OPERATOR'S MANUAL

ORADEA ARAD

QUADRUPLE VOLTAGE CONTROLLED RESONATOR
& RESONATOR COMMANDER
Models of 1950

Oradea: Quadruple analog resonator · Four independently adjustable bands · Manual and voltage control over tuning frequency, resonance, and level · Joint and individual CV inputs with calibrated V/oct tracking · Dedicated trigger inputs for exciting individual channels · Individual outputs and mixed output · Signal polarity switchable for each channel · Signal level indicators with multi-color LEDs

Arad: Expander for Oradea Quadruple Voltage Controlled Resonator · Clickless muting and unmuting buttons and gate/trigger inputs · Manual trigger buttons · Individual audio input for each channel

XAOC DEVICES SP. Z O. O.
WORKING CLASS ELECTRONICS
MADE IN THE EUROPEAN UNION
WWW.XAOCDEVICES.COM

MODULE INSTALLATION

Salut! Thank you for purchasing these Xaoc Devices products. Oradea [ˌɔraˈdɛa] is a quadruple voltage-controlled analog resonator. It enhances or generates tones by emphasizing specific frequencies and can mimic the resonant characteristics of physical objects or spaces. Its frequency response comprises four bands that can be tuned over the entire range of audible frequencies with V/oct response. It offers precise control over the resonance of each band up to extremely high values with a long response to pinging.

Oradea features individual trigger inputs for exciting its filters with uniform and strictly controlled impulses, as well as individual outputs for separate processing of the bands. The gain at the resonant frequency is compensated so that it does not increase with increased resonance, thus preventing uncontrolled distortion.

A VCA and a polarity switch in each channel enable the shaping of the overall amplitude and phase response. Each channel is equipped with a post-VCA signal level indicator.

Arad ['arat] is an expander for Oradea, offering three additional features: individual channel direct audio inputs, clickless muting and unmuting via manual buttons or trigger/gate inputs, and manual triggering via another group of four buttons that act in parallel to the **EXCITE** *inputs of Oradea.*

INSTALLATION

Make sure your power supply can handle the substantial load increase with a reasonable power reserve. Oradea requires 20hp worth of free space in the Eurorack cabinet. Place Oradea away from large digital modules, especially those featuring OLED screens or plenty of blinking LEDs. It is normal for Oradea to run warm. For optimal operating conditions, ensure that your system has some form of ventilation.

Always turn the power off before plugging the module into the bus board using the supplied 16-wire ribbon cable, paying close attention to power cable pinout and orientation. The red stripe indicates the negative rail and should match the arrowhead or **–12V** *mark on the bus board as well as the unit.* **WARNING: DO NOT PLUG THE POWER CABLE INTO THE EXPANDER CONNECTOR AT THE EDGE OF THE BOARD!**

Oradea is internally secured against reversed power connection; however, flipping 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 check the proper orientation of your ribbon cable on both ends.*

Arad requires an additional 6hp of space next to your Oradea. It connects to Oradea with the supplied 16-wire ribbon cable, which is deliberately short and must not be replaced with a longer cable. **DO NOT PLUG A POWER SUPPLY CABLE INTO ARAD'S SIGNAL CONNECTOR!** *Arad is powered by the main unit (i.e., Oradea) and does not require a separate supply. Both modules should be fastened by mounting the supplied screws before powering up.*

To better understand both devices and avoid common pitfalls, we strongly advise the user to read through the entire manual before using the modules.

ORADEA AT A GLANCE

The front panel of Oradea (fig. 1) features four vertical sections corresponding to the four channels of the resonator: **A, B, C,** *and* **D.** *The main audio* **INPUT** *jack at the bottom ❶ feeds the same signal to all channels.*

Each section has an individual **EXCITE** *input ❷, which generates an optimized uniform impulse that pings the corresponding channel, producing a decaying oscillatory response. The* **CENTER FREQ** *potentiometer at the top ❸ controls the tuning frequency of the corresponding channel in the entire audible range. This frequency may also be controlled by CV patched to the* **FREQ** *input ❹, which is calibrated to the V/oct scale. There is also an* **ALL FREQ** *jack ❺, which affects all channels.*

