b:art instruments

b:ond

Dual Voltage-Controlled Oscillator with Through-zero Frequency and Phase Modulation

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Introduction

b:ond is a multi-purpose sound generator and processor Eurorack module. At its core, it comes with two high-quality analog voltage-controlled oscillators with through-zero FM and PM capabilities, providing rich and complex sound generation for your modular synthesiser setup.

The precision analog multipliers inside the VCOs provide exceptional temperature-compensation and rock-solid tuning across ten octaves - ranging from sub-sonic LFO territory to the highest audible frequencies.

Simultaneous outputs for SINE, SAW, TRIANGLE, SQUARE and PULSE waves provide rich harmonic content and tonal flexibility. The module offers additional PULSE wave controls for dynamic timbral variations, and provides soft and hard sync capabilities for aggressive, harmonically rich sounds. Designed with through-zero FM and PM in mind, the oscillators can invert their phase and continue oscillating smoothly through zero frequency, resulting in rich, complex tones that are impossible to achieve with standard FM and PM techniques.

Two five-channel VCA expanders included with the module allow for seamless blending of multiple waveforms and modulation sources directly within the module, offering unparalleled flexibility and sound-shaping capabilities.

Safety Information

Ensure your modular system is powered off before installing the module. Only power on the system once every module is connected and properly installed in your system using the provided screws.

The module uses shrouded headers to minimise the risk of failure due to incorrect power cable orientation, however caution must be exercised to avoid plugging the power cable into the expander headers. Please refer to the markings at the back of the module to correctly install the power cable.

Do not expose the module to moisture or extreme temperatures.

Do not operate the module in environments with severe amount of dust in the air.

The module’s inputs are protected against electrostatic discharge, but be careful when handling the module itself.

Module Overview

1. Octave Switch
2. Fine Tune Knob
3. V/OCT (CV) Inputs
4. Pulse Width Knob
5. Pulse Width CV Input
6. Pulse Wave Output
7. Soft/Hard Sync Switch
8. Sync Input
9. Frequency / Phase Modulation Switch
10. Modulation input
11. Square Wave Output
12. Saw Wave Output
13. Triangle Wave Output
14. Sine Wave Output
15. VCO Link Switch

Tuning

b:ond offers precise control over its' oscillators pitch through several methods. This section details the four primary ways to affect the tuning of the VCOs: the octave switch, fine tune knob, CV or 1V/OCT inputs, and the FM input.

Octave Switch

Each oscillator is equipped with an octave switch that allows for quick and easy transposition of the oscillator frequency across different octaves.

This 8-position switch provides discrete steps for changing the base frequency from -2 to +5 octaves.

Fine Tune Knob

The fine tune knob offers precise control over the oscillator's pitch within a single octave range. This allows for subtle adjustments to the frequency, which is especially useful for fine-tuning the pitch to match other oscillators or instruments.

At fully counter-clockwise, the pitch corresponds to note A (440Hz when the Octave Switch is set to it's fifth position).

CV Inputs

The module features two CV inputs for each oscillator, allowing external control voltages (CV) to modulate the pitch.

The inputs' sensitivity matches the 1-Volt-per-Octave (1V/OCT) standard.

The inputs are bi-polar, meaning that you can use negative voltages to lower the pitch of the oscillators.

FM Input

Frequency modulation (FM) allows for complex and dynamic sound shaping by modulating the oscillator frequency with an external signal in a linear fashion.

The through-zero FM input accepts bipolar signals (-5V to +5V), allowing for full-range modulation. Details about through-zero capabilities can be found on **page 7**.

Pulse Width, Sync & VCO Linking

Pulse Width Knob & PWM CV Input

Pulse Width Modulation (PWM) alters the duty cycle of the pulse wave, changing the width of the pulse without affecting its frequency. This results in a change in the harmonic content and timbre of the wave.

The PWM knob manually adjusts the pulse width of the pulse wave from 90% to 10% duty cycle. Setting the duty cycle to 50% results in a square wave.

When the PWM CV input is patched in, the knob acts as an attenuator for the incoming signal. This input accepts CV in the 0-5V range.

Sync Input and Soft / Hard Sync Switch

Synchronisation (sync) forces the oscillator (slave) to reset its cycle based on the frequency of another oscillator (master) patched into the SYNC input. This creates harmonically related waveforms and can produce complex sounds, especially when the slave oscillator's frequency is higher than the master’s.

The SYNC input accepts standard Eurorack 10Vp-p levels (-5V to 5V).

Both Soft and Hard Sync share one input (the Sync Input marked no. 8) and are selectable with the Soft/Hard Switch (no. 7).

Soft sync gently nudges the slave oscillator to match the phase of the master oscillator without completely resetting its cycle. This results in more subtle and complex interactions between the two oscillators.

Hard sync, on the other hand, forces the slave oscillator to reset its cycle abruptly whenever the master oscillator completes a cycle. This creates a more pronounced and aggressive synchronisation effect.

