

Photodiode as current source

Student Group

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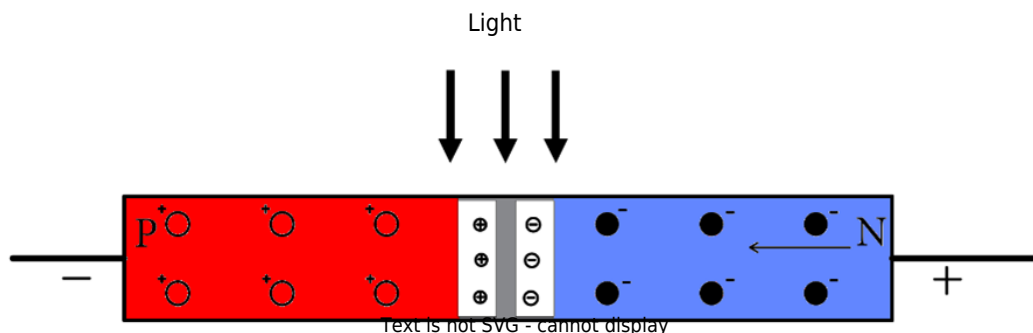
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Photodiode as current source

A photodiode is a special type of diode which, **in the absence of light**, exhibits a **current-voltage relationship** very similar to that of a standard diode (see the **dark current** characteristic in the **I-V diagram**).

When illuminated, it generates additional electron-hole pairs within the crystal.



Photodiodes are often operated **in reverse bias, where** the charge carriers (electrons and holes) generated by the incident light cause an increased **reverse** current flow (**third quadrant** of the I-V diagram). The higher the light intensity, the greater the reverse current. **Forward bias operation** is also possible, where the photodiode behaves like a solar cell (**first quadrant** of the I-V diagram).

Applications include remote controls (IR range), galvanic isolation (optocouplers), light measurement, positioning, and light barriers.

