

VOCODIZER

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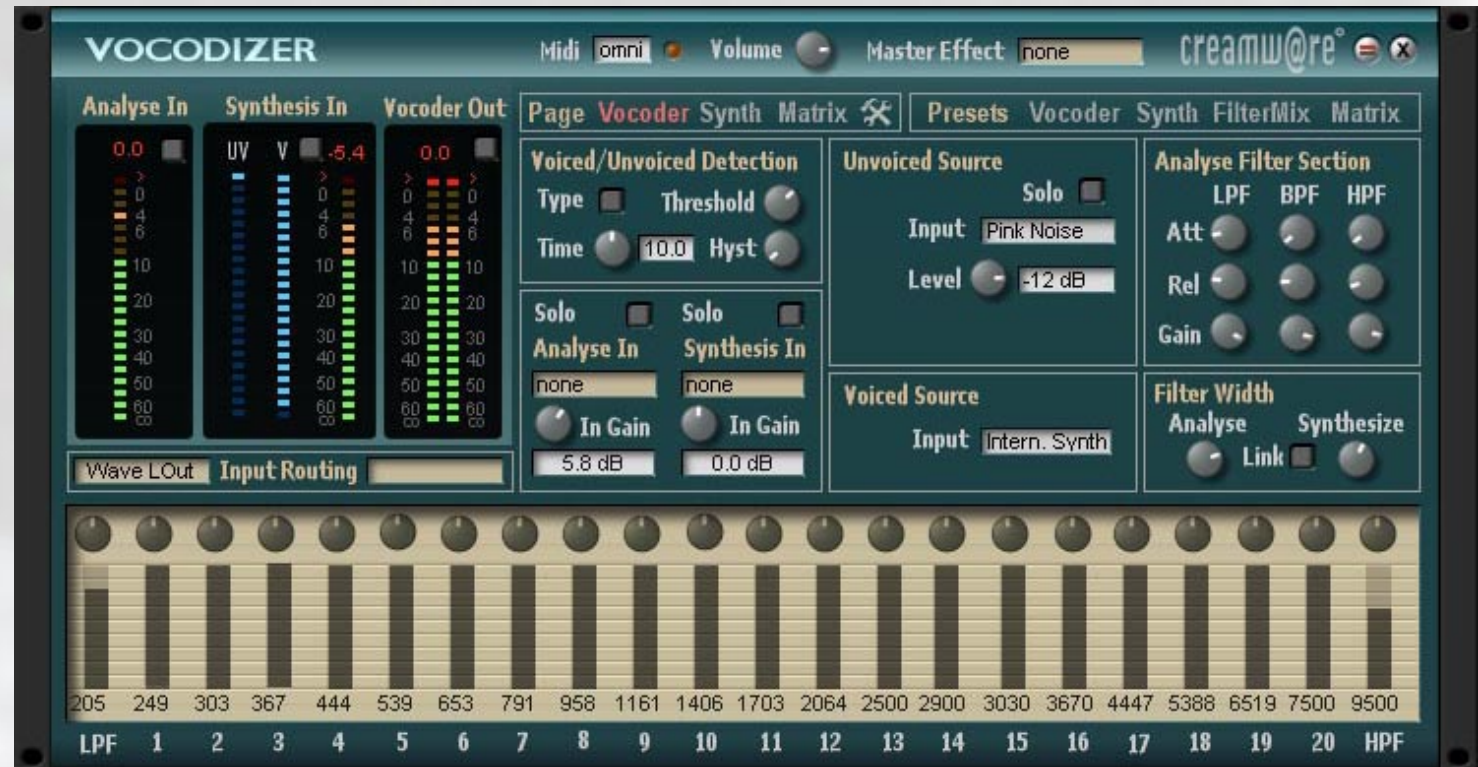
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Introduction

The Vocoder is, without a doubt, one of the most extensive and flexible vocoders ever devised. From its freely configurable and assignable filters, to individual level and pan controls for each synthesis filter output, the vocoder part of the Vocoder gives you not only what you would expect in a classic vocoder—it extends the concept significantly. Switchable Voiced/Unvoiced Detection allows you to optimize the voicing intelligence depending on the input signal. And integrated effect inserts make it easy to process the input signals with compressors, EQs, or other effects.

