WARP CORE

User Manual
Version 1.3.1

TABLE OF CONTENTS

OVERVIEW

Warp Core is a stereo/dual-output complex oscillator designed for deep and uniquely digital timbral exploration. Unlike traditional oscillators, Warp Core does not produce perfect geometric wave shapes (triangle, saw, square, etc), but instead uses a digital synthesis technique called phase distortion to produce variably complex waveforms with rich harmonic content from a pure sine wave lookup table.

The phase distortion engine features 8 different continuously variable algorithms assignable to two slots (WARP A and WARP B) routed in series, for a total of 64 possible combinations. Because these algorithms are almost all nonlinear, in most cases different timbres will be produced when swapping the order of the selected algorithms.

Warp Core also features phase modulation pre- or post- phase distortion via an internal sine modulation oscillator with a configurable frequency ratio relative to the main oscillator. For even more phase modulation possibilities, there is also an audio-rate external PM input.

Two configurable “thickness” parameters serve to reinforce the fundamental and/or sub-octave of the oscillator output and provide slight detuning on the 90º output for thicker stereo or unison sounds.

Last but not least, Warp Core’s calibrated tuning controls enable quickly and easily tuning the oscillator to arbitrary frequencies or perfectly tuned (A=440Hz 12-TET) semitones in multiple octaves as we all as locking the tuning knob to preserve perfect tuning for a live performance.

** Aliasing is mitigated, but still sometimes audible when tuned to high pitches and using more extreme settings. We suggest embracing it and considering it part of the character of an unabashedly digital oscillator pushed to its limits.*

TECHNICAL SPECIFICATIONS

- **Width**: 12hp
- **Depth**: 30mm
- **Power consumption (peak):**
  - +12V: 145 mA
  - -12V: 8 mA
  - 5V: 0 mA
- **Input Impedance (All Inputs):** 100k Ohm
- **Audio Output Impedance:** 100 Ohm
- **CV Input Range:** +/- 5V (tolerant up to rail voltages)

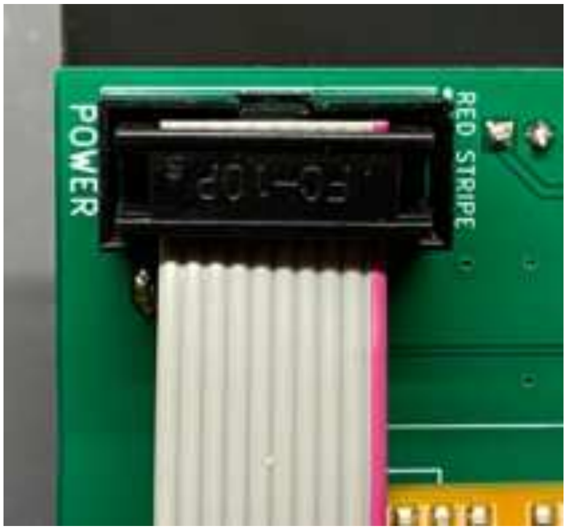
The audio codec operates at 96kHz, but the DSP engine is internally oversampled by 4x to an effective sample rate of 384kHz to mitigate aliasing*.

Important Note:

*The Daisy Patch Submodule on the back of the Warp Core PCB is held on very tightly by the friction of the headers. If for any reason you decide to attempt to remove this module, be **extremely careful** - go slowly and always apply force directly upwards away from the PCB, never rock it from side to side. Too much force and the SMD headers may rip off of the PCB. **Infrasonic Audio is not liable for any damage caused by attempted removal of the Patch Submodule.***

INSTALLATION

Power Ribbon



The power connector on Warp Core is shrouded and keyed to ensure proper orientation, but just in case, always ensure that the red stripe (-12V) is aligned to the right side as shown above.

The other end of the cable should be connected to your power bus with the red stripe aligned to the -12V side of the bus connector.

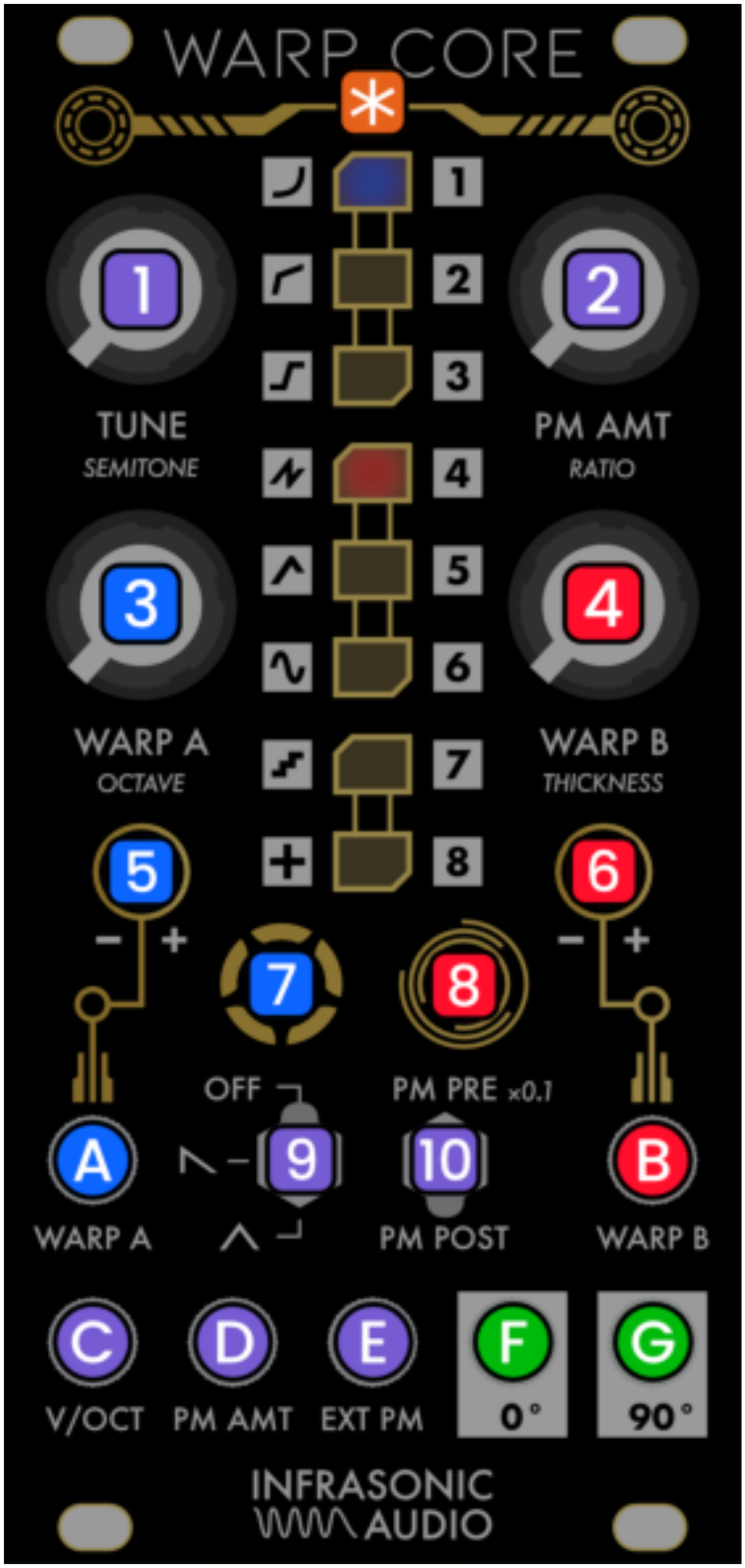
Expansion Jumper (Rev 1.2 and above)

Revision 1.2 and later of the hardware (serial numbers 100 and above) comes with a surface-mount slide switch used to enable the Expander module. For usage without the expander, please leave this jumper in the factory default position, with the lever switched toward the bottom of the PCB (away from the direction of the EXP arrow). See Expander section for instructions on connecting the expander.

Expansion Jumper
(Rev 1.1 and below)

Revision 1.1 and below of the hardware (serial numbers below 100) comes with a pre-installed jumper on a header used to enable the Expander module. For usage without the expander, please leave this jumper in the factory default position on the top two pins (i.e. **not** connecting the two lower pins labeled EXP). See Expander section for instructions on connecting the expander.

