



**L'LIQUID SKY D-VICES**

*Santana da Serra*

# PPG W 2.2x4

## Wavetable Oscillator Module

Designed by Matthias Beese (MMS/Liquid Sky artistcollective)  
Advanced Design, PCB and Artwork by Thilo Goldschmitz  
Original wavetables from PPG Wave 2.2 (1982)



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# This is an oscillator module, but it's also the reincarnation of a legend.

The PPG W 2.2x4 is a multifunctional dual-oscillator wavetable module. Like its sibling from Liquid Sky, the V4CO, the W 2.2x4 has internal VCA (voltage controlled amplifier), SUB-OSCILLATOR, independent WAVE OUTPUTS, switchable (and hackable) DUAL 8-BIT WAVETABLES, OVERDRIVE, and full voltage control of pitch, oscillation, wavetable sync, and mixing. Each of the two oscillators can be optionally configured as LFOs.

It's more than just a dual oscillator module. It's a sound exploration laboratory. And now it has the spirit of PPG, with all the original wavetables from the PPC Wave 2.2 from 1982.

The PPG W 2.2x4 is compatible with the GLITHc ExpendR, for bit-by-bit hacking of each wavetable, patchable circuit bending, MIDI interface, bitwise operators, internal sequencers, and utility mults. (While the GLITHc functionality can be used with both modules, V4CO cannot be converted to PPG W 2.2x4 or visa versa.)

We're proud to make new hardware with all the original sounds of a PPG icon, now with new modern features for Eurorack and never-before-dreamt sound possibilities -- fully licensed for the PPG name you see on the panel, and with the soul of the original.



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## What's in the box

One ribbon cable for connection to your Eurorack skiff

*(GLITHc eXPenDR includes two additional cables for connecting to the W 2.2x4 module)*

Four gnurlies (for screwing in the module)

40HP PPG W 2.2x4 module

## What's new

The PPG W 2.2x4 shares the primary architecture of the V4-CO module from Liquid Sky D-vices, and the same powerful hackability and patchability when paired with the GLITHc. But it also features additions and tweaks exclusive to the PPG module. If you're adding a PPG W 2.2x4 to your existing V4-CO, combining their unique sounds (good choice!), here's what's new on the PPG module:

### **Complete wavetable library from the original PPG Wave 2.2**

### **New dedicated controls for accessing the main and sub oscillator wavetables**

### **Expanded sound design and menu options**

End of wave, fold modulation, and more determine how you switch and modulate through wavetable changes.

