

Laser Fun

This month we're going to do some experimenting with a low-cost laser sight. These sights are available at most sporting goods stores, as well as the large discount super centers like Wal-Mart. The one I'm using is an ACC-Laser Sight System for pistols or rifles (#7950) supplied with a remote touchpad switch from Daisy Outdoor Products, the Red Rider BB gun maker. The output is rated at less than 3.5 mW, at a wavelength of 650 nm. Other similar sights might also work in our circuits; however, each one will require basic testing to determine its compatibility.

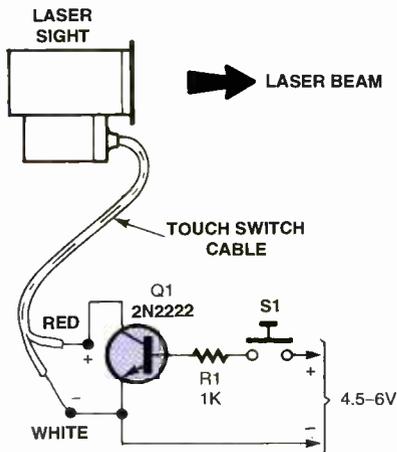


Fig. 1. Connect a NPN 2N2222 transistor to the laser's remote switch wires, as shown in Fig. 1. Closing S1 should turn the laser on. If so, we can continue with our next experiment to see how fast the laser can be turned on and off.

PARTS LIST FOR THE ELECTRONIC LASER SWITCH (FIG. 1)

- ACCU-LASER #7950, "Daisy Outdoor Products" (see text)
- Q1—2N2222 NPN transistor
- R1—1000-ohm, ¼-watt, 5% resistor
- S1—Normally open pushbutton switch

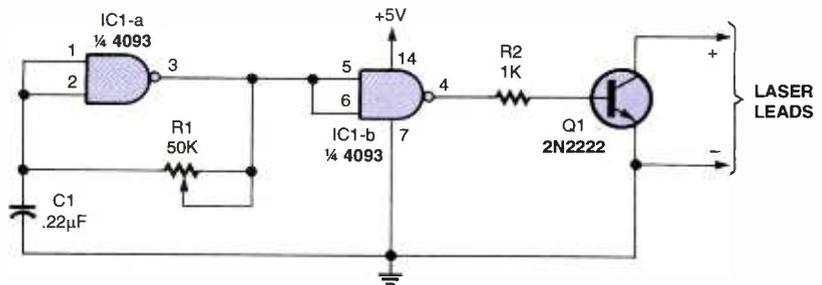


Fig. 2. The circuit is a variable frequency oscillator (100 Hz to over 5 kHz), with the output driving a 2N2222 transistor. The transistor operates like a switch, opening and closing at the oscillator's frequency turning the laser's power on and off at the same rate.

PARTS LIST FOR THE VARIABLE FREQUENCY OSCILLATOR (FIG. 2)

- IC1—4093 CMOS, Quad 2-input NAND Schmitt trigger
- Q1—2N2222 NPN transistor
- C1—.22-µF, ceramic-disc capacitor
- R1—50,000-ohm potentiometer
- R2—1000-ohm, ¼-watt, 5% resistor

First, we must determine if the laser sight can be turned on and off electronically. Cut the remote-control cable near the touch switch end and bare both wires. Connect a voltmeter to the leads and determine the polarity. In the one I'm using, the red wire is positive and the white wire is negative; however, never go by color-code alone without testing first with a voltmeter. If you do, Murphy will get the last laugh.

Danger: Avoid Direct Eye Exposure

Treat these devices with respect and follow all recommended precautions accompanying the laser product.

Connect a NPN 2N2222 transistor to the laser's remote switch wires, as shown in Fig. 1. Closing S1 should turn the laser on. If so, we can continue with our next experiment to see how fast the laser can be turned on and off.

The circuit in Fig. 2 is a variable frequency oscillator going from about 100 Hz to over 5 kHz, with the output driving a 2N2222 transistor. The transistor operates like a switch, opening and clos-

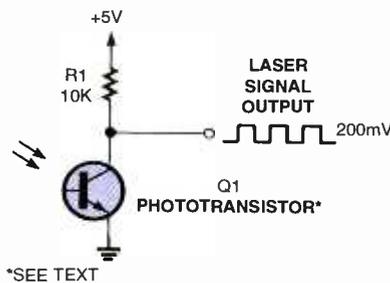


Fig. 3. You'll need something faster than our eyes to detect the interrupted laser beam. A phototransistor looking at the laser beam just might do the trick. A simple laser-detector circuit is shown above.

