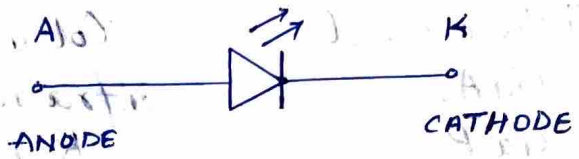
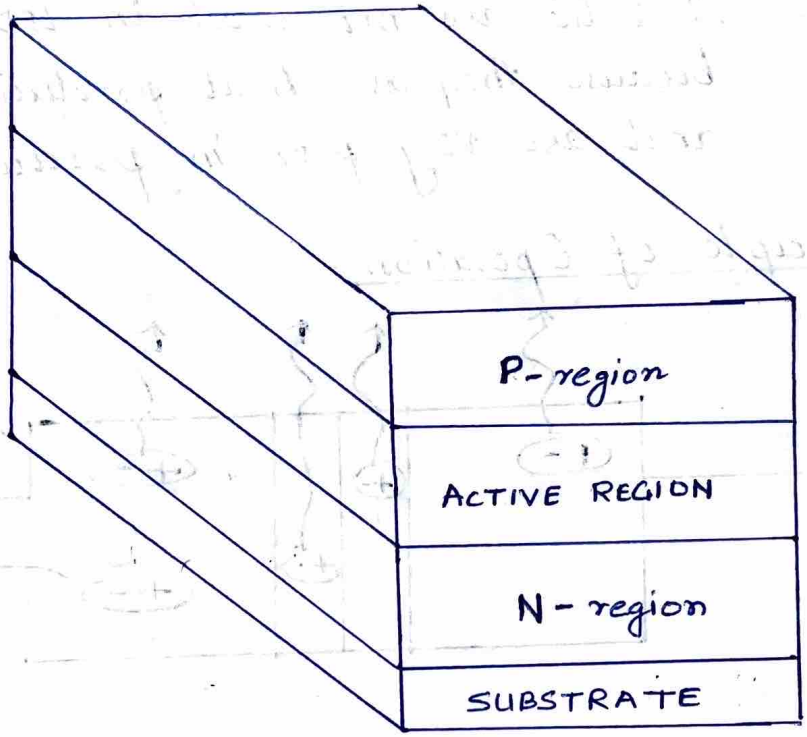
LED (LIGHT EMITTING DIODE) :-

An LED emits light when electrical energy is applied to it.

Symbol :-



Construction :-



1.) The construction of LED is the same as that of a pn junction semiconductor diode.
2.) One of the popular method of LED construction is to deposite 3 semiconductor layers on the substrate as shown in the fig.
3.) The active region exist between the p & n regions.
4.) The light emerges from the active side in all directions when electron hole pairs recombine.
5.) As the LED emits light in all the direction, a small reflective cup is used so as to focus light in the desired direction.
6.) Semiconductor materials used are (GaAs), (GaP) & (GaAsP).

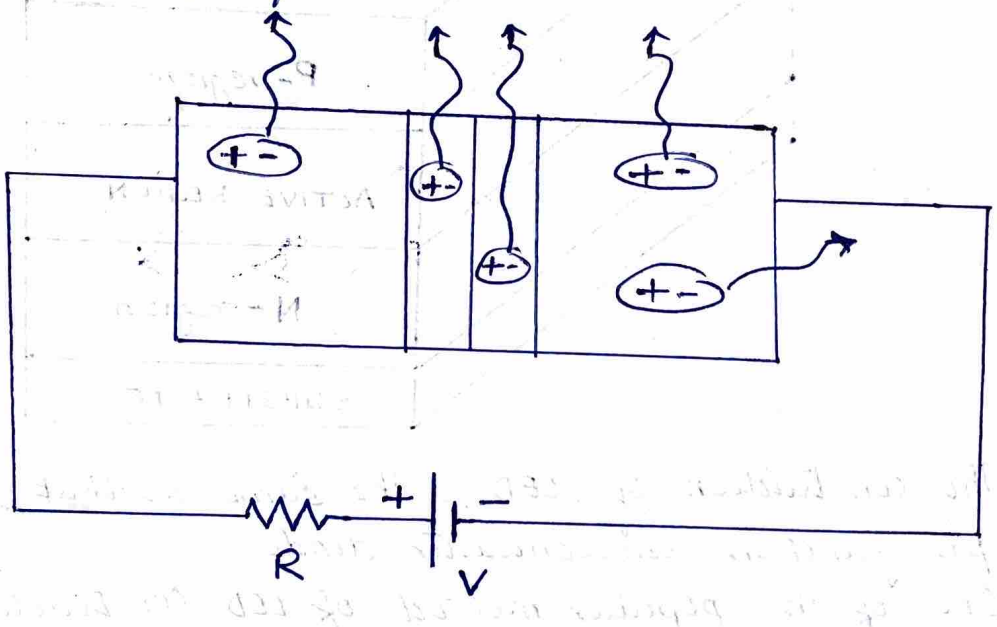
7.) The colour of emitted light is decided by its wavelength which depends on forbidden energy gap.

