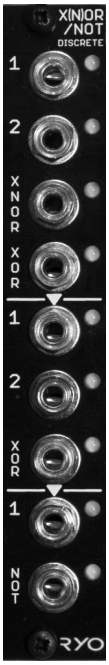
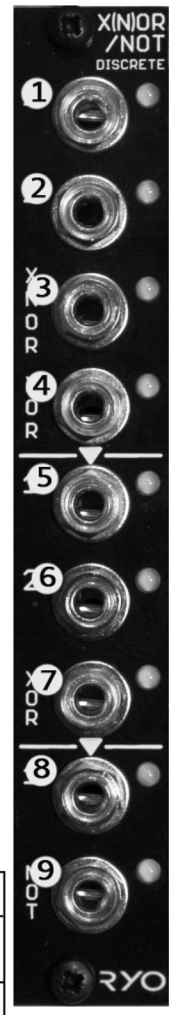


LjunggrenAudio RYO Boolean Logic Series:
Discrete Resistor-Transistor-Logic.

Quickstart – what is the XNOR/XOR/NOT and how do I get going?

The circuitries of the RYO logic gate modules are directly modelled after the very earliest form of digital logic gate designs using resistor-transistor-logic (RTL) pioneered in the 1950s and used in computing equipment throughout the 50s and 60s. The Apollo Guidance Computer for instance used the same type of 3-input NOR gate design now found in the RYO NOR/OR module, although in vastly greater numbers.

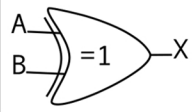
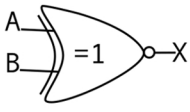
RYO Discrete TRL Boolean Logics XNOR/ NOR/NOT

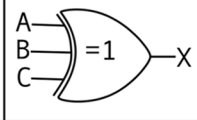
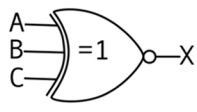


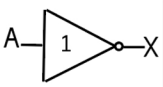
1. Gate one input 1
2. Gate one input 2
3. Gate one XNOR output
4. Gate one NOR Output (normalled to Gate two input 1)
5. Gate two input 1
6. Gate two input 2
7. Gate two XOR output (normalled to Gate three input 1)
8. Gate three input 1
9. Gate three NOT output

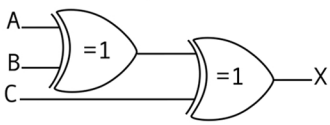
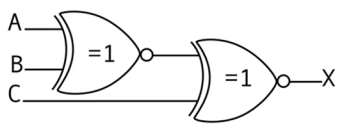
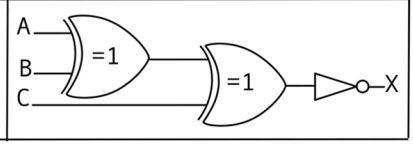
[Try dif input amplitudes, waveforms and frequency rates

including audio into inputs!] Width: 4 hp

Name			XOR	XNOR
Alg. Expr.			$X=A \oplus B$	$X=\overline{A \oplus B}$
Symbol	A	B		
Truth Table	0 0 1 1	1 0 1 0	0 1 1 0	1 0 0 1

Name				XOR	XNOR
Alg. Expr.				$X=A \oplus B \oplus C$	$X=\overline{A \oplus B \oplus C}$
Symbol	A	B	C		
Truth Table	0 0 0 0 1 1 1 1	0 0 1 1 0 0 1 1	0 1 0 1 0 1 0 1	0 1 1 0 1 0 0 1	1 0 0 1 0 1 1 0

Name		NOT
Alg. Expr.		X=NOT A OR $\overline{A}$
Symbol	A	
Truth Table	0 1	1 0

Option 1	Option 2	Option 3
		

Installation

To begin installation, please make sure that:

- you have a standard pinout eurorack bus board
- you have +12V and -12V power rails on that bus board [no +5V supply is required]
- the power rails are not overloaded

!!!Before installing this module disconnect the power from your system!!!

- Double check the polarity of the ribbon cable - The red stripe should be aligned with the -12V rail, on both the module and on the bus board

[we use shrouded headers but it's still possible a cable has been assembled with the stripe on the wrong side of the shroud so always double check!].

Also make sure when using busboards without shrouded headers that the pins aren't transposed a row vertically or horizontally – all pins should insert into holes on the cable.

Although we use both PTC fuses and schottky diodes to provide reverse polarity and excess current protection, we do not take any responsibility for damages caused by wrong power supply connection!
After you have connected everything, double checked it and ensured your case is closed such that no power lines can be touched by your hand or any stray cables drop into holes, turn on your system and test the module

The RTL circuit design gives the modules some interesting quirks thanks to the transistors threshold windows when playing around with different amplitudes, waveforms and frequency rates of the incoming signals, making it fun and useful to explore beyond typical logic gating duties, for example as an audio waveshaper/distortion.

