OPERATOR'S MANUAL

SOFIA

TRANSCENDENT WAVEFORM ANALOG OSCILLATOR
Model of 1955

Analog VCO with complex waveforms · Extended FOF synthesis · 3 frequency control inputs · 8 parameter control inputs · 6 signal outputs

XAOC DEVICES SP. Z O. O.
WORKING CLASS ELECTRONICS
MADE IN THE EUROPEAN UNION
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Salut! Thank you for purchasing this Xaoc Devices product. Sofia ['sɔfja] is a fully analog voltage-controlled oscillator (VCO) based on an original waveforming principle. It features a modern, well-calibrated, temperature compensated triangle core and two elaborate waveshaping and modulating sections.

The sound is a mixture of a warm, saturated base tone and two ripple components. Besides its main output, Sofia offers access to individual components of the sound plus a multitude of modulation inputs allowing for extensive self-patching and animation of the waveform.

INSTALLATION

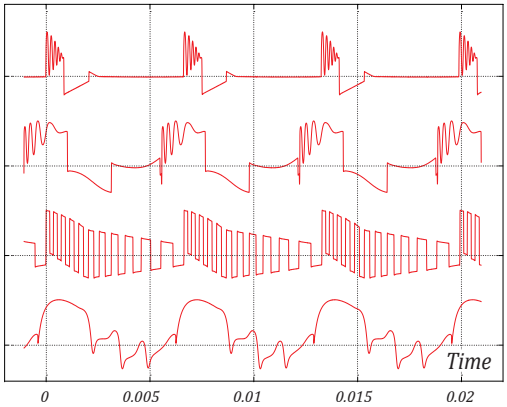
The module requires 24hp worth of free space in the Eurorack cabinet. The ribbon-type power cable must be plugged into the bus board, paying close attention to polarity orientation. The red stripe indicates the negative **–12V** *rail and should point in the same direction on both the bus board and the unit. The module itself is secured against reversed power connection, however, reversing the 16-pin header* **MAY CAUSE SERIOUS DAMAGE** *to other components of your system because it will short-circuit the +12V and +5V power rails. The module should be fastened by mounting the supplied screws before powering up.*

To better understand the device, we strongly advise the user to read through the entire manual before using the module.

OPERATING PRINCIPLE

Sofia implements and extends the classic computer music method for synthesis of formant sounds called FOF (fonction d'onde formantique), which uses a combination of simple, time-domain components (decaying sinusoidal waves) to achieve desired spectral characteristics (see infobox below).

fig. 1: EXAMPLE WAVEFORMS



In Sofia, two of such ripple elements are added on top of a slightly saturated sinusoidal base tone. Each new cycle of the base tone spawns a new pair of ripple elements. The ripples' density and decay rate may be adjusted over a wide range. Additionally, the elements may be warped so that their density accelerates or decelerates within the cycle. Finally, their basic waveform may be switched from sine-like to square-like for additional richness.

Despite the seemingly divergent frequencies present in the signal, it remains strictly harmonic due to how all elements are waveshaped from the core tone and therefore phase coherent. Thus, Sofia is not a complex oscillator in the Buchla sense; however, it goes beyond the traditional set of primary waves and wavetables, hence the name.

MODULE OVERVIEW

The front panel of Sofia (fig. 2) offers direct access to all parameters in a one-knob-per-function arrangement. The big, central **PITCH** *knob* ❶ *offers continuous pitch control in the range of two octaves, while the rotary* **OCTAVE** *switch above it* ❷ *offers eight additional octaves with the lowest* **LO** *position referring to subsonic frequencies. The pitch frequency is also controlled via the* **PITCH CV V/OCT** *input* ❸*, which accepts voltages from –10V to +10V. However, the usable range of voltages depends on the position of the manual controls. The entire frequency range of Sofia extends from about 0.4Hz to 12kHz for the fundamental tone and well into ultrasonic range (over 120 kHz) for the ripple* **ELEMENTS**.