The **PEAKING** *potentiometer ❻ and corresponding CV input ❼ control the degree of resonance, which is inversely related to bandwidth. Their response is deliberately expanded as resonance approaches maximum values, allowing you to set a very narrow band without falling into self-oscillation. In addition to the individual* **PEAKING** *CV inputs, there is an* **ALL PEAKING** *CV input ❽, which affects all channels.*

Each channel of Oradea features an output VCA, allowing you to adjust its gain using the bottom potentiometer labeled **LEVEL** *❾ and via CV patched* *to the corresponding jack* **10**. *The control response is exponential—a multi-color LED indicator of signal level* **11** *appears at the VCA output.*

Oradea features an individual audio output **12** *for each channel and a* **SUM OUT** **13**, *which employs a soft-saturation circuit to prevent harsh clipping due to the summing of multiple hot signals. The polarity of signals going to the summing mixer can be inverted by* **PHASE FLIP** *toggle switches* **14**, *allowing for additional tone control due to phase cancellation or reinforcement between overlapping bands.*

IS IT JUST FOUR BANDPASS FILTERS?

Yes and no. Oradea consists of four bandpass filters in a parallel configuration, which means that all four operate independently on the same source signal. But these are not standard off-the-shelf filters. Oradea's unique resonant characteristics require a precise combination of high Q-factor (the degree of resonance), low noise, and gain compensation.

Typical filters can reach Q values in the range of 30-50 before they fall into self-oscillation. The filters in Oradea can go as high as 300. High resonance makes any filter sensitive to even tiny amounts of internal and supply noise. Amplification of this noise is what drives a filter to self-oscillation without any input signal. Hence, for extreme Q, the internal design must also be super quiet, and this is not achievable with common integrated circuits and filter topologies.

fig. 1: ORADEA FRONT PANEL LAYOUT AND CONTROLS

PINGING THE FILTERS

In the majority of Eurorack filters, the gain at the peak frequency increases significantly with increased resonance. At very high Q, this would yield a gain of 40-50dB, which is hard to tame and leads to extreme distortion. The filters in Oradea feature a special topology that compensates for this increase, thereby restricting the level increase to a minimum (fig 2).

Please note that as the resonance increases, the filter's bandwidth narrows, and maintaining a constant peak gain may result in a decreasing output signal energy. If the input is a sinusoid that matches the filter frequency, the output amplitude will change only slightly. However, if the input is spectrally rich, only a small part of its original energy will pass through the filter, and it may sound "thin."

For example, a narrow impulse (often used to "ping" filters) has a very wide and almost flat spectrum. Filtering out most of this wide-band energy leaves only a fraction for the decaying ping response. Thus, the amplitude of this response significantly decreases (when the audio input is used). A similar effect is observed if the input signal is white noise.

DYNAMIC BEHAVIOUR OF A RESONATOR

Any narrowband filter (especially one as narrow as a resonator) reacts with certain dynamics to a varying input signal and modulation of its tuning frequency. A good analogy is a pendulum or a swing. If you push it at the precise rate, it will continue to swing, but any departure from this rate has an inhibitory effect.

Sweeping the resonator or the input signal may result in rapid changes in the output signal level. It is a natural effect of input harmonics being captured by the narrow passbands of filters for a short time when the frequencies match and then jumping out of these passbands after the match is lost.

The higher the resonance, the more reluctant the filter is to change its state from resonating with the input signal to being damped. You can observe either a locking or a beating effect, depending on how closely the signal and the filter frequencies align, and creative patching can exploit these unique phenomena.

