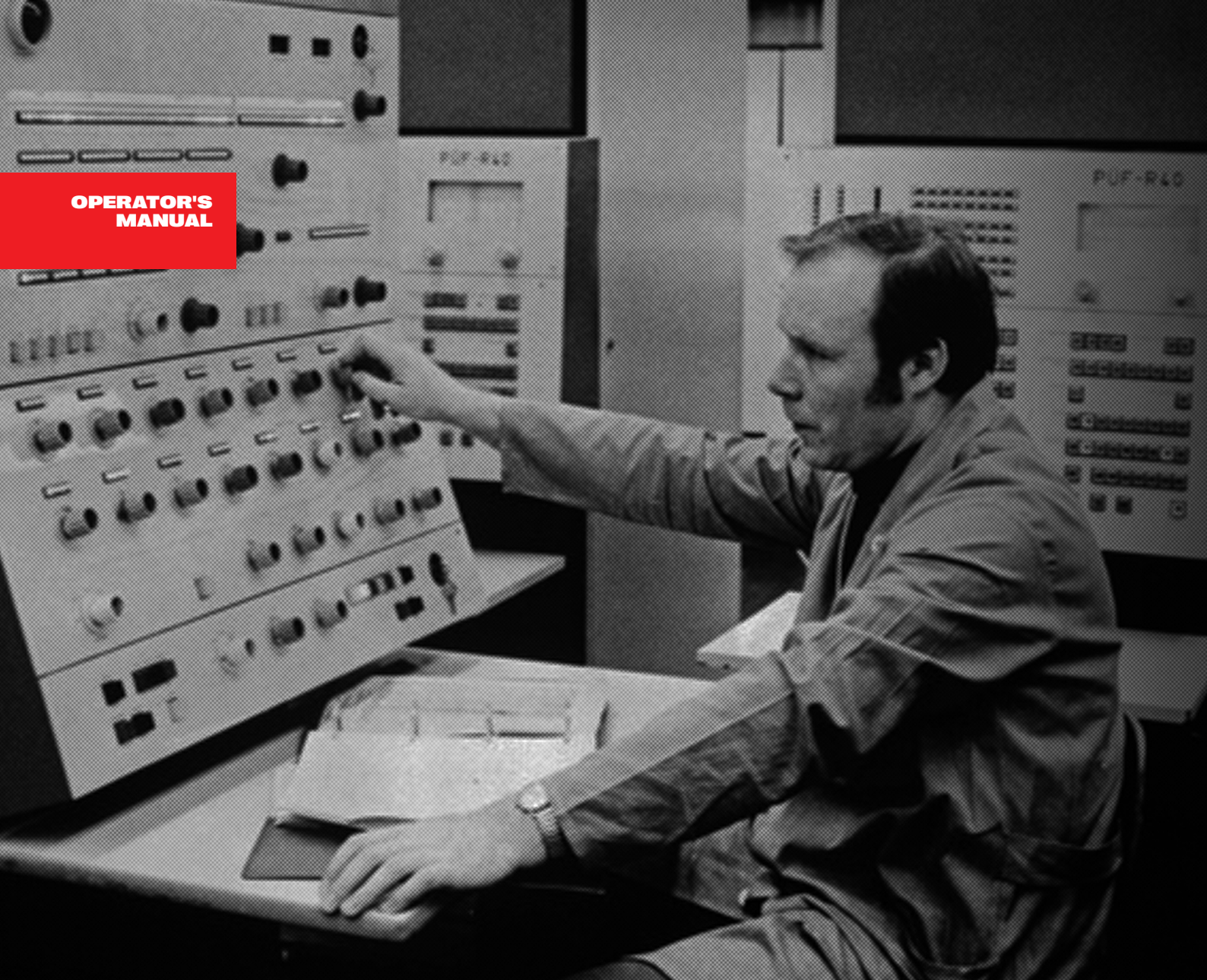


**OPERATOR'S
MANUAL**



JENA

BINARY TRANSFUNCTIONER

Model of 1989

Component of Leibniz Binary Subsystem · 15 banks of 256 digital transform functions · Digital waveshaper · Wavetable oscillator · Through-zero linear phase modulation · Walsh function generator · Drum pattern generator



