

Chris Hooker's  
**OC-D2 Octaver**  
Version 1.4



# User Manual

Thank you for downloading OC-D2!

## Compatibility

OC-D2 is a 32-bit Windows VST 2.3 plug-in.

It operates with 32-bit floating point internal processing, at zero latency.

## Installation

To install, simply copy the dll file into your VST folder. Your host program may require that you manually re-scan this folder to register the plug-in with the host program.

## What is OC-D2?

OC-D2 is an octave divider plug-in that generates signals one and two octaves below the original. It's based on the popular Boss OC-2 pedal, but with many more features far beyond what other octavers offer (both pedal and plug-in types), in order to make the tone more customized.

It's unique from the Boss and other octaver pedals and plug-ins in that it offers:

- Controls to all the typically fixed Low-Pass Filters - both on the octave-down signals to control tone, as well as on the detection circuit (which can help the accuracy of the octave-divider's tracking, by reducing harmonic content that can confuse the zero-crossing "pitch detection").
- Three different methods of Octave-signal generation.  
The OC-D2 provides the option of two MAIN modes of operation: Oscillator generation, or Polarity-Multiplying (of which there are two methods). The Oscillator mode simply provides octave-down square wave signals (filterable to sin wave) which yield a synth-like character, whereas the Polarity-Multiplier mode flips the polarity of the key signal, to create a more organic sound, based off the original signal... for more info on the two methods of this (and additional hidden tone-shaping features), see the Polarity Multiplier section later in this manual).
- Many users of the Boss OC-2 pedal seek to add a hardware modification that produces a more synth-like tone, by disabling the output filter and tapping the flip-flop circuit's direct square waves. This plug-in has the capability to easily reproduce this mod, by adjusting only a few parameters.

## Operation

OC-D2 was designed for use with mono channel (and monophonic) sources, and given the nature of the analog octave divider circuits that it is based off of, would not perform well with other types of material (such as a mix of instruments, polyphonic / chordal, or stereo material)... just like any of the pedals that employ this processing.

Although OC-D2 is a mono-processing plug-in, some host programs can only correctly support dual channel interfacing, and will either not recognize mono-channel plug-ins, list them as unsupported plug-ins, or process them with one channel being the processed signal and the other channel being the dry signal.

For compatibility with such programs, OC-D2 is provided in both a Mono interface format, as well as a Dual-Channel interface format.

The Dual-Channel version of OC-D2 SUMS the two channels. The internal operation is still mono, and it will output the summed signal to both output channels.

## Knob Controls

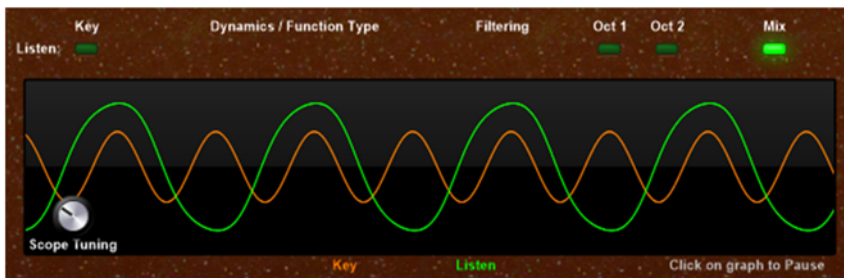
For all knobs in the OC-D2, holding shift while dragging the knob can fine-tune the movement. Holding [Ctrl] and clicking sets the knob to its default value. Filter knobs additionally have a text-edit box where the user can type in the desired value. All other knobs that appear to only show their functions will temporarily show values while they are being changed (with the exception of the Attack and Release knobs, which are based on ratios of the signal level, not specific time values).

## Signal Flow

OC-D2's GUI is arranged in the general signal flow of how it processes signals. We'll run through each section in order, including the Listen function (audio tap) and Scope display, which allow the user to monitor the signal between stages.

- [“Listen” Audio Tap and Scope Display](#)
- [Input / Key Section](#)
- [Dynamics / Function Type Section](#)
- [Filter Section](#)
- [Octave 1 & 2 Volume Section](#)
- [Mix Section](#)
- [Output Section](#)

## “Listen” Audio Tap Section and Scope Display



The oscilloscope-style display shows two signals at all times: the filtered Key signal (drawn in orange), and the user's selection from amongst the four Listen signal tap positions (drawn in green).

To choose which signal tap position to audition, simply click the corresponding green LED button above the scope.

Tapping the signal at various points in the signal chain not only shows the signal on the scope at that stage, but also routes that signal to the Output for monitoring purposes. By hearing and seeing what the signal is doing at each stage, it can help the user to identify what controls need to be adjusted in order to track the input pitch more accurately, or produce the intended sound, and shows how the output relates to the Key input. You can also temporarily listen to each Octave signal individually without changing the independent Octave Volume or Mix settings.

The graph includes a "Scope Tuning" control, which can be used to scale the zoom ratio. You can pause the scope by clicking anywhere on the plot display.

No matter which Listen stage you select, the audio will always route through the Output Volume control and soft-saturation / limiter.

