## PROJECT OF THE MONTH

# Constructing A Two-Way Optoisolator

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CONVENTIONAL optoisolators or optocouplers are made by installing a light source and light detector in a lighttight package. The source is electrically separated from the detector by an optically clear dielectric such as epoxy, glass or air. With this arrangement, two separate circuits or two portions of the same circuit can interact without any intervening electrical connections.

Some optoisolators use a neon glow lamp or an incandescent lamp as a light source. Most, however, use a visible or near-infrared light emitting diode. Detectors include cadmium-sulfide photoresistors, phototransistors, photodarlington transistors, photodiodes, light-activated SCRs, light-activated triacs, etc.

Conventional optoisolators are *unidirectional.* In other words, they transfer an incoming signal from the source to the detector in only one direction. It's possible, however, to make a *bidirectional* or two-way optoisolator by using components that function as both sources *and* detectors. Many LEDs and some ternary and quaternary photodiodes (such as GaAsP photodiodes made by Hamamatsu) can be used as dual-function emitter/detectors.

**A Practical Two-Way Optoisolator.** Figure 1 shows how to make a functional two-way optoisolator by installing two LEDs face-to-face in a short length of heat shrinkable tubing. (For very high-voltage isolation or for applications in which two circuits are some distance apart, the LEDs can be coupled to one another by means of a fiber-optic cable.)

Though many different commercial LEDs can function as both sources and detectors, GaAs, GaAs:Si, and AlGaAs:Si near-infrared emitters work better as detectors than do most visible light emitting diodes. Figure 2 shows the current transfer of a pair of TRW Optron OP-195 GaAs:Si near infrared emitters arranged in the configuration shown in Fig. 1. Data was obtained by operating the detector LED in an unbiased, photovoltaic mode. The detector LED can also be operated in a reverse-biased, photoconductive mode. If this is done, the resulting current-transfer curves are almost identical to those in Fig. 2.

The current transfer ratio ($I_{out}/I_{in}$) for the OP-195 LEDs which I used is only about 0.06% when the input current is 20 mA. While this is much lower than conventional LED-phototransistor optoisolators, the output current can be easily amplified. The additional circuitry needed can be justified in applications where two-way optoisolation is required.

Figure 3 shows an experimental circuit I've designed to implement, under digital control, two-way optoisolation. The circuit preserves input-output isolation by employing conventional LED phototransistor optoisolators. In operation, a low or high bit at the control input forward biases the LED in *one* of the two conventional optoisolators. For example, assume the control bit is *high.* This causes the LED in optoisolator 1 to be forward biased which, in turn, turns on its phototransistor. Any signal present at the phototransistor's collector can now forward bias *LED1* in the LED-LED (two way) optoisolator. In this case, *LED2* functions as a detector. It cannot receive any signal present at the collector of the phototransistor in optoisolator 2 since that phototransistor is turned off. When the control bit is changed from high to low, the operating mode is reversed and the LED-LED optoisolator transmits in the opposite direction. ◇

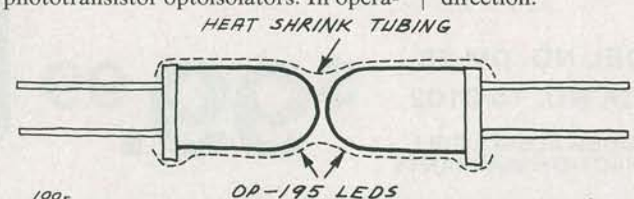


Fig. 1. How to assemble a LED/LED optoisolator.

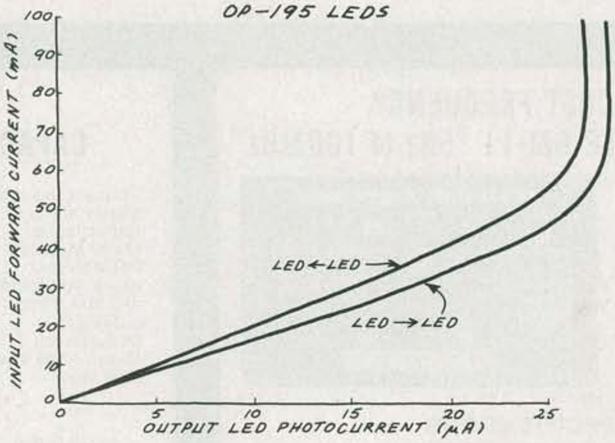


Fig. 2. LED/LED optoisolator current transfer.

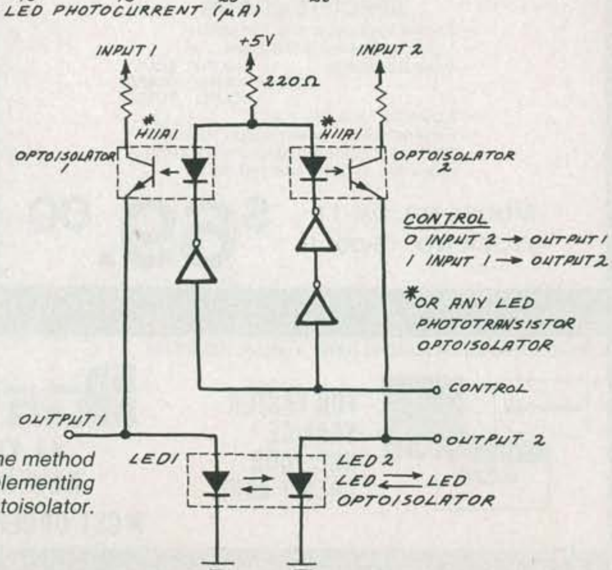


Fig. 3. One method for implementing two-way optoisolator.