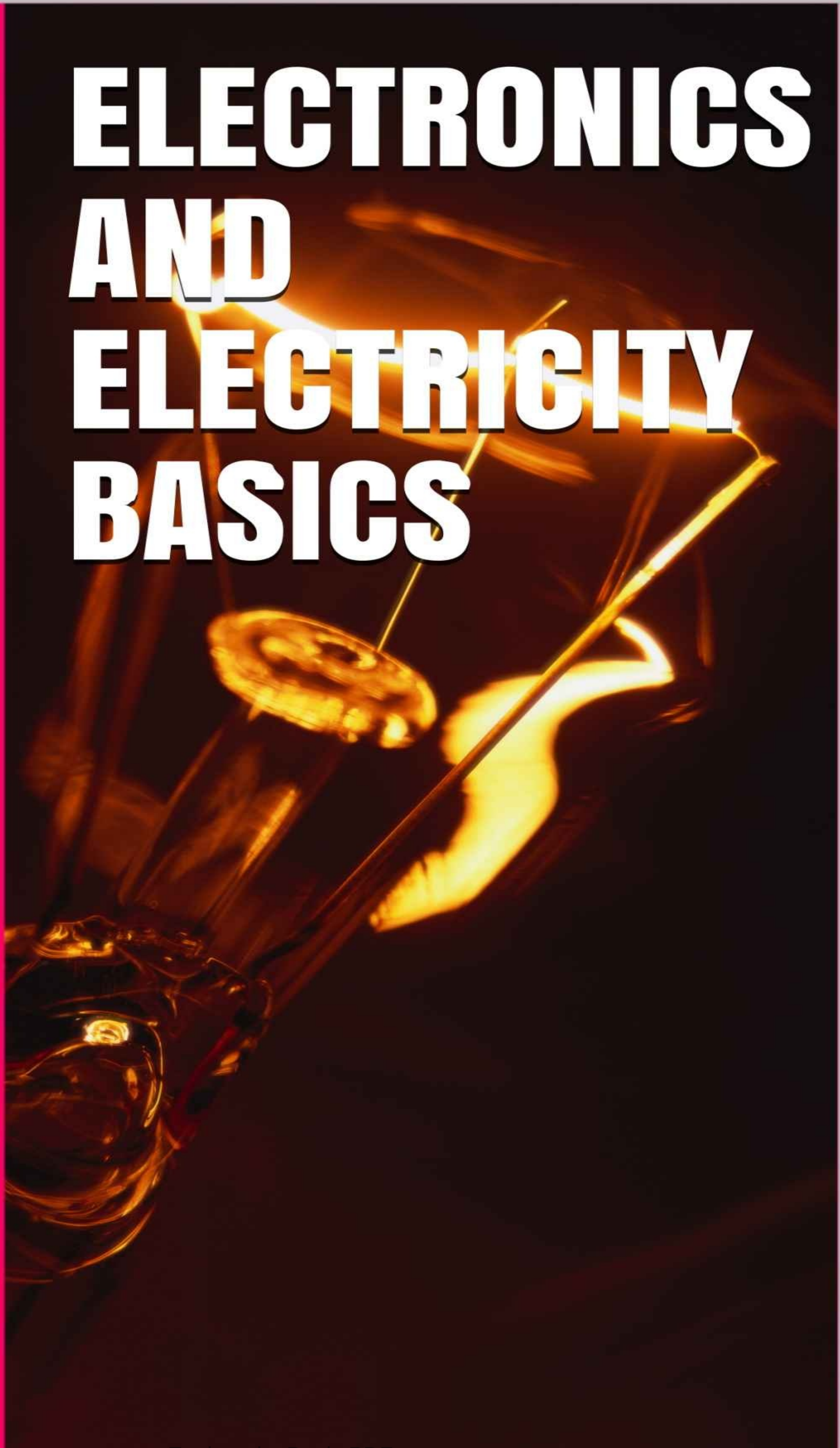
ELECTRONICS AND ELECTRICITY BASICS



N.C.R.T EDUCATION COUNCIL

Electronics And Electricity Basics
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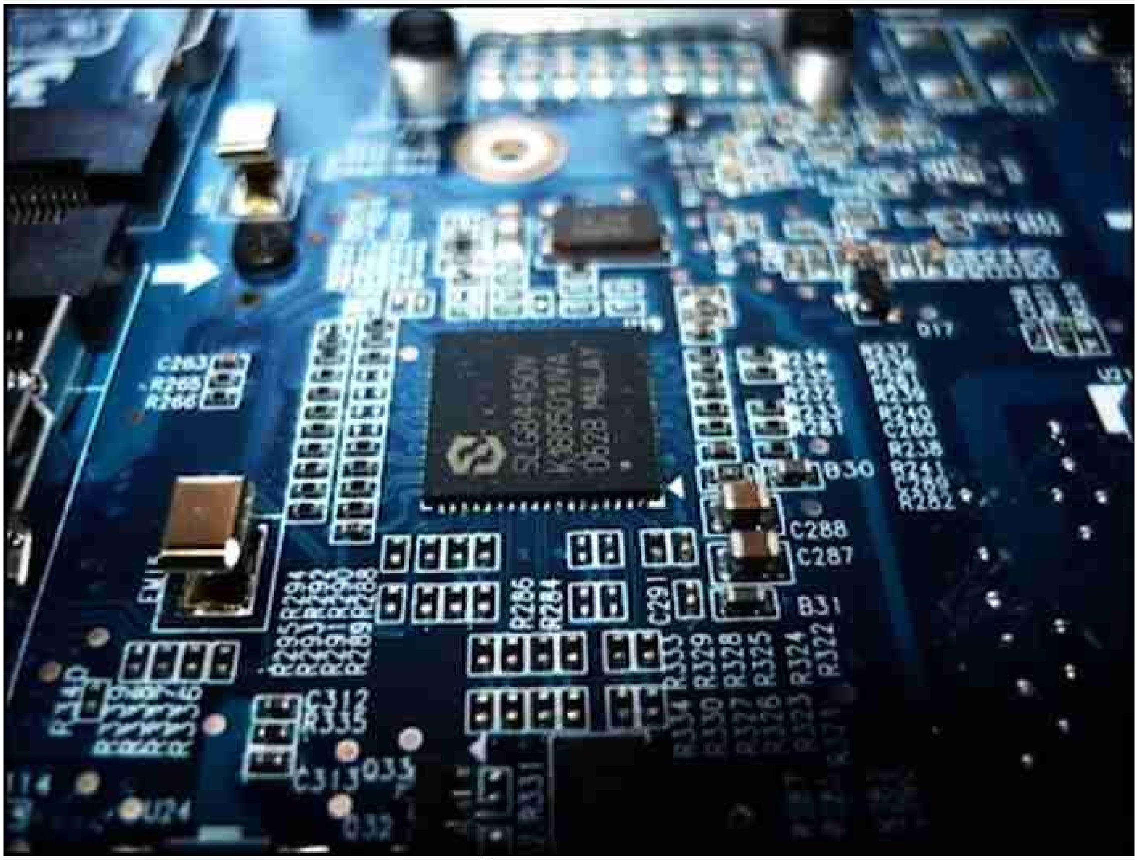
Electricity and electronics



Electricity is a kind of energy, a very versatile kind of energy that we can make in all sorts of ways and use in many more. Electricity is all about making electromagnetic energy flow around a circuit so that it will drive something like an electric motor or a heating element, powering appliances such as electric cars, kettles, toasters, and lamps. Generally, electrical appliances need a great deal of energy to make them work so they use quite large (and often quite dangerous) electric currents.

Electronics is a much more subtle kind of electricity in which tiny electric currents (and, in theory, single electrons) are carefully directed around much more complex circuits to process signals (such as those that carry radio and television programs) or store and process information. Think of something like a microwave oven and it's easy to see the difference between ordinary electricity and electronics. In a microwave, electricity provides the power that generates high-energy waves that cook your food; electronics controls the electrical circuit that does the cooking.

Electronics is the science of controlling electrical energy electrically, in which the electrons have a fundamental role. Electronics deals with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes, integrated circuits, associated passive electrical components, and interconnection technologies. Commonly, electronic devices contain circuitry consisting primarily or exclusively of active semiconductors supplemented with passive elements; such a circuit is described as an electronic circuit.

The nonlinear behaviour of active components and their ability to control electron flows makes amplification of weak signals possible, and electronics is widely used in information processing, telecommunication, and signal processing. The ability of electronic devices to act as switches makes digital information processing possible. Interconnection technologies such as circuit boards, electronics packaging technology, and other varied forms of communication infrastructure complete circuit functionality and transform the mixed components into a regular working system.

Electronics is distinct from electrical and electro-mechanical science and technology, which deal with the generation, distribution, switching, storage, and conversion of electrical energy to and from other energy forms using wires, motors, generators, batteries, switches, relays, transformers, resistors, and other passive components. This distinction started around 1906 with the invention by Lee De Forest of the triode, which made electrical amplification of weak radio signals and audio signals possible with a non-mechanical device. Until 1950 this field was called "radio technology" because its principal application was the design and theory of radio transmitters, receivers, and vacuum tubes.

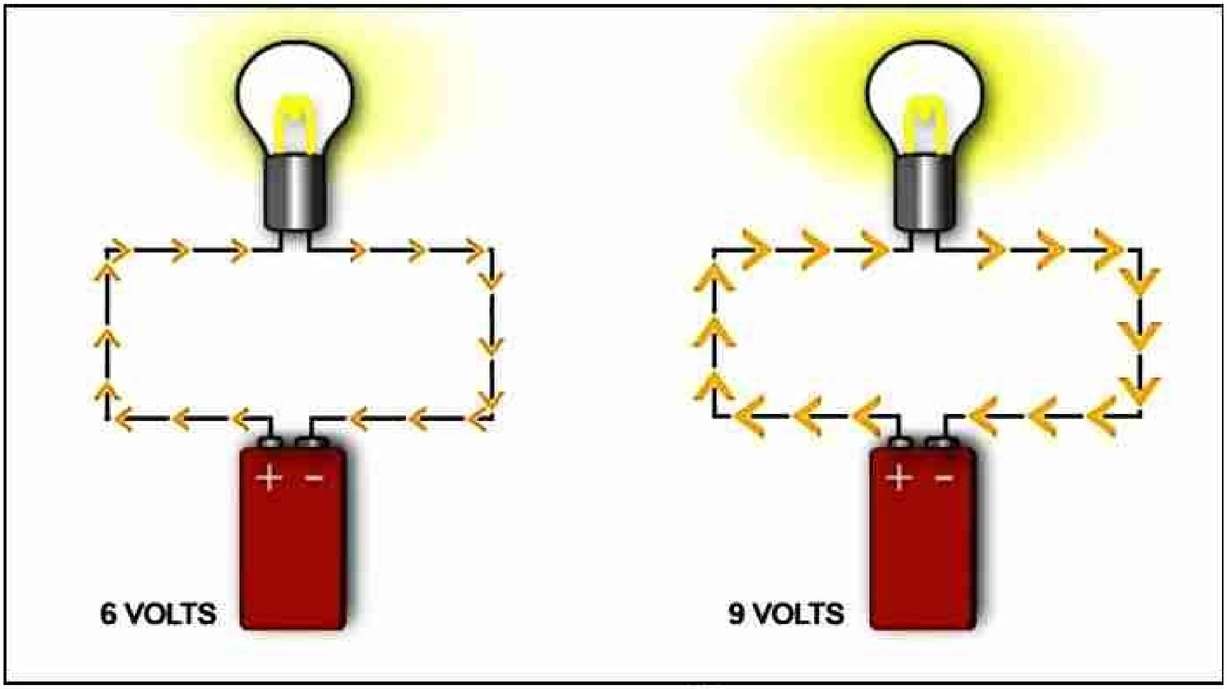
Today, most electronic devices use semiconductor components to perform electron control. The study of semiconductor devices and related technology is considered a branch of solid-state physics, whereas the design and construction of electronic circuits to solve practical problems come under electronics engineering. This article focuses on engineering aspects of electronics.

Basic Electronics

Now that you have a general background in electricity and moving charges you can move on to learning more about basic electronics. Electronics puts a knowledge of electricity to useful work. Electronics applies electrical current flow of electrical charges to circuits to accomplish specific tasks. Amplifiers can be constructed from glass "tubes" containing metal elements, or more commonly today with solid state diodes, transistors, or integrated circuits. An amplifier is simply a device or circuit that takes a small signal input and controls a larger current as it output. The input signal voltage is small and the output voltage is larger - amplified. A circuit containing wire conductors, resistors, capacitors, inductors and amplifiers can be configured in many ways to build various electronic circuits like oscillators, digital logic circuits, computer circuits, television and video circuits and much more. An oscillator by the way

is just an amplifier with some of the output fed back into the input. Sounds like a perpetual motion machine but it isn't as the amplifiers power supply is providing the additional energy that is lost in the circuit and keeps the circulation, i.e. oscillations going.
Basic electronics is all about electrical components and the circuits consisting of those components . Common components are resistors, capacitors, inductors, transistors, and integrated circuits. You will find each of these components described in detail in the following numbered sections. The components are interconnect with conductors, either physical wires or printed circuits. The components make up linear analog amplifiers, oscillators, and filters as examples. They also can be configured to create digital logic circuits such as memories, gates, arithmetic units, and central processing units. So you will find basic electronics in every computer, mp3 player, radio, TV and may other appliances in your home, car, or on your body. Each circuit has a job. Components are interconnected to perform a specific task. First learn about each individual component and how it works then learn about how to interconnect them to make useful end products.

Voltage



Voltage, electric potential difference, electric pressure or electric tension (formally denoted simply as V or U, for instance in the context of Ohm's or Kirchhoff's laws) is the difference in electric potential energy between two points per unit electric charge. The voltage between two points is equal to the work done per unit of charge against a static electric field to move the test charge between two points and is measured in units of volts (a joule per coulomb).

