ROMAC H19MK101 Terminal

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SECTION 1
INTRODUCTION

In a computer system, the terminal serves as an interface between the computer and its human operator. Through it the operator controls the computer, enters data, and views the output from the computer. This makes the terminal a very important part of the total system. To increase efficiency, the terminal must provide the user with an easy and error-free method of entering data. It must also be versatile enough to provide the programmer with more effective ways to display the output of a program to the user. Such things as cursor control and graphics characters can greatly enhance a display on a CRT monitor.

The ROMAC H19MK101 Terminal provides the versatility needed for a truly efficient user-computer interface through its many built in features. These features include such things as Cursor Control, Reverse Video, simple Graphics, Report Cursor Position, Downloadable Keyboard Handler Routines, Editing Functions and much more! It also provides a keyboard interface which can support special function keys and detachable keyboards easily. All this on a board physically small enough to fit into almost any keyboard enclosure along with the keyboard!

For compatability with available software, the ROMAC Terminal uses the same command format as two popular terminals; the Heath H-19 (or Zenith Z-19) and the Digital Equiptment Corporation VT-52. This means that any program written to use the special functions of either of these terminals will be totally compatible with the ROMAC Terminal.

SECTION 2
CIRCUIT DESCRIPTION

This section will provide a brief circuit description of each of the major integrated circuit components of the ROMAC H19MK101 Terminal. Detailed descriptions of the Z80 CPU and associated peripherals are provided by Zilog in their Z80 Technical Manuals. Various books and computer publications provide additional information on the Z80 family and can be obtained from most computer stores. Information on the 6845 CRT Controller can be obtained from Motorola.

Z80 CPU

The Zilog Z80 microprocessor was designed by the same people who designed the 8080 CPU. Therefore, the Z80 can be considered an enhancement of the 8080. The Z80A is a 4MHz version of the Z80 processor.

The Z80 instruction set includes all 8080 instructions as a subset. Consequently, most application programs written for the 8080 will work with the Z80. The hardware features of the Z80 are: a single power supply (+5 Volts), a single system clock signal, an additional non-maskable interrupt line, and internal logic to control dynamic memories. In fact, the Z80 replaces three chips used in the older 8080 systems and this accounts for the pin incompatability.

There are three types of control signals associated with the Z80:

1. System Control Signals

M1	Identifies the instruction fetch machine cycle of an instruction's execution.
MREQ	Identifies any memory access operation in progress; it is a tri-state control signal.
IOREQ	Identifies an I/O operation in progress.
RD	A tri-state signal which indicates that the CPU wishes to read data.
WR	A tri-state signal which indicates that the CPU wishes to write data.
RFSH	A control signal used to refresh dynamic memory.

2. CPU Control Signals

HALT — An output signal which goes low following the execution of a Halt instruction.

WAIT — The Equivalent to the 8080 Ready input.

INT — Interrupt request input, can be disabled.

NMI — Non-maskable interrupt request input, cannot be disabled.

3. Bus Control Signals

RESET — Standard Reset control input.

BUSRQ and BUSAK — Bus access request and acknowledge signals used for DMA.

Z80 DART or SIO/0 Serial I/O Devices

These Z80 serial communication devices contain two serial I/O ports and their associated control logic. All common asynchronous serial protocols are supported. The SIO also supports many common bit or byte oriented synchronous protocols.

Each channel of these devices has an 8 bit register for data to be transmitted and three registers in a FIFO arrangement for received data. In addition, each channel has eight control registers (ten for the SIO). These registers are accessed by first writing a byte which indicates which register is to be used. Register 2 of port B is used for the interrupt vector. See the Zilog Data Book for more detailed programing information.

6845 CRT Controller

The 6845 is a device which coordinates all the functions necessary to control a CRT monitor device. Though video data doesn't actually pass through the device, it handles data transfer control, cursor positioning, and screen formatting tasks. It is in control of the display memory and character generation memory which provide the data to be displayed on the screen.

Although the 6845 is a complex device, it provides no internal logic for handling memory access arbitration or

cursor generation. These functions have to be provided by external logic.

The CRT Controller has 19 internal registers which must be programmed with the operating parameters before the device can function. These parameters determine the timing characteristics of the CRT interface. The number of lines, number of characters per line, and location of the top of the page are derived from these characteristics. See the 6845 Data Sheet for detailed programming information.

SECTION 3
ASSEMBLY

Assembly of the H19MK101 is a complex procedure and should not be attempted as a first project. If you are new to this procedure, we suggest that you read the assembly tips manual (included with all ROMAC kits and boards) and try building something simpler at first. Once you have the general idea, however, assembling the terminal is a snap provided you follow this test as you go assembly procedure.

PARTS INSPECTION AND TESTING

It is helpful to check the transistor, all resistors, capacitors, and diodes, to make sure they are good. Although uncommon, resistors and capacitors have been found marked incorrectly or were out of tolerance and somehow slipped through the manufacturer's quality control processes.

An ohmmeter test is sufficient on the capacitors. But if you have a capacitance meter, use it. All filter and bypass capacitors may be larger than rated value by up to 100 percent, but not smaller by more than 5 percent. ALL parts used in the clock and timing circuits must have a tolerance of 5 percent or better. A ten percent resistor that measures five precent is okay to use and the same rule applies to capacitors if you have good equipment with which to measure them.

The transistors and small 74XX IC's should be tested providing you have the proper facilities. The CPU, RAM memories, DART, and CRT Controller chips are to be tested only by operating the terminal since they are too complex to test separately without an elaborate test setup.

SOME GOOD ADVICE

It is NOT recommended that you solder any ICs directly on the board. Use high quality sockets for ALL ICs. If you have to replace even a 14 pin device later, you will be glad that you used sockets.

There may be some variation in the green solder mask on the bottom side of some boards. This solder mask is generally used in automatic wave-soldering operations and won't normally cause any problem in hand soldering unless it gets too close to the holes in the PC board. In that case, some of the solder mask can be scraped off (carefully) with a sharp, narrow-bladed jeweler's screwdriver or similar instrument.

STEP 1: INSTALLING IC SOCKETS

You will notice that all IC's have pin 1 indicated by a U-shaped depression on the parts layout diagram. This matches pin 1 (U-shaped depression, dot, or notch) of the IC and the IC socket.

It is recommended that all I.C. sockets be soldered to the board before other lumpier parts, such as capacitors, are installed. Place 2 or 3 sockets on each end of the board first to make it lie flat when it is upside down for soldering.

If all sockets are the same thickness (i.e., all low profile), there will be no problem getting them all soldered straight. If a mixture of sockets is used (some standard and some low profile), install the low profile sockets first.

