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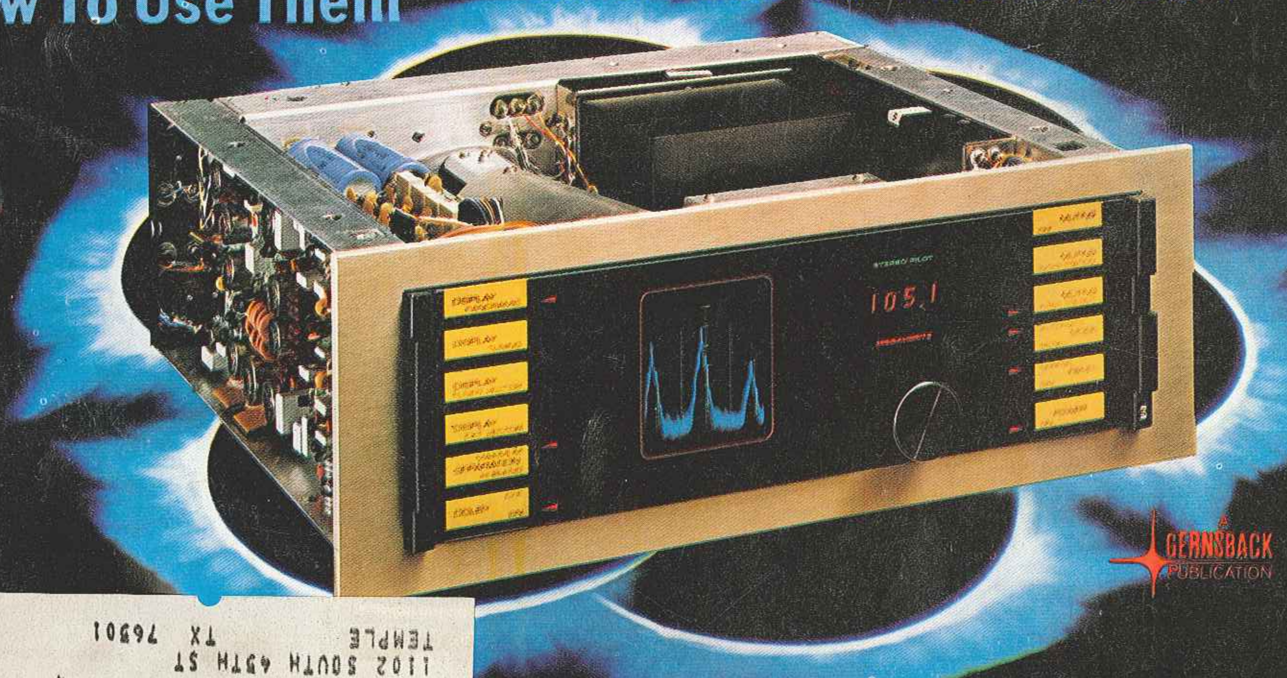

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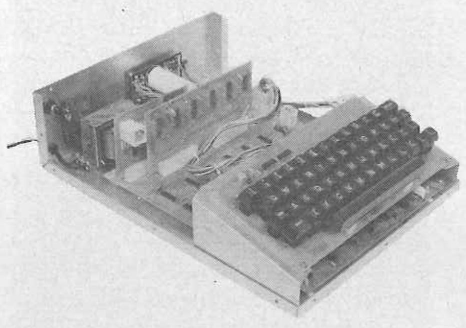
TV TYPEWRITER II

by ED COLLE

Build this new TV Typewriter. It has many new features including plug-on option boards

IN LAST MONTH'S ISSUE OF **Radio-Electronics,** we presented the schematic diagram and a generalized description of the TV Typewriter II. This month, the article will continue with a technical description of how the circuit works plus some of the foil patterns for the circuit boards.

The entire circuit is built on one double-sided printed circuit board with the exception of the memory and option boards that plug perpendicularly onto the main board. The total size including the plug-on options is 12" long × 9¾" wide × 3½" high. The circuit boards are double-sided, with plated-through holes, eliminating a good many jumpers. It is not the sort of project to be attempted by the inexperienced beginner, but the experienced hobbyist should have little trouble.



