Hack into a stopwatch to make a phototimer

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The exposure tester in this Design Idea measures the on time of a light source, whether an LED, an incandescent lamp, a halogen lamp, or another source. It can be made with an ordinary stopwatch and a few simple components (**figures 1** and **2**). An electronic stopwatch needs two pulses to operate; one starts the internal counter, and another one stops it. A light source provides only one pulse, corresponding to the time the light is illuminated. This circuit generates a short trigger pulse whenever the luminous intensity changes.

When the photodiode is not illuminated, capacitor C_1 charges to 1.5V (**Figure 3**). The charge initially comes through the base-emitter junction of Q_1 with a time constant that $R_1 \times C_1$ sets. Once C_1 charges to 1.5V minus the base-to-emitter voltage, R_3 tops off the charge on C_1 until it reaches 1.5V. Because R_3 and R_1 are in series during this time, this topping off occurs with a slower time constant that $(R_1+R_3) \times C_1$ sets.

When the photodiode is illuminated, photocurrent flows through R_1, raising its voltage to more than 0V, which drives the right side of C_1 above the 1.5V rail. The base of Q_1 is reverse-biased and has no effect. However, Q_2's emitter is now forward-biased because R_4 holds the base near 1.5V. As Q_2 turns on, the charge in C_1 dissipates across R_2, raising its voltage and creating a positive pulse. You convey this pulse to the stopwatch through R_5, which is necessary in the case of extreme illumination of the photo-

Figure 1 You build the circuit on a small prototype board that connects to the CG-501 stopwatch.

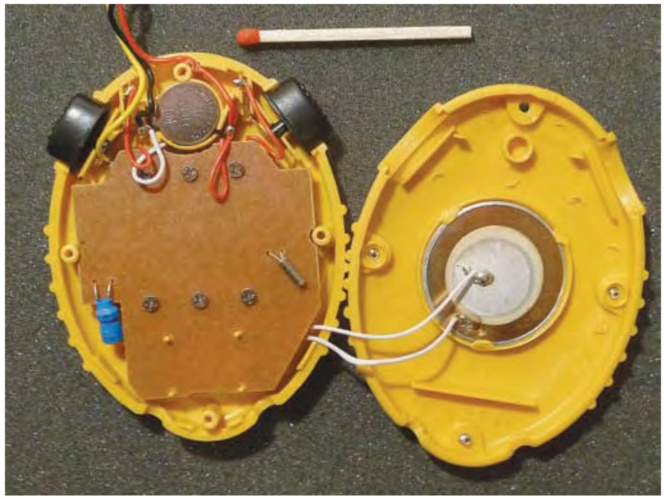

Figure 2 You can solder in pigtails to bring power, ground, and the trigger circuit to the prototype.

diode. It limits the current into the stopwatch circuitry so that a large pulse cannot latch or overpower the internal stopwatch circuitry. The photocurrent creates a difference between 1.5V and the voltage of R_1; this difference causes C_1, under illumination, to enter a final voltage.

When the photodiode is not illuminated, no photocurrent goes through R_1, so C_1 can charge back up as its left side goes to ground and its right side goes first to a base-emitter drop below 1.5V and subsequently all the way to 1.5V. Because the initial charge conducts through the base-emitter junction of Q_1, that transistor again turns on, delivering a pulse across R_2 and halting the stopwatch.

Your selection of the value of C_1 depends on the exposure time to be measured and on the photodiode used. The response rate of this circuit is approximately 500 msec. This example uses an Everlight PD333-3C/HO/L2 photodiode with a large spectral bandwidth, but any other photodiode or even a photoresistor will also work. EDN

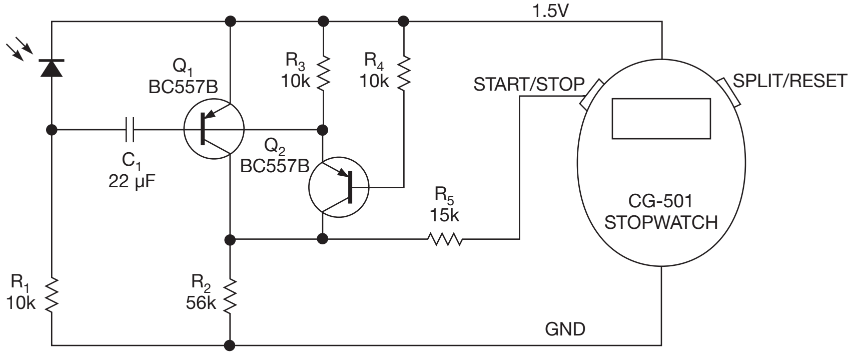

Figure 3 This simple circuit times a light source. When you illuminate the photodiode, Q_2 creates a pulse. When you remove the illumination, Q_1 creates a pulse.