B PIZZA

FM & WAVE—SHAPE OSCILLATOR

PIZZA
WAVE-SHAPING OSCILLATOR

PITCH

SEMI
OCTAVE

LONG

DETUNE
FINE

RATIO
OSC

FM
INDEX

OCT
OSC

EXT

+2

+1 −1

0

LONG:SET

INDEX
MOD

SHAPE

SHAPE

WAVE

RING

LONG:ASSIGN

CTRL

SYNC   CTRL   FM INDEX   EXT

V/OCT   PULSE   MAIN   OCT OSC

BASTL
PIZZA

PIZZA V0.6

−12V.

USB

DESIGNED AND PRODUCED IN CZECH REPUBLIC
BASTL-INSTRUMENTS.COM
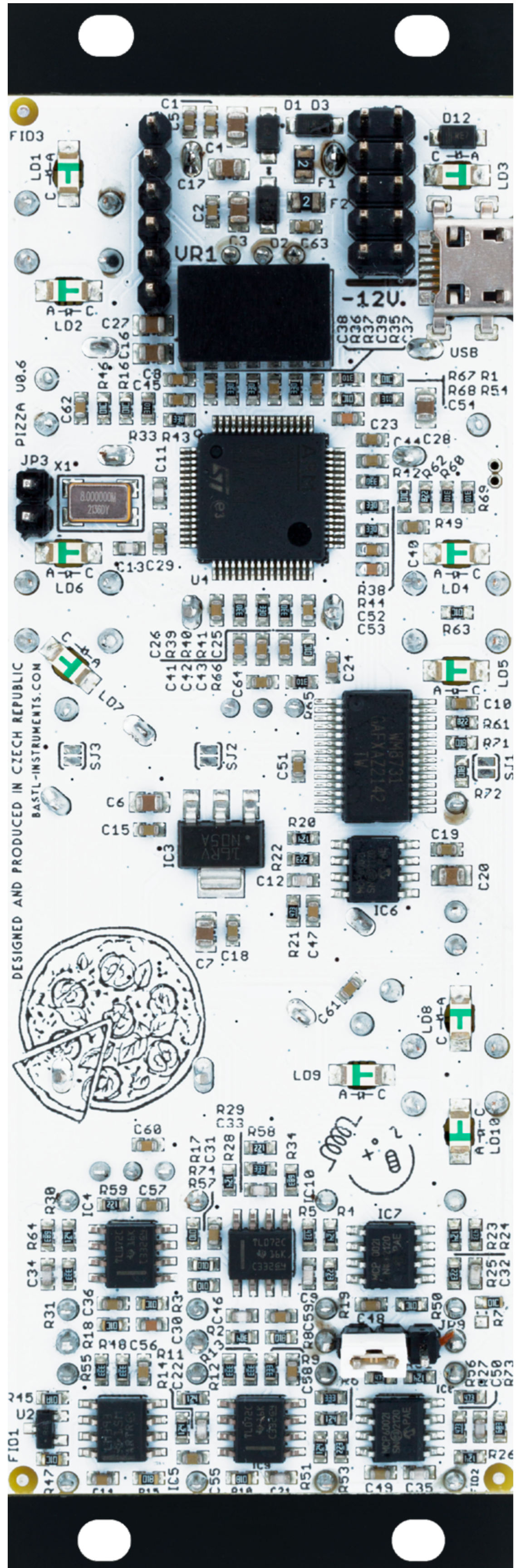
Pizza Manual

Note:

If the Pizza boots and animates a sequence of 2 flashes near the OCT OSC button and the lights on the left side of the module pointing down, it requires the V/OCT input to be re-calibrated. This can happen when the power rails in your system are balanced differently than in the previous modular case.

To calibrate: Plug a cable from OCT OSC to V/OCT, wait for a few seconds and disconnect the cable. Pizza will boot to normal operation.

Architecture

Pizza Oscillator architecture is centered around 3 oscillators: MAIN, OCT, and RATIO.

The core of the module is digital FM (phase) modulation, where the MAIN oscillator is the carrier while OCT and RATIO are the modulators. Both OCT and RATIO can be WAVE-shaped (SQUARE-SINE-SAW) before applied to the FM. The amount of FM is set by the FM INDEX crossfader that goes either to OCT or RATIO oscillator side. It can be modulated by a CV, which is attenuverted by the INDEX MOD knob.

The output of the MAIN oscillator can be wave-folded and then ring-modulated with either of the modulating oscillators in the SHAPE section. The OCT oscillator has a dedicated output that is affected by the WAVE shaper. The OCT oscillator can be replaced by an EXTernal signal for more advanced FM duties.

MAIN OUT and OCT OSC OUT can also be affected by the built-in bipolar VCA that is only accessible via assigning the CTRL knob and CV.

