Not Just Another DIGITAL CLOCK

Digital electronic clocks are no longer a novelty, except when they are designed in an unusual format. This electronic digital clock is unique in that hours and minutes are flashed sequentially in a specific pattern on a single 7-segment display nearly five inches high.

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DIGITAL CLOCKS ARE CERTAINLY PLENTIful thanks to the many large-scale integrated circuits currently being produced by several major electronics manufacturers. This clock uses one of the readily available LSI clock IC's, but what makes it unique is the novel approach used to display the time. Instead of the four small 7-segment displays that can be found on most digital clocks, this clock has one 7-segment display that is nearly five inches high. The time is flashed sequentially on the single readout in a specific pattern. The pattern is set so that the time is easily interpreted but it also gives an intriguing effect, especially to those who haven't been told that this strange device in really a clock!

The bright readout is clearly visible, even from across a large room. In addition, the completed clock is less than one inch thick. This means the project can be placed in a standard picture frame and hung on a wall to make an attractive addition to anyhome or office.

Circuit description

The basis of the circuit (Fig.1) is the MM3518 clock IC. This device contains all the logic required to set and maintain a 4-digit representation of the time, with the timebase derived from the 60-Hz AC line frequency. It also provides 7-segment outputs that are multiplexed for each digit through a 3-line input code.

The supporting circuitry selects the proper code in the correct sequence. The 555 timer is wired in an astable mode and used to provide a clocking signal to the CD4060 counter (IC3). The 4060 is a 14-stage ripple binary counter/divider and oscillator that gives a repeating binary count of 0 to 15 on its Q5, Q6, Q7 and Q8 outputs. The count is used to alternately select each of the eight output lines of a CD4051 analog switch. Only four of the eight lines are used. These are combined in a diode matrix to generate the codes on the MM5318 to flash properly the sequence of digits and blanks in the display. (See Fig. 1 and Table 1.) The blank intervals are developed during the periods that the four unused output lines of the CD4051 are selected.

Since the clock IC is normally intended

TABLE 1

Count	4060 Outputs	4051 Line Selected	MM5318 Inputs XYZ	Time Digit Displayed
0	000 0	0	000	Blank
1	000 1	Inhibit	000	Blank
2	001 0	1	000	Blank
3	001 1	Inhibit	000	Blank
4	010 0	2	111	Tens Hours
5	010 1	Inhibit	000	Blank
6	011 0	3	011	Unit Hours
7	011 1	Inhibit	000	Blank
8	100 0	4	000	Blank
9	100 1	Inhibit	000	Blank
10	101 0	5	101	Tens Minutes
11	101 1	Inhibit	000	Blank
12	110 0	6	100	Unit Minutes
13	110 1	Inhibit	000	Blank
14	111 0	7	000	Blank
15	111 1	Inhibit	000	Blank

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the proper time, it displays the time by flashing the digits sequentially through a single seven-segment display. The sequence of digits is: HHxMMxxx where x represents a blanked pause period. (The clock features leading-zero blanking so the sequence can also be: xHxMMxxx)

The three pushbutton switches on the front panel are, from left to right, S1, S2 and S3. Switch S1 is a "freeze" button and will stop the flashing sequence anywhere in its cycle. Switch S2 is the slow-set button and S3 is fast time set.

Upon plugging in the power transformer, the clock comes up in an undefined state and usually flashes two zeros. Pressing S3 for approximately 1 second will toggle the counters and put the clock in a correct timekeeping state. Now the correct time can be set.

This is best done by watching whatever time is currently sequencing so you can identify the first hour digit and anticipate when it will flash again on the next cycle. By depressing S1 at just the right instant, you can "capture" the hour digit in the display and hold it there by continuing to hold down S1. (This may take a few tries for someone who has never set the time before). With the hours digit captured in the display, simultaneously depressing S3 will advance that digit at the rate of 1 hour per second. When the hours are properly set, release S3 and S1 to continue the flashing cycle. Now S1 is used again, this time to capture the tens of minutes digit. S2 or S3 may be used to advance that digit to the proper setting. Then repeat the procedure once more for the unit minutes, this time using S2 to set that digit.

TOP VIEW of the PC board as it appears when the red plastic panel is removed. The six jumpers are clearly visible.

