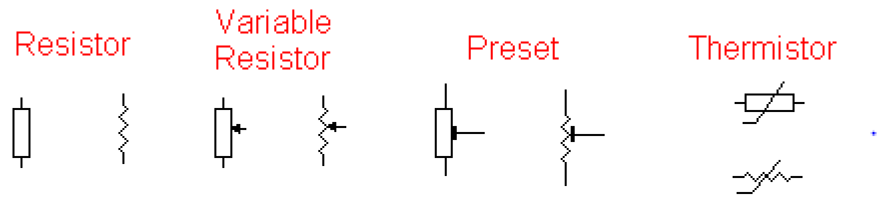
Electronic Components

Resistors

Circuit diagram symbols



Resistors come under passive electronic components and are extensively used in electronic circuits. So important are these components that it may be virtually impossible to build an electronic circuit without involving resistors. Basically the function of a resistor is always to oppose the flow of current through it and the strength of this opposition is termed as its resistance. German physicist, Georg Simon Ohms was able to discover a definite relationship between voltage, current and resistance.

According to him a potential difference or a voltage (V) across a resistor (R) is proportional to the instantaneous current (I) flowing through it and is given as:

Ohms Law

$V = IR$

Here R is the constant of proportionality and is known as the resistance of the resistor.

Capacitor

Circuit diagram symbols

A capacitor consists of two conductors separated by a non-conductive region. The non-conductive region is called the dielectric. In simpler terms, the dielectric is just an electrical insulator. Examples of dielectric media are glass, air, paper, vacuum, and even a semiconductor depletion region chemically identical to the conductors. A capacitor is assumed to be self-contained and isolated, with no net electric charge and no influence from any external electric field. The conductors thus hold equal and opposite charges on their facing surfaces, and the dielectric develops an electric field. In SI units, a capacitance of one farad means that one coulomb of charge on each conductor causes a voltage of one volt across the device. An ideal capacitor is wholly characterized by a constant capacitance C, defined as the ratio of charge ±Q on each conductor to the voltage V between them

$$C = \frac{Q}{V}$$

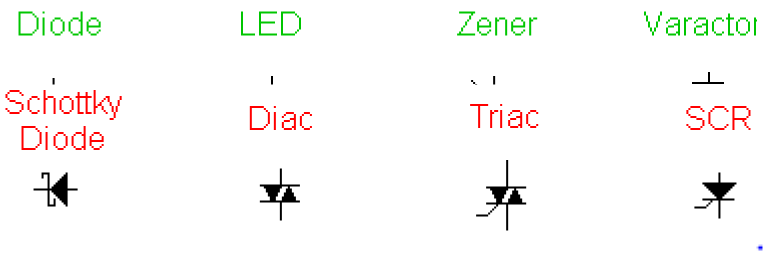
Because the conductors (or plates) are close together, the opposite charges on the conductors attract one another due to their electric fields, allowing the capacitor to store more charge for a given voltage than if the conductors were separated, giving the capacitor a large capacitance.

Sometimes charge build-up affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes:

$$C = \frac{\mathrm{d}Q}{\mathrm{d}V}$$

Diode

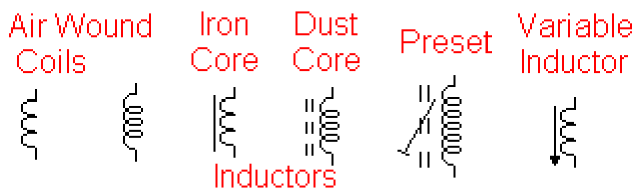
Circuit diagram symbol



In electronics, a diode is a two-terminal electronic component that conducts primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance to the flow of current in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals.
A vacuum tube diode has two electrodes, a plate (anode) and a heated cathode.
Semiconductor diodes were the first semiconductor electronic devices. The discovery of crystals' rectifying abilities was made by German physicist Ferdinand Braun in 1874. The first semiconductor diodes, called cat's whisker diodes, developed around 1906, were made of mineral crystals such as galena. Today, most diodes are made of silicon, but other semiconductors such as selenium or germanium are sometimes used

Inductor

Circuit diagram symbol



An inductor, also called a coil, choke or reactor, is a passive two-terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. When a current flows through it, energy is stored temporarily in a magnetic field in the coil. When the current flowing through an inductor changes, the time-varying magnetic field induces a voltage in the conductor, according to Faraday’s law of electromagnetic induction, According to Lenz's law the direction of induced e.m.f is always such that it opposes the change in current that created it. As a result, inductors always oppose a change in current, in the same way that a flywheel oppose a change in rotational velocity. Care should be taken not to confuse this with the resistance provided by a resistor.