How it works

The entire screen of the video display has been arranged for 16 lines of 32 characters each. Although the second page of memory allows twice as many characters to be stored in memory, only one page can be displayed at a time. Each character displayed is actually an array of 35 dots arranged in a 5 × 7 pattern—5 horizontal and 7 vertical dots. The 2513 character generator decodes the binary ASCII data provided at its input terminals from memory into the correct dot patterns for the character to be displayed. The dots are selected and used one character row at a time since television receivers sweep the trace horizontally one video line at a time. Horizontal spacing between characters is provided by displaying a blank dot column between each displayed character and vertical spacing is provided by sweeping three blank video lines between each set of seven "character dot video" lines. This means our vertical data is 10 lines/character × 16 character row = 160 "character-dot video" lines. Our television or video monitor also requires a vertical and horizontal sync pulse in addition to the actual video data, so the TV typewriter must generate these signals too.

The timebase oscillator initiates the horizontal sync pulse and starts the chain of events that generate one line of video data to be displayed. The circuit itself is a phase-locked-loop (PPL) used as a frequency multiplier. IC1 is used as an astable voltage controlled oscillator with bipolar transistors Q3 and field effect transistor (FET) Q4 along with C12 forming a sample-and-hold circuit that feeds IC1's voltage control input through FET Q5. The sample-and-hold in this case is being used as a phase comparator providing an output voltage proportional to the phase difference of the 60-Hz power line and the multiplied output frequency of IC1. The actual amount of frequency multiplication is equal to the amount of frequency division between the output of the oscillator IC1 and the input reference frequency. As we will see later, the value of the frequency divider is 262, and since our reference is 60 Hz the f_o = 60 Hz × 262 or 15720 Hz which is very close to the horizontal oscillator frequency of a standard television set.

The output of IC1 is fed via inverter IC20-d to IC9-a and b where among other things a 4-μs horizontal sync pulse is generated. From here the pulse is routed to IC17-a where it is OR'ed with the vertical sync pulse which will be described in detail later.

