BUILD THIS

This new TV Typewriter is primarily designed around TTL logic and provides the builder with many plug-on option boards. The options include a manually operated cursor control, computer operated board and much more

by ED COLLE

TV TYPEWRITER II

AFTER SEEING THE OVERWHELMING response shown for the TV typewriter story featured in the September 1973 issue of **Radio-Electronics** magazine, it is obvious that there are many readers interested in these units. As described in the previous article, there are many uses for a display such as this with the possibilities limited only by the imagination of the user.

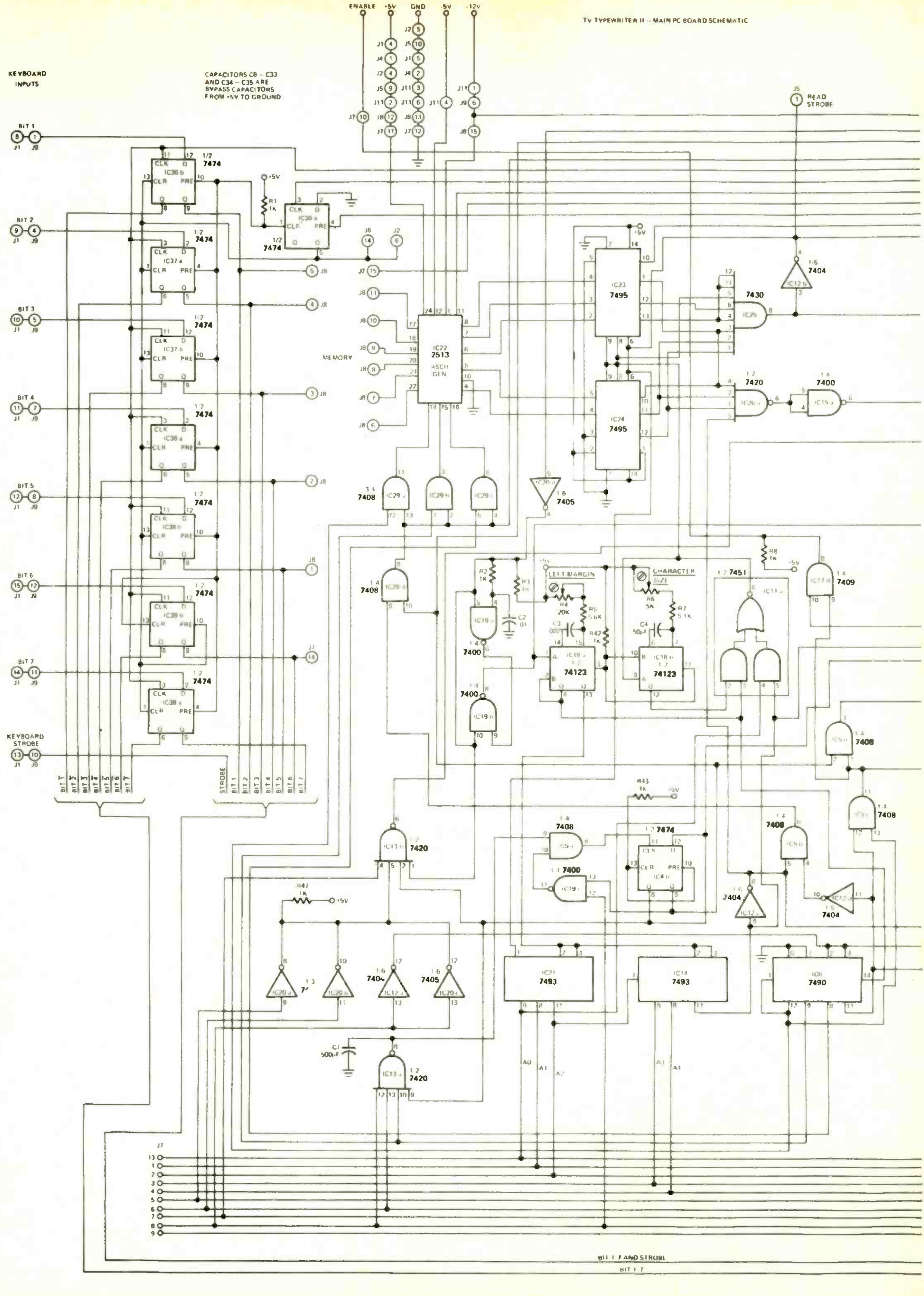
One of the biggest applications of these units, however, is for data communications with computers. Combined with a keyboard, we have one of the fastest and most efficient means for an individual to communicate with a machine. An excellent example is the Mark-8 minicomputer shown on the front cover of the July 1974 issue of **Radio-Electronics** magazine. You can be sure that more powerful and more economical units will follow. Then of course, if you don't have or don't want your own machine, you can always tie into a full size time-shared system, assuming you have access to one.

If you tried to build the terminal in the September 1973 issue, you probably discovered as many did that although the printed circuit boards were commercially available, some of the semiconductor chips were rather difficult to get. For this reason, this terminal has been built using 74 series TTL IC's that are common, easy to get, and inexpensive. The only MOS chips used are 2102 RAM's (Random Access Memories) and a 2513 character generator. And just to make things really easy, the unit is available as a complete kit including circuit boards, IC's, discrete components, interconnectors and optional power supply. A cabinet, however, is not being made available at this time. Since in most cases you will want to use the TV typewriter in combination with a keyboard of some kind to enter messages, the supplier of the TV typewriter is making available a low-cost compatible keyboard/encoder too.

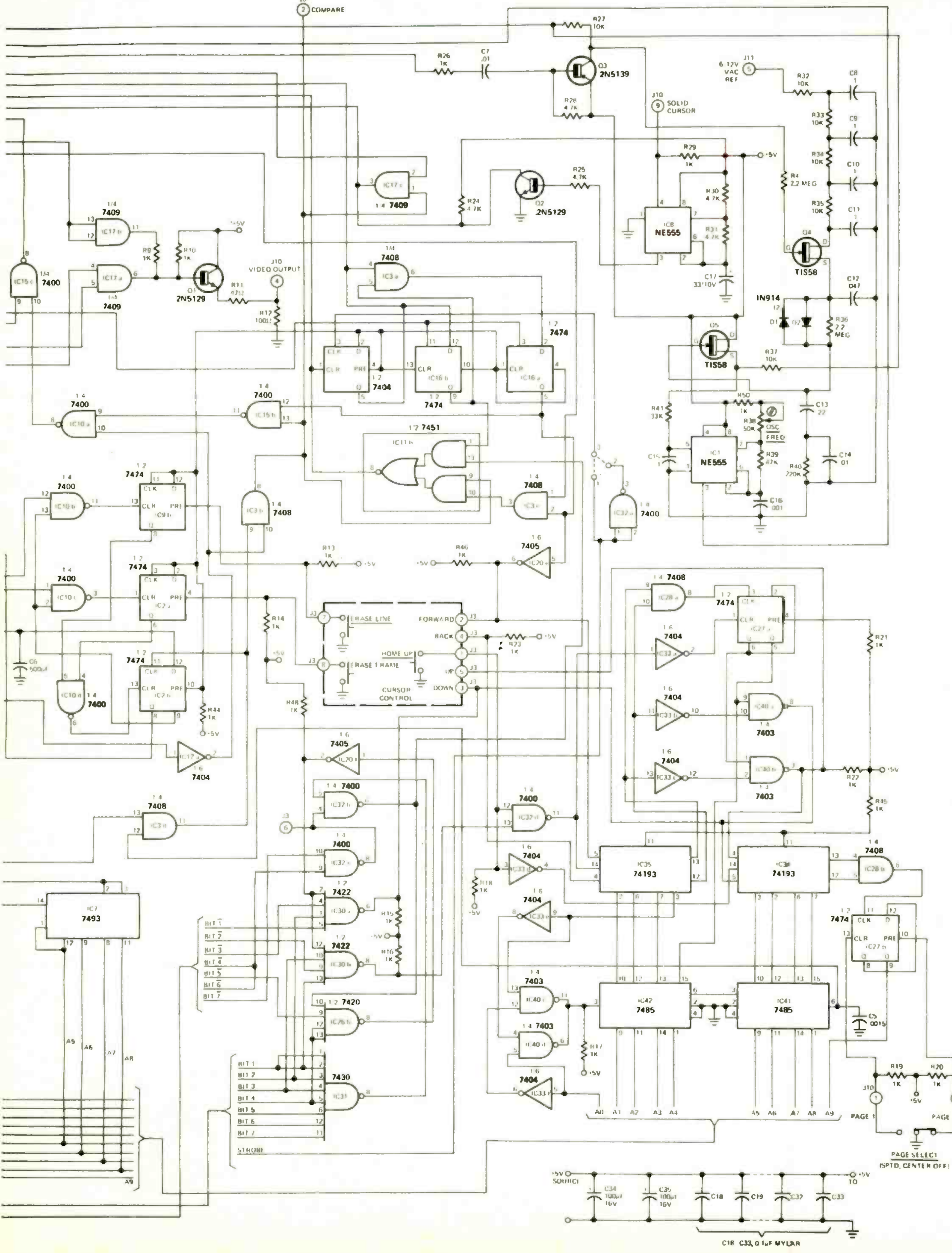
To make the unit as flexible as possible, extra effort has gone into designing plug-on options including a manually operated cursor control board, a computer operated plug-on board, screen read board and a URT communications board.

(text continues on page 30)
(complete schematic on pages 28 & 29)

TV TYPEWRITER II – MAIN PC BOARD SCHEMATIC



COMPLETE SCHEMATIC of the TV Typewriter is shown. The circuit is primarily designed around TTL logic.



SPECIFICATIONS

DATA FORMAT	1024 characters arranged as 2 pages of sixteen lines of 32 characters each.
OUTPUT	2.25-volt video pulse — 1-volt sync pulse compatable with the video input of a standard television or video monitor. The display's response must be to 1.6 MHz for maximum character size and to 3 MHz for minimum character size and should be flat to 4.5 MHz for best appearance.
INPUT	7 bit parallel ASCII positive logic with a key-press strobe that may be either positive or negative going.
CONTROLS	Page select Home up (moves cursor to upper left hand corner) Erase to end of line Erase to end of frame Cursor on off Line feed Carriage return Adjustable left hand margin positioning Adjustable character size
POWER REQUIREMENTS	5 Vdc, 2A, 5% regulation; —5 Vdc, 15mA; —12 Vdc, 20mA.
SIZE	12" long × 9¾" wide × 3½" high.
ACCESSORIES	Manual cursor control board. Computer cursor control board. Screen read board (allows transfer of accumulated data to an outside device — should be used with the cursor control and URT boards). URT board (receives and transmits data in RS 232 format using 7 bit ASCII code at 110, 220, 440, or 880 baud or if a different crystal is used 150, 300, 600, or 1200 baud).

1. **Cursor control (manually operated)** allowing the operator to position the cursor anywhere on the screen by using a set of switches similar to the keyboard switches.
2. **Cursor control (computer operated)** allowing the operator to position the cursor on the screen by sending commands to the display through software.
3. **Screen read** allows the user to edit all of the information on the screen using the cursor control board and then to send all of the accumulated data out to some external device using URT board, or as parallel data directly to a computer.
4. **URT board** receives and transmits data in RS 232 format using a seven-bit ASCII code. Baud rates can be multiples of either 110 or 150 depending upon a choice of crystals, up to 1200 baud.

The basic character organization is very similar to the original TV Typewriter, in that there are sixteen lines of 32 characters, however, this unit has a second page of memory as part of the basic unit rather than as optional accessory, providing a total character memory of 1024 characters.

Since the FCC is very rigid in their requirements for transmitters in the television frequencies, the unit has been designed to be connected directly to the input to the video amplifier of a standard television set.

Although any set may be used, the small-screen black and white portables give the best picture. The connections are simple and a jack can be provided to allow switching between terminal and normal television operation.

Automatic carriage return is provided after the last character of each line, returning the cursor to the beginning of the next line. Unless switched off, a blinking cursor always shows where the next character is to go and you have the option of writing on either one of two pages of memory which are independently selected and displayed on the screen, through the PAGE SELECT switch. This same switch also provides automatic carry-over of the cursor from one page to the other when the end of frame is reached; or when selected, automatically performs a "home up" (return to line 1— column 1) of the same page. Erase to end of line (EOL) and erase to end of frame (EOF) functions are also provided. When enabled, they perform the erase function from the cursor location on the page selected. Line feed and carriage return are provided as well; with a line feed being a binary 0001010 or a control J, and a carriage return as a binary 0001101 or a control M.

Next month's issue will contain the construction details and foil patterns plus a detailed description of how the unit works.

PARTS LIST TV TYPEWRITER

PARTS LIST — MAIN BOARD

IC1, IC8 — NE555 timer
IC2, IC4, IC9, IC16, IC27, IC36, IC37, IC38, IC39 — 7474 dual "D" flip flop
IC3, IC5, IC28, IC29 — 7408 quad AND gate
IC6 — 7490 decade counter
IC7, IC14, IC21 — 7493 4 bit binary counter
IC10, IC15, IC19, IC32 — 7400 quad NAND gate
IC11 — 7451 dual AND-OR-INVERT gate
IC12, IC33 — 7404 hex inverter
IC13, IC26 — 7420 dual NAND gate
IC17 — 7409 quad AND gate (open collector)
IC18 — 74123 dual one shot
IC20 — 7405 hex inverter (open collector)
IC22 — 2513 ASCII character generator
IC23, IC24 — 7495 4 bit shift register
IC25, IC31 — 7430 8 input NAND gate
IC30 — 7422 dual NAND gate (open collector)
IC34, IC35 — 74193 4 bit up/down counter
IC40 — 7403 quad NAND gate (open collector)
IC41, IC42 — 7485
R1, R2, R3, R8, R9, R10, R13 to R23, R26, R29, R42 to R49 — 1000 ohms, ¼-watt carbon
R4 — 20,000 ohms, trimmer
R5 — 5600 ohms, ¼-watt
R6 — 5000 ohm trimmer resistor
R7 — 5100 ohms, ¼-watt, 5%
R11 — 47 ohms, ½-watt
R12 — 100 ohms, ½-watt
R24, R25, R28, R30, R31 — 4700 ohms, ¼-watt
R27, R32 to R35, R37 — 10,000 ohms, ¼-watt
R36, R50 — 2.2 meg ohms, ¼-watt
R38 — 50,000 ohm trimmer
R39 — 47,000 ohms, ¼-watt
R40 — 220,000 ohms, ¼-watt
R41 — 33,000 ohms, ¼-watt
C1, C6 — 500 pF
C2, C7, C14 — 0.01 μF
C3 — 0.002 μF
C4 — 50 pF
C5 — 0.0015 μF
C8, C9, C10, C11, C15, C18 to C33 — 0.1 μF
C12 — 0.047 μF
C13 — 0.22 μF Mylar
C16 — 0.001 μF
C17 — 33 μF, 10V, tantalum
C34, C35 — 100 μF, 16V, electrolytic
Q1, Q2 — 2N5129 silicon
Q3 — 2N5139 silicon
Q4, Q5 — TIS58 field effect transistor
D1, D2 — 1N914 silicon

PARTS LIST — MEMORY BOARD

IC1 to IC6 — 2102 1024 bit static RAM
C1, C2 — 0.1 μF, 10V

The following items are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX.

#CT-1024 Terminal System Kit with 1024 Memory Card — less cabinet or power supply. $175.00 postpaid.

#CT-E Screen Read Plug-in Card kit. $17.50 postpaid.

#CT-M Manual Cursor Control Plug-in Card kit. $11.50 postpaid.

#CT-P Power Supply for CT-1024 — 115-230 Volt Primaries. $15.50 postpaid.

#KPD-2 Keyboard Kit — 53 Keys. $39.95 postpaid.

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 pro-

portional 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.