An inductor is characterized by its inductance, the ratio of the voltage to the rate of change of current, which has units of henries (H). Inductors have values that typically range from 1 µH (10−6H) to 1 H. Many inductors have a magnetic core made of iron or ferrite inside the coil, which serves to increase the magnetic field and thus the inductance. Along with capacitors and resistors, inductors are one of the three passive linear circuit elements that make up electric circuits. Inductors are widely used in alternating current (AC) electronic equipment, particularly in radio equipment. They are used to block AC while allowing DC to pass; inductors designed for this purpose are called chokes. They are also used in electronic filters to separate signals of different frequencies, and in combination with capacitors to make tuned circuits, used to tune radio and TV receivers.

Transformer

Circuit diagram symbol

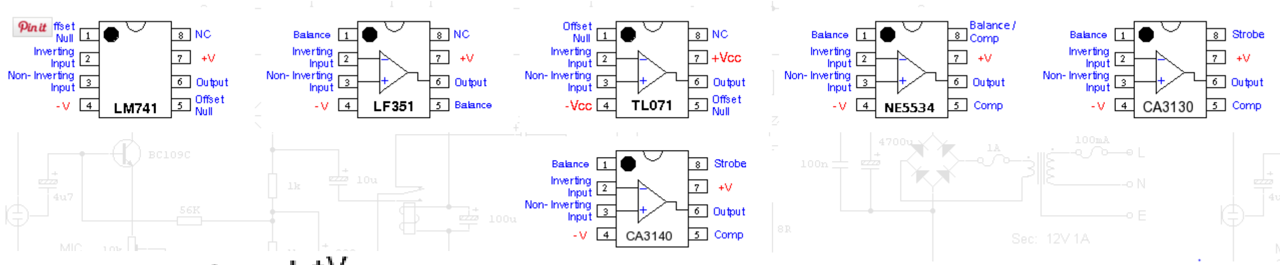
A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force across a conductor which is exposed to time varying magnetic fields. Commonly, transformers are used to increase or decrease the voltages of alternating current in electric power applications.

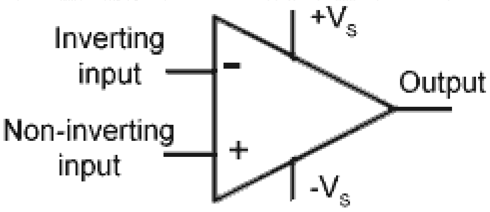
A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying magnetic field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding due to electromagnetic induction. Making use of Faraday's Law (discovered in 1831) in conjunction with high magnetic permeability core properties, transformers can thus be designed to efficiently change AC voltages from one voltage level to another within power networks.

Since the invention of the first constant potential transformer in 1885, transformers have become essential for the transmission, distribution, and utilization of alternating current electrical energy.[3] A wide range of transformer designs are encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume to units interconnecting the power grid weighing hundreds of tons.

Operational Amplifiers (OP-AMPs)

Circuit diagram symbol





An operational amplifier (op-amp) is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output. In this configuration, an op-amp produces an output potential (relative to circuit ground) that is typically hundreds of thousands of times larger than the potential difference between its input terminals.

