Experimenter's Corner

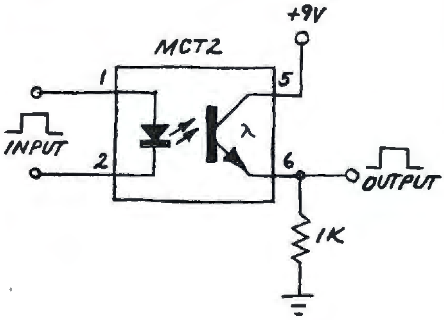
By Forrest M. Mims

USING AN OPTOISOLATOR

OPTOISOLATORS are ideal for solving many noise and high-voltage isolation problems in electronic circuits. Until fairly recently, their prices have been rather high for experimenter use. But now some real bargains are available from a number of electronic parts dealers, such as those who advertise in the back of this magazine.

An optoisolator is a relatively simple device, consisting of a light source and a light sensor housed in a light-tight package in such a manner that their active elements face each other. While the source is always electrically isolated from the sensor (in the low kilovolt range), the two are optically coupled in such a manner that a signal activating the source will trigger the sensor.

Most optoisolators use a gallium-arsenide (GaAs) infrared emitter for the light source and a silicon detector. The latter can be a photodiode, light-activated SCR (LASCR), photosensitive FET, photo-Darlington, or, most commonly, a phototransistor. The housing for the two elements that make up the optoisolator is usually a semiconductor package, with the common IC DIP configuration predominating.



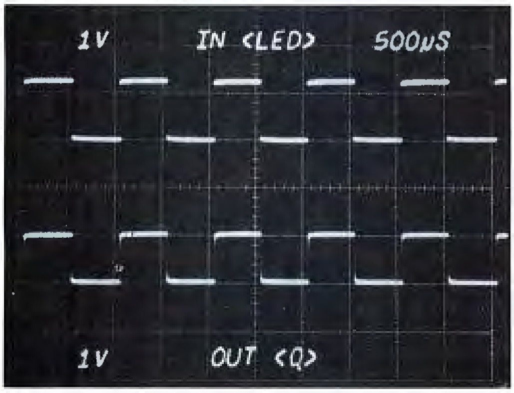


Fig. 1. An arrangement for coupling one signal to another with an optoisolator is shown at right above. The scope photo at right is typical of input and output pulses for the circuit.

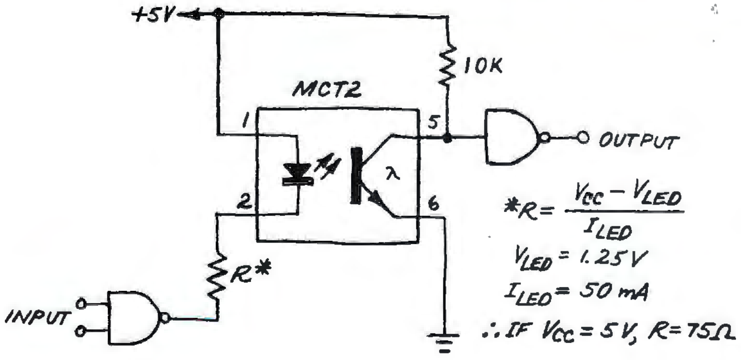


Fig. 2. One way of coupling circuits with an optoisolator.

Simple Couplers. A simple arrangement you can use to isolate an analog or pulsed signal to be coupled from one circuit to another is shown in Fig. 1. The circuit can use any phototransistor optoisolator. (I used a Motorola MCT2, but any similar device can be substituted.) The photograph in Fig. 1 illustrates a pair of typical input and output pulses for the circuit. I calibrated the 4-volt, 1-kHz squarewave output from the scope to pulse the LED in the optoisolator and monitored both sides of the MCT2 to obtain this photo. Notice that the base of the transistor is not used. This is the case with most phototransistor optoisolator circuits, even though manufacturers usually make the base available for special applications such as external biasing.

There are dozens of ways to couple optoisolators to RTL and TTL circuits. A typical circuit for this is shown in Fig. 2. The various manufacturers who make optoisolators (Texas Instruments, Monsanto, Litronix, Fairchild, etc.) all include this and many other basic hookup schemes in their spec sheets, so there's no need to go into details here. Just remember to include a current-limiting resistor between the drive circuit and LED side of the optoisolator. If you omit this resistor, excessive current might be pumped through the LED, causing damage.

