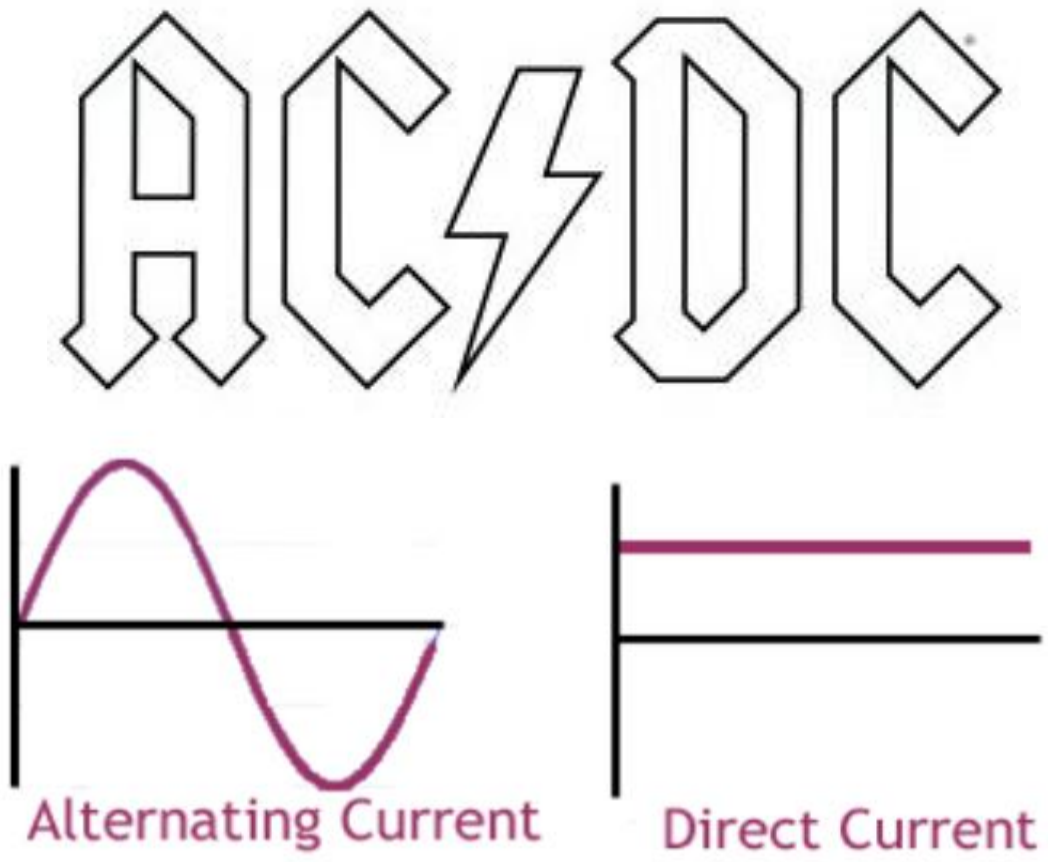
ANALOGUE ELECTRONICS

SYMBOLS

Mike Doyle
September 14, 2016

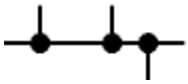


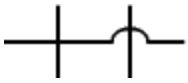
Circuit symbols are used in circuit diagrams showing how a circuit is connected together. The actual layout of the components is usually quite different from the circuit diagram.

To build a circuit you need a different diagram showing the layout of the parts on breadboard for temporary circuits), stripboard or printed circuit board.

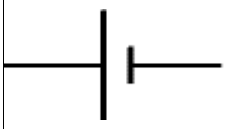
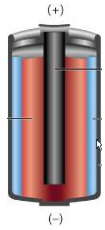
Wire and connection symbols

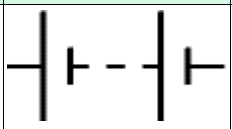
Wire		
Conductor: Connects components and passes current easily from one part of a circuit to another.		

Wires Joined	
A 'blob' or “node” should be drawn where wires are connected (joined), but it is sometimes omitted. Wires connected at 'crossroads' should be staggered slightly to form two T-junctions, as shown on the right.	

Wires not joined	
In complex diagrams it is often necessary to draw wires crossing even though they are not connected. The simple crossing on the left is correct but may be misread as a join where the 'node' has been forgotten. The bridge symbol on the right leaves no doubt!	

Power supply symbols

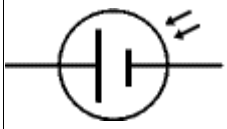
Cell		
Supplies electrical energy. The larger line is positive (+). A single cell is often called a battery, but strictly speaking a battery is two or more cells joined together.		

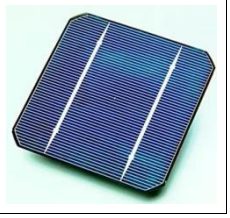
Battery		
Supplies electrical energy. A battery is more than one cell. The larger line is positive (+).		