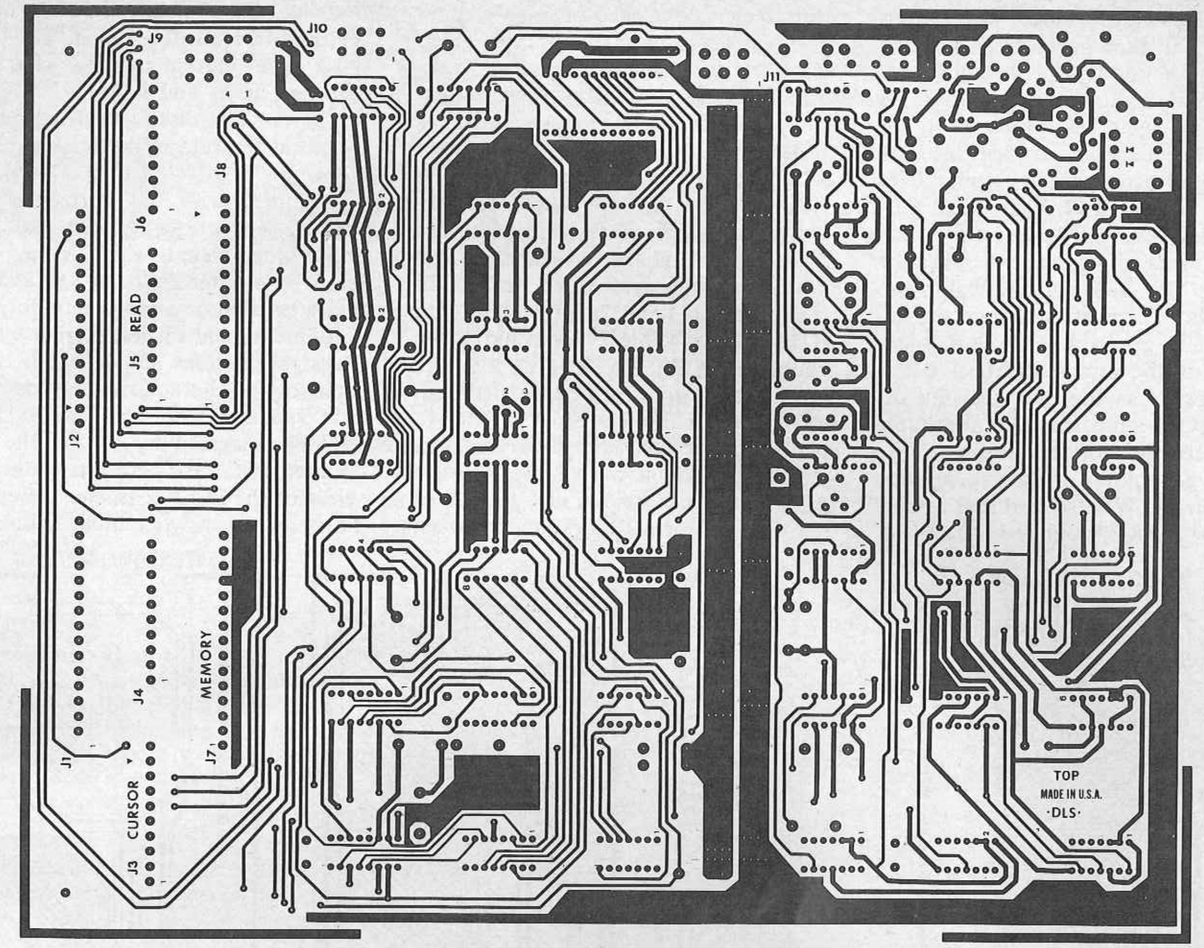
The falling edge of this sync pulse at the output of IC19-b triggers IC18-a, a one shot, which puts out a positive pulse on pin 4 that can be adjusted by potentiometer R4 from 4 to 20 μs. The delay pulse creates a lag between the television's start of video sweep and the TV Typewriter's generation of data, thus giving an adjustable left margin. Pin 4 of IC18-a inhibits dot oscillator IC18-b through AND-OR-INVERT gate IC11-a. Pin 13 resets IC21 and IC14, the 16-bit counters that keep track of the selected horizontal character. Since we are just starting a new line, we must first clear the counter to prepare it for incoming data. At the end of a high-to-low transistion of pin 4, IC6, the row counter is incremented and if there is a RIPPLE CARRY, IC7, the line counter is incremented as well.

The row counter, IC6, is a decade counter that keeps track of each of the ten horizontal lines forming a character row. Remember, we said earlier that each character would be formed by 7 vertical dot rows and three blank lines for vertical spacing, well, IC6 has a distinct BCD output for each of these 10 lines and tells the rest of the circuitry which of the 10 lines it is generating.