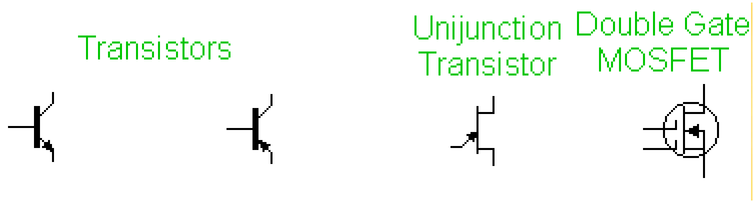
Operational amplifiers had their origins in analog computers, where they were used to do mathematical operations in many linear, non-linear and frequency-dependent circuits. The popularity of the op-amp as a building block in analog circuits is due to its versatility. Due to negative feedback, the characteristics of an op-amp circuit, its gain, input and output impedance, bandwidth etc. are determined by external components and have little dependence on temperature coefficients or manufacturing variations in the op-amp itself.

Op-amps are among the most widely used electronic devices today, being used in a vast array of consumer, industrial, and scientific devices. Many standard IC op-amps cost only a few cents in moderate production volume; however some integrated or hybrid operational amplifiers with special performance specifications may cost over $100 US in small quantities. Op-amps may be packaged as components, or used as elements of more complex integrated circuits.

The op-amp is one type of differential amplifier. Other types of differential amplifier include the fully differential amplifier (similar to the op-amp, but with two outputs), the instrumentation amplifier (usually built from three op-amps), the isolation amplifier (similar to the instrumentation amplifier, but with tolerance to common-mode voltages that would destroy an ordinary op-amp), and negative feedback amplifier (usually built from one or more op-amps and a resistive feedback network).

Transistors

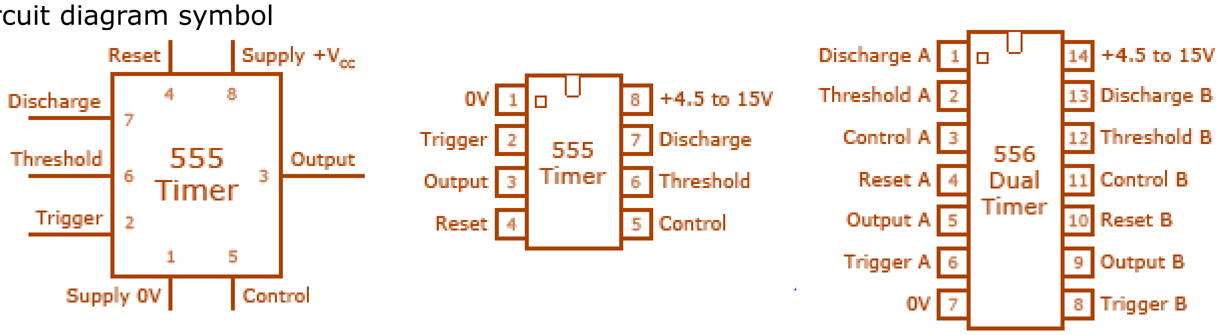
Circuit diagram symbol



A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.
The transistor is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. Following its development in 1947 by American physicists John Bardeen, Walter Brattain, and William Shockley, the transistor revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things. The transistor is on the list of IEEE milestones in electronics, and the inventors were jointly awarded the 1956 Nobel Prize in Physics for their achievement

555 Timers

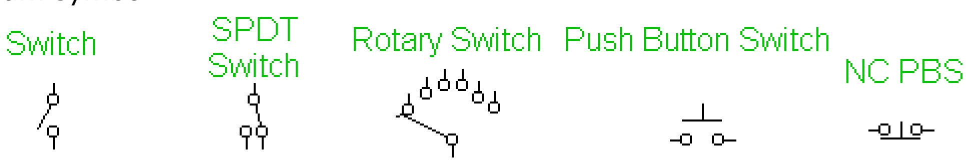
Circuit diagram symbol



The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package.
Introduced in 1971 by American company Signetics, the 555 is still in widespread use due to its low price, ease of use, and stability. It is now made by many companies in the original bipolar and also in low-power CMOS types. As of 2003, it was estimated that 1 billion units are manufactured every year.