Solar Cell

Converts light to electrical energy.

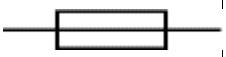
The larger line is positive (+).





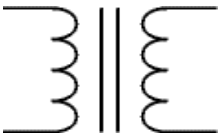
Fuse

A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.



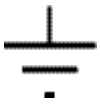
Transformer

Two coils of wire linked by an iron core. Transformers are used to step up (increase) and step down (decrease) AC voltages. Energy is transferred between the coils by the magnetic field in the core, there is no electrical connection between the coils.

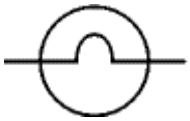


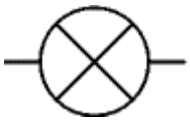
Earth (Ground)

A connection to earth. For some electronic circuits this symbol is used for the 0V (zero volts) of the power supply, but for mains electricity and some radio circuits it really means the earth. It is also known as ground.

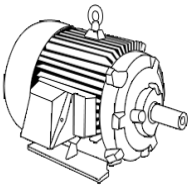


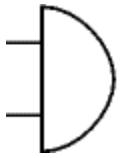
Output device symbols

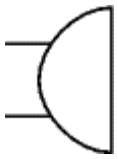
Lamp (lighting)		
A transducer which converts electrical energy to light. This symbol is used for a lamp providing illumination, for example a car headlamp or torch bulb.		

Lamp (indicator)		
A transducer which converts electrical energy to light. This symbol is used for a lamp which is an indicator, for example a warning light on a car dashboard.		

Heater		
A transducer which converts electrical energy to heat.		

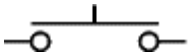
Motor		
A transducer which converts electrical energy to kinetic energy (motion).		

Bell		
A transducer which converts electrical energy to sound.		

Buzzer		
A transducer which converts electrical energy to sound.		

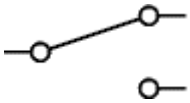
Inductor, Coil, Solenoid		
A coil of wire which creates a magnetic field when current passes through it. There may be an iron core inside the coil. It can be used as a transducer converting electrical energy to mechanical energy by pulling on something magnetically.		

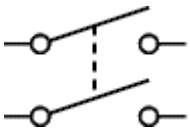
Switch symbols

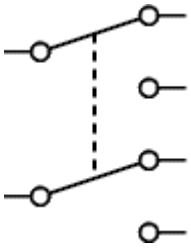
Push-to-make switch		
A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.		

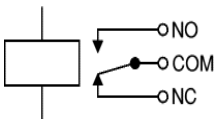
Push-to-break switch		
This type of push switch is normally closed (on), it is open (off) only when the button is pressed.		

SPST, on-off switch		
SPST = Single Pole, Single Throw. Current flows only when the switch is in the closed (on) position.		

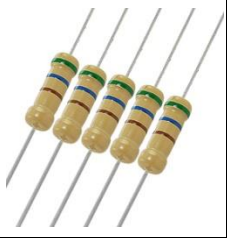
SPDT, 2-way switch		
SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position. Some SPDT switches have a central off position and are described as 'on-off-on'.		

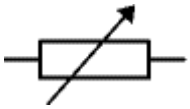
DPST switch		
DPST = Double Pole, Single Throw. A dual on-off switch which is often used to switch mains electricity because it can isolate both the live and neutral connections.		

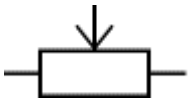
DPDT switch		
DPDT = Double Pole, Double Throw. This switch can be wired up as a reversing switch for a motor. Some DPDT switches have a central off position.		

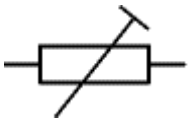
RELAY		
An electrically operated switch, for example a 9V battery circuit connected to the coil can switch an AC mains circuit. The rectangle represents the coil. NO = Normally Open, COM = Common, NC = Normally Closed.		

Resistor symbols

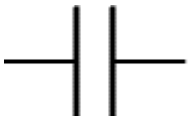
Resistor		
A resistor restricts the flow of charge. Uses include limiting the current passing through an LED, and slowly charging a capacitor in a timing circuit. Some publications use the old resistor symbol 		

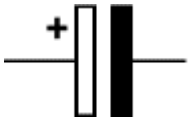
Rheostat variable resistor		
A rheostat has 2 contacts and is usually used to control current. Uses include controlling lamp brightness or motor speed and changing the rate of flow of charge into a capacitor in a timing circuit.		

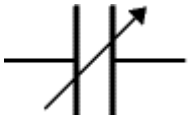
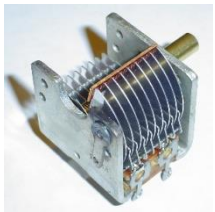
Potentiometer variable resistor		
A potentiometer has 3 contacts and is usually used to control voltage. It can be used like this as a transducer converting position (angle of the control spindle) to an electrical signal.		

