

## GT-6144 Graphics Terminal Kit

The GT-6144 Graphics Terminal Kit is a low cost graphics display unit designed to display 96 lines of 64 small rectangles per line on a standard video monitor or a slightly modified television set.

The SWTPC GT-6144 can be connected to most computer systems on the market today. Communication to the GT-6144 is via eight parallel data lines and one DATA READY line. The DATA READY line must be at logic 0 for a character to load and must remain low for at least two microseconds. The parallel interface boards of most computer systems are capable of meeting the requirements of the GT-6144.

The actual display device for the terminal may be an unmodified video monitor or slightly modified television set. Although specific instructions are supplied for modifying a small-screened Motorola set, almost any set may be used. Be sure to use one that does not have a "hot" chassis, otherwise you will need an isolation transformer. The suggested modification to the television set even includes a switch to allow one to select terminal or normal television reception.

The circuitry of the GT-6144 terminal is designed primarily for a 60 Hz power line frequency and a standard U.S. 525 line television set, but by changing and adding some jumpers the terminal can be used on 50 Hz, 625 line operation. The terminal is not designed to accept external sync sources which eliminates its use in superimposed video applications except when using a SWTPC CT-1024 Terminal System.

### Features of the GT-6144 Graphics Terminal

SCREEN BLANKING/UNBLANKING - By using two optional SPST pushbutton switches you have the option of BLANKING the screen of your GT-6144. When in the BLANKED mode no graphics video data is sent to the monitor. UNBLANKING allows normal operation.

SCREEN REVERSING - With optional pushbutton switches display of the GT-6144 can be put on the screen in reverse (black display on a white screen).

VIDEO MIXING WITH A CT-1024 - If desired the video data from a CT-1024 can be mixed with the GT-6144 display. This gives you the capability of generating a GRAPHICS-ALPHANUMERIC display. By using optional switches, either or both terminal outputs may be selected and displayed on the same monitor.

NOTE: All of the above features are also under complete SOFTWARE control giving you the capability of performing blanking/unblanking, screen reversing, etc. from your program.

STRAIGHT FORWARD PROGRAMMING - Accessing a particular location on the screen to make it either white or black is done using two eight bit data words - one contains the horizontal position of the cell and the other contains the vertical position and whether or not the rectangle is to be black or white. Blanking, and reversing functions are done by sending out special 8 bit data words.

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The GT-6144 kit includes the 13" x 9 1/2" double sided, plated thru hole board and all of the components that go on the board. There are connector provisions for all connections to your computer interface, power supply, video monitor and CT-1024 (if used). Power requirements for the GT-6144 are +5 VDC +5% @2.1 A and -12 VDC @60 mA. Our SWTPC CT-P power supply meets the above requirements. For owners of the SWTPC 6800 computer system one MP-L Parallel Interface board will be needed.

The GT-6144 comes with a SWTPC 6800 Computer System compatible display program with a sample output routine for diagnostic purposes. Because of the infinite number of applications for this unit extensive specialized output routines and programs are not included and must be written by the user.

## Assembly Instructions - GT-6144 Graphics Display Terminal

### 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 in 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. Solder.
- ( ) Install all of the capacitors on the board. 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. Do not 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. Integrated circuits IC-27 - IC-29 and IC-31 - IC-33 are MOS IC's and should be handled as little as possible during assembly. Make sure the integrated circuits are down firmly against the board and 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 J1 position from the "TOP" side of the board.
- ( ) Attach PC mount connectors J2 and J3 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 J1, J2 and J3 in place.
- ( ) Working from the "TOP" side of the board fill in all the unused feed-thrus with molten solder. This assures maximum reliability in connection from the top to bottom. Do not fill in any of the labeled holes where jumpers will be installed.

