Put Your Telephone On Hold

Low-cost add-on circuit gives any telephone instrument a "hold" feature

By Andrew Van Loenen

One of the nice features you will find on many modern telephone instruments is a "hold" button. The ability to put your line on hold allows you to hang up the phone in one room and pick up an instrument in a different room without disconnecting the person at the other end of the line or having to run back to hang up the original instrument. It also allows you to converse privately with someone in the same room without having to hold your hand over the mouthpiece of the handset or juggle with the tiny "mute" button found on some phones. Hence, the hold feature also doubles as a "mute" function.

In this article, we describe a simple, low-cost circuit that you can build and install in just about any telephone instrument to give the latter a true hold feature. The circuit is so simple, containing just five very small components and a standard size switch, that it can easily mount *inside* virtually any telephone instrument, no matter how compact it might be. Installation in no way interferes with normal operation of your telephone instrument.

About the Circuit

Most single-line home telephone instruments operate from a single pair of wires. The exception are instruments that have a light in the dial; but even then, the talk/listen path is a single pair of wires that come from your local telephone company. By tradition, the wires are identified by the telephone company as "tip" (green insulation) and "ring" (red insulation). These identifiers date back to when operators used to patch telephone lines from origin to destination with patch cords that had plugs with "tip" and "ring" contacts on them. Also by tradition, telephone voltages are negative with respect to ground (common).

Green-insulated wire is the common "ground" line, and the red-insulated wire carries −48 volts when your telephone instrument is on-hook and about −6 volts when the handset is lifted off the hook.

To answer a telephone, it is necessary to provide a relatively low-resistance dc current path across the tip and ring conductors. As long as this path is maintained, the telephone line is in the "busy" mode. The object of our hold circuit is to provide this path, by pushing a button, as you replace the handset in its cradle. Furthermore, the circuit automatically deactivates when you pick up the same handset or one on another instrument.

If you were to connect a resistor with a value in the range of 1,000 to 2,000 ohms across your telephone line while the instrument is in use, replacement of the handset in its cradle would maintain the talk/listen path active. However, the hookswitch, located in the cradle, will have disconnected the handset from the circuit so that whoever is at the other end of the line will be effectively excluded from any communication with you.

Shown in Fig. 1 is the schematic diagram of the hold feature's very simple circuit. With the circuit connected to the telephone line as indicated, resistor *R1* provides the actual hold function. This resistor is ordi-

narily kept isolated from the telephone line by silicon-controlled rectifier *SCR1*.

One of the operating principles of an SCR is that it is connected in series with its load—in this case, *R1*—and appears to be an open circuit through its anode/cathode (A/K) circuit until its gate (G) "sees" a positive-going pulse voltage. Once gated on, the SCR continues to conduct current through its anode/cathode circuit until that circuit is interrupted or its current falls below the threshold where conduction is possible. At this point, the SCR goes back to being an open circuit and remains as such until it is once again gated on by a positive-going pulse voltage applied to its gate.

Normally-open pushbutton switch *S1* provides the gating signal for *SCR1* through the voltage divider made up of *R1* and *R2*. Diode *D1* puts a small bias on the cathode of *SCR1* to make it work more reliably in this application. Light-emitting diode *LED1* is a visual indicator that turns on whenever the line is put on hold (*SCR1* is conducting current).

Construction

Owing to the very few components that make up this circuit, construction is extremely simple and straightforward. You can use any mounting medium that suits your fancy, including a printed-circuit board, perforated board and soldering hardware or a solderless breadboarding block.