PARTS LIST FOR THE SIMPLE LASER DETECTOR (FIG. 3)

- Q1—Mouser Electronics #512-L14G1 or 512-QSD124 (see text)
- R1—10,000-ohm, ¼-watt, 5% resistor

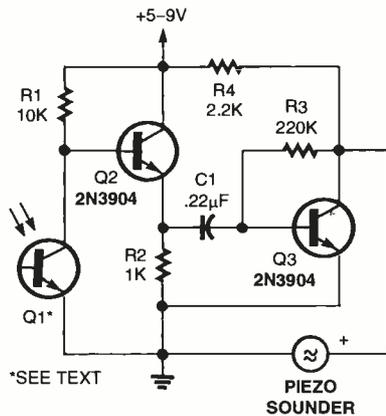


Fig. 4. In the circuit above the laser beam hitting the phototransistor supplies a forward bias that follows the on/off cycle of the oscillator-driver circuit in Fig. 2.

PARTS LIST FOR THE BASIC RECEIVER CIRCUIT (FIG. 4)

SEMICONDUCTORS

Q1—Mouser Electronics #512-L14G1 or 512-QSD124 (see text)
 Q2, Q3—2N3904 NPN transistor
 Piezo transducer

RESISTORS

(All resistors are 1/4-watt, 5% units.)

R1—10,000-ohm
 R2—1000-ohm
 R3—220,000-ohm
 R4—2200-ohm

ADDITIONAL PARTS AND MATERIALS

C1—.22-µF, ceramic-disc capacitor

ing at the oscillator's frequency turning the laser's power on and off at the same rate. Even at 100 Hz the laser looks like a constant beam of light. Here we need something faster than our eyes to detect the interrupted laser beam. A phototransistor looking at the laser beam just might do the trick. A simple laser-detector circuit is shown in Fig. 3.

Several different phototransistors were tested in the circuit with the best results using a Mouser Electronic #512-L14G1 that is available for less than two bucks. A less expensive phototransistor, Mouser #512-QSD124, that's available for less than a buck also worked though with less sensitivity. Most any phototransistor should respond to the laser beam and produce a useable output.

Aim the laser beam at the phototransistor, from about a one-foot distance,

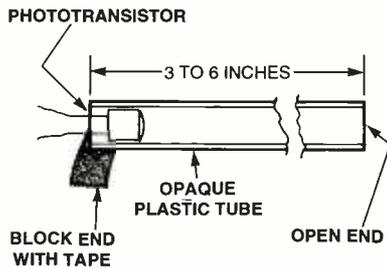


Fig. 5. Most phototransistors are sensitive to most available light sources and must be shielded from all but the laser beam. A simple method is to mount the phototransistor in one end of a long opaque tube, as shown in this diagram.

and monitor the phototransistor's output on an oscilloscope. Start with the oscillator at its lowest frequency and observe the waveform as the frequency is increased. Note the frequency when the output drops off to about one-half of the level obtained at the lowest frequency. This will be the laser's highest useful operating frequency for our experiments.

If an oscilloscope is not handy, jump ahead to the circuit in Fig. 4 and listen to the oscillator's tone to determine the maximum useable frequency. Also, we'll use this circuit for our next laser experiment.

First, let's take a quick look at the circuit in Fig. 4 and see how it works. The laser beam hitting the phototransistor supplies a forward bias the on/off cycle of the oscillator-driver

circuit in Fig. 2. Q2 is connected in an emitter-follower circuit to isolate the phototransistor from the loading effect of Q3. Q3 is connected in a common emitter audio-amplifier circuit, raising the phototransistor's output signal to a level sufficient to drive a piezo element.

Experimenting And Having Fun

Now, we'll find out just how far away we can intercept and monitor the laser beam's transmitted audio tone. Most phototransistors are sensitive to most available light sources and must be shielded from all but the laser beam. A simple method is to mount the phototransistor in one end of a long opaque tube, as shown in Fig. 5. Plastic tubing will do, as long as no light can enter anywhere except the open end. The tube can be any length, but should be at least 3 inches long.

The longer the tube the more directional the detector becomes. Bring the phototransistor's leads out and tape over the tube's end with black electrical tape. I used an old ball point pen housing that ended up being 5 inches long with the phototransistor in place.

