Build Thumb Thing for next to nothing

Fire off your digital circuits. Inject test signals into amplifiers and am radio circuits. Build our classy three-speed wave squarer and you can do all this and more.

by Fred Blechman

You can't get something for nothing. Or so they say. But you can get a Thumb Thing for next to nothing: about $6 in parts. And the Thumb Thing really is something!

It's a handy-dandy three-speed *square wave generator* you hold in the palm of your hand. With it, you can trigger digital circuits; test amplifiers; and check out am radio circuits.

But what is it?

If you select manual operation, press the button with your thumb and you get a change of digital state from *low* to *high* or *high* to *low*. For slow speed, use your thumb to move the *rate* slide switch to slow. The logic state coming out will change about once each second. Set the same switch to *fast* with your thumb and the output jumps up to about 460 Hz. That means the square waves change from high to low and low to high 460 times each second.

And here's a big plus bonus: power for these operations is stolen from the circuits you are testing!

Who needs it?

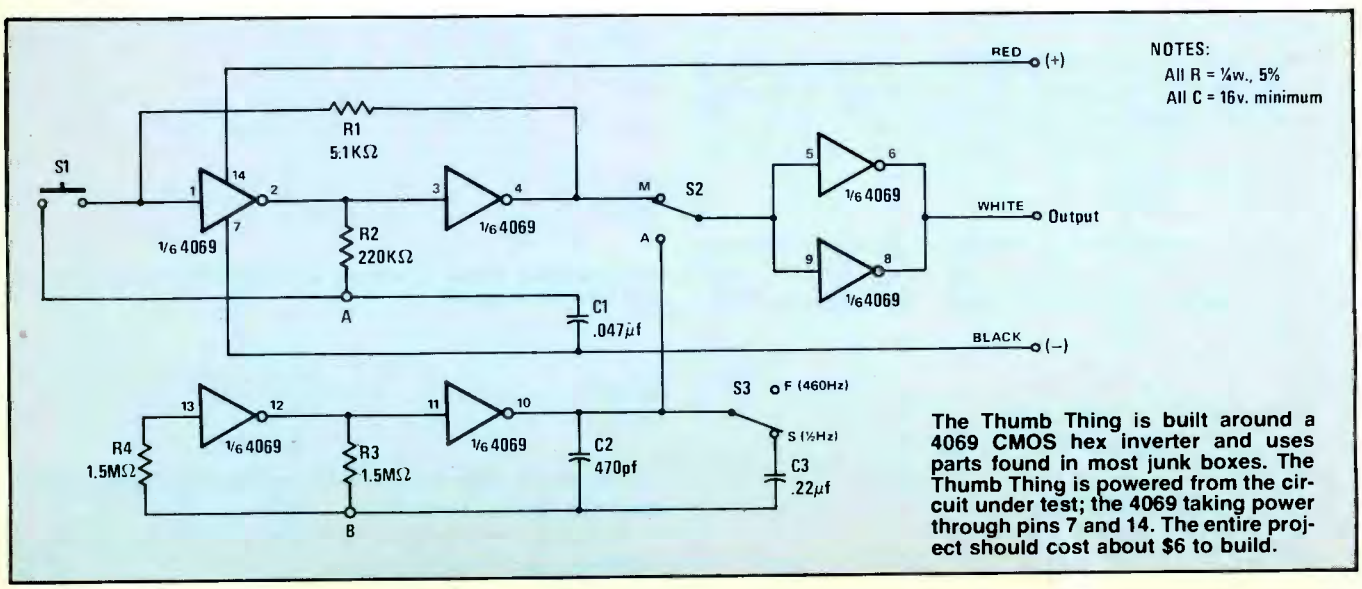
Control of the Thumb Thing is, literally, under your thumb. You can use it to trigger all sorts of digital counters and flip-flops and the like. Even linear devices and transistors can be fired off with this simple one-IC (integrated circuit) device. Use it to test TTL, DTL, or CMOS circuits.

The Thumb Thing provides a high or low (slow or fast) square wave clock, particularly useful with counting and logic circuits when you want to slow things down so you can see what is happening electronically.

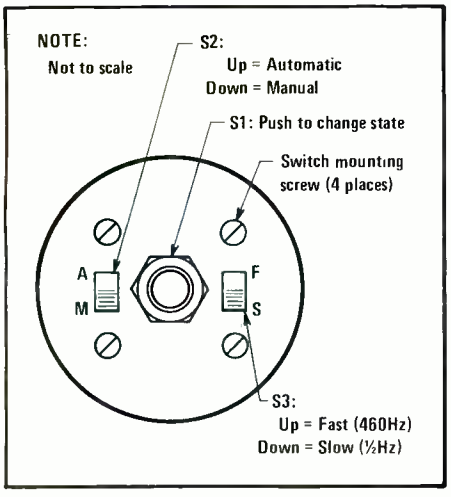
The square output wave is like a sine wave, only rich in harmonic frequencies up to several thousand cycles per second. That means the signal will even go through tuned circuits. That's how you can make the Thumb Thing work for you in testing amplifier and receiver circuits.

