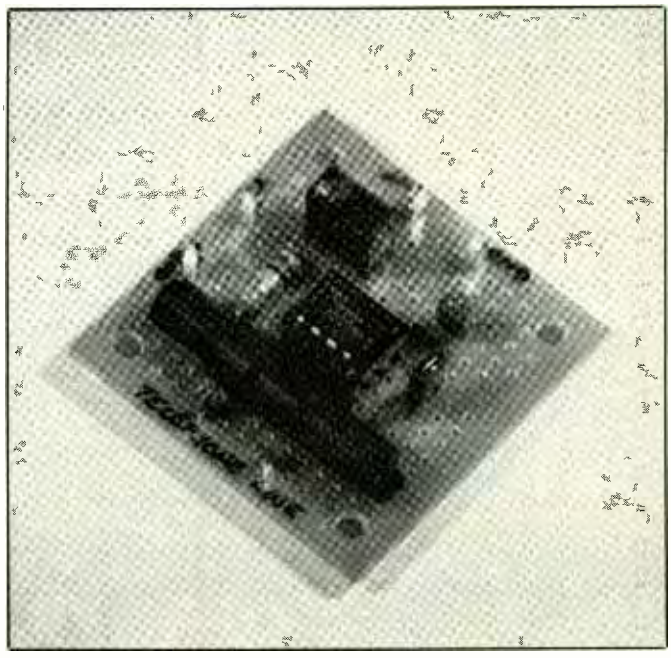
Phone-Ring Visual Indicator

Lighting up a lamp when a phone call comes in is a helpful signal for hearing-impaired people and those who are awaiting a call but do not want to wake up sleeping persons



By Andrew Van Loenen

In the old days, when visual indication of a ringing telephone was needed, telephone company personnel used a neon lamp. Though it wasn't good at a distance, if several telephone instruments were close together, it could identify which instrument was ringing. The appeal of the neon lamp was that it was cheap and extremely easy to connect. All you had to do was connect the arrangement across the telephone line. No capacitors or resistors (other than the one in the lamp assembly) were needed because, when the phone isn't ringing, the −48-volt dc line potential isn't sufficient to ionize the neon gas; so, the lamp appears as an open circuit to the telephone line. When the ring signal of approximately 90 volts ac at 20 Hz is superimposed on the −48 volts appears on the line, however, the neon gas ionizes as the potential increases beyond about 65 volts. The lamp then flashes on and off at the ringing rate. The lamp draws so little current from the telephone line that there is no danger of it "answering" the phone when it lights.

With modern technology, solid-state electronics makes it possible to build a much more sophisticated ring indicator that has all the benefits of the original lamp assembly, plus a few of its own. The Telephone Ring Indicator to be described is such a circuit. It can be adapted to a variety of applications, such as the controller for a flashing table lamp to signal the hearing impaired of an incoming call, a ring counter, and any number of other uses you can think up.

About the Circuit

Shown in Fig. 1 is the complete schematic diagram of the Telephone Ring Indicator. In this circuit 555 timer *IC1* is configured as a monostable, or one-shot, multivibrator. When TRIGGER pin 2 is brought low, OUTPUT pin 3 goes high for a period of time determined by the relationship of the values of *R2* and *C1*, expressed mathematically by the formula 0.693 R2C1. With the values shown for these components, the output will ideally remain high for about 2.5 seconds.

Phototransistor *Q1* normally holds the TRIGGER input at pin 2 of *IC1* high (not triggered). However, when light from neon lamp *I1* strikes the photosensitive surface of *Q1*, the phototransistor is biased into conduction and pin 2 of *IC1* goes to ground potential through its collector/emitter circuit. This triggers the timer into operation.

One of the features of a monostable multivibrator is that it will not respond to more than one trigger pulse during its timing cycle. The key to successful operation of this circuit lies in exploiting this feature because *I1* flashes at the ringing rate and thereby provides multiple trigger pulses to *IC1*. Therefore, the time constant provided by *R2* and *C1* must be long enough to permit *I1* to stop flashing before it allows the output of *IC1* to return to logic low.