The laser's maximum operating frequency was above 4 kHz with the circuits as shown; however, with a few component changes it's possible to go even higher in frequency.

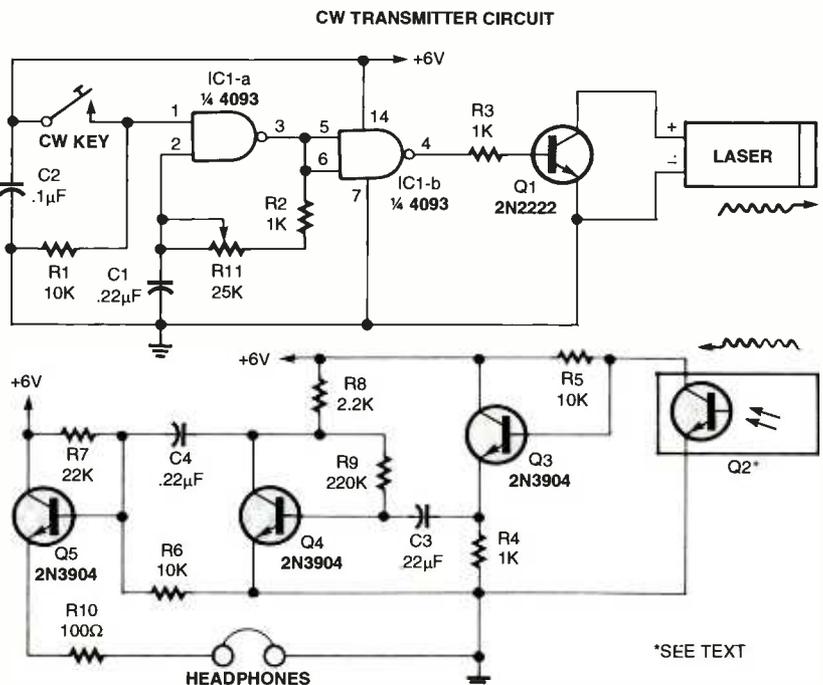


Fig. 6. This CW transmitter can be fun to use learning the code or for private communications over a reasonable distance, and it offers a feature not often found in other transceivers—the ability to transmit a signal at the same time a signal is being received.

PARTS LIST FOR THE CW TRANSCEIVER (FIG. 6)

SEMICONDUCTORS

IC1—4093 CMOS, Quad 2-input NAND Schmitt trigger
 Q1—2N2222 NPN transistor
 Q2—Mouser phototransistor, see text.
 Q3, Q4, Q5—2N3904 NPN transistor

Going The Distance

Very little difference in the receiver's output was noted when moving from a distance of 10 ft. to over 50 ft. I ran out of shop room long before noticing much change in the received signal. At night the range could be well over 100 ft. Refinements in the receiver tube including the addition of a lens system and more audio gain to the receiver circuit could increase the range much farther.

Several applications come to mind for the laser transmitter/receiver combination. Even though CW is no longer a difficult matter to master for an Amateur radio license, it still remains a fun mode of communication. It's an easy matter to modify the two circuits and combine them for a dandy little CW laser transceiver, as shown in Fig. 6. This CW transceiver can be fun to use learning the code or for private communications over a reasonable distance.

There are some minor differences between our original two circuits and the CW transceiver circuit in Fig. 6.

PARTS LIST FOR THE LASER UNIT (FIG. 6)

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1, R5, R6—10,000-ohm
 R2, R3, R4—1000-ohm
 R7—22,000-ohm
 R8—2200-ohm
 R9—220,000-ohm
 R10—100-ohm

CAPACITORS

C1, C3, C4—.22- μ F, ceramic-disc
 C2—.1- μ F, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

CW key, opaque tubing, headphones, etc.

