SM 7210

SERVICE MANUAL
for
MODELS 7220 and 7230
VIDEO DISPLAY TERMINAL

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basic / FOUR corporation
an MAI company ®

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Section 1

GENERAL DESCRIPTION

1.1 SCOPE

This manual contains the general description, operation, and maintenance data for the Model 7220 and Model 7230/0973 Video Display Terminals, manufactured by Basic/Four Corporation, 18552 MacArthur Boulevard, Santa Ana, California 92707. The Video Display Terminal is an integral part of the BASIC/FOUR® data processing systems. Control of the Video Display Terminal (VDT) by the Central Processing Unit (CPU) is effected through one of the following terminal controllers.

1. A Local/Remote Single Channel Controller is used when the data processing system includes a single VDT or an additional VDT that is in a location remote from the rest of the system. In this case interchange of data is transmitted over telephone lines.
2. A Switch Selectable Baud Rate Four Channel Controller is used when there are two, three, or four local VDT associated with the data processing system.
3. A Switch Selectable Baud Rate Eight Channel Controller is used when there are from five to eight VDT associated with the data processing system.

All of the controllers are described in TM 1010 and LD 1010. Figure 1-1 shows the VDT.

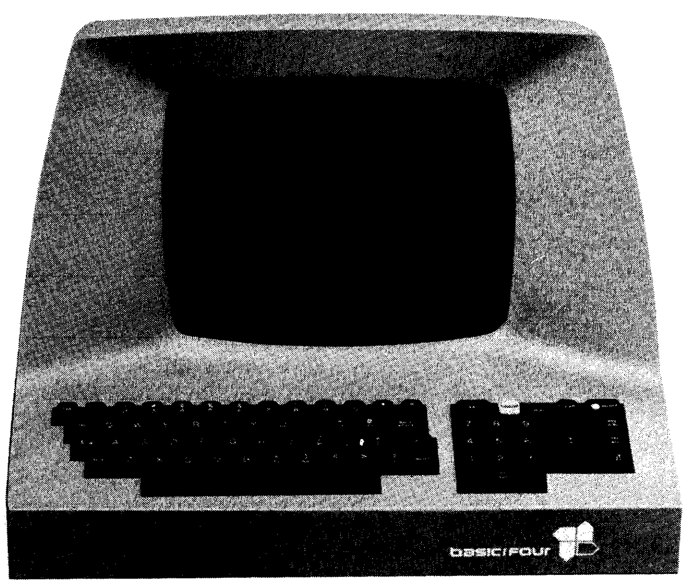


Figure 1-1. Model 7220 Video Display Terminal

Section 1, general description, includes both physical and functional descriptions of the VDT. Section 2, operation, contains descriptions of control functions applicable to maintenance operations. Section 3, maintenance, contains a detailed functional description of the VDT, preventive maintenance, cleaning, removal, replacement and alignment procedures followed by functional block and timing diagrams. Section 4 is an illustrated parts list.

1.2 PURPOSE

The Model 7220 Video Display Terminal displays up to 24 lines of 80 characters. Each character is generated by intensity modulation of a 5 X 7 dot matrix. Adjacent columns of characters are separated by a horizontal space equal to 2/5 of the character width. Adjacent lines of characters are separated by a vertical space equal to 2/7 of the character height. The display is refreshed approximately 60 times a second. The characters displayed in normal operation are transmitted from a controller in the CPU as 7-bit serial binary USASCII codes. When characters are entered at the keyboard they are transmitted to the controller where they are transferred to the CPU for storage in memory. Each character is then immediately transmitted back to the VDT by the controller for display. When the CR key (carriage return) is pressed, the cursor is repositioned to the start of the next line and the CPU then processes the statement preceding the carriage return. All characters transmitted from the CPU are stored in the VDT memory for display on the CRT. This applies to characters resulting from program control as well as those originating from the keyboard. Also characters may be displayed at two different intensities so they appear as foreground or background characters.

For most applications of the data processing systems the keyboard is the only source of data entry. And in applications where other media are used for data entry the keyboard is still the prime source of data entry. Although the VDT can only display 24 lines of characters at one time there is automatic roll up (top line is lost, all others move up one line) of the display when more characters are entered to a full screen so there is no limit to the number of characters that may be entered.

1.3 PHYSICAL DESCRIPTION

The dimensions of the VDT are listed in table 1-1. Mounted inside the cover at the bottom of the unit is the Logic Board which contains all of the logic for the operation of the VDT and the memory for the display. Above the Logic Board at the front of the VDT is the Keyboard and its logic circuits. Above the Logic Board near the center of the unit is the Monitor Board which contains all of the electronic circuits for CRT deflection and intensity control. To the right of the Monitor Board is the +5 volt regulator assembly and its power transformer. These circuits provide the voltages required for the Logic Board and Keyboard. To the left of the Monitor Board is the supply and regulator boards which provide +15 volts to the Monitor Board. At the rear of the VDT are the exhaust fan and display controls.

Table 1-1. Specifications

Parameter	Characteristics
Display:	
Lines	24
Character positions	1920
Character set	64 USASCII
Screen phosphor	P4
Refresh rate	60 times per second
Protected fields	reduced intensity
Cursor:	
Format	Reverse image block
Controls	Forespace, backspace, upline, down-line, new line, return home tab, absolute cursor addressing, read cursor addressing.
Data Transmission:	
Codes	Seven bit USASCII
Modes	Full duplex, half duplex, or batch
Interface	RS-232-C
Baud rates	Switch selectable 300 or 2400 for Model 7220 and 2400 or 9600 for the Model 7230 and 0973.
Keyboard:	
Main	Forty-two character keys, seven function keys and space bar.
Numeric	Keys 0 through 9, five function keys and four mode select keys.
Data Editing:	
Character	Type over
Unprotected fields	Clear to spaces
Screen	Clear to nulls

Table 1-1. Specifications (continued)

Parameter	Characteristics
Physical Characteristics:	
Dimensions	12 inches high, 16 inches wide, 21 inches deep.
Weight	45 pounds
Power requirements	115V, 60Hz, 130 watts 230V, 50Hz, 130 watts
Environment	41-122°F 5-95% humidity without condensation.

1.4 FUNCTIONAL DESCRIPTION (figure 1-2)

The VDT is normally the only two-way interface between the operator and the data processing system. Depending on the dictates of the program, serial data from the CPU is transmitted by the terminal controller for display on the CRT. In this case the receiver reconstructs a 7-bit byte and puts a receiver status byte on the tri-state bus (TSB). The status byte results in a conditional jump situation being identified. The conditional jump causes the control memory to issue commands transferring the data byte to the TSB and from there to memory. Subsequently this data is retrieved from memory and loaded into the row memory shift register one row at a time. As each byte is shifted out of the row memory shift register it is temporarily stored in a character buffer register. The byte is then decoded into a dot pattern by the character generator and the dot pattern stored in a dot shift register. Each dot shifted out causes a dot to be painted on the CRT. The displayed data is usually intended to prompt a response by the operator.

The operator's response is entered at the keyboard one character at a time. The character is translated into an USASCII code by the keyboard logic and transmitted as a 7-bit data byte to the TSB concurrent with a keyboard strobe. During full duplex operation (the usual mode) the data byte is loaded from the TSB into the transmitter. The transmitter sends the byte in serial form to the terminal controller where it is reassembled into a data byte and stored by the CPU. The data byte is immediately retransmitted through the same sequence of events as was the data transmitted by program direction and immediately displayed on the CRT.

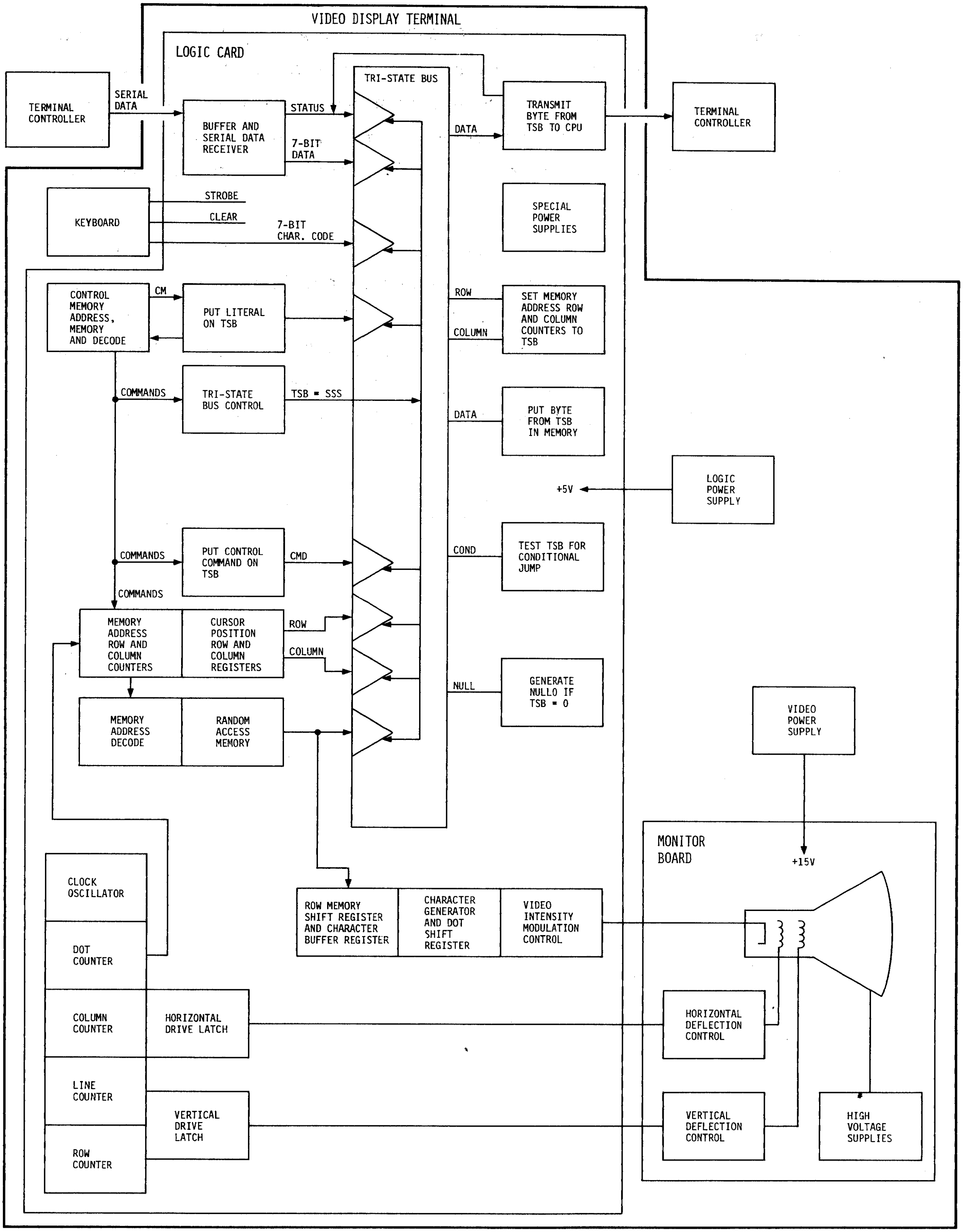


Figure 1-2. VDT Block Diagram

The position of characters displayed on the CRT is controlled by the dot, column, line, and row counters. The horizontal sweep is synchronized by the column counter so a new sweep is started after the hundredth column count. The vertical sweep is synchronized so a new vertical sweep is started after the twenty-ninth row count. Since there are only 80 columns and 24 rows in a full display, the extra counts allow time for retrace and settling.