PANEL LAYOUT



CONTROLS

✳ LED DISPLAY COLUMN

The vertical column of LEDs is used for several purposes:

- Displays the currently select Warp Modes
- Provides visual feedback of the level of various controls, including the influence of CV
- Provides visual feedback while adjusting parameters

Please see individual function sections for more details.

1 TUNE / *SEMITONE*

Adjusts the frequency of the oscillator output.

- Holding the 7 **LEFT BUTTON** and turning this knob quantizes the frequency to exact 12-TET semitones.

See section Tuning for more information.

2 PM AMT / *RATIO*

Sets the amount of phase modulation applied to the phasor using the internal PM oscillator. Does not affect the amount phase modulation applied by the EXT PM signal input.

- Holding the 7 **LEFT BUTTON** and turning this knob adjusts the **numerator** of the ratio of the internal modulation oscillator's frequency relative to the main oscillator's phasor frequency.
- Holding the 8 **RIGHT BUTTON** and turning this knob adjusts the **denominator** of the ratio of the internal modulation oscillator's frequency relative to the main oscillator's phasor frequency.

- The position of the 10 **PM ROUTING SWITCH** influences the maximum internal PM phase deviation amount - when the switch is in the **PM PRE x0.1** position, the maximum phase deviation configurable with the knob is 10x smaller than when in the **PM POST** position.

See section Phase Modulation for more information.

3 WARP A / *OCTAVE*

Controls the amount of phase distortion applied to the signal using the algorithm of the Warp Mode assigned to WARP A.

- Holding the 7 **LEFT BUTTON** and turning this knob adjusts the octave offset for the oscillator's tuned frequency (see Tuning).

See section Phase Distortion for more information.

5 WARP A CV ATTENUVERTER

Attenuverter for A **WARP A CV INPUT**

Please note that the attenuation is applied digitally in order to preserve resolution. This means that signals exceeding the valid -5V to 5V range of the A **WARP A CV INPUT** will clip *before* being attenuated.

7 LEFT BUTTON

- Press and release quickly once to cycle the WARP A Warp Mode
- Press and hold while adjusting one of the four primary knobs for alternate functions

4 WARP B / *THICKNESS*

Controls the amount of phase distortion applied to the signal using the algorithm of the Warp Mode assigned to WARP B.

- Holding the 7 **LEFT BUTTON** and turning this knob adjusts the fundamental / sub-octave reinforcement level (see Thickness Parameters).
- Holding the 8 **RIGHT BUTTON** and turning this knob adjusts the detuning of the **90° OUTPUT** (see Thickness Parameters).

See section Phase Distortion for more information.

6 WARP B CV ATTENUVERTER

Attenuverter for B **WARP B CV INPUT**

Please note that the attenuation is applied digitally in order to preserve resolution. This means that signals exceeding the valid -5V to 5V range of the B **WARP B CV INPUT** will clip *before* being attenuated.

8 RIGHT BUTTON

- Press and release quickly once to cycle the **WARP B** Warp Mode.
- Press and hold while adjusting 2 **PM AMT / *RATIO*** or 4 **WARP B / *THICKNESS*** for alternate functions.
- Press and hold while powering on module to reset all parameters to their defaults (see Restoring Defaults)
- Press and hold for a few seconds to reset "shift" parameters to their defaults (see Restoring Defaults)

9 WINDOWING MODE SWITCH

Selects the periodic output window applied to the oscillator signal.

See section Windowing for more information.

** Accepts -5V to 5V but tuning tracking may not be accurate below -3V or all the way up to exactly 5V due to 0V offset calibration*

10 PM ROUTING SWITCH

Selects where in the synthesis chain Phase Modulation is applied to the phasor (for both internal and external PM) as well as the maximum internal PM level.

See section Phase Modulation for more information.

CV INPUTS

A WARP A CV INPUT

Controls the amount of phase distortion applied to the signal using the algorithm of the Warp Mode assigned to WARP A, subject to the 5 WARP A CV ATTENUVERTER.

Value is summed with 3 WARP A knob setting.

Input Range: -5V to 5V

B WARP B CV INPUT

Controls the amount of phase distortion applied to the signal using the algorithm of the Warp Mode assigned to WARP B, subject to the 6 WARP B CV ATTENUVERTER.

Value is summed with 4 WARP B knob setting.

Input Range: -5V to 5V

C V/OCT CV INPUT

Volt per octave CV input for changing the frequency of the oscillator relative to its current Tuning.

Input Range: -3V to ~5V*

D PM AMT CV INPUT

Controls the amount of phase modulation applied to the phasor using the internal PM oscillator. Does not affect the amount phase modulation applied by the EXT PM signal input.

Value is summed with 2 **PM AMT** knob setting.

Input Range: -5V to 5V

E EXT PM INPUT

AC-Coupled audio signal input for modulating the phasor pre- or post Phase Distortion, proportional to the voltage of the input (i.e. the signal at this jack becomes the modulator signal for the oscillator's phase).

Because this is an audio-rate input the signal is processed at the audio codec's 96kHz sample rate, whereas the other CV inputs are processed at a lower sample rate.

See section External PM for more details.

Input Range: -10V to 10V

AUDIO OUTPUTS

F 0° OUTPUT

Main oscillator output. Signal is a sine wave proportional to the phase of the phasor signal after having undergone phase distortion and modulation, with optional fundamental/sub-octave reinforcement oscillator signal mixed in.

G 90° OUTPUT

Main oscillator output. Signal is a sine wave proportional to the phase of the phasor signal shifted by 90 degrees (i.e. a cosine lookup) after having undergone phase distortion and modulation, with optional fundamental/sub-octave reinforcement oscillator signal mixed in and optional detune applied.

PHASE DISTORTION

WHAT IS PHASE DISTORTION?

Phase Distortion is a digital synthesis method which creates complex wave shapes by affecting the phase of an oscillator in a precisely controlled, usually nonlinear manner. Phase Distortion is not the same thing as Phase Modulation, though Phase Modulation can be thought of as a form of Phase Distortion.

Perhaps it is easiest to understand how it works with a visual example. In **Figure 1** below, the red line is the "phasor" - a type of period ramp representing the phase of the oscillator. Here, the phasor is normalized to the unit range (0 to 1), but mathematically it represents phase angles between 0 and 2π radians.

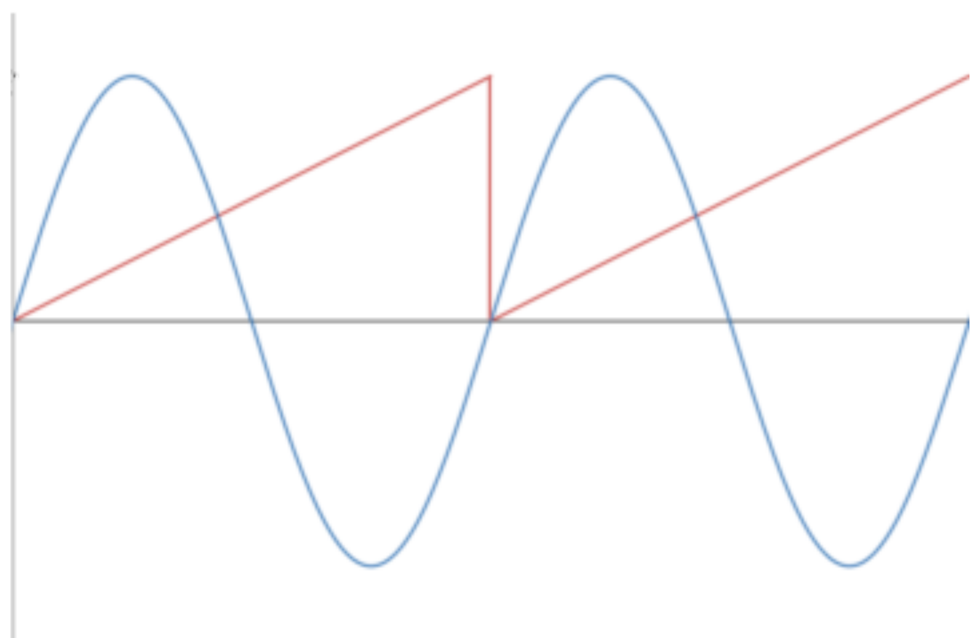


Figure 1: Linear phasor and sine wave

The phasor will be used to calculate the amplitude of the oscillator's output signal – the blue line – by taking the value of a sine function at that phase. In this sense, it is intuitive to interpret the phase as the angle of a point traveling around a unit circle (remember your trigonometry?)