The MAIN oscillator also has a PULSE output taken before the FM modulation. The pulse width can be modulated by the FM INDEX.
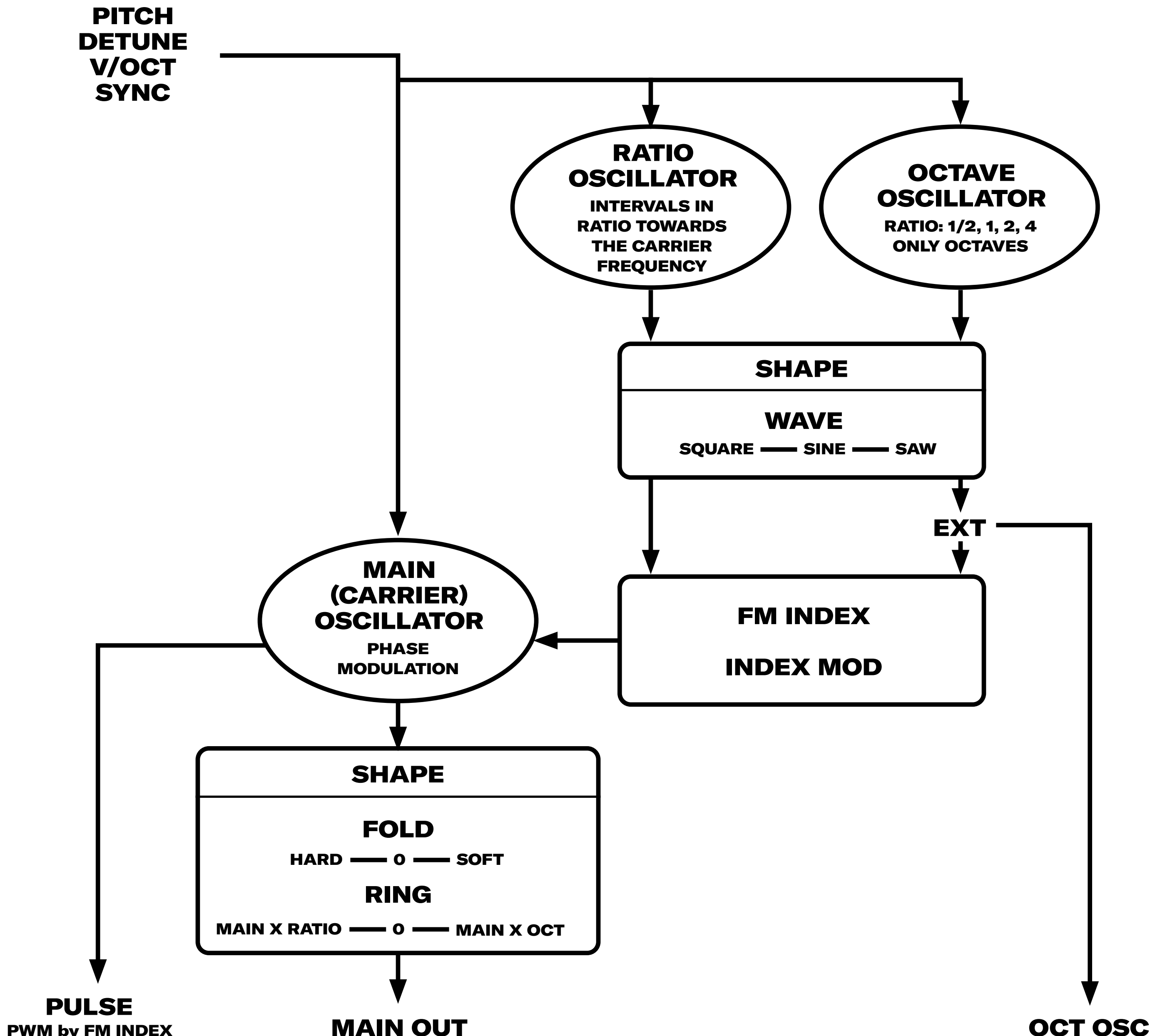
B PIZZA

FM & WAVE-SHAPING OSCILLATOR

POST SOUN

TUNE

1

PITCH

SEMI

OCTAVE

1 PITCH BUTTON

LONG

DETUNE

FINE

2

EXT

RATIO OSC

FM INDEX

OCT OSC

G/H

5

A/B E/F

C/D

LONG:SET

RATIO OSC BUTTON

3

− INDEX MOD +

+2

4

+1 −1

0

OCT OSC BUTTON

7 SHAPE

7

7 SHAPE

SHAPE

WAVE

8

SHAPE BUTTON

FOLD **9**

RING **10**

LONG:ASSIGN

11

− CTRL +

12 SYNC

11 CTRL

3 FM INDEX

6 EXT

13 V/OCT

14 PULSE

15 MAIN

16 OCT OSC

BASTL PIZZa

PROGRAMMING
HEADER

FID3   SWO

NRST

SWDIO

GND

3V3

SWDCLK

BOOT TO STM
BOOTLOADER

-12V

!

