Circle 521

Ultra-Sensitive Photosensor Ignores Ambient Light

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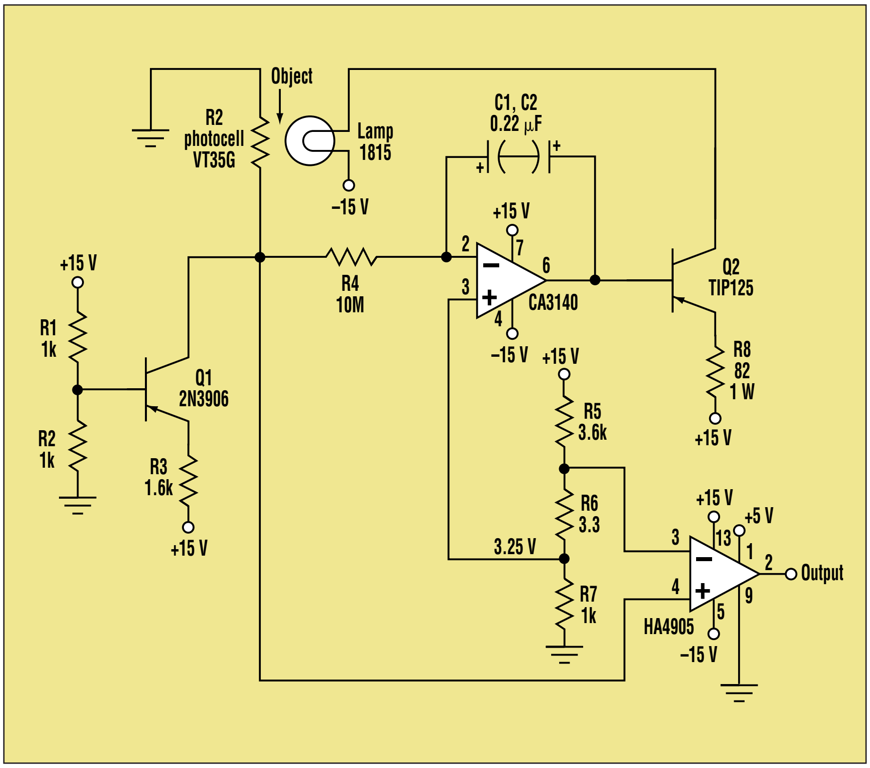
Since photosensors must not trigger on ambient light changes, it limits their sensitivity. That's because large ambient light variations cause large changes in photocell resistance and sensitivity. In attempts to increase sensitivity, users typically resort to shielding, filtering the ambient light, or restricting the application. Ambient light changes are slow, so the circuit described here combines this characteristic with electronic feedback to produce an ultra-sensitive photo detector.

With the lamp voltage set at 9 V, the change in photocell resistance from ambient room light to dark is 100 Ω (from 600 to 700 Ω). The resistance change generated by clear plastic moving between the cell and light



The circuit shown utilizes electronic feedback to produce an ultra-sensitive photo detector.

is 20 Ω. The only way to sense the plastic under all light conditions is to make the cell resistance independent of ambient light changes. A dc-coupled circuit accomplishes this by varying the lamp voltage to compensate for ambient light changes.

The current source (Q1) shown in the figure biases the photo cell with 5 mA, and this yields a cell voltage of 3.25 V for the average cell resistance of 650 Ω. The divider string consisting of R5, R6, and R7 puts 3.25 V on the noninverting lead of the CA3140 op amp. The CA3140 was selected for the op amp because it has very small input currents required for an integrator. The integrator causes Q2 to push current through the lamp until the voltage at the inverting lead of the op amp equals 3.25 V.

The integration time constant consists of R4 and the series combination of C1 and C2. C1 and C2 are connected in series to create a large-value, non-polarized capacitor. The integration time constant is 110 seconds, so the feedback loop can only respond to very slow changes in the light level. The loop is fast enough to correct for ambient light changes, but when the plastic moves rapidly between the lamp and the cell, the cell responds by producing a positive 100-mV change across the photocell. When the time constant is selected to be as fast as ambient light changes allow, fast signals have no discernible effect on the feedback circuit.

The voltages at both op-amp inputs are equal at 3.25 V when no signal is present. No current flows through R4, so the voltage drop across R6 biases the comparator output to the low state. The HA4905 comparator was chosen for this application because it can sense input voltages close to the 15-V supply rail, yet it still has a logic-compatible output voltage. The current flowing through R6 generates 10.7 mV of bias, which is large enough to overcome voltage and current offsets.

The 100-mV signal resulting from the clear plastic passing between the lamp and cell overcomes the bias causing the output voltage to go high. There's no capacitor in the signal path, thus there are no recovery time problems associated with this design.

This circuit preserves the photocell sensitivity across a wide range of ambient light changes. It has been adapted for interior and exterior use. Moreover, the sensor can be adjusted to sense the presence of clear glass.