A Pilot-Lamp Beeper

Audibly alerts you when an electrical appliance with a pilot lamp is left on

By Dan Becker

Many electrically powered appliances for the home use a pilot lamp to indicate when certain functions, among them power-on, have been activated. Visual indicators, however, frequently go unnoticed, especially if they're small lamps. Forgetting to turn off some types of appliances may simply cost you some extra money on your monthly electric bill. Others can pose serious hazards to you and your family, such as the potential fire hazard of a left-on electric stove. In a case like this, an *audible* indicator, which isn't so easy to ignore, is much the better choice. You can equip your electrically powered appliances with an audible alarm, using the Pilot Lamp Beeper described here.

The Pilot Lamp Beeper sounds a series of "beeps" whenever it detects light from the pilot lamp of an electrical appliance. A simple light coupling arrangement from the appliance's pilot lamp to a phototransistor triggers a solid-state beeper in the project. The phototransistor/beeper circuit can be set to monitor any incandescent or neon lamp or light-emitting diode used as a pilot lamp. It requires no electrical connection to the lamp circuit. It is always powered; so you don't have to remember to turn it on. A low-power circuit design allows the Pilot Lamp Beeper to operate many months from a single 9-volt battery. Finally, there are only two set-and-forget controls, one to adjust pickup sensitivity to deal with various ambient lighting conditions and the other to set the beep repetition rate as desired.

About The Circuit

The Pilot Lamp Beeper, shown schematically in Fig. 1, is designed around two key elements. One of these is phototransistor *Q1*, which serves as a variable-resistance light sensor and is part of a voltage divider (*R3* and *R4* are the other two elements that make up the divider network). The other key element is piezoelectric buzzer *X1*, which is an integrated device that sounds a "beep" whenever a dc voltage is applied across it. The circuit is designed to periodically sound a beep whenever *Q1* detects a light-on condition, even in the presence of some ambient light.

This circuit is powered by 9-volt battery *B1*. Battery powering is practical in this application because the components, including the CMOS version of the 555 timer used for *IC1*, draw very little current in the standby mode. Additionally, the circuit will normally be triggered for only a small fraction of the time, when compared with its standby mode condition. Consequently, you can expect a very long life from the 9-volt battery.

With light falling on the photosensitive surface of *Q1*, pin 4 of *IC1* is effectively at V+ (about +9 volts). This puts *IC1* in its astable timing mode. Thereafter, once during each timing cycle, pin 3 momentarily goes low (to ground) and provides a current path through field-effect transistor *Q2* to briefly sound *X1*.

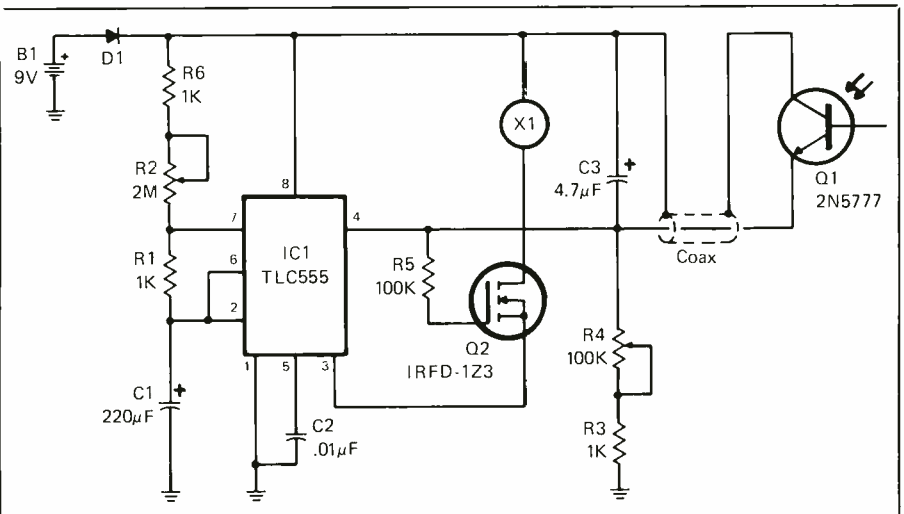
In this circuit, potentiometer *R4* serves as a sensitivity control. It can be set so that the circuit will reliably trigger under various ambient lighting conditions. The values of *R1*, *R2* and *R6* determine the length of silent time between beeps. By adjusting potentiometer *R2*, this period can be set from zero (continuous beeping) to one beep about every seven minutes.