A very common ring sequence, used by telephone companies throughout the country, is 2 seconds ringing followed by 4 seconds of silence, repeated for as long as an at-

tempt is made to reach a dialed number or for the recipient of a call to pick up the receiver of his instrument. This being the case, *I1* will flash for about 2 seconds. Therefore, it is necessary that the product of the *R2* and *C1* values provide a time constant that will exceed this. In practice, it is a good idea not to exceed it by very much to allow *IC1* to have an output timing that resembles as nearly as possible the phone company's ring timing.

If your local telephone company uses a different ringing sequence from that described above, use the above equation to determine the best resistor/capacitor value combination to use for your needs. In general, it's a good idea to stay away from extremely low values of capacitance teamed with extremely high values of resistance.

As has already been mentioned, the values of *R2* and *C1* will ideally permit the output of *IC1* to be high for about 2.5 seconds. However, this assumes a capacitor whose value is exactly 10 microfarads and a resistor whose value is exactly 360,000 ohms. In practice, this is almost never the case. Electrolytic capacitors usually have a wide tolerance and most tend to err to the high side of that tolerance. Beyond this, electrolytic capacitors are often too "leaky" for reliable use in a timing circuit. Tantalum capacitors, on the other hand, are smaller, less leaky and commonly have a tolerance of 20 percent or better. That is the reason why a tantalum capacitor is specified for *C1* in the Parts List. Nevertheless, you may have better luck using a 500,000-ohm, 10-turn trimmer potentiometer for *R2* so that you can "tune" the time constant as needed for the desired results.

Capacitor *C2* provides bypassing to ground for the MODULATING input at pin 5 of *IC1* to prevent pickup of unwanted signals that could interfere with the proper timing.

This circuit always draws current from the power source and, therefore, battery operation is not recommended. However, a small plug-in wall transformer with an output between 5 and 15 volts dc will work well with the circuit. Alternatively, you can build your own power supply inside the enclosure used for housing the project. Building your own supply would make sense in projects like the aid for the hearing-impaired (described below) because you must have available inside the enclosure 117 volts ac anyway.

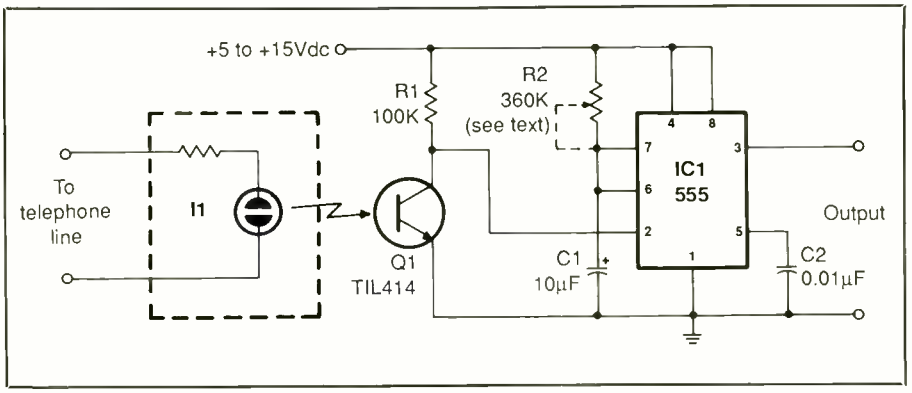


Fig. 1. Schematic diagram of the basic Telephone Ring Indicator circuit.

Shown in Fig. 2 is the schematic diagram of an ac-line-operated 9-volt dc supply suitable for powering the project. Because the project is meant to be on at all times, there is no power switch in the supply's design. Also, if you wish, power transformer *T1* can be either a discrete device built into the project's enclosure or an external plug-in transformer.

You will note that no output device is specified for the Fig. 1 circuit. This is because the output from the circuit can be used to drive a variety of devices according to specific needs.