VCO Linking

The LINK Switch can be pulled down to link the right oscillator’s OCTAVE and FINE TUNE knob to the left’s. This allows precise tuning of both oscillators at once, while maintaining the flexibility of their respective CV and other inputs.

Frequency / Phase Modulation

Both Frequency Modulation and Phase Modulation share one input (the MOD Input) and are selectable with the Modulation Switch.

Frequency Modulation

Through-zero FM (TZFM) is an advanced form of frequency modulation where the modulating signal can drive the carrier oscillator's frequency both above and below zero, effectively reversing its phase when the frequency crosses zero. This allows for a wider range of modulation and richer harmonic content compared to traditional FM.

Any external modulation source, such as an LFO, Envelope, or Audio can be patched into the TZFM input. The accepted voltage range is -5V to 5V.

TZFM is particularly useful for creating metallic, bell-like tones, evolving textures, and complex harmonic structures. Experiment with different modulation sources and rates to explore the full potential of through-zero FM.

Phase Modulation

Phase Modulation involves modulating the phase of the oscillator rather than its frequency. Through-zero PM (TZPM) allows the phase to shift through zero, creating unique and complex waveforms that differ from standard PM.

As with TZFM, any external modulation source is accepted in the -5V to 5V range.

TZPM can be used to generate rich and dynamic textures, adding complexity to the sound. It's particularly effective for creating evolving pads, complex leads, and experimental sounds.

VCO Outputs

Each VCO features five simultaneous outputs:

- Pulse Wave;
- Square Wave;
- Saw Wave;
- Triangle Wave;
- Sine Wave.

Each output is an AC coupled 10Vp-p output, meaning it swings from -5V to 5V. The output impedances are 1000 ohm for each output.

VCO Calibration

The VCO, due to its analog nature, will inevitably fall out of tune with use. When that happens, the following procedure is required to tune the oscillator cores:

1. Prepare the following equipment: A precise CV voltage source, an oscilloscope, a spreadsheet, and a small screwdriver.
2. Set the octave switch of the VCO to the third position from the left.
3. Make sure the LINK switch is inactive.
4. Set the FINE TUNE knob all the way to the left.
5. Apply 1.00V CV to the oscillator's V/OCT input and note the frequency (FA) of the square output.
6. Apply 5.00V CV to the oscillator's V/OCT input and note the frequency (FB) again.
7. Calculate 2^{5 + log2(FA) - [log2(FB) - log2(FA)] / 4}.
8. With V/OCT input still set to 5.00V CV turn the SCALE trimmer on the back of the module until the measured frequency matches the calculation.
9. Unplug any voltage source from the V/OCT input.
10. Turn the BASE trimmer on the back of the module until 32.70 Hz is the measured frequency.
11. Plug the voltage source back into the V/OCT input and apply 9.00V CV to it.
12. Turn the HF trimmer on the back of the module so that 16 742 Hz is the measured frequency.
13. Repeat for the second oscillator.
14. Repeat the whole process up to three times if more precise tuning is required.

VCA Expanders

The module offers two identical expanders, one for each VCO:

1. Square Gain / CV
2. Saw Gain / CV
3. Triangle Gain / CV
4. AUX 1 Gain / CV
5. AUX 1 Input
6. AUX 2 Gain / CV
7. AUX 2 Input
8. MIX Output

Expander Features

Each expander is connected to the main module via an included 10-pin ribbon cable. Please refer to the markings on the back of the main module to correctly connect the expander cables and the power cable.

Mixer Inputs

The expanders feature a five channel mixer where 3 inputs are already patched (the PULSE, SAW & TRI outputs from the main module), plus 2 AUX inputs that take any audio signal in the -5V to 5V range.

Gain Controls

Each channel has a dedicated Gain knob ranging from 1% to 100% gain, and a CV input. The CV input accepts voltages from 0V to 5V, completely ignoring negative voltages. While this input is patched, its respective gain knob becomes an attenuator for the incoming CV signal.

Output

All 5 inputs are mixed into a single MIX output, which can output a 10Vp-p signal and has a 1000 ohm impedance. Beware of setting all channels' gain knobs to maximum - the expander will act like a Unity Gain Mixer that will clip easily.

Technical Specifications

Operating voltages: -12V / +12V
Power draw: 67 mA -12V / 74 mA +12V
Width: 12HP + 2 * 6HP (VCA expanders)
Depth: 17mm (22mm with power header)
Oscillator frequency tracking: 1V/oct
SYNC IN & MOD IN level: 10Vp-p (-5V/+5V)
PWM CV input level: 0 - 5V
Expander CV inputs level: 0 - 5V
V/OCT CV input level: -4V - 8V
Audio outputs level: 10Vp-p (-5V/+5V)
Output impedance: 1000ohm (all outputs)

CE

This product was tested and found compliant with the following standards:
EN 55032:2015/A11:2020, EN 55035:2017, EN IEC 63000:2018.
For details, please visit: www.bartinstruments.com/conformity

Revision: 1.2 // November 2024