Insert as many sockets as you can hold with 3 or 4 fingers, turn the board and sockets upside down near the edge of a clean, flat bench and slide the board and sockets off your fingers onto the bench. The work surface will hold the sockets in place. Push down on the board adjacent to each socket as you solder two diagonally opposite pins. This action will seat and secure each socket properly. Install all the sockets in this manner and inspect your work to make sure all the sockets are in the right places and are properly seated. Make sure pin 1 of each socket is oriented correctly.

Now, solder the remaining pins of all sockets, checking your work as you go. Since this takes about an hour, you should take a rest break first and then check for shorts between adjacent pins and p.c. traces that are routed between pins.

STEP 2: TESTING FOR SHORTS AND CONTINUITY

Before installing any other parts, run a pin-to-pin continuity test. Use the schmatic diagrams as an aid and assure yourself that everything is properly connected. Check for shorts between adjacent socket pins, especially in the memory sections where traces run between pins. You might also wish to connect your power supply to the board temporarily. Check the voltages to make sure they still appear normal. A drop in the supply voltage after connecting the board indicates a short somewhere.

STEP 3: INSTALLING RESISTORS AND CAPACITORS

When everything checks out up to this point, you are ready for discrete components. Study the schematics and the board layout drawing carefully and install the resistors in groups; for example all of one value starting with the lowest.

Be careful not to scratch or cut through nearby printed circuit traces when cutting components leads after soldering. Check for proper solder connections. Install the resistor SIP's (single inline package); Z1 and Z2. Make sure to orient pin 1 of the SIP's the proper way. Pin 1 of the SIP has a dot which should match a double line on parts layout drawing. Do a visual and ohmmeter check to verify that all resistor values are in the correct places and properly connected to socket pins, etc.

Install the capacitors next, being careful to get the right values in the right places, especially in the timing section. Observe the polarity requirements of the electrolytic and tantalum capacitors.

STEP 4: INSTALLING OTHER PARTS

When installing the transistors, crystals, and voltage regulators, it is a good idea to use heat sinks (alligator clips or similar device) since excess heat could damage these devices. Make sure to orient the transistors and regulators the right way. Bend a piece of wire to fit over the crystal as a strap. Solder both ends of the wire to the board. Then, solder the strap to the case of the crystal. Be careful to use just enough heat to do the job. Do this for both crystals.

Bend the leads of the trim pot to fit into the holes on the board. This can be a trick with some pots since there is so much variety between products from different manufacturers. If the pot fits right away, fine and dandy. If not, bend the leads under the body of the pot and then out. Needle-nose pliers are good for this operation.

STEP 5: INSTALLING IC'S

NOTE: If you are using the optional power supply section, it would be wise to connect the transformer (or plug the S-100 version into the bus) and test the power regulation before installing any IC's. Voltages may be checked easily at connector D. Make sure all voltages are within 5% of specified values and check them (especially the +12) for

excessive ripple with an oscilloscope (if you have one). If any supply voltage fails these tests, fix it now before you install any IC's.

The 74XX and 75XX TTL chips may now be placed in their sockets. Be very careful not to insert any chips backwards. Pin 1 is on the end with the notch or is designated with a mark, dot or small hole. ICs are normally shipped with the pins canted out a small amount for use in automatic machinery. This can make manual insertion difficult. Straighten them as follows:

> For TTL, grasp the IC with a thumb and forefinger of each hand on each end of the IC. Hold the IC on edge with pins parallel to hard flat work surface and pointing away from you. Pressing down firmly, tilt IC body away from you enough to bend pins at the body of IC so they will form a 90 degree angle to the body of the IC. Turn IC over and repeat on the other side. With a little practice, you will be able to form the pins straight and perpendicular to the IC body so they will fit the socket easily. Don't let the pins bend at the half-way point where they change width.
>
> For MOS ICs, push the pins through a small piece of thin aluminum foil. Fold the edges of the foil out of the way and then use the above procedure on a flat, grounded metal surface.

Individual pins that are bent may be lined up with grounded needle-nose pliers, but don't try to straighten all the pins on one side at once. It doesn't work.

From now on you must observe special precautions to protect MOS ICs from damage by static charges. This includes the 6116 memories, EPROMS, Z80 CPU, DART, 6845 CRT Controller, and in general any chip that does not have a 74XX or 75XX number designation. Some TTL chips have numbers other than 74XX, but you want to be on the safe side - right?

Keep all MOS chips in the conductive foam or anti-static containers in which they are shipped until you are ready to install them into their sockets. After an MOS chip is installed into its socket on the board, the board can generally be handled safely because all the sensitive inputs are now connected either to outputs of other chips or to pull-up or pull-down resistors which offers protection against static discharge.

The following precautions should be followed when handling MOS IC's:

1. Do not wear ANY nylon, polyester, or synthetic fabric clothing, or shoes of any kind, (wool and cotton are acceptable) while working with, or installing MOS integrated circuits.

2. Do not stand on a carpet or use a chair with a plastic seat, or upholstry. Provide a workplace with a concrete or conductive floor space and use a metal chair.

3. Provide a metal work surface or tape a sheet of aluminum foil to your bench to work on. Run a ground wire from a water pipe (not a gas pipe) or ground rod to your work area. Small wire is adequate as no measurable current will be carried.

4. Connect everything that may come in contact with MOS IC pins to your static ground through a 1 MOhm resistor. Either one resistor for all items or a separate resistor for each may be used. Connect the bench top, (or foil) chair leg, tools, yourself and the 1 MOhm resistor to ground potential through flexible leads. For yourself, find or make a bracelet (a piece of co-ax shield braid and an alligator clip) and connect it to a long flexible lead and the 1 MOhm resistor. This will bleed off any static charges before they can build up to destructive levels and the 1 MOhm resistor protects you from electric shock. In dry weather, add humidity to the air (50 percent RH or more).

Soldering with MOS Installed

If modifications are to be made after MOS chips are installed, you can do it without removing them. The less you handle 40 pin ICs and RAMs, the better.

Disconnect all cables and power supply to get rid of any ground paths through chips. Make a hole large enough to work through in a piece of aluminum foil that will cover the whole board on both sides. Place the hole over the area you are going to solder to on the solder side of the board. Wrap the foil around to the component side and secure with large rubber bands leaving a hole in the proper place large enough to put parts and sockets in through. Press the foil down all around the hole that is on the solder side so it makes contact with every component lead and socket pin all around the IC you are working on. Study the diagrams and make sure you contact every conceivable pin or pad that could lead to a memory chip, MOS IC, or CPU. Pack the foil down in the RAM area to ground all bus lines.

