ELECTRONICS WORKSHOP

LABORATORY MANUAL

I / IV B.Tech (ECE) : II – SEMESTER

JNTUK – R20

Name of the Student :

Regd. No & Section :

Academic Year :

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

SIR C. R. REDDY COLLEGE OF ENGINEERING, ELURU – 534 007

LIST OF EXPERIMENTS

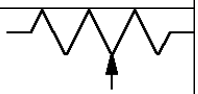
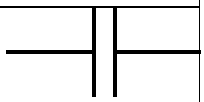
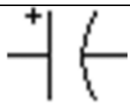
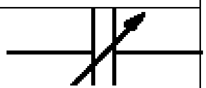
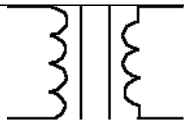
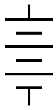
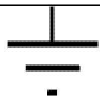
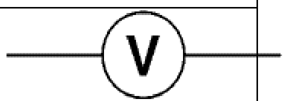
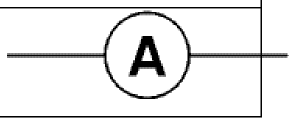
1. Symbols of Various Electronic Devices
2. Identify resistors, capacitors using Different codes
3. Types of Rheostat, Potentiometers, Relays, Switches and Cables
4. IDENTIFICATION AND TESTING OF TWO TERMINAL DEVICES AND IC'S
5. IDENTIFICATION, SPECIFICATIONS AND TESTING OF ACTIVE DEVICES
6. Different Types of Meters
7. STUDY AND OPERATION FUNCTION GENERATOR, REGULATED POWER SUPPLIES
8. Soldering and de-soldering
9. SINGLE LAYER AND MULTI LAYER PCBs
10. Testing of various components
11. STUDY of CRO
12. Operations of CRO

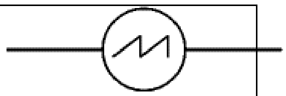
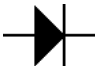
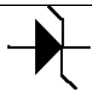
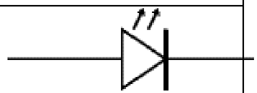
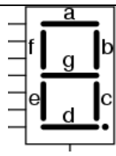
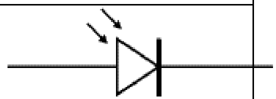
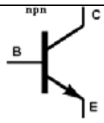
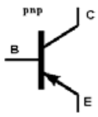
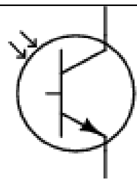
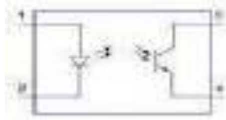
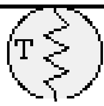
1. Symbols of Various Electronic Devices

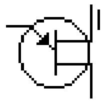
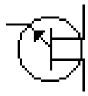
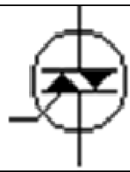
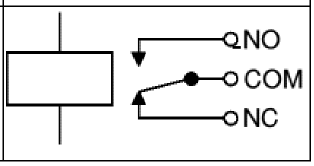
Exp. No: **Date:**

AIM: **To understand & Draw the symbols of various electronic devices.**

CIRCUIT DIAGRAM:

S. N	Device Name	Symbol
1.	Resistor	
2.	Variable resistor	
3.	Capacitor	
4.	Electrolyte (polarized) Capacitor	
5.	Variable capacitor	
6.	Inductor	
7.	Transformer	
8.	DC power supply	
9.	Ground	
10.	AC supply	
11.	voltmeter	
12.	Current meter	

13.	CRO	
14.	ohm meter	
15.	PN junction diode	
16.	Zener diode	
17.	Tunnel diode	
18.	Light Emitting diode(LED)	
19.	Seven segment display	
20.	Photo diode	
21.	npn transistor	
22.	pnp transistor	
23.	Photo transistor	
24.	Optocoupler	
25.	Thermistor	
26.	LDR(Light Dependent Resistor)	

27.	UJT(Uni Junction Transistor) n-type	
28.	UJT(Uni Junction Transistor) p-type	
29.	SCR(Silicon Controlled Rectifier)	
30.	DIAC	
31.	TRIAC	
32.	n-channel JFET	
33.	p-channel JFET	
34.	n-channel depletion MOSFET	
35.	p-channel depletion MOSFET	
36.	n-channel enhance MOSFET	
37.	p-channel enhance MOSFET	
38.	Relay	

39.	DC Supply	
40.	AC Supply	

CONCLUSION:

2. Identify resistors, capacitors using Different codes

AIM: **Identify resistors, capacitors using Different codes**.

APPARATUS:

Resistors

Capacitors

Inductors

THEORY:

1. **RESISTORS:**

The resistor's function is to reduce the flow of electric current. This symbol is used to indicate a resistor in a circuit diagram. Resistance value is designated in units called the "Ohm".

There are two classes of resistors; **fixed resistors** and the **variable resistors**. They are also classified according to the material from which they are made. The typical resistor is made of either carbon film or metal film. There are other types as well, but these are the most common.

Symbol of fixed resistor   Variable resistor

a. Fixed Resistors:

A fixed resistor is one in which the value of its resistance cannot change. They are given below:

Carbon composition resistors:

This is the most general purpose, cheap resistor. These are made of finely divided carbon mixed with a powdered insulating material as a binder. The elements is enclosed in a plastic case for insulation and for providing mechanical strength. The two ends are connected to metal caps with copper wires for connecting in the circuits. Power ratings of 1/10W,1/8W, 1/4W , 1/2W , 1W and 2W are frequently used.

Wire –Wound Resistors:

These are made of special type of wire. The wire is known as resistance wire. The wire is wrapped around an insulting core. The resistance of the wire depends on the wire resistivity and length .the wire is usually made with tungsten and manganin. The insulating core is made with porcelain, Bakelite or paper.

These resistors are used for high current applications. Their power ranges between 5w to 100W.

Film Resistors:

These are of two types. Carbon film and metal film resistors. The carbon film has a thin coating around an insulator and metal film resistors have a spiral around a ceramic substrate.

Flim resistors are more precise and they have metal end caps as the terminal leads.

B	B	R	O	Y	G	B	V	G	W	Tolerance		
black	brown	red	orange	Yellow	green	blue	violet	gray	White	Gold	silver	None
0	1	2	3	4	5	6	7	8	9	±5%	±10%	±20%

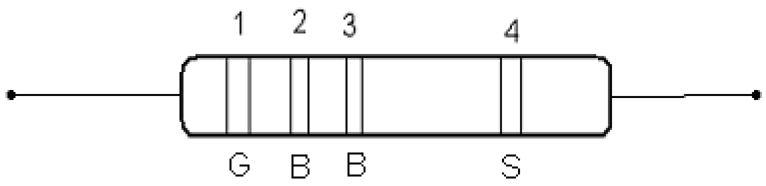
These are more stable and their tolerance ranges between plus or minus 0.5 to 5%.

Resistor color code:

The resistance value and tolerance of carbon resistor is usually indicated by color coding. Color bands are printed on insulating body. They consist of four color bands or 5 color bands & they are read from left to right.

The numerical value associated with each color

EXAMPLE:The resistor has a color band sequence green, blue, brown and silver identify the resistance value.



1ST Band	2nd band	3rd band	4th band
1st digit	2nd digit	multiplier	tolerance
5	6	10^1	±10%

The resistance value=56x10^1±10%

=560Ω±10%

Therefore the resistance should be with in the range of 555Ω to 565Ω

b. Variable Resistors:

Variable resistors provide varying degrees of resistance that can be set with the turn of a knob. Special kinds of variable resistors include Decade Resistance box(DRB), potentiometers, rheostats and trimmers.

Potentiometers and rheostats are essentially the same, but rheostats are used specially for high power AC electricity, whereas potentiometers are used specially for high power DC electricity. Both Potentiometers and rheostats are designed for frequent adjustment.

Trimmers, on the otherhand, are miniature potentiometers that are adjusted infrequently and usually come with pins that can be inserted into PCB.

DRB Provides wide range of variation of R. It is apart of test equipment for setting different R values. A few series of strings of strings of resistors exist in a box. The resistance can be varied in steps.

c. Ohm's Law:

At constant temperature voltage across a resistor is proportional to the current through it. Where the constant of proportionality is resistance.Vα I.

V=IR .

P = I * I * R that is, power equals the current squared times the resistance.

2. Inductors

Inductors are a type of passive electrical devices that are used to store energy from magnetic fields and release it when needed. Together with chokes and capacitors, inductors have helped to reduce the size of electrical devices by providing a compact way to store power. Inductance measures the quantity of magnetic flux that is produced by the current flowing through a coil. It **is measured in units of Henries denoted by 'H'**. Its value increases with the amount of current flowing and the number of loops in the coil.

a.Energy Storage in Fields:

An inductor stores energy in the magnetic field produced by the current flowing through it. When the magnetic field collapses, its energy is given up, sometimes appearing as a spark when a circuit is broken. An inductor tries to keep a current flowing, providing the voltage necessary. The relation between voltage and current in an inductor **is V = L (dI/dt),** If V is in volts, I in amperes and t in seconds, L is in henries, H. Magnetic fields in air (space) created by ordinary currents are very small, so it is difficult to store much energy this way, and inductors are not common circuit elements, at least at low frequencies.

b.Magnetic Fields:

The inductor has as a coil of copper conductors wound around a central core. When current is passed through the coil a magnetic flux is created around the coil due to the properties of electromotive force. The resistance increases when a core is placed in the coil and this increases the inductance by hundreds of times. The core can be made of different materials but cores made of ferrite produce the maximum inductance. The current to voltage lag is 90° but with the use of resistive substance a resistive and inductive circuit is formed, the phase angle lag becomes smaller and is based on the frequency that is constant. Inductance is the circuit's resistance to change in current. Inductance tolerance is the amount of variation that is permitted within the nominal value. The frequency for which the distributed capacitance starts resonating with the inductance and canceling the capacitance is called the self-resonant frequency or SRF. At SRF, the inductor works as a high impedance, resistive element. Quality factor (Q value) is the measure of relative losses of the inductor and is expressed as capacitive resistance divided by the equivalent serial resistance.

c. Some applications of inductors include:

- Blocking out noise, unwanted frequencies and reducing hum in radio broadcasting stations and equipment - When used in conjunction with capacitors

- DC filtering- When used as chokes in power supplies to remove hum and other types of fluctuations from the DC output
- Removing radio frequency (RF) interference - When used as filters
- Small and compact transformers with 400-Hz cycle AC current frequency for aircraft - When utilizing their coupled magnetic flux.

Types of inductors

Air core inductor:

The term air core coil describes an inductor that does not use a magnetic core made of a ferromagnetic material. The term refers to coils wound on plastic, ceramic, or other nonmagnetic forms, as well as those that actually have air inside the windings. Air core coils have lower inductance than ferromagnetic core coils, but are often used at high frequencies because they are free from energy losses called core losses that occur in ferromagnetic cores, which increase with frequency. A side effect that can occur in air core coils in which the winding is not rigidly supported on a form is 'microphony': mechanical vibration of the windings can cause variations in the inductance.

Radio frequency inductor:

At high frequencies, particularly radio frequencies (RF), inductors have higher resistance and other losses. In addition to causing power loss, in resonant circuits this can reduce the Q factor of the circuit, broadening the bandwidth. In RF inductors, which are mostly air core types, specialized construction techniques are used to minimize these losses.

Ferromagnetic core inductor:

Ferromagnetic-core or iron-core inductors use a magnetic core made of a ferromagnetic or ferrimagnetic material such as iron or ferrite to increase the inductance. A magnetic core can increase the inductance of a coil by a factor of several thousand, by increasing the magnetic field due to its higher magnetic permeability. However the magnetic properties of the core material cause several side effects which alter the behavior of the inductor and require special construction:

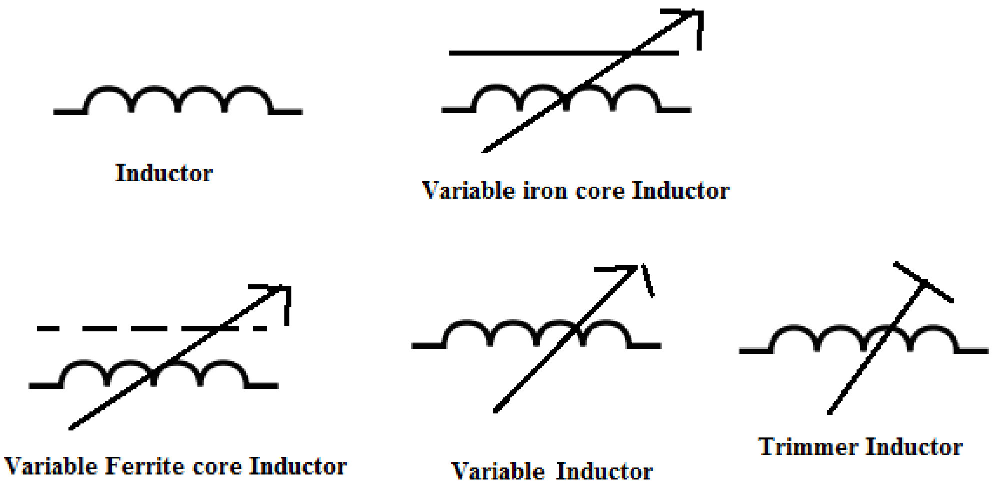
Variable inductor:

A variable inductor can be constructed by making one of the terminals of the device a sliding spring contact that can move along the surface of the coil, increasing or decreasing the number of turns of the coil included in the circuit. An alternative construction method is to use a moveable magnetic core, which can be slid in or out of the coil. Moving the core farther into the coil increases the permeability, increasing the inductance. Many inductors used in radio applications (usually less than 100 MHz) use adjustable cores in order to tune such inductors to their desired value, since manufacturing processes have certain tolerances (inaccuracy).