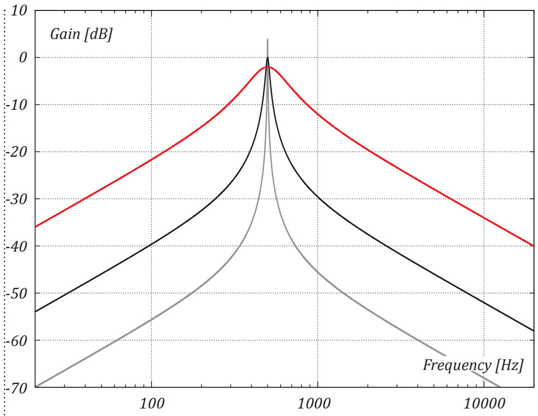


fig. 2: FREQUENCY RESPONSE OF A SINGLE RESONATOR CHANNEL WITH VARYING Q-FACTOR

PINGING THE FILTERS

Oradea features dedicated **EXCITE** *inputs that offer constant amplitude pinging even at the high resonance required for a long response (fig. 3). Each of these inputs generates an optimized uniform impulse when triggered and feeds it to an internal node of the corresponding filter, bypassing the gain compensation loop.*

Note that the audible length of the ping response naturally decreases with increasing peak frequency (fig. 4, which is similar to equivalent phenomena in acoustics. The value of the Q-factor in a filter determines how many cycles it takes for a response to decay by a certain number of dB. Thus, for high frequencies (short cycles), it takes proportionally less time to decay than at low frequencies.

Please remember that while the **EXCITE** *inputs can handle a series of rapid triggers, such triggers should be used carefully. Since the gain is not compensated for high resonance, multiple overlapping tails may yield uncontrolled signal build-up and inevitable distortion. This is particularly noticeable for low frequencies.*

Note also that cyclic pinging of a highly resonant channel tuned to a low frequency may result in inconsistent amplitude when the input impulses encounter negative peaks in the output wave. This is a manifestation of beating between filter frequency and excitation frequency, observed at frequencies so low that we perceive them as time-domain phenomena (i.e., as discrete events rather than a single frequency).

