Logic Gates

Introduction

Logic gates process signals which represent **true** or **false**. Normally, the positive supply voltage +5V represent true and 0V represents false. Other terms which are used for the true and false states are shown in the table. It is best to be familiar with them all.

Logic States	
True	False
1	0
High	Low
On	Off
+5V	0V

Gates are identified by their function: AND, OR, NOT, NAND, NOR, EX-OR and EX-NOR. Capital letters are normally used to make it clear that the term refers to a logic gate.

The above said logic gates can be classified into following categories:

1. Basic Logic Gates
    a. AND Gate
    b. OR Gate
    c. NOT Gate
2. Universal Gates
    a. NAND Gate
    b. NOR Gate
3. Combinational Gates
    a. X-OR Gate
    b. X-NOR Gate

The basic operations are described below with the aid of truth tables.

Basic Logic Gates

AND Gate

The AND gate is an electronic circuit that gives a **high** output (1) only if **all** its inputs are high. A dot (.) is used to show the AND operation i.e. A.B. Bear in mind that this dot is sometimes omitted i.e. AB.

2 Input AND gate		
A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1

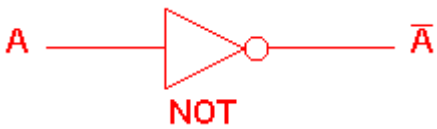
OR Gate

The OR gate is an electronic circuit that gives a high output (1) if **one or more** of its inputs are high. A plus (+) is used to show the OR operation.

2 Input OR gate		
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

NOT gate

The NOT gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an *inverter*. If the input variable is A, the inverted output is known as NOT A. This is also shown as A', or A with a bar over the top, as shown at the outputs.



NOT gate	
A	$\overline{A}$
0	1
1	0

Universal Gates

NAND Gate

This is a NOT-AND gate which is equal to an AND gate followed by a NOT gate. The outputs of all NAND gates are high if **any** of the inputs are low. The symbol is an AND gate with a small circle on the output. The small circle represents inversion.

2 Input NAND gate		
A	B	$\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

This is a NOT-OR gate which is equal to an OR gate followed by a NOT gate. The outputs of all NOR gates are low if **any** of the inputs are high. The symbol is an OR gate with a small circle on the output. The small circle represents inversion.

2 Input NOR gate		
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Combinational Gates

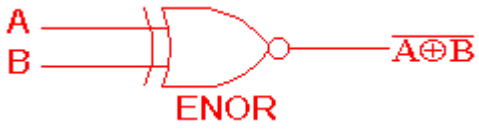
X-OR Gate

The '**Exclusive-OR**' gate is a circuit which will give a high output if **either, but not both**, of its two inputs are high. An encircled plus sign (⊕) is used to show the X-OR operation.

2 Input EXOR gate		
A	B	A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

X-NOR Gate

The '**Exclusive-NOR**' gate circuit does the opposite to the X-OR gate. It will give a low output if **either, but not both**, of its two inputs are high. The symbol is an X-OR gate with a small circle on the output. The small circle represents inversion.



2 Input EXNOR gate		
A	B	$\overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

Table 1: Logic Gate Symbols

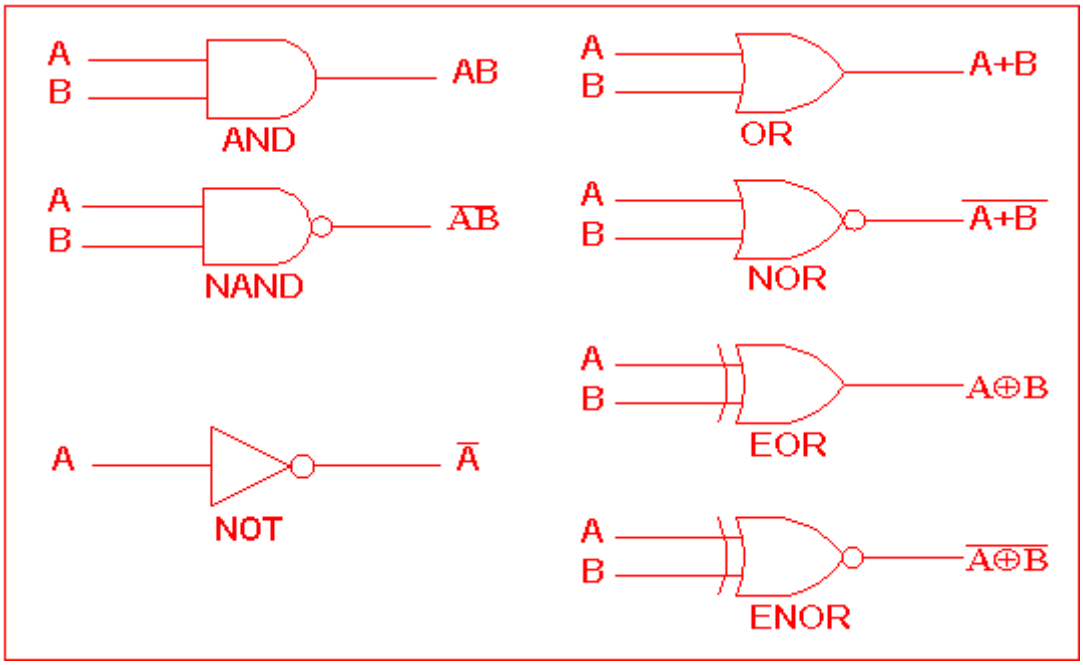


Table 2 is a summary truth table of the input/output combinations for the NOT gate together with all possible input/output combinations for the other gate functions.

Table 2: Logic gates representation using the Truth table

NOT gate	
A	$\overline{A}$
0	1
1	0

INPUTS		OUTPUTS					
A	B	AND	NAND	OR	NOR	EXOR	EXNOR
0	0	0	1	0	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	0	1	0	0	1