Ferrite-core inductor:

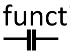
For higher frequencies, inductors are made with cores of ferrite. Ferrite is ceramic ferromagnetic material that is nonconductive, so eddy currents cannot flow within it. The formulation of ferrite is $xxFe_2O_4$ where xx represents various metals. For inductor cores soft ferrites are used, which have low coercivity and thus low hysteresis losses. Another similar material is powdered iron cemented with a binder.

Inductor Symbols



3. Capacitors:

The capacitor's function is to store electricity, or electrical energy. The capacitor also functions as a filter, passing alternating current (AC), and blocking direct current (DC).



This symbolis used to indicate a capacitor in a circuit diagram. The capacitor is constructed with two electrode plates facing each other, but separated by an insulator. When DC voltage is applied to the capacitor, *an electric charge* is stored on each electrode. While the capacitor is charging up, current flows. The current will stop flowing when the capacitor has fully charged. The capacitor has an insulator (the dielectric) between 2 sheets of electrodes. Different kinds of capacitors use different materials for the dielectric. According to dielectric material, the capacitor types are

Air Capacitor:

These are constructed with meshed plates.they have capacitance range of 10-40PF.

Paper capacitors:

These are constructed with two rolls of tinfol conductor separated by a tissue paper insulator.they have capacitance range of 0.001-1μF.

Mica Capacitors:

These are made of stcaked sheets and offer capacitance in the range of 10-5nF.

Ceramic capacitors:

Ceramic capacitors are constructed with materials such as titanium acid barium used as the dielectric. Internally, these capacitors are not constructed as a coil, so they can be used in high frequency applications. These capacitors have the shape of a disk. Their capacitance is comparatively small. Ceramic **capacitors have no polarity**. Ceramic capacitors should not be used for analog circuits, because they can distort the signal.

Electrolytic Capacitors (Electrochemical type capacitors):

Aluminum is used for the electrodes by using a thin oxidization membrane. Large values of capacitance (1-1000 μF) can be obtained in comparison with the size of the capacitor, because the dielectric used is very thin. **The most important characteristic of electrolytic capacitors is that they have polarity**. They have a positive and a negative electrode [Polarized]. This means that it is very important which way round they are connected. If the capacitor is subjected to voltage exceeding its working voltage, or if it is connected with incorrect polarity, it may burst. The positive side is indicated by a "+" (plus) symbol. It isn't possible to use for high frequency circuits. The size of the capacitor sometimes depends on the manufacturer.

Tantalum Capacitors:

Tantalum Capacitors are electrolytic capacitors that use a material called tantalum for the electrodes. Large values of capacitance similar to aluminum electrolytic capacitors can be obtained. Also, tantalum capacitors are superior to aluminum electrolytic capacitors in temperature and frequency characteristics. When tantalum powder is baked in order to solidify it, A crack forms inside. An electric charge can be stored on this crack. These capacitors have polarity as well. Capacitance can change with temperature as well as frequency, and these types are very stable

a. CAPACITOR CODINGS:

The value of a capacitor (the capacitance), is designated in units called the Farad (F). The capacitance of a capacitor is generally very small, so units such as the microfarad (10^{-6}F), nanofarad (10^{-9}F), and picofarad (10^{-12}F) are used. The method used differs depending on the capacitor supplier. Also for different types of capacitors the coding is different. For example, on electrolytic capacitors the value is directly printed on the capacitor. For ceramic capacitor there are four types ofcodings.

(i) Using numbers, (ii) Using letters and numbers both, (iii) directly printed for µF.

1. Coding usingnumbers:

A three-digit code is used to indicate the value of a capacitor. In the case that the value is displayed with the three-digit code, the 1st and 2nd digits from the left show the 1st figure and the 2nd figure, and the 3rd digit is a multiplier which determines how many zeros are to be added to the capacitance. Picofarad (pF) units are written this way.

For example,

- [103] indicates 10 x 10^3, or 10,000pF = 10 nanofarad (nF) =0.01microfarad (µF).
- [224] indicates 22 x 10^4 or 220,000pF=220nF=0.22µF.

2. Coding using letters and numbersboth:

When letter K comes in between two digits, it acts as a decimal point. Picofarad (pF) units are also written this way.

For example,

- [3K3] indicates 3.3k=3300 pF=3.3nF.
- [1k] indicates 1k=1000pF=1nF,

3. Directly printed for microfarad:

If decimal dot is given in the code, directly consider the value in microfarad. For example,
[0.1] indicates 0.1 µF,

[0.22] indicates 0.22µF

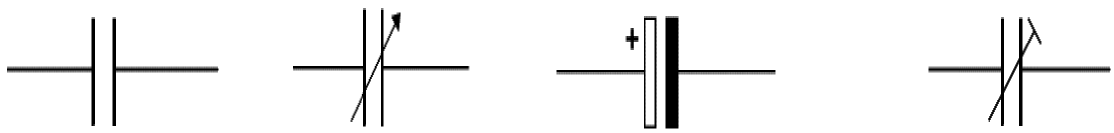
Three prefixes (multipliers) are used, µ (micro), n (nano) and p (pico).

Property: Property of a capacitor is Capacitance .It is denoted by 'C' Capacitance is the property of the circuit which opposes change in voltage and in which energy may be stored in the form of an electric field . The capacitance is defined as the ratio of the electric charge 'Q ' stored in the capacitor by virtue of the applied voltage 'V'.

C= Q/V where C – Capacitance in Farads

Q- Charge in Coulombs

V – Electromotive force (emf)



Fixed Capacitor Variable Capacitor Polarized capacitors Trimmer Capacitor

PROCEDURE:

1. Different components can be identified by using their different colour codes and symbols.

CONCLUSION:

Components should be identified by using their symbols.

3. Types of Rheostat, Potentiometers, Relays, Switches and Cables

AIM: To Study about the different types of Rheostat, Potentiometers, Relays, Switches and Cables

APPARATUS: Rheostat,

Potentiometers,

Relays,

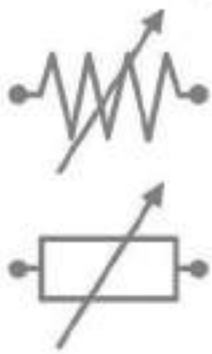
Switches

Cables

THEORY:

I. RHEOSTAT:

This is the simplest way of using a variable resistor. Two terminals are used: one connected to an end of the track, the other to the moveable wiper. Turning the spindle changes the resistance between the two terminals from zero up to the maximum resistance. Rheostats are often used to vary current, for example to control the brightness of a lamp or the rate at which a capacitor charges.



Rheostat Symbol

A.Types of Rheostats:

1. Linear Rheostat:

These rheostats have a linear resistive path. The sliding terminal glides over this path. There are two fixed terminals however only one of the two is used. The other terminal is connected to the slider. These are mostly used in laboratory applications. Mostly wire-wound resistive path along a linear cylinder shaped material, is used.

Linear Rheostat

2. Rotary Rheostat:

With full justice to its name, a rotary rheostat has a rotary resistive path. These are mostly used in power applications. These rheostats have a shaft on which the wiper is mounted. Wiper is nothing but the sliding contact for a rotary rheostat, which can rotate over ¾ of a circle.The function and working principle are all same for both types of rheostats.

Rotary Rheostat

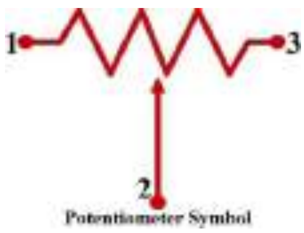
3. Preset Rheostat:

When rheostats are used in a printed circuit board, they are used as trimmers or preset rheostats. Trimmers are nothing but a small rheostat, mostly used in calibration circuits. Two terminal trimmers are available, although in most cases three terminal potentiometer trimmer is used as a two terminal rheostat.

Preset

II. POTENTIOMETER:

A potentiometer is also commonly known as pot. Variable resistors used as potentiometers have all three terminals connected. This arrangement is normally used to vary voltage, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit. If the terminals at the ends of the track are connected across the power supply then the wiper terminal will provide a voltage, which can be varied from zero up to the maximum of the supply.



Potentiometer Symbol

A.Types of Potentiometers:

Both rotary and linear controls have the same basic operation. The most common form of the potentiometer is the single turn rotary potentiometer. This type of potentiometer is often used in audio volume control (logarithmic taper) as well as many other applications. Different materials are used to construct potentiometers, including carbon composition, cermet, conductive plastic, and metal film.

1. Rotary Potentiometers

These are the most common type of potentiometers, where the wiper moves along a circular path. These potentiometers are mainly used to get a changeable voltage supply to a fraction of circuits. The best example of this rotary potentiometer is a radio transistor's volume controller where the rotating knob controls the current supply toward the amplifier.

This kind of potentiometer includes two terminal contacts where a consistent resistance can be located in a semi-circular model. And also it includes a terminal in the middle that is allied to the resistance using a sliding contact that is connected through a rotating knob. The sliding contact can be turned by turning the knob over the half-circular resistance. The voltage of this can be obtained among the two contacts of resistance & the sliding. These potentiometers are used wherever level voltage control is necessary.

2. Linear Potentiometers

In these types of Potentiometers, the wiper moves along a linear path. Also known as slide pot, slider, or fader. This potentiometer is similar to the rotary-type but in this potentiometer, the sliding contact simply rotated on the resistor linearly. The connection of the resistor's two terminals is connected across the voltage source. A sliding contact on the resistor can be moved using a path that is connected through the resistor.

The terminal of the resistor is connected toward the sliding which is connected to one finish of the circuit's output & another terminal is connected to the other finish of the circuit's output. This kind of potentiometer is mostly used to calculate the voltage in a circuit. It is used to measure the battery cell's internal resistance and also used in the mixing systems of sound & music equalizer.

3. Mechanical Potentiometer

There are different kinds of potentiometers available in the market, in that mechanical types are used for controlling manually to change the resistance as well as the output of the device. However, a digital potentiometer is used to change its resistance automatically based on the given state. This type of potentiometer works accurately like a potentiometer and its resistance can be changed through digital communication such as SPI, I2C rather than turning the knob directly.

These potentiometers are called POT due to its POT shaped structure. It includes three terminals like i/p, o/p, and GND along with a knob on its pinnacle. This knob works like control to control the resistance by rotating it in the two directions like clockwise otherwise anticlockwise.

The main drawback of potentiometers is that they are simply influenced by different environmental factors such as dirt, dust, moisture, etc. To overcome these disadvantages, digital Potentiometers (digiPOT) were implemented. These potentiometers can work in environments like dust, dirt, moisture without altering its operation.

4. Digital Potentiometer

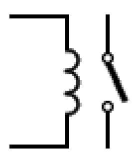
Digital potentiometers are also called as digiPOTs or variable resistors which is used to control analog signals using microcontrollers. These types of potentiometers give an o/p resistance that is changeable depending on digital inputs. Sometimes, these are also called RDACs (resistive digital-to-analog converters). The controlling of this digipot can be done by digital signals rather than through mechanical movement.

Each step on the resistor ladder includes one switch which is connected to the o/p terminal of the digital potentiometer. The ratio of the resistance in the potentiometer can be determined through the chosen step over the ladder. Generally, these steps are indicated with a bit value, for instance. 8-bits are equal to 256 steps.

This potentiometer utilizes digital protocols such as I^2C otherwise SPI Bus (Serial Peripheral Interface) for signaling. Most of these potentiometers utilize simply volatile memory so that they did not remember their place once they are powered down and their final place may be stored through the FPGA or microcontroller to which they are connected.

III. RELAY:

A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.



RELAY

A.Relay Types

In addition to the electromechanical and electromagnetic relay, there is a wide variety of relays with different working principles; principles of operation and polarity.

1. **Electrothermal Relay** – When two different material gets in contact, bimetallic strip is formed, and when it is energized, it bends. This bending allows the users to make contact connections

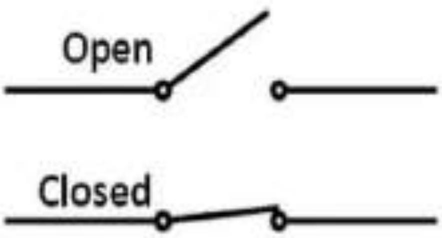
2. **Electromechanical Relay** – When different mechanical parts are connected on the basis of the electromagnet, contact connection is established

3. **Solid State Relay** –This relay uses semiconductor devices to make a connection to ensure the effectiveness, efficiency, and easiness of the switching speed. This is commonly used for two reasons; faster-switching process and durability

4. **Hybrid Relay** – It is the name given to the solid-state and electromechanical relays

IV. SWITCHES:

In electronics, an **electronic switch** is an electronic component or device that can switch an electrical circuit, interrupting the current or diverting it from one conductor to another. Electronic switches are considered binary devices because they can be on or completely off. When an electronic switch is on, it is considered closed in a circuit. When the switch is classified as off the switch is open in the circuit. Typically, electronic switches use solid state devices such as transistors, though vacuum tubes can be used as well in high voltage applications.

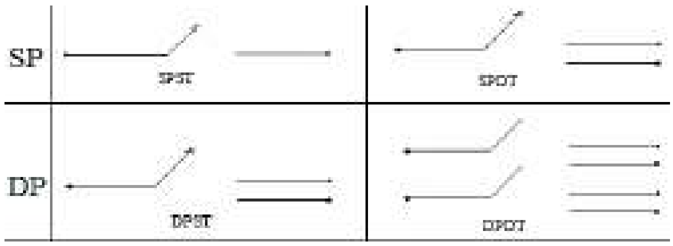


OPEN AND CLOED SWITCH

Switches can be of mechanical or electronic type,

- **Mechanical switches** must be activated physically, by moving, pressing, releasing, or touching its contacts.

