BY DOUG FARRAR

CMOS logic allows more effective control of time and prevents track-change interruptions

8-Track Timer Simplifies Recording

THE 8-Track Timer (8TT) described here is the perfect companion to an 8-track tape deck. Its primary feature is a digital elapsed-time indicator that eliminates guesswork—and track changes in the middle of a song. In essence, the 8TT provides a visual indication of the amount of time used to record on one track and then tells you how much of that time you have used as you continue to record on each succeeding track. Thus, you'll always know exactly how much time remains before an end-of-track or end-of-tape occurs, and will be able to plan your recording sessions accordingly.

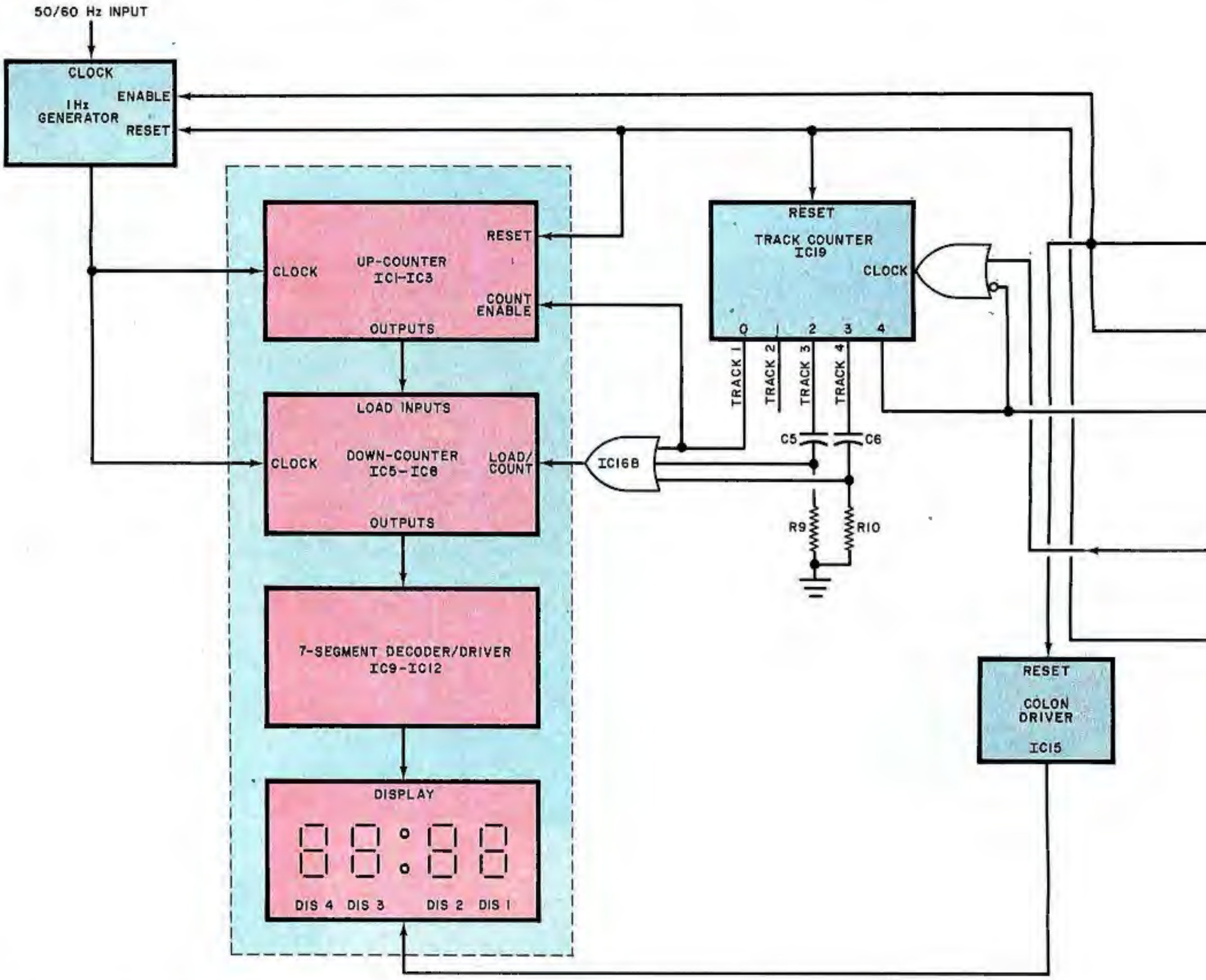
The project also offers the following:

- a PAUSE control;
- automatic shutoff after four "tracks" (that is, track pairs) have played;
- a CLEAR TAPE function that shuts the deck off after any change-of-track.

