Intro to Digital Logic

Logic Gates

By Apowware

Ref. Digital Design Principles & Practices (4th Ed.) John F. Wakerly

Introduction

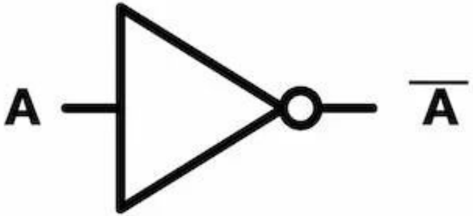
A logic gate is an elementary building block of a digital circuit. Most logic gates have two inputs and one output. At any given moment, every terminal is in one of the two binary conditions low (0) or high (1), represented by different voltage levels (3.3V/5V). The logic state of a terminal can, and generally does, change over time as the circuit processes data.

Basic Logic Gates

NOT Gate

The output is the INVERSE of the input. If the input is HIGH (1), the output is LOW (0), and vice versa.

Z = A’



2 input NOT gate

A	$\overline{A}$
0	1
1	0

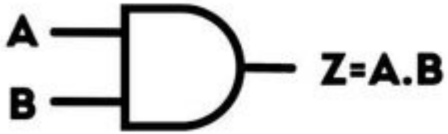
AND Gate

The output is HIGH (1) only if ALL inputs are HIGH (1). Otherwise, the output is LOW (0).

Z = AB

Z = A.B

symbol + notation



*output = Z

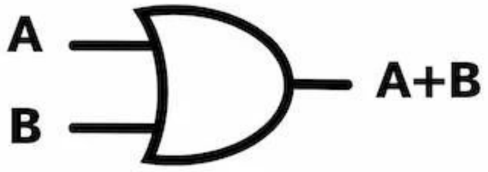
truth table

A	B	Z=A.B
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate

The output is HIGH (1) if AT LEAST ONE input is HIGH (1). Otherwise, the output is LOW (0).

Z = A + B



2 input OR gate

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

NAND Gate

The output is LOW (0) only if ALL inputs are HIGH (1). It's the inverse of an AND gate.

Z = (AB)’

$$X = \overline{A.B}$$

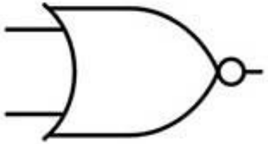
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

The output is HIGH (1) only if ALL inputs are LOW (0). It's the inverse of an OR gate.

$Z = (A + B)'$

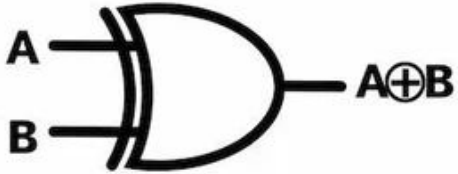
NOR



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

XOR Gate

The output is HIGH (1) if the inputs are DIFFERENT. The output is LOW (0) if the inputs are the SAME.



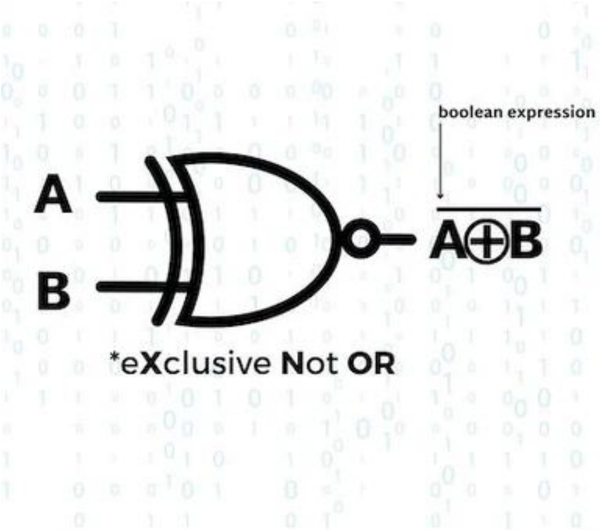
*eXclusive OR

2 input XOR gate

A	B	A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

XNOR Gate

The output is HIGH (1) if the inputs are the SAME. The output is LOW (0) if the inputs are DIFFERENT. It's the inverse of an XOR gate.



2 input XNOR gate

A	B	$\overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

Conclusion

Digital logic gates are fundamental components that enable the complex operations of modern digital technology. By combining these basic gates, engineers can create intricate circuits capable of performing everything from simple arithmetic to highly complex data processing. Understanding their behavior and truth tables is the first step in comprehending the digital world around us.