Besides V/Oct control, Sofia also offers two adjustable CV inputs for modulating pitch frequency: **PITCH FM** ❹ *and* **GLOBAL FM** ❺ *with their corresponding attenuators. The main difference between these two is that* **PITCH FM** *preserves the shape of the waveform, while* **GLOBAL FM** *preserves the overall spectrum, mainly affecting the frequency of the base tone.*

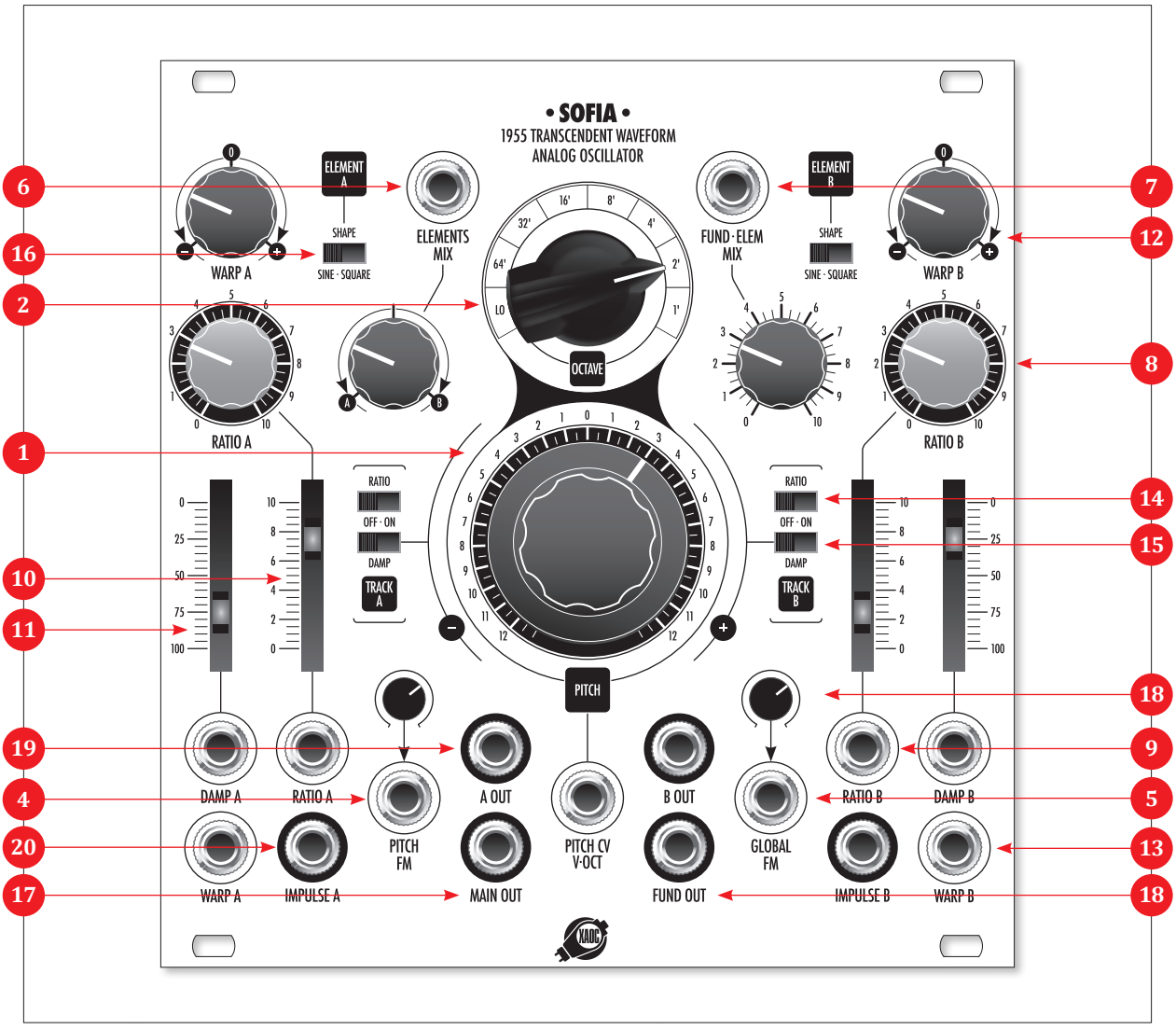
Situated on each side of the pitch controls are two knobs dedicated to component mixing. The left **EL-**

EMENTS MIX *knob* ❻ *adjusts the mix balance between the two ripple* **ELEMENTS** *(***A** *and* **B***), offering 1:1 proportions in the middle. The corresponding CV input labeled* **ELEMENTS MIX** *accepts voltages in the -5V to +5V range, adding an offset to the manual setting. The right* **FUND·ELEM MIX** *knob* ❼ *controls the balance between the fundamental tone and the ripple elements. There is just the base tone in its minimum position and just the elements without the base tone in the maximum position. The corresponding CV input labeled* **FUND·ELEM MIX** *accepts voltages in the -5V to +5V range, adding an offset to the manual setting.*