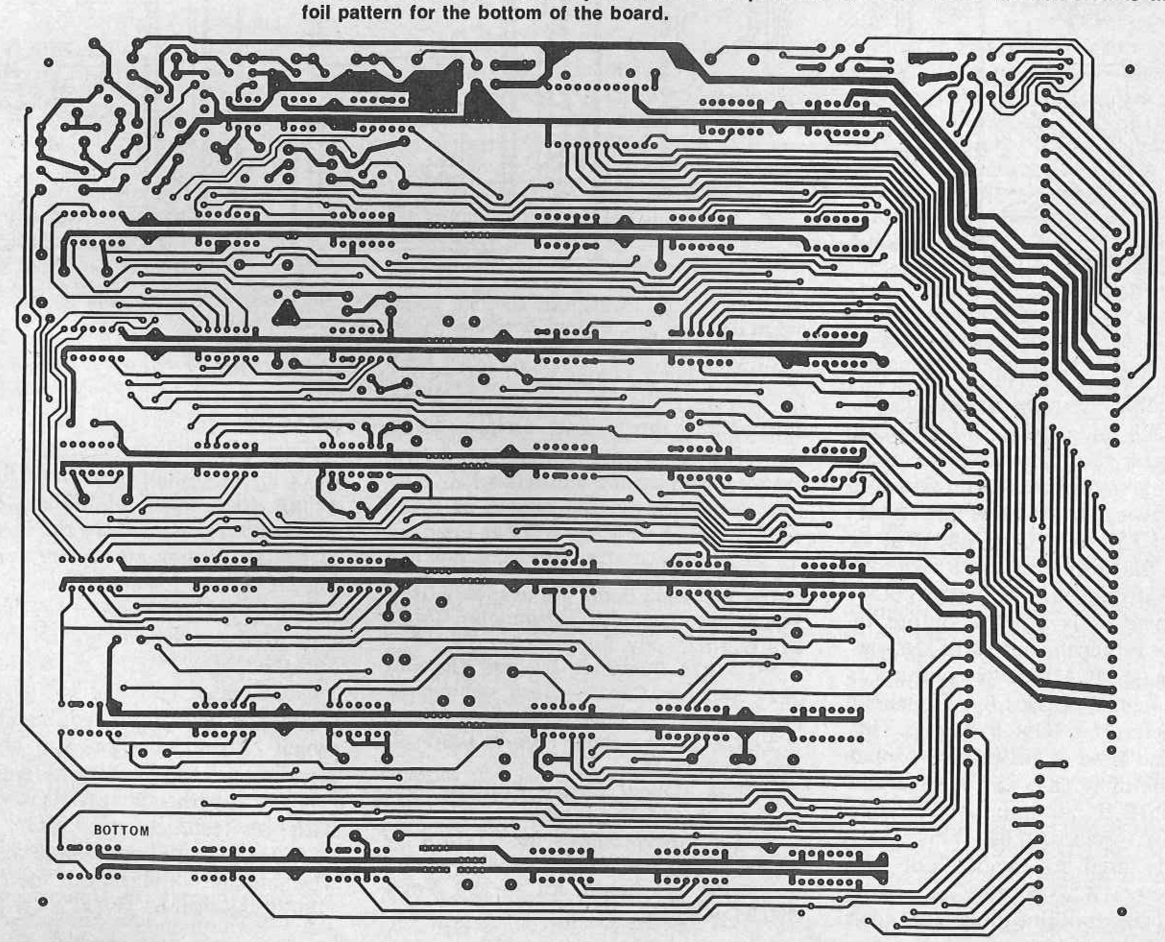
Since we also have 16 sets of these ten lines, one for each of the 16 character rows, we must have the 16-bit counter, IC7, to tell the rest of the circuitry which of the 16 character lines it is displaying. Together, IC6 and IC7 provide a unique BCD code for each of the 10 × 16 = 160-dot video scan lines.

Now for those of you who are familiar with television circuits, you probably know that we need more like 262 lines and not 160 for a complete frame and since our scan line counter composed of IC6 and IC7 is only good to 160, we let it continue to count past 160 which is essentially the same as resetting the counter at 160 since the bit pattern is the same. Flip-flop IC4-b has been in the Q output = 1 state during the last 160 video data lines and is now toggled through AND gate IC5-a and NAND gates IC19-c and IC13-a. When IC4-b toggles the Q output goes low which instigates a sample command for the sample-and-hold portion of the timebase oscillator which was described earlier. It also activates the video blanking circuit feeding the 2513 character generator. This simply forces the generation of all blanks from the character generator as long as the Q output of IC4-b is low.

This mode continues line by line until the line counter reaches a count of 40. Lines 40 through 50 are then used to generate the vertical sync pulse required by the TV set. NAND gate IC13-b along with inverters IC20-a, b, and c perform the actual line number decoding. Note that the output of the timebase generator is NAND'ed as well in IC13-b along with the line counter data. This chops the vertical sync signal as required by the television. The output of IC13-b is then fed along to IC17-a where it is combined with the horizontal sync signal to form the composite sync signal at the output of AND gate IC17-a. At line 50, the vertical sync generation is stopped and the line and row counters continue to count to 102 which is decoded by IC13-a. Note that the Q output of IC14-b is NAND'ed as well by the decoder IC13-a, since the 102 count is not significant when in the



MAIN CIRCUIT BOARD FOIL PATTERN shown half-size. This printed circuit board is a double sided board. The foil pattern for the top of the board is shown above. Below is the foil pattern for the bottom of the board.