8.) This gap is different for different mixtures. Hence mixtures give the different colours.

	Mixture used	Colour.
1.	GaAs	infra-red, invisible.
2.	GaP	Red or Green.
3.	GaAsP.	Red or Yellow.

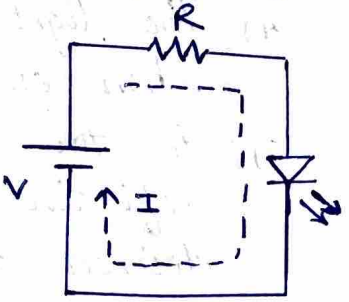
NOTE:- Si & Ge are not used in LED construction because they are heat producing materials and are very poor in producing light.

Principle of Operation:-

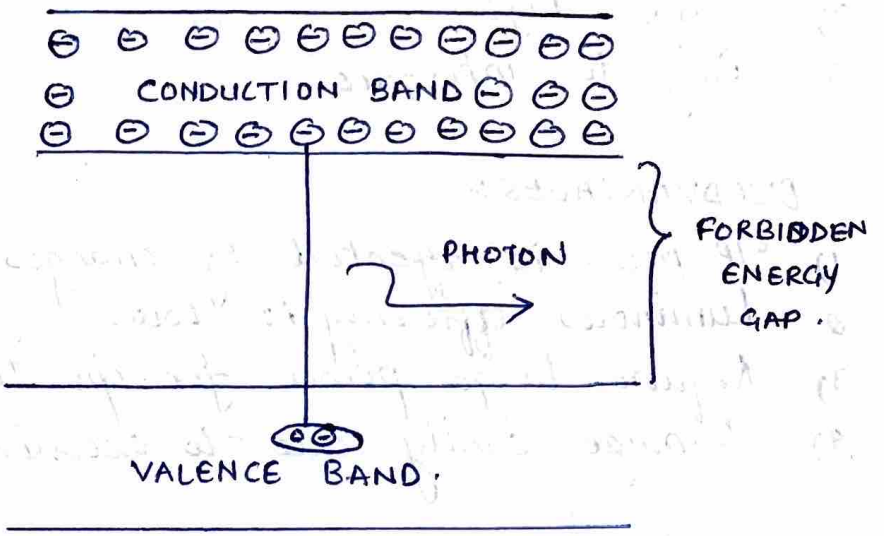


1.) The LED operates on the principle which state that when the recombination of electron hole takes place, an energy is released in the form of light.

2.) When LED is forward biased, the $e^{\ominus}$ in the n-region will cross the junction and will recombine with the holes in the p-region.



7.) During recombination, these $e^{\ominus}$s return back to the valence band which is at a lower energy level than the conduction band.