1. SPST: Single pole single throw,	2.SPDT: Single pole double throw
3.DPST: Double pole single throw	4.DPDT: Double pole double throw
5.Oushbuton switch	6.Toggle switch
7.Limit switch	8.Float switch
9.Flow switch	10.Pressure switch
11.Temparature switch	12.Joystick switch
13.Rotary switch	



Some Mechanical switches symbols

- **Electronic switches** do not require any physical contact in order to control a circuit.
  These are activated by semiconductor action. Some are
  1.Bipolar
  2.power diode
  3.MosFET
  4.SCR(Silicon Controlled Rectifier)
  5.DIAC(DIode AC switch)
  6.TRIAC(TRIode AC)
  7.IGBT(Insulated Gate Bipolar Transistor)
  8. Gate Turn-Off Thyristor

Electronic switches are used in all kinds of common and industrial applications. Household applications consist of simple hand switches like toggle switches and push-button switches. Turning on lights, opening garage doors, and rolling down a car window all use simple switches. Industrial applications for electronic switches consist of more complex systems like conveyors, furnaces, welders, and water pumps. With complex systems, a variety of switches can be used to complete a task, but due to the advantages or disadvantages of certain switch types, the switch should be chosen based on graded efficiency and reliability metrics.

V. CABLES:

Cable, in electrical and electronic systems, a conductor or group of conductors for transmitting electric power or telecommunication signals from one place to another. Electric communication cables transmit voice messages, computer data, and visual images via electrical signals to telephones, wired radios, computers, teleprinters, facsimile machines, and televisions. There is no clear distinction between an electric wire and an electric cable. Usually the former refers to a single, solid metallic conductor, with or without insulation, while the latter refers to a stranded conductor or to an assembly of insulated conductors. With fibre-optic cables, made of flexible fibres of glass and plastic, electrical signals are converted to light pulses for the transmission of audio, video, and computer data.

CONCULSION: Types of Rheostat, Potentiometers, Relays, Switches and Cables are studied.

4. IDENTIFICATION AND TESTING OF TWO TERMINAL DEVICES AND IC'S

AIM: Identify the measure the Two terminal active devices

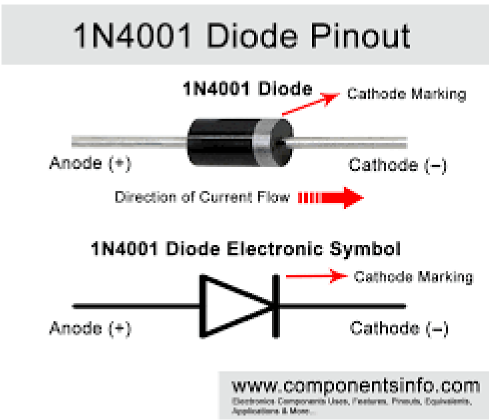
APPARATUS: SC diode,
Zener diode
DIAC
Integrated circuit
Multimeter

THEORY:

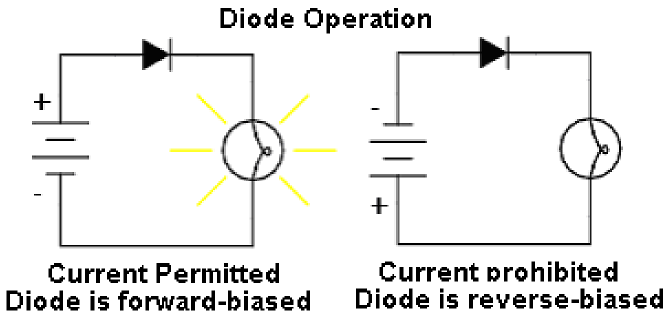
1. TWO TERMINAL DIODE:

A.SEMI CONDUCTOR DIODE

A diode is an electrical device allowing current to move through it in one direction with far greater ease than in the other. The most common type of diode in modern circuit design is the semiconductor diode, although other diode technologies exist. Semiconductor diodes are symbolized in schematic diagrams as such:



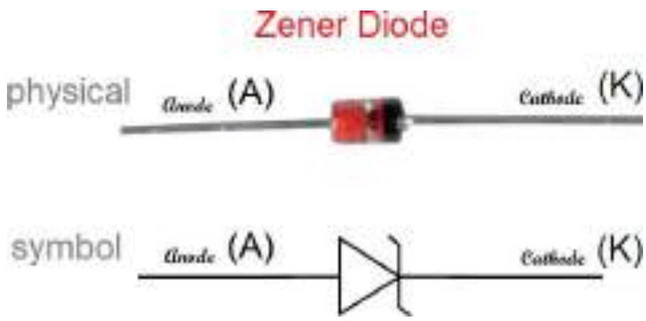
When placed in a simple battery-lamp circuit, the diode will either allow or prevent current through the lamp, depending on the polarity of the applied voltage:



When the polarity of the battery is such that electrons are allowed to flow through the diode, the diode is said to be forward-biased. Conversely, when the battery is "backward" and the diode blocks current, the diode is said to be reverse-biased. A diode may be thought of as a kind of switch: "closed" when forward-biased and "open" when reverse-biased.

B.ZENER DIODE:

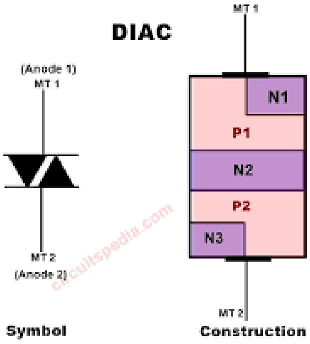
Zener diode is basically like an ordinary PN junction diode but normally operated in reverse biased condition. But ordinary PN junction diode connected in reverse biased condition is not used as Zener diode practically. A Zener diode is a specially designed, highly doped PN junction diode. The name zener diode was named after the American physicist Clarance Melvin Zener who discovered the zener effect. Zener diodes are the basic building blocks of electronic circuits. They are widely used in all kinds of electronic equipments. Zener diodes are mainly used to protect electronic circuits from over voltage.



C.DIAC:

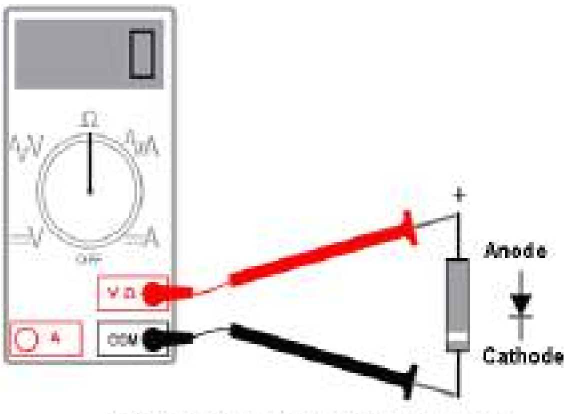
The term DIAC stands for the **DI**ode for **A**lternating **C**urrent (DIAC), it is a **bidirectional semiconductor switch** that can be turned ON in both forward and reverse direction. The device is a member of the Thyristor family and it is mostly used in triggering TRIAC and other Thyristor based circuits. The DIAC starts conducting electric current if the applied voltage goes beyond its break-over voltage.

DIACs are available in **different types of DIAC packages** such as discrete components in small leaded packages, surface-mount packages, large packages that are bolted to chassis and various other packages. Most of the time the DIAC and TRIAC are used together, so they are available in integrated packages also.



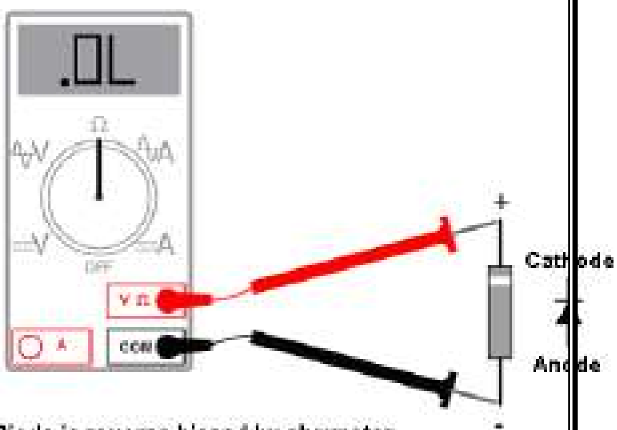
D.Meter check of a diode:

Being able to determine the polarity (cathode versus anode) and basic functionality of a diode is a very important skill for the electronics hobbyist or technician to have. Since we know that a diode is essentially nothing more than a one-way valve for electricity, it makes sense we should be able to verify its one-way nature using a DC (battery-powered) ohmmeter. Connected one way across the diode, the meter should show a very low resistance. Connected the other way across the diode, it should show a very high resistance.



Diode is forward-biased by Ohmmeter
shows 0 ohms of resistance

In



Diode is reverse biased by ohmmeter
Shows infinite resistance

Inorder to determine which end of the diode is the cathode and which is the anode, you must know with certainty which test lead of the meter is positive (+) and which is negative (-) when set to the "resistance" or "Ω" function.

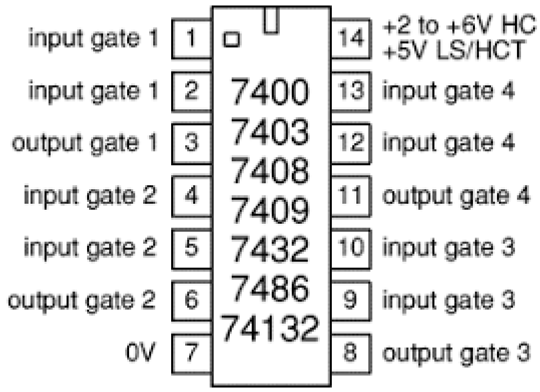
II. Integrated Circuit

An integrated circuit is electronic circuit or device that has electronic components on a small semiconductor chip. It has functionality of logic AND or amplifying of a signal. These are mainly two types of circuits: Digital or Analog. Analog ICs handle continuous signals such as audio signals and Digital ICs handle discrete signals such as binary values.

- **Types of Integrated Circuits**

Analog ICs	Digital ICs
Linear ICs (Linear Integrated Circuits) are called as analog IC.	Digital ICs (Digital Integrated Circuits) are also called as non linear IC.
Linear integrated circuits inputs and outputs can take on a continuous range of values and the outputs are generally proportional to the inputs.	Digitals ICs contain circuits whose inputs and outputs voltage are limited to two possible levels low or high.
It is used in aircraft, space, vehicles, radars, PLL, Oscilloscopes etc.	Its used in microprocessor, computers, clocks, digital watches, calculator etc.
The design requirements are more drastic as compared to digital ICs.	The design requirement as less drastic as compare To linear ICs.
It is commercially available as operational amplifiers, voltage multipliers, voltage comparator, regulators, microwave amplifiers Etc.	Its commercially available as microprocessor chips, memory chips, analog to digital chips , digitals to analog chips, logic gates, flip flops, counters, registers etc.
Its consist of very less number of transistor as compared to digital ICs..	Its consist of more number of transistor as compared to linear ICs.

- **Some IC's numbers and pin diagram of IC**



Logic gates

- If you are interested in digital electronics you 'd like to use logic gates.
- Mentioned in this table 74xx TTL logic family part numbers.

Part number	Description
7400	NAND
7402	NOR
7404	NOT
7408	AND
7432	OR
7486	XOR
7474	D-flip flop
7476	J-K flip flop
7448,7447	7 segment driver
7407	Open collector buffer

CONCLUSION:

5.IDENTIFICATION, SPECIFICATIONS AND TESTING OF ACTIVE DEVICES

AIM: Identify the measure the Three terminal active devices

APPARATUS: BJT,

FET,

MOSFET,

SCR,

UJT,

TRIAC,

MULTIMETER

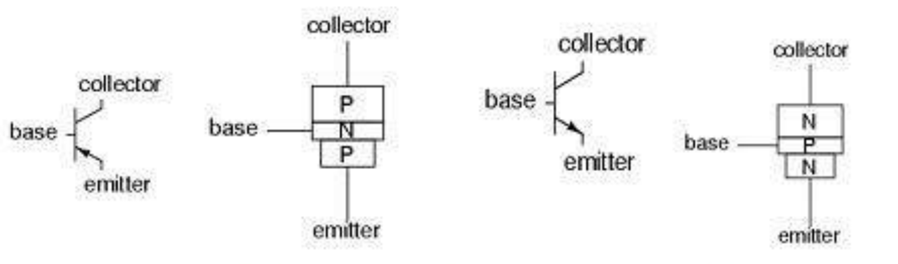
THEORY:

II.THREE TERMINAL DIODE:

A.BIPOLAR JUNCTION TRANSISTORS

Transistors amplify current, for example they can be used to amplify the small output current from a logic chip so that it can operate a lamp, relay or other high current device. In many circuits a resistor is used to convert the changing current to a changing voltage, so the transistor is being used to amplify voltage. A transistor may be used as a switch and as an amplifier. The amount of current amplification is called the current gain, symbol h_{FE}.

There are two types of standard transistors, NPN and PNP, with different circuit symbols. The leads are labeled base (B), collector (C) and emitter (E).A bipolar transistor consists of a three-layer "sandwich" of doped (extrinsic) semiconductor materials, either P-N-P or N-P-N. Each layer forming the transistor has a specific name, and each layer is provided with a wire contact for connection to a circuit. Shown here are schematic symbols and physical diagrams of these two transistor types:

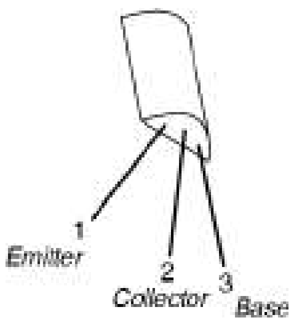


(a) schematic symbol (a) physical diagram (b) schematic symbol (b) physical diagram

(a) PNP Transistor (b) NPN Transistor

The only functional difference between a PNP transistor and an NPN transistor is the proper biasing (polarity) of the junctions when operating. For any given state of operation, the current directions and voltage polarities for each type of transistor are exactly opposite each other. Bipolar transistors work as current-controlled current regulators. In other words, they restrict the amount of current that can go through them according to a smaller, controlling current. The main current that is controlled goes from collector to emitter, or from emitter to collector, depending on the type of transistor it is (PNP or NPN, respectively). Bipolar transistors are called bipolar because the main flow of electrons through them takes place in two types of semiconductor material: P and N, as the main current goes from emitter to collector (or visa-versa). In other words, two types of charge carriers -- electrons and holes -- comprise this main current through the transistor.