TUNING THE RESONATOR

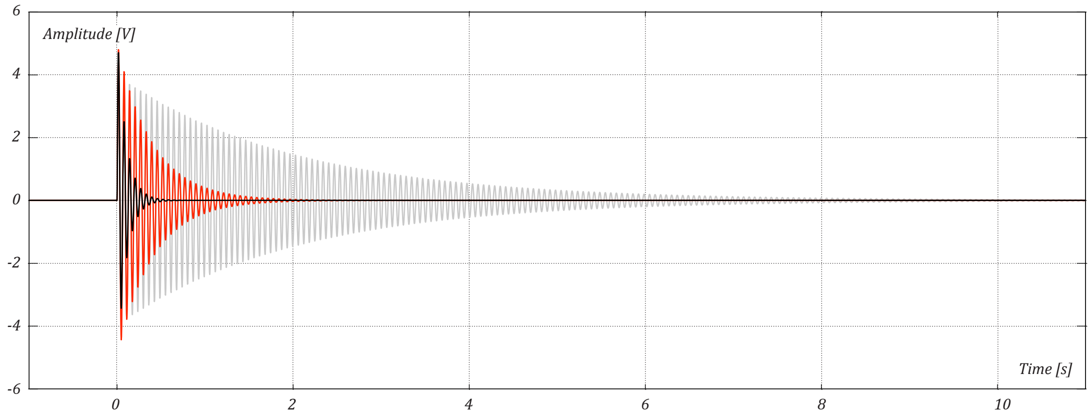


fig. 3: TEMPORAL RESPONSE FOR AN EXCITE IMPULSE AT THE SAME FREQUENCY AND VARIOUS SETTINGS OF PEAKING

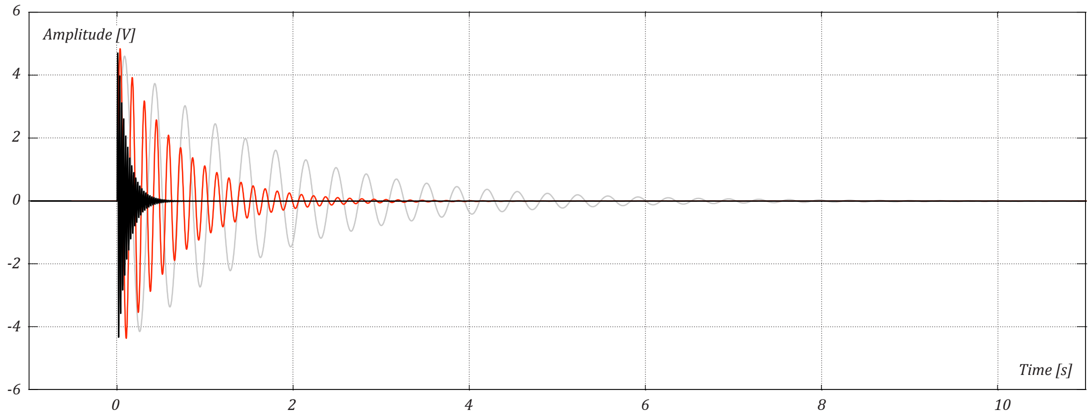


fig. 4: TEMPORAL RESPONSE FOR AN EXCITE IMPULSE AT THE SAME PEAKING AND VARIOUS TUNING FREQUENCY

TUNING THE RESONATOR

Oradea can follow the pitch of your oscillators when the same CV is patched to both the resonator and oscillator. Every channel of Oradea is factory-calibrated to the V/oct scale and can be controlled independently, while the **ALL FREQ** *input allows you to control all channels simultaneously. Thus, it is possible to use Oradea to shape the spectrum of the oscillator signal and maintain it within a tracking range.*

Note that with **PEAKING** *set to the max, the corresponding bands become so narrow it may be very difficult to tune them manually to particular overtones of your signal. Therefore, we advise setting the resonance to moderate values for initial tuning and increasing it (when necessary) only after a perfect match has been achieved.*

Oradea may serve as a model of resonant bodies of acoustic instruments, which often feature a fixed frequency response. In such an application, all **FREQ** *inputs should remain unpatched.*

GAIN CONTROL

Each Oradea channel is equipped with a high-quality VCA featuring an exponential response to CV, allowing you to slightly amplify the signal or reduce the gain to inaudible levels.

Within each channel, the corresponding **LEVEL** *control voltage is combined with the voltage from the* **LEVEL** *potentiometer, which means that a positive CV opens the VCA even when it is manually turned down. In contrast, a negative CV closes the VCA when it is manually turned up.*

A carefully tweaked soft-saturation circuit prevents harsh clipping distortion at each VCA output. Nevertheless, levels should be adjusted to avoid excessive overdrive (unless that is a desired effect).

PHASE CONTROL

Each channel of Oradea features a **PHASE FLIP** *switch affecting the polarity of the signal participating in the final summed output. Note that the switches do not affect the individual channel outputs.*

Please keep in mind that the individual filters are described by their amplitude and phase response. Phase is a measure of signal delay with respect to its cycle length expressed in degrees (because it refers to rotation around a circle). A phase response diagram illustrates how spectral components are shifted in phase according to their frequency.

The phase response of a single bandpass filter is zero strictly at the middle of its passband (the peak frequency). However, components below this frequency, besides being attenuated, are phase-shifted progressively, up to 90 degrees at very low frequencies, while components above that point are shifted down, approaching -90 degrees.

Consider a signal passing through two parallel filters, tuned slightly apart and summed at the output. The slopes of their bands overlap, which means some spectral components arrive at the output from both filters, shifted in phase in opposite directions (see fig 5). Depending on the proximity and relative shift of the bands, the overlap may create an additive effect (when the phase difference is close to zero) or a canceling effect (when the phase difference is closer to 180 degrees than zero), ultimately creating a shallow valley or a notch in the overall frequency response.

Thus, changing the polarity (flipping the phase) of a band of Oradea affects its relationship with other bands, which yields a tone variation (fig. 6). Note that the effect becomes less pronounced when channels are tuned further apart from each other because the degree of the overlap is low. The shared frequencies are strongly attenuated anyway.

SIGNAL LEVEL INDICATORS

Each Oradea channel is equipped with a multi-color LED signal level indicator. It employs a PPM (peak detection) method with an appropriate discharge time constant, allowing for easier observation of short transients.

Output levels from silence up to the normal 10Vpp level are shown by the LEDs gradually lighting green. Exceeding 10Vpp is indicated by the color turning yellow, and finally red whenever very hot levels are reached (above 16Vpp).

