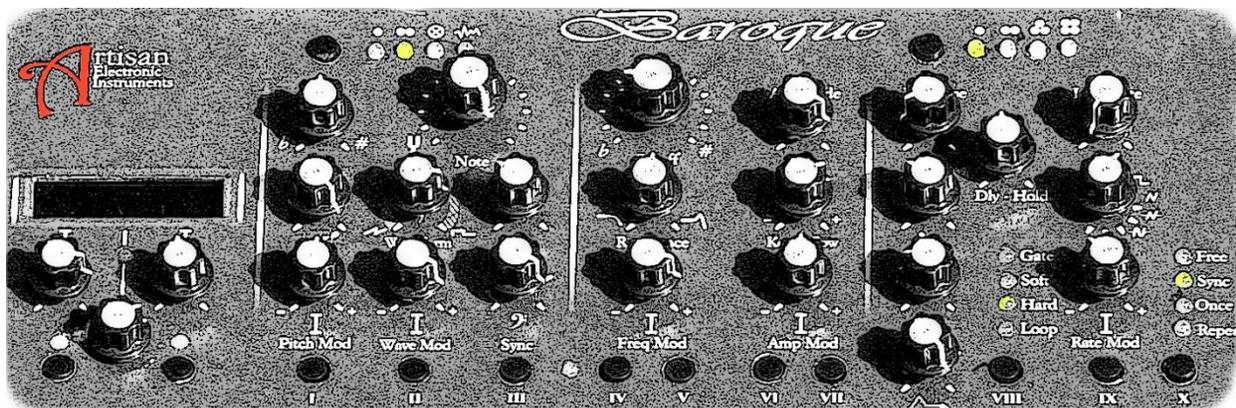


Ottava User's Manual

Analog Hybrid Performance Synthesizer



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Contents

Your Ottawa Performance Analog-Hybrid Synthesizer	3
Right Up Front.....	4
Ottava’s Voice	6
Sources.....	7
Oscillators.....	8
AXoR Function.....	10
Noise Source	12
Filter	13
VCA.....	14
Envelope Generators	14
LFOs.....	16
Trigger	17
Modulation Selection and Modifiers	18
Multiplier.....	20
Adder.....	21
Contour	21
MIN-MAX	22
Quantizer.....	22
Lag.....	22
Patch Save, Recall and Assign	23
Play Patch.....	23
Save Patch.....	23
Assign Button 1-10 and Quick Patch.....	24
MIDI and Mode Setup.....	25
Specifications	25
Parameter access and MIDI CC Assignments.....	26

Your Ottawa Performance Analog-Hybrid Synthesizer

So you just un-boxed your Ottawa.. nice feeling isn't it? If you are like me, you just want to get playing... Well that's easy, let's do it!

- Plug in the adapter
- Turn on the switch
- Hit the Trig button (it's the upper button on the far right side of the front panel)
- Woah!

So what just happened? Ottawa, when powered up, automatically loads the patch assigned to quick-patch button #1. The Trigger button acts like 1/12th octave keyboard and plays a note just as if a MIDI keyboard was attached. (You can change this note and this initial patch if you want... we'll get into that later.)

If you love this sound as much as we do, just plug in a MIDI keyboard or sequencer into the MIDI In port and go play... Come back here when you're done and we'll fill in the rest. See you later!

Welcome back! So you twiddled some knobs and pressed some buttons and we hope most of that was intuitive and fun. This manual will hopefully help with the rest.

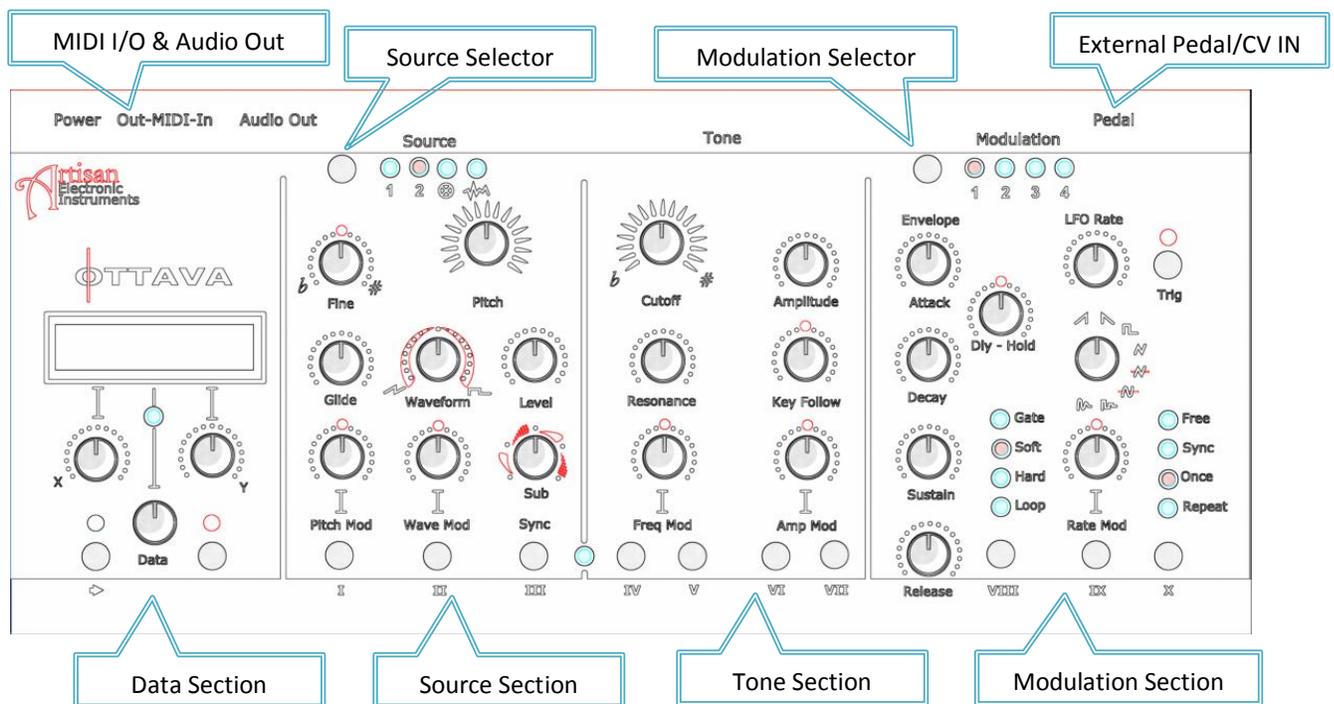
- We'll go over the Front Panel and let you know what all those buttons and knobs do
- Next we'll introduce the sound path and modulation routing
- Then we go into detail on each section of the synthesizer
- The next section will go into detail on how to assign modulation and make new modulations using the Modifiers
- Then we will go through the other menus and describe how to save and play patches, update software, apply tuning, get to "secret" parameters and setup the MIDI functionality.
- Finally, we have the obligatory specification page. He, we're proud of this thing and we love to show off its dimensions and power.

Right Up Front

Ottava has 25 knobs and 15 push buttons for direct control of most functions. Very little menu diving is required to setup a patch... wouldn't be a performance synthesizer if it did, right? But we did need to keep this thing compact while providing so much under the hood...

...So several knobs are used to control different banks. These banks are selected by the Source and Modulation Select buttons and indicated by the corresponding LEDs.

Let's just take a look; this is the Atomic version, but the Baroque follows the exact same layout...



The panel is set out in 4 sections; Data, Source, Tone and Modulation.

The Data section is where you can set Ottava's operational mode and MIDI channel, update firmware, store and assign patches, dabble in alternate keyboard tunings and configure the modifiers.