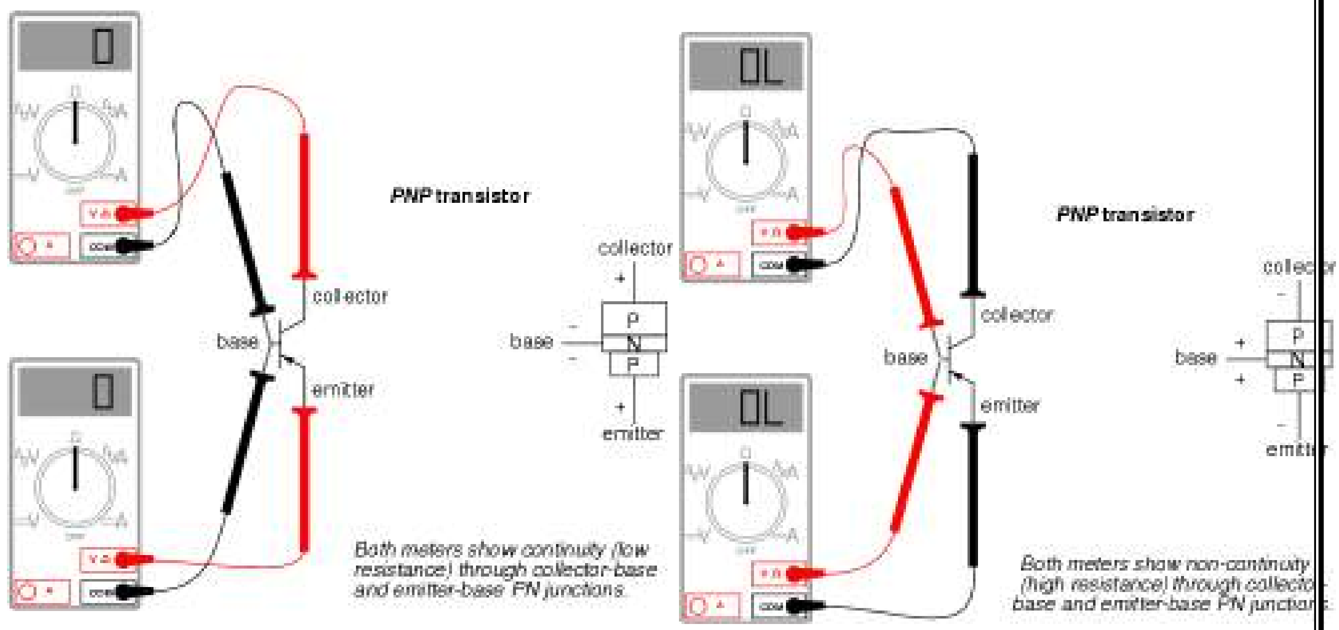
- **Identification of terminals in a transistor:**



- **Codes beginning with B (or A), for example BC108, BC478:**

The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example C means low power audio frequency; D means high power audio frequency; F means low power high frequency. The rest of the code identifies the particular transistor. There is no obvious logic to the numbering system. Sometimes a letter is added to the end (eg BC108C) to identify a special version of the main type, for example a higher current gain or a different case style. If a project specifies a higher gain version (BC108C) it must be used, but if the general code is given (BC108) any transistor with that code is suitable.

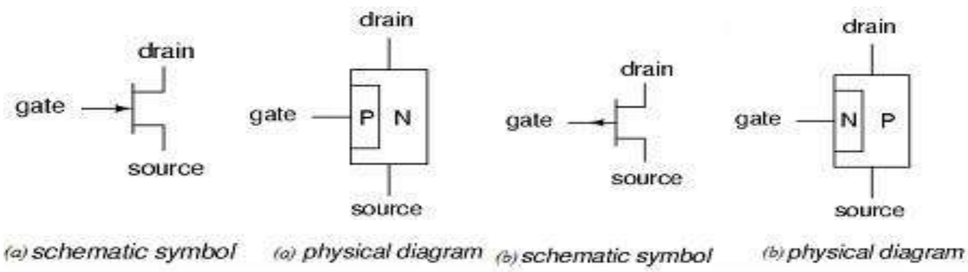
- **Meter check of a transistor:**



Bipolar transistors are constructed of a three-layer semiconductor "sandwich," either PNP or NPN. As such, they register as two diodes connected back-to-back when tested with a multimeter's "resistance" or "diode check" functions: Meter readings will be exactly opposite, of course, for an NPN transistor, with both PN junctions facing the other way. If a multimeter with a "diode check" function is used in this test, it will be found that the emitter-base junction possesses a slightly greater forward voltage drop than the collector-base junction. This forward voltage difference is due to the disparity in doping concentration between the emitter and collector regions of the transistor: the emitter is a much more heavily doped piece of semiconductor material than the collector, causing its junction with the base to produce a higher forward voltage drop.

B. JUNCTION FIELD-EFFECT TRANSISTOR

Field-effect transistors are unipolar rather than bipolar devices. That is, the main current through them is comprised either of electrons through an N-type semiconductor or holes through a P-type semiconductor. This becomes more evident when a physical diagram of the device is seen:



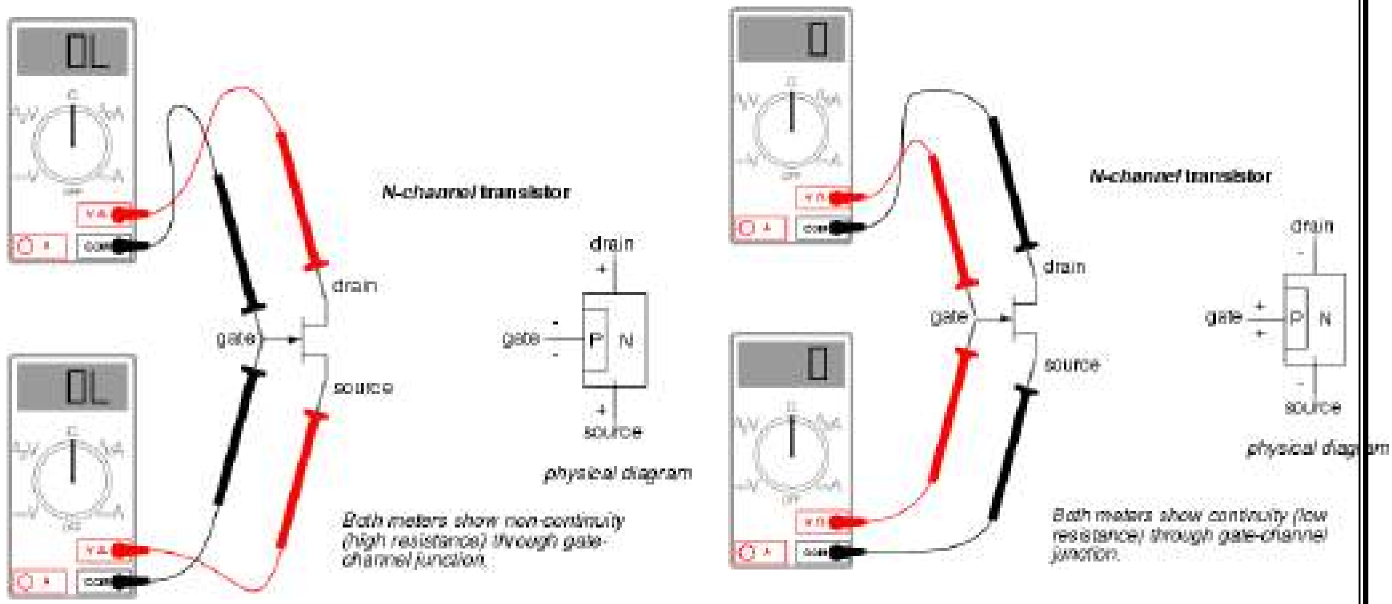
(a)N-Channel JFET (b)P-Channel JFET

In a junction field-effect transistor, or JFET, the controlled current passes from source to drain, or from drain to source as the case may be. The controlling voltage is applied between the gate and source. Note how the current does not have to cross through a PN junction on its way between source and drain: the path (called a channel) is an uninterrupted block of semiconductor material. In the image just shown, this channel is an N-type semiconductor. P-type channel JFETs are also manufactured:

Generally, N-channel JFETs are more commonly used than P-channel. The only practical difference between N- and P-channel JFETs is biasing of the PN junction formed between the gate material and the channel. With no voltage applied between gate and source, the channel is a wide-open path for electrons to flow. However, if a voltage is applied between gate and source of such polarity that it reverse-biases the PN junction, the flow between source and drain connections becomes limited, or regulated, just as it was for bipolar transistors with a set amount of base current. Maximum gate-source voltage "pinches off" all current through source and drain, thus forcing the JFET into cutoff mode. With the gate-source PN junction reverse-biased, there should be nearly zero current through the gate connection. For this reason, we classify the JFET as a voltage-controlled device, and the bipolar transistor as a current-controlled device. If the gate-source PN junction is forward-biased with a small voltage, the JFET channel will "open" a little more to allow greater currents through.

- ***Meter check of a JFET:***

Testing a JFET with a multimeter might seem to be a relatively easy task, seeing as how it has only one PN junction to test: either measured between gate and source, or between gate and drain.

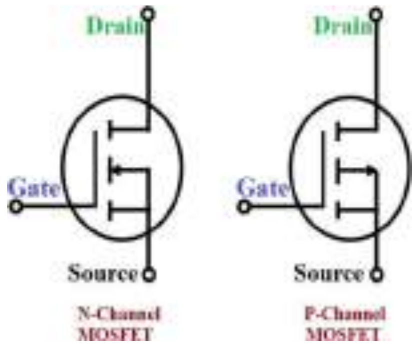


C. MOSFET:

MOSFET(metal–oxide–semiconductor field-effect transistor) was invented to overcome the disadvantages present in FETs like high drain resistance, moderate input impedance, and slower operation. So a MOSFET can be called the advanced form of FET. In some cases, MOSFETs are also be called **IGFET** (Insulated Gate Field Effect Transistor). Practically speaking, MOSFET is a voltage-controlled device, meaning by applying a rated voltage to the gate pin, the MOSFET will start conducting through the Drain and Source pin.

The main difference between FET and MOSFET is that MOSFET has a Metal Oxide Gate electrode electrically insulated from the main semiconductor n-channel or p-channel by a thin layer of Silicon dioxide or glass. The isolation of the controlling Gate **increases the input resistance** of the MOSFET extremely high in the value of the Mega-ohms (MΩ).

In general, the MOSFET is a four-terminal device with a **Drain (D), Source (S), gate (G)** and a Body (B) / Substrate terminals. The body terminal will always be connected to the source terminal hence, the MOSFET will operate as a three-terminal device. In the below image, the **symbol of N-Channel MOSFET** is shown on the left and the **symbol of P-Channel MOSFET** is shown on the right.



D.THE SILICON-CONTROLLED RECTIFIER

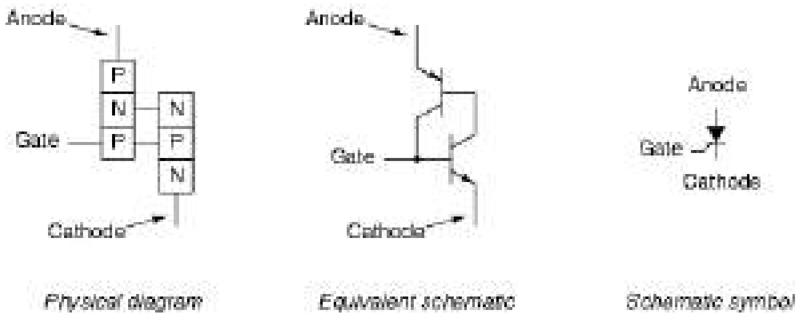
The Silicon Controlled Rectifier, SCR or just Thyristor as it is more commonly known, is similar in construction to the transistor.

It is a multi-layer semiconductor device, hence the "silicon" part of its name. It requires a gate signal to turn it "ON", the "controlled" part of the name and once "ON" it behaves like a rectifying diode, the "rectifier" part of the name. In fact the circuit symbol for the *thyristor* suggests that this device acts like a controlled rectifying diode.

However, unlike the junction diode which is a two layer (P-N) semiconductor device, or the commonly used bipolar transistor which is a three layer (P-N-P, or N-P-N) switching device, the **Thyristor** is a four layer (P-N-P-N) semiconductor device that contains three PN junctions in series, and is represented by the symbol as shown.

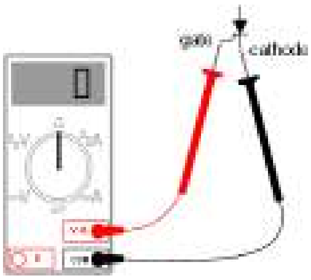
The SCR is a three-terminal device labelled: "Anode", "Cathode" and "Gate" and consisting of three PN junctions which can be switched "ON" and "OFF" at an extremely fast rate, or it can be switched "ON" for variable lengths of time during half cycles to deliver a selected amount of power to a load. The operation of the thyristor can be best explained by assuming it to be made up of two transistors connected back-to-back as a pair of complementary regenerative switches as shown.

The Silicon-Controlled Rectifier (SCR)



- **Meter check of SCR:**

All other continuity measurements performed on an SCR will show "open" ("OL" on some digital multi meter displays). It must be understood that this test is very crude and does not constitute a comprehensive assessment of the SCR. It is possible for an SCR to give good ohmmeter indications and still be defective. Ultimately, the only way to test an SCR is to subject it to a load current.