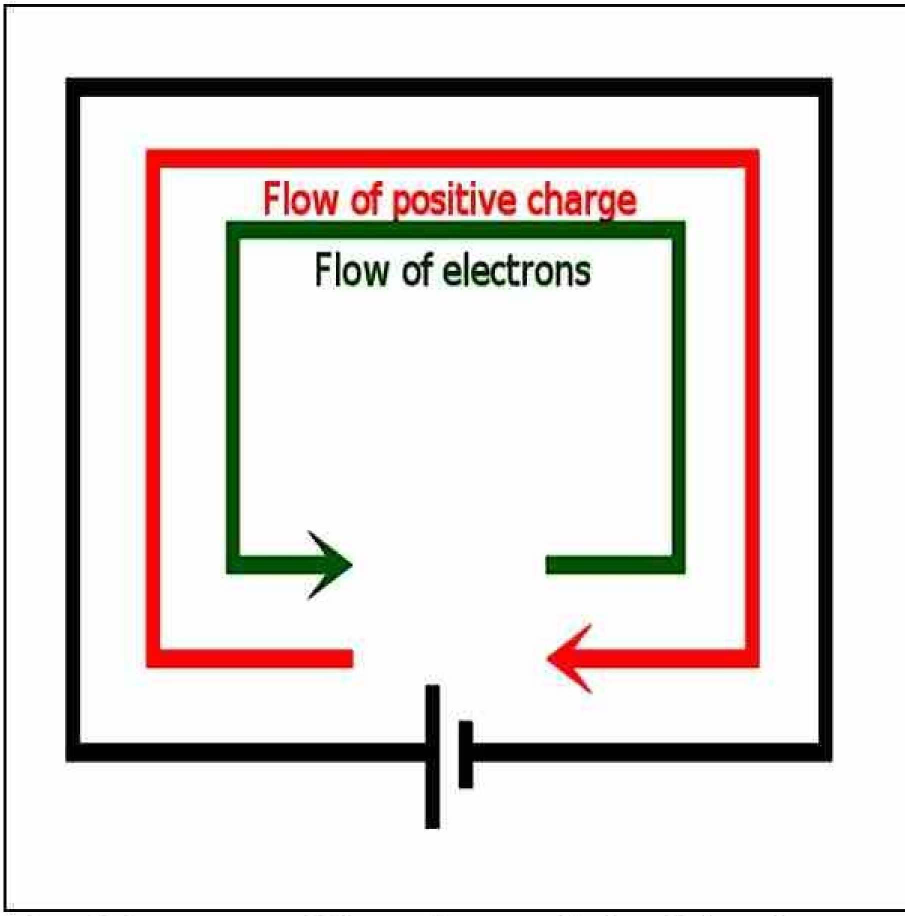
Voltage can be caused by static electric fields, by electric current through a magnetic field, by time-varying magnetic fields, or some combination of these three.[1][2] A voltmeter can be used to measure the voltage (or potential difference) between two points in a system; often a common reference potential such as the ground of the system is used as one of the points. A voltage may represent either a source of energy (electromotive force), or lost, used, or stored energy (potential drop).

The volt (symbol: V) is the derived unit for electric potential, electric potential difference (voltage), and electromotive force. The volt is named in honour of the Italian physicist Alessandro Volta (1745Ð1827), who invented the voltaic pile, possibly the first chemical battery.

Measuring instruments

Instruments for measuring voltages include the voltmeter, the potentiometer, and the oscilloscope. The voltmeter works by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage.

Electric current



An electric current is a flow of electric charge. In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in a plasma.

The SI unit for measuring an electric current is the ampere, which is the flow of electric charge across a surface at the rate of one coulomb per second. Electric current is measured using a device called an ammeter.

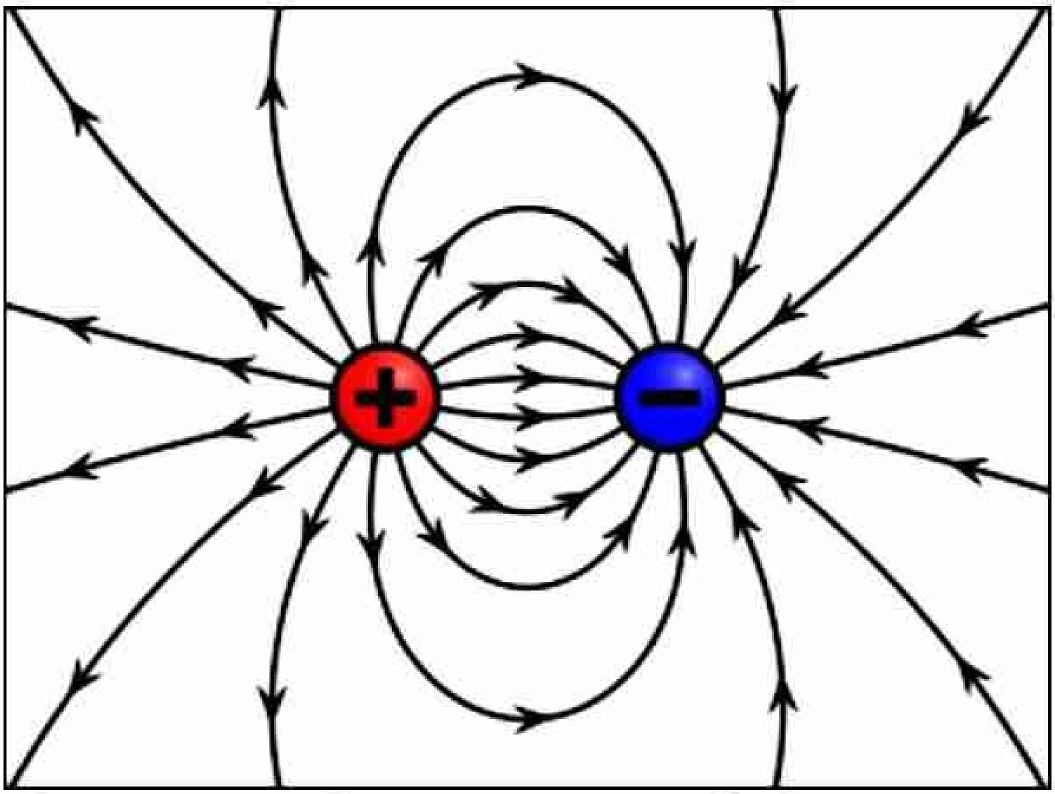
Electric currents cause Joule heating, which creates light in incandescent light bulbs. They also create magnetic fields, which are used in motors, inductors and generators.

The particles that carry the charge in an electric current are called charge carriers. In metals, one or more electrons from each atom are loosely bound to the atom, and can move freely about within the metal. These conduction electrons are the charge carriers in metal conductors.

Symbol

The conventional symbol for current is I, which originates from the French phrase intensité de courant, meaning current intensity. Current intensity is often referred to simply as current.

Electrical Charge



Electricity is the movement of electrons. Electrons create charge, which we can harness to do work. Your lightbulb, your stereo, your phone, etc., are all harnessing the movement of the electrons in order to do work. They all operate using the same basic power source: the movement of electrons.

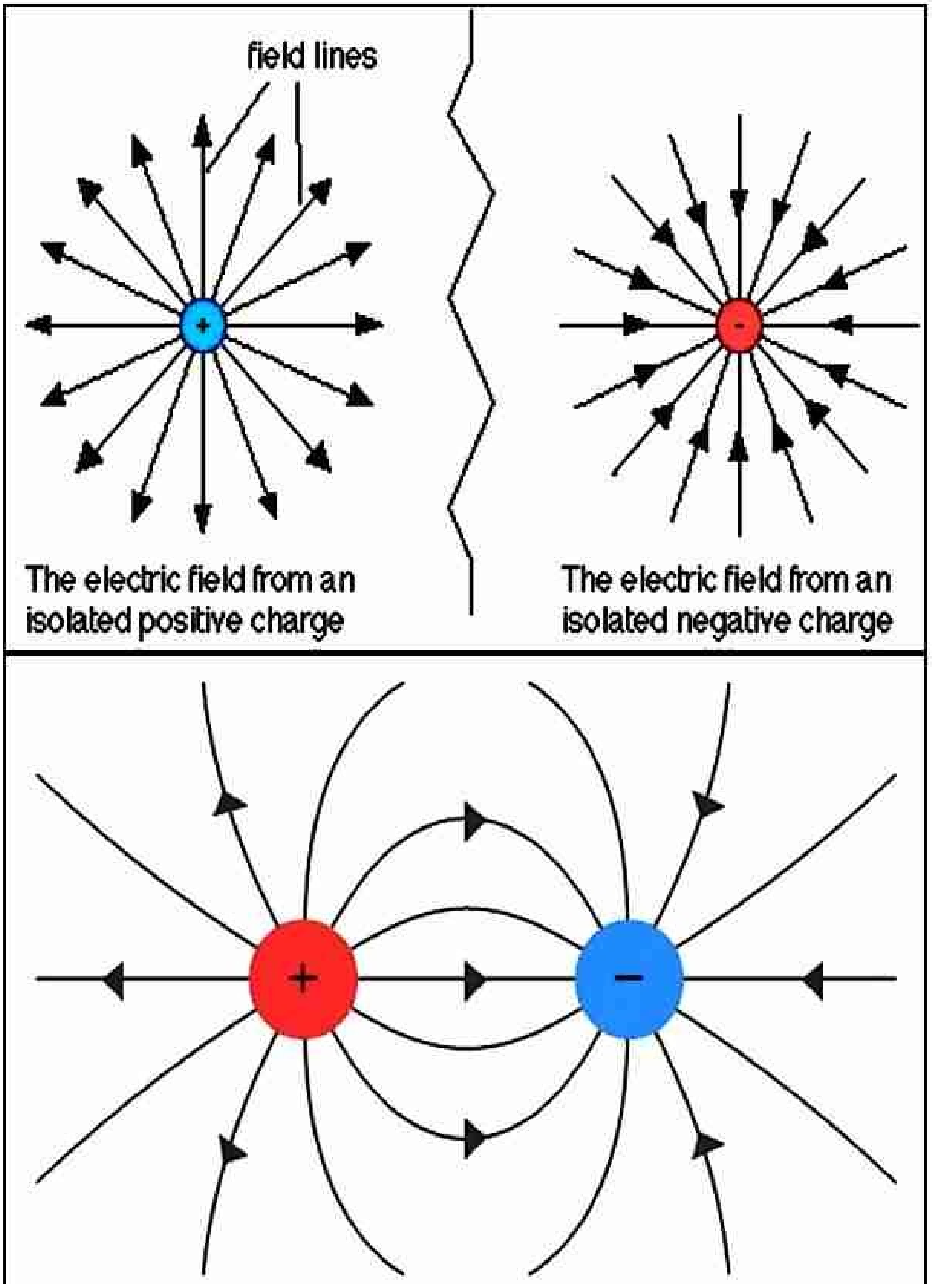
The three basic principles for this tutorial can be explained using electrons, or more specifically, the charge they create:

- Voltage is the difference in charge between two points.
- Current is the rate at which charge is flowing.
- Resistance is a material's tendency to resist the flow of charge (current).

So, when we talk about these values, we're really describing the movement of charge, and thus, the behavior of electrons. A circuit is a closed loop that allows charge to move from one place to another. Components in the circuit allow us to control this charge and use it to do work.

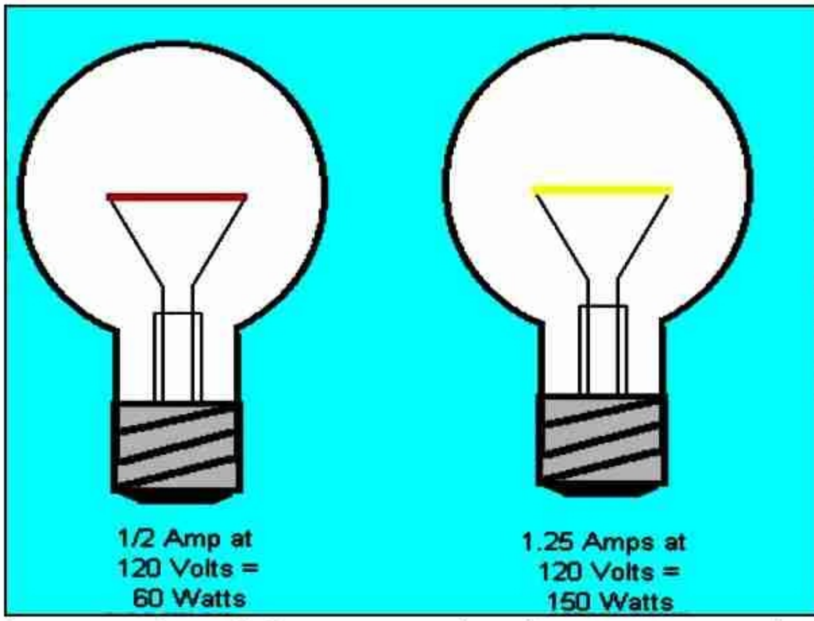
Georg Ohm was a Bavarian scientist who studied electricity. Ohm starts by describing a unit of resistance that is defined by current and voltage. So, let's start with voltage and go from there.

Electrical Field



Around a charge is an electric field. With every electric field there is a magnetic field. While we can't see these fields, or yet know exactly what they consist of, we can measure them with instruments and tell a great deal about their behavior. We can then use this knowledge to our benefit. The design and construction of electric motors, computers, radios, televisions, stereos, and many other electrical and electronic devices depend upon a knowledge of these basic principles of electricity. As you can see we have given names to these phenomenon to make it easier for us to study and use. We could have called them Dick, Jane and Mary but instead we named them for the scientists that discovered or first studied them; Volt, Ampere, and Ohm. Mr. Volt, Mr. Ampere, and Mr. Ohm spent many years of their lives studying electricity. They were not alone however as many other scientist were studying and learning more about electricity as well.

Watts-Power



What is a watt? A watt is the International System unit of power equal to one joule per second. The symbol used for a watt is "P" for power. Power in watts is found by multiplying a circuits current (I) times its voltage (V). You will learn more about power in watts in the upcoming sections.

Resistance

Resistance is the opposition to current flow in various degrees. The practical unit of resistance is called the ohm. A resistor on one ohm is physically very large but provides only a small resistance to current flow. A resistor of one million ohm's is physically small but presents a high resistance to current flow. A resistance that develops 0.24 calorie of heat when one ampere of current flows through it for one second has one ohm of resistance. The unit of resistance is often represented by the Greek letter omega. Resistors are often made of thin layers of carbon or lengths of small copper wire. They can also be thin deposited layers of metallic material. An image of a few resistor types is shown below.