As depicted in **Figure 1,** if the phasor is a linear ramp function, the output is a perfect sine wave because the phase is increasing at a steady linear rate. The “wrapping” of the phasor back to zero when it reaches 2π radians is a convention, since phase angles spaced exactly 2π radians apart are mathematically equivalent for the purposes of determining sinusoidal amplitude. The faster the rate of increase of the phasor (and consequently, after wrapping, the shorter its period) the higher the frequency of the resulting sine wave.

Now, let’s see what happens when we change – or distort – the phasor, while still keeping it periodic at is original frequency. **Figure 2** below demonstrates what happens when applying a small amount of the “Bend” Warp Mode, which imparts a curve to the phasor. Now, the phasor is no longer linear - the phase angle’s rate of increase slows down as it approaches the end of its fundamental period. This yields a distorted sine wave shape since the sinusoidal amplitude calculation as a function of phase is no longer linear. However, the phasor itself is still periodic - resetting back to zero at a rate equal to the fundamental frequency of the oscillator. Increasing the level of curve further distorts the wave by compressing the first crest and stretching the second.

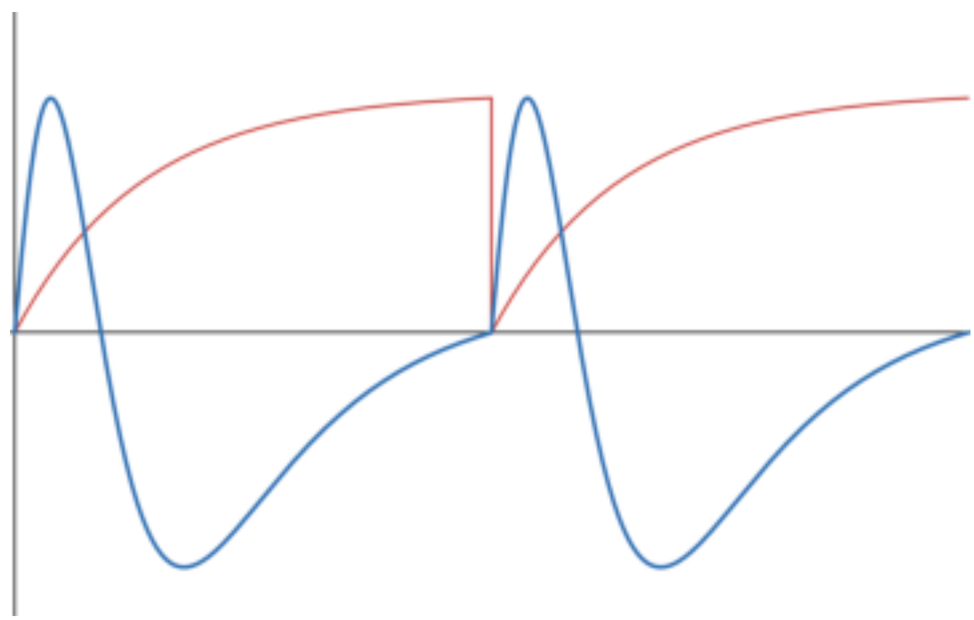


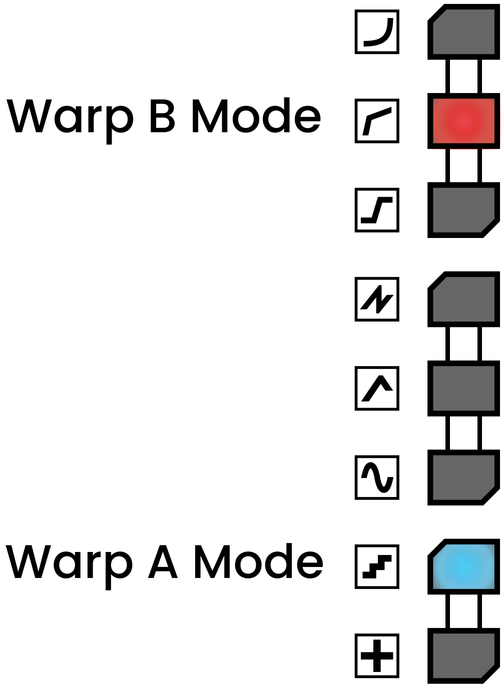
Figure 2: “Bent” phasor and resulting distorted waveform

This is the essence of phase distortion. By stacking and modulating distortion functions on the phasor we can create highly complex, evolving wave shapes and timbres.

WARP SLOTS

Warp Core's 8 unique "Warp Modes" (i.e. phase distortion transfer functions) may each be assigned to one of two slots – WARP A and WARP B – which are applied to the phasor in series.

Each of these modes may be assigned to either slot by pressing and releasing the corresponding button – 7 **LEFT BUTTON** for WARP A and 8 **RIGHT BUTTON** for WARP B – to cycle through the options.



The Blue LED indicates which mode is assigned to WARP A and the Red LED indicates which mode is assigned to WARP B. The icons to the left of the LED column represent the effect selected Warp Mode (explained in Warp Mode Reference). If the same mode is assigned to both slots, the corresponding LED will be pink.

The corresponding **WARP** amount knob and CV input (scaled via its attenuverter) control "how much" of each transfer function's algorithm is applied to the phasor.

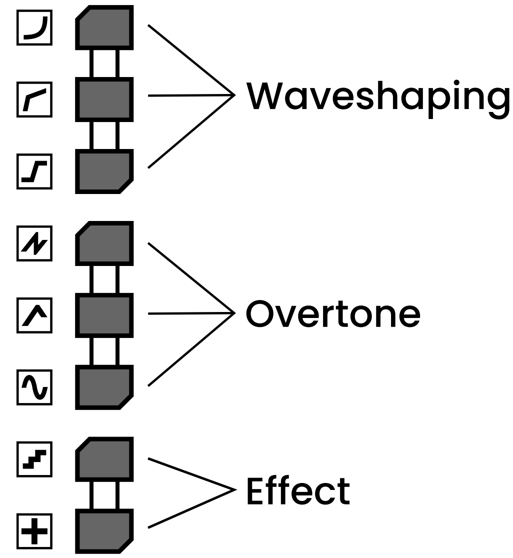
Almost every Warp Mode's transfer function is nonlinear, and therefore because the pair of selected modes are applied to the phasor in series, the order matters. In most cases dramatically different timbres will be produced when assigning the same two mode selections to the slots in the opposite order.

Quickly pressing and releasing both buttons simultaneously will swap the selected Warp Mode in each slot. This is a handy shortcut to explore the differences in sound the same pair of transfer functions can produce when applied in the opposite order.

WARP MODE REFERENCE

The Warp Modes are divided into three groups: Waveshaping, Overtone, and Effect. The significance of the groups as well as the individual modes in each group are described below.

In all diagrams in this section, the RED line is the phasor with the Warp Mode's transfer function applied at a moderate level and the BLUE line is the resulting signal output. Actual results will depend on the level of WARP AMT *applied.*



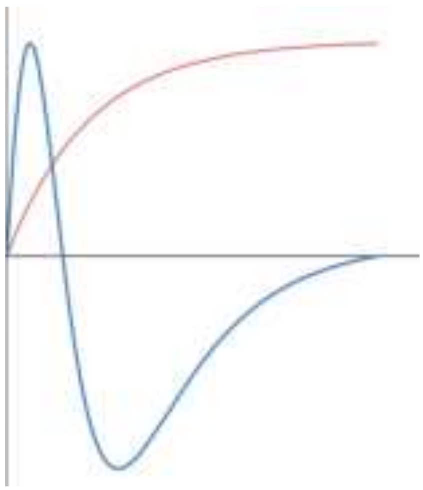
The order of the two selected modes is significant! Try selecting a Waveshaping mode in the WARP B slot and an overtone mode in the WARP A slot – this will have a drastically different effect on the resulting waveform and sound.

