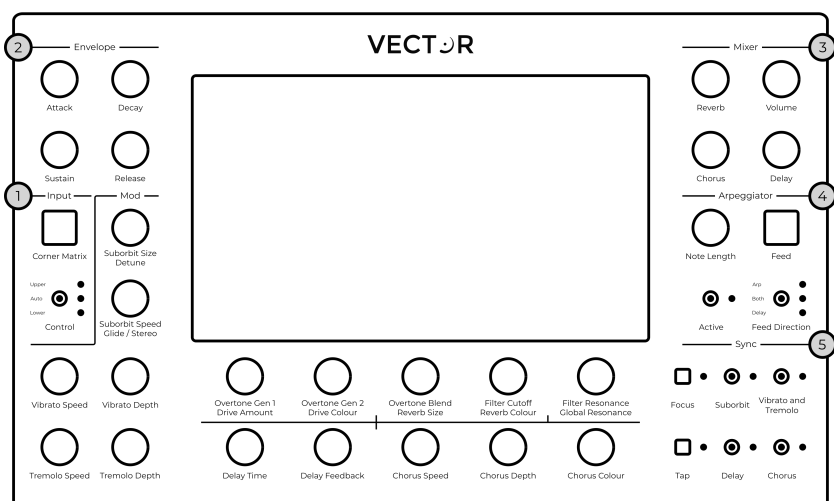
3.1.1 Input

The **Corner Matrix** button brings up the Corner Matrix, which allows the configuration and routing of filters and selecting which of the four Corners of the Orbiter are currently under editing.

Some rotary encoders have more than one function – in such a case the two functions are written below the encoder. The **Upper** function corresponds to elements on the **Orbiter screen** ☽ and the **Lower** function controls elements on the **Effects screen** ⦀.

The **Control** switch sets which function is used. In **Auto** mode, the function follows the active screen on the display for convenience.
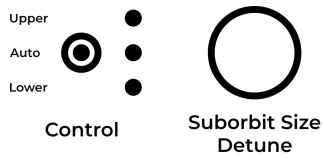
In the case illustrated above, the **Control** switch is in the **Auto** mode which means the encoder either functions as **Suborbit Size** or **Detune**, depending on the active screen.

> **Note:**
>
> The **Corner Matrix** button is called **Corner Select** on Vectors manufactured before 2021.

3.1.2 Envelope

Vector has two independent envelopes. The **Amp** envelope defines the shape of the amplitude of produced sounds, while the **Orbit** envelope defines the movement of the ADSR orbiter shape (see the Warp section for more details).

The knobs in the **Envelope** section control the the lengths of the **Attack**, **Decay** and **Release** phases and the level of the **Sustain** phase.
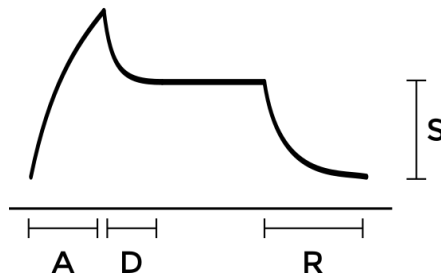
The envelope is triggered on a per-voice basis when a note is played. It is possible to choose either exponential (**Exp**) or linear (**Lin**) curve for each envelope.

Hints

- To use the same ADSR envelope for both the amplitude and orbiter shape, select the **Both** option on the screen.
- The final amplitude of the played note is affected by its MIDI velocity (subject to MIDI configuration).

3.1.3 Mixer

The **Mixer** section controls the amount of the individual effects (Reverb, Chorus, Delay) mixed with the dry signal and also the **Volume** of the final stage of the audio chain.

The level of the output signal is indicated on a bar graph meter on the **Orbiter screen** ☽. If clipping occurs, its colour turns red.

3.1.4 Feed

The **Feed Direction** switch enables the routing of notes to **Arpeggiator** and of audio input to **Delay**.

The **Feed** button cuts the connections altogether, while both Arpeggiator and Delay continue processing normally. When Feed is active, the respective LED next to the **Feed Direction** switch is flashing.
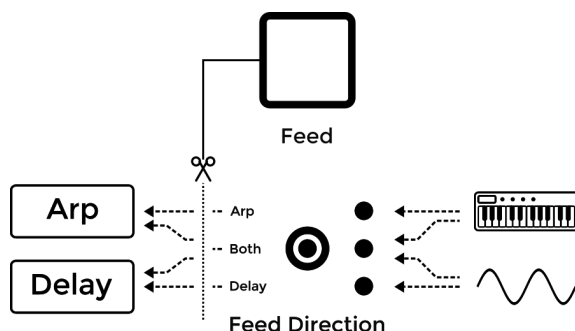
Using the two control elements, it is possible to have the following routing:

- Notes to Arpeggiator,
- Audio to Delay,
- Both, or
- None of the above.

The status of **Feed Direction** is also indicated in the **Delay** section on the **Effects screen** ⥮.

3.1.5 Sync

The **Sync** section allows the synchronization of the Orbiter's suborbit movement, Vibrato and Tremolo, Delay and Chorus to the main tempo or to let them run on their own. When an element is synchronized, it snaps to the closest time signature.

The LED next to the **Tap** button indicates the current tempo and the tempo can be changed by tapping the button several times. See the Tempo section for more details.

The **Focus** button temporarily disables the Orbiter movement and cycles through each the four Corners, making it easy to tweak the Corners' synthesis parameters. The focus mode is indicated by the associated LED and can be exited by holding the **Focus** button longer.

When the Corner Matrix is displayed, the focus mode cycles through the four Corners. When the Orbiter is displayed, the focus mode has an additional step in which the Orbiter is collapsed and placed in the middle of the screen. The additional step is useful to temporarily bypass the Orbiter and perform the movement manually.

4   SOUND ENGINE

4.1 Orbiter

Orbiter is at the heart of Vector. Each **Corner** (6) of the universe, or rather, the two-dimensional space (1), is formed by two Overtone Generators, Overtone Blend, and a filter.

The space also contains two orbs, blue (4) and green (5). The blue orb follows a given trajectory within the two-dimensional space, which is determined by Warp. The green orb orbits around the blue orb in a circular motion. This motion is referred to as Suborbit and its speed can be synchronized to the main Tempo. **Suborbit Size** and **Suborbit Speed** can be controlled by dedicated knobs. The whole mechanism is called the Orbiter.
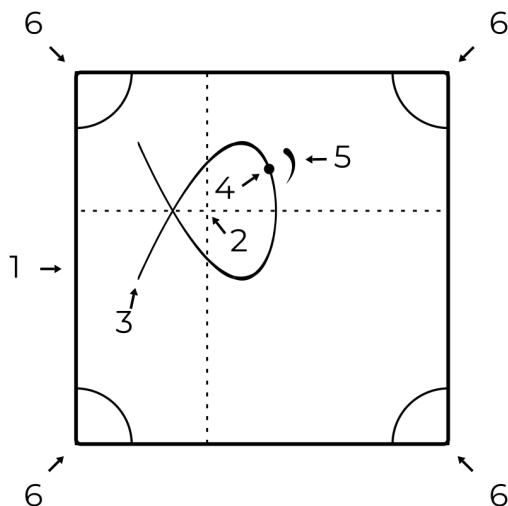
When a note is triggered, all four Corners play simultaneously and the final mix point of their outputs is determined by the green orb's position.