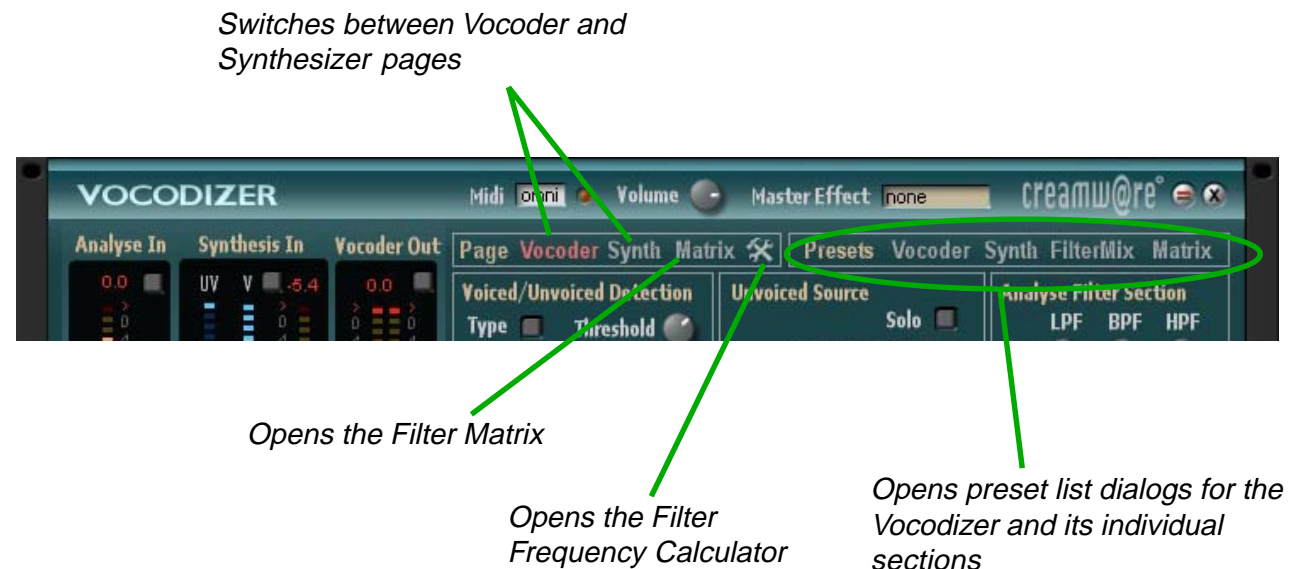
The Vocoder is self-contained—able to operate as a stand-alone device thanks to its integrated sound generators and related components that provide a complete onboard synthesizer. Of course, the Vocoder can also process external sources, such as the output from a Pulsar/SCOPE synthesizer or a live audio signal from one of the hardware inputs.

The Vocoder also features an integrated matrix to enable the control signals of the analysis section to control any arbitrary filters in the synthesis section.

Soon you'll discover that the Vocoder can produce almost any effect you've ever imagined of a vocoder—and some you haven't. In this spirit we hope your work with the Vocoder will be both inspiring and productive.

Most of the Vocoder's adjustable parameters are organized into two pages (panels): the Vocoder page and the Synthesizer page. Two additional independent dialogs provide the Filter Matrix and a Frequency Calculator.

In the Vocoder you can store and recall Presets for the device as a whole, and also for individual subsections of the device. For this reason, the buttons to open and close the various preset lists are located together in their own section.



Presets

The Vocoderizer stores different parameter groups in separate preset lists. This lets you manage, for example, the synthesizer presets completely independent of the vocoder presets.

The following preset lists are available:

Vocoder: Stores and recalls settings specific to the Vocoder section.

A few settings are not stored, however. For example, settings related to input signal levels are not stored in presets, as it would be self-defeating to do so. Usually you will be experimenting with different presets to process the same input signal. If the input level changed each time you loaded a new preset, the process would be unnecessarily clumsy.

Settings *not* stored in presets include: all Voiced/Unvoiced Detection, Analysis/Synthesis Input gains, Input Insert Effects, Solo, Voiced Source, and Master Insert Effects.

Note that all parameters are stored when you save your current setup as a project, and will be restored accordingly when you reload the project.

Synthesizer: Stores the parameters of the integrated synthesizer. Because Main Out is a performance setting, its value is not stored in the presets, but only with the project.

FilterMix: These presets store the filter settings. Along with the frequency, they also store the volume and pan positions of the individual filters. Depending on the number of filter bands, and their proximity to each other (in terms of frequency) the bandwidth of each filter is also important, and is also saved in the preset.