WAVESHAPING MODES

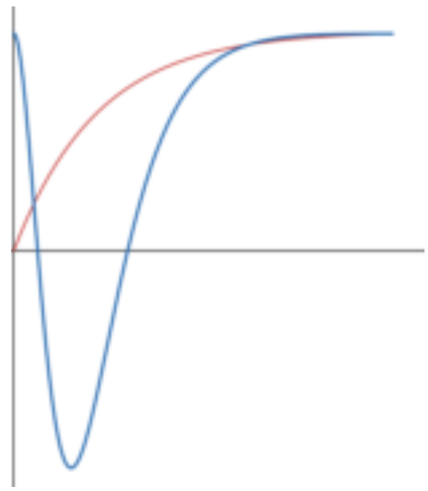
The top three Warp Modes apply waveshaping-like distortions to the phasor, sometimes approximating classic subtractive waveforms, but always resulting in additional harmonics with a relatively clearly perceived fundamental pitch. In these modes, the distortion applied to the phasor (in isolation) always results in the phasor still increasing monotonically and not "wrapping around" within its fundamental period.

Bend

Applies an increasingly exponential curve to the phasor, resulting in an output that begins to roughly resemble a rounded pulse wave. The (F) **0° OUTPUT** will be more similar to a low duty cycle pulse wave while the (G) **90° OUTPUT** will be more similar to a high duty cycle pulse wave.



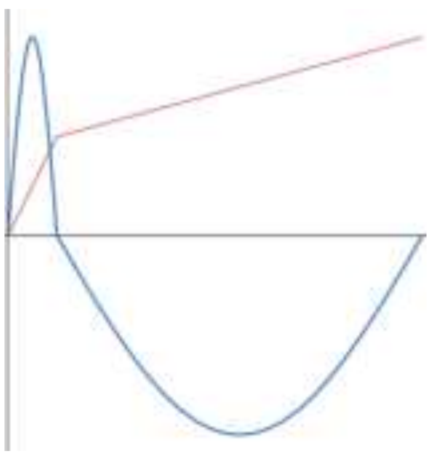
Bend – 0° Output



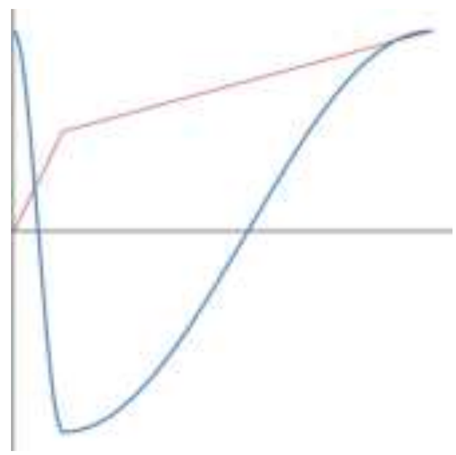
Bend – 90° Output

Kink

Shapes the phasor using two sloped line segments that join at the periodic midpoint of the phase, i.e. at an angle of π radians. The corresponding **WARP** amount controls the slope of the segments. For the (G) **90° OUTPUT**, this creates a very sawtooth-like waveform as the amount increases.



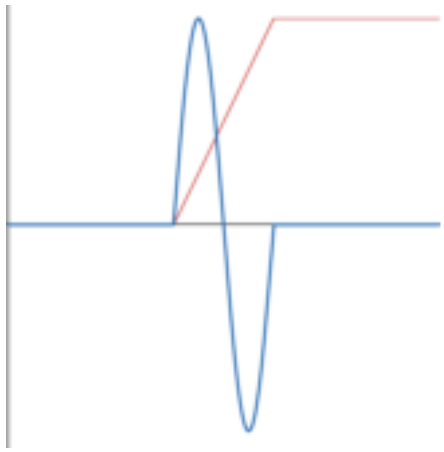
Kink – 0° Output



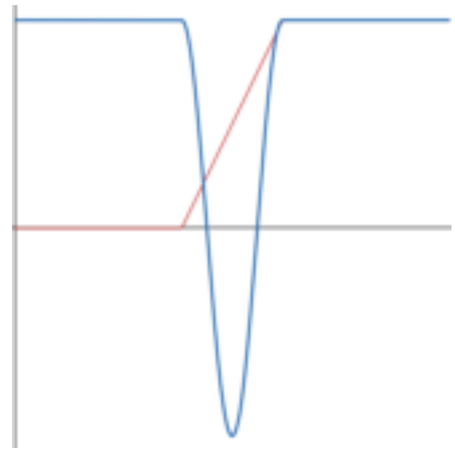
Kink – 90° Output

Pinch

Shapes the phasor by "pinching" the sloped portion toward the center of the period, clipping to the boundaries. The result is vaguely like PWM for arbitrary wave shapes, with the "active" portion of the wave getting progressively smaller within the same period.



Pinch – 0° Output



Pinch - 90° Output

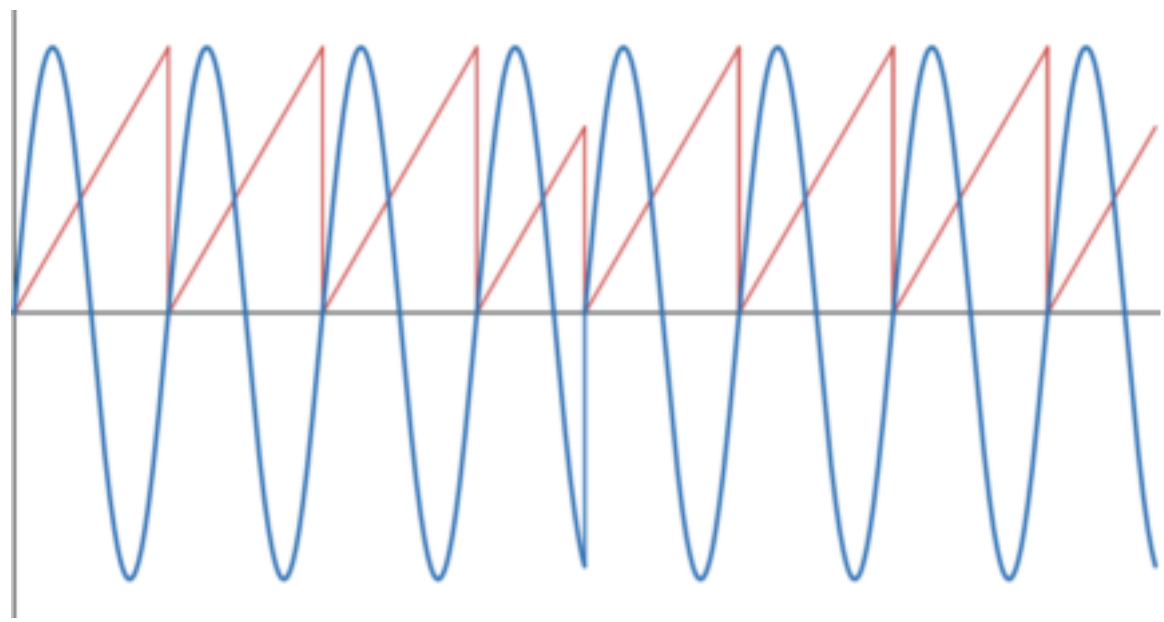
Pinch has a tendency to "thin out" the sound of the oscillator due to reducing the energy at the fundamental frequency. Try using Fundamental / Sub Octave Reinforcement for a thicker tone when using Pinch.

OVERTONE MODES

The next three Warp Modes are phase distortion functions which result in the phasor "wrapping around" within its fundamental period and sometimes changing direction. This tends to emphasize a specific harmonic overtone in the output signal, creating sounds reminiscent of resonant filter sweeps, oscillator sync, wavefolding, and more. These modes can sometimes mask the fundamental pitch, causing the oscillator to sound like it's tuned to an integer multiple (harmonic) of the phasor frequency.

Sync

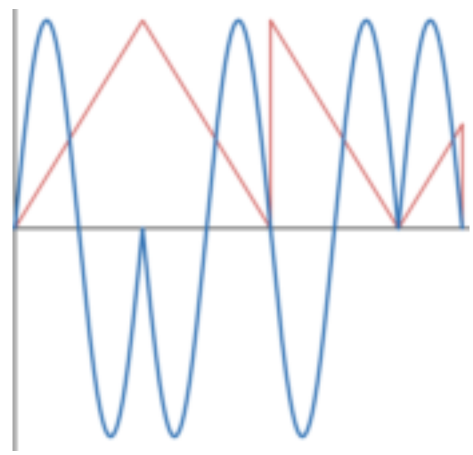
Hard-syncs the phasor to a "virtual" frequency increasing from the phasor's fundamental frequency by wrapping it back around to zero. This often creates a discontinuity at the end of the period, resulting in "buzzing" sounds as the WARP AMT is manipulated, which can be tempered by using Windowing.