The centre point (2) as well as the rotation and size of the Orbiter trajectory can be set from the touchscreen interface. When **Retrigger** ●→ is enabled, the Orbiter motion always starts from the beginning of the shape – its zero phase (3) – on note input or after each cycle of the Arpeggiator sequence. Note that the zero phase can be changed by Warp.

Hints

- To control the movement of the Orbiter manually, press the Focus button once to stop the Orbiter movement along the warped trajectory.
- The centre point of the Orbiter can be also controlled by MIDI Control Change (CC) messages.
- If your MIDI controller supports aftertouch or MPE, try Routing it to Suborbit Speed.

4.1.1 Corners

Corners are the origin of sound synthesis in Vector.

Each of the four Corners consists of two **Overtone Generators** with six specific overtone patterns. The two generators are combined by the **Blend** element – additive in the first half (G1+G2), modulated in the second (G1×G2). In addition, each of the Corners has an associated filter which can be placed after Generator, Blend or Mix in the Corner Matrix.

All four Corners play at the same time and the resulting **Mix** is modulated by the position of the Orbiter.
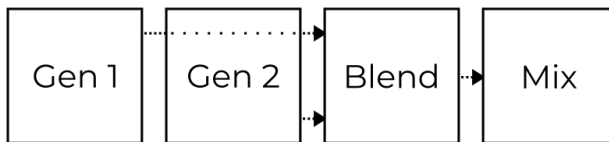
Each Corner is controlled by five parameters (**Overtone Gen 1 and 2**, **Overtone Blend**, **Filter Cutoff** and **Filter Resonance**) which are assigned to the five knobs just below the display. These knobs increase or decrease values of the selected Corners' parameters.

The individual filters' resonances are limited by the **Global Resonance** knob.

Hint:

The selection of Corners under editing can be changed in the Corner Matrix.

4.1.2 Warp

The Orbiter trajectory is defined by a warped shape. There are six basic shapes selectable on the **Orbiter screen** ☾:

- **ADSR shape** ⊐,
- Three **Lissajous shapes** ⋈⋈⋈ with increasing complexity,
- **N-gon shape** ⬡, and
- **Pulse shape** ⊓⊓.

These basic shapes can be distorted by dragging the rectangular **Warp Pad** (just below the shape selector) horizontally and vertically, or by dragging two separate sliders (for N-gon and Pulse shapes) in the same area.

The Lissajous, N-gon and Pulse shapes are always periodic and their speed can be set relatively (8 to 1/32) to the main Tempo using one of the speed selectors below the Warp Pad. Moreover, the resulting trajectory can be resized, moved or rotated by dragging it on the Orbiter screen.

When the ADSR shape is selected, the Orbiter follows a figure in which each stage of the envelope covers a different segment of the 2D space. The segments can be warped individually based on the segment selectors below the Warp Pad (A-D, D-S, S-R), while their endpoints can be moved on the Orbiter screen to form the desired trajectory. It is possible to use the same ADSR envelope for both amplitude and Orbiter or to have two independent sets of values depending on the selected configuration. See the Envelope section for more details.

The initial orbiter shape and position can be restored using the **Warp Reset** ⑧ button.

The pictures below shows examples of warped Lissajous 𝄂, ADSR ⊐, N-gon ⬡ and Pulse ⊓⊓ shapes.

Warp

Warp

Warp

Warp
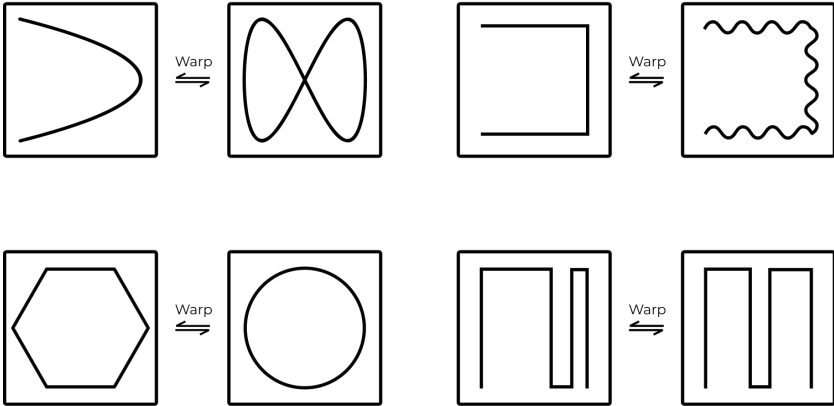
4.2 Synthesis

4.2.1 Overtone Generators

The **Overtone Generators** produce overtones (harmonics) in seven specific patterns. The first six patterns A-F are described in the table below while the seventh pattern, N, generates random noise. For a familiar mental model, It might be useful to think of the overtone patterns in a similar way as you would think of accordion or organ registers.

Overtone number

Overtone pattern	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	...	
A	+	-								-						...	Even
B	+	-				-				-				-		...	Even
C	+	+		+		+		+		+		+		+		...	Even
D	+		+		+		+		+		+		+		+	...	Odd
E	+		-				-				-				-	...	Odd
F	+		-								-					...	Odd

Patterns A–C include even overtones while patterns D–F include odd overtones (note that the 1st overtone, the fundamental, is always implied unless turned off in the Prime Slot tab of the Corner Matrix). Some overtones are present with positive and other with negative amplitudes, making it possible to subtract overtones when blending two patterns together.

> **Hint:**
>
> The blend of patterns C and D produces a sawtooth waveform.

The amplitudes of the overtones decrease such that the amplitude of the n-th overtone is either 1/n or -1/n, depending on the sign in the table.

The **Noisy overtones** pattern (N) generates random noisy content above the fundamental frequency played. It is based on a pink noise (1/f) generator with a resonant high pass filter tuned to the fundamental and can be used on its own or employed as a modulator or carrier in the all blend modes.
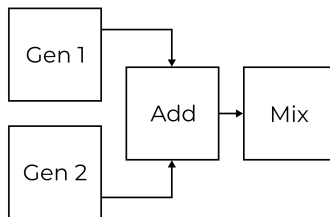
4.2.2 Overtone Blend

The Overtone Generators 1 and 2 can be blended together using the **Overtone Blend** knob. When the knob is in the centre position, the resulting set of overtones equals to Generator 1 (while Generator 2 is ignored).

