SUPER HOLD: A TELEPHONE PERIPHERAL

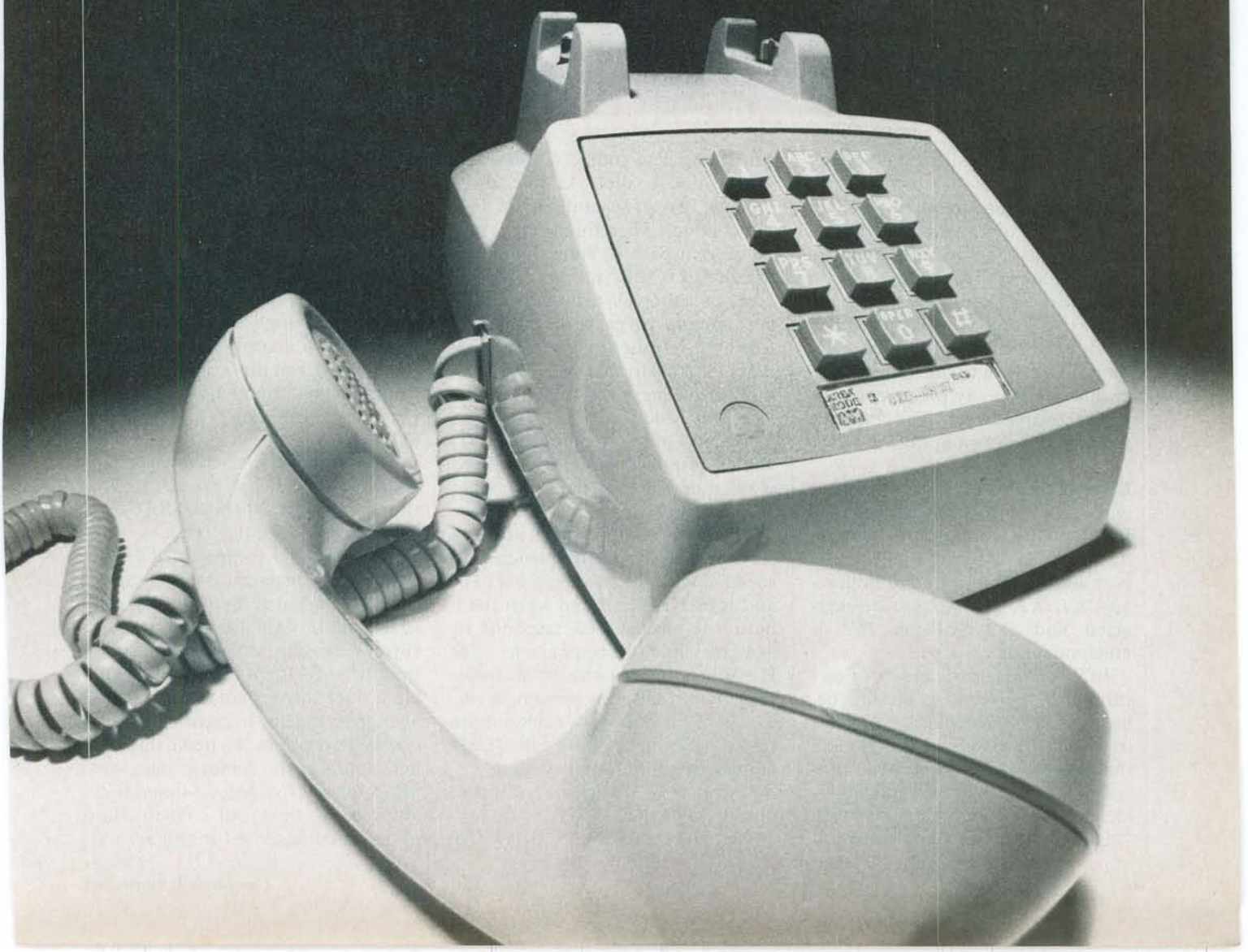
Allows a hold function on any touch-tone phone and has provisions for music during the hold

By Thomas E. Black

IF YOU want to add a "hold" feature to your touch-tone phone, it means adding circuitry, or disassembling and modifying an existing phone. Most telephone companies object to this.

