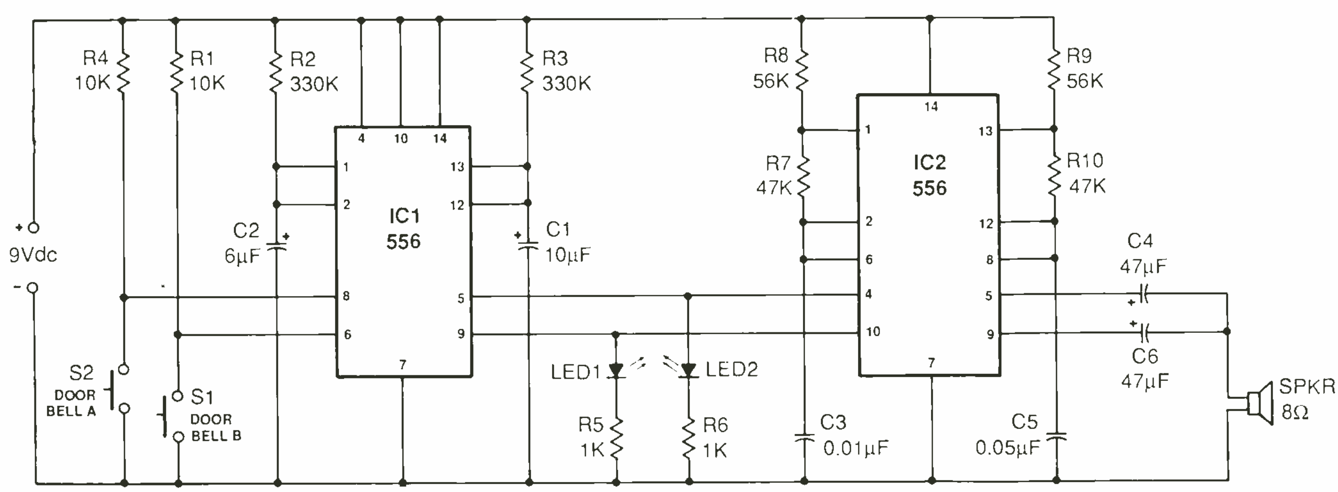
Two-Tone Electronic Doorbell

Sounds distinctively different audio tones when front and back doorbell buttons are pressed

By Charles Shoemaker D.Ed.

If you have front and rear doorbells—or wish to have both—the usual procedure is to wire the pushbuttons for each so that either sounds the same bell or chime. This can be confusing when a visitor presses the rear-door button and you answer the front door. To have distinctively different sounds that will announce to you which button has been pressed, the usual procedure has been to wire the two buttons to different annunciators, like bells and chimes. A much better solution is provided by our Two-Tone Electronic Doorbell, which sounds a distinctively different audio tone that instantly lets you know which doorbell button has been pressed. If both buttons are pressed simultaneously, the project will sound a chord that is a mixture of both tones.

This project not only sounds different tones for the front and rear doorbells, it also sounds them for different durations. This makes it even easier to distinguish which bell button has been pressed. Also, most people have little confidence in doorbell mechanisms and, thus, ring more than once. With our Electronic Doorbell, repeated pressings of a button have no effect while the circuit is in its triggered state, which is



PARTS LIST

Semiconductors
IC1,IC2—LM556 dual timer
LED1—Red light-emitting diode
LED2—Green light-emitting diode
Capacitors (15 WV minimum)
C1—10-µF electrolytic
C2—6-µF electrolytic
C3—0.01-µF ceramic disc
C4,C6—47-µF electrolytic
C5—0.05-µF ceramic disc

Resistors (¼-watt, 10% tolerance)
R1,R4—10,000 ohms
R2,R3—330,000 ohms
R5,R6—1,000 ohms
R7,R10—47,000 ohms
R8,R9—56,000 ohms
Miscellaneous
S1,S2—Existing doorbell pushbutton switches (see text)
SPKR—4- or 8-ohm miniature speaker

Printed-circuit board or perforated board with holes on 0.1" centers and suitable Wire Wrap or soldering hardware; sockets for IC1 and IC2; suitable 9-volt dc power supply (see text); enclosure; 4- or 6-position screw-type terminal strip or barrier block; twisted-pair bell or telephone wire; machine hardware; hookup wire; solder; etc.

Fig. 1. Complete schematic diagram of Two-Tone Electronic Doorbell. Pushbutton switches S1 and S2 are existing doorbell switches. Power this circuit from any plug-in wall-type 9-volt dc power supply.

the duration time of the generated tone. Of course, another pressing after the timed cycle has elapsed will once again sound the tone.