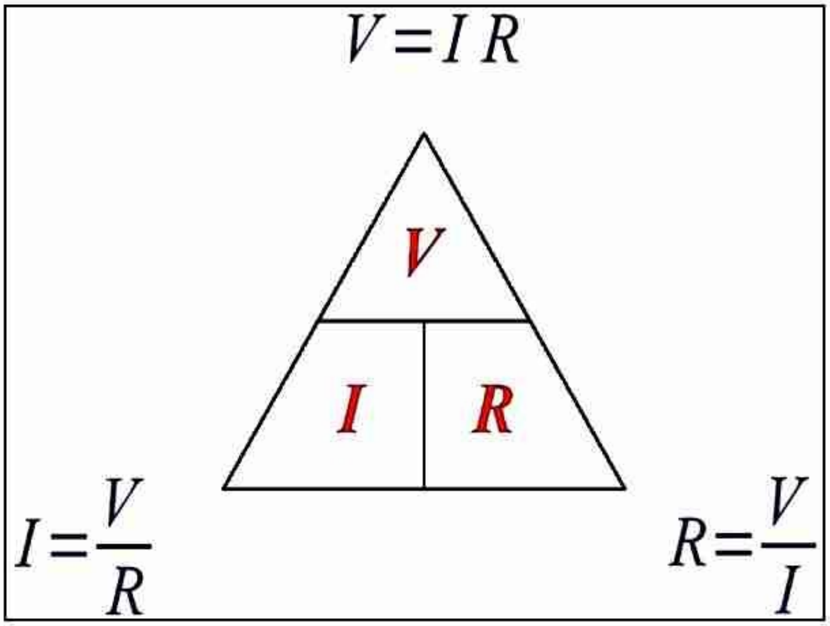
What is electrical current? Electrical current, represented by the letter "I" in formulas, and it is the flow or rate of electric charge. This flowing electric charge is typically carried by moving electrons in a metallic conductor or electronic components such as resistors or transistors as an example. The unit of electrical current is the ampere, named after a french mathematician, Andre Marie Ampere. What is electrical voltage? Electrical voltage is represented by the letter "V" in formulas and it is the electrical pressure a moving charge is under. In the case of a static charge, one that is not moving, then voltage is the potential difference or pressure of the charge. The relationship between current (I), resistance (R), and voltage (V) is represented by the formulas developed in Ohm's law. We will study that in section 5 below.

Resistors can be connected in series (end to end), or in parallel (across one another), or in a combination of series and parallel. If you connect two, 1/4 watt, 100 ohm resistors across one another (i.e. in parallel) then the total resistance in ohms is one half of one of the resistors. In this example the resistance would be 50 ohms. The wattage doubles as the current is now split between the two resistors. The combination can now handle up to one half a watt safely. If the two resistors were connected end-to-end (i.e. in series) the resistances add and in this case would be 200 ohms. The wattage in this series case stays the same, 1/4 watt. This information is handy to know as it is easy to calculate in your head and will allow you to devise additional resister values from a limited resistor bench stock.

RESISTOR COLOR CODES

Resistors use color coded stripes to indicate their value in ohms. 0=Black, 1=Brown, 2=Red, 3=Orange, 4=Yellow, 5=Green, 6=Blue, 7=Purple, 8=Gray, 9=White.

OHMS Law



Ohm's Law is extremely important in learning basic electronics.

What is Ohm's Law? Ohm's Law is a formula that describes the relationship between resistance, current and voltage in an electrical circuit. The formula is R (resistance in ohms) = (equals) V (voltage in volts) divided by I (current in amperes).

That is: R = V/I

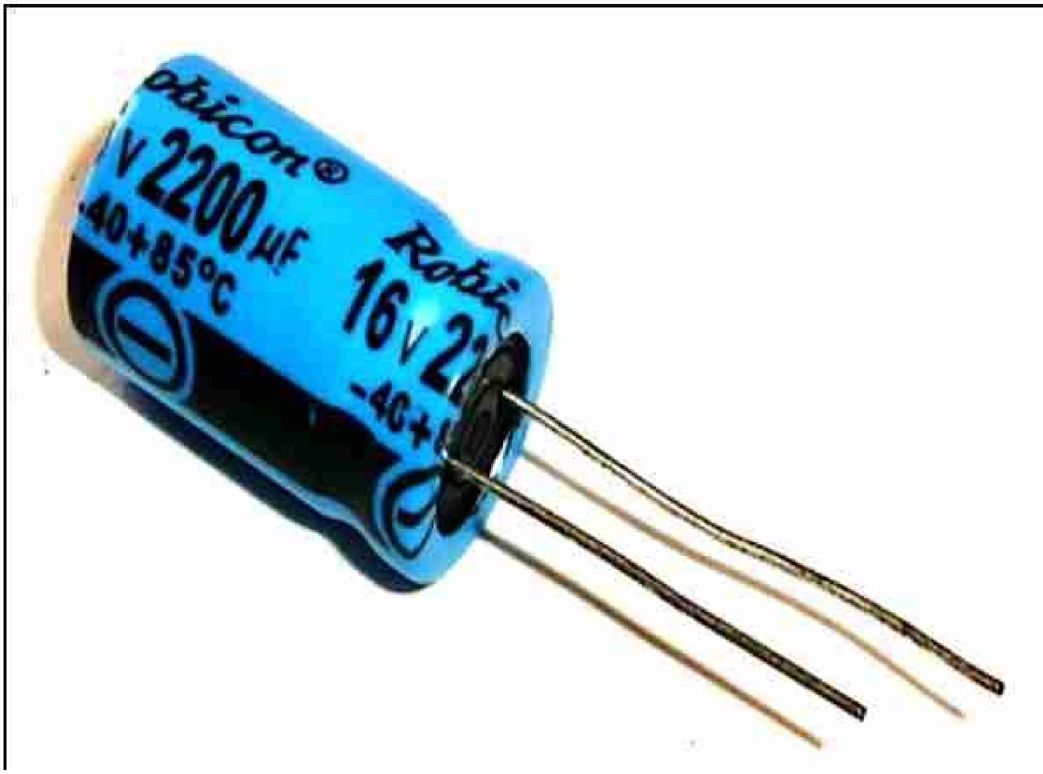
...and algebraic rules tells us that I - V/R and V = IxR.

I = V/R, V = IxR, R = V/I, and P (power in watts) = IxV are the fundamental formulas of Ohm's law. (The * means to multiply the two quantities together). Where V is the circuit voltage in volts, I is the circuits amperage in amps, and R is the resistance in ohms.

Almost every electrical and electronic circuit involves resistance, current and voltage. This is why it is vital you understand the relationships between them.

As an experiment you can set up a circuit by connecting resistors in series with a battery, measure the voltage across the resistors with a voltmeter, measure the current in the circuit by placing an ammeter in series with the resistors and the battery. If you know the voltages and current in the circuit you can use Ohms law to calculate the resistance. With the resistor out of the circuit you can measure it's resistance directly with an ohm meter. The multi-meters today can measure ohms, volts and amperes (usually measured in miliamperes in practical circuits) all in one piece of test equipment.

Capacitors



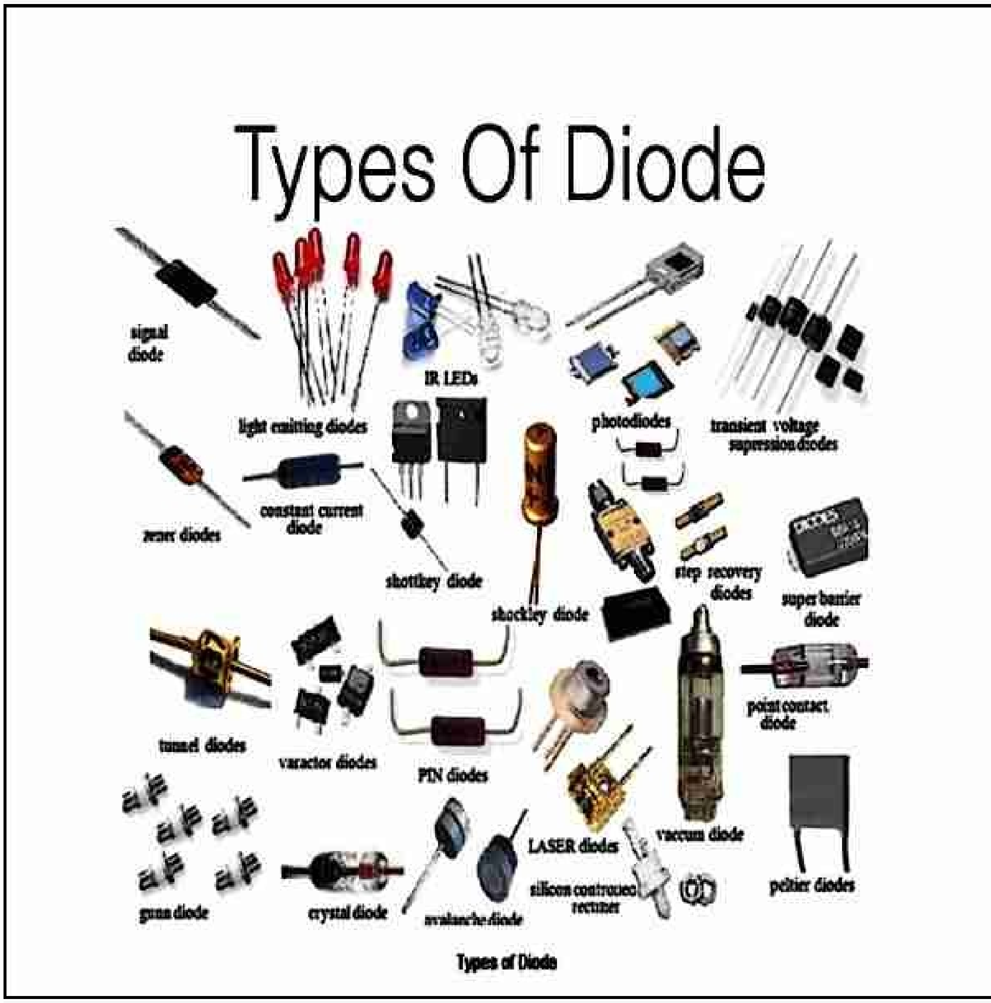
A

capacitor is a device that stores an electrical charge when a potential difference (voltage) exists between two conductors which are usually two plates separated by a dielectric material (an insulating material like air, paper, or special chemicals between two sheets of aluminum foil). Capacitors block DC voltages and pass AC voltages. They are used as filters, AC coupling capacitors and as by-pass capacitors. They are also used in conjunction with resistors and inductors to form tuned circuits and timing circuits. A capacitors value C (in Farads) is dependent upon the ratio of the charge Q (in Coulombs) divided by the V (in volts). Common capacitors come in values of microfarads or Pico farads. Often you will have to convert between Pico farads and micro farads. A chart is provided below to assist in the conversion. Measuring capacitance requires a capacitance meter. This is separate piece of test equipment. There are attachments for multimeters that allow measurement of capacitance directly.

A capacitor is essentially two conductive plates, separated by an insulator (the dielectric). To conserve space, the assembly is commonly rolled up, or consists of many small plates in parallel for each terminal, each separated from the other by a thin plastic film. See below for more detailed information on the different constructional methods. A capacitor also exists whenever there is more than zero components in a circuit - any two pieces of wire will have some degree of capacitance between them, as will tracks on a PCB, and adjacent components. Capacitance also exists in semiconductors (diodes, transistors), and is an inescapable part of electronics.

Capacitors are rated in Farads, and the standard symbol is 'C' or 'F', depending upon the context. A Farad is so big that capacitors are most commonly rated in micro-Farads (uF). The Greek letter (lower case) Mu (�) is the proper symbol, but 'u' is available on keyboards, and is far more common.

Diodes



The electronic equivalents of one-way streets, diodes allow an electric current to flow through them in only one direction. They are also known as rectifiers. Diodes can be used to change alternating currents (ones flowing back and forth round a circuit, constantly swapping direction) into direct currents (ones that always flow in the same direction).

A diode is a specialized electronic component with two electrodes called the anode and the cathode. Most diodes are made with semiconductor materials such as silicon, germanium, or selenium. Some diodes are comprised of metal electrodes in a chamber evacuated or filled with a pure elemental gas at low pressure. Diodes can be used as rectifiers, signal limiters, voltage regulators, switches, signal modulators, signal mixers, signal demodulators, and oscillators.

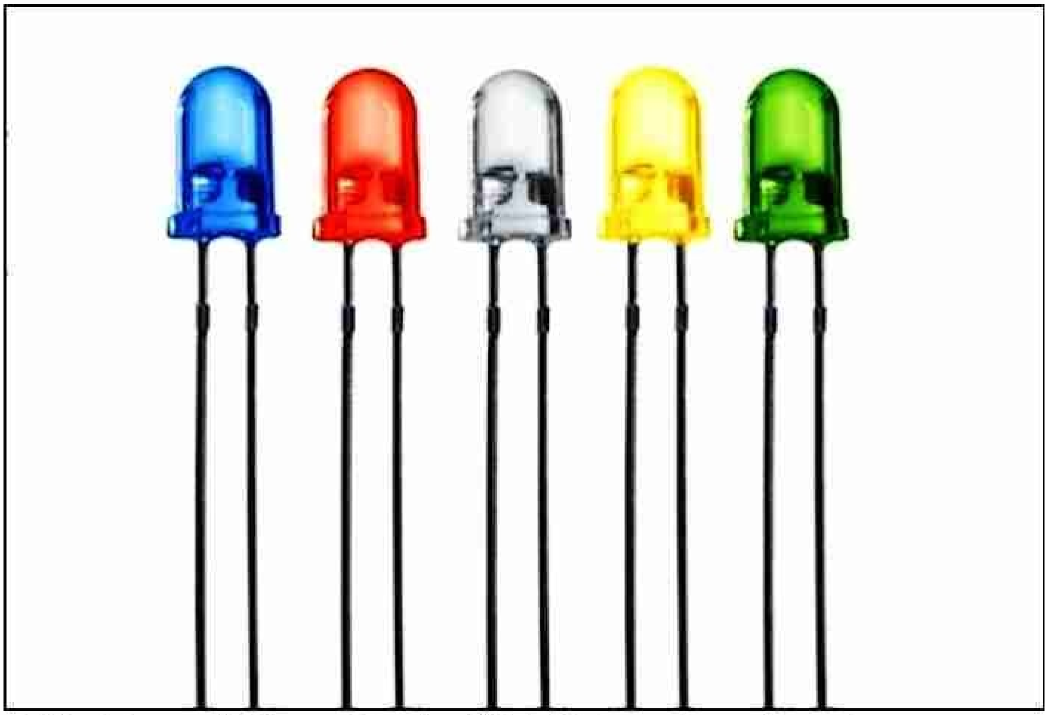
The fundamental property of a diode is its tendency to conduct electric current in only one direction. When the cathode is negatively charged relative to the anode at a voltage greater than a certain minimum called forward breakover, then current flows through the diode. If the cathode is positive with respect to the anode, is at the same voltage as the anode, or is negative by an amount less than the forward breakover voltage, then the diode does not conduct current. This is a simplistic view, but is true for diodes operating as rectifiers, switches, and limiters. The forward breakover voltage is approximately six tenths of a volt (0.6 V) for silicon devices, 0.3 V for germanium devices, and 1 V for selenium devices.

