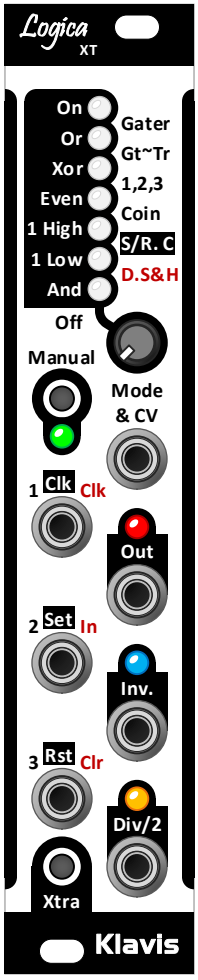
Logica XT

Voltage-controlled multiple-input logic and gate processor

Introduction

Built upon the foundations of its acclaimed predecessor, this new version drastically expands the feature set within the same footprint. All the original goodies are still there, now enriched by a full list of state-based logic functions including a delay line. Faster processing allows perfect handling of audio signals. User editable settings are stored in non-volatile memory.
With its versatility and features never seen before, the Klavis Logica XT will arouse your creativity and bring inventiveness to your soundscapes.



Features at a glance

- 14 modes of operation:
  - 6 basic logic functions
  - 2 forced states
  - 6 advanced logic functions:
    - The Gater adds-up multiple gate signals while maintaining each triggering with adjustable retrigger gap time
    - Gate to/from trigger with adjustable length
    - Chronological sequence validation (safe locker)
    - Toss a coin with different chance weighs from the 3 inputs
    - Flip-flop with separate Set and Reset
    - Digital Sample & hold, with adjustable delay/memory line (from milliseconds to several seconds)
- 3 normalized input jacks + user defined manual button for quad signal handling
- User settings stored in non-volatile memory
- Simultaneous normal and inverted outputs (e.g. And & Nand)
- Dedicated divide-by-two output
- Continuous manual + bipolar CV control of the mode
- LED column telling the current operation mode
- LEDs on all outputs indicating the current state
- LED on the manual button indicating its default and current status
- Low consumption, skiff-friendly & compact module

Installation and security

Purpose

This module is meant for installation in a Eurorack-compliant chassis.
It adheres to Doepfer Eurorack mechanical and electrical specifications.

Do not attempt using this module in other mechanical or electrical contexts.

Installation

Before the installation, disconnect the mains power supply from your modular system. Some power supplies are not safely isolated; there is a risk of injury!

See in the specifications if this module requires 5V from the supply rails. If 5V is needed and your rack is not providing 5V, do not attempt connection!

Check that the current consumption requirements of this module, when added to your installed set of modules do not exceed the available current from your supply. This is done by adding up the current draw of all modules (mA) separately for each of 5V, 12V and -12V rails. If any of these 3 sums exceeds the available current of your supply for that voltage, do not connect the module to your system; you need a stronger power supply.

The provided supply flat cable can only be inserted in the appropriate orientation at the back of the module, so there is no risk of error on that end. However, you should pay attention to the orientation of the cable in the socket of the supply PCB inside your chassis. Cheap sockets without shrouding may allow you to plug in the connector the wrong way!

The red stripe on the cable should match a stripe printed on the supply board. The stripe also indicates the -12V side. In case there is no stripe, a -12V marking is a safe indication of the orientation.

Double check that the connectors are fully inserted and correctly oriented before switching on the power supply. In case of an anomaly, switch off the power supply immediately and check everything again.

Factory reset

The module has a number of user editable settings. In case you experience unexpected result this may due to polarity and/or delay settings that are inadequate for the current purpose.
In case you're lost, you can restart fresh by resetting all settings to their default value. This is done by maintaining the Manual and Xtra buttons pressed before applying power to your case. You can release the buttons after a couple of seconds. Keep the supply on for at least 10 seconds after a reset procedure for the default data to be stored in memory.

Quick overview

The Logica XT combines up to 3 inputs plus a push button to realize logic operations.
The functions are split into two categories:

- Simple logic operations (left column of the panel) are indicated by one LED
- Advanced logic operations (right column on the panel) are indicated by a LED pair

Switching between the columns is done by a short press of the Xtra button.

The potentiomer selects a function in the active column.

For some functions, a long press on the Xtra button allows editing their related setting.
Changes are saved automatically without user intervention.

The module is delivered ready to use with sensible predefined settings.