The procedure is complicated to describe, but with a little practice becomes very simple to do. This clock "grows on you" and attracts lots of attention so you had better be prepared to build others for your friends. **R-E**

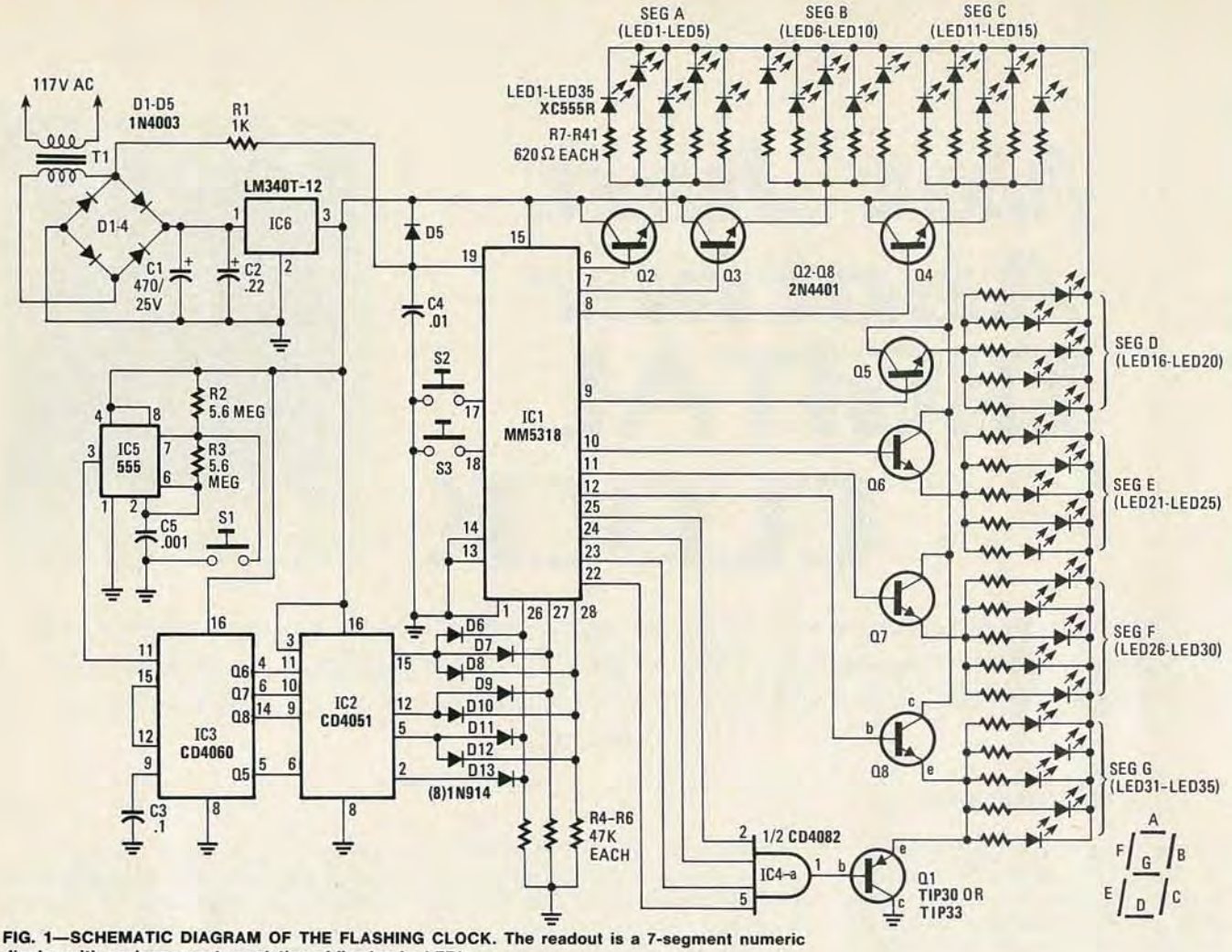

FIG. 1—SCHEMATIC DIAGRAM OF THE FLASHING CLOCK. The readout is a 7-segment numeric display with each segment consisting of five jumbo LED's.

to drive four separate displays, the digit-select lines are combined by the CD4082 AND gate so they all activate the single readout.

Construction

The printed circuit board makes assembly fast and straightforward. The foil pattern is in Fig. 2 and component positions are shown in Fig. 3. Begin by installing and soldering the six jumpers. Diodes and resistors are done next, making sure to observe diode polarities as indicated. A low-profile IC socket should be used for the MM5318 clock IC. Sockets for the other integrated circuits are optional. Note that pin 1 of all IC packages is oriented in the same direction on the board. Bend the leads of the voltage regulator and the TIP30 transistor so that they lie flat against the board when soldered in place.