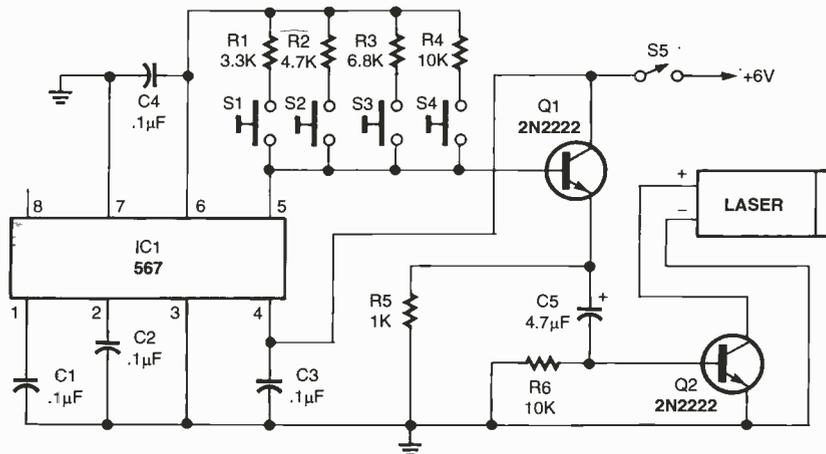


Fig. 7. A low-cost 567 phase-locked-loop IC serves as the multi-frequency tone generator set up for four separate output functions in this multi-channel remote control laser transmitter.

PARTS LIST FOR THE LASER REMOTE-CONTROL TRANSMITTER (FIG. 7)

SEMICONDUCTORS

IC1—567 PLL IC
 Q1, Q2—2N2222 NPN transistor

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1—3300-ohm
 R2—4700-ohm
 R3—6800-ohm
 R4, R6—10,000-ohm
 R5—1000-ohm

CAPACITORS

C1-C4—.1- μ F, ceramic-disc
 C5—4.7- μ F, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1-S4—Normally open pushbutton switch
 S5—On/off SPST switch
 Laser unit

The oscillator circuit has been modified to operate with a CW key. The input, pin #1, of gate "A" is connected to ground, disabling the oscillator until the CW key is closed and taking pin #1 to battery positive. Each time the CW key closes the oscillator starts and sends an on/off laser signal at the oscillator's operating frequency toward the companion receiver. Resistor R11 allows the transmitted frequency to be adjusted for a pleasant CW tone. Normally, this is a frequency between 600 and 1000 Hz.

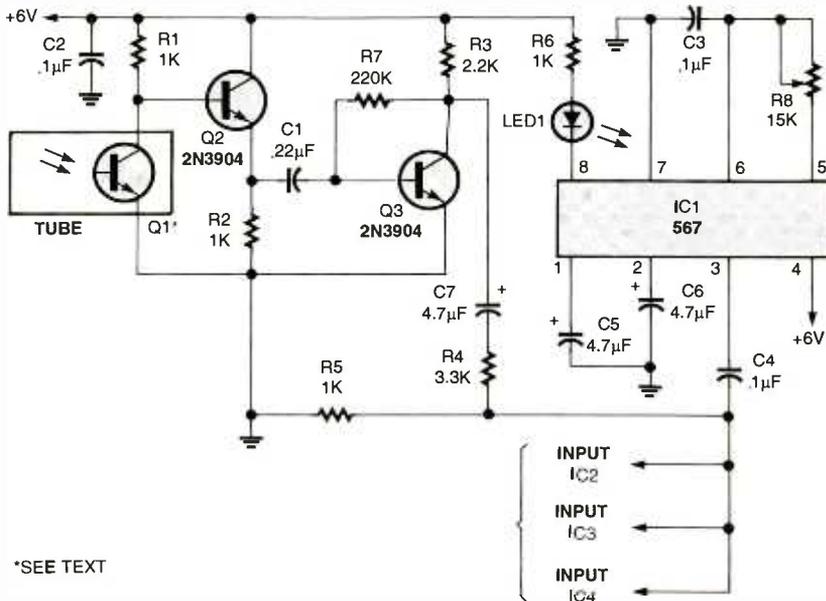
This laser CW transceiver offers a feature not often found in other transceivers, and that is the ability to transmit a signal at the same time a signal is being received. In an RF transceiver, the antenna is common to both the receiver and transmitter. Each time the transmitter is keyed on, the receiver must be disabled or sustain front-end damage. In our laser transceiver an antenna is not required, only a clear path between the two units. Of course it's difficult to talk and listen at the same so this feature may only be interesting and not a practical application for CW communication.

Laser Remote Control

If we can communicate over a laser beam, why not use the same beam of light to control circuitry or equipment at a remote location? Of course, we can. A multi-channel remote-control laser-transmitter circuit is shown in Fig. 7. A low-cost 567 phase-locked-loop IC serves as the multi-frequency tone generator set up for four separate output functions. Pushbutton switches, S1, S2, S3, and S4, select the output-tone frequencies.