The above general rule notwithstanding, if the cathode voltage is positive relative to the anode voltage by a great enough amount, the diode will conduct current. The voltage required to produce this phenomenon, known as the avalanche voltage, varies greatly depending on the nature of the semiconductor material from which the device is fabricated. The avalanche voltage can range from a few volts up to several hundred volts.

When an analog signal passes through a diode operating at or near its forward breakover point, the signal waveform is distorted. This nonlinearity allows for modulation, demodulation, and signal mixing. In addition, signals are generated at harmonics, or integral multiples of the input frequency. Some diodes also have a characteristic that is imprecisely termed negative resistance. Diodes of this type, with the application of a voltage at the correct level and the polarity, generate analog signals at microwave radio frequencies.

Semiconductor diodes can be designed to produce direct current (DC) when visible light, infrared transmission (IR), or ultraviolet (UV) energy strikes them. These diodes are known as photovoltaic cells and are the basis for solar electric energy systems and photosensors. Yet another form of diode, commonly used in electronic and computer equipment, emits visible light or IR energy when current passes through it. Such a device is the familiar light-emitting diode (LED).

LED



A light-emitting diode (LED) is a two-lead semiconductor light source. It is a pĐn junction diode, which emits light when activated.[4] When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

An LED is often small in area (less than 1 mm2) and integrated optical components may be used to shape its radiation pattern.[5]

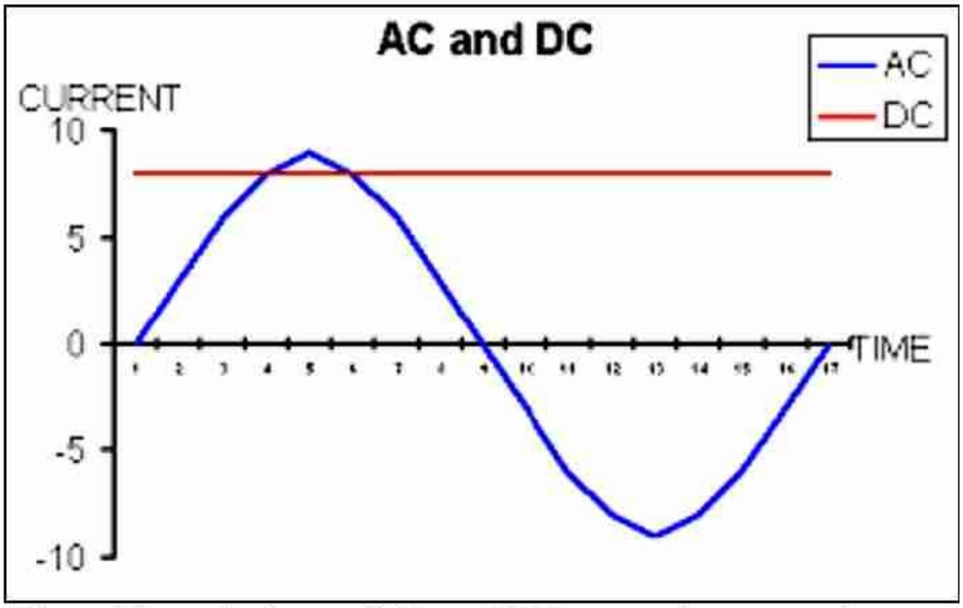
Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks.

We use LEDs to give a visual feedback from our circuit.

For example to show that the circuit has power. But, you can also used them to make cool light-show circuits.
You see these components everywhere:
In your laptop, on your mobile phone, on your camera, in your car +++
And you can find many different types of LEDs.
A very common circuit to build as a beginner is the blinking light circuit.

AC and DC



The abbreviations AC and DC are often used to mean simply alternating and direct, as when they modify current or voltage.

Direct current (DC)

Main article: Direct current Direct current (DC) is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries, thermocouples, solar cells, and commutator-type electric machines of the dynamo type. Direct current may flow in a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric charge flows in a constant direction, distinguishing it from alternating current (AC). A term formerly used for direct current was galvanic current.

Alternating current (AC)
In alternating current (AC, also ac), the movement of electric charge periodically reverses direction. In direct current (DC, also dc), the flow of electric charge is only in one direction.

AC is the form of electric power delivered to businesses and residences. The usual waveform of an AC power circuit is a sine wave. Certain applications use different waveforms, such as triangular or square waves. Audio and radio signals carried on electrical wires are also examples of alternating current. An important goal in these applications is recovery of information encoded (or modulated) onto the AC signal.

Batteries and Their Applications

A battery is a source of electrical energy, which is provided by one or more electrochemical cells of the battery after conversion of stored chemical energy. In today's life, batteries play an important part as many household and industrial appliances use batteries as their power source.

Types of Batteries

Batteries can be divided into two major categories, primary batteries and secondary batteries. A primary battery is a disposable kind of battery. Batteries

Once used, it cannot be recharged. Secondary batteries are rechargeable batteries. Once empty, it can be recharged again. This charging and discharging can happen many times depending on the battery type. Alkaline batteries, Mercury batteries, Silver-Oxide batteries, and Zinc carbon batteries are examples of primary batteries whereas Lead-Acid batteries and Lithium batteries fall into the secondary battery's category.

Alkaline Batteries

Alkaline batteries are non-rechargeable, high energy density, batteries that have a long life span. This battery obtained its name because the electrolyte used in it is alkaline (potassium hydroxide). The chemical composition features zinc powder as an anode and manganese dioxide as the cathode with potassium hydroxide as the electrolyte.

The chemical reactions are:

$Zn (s) + 2OH^- (aq) \rightarrow ZnO (s) + H_2O (l) + 2e^-$

$2MnO_2 (s) + H_2O (l) + 2e^- \rightarrow Mn_2O_3 (s) + 2OH^- (aq)$

If we compare the capacity of an alkaline cell with a zinc-chloride cell of same size, the former can provide about four to five times more energy under equal load conditions. The supply voltage level decreases over time so the minimum required voltage level for a particular load may not match the supplied voltage level and thus results in no operation. But the rate of decline of alkaline batteries is lower than the Leclanche cell, thus longer life. The typical values of voltage and current supplied by a single alkaline cell are 1.5V and 700mA respectively. These batteries are distributed in various standard cylindrical shapes.

Applications

Alkaline batteries are the most common type of batteries used in the world with major consumption in the US, UK and Switzerland. Designed for long lasting performance, these can be found in remote controls, clocks, and radios. The high run time makes alkaline batteries ideal for digital cameras, hand held games, MP3 players etc.

Zinc-Carbon Batteries

Zinc-Carbon batteries are also known as dry cells (as the nature of electrolyte used in these cells is dry), which come in a composition of a carbon rod (cathode) surrounded by a mixture of carbon powder and manganese dioxide (to increase the conductivity). This whole combination is packed in a zinc container acting as the anode. The electrolyte is a mixture of ammonium chloride and zinc chloride. The typical voltage value is a little less than 1.5V. These batteries are durable and have longer lives. Zinc-Carbon batteries can be used effectively at moderate temperature but do not work well at low temperatures.

Applications

These general purpose batteries are available for lower prices which is why many electronic devices are sold with these batteries included free. The basic use is in low power drain applications such as flash lights, remote controsl, toys, and table clocks.

Lead-Acid Batteries

Lead-acid batteries are the rechargeable kind of batteries invented in the 1980s. These large, heavyweight batteries find the major application in automobiles as these fulfill the high current requirements of the heavy motors. The composition of Lead-Acid battery changes in charged and discharged states.

A combination of Pb (negative) and PbO_2 (positive) as electrodes with H_2SO_4 as electrolyte in charged form and $PbSO_4$ and water in discharged form.

Applications

The major application of lead acid battery is in starting, lightning, and ignition systems(SLI) of automobiles. Its other form, wet cell battery is used as backup power supply for high end servers, personal computers, telephone exchanges, and in off grid homes with inverters. Portable emergency lights also use lead acid batteries.

Mercury Batteries

Mercury batteries are non-rechargeable batteries that contain mercuric oxide with manganese dioxide. They are deep discharge batteries and voltage level does not fall below 1.35V until 5% energy level is reached. These batteries are less popular because of low output voltage. Furthermore, mercury is toxic and can cause hazards for humans.

Applications

The flat discharge curve makes this battery useful for photographic light meters and electronic devices such as to run the real-time clock of CPU.

Lithium and Silver Oxide Batteries

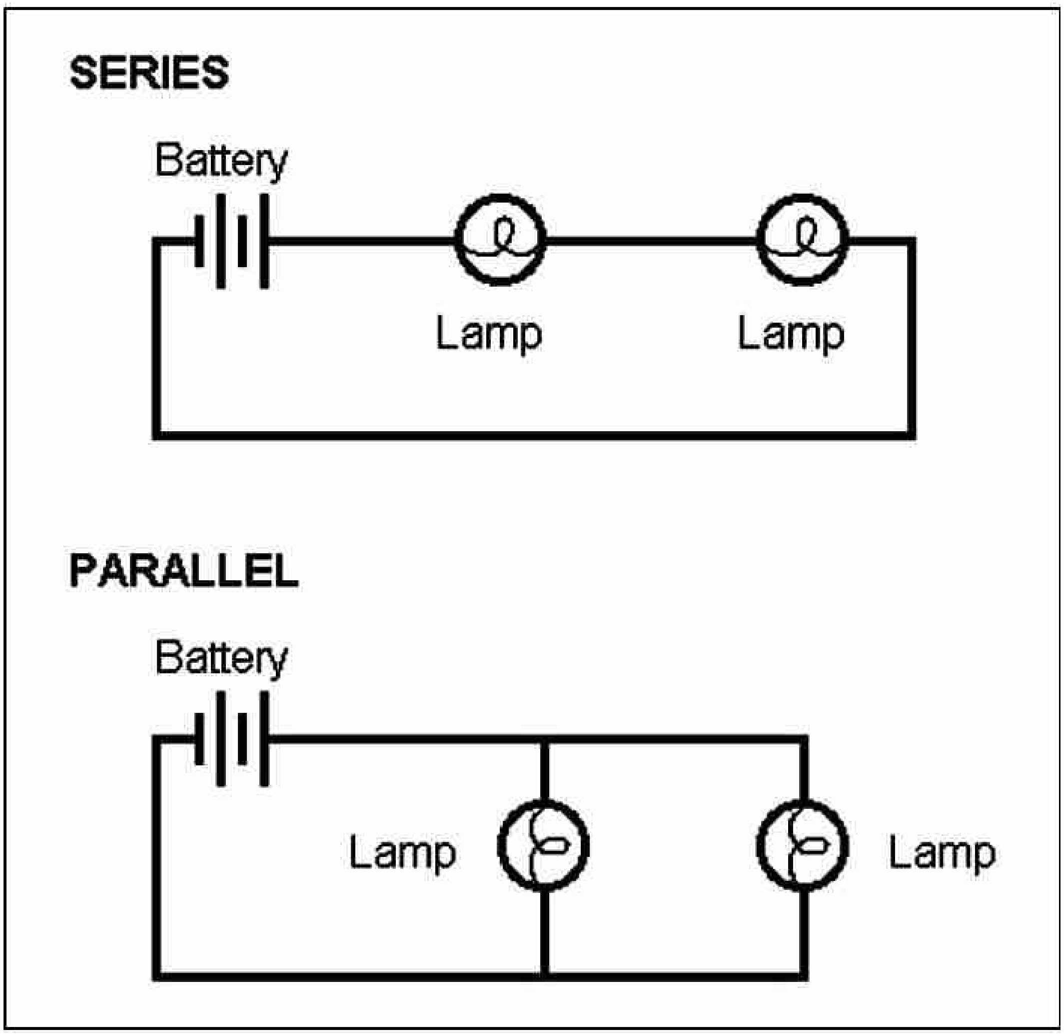
Lithium batteries are rechargeable (secondary) batteries, where lithium in its pure ion compound form is used. Depending on the design and chemical compounds used, lithium batteries can produce voltages from 1.5 Volts to 3.7 Volts. The most common type of lithium battery used in consumer applications uses manganese dioxide as cathode and metallic lithium as anode. Compared to ordinary zinc–carbon batteries or alkaline batteries, the voltage production of lithium cell is twice from them.

Silver oxide batteries are expensive, small to large sized primary cells that offer better run time than alkaline batteries. They are usually suitable for powering low-current electrical devices.They use silver oxide as positive (cathode) electrode, zinc as negative (anode) electrode plus alkaline electrolyte, normally Potassium hydroxide (KOH) or Sodium Hydroxide (NaOH).

Applications
These long life batteries are used in portable consumer instruments like calculators, iPods, digital diaries, wrist watches and stop watches, toys, and artificial pacemakers. Lithium cells can also be used as a replacement of alkaline batteries in many devices, such as cameras and clocks. Although they are more expensive, lithium batteries will provide much longer life. Silver Oxide batteries are used in military and submarines.

From alkaline batteries to silver-oxide, the different types of batteries are used in different applications.

Series and parallel circuits



Components of an electrical circuit or electronic circuit can be connected in many different ways. The two simplest of these are called series and parallel and occur frequently. Components connected in series are connected along a single path, so the same current flows through all of the components. Components connected in parallel are connected, so the same voltage is applied to each component.[dubious Ð discuss]

A circuit composed solely of components connected in series is known as a series circuit; likewise, one connected completely in parallel is known as a parallel circuit.

In a series circuit, the current through each of the components is the same, and the voltage across the circuit is the sum of the voltages across each component.[1] In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the currents through each component.

Consider a very simple circuit consisting of four light bulbs and one 6 V battery. If a wire joins the battery to one bulb, to the next bulb, to the next bulb, to the next bulb, then back to the battery, in one continuous loop, the bulbs are said to be in series. If each bulb is wired to the battery in a separate loop, the bulbs are said to be in parallel. If the four light bulbs are connected in series, there is same current through all of them, and the voltage drop is 1.5 V across each bulb, which may not be sufficient to make them glow. If the light bulbs are connected in parallel, the currents through the light bulbs combine to form the current in the battery, while the voltage drop is across each bulb and they all glow.

In a series circuit, every device must function for the circuit to be complete. One bulb burning out in a series circuit breaks the circuit. In parallel circuits, each light has its own circuit, so all but one light could be burned out, and the last one will still function.

Simply put, in a parallel circuit current increases but the voltage stays the same, and in a series circuit current stays the same but the voltage decreases.

Series circuits

Series circuits are sometimes called current-coupled or daisy chain-coupled. The current in a series circuit goes through every component in the circuit. Therefore, all of the components in a series connection carry the same current. There is only one path in a series circuit in which the current can flow.

A series circuit's main disadvantage or advantage, depending on its intended role in a product's overall design, is that because there is only one path in which its current can flow, opening or breaking a series circuit at any point causes the entire circuit to "open" or stop operating. For example, if even one of the light bulbs in an older-style string of Christmas tree lights burns out or is removed, the entire string becomes inoperable until the bulb is replaced.