Hold the foil against the board with pieces of sponge rubber or foam plastic (the black stuff MOS ICs are shipped in is ideal) stuck under the rubber bands so the foil can't pull away. Clip the foil to your static-dissipating ground system. You are already grounded for this operation, of course.

Now you can put sockets and parts on the board and solder them (with a properly grounded leakage free iron) without blowing your MOS because you can't touch anything that isn't grounded. This technique was developed for working with CMOS computers such as the 1802. It sure saves a lot of frustration trying to put large MOS chips back in - they were bad enough the first time.

NOTE: When installing the EPROMs, you may notice that the 2732 EPROM has only 24 pins and the socket for it has 28 pins. This is to allow the use of a 2764, which has 28 pins. Install the 2732 as far down in the socket as it will go (i.e. pin 1 of the 2732 should be in pin 3 of the socket).

STEP 6: CHECKING OUT THE SYSTEM

Now that your terminal board is finished, you will want to connect it to a power supply, CRT monitor, and your computer system. This is probably best done out of the cabinet on a clean insulated work surface so you can get at everything. See the next section for information on configuring the terminal board and interfacing it to your monitor and keyboard.

You should monitor the power supply voltages on initial power up. If any are off rated value by more than 5%; shut off the power immediately and find out why. You have already checked the board minus all ICs and should also have checked your power supply to make sure it is OK. If any voltage is too low it indicates excessive current (bad IC) or a bad power supply (or current limiting if any, in operation). Remember, if you have any problems you can't figure out, call ROMAC.

SECTION 4
INSTALLATION INSTRUCTIONS

After the construction of your Terminal board is complete, there are only a few more steps to complete before it may be put into operation. These steps involve interfacing the terminal board to your keyboard and monitor and configuring the board to work properly with your system.

YOUR MONITOR

The H19MK101 Terminal video driver section can be configured to drive any kind of CRT monitor. A composite video signal as well as seperate data, video and sync signals are available. The polarities of all these signals are jumper selectable. In addition, the width of the horizontal sync pulse can be adjusted with a trim pot on the board. Consult your monitor's instruction manual and follow the table below to configure this section.

JUMPERS	OPTION
B1-B2	Positive Video Data
B2-B3	Negative Video Data
C2-C3	Positive Horizontal Sync
C1-C2	Negative Horizontal Sync
E2-E3	Positive Vertical Sync
E1-E2	Negative Vertical Sync

The video section also allows the use of an external video inhibit signal. A positive signal on the INH line will inhibit the transmission of video data to blank the screen. If you do not wish to utilize this option, jumper G1 to G2.

Because of the widely varying specifications of monitors from different manufacturers, it is quite possible that the display you obtain initially will not be completely satisfactory. If this is the case, turn to Appendix F for information on how to get the best display from your terminal.

YOUR KEYBOARD

The H19MK101 Terminal can be used with any keyboard which has a serial, ASCII encoded output. The interface is a standard asynchronous one. Baud rate is selected by a DIP

switch on the board. The serial port is programmed to use 8 data bits, 1 stop bit, and no parity (these parameters are under program control and may be altered by the user with a simple code change).

With most keyboards, only the RD (receive data) line will be used. This line may be either TTL or RS-232 level. The TD (transmit data) line of the keyboard serial port is used to directly drive the high impedance audio speaker. By jumpering F2 to F3, this line is at TTL level and will give a soft audio volume. When F1 is jumpered to F2, however, the TD line is RS-232 level and will provide a loud audio volume. If your keyboard is intelligent and has a serial receiver and its own audio section, you may wish to change the terminal board software to utilize this capability.

KEYBOARD BAUD RATE SELECT — DIP SWITCH 1

SWITCH 1	2	3	4	BAUD RATE
ON	ON	ON	ON	50
OFF	ON	ON	ON	75
ON	OFF	ON	ON	110
OFF	OFF	ON	ON	134.5
ON	ON	OFF	ON	150
OFF	ON	OFF	ON	300
ON	OFF	OFF	ON	600
OFF	OFF	OFF	ON	1200
ON	ON	ON	OFF	1800
OFF	ON	ON	OFF	2000
ON	OFF	ON	OFF	2400
OFF	OFF	ON	OFF	3600
ON	ON	OFF	OFF	4800
OFF	ON	OFF	OFF	7200
ON	OFF	OFF	OFF	9600
OFF	OFF	OFF	OFF	19200

TERMINAL OUTPUT

The output of the H19MK101 Terminal board is RS-232-C commpatible. Baud rate, parity, half or full duplex and number of data bits are all selected by the setting of a DIP switch on the board. The table on the following page will help you set these switches. These parameters can also be set from the keyboard.

The ROMAC distribution software requires the CTS signal to be at a positive level before the terminal will transmit data. A minor software change can configure the terminal to require CTS, DCD, both or neither to transmit

data. The terminal provides positive RTS and DTR signals. This can also be changed in the software if required.

Interfacing the H19MK101 terminal to your system is as easy as plugging one end of a standard RS-232 cable into the terminal and plugging the other end of the cable into the RS-232 output jack of your computer or modem.

BAUD RATE SELECT DIP SWITCH 2

SWITCH	1	2	3	4	BAUD RATE
	ON	ON	ON	ON	50
	OFF	ON	ON	ON	75
	ON	OFF	ON	ON	110
	OFF	OFF	ON	ON	134.5
	ON	ON	OFF	ON	150
	OFF	ON	OFF	ON	300
	ON	OFF	OFF	ON	600
	OFF	OFF	OFF	ON	1200
	ON	ON	ON	OFF	1800
	OFF	ON	ON	OFF	2000
	ON	OFF	ON	OFF	2400
	OFF	OFF	ON	OFF	3600
	ON	ON	OFF	OFF	4800
	OFF	ON	OFF	OFF	7200
	ON	OFF	OFF	OFF	9600
	OFF	OFF	OFF	OFF	19200

SERIAL PORT PARAMETERS DIP SWITCH 2

SWITCH	5	6	7	PARAMETERS SELECTED
	ON	ON	ON	NO PARITY, 7 DATA BITS, 1 STOP BIT
	OFF	ON	ON	EVEN PARITY, 7 DATA BITS, 1 STOP BIT
	ON	OFF	ON	NO PARITY, 8 DATA BITS, 1 STOP BIT
	OFF	OFF	ON	ODD PARITY, 7 DATA BITS, 1 STOP BIT
	ON	ON	OFF	NO PARITY, 7 DATA BITS, 2 STOP BITS
	OFF	ON	OFF	EVEN PARITY, 7 DATA BITS, 2 STOP BITS
	ON	OFF	OFF	NO PARITY, 8 DATA BITS, 2 STOP BITS
	OFF	OFF	OFF	ODD PARITY, 7 DATA BITS, 2 STOP BITS

SWITCH	8	PARAMETER SELECTED
	OFF	HALF DUPLEX
	ON	FULL DUPLEX

SECTION 5
DISTRIBUTION SOFTWARE

The 8" single sided single density disk provided with your ROMAC Terminal board contains all the information you will need to program the EPROMs needed for its operation. The following is a description of each file included on the distribution disk and its purpose.