About the Circuit

The complete schematic diagram of the Electronic Doorbell is shown in Fig. 1. In this circuit 556 dual timer *IC1* is configured as two separate astable (one-shot) multivibrators. Triggering of the timers inside the *IC1* chip is accomplished with push-button doorbell switches *S1* and *S2*. Pins 1 through 6 of the IC are assigned to the first on-chip timer, while pins 8 through 13 are assigned to the other timer. Positive and negative supply lines for the 556 dual timer are at pins 14 and 7, respectively.

Note that *IC2* is another dual 556 timer. The timers in this chip are configured to generate two distinctly different audio tones that are fed through coupling capacitors to speaker *SPKR*. Using different tones makes it easy to distinguish between front and rear doorbell activation.

Operation of the circuit is simple and straightforward. Pressing doorbell switch *S1* causes a negative spike to be generated, which is coupled into the first on-chip multivibrator timer at pin 6. When this occurs, output pin 6 goes positive and causes current to flow through *R6* and *LED2*, turning on this green light-emitting diode. The LED is included in this circuit to provide visual indication of the "on" time of the multivibrator.

Output pin 5 of *IC1* is also directly connected to pin 4 of the first timer inside *IC2*. Consequently, the positive voltage that makes *LED2* light enables the timer oscillator. This timer now produces a tone at output pin 5, which is coupled through capacitor *C4* to the speaker.

When *IC1* is triggered, *C2* begins to charge up through *R2* toward the potential on the positive supply rail. When the charge on this capacitor reaches approximately 66 percent of the positive-rail potential, which is about 6 volts when the circuit is powered from a 9-volt source, the output at pin 5 of *IC1* goes low and extinguishes *LED2*. Simultaneously, the first timer inside *IC2* is disabled so that its multivibrator ceases oscillating. As a result, the tone being delivered to the speaker is cut off.

Increasing the value of either *C2* or *R2* increases the "on" time of the first timer inside *IC1*. This "on" time is calculated using the formula: $t_{1ON} = 0.7(2 \times R3) \times C2$. Plugging the values specified for *C2* and *R1* into the formula, we get: $t_{1ON} = 0.7 \times 2 \times 0.33 \times 6$, which yields an "on" time of 2.8 seconds. (Note that capacitor and resistor values are given in microfarads and megohms in this formula.)

The "on" time for the other timer inside *IC1* is calculated in the same manner. Using the values specified for *C1* and *R3*, we obtain: $t_{2ON} = 0.7 \times 2 \times 0.33 \times 10$, which works out to 4.6 seconds.

From the foregoing, it is obvious that this circuit is rigged to sound one tone for a longer period of time than the other. Subtracting the 2.8-second duration of the first timer from the 4.6-second duration of the second timer yields a difference of 1.8 seconds, which is how much longer the second timer's tone is sounded. If a 12-microfarad capacitor were to be used for *C1* instead of the 10-microfarad value specified, time t_{2ON} would be twice that of time t_{1ON}.

Astable multivibrator *IC2* provides the two tones that make front and rear doorbell rings distinctive. Pin assignments for timer 1, timer 2, V+ and ground in *IC2* are the same as for *IC1*, with the exceptions for connections of timing capacitors *C3* and *C5*.

The *C3* side is the higher-frequency oscillator, which generates a 935-Hz tone, while the lower-frequency *C5* side generates a 190-Hz tone. You can calculate these frequencies yourself using the formulas: $f_1 = 1.43/(R8 + 2R7 \times C3)$ and $f_2 = 1.43/(R9 + 2R10 \times C5)$. Plugging values into each formula yields: $f_1 = 1.43/[0.65 + (2 \times 0.047)] \times 0.1 = 953$ Hz, $f_2 = 1.43/[0.056 + (2 \times 0.047) \times 0.05] = 190$ Hz.

As you can see, both *IC2* oscillator outputs are coupled to the same speaker through capacitors *C4* and *C6*. Pressing *S1* causes the higher-frequency tone to be heard from the speaker, while pressing *S2* causes the lower-frequency tone to be heard. Should both switches be pressed at the same time, both tones will be generated and will be reproduced by the speaker as a mix of the two.

Power for the project can be supplied by just about any 9-volt dc source, such as a plug-in type used with many small appliances.

Construction

Owing to the very few discrete components required and the fact that component placement and routing of wiring are not critical, this is a very simple circuit to build. Consequently, you can use any traditional wiring technique when assembling the project, including a printed-circuit board, perforated board and suitable Wire Wrap or soldering hardware or even a medium-size solderless breadboarding block.

