BY BONNIE BAKER

Photosensing with ambient background

Trying to shield ambient light from your photo circuit is not a trivial task. You would think that you could just cover your circuit with your hands, but that is not a solution: Pulse oximeters depend on the translucency of flesh. Covering the photosensor with black electrical tape doesn't work, either, because light is somehow able to get through even that material.

So it is fair to say that ambient light can be a problem in some light-sensing applications. **Figure 1**'s oscilloscope photo of A_1, a dual-supply, transimpedance amplifier, shows a square-wave light signal in the presence of background light. This environment creates a dc offset voltage of approximately 3.5V referred to the output. The transimpedance amp has a built-in offset due to the fact that the photodiode can conduct current in only one direction. The combination of ambient light and the amplifier's built-in offset makes a total offset of about 7.5V, which you may be able to calibrate from your system. However, you are using only one quadrant of the amp's output range. Further, when the measured light signal increases to maximum intensity, the amplifier's output starts to saturate.

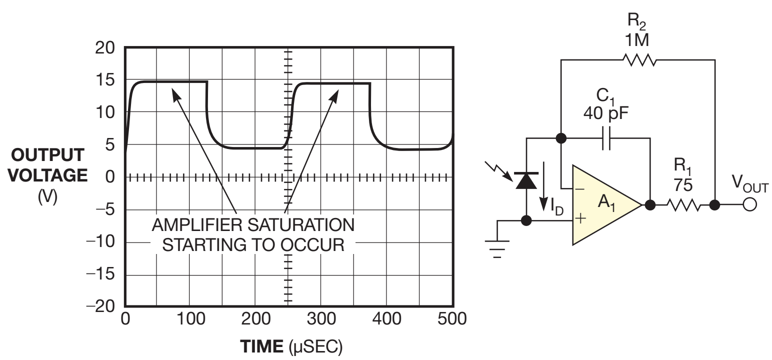

Figure 1 The output range of a transimpedance amplifier spans only one quadrant.

A dc-restoration circuit, A_2, comprises a noninverting integrator driving the summing junction of the transimpedance amplifier through R_5 (**Figure 2**). The current through R_5 cancels the current from the photodiode at frequencies below the integrator's signal-zero frequency. In **Figure 2**, the signal-zero frequency from the dc-restoration circuit is $R_2/[R_5(2\pi R_4C_4)]$. You adjust this zero by changing R_5. This dc-restoration circuit requires that the portion of the signal zero that R_3 and C_3 generate matches that of R_4 and C_4. The transimpedance amplifier's output signals above the signal-zero frequency do not feed directly back into the transimpedance amp's summing junction.

The value of R_5 depends on the relationship between the signal-zero frequency and the signal-pole frequency. The signal-pole frequency in this circuit is $1/(2\pi R_2C_2)$. If the output of the dc-restoration amplifier is 10V, a higher-than-100-kΩ resistor value for R_5 decreases the signal-zero frequency and increases the dc-restoration range. Combining the signal-pole and signal-zero frequencies distorts the output signal with R_5 values below about 10 kΩ.

By using the dc-restoration circuit, the transimpedance amplifier's output reaches approximately 0V. The dc-restoration circuit also brings the transimpedance amplifier's output signal into the linear region of A_1's operation. EDN

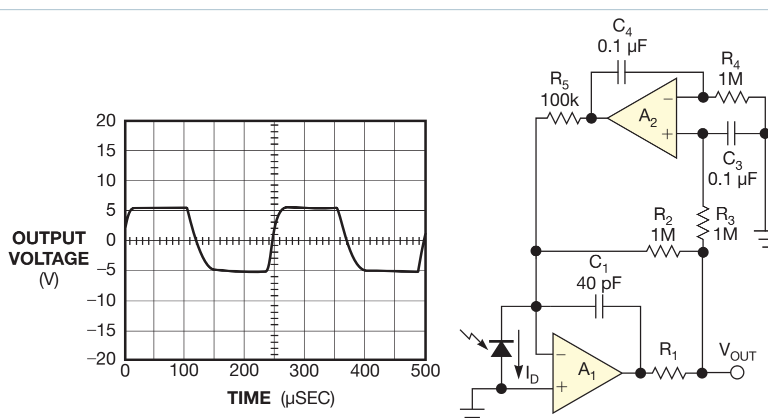

Figure 2 A dc-restoration circuit expands the output range of a transimpedance amplifier across both quadrants.

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