BUILD A UNIVERSAL ELECTRONIC TIMER

By Michael S. Robbins

Time any event occurring in a 24 hour period in seconds, minutes or hours. Includes audible alert and automatic on/off.

Timing is becoming increasingly more important around the home, in the workshop, and in the lab. For example, we routinely time such diverse things as cooking, watering the lawn, long-distance telephone calls, photographic film processing, etc. Hence, there is an increasing need for an accurate timer to help us. The "Universal Electronic Timer" described here was designed to fill virtually any timing need

The basic function of the Universal Electronic Timer is to turn on and off an electrical or electrically operated device or to generate a tone for a predetermined period of time at regular programmed intervals. An interval-selection switch gives you a choice of 0.5, 1, 5, 10, 30, or 60 seconds; 5, 10, 30, or 60 minutes; or 12 or 24 hours. The "on" time can be adjusted over a 10-ms to 10-second range and can be expanded to more than 30 minutes by a simple change in component values. The "thing" that gets turned on or off can be external to the timer (as mentioned above) or it can be the self-contained tone generator. The latter is a gated 1000-Hz oscillator driving a speaker. If the gate control is short enough, the output will be a sharp "tick." By setting the interval switch to 1 second and the period control to 0.01 second, one tick per second will be generated. A one-second beep every 10 minutes, with the indicator displaying the minutes, can be obtained with an interval setting of 10 minutes and a period control of 1 second.

This timer project is built around a 5309 six-digit clock chip that features both seven-segment and BCD outputs. The feature that distinguishes the 5309 from the 5311 through 5314 chips is a reset function that sets all digits to zero. (The 5315 will work, but it has a different pin configuration.)

The seven-segment and BCD outputs of the 5309 IC are multiplexed. Digit-enable outputs indicate which digit is present at the outputs at any instant. By sensing the desired digit-enable output, the internal multiplex oscillator can be stopped while the desired digit is present. Hence, the IC can be made to output only one of its six digits.

The 5309 IC can directly drive a common-cathode LED display to indicate the state of the seven-segment outputs.

About the Circuit. Transistor *Q1* in Fig. 1 controls clock chip *IC1*'s multiplex oscillator. Switch *S1B* is used to select the digit at which the oscillator stops.

Since a zero will appear in the units-seconds digit only once every 10 seconds and in the tens-seconds digit only once every minute, the circuit must be speeded up. By connecting the slow-set input of the 5309 to ground through *S1A*, the clock chip operates 60 times its normal speed. Thus, instead of the tens-seconds zero appearing once a minute, it now appears once a second.

The zero is detected by testing the states of segments *f* and *g* in the display. The only digit for which the *f* segment is on and the *g* segment is off is the zero. Hence, each time the zero occurs, the voltage at the collector of *Q2* drops. This generates a negative-going pulse that toggles one-shot multivibrator *IC2*, which generates a signal whose duration is determined by the values chosen for *C5*, *R3*, and *R5*. The values specified