Preset variable resistor		
A preset is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment. Presets are cheaper than standard variable resistors so they are sometimes used in projects to reduce the cost.		

Capacitor symbols

Capacitor, unpolarised		
A capacitor stores electric charge. It can be used with a resistor in a timing circuit, for smoothing a supply (it provides a reservoir of charge) and can be used as a filter (blocking DC signals but passing AC signals). Unpolarised capacitors usually have small values, less than 1µF.		

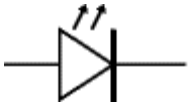
Capacitor, polarised		
A capacitor stores electric charge. Polarised capacitors must be connected the correct way round. They usually have larger values, 1µF and greater. See above for uses.		

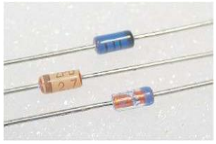
Variable capacitor		
A variable capacitor is used in a radio tuner.		

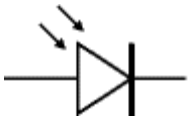
Trimmer variable capacitor		
This type of variable capacitor is designed to be set when a circuit is made and then left without further adjustment.		

Diode symbols

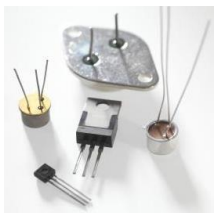
Diode		
A device which allows current to flow in only one direction.		

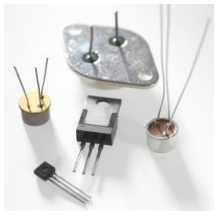
Light Emitting Diode		
A transducer which converts electrical energy to light. Usually abbreviated to LED.		

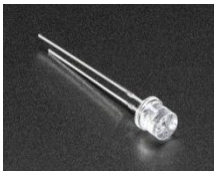
Zener diode		
A zener diode can be used to maintain a fixed voltage.		

Photodiode		
A light-sensitive diode.		

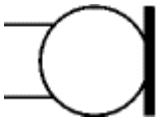
Transistor symbols

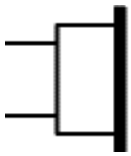
Transistor NPN		
A transistor amplifies current and can be used with other components to make an amplifier or switching circuit. This symbol is for a bipolar junction transistor (BJT), the type you are most likely to use at first.		

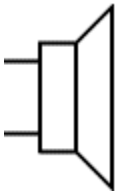
Transistor PNP		
A transistor amplifies current and can be used with other components to make an amplifier or switching circuit. This symbol is for a bipolar junction transistor (BJT), the type you are most likely to use at first.		

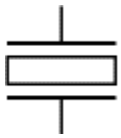
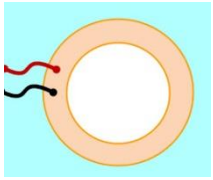
Phototransistor		
A light-sensitive transistor.		

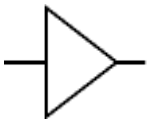
Audio and Radio symbols

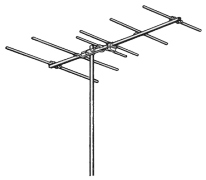
Microphone		
A transducer which converts sound to electrical energy.		

Earphone		
A transducer which converts electrical energy to sound.		

Loudspeaker		
A transducer which converts electrical energy to sound.		

Piezo Transducer		
A transducer which converts electrical energy to sound.		

Amplifier (general symbol)		
An amplifier circuit with one input. Really this is a block diagram symbol because it represents a circuit rather than just one component.		

Aerial (Antenna)		
A device to receive or transmit radio signals. It is also known as an antenna.		

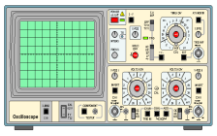
Meters and Oscilloscope

Voltmeter		
Measures voltage. The proper name for voltage is 'potential difference' but voltage is more widely used.		

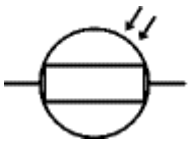
Ammeter		
Measures current.		

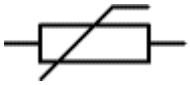
Galvanometer		
A very sensitive meter used to measure tiny currents, usually 1mA or less.		

Ohmmeter		
Measures resistance. Most multimeters have an ohmmeter setting.		

Oscilloscope		
An oscilloscope is used to display the 'shape' of electrical signals - showing how they vary with time. It can be used to measure voltage and time periods.		