#### 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.

	<u>GAUGE</u>	<u>FROM</u>	<u>TO</u>
1.	#18 or heavier	+5	connector pin #2 of J1
2.	#18 or heavier	GND	connector pin #3&6 of J1
3.	#18 or heavier	GND	chassis ground
4.	#22 or heavier	-12	connector pin #1 of J1
5.	#22 or heavier	REF	connector pin #5 of J1

## Parts List - GT-6144 Graphics Terminal

### Integrated Circuits

IC1	555/1455 timer
IC2	74279 Quad R-S latch
IC3, IC10	7451 AND-OR-INVERT gate
IC4, IC34	7474 dual D flip-flop
IC5, IC23, IC36, IC40	7404 hex inverter
IC6, IC7, IC13, IC19	7493 binary counter
ICS, IC43	7408 quad AND gate
IC9, IC38	7432 quad OR gate
IC11	7420 dual 4 input NAND gate
IC12	7486 quad EXCLUSIVE-OR gate
IC14	7442 BDC decoder
IC15	7409 quad open-collector AND gate
IC16	74123 dual one-shot
IC17, IC35	7400 quad NAND gate
IC18, IC37, IC39, IC42	7410 triple 3 input NAND gate
IC20 - IC22, IC24 - IC26	74157 data selector
IC27 - IC29, IC31 - IC33	2102-1/TMS4033NL 1024 x 1 static memory
IC30	7402 quad NOR gate
IC41	74174 hex D flip flop

### Resistors

R1 - R4, R6, R9	10K ohm 1/4 watt resistor
R5, R8	2.2M ohm 1/4 watt resistor
R7, R27, R31 - R33, R35, R36	100 ohm 1/4 watt resistor
R10, R18	4.7K ohm 1/4 watt resistor
R11, R13, R17, R22 - R25	1K ohm 1/4 watt resistor
R28 - R30, R34, R37 - R48	50K ohm trimmer resistor
R12	220K ohm 1/4 watt resistor
R14	33K ohm 1/4 watt resistor
R15, R16	5K ohm trimmer resistor
R19	20K ohm trimmer resistor
R20	5.6K ohm 1/4 watt resistor
R21	47 ohm 1/4 watt resistor
R26	

### Capacitors

C1 - C4, C10, C15	0.1 mfd mylar capacitor
C5	0.047 mfd mylar capacitor
C6, C27	100 mfd @16 V electrolytic capacitor
C7	0.22 mfd mylar capacitor
C8, C11	0.01 mfd disc capacitor
C9, C13, C14, C17, C21 - C26, C34	1000 pf polystyrene capacitor
C12	3300 pf polystyrene capacitor
C16	0.01 mfd mylar capacitor.
C18	220 pf polystyrene or silver mica capacitor
C19, C20, C28 - C33	0.1 mfd disc capacitor

Semiconductors

D1 - D8	1N914/1N4148 silicon diode
D9	1N5402 or equiv. 3A diode
Q1, Q2	TIS58 field effect transistor
Q3	2N5139 silicon transistor
Q4	2N5129 silicon transistor

## Initial Checkout Procedure

This initial checkout procedure should enable you to check out the main functions of the GT-6144 and to adjust the various controls on the unit.

- ( ) Connect jumpers between one set of the following points depending, on where the unit will be used:

<u>60-Hz, 525 line (U.S.)</u>		<u>50Hz, 625 line (Europe)</u>	
U1 to E1	A to B	E1 to C	A to B
U to C	D to F	U to E	J to F
H to G	R to S	H to G	R to S

- ( ) Connect a jumper from the P terminal to the G terminal. This disables the normal power-up screen blanking function of the terminal.
- ( ) Connect your power supply to the unit. Do not apply power yet.
- ( ) 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. Also make absolutely sure the power supply is connected correctly. Accidentally reversing the voltage may short the protection diode D7 and hopefully protect the IC's, however, excessive current may open the diode which in turn can damage most of the IC's on the board.
- ( ) Set trimmer resistors R12, R19 and R20 for the center of rotation.
- ( ) Attach the output of the terminal to the input jack of the television or video monitor thru a shielded connecting cable as described on page
- ( ) 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 J1 running across the board on the component side. Polarity is indicated by the markings on electrolytic capacitor C27.
- ( ) 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 -12 supply bus to make sure this voltage is 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 rectangles on the screen. If you do not have a readable display, adjust trimmer resistor R12 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 a whine. Intermixed in this noise, you will hear a beat frequency which should vary with the setting of R12. 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 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 R20 to center the display and adjust trimmer resistor R19 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 OK so far you are ready to connect, your unit to a computer for further checkout. If you want the power up - screen blanking feature, remove the jumper from P to G. Included is a general description of the input requirements for the terminal and a description of how to access characters and to enable/disable the blanking and other functions through software. Detailed connection instructions and sample test program, BARIST, is given if s you are using our SWTPC 6800 Computer System. Also the program to display the STAR-SHIP U.S.S. Enterprise included for 6800 users.