Small, compact

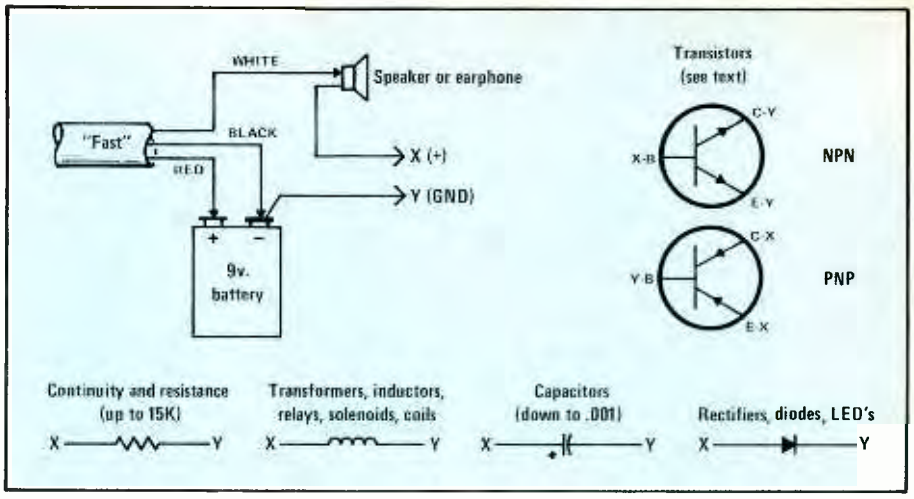
Although Thumb Thing can be assembled on perforated board, many of the connections are close together and it takes special care in hand wiring to prevent short circuits between adjacent connections. Using a printed circuit board layout will simplify assembly. A



The Thumb Thing is built around a 4069 CMOS hex inverter and uses parts found in most junk boxes. The Thumb Thing is powered from the circuit under test; the 4069 taking power through pins 7 and 14. The entire project should cost about $6 to build.



The *mode* and *frequency* slide switches are mounted beside the pushbutton using 2-56 machine screws and nuts.



You can use your Thumb Thing to test components. Just connect the output (X) and ground (Y) leads across the components as shown. Transistors should be treated as two diodes, with the leads connects as shown for each diode junction.

complete kit of parts is available from Optoelectronics Inc., Box 219, Hollywood, FL 33022. The $5.95 kit includes a PC board, IC and socket, three-conductor cable, subminiature slide switches and mini-alligator clips with insulators.

The case can be a small plastic pill bottle or any other enclosure of sufficient size to hold the PC board. However, an *ideal* case is a 35MM film container, which you can get from any film dealer. These are made from a soft plastic easily cut with a razor blade or X-acto knife, and the cap snaps firmly on the formed rim of the can.

Cut a hole in the bottom large enough for the three-conductor cable, and cut holes in the cap for the three switches. The pushbutton switch is held in position with the large nut that comes with it. The subminiature slide switches are held to the cap with #2-56 screws and nuts.

