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UNIT 6: OPTICAL DETECTORS.

Photodector is one of the components used in the receiver circuit of optical fiber communication. It receives the modulated photon energy and converts it to electrical signal which is further processed to get the orignal message signal. Photodetectors are designed to meet very high standard of performance in term of high output at the wavelength of operation alongwith distortion free and noisless output. The detector should be insensitive to the variation of temperature, have large operating life cycle and suitable size and shape. Such a properties have been built in PIN diode or avalanche Photodiode so that the optical communication to long haul application at 40 terabits are possible today.

Note:- Photodetector are also known as Photodiode, it behave as a energy generator which converts light energy into electrical energy. This is the principle on which the solar battery is based.

When the junction of the Photodiode is illuminated and the applied reverse bias voltage reduces to zero, it is observed that a current flows in the circuit and a voltage develop across the terminal of the photodiode.

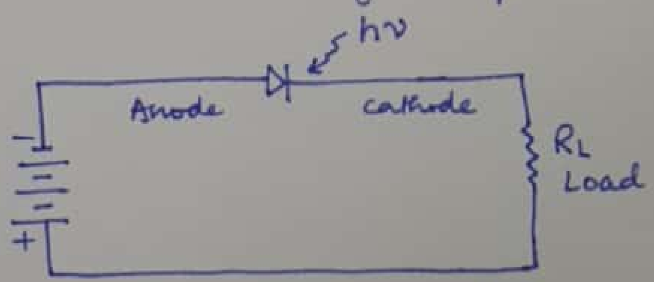
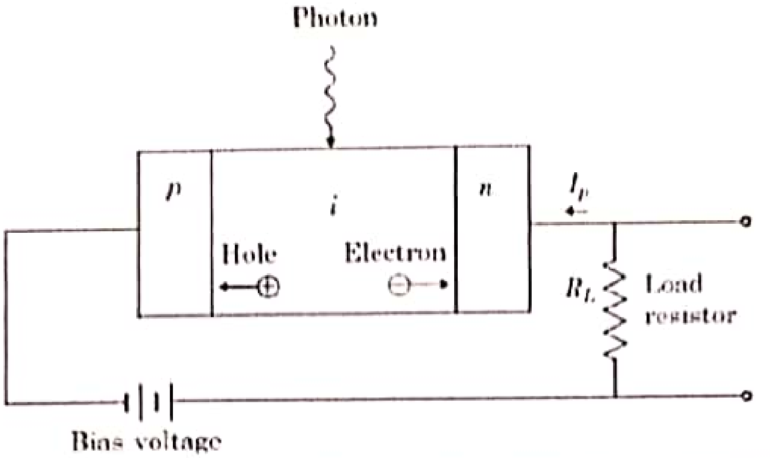


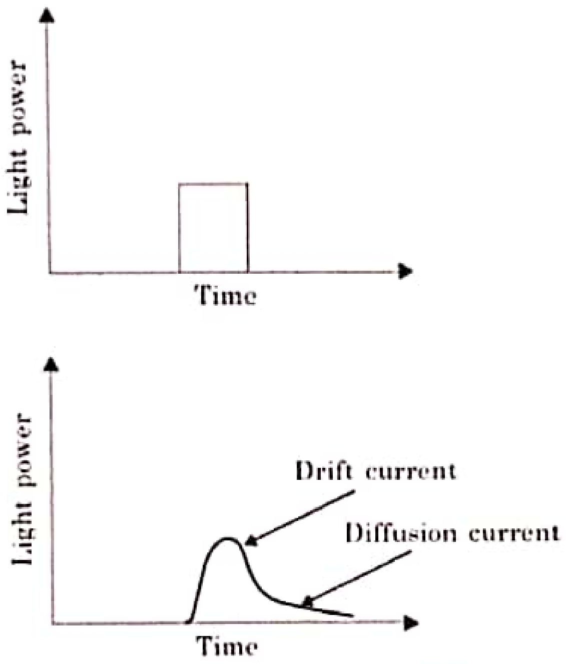
Fig: A basic circuit of photodiode.

PIN PHOTODIODE: The main characterstic of PIN Photodiode is that it consist of a thick, lightly doped intrinsic layer sandwiched between thin P and n regions. The term intrinsic means undoped. Thus, the full form of PIN is positive intrinsic negative.

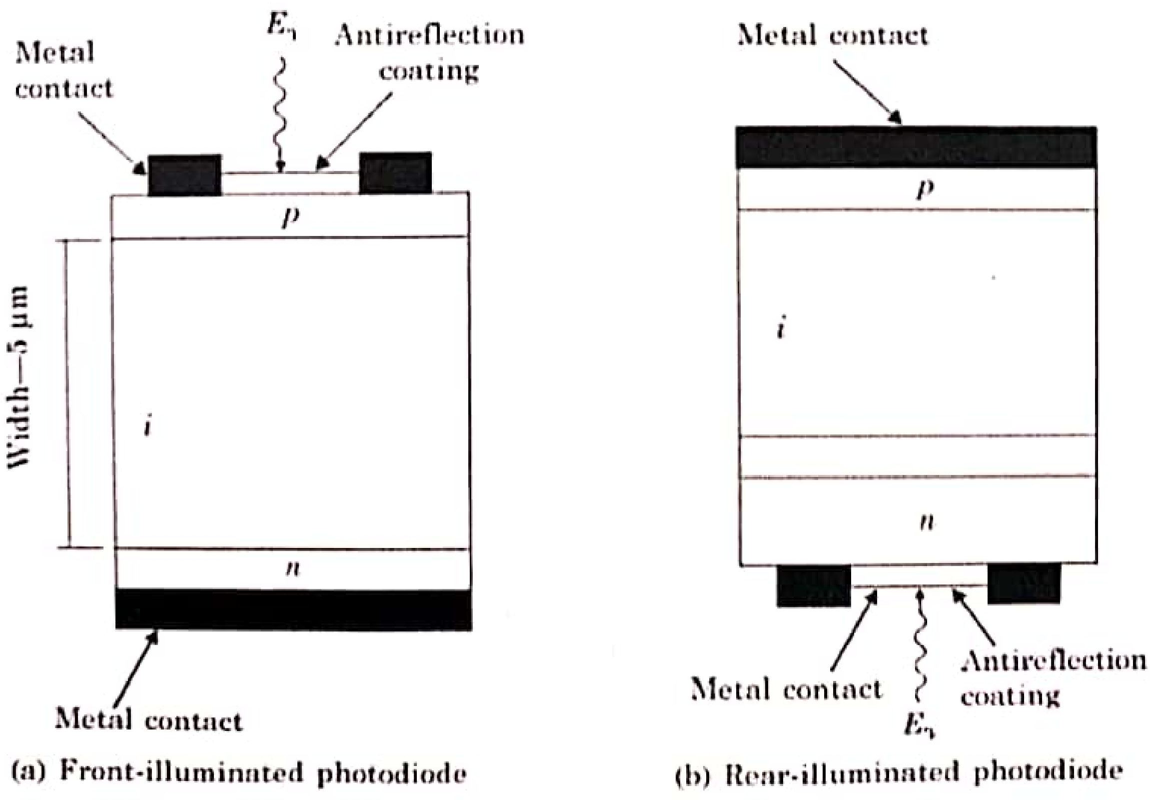
There are two major types of Photodiode
1. Front illuminated.
2. Rear illuminated.



Schematic representation of a PIN photodiode circuit with an applied reverse bias.



Input and output response.



PIN photodiode.

Since the intrinsic layer is wide, there is a high probability that incoming photons will be absorbed in it rather than in the P or N regions. Thus it has an improved efficiency and speed in comparison to P-N photodiode.

WORKING:

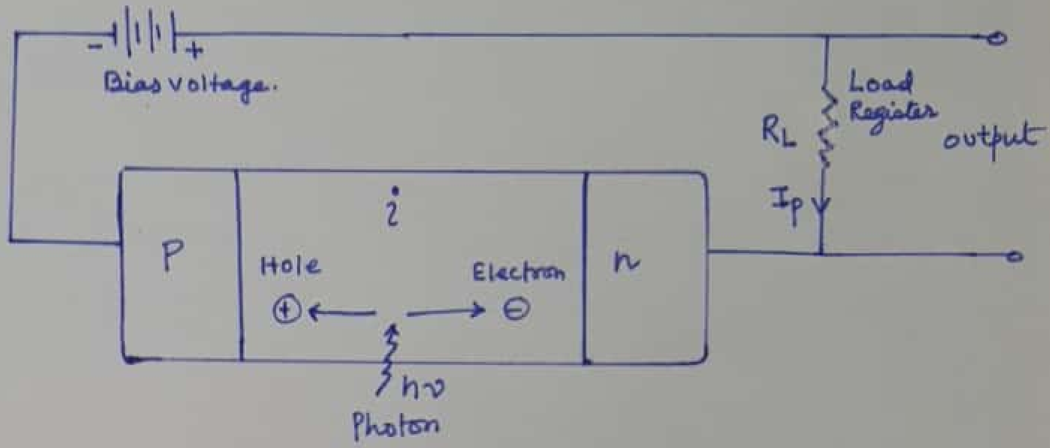
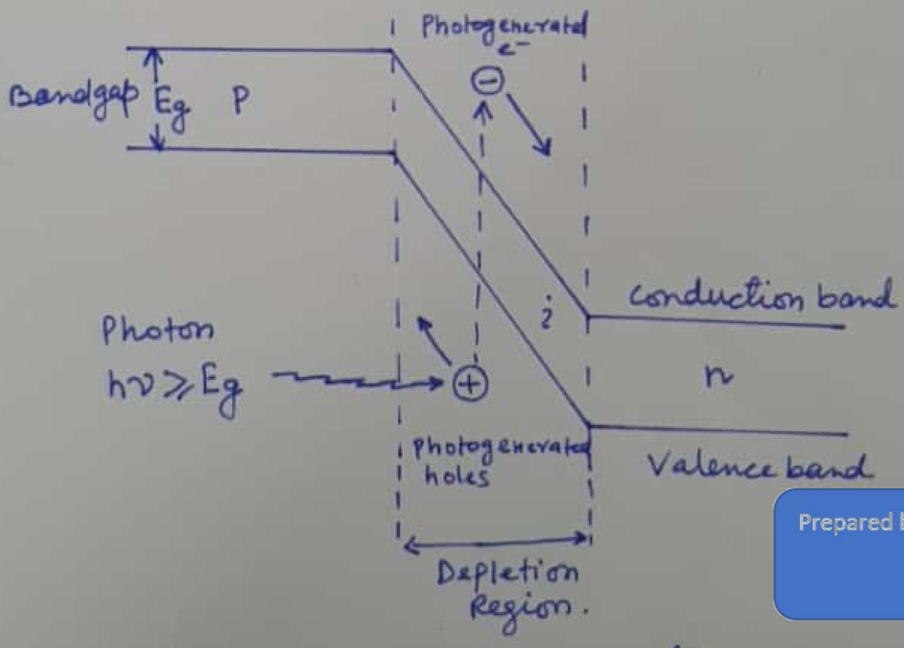


Fig: PIN Photodiode circuit with an applied reverse bias.



When an incident Photon has an energy greater than or equal to the band-gap energy of the semiconductor material, the photon can give up its energy and excite an electron from the valence band to the conduction band. This process generates free electron-hole pair which are known as photocarriers. Therefore photocarriers produces a Photocurrent, when a reverse-bias voltage is applied across the device. The Photocurrent "Ip" flows through external load Resistor and Produces electrical output signal. The distance moved by charged carrier is known as the "diffusion length" after travelling this distance the carriers recombine. The time taken for recombination is known as "carrier life time".

Diffusion length for electrons : $L_n = \sqrt{D_n \tau_n}$

Diffussion length for holes : $L_p = \sqrt{D_p \tau_p}$

where, D_n = electron Diffusion co-efficient in cm^2/s

D_p = hole Diffusion co-efficient in cm^2/s

τ_n = Carrier lifetime of electron

τ_p = carrier lifetime of hole