The last-mentioned function prepares the cartridge inserted in the deck for a recording session. If you don't want the 8TT to control the tape deck, simply remove line power from the project. Normal operation can then be resumed.

About the Circuit. The block diagram of the 8TT is shown in Fig. 1 and its schematic diagram in Fig. 2. A glance at the block diagram reveals five major functional sections: a 1-Hz pulse-train generator; an elapsed-time counter and display; a track counter; a motor flip-flop and controller; and a "logic" circuit.

The 1-Hz generator accepts a low-level signal derived from the ac power line and divides its frequency by either 50 or 60. The position of a jumper on the project's main printed circuit board determines which divisor is selected. This choice is of course governed by the line frequency of the commercial power source (50 or 60 Hz). The resulting train of 1-Hz pulses is employed as a time-



base for the elapsed-time counter.

CMOS up- and down-counter IC's perform the actual timing of the 8-track cartridge. The up-counter is enabled during the interval that track 1 is being used. It serves double-duty by counting the tape cartridge's start-of-track to end-of-track playing (or recording) time and by acting as a latch, storing this information for the rest of the recording session.

The outputs of the up-counter are connected to the parallel-load inputs of the down-counter. When the down-counter is placed in its asynchronous, parallel-load mode, its outputs follow the information presented to its parallel inputs. Removing the parallel-load command causes the counter to commence counting down from the last binary number to which the outputs followed the parallel inputs. The down-counter can thus be ordered to either pass the binary number generated by the up-counter directly to the display decoder/driver or

PARTS LIST

- C1 through C12—0.1-µF disc ceramic
- C13—500-µF, 25-volt electrolytic
- D1 through D5—1N4001
- F1—1-ampere fast-blow fuse
- DIS1 through DIS4—FND70 or similar common-cathode LED display
- IC1,IC3,IC14—4518 dual decade counter
- IC2—4019 quad 2-input multiplexer
- IC4,IC13,IC18—4001 quad 2-input NOR gate
- IC5 through IC8—4510 decade counter
- IC9 through IC12—4511 BCD-to-seven-segment decoder/driver
- IC15—555 timer
- IC16—4072 dual 4-input OR gate
- IC17—4002 dual 4-input NOR gate
- IC19—4017 decade counter/divider with 10 decoded outputs
- IC20—7805 5-volt regulator
- K1—12-volt relay with 250-ohm coil and 3-ampere spdt contacts
- LED1,LED2—Light emitting diode
- OC1—MCT-2 optoelectronic coupler
- Q1—MPSA13 npn Darlington

The following are ¼-watt, 5% tolerance carbon-composition fixed resistors.

- R1,R2,R3—1000 ohms
- R4 through R7, R9 through R12, R48—10,000 ohms
- R8,R13,R14,R15—100,000 ohms
- R16—1 megohm
- R17—330,000 ohms
- R18—3.3 megohms
- R19 through R46—220 ohms
- R47–150 ohms
- S1—1-pole, 5-position nonshorting rotary switch
- S2—Spst toggle switch
- T1—12.6-volt, 1-ampere transformer.
- Misc.—Suitable enclosure, display bezel, 4-conductor chassis-mount female connectors, 4-conductor male connectors, printed circuit board, standoffs, line cord, etc.

Note—An etched, drilled and silk-screened printed circuit board is available for $15 postpaid (in U.S.) from Noveltronics, Box 4044, Mountain View, CA 94022. California residents add sales tax. Foreign orders: write for prices. Allow 2 weeks for checks to clear.