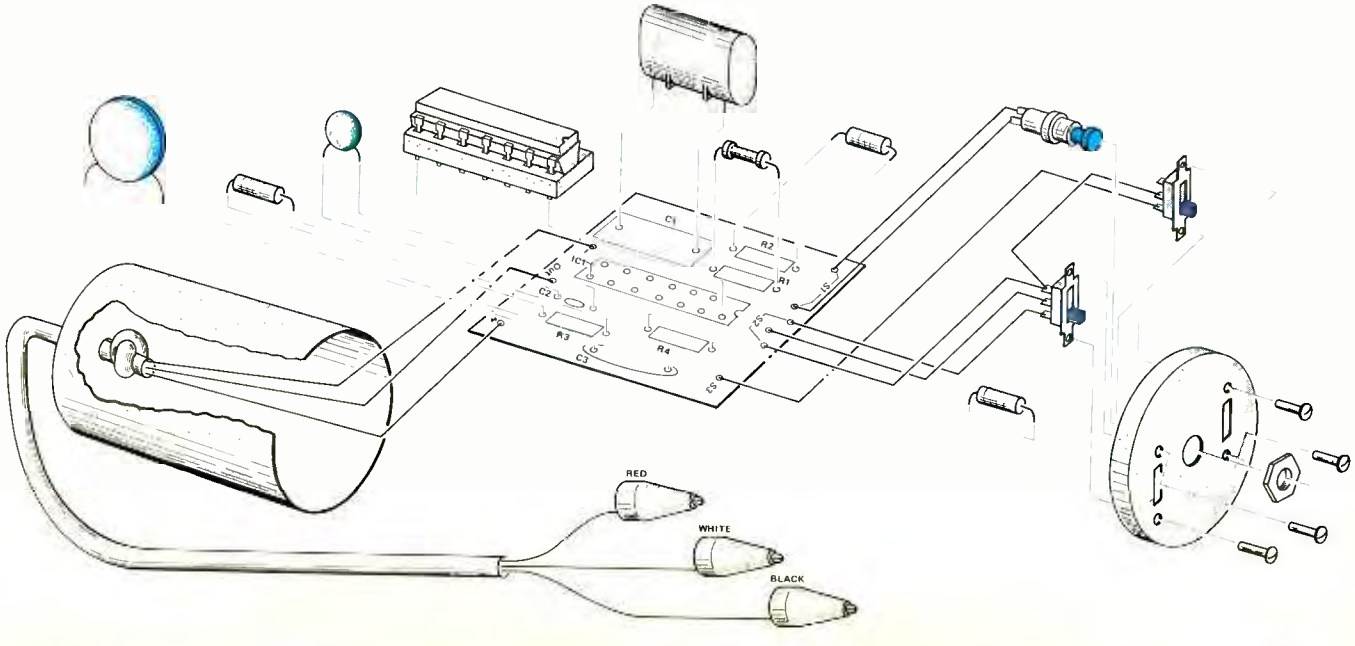
Insert the components into the top (non-foil) side of the PC board, following the layout shown. The PC board supplied with the kit is pre-drilled and silk-screened with the parts locations and switch wiring points. Solder carefully to the foil side, using 0.031 diameter resin-core solder and a fine-tipped 25 to 50 watt soldering iron. Clip off the excess leads and examine the soldering carefully for unintentional solder bridges across the gaps between foil strips.

Next, wire the PC board assembly to the cap switches. The top edge of the PC board fits between the solder lugs of the pushbutton, with the component side facing S2 (mode) and the foil side facing S3 (rate). Follow the wiring diagram.

Particular care should be paid to making the connection to the pushbutton on the foil side of the board. First bend the pushbutton lug upward, away from the board, and then use a short solid wire jumper to the PC board. The jumper can be a clipped-off component lead. This insures that the switch terminal will not contact the solder at points M or A on the PC board.

Imaginative uses

Now connect one end of the three-wire cable to the PC board, observing the wire colors as shown in the wiring diagram. Solder the clips on the other ends of the wires, slip the proper col-



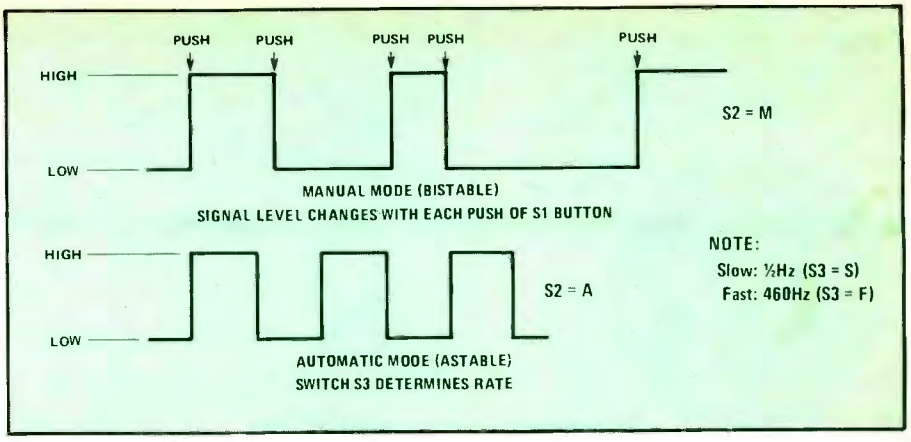
ored insulator over each clip, and your Thumb-Thing is complete!

The basic use for the Thumb-Thing is to trigger digital circuits. Connect the red clip to circuit positive voltage, the black clip to ground, and use the white clip as the *trigger*, setting the switches for manual or automatic operation.

In the manual mode, you can operate a counting circuit, holding the desired state as long as you want. You also can determine if the circuit operates on a positive-going or negative-going pulse edge with a voltmeter, scope or LED status indicator.