The Source section is where the sound starts. This is where you get to mix the analog waveshapes, add the sub oscillators, engage the hard sync and choose the AXoR functions. Pitch and shape modulation sources and amounts are directly accessible. The Noise Source can

be brought in and has both pitch and level modulation. All this is mixed and sent to the next stage...the filter.

The Tone Section contains the controls for the 4 pole cascade low pass filter. This 24db filter starts with an over-drivable asymmetric soft clip distortion stage and mixes in the feedback to create smooth to sharp singing resonance. In addition to the adjustable key-tracking, there are 2 selectable cut-off modulation sources and amount controls for a wide range of harmonic play. The tone section ends in a classic VCA also with 2 modulation sources and amount controls.

The final section provides direct control of 4 six-stage envelope generators and 4 eight-waveshape LFOs. Envelope generators can be triggered in 3 modes or set to a looping mode (what could you do with 8 LFOs!!) LFOs can run free, be synced to the keyboard or set to run once, providing 4 more AR-like functions (what could you do with 8 envelope generators!!) Additionally, the LFOs have rate modulation allowing very naturally flowing vibratos to wild time-shifting modulation waveshapes.

The Trigger button allows Ottava to play on its own. A simple way sample the sound or to use Ottava as a drone box.

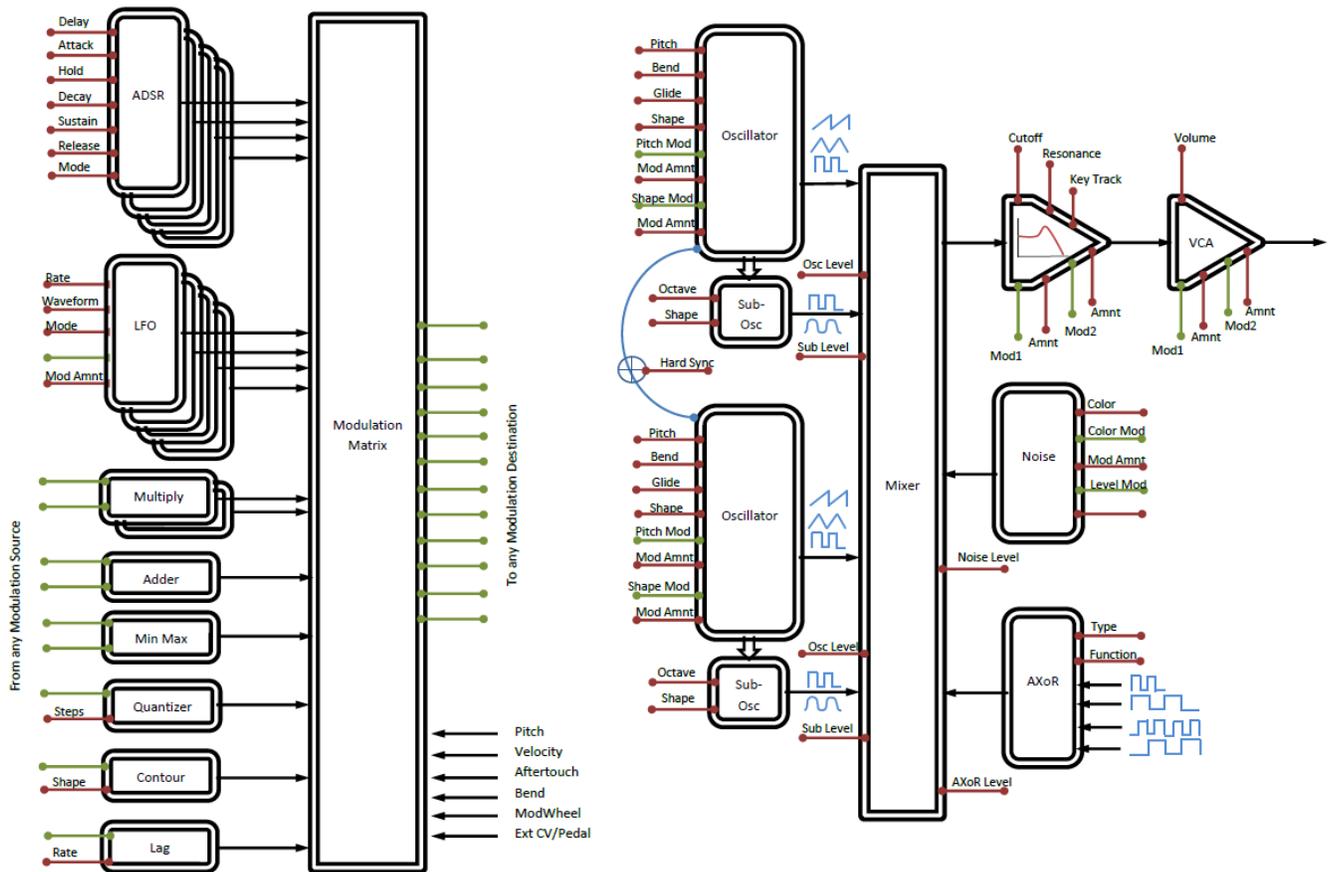
TIP: To read the present value of a sound parameter without changing the value, press and hold the Green button and then slightly rotate a knob that you are interested in and the present value will be displayed on the OELD, unchanged.

By the way, the power switch is on the top panel, just to the right of the Audio Out ¼" jack... Of course you know that, but just thought we should say that *somewhere* in this manual.

Ottava's Voice

All those knobs and buttons and LEDs on the Front Panel exist for one basic purpose, accessing the sound engine under the cover. Without this, Ottava would just be a cool looking MIDI controller. Thank goodness there is that second PCB.

Behold!



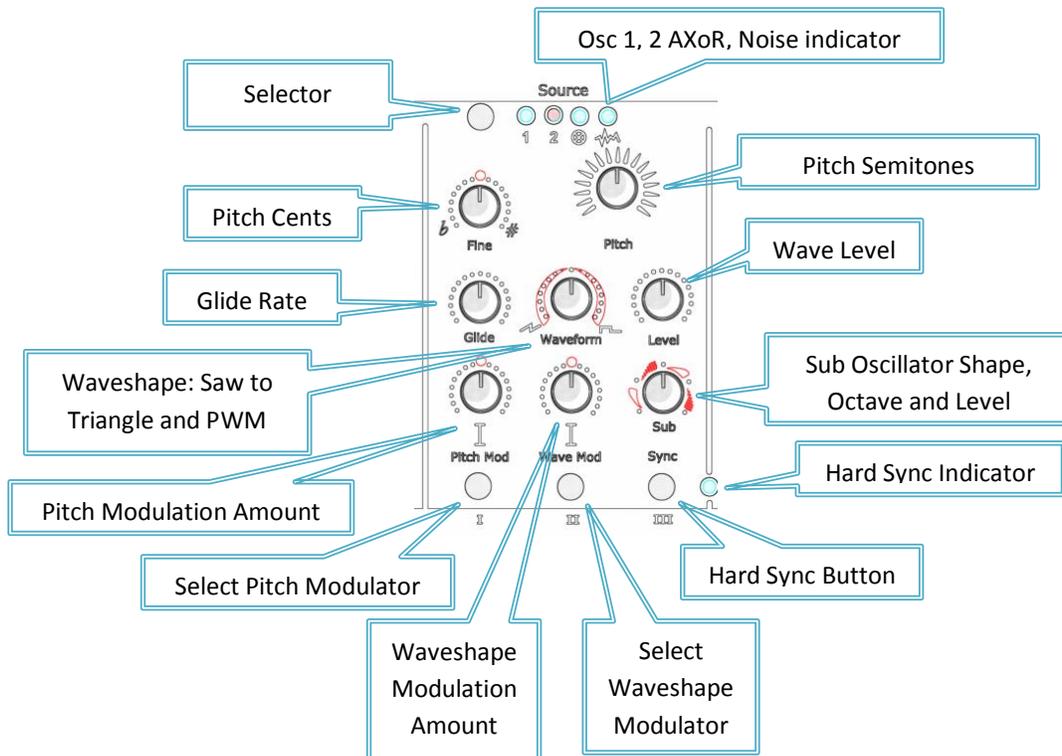
On the left, you can follow the analog signal path from dual VCO, subs, Noise and AXoR, through the mixer to the VCF and VCA. The red signals ●—● connect to knobs on the Front Panel; the green signals ●—● are connections to the modulation matrix.