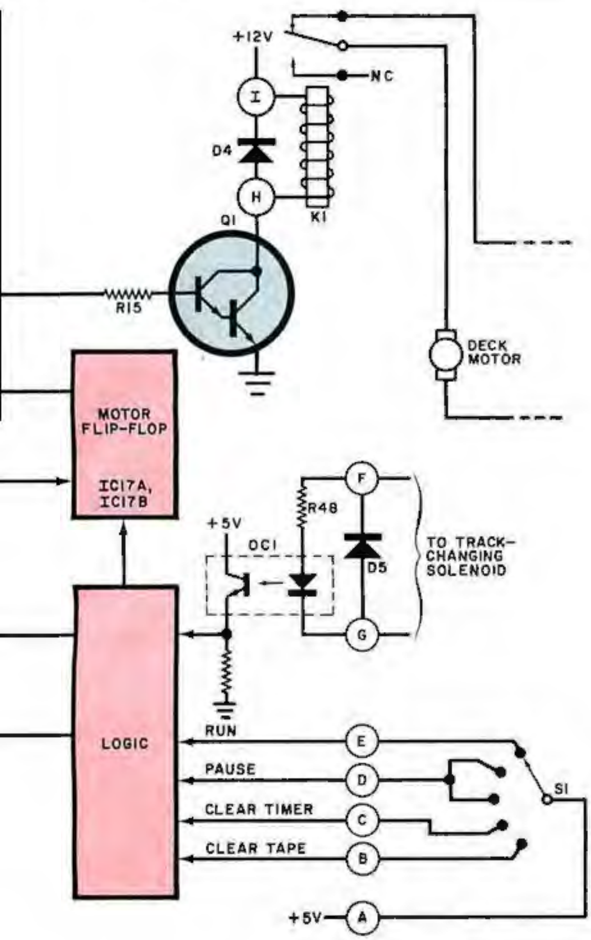


Fig. 1. Five major functional sections of the 8TT are shown in block diagram. The motor flip-flop is actually two cross-coupled NOR gates.

briefly sample the up-converter's output lines and then count down.

The first operation is performed during the time track 1 is being used and the second during the intervals associated with tracks 2, 3, and 4. The binary information present at the output of the down-counter is applied to a BCD-to-seven-segment decoder/driver network for the common-cathode LED displays.

The display's colon driver is a 555 astable multivibrator (*IC15*) that oscillates at a 2-Hz rate. The astable can be gated off by grounding its RESET input (pin 4). This happens whenever the deck is running normally and causes the display's colon to glow steadily. When the motor is shut off, the 555 indicates that fact by pulsing the display colon.

Every 8-track cartridge contains a short section of metallic tape. This tape trips a solenoid to move the deck's tape head through its four track positions. The voltage pulse generated when the solenoid is activated is sensed via optoisolator *OC1* and applied to the track counter's CLOCK input. In this way, the deck's mechanical track position is sensed by the 8TT.

Track counter *IC19* controls the operation of the up- and down-counters. During the track 1 interval, *IC19* enables the up-counter and places the down-counter in its parallel-load mode by way of OR gate *IC16B*. At the end of track 1, the track counter prevents the up-counter from incrementing further and enables the down-counter. At the start of tracks 3 and 4, a pulse generated by either *R9C5* or *R10C6*, respectively, is applied to the down-counter by way of *IC16B*. This loads the up-counter's latched value into the down-counter which then decrements toward zero.

Because each track should take an equal amount of playing time, the display will read 0:00 (or close to it) at the ends of tracks 2, 3, and 4. At the end of track 4, the track counter inhibits further timing and sets the motor flip-flop, stopping the deck motor.

The motor flip-flop is controlled by the logic section. Setting the flip-flop disables the 1-Hz generator, allows the display colon driver to oscillate, and energizes relay *K1*, which is mounted inside the tape deck. The relay's normally closed contacts are wired in series with one of the deck motor's power leads, so that setting the flip-flop removes power from the deck's motor.

The position of rotary switch *S1* determines the 8TT's operating mode. Setting it to its CLEAR TIMER position resets the up-counter and the track counter, and sets the motor flip-flop. This readies the 8TT for the start of a recording session. Placing *S1* in the PAUSE position sets the motor flip-flop, but switching it to the RUN position resets the motor flip-flop. With the switch in the RUN position, recording proceeds as previously described. Placing *S1* in its CLEAR TAPE position initially resets the motor flip-flop and allows the tape to run. At the first change of tracks, the 8TT sets the flip-flop. This stops the deck, leaving the cartridge "cleared" for recording.

Readily available CMOS IC's comprise almost all of the 8TT circuit. A regulated 5-volt and unregulated 12-volt supply is used as the power source. The 12-volt ac waveform developed across the transformer secondary is conditioned to a level compatible with the CMOS logic circuit before being applied to the input of the 1-Hz generator.