#### Video Output Wiring

J1 pin 4 is the video output that goes to your video monitor. Shielded cable should be used when connecting to your monitor.

#### Connecting the GT-6144 to a Computer System

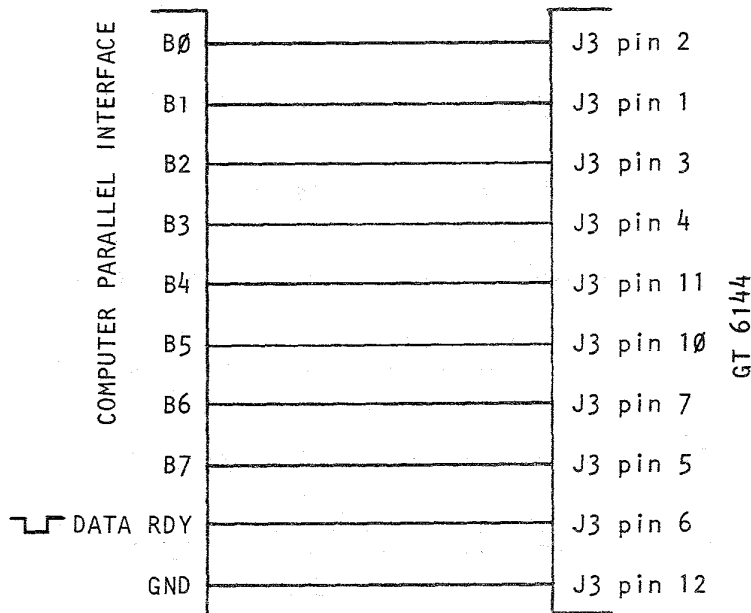
Inputs to and outputs from the GT-6144 are all made via the three Molex connectors J1 - J3. J3 connects eight data lines and one DATA READY line from a computer to the terminal, J1 contains all power supply connections and the composite video output and J2 contains inputs from a CT-1024 if mixed video is desired.



### Computer Connector Wiring

With the aid of the connector drawing attach and solder #22 gauge or heavier wire of the desired length to go to your computers outputs Bit 0 - Bit 7, DATA READY and ground pads. 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. Try to keep the wire lengths as short as possible.

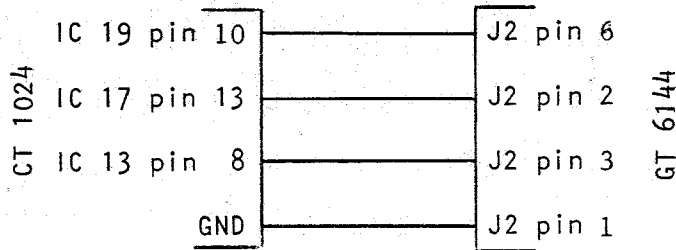
The data outputs from your computer must be at TTL low for a logical 0 and TTL high for a logical 1. The DATA READY line must stay at logical 1 normally and go to 0 only after the data from the computer to be loaded into the terminal is guaranteed valid. The DATA READY strobe should stay low for at least two microseconds and the data must stay valid during this time. Cable lengths from the computer to the terminal should be as short as possible.



