



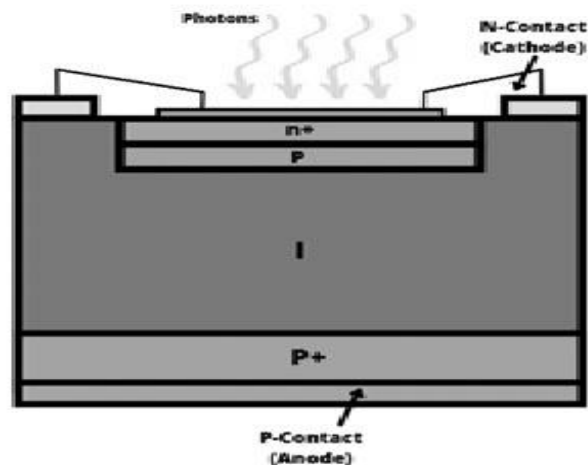
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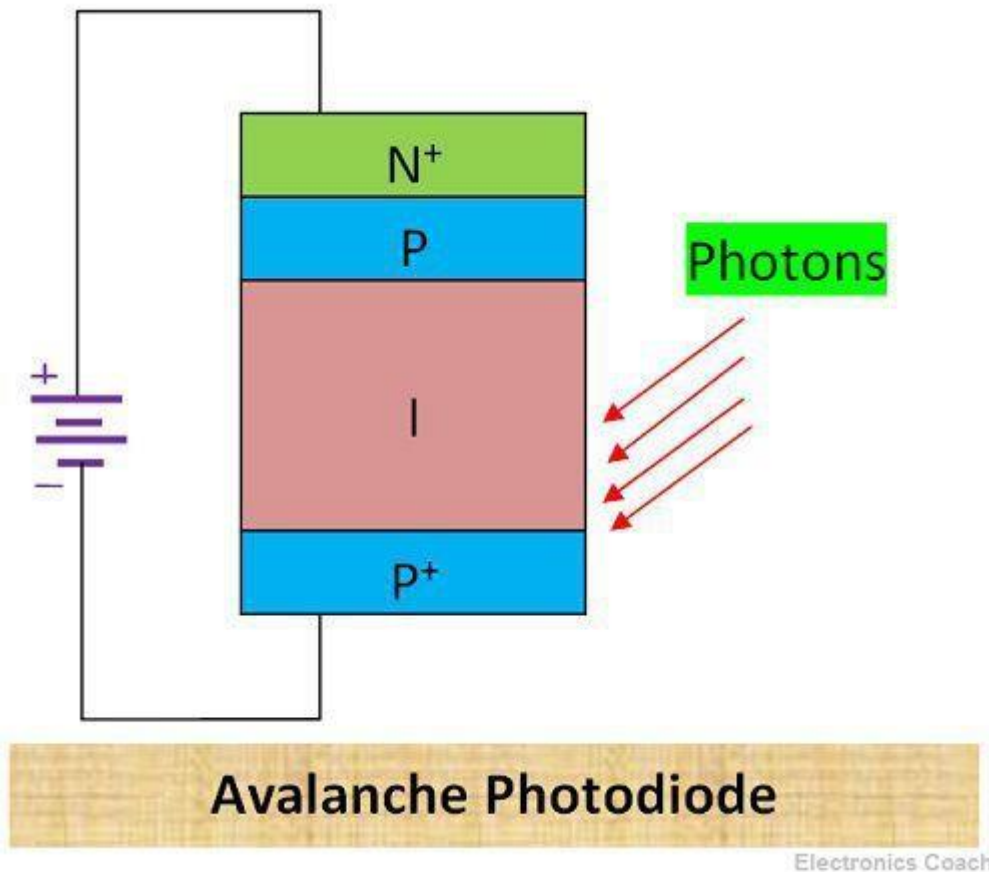
DEP. OF MEDICAL INSTRUMENTATION TECHNIQUES ENGINEERING

Lecture 12 : Avalanche photodiode (APD)

1. Avalanche photodiode : is the diode which uses the **avalanche method** to provide extra performance as compared to other diodes .
2. **An avalanche method is** a process in which a number of free electrons in a transmission medium are subjected to strong acceleration by an electric field then collide with other atoms of the medium, thereby ionizing them.
3. The construction of both the PIN photodiode and Avalanche photodiode is similar. This diode includes two heavily doped & two lightly doped regions. Here, heavily doped regions are P⁺ & N⁺ whereas lightly doped regions are I & P shown in Figure bellow:



4. Avalanche photodiodes are highly sensitive, high-speed-based diodes which works through applying a reverse voltage. When this diode is reverse biased then the depletion layer's width will be increased. So this decreases the response time. The reverse bias can cause a quick response time for this diode.



