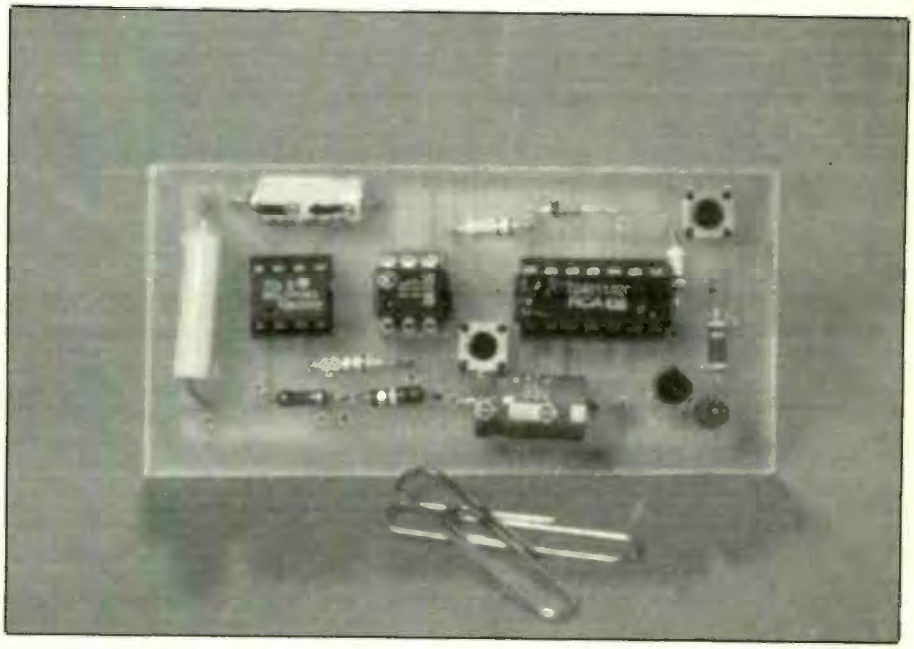
The Telephone Minder

This handy accessory tells you if someone tried to call you when you were not at home

By Anthony J. Caristi



Have you ever left your home and upon returning wondered if you missed a telephone call? If you have a telephone answering machine, your caller probably left a message that you can play back. Without it, all you can do is wonder.

Our Telephone Minder may be the answer to this dilemma. It monitors your telephone line for incoming calls and turns on a light-emitting diode when it detects a ring signal as someone tries to get through to you. You simply press a button to see if the LED is lit. If it is on, you know someone tried to reach you; if it is off, no one called while you were out.

Of course, the Telephone Minder has one major disadvantage: it may tell you that someone tried to contact you by phone, but you have to figure out who it was. On the plus side, since it never answers an incoming call, your caller will not be billed for a completed call, nor will you have the obligation to call back.

A very easy project to install in your telephone system, either inside an existing instrument or as a stand-alone device, the Telephone Minder gets its power from the telephone line itself. It does not interfere with normal telephone service, nor does it load down the telephone line. Its two-button operation makes it easy to use as well.