Most of the remaining potentiometers and jacks correspond to individual ripple **ELEMENTS** *(***A** *and* **B***) and offer identical controls over their parameters on each side of the panel. The red* **RATIO** *knobs* ❽ *define how dense the ripples are relative to the fundamental tone. At the minimum position, there is no ripple, just a single parabolic fold squashed by the decay curve. Increasing the* **RATIO** *adds more cycles to the wave, thus shifting the frequency of the corresponding formant further from the fundamental frequency. At the maximum position, about 240 ripples yield a spectral peak 8 octaves above the fundamental frequency. The two* **RATIO** *inputs* ❾ *with their corresponding attenuators* ❿ *facilitate continuous modulation with external bipolar control voltages.*

The **DAMP** *parameters control the decay rates of the ripples, which are adjusted by the slider potentiometers* ⓫ *near the edges of the panel and their*

fig. 2: SOFIA FRONT PANEL LAYOUT AND CONTROLS



corresponding CV inputs, which act as offsets. At the minimum position, narrow spikes are generated (about 1% of the fundamental period), while at the top position, the decay is sufficiently slow, so the ripple amplitude decreases only slightly along the cycle. **NOTE:** *while these controls behave like parameters of a resonant filter (resonant frequency and resonance/ damping), the actual signal is not obtained through filtering.*

The **WARP** *knobs* ⑫ *affect the ripples' uniformity during the wave's fundamental period. In the middle position, the density of the ripple is constant (if not modulated by the* **RATIO** *parameter). Turning this up bends the wave so that the density is higher at the beginning of the period and gradually decreases towards the value set with the* **RATIO** *knob as it decays (fig. 3a). Turning the* **WARP** *knob CCW from the middle bends the wave in the opposite direction: the density is decreased at the beginning of the period and gradually rises to the value set with* **RATIO** *at the end of the decay (fig. 3b). The* **WARP** *parameter can also be modulated with bipolar CV plugged into the corresponding jacks* ⑬.

The two miniature switches for each **ELEMENT**, **RATIO TRACK** ⑭ *and* **DAMP TRACK** ⑮, *allow one to choose whether or not the density of the ripples and the decay rate are proportional to the length of the fundamental period. In other words, they allow switching between constant spectrum of the* **ELEMENTS** *(not tracking the pitch) and constant overall waveform shape (tracking the pitch).*

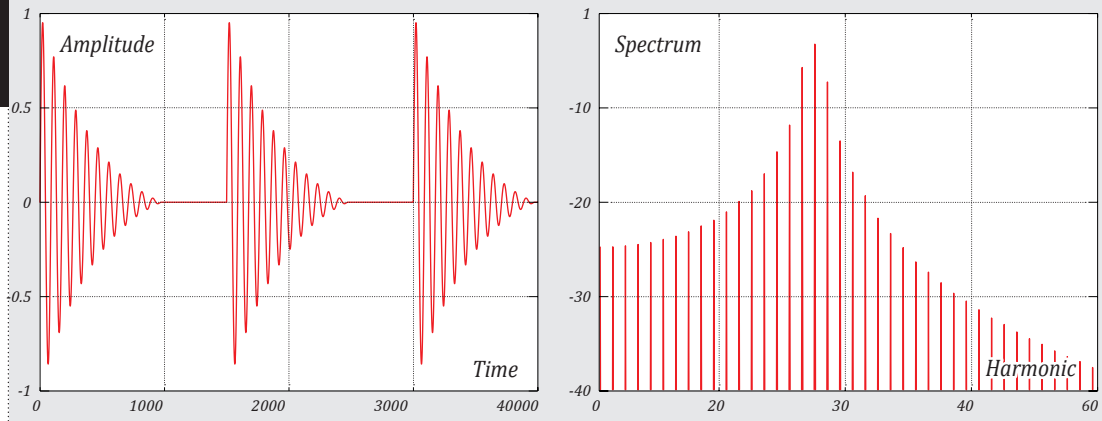
The **SHAPE** *switches* ⑯ *select between a sine-like and square-like waveform for each* **ELEMENT.** *The square wave's richer spectrum offers a more aggressive sound of that particular signal component.*

Sofia has several signal outputs. The **MAIN OUT** *jack* ⑰ *contains the final mix of the fundamental wave and ripple elements as defined by the mixing controls. The fundamental tone (a pure sinusoid, not affected by the saturation) is available at the* **FUND OUT** *jack* ⑱. *The two individual* **ELEMENT A** *and* **B OUT** *jacks* ⑲ *offer the ripple waves at full amplitude, without the decay response. The decay curve is individually available for* **A** *and* **B** *at the* **IMPULSE** *outputs* ⑳.