The XNOR/XOR/NOT module is a novice-friendly project, it is a low part count build that only requires basic experience in PCB soldering and module assembly:

The XNOR/XOR/NOT module can be patched as:
- **two NOT gates and one 2-input XOR gate,**
- **one NOT gate, one 2-input XOR gate and one 2-input XNOR/XOR gate,**
- **two 2-input XNOR/XOR gates, or,**
- **one NOT gate and one 3-input XNOR/XOR gate.**

Gates one and two have two inputs, the third has one. *The XOR out from gate one is normalized to input 1 on gate two. The XOR out from gate two is normalized to the single input on gate three (NOT).*

The module has signal indicator LEDs on every input and output; *Green LEDs light if a signal is present at an input, amber LEDs light when an output goes high.*

The module can accept: *any input signal between 0V and +5V to +10V peak* **and outputs** *logic lows and highs within the Doepfer A100 standard Eurorack range of 0V and +5V.*

Dimensions	
Height:	**3U** (128.5mm)
Width:	4HP (20mm)
Depth:	50mm (with cable attached)
Weight:	35g

Current consumption	
+12V rail	**28mA** @10V input signals*
-12V rail	**0V**
+5V rail	**no +5V** supply required
	**14mA @5V input signals*

Basic specifications	
total frequency controllable range	dc to 50kHz
max input/output audio signal	20Vpp
CV input range	n/a
Max gain	n/a

Nominal impedances	
Audio signal input:	100kohm
Audio Signal output:	1kohm
CV input:	n/a

Patch ideas:

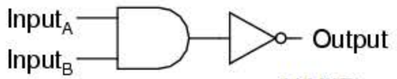
below i've included some inspiring words to give ideas of patches that can be achieved with the module; and, as ever, experiment – RYO modules are designed with all necessary protection and fail-safes so you can just start plugging in patch cables and see what happens!

Ring modulation:
XOR logic is oft-used for ring modulator sounds, as seen in the MS-20 most prominently. Patch 2 different oscillators into it and watch the chaos unfold!

Audio rate signals:
try audio rate signals at different amplitudes and frequencies and pulsewidths/shapes for a variety of new waveforms.

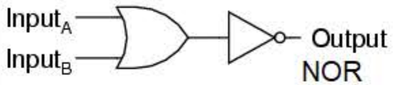
Combine with other logic gates:
build more complex logic gates, counters/multiplexers or even analog computers using multiple logic modules (See the upcoming resources section in the currently under construction RYO website for further information).

