

# SONICBITS

## Exakt User Manual



Version 1.0.0  
2024-10-12

[www.sonicbits.com](http://www.sonicbits.com)

# Table of Contents

About FM Synthesis .....	1
Introduction and Overview .....	2
Getting in touch .....	2
Exakt Structure .....	2
Getting Started .....	3
Installing Exakt .....	3
Installing on Windows .....	3
Installing on macOS .....	3
Demo Version Limitations .....	4
Using Exakt in your DAW .....	4
Add Exakt .....	4
Adjust the UI size .....	4
Showing or hiding the virtual keyboard .....	4
Select and play a Preset .....	5
Using the controls to edit a preset .....	5
Initialize and Save a Preset .....	8
Importing Sysex Files .....	8
Exakt in Detail .....	9
Operators and the FM Algorithm .....	9
The Filter .....	12
The Modulation Sources .....	13
The Modulation Matrix .....	14
The Effects .....	15
The Output Section .....	16



# About FM Synthesis

Frequency Modulation is a method of synthesis that uses the frequency of one waveform to modulate the frequency of another.

In essence, FM synthesis is about generating complex waveforms from simpler ones. One signal, called the “**modulator**”, modulates the pitch of another signal, the “**carrier**”, that’s in the same or a similar audio range. This creates brand new frequency information in the resulting sound, changing the timbre even without the use of filters.

The selected **FM algorithm** determines whether an operator is a carrier or a modulator.

Frequency Modulation (FM) synthesis has been invented by Dr. John Chowning at Stanford University in the late 1960s. Dr. Chowning’s theory was that instrument emulations would be possible by modulating a waveform with others that were tuned to the harmonic series.

Digital FM synthesis (implemented as phase modulation) was the basis of several musical instruments beginning as early as 1974. Yamaha built the first prototype digital synthesizer in 1974, based on FM synthesis, before commercially releasing the Yamaha GS-1 in 1980.

The Synclavier I, manufactured by New England Digital Corporation beginning in 1978, included a digital FM synthesizer, using an FM synthesis algorithm licensed from Yamaha. Yamaha’s groundbreaking DX7 synthesizer, released in 1983, brought FM to the forefront of synthesis in the mid-1980s.

Unlike previous FM synthesizers of the era, released in 1987, Yamaha’s TX81Z was the first to offer a range of oscillator waveforms other than just sine waves, conferring the new timbres of some of its patches when compared to older, sine-only FM synths. The TX81Z has developed a famous reputation, largely based on some of its preset bass sounds which have been used in many popular tracks in the 1990s. A keyboard version with more onboard editing abilities was released the following year as the Yamaha DX11.

The Exakt synthesizer plugin tries to recreate the sound of these 4 operator machines. Many additional features allow you to shape the sound in ways not possible in the original hardware devices.

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# 2

## Introduction and Overview

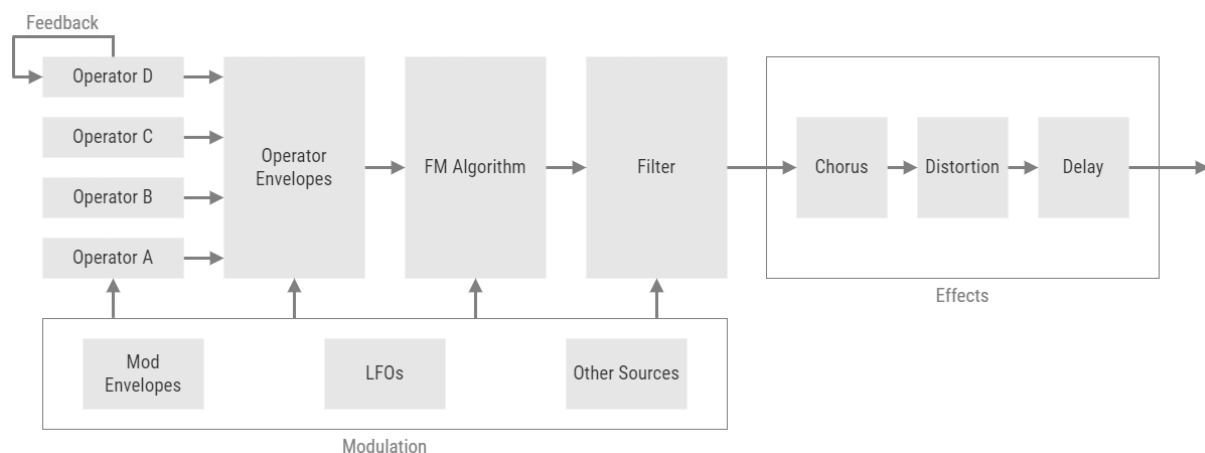
Thank you for using Exakt!