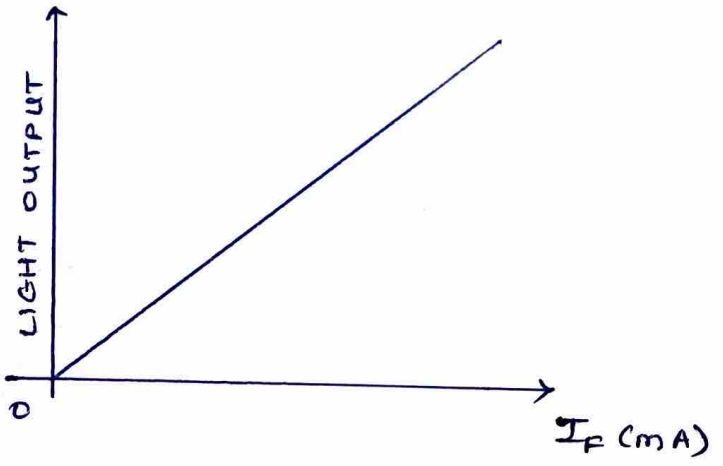


8.) While returning back, the recombining $e^{\ominus}$'s give away the excess energy in the form of light.

9.) This process is called as electroluminescence. In this way an LED emits light.

10.) Voltage drop across conducting LED is in the range of 1.2V to 3.2V.

Characteristics.



With increase in the applied voltage, the current increase which further increases the light output.

ADVANTAGES :-

1.) Small size and light weight.
2.) Available in different spectral colours.
3.) Longer Life.
4.) Easy to interface.

DISADVANTAGES :-

1.) O/P power is affected by changes in temperature.
2.) Luminous efficiency is Low.
3.) Require large power for operation.
4.) Damage easily due to excessive current.

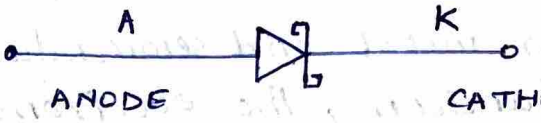
APPLICATION :-

1.) Used in optocouplers.
2.) Infrared remote control.
3.) Seven segment & dot matrix displays.

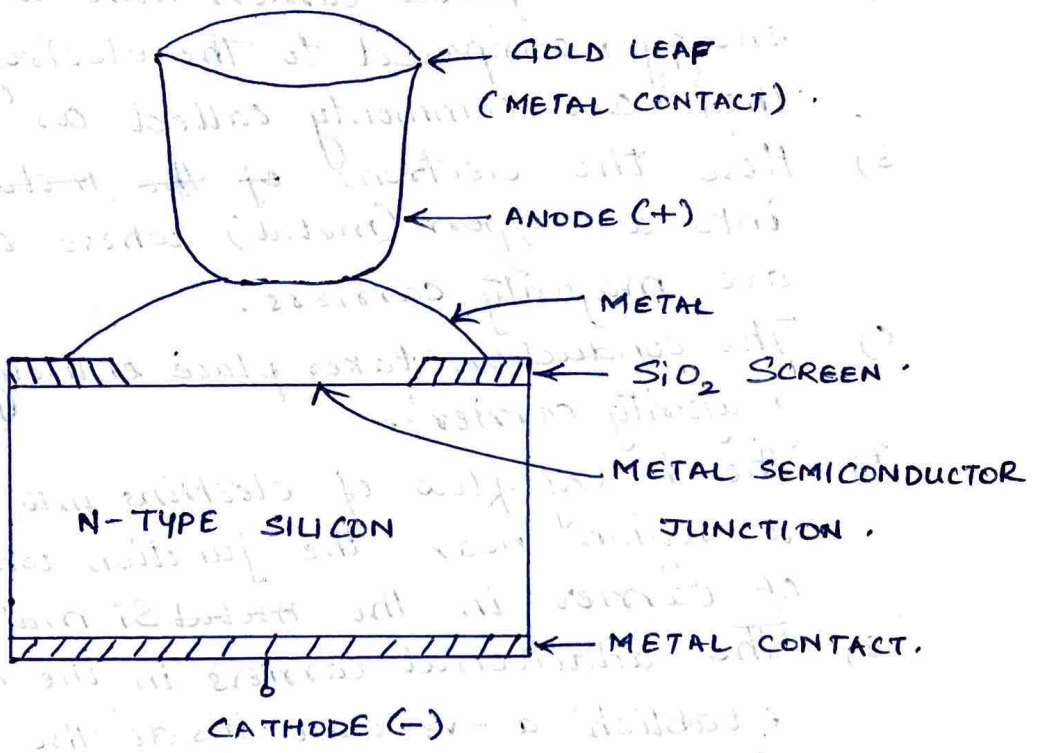
SCHOTTKY DIODE :-

Schottky diode is also called as 'surface barrier diode' or 'hot carrier diode'.

