CONTENT

INTRODUCTION TO ELECTRONICS

ELECTRONICS

The branch of engineering which deals with current conduction/transfer through a medium like vacuum, gas or semi-conductor is known as Electronics.
The word ELECTRONICS device its name from electrons present in all materials and specially in metallic device.

ELECTRONIC SIGNAL

There are three types of Electronic Signals: -

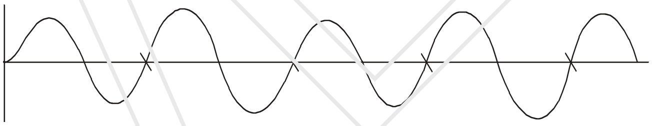
- **ANALOG SIGNAL.**
- **DIGITAL SIGNAL**
- **HYBRID SIGNAL**

ANALOG

These are the electronic signal which has variations. As shown in the picture, to reach at the peak value of this sine wave form signal has to travel between several points (Value). So we can say that this type of signal has variation. It is widely used in transmission.

OR

Analog works on the principal of measurement method like; length, breadth, rotation, electric effects etc. A computer, which works on analog principal is called analog computer. It's accepts signal (Electronics Pulse) as input. These types of computer are used in engineering and scientific.



Analog Signal

Topics Based On Analog Electronics

- Resistor.
- Current and Voltage
- Ohm's law & Power.
- Capacitor & Inductor
- Transformer.
- Semi-Conductor.
- Diode.

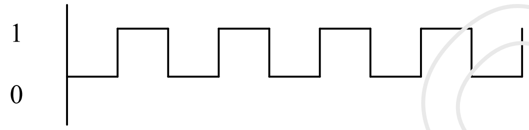
DIGITAL

These are the electronic signal, which has accurate value, or fix result. There are only two types of value it has. It can be either high (1) or low (o).

OR

A computer, which works on digital computation, is called digital computer. It accepts alphabets & number as input. Digital computer is much faster than analog computer and far accurate. These types of computer are used in field of education & business for example personal computer.

Note: -Analog is a variable signal but digital has a result if you give variable input, there is fix result. Computer used digital signal



Digital Signal

Topics Based On Digital Electronics

- Number System Conversion
- Binary Addition & Subtraction
- Gates
- Multiplexer & Demultiplexer
- Flip-Flop
- Shift Register
- Counter

HYBRID

It is generally refer as combination of both. It means analog and digital. These types of computer are used in coalmines and ICU in a hospital.
It gives reading in mixed mode. Example, heart beat analyzer.

CHAPTER 1ST : CURRENT & VOLTAGE

CURRENT

The flow of electrical charge from one point to another is called current.

OR

The flow of free electrons from one point to another point is called current.

Unit of current is Ampere (A)

It is denoted by 'I' and Ammeter is used to measure the current.

INSULATOR

Any substance, which doesn't allow the passage of current through itself.

Ex - Rubber, Wood, Paper, Plastics etc.

CONDUCTOR

Which allow the flow of the current through itself?

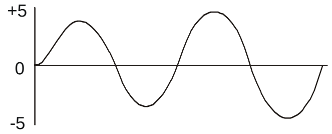
Ex - All metal are known as Conductor. Pure metals like gold are proved to be a good conductor.

Types of Current: -

- **Alternating Current**
- **Direct Current**

Alternating Current

In an alternating current the electron first flow in one direction and then in the other, i.e they alternate. The current starts from zero, rises to a maximum in one direction, falls to zero again before becoming a maximum in the opposite direction and then rises to zero once more. Alternating Current periodically changes its direction of flow, in other words - It is the current which flowing in both direction or we can say in other wards that the AC flow first in the Positive direction & then Negative direction.



AC Sine waveform

Why AC is used?

- Alternating current is used when a large amount of power or electrical energy is required.
- AC is used as primary source of electrical power.
- It can be easily transmit from one point to another point.
- It is much easier to generate and transmit A.C. than D.C., through generator.
- An AC voltage can be easily transformed to higher or lower voltages through transformer.

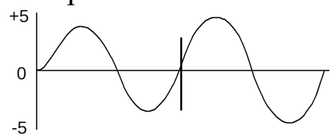
- AC can be easily converted into D.C.
- It is safe than D.C.
- AC is used to transmit information from one point to another.
- It is cheaper than D.C.

(Note: -D.C. can be also generating through generator but it is tough and lengthy process as compare to generate AC.)

<u>Basic Terms Related to A.C.</u>

Cycle

One positive Alternation and one negative alternation means one cycle.



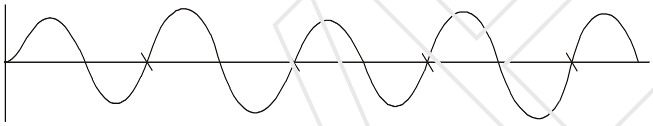
One cycle

Frequency

Total number of cycles completed in one second is called frequency of AC sine wave form. 'F' denotes it. Frequency=cycle/second

Unit - Hz (Hertz)

F= 1/T



Frequency

Ex: - If time period of a sine wave forms are 20ms, than find the frequency of the AC sine wave form.

Ans. F= 1/T

= 1/20ms

= 50 Hz

Period or Time Period

The time taken to complete one cycle is called time-period of AC sine wave form. It is measured in seconds and the latter 'T' represents it.

Unit -Second

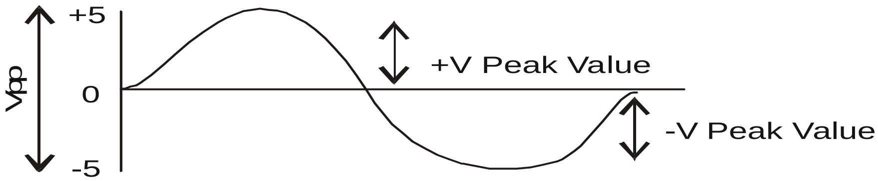
T=1/f

Ex: - Four cycles are produces in one second. Find the time period of AC sine wave form.

Ans. 1/4 Second

Peak Value

Peak value is the maximum height from the X-axis- (horizontal line). One cycle has two-peak value called positive peak value and negative peak value? In the following picture positive peak value is +5v and negative peak value is -5v



Peak to peak Value (V_{PP})

The total height or value of a (sinusoidal) sine wave form between its peak values is called peak-to-peak value.

$V_P=V_P+V_P=2V_P$

Average Value

Average value can be determined by taking a large no. of instantaneous value which occur during the alternation and computing their Average value. The Average value of a full cycle of a sine wave=0.

Average Value = 0.636 x V_P

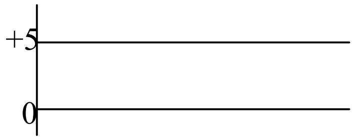
Effective value or R.M.S. Value (Root means square value)

An alternating current that will produce the same amount produce as Direct current that was a value of 1 Ampere is considered to have an effective value of 1 Ampere. In other words, a direct current of 1 Ampere is equivalent to an AC, which has an effective value of 1 Ampere as for as their ability to produce heat to consider.

Effective Value = 0.707 X V_P

Direct Current

Direct Current flows in only one direction and has steady or constant value. Cell and batteries produce D.C. voltages and currents.

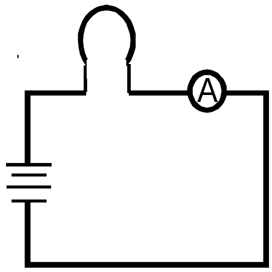


Direct Current

How to Measure Current?

- Open the circuit.
- Attach Ammeter to the circuit.
- Close the circuit and note down the value that is display in the Ammeter's screen.A

Note: -To measures the current we have to connect the Ammeter in series to the circuit.



Electromotive force (EMF)

It is the force, which sets electrons in motion. This force is a natural result of Columbus low. It is measured in a closed loop circuit.

OR

A battery can supply the force needed to cause a current to flow in a wire. we say the battery produces an electromotive force because of the chemical action which occurs inside it.

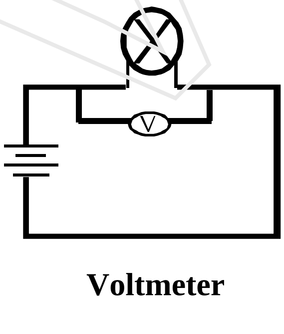
It is measured in volts (V) by connecting voltmeter across the battery.

Potential Difference

Potential means the capability of doing work. If the switch is closed current flows and useful work is done whether a battery is connected into a circuit or not, it has the potential of doing work. Potential difference is the difference of potentials between two points. Unit-Volts.

<u>Voltage</u>

Voltage is the force, which tends to move electron from one terminal to another terminal.
The measurement of potential differences or electromotive force is known as voltage but it doesn't mean that potential difference and electro motive force is the exactly same things. It is measured in Volt (V) and voltmeter is used to measure voltage. To measure the voltage Voltmeter is connected across the circuit.



Voltmeter

<u>OHM'S LAW & POWER</u>

<u>Ohm's Law</u>

Ohm's low is the most important and most basic low of electricity and electronics. It defines the relationship between the three fundamental electrical quantities: Current, Voltage and Resistance. Sir Albert ohm puts this law forward.

Ohm's law state that current is directly proportional to voltage and inversely proportional to resistance.

The source of voltage is the battery. Voltage is the force, which forces current to flow. Therefore, the higher the voltage, the higher the current and, the lower the voltage, the lower the current. This assumes that the resistance remains constant. However, as we have seen that the resistance also determines the current, resistance is the opposition to current flow.

Practical Table

Current = Voltage/Resistance

AMP = Volt/Ohm

V	1	2	3	3
I	0.1	0.2	0.3	0.2
R	10	10	10	15

To Find Voltage

Q.1 If circuits have two Resistances in parallel of 10K Directly each and current Inversalyis 5AMP. Find the voltage.

Solution

V = IR

V = 5A x 10k

V = 50 V

To Find Current

Q.1 If circuit having 50V voltage and 10kΩ of resistivity. Find out that how much current will flow in the circuit.

Solution

I = V/R => 50V/10kΩ =>

<u>Power</u>

The rate at which work is done is called power in another words.

Power refers to the amount of work done in a specific length of time. Power is directly proportional to both, voltage and current.

The power of an appliance is the rate at which it changes energy from one form to another, i.e energy change per second.

Unit=Watt (w)

Power = Voltage X Current

Watt = Volt X Amp.

Power is the product of voltage and current.

Wattage

It is the maximum handling capacity of equipment of power.

Ex. Voltage = 50V, Resistance = 10k ohm, Find Power V=IR

Solution

Power = VI

I = V/R => 50/10 => 5Amp.

Power = 50x5 => 250W

Hence, the power of this circuit we have to get the current first, than after are able to find the power. But according to ohm's low

$$W = I^2 R$$

Ex - I = 5A , R = 10 Find Power

Solution Power = V x I

Power = IR x I

$= I^2 R = 5^2 \times 10$

$= 500W$

Chapter 2nd: RESISTOR

Objectives

- About Resistor and its property.
- How to find the value of a Resistor.
- How many types of Resistor.

Resistor

The resistor is the simplest, most basic electronic component. In an electronic circuit, the resistor opposes the flow of electrical current through itself. It accomplishes this by absorbing some of the electrical energy applied to it, and then dissipating that energy as heat. By doing this, the resistor provides a means of limiting or controlling the amount of electrical current & devides the voltage in any electronics circuit.

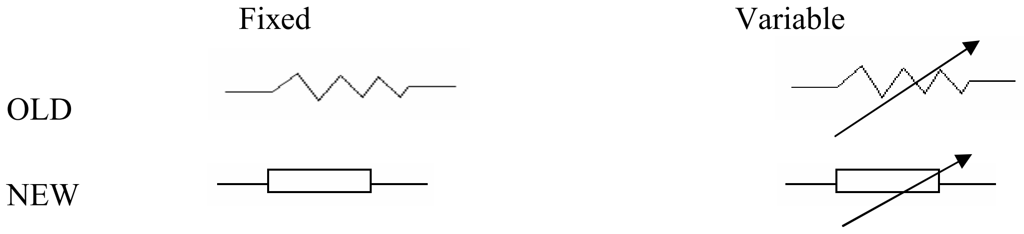
Every substance has some kind of property due to which it apposes the flow of current. The opposition of current flow is known as Resistivity or Resistance.

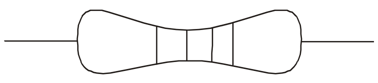
Resistor is a device that opposes the flow of current.

The job done by the resistors done by the resistors include directing and controlling current, making changing currents produce changing voltages and obtaining variable voltage from the fixed ones

Resistance is the property of a resistor; due to which it appose the flow of current. **'R'** denotes it and the unit is Ohm (Ω)

It is of two main type:-those with fixed values and those with variable values.





Shape

Ohmmeter is used to measure the value of a resistor. We always keep the lead of ohmmeter at ohm range to measure the value of a resistor.

Resistivity of some substance

Substance	Resistivity (in ohms)(Mil Foot)
Silver	9.9
Copper	10.4
Gold	15.3
Aluminum	17.0
Iron	58.0
Steel	100.0
Nichrome	660.0
Glass	10^{16}

Conductance

The ease with which a substance allows current to flow through it is called conductance and it is reciprocal of Resistor. 'G' denotes it

G = ½

Unit-Mho (Moe)

Cross-Sectional Area

The thickness or diameter of a conductor determines it's cross sectional Area.

Resistance

The length, the cross-sectional area and the resistivity of a material determine Resistance.

Tolerance

The first three colour bands of a resistor indicate the initial value and the fourth band represent the tolerance rating. It may be defined as the amount of variation allowed from a standard, accuracy, etc.

For example:

If a resistor which value is 100 $\pm$ 5% Ωits mean the value of the resistor can be varied from 95Ω to 105Ω. Any value between 95Ω to 105Ω can be the value of the resistor.

Value of Resistor

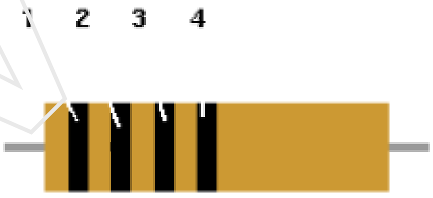
There are two methods to find the value of a Resistor-

- With the help of color-coding.
- With the help of Ohmmeter.

<u>Colour coding table of a Resistor</u>

Color	**1st Band Number**	**2nd Band Number**	**3rd Band Multiple**	**4th Band Tolerance.**
Black	0	0	10^0 = 1	----
Brown	1	1	10^1 = 10	$\pm$ 1%
Red	2	2	10^2 = 100	$\pm$ 2%
Orange	3	3	10^3 = 1000	$\pm$ 3%
Yellow	4	4	10^4 = 10000	$\pm$ 4%
Green	5	5	10^5 = 100000	----
Blue	6	6	10^6 = 1000000	----
Violet	7	7	10^7 = 10000000	----
Gray	8	8	10^8 = 100000000	----
White	9	9	10^9 = 1000000000	----
Gold	----	----	10^{-1} = 0.1	$\pm$ 5%
Silver	----	----	10^{-2} = 0.01	$\pm$ 10%
No Band	----	----	10^{-3} = 0.001	$\pm$ 20%

Starting with the color band or stripe closest to one end of the resistor, the bands have the following significance: The first two bands give the two significant digits of the resistance value. The third gives a decimal multiplier, which is some power of 10, and generally simply defines how many zeroes to add after the significant digits. The fourth band identifies the tolerance rating of the resistor. If the fourth band is missing, it indicates the original default tolerance of 20%. The bands may take on colors according to the following figure and table:



Color Significant Digits (1 and 2) Multiplier (3) Tolerance (4)

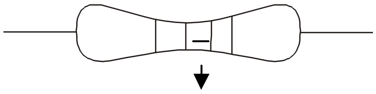
Standard resistors may be obtained in values ranging from 0.24Ω to 22 Mega ohms (22,000,000Ω). However, they are not available in just any value; only the following combinations of first and second significant digits are used:

10 *	11	**12**	13	**15** *	16	**18**	20	**22** *	24	**27**	30	**33** *	36	**39**	43	**47** *	51	**56**	62	**68** *	75	**82**	91

All values above may be obtained in 5% tolerance, while the boldface entries are available in 10% tolerance. Only the ones marked with an asterisk (*) are available in 20% tolerance, and you probably won't be able to find even them on today's market.

IMPORTANT NOTES

1. Black Gold Silver & No Colour Never Comes in first band
2. Gold and Silver always Comes after Second band
3. Always Gap between 3^{rd} band and 4^{th} band
4. Any Resistor has been Min. 3 Colour and maximum. 6 Colour.



GAP

5 Band Resistor

Brown	Black	Black	Brown	Sold
1	0	0	$x10^1$	± 5%

= 100 x 10 ± 5%
= 1000r ± 5%
= 1kr ± 5%

6 Band Resistor

Red	Red	Black	Brown	Gold	Red

= 220 x 10^1 ± 5 x 2 w
= 2200r ± 5 x 2 w
= 2.2 Kr ± 5 x 2 w

6^{th} Band indicate Power Rating of the Resister
Brown - 1w
Red - 2 w

Procedure to find the colour Coading of Resistor

Ex 0.5r + - 5%

1^{st}	2^{nd}	3^{rd}	4^{th}
Green	Black	Silver	Gold

Ex- 1r ±10%

Brown Black Orange gold

Ex- 10K ±5r

Brown Black Orange Gold
1

- Silver colour is must in forth band of Resistor if the Resistance is less then 1Ω
- Gold colour is must in forth band of Resistor if the Resistance is less then 10Ω
- Black colour is must in forth band of Resistor if the Resistance is less then 100Ω

- Brown colour is must in forth band of Resistor if the Resistance is less then 1KΩ
- Red colour is must in forth band of Resistor if the Resistance is less then 10KΩ
- Black, Gold, Sliver & No Band are never be 1st Band.

Procedure to find the value of a Resistor

Ex1. The color-coding of a resistor is
Brown, Black, Red, Gold.
Then find the value of the resistor.

Solution: -

Brown, Black, Red, Gold.
=> 1 0 $X10^2 \pm 5\%\Omega$
=> 10 X 100 $\pm$ 5% Ω
=> 1000 $\pm$ 5% Ω or 1KΩ $\pm$ 5%

Ex2. The color-coding for a Resistor is Red, Red, Red, and Gold; find the value.

Solution: -

Red, Red, Red, Gold.
=> 2 2 $X10^2 \pm 5\%\Omega$
=> 22 X 100 $\pm$ 5%Ω
=> 2200 Ω $\pm$ 5% or 2.2KΩ$\pm$ 5%

Ex3.

I	II	III	IV

Solution: -

Brown	Red	Yellow	Gold
1	2	x 10^4	$\pm$ 5%

= 1,20,000Ω=120KΩ

Ex4.

Red	Red	Red	Red

Solution: -

2	2	x 10^2	$\pm$5%

=2200Ω=2.2KΩ

Type Of Resistor

- **Carbon composition**
These are made from a mixture of carbon (a conductor) and clay (a non-conductor), which is pressed and molded into rods by heating. Values range form a few ohms to 10MΩa typical tolerance is $\pm$ 10% and ratings are from 0.125W to 1W. Although their stability is poor, they are cheap but ‘noisy’ i.e. loudspeaker of audio equipment.

- **Carbon film**
A film of carbon is deposited on a ceramic rod and protected by a tough insulating coating. Values, ratings and cost are similar to the carbon composition type but tolerances are better (e.g. $\pm$5 %) and stability very good.

- **Metal oxide**
  These offer high stability over a long period of time. Tolerance is $\pm$ 3 % and rating typically 0.5W. Their construction and appearance is similar to the carbon film type, tin oxide replacing carbon.

- **Wire-wound**
  Low tolerance (i.e. high accuracy), high stability resistors such as are used in good quality multimeters are of this type. Those with large power rating (e.g. over 2W) are also wire-wound. Values range from a fraction of an ohm up to about 25kΩdepending on the length and diameter of wore used Physically, they tend to be large in size.

- **Variable Resistors**
  Variable resistors used as volume and other controls in radio and TV sets are usually called ‘pots’. They consist of an incomplete circular track of either a fixed carbon resistor for high values and low power (upto2W) or a fixed wire-wound resistor for high powers.
  Maximum values range from a few ohms to several mega ohms, common values are 10kΩ, 50kΩ, 100kΩ, 500kΩ, 1mΩ

.

Uses.

There are two ways of using a variable resistor. It may be used as a *rheostat* to control the current in a circuit. It can also act as a potential or voltage divider to obtain any voltage from zero to the maximum voltage of the supply by rotating the spindle (clockwise).

CONSTRUCTION OF RESISTORS

The traditional construction of ordinary, low-power resistors is as a solid cylinder of a carbon composition material. This material is of an easily controlled content, and has a well-known resistance to the flow of electrical current. The carbon cylinder is molded around a pair of wire leads at either end to provide electrical connections. The length and diameter of the cylinder are controlled in order to define the resistance value of the resistor — the longer the cylinder, the greater the resistance; the greater the diameter, the less the resistance. At the same time, the larger the cylinder, the more power it can dissipate as heat. Thus, the combination of the two determines both the final resistance and the power rating.

A newer, more precise method is shown to the left. The manufacturer coats a cylindrical ceramic core with a uniform layer of resistance material, with a ring or cap of conducting material over each end. Instead of varying the thickness or length of the resistance material along the middle of the ceramic core, the manufacturer cuts a spiral groove around the resistor body. By changing the angle of the spiral cut, the manufacturer can very accurately adjust the length and width of the spiral stripe, and therefore the resistance of the unit. The wire leads are formed with small end cups that just fit over the end caps of the resistor, and can be bonded to the end caps.

With either construction method, the new resistor is coated with an insulating material such as phenolic or ceramic, and is marked to indicate the value of the newly finished resistor.

HIGH-POWER RESISTOR

High-power resistors are typically constructed of a resistance wire (made of nichrome or some similar material) that offers resistance to the flow of electricity, but can still handle large currents and can withstand high temperatures. The resistance wire is wrapped around a ceramic core and is simply bonded to the external connection points. These resistors are physically large so they can dissipate significant amounts of heat, and they are designed to be able to continue operating at high temperatures.

These resistors do not fall under the rule of selecting a power rating of double the expected power dissipation. That isn't practical with power dissipations of 20 or 50 watts or more. So these resistors are built to withstand the high temperatures that they will produce in normal operation, and are always given plenty of physical distance from other components so they can still dissipate all that heat harmlessly.

CHECKING PROCEDURE OF RESISTOR

Low Power Resistor

Step :- 1) Find out the Value by Colour Code.
2) Then Set the Multimeter as per value at ohm Scale.

Condition :-
OK – if Multimeter show deflection but not full –
OPEN – If Multimeter not show any deflection. (Digital -1)
SHORT – If Multimeter show full deflection (Digital – 0.0)

To find the resistance with the help of Multimeter.

- Set the multimeter at ohm range.
- Touch the multimeter probe to both side of the resistor.
- Look at the screen of multimeter and note down the value.