A

USB

DESIGNED AND PRODUCED IN CZECH REPUBLIC

BASTL-INSTRUMENTS.COM

PIZZA V1.0

FID1

FID2

PULSE
/CV4
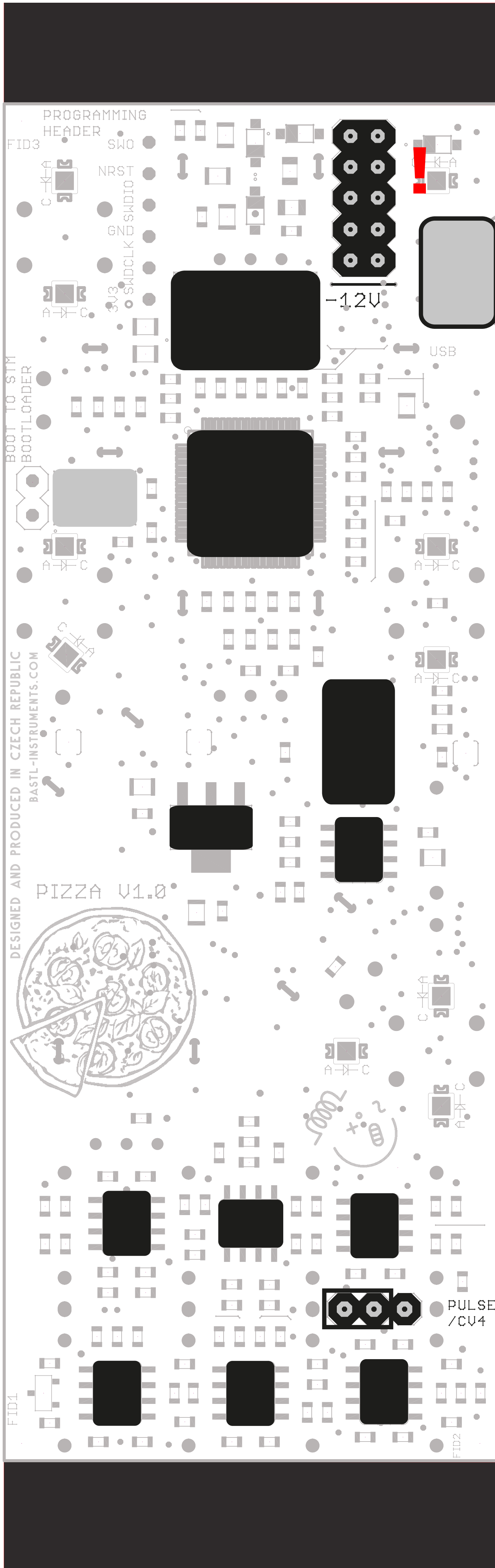
B

Power

Before connecting the ribbon cable to this module, disconnect your system from power! Double-check the polarity of the ribbon cable and that it is not misaligned in any direction. The red wire should match the -12V rail both on the module and the bus board.

! please make sure of the following
● you have a standard pinout eurorack bus board
● you have +12V and -12V rails on your bus board
● the power rails are not overloaded by current

Although there are protection circuits on this device, we do not accept any responsibility for damages caused by the wrong power supply connection. After you've connected everything, double-checked it, and closed your system (so no power lines can be touched by hand), turn on your system and test the module.
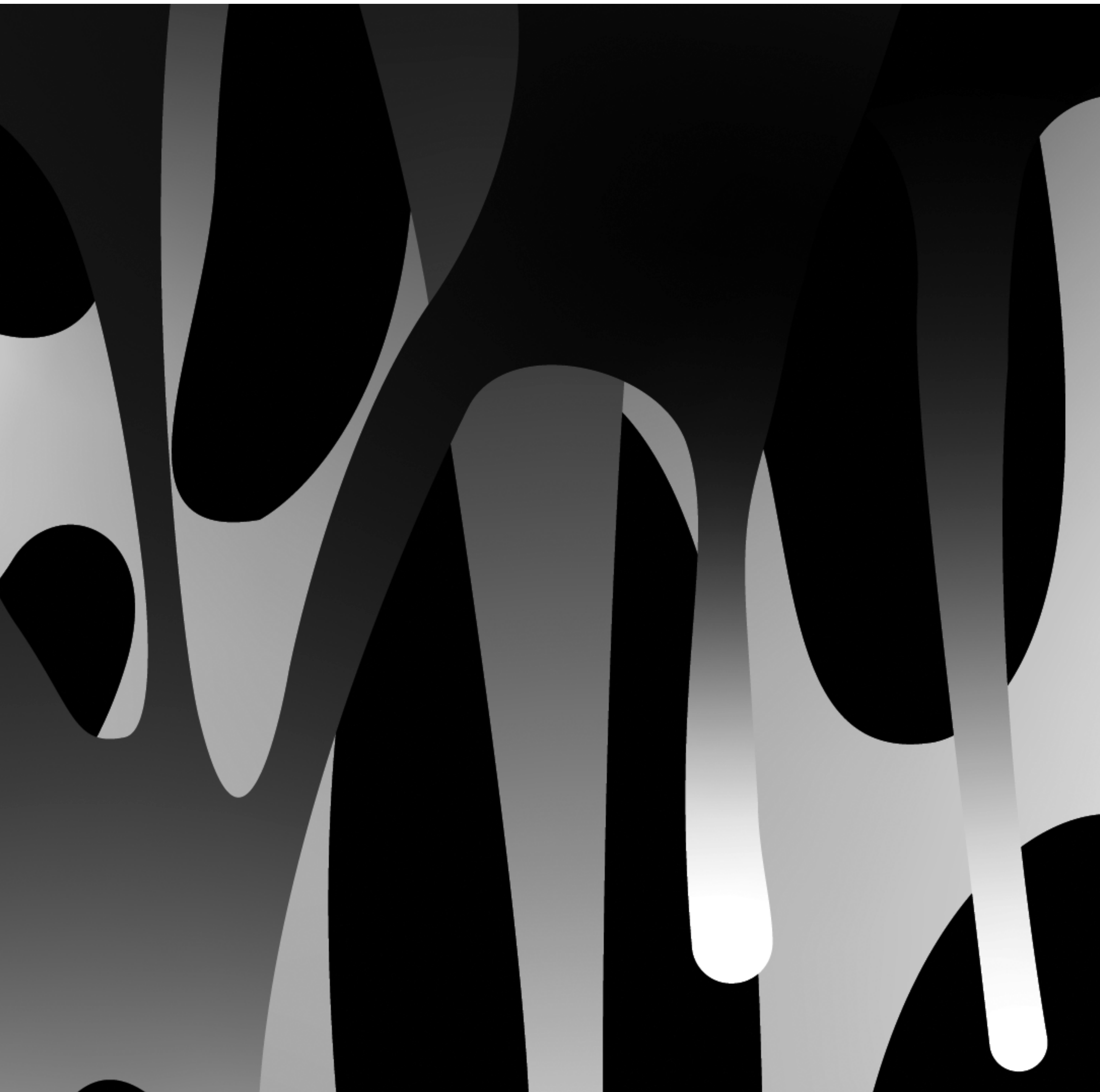
PITCH and TUNE

1

The PITCH knob and button give access to all tuning-related duties and will prevent you from accidentally detuning your oscillator.

OCTAVE and DETUNE

A single press of the PITCH button will switch between OCTAVE mode and DETUNE mode.