MANUAL.DOC - This file contains a copy of this manual. It is provided for your convenience.

TERM.ASM - This is an assembly source listing of the terminal operation code. You will need this file if any modifications are to be made to the code. It is heavily commented for easy use and should provide an inside look at how the terminal board operates. Assemble this file using your macro assembler.

TERM.HEX - An assembler output file containing the code from TERM.ASM in Intel Hex format.

TERM.SYM - An assembler output file containing the symbol table from TERM.ASM.

CHARGEN.BIN - This file contains the information to be programmed into your character generator EPROM. It is in binary format. If you are using a 4K character generator, this file contains only the first 2K.

AMKEY.BIN - This file contains the information to be programmed into the AMKEY 101 key code EPROM. It is in binary format.

The current terminal board software is set up to optimize performance whin using the AMKEY 101 serial output keyboard. The software accepts 8 bit serial ASCII characters from the keyboard. When bit 8 of the character is a zero the character is simply passed on through to the terminal output port. When bit 8 of the character is a one, the character is translated into a single or multiple character string which is sent to the terminal output port or decoded as an internal terminal command.

For the most part, the AMKEY keyboard provides an H19 compatible arrangement. The alternate keyboard mode of the H19 has, however, been changed to allow the terminal board

to provide a WordStar mode of operation which uses the numeric keypad for cursor control and the function keys for many commonly used WordStar control functions. The terminal reduces many multiple key WordStar commands to a single keystroke.

The keyboard translation table can be easily changed to meet the requirements of almost any application. For those who need multiple key definitions (depending on the program being used), a keyboard handler routine may be downloaded to the terminal to conveniently redefine the keyboard.

PHYSICAL SPECIFICATIONS

CPU	Z80A
CLOCK	4 MHZ
INTERRUPTS	STANDARD Z80 STRUCTURE NMI USED FOR SYNC WITH CRT

MEMORY

PROGRAM	2K STATIC RAM, 4K or 8K EPROM
DISPLAY	2K STATIC RAM
CHARACTER	2K or 4K EPROM

I/O

TO COMPUTER	RS-232-C COMPATIBLE 50 to 19,200 BAUD *
TO KEYBOARD	RS-232-C or TTL SERIAL 50 to 19,200 BAUD *
TO MONITOR	1.5V P-P COMPOSITE VIDEO SEPERATE SYNC AND VIDEO OUTPUTS (POLARITIES SELECTABLE, WIDTHS PRORAMMABLE)

DISPLAY

DISPLAY FORMAT	24 LINES OF 80 CHARACTERS OPTIONAL 25TH LINE
ATTRIBUTES	REVERSE VIDEO AND ALTERNATE CHARACTER MODE AVAILABLE ON A PER CHARACTER BASIS
SPECIAL CHARACTERS	33 GRAPHICS CHARACTERS WITH STANDARD (2K) CHAR. GENERATOR (H19 COMPATIBLE)
COMMANDS	H-19 or VT-52 COMPATIBLE IMPLEMENTED AS ESCAPE SEQUENCES
POWER REQUIREMENTS	+5 VDC 1A, +/-12 VDC 30 mA (30 VAC TRANSFORMER W/ CT when using on board power supply)

* NOTE: The H19MK101 Terminal uses a Z80 SIO/DART serial device for communication and therefore is not limited to asynchronous communication. The terminal can be reprogrammed to communicate in bit or byte synchronous modes.

PARTS LIST

PART	QUANTITY	LOCATION	DESCRIPTION
74LS00	1	IC1	
74S04	1	IC19	Z80 CLOCK DRIVER
74LS04	1	IC4	
74LS08	1	IC9	
74LS14	1	IC7	
74LS32	2	IC8,IC10	
74LS74	2	IC6,IC11	
74LS86	1	IC12	
74LS125	1	IC5	
74LS139	1	IC29	
74LS157	3	IC21-23	
74S163	1	IC2	DOT CLOCK COUNTER
74LS166	1	IC17	
74LS174	1	IC3	
74LS175	1	IC16	
74LS373	1	IC24	
74LS374	1	IC18	
81LS95	2	IC25,IC26	
1488	1	IC35	RS232 LINE DRIVER
1489	1	IC36	RS232 LINE RECEIVER
555	1	IC13	
1941	1	IC33	BAUD RATE GENERATOR
2716 (2732)	1	IC14	CHARACTER GENERATOR EPROM
2732 (2764)	1	IC31	TERM. CODE EPROM
6116	2	IC15,IC32	2K X 8 STATIC RAM (CMOS)
Z80A DART	1	IC28	MOUNT PIN 1 DOWN
Z80A CPU	1	IC30	
6845	1	IC20	CRT CONTROLLER
4 POS DIP SW	1	SW1	
8 POS DIP SW	1	SW2	MOUNT PIN 1 DOWN
4.7K SIP	1	Z1	6 PIN
4.7K SIP	1	Z2	10 PIN

CONNECTORS

25 PIN 'D' SUB	2	A,B	FEMALE RIGHT ANGLE MOUNT (B IS OPTIONAL)
20 PIN DUAL ROW HEADER	1	H	.1" PIN CENTERS
AMP#640466-1	1	D	5 PIN MATE-N-LOCK (FOR DC POWER)

DISCRETE COMPONENTS

PART	QUANTITY		DESCRIPTION
33 OHM	2		ALL RESISTORS ARE
47 OHM	2		1/4 WATT 5%
68 OHM	2		
220 OHM	1		
330 OHM	1		
560 OHM	2		
1 KOHM	2		
1.5KOHM	3		
4.7KOHM	1		
10 KOHM	1		
30 PF	1		RADIAL CERAMIC, 5%
47 PF	1		RADIAL CERAMIC, 5%
100 PF	1		RADIAL CERAMIC, 5%
150 PF	1		RADIAL CERAMIC, 5%
220 PF	1		RADIAL CERAMIC, 5%
680 PF	8		AXIAL CERAMIC, 20%
0.001 UF	1		RADIAL CERAMIC, 10%
0.01 UF	2		RADIAL CERAMIC, 10%
0.1 UF	25		RADIAL CERAMIC
10 UF/ 16V	4		RADIAL TANTALUM
47 UF/ 8V	1		AXIAL ELECTROLYTIC
DIODE	1		1N914 OR SIMILAR
FUSE	1		100 MA PICO FUSE
50 KOHM POT	1		3 PIN PC FLAT MOUNT
TRANSISTOR	1	Q1	2N3904 OR 2N4401 NPN
TRANSISTOR	1	Q2	2N4126 OR 2N5401 PNP
CRYSTAL	1	XTAL1	12.288 MHZ CRYSTAL
CRYSTAL	1	XTAL2	5.068 MHZ CRYSTAL
SPEAKER	1		HIGH IMPEDANCE PIEZO

