Assembly Instructions - CT1024 CRT Terminal

Introduction

The CT1024 unit is designed to store and display two individual pages of 16 lines of 32 characters on a modified television or video monitor. Connections to the television are made to the video input circuit which should be wired to the rear of the set with a jack. By providing a switch as well, you have the option of switching between terminal and normal television reception. Data input to the terminal can be from any ASCII source providing the 7 bits of alphanumeric data, however, an ASCII keyboard like our KBD unit will normally be used. Plug-in options also provide for manual cursor control, computer cursor control, screen read, and a universal asynchronous receiver/transmitter (UART). The power required for the unit is +5.0 volts @ 2.25 amps, 2% regulation, -5 volts @ 20 mA and -12 volts @ 60 mA. These requirements are satisfied by our P-197 power supply.

When the unit is assembled, it should be done so, one board at a time in accordance with the instructions.

Main PC Board Assembly

NOTE: Since all of the holes on the PC board have been plated thru, it is only necessary to solder the components from the bottom side of the board. The plating provides the electrical connection from the "BOTTOM" to the "TOP" foil of each hole. It is important that none of the connections be soldered until all of the components of each group have been installed on the board. This makes it much easier to interchange components if a mistake is made during assembly. Be sure to use a low wattage iron (not a gun) with a small tip. Do not use acid core solder or any type of paste flux. We will not guarantee or repair any kit on which either product has been used. Use only the solder supplied with the kit or a 60/40 alloy resin core equivalent. Remember all of the connections are soldered on the bottom side of the board only. The plated-thru holes provide the electrical connection to the top foil.

( ) Attach all of the resistors to the board. As with all other components unless noted, use the parts list and component layout drawing to locate each part and install from the "TOP" side of the board bending the leads along the "BOTTOM" side of the board and trimming so that 1/16" to 1/8" of wire remains. Trimmer resistors R4, R6 and R38 should be installed so the bottom of their cases are 1/8" above the PC board. Solder.

( ) Install all of the capacitors on the board excluding capacitor C6. Be sure to orient the electrolytic capacitors correctly. The polarity is indicated on the component layout drawing. Solder

( )   Install the transistors and diodes on the board. The diodes must be turned so the banded end corresponds with that shown on the component layout drawing, and the transistors must be turned to match the outlines on the component layout drawing as well. Solder.

( )   Install all of the integrated circuits on the board being very careful to install each in its correct position. <u>Do not</u> bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The semicircle notch on the end of the package is used for reference and should match with that shown on the component layout drawing for each of the IC's. Make sure the integrated circuits are down firmly against the board and solder.

( )   Now install electrolytic capacitor, C6, in is proper location between integrated circuits, IC1, and IC8. Be sure to polarize it correctly. Solder.

( )   Now that most of the components have been installed on the board, double check to make sure that all have been installed correctly in their proper location.

( )   Now check very carefully to make sure that all components have been soldered. It is very easy to miss some connections when soldering which can really cause some hard to find problems later during the check out phase. Also check for solder "bridges" and "cold" solder joints which are also a common problem.

( )   The six male printed circuit type pins should now be inserted into the blank Molex connector housing that does not have the nylon insulation between the pins. Do not confuse these pins with the crimp type which look very similar. The pins must be inserted from the back side of the connector into the housing until they snap into place. Orient the connector exactly as it is shown on the component layout drawing and install it in the J11 position from the "TOP" side of the board.

( )   Attach male connectors J9 and J10 to the circuit board from the "TOP" side making sure to orient them exactly as shown in the component layout drawing. Note that these connectors already have the pins installed. Make sure all of the pins are firmly against the nylon support. They can work loose when pressing them against the circuit board.

( )   After double checking to make sure the connectors are down firmly against the board and are oriented correctly solder the connectors J9, J10 and J11 in place.

( )   Now install all of the Molex straight pin male connectors, J1 thru J8. Insert the connectors from the "TOP" side of the board so the shorter pinned side goes into the board.

( )   After making sure that all of the connectors J1 - J8 are firmly against the board, solder each pin from the "BOTTOM" side of the board.

( )   Now the appropriate "keypressed" strobe jumper should be installed. There are three numbered pads adjacent integrated circuit IC32. If your keyboard strobe is positive going and narrow or, if negative, the data is held for at least 100 nanoseconds after the trailing edge of the strobe pulse: solder a jumper wire from pads 1 to 3. Almost all keyboards including our KBD unit will work in this configuration. Jumping pad 2 to 3 instead is used for positive edge level triggering where the pulse is clean and there is no ringing. Insulate the jumper to prevent its shorting to adjacent conductors.

