

A LOW-COST ELECTRONIC RINGER FOR TELEPHONE LINES

*Solid-state circuit can replace
the electromechanical ringer in a telephone*

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RECENT FCC rules changes allow users to connect electronic devices of non-Bell manufacture to telephone-company lines. One such device is the low-cost Electronic Ringer. Like a standard electromechanical ringer, it generates bursts of sound when triggered by ring pulses. However, it is not physically bulky and doesn't load down the telephone line. The sound it generates can be modified in several respects to suit the user's taste and to help him differen-

tiate activity on one telephone line from that on another. The Electronic Ringer can also be used to actuate external devices in response to an incoming call. Several optional circuits for this application will be described.

About the Circuit. The schematic diagram of the Electronic Ringer appears in Fig. 1. At the onset of an incoming telephone call, an ac signal is applied between the green (*tip* or *T*) and red (*ring* or *R*) wires of the tele-

phone line. This signal, which has an amplitude of approximately 90 volts root mean square and a frequency of between 20 and 40 Hz, is capacitively coupled to optoisolator *IC1*. The input network comprising *R1*, *R2*, *C1*, *D1*, *D2* and *IC1* minimizes the line loading and imbalance that simpler ring-detection circuits can cause. Diodes *D1* and *D2* are included to suppress "dial tapping"—the tendency of rotary-dial pulses to actuate the ringer circuit.

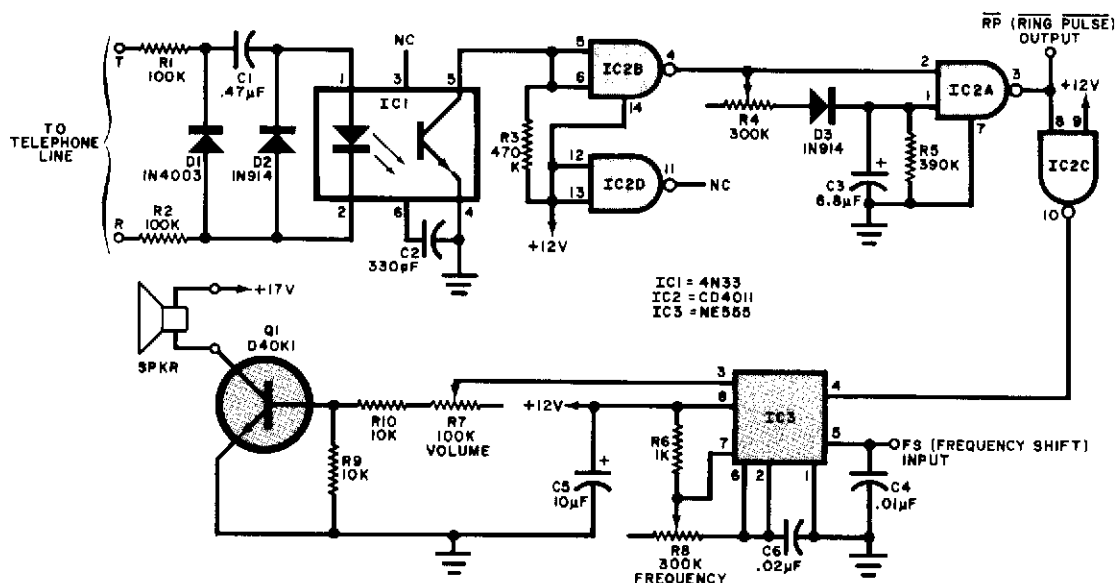


Fig. 1. Schematic diagram of the Electronic Ringer. Optoisolator *IC1* couples ring pulses from the telephone line to the detector circuit.

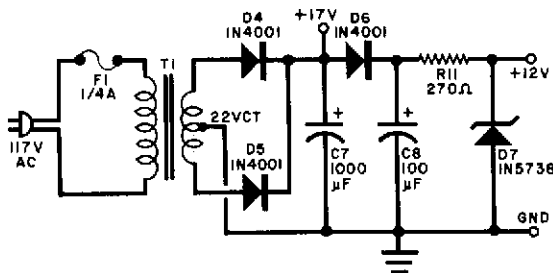


Fig. 2. Schematic diagram of the project's power supply which provides required operating voltages.

Output pulses from IC1 are applied to IC2B, which squares and passes them to one input of NAND gate IC2A and to the delay network consisting of R4, D3, C3 and R5. This network furnishes additional protection against dial tapping. Capacitor C3 is initially discharged, so pulses of sufficient quantity or energy or both must be integrated by C3 to cause the output of IC2A to change state. The pulses generated by a rotary-dial telephone are neither sufficiently numerous nor energetic. Potentiometer R4 determines the charging time constant (delay time), and resistor R5 discharges C3 shortly after the end of the input pulse train.

