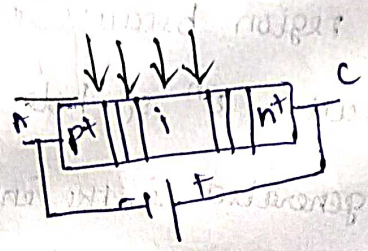
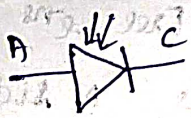
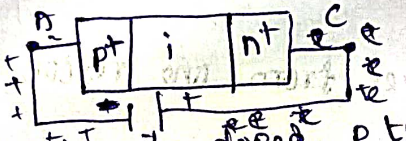
Pin diode:

* It is a type of photo detector.
* It converts light energy into electrical energy.
* PIN diodes are ~~speci~~ operate in reverse bias conditio
* PIN diode is very sensitive to light so when light falls on the photodiode it easily converts light into electric current.

Symbol:







Here p^+ → heavily doped p type semiconductor.

n^+ → heavily doped n type semiconductor.

i → undoped intrinsic semiconductor.
(highly resistive)

The intrinsic semiconductor is sandwitched btn p type & n type semiconductors.

Working:

PIN diode is madeup of P & n region seperated by a highly resistive intrinsic layer.

Intrinsic layer is placed btn P & n ~~because~~ region to ↑se width of the depletion region.

P & n are heavily doped, Therefore, P & n region of PIN diode has large number of charge carriers to carry electric current.

Intrinsic → undoped → It doesn't have charge carriers to conduct electric current.

under reverse bias condition, majority charge carriers in n type & p region move away from the junction.

As the result, the width of the depletion region becomes very wide.

When light (or) photon is applied to the PIN diode, the most part of the energy is observed by the intrinsic region because of wide depletion width.

As the result, e^{th} & hole pairs are created.

Free e^{ns} generated in the intrinsic region moves towards N side & holes moves towards P side.

Free e^{ns} moves from one region to another region cares electric current.

When forward bias is applied to the PIN diode it behaves as a "resistor".

When reverse bias is applied to the PIN diode it behaves as a "capacitance".

Advantages:

(i) wide band width
(ii) High response speed
(iii) High sensitivity to light
(iv) Low sensitivity to temp.
(v) Low cost
(vi) small size.
(vii) Long life time

disadvantage:

* PIN diode should always operated in reverse bias condition.
* Reverse bias voltage is low

Applications:

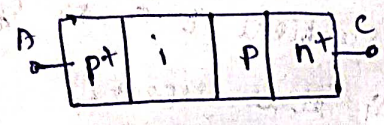
* In signal isolators.
* used as radio frequency switching
* used as photo detector.
* used as photo detectors in optical fibres
* In medical treatment (MRI)
* High voltage rectifier.

Avalanche photo diode:

It is the photo detector. It converts light energy into electrical energy.

It operates in reverse bias condition.

Symbol:



It is the four layer device.

p+ → heavily doped } There are very large no. of charge carriers and its resistivity is low

n+ → heavily doped

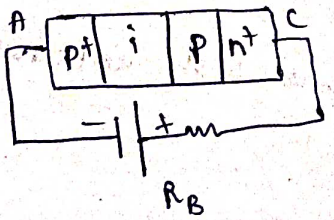
i → intrinsic layer.

p → lightly doped region.

p+ acts like anode

n+ " " cathode.

APD works like photo detector, when it operate in reverse bias condition.



when the light is applied, light enters into p+ region to i region, the photons are interact with atoms in the intrinsic region.

Because of interaction the e^{-} & hole pairs are generated in intrinsic region.

In Intrisic region the e^{-} & hole pairs experiences high electric field because of reverse bias.

Because of this high electric field, the e^{-n} moves toward P region & holes moves towards p^+ region.

e^{-n} drifted to P region will again experiences p^+ region very high electric field both P & n^+ region are accelerated e^{-ns} are accelerated due to high EF in P-n^+ function. They will get sufficient energy to emit secondary e^{-ns} in its path.

These secondary e^{-ns} has sufficient K.E to generate one more e^{-n} & hole pairs & it is repeated.

The process of generating more member of e^{-n} & hole pair is called "Impact Ionization".

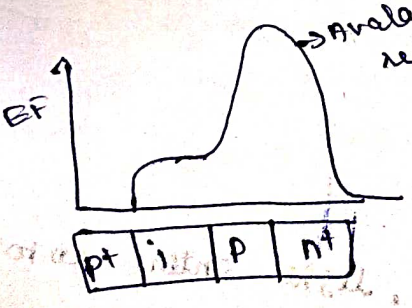
Because of impact ionisation → multiple charge carriers are produced.

Only the e^{-ns} will participate in the process of impact ionisation.

Every e^{-n} & hole pair has ability to generate the m no. of e^{-n} & hole pairs.

M → multiplication factor.

$I_p = q N_e^M$ ⇒ I_p → Photo current.
q → charge of e^{-n}.
N_e → no. of charge carriers



It has high internal gain

Application:

(i) High sensitivity (detect light in low intensity)
(ii) Very high response time.
(iii) ability to generate very high current.
iv) They have internal current gain mechanism

disadvantages:

- It requires very high voltages to operate
- O/P is not linear.