Sync – two fundamental periods of 0° Output
demonstrating "hard sync" behavior

Fold

Similar to Sync, but instead of wrapping the phasor back around to zero when reaching its maximum, it reflects it back the other direction. This is akin to applying a perfect wavefolder to the phasor itself and wrapping the result to the normal range. When applied to the G 90° OUTPUT with no windowing, this mode ends up producing an identical result to Sync.



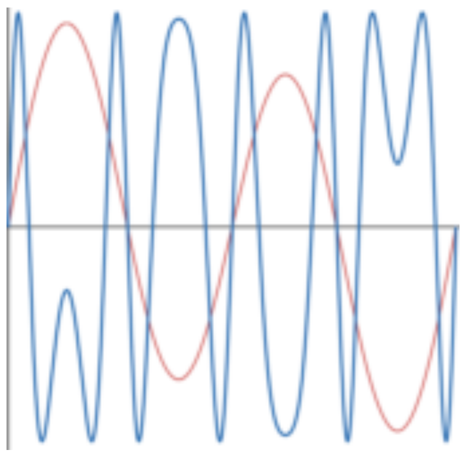
Fold – 0º Output

The result of Fold is dependent on the "phase shift" of the phasor. Try using the OFFSET Warp Mode in tandem with Fold to "scan" through different folded shapes.

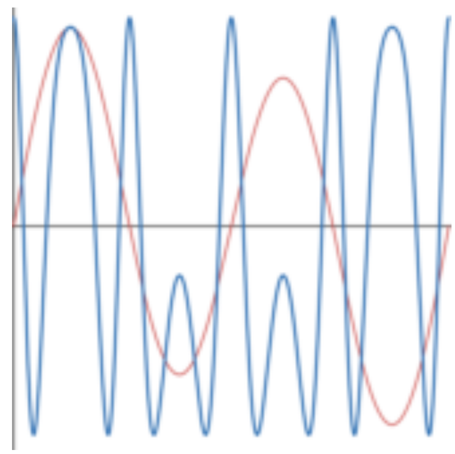
Scream

Applies a sine function to the phasor, interpolating between harmonics. Results in strong, clean overtones that can mask the fundamental frequency. The result on each of the two outputs has a different harmonic biasing.

At the very beginning of the **WARP AMT** range for this algorithm, the phasor transitions from a line (normal linear phase) to a sine wave, and as a result produces a discontinuity at the end of each cycle. This can either be embraced and used creatively, or mitigated with Windowing.



Scream – 0° Output



Scream – 90° Output

EFFECT MODES

The final two Warp Modes are utilities which can add additional color and subtle variation to the sound.

Crush

Applies continuously variable quantization to the phasor. This is essentially a "bitcrush" effect, down to a minimum of about 2 bits. The perceived result is the same on either output, but the tone will be different when combined with another Warp Mode depending on whether this mode is assigned to WARP A or WARP B.

Offset

Adds a constant offset to the phasor - effectively acting as another source of DC-coupled Phase Modulation.

When assigned to WARP A, modulating **WARP AMT** in this mode with an LFO tends to result in subtle to extreme pitch wobbling. Since the frequency shifting effect is proportional to the derivative of the phase, interesting things can happen with envelopes and different LFO shapes as modulation sources.

When assigned to WARP B, modulating **WARP AMT** in this mode often also results in timbral shifts and motion of the resulting wave within other period-locked distortions. In stereo patches, this tends to "rotate" the stereo image, creating interesting movement for drones (try a slow LFO or smooth random CV).

In Firmware versions prior to 1.3, the amount of phase offset in this mode was limited and clamped to one period. In version 1.3 and later, the phase can be offset up to 4 periods across the range of the knob, and can be offset even further via CV without clamping to an internal min or max - the only limitation is the CV input range.

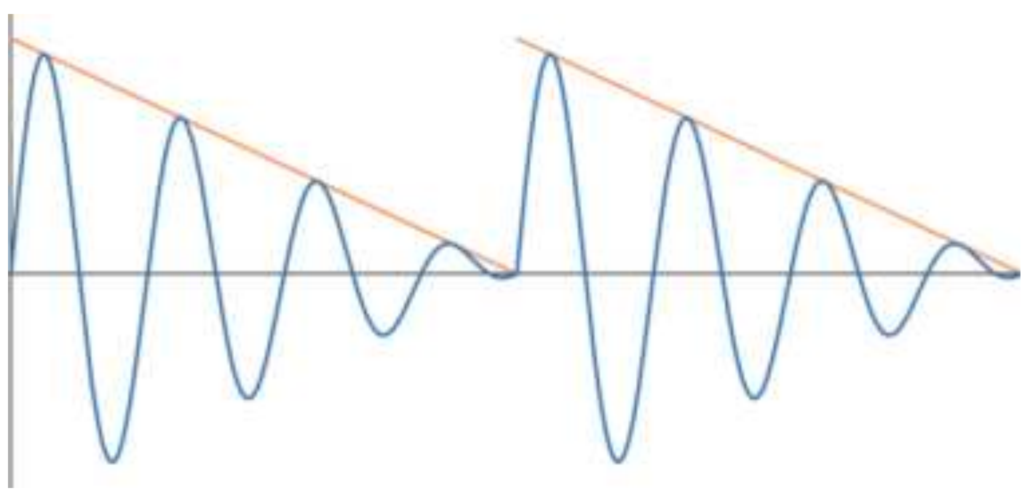
WINDOWING

The 9 **WINDOWING MODE SWITCH** controls whether to "window" each period of the resulting waveform with the selected shape. This is a simple form of synced amplitude modulation which adds additional color/harmonics to the sound, but more interestingly also helps eliminate discontinuities at the endpoints of the waveforms that emerge due to phase distortion algorithms which result in the phasor jumping back to zero at the end of a period (e.g. sync, fold).

Generally speaking, windowing can be used to reduce "buzzing" harshness from some combinations of other settings. However, be aware that due to the phase shift of the 90 degree output (or when using the OFFSET algorithm), the SAW window may actually introduce its own discontinuity/buzzing.

OFF - no windowing

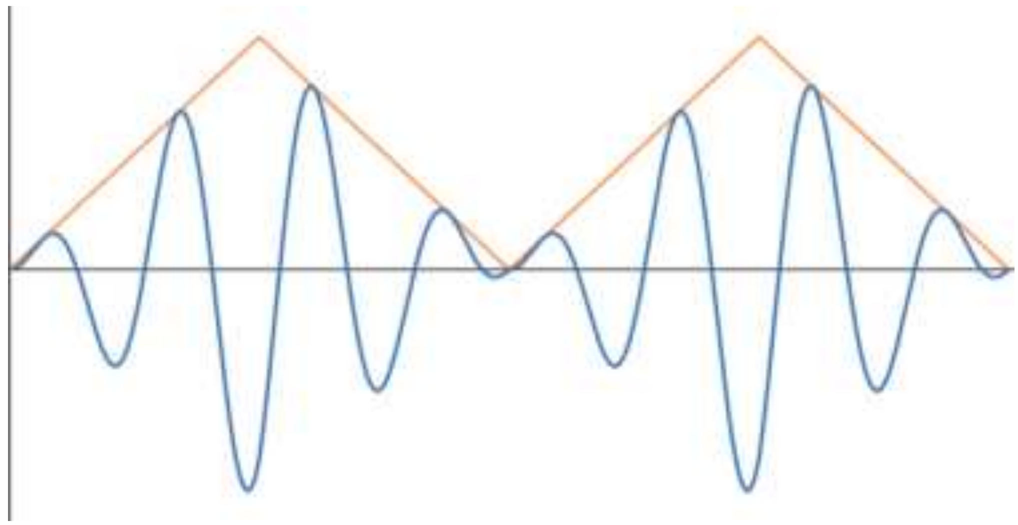
SAW - a unipolar sawtooth window is applied, smoothing discontinuities at the start of each period (provided the waveform output is zero at the start of the next period)



Saw window applied with Sync Mode

Window shown in orange for reference only

⋀ TRIANGLE - a unipolar, equilateral triangle window is applied, smoothing discontinuities at the start of each period. This method also sometimes adds a noticeable tone at the second harmonic.