CHAPTER 3^RD : CAPACITOR

CAPACITOR

A Capacitor is an electrical device for storing electrical energy by accumulating electrons on a metallic surface.

This electrical charge can then be released in the form of a current into the circuit. Capacitors are important components used in radio, TV and other electronic and electrical circuits.

In its simplest form capacitor consists of into two-matatic surface speared by an insulating material, which may be air, gas, liquid or solid. This material repeating the two plates of a capacitor is call dielectric.

OR

It is a device, which stories electrical charge by means of electro static field. Capacitance is the property of a circuit or device, which enable it to store electrical charge by means of electro-static field. So, we can say that capacitor is a device that is used store electrical charge or energy and its property are called capacitance.

The basic unit of capacitance is the *farad*, named after British physicist and chemist Michael Faraday (1791 - 1867). For you physics types, the basic equation for capacitance is:

$C = q/V$,
where:

- C is the capacitance in farads.
- q is the accumulated charge in coulombs.
- V is the voltage difference between the capacitor plates.

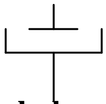
Verbally, a capacitance of one farad will exhibit a voltage difference of one volt when an electrical charge of one coulomb is moved from one plate to the other through the capacitance.

To help put this in perspective, one ampere of current represents one coulomb of charge passing a given point in an electrical circuit in one second.

In practical terms, the farad (f) represents a extremely large amount of capacitance. Real-world circuits require capacitance values very much smaller. Therefore, we use microfarads (µf) and picofarads (pf) to represent practical capacitance values. The use of the micro- and pico- prefixes is standard. $1\ \mu f = 1 \times 10^{-6}$ f and $1\ pf = 1 \times 10^{-6}\ \mu f$. Sometimes you will see the designation µµf in place of pf; they have the same meaning.

Like resistors, capacitors are generally manufactured with values to two significant digits. Also, small capacitors for general purposes have practical values greater than 1 pf and less than 1 µf. As a result, a useful convention has developed in reading capacitance values. If a capacitor is marked "47," its value is 47 pf. If it is marked .047, its value is .047 µf. Thus, whole numbers express capacitance values in Pico farads while decimal fractions express values in microfarads. Any capacitor manufactured with a value of 1 µf or greater is physically large enough to be clearly marked with its actual value.

A newer nomenclature has developed, where three numbers are printed on the body of the capacitor. The third digit in this case works like the multiplier band on a resistor; it tells the number of zeros to tack onto the end of the two significant digits. Thus, if you see a capacitor marked "151," it is not a precision component. Rather, it is an ordinary capacitor with a capacitance of 150 pf. In this nomenclature, all values are given in picofarads. Therefore you might well see a capacitor marked 684, which would mean 680000 pf, or 0.68 µf.



Symbol

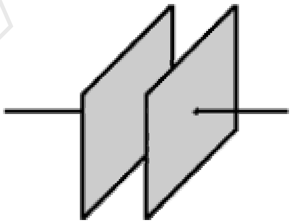
Sub names of Capacitor

- Filter
- Condenser

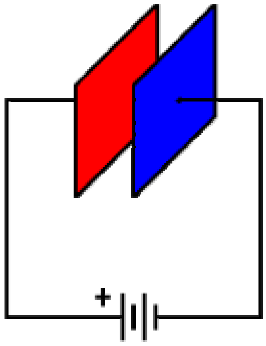
Construction

A Capacitor consists of two metal plates repeated by unknown conducting material called dielectric metal foil is used for plates, oil. glass, ceramic, paper or same other types of insulator is used.

We have said that an electrical current can only flow through a closed circuit. Thus, if we break or cut a wire in a circuit, that circuit is opened up, and can no longer carry a current. But we know that there will be a small electrical field between the broken ends. What if we modify the point of the break so that the area is expanded, thus providing a wide area of "not quite" contact?



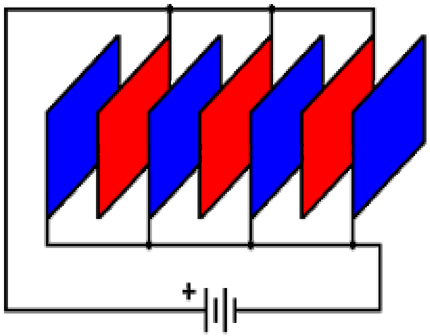
The figure to the right shows two metal plates, placed close to each other but not touching. A wire is connected to each plate as shown, so that this construction may be made part of an electrical circuit. As shown here, these plates still represent nothing more than an open circuit. A wide one to be sure, but an open circuit nevertheless.



Now suppose we apply a fixed voltage across the plates of our construction, as shown to the left. The battery attempts to push electrons onto the negative plate (blue in the figure), and pull electrons from the positive plate (the red one). Because of the large surface area between the two plates, the battery is actually able to do this. This action in turn produces an electric field between the two plates, and actually distorts the motions of the electrons in the molecules of air in between the two plates. Our construction has been given an electric charge, such that it now holds a voltage equal to the battery voltage. If we were to disconnect the battery, we would find that this structure continues to hold its charge — until something comes along to connect the two plates directly together and allow the structure to discharge itself.

Because this structure has the capacity to hold an electrical charge, it is known as a *capacitor*. The area of the two plates and the distance between them determines how much of a charge it can hold. Large plates close together show a high capacity; smaller plates kept further apart show a lower capacity. Even the cut ends of the wire we described at the top of this page show some capacity to hold a charge, although that capacity is so small as to be negligible for practical purposes.

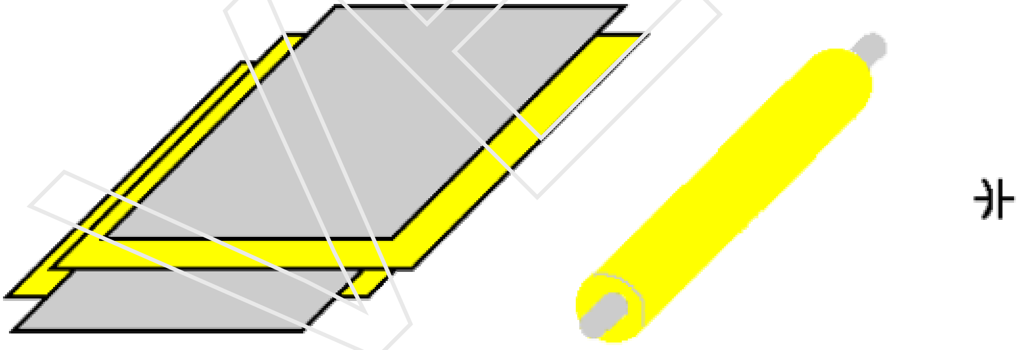
The electric field between capacitor plates gives this component an interesting and useful property: it resists any change in voltage applied across its terminals. It will draw or release energy in the form of an electric current, thus storing energy in its electric field, in its effort to oppose any change. As a result, the voltage across a capacitor cannot change instantaneously; it must change gradually as it overcomes this property of the capacitor.

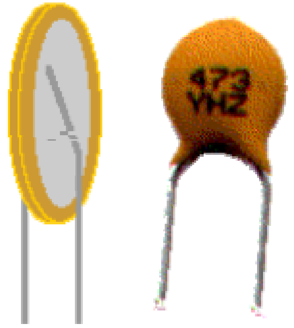


A practical capacitor is not limited to two plates. As shown to the right, it is quite possible to place a number of plates in parallel and then connect alternate plates together. In addition, it is not necessary for the insulating material between plates to be air. Any insulating material will work, and some insulators have the effect of massively increasing the capacity of the resulting device to hold an electric charge. This ability is known generally as *capacitance*, and capacitors are rated according to their capacitance.

It is also unnecessary for the capacitor plates to be flat. Consider the figure below, which shows two "plates" of metal foil, interleaved with pieces of waxed paper (shown in yellow). This assembly can be rolled up to form a cylinder, with the edges of the foil extending from either end so they can be connected to the actual capacitor leads. The resulting package is small, light, rugged, and easy to use. It is also typically large enough to have its capacitance value printed on it numerically, although some small ones do still use color codes.

The schematic symbol for a capacitor, shown below and to the right of the rolled foil illustration, represents the two plates. The curved line specifically represents the outer foil when the capacitor is rolled into a cylinder as most of them are. This can become important when we start dealing with stray signals which might interfere with the desired behavior of a circuit (such as the "buzz" or "hum" you often hear in an AM radio when it is placed near fluorescent lighting). In these cases, the outer foil can sometimes act as a shield against such interference.





An alternate construction for capacitors is shown to the right. We start with a disc of a ceramic material. Such discs can be manufactured to very accurate thickness and diameter, for easily-controlled results. Both sides of the disc are coated with solder, which is compounded of tin and lead. These coatings form the plates of the capacitor. Then, wire leads are bonded to the solder plates to form the structure shown here.

The completed construction is then dipped into another ceramic bath, to coat the entire structure with an insulating cover and to provide some additional mechanical protection. The capacitor ratings are then printed on one side of the ceramic coating, as shown in the example here.

Factors determine capacitance

- *Area of two metal plates (A)*
  It is directly proportional to capacitance. If we increase the area of two metal plates of a capacitor than capacitance will also increased and as we decrease the area of two metal plates, than capacitance will also reduce.

$$C \propto A$$

- *Distance between two metal plates (d)*
  It is inversely proportional to capacitance. When we increase the distance between two metal plates. Its capacitance will reduce and vie versa.

$$C = 1/d$$

Types of Capacitor

- Polarized
- Non-Polarized
- Variable
- Special

(Variable, Special: Not used in Computer Hardware)

Polarized

- It has separate negative and positive terminals.
- Mostly used to store D.C.
- Can be checked by meter.
- Value above 1 μf.
- Cylindrical shape.

There are two types of Polarized Capacitor and both can be used in one another place.

Tantalum	**Electrolytic**
• Small Size	Big Size
• Costly (double than electrolyte)	Cheaper than tantalum
• Durable (10 to 15 yrs.)	Not so durable 5 to 7 yrs.
• +Ve sign on the surface of capacitor	-Ve Sign on the surface of capacitor
• Just like a pea seeds as shown in picture.	Shape like a cylinder.

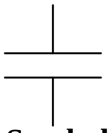
Non-Polarized

- Mostly used to pass AC.
- Check by applying AC

- Value below 1uf, .1uf, .2uf
- Flat shape
- There is no specific positive or negative pin.

Types of non-polarized capacitor

- Ceramic Disk
- Ceramic Flat
- Mica
- Paper



Symbol

Testing Of "Capacitor"

Testing of Polarized Capacitor

We can test it with multimeter.

Conclusion:

OK	>	Meter will show a kick & come back to the initial position.
Leakage	>	Meter will show a kick and come back & again start rising.
Short	>	Meter shows full deflection or meter goes but come back.
Open	>	Meter show no deflection or (Meter point cannot be move)

Testing of non-polarized:

- Not fully tested in Multimeter.
- Conclusion:

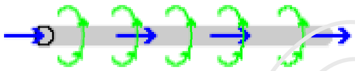
  In multimeter, No deflection.

  Pass the AC - 100% right when pass the AC Current.

PROPERTY OF CAPACITOR . Higher the frequency lower thw reactance & lower the frequency higher the reactance.

CHAPTER 4TH : INDUCTOR

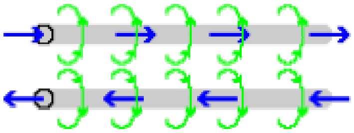
One characteristic of electricity is that as current flows it generates a magnetic field. The greater the current, the stronger the magnetic field it generates. However, this magnetic field is generally small and weak, an can't be used for very much. Indeed, most of the time it doesn't have a noticeable effect on anything less sensitive than a small compass needle. Is there a way we can intensify this field so we can experiment with it and study its properties?



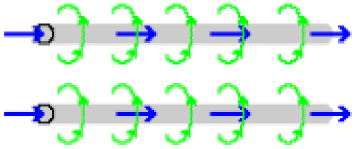
In the figure to the right, electrons are moving through a wire from left to right, as shown by the blue arrows. This motion of electrically charged electrons generates a circular magnetic field around the wire, and extending along the entire length of the wire, as indicated by the green lines. The direction of the magnetic lines of force shown here is upwards on the "front" side of the wire, and downwards behind it.

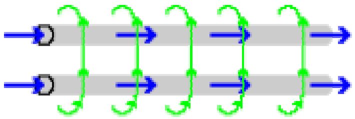
You can always determine the direction of the magnetic field by applying the *Left Hand Rule*: Grasp the wire in your left hand, with your thumb pointing along the wire in the direction of electron flow. Your fingers will curl around the wire, pointing in the direction of the magnetic field.

Note: Under the original assumptions of conventional current, this was stated as the *Right Hand Rule*, because current carriers were assumed to be positive. Since we are using the more modern electron current specifications, we must switch to a Left Hand Rule to correctly describe the direction of the magnetic field.



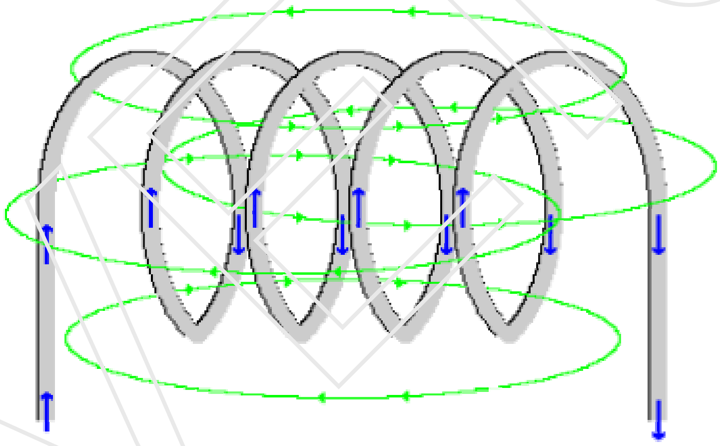
If we have two wires close together, with the same current flowing through them but in opposite directions as shown to the left, the magnetic field between the two wires will be the sum of the two separate fields, and therefore will be stronger than the field around a single wire. However, this doesn't help much — adding a third wire must reinforce one of these two, but oppose the other. Hamm. Maybe we can make use of this phenomenon, but clearly it won't work by itself.





On the other hand, if we put two wires next to each other with each one carrying the same amount of current in the same direction (see the figure to the right), an interesting phenomenon occurs. The magnetic fields between the two wires oppose each other and cancel out, but the overall field around both wires together is strengthened. Adding more wires in this manner enhances this effect, making the overall magnetic field still stronger.

Is there an easy way to accomplish this?



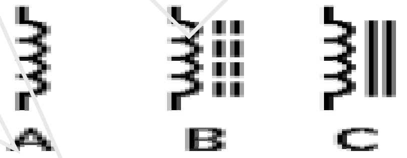
The figure to the left shows a wire that has been wrapped into a spiral structure, forming a *coil*. This structure combines both effects of adjacent, current-carrying wires discussed above. The magnetic field through the middle of the coil is directed from left to right, and is highly intensified. This magnetic field gives the coil some interesting and useful properties, which we will cover in detail when we discuss the behavior of coils in an electrical circuit.

The property conferred on this component by the concentrated magnetic field is known as *inductance*. The effect of inductance is to oppose any change in current through itself. It does this by generating an EMF across its terminals, which opposes the applied voltage. As a result, the current through an inductance can only change gradually; it cannot change instantaneously as it could with only resistors in the circuit. The coil will store or release energy in its magnetic field as rapidly as necessary to oppose any such change.

The unit of inductance is the *Henry* (H). By definition, one Henry is that amount of inductance that will cause a counter EMF of 1 volt to be generated when the current changes at a rate of 1 ampere/second. Practical values of inductance range from a few micro henrys (µH) up to tens of henrys.

The image to the right shows a few typical, commercially available coils. The large one to the left is mounted on an iron core to help concentrate the magnetic field and thus augment the inductance of the component. It has an inductance of 1 henry. To its right is a small coil with a movable core made partly of powdered iron. This allows the core to be adjusted to set the precise value of inductance, which is on the order of 30 microhenrys (µH). In the foreground is a 50 millihenry (mH) coil, consisting of multiple layers of wire wrapped on a non-magnetic core.

Each of these devices can be purchased directly, and each of them has practical applications in electronics.



The schematic symbols to the right represent inductors, or coils. Symbol A is used for a basic inductor with only air anywhere in the magnetic field. Symbol B shows an inductor with a core made of powdered iron (known as *ferrite*). Such a core helps to concentrate the magnetic field somewhat, and so increases the effective inductance of the coil. Symbol C shows a laminated iron core. This kind of core concentrates the magnetic field greatly, and therefore increases the effective inductance even more than a ferrite core.

As you can see, in each case the symbol itself suggests the multiple turns of wire that form the coil.

Inductance

Inductance is defined as the propriety of the current, or A Coil which opposites any changes in flow of current. Coil is a wire, the wire wrapped wound a object called be coil. The object called is core.

Its measuring Unit is Henry (H)

"L" denoted coil.

The main factor that determine the Inductance of a Coil are:

- The number of turns in the coil.
- The core material used.

Work

- Some voltage dropped.
- Filter the current.
- Delay current.

Property of Coil

Higher the Frequency, Higher the Reactance.

Used of Coil

- Used in Printer Head
- Used in Filtration

Difference between capacitor & coil about filtration

	Capacitor	Coil
Higher frequency	Allow to go	Do not allow (Stay)
Low frequency	Do not allow (Stay)	Allow to go

Main Instruction

- An area occupied by electric lines of force called electric field.
- In a wire where is more electric field. That pall in non-as south pall and another one is non-as north pall.

- Mutual Induction
- When we transfer as wire into coil than electric magnetic field present around the coil together and due to it magnetic field because stronger by a coil.

Types of coil

- Iron Core Coil
- Farad Core Coil
- Air Core Coil
- Carbon Core Coil
- Brass Core Coil

Testing of Coil

Deflection of probe depends upon the length and diameter.

OK > Its show some deflection

OPEN > No defection

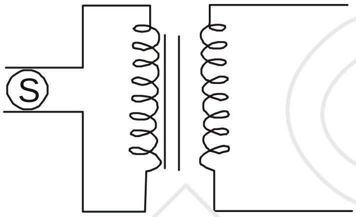
Short > Full deflection.

CHAPTER 5TH : TRANSFORMER

Transformer

Transformer is a device that is used to transfer electronic signals (Current, voltage or power) from one circuit to another without any direct communication medium.

Transformer consists of two or more coil wound on the same care. The coil to which the input voltage applied is called the primary winding and the other coil in which the voltage is induced due to changing magnetic flux are called secondary winding.



Symbol & Shape

In transformer, there is a transfer of electrical energy from one on more coils to another through the magnetic flux linkages

Transformers as electric components

In electric systems transformers have the task to adapt voltages and amperages so that they correspond to the respective requirements.

If e.g. a high electric power of 500MW should be transported over a conductor with a voltage of 230V, very high amperages would result:

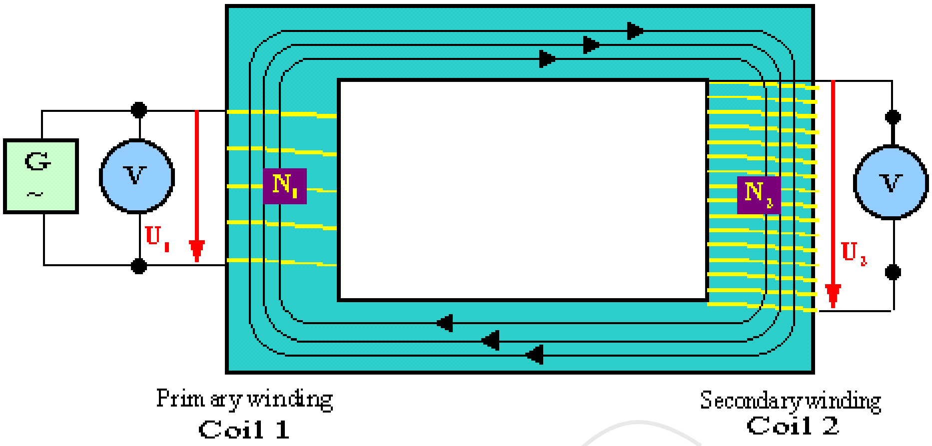
I = P / U
I = 500MW / 230V
I = 2200000A

In order to realise this, line cross sections of several square meters would be necessary. For this reason, one normally transports electric powers P with high voltages U and low amperages I.

Transformer structure

A transformer consists of an iron core with two coils. These two coils have different numbers of windings. If an alternating current of U1 is applied to the primary winding (coil 1), a magnetic power flow occurs in the iron core of the transformer. The magnetic power flow induces (produces) an alternating current U2 in the secondary coil (coil 2). This alternating current depends on the ratio of the number of windings (N1 and N2) of the two coils.

Diagram 39: Structure of a transformer



The voltages in a transformer depend on the number of windings of the coils. The amperages of a transformer depend inversely on the number of windings and the voltages.

Because an inductor operates by building a magnetic field around itself, we can take a second inductor and place it inside the same magnetic field. This gives us a transformer. In the case of the circuit shown to the right, the two solid lines between the symbols of the two coils indicate that the coils are wrapped around an iron core. The iron serves to concentrate the magnetic field and to help make sure that the field fully envelopes both coils. This greatly increases the inductance of each coil as well as the magnetic coupling between them.

Because the transformer is built with the two coils of wire wound around the commmon core, each coil is sometimes also called a "winding." The winding to which the original voltage is applied is designated the *primary winding*, while the other winding is designated the *secondary winding*. A transformer can have multiple secondary windings, but except for a very special circumstance, it only has one primary winding.

That special circumstance has to do with power transformers designed to operate from houshold line voltage in either North America (120 volts, 60 Hz) or Europe (240 volts, 50 Hz). These transformers have two primary windings each rated at 120 volts. They are connected in parallel for a 120 volt system, or in series for a 240 volt system. Thus, each winding serves as half of the required primary winding. This arrangement makes it possible to use that piece of equipment in many different places in the world without requiring special adapters.

Remember that any inductor consists of a coil of wire. We can count the number of turns of wire that make up that coil. When a voltage appears across the coil as a whole, that voltage is shared equally by the individual turns of wire in the coil. Thus, if a coil contains 1200 turns of wire and has a voltage of 120 volts across it, each individual loop or turn of wire has 0.1 volt across itself.

Another point to keep in mind is that the inductor itself generates this voltage in its effort to prevent the current through the coil from changing. The changing magnetic field induces that voltage and shares it across the entire coil. Therefore, that same magnetic field also induces the same voltage in each turn of the secondary winding or windings.

Thus, if our example transformer has a secondary winding of 100 turns, it will generate a total voltage of 10 volts across itself. This will be the voltage appearing across the resistor.

Types of transformer

- Stop down Transformer
- Step up transfer
- Main TX'MAR

Stop down Transformer

A step down transformer consists of two coils wound on the same care. The coil to which the input voltage applied is called the primary winding and the other coil in which the voltage is induced due to changing magnetic flux is called secondary winding.

