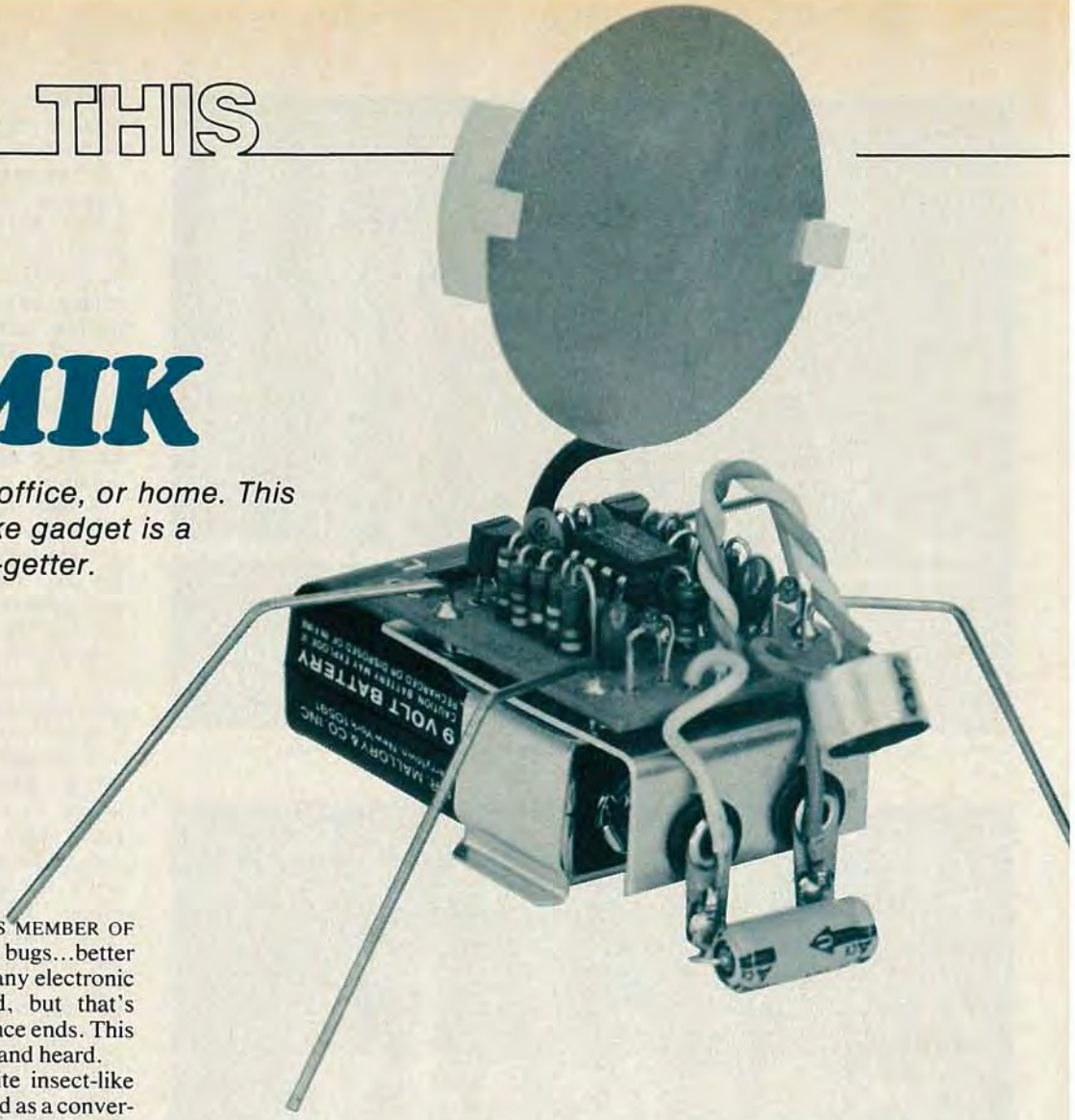
BUILD THIS

LIMIK

Bug your friends, office, or home. This harmless insect-like gadget is a sure-fire attention-getter.