Outside of the centre position, Blend operates in two different modes: **Additive** in the left and **Modulated** in the right half of the range.

Additive mode

When moving the knob to the left from the centre, the two generators are blended **additively** and the Overtone Blend knob determines the amount of Generator 2 overtones added to or subtracted from the overtones produced by Generator 1 (depending on the +/- signs in the Overtone Generators table), with the leftmost position corresponding to G1+G2.
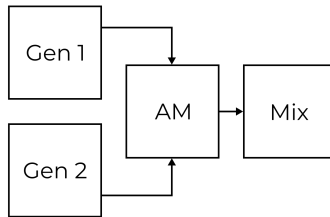

Modulated mode

When turning the knob to the right from the centre, the two generators are **modulated** (marked as G1×G2). Five different modulations are available in the Blend Mode tab of the Corner Matrix for each **Overtone Blend**:
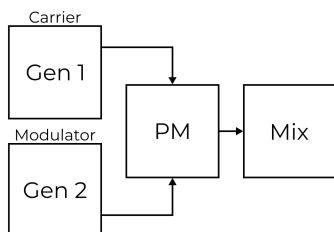
 - Amplitude modulation (AM),
 - Phase modulation (PM),

- Combination of both (PM+AM),
- Phase distortion and amplitude modulation (PD+AM), and
- Reversed PD+AM (rPD+AM).

In the **Amplitude modulation** mode, Generator 1 and Generator 2 are amplitude cross-modulated at the audio rate.

In the **Phase modulation** mode, Generator 1 is a carrier and Generator 2 is a modulator while the Overtone Blend knob determines the amount of the modulation.


In the **Combined PM+AM modulation** mode, Generator 2 frequency-modulates Generator 1, and then the result is audio-rate amplitude cross-modulated between the frequency-modulated Generator 1 and the original Generator 2.
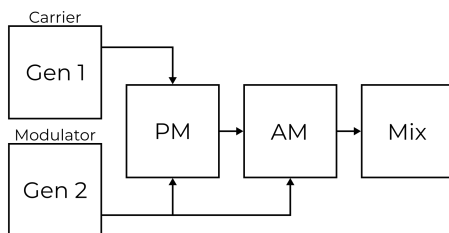
Finally, the **Phase distortion followed by amplitude modulation** mode applies a non-linear phase curve on Generator 2, which results in a time-domain "squeeze" of the waveform. The result is then cross-modulated using audio-rate amplitude modulation.
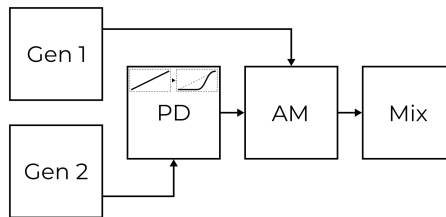
The **PD+AM** mode is complemented by a **reversed PD+AM** (or **rPD+AM**) mode with a reversed phase curve.
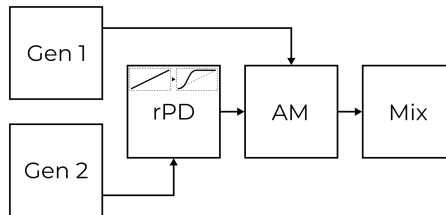
4.2.3 Corner Matrix

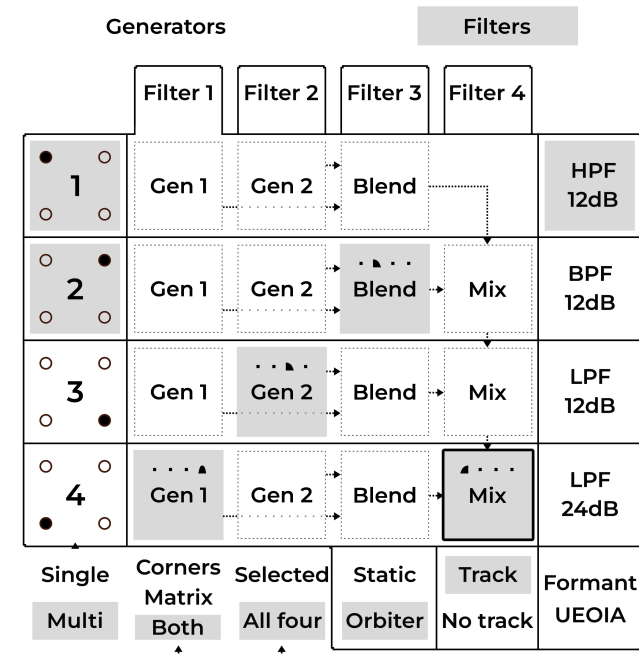The Corner Matrix is accessible on the **Orbiter screen** ☽ through the **Corner Matrix** button and allows for

1. selection of the Corners under editing (with **Single** or **Multi** selection possible),

2. configuration of the Randomizer (**Corners**, **Matrix** or **Both** and **Selected** or **All Four**),

3. versatile configuration of four independent filters (each filter can be placed to any point in the synthesis engine pipeline or bypassed), available in the Filters section,

4. configuration of the fundamental frequency (prime) slot, available in the Generators section,

5. selection of the modulation (G1×G2) mode for each Overtone Blend, available in the Generators section, and

6. individual detuning of all Overtone Generators, also available in the Generators section.

Hint:

The behaviour of the Corner Matrix button can be configured in Global settings.

Filters

The **Filter Matrix** allows for configuration of four independent filters. The picture below shows the Corner Matrix interface with four tabs representing each filter and four rows corresponding to each Corner.

Generators	Filter 1	Filter 2	Filter 3	Filter 4	Filters
1	Gen 1	Gen 2	Blend		HPF 12dB
2	Gen 1	Gen 2	Blend	Mix	BPF 12dB
3	Gen 1	Gen 2	Blend	Mix	LPF 12dB
4	Gen 1	Gen 2	Blend	Mix	LPF 24dB

Single	Corners Matrix	Selected	Static	Track	Formant
Multi	Both	All four	Orbiter	No track	UEOIA

Hint:

Notice the signal flow of the corners pipeline: the signal is cascading down in such a way, that if a filter is placed on the Mix element, that filter will process the sum of all previous corners' outputs.

To select Corners for editing, tap one or more of the buttons (labeled 1 to 4) in the first column. The selected Corners can then be controlled by the five Corner parameters knobs just below the display.

To slot a filter, select one of the four filters on the tabs (labeled Filter 1 to Filter 4) and then tap one of the elements in the Corner Matrix. The filter is then placed between the selected element's output and the next element's input, as an insert.

In this particular example, Filter 1 is currently under editing and it is configured as a high-pass filter tracking the fundamental frequency of played notes. Filter 2 is placed after Blend of Corner 2, Filter 3 is placed after Generator 2 of Corner 3 and Filter 4 is placed after Generator 1 of Corner 4 – the number of the filter is always indicated by one of the four icons for convenience. Two Corners 1 and 2 are selected, which means their values are changed by the five knobs just below the display.