MODULATION & SELF PATCHING

Although Sofia alone can synthesize a wide range of acoustic, woody, organic, and animal-like, as well as high, fuzzy, and bright sounds, it greatly benefits from being animated through its multiple CV inputs.

FOF SYNTHESIS



The classic FOF synthesis technique proposed by X. Rodet in the 1980s efficiently synthesizes vocal-like formants in the time domain without resorting to digital filters, which, at the time, were expensive to implement.

Rodet observed that the complex response of a vocal tract may be decomposed to parallel acoustic resonant filters that produce decaying sinusoidal tones (ripples) in response to each pulse of air pressure from the larynx. There is a direct relationship between the density and decay rate of the decaying sinusoid and the frequency position and spectral width of the formant.

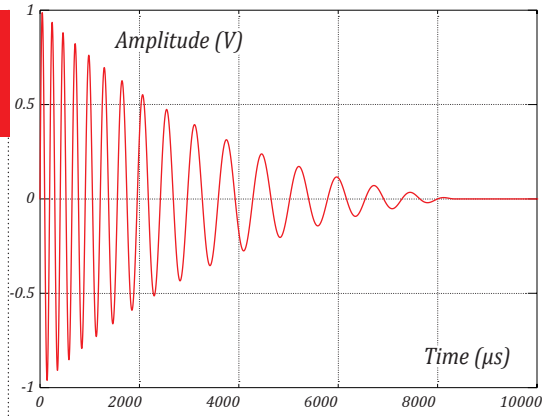


fig. 3a: EFFECT OF THE WARP KNOB TURNED CW

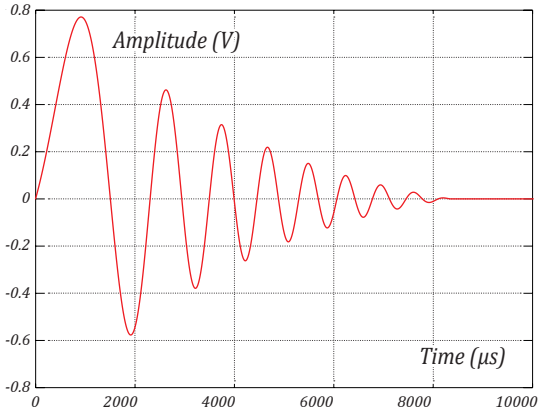


fig. 3b: EFFECT OF THE WARP KNOB TURNED CCW

Patching complex modulations, e.g., envelopes from Xaoc Devices Zadar, some audio signals, or even white noise to various parameter inputs, adds a whole new dimension to the sound.

The user is encouraged to try various self-patches from the individual outputs to inputs within and between **ELEMENTS A** *and* **B**, *which sometimes transforms Sofia into a wild and scary beast.*

ACCESSORY

Our Coal Mine black panels are available for all Xaoc Devices modules. Sold separately. Ask your favorite retailer. •

TECHNICAL SPECIFICATION

WIDTH	DEPTH TOTAL	CURRENT DRAW	REV. POWER PROTECT.
24hp	*30mm (including cable bracket)*	*+90mA* *-80mA*	*protected*

INPUTS		OUTPUTS	
PITCH CV	*-10V to +10V*	**MAIN OUT**	*10Vpp*
PITCH FM, GLOBAL FM	*-10V to +10V*	**FUND OUT**	*10Vpp*
ELEMENTS MIX	*-5V to +5V*	**A OUT, B OUT**	*10Vpp*
FUND·ELEM MIX	*-5V to +5V*	**IMPULSE A, IMPULSE B**	*8Vpp (unipolar, 0 to +8V)*
DAMP A, DAMP B	*-10V to +10V*		
WARP A, WARP B	*-10V to +10V*		
RATIO A, RATIO B	*-10V to +10V*		

FREQUENCY RANGE
0.4Hz to 12kHz (basic pitch range)

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