Construction. Almost all of the 8TT circuit fits on a single pc board whose etching and drilling and parts placement guides are shown in Figs. 3 and 4. An unusual feature of the board is the "wireless" connection between the logic and display sections. After the board has been fabricated as a single unit, it is cut along the indicated line. The two sections are then soldered together along the cut line to form a right angle. The resulting structure is rigid. The logic board is mounted parallel to the bottom of the project enclosure using spacers as shown in Fig. 5. This automatically positions the display board vertically.

Before soldering the two boards together at a right angle, mount and solder all components and jumpers on each board. Note that *C13*, the elec-

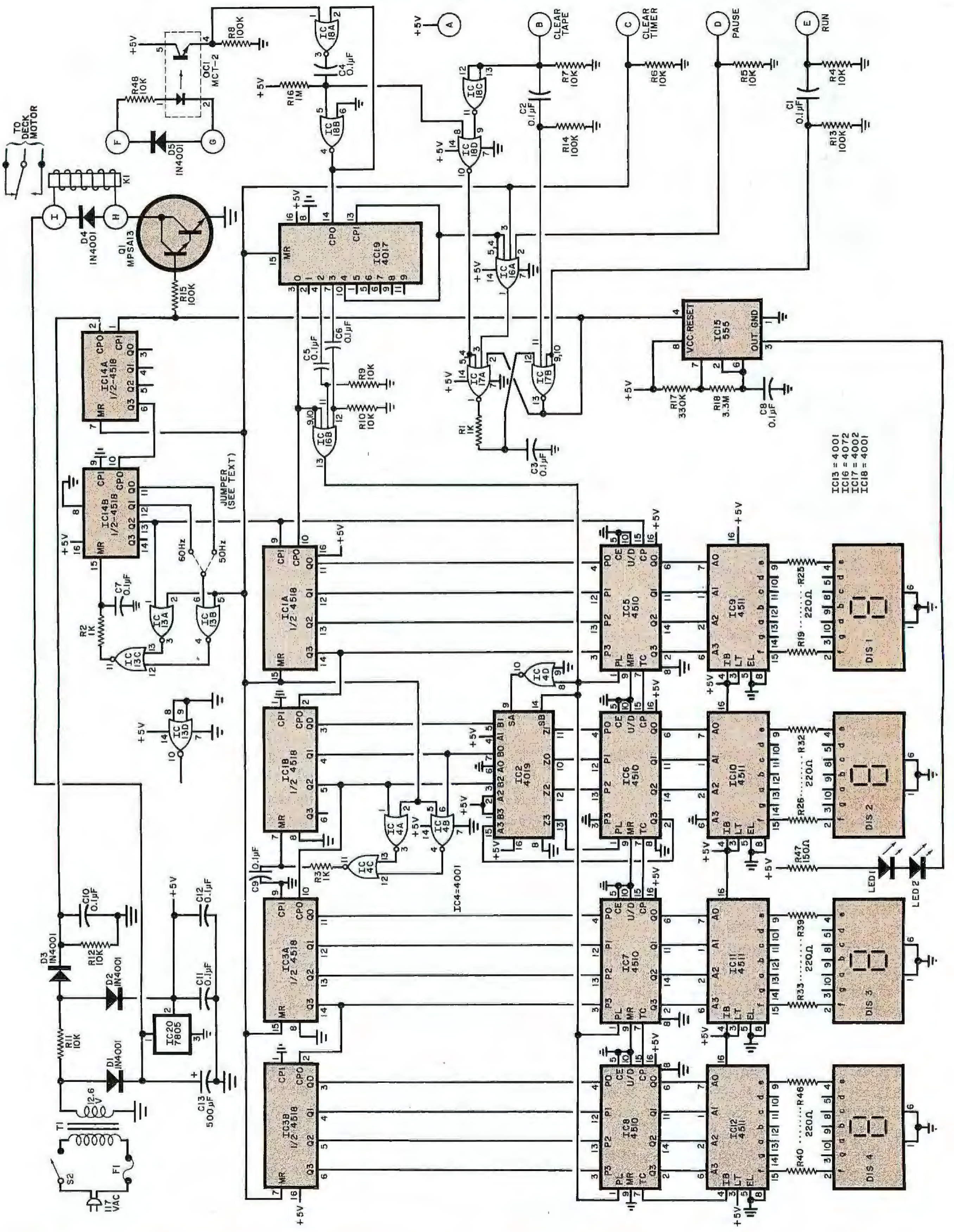


Fig. 2. Schematic diagram of 8TT. CMOS logic is used throughout.

trolytic filter capacitor in the power supply, is located on the display board, but is mounted on the foil side. This allows the vertical display board to fit flush with the front panel of the project enclosure. If the line frequency of the available power source is 60 Hz, use a jumper to connect pin 12 of *IC14B* to pin 6 of *IC13B*. If a 50-Hz ac source is used, the jumper should interconnect pin 11 of *IC14B* and pin 6 of *IC13B*.