The Super Hold described here requires no modification of the telephone, can be connected anywhere on the telephone line, and can even be used to provide music to the person on hold. (As good as Super Hold is, some telephone companies may require special compliance rulings for such a change, so be sure to check local ordinances with the telephone company before connecting anything to the telephone line.)

Super Hold is essentially a dual-tone decoder that monitors the telephone line and responds to the two frequencies that form the "*" signal (941 and 1209 Hz). Although it is necessary to use a touch-tone



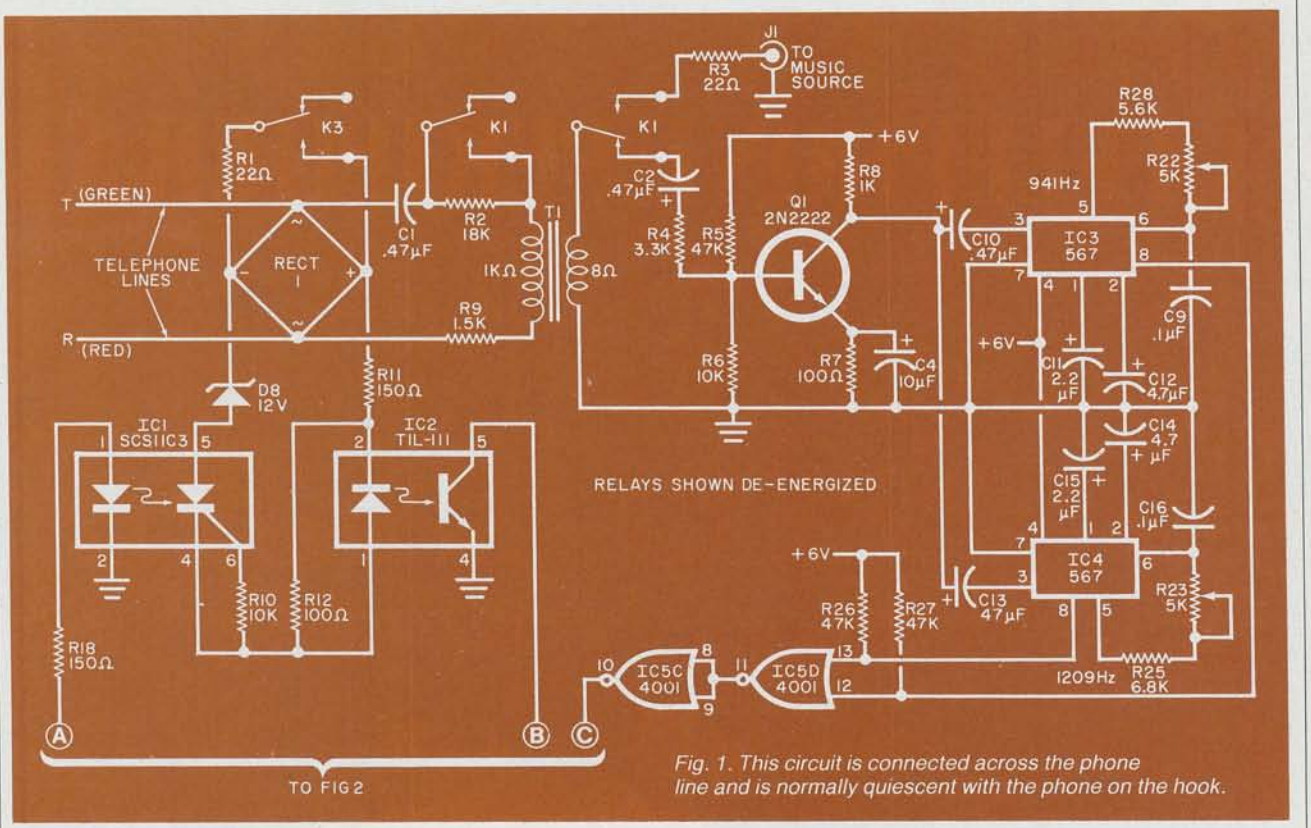


Fig. 1. This circuit is connected across the phone line and is normally quiescent with the phone on the hook.

phone to place a caller on hold, any type of phone can be used to return to the caller and remove the hold condition. Power is supplied by a conventional line-operated supply.

