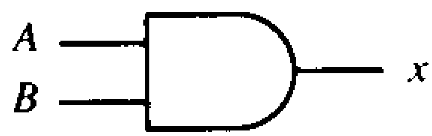
Digital Logic Gates

Logic gates are hardware blocks that produce signals equivalent to a binary 1 or 0 depending upon their input signals that are also equivalent to binary 1's or 0's.

Each gate has a distinct name and graphic symbol i.e.

AND gate:

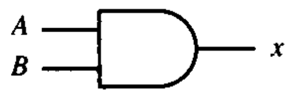
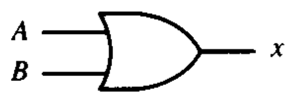
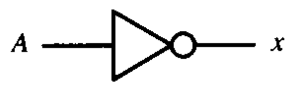


The operation of each gate can be described with an algebraic expression. i.e.

$$x = A \bullet B$$

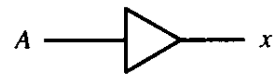
Alternatively, the operation can be described using a truth table i.e.

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

Name	*Graphic symbol*	*Algebraic function*	*Truth table*
AND		$x = A \cdot B$ or $x = AB$	A B x 0 0 0 0 1 0 1 0 0 1 1 1
OR		$x = A + B$	A B x 0 0 0 0 1 1 1 0 1 1 1 1
Inverter		$x = A'$	A x 0 1 1 0

All digital functions can be implemented using these three gates**.**

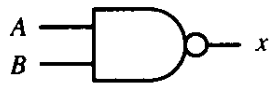
Buffer



$x = A$

A	x
0	0
1	1

NAND



$x = (AB)'$

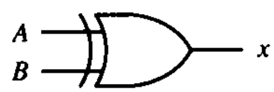
A	B	x
0	0	1
0	1	1
1	0	1
1	1	0

NOR

$x = (A + B)'$

A	B	x
0	0	1
0	1	0
1	0	0
1	1	0

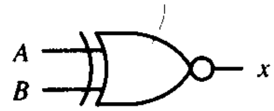
Exclusive-OR (XOR)



$x = A \oplus B$
or
$x = A'B + AB'$

A	B	x
0	0	0
0	1	1
1	0	1
1	1	0

Exclusive-NOR or equivalence



$x = (A \oplus B)'$
or
$x = A'B' + AB$

A	B	x
0	0	1
0	1	0
1	0	0
1	1	1

Axioms and Theorems of Boolean Algebra

(1) Identity for +

x + 0 = x

(2) Identity for •

x • 1 = x

(3) Dominator for +

x + 1 = 1

(4) Dominator for •

x • 0 = 0

(5) Idempotence

x + x = x

(6) Idempotence

x • x = x

(7) Complements

x + x’ = 1

(8) Complements

x • x’ = 0

(9) Commutative

x + y = y + x

(10) Commutative

x • y = y • x

(11) Associative

x + (y + z) = (x + y) + z

(12) Associative

x • (y • z) = (x • y) • z

(13) Distribution of • over +

x • (y + z) = x • y + x • z

(14) Distribution of + over •

x + (y • z) = (x + y) • (x + z)

(15) DeMorgan’s

(x + y)’ = x’ • y’

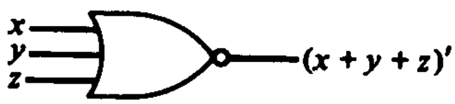
(16) DeMorgan’s

(x • y)’ = x’ + y’

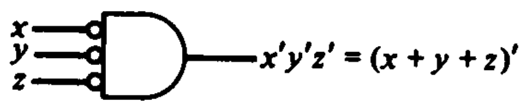
(17) Involution

(x’)’ = x

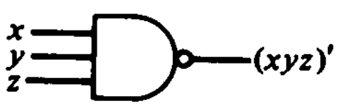
NOR and NAND gates



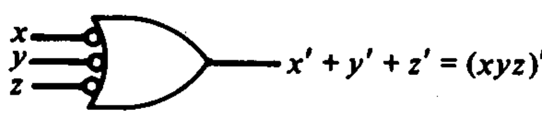
(a) OR-invert



(b) invert-AND



(a) AND-invert



(b) invert-OR