If you wish to fabricate a printed-circuit board for this project, use the actual-size etching-and-drilling guide shown in Fig. 2(A). With only four on-board components, you can easily use a resist pen or dry-transfer patterns to directly etch the board. Note that no outline is provided in Fig. 2(A) for the etch pattern. This is because you can make the board as large or small as needed to fit inside the case of any particular telephone instrument. For example, for my prototype, I needed a board that measured 1 inch by 3¾ inches because that

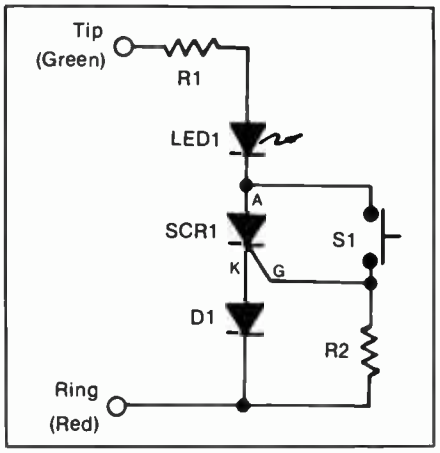

Fig. 1. Schematic diagram of the extremely simple circuit that makes up the telephone hold function.

size fitted a ready-made but unused mounting bracket in the base of the telephone instrument I selected to house my hold circuit. You can make the board as small as ¾ inch wide by 1¼ inches long.

Wire the board exactly as shown in Fig. 2(B). Note here that the switch and LED mount off the board. When you install *D1* and *SCR1*, make absolutely certain that the former is properly oriented and the latter is properly based before soldering their leads to the pads on the bottom of the board.

If you decide to use a perforated board or a solderless socket instead of a pc board, use Fig. 2(B) as a guide to component layout and orientation and interconnections.

You need six 10-inch-long stranded hookup wires to complete wiring the circuit. One of these wires should have green insulation, two should have red insulation, a fourth should have black insulation, and the remaining two can have any other color insulation. Strip ¼ inch of insulation from both ends of all six wires. Tightly twist together the fine conductors at both ends of all wires and tin with solder.

Plug one end of the green- and one red-insulated wire into the holes labeled GREEN and RED, respectively and solder into place. Using the holes for *LED1*, plug one end of the black- and the remaining red-insulated wires into the cathode and anode holes, respectively, and solder both connections. Loosely twist together these two wires. Plug one end of the remaining two wires into the two S1 holes and solder them into place.

Select a location inside the telephone instrument to mount the circuit-board assembly where it will not physically or electrically interfere with any portion of the instrument. If necessary, *carefully* trim away the tab on the SCR (there will be no degradation in circuit performance if you do this). If there is no room inside the instrument for the circuit-board assembly, house it in a separate box and connect it to the telephone line via a cable equipped with a modular connector (this is an FCC requirement for all telephone accessory devices).

Wherever you mount the circuit-board assembly, make certain that you insulate its bottom from any

Special Note

This project was designed to fit inside just about any telephone instrument. For you to exercise this mounting option, you must drill holes in the instrument's housing to permit you to mount a switch and light-emitting diode on it. Therefore, make sure you do this only to an instrument you own—not one you are leasing.

If you do not own your telephone instrument(s) but would still like to use the hold circuit described in the text, you can do so by housing the circuit in a separate enclosure. In this event, connect the project to the telephone line via a standard cable terminated in a modular plug.

Keep in mind that this project connects directly across the telephone line. If it causes problems on the line, the telephone company has the right to temporarily discontinue service to you. In this event, you will be notified and given the opportunity to correct the problem. However, it is always better to make sure no problem exists from the start.

