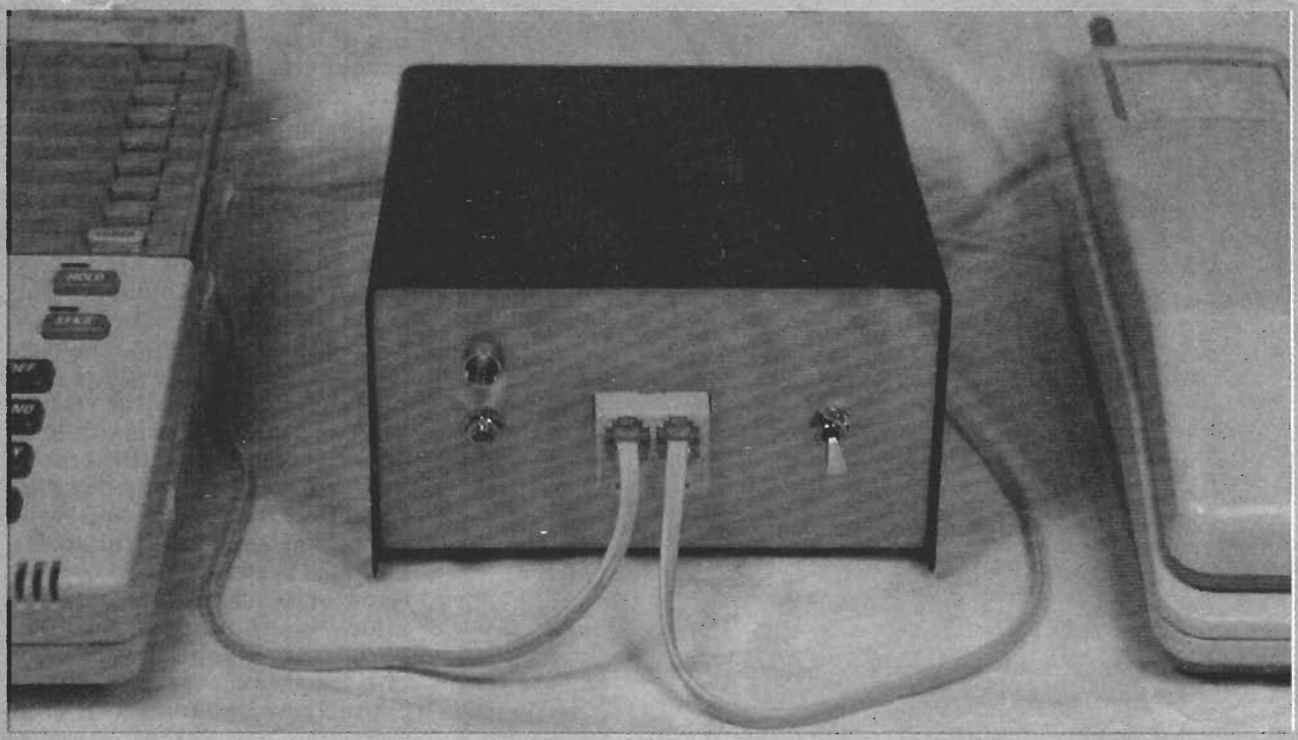

TELCO IN A BOX

Simulate a telephone line with the Telephone Company in a Box.

JAMES E. CICON

YOU JUST BOUGHT A BRAND NEW answering machine and you want to test it out. You set it up, connect it to the telephone line, and then just sit there looking at it. You want to see and hear it work, so you drive to a pay telephone and call your home number—nothing happens. Then you rush back home, decide to read the user's manual to find the problem, and then rush back to the telephone booth to test it again.

Now suppose that instead of an answering machine, you have some old telephones lying around in your house that don't work any more. To test those telephones completely, they must be connected to your telephone line and then someone must call you. Perhaps you have a modem or a fax machine that you would like to test but don't want to pay your local copy shop $1 a page.

These hypothetical examples are some of reasons why you will want to build a Telephone Company in a Box, or TCB for short, the subject of this article. It will solve all of the problems posed in these scenarios, cheaply and quickly. All of the components needed to build this project are readily available. You will not need a PC board, nor will you be required to program a microprocessor or microcontroller.

The telephone company

To understand how the TCB works, it is helpful to know what happens on your telephone line when an outgoing call is made or an incoming call is received. When a telephone handset is on-hook, the telephone line voltage is about 50 volts DC. When a handset is off-hook, the telephone line is loaded and the voltage drops to about 7 volts DC; this voltage is detected by the telephone company's central office equipment as an off-hook condition. The central office then provides a dial tone and the equipment waits for you to start dialing. When you dial a telephone number, the central-office equipment halts the dial tone, waits to receive a valid dialed number, and then makes a connection between your telephone and the number you dialed.