Exakt is an easy-to-use FM synthesizer instrument plugin which can be used from within your DAW.

### Getting in touch

If you experience any problems while using this plugin, or you just wish to pass on your comments regarding Exakt or this manual, or links to cool tunes made with Exakt, you can email the developer directly at: [info@sonicbits.com](mailto:info@sonicbits.com).

### Exakt Structure



The top-level structure of Exakt is actually pretty easy. The audio signal flows from the left, where the 4 operators generate their signals. Every operator has got an multistage envelope where the operator signal is shaped. The FM algorithm determines the operators which are modulated and those which produce an output signal. The signal is then filtered. After that, the signal goes through the three optional effects.

Various operator, FM and filter parameters can be modulated by the mod sources.

All these components are explained in full detail later on.

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# 3

## Getting Started

### Installing Exakt

Exakt is available in both Windows and macOS versions. On macOS, both Intel and ARM based systems are supported. It is designed to be used within a 64bit host audio application that supports the VST2, VST3 and AU (macOS only) plugin format.

Along with the selected plugin formats the installer will also create various synth and envelope presets.

### Installing on Windows

Double-click the Exe installer. It will prompt for the location of your VST folder. You can choose whether you want to install the VST2 and/or the VST3 plugin format.

The synth presets will be installed to

**C:\Users\USERNAME\AppData\Roaming\Sonicbits\Exakt\Presets**

The envelope presets will be installed to

**C:\Users\USERNAME\AppData\Roaming\Sonicbits\Exakt\Envelopes**

### Installing on macOS

Double-click the PKG installer. You can either install everything or you can choose whether you want to install the VST2, VST3 and/or the Audio Unit (AU) plugin format.

The synth presets will be installed to

**/Library/Application Support/Sonicbits/Exakt/Presets**

The envelope presets will be installed to

**/Library/Application Support/Sonicbits/Exakt/Envelopes**

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## Demo Version Limitations

The unregistered demo version of Exakt can be used for an unlimited time. However, no presets can be saved and every 60 seconds the audio signal of Exakt is muted for a short moment.

Furthermore, sysex files from Yamaha 4 operator synthesizers cannot be imported in the demo version.

When you open Exakt in a new DAW session, you will be asked for a serial number.

You can buy a serial number at [www.sonicbits.com](http://www.sonicbits.com) to unlock the full version of Exakt.

## Using Exakt in your DAW

### Add Exakt

Exakt should be added to an instrument (MIDI) track. This is the same procedure as if you add any other software instrument in your DAW.

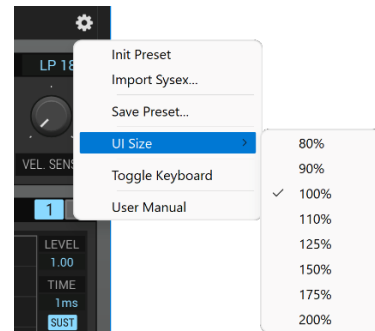
Depending on your DAW and whether you're on Mac or PC, select your preferred plugin format (VST2, VST3 or AU).

For details about adding a software instrument inside your DAW, please refer to your audio host documentation or contact us via email or Twitter, and we'll try to help you.

### Adjust the UI size

The Exakt user interface can be displayed in different sizes. In order to adjust the size, select the cog symbol on the top right of the plugin window and choose one of the size entries from the menu.

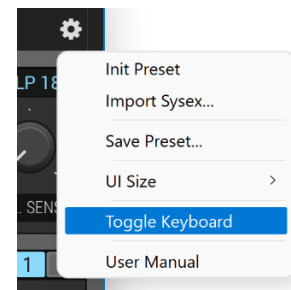
This setting is stored globally and will be applied each time when a new instance of the plugin is opened.