With no light falling on *Q1*, the phototransistor's resistance is very high. This forces *IC1* into the reset mode, which interrupts the astable timing mode and causes pin 3 to go low. To prevent *X1* from sounding again when this occurs, *Q2* is biased by *Q1* to turn off the IC when no light is detected.

Capacitor *C3* smooths out any rapid variations in voltage that would be passed from *Q1* to *Q2* when the circuit is used to monitor the status of neon lamps. (Neon lamps operated from the ac power line almost always flicker at the 60-Hz rate.) Without this capacitor in the circuit as shown, *Q2* would rapidly turn on and off at the 60-Hz rate and cause the beeper to emit more of a "chirp" than a beep.

Construction

This very simple circuit is quite easy to build. It can be assembled on a home-made printed circuit board (see Fig. 2 for actual-size etching-



PARTS LIST

Semiconductors
D1—1N4001 or 1N914 diode
IC1—TLC555 CMOS timer
Q1—2N5777 or similar phototransistor (Circuit Specialists, P.O. Box 3047, Scottsdale, AZ 85257)
Q2—IRFD-173 MOSFET (Radio Shack No. 276-2073)

Capacitors
C1—220-μF, 16-volt electrolytic
C2—0.01-μF ceramic disk
C3—4.7-μF tantalum

Resistors (all ¼-watt, 10%)
R1,R3,R6—1000 ohms
R5—100,000 ohms
R2—2-megohm pc-type trimmer potentiometer
R4—100,000-ohm pc-type trimmer potentiometer

Miscellaneous
B1—9-volt battery
X1—Piezoelectric buzzer (Radio Shack No. 272-131)
Printed-circuit board or perforated board and solder posts; suitable plastic enclosure; socket for IC1; battery holder; connector for B1; coaxial audio cable; heat-shrinkable tubing; machine hardware; hookup wire; solder; etc.

Fig. 1. Operation from a battery is practical because of the use of low-power devices. Significant power is drawn from B1 only when X1 sounds.

and-drilling guide and components-placement diagram), or perforated board with solder posts. Whichever you choose, use a socket for *IC1*.

All components, except *Q1*, mount directly on the circuit board. When installing components on the board, be sure to observe proper orientations, and use safe handling procedures for the MOS devices (*IC1* and *Q2*). Also, if you're using a pc board, make sure you install the wire jumper on it as shown in Fig. 2, and use heat and solder sparingly.

Phototransistor *Q1* connects to one end of a coaxial audio cable. The length of the cable will be determined by the particular application(s) for which the project is to be used. In any event, keep this cable to 6 feet or less in length.

Prepare both ends of the cable by removing 1" of outer insulation and separating the wire braid from the inner conductor. Tightly twist together the fine braid wires at each end of the cable and lightly tin with solder. Then strip away ¼" of insulation from the inner conductor at both ends of the cable.

Slip a ½" length of small-diameter heat-shrinkable tubing over the shield and the inner conductor at one end of the cable. After trimming the leads of the phototransistor to about ½", form a small hook in each lead stub and crimp around the cable's conductor's (emitter to inner conductor, collector to shield). Solder the connections. Slide the tubing over the connections and butt it against the bottom of the transistor's case and carefully shrink it. Slip a 1½" length of larger-diameter heat-shrinkable tuning over *Q1*. Position it so that is does not overhang the sensitive (lensed) end of the transistor and heat to tightly shrink it.

Place the circuit board assembly inside the plastic box that is to house it, in the exact location where it's to be mounted. Mark the locations on the box where the holes for cable exit, access to the adjust slots of the pots, and mounting of the board are to be drilled. Remove the circuit board and drill the appropriate-size holes at the marked locations.

Pass the free end of the cable through its hole, route the conductors to the proper points on the board and solder. Mount the battery holder on the board with machine hardware. Connect and solder the battery connector's leads into the circuit. Then mount the circuit board assembly in the box, using spacers and machine hardware.

Determine where under the top of the box *X1* will be when the project is fully assembled. Drill a dozen or more ⅛" holes in a circular area around this location to allow sound from the buzzer to escape.