With Super Hold installed, to place someone on hold, simply depress the * pushbutton, then hang up immediately (within five seconds). To return to the holding party, just pick up any phone connected to the same circuit. The complete schematic is shown in Figs. 1 and 2.

Circuit Operation. Super Hold is wired in parallel with the telephone line via the connections marked "T" and "R" shown in Fig. 1. In the non-hold (illustrated) condition, relays *K1, K2,* and *K3* are de-energized and the SCR in *IC1* is nonconducting.

In this mode, no dc current flows through the circuit, so the line behaves as if Super Hold does not exist. With the telephone "on hook," the phone line has 48 volts dc provided by the telephone company's local office. When a phone is taken "off hook," this potential drops to something less than 12 volts, but more than 4 volts. At this lower voltage, 12-volt zener diode *D8* does not conduct. Therefore there is still no current path to Super Hold and the circuit is still "invisible." However, capacitor *C1* provides enough ac coupling to pass all the audio from the telephone line to the primary of transformer *T1.* The contacts of de-energized relay *K1* provide an audio path from the secondary of *T1* to amplifier *Q1,* whose output is sufficient to drive parallel-connected tone decoders *IC3* and *IC4.*

These two tone decoders are preset to respond to the frequencies associated with the two tones (941 Hz and 1209 Hz) generated when the * button is pushed, *IC3* responds to 941 Hz, while *IC4* responds to 1209 Hz. When these two tones (and only these two tones) are present at the inputs of the decoders, each output (pin 8) goes low. NOR gate *IC5D* has its two inputs pulled high via *R26* and *R27.* Thus, its output at pin 11 will be low.

When the two inputs (from the two tone decoders) go low at the same time, the output of *IC5D* goes high. After inversion by *IC5C,* the resulting low is applied to the trigger input (pin 2) of timer *IC6,* as shown in Fig 2. Upon receipt of the input trigger, pin 3 of *IC6* goes high and remains high for the five-second interval determined by *R20* and *C8.* The high on pin 3 performs two simultaneous functions—it drives *Q4* to energize relay *K3* and it enables *IC1.*

When relay *K3* is activated, low-value resistor *R1* is placed across the phone line through *RECT1.* This action greatly reduces the touch-tone level to prevent it from annoying a listener. At the same time, the high at *IC6* pin 3 is applied to the anode of the LED within *IC1* (Fig. 1), causing it to glow. The photosensitive SCR within *IC1* does not latch since there is not enough voltage across the line to cause zener diode *D8* to conduct. To make this zener conduct, the handset must be hung up, and five-second timer *IC6* allowed to time out. When the phone is hung up, *R1* is still across

the line. Hence, no current flows through *D8*. When *IC6* times out, relay *K3* de-energizes, removing the *R1* load from the line. Capacitor *C6* momentarily provides enough current to keep the LED within *IC1* glowing, while *K3* is de-energizing. This ensures that the SCR within *IC1* will latch when *D8* conducts. This latter event occurs as the line voltage increases when the load is removed. With *IC1* enabled, a current path exists across the line, and the incoming call is placed on hold.

With *IC1* latched, current also flows through the LED within opto-coupler *IC2*. When this opto-coupler latches on, it provides a low to *IC5A* via diode *D1*, and to *IC5B* via diode *D2*.

IC5A inverts the low to turn on *Q2* which, in turn, operates relay *K2*. The contacts of this relay can be used to turn on an (optional) tape recorder or radio to feed music to the line (via *J1*) while on hold. The low at *D2* cathode also discharges *C5* via *R16*. After the brief discharge interval, *IC5B* pin 3 goes high, turning on *Q3* and energizing relay *K1*. The delay associated with *C5* and *R16* allows the optional tape deck to get up to speed before applying the tape-recorded music to the phone line. This prevents "slurred" music as the recorder reaches proper speed.