If you want to add an LED status indicator to your Thumb-Thing, you can mount the LED in the cap of the case permanently. However, the current requirement for the Thumb-Thing will go from about 1 ma without the LED to over 5 ma with the LED. In manual mode the LED will light when the output is high. In the automatic mode it will blink at the cycle rate when in the slow mode, and appear to be on all the time when in *fast* mode, although it's only on half the time.

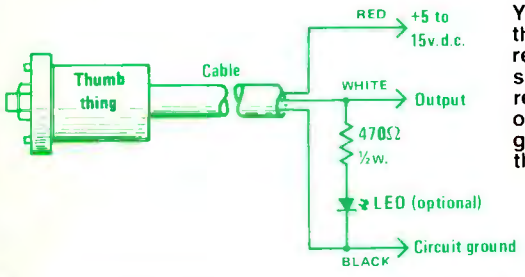
The Thumb-Thing also can be useful in testing amplifiers, radios and many electronic components. In typical transistor radios, which operate on 6, 9, or 12 volts, the Thumb-Thing can be powered by the radio power supply. If this is inconvenient, use a standard nine-volt transistor radio battery, 2U6 or equivalent, to power the Thumb-Thing.



You can set your Thumb Thing to provide a continuous square wave output, as shown on the lower trace, of ½ or 460 Hz. You can also operate your Thumb Thing manually, as shown on the upper trace. When operated manually, the output state changes each time the pushbutton is depressed.

Connect the negative lead of the battery to the circuit ground of the radio you're testing. Use a 0.01 mfd capacitor of sufficient voltage to isolate the circuits. Probe the radio circuits using the Thumb-Thing in its fast automatic mode as a signal injector. It has sufficient power to drive the speaker, so start there and move backwards through the circuitry until you find a dead stage. At that point, voltage and continuity checks will isolate the bad part.

Using a nine-volt battery and a small speaker, you can put the Thumb-Thing to work as a component tester. In this application, it should be set for *fast*. When testing resistive devices, the sound from the speaker will be loudest when resistance is lowest. You'll still be able to hear some sound with up to 15,000 ohms in series with the speaker.



You can add an LED to indicate the output state. A 470 ohm resistor limits the current to a safe level. You can clip the resistor-LED circuit across the output as shown in the diagram, or permantly mount it in the case.

Tests almost anything

When testing capacitors, the larger the capacitance, the louder the sound through the speaker. Capacitors as small as 0.001 mfd (1000 pf) still will be audible. When testing polarized capacitors (electrolytic, tantalum, etc.) be sure test point *X* is connected to the positive lead.

The rectifier/diode/LED test determines both condition and polarity, since the speaker is silent if the component connection is reversed. An LED under test will light when properly connected, with current limiting provided by the IC output and the speaker impedance.

Transistors are tested as if they were composed of two diodes with a common base. First determine which leads are the base, and alternately connect *Y* to the collector and emitter. Speaker sound in *both* cases tells you the transistor is a functioning NPN type. If the speaker is silent, reverse the leads so test lead *Y* is connected to the base, and *X* alternately connected to the collector and emitter. Sound now means you have a functioning PNP transistor.

Many other components, such as switches, incandescent bulbs, photocells, earphones, some microphones, potentiometers, and patch cords can be tested for continuity. You can use any battery from 5 to 15 volts for these tests. If you choose, you can build the Thumb-Thing circuitry in a larger case to include a battery, LED and speaker and have a portable universal tester!

Simple, small, inexpensive, portable, easy to build and versatile in its applications, the Thumb-Thing can become one of your most useful pieces of test equipment.

Parts List

IC	CMOS 4069 or 4069B
R	all resistors ¼ watt 5% carbon
R1	5.1 K ohm
R2	220 K ohm
R3	1.5 Meg ohm
R4	1.5 Meg ohm
C	all capacitors disc ceramic, 16 volts dc minimum
C1	0.047 mfd
C2	470 pf
C3	0.22 mfd
S1	pushbutton switch, normally open
S2	subminiature slide switch, SPDT
S3	subminiature slide switch, SPDT
Misc.	PC board, 14-pin IC socket, 3-conductor cable, 3 mini-alligator clips, 3 colored clip insulators, nuts, screws, enclosure

A complete kit of parts, with all items in the parts list except the enclosure, is available from Optoelectronics Inc., Box 219, Hollywood, FL 33022. Kit TT-1 is $7.25 each including $5.95 kit price, 30¢ shipping and insurance for each kit and a $1 handling charge for orders under $15. Florida residents add 4% sales tax (24¢) per kit.