In OCTAVE mode, the PITCH knob adjusts the octave (+/-4 octaves).

In DETUNE mode, the PITCH knob will detune the OCT OSC and the RATIO OSC from the MAIN OSC. The detuning will animate the FM timbres and bring the RING modulation to life.
If you move the PITCH knob to the right, it will detune the OCT and RATIO OSC exponentially. If you move it to the left, it will detune them linearly in Hz, which will keep the resulting beating LFO-style modulation constant regardless of the pitch.

TUNE mode

A long press of the PITCH button will access the TUNE mode, where you can adjust semitone transposition and fine-tuning.
The TUNE and the OCTAVE lights will pulsate, alternating: the PITCH knob adjusts semitone transposition (+/-12 semitones).
By pressing the PITCH button again, the lights will pulsate, alternating between the TUNE and the DETUNE light: the PITCH knob adjusts the fine-tune +/-120 cents.

The PITCH section affects all oscillators, and further, you can adjust their relative frequency ratios. You do that either by selecting one of the 4 options with the RATIO and OSC buttons, or by assigning the CTRL to control the pitch of either of these oscillators.

FM

2 – FM INDEX fader

FM INDEX is the depth of frequency modulation (phase modulation, in fact) applied to the MAIN oscillator (carrier). In the middle position, no modulation is applied, and when no other waveshaping is applied, you should hear a sine-wave at the MAIN output.
When moving FM INDEX to the left, the RATIO oscillator modulation is applied.
When moving FM INDEX to the right, the OCT oscillator is applied as the modulator.

3 – INDEX MOD knob and FM INDEX CV (-6V to +6V)

The INDEX MOD knob is an attenuverter that will control how much of the CV applied to FM INDEX CV input affects the FM INDEX. Turning the knob to the right will apply the modulation in a positive sense (as if moving the FM INDEX fader to the right). Turning the knob to the left will apply the inverted modulation (as if pushing the FM INDEX fader to the left).

4 – OCT OSC button

Press the OCT OSC button to select one of 4 octaves for the octave oscillator. The lights indicate the active setting.

5 – RATIO OSC button

Press the RATIO OSC button to select one of 4 user-settable frequency ratios for the RATIO oscillator. The frequency ratios can be adjusted in the RATIO SETTING mode.

RATIO SETTING mode:

Long-press the RATIO OSC button to enter the RATIO SETTING mode. Select the ratio to be edited by clicking the RATIO OSC button.
Most musical intervals can be defined as simple ratios between frequencies. Perfect fifth has a ratio of 3/2 to the root note, major third has a ratio of 5/4, and so on.

Use the PITCH knob and PITCH button to set the frequency ratio.
There are 2 components to the ratio A/B: A = numerator and B = denominator.
When the OCTAVE light is on, you can set the numerator of the current ratio with the PITCH knob (range 1-16). When the DETUNE light is on, you can set the denominator of the current ratio with the PITCH knob

(range 1-16). Switch between setting the numerator and denominator by short pressing the PITCH button. When turning the PITCH knob, the TUNE led will blink each time the value changes, so it can help you to count specific number ratios.

Long-press the RATIO OSC button to leave the RATIO SETTING mode.

Example: I want to set the RATIO oscillator to 3/2 = perfect fifth above the main oscillator frequency. I press the PITCH button, so OCTAVE is blinking. Set the pitch knob fully left to set it to 1, and turn it slowly clockwise until I count 2 blinks of the TUNE led. Now the numerator is 3. I press the PITCH button again. Turn the PITCH knob fully left, and turn it slowly clockwise until the TUNE led blinks once. Now the denominator is 2, and therefore the ratio is 3/2.

Ratio	Semitones	Interval
1/1	0	Unison
16/15	1	Minor 2nd
9/8	2	Major 2nd
6/5	3	Minor 3rd
5/4	4	Major 3rd
4/3	5	Perfect 4th
3/2	7	Perfect 5th
8/5	8	Minor 6th
5/3	9	Major 6th
16/9	10	Minor 7th
15/8	11	Major 7th
2/1	12	Octave
9/4	14	Major 9th
12/5	15	Minor 10th
5/2	16	Major 10th

6 – EXT input (-6V to +6V)

If there's a cable plugged in the EXT input, that signal will be used as the modulator instead of the octave oscillator. Connect the input with external oscillators for even wilder FM timbres.

SHAPE

7 – SHAPE fader and SHAPE CV (-6V to +6V)

Similar to the FM modulation section, the waveshaper slider is neutral in the middle with two different modes on the left and right sides of the slider. It's possible to use two shapers simultaneously by assigning the CTRL to one of the shape modes. Use the SHAPE CV to animate the position of the SHAPE fader.

8 – WAVE

The WAVE mode controls the shape of the OCT and RATIO oscillators. It morphs between square, sine, and saw waveforms. The effect will only be heard on the MAIN output when FM INDEX or RING modulation is engaged. The waveform on the OSC OSC output will also be affected.
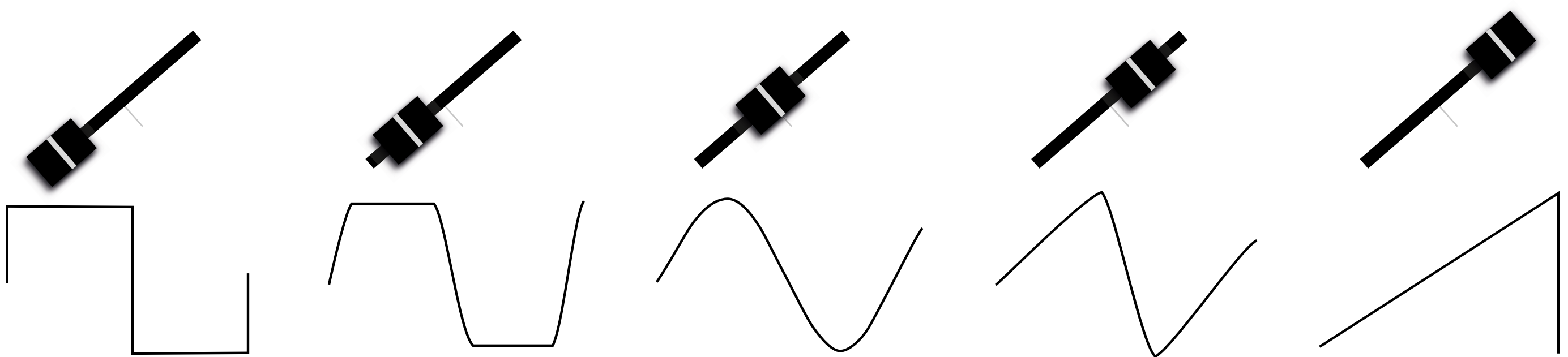
9 – FOLD