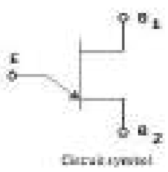


If you are using a multi meter with a "diode check" function, the gate-to-cathode junction voltage indication you get may or may not correspond to what's expected of a silicon PN junction (approximately 0.7 volts). In some cases, you will read a much lower junction voltage: mere hundredths of a volt. This is due to an internal resistor connected between the gate and cathode incorporated within some SCRs. This resistor is added to make the SCR less susceptible to false triggering by spurious voltage spikes, from circuit "noise" or from static electric discharge. In other words, having a resistor connected across the gate-cathode junction requires that a strong triggering signal (substantial current) be applied to latch the SCR. This feature is often found in larger SCRs, not on small SCRs.

E. UNI - JUNCTION TRANSISTOR

A Uni-junction transistor (UJT) is an electronic semiconductor device.There are two types of uni-junction transistor:

The original unijunction transistor, or UJT, is a simple device that is essentially a bar of N type semiconductor material into which P type material has been diffused somewhere along its length. The Uni Junction Transistor has only one junction, hence the name: 'Uni Junction transistor. The UJT has three terminals. The terminals are emitter (E) and two bases (B1 and B2). The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p-type and it is heavily doped. The resistance between B1 and B2, when the emitter is open-circuit is called inter base resistance. The very basic specifications of a UJT are:



(a) V_{bb}(max) - The maximum inter base voltage that can be applied to the UJT

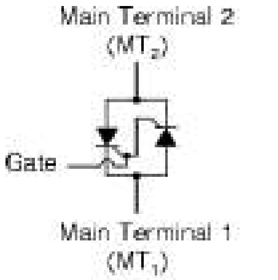
(b) R_{bb}-the inter base resistance of the UJT

(c) n - The intrinsic standoff ratio that defines V_p.

(d) I_p - The peak point emitter current

F.TRIAC

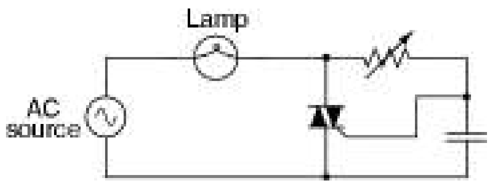
SCRs are unidirectional (one-way) current devices, making them useful for controlling DC only. If two SCRs are joined in back-to-back parallel fashion just like two Shockley diodes were joined together to form a DIAC, we have a new device known as the TRIAC:



TRIAC equivalent circuit

TRIAC schematic symbol

Because individual SCRs are more flexible to use in advanced control systems, they are more commonly seen in circuits like motor drives, while TRIACs are usually seen in simple, low-power applications like household dimmer switches. A simple lamp dimmer circuit is shown here, complete with the phase-shifting resistor-capacitor network necessary for after-peak firing.



CONCLUSION:

Types of Rheostat, Potentiometers, Relays, Switches and Cables are studied.

6. Different Types of Meters

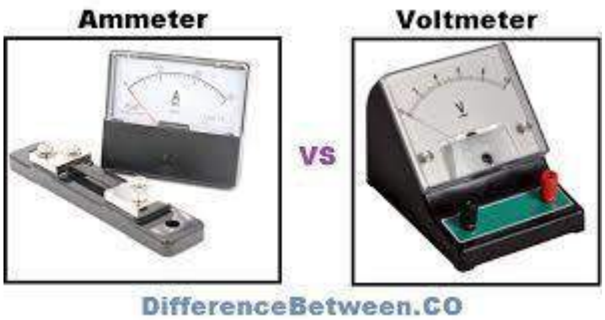
Aim: To learn working of devices Ammeter, Voltmeter, and AVO meter

Apparatus: Ammeter
Voltmeter
AVO METER

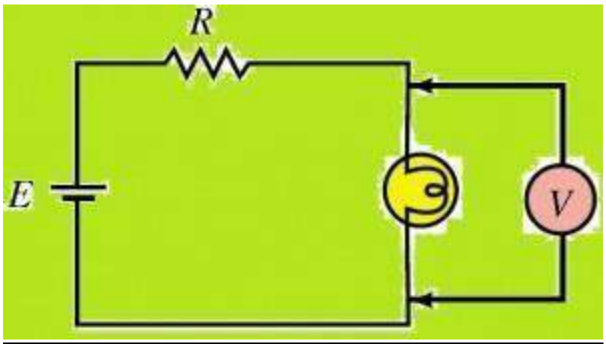
Theory:

I. Ammeter and voltmeter:

Direct measurement of voltage and current is done with the use of voltmeter and ammeter respectively. In construction and principle of operation, both the instruments are very much same.

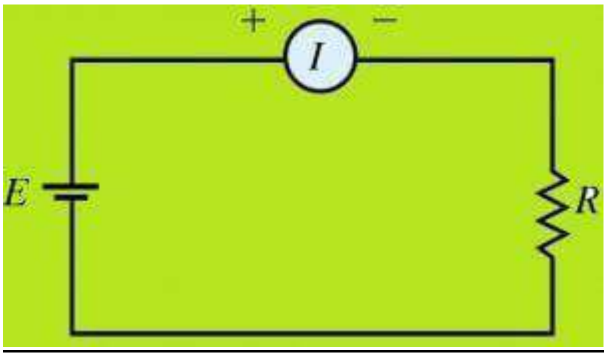


- **Connecting voltmeter and ammeter in a Circuit:**



- Voltmeter is used to measure the potential difference across a load.
- So the resistance of the voltmeter shall be very high compared to circuit resistance.
- In contrast to this, if the voltmeter resistance is small, and connecting the voltmeter across load will be equal to parallel connecting another load.
- Then the circuit conditions are changed very much and no worth-while reading will be measured.
- So the resistance of voltmeter must be very high.

- If the meter's moving system has only a small resistance, additional resistance will be included in series with the moving coil.
- This additional resistance is known as swamping resistance.



- An ammeter is used to measure the current flows through the circuit.
- So the resistance must be very small.
- If the ammeter resistance is very high, it will introduce high resistance in series with the existing circuit an disturb the circuit conditions.
- Ammeter should never connect across a load or voltage source.

- Classification of Ammeters and Voltmeters

Types of Ammeters, Voltmeters are discussed in the below section:

Ammeters and voltmeters are classified as follows:

1. Moving Iron Type
   (a) Attraction type.
   (b) Repulsion type
2. Moving Coil
   (a) Permanent magnet type
   (b) Dynamometer type
3. Hot wire
4. Induction type
5. Electrostatic (voltmeter only)

Some of the meters may be used for DC as well as AC measurements. Some may be used for DC only and some for ac measurements only.

- **DC and AC instruments:**

Those instruments whose deflections are proportional to the square of the current or voltage to be measured may be used for DC as well as ac measurements.

The following types of instruments are used for dual purpose.

- Moving Iron attraction type
- Moving Iron repulsion type
- Moving coil dynamometer type

- Electro static type
- Hot wire type

One more type called as rectifier instruments. It is a permanent magnet moving coil instrument plus a rectifier is also suitable for ac/dc measurements.

In DC, only the coil resistance is the opposition to current flow. But in ac, the coil resistance and reactance will oppose the flow of current. So one scale may not suit for both ac and dc readings. Some meters (like rectifier type meters), will have separate scale for dc and ac measurements.

- **Only DC instruments**

  In any instrument, if the deflection is directly proportional to the voltage or current to be measured, then they are suitable for dc measurement only. If we use such kind instrument in ac circuit, the moving system will try to move forward and backward several times within a second. So it will simply vibrate and no reading will be shown. The permanent Magnet Moving Coil meter (PMMC) is the one suited for dc measurement only.

- **Only AC Instruments**

  The instruments which utilize the electromagnetic induced current for producing deflection are used for ac measurement only. We know that electromagnetic induction is not possible with DC current. Therefore, induction type instruments (Voltmeter, ammeter and wattmeter) are used only for AC measurements.

II. Digital ammeter:

Digital ammeter

Digital ammeters are instruments that measure current flow in amperes and display current levels on a digital display. These devices provide information about current draw and current continuity in order to help users troubleshoot erratic loads and trends. They have both positive and negative leads and feature extremely low internal resistance.

Digital ammeters are connected in series with a circuit (and never parallel) so that current flow passes through the meter. High current flow may indicate a short circuit, unintentional ground, or defective component. Low current flow may indicate high resistance or poor current flow within the circuit.

- ***Measurement Type***

Digital ammeters can measure levels of alternating current (AC) and direct current (DC). Some devices that measure AC current also measure root mean square (RMS) power, which is the square root of the time average of the square of the instantaneous power. Many digital ammeters include a current sensor built into the meter or that clamps around the wire. Different types of digital ammeters can measure different ranges of AC current, DC current, and AC current frequency.

III. AVO meter

AVO meter

An AVO meter (Ampere, Volt, Ohm meter) or a multimeter can measure several different electrical quantities, usually a current, voltage, and resistance. There are two kinds of multimeter, namely analog and digital.

Both multimeter has a socket or a hole for the probe step on the test rod. Positive hole is marked with a + symbol is usually red, common hole (negative) is marked with a COM or symbol - usually black. Some multi meters have a positive second socket, which should be used to measure high voltages.

Both types of meter has a rotary knob to select where the quantity to be measured. This rotary knob is often also used to select a range of measurements. With an analog meter, there is a reading error problem when you do not read the measurement scales in a straight line from the top. Such errors are called parallax error. To help you avoid this, the meter is equipped with a curved mirror on the scale readings. You can see the reflection or shadow of the needle gauge on this mirror. When doing readings, move your head left and to right until you get the shadow coincides with a needle gauge needle. This ensures that you are looking straight down the scale and the reading will be correct.

Digital meters may also have features auto ranging. This feature allows the meter to choose the appropriate range automatically when the measurement was made.

conclusion:

7.STUDY AND OPERATION FUNCTION GENERATOR, REGULATED POWER SUPPLIES

AIM: To study and operation of multiimeters, function generator, and regulated power supply.

APPARATUS: Multimeter

Function generator

Regulated power supply.

THEORY:

A. FUNCTION GENERATOR

A function generator is a piece of electronic test equipment or software used to generate electrical waveforms.

Analog function generators usually generate a triangle waveform as the basis for all of its other outputs. The triangle is generated by repeatedly charging and discharging a capacitor from a constant current source. This produces a linearly ascending or descending voltage ramp. As the output voltage reaches upper and lower limits, the charging and discharging is reversed using a comparator, producing the linear triangle wave. By varying the current and the size of the capacitor, different frequencies may be obtained.

A 50% duty cycle square wave is easily obtained by noting whether the capacitor is being charged or discharged, which is reflected in the current switching comparator's output. Most function generators also contain a non-linear diode shaping circuit that can convert the triangle wave into a reasonably accurate sine wave. It does so by rounding off the hard corners of the triangle wave in a process similar to clipping in audio systems.

The type of output connector from the device depends on the frequency range of the generator. A typical function generator can provide frequencies up to 20 MHz and uses a BNC connector, usually requiring a 50 or 75 ohm termination. Specialized RF generators are capable of gigahertz frequencies and typically use N-type output connectors.

Function generators, like most signal generators, may also contain an attenuator, various means of modulating the output waveform, and often the ability to automatically and repetitively "sweep" the frequency of the output waveform (by means of a voltage-controlled oscillator) between two operator-determined limits. This capability makes it very easy to evaluate the frequency response of a given electronic circuit.

Designation	Specifications
Wave form	: Sine, squares, triangles, TTL square waves
Amplitude	: 0-20V for all the functions.
Sine distortion	: Less than 1% from 0.1 HZ to 100 HZ harmonics Modulation showed down fundamental for 100K HZ to 1MHG.
Offset	: Continuously variable 10V
Frequency range	: 0.1 HZ to 1Mhz in ranges.
Output impedance	: 600 ohms, 5%.
Square wave duty cycle	: 49% to 51%.
Differential linearity	: 0.5%

1. Range selectors: Decode frequency by multiplying the range selected with the frequency indicated by dial gives the output frequency, which applies for all functions.

2. Function selectors: Selected desired output wave form which appears at 600Ω output.

3. VCO input: An external input will vary the output frequency. The change in frequency is directly proportional to input voltage.

4. TTL output: A TTL square wave is available at this jack. The frequency is determined by the range selected and the setting of frequency dial. This output is independent of amplitude and D.C OFFSET controls.

5. Amplitude control: Control he amplitude of the output signal, which appears at 600ohms.

6. OFFSET control: Control the DC offset of the output. It is continuously variable for ±5V, ±100V.

7.Fine frequency dial: Multiplying the setting of this dial to the frequency range selected gives the output frequency of the wave forms at the 600ohms.

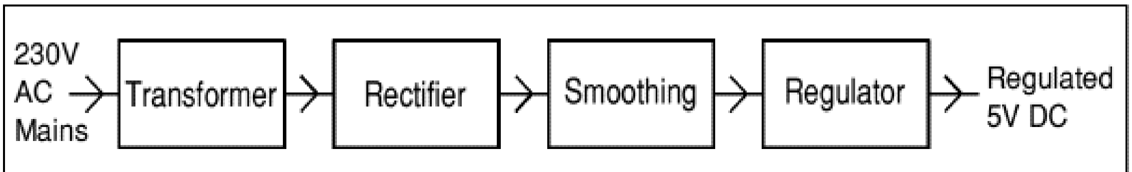
B.REGULATED POWER SUPPLIES

Power supplies provided by a regulated DC voltage facilities fine and coarse adjustments and monitoring facilities for voltage and current. They will work in constant voltage and current mode depending on current limit and output load. The current limit has good stability, load and line regulations. Outputs are protected against overload and short circuit damages. They are available in single and dual channel models with different voltage and current capacities. Overload protection circuit of constant self restoring type is provided to prevent the unit as well as the circuit under use. The power supplies are specially designed and developed for well regulated DC output. These are useful for high regulation laboratory power supplies, particularly suitable for experimental setup and circuit development in R&D.

A variable regulated power supply, also called a variable bench power supply, is one where you can continuously adjust the output voltage to you requirements. Varying the output of the power supply is the recommended way to test a project after having double checked parts placement against circuit drawings and the parts placement guide. This type of regulation is ideal for having a simple variable bench power supply. Actually I think this is quite important because one of the first projects a hobbyist should undertake is the construction of a bench supply. While a dedicated supply is quite handy e.g. 5V or 12V, it's much handier to have a variable supply on hand, especially for testing.