5. As compared to other photodiodes, this diode works in a high reverse bias condition. So, the avalanche action allows the gain of the photodiode to be enhanced several times to provide a high range of sensitivity.
6. As a comparison with PIN photodiode ..

Avalanche photodiode	PIN photodiode
the P terminal works as the anode and the N terminal acts as the cathode	The same
Response time is very high	Response time is lower
Internal gain is 200 dB	Internal gain is insignificant
Sensitivity is high	Sensitivity is low
High noise	Low noise
The reverse bias voltage is very high	The reverse bias voltage is very low
High-temperature stability	Low temperature stability
The amplifier is not necessary because of the available gain	The amplifier is mandatory due to not available gain.

7. Advantages of avalanche photodiode

- (1) The sensitivity range is high.
- (2) High performance
- (3) Quick response time
- (4) It detects low-intensity light

8. Disadvantages of avalanche photodiode

- (1) The required operating voltage is high.
- (2) The output of this diode is not linear
- (3) High range of noise
- (4) It uses high reverse bias for its proper operation

(9) Silicon-based avalanche photodiodes are sensitive in the wavelength region from ≈ 450 to 1000 nm (sometimes up to 1100 nm), i.e., at somewhat shorter wavelengths than for silicon PIN photodiodes.

(10) Depending on the device and the reverse voltage applied, the multiplication factor (also called *gain*) of silicon APDs can vary between 50 and 1000.

(11) For longer wavelengths up to roughly $1.7 \mu\text{m}$, APDs based on germanium or indium gallium arsenide (InGaAs) are used. These have lower current multiplication factors of 10 to 40.

(12) Typical applications of avalanche photodiodes include receivers in optical fiber communications, range finding, imaging, high-speed laser scanners, laser microscopy and some medical devices.

Receiver circuits

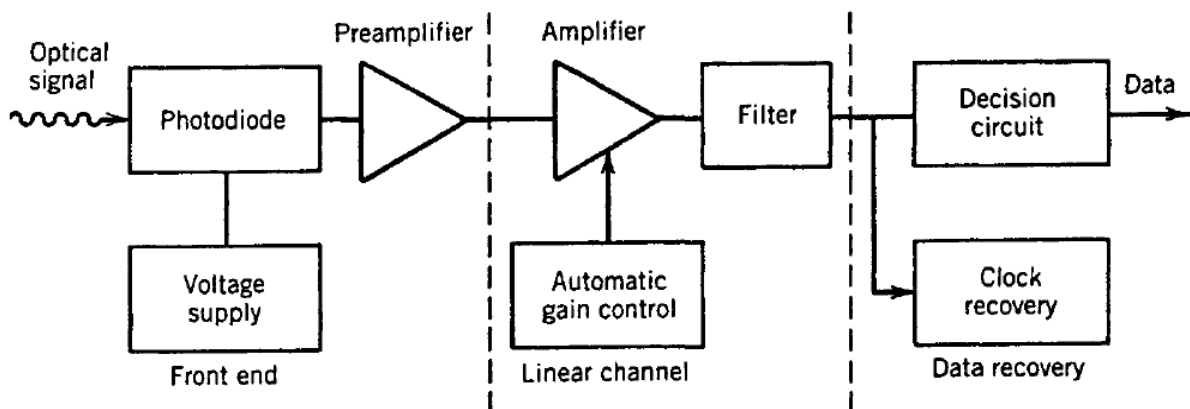


Diagram of a digital optical receiver showing various components. Vertical dashed lines group receiver components into three sections.

This figure shows a block diagram of such a receiver. Its components can be arranged into three groups - the front end, the linear channel, and the decision circuit.