Mount the logic board on spacers at least 2″ high so that power transformer *T1* can be mounted directly beneath it. The regulator IC (*IC20*) should be mounted directly to the project enclosure to provide heat sinking. Be sure to add a thin layer of silicone heat-sink compound to improve thermal transfer between the IC package and project enclosure. A 1″ × 2½″ (2.5- × 6.4-cm) rectangular hole should be cut into the project enclosure's front panel for the digital display. To increase the legibility of the display, affix a red filter to the back side of the front panel using epoxy or similar adhesive.

The tape deck to be controlled must be slightly altered (see Fig. 6). Mount relay *K1* inside the deck enclosure at a convenient location. Cut one of the power leads running to the motor. Connect one end of the severed lead to the normally closed contacts of the relay and connect the other end to the relay's pole. The coil leads will be connected to a jack to be described shortly.

Now locate the track-changing solenoid. When a track change occurs, dc voltage will be momentarily applied across the solenoid. The polarity of this applied voltage must be determined. This is most easily accomplished by means of an oscilloscope or voltmeter. With the meter or scope probes connected across the solenoid, depress the deck's program or track change pushbutton and note the meter's (or scope trace's) deflection. Compare this with the polarity of the probes and determine which side of the solenoid becomes positive with respect to the other. Mark this lead with a small flag of vinyl tape.

Make a hole on the tape deck's rear apron large enough to accommodate a chassis-mount, 4-conductor female connector. Install this connector and solder the leads from the track-changing solenoid and relay coil to the connector lugs. An identical connector should be in-