Triangle window applied with Sync Mode
Window shown in orange for reference only

For a classic "faux resonant filter sweep" phase distortion sound, use the F **0° OUTPUT** with the **SYNC** algorithm and **SAW** windowing.

PHASE MODULATION

In addition to Phase Distortion, Warp Core also features a flexible Phase Modulation system, which itself can be considered a specific type of Phase Distortion. The modulating signal is directly added to the phasor, resulting in additional phase angle modulation proportional to the modulating signal.

Phase Modulation from both internal and external sources may be applied either PRE or POST phase distortion. The internal modulator tracks the fundamental (carrier) frequency of the phasor, multiplied by a configurable integer ratio.

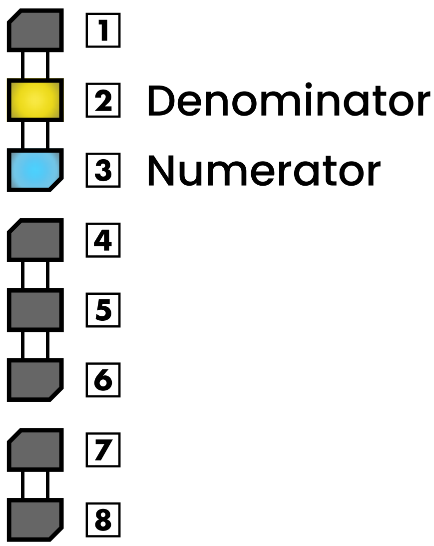
INTERNAL PM

The 2 PM AMT knob controls the amount of internal modulation applied to the phasor. The value represented by the voltage at the D PM AMT CV INPUT is added to the knob value for CV control over the modulation amount. Any LEDs that are not currently displaying the assigned Warp Modes will illuminate in a teal/green color with brightness proportional to the level of internal PM.

When PM PRE routing is selected on the 10 PM ROUTING SWITCH, the maximum phase deviation amount for the internal phase modulation oscillator is 0.1x of what it is when PM POST is selected. The primary reason for this is because the PM PRE routing setting can produce drastically harsher and more complex tones when combined with Phase Distortion than the POST setting, so the max phase deviation range, which is proportional to the resulting spectral bandwidth, is reduced in order to compensate. This is also useful for limiting the D PM AMT CV INPUT range when using the oscillator solely with internal Phase Modulation and no Phase Distortion.

The 10 PM ROUTING SWITCH position also affects the routing of the E EXT PM INPUT signal (i.e. modulating the phasor PRE- or POST- Phase Distortion) but does **not** affect the phase deviation scaling of the external modulation signal.

ADJUSTING INTERNAL PM RATIO



Example: *Internal PM Oscillator Ratio of 3/2*

Hold the 7 **LEFT BUTTON** and adjust the 2 **PM AMT** knob to change the numerator of the Internal PM oscillator frequency ratio, indicated by the number next to the blue LED.

Hold the 8 **RIGHT BUTTON** and adjust the 2 **PM AMT** knob to change the denominator of the Internal PM oscillator frequency ratio, indicated by the number next to the yellow LED.

As an additional visual clue as to which is the numerator and denominator, the LED display will animate a pattern of dimmed white *upwards* while editing the numerator and *downwards* while editing the denominator

EXTERNAL PM

The E **EXT PM INPUT** is an AC-coupled audio input that also modulates the phasor proportionally to the input signal. In this case the PM is arbitrary, as any signal can be patched into this input. The routing is also controlled by the 10 **PM ROUTING SWITCH** - either **PRE-** or **POST-** phase distortion – but unlike Internal PM, the maximum phase deviation amount is not affected by the switch.

The signal going into this input is not affected by the 2 **PM AMT** knob or D **PM AMT CV INPUT.** The signal must be attenuated externally to control the phase deviation amount.

TUNING

Warp Core's unique tuning system aims to balance the precision tuning capabilities of a fully digital oscillator with the flexibility of un-quantized tuning that is common in the Eurorack format.

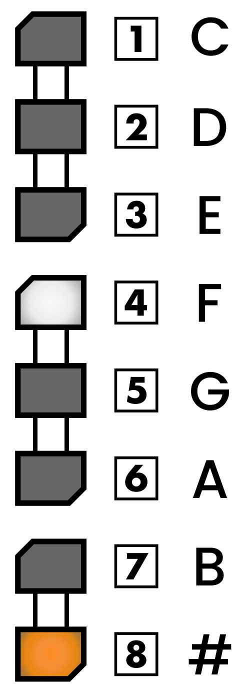
The 1 **TUNE** knob has a range of 12 semitones (one octave). Warp Core comes factory calibrated such that when the knob is turned fully clockwise or counterclockwise, the nominal oscillator frequency will be perfectly tuned to a pitch of "C"* in the currently selected octave.

This tuning is "nominal" because the oscillator's frequency is still subject to the CV input – the indicated pitch will only be heard if 0V (or an exact integer voltage, i.e. octave shift) is present at the C **V/OCT CV INPUT**. However, this is still extremely useful since it enables quick and accurate on-the-fly key shifting and retuning relative to a 0V CV input.

While adjusting the 1 **TUNE** knob, the LEDs will display a strobing pattern to aid in quickly tuning the oscillator frequency to different pitches/keys.

The solid white LED indicates the nearest exact semitone, and the speed of the strobing indicates how far from the exact semitone the oscillator is currently tuned (faster = more detuned). The bottom LED will illuminate orange if the nearest semitone pitch is a "sharp", otherwise the bottom LED will be turned off.

For example, if the fourth LED from the top is brighter than the others and the bottom LED is orange, the oscillator is nominally tuned closest to an F# (i.e. assuming there is 0V – or 1V, 2V, 3V… etc – present at the C **V/OCT CV INPUT**).

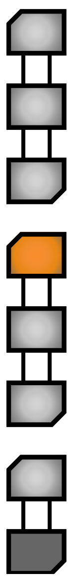


Example:
0V tuned to F#

** Relative to standard 12-TET A=440Hz tuning*

OCTAVE SELECTION

Holding the 7 **LEFT BUTTON** and turning the 3 **WARP A /** ***OCTAVE*** knob will adjust the octave of the oscillator's nominal tuned frequency. There are 7 octaves available via this setting. The LED corresponding to the active octave offset will be illuminated orange and the LEDs corresponding to the selectable offsets will be illuminated in dimmed white, as shown below.



1	-3 Octaves	(C1 - C2)
2	-2 Octaves	(C2 - C3)
3	-1 Octave	(C3 - C4)
4	+0 Octaves*	(C4 - C5)
5	+1 Octave	(C5 - C6)
6	+2 Octaves	(C6 - C7)
7	+3 Octaves	(C7 - C8)
8		

Octave Selection Indication
**Default setting*

QUANTIZED TUNING

Holding the 7 **LEFT BUTTON** and turning the 1 **TUNE** knob will quantize the nominal oscillator frequency to a perfect semitone within the range of the knob. The tuning will be held steady until the 1 **TUNE** knob is moved again with Tune Lock disabled, including between power cycles.

When tuning in this manner, the "strobe effect" will not be visible since it is impossible to for the nominal tuning to deviate from a perfect semitone.

TUNE LOCK

Holding both of the buttons for a few seconds will enable Tune Lock, which "locks" the current position of the 1 **TUNE** knob (with semitone-quantize applied, if applicable) until Tune Lock is disabled again – including between power cycles.

When Tune Lock is first enabled, all the LEDs will flash red twice, or until the buttons are released. While Tune Lock is enabled, moving the 1 **TUNE** knob has no effect and will result in the red flash pattern repeating as a reminder that Tune Lock is enabled.

Holding both of the buttons for a few seconds while Tune Lock is enabled will disable it, indicated by all the LEDs flashing green a few times. This pattern moves at a rate faster than the "enable" pattern to help distinguish between the two patterns without solely relying on color.

TUNE LOCK ENABLED = All LEDs flash red slowly
TUNE LOCK DISABLED = All LEDs flash green quickly

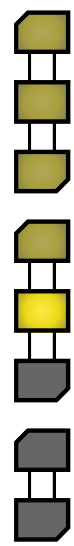
Octave Selection is still available while Tune Lock is enabled. Changing the Octave Offset will result in the locked output pitch/frequency moving up or down an exact octave.