( )   In order to prevent the plug-on boards from being accidentally installed backwards, a pin has been allocated for indexing on all but the READ board slot. The indexed pins are those indicated by the triangle adjacent the appropriate pin. There were no unused pins on the READ board so an indexing pin was not provided. Using a pair of wire cutters, snip off the indicated pin on each of the three connector strips. (J2 pin 2, J3 pin 9, and J8 pin 14). Later, pugs will be installed in the female connector of each of the boards to complete the indexing.

( )   Now go back and recheck all of the connections on the board to be sure everything has been soldered and to see that there are no solder "bridges" or "cold" solder joints. Note that the connectors J9, J10, J11 and their pins hove been supplied with their mate. These should be set aside and used as called for later in the instructions.

( )   Using a cotton swab and some lacquer thinner, clean the circuit board and solder connections within a 1" radius of transistors Q4 and Q5 as well as the leads and cases of transistors 04 and Q5. Be very careful with the lacquer thinner since it is very flammable. The lacquer thinner will remove excess flux and contaminates which may cause Problems in this portion of the circuit. It air dries very quickly and need not be washed off.

( )   Set this board aside now and start on the memory board.

Memory PC Board Assembly

( )   Install the capacitors on the circuit board. Insert them from the "TOP" side of the board, bend the leads along the "BOTTOM" side and trim so that 1/16" to 1/8" of wire remains.

( )   Now attach the two fifteen pin female connectors to the board. These must be installed from the "TOP" side of the board and pressed down so the connectors seat firmly against the board.

( )   The six IC's may be installed on the board now. The integrated circuits on this board are MOS devices which are sensitive and can be damaged by static electricity. It is best to try to avoid handling and touching the pins of the IC's as much as possible. Be sure and insert the integrated circuits from the "TOP" side of the board and orient them as is shown in the component layout pictorial. <u>Do not</u> bend the leads on the back side of the board. This makes it very difficult to replace the integrated circuit should it ever be necessary.

( )   Check to make sure all of the components are down firmly against the board, installed in the right location and oriented correctly. Flip the board over so the "BOTTOM" side is up and solder all of the connections with a low wattage iron. Note that the board need only be soldered on the "BOTTOM" side. The plated-thru holes provide the electrical connections to the "TOP" foil.

( )   Looking at the board from the "TOP" side with the connectors at the bottom, press the nylon indexing plug into the second position from the outside end on the right connector (J8 pin 14).

( )   Now go back and check for missed solder connections and solder "bridges" and "cold " solder joints. When everything looks OK then set the board aside and do not plug the memory board onto the main PC board. Proceed now to the P-197 Power Supply board assembly instructions supplied with the power supply kit, unless you plan to use a different one in which case you should continue with the connector wiring instructions below.

Power Supply Connector Wiring

It will be necessary to attach a wiring harness and connector to the power supply you plan to use. Follow the wiring table given below, attaching the power output wiring to the female pins of the six pin connector supplied with the terminal kit. Try to keep the length of the wiring harness less than 1 ft. When all of the pins have been attached, insert each into the six pin nylon housing from the numbered side making sure you snap each pin into the appropriate hole. Note that the connector block is marked with the assigned pin numbers. Apply power to the supply and check at the connector to make sure that you have the correct voltage at each pin. Remove power and proceed to the keyboard assembly phase of the instructions.

	GAUGE	**FROM**	**TO**
1.	#18 or heavier	+5	connector pin #2 of J11
2.	#18 or heavier	GND	connector pin #3 & 6 of J11
3.	#18 or heavier	GND	chassis ground
4.	#22 or heavier	-5	connector pin #4 of J11
5.	#22 or heavier	-12	connector pin #1 of J11
6.	#22 or heavier	REF	connector pin #5 of J11

Keyboard Assembly

The terminal has been designed to work with any keyboard providing ASCII output. If you plan to use our KBD keyboard then refer now to the keyboard assembly instructions. If you plan to use your own keyboard or when you have finished assembling the KBD kit, it will be necessary to attach the connector and wiring harness to the unit as described below.

( )   With the aid of the connector drawing attach and solder #22 gauge or heavier wire to the keyboard outputs Bit 1 - Bit 7, "keypressed" strobe and ground pads. If the keyboard requires +5 or -12 volts, it can be obtained through the wiring harness as well. If the optional screen read board is used, the "START READ" line can be driven off of an unused keyboard key or switch if you have one. Connector pins should be attached and soldered to each of the wires. Note that the pins should all be female except for pins 3, 7, and 12 which should be male pins. Snap each of the pins into the 12 pin nylon housing from the numbered side making sure to snap the correct pin into the correct location. Note that the nylon connector block is marked with the assigned pin numbers. The male pins provide the indexing necessary for proper orientation.

