Logic Gates

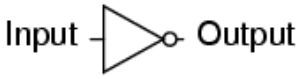
A logic gate is a small device that takes one or two input signals and produces a single output. Each logic gate has a **truth table** that describes the output given from a given set of inputs.

NOT Gate

Description: Inverts the signal.

Boolean Algebra: Output = $\overline{A}$

NOT gate truth table



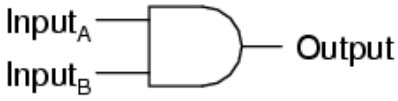
Input	Output
0	1
1	0

AND Gate

Description: Outputs a positive signal only if both A **and** B are positive.

Boolean Algebra: Output = $A.B$

2-input AND gate



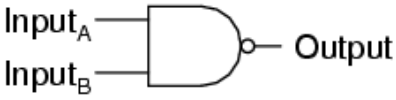
A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

NAND Gate

Description: Inverts the output of a normal AND gate.

Boolean Algebra: Output = $\overline{A.B}$

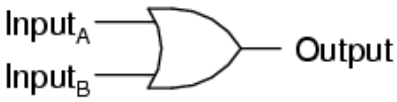
2-input NAND gate



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

OR Gate

2-input OR gate



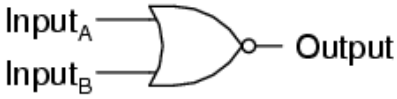
Description: Outputs a positive signal if A **or** B **or** both are positive

Boolean Algebra – Output = $A + B$

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

NOR Gate

2-input NOR gate



Description: Inverts the output of a normal OR gate.

Boolean Algebra: Output = $\overline{A + B}$

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

XOR Gate

Exclusive-OR gate

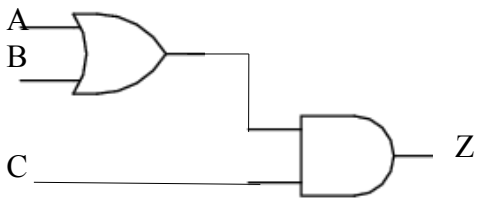
Description: Exclusive OR. Outputs a positive signal if A **or** B is positive but not if both are positive.

Boolean Algebra – Output = $A \oplus B$

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

Combining Logic Gates

You can combine a number of logic gates to produce a desired output. For example a warning light in a car will illuminate if either of the doors is open (labelled A and B) and the key is in the ignition (labelled C).



A	B	C	Z
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Boolean Algebra: $Z = (A + B).C$

Boolean Algebra

Boolean Algebra is a way of calculating or representing logic gates without the need for diagrams. The rules of boolean algebra are largely the same as traditional algebra.

e.g. (A+B).C = A.C + B.C

Running through the truth table will give the same output as above.

De Morgan's Laws

De Morgan's Laws are a way of dealing with negative logical operators.

NOT (P OR Q) = (NOT P) AND (NOT Q) $\overline{P+Q} = \overline{P}.\overline{Q}$

NOT (P AND Q) = (NOT P) OR (NOT Q) $\overline{P.Q} = \overline{P} + \overline{Q}$

This allows you to deal with multiple 'bars':

$\overline{\overline{A} + BC} = \overline{\overline{A}} + \overline{BC} = A + \overline{BC}$