Hint:

It is possible to cycle through the selected Corners/Filters by entering the Focus mode (this temporarily bypasses the **Single** or **Multi** selection).

Filter types

Five different filter types are available:

- ◢ **12dB/oct High-pass** filter passes frequencies above **Filter Cutoff** (and attenuates frequencies below the cut-off frequency).

- ◣ **12dB/oct Low-pass** and ◥ **24dB/oct Low-pass** filters pass frequencies below Filter Cutoff.

- ◢ **12dB/oct Band-pass** filter passes frequencies inside a band with its centre frequency defined by Filter Cutoff.

- ◣ **Formant** filter boosts or attenuates frequencies selectively as to emulate the resonance of different vowels. The Filter Cutoff parameter aligns the filter with the U-E-O-I-A vowels, while Filter Resonance controls the filter's amount.

A filter can be configured to either **Track** the played notes (so the cut-off frequency is relative to the fundamental frequency of the note) or interpret the cut-off frequency as an absolute value.

If a filter is **Static**, it is assigned to one specific Corner of the Orbiter (Filter 1 to Corner 1 etc.), which means its properties are always controlled by the specific Corner's parameter no matter where in the Corner Matrix it is placed. Otherwise the parameters **Filter Cutoff** and **Filter Resonance** are modulated by the current Orbiter's position, as shown by the top-most bar of the Resonance and Cutoff indicators at the bottom of the screen.

> **Hint:**
>
> By stacking filters on top of each other, they will be processed serially. Filters of the same type and tuning will effectively increase their total cutoff to up to 48dB/oct, but beware of out of control resonances in such scenarios.
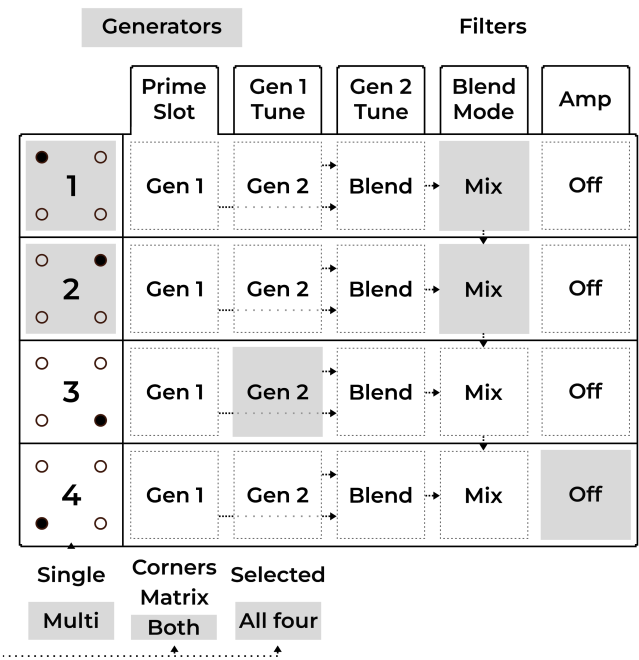
Generators

The **Generators** section of the Corner Matrix allows of the individual Overtone Generators (two per each corner).

Prime Slot

The **Prime Slot** tab determines where in the signal chain the fundamental frequency is added.

In this particular example, the fundamental of Corners 1 and 2 is added to the final mix of the corners, the fundamental of Corner 3 is added to the output of its Generator 2 and the fundamental of Corner 4 is not utilised (Off):

Chapter 4. Sound engine

Gen Tune

The **Gen 1 Tune** and **Gen 2 Tune** tabs allow for individual de-tuning of all Overtone Generators by a fixed ratio (before the Blend modulation). However, the fundamental frequency remains unchanged.

The fixed ratios 1/2, 1/3, 1/4, and 1/5 correspond to one octave down, one octave and a fifth down, two octaves down, and two octaves and a major third down, respectively.

In this particular example, Generator 1 of Corner 2 is detuned to one third of the fundamental frequency while others are unchanged (1×):

Blend Mode

The **Blend Mode** tab allows for selection of one of the five modulation (G1×G2) modes modes for each corner. The individual modes are described in the Overtone Blend section.

In this particular example, all corners are using the combined PM+AM mode:

|	Generators			Filters	
	Prime Slot	Gen 1 Tune	Gen 2 Tune	Blend Mode	Amp
1	PM	AM	PM AM	PD AM	rPD AM
2	PM	AM	PM AM	PD AM	rPD AM
3	PM	AM	PM AM	PD AM	rPD AM
4	PM	AM	PM AM	PD AM	rPD AM

Single — Corners Matrix — Selected
Multi — Both — All four

Amp

Finally, the **Amp** tab allows for individual volume configuration of each corner with an optional per-corner limiter.

In this particular example, corners 1, 3 and 4 are set to the maximum volume, while the volume of corner 2 is lower. Corners 1 and 2 have the limiter enabled.
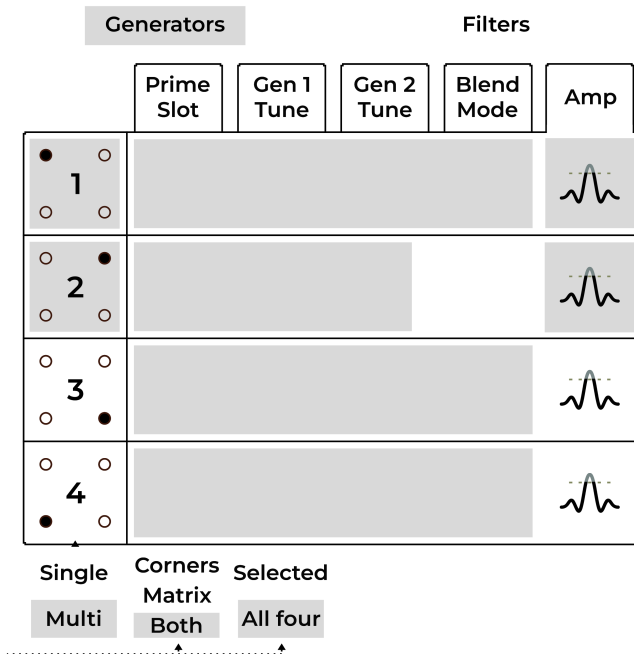
4.2.4 Randomizer

The Randomizer is available on the **Orbiter screen** ☽ and allows for randomization of the Corner's parameters and Corner Matrix.

The **Randomize** ⊞ button generates a new set of parameters for all selected Corners (and the Corner Matrix) while the **Undo** ☏ button reverts back to the previous state.

The scope of randomization can be either four **Corners**' parameters, the **Corner Matrix** configuration or **Both**. Moreover, it is possible to restrict the randomization to only the **Selected** corners as opposed to **All Four** of them.