THICKNESS PARAMETERS

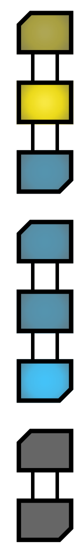
FUNDAMENTAL/SUB-OCTAVE REINFORCEMENT

Hold the 7 **LEFT BUTTON** and turn the 4 **WARP B / *THICKNESS*** knob to mix in a pure sine wave oscillator locked at the carrier phasor's fundamental frequency or an octave below. This is useful to "reinforce" the tone when the warp or phase modulation settings result in less energy in the lower end of the complex waveform's spectrum.

- When the knob is fully counterclockwise, there is no additional sine wave oscillator mixed into the outputs. The topmost LED will be illuminated in faint yellow.
- With the knob between full counterclockwise and "noon", a sine wave at the fundamental frequency is added to both outputs. The LED column will fill yellow downwards to indicate the level of the fundamental sine signal.
- At points in between noon and fully clockwise, the fundamental frequency sine oscillator is faded out and a sine wave oscillator one octave below the fundamental is faded in. The yellow fill of the LED column will begin to recede upwards as a blue fill representing the sub-octave oscillator level extends downwards



Fundamental at ~65%



Fundamental at ~25% and Sub at ~75%

In all cases, the output level is normalized so that the overall signal amplitude remains fairly consistent. The added reinforcement oscillator signals are always in phase with each other in both outputs, so when using the two outputs as a stereo signal, no low-end phasing issues will be introduced.

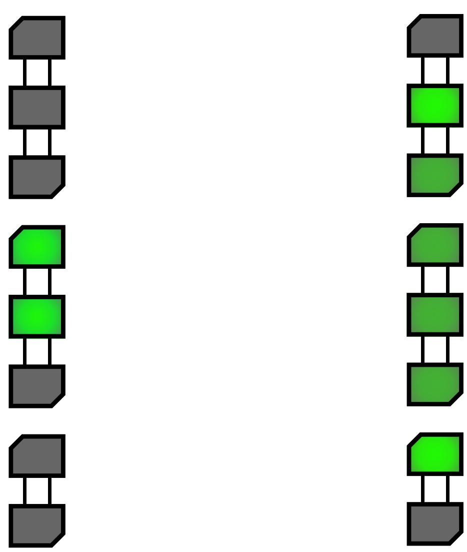
90° OUTPUT DETUNE

Hold the 8 **RIGHT BUTTON** and turn the 4 **WARP B /** ***THICKNESS*** knob to cause the G **90° OUTPUT** to become detuned relative to the F **0° OUTPUT**. With the outputs mixed together or in stereo (full or partial pan spread), this is reminiscent of a 2-voice unison effect. The G **90° OUTPUT** can be detuned up to 75 cents.

The entire PD/PM chain and the windowing period on the G **90° OUTPUT** is subject to the detuning - it's essentially a totally separate channel with its own phasor, even though the PD/PM algorithms and amounts applied to the phasor(s) are the same on both channels.

Additionally, the Fundamental/Sub-octave Reinforcement tone present at the G **90° OUTPUT,** if enabled, is *not* affected by the detune - its frequency is always equal to or one octave below the F **0° OUTPUT** frequency.

The LED column displays a green pattern to indicate the level of detune. When the two centermost LEDs (4 and 5) are the only ones illuminated green, there is no detune between the two outputs. As the detune is increased, the LEDs begin to fill toward the top and bottom.



No Detune   Much Detune

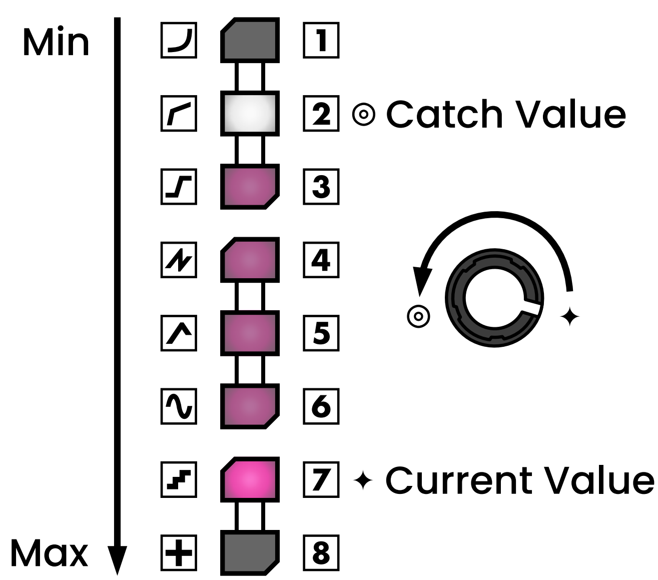
PARAMETER "CATCHING"

As described throughout this manual, Warp Core's secondary "shift" parameters (Octave Offset, PM Ratio, etc) are adjusted by holding the 7 **LEFT BUTTON** or 8 **RIGHT BUTTON** and adjusting a knob. When releasing the held button, one might expect the "non-shift" parameter represented by that knob to immediately jump to its new face value. However, in most cases this would suddenly and drastically change the timbre of the oscillator, which can be jarring and disruptive.

Instead, Warp Core uses a "catching" system in which the knob must be moved back to the position representing the internal value of the parameter in order to "catch" it and modify it again. Accordingly, parameters are always adjusted smoothly from their current position and there are no unexpected/discontinuous jumps in timbre or tuning.

The "catch" system also applies to editing "shift" parameters, since they also may have internal values different from the knob position when the parameter is modified again.

When a parameter is changed (by turning a knob) and it needs to reach the catch value to resume tracking its internal value, the LED display indicates this by displaying the LED nearest the catch point in glowing white, and the rest of the LEDs extending in a pink color above or below that to represent the distance between the current knob value and the catch value.



PATCHING TIPS

- Warp Core's controls span a huge range of timbral variation. It's best to start simple - get familiar with the Warp Modes in isolation, then try combining them.
- Try changing the order of the Warp Modes. Quickly press and release both buttons at the same time as a shortcut to swap them. Using a Waveshaper (1-3) mode on WARP B and an Overtone (4-6) mode on WARP A are some our favorite combos.
- Modulation of **WARP AMT** can have a huge effect on the sound. Start Small!
  - Explore the effects of modulations with the attenuverters on "low" settings and then start bringing things up. Find the sweet spots!
- Warp Core can also do PM/FM type sounds!
  - To get "classic" single-modulator PM/FM sounds, turn both WARP AMT controls all the way down and turn Windowing OFF. Dial in the PM Ratio to taste, then bring up **PM AMT** and/or modulate it with an envelope. Try attenuating the envelope to find the perfect amount of punch - often times, as with many things, less is more!
  - To add some additional grit, listen to what happens when you start turning up the **WARP AMT** controls a little bit. Try both **PM PRE** and **PM POST** to hear how it influences things - the results are often starkly different.
- Don't sleep on **EXT PM**! Here's some tips on how to make the most of it:
  - Set **PM AMT, WARP A** and **WARP B** to their minimum levels to start.
  - Using a buffered multiple, send V/Oct from a sequencer to Warp Core and another oscillator tuned to a different frequency. Send the other oscillator's output through a VCA and then into EXT PM.
  - Use an envelope triggered by the same gate as Warp Core to modulate the VCA. Play with the envelope level and timings.
  - Keep things pretty attenuated on the VCA to start - the higher the amplitude of the signal fed into EXT PM, the greater the impact on the sound.
  - Try different octaves, intervals, and waveforms on the other oscillator (sawtooth is one of our particular favorites!) and try bringing in a little bit of WARP AMT on various modes (the top three "wave shaper" modes work well with EXT PM).

RESTORING DEFAULTS

To restore all settings to their factory defaults:

1. Turn off power to your system
2. Hold the 8 **RIGHT BUTTON** while powering the system on.

To restore defaults for only the non-tuning-related "shift" parameters (Internal PM Ratio, Fundamental/Sub Reinforcement, 90° Output Detune):

1. With the module powered on, hold the 8 **RIGHT BUTTON** without turning any of the knobs
2. Continue holding the button for a few seconds while the LEDs animate downwards
3. Once all the LEDs illuminate red and fade away simultaneously, release the button

UPDATING FIRMWARE

Warp Core is based on the Electro-smith Daisy platform and its firmware can easily be updated using a web-based flashing utility in Google Chrome and a USB Micro-B cable.