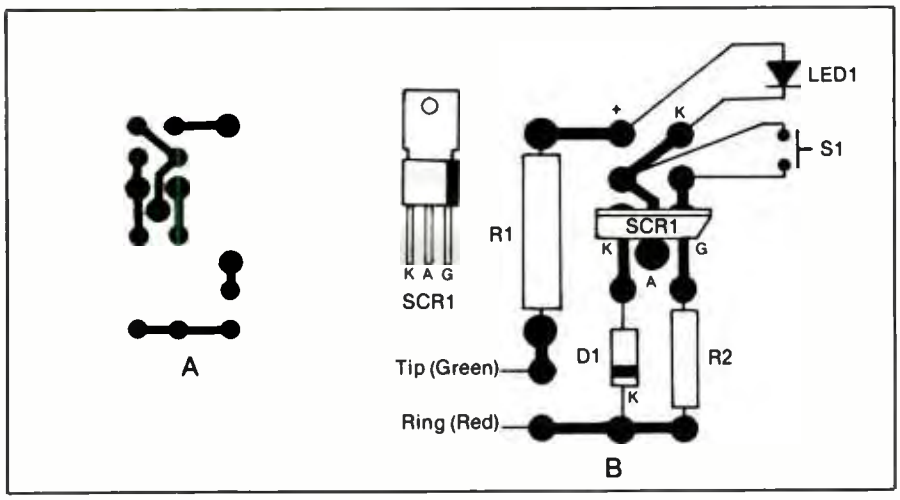

Fig. 2. Actual-size etching-and-drilling guide (A) for fabricating a printed-circuit board for the project. No board outline is shown because the dimensions of the board you actually use will depend on available space and mounting conditions inside a particular telephone instrument. Wiring details (B) for on- and off-board components for pc board. Use this as a guide to mounting components and wiring them together if you use perforated board instead of a printed-circuit board.

PARTS LIST

D1—1N4003 or similar silicon rectifier diode
LED1—General-purpose light-emitting diode
R1—1,500-ohm, 1-watt, 5% tolerance resistor (see text)
R2—680-ohm, ½-watt, 5% tolerance resistor
S1—Normally-open, momentary-action spst pushbutton switch
SCR1—C106B1 (General Electric), ECG 5455 or S3597 silicon-controlled rectifier
Misc.—Printed-circuit board or perforated board (see text); panel clip or small rubber grommet for mounting LED1; small-diameter heat-shrinkable or plastic tubing; small enclosure and modular cable/plug assembly (needed only if project is housed separately from telephone instrument—see text); thick double-sided foam tape; hookup wire; solder; etc.

metal or other parts of the telephone instrument. One way to assure this is to use thick double-sided foam tape as the mounting medium, rather than machine hardware.

Once the circuit-board assembly is mounted, drill holes for mounting the switch and LED on the instrument's case where they will be readily visible and accessible. Examples of typical locations for these holes are shown in the lead photo. Mount the switch in its hole, and use a panel clip or small rubber grommet to mount the LED.

Crimp and solder the free ends of the S1 wires coming from the circuit-board assembly to the lugs of the switch. Then untwist the LED wires a distance of 1½ inches at the free end and slip 1-inch lengths of small-diameter or insulating plastic tubing over the ends of both LED1 wires. Identify and clip the cathode lead of the LED to a length of ½ inch. Form a small hook in the remaining lead stub and crimp and solder this to the black-insulated cathode wire. Do the same with the LED's anode lead and red-insulated anode wire. Push the tubing up over the connections until it is flush against the bottom of the LED's case. Shrink into place.

With the telephone instrument's cover removed (see Fig. 3), find the points in the circuitry to which the incoming red- and green-insulated telephone-line conductors connect. Plug the instrument's cord into the wall jack. Holding the hookswitch down, use a multimeter set to the dc volts function and a 100-volt full-scale range to take a reading across the incoming telephone line. Connect the meter's "hot" and common probes to the line's red- and green-insulated conductors, respectively as you take this reading.

If you obtain a reading of −48 volts or so, the line is wired correctly. If your reading is +48 volts or so, the line is wired backward. It is much more important to observe polarity that to match insulation colors when connecting the project to the telephone line. If you connect the project in reverse polarity across the telephone line, the hold function will not work. Once you know the polarity of the telephone line, unplug the instrument from the wall jack and tag the two remaining wires coming from the circuit-board assembly accordingly.

The two wires that remain to be connected go to the telephone line and must be connected in proper polarity, as determined above. Route these wires from the circuit-board assembly to any two points inside the instrument to which wires from the incoming telephone line connect. If these points are soldered, solder the free ends of these wires to their respective points.