The FOLD mode contains two different wave folding algorithms that are applied to the MAIN output. Wavefolder amplifies the signal and feeds it through a series of folding stages, so the points of the highest amplitudes fold inward. That will effectively multiply the frequency of the incoming signal and introduce higher harmonics. As opposed to a filter, removing harmonics of rich waveforms (saw, pulse) in subtractive synthesis, the wave-folder introduces new harmonics to simple waveforms (sine).

When the SHAPE fader is in the middle, there is going to be no wave folding. The left side is inspired by the Buchla 259 complex oscillator, has a harsher character and emphasizes mainly odd harmonics. The right side is an original digital folding algorithm based on Chebyshev polynomials. The right side folds only one of the sine wave peaks in an asymmetrical fashion, so it folds the fundamental sine wave into all harmonic intervals (not just odd or even harmonics, unlike most analog folders).

9:1   5:1   3:1   1:1

2:1   3:1   4:1   6:1   8:1
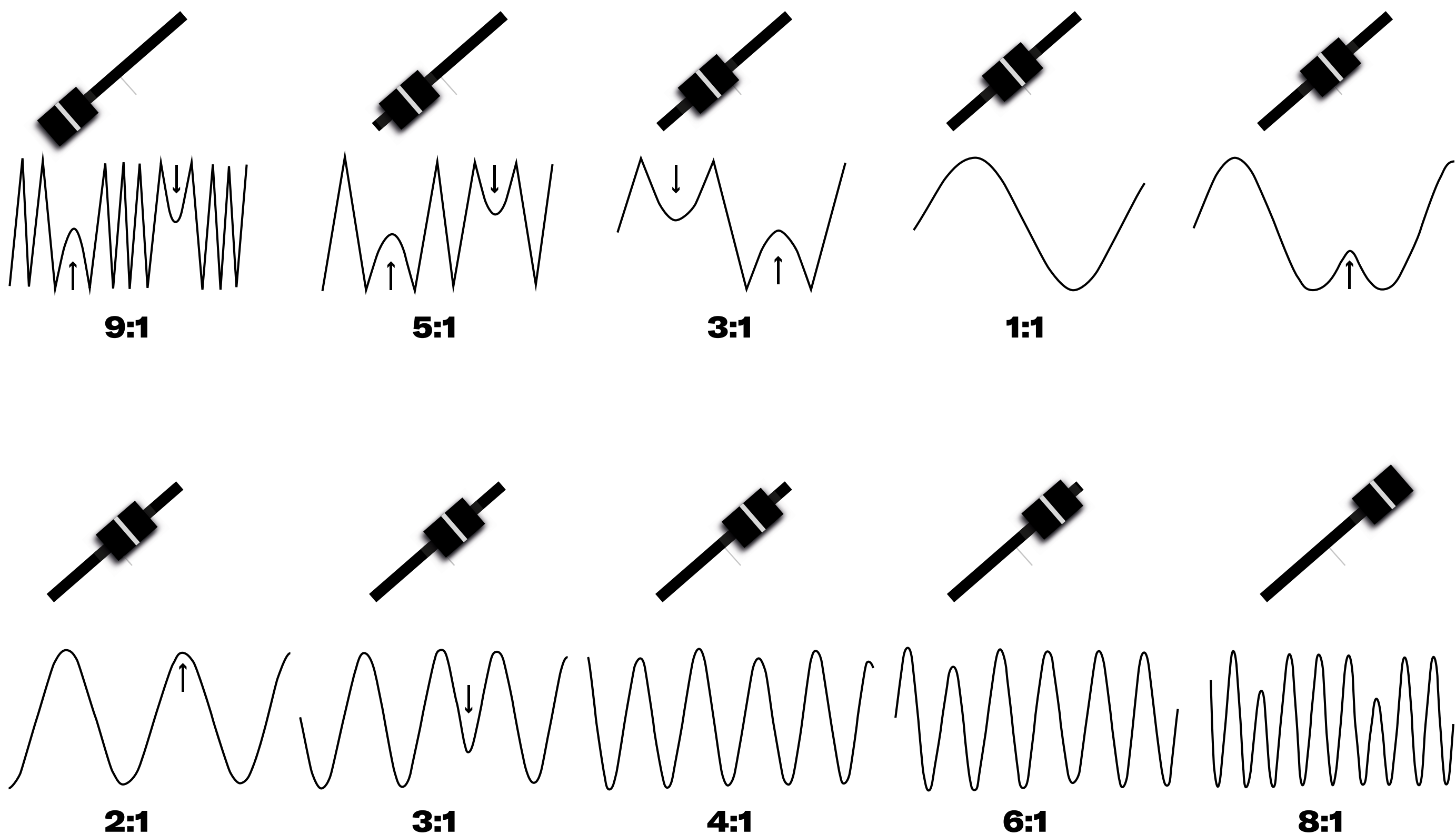
💡   Ranges of both folding algorithms can be extended via CV or by assigning the CTRL knob to FOLD.