The regulated power required for the Monitor Board and CRT is provided by an independent transformer and +15-volt supply. Another transformer and +5-volt supply provide all the power required by the Logic Board and Keyboard. On the Logic Board are four regulators which supply ±5 and ±12 volts needed for special functions on the Logic Board and Keyboard. The high voltages (+34, +400, +12,000, and -160 volts) required by the CRT are developed from the +15 volts by the horizontal deflection control circuits.

Section 2

OPERATION

2.1 MONITOR CONTROLS (figure 2-1)

The monitor controls are located on the back of the VDT and are of two types. The first consists of those controls frequently used by the operator; the other consists of switches set only during installation.

2.1.1 POWER SWITCH

The power switch controls all power to the VDT.

2.1.2 CIRCUIT BREAKER

The circuit breaker reset switch is the red button immediately below the power switch. The reset button should be pressed whenever there is an indication of a power failure in the VDT.

2.1.3 BRIGHTNESS

This control adjusts the intensity of the display. Normally it is adjusted until the raster is visible then backed off until the raster just disappears.

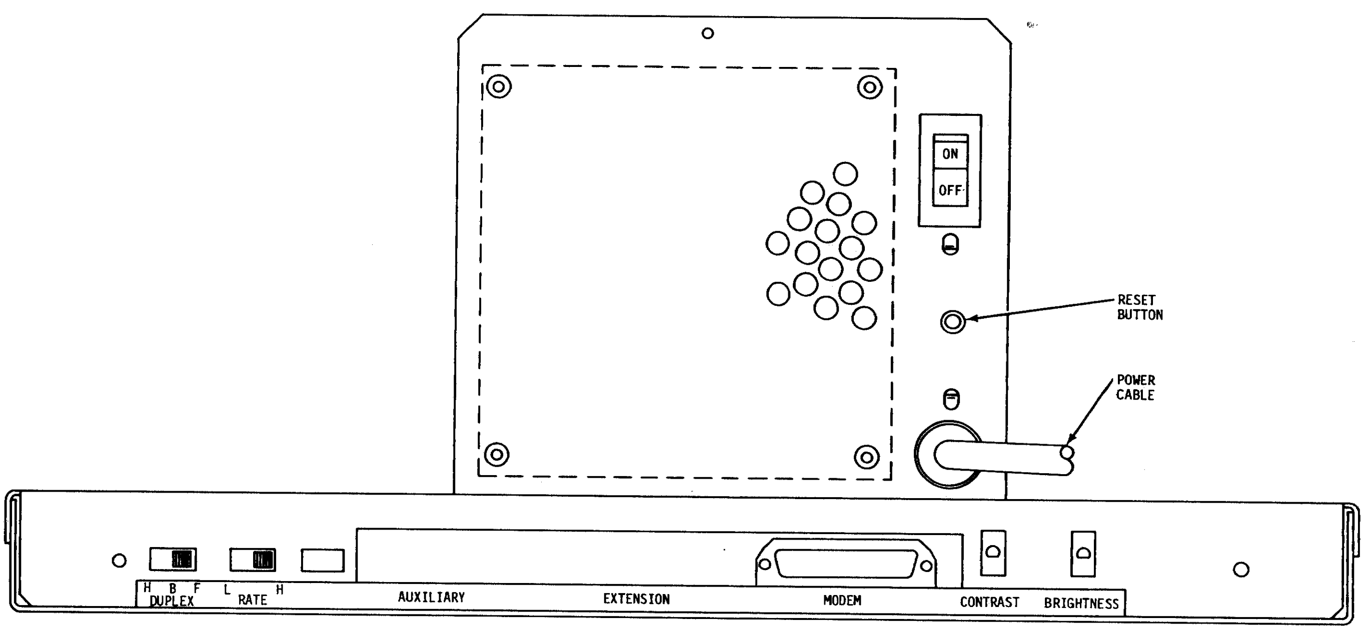


Figure 2-1. VDT Back Panel

2.1.4 CONTRAST

This control adjusts the difference in intensity between the background and the characters in the display. It is adjusted to suit the operator's preference after BRIGHTNESS has been adjusted.

2.1.5 RATE

This is the baud rate selector. It selects 2400 in the H position and 300 in the L position for the Model 7220 and 2400 or 9600 for the Model 7230 and Model 0973. When the VDT is installed close enough to the CPU to be connected to the back panel connector the RATE switch should be set to H. Some remote installations will require the RATE switch to be set to L.

2.1.6 DUPLEX

The DUPLEX switch should normally be set to F (full duplex operation). It may be helpful during troubleshooting to set the DUPLEX switch to H (half duplex operation; characters entered from the Keyboard are double displayed) or to B (batch mode; the VDT will operate without being connected to a controller).

2.2 KEYBOARD CONTROLS (figure 2-2)

The Keyboard contains a typewriter keyboard, a numeric key cluster, a group of special control keys, an error indicator, and an on/off switch/indicator. The functions of these controls and indicators are described in table 2-1.

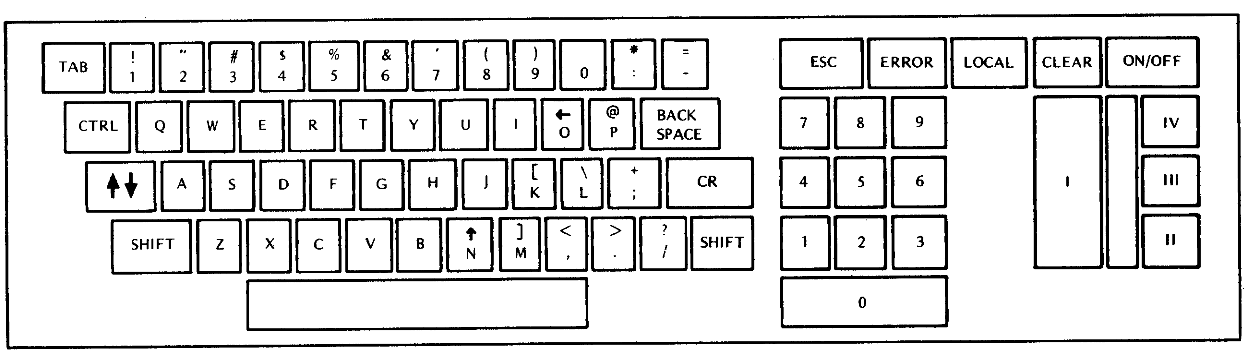


Figure 2-2. VDT Keyboard

Table 2-1. Keyboard Controls and Indicators

Key	Function
TAB key	This key is operative only in the full- or half-duplex mode. Striking the key causes the CPU, under program control, to position the cursor at the next tab stop. The SHIFT and CTRL keys have no effect on the TAB key.
CTRL key	The CTRL (control) key is used in conjunction with any of the alphameric and symbol keys on the typewriter keyboard to generate transmittable character codes used for function commands, security, etc. The CTRL key is also interlocked with the CLEAR key, preventing accidental clearing of the display.
↑↓lock key	Pressing this key causes subsequent characters to be displayed at background intensity. This key remains engaged until pressed a second time.
SHIFT keys	The SHIFT key (left or right) is pressed to produce the upper characters marked on the keytop labels for keys having shifted and unshifted characters. To produce the shifted character, the SHIFT key must be pressed, and the appropriate key must be struck. The SHIFT key can be used with any alphameric key on the typewriter keyboard. When the SHIFT key is pressed while striking the A through J keys, characters Q through Z are produced. When the SHIFT key is pressed while striking the Q through Z keys, characters A through J are produced.
BACKSPACE	This key is operative only in the full- or half-duplex mode. The cursor is moved one position to the left, non-destructively. That is, the character above the cursor location when the BACKSPACE key is struck is not deleted from the screen. If the cursor is located at the start of a line when the BACKSPACE key is struck, no action is produced. The SHIFT and CTRL keys have no effect on the BACKSPACE key.
CR key	When the VDT is under CPU control, striking this key causes the cursor to be moved to the start of the next lower line on the display, accomplishing a carriage return and line feed. All characters entered since the preceding CR are stored in the CPU.
Space bar	Striking the space bar causes the character at the cursor position to be erased, and moves the cursor one position to the right. The SHIFT and CTRL keys have no effect on the space bar.

Table 2-1. Keyboard Controls and Indicators (continued)

Key	Function
Typewriter keyboard alphameric and symbol keys	These keys are used to produce all displayable characters in the VDT symbol repertoire, and can also be used in conjunction with the SHIFT and CTRL keys to produce function commands. See tables 2-2 and 2-3.
Numeric key cluster (0 through 9)	These keys provide a more convenient way of making numerical entries than the same keys on the typewriter keyboard. The keys in the numeric key cluster are unaffected by the SHIFT and CTRL keys.
ESC key	The ESC (escape) key is generally used to generate a program interrupt. The use of this key is entirely dependent upon the system software (see notes).
ERROR indicator light	This indicator is inoperative in the VDT application.
LOCAL pushbutton	This key is inoperative in the VDT application.
CLEAR key	When the CTRL key is pressed and the CLEAR key is struck (^{C}CLEAR), all characters are cleared from the screen (total clear), and the cursor is moved to the home position (upper left corner of display).
Power ON/OFF pushbutton/indicator	The ON/OFF switch is inoperative in the VDT. When power is applied, the indicator is lighted.
Special function keys I through IV	The functions of these keys are determined by program software.

NOTES:

1. The distinction implied between system software and program software is that system software is common to all systems of the same model number, whereas, program software is unique to each system according to user applications.

2. The most common sequence used to generate a program interrupt is ESC, E, S, and C. Other combinations are used, however, it is unlikely that a program would acknowledge a single ESC code as an interrupt.

3. Lower case letters are enabled by locking the [↑ ↓] key in the down position. In this mode, upper case characters may be keyed by depressing the [shift] key. Lower case letters are displayed as inverted upper case letters.

   Example:

4. The VDT responds in special ways to certain program commands. These are summarized below.

   a. Control characters other than NUL and "action" characters (e.g., backspace) are displayed as inverted numerics or specials.

   b. The transmit character, \$60\$, is displayed as an inverted @.

   c. BS - Cursor moves in the reverse direction, and additionally, deletes the characters through which it backspaces, for keyboard operations only.

   d. CL - Clears the balance of the line but does not cause lines below the line cleared to roll up. Also resets to foreground intensity mode.

   e. LF - Cursor executes a carriage return and line feed.

   f. FF - Cursor executes a carriage return and double space line feed.

   g. CR - Cursor executes a carriage return and line feed.

   h. The display will shift from background to foreground mode whenever a 'CF', 'CS', 'LI', 'LD' or 'CL' is executed or the screen rolls up.

Section 3

MAINTENANCE

3.1 DETAILED FUNCTIONAL DESCRIPTION

Operation of the VDT is divided into four functional groups: the Power Function, the Data Transfer Function, the Display Function, and the Tri-State Bus and Video circuits. The three functions are presented in their operational sequence. The Tri-State Bus and Video circuits are repeatedly involved in the three functions and deserve specific coverage as entities.

