A

References

1- Digital Design, by Morris Mano.

2- Introduction to Logic Design, by Alan Marcovitz.

3- Digital Principles and Application, by Malvino & Leach

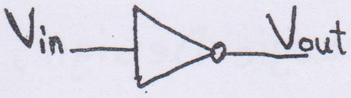
4- Fundamental Logic Design, by Roth.

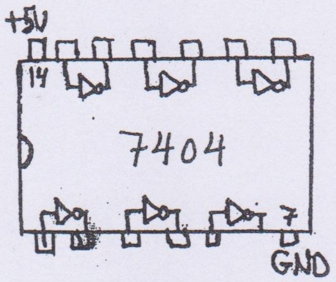
B

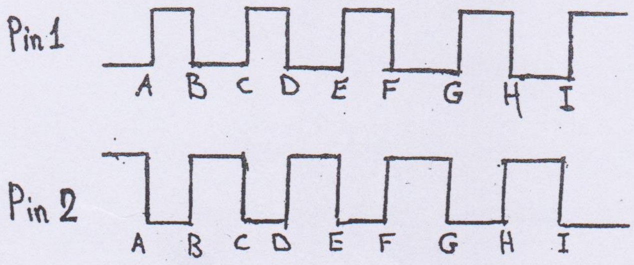
Inverters

An Inverter is a gate with only one input and one output. It is called an inverter because the output state is always opposite the input state. Specifically, when the input voltage is high, the output is low. On the other hand, when the input voltage is low, the output is high.

V_{in}	V_{out}
0	1
1	0

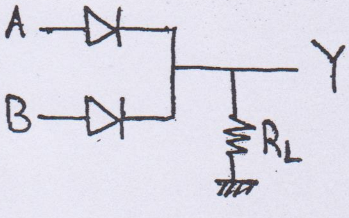






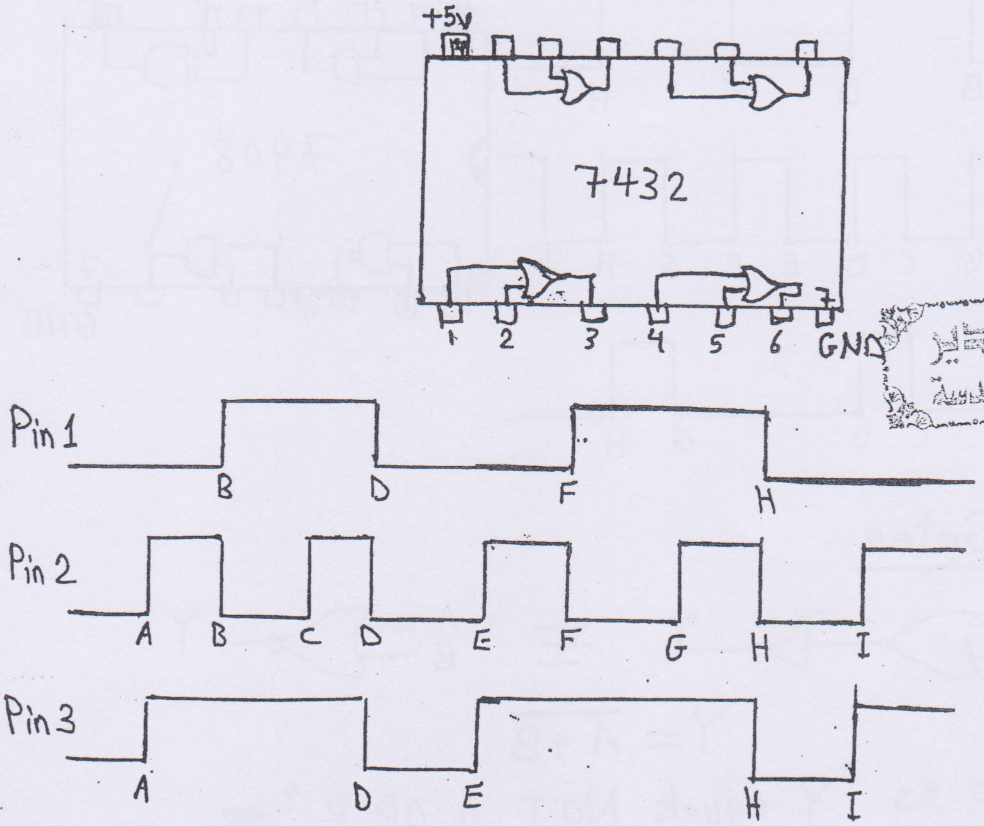
OR Gates

An OR gate has two or more input signals but only one output signal. It is called an OR gate because the output voltage is high if any <u>or</u> all of the input voltages are high.