"display dot video" mode. The output of IC13-a in turn generates a positive clock pulse to IC4-b through AND gate IC5-a, making the Q output of IC5-a high again; as it was when we started. The same signal from the output of IC13-a resets row counter IC6, and line counter IC7, back to 0, thus completing the 262-line/frame cycle of 160 lines of video, 40 lines of blanking, 10 lines of vertical sync, and 52 more lines of blanking.

Now let's get back to the horizontal portion of the circuit again. We left off earlier by saying that one-shot oscillator IC18-a, provided an adjustable delay between horizontal sync pulse and the generation of data to provide a left margin. We also said that astable oscillator IC18-b, inhibited during this delay phase via IC11-b, is the dot generator that actually clocks off the dots for each line of video which form the character. So from here we may continue by saying that potentiometer R6 sets the cycle time for this oscillator from 150 to 300 ns, and that in turn sets the horizontal width of the characters displayed. The "DOT CLOCK" output however is not the output of IC18-b but rather the output of AND-OR-INVERT gate IC11-a. Its output is normally high, but goes low for about 30 ns each time IC18-b resets. This 30-ns pulse time is set by the propagation time of IC18-b and IC11-a and is very hard if not impossible to see with most oscilloscopes. This "DOT CLOCK" is used to toggle "dot bit" shift registers IC23 and IC24.

The horizontal dot data for each character is composed of five dots and one blank for spacing on each video scan line for each of the seven vertical character data lines. Then three completely blank lines are scanned for vertical spacing followed by the next set of character data scan lines. The video dot data for the horizontal portion of each character is parallel loaded from the 2513 character generator into 4-bit shift registers IC23 and IC24 with zero, bit 1, bit 2, bit 3 going into IC23 and bit 4, bit 5, zero, and a one going into IC24.

The serial input of IC24 is tied high to load one's into the shift register in place of the character data as it is shifted bit by bit out of the register. IC25 monitors the parallel output of the dot register and goes low when six bits have been clocked out. It senses by detecting the one's that have been shifted into the register serially while the significant dot data was being clocked out by the "dot clock." This low transition on the output of IC25 which is inverted by IC12-b changes the dot register from the shift-up to the parallel-load data mode. The same pulse also increments the character counters, IC21 and IC14.

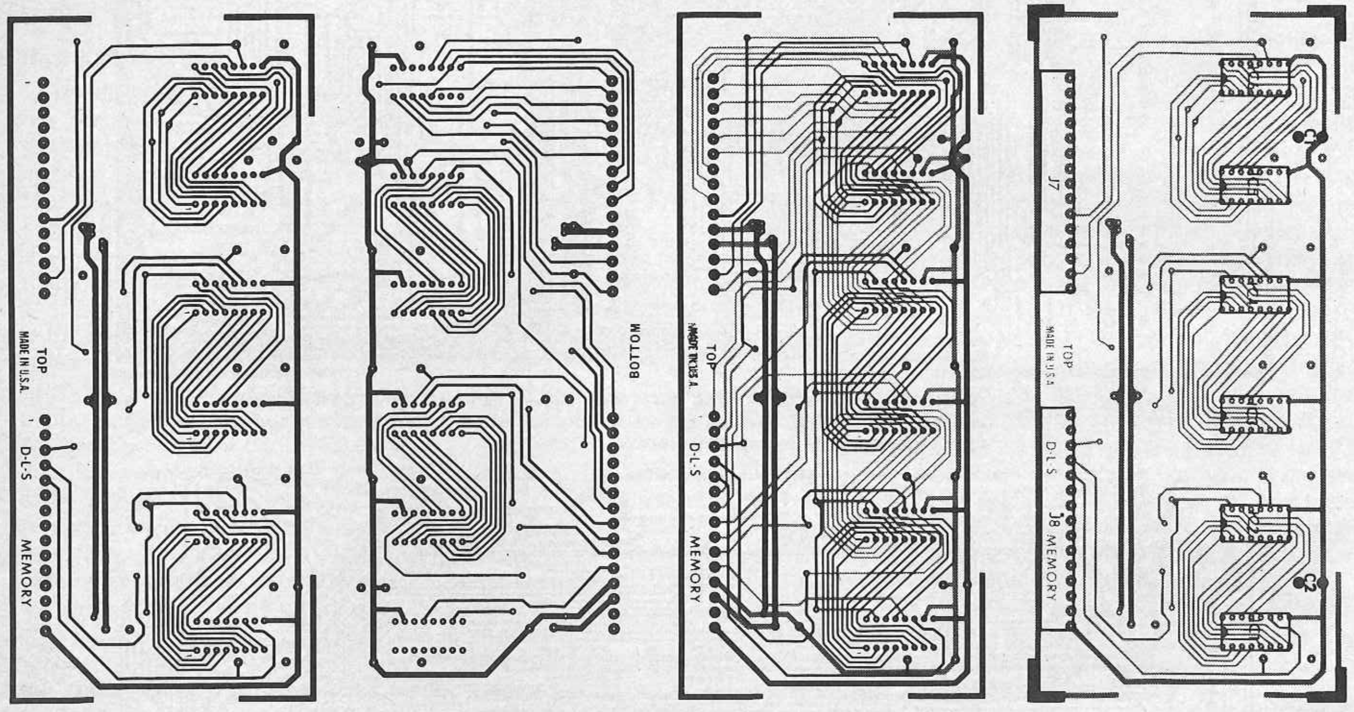
The dot data itself is shifted out bit by bit, at the rate set by the dot clock, from pin 10 of IC23 to IC17-b where it is mixed with the horizontal and vertical sync pulses to form the composite video signal, which is then buffered by emitter follower Q1 and fed to a television or a video monitor.