Symbol :-



Construction :-



1.) A metal semiconductor junction is formed between a metal and n-type semiconductor.
2.) Sometimes a p-type semiconductor is even used.
3.) The metals used are molybdenum, chrome, tungsten or platinum.
4.) Different construction techniques are used.
5.) The metal side acts as the anode and n-type semiconductor acts as cathode of the schottky diode.

Operation of Schottky diode :-

1.) On metal acting as anode and n-type semiconductor acting as cathode, electrons are majority charge carrier.

2.) When metal and semiconductor are joined to form a junction, the electrons in n-type material will flow in the adjoining metal.

3.) This establishes a heavy flow of majority carriers.

4.) Since the injected carriers have a very high kinetic energy, compared to the electrons of the metal, they are commonly called as 'hot carriers'.

5.) Here the electrons ~~of the metal~~ are injected into a region (metal) where electrons only are majority carriers.

6.) The conduction takes place entirely due to the majority carrier'.

7.) The heavy flow of electrons into metal creates a region near the junction which is depleted of carrier in the ~~metal~~ Si material.

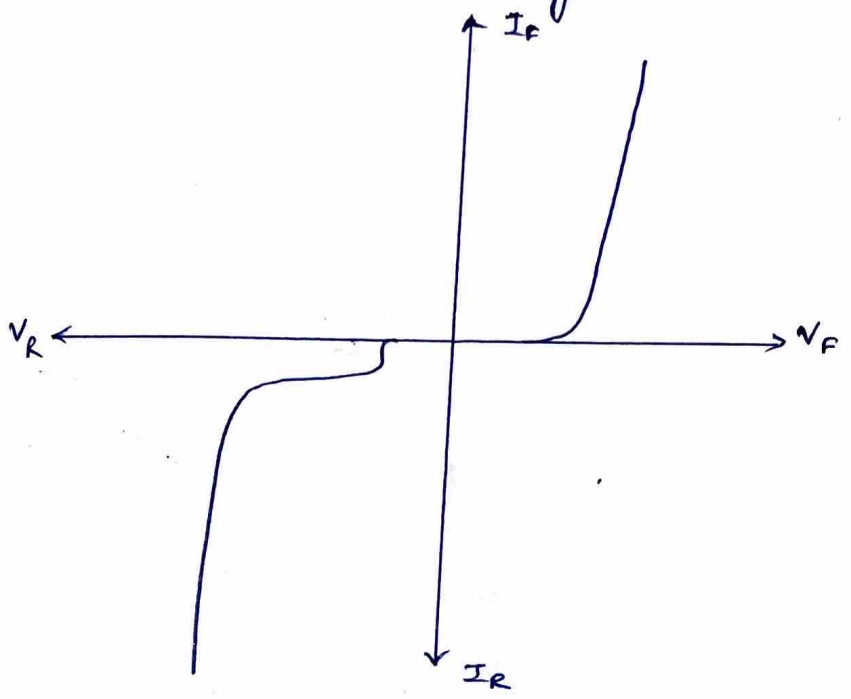
8.) The additional carriers in the metal will establish a -ve wall inside the metal at the boundary between the 2 materials.

9.) When -ve wall is created, it results in a surface barrier between the 2 materials.

10.) When the diode is forward bias the strength of the -ve barrier is reduced because the +ve terminal of the supply will attract $e^{\ominus}$s from p-side (metal).

11.) Due to this a heavy flow of electrons across the junction will begin.