A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

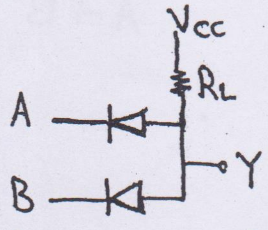
Logic Symbol



AND Gates

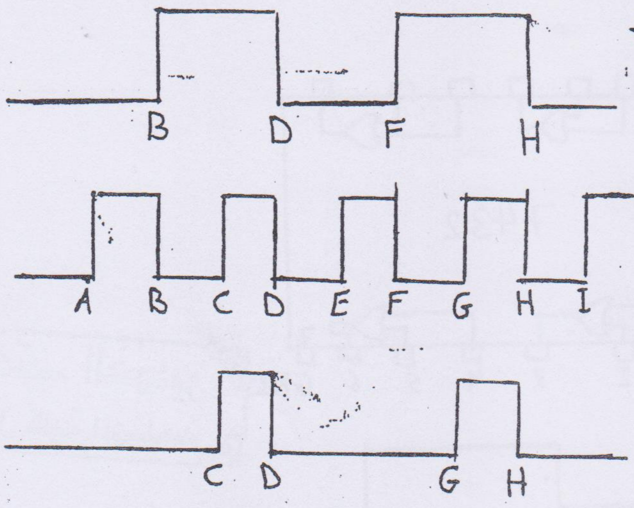
The AND Gate has a high output only when all inputs are high.

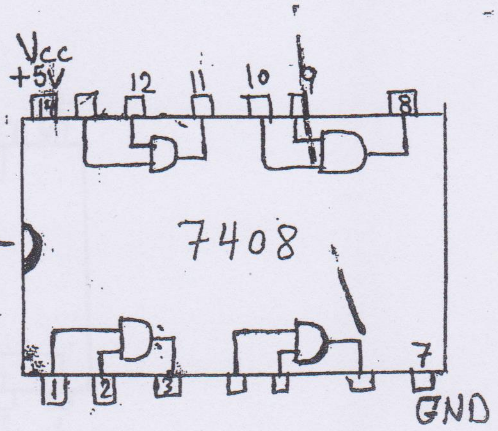
In other words, the AND gate is an all-or nothing gate; a high output occurs only when all inputs are high.



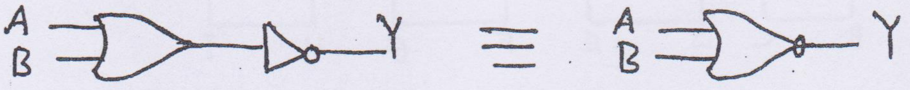
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

D





NOR Gates



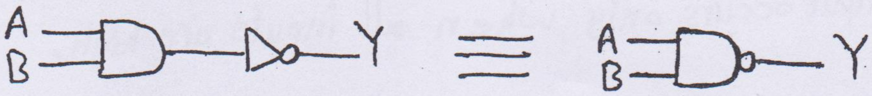
$$Y = \overline{A + B}$$

Read this as "Y equals NOT A OR B" ~~or~~
the only way to get a high output is to have both inputs low

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

$$\overline{A + B} = \bar{A}\,\bar{B}$$

NAND Gates



$$Y = \overline{AB}$$

Read this as "Y equals NOT A AND B"
the only way to get a low output is for both inputs to be high.

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$$\overline{AB} = \bar{A} + \bar{B}$$

F

Chapter Two

Boolean Algebra and Logic Gates

We define three operators of switching algebra (Boolean algebra) and then develope a number of properties of switching algebra:

OR (written as +)

a+b (read a OR b) is 1 if and only if (iff) a=1 or b=1 or both.

AND (written as • or simply two variables catenated)

a.b = ab (read a AND b) is 1 iff a=1 and b=1.

NOT (written ¯)

$\bar{a}$ (read NOT a) is 1 iff a=0.

The term complement is sometimes used instead of NOT. The operation is also referred to as inversion, and the device implementing it is called an inverter.

ab is often referred to as a product term and a+b as a sum term.

a	b	a+b
0	0	0
0	1	1
1	0	1
1	1	1

a	b	ab
0	0	0
0	1	0
1	0	0
1	1	1

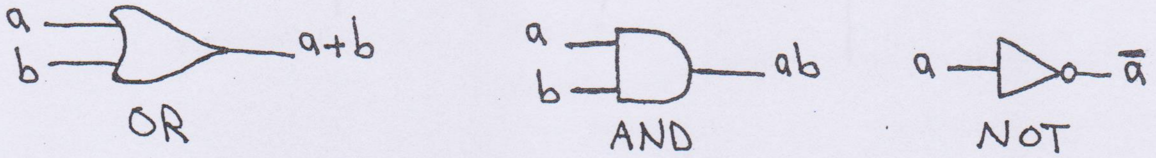
a	$\bar{a}$
0	1
1	0

P1a. $a+b = b+a$ P1b. $ab = ba$ (commutative property)

P2a. $a+(b+c) = (a+b)+c$ P2b. $a(bc) = (ab)c$ (associative law)

Logic Gates

A gate is a circuit with one output that implements one of the basic functions, such as the OR and AND. Gates are available with two inputs, as well as three, four, and eight inputs. The symbols most commonly used are shown below.



Basic Properties of Boolean Algebra

P3a. $a+0 = a$ P3b. $a.1 = a$

P4a. $a+1 = 1$ P4b. $a.0 = 0$

P5a. $a+\bar{a} = 1$ P5b. $a.\bar{a} = 0$

P6a. $a+a = a$ P6b. $a.a = a$

Each of these equalities is <u>bidirectional</u>

P7. $\overline{(\bar{a})} = a$

P8a. $a(b+c) = ab+ac$ P8b. $a+bc = (a+b)(a+c)$

(Distributive law)

Truth table to prove Property 8b.

a	b	c	bc	LHS	a+b	a+c	RHS
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1