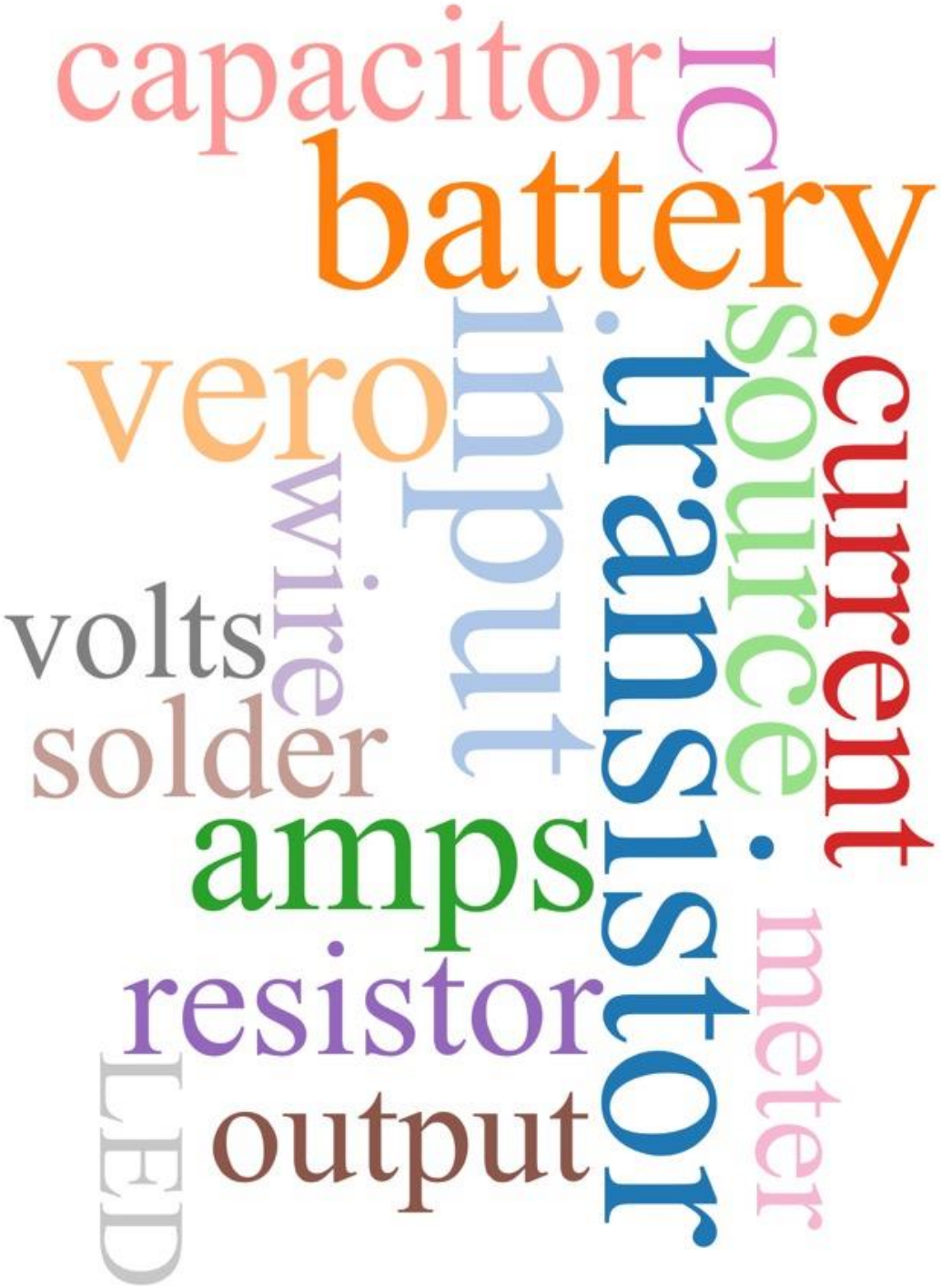
Sensors (input devices)

LDR		
A transducer which converts brightness (light) to resistance (an electrical property). LDR = Light Dependent Resistor		

Thermistor		
A transducer which converts temperature (heat) to resistance (an electrical property).		

DIGITAL ELECTRONICS

SYMBOLS



Introduction

Logic gates process signals which representone of two states either ***true*** or ***false***.

Normally the positive supply voltage +Vs represents true and 0V represents false.

Other terms used for the ***true*** and ***false*** states are shown in the table, it is best to be familiar with them all.

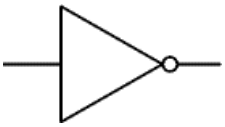
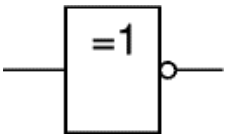
LOGIC STATES	
TRUE	FALSE
1	0
HIGH	LOW
+Vs	0V
ON	OFF

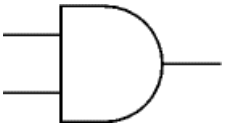
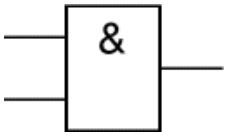
Logic Gates are identified by their function: NOT, AND, NAND, OR, NOR, EX-OR and EX-NOR. Capital letters are normally used to make it clear that the term refers to a logic gate.

