

DIGITAL ELECTRONICS AND LOGIC GATES

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DIGITAL ELECTRONICS AND LOGIC GATES

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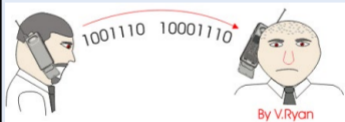
WHAT IS DIGITAL ELECTRONICS?

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Electronic devices such as mobile phones and computers depend on digital electronics. In fact, most electronics about the home and in industry depend on digital electronics to work.

Digital electronics is normally based on 'logic circuits. These depend on pulses of electricity to make the circuit work. For instance, if current is present - this is represented as '1'. If current is not present, this is represented as '0'. Digital electronics is based on a series of 1s and 0s.

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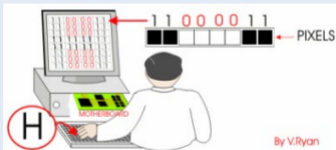


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The various parts of a computer communicate through the use of electronic pulses (1s and 0s). Consequently digital logic circuits are ideal for the internal electronics. The main part of the computer is the motherboard. This is a complex piece of electronics that processes all the important data. For instance, when word processing, it is very important to display letters and words on the monitor. The motherboard generates the individual letters on the monitor by sending a series of 1s and 0s to the screen.

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LOGIC GATES

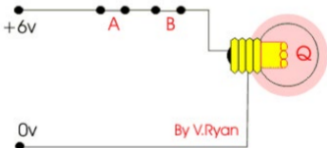
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LOGIC circuits are normally composed of 'gates'. A combination of gates make up a circuit and some digital circuits can be extremely complex. It is the logic gates that produce pulses of electrical current (1s and 0s).

At school level, digital logic circuits are relatively simple. Below is a simple AND gate.

Both switch A **AND** B must be closed, for current to flow through the bulb and illuminate it.

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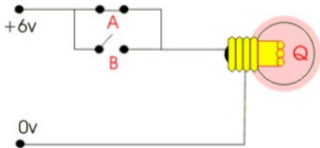


LOGIC GATES

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The simplified **OR** gate shown below has two inputs, switch A and switch B. The bulb 'Q' will light, if either switch A or B are closed. This will allow current to flow through the bulb, illuminating the filament.

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THE ROLE OF TRANSISTORS

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Transistors are used as very fast switches in digital logic circuits. Transistors are normally so small, that hundreds of thousands fit on one processing chip, on a computer motherboard. The types of transistors used in school projects are normally large enough to fit on the end of a small finger. However, the way they are switched on and off is the same ([click here for transistor information sheets](#)) . When a transistor is switched on it produces a '1' and when it is switched off it produces a '0'.

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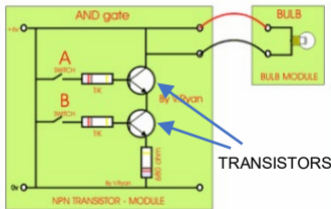


TRANSISTORS AND LOGIC GATES

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This is an **AND** gate circuit. Both switches 'A' and 'B' must be pressed together for the bulb to light. If you construct this circuit, you may need to alter the value of the resistors. This will depend on the type of transistors used and whether to bulb or an LED is used.

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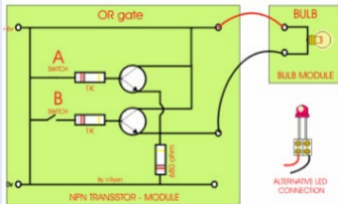


TRANSISTORS AND LOGIC GATES

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This is an **OR** gate circuit. Either switch 'A' or 'B' must be pressed for the bulb to light. The switches do not have to be pressed together.

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BASIC LOGIC TABLES

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A range of logic gates exist and they are represented as symbols, each with its own truth table (sometimes called a logic table). Gates have inputs and produce outputs and these are in the form of 1s and 0s. Remember, a 1 represents an input or output of electrical current. Each truth table clearly shows the 'state' of inputs and outputs at any one time. Study the symbols and tables on the next few slides. You will soon find, that they can be combined to design interesting logic circuits.

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AND GATE

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The AND gate will only output current (produce a 1 at Q) if both logic states at inputs A and B change to 1.

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AND gate

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

INPUT

OUTPUT



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NAND GATE

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The NAND gate has the opposite outputs to the AND gate. How does the NAND gate symbol differ to the AND gate?

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NAND gate

A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

INPUT

OUTPUT



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OR GATE

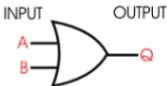
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The OR gate will output current at Q if either of the logic states of inputs A and B change to 1.

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OR gate

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1



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NOR GATE

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The NOR gate has the opposite outputs to the OR gate. How does the NOR gate symbol differ to the OR gate?

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NOR gate

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0



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INVERTER GATE

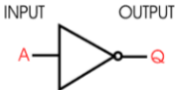
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The INVERTER gate reverses input. For example, if the input is 1 then the output is 0. This is a very useful gate especially when designing logic circuits.

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INVERTER gate

A	Q
0	1
1	0



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ALTERNATIVE REPRESENTATIONS OF LOGIC GATES

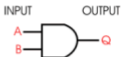
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LOW / HIGH

AND gate

A	B	Q
LOW	LOW	LOW
LOW	HIGH	LOW
HIGH	LOW	LOW
HIGH	HIGH	HIGH



ON / OFF

AND gate

A	B	Q
OFF	OFF	OFF
OFF	ON	OFF
ON	OFF	OFF
ON	ON	ON



TRUE / FALSE

AND gate

A	B	Q
FALSE	FALSE	FALSE
FALSE	TRUE	FALSE
TRUE	FALSE	FALSE
TRUE	TRUE	TRUE



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EXAMPLE OF A LOGIC CIRCUIT

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In manufacturing industry, safe use of machines is very important.

This saw has been fitted with a logic circuit. The guard must be in the correct position and the 'ON' switch is pressed simultaneously, before the machine will work. This means the saw is safe to use.

Go to the next slide for the logic circuit diagram

Tap the image for information/exercises



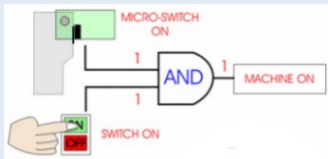
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Tap the image for information/exercises



AND gate

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1



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THE 4081B LOGIC CIRCUIT

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AUTOMATIC ANIMAL FEEDER. A micro-switch (pressure pad) is used as one input device and a dark sensing circuit as the other.

The **AND** gate has two inputs. If both are activated - the dark sensor and the micro-switch - the logic state of the output changes to high and the motor releases food to the hungry dog.

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Go to the next slide for the logic diagram



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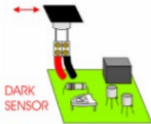
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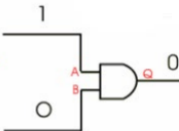
THE 4081B LOGIC CIRCUIT

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MICRO-SWITCH



AND gate

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

INPUT

OUTPUT



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THE 4081B LOGIC CIRCUIT

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Tap the link button for a detailed explanation of the 4081 LOGIC CIRCUIT



Tap the link button for an examination question



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ADVANCED DIGITAL LOGIC CIRCUIT EXAMPLES

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