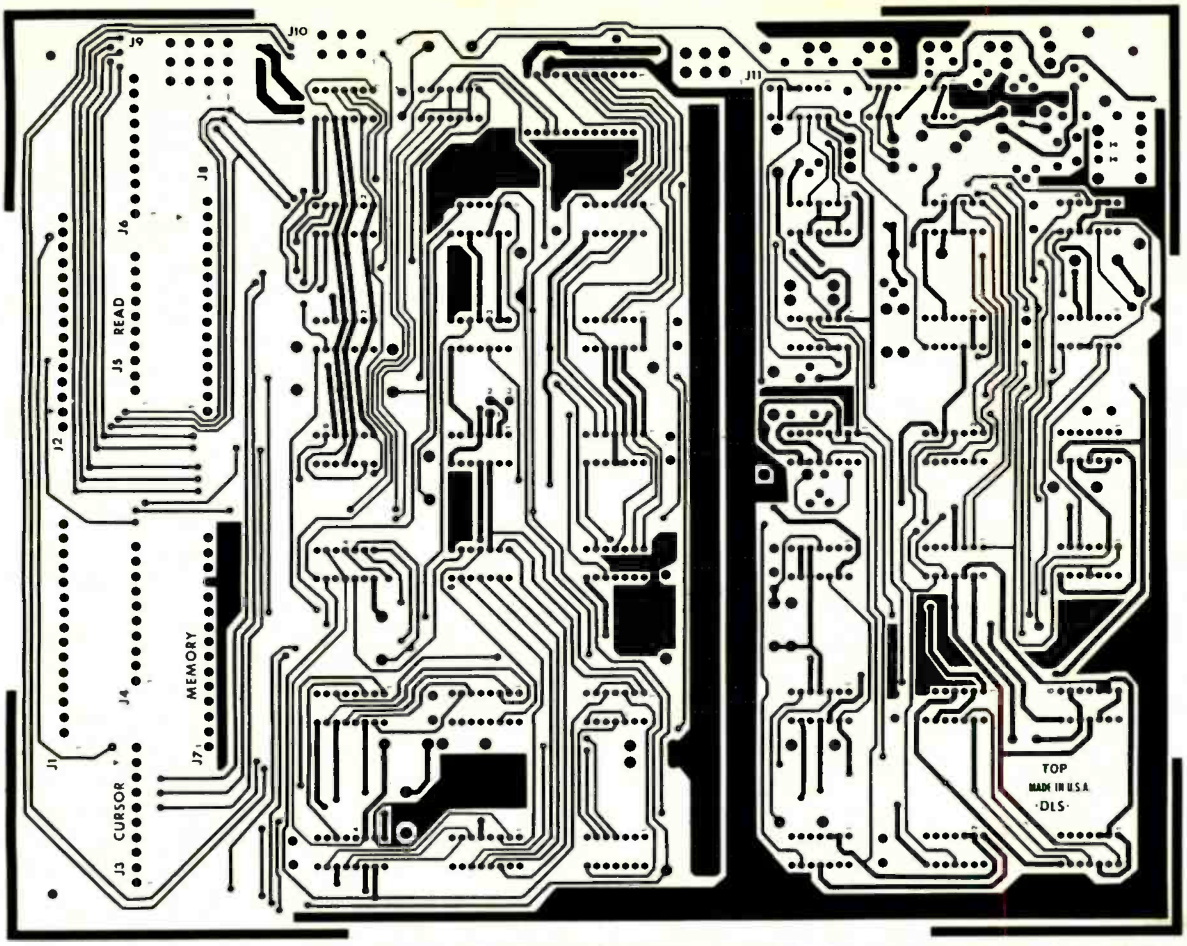
The falling edge of this sync pulse at the output of IC19-b triggers IC18-a, a one shot, which puts out a positive pulse on pin 4 that can be adjusted by potentiometer R4 from 4 to 20 μs. The delay pulse creates a lag between the television's start of video sweep and the TV Typewriter's generation of data, thus giving an adjustable left margin. Pin 4 of IC18-a inhibts 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.

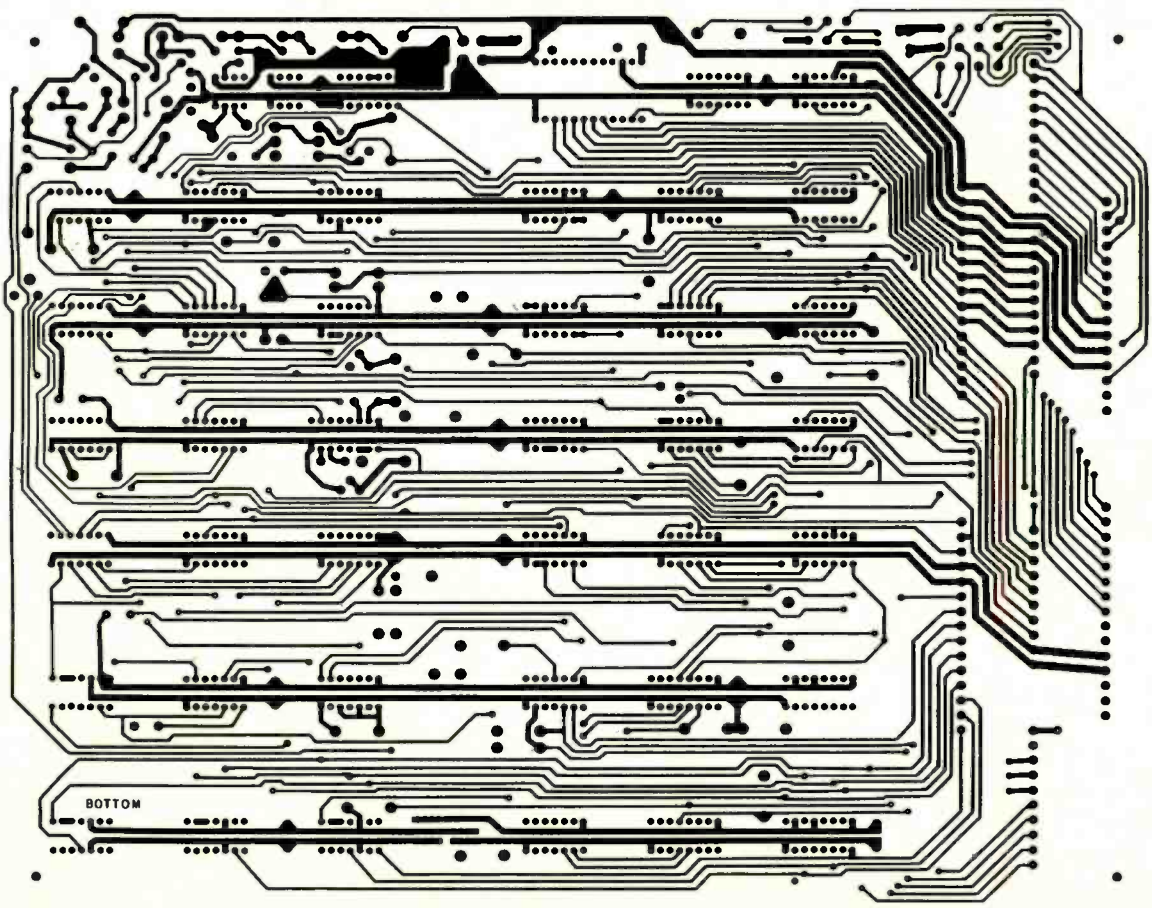
Since we also have 16 sets of these ten lines, one for each of the 16 character rows, we must have the 16-bit counter, IC7, to tell the rest of the circuitry which of the 16 character lines it is displaying. Together, IC6 and IC7 provide a unique BCD code for each of the 10 × 16 = 160-dot video scan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

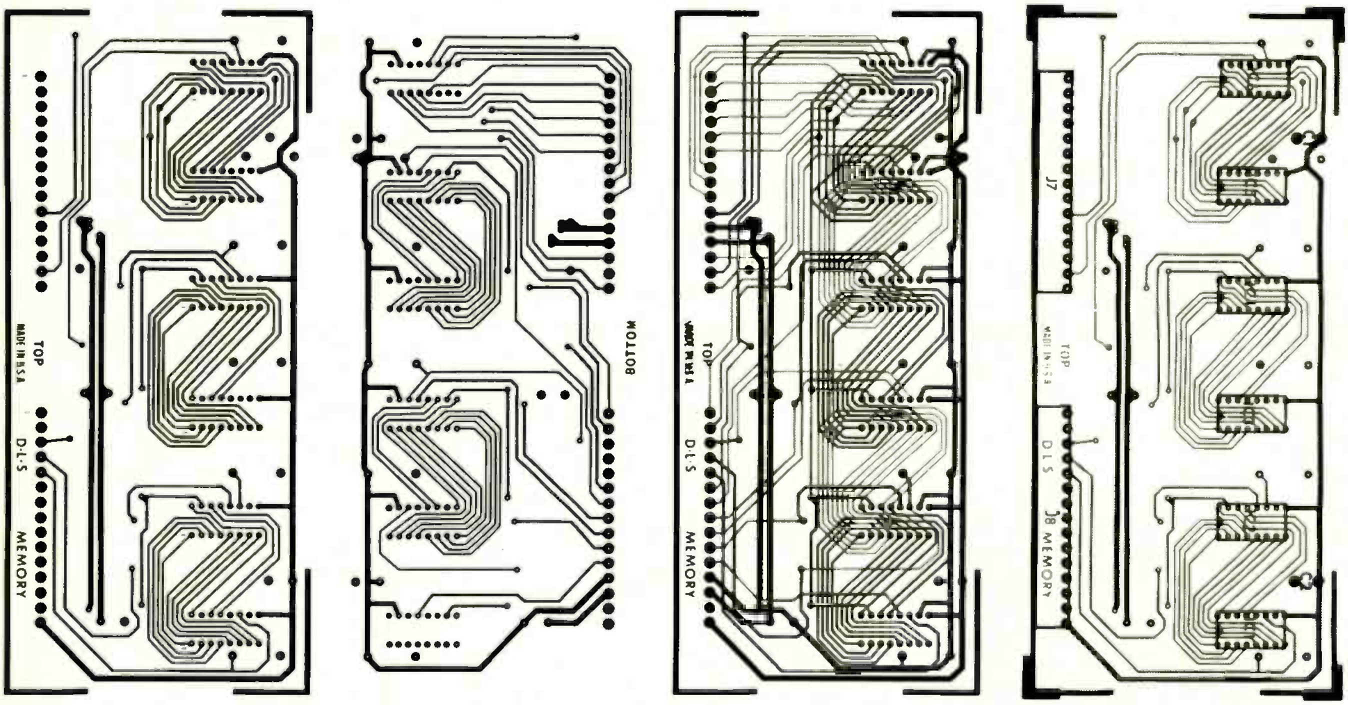
The dot data itself is shifted out bit by bit, at the rate set by the dot clock, from pin 10 of IC23 to IC17-b where it is mixed with the horizontal and vertical sync pulses to form the composite video signal, which is then buffered by emitter follower Q1 and fed to a television or a video monitor.

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-h 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.

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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 THE FEBRUARY 1975 AND MARCH 1975 issue of **Radio-Electronics**, we presented a general description of the TV Typewriter II, some foil patterns, the schematic of the main board and began a technical description.

This month the series will conclude with the construction details.

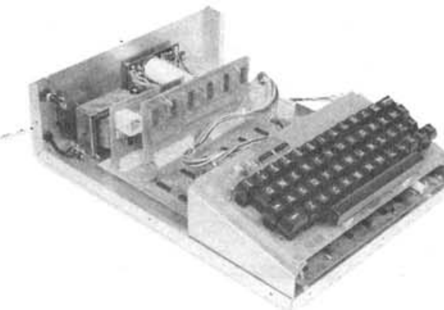
When the character counter reaches character slot 33, the 2^5 and 2^0 bits go to a one which in turn disable the "DOT CLOCK" until a new character line is started. Being in the 33rd character position also enables the video blanking circuit through IC12-c and IC5-b. Since the dot clock is stopped, the video generation ceases after the 33rd character until a new video line is started.

Now that we know how to get the data from the 2513 character generator data inputs to the screen, lets see how the incoming data is put into and accessed from memory. We must first have some means of inputting data to the TV typewriter which in most cases will be a standard keyboard/encoder with a seven-bit ASCII output. The input device must also provide some kind of a "data ready" line to tell the terminal when new data has been applied to the data input terminals. For a keyboard/encoder this is called a "keypressed strobe" line and gives us a pulse whenever a key has been depressed.

Although the seven data inputs are set up for positive logic, the "keypressed strobe" line may be either positive or negative going since NAND gate IC32-a has been provided as an optional inverter. When the "keyboard strobe" pulse reaches the "clock" input of IC9-a, it toggles forcing IC36-b, IC37-a, IC37-b, IC38-a, IC38-b, IC39-a and IC39-b to latch onto the new ASCII data provided at the data inputs, which is in turn fed to the data input terminal of the RAM memory but not loaded.

You must remember that the memory is constantly being readdressed and read and that the address of memory at the time of the "keypress strobe" is completely arbitrary and is most likely not the place where we want to store the character. Keep in mind also that we will want to input special control characters which will command the typewriter to perform a certain function but at the same time not write these control characters into memory.

The latched input character is fed to the function decode circuitry where it is determined whether or not a control function is being input. If it is, such as any input with bits 6 and 7 equal to zero or a rubout with all bits set to 1, the output of IC32 will go high forcing the output of IC11-b low



resetting IC9-a and preparing IC36-a to dump the input control character on the next load pulse for the "dot registers" IC23 and IC24 from IC25. Note the next time the "clock" input on IC36-a goes high it clears all of the data input latches IC36 through IC39. If on the other hand, the character is a printable character, IC32-b will stay low forcing IC11-b low thus eliminating IC9-a's clear command allowing the Q output to go to a one when toggled by the keyboard strobe. On the next "load pulse", IC16-b is clocked high. The high output of IC9-a and IC16-b are now AND'ed and prepare IC16-a to be switched on the next load pulse from IC25. When IC16-a toggles, its Q output goes high setting up one of the two inputs to NAND gate IC15-b and it then waits for a "compare" command from AND gate IC3-d. The input from IC12-d is ANDed at the same gate just to eliminate false counts after the character counter has reached a count of 33.

The compare circuit will be discussed in detail later, but basically it determines and acknowledges when the memory is indexed to the position in which we want to store the character being processed. When the compare is confirmed, IC3-d goes high forcing IC3-b high, which forces IC15-b low. This makes IC10-a go high generating a write pulse for the memory, thus loading the character at the proper position. At the onset of the next load pulse IC3-c goes high forcing IC11-b low which resets IC9-a and dumps the input latches, leaving the ASCII code for a blank or space stored. IC16-a and IC16-b both reset on the following load pulse.

