Collecting light power: voltaic or conductive?

Bonnie Baker - October 19, 2012

Photovoltaic versus photoconductive terminology for photodetecting circuits has always been confusing for me. My research shows that others share my confusion.

In photoconductive mode, a photodetector has a consistent voltage impressed across the anode and cathode of the diode. The constant voltage can range from approximately 0V (less than 20 mV) to hundreds of negative volts. Higher negative voltages across the photodetector decrease the diode’s parasitic capacitance, which in turn increases the system’s frequency response. At a given reverse bias voltage, the magnitude of the parasitic capacitance remains constant.

The trade-off for this improvement in capacitance is an increase in the dark current through the diode. The configuration in Figure 1a creates a very linear response in terms of the irradiance of the light source and the resulting magnitude of the photodiode current ($I_{ph}$).

![Figure 1](image)

**Figure 1** A photoconductive circuit, with zero bias voltage or a reverse bias voltage (a), uses a transimpedance amplifier circuit to convert the light-generated current to voltage. A photovoltaic circuit, with no voltage impressed across the photodetector (b), generates its own voltage and current because of light hitting the photosensor element.

A photovoltaic diode (or solar cell) generates electrical power from solar radiation. The solar cell converts solar rays into a direct current (Figure 1b) that forward biases the diode and creates an output voltage. In this configuration, the output voltage versus the photocurrent is nearly logarithmic (Figure 2), as would be the case with any diode. This logarithmic response gradually gets more linear as the load resistance decreases.
Three basic types of photodetectors are available today: PDs (photodiodes), PIN-PDs (positive-intrinsic-negative PDs), and APDs (avalanche PDs). A PD is an ordinary PN-junction diode. The PIN-PD has an intrinsic (undoped) region between the N- and P-doped regions. This feature provides a thicker depletion area, leading to lower capacitance and wider bandwidths. APD designs support high reverse bias voltages (tens to hundreds of volts). For best results, bring the reverse bias voltage to just below the diode’s breakdown voltage, creating an amplification factor. An APD can achieve very high detection bandwidths.

This is just a short overview of uses for the many types of photodetectors available in the market. I imagine that you have had some experience with this topic. If you’ve used a photodiode in a system, I’d love to hear about it. Experts are welcome to offer additional comments or suggestions.

References


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