The seven NPN transistors (Q2-Q8) are in two groups; three on the left and four on the right. Be sure to follow the lead orientation indicated for each group. Capacitors C1 and C2 are polarized and must both be installed in the proper direction for the clock to work correctly. Check the parts layout diagram carefully when installing the 35 LED's. The flat

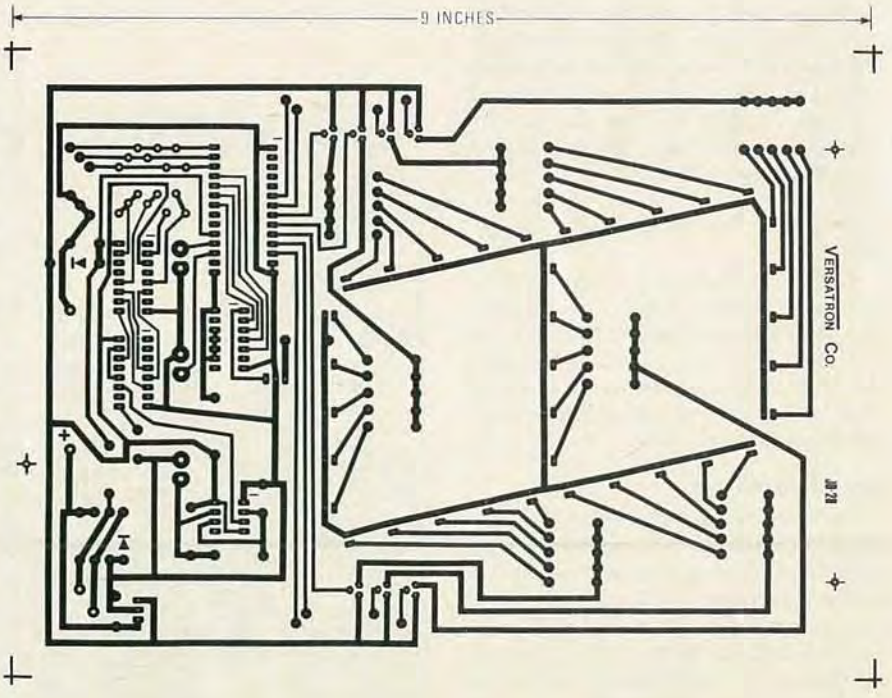

FIG. 2—PRINTED-CIRCUIT FOIL PATTERN is easy to duplicate photographically or by other means. An etched and drilled board is available at a moderate cost.

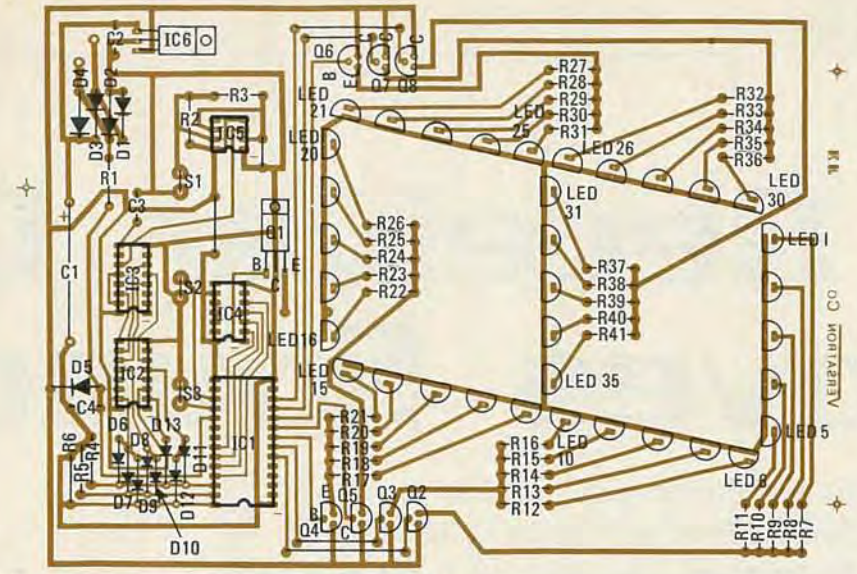

FIG. 3—COMPONENT PLACEMENT LAYOUT. Be careful and check the polarity of each diode and LED before installing it in the board. Use exceptional care when handling the COS/MOS IC's. They are easily damaged by static electricity.

FIG. 4—DRILLING GUIDE for the front panel. The two holes near the top are for mounting screws and spacers. The ones at the bottom are for the three pushbutton switches.