If you desire pc construction, fabricate your board using the actual-size etching-and-drilling guide shown in Fig. 2. On the other hand, if you prefer perforated-board construction, rather than going to the effort of making a pc board, use board that has holes on 0.1-inch centers if you do not use a solderless socket. If you use pc- or perf-board construction, it is a good idea to use sockets for *IC1* and *IC2*.

Assuming you opted for pc construction, refer to Fig. 3 for wiring details. (Note: Use the layout shown in Fig. 3 as a rough guide to component placement when assembling the

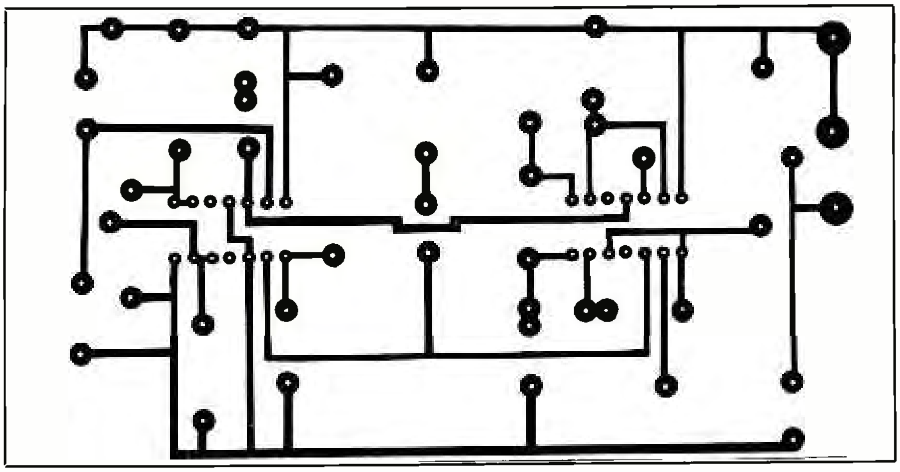


Fig. 2. Actual-size etching-and-drilling guide for making pc board.

circuit using perf board or a solderless socket.) Orient the board in front of you as shown. Then install and solder into place the two DIP IC sockets, but do *not* install the ICs in the sockets until after preliminary voltage checks have been performed and you are certain of your wiring.

Proceed with construction by installing and soldering into place the resistors, followed by the capacitors. Make sure all electrolytic capacitors are properly polarized before soldering their leads to the copper pads on the bottom of the board. Also mount *C5* (or *C4*) on the *bottom* of the board. Use a cut-off capacitor lead or short length of bare solid hookup wire for the single required jumper.

Strip ¼ inch of insulation from both ends of 12 6-inch lengths of hookup wire. If you are using stranded hookup wire, twist together the fine conductors at both ends of each and sparingly tin with solder. Plug one end of each of these wires in turn into the holes labeled S1, S2, LED1, LED2, SPKR, +9V and GND. Solder each wire into place as you install it.

When the circuit-board assembly has been fully wired, it can be housed inside any enclosure that will accommodate it, the speaker and a 4- or 6-contact screw-type terminal strip or barrier block at one end. The last provides a convenient means for connecting the doorbell-switch wires and, optionally, the two power-supply conductors. An ordinary plastic project box that has a removable aluminum panel is an excellent choice for an enclosure, especially since it is much easier to machine than a metal utility box without specialized tools.

Machine the enclosure as needed. Drill mounting holes for the circuit-board assembly, LEDs, terminal strip or barrier block, and a number of small holes in the area over which the speaker will be mounted to permit the sound to escape. Also drill a hole to accommodate the mating jack for the plug at the end of the plug-in dc power supply you will be using with the project, or use a 6-contact terminal strip or barrier block and use two of its contacts for the supply connections instead of drilling the jack hole. Do not drill mounting holes for the speaker if it offers machine hardware mounting. Also drill a couple of holes that will permit suitable hardware to be used to mount the project in the selected location. If you are using a metal enclosure, deburr all but the small sound-escape holes. Run a bead of silicone adhesive around the perimeter of the speaker and set it in place in the enclosure to set at least overnight and preferably longer.

Meanwhile, if they do not already exist, install the two doorbell switches near the front and rear doors of your home and run twisted-pair bell or telephone wire from them to the location where the electronics package will be located. Dress all wiring neatly and hide as much of it as you can behind moldings and other parts of the structure.

