OPERATOR'S MANUAL

BATUMI POTI

QUADRUPLE LOW FREQUENCY OSCILLATOR II
& EXPANDER II
Models of 1974

Batumi: Four wide range, voltage controlled low frequency oscillator channels · 1V/oct tracking · Free, phase, divide, and multiplication modes · Twelve simultaneous waveform outputs · Assignable waveforms, including two random shapes · Easily assignable wave selection · Per-channel phase reset and frequency synchronization

Poti: Per-channel input and output attenuation on Batumi II · Per-channel shape modulation inputs, switchable destination

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Salut! Thank you for purchasing this Xaoc Devices product. Batumi [,ba'tumi] II is not merely a common LFO, times four. Instead, it offers four channels of wide-range voltage and tempo-controlled oscillators that may operate independently or in several synchronous modes, scoring 12 simultaneously available waveforms that may be phase offset or frequency dependent with variable ratios. It is a powerful, versatile, multifaceted modulation hub that may act as the central driving force for any modular patch. Even though it is a digital module, the output waveforms are anti-aliased and then smoothed with adaptive analog filters; hence no digital artifacts should be noticeable.

Batumi II is a second, vastly upgraded revision of the original Batumi, preserving its form factor and layout. It has been internally redesigned from scratch using modern components and it now offers extended frequency range (up to audio rates) with V/oct tracking, a new frequency multiplication mode, and more waveforms (including two types of random).

While Batumi II is a complete device incorporating the controls previously handled by the original Poti ['pɔti], we decided to offer a new optional expander to include a new set of features that didn't fit in the already tight 10hp. Poti II adds the ability to attenuate voltages and signals, select the **ASGN** *waveform on each channel and modulate the waveform shapes with CV. You may also appreciate that it is 4hp wide this time.*

INSTALLATION

Batumi II requires 10hp worth of free space in the Eurorack cabinet. Always turn the power off before plugging the module into the bus board using the supplied ribbon cable.

DO NOT PLUG THE POWER RIBBON CABLE INTO THE UNSHROUDED POTI EXPANDER PORT, *which is clearly marked on the board.*

The red stripe indicates the negative rail and should match the arrow head or **–12V** *mark on the bus board and the unit. Batumi II is internally secured against reversed power connection; however, rotating the 16-pin header* **MAY CAUSE SERIOUS DAMAGE** *to other components of your system because it will short-circuit the +12V and +5V power lines. Always pay close attention to the proper orientation of all ribbon cables on both sides!*

Poti II requires an additional 4hp of free space, and we recommend installing it next to your Batumi II using the provided 20-wire flat ribbon cable while orienting the cable in the same direction on both devices. Batumi II powers Poti II, which does not require any connection to the bus board and it must not be plugged into it. Please note that incorrect installation may damage your modules and void the warranty.

Batumi II and Poti II should be fastened by mounting the supplied screws before powering up.

BATUMI II OVERVIEW

*The four channels of Batumi II (***A, B, C** *and* **D***) are arranged vertically (fig. 1), each featuring a slider potentiometer* ❶ *with an illuminated shaft and a column of jacks below. The first slider potentiometer controls channel* **A***'s frequency. The other three sliders control one of the four main parameters as determined by the global mode setting: channels' frequency (***Hz***), phase shift (***Φ***), frequency division, or multiplication ratio (:).*

Note there are three parallel scales alongside the sliders which identify the particular parameter's value depending on the mode. For example, in FREE MODE*, the sliders allow you to set each channel's frequency in the range of 0.01Hz to 100Hz (with no external CV patched), while in* PHASE MODE *sliders* **B, C,** *and* **D** *change the relative phase in the range of 0˚ to 360˚. The LEDs in the shafts pulsate according to their corresponding channel's frequency and phase.*

Each channel of Batumi generates three simultaneously available bipolar (±5V) waves, present at the three jacks: **SINE** ❷, **ASGN** ❸, *and* **RECT** ❹*. Within each channel, the cycles of these three waves are strictly synchronous (fig. 2). However, there may be frequency and phase differences between channels, depending on the mode of the device. Also, with the Poti II expander, it is possible to deform and attenuate the waves.* **NOTE:** *there is no provision for attenuating the rectangular outputs.*