### Video Mixing with a CT-1024

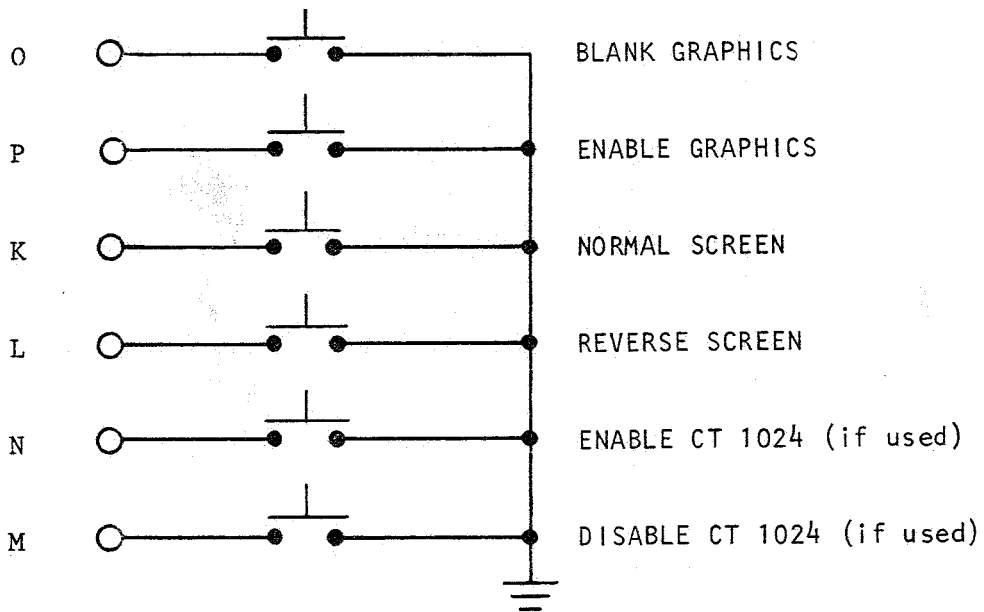
If desired, the video from a SWTPC CT-1024 can be mixed with the video from the GT-6144 to give an ALPHANUMERIC /GRAPHIC display. No extensive modifications need be made to your CT-1024 but four wires do need to be added. Try to keep all connecting wires as short as possible to help decrease noise pick-up.

First connect a length of wire from IC19 pin 5 of your CT-1024 to a male connector pin to be installed in J3. Connect another length of wire from IC13 pin of the CT-1024 to another male pin. One final wire should be connected from the CT-1024 ground bus to a female pin. The pin coming from IC19 pin 5 should be snapped into hole 4 of J2, the pin from IC13 pin 8 should be snapped into hole 2 and the grounded pin should be snapped into hole 3. The jumpers from R to S and from H to G on the GT-6144 board should now be removed and one installed from H to T. When in the mixed video mode the GT-6144 phase lock has no effect on circuit operation - the phase locked oscillator in the CT-1024 takes over. Which terminal is displayed on the screen can be controlled through software as described in the PROGRAMMING section.



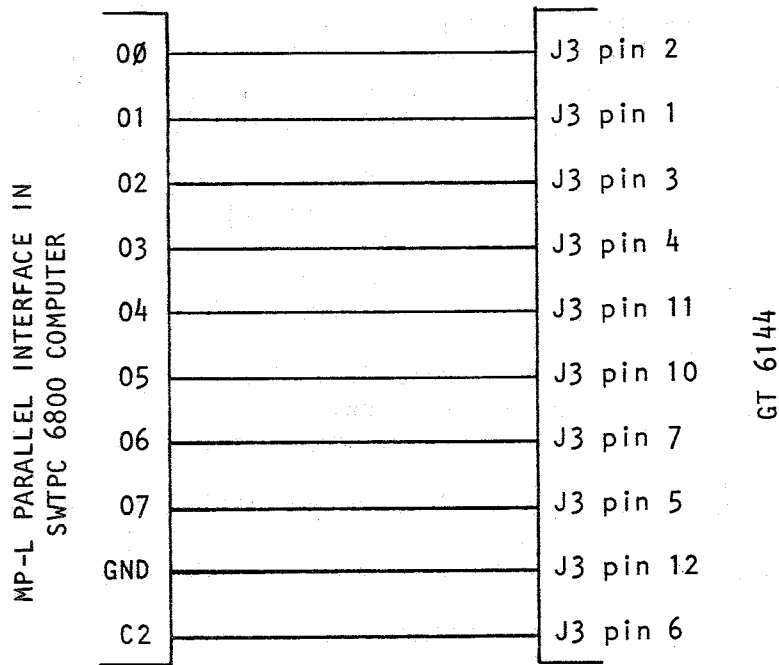
Optional Function Switch Wiring

If desired the screen blanking/reverse functions can be connected to SPST pushbutton switches (not supplied) for manual as well as software control. The wiring diagram below should be followed.