Matrix: The Matrix also has its own preset list. The positions of each of the 22 routing switches are stored in the Matrix presets.

How does a Vocoder actually work?

A typical vocoder contains two filter banks: an *analysis* bank and a *synthesis* bank. As the name implies, the analysis bank takes the incoming voice signals and analyzes them to extract frequency and timing information, creating a "signature" for each filter in the bank. These signatures are later applied to an identically tuned filter bank in the synthesis section, and used to process a second, synthesized, signal (or, it could be an entirely unrelated external input signal). In both filter sections, the filters are divided into an equal number of frequency bands.

After the analysis phase, the vocoder examines each individual analysis filter output with an envelope follower to extract dynamic level information. The envelope follower then generates control signals corresponding to the changing volume levels.

The component signals from the synthesis filter bank (whose filters are tuned to the same "signatures" as the analysis filters) are multiplied by the control signals from the envelope follower. In other words, the

dynamic level progression of the signals filtered by the synthesis section match exactly the dynamics of the filtered signals of the original voice input. Finally, the synthesized signal components are mixed to produce the final output. The result is vocoder output that produces a synthesized sound with the character and articulation of the original input voice. The vocoder is often used to produce the "talking synthesizer" effect made popular by artists such as Stevie Wonder.

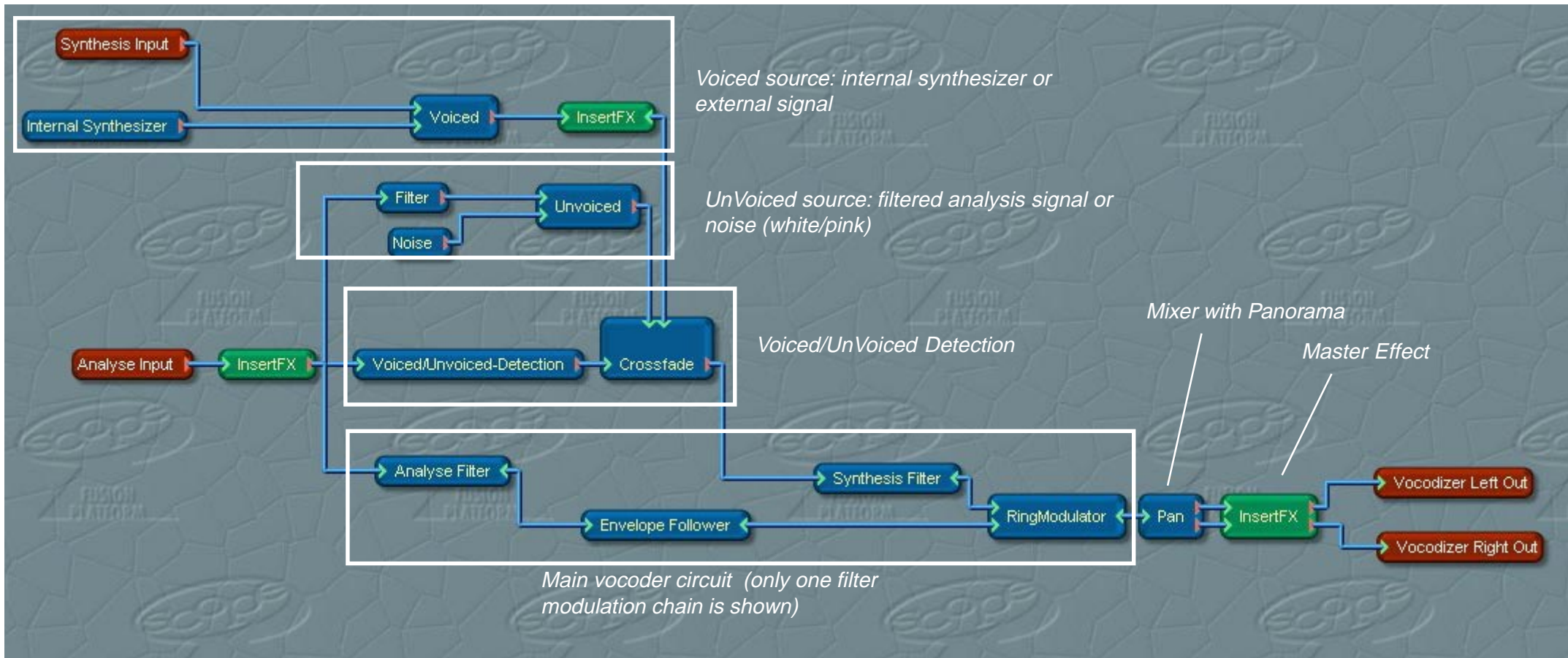
To guarantee the highest quality results, the Vocoderizer implements Voiced/Unvoiced Detection. During the analysis phase, the signal is examined for its tonal vs. noise content. Vowels, such as "A" are identified as tonal (voiced), and consonants such as "S" as noise (unvoiced). Depending on the results of this analysis, either the synthesizer signal or a noise signal is passed on to the synthesis filter bank. A noise signal (noise, in this case, referring to a signal containing all frequencies in appropriate proportions) can help to reproduce the sibilant portions of the original signal.