The Modulation matrix takes the output signals from the four LFOs, four envelope generators, various Modifiers (adders, multipliers, etc) and the keyboard and routes them to the various destinations. All 21 modulation outputs are available to all 25 destination inputs simultaneously. Why have modulation matrix limits?

Any every setting and routing can be recorded in a patch. Nice.

Sources

The harmonic character of a sound starts with the oscillators, so Ottava was designed to provide a wide range of control and capabilities in its stable oscillators without sacrificing the warmth and feel that can only be derived from a discrete analog design.



There are two “nearly” identical analog oscillators in Ottava. The waveform generation starts from a classic Ramp-core, from which Triangle and Pulse waveforms are derived. The sub-oscillator is also driven from this core. After generation, all 4 waveforms are sent through the digitally controlled analog mixer.

The Shape Modulation morphs a Ramp, into Blade and Triangle waveshapes and the Pulse Width Modulation produces Square to Spike waves. The sub-oscillators have a few tricks themselves and can have selections for 1 or 2 octaves down and produce both square and smooth waveforms.

As you can imagine, all this provides wide sonic capability and control. And then there is Hard Sync and the AXoR to really up the harmonic spectrum!

Hard Sync forces Oscillator 2 to reset its ramp core under the tyrannical control of Oscillator 1. It’s hard to describe the unique sound this produces and small variations of pitch offset can create wide ranges of tone.

Last but definitely not least is the AXoR oscillator combining, wave mangling advanced logic ring modulator. This takes both oscillators and both sub-oscillators and generates 17 different wave functions producing mild bell-tones to wild thrash.

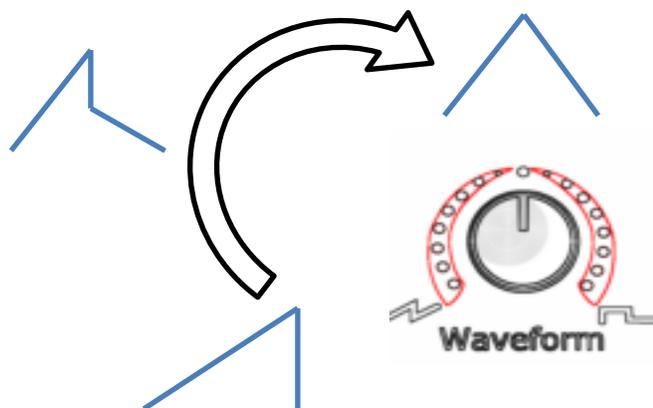
Wait, how could we forget the Noise Source? This is no ordinary noise generator. It has both independent Color and Amplitude modulation capabilities. This guy can create everything from a pulsing breathy flute character to deep rumbling explosions.

So in the end, there are 10 sound sources running into the mixer and feeding that filter. 10!

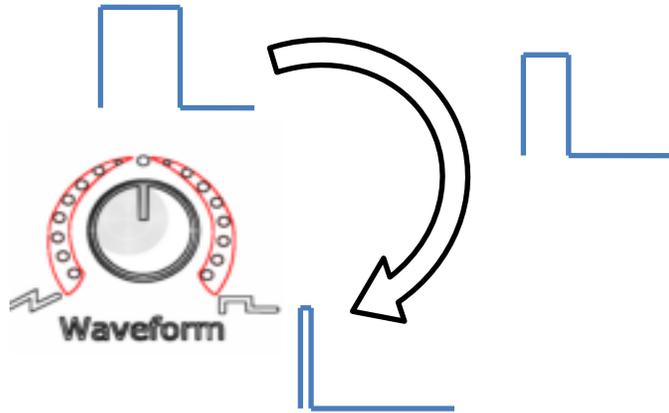
Oscillators

The Oscillators are true VCOs, voltage controlled saw-core frequency discrete component & op-amp goodness. The Saw wave is transformed by Triangle wave converter and Pulse Width Modulation circuits. Additionally, the core signal is passed to the sub-octave circuit that divides the signal into 1 and 2 octaves down square waves, which are passes through 2-pole Bessel filters to provide additional smoothed waves for the subs... It's all these sub-octave options found on both both oscillators that give rise and credence to the OTTAVA name.*

The Waveshape knob morphs the core waveshape from Saw through blade through Triangle waves continuously. Shape modulation directly effects this morphing and can add subtle texture to the sound.



Beyond the half-way 12 o'clock point, the Waveshape knob waveform changes to Square wave and the position of the waveshape knob controls Pulse Width. Shape modulation now provides that classic and wonderful PWM* sound.



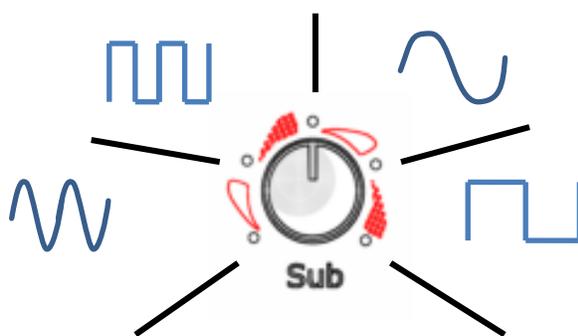
* PWM modulation can change the shape from 0% to 100% pulse width. 0% and 100% are actually useful... it is a neat trick to remove an oscillator from the mix dynamically

The Wave level knob controls the mix level of the fundamental wavelshape.

The Sub-Oscillator shape control knob combines functions; Sub-Level, Sub Octave and Sub Shape. Thus the knob has 4 sections;

- One octave down, smooth shape
- One octave down, Squarewave shape
- Two octaves down, smooth shape
- Two octaves down, Squarewave shape

Within each section, the mix level of the selected sub-wave increases from 0 to 100%.

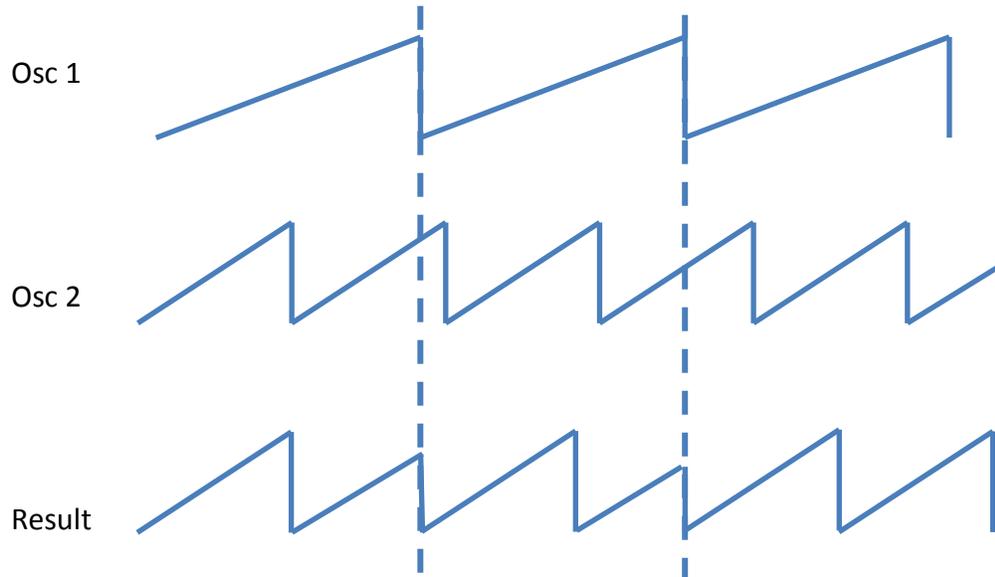


There is one difference between Oscillator 1 and 2 (remember all modulations, levels, bend amounts, glide etc are completely independent for the 2 oscillators!) and that is Hard Sync.