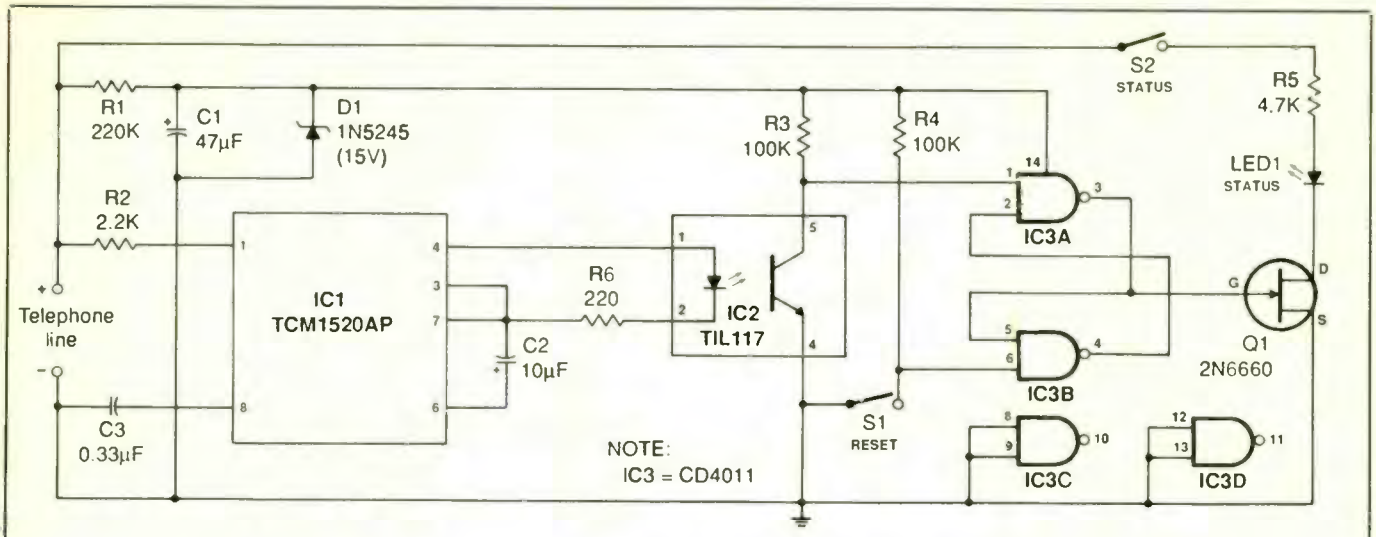
About the Circuit

As shown in Fig. 1, the Telephone Minder consists of three integrated circuits, each of which has a specific task to perform. Telephone ring detector *IC1* contains all the circuitry needed to detect the 20-Hz, 90-volt ring signal that appears across the telephone line to announce an incoming call. On-chip are a bridge rectifier, current sensor, 5-volt regulator and transient suppression circuitry to prevent damage and false operation in the event of a lightning strike or other transient voltage that might appear on the telephone line.

On standby, *IC1* presents a very high impedance across the telephone line. This obviates any interference with normal telephone operation of incoming and outgoing calls. When a ring signal appears across the telephone line, external capacitor *C2* stores the energy of the signal. This energy ultimately appears at output pin 5 as regulated 5 volts dc, which is used to turn on a light-emitting diode inside optical isolator *IC2*.

Also contained inside *IC2* is a photosensitive transistor "switch" that is turned on whenever light from the on-chip LED strikes it. During standby, this transistor is held in cutoff, with its collector potential held at 15 volts, as supplied by the telephone line and zener diode *D1*. When a call comes in, *LED1* lights and the collector potential of the transistor inside *IC2* (at pin 5) drops to zero. This transition to a logic-0 level is passed on to the pin 1 input of *IC3*.

Two of the four NAND gates inside *IC3* are wired in a flip-flop configuration and operate in a mono-



PARTS LIST

Semiconductors

D1—1N5245 or similar 15-volt zener diode

C1—TCM1520AP ring detector (Texas Instruments)

IC2—TIL117 optical isolator (Texas Instruments)

IC3—CD4011BE quad 2-input NAND gate

LED1—Red T-1¾ light-emitting diode (2 volts at 20 mA)

Q1—2N6660 or equivalent 60-volt breakdown enhancement-mode n-channel field-effect transistor (see text)

Capacitors

C1—47-µF, 25-volt electrolytic

C2—10-µF, 35-volt electrolytic

C3—0.33-µF, 250-volt Mylar or paper

Resistors (¼-watt, 10% tolerance)

R1—220,000 ohms

R2—2,200 ohms

R3,R4—100,000 ohms

R5—4,700 ohms

R6—220 ohms

Miscellaneous

S1,S2—Spst momentary-action push-button switch (preferably calculator-key type)

Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable soldering or Wire Wrap hardware; DIP sockets for ICs (see text regarding IC2 socket); suitable enclosure for stand-alone unit (see text); telephone cable with modular connector at one end (see text); small-diameter heat-shrinkable tubing; at least ⅛-inch thick double-sided foam tape; hookup wire; solder; etc.

Note: The following items are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: Printed-circuit board, $9.95; TCM1520AP ring detector IC, $5.75; TIL117 optical isolator, $2.75; CD4011BE NAND gate IC, $1.95; 0.33-µF, 250-volt Mylar or paper capacitor, $1.00. Add $1.00 P&H per order. New Jersey residents, please add state sales tax.

Fig. 1. Complete schematic diagram of Telephone Minder. Circuit gets its power directly from telephone line with minimal loading.

stable mode. That is, the flip-flop has two stable states. Each state depends on the logic level fed to the circuit's input terminals at pins 1 and 6. When the flip-flop circuit is first energized, you set the logic state to 0 by pressing RESET switch *S1*. Grounding the pin 6 input of *IC3* by closing *S1* pulls the output of the flip-flop to logic 0, placing the circuit in the standby mode. The circuit will remain in this state until it is toggled by a 0-logic level felt at pin 1 of *IC3* from the preceding circuitry.