One of the features that make this Telephone Ring Indicator so versatile is that it will operate from any dc power supply that delivers between 5 and 15 volts and the logic transitions are from ground to very near the positive rail. This makes the project suitable for use with both TTL and CMOS logic families, as well as analog circuits. In fact, the number of uses to which you could put the project are limited only by your imagination. Some examples of projects that you might want to undertake include: a ring counter, an automatic answering device, a distinctive ringer, a loud outdoor ringer, a delayed

PARTS LIST

Semiconductors

D1,D2—1N4001 rectifier diode
IC1—555 timer
Q1—TIL-414 infrared phototransistor (Radio Shack Cat. No. 272-145 or equivalent)

Capacitors

C1—10-µF, 16-volt tantalum
C2—0.01-µF, 50-volt polyester or ceramic disc
C3—1,000-µF, 50-volt electrolytic

Resistors

(¼-watt, 5% tolerance)
R1—100,000 ohms
R2—360,000 ohms (or substitute 500,000-ohm, 10-turn trimmer potentiometer—see text)

Miscellaneous

I1—Amber neon-lamp assembly with current-limiting resistor (Radio Shack Cat. No. 272-707 or equivalent)
T1—12.6-volt center-tapped miniature power transformer
Printed-circuit or perforated board and suitable Wire Wrap or soldering hardware; socket for IC1; ¼-inch-diameter heat-shrinkable tubing; suitable enclosure (see text); fast-set clear epoxy cement; hookup wire; solder; etc.

ringer to cut down on nuisance calls, remote control of devices as home while you are away, and an aid for the hearing impaired.

Shown in Fig. 3 is a schematic diagram of a circuit that adapts the project for use as an aid to the hearing impaired. This circuit will flash a table lamp in step with the rings of the telephone. A solid-state relay can be used for *K1*. Generally, these relays require an input of from 3 to 36 volts dc, are capable of being directly driven from TTL and CMOS sources, and the output can switch several amperes of current at 117 or 240 volts ac, depending on device rating.

When the output of *IC1* goes high, *K1* energizes. At this time, 117 volts ac is conducted through fuse *F1* to relay *K1* and its contacts and on to the ac receptacle. Note that the neutral side of the ac line is connected directly to the ac receptacle. The table lamp, plugged into the ac receptacle, must be left in the turned-on state so that it can be controlled by the ringing telephone signal.

The rating of *F1* depends on the amount of current drawn by the table lamp and the current-carrying capability that connects the project to the ac line. If you use an 18-gauge line cord for the project, the rating of *F1* should not exceed 3 amperes, regardless of the current demand of the load plugged into the ac receptacle. Therefore, if you want to be able to control a load rated at more than 3 amperes, use a 16-gauge or larger line cord for the project.

Switch *S1* provides a means for turning on the lamp when the telephone is not ringing. It simply applies V+ to the input of the solid-state relay, bypassing the *IC1* controller. Diode *D1* provides protection for *IC1* when *S1* is closed.

Construction

Building the Telephone Ring Indicator presents no particular difficulties. The simple circuit is very straightforward and requires no attention to component layout. The only potential difficulty with regard to construction is in assembly of the *I1/Q1* assembly, though there is no real difficulty involved.

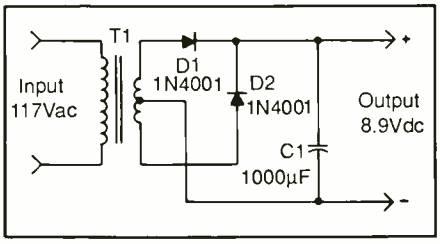


Fig. 2. Schematic diagram of an ac-line-operated 9-volt dc power supply suitable for use with the Telephone Ring Indicator.

For this project, perforated-board construction (use a board that has holes on 0.1-inch centers) is perhaps the simplest way to go, though if you wish to design and fabricate your own printed-circuit board instead, feel free to do so. In either case, be sure to use a socket for *IC1*.

Start construction by assembling the *I1/Q1* assembly. These components must be in close physical contact with each other, and *Q1* must be shielded from extraneous light for it to properly respond to only the light from the neon lamp. Start with a 1 5/16-inch length of ¼-inch-diameter heat shrinkable tubing.