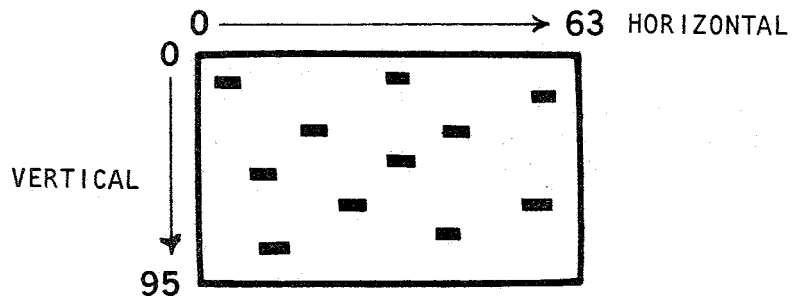
Using the GT-6144 with a SWTPC 6800 Computer System

To use the GT-6144 with a SWTPC 6800 Computer System one MP-L Parallel Interface must be used in the computer. Below is a wiring interconnection diagram for the 6800 and 6144.



### Programming

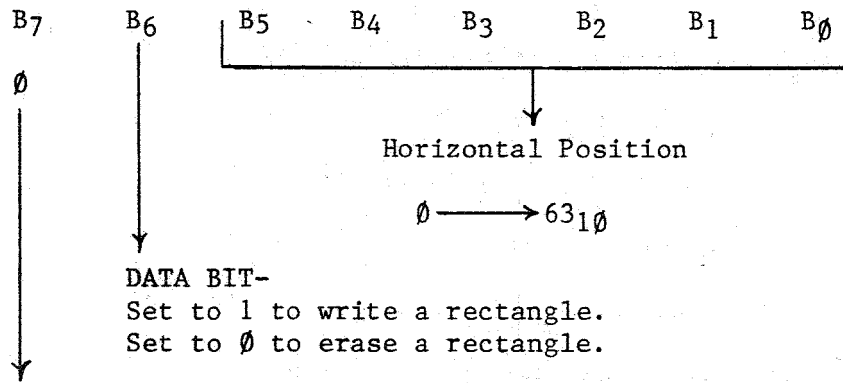
The display of the GT-6144 graphics terminal consists of 6144 small rectangles formatted 64 across and 96 down that can be turned on or off at will. In order for the GT-6144 to do a particular function the data fed to it must be formatted correctly. The coordinate of a particular location is referenced from the top left corner of the screen with the first square residing at location, (0, 0).



When inputting data to the GT-6144 the first byte (8 bits) sent to the terminal must be the HORIZONTAL POSITION. The actual position is determined in bits B0 - B5 and is in binary. When bit 6 = 0 a rectangle will be removed at the desired coordinates, when bit 6 = 1 a white rectangle will be generated. Bit 7 must always equal 0 for the terminal to know that a HORIZONTAL position is being loaded. A 0 in the bit 7 position causes the data holding flip flops in the terminal to store the present data.

The second byte from the computer contains the VERTICAL coordinate. The location is contained in binary in bits B0 - B6 of this second byte while bit 7 must equal a 1.

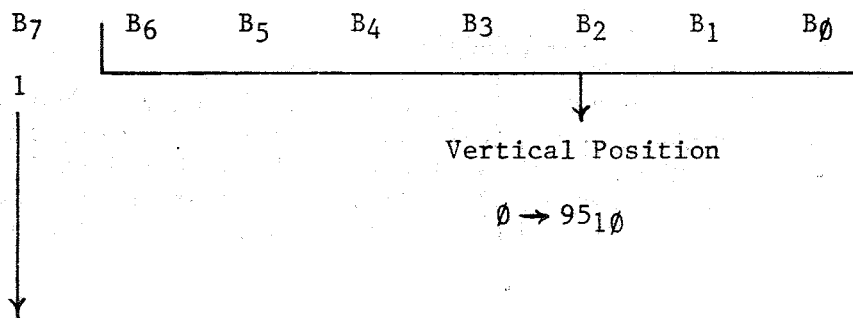
FIRST BYTE FROM COMPUTER - HORIZONTAL POSITION



FF LOAD BIT

this bit should always = 0 for a horizontal position.  
 When this bit equal 0 bit 0 - 6 are stored in the  
 DATA HOLDING FLIP-FLOPS.