MERRITT KEPPEL

THE LIMIK IS A HARMLESS MEMBER OF the species of electronic bugs...better make that insects. Like many electronic bugs it's sound-activated, but that's about where the resemblance ends. This bug is intended to be seen and heard.

The Limik has a definite insect-like appearance and can be used as a conversation piece, a psychological "watchdog", or even as a noise-level meter in the office. If you want to attract someone's attention, just set the Limik down and watch what happens.

The Limik responds to noise by turning on its audio oscillator for a brief period of time. It emits a sound similar to a cricket's chirp and its eyes—two LED's—light up.

Its head is a miniature condenser microphone element and its tail is a piezoelectric sounder (see the September 1980 issue of **Radio-Electronics**). Its body is made up of a small PC board atop a 9-volt battery, and is supported by four brass legs.

How it works

The circuit is divided into three sections: an audio amplifier, a comparator/timer, and an audio oscillator—all of which are somewhat interactive. Refer to Fig. 1. as we discuss its operation.

The oscillator (output section) is the easiest to understand—it's a standard transistor multivibrator circuit, gated when the output of IC1-a goes negative. The frequency of the oscillator is determined by R11-C6 using the formula:

$$f = 1.38RC$$

where R11=R12 and C5=C6 to give a

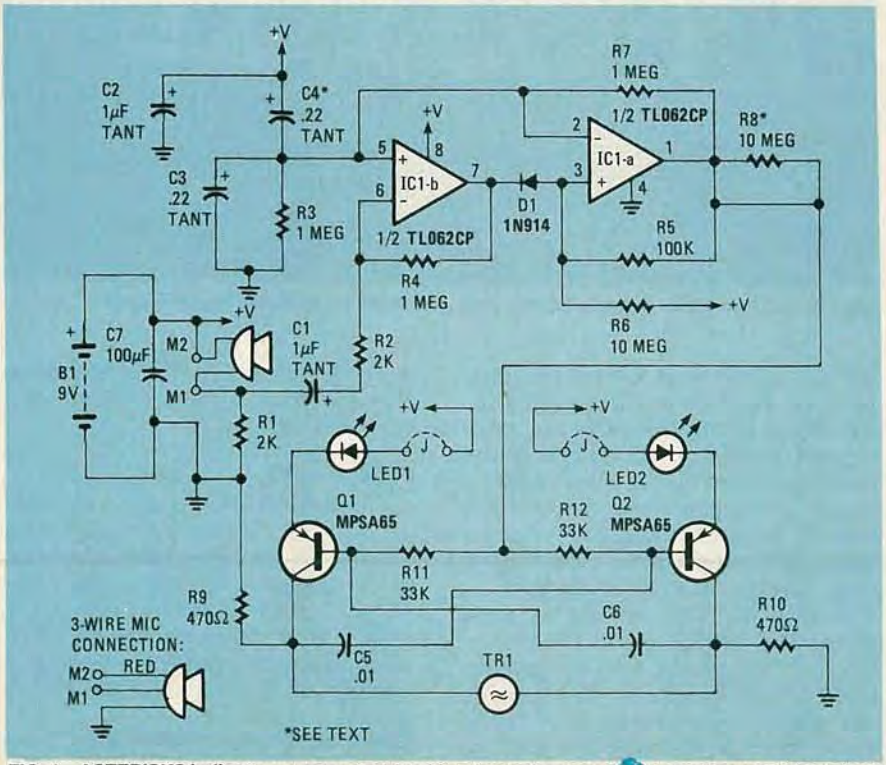
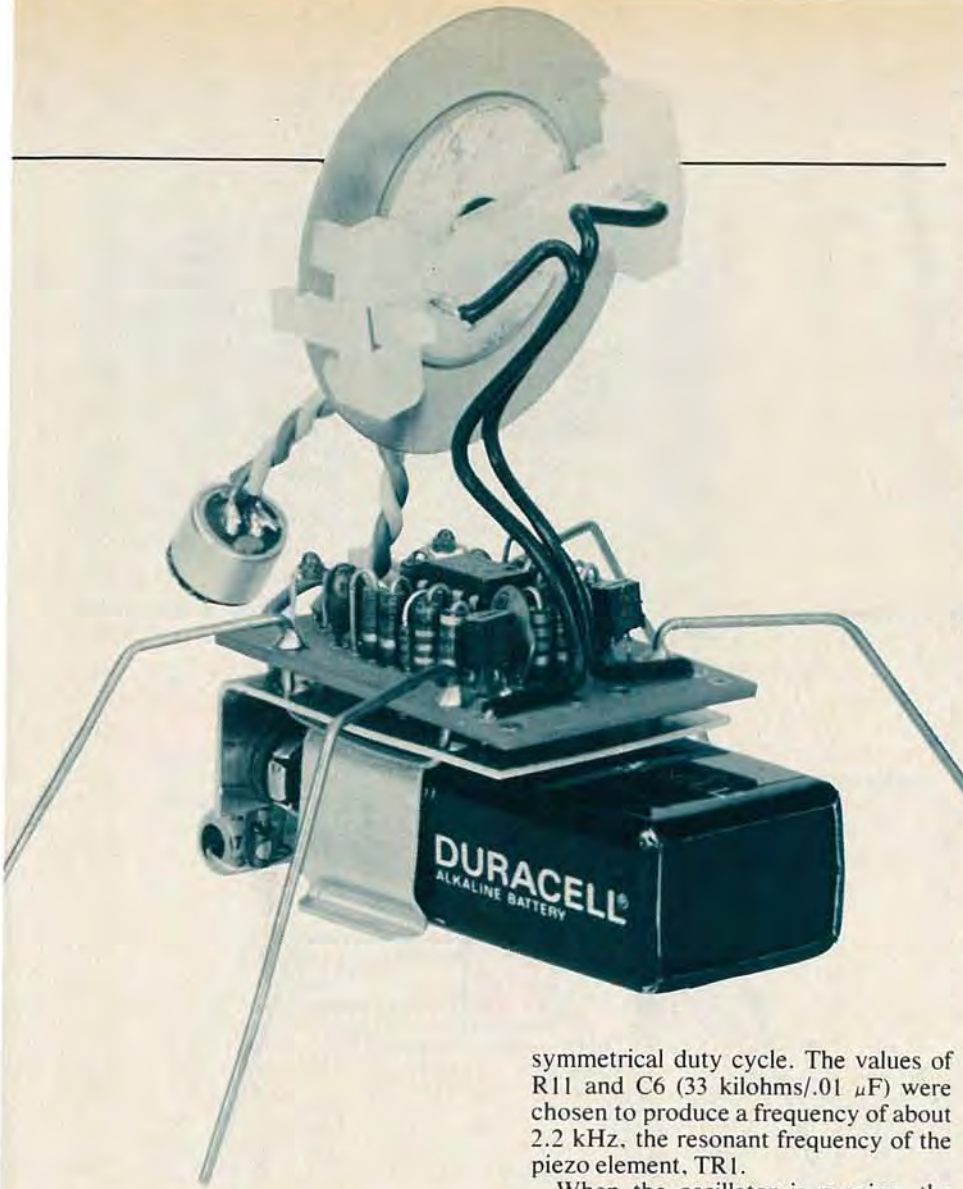


FIG. 1—ASTERISKS indicate components added for physical symmetry. Jumper across R8 effectively eliminates it from circuit. Connections for 3-lead microphone are shown at lower left.



symmetrical duty cycle. The values of R11 and C6 (33 kilohms/.01 μF) were chosen to produce a frequency of about 2.2 kHz, the resonant frequency of the piezo element, TR1.

When the oscillator is running, the "eyes," LED1 and LED 2, are forward-biased, and light. Resistors R9 and R10 develop a load for the oscillator and limit the current to the transistors and LED's. Battery life is determined by the length of time the oscillator runs—it consumes the most power. If the Limik is not triggered, current drain is negligible (less than 1 mA).