LEDs

All outputs have LEDs that indicate a logic level 1 when on.

The manual button LED tells the setting of the button; the LED is ON when level is one.

Inputs jacks

CV control input

This input works jointly with the Mode potentiometer. Their settings are summed to select one of the simple logic functions. With advanced logic functions, the CV input is not used.

Input jacks 1, 2 and 3

With simple logic functions, these all work in the same way. Any signal can be brought to any jack. With some advanced logic functions the jacks may have dedicated roles.

Normalization of inputs

With simple logic, unused jacks automatically get the necessary default value so that it is not needed to replicate a signal if less than 3 input jacks are required. This is called "normalization".

Normalization allows having a logic condition being realized with fewer signals than inputs connected. For example, a 2-input AND function would not work if the unused jack(s) were not normalized: the condition where all inputs go on would not be possible without patching (duplicating) one of the signals to the remaining input(s). Normalization is solving that for you.

Contrarily to the usual scheme where normalized inputs are chained, in the Logica XT, it is not required using the jacks in a preferred order for the normalization to work. This is why the usual arrows printed between jacks to indicate a normalization order are missing.
Could the Logica XT clever jack behavior be called "cleverized" ?

Output jacks

Main output (Out)

This output provides the logic result of the operation currently selected.

Inverted output (Inv)

This output provides the opposite state of the main out (Out) jack. It therefore represents the negative logic of the currently selected option. (see further)

Division by two output (Div/2)

This output toggles its state every time the main output transitions from off to on (also with short pulses). It provides a division by two of the main output and can be used for clocking purposes or sub-octave creation when handling audio signals.

Oring of outputs

It is possible to Or the outputs of the Logica XT without additional module or processing. The signals generated by the Logica XT can be joined together via a "multiple", stackable jacks, or other any other passive patching accessory normally used to distribute a signal over several destinations. Such capability is only for Logica XT or other modules with similar feature.

As long as one of the signals is at level one, the end result will be one, actually realizing a logic Or function just by patching. Note that since the Main out and the Inv out are the opposite of each other, joining them will result in a signal being stuck at one. However, joining the Div/2 and one of the other outputs can make special patterns (e.g. alternating pulses of two different lengths).

Controls

Mode potentiometer

It selects one of the logic functions/modes in the currently active column.

Manual input button

This button acts as a fourth input.
The default status of the button depends on the logic function selected. If needed, this default status can be changed by the user.

Xtra button – simple vs. advanced functions - editing

This button has two roles:

1. A short press toggles between the simple and advanced logic columns.
2. Holding the button enables the editing of the function currently selected (if available). During editing, the CV is disabled. While holding the Xtra button:
    - With simple logic functions, pressing the Manual button toggles its default state – the result is reflected on the Manual LED.

- With some advanced logic functions, the potentiometer is adjusting a time setting. This is detailed in the related functions.

When done with editing, release the Xtra button and the changes are automatically stored.

Logic terminology

There is a correspondence between various terms used when dealing with logic.

Logic	1	0
State and LED	On	Off
Voltage presence (positive!)	Yes	No
Level	High	Low

Logic voltages

Logic signals are represented by a voltage or lack of it. In the modular world, any gate, trigger, clock and even square output from an LFO or VCO can be considered a logic signal.

Logic functions are the interaction of logic signals. Logic functions do not respond to amplitude nuances in the way analog signals do. Nevertheless, they obey to electrical ranges and levels. Logic signals are normally positive only; negative voltages are ignored and interpreted as zero. Typically, a voltage close to zero volts will be considered logic 0 (off) and a voltage of at least a few volts will be seen as logic 1 (on). Incoming voltages can go beyond or below what are valid one and zero without any problem. In other words, you can't go beyond On when it's already On!

Therefore, it is perfectly valid to drive this module with almost anything, including analog signals from any source. Moreover, you are not limited to "squary" type signals; any wave shape can be used as a logic source signal. For example, passing the saw wave output of an oscillator through an OR function will create pulses since only the positive half of the wave will be accepted, and within that half, only levels high enough will produce a logic one on the output. So, changing the amplitude or the voltage offset of the saw will change the width of the resulting pulse: saw to PWM waveshaping !

Simple logic functions

These are also known as combinatorial logic, or Boolean logic.

They are listed on the panel's left column and indicated by a single white LED being lit.