Below the sliders, there are two miniature buttons surrounded by three LEDs. The left **MODE** *button* ❺ *selects the current mode, confirmed by the col-*

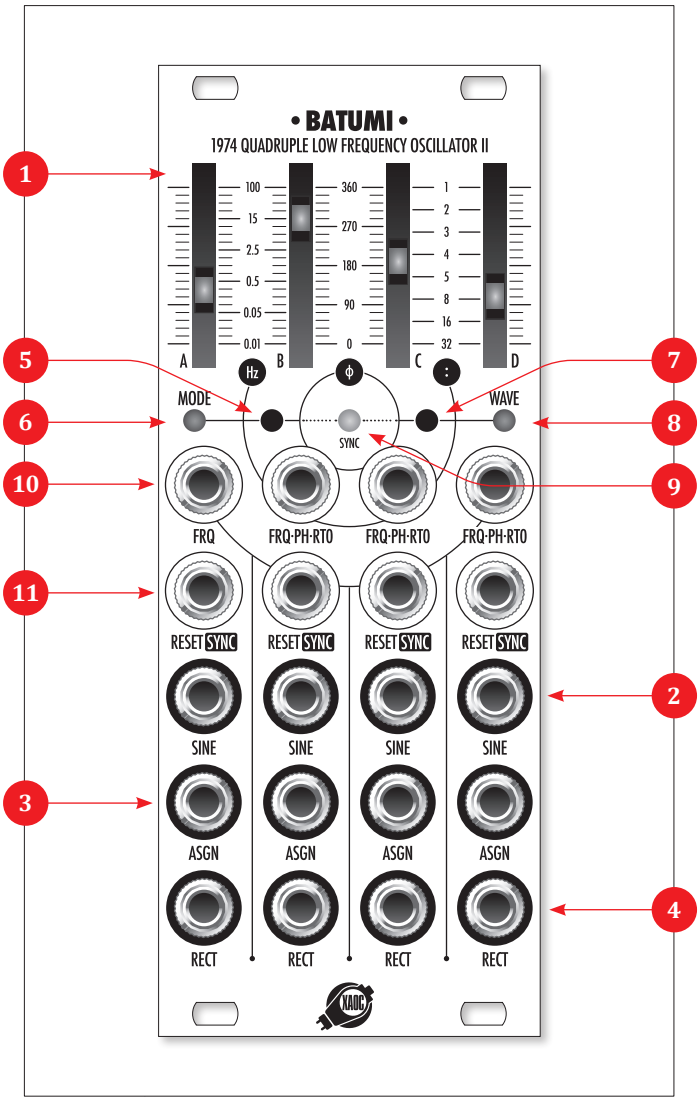
OPERATIONAL MODES

or of the LED labeled **MODE** ❻**:** FREE MODE *(red),* PHASE MODE *(yellow),* DIVIDE MODE *(blue), and* MULT MODE *(turquoise). The right* **WAVE** *button* ❼ *selects the waveform produced at the outputs labeled* **ASGN,** *confirmed by the color of the LED labeled* **WAVE** ❽*: triangle (red), downward saw (yellow), upward saw (orange), trapezoid (green), step-random (blue), and smooth random (turquoise).*

The middle **SYNC** *LED* ❾ *shows one of the two synchronization methods (common to all channels):* **RESET** *(LED unlit) or tap-tempo* **SYNC** *(LED lit). Toggling between them is possible by pressing one of the buttons while holding the other.*