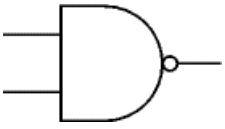
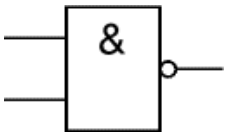
Note that logic gates are not always required because simple logic functions can be performed with switches, transistors or diodes.

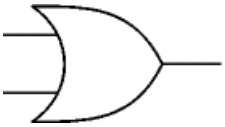
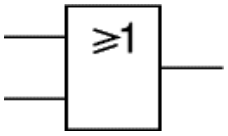
Logic gate symbols

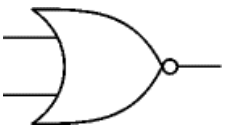
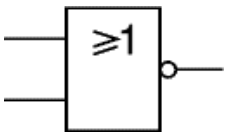
Logic gates process signals which represent ***true*** (1, high, +Vs, on) or ***false*** (0, low, 0V, off). There are two sets of symbols: traditional and IEC (International Electrotechnical Commission). We tend to use Traditional, but must also be able to identify IEC symbols.

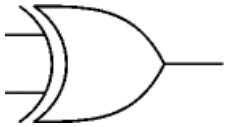
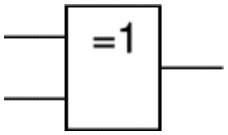
NOT	Traditional	IEC	Truth Table
A NOT gate can only have one input. The 'o' on the output means 'not'. The output of a NOT gate is the inverse (opposite) of its input, so the output is true when the input is false. A NOT gate is also called an inverter.			INPUT | OUTPUT A | X 0 | 1 1 | 0 **BOOLEAN EXPRESSION** $X = \overline{A}$
If the input is low [0] then the output is high [1] – if the input is high [1] the output is low [0]. THE OUTPUT STATE IS ALWAYS THE OPPOSITE OF THE INPUT STATE			

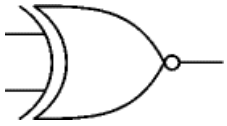
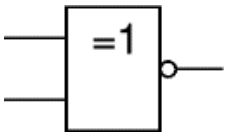
AND	Traditional	IEC	Truth Table
An AND gate can have two or more inputs. The output of an AND gate is true when all its inputs are true.			INPUT | OUTPUT A B | X 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1 **BOOLEAN EXPRESSION** X = A.B
THE OUTPUT STATE IS [1] ONLY WHEN INPUTS A **AND** B ARE [1] THE OUTPUT STATE IS [1] ONLY WHEN ALL INPUTS ARE [1]			