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MODULE OVERVIEW

Salut! Thank you for purchasing this Xaac Devices product. Jena [*ˈjɛna*] is a digital module that may be used as a flexible waveshaper for CV and audio signals, a wavetable oscillator, a Walsh function generator, or a rhythm generator. Jena is a new member of the Leibniz Binary Subsystem which operates on signals and voltages by manipulating binary 8-bit numbers. The Leibniz subsystem offers direct access to all individual bits of data which can be mixed and cross-patched (like in the popular circuit bending experimental technique, but without the risk of damaging your device).

Please note that for analog inputs and outputs it needs to be paired with other Leibniz modules, such as Drezno or Berlin. Complex chains are possible as more components are added to the system.

INSTALLATION

The module requires 8hp 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. Pay close attention to power cable pinout and orientation. The red stripe indicates the negative rail and should match the arrow head or **-12V** mark on the bus board as well as the unit. Jena 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 particularly close attention to the proper orientation of your ribbon cable on both sides!

Besides the power cable, you will also need to connect Jena to other components of your Leibniz Subsystem. For this purpose, Jena comes equipped with a single 10/10-pin ribbon cable, and there should also be at least one such cable included with your other Leibniz module(s).

The general logic is simple: connect inputs to outputs. For example, you can use one ribbon to join the **OUT** header of your Drezno to the **IN** header of Jena, and another to connect the **OUT** header of Jena to the **IN** header in Drezno. This will make the data from the ADC section in Drezno pass through Jena before returning to the DAC section in Drezno.

It is a good idea to have all your Leibniz modules connected before mounting them in the case. Again, pay attention to the markings on the boards and always connect the ribbon cable so that the red stripe matches the dot mark on the board. For technical reasons, these dot marks may not always face down.

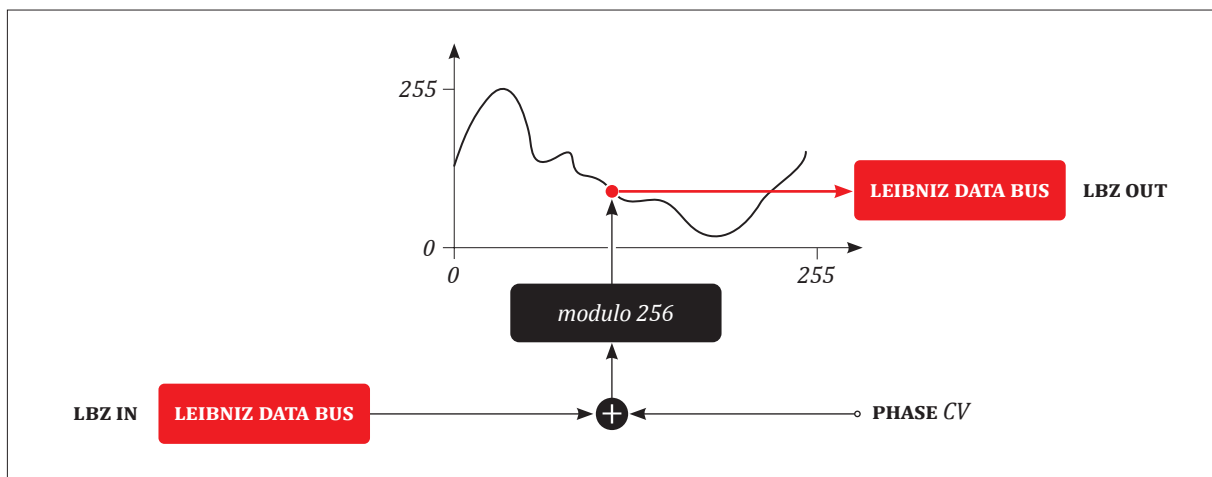
WARNING: Never plug power to the 10-pin Leibniz data headers, this would heavily damage your Berlin and jeopardize other modules connected to it.

