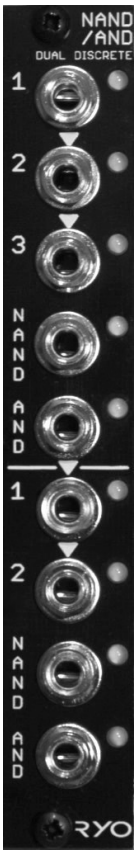
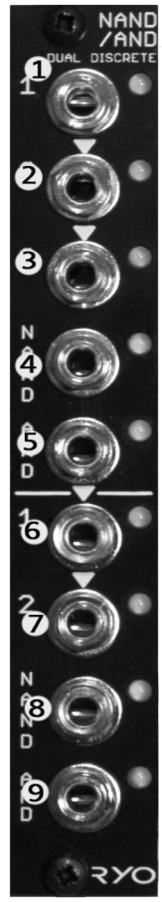


LjunggrenAudio RYO NAND/AND
Discrete Resistor-Transistor Boolean Logic in 4hp

Quickstart – what is the NAND/AND and how do I get going?

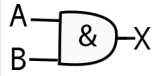
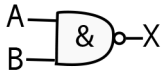
The circuitries of the RYO logic gate modules are directly modelled after the very earliest form of digital logic gate designs using resistor-transistor-logic (RTL) pioneered in the 1950s and used in computing equipment throughout the 50s and 60s. For instance, the Apollo Guidance Computer used the same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

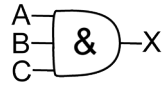
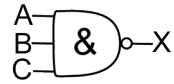
RYO Discrete TRL Boolean Logics
NAND/AND

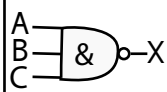
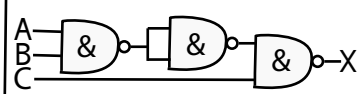
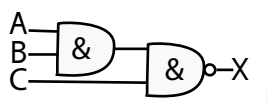


1. Gate one input 1 (normalled 1>2)
2. Gate one input 2 (normalled 2>3)
3. Gate one input 3
4. Gate one NAND Output
5. Gate one AND Output (normalled to Gate two input 1)
6. Gate two input 1 (inputs normalled 1>2)
7. Gate two input 2
8. Gate two NAND output
9. Gate two AND output

[Try dif input amplitudes, waveforms and frequency rates including audio into inputs!] Width: 4 hp

Name			AND	NAND
Alg. Expr.			$X = AB$	$X = \overline{AB}$
Symbol	A	B		
Truth Table	0 0 1 1	0 1 0 1	0 0 0 1	1 1 1 0

Name				AND	NAND
Alg. Expr.				$X = ABC$	$X = \overline{ABC}$
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 0 0 0 0 0 0 1	1 1 1 1 1 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 NAND/AND is a relatively low skill-level project, it is a low part count, twin-PCB build that only requires fairly basic experience in PCB soldering and module assembly:

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 NAND/AND module can be patched as:
- **two NOT gates**,
- **one NOT gate** and **one 2- or 3-input NAND/AND gate**,
- **one 2-input NAND/AND gate** and **one 2- or 3-input NAND/AND gate**, or,
- **one 4-input NAND/AND gate**.

Gate one has three inputs, the second has two. The inputs on gate one is normalised in a 1>2>3 fashion for efficient cable and time-saving patching. The inputs on gate two has also been normalised 1>2, with the AND out from gate one in turn being normalised to input 1 on gate two.

Dimensions	
Height:	**3U** [128.5mm],
Width:	**4HP** [20mm],
Depth:	**45mm** (with power cable attached)
Weight:	35g (approx w/cable)

Current consumption	
+12V rail	**max 28mA** (@10V input signal)*
-12V rail	**0V**
+5V rail	**no +5V** supply required
	**(14mA @ 5V input signal)*

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:	100k ohm
Audio Signal **output**:	1k ohm
CV input:	n/a

Patch ideas:

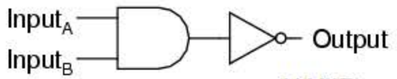
below i've included some inspiring words of things to rey with the module; and, as ever, experiment – RYO modules are designed with all necessary protection and fail-safes so you can just start plugging in patch cables and see what happens!

