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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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TV TYPEWRITER II
Final Details

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quently, it will not be measureable at all. If I_{CES} is to be determined, short the base lead to the emitter lead and make the measurement in the same way as for I_{CEO}.

Transistors that are used in digital circuits have a few additional special characteristics, as they specify that the device may be used as a switch. When a transistor is used as a switch, the collector-to-emitter voltage when the transistor is saturated (that is, drawing its maximum collector current) is very important. For instance, if we wanted to use a transistor in a common-emitter circuit to drive the input of a series 7400 TTL gate, we would need a logic zero of at least 0.4 volt. This means that the collector-emitter voltage of less than 0.4 of a volt when sinking a maximum current of 1.6 mA from the input of the gate plus its own collector current.

To determine whether this transistor will properly drive its gates, use a curve tracer to measure V_{CE} (sat) or the collector-emitter saturation voltage. Figure 13-a shows the curves of an npn 2N2369 that is often used in such applications. Note that the saturation voltage increases as the collector current increases. Figure 13-b shows the same transistor, but here the base current is 100 times larger.

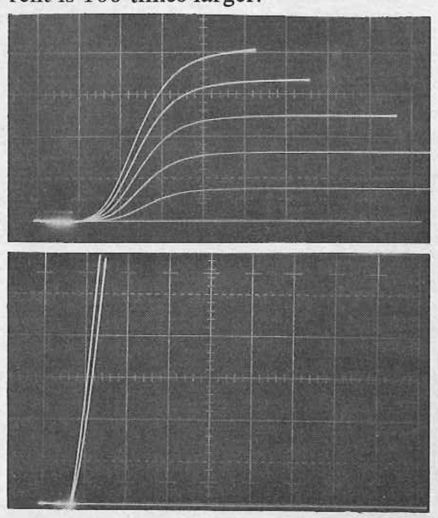


FIG. 13 — SATURATION VOLTAGE ON A 2N2369 switching transistor. a). The transistor is operated at moderate levels of base drive. Settings are: step generator, 0.02 mA/step; collector series limiting resistance, 50 ohms; horizontal sensitivity, 0.1 volts/cm; vertical sensitivity, 2 mA/cm. b). The transistor operates at high levels of the base drive, as might be found in a switching circuit. Settings are: step generator, 2 mA/step; collector series limiting resistance, 50 ohms. Horizontal sensitivity, 0.1 volt/cm; vertical sensitivity, 2 mA/cm.

In some critical applications, temperature has a great effect on transistor characteristics. One way to determine if a transistor will or will not cause problems in a circuit is to operate the transistor in a curve tracer, using collector voltages and currents that represent those of the anticipated application. Once a family of curves has been established, heat the transistor (a soldering iron, or even finger heat may be sufficient) and note any variations in these curves. With "looping", shown in Fig. 14, the characteristics of the transistor have actually changed

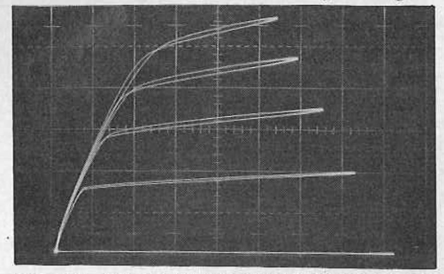


FIG. 14—THERMAL LOOPING CAUSED BY INTERNAL HEATING of the transistor. Transistor is a 2N3393, that has 200 mW dissipation. The curve tracer settings are: step generator, 0.1 mA/step; collector series limiting resistance, 100 ohms; horizontal sensitivity, 5 volts/cm; vertical sensitivity, 20 mA/cm. At the center of the display, the point where there is distinct thermal looping, represents a collector-emitter voltage of 20 volts at a current of 60 mA. This yields a power of 1.2 watts.

between the time the sweep makes the deflection from the left hand to the right hand side of the screen and its return.