All units should be fastened by mounting the supplied screws before powering up.

MODULE OVERVIEW

The main purpose of Jena is to map incoming digital data to some other digital data through a transfer function selected from its waveform shape bank. For example, Jena may be connected in a loopback to a Berlin or Drezno module so as

fig. 1: DATA PROCESSING PRINCIPLE OF JENA



CLOCKING

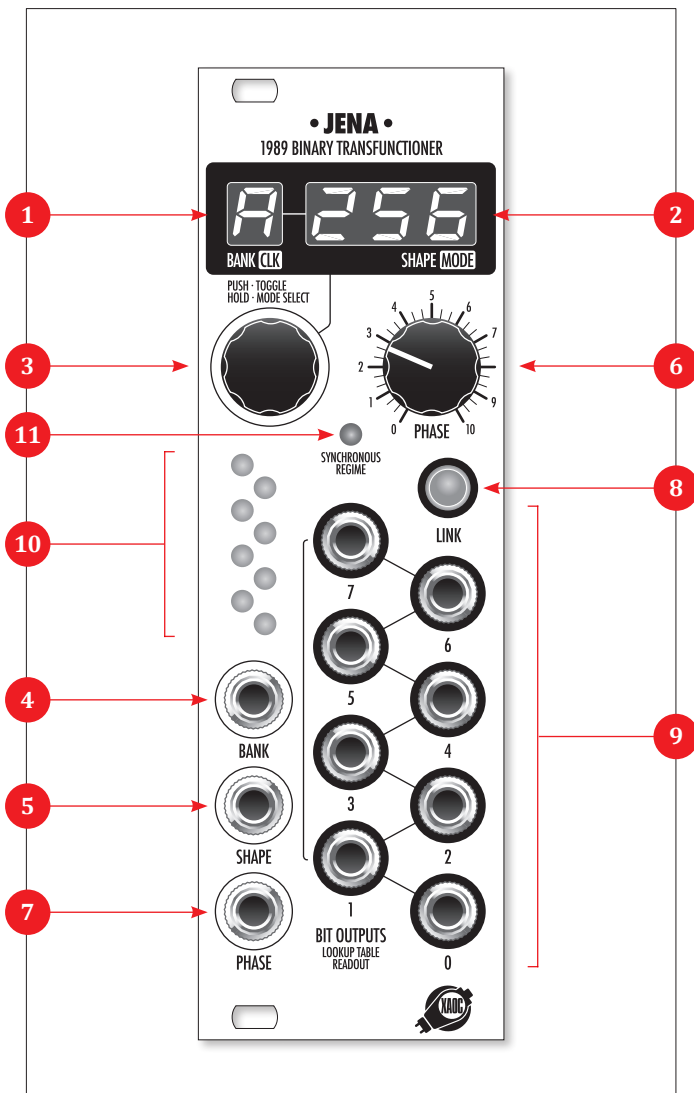
to transform input waveforms to some other output waveforms. Jena allows one to waveshape signals through the classic table look-up technique: input 8-bit values are treated as arguments of a function stored in memory and values read from successive locations in memory are passed to the output (fig. 1). When you feed a simple sawtooth or a triangle wave from your VCO, it will be transformed into variety of waveshapes (from 11 wavetable banks) with the additional option of through-zero (DX-style) phase modulation. The shape of the wave may be also morphed with the panel knob and/or external CV.

Individual bit outputs on Jena may also be used to produce interesting signals. There is a dedicated bank of Walsh functions that can be used for an un-

usual twist on additive synthesis. Also, transforming slow waveforms to sequences of binary signals using the individual bit outputs is a great way to create rhythmic drum patterns. Jena comes with a special bank of 256 modern drum loops split to individual voice triggers.