## Input / Key Section



The signal first hits a volume control, which can both cut and boost volume to get the signal into optimal range. A clip LED also shows when signal reaches or exceeds digital zero.

A DC-offset switch corrects rectified or offset signals to improve tracking. Since the octave divider circuit is based off of zero-crossings, it will not be able to drop the octave of an offset signal that never crosses zero.

The Low-Pass Filter (LPF) allows signals below the user-specified frequency to pass through. Frequencies above this are reduced. This brings the signal closer to resembling a sine wave at the fundamental frequency, and allows the octave-dividing flipper circuit to act only on this frequency, instead of being triggered by zero-crossings from harmonics or other higher frequency noises in the signal. This results in a cleaner octave signal. If multiple notes are played at the same time that are close enough in frequency to evade filtering, there could be more zero-crossings than just the lowest pitch itself causes, which would result in irregular flipping of the circuit. It is for this reason that polyphonic material (multiple notes played at the same time) will not be detected accurately, and therefore is not supported by this plug-in.

Decreasing the higher frequencies so that the octave divider tracks only the fundamental notes can end up reducing the overall level of the key signal. An additional gain control after the Low-Pass Filter is provided to allow the user to compensate for this drop in level. This level will be shown in the signal graph, as well as the Gate Threshold control for the Oscillator mode. Additionally, when in either of the two Polarity Multiplier modes, the key level will affect the output level of the octave signals.

## Basics of Flipper Circuits for Octave Dividing

Here is where the signal goes to the flip-flop (AKA: flipper) circuits that create the octave-down signals. There are two types of flipper circuits used in the OC-D2. We'll start by detailing the first, which is implemented in the OC-D2's Oscillator mode and Polarity Multiplier A mode.

...How does it work? The key signal is analyzed in volume, and each time the signal rises above zero, it triggers a change in a toggle between 1 and -1. This toggling generates a square wave. Since the state of the square wave changes only on positive-vectored zero-crossings, instead of both positive and negative crossings, the rate of change is precisely half that of the input. Half the frequency of oscillation means it is an octave down from the input. By running the output of this first flipper into another flipper, we can generate another square wave, this time a second octave down. With these two square waves, we can now feed the next section of our controls.



## Dynamics / Function Type Section



In this section, the user has the choice of making the octave signal either an oscillator or a processed version of the key signal.

In Oscillator mode, the raw outputs of the flipper circuits are provided. We can choose whether these are gated to the key input, or follow the envelope of the key.

- In Gate mode, the oscillator will sound with no dynamics, but only turns on and off with the use of a noise gate triggered by the key signal. The threshold control sets the level of the key at which the oscillator turns on/off. The Gate Attack control sets the speed at which the gate opens, letting the octave signal sound. The Gate Release control sets the speed at which the gate closes, silencing the octave signal.
- In Envelope Follower mode, the octave signal follows the dynamics of the key signal. This can help it to blend with the dry tone better than a constant volume would, as with the Gate mode. The Attack setting controls how quickly the octave signal follows increases in volume changes in the key signal. The Release settings control how quickly the octave signal dies back down.

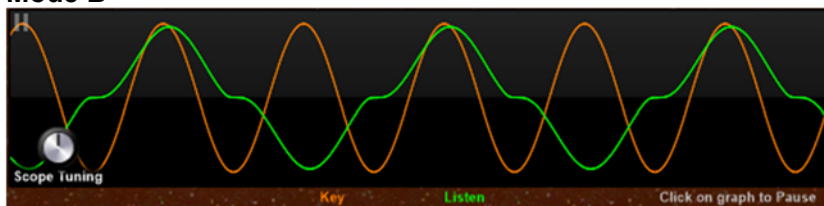
In Polarity-Multiplier mode, the key signal is processed in one of two user-selectable methods. Both involve flipping the polarity of the key signal without additional dynamics processing, thus the full dynamics of the key signal are retained. The user has the option of Multiplier mode A or B.

### Mode A



Mode A flips the polarity of the key signal directly at the positive zero-crossings, by simply multiplying it against the raw flipper output (1 or -1). The abrupt change in direction caused by flipping the signal's direction at zero-crossings results in a fair amount of harmonics, and yields a brassy tone (though it can be filtered out).

### Mode B



Mode B is a more complex circuit, and a more accurate simulation of the original Boss OC-2 pedal. A different version of a flipper circuit is used for this mode. Here, the key signal is DC-offset, following the amplitude at the signal's negative peaks\*. The signal is clamped, or pushed up in level, by this peak amplitude, so that the resultant wave oscillates entirely above zero, instead of alternating above and below. The signal is then split, with one branch being inverted (so that it oscillates *below* zero).

These two signals are then switched on and off, flipping between the two as they meet at zero amplitude. Since the peaks/crests of the sine(ish) waves slow their rate of change at the point where they begin to change direction, crossing at this point instead of at the quick zero-crossing of the original waveform results in smoother transitions with less harmonics.