Hard Sync takes a sharp pulse from the edge of Oscillator 1 and resets the Saw-core generator of Oscillator 2. Normally, you would then take Osc1 out of the mix and listen to Osc 2 as that is

where all the fun is happening. To turn on Hard Sync, just press the button and the LED will light up, telling you its on.

This is what Hard Sync looks like.



You can see that the result has one more peak and that the Osc 2 waveform (what the waveform would have been if not for the Hard Sync) was “cut short” in two places because of the reset by Osc 1. The result contains new harmonics and a new fundamental pitch... can be quite dynamic. Small changes to Osc 1 or 2 frequencies can create large harmonic changes.

There are 2 knobs to control fundamental pitch. The Big Kknob is chromatic and steps by semitones (notes) and the fine pitch allows precede +/- one semitone (+/- 100 cents).

And don't forget the Glide knob... each osc has its own glide rate... and Pitch Bend amount. That's the only one you need to get to through the parameter menu.

AXoR Function

The AXoR function is unique (as far as I know) to Ottava. The AXor is a digiat ring modulator on steroids... and it shows. Most ring modulators take in 2 sources, the AXoR takes in 4. The PWM from each Oscillator and the two Sub-oscillators. It then allows 3 types of Waveform Transforms, 2 of which have 8 sub-functions.

The three transforms are

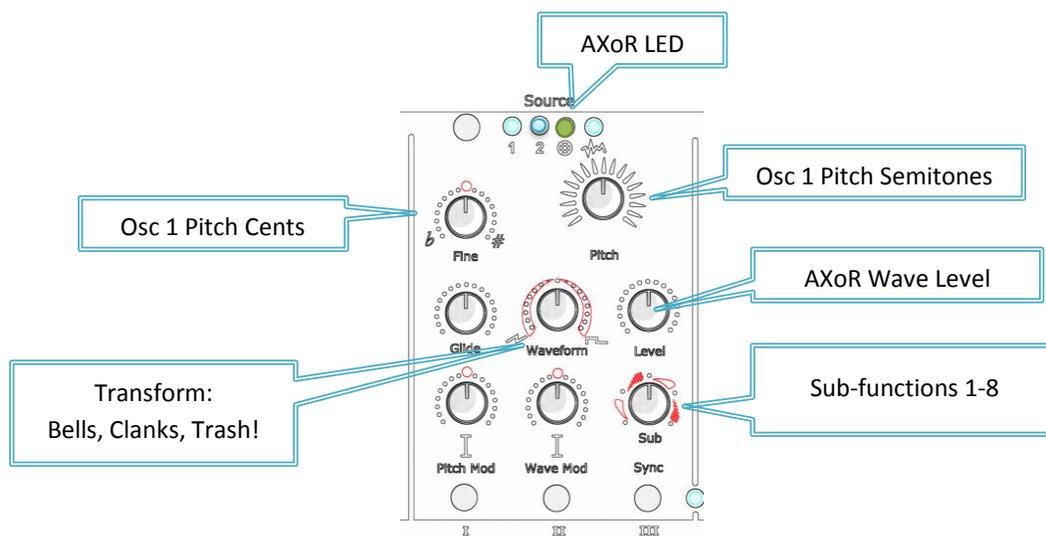
- Bells (Combines the 2 oscillator's PWM waveforms)
- Clanks (Combines the 2 Sub-oscillator's waveforms)
- Thrash! (Combines all 4 waveforms!)

The Clanks and Thrash transforms have additional sub functions

- 1-4 Select combinations squares waves from the sub-oscillators
- 5-8 Select frequency dependent combinations.

For the Bells and Thrash transforms, the pulse width setting of each oscillator affects the resulting tone tremendously.

Here is how the Front Panel Source Controls function when in the AXoR selection mode;



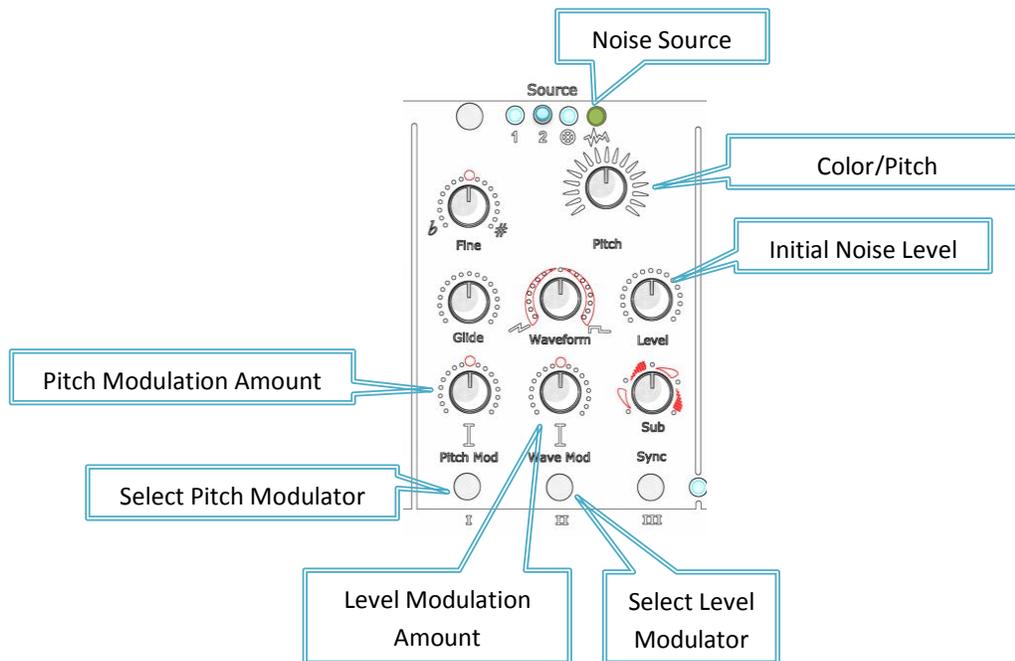
Having the Osc 1 pitch available is a helpful as this is one of the most important sonic character influences. Remember to turn the oscillator and sub oscillator mix levels off if you want to hear just the AXoR function. BTW, try Hard Sync with the AXoR sometime too.

Noise Source

The noise source on the Ottawa is digitally generated. It can provide a very random white noise source (has over 10 years before the pattern repeats, this is not a 1980s noise source, no chug-chug sounds here). Being digital has its benefits. For one, it allows the noise to change “color” and change the sonic “pitch” of the noise.. not quite like have pink to red noise, but different and useful in its own way. Remember those arcade game explosion effects? No problem for Ottawa.

That’s because Ottawa allows both the Color/Pitch and the Level to be modulated. Basically, the Noise Source has its own VCA into the final mixer pre-filter. Add an Envelope generator to the Level and Pitch modulation and Boom; Explosions, space drums or percussive attacks to organ or flute sounds.