### Showing or hiding the virtual keyboard

In order to save some screen space, the virtual keyboard (and the wheels and controls to the right of the virtual keyboard) can be hidden. To do that, select the cog symbol on the top right of the plugin window and click on "Toggle Keyboard".

This setting is stored globally and will be applied each time when a new instance of the plugin is opened.



## Select and play a Preset

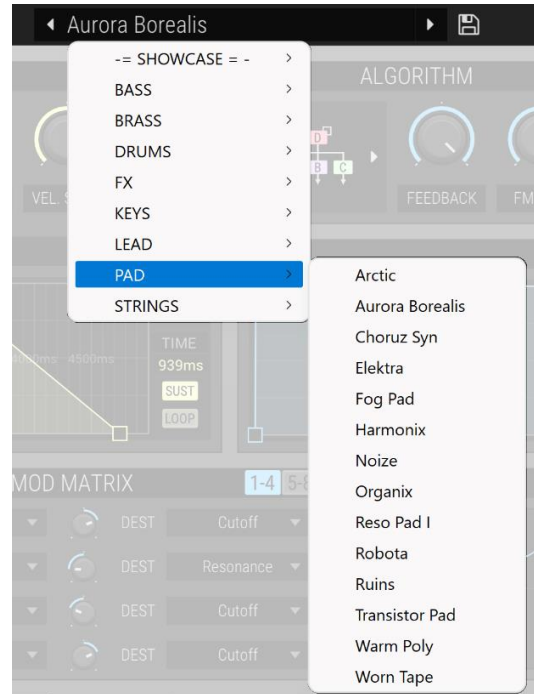
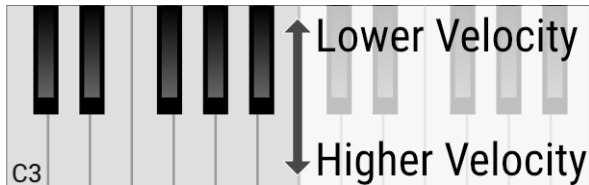
Let's just assume that at this point you don't want to create your own sounds from scratch. A good place to get started with the instrument is by selecting and playing a preset. The preset list is at the top of the plugin window:

Select a preset by clicking somewhere on the preset name in the black top bar.

A list with all available presets grouped by category appears. You can also cycle through this list by clicking on the left and right arrows beside the preset name in the top bar.

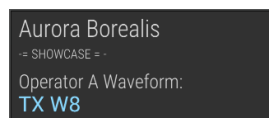
You can play the preset by clicking on the virtual keyboard within the plugin window or by simply play a few keys on your connected MIDI keyboard.

The virtual keyboard in the plugin window supports different velocity levels. Clicking the keys in the lower area plays with higher velocities, the key area at the top produces lower velocity values.



## Using the controls to edit a preset

Using the mouse, you can edit any parameter. These are the different UI elements:



### Info Panel

The info panel on the right side shows the currently selected preset. Below the preset name is the preset category name, which is the name of the preset parent folder.

The currently edited parameter value is displayed at the bottom of the info panel. If you hover over an UI element, its current value is displayed here.



### Knobs

Knobs can be rotated using the mouse. If you click on a knob and hold the mouse button, moving the mouse up and down increases and decreases the value. For finer control hold the Ctrl key while moving the mouse.

Also using the mouse wheel while hovering above the knob changes its value.



### Dropdown lists

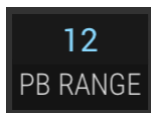
Dropdown lists can be used to select an item from a given list. Clicking somewhere in the dropdown area opens the list.



### Text Values

These values can be adjusted by clicking on the value and dragging the mouse up or down. Also using the mouse wheel while hovering above the number changes its value.

If you need precise control, hold the Ctrl key while moving the mouse. The values can also be by clicking on one of the horizontal lines above or below the value, this increases or decreases the value.



The value for the pitch bend range can also be modified by clicking and dragging on the value. Here a double click resets it to the default value of 2.



### Buttons

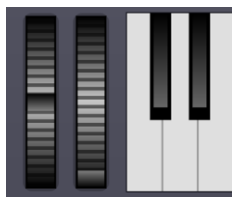
Buttons can be clicked to turn something on or off.