SECOND BYTE FROM COMPUTER - VERTICAL POSITION



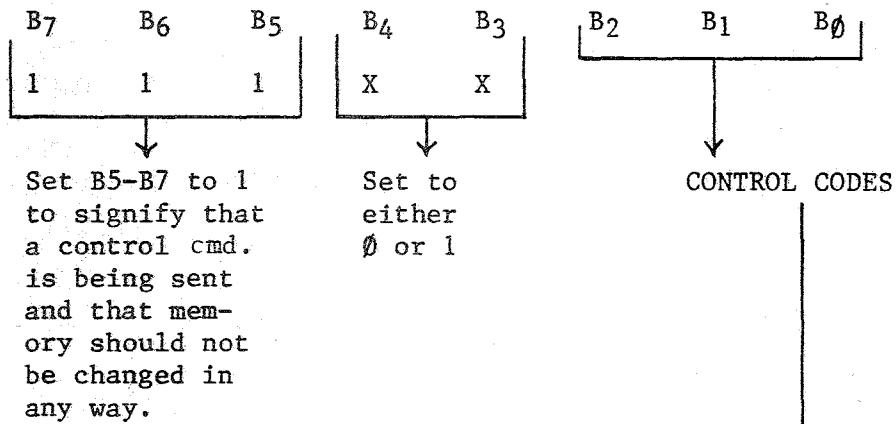
MEMORY STORE BIT

This bit should equal 1 for a vertical position.  
 A 1 in this position causes the data in the  
 holding flip flops and the data in bits  $B_0 - B_6$   
 to be transferred to the memory.

When programming a design to appear on the screen there are two ways the characters can be loaded the method you use depends on how your software is organized. One method is to just send out successive coordinates (H1, V1); (H2, V2) etc., until all H, V locations are specified. With this method two bytes must be sent out for each character.

Another method can be used that can result in saving time and memory space. In this method the HORIZONTAL position of a particular column is loaded only once into the terminal. The VERTICAL coordinate of all other characters that have this same HORIZONTAL coordinate can then be loaded by themselves since the HORIZONTAL position is latched in the holding flip flops.

Since there are 96 characters to be accessed in the vertical direction at least seven address lines must be used. Seven lines gives the possibility of addressing  $2^7$  ( $128_{10}$ ) locations giving us  $32_{10}$  extra undefined locations. These extras can be used as control commands for controlling BLANKING ON/OFF, REVERSE SCREEN, etc. The correct format for control commands for the GT-6144 terminal is as-follows:



B0	B1	B2	
0	0	0	INVERTED SCREEN
0	0	1	NORMAL SCREEN
0	1	0	DISABLE CT-1024
0	1	1	ENABLE CT-1024
1	0	0	ENABLE GRAPHICS
1	0	1	BLANKED GRAPHICS
1	1	0	] — NOT USED.
1	1	1	

- NORMAL SCREEN** In the normal screen mode white-characters appear on a black background. This applies both to graphics and alphanumeric data.
- INVERTED SCREEN** In the inverted screen mode all characters appear as black characters on a white background.
- BLANKED GRAPHICS** In this mode no video from the GT-6144 is transferred to the video monitor. This gives an "all rectangles off" condition. This condition does not effect the status of alphanumeric data.
- ENABLE GRAPHICS** In this mode video from the GT-6144 is transferred to the monitor and mixed with alphanumeric data if this data is enabled.
- ENABLE CT-1024** In this mode video data from the CT-1024 is mixed with video from the GT-6144. If the 6144 is disabled only alphanumeric data will appear on the screen.
- DISABLE CT-1024** No CT-1024 data is mixed with the GT-6144 video data.

When writing input-output programs care should be taken to optimize them for speed and memory conservation. The sample programs for the SWTPC 6800 are easy to understand examples only and are not optimized.

#### How it Works

The entire screen of the video display has been arranged for 96 lines of 64 characters per line. In addition to the 96 lines of video data the television or monitor also requires the terminal to generate vertical and horizontal sync pulses. The GT-6144 consists of two major sections: one which generates the necessary sync pulses while the other takes care of storing the necessary information in memory.

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. ICI is used as an astable voltage controlled oscillator with bipolar transistor Q3 and field effect transistor (FET) Q1 along with capacitor C5 forming a sample and hold circuit which feeds IC1's voltage control input through FET Q2. 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 IM. 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 you will see later the value of the frequency divider is 264 and since our reference is 60 Hz the  $f_o = (60 \text{ Hz}) (264) 15,840 \text{ Hz}$  which is very close to the horizontal oscillator frequency of standard television set.