Fig. 1: Inverting Op-Amp: Operating principle of a photodiode

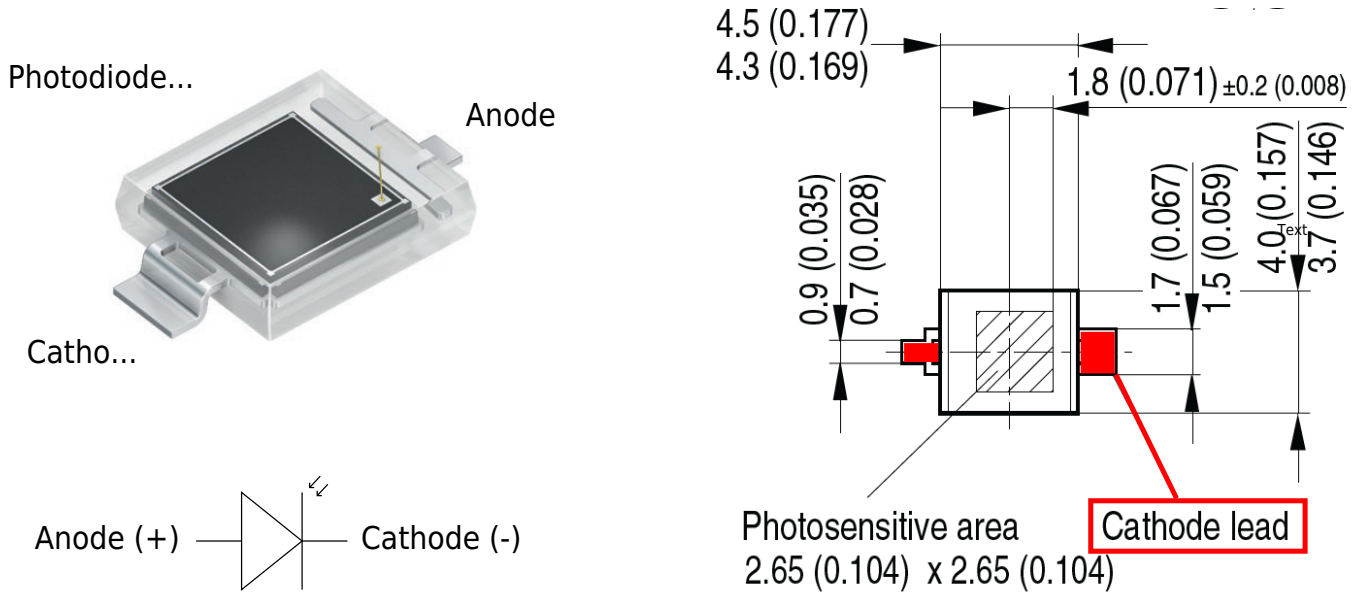


Fig. 2: Inverting Op-Amp: Photodiode BPW 34 S

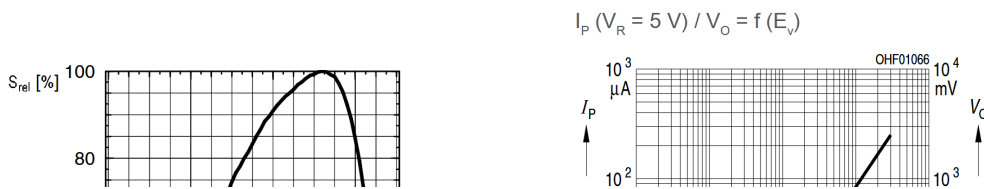


Fig. 3: Inverting Op-Amp: Diagramms of BPW 34 S

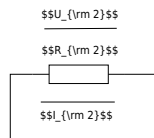


Fig. 4: Inverting Op-Amp: Photo Diode as current source

$$U_{DD} = 10\text{ V}, U_{SS} = -10\text{ V}$$

We are assuming a well-lit room with an illuminance of 300 lx, lit by a white LED. White light is a mixture of many wavelengths across the visible spectrum, roughly 380 to 780 nm. For a typical white LED, the spectrum usually comes from a blue LED chip with a peak around 450 nm, plus a broader phosphor emission that spreads across green, yellow, and red wavelengths. For an easier calculation, we take a mean value of 500 nm which is close to the peak value of the blue LED and 300 lx for the illumination. (500 nm is in reality a greenish light and not blue)

The graph in [figure 3](#) shows that the photodiode sensitivity at 500 nm is only 30%. The maximum current (100%) at 300 lx is 30 μA .

We can now estimate the current we would expect from the photodiode at 300 lx:

$$I_1 = 30\ \mu\text{A} * 0.3 = 9\ \mu\text{A}$$

$$I_1 \approx 10\ \mu\text{A}$$

30% of 30 μA is roughly 10 μA .

We will assume a current of 10 μA at 300 lx for our calculations.

Complete the arrows in the circuit diagram in [figure 4](#).

Calculate R_2 so that $U_{OUT} = 5\text{ V}$ at 300 lx. Take a resistor from the E6 series that is as close as possible to the calculated value.

Also enter the values for I_1 , I_2 , U_2 and U_{OUT} .

I_{1}

I_{2}

U_{2}

U_{OUT}

R_{2}

What value would you expect for U_{D} in figure 4 and why?

U_{D}

$\{\text{rm}\}$

$\{\text{rm}\}$

$\{\text{rm}\}$

$\{\text{rm}\}$

$\{\text{rm}\}$

$\{\text{rm}\}$

What value would you expect for U_{D} at 300 lx when the photodiode is not connected to the Op-Amp or any other electronic component (open-circuit voltage) and why?

$U_{\text{D}} \approx$

mV

mV

mV

mV

mV

mV

Measure or calculate the values given in the table below.

| Illumination | U_{OUT} [mV] | I_{1} [μA] | I_{2} [μA] | U_{D} [mV] | U_{D} [mV] |
|--------------|-----------------------|----------------------------------|----------------------------------|---------------------|---------------------|
| dark... | | | | | X |
| 300 lx... | | ... | | | |

Tab. 1: Photodiode measured and calculated values

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Last update: **2026/04/29 09:57**