The front panel of Jena (fig. 2) features all the controls as well as a 1+3 digit LED display. During normal operation, the display shows the currently selected **BANK** of shapes or functions ① as well as the current shape number within the bank ②. Additional information is displayed during operating mode selection. The endless rotary encoder below the display ③ allows for manual selection of the current **BANK** or **SHAPE**. A short press on the encoder switches between the **BANK** and **SHAPE** layer. A small dot on the display indicates which layer is currently selected for editing. Both the **BANK** number and **SHAPE**/function number may be additionally controlled via the corresponding **BANK** ④ and **SHAPE** ⑤ CV inputs that accept -5V to +10V. The voltage values add to the panel selection. The second knob, **PHASE** ⑥, sets the initial phase of the waveform which can also be modulated by external CV via the **PHASE** jack ⑦. The range of modulation is -5V to 5V which corresponds to the phase change of four full cycles. The blue **LINK** button ⑧ controls whether the processed input data in Jena is passed to its Leibniz output (the ribbon cable connected at the back). When unlinked, the incoming data is passed through unaffected. Regardless of the status of the **LINK** button, the processed data is always available from eight **BIT OUTPUTS** jacks ⑨ in the form of eight binary gate (5V) signals corresponding to individual bits (as with the other Leibniz modules). The cluster of yellow LEDs ⑩ indicates the bit outputs' activity. The central red LED ⑪ indicates whether Jena is operating in the **ASYNCHRONOUS** (waveshaper) or **SYNCHRONOUS** (oscillator) REGIME.

fig. 2: JENA FRONT PANEL LAYOUT AND CONTROLS



CLOCKING AND SYNCHRONOUS VS. ASYNCHRONOUS OPERATION

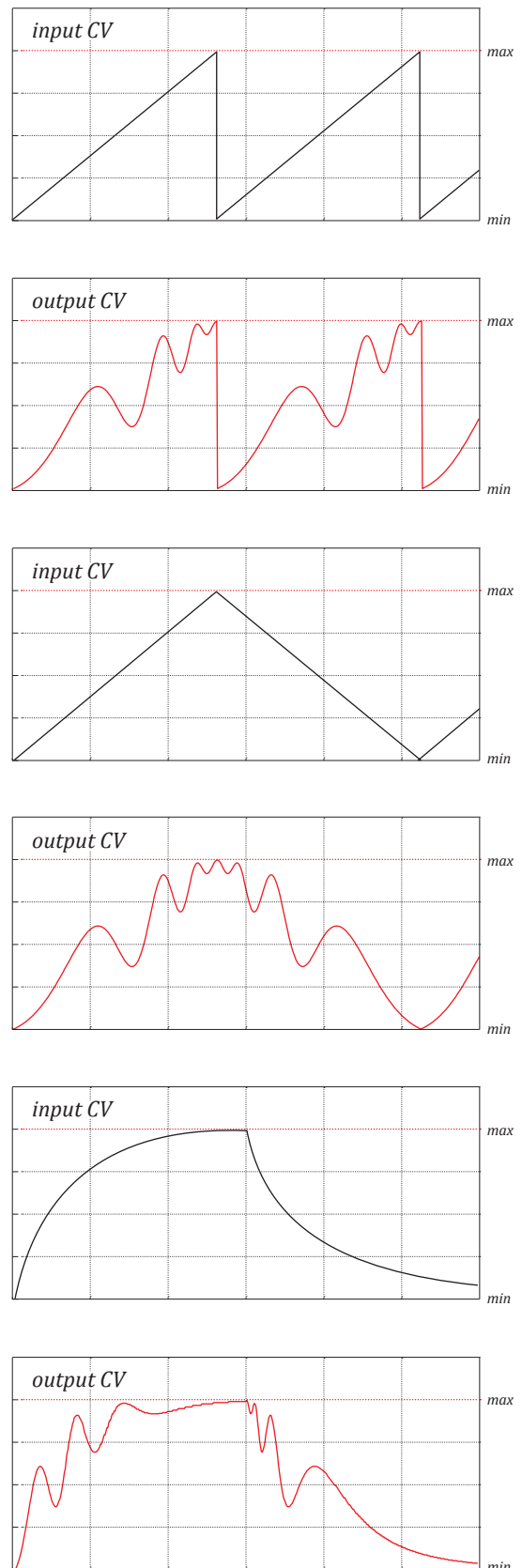
The incoming data is delivered to Jena through the Leibniz interface which transmits all bits alongside the data clock. For example, if you connect Jena to Drezno, samples will be transmitted at a rate of nearly 2MHz unless you patch an external clock signal to the adc clk jack in Drezno. Jena's processed data may be delivered to its output syn-