The output of IC2A, designated the RP (RING PULSE) OUTPUT, is inverted by IC2C and applied to the RESET input of 555 timer IC3 (pin 4). The timer is connected as a gated astable multivibrator. Its RESET input is normally at logic 0, which prevents the timer from oscillating. When ring

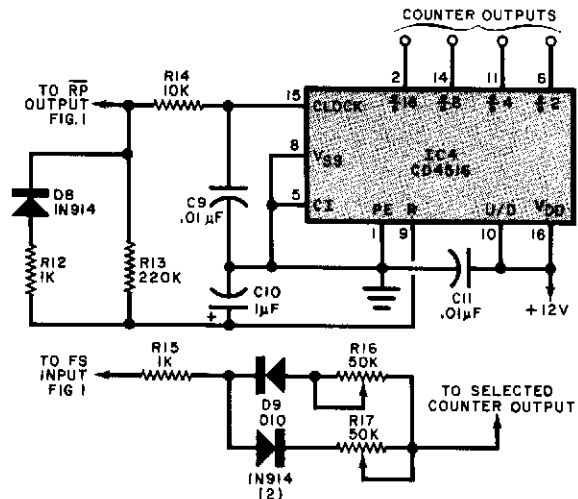


Fig. 3. An optional circuit that can convert the project into a two-tone ringer.

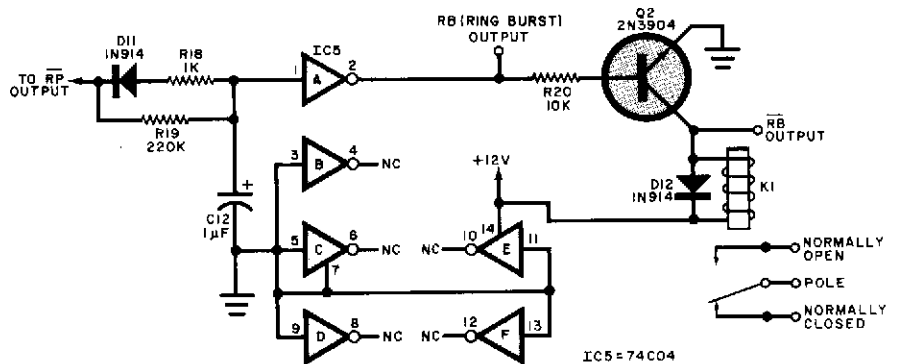


Fig. 4. Schematic diagram of an optional circuit that can actuate external electronic equipment by means of relay K1.

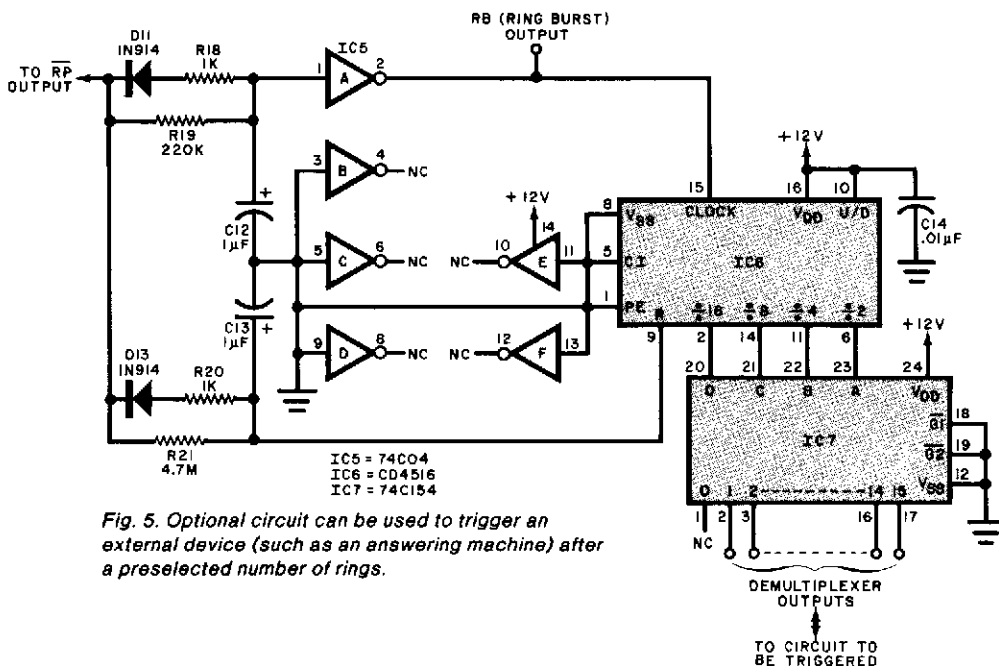


Fig. 5. Optional circuit can be used to trigger an external device (such as an answering machine) after a preselected number of rings.

telephone ringer

Components denoted by an asterisk comprise the optional circuits shown in Figs. 3, 4 and 5.