The circuit is designed to use IC1, a TL062CP dual low-power FET op-amp, as an amplifier, comparator, and timer, all in one. Let's examine each element of that section of the circuit separately.

Amplifier: The output of the microphone is amplified by IC1-b, whose gain is determined by the ratio of R4:R2. In the Limik, that gain factor is 500. With no signal input, the output of IC1-b is equal to approximately ½ V_{CC}, a value determined by resistors R7 and R3 and IC1-b's logic-high state.

Comparator: Under no-signal conditions the output of IC1-a is at a "logic-high" state because its non-inverting input is at ½ $V_{CC}+V_D$ (where V_D is the voltage drop across diode D1) and its inverting input is at ½ V_{CC}. Negative-going signals at the output of IC1-b, if strong enough, will cause IC1-a to change states. That gives a comparator effect—if the input signal is not strong enough, nothing will happen; if it is, IC1-a goes to a "logic-low" state and triggers the timer phase of the Limik's cycle.

Timer: As soon as the output of IC1-a changes state, its non-inverting input is pulled to a level determined by $(R5/[R5-R6])V_{CC}$ + 0.6 volt—approximately 0.7 volt. The output of IC1-a will remain low until the voltage at its inverting input becomes less than that at its non-inverting input. This is determined by the time constant of R7, R3, and C3, and is set at about 200 ms.

When the output of IC1-a returns to its high state, C3 charges through R7 towards a state of equilibrium (where it is neither charging nor discharging). Equilibrium, however, is not obtained

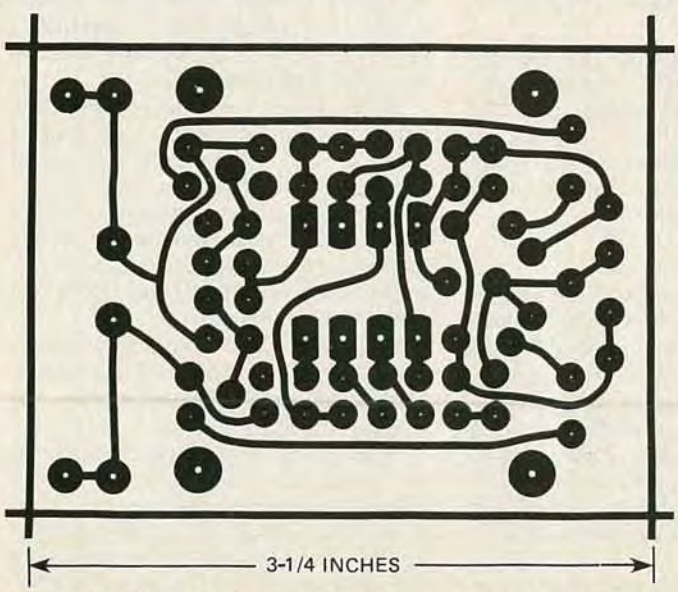


FIG. 2—PC BOARD measures just 1.2 by 1.6 inches. A prefabricated board is available if you do not wish to make your own.

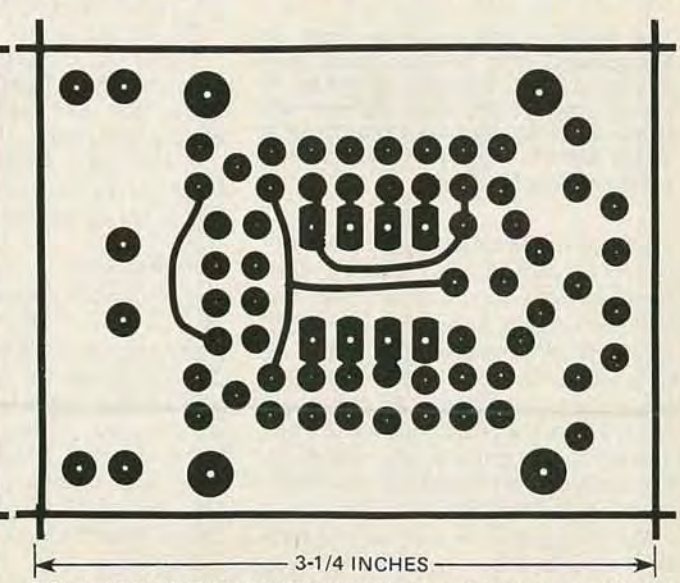


FIG. 3—TOP SIDE OF BOARD contains several traces necessary for proper operation. Since board is not plated-through, those traces may be replaced by jumpers.