The top two rows of jacks are individual channel inputs. Labeled according to available functions that depend on the current mode, the **FRQ·PH·RTO** *CV inputs* ❿ *control the channel's frequency, phase, or frequency ratio (division or multiplication factor). These jacks accept voltages in the range of -10V to 10V. Note that the value is added to the corresponding slider, and in certain situations, the minimum or maximum value may be reached before the voltage hits these limits. The four* **RESET·SYNC** *inputs* ⓫ *allow you to synchronize each Batumi II channel to an external signal's phase or frequency and phase. Since these inputs respond to rising edges, gate or trigger signals are recommended for the most precise action.*

fig. 1: BATUMI II FRONT PANEL LAYOUT AND CONTROLS



FREE MODE

In FREE MODE, *all four channels are entirely independent. To enter, press the* **MODE** *selection button multiple times until the* **MODE** *LED lights red. The four sliders and CV inputs control the frequencies of the corresponding channels. While the range from each slider alone is 0.01Hz to 100Hz, the available frequency range with external CV patched is 9.76μHz (duty cycle of 28.4 hours) to 5.0kHz. The CV inputs offer V/oct tracking throughout the entire range; thus, Batumi II can serve as a set of four independent slow modulation sources and four VCOs.*

In FREE MODE, *random waves (both stepped and smooth) are generated entirely independently with 2 samples per cycle (fig. 3). Therefore, four non-correlated sample-and-hold and linearly smoothed noise waves are available.*

PHASE MODE

This mode is indicated by a yellow color of the LED. The frequency of channel **A** *is controlled in the same way and has the same range as in* FREE MODE. *All the remaining channels follow the frequency of channel* **A,** *but their waveforms are phase-shifted (fig. 4). The shift of phase (Φ) relative to channel* **A** *(i.e. delay relative to the length of the cycle) is controlled by the slider potentiometers in the range of 0 to 360°. To make operating the slider easier, a short blink of the* **MODE** *LED confirms each crossing of the 90°, 180°, and 270° phase shift values. The corresponding CV input offers additional modulation as deep as ±5 cycles.*

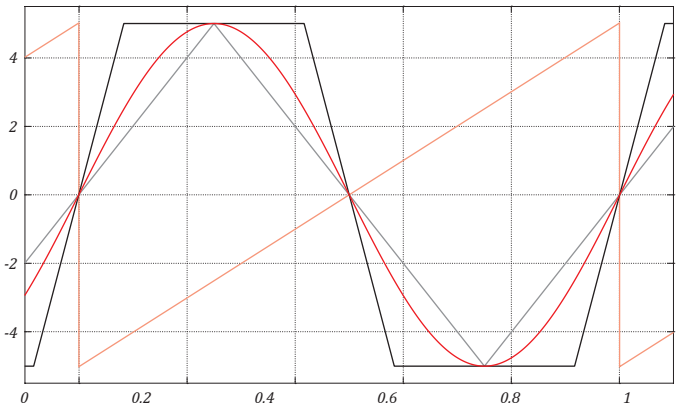


fig. 2: A SELECTION OF WAVEFORMS AVAILABLE FROM BATUMI II: SINE, TRIANGLE, UPWARD SAW, TRAPEZOID, AND THEIR TEMPORAL RELATIONSHIP

Feeding impulses to the **RESET·SYNC** *inputs of channels* **B, C,** *and* **D** *resets their corresponding phase (only with* **RESET** *chosen as the synchronization method). After such a reset, the positions of sliders no longer represent the absolute phase difference. Instead, a new phase offset is determined, which shifts the whole waveform in a cycle, and this new shift is added to the sliders and CV modulation. Note that the offset is canceled after changing the operation mode.*

Continuous phase modulation of a waveform using a signal plugged into CV input can yield radical deformations of the shape as it alters its instantaneous frequency (which is the underlying principle of FM synthesis). Thus, this mode offers a wide range of waveforms, vastly expanding the initial palette. With audio rate operation it delivers classic FM tones. Note that in PHASE MODE*, the random waves are not independent. Instead, they are copies of the same random sequence from channel* **A,** *delayed by the appropriate amount (or anti-delayed when the phase is negative!). Combined with deep phase modulation, this facilitates generating four CV sequences with variable temporal relationships within a wide range of shifts—a fugue machine, if you will.*