3.2 POWER FUNCTION (figure 3-1)

The Power Function consists of ac distribution, the Video Power Supply and Regulator Driver, the Monitor Board power supply, the Main Logic Power Supply, and the special functions power supply on the Logic Board. The power source for the VDT may be either 115 volts, 60 Hertz or 220 volts, 50 Hertz. The only difference between models using the different power sources is in the input connector and the connections to the power transformer.

3.2.1 AC DISTRIBUTION

When the power switch is ON, ac is applied through the circuit breaker to a terminal strip. At the terminal strip the ground wire is connected to the VDT chassis and a 0.01µf capacitor is connected from each of the ac lines to the chassis to provide transient protection. When the VDT is wired for 220 volt operation, the switched line is connected directly to the power transformers and the lead from pin 3 of the main power transformer returns the 115 volt line to pin 1 of the terminal strip so the fan is always operated from 115 volts. The main power transformer also supplies stepped-down, center-tapped ac voltage to full-wave rectifiers on the Main Logic Power Supply and a bridge rectifier on the Logic Board.

3.2.2 VIDEO POWER SUPPLY AND REGULATOR DRIVER

The Video Power Supply power transformer provides filament current for the CRT and power to the bridge rectifier. The Regulator Driver senses changes in the regulated +15 volts and drives the series regulator mounted on the Video Power Supply. The

+15 volts supplies the energy used by the horizontal oscillator to operate the CRT. The voltage adjustment on the Regulator Driver can vary the output voltage by about ±30%.

Figure 3-5 is the schematic of the Video Power Supply and Regulator Driver. The filtered voltage from bridge rectifier CR1 is the collector supply for series regulator Q1. Base control for Q1 is provided by emitter follower Q201. During normal operation Q202 compares the regulated output voltage with the reference voltage across VR201 and changes the conduction of Q201 as necessary to maintain +15 volts. Under normal operating conditions Q203 is cutoff and so has no effect on the regulator. In the event of a short across the supply output, the voltage drop across R204 increases switching Q203 on and Q202 is cutoff since its base and emitter voltages drop to zero. Q203 now reduces the conduction of Q201 limiting the conduction of Q1 to a safe level thus protecting the regulator from overheating and catastrophic failure.

3.2.3 MONITOR BOARD POWER SUPPLY

The horizontal circuits generate about 15,400 sweeps per second. As each sweep is generated, energy is stored in the yoke. At the termination of the sweep this stored energy is dumped into flyback transformer T2. During flyback approximately 160 volts is dropped across the primary of T2. This charges C110 through CR104 to provide the -160 volts for the brightness control circuit. The secondary of T2 is tapped to provide the sources for the +34-volt, +400-volt, and +12,000-volt supplies. The +34 volts is the video amplifier supply, the +400 volts is the focus supply, and the +12,000 volts is the CRT high voltage.

3.2.4 MAIN LOGIC POWER SUPPLY

The Main Logic Power Supply has a full-wave rectifier for the regulator control circuits and a full wave rectifier for the regulated +5.2 volts output. The regulator is protected against overcurrent conditions and the load is protected against overvoltage output from the regulator. The output voltage is adjustable from +4.75 to +7.0 volts, however, the output voltage must never be adjusted above 5.2 volts when P5 is connected to the logic board. The normal position for the current limit adjustment is for maximum current before limiting (approximately 7.75 amperes). The overvoltage protection is adjusted to 5.5 volts.

Figure 3-5 is the schematic of the Main Logic Power Supply. The power transformer and full-wave rectifier for the regulated +15 volts are connected so the current to the center tap of the transformer is regulated. This type of connection makes it possible to use the supply as either a +5-volt or -5-volt supply but requires a second full-wave rectifier for the control circuits. CR1, CR2, C1, and C2 provide a positive filtered voltage for the regulator control circuits. CR3 through CR6, C3 and C4 provide rectified, filtered voltage across the capacitors. A constant voltage is maintained across the output terminals by series regulator Q3. Base control for Q3 is provided by emitter follower Q2. U1 provides voltage control to Q2 during normal operation or, during overcurrent conditions, limits the current through Q2 and, thereby, through Q3 to a safe level. The overvoltage protection circuit compares the voltage across the output circuit against the reference provided by CR9 and R22. When the output voltage exceeds the limit established by the reference, Q4 conducts firing SCR1. SCR1 shorts the output causing U1 to limit the current through Q3 to a level that just keeps SCR1 conducting. Once overvoltage protection circuit is activated, power to the VDT must be turned off or the E OUT ADJ reset to lower limit in order to reestablish the normal output voltage.

3.2.5 SPECIAL FUNCTIONS POWER SUPPLY

The power supply on the Logic Board provides +20 volts to the beep speaker; regulated +5 volts to the two voltage controlled oscillators; regulated -5 volts to the memory read amplifier and character generator; -12 volts to the line memory shift register, character generator, receiver/transmitter, and the Keyboard; and +12 volts to the line drivers and line receivers.

3.3 DATA TRANSFER FUNCTION (figure 3-2)

Normal operation of the VDT under system control begins with the operator calling up a specific program. After that, operator entries are usually the result of questions or instructions from the program. All of these operations involve the Data Transfer Function.

3.3.1 KEYBOARD ENTRIES

When the operator enters a character at the Keyboard, the character is encoded as an USASCII code byte. Whenever any key on the Keyboard except CTRL, ↑↓, SHIFT, and CLEAR is pressed, it is processed as a character. The Keyboard electronics accompolishes the encoding. A Schmitt trigger is connected as a free-running multivibrator which generates a 2X clock count with an 8-microsecond period. The 2X clock count drives the clock generator. The clock generator provides a count clock to the modulo-128 counter, the count coincidence flip-flop and the stop clock flip-flop. The clock generator also provides a shift clock for the 128-bit shift register. The modulo-128 counter completes a full count cycle every two milliseconds. The three high order bits of the counter are decoded into eight separate counts and applied to the diode matrix for the keyboard. When a key is pressed one of these counts is gated to one of the 16 lines to the two multiplexers. The four low order bits of the counter sequentially gate each of the 8 lines per multiplexer to the multiplexer output. An output from either can occur at only one count unique for each key. When such an output occurs, the free-running multivibrator is stopped which stops the counter and the shift register. A 30 millisecond keyboard strobe is generated for use on the Logic Board. The three high order bits of the counter are modified depending on which, if any, of the special control keys (CTRL, ↑↓, or SHIFT) are also pressed. Concurrent with the keyboard strobe is a data strobe which gates the four low order counter bits and the three modified high order bits out to the Logic Board as the Character Byte. The display screen is cleared and the cursor is repositioned to the first character position of the first line when CTRL and CLEAR are pressed at the same time.

The clear signal, the keyboard strobe and the power turnon reset signal are applied to a multiplexer where they are sequentially selected by the three low order bits of the control memory. When one of these signals is active a conditional signal is generated. The configuration of the low order control memory bits identifies the interrupt and dictates the next control memory address. When the interrupt is a keyboard strobe, the character byte from the Keyboard is placed on the TSB. The next control memory location addressed loads the TSB byte into the transmitter holding register. The byte is transferred to the transmitter register at the end of CDD2 or as soon thereafter as the transmitter register becomes empty. The transmit/receive clock generated by the baud rate oscillator/counter shifts the bits of the character byte to the transmitter data output buffer one at a time. As soon as the character byte is transferred from the transmitter holding register to the transmitter register, the transmitter holding register empty bit becomes active. This bit is placed on the TSB the next time the control memory is sequenced to check the transmitter/receiver status. As soon as the stop bit is transmitted by the transmitter register the transmitter register empty status bit is active. The transmitter register empty status bit is active until another byte is transferred from the transmitter holding register.

When the clear signal causes the conditional jump, the control memory location is addressed that starts the sequence for clearing the display memory and resetting the cursor to character position 1 of line 1. The discussion of the Display Function, paragraph 3.4, describes addressing and writing in memory and cursor positioning.

When the power turnon reset signal causes the conditional jump, control memory location 0 is addressed and the reset sequence is begun. The reset sequence and the clear signal both terminate with the control memory in the idle sequence. The idle sequence consists of 23 commands which checks the status of the transmitter/receiver then the keyboard. Since this takes less than 15 microseconds, any data transfer gets almost instantaneous attention.

3.3.2 CPU DATA TRANSFERS

The terminal controller transmits serial data to the VDT under two circumstances: (1) a displayable character entered at the Keyboard has been received and stored in the CPU memory or (2) the program commands that characters be displayed. In either case, the serial data is assembled in the receiver holding register until a character byte, a memory address byte, or a command byte is complete. The receiver then makes its status bits active. The receiver status bits are: parity error, framing error, overrun error, and data received. When the transmitter/receiver status is scanned by the control memory, the status is entered on the TSB and then the data byte. When the data byte is a character that was just entered at the keyboard, it is entered into the display memory and the cursor is advanced to the next character position. When it is a memory address byte, the memory address counter (row or column) is reset to that address. When the data byte is a command byte, a conditional jump resets the control memory address and the commanded sequence begins.

The conditional bus is activated by the control memory sequencing to a number of switch positions and special conditions connected to the conditional multiplexer or by the cursor position register contents equalling the memory address counter in addition to the cases already discussed. In all cases, bit configurations from the control memory amount to the statement, "If (some condition) is true, then jump to control memory location (XXX)".

3.4 DISPLAY FUNCTION (figure 3-3)

The display function includes the position counters that control the CRT beam position, the display memory and its address counters, the control memory, its address counter, and its decoder, and the video control circuits that convert USASCII codes into dot patterns that are recognizable symbols.

3.4.1 POSITION COUNTERS

The time base for the position counters is the output of a 10.962 megahertz voltage-controlled oscillator. This provides a clock every 91 nanoseconds that is counted down by five counters. The dot counter is a divide-by-seven counter that counts seven horizontal dot positions for each column. The column counter advances each time the dot counter resets. The column counter is a divide-by-100 counter that is decoded to provide the drive signal for the horizontal sweep. The line counter is a divide-by-nine counter. Each count of the line counter corresponds to the vertical dot spacing of a row of characters. The row counter is a divide-by-29 counter that provides the synchronizing signal to start the vertical sweep. The fifth counter is not used. The outputs of the dot counter are decoded to provide a count 6 which generates the TSB clocks and a count 4 which generates the row clock which advances characters through the 80-bit shift register row memory.

3.4.2 CONTROL MEMORY

The sequences of command bytes are stored in the control memory for every operation performed by the VDT except the display of characters already stored in the display memory. Each of these sequences is entered by an interrupt (conditional jump). Once a sequence is started the control memory address counter advances from the count of the first address of the sequence every 640 nanoseconds until it is jumped to a new sequence. Five of the sequences have been mentioned in paragraph 3.3; reset, idle, Keyboard entry, transmit, and receive. There are sequences that vary operation such as those selected by the duplex switch and by protected characters. The control memory issues specific commands for some operations, however, its most important function is control of traffic on the TSB. The group of bytes from the control memory that may be decoded into octal numbers from 160 to 177 load bytes from ten specific circuits onto the TSB. Once these bytes are on the TSB they may be transferred by other control memory bytes to one of seven other circuits. The transfer of data on the TSB is discussed in paragraph 3.5.