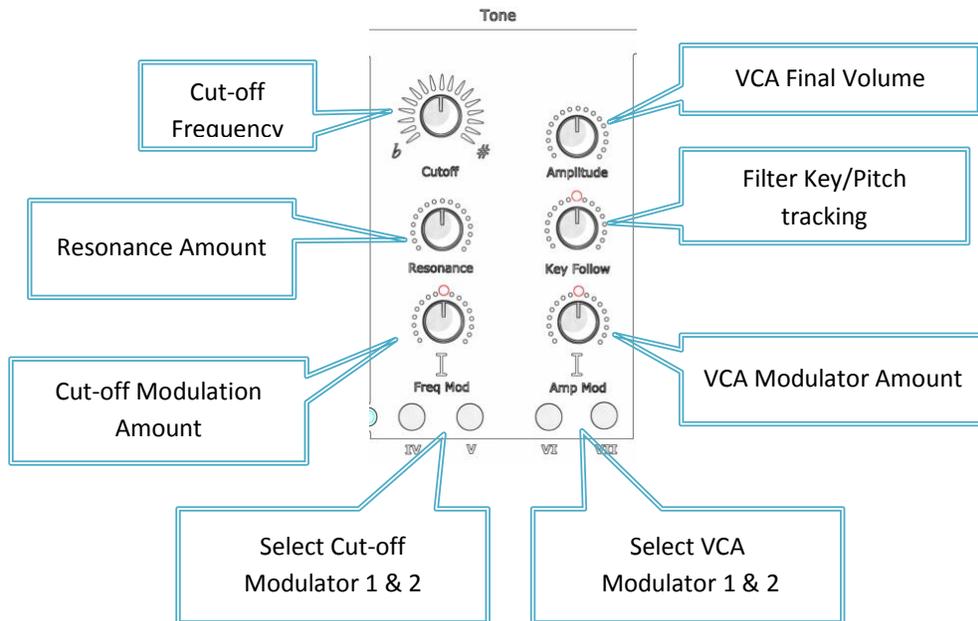
Here is how the Front Panel Source Controls function when in the Noise Source mode;



* Ottawa means an octave higher or lower as written in music notation.

Filter

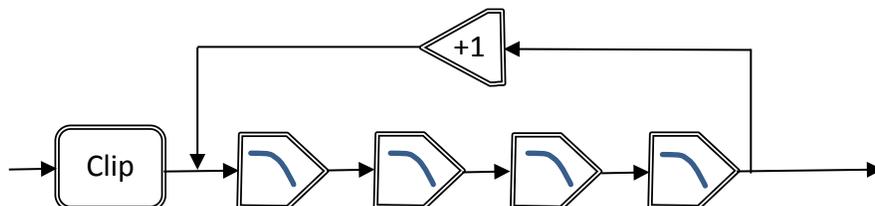
So with all that sonic character control coming from the Sources, who needs a filter? Well you do and Ottava provides a beautiful 4 pole cascade resonant filter. The 24db/octave filter can go from smooth through some wild high resonance sizzle to full-self oscillation sinewave that tracks perfectly over a 5+ octave range.



The filter cutoff can be modulated by 2 different sources of your choice from 21 different modulation sources. Keyboard tracking can be set from 2x inverted tracking to 2X positive.

We know you will love sweeping this filter, so Ottava has a nice big knob right in the middle of its panel. You can thank us later... 😊

Here is a basic look at the Filter Signal flow;



The Clipper is a soft asymmetrical distortion circuit that can be overdriven by the mixer stage. Simply crank up the Source levels. The 4 signal1 pole filters are identical OTA based circuits and the feedback path provides the Q peak or AKA Resonance. There are some additional circuits to reduce the effect that higher resonance has on bass and signal level... but you get the basic idea.

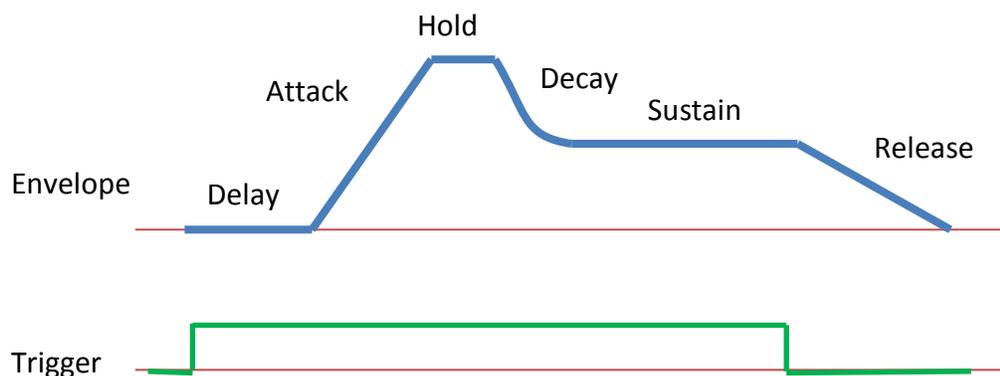
The two Cutoff Modulation sources combine with the Cutoff knob to create a voltage that is converted to a current that then equally affects the corner frequency of each pole. Classic analog VCF design. Yes, there are transistor ladder filters and State Variable Filters, but a Cascade 4 pole is a classic too.

VCA

Yep, there is a OTA based analog VCA at the end of the signal chain. It also has two modulation inputs. Typically these are set to an Envelope and a LFO... but replace one of these with the Offset modulation source and you have a Drone box.

Envelope Generators

There are 4 identical Envelope Generator in Ottawa.. We resist using the ADSR term because they are more than that. We could use DAHDSR as that is a more accurate abbreviation (and you will find this term used sometimes) . So what is a DAHDSR?

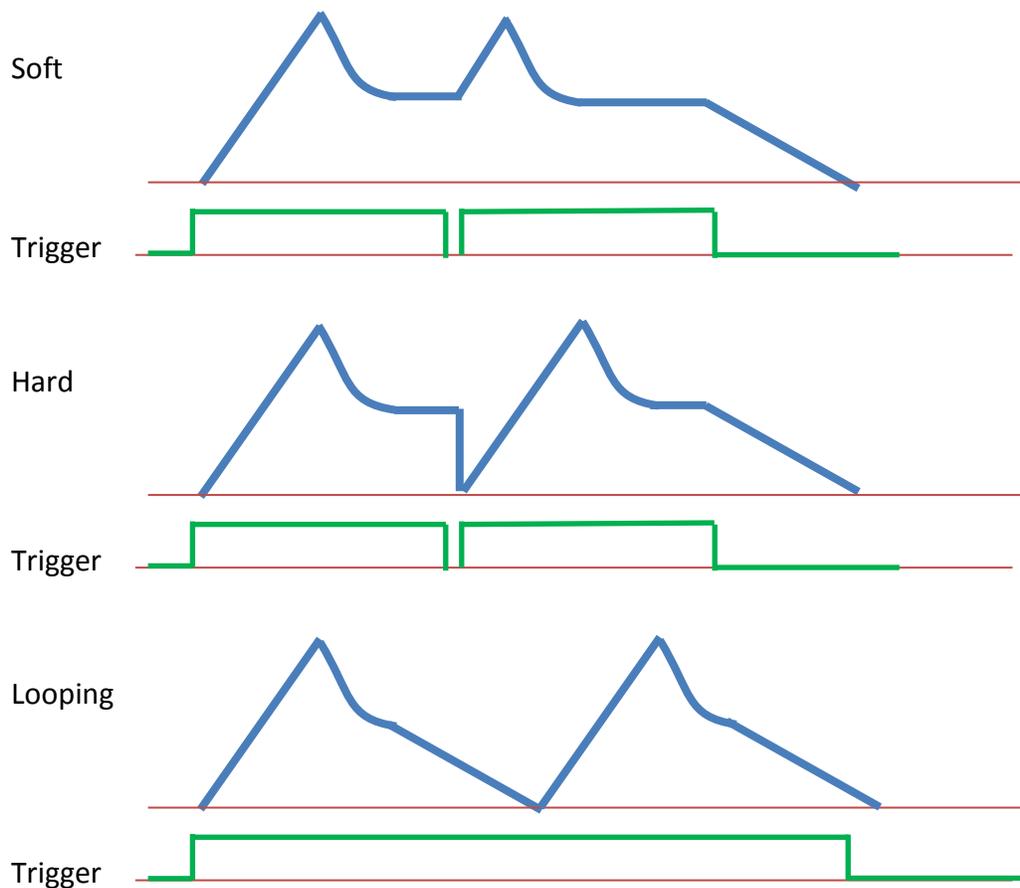


The Attack, Decay, Sustain and Release phases are controlled by their respective knobs. For ADR phases, these knobs are exponential, with the fastest response fully CCW (about 4ms) and slowest response CW (about 10sec). Sustain is Linear.