Hint:

The scope of the Randomizer can be configured in the Corner Matrix.

4.3 Polyphony

Vector supports three distinct polyphony modes with different sets of parameters.

Table 1: Available parameters in different modes

	Mono	**Dual**	**Poly**
Detune	Stack	Follower	Drift
Glide/Stereo	Glide	Stereo Bias	Stereo Scatter
Volume	Stack	Follower	–
Suborbit Offset	–	Follower	–
Voices	1 to 16	8	16

4.3.1 Poly Mode

In the **Poly Mode**, each new note is played by a separate voice, resulting in a 16-voice polyphony. New individual voices can be randomly scattered (panned) across the stereo space using the **Glide/Stereo** knob and periodically randomly detuned by an amount controlled by the **Detune Drift** knob.

4.3.2 Dual Mode

In the **Dual Mode**, each note is played by a separate voice which is complemented by a second **follower voice** with an altered pitch and amplitude. This mode thus effectively reduces the maximum number of concurrently playing voices to eight.

The pitch of the follower voice can be adjusted by the **Detune Follower** knob while the amplitude is controlled by the **Follower Volume** slider on the **Effects screen** ⦙⦙.

The **Suborbit Offset** slider controls the suborbit phase offset between the main and the follower voice while the **Glide/Stereo** knob controls the stereo bias of the main voice (with the 50% value representing no bias). When the main voice is biased to the left, the follower voice is panned to the right and vice versa.

4.3.3 Mono Mode

In the **Mono Mode**, all voices form a **voice stack** dedicated to playing one note, with each of the voices being slightly detuned by an amount derived from the **Detune Stack** knob and panned (evenly spread across the stereo space).

The number of available voices can be reduced using the **Voices** slider on the **Effects screen** ⦙⦙, which when reduced to a single voice makes Vector act as a monophonic synthesizer. The **Stack Volume** controls the relative amplitudes of the voices in the stack except for the first voice.

The **Glide** knob controls the portamento time (i.e. the amount of time it takes to change the oscillator pitch between two overlapping notes). Glide can thus be used to play a legato effect by pressing a note followed by another note without releasing the first one. Legato can be also played by the Arpeggiator if two adjacent steps are **chained** ⦻ together.
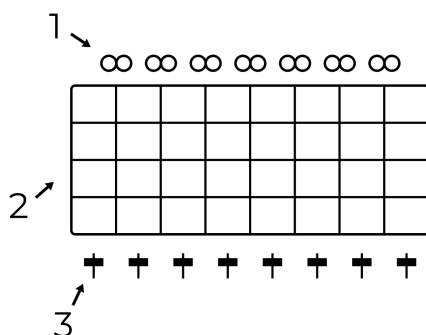
4.4 Arpeggiator

The Arpeggiator records notes from its input and plays them out sequentially in eight steps, with multi-octave transpositions.

The **Active** switch enables or disables the arpeggiator while the **Note Length** knob adjusts the length of notes played in each step relatively to the arpeggiator tempo (which is derived from the main Tempo and can be set to different time signatures).

4.4.1 Step Grid

The **Effects screen** allows for more detailed control over the arpeggiator. The **Step Grid** (2) represents the arpeggiator sequence with octaves spread vertically. It is possible to select octave transposition for each step or to disable it completely. The velocity of each step in the sequence can be adjusted using the sliders below (3). The adjacent notes can be chained together (1) into one.

The chaining either generates legato in the Mono polyphony mode or joins two steps with equal octaves in the Dual and Poly modes.

The arpeggiator note memory can be temporary (with arpeggiator playing only the currently pressed notes), **Latched** 🎹 (notes stay in memory even after they are released), or **Step-recorded** ●REC. The order in which the notes are played out can be sorted **Up ↑**, **Down ↓** or **Shuffled ⤨**.

4.4.2 Randomization

To make the pattern produced by the arpeggiator vary over time, some of the parameters can be set to be automatically randomized while the arpeggiator is playing:

- **Octave Walk** 🎹 periodically alters octave transpositions of the individual steps.
- **Chain Walk** ⟳ alters the steps' chaining.
- **Humanize** alters note lengths.

Hints

- To feed notes into the arpeggiator, the **Feed Direction** switch must be set to **Arp** or **Both** and the **Feed** button has to be active (indicated by flashing LED), as described in section Feed.
- Depending on the Feed configuration, the arpeggiator can play in the background.
- To release notes from the arpeggiator, press the **Latch** 🎹 button twice.
- At least some octaves in the grid have to be enabled in order to make the arpeggiator output notes.
- The arpeggiator can be fed from a separate MIDI channel as described in MIDI configuration. It can be also configured to output notes to a selected MIDI channel.

4.5 Effects

Vector has multiple effects connected to the output stage of the main mix of all Corners. Unlike Corners, the effects are independent of the Orbiter position.

The Effects' parameters are accessible on the two bottom-most rows of encoders (depending on the Control switch configuration for some of them) with additional options available on the **Effects screen** ⌗.

> **Hint:**
>
> To hear the output of Reverb, Chorus or Delay, the respective knob in the Mixer section has to be turned up.

4.5.1 Vibrato and Tremolo

Vibrato and tremolo are effects which periodically modulate the pitch and amplitude of the played notes. They are characterized by two parameters, depth and speed.

Vibrato Depth controls the amount of the pitch variation and **Tremolo Depth** controls the amplitude variation, while **Vibrato Speed** and **Tremolo Speed** control the frequency of each variation.

The speed can be synchronized with the main Tempo using one of the switches in the Sync section.

> **Hint:**
>
> To disable Vibrato or Tremolo, turn the respective Depth knob to zero.

4.5.2 Drive

Drive is derived from an overdrive effect known from guitar amplifiers where the input signal is saturated so that clipping occurs, adding a number of new harmonics to the signal.

The effect consists of a band-pass filter followed by a saturator, wired in parallel. The filter's cut-off frequency is controlled by the **Drive Colour** knob, while **Drive Amount** controls both the input gain of the saturator and the contribution of the Drive effect to the final mix.
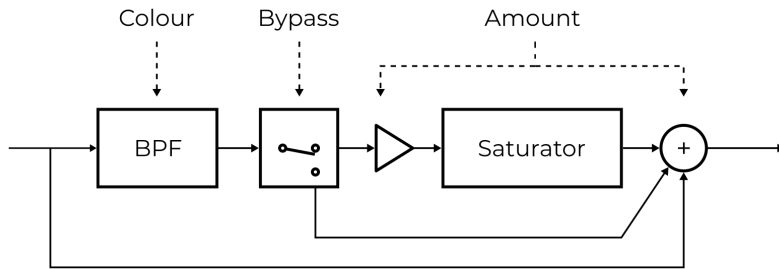
The **Bypass** button on the **Effects screen** disables the saturator. In this case, the **Drive Amout** only sets the mix level of the effect's band-pass filter.