- C1—0.47- μ F, 200-V Mylar capacitor
- C2—330-pF, 25-V disc ceramic capacitor
- C4, C9*, C11*, C14*—0.01- μ F, 25-V disc ceramic capacitor
- C3—6.8- μ F, 16-V tantalum capacitor
- C5—10- μ F, 16-V tantalum capacitor
- C6—0.02- μ F, 25-V disc ceramic capacitor
- C7—1000- μ F, 35-V aluminum electrolytic
- C8—100- μ F, 35-V aluminum electrolytic
- C10*, C12*, C13*—1- μ F, 16-V tantalum
- D1—1N4003 rectifier
- D2, D3, D8*, D9*, D10*, D11*, D12*, D13*—1N914 silicon switching diode
- D4, D5, D6—1N4001 rectifier
- D7—1N5736 12-V, 1/2-W zener diode
- F1—1/4-A, fast-blow, type 3AG fuse
- IC1—4N33 optoisolator
- IC2—CD4011 quad two-input NAND gate
- IC3—NE555 timer
- IC4*, IC6*—CD4516 four-stage, up/down programmable binary counter

PARTS LIST

- IC5*—74C04 hex inverting buffer
 - IC7*—74C154 4-line-to-16-line decoder/demultiplexer
 - K1*—12-V dc spdt relay
 - Q1—D40K1 or equivalent npn silicon power transistor
 - Q2—2N3904 or equivalent npn silicon switching transistor
- The following, unless otherwise specified, are 1/4-watt, 10% tolerance, carbon-composition fixed resistors.
- R1, R2—100 k Ω
 - R3—470 k Ω
 - R4, R8—300-k Ω , linear-taper, pc-mount trimmer potentiometer
 - R5—390 k Ω
 - R6, R12*, R15*, R18*, R20*, R22*—1 k Ω
 - R7—100-k Ω , linear-taper, pc-mount trimmer potentiometer
 - R9, R10, R14*—10 k Ω
 - R11—270 Ω
 - R13*, R19*—220 k Ω

- R16*, R17*—50-k Ω , linear-taper, pc-mount trimmer potentiometer
 - R21—4.7 M Ω
 - SPKR—8- Ω dynamic speaker
 - T1—22-V, 500-mA, center-tapped step-down transformer
- Misc.—Printed circuit or perforated board, IC sockets or Molex Soldercons, fuseholder, line cord, strain relief, suitable enclosure, standoffs, terminal strips, suitable connectors, two-conductor cable, hookup wire, solder, etc.

Note—The following is available from BFA Electronics, Box 212, Northfield, OH 44067: Kit of parts for the basic Electronic Ringer project (Figs. 1 and 2) excluding the dynamic speaker, No. ER-Kit, priced at \$25.00 plus \$2.00 postage and handling for U.S.A. Also available separately is an etched and drilled printed-circuit board (Fig. 6), for \$6.00 plus \$1.00 postage and handling for U.S.A. orders. Ohio residents, add state sales tax.

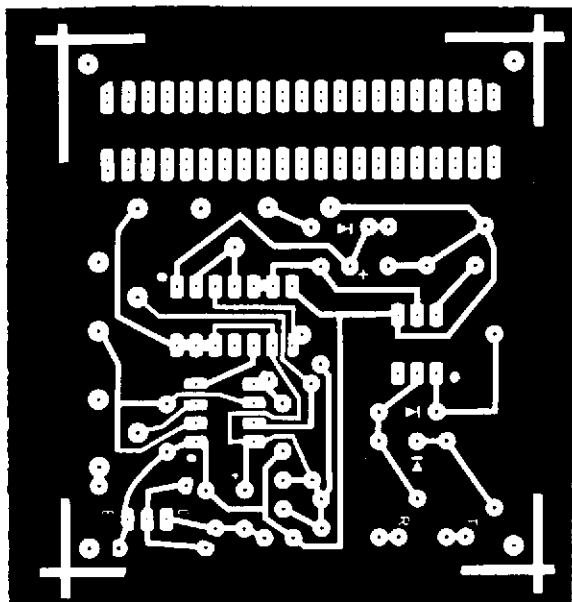


Fig. 6. Etching and drilling guide for pc board.