Delay and Hold share the same knob. Center is zero for both, CCW increases the Delay and CW increases the Hold. To get both functions at once, set the delay or hold on the knob and set the other using the Parameter Menu function.

The Envelope generators have 4 triggering modes;

- Gated = Envelope will go through the DAHD stages and stay at the Sustained stage as long as any key is down. It will not re-trigger on a new note.
- Soft = The Envelope will re-trigger on each note back to the Attack phase, starting at the present level.
- Hard = The Envelope will re-trigger on each note back to zero and restart at the Delay stage.
- Looping = The Envelope will run through the Delay, Attack, Hold, Decay and Release stages and will restart again over and over as long as there is a key down.



LFOs

Ottava also has 4 LFOs.. for the most part they are identical except LFO 1 runs 4 times faster than the other 3... It runs up to 80 Hz.

The LFOs produce one of 8 waveforms;

- Ramp Up
- Ramp Down
- Square
- Triangle
- Bipolar Triangle
- Bipolar Sine
- Random
- Random Slope

The Bipolar waves modulate both + and – equally and are thus great for vibrato as they will keep the fundamental pitch intact, no matter how much vibrato is dialed in. All the other wave shape go from 0 to +100% modulation only. (you can always get negative modulation by turning any Mod Amount knob CWW past the center detent)

The LFOs will run in one of 4 modes:

- Free. = waveform is just running at the LFO rate set
- Sync = Waveform always starts at 0 at the first key press and then runs free
- Once = Waveform starts at the keypress and runs one and only one complete cycle.. like a mini envelope generator.
- Repeat = Line Once, but the waveform will repeat with each keypress.

LFOs have something that the Envelopes do not, and that is rate Modulation. And yes, you can even modulate the LFO rate based on its own output... it turns that linear Ramp up into an exponential Ramp.

Trigger

The Trigger button will trigger the envelopes and LFO sync. The Note played by the Trigger button (Trigger Note #) can be adjusted under the Parameter menu.

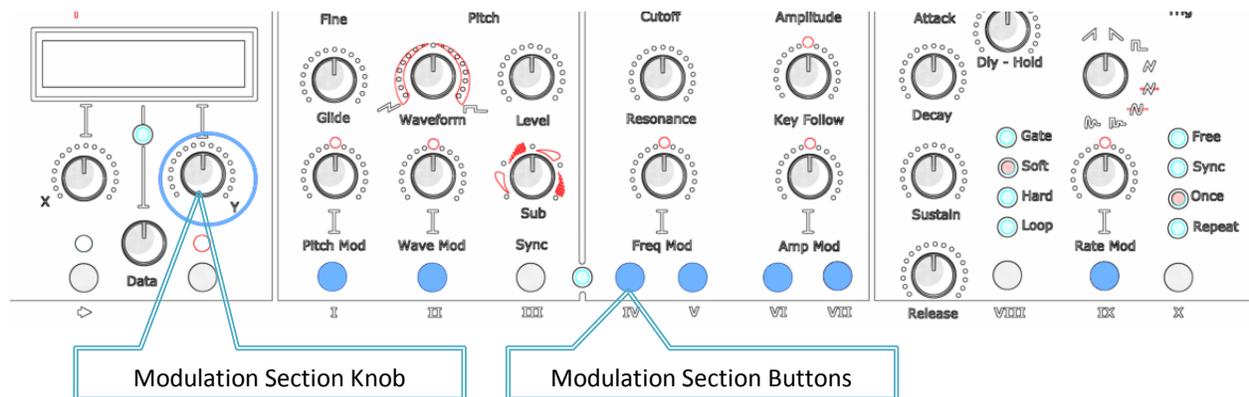


To access the Trigger Note # parameter, rotate the Data Knob until it says “Parameters” and then press the Data Knob. Rotate the Data Knob 7 clicks CCW to “Trigger Note #”. The Y/Right knob will now select the MIDI Note that will be played when the trigger is pressed. You can play Ottava and edit the sound while in the Parameter Mode, so go ahead and press the trigger, adjust the pitch, play again... who knows, you could get good at this! Try playing “Mary had a Little Lamb”.., come on, you know you want to!

Modulation Selection and Modifiers

The key to giving “life” to a sound is the subtle and sometime wild application of modulation. In Ottava, all 21 modulation sources are available to any of the 25 destinations, but those destinations need to be set and selected.

Modulation destinations into the voice are selected by pressing one of the 7 Source Select buttons. (in light blue below)



Once the desired button is pressed (you don’t need to hold it down), the first line of the OLED design will show which Destination is being address; such “Osc 1 Pitch Src” or “Osc 2 Shape Src” ... which reminds me, make sure you have selected the source or modulation desired first, using the Selector button at the top of the Front panel.

The second line of the OLED display will show the presently, in-use, modulation for that destination. To change the modulation used, rotate the Y/Right data knob... a list of modulations sources will scroll through. You can ply the synth and hear the results of the modulation on-the-fly. Just stop on the one you like... Note that you have a few seconds after pressing the Modulation Section button to start selecting a new modulation.

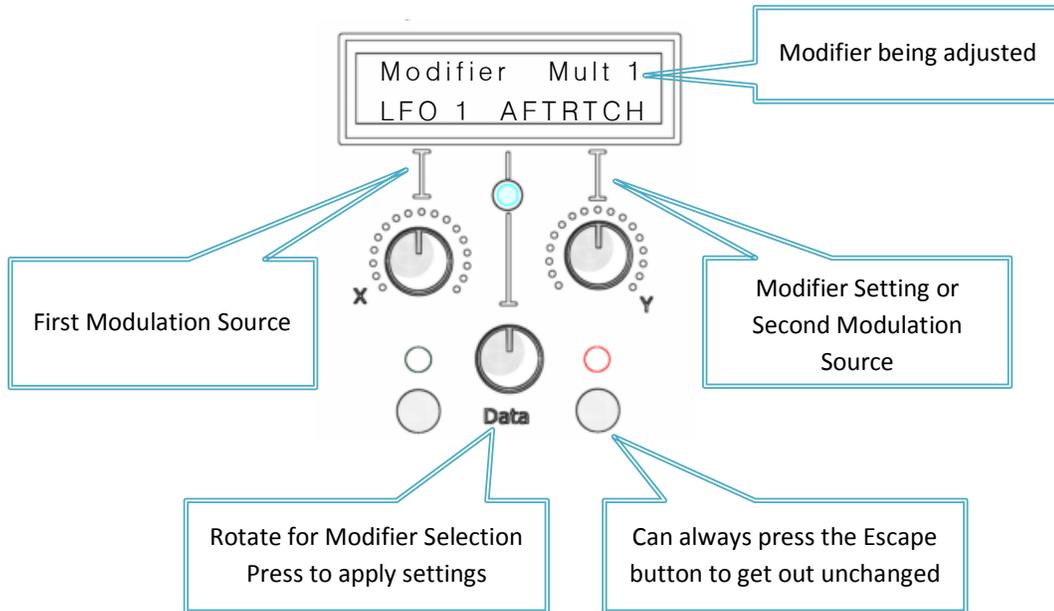
Each Modulation destination has an Amount knob on the Front Panel that allows for +/- 1--% modulation depth... they also have a nice detent in the center for easy 0% selection. For the Filter and VCA, which have two sources of modulation, press the Modulation Selection button first and then adjust the Amount knob. This tells the control card which modulation rate source you want to control. The OLED always lets you know what is going on...