When the button is lit, it means the according parameter is turned on.



### Tabs

Exakt has got 4 operators, 2 modulation envelopes, 2 LFOs and 2 pages for modulation assignments which are displayed on a separated page each. By clicking a tab button, the page for the according elements appears. The selected tab is lit.



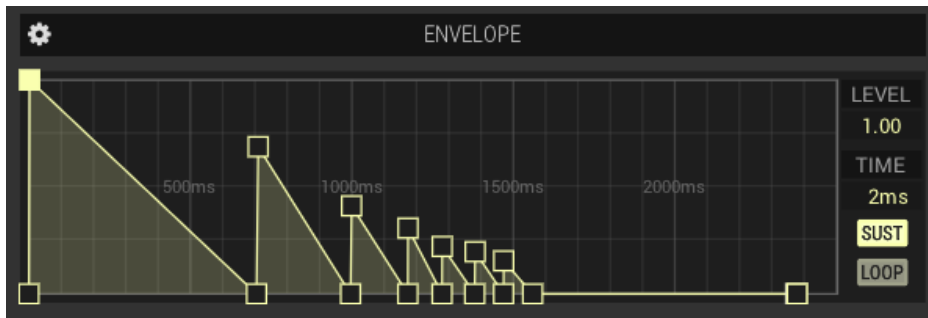
### Pitch Bend and Modulation Wheels

The sound of Exakt can also be changed by moving the pitch bend wheel. If assigned to any destination in the mod matrix, moving the mod wheel controls the according parameter.

If you have connected a MIDI keyboard or controller to your DAW, the wheel controls in **Exakt** reflect the position of the real wheels. This setting is also stored globally and will be applied to all new plugin instances.



## Envelopes

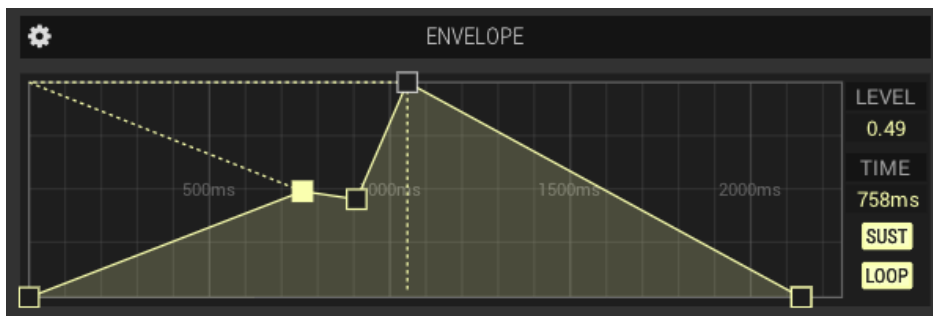


Exakt has got an envelope for each of the 4 operators and 2 modulation envelopes. They all work the same way.

To modify the envelope shape, select and drag one of the points. This way the point level and its time can be changed. The time of the currently edited segment is displayed on the right.

An envelope can have a sustain point and can be looped. This can be switched on or off by clicking on the according button on the right of the envelope.

If the envelope does not sustain, it cannot be looped. The loop starts when the sustain point is reached. There will be a ramp to the second envelope point from the sustain point. This is indicated by the dashed lines.



The envelope view can be zoomed in and out. To do this, click and drag the mouse somewhere in the envelope area outside of an editable point. If the mouse is moved upwards, the envelope will be zoomed in, moving downwards will zoom out. Dragging the mouse left or right moves the area in the according direction.

To zoom the area to the whole envelope, simply double click somewhere inside the envelope area.

Each envelope can have up to 16 points which can be inserted and removed to get the desired shape. To insert a new point, right click in an empty space inside the envelope area. The segment at this location will be split and the new point is inserted. A point can be removed by right clicking on it.

Inserting points to the left of the sustain point add segments which can be looped. Inserting points to the right of the sustain point create a more complex sustain shape.

Envelope shapes can be copied to another operator or to the modulation envelope. The cog symbol above the envelope opens a menu for that.