Current

I = I1 = I2 = I3 In a series circuit the current is the same for all of elements.

Parallel circuits

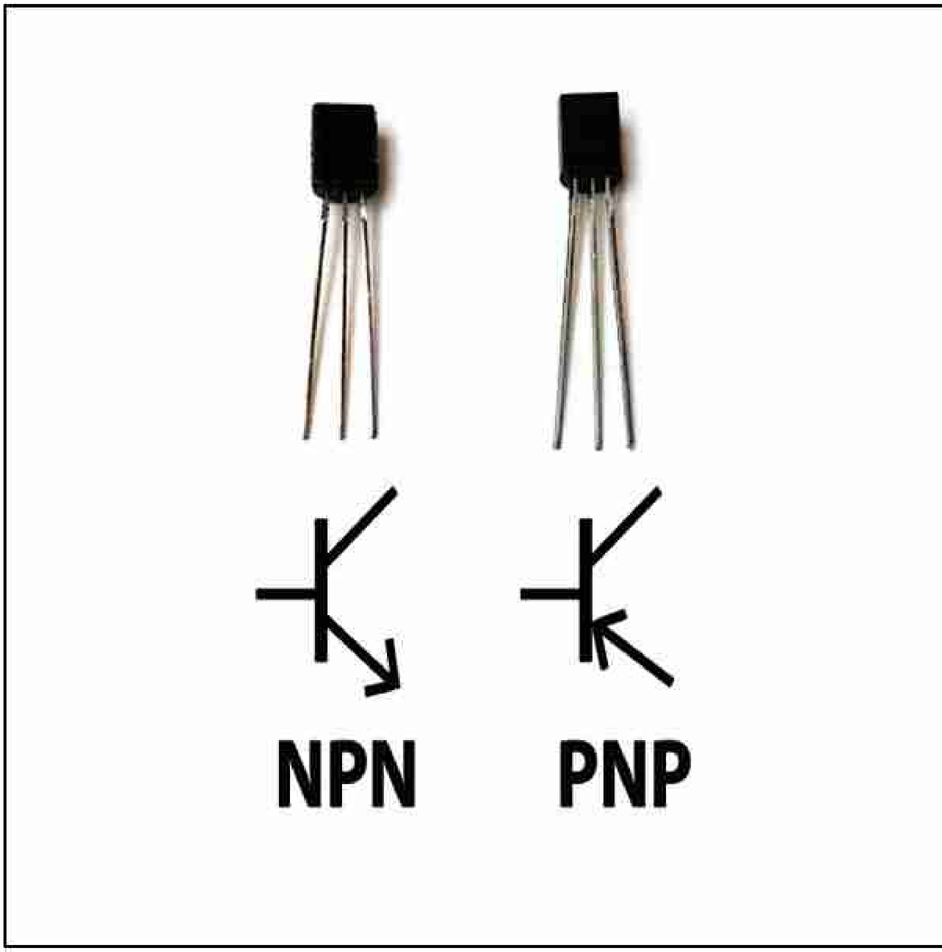
If two or more components are connected in parallel they have the same potential difference (voltage) across their ends. The potential differences across the components are the same in magnitude, and they also have identical polarities. The same voltage is applicable to all circuit components connected in parallel. The total current is the sum of the currents through the individual components, in accordance with KirchhoffÕs current law.

Voltage

In a parallel circuit the voltage is the same for all elements.

V = V1 = V2 = Vn

Transisters



A transistor takes in a small electrical current at its base pin and amplifies it such that a much larger current can pass between its collector and emitter pins. The amount of current that passes between these two pins is proportional to the voltage being applied at the base pin.

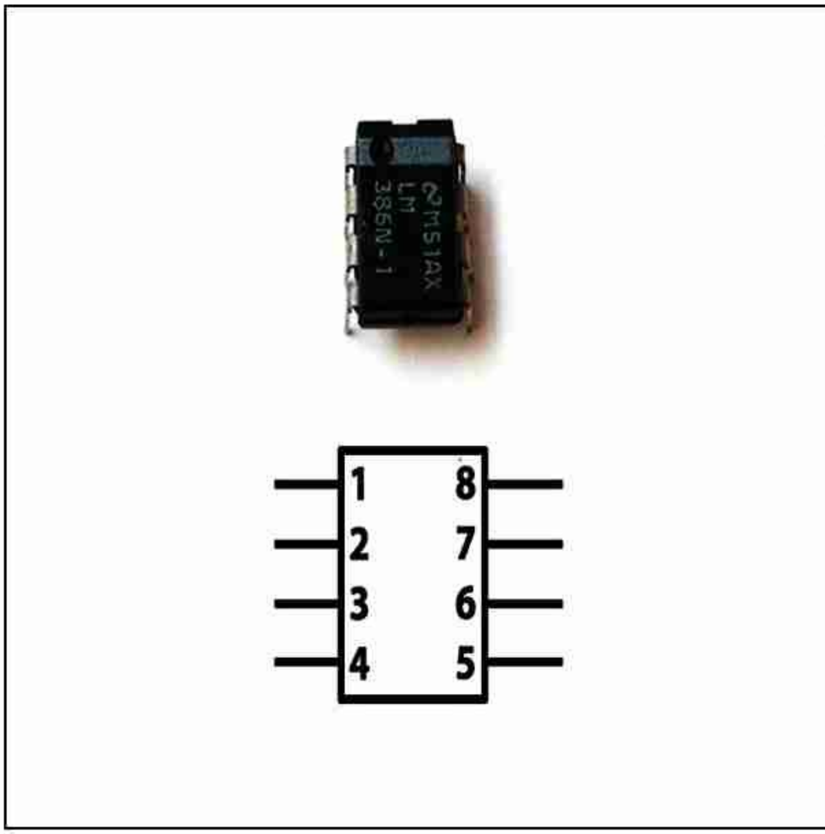
There are two basic types of transistors, which are NPN and PNP. These transistors have opposite polarity between collector and emitter.

NPN transistors allow electricity to pass from the collector pin to the emitter pin. They are represented in a schematic with a line for a base, a diagonal line connecting to the base, and a diagonal arrow pointing away from the base.

PNP transistors allow electricity to pass from the emitter pin to the collector pin. They are represented in a schematic with a line for a base, a diagonal line connecting to the base, and a diagonal arrow pointing towards the base.

Transistors have their part number printed on them and you can look up their datasheets online to learn about their pin layouts and their specific properties. Be sure to take note of the transistor's voltage and current rating as well.

Integrated Circuits



An integrated circuit is an entire specialized circuit that has been miniaturized and fit onto one small chip with each leg of the chip connecting to a point within the circuit. These miniaturized circuits typically consist of components such as transistors, resistors, and diodes.

Like transistors, you can learn all about integrated circuits by looking up their datasheets. On the datasheet you will learn the functionality of each pin. It should also state the voltage and current ratings of both the chip itself and each individual pin.

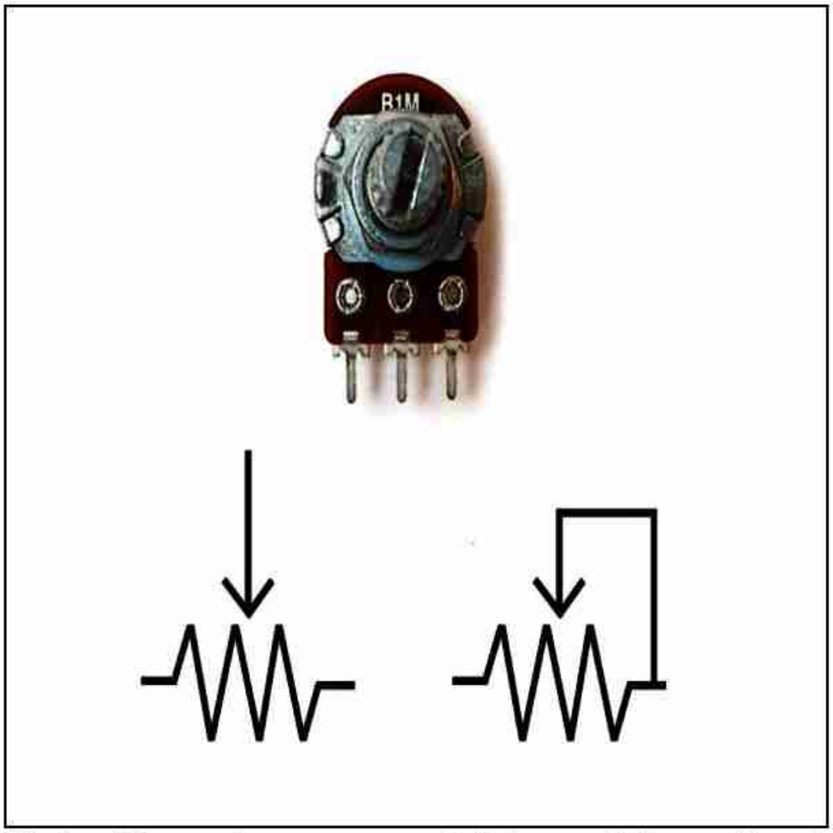
Integrated circuits come in a variety of different shapes and sizes. As a beginner, you will be mainly working with DIP chips. These have pins for through-hole mounting. As you get more advanced, you may consider SMT chips which are surface mount soldered to one side of a circuit board.

The round notch on one edge of the IC chip indicates the top of the chip. The pin to the top left of the chip is considered pin 1. From pin 1, you read sequentially down the side until you reach the bottom (i.e. pin 1, pin 2, pin 3..). Once at the bottom, you move across to the opposite side of the chip and then start reading the numbers up until you reach the top again.

Keep in mind that some smaller chips have a small dot next to pin 1 instead of a notch at the top of the chip.

There is no standard way that all ICs are incorporated into circuit diagrams, but they are often represented as boxes with numbers in them (the numbers representing the pin number).

Potentiometers



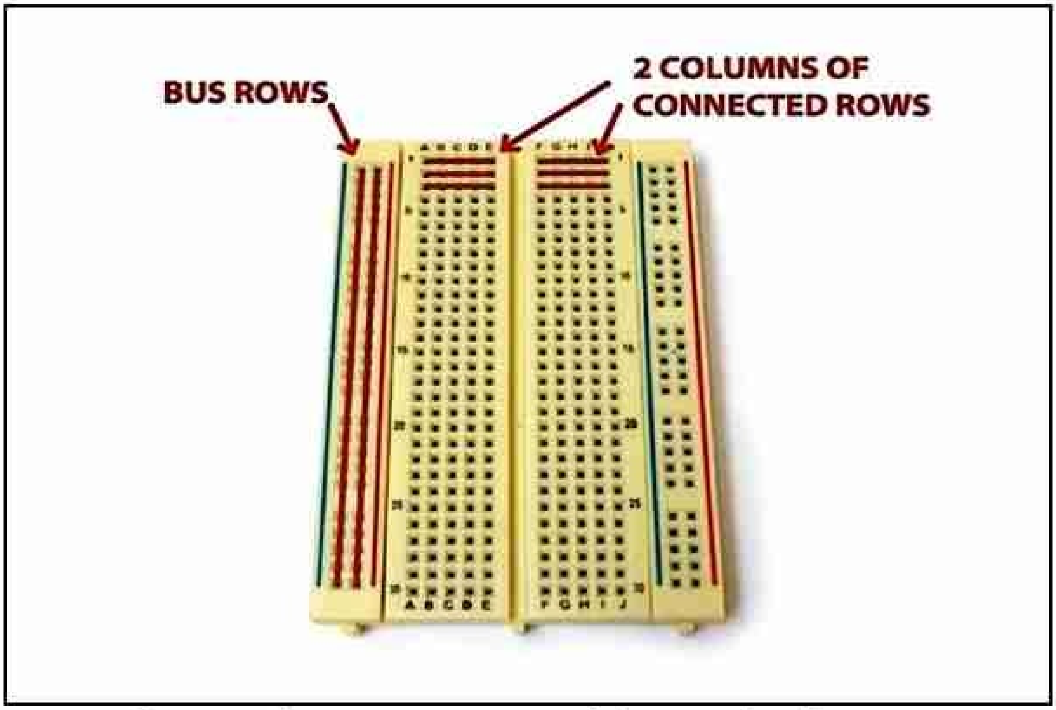
Potentiometers are variable resistors. In plain English, they have some sort of knob or slider that you turn or push to change resistance in a circuit. If you have ever used a volume knob on a stereo or a sliding light dimmer, then you have used a potentiometer.

Potentiometers are measured in ohms like resistors, but rather than having color bands, they have their value rating written directly on them (i.e. "1M"). They are also marked with an "A" or a "B, " which indicated the type of response curve it has.

Potentiometers marked with a "B" have a linear response curve. This means that as you turn the knob, the resistance increases evenly (10, 20, 30, 40, 50, etc.). The potentiometers marked with an "A" have a logarithmic response curve. This means that as you turn the knob, the numbers increase logarithmically (1, 10, 100, 10,000 etc.)

Potentiometers have three legs as to create a voltage divider, which is basically two resistors in series. When two resistors are put in series, the point between them is a voltage that is a value somewhere between the source value and ground.