Checkout And Adjustment

Set both trimmer pots to their fully counterclockwise positions and plug the battery into its connector. Cover the phototransistor so that no light can fall on it. No beeping should be heard. Now allow light to fall on *Q1*; this time, if all is well, the beeper should sound with a repetition rate of

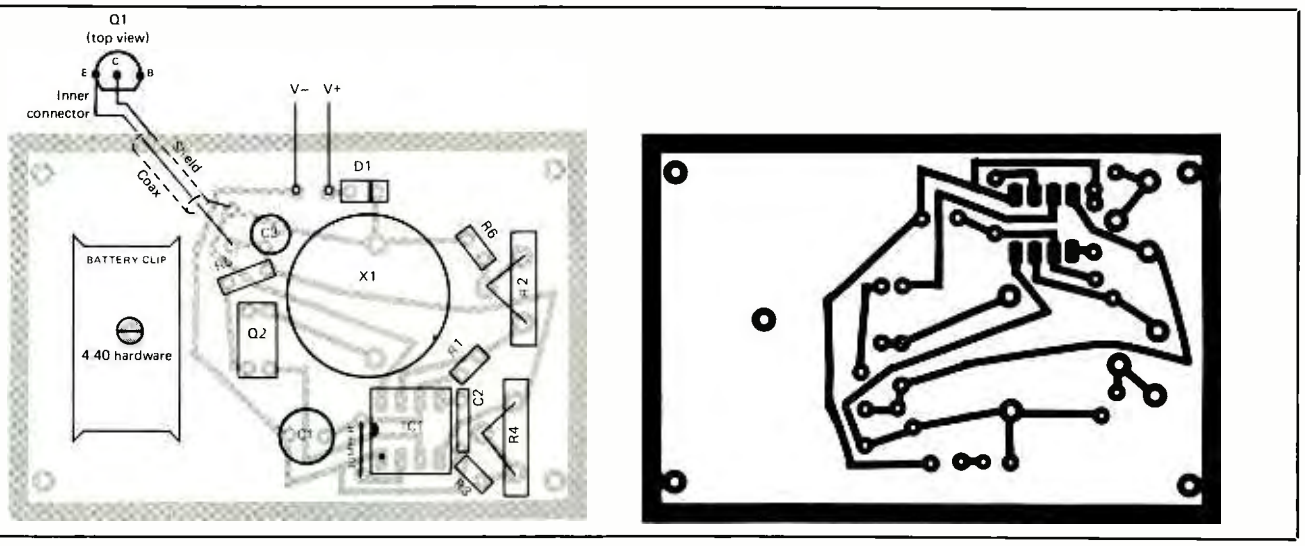


Fig. 2. An actual-size etching-and-drilling guide for home fabrication of a printed-circuit board is shown at right. Wire the components to the board as shown in the placement diagram at the left; observe polarity!

about two beeps per second. Adjusting *R4* fully clockwise should cause the beeping to cease.

Slowly rotate *R4* counterclockwise just enough to reestablish strong, clear beeping. This is the correct setting for this control under *existing* lighting conditions. You'll have to readjust the trimmer pot to suit the conditions of the actual application(s) to which the project is put.

The intervals of silence between beeps can also be adjusted. The interval range, with the value for trimmer control *R2* specified in the Parts List yields up to one beep about every seven minutes with the pot set fully clockwise.

When you've completed testing and adjusting the Pilot Lamp Beeper, fasten the lid of the box in place. This done, you can install the project anywhere convenient to the pilot lamp it is to monitor.

Installation of the project is really very simple. You must first determine if the project is to be used exclusively with one specific appliance only. If so, find an out-of-the-way location into which you can tuck the box that houses the electronics and route the pickup cable to the pilot lamp the project is to monitor. If there's a way to couple the phototransistor to the pilot lamp from inside the appliance, so much the better. If not, make the coupling to the front of the lamp assembly. Remember, the tighter the coupling, the more reliable the operation of the project. With permanent installations, such as in an electric stove, you can complete mechanical coupling by cementing the lensed end of the phototransistor to the pilot lamp with *clear* fast-set epoxy.

If you plan to use your Pilot Lamp Beeper to monitor more than one appliance, you'll have to determine how to fabricate a coupling arrangement that will suit whatever different pilot lamp arrangements are involved. This might be something as simple as a plastic tube that fits snug over the phototransistor and lenses of the pilot lamps. **ME**

"I've finished my homework for the next seven years."