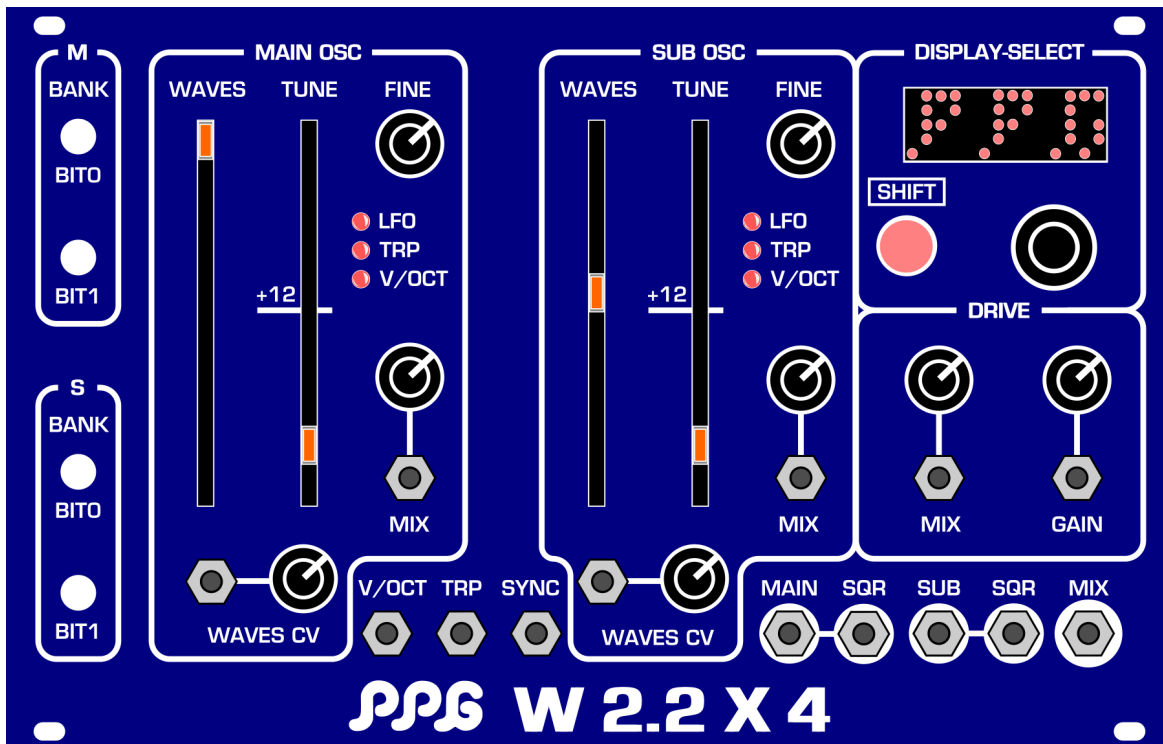
### **Load/save capability**

Save and recall up to 10 programs.

### **Updated MIDI implementation with additional controls**

When used with GLITHc ExpendeR

# Overview and specifications



## Controls

### Main Oscillator:

WAVES select  
 TRANPOSE  
 FINE tuning  
 VCA level

### Sub Oscillator:

WAVES select  
 TRANPOSE  
 FINE tuning  
 VCA level

## CV Inputs

[0-5V unless otherwise specified]

V/OCT, 0-8V  
 TRP (transposition), 0-4.6V  
 SYNC input trigger, 5V  
 WAVES CV (waveform select) [0 to 5V]  
 SUB WAVES CV (waveform select)  
 MAIN MIX [0 - 10V]

SUB MIX [0 - 10V]  
 DRIVE MIX [0 - 10V]  
 DRIVE GAIN [0 - 10V]

## Audio Outputs

MAIN OSC, 10V pp  
 MAIN SQR [primary oscillator sub oscillator square wave], 5V pp  
 SUB OSC, 10V pp  
 SUB SQR [second oscillator sub oscillator square wave], 5V pp  
 MIX [both oscillators + overdrive], typ 10Vpp, max 21V pp

MIX output is AC coupled; all other outputs are DC coupled.

## Menu

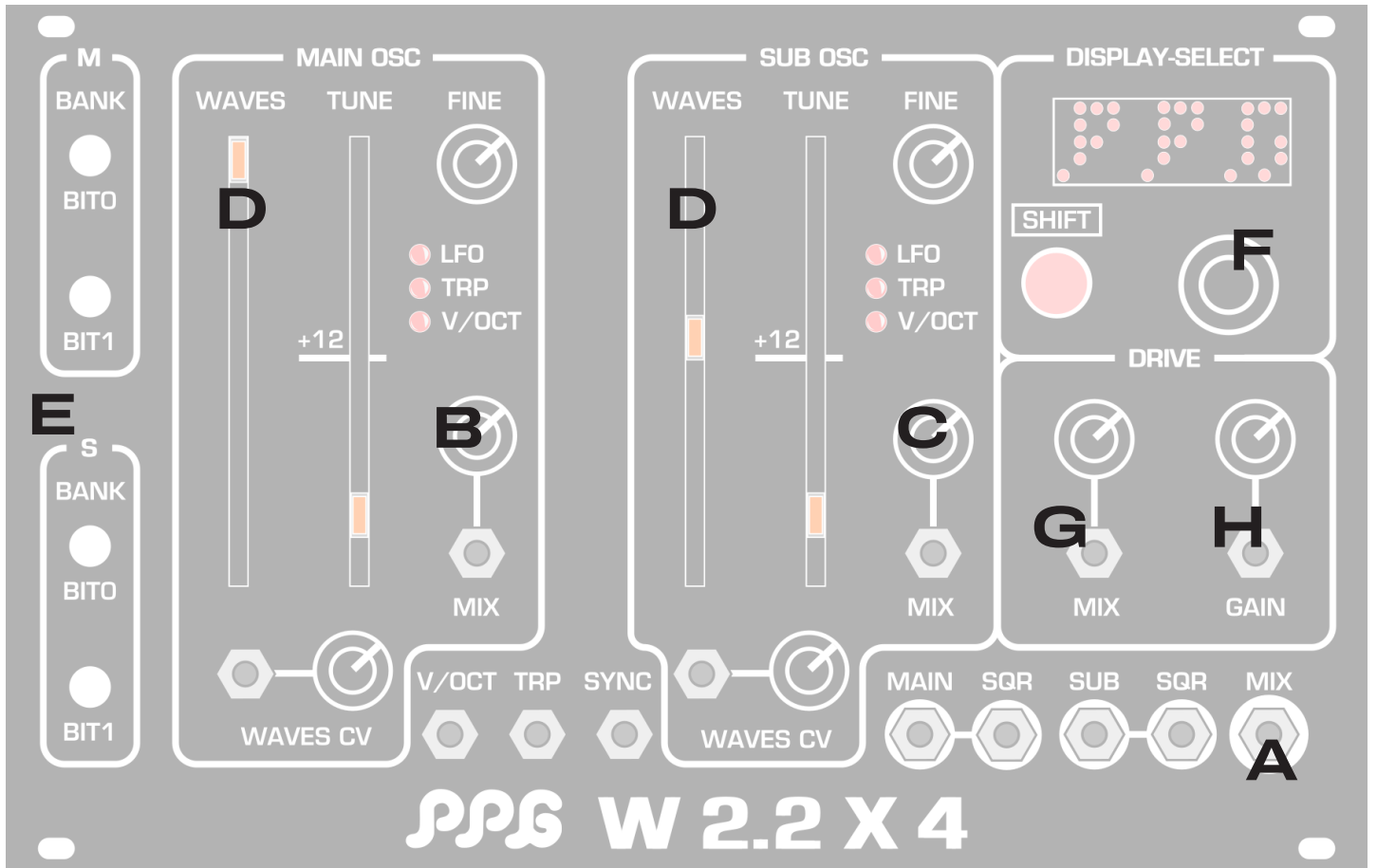
Enter the menu by long-pressing the menu encoder. Turn the encoder to choose a menu item. Press SHIFT to toggle oscillators. The SHIFT button is lit when the main oscillator is selected, and unlit to indicate the sub oscillator is selected.