Final Assembly

The last connector to be wired is the output connector, J10. The only connection that must be wired for the unit to work is the video output connection, pin 3. Page 1 and page 2 select pins, pin 2 and 1 respectively, can be wired to a center off SPDT switch to select a specific page of memory or in the center off position alternate between pages 1 and 2. Grounding the selected page pin will display and maintain that page until the ground is removed at which time it will alternate from page to page each time end of frame (EOF) is reached. The cursor ON/OFF, pin 6 may be grounded to stop the blinking of the cursor and make it solid. You can eliminate the cursor entirely by grounding point "M" on the main circuit board thru a switch. If you plan to use the screen read option, the "read enable" line is accessed thru J10 pin 4.

If you do not plan to use either of the cursor board options, you can still have home up, erase to end of line (EOL) and erase to end of frame (EOF) by providing momentary contact pushbutton or toggle switches which temporarily ground J3 pin 1, J3 pin 7 and J3 pin 8 respectively.

( ) Attach and solder all of the J10 wires from the switches or jacks to the appropriate female connector pins, except for pins 3 and 5 which should be male pins. Insert the pins into the six pin nylon housing from the numbered side making sure to insert the pins into their correct position on the connector from the numbered side. Note that the nylon connector block is marked with the assigned pin numbers.

( ) If you have plugged the memory board, onto the main board, remove it. The memory board should not be installed during the initial checkout.

( ) Now attach the large PC board to the chassis or base plate you wish to use. (Not supplied with the kit).

( ) Attach the keyboard connector J9, output connector, J10 and the power supply connector, J11 to the main board. Do not apply power yet however. If you plan to use any of the add-on options, it is best that you wait to make sure the main board and memory works first before building and plugging them on.

Television Modification

As it stands now your unit should work on a video monitor or modified television set. Because of rigid FCC requirements, the circuit has been designed to be connected directly to the video input circuit of a television. This requires the addition of a jack and if normal television reception is desired as well, a switch to select the operating mode.

Although the actual modifications necessary will vary from set to set, the modifications shown will probably be satisfactory for most small screened transistor portables. In order to make things as easy as possible, however, it is recommended that if you're going to invest some money in a new set that you use the same model as was used with our unit. This will assure you that the modifications suggested will work. The T. V. typewriter's output must be connected to the input of the television's video amplifier, which is located between the last video IF 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 IF amplifier. The circuit shown in figure 2 is for the Motorola 9TS-469 Q set used with the prototype. A switch and BNC connector were provided to allow either T. V. typewriter or normal television viewing, however a RCA type connector can be used. A 10 pfd capacitor was connected from the screen grid (pin 6) to cathode (pin 2) of the CRT to flatten out a peak the television's response. This is not necessary on all sets but if so corrects a peak which causes the character's left side to be brighter than the right side.

A DC restore circuit was also added to prevent the screen intensity from changing as a function of the density of dots displayed. It consists of two series 1N914 diodes in parallel with the resistor coming off the wiper of the brightness control going to the cathode resistor of the CRT. The cathode end of the diodes goes toward the wiper of the control. A 2 mfd @ 250 VDC non-polarized capacitor is also connected from the wiper of the brightness control to the grid (pin 6) CRT where the 10 pfd capacitor was just connected.
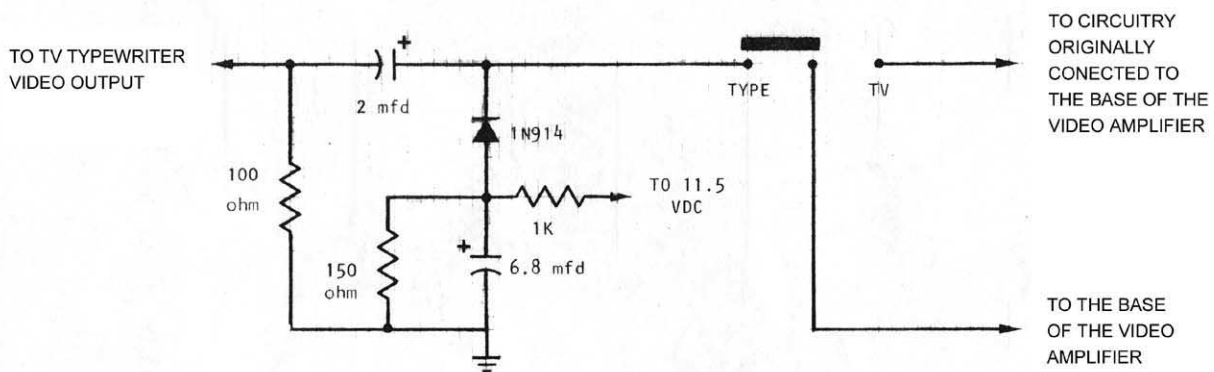