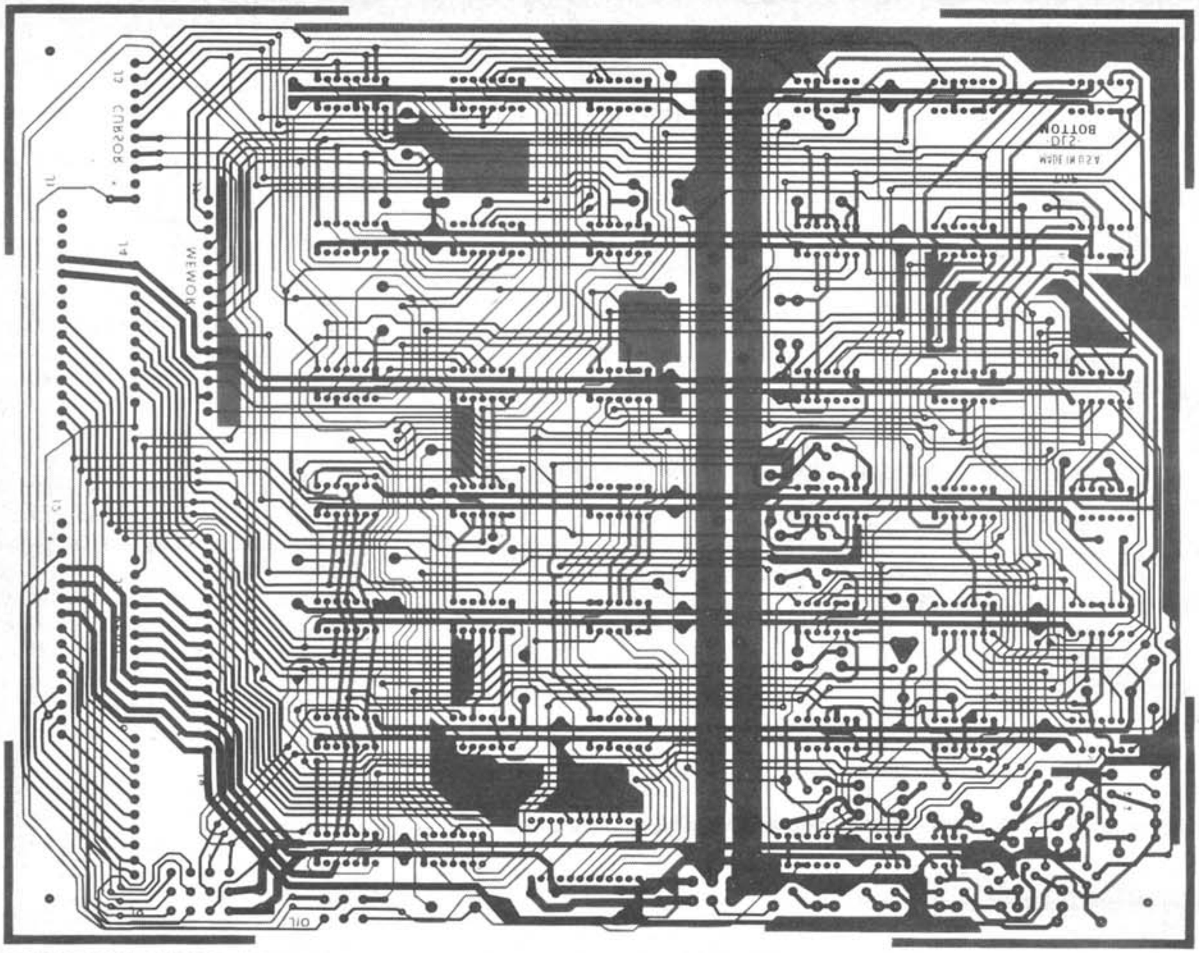
Each input character requires 3 "load pulse" time or 4.5μs to load. Because of this requirement and the fact that only 9 load pulses per character can be guaranteed; 540 characters per second is the maximum input rate. The first 102 lines are slected twice per frame so the write speed on the ⅝ of each page will be doubled or 1800 characters per second.

The cursor and compare circuits are very interelated since the circuitry must know where the cursor is positioned on the screen and when the memory is indexed to match with the cursor location so the cursor will blink in the right location. Since the character we will be entering through the keyboard will be entered in the cursor's position, the cursor counter also provides the address of the character we want to load into memory. The memory location of the cursor or character to be loaded into memory is stored in a 10-bit counter made up of IC35, IC27-a, IC34 and IC27-b. IC35 holds the data for the first sixteen horizontal character locations on a line and IC27-b sets if the location is on lines 17 through 32. The number of one of the 16 vertical page lines is stored in IC34, and IC27-b holds the bit addressing one of the two pages of memory.

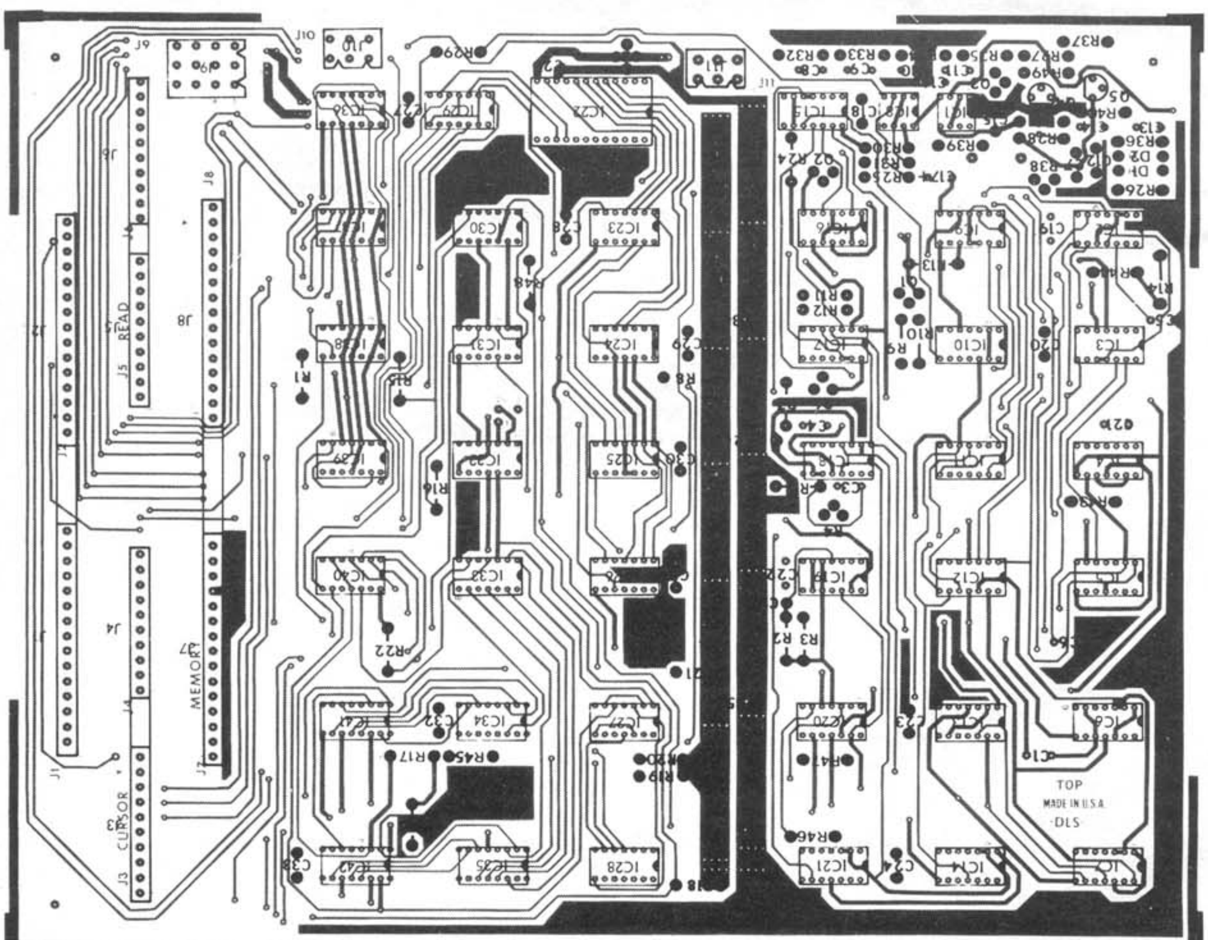
IC41 and IC42 are two 4-bit comparators that tell us when the data on two sets of its inputs is identical. The required 9th-bit compare is provided by IC40-c and IC40-d. The comparators are cascaded to generate one output telling whether two independent 9-bit addresses are equal, the address being that of the cursor and the location presently indexed. It is not necessary to perform a compare on the tenth or page bit because we will never be writing to or blinking the cursor on the page that is not currently accessed. The comparator circuitry monitors the address of the cursor counter and the outputs of the character counter, IC21 and IC14, and the line counter, IC7, and generates a high "compare" output when there is a match.

The cursor itself is generated by turning on all 35 of the character dots when AND gate IC17-c sees both a "compare" match and inactive blanking. The several times per second blinking is generated by the timer IC8 operating as an astable oscillator.

The cursor is positioned by incrementing and decrementing the up/down cursor counters IC35, IC27-a and IC34, which have full wrap around in each location and automatically



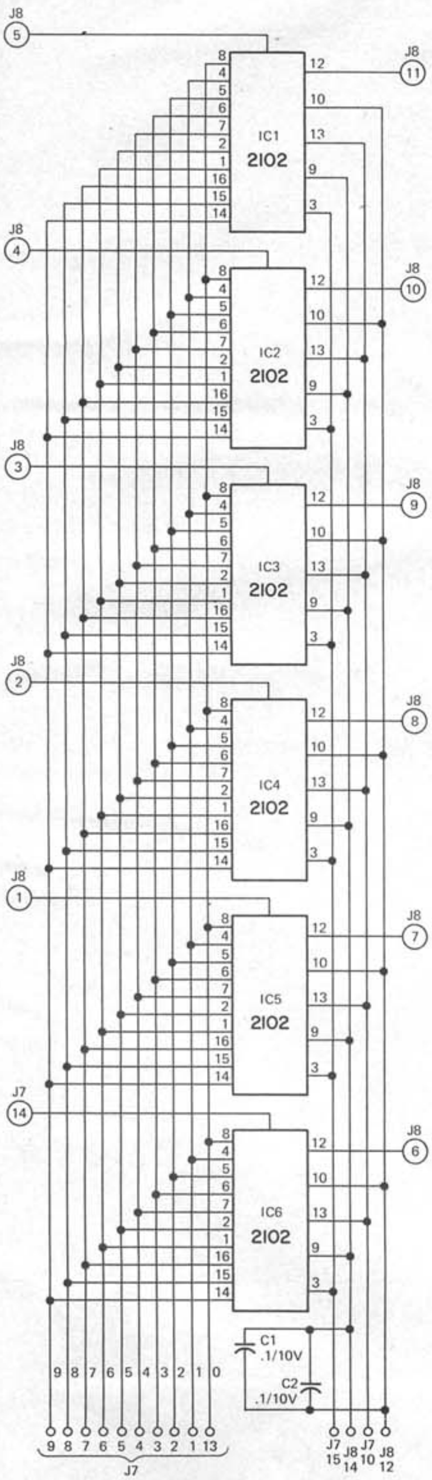
MAIN CIRCUIT BOARD foil patterns shown half-size. Above is an X-Ray view of the double sided board. The component layout is shown below.



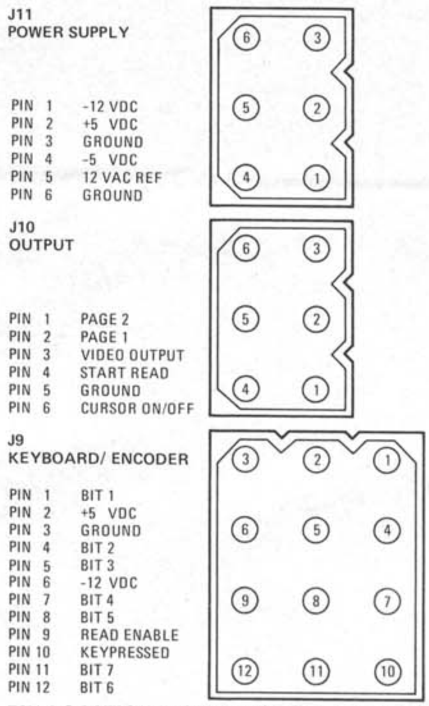
change pages as required. Although most of the actual cursor control circuitry is provided on the main board, the optional cursor control board is necessary to provide the switch debouncing necessary for reliable operation.

There are several cursor positioning functions provided. IC35 pin 5 and IC35 pin 4 move the cursor location one position forward and one location backward respectively. IC34 pin 5 and IC34 pin 4 move the cursor one location down and one location up respectively. IC35 pin 14 generates a carriage return and IC34 pin 14 generates a return to line 1 which means together they generate a home-up. IC34 and IC35 are responsible for line feed. The interconnected gating allows combinations to be performed with only one control command.

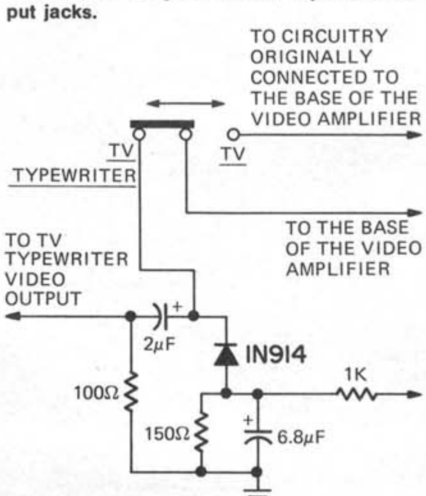
The erase functions have been provided for as well and do not require the optional cursor control board. Erase from the cursor position to the end of the line is initiated by setting the preset input of IC9-b low, and erase from the cursor to the end of frame is initiated by setting the preset input of IC2-a low. If either of these two latches is set, it allows IC2-b to toggle at the onset of the next compare when the row counter reaches line nine. This generates a "memory load" command which loads a space or blank from the input latches into memory. IC2-b will reset on the first 33rd character indication from IC14 after latch IC2-b is set thus completing an erase to end of line (EOL). IC2-a will reset on the first blanking pulse from IC4-b after latch IC2-b is set, thus completing an erase to end of frame (EOF). The resetting of either causes IC2-b to reset and return it to its initial state.



SCHEMATIC DIAGRAM of the memory circuit is shown.



PIN LOCATION guide for the input and output jacks.



SWITCHING CIRCUIT permits normal operation of TV receiver or as TV Typewriter display.

Assembly is not difficult

It cannot be emphasized enough that the best guarantee for initial and future trouble-free operation is to be extremely careful when putting the unit together.

The circuit board will be more rugged and reliable if the IC's are soldered in place on the board as shown in the photographs, but those with little experience in digital circuits, or electronic assembly might be wise to invest in some sockets; particularly for the memory IC's.

Install all of the integrated circuits, resistors, diodes, capacitors and then transistors before soldering anything. Note the components are to be mounted on the top side of the board, and the top side is marked "TOP". Double check everything to make absolutely sure all parts have been installed in their proper location and oriented correctly. Check carefully to be sure you haven't inadvertently oriented an integrated circuit incorrectly. This is easy to do and almost impossible to correct after soldering without ruining either the integrated circuit or the PC board, or both. When you are sure that everything has been installed correctly, then you may solder all of the component connections on the bottom of the board. All of the connections should be soldered regardless of whether or not there are electrical connections to the pad. This helps insure that none of the integrated circuits or component leads get bent and inadvertently short out to near-by foil conductors.

Now is the time to carefully check the entire board to be sure that all connections where applicable have been soldered. Make sure also that there are no solder bridges, or improperly installed components.

Follow the same procedure for assembling the memory board as you did for the main circuit board. The memory integrated circuits are MOS devices which are very intolerent of static electricity so be sure to take appropriate precautions. Here again be sure to check over the board very carefully after assembly to be sure there are no mistakes.

Attach all of the wires to the connector plugs for the power supply, J11, output, J10, and keyboard, J9. Use the connector drawing to show the appropriate pin connection for each of the

(continued on page 87)

TV TYPEWRITER II

(continued from page 63)

plugs and note that each of the connectors is indexed to allow them to be plugged in only one way. J10 and J11, however, are physically the same type of connector so use a felt tipped pen to mark one of the two sets to prevent yourself from inserting one of the plugs into the wrong jack. Try to keep all of the wires in the connector harnesses as short as possible and be sure the ground and +5v wires between the power supply and the main board are 18 gauge or heavier.

The power supply must be capable of supplying 5 Vdc, 2A at 5% regulation or better; −12 Vdc, 200 mA; and −5 Vdc, 15 mA. You can either build your own from scratch or purchase one from the source supplying the TV typewriter kits. You must make absolutely sure all of the power leads are wired correctly to the connector; otherwise you can cause a lot of damage when the power is applied.

Now its time to get out the television or monitor you plan to use. Although the actual modifications necessary will vary from set to set, the modifications shown will probably be satisfactory for most small screen transistor portables. The TV typewriter's output must be connected to the input of the television's video amplifier, which is located between the last video i.f. stage and the video output circuit. When you break the circuit right at the input to the video amplifier, you will probably have to provide a dc bias circuit for the stage since in most cases it is supplied by the now disconnected video i.f. amplifier. The circuit in Fig. 2 is for the Motorola 9TS-469 Q set used with the prototype. A switch and BNC connector were provided to allow either TV typewriter or normal television viewing.

A dc restoration circuit was also added to keep the screen intensity from changing as a function of the density of dots displayed.