## Quick start: make some noise

First, let's get some gnarly sounds – just listening to the wavetables here already provides some satisfaction.

1. Connect the **MIX audio output** [A] to a mixer/output to your speakers.
2. Turn up the **main oscillator VCA** [B] and **sub oscillator VCA** [C]. You should immediately hear some sound. (Try adjusting the sub and main oscillators independently to adjust the balance.)
3. Try adjusting the **WAVES sliders** [D] for main and sub osc to select different waveforms for each. You'll see an indication of the waveform number on the display.
4. Change the wavetable bank by using the **BANK SELECT** switches [E] for main and sub oscillator. Two switches per oscillator give you a total of four banks each. 00 = 1, 01 = 2, 10 = 3, 11 = 4. Each main bank has eight sub banks. Hold down SHIFT to access the sub banks; number 1-8 is displayed in an inverse character set). Main and sub banks are identical.
5. Randomly change wavetables (across all banks) by **holding SHIFT and short-pressing the MENU encoder**. [F] (Note that this reflects a change from the V4-CO, which randomized with just a short-press of the menu encoder.)
6. Turn up **DRIVE MIX** [G] and adjust **DRIVE GAIN** [H] to hear the impact of the overdrive on the output signal. (MIX is an additional VCA for the output of the overdrive circuit; DRIVE determines the intensity of the overdrive.)

Now you've already got a lot to play with, and you may have guessed at the rest but there are some other additional features – customizable LFO outputs, step mode, and pitch range and quantization options – so let's look at the full module in detail!