When the silicone adhesive has fully set, mount the circuit-board assembly in place with ½-inch-long spacers and 4-40 × ¾-inch machine

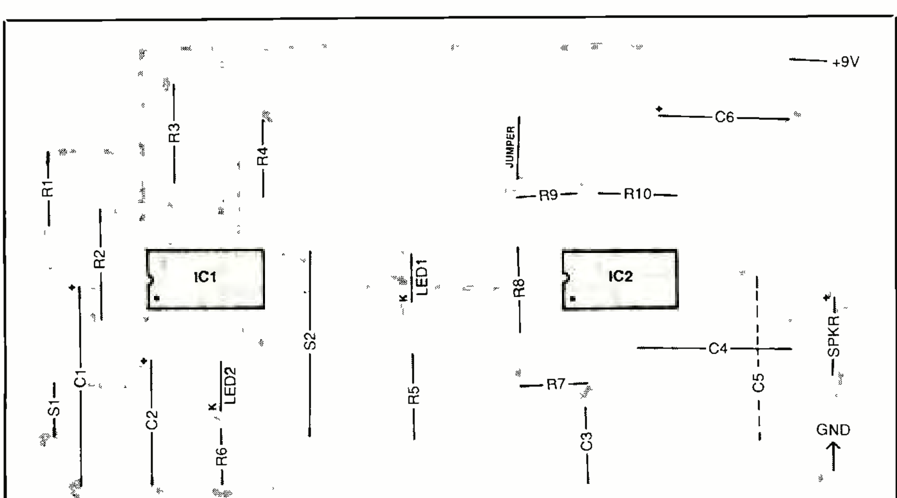


Fig. 3. Wiring guide for pc board.

Experimental Triggering Methods

This "Electronic Doorbell" will trigger with any negative-going pulse. Thus, it allows for other possible triggering schemes and applications. For example, you can replace the standard pushbutton bell switch with a copper touch plate, as illustrated in drawing (A). A length of wire routed from the touch plate to pin 6 of *IC1* completes the circuit. If you wish touch plates at both entries, connect the other to pin 8 of *IC1*. With a little imagination, you can have the pins 5 and 9 outputs of *IC1* drive transistors that control relays to give you control over two different electrically powered devices from two separate locations, while at the same time signaling which device is active.

Another triggering possibility is the photoelectric method illustrated in drawing (B). Here, a photoresistor replaces one or both bell switches. This circuit is activated by shining light on the photoresistor(s). To sound either tone, the photoresistor(s) should be positioned so that they are normally in darkness and respond only when light strikes them. Alternatively, they can have light on them at all times except when an object interrupts the light beam(s). With the photoresistor method of triggering the circuit, you can adapt a shutter mechanism to trigger a one-shot multivibrator state.

Drawing (C) illustrates yet another method of triggering the project. This time, moisture is used as the trigger. The sensors connected to one or both trigger inputs to *IC1* are simple interleaved copper "finger" moisture sensors. When either or both sensors becomes damp enough, the resulting drop in resistance between the electrodes generates the negative-going spike that triggers *IC1*.

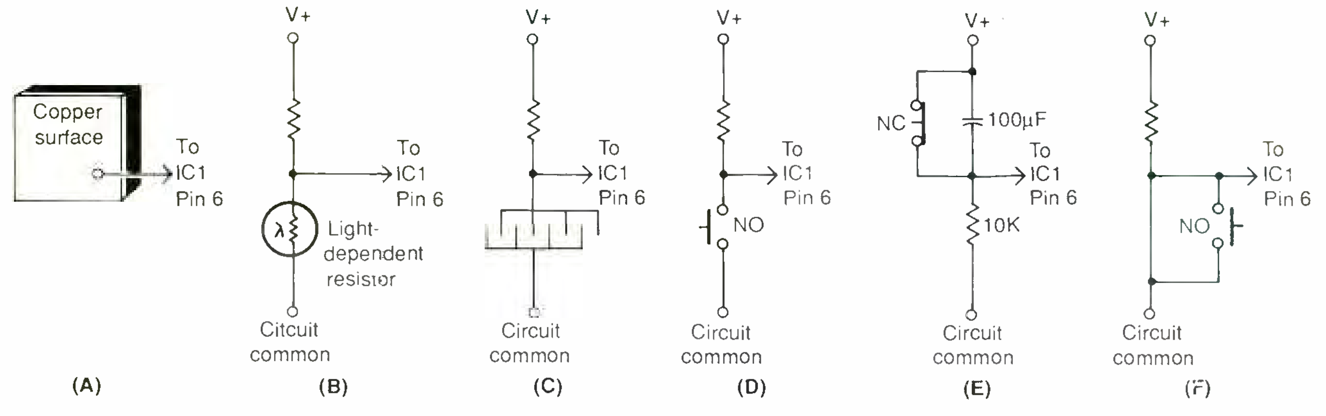
Drawing (D) is also for use in "wet" situations. This time a "float" switch is used to sense when the water level in your basement or anywhere else rises above a certain point. When it does, the switch closes and triggers the project's circuitry to let you know that a problem exists. With a little ingenuity, you can feed the output from *IC1* to a driver transistor that controls a relay. The relay, in turn, then starts up a pump that runs until the water level drops enough to once again open the switch.