Checkout & Use

Checkout of the hold function is simple. Start by placing the telephone instrument's handset on-hook. Then plug the instrument's cord into the wall jack. Pick up the handset and press the HOLD button you installed and note that the LED lights.

While continuing to press the HOLD button, return the instrument's handset to its cradle and release the button. The LED should remain lit when you release the button. At this point, picking up the handset

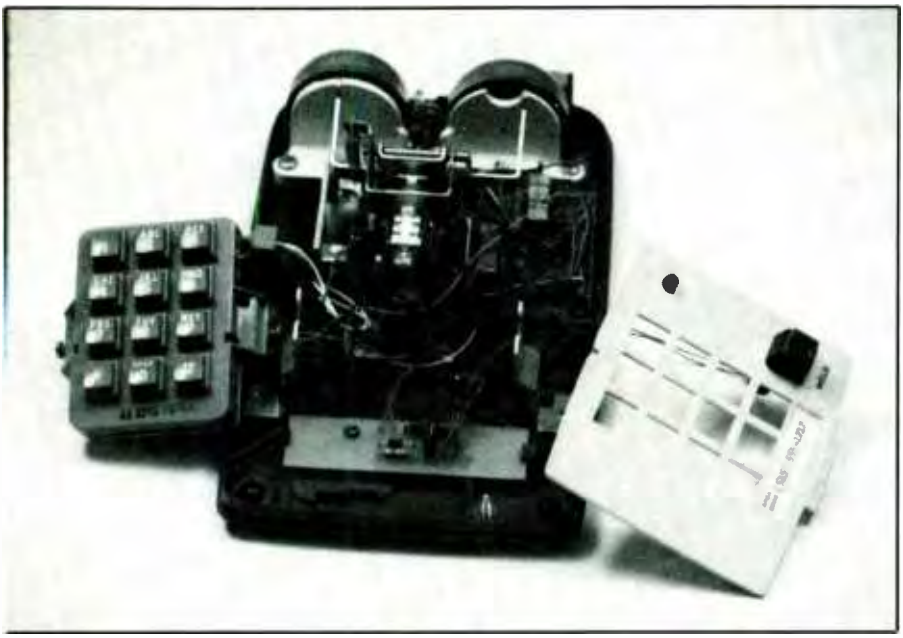

Fig. 3. Interior view of disassembled telephone instrument with dial assembly removed to permit project to be mounted on floor and LED and switch on dial bezel. Other instruments offer different mounting locations.

should cause the LED to extinguish and the telephone line to return to its normal off-hook condition.

If the LED does not light at all, check to make sure you connected the circuit to the telephone line in the proper polarity. If so, the LED may be installed in the wrong polarity or it might be defective. Whichever the case, either correct your wiring or replace the LED.

If the LED turned on but did not remain lit after you replaced the handset in its cradle and released the HOLD button, in that order, the value of *R1* is probably too high for your particular phone line. Solve this problem by replacing *R1* with a resistor of lower value. Both 1,200- and 1,300-ohm, 5-percent tolerance resistors are available, with the former being more common. Just keep in mind that you should generally use the highest value of resistance for *R1* that permits reliable operation of the hold circuit.

If the LED remains lit all the time, no matter what you do with the HOLD switch and handset, look for a shorted SCR, shorted HOLD switch or a short circuit on the circuit board or in your wiring related to these components. In any case, rectify the problem before attempting to put the project into service.

This hold function is extremely easy to use. Whenever you wish to place a call on hold, simply press the HOLD button and continue to do so until you have hung up the handset. You then release the HOLD button to keep the telephone line on hold.

Picking up the handset of the instrument in which the hold-function circuit is installed or any other instrument connected to the same telephone line automatically reinstates the two-way connection.

A bonus offered by this implementation of the hold function is that you can activate it to place a "busy" signal on the line to prevent calls from getting through when you do not want to be bothered. To activate the "busy" signal, simply press the hold button while leaving the handset in its cradle. The LED will light and any caller who dials your number will get a busy signal. To deactivate this function, all you have to do is lift the receiver from the cradle. **ME**