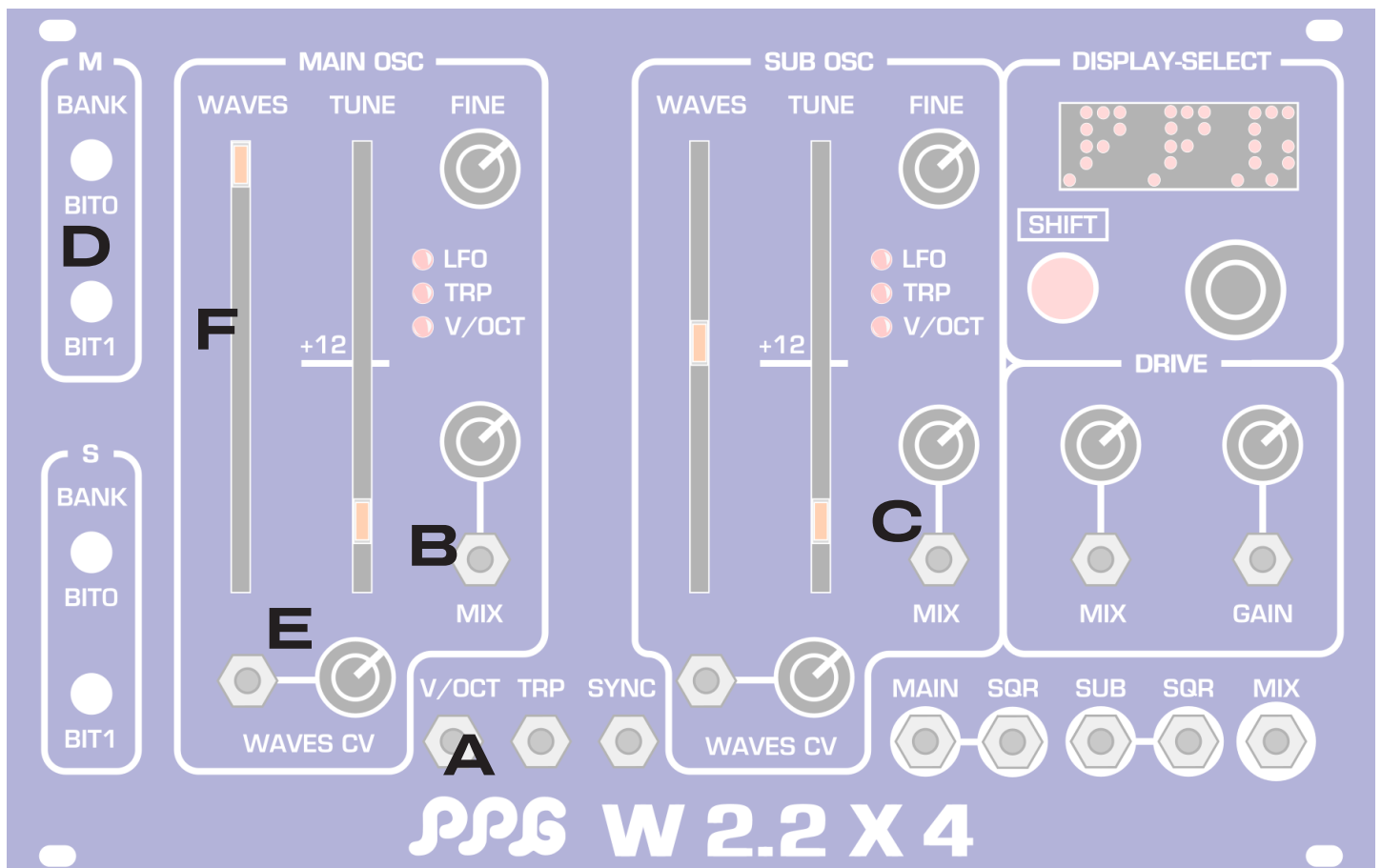
## Quick start: voltage control

Okay, we're just droning – let's add some additional control.

1. Connect a voltage to **V/OCT input [A]** to change pitch.
2. Connect a voltage to **MAIN MIX [B]** to control the VCA for the main oscillator, and **SUB MIX [C]** to control the VCA for the sub oscillator. The MAIN and SUB MIX knobs above the inputs are summed with the CV input voltage. To use an envelope, you'd turn these down.

These are independent VCAs for each oscillator, but the MAIN input is normaled to both. To control both, then, connect the voltage to MAIN. To control SUB separately, connect a voltage to SUB. To control MAIN alone, connect a voltage to main and a blank (like a disconnected cable) to SUB.

3. Connect a continuously-varying voltage to the **WAVES CV [D]** CV input and turn up the **MAIN WAVES CV amount knob [E]**. Adjust the **WAVES slider [F]** through its range and listen to the impact on the sound; try attenuating the range of the WAVES control signal by adjusting the WAVES CV knob. Depending on the bank you have selected, this may sound continuous or abrupt, but you can use the attenuation and waves position to dial in some wavetable variation you especially like.



# Wavetables

The heart of the PPG W 2.2x4 sound is the combination of analog circuitry and overdrive with two wavetables sources, the main oscillator and sub oscillator. The 8-bit character of these can give you sounds that can be richly harmonic or glitchy and grimy, just as on the original PPG Wave 2.2 and its ilk. Not only did we include the Wave 2.2's complete original wavetable bank, but the hardware inside the module is similar. The W 2.2x4 runs on an 8-bit microprocessor and dual parallel 8-bit DACs.