chronously with the incoming clock period, or it can be re-sampled with the internal (also very fast) clock. External/internal clocking is selected using the setup mode. Setting the internal clock may be advantageous when your data is clocked slowly at the source (e.g. Drezno) but you still want to apply a quick modulation to the wave.

Regardless of the currently selected clock source, processing in Jena occurs within two distinctive regimes. With ASYNCHRONOUS REGIME operation, every new input digital value is translated almost instantly (there is a several microsecond delay due to processing) to the sample value of the current shape. This type of operation is best suited for waveshaping applications (e.g. folding and warping CV signals), as shown in fig. 3.

However, if you want to use Jena as an oscillator you may prefer the input data to scan the entire phase range of the waveform to avoid the cycle being abruptly cut off before its end (fig. 4). Note also that the returning edge of your ramp scans the waveshape and may produce an audible glitch when not perfectly sharp. The SYNCHRONOUS REGIME does not require the input data to scan the entire range of 0...255 accurately and with a sharp returning edge. Instead, it uses an algorithm to analyze the incoming data and determine its current frequency and phase. It then internally generates a perfect virtual ramp that scans the function cycle in accordance with the input cycles. This enables easy generation of undistorted waveforms from the bank, like in a classic wavetable oscillator, but with the addition of through-zero phase modulation from the phase jack. The disadvantage of the SYNCHRONOUS REGIME operation is that there is a little lag after each abrupt pitch change when the new period length is computed. Also, modulating the shape of the driving wave may confuse the algorithm and cause pitch artifacts. To select between external or internal clock as well as to select between ASYNCHRONOUS and SYNCHRONOUS REGIMES, press and hold the encoder knob for a second. The display then shows **E** or **I** on the first digit to indicate the clock source, and a semi-graphical representation of the signal model (rising or falling ramp) or off (indicating ASYNCHRONOUS REGIME operation). Turn the encoder knob to cycle between all combinations of settings, and press again to select.

fig. 3: VARIOUS INPUT CV SIGNALS TRANSFORMED WITH THE SAME NONLINEAR SHAPING FUNCTION



SMOOTHING

When wavefolding is applied to signals with certain amount of noise, the resulting signal is usually more noisy, because the nonlinearity of the transformation amplifies it. This general rule applies to all analog wavefolders and also digital ones. In order to handle this problem, a smoothing filter is often applied to the input signal or data before the nonlinear shaping. This solution was also implemented in the original 1.0.0 firmware of Jena which was developed mostly for co-operation with Drezno I. Filtering is implicitly performed in ASYNCHRONOUS REGIME. Since the introduction of clean digital data sources in the Leibniz subsystem such as Erfurt, Berlin, or even Drezno II, it is sometimes beneficial to disable the filter, which results in "sharper" waveforms and more precise rhythms. As of firmware 1.0.2, filtering is no longer performed by default. However, the list of modes is augmented with another one named **FIL**, which allows to engage it, either with **I** (internal) or **E** (external) clock.