Check the power supply to be sure the voltages are OK and that wiring to the connector is correct. Go back now to the main PC board and wire in the correct keyboard jumper. If your keyboard has a positive "keypress strobe" pulse, wire terminal 3 to terminal 1, and if it has a negative "keypress strobe" pulse, wire terminal 3 to terminal 2. These pads are just adjacent IC32 and are numbered on the top side of the board. If the keyboard has a 1 microsecond or less strobe pulse, either of the two positions will work properly.

Plug the "memory" board onto the main board using the set of connectors marked "memory." Be sure the top side of the memory board faces in toward the main PC board. It must not be plugged on the other way.

Connect the power supply, keyboard and television to the main board and after making a final check for errors, apply power. If you haven't made any mistakes and have a little luck, the unit will work first off. The only adjustments are the oscillator frequency adjustment pot, R38, the left margin control, R4 and the horizontal character size control, R6. The phase-locked oscillator should lock in over most of the range of the control R38, but may vary from unit to unit. An out of lock condition will be indicated by a slight vertical roll and a jitterey character presentation. The other two controls should be set to give the best display.

If the unit doesn't work, first check the power supply voltages to make sure they are OK and then use an oscilloscope to see whether or not there is a video output signal. If not, start checking from the phase-locked oscillator with your scope and try to locate the problem from there.

If you don't have any problems and everything seems to work correctly then go ahead and connect up the control switches. For maximum flexability the page-select switch, available at jack J10, should be a spdt center off switch;

(continued on page 90)

Circle 72 on reader service card

Circle 71 on reader service card

Circle 73 on reader service card

TV TYPEWRITER II
(continued from page 87)

then when either of the two pages are selected, the cursor will always remain on the same page even when the end of frame is reached. In the center position, the cursor will alternately jump from one page to the other as the end of frame is reached. As with all of the other switch connections to follow, the inputs are all tied high with pull up resistors so all switching should be done by grounding the appropriate terminal.

The cursor ON/OFF terminal, available on jack J10, if left unconnected will always cause the cursor to blink in the next character position to be typed. However, the blinking cursor may be turned off at any time by grounding the "CURSOR ON/OFF" pin on jack J10.

For maximum manual cursor control, the optional cursor control board should be used, however, the home-up (move cursor to upper left hand corner), erase to end of line (EOL) and erase to end of frame (EOF) are available at the pins to be used for the cursor control board. Temporarily grounding pin 10 of IC9-b will generate an erase of end of line, and temporarily grounding pin 4 of IC2-a will generate and erase to end of frame and grounding pin 12 of IC32-d will force a "home up." **R-E**

TV Typewriter II
screen-read board

Add this optional plug-in board to the TV Typewriter II and you can automatically access information that has been typed onto the TV screen.

by ED COLLE

IF YOU EVER NEED TO USE YOUR TV Typewriter II (see **Radio-Electronics,** Feb. 1975 issue) in a situation where you want to acquire information that has been typed onto the TV screen and into another parallel input device, you will probably want to use the screen read board. The TV Typewriter II's memory is constantly addressed and read out to generate the video data used by the television display. So the idea is to capture and hold the data in a particular location in memory and tell the parallel input device thru a "data ready" line that the data is ready to be used. When the parallel input device accepts the data, it in turn tells the screen read board thru the "data accepted" line to seek and provide data in the next character location. The screen read board retrieves information in the screen cursor location and continues until a manual switch stop command is given or if desired, until an exclamation point is encountered.

Since the cursor is automatically advanced by the screen read board, it is seldom seen at fast read rates that may be as high as the memory read speed or 16.6 ms. This speed can only be achieved if the parallel input device connected to the screen read board can accept the data at a one character-per-microsecond or faster rate. This speed is very useful when performing memory search routines where you are looking for a specific character or symbol somewhere in memory. If the device connected to the screen read board is not capable of handling a 1-ms acquisition time, but is capable of a 63-ms rate, the entire screen can be read in about 500 milliseconds. In both situations, however, up to 16.6 milliseconds of delay may be encountered between the time the read command is given and the time the screen read board actually begins accessing data. This allows the memory address counters to cycle to the current cursor location.

The entire circuit is built on a 3-1/16 in. × 4½ in. fiber glass circuit board which is plugged onto connector strips J5 and J6 on the main board of the TV Typewriter II next to the cursor board.

(continued on page 76)

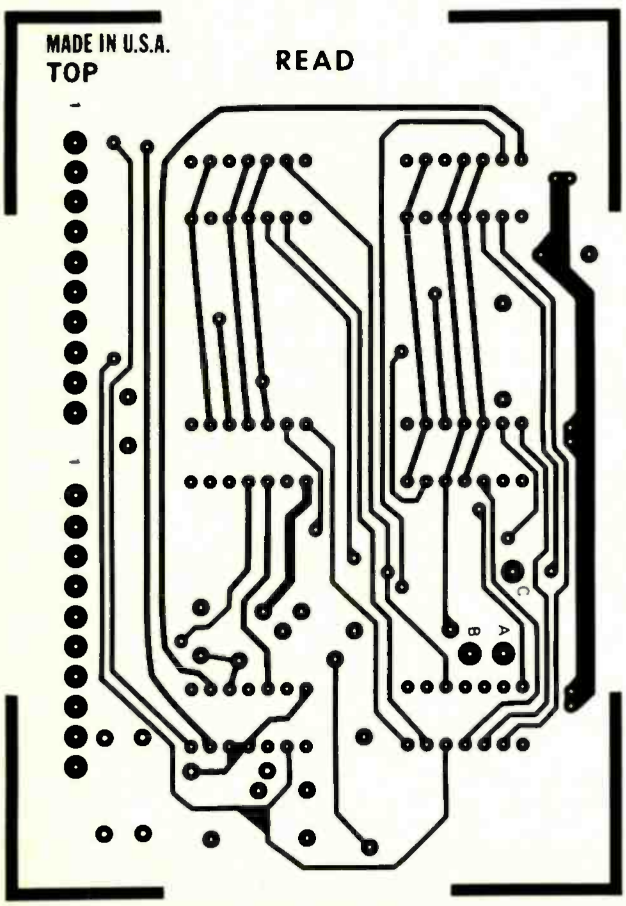


FIG. 2—FOIL PATTERN for component side of double-sided board shown full size.

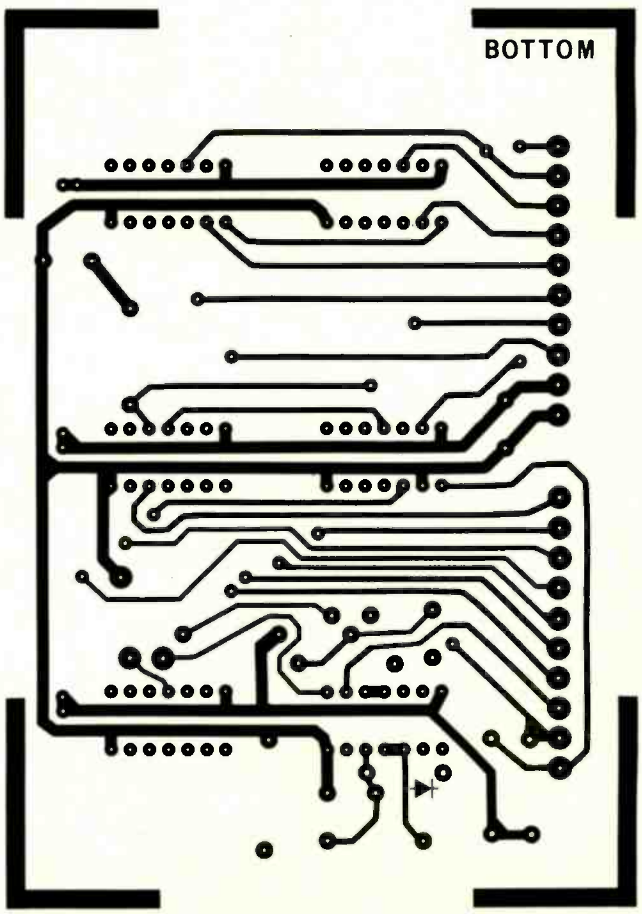


FIG. 3—FOIL PATTERN for foil side of double-sided board shown full size.

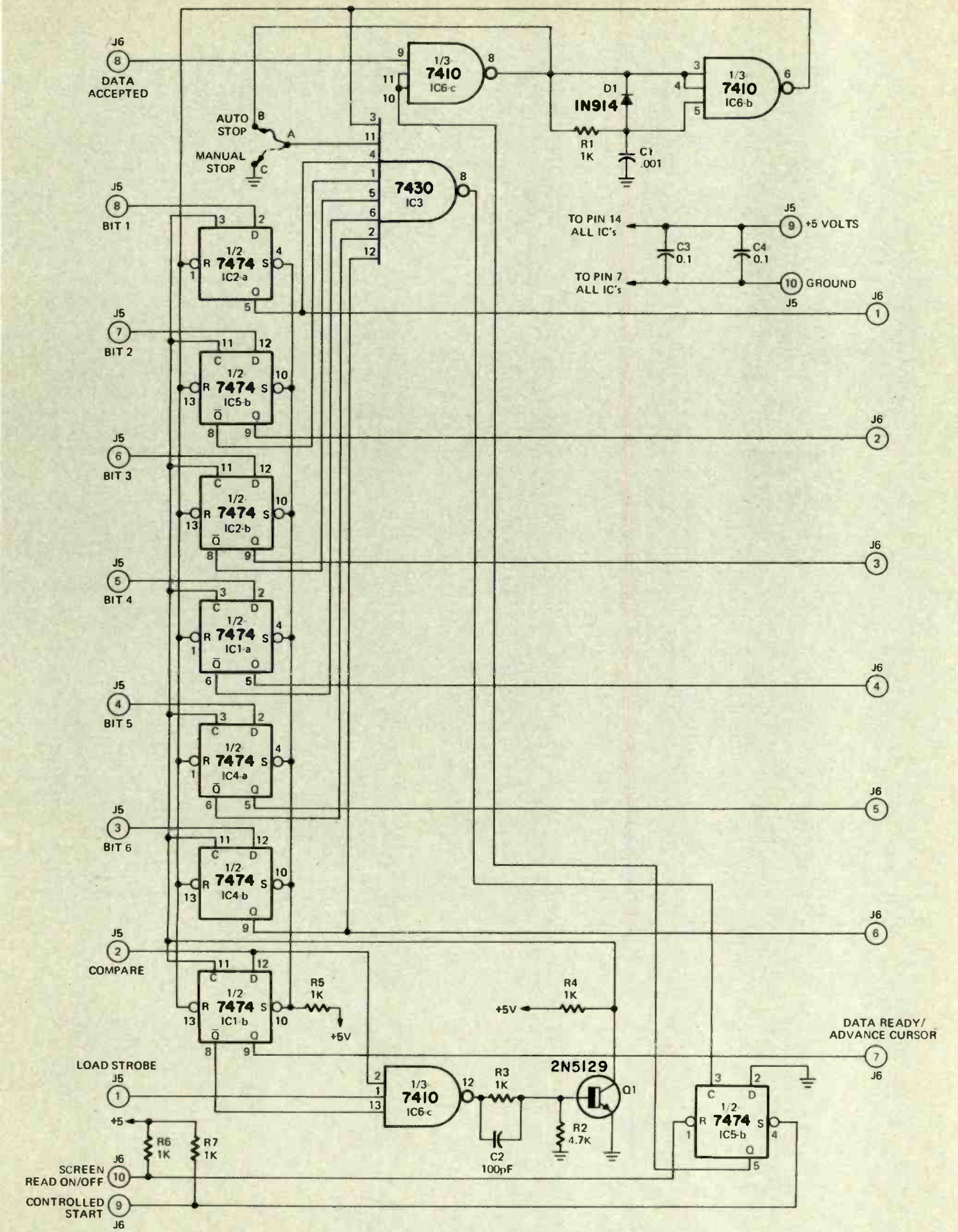


FIG. 1—SCREEN READ BOARD schematic diagram.

PARTS LIST

R1, R3-R7—1000 ohms, ¼-watt, 10%
R2—4700 ohms, ¼-watt, 10%
C1—1000 pF polystyrene
C2—100 pF polystyrene
C3, C4—0.1 μF, 12V
D1—1N914 silicon diode
Q1—2N5129 transistor
IC1, IC2, IC4, IC5—7474 dual type D flip-flop
IC3—7430 eight input NAND gate
IC6—7410 triple 3-input NAND gate.

SCREEN-READ BOARD
(continued from page 36)

How it works

Figure 1 shows the schematic diagram. The "compare" and "load strobe" signals from the main board tell the screen read board when the memory has been indexed to the current cursor location and when the data is actually ready for reading. These signals are gated with the "ready to load" signal from IC1 pin 8 forcing IC6-c pin 12 low and transistor Q1's collector high. This loads each of the holding registers, IC1-a, IC2, IC4 and IC5-b, with the memory data located in the cursor position. The "data ready" line goes high and the "ready to load" line, IC1 pin 8, goes low signaling that valid data is contained in the holding registers and inhibiting IC6-c from clocking in new data. The cursor is also advanced one forward position or carriage return/line feed if in column 32, since the "data ready" line drives a transistor on the cursor board which is wire OR'ed to the cursor counter "forward" input on the main board. It is for this reason that the screen read board must always be used in conjunction with a cursor control board.

When the device connected to the read board accepts data it must put a low on the "data accepted" line, J6-8. This in turn dumps the holding registers and resets the "data ready" line. A variable delay has been built into the read board which allows for a premature "data accepted" acknowledge-

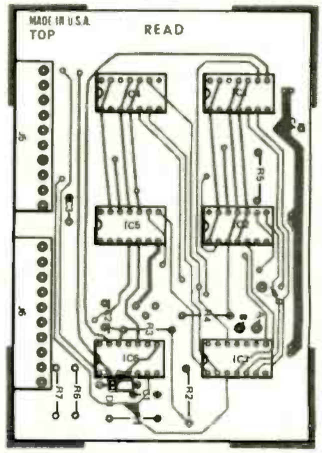


FIG. 4—COMPONENT LAYOUT.

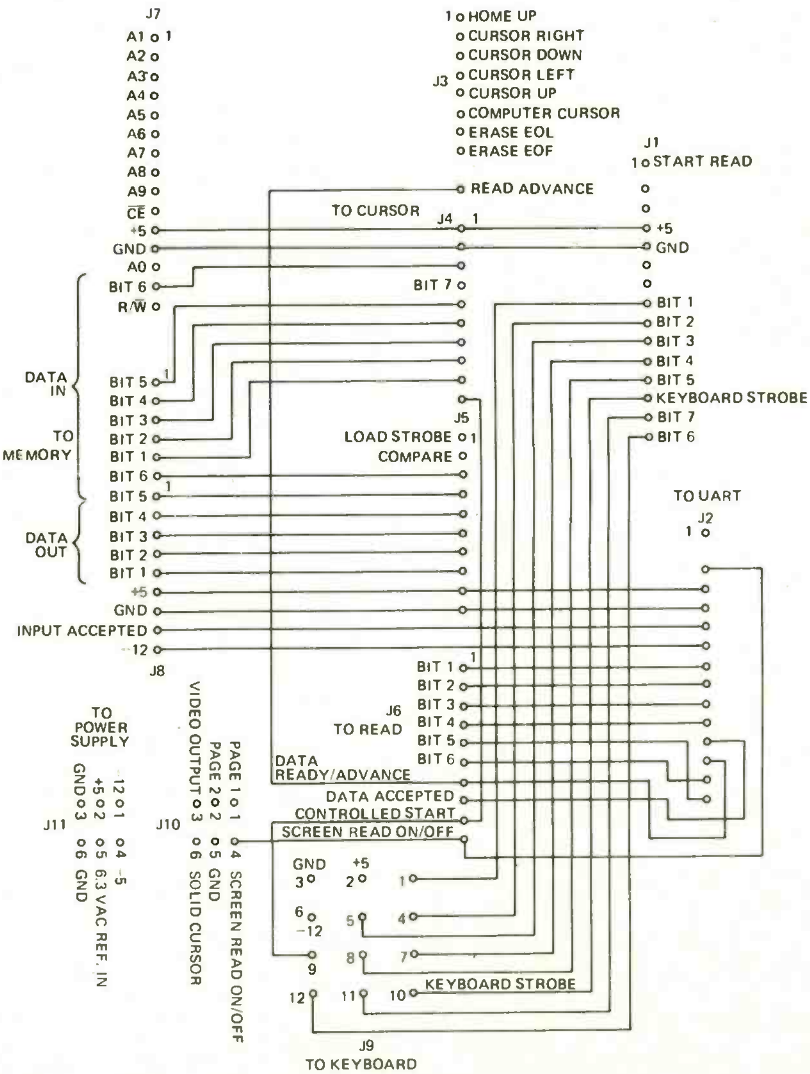


FIG. 5—JACK INTERCONNECTION diagram of TV Typewriter II.

ment since some devices connected to the read board generate the acknowledge signal and yet require that the holding registers not be dumped immediately. The delay time can be increased by making capacitor C1 larger, however, for maximum output speed the capacitor should be made as small as possible with a minimum capacitance of 100 pF. New data is then loaded into the holding registers and the "data ready" line goes high, completing one cycle of the operation which continues until a stop command is received from the screen read ON/OFF switch, or if the auto stop jumper is installed, a /. This clocks the Q output of IC5-a low and stops the screen read function. The controlled start input, J6-9, must be pulsed low either with a manually operated switch, computer controlled cursor or a combination since the input may be wire OR'ed to initally start the read sequence or restart it after a stop. Note however that the screen read ON/OFF switch must be in the ON position.