Note that the levels are post-VCA and are measured before signals are mixed at the final stage. To avoid

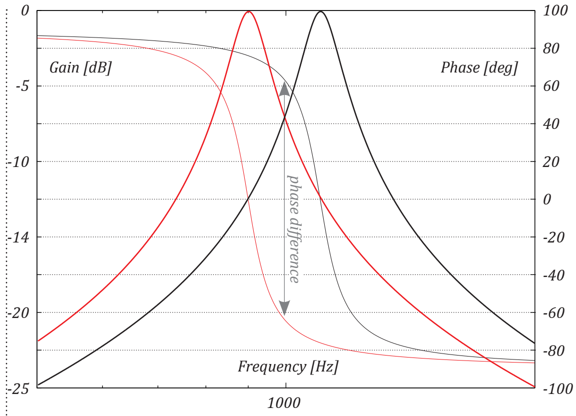


fig. 5: AMPLITUDE (THICK LINE, LEFT SCALE) VS PHASE (THIN LINE, RIGHT SCALE) RESPONSE OF TWO NEIGHBORING CHANNELS OF A RESONATOR. NOTE 130° PHASE DIFFERENCE BETWEEN FREQUENCIES NEAR 1kHz

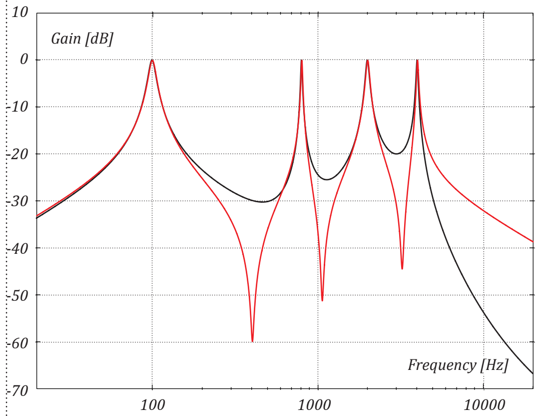


fig. 6: EXAMPLE FREQUENCY RESPONSE OF ORADEA WITH NON-FLIPPED VS FLIPPED PHASE IN CHANNELS B AND D.

distortion, adjust the **LEVEL** *knobs so that each output is within a safe margin.*

FACTORY CALIBRATION

There are several trimmers at the back of Oradea that require very careful factory tuning for the module to function properly. Do NOT adjust them, even if you think your unit shows some anomalies because it will be very difficult to return to proper settings. If you have any doubts, please contact us at support@xaocdevices.com.

ARAD OVERVIEW

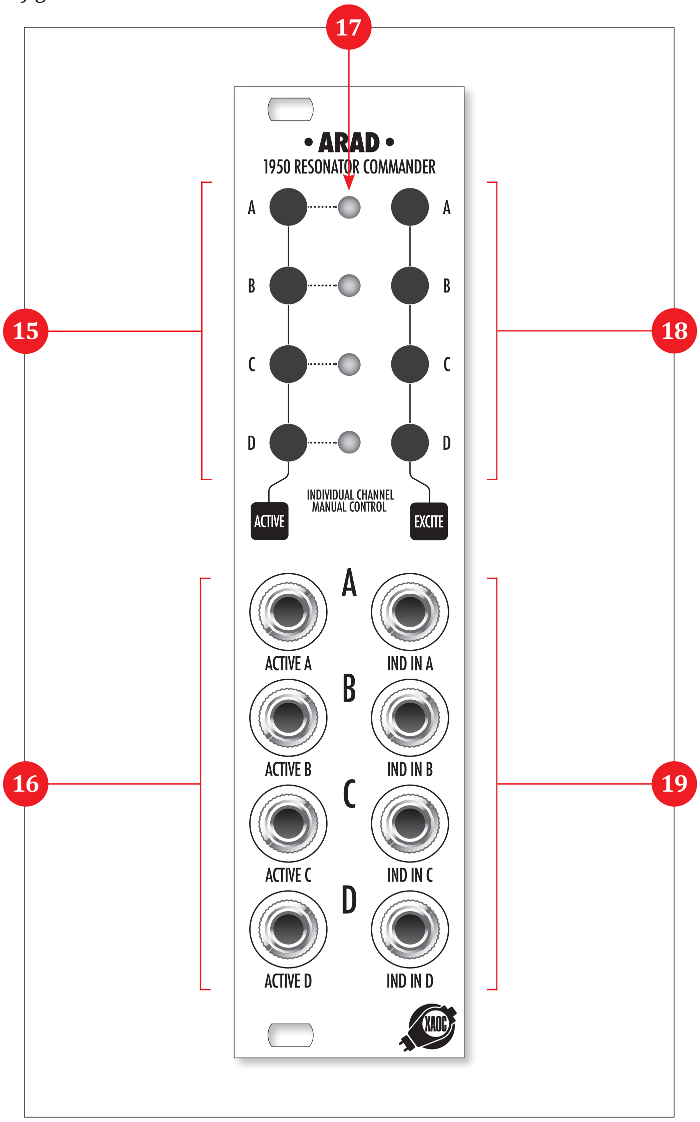
The front panel of Arad is shown in fig. 7. In its upper section, it features two columns of push buttons corresponding to the four channels of the resonator. The buttons in the left column, labeled **ACTIVE**, 15 *offer manual clickless muting and unmuting of* *individual Oradea channels.*

