Photodiode explained

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In this guide you are going to learn what a photodiode is, how it works, and more importantly, how you can use it in your own circuits. We"ll go through the basics, then build a fully working fire sensor circuit!

Did you know that there are two different ways to use photodiodes? Both of them are straightforward once you"ve learned them, but one is more common than the other.

A photodiode is a diode that senses light. It has two legs and comes in various shapes and packaging. When light hits a photodiode, current flows through it in one of two ways: either a small current is created from the light, or the light allows a larger current to flow through.

The photodiode symbol looks like the symbol for the light-emitting diode, except that its arrows point inward.

When you operate a photodiode without any bias voltage, shining light on it generates a small voltage across its terminals.

If you connect a resistor across it, a very small current flows through the resistor. This is called photovoltaic mode and works best in low-frequency conditions (i.e. when the light does not turn on and off really fast).

On the other hand, when it is reverse biased, i.e. the anode is connected to the negative voltage and the cathode to the positive voltage, it is in photoconductive mode. In this mode, it works more like a switch. Light on the photodiode "closes the switch" and current flows through the photodiode:

In this mode, it can switch on and off much faster. Photodiodes are usually used in this mode.

That said, the circuit above isn’t really a practical one since the current through the diode will be tiny (typically a few microamperes).

Internally, a photodiode has a p-n junction, which is formed when a p-type semiconductor material is fused with an n-type semiconductor material. A p-type semiconductor material has holes as positive mobile charge carriers, while an n-type semiconductor material has electrons as negative mobile charge carriers.

Since the p-n junction has oppositely charged mobile carriers, they neutralize each other and form a depletion region at the juncture. It is called a depletion region because it is devoid of any mobile charge carriers. The part of the p-type material in the p-n junction is devoid of holes, so it becomes negatively charged. Similarly, the part of the n-type semiconductor in the p-n junction becomes positively charged.

When photons - or light - of sufficient energy fall on the p-n junction of the photodiode, they break and ionize

the covalent bonds of the immobile atoms. This generates new electron-hole pairs. This phenomenon is called the photoelectric effect. The generated electrons are swept toward the n-type material (because the depletion region of the n-type material is positively charged). The holes are swept towards the p-type material (because the depletion region of the p-type material is negatively charged). This flow of charge leads to photocurrent or simply current.

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