As mentioned earlier, there are three blank scan lines displayed between each row of characters to provide vertical spacing. The first line, a BCD "0," is generated by having the row counter, IC6, feed zero bits to the row select of the 2513 character generator. Then as the row counter counts off rows 1 thru 7, rows 1 thru 7 of the character are decoded and processed, but when IC5-b sees the 8 and 9 counts of the row counter through IC12-a, its output goes low thus enabling the video blanking circuitry which forces all zeros to the row select of the 2513 character generator creating the other two blank lines.

Going back to the dot register now, note that each time pin 6 goes high and the dot register is set up to parallel load, new data and IC14 is incremented as well thus keeping track of which of the 32 horizontal character positions we are working with.

Next month, the article concludes with the technical description of the circuits and the construction details. The schematic diagram of the memory circuit will also be given.

(continued next month)

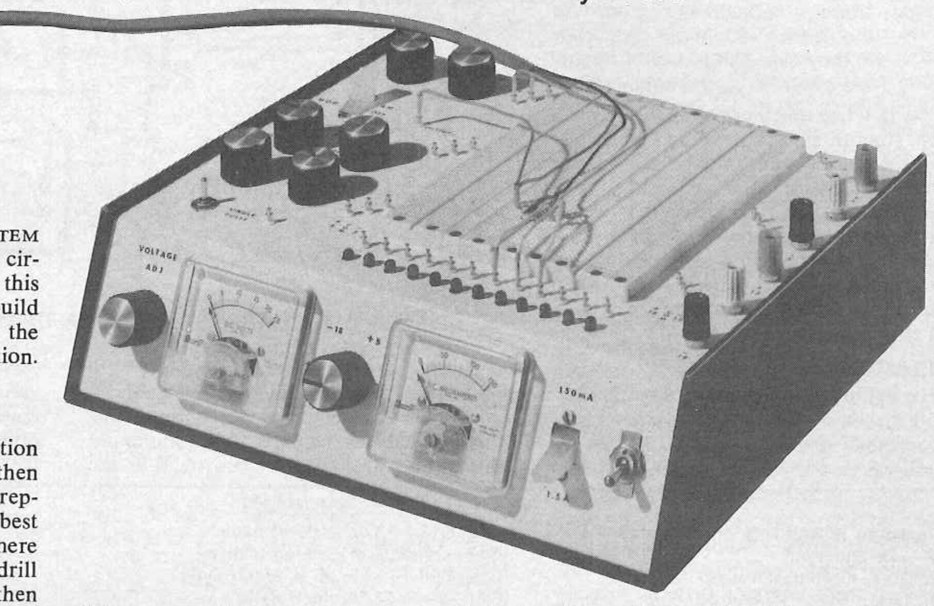


HALF-SIZE FOIL PATTERNS OF THE MEMORY circuit board. The patterns are, going from left to right, the top, bottom, combination, and component layout.