Breadboards



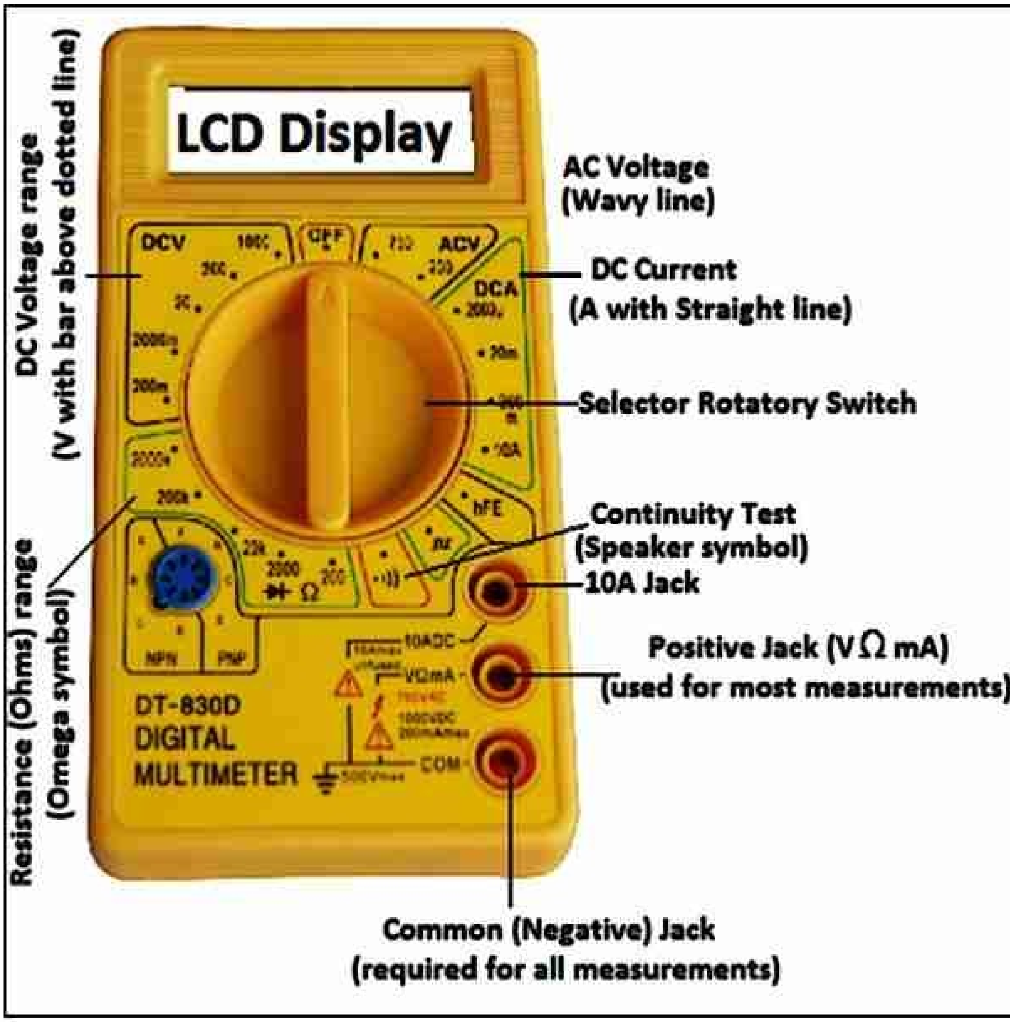
Breadboards are special boards for prototyping electronics. They are covered with a grid of holes, which are split into electrically continuous rows.

In the central part there are two columns of rows that are side-by-side. This is designed to allow you to be able to insert an integrated circuit into the center. After it is inserted, each pin of the integrated circuit will have a row of electrically continuous holes connected to it.

In this way, you can quickly build a circuit without having to do any soldering or twisting wires together. Simply connect the parts that are wired together into one of the electrically continuous rows.

On each edge of the breadboard, there typically runs two continuous bus lines. One is intended as a power bus and the other is intended as a ground bus. By plugging power and ground respectively into each of these, you can easily access them from anywhere on the breadboard.

Multimeter



The digital multimeter, DMM, is one of the most common items of test equipment used in the electronics industry today.

While there are many other items of test equipment that are available, the multimeter is able to provide excellent readings of the basic measurements of amps, volts and ohms.

In addition to this the fact that these digital multimeters use digital and logic technology, means that the use of integrated circuits rather than analogue techniques, enables many new test features to be embedded in the design.

As a result, most of today's digital multimeters incorporate many additional measurements that can be made.

DMM facilities

While the facilities that a digital multimeter can offer are much greater than their analogue predecessors, the cost of DMMs is relatively low. DMMs are able to offer as standard the basic measurements that would typically include:

- Current (DC)
- Current (AC)
- Voltage (DC)
- Voltage (AC)
- Resistance

However, using integrated circuit technology, most DMMs are able to offer additional test capabilities. These may include some of the following:

Capacitance

Temperature

Frequency

Transistor test - hfe, etc

Continuity (buzzer)

While some of these additional test features may not be as accurate as those supplied by dedicated test instruments, they are nevertheless very useful, especially where approximate readings only are needed.

In addition to an increase in the number of basic measurements that can be made, refinements of some of the basic measurements are also available on some models. True RMS multimeters are available. In many instances, AC waveforms use forms of average measurements that are then converted to RMS measurements using a form factor. This method of measurement is very dependent upon the shape of the waveform and as a result a true RMS digital multimeter may be required. In addition to the availability of a true RMS meters, similar refinements of the other basic measurements are also available in some instances.

In addition to the additional measurement capabilities, DMMs also offer flexibility in the way measurements are made. Again this is achieved because of the additional capabilities provided by the digital electronics circuitry contained within the digital multimeter. Many instruments will offer two additional capabilities:

Auto-range: This facility enables the correct range of the digital multimeter to be selected so that the most significant digits are shown, i.e. a four-digit DMM would automatically select an appropriate range to display 1.234 mV instead of 0.012 V. Additionally it also prevent overloading, by ensuring that a volts range is selected instead of a millivolts range. Digital multimeters that incorporate an auto-range facility usually include a facility to 'freeze' the meter to a particular range. This prevents a measurement that might be on the border between two ranges causing the meter to frequently change its range which can be very distracting. **Auto-polarity:** This is a very convenient facility that comes into action for direct current and voltage readings. It shows if the voltage of current being measured is positive (i.e. it is in the same sense as the meter connections) or negative (i.e. opposite polarity to meter connections). Analogue meters did not have this facility and the meter would deflect backwards and the meter leads would have to be reversed to correctly take the reading. DMM measurements

Digital multimeters can make a variety of different measurements. Using them is normally very easy, but the right techniques must be adopted to make the measurements correctly.

This DMM tutorial includes pages outlining the techniques required for making various measurements.

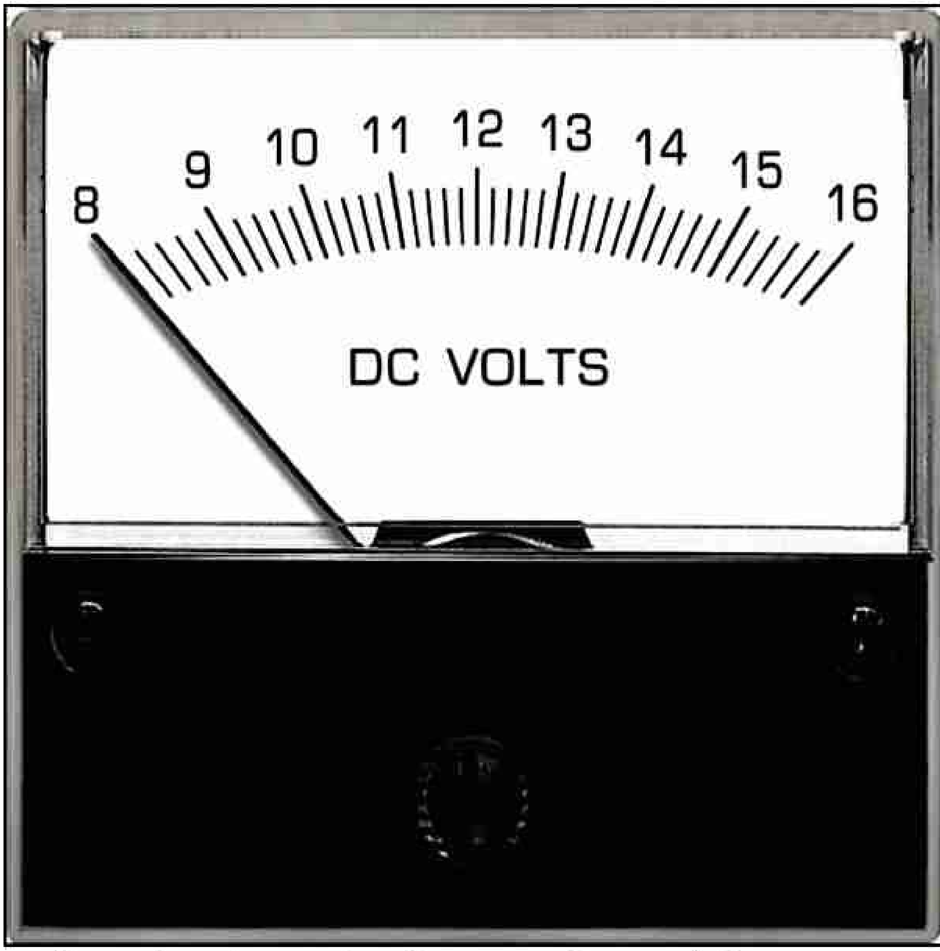
How to use a DMM: There are some basic hints and tips on using a DMM that apply across most DMM measurements. Read how to use a digital multimeter

Voltage measurements: The voltage measurement is one of the most widely used and most simple DMM measurements. Read how to make a voltage measurement.

Current measurement: Current measurements are a little more complicated requiring the digital multimeter to be placed within the circuit Read how to make a current measurement.

Resistance measurement: It is often necessary to measure the resistance of a component. This is easy to accomplish, but certain precautions must be observed. Read how to make a resistance measurement.

Voltmeter



A

voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.

A voltmeter in a circuit diagram is represented by the letter V in a circle.

Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

General purpose analog voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less.

Part of the problem of making an accurate voltmeter is that of calibration to check its accuracy. In laboratories, the Weston Cell is used as a standard voltage for precision work. Precision voltage references are available based on electronic circuits.

Ammeter

An ammeter is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as milliammeters or microammeters. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems.

Solar Introduction

Since the dawn of time the sun has been providing energy for the planet, helping plants grow, warming the seas, and maintaining the conditions for life to thrive. In the last century and a bit, man has been seeking to develop new and ingenious ways to harness that energy in the form of solar panels, turning sunlight into electricity that feeds millions of homes.

Solar panels are one of the major technical innovations of our lifetime and are beginning to change the way we look at our energy needs, now and in the years to come.

In our quest for sustainable and renewable energy that leaves us less reliant of fossil fuels, solar energy and the development of efficient solar panels lies at the forefront of green technologies today. We see them being used for domestic houses and businesses but also produced on an industrial scale with solar farms that have transformed our landscape, bringing us ever closer to the technology that can make a difference to our lives and the planet we live on.

The History of Solar Panels

We have used the energy of the sun to make our lives better ever since we discovered how to magnify its rays to make fire. The Greeks used a system of mirrors to light torches as far back as the third century BC. The humble green house has been around for centuries and is simply a way of collecting the sun�s energy to create heat to grow plants, whilst the first legitimate solar panel was actually created way back in 1767 by Swiss scientist Horace-Benedict de Saussure who used it to heat water and make steam.

The history of the solar panel is a reflection of man�s burgeoning ingenuity to use his environment in a safe and sustainable way.

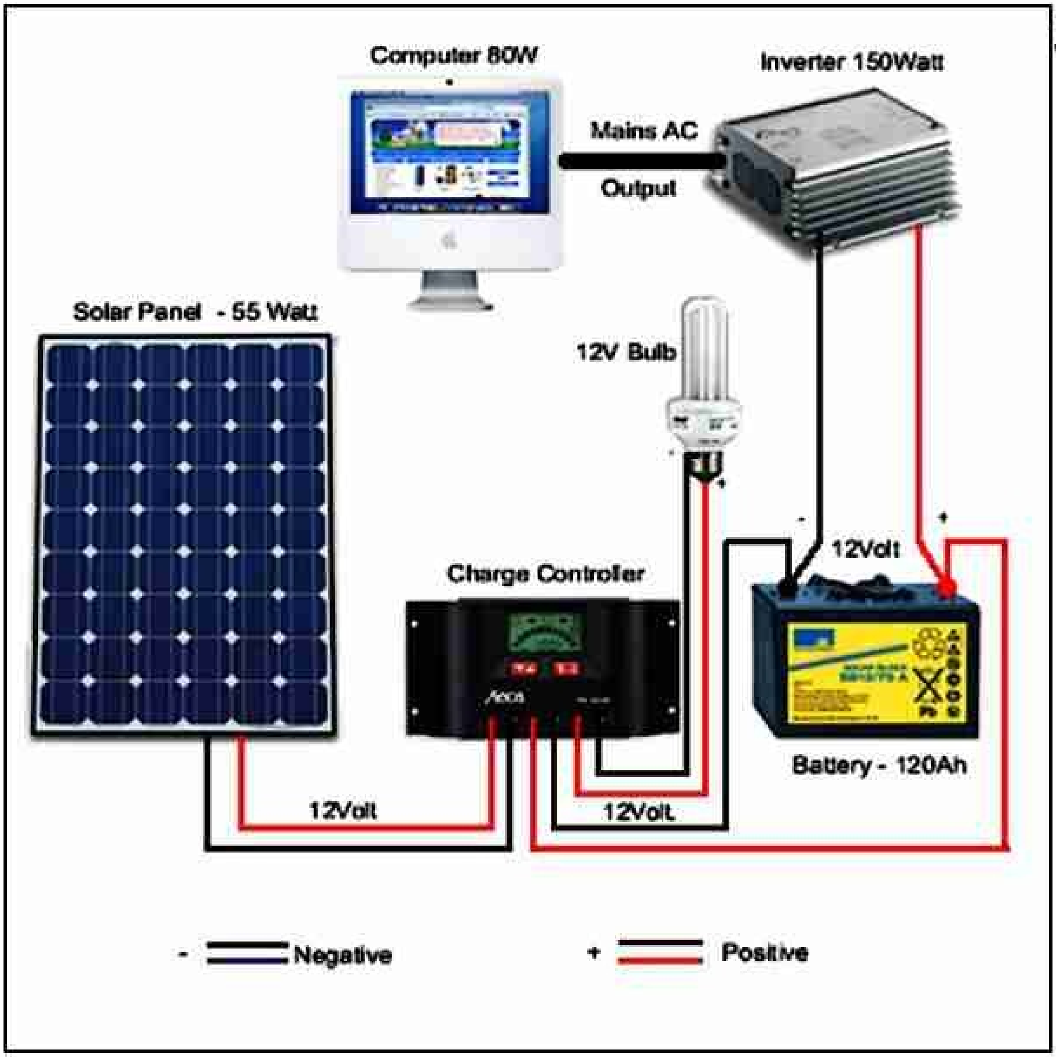
How Do Solar Panels Work?
Energy travels the 93 million miles from the Sun in approximately 8 minutes, arriving in the form of light and heat of varying wavelengths. We can convert this sunlight into electricity by the use of photovoltaic cells that collect the energy. At the present time, these cells are normally made of silicon. When the sun strikes the molecules in photovoltaic cells it knocks electrons loose that generate electricity as they flow through it.

The great thing is that this process doesn�t require bright sunshine and hot conditions which means that a temperate climate like we have in the UK is just as good for producing electricity from solar panels as hotter climes like California or Africa.

Types of Photovoltaic Cells
One of our fastest developing technologies is found in the photovoltaic cell that powers solar panels and provides the electricity and heat used in our homes and businesses. Researchers and developers are working harder than ever to bring the price down and produce new technologies that decrease our reliance on fossil fuels. That means solar panels are becoming more and more viable as renewable energy generating technology.