With *K1* energized, the music

PARTS LIST

C1—0.47-μF, 200-V Mylar capacitor
C2, C10, C13—0.47-μF, 16-V electrolytic
C3—Not used
C4, C17—10-μF, 16-volt electrolytic
C5, C8—33-μF, 16-V tantalum capacitor
C6—220-μF, 16-V electrolytic
C7—22-μF, 16-V electrolytic
C9, C16—0.1-μF, 16-V metal film
C11, C15—2.2-μF, 16-V electrolytic
C12, C14—4.7-μF, 16-V electrolytic
C18—1000-μF, 25-V electrolytic
D1 through D4, D8, D9—1N914 or 1N4148
D5 through D7—1N4001 diode
D10—12 V, 1-W zener diode
F1—½-A fast-blow fuse
IC1—SCS11C3 opto-coupler (Radio Shack 276-136)
IC2—TIL-111 opto-coupler (Radio Shack 276-132)
IC3, IC4—LM567 tone decoder
IC5—4001 quad two-input NOR gate
IC6—555 timer
IC7—7805 5-V regulator
J1, J2—Miniature phone connector
K1—Dpdt subminiature relay, 5-V coil (Radio Shack 275-215)
K2, K3—Spdt subminiature relay, 5-V coil (Radio Shack 275-216)
LED1—Red light emitting diode
Q1 through Q4—2N2222 transistor
The following are ¼-W resistor unless otherwise noted:
R1, R3—22 ohms, ½-W
R2—18 kilohms
R4—3.3 kilohms
R5, R13, R16—47 kilohms
R6, R10, R15—10 kilohms
R7, R12—100 ohms
R8, R21—1 kilohm
R9, R14, R17—1.5 kilohms
R11, R18, R24—150 ohms
R19—180 kilohms
R20—68 kilohms
R22, R23—5 kilohm potentiometer (Radio Shack 273-1380)
R25—6.8 kilohms
R26, R27—47 kilohms
R28—5.6 kilohms
RECT1—200-V, 1-A diode bridge
RECT2—50-V, 1-A diode bridge
T1—Audio transformer, 1000:8 ohms, (Radio Shack 273-1380)
T2—Power transformer, 12.6 V at 300 mA
Misc.—Suitable enclosure, fuseholder, rubber grommetts, music source, mounting hardware.