4.5.3 Chorus

Chorus mixes together sounds played back at different pitches, resembling the effect of a choir or an orchestra section. It consists of several variable delay lines and an optional band-pass filter which are characterized by three parameters:

- **Chorus Depth** controls the amount of detuning.

- **Chorus Speed** determines the speeds of the variable delay lines (this can be synchronized with the main Tempo using one of the switches in the Sync section and additionally **slowed down** 🐢 by a factor of two).

- **Chorus Colour** controls the band-pass filter's cutoff frequency if the filter is **enabled** ⟑.

The effect can operate in mono or stereo. If the **Stereo Mode** 🎧 is enabled, the effect's output is different for the left and right channels.

4.5.4 Delay

The Delay effect adds a delayed version of the audio signal to the final mix.

Delay Time controls how much is the signal delayed and **Delay Feedback** controls the amount of output signal being fed back into the delay. Furthermore, Delay can be set to a **dotted time** ● and the feedback signal can be routed through an optional **Band-pass Filter** ⌐△.

If the Delay Feedback is set to a maximum (and the band-pass filter is disabled), the Delay effect behaves as a looper. If the feedback is set to zero, the internal audio buffer is fully cleared after one Delay Time period. If needed, the buffer can be **cleared manually** 🗑.

Delay can operate in mono or stereo. In the **Stereo Mode** 🎧, the effect's output is different for the left and right channels ("ping-pong").

Hints

- To feed notes into the delay, the **Feed Direction** switch must be set to **Delay** or **Both** and the **Feed** button has to be active (indicated by flashing LED), as described in Feed.
- Try recording a sample played by the Arpeggiator and then play it over a different sequence.

4.5.5 Reverb

Reverb simulates the reverberation of sound in a physical environment caused by reflections from the boundaries (walls of a concert hall for example).

Reverb Size increases the persistence of the processed sound (in the same way as larger rooms produce longer reverberation), while **Reverb Colour** controls the cutoff frequency of a band-pass filter at the effect's output.

The effect operates in stereo mode so its output is different for the left and right channels.

5   CONFIGURATION

5.1 Tempo

Vector works with a main tempo which is used to synchronize the movement of the suborbit, sequencing of the Arpeggiator or timing of effects. The synchronization of the individual parts can be enabled or disabled by the switches in the Sync section.

When Vector is **playing** ▶, the tempo is indicated by an LED next to the **Tap** button in the Sync section. The tempo can be either tapped into the button or adjusted by pressing and dragging the BPM indicator on the **Effects screen** ⁝⁝⁝. When Vector is **stopped** ■, no tempo is being generated and Orbiter and Arpeggiator are also stopped.

The main tempo operates in multiple modes:

- 🎚 **Stand-alone Mode** (default), in which the tempo is generated by Vector and used only internally.

- 🎚 **Send Mode**, in which the tempo is generated by Vector and transmitted over MIDI to other devices.

- 🎚 **Receive Mode**, in which the tempo is received from an external device (such as a drum machine or a sequencer).


Hints

- The tempo mode and BPM can be stored persistently on the **Settings screen** ⚙. See MIDI configuration.
- The MIDI tempo can be additionally slowed down by a fixed divider. See the Global slowdown parameter in MIDI configuration.

5.2 Presets

The **Presets screen** 📖 allows access to presets organized in categories and pages (with 50 presets per page). A preset contains all parameters defined on the Orbiter and Effects screens.

The **System presets** category contains read-only presets which can change with firmware upgrades while the **User presets** have space for presets which can be stored and renamed and are preserved during firmware upgrades. There are three pages (150 slots) available for the user presets.

To store a preset, select a slot and press **Save**. If the slot is not free, it will be overwritten with the new values. The **Routing lock** ♨ button next to the Save button controls handling of the Routing table.

Warning:

Do not power off Vector when saving a preset, wait for the confirmation message first.

Hints

- The **default preset** (loaded after Vector is powered up) can be configured on the **Settings screen** ⚙ (see the Miscellaneous configuration section).
- It is possible to change the current preset by MIDI **Bank Select** and **Program Change** messages. The Bank Select chooses the preset category and page while the Program Change loads an individual preset from that page.

5.2.1 Preset import and export

User presets can be stored to or loaded from a USB drive either individually or as a full backup. Only drives formatted to the FAT32 filesystem are supported at the moment.

The external drive connected to the USB Host port can be accessed on the **Presets screen** 📑. When a USB drive is plugged in, a third category **External** appears alongside **User** and **System**.

Warning:

Always use the **Eject** ◀ 💾 button before physically unplugging the external drive to prevent data loss.

Accessing individual presets

When a USB drive is present, the **External** category allows access to presets stored on the drive. This method is useful for transferring presets between Vector and a computer.

The category has 5 pages and supports **Save**, **Load** and **Rename** operations in the same way as the **User presets** category.

Presets on the external drive are stored in a directory named `vector-presets` as one file per preset slot. Preset file names are derived from their slot numbers (shown in the bottom left corner of each slot).


Hint:

To copy a preset from User to External, first load the target preset and then save it to a free slot in the **External** category.

Archiving all presets at once

It is also possible to backup or restore an archive containing all **User presets** at once. This method is useful for making backups of the full preset bank.

The **Backup** ↺➜⬗ button archives all User presets to file named `vector-user-archive.zip`. If the file is already present on the external drive, it is overwritten by the backup operation.

The **Restore** ⬗➜↺ button overwrites all User presets slots with presets present in `vector-user-archive.zip`. Preset slots which are used in Vector but are not present in the archive are preserved.

Hint:

Please note that the preset archive created by the Backup button is stored in a different location than presets in the **External** category. As a result it is not possible to load only a specific preset from the archive; it is only possible to perform a backup or restoration of all presets at once.

5.3 Routing

The **Routing screen** ⠿ enables custom mapping from MIDI **Controllers** to polyphonic **Parameters**. The routing is stored per-preset so that each preset can respond to an expressive controller in a different way.
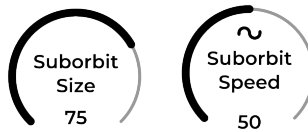
When a Parameter is connected to a MIDI Controller, its control element on the **Orbiter screen** ☽ or **Effects screen** ⋮⋮⋮ is marked by a small wave **~**. In the following example, Suborbit Speed is routed to a controller while Suborbit Size is not connected:

Suborbit
Size

75

~
Suborbit
Speed

50

5.3.1 Routing table

Each **Parameter** is represented by a single row of the multi-page routing table:

Controller	Controller Range		Parameter Range		Preview	Operator	Parameter
	Min	Max	Min	Max			
Velocity	0	127	0	127	⟋	Set	Volume

The **Controller** button selects one of the supported MIDI message as an input for a **Parameter** (or sets it to **Not connected**, i.e. not controlled by MIDI). In this particular example, the maximum amplitude of each voice (volume) is controlled by the velocity of Note On messages.