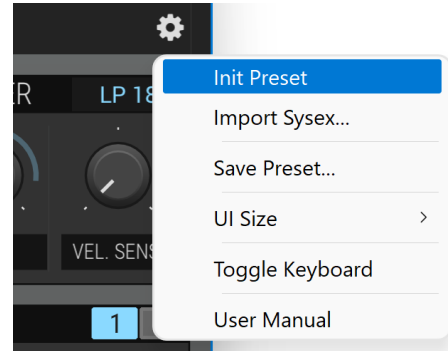
You can also save and load envelopes using that menu.

## Initialize and Save a Preset

In order to get started with a basic sound, you can initialize a preset. Select the cog symbol on the top right of the plugin window and choose "Init Preset" from the menu.

This will reset all parameters to a default value and you will only hear a single sawtooth from oscillator 1 without any modulation or effects.

This is a good starting point for creating your own presets. Alternatively, you can select a factory preset and edit it until you like it.



When you're happy with your sound editing, you can save your own presets by clicking on the save button on the right of the preset browser. Another way is by clicking on the cog symbol in the top right of the plugin window. Select "Save Preset...", select a matching category folder and enter a preset name to preserve your sound for another session.

Please note that saving presets is only available in the unlocked version of Exakt.

## Importing Sysex Files

Exakt also supports importing sysex bank files from the following 4 operator Yamaha FM synthesizers:

- Yamaha TX81Z
- Yamaha DX21
- Yamaha DX100

You can either directly create a sysex file by exporting a bank from such a device or you can get many bank files on the internet.

Select the cog symbol on the top right of the plugin window and choose "Import Sysex..." from the menu. You can then browse your file, select the desired sysex file and click OK.

All the patches in the bank will be converted and will be saved in the presets folder. These imported presets are then available in a folder with the same name as the bank file.

Importing presets this way provides a good starting point for your own presets.

Please note that importing sysex files is only available in the unlocked version of Exakt.

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# 4

## Exakt in Detail

### Operators and the FM Algorithm

The **OPERATOR** section at the top left of the plugin window builds the sonic heart of Exakt.



For each of the 4 operators, the following parameters can be set. Select the operator A to D by clicking on the according tab button. Each operator has got its own colored controls in order to better distinguish them from each other. The same colors also appear in the FM algorithm.

**WAVEFORM** presents a selection of the following 15 operator waveforms:

- Sine
- Sawtooth
- Square
- Triangle
- TX W2 to TX W12

The Sine and TX W2 to TX W8 represent the waveforms as they are found in the Yamaha TX81Z. The TX W9 to W12 are new combinations and enhanced modifications of these waveforms.

Clicking on the **INV** button inverts the selected waveform.

The **RATIO** and **OFFSET** values control the frequency of each operator. The standard ratio is 1.0, this produces a 440Hz tone for an A3 note (standard pitch). A ratio of 2.0 would be an octave higher, and 4.0 would be two octaves higher.

With the offset value a fixed frequency can be set for each operator. While many hardware FM synthesizers could either use a ratio or a fixed frequency, Exakt allows you to combine those two values.

By setting the rate to other values than multiples of the base rate, interesting modulations and atonal effects can occur.

You can also input values by keyboard. Double-clicking with the right mouse button shows an input field where you can enter the desired value.

Here are some ratio values to get you started:

Semitones deviation from pitch	Ratio
-12	0.5000
+1	1.0595
+2	1.1225
+3	1.1892
+4	1.2599
+5	1.3348
+6	1.4142
+7	1.4983
+8	1.5874
+9	1.6817
+10	1.7818
+11	1.8877
+12	2.0000

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**PHASE** moves the phase of the operator waveform in a range from 0 to 180 degrees.

**VEL. FREQ.** can be used to make the operator frequency sensitive to the velocity of the keyboard. By selecting positive values, the frequency will increase with higher velocities and negative values lead to decreased frequencies for high velocities.

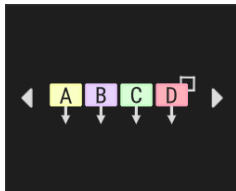
**VEL. SENS.** controls how much the operator level is affected by the keyboard velocity.

The **LEVEL** knob controls the overall operator output level.

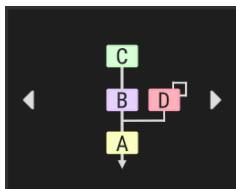
By clicking on the **LINK** button, all these settings can be applied to all operators while a parameter is edited.