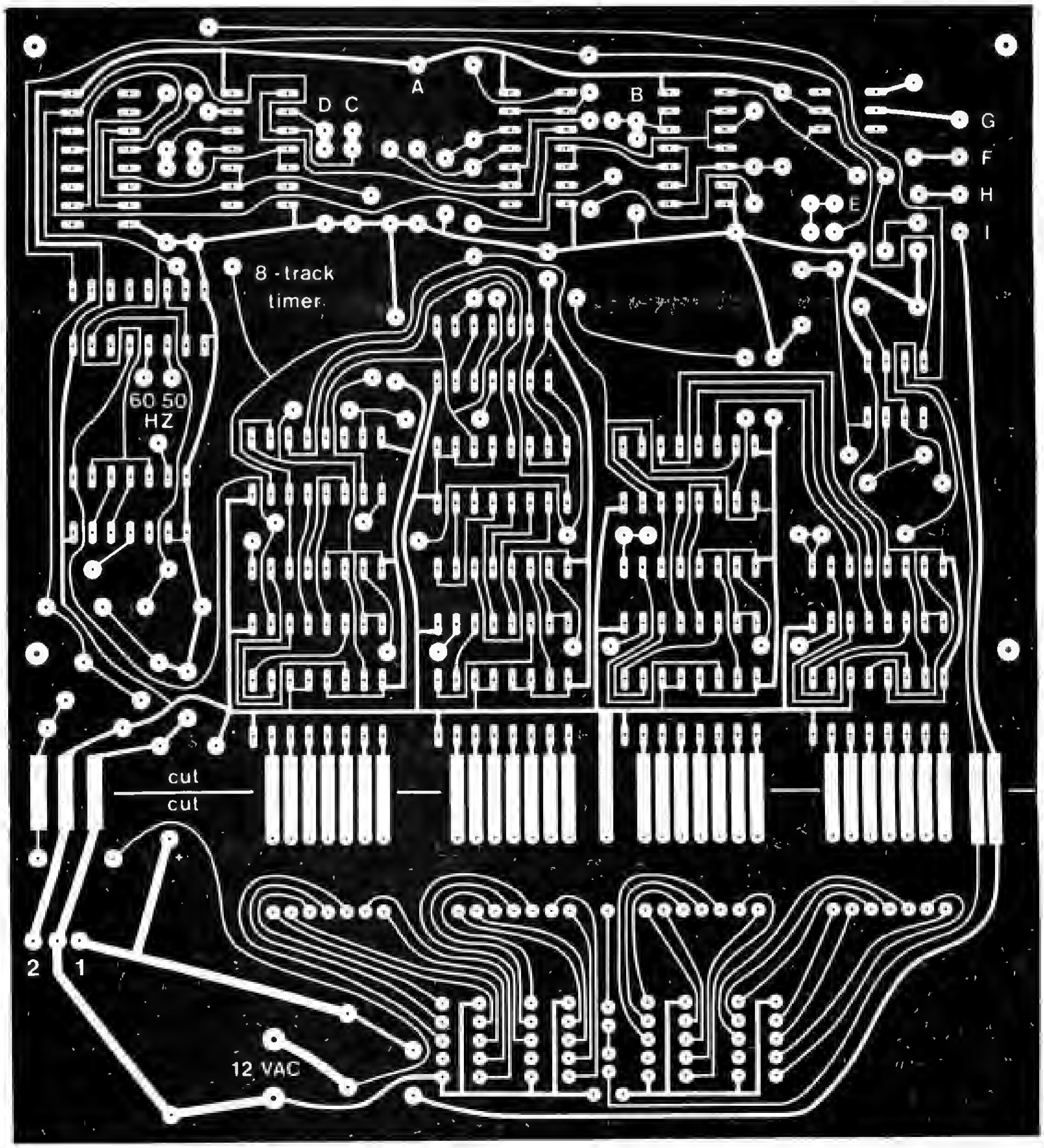


Fig. 3. Actual-size foil pattern for the 8TT's single pc board.

stalled on the rear apron of the 8TT enclosure and appropriate leads from the pc board soldered to it. Be sure that the connections to this second jack match those made to the first. The circled-letter markers on the schematic correspond to the designated foil pads on the project's printed circuit board.

For convenience, protective diodes *D4* and *D5* can be soldered to the lugs of one of the female connectors—either the one mounted on the rear apron of the project enclosure or that installed on the rear apron of the 8-track tape deck. Prepare a 4-conductor cable of a length sufficient to interconnect the project and tape deck. Solder the cable conductors to the lugs of male connectors compatible with the rear-apron female connectors. Take care to solder each conductor to the identically corresponding lug on each connector.

Flexible hook-up wire should be used to interconnect the main circuit board and rotary switch *S1*, the rear-apron connector, and the off-board power supply components. Rotary switch *S1* should be wired so that there are two adjacent PAUSE positions between the RUN and CLEAR TIMER positions. This minimizes the possibility of inadvertently entering the CLEAR TIMER mode (which would erase the information stored in the 8TT latch) when a switch to the RUN position was actually intended.

Testing and Use. Interconnect the 8TT and tape deck with the 4-conductor cable that you have prepared. Insert a tape cartridge into the deck and apply power to both the 8TT and the deck. Then place rotary switch *S1* in its CLEAR TIMER position. If all is well, the deck motor will stop turning, the display will read 0:00 and the display colon will blink on and off at a 2-Hz rate. Switching to the PAUSE position will cause no change. Placing the 8TT in its RUN mode, however, will cause the deck motor to start running and the display to function as an elapsed-time indicator. The display colon will glow steadily.

After approximately one minute of running time, make a mental note of the interval indicated by the display and depress the tape deck's track change pushbutton switch. The elapsed time indicated by the display will begin to decrement toward 0:00. Depressing the track-change pushbutton twice more will initiate the same count-down sequence, starting each time at the first track's running interval.

If you find that track counter *IC19* has trouble following the track state, decrease the value of *R48*. This will allow more current to flow through the LED in optoelectronic coupler *OC1* and provide stronger pulsing of the internal phototransistor. If the problem persists, doublecheck the wiring associated with the optocoupler and the solenoid to ensure that the voltage applied across the LED is of the correct polarity.

Depress the track-change pushbutton switch one more time. The 8TT will interpret this to mean that the tape has ended and will turn off the deck motor, cease timing, and cause the display colon to blink on and off. Any further depression of the track-change pushbutton will be ignored by the 8TT.

Once these operations have been verified, place rotary switch *S1* in its CLEAR TAPE position. The deck motor will then begin to run but will be shut off at the first change of tracks. Place *S1* in its CLEAR TIMER position and then in its PAUSE position. Prepare the cartridge for recording as required by your deck and you're ready to go.