V – I Characteristics of Schottky diode:-



1.) Schottky diode has a very low cut-in voltage (0.2 Volts) when forward biased.
2.) The reverse breakdown voltage of a schottky diode is less than that of a p-n junction diode. (Typically it is about 50V).
3.) The reverse leakage current is higher than pn junction diode. It flows due to the electrons in metal passing into the semiconductor material.

ADVANTAGES:-

1.) Low on state forward voltage drop.
2.) Higher switching speed. ($1GHz = 10^9 Hz$)
3.) Total power dissipation is less.

DISADVANTAGES:-

1.) Low reverse breakdown voltage.
2.) High leakage current.

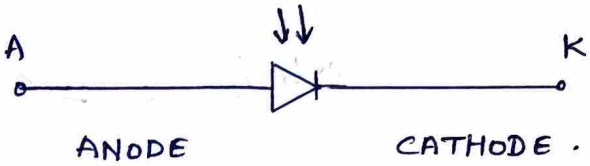
APPLICATIONS:-

1.) SMPS
2.) AC to DC converter
3.) Radar Systems
4.) Mixer & Detectors in communication equipment.

PHOTODIODE :-

Photodiode is a pn junction semiconductor diode which is always operated in reverse biased condition.

Symbol :-

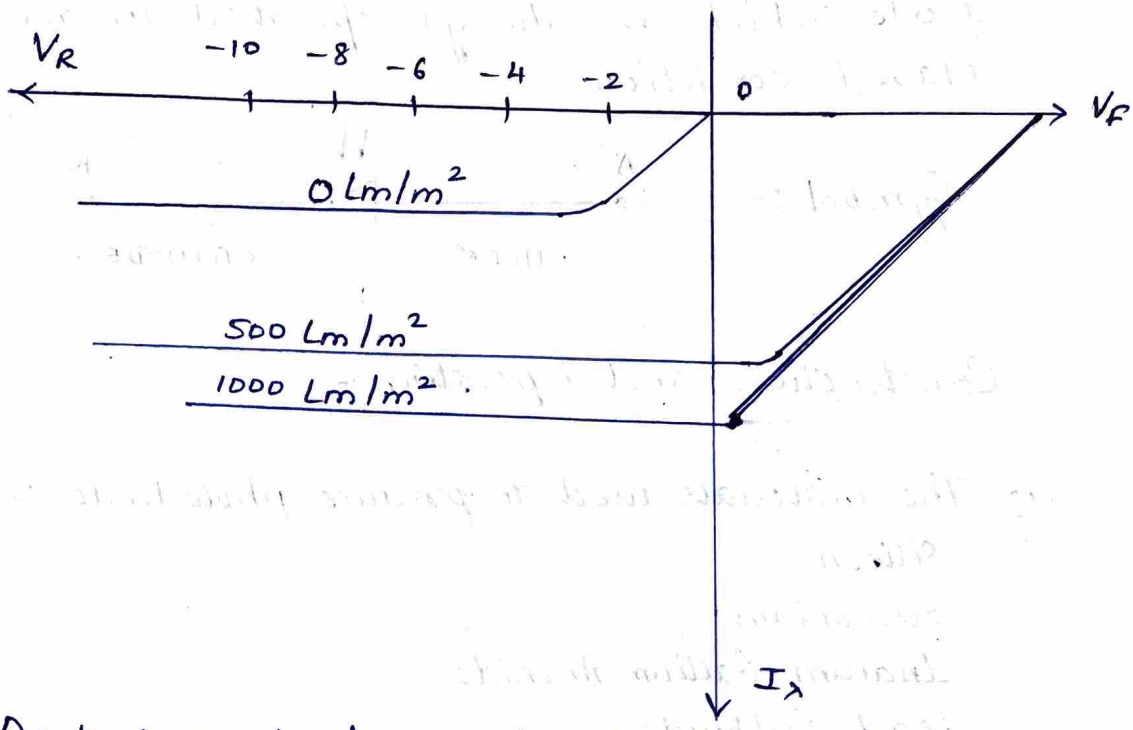


Construction and Operation :-

1.) The materials used to produce photodiode are
   Silicon
   Germanium
   Indium Gallium Arsenide
   Lead Sulphide.
2.) Photodiode is a p-n junction semiconductor diode which is always operated in reverse biased condition.
3.) The light is always focussed on the junction of diode through a glass lens.
4.) The width of the depletion region is quite wide as the photodiode is reverse bias.
5.) The photon incident on the depletion region will impart their energy to the ions present there and generate electron-hole pairs.
6.) The no. of $e^{\ominus}$ hole pairs produce will be dependent on the intensity of light (no. of photons).
7.) The $e^{\ominus}$s and holes will be attracted towards the +ve and -ve terminals respectively of the supply to constitute 'photocurrent'.
8.) As the light intensity ↑ses more no. of $e^{\ominus}$ hole pairs are generated and the photocurrent increases.