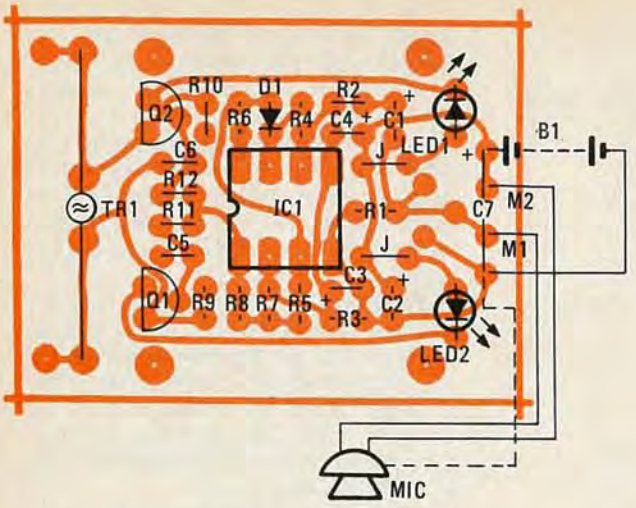


FIG. 4—LIMIK'S HEAD is at right; tail at left. Dashed line indicates connection for 3-lead electret microphone.

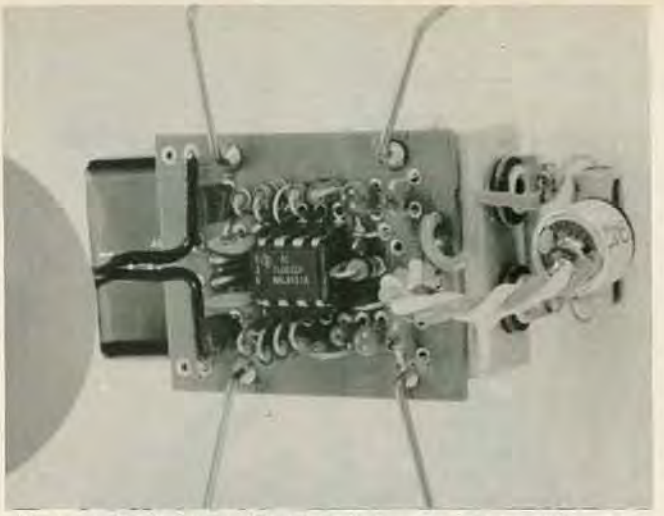


FIG. 5—COMPLETED CIRCUIT BOARD. Piezo sounder is visible at left and microphone and C7 at right.

PARTS LIST

All resistors ¼-watt, 5%
R1, R2—2000 ohms
R3, R4, R7—1 megohm
R5—100,000 ohms
R6, R8—10 megohms
R9, R10—470 ohms
R11, R12—33,000 ohms
Capacitors
C1, C2—1.0 μF, 35 volts, tantalum
C3, C4—0.22 μF, 35 volts, tantalum
C5, C6—0.01 μF, 25 volts, ceramic
C7—100 μF, 10 volts, electrolytic
Semiconductors
IC1—TL062CP or equivalent FET-type 747 dual op-amp
Q1, Q2—MPSA65 Darlington pair
LED1, LED2—MV-50 subminiature LED
D1—1N914 or 1N4148
TR1—piezo sounder (Gulton 105-CFB or equivalent)
B1—nine-volt battery
Miscellaneous: PC board, 2 or 3-lead electret microphone, holder for piezo sounder, battery holder (Colectro No. 86 or similar), 3/64-inch brass rod for legs, etc.