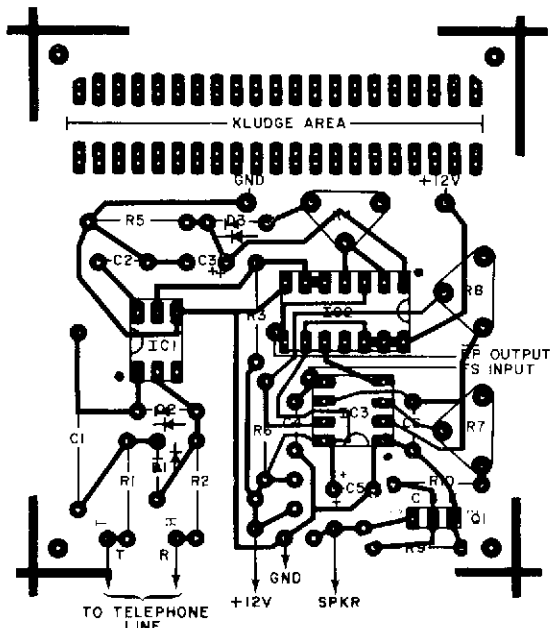


Fig. 7. Component-placement guide for pc board.

pulses are received, the RESET input is switched between logic 0 and logic 1 by IC2C, and the multivibrator produces bursts of oscillation at a rate determined by the frequency of the pulse train. The output of the timer is a square wave whose frequency (nominally 500 Hz to 2 kHz) is determined by potentiometer R8. The square wave appears at pin 3 and is coupled to driver transistor Q1 via VOLUME control R7 and resistor R10. The transistor alternately saturates and cuts off at an audio rate and causes a square-wave current to flow through the voice coil of the dynamic speaker.

Power for the Electronic Ringer is provided by the supply shown in Fig.

2. Line-voltage ac is stepped down by T1 and full-wave rectified by D4 and D5. Capacitor C7 filters the output of the rectifier into an unregulated +17 volts dc. This voltage is applied to one side of the voice coil of SPKR and to the voltage-regulating network D6, C8, R11 and D7. This network provides -12 volts dc, regulated, to the rest of the circuit. Note that the supply lacks a switch; in use, the project should be powered continuously.

Circuit Options. The pitch of the Electronic Ringer's tone signal can be varied by means of potentiometer R8, and its volume by means of R7. Further modification of the tone is possi-

ble by use of the circuit shown in Fig. 3. The RP OUTPUT from IC2A clocks four-bit binary counter IC4, which generates output pulse trains at one-half, one-fourth, one-eighth and one-sixteenth of the input signal frequency. One of these outputs can be fed back to the RS INPUT of timer IC3 by means of the network R16, R17, D9, D10 and R15 to shift the frequency of the timer's square-wave output. The high- and low-frequency tones can be adjusted independently by means of R16 and R17. At the end of each burst of ring pulses, counter IC4 is reset by the network D8, R12, R13 and C10.

The RP OUTPUT can be used to drive

telephone ringer

other circuits, such as those shown in Figs. 4 and 5. External devices can be actuated by means of the circuit shown in Fig. 4. The network *D11*, *R18*, *R19* and *C12* integrates the \overline{RP} OUTPUT into a dc level that is inverted by *IC5A*. This inverting buffer provides base drive to *Q2* when its output is at logic 1. When the transistor receives base drive, it conducts and sinks current for the coil of relay *K1*. The contacts of this relay can control an external electronic circuit or electromechanical device.

In the more complex circuit of Fig. 5, the \overline{RP} OUTPUT is processed by an input network similar to that of Fig. 4. The output of inverting buffer *IC5A*, however, drives four-bit binary counter *IC6*, whose four output lines are connected to the address inputs of demultiplexer *IC7*. Fifteen of the demultiplexer's output lines are employed in this project. Each in turn changes states when the appropriate number of pulses clocks counter *IC6*. A selected demultiplexer output can be connected to a driver/relay circuit or similar interface. If this is done, an external circuit or device will be actuated after the appropriate number of rings.

Construction. The Electronic Ringer can be assembled on either a printed-circuit or perforated board. Full-size etching-and drilling, and component-placement guides for a suitable pc board appear in Figs. 6 and 7, respectively. The board contains a kludge area at one end within which circuit options can be installed. If the existing ringer of a standard 500-series desk telephone is removed, this pc board can be installed inside the telephone enclosure. Alternatively, a custom enclosure can be used.

The project's power supply should be isolated from the telephone to prevent stray pickup of 60-Hz ac radiated by the power line and the step-down transformer. A two-conductor cable can be used to connect the *T* and *R* input terminals of the project to the green and red wires, respectively, of the telephone line. If desired, telephone-type connectors can be used to facilitate interconnection of the project and the line.

If the project won't respond to incoming calls or if dial tapping occurs, reverse the *T* and *R* connections. Also, reverse the polarity of the connections between power transformer *T1* and the ac line cord. ♦