Employ the 8TT's PAUSE mode when you want to stop recording momentarily. By keeping an eye on the 8TT's display, you will be able to interleave the program material neatly between the track-change interruptions.

If you want to use your tape deck without the assistance of the 8TT, simply remove power from the project by opening toggle switch *S2*. Although the deck has been modified in that the 4-conductor female connector and relay *K1* have been installed inside it, the deck is unaltered electrically. This means that the deck will function normally with the 4-conductor umbilical cable disconnected. Practically speaking, you can even leave the

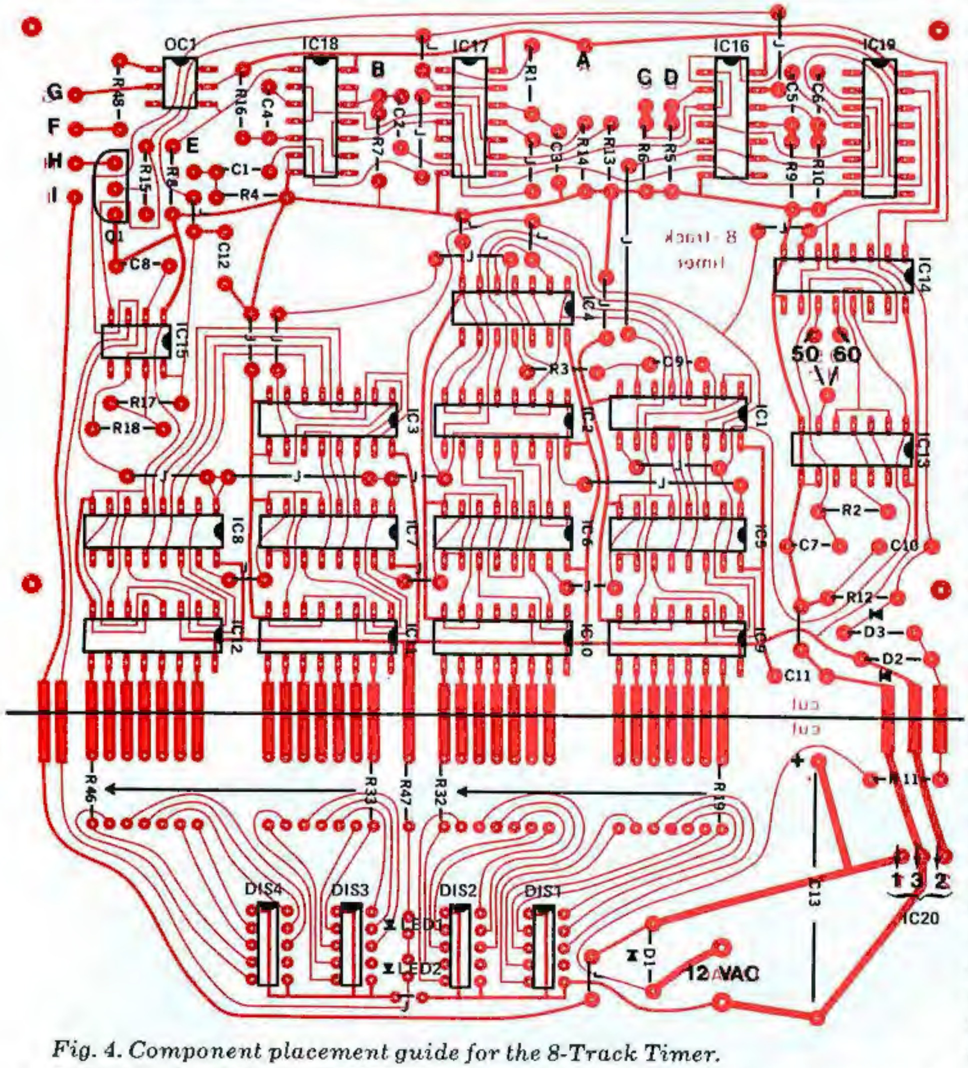


Fig. 4. Component placement guide for the 8-Track Timer.