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:



Block Diagram of a Regulated Power Supply System

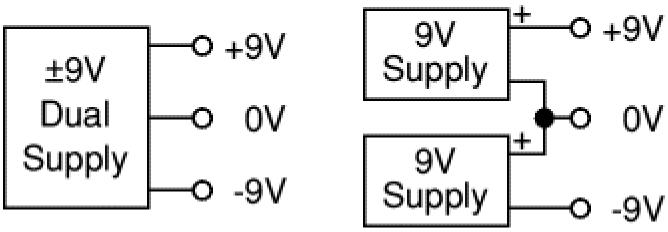
Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

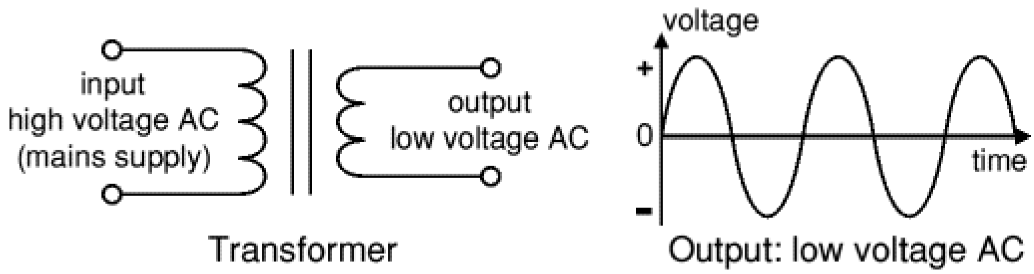
Dual Supplies:



Some electronic circuits require a power supply with positive and negative outputs as well as zero volts (0V). This is called a 'dual supply' because it is like two ordinary supplies connected together as shown in the diagram.

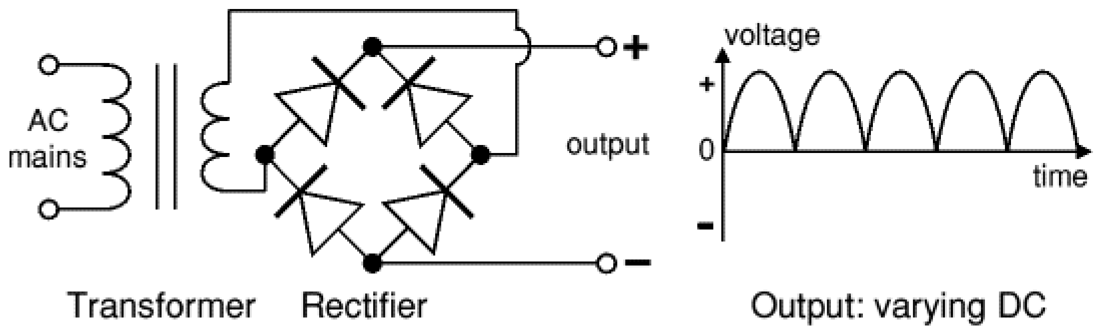
Dual supplies have three outputs, for example a ±9V supply has +9V, 0V and -9V outputs.

C. I.Transformer (POWER):



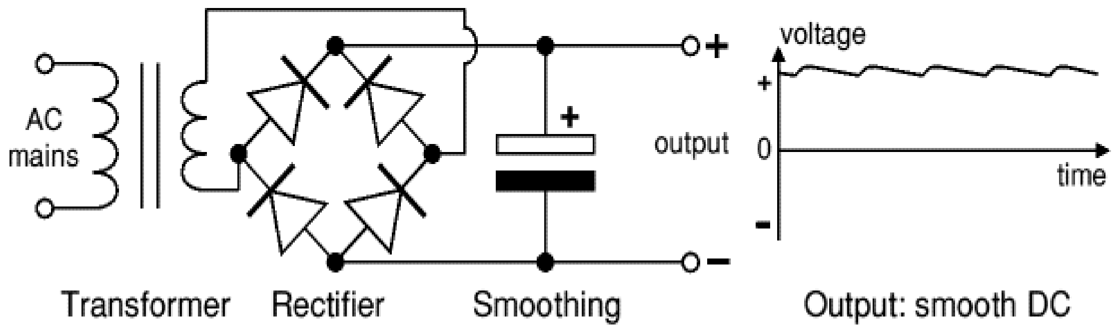
The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

- **Transformer + Rectifier:**



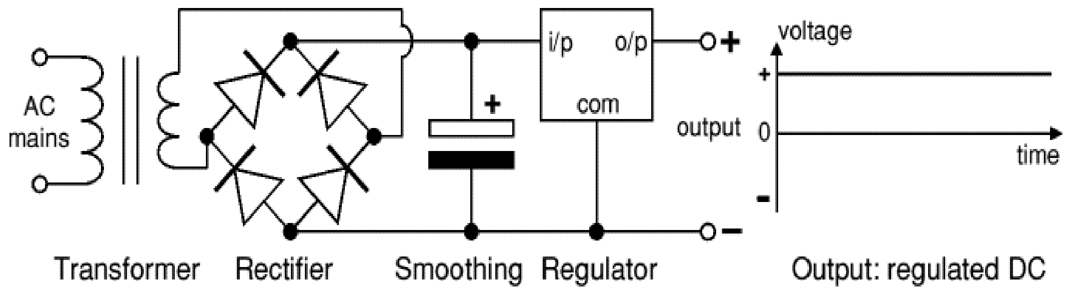
The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

- **Transformer + Rectifier + Smoothing:**



The smooth DC output has a small ripple. It is suitable for most electronic circuits.

- **Transformer + Rectifier + Smoothing + Regulator:**



The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

II. Audio Frequency (AF) Transformers

Audio Frequency (AF) Transformers work at frequencies between about 20Hz to 20kHz and are used in audio amplifier circuits, they were essential in valve (tube) designs for matching the high impedance outputs of these amplifiers to low impedance loudspeakers, but transistor amplifiers have much less need for output transformers.

Audio transformers often perform several functions at once:

- Where used, they allow the AC audio signal to reach the loudspeaker whilst preventing any DC from the amplifier affecting the operation of the loudspeaker.
- They provide an isolated external connection for the loudspeakers, improving safety.
- They can match the low input impedance of the loudspeaker (typically a few ohms) to the much higher output impedance of an amplifier, allowing maximum power to be transferred from the amplifier to the speaker.

III. RF Transformers

RF is considered to be the lowest band of frequencies in this group, and transformers working at frequencies between 30kHz to 30MHz may often have their windings "tuned" to a particular frequency by the addition of a small capacitor to one winding.This forms a parallel LC resonant circuit with the transformer primary, and therefore have high impedance at one particular frequency. The inductance of such transformers is often made adjustable and the whole assembly housed inside a metal screening can. The resonant frequency of the circuit can then be fine tuned after assembly. Once adjusted during manufacture, it is normally intended that further adjustment should not be needed.

RF transformers are widely used in electronic circuits for :

1. Impedance matching to achieve maximum power transfer and to suppress undesired signal reflection.

2. Voltage, current step-up or step-down.

3. DC isolation between circuits while affording efficient AC transmission.

4. Interfacing between balanced and unbalanced circuits; example: balanced amplifiers.

conclusion: The operation of multiimeters, function generator, and Regulated Power Supply are studied

8.Soldering and de-soldering

AIM: To study Soldering and de-soldering techniques.

APPARATUS:

1. Solder Iron
2. Solder wire
3. De-soldering pump
4. Flux
5. PCB
6. Different electronic components

THEORY:

Introduction: Soldering is the act of unifying two pieces of similar or dissimilar metals by an alloy called Solder, the melting point of which is lower than that of the metal to be united. When two surfaces of the metal are soldered together, the solder penetrate pores of the metal and it makes firm grip with permanent electrical continuity and strength.

Solder: The soldering material or solder usually employed for the purpose of joining together two or more metals at temperature below their melting point and is a fusible alloy consisting essentially of lead and tin. Solder is an alloy (mixture) of tin and lead, typically 60% tin and 40% lead. It melts at a temperature of about 200°C. Coating a surface with solder is called 'tinning' because of the tin content of solder. Solder for electronics use contains tiny cores of flux, like the wires inside a mains flex.

Flux: When a metal is heated in free air, it is immediately affected by oxygen. A layer of oxide is formed over the surface which is a hindrance during soldering. This layer of oxide can be removed using chemical compounds called fluxes. They are deoxidizes agents and are used to keep the surface clean from oxide, increase the fluidity of the solder and help the joints to adhere perfectly. The melting temperature of the flux is always less than that of the solder used.

Soldering Techniques: Soldering techniques can be broadly classified in two groups:

1. Iron soldering or Manual soldering
2. Mass soldering or Automatic soldering

Manual soldering requires solder iron, solder wire, flux and electronic components. Solder irons are available in different temperature ranges, and available with ratings of 6 W, 12 W, 25 W, 35 W, 100 W, 150 W etc. Selection of the solder iron depends on the use.

SOLDERING:

1. Take one PCB, solder iron, solder wire and electronic components and give supply to solder iron.
2. Place the iron at the angle of 45 degree, with the tip touching as many elements of the joints as possible.

3. Place the solder wire near the iron and let it flow. Pass it around the joints.
4. Remove the iron and let the solder flow in the area from where the iron has been removed.
5. When the solder has successfully flowed in the lead and track, take the solder away and then remove the iron.

DESOLDERING:

To de-solder means to remove a joint or re-position a wire or component. There are two ways to remove the solder:

1. With a de-soldering pump (solder sucker)

1. Set the pump by pushing the spring-loaded plunger down until it locks.
2. Apply both the pump nozzle and the tip of your soldering iron to the joint.
3. Wait a second or two for the solder to melt.
4. Then press the button on the pump to release the plunger and suck the molten solder into the tool.
5. Repeat if necessary to remove as much solder as possible.
6. The pump will need emptying occasionally by unscrewing the nozzle.

2. with solder remover wick (copper braid)

1. Apply both the end of the wick and the tip of your soldering iron to the joint.
2. As the solder melts most of it will flow onto the wick, away from the joint.
3. Remove the wick first, then the soldering iron.
4. Cut off and discard the end of the wick coated with solder.

After removing most of the solder from the joint(s) we can remove the wire or component lead straight away (allow a few seconds for it to cool). If the joint will not come apart easily apply your soldering iron to melt the remaining traces of solder at the same time as pulling the joint apart.

conclusion:: **Soldering and de-soldering techniques are studied.**

9.SINGLE LAYER AND MULTI LAYER PCBs (Identification and Utility)

AIM: To study the single layer and multi layer PCBs.

APPARATUS: PCB

THEORY:

The design of PCB is considered as the last step in electronic design as well as the major step in the production of PCB. It is a board consisting of printed circuit of electronic equipment on it and is used for the designing of circuit.

THE STEPS FOR DESIGNING PCB are

1. Layout planning
2. Art work
3. Film master production
4. Pattern transfer (photo/screen printing)
5. Plasting
6. Etching
7. Mechanical matching operations

The layout is the work done before the art work in the PCB. It provides all the information about the circuit, which has to drawn on PCB. Protection of copper tracks is very much essential Plasting is such a process which forms a thin layer over copper tracks and protect them. Generally, it is done with gold.

Types of copper plating: Copper plating, Nickel plating, Gold plating, Tin plating, Tin lead plating.

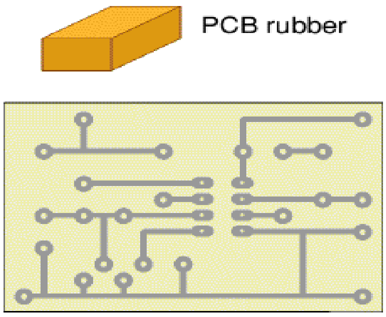
Etching means to draw on board by the action of acid, especially by coating the surface with wax and letting the acid cast into the lines or area laid bar with needle. Types of etching: Spray etching,Laminate etching,Splash etching (Configured force by rotating in centre).

The double sided PCB's are made with or without plated through holes.Fabrication of plated through holes type boards is very expensive.Two types: Plated through holes, No plated through holes.

In plated through holes, the total no. of holes is kept minimum for economy and reliability.

In no plated through holes, contacts are made by soldering the component lead on both sides of board when required and jumper wires are added. There should be minimum solder joints on the component sides. Replacing of such components is different.

Printed circuit boards have copper tracks connecting the holes where the components are placed. They are designed specially for each circuit and make construction very easy. Electronics Club members will receive an etched PCB that will need cleaning and drilling before soldering.



Printed Circuit Board (PCB)

Cleaning and Drilling a PCB ready for Soldering:

1. Clean off the protective coating from the PCB using a PCB rubber or steel wool so that all the copper tracks are bright and shiny. The PCB rubber has grit in it to make it very abrasive. In fact the coating can be left on and it should melt away around the joints as you solder, but in the Electronics Club we have generally had better results by removing the coating.
2. Drill the holes with a 1mm diameter bit. This is easiest with a proper electric PCB drill in a stand, but a hand-held miniature electric drill can be used if you take care to avoid twisting and snapping the small drill bit. Wear safety spectacles. A hand-drill is not suitable for such small bits unless you are very skilled.
3. A few may holes may need to be larger, for example preset resistors usually need a 1.5mm diameter hole. It is simplest to re-drill these special holes afterwards.
4. Check carefully to make sure you find all the holes.

<u>conclusion:</u> Single Layer and Multilayer PCB's are studied.

10.Testing of various components

AIM: To study digital multimeter and perform testing of various components.

APPARATUS:

1. digital multimeter
2. resistors
3. diode
4. P-n-p and n-p-n transistors.

Theory:

I. Typical Voltage/Current Test

Voltmeters are usually connected across a circuit. You can perform two types of tests with a voltmeter. If you connect it from the positive terminal of a component to ground, you will read the amount of voltage there is to operate the component. It will usually read 0 volts or full voltage. If you test a component that is supposed to have 12 volts, but there is 0 volts, there is an open in the circuit. This is where you will have to trace back until you locate the open.