DIVIDE MODE

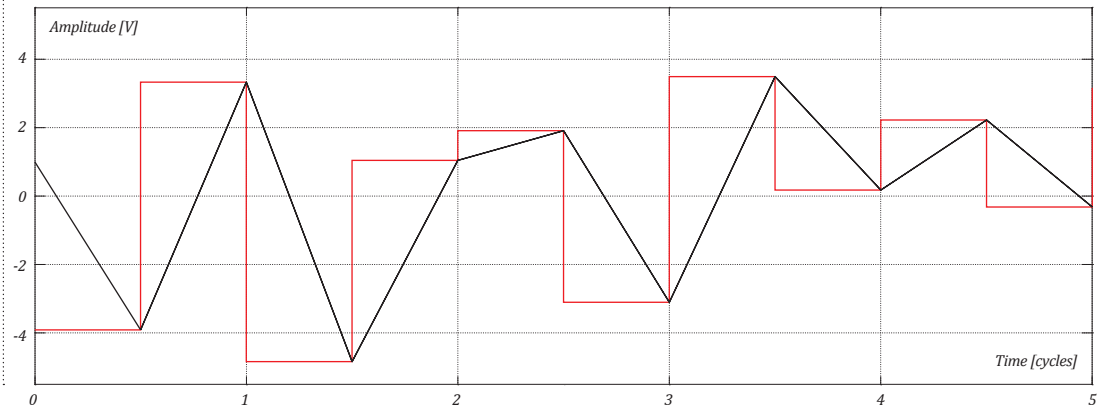
This mode is indicated by a blue **MODE** *LED color. The frequency of channel* **A** *is controlled in the same way as in* FREE MODE*. The frequencies of the remaining channels can be set as integer subdivisions of the first channel's frequency (fig. 5).*

*The available division factors (***:***) are 1 (no division), 2, 3, 4, 5, 8, 16, and 32. They are set by the potentiometers and may be modulated by voltage patched into each channel's CV input. In other words, the waveforms are slowed down by integer factors, and their corresponding cycles are longer by these factors. Note that varying the ratio can yield discontinuity in the waveform. A short blink of the* **MODE** *LED confirms each change between division factors.*

Note that frequency division can generate much slower cycles than the minimum offered from the front panel setting and external voltage. With the factor set to 32, the longest available cycle is 53.3 minutes without external CV and 37.9 days (!) with CV of -10V (we are not mad enough to try, so consider this a challenge!)

Since entering this mode, all channels operate synchronously in that they all start at the same point of zero phase and meet again at this point after several cycles. However, the channel phase relationships may be modified by feeding impulses to the **RESET·SYNC** *inputs.*