Note: The fundamental frequency will be weakened by such a process, which will result in less bass in your signal. This issue is commonly addressed by mixing the oscillator outputs together.

10 – RING

The RING mode does ring modulation between the MAIN oscillator and one of the OCT or RATIO oscillators. The RING mode is, in fact, a multiplication of two waveforms (as if one modulates the other thru a bipolar VCA), and the increased modulation introduces new harmonics and mainly the frequency of adding and subtracting the initial oscillator frequencies.

The SHAPE fader works similarly to the FM INDEX fader with the RATIO oscillator ring-modulation depth on the left and OCT oscillator on the right (and no ring-mod in the middle).

Tip: Use FM INDEX with RATIO oscillator and RING with OCT oscillator (or vice versa) to engage both modulating oscillators.

Note: With CTRL assigned to one SHAPE parameter and the SHAPE fader to another, you can use both at once.

CTRL

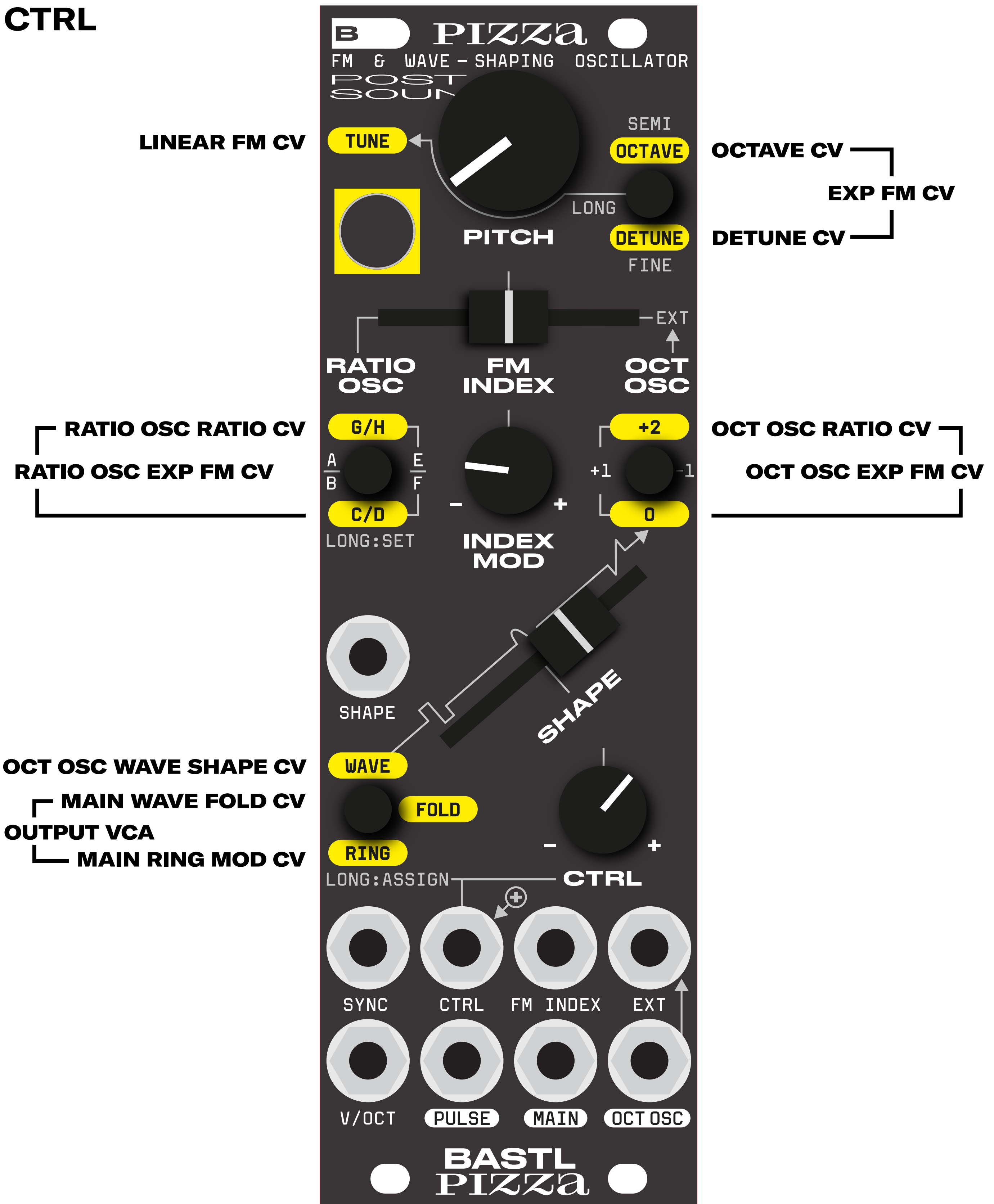**11 – CTRL knob and CTRL CV** (-6V to +6V)

The CTRL is an assignable control. The CTRL knob can serve as a static control or, when you plug voltage into the CTRL CV input, as an attenuverter.

To enter ASSIGNMENT mode, hold the SHAPE button for a few seconds. The currently assigned CTRL destination will start blinking. Set the destination you want by pressing the button nearest to it. Long-press the SHAPE button again to return to normal operating mode.