IC SOCKETS

8 PIN SOCKETS	1
14 PIN SOCKETS	13
16 PIN SOCKETS	8
18 PIN SOCKETS	1
20 PIN SOCKETS	4
24 PIN SOCKETS	3
28 PIN SOCKETS	1
40 PIN SOCKETS	3

OPTIONAL PARTS FOR ON BOARD POWER SUPPLY REGULATION

7805	1	RG1	5 VOLT REGULATOR (TO-220)
78L12	1	RG3	12V REGULATOR (TO-92)
79L12	1	RG2	-12V REGULATOR (TO-92)
1N4003	4	D1-4	RECTIFIER DIODES
AMP#350430-1	1	C	4 PIN MATE-N-LOCK
10 UF/ 50V	2		AXIAL ELECTROLYTIC CAP.
50 UF/ 50V	1		AXIAL ELECTROLYTIC CAP.
HEAT SINK	1	RG1	IERC HEAT SINK (PA1-1CB)
TRANSFORMER	1		30 VAC 1.2A TRANSFORMER WITH CENTER TAP
RESISTOR	1		10 OHM 10 WATT RESISTOR To be connected between the input pin of the 7805 and its pad.

NOTE: This power supply section is designed to handle the load of the terminal board only. If you wish to power the keyboard with the same supply, make the following changes:

7805	(RG1)	Use one in a TO-3 case. It will have to be mounted on a heat sink off the board.
50 uF Cap		Increase value to 470 uF / 50V
10 Ohm 10 W Res.		Decrease value to 5 Ohms 10 Watts

CONTROL CODES

STANDARD CONTROL CODES SUPPORTED

CTL G	Bell
CTL H	Backspace
CTL I	Horizontal Tab
CTL J	Line Feed
CTL L	Form Feed (Clear and Home)
CTL M	Carriage Return

HEATH MODE CONTROL CODES SUPPORTED

ESC <	Enter ANSI Mode
ESC #	Transmit Page
ESC @	Enter Insert Character Mode
ESC A	Cursor Up
ESC B	Cursor Down
ESC C	Cursor Forward (Right)
ESC D	Cursor Backward (Left, Backspace)
ESC E	Clear Screen and Home Cursor
ESC F	Enter Graphics Mode

There are 33 graphics symbols available. When this mode is enabled, ASCII values 60H-7FH and 5EH are displayed as graphics.

ESC G	Exit Graphics mode
ESC H	Home Cursor
ESC I	Reverse Linefeed
ESC J	Erase to End of Page
ESC K	Erase to End of Line
ESC L	Insert Line
ESC M	Delete Line
ESC N	Delete Character
ESC O	Exit Insert Character Mode
ESC Y r c	Direct Cursor Address

r = row (0-24)
c = column (0-79)

If the row number is too high, the cursor will not move. If the column number is too high, the cursor will move to the end of the line. This is the only way to move the cursor to the 25th line, but the 25th line must first be enabled. (see set mode)
The row and column are specified using the ASCII character corresponding to the binary number plus 20H. See the partial listing on the following page.

NUMBER	ASCII CHARACTER
0	space
1	!
2	"
3	#
4	$
5	%
.	.
23	7
24	8
.	.
78	n
79	o

ESC Z Identify as VT-52 (Transmits ESC / K)

ESC [Enter Hold Screen Mode

This mode uses X-ON and X-OFF codes in conjunction with the SCROLL key to control the flow of data from the computer. For this to function properly, your computer must support X-ON and X-OFF.

ESC \ Exit Hold Screen Mode

ESC] Transmit 25th Line

ESC b Erase Beinning of Screen

ESC c Enable Auxiliary Character Generator

This allows the use of a 4K byte character generator (2732) to provide an additional 128 characters as an alternate to reverse video. (see ESC p for more detail)

ESC d Disable Auxiliary Character Generator

ESC j Save Cursor Position

ESC k Set Cursor to Saved Position

ESC l Erase Line

ESC n Cursor Position Report

This reports the present cursor position in the form of ESC I r c where r and c are the row and column numbers in binary plus 20H. (see ESC Y for partial table)

ESC o Erase From Beginning of Line

ESC p Enter Reverse Video Mode

Characters entered after this mode is enabled will be displayed in either reverse video or from the Auxiliary half of the character generator, depending on the state of the Auxiliary Character Mode. (ESC c)

ESC q Exit reverse Video Mode

ESC r # Modify Baud Rate

= A - O

The baud rate selected is determined from the following table.

A = 75	I = 2000
B = 110	J = 2400
C = 134.5	K = 3600
D = 150	L = 4800
E = 300	M = 7200
F = 600	N = 9600
G = 1200	O = 19200
H = 1800	

ESC v Wrap at end of Line
ESC w Discard at end of line
ESC x # Set Mode
= option number

0	Full Duplex
1	Enable 25th Line
2	Enable Click
3	Enter Hold Screen Mode
4	Set Block Cursor
5	Enable Cursor
6	Set Keypad Shifted Mode
7	Set Alternate Keypad Mode
8	Enable Automatic Line Feed
9	Enable Auto Return on Line Feed
:	Enable Automatic Keyboard Repeat
;	Enable Flow Control using Flow Control Mask (i.e. CTS)

ESC y # # = option number

0	Half Duplex
1	Disable 25th Line
2	Disable Click
3	Exit Hold Screen Mode
4	Set Underline Cursor
5	Disable Cursor
6	Reset Keypad Shifted Mode
7	Reset Alternate Keypad Mode
8	Disable Automatic Line Feed
9	Disable Auto Return on Line Feed
:	Disable Automatic Keyboard Repeat
;	Reset Flow Control Enable

ESC z Reset to Power Up Configuration
The terminal is configured with the following options on power up.