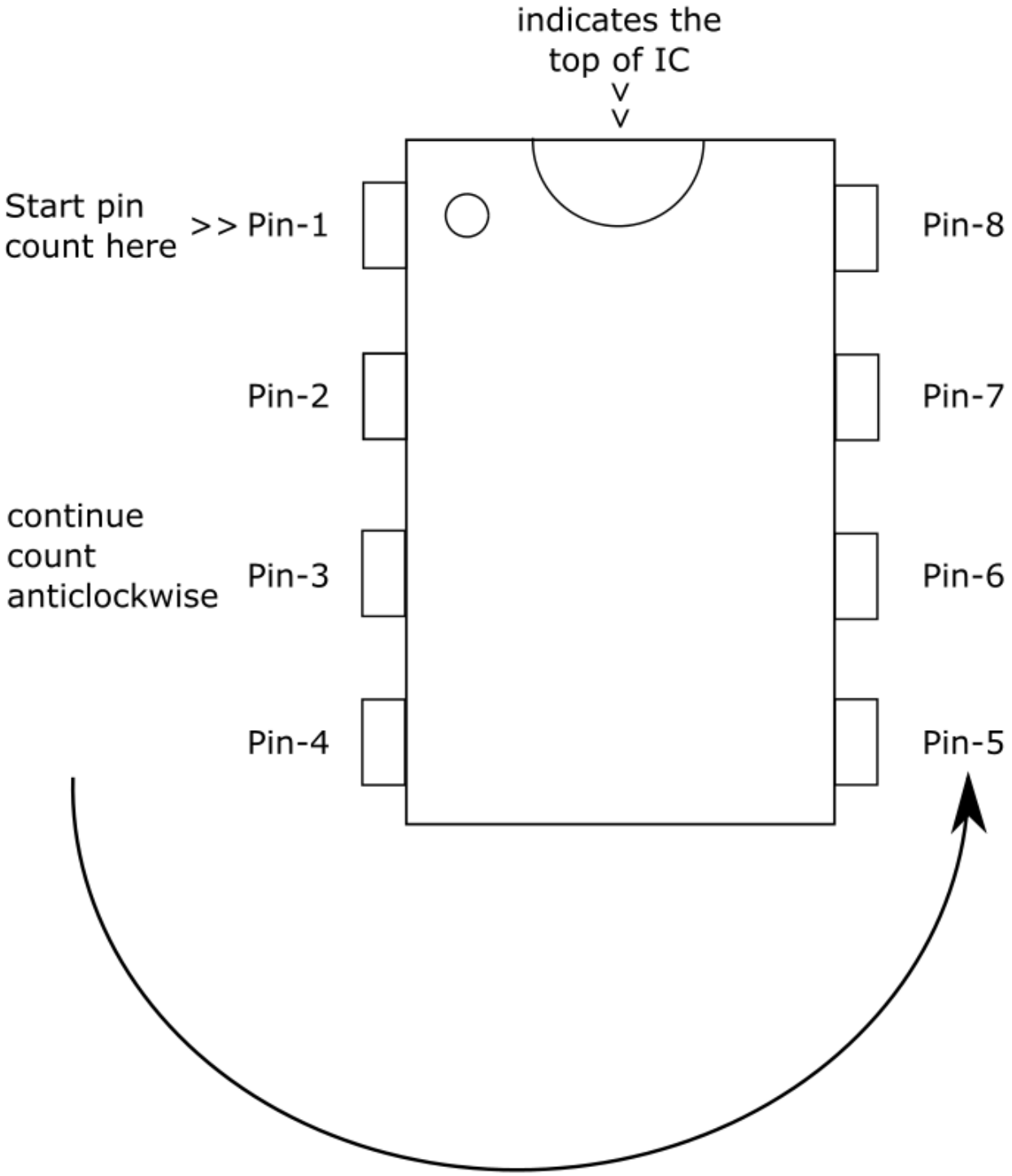
NAND	Traditional	IEC	Truth Table
A NAND gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a **N**ot **AND** gate. The output of a NAND gate is true unless all its inputs are true.			INPUT A B / OUTPUT X 0 0 1 0 1 1 1 0 1 1 1 0 **BOOLEAN EXPRESSION** $X = \overline{A.B}$
THE OUTPUT STATE IS ALWAYS [1] UNLESS A AND B ARE [1]			

OR	Traditional	IEC	Truth Table
An OR gate can have two or more inputs. The output of an OR gate is true when at least one of its inputs is true.			INPUT A B / OUTPUT X 0 0 0 0 1 1 1 0 1 1 1 1 **BOOLEAN EXPRESSION** $X = A+B$
THE OUTPUT WILL BE A [1] WHEN A OR B OR BOTH INPUTS ARE [1] THE OUTPUT WILL BE A [1] WHEN ANY OR ALL INPUTS ARE [1]			

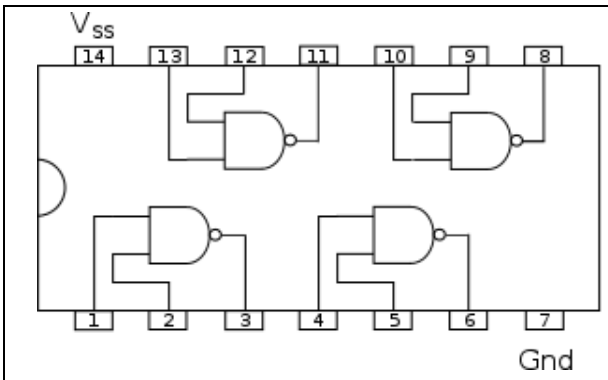
NOR	Traditional	IEC	Truth Table
A NOR gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a **N**ot **OR** gate. The output of a NOR gate is true when none of its inputs are true.			INPUT A B / OUTPUT X 0 0 1 0 1 0 1 0 0 1 1 0 **BOOLEAN EXPRESSION** $X = \overline{A+B}$
THE OUTPUT WILL BE [1] WHEN A AND B ARE [0] THE OUTPUT WILL BE [1] ONLY WHEN ALL INPUTS ARE [0]			

EX-OR	Traditional	IEC	Truth Table
An EX-OR gate can only have two inputs. The output of an EX-OR gate is true when its inputs are different (one true, one false).			INPUT A B / OUTPUT X 0 0 / 0 0 1 / 1 1 0 / 1 1 1 / 0 **BOOLEAN EXPRESSION** $X = A \oplus B$
THE OUTPUT WILL BE [1] WHEN ANY INPUT IS [1] – BUT EXCLUDES WHEN ALL INPUTS ARE [1]			