For each button, there is also a corresponding trigger/gate **ACTIVE** *input* ⑯ *in the lower section. This input responds to the rising edge of the signal, toggling the internal flip-flop between ON and OFF states, just like pressing the button does. An LED* ⑰ *in the upper section indicates the combined state, whether the channel is active or not (i.e., muted).*

The buttons on the right side of the panel ⑱ *duplicate the function of individual* **EXCITE** *inputs of Oradea, allowing you to manually ping the filter with a uniform pulse.*

The four **IND IN** *jacks in the right column* ⑲ *are individual audio inputs that are mixed with the all-channels* **INPUT** *of the resonator. Together with the individual outputs in Oradea, these four offer the optional use of the resonator as four entirely independent filters.*

fig. 7: ARAD FRONT PANEL LAYOUT AND CONTROLS



PATCH EXAMPLES

- *To synthesize wind instrument sounds—particularly flute-like tones—feed Oradea with white noise. Use the resonator channels to sculpt formants to taste. For added realism, introduce subtle pitch and amplitude modulation to simulate natural articulation. Keep in mind that creating convincing acoustic emulations is challenging, as they rely on multiple factors, including natural envelope contours, attack transients, reverberation, and other nuances. You can also experiment with mixing the noise with other signals such as pulse waves.*

- *Patch four modulation sources in quadrature (e.g., four sinusoids from Batumi) to the* **LEVEL** *inputs in Oradea for continuous morphing between its four channels.*

- *For synthesizing acoustic strike sounds, patch bursts of triggers, or other complex transient signals (e.g., from Xaoc Devices Zadar) to the* **INPUT**.

- *Patch four time-shifted gate signals to the* **EXCITE** *inputs of Oradea to create a nice strumming effect. You can use the* **SQR/RECT** *outputs of Batumi (I/II) in* PHASE MODE, *or* **LO** *shapes from Zadar with* **PHASE** *parameters tweaked to taste.*

- *Using Arad, create a feedback loop for each channel from its individual* **OUT** *(on Oradea) to its corresponding* **IND IN** *jack (on Arad). This creates positive feedback around individual channels, which can turn Oradea into a 4-voice sinusoidal oscillator.*

- *Patching the individual channel outputs to* **FREQ** *inputs (for FM effects) or level inputs (for AM effects) of other channels can easily yield some unpredictable inharmonic sounds. Use the onboard* **LEVEL** *potentiometers to set the modulation depth or add external attenuators for more flexibility.*

ACCESSORY

Black panels are available for all Xaoc Devices modules. Sold separately. Ask your favorite retailer. •

ORADEA TECHNICAL SPECIFICATION

WIDTH	DEPTH TOTAL	CURRENT DRAW	REV. POWER PROTECT.
20hp	*40mm (including ribbon bracket)*	*+210mA* *–190mA*	*Protected*