In the step down transformer primary winding lengthier than secondary winding. In this TX'MAR input voltage applied high and output induced low voltage due to changing magnetic flux and become of secondary winding number of turn less than the primary coil.

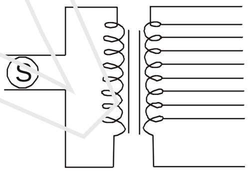
Step up transfer

A Step up transfer consists of two coils wound on the same care. The coil to which the input voltage applied is called the primary winding and the other coil in which the voltage is induced due to changing magnetic flux are called secondary winding.

In the step up transfer secondary winding lengthier than primary winding. In this transformer input voltage applied low and output induced high voltage due to changing magnetic flux and because of secondary coils number of true more they primary coil.

Main X'MAR

Main or multi X'MAR. The TX'MAR which give vary voltage with the single input is called multi X'MAR. It give then multi outputs because in the output will be have attach tap coil at several place & get such multi output or different voltage.

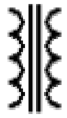


Multi Transformer

In our discussions of inductors in series and in parallel, we noted that the mutual inductance between coils could have a profound effect on the total inductance, depending on how much of the magnetic field of each coil overlaps the other coil. However, it is also possible to have two coils with interacting magnetic fields, but not connected electrically in the same circuit. The question then is, how does such a construction behave?

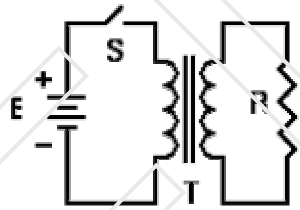
Before we address that question, however, we must consider that the amount of interaction between coils is not fixed. Therefore we must introduce the concept of **coupling** between coils. *Coupling* is the extent to which the magnetic field of each coil overlaps the other coil. Coupling can range from 0% (no interaction at all) to 100% (full interaction). In practice, 100% coupling is not possible, as some of the magnetic field will remain outside of the opposite coil. However, we can get close to it.

Qualitatively, coils with more than 50% coupling are said to be *tightly coupled*, while coils with less than 50% coupling are *loosely coupled*.



The schematic symbol for an iron-core transformer is shown to the right. It shows two coils sharing a common iron core. Because of the core, coupling between the two coils is as close to 100% as it can get. This is the standard arrangement for power transformers.

It is also possible to have two coils with a ferrite core, or with no core at all. These are still transformers and have the same basic properties. Only their design and construction varies, in accordance with their intended application.



Because the two coils are not electrically connected, only the magnetic field between them has any effect here. Therefore, let's take a look at what the magnetic field does.

In this circuit, the left-hand coil in the transformer is connected to the source of energy. Therefore, it is known as the *primary* or *primary winding* of the transformer. ("Winding" because the coils are wound around the core.) The right-hand coil receives energy magnetically, so it is known as the *secondary winding*.

As long as switch S is open, the battery is not connected to the left-hand winding and no current flows. Therefore, there is no magnetic field around either coil of the transformer, and nothing happens.

When the switch closes, current begins to flow through the primary winding. This creates an expanding magnetic field around the primary winding, which also affects the secondary winding. The expanding magnetic field induces a voltage across the secondary winding, which causes current to flow through resistor R. The magnitude of the current depends on the induced voltage and the value of R, in accordance with Ohm's Law.

As switch S remains closed, the circuit current eventually reaches its maximum value and remains there, no longer changing. Therefore the magnetic field stops expanding and remains constant. Since the induced voltage in the secondary winding depends on a changing magnetic field, that has now ended and no current flows through resistor R.

Finally, when switch S is opened again, current stops flowing through the primary. The magnetic field collapses as it induces a voltage in both windings that tries to keep current flowing. Therefore current again flows through R, this time in the opposite direction from when S was first closed.

Once the magnetic field has completely collapsed, all current stops flowing, and the circuit remains in its original quiescent state as long as S remains open.

Since a transformer only works with changing currents, you may be wondering why we would even use a circuit like this one. However, there's a very practical application that people use every day. The number of turns of wire in the secondary does not have to be the same as the number of turns in the primary, and indeed generally is not the same. If the secondary has more turns of wire, it will step up the voltage generated in the secondary winding (and use up the energy in the magnetic field faster). This makes for an easy way to generate the high-voltage impulse needed to fire the spark plugs in your car's engine. It requires only a very slight adaptation of the above circuit to accomplish this.

Transformer Losses

Core losses: - In copper losses we basically deal with the loss of current of wastage of current due to the material around which the wire is wound

1) Eddy Current Loss: -When A.C flows to winding, a changing magnetic field is stabilizing in the core. As the field expands and construct it induced a voltage into the core. The induced EMF causes eddy current to flow which results in reduction of power. This can be controlled by using thin metal sheets for the core instead of block of metal.

2) Hysteresis Losses:-It is the loss occurs due to the core of the transformer. Because due to which there is the formation of loops of electric field the stop the flow of current.

Copper Loss:-In copper loss we basically deal with the loss caused by the A.C. resistance of copper wire in primary and secondary winding as current flows through this resistance. Some power dissipates in the form of heat. And increasing the size of the copper wire in the winding can reduce it.

External Losses:- As the magnetic field expands and contracts around the transformers it often cuts an external conductors. If a current is introduced into the conductor, some power is loosed from the transformers these losses can be reduced if transformers are placed in housing to prevent magnetic field from escaping.

CHAPTER 6TH **Semi-Conductor**

Semi-Conductor

A semi-conductor is a material that is higher a conductor has an insulator but can be chemically altered to be either one.

OR

It is a tetravalent element, which has four valence electron and its acts as an insulator at normal room temperature.

The atom which has four electrons in its valence shall and its conducting lines between conductor and insulator. Ge and Si are mostly used as Semi-Conductor.

Ge_{32} 2, 8, 18, 4 Valence Electrons.

Si_{14} 2, 8, 4 Valence electron.

Atomic Structure of Silicon Atom.

Valence Shall - The outer most shell of an atom is known as valence shell.

Elements: -

1.Trivalent Element :-which has three valence electrons (Conductor)

2.Tetravalent Element: -which has four valence electrons (Conductor)

3.Penta-valent Element: -which has five valence electrons (Conductor)

Co-Volant Bond

It is form due to sharing of electrons.

Types

There are two types of Semi-Conductor

- Intrinsic semi-conductor. (Pure semi-conductor)
- Extrinsic semi-conductor. (Impure semi-conductor)

Intrinsic Semi-Conductor

There is the semi-conductor. which is free from impurity.

Conduction in Intrinsic Semi-Conductor

The electrical characteristic of semi-conductor materials is highly dependent upon temperature. It's conductivity increase with temperature.

Holes

When an electron breaks away from a co-valent bond, an open space or valency exits in the bond. The space that was previously occupied by the electron is generally referred to as a Hole and it has positive charge, because it represents the absence of electron. It increases by increasing the temperature.

Current Flow

Current flow in a semi-conductor consists of both electrons and holes. The holes function like positively charged particles while the electrons are actually negatively charged particles. The holes and electrons flow in opposite directions and number of electron hole pair produced with in a material increases as the temperature of the material increases. Since, the number of electron-hole pairs in the material determines the amount of current flow in a semi-conductor

.

Extrinsic semi-Conductor

The semi-conductor, which is free from purity, is called extrinsic semi-conductor.

Types of Extrinsic

- N-type Semi-Conductor.
- P-type Semi-Conductor.

N-types semi-conductor-

Arsenic (As-33) 2, 8, 18, 5 (Pentavalent element)

Impurity Ration
Semi-Conductor: Impurity.
1 Million: 1.

When a pure semi-conductor material is doped with semi-conductor electron (As), some of the atoms of semi-conductor are replaced by Arsenic Atom. The Arsenic atom replaces one of the semi-conductor atom and share four of its valence electrons with adjacent atom in a covalent bond. However, the fifty electrons is not a part of covalent bond and can be easily free from atoms. The Arsenic atom denotes a free electron to the crystal. Actually there is a large no. of Arsenic atom in a crystal. So there are many free electrons in the semi-conductor. This material is called N-type semi-conductor, Because of the large no. of free electrons in the structure. The electrons being in majority are referred to as majority carrier by the notes, which are in minority carrier.

Charge Carrier

- Free electrons due to impurity (As) s
- Positive immobile icon (As+)
- Electrons due to increase in temperature.
- Holes due to increase in temperature.

"Electrons are majority carrier and holes are minority carrier."

P-types semi-conductor

Gallium (Ga31) 2, 8, 18, 3

When a pure semi-conductor material is doped with a trivalent element (Ga), some of the atoms of semi-conductor are replaced by Ga Atom each trivalent atom share its valence electrons with three adjacent atom in the semi-conductor. The four tetravalent atoms should not share a covalent bond, because of missing electrons. This creates holes in the crystal. A large number of holes are present in the semi-conductor, because of trivalent atoms. These holes accept electrons from other atoms. When a hole is filled by an electron of another moves from one covalent bond to another in apposite direction of electrons. The holes being in majority are referred to as majority carrier and electrons are called minority carrier.

Charge Carrier00

- Holes due to impurity (Ga)
- Negative immobile icons (Ga)
- Electrons and holes due to increase in temperature.

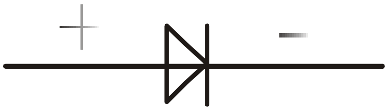
"Majority carrier are holes and majority carrier are electrons".

CHAPTER 7^{TH} DIODE

Diode

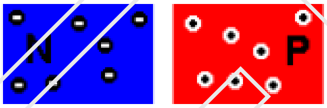
Diode is a very important component. It's made by semi-metal also called semi-conductor. They are two type metal silicon & germanium. Their functions are converting AC to DC. Anode give positive to Cathode & Cathode give negative to Anode.

Shape



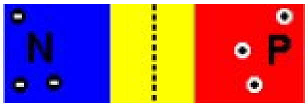
Symbol

We've seen that it is possible to turn a crystal of pure silicon into a moderately good electrical conductor by adding an impurity such as arsenic or phosphorus (for an N-type semiconductor) or aluminum or gallium (for a P-type semiconductor). By itself, however, a single type of semiconductor material isn't very useful. Useful applications start to happen only when a single semiconductor crystal contains both P-type and N-type regions. Here we will examine the properties of a single silicon crystal which is half N-type and half P-type.



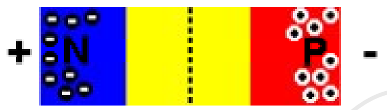
Consider the silicon crystal represented to the right. Half is N-type while the other half is P-type. We've shown the two types separated slightly, as if they were two separate crystals. The free electrons in the N-type crystal are represented by small black circles with a "-" sign inside to indicate their polarity. The holes in the P-type crystal are shown as small white circles with a "+" inside.

In the real world, it isn't possible to join two such crystals together usefully. Therefore, inserting different impurities into different parts of a single crystal can only create a practical PN junction. So let's see what happens when we join the N- and P-type crystals together, so that the result is one crystal with a sharp boundary between the two types.

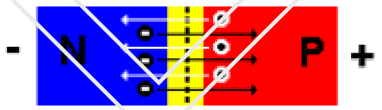


You might think that, left to itself, it would just sit there. However, this is not the case. Instead, an interesting interaction occurs at the junction. The extra electrons in the N region will seek to lose energy by filling the holes in the P region. This leaves an empty zone, or *depletion region* as it is called, around the junction as shown to the right. This action also leaves a small electrical imbalance inside the crystal. The N region is missing some electrons so it has a positive charge. Those electrons have migrated to fill holes in the P region, which therefore has a negative charge. This electrical imbalance amounts to about 0.3 volt in a germanium crystal, and about 0.65 to 0.7 volt in a silicon crystal. This will vary somewhat depending on the concentration of the impurities on either side of the junction.

Unfortunately, it is not possible to exploit this electrical imbalance as a power source; it doesn't work that way. However, we can apply an external voltage to the crystal and see what happens in response. Let's take a look at the possibilities.



Suppose we apply a voltage to the outside ends of our PN crystal. We have two choices. In this case, the positive voltage is applied to the N-type material. In response, we see that the positive voltage applied to the N-type material attracts any free electrons towards the end of the crystal and away from the junction, while the negative voltage applied to the P-type end attracts holes away from the junction on this end. The result is that all available current carriers are attracted away from the junction, and the depletion region grows correspondingly larger. There is no current flow through the crystal because all available current carriers are attracted away from the junction, and cannot cross. (We are here considering an ideal crystal -- in real life, the crystal can't be perfect, and some leakage current does flow.) This is known as *reverse bias* applied to the semiconductor crystal.



Here the applied voltage polarities have been reversed. Now, the negative volatge applied to the N-type end pushes electrons towards the junction, while the positive voltage at the P-type end pushes holes towards the junction. This has the effect of shrinking the depletion region. As the applied voltage exceeds the internal electrical imbalance, current carriers of both types can cross the junction into the opposite ends of the crystal. Now, electrons in the P-type end are attracted to the positive applied voltage, while holes in the N-type end are attracted to the negative applied voltage. This is the condition of *forward bias*.

Because of this behavior, an electrical current can flow through the junction in the forward direction, but not in the reverse direction. This is the basic nature of an ordinary semiconductor diode.

It is important to realize that holes exist only within the crystal. A hole reaching the negative terminal of the crystal is filled by an electron from the power source and simply disappears. At the positive terminal, the power supply attracts an electron out of the crystal, leaving a hole behind to move through the crystal toward the junction again.

In some literature, you might see the N-type connection designated the *cathode* of the diode, while the P-type connection is called the *anode*. These designations come from the days of vacuum tubes, but are still in use. Electrons always move from cathode to anode inside the diode.

One point that needs to be recognized is that there is a limit to the magnitude of the reverse voltage that can be applied to any PN junction. As the applied reverse voltage increases, the depletion region continues to expand. If either end of the depletion region approaches its electrical contact too closely, the applied voltage has become high enough to generate an electrical arc straight through the crystal. This will destroy the diode.

It is also possible to allow too much current to flow through the diode in the forward direction. The crystal is not a perfect conductor, remember; it does exhibit some resistance. Heavy current flow will generate some heat within that resistance. If the resulting temperature gets too high, the semiconductor crystal will actually melt, again destroying its usefulness.

Types of diode

- Low power
  Low power diode work is low voltage circuit. Work on minimum 5amp. Used in SMPS, mostly used in Bridge rectifying max voltage is 150 volt.

- High Power Diode
  Its work on high voltage bigger in size. Work on 5 to 10 amp no used in computer. Its use wherever above 150v (548, 538).

- Short-key Diode
  Works on minimum 25 amp, maximum no limit used in SMPS costly, +5v.

- Gun Diode
  Work on 10, 000v or 10 Kv. Used in Monitor as EHT.

- Photo Diode
  It emits infra red light [can't see open eyes] used in remote, floppy drive etc. [work as a remote].

- LED (Light Emitting Diode)
  Used in indicate works a 5 mill volt to 10 mill volt. LED comes in several color including red, green and white.

- Zener Diode
  5 to110v available in mkt. Its work on particular voltages. Its special types of diode it's provided constant voltage. Its always find with capacitor or resistance Denoted on its body z always.

Structure and function of photodiodes and phototransistors

Photodiodes and phototransistors are so called optoelectric devices or components.

They make use of a semiconductors characteristic that the material resistance is reduced if the semiconductor material is illuminated/lit up. During the illumination of the material electrons free themselves from their connections through the influence of the energy of light.

In connection with other electronic components this characteristic of photodiodes and phototransistors can be used for various control and regulation tasks (e.g. gas flame control, light-dependent switches, sensors, etc....)..

Diagram: Characteristic curve and circuit symbol of a rectifier diode

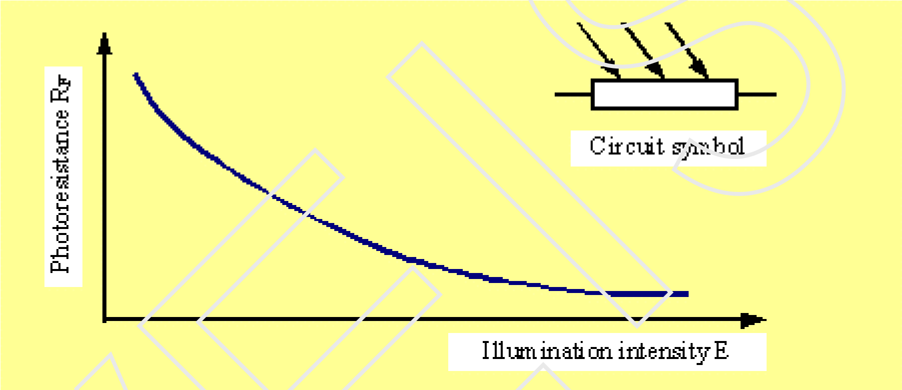
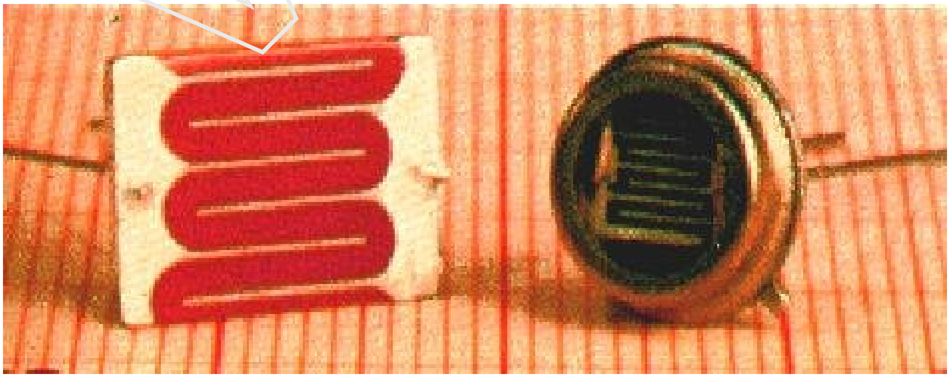


Diagram :Two photo resistors (on the left side without case and on the right side with case, ready for installation)



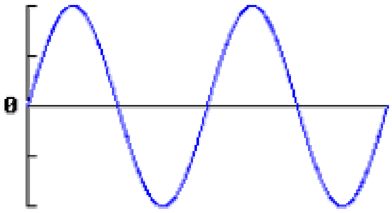
Checking

Meter RX1	Diode
Red Positive	Negative Black
Black Negative	Positive Red

OK	It wills shows one side deflection in meter
Short	It will full deflection
Open	No deflection.

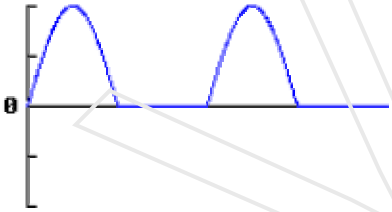
Rectifier circuits

Overview

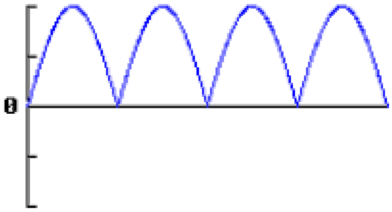


As we have noted when looking at the Elements of a Power Supply, the purpose of the rectifier section is to convert the incoming ac from a transformer or other ac power source to some form of pulsating dc. That is, it takes current that flows alternately in both directions as shown in the first figure to the right, and modifies it so that the output current flows only in one direction, as shown in the second and third figures below.

The circuit required to do this may be nothing more than a single diode, or it may be considerably more complex. However, all rectifier circuits may be classified into one of two categories, as follows:



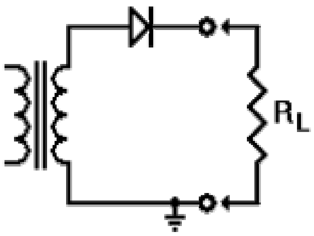
Half-Wave Rectifiers. An easy way to convert ac to pulsating dc is to simply allow half of the ac cycle to pass, while blocking current to prevent it from flowing during the other half cycle. The figure to the right shows the resulting output. Such circuits are known as *half-wave rectifiers* because they only work on half of the incoming ac wave.



Full-Wave Rectifiers. The more common approach is to manipulate the incoming ac wave so that both halves are used to cause output current to flow in the same direction. The resulting waveform is shown to the right. Because these circuits operate on the entire incoming ac wave, they are known as *full-wave rectifiers*.

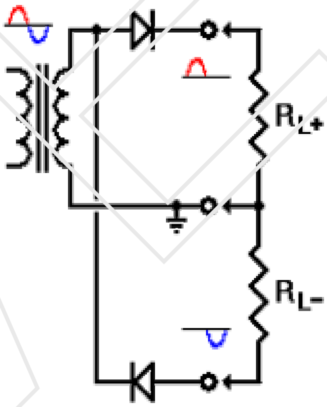
Rectifier circuits may also be further clasified according to their configuration, as we will see below.

The Half-Wave Rectifier



The simplest rectifier circuit is nothing more than a diode connected in series with the ac input, as shown to the right. Since a diode passes current in only one direction, only half of the incoming ac wave will reach the rectifier output. Thus, this is a basic half-wave rectifier.

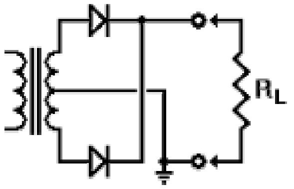
The orientation of the diode matters; as shown, it passes only the positive half-cycle of the ac input, so the output voltage contains a positive dc component. If the diode were to be reversed, the negative half-cycle would be passed instead, and the dc component of the output would have a negative polarity. In either case, the DC component of the output waveform is $v_p/\pi = 0.3183v_p$, where v_p is the peak voltage output from the transformer secondary winding.



It is also quite possible to use two half-wave rectifiers together, as shown in the second figure to the right. This arrangement provides both positive and negative output voltages, with each output utilizing half of the incoming ac cycle.

Note that in all cases, the lower transformer connection also serves as the common reference point for the output. It is typically connected to the common ground of the overall circuit. This can be very important in some applications. The transformer windings are of course electrically insulated from the iron core, and that core is normally grounded by the fact that it is bolted physically to the metal chassis (box) that supports the entire circuit. By also grounding one end of the secondary winding, we help ensure that this winding will never experience even momentary voltages that might overload the insulation and damage the transformer.

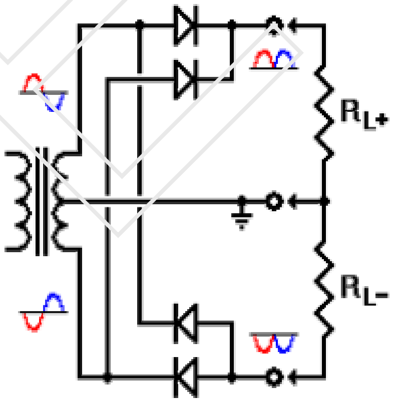
The Full-Wave Rectifier



While the half-wave rectifier is very simple and does work, it isn't very efficient. It only uses half of the incoming ac cycle, and wastes all of the energy available in the other half. For greater efficiency, we would like to be able to utilize both halves of the incoming ac. One-way to accomplish this is to double the size of the secondary winding and provide a connection to its center. Then we can use two separate half-wave rectifiers on alternate half-cycles, to provide full-wave rectification. The circuit is shown to the right.