In Fig. 15, we can see that with increasing collector voltages this effect can be carried to the limit, and

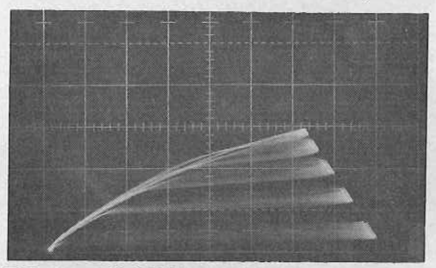


FIG. 15—THERMAL RUNAWAY CAUSED BY EXCESSIVE internal heating of the transistor. The entire characteristics of this transistor were changing as this photograph was being taken (one second exposure). The transistor was destroyed a short time later. Settings are: step generator, 0.1 mA/step; collector series limiting resistance, 50 ohms; horizontal sensitivity, 5 volts/cm; vertical sensitivity, 50 mA/cm.

the curves shown in Fig. 15 represent thermal runaway. At this stage, the transistor parameters are no longer under the control of the base current, but have completely succumbed to device heating. A transistor subjected to this test may be damaged quite rapidly, so work quickly.

When testing transistors on a curve tracer, setups should be made carefully, always starting with low initial voltages and currents, as semiconductor devices can be easily damaged. Curve tracers can produce large voltages and large currents, especially when compared to the limit parameters on small signal semiconductors. You can destroy a transistor within the first few sweeps of an improperly set-up curve tracer.

Certain hazardous conditions exist when making measurements. Transistors can get very hot when their parameters are exceeded and severe burns can result from touching the cases of both power transistors *and small-signal* transistors that have been used beyond their limits.

Curve tracers can produce exceptionally high voltages to insure breakdown of most junctions; they also have fairly large current capabilities. The net result is power supplies that are potentially lethal. It is altogether too easy for a person to come in contact with leads on devices that are under test, especially those which have metal cans. *Be sure to reduce the sweep voltage to zero before connecting or disconnecting the device from its test socket or leads.*

When intermittent tests for transistor breakdown are desired, the A-B switch is an excellent way to rapidly control the curve tracer. To compare devices, a "standard" transistor can be left in one socket and the second socket used to interchange transistors that are being compared or sorted.

The user must remember when making in-circuit tests, that parameters may not be exactly as expected, due to other components in the circuit such as resistors and large capacitors. To make exact parameter measurements on a transistor, remove it from the circuit.

3. Field-effect transistors—Like the bipolar transistor, the field-effect transistor has two major categories of different polarity devices. Unlike the bipolar device, field-effect transistors are voltage operated devices. Initial set ups for measuring field-effect devices include changing the step generator from the current mode to the voltage mode. Today there are six major categories of field-effect devices. Their set ups are shown in the setup table (see May 75 issue). A special note should be made of enhancement-mode field-effect devices, as some curve tracers can not provide the combination of sweep polarity and step generator voltage polarity to properly display their characteristics. One method to overcome this, for example with the n-channel enhancement type, would be to use a positive collector sweep voltage and a negative step voltage. This step voltage must be offset by some positive voltage so the most negative step produces a zero gate to source voltage. One way to do this is to place a battery or an adjustable power supply in series with the gate (the base terminal) of the curve tracer.

(to be continued)

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.

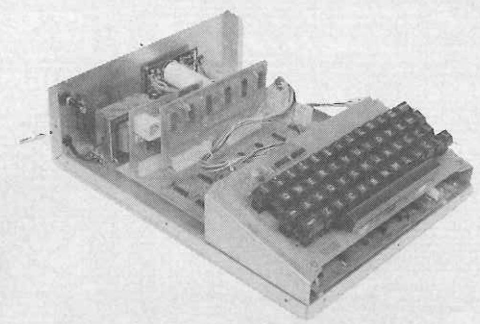
When the character counter reaches character slot 33, the 2^5 and 2^0 bits go to a one which in turn disable the "DOT CLOCK" until a new character line is started. Being in the 33rd character position also enables the video blanking circuit through IC12-c and IC5-b. Since the dot clock is stopped, the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