INPUTS		OUTPUTS	
FREQ	*-10V to +10V*	**OUT A, B, C, D**	*0 to 6Vpp*
EXCITE	*Any signal with sharp edges, min. 4Vpp*	**SUM OUT**	*0 to 16Vpp*
LEVEL	*-10V to +10V*		
PEAKING	*-10V to +10V*		
INPUT	*0-20Vpp, recommended 10Vpp*		
ALL FREQ	*-10V to +10V*		
ALL PEAKING	*-10V to +10V*		

FREQUENCY RANGE
16Hz to 20kHz

ARAD TECHNICAL SPECIFICATION

WIDTH	DEPTH TOTAL	CURRENT DRAW	REV. POWER PROTECT.
6hp	*30mm (including ribbon bracket)*	*+10mA* *–0mA*	*Not protected!*

INPUTS	
IND A, B, C, D	*0-20Vpp, recommended 10Vpp*
ACTIVE A, B, C, D	*Any signal with positive/rising edge, threshold: +1.5V*

ALL RIGHTS RESERVED. CONTENT COPYRIGHT ©2025 XAOC DEVICES. COPYING, DISTRIBUTION, OR COMMERCIAL USE IN ANY WAY IS STRICTLY PROHIBITED AND REQUIRES WRITTEN PERMISSION FROM XAOC DEVICES. SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT PRIOR NOTICE. EDITING BY BRYAN NOLL. **WARRANTY TERMS:** XAOC DEVICES WARRANTS THIS PRODUCT TO BE FREE OF DEFECTS IN MATERIALS OR WORKMANSHIP AND TO CONFORM WITH THE SPECIFICATIONS AT THE TIME OF SHIPMENT FOR ONE YEAR FROM THE DATE OF PURCHASE. DURING THAT PERIOD, ANY MALFUNCTIONING OR DAMAGED UNITS WILL BE REPAIRED, SERVICED, AND CALIBRATED ON A RETURN-TO-FACTORY BASIS. THIS WARRANTY DOES NOT COVER ANY PROBLEMS RESULTING FROM DAMAGES DURING SHIPPING, INCORRECT INSTALLATION OR POWER SUPPLY, IMPROPER WORKING ENVIRONMENT, ABUSIVE TREATMENT, OR ANY OTHER OBVIOUS USER-INFLICTED FAULT. **LEGACY SUPPORT:** IF SOMETHING GOES WRONG WITH A XAOC PRODUCT AFTER THE WARRANTY PERIOD IS OVER, THERE IS NO NEED TO WORRY, AS WE ARE STILL HAPPY TO HELP! THIS APPLIES TO ANY DEVICE, WHEREVER AND WHENEVER ORIGINALLY ACQUIRED. HOWEVER, IN SPECIFIC CASES, WE RESERVE THE RIGHT TO CHARGE FOR LABOR, PARTS, AND TRANSIT EXPENSES WHERE APPLICABLE. **RETURN POLICY:** THE DEVICE INTENDED FOR REPAIR OR REPLACEMENT UNDER WARRANTY NEEDS TO BE SHIPPED IN THE ORIGINAL PACKAGING ONLY AND MUST INCLUDE A COMPLETED RMA FORM. XAOC DEVICES CAN NOT TAKE ANY RESPONSIBILITY FOR DAMAGES CAUSED DURING TRANSPORT. SO BEFORE SENDING US ANYTHING, PLEASE CONTACT US AT SUPPORT@XAOCDEVICES.COM. NOTE THAT ANY UNSOLICITED PARCEL WILL BE REJECTED AND RETURNED! **GENERAL INQUIRIES:** FOR USER FEEDBACK SUGGESTIONS, DISTRIBUTION TERMS, AND JOB POSITIONS, FEEL FREE TO CONTACT XAOC DEVICES AT INFO@XAOCDEVICES.COM. PLEASE VISIT XAOCDEVICES.COM FOR INFORMATION ABOUT THE CURRENT PRODUCT LINE, USER MANUALS, AND FIRMWARE UPDATES.

XAOC DEVICES SP. Z O. O.
WORKING CLASS ELECTRONICS
MADE IN THE EUROPEAN UNION
WWW.XAOCDEVICES.COM