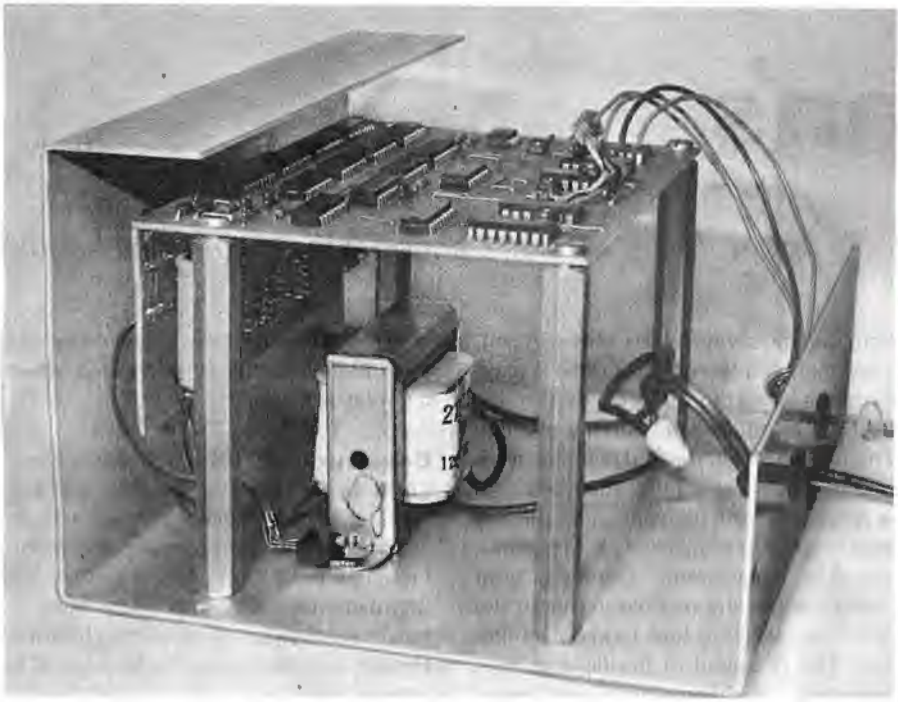
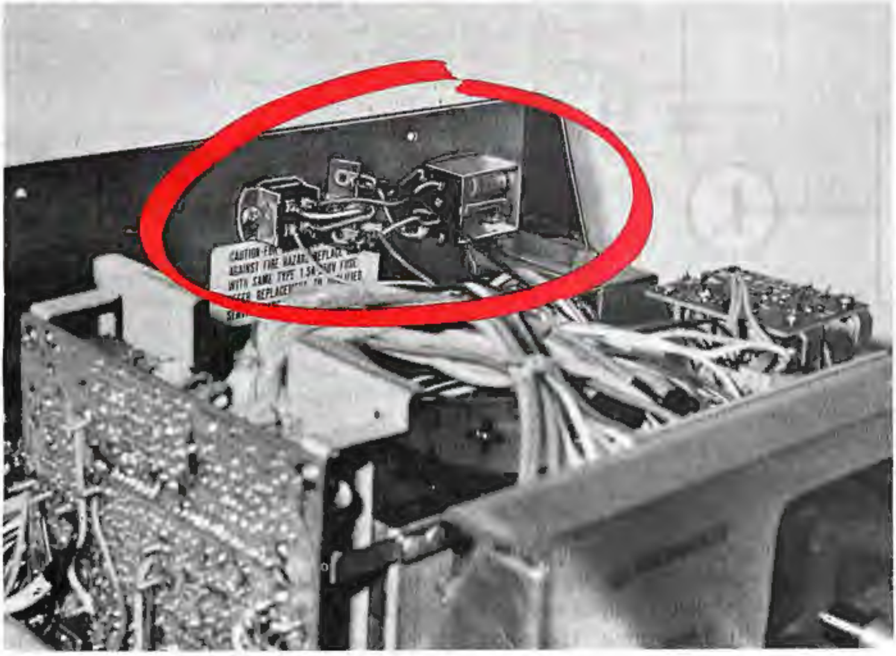


Fig. 5. Interior view of author's prototype reveals printed circuit board mounting details.

Fig. 6. View of tape deck shows how relay and connector were mounted on deck's rear apron.



cable connected to both units. As long as the 8TT's power switch is in its OFF position, the deck will behave as if the 8TT were not connected to it. Also, because the interface between the deck and timer consists of a relay and optoelectronic coupler, there is no possibility that hum will be introduced into the deck by the 8TT.

One word of warning: fluctuations in tape speed, caused either by worn componehts in the deck's transport or by a binding tape cartridge will make the indications given by the 8TT misleading (if not useless). For best results, make sure your tape deck is in good working order and that the cartridges you use are in good condition. ◇