Using digital multimeter, we can measure voltage across any electronic component. We have to connect the multimeter probes across that component. We can measure ac or dc voltage. The switch position must be kept at particular position to ensure correct readings. To measure ac voltage/current, the switch should be kept on V~ / A~ range. Same way, to measure dc voltage/current, the switch should be kept on V- / A- range.

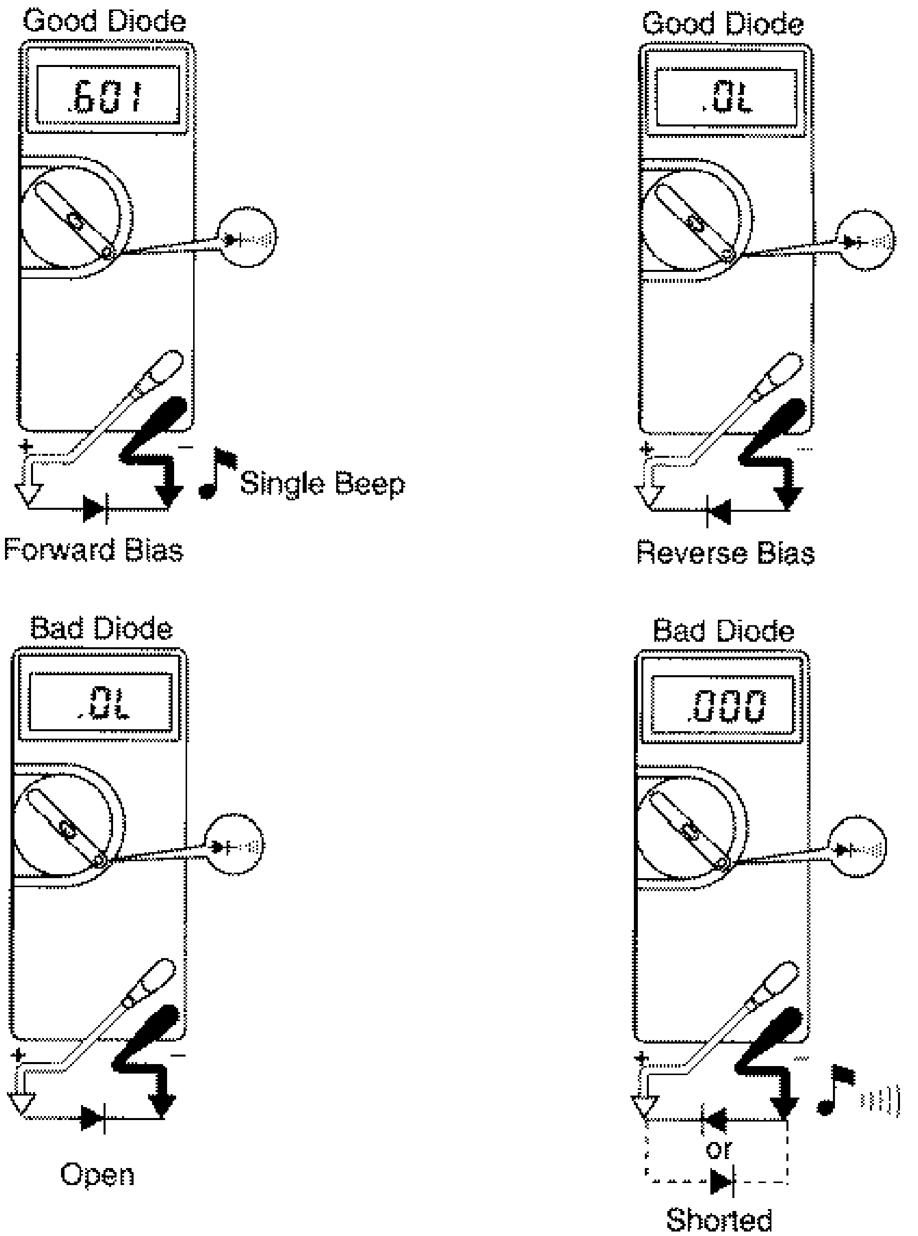
II.Typical Resistance Test:

Another useful function of the DMM is the ohmmeter. An ohmmeter measures the electrical resistance of a circuit. The switch should be kept on Ω range. If you have no resistance in a circuit, the ohmmeter will read 0. If you have an open in a circuit, it will read infinite.

An ohmmeter uses its own battery to conduct a resistance test. Therefore there must be no power in the circuit being tested or the ohmmeter will become damaged.

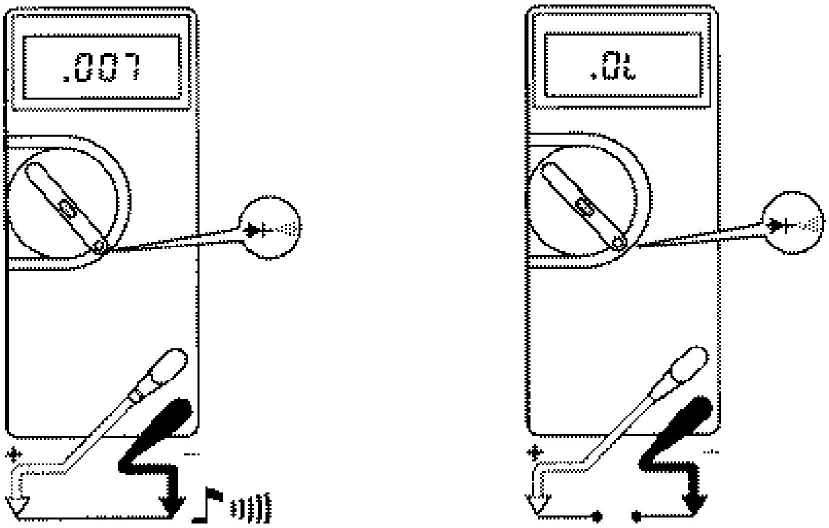
When you test a component you put the red lead on the positive side and the black lead on the negative side. Current from the battery will flow through the component and the meter will determine the resistance by how much the voltage drops. If the component has an open the meter will flash "1.000" or "OL" to show an open or infinite resistance. A reading of 0 ohms indicates that there is no resistance in the component and it is shorted. If a component is supposed to have 1,000 ohms of resistance and a test shows it has 100 ohms of resistance, which indicates a short. If it reads infinite, then it is open.

III.Testing Diode:



On a (digital) DMM, there will usually be a diode test mode. Using this, a silicon diode should read between .5 to .8 V in the forward direction and open in reverse. For a germanium diode, it will be lower, perhaps .2 to .4 V or so in the forward direction. Using the normal resistance ranges - any of them - will usually show open for any semiconductor junction since the meter does not apply enough voltage to reach the value of the forward drop. Note, however, that a defective diode may indeed indicate a resistance lower than infinity especially on the highest ohms range. So, any reading of this sort would be an indication of a bad device but the opposite is not guaranteed.

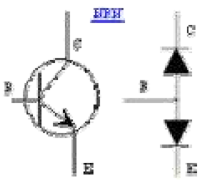
IV.Continuity test



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.

V.Testing bipolar transistors

The assumption made when testing **transistors** is that a transistor is just a pair of connected diodes. Therefore it can be tested for shorts, opens or leakage with a simple digital multimeter.



To test a bipolar transistor with a digital multimeter, take it out of circuit and make the following measurements using the diode test mode:

- Connect the red (positive) lead to the base of the transistor. Connect the black (negative) lead to the emitter. A good NPN transistor will read a **junction drop voltage** of 0.4V to 0.9V. A good PNP transistor will read **open**.
- Leave the red meter lead on the base and move the black meter lead to the collector - the reading should be *almost the same as the previous test*, open for PNP and a *slightly lower*

voltage drop for NPN transistors.

- Reverse the meter leads and repeat the test. This time, connect the black meter lead to the base of the transistor and the red lead to the emitter. A good PNP transistor will read a **junction drop voltage** of 0.4V to 0.9V. A good NPN transistor will read **open**.
- Leave the black meter lead on the base and move the red lead to the collector - the reading should be *almost the same as the previous test*, open for NPN and a *slightly lower voltage drop* for PNP transistors.
- Place one meter lead on the collector, the other on the emitter, then reverse. Both tests should read **open** for both NPN and PNP transistors.

If you read a short circuit (zero ohms or a voltage drop of zero) between two leads, or the transistor fails any of the tests described above, it is bad and must be replaced.

If you get readings that do not make sense, try to compare them with measurements done on a good transistor of the same type.

VI.Identifying the leads and polarity of unknown bipolar transistors

The type (**PNP** or **NPN**) and the **lead arrangement** of unmarked transistors can be determined easily using a digital or analog multimeter, if the transistor is seen as a pair of connected diodes. The collector and emitter can be identified knowing the fact that the doping for the B-E junction is always much higher than for the B-C junction, therefore, the forward voltage drop will be slightly higher. This will show up as a couple of millivolts difference on a digital multimeter's diode test scale or a slightly higher resistance on an analog VoltOhmMeter.

First *make the a few measurements between various leads*. Soon you'll identify a lead (the **Base**) that will show a forward voltage drop (on DMMs) combined with two other leads (the Emitter and Collector). Now that the Base is identified, observe carefully the voltage drops across B-E and B-C. The **B-C** junction will have a slightly less voltage drop.

If you arrived at this point, you already know the **polarity** of the transistor under test. If the negative lead (black lead connected to the COM on most digital multimeters) is placed on the Base when measuring the B-C and B-E voltage drops - you have a **PNP transistor**. Similarly - if the positive meter lead is placed on the base, you have a **NPN transistor**.

CONCLUSION:

11.STUDY OF CRO

AIM:

To learn how to operate a cathode-ray oscilloscope.

APPARATUS:

Cathode-ray oscilloscope, multi meter, and oscillator.

THEORY:

An oscilloscope is a laboratory instrument commonly used to display and analyze the waveform of electronic signals.The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. A typical oscilloscope can display alternating current (AC) or pulsating direct current (DC) waveforms having a frequency as low as approximately.Its reliability, stability, and ease of operation make it suitable as a general-purpose laboratory instrument. The heart of the CRO is a cathode-ray tube shown schematically in Fig. 1.

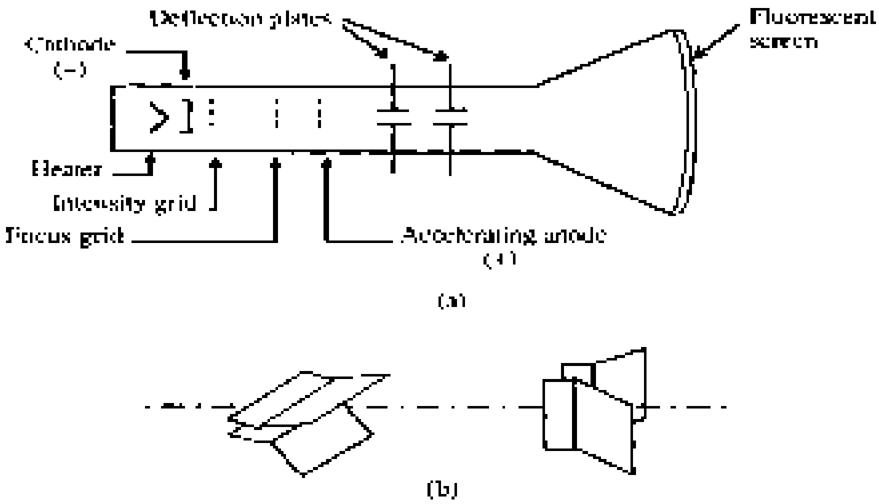


Figure 1. Cathode ray tube: (a) schematic, (b) detail of the deflection plates.

Cathode Ray Oscilloscope (CRO)

The cathode ray is a beam of electrons, which are emitted by the heated cathode (negative electrode) and accelerated toward the fluorescent screen. The assembly of the cathode, intensity grid, focus grid, and accelerating anode (positive electrode) is called an electron gun. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen is two pair of metal plates - one oriented to provide horizontal deflection of the beam and one pair oriented to give vertical deflection to the beam. These plates are thus referred to as the horizontal and vertical deflection plates. The combination of these two deflections allows the beam to reach any portion of the fluorescent screen. Wherever the electron beam hits the screen, the phosphor is excited and light is emitted from that point. This conversion of electron energy into light allows us to write with points or lines of light on an otherwise darkened screen.

In the most common use of the oscilloscope the signal to be studied is first amplified and then applied to the vertical (deflection) plates to deflect the beam vertically and at the same time a voltage that increases linearly with time is applied to the horizontal (deflection) plates thus causing the beam to be deflected horizontally at a uniform (constant) rate. The signal applied to the vertical plates is thus displayed on the screen as a function of time. The horizontal axis serves as a uniform time scale.

The linear deflection or sweep of the beam horizontally is accomplished by use of a sweep generator that is incorporated in the oscilloscope circuitry. The voltage output of such a generator is that of a saw tooth wave as shown in Fig. 2. Application of one cycle of this voltage difference, which increases linearly with time, to the horizontal plates causes the beam to be deflected linearly with time across the tube face. When the voltage suddenly falls to zero, as at points (a) (b) (c), etc. , the end of each sweep - the beam flies back to its initial position. The horizontal deflection of the beam is repeated periodically, the frequency of this periodicity is adjustable by external controls.

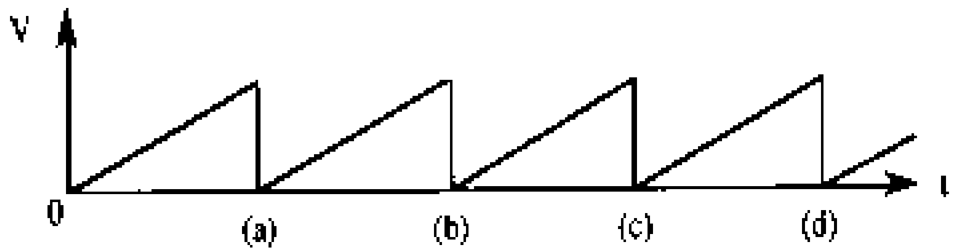


Figure. 2. Voltage difference V between horizontal plates as a function of time t.