fig. 3: SMOOTH AND STEPPED RANDOM WAVES AND THEIR TEMPORAL RELATIONSHIP



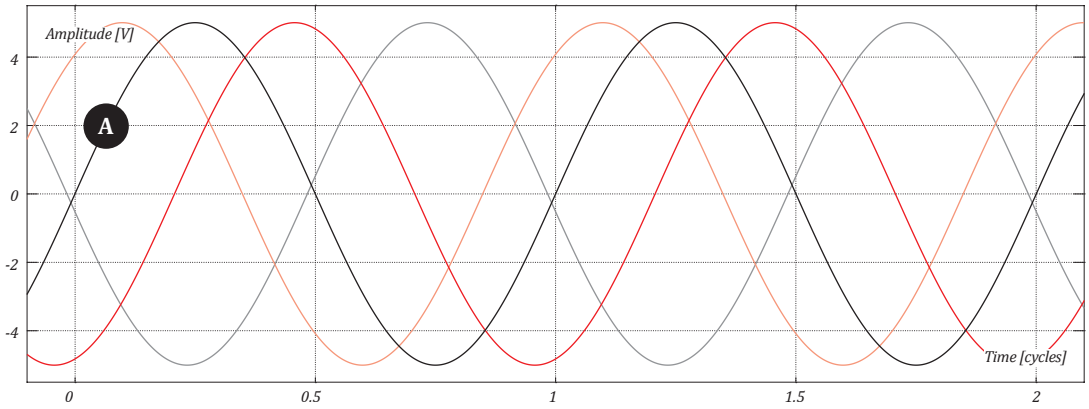


fig. 4: EXAMPLE OF SINE OUTPUTS IN PHASE MODE

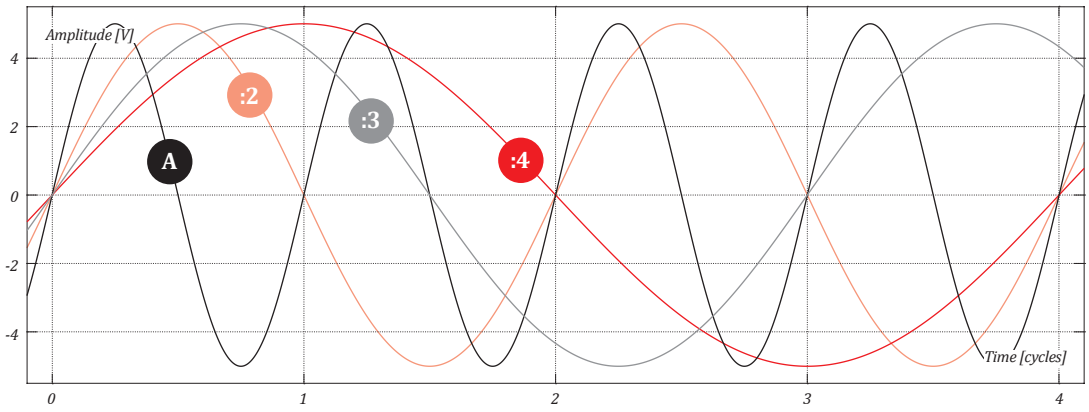


fig. 5: EXAMPLE OF SINE OUTPUTS IN DIVIDE MODE

Syncing or resetting the phase in channel **A** *restarts its initial point of the cycle to the given instant in time, and channels* **B, C,** *and* **D** *follow this. Resetting channels* **B, C,** *and* **D** *separately affects only that particular channel.*

In this way, it is possible to obtain any combination of waves in constant frequency and phase relationship that strictly follow the tempo of channel **A.**

Note that in DIVIDE MODE, *random waves are not independent. Instead, they are copies of channel* **A***'s random sequences, but the division factor appropriately downsamples them.*

For example, when the ratio is set to 5 in channel **B, C,** *or* **D,** *a new sample is taken from channel* **A** *per each of five consecutive random values. However, the values may occur at different times in different channels even if all are set to the same division value because the three channels may also be shifted by resetting their phase (as described above).*

MULT MODE

This mode is indicated by a turquoise **MODE** *LED color. The frequency of the first channel is controlled in the same way as in the* FREE MODE. *The frequencies of the remaining channels can be set as integer multiples of the frequency of channel* **A** *(fig. 6). In other words, there are multiple cycles of waves in channels* **B, C,** *and* **D** *per a single cycle in channel* **A.** *The multiplication factors (ratios) available are 1 (no multiplication), 2, 3, 4, 5, 8, 16, and 32. They are set by the potentiometers and may be modulated by the voltage patched to each channel's CV input. A short blink of the* **MODE** *LED confirms each change between multiplication factors.*

Since entering this mode, all channels operate synchronously in that they all start at the same point of zero phase and meet again at this point after each cycle of channel **A.** *Changing the ratio exactly at this point does not yield discontinuities, which are inevitable otherwise.*