To make it possible for the neon lamp's case to fit into one end of the tubing, slide the tubing over the closed jaws of longnose pliers and *gently* stretch the tubing by slowly opening the jaws of the pliers, as illustrated in Fig. 4(A). Test the fit of the lamp in the stretched end of the tubing, as in Fig. 4(B). If it is still a bit too tight, stretch the tubing some more. Push the neon lamp into the stretched end until the tubing is flush with the read edge of the lamp's housing.

Next, apply a small bead of fast-setting clear epoxy cement around the case flange of the phototransistor, as in Fig. 4(C). Then insert the transistor into the open end of the heat-shrinkable tubing until its case touches the case of the neon lamp, as in Fig. 4(D). Use a cigarette lighter or heat gun to solidly shrink the tubing over the neon lamp and phototransistor, as in Fig. 4(E), but be careful to avoid heat damaging the components. Shown in Fig. 4(F) is the completed neon-lamp/phototransistor assembly as it should appear after shrinking the tubing. Note the solid outlines of both components, indicating a solidly made assembly that will meet all criteria.

As you install and wire together the components on the circuit board, be sure not to have *IC1* in its socket. Install the 555 timer in its socket only after all connections to its socket pins

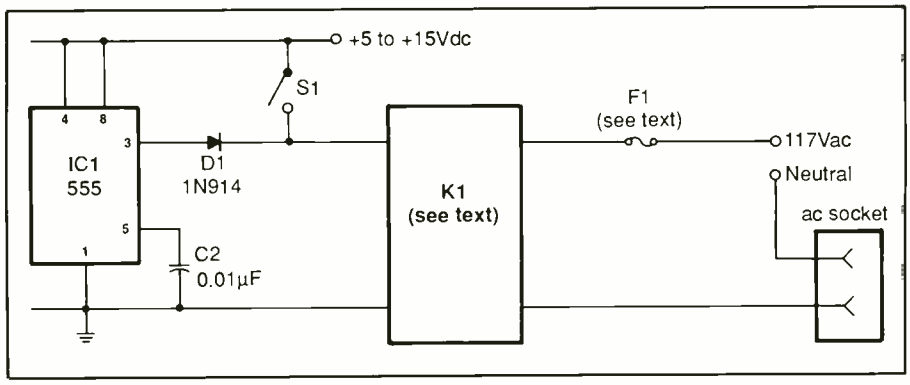


Fig. 3. How to adapt the basic Telephone Ring Indicator circuit to flash a table lamp in step with the ring signal on the telephone line to alert the hearing impaired to incoming calls.