The slope and offset of the transfer function from a controller to a parameter can be controlled using the **Controller Range** and

Parameter Range columns, each with **Min** and **Max** sliders. The shape of the transfer function is displayed in **Preview**. In the example above the mapping is 1:1 and no scaling takes place (note that the range of MIDI messages is 0 to 127).

Moreover, there are three different **Operators** available for each Controller-Parameter pair:

- The **Set** operator overrides the current position of the knob on the Front panel.

- The **Add** operator adds the controller value to the current knob position. Values less than or equal 63 are subtracted while values greater than 63 are added to the knob position.

- The **Mul** operator multiplies the controller value with the current knob position. This allows to control the maximum possible amount of modulation while playing.

Some of the parameters support only the Set operator (Volume and Pitch) while some only support the Add and Mul operators (the corner parameters Overtone Blend, Filter Resonance and Filter Cutoff).

Hints

- A single controller can transmit to multiple parameters scaled in different ways with different operators.
- To invert a parameter, set Controller range to 0–127 and the Parameter range to 127–0.
- To scale a parameter 2×, set the Controller range to 0–64 and the Parameter range to 0–127.
- The dot in Preview is live and shows the current value of the controller, handy for routing verification.
- The velocity sent by the Arpeggiator step sliders can be routed too.


5.3.2 Storing and copying

The Routing table is stored per-preset. To store modifications in a routing table, navigate to the **Presets screen** 📄, choose a preset in the **User** section and press **Save**.

The **Routing lock** 🔒 button next to the Save button allows to load or save a preset without modifying the current routing. When active, loading a preset will not affect the current routing table and saving or overwriting a preset will preserve its original routing table.

The **Copy** and **Paste** buttons allow to transfer the routing table between presets. It is also possible to **Clear** the routing table or initialize it to the **Default** state.

Hint

To copy a routing table from preset A to preset B:
1. Load preset A on the **Presets screen** 📄 (make sure **Routing lock** 🔒 is not active).
2. Press **Copy** on the **Routing screen** ☰.
3. Load preset B on the **Presets screen** 📄.
4. Press **Paste** on the **Routing screen** ☰.
5. Save preset B on the **Presets screen** 📄.

5.3.3 Routable controllers and parameters

The following tables list all controllers and parameters currently available for routing. Some of the controllers are inherently polyphonic (which means the MIDI controller can modulate the parameters independently for each played note/voice) while others are polyphonic only when MPE is enabled.

Table 1: Controllers available for routing

Controller	Polyphonic	Standard MPE function
Velocity	Always	
Key Pressure	Always	
Pitch Bend	With MPE	Per-note pitch (X)
Channel Pressure	With MPE	Per-note pressure (Z)
Modwheel (CC1)	With MPE	
Timbre (CC71)	With MPE	
Brightness (CC74)	With MPE	Per-note control (Y)
CC9, CC16, CC17, CC89, CC114, CC115	With MPE	

Table 2: Parameters available for routing

Page 1	Page 2	Page 3
Volume	Orbiter Offset Y	Tremolo Depth
Pitch	Suborbit Size	
Filter Cutoff	Suborbit Speed	
Filter Resonance	Vibrato Speed	
Overtone Blend	Vibrato Depth	
Orbiter Offset X	Tremolo Speed	

MIDI Polyphonic Expression (MPE) support

When MPE is enabled in the MIDI configuration section of **Global settings** ⚙, any of the available controllers can be used to control polyphonic parameters using the channel rotation scheme (with channel 1 being a *manager channel* used for global control applied to all voices).

The MPE standard defines that Pitch Bend is used for per-note pitch variations, Channel Pressure for per-note pressure and CC74 for additional per-note control. However, as some MPE keyboards and controllers have non-standard configuration, the Routing table allows to choose from other source options.

When MPE is disabled, the routed parameters apply to all voices with the exception of Velocity and Key Pressure (polyphonic aftertouch).

5.3.4 Fixed controllers and parameters

Apart from Routable controllers and parameters there is a number of parameters which are assigned to fixed controllers, listed in the following table:

Table 3: Fixed Control Change (CC) parameters

CC	Parameter
0	Bank select MSB
1	Routable parameter
2	Suborbit size
3	Orbiter centre point position X
4	Orbiter centre point position Y
5	Orbiter width
6	Data entry MSB
7	Lissajous shape warp X
8	Lissajous shape warp Y
9	Routable parameter
10	Reverb amount
11	Chorus mix
12	Delay mix
13	Envelope attack
14	Envelope decay
15	Envelope sustain
16	Routable parameter
17	Routable parameter
18	Vibrato depth

Table 3 – continued from previous page

CC	Parameter
19	Tremolo speed
20	Tremolo depth
21	Drive amount
22	Drive colour
23	Reverb size
24	Reverb colour
25	Global resonance
26	Delay time
27	Delay feedback
28	Chorus speed
29	Chorus depth
30	Chorus colour
31	Arpeggiator note length
32	Bank select LSB
33	Stack volume (Mono)
34	Detune stack (Mono)
35	Glide (Mono)
36	Voices (Mono)
37	Follower volume (Dual)
38	Data entry LSB
39	Suborbit offset (Dual)
40	Stereo bias (Dual)
41	Detune drift (Poly)

Table 3 – continued from previous page

CC	Parameter
42	Stereo scatter (Poly)
43	Orbit Attack
44	Orbit Decay
45	Orbit Release
46	Arpeggiator humanize
47	Suborbit Speed
48	Orbiter height
49	Volume
50	Envelope release
51	Vibrato speed
52	Detune follower (Dual)
64	Damper/Sustain pedal (0–63 off, 64–127 on)
66	Sostenuto pedal (0–63 off, 64–127 on)
89	Routable parameter
114	Routable parameter
115	Routable parameter
100	Registered Parameter Number LSB
101	Registered Parameter Number MSB

Hint:

The **Sustain** controller holds notes until the pedal is released. The **Sostenuto** controller works in a similar way but only holds notes which were active when the pedal was pressed.

5.4 Global settings

The **Settings screen** ♂ contains global configuration which is common for all presets. The configuration can be stored using the Save button, reloaded from memory using the Load button or reset to defaults using the Default button.