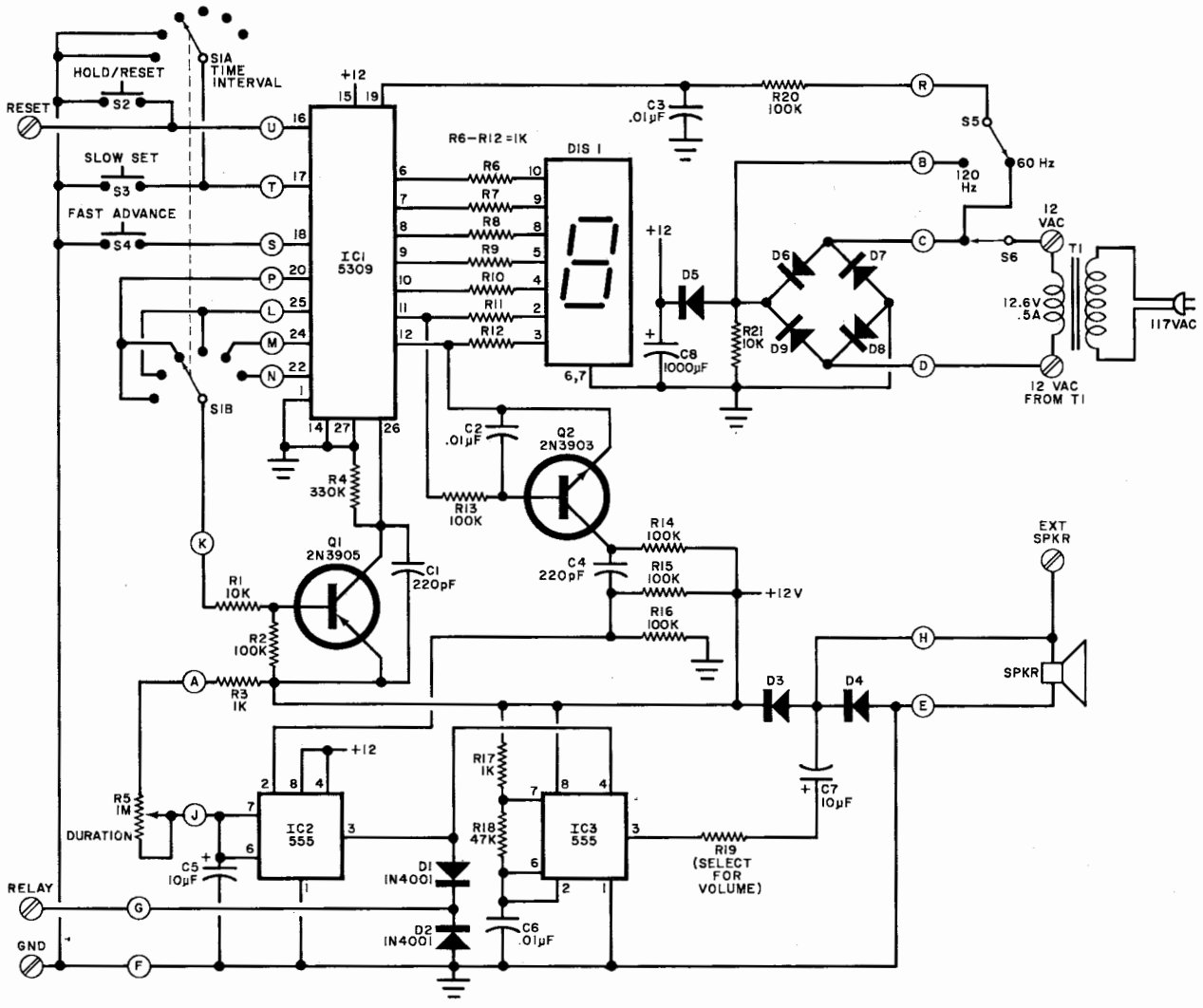

Fig. 1. A conventional digital clock chip forms a 0.5-s to 24-h timer. Gated tone generator creates desired "beep." Timer also activates relay for external control.

PARTS LIST

C1, C4—220-pF disc capacitor
C2, C3, C6—0.01-μF, 16-volt disc capacitor
C5—10-μF, 10-volt tantalum capacitor
C7—10-μF, 16-volt electrolytic capacitor
C8—1000-μF, 25-volt electrolytic capacitor
D1 thru D9—1N4001 rectifier diode
DIS1—Seven-segment display (common-cathode) TIL313 or HP5082-7740
IC1—MM5309 clock IC (National)
IC2, IC3—555 timer IC
Q1—2N3905 or 2N3906 transistor
Q2—2N3903 or 2N3904 transistor
All resistors ¼ watt, 10% tolerance:
R1, R21—10,000 ohms
R2, R13, R14, R15, R16, R20—100,000 ohms
R3, R6 thru R12, R17—1000 ohms
R4—330,000 ohms
R18—47,000 ohms
R19—10 ohms minimum (select for desired volume)
R5—1-megohm audio-taper potentiometer with switch
S1—Two-pole, six-position nonshorting rotary switch
S2, S3, S4—Normally-open spst pushbutton switch
S5—Spdt slide switch
S6—Spst switch (part of R5)
SPKR—45-ohm loudspeaker
T1—12.6-volt, 500-mA power transformer
Misc.—Two-screw terminal strip or barrier block; four-screw terminal strip or barrier block; Molex Soldercons® (for DIS1); sockets for ICs (or substitute Soldercons); suitable enclosure; 1" (2.54-cm) threaded spacers (4); red acrylic filter; control knobs (2); dry-transfer lettering kit; machine hardware; hookup wire; solder; etc.
Note: The following items are available from Caringella Electronics, Inc., P.O. Box 727, Upland, CA 91786: Complete kit of parts, including cabinet, No. UET-1K, for $34.95 plus $2.00 shipping and handling; etched and drilled pc board No. UET-1PC for $6.95 postpaid in USA. California residents, please add 6% sales tax.

in the schematic diagram and Parts List will produce a range of from approximately 10 ms to 10 seconds. If you require a longer period, you can increase the value of *C5*. For example, a 100-μF capacitor will yield a range from 100 ms to 100 seconds. If a 10-M potentiometer is used for *R5*, the range becomes 100 ms to 18 minutes. If a 10-megohm resistor is connected in series with the 10-megohm potentiometer, the range will be from 18 to 36 minutes.