Often the synthesized results produced by a traditional vocoder do not contain enough high frequencies. The Vocoderizer's "noise substitution" strategy is able to produce more convincing results.

If you want, you can use the sibilant portions of the original signal for the unvoiced source instead of a random noise signal. In this case, the vocoder section filters the input signal in such a way that only the higher frequency components remain, letting you use the original "S" sounds to replace noise as the unvoiced source. In most cases, though, the broadband noise signal is a more appropriate source for unvoiced signal components, as the output already has a synthetic quality to it, and the original signal, if used, tends to stand out too much. But this option can come in handy sometimes, and in the long run it's all a matter of taste and appropriateness for the situation.

How is the Vocoder's circuit constructed?

This illustration is a schematic of the Vocoder's basic signal flow. This is an approximation simplified for the purposes of illustration; the actual circuit is significantly more complex. But you don't need to know all the dirty details to understand the Vocoder's functionality.



Controls

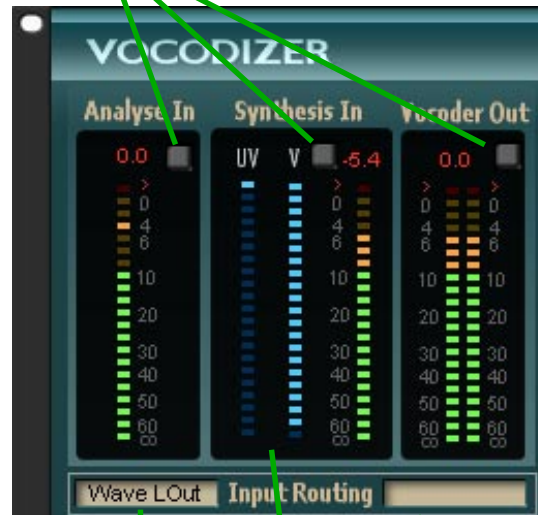
Meter Section

The Vocoder's level meters are located in the upper left side of the main window. Use these meters to monitor the input levels of the source and synthesis signals, and the level of the output. Well regulated signals are important for optimal results.

Margin: Displays the highest signal level reached so far. Use the Margin Reset button to set the margin display back to 0.

Routing Text: The Routing Text indicates the name of the module connected to the relevant pad. Right click (Mac: Ctrl+click) to open a menu showing the available modules and pads.

Margin Reset



Routing Text

Voiced/Unvoiced Detection

Volume: Controls the Vocoder's basic volume level.

To be able to produce very narrow filter settings while retaining sufficient output level, the Vocoder amplifies signals internally by up to 24dB. In most cases you will not find it necessary to adjust this control.

Master Effect: Insert any effect here to process the Vocoder's output signal.

MIDI: Selects the Vocoder's MIDI channel.

The Vocoder Section

The Vocoder section contains several groups of parameters.

Voiced/Unvoiced Detection

The Voiced/Unvoiced Detection feature examines the analysis input signal for its tonal and noise content to determine which is dominant.

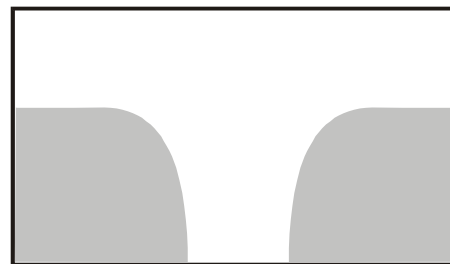


Voiced/Unvoiced Detection, as we have said, determines whether the input signal contains noise (like a sibilant "s" sound) or tone (like a spoken "a", or other vowel). Depending on the content, one of two possible signals is sent to the synthesis filter bank: Unvoiced source (usually noise) or Voiced source (the filtered internal synth or external audio source).