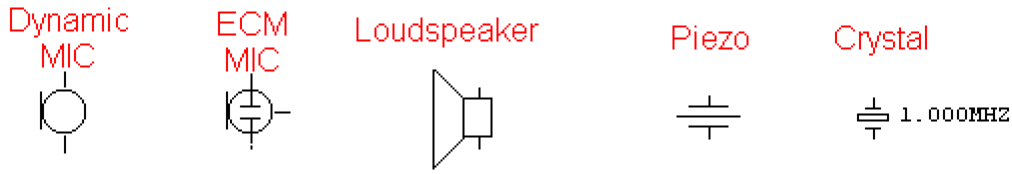
Switches

Circuit diagram symbol



In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), may be operated by a moving object such as a door-operated switch, or may be operated by some sensing element for pressure, temperature or flow. A relay is a switch that is operated by electricity. Switches are made to handle a wide range of voltages and currents; very large switches may be used to isolate high-voltage circuits in electrical substations.

Microphone and speakers



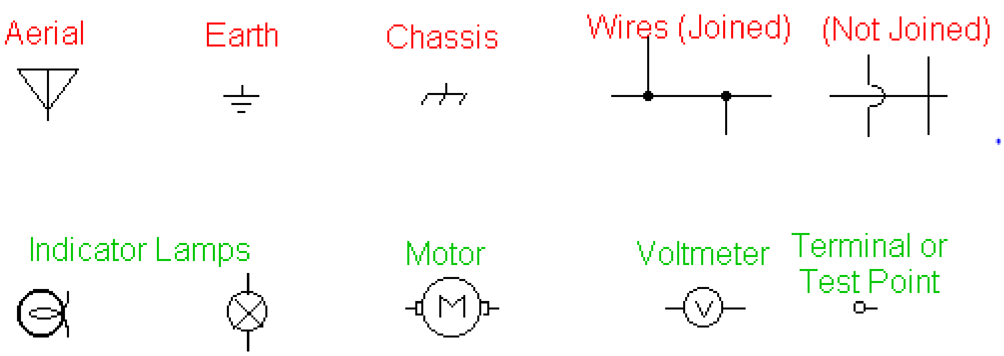
Speaker

A loudspeaker (or loud-speaker or speaker) is an electroacoustic transducer; a device which converts an electrical audio signal into a corresponding sound. The first primitive loudspeakers were invented during the development of telephone systems in the late 1800s, but electronic amplification by vacuum tube beginning around 1912 made loudspeakers truly practical. By the 1920s they were used in radios, phonographs, public address systems and theatre sound systems for talking motion pictures.
The most widely-used type of speaker today is the dynamic speaker, invented in 1925 by Edward W. Kellogg and Chester W. Rice. The dynamic speaker operates on the same basic principle as a dynamic microphone, but in reverse, to produce sound from an electrical signal. When an alternating current electrical audio signal input is applied through the voice coil, a coil of wire suspended in a circular gap between the poles of a permanent magnet, the coil is forced to move rapidly back and forth due to Faraday's law of induction, which causes a diaphragm (usually conically shaped) attached to the coil to move back and forth, pushing on the air to create sound waves. Besides this most common method, there are several alternative technologies that can be used to convert an electrical signal into sound. The sound source (e.g., a sound recording or a microphone) must be amplified with an amplifier before the signal is sent to the speaker.
Speakers are typically housed in an enclosure which is often a rectangular or square box made of wood or sometimes plastic. Where high fidelity reproduction of sound is required, multiple loudspeakers may be mounted in the same enclosure, each reproducing a part of the audible frequency range (picture at right). In this case the individual speakers are referred to as "drivers" and the entire unit is called a loudspeaker. Miniature loudspeakers are found in devices such as radio and TV receivers, and many forms of music players. Larger loudspeaker systems are used for music, sound reinforcement in theatres and concerts, and in public address systems.

Microphone

A microphone, colloquially mic or mike (/ˈmaɪk/), is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal. Electromagnetic transducers facilitate the conversion of acoustic signals into electrical signals. Microphones are used in many applications such as telephones, hearing aids, public address systems for concert halls and public events, motion picture production, live and recorded audio engineering, two-way radios, megaphones, radio and television broadcasting, and in computers for recording voice, speech recognition, VoIP, and for non-acoustic purposes such as ultrasonic checking or knock sensors.
Most microphones today use electromagnetic induction (dynamic microphones), capacitance change (condenser microphones) or piezoelectricity (piezoelectric microphones) to produce an electrical signal from air pressure variations. Microphones typically need to be connected to a preamplifier before the signal can be amplified with an audio power amplifier and a speaker or recorded.