Equivalent gate circuit



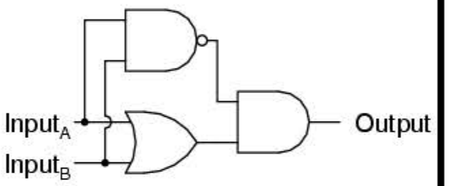
NAND

Equivalent gate circuit

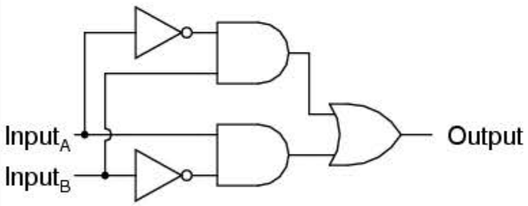


NOR

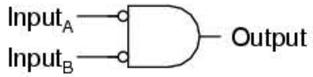
Exclusive-OR equivalent circuit



Exclusive-OR equivalent circuit

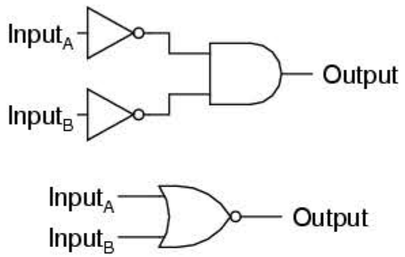


2-input Negative-AND gate

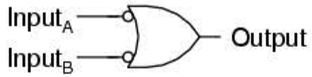


A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Equivalent gate circuits

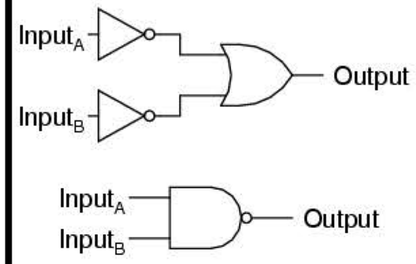


2-input Negative-OR gate

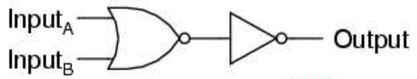


A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

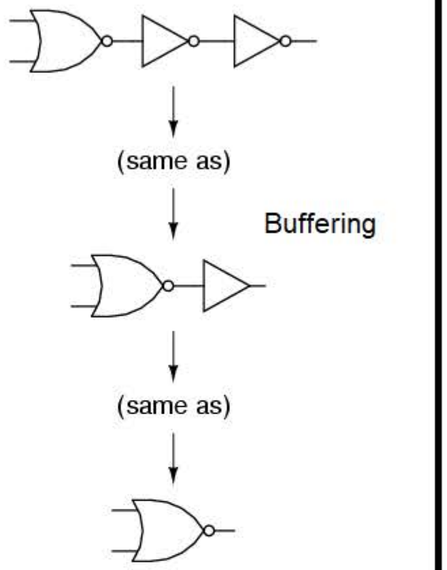
Equivalent gate circuits



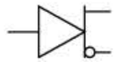
Equivalent circuit



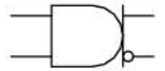
OR



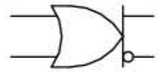
Complementary buffer



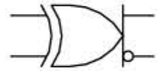
Complementary AND gate



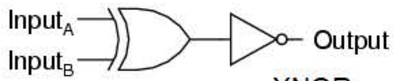
Complementary OR gate



Complementary XOR gate

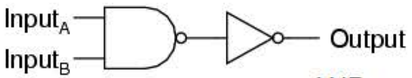


Equivalent gate circuit

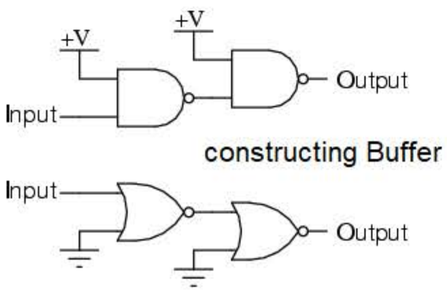


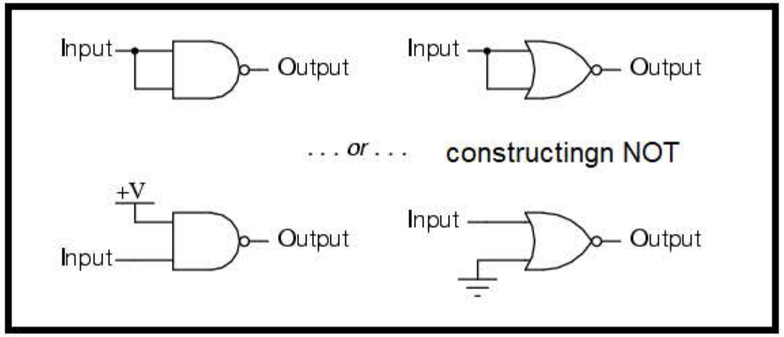
XNOR

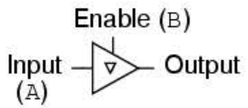
Equivalent circuit



AND



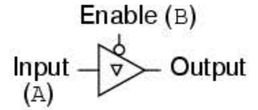




Truth table

A	B	Output
0	0	High-Z
0	1	0
1	0	High-Z
1	1	1

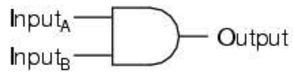
Tristate buffer with inverted enable input



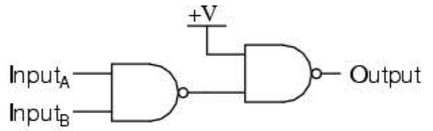
Truth table

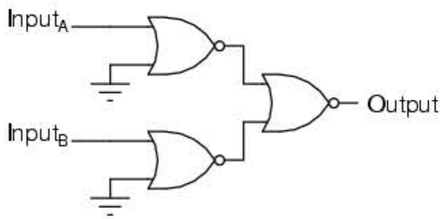
A	B	Output
0	0	0
0	1	High-Z
1	0	1
1	1	High-Z

2-input AND gate

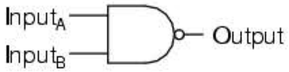


A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

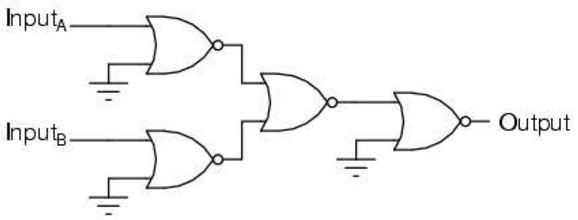




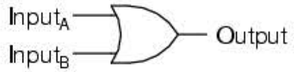
2-input NAND gate



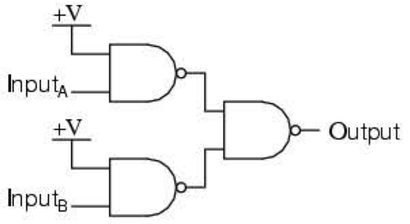
A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

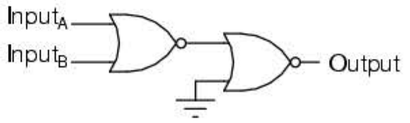


2-input OR gate

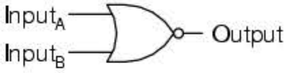


A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1





2-input NOR gate



A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0