Because both half-cycles are being used, the DC component of the output waveform is now $2v_p/\pi = 0.6366v_p$, where v_p is the peak voltage output from *half* the transformer secondary winding, because only half is being used at a time.

This rectifier configuration, like the half-wave rectifier, calls for one of the transformer's secondary leads to be grounded. In this case, however, it is the center connection, generally known as the *center tap* on the secondary winding.

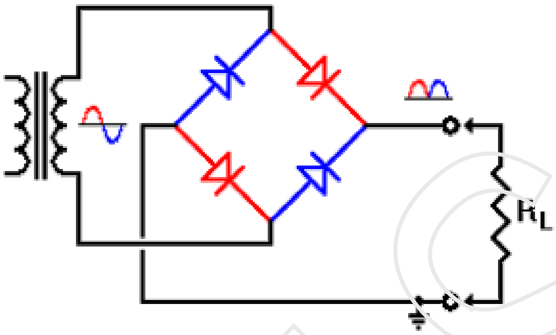


The full-wave rectifier can still be configured for a negative output voltage, rather than positive. In addition, as shown to the right, it is quite possible to use two full-wave rectifiers to get outputs of both polarities at the same time.

The full-wave rectifier passes both halves of the ac cycle to either a positive or negative output. This makes more energy available to the output, without large intervals when no energy is provided at all. Therefore, the full-wave rectifier is more efficient than the half-wave rectifier. At the same time, however, a full-wave rectifier providing only a single output polarity does require a secondary winding that is twice as big as the half-wave rectifier's secondary, because only half of the secondary winding is providing power on any one half-cycle of the incoming ac.

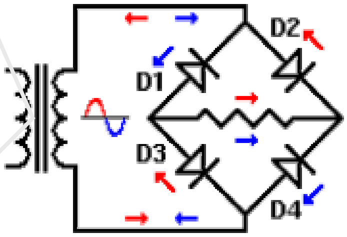
Actually, it isn't all that bad; because the use of both half-cycles means that the current drain on the transformer winding need not be as heavy. With power being provided on both half-cycles, one half-cycle doesn't have to provide enough power to carry the load past an unused half-cycle. Nevertheless, there are some occasions when we would like to be able to use the entire transformer winding at all times, and still get full-wave rectification with a single output polarity.

The Full-Wave Bridge Rectifier



The four-diode rectifier circuit shown to the right serves very nicely to provide full-wave rectification of the ac output of a single transformer winding. The diamond configuration of the four diodes is the same as the resistor configuration in a Wheatstone bridge. In fact, any set of components in this configuration is identified as some sort of bridge, and this rectifier circuit is similarly known as a *bridge rectifier*.

If you compare this circuit with the dual-polarity full-wave rectifier above, you'll find that the connections to the diodes are the same. The only change is that we have removed the center tap on the secondary winding, and used the negative output as our ground reference instead. This means that the transformer secondary is never directly grounded, but one end or the other will always be close to ground, through a forward-biased diode. This is not usually a problem in modern circuits.



To understand how the bridge rectifier can pass current to a load in only one direction, consider the figure to the right. Here we have placed a simple resistor as the load, and we have numbered the four diodes so we can identify them individually.

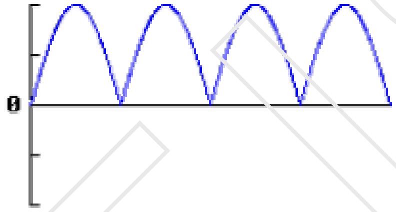
During the positive half-cycle, shown in red, the top end of the transformer winding is positive with respect to the bottom half. Therefore, the transformer pushes electrons from its bottom end, through D3 which is forward biased, and through the load resistor in the direction shown by the red arrows. Electrons then continue through the forward-biased D2, and from there to the top of the transformer winding. This forms a complete circuit, so current can indeed flow. At the same time, D1 and D4 are reverse biased, so they do not conduct any current.

During the negative half-cycle, the top end of the transformer winding is negative. Now, D1 and D4 are forward biased, and D2 and D3 are reverse biased. Therefore, electrons move through D1, the resistor, and D4 in the direction shown by the blue arrows. As with the positive half-cycle, electrons move through the resistor from left to right.

In this manner, the diodes keep switching the transformer connections to the resistor so that current always flows in only one direction through the resistor. We can replace the resistor with any other circuit, including more power supply circuitry (such as the filter), and still see the same behavior from the bridge rectifier.

Filter circuits

Overview

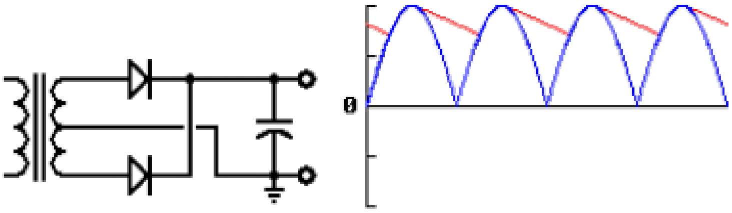


As we have already seen, the rectifier circuitry takes the initial ac sine wave from the transformer or other source and converts it to pulsating dc. A full-wave rectifier will produce the waveform shown to the right, while a half-wave rectifier will pass only every other half-cycle to its output. This may be good enough for a basic battery charger, although some types of rechargeable batteries still won't like it. In any case, it is nowhere near good enough for most electronic circuitry. We need a way to smooth out the pulsations and provide a much "cleaner" dc power source for the load circuit.

To accomplish this, we need to use a circuit called a filter. In general terms, a *filter* is any circuit that will remove some parts of a signal or power source, while allowing other parts to continue on without significant hindrance. In a power supply, the filter must remove or drastically reduce the ac variations while still making the desired dc available to the load circuitry.

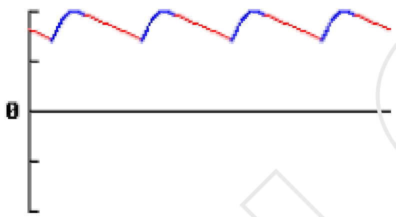
Filter circuits aren't generally very complex, but there are several variations. Any given filter may involve capacitors, inductors, and/or resistors in some combination. Each such combination has both advantages and disadvantages, and its own range of practical application. We will examine a number of common filter circuits on this page.

A Single Capacitor



If we place a capacitor at the output of the full-wave rectifier as shown to the left, the capacitor will charge to the peak voltage each half-cycle, and then will discharge more slowly through the load while the rectified voltage drops back to zero before beginning the next half-cycle. Thus, the capacitor helps to fill in the gaps between the peaks, as shown in red in the first figure to the right.

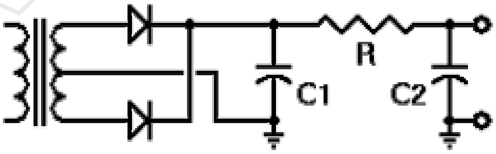
Although we have used straight lines for simplicity, the decay is actually the normal exponential decay of any capacitor discharging through a load resistor. The extent to which the capacitor voltage drops depends on the capacitance of the capacitor and the amount of current drawn by the load; these two factors effectively form the RC time constant for voltage decay.



As a result, the actual voltage output from this combination never drops to zero, but rather takes the shape shown in the second figure to the right. The blue portion of the waveform corresponds to the portion of the input cycle where the rectifier provides current to the load, while the red portion shows when the capacitor provides current to the load. As you can see, the output voltage, while not pure dc, has much less variation (or *ripple*, as it is called) than the unfiltered output of the rectifier.

A half-wave rectifier with a capacitor filter will only recharge the capacitor on every other peak shown here, so the capacitor will discharge considerably more between input pulses. Nevertheless, if the output voltage from the filter can be kept high enough at all times, the capacitor filter is sufficient for many kinds of loads, when followed by a suitable regulator circuit.

RC Filters



In order to reduce the ripple still more without losing too much of the dc output, we need to extend the filter circuit a bit. The circuit to the right shows one way to do this. This circuit does cause some dc loss in the resistor, but if the required load current is low, this is an acceptable loss.

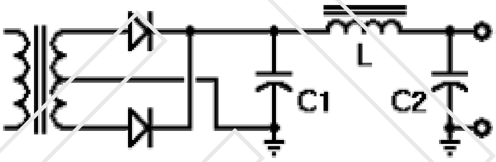
To see how this circuit reduces ripple voltage more than it reduces the dc output voltage, consider a load circuit that draws 10 mA at 20 volts dc. We'll use 100 µf capacitors and a 100Ω resistor in the filter.

For dc, the capacitors are effectively open circuits. Therefore any dc losses will be in that 100Ω resistor. For a load current of 10 mA (0.01 A), the resistor will drop 100 × 0.01 = 1 volt. Therefore, the dc output from the rectifier must be 21 volts, and the dc loss in the filter resistor amounts to 1/21, or about 4.76% of the rectifier output. This is generally quite acceptable.

On the other hand, the ripple voltage (in the USA) exists mostly at a frequency of 120 Hz (there are higher-frequency components, but they will be attenuated even more than the 120 Hz component). At this frequency, each capacitor has a reactance of about 13.26Ω. Thus R and C2 form a voltage divider that reduces the ripple to about 13% of what came from the rectifier. Therefore, for a dc loss of less than 5%, we have attenuated the ripple by almost 87%. This is a substantial amount of ripple reduction, although it doesn't remove the ripple entirely.

If the amount of ripple is still too much for the particular load circuit, additional filtering or a regulator circuit will be required.

LC Filters



While the RC filter shown above helps to reduce the ripple voltage, it introduces excessive resistive losses when the load current is significant. To reduce the ripple even more without a lot of dc resistance, we can replace the resistor with an inductor as shown in the circuit diagram to the right.

In this circuit, the two capacitors store energy as before, and attempt to maintain a constant output voltage between input peaks from the rectifier. At the same time, the inductor stores energy in its magnetic field, and releases energy as needed in its attempt to maintain a constant current through itself. This provides yet another factor that attempts to smooth out the ripple voltage.

CHAPTER 8TH TRANSISTOR

Transistor

Transistor is a three clement semi-conductor device formed by placing two P-N semi-conductor junctions back to back.

Three terminals

Base (B)	=	Voltage Amp (Input)
Collect (C)	=	Power Amp (Output)
Emit (E)	=	Current Amp

Emit is Emitter, Collect is collector

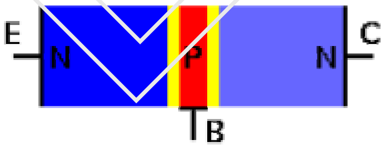
By Width	=	F>C>B
By more electron	=	C>B>E

E+B=C

E*B = C

While a single PN junction is useful, it also has its limitations. It can either conduct current or not, but can't really control how much current it will conduct.

So what happens if we add a second junction? Can we play around with that idea and see where it goes?

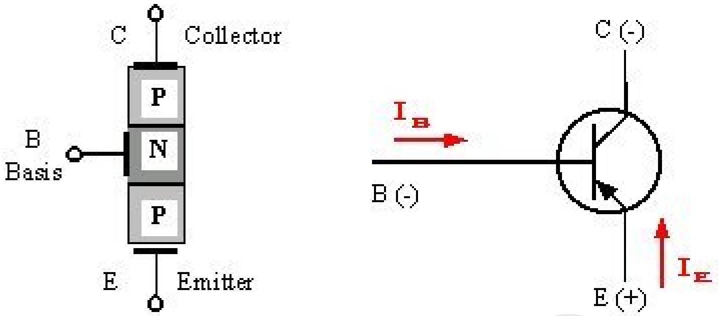


A basic two-junction semiconductor must necessarily have one type of region sandwiched between two of the other type. To the right is an example of a semiconductor device consisting of a narrow P-type region between two N-type regions. For reasons we will see shortly, the three regions are designated the *emitter* (E), *base* (B), and *collector* (C), respectively. In modern versions of this device, the emitter region is heavily doped with the appropriate impurity, while the base region is very lightly doped. The collector region has a moderate doping level so it will have a low internal resistance.

We have shown a device consisting of N, P, and N regions in order, but there is no reason not to build equivalent devices in P, N, and P order instead. In fact, it is often very useful to have both types of devices available.

With no electrical voltages applied, of course, this semiconductor will of course just sit there and do nothing. So let's move forward and see what happens when we apply bias voltages to the device.

Diagram: Doping sequence P - N - P (= PNP-Transistor):



To the left we see the same semiconductor device as above, with a small forward bias applied to the emitter-base junction, and a larger reverse bias applied to the collector-base junction. As we will see, these are the normal operating conditions of this device.

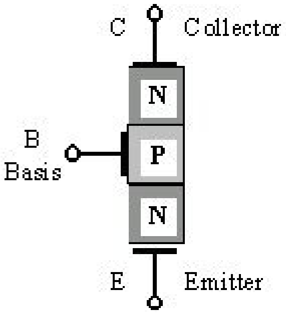
Since we already know how a single-junction device, the diode, behaves, we would normally expect the base voltage to be about 0.65 to 0.7 volt positive with respect to the emitter, and to have electrons move from emitter to base, and leave the device at that point. With the collector junction reverse biased, we would expect no current to flow through that junction.

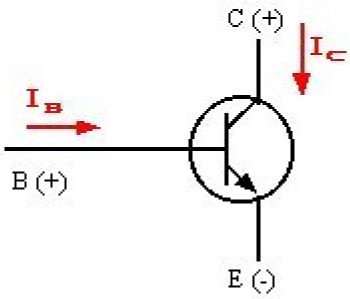
But a funny thing happens inside the base region. The forward bias on this junction does indeed attract electrons from the emitter into the base, but there the forward momentum of the electrons carries them across most of the base region and into the depletion region around the collector junction. From there, the higher positive collector voltage attracts these electrons across the collector junction and into the collector region. (Remember that the electrons are *minority current carriers* within the P-type base region, and can therefore cross the reverse-biased junction as a leakage current.)

A small amount of current does still leave the device through the base contact, but most of the current is diverted through the collector instead. In this way, the small base bias current controls the much larger collector current. If a small varying current is applied to the base along with the bias, the collector current will vary to a much greater degree. Thus, this device can not only be used to control a varying signal; it can amplify that signal as well.

Because of the way this device operates to transfer current (and its internal resistances) from the original conduction path to another, it's name is a combination of the words "transfer" and "resistor:" *transistor*.

Diagram : Doping sequence N - P - N (= NPN-Transistor)





It's also quite possible to build a transistor with the region types reversed, as shown to the right. In this case, holes will be drawn from the emitter into the base region by the forward bias, and will then be pulled into the collector region by the higher negative bias. Otherwise, this device works the same way and has the same general properties as the one described above.

To distinguish between the two types of transistors, we refer to them by the order in which the different regions appear. Thus, this is a *PNP transistor* while the device described above is an *NPN transistor*.

Function of transistor

- Which used to amplifier the signal.
- Transistor work same processor if due have frequency or cycle than give high frequency and cycle.

Types of Transistor

- ***High Frequency Transistor***

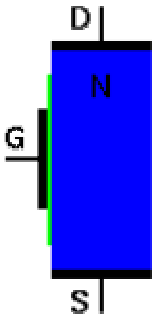
  Its use in high ckt. Its base always in left side before the number Denote F [DF546]. Its have number of NPN on PNP.

- ***Power Frequency Transistor***

  It's used in power ckt. Its have heat sink because its very heat able transistor. It has in so many designed some are there.

- ***MOSFET (Metal Oxide Semi-Conductor Field Effect Transistor)***

  It is used in monitor. It is available in 3, 5, 7 Terminal Bigger in size.



First, we note that the main ingredient of the channel is silicon. It can be a p-type or n-type channel; it is still mostly silicon. Next, we take note that silicon dioxide is simply glass, which is a good insulator. So we can form a thin layer of silicon dioxide along one surface of the channel, and then lay our metal gate region down over the glass. The result is shown to the left.

This device is sometimes known as an *insulated-gate field effect transistor*, or IGFET. More commonly, noting the construction of the gate, it is called a *metal-oxide-semiconductor FET*, or MOSFET.

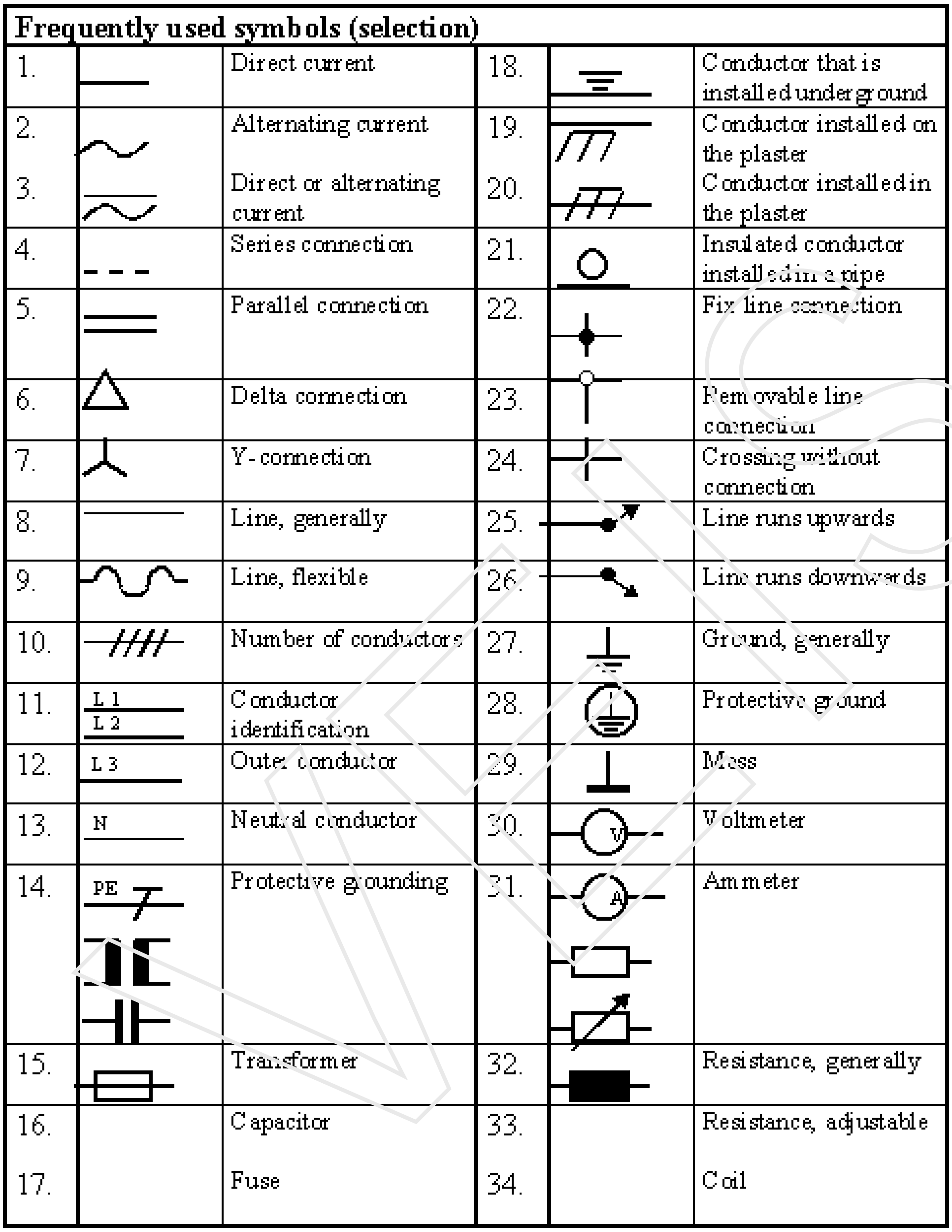
With no voltage applied to the gate (G) electrode, the channel really is just a semiconductor resistance, and will conduct current according to the voltage applied between source (S) and drain (D). There is no pn junction, so there is no depletion region.

How to find PNP and NPN transistor

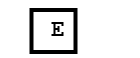
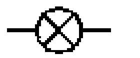
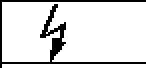
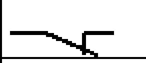
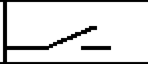
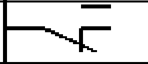
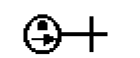
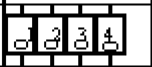
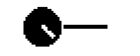
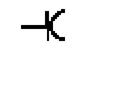
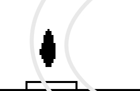
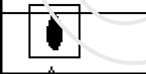
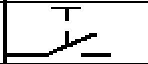
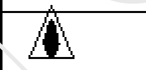
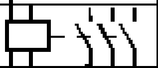
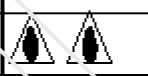
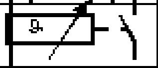
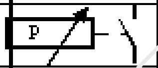
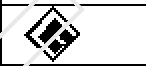
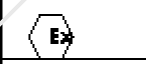
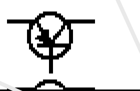
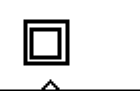
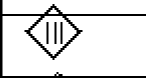
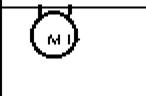
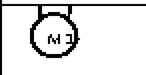
- *PNP*
  It deflection comes by common red probe only
- *NPN*
  It deflection comes by common block probe only.

SOME COMMON REPRESENTATION SYMBOLE

Structure, function and symbols of electrical components and devices



Frequently used symbols (selection)					
1.		Direct current	18.		Conductor that is installed underground
2.		Alternating current	19.		Conductor installed on the plaster
3.		Direct or alternating current	20.		Conductor installed in the plaster
4.		Series connection	21.		Insulated conductor installed in a pipe
5.		Parallel connection	22.		Fix line connection
6.		Delta connection	23.		Removable line connection
7.		Y-connection	24.		Crossing without connection
8.		Line, generally	25.		Line runs upwards
9.		Line, flexible	26.		Line runs downwards
10.		Number of conductors	27.		Ground, generally
11.	L1 L2	Conductor identification	28.		Protective ground
12.	L3	Outer conductor	29.		Mess
13.	N	Neutral conductor	30.	V	Voltmeter
14.	PE	Protective grounding	31.	A	Ammeter
15.		Transformer	32.		Resistance, generally
16.		Capacitor	33.		Resistance, adjustable
17.		Fuse	34.		Coil

35.		Light, generally	57.		Electric device, generally
36.		Indicating lamp, Lamp	58.		High voltage device
37.		Closer	59.		Rectifier
38.		Opener	60.		Hot water storage
39.		Change-over switch	61.		Instantaneous water heater / boiler
40.		Connection strip	62.		Hot water device
41.		Single socket outlet	63.		Storage heating device
42.		Protecting ground outlet	64.		Dripping water-protected, IP 31
43.		Three-way socket outlet	65.		Spray water-protected, IP 33
44.		Switch, manually operated	66.		Splash water-protected, IP 54
45.		Relay with three closers	67.		Jet water-protected, IP 55
46.		Thermostat, adjustable	68.		Waterproof, IP 67
47.		Pressostat, adjustable	69.		Pressurized water-protected, IP 68
48.		Rectifier diode	70.		Dust-protected, IP 5X
49.		Photodiode	71.		Dustproof, IP 6X
50.		Thyristor	72.		Explosion-proof, DIN 40012
51.		PNP-Transistor	73.		Device with protective insulation
52.		NPN-Transistor	74.		Device for protective small voltage
53.		Galvanic element, accumulator	75.		VDE-Test mark
54.		Alternating current motor	76.		Radio protection mark
55.		Three-phase motor	77.		CEE-Test mark
56.		Direct current motor	78.		Tested security mark

SOLDERING & DESOLDERING

As the doctor said to the patient, "I've got good news and bad news." The bad news is all around us-- increasing prices, decreasing skills base, no more Heath kits... and if you want more, just pick up a newspaper. The good news is that you can still build a lot of useful ham radio equipment and you don't have to be an electrical engineer to do it. All it takes is the right tools, knowledge of a few "tricks of the trade," and the will to succeed. Oh yeah-- a bit of patience helps too! We're going to try to cover the whole topic here in enough detail for you to pick up a soldering iron and get to work on a real project. First we'll talk about the basics, things like tool selection and soldering, then we'll move on to middle-to-advanced techniques, and finally trouble-shooting the finished project and installing it in an enclosure. Along the way we'll build something useful, I promise. You're going to discover that building is rewarding, educational, and fun!