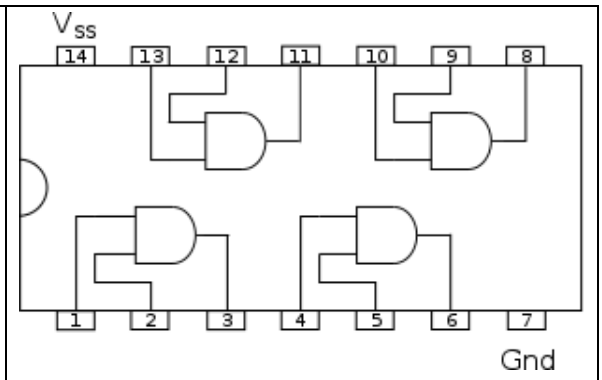
EX-NOR	Traditional	IEC	Truth Table
An EX-NOR gate can only have two inputs. The 'o' on the output means 'not' showing that it is a **N**ot **EX-OR** gate. The output of an EX-NOR gate is true when its inputs are the same (both true or both false).			INPUT A B / OUTPUT X 0 0 / 1 0 1 / 0 1 0 / 0 1 1 / 1 **BOOLEAN EXPRESSION** $X = \overline{A \oplus B}$
THE OUTPUT WILL BE [1] WHEN BOTH INPUTS ARE THE SAME [0] OR [1] THE OUTPUT WILL BE [1] WHEN ALL INPUTS ARE THE SAME [0] OR [1]			


indicates the
top of IC
Start pin
count here
>> Pin-1
Pin-2
Pin-3
Pin-4
Pin-8
Pin-7
Pin-6
Pin-5
continue
count
anticlockwise