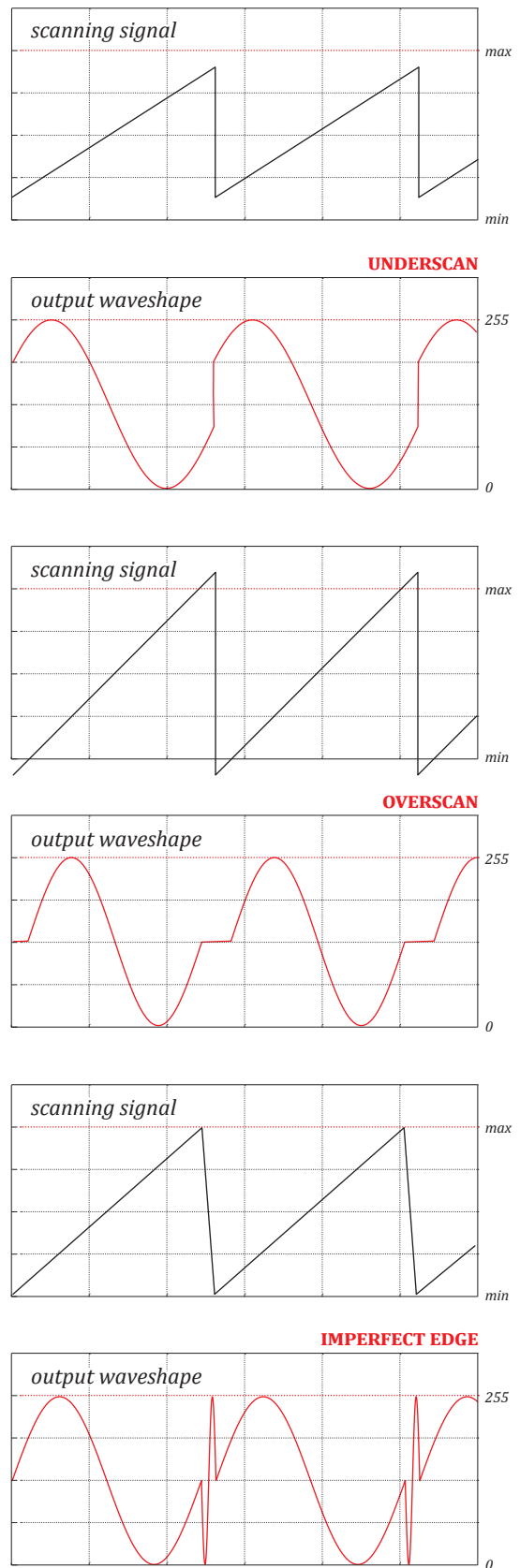
TRANSFORM BANKS

Jena offers 15 banks of digital transform data. Please refer to the "Jena Chart" PDF file for a detailed list with diagrams. The first 11 banks (numbered **0** to **9**, and **A**) are wavetables intended mostly for audio waveform generation. Each wavetable contains 256 smoothly morphing waves that are arranged circularly so that there is no audible step while jumping from wave 255 to 0. The wavetables have been carefully designed to suit various sound synthesis needs. For example, bank **7** contains smooth curves consisting of low-order Chebyshev polynomials (fig. 5) that are well-suited for experiments with deep, through-zero phase modulation, while bank **0** contains waveforms with distinctive human speech formants.

Some banks are specifically designed for efficient warping of CV signals, like LFO waveforms or simple envelopes. For example, bank **B** features a simple shape that gradually morphs between linear ramp through triangle to inverted ramp, while bank **c** introduces an increasing number of symmetric as well as asymmetric folds to an initially linear (1:1) transform.

A special bank **D** contains a very particular set of waveforms. Besides being interesting shapes, each