The possible CTRL destinations are (indicated by LEDs):

● Octave (Octave LED)
● Detune (Detune LED)
● Linear FM (Tune LED)
● Exponential FM (Octave and Detune LED)
● OCT OSC Ratio (top OCT OSC LED)
● OCT OSC Exp FM (both OCT OSC LEDs)
● RATIO OSC Ratio (top RATIO OSC LED)
● RATIO OSC Exp FM (both RATIO OSC LEDs)
● FM INDEX modulation (top RATIO and OCT OSC LEDs, press OCT and RATIO button together)
● Waveshape (Wave LED)
● Folding (Fold LED)
● Ring Modulation (Ring LED)
● Bipolar VCA - applied to MAIN and OCT OSC output (both Ring and Fold LEDs)

CTRL

B **PIZZa**
FM & WAVE-SHAPING OSCILLATOR
POST SOUN

LINEAR FM CV — TUNE

SEMI
OCTAVE — OCTAVE CV
EXP FM CV
LONG
DETUNE — DETUNE CV
PITCH
FINE

— EXT

RATIO
OSC | FM
INDEX | OCT
OSC

RATIO OSC RATIO CV — G/H
RATIO OSC EXP FM CV

A/B | E/F

C/D
LONG:SET

+2 — OCT OSC RATIO CV
+1 — -1 — OCT OSC EXP FM CV
0

INDEX
MOD

SHAPE

SHAPE

OCT OSC WAVE SHAPE CV — WAVE
MAIN WAVE FOLD CV — FOLD
OUTPUT VCA
MAIN RING MOD CV — RING

CTRL

LONG:ASSIGN — ⊕

− | +

SYNC | CTRL | FM INDEX | EXT

V/OCT | PULSE | MAIN | OCT OSC

BASTL
PIZZa

12 – SYNC (-6V to +6V)

The SYNC input will reset the phases of all oscillators and can be used to create hard-synced sounds. The SYNC is also good for cleaning up your transients. The perceived harmonics in FM sound transients are highly dependent on the current phase of the oscillators.

13 – V/OCT (-5V to +8V)

V/OCT input serves as external control of the oscillator's pitch. It includes several features to keep you in tune. The main struggle in modular synthesis is to match your V/OCT source and your oscillator. Pizza has you covered with the V/OCT CALIBRATION MODE.

V/OCT CALIBRATION MODE

Enter the V/OCT CALIBRATION MODE by holding the SHAPE and PITCH buttons. All LEDs will turn on to indicate the mode.

Press the SHAPE button to quantize the V/OCT input (stepped animation on SHAPE leds) or leave it unquantized (smooth fading of SHAPE leds).

Exit the V/OCT CALIBRATION MODE by pressing SHAPE and PITCH buttons together.

Press the PITCH button to initiate automatic V/OCT calibration.
1   Connect the OCT OSC output to the V/OCT input and wait until all LEDs turn ON.
2   Unplug the cable, and the module will return to the V/OCT CALIBRATION MODE.
The LEDs will animate pointing down towards the V/OCT jack. This method uses internally calibrated OCT OSC output and calibrates the V/OCT input by sending precise voltages.
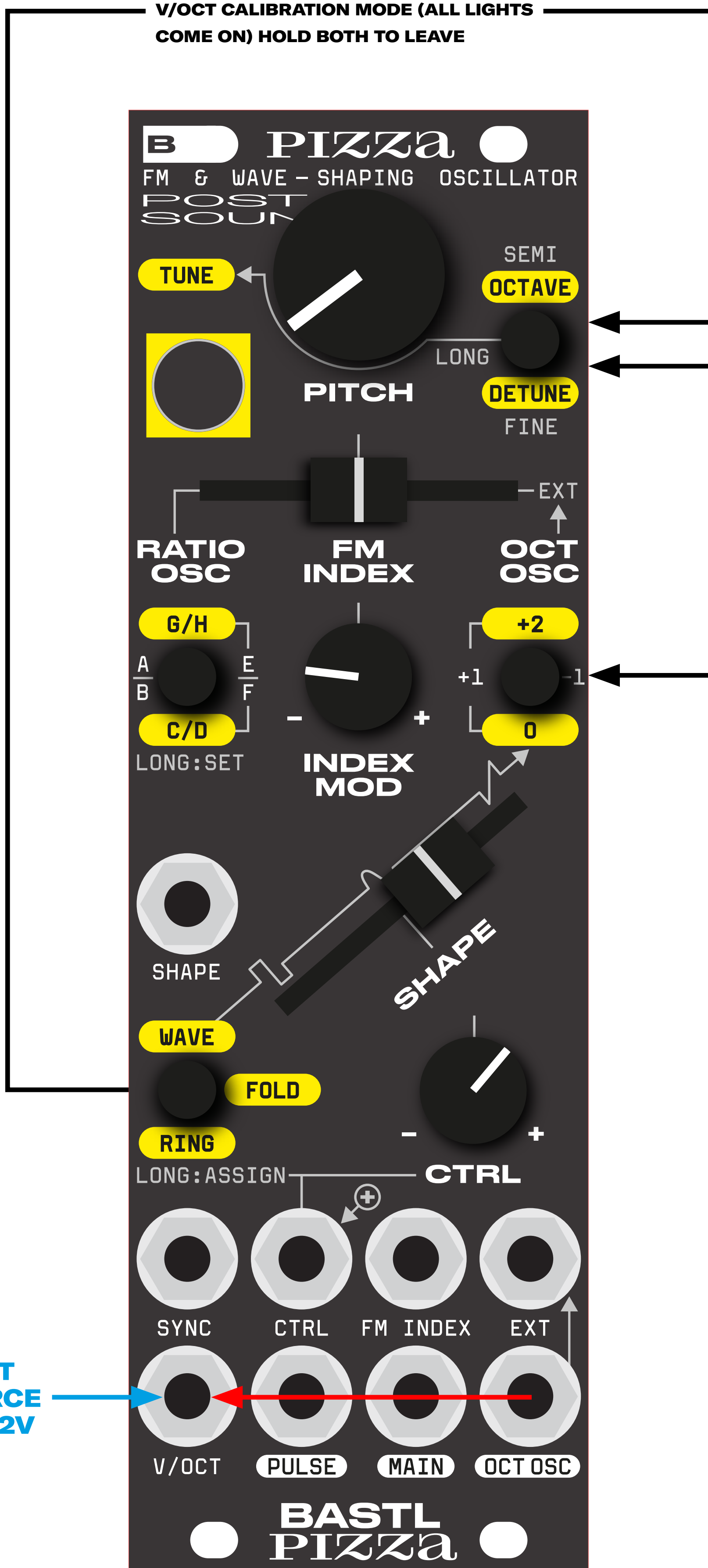
Press OCT OSC button to initiate external V/OCT calibration.
1   Plug a cable from your V/OCT source to the V/OCT input of Pizza.
2   0 is blinking = apply 0V (C note in lowest octave) on your V/OCT source.
3   Press the OCT OSC button to learn what 0V means.
4   2 starts blinking = apply 2V on your V/OCT source (play a note that's two octaves higher =2V).
5   Press OCT OSC button to learn what 2V means and Pizza will return to V/OCT CALIBRATION MODE.