The following are available from MK Enterprises, 8911 Norwick Road, Richmond, VA 23229: complete kit, $18.95; PC board only, $5.00; piezo element with holder, $2.25; microphone, $2.00; TL062CP, $1.50; battery clip, $2.00. VA residents please add 4% tax.

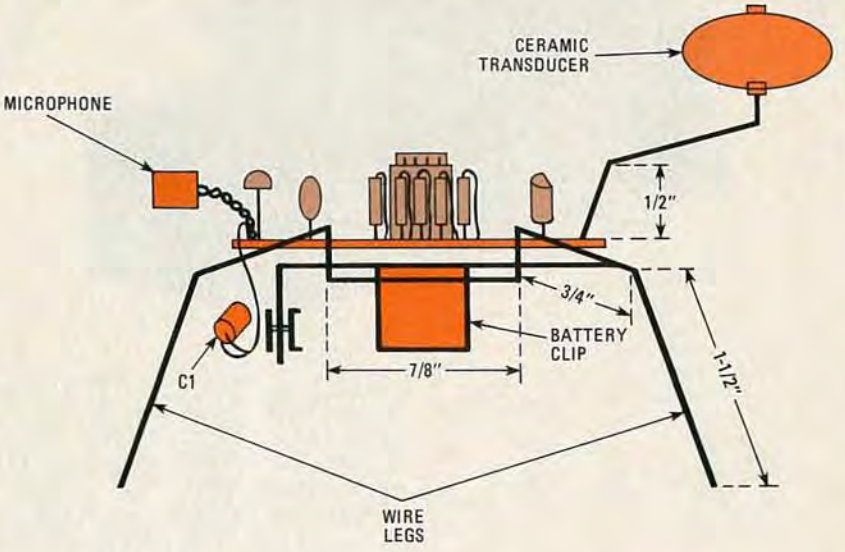


FIG. 6—SIDE VIEW OF LIMIK. Legs are made of 3/64 brass rod bent as shown and splayed out to sides.

because C1 inhibits the process by trying to charge itself to a state of equilibrium. That effect, coupled with the hysteresis effect caused by the offset voltage of IC1-b causes the output of IC1-a to gate the oscillator (Q1 and Q2) for several seconds and a chirping sound is heard from the piezo sounder. A one-shot action prevents the tone emitted by the sounder from retriggering the circuit and prevents "feedback."

The component values used in the circuit produce a sound similar to a cricket's chirp. They may be changed, if desired, to modify the sound. For good performance, though, make sure that C3 is no more than six times the value of C1. If less gain is desired, reduce the value of R4.

Capacitor C7 stabilizes the battery voltage. The TL062N consumes only about 150 μA (microamps) and the microphone bias-current is about 700 μA. The nine-volt battery should last for a fairly long time as long as the Limik doesn't chirp too frequently.

Construction

The Limik's components are mounted on a 1.2 × 1.6-inch PC board, which forms the top of the bug's body. Figures 2 and 3 provide foil patterns for the bottom and top of the board, respectively, but because plated-through holes are not required, a single-sided board with wire-wrap wire jumpers on the top can also be used. An already etched and drilled board is also available—see the Parts List.

To give the Limik a symmetrical appearance, several components are added which serve no real functional purpose. If you like, you can eliminate resistor R8 without altering the Limik's operation. Capacitor C4 is optional; it can be added without seriously affecting the quality of the sound.

Refer to Figs. 4 and 5 as you install the components on the board. You'll find it easier to start at the oscillator (tail) end and work toward the front. All resistors should be mounted vertically, with the body of the resistor toward the outside of the board and the bare lead bent over toward the inside. That makes the board visually appealing.

Because of the density of the board, use a very fine-tip soldering iron and be extra careful about solder bridges. Be sparing with the solder.

After the resistors have been inserted, soldered, and had their leads clipped, the remaining parts can be installed in any order. (If you use jumpers on the top side of the board, make sure they're in place before you mount the IC socket.)

Be sure to observe the polarities of

C1, C2, C3, and C4, if used, as well as those of the two LED's and D1. Also, make sure that the two jumpers indicated by "J" are in place.