9.) Photocurrent is thus proportional to the intensity of light.

Characteristics of Photodiode.



1.) Dark current flows due to thermally generated minority carriers.
2.) Hence minority carriers increases with increases in temperature.
3.) The reverse current I_λ i.e; photocurrent depends only on the intensity of light incident on the junction.
4.) It is almost independent of the reverse voltage.

ADVANTAGES:-

1.) High sensitivity
2.) High speed of operation.

DISADVANTAGES:-

1.) Dark current ↑sc with ↑se in temperature.
2.) Poor temperature stability
3.) External bias voltage required.
4.) Amplification is required.

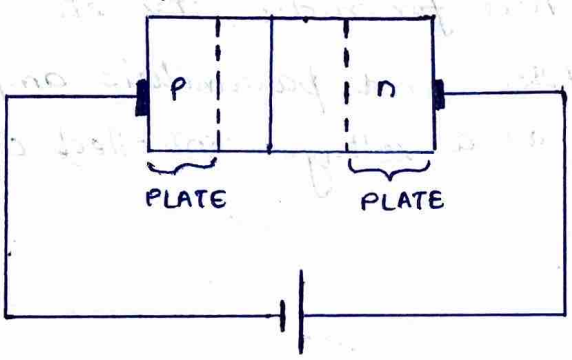
APPLICATIONS:- 1.) Used in cameras for sensing light intensity.
2.) fiber optic receivers. 3.) Light intensity meter.

VARACTOR DIODE :- (VARICAP, VOLTCAP, VOLTAGE VARIABLE CAPACITANCE).

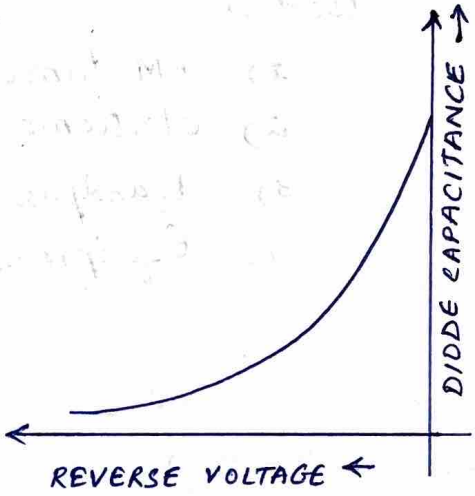
A varactor diode is a specialized p-n junction diode with a suitable impurity concentration profile. That changes its level of capacitance depending on the value of the reverse bias voltage applied to the diode. Its function is to store charge.

Symbol :-

Working of Varactor Diode.



Reverse biased p-n junction.



Capacitance Vs Reverse voltage.

1.) When a p-n junction diode is reverse biased, the depletion region acts as a capacitor dielectric.
2.) On the otherside of depletion region, the resistance of the p and n region gets reduced and acts like the plates of parallel capacitors.
3.) This junction capacitance is called Transition capacitance or space charge capacitance (C_T or C_{pn}).
4.) The junction capacitance

$$C = \frac{\varepsilon A}{d}.$$

where, ε - Permittivily of depletion region.
A - Area of junction & d - distance or width of DR.