Note that these are single-cycle waveforms; they're made up of 256 8-bit samples that play through cyclically. There's therefore no "position" parameter as on some wavetable synths with longer wavetables. Only one 256-sample waveform is selected from the larger wavetable (bank). (We use the same terminology as PPG did on its original hardware.) You can use Waves CV to change wavetable selection via CV input, however, which allows for more complex outputs, and creates the effect of scanning through a wavetable.

## Waves selection

The waves slider has 64 steps. Move the slider to shift between waves 1-64; by default, the display will show the active wave (M + number for the main oscillators, S + number for sub oscillator.) Set the wavetable banks for each oscillator with the wavetable select switches on the left-hand side. Setting both to up (o) gives you oo = bank 1; o1 is bank 2, 1o is bank 3, and 11 is bank 4, with feedback shown on the display. Hold shift, and access eight sub banks for each of those main banks, displayed as 1-8 in an inverse character set. (Main and sub banks are identical.)

## Wavetable sync input [Trigger input, 5V]

The SYNC input resets the wavetable position to the start of the wavetable. Send a trigger to this input, and you reset the active wavetable (applied to both sub and main oscillators simultaneously). This can be used for rhythmic effects, to synchronize wavetable position with other modulation, or at extreme settings for unexpected timbral results.

## Pitch

Pitch control of each oscillator is provided via multiple methods, which are summed:

### **TRANSCOPE fader**

Adjust for quantized pitch over a two octave range – you can think of this as a quantized macro knob.

### **FINE pitch knob**

Adjust for +/- two semitones (a four semitone range).

### **V/OCT input [o – 8V]**

Voltage input which can be set to one of three modes:

1. Chromatic mode: quantized pitch control over an eight-octave range (with control voltage input of 0-8V).
2. v/oct as a trigger for step operation - stepping through wavetables (a unique way of treating the oscillator, so likely different to how you're used to thinking of v/oct - see description below)!
3. CV control switched OFF.

### **TRP control voltage input [0 - 4.6 V]**

Voltage input for upward transposition with a four octave range. Note that this does not override the setting of the transposition slider - it acts as an offset; the two positions are summed. Again, multiple modes are available:

1. Chromatic mode: quantized 4-octave transposition with a 0-4.6V CV input
2. Linear FM: approximately two octaves, unquantized, with 0-4.6 CV input. (This also can be used for microtuning increments or, more quickly, for vibrato effects.)
3. CV control switched off

Note that unlike conventional/classic frequency modulation applications, this is a uni-directional input: it only takes positive control voltages, and the resulting modulation is only upwards.

Why have an OFF setting for CV control of these two parameters? You can use this to independently play the main and sub oscillators. For instance, you could set MAIN OSC > v/oct to chromatic and TRP to off, and the sub oscillator's v/oct to off and TRP to chromatic, allowing you to use your v/oct CV input to play the main osc and use the trp input for the sub oscillator - treating this as two separate voices.

### **Changing the quantization mode**

Long-press the menu encoder to enter the menu mode, select the oscillator you want to modify (lit = main, unlit = sub), and scroll to FML(TRP) to choose the transposition mode. The active mode is indicated by the TRP lamp by each oscillator:

**Fully lit** = Unquantized (fine) pitch, two-octave range

**Half-lit** = Quantized pitch, 4-octave range

### **Setting per-oscillator v/oct control**

V/OCT has some hidden tricks - it's really a multifunctional input, which you can use normally for volts/octave pitch control (quantized), or disable entirely, or use as a trigger input for stepping through individual values of a single waveform. Long-press the menu encoder to enter the menu mode, select the oscillator you want to modify (lit = main, unlit = sub), and scroll to VOC to enable or disable V/OCT control voltage input for each oscillator or set this input to STEP mode, indicated by the V/OCT lamp.

**Fully lit** = v/oct input is enabled; each oscillator responds to v/oct signals for quantized pitch control.

**Half-lit** = v/oct input is configured to STEP mode, so any 5V trigger sent to the v/oct input steps through the wavetable one byte at a time. (byte 0 - 255) See notes below.

**Unlit** = v/oct is effectively disabled – but will still respond to voltage signals, allowing you to create some glitchy/garbled crackles and offsets for subtler wavetable modification.