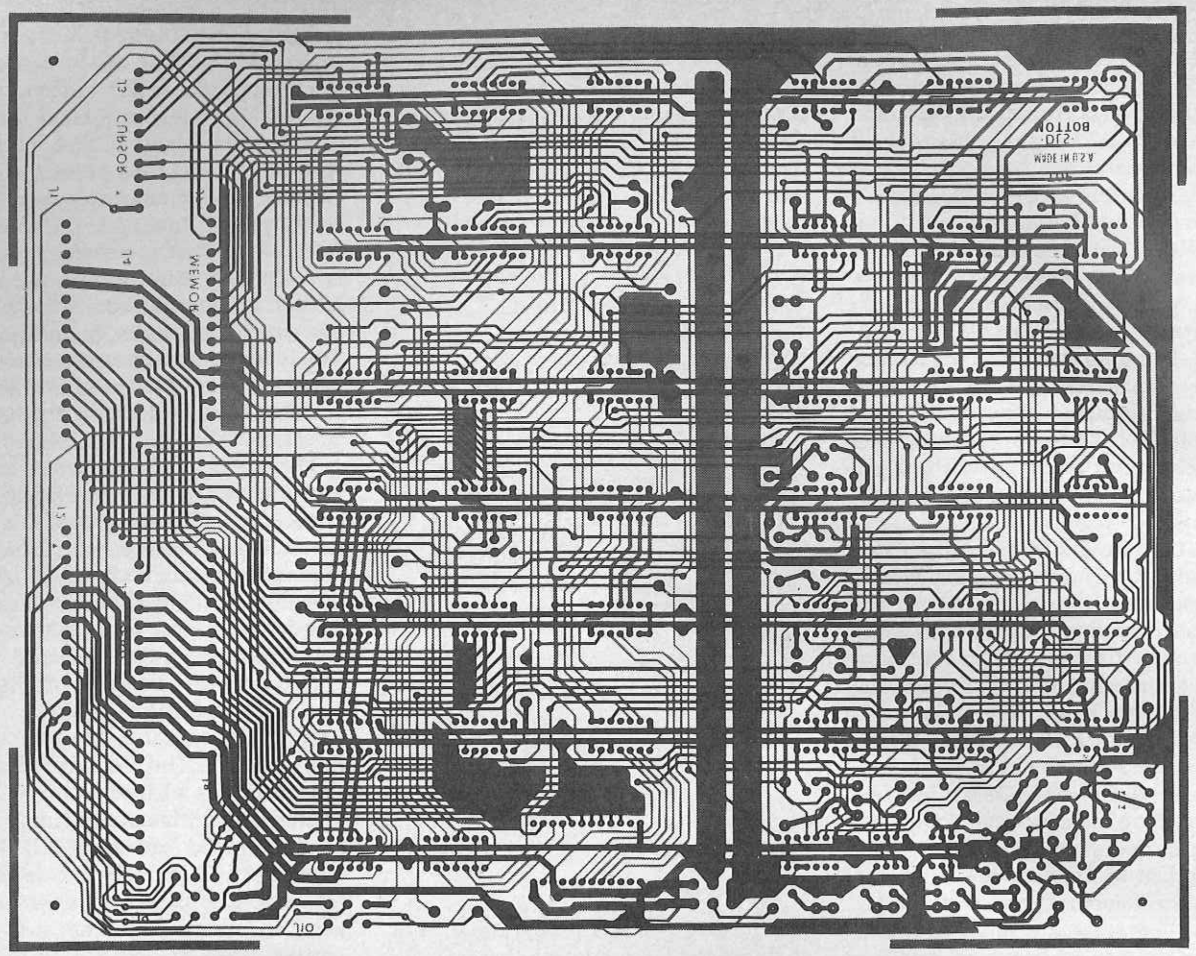
Each input character requires 3 "load pulse" time or 4.5μs to load. Because of this requirement and the fact that only 9 load pulses per character can be guaranteed; 540 characters per second is the maximum input rate. The first 102 lines are slected twice per frame so the write speed on the ⅝ of each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