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 upcoming info on the RYO resources section of the to be soon made available website)

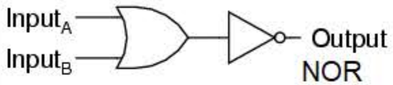
Window Comparator:
using an AND gate, you can effectively perform window comparator operations using 2 bipolar signals where the positive portions of either of the inputs are swapped with the negative portions of the other input.

Equivalent gate circuit



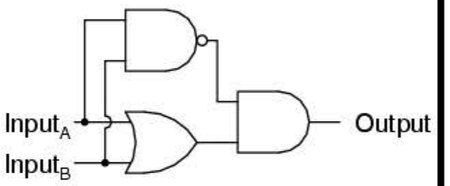
NAND

Equivalent gate circuit

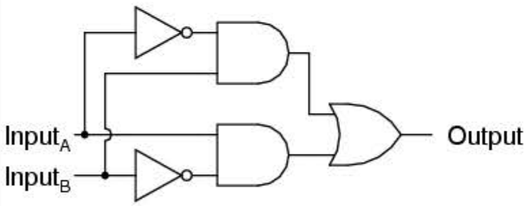


NOR

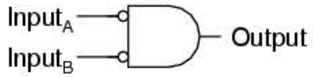
Exclusive-OR equivalent circuit



Exclusive-OR equivalent circuit

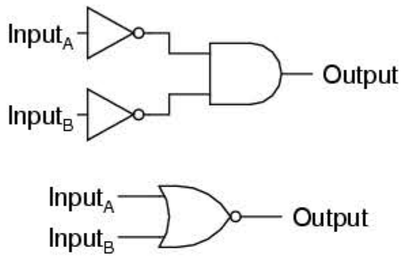


2-input Negative-AND gate

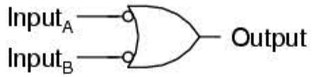


A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Equivalent gate circuits

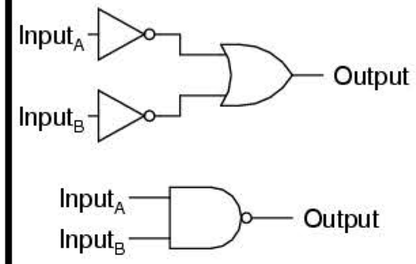


2-input Negative-OR gate

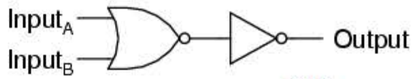


A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

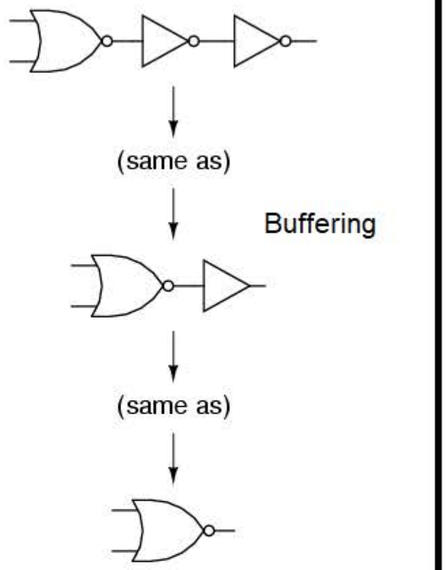
Equivalent gate circuits



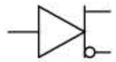
Equivalent circuit



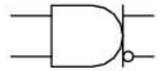
OR



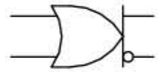
Complementary buffer