The output of IC1 is fed via inverter IC23 C to IC17 B and C where among other things a 4 microsecond horizontal sync pulse is generated. From here the pulse is routed to IC15 B 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 IC17 C triggers IC16 A, a one shot, which puts out a positive pulse on pin 4 adjustable by potentiometer R20 from 8 to 30 microseconds. The delay pulse creates a lag between the generation of data thus giving an adjustable left margin. Pin 4 of IC16 A inhibits dot oscillator IC16 B-thru AND-OR-INVERT gate IC10 A. Pin 13 resets IC19 and IC13 the 16 bit counters which keep track of the selected horizontal rectangle. 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 of IC16, IC6, the line counter is incremented and if there is a ripple carry IC7 is incremented as well. IC6 and IC7 together keep track of the horizontal scan line presently in use. Together these two IC's provide a unique BCD code for each of the  $96 \times 2 = 192$  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 192 for a complete frame. When a count of 192 (the 193<sup>rd</sup> line) is reached IC15 A sends out a clock pulse to IC4 A and to IC9 C which resets the line counters. When IC4 A is clocked pin 6 goes low giving a BLANKING pulse to prevent any video data from being transmitted from the GT-6144. When pin 6 of IC4 is low pin 5 is high and enables decoders IC11 A and B. When the line counters reach a count of 32 IC11 A triggers and remains so for 8 lines until count 40 is reached. The low output on Pin 6 during this time is the VERTICAL SYNC PULSE, which goes to IC15 B as mentioned earlier. At count 72 IC11 B triggers clearing flip-flop IC4 A which unblanks the video and resets line counters IC6 and IC7 for the generation of new lines of displayed data. The above described circuitry gives us a total of  $192 + 72 = 264$  scan lines.

Now lets get back to the horizontal portion of the circuit again. We left off earlier by saying that one shot oscillator, IC16A, 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 IC16B which is inhibited during this delay phase via IC10A is the "dot" generator which actually clocks off the "dots" for each line of video which form the rectangle. So from here we may continue by saying that potentiometer R19 sets the cycle time for this oscillator from 500 to 1000 nanoseconds which in turn sets the horizontal width of the rectangles displayed. The "dot clock" output however is not the output of IC16B but rather the output of the AND - OR - INVERT gate IC10A. It's output is normally high, but goes low for about 30 nanoseconds each time IC16B resets. This 30 nanosecond pulse time is set by the propagation of IC16B and IC10A and is very hard if not impossible to see with most oscilloscopes. This "dot clock" is used to toggle flip flop IC4B which regulates the transmission data from memory to the video output. When IC4B is clocked by the "dot clock" the data on pin 12 from the memory is latched until another clock pulse appears or until the flip-flop, is preset on pin 10. Presetting IC4B sets pin 8 to 0.

The second major portion of the GT-6144 consists of the memory and its associated components. When no data is being loaded; into the terminal by a computer appropriate outputs from both the horizontal and vertical counters are used as address lines for the memories. IC18 and IC37 along with the necessary inverters form the decoders that select the appropriate memory IC depending on the location being addressed. Note that IC31 - IC32 can be enabled when CB0 = 0 while IC27 - IC29 can be enabled when CB0 = 1 therefore adjacent rectangles alternate back and forth between the two memory halves. The data outputs of IC27 - IC29 are OR tied as are the outputs of IC31 - IC33. AND - OR - INVERT gate MOB selects which data will be transmitted to the video output depending on the state of CB0.