Q1 is connected in an emitter-follower configuration to isolate the IC's output from loading by the driver transistor, Q2. Q2 operates like a switch, as in our previous circuits, to turn the laser on and off at the selected tone frequency. S5 is the power switch and may only be needed when operating from battery power.

The remote-control receiver circuit is shown in Fig. 8. To keep it simple, only one decoder channel is shown. The three other decoders are duplicates of the 567 circuitry in Fig. 7. Let's look



*SEE TEXT

Fig. 8. The remote-control receiver circuit is shown here. To keep it simple, only one decoder channel is shown. The three other decoders are duplicates of the 567 circuitry in Fig. 7.

over the receiver circuitry, and that may clear up any questions about the missing decoders.

The phototransistor, buffer amplifier, and voltage amplifier are the very same circuit used in our CW transceiver. Q3's

output is reduced, with the voltage divider made up of R4 and R5 to better match the input level requirements of the 567 decoder IC. The tone signal is fed to the 567's input at pin #3. The decoded output at pin #8 goes low when the correct tone is received.

By adjusting R8, the decoder-tone frequency is set to the same frequency as the transmitter is sending out for the corresponding channel. The remaining three channels are adjusted in the same manner.

The circuit in Fig. 8 shows the decoder turning on an LED when the correct tone is received; however, to control an external circuit or piece of equipment, take a look at the two circuits in Fig. 9.

The circuit in Fig. 9 "A" uses a

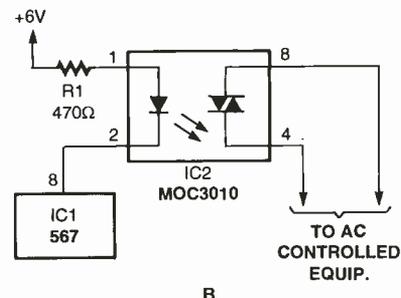
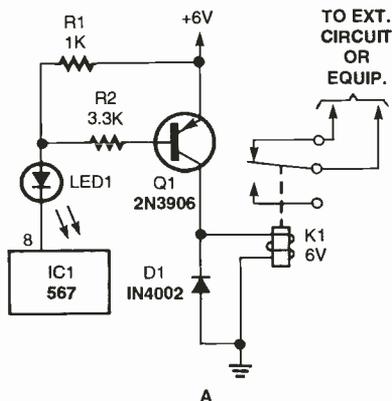


Fig. 9. Circuit "A" uses a 2N3906 PNP transistor to turn on a relay when a tone is received. Pin 8, on the 567 decoder, goes low when a correct tone is received. Circuit "B" connects to a MOC3010 optocoupler triac-driver IC to control an AC-operated device.

PARTS LIST FOR THE LASER REMOTE-CONTROL RECEIVER (FIG. 8)

SEMICONDUCTORS

- Q1—Mouser phototransistor, see text
- Q2, Q3—2N3904 NPN transistor
- LED1—Light-emitting diode, any color
- IC1-IC4—567 PLL IC

RESISTORS

(All resistors are 1/4-watt, 5% units.)

- R1—10,000-ohm
- R2, R5, R6—1000-ohm
- R3—2200-ohm
- R4—3300-ohm
- R7—220,000-ohm
- R8—15,000-ohm potentiometer

CAPACITORS

- C1—.22-μF, ceramic-disc
- C2, C3, C4—.1-μF, ceramic-disc
- C5, C6, C7—4.7-μF, 25-WVDC, electrolytic

2N3906 PNP transistor to turn on a relay when a tone is received. Pin 8, on the 567 decoder, goes low when a correct tone is received. This takes the base of Q1 low, turning it on and closing the relay to activate the external equipment or circuit.

The circuit in Fig. 9 "B" is connected to a MOC3010 optocoupler triac-driver IC to control an AC-operated device. Here's a good place to use your imagination to come up with other ways to use the laser remote-control system.

I'm sure there are many more applications for our laser, but we've run out of time once again. Come back next month and see what's going on here at the lab and in the meantime may all of your circuits work Murphy free!

PARTS LIST FOR TWO LASER REMOTE-CONTROL SYSTEMS (FIG. 9)

- "A"
- Q1—2N3906 PNP transistor
 - IC1—567 PLL
 - D1—1N4002 diode
 - K1—6-volt DC relay

- "B"
- IC1—567 PLL
 - IC2—MOC 3010 optocoupler IC
 - R1—470-ohm resistor



"Oh, Mr. Communicator, I don't think you're putting out enough power!"