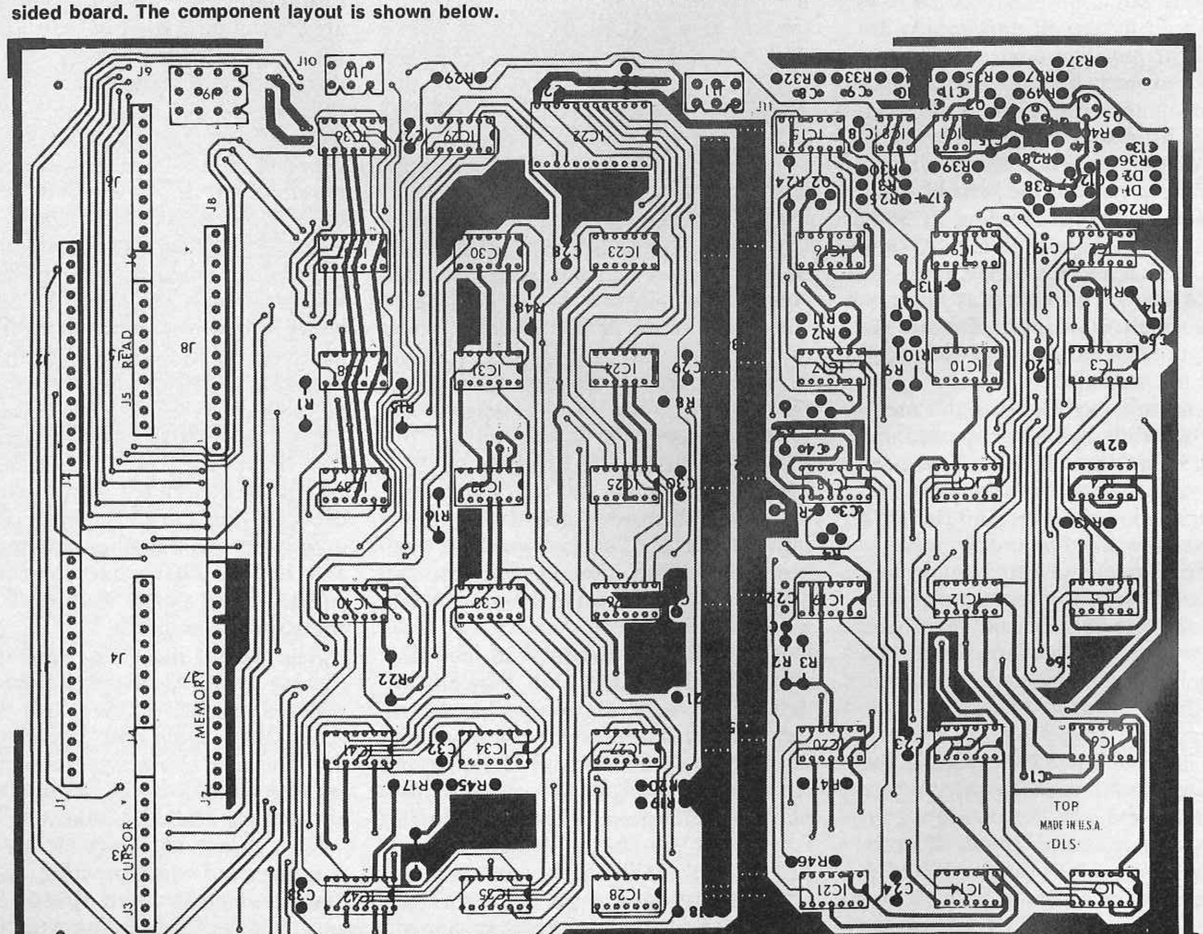
IC41 and IC42 are two 4-bit comparators that tell us when the data on two sets of its inputs is identical. The required 9th-bit compare is provided by IC40-c and IC40-d. The comparators are cascaded to generate one output telling whether two independent 9-bit addresses are equal, the address being that 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