Build this IC Breadboard System

Use it to design your own circuits. It contains its own power supplies, signal generator and LED monitor. It's a lab-quality instrument that can save many hours

by C. D. WADSWORTH



VERSATILE IC BREADBOARDING SYSTEM will aid you in designing your own circuits. Here is the second part in this series of articles describing how to build your own. Last month we presented the schematic and a technical description. Now for the construction details.

Construction

Be sure to read all of the construction information before you start and then break it up into parts (i.e.: cabinet preparation, PC board, wiring, etc.) that best suit your situation. A wrong step here can cost time and money—if you drill holes for the specified LED's and then find something better but the holes are too large.

All of the circuits for this project are laid out on one printed circuit board and shown in Fig. 7 with the parts layout shown in Fig. 8. Figure 9 shows the circuit board divided into the various circuits. The layout is rather tight so rather than the standard assembly procedure of installing the resistors and capacitors first, it is suggested you leave the capacitors until last. Of course, additional care should be taken when soldering the capacitors to prevent excessive heat on the IC's and semiconductors.

The resistors in the LED driver circuitry are ¼W and mounted on end. Although this procedure doesn't seem to conserve a great deal of space, the space that is saved is critical and allows all of the circuitry to be placed on one pc board. For this reason it is strongly suggested you use the pc layout provided rather than attempt construction using standard perforated board.

All wiring interconnections for the function generator should be kept as short as possible, to 2 inches if you can. Capacitor C2 is utilized to reduce the inherent problems of longer wiring runs, but nothing works as well as short wire.

In this construction it might be beneficial to lay out the entire cabinet, drill all the holes, deburr the holes, repaint the cabinet to cover any imperfections, lay on the lettering or legends, spray the cabinet with clear plastic to protect the letters and legends, and then attach switches, meters, breadboard sockets, etc. A little planning will make a much more professional looking finished product. It is a real pleasure to work with well designed equipment and it improves your work attitude and consequently improves the circuits you are designing.

The cabinet shown in the accompanying pictures is a BUD cabinet #SC-12101 and measures 2⅞ in. high by 12 in. wide by 10 in. deep. This allows enough room for the PC board, transformers, etc. but there isn't too much space left over so it is suggested you place the transformers and circuit board in the cabinet as far to the rear as possible and then mark the cabinet base for drilling. Don't forget, the leads to the function generator should remain as short as possible so you will want to position the PC board so the function generator section is going to be close to the function generator control switches on the cabinet top. Also, the power cord and fuse holder will be in the rear of the cabinet and inside space must be allowed for these items.

Two types of outputs are provided on the cabinet for the two dual power supplies. Six 5-way binding posts so these supplies can be used for projects other than breadboarded circuits, and 18 low profile feed-through pins for breadboarding connections. These low profile pins are rather expensive but ideal for this purpose as they reduce cabinet clutter and direct wire connections can be made without the need for alligator clips. These pins are also used for the outputs from the function generator, pulse generator, and the inputs to the LED displays. These pins can be forced into a .136" hole (No. 29 drill) that provides a secure fit without further worry.

The plastic encapsulated LED's were mounted in the cabinet the same way as the low profile pins. Drill a .201" hole (No. 7 drill) then press fit the LED up from inside the cabinet. I used a long narrow strip of perforated board (0.1 centers) to keep the LED leads separated and for stability and support.

When you mount any of the multi-deck switches and the meters on the front panel, remember the panel is at an angle so you will have to drill your holes high enough so the lowest point of the switch or meter inside the cabinet will clear the bottom of the cabinet after assembly.

The pass transistors for the dual power supplies are mounted on the back panel of the cabinet which acts as a reasonably good heat sink for these transistors. Remember, the case of the transistor is the collector connection so don't forget to use your mica insulators and your plastic or mylar washers on the machine screws. A good heat transfer compound is recommended.

There is a considerable amount of wiring in this project and lacing the different wiring sections is almost a must, especially if you ever plan to repair the unit or if you are justifiably proud of your