The ring signal detected by *IC1* and the resulting current through the transistor inside *IC2* provide the required logic-0 signal level to cause the flip-flop to assume its opposite state (logic 1 at the pin 3 output of *IC3*). When the flip-flop's output pulse does toggle to logic 1, it remains at this level (about 15 volts) until it is manually reset to logic 0 by closing *S1*. This being the case, *IC3* "remembers" if a call has been received.

No conduction occurs between the drain (D) and source (S) of n-channel enhancement-mode field-effect transistor *Q1* unless a positive bias is applied to the gate G terminal. Unless a call (ring signal) has been detected, *Q1* remains in cutoff and *LED1* remains off when STATUS switch *S2* is pressed.

If a call was detected in your absence, the resulting positive output at pin 3 of *IC3* sends *Q1* into conduction when *S2* is pressed. Since conduction is through *LED1*, the light-emitting diode will turn on to indicate that there was a call.

Since power for the circuit is derived from the telephone line, current drain is kept at an absolute minimum (about 0.15 milliamperes, or 150 microamperes). When the Telephone Minder is installed you must press *S2* to see if *LED1* is off or on. If the LED is off, no one attempted to call you; if it is on, someone did attempt to call. In the former condition, *LED1* and *Q1* would be off.

If someone had attempted to call you, *Q1* would conduct and *LED1* would be on, placing at least 20 milliamperes more load on the telephone line constantly if limiting resistor *R5* had been wired directly to the + side of the telephone line and *S2* had been eliminated. With the circuit wired as shown, the current drain when *Q1* is conducting and *LED1* is on would be for a very brief period of time, just long enough for you to see the status of the circuit.

If the telephone line had been tripped, indicated by *LED1* being on when you press *S2*, you would know that someone had attempted to call you. To restore the circuit to its standby mode, you simply press and release *S1*.

Bear in mind that the Telephone Minder does *not* answer an incoming call. It simply detects when a ring signal that announces an attempt to reach your number has come over the line. Since it does not initiate an off-hook condition, which signals the telephone company that the caller has completed the connection, the caller will not be charged for a call.

Construction

As you can see in Fig. 1, this project's circuit is very simple. You can assemble the circuit on a small printed-circuit board. Since there is nothing critical about circuit layout and wire routing, you also have the option of using a small perforated board with holes on 0.1-inch centers and soldering or Wire Wrap hardware. Whichever technique you choose, be sure to use sockets for the ICs.

If you plan on fabricating your own printed-circuit board, use the ac tual-size etching-and-drilling guide shown in Fig. 2. Alternatively, if you wish pc wiring but do not care to etch and drill your own board, you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List.

Wire the board exactly as shown in Fig. 3. (Use this illustration as a rough guide to component layout on perforated board if you do not use a printed-circuit board.) Start by installing and soldering into place the three DIP IC sockets. You may have difficulty finding a six-pin DIP socket to use for *IC2*. If you do, use either Molex Soldercon® socket connectors, three to each socket side, leaving vacant the left-most *IC2* holes in the upper and lower rows (with the board viewed as shown in Fig. 3), or install an eight-pin socket in this location. Do *not* install the ICs themselves at this time.

Next, install the resistors, zener diode, capacitors and transistor. Make sure *C1*, *C2* and *D1* are properly oriented and that *Q1* is properly based before soldering their leads to the copper pads on the bottom of the board.

It is very important that you use the proper type of transistor for *Q1*. This *must* be an n-channel *enhancement-mode* field-effect transistor. Ordinary FETs are depletion-mode types that will not work with this circuit. If you substitute a transistor with a different part number from that specified in the Parts List, be sure to use a FET that is electrically equivalent to it.

At this point, you can exercise either of two options, depending on the type of telephone instrument with which you plan to use the Telephone Minder. You can build the project into an existing telephone instrument, assuming it has sufficient room inside it to accommodate the circuit-board assembly and has enough panel space on which to mount the switches and light-emitting diode. Alternatively, you can build the project as a stand-alone unit. For the latter, which requires its own separate enclosure, proceed as follows.

