Digital Logic Tips

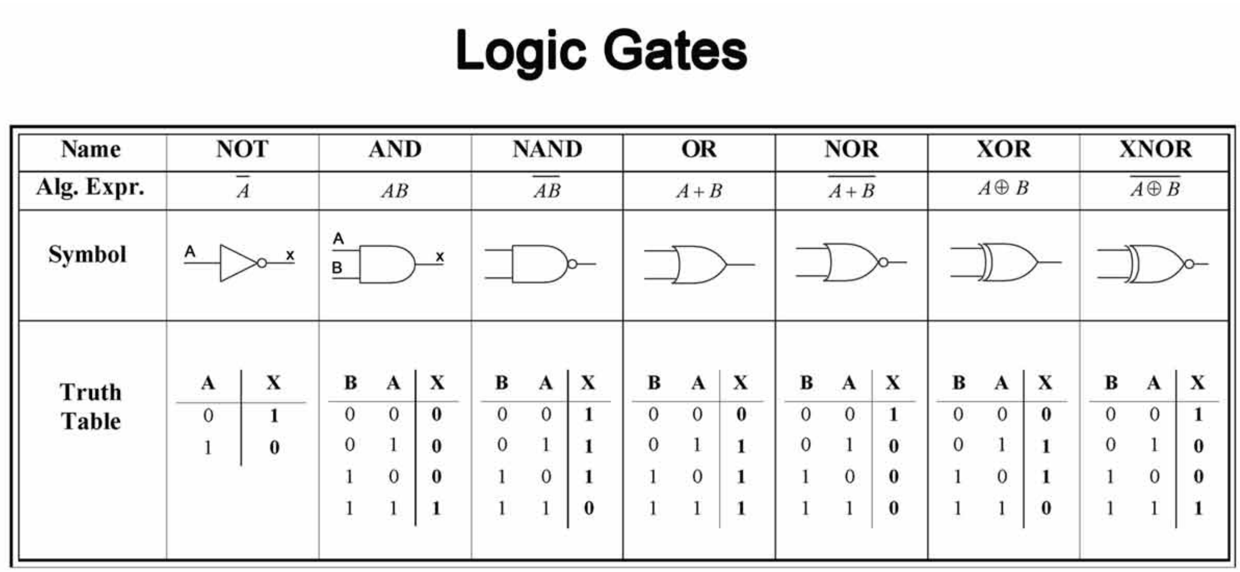
Introduction

Digital logic is the foundation of all computer systems today. It is the simplification of digital circuits into single logical gates. An easier way of thinking about digital logic, is that it breaks down complex computer logic into simple true and false statements. These true and false statements are expressed in terms of logic gates, and inputs and outputs. The inputs and outputs are represented in 1's and 0's, 1 representing true, and 0 representing false. There are two types of digital logic, however for this specific event we will be solely focusing on one type, and that is **combinational digital logic.** Combinational digital logic is dependent only on the information given at the present, and does not depend on previous inputs.

Logic Operators

Within combinational logic circuits there are 5 important gates these gates symbolize the basic building blocks of digital circuits. These logical gates, represent simple combinations of 1's and 0's, and each gate behaves differently based on your input and output. There is also a logical unit called a **NOT gate**, this gate is designed to invert whatever your input is. Below is a chart of the most commonly used logic gates, as well as their input/output tables, which are commonly known as **Truth Tables**.

Below you may see a simple logical gate, with an added clear circle at the end of the operator. This circle symbolizes the combinations of a NOT gate and that specific gate, for example a NOT gate and an AND gate combined form the below illustrated NAND gate. You will notice that X column, or the outputs, of the NAND gate are an inverse of the original AND gate X column. This really illustrates the inverting property of a NOT gate.



Logic Gates

Name	NOT	AND	NAND	OR	NOR	XOR	XNOR
Alg. Expr.	$\overline{A}$	AB	$\overline{AB}$	$A+B$	$\overline{A+B}$	$A \oplus B$	$\overline{A \oplus B}$
Symbol	A x	A B x					
Truth Table	A X 0 1 1 0	B A X 0 0 0 0 1 0 1 0 0 1 1 1	B A X 0 0 1 0 1 1 1 0 1 1 1 0	B A X 0 0 0 0 1 1 1 0 1 1 1 1	B A X 0 0 1 0 1 0 1 0 0 1 1 0	B A X 0 0 0 0 1 1 1 0 1 1 1 0	B A X 0 0 1 0 1 0 1 0 0 1 1 1

Figure 1 | Logic Gate Table

Application

AND Gate

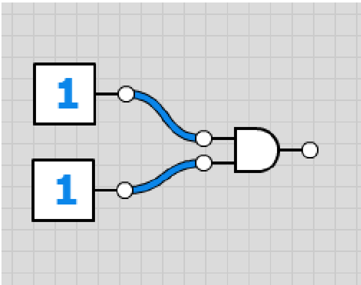


Figure 2 | AND Gate

Inputs: 1 & 1

Output: 1

The inputs for the AND gate above are both 1.

The output, after reviewing the truth table you'll notice is also 1. This AND gate with two inputs is an example of a one stage logic circuit. Since these logic gates are the building blocks of computer logic, you can also build them on top of each other!

Below you see the same AND gate as before, however now there is an attached NOT gate, making it a 2-stage digital circuit! From the AND gate, we see from the above example that our output is 1. Now, since that 1 is moving into the NOT gate, after reviewing the truth table for NOT gates you'll notice that the output is a 0.

Thus, the output for the entire 2 stage circuit is 0.

Inputs: 1 & 1

Output: 1

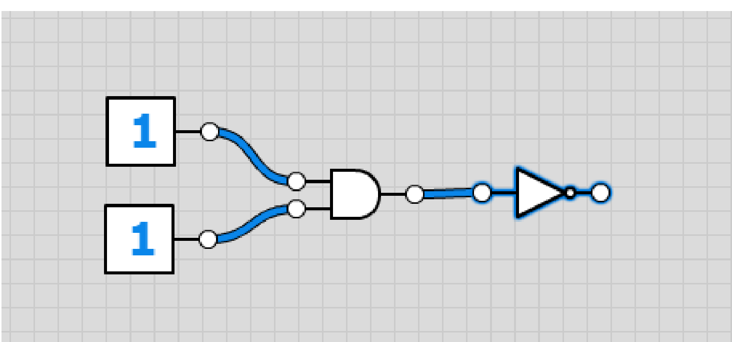


Figure 3 | AND Gate with An Inverter