Type: The Detection algorithm can operate in one of two modes depending on some specific signal criteria.

Standard Mode (Type = off)

In standard mode the Vocoderizer splits the signal's energy content into high and low frequency components by means of two filters, and then analyzes the two components separately. By adjusting the Threshold setting you can determine how



much high frequency content triggers the detection circuit to identify the signal as unvoiced. However, at the same time, the Vocoderizer also examines the spectrum of the low frequency component. The Vocoderizer therefore considers two

conditions: Only if the high frequencies contain sufficient energy AND the low frequencies do not, will the Vocoderizer interpret the signal as being unvoiced.

Example: A pure "s" sound contains sufficient high frequencies to satisfy the requirements of the first criterion, but the lower frequency energy is not sufficient to qualify it as a tonal sound (second criterion). The Vocoderizer interprets this signal to be unvoiced.

With the same settings, the detection circuit now encounters a spoken "k" sound. As before, the high frequency component is determined to be sufficiently high in energy to qualify it as an unvoiced signal. But this time there is also enough tonal energy in the low frequencies to override the initial determination, and the Vocoderizer interprets the signal to be voiced. You can adjust the relationship of the weighting of the two criteria with the Hyst (Hysteresis) setting.

Alternate Mode (Type = On)

As an alternative to the standard mode in which the Vocoder analyses both upper and lower frequency ranges, you can use a simplified detection mode in which only the high frequencies are examined to determine the signal characteristic (voiced or unvoiced).



Highpass

In this mode it is sufficient only for the high frequency content to exceed the threshold for the signal to be identified as unvoiced. In Alternate mode the signal is determined to be unvoiced more frequently than in Standard mode, and the intelligibility in some cases improves because, along with the consonants like "k" and "s", some of the other overtone-rich parts of the signal are also identified as unvoiced.

Threshold: Sets the level at which the high frequency energy triggers the detection circuit to identify the signal as unvoiced.

When set to minimum, none of the signal will be classed as unvoiced, and the noise source will never replace the original signal in the output. And, as you would expect, setting this parameter to maximum results in the entire signal being identified as unvoiced. In this case, the noise source replaces the entire signal.

Hyst: Hysteresis describes the difference in threshold values for the upper and lower frequency ranges. At 0, the same level criterion applies to both ranges. With increasing hysteresis values, less energy is required in the lower frequency range to defeat the unvoiced detection in the upper range. Therefore, as you increase the hysteresis value, signals with sibilance are less likely to be identified as unvoiced leading to fewer replacements of the synthesized signal with noise.

The Hyst setting applies only in Standard mode as Alternate mode employs only a single threshold value.

Time: Depending on the result of the V/UV detection, the synthesis filter is fed either with noise (unvoiced) or the synthesized signal (voiced). However, the change from one to the other does not take place immediately; rather, the signals are cross-faded. The Time setting adjusts the duration of the cross-fade in milliseconds. With higher values, noise is fed into the synthesis section more slowly after unvoiced detection.

Input Section

Here you control the levels of the analysis and synthesis inputs, and include effects if desired.



Analysis Input

InGain: Adjusts the level of the analysis input signal with up to 24dB of amplification. Use the level meters to help set a satisfactory level.

Pay close attention to your levels. In particular, avoid letting signals overload the input. It's not so much that strong signals create audible problems with distortion; the bigger problem is that they influence the automatic controls to produce unexpected results.

Insert: Use the Effect Insert feature to condition the signal for subsequent analysis. For example, if the signal contains a lot of volume peaks or strong transients, you can insert a compressor or limiter to produce a more even vocoder signal. Also, an equalizer can help to optimize the signal for voiced/unvoiced detection by emphasizing the appropriate frequency required to produce the desired result.

Effects that alter the sounds in other ways may not be appropriate, as their effect, as such, will be lost. But you should always feel free to experiment. Who knows, maybe by applying a little delay...

Note that changes to the input gain have an influence on the voiced/unvoiced detection process. Usually you will also have to adjust the Threshold setting after you change the gain control setting.

Synthesis Input

Here you adjust the level of the synthesis input signal with amplification of up to 24dB. Use the level meters to help set the correct level.

Again, pay close attention to the level, especially avoiding signals that are too strong. Such signals will produce unexpected high frequency components in the synthesis signal.