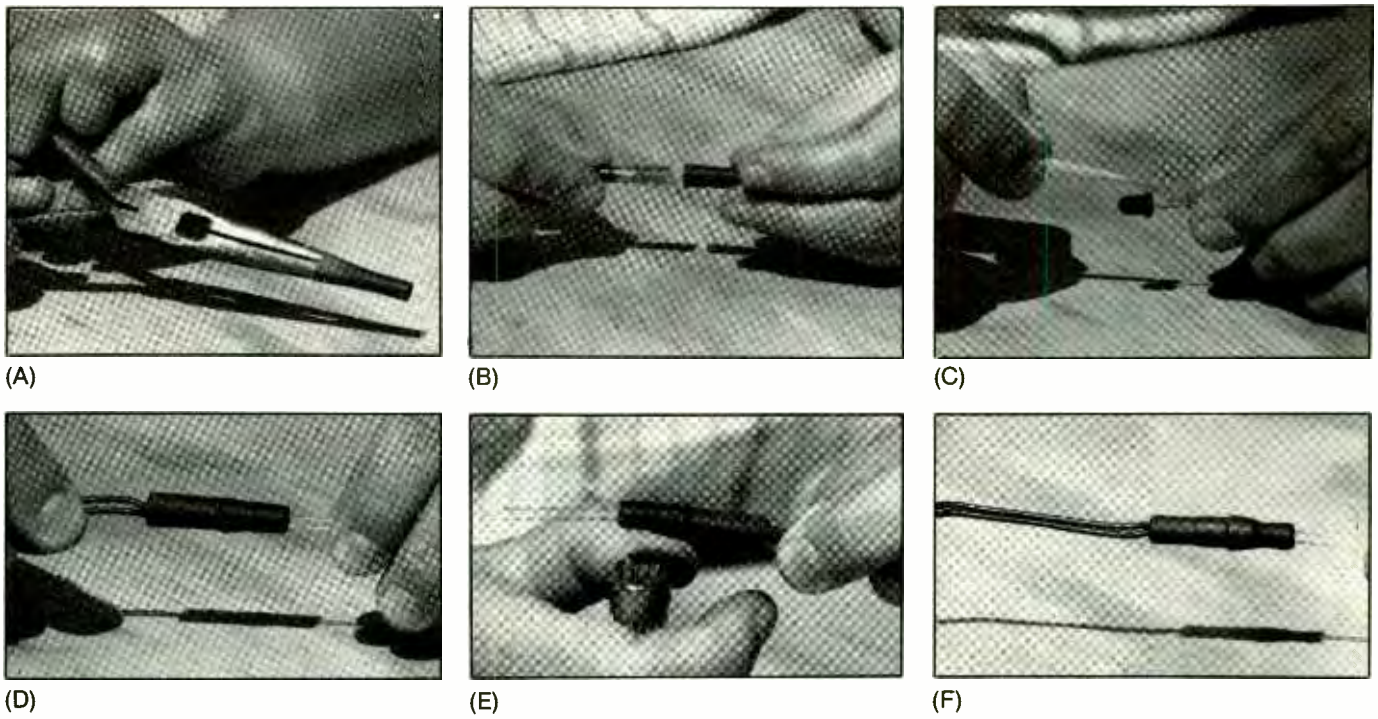


Fig. 4. Assembly of the neon-lamp/phototransistor assembly: (A) stretch heat-shrinkable tubing to accept the neon lamp; (B) test fit lamp into tubing; (C) apply epoxy cement to phototransistor prior to installation in tubing; (D) insert transistor into tubing; (E) heat shrink tubing to form a light-tight assembly; (F) neon-lamp/phototransistor ready for installation in circuit.

have been soldered. If you elected to use a trimmer potentiometer for *R2* set its resistance for 360,000 ohms as indicated on a high-accuracy digital multimeter between pins 7 and 8 of the IC socket before installing the timer chip in the socket. This will give you a reasonably good starting point for calibration later on. When installing the timer in its socket, make certain that it is properly oriented and that no pins overhang the socket or fold under between socket and chip as the IC is pushed home.

You can house your Telephone Ring Indicator in any small enclosure that will comfortably accommodate it and its ac power supply and whatever controlled circuit you use with it. Machine the enclosure to permit entry of the Telephone Line and Output cables for the basic project and for jacks or other receptacles and cords you decide to use with the project. A simple way to mount the circuit-board assembly in place is with a 2-inch square or two 2 × 1-inch pieces of thick double-sided foam tape.

Calibration

Once construction is completed and the project is checked for wiring and component installation errors, proceed with calibration. For purpose of adjustment, power up the circuit with a 9-volt battery and connect an oscilloscope, logic probe or LED and resistor across the output of *IC1*. Connect the Telephone Line cord to a convenient modular connector block (polarity is not important in this project) while leaving the telephone instrument connected to the line as well. If necessary, use a one-to-two adapter to obtain a second jack at the telephone's location.

Now either call the number yourself from a nearby telephone or have someone else call it if there is no nearby telephone. When the phone rings, the output of *IC1* should go from low to high and should remain high until very shortly after the phone stops ringing. At this point, the output of *IC1* should return to its normally low condition. This sequence should repeat every time the telephone rings.

With the values of *R2* and *C1* taken out to the high end of their tolerances, the worst-case on time for *IC1* is about 4.6 seconds. Keep in mind that the time constant should never be so long that it ends on subsequent rings. If it is too short, it can give the appearance of being too long because as the 555 times out, it is immediately retriggered. The result is that the output goes low and then immediately high again. This can best be seen with an oscilloscope or logic probe. A resistor/LED arrangement will also show it, but you must watch carefully. You can guard against these conditions by using a multi-turn trimmer control in instead of a fixed-value resistor for *R2* and adjust its setting as required. **ME**