Before we start, let's look at a fairly obvious question-- why build something when you can buy it? There are several reasons for building (even if you only need *one)*--

- The creativity factor. You have the pleasure and pride of doing something with your own hands. In fact, it's so rewarding that many of us will build a device even when it is *more expensive* than buying it.

- The economic factor. Building is often less expensive than buying off the shelf.

- The availability factor. Sometimes what you want is simply not available, or available only as a kit.

- The knowledge factor. If you build it, you will probably be able to fix it if it breaks, or modify it. You will also gain a better understanding of how that particular type of equipment actually works.

These four factors will influence your decision to build something, and whether to buy a kit or start from scratch. The project that we will build together can be purchased as a kit or built from scratch-- virtually everything in this series will relate equally to either approach.

A Disclaimer, of Sorts

I'm in the business. My company, Milestone Technologies, sells some of the tools that I am going to recommend and also the kit that we're going to do as a project. I'd hate to think that you would think I'm writing this series to sell stuff, so I will make a point of providing an alternate source for each of those items that I sell. Making some of these things available to you from Milestone Technologies is a service which you are free to decline.

A Poor Workman Blames his Tools

A crummy violinist playing a Stradivarius is going to sound like someone scraping a horse's tail across a cat's gut. A great violinist can make a cigar-box violin sound like a Strad. Or to put it in more familiar terms, an unskilled ham will have trouble making contacts with a three thousand dollar rig and a beam on a 100' tower, while a skilled operator can work DXCC on a home-made QRP rig with a dipole. The point here is that skill is more important than tools-- investing hundreds of dollars in tools and test equipment is not going to make you a good builder or technician. The value of your tool armory will increase as time goes by, but the basic tools for electronic construction are relatively inexpensive, and all of them are available at your local radio parts store and by mail-order.

Let's talk about a *two* basic tool kits for electronic construction-- hand tools and soldering tools.

The hand tools are really simple at "entry level" but even basic soldering tools start to get into areas of complexity, so you may want to read the section on soldering before deciding what to buy. The recommendations are summarized in table 1, which shows suppliers part numbers for Radio Shack (RS)[(1)] and Milestone Technologies (MT)[(2)].

Hand tools:

A pair of long nose pliers, for bending the leads on components and holding nuts while you tightens bolts.
A pair of cutting pliers-- what you are looking for is "flush cutting" pliers rather than the traditional "dikes" or "diagonal cutting pliers." These are used for cutting wire and trimming leads on the soldered side of a circuit board, and "dikes" just won't get close enough to the board.

Screwdrivers-- you will need two large screwdrivers, one with a straight tip for slotted screws, the other with a phillips head; and a set of miniature drivers. The mini drivers (often called "jeweler's drivers") can be bought as separate sets for straight and phillips, or as a combination set.

Hobby knife-- for example, a "Stanley" knife, with a razor-sharp blade, for stripping wires and trimming things.

Multimeter-- for checking voltages, resistances, continuity, and current. A digital multimeter with an "audible continuity feature" is great, but you can get by with an inexpensive VOM (Volt-Ohm-Milliameter).

Magnifiers-- for examining circuit board traces and solders connections. If you can, you should *solder under magnification* using a magnifying work lamp, but you can start with a hand magnifier or loupe.

Clip leads-- wires with aligator clips on the ends for making temporary connections.

Sheet Metal Nibbling Tool-- for making large or odd shaped openings in sheet metal, for example aluminum panels for mounting controls. Much faster and easier than filing.

Soldering tools:
A soldering iron. That's so easy to say, but there's so much more to it! We're talking molten metal here, in close proximity to delicate electronic components. When you're working on a printed circuit board you need to apply a precise amount of heat for a reasonably precise amount of time to a *very* precise area! Your beginner's tool kit should include a 15-30 Watt soldering pencil with a fine chisel tip and at least one spare tip. Ultimately you may want to invest in a "soldering station," but please buy one with temperature control rather than wattage control (see the section on soldering for details). You will need a much heavier iron (100+ Watts) if you are going to work with coax connectors, but don't try to use it on a circuit board!

Solder-- it's traditional to start out with a caution that you must use rosin core solder and never acid core solder, but in practice acid core solder is so hard to find that the warning is almost superfluous. There are three factors to consider-- metallic content, type of flux (core), and diameter, and the result is a huge range of solders available on the market. For now, let's leave it with a recommendation that you start with 60/40 (60% tin, 40% lead) rosin core solder with a diameter of around .03 inch. This will be fine for almost any kit or project and there's no point in departing from it until you have a particular reason to do so.

Solder wick-- you *will* make mistakes. I do, and everyone does. Besides, there will be times when you want to remove a component for testing, or to substitute a different value. The *only* practical way to "unsolder" a connection is with solder wick. You'll see solder suckers and other "one hand" desoldering devices, but if they are any use it all it is because you used way too much solder on the connection to start with!

Your "work bench" is important too, although it doesn't have to be elaborate. A kitchen table or desk will do. Things to consider are light, ventilation, and access to mains power and ground.

When it comes to light, you simply can't have too much. Flourescent light is best for electronic work because it is "whiter" than incandescent light. Ventilation is particularly important when you are soldering, because the fumes from the rosin can be irritating or even harmful over time. You will need mains power for your soldering iron, and you will often need to connect things to a good electrical ground (the center screw in the AC outlet will do).

Other than that, all you need to worry about is a reasonable amount of clear space, and places for tools and components. If you are using a space that has other purposes (i.e. your kitchen table) it's easy enough to keep your tools and components in trays so they can be easily put aside when you are not working.

Soldering 101

Entire magazine articles, even books, have been written about soldering. So how can I hope to teach you to solder with a few paragraphs and illustrations? Easy. Soldering is not difficult, and the basics are easily within your grasp if you have the right soldering iron, the right solder, and a little bit of practice.

Practice is important, so if you are new to soldering please take the time to do some before we start on the project! You can practice on any old components and a bit of scrap circuit board material-- or skip ahead to *un*-soldering, remove a couple of components from a junk circuit board and re-solder them. Kit suppliers will tell you that 90% of all problems in kit building are a result of poor soldering-- how can that be if soldering is not difficult? Simple-- carelessness and ignorance. We'll fix the ignorance problem right now-- carelessness is up to you.

Soldering is a process of amalgamating metals to provide a good electrical connection. Solder is a mixture (alloy) of two or more metals with a relatively low melting point, that will flow onto the surface of other metals creating a low-resistance electrical connection. Ordinary solder is not very strong, and you should never rely on solder alone to hold components together physically.

Rule #1: *A good <u>mechanical</u> connectionis is necessary <u>before</u> you solder!*

The mechanical connection should be secure before you apply solder, and the parts should not be able to move in relation to eachother. The flux is vaporized by the heat of the iron and the vapors will clean the surfaces of any oxidation (often invisible to the naked eye), allowing the solder to flow freely onto the metal surfaces.

The purpose of the soldering iron is to transfer heat into the work to be soldered; the solder should melt upon contact with the work. The iron must be at the correct temperature to do this, and some elementary principles of thermodynamics are involved here.

Rule #2: *Strike while the iron is hot!*

Fortunately, we don't have to worry about the details too much-- a 15-30W iron will heat up to an appropriate temperature and won't get too hot under ordinary circumstances. But let's look at the basics anyhow, because they will help you to understand what is going on, and also influence your decision to buy a temperature controlled soldering iron later!

The wattage of an iron is a measure of the power that is used to generate heat. Your soldering pencil is *always* running at that level of power consumption, and it is *always* generating heat. The tip has a specific mass which can absorb heat. As long as power is supplied it will continue to get hotter until it reaches equilibrium-- at its maximum temperature heat will be conducted away from it (into the surrounding air) as quickly as it is generated by the applied power. Heat will transfer out of the tip more quickly when it is in contact with the work, and the rate at which that occurs will depend on the size and shape of the tip, the amount of its surface that is in contact with the work, and the nature of the work (how quickly heat is conducted away from the point of contact). When your soldering pencil is sitting idle it very definitely gets *much hotter* than required for soldering, but it cools down almost instantaneously when you apply it to the work, and the applied power sustains the working temperature. When it's idle though, at higher temperatures, its surface is much more susceptible to corrosion. So turn it off when you are not actually soldering (for more than five minutes or so). Otherwise, you can expect to replace or refinish the tip fairly frequently. Leaving it on overnight *once* will ruin the tip. Once the tip has been overheated and cannot be tinned (see below) you can file or grind it down and start over, but it is usually a lot easier just to replace it.

All else being equal, the wattage of an iron is a poor indicator of its performance because it's main effect is in how quickly the iron will heat up to its maximum equilibrium temperature, or how fast it will create new heat for transfer into the work, and not necessarily how hot that temperature will be! That's why the best irons, if somewhat more expensive, are temperature controlled and not "variable output." I finally worked that out for my self after going through perhaps a hundred soldering iron tips.

From this point on, I'll be talking about soldering components onto a printed circuit board, but the principles apply to other soldering such as wire connections to controls.

Allow the iron to heat until solder flows freely on the tip, "tinning it." This means there should be a thin, shiny coating of solder on the working surface of the tip-- it should not "ball up" and drop off. Apply a small amount of solder to the tip and then wipe it off quickly with a soft cloth or a damp sponge. You can probably do three or four joints in immediate succession without having to repeat this process, but if you stop soldering to place components on the board you will need to repeat it.

Here are the steps in soldering a component into a circuit board:

1. Inspect the board and the component leads, and make sure they are clean. Older components may be oxidized and require cleaning (use fine sandpaper, or scrape with the edge of your hobby knife). Most circuit boards do not require cleaning before use, but it can't hurt. Wash the board with soap and water, and use a mild abrasive (Scotch scouring pad for example) or metal polish only if absolutely necessary. The surface of the tracks should be shiny and free of smudges and fingerprints. Some builders (and kit suppliers) will recommend cleaning a board before use and completing it in one session but I have never found this to be necessary-- that's why there's flux in the solder!.

2. *Mechanically* install the component. Use your long-nose pliers to bend the component's leads so that they will go straight into the holes in the board. If the spacing permits, hold the lead with the pliers and bend the end of the lead against the jaws of the pliers. Otherwise, watch what you are doing and make sure you are not exerting excessive pulling force on the lead-- you can easily ruin a diode or inductor by pulling on the lead. Check the value before you insert it in the board. If it is a polarized component such as an electrolytic capacitor, double check the orientation. If the component isn't polarized (for example a resistor or ceramic capacitor) then it doesn't matter which way it goes, but it's a good idea to mount it so that you will be able to read the value later. I usually put resistors in with the tolerance band to the right or bottom depending on how the resistor is mounted, and capacitors with the value facing me or to the right (unless they are very close to a larger component, in which case I turn them around). The aim is simply to make it easy to see and verify all of the component values after the board is complete. Before you solder it, RECHECK the value, the orientation, and that it is in the right holes! In most cases, the body of the component should be snug against the component side (opposite from the "track" or soldering side) of the boards. Obvious exceptions are transistors and other components which might run hot. Looking at the solder side of the board, bend the leads outward at about 45 degrees to hold the component in place.

2. Inspect the un-soldered connection. Make sure you know where solder is supposed to go. For example, if there is a pad for another component very close to where you are going to solder, you can "memorize" the pad layout and be sure that there is no unwanted solder "bridge" when you finish the connection. If you don't do this, it's often hard to tell whether two points should be connected or not.

3. Solder the connection. Tin and wipe the tip of the iron as described above. Apply the tip to one side of the pad, wedging the tip against the lead where it protrudes from the hole, Count to three and apply solder to the opposite side of the pad, and it should flow across the pad, around the lead, and slightly up the lead from the surface of the board. Do NOT apply the solder to the tip of the iron, as it will melt instantly and may flow onto the joint without bonding properly.

Rule #3: *Heat the work, not the solder!*

Figure 2 shows a good joint and a bad joint. The bad joint is often called a "cold" joint because it is most often caused by inadequate heating of the joint. It doesn't just *look* ugly-- if I can coin a new term here, it's "electrically ugly," offering no electrical connection between the two surfaces, or a weak one which is bound to fail, or (worst of all) an intermittent fault.

5. Inspect the soldered connection. Use a magnifying device of some kind, ideally 5-10x power and make sure the connection is sound and conforms to the illustration in figure 2.

Rule #4: *Inspect the connection under magnification!*

Make sure solder hasn't flowed onto any adjacent pads or tracks. If it has, remove it immediately (see "unsoldering," below).

6. Trim the component leads. Use your flush cutting pliers and trim at about the point where the solder has risen up the lead. It is not usually necessary, or even a good idea, to trim the leads of integrated circuits and other devices where the lead protrude only an eighth of an inch or so.

That's all there is to it. And with practice, you won't even need to think about the steps as you go through them. There are variations and some specialized techniques that will be helpful later, but usually they are self-evident, and we'll mention them when we come to them in the course of building our project.

When you've soldered all the components onto the board, *check everything again*-- component values, orientations, and above all look for solder bridges and cold joints! When it comes to the latter two, it may be a good idea to remove excess solder flux from the board, but don't bother with that unless you really need to-- in my experience more problems are caused in the process of removing flux than are solved by it. If you do need to remove flux, use acetone or a commercial flux remover, in a *well ventilated area*. If you have invested solder with a water soluble flux, you will use water, of course, but do make sure the board is thoroughly dry before applying power to it!

***Un*-Soldering101**

For the most part, anything you can do with solder you can undo, if you know what you're doing. The secret is "solder wick," a fine copper braid impregnated with flux. Used properly, it can remove virtually all of the solder from a connection and a component, even an integrated circuit chip, will just fall out. A lot of people seem to have difficulty with it though-- it's one of those things where it's hard to figure out how to use it by yourself. One big problem is that solder wick should be marked with a "use by" date! The braid itself can oxidize over time, and the flux can dry out and fall out of the mesh, making it practically useless. So use *fresh* solder wick, and do it like this.

1. Make sure the soldering iron is hot. De-soldering requires more heat than soldering, so if you have an adjustable iron, turn it up. And make sure the iron is tinned-- that film of molten solder on the tip is essential for heat transfer into the work.

2. Lay the end of the wick on top of the connection that is to be desoldered, and press the iron firmly into the wick. Hold in place (you'll want to hold the wick by its container, or at least six inches from the end) and watch for solder to appear in the wick. When solder is has been drawn about half an inch from the end of the wick remove the iron and the wick.

3. Cut the used end of the wick off, about a quarter inch *above* the point at which solder is visible. Solder has not been drawn up that far, but the flux has boiled out.

4. Repeat steps 2 and three until the component is free. It will usually take two or more applications for each lead. Keep in mind that where circuit board holes are plated through, solder has flowed down from the track side of the board and as a result there will be more solder to remove than on a simple single-sided board.

If you have trouble, remember that the two secrets are *fresh solder wick*, and *plenty of heat*!

To repair (remove) a solder bridge, apply the wick to the bridge and the solder should be removed from the board between the two pads-- you may need to resolder the connections, though.

Next month we'll build our project-- in the mean time you can get your tool kit together, practice soldering, and order a kit. It's the VM-110 AC Voltage Monitor from Electronic Rainbow , and if you don't want to order the kit you can find most of the parts pretty easily-- a list will be printed next month along with the schematic. The VM-110 kit costs $10.95 and you can order the complete kit or just the circuit board from Electronic Rainbow[3], or the complete kit from Milestone Technologies.

Table 1A: Basic Hand Tools[4]			
Item	Supplier	Price	Part Number
Long Nose Pliers	RS	3.99	64-1844
Cutting Pliers	RS	3.99	64-1833
Screwdriver, reversible	RS	2.69	64-1950
Jeweler's driver combo set	RS	4.79	64-1959
Hobby Knife	RS	1.49	64-1805
Magnifying Glass	RS	5.99	63-848
OR Jeweler's Loupes Set(3)	MT	7.95	35450
Multimeter, 8-Range Analog	RS	14.99	22-218
OR Multimeter, 14-Range Analog	MT	9.95	30812
Clip Lead Set (10) mini aligator	RS	3.99	278-1156

Sheet-metal Nibbling Tools	RS	10.99	64-823
OR Heavy Duty Nibbling Tool	MT	9.95	00539
Table 1B: Basic Soldering Tools			
15-Watt Soldering Iron	RS	7.99	64-2051
Replacement Tip for Above	RS	0.99	64-2052
Solder, 60/40 rosin core .032" 2.5oz	RS	3.79	64-005
Desoldering Braid	RS	2.29	64-2090

DEVICES COMES IN FRONT OF YOU WHILE TESTING

Using a Multimeter

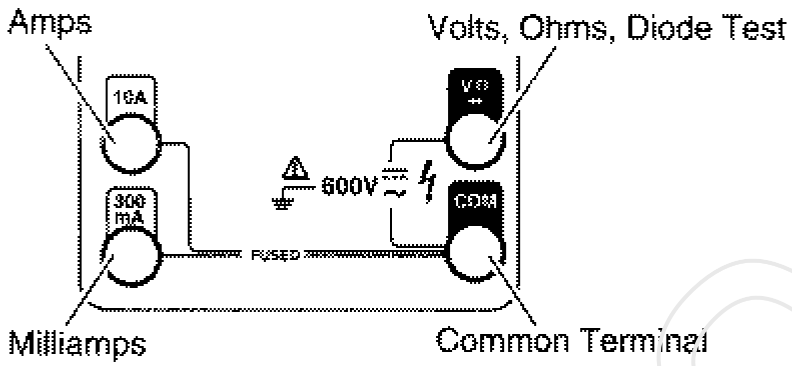
A multimeter is used to make various electrical measurements, such as AC and DC voltage, AC and DC current, and resistance. It is called a *multi*meter because it combines the functions of a voltmeter, ammeter, and ohmmeter. Multimeters may also have other functions, such as diode and continuity tests. The descriptions and pictures that follow are specific to the Fluke 73 Series III Multimeter, but other multimeters are similar.

> **Important note: The most common mistake when using a multimeter is not switching the test leads when switching between current sensing and any other type of sensing (voltage, resistance). It is critical that the test leads be in the proper jacks for the measurement you are making.**

Safety Information

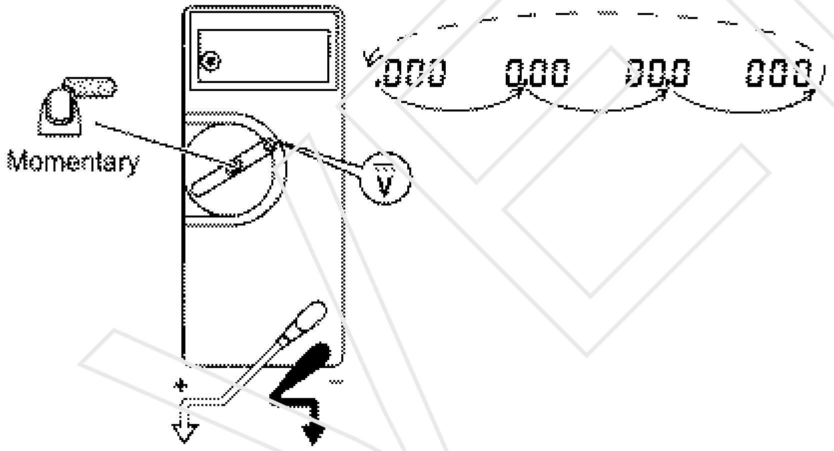
- Be sure the test leads and rotary switch are in the correct position for the desired measurement.
- Never use the meter if the meter or the test leads look damaged.
- Never measure resistance in a circuit when power is applied.
- Never touch the probes to a voltage source when a test lead is plugged into the 10 A or 300 mA input jack.
- To avoid damage or injury, never use the meter on circuits that exceed 4800 watts.
- Never apply more than the rated voltage between any input jack and earth ground (600 V for the Fluke 73).
- Be careful when working with voltages above 60 V DC or 30 V AC rms. Such voltages pose a shock hazard.
- Keep your fingers behind the finger guards on the test probes when making measurements.
- To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears.

Input Jacks



The black lead is always plugged into the common terminal. The red lead is plugged into the 10 A jack when measuring currents greater than 300 mA, the 300 mA jack when measuring currents less than 300 mA, and the remaining jack (V-ohms-diode) for all other measurements.

Range



The meter defaults to autorange when first turned on. You can choose a manual range in V AC, V DC, A AC, and A DC by pressing the button in the middle of the rotary dial. To return to autorange, press the button for one second.