By extension, arrangement (D)'s switch can be a temperature sensor that closes when the temperature being monitored in, say, your freezer rises above a certain point to alert you to loss of refrigeration.

The arrangement shown in (E) provides a delayed off-to-on state. It keeps the project triggered as long as the switch is open. Finally, the arrangement shown in (F) provides a very strong negative-going trigger pulse for the project.

As you can see from the foregoing, this project can be adapted to other uses besides serving as a dual doorbell. With the proper switching arrangements, it can serve as the active element of an intruder alarm. For example, wiring to both inputs will let you monitor two locations. Alternatively, separate perimeter sensing-system switch loops can be wired to the two inputs to give you progressive position warning.

Try experimenting with different triggering schemes for this project's circuit to suit different applications. You will find that the circuitry is very adaptive, as we have shown.



Examples of possible alternate triggering techniques to suit applications other than doorbells.

hardware. Locate the wires coming from the SPKR holes in the board and crimp and solder the free end of the one coming from the + hole to the "hot" lug on the speaker. Then crimp an solder the free end of the other wire to the unidentified lug on the speaker. Be careful not to puncture or drop hot solder on the cone of the speaker.

Identify the leads of the red light-emitting diode and clip the cathode one to ½ inch. Form a small hook in the remaining cathode-lead stub. Slip a 1-inch length of small-diameter heat-shrinkable tubing or insulating plastic tubing over the free ends of the *LED1* and *LED2* wires. Crimp

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the free end of the *LED2* wire coming from the K hole to the hook and solder the connection. Do the same for the other LED lead and *LED2* wire. Repeat for the green LED and the *LED1* wires on the circuit-board assembly. Then slide the tubing up over the connections until it is flush with the bottoms of the LED cases and shrink into place.

Plug the LEDs into the holes drilled for them and, if necessary, secure them in place with clear fast-set epoxy or plastic cement. If you are using a jack for bringing dc power into the enclosure, mount it in its hole. Otherwise, mount the screw-type terminal strip or barrier block in its location. Connect and solder the free ends of the +9V and GND wires to the jack's lugs (watch polarity!) or to two of the lugs on the terminal strip or barrier block (mark the polarity of each contact on the enclosure as you make each connection). Then crimp and solder the free ends of the S1 and S2 wires to four separate lugs on the strip or block and label the contacts accordingly.

Checkout & Use

With the ICs still not installed in their sockets, plug the power supply into its jack (or fasten it to its contacts on the terminal strip or barrier block) and plug it into an ac outlet. Connect the common probe of a dc voltmeter or a multimeter set to the dc volts function to circuit ground. Then touch the "hot" probe to pins 4, 10 and 14 of the *IC1* socket and pin 14 of the *IC2* socket. The meter should indicate about +9 volts.

You should also obtain a +9-volt reading at pins 1, 2, 6, 8, 12 and 13 of the *IC1* socket but nothing at pins 3, 5, 9 and 11. Similarly, you should obtain a +9-volt reading at pins 1, 2, 6, 8, 12 and 13 of the *IC2* socket but nothing at pins 3, 4, 5, 9, 10 and 11. These readings are based on *empty* IC sockets.

If you do not obtain these readings, power down the project and rectify the problem. Then, when you have ascertained that the project has been correctly wired, make sure no power is applied to it and install the ICs in the sockets. Make sure each is properly oriented and that no pins overhang the sockets or fold under between ICs and sockets.

Power up the project once again. Then use a short jumper wire to momentarily bridge the *S1* contacts of the terminal strip or barrier block for *S1*. You should hear an audio tone from the speaker. If you do, momentarily bridge the contacts for *S2*. You should also hear an audio tone, but one of a different (higher or lower) frequency.

When you are sure that the project is working properly, mount it in the selected location and run power to it. Terminate the wires from your front and rear doorbells at the terminal strip or barrier block to finish construction and installation. The Electronic Doorbell is now in service. **ME**