Note that the frequency of each channel cannot

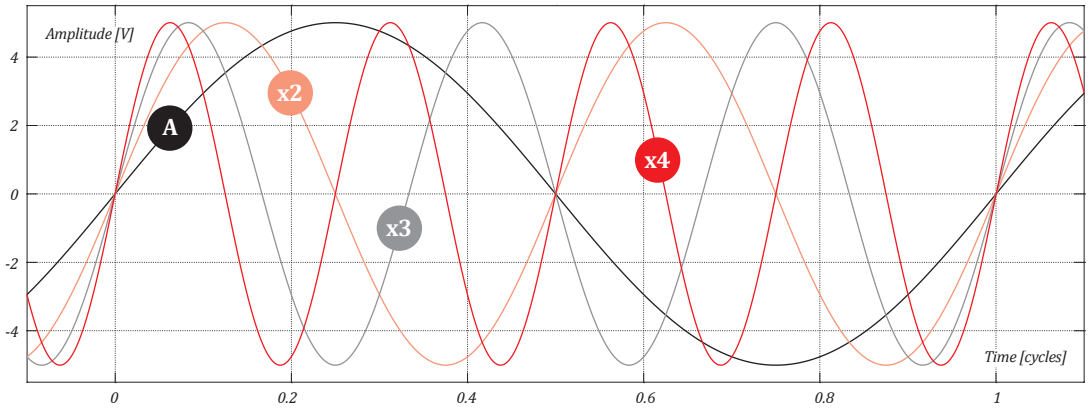


fig. 6: EXAMPLE OF SINE OUTPUTS IN MULT MODE

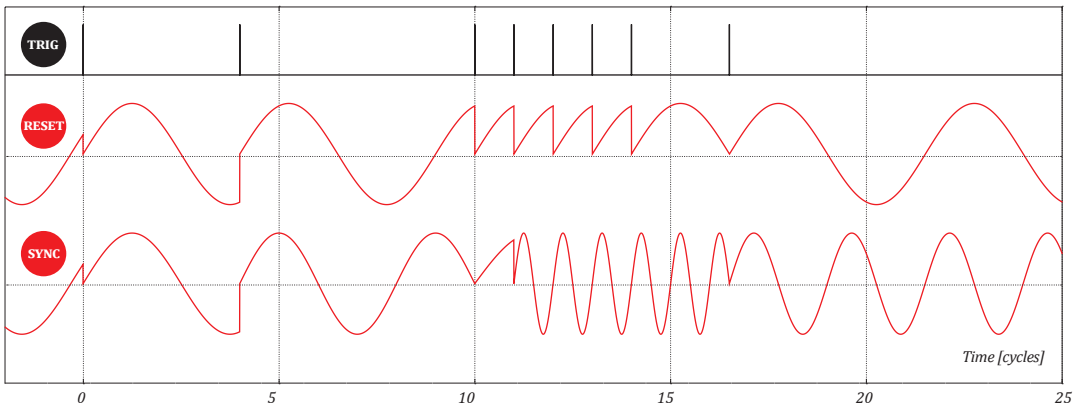


fig. 7: DIFFERENCES BETWEEN RESET AND SYNC MODES IN RESPONSE TO VARYING DENSITY OF EXTERNAL TRIGGERS. FOR CLARITY, THE WAVEFORMS ARE SHOWN WITHOUT THE ADDITIONAL FREQUENCY DIVISION

exceed 5.0kHz. Therefore, when the multiplication of the first channel's frequency results in a greater value, the factor is automatically reduced to the closest value resulting in a frequency below 5kHz. For example, if multiplication by 8 yields a result over 5kHz, the mult factor is reduced to x5 (or lower if need be).

The channel phase relationships may be modified by feeding impulses into the **RESET·SYNC** *inputs. Syncing or resetting the phase in channel* **A** *restarts its initial point of the cycle to the given instant in time, and channels* **B, C,** *and* **D** *follow this. Resetting channels* **B, C,** *and* **D** *separately affects only that particular channel.*

Please note that the rate at which channels **B, C,** *and* **D** *can be reset is limited by the algorithm's ability to calculate and maintain the phase relationship. It will handle audio rate sync combined with frequency multiplication, but perhaps not as gracefully as an analog oscillator.*

Note that the random waves are not independent in this mode of Batumi II. The sequences in channels **B, C,** *and* **D** *are upsampled by the factor set by the sliders and CV. In other words, they share some values with the sequence from channel* **A.** *For example, when the ratio is set to 3 in channels* **B, C,** *and* **D,** *each third value is the same as the corresponding value in channel* **A.**

However, these values may occur at different times even if all are set to the same multiplication value because you can shift the channels in phase using the **RESET·SYNC** *inputs.*

SYNC AND TEMPO CONTROL

Batumi II offers numerous options to sync and follow the tempo of external clock sources. Each channel features a jack labeled **RESET·SYNC** *equipped with a cable plug detector. There are two synchronization methods defining how the receiving channel reacts to the incoming signal.*

You can switch the method by pressing the two front panel buttons, as described in the "Module Overview" section above.