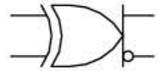
Complementary AND gate



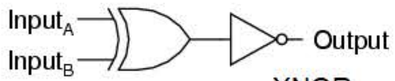
Complementary OR gate



Complementary XOR gate

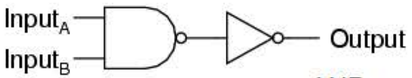


Equivalent gate circuit

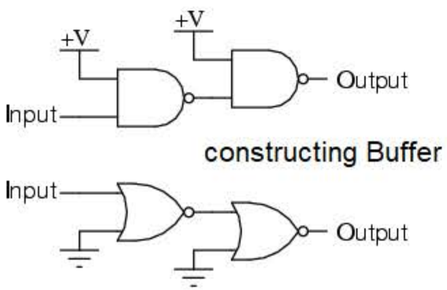


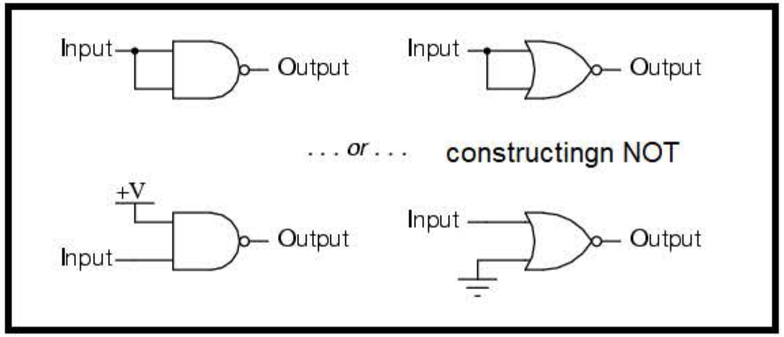
XNOR

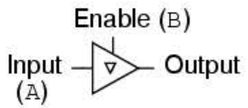
Equivalent circuit



AND



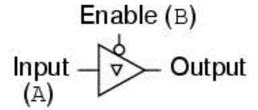




Truth table

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

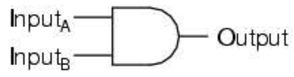
Tristate buffer with inverted enable input



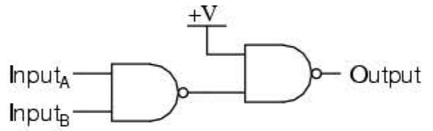
Truth table

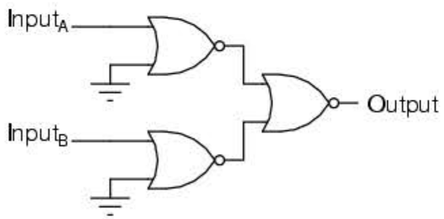
A	B	Output
0	0	0
0	1	High-Z
1	0	1
1	1	High-Z

2-input AND gate

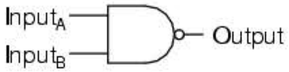


A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

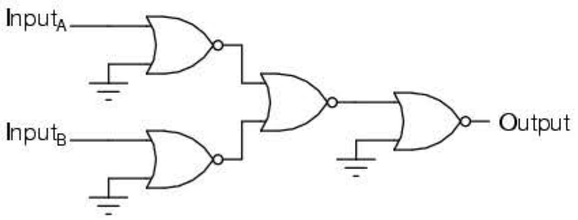




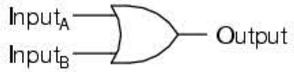
2-input NAND gate



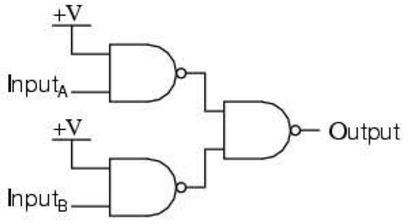
A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

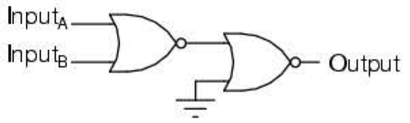


2-input OR gate

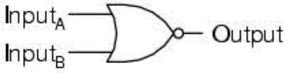


A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1





2-input NOR gate



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