Here is the Modulation list controlled by the Y data knob:

- No Modulation
- Velocity
- Mod Wheel
- Pitch Bend
- After Touch
- Ext Pedal CV
- LFO 1
- LFO 2
- LFO 3
- LFO 4
- Envelope 1
- Envelope 2
- Envelope 3
- Envelope 4
- Multiplier 1
- Multiplier 2
- Adder
- Contour
- MIN-MAX
- Quantizer
- Lag
- Offset (apply a constant modulation... actually useful)
- Pitch (The MIDI note #)

The **RED** modulations are Modifiers. Modifiers take a modulation source and apply some mathematical function to create new unique modulations.

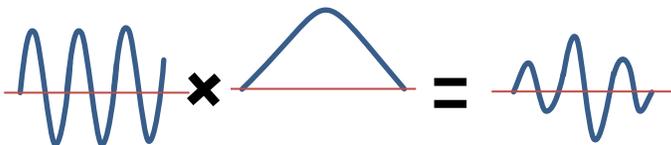
Modifiers have their modulation sources selected differently. This is one of those time we have to dive into the menu.. Rotate the Data Knob until it says “Modifiers” and press the data knob. At this point, the OLED will switch and display something like;



The Data Knob will select which Modifier is being updated. The X/Left knob will select the First Modulation Source and the Y/Right knob will select the setting or second modulation source. The Multipliers, Adder and Min-Max require 2 sources while the others take a single modulation and modify it.

Multiplier

The Multiplier takes two modulation signals and.... multiplies them. Big Surprise. But it does a few other things too. It never lets the total value go above 100% modulation and it is a 4-quadrant multiplier, so it takes into account the sign of the modulation, as from the LFO bipolar signals. It also allows you to invert the second modulation signals That what the “-“ you see is when you go past center in the Y/Right data knob.

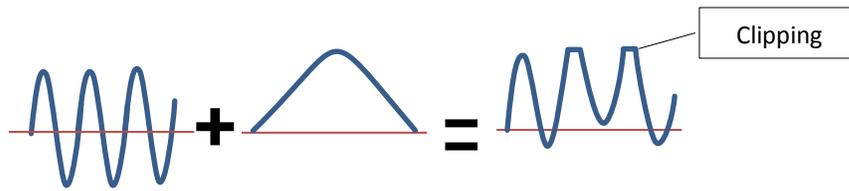


BTW, you have 2 of these...

One major use for the Multipliers is to allow the Mod Wheel to affect the depth of an LFO or Envelope generator. By multiplying in the Mod wheel, when it is at 0%, the modulation is effectively turned off and when the wheel is at 100% the modulation depth is set by the Mod Amount knob on the front panel.

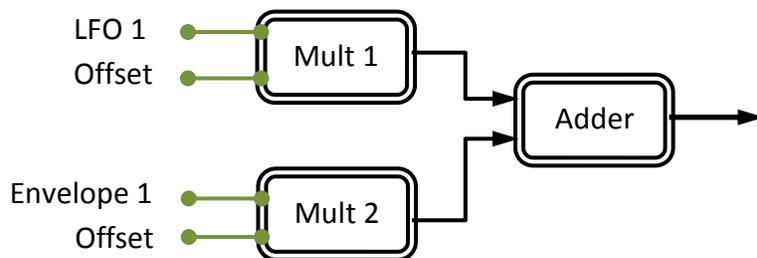
Adder

The Multiplier takes two modulation signals and.... adds them. So far so good. But like the Multiplier limits the total value to + or - 100% modulation and allows you to invert the second modulation signals



Notice the difference between this result and the Multipliers.. you can see the clipping that occurs... this can actually be useful.

The adder can be useful when you need more than the allotted number of modulation inputs provided, like for pitch modulation (there is only one).. you can add an LFO and Envelope together to get 2 modulation effects on pitch... Use the Multipliers first with a 50% Offset input before the adder and you can eliminate the clipping! Like This...

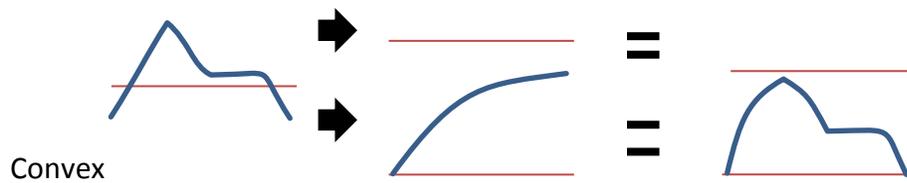


Contour

The contour generator takes a signal and applies a non-linear function/curve to the result.. This curves is either convex or concave.. apply it to an ADSR or Ramp wave from the LFO or to the Modulation wheel to change it from a linear to logarithmic effect

Concave

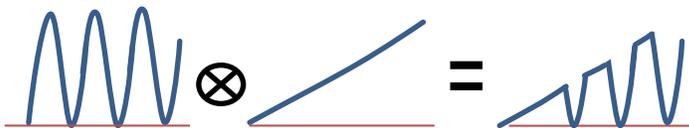




MIN-MAX

The Min-Max selector takes in two modulations and outputs one based on which is great (max option) or lower (min option). This can create some really great effects, such as a vibrato that is clipped by the modulation wheel (min function) or complex LFO shapes (Max of 2 LFOs). The Min option is selected when the “-” sign appears before the second (right most) modulation selection.

Minimum Select Function



Maximum Select Function



Quantizer

The Quantizer takes a single smooth modulation and converts it to a series of steps. If the step parameter is set to 10, then the modulation input is chopped into 10 evenly spaced steps. A ramp wave becomes a staircase. Random notes can be limited to even pitches. This is great for 8-bit type sounds or simple arpeggios.

Lag

The lag modifier adds a simple one-pole exponential lag filter to the selected modulations. High Time Constants (TC) create slower filters and longer lags. This can be used to create a phase shift in an LFO or change the shape of a envelope, slow the pitch bend or modulation wheel response or create a filter that reduces the final output of a modulation based on its rate

(like a low pass filter)... set the TC high and as the modulation rate increase, the effective modulation decreases.

Patch Save, Recall and Assign

Patch management is accessed under the Patched Menu. Rotate the data Knob to Patches and press the Data knob.

The Data Knob will scroll through the sub-menu:

- Play Patch
- Save Patch
- Assign Button 1
- Assign Button 2
- .
- .
- Assign Button 10

Play Patch

When Play Patch is displayed, the Y/Right knob will scroll through the 60 patches by name and number. Select the patch you want and press the Data Knob. That sound will be ready to play in about 1/10 second. You don't have to stop playing while selecting a patch.

Hit the Red button to get out and not select a patch.

Save Patch

When the Save Patch is displayed, the Y/Right knob will scroll through the 60 patches by name and number. Select the patch # you want write to and press the Data Knob.

The display will now say Edit Patch Name. At this point, the X/Left knob will scroll through the 12 available characters (indicated by a blinking block) and the Y/Right knob will scroll through the alphanumeric characters. Once you have enter the name you want, press the Data knob and it will be written in about 300ms.