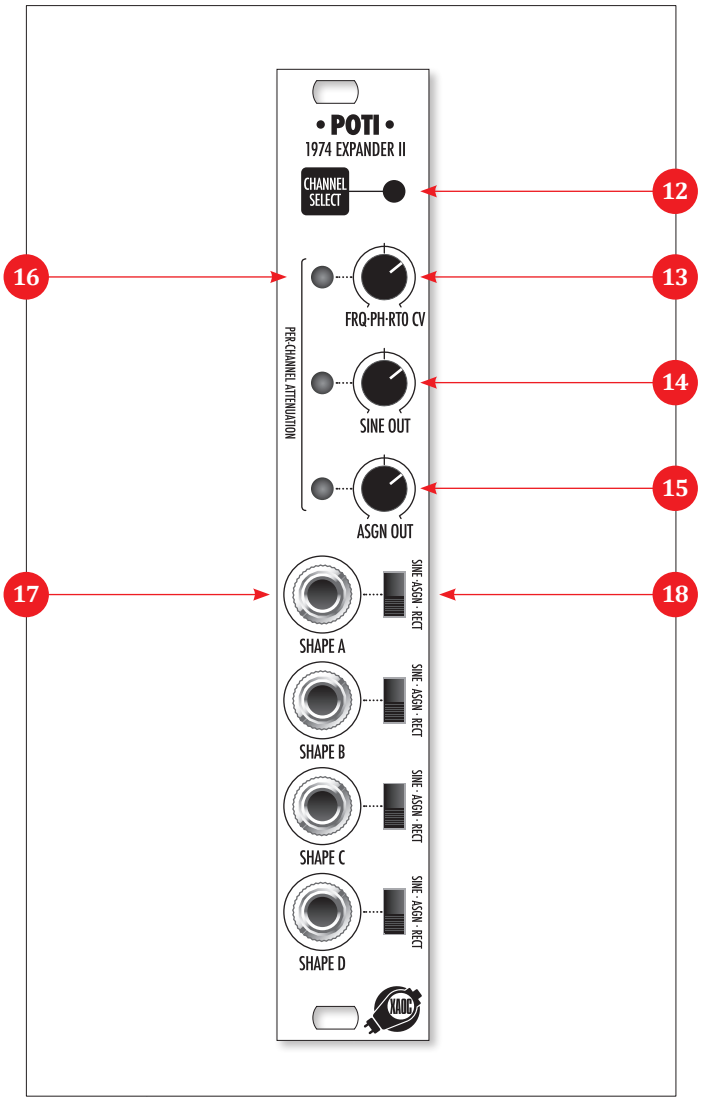
RESET *(LED unlit) restarts the wave to its initial point of the cycle (φ=0) upon receiving any impulse. Note that even several consecutive impulses do not affect the channel's frequency in the long run because each only shortens a single wave cycle. However, when a periodic signal is used for resetting, the effective frequency is changed. The resulting waveform may be distorted in a very specific way: either each cycle is shortened, or once every few cycles, it is shortened (fig. 7).*

SYNC *(LED lit yellow) adaptively tracks the incoming signal and adjusts the period of the particular channel to match the time distance between the two most recent impulses. However, it does not need a continuous clock signal to maintain the tempo. When an external clock is provided, Batumi II follows all its fluctuations. Note that the temporal scale of the wave needs to be re-adjusted each time there is a change in the clock frequency, which yields some shape deformation at that point.* **NOTE:** *syncing to external tempo is possible on all channels in the* FREE MODE *but only on channel* **A** *in the other modes.*

After syncing, the corresponding slider and CV input no longer provide continuous frequency control. Instead, they select a range of discrete frequency division factors, the same as in DIVIDE MODE*. In other words, the effective cycle length of the synced channel may be equal to one or several periods of the external signal (e.g., your master clock).*

Returning to continuous control is possible after unplugging the cable from the **RESET·SYNC** *jack.*

fig. 1: POTI II FRONT PANEL LAYOUT AND CONTROLS



POTI II EXPANDER MODULE

The numerous secondary functions of Batumi II available via Poti II have been squeezed behind a purposely compact interface (fig. 8).