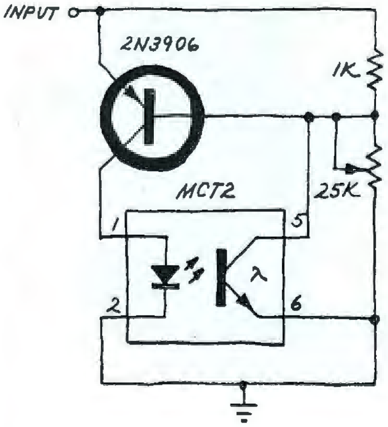


Fig. 3. This optoisolator circuit exhibits negative resistance.

Negative-Resistance Circuit. A circuit you won't find in anyone's spec sheet is the unusual optoisolator negative-resistance configuration shown in Fig. 3. This novel circuit was dreamed up by Japanese engineers Haruo Takahashi and Yasuo Kitahama and first published in the April 1974 *IEEE Journal of Solid State Circuits* ("An Optronic Negative Resistance

Circuit"). Here's how it works. The transistor in the isolator is normally cut off, but an applied voltage causes a small current to flow through the outboard transistor and the LED. As the input voltage increases, the LED turns on and triggers the isolator's transistor into conduction. The circuit exhibits negative resistance because it begins to conduct only above a certain voltage threshold at the input.

Relaxation Oscillator. If you've ever built a neon-lamp flasher circuit, you already know that you can make a simple relaxation oscillator by connecting a resistor and capacitor to a negative-resistance component. The circuit in Fig. 4 shows how this is done with the optoelectronic negative-resistance circuit. Operation begins with the capacitor charging through the 10 k resistor until the negative-resistance circuit switches on. At this point, the capacitor discharges through the circuit and the system resets to the off state to repeat the cycle.

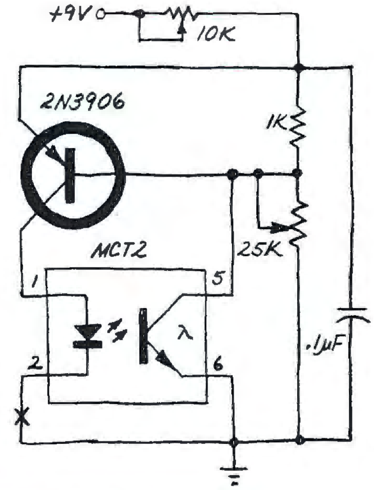


Fig. 4. Relaxation oscillator.

For best results, start with the component values specified in Fig. 4. After you get the circuit working, you can experiment with different capacitor values to change the oscillation range of the circuit. With the values shown, I measured a freqency range of about 3 to 8 kHz with the potentiometer adjusted for a resistance of about 5 k. Changing the capacitor's value to 1 µF caused the freqency range to drop to between 120 Hz and 1.8 kHz.

You can monitor the operation of this circuit with a scope connected across the LED and/or a I k resistor inserted between the emitter of the isolator's transistor and ground. The waveforms I obtained are shown in Fig. 5. Alternatively, you can connect a miniature 8-ohm speaker at point "X" to make the oscillator's tone audible.

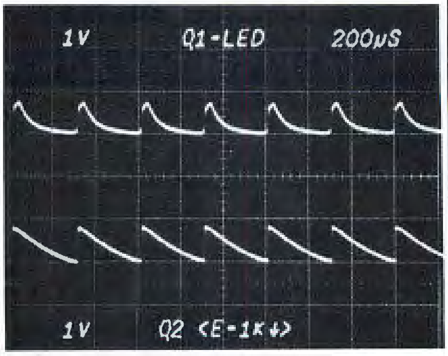


Fig. 5. Waveforms for Fig. 4.

Parting Comment. So far, we've examined only one particular optoisolator, but there is a wide range of other useful gadgets that include electrically isolated emitters and detectors. These source-sensor pairs, as they are usually called, can be used for limit switches, object detectors, position sensors, reflectance sensors, and many other applications. I haven't seen any of these source-sensor pairs on the surplus/hobby market yet. ◈

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