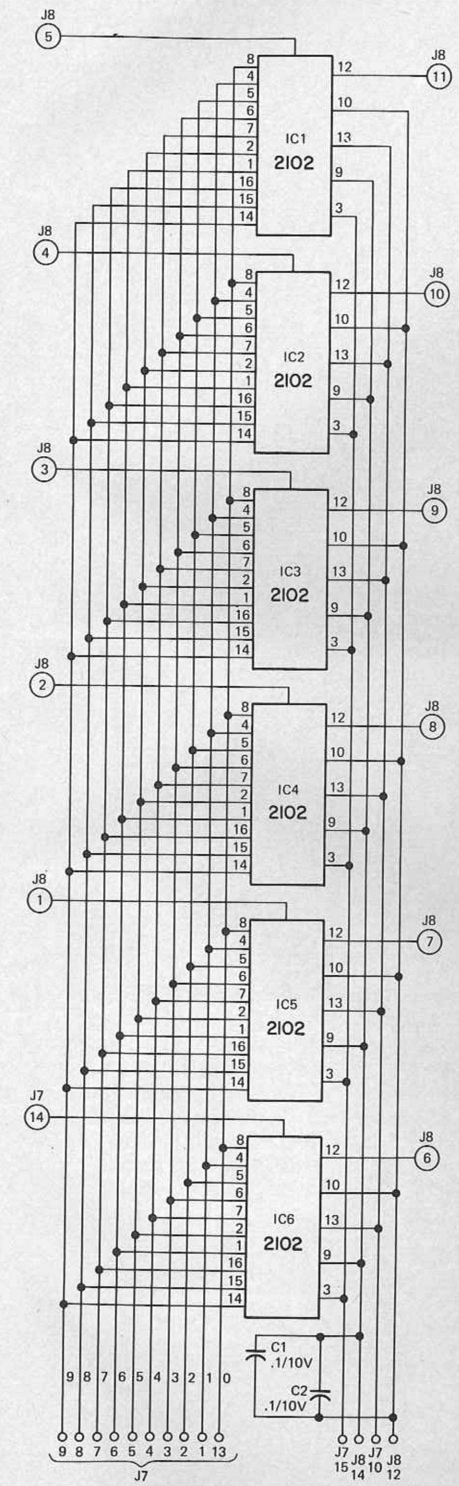


MAIN CIRCUIT BOARD foil patterns shown half-size. Above is an X-Ray view of the double sided board. The component layout is shown below.



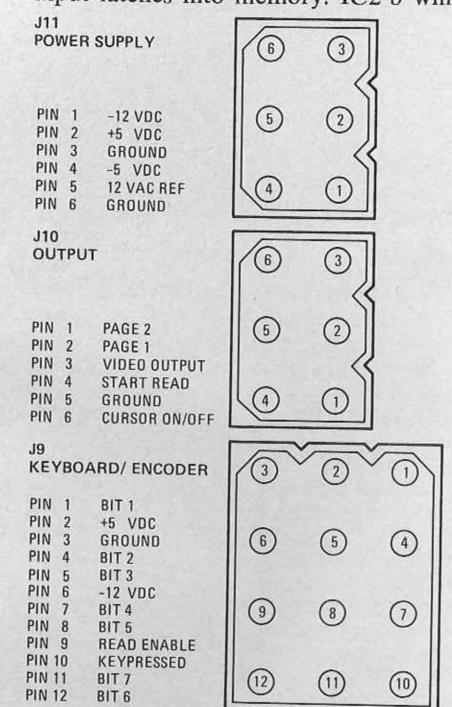
change pages as required. Although most of the actual cursor control circuitry is provided on the main board, the optional cursor control board is necessary to provide the switch debouncing necessary for reliable operation.

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.

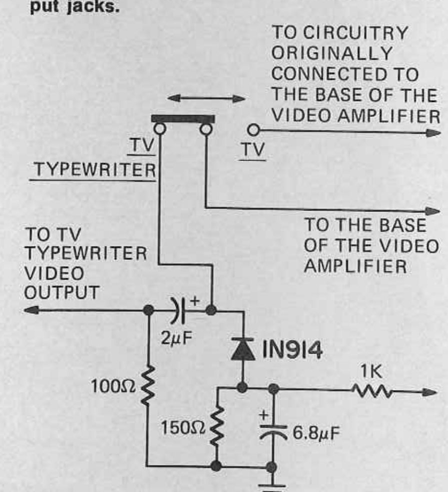


SCHEMATIC DIAGRAM of the memory circuit is shown.

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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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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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**

next month

MAY 1975

■ Understanding Tape and Bias

Matching the bias to the tape and getting it right will improve the performance of any tape recorder. See why it works and how to do it.

■ Electronic Ignition — 1975

A study of several of the latest circuits and how they work.

■ Servicing MATV Systems

Finding a fault in an MATV system isn't alway's easy. But there are ways to speed the job. Let an expert show you how.

■ Using The Curve Tracer

Final installment shows how to test semiconductors with a curve tracer, and what the results mean.

■ New Power Supply Kits From Heath

Eight new power supplies, in kit form. Four with digital readouts, 4 with analog meters. See how they work and what you can use them for.

PLUS

Equipment Reports

Jack Darr's Service Clinic

Radio-Electronics Replacement Semiconductor Guide

May issue goes on sale April 17, 1975