When all the on-board components are mounted, it is time to install the microphone and piezo sounder. First, cut four 2-inch lengths of No. 22 solid wire and strip the ends. (If the wires are of different colors—say red and yellow—they'll enhance the appearance of the Limik.) Solder the red wires to the positive battery and microphone pads, and the yellow wires to the negative ones.

Connect the battery leads to the appropriate terminals on the battery clip and install capacitor C7 across them. Again, watch the polarity.

The original Limik used a 2-terminal microphone. The red wire from point "M2" was attached to the mike's positive terminal, and the yellow one from point "M1" to its negative (case) terminal. If you use a 3-terminal microphone, connect the mike's red lead to +V (point "M2"), its audio lead to "M1", and its ground lead to −V.

Form two lengths of No. 22 solid wire as shown in Fig. 6 and connect them to the piezo sounder. The original Limik used a "naked" sounder that was mounted in a Molex holder. The one you use may have a case, and the wires can be threaded through the holes in the "ears" for added support. The other ends of the wires are soldered to the PC board as indicated in Fig. 6.

Checkout

Before you attach the battery clip to the PC board, it's a good idea to check out the circuit to make sure that it works. Now is a good time to make other last-minute adjustments—such as the height of the "eyes" (about 0.2-inch)—too.

Plug IC1 into its socket and then slip a 9-volt battery into the clamp and connectors. When you make a noise (whistle, clap your hands, shout...) the LED's should light and you should hear the Limik chirp.

If nothing happens, first check to see that everything—including the battery—is inserted properly and in its proper place. Make sure that you've soldered all the points necessary, and if you're using jumpers, that they are in place.

You can verify the condition of the LED's by temporarily bridging a 1K resistor from their cathodes (banded ends) to the negative battery terminal. That should cause them to light.

If the sound from a "naked" sounder is raspy, or erratic, check its mounting in the holder. The contact pins may need to be bent to provide more pressure.

Finishing up

When the circuit is working properly, clip or file the leads on the foil-side of the board as short as possible. Again, check for proper operation.

Now, referring again to Fig. 6, form the legs from two 6-inch lengths of 3/16-inch brass rod. Insert them from the battery-side of the holder up through the PC board. Solder the legs firmly to the PC board (bottom *and* top, if possible) and adjust them so the Limik's body is parallel to whatever surface it stands on.

With that, your Limik should be complete. Have fun—but don't let it "bug" you. **R-E**

HI-FI CX DECODER

continued from page 46

millisecond attack time and a 30-millisecond decay time, to handle high-level transients, consists of C4, R15, R16, and Q3. The output of Q3 feeds into summing amplifier IC2-c through R17, where it joins the gain-control signal that is summed through R18. Op-amp IC2-c and transistor Q4 make up a voltage-to-current converter, and the collector of Q4 supplies the control current for the left- and right-channel transconductance amplifiers.

The LED-indicator circuit consists of a dual-element (red and green) LED driven by two voltage comparators (IC4-b and IC4-c). When S2 is in the OFF position, the LED's common cathode is unconnected; when S2 is ON, the common cathod is grounded. The comparators' reference voltages are derived from the +15-volt power supply through R49, R50, R51, and R52. The reference voltages are slightly higher and lower than 5 volts, which is the DC voltage that should appear at TP1 when a 0-dB reference signal is supplied to the expander. For low-level signals where the voltage at TP1 is less than 5 volts, IC4-c supplies a current through R53 to the green element of the dual LED, causing it to light. For signals where the voltage at TP1 is exactly 5 volts, IC4-b supplies a current through R54 to the red element of the dual LED, causing *it* to light. Since, at that voltage, both elements of the LED are lit, the LED will glow with an orange color. If the voltage at TP1 slightly exceeds 5 volts, the voltage from IC4-c is cut off, leaving just the red element of the LED lit.

That concludes the theory section of the *CX* expander. A foil pattern for the single-sided PC board required is shown in Fig. 4 for those of you who want to be ready for the construction portion of this article, which will appear next month. **R-E**