Prepare six 4-inch lengths of

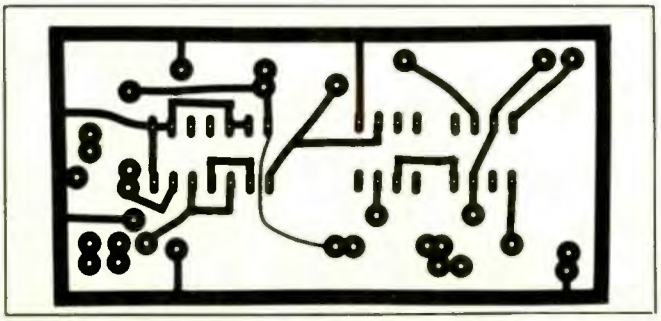


Fig. 2. This is the actual-size etching-and-drilling guide to use for home fabricating your own printed-circuit board.

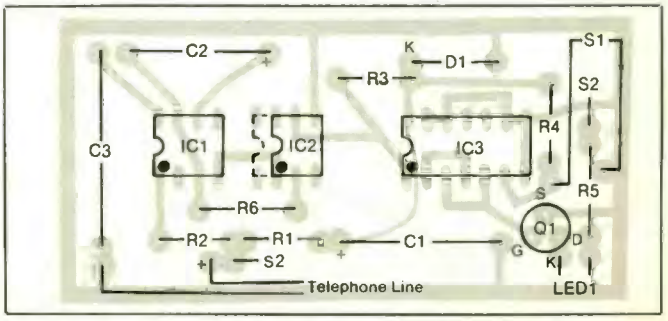


Fig. 3. Wiring guide for pc board and rough component-placement guide when using perforated board.

hookup wire by removing ½ inch of insulation from both ends. If possible, use a wire with a different color of insulation from the other five for the connection to the cathode pad for *LED1* on the board. Plug one end of the wire that has a different color of insulation into the LED1 hole identified with a K and solder it into place. Then plug one end of each of the other wires into the S1, S2 and remaining LED1 holes. When you are finished, there should be only two holes in the circuit board that are not occupied, identified as TELEPHONE LINE + and −.

Prepare a suitably sized plastic box by drilling the holes in which to mount the light-emitting diode and switches and to provide entry for the cable that will connect the project to the telephone line. Mount the switches in their respective holes. Slip a 1-inch length of small-diameter heat-shrinkable tubing over the ends of the LED1 wires on the board. Trim the LED's cathode lead to ½ inch long and solder it to the cathode wire (with different-color insulation). Do the same for the other wire and the anode lead. Then push the heat-shrinkable tubing up over the connections until both are resting against the bottom of the LED's case and shrink into place.

To connect the Telephone Minder to the telephone line, you need an appropriate length of cable terminated at one end in a standard plug. (Note that FCC Regulations require this arrangement so that the device can be quickly disconnected from the telephone line.) The length of cable needed will depend on where the project will be located with respect to the wall jack. If you purchase a telephone cable that is terminated on both ends in a plug, cut off and discard one plug. Trim off 1 inch of outer plastic jacket from this end of the cable.

Since you need only the red and green cable conductors, you can clip off the yellow and black ones. Then strip ¼ inch of insulation from the red and green conductors. Tightly twist together the fine wires in each conductor and sparingly tin with solder. Pass the free end of the cable through the entry hole into the box in which the project will be housed. Tie a knot about 4 inches from the end inside the box to serve as a strain relief for the cable.

If you prefer, you can use a chassis-mount telephone jack instead of having to hard-wire the telephone cord directly to the circuit-board assembly. In this case, connect and solder appropriately color-coded hookup wire between the jack and board and use a cord terminated at both ends in quick-disconnect plugs.

Before attempting to solder the telephone cable's conductors to the circuit-board assembly, you must determine the polarity of your telephone line. To do this, connect the "hot" probe of a voltmeter to the red conductor and the meter's common probe to the green wire. Set the meter to indicate at least 20 volts dc. Before turning on your meter, make sure that neither conductor or probe touches each other.

If there is only one jack available at the wall box, temporarily unplug the telephone instrument plugged into it and use it for this test. If there is only one telephone instrument and one wall jack in your installation, you will need a one-to-two jack adapter to accommodate both instrument and Telephone Minder for final installation.

If you obtain a positive (+) reading on your meter during checkout, tag the red cable conductor with a + label. On the other hand, if the reading is a negative voltage, tag the *green* conductor with a + label. Unplug the cable from the wall jack and disconnect the meter.

Plug the + labeled conductor into the board labeled TELEPHONE LINE + and solder it into place. Similarly, plug the unlabeled conductor into the − hole in the board and solder it into place. Referring to Figs. 1 and 3, connect and solder the free ends of the remaining wires to the lugs on the switches. Turn over the board and clip all leads as close as possible to the board.