When the telephone company's central office equipment has a call for you, it rings your telephone by pulsing the 50-volt DC line voltage on and off at about 20 Hz for a short period of time, then it pauses, pulses again, pauses again, and so on. This produces the ring-ring-ring effect that informs you that there is an incoming call. When

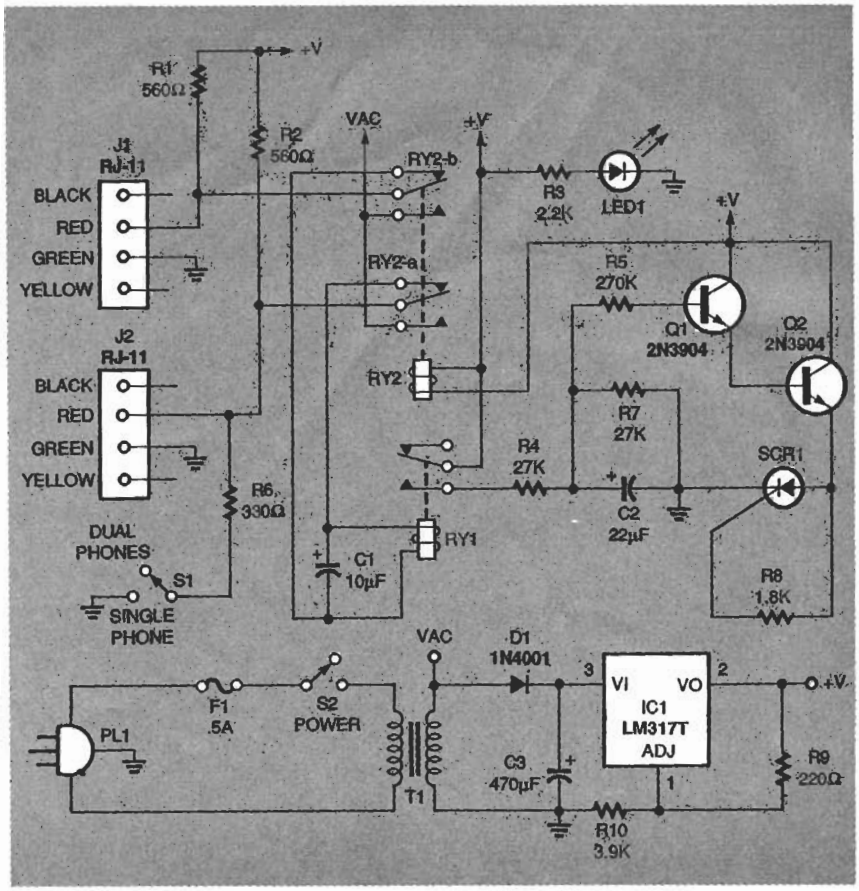

FIG. 1—TCB SCHEMATIC. When telephones plugged into J1 and J2 are both off-hook, they transmit and receive their own audio.

you pick up the handset, the telephone line voltage drops back down to about 7-volts DC. The central office equipment detects the drop in line voltage, stops ringing the telephone, and connects your telephone to the calling party.

How does TCB work?

Two telephones can be plugged into the TCB, which will then simulate all telephone-line functions. When both telephones are on-hook, the TCB supplies 24-volt DC line voltage to both telephones. Although the telephone company supplies 50 volts, the 24 volts will work well because the resistors in series with the telephones have lower values than those used by the telephone company. Moreover, 24 volts DC is both safer to work with and easier to generate.

When one telephone handset is taken off-hook, its line voltage drops to 7 volts DC. The TCB senses this and, if the other telephone handset is on-hook, it emits a ring signal. The ring signal is a 60-Hz sinewave at about 37-volts peak-to-peak. It is applied to the line for one second and halted for one second, repeatedly, until the other handset is picked up. Although the telephone company's ring signal is a 20-Hz squarewave at 50-volts peak-to-peak, the lower ringing voltage is used for two reasons. One is for safety, and the other is because it's easier to pick the ring voltage directly from the secondary of an AC transformer than to generate it with additional circuitry.

When both handsets are off-hook, both lines are loaded to 10-volts DC. The TCB senses the condition, halts the ring signal, and connects both telephones together. Note that when the TCB is ringing the on-hook telephone, it is also sending the ring signal to the off-hook telephone. Depending on the design of the off-hook telephone, it might or might not ring. You might also hear the ringing from the speaker of the handset as a loud buzzing. This is not a problem—just a distraction. Telephones are designed to accept a ring signal even when they are off-hook.

Circuit description

Figure 1 is the schematic for the TCB circuit. When both handsets are on-hook, resistors R1 and R2 supply power to them, and the rest of the circuit can be ignored. When both telephones are off-hook, they transmit and receive their own audio, so all that the TCB does is supply power to them through R1 and R2. If switch S1 is closed, resistor R6 simulates a telephone being plugged into J2, permitting the testing of only one telephone. The rest of the circuit can be ignored in this example.

Now consider the situation where one handset is on-hook and one is off-hook. That causes

PARTS LIST

All resistors are ½-watt, 5%.
R1, R2—560 ohms
R10—3900 ohms
R3—2200 ohms
R4, R7—27,000 ohms
R5—270,000 ohms
R6—330 ohms
R8—1800 ohms
R9—220 ohms
Capacitors
C1—10 µF, 35 volts, electrolytic
C2—22 µF, 35 volts, electrolytic
C3—470 µF, 35 volts, electrolytic
Semiconductors
D1—1N4001 diode
Q1, Q2—2N3904 NPN transistor
LED1—light-emitting diode, any color
IC1—LM317 3-terminal adjustable positive voltage regulator
SCR1—200-volt, 6-ampere silicon controlled rectifier (Radio Shack No. 276-1067)
Other components
F1—½-ampere fuse
J1, J2—RJ-11 telephone jack (see text)
PL1—AC plug and linecord
RY1—SPST reed relay (12 VDC, 11 mA coil; 1-ampere, 125 VAC contacts)
RY2—DPDT miniature relay (12 VDC, 43 mA coil; 1-ampere, 125 VAC contacts)
S1, S2—SPST switch
T1—120/25.2 VAC transformer, 450 mA
Miscellaneous: perforated construction board, fuse holder, project case, wire, solder