The output of *IC2* is used to drive an external relay and tone generator *IC3*. Any 12-volt dc relay whose coil resistance is at least 120 ohms can be used. If a visual output is desired, connect a LED in series with a 240-ohm resistor to this point.

To increase the frequency of the 1000-Hz audio tone generated by *IC3*, decrease the value of *R18*. You can decrease the frequency by increasing the value of *R18*.

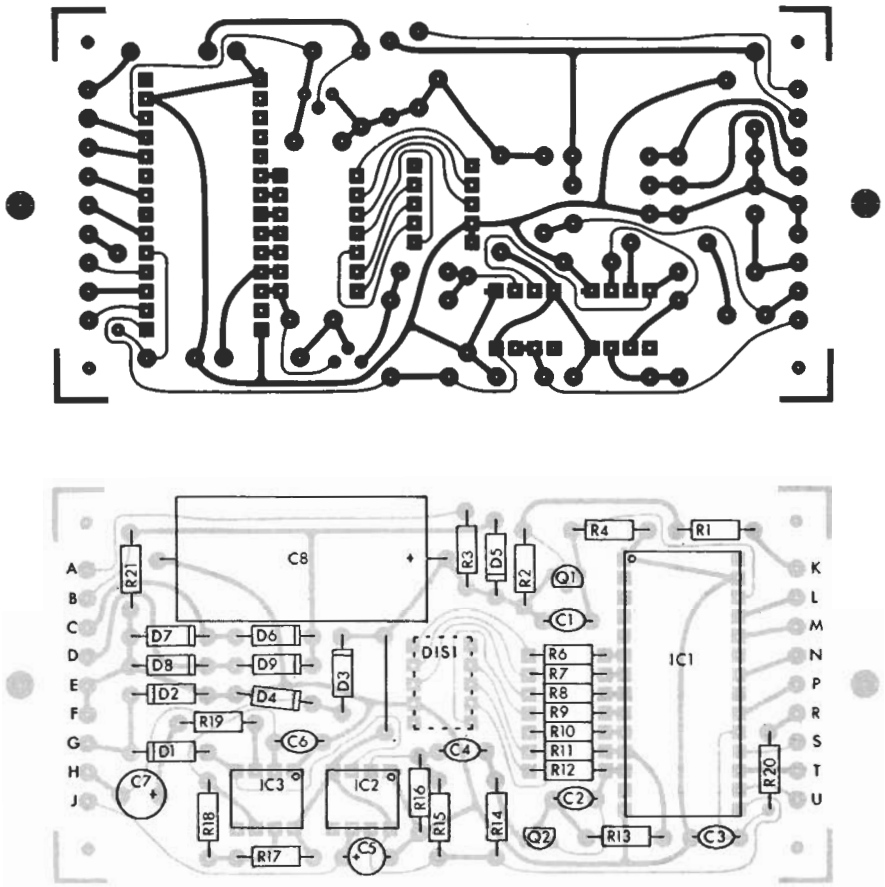

Fig. 2. Actual-size etching and drilling guide for printed circuit board is shown at top. Component placement diagram is directly above.

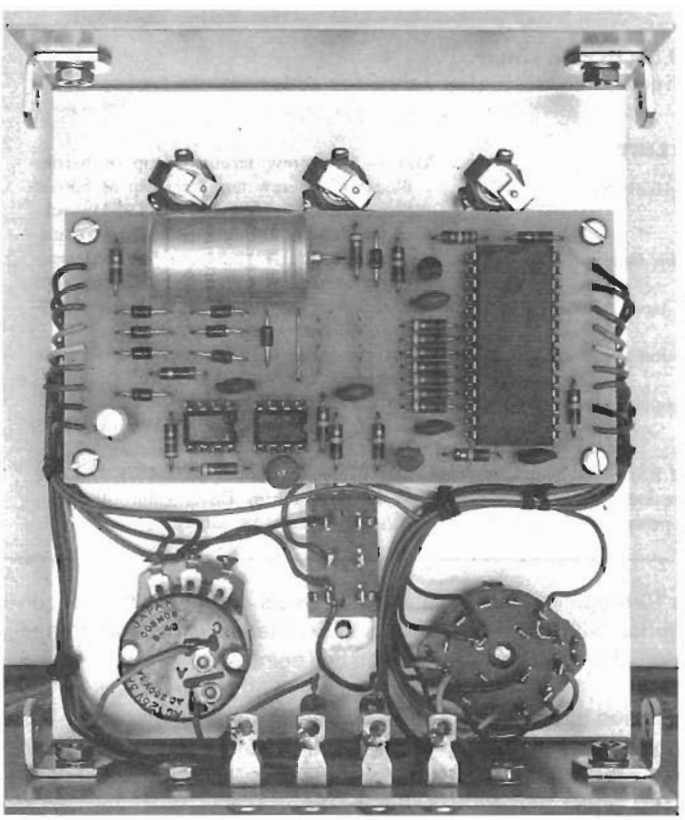

Fig. 3. Photo shows interior construction details of author's prototype.