Cut one or more pieces of double-sided *foam* tape that is at least ⅛ inch thick to a length of 3 inches. If the tape is less than 1 inch wide, cut two strips and trim them so that their combined width does not exceed 1½ inches. Lift off the protective paper backing from only one side of the tape and press the tape firmly into place in the plastic box in the exact location where the circuit-board assembly is to be mounted. Do *not* remove the protective paper from the other side of the tape until after you have performed initial checkout and have installed the ICs in their respective sockets.

Building the Telephone Minder into an existing telephone instrument simplifies matters a bit, since the housing for the project it the telephone instrument itself. Just make sure that there is sufficient room inside the telephone instrument's housing to accommodate the project and that sufficient panel space is available for mounting the LED and switches. Use the same double-sided foam tape arrangement described above for mounting the circuit-board assembly inside the telephone instrument in a location where it will not interfere with operation of the telephone instrument or touch any of its circuitry.

Checkout

Before attempting to operate the Telephone Minder, and before installing the ICs in their sockets, make a preliminary check of the power supply as follows. Plug the modular connector on the project into a telephone line receptacle and measure the potential across *C1* with a voltmeter that has at least a 1-megohm input resistance. Set the meter to

(Continued on page 98)

read at least 50 volts dc, with the common probe of the meter connected to the negative (−) side and positive probe connected to the positive (+) side of *C1*. As you take a reading, check for proper polarity. Note that *all* voltage readings are referenced to the − side of *C1*, which is circuit ground.

Initially, the meter reading should climb toward 14 to 16 volts as *C1* charges. If you do not obtain this reading, check the orientation of *C1*, *D1* and the polarity of the telephone line at the TELEPHONE LINE pads on the circuit-board assembly. The potential measured at the junction of *R1* and *R2* should be +50 volts with the meter's common probe connected to the − side of *C1*.

If the power supply checks out as described, disconnect the project from the telephone line and give *C1* time to discharge. Then carefully plug only *IC3* into its socket, making certain that the IC is properly oriented (see Fig. 3) and that no pins overhang the socket or fold under between socket and IC. Handle this CMOS device with the same precautions you would use for any other MOS device. Plug the project back into the telephone line and allow *C1* to charge to 15 volts. Press and release RESET switch *S1* and measure the potential at pin 3 of *IC3*; it should register 0 volt.

Now use a piece of hookup wire to jumper from pin 1 of *IC3* and circuit ground. While measuring the potential at pin 1 of *IC3*, you should obtain a reading of 15 volts. Pressing and releasing the RESET switch should cause the reading at pin 1 of *IC3* to drop to 0 volt.

If you do not obtain the above results, power down the project by unplugging it from the wall jack and carefully check the wiring associated with *IC3* and *S1*. Check in particular for accidental short circuits between the closely spaced copper pads to which the IC's socket pins are soldered. Make absolutely certain that *IC3* is not installed backwards in its socket. If all still looks okay but the circuit does not work, the CD4011 may be bad; try replacing it with another known to be good.

When you are satisfied that the *IC3* circuit is performing as it should, disconnect the project from the telephone line and plug *IC1* and *IC2* into their respective sockets, taking the same precautions as you did when you installed *IC3*.

If you used an eight-pin socket for *IC2*, make sure you plug the optoisolator into the appropriate slots in the socket. To avoid confusion, bend a ¾-inch solid bare hookup wire into a U shape with equal-length legs and 0.3 inch bottom. Plug the legs of this wire into *IC2* socket pin slots 1 and 8. Leave this wire permanently in place.

To ascertain that your Telephone Minder is operating properly, plug its cord into the telephone wall box and press and release the RESET switch. Then press and hold the STATUS switch long enough only to see if the LED is on or off. If the circuit is operating as it should, the LED should be off.

Mount the circuit-board assembly into place inside the telephone instrument with which you are using it or in its own separate box. To do this, remove the protective paper from the double-sided foam tape mentioned above and gently press the circuit-board assembly into it. Make sure the circuit-board assembly will not interfere with the normal functioning of the mechanical elements or short to any of the electronics inside the telephone instrument.

Now ask a friend to call your telephone number. When the ringing ceases, press the STATUS switch *without* lifting the handset off the hook. The LED should be on and remain on until you press and release the RESET switch.

You can leave the Telephone Minder permanently connected to your telephone line at all times. Telephone operation will not be affected by the presence of the project on your telephone line.