V/OCT CALIBRATION MODE

START
HOLD PITCH & SHAPE TO ENTER THE V/OCT CALIBRATION MODE (ALL LIGHTS COME ON) HOLD BOTH TO LEAVE

AUTOMATIC CALIBRATION

PRESS THE PITCH BUTTON TO START AUTOMATIC CALIBRATION

1   CONNECT A CABLE FROM OCT OSC TO V/OCT
2   WAIT FOR ALL LIGHTS TO GO ON AND THEN DISCONNECT THE CABLE

EXTERNAL CALIBRATION

PRESS THE OCT OSC BUTTON TO START EXTERNAL CALIBRATION

1   PLUG A CABLE FROM YOUR V/OCT SOURCE TO THE V/OCT INPUT OF PIZZA.
2   0 IS BLINKING = APPLY 0V (C NOTE IN LOWEST OCTAVE) ON YOUR V/OCT SOURCE.
3   PRESS THE OCT OSC BUTTON TO LEARN WHAT 0V MEANS.
4   2 STARTS BLINKING = APPLY 2V ON YOUR V/OCT SOURCE. (PLAY A NOTE THAT'S TWO OCTAVES HIGHER =2V)
5   PRESS OCT OSC BUTTON TO LEARN WHAT 2V MEANS AND PIZZA WILL RETURN TO V/OCT CALIBRATION MODE.

V/OCT SOURCE 0V & 2V

14 – PULSE output (-5V to +5V)
PULSE outputs a pulse version of the MAIN Oscillator. The VCA CTRL destination does not apply to it. The width of the pulse is set by the FM INDEX fader and its modulation.

15 – MAIN output (-5V to +5V)
The MAIN output outputs the MAIN oscillator after FM, FOLD, and RING. This output is affected by the bipolar VCA CTRL destination.

16 – OCT OSC output (-5V to +5V)

OCT OSC output always outputs the OCT Oscillator after WAVE-shaping is applied. This output is affected by the bipolar VCA CTRL destination. Use this output as a sub-oscillator output or to strengthen your fundamental frequency.

A

Micro USB connector for firmware updates.

B

Jumper to switch functionality of the PULSE output to additional CV input (currently not implemented on the Pizza Oscillator). Keep in the PULSE position for the Pizza Oscillator.

FIRMWARE UPDATE

1.   Connect a micro USB cable to Pizza
2.   Hold the PITCH button and plug the USB into your computer
3.   Pizza shows up as an external disk on your computer
4.   Copy the pizza*version*.uf2 file to this drive and wait for Pizza to update and boot to normal operation
5.   Disconnect the USB and install Pizza in your rack

Pizza shows the firmware version by a static light of the LEDs at startup.
The first beta firmware has the TUNE light ON.
V1.0 has G/H light ON.

TIPS & TRICKS

1   Mix all 3 outputs and then run this signal into a filter.
2   Set CTRL to EXP FM of OCT OSC and turn the CTRL knob to adjust its frequency freely.
3   Set RING to the left half and FM INDEX to the right half. Now the MAIN output is affected by both RATIO and OSC oscillators. Use linear DETUNE (to the left) to keep constant beating frequency.
4   Assign CTRL to WAVE and use it with the RING setting on the SHAPE fader. This way, the ring modulation can happen with variable waveforms.
5   Use OCT OSC as a sub-oscillator or mix it with the main output to strengthen the fundamental frequency.
6   Set CTRL to OCTAVE and make arpeggios with LFOs.
7   Set CTRL to bipolar VCA and feed it with an envelope to get a full voice. Feed it with an audio rate oscillator to get external ring modulation.
8   Connect MAIN and OCT OSC outputs to an oscilloscope in XY mode. Connect static voltage to EXT input and observe how phase relationships distort the image.
8   While playing melodies on Pizza, go to CTRL assignment mode and switch between OCTAVE, RATIO OSC, and OCT OSC to get various flavors of arpeggiation.

CREDITS

Development Team Florian Helling & Martin Klecl
Supervised by Václav Peloušek
Bootloader Lennart Schierling (Binary Labs)
Main Tester Juha Kivekäs
Beta Testers David Žáček, Milan Říha, John Dinger, Václav Mach, Peter Edwards, Oliver Torr, Patrik Veltruský, Niels Aras, David Herzig, Leo Hivert
Management John Dinger
Graphic design Anymade Studio

The idea turned into reality thanks to everyone at Bastl Instruments and thanks to the immense support of our fans.

BASTL

more info
and video tutorials

www.bastl-instruments.com