There are three miniature potentiometers offering per-channel attenuation of input and output voltages. A short press of the **CHANNEL SELECT** *button at the top* ⓬ *selects the channel these three controls currently apply to, which is confirmed by changing the color of the corresponding slider's LED from red to green.*

Not only can you adjust the attenuation for each channel separately, with Poti II, you can also use the **WAVE** *button on Batumi II to choose a different* **ASGN** *waveform for each channel. When the channels are switched, the current settings are remembered for the given channel (including the* **ASGN** *waveform) and persist through a power cycle.*

After cycling through the individual channels, the last button push lights up all Batumi II sliders green, signaling that Poti II is controlling all channels simultaneously.

NOTE: *unplugging Poti II reverts the values to default (no attenuation).*

The top **FRQ·PH·RTO CV** *potentiometer* ⓭ *attenuates the input CV of the selected channel. Depending on the current mode, this may decrease the CV sensitivity of frequency, phase, or ratio. The middle* **SINE OUT** *potentiometer* ⓮ *attenuates the* **SINE** *outputs. The bottom* **ASGN OUT** *potentiometer* ⓯ *controls the amplitude of the* **ASGN** *outputs. There is deliberately no provision for attenuating the* **RECT** *outputs.*

As the attenuators are switched between channels of Batumi II, the current position of the potentiometer may not match the value set previously and remembered for the given channel. This is signaled by the bi-color LEDs ⓰ *next to the pots. When the LED is unlit, the values match, and when it is lit, there is a mismatch. If the value set previously is higher than the current position of the potentiometer, the LED is red, and if the previous value is lower, the LED lights green. In the case of a mismatch, Poti II waits until you move the potentiometer past its stored value before it changes anything.*

Besides attenuation and individual **ASGN** *waveform selection, Poti II offers four CV inputs labeled* **SHAPE** ⓱ *which facilitate individual modulation of the selected waveform in each of the four channels of Batumi II. Each of these jacks is associated with a miniature slider switch* ⓲*. Depending on its position, the CV (in the range of +/-5V) affects a single wave output as such:*

— for the **SINE** *output, it performs wavefolding with automatic amplitude compensation;*

— for the **ASGN** *output, it switches between the available waveforms;*

— for the **RECT** *output, it modulates the pulse width.*

Note that only one wave output for a given channel can be modulated at a time.

ACCESSORY

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BATUMI II TECHNICAL SPECIFICATION

WIDTH	DEPTH TOTAL	CURRENT DRAW	REV. POWER PROTECT.
10hp	*45mm (including cable bracket)*	*+90mA* *-50mA*	*protected*

INPUTS		OUTPUTS	
FRQ *(frequency)*	*-10V to +10V; 1V/octave*	**SINE**	*-5V to +5V*
PH *(phase)*	*-10V to +10V*	**ASGN** *(assignable)*	*-5V to +5V*
RTO *(ratio)*	*-10V to +10V, 1V/octave*	**RECT** *(rectangle)*	*-5V to +5V*
RESET **SYNC** *(synchronization)*	*+5V standard trigger*		

FREQUENCY RANGE	
0.01Hz to 100Hz	*without external CV*
9.76µHz to 5kHz	*with external CV*

POTI II TECHNICAL SPECIFICATION

WIDTH	DEPTH TOTAL	CURRENT DRAW	REV. POWER PROTECT.
4hp	*32mm (including cable bracket)*	*+10mA* *-0mA*	*not applicable, power drawn from Batumi II*

INPUTS	
SHAPE	*-5V to +5V*

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