The operator **ENVELOPE** controls the output level over time. As explained in chapter 3, the envelopes can have up to 16 points and can be sustained or not. A sustained envelope can also be looped. Clicking on the cog symbol above each envelope lets you copy an envelope to another operator or to one or both the modulation envelopes.

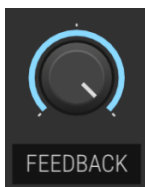
The envelope shapes can also be saved to be used in another session again. These envelope presets are also available in the menu.



Operators are arranged in different relationships to one another; these arrangements are known as **algorithms**. Depending on the algorithm, one or more operator is usually routed directly to the audio output. For example, with Exakt's algorithm 16, all four of operators are routed directly to the output and produce sound directly.



In other algorithms such as the algorithm 3, some operators are not routed directly to the output, but modulate another operator. These modulating operators are then called **modulators**, and those modulated and outputting sound are **carriers**.



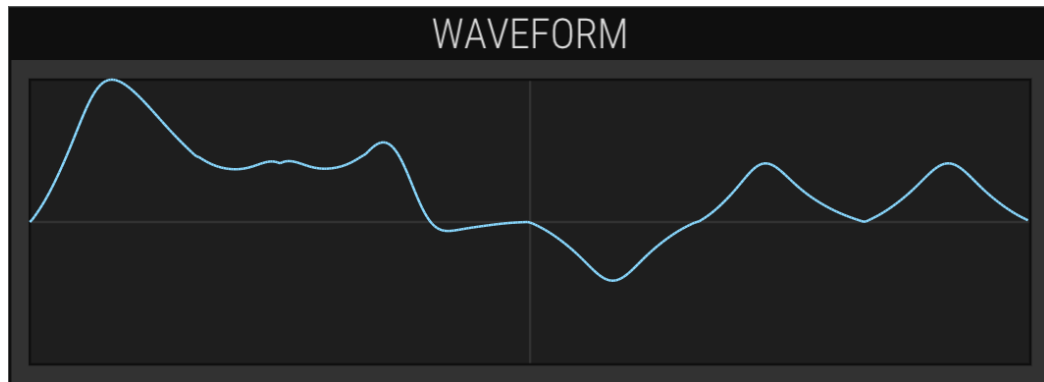
The graphic for each algorithm has a loop drawn around operator D. This indicates that there is a **feedback** loop attached to that operator. The feedback level can be controlled by the feedback knob. This feedback loop modulates operator D with itself leading to resonant and sharp sounding signals.



How much a **modulator** impacts the signal of a connected **carrier** depends on its output level, which is also shaped over time by the according operator envelope.

The global amount of how much a modulator signal modulates the connected carriers can be controlled by the FM amount knob.

After selecting an **FM Algorithm** you can start by modulating the carriers with the modulators. As soon as you increase the level of a modulator, the **Waveform** display shows how the final waveform will look like when the operators have reached their dialed-in final level.



## The Filter



The filter section lets you select the filter type and edit the cutoff frequency, the resonance amount and the keyboard tracking value.

On the top right of the filter panel, you can choose between the following filter types:

- Lowpass 6 dB/oct
- Lowpass 12 dB/oct
- Lowpass 18 dB/oct
- Lowpass 24 dB/oct
- Highpass 12 dB/oct
- Bandpass 12 dB/oct
- Formant Filter (emphasis for A, E, I, O and U vowels)

The first 6 filter types are self-explanatory by their names. The number after the name indicates the slope.

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The formant filter is a cascade of bandpass filters connected in parallel. You can choose between different vowel emphasis types settings for this filter type, each emphasizing the frequencies of a vowel from the spectrum.

There are predefined settings for the vowels A, E, I, O and U.

When the formant filter is selected, changing the cutoff frequency causes a shift in the emphasized frequencies so that a "morph" to another vowel can occur.

Altering the resonance value changes the slope of the emphasized frequencies.

## The Modulation Sources

In Exakt there are several modulation sources available in order to change the sound dynamically.

There are two modulation envelopes and two LFOs per voice. In addition, (channel) aftertouch values and the modulation wheel can be used.