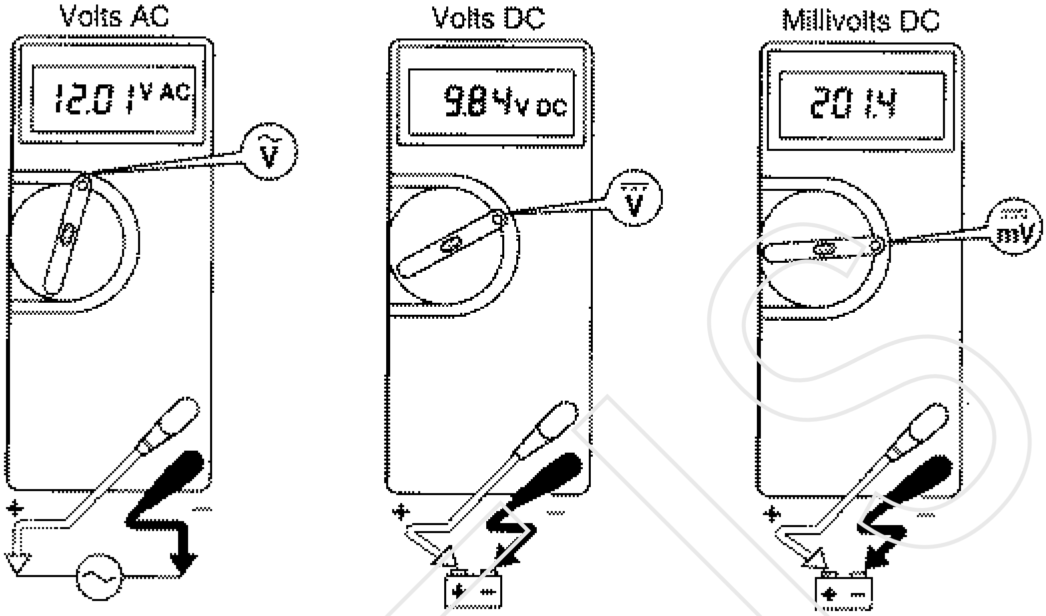
Automatic Touch Hold Mode

The Touch Hold mode automatically captures and displays stable readings. Press the button in the center of the dial for 2 seconds while turning the meter on. When the meter captures a new input, it beeps and a new reading is displayed. To manually force a new measurement to be held, press the center button. To exit the Touch Hold mode, turn the meter off.

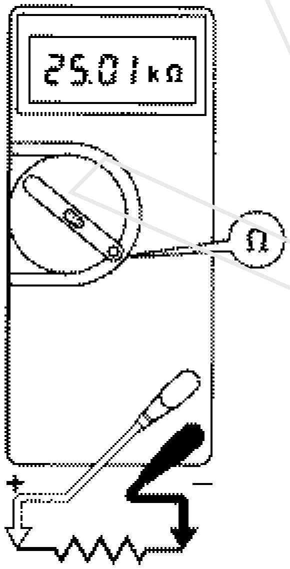
Note: stray voltages can produce a new reading.

Warning: To avoid electric shock, do not use the Touch Hold to determine if a circuit with high voltage is dead. The Touch Hold mode will not capture unstable or noisy readings.

AC and DC Voltage

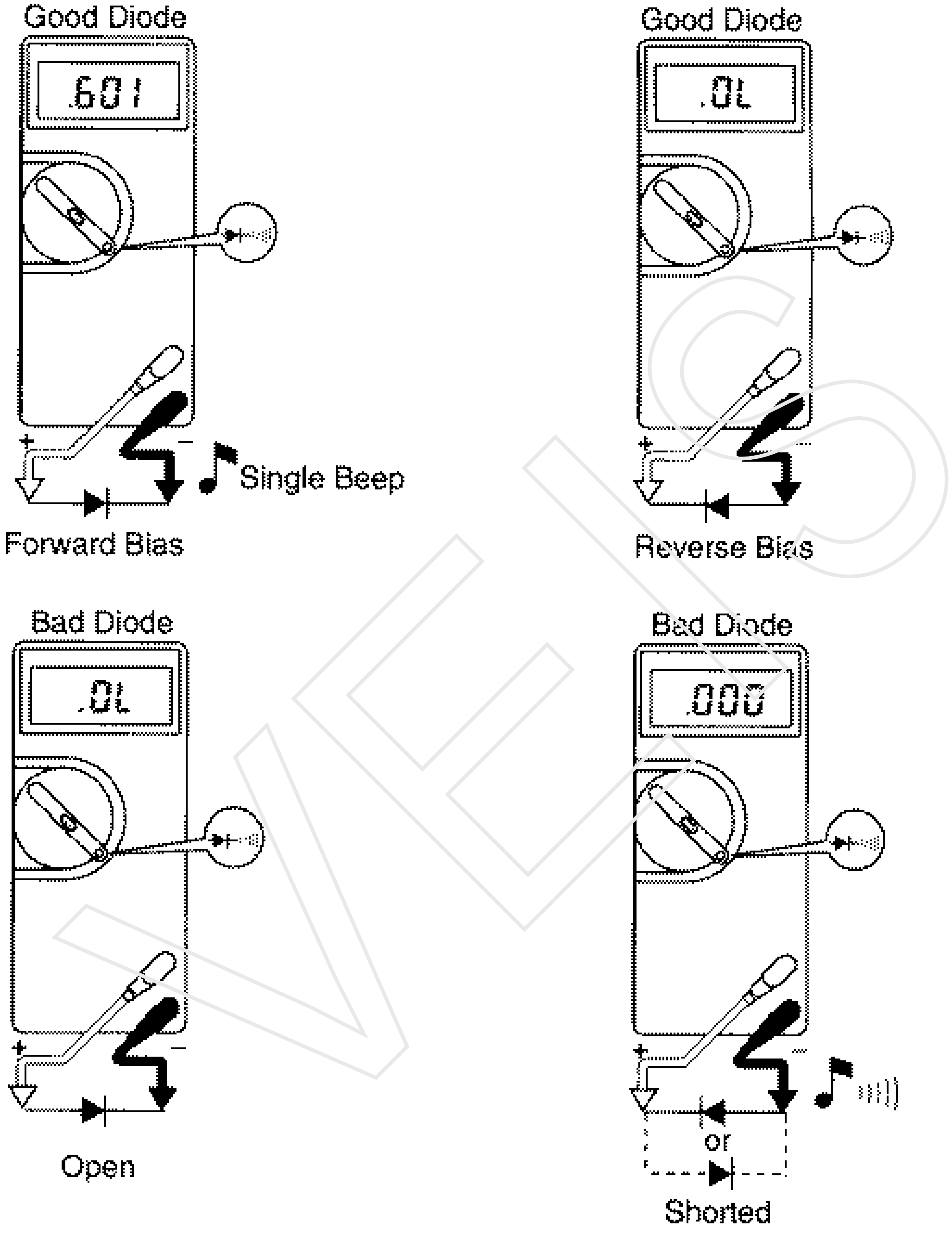


Resistance

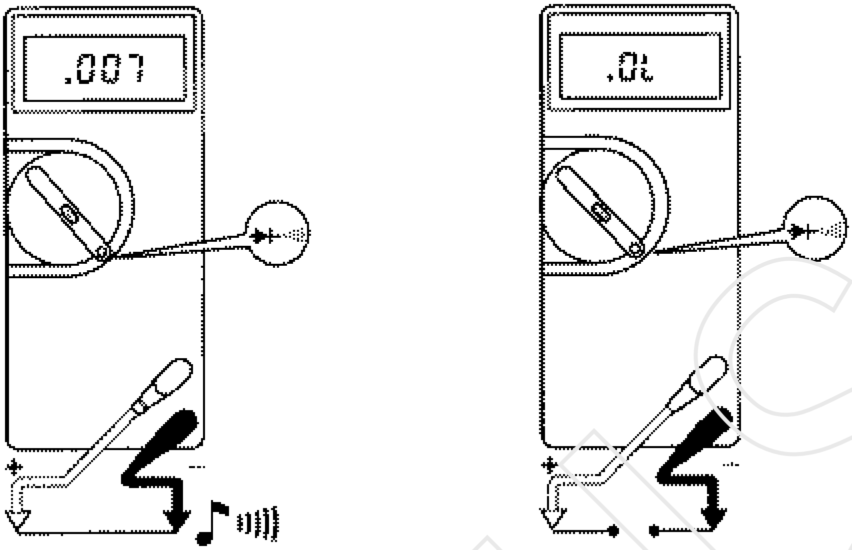


Turn off the power and discharge all capacitors. An external voltage across a component will give invalid resistance readings.

Diode Test


Good Diode
.601
Single Beep
Forward Bias
Good Diode
.0L
Reverse Bias
Bad Diode
.0L
Open
Bad Diode
.000
or
Shorted

Continuity Test



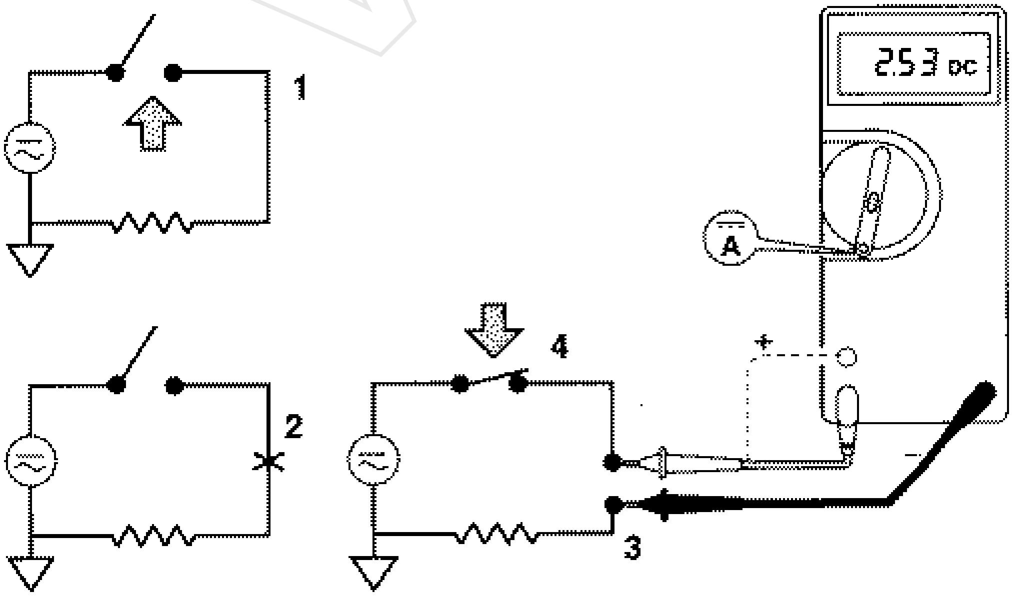
This mode is used to check if two points are electrically connected. It is often used to verify connectors. If continuity exists (resistance less than 210 ohms), the beeper sounds continuously. The meter beeps twice if it is in the Touch Hold mode.

Current

Warning: To avoid injury, do not attempt a current measurement if the open circuit voltage is above the rated voltage of the meter.

To avoid blowing an input fuse, use the 10 A jack until you are sure that the current is less than 300 mA.

Turn off power to the circuit. Break the circuit. (For circuits of more than 10 amps, use a current clamp.) Put the meter in series with the circuit as shown and turn power on.



DIGITAL

CHAPTER 1TH NUMBER SYSTEM CONVERSIONS

Binary Number System

All digital circuits, instruments and system work with numbers that represent specific quantities. The actual form of the input and output numbers depends on the applications the inputs or output may be in analog form despite the digital processing.

The types of numbers w are almost familiar with are decimal numbers. In decimal number system we combine the digits 0 to 9 in a certain way so that they indicate a specific quantity. In the binary number system, we use only two digits 0 and 1.These binary digits, or bits appropriately arranged can also represent any decimal number. All modern digital technique is based on the binary number system.

The basic distinguishing feature of a number system is its base or radix. The base indicates the number of characters or digits used to represent quantities in that number system. The decimal number system has a base or radix of 10 because we use the ten digits 0 to 9 to represent quantities.
The binary number system has a base of 2 since only the digits or bits 0 and 1 are used in forming the numbers.

Binary	Decimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15

Binary to decimal conversion

Above table lists the binary numbers from 0000 to 1111.for instance, take an example of a binary number i.e. 1011
In decimal form we can written it as

$$\begin{array}{ccccl} 1 & 0 & 1 & 1 & \text{binary form} \\ 2^3 + & 2^2 + & 2^1 + & 2^0 & \text{base form} \end{array}$$

8 + 0 + 2 + 1 decimal equivalent

We can cancel out the value regarding binary ‘0’ and add the remaining value.

Octal Numbers

The base of number system equals the number of digits its uses. The octal number system has the base of 8. Although we can use any eight digits, it is customary to use the first eight decimal digits.
0,1,2,3,4,5,6,7

Octal to decimal conversion

In octal number system each digit position corresponds to a power of 8 as follows
$8^3\ 8^2\ 8^1\ 8^0 \,.\, 8^{-1}\ 8^{-2}\ 8^{-3}$

Therefore to convert from octal to decimal, multiply each octal digit by its weight and add the resulting products.
For example octal 23 converts to decimal as
$2(8^1) + 2(8^0) = 16+13 = 19.$

Decimal to octal conversion
To convert decimal to octal we divide the number by 8.
For example decimal 139

8	139	
8	17	-3
	1	-1

$(139)_{10} = (213)_8$

Octal to binary conversion
You can convert from octal to binary as follows:Change each octal digit to its binary equivalent for instance changes octal 23 to its binary equivalent as follows

For example 2 3
↓ ↓
010 011

i.e. $(23)_8 = (101\ 001)_2$

Binary to octal conversion:

Conversion from binary to octal is a reversal of the foregoing procedures.Simply remember to group the bits in threes starting at the binary point then convert each group of three to its octal equivalent.

Binary number 001011.011010

001 011.011 010

001 011.011 010

1 3 3 2 = 13.32

Hexadecimal Numbers

Hexa decimal numbers are used extensively in microprocessor work .to begin with they are much shorter than binary numbers .this makes them easy to write and remember .The hexadecimal number system has a base of 16.Although any 16 digits may be used everyone uses 0 to 9 and A to F as shown below .

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

Hexadecimal to binary conversion

To convert a hexadecimal number to a binary number, convert each hexadecimal to its 4 bits equivalent using the code given.

For example 9 AF

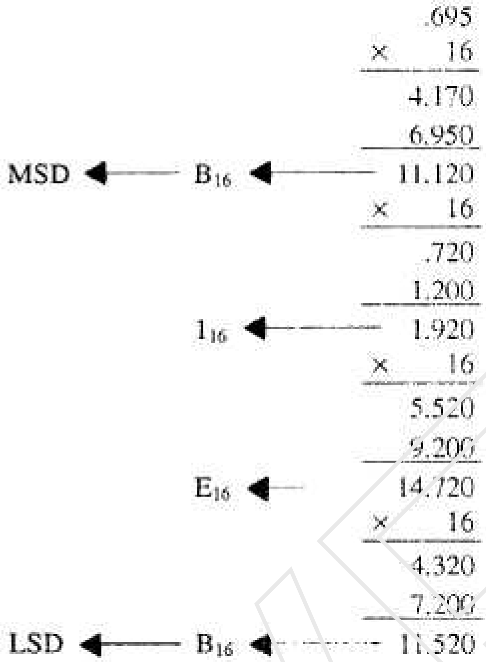
1001 1010 1111

Binary to hexadecimal conversion

To convert binary to hexa follow the table

Conversion of hexadecimal fractions

Write the solution from MSD to LSD: AE_{16} There will probably be very few times when you will have to convert a decimal fraction to a hex fraction. If the occasion should arise, the conversion is done in the same manner as binary or octal. Use the following example as a pattern: Convert 0.695_{10} to hex: The solution: $.B1EB_{16}$ Should you have the need to convert a decimal mixed number to hex, convert the whole number and the fraction separately; then recombine for the solution. Convert the following decimal numbers to hex: *Q60. 42_{10}. Q61. 83_{10}. Q62. 176_{10} . Q63. 491_{10}. Q64. 0.721_{10} (four places).* The converting of binary, octal, and hex numbers to their decimal equivalents is covered as a group later in this section.



- 1-47 Write the solution from MSD to LSD: AE_{16} There will probably be very few times when you will have to convert a decimal fraction to a hex fraction. If the occasion should arise, the conversion is done in the same manner as binary or octal. Use the following example

Binary Addition & Subtraction

A key requirement of digital computers is the ability to use logical functions to perform arithmetic operations. The basis of this is addition; if we can add two binary numbers, we can just as easily subtract them, or get a little fancier and perform multiplication and division. How, then, do we add two binary numbers?

Let's start by adding two binary bits. Since each bit has only two possible values, 0 or 1, there are only four possible combinations of inputs. These four possibilities, and the resulting sums, are:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 10

Whoops! That fourth line indicates that we have to account for two output bits when we add two input bits: the sum and a possible carry. Let's set this up as a truth table with two inputs and two outputs, and see where we can go from there.

INPUTS		OUTPUTS	
A	**B**	**CARRY**	**SUM**
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	1

Well, this looks familiar, doesn't it? The Carry output is a simple AND function, and the Sum is an Exclusive-OR. Thus, we can use two gates to add these two bits together.

Binary subtraction

It is also quite possible to use this circuit for binary subtraction. If a negative number is applied to the **B** inputs, the resulting sum will actually be the difference between the two numbers.

INPUTS		OUTPUTS	
A	**B**	**CARRY**	**SUM**
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

In a modern computer, the adder circuitry will include the means of negating one of the input numbers directly, so the circuit can perform either addition or subtraction on demand. Other functions are commonly included in modern implementations of the adder circuit, especially in modern microprocessors.

CHAPTER 2ND **GATES**

Logic Gate

While each logical element or condition must always have a logic value of either "0" or "1", we also need to have ways to combine different logical signals or conditions to provide a logical result.

For example, consider the logical statement: "If I move the switch on the wall up, the light will turn on." At first glance, this seems to be a correct statement. However, if we look at a few other factors, we realize that there's more to it than this. In this example, a more complete statement would be: "If I move the switch on the wall up *and* the light bulb is good *and* the power is on, the light will turn on."

If we look at these two statements as logical expressions and use logical terminology, we can reduce the first statement to:

Light = Switch

This means nothing more than that the light will follow the action of the switch, so that when the switch is up/on/true/1 the light will also be on/true/1. Conversely, if the switch is down/off/false/0 the light will also be off/false/0.

Looking at the second version of the statement, we have a slightly more complex expression:

Light = Switch *and* Bulb *and* Power

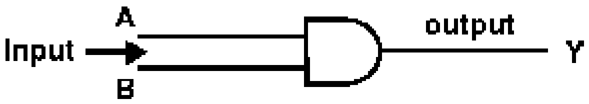
Normally, we use symbols rather than words to designate the *and* function that we're using to combine the separate variables of Switch, Bulb, and Power in this expression. The symbol normally used is a dot, which is the same symbol used for multiplication in some mathematical expressions. Using this symbol, our three-variable expression becomes:

Light = Switch •Bulb •Power

When we deal with logical circuits (as in computers), we not only need to deal with logical functions; we also need some special symbols to denote these functions in a logical diagram. There are three fundamental logical operations, from which all other functions, no matter how complex, can be derived. These functions are named *and*, *or*, and *not*. Each of these has a specific symbol and a clearly defined behavior, as follows:

AND Gate

The output is available only when all the input an available i.e. the output is a logical I when all input one at logical.



A.B = Y

Symbol of AND Gate   Truth Table Of AND Gate

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

TRUTH TABLE

True value or condition of gates called truth table.

OR

Truth Table Show the true value or condition of gates.

Function of AND Gate

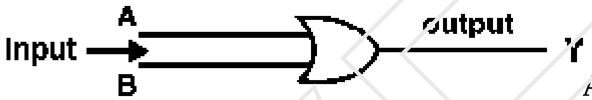
Case-I A=0, B=0 than Y = 0
If both input is low than output is also low.

Case-II A=0, B=1 than Y = 0 or A=1, B=0 than Y=0.
If the one input is low than output is low. Gate

Case-III A=1, B=1 than Y=1
If both input is high than output is high.

OR Gate

The output is available, if any one or more inputs are available.



A + B = Y

Symbol of OR Gate

Truth Table Of OR Gate

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Function of OR Gate

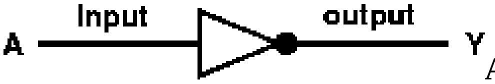
Case-I A=0, B=0 than Y = 0
If both input is low than output is also low.

Case-II A=0, B=1 than Y = 1 or A=1, B=0 than Y=1.
If in which of both input one input is high than output is high.

Case-III A=1, B=1 than Y=1
If both input is high than output is high.

NOT Gate

This is one of the Gates, which is essential in any basic set of logic functions. Its function is to give an output logic state, which is different to the input.



A = Y

Symbol of NOT Gate

Truth Table Of OR Gate

A	Y
0	1
1	0

Function of NOT Gate

NOT Gate is compliment of each other. If input is high than output is low or input is low than output is high. So that it's always output opposite the input.

The logic gates shown above are used in various combinations to perform tasks of any level of complexity. Some functions are so commonly used that they have been given symbols of their own, and are often packaged so as to provide that specific function directly. On the next page, we'll begin our coverage of these functions.

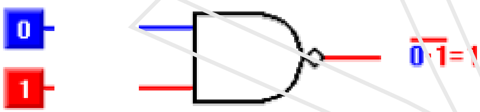
While the three basic functions AND, OR, and NOT are sufficient to accomplish all possible logical functions and operations, some combinations are used so commonly that they have been given names and logic symbols of their own.

We will discuss three of these on this page. The first is called NAND, and consists of an AND function followed by a NOT function. The second, as you might expect, is called NOR. This is an OR function followed by NOT. The third is a variation of the OR function, called the Exclusive-OR, or XOR function. As with the three basic logic functions, each of these derived functions has a specific logic symbol and behavior, which we can summarize as follows:

Universal Gates

The NAND Gate

The NAND gate implements the NAND function, which is exactly inverted from the AND function you already examined. With the gate shown to the left, both inputs must have logic 1 signals applied to them in order for the output to be a logic 0. With either input at logic 0, the output will be held to logic 1.

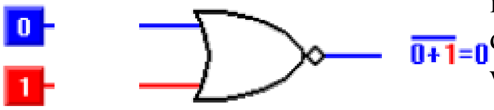


The circle at the output of the NAND gate denotes the logical inversion, just as it did at the output of the inverter. Also in the figure to the left, note that the overbar is a solid bar over both input values at once. This shows that it is the AND function itself that is inverted, rather than each separate input.

As with AND, there is no limit to the number of inputs that may be applied to a NAND function, so there is no functional limit to the number of inputs a NAND gate may have. However, for practical reasons, commercial NAND gates are most commonly manufactured with 2, 3, or 4 inputs, to fit in a 14-pin or 16-pin package.

The NOR Gate

The NOR gate is an OR gate with the output inverted. Where the OR gate allows the output to be true (logic 1) if any one or more of its inputs are true, the NOR gate inverts this and forces the output to logic 0 when any input is true.



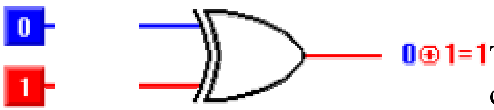
In symbols, the NOR function is designated with a plus sign (+), with an overbar over the entire expression to indicate the inversion. In logical diagrams, the symbol to the left designates the NOR gate. As expected, this is an OR gate with a circle to designate the inversion.

The NOR function can have any number of inputs, but practical commercial NOR gates are mostly limited to 2, 3, and 4 inputs, as with other gates in this class, to fit in standard IC packages.

Special Gate

The Exclusive-OR, or XOR Gate

The Exclusive-OR, or XOR function is an interesting and useful variation on the basic OR function. Verbally, it can be stated as, "Either A or B, but not both." The XOR gate produces logic 1 output only if its two inputs are *different*. If the inputs are the same, the output is logic 0.