Please visit the Infrasonic Audio Firmware Update Utility for instructions and firmware updates. **Note: this tool requires Google Chrome or another Chromium-based browser that supports WebUSB.**

The boot-up LED pattern indicates the current version of the firmware installed. The numbered LED representing the major and minor version digit will illuminate as follows.

- BLUE = Major Version
- RED = Minor Version

If the major and minor version digits are the same, the LED indicating that digit will alternate between blue and red. The table below indicates the patterns for currently released firmware versions.

Firmware Version	Release Date	Blue LED	Red LED
1.0	Initial Release	Position 1	None
1.1	2023-11-17	Position 1 (alternating red)	Position 1 (alternating blue)
1.2	2024-02-01	Position 1	Position 2
1.3	2024-09-05	Position 1	Position 3

WC:EX EXPANDER MODULE

WC:EX is a 4hp expander for Warp Core which transforms the module into a full synth voice with its own internal VCA and envelope generator.

The expander will work with all firmware versions back to the original 1.0 release, but it is recommended to update to the latest firmware for best results.

Technical Specifications

- 4hp
- 20mm deep
- Draws negligible current from Warp Core

INSTALLATION

Before installing, please ensure that you have 4hp of empty space immediately to the *left side* of Warp Core in your rack.

Step 1

Turn off your the power to your rack and remove Warp Core from the rack.

Step 2

This step depends on which hardware revision you have. Please check the back of the module to determine the revision and serial number, and follow the appropriate instructions below

Hardware Revision 1.2 and later (Serial numbers 100 and above)

On the back of Warp Core, locate the small slide switch on the right side, next to the upward arrow marked EXP. Move the switch to the upper position, so that the lever is closer to the top (the direction the arrow is pointing).

If you decide to remove the expander from your rack later and use Warp Core on its own without the expander, you must move the switch back to the lower position for it to function correctly.

Hardware Revision 1.1 and earlier (Serial numbers below 100)

On the back of Warp Core, locate the 3-pin header on the right side. Move the jumper so that it connects the lower two pins marked "EXP" on the circuit board.

If you decide to remove the expander from your rack later and use Warp Core on its own without the expander, you must move the jumper back to the top two pins for it to function correctly.

Step 3

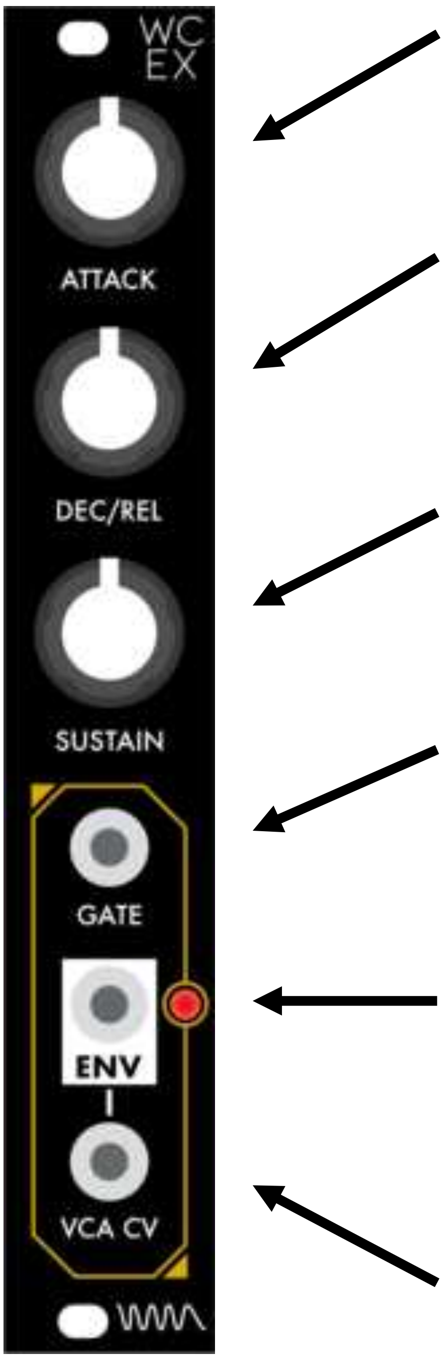
Carefully connect the connector on the other end of the cable attached to the expander to the header on Warp Core marked EXP. This connector is keyed so it only goes in one way. Check the notches on the side to ensure it is positioned correctly. The wires running from the expander to Warp Core should be straight and not twisted 180 degrees. Check the image on the previous page for reference.

*We deliberately chose **not** to use an IDC ribbon cable here so that there is no possibility of accidentally connecting Eurorack bus power to the wrong header. The connector is designed to be snug, so press gently but firmly - if it's not budging, double check the alignment of the notches. If you decide to remove the expander later, it is recommended that you try as much as possible to grip the connector and not just the wires before pulling the connector – firmly but gently – out of the header.*

Step 4

Reinstall Warp Core and the expander in your rack and power it back on. With no patch cable inserted into GATE, the red LED on the expander should be constantly illuminated.

EXPANDER CONTROLS



ATTACK KNOB

Adjusts envelope attack time.

Range: ~1ms to ~10s

DECAY/RELEASE KNOB

Adjusts envelope decay and release time simultaneously. Decay time increases faster than release time for macro-like variations across range of knob.

Range: ~10ms to ~20s

SUSTAIN KNOB

Adjusts envelope sustain level.

GATE INPUT

Gate input for envelope generator. When unpatched, envelope output is always at max and Warp Core's outputs are always producing a signal.

ENV OUTPUT

CV output for envelope signal. Normalled to VCA CV input below, and WARP A / WARP B CV inputs on Warp Core. Adjacent LED indicates output level.

Range: 0 - 5V

VCA CV INPUT

CV input to externally provide VCA level CV

Range: 0 - 5V

EXPANDER FUNCTIONAL DESCRIPTION

The WC:EX expander is designed to be a simple, useful, and performable extension to Warp Core which enables you to use it as a complete voice without separate VCA and envelope generator modules, while also allowing you to continue to use using Warp Core as a traditional free running oscillator “by default” if you so choose.

With nothing patched into GATE, Warp Core's outputs behave as they normally would, i.e. always outputting a signal. With a patch cable inserted into GATE, both of Warp Core's outputs are internally amplitude-modulated by an envelope generated in response to incoming gates at the GATE input. In other words, **with just a pitch CV and gate input signal, you can directly play individual notes out of Warp Core – in Stereo!**

The envelope has been parameterized to have a natural sounding attack capable of a good amount of snap and a smooth exponential decay/release. The envelope signal is also internally normalled to both the A WARP A CV INPUT and B WARP B CV INPUT on Warp Core for fast and easy timbral modulation and the ENV jack makes the envelope CV signal available to patch out to other modulation destinations in your rack.

The dedicated VCA CV input overrides the envelope as the CV source for the internal linear VCA level, so you can use whatever 0-5V signal you want to control the amplitude of Warp Core's outputs. When using the VCA CV input, the GATE input and ENV output are both still fully functional as an independent envelope generator and the internal normalling of the envelope signal to WARP A and WARP B CV inputs remains active.

ACKNOWLEDGMENTS

Warp Core is Infrasonic Audio's first module release and would not have been possible without the incredible advice and support received from the folks below.

Electro-smith

Circuit Happy

Colorado Modular Synth Society

Friends in the SynthUX Academy, Daisy, and Plinky Discord servers

Users of Warp Core for VCV Rack

User Manual Changelog

Version	Date	Description
1.0.0	2023-09-06	Initial Release
1.0.1	2023-09-13	Update V/Oct range info
1.0.2	2023-10-09	Add compliance logos (FCC/CE)
1.0.3	2023-10-26	Minor corrections to text
1.1.0	2023-11-17	Add information about firmware updates and expander module
1.2.0	2024-02-01	Add firmware 1.2 legend
1.3.0	2024-09-05	Updates for firmware 1.3 Fix incorrect output legend symbols Add Patching Tips section
1.3.1	2024-11-19	Add hardware Rev 1.2 updates