6. photodiodes
Photo diodes are often used as counterparts to LEDs. Here some brief information about PDs:

6.1. sensitivity or responsivity
The sensitivity of a photodiode is defined as the ratio of generated photocurrent (I_{ph} in Ampere) to the incident radiation power (P in Watt) at a given wavelength:

$$s\ (\lambda) = I_{ph}\ /\ P\quad (A/W)$$

6.2. operation modes of PDs

6.2.1. photoconductive mode
In photoconductive mode, an external reverse bias is applied. The measured output current is linearly proportional to the incident optical power. This mode produces a very linear response, high electrical bandwidth and a somewhat higher dark current.
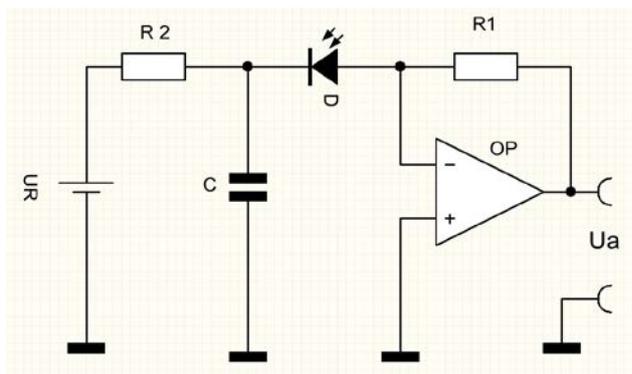

Fig. 1. Photodiode in photoconductive mode (with operational amplifier).

6.2.2. photovoltaic mode
In photovoltaic mode the photodiode is zero biased. The flow of current out of the device is restricted and a voltage builds up. This mode of operation exploits the photovoltaic effect, which is the basis for solar cells. The amount of dark current is kept at a minimum when operating in photovoltaic mode.
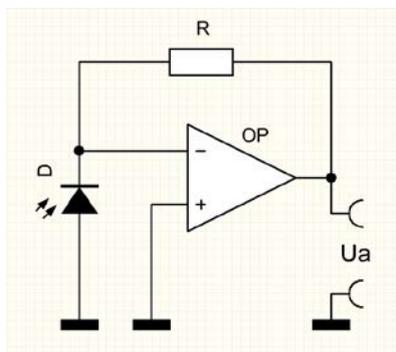

Fig. 2. Photodiode in photovoltaic mode (with transimpedance amplifier).

6.3. rise and fall time

Switching time of photo detectors strongly depends on the measurement conditions. There are two major conditions: reverse bias and the value of load resistor used in the circuit. Switching time of a photo diode varies by two orders of magnitude when the load resistor value changes from 50 Ω to 10 kΩ. The lower the value of the load resistor, the faster the diode becomes. Also, the higher the reverse bias, the faster the switching times.

Rise time is the time taken by a signal (output power) to change from a specified low value (10%) to a specified high value (90%). Fall time is the time taken by a signal to change from a specified high value (90%) to a specified low value (10%).