Insert: Use the Effect Insert feature to process the synthesis signal. For example, if the signal contains a lot of volume peaks or strong transients, you can insert a compressor or limiter to produce a more even vocoder signal.

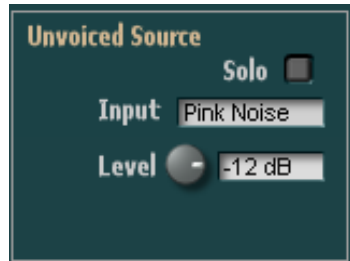
You can also include effects such as a chorus or flanger to enhance the dry synthesizer sound.

Solo: Click one of these buttons to hear only the analysis or synthesis input signal.

Attention: Often the input signal level is higher than the Vocodizer's output level. In this case, turn down the Master Volume control.

Unvoiced Source Section

Here you select the source signal to use for passages determined by the detection circuit to be unvoiced.



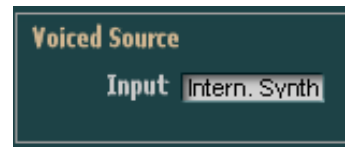
Input: Selects one of the following possible sources: White Noise, Pink Noise, and Filt. Original.

Level: Adjusts the level of the unvoiced source signal.

LowCut: If Filt. Original is your noise source, this control adjusts the cutoff frequency below which frequencies in the original signal are attenuated. This filter reduces the tonal (low frequency) content of the original signal.

Voiced Source Section

Here you choose whether to use the internal synthesizer, or the Vocoder's external signal input to provide the processed output signal.



When you choose not to use the internal synthesizer, all software processes that aren't required are unloaded from the DSPs. This economizes on DSP usage.

Analysis Filter Section

The settings in this section control the behavior of the Envelope Follower. You can make adjustments independently for each filter type—low pass, band pass, and high pass. In each case the parameters are the same.

Att (Attack): Adjusts the rate with which the Envelope Follower responds to rising signal levels.



Rel (Release): Adjusts the rate with which the Envelope Follower responds to falling signal levels.

Gain: Adjusts the output level of the Envelope Follower signals. When you adjust the gain, you are indirectly controlling the overall weighting of the low pass, band pass, and high pass section.

Filter Width Section

These controls adjust the bandwidth of the filters in the analysis and synthesis bandpass filter banks. The width for the filters in each bank can be adjusted separately, or they can be coupled together. As a general guide, the closer the center frequencies lie to each other, the narrower the bandwidth should be.

Link: Couples the two controls so they operate together.

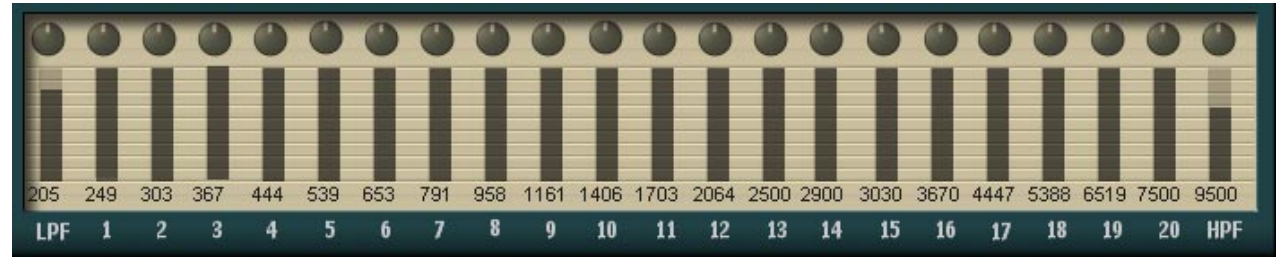
FilterMix Section

Here you can adjust the cutoff or center frequencies of each filter individually. To adjust a filter's frequency, click on its frequency value and enter the new value with your keyboard. The new value applies to each respective analysis and synthesis filter.

After modulation by the Envelope Follower, the 22 synthesis filters in the synthesis bank are mixed down to stereo through an internal mixer. You can set each filter output's stereo pan position individually to create some very pleasing and spacious stereo effects.

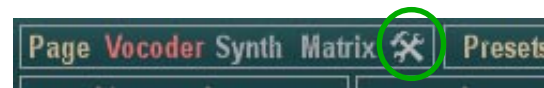
If you also modulate the frequency or pitch of the synthesized sound, you can create some very striking stereo effects.

Because you can control the volume levels of each individual filter output, extremely detailed control of the vocoder effect is possible.

