Light-Wave Voice Communicator

BY FORREST M. MIMS

THIS MONTH'S project is an amplitude-modulated light-wave voice communicator that you can assemble from inexpensive, readily available components. You can use the communicator to send and receive high-quality voice signals over distances of hundreds of feet through the atmosphere or through an optical fiber "waveguide."

The Transmitter. The transmitter, which is shown schematically in Fig. 1, employs a 741 op amp as a high-gain audio amplifier which is driven by a microphone. The output of the 741 is coupled to *Q1*, which serves as the driver for a LED. Potentiometer *R1* is the amplifier's gain control. Miniature trimmer resistor *R6* permits adjustment of the base bias of *Q1* for best transmitter performance.

Gain control *R1* can be eliminated if *C1* and *R2* are connected directly to pin 2 of the 741. For maximum sensitivity, increase the value of *R2* from one to ten megohms and use a crystal microphone with a large diaphragm such as the Radio Shack Model 270-095. The miniature crystal microphones sold by many parts suppliers will also work, but they generate less output.

If you prefer, fixed resistors *R5* and *R7* and potentiometer *R6* can be replaced with two fixed resistors after *R6* has been adjusted for best transmitted voice quality. Disconnect *R5* from +9 volts and *R7* from ground, measure the resistance between the wiper of *R6* and the disconnected ends of *R5* and *R7*, and substitute fixed resistors having similar values.

The transmitter works best with near-infrared emitting GaAs, GaAlAs and GaAs:Si LEDs. GaAsP red LEDs can also be used, but they emit considerably less optical power and therefore are best suited for optical fiber links.

Whichever LED you select, it is important to limit its forward current to a safe operating level. A reasonable range of quiescent current is from 10 to 40 milliamperes. High-level audio inputs will raise the current substantially. Resistor *R8* determines the quiescent current, and its resistance should be 100 or more ohms. In my prototype, 330 ohms gave a standby current of 22 milliamperes.

For best results, insert a milliammeter between the emitter of *Q1* and the LED's anode and substitute a 1000-ohm potentiometer for *R8*. Adjust the potentiometer until the desired current level is achieved. Then remove the pot, measure its resistance, and replace it with a fixed resistor.

The Receiver. The light-wave receiver, which is shown in Fig. 2, consists of a 741 operated as a preamplifier and an LM386 power amplifier. Potentiometer *R2* is the gain control.

You can use various kinds of detectors as the front end of the receiver. Phototransistors are very sensitive, but they do not work well in the presence of too much ambient light. Note that a 100,000-ohm series resistor is required if you use a phototransistor. Solar cells and photodiodes work well. So do LEDs of the same semiconductor as the transmitter.

An interesting aspect of using LEDs as detectors is that, although they are not as sensitive as phototransistors, they are much less sensitive to the adverse swamping effects of ambient light. Using a LED as a detector also means you can switch the LED's anode between the input of the receiver and the output of the transmitter to form a light-wave voice transceiver capable of bidirectional communications through a single optical fiber. Of course, you'll need two complete transceivers to fully use this operating mode.

Going Further. This transmitter and receiver system will send voice across a room without the need for external optics. For ranges of hundreds of feet, you must use a lens to collimate the light from the LED. You must also use a lens to collect and focus light on the receiver's detector. For more information on the use of lenses and related subjects, see *Light-Beam Communications* (F. Mims, Howard W. Sams & Co., 1976).

It's difficult to align the invisible beam from an infrared transmitter LED, but you can eliminate this problem *and* communicate around corners by using an optical fiber. See this month's "Experimenter's Corner" for more about this subject. ◇

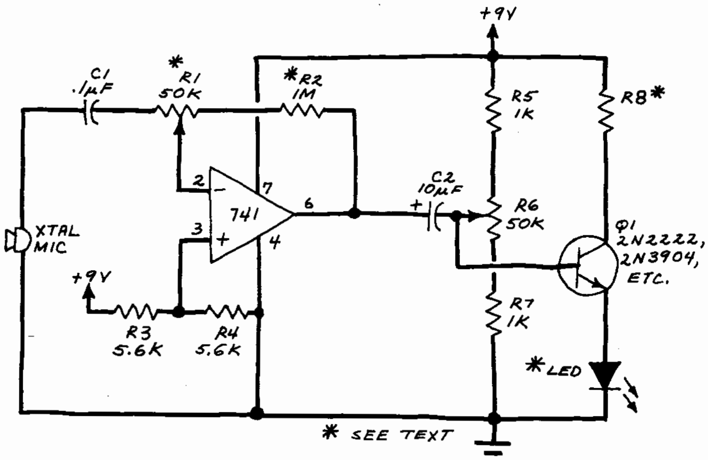

Fig. 1. Schematic of a light-wave voice transmitter.

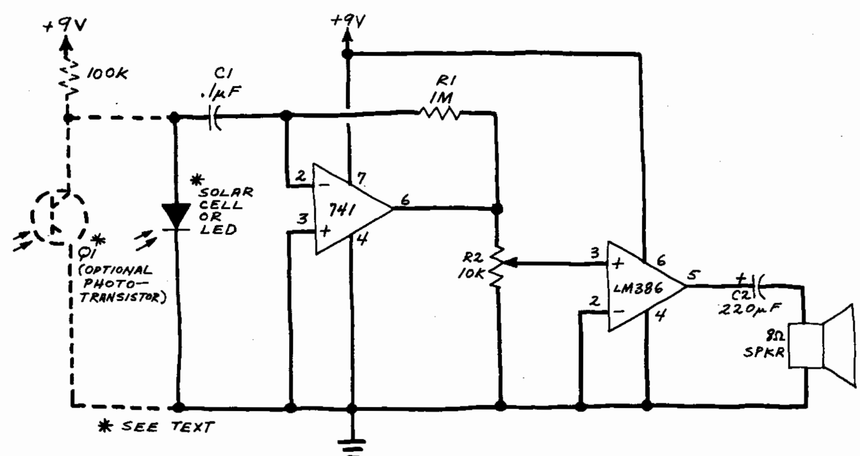

Fig. 2. A light-wave receiver to go with the transmitter.