Most commercially used solar panels currently use silicon photovoltaic cells in one form or another and they are judged primarily upon their efficiency at producing electricity and their subsequent cost. Pure silicon cells such monocrystalline have a high efficiency but also cost more, which may not make them suitable for use in domestic abodes. Hybrid cells, a mix of silicon and organic substances, have a lower efficiency but cost less.

Solar Panels



Solar panels get energy from the sun for people to use. There are two types of solar panels, those that collect heat (thermal), and those that produce electricity (photovoltaic). Heat from solar panels is often used for space heating and for hot water.

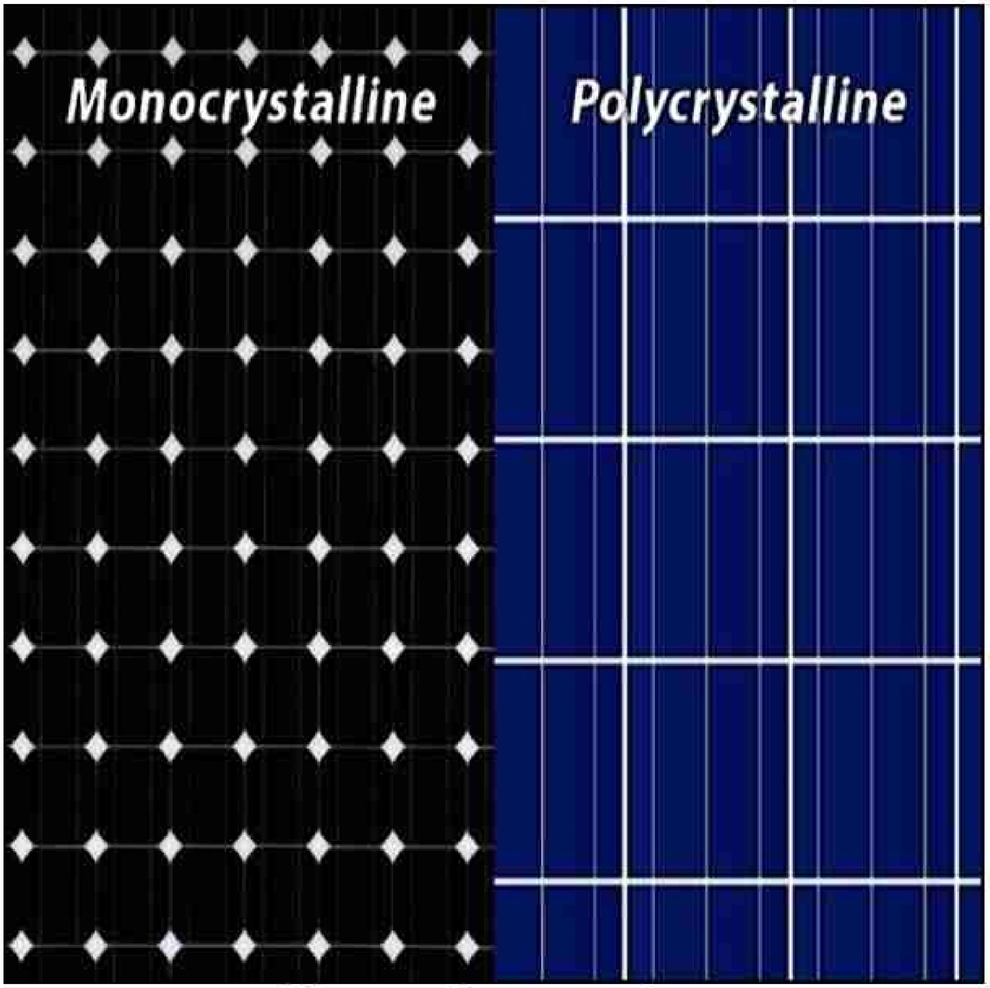
Solar panels collect renewable energy. In the 20th century some used the heat of the sun to make steam for a steam engine to turn a generator. Nowadays producing electricity from the sun's light is cheaper. This is a solid state way of producing electricity, meaning that it has no moving parts. Solar panels are often mounted on rooftops. Commercial or industrial installations are often on trackers mounted on the ground. The trackers point the panel towards the sun as the sun moves across the sky. Solar panels are also commonly used in outer space, where they are one of the few power sources available.

Usage

The top ten uses for solar panels include,

- heat for your home
- power pumps
- indoor and out door light battery charging which can be a beneficial if you have a reserve battery bank that is charged through the day while sunlight is present and is used through the nighttime hours. It can also be used for simple solar panels to collect sunlight and convert it into electricity.
- powering your home, camper, cabin, tool shed, or any other building for that matter.
- when heating swimming pools, a solar hot water heating system utilizes the solar hot water heating panels, that can be mounted on your roof to collect the sun�s heat and then is circulated to the pool.
- Solar panels are also being used in space exploration and other forms of transportation.

Types of Solar panels



Monocrystalline solar panels :

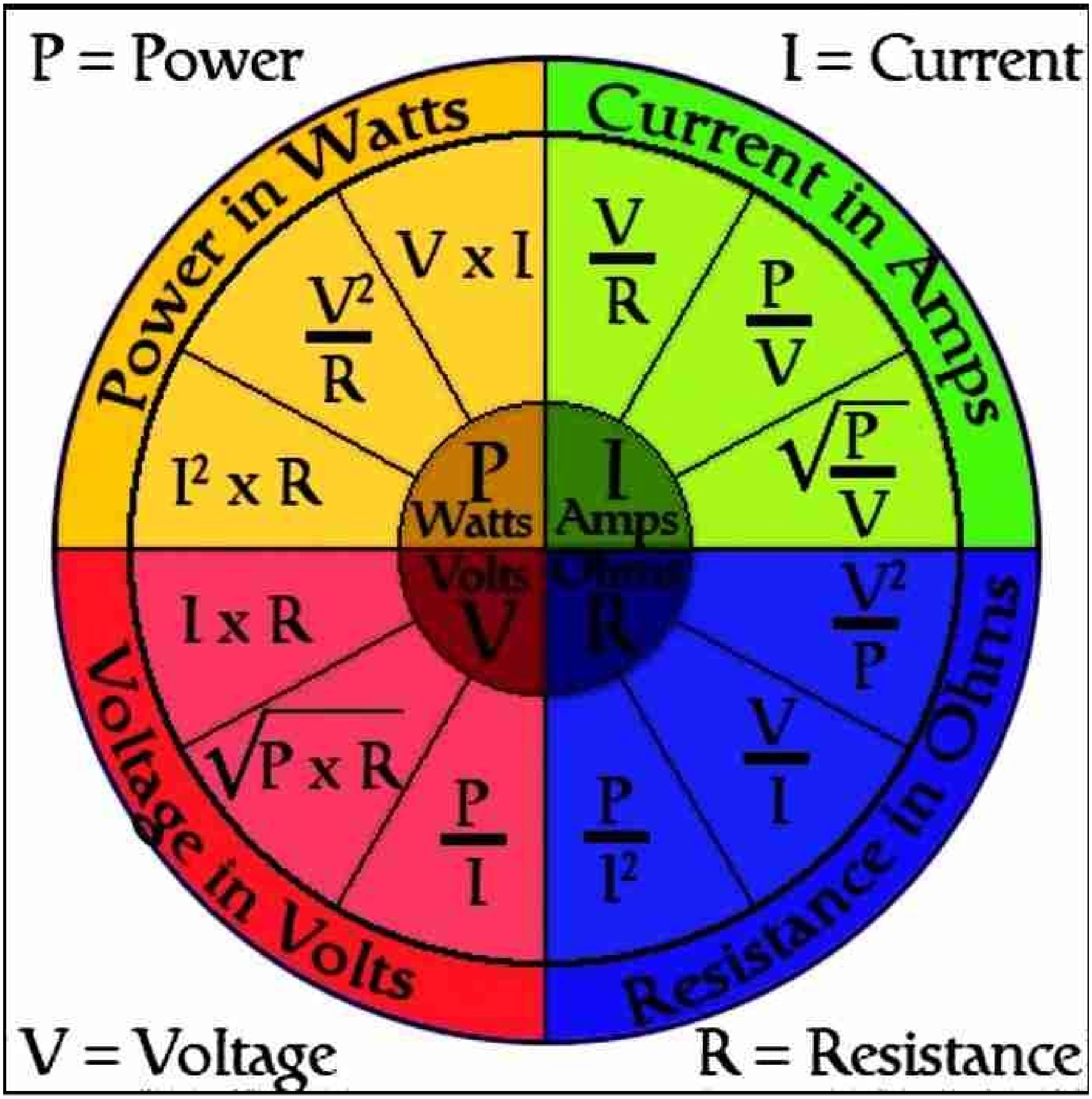
The most efficient and expensive solar panels are made with Monocrystalline cells. These solar cells use very pure silicon and involve a complicated crystal growth process. Long silicon rods are produced which are cut into slices of .2 to .4 mm thick discs or wafers which are then processed into individual cells that are wired together in the solar panel.

Polycrystalline solar panels :
Often called Multi-crystalline, solar panels made with Polycrystalline cells are a little less expensive & slightly less efficient than Monocrystalline cells because the cells are not grown in single crystals but in a large block of many crystals. This is what gives them that striking shattered glass appearance. Like Monocrystalline cells, they are also then sliced into wafers to produce the individual cells that make up the solar panel.

Amorphous solar panels :
These are not really crystals, but a thin layer of silicon deposited on a base material such as metal or glass to create the solar panel. These Amorphous solar panels are much cheaper, but their energy efficiency is also much less so more square footage is required to produce the same amount of power as the Monocrystalline or Polycrystalline type of solar panel. Amorphous solar panels can even be made into long sheets of roofing material to cover large areas of a south facing roof surface.

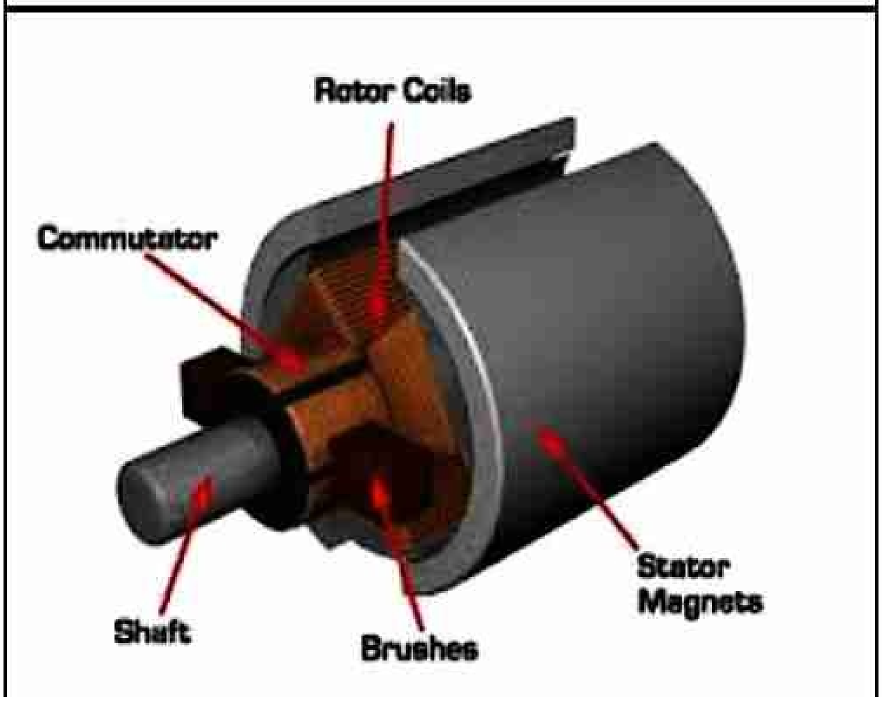
Basic Formula

Parameter	Symbol	Measuring Unit	Discription
Voltage	Volt	V or E	Unit of Electrical Potential $V = I \times R$
Current	Ampere	I or i	Unit of Electrical Current $I = V \div R$
Resistance	Ohm	R or Ω	Unit of DC Current $R = V \div I$
Conductance	Siemen or Mho	G or ℧	Unit of Conductance $G = 1 \div R$
Power	Watts	W	Unit of Power $P = V \times I$
Capacitance	Farad	C	Unit of Capacitance $C = Q \div V$
Inductance	Henery	L or H	Unit of Inductance $V_L = -L(di \div dt)$
Impedance	Ohm	Z	Unit of AC Resistance $Z^2 = R^2 + X^2$
Charge	Coulomb	Q	Unit of Electrical Charge $Q = C \times V$
Frequency	Hertz	Hz	Unit of Frequency $f = 1 \div T$
Period	sec	s	Unite of Period $T = 1 \div f$



P = Power
I = Current
V = Voltage
R = Resistance
Power in Watts
Current in Amps
Voltage in Volts
Resistance in Ohms
P
Watts
I
Amps
Volts
V
Ohms
R
V x I
V²/R
I² x R
V/R
P/V
√(P/V)
I x R
√(P x R)
P/I
V²/P
V/I
P/I²

DC Motor



Almost every mechanical movement that we see today is accomplished by an electric motor. An electric motor takes electrical energy and produces mechanical energy. Electric motors come in various ratings and sizes. Some applications of large electric motors include elevators, rolling mills and electric trains. Some applications of small electric motors are robots, automobiles and power tools. Electric motors are categorized into two types: DC (Direct Current) motors and AC (Alternating Current) motors. The function of both AC and DC motors is same i.e. to convert electrical energy to mechanical energy.

The basic difference between these two is the power supply which is an AC source for AC motors and a DC source like a battery for DC motors. Both AC and DC electric motors consist of a stator which is a stationary part and a rotor which is a rotating part or armature of the motor. The principle of working of an electric motor is based on the interaction of magnetic field produced by the stator and the electric current flowing in the rotor in order to produce rotational speed and torque.

There are different kinds of DC motors and they all work on the same principle. A DC motor is an electromechanical actuator used for producing continuous movement with controllable speed of rotation. DC motors are ideal for use in applications where speed control and servo type control or positioning is required.

As mentioned earlier, any motor consists of two parts viz. stator and rotor. Based on the configuration and construction, there are three types of DC motors: brushed motor, brushless motor and servo motor.

Types of DC Motors

DC motors are mainly classified into two types in the way of rotor is powered. They are Brushed DC motors and Brushless DC motors. As its name indicates, the brushes are present in brushed DC motor to supply the current to the rotating armature via the commutator whereas in a brushless DC motor no need of brushes as it uses a permanent magnet rotor.