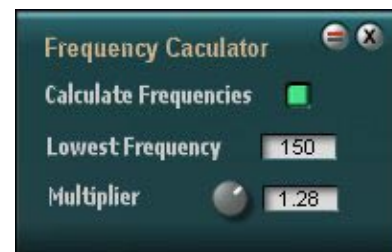


The Frequency Calculator

To open the Frequency Calculator, click the Tool icon in the Page selector area.



This dialog lets you adjust the frequencies of all the filters by specifying a base frequency and a factor.



Calculate Frequencies: Click this option to re-compute the filter frequencies. The new frequencies replace the old ones.

Lowest Frequency: Specify the base frequency here. The low pass filter is given this value as its cutoff frequency. For the band pass filters to start at a value of 200 Hz, set the low pass filter to 100 and adjust the volume to 0.

Multiplier: This is the factor used to calculate subsequent filter frequencies. For example, if the sequence starts at 200 Hz, a factor of 2 will produce the following sequence: 200, 400 (200×2), 800 (400×2), 1600 (800×2)...

The maximum allowable frequency is 12,000 Hz. Any filters exceeding this value are automatically switched off, and the volume controls associated with them will have no effect.

The Synthesizer Page

This page contains all the controls for the integrated synthesizer.

The integrated tone generation is based on a 2-oscillator short-wavetable synth. The oscillators correspond to the those on the Lightwave Synthesizer.



Osc1/2

Here you can select one of the 128 waveforms for each of the two oscillators.

Coarse: Adjusts the tuning of the oscillators in half-tone steps.

Fine: Adjusts the tuning of the oscillators in Cents.

LFO Mod: Adjusts the depth of the pitch modulation produced by the internal LFO.

Level

Osc1/2: Adjusts the volume level of the respective oscillator.

RingM: Oscillators 1 and 2 are internally configured to produce a ring modulation effect with each other. This control adjusts the amount of the ring-modulated signal to be added back into the oscillator mix.

Out: Adjusts the overall level of the synthesizer.

Note: The greater the polyphony you use, the more you should reduce the Out level to avoid internal distortion.

Filter/Amplitude Envelope

The Filters and Amplifier have separate ADSR envelope generators.

A (Attack): Adjusts the time it takes the envelope level to reach its maximum level.

D (Decay): The time it takes the envelope level to fall to the sustain level after reaching the maximum level.

S (Sustain): This is the level that is held as long as the key is pressed.

R (Release): The time it takes the envelope level to fall to 0 after the key is released.

Vel: Controls the degree of influence the performance dynamics (MIDI velocities) have over the envelope.

Filter Section

The Vocoder's output filter is a 24dB low-pass filter with resonance that can be modulated by various sources.

CutOff: Adjusts the filter's cutoff frequency. Frequencies lying above this value are attenuated.

Res: Adjusts the resonance factor. As this value increases, frequencies close to the cutoff frequency are more strongly reinforced.

Env: Adjusts the influence of the filter envelope over the filter frequency. In the center position, the envelope has no influence over the filter frequency.

LFO: Adjusts the modulation depth of the LFO on the filter frequency.



KF CNote (Key Follow Center Note): The filter frequency can be associated with keyboard position. The Center Note indicates the position at which the keyboard has no influence over the frequency value (that is, the neutral position).

KF Val (Key Follow Value): Adjusts the amount of influence Key Follow has over the filter frequency. The range is from -200% to +200%, with 100% indicating that a pitch change of an octave on the keyboard will result in a filter frequency change of an octave as well.

LFO: Sets the frequency of the internal Sine LFO.

Synth to Main Out: Select this option to send the synthesizer signals out through the normal Vocoder outputs. You can also send the synth signals over the Vocoder's synth outputs to make them available to a mixer in parallel with the vocoder signals.

The Matrix

With the Vocoder's Matrix you can route the control signals of the Envelope Follower to any arbitrary synthesis filter. You can also route the control signal of a particular analysis filter to multiple synthesis filters. The Matrix lets you accomplish a variety of effects, from "simple" formant displacement to a complete inversion of the filter assignments.

You can also change the frequencies of individual filters in the Matrix. However, note that each analysis and synthesis filter pair is always adjusted to the same frequency.

Randomize: Click here to establish random assignments of the analysis section to the synthesizer section. Use this to experiment with completely unpredictable results. Many of these will suggest new ideas, or provide new points of departure.



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