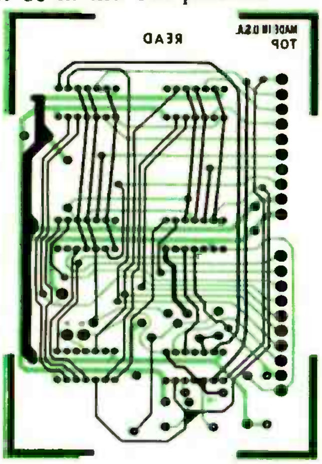


DIAGRAM SHOWS how both foil patterns overlap to form a double-sided board.

Assembly

The board assembly is easy since there aren't many parts, but be sure to orient the transistor, diode and integrated circuits correctly. The foil pattern for both sides of the double-sided board is shown in Figs. 2 & 3. Figure 4 shows the component layout. When plugging the assembled screen read board onto the main board, be sure not to plug in the board backwards. Since all of the pins were used there was not room for an indexing key, so be sure to orient the board the same as the memory and cursor boards. Also be sure that the main board of the terminal is working properly before plugging in the screen read board onto it. The jack interconnection diagram of the TV Typewriter II is shown in Fig. 5.

You can use the jack interconnection diagram of the TV Typewriter II to determine how the screen-read board connects to the rest of the circuitry. **R-E**

Great leap ahead for pay TV due with satellite programming

More than 800,000 persons will be served with Home Box Office pay cable television programs by one company alone this Fall. Teleprompter, largest cable TV operator in the country, plans to build 24 earth stations across the country to receive programs via satellite and retransmit them to its subscribers. The new service will be available to 82 of Teleprompter's 140 cable systems by the end of 1976.

Home Box Office has contracted with RCA Global Service for satellite facilities and will begin distributing programs by satellite late this year. At present, it provides about 70 hours of programming a week over cable and microwave nets.

Manhattan Cable Television, which has a franchise for the lower half of Manhattan, NY, now offers Home Box Office programs to more than 17,000 subscribers. They pay $9 per month for the special paid program service in addition to $9 per month for the regular cable hookup. Teleprompter, covering the upper half of Manhattan, is offering Home Box Office programs to its 55,000 subscribers, beginning late summer or early Fall. It also expects to be able to offer the pay programs by microwave transmission to seven other Teleprompter cable systems in New Jersey, New York and Connecticut.

TV Typewriter II manual cursor board

Add this optional plug-in board to the TV Typewriter II and you can manually position the cursor anywhere on the TV screen.

by ED COLLE

IF YOU HAVE BUILT THE TV TYPEWRITER II that has recently appeared in **Radio Electronics** (see Feb. 1975 issue), you've probably been waiting for the manual cursor plug-in option. This board allows you to manually, with pushbutton switches, move the cursor one space left, right, up or down as well as home-up, erase to end of line (EOL) and erase to end of frame (EOF). The last three options, home-up, erase EOL and erase EOF do not require the cursor board but it is recommended.

The circuitry provides the switch debouncing necessary to prevent multiple cursor counting thus insuring the cursor jumps only one position each time a directional button is depressed. The control switches themselves are SPST normally open pushbutton switches that should be mounted on an aluminum strip just in front of the keyboard. The debouncing delay provided is 100 milliseconds, but longer delays can be achieved by increasing the capacitance of C1 (see Fig. 1). The entire circuit is built on a 3-1/16 in. x 4-1/2 in. fiberglass circuit board that plugs into the main board of the TV Typewriter II on connector strips J3 and J4 just behind the memory board. Switch connections to the cursor board are provided on the nine pin connector attached to the circuit board.

How it works

Since all of the pushbutton control switches are normally open, the switch inputs are all tied high with resistors R1-R7. The input commands are directed to the output NAND gates (IC1, IC5-a, IC5-b and IC5-c) through inverters IC4 and IC5. Note that none of the control switches affect the output gates unless the logic signal from pin 5 of IC2-b is high. IC3 monitors the control switches and its output goes high when any one of the seven switches are depressed. This forces the $\overline{Q}$ output of IC2-a low where it will remain for approximately 100 ms. After the 100-ms delay, the $\overline{Q}$ output of IC2-a goes high again. This triggers IC2-b forcing its $\overline{Q}$ output high for 1 μs. This gates the appropriate control command into the TV Typewriter II circuitry.

PARTS LIST

All resistors are ¼ watt, 10%, unless noted.

R1–R7, R10, R12, R13—1000 ohms
R8, R9—5600 ohms
R11—2200 ohms
C1—33-μF, 6 volts, electrolytic
C2, C3—100-pF polystyrene
C4—0.1-μF, 12 volts
D1—1N914 silicon diode
IC1, IC5—7403 quad NAND gate
IC2—74123 dual one-shot multivibrator
IC3—7430 eight-input NAND gate
IC4—7404 hex inverter
Q1—2N5129 transistor.

Assembly and use

It's not very difficult to assemble the unit, just be sure to orient the integrated circuits, diode, electrolytic capacitor,

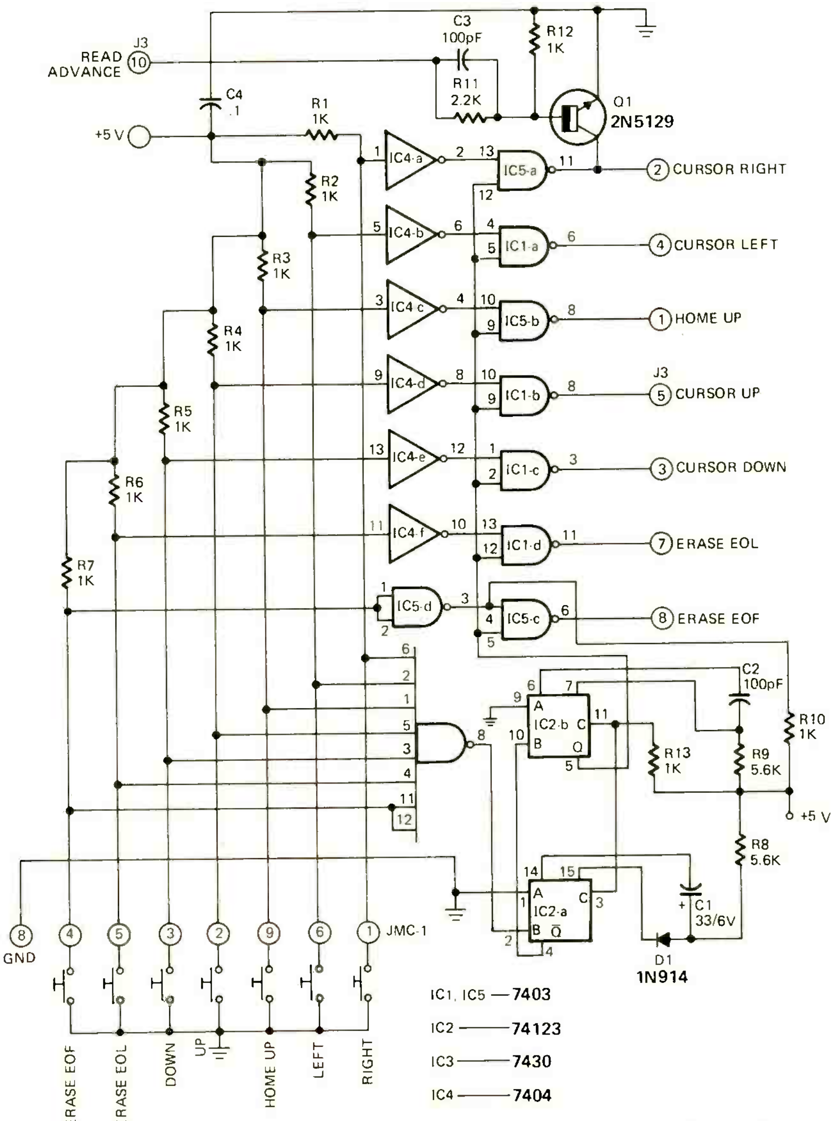


FIG. 1—MANUAL CURSOR BOARD schematic.

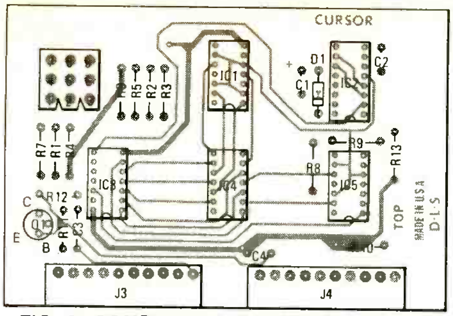
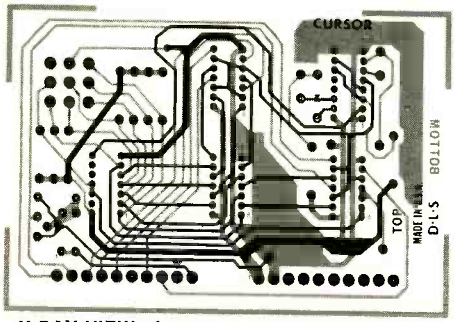


FIG. 2—COMPONENT PLACEMENT diagram.



X-RAY VIEW of the double-sided printed circuit board.

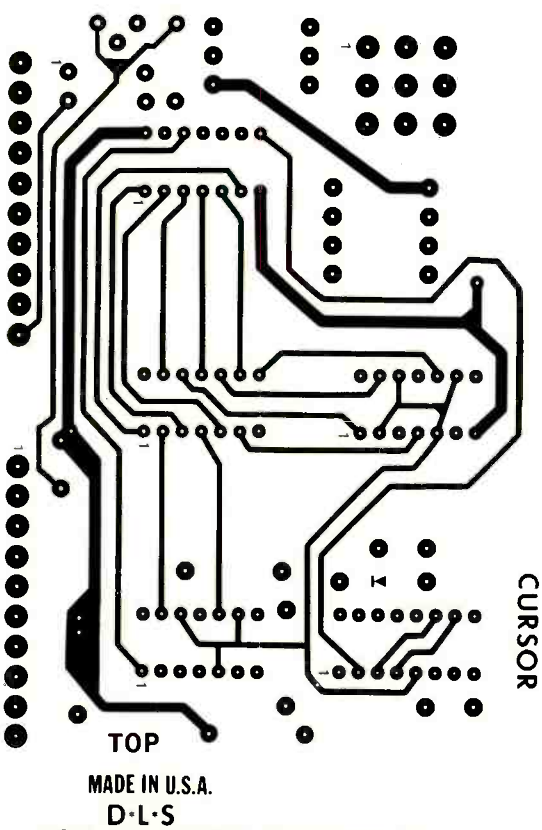


FIG. 3—FOIL PATTERN of component side of double-sided board shown full size.

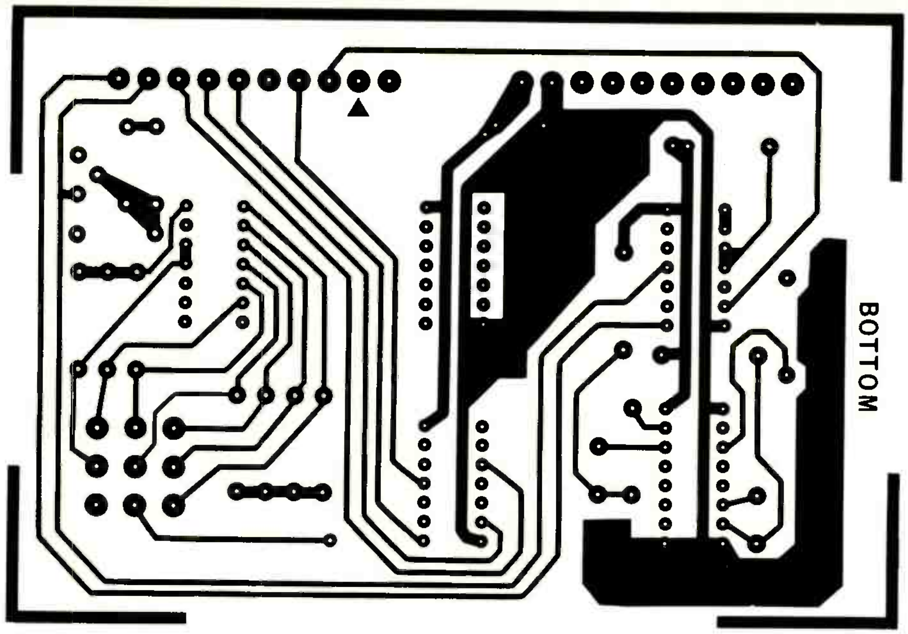


FIG. 4—FOIL PATTERN of foil side of double-sided board shown full size.

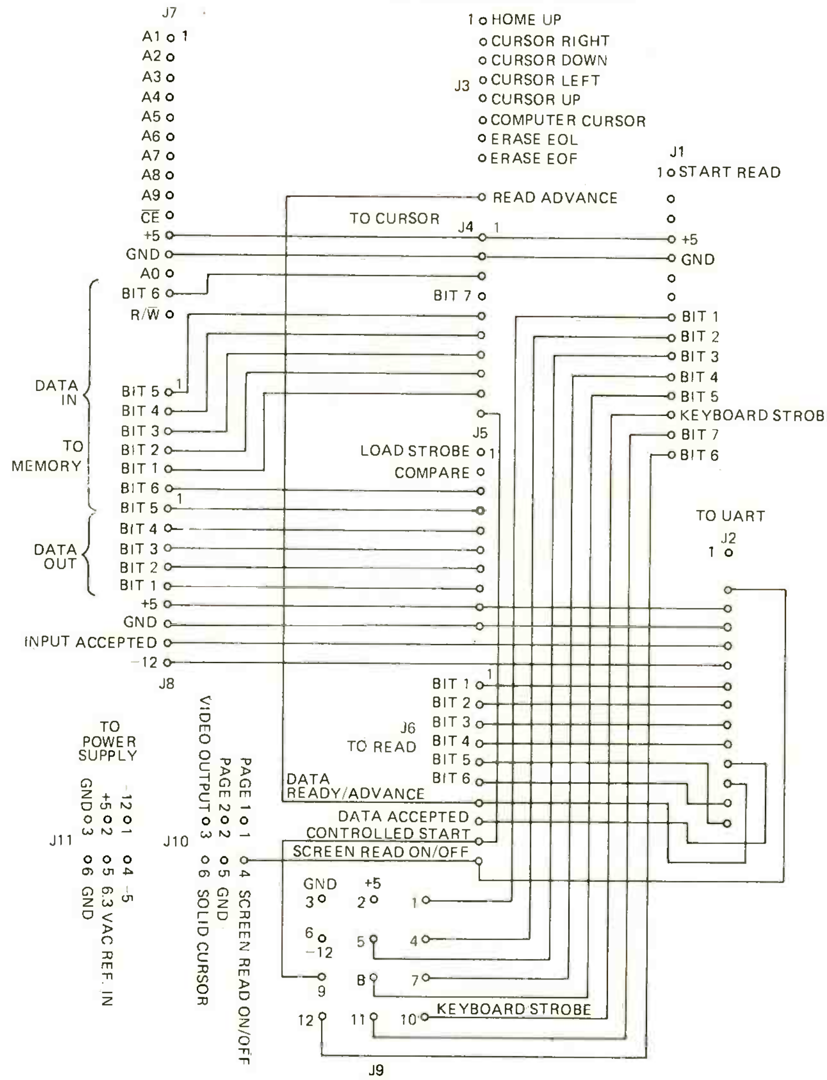


FIG. 5—JACK INTERCONNECTION DIAGRAM of TV Typewriter II.

transistor and connector correctly. Figure 2 shows the component layout. The connector is notched and must be installed exactly as shown in the component side of the foil pattern (Fig. 3). There is a provision for an indexing key on the mounting connectors, J3 and J4, so after soldering the connectors insert a nylon plug in J3 pin 9. This pin is marked with an arrow on the foil side of the board (See Fig. 4). If you have any problems, check to see if the cursor board is working correctly by checking it with a voltmeter and scope. If your TV Typewriter II has never been used, be sure to check it out first without the cursor board. The cursor board should not be plugged in until the main board has been thoroughly checked out. The jack interconnection diagram of TV Typewriter II is shown in Fig. 5. **R-E**

TV TYPEWRITER II

by ED COLLE

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

IN THE FEBRUARY 1975 AND MARCH 1975 issue of **Radio-Electronics**, we presented a general description of the TV Typewriter II, some foil patterns, the schematic of the main board and began a technical description.