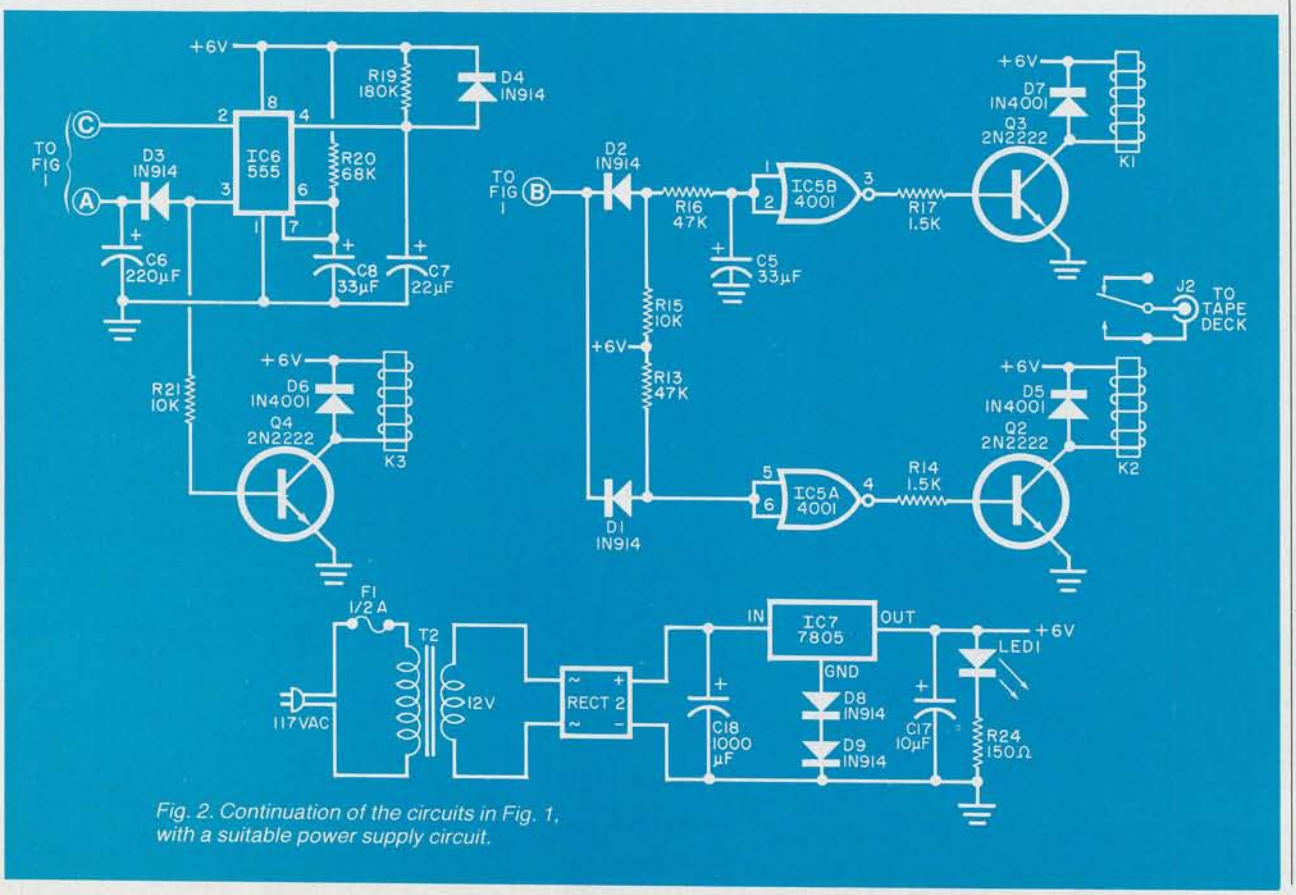


Fig. 2. Continuation of the circuits in Fig. 1, with a suitable power supply circuit.