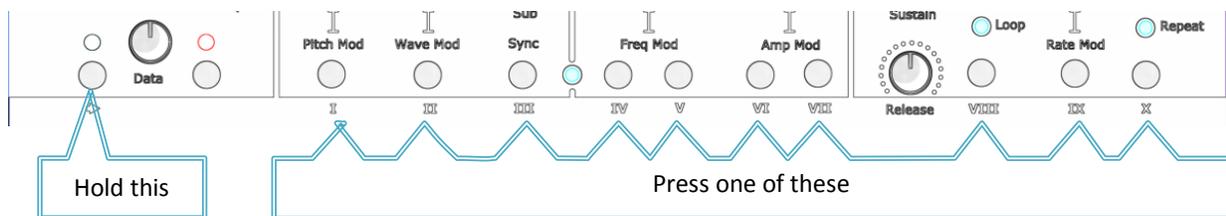
At any time (before you save), you can hit the Red button to get out and not save a patch.

Assign Button 1-10 and Quick Patch

The Assign Button Function allows the user to setup 10 quickly accessible patches on the front panel.

Rotate the data Knob to select which button you want to assign and then rotate the Y/Right knob to select the patch you which to assign. Press the data knob to set the assignment.

Now you can quickly access that sound directly from the front panel. Press and hold the Green button and then press any of the 10 numbered buttons you have assigned a patch to... Bam, new patch in 100ms.



Note that whatever patch you assign to button 1 will be set when Ottawa powers up.

MIDI and Mode Setup

Under the Configuration menu, there are the MIDI setup and Play Mode setup functions.

The MIDI Channel (or Omni mode) is selected by the Y/Right knob and by pressing the Data Knob. Omni mode will make Ottava respond to MIDI not and CC on any channel.

The Play Mode is set by the X/Left knob and by pressing the Data Button. The Play Mode can be Monophonic or Duophonic. In Monophonic mode, the last note pressed has precedence (plays) . In Duophonic mode, the if only one note is played, both oscillators will sound on that one note, much like the Monophonic mode, but if a second not is pressed (the other note is held) the oscillator2 will play at the new not and oscillator 1 will play the last held note. If two keys are played simultaneously, Osc 1 will take the low note and Osc 2, the high.

Specifications

Power: 15VDC @ 500mA

Size: 500mm x 200mm x 90mm (20"x 8" x 3.5")

Weight: TBD

CV Pedal In: ¼" TRS input. Ring = Wiper, 50Kohm total from Tip to Sleeve nominal or 0-5V signal.

Audio Out: 680 Ohms TBD P-P voltage

Parameter access and MIDI CC Assignments

The following parameters can be accessed under the Parameters menu. Press the data knob while Parameters is displayed to enter this menu. Rotating the Data knob scrolls the the list below and displays the current setting. Rotating the Y/Right knob or the assigned Front Panel knob or button will change the value.

The values are set while high resolution/precision using Ottawa's own knobs, but Ottawa will also respond to MIDI CC, albeit to a lower 0-127 resolution.

MIDI CC	Parameter
1	OSC_1_SEMITONES
2	OSC_1_CENTS
3	OSC_1_BEND
4	OSC_1_GLIDE_RATE
5	OSC_1_WAVE_SHAPE
6	OSC_1_WAVE_LEVEL
7	OSC_1_SUB_CONTRL
8	OSC_1_PITCH_SRC
9	OSC_1_PITCH_MOD
10	OSC_1_SHAPE_SRC
11	OSC_1_SHAPE_MOD
12	OSC_2_SEMITONES
13	OSC_2_CENTS
14	OSC_2_BEND
15	OSC_2_GLIDE_RATE
16	OSC_2_WAVE_SHAPE
17	OSC_2_WAVE_LEVEL
18	OSC_2_SUB_CONTRL
19	OSC_2_PITCH_SRC
20	OSC_2_PITCH_MOD
21	OSC_2_SHAPE_SRC
22	OSC_2_SHAPE_MOD
23	METALIZE_LEVEL
24	METALIZE_WAVE
25	NOT_USED
26	METALIZE_SUB_CTL
27	NOISE_LEVEL
28	NOISE_COLOR
29	NOISE_LEVEL_SCR
30	NOISE_LEVEL_MOD
31	NOISE_COLOR_SRC
32	NOISE_COLOR_MOD

33	FILTER_CUTOFF
34	FILTER_RESONANCE
35	FILTER_MOD1_SRC
36	FILTER_MOD1_AMNT
37	FILTER_MOD2_SRC
38	FILTER_MOD2_AMNT
39	FILTER_KEYFOLLOW
40	VCA_AMPLITUDE
41	VCA_MOD1_SRC
42	VCA_MOD1_AMNT
43	VCA_MOD2_SRC
44	VCA_MOD2_AMNT
45	ENVELOPE_1_ATTCK
46	ENVELOPE_1_DECAY
47	ENVELOPE_1_SUSTN
48	ENVELOPE_1_RELSE
49	ENVELOPE_1_DELAY
50	ENVELOPE_1_HOLD
51	ENVELOPE_1_TYPE
52	ENVELOPE_2_ATTCK
53	ENVELOPE_2_DECAY
54	ENVELOPE_2_SUSTN
55	ENVELOPE_2_RELSE
56	ENVELOPE_2_DELAY
57	ENVELOPE_2_HOLD
58	ENVELOPE_2_TYPE
59	ENVELOPE_3_ATTCK
60	ENVELOPE_3_DECAY
61	ENVELOPE_3_SUSTN
62	ENVELOPE_3_RELSE
63	ENVELOPE_3_DELAY
64	ENVELOPE_3_HOLD
65	ENVELOPE_3_TYPE
66	ENVELOPE_4_ATTCK
67	ENVELOPE_4_DECAY
68	ENVELOPE_4_SUSTN
69	ENVELOPE_4_RELSE
70	ENVELOPE_4_DELAY
71	ENVELOPE_4_HOLD
72	ENVELOPE_4_TYPE
73	LFO_1_RATE
74	LFO_1_WAVEFORM
75	LFO_1_TYPE
76	LFO_1_MOD_SOURCE

77	LFO_1_MOD_AMOUNT
78	LFO_2_RATE
79	LFO_2_WAVEFORM
80	LFO_2_TYPE
81	LFO_2_MOD_SOURCE
82	LFO_2_MOD_AMOUNT
83	LFO_3_RATE
84	LFO_3_WAVEFORM
85	LFO_3_TYPE
86	LFO_3_MOD_SOURCE
87	LFO_3_MOD_AMOUNT
88	LFO_4_RATE
89	LFO_4_WAVEFORM
90	LFO_4_TYPE
91	LFO_4_MOD_SOURCE
92	LFO_4_MOD_AMOUNT
93	RESERVED_1
94	RESERVED_2
95	RESERVED_3
96	RESERVED_4
97	RESERVED_5
98	MULTPLY_1_X_SRC
99	MULTPLY_1_Y_SRC
100	MULTPLY_1_Y_INV
101	MULTPLY_2_X_SRC
102	MULTPLY_2_Y_SRC
103	MULTPLY_2_Y_INV
104	ADDER_X_SOURCE
105	ADDER_Y_SOURCE
106	ADDER_Y_INVERT
107	MIN_MAX_X_SOURCE
108	MIN_MAX_Y_SOURCE
109	MIN_MAX_Y_INVERT
110	CONTOUR_MOD_SRC
111	CONTOUR_SHAPE
112	BIT_CRUSHER_MOD
113	BIT_RESOLUTION
114	LAG_MOD_SOURCE
115	LAG_RATE
116	OFFSET_OUTPUT_1
117	PITCH
118	RESERVED_6
119	RESERVED_7
120	OSC_HARD_SYNC

121	TRIGGER_NOTE
122	MIDI_MODE
123	MIDI_CHANNEL
124	EXT_PEDAL_CV
125	AFTER_TOUCH
126	MODULATION_WHEEL
127	PITCH_BEND