### Using wavetable step mode

With V/OCT input set to step mode, you'll only hear output via the individual oscillator outs, as they're DC coupled. (You can also hear a result if you use the MIX output but turn up the mix of the other oscillator, since then you'll hear the impact on the other oscillator.) You can use this in various ways, creating flurries of beats, pops, and clicks on their own, routing those into other modules, or (via eXPendR) routing beats and offsets back into more complex patches.

## VCA's, mixing, and overdrive

W 2.2x4 has three internal analog VCAs -- one for each oscillator plus one for the overdrive circuit. These control the level mixed to the MIX output. Each has both a potentiometer for manually adjusting the level, and corresponding CV input.

### MAIN MIX [A]

### SUB MIX [B]

### DRIVE MIX [C]

Turn the potentiometer up, and you'll increase the mix level of the oscillator or overdrive manually. With a voltage connected to VCA CV input, the pot determines the maximum level (at full voltage of the input).

CV input range for the VCA inputs is 0-10V.

These are analog inputs, so while you can route an LFO or an envelope to the VCA, you can also route an audio input and manipulate the oscillator's VCA with that!

Since you have separate VCAs, you could choose to modulate individual oscillators (and overdrive) independently for more variety. Keep in mind that the MAIN VCA input is normaled to the SUB VCA, so you can control both by routing signal to the MAIN VCA input.

## Audio outputs

Each oscillator has its own square sub oscillator, and dedicated outs are provided for each of these. So in addition to the main mix out, you'll find independent outputs for the main oscillator and its pure square wave output, plus the sub oscillator and its square wave output.

## LFO modes

You can switch one or both oscillators from its normal frequency range to low frequency oscillator

range. That means each of those separate audio outputs also can become a modulation source for another module (or the W 2.2x4 itself, or another W 2.2x4)!

Long-press the menu encoder to enter the menu mode and select the oscillator you want to modify (lit = main, unlit = sub) using the SHIFT button. Scroll to LFO and press the menu encoder to toggle LFO for the selected oscillator. The LFO lamp by the corresponding oscillator will illuminate to indicate the frequency range selected:

**Fully lit = slow mode (normal LFO operation)**

**Half-lit = super slow mode**

**Unlit = normal frequency range (LFO mode is disabled)**

When we say super slow, we mean really super slow: if you turn the frequency all the way down, a single cycle will take two minutes, 14 seconds!

## Overdrive

The overdrive circuit is applied to the mixed signal of the two oscillators, and then routed to the main mix. A DRIVE control determines the amount of the effect. The overdrive circuit also has its own independent VCA, mix control, and VCA CV input. Since it's routed to the mix out, you'll only hear it via the output from the mix out jack – and since it has its own VCA, only if you turn up its level.

W 2.2x4's oscillators can get grimy on their own without any additional intervention, especially depending on what you're doing with the wavetables, but the overdrive can push the sound even further. You can add some subtle drive and richness, or screaming harmonic distortion, and plenty of range in between.

## Calibration

Generally, there is no need to calibrate your W 2.2x4 – it ships to you fully tested and calibrated. In the rare instance of unwanted response to voltages, though, there is a built-in calibration facility available in the menu system that gives you access to the fine-tuning of analog-to-digital conversion of the control voltage inputs. Long-press the menu encoder to select the menu mode, scroll to CAL, and press again to enter calibration mode.

An easy way to ensure a reliable reference is just to play a note C on a connected keyboard, pad, or sequencer. The display will show the internal note number (depending on octave, 0, 12, 24, 36, 48, 60, 72, or 84). This display should be stable; if it's flickering, it's a sign you need to adjust the calibration potentiometer on the back of the module. It's most effective to tune from the highest note - 84. Adjust until the display remains solid, and you're fully tuned.

Exit setup mode by short-pressing the encoder again to return to menu options, then long-press. The display will read RUN indicated your settings changes have been saved.



## Menu options and utility features (new)

Customize the behavior of your PPG W 2.2x4 and find more sound possibilities with these additional options. (These are exclusive to the W 2.2x4 and not available on the V4-CO.) End of Wave, Skip Break Wave, and Fold Modulation all configure how the module behaves when you modulate the wavetable selection, especially via CV input.

### Wavetable options

#### **EOW (End of Wave)**

This determines how the module responds when you change wavetables, either by moving the WAVES slider or sending a WAVE CV input.