Figure 2 – Video Input Modification for Motorola K9TS-460Q Television

Testing and Calibration

Turn the television on, flip the switch to the "TV" position, and make sure it still works. Adjust all of the controls for the best picture and then flip the switch to the "terminal" position. Turn the volume down and advance the brightness until the white background is faintly visible. The settings should now be left where they are until you have connected the terminal and have a character field displayed on the screen as described in the forthcoming instructions. It is also recommended that you give the unit one last check to make sure everything has been wired and installed correctly. The board has been laid out so all of the IC's are oriented the same way so check and make sure they are installed that way. Also make absolutely sure the power supply is connected correctly. Accidentally reversing the voltage may short the protection diodes D3 - D5 and hopefully protect the IC's, however, excessive current may open the diodes which in turn can damage most of the IC's on the board.

( )   Remove the memory board if it has been plugged onto the mainboard. It should not be installed for the initial checkout.

( )   Set trimmer resistors R4 and R38 for the center of rotation and set trimmer resistor R6 fully counterclockwise.

( )   Attach the output of the terminal to the input jack of the television or video monitor thru a shielded connecting cable.

( )   Before applying power to the unit, it is a good idea to attach a voltmeter between ground and the +5 volt bus on the unit. Easy access is provided by the two large buses extending from jack J11 running across the board on the component side. Polarity is indicated by the markings on electrolytic capacitor C34.

( )   Plug the unit's line cord into a wall outlet, and flip the power switch on and then quickly off again. Watch the meter and confirm that the power supply polarity is correct. Apply power again making sure the voltage comes up to +5 volts DC. If it does not, remove power and determine whether the problem is in the supply or the main board. The power supply recommended for the unit should easily provide sufficient voltage for currents up to 2.25 Amps, but high currents will cause reduced voltage and eventual damage to the supply and terminal. Also check the -5 and -12 supply buses to make sure these voltages are correct. The reading should be within about 10%.

( )   Going back to the +5 volt supply now, it may be necessary to readjust the trimmer on the P-197 power supply board to get exactly 5 volts DC. If readjustment is necessary, be very careful not to advance the voltage any more above 5 volts DC than necessary.

( ) You should have a display of random characters on the screen probably @ or ? changing back and forth on certain areas of the screen. If you do not have a readable display, adjust trimmer resistor R38 slowly until the picture becomes readable. To make things easy, you can turn up the volume on the set to the point where you hear whine. Intermixed in this noise, you will hear a beat frequency which should vary with the setting of R38. When the beat frequency goes to zero, the television is synced with the terminal and you should have a readable display. The brightness and contrast controls on the television may then be adjusted to give the most attractive display. If you are not able to get a readable display, remove power and recheck all assembly procedures. If this proves fruitless, the next alternative involves probing through the circuit with an oscilloscope along with a thorough knowledge of how the circuit works. This requires a good background in digital theory and is not a recommended procedure for the novice.

( ) Adjust trimmer resistor R4 to center the display and adjust trimmer resistor R6 to give a character size that is most attractive. Making the character size too small sometimes will cause the unit to display incorrect characters so watch out.

( ) If everything has checked out so far, remove power and install the memory board. Do not install the memory board if you are having problems. Its IC's are expensive and it is best left off until the problems have been corrected. Orient the board so the component side faces toward the IC's on the main board. An indexing key has already been inserted to help prevent board reversal from happening. Make sure, however, the indexing key was put in the proper position during assembly.

( ) Apply power again. Now the home-up, erase to end of the line (EOL) and erase to end of frame (EOF) functions should be working. If you are using one of the cursor boards, it would be best to wait until you finish checking out the main board before installing them. However, you can check the main board home-up by temporarily grounding J3 pin 1, erase from cursor position to end of line (EOL) by temporarily grounding J3 pin 7, and erase from cursor position of end of frame (EOF) by temporarily grounding J3 pin 8. If you are not using one of the cursor control board options and have provided switches for these functions, simply depress the appropriate switch and check for proper operation.

( ) Cursor vertical and horizontal positioning can be checked by temporarily grounding the appropriate control pin. Upon grounding and ungrounding J3 pin 3, the cursor should move down several spaces and upon reaching the bottom of the screen, wrapping back around to the top. J3 pin 5 moves the cursor up. J3 pin 2 moves the cursor forward and J3 pin 4 moves the cursor backward; here again with wrap around upon reaching the and of the screen. Note that you have no real control over the number of spaces the cursor jumps. The cursor control boards when installed provide the switch debouncing necessary to prevent this from happening.