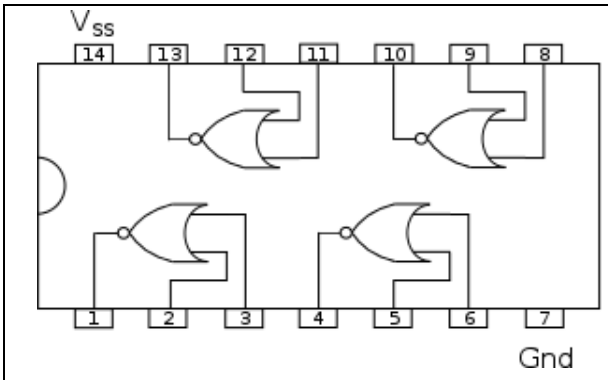
7400 Series TTL Logic IC Pinouts



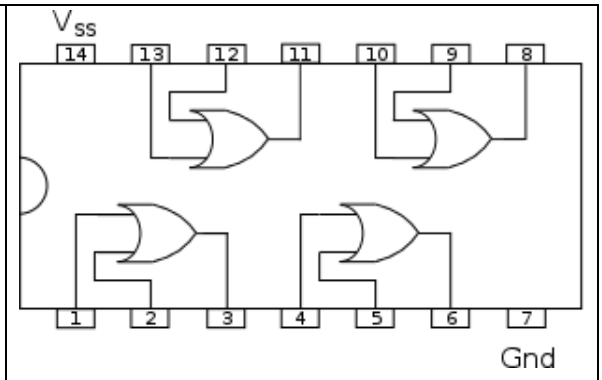
7400 Quad 2-input NAND



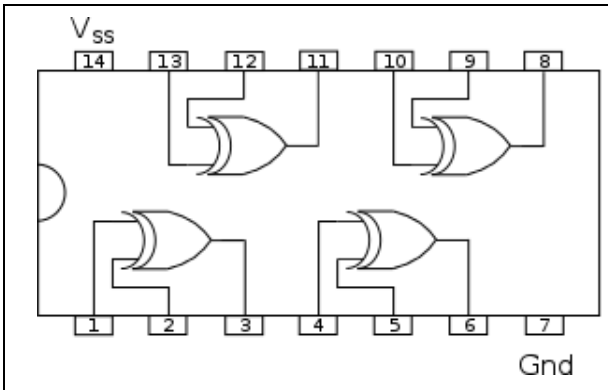
7408 Quad 2-input AND



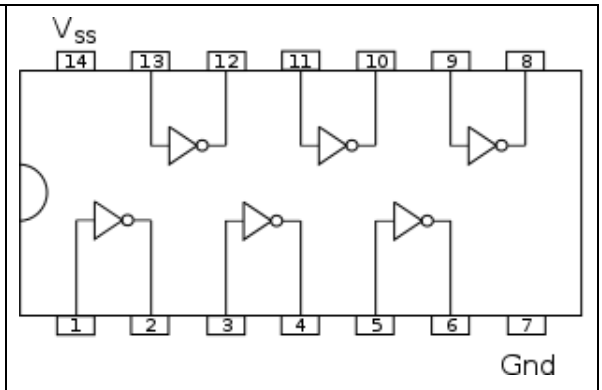
7402 Quad 2-input NOR



7432 Quad 2-input OR

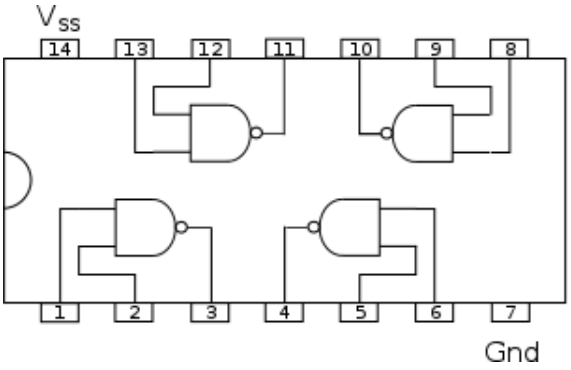


7486 Quad 2-input EX-OR

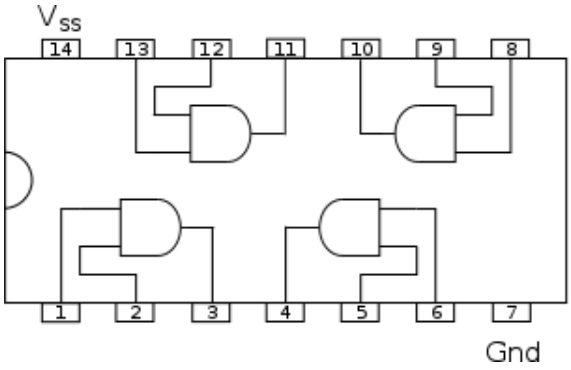


7404 Hex Inverter

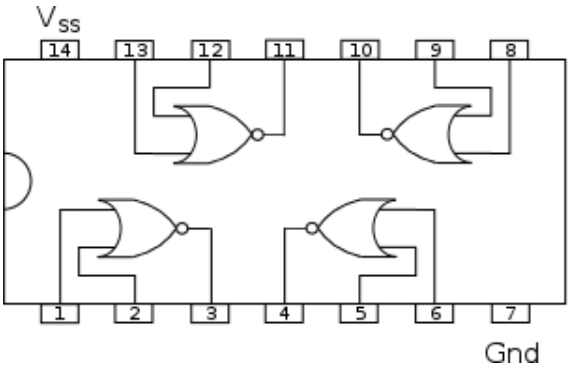
4000 Series CMOS Logic IC Pinouts



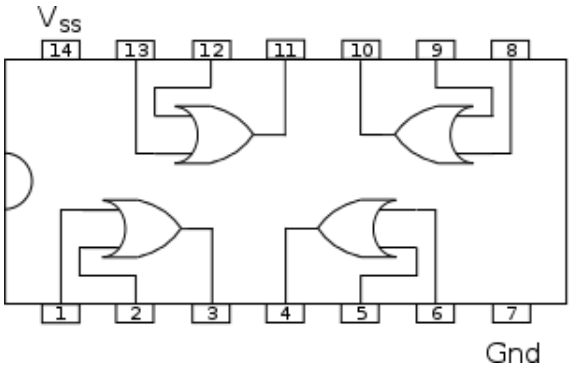
4011 Quad 2-input NAND



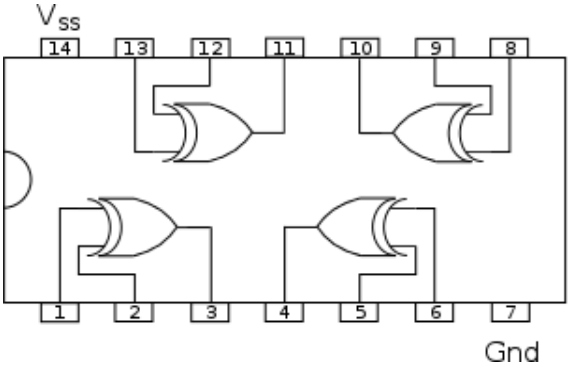
4081 Quad 2-input AND



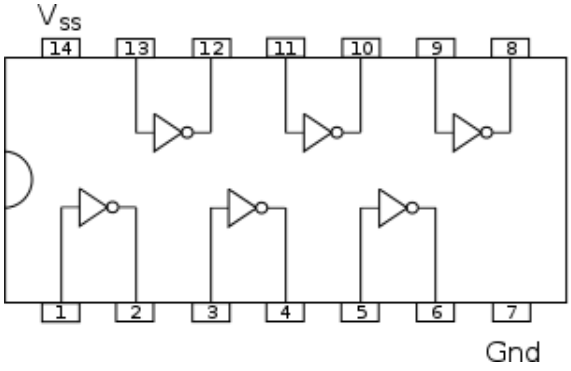
4001 Quad 2-input NOR



4071 Quad 2-input OR



4070 Quad 2-input EX-OR



4069 Hex Inverter