The desired display for our graphics terminal is 64 characters across and 96 characters down. This gives a total of 6144 possible character positions which states that at least 13 address lines are needed since  $2^{12} = 4096$  and  $2^{13} = 8192$ . Since some computers are not capable of sending out a 16 bit word the most logical thing is to use two 8 bit words with some type of temporary storage in the terminal. The temporary storage in the GT-6144 is done in flip-flops IC34B and IC41. Since the GT-6144 can accept data faster than most small computers can send it only a DATA READY output from the computer is needed. This DATA READY strobe should be normally high and go low only after the data output from the computer is valid. During the time that the DATA READY strobe is low one of two things can happen. If the bit pattern from the computer is such that it is a HORIZONTAL position (Bit 7 = 0) IC30B will trigger causing the data present to be latched into the flip-flops. During this time the memory is changed in no way. If the data present is a VERTICAL position (B7 = 1, B6 ≠ B7 ≠ 1) IC30B will not trigger but IC39A or C will depending on the state of the latched Bit 0 on pin 5 of IC41. If IC41 pin 5 is 0 IC39-C will go low. When the counters come around such that CB0 = 1 (the opposite side of memory accessed as far as reading goes) IC40 C will trigger causing the data selectors IC24 - IC26 to select the address lines formed by the data from the computer rather, than from the counters. IC18 will select and enable the correct memory IC, and after a small time delay caused by C13, R31 and IC15-C a low WRITE pulse will be routed to the enabled memory. When the DATA READY goes back to its high state the WRITE pulse will immediately disappear and after a small delay caused by R36, C17 and IC38-B the memory IC will be disabled and the data selectors will return to outputting addresses from the terminal's counters. Note that the data will write in one half of the memory while the terminal reads and outputs data from the other half. The other half of memory works exactly as above but when B0 = 1.

When the computer sends out data where  $B5 = B6 = B7 = 1$ , the control command mode, IC42 pin 8 goes high so that no changes will be made in memory. Appropriate data lines from the computer are fed to the BCD decoder IC14. IC39-B disables the decoder in all but the control command mode. Depending on the A, B and C inputs of IC14 the proper output of IC14 is brought low which controls the appropriate control function. The outputs of IC14 are latched in IC1. Pin 4 of IC2 concerns the screen reversing function. IC34 prevents the screen from being reversed except immediately after a vertical sync pulse. While in the reversed mode the blanking pulse is removed giving a totally white screen (except for characters). This switching is done in IC3-B. IC2 pin 7 concerns controlling the CT-1024 video data. When IC3 pin 4 is high CT-1024 data is enabled and is disabled when pin 4 is low. Pin 9 of IC2 performs a similar enable/disable function on graphics video data. Video data from IC3 pin 6 is routed to IC15-D where it is mixed with the appropriate blanking pulse. The outputs of IC15-B and D are then mixed in Q4 to give the required composite video output.

### Television Modification

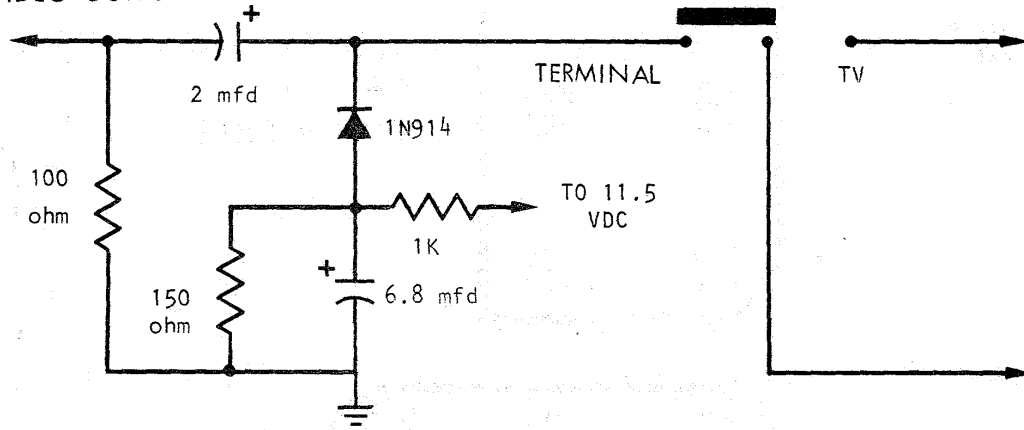
As it stands now your unit should work on a video monitor or modified television set. Because of rigid FCC-requirements, the circuit has been designed to be connected directly to the video input circuit of a television. This requires the addition of a jack and if normal television reception is desired 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. The terminal'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 0 set used with the prototype. A switch and BNC connector were provided to allow either terminal 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 nonpolarized 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.



TO GT-6144  
VIDEO OUTPUT



TO CIRCUITRY  
ORIGINALLY  
CONNECTED TO  
THE BASE OF THE  
VIDEO AMPLIFIER

TO THE BASE  
OF THE VIDEO  
AMPLIFIER

Video Input Modification for Motorola K9TS-460Q Television