3.4.3 DISPLAY MEMORY

Before a character can be displayed on the VDT it must be assigned a location in the display memory. The display memory is addressed by the memory address row and memory address column counters. These counters may be reset to address a specific location by successively putting a column address byte on the TSB concurrent with a control memory 021_8 command followed by a row address byte on the TSB concurrent with a control memory 031_8 command. The memory column and row address are entered into the cursor position column and row registers by control memory command 027_8. The cursor and row registers are reset to row 0, column 0 when power is turned on. Any time the memory address is entered into the cursor position registers successfully, CPR = MAC and this condition is recognized as a conditional jump to continue the display sequence. The memory and row address source select multiplexers select the column and row position counters for the memory address during display refreshing. The memory column and row address counters are selected during a read command (001_8) and a write command (003_8). This means that most of the time, the column and row counters select the characters in memory to be displayed. It is the time-sharing effected in the multiplexers that permits changes to the display memory without detracting from the quality of the display.

Since each of the memory modules used consists of 1024 addressable storage locations for a single input and the display needs 8 (one for each bit of a character byte) storage locations for each of 1920 character positions on the screen, the display memory is an array of eight pairs of memory modules. Each memory module has ten address lines and an enable input. This makes it necessary to convert the seven column address and five row address bits that define the 1920 character positions on the display to ten address and two enable lines that define the memory locations. This is done by adding the three high order bits from the memory column address multiplexer to the outputs of a read only memory that is addressed by the five bits of the memory row address multiplexer to get the six high order memory address bits and a bit that enables one half of the memory modules at a time. The four low order bits from the memory column address multiplexer are the four low order memory address bits.

Once a memory location is addressed, control memory commands 001 and 003 through 007 are decoded to command a read or write operation. When a read operation is commanded the contents of the addressed memory location are placed on the TSB. If a write operation is to be commands it requires the following sequence:

(1) A write protect bit if required (006),
(2) then a load the write display register command (005),
(3) then the write command (003),
(4) then a clear the write display register command (004),
(5) a clear write protect command (007) if there was a write protect command for the character.

3.4.4 VIDEO CONTROL

Most of the time a memory location is addressed by the position counters and there is neither a read nor write command. Then the character in the addressed location is loaded into the 80-bit shift register row memory at count 5 of the dot counter. Characters are loaded into the row memory until all 80 characters are entered (including nulls for columns to the right of the last character). The row memory is loaded only during the first line of a row (no dots are displayed since it is one of the spacing lines on the display). During the next seven lines (sweeps) the contents of the row memory is recirculated and each character is loaded into the character buffer as it is available at the output of the shift register. The line counter bits and the USASCII code cause the character generator to output five bits representing the five horizontal dot positions into the dot shift register. For an "A", the seven bit patterns loaded into the dot shift register for the seven lines would be: 00100, 01010, 10001, 10001, 11111, 1001, and 1001. Each of the 1's would cause a dot on the display. If the "A" were protected it would be displayed at approximately two-thirds intensity or as background. Otherwise, it would be displayed as foreground at full intensity.

3.5 TRI-STATE BUS AND VIDEO CIRCUITS (figure 3-4)

The tri-state bus is the common interface between the circuits of the VDT through which character and command information is exchanged. It is common to all functions performed by the VDT. The video circuits are unique in the VDT in that there are adjustments available to the serviceman that require the use of special care and often the use of an oscilloscope as well.

3.5.1 TRI-STATE BUS

The TSB is so named because the outputs of all of the TSB input amplifiers may have three possible conditions. The output may be the normal logic levels of 0 (ground) or 1 (+5V) or disconnected from the bus. Since the amplifiers are enabled only when they are to place a byte on the TSB, the other nine TSB input amplifiers are disconnected from the TSB. Except for the circuits that detect a null (all bits are zeroes), the byte on the TSB is only gated to one group of circuits at a time. The following is a summary of operations involving transfer of data through the TSB.

Although data transfers have been discussed as isolated events, a complete sequence of events associated with displaying the first character entered at the keyboard would involve at least the following sequence. Assume that the VDT is operating full duplex and remember that there may be up to 8 VDT attached to one CPU and that the display sweeps are continuously cycled independent of any other VDT operation.

1. Power is turned on generating the reset interrupt. The reset interrupt resets the cursor position registers to column 0, row 0.
2. The memory address counters are cleared.
3. The byte in the first memory location is put on the TSB and checked for a conditional jump (a protected character bit). If the character is protected, the memory address counter is advanced to the next memory location and this step is repeated.
4. When the character is not protected, a null (no input to the TSB) is written in that memory location. The memory address counter is increased unless this is the last memory location, and step 3 is repeated.
5. When the last memory location has been cleared the memory address counter is reset and the first memory location checked again. If it is a protected character, the memroy address counter is advanced and the next location read until an unprotected location is found. The contents of the memory address counter is transferred to the cursor position register.
6. The cursor symbol code (literal on TSB) is entered in this memory location and displayed until a character is entered.
7. When a key is pressed (except CTRL, ↑↓, and SHIFT), a Keyboard strobe is generated.
8. The USASCII code for the entered character (character byte) is transferred to the TSB.
9. The character byte is transferred to the transmitter and the control memory jumps to the idle sequence.
10. When the character byte is returned from the CPU, the cursor position is put on the TSB and transferred to the memory address counter. The character byte is then put in memory and displayed during the next refresh cycle.
11. The memory address counter is advanced and loaded into the cursor position register.
12. The cursor symbol code is entered in that memory location and displayed until the next character is entered.

The operations listed above required a number of control memory jumps. These jumps require that a literal or a control command be put on the TSB.

3.5.2 VIDEO CIRCUITS

The BRIGHTNESS control is part of a voltage divider network from the +34V to the -160V. The potential from the wiper of the BRIGHTNESS control may apply a bias from -75 to +30 volts to the CRT control grid. R101, CR107, and C119 are in the circuit to avoid the effects of the video amplifier on the +34V. C119 charges to approximately +30V when Q101 is not conducting. When Q101 conducts, the +34V drops, back-biasing CR107, so the potential across C119 remains virtually unchanged.

Video form the Logic Board is applied across the CONTRAST control. The video signal consists of +4V or +3V pulses (open circuit voltage). The CONTRAST control is set to a level for comfortable viewing by the operator and so, when connected to the video amplifier, the pulses at the CONTRAST control wiper will normally have an amplitude considerably lower than the maximum levels available. The video is self-biased for class B operation and has a gain of approximately 17.

The VDMON- pulse from the Logic Board is coupled through R113, C104 and CR101 to the gate of SCR, Q102. Q102 and its associated circuits are a relaxation oscillator that is synchronized by the VDMON- pulse. The vertical sweep is generated across C105 and C106. Q103 is actually a Dorlington pair of transistors on a single chip so it has a high impedance input thus minimizing its effect on the sweep generator. The V.FR. control changes the R-C time constant of the sweep circuit and so, changes the free-running frequency of the relaxation oscillator. It should be adjusted so the free-running frequency is slightly less than the synchronized frequency (display slowly rolls up). Q107 performs the same function as the synchronizing pulse. When the sweep increases to the point where the conduction through Q102 increases the voltage across R120 beyond the forward conduction voltage of CR109 and the base-emitter junction of Q107, Q107 conducts putting a negative pulse on the gate of Q102. The V.LIN. control controls the amount of "positive feedback" to C106. When V.LIN. is correctly adjusted, the sum of the voltages across C105 and C106 changes linearly with time. The vertical sweep output amplifier, Q104, is a class A amplifier. The HEIGHT control is adjusted so the raster just fills the linear viewing area of the screen. C107 ensures that only the ac sweep signal causes current through the yoke. During retrace time, L1 provides a large reverse current through the yoke to move the beam from the bottom to the top of the screen. Damping resistor, R126, prevents oscillations in the vertical deflection circuit. R114 and VR101 provide a quiet +10V for the vertical sweep generator to further ensure linearity.

The HDMON+ pulse from the Logic Board synchronizes the horizontal sweep to the position counters. The synchronizing pulse drives Q105 into saturation, otherwise Q105 is cut off. This pulse is transformer coupled to Q106 with the polarity chosen to have Q106 cut off when Q105 is saturated. The R-C coupling form T101 to Q106 emphasizes the square wave aspects (abrupt rise and fall) of the drive signal. When power is first applied to the circuit, C113 charges through the primary of T2, the horizontal deflection coils (yoke) and R130 to the +15V. When Q106 is turned on, C113 discharges through the yoke moving the beam to the right of the screen. When Q106 is turned off, the inductance of the WIDTH coil and yoke and the distributed capacitance of the yoke combine to charge C113 beyond the supply voltage by forward biasing CR103. The magnetic field created by this current through the yoke moves the beam from the right side back to the center and on to the left side.

The oscillations in the horizontal deflection circuit causes current to flow through the primary of T2 and through CR104. The current through CR104 charges C110 to -160V and the current through T2 generates +34V through CR105 and C112, +400V through CR106 and C111, and +12,000V through CR2. The +400V is applied through R104 to the accelerating anode of the CRT and across a voltage divider. The FOCUS control is part of the voltage divider and is adjusted for the sharpest image on the display.

3.6 CLEANING

Normally, clean the VDT case with a soft, damp, lint-free cloth and the Keyboard with a soft-bristle brush. Clean stubborn smudges with conventional spray cleaners but do not spray the keyboard (dampen a cloth or paper towel with the cleaner).

NOTE

> Do not use lighter fluid or other petroleum base cleaners. They will damage the finish.

3.7 ADJUSTMENTS

Before attempting to make adjustments on the Monitor Board, verify that the output of the Main Logic Power Supply is +5.0 to +5.2V and that the voltage at the junction between R114 and R130 on the Monitor Board is +14.8 to +15.2V. If these voltages are incorrect perform the power supply adjustments.