( ) If you are feeding the terminal directly from a keyboard, try all of the keys and make sure everything is working correctly. If double printing occurs, it is probably due to ringing created by excessively long wire between the keyboard or the driving device feeding the terminal. If this occurs try putting a 330 pfd capacitor from the "keypressed" strobe output on your keyboard to ground. Most MOS type keyboard encoders are too slow to cause problems such as this but TTL ones are not, especially if connected with 3 feet or more of wire.

( ) Check the line feed and carriage return for proper operation. If this page select switch is in the center off position, repeated line feeds should bring up the alternate page at the end of the screen. Either one of the two pages may be selected or maintained at any time by flipping the switch to the appropriate page position.

Note: Upon applying power both pages of memory will generally come up with random data. To clear each page, it is necessary to select the page to be cleared, perform a home-up and then erase to end of frame (EOF).

This completes the checkout phase. Although this doesn't guarantee that everything is working correctly, it does check most of the circuitry on the main unit which is helpful should you have problems with any of the option boards. You should now be build, install and test your optional boards following the instructions supplied with the option.

In Case of Problems

If you have problems on some phase of operation of the terminal, the best recommendation is to remove power and recheck your assembly over very carefully with the instructions. If you still cannot find the problem and feel secure in your understanding of digital circuits, you can troubleshoot the unit with an oscilloscope. This does, however, require a thorough understanding of how the unit works as is described in the accompanying article. If you are still not able to locate the problem or prefer not to service the unit yourself, please consult us before sending the unit in for repairs.

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 so there are 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 televisions 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/char x 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 as well.

The timebase oscillator as indicated in the schematic is responsible for initiating the horizontal sync pulse and for starting the chain of events that will generate one line of video data to be displayed. The circuit itself is a phase locked loop employed as a frequency multiplier. IC1 is used as an astable voltage controlled oscillator with bipolar transistors Q3 and field effect transistors (FET) Q4 along with capacitor C12 forming a sample and hold circuit which feeds IC1's voltage control input through FET Q5. The sample and hold in this case is being used as a phase comparator providing an output voltage proportional to the phase difference of the 60 Hz power line and the multiplied output frequency of IC1. The actual amount of frequency multiplication is equal to the amount of frequency division between the output of the oscillator IC1 and the input reference frequency. As we will see later, the value of the frequency divider is 264 and since our reference is 60 Hz the fo = 60 Hz x 264 - 15840 Hz which is very close to the horizontal oscillator frequency of a standard television set.

The output of IC1 is fed via inverter IC20A to IC19 A and B where among other things a 4 microsecond horizontal sync pulse is generated. From here the pulse is routed to IC17A where it is ORed with the vertical sync pulse which will be described in detail later.

The falling edge of this sync pulse at the output of IC19B triggers IC18A, a one shot, which puts out a positive pulse on pin 4 adjustable by potentiometer R4 from 4 to 20 microseconds. The delay pulse creates a lag between the television's start of video sweep and the T. V. typewriter's generation of data thus giving an adjustable left margin. Pin 4 of IC18A inhibits dot oscillator IC18B thru AND-OR-INVERT gate IC11A. Pin 4 also resets IC21 and IC14 the 16 bit counters which 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 transition of pin 4, IC6, the now 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 which 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 lot 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 x 6 = 160 dot video scan lines.

Now for those of you who are familiar with television circuits, you probably know that we need more like 264 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 IC4B which has been in the Q output = 1 state during the last 160 video data lines is now toggled through AND gate IC5A and NAND gates IC19C and IC13A. When IC4B 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 IC4B is low. This mode continues line by line until the line counter reaches a count of 40. Lines 40 thru 50 are then used to generate the vertical sync pulse required by the television. NAND gate IC13B along with inverters IC20A, B, and C perform the actual line number decoding. Note that the output of the timebase generator is NAND ed as well in IC13B along with the line counter data. This chops the vertical sync signal as required by the television. The output of IC13B is then fed along to IC17A where it is combined with the horizontal sync signal to form the composite sync signal at the output of AND gate IC17A. At line 50 the vertical sync generation is stopped and the line and row counters continue to count to 104 which is decoded by IC13A. Note that the Q output of IC4B is NAND ed as well by the decoder IC13A, since the 104 count is not significant when in the "display dot video" mode. The output of IC13A in turn generates a positive clock pulse to IC4B through AND gate IC5A making the Q output of IC5A high again as it was when we started. The same signal off the output of IC13A resets the row counter, IC6, and line counter, IC7, back to a count of 0 thus completing the 264 line/frame cycle of 160 lines of video, 40 lines of blanking, 10 lines of vertical sync, and 54 more lines of blanking.