**On (EON):** wavetables play back completely before playing a newly selected wave.

**Off (EOF):** Waves switch immediately as soon as a wavetable is selected, producing a light crackle. Wolfgang Palm's rare 1979 Wave Computer 360 exhibited this behavior. You may find this desirable for rapid wavetable modulation and glitchy sounds.

**SBW (Skip Basic Waves)**

You have two options for how the final cycles of a wavetable are played as you modulate the wavetable selection. All four banks bank from the PPG Wave 2.2 has the same basic waveforms at the end of each wavetable. This will result in a distinct “brzzzt!” sound each time you modulate through the wavetables. If you’d prefer some variety instead, retaining the distinctive characteristic of each bank, you can disable those four wavetables from being included. This may prove useful if you’re doing a lot of complex, rapid, or glitchy wavetable modulation.

**On (SON):** the modulation will stop at the last “real” waveform of the table.

**Off (SOF):** four waveforms are included normally.

**FLD (Fold Modulation)**

You can choose whether modulating the wavetable selection wraps to the start of the wavetable or not:

**On (FON):** As modulation reaches the end of the wavetable, an increase of voltage will “wrap” it over to the start of the wavetable.

**Off (FOF):** Once modulation reaches the end of the wavetable, the wavecycle will remain there.

In other words, if you send an LFO signal to wave CV, an FON configuration will mean the wavetable “wraps” through possible values, whereas FOF will see the LFO modulate to the end of the wavetable with rising voltages and cycle back to the start with falling voltages.



**DIW (Display Wavenumber)**

Toggles whether the display shows the active wave number (**on/DON**) or stays blank (**off/DOF**) to reduce power draw (slightly).

**Save and recall**

PPG W 2.2x4 has 10 program memories. Each slot saves all available settings for quick recall.

**Select programs** by turning the menu encoder and choosing a program slot, displayed P01 - P10.

**Short-press the encoder** to load the selected program.

**To save a program**, long-press the menu encoder to enter menu mode, then long-press the menu encoder again.

**MIDI implementation (expanded)**

PPG W 2.2x4 differs from and expands on the MIDI implementation already available on the V4-CO. Note that with either device, you'll need the GLITHc ExpendeR to take advantage of the internal MIDI mapping. (You can always freely patch CV from your own MIDI-to-CV converter as you wish, of course.)

With the two modules connected, the following parameters are mapped to MIDI CC (Control Change) messages:

CC 1: Amplitude of pitch LFO (rhe equivalent of a vibrato amount; referred to hear as vibrato)

CC 12: Change main wavetable

CC 13: Change main wavetable bank

CC 17: Sets vibrato mode. A value of 0...31 disables vibrato (no MIDI is mapped to the internal pitch LFO.) A value of 32 ... 63 enables vibrato receiving on CC 1. 64 .... 95 sets vibrato to channel after-touch. 96...127 enables both channel aftertouch and CC 1.

CC 18: Enable or disable routing velocity to waveable position. This is relative to the position of the slider and the CV input; it adds to that value. A CC value of 0... 31 is off; 21 ... 63 routes velocity to wavetable

CC 20: Set v/oct input. Value 0...42 disables v/oct in. 43...84 sets v/oct to on (continuous pitch variation). 85...127 sets CV input to STEP mode.

CC 21: Linear FM CV mode: 0-42 sets off, 43-84 sets CV pitch to fine; 85...127 sets quantized/chromatic 4-octave range