NOTE:- In varactor diode, the capacitance parameter can be controlled by the method of doping in the depletion region.

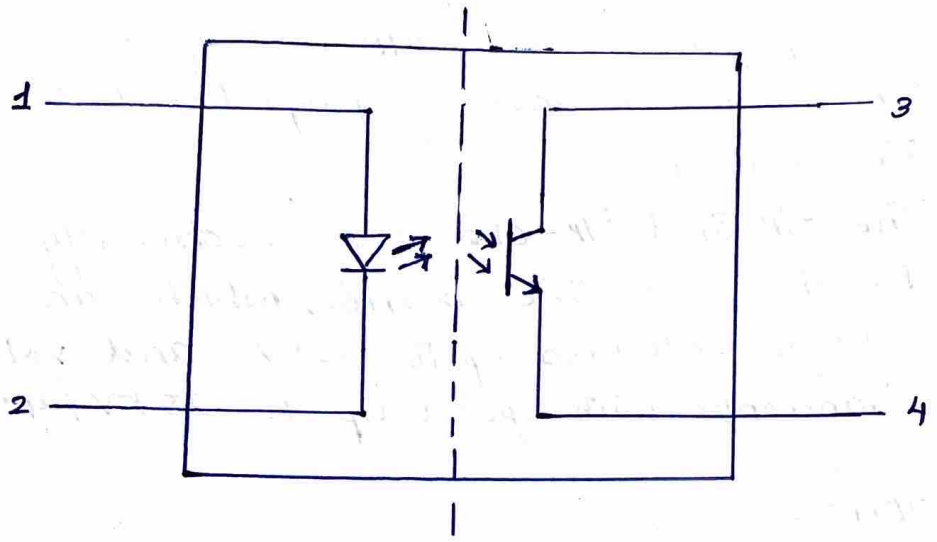
When the reverse bias voltage decreases the depletion region gets narrowed. This ↓ses the dielectric thickness, in turn, ↑ses the capacitance.

APPLICATIONS :-

Used in.

1.) FM tuner for automatic frequency control.
2.) Electronic tuners for radio, TV etc.
3.) Bandpass filter and parametric amplifier.
4.) Equipment as a voltage-controlled capacitor.

OPTOISOLATOR (OPTOCOUPLER)



OPTOISOLATOR.

1.) An optoisolator is an electronic component that transfers electrical signals between 2 isolated circuits by using light.

2.) Optoisolators consist of a light source, a light sensor, and a dielectric barrier that blocks electric current.

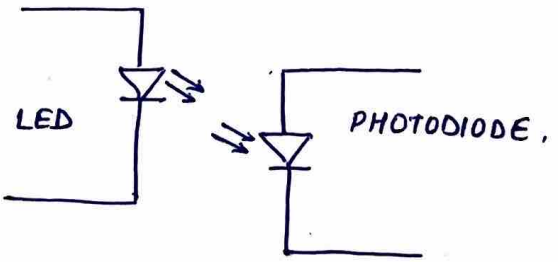
LIGHT SOURCE : LED.

LIGHT SENSOR : PHOTORESISTOR, PHOTODIODE OR PHOTOTRANSISTOR.

3.) The light sensor detects the incoming light and either generates electric energy directly or modulates the electric current flowing from an external power supply.

Working :-

1.) When I/P voltage is applied to the LED, it emits infrared light proportional to the I/P signal.



2.) The light travels across the dielectric barrier and reaches the phototransistor, which is reverse-biased.

3) The phototransistor converts light into electric current, which flows through the load resistor and produces an O/P voltage.

4.) O/P voltage is inversely proportional to the I/P voltage.

5.) The I/P and O/P ckts are electrically isolated by the dielectric barrier, which can withstand high voltages up to 10KV and voltage transients with speed up to 25 KV/μs.