Now lets get back to the horizontal portion of the circuit again. We left off earlier by saying that one shot oscillator, IC18A, provided an adjustable delay between the horizontal sync pulse and the generation of data to provide a left margin. We also said that an astable oscillator IC18B which is inhibited during this delay phase via IC11B is the dot generator which 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 nanoseconds which in turn sets the horizontal width of the characters displayed. The "dot clock" output however is not the output of IC18B but rather the output of the AND - OR - INVERT gate IC11A. It's output is normally high, but goes low for about 30 nanoseconds each time IC18B resets. This 30 nanosecond pulse time is set by the propagation time of IC18B and IC11A and is very hard if not impossible to see with most oscilloscopes. This "dot clock" is used to toggle the "dot bit" shift registers IC23 and IC24.

The horizontal dot data for each character is composed of five dots and two blanks 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 in order 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 seven bits have been clocked out. It senses by detecting the one's that have been shifted into the register serially while the significant dot data was being clocked out by the "dot clock". This low transition on the output of IC25 which is inverted by IC12B changes the dot register from the shift up to the parallel load data mode. The some 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 IC17B 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 IC5B sees the 8 and 9 counts of the row counter through IC12A, it's 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. 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 IC12C and IC5B. 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 inputing 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 soma kind of a "data ready" line to tell the terminal when new data has been applied to the data input terminals. In the case of 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 IC32A has been provided as an optional inverter. When the "keyboard strobe" pulse reaches the "clock" input of IC9A, it toggles forcing IC36B, IC37A, IC37B, IC38A, IC38B, IC39A and IC39B 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 IC32B will go high forcing the output of IC11B low resetting IC9A and preparing IC36A 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 IC26A goes high it clears all of the data input latches IC36 - IC39. If on the other hand, the character is a printable character, IC32B will stay low forcing IC11A low thus eliminating IC9A's clear command allowing it's Q output to go to a one when toggled by the keyboard strobe. On the next "load pulse" IC16B is clocked high. The high output of IC9A and IC16B are now AND ed and prepare IC16A to be switched on the next load pulse from IC25. When IC16A toggles, its Q output goes high setting up one of the two inputs to NAND gate IC15B and it then waits for a "compare" command from AND gate 10D. The input from IC12D is AND ed 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, IC3D goes high forcing IC3B high, which forces IC15B low. This makes IC10A 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 IC3C goes high forcing IC11B low which

resets IC9A and dumps the input latches, leaving the ASCII code for a blank or space stored. IC16A and IC16B both reset on the following load pulse.

Each input character requires 3 "load pulse" times or 4.5 microseconds 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 104 lines are selected twice per frame so the write speed on the first 5/8 of each page will be doubled or 1080 characters per second.

The cursor and compare circuits are very interrelated 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, IC27A, IC34 and IC27B. IC35 holds the data for the first sixteen horizontal character locations on a line and IC27B sets if the location is on lines 17-32. The number of one of the 16 vertical page lines is stored in IC34, and IC27B 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 IC40C and IC40D. 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 of memory 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 IC17C 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, IC27A and IC34, which have full wrap around in each location and automatically 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.

IC34-5 is 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 IC9B low, and erase from the cursor to the end of frame is initiated by setting the preset input of IC2A low. If either of these two latches is set, it allows IC2B 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. IC2B will reset on the first 33rd character indication from IC14 after latch IC2B is set thus completing an erase to end of line (EOL). IC2A will reset on the first blanking pulse from IC4B after latch IC2B is set thus completing an erase, to end of frame (EOF). The resetting of either causes IC2B to reset and return it to its initial state.
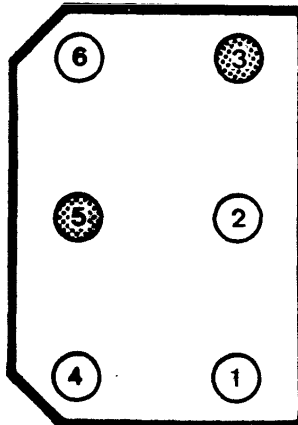
Connector Drawing

Pin 1   -12 VDC
Pin 2   +5 VDC
Pin 3   Ground
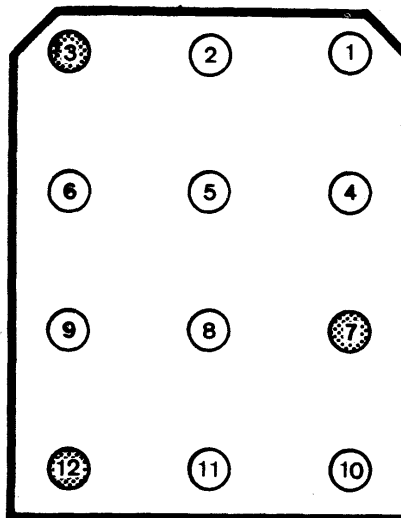Pin 4   -5 VDC
Pin 5   6 VAC Ref
Pin 6   Ground
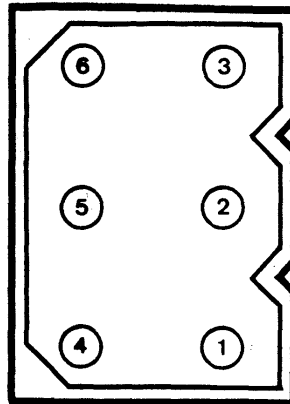
J 11