Block Cursor	Key Click On
End of Line Wrap On	Auto Linefeed Off
On Line	Flow Control On
25th Line Off	Keyboard Enabled

```
ESC {      Enable Keyboard
ESC }      Disable Keyboard
ESC $      Download Keyboard Handler Routine
               The  keyboard handler routine should be  sent
               in  Intel Hex format.  Origin of the program
               should be set at 4400H.  Program must be less
               than or equal to 1024 bytes in length.
```

ANSI CONTROL CODES SUPPORTED

```
ESC =         Enter Alternate Keypad Mode
ESC >         Exit Alternate Keypad Mode
ESC M         Reverse Linefeed
ESC [ > H #   Set Mode  (see Set Mode Codes above)
ESC [ > L #   Reset Mode (see Reset Mode Codes above)
ESC [ ? H #   Change Mode
                    If # = 02H then set Heath Mode
                         = 07H then set Line Wrap

ESC [ ? L #   Change Mode
                    If # = 07H then set Line Wrap

ESC [ A #     Cursor Up (# Lines)
ESC [ B #     Cursor Down (# Lines)
ESC [ C #     Cursor Forward (# Columns)
ESC [ D #     Cursor Backwards (# Columns)
ESC [ H r,c   Cursor Address
                    r & c are ASCII Numbers representing row and
                    column

ESC [ J       Erase Screen
ESC [ K #     Erase # Line (s)
ESC [ L #     Insert # Line (s)
ESC [ M #     Delete # Line (s)
ESC [ P #     Delets # Character (s)
ESC [ f       Cursor Address (see ESC [ H )
ESC [ h #     Modify Mode
                    If # = 02H then Disable Keyboard
                         = 04H then Enable Insert Character Mode
                         = 14H then Enable Auto Carriage Return Mode

ESC [ l #     Modify Mode 2
                    If # = 02H then Enable Keyboard
                         = 04H then Disable Insert Character Mode
                         = 14H then Disable Auto Return Mode
```

```
ESC [ m #    Display Mode
                  If # = 00H then Reset Reverse Video Mode
                       = 07H then Set Reverse Video Mode
                       = 0AH then Set Graphics Mode
                       = 0BH then Reset Graphics Mode

ESC [ n 06H Cursor Position Report
                  Returns ESC [ R; c r  where r and c are row
                  and column numbers in ASCII

ESC [ p      Transmit Page
ESC [ q      Transmit 25th Line
ESC [ r #    Modify Baud Rate
                  If # = 00H then Set to DIP switch rate
                       = 01H      110 BAUD
                       = 02H      150 BAUD
                       = 03H      300 BAUD
                       = 04H      300 BAUD
                       = 05H      600 BAUD
                       = 06H      1800 BAUD
                       = 07H      1200 BAUD
                       = 08H      2000 BAUD
                       = 09H      2400 BAUD
                       = 0AH      3600 BAUD
                       = 0BH      4800 BAUD
                       = 0CH      7200 BAUD
                       = 0DH      9600 BAUD
                       = 0EH      9600 BAUD
                       = 0FH      19200 BAUD

ESC [ s      Save Cursor Position
ESC [ u      Set Cursor to Set Position
ESC [ z      Reset to Power Up Configuration
```

AMKEY KEYBOARD LAYOUT

This table indicates the definition of the function keys on the AMKEY 101 keyboard when in the WordStar* (alternate keypad) mode. (Applicable only when the special EPROM is installed on the keyboard)

NORMAL MODE

Key #	Base Code	No-Shift	Shift	Control
1	80H	^[S	^[S	
2	81H	^[T	^[T	
3	82H	^[U	^[U	
4	83H	^[V	^[V	
5	84H	^[W	^[W	
6	85H	^[P	^[P	
7	86H	^[Q	^[Q	
8	87H	^[R	^[R	
9	8CH	^@	^@	
10	8EH	^@	^@	
11	8FH	^@	^@	
12	90H	^@	^@	
13	91H	^@	^@	
14	92H	^@	^@	
15	93H	^@	^@	
16	94H	STAT	^@	
17	95H	ZSID	^@	
18	96H	PIP	PIP LST:=	
19	9FH	OFF LINE	ON LINE	ALT MODE
20	9EH	`	~	
34	08H	ESC	ESC	ESC
35	37H	7	^[@	
36	38H	8	^[A	
37	39H	9	^[N	
38	9CH	^[J	^[E	
39	9DH	{	}	
53	34H	4	^[D	
54	35H	5	^[H	
55	36H	6	^[C	
71	31H	1	^[L	
72	32H	2	^[B	
73	33H	3	^[M	
74	99H	SCRL LINE *	SCRL PAGE *	
75	9AH	^@	^@	
88	2CH	,		
89	30H	0		
90	2EH	.		
91	98H	^P		

Key #	Base Code	No-Shift	Shift	Control
92	97H	^S		
93	8BH	^X		
94	89H	^C		
96	88H	BACK SPACE		
97	8AH	LINE FEED		
98	7FH	^@		
99	2BH	+		
100	2DH	-		
101	9BH	BREAK	RESET	

INTERPRETATION OF NORMAL CODES WHEN OFF LINE

Key #	No-Shift	Shift
38	ERASE TO END OF SCREEN	CLEAR SCREEN
35	7	INSERT CHARACTER
36	8	CURSOR UP
37	9	DELETE CHARACTER
53	4	CURSOR LEFT
54	5	CURSOR HOME
55	6	CURSOR RIGHT
71	1	INSERT LINE
72	2	CURSOR DOWN
73	3	DELETE LINE

* NOTE: Can only be used in hold screen mode. Scrolls using XON and XOFF.

ALTERNATE (WORDSTAR) MODE

Key #	Base Code	No-Shift	Shift	Control
1	80H	^KP	^JD	
2	81H	^KY	^JM	
3	82H	^KR	^JP	
4	83H	^KV	^JR	
5	84H	^KC	^JS	
6	85H	^KH	^JV	
7	86H	^KB	^QB	
8	87H	^KK	^QK	
9	8CH	^OI	^OV	
10	8EH	^ON	^OW	
11	8FH	^OC	^P-	
12	90H	^OS	^PM	
13	91H	^OL	^PO	
14	92H	^OR	^OT	
15	93H	^OF	^OP	
16	94H	^OX	^OJ	
17	95H	^KW	^KD	
18	96H	^KS	^KX	
19	9FH	OFF LINE	ON LINE	NORM MODE
20	9EH			
34	08H	ESCAPE	ESCAPE	ESCAPE
35	37H	^C		
36	38H	^R		
37	39H	^QR		
38	9CH	^[J	^[E	
39	9DH	{	}	
53	34H	^Z		
54	35H	^W		
55	36H	^QC		
71	31H	^A	^S	^QS
72	32H	^F	^D	^QD
73	33H	^QE		
74	99H	^QA		
75	9AH	^B	^U	
88	2CH	^E		
89	30H	^X		
90	2EH	^QX		
91	98H	^QF		
92	97H	^L	^QP	
93	8BH	^OJ	^OC	
94	89H	^JH3	^JH1	
96	88H	DEL	^Y	
97	8AH	^G	^T	
98	7FH	^S	^Q DEL	
99	2BH	^D	^QY	
100	2DH	^V		
101	9BH	BREAK	RESET	

MODIFYING DISPLAY PARAMETERS

Because of the widely varying specifications of monitors from different manufacturers, it is impossible to compute CRT display parameters that will work with any monitor. ROMAC has calculated values which will provide a satisfactory display on most common monitors and these are the values presently written into the software for the H19MK101 terminal. If the display on your particular monitor isn't quite satisfactory, however, this section should provide some help in correcting the problem.