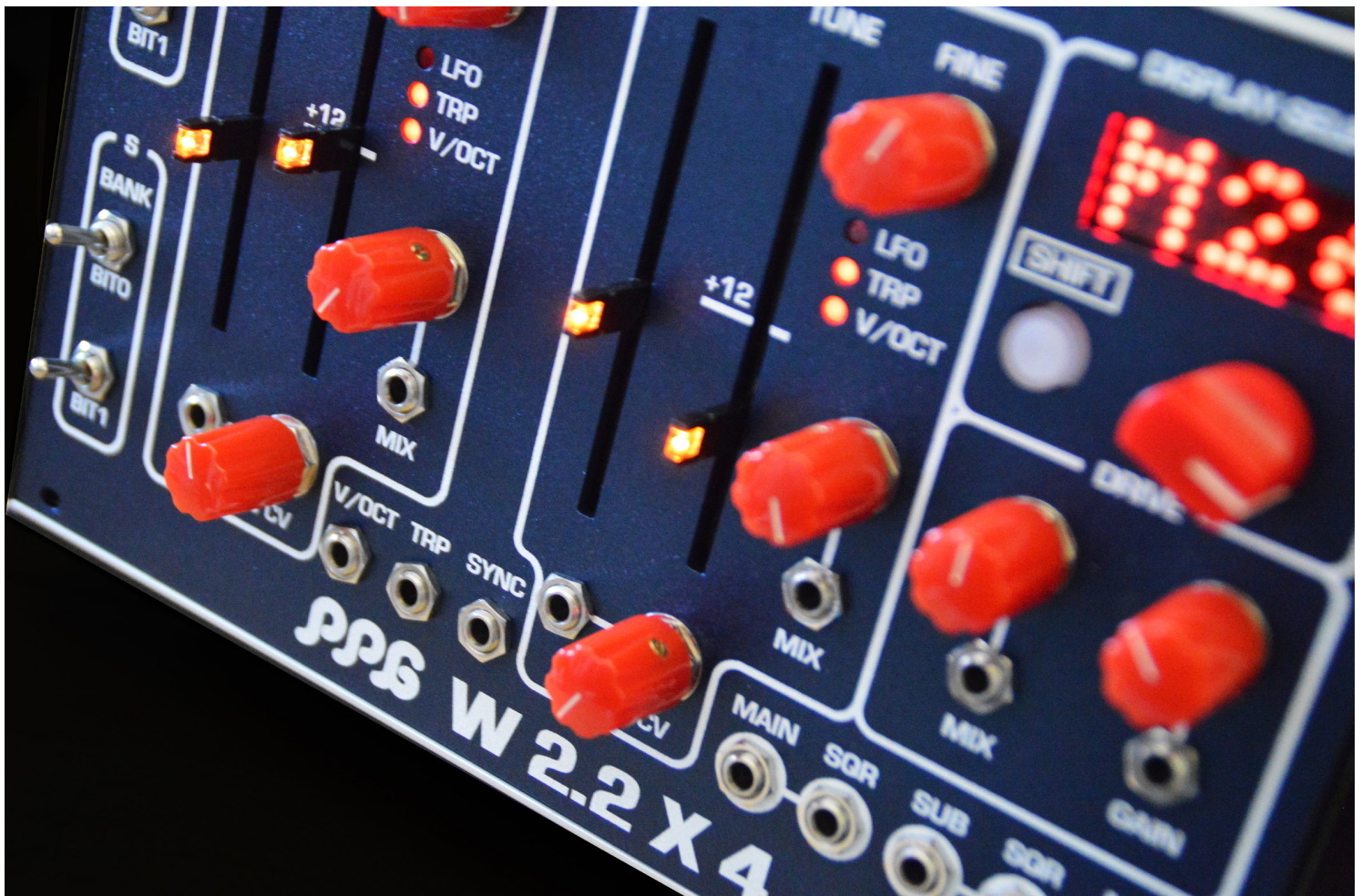
CC 22: LFO mode: 0-42 sets off, 43-84 sets LFO to fast mode, 85-127 sets LFO to slow mode

- CC 23: Enable/disable skipping basic waves. Disable by sending value 127; enable by sending 0...126.
- CC 31: Set vibrato to off
- CC 32: Set vibrato to on (uses CC 1 for pitch modulation)
- CC 44: Change sub wavetable
- CC 45: Change sub wavetable bank
- CC 53: linear FM CV mode for sub (like above, but for the sub oscillator)
- CC 54: LFO mode for sub (again, like above)
- CC 55: Enable/disable Skip Basic Waves (SBW). Disable by sending 127; enable by sending 0...126.
- CC 56: Enable/disable wavetable foldover (127= on, all other values = off)
- CC 70: Randomize wavetables (if value is 127)
- CC 75: End of Wave (EOW) toggle - 127 to enable, all other values to disable

## What's next

Adding the **GLITHc eXPenDR** opens up added possibilities for your PPG W 2.2x4, including control of pitch via MIDI, the ability to hack and transform wavetables - like patchable circuit bending - and use multiple sequencers. You can also imagine more with creative patching, or combine two W 2.2x4 modules for even more fun. See the GLITHc manual for more. And visit us for the latest ideas:

<https://www.liquidskyartistcollective.com>





PPG

LIQUID SKY D-VICES

*Santana da Serra*