Power Supply

Pin 1   Page 2
Pin 2   Page 1
Pin 3   Video Output
Pin 4   Read Enable
Pin 5   Ground
Pin 6   Cursor ON/OFF

J 10·

Output

Pin 1   Bit 1
Pin 2   +5 VDC
Pin 3   Ground
Pin 4   Bit 2
Pin 5   Bit 3
Pin 6   -12 VDC
Pin 7   Bit 4
Pin 8   Bit 5
Pin 9   Start Read
Pin 10 Keypressed
Pin 11 Bit 7
Pin 12 Bit 6

J 9

Keyboard / Encoder

Parts List - TV Typewriter II Main Board

Integrated Circuits

IC1, IC8	NE555 timer or 72555
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	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
IC19, IC32	74132 quad schmitt NAND gate
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 4 bit comparator

Resistors

R1, R2, R3, R9, R10, R13 - R23, R26, R29, R42 – R48, R50	1K ohm 1/4 watt resistor
R4	20 K ohm trimmer resistor
R5	5.6K ohm 1/4 watt resistor
R6	5 K ohm trimmer resistor
R7	4.7K ohm 1/4 watt resistor
R8	100 ohm 1/4 watt resistor
R11	47 ohm 1/4 watt resistor
R12	100 ohm 1/4 watt resistor
R24, R25, R28, R30, R31	4.7K ohm 1/4 watt resistor
R27, R32 - R35, R37	10K ohm 1/4 watt resistor
R36, R49	2.2M ohm 1/4 watt resistor
R38	50K ohm trimmer resistor
R39, R41	33K ohm 1/4 watt resistor
R40	220K ohm 1/4 watt resistor
R41	33K ohm 1/4 watt resistor

Capacitors

C1, C5	470 pfd capacitor
C2, C7, C14	0.01 mfd capacitor
C3	3300 pfd capacitor
C4	39 pfd capacitor
C6, C34	100 mfd @16 VDC electrolytic capacitor
C8, C9, C10, C11, C15,	0.1 mfd mylar capacitor
C18 - C24, C27 - C33	0.1 mfd (cermaic disc capacitor)
C12	0.047 mfd capacitor
C13	0.22 mfd mylar capacitor
C16	0.001 mfd capacitor
C17	33 mfd @ 25 VDC electrolytic capacitor

## Transistors and Diodes

|	
Q1, Q2	2N5129 silicon transistor
Q3	2N5139 silicon transistor
Q4, Q5	TIS58 field effect transistor
D1, D2	1N914 silicon diode
D3 - D5	1N5060 silicon diode

The TIS58 is a N-channel JFET. It can be replaced with a 2N5457 or a 2N5484. This substitution information is from Arthur Harrison's "Art's Theremin Page " web site. This site covers the Theremins including the SWTPC 142.