This month the series will conclude with the construction details.

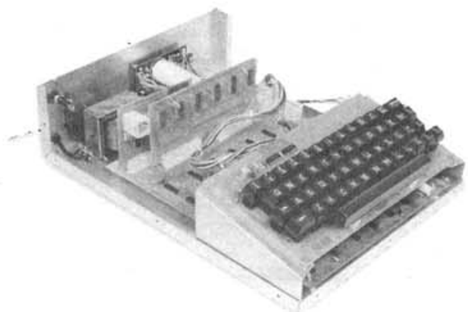
When the character counter reaches character slot 33, the 2^5 and 2^0 bits go to a one which in turn disable the "DOT CLOCK" until a new character line is started. Being in the 33rd character position also enables the video blanking circuit through IC12-c and IC5-b. Since the dot clock is stopped, the video generation ceases after the 33rd character until a new video line is started.

Now that we know how to get the data from the 2513 character generator data inputs to the screen, lets see how the incoming data is put into and accessed from memory. We must first have some means of inputting data to the TV typewriter which in most cases will be a standard keyboard/encoder with a seven-bit ASCII output. The input device must also provide some kind of a "data ready" line to tell the terminal when new data has been applied to the data input terminals. For a keyboard/encoder this is called a "keypressed strobe" line and gives us a pulse whenever a key has been depressed.

Although the seven data inputs are set up for positive logic, the "keypressed strobe" line may be either positive or negative going since NAND gate IC32-a has been provided as an optional inverter. When the "keyboard strobe" pulse reaches the "clock" input of IC9-a, it toggles forcing IC36-b, IC37-a, IC37-b, IC38-a, IC38-b, IC39-a and IC39-b to latch onto the new ASCII data provided at the data inputs, which is in turn fed to the data input terminal of the RAM memory but not loaded.

You must remember that the memory is constantly being readdressed and read and that the address of memory at the time of the "keypress strobe" is completely arbitrary and is most likely not the place where we want to store the character. Keep in mind also that we will want to input special control characters which will command the typewriter to perform a certain function but at the same time not write these control characters into memory.

The latched input character is fed to the function decode circuitry where it is determined whether or not a control function is being input. If it is, such as any input with bits 6 and 7 equal to zero or a rubout with all bits set to 1, the output of IC32 will go high forcing the output of IC11-b low resetting IC9-a and preparing IC36-a to dump the input control character on the next load pulse for the "dot registers" IC23 and IC24 from IC25. Note the next time the "clock" input on IC36-a goes high it clears all of the data input latches IC36 through IC39. If on the other hand, the character is a printable character, IC32-b will stay low forcing IC11-b low thus eliminating IC9-a's clear command allowing the Q output to go to a one when toggled by the keyboard strobe. On the next "load pulse", IC16-b is clocked high. The high output of IC9-a and IC16-b are now AND'ed and prepare IC16-a to be switched on the next load pulse from IC25. When IC16-a toggles, its Q output goes high setting up one of the two inputs to NAND gate IC15-b and it then waits for a "compare" command from AND gate IC3-d. The input from IC12-d is ANDed at the same gate just to eliminate false counts after the character counter has reached a count of 33.



The compare circuit will be discussed in detail later, but basically it determines and acknowledges when the memory is indexed to the position in which we want to store the character being processed. When the compare is confirmed, IC3-d goes high forcing IC3-b high, which forces IC15-b low. This makes IC10-a go high generating a write pulse for the memory, thus loading the character at the proper position. At the onset of the next load pulse IC3-c goes high forcing IC11-b low which resets IC9-a and dumps the input latches, leaving the ASCII code for a blank or space stored. IC16-a and IC16-b both reset on the following load pulse.

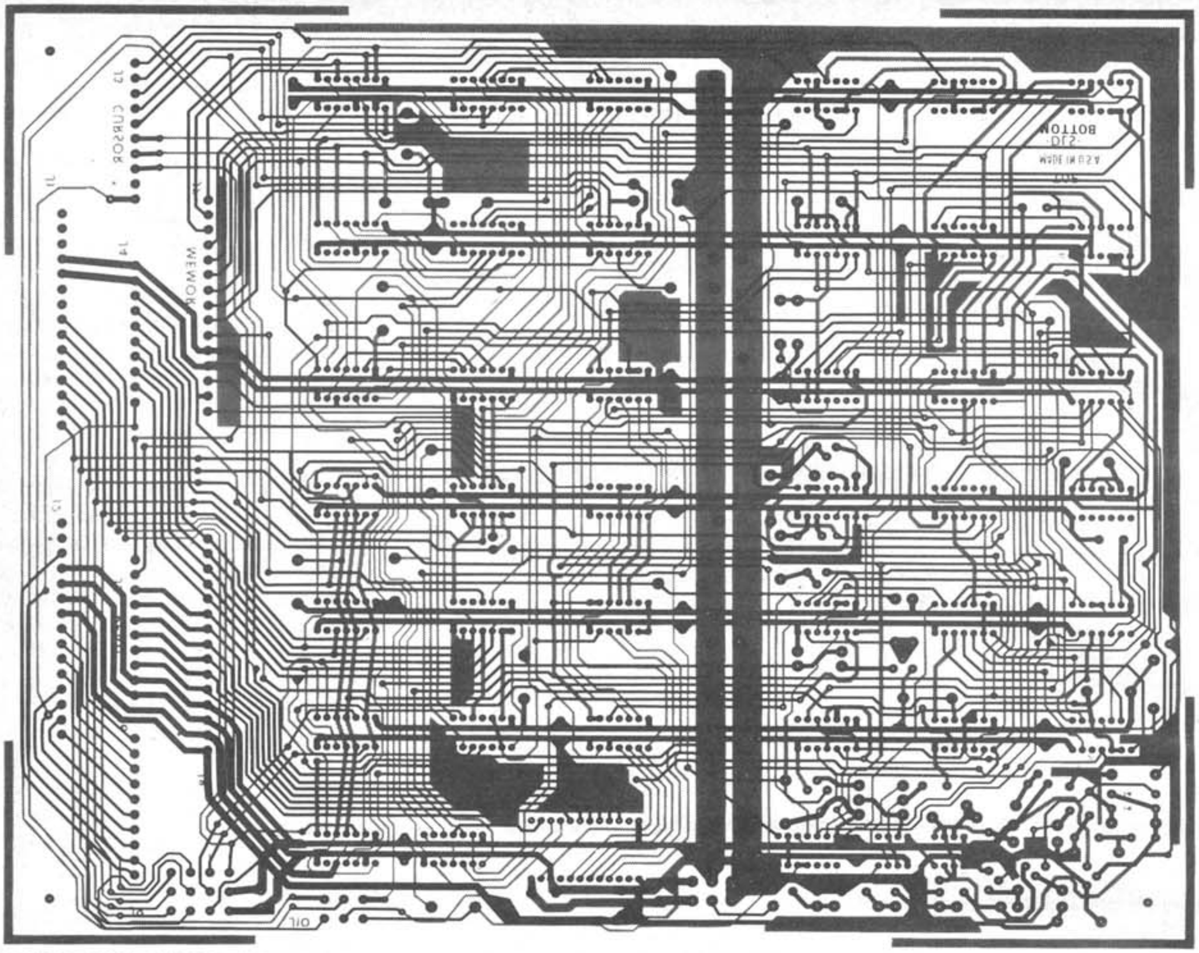
Each input character requires 3 "load pulse" time or 4.5μs to load. Because of this requirement and the fact that only 9 load pulses per character can be guaranteed; 540 characters per second is the maximum input rate. The first 102 lines are slected twice per frame so the write speed on the ⅝ of each page will be doubled or 1800 characters per second.

The cursor and compare circuits are very interelated since the circuitry must know where the cursor is positioned on the screen and when the memory is indexed to match with the cursor location so the cursor will blink in the right location. Since the character we will be entering through the keyboard will be entered in the cursor's position, the cursor counter also provides the address of the character we want to load into memory. The memory location of the cursor or character to be loaded into memory is stored in a 10-bit counter made up of IC35, IC27-a, IC34 and IC27-b. IC35 holds the data for the first sixteen horizontal character locations on a line and IC27-b sets if the location is on lines 17 through 32. The number of one of the 16 vertical page lines is stored in IC34, and IC27-b holds the bit addressing one of the two pages of memory.

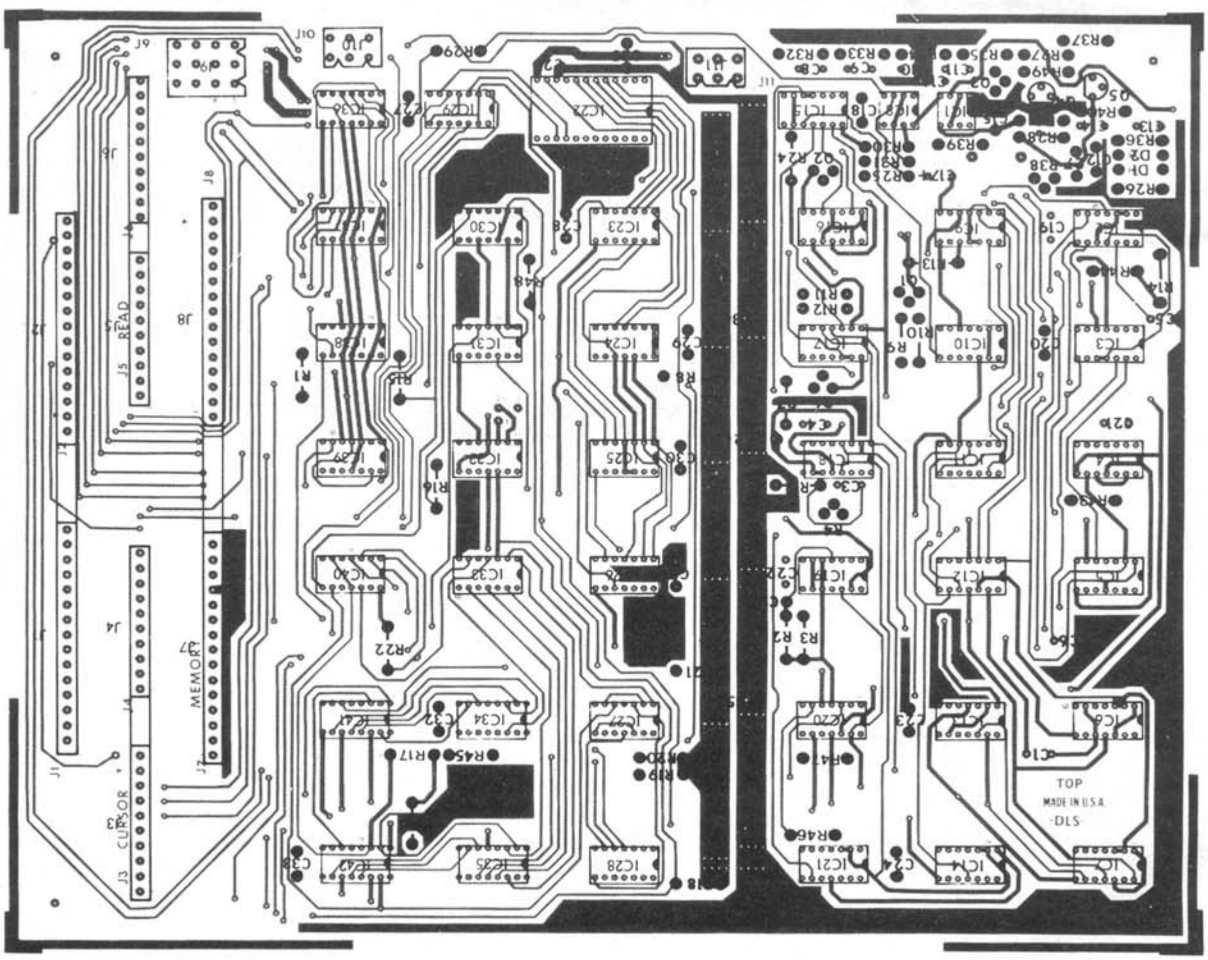
IC41 and IC42 are two 4-bit comparators that tell us when the data on two sets of its inputs is identical. The required 9th-bit compare is provided by IC40-c and IC40-d. The comparators are cascaded to generate one output telling whether two independent 9-bit addresses are equal, the address being that of the cursor and the location presently indexed. It is not necessary to perform a compare on the tenth or page bit because we will never be writing to or blinking the cursor on the page that is not currently accessed. The comparator circuitry monitors the address of the cursor counter and the outputs of the character counter, IC21 and IC14, and the line counter, IC7, and generates a high "compare" output when there is a match.

The cursor itself is generated by turning on all 35 of the character dots when AND gate IC17-c sees both a "compare" match and inactive blanking. The several times per second blinking is generated by the timer IC8 operating as an astable oscillator.

The cursor is positioned by incrementing and decrementing the up/down cursor counters IC35, IC27-a and IC34, which have full wrap around in each location and automatically

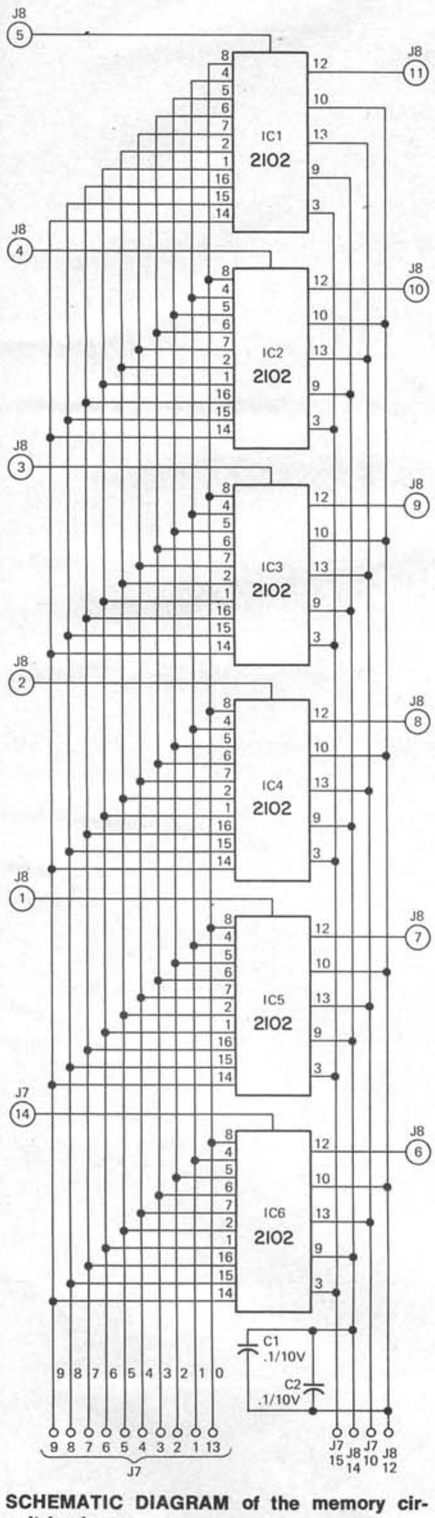


MAIN CIRCUIT BOARD foil patterns shown half-size. Above is an X-Ray view of the double sided board. The component layout is shown below.