fig. 4: DISTORTIONS OF WAVETABLE SINUSOID SIGNAL RESULTING FROM INACCURATE SCANNING OF THE CYCLE



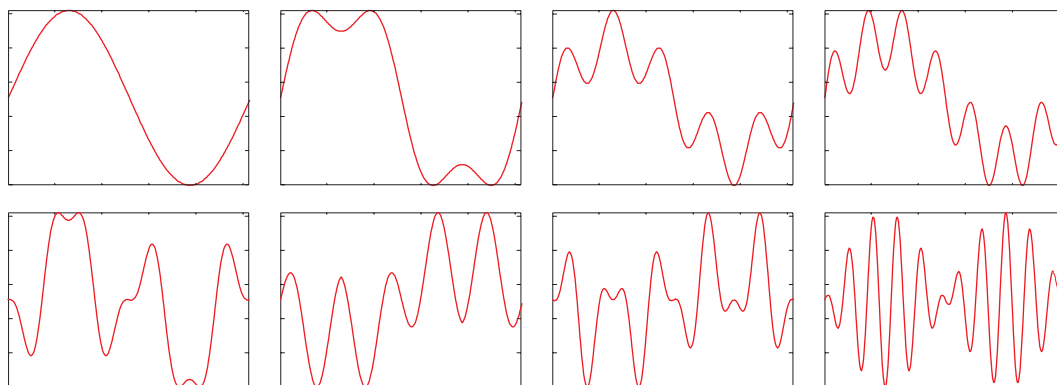


fig. 5: EXAMPLE WAVES FROM BANK 7 CONSISTING OF LOW-ORDER CHEBYSHEV POLYNOMIALS

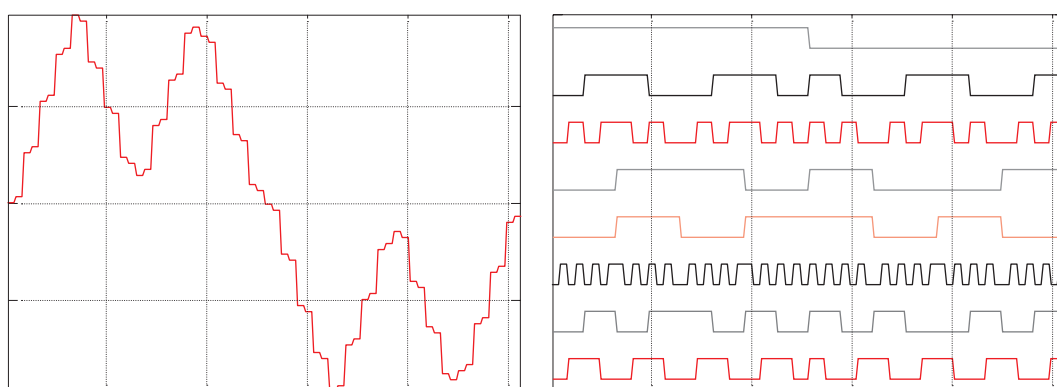


fig. 6: EXAMPLE WAVE FROM BANK D AND ITS WALSH COMPONENTS

of them is a combination of 8 so-called Walsh functions. Similar to sinusoids, these semi-rectangular functions (fig. 6) can be used for additive synthesis. We have selected 256 different Walsh combinations that are generated at the individual binary outputs of Jena, and at the same time, their sum with corresponding factors ($A_7=1/2$, $A_6=1/4$, $A_5=1/8$, $A_4=1/16$... etc.) yields the main output signal.

Bank E has a special purpose: it generates drum patterns instead of waveshapes. With this bank, the individual binary outputs of Jena are used to produce sequences of short gate impulses that can fire up to 8 drum voices in your rack.

There are 256 patterns of 32 steps corresponding to a single bar that may be selected by function or waveshape controls. They are arranged so that several consecutive positions offer mutations of the same pattern. Please refer to the "Jena Chart" PDF file for a complete listing of available rhythms. Use the SYNCHRONOUS REGIME with this bank when the loop is driven from Drezno, and ASYNCHRONOUS REGIME if you employ Erfurt or Berlin for this

purpose. To produce loops with proper tempo, the period of the sequence should be derived from an appropriately slow wave. For example, if Jena is linked with Drezno, use an LFO signal whose period corresponds to a 32nd note in Drezno's ADC input.

You can then beat match your sequence with other loops synced to the same LFO by adjusting the phase knob on Jena. phase CV input remains active as well.

CONNECTIVITY

With the provided Leibniz data cables, Jena connects to all modules compatible with the Leibniz Binary Subsystem: Lipsk, Gera, Berlin, Erfurt, Poczdam, Rostock, Drezno, Drezno II, Ostankino II, and Odessa.

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.
8hp	41mm (including the cable and bracket)	+95mA -30mA	protected

INPUTS		OUTPUTS	
BANK	-5V to +50V	BIT OUTPUTS	0/5V digital
SHAPE	-5V to +50V		
PHASE	-5V to +50V		

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