The **MOD ENV** section contains two envelopes which can be used as a modulation source for various targets. Editing the envelopes has been described in chapter 2, they work the same as the operator envelopes.



The **LFO** section contains the two LFOs (low frequency oscillator). You can switch between the two by clicking on the tab number.

The LFO supports different waveforms, and its tempo can be set using the **RATE** knob. The tempo can either be synchronized to the DAW host or can be set to a fixed frequency value in Hz. In order to synchronize the tempo, make sure the **SYNC** button is lit. The **RATE** knob will then show the different time markers.

If the **FREE** button is off, the LFO will be reset by each note played. If it's off, it will run freely.

You can choose between the following LFO waveforms:

- Sine
- Saw
- Square
- Triangle
- Sample and Hold (S & H)
- Perlin

The LFO produces a value range from -1 to +1. The start of the modulation value can be delayed by the **DELAY** value.

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# The Modulation Matrix



Exakt has got eight slots or rows for modulations per preset, they are arranged in two pages in the **MOD MATRIX**.

Each of the modulation sources introduced in the last chapter can modify one of the total 17 destinations.

In each row the selected **SOURCE** modifies the selected **DEST**ination. The current source value is multiplied by the value of the modulation depth knob. This depth value can be positive or negative. If negative, the modulation value is inverted.

In the above example, when the LFO 1 value goes up, the filter resonance value decreases down and vice versa.

Using the Mod Matrix is an excellent idea to add time-controlled changes to the sound!

You can select between the following modulation destinations:

- Operator A Level
- Operator B Level
- Operator C Level
- Operator D Level
- Operator A Phase
- Operator B Phase
- Operator C Phase
- Operator D Phase
- Operator D Feedback
- FM Amount
- Filter Cutoff
- Filter Resonance
- Global Pitch
- Operator A Pitch
- Operator B Pitch
- Operator C Pitch
- Operator D Pitch

The note pitch can be modified from -2 to +2 octaves.

Modulated destinations show the value range in a lighter blue around the knobs, as in the example below where the filter cutoff and resonance are modulated. If several sources modulate the same destination, the shown value range of them all is combined.





# The Effects

On the bottom of the plugin window are the three effects in Exakt: A creamy 2-stage chorus, a distortion to add some grit to the sound and a stereo delay with continuously switchable ping-pong. The audio signal passes these effects one after another, from “left to right”.

If you would like to bypass Exakt’s effects and only use your own DAW effects, simply dial in 0 for all three effect **MIX** parameters.



The **CHORUS** has two individually switchable stages. Just click the buttons **I** and **II** to switch them on or off.

The modulation depth can be controlled via the **DEPTH** knob. **MIX** controls the amount of chorus in the audio signal.



The **DISTORTION** effect can be used to add harmonic frequencies to the audio signal. In order to achieve that, the **GAIN** is increased and the peak levels are compressed and clipped. The amount of compression can be set with the **SHAPE** knob. The **MAX VOL** sets the level where the clipping and compression takes place.

**MIX** controls the amount of distortion in the audio signal.

Using extreme values for the distortion can massively alter the audio signal and can also increase the output level. In order to prevent clipping, you might lower the gain in the output section.



The stereo **DELAY** time can either be synchronized to the DAW host or can be set to a fixed frequency value in Hz.

In order to synchronize the tempo, make sure the **SYNC** button is lit. The **TIME** knob will then show the different time markers.

**FEEDBACK** controls the amount of the delayed audio signal which is fed back into the delay.

If you increase the value of **WIDTH**, the stereo delay changes to a ping-pong delay, where the delay bounces back and forth between the left and right channels.

**MIX** controls the dry/wet ratio of the delay in the audio signal.

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## The Output Section



The **OUTPUT** section contains the pitch bend range control and knobs for the pitch drift, note glide and the output gain.

The **PITCH BEND RANGE** can be set from 0 to 12 semitones.

Pressing the **MONO** button will set the synthesizer to monophonic mode. In this mode, only the most recent note you press will be sounded. This can be desirable for bass sounds or when plying solos.

**DRIFT** controls the amount of the pitch drift. This can be used to achieve the pitch instabilities found in vintage analog devices.

The note **GLIDE** time can be set from 0 to 500 milliseconds.

The output **GAIN** knob contains a range from -70 dB to 24 dB.

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