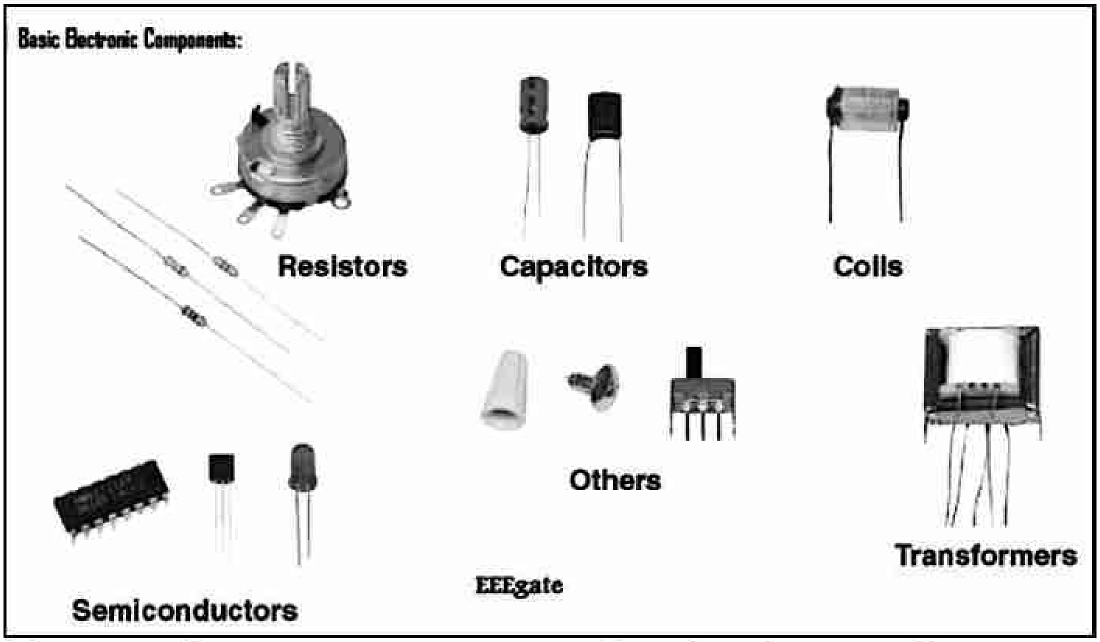
1. Brushed DC Motor

In this type of motors, magnetic field is produced by passing current through a commutator and brush which are inside the rotor. Hence, they are called Brushed Motors. The brushes are made up of carbon. These can be separately excited or self-excited motors.

2. Brushless DC Motor

Brushless DC motors typically consist of a permanent magnet rotor and a coil wound stator. This design by using permanent magnets in rotor eliminates the need for brushes in the rotor part. Hence, in contrast to brushed DC motors, these type do not contain any brushes and therefore no wear and tear of brushes as little amount of heat is generated.

Electronic Components, Parts and Their Function



Electronic components are basic electronic element or electronic parts usually packaged in a discrete form with two or more connecting leads or metallic pads.

Electronic Components are intended to be connected together, usually by soldering to a printed circuit board (PCB), to create an electronic circuit with a particular function (for example an amplifier, radio receiver, oscillator, wireless). Some of the main Electronic Components are: resistor, capacitor, transistor, diode, operational amplifier, resistor array, logic gate etc.

Types of Electronic Components :

Electronic Components are of 2 types: Active and Passive Electronic Components.

Passive electronic components are those that do not have gain or directionality. They are also called Electrical elements or electrical components. e.g. resistors, capacitors, diodes, Inductors.

Active components are those that have gain or directionality. e.g. transistors, integrated circuits or ICs, logic gates.

Electronic Components and Their Functions :

Terminals and Connectors: Components to make electrical connection. Resistors: Components used to resist current. Switches: Components that may be made to either conduct (closed) or not (open). Capacitors: Components that store electrical charge in an electrical field. Magnetic or Inductive Components: These are Electrical components that use magnetism. Network Components: Components that use more than 1 type of Passive Component. Piezoelectric devices, crystals, resonators: Passive components that use piezoelectric. effect. Semiconductors: Electronic control components with no moving parts. Diodes: Components that conduct electricity in only one direction. Transistors: A semiconductor device capable of amplification. Integrated Circuits or ICs: A microelectronic computer electronic circuit incorporated into a chip or semiconductor; a whole system rather than a single component

Electronic Components Abbreviations :

Here is a list of Electronic Component name abbreviations widely used in the electronics industry:

AE: aerial, antenna
B: battery
BR: bridge rectifier
C: capacitor
CRT: cathode ray tube
D or CR: diode
F: fuse
GDT: gas discharge tube
IC: integrated circuit
J: wire link
JFET: junction gate field-effect transistor
L: inductor
LCD: Liquid crystal display
LDR: light dependent resistor
LED: light emitting diode
LS: speaker
M: motor
MCB: circuit breaker

Mic: microphone
Ne: neon lamp
OP: Operational Amplifier
PCB: printed circuit board
PU: pickup
Q: transistor
R: resistor
RLA: RY: relay
SCR: silicon controlled rectifier
FET: field effect transistor
MOSFET: Metal oxide semiconductor field effect transistor
TFT: thin film transistor(display)
VLSI: very large scale integration

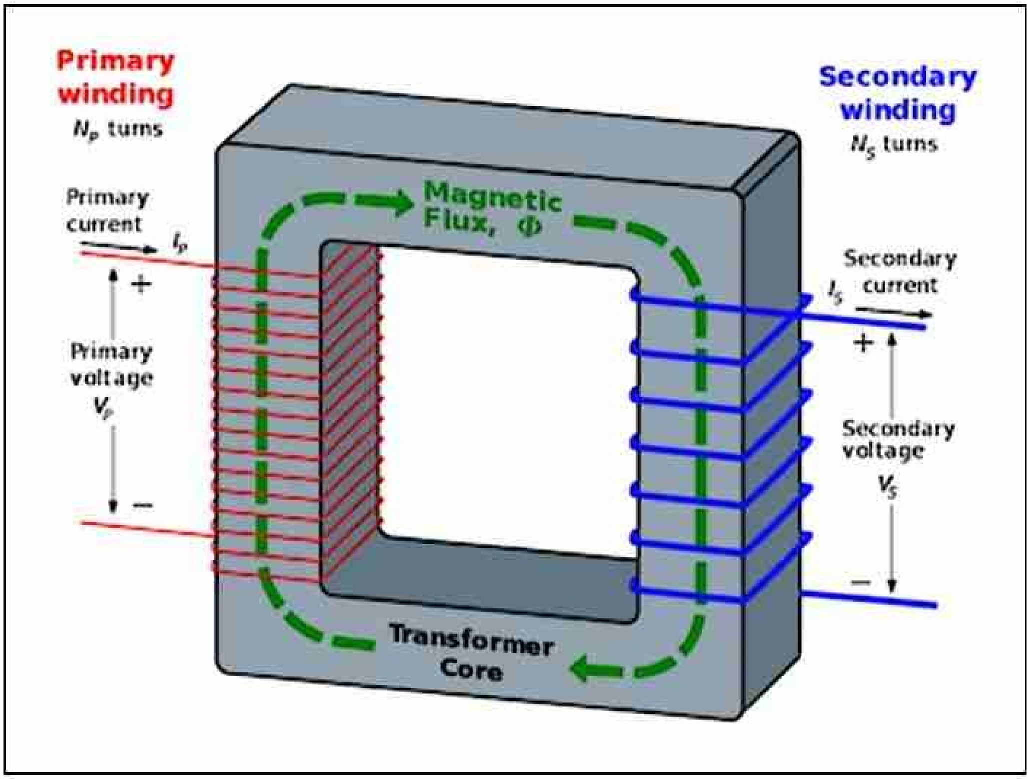
DSP: digital signal processor
SW: switch
T: transformer
TH: thermistor
TP: test point
Tr: transistor
U:integrated circuit
V: valve (tube)
VC: variable capacitor
VFD: vacuum fluorescent display
VR: variable resistor
X: crystal, ceramic resonator
XMER: transformer
XTAL: crystal
Z: zener diode

Transformers

The transformer is one of the most common devices found in electrical system that links the circuits which are operating at different voltages .These are commonly used in applications where there is a need of AC voltage conversion from one voltage level to another. It is possible either to decrease or increase the voltage and currents by the use of transformer in AC circuits based on the requirements of the electrical equipment or device or load. Various applications use wide variety of transformers including power, instrumentation and pulse transformers.

In a broad, transformers are categorized into two types, namely, electronic transformers and power transformers. Electronic transformers operating voltages are very low and are rated at low power levels. These are used in consumer electronic equipments like televisions, personal computers, CD/DVD players, and other devices. The term power transformer is referred to the transformers with high power and voltage ratings. These are extensively used in power generation, transmission, distribution and utility systems to increase or decrease the voltage levels. However, the operation involved in these two types of transformers is same.

What is an Electric Transformer?



The transformer is a static device (means that has no moving parts) that consists of one, two or more windings which are magnetically coupled and electrically separated with or without a magnetic core. It transfers the electrical energy from one circuit to the other by electromagnetic induction principle. The winding connected to the AC main supply is called primary winding and the winding connected to the load or from which energy is drawn out is called as secondary winding. These two windings with proper insulation are wound on a laminated core which provides a magnetic path between windings.

When the primary winding is energized with alternating voltage source, an alternating magnetic flux or field will be produced in the transformer core. This magnetic flux amplitude depends on the applied voltage magnitude, frequency of the supply and the number of turns on the primary side. This flux circulates through the core and hence links with the secondary winding. Based on the principle of electromagnetic induction, this magnetic linking induces a voltage in the secondary winding. This is called as mutual induction between two circuits. The secondary voltage depends on the number of turns on the secondary as well as magnetic flux and frequency.

Transformers are extensively used in electrical power systems to produce the variable values of voltage and currents at the same frequency. Therefore , by an appropriate primary and secondary turns proportion desired voltage ratio is obtained by the transformer.

Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

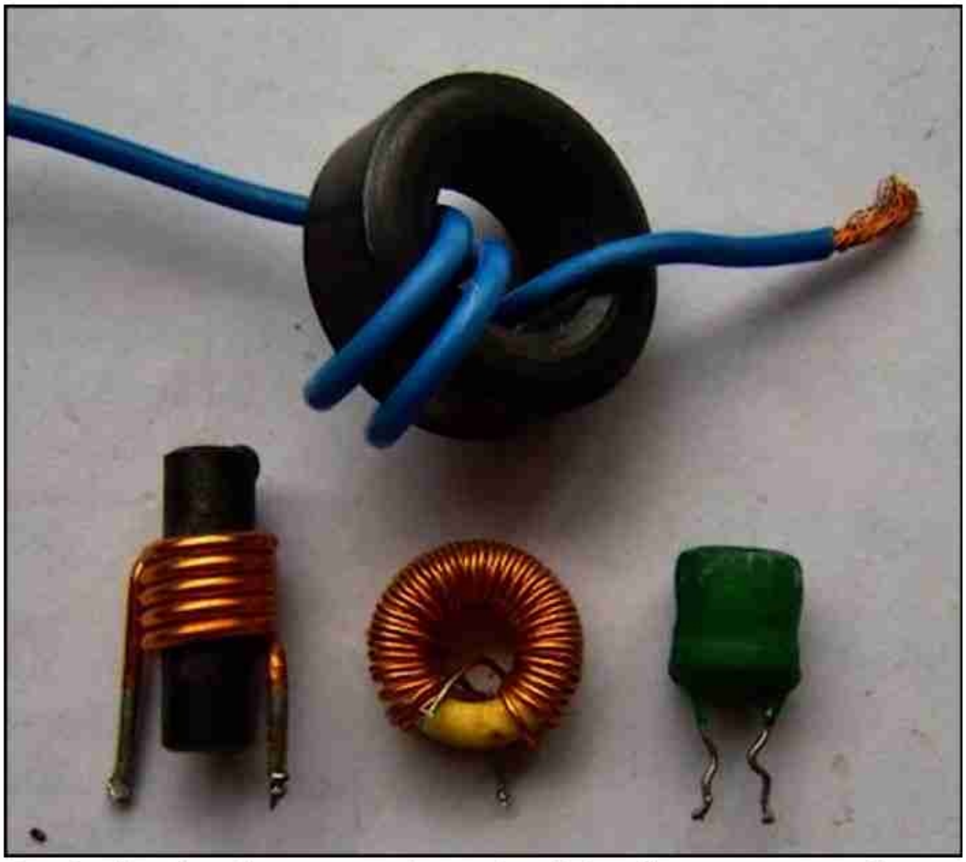
The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

Potentiometers consist of a resistive element, a sliding contact (wiper) that moves along the element, making good electrical contact with one part of it, electrical terminals at each end of the element, a mechanism that moves the wiper from one end to the other, and a housing containing the element and wiper.

See drawing. Many inexpensive potentiometers are constructed with a resistive element (B) formed into an arc of a circle usually a little less than a full turn and a wiper (C) sliding on this element when rotated, making electrical contact. The resistive element can be flat or angled. Each end of the resistive element is connected to a terminal (E, G) on the case. The wiper is connected to a third terminal (F), usually between the other two. On panel potentiometers, the wiper is usually the center terminal of three. For single-turn potentiometers, this wiper typically travels just under one revolution around the contact. The only point of ingress for contamination is the narrow space between the shaft and the housing it rotates in.

Inductor



An Inductor is a passive electrical component consisting of a coil of wire which is designed to take advantage of the relationship between magentism and electricity as a result of an electric current passing through the coil.

In its most basic form, an Inductor is nothing more than a coil of wire wound around a central core. For most coils the current, (i) flowing through the coil produces a magnetic flux, (NΦ) around it that is proportional to this flow of electrical current.

The Inductor, also called a choke, is another passive type electrical component which is just a coil of wire that is designed to take advantage of this relationship by inducing a magnetic field in itself or in the core as a result of the current passing through the coil. This results in a much stronger magnetic field than one that would be produced by a simple coil of wire.

Inductors are formed with wire tightly wrapped around a solid central core which can be either a straight cylindrical rod or a continuous loop or ring to concentrate their magnetic flux.

The schematic symbol for a inductor is that of a coil of wire so therefore, a coil of wire can also be called an Inductor. Inductors usually are categorised according to the type of inner core they are wound around

DC power supply

A DC power supply is one that supplies a constant DC voltage to its load. Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains.

Bench Power Supply is an important piece of equipment when it comes to working around electronic circuits. Electronic components majorly work on DC Power Supply and hence having a reliable source of DC Power Supply is very important.

There are many types of Power Supplies like AC – to – DC Power Supplies, Linear Regulators, Switching Mode Power Supply, etc.An alternative to bench power supply is to use a wall adapter as per the project requirement like 5V or 12V.