To obtain steady traces on the tube face, an internal number of cycles of the unknown signal that is applied to the vertical plates must be associated with each cycle of the sweep generator. Thus, with such a matching of synchronization of the two deflections, the pattern on the tube face repeats itself and hence appears to remain stationary. The persistence of vision in the human eye and of the glow of the fluorescent screen aids in producing a stationary pattern. In addition, the electron beam is cut off (blanked) during fly back so that the retrace sweep is not observed.

I. CRO Operation:

A simplified block diagram of a typical oscilloscope is shown in Fig. 3. In general, the instrument is operated in the following manner. The signal to be displayed is amplified by the vertical amplifier and applied to the vertical deflection plates of the CRT. A portion of the signal in the vertical amplifier is applied to the sweep trigger as a triggering signal. The sweep trigger then generates a pulse coincident with a selected point in the cycle of the triggering signal. This pulse turns on the sweep generator, initiating the saw tooth waveform. The saw tooth wave is amplified by the horizontal amplifier and applied to the horizontal deflection plates. Usually, additional provisions signal are made for applying an external triggering signal or utilizing the 60 Hz line for triggering. Also the sweep generator may be bypassed and an external signal applied directly to the horizontal amplifier.

II. CRO Controls:

The controls available on most oscilloscopes provide a wide range of operating conditions and thus make the instrument especially versatile. Since many of these controls are common to most oscilloscopes a brief description of them follows.

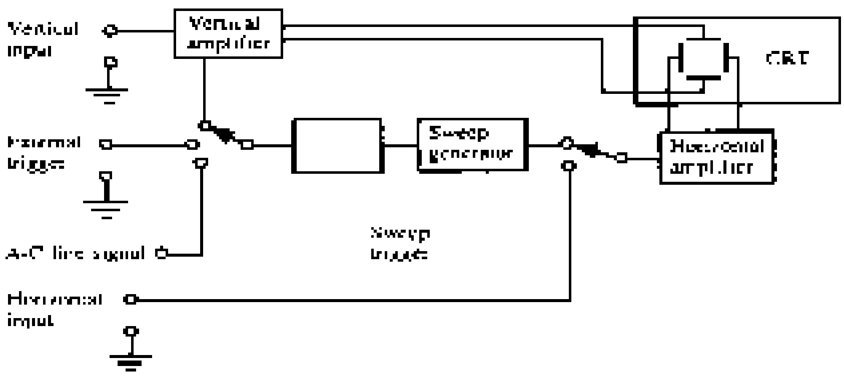
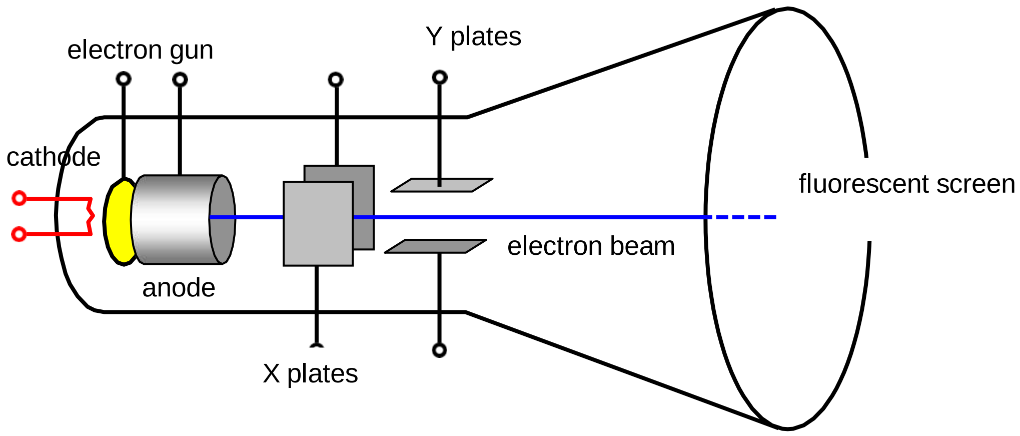


Figure 5. Block diagram of a typical oscilloscope.

III. Cathode-Ray Tube (CRT):



- **Power and Scale Illumination:** Turns instrument on and controls illumination of the graticule.
- **Focus:** Focus the spot or trace on the screen.
- **Intensity:** Regulates the brightness of the spot or trace.

Basic operation:

Before doing the experiments you should adjust the controls for focus, brilliance, X and Y shift until you have a dot in the middle of the screen. The simplified diagram above shows the inside of a cathode ray oscilloscope.

A. Vertical Amplifier Section:

- ✓ **Position:** Controls vertical positioning of oscilloscope display.
- ✓ **Sensitivity:**Selects the sensitivity of the vertical amplifier in calibrated steps.
- ✓ **Variable Sensitivity:** Provides a continuous range of sensitivities between the calibrated steps. Normally the sensitivity is calibrated only when the variable knob is in the fully clockwise position.
- ✓ **AC-DC-GND:** Selects desired coupling (ac or dc) for incoming signal applied to vertical amplifier, or grounds the amplifier input. Selecting dc couples the input directly to the amplifier; selecting ac send the signal through a capacitor before going to the amplifier thus blocking any constant component.

B. Horizontal-Sweep Section:

- ✓ **Sweep time/cm:** Selects desired sweep rate from calibrated steps or admits external signal to horizontal amplifier.

- ✓ **Sweep time/cm Variable:** Provides continuously variable sweep rates. Calibrated position is fully clockwise.
- ✓ **Position:** Controls horizontal position of trace on screen.
- ✓ **Horizontal Variable:** Controls the attenuation (reduction) of signal applied to horizontal amplifier through Ext. Horiz. Connector.
- ✓ **Trigger:**The trigger selects the timing of the beginning of the horizontal sweep.
- ✓ **Slope**: Selects whether triggering occurs on an increasing (+) or decreasing (-) portion of trigger signal.
- ✓ **Coupling**: Selects whether triggering occurs at a specific dc or ac level.
- ✓ **Source:** Selects the source of the triggering signal.
  INT-(internal)-from signal on vertical amplifier
  EXT - (external) - from an external signal inserted at the EXT. TRIG. INPUT.
  LINE - 60-cycle trigger .
- ✓ **Level:** Selects the voltage point on the triggering signal at which sweep is triggered. It also allows automatic (auto) triggering of allows sweep to run free (free run).

IV. Connections For The Oscilloscope:

- **Vertical Input:** A pair of jacks for connecting the signal under study to the Y (or vertical) amplifier. The lower jack is grounded to the case.
- **Horizontal Input:** A pair of jacks for connecting an external signal to the horizontal amplifier. The lower terminal is graounted to the case of the oscilloscope.
- **External Trigger Input:** Input connector for external trigger signal.
- **Cal. Out:** Provides amplitude calibrated square waves of 25 and 500 mill volts for use in calibrating the gain of the amplifiers. Accuracy of the vertical deflection is $\pm$ 3%. Sensitivity is variable. Horizontal sweep should be accurate to within 3%. Range of sweep is variable.
- **Operating Instructions:**

Before plugging the oscilloscope into a wall receptacle, set the controls as follows:(a) Power switch at off

(b) Intensity fully counter clockwise

(c) Vertical centering in the centre of range

(d) Horizontal centering in the centre of range

(e) Vertical at 0.2

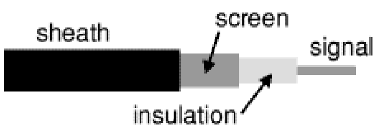
(f) Sweep times 1

Plug line cord into standard ac wall receptacles (nominally 118 V). Turn power on. Do not advance the Intensity Control. Allow the scope to warm up for approximately two minutes, and then turn the Intensity Control until the beam is visible on the screen. Switch on your oscilloscope and adjust the controls to give a straight line across the centre of the screen. The Y gain should be set at 1V / division and the time base set at 1 ms / division,

1. Connect one 1.5 V cell to the Y inputs and adjust the Y gain, if necessary, so that the line moves up 1.5 divisions.
2. Now connect two cells and then three cells. Record the line deflection each time.
3. Reverse the leads and repeat number two.
4. Now connect the 1 V ac supply from the high current power supply (Extra low voltage supply or Westminster power supply) to the Y inputs. If the signal source and oscilloscope both have earthed terminals make sure that the earthed lead of the oscilloscope (often black) is connected to the earthed terminal of the supply (often yellow), or you will short out the signal generator through the CRO. Record the size and shape of the trace. Repeat with the 2 V ac input and then the dc input, recording the trace each time.

V. Precautions:

- An oscilloscope should be handled gently to protect its fragile (and expensive) vacuum tube.



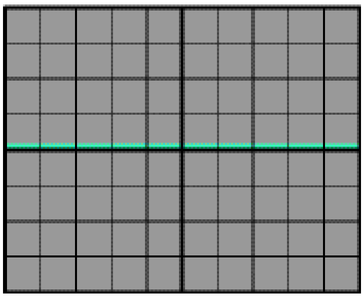
Construction of a co-axial lead

Oscilloscope lead and probes kit

- Oscilloscopes use high voltages to create the electron beam and these remain for some time after switching off - for your own safety do not attempt to examine the inside of an oscilloscope.

VI. Setting up an oscilloscope:

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully. It is quite easy to 'lose' the trace off the screen if controls are set wrongly. There is some variation in the arrangement and labeling of the many controls so the following instructions may need to be adapted for your instrument.



This is what you should see after setting up, when thereis no input signal connected

1. Switch on the oscilloscope to warm up (it takes minute or two).
2. Do not connect the input lead at this stage.
3. Set the AC/GND/DC switch (by the Y INPUT) to DC.
4. Set the SWP/X-Y switch to SWP (sweep).
5. Set Trigger Level to AUTO.
6. Set Trigger Source to INT (internal, the y input).
7. Set the Y AMPLIFIER to 5V/cm (a moderate value).
8. Set the TIMEBASE to 10ms/cm (a moderate speed).
9. Turn the time base VARIABLE control to 1 or CAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace across the middle of the screen, like the picture.

11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharp trace.

12. The oscilloscope is now ready to use.

<u>conclusion:</u>

12.Operations of CRO

AIM: To observe front panel control knobs and to find amplitude, time period and frequency for given waveforms**.**

APPARATUS: Cathode Ray Oscilloscope, function generator, connecting wires.

THEORY: C.R.O is a versatile instrument used for display of wave forms and is a fast x-y plotter.

The heart of C.R.O is and the rest is the circuitry to operate C.R.O.The main parts are

1. Electron gun: - it is used to produce sharply focused beam of electron accelerated to very high velocity.

2. Deflection system: - it deflects the electron both in horizontal and vertical plan.

3. Florescent screen:- the screen which produces, spot of visible light . when beam of electrons are incident on it the other side of tube is coated with phosphorus material.

- **FRONT PANNEL**:

1. ON-POWER: toggle switch for switching on power.
2. INTENSITY: controls trace intensity from zero to maximum.
3. FOCUS: It controls sharpness of trace a slight adugestement of focus is done after changing intensity of trace.
4. AC-DC: GROUND:It selects coupling of AC-DC ground signal to vertical amplifier.
5. X-MAG: It expands length of time base from 1-5 times continuously and to maximum time base to 40 ns/cm.
6. SQUARE: This provides square wave 2v (p-P) amplitude and enables to check y calibration of scope.
7. SAWTOOTH WAVE FORM: This provides saw tooth wave form output coincident to sweep speed with an output of saw tooth wave (p-p)
8. VERTICAL SECTION: y position: This enables movement of display along y-axis.
9. Y-INPUT: It connects input signal to vertical amplifier through AC-DC ground coupling switch

10. CALIBRATION: 15mv – 150mv dc signal depending on position selection is applied to vertical amplifier.
11. DC BALANCE: It is control on panel electrostatic ally in accordance with waveforms to be displayed.
12. VOLTS/CM: Switch adjusts sensitivity.
13. HORIZANTAL SECTION:
14. X-POSITION: This control enables movement of display along x-axis.
15. TRIGGERING LEVEL: It selects mode of triggering.
16. TIMEBASE: This controls or selects sweep speeds.
17. VERNUIS: This control the fine adjustments associated with time base sweep.
18. SIGN SELECTOR: It selects different options of INT/EXT, NORM/TO.
19. STAB: Present on panel, EXITCAD: It allows time base range to be extended.
20. HORIZANTAL INPUT: It connects external signal to horizontal amplifier.
21. Ext SYN: it connects external signal to trigger circuit for synchronization.

- **FRONT PANNEL OF CRO**

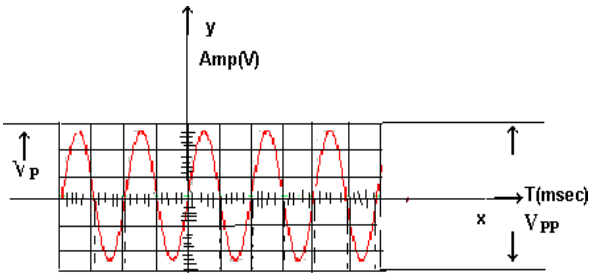
- **OBSERVATIONS:**

1. Amplitude = no. of vertical divisions * Volts/div.
2. Time period = no. of horizontal divisions * Time/div.
3. Frequency=1/T

4.Amlitude taken on vertical section (y).

5.Time period taken on horizontal section(x)

- **MODEL WAVE FORMS**



- **APPLICATIONS OF CRO:**

1. Measurement of current
2. Measurement of voltage
3. Measurement of power
4. Measurement of frequency
5. Measurement of phase angle
6. To see transistor curves
7. To trace and measuring signals of RF, IF and AF in radio and TV.
8. To trace visual display of sine waves.

CONCULSION: Operation of CRO is studied.