5.4.1 MIDI configuration

The following MIDI parameters can be set in the Global settings:

- **Input MIDI channel** for receiving MIDI messages,

- Separate **Arp in MIDI channel** for Note On/Off events fed into the Arpeggiator (equals to the **MIDI input channel** by default),

- **Output MIDI channel** for sending MIDI messages (Start/Stop, Timing Clock, and also notes received from connected MIDI controllers if **Forward MIDI notes** is enabled),

- Separate **Arp out MIDI channel** for sending notes played by the Arpeggiator if **Output Arp MIDI notes** is enabled,

- The option to ignore note velocity and use a **Fixed MIDI velocity** to play all notes with the same (maximum) amplitude,

- The option to divide the received MIDI Timing Clock (depending on the Tempo configuration) by a factor defined by the **Global slowdown**,

- The option to set the **Tempo sync mode** (OFF for the Stand-alone Mode, OUT for Send Mode and IN for the Receive Mode),

- The option to configure the **Default BPM** used by the main Tempo,

- The option to configure **MIDI Out as Through** so that all MIDI messages received on the MIDI IN jack are forwarded to the MIDI OUT jack, enabling the MIDI Through (Thru) functionality,

- The option to configure **Pitch bend semitones** from 1 to 24 semitones up/down,

- The option to **Hide MIDI popup** notification, normally displayed when a MIDI Control Change (CC) message is received, and

- The option to **Enable MPE** (MIDI Polyphonic Expression) for the Routing table.

Both **Input MIDI channel** and **Arp in MIDI channel** can be set to receive messages on all sixteen channels simultaneously.

5.4.2 Miscellaneous configuration

Apart from MIDI configuration, the Global settings screen also contains the following configuration options:

- If **Sticky Corner Matrix** is enabled, the Corner Matrix button alternates between visible and hidden Corner Matrix. If disabled, the Corner Matrix stays visible only as long as the button is pressed.

- The **Knob speed** selector allows to increase the rate of change of the 25 rotary encoders on the front panel.

- The **Screen brightness** configures the LCD screen brightness in 10 steps.

It is also possible to mark the current preset as default (loaded automatically when Vector is powered up) using the **Preset as default** button.

Hints

- The **Settings screen** ⚙ also allows for Firmware updates. User presets are preserved during an update.
- Updating the default preset must be followed by pressing the **Save** button, otherwise it has not effect.

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6 SPECIFICATIONS

- 7" capacitive touchscreen display
- ARM® Cortex™-A53 with NEON™ DSP instructions
- 32-bit internal processing
- 32-bit DAC, 48kHz, 106dB SNR
- Headphone amplifier
- Runs Linux with a real-time kernel
- MIDI TRS input and output ports
- USB MIDI host and device ports (both capable of input and output)
- MIDI Polyphonic Expression (MPE) support
- Up to 16-voice polyphony
- Ethernet (LAN) connection
- Firmware easily upgradable over the network or with a USB flash drive

6.1 What's in the box

- The Vector synthesizer unit (with a serial number on the bottom plate)
- Power supply with a region-matching plug
- Printed manual
- 2× MIDI-TRS adapter cable

6.2 Connectivity
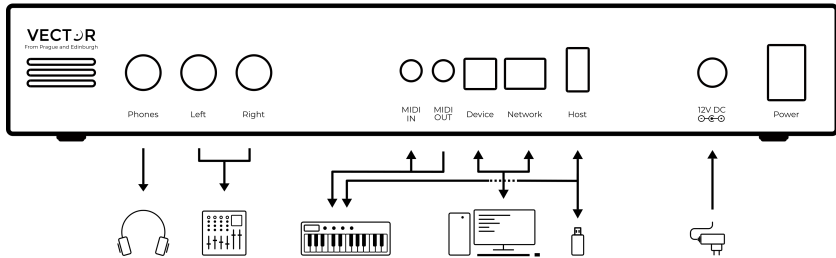
The rear side of Vector offers various connections. From left to right:

- **Phones** is a 6.35mm TRS jack with a stereo output. Connect it to a pair of headphones for monitoring.

- **Left** and **Right** are two 6.35mm TS jacks with line outputs (left and right channels). Connect them to a mixer or an audio interface.

- **MIDI IN** and **MIDI OUT** are 3.5mm TRS jacks with MIDI input and output channels. The pin-out is "Type A" as per the official MIDI terminology. Connect them to other MIDI gear with a compatible connector or to a legacy 5-pin DIN cable (adapters are included with Vector). The MIDI OUT jack can be configured as MIDI Thru.

- **Device** is a USB Type B connector with class-compliant MIDI interface (both input and output). Connect it to a DAW etc.

- **Network** is a RJ-45 network connector used for firmware updates. Connect it to a LAN network with Internet access and DHCP.

- **Host** is a USB Type A connector with a class-compliant MIDI interface (both input and output). Connect it to a USB

MIDI keyboard or a USB flash drive for software updates.

· **Power** is a connector for the provided 12V DC 1000mA (centre-positive) power supply with a dedicated power switch.

Note:

It is possible to connect more devices to the **Host** connector using a USB hub. Follow the current rating of connected devices; if the total current exceeds 500mA, use a hub with external power adapter. For software updates, the flash drive has to be connected directly without any hubs or cables in between. Do not use hard drives for software updates as they might draw too much current.

6.3 Firmware updates

Vector can be updated either over network or using a USB flash drive. To find if there is an update available, start Vector with a network cable connected and navigate to the **Settings screen** ⚙. The bar in the bottom of the screen will indicate available updates and guide you through the update process.

Please note that some major updates are only available over USB and as such do not appear in the **Settings screen**. Check beetlecrab.audio/vector/support for announcements and a detailed description of the firmware update procedure.

Warning:

Do not power off Vector when a firmware update is in progress.

6.4 MIDI implementation

Function	Transmitted	Recognized	Note
Channel	1–16	1–16	*1, *7
Note: Number	1–127	1–127	*2
Note: Velocity	1–127	1–127	*2
Pitch Bend	–	Yes	*3
Channel Pressure	–	0–127	*4
Key Pressure	–	0–127	*4
Program Change	–	0–49	*6
Control Change (CC)	–	Yes	*4
Song Position Pointer	–	Yes	*5
Timing: Clock	Yes	Yes	*5
Timing: Start	Yes	Yes	*5
Timing: Continue	–	Yes	*5
Timing: Stop	Yes	Yes	*5

Notes:
1. Separate channel for the Arpeggiator is possible, see MIDI configuration.
2. Transmitted are notes played by the Arpeggiator and/or notes forwarded from the MIDI input if enabled.
3. Range is configurable, see MIDI configuration.
4. Routing is configurable, see Routable controllers and parameters and Fixed controllers and parameters.
5. Disabled by default, configurable in the Tempo section.
6. Preset page can be controlled using Bank select CC: 0–1 System, 32–34 User, 64–68 External preset pages.
7. Also see MIDI Polyphonic Expression (MPE) support.

6.5 Health and safety

Use common sense when handling Vector. Standard guidelines for handling electronic devices apply, which, among others, are:

- Use only the supplied power supply.
- Do not expose the machine to any liquids or excessive levels of humidity.
- Do not cover the ventilation holes on back and bottom.

6.6 Free and open-source software

Vector is built using many great free and open-source (FOSS) software components.

See beetlecrab.audio/vector/licenses for the license agreement and a complete list of the FOSS components used in Vector's firmware.

INDEX