Forced On & OFF states

When the potentiometer (or CV in) pushes the setting at the top and bottom of the logic options offered in the column, the output is forced to a static level: To one when pushed full up, to zero when pushed full down.

The On state has a dedicated LED at the top of the column; the Off state is indicated by all LEDs of the column being off. With forced states, the input jacks are disabled; only the manual button can be used to invert the output.

And & Nand

The main output goes on when all inputs plus the button are on. The manual button defaults to On. AND is somehow the logic equivalent of a VCA where one input has to be On for the other to pass through. The difference being that, contrarily to a VCA, all inputs are simultaneously controlling and controlled.

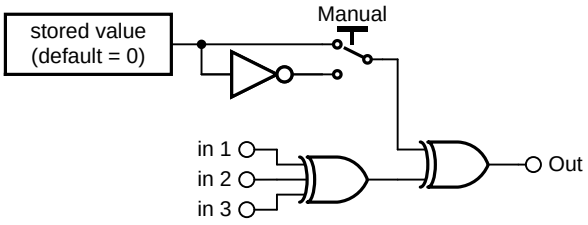
Or & Nor

The main output goes On when at least one input or the button is on. OR is the logic equivalent of a mixer: if there is something being On at any input there's something coming out (On).
The manual push button defaults to Off.

Xor & Xnor

This logic option works like the OR, except that the main output goes Off when all active jacks are On. In the Logica XT an unusual 3-input Xor is implemented whose results are different from chaining a pair of 2-input Xor gates.

Also, conversely to other simple logic modes, the button is not equal to an input jack. Instead, it feeds a cascaded Xor function. See the logical chain hereafter.



Xor can be used as a "digital ring modulator" such as implemented in the ARP Odyssey and KORG MS-20 synthesizers. Feed two inputs with two oscillators to get the effect.
With 3 oscillators feeding this 3-in Xor, you can create sounds much different from cascading two 2-input Xor; the div/2 out can even provide melodies out of subtly detuned static pitches!

Here is the detail of the Xor/Xnor function:

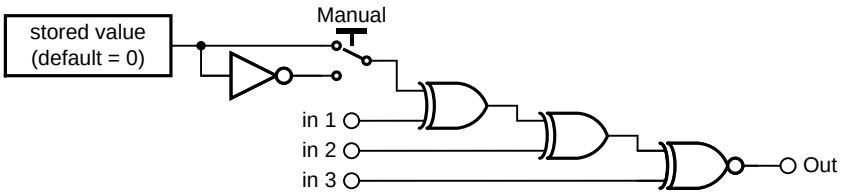
Input jacks	**Out jack = Xor**	**Inv jack = Xnor**
All low	low	high
One or more high, but not all	high	low
All high	low	high

- When only two input jacks are connected you get a standard two-input Xor function
- When a single jack is connected, the first (triple) Xor is bypassed
- The manual button inverts the final result

Even & Odd

The main output goes on when an even number of inputs – including the button – are on. The inverted output works the same for an odd number of inputs. The button defaults to off.
A sum of zero is considered even.

This function, made of chained Xor can also do a digital ring modulator, albeit less creative musically than the dedicated 3-input Xor function above when used with 3 signals.



1 High

The main output goes on when only one input – including the button – is on.
The button defaults to off.

This function can complement a rhythm pattern generator by providing a gate for a fourth sound when only one of the 3 other sound gates is active at a given step.

1 Low

The main output goes on when only 1 input – including the button – is off.
The button defaults to on.

Advanced logic functions

With these functions, the output depends on a sequence of actions or involves a time-related effect. They are also known as sequential logic or state-based logic.

Differences with simple logic functions:

- There is no input normalization (because it is not needed)
- While editing settings, the manual LED is flashing
- The default value of the manual pushbutton cannot be edited
- The CV input has no effect

Gater

The Gater combines all inputs as an Or function does, but also retriggers the output every time a new gate starts while one or more are already active.

All inputs work the same; the button brings a 4th gate signal.

The output signal reflects the duration of the incoming gate signals.

Editing

By maintaining the Xtra button, you can set the duration of the gap created for retriggering.

Turning the pot, the LED column indicates the duration as follows, LED off = 1ms, then one LED at a time corresponding to values 2, 3, 4, 5, 6, 7, and 8ms; turning further brings a bar-graph that reflects values continuously adjustable from 10ms to 1 second.

The default value is 3ms. It is recommended to set the shortest possible value that your target modules accept such as to maintain a tight timing. Longer gap durations are here for more creative purposes.

