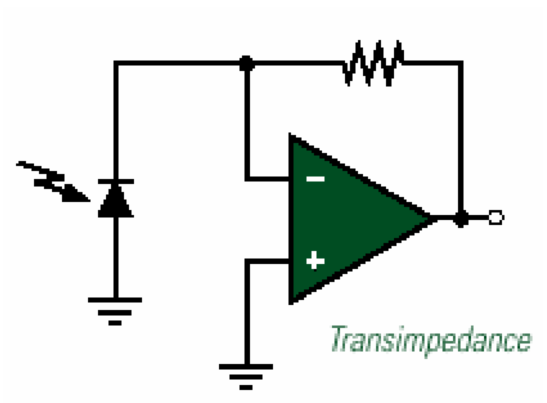
Measurement of Photodiode Currents

Photometric measurements for industrial, test, analytical, laboratory, photographic, and general light detection have many similar requirements to those in high-speed optical communications systems. Best results depend on how the photodiode is used and the amplifier techniques that follow it.

Many light sources produce slow variations but often have wide dynamic range up to 8 decades or 160dB. In contrast, fiber optic transmission systems have high bandwidth and also wide variation in optical power level. There are many ways to optimally configure a photodiode circuit.

A common technique utilizes a transimpedance amplifier in which a short circuit is forced across the photodiode. This keeps the photodiode's dark current and the associated noise and temperature drift low but results in higher photodiode capacitance. Therefore, the zero-bias technique is used for relatively slow systems where optical power levels vary from very tiny to very large. For faster systems, a reverse-biased photodiode circuit is commonly used. This results in smaller photodiode capacitance but dark current, temperature drift and noise are increased. To keep errors to a minimum, the bias voltage must be very clean; meaning low noise and good temperature stability. In certain very fast systems that use an avalanche photodiode with a large active optical light gathering area, reverse bias is mandatory.

In addition to diode-biasing, different types of transimpedance circuits are employed. One is an op amp with a resistor in the feedback loop. This produces a linear, continuous response of output voltage to input current. Spike transitions will occur, however, if the feedback resistor is switched to other values to change the gain during signal acquisition.



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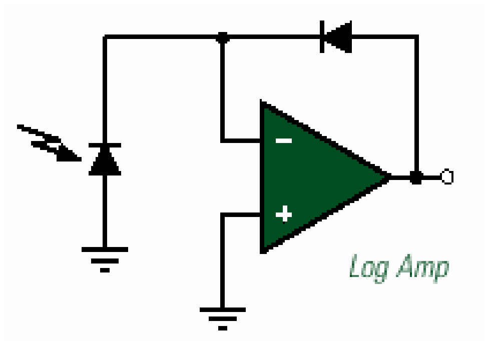
Another approach is the logarithmic amplifier with a diode in the op amp's feedback loop. This produces a continuous non-linear response of output voltage to input current. It has the unique ability to apply high gain to low-level signals, while providing low gain to high-level signals. It's like a smooth automatic gain circuit without switching transitions that does not disrupt the signal at any time.



Yet another approach is the switched integrator with a capacitor in the feedback loop. It has the advantage of integrating the noise and allowing easy ability to change gain by simply altering the time allowed for the capacitor to charge. Output voltage depends on how long the capacitor is allowed to charge. In fact it is easy to change the gain by simply changing the charging time. The switched integrator configuration is used as an analog front end in the direct digital converter (DDC) where the analog output voltage is directly converted into a high-resolution digital word on the same chip.