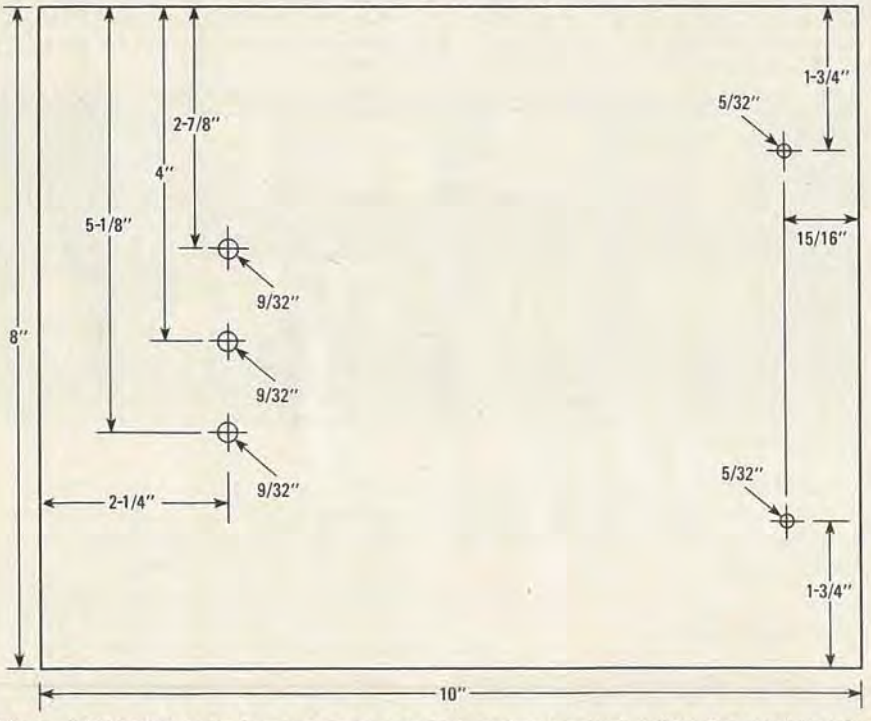

FIG. 5—SIDE VIEW shows how the panel and PC board go together. Adjust the switch heights carefully before soldering the switch to the PC board.

side indicates the proper orientation and corresponds to the flat spot on the base of each LED.

Install two ½-inch plastic standoffs in the holes at the top edge of the circuit board. (The drilling guide is in Fig. 4.) These are used to hold the acrylic front parallel in front of the clock. The three pushbutton switches are installed as shown in Fig. 5. They must be soldered at the proper height so they protrude through the front panel correctly.

Feed the transformer leads through the hole on the lower edge of the circuit board, starting from the foil side. Tie a knot in the leads so they cannot get pulled back through the hole and then install and solder the ends in the proper locations. This keeps the wires from becoming detached if they are accidentally pulled sharply.

PARTS LIST

Resistors ¼ watt, 5% carbon unless otherwise noted

R1—1000 ohms
R2, R3—5.6 megohms
R4–R6—47,000 ohms
R7—R41—620 ohms
C1—470 μF, 25 volts, electrolytic
C2—0.22 μF, 35 volts, dipped tantalum
C3, 0.1 μF, 50 volts, ceramic disc
C4—.01 μF, 50 volts, ceramic disc
C5—.001 μF, 50 volts, ceramic disc
D1–D5—1N4003 rectifier diode
D6–D13—IN914 switching diode
IC1—MM5318 digital clock (National)
IC2—CD4051 8-line analog switch (RCA—analog multiplexer/demultiplexer)
IC3—CD4060 14-stage ripple-carry binary counter (RCA)
IC4—CD4082 dual 4-input AND gate (RCA)
IC5—555 timer
IC6—LM340T-12 positive 12-volt regulator (National)
Q1—TIP30 or TIP32 pnp transistor (Texas Instruments)
Q2–Q8—2N4401 or equal
LED1–LED35—jumbo red LED (XC555R or equal)
S1, S2, S3—push-button switches, normally open, PC mount
T1—plug-type transformer: 12 VAC, 930 mA (Dormeyer model PS-7204)
Miscellaneous: 28-pin low-profile IC socket, two ½-inch long standoffs and screws, 8 in. x 10 in. sheet of ⅛ in. thick red acrylic plastic.

Note: The following kit and parts may be ordered from Versatron Co., PO Box 23573, Pleasant Hill, CA 94523. Phone 415-935-2419:
No. JD-28 PC board, drilled and etched $13.00
8 × 10 inch metal frame $4.95
Complete No. JD-28 clock kit (includes all parts except metal frame) $49.95. California residents add appropriate tax.

Checkout

Before installing the 5318 clock IC and acrylic front panel, recheck all components against the location guide in Fig. 3. Double check polarities and positioning of the integrated circuits and LED's. Turn the board over and carefully check for any solder bridges. If all components appear to be installed properly, insert IC1 and plug in the transformer.

Operation

When the clock is plugged in and set to

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