The following is a short description of each of the registers in the 6845 CRT Controller.

HORIZONTAL TIMING REGISTERS (R0-R3)

R0 - Horizontal Total Register

This register determines the frequency of HS. It is the total of displayed plus non-displayed character time units minus one.

R1 - Horizontal Displayed Register

This register determines the number of displayed characters per horizontal line.

R2 - Horizontal Sync Position Register

This register deterines the position of the horizontal sync pulse on each horizontal line.

R3 - Horizontal Sync Width Register

This 4-bit register determines the width of the HS pulse. It may not be apparent why this width needs to be programed. However, consider that all timing widths must be programmed as multiples of the character clock period which varies. If HS width were fixed as an integral number of character times, it would vary with the character rate and might end up out of tolerance for some monitors.

On the H19MK101, a hardware adjustment of the HS width is provided. This trim pot allows the user to fine tune this parameter and provide a perfectly centered display.

VERTICAL TIMING REGISTERS (R4-R9)

R4,R5 - Vertical Total and Vertical Total Adjust Register

The vertical frequency of VS is determined by both R4 and R5. The calculated number of character line times is

usually an integer plus a fraction to get exactly a 50 or 60 Hz vertical refresh rate. The integer number of character line times minus one is programmed in the 7-bit Vertical Total register; the fraction is programmed in the 5-bit Vertical Scan Adjust register as a nuber of scan line times.

R6 - Vertical Displayed Register

This 7-bit register determines the number of displayed character rows on the CRT screen, and is programmed in character row times.

R7 - Vertical Sync Position

This 7-bit register determines the vertical sync position with respect to the reference. It is programmed in character row times.

R8 - Interlace Mode Register

This 2-bit register controlls the raster scan mode. On the H19K101 terminal, it is always set to zero.

R9 - Maximum Scan Line Address Register

this 5-bit register determines the number if scan lines per character row including spacing. The programed value is a maximum address and is one less than the number of scan lines.

DISPLAY FORMAT WORKSHEETS

On the following pages are worksheets for calculating the CRT display parameters. The first is an example which is filled in with the present values. The second is blank and is for your use. The specifications from your monitor's manual will be necessary to complete this sheet and calculate new CRT controller parameters. To change these paraeters in the software, look for a table labeled CRTCTAB1 which is located near the end of the source file. Replace the old values with the new values you have calculated.

SAMPLE CRT DISPLAY PARAMETER CALCULATION WORKSHEET

PART 1 - DISPLAY FORMAT

1. DISPLAYED CHARACTERS PER ROW		80	CHARACTERS
2. DISPLAYED CHARACTER ROWS PER SCREEN		24	ROWS
3. CHARACTER MATRIX	A. COLUMNS	7	COLUMNS
	B. ROWS	9	ROWS
4. CHARACTER BLOCK	A. COLUMNS	8	COLUMNS
	B. ROWS	10	ROWS
5. FRAME REFRESH RATE		60	HZ
6. CRT HORIZONTAL OSCILLATOR FREQUENCY		16.5	KHZ
7. ACTIVE SCAN LINES (LINE 2 X LINE 4B)		240	LINES
8. TOTAL SCAN LINES (LINE 6 / LINE 5)		275	LINES
9. TOTAL ROWS PER SCREEN (LINE 8/LINE 4B)		26	ROWS
	AND	13	LINES
10. VERTICAL SYNC DELAY (CHARACTER ROWS)		2	ROWS
11. VERTICAL SYNC WIDTH (SCAN LINES)		16	LINES
*THIS VALUE IS 16 FOR THE 6845			
12. HORIZONTAL SYNC DELAY (CHARACTER TIMES)		1	CHAR. TIMES
13. HORIZONTAL SYNC WIDTH (CHARACTER TIMES)		8	CHAR. TIMES
14. HORIZONTAL SCAN DELAY (CHARACTER TIMES)		4	CHAR. TIMES
15. TOTAL CHAR. TIMES (LINE 1+12+13+14)		93	CHAR. TIMES
16. CHARACTER RATE (LINE 6 X LINE 15)		1.5360	MHZ
17. DOT CLOCK RATE (LINE 4A X LINE 16)		12.2880	MHZ

PART 2 - CRTC REGISTERS

		DECIMAL	HEX
R0	HORIZONTAL TOTAL (LINE 15 MINUS 1)	92	5C
R1	HORIZONTAL DISPLAYED (LINE 1)	80	50
R2	HORIZ SYNC POSITION (LINE 1 + LINE 12)	81	51
R3	HORIZONTAL SYNC WIDTH (LINE 13)	8	08
R4	VERTICAL TOTAL (LINE 9 MINUS 1)	25	19
R5	VERTICAL ADJUST (LINE 9 LINES)	13	0D
R6	VERTICAL DISPLAYED (LINE 2)	24	18
R7	VERTICAL SYNC POSITION (LINE 2 + LINE 10)	26	1A
R8	INTERLACE (SHOULD BE ZERO)	0	00
R9	MAX SCAN LINE (LINE 4B MINUS 1)	9	09

THE VALUES WRITTEN TO REGISTERS 10-15 ARE NOT CALCULATED IN THESE TABLES. THE VALUES USED IN THE ROMAC SOFTWARE ARE SHOWN BELOW. SEE THE MOTOROLA 6845 DATA MANUAL FOR THE PURPOSE OF THESE REGISTERS.