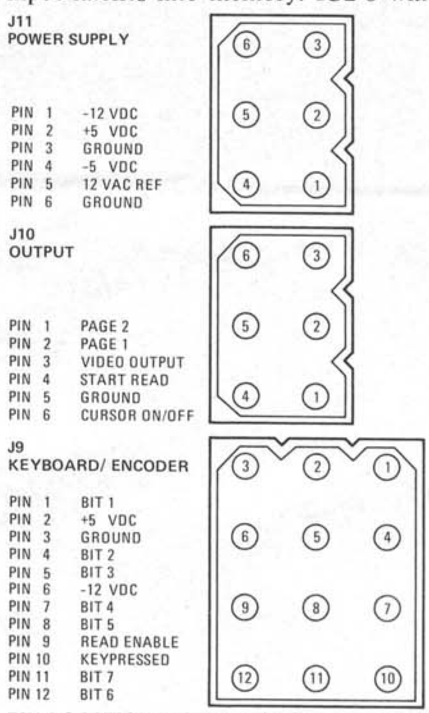
change pages as required. Although most of the actual cursor control circuitry is provided on the main board, the optional cursor control board is necessary to provide the switch debouncing necessary for reliable operation.

There are several cursor positioning functions provided. IC35 pin 5 and IC35 pin 4 move the cursor location one position forward and one location backward respectively. IC34 pin 5 and IC34 pin 4 move the cursor one location down and one location up respectively. IC35 pin 14 generates a carriage return and IC34 pin 14 generates a return to line 1 which means together they generate a home-up. IC34 and IC35 are responsible for line feed. The interconnected gating allows combinations to be performed with only one control command.

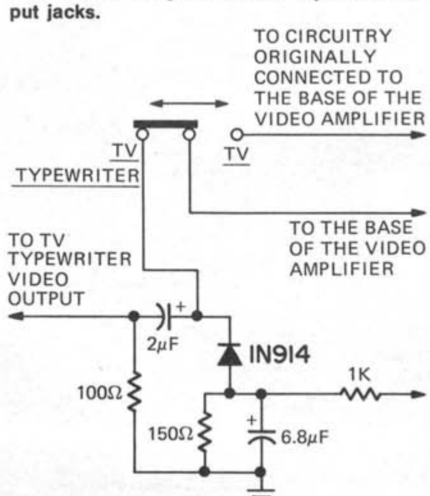


SCHEMATIC DIAGRAM of the memory circuit is shown.

The erase functions have been provided for as well and do not require the optional cursor control board. Erase from the cursor position to the end of the line is initiated by setting the preset input of IC9-b low, and erase from the cursor to the end of frame is initiated by setting the preset input of IC2-a low. If either of these two latches is set, it allows IC2-b to toggle at the onset of the next compare when the row counter reaches line nine. This generates a "memory load" command which loads a space or blank from the input latches into memory. IC2-b will reset on the first 33rd character indication from IC14 after latch IC2-b is set thus completing an erase to end of line (EOL). IC2-a will reset on the first blanking pulse from IC4-b after latch IC2-b is set, thus completing an erase to end of frame (EOF). The resetting of either causes IC2-b to reset and return it to its initial state.



PIN LOCATION guide for the input and output jacks.



SWITCHING CIRCUIT permits normal operation of TV receiver or as TV Typewriter display.

Assembly is not difficult

It cannot be emphasized enough that the best guarantee for initial and future trouble-free operation is to be extremely careful when putting the unit together.

The circuit board will be more rugged and reliable if the IC's are soldered in place on the board as shown in the photographs, but those with little experience in digital circuits, or electronic assembly might be wise to invest in some sockets; particularly for the memory IC's.

Install all of the integrated circuits, resistors, diodes, capacitors and then transistors before soldering anything. Note the components are to be mounted on the top side of the board, and the top side is marked "TOP". Double check everything to make absolutely sure all parts have been installed in their proper location and oriented correctly. Check carefully to be sure you haven't inadvertently oriented an integrated circuit incorrectly. This is easy to do and almost impossible to correct after soldering without ruining either the integrated circuit or the PC board, or both. When you are sure that everything has been installed correctly, then you may solder all of the component connections on the bottom of the board. All of the connections should be soldered regardless of whether or not there are electrical connections to the pad. This helps insure that none of the integrated circuits or component leads get bent and inadvertently short out to near-by foil conductors.

Now is the time to carefully check the entire board to be sure that all connections where applicable have been soldered. Make sure also that there are no solder bridges, or improperly installed components.

Follow the same procedure for assembling the memory board as you did for the main circuit board. The memory integrated circuits are MOS devices which are very intolerent of static electricity so be sure to take appropriate precautions. Here again be sure to check over the board very carefully after assembly to be sure there are no mistakes.

Attach all of the wires to the connector plugs for the power supply, J11, output, J10, and keyboard, J9. Use the connector drawing to show the appropriate pin connection for each of the

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TV TYPEWRITER II

(continued from page 63)

plugs and note that each of the connectors is indexed to allow them to be plugged in only one way. J10 and J11, however, are physically the same type of connector so use a felt tipped pen to mark one of the two sets to prevent yourself from inserting one of the plugs into the wrong jack. Try to keep all of the wires in the connector harnesses as short as possible and be sure the ground and +5v wires between the power supply and the main board are 18 gauge or heavier.

The power supply must be capable of supplying 5 Vdc, 2A at 5% regulation or better; −12 Vdc, 200 mA; and −5 Vdc, 15 mA. You can either build your own from scratch or purchase one from the source supplying the TV typewriter kits. You must make absolutely sure all of the power leads are wired correctly to the connector; otherwise you can cause a lot of damage when the power is applied.

Now its time to get out the television or monitor you plan to use. Although the actual modifications necessary will vary from set to set, the modifications shown will probably be satisfactory for most small screen transistor portables. The TV typewriter's output must be connected to the input of the television's video amplifier, which is located between the last video i.f. stage and the video output circuit. When you break the circuit right at the input to the video amplifier, you will probably have to provide a dc bias circuit for the stage since in most cases it is supplied by the now disconnected video i.f. amplifier. The circuit in Fig. 2 is for the Motorola 9TS-469 Q set used with the prototype. A switch and BNC connector were provided to allow either TV typewriter or normal television viewing.

A dc restoration circuit was also added to keep the screen intensity from changing as a function of the density of dots displayed.

Check the power supply to be sure the voltages are OK and that wiring to the connector is correct. Go back now to the main PC board and wire in the correct keyboard jumper. If your keyboard has a positive "keypress strobe" pulse, wire terminal 3 to terminal 1, and if it has a negative "keypress strobe" pulse, wire terminal 3 to terminal 2. These pads are just adjacent IC32 and are numbered on the top side of the board. If the keyboard has a 1 microsecond or less strobe pulse, either of the two positions will work properly.

Plug the "memory" board onto the main board using the set of connectors marked "memory." Be sure the top side of the memory board faces in toward the main PC board. It must not be plugged on the other way.

Connect the power supply, keyboard and television to the main board and after making a final check for errors, apply power. If you haven't made any mistakes and have a little luck, the unit will work first off. The only adjustments are the oscillator frequency adjustment pot, R38, the left margin control, R4 and the horizontal character size control, R6. The phase-locked oscillator should lock in over most of the range of the control R38, but may vary from unit to unit. An out of lock condition will be indicated by a slight vertical roll and a jitterey character presentation. The other two controls should be set to give the best display.

If the unit doesn't work, first check the power supply voltages to make sure they are OK and then use an oscilloscope to see whether or not there is a video output signal. If not, start checking from the phase-locked oscillator with your scope and try to locate the problem from there.

If you don't have any problems and everything seems to work correctly then go ahead and connect up the control switches. For maximum flexability the page-select switch, available at jack J10, should be a spdt center off switch;

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Circle 72 on reader service card

Circle 71 on reader service card

Circle 73 on reader service card

TV TYPEWRITER II

(continued from page 87)

then when either of the two pages are selected, the cursor will always remain on the same page even when the end of frame is reached. In the center position, the cursor will alternately jump from one page to the other as the end of frame is reached. As with all of the other switch connections to follow, the inputs are all tied high with pull up resistors so all switching should be done by grounding the appropriate terminal.

The cursor ON/OFF terminal, available on jack J10, if left unconnected will always cause the cursor to blink in the next character position to be typed. However, the blinking cursor may be turned off at any time by grounding the "CURSOR ON/OFF" pin on jack J10.

For maximum manual cursor control, the optional cursor control board should be used, however, the home-up (move cursor to upper left hand corner), erase to end of line (EOL) and erase to end of frame (EOF) are available at the pins to be used for the cursor control board. Temporarily grounding pin 10 of IC9-b will generate an erase of end of line, and temporarily grounding pin 4 of IC2-a will generate and erase to end of frame and grounding pin 12 of IC32-d will force a "home up." **R-E**

Serial Interface for TV II

To connect TV Typewriter II to a telephone or other two-wire system or to a magnetic-tape memory you need an adequate modem. Here's how to build one

ED COLLE

FOR THE TV TYPEWRITER II TO COMMUNICATE via a two-wire system, a phone line or a magnetic-tape data storage system, the parallel ASCII data must be broken down into sequential one-bit-at-a-time form both when coming out of the keyboard and going into the terminal. The serial interface or UART (*U*niversal *A*synchronous *R*eceiver/*T*ransmitter) provides this conversion from the parallel form into a series of properly timed one's and zero's including not only the serial data, but the start, stop and parity bits as well. The reverse is true during the receive mode. The baud rate or speed at which the serial data is transmitted or received can be selected from 110, 150, 300, 600 or 1200 baud with a single-pole rotary switch. There is a provision for "echo off" where the data is transmitted to the receiver, but is not put up on the screen until it is transmitted back by the receiver and displayed by the terminal; or "echo on" where the data is transmitted and simultaneously put up on the screen and is not echoed back by the receiver.

The input/output connections are type RS-232 compatible which will attach directly to most couplers and data sets, however, to record on or playback from magnetic tape it will be necessary to build some kind of FSK encoder/decoder system to get the digital data on and off the tape since this is not provided by the interface. Data to be transmitted can either be provided by the screen-read board or the keyboard. The interface normally monitors the keyboard, however, a "ready to send" command from the screen board locks out the keyboard and allows the screen-read board to transmit its data.

The entire circuit is built on a 3⅜" × 9½" circuit board that is plugged onto the main board at connector strips J1 and J2 just behind the cursor and screen-read boards. Switch connections to the serial

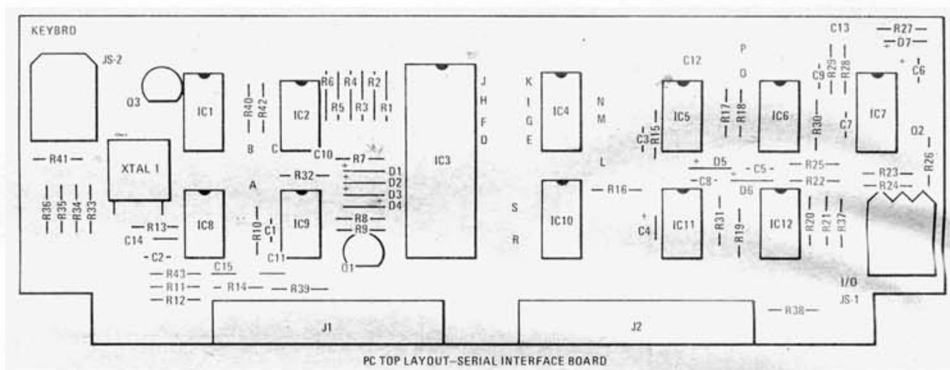


FIG. 2—COMPONENT PLACEMENT diagram.

SPECIFICATIONS

Receive Format:	E1A RS-232 and TTL compatible with a mark equal to + 1.5 to − 25 volts and a space equal to + 3 to + 25 volts. The range from + 1.5 to + 3 is the hysteresis region.
Input Impedance:	1800 ohms
Transmit Format:	E1A RS-232 with a mark equal to − 4.7 volts and a space equal to + 4.7 volts (2000-ohm load)
Baud Rates	
Standard:	110 baud
Optional:	110, 150, 300, 600, 1200—selectable
Stop Bits:	Automatic selection of 2 stop-bits for 110 baud and 1 stop-bit for 150, 300, 600 and 1200 baud
Parity	
7 bit:	odd, even, none
8 bit:	no parity (bit 8 programmable to a 0 or 1)

PARTS LIST
Serial Interface Board—110 baud

All resistors are ¼-watt, 10%, unless noted

R1-R7, R16, R24—22,000 ohms
R8, R15, R17, R20-R22, R29, R31, R37, R39, R42—1000 ohms
R9, R27—47,000 ohms
R18, R38—12,000 ohms
R19—2000 ohms
R23—3900 ohms
R25—27 ohms
R26—2700 ohms
R28—5600 ohms
R30—330 ohms
C3—470 pF capacitor
C4, C6—33 μF, 25 volt electrolytic
C5—.01 μF capacitor
C7—100 pF capacitor
C8—.001 μF capacitor
C9—330 pF capacitor
C10-C13—0.1 μF capacitor
D1-D7—1N4148 silicon diode
Q1—2N5210 silicon transistor
Q2—PNP general purpose transistor, gain = 100, maximum V_{ce} = 40 volts
IC2—7493 counter
IC3—S1883 UART
IC4, IC10—74157 data selector
IC5—74132 quad NAND gate
IC6—7400 quad NAND gate
IC7—74123 dual one-shot
IC9—7474 dual type-D flip-flop
IC11—7404 hex inverter
IC12—7403 quad open collector NAND gate

PARTS LIST
150, 300, 600, 1200 baud option

All resistors are ¼-watt, 10%, unless noted

R10—180 ohms
R11, R13—1800 ohms
R12, R14—470 ohms
R32-R36, R40, R41—1000 ohms
R43—2700 ohms
C1, C14—300 pF capacitor
C2—50 pF capacitor
C15—.005 μF capacitor
Q3—2N5210 silicon transistor
IC1—7497 rate multiplier
IC8—7404 hex inverter
XTAL 1—307.200 kHz series resonant crystal

The following items are available from Southwest Technical Products Corp., 219 West Rhapsody, San Antonio, TX 78216.

CT-S Serial Interface Kit $39.95
S1-b Serial Interface Circuit $11.75
Other add-ons for TVT-II include:
Screen Read Board Kit $17.50
(September 1975 issue)
Manual Cursor Kit $11.50
(November 1975 issue)

interface board are provided by a 12-pin connector (J1) while the keyboard is plugged into another 12-pin connector (J2) rather than J9 of the main terminal board as is done if the interface board is not used.

How it works

The serial interface circuit has been designed around a single UART chip that actually does most of the work. The other circuitry on the interface board interfaces the chip itself to the circuitry on the main terminal board. The schematic diagram appears in Fig. 1.