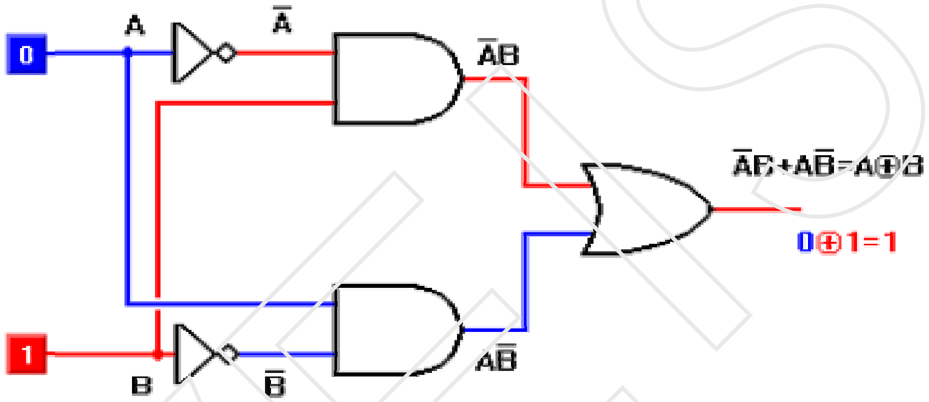
The XOR symbol is a variation on the standard OR symbol. It consists of a plus (+) sign with a circle around it. The logic symbol, as shown here, is a variation on the standard OR symbol.

Unlike standard OR/NOR and AND/NAND functions, the XOR function always has exactly two inputs, and commercially manufactured XOR gates are the same. Four XOR gates fit in a standard 14-pin IC package.

The three derived functions shown above are by no means the only ones, but these form the basis of all the others. On the next page we will look at *how* the XOR function is derived. Then we will begin our look at practical applications for logic gates in various combinations, to see just how these simple gates can be combined to perform every possible operation in a computer.

On the previous page we stated that the Exclusive-OR, or XOR function can be described verbally as, "Either A or B, but not both." In the realm of digital logic there are several ways of stating this in a more detailed and precise format. We won't go here into such devices as Truth tables and graphic representations. We will stick with the more complete verbal statement, "NOT A and B, or A and NOT B."

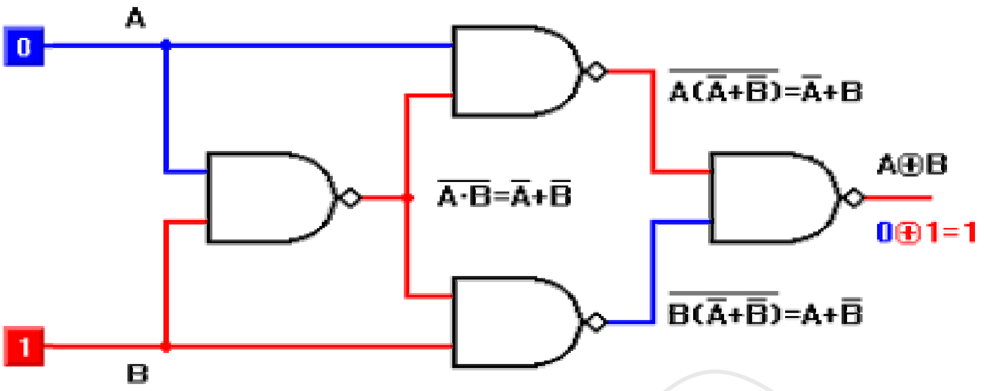
The circuit required to implement this description is shown below:



The practical problem with the circuit above is that it contains three different kinds of gates: AND, OR, and NOT. While this illustrates a practical application using all three of the basic gate types, it is cumbersome to construct on a printed circuit board.

There are commercial packages that contain four XOR gates, but often only a single XOR function is wanted in a given application. What is also wanted is a way to create that function with a single IC package.

This can easily be done with a single quad two-input NAND gate, as shown in the circuit below:



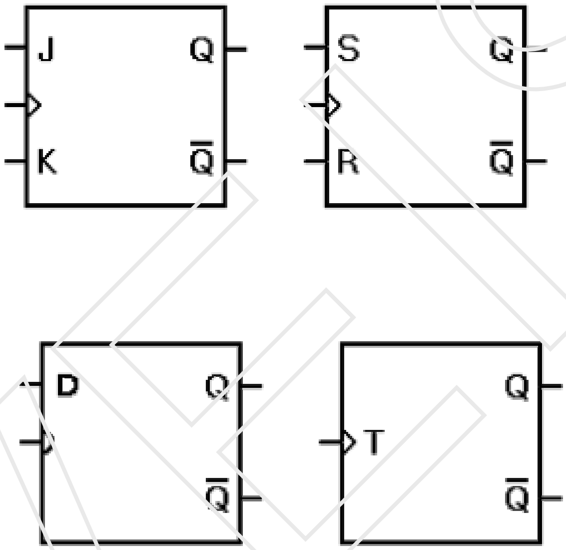
There are many ways in which the simple logic gates we have examined can be combined to perform useful functions. Some of these circuits produce outputs that are only dependent upon the current logic states of all inputs. These are called *combinational* logic circuits. Other circuits are designed to actually remember the past states of their inputs, and to produce outputs based on those past signals as well as the current states of their inputs. These circuits can act in accordance with a sequence of input signals, and are therefore known as *sequential* logic circuits.

In these pages, we will look first at combinational circuits. Then we will move on to sequential circuits. If you wish to skip immediately to sequential circuits, use the navigational links at the top of this page to select the type of circuit you would like to examine.

CHAPTER 3RD FLIP-FLOP

Although the internal circuitry of latches and flip-flops is interesting to watch on an individual basis, placing all of those logic symbols in a diagram involving multiple flip-flops would rapidly generate so much clutter that the overall purpose of the diagram would be lost. To avoid this problem, we use the "black-box" approach. This is actually just one step further that the "black-box" approach we used in specifying logic gate symbols to represent specific clusters of electronic components — now we are using one symbol to represent a cluster of logic gates connected to perform a specific function.

Some typical flip-flop symbols are shown below:



As you have no doubt noticed, the symbols above are nearly identical — only the inputs vary. This is typical of the "black-box" approach. However, there is one other variation, as shown to the right.

In each of the symbols above, the clock input is marked by the small angle, rather than by the letters CLK. That little angle marker actually provides two pieces of information, rather than one. First, of course, it marks the clocking input. Second, it specifies that these are edge-triggered flip-flops. The D latch shown to the right uses a rounded marker for the clock input. This signifies that the clock level, not the clock edge, controls the circuit. In fact, the symbol to the right would normally be used for the D latch circuit shown separately. If we change that rounded input to a sharp angle, it would indicate an edge-triggered master-slave D flip-flop.

Any of these symbols may be modified according to their actual use within the larger circuit. For example, if only the Q output is used, it may well be the only output shown. Some flip-flops incorporate master preset or reset inputs, which bypass the clock and the master section of an edge-triggered flip-flop and force the output to an immediate known state. This is often used when a circuit comprised of many flip-flops is first powered up, so that all circuits will start in a known state.

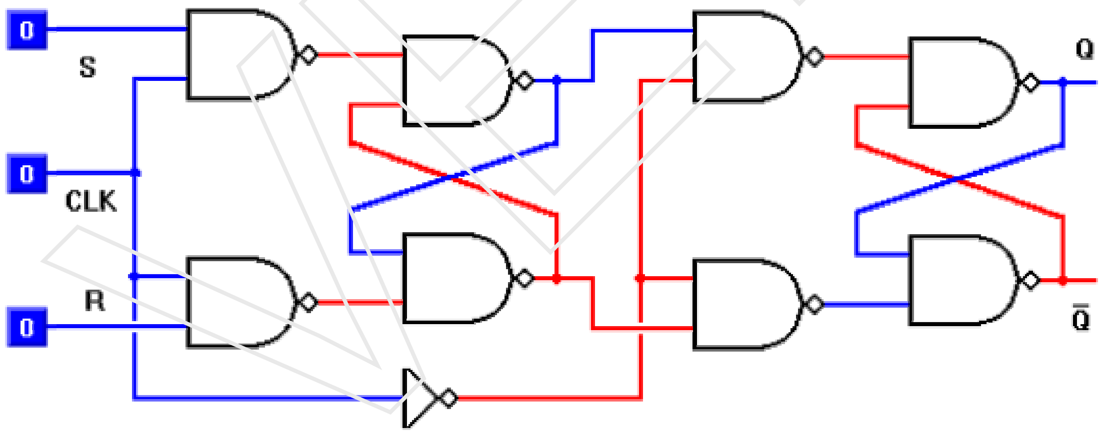
It is very seldom that a flip-flop will actually be used alone. Such circuits are far more useful when grouped together and acting in concert. There are two general ways in which flip-flops may be interconnected to perform useful functions: *counters* and *registers*. When we're done with individual flip-flops, we'll go on to counters and then look at registers

R-S Flip-Flop

To adjust the clocked RS latch for edge triggering, we must actually combine two identical clocked latch circuits, but have them operate on opposite halves of the clock signal. The resulting circuit is commonly called a *flip-flop*, because its output can first flip one way and then flop back the other way. The clocked RS latch is also sometimes called a flip-flop, although it is more properly referred to as a latch circuit.

The two-section flip-flop is also known as a *master-slave* flip-flop, because the input latch operates as the master section, while the output section is slaved to the master during half of each clock cycle.

The edge-triggered RS NAND flip-flop is shown below.



The edge-triggered RS flip-flop actually consists of two identical RS latch circuits, as shown above. However, the inverter connected between the two CLK inputs ensures that the two sections will be enabled during opposite half-cycles of the clock signal. This is the key to the operation of this circuit.

If we start with the CLK input at logic 0 as initially depicted above, the S and R inputs are disconnected from the input (master) latch. Therefore, any changes in the input signals cannot affect the state of the final outputs.

When the CLK signal goes to logic 1, the S and R inputs are able to control the state of the input latch, just as with the single RS latch circuit you already examined. However, at the same time the inverted CLK signal applied to the output (slave) latch prevents the state of the input latch from having any effect here. Therefore, any changes in the R and S input signals are tracked by the input latch while CLK is at logic 1, but are not reflected at the Q and Q' outputs.

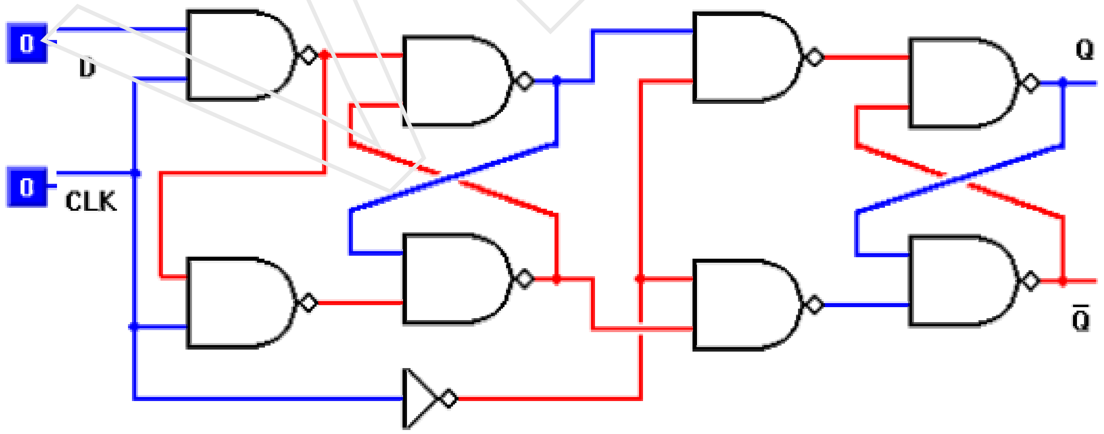
When CLK falls again to logic 0, the S and R inputs are again isolated from the input latch. At the same time, the inverted CLK signal now allows the current state of the input latch to reach the output latch. Therefore, the Q and Q' outputs can only change state when the CLK signal falls from a logic 1 to logic 0. This is known as the *falling edge* of the CLK signal; hence the designation *edge-triggered* flip-flop.

D-Flip Flop

The edge-triggered D flip-flop is easily derived from its RS counterpart. The only requirement is to replace the R input with an inverted version of the S input, which thereby becomes D. This is only needed in the master latch section; the slave remains unchanged.

One essential point about the D flip-flop is that when the clock input falls to logic 0 and the outputs can change state, the Q output always takes on the state of the D input at the moment of the clock edge. This was not true of the RS and JK flip-flops. The RS master section would repeatedly change states to match the input signals while the clock line is logic 1, and the Q output would reflect whichever input most recently received an active signal. The JK master section would receive and hold an input to tell it to change state, and never change that state until the next cycle of the clock. This behavior is not possible with a D flip-flop.

The edge-triggered D NAND flip-flop is shown below.



COUNTER

In our initial discussion on counters (A Basic Digital Counter), we noted the need to have all flip-flops in a counter to operate in unison with each other, so that all bits in the output count would change state at the same time. To accomplish this, we need to apply the same clock pulse to all flip-flops.

However, we do not want all flip-flops to change state with every clock pulse. Therefore, we'll need to add some controlling gates to determine when each flip-flop is allowed to change state, and when it is not. This requirement denies us the use of T flip-flops, but does require that we still use edge-triggered circuits. We can use either RS or JK flip-flops for this; we'll use JK flip-flops for the demonstrations on this page.

To determine the gates required at each flip-flop input, let's start by drawing up a truth table for all states of the counter. Such a table is shown to the right.

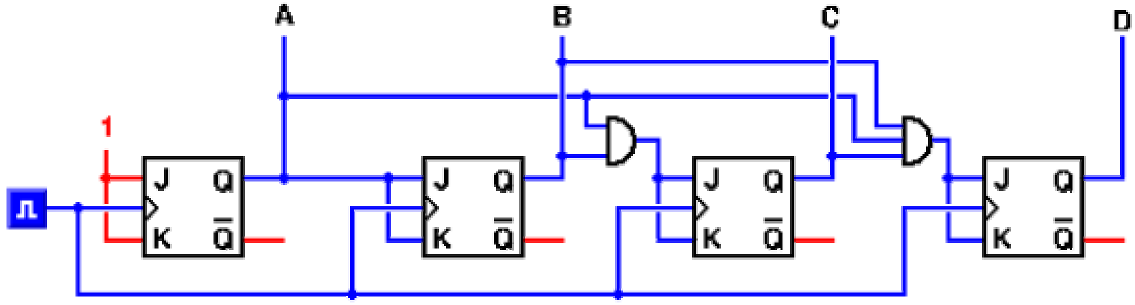
Looking first at output A, we note that it must change state with every input clock pulse. Therefore, we *could* use a T flip-flop here if we wanted to. We won't do so, just to make all of our flip-flops the same. But even with JK flip-flops, all we need to do here is to connect both the J and K inputs of this flip-flop to logic 1 in order to get the correct activity.

Flip-flop B is a bit more complicated. This output must change state only on every *other* input clock pulse. Looking at the truth table again, output B must be ready to change states whenever output A is logic 1, but not when A is a logic 0. If we recall the behavior of the JK flip-flop, we can see that if we connect output A to the J and K inputs of flip-flop B, we will see output B behaving correctly.

Continuing this line of reasoning, output C may change state only when both A and B are logic 1. We can't use only output B as the control for flip-flop C; that will allow C to change state when the counter is in state 2, causing it to switch directly from a count of 2 to a count of 7, and again from a count of 10 to a count of 15 — not a good way to count. Therefore we will need a two-input AND gate at the inputs to flip-flop C. Flip-flip D requires a three-input AND gate for its control, as outputs A, B, and C must all be at logic 1 before D can be allowed to change state.

The resulting circuit is shown in the demonstration below.

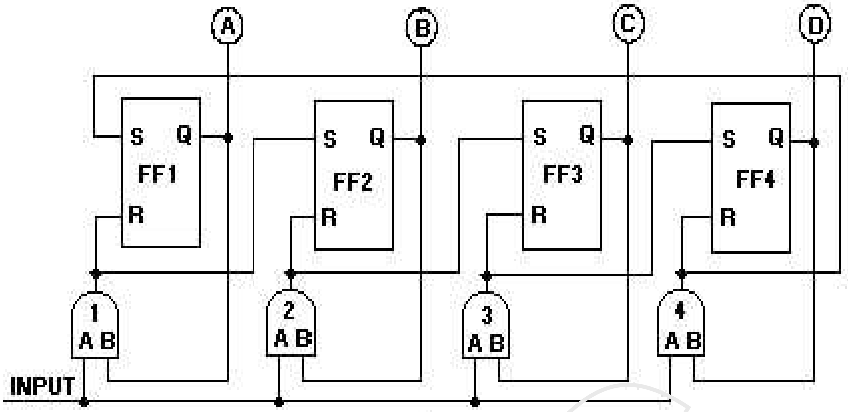
States				**Count**
D	**C**	**B**	**A**	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15



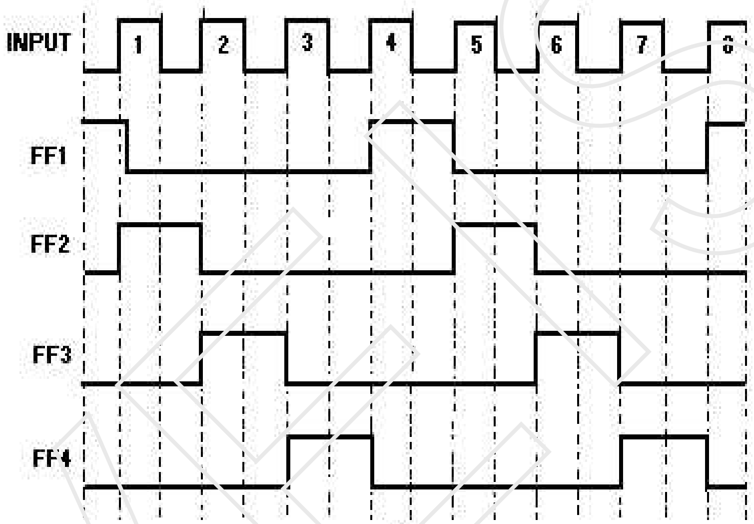
When we started our look into counters, we noted a lot of applications involving numeric displays: clocks, ovens, microwave ovens, VCRs, etc. These applications require a decimal count in most cases, and a count from 0 to 5 for some digits in a clock display. Can we use a method of gating, such as we used above in the synchronous binary counter, to shorten the counting sequence to the appropriate extent.

Ring counter (shift register counter)*

A ring counter is defined as a loop of bitable devices (flip-flops) interconnected in such a manner that only one of the devices may be in a specified state at one time. If the specified condition is HIGH, Figure 3-26, view A, shows a typical four-stage ring counter. This particular counter is composed of R-S FFs. J-K FFs may be used as well. Notice that the output of each AND gate is input to the R, or reset side, of the nearest FF and to the S, or set side, of the next FF. The Q output of each FF is applied to the B input of the AND gate that is connected to its own R input. *Figure 3-26. --Ring counter: A. Logic diagram; B. Timing diagram.* The circuit input may be normal CLK pulses or pulses from elsewhere in the equipment that would indicate some operation has been completed. Now, let's look at the circuit operation and observe the signal flow as shown in figure 3-26, view B. For an initial condition, let's assume that the output of FF1 is HIGH and that the input and FF2, FF3, and FF4 are LOW. Under these conditions, lamp A will be lit; and lamps B, C, and D will be extinguished. The HIGH from FF1 is also applied to the B input of AND gate 1. The first input pulse is applied to the A input of each of the AND gates. The B inputs to AND gates 2, 3, and 4 are LOW since the outputs of FF2, FF3, and FF4 are LOW. AND gate 1 now has HIGHs on both inputs and produces a HIGH output. This HIGH simultaneously resets FF1 and sets FF2. Lamp A then goes out, and lamp B goes on. We now have a HIGH on AND gate 2 at the B input. We also have a LOW on AND gate 1 at input B.

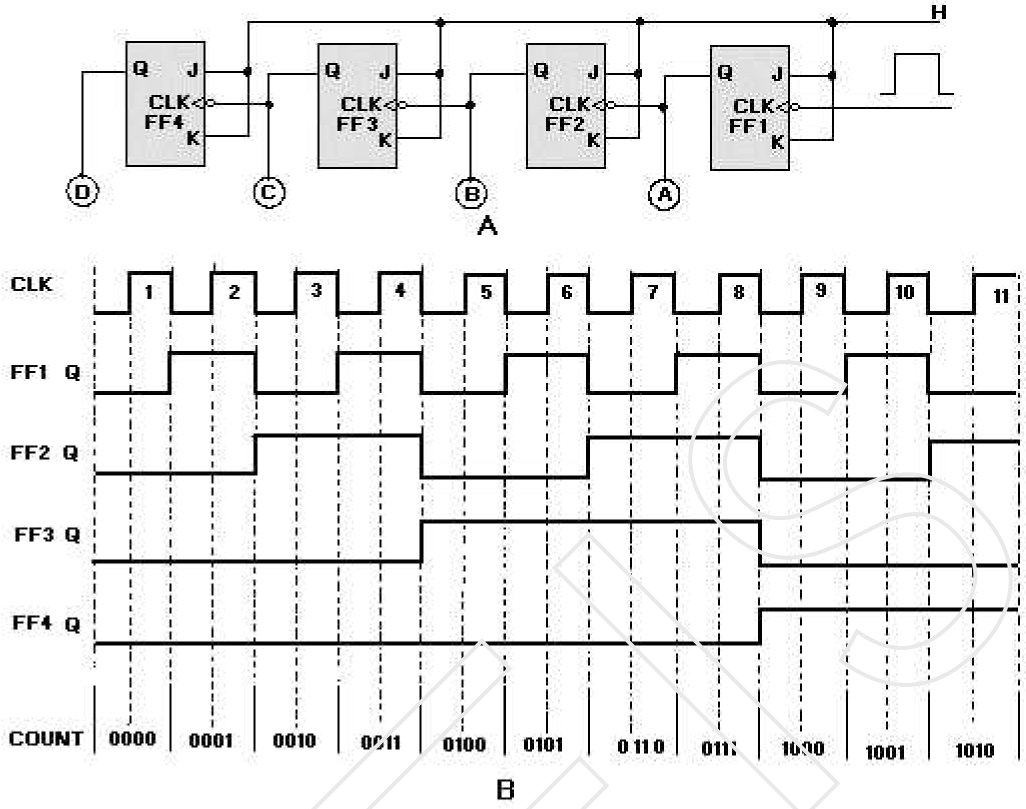

A
B
C
D
S
Q
FF1
R
FF2
FF3
FF4
1
2
3
4
A B
INPUT

A


INPUT
1
2
3
4
5
6
7
8
FF1
FF2
FF3
FF4

B

Ripple counter (asynchronous)*

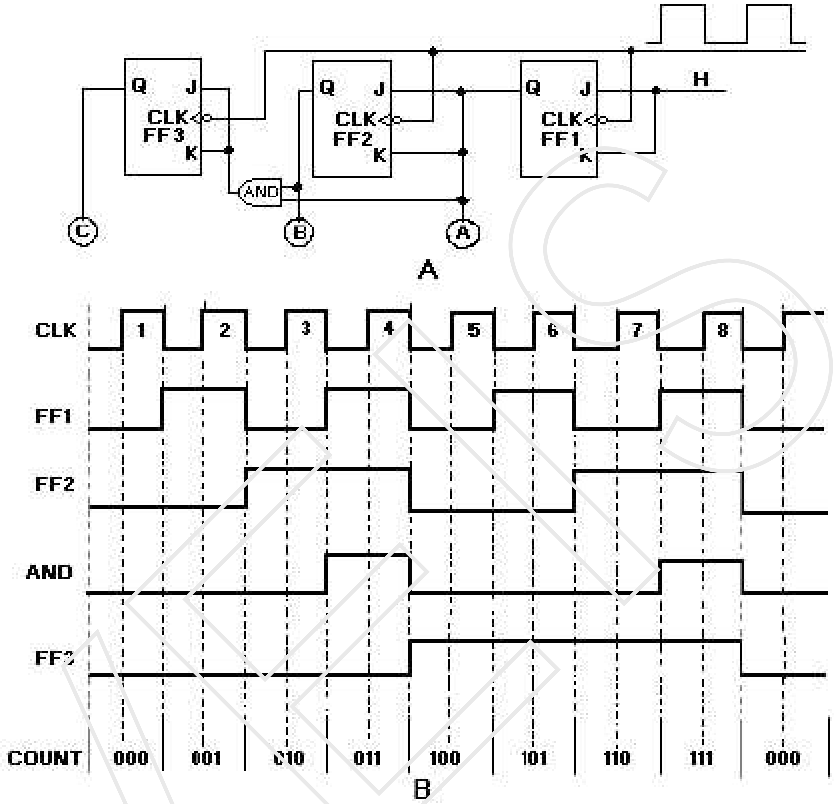


Four-stage ripple counter: A. Logic diagram; B. Timing diagram.