http://home.att.net/~theremin1/
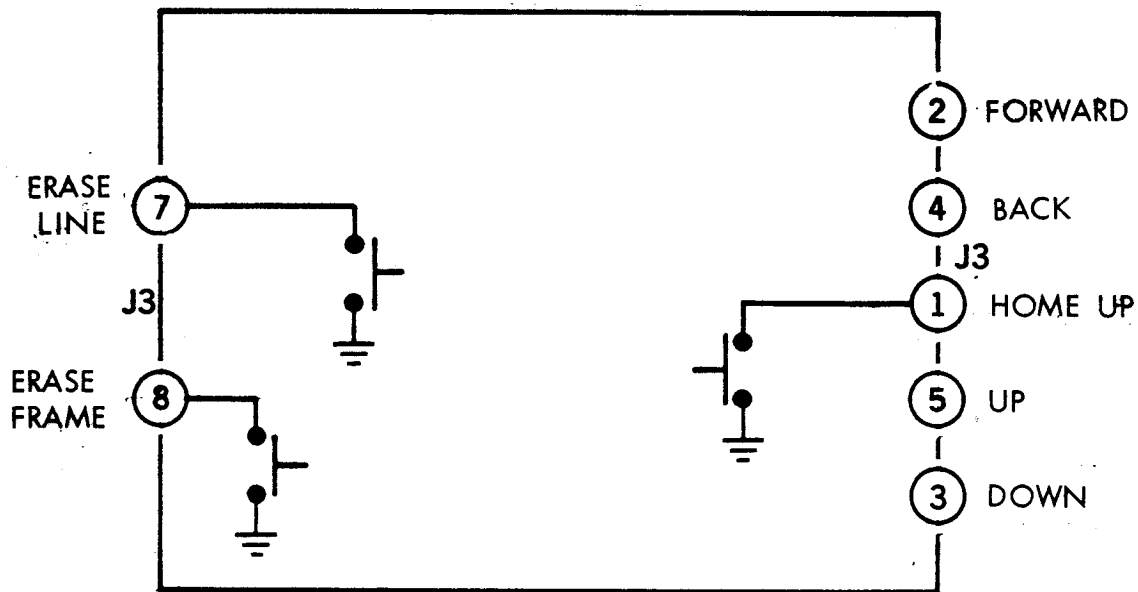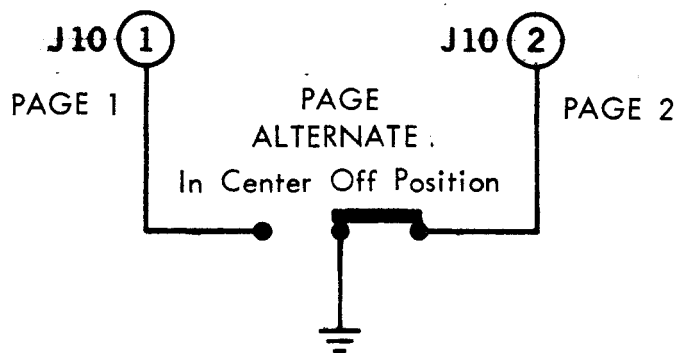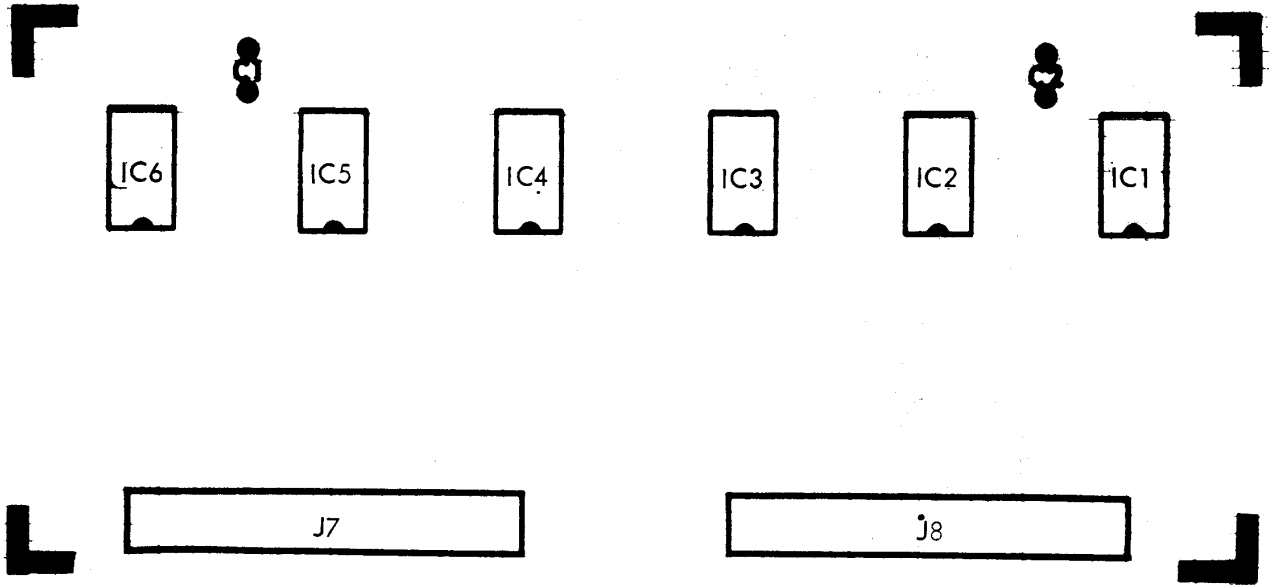
Cursor and Page Select Wiring for the TV Typewriter II

Parts List - TV Typewriter II Memory Board

IC1 - IC6   2102 1024 bit static RAM

CI, C2   0.1 mfd capacitor

IC6   IC5   IC4   IC3   IC2   IC1

J7   J8

Component Layout CT-1024 Memory Board

TV TYPEWRITER II - Memory Board Schematic