During the transmit mode, both the outputs from the keyboard and the screen-read board are fed into data selectors IC4 and IC10. These data selectors select either one of the two sets of inputs with the input from the screen-read board taking priority. Normally the keyboard is selected as the input. However, if the screen-read board starts to send data, the incoming low-to-high transition at J2 pin-13 triggers IC7-a, a retriggerable 350 ms one-shot. This selects the screen-read inputs and locks out the keyboard by driving pin 1 of IC4 and IC10 low. It also blocks any data from being received during a screen read operation if the jumper from S to R is installed by forcing pin 8 of IC9-a low. This gates the "output data available" line into the "reset data available" line of the UART chip. Since the keyboard and receiver are disabled for at least 350 ms after

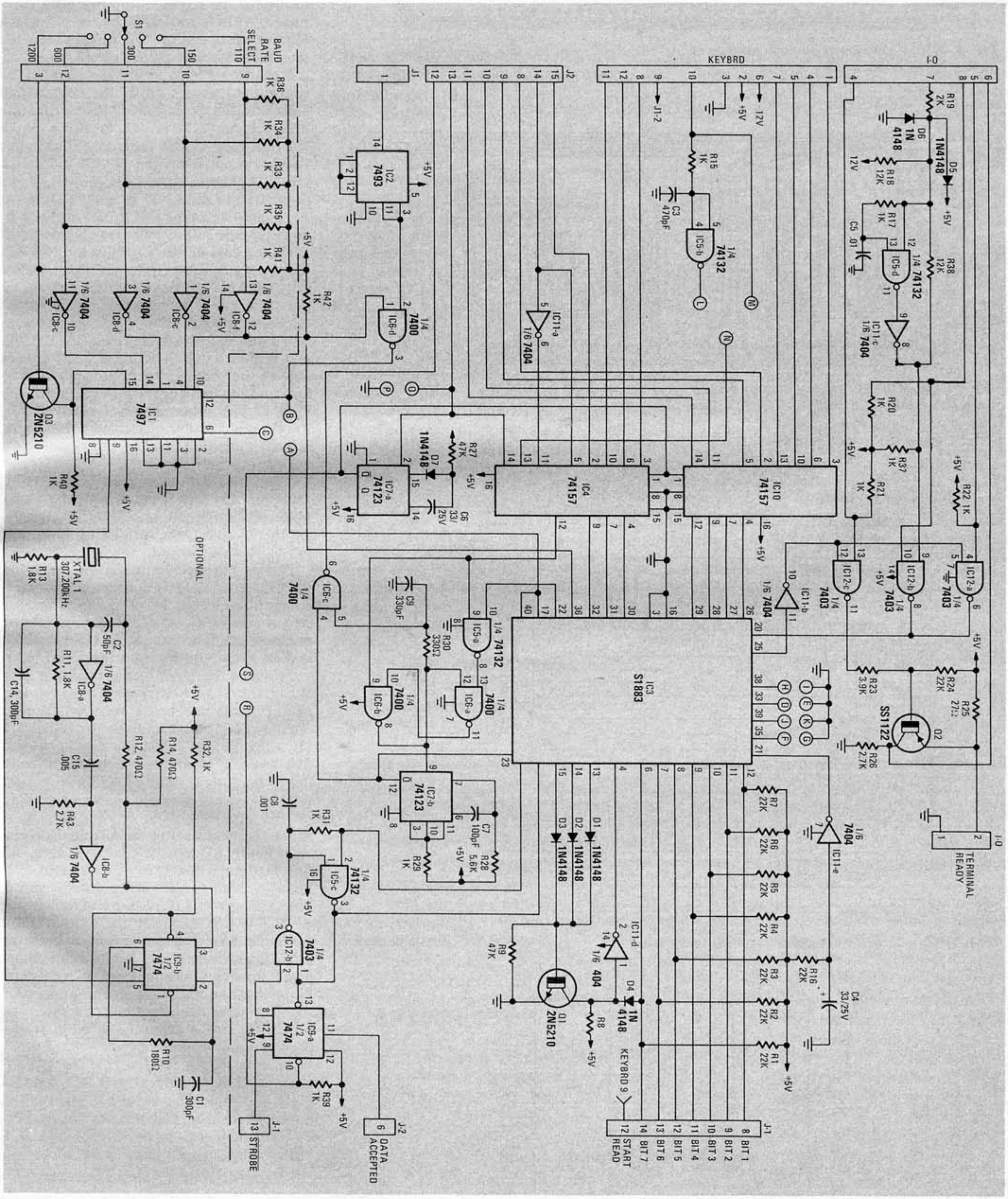


FIG. 1—SERIAL INTERFACE OPTION for TV Typewriter II.

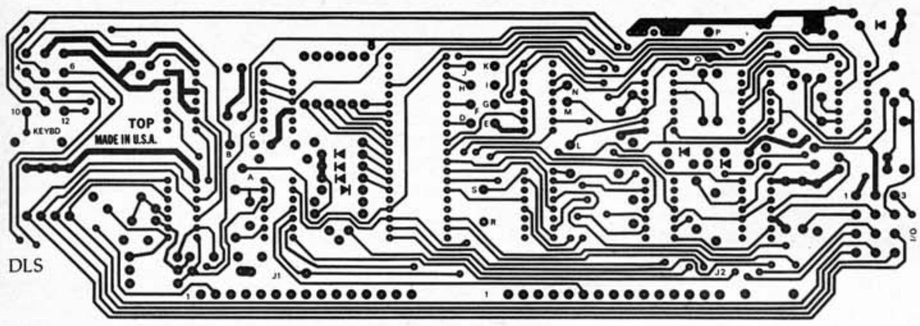


FIG. 3—FOIL PATTERN of component side of double sided board shown ½ size.

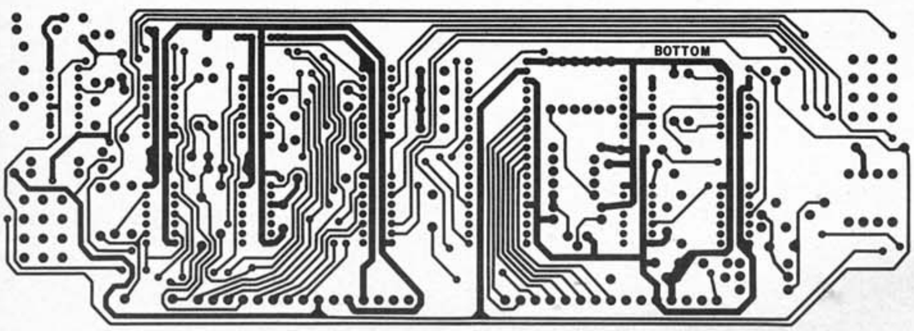
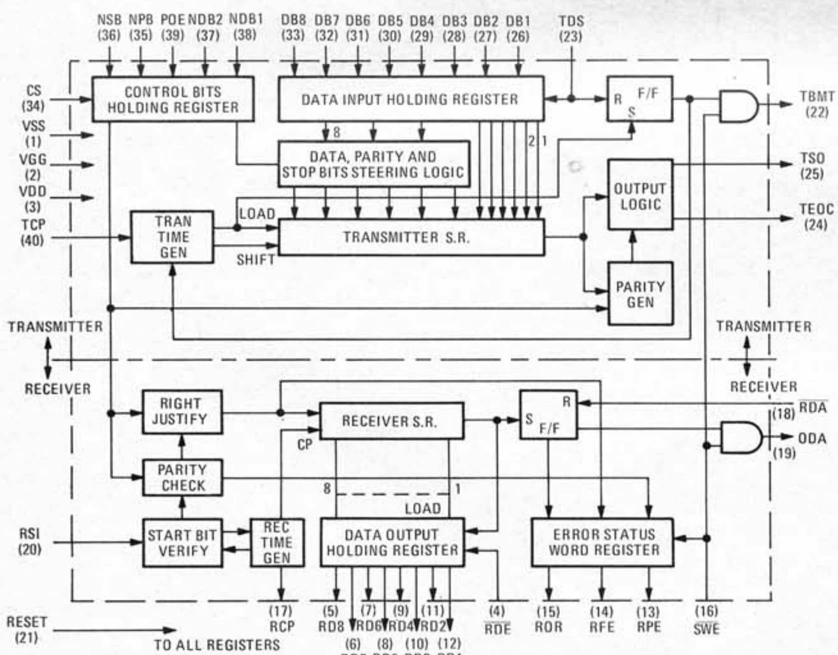
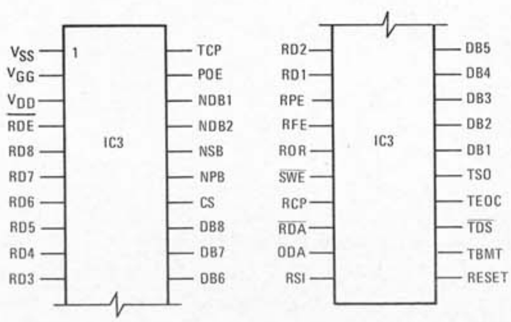


FIG. 4—FOIL PATTERN of foil side of double sided board shown ½ size.





each character is dumped during a screen-read operation, there may be problems with a computer sending a return message too soon after the screen-read operation is completed, especially when using high baud rates. In these situations, you may not want to lock out the receiver during a screen-read transmission and can omit the jumper between points S and R. You must be sure, however, that the TV Typewriter II is not in the echo mode and that the computer does not attempt to send data to it until the screen dump has been completed. This is indicated by an "!" transmission if the auto-stop function on the screen read-board is being used.

Regardless of whether the data to be transmitted comes from the screen-read board or the keyboard, it exits from the data selector IC4 pin-12 to IC5-a pin 9 where it is gated with the transmitter buffer empty output from the UART chip, IC3 pin 22. When IC3 pin 22 goes high, it sets the output of the AND gate latch (IC6 pin 11) high. Each time this (IC6-a and IC6-b) latch is set, a 250-ns pulse is generated that loads the data at the output of the IC4 and IC10 data selectors into the input buffer of the UART chip. At the trailing edge of the same pulse, a pulse is supplied to the screen read board until it resets and forces IC6-a pin 9 low which resets the (IC6-a and IC6-b) latch. This reset pulse that is sent to the screen-read board allows it to find and store its next character until the UART transmitter buffer is ready for it. This double buffering enables the transmitter to transmit at up to 1200 baud without gaps or hesitations.

The serial data leaves the UART chip, (IC3 pin 25) and is gated with the transmitter on/off input at IC12-c. Transistor Q2 then converts the serial TTL level output to RS-232 format.

During the receive mode, the incoming RS-232 serial data is converted into TTL compatible levels by a Schmitt trigger circuit consisting of IC5-d and its related components. The output at IC11-c pin 8 is then gated and fed into the serial input terminal of the UART chip (IC3 pin 20.) When the UART chip sees the stop bits of the character being received, output data available line changes to logic "1" (IC3 pin 19). If IC9-a pin 8 is at a logic "1" level, it means the terminal already has a character awaiting loading and is not ready to accept the new character waiting in the receiver data holding registers. When the character in the terminal's register is finally loaded, the character accepted line feeding IC9-a (pin 11) changes to a logic "0" and toggles IC9-a forcing pin 8 low. This permits IC12 to pulse the output of IC5-c low clearing the output data available line and generating a negative going keypress strobe to load the new character into the terminal's data registers. Note that the keypress strobe jumper of the main terminal board must be wired for a negative strobe when the serial interface is being used.

If an error is detected by the UART chip, it drives one of three IC3 outputs high. IC3 pin 14 changes to a logic "1" if a stop bit does not follow after the start bit and the correct number of data bits. IC3 pin 13 changes to a logic "1" if there is a parity error received. IC3 pin 15 changes

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SERIAL INTERFACE

(continued from page 62)

to a logic "1" if there is a condition where the receiver is being sent characters faster than it can accept them. If any one of these three error conditions occurs, transistor Q1 turns on and presents a "?" to the terminal as an error indication for the character(s) for which the error was received.

The standard baud rate for the unit is 110 baud and is derived from the 15,840 Hz phase-locked oscillator on the main board that is brought in through pin 1 of J1. The 15,840 clock frequency is divided-by-nine by IC2 to produce 1760 Hz required by the UART chip for 110 baud. For higher baud rates, a crystal oscillator with a 307.200 kHz crystal is required as well as IC1 and IC8. Inverters IC8-a and IC8-b form an oscillator with a frequency of 307.200 kHz that is fed to flip-flop IC9-b pin 4 where it is divided by two and in turn fed to a programmable divider, IC1 pin 9. By selecting correct inputs of this integrated circuit, the correct output frequency neccesary for each baud rate can be easily set. A five position rotary switch can be attached at jack J1 that grounds the selected baud rate line providing easy selection of either 110, 150, 300, 600 or 1200 baud. The 110-baud input inverter (IC8-f) also drives the stop bit select line of the UART chip, IC3 pin 36, to select the correct number of stop bits for 110 baud operation.

A terminal ready signal is provided at J1 pin 2 to tell external devices when the terminal is powered up, however, this output is a sense line only and should not be loaded when anything sourcing or sinking a current of more than 5 mA.

A power-up reset is provided by IC11-e to clear the registers inside the UART chip when power is applied to the terminal.

Construction

It is not very difficult to assemble the unit, just be sure to orient all of the integrated circuits, diodes, electrolytic capacitors, transistors, and connectors as shown in Fig. 2. Note that the connectors are notched and must be installed exactly as shown in the drawing. The foil pattern of the component side of the double sided printed circuit board is shown in Fig. 3, while the foil pattern of the foil side of the board is shown in Fig. 4. If you use the 150, 300, 600 or 1200 baud option, install the parts used for the crystal controlled oscillator and its related circuitry. Also attach a jumper between points A and C on the interface board. The various baud rates are selected by grounding the appropriate pin of connector J1. If you are not using the optional baud rates and wish to use the standard 110 baud then attach a jumper between points A and B instead of A and C on the interface board.

Without the screen-read board inserted on the TV Typewriter II main terminal board it will be necessary to jumper point O to P on the interface board. With the screen-read board installed on the main terminal board, omit the jumper.

If you want to guarantee that the receiver remains off during a screen-read dump, you will probably want to jumper point S to R on the interface board. If high baud rates are used and/or the turnaround time from whatever feeds the terminal is fast you may have to omit this jumper. If so, you must be sure the terminal is not in the echo mode and that whatever feeds the receiver of the terminal doesn't transmit during the time a screen-dump operation takes place.

It is also necessary to program the interface board for the correct parity and number of bits to be handled. The transmit and receive formats are identical and are programed with jumpers as follows:

Odd parity, no bit 8—jumper J to K and jumper I to H
Even parity, no bit 8—jumper I to H
No parity, no bit 8—jumper G to F and jumper I to H
No parity, bit 8 = 1—jumper G to F
No parity, bit 8 = 0—jumper G to F and jumper E to D

The appropriate keypressed strobe jumper should be installed. If your keyboard's strobe is positive going and narrow or if it is negative going and the data is held for at least 100 nanoseconds after the trailing edge of the strobe pulse, solder a jumper wire between pads L and N. Almost all keyboards will work in this configuration. Jumpering pad M to N instead is used for positive edge level triggering where the pulse is clean and there is no ringing. The board must not be wired for a positive keypressed strobe (M to N) if the screen-read board is used.

Before plugging the interface board into the main terminal board, be sure to insert the indexing key in J2 pin 2 to prevent the board from being plugged in backwards. Then orient the interface board so its component side is toward the center of the main terminal board and plug it into connectors J1 and J2.

Input/output and control lines for the interface are accessed thru connector J1. J1 pin 7 is the RS-232 compatible input and J1 pin 6 is the RS-232 compatible output. Pin 2 of J1 is a terminal ready status line that is high when power is applied to the terminal. You must be sure not to draw more than 5 mA from this pin when sensing this line. J1 pin 5, pin 4 and pin 8 control the receiver off, transmitter off and echo off, respectively. Grounding the respective control line shuts off the selected function and J1 pin 1 is ground. Note that when the serial interface board is used, the keyboard must be plugged into jack J2 on the interface rather than the J9 connector on the main terminal board on the chassis.

Checkout and use

The easiest way to check the unit out is to operate it in the echo mode and the receiver and transmitter switched off. This should display everything that is typed on the screen where it can be seen and checked. Since this mode uses both the transmit and receive circuitry, it is a good way to check everything on the interface for proper operation. If you have any problems, remove power and check carefully for assembly errors. If you find it necessary to troubleshoot the circuit, you will need an oscilloscope, a good background in digital theory and a thorough knowledge of how the unit operates. **R-E**