Assume that A, B, C, and D are lamps and that all the FFs are reset. The lamps will all be out, and the count indicated will be 0000_2. The negative-going pulse of clock pulse 1 causes FF1 to set. This lights lamp A, and we have a count of 0001_2. The negative-going pulse of clock pulse 2 toggles FF1, causing it to reset. This negative-going input to FF2 causes it to set and causes B to light. The count after two clock pulses is 0010_2, or 2_{10}. Clock pulse 3 causes FF1 to set and lights lamp A. The setting of FF1 does not affect FF2, and lamp B stays lit. After three clock pulses, the indicated count is 0011_2. Clock pulse 4 causes FF1 to reset, which causes FF2 to reset, which causes FF3 to set, giving us a count of 0100_2. This step shows the ripple effect. This setting and resetting of the FFs will continue until all the FFs are set and all the lamps are lit. At that time the count will be 1111_2 or 15_{10}. Clock pulse 16 will cause FF1 to reset and lamp A to go out. This will cause FF2 through FF4 to reset, in order, and will extinguish lamps B, C, and D. The counter would then start at 0001_2 on clock pulse 17. To display a count of 16_{10} or 10000_2, we would need to add another FF. The ripple counter is also called an ASYNCHRONOUS counter. Asynchronous means that the events (setting and resetting of FFs) occur one after the other rather than all at once. Because the ripple count is asynchronous, it can produce erroneous indications when the clock speed is high. A high-speed clock can cause the lower stage FFs to change state before the upper stages have reacted to the previous clock pulse. The errors are produced by the FFs' inability to keep up with the clock.

Synchronous Counter*

High-frequency operations require that all the FFs of a counter be triggered at the same time to prevent errors. We use a SYNCHRONOUS counter for this type of operation. The synchronous counter is similar to a ripple counter with two exceptions: The clock pulses are applied to each FF, and additional gates are added to ensure that the FFs toggle in the proper sequence. A logic diagram of a three-state (modulo-8) synchronous counter is shown in figure 3-24, view A. The clock input is wired to each of the FFs to prevent possible errors in the count. A HIGH is wired to the J and K inputs of FF1 to make the FF toggle. The output of FF1 is wired to the J and K inputs of FF2, one input of the AND gate, and indicator A. The output of FF2 is wired to the other input of the AND gate and indicator B. The AND output is connected to the J and K inputs of FF3. The C indicator is the only output of FF3.



Three-stage synchronous counter: A. Logic diagram; B. Timing Diagram.

During the explanation of this circuit, you should follow the logic diagram, view A, and the pulse sequences, view B. Assume the following initial conditions: The outputs of all FFs, the clock, and the AND gate are 0; the J and K inputs to FF1 are HIGH. The negative-going portion of the clock pulse will be used throughout the explanation. Clock pulse 1 causes FF1 to set. This HIGH lights lamp A, indicating a binary count of 001. The HIGH is also applied to the J and K inputs of FF2 and one input of the AND gate. Notice that FF2 and

topic not in syllabus

SHIFT REGISTER

REGISTERS A register is a temporary storage device. Registers are used to store data, memory addresses, and operation codes. The number of stages they contain or normally refer to registers by the number of bits they will store. Registers are also used in the transfer of data to and from input and output devices such as teletypes, printers, and cathode-ray tubes. Most registers are constructed of FFs and associated circuitry. They permit us to load or store data and to transfer the data at the proper time.

Shift registers are a type of sequential logic circuit, mainly for storage of digital data. They are a group of flip-flops connected in a chain so that the output from one flip-flop becomes the input of the next flip-flop. Most of the registers possess no characteristic internal sequence of states. A common clock drives all the flip-flops, and all are set or reset simultaneously.

In this chapter, the basic types of shift registers are studied, such as Serial In - Serial Out, Serial In - Parallel Out, Parallel In - Serial Out, Parallel In - Parallel Out, and bi-directional shift registers.

PARALLEL REGISTERS Parallel registers are designed to receive or transfer all bits of data or information simultaneously. A 4-bit parallel register is shown in figure 3-28. The data inputs are A, B, C, and D. The FFs store the data until it is needed. AND gates 5, 6, 7, and 8 are the transfer gates.

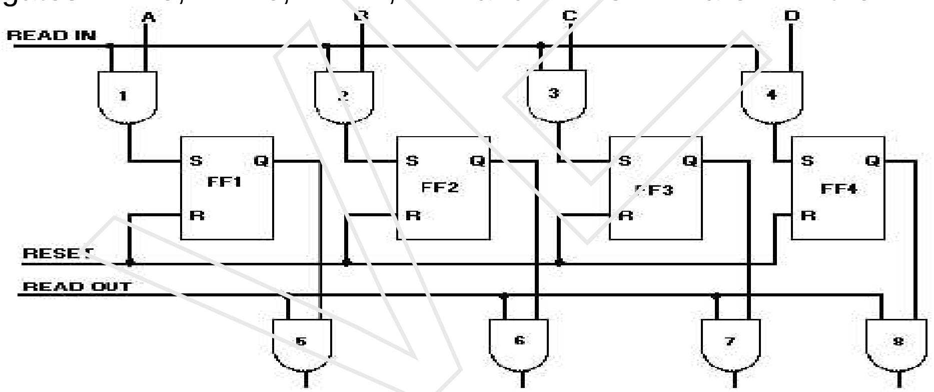


Figure 3-28. —Four-bit parallel register.

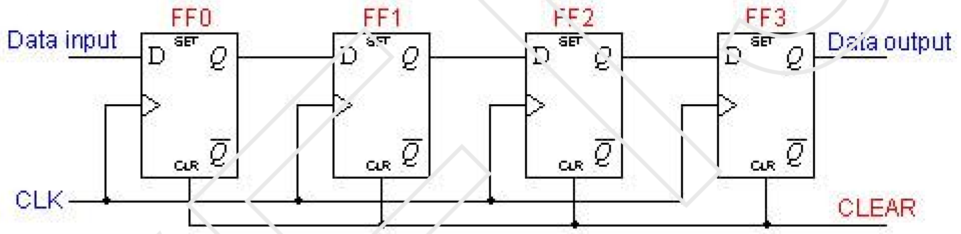
The term *register* can be used in a variety of specific applications, but in all cases it refers to a group of flip-flops operating as a coherent unit to hold data. This is different from a counter, which is a group of flip-flops operating to generate new data by tabulating it.

In this context, a counter can be viewed as a specialized kind of register, which counts events and thereby generates data, rather than just holding the data or changing the way it is handled. More commonly, however, counters are treated separately from registers. The two are then handled as separate concepts which work together in many applications, and which have some features in common.

The demonstration circuit below is known as a *shift register* because data is shifted through it, from flip-flop to flip-flop. If you apply one *byte* (8 bits) of data to the initial data input one bit at a time, and apply one clock pulse to the circuit after setting each bit of data, you will find the entire byte present at the flip-flop outputs in parallel format.

Serial In - Serial Out

A basic four-bit shift register can be constructed using four D flip-flops, as shown below. The operation of the circuit is as follows. The register is first cleared, forcing all four outputs to zero. The input data is then applied sequentially to the D input of the first flip-flop on the left (FF0). During each clock pulse, one bit is transmitted from left to right. Assume a data word to be 1001. The least significant bit of the data has to be shifted through the register from FF0 to FF3.



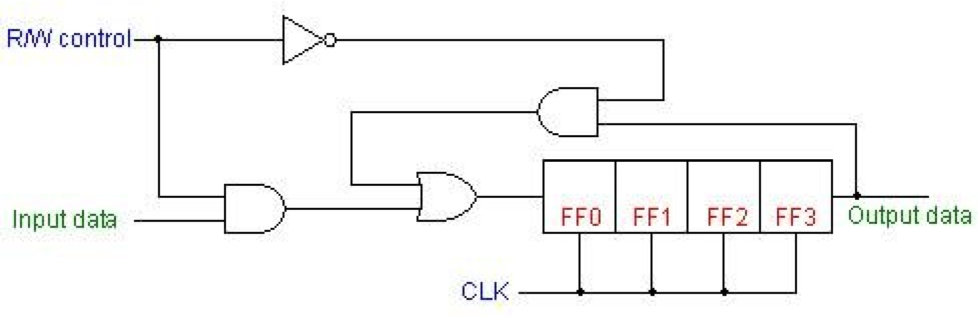
CLEAR

FF0	FF1	FF2	FF3
0	0	0	0

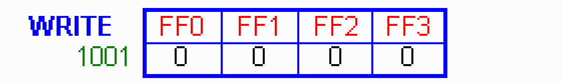
In order to get the data out of the register, they must be shifted out serially. This can be done destructively or non-destructively. For destructive readout, the original data is lost and at the end of the read cycle, all flip-flops are reset to zero.

	FF0	FF1	FF2	FF3	
0000	1	0	0	1	0000

To avoid the loss of data, an arrangement for a non-destructive reading can be done by adding two AND gates, an OR gate and an inverter to the system. The construction of this circuit is shown below.

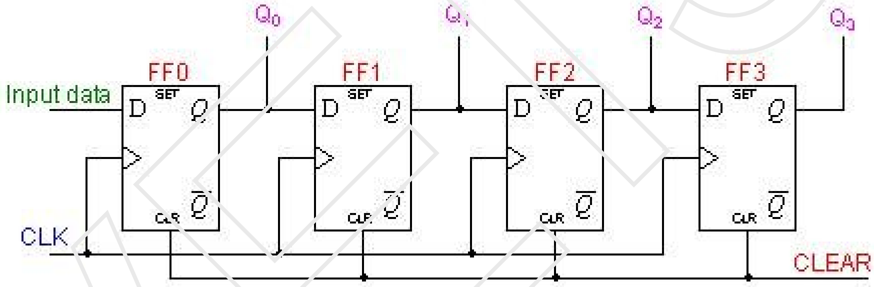


The data is loaded to the register when the control line is HIGH (ie WRITE). The data can be shifted out of the register when the control line is LOW (ie READ). This is shown in the animation below.

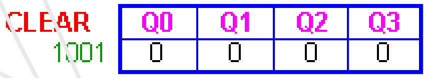


Serial In - Parallel Out

For this kind of register, data bits are entered serially in the same manner as discussed in the last section. The difference is the way in which the data bits are taken out of the register. Once the data are stored, each bit appears on its respective output line, and all bits are available simultaneously. A construction of a four-bit serial in - parallel out register is shown below.

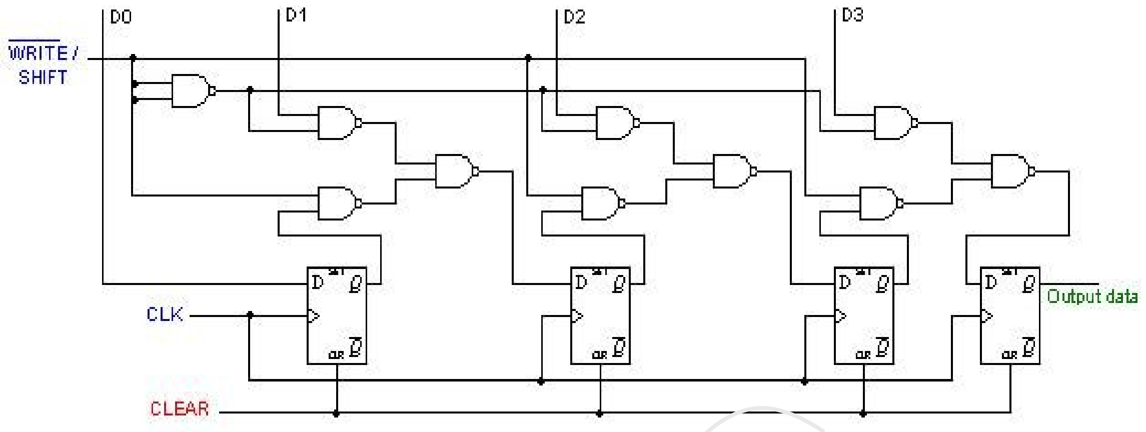


In the animation below, we can see how the four-bit binary number 1001 is shifted to the Q outputs of the register.



Parallel In - Serial Out

A four-bit parallel in - serial out shift register is shown below. The circuit uses D flip-flops and NAND gates for entering data (ie writing) to the register.



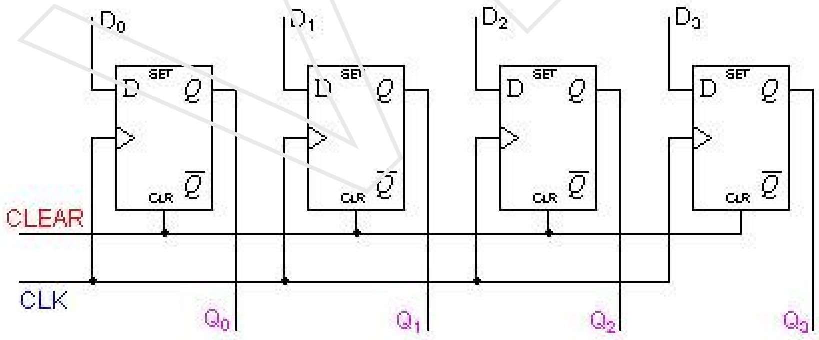
D0, D1, D2 and D3 are the parallel inputs, where D0 is the most significant bit and D3 is the least significant bit. To write data in, the mode control line is taken to LOW and the data is clocked in. The data can be shifted when the mode control line is HIGH as SHIFT is active high. The register performs right shift operation on the application of a clock pulse, as shown in the animation below.

CLEAR

Q0	Q1	Q2	Q3
0	0	0	0

Parallel In - Parallel Out

For parallel in - parallel out shift registers, all data bits appear on the parallel outputs immediately following the simultaneous entry of the data bits. The following circuit is a four-bit parallel in - parallel out shift register constructed by D flip-flops.



The D's are the parallel inputs and the Q's are the parallel outputs. Once the register is clocked, all the data at the D inputs appear at the corresponding Q outputs simultaneously.

BI-Directional Shift Resister

Registers in which data is entered or taken out in series form are referred to as BI-Directional Shift Resister, since bits are shifted in the flip-flop with accurence of clock pulses either in the right direction or in left direction

IC – 74295 A is a bi-directional shift register.

Universal Shift Resister

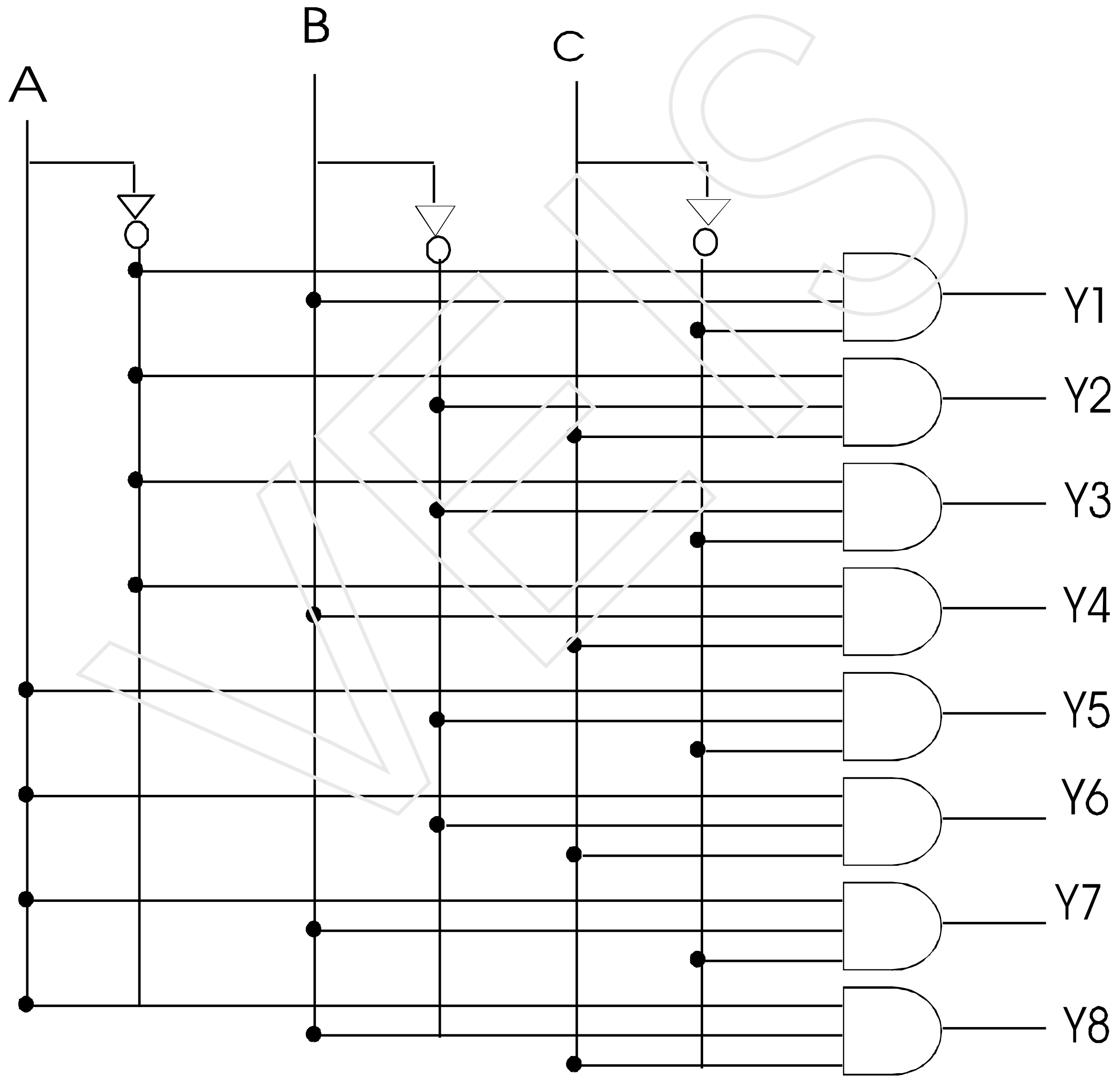
A register is said to be universal shift register, if it can be operated in all the four possible modes and also as a bi-directional shift register.

IC-74194 is a universal register.

DECODER

to – 16 Decoder :

A decoder is simpler to a demultiplexer, with one exception – there is no data input. The only inputs are the control bit ABCD.
The subscript of the high out put always equals the decimal equivalent of ABCD. For this reason the circuit is sometimes called a binary – to decimal decoder. Because it has 41 / Ps lines and 16 O/P Lines the circuit is known as a 4 line – 6 to – 14 line decoder.



*Low the first is active : Second is inactive.
* High the first is inactive : second is active

BCD – to – decoders :

BCD is an abbreviation for binary – coded decimal. The BCD code expresses each dight in a decimal number by its nibble equivalent for instance, decimal number 429 is changed to its BCD from as follows :

4	2	9
100	0011	1001

To anyone using the BCD code 01000011 1001 is equivalent to 429

The subscript of the high output always equals the decimal equivalent of the I/P BCD digit, for this reqson, the circuit ip also called a BCD – to -- decimalconverter.\

7445 –

1 – 7	**O/Ps,**	**12,13,14,15**	**8**	**16**
9 – 11		**A B C D**	**GND**	**VCC**

Encoder and Parity generator :

Encoders :

It is a logic device which converts active I/P signal to coded out put signal. It is also called decimal to BCD encoder.

<u>Exclusive or gate :</u>

It has a high O/P only when an odd number of I/Ps is high. In other words ,the O/P is a one only when the I/ps are different.

Parity Generator Checkers :

Parity :

Combination of bits used to check the error in data tranmission Types :

a. Odd Parity
b. Even Parity

Parity Checkers :

It is a device use to check the parityh of a bits. Exclusive or gate is used for parity checking because they produce an O/P I when the I/P has an odd numbers of 1's

Parity Generator :

It is a device used to generator a parity Types :

a. Odd Parity Generator
b. Even Parity Generator

Odd parity generator :

It's function is to generate odd parity only even through the I/P is oaa or even.

Case – I

If we give odd parity-
Ex-01110101, so ex-or produces an O/P 1, but the invertor produces a 0, so that the final the result is 9 bit O/P – 001110101

Case – II

If we gives even parity –
Ex-0100,0001,so Ex-or gate produce an O/P 0, the invertor
Produces a 1, so that the final 9 bit O/P is 10100, 0001
Note – It is also odd numbers.

Even parity generator :

It's function is to generator even parity

Case – I

If we give odd parity.
Ex-01110101, so ex-Or gate produce on O/P I, So that the final 9 bit O/P is 101110101.

Note – it is even number

Case II

If we give even parity –
Ex-0100,0001, so x-Or gate produce an O/P 0, final O/P – 00100,0001.

Application :

Because of the transients noise and other disturbances. 1-bit error sometimes occure when binary data is transmitted over telephone lines or other communication parth. One way to check for errors is to use an odd parity generator at the tranmitting end and an odd parity checker at the receiving end . If no 1-bit errors occurs in transmission , the received data will have odd parity . but if one of the transmitted bits is changed by noise or any other disturbance, the received data will have even parity.