Gt ~ Tr - Gate to Trigger & Trigger to Gate

Gate or trigger signals on any input are converted to trigger/gate pulses of adjustable length.

All inputs work the same; the button brings a 4th trigger/gate signal. All signals are combined (ORed) to the output.

Editing

Turning the pot, the LED column indicates the duration as follows, LED off = 1ms, then one LED at a time corresponding to values 2, 3, 4, 5, 6, 7, and 8ms; turning further brings a bar-graph that reflects values continuously adjustable from 10ms to 10 second.

The default value is 4ms which should suffice for typical Gate to Trigger conversion. Longer triggers could be used for punchy envelopes (use an ADSR set to AR and acting as A, hold, D).

Trigger to gate is realized with longer durations whatever the length of the incoming signals.

1, 2, 3 – Sequence validation

In this function the numbering of the inputs is important. The output will go on only after the inputs have seen triggers or gates in the proper chronology from input 1 to input 3.

Any time the sequence is broken (e.g. input 3 was activated immediately after input 1) the validation is reset and should start again from the beginning.

After the output successfully goes on, any further signal to any input will shut it off (possibly restarting a new sequence if that signal came on input 1).

Signals on the different inputs may overlap; only their rising edge is considered.

The manual button inverts the current state of the output.

Coin

This function offers 3 heads or tails random generators with variable odds depending on the input used. When won, the out goes on for the duration of the input signal.

When more than one input is used, winning signals are combined (ored) on the output.

- A signal on input 1 has a fifty-fifty chance of passing through.
- A signal on input 2 has one in four chance of passing through.
- A signal on input 3 has one in eight chance of passing through.

Feeding the same input signal to more than one input offers additional odds values, as shown:

Signal brought to input			Odds of pass-thru (rounded)
In 1 (div/2)	In 2 (div/4)	In 3 (div/8)	
		x	12.5%
	x		25.0%
	x	x	34.4%
x			50.0%
x		x	56.3%
x	x		62.5%
x	x	x	67.2%

The manual button creates a On that is mixed (ORed) with the current output state.

Set/Reset + Clock – S/R+C

The labeling of the inputs is in the black boxes above the jacks (Clock, Set, and Reset).

The function implements a typical flip-flop circuit. In its simplest use, feed any cyclic signal to the Clock input and you get a division by two on the main output.

The set and reset inputs can respectively force and clear the output. A pulse at the clock inverts the current result. The manual button is an additional clock option.
Without clocking, only using Set and Reset gives you an S/R latch whose result remains stable until the other input goes high.

Only the rising edges of the incoming signals are taken into account.

Audio use
Since there is already a divider hardwired to the Div/2 out jack, you end up with a divide by four circuit. Feeding this function with an oscillator simultaneously gives sub-octave and two-octave lower audio signals.

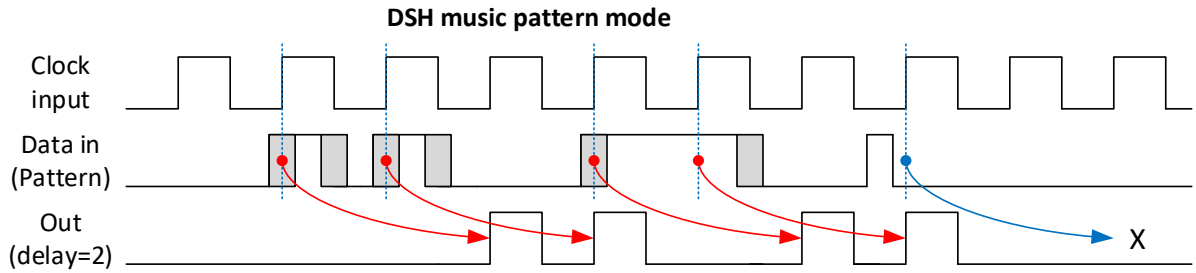
Digital Sample & Hold – D.S&H

For this function, the labeling of the inputs is on the right side of the jacks (Clock, In, and Clear). This versatile function is made of a Sample & Hold followed by an optional gate-shaper. There are two working modes depending on the pot position: the first half is for pattern delay, the second half is for general purpose sample and hold with delay.

1. Pattern delay

This is useful to create delayed rhythmic patterns.