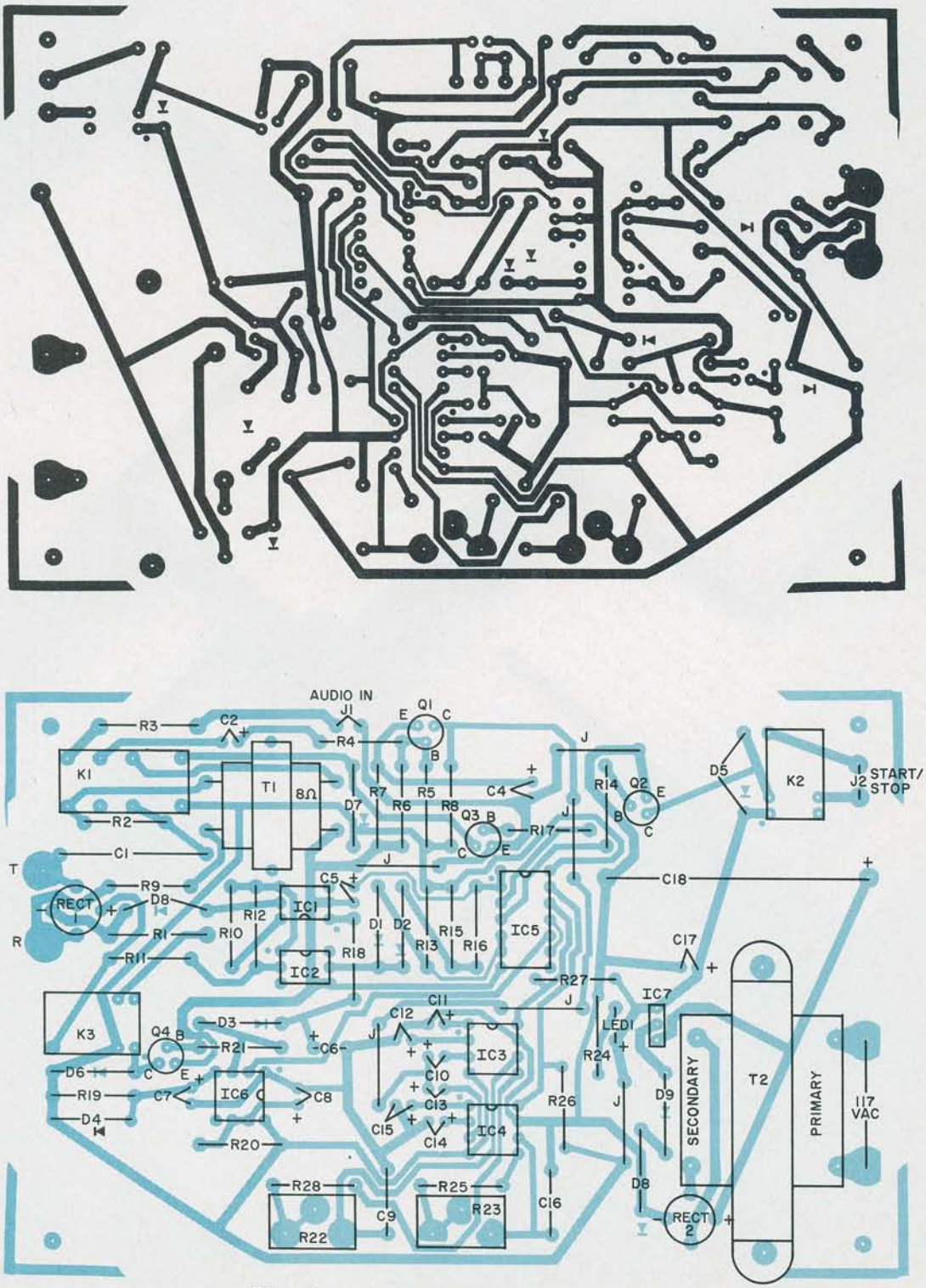


Fig. 3. Same-size foil pattern (top) and component layout for a printed circuit board for the Super Hold.

source is applied to *T1* via *R3*, while other contacts of *K1* short resistor *R2* to prevent attenuation of the music.

To exit the hold condition requires that the SCR within *IC1* have its current interrupted. This can be accomplished in two ways. When the handset is picked off the cradle, the reduced line voltage causes *D8* to stop conducting. This will unlatch the *IC1* SCR and remove power from the LED within *IC2*. Thus, the outputs of gates *IC5A* and *IC5B* go low, de-energizing *K1* and *K2*.

The other source of hold termination may not occur in all telephone districts. If available, the telephone company provides a momentary current interruption to the line when the holding party hangs up. This momentary interruption will reset the *IC1-IC2* loop. In some instances, the current interruption may not occur until a minute or so after hangup or may not occur at all. In any case, picking up the telephone handset will always reset the hold condition.

Construction. Although any form of construction can be used, a pc board using the foil pattern of Fig. 3 is recommended.

Using sockets for all ICs, install all components except *R1* (which will be installed after calibration). Use a heat sink on regulator *IC7*, and mount the fuseholder, jacks *J1* and *J2*, and power transformer *T2* in a suitable enclosure. Mount *LED1* in a grommetted hole, and provide grommetted holes for the power cord and telephone cable.

After temporarily mounting the board (remember that *R1* is missing), turn on the power and note that 6 to 7 volts dc exists across filter capacitor *C17*. Diodes *D6* and *D7* are used to modify the output of the 5-volt regulator to provide about 6 volts.

Calibration. The easiest way to calibrate *IC3* and *IC4* is to use a frequency counter. Connect the high-impedance probe to *IC3* pin 6 and adjust *R22* for 941±10 Hz. Move the probe to *IC4* pin 6 and adjust *R23* for an indication of 1209±10 Hz.