Construction. The timer circuit is best assembled on a printed-circuit board. The actual-size etching-and-drilling guide and separate components-placement diagram for the pc board are shown in Fig. 2.

Before you proceed to wire the pc board, place it *foil* side up on a hard, flat surface. Slip a strip of five Molex Soldercons® onto the pins on each side of *DIS1*. (Do *not* remove the connecting strips of metal on the Soldercons until directed to do so.) Lower the display onto the pc board, guiding the pins of the Soldercons into the appropriate holes on the board. Because of the hard surface under the board, the pins will not go in as far as they might otherwise. Do not try to push them in all the way. Simply solder them to their respective traces on the board, using only as much heat and solder as necessary to assure a good electrical and mechanical connection in each case. Leave the display in place and cover its top surface with a piece of masking tape.

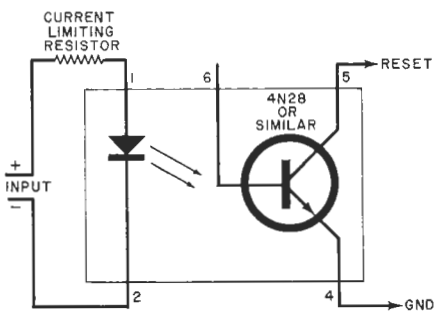

Fig. 4. An optoisolator can be used to interconnect two timers for extremely long timing durations.

Flip over the pc board and install the resistors, capacitors, diodes, and transistors. Refer to the components-placement diagram in Fig. 2 for proper component location and orientation. Install sockets in the locations for the integrated circuits. Then install *IC2* and *IC3* in their sockets. Do *not* install *IC1* until last and, when you do so, be sure to practice safe handling procedures for MOS devices. (This clock chip is a PMOS device that can be damaged by static fields if it is not handled properly.) Flip over the board assembly and carefully flex the connecting strips on the display's Soldercons until they break away. Three or four flexes will generally do the trick. Temporarily set the board assembly aside.

Next, referring to Fig. 3 and the lead

photo, machine the top half of the enclosure in which the project is to be housed. (If you plan to build the power supply into the project, select a large enough enclosure to accommodate it without interference to the other elements in the circuit.) Drill the holes for the various switches, control, and circuit board standoffs; cut a window for the display; and make a pair of slots (or drill ½" holes) for the screw-type terminal strips or barrier blocks. Use a dry-transfer lettering kit to label the various switches, control, and terminal strip points, as shown in the lead photo. Then mount each item, except the circuit board assembly, in its respective location.

Solder an 8" (20.3-cm) length of hookup wire to pads A through U on the circuit board assembly. Flip over the board and peel away the tape from the display. Then mount the circuit board assembly, with *DIS1* centered in the window in the top half of the box, with threaded spacers and machine hardware. If you wish to protect the display and enhance its contrast for easier reading, cement a piece of red acrylic plastic over the window on the inside of the box before mounting the circuit board assembly on its spacers.

Drill a series of ¼" holes in the bottom half of the enclosure to perforate it for the loudspeaker. Then mount the speaker, with a protective screen between it and the enclosure wall. Refer back to Fig. 1 and interconnect the circuit board assembly with the control, switches, terminal strips, and speaker, using the wires connected to holes A through U on the board. Trim the wires as necessary as you connect them. Finally, arrange the wires neatly and lace them together and assemble the case.

Using the Timer. RESET pushbutton switch *S2* or the RESET input on the four-lug terminal strip returns the interval timer and display to zero. The display remains at zero as long as the RESET switch is closed or the RESET input is grounded. Releasing either initiates the timing cycle. If you desire remote operation of the reset feature, you can use the optoisolator circuit shown in Fig. 4.

The SLOW SET and FAST SET pushbuttons are used to preset the interval timer. The SLOW SET button is not operational in the two shortest interval positions of *S1* (1 second and 10 seconds).

The divide-by-two switch (*S5* in Fig. 1 but not labelled in Fig. 3) effectively cuts all of the timing intervals that are selected by *S1* in half. ◇