- A regular trigger/gate at typical pattern rate is brought to the clock input.
- A gate pattern is brought to the data input
- The output will provide a delayed copy of the pattern but shaped with the phase and duration of the trigger/gate signal.



By maintaining the Xtra button pressed, you can set by how many steps the pattern will be delayed. Turning the pot within its first half, the LED column indicates the delay as follows:

- LED off = 1; input is copied to out on the next clock
- then, each LED up corresponding to 2, 3, 4, 6, 8, 12 and 16 delay steps,
- then, by LED pairs for 24, 32, 48, 64, 96, and 128 delay steps.

Notes:

- The sampling works even when the data is slightly ahead or later than the Clock rise.
- The end time of the Data is irrelevant as the output signal will be shaped as the Clock.

2. Digital delay line

This is used to arbitrarily delay a digital signal for up 5000 steps with a clock of any rate. Contrarily to the previous mode, the output signal is not reshaped according to the clock shape.

When no jack is present at the clock input, the module generates its own 1 KHz clock internally. This gives you a delay adjustable up to 5 seconds with a 1ms precision.

By maintaining the Xtra button pressed, the right half of the pot allows adjusting the delay from 1ms to beyond 5000ms. The LEDs are lit in bargraph way. With clocks slower than 1ms, much longer delays are achievable (e.g. 20 seconds long at 4ms precision with a 250Hz external clock).

Connecting the inv out to the data in creates a rate-adjustable clock generator.

Notes for audio purposes

- If the clock is modulated, and using an audio mixer, one can create typical double-tracking, unison and flanging effects.
- Remember that only squary-shaped/pulse audio signals are handled!
- The clock must run at several times audio rate for proper sampling.

Summary – Simple logic

In this table, "inputs" include the manual button (except with Xor/Xnor)

White LED	Function	Out jack	Inv jack logic	Details
Top	On	On	Off	Input jacks are disabled Button inverts
2	Or	On if at least 1 input is on	Nor	Button defaults to Off
3	Xor	On if 1 or more inputs are on Off if all inputs are on Button inverts the final result	Xnor	Button defaults to Off
4	Even	On if the number of inputs high is even	Odd	Button defaults to Off
5	1 High	On if only 1 input is high	Off with 1 high	Button defaults to Off
6	1 Low	On if only 1 input is low	Off with 1 low	Button defaults to ON
Bottom	And	On when all inputs are on	Nand	Button defaults to ON
None – Below lowest	Off	Off	On	Input jacks are disabled Button inverts

Summary – Advanced logic

White LED	Function	Out jack	Details
Top	On	On	Input jacks are disabled Button inverts
Top + 2	Gater	On if at least 1 input is on; retriggers with every new off-to-on input transition while out is already on	Button is a 4th gate signal Gap can be adjusted
2 +3	Gt → Tr	Any gate becomes a trigger or reverse	Duration can be adjusted
3 +4	1, 2, 3	On after sequence is valid Zero in all other cases	Button toggles the validation and output
4 +5	Coin	Copy of input if chance is OK	Button makes a gate
5 +6	S/R+C	Can be Set, Reset, or toggled	Button is a clock signal
6 +7	D.S&H	Follows the input after 1 to max Clock pulses; zero when Clear	Button is Clear Steps/delay can be adjusted
None – Below lowest	Off	Off	Input jacks are disabled Button inverts

- The Inv out is the opposite of Out
- The Div/2 out toggles when Out changes from low to high.

Specifications

Mechanical

Dimensions	mm	inches	Eurorack compliance
Height	128.40	5.06	3HE
Width	25.20	0.99	5HP
Depth behind panel (with supply cable inserted)	25.00	0.98	

Supply

The supply socket is protected against reverse insertion.

Supply rail	Current draw
+12V	0 mA
-12V	1 mA
+5V	17 mA

Older versions with a 16-pin connector also require a 5V rail.

Input/output

All inputs and outputs can withstand signals between -12V and +12V without harm.

Jack	Effective voltage range received or generated
CV control input	-5V to +5V
All outputs	0 or 5V (logic levels) can be Ored electrically
Input low to high change	3.5V or higher
Input high to low change	2.8V or lower (incl. negative voltage)

Signals

Parameter	Values
Frequency range	DC to beyond audio

Packing list

The box contains:

- Logica XT module
- 2x M3 black mounting screws + washers
- Eurorack-compliant 16-pin supply cable
- Quick setup notice

Klavis products, including PCB and metalwork, are designed and manufactured in Europe.