6.4. spectral bandwidth: $\Delta\lambda_{0.5}$ and $\Delta\lambda_{0.1}$

The bandwidth of the detector can be defined by using a relative spectral sensitivity value of 0.5 or 0.1. EPIGAP datasheets show one of these values. In the case of the EOPC-300-1.5 the bandwidth $\Delta\lambda_{0.5}$ shown in the datasheets graph is about 100 nm (from 240 nm to 340 nm).
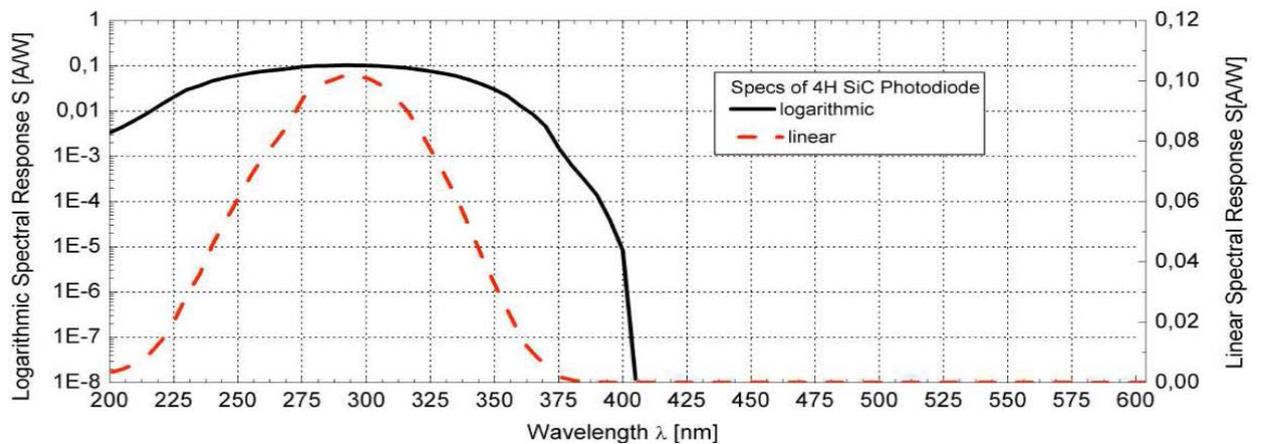

Fig. 3. Spectral response of 4H Sic photodiode in linear and logarithmic scales.

6.4. parameter spread of photodiodes

Photodiodes have parameter spread. Below a typical distribution of photocurrents of SiC photodiodes at constant illumination at 275 nm is shown. One should consider this effect when designing electronics like photocurrent amplifiers etc.
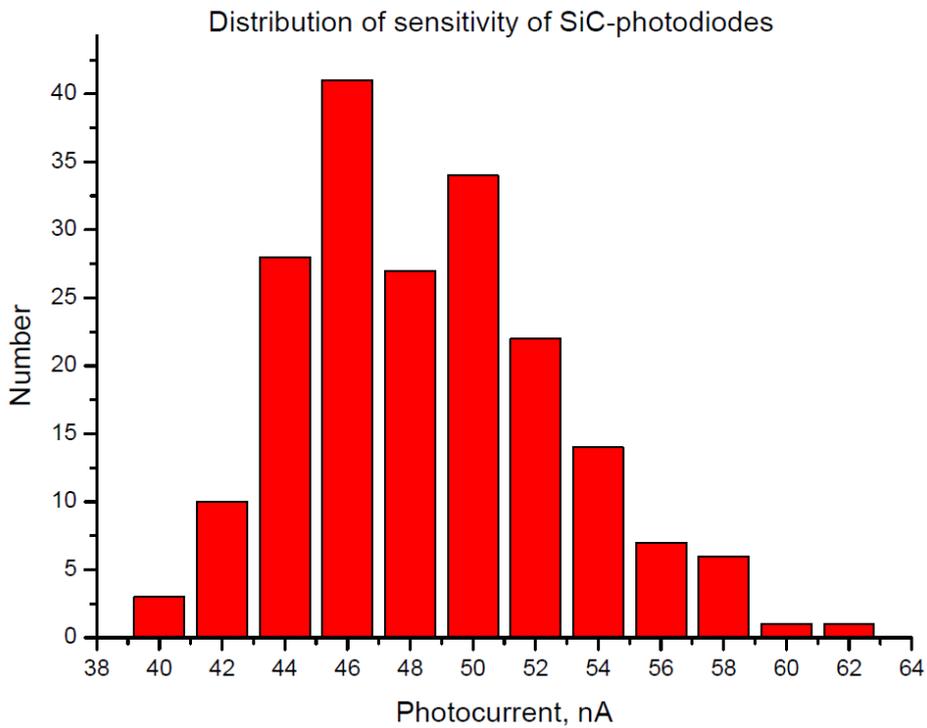

Fig.4. Typical distribution of sensitivity of SiC photodiodes.

The binning of photodiodes is possible, but uncommon.