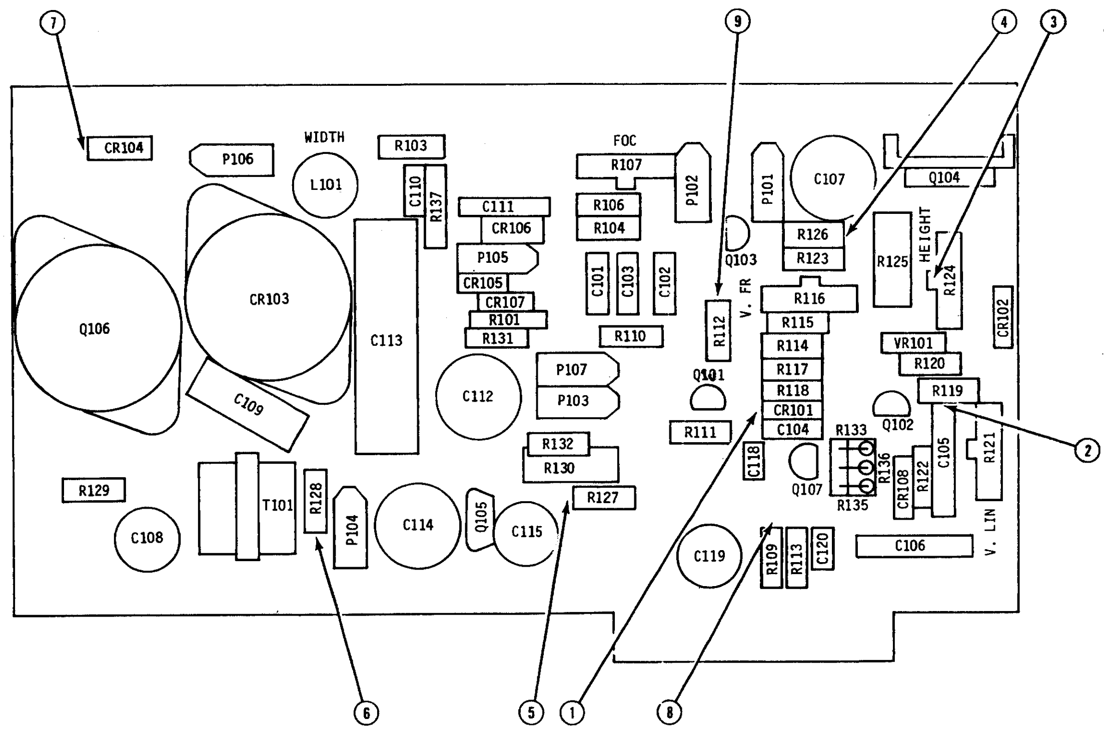


Figure 3-1. Video Circuits Timing Diagram, Sheet 1

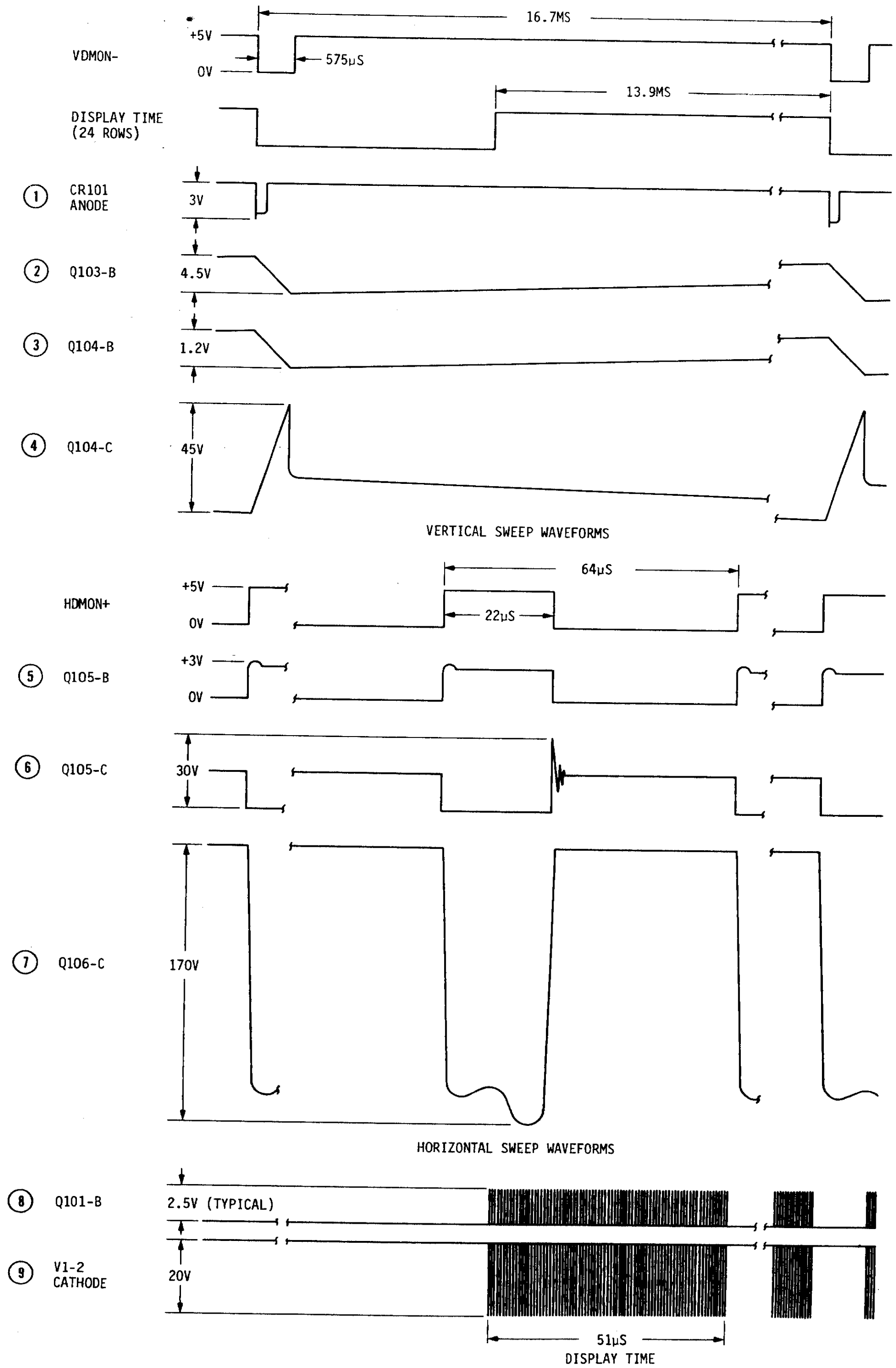


Figure 3-1. Video Circuits Timing Diagram, Sheet 2

3.7.1 MAIN LOGIC POWER SUPPLY ADJUSTMENTS

1. Turn off power switch and disconnect P5 from the Logic Board.
2. Connect a voltmeter across the output terminals of the Main Logic Power Supply.
3. Turn on power switch.
4. Set overvoltage protection control to maximum clockwise position.
5. Adjust voltage output to +5.5 volts.
6. Adjust overvoltage protection control counterclockwise until output voltage drops to near zero volt.
7. Adjust output voltage to counterclockwise limit. Then adjust clockwise while watching the voltmeter. When the voltage reaches +5.5 volts it should return to low voltage in step 6. If limiting does not occur at +5.5 volts, repeat steps 5, 6, and 7.
8. Turn off power switch and reconnect P5 to Logic Board.
9. Turn on power and adjust output voltage to +5.2 volts.
10. Adjust current limiting control to maximum clockwise position.

3.7.2 REGULATOR DRIVER ADJUSTMENT

Adjust R208 on the Regulator Driver until the voltage at the junction of R114 and R130 on the Monitor Board is +15.0 volts.

3.7.3 MONITOR BOARD ADJUSTMENT

1. Fill the display with characters so each row has 80 characters and there are 24 rows. Horizontal adjustments start at step 10.
2. Set the V.FR. control to mid position.
3. Adjust HEIGHT control until the display is about six inches from top to bottom.
4. Adjust V.LIN. for best vertical linearity.
5. Turn power switch off.
6. Connect a jumper from R113 to ground. Turn power switch on.
7. Adjust V.FR. until the display slowly rolls up.
8. Turn power switch off and remove jumper.
9. Check display for height and vertical linearity. Readjust as necessary.
10. The horizontal linearity sleeve is inserted between the neck of the CRT and the yoke. Mark its present position on the neck of the CRT then loosen the sheet metal screw in its clamp.
11. Slide the linearity sleeve toward the face of the CRT until two-thirds of its length is under the yoke.
12. Adjust the WIDTH (slug in L101) until display is approximately eight inches wide.

13. Return linearity sleeve to original position and move back and forth slightly to obtain best horizontal linearity. Tighten clamp screw.
14. Readjust WIDTH until display is approximately eight inches wide.
15. Check display for width and horizontal linearity. Readjust as necessary.
16. Adjust FOCUS control for sharpest clarity of display.
17. The raster may be centered by rotating the ring magnets behind the yoke.
18. Rotate entire yoke assembly if display is tilted.

3.8 TROUBLESHOOTING

Figure 3-6 is a troubleshooting flow diagram that summarizes checks that should isolate troubles to a faulty assembly. Troubleshooting to a replaceable part usually requires the use of an oscilloscope except for power supplies.

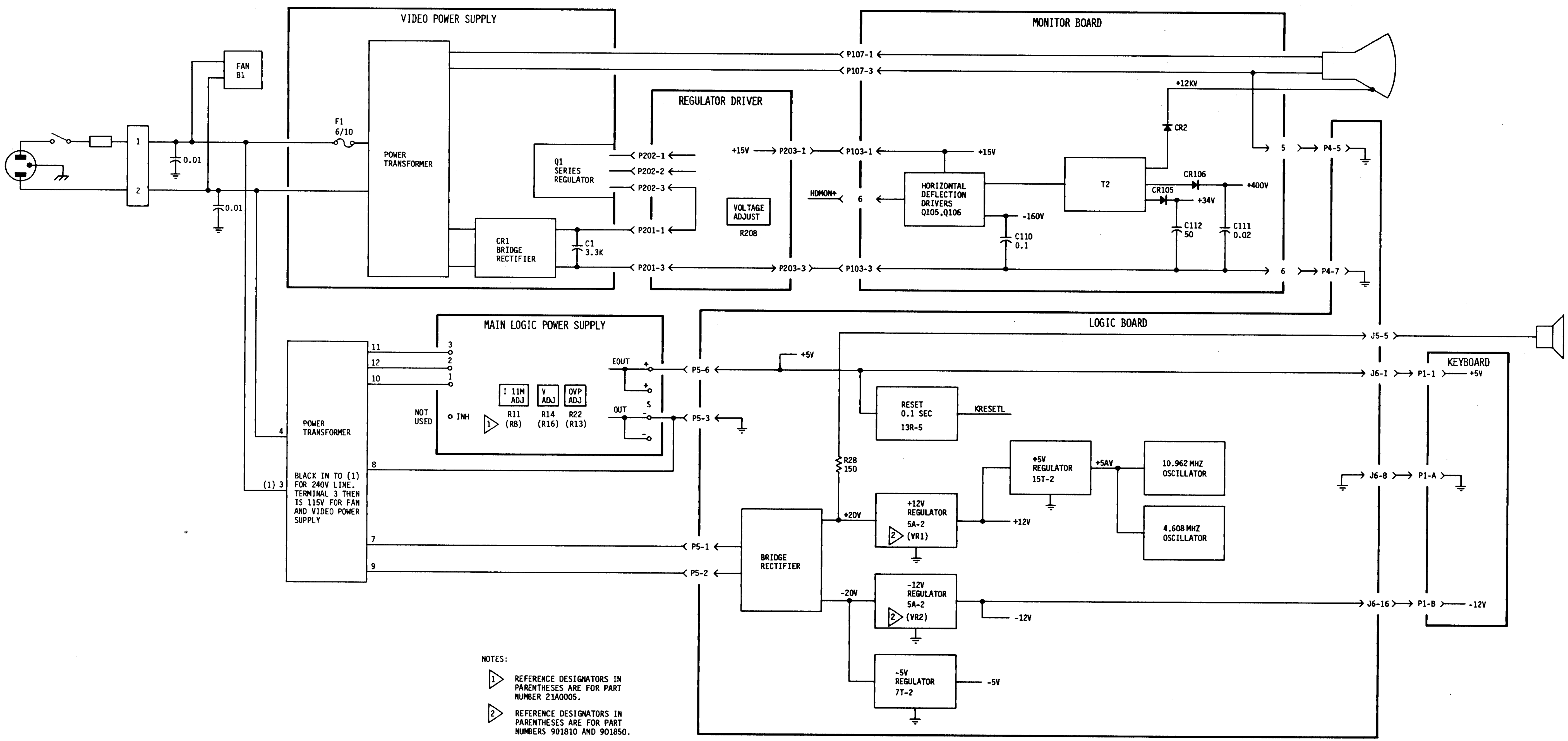
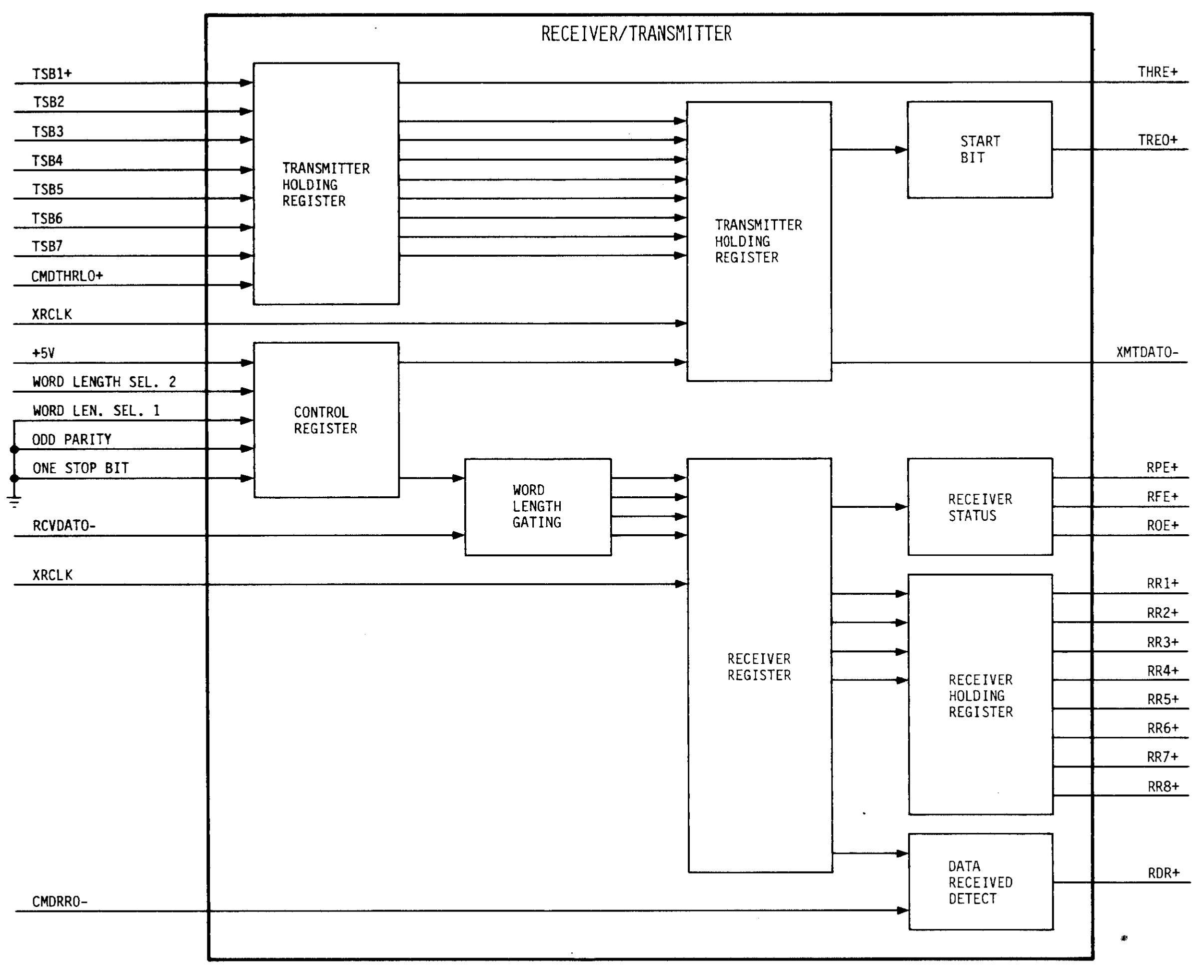


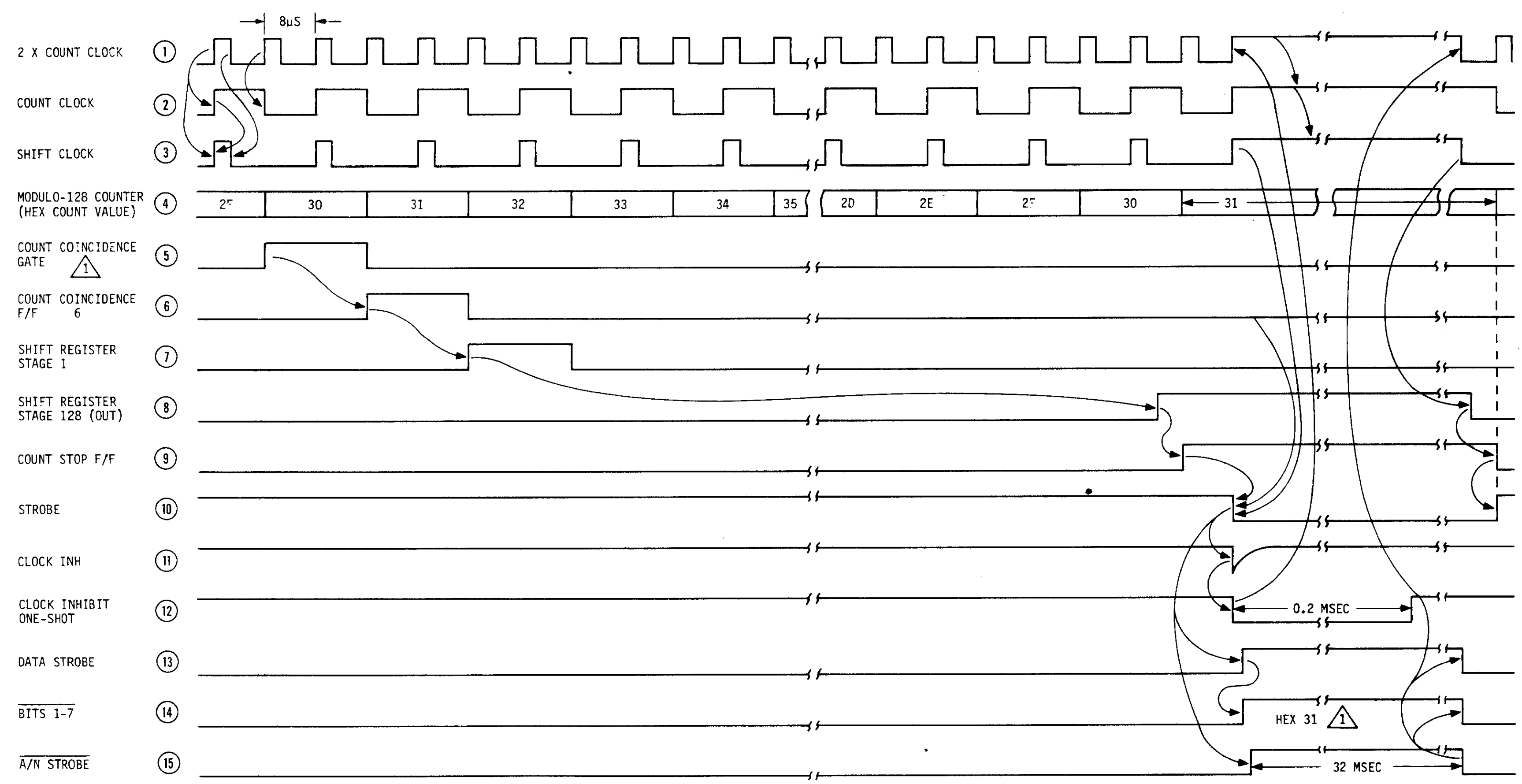
Figure 3-1. Power Function

FUNCTION KEY DOWN	B5 EQUALS	B6 EQUALS	B7 EQUALS
NONE	BC5	BC6	(BC7)(BC6-)
CONTROL	BC5	BC6+BC7	LOW
SHIFT	BC5-	BC6	(BC7)(BC6-)
CONTROL & SHIFT	BC5	BC6-	(BC7)(BC6-)
CONTROL & ↑↓	BC5	BC6-	LOW
↑↓	BC5	BC6	(BC7)(BC6-)

RECEIVER/TRANSMITTER SIGNAL DEFINITIONS

PIN	SIGNAL	DESCRIPTION
17,40	XRCLK+	THIS CLOCK IS 16 TIMES THE BAUD RATE AND IS USED FOR BOTH RECEIVER AND TRANSMITTER.
21	PRESET+	POWER TURN ON RESETS ALL REGISTERS AND TRANSMITTER OUTPUT TO HIGH.
	RECEIVER	
18	CMDDRRO-	COMMAND 124_8. RESETS RDR STATUS.
20	RCVDATO-	SERIAL DATA FROM CPU.
19	RDR+	ENTIRE CHARACTER HAS BEEN TRANSFERRED TO RECEIVER HOLDING REGISTER.
13	RPE+	RECEIVER PARITY ERROR; HIGH FOR ERROR.
14	RFE+	RECEIVER FRAMING ERROR; HIGH FOR ERROR.
15	ROE+	RECEIVER OVERRUN ERROR; HIGH WHEN RDR IS NOT RESET BEFORE NEXT CHARACTER BIT IS RECEIVED.
5-12	RR1-8	RECEIVED CHARACTER BYTE BITS.
	TRANSMITTER	
23	CMDTHRLO+	ENTERS A CHARACTER IN TRANSMITTER HOLDING REGISTER WHEN LOW, TRANSFERS CHARACTER TO TRANSMIT REGISTER WHEN HIGH (OR AS SOON AS TRANSMIT REGISTER IS EMPTY).
26-33	TSB1-7+	BITS OF BYTE TO BE TRANSMITTED.
25	XMTDATO-	SERIAL DATA TO CPU. CONSISTS OF A START BIT, 7 DATA BITS, A PARITY BIT, AND A STOP BIT.
22	THRE+	A HIGH LEVEL INDICATES THAT BYTE HAS BEEN TRANSFERRED FROM THE TRANSMITTER HOLDING REGISTER TO THE TRANSMITTER REGISTER.
24	TREO+	TRANSMITTER REGISTER EMPTY. A HIGH LEVEL INDICATES THAT A COMPLETE BYTE HAS BEEN TRANSMITTED. REMAINS HIGH UNTIL START OF NEXT TRANSMISSION.
35	GND	TRANSMITTED BYTE PARITY IS ODD, RECEIVED BYTE CHECKED FOR ODD PARITY.
36	GND	TRANSMITTED BYTE TERMINATED BY ONE STOP BIT.
37 38	OPEN GND	STRAPPING FOR 7 BIT CHARACTER, OTHER COMBINATIONS PROVIDE 5, 6, AND 8 BIT CHARACTER LENGTHS.





NOTES:

1. COUNT COINCIDENCE GATE GOES TRUE AT HEX COUNT 30 WHEN KEY "1" ON NUMERIC PAD IS STRUCK. THE RESULTING CODE TRANSMITTED TO THE VDT IS 31 HEX, WHICH IS THE ASCII CODE FOR THE NUMERAL "1".
2. CIRCLED NUMBERS ARE WAVEFORM NUMBERS, WHICH ARE INDICATED ON BLOCK DIAGRAM

Figure 3-3. Data Transfer Function, Sheet 1

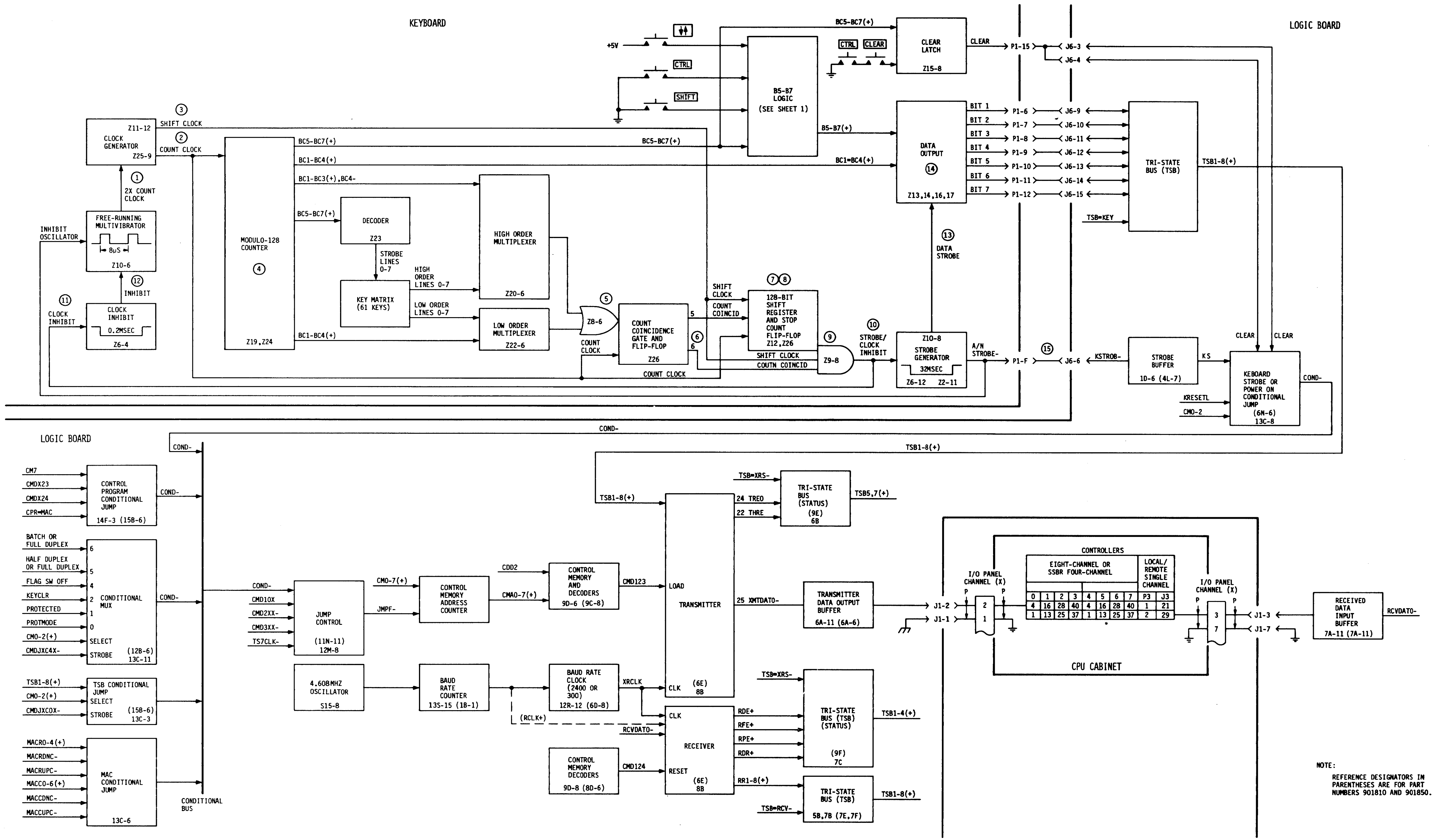
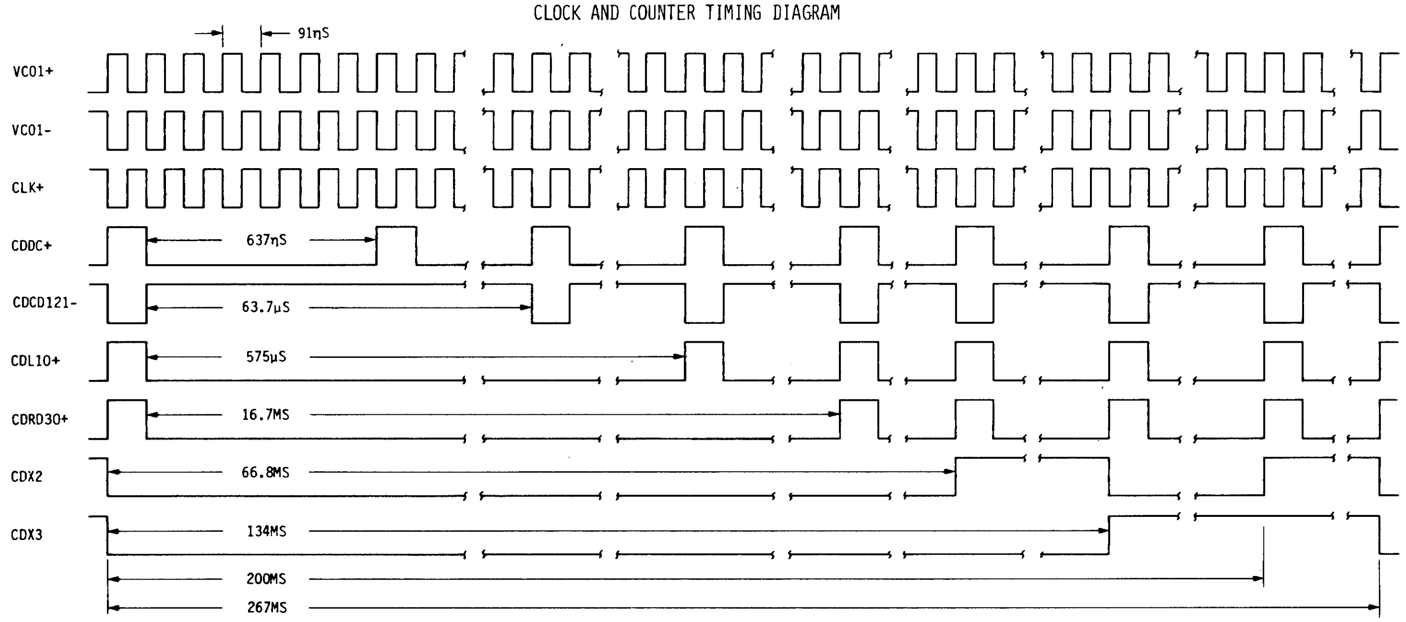
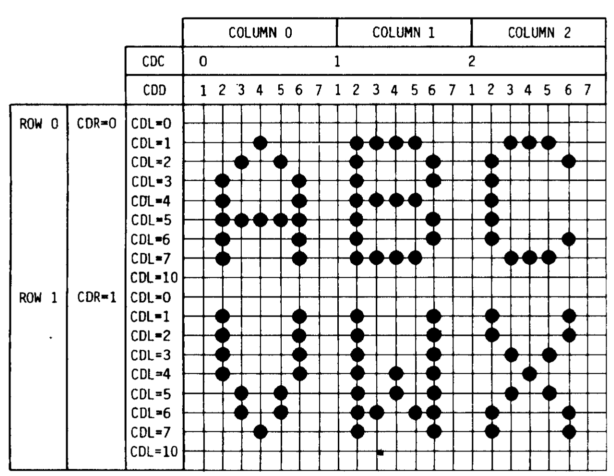


Figure 3-3. Data Transfer Function, Sheet 2

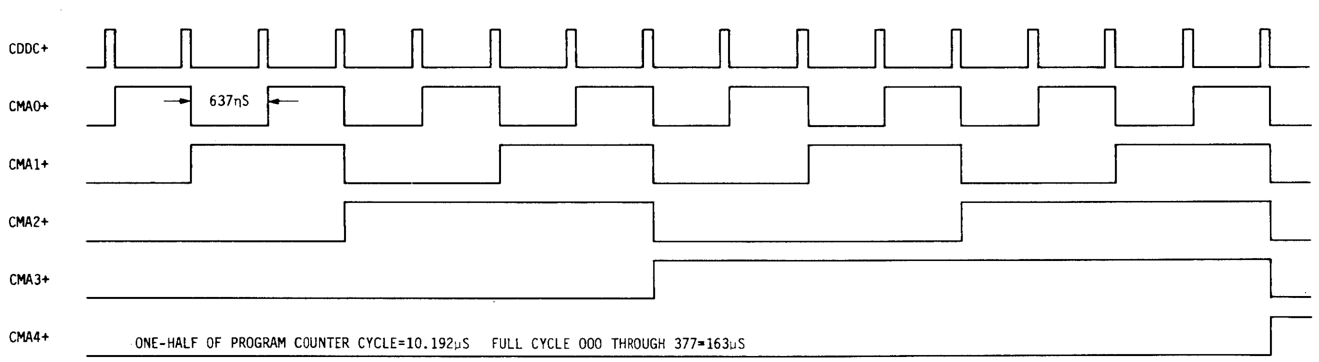
CLOCK AND COUNTER TIMING DIAGRAM



COUNTER CONTROL OF DISPLAY RASTER (DOT, COLUMN, LINE, ROW)



CONTROL MEMORY (PROGRAM) COUNTER TIME

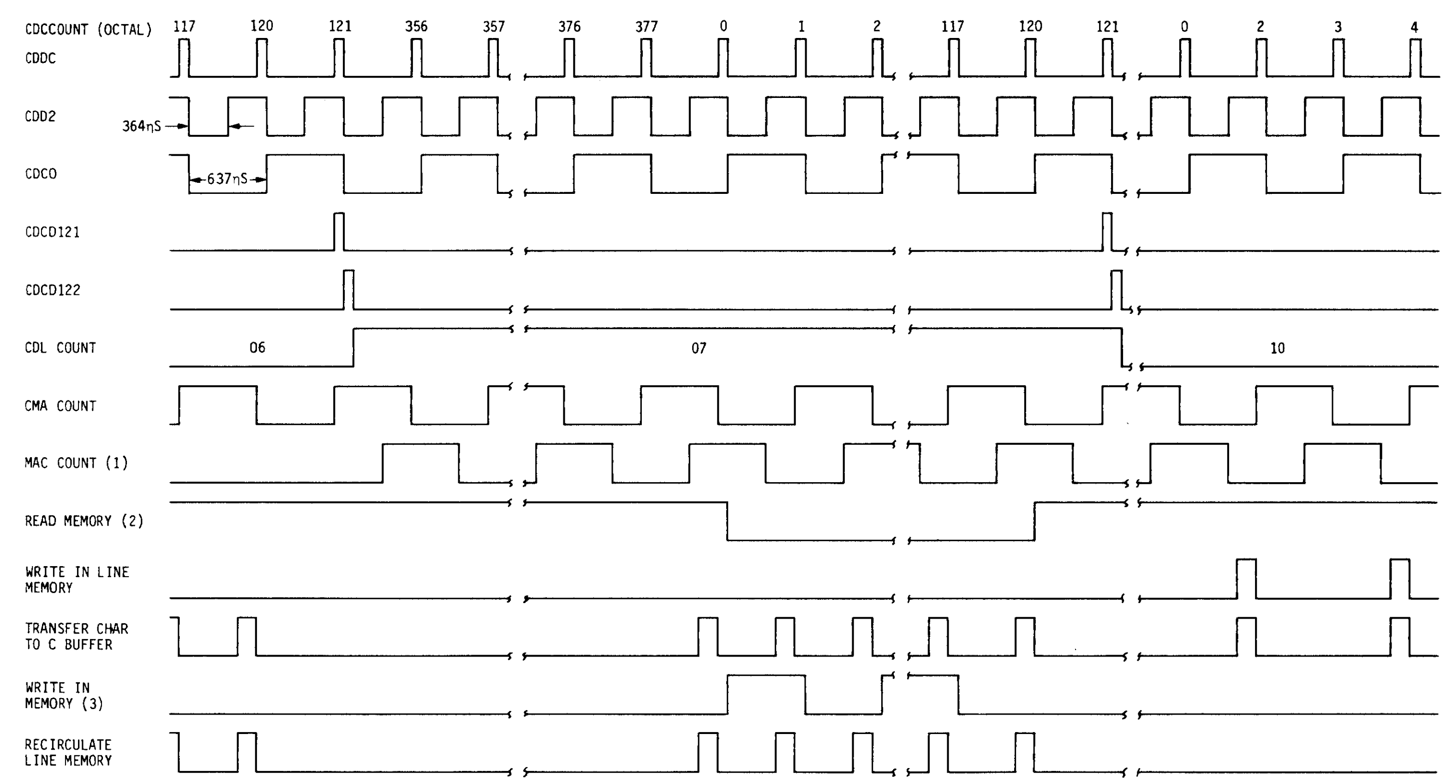


CONTROL MEMORY COMMANDS

CM0-2(+)=CMDXX1-7(-), CM3-5(+)=CMDX0X-7X(-), CML, CM7(+)=CMD0XX-3XX(-)

001=CMDREAD	037=BEEP
002=	06X=LOAD CMDXX0-7(-) REGISTER FORTSB1-4(+)
003=CMDWRITE	07X=LOAD CMDXX0-7(-) REGISTER FORTSB5-8(+)
004=CLRWDRC	100-107=CMDJMP
005=LOAWDRC	121=SETRTSO
006=SET WRITPROT	122=CLRRTSO
007=CLR WRITPROT	123=CMDTHRLO
016=SET PROTMODE	124=CMDDRRO
017=CLR PROTMODE	150=CMDLIT
020=MACCCLR1	156=LRCCLK
021=MACCLD	157=LRCCLR
022=MACCSET	160-177=LOATSBR
023=MACCINC	200=CMDJXC
024=MACCDEC	210=CMDJXC1X
027=CPRCLK-	220=CMDJXC2X
030=MACRCLR1	240=CMDJXC4X
031=MACRLD	300=CMDJMPF
032=MACRSET	
033=MACRINC	
034=MACRDEC	

CONTROL OF MEMORY OPERATIONS



(1) MEMORY ADDRESS COUNTER ADVANCES FOR CMD023 AND CMD033, COUNTS DOWN FOR CMD024 AND CMD034. MAC DOES NOT CHANGE UNLESS ONE OF THESE FOUR COMMANDS IS ACTIVE.

(2) READ MEMORY CAN ALSO BE MADE ACTIVE BY CMD001.

(3) WRITE IN MEMORY CAN ALSO BE MADE ACTIVE BY CMD003.

Figure 3-4. Display Function, Sheet 1

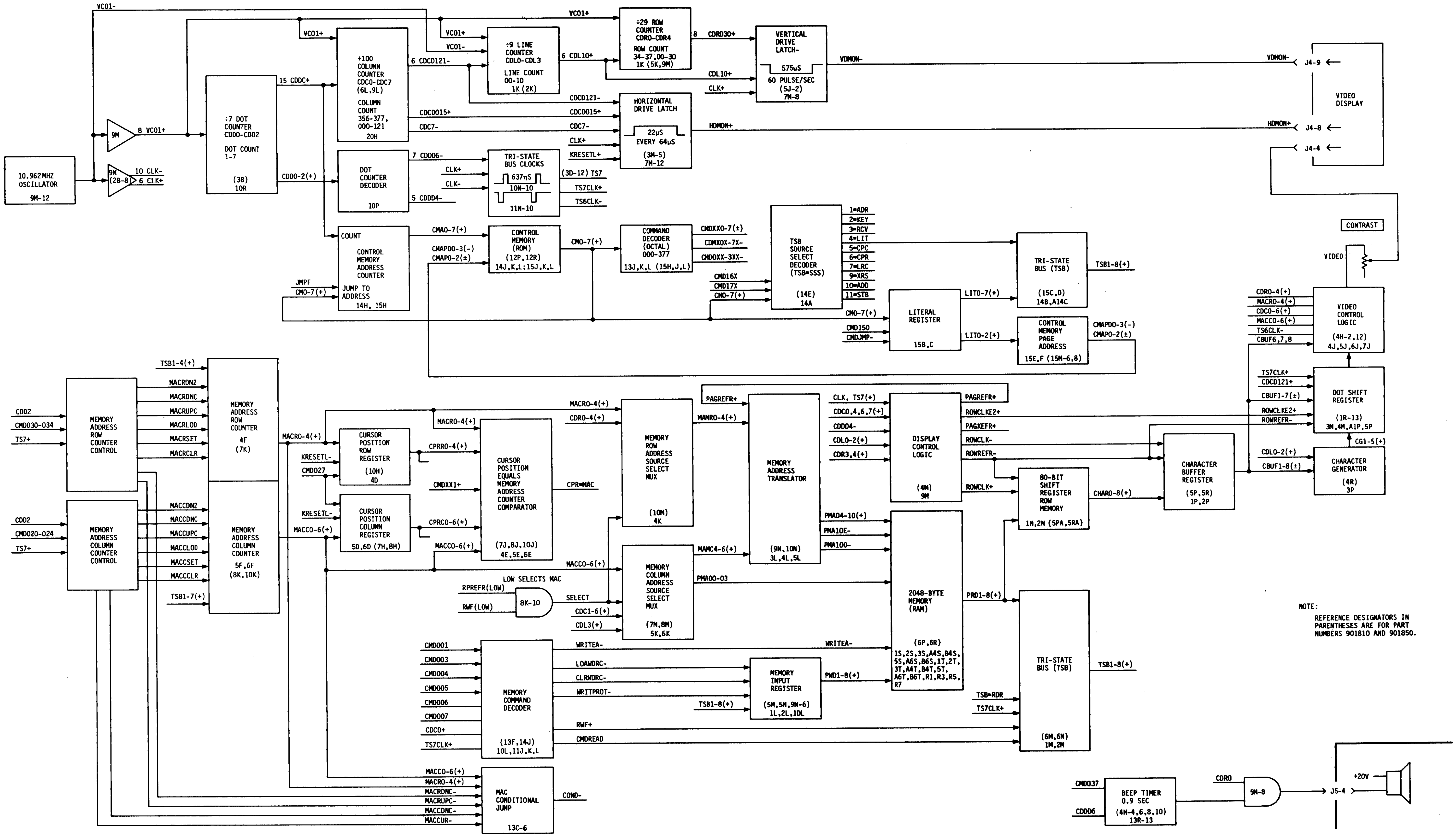


Figure 3-4. Display Function, Sheet 2

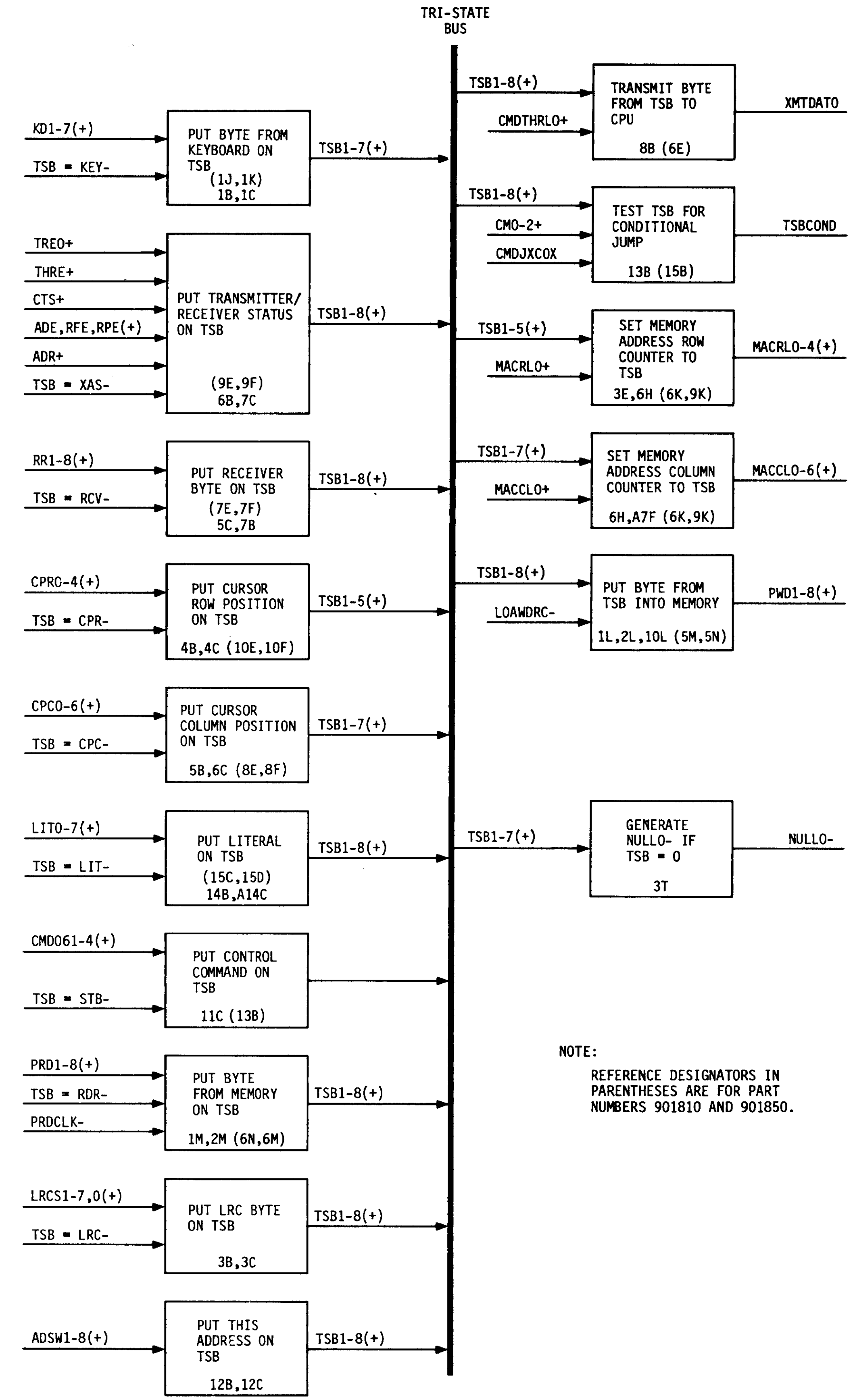