Wires connectors etc..



Identifying Components

Device Numbering Systems

Semiconductor devices are classified by the manufacturer using a unique part numbering system. There are many systems in use, but here are some popular schemes in detail; the European based Pro-electron system, the American based JEDEC system and the Japenese based JIS system. Major manufacturers introduce their own schemes as well.

<u>JEDEC Numbering System</u>
The JEDEC system, (**J**oint **E**lectron **D**evice **E**ngineering **C**ouncil. This system has the following format:

digit, letter, serial number, [suffix]

The first digit designates the amount of P-N junctions in the device. So a device starting with "2" would contain 2 P-N junctions and would most likely be either a transistor or a FET. Common part numbers are listed below:
1. Diodes
2. Bipolar transistors or Field Effect Transistors
3. Double Gate MOSFETS, SCR's
4. Opto Couplers

The letter is always "N", and the remaining figures contain the device serial number.

The serial number runs from 100 to 9999 and indicates nothing about the transistor.

If a suffix is present then this indicates the gain group as below:

A = low gain
B = medium gain
C = high gain
No suffix = ungrouped (any gain).

So for example, 1N4001 would be a diode and 3N201 would be a double gate MOSFET.

<u>Pro-Electron Numbering System</u>
This system uses the following format:
two letters, [letter], serial number, [suffix]
specifies the semiconductor material :

A Germanium
B Silicon
C Gallium Arsenide
R Compound Materials

specifies the type of device :
A Diode, low power or signal
B Diode, variable capacitance
C Transistor, audio frequency low power
D Transistor, audio frequency power
E Diode, tunnel
F Transistor, high frequency low power
G Miscellaneous devices

H Diode, sensitive to magnetism
K Hall effect device
L Transistor, high frequency power
N Photocoupler
P Light detector
Q Light emitter
R Switching device, low power e.g. thyristor, diac, unijunction etc
S Transistor, low power switching
T Switching device power, e.g. thyristor, triac, etc.
U Transistor, switching power
W Surface acoustic wave device
X Diode, multiplier, e.g. varactor
Y Diode, rectifying
Z Diode, voltage reference

If present this indicates that the device is intended for industrial or professional rather than commercial applications. It is usually a W,X,Y or Z. Examples- BFY51.

The serial number runs from 100-9999.

If a suffix is present then this indicates the gain group as below:

JIS System
The **J**apanese **I**ndustrial **S**tandard has the following format:

digit, two letters, serial number, [suffix]

Digit:
This indicates the amount of p-n junctions as in the JEDEC code.

Letters:
The letters indicate the intended application for the device according to the following code:

SA: PNP HF transistor
SB: PNP AF transistor
SC: NPN HF transistor
SD: NPN AF transistor
SE: Diodes
SF: Thyristors
SG: Gunn devices
SH: UJT
SJ: P-channel FET/MOSFET
SK: N-channel FET/MOSFET
SM: Triac
SQ: LED
SR: Rectifier
SS: Signal diodes
ST: Diodes
SV: Varicaps
SZ: Zener diodes

Serial Number:
The serial number runs from 10-9999.

Suffix:
The (optional) suffix indicates that the type is approved for use by various Japanese

organizations.

Major Manufacturers
Major manufacturers often produce their own code and numbering scheme for commercial reasons. The following abbreviations represent some of the larger semiconductor manufacturers:

MJ: Motorolla power, metal case
MJE: Motorolla power, plastic case
MPS: Motorolla low power, plastic case
MRF: Motorolla HF, VHF and microwave transistor
RCA: RCA
RCS: RCS
TIP: Texas Instruments power transistor (platic case)
TIPL: TI planar power transistor
TIS: TI small signal transistor (plastic case)
ZT: Ferranti
ZTX: Ferranti

Common examples include: TIP32A, MJE3055, ZTX302