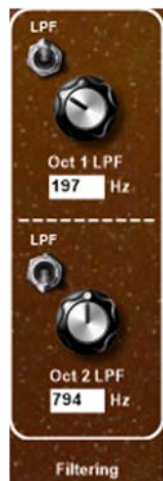
\*In the analog circuits of octaver pedals that utilize this method, the DC offset is traditionally created by implementing a capacitor to hold and slowly discharge the voltage from the negative peaks of the key signal.

There is a hidden control in the OC-D2 plug-in that allows the user to adjust the discharge time (⌚) of the simulated capacitor in Polarity Multiplier B mode: Right-clicking on the A/B mode selection will toggle on/off hidden controls for both Octave 1 and 2. The settings are shown in the Filter section.

Setting the discharge time to a slower / larger value will cause less ripple in the DC offset signal, and thus provide less harmonic distortion, but can result in the DC-offset being greater than subsequent peak voltages. This misalignment can cause poor tracking artifacts.

A faster capacitor discharge time will track pitch changes better, but will also cause more harmonics, in the form of flattening out the output waveform at zero-crossings.

## Filter Section



In this section, the user can enable or disable Low-Pass filters, and set the cut-off frequency. This can tame the brightness and harmonics of the octave signals, and bring the shape of the octaves' waveforms closer to smooth sine waves.

One drawback to both square waves (Oscillator Mode) and the Polarity Multiplier methods (forms of ring modulation (multiplying two signals)) is the additional odd harmonics that are generated above the octave's fundamental pitch, which may sound dissonant. Beyond just the low-pass filtering available within the OC-D2, the Polarity Multiplier Modes also provide a means to help mask these odd harmonics:

Within the hidden controls available when in either Polarity Multiplier mode (right-click on the A/B mode selection to enable/disable) are diodes (⚡) for each octave section. Enabling these diodes blocks negative signal in the flipper outputs. This half-rectification results in adding an even-harmonic series, starting an octave above the octave dropped frequency (AKA: the original fundamental of the input). This lies between the octave-down pitch and the prominent Perfect 5<sup>th</sup> of the original frequency. Filling this frequency (and the additional even-harmonic series) results in a slight masking of the odd harmonics, and also reinforces the fundamental.

Also included in the hidden options is a polarity switch (⌀). This switch is only visible when the diode for the corresponding Octave is enabled. (The non-rectified signal is symmetrical above and below zero, therefore flipping the polarity makes no difference.) When the diode is activated, the octave signal will no longer be symmetrical, and thus the polarity switch can be used to help ensure the octave signal is in phase with the key signal / dry signal. When using less than 100% wet mix, you may find that different polarity settings may result in different tonal variations, as certain harmonics will either cancel or be reinforced. In B mode, the diode and polarity functions of octave 1 have an effect on the octave 2 circuit, adding further complexity of wave-shaping, providing even more tonal options.

## Octave 1 & 2 Volume Section



The user has control over the volume of both Octaves.

Volume knobs go from 0% to 300%, so that you can boost the volume of each Octave signal if needed, or mute it entirely.

After filtering out higher harmonic content from the Octave signals you may desire to bring up the Octave signal.

This section is where you can control the balance between the two Octaves, or mute an Octave entirely.

(Muting both Octaves will allow you to apply the Output section's saturation to the dry signal, if you want to use the plug-in only for the saturation.)

You can also use the Listen Buttons at the bottom of this section to solo an Octave, bypassing the Mix section.

## Mix Section



The Mix control adjusts the wet/dry balance with center being 100% volume of both dry signal and wet signal. As you rotate the knob counter-clockwise from center, towards Dry, the wet signal dies off, and vice-versa.

Left, Center, and Right values are thus:

L: 100% Dry / 0% Wet

C: 100% Dry / 100% Wet

R: 0% Dry / 100% Wet

## Output Section



The Output section is active regardless of your Listen selection. The volume control and limiting come after the Mix section as well... so even if you have the mix set to full dry, the Output Volume and Limiter settings will affect the signal.

The Output Volume knob both boosts and cuts, for optimum level-setting.

An LED shows when signal is clipping, or in the case of when the limiter is engaged, when clips are being prevented.

Following the Output Volume control, the limiter employs soft-saturation to prevent clipping. It applies a gradual rounding of the signal as it approaches maximum, instead of a hard-knee limit. This creates a much smoother, almost compression-like character.

## Automation and Preset Handling

Every control in the OC-D2 is automatable and stored / recalled in presets.

20 Factory presets are included, which run through the capabilities of the plug-in. There are also 20 User preset slots in which you can save your own settings. (Please note that to share your own custom presets between instances of the plug-in, you must use the "Save... to Disk" feature, and then in the separate instance of the plug-in, load either individual or all presets that you have saved to disk.)

## Important Notes

This plug-in is free for both personal and commercial use, but please don't redistribute - just refer others directly to the webpage or download link below.

Webpage:

<http://christopherhooker.com/plug-ins.htm>

Free direct download link:

<http://www.christopherhooker.com/Public%20Refs/OC-D2.zip>

Comments? Suggestions? Contact the developer at [chris@christopherhooker.com](mailto:chris@christopherhooker.com)

I'd love to hear any projects in which you use this plug-in!

Thanks for using OC-D2!

You can show your appreciation and support future development by donating:

