Photodiode and LED Circuits

A photodiode converts an optical signal into electrical current, and a light emitting diode (LED) transforms electrical current into an optical signal.

Photodiode Circuit

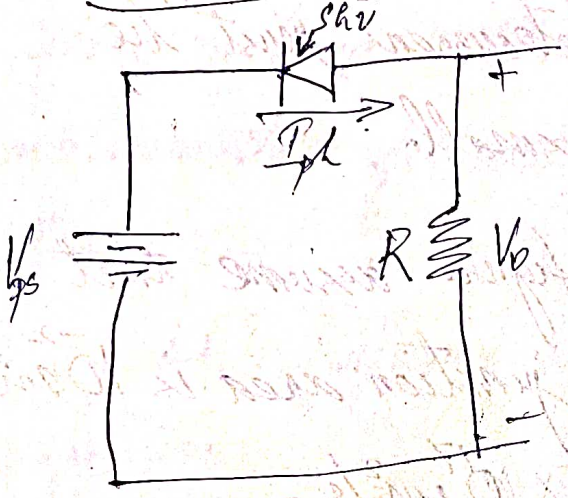


Figure shows a typical photodiode circuit in which reverse bias voltage is applied to the photodiode. If the photon intensity is zero, only the current through the diode is reverse saturation current, which is normally very small. Photons striking the diode create excess electrons and holes in the space charge region. The electric field quickly ~~sweeps and~~ separates these excess carriers and sweeps them out of the space charge region, thus creating a photocurrent in the reverse-bias direction. The photocurrent is

$$I_{ph} = \eta q \Phi A$$

where η is the quantum efficiency, q is the electronic

charge, Φ is the photon flux density (#/cm²-s) and A is the junction area. This linear relationship between photon current and photon flux is based on the assumption that the reverse bias voltage across the diode is constant. This in turn means that the voltage drop across R induced by the photocurrent must be small or that the resistance is small.

For the photodiode shown in figure assume that the quantum efficiency is 1, the junction area is 10^{-2} cm² and the incident photon flux 5×10^{17} cm²/s.

$$I_{ph} = \eta q \Phi A = 1 \times 1.6 \times 10^{-19} \times 5 \times 10^{17} \times 10^{-2} = 0.8 \text{ mA}$$

LED Circuit

A light emitting diode (LED) is the inverse of the photodiode; that is a current is converted into optical signal. If the diode is forward biased, electrons and holes are injected across the space charge region, where they become excess minority carriers. These excess carriers diffuse into the neutral n and p regions where they recombine with majority carriers, and

the recombination can result in the emission of a photon.

LEDs are fabricated from compound semiconductor materials such as GaAs and GaAsP. These materials are direct-bandgap semiconductors. Because these materials have higher bandgap energies than silicon the forward bias junction voltage is larger than that in the silicon based diodes.

LEDs always operate in the forward bias condition.