APPLICATIONS:-

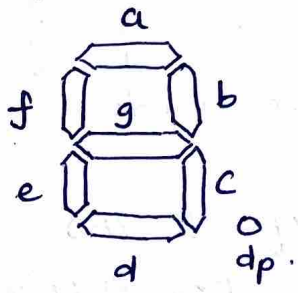
1) Power electronics:- Optoisolators can ctrl high-voltages or high-current devices. such as relays, motors, lamps, heaters etc.

2.) Communication:- Optoisolators enables data transmission blw different ckts or systems that have different voltage levels, gnd potentials, modems, telephone lines.

70, 80, 97,

SEVEN SEGMENT DISPLAY.

It displays numbers from 0 to 9 by turning on various combinations of the segments



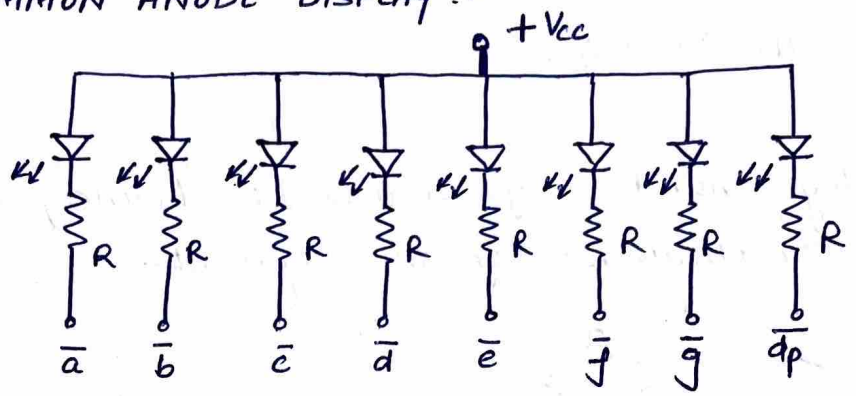
These segments are nothing but LED's.
By apply forward voltage to the segments, the segments are made to glow

Segments							Number	Display.
a	b	c	d	e	f	g		
ON	ON	ON	ON	ON	ON		0	
	ON	ON					1	
ON	ON		ON	ON		ON	2	
ON	ON	ON	ON			ON	3	
	ON	ON			ON	ON	4	
ON		ON	ON		ON	ON	5	
ON		ON	ON	ON	ON	ON	6	
ON	ON	ON	-	-	-	-	7	
ON	ON	ON	ON	ON	ON	ON	8	
ON	ON	ON	ON		ON	ON	9	

TYPES OF SEVEN SEGMENT DISPLAYS:-

There are 2 types of seven segment LED display
Common Anode
Common Cathode.

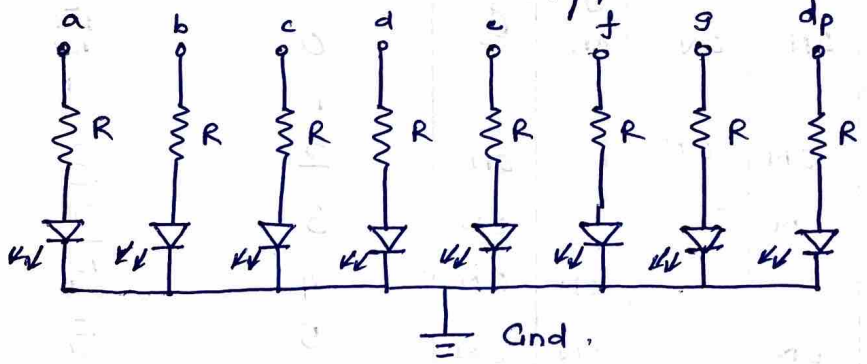
COMMON ANODE DISPLAY :-



Common anode.

The anode terminals of all LED segments are connected together to Vcc. i.e +ve supply voltage.
A current limiting resistor is externally connected in series with each segment.
The cathodes of segments to be turned 'ON' are connected to ground.

COMMON CATHOD DISPLAY.



The cathode terminals of all LED segments are connected together to Gnd. i.e -ve supply voltage.
A current limiting resistor is externally connected in series with each segment.
The anodes of segments to be turned 'ON' are connected to Vcc.