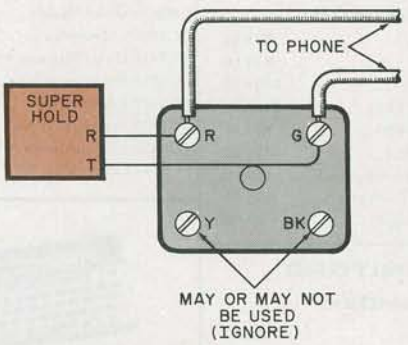


Fig. 4. Use this simple connection while calibrating the Super Hold circuit.

The other approach is to connect the Super Hold to the telephone line as shown in Fig. 4, call a friend on the phone and have him remain silent during the following calibration procedure.

Connect the positive lead of a dc voltmeter to *IC5* pin 13 and the negative lead to ground. The meter should indicate about 6 volts dc. Depress the * button on your phone and adjust *R23* until the meter indication drops to about 0.5 volt. Release the * key and note that the voltage increases. Depress the 7 key and note the voltage drop to about 0.5 volt. If not observed, return to the * key and adjust *R23* for a 0.5-volt indication. Depressing the 7 key should cause a drop from 6 to about 0.5 volt dc. This calibrates *IC4*, the 1209-Hz tone decoder.

To adjust *IC3*, the 941-Hz decoder, place the voltmeter positive lead at *IC5* pin 12, depress the * key, and note the voltage drop to about 0.5 V. Release the * key and depress the # key. The meter indication should drop to 0.5 V.

If not, depress the * key and adjust *R22* for a meter indication of about 0.5 V. Depressing the # key should also produce the voltage drop. This calibrates *IC3*, the 941-Hz tone decoder.

Connect the voltmeter to *IC5* pin 10 and note about 6 volts dc on this pin. Depress the * key and note that the voltage drops to about 0.5 V. No other key should produce this effect. If any does, then both *IC3* and *IC4* must be re-calibrated.

Terminate the phone call, remove all test equipment, and disconnect the power. Install *R1* in the circuit. Then connect the Super Hold back to the telephone line and turn on the power. Lift up the phone, depress the * key, and hang up the handset. Relay *K3* should have energized as soon as the * key was depressed. After about five seconds, *K3* should drop out and *K2* (if installed) should be energized. A couple of seconds later, *K1* will also be energized. Picking up the telephone handset should cause relays *K1* and *K2* to be de-energized.

When all works well, install the board in a suitable enclosure, connect *J2* to the tape-deck power on/off, and connect the audio output of the tape deck to *J1*.

Phone a friend, depress the * key to put him on hold, replace the phone in its cradle, and let him listen to the music for a few moments to check the volume. If necessary, re-adjust the volume. If desired, the tape deck components (*Q2* and its associated components) can be left off the circuit and a conventional line-powered radio used as the music source for *J1*. ◇

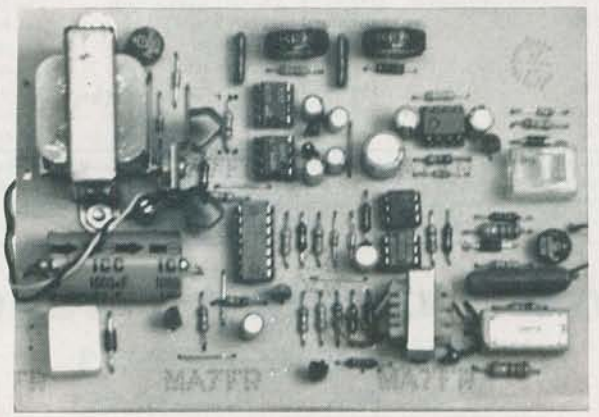


Photo showing layout of the printed circuit board in the author's prototype.

In "Super Hold: A Telephone Peripheral" (May 1983), the polarity of *RECT1* should be reversed on both the schematic and the component layout; on the schematic, *C13* should be 0.47 μF and *R21* should be 1 kilohm; and on the component layout, *IC7* should be installed with its OUT terminal facing up.

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