R10 = 48H R11 = 08H R12 = 00H
R13 = 00H R14 = 00H R15 = 00H

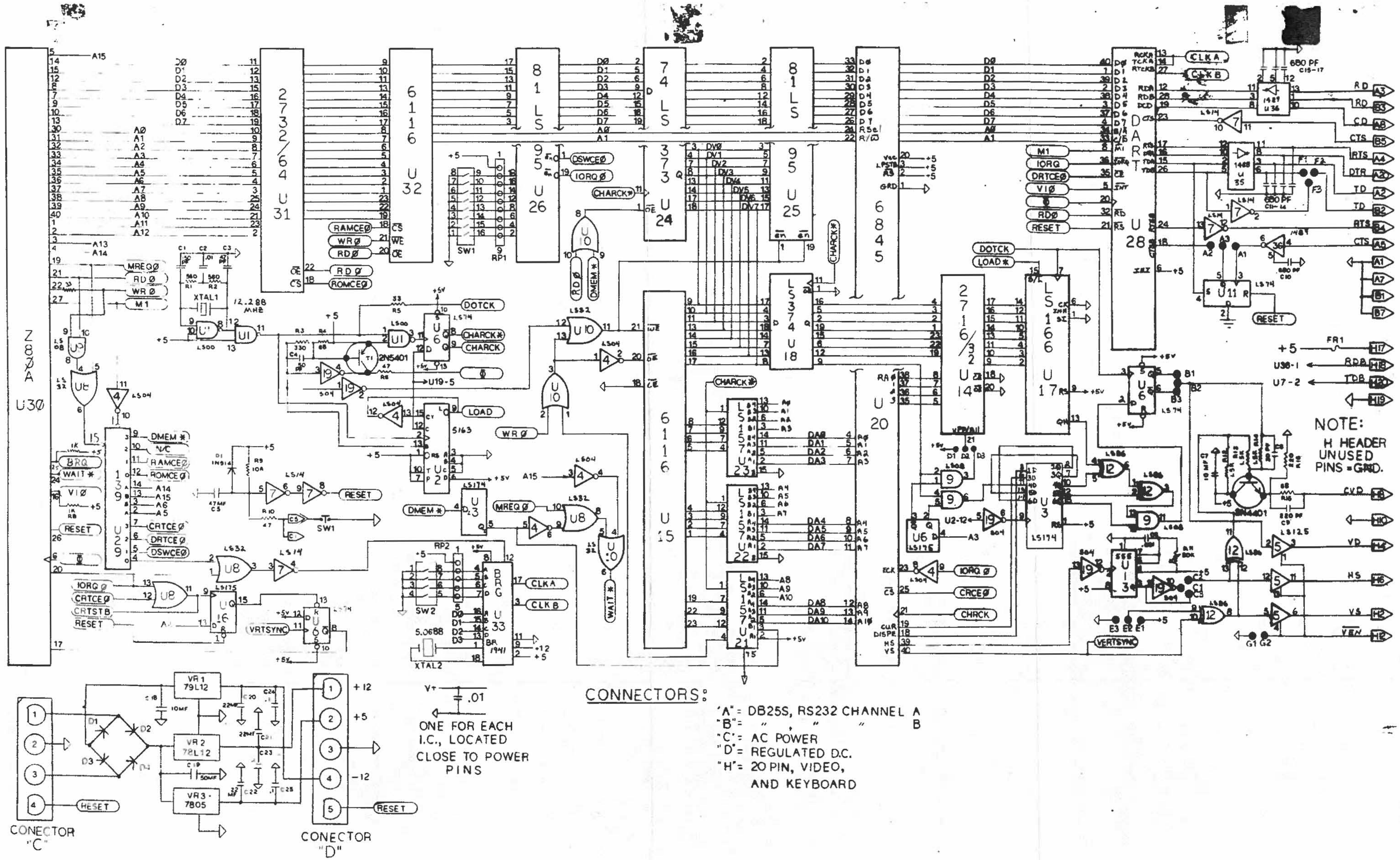
CRT DISPLAY PARAMETER CALCULATION WORKSHEET

PART 1 - DISPLAY FORMAT

1. DISPLAYED CHARACTERS PER ROW		_____	CHARACTERS
2. DISPLAYED CHARACTER ROWS PER SCREEN		_____	ROWS
3. CHARACTER MATRIX	A. COLUMNS	_____	COLUMNS
	B. ROWS	_____	ROWS
4. CHARACTER BLOCK	A. COLUMNS	_____	COLUMNS
	B. ROWS	_____	ROWS
5. FRAME REFRESH RATE		_____	HZ
6. CRT HORIZONTAL OSCILLATOR FREQUENCY		_____	KHZ
7. ACTIVE SCAN LINES (LINE 2 X LINE 4B)		_____	LINES
8. TOTAL SCAN LINES (LINE 6 / LINE 5)		_____	LINES
9. TOTAL ROWS PER SCREEN (LINE 8/LINE 4B)		_____	ROWS
	AND	_____	LINES
10. VERTICAL SYNC DELAY (CHARACTER ROWS)		_____	ROWS
11. VERTICAL SYNC WIDTH (SCAN LINES)		16	LINES
12. HORIZONTAL SYNC DELAY (CHARACTER TIMES)		_____	CHAR. TIMES
13. HORIZONTAL SYNC WIDTH (CHARACTER TIMES)		_____	CHAR. TIMES
14. HORIZONTAL SCAN DELAY (CHARACTER TIMES)		_____	CHAR. TIMES
15. TOTAL CHAR. TIMES (LINE 1+12+13+14)		_____	CHAR. TIMES
16. CHARACTER RATE (LINE 6 X LINE 15)		_____	MHZ
17. DOT CLOCK RATE (LINE 4A X LINE 16)		_____	MHZ

PART 2 - CRTC REGISTERS

		DECIMAL	HEX
R0	HORIZONTAL TOTAL (LINE 15 MINUS 1)	_____	_____
R1	HORIZONTAL DISPLAYED (LINE 1)	_____	_____
R2	HORIZ SYNC POSITION (LINE 1 + LINE 12)	_____	_____
R3	HORIZONTAL SYNC WIDTH (LINE 13)	_____	_____
R4	VERTICAL TOTAL (LINE 9 MINUS 1)	_____	_____
R5	VERTICAL ADJUST (LINE 9 LINES)	_____	_____
R6	VERTICAL DISPLAYED (LINE 2)	_____	_____
R7	VERTICAL SYNC POSITION (LINE 2 + LINE 10)	_____	_____
R8	INTERLACE (SHOULD BE ZERO)	_____	_____
R9	MAX SCAN LINE (LINE 4B MINUS 1)	_____	_____



CONNECTORS:

"A" = DB25S, RS232 CHANNEL A
"B" = " " " " B
"C" = AC POWER
"D" = REGULATED D.C.
"H" = 20 PIN, VIDEO, AND KEYBOARD

OPTION JUMPERS

A1-2	NORMAL CTS	A2-3	CTS = XMTPRDY↓
B1-2	+ Video Data	B2-3	- Video Data
C1-2	- HORIZONTAL SYNC	C2-3	+ HORIZONTAL SYNC
D1-2	2716 CHAR GEN	D2-3	2732 CHAR GEN
E1-2	- VERTICAL SYNC	E2-3	+ VERTICAL SYNC
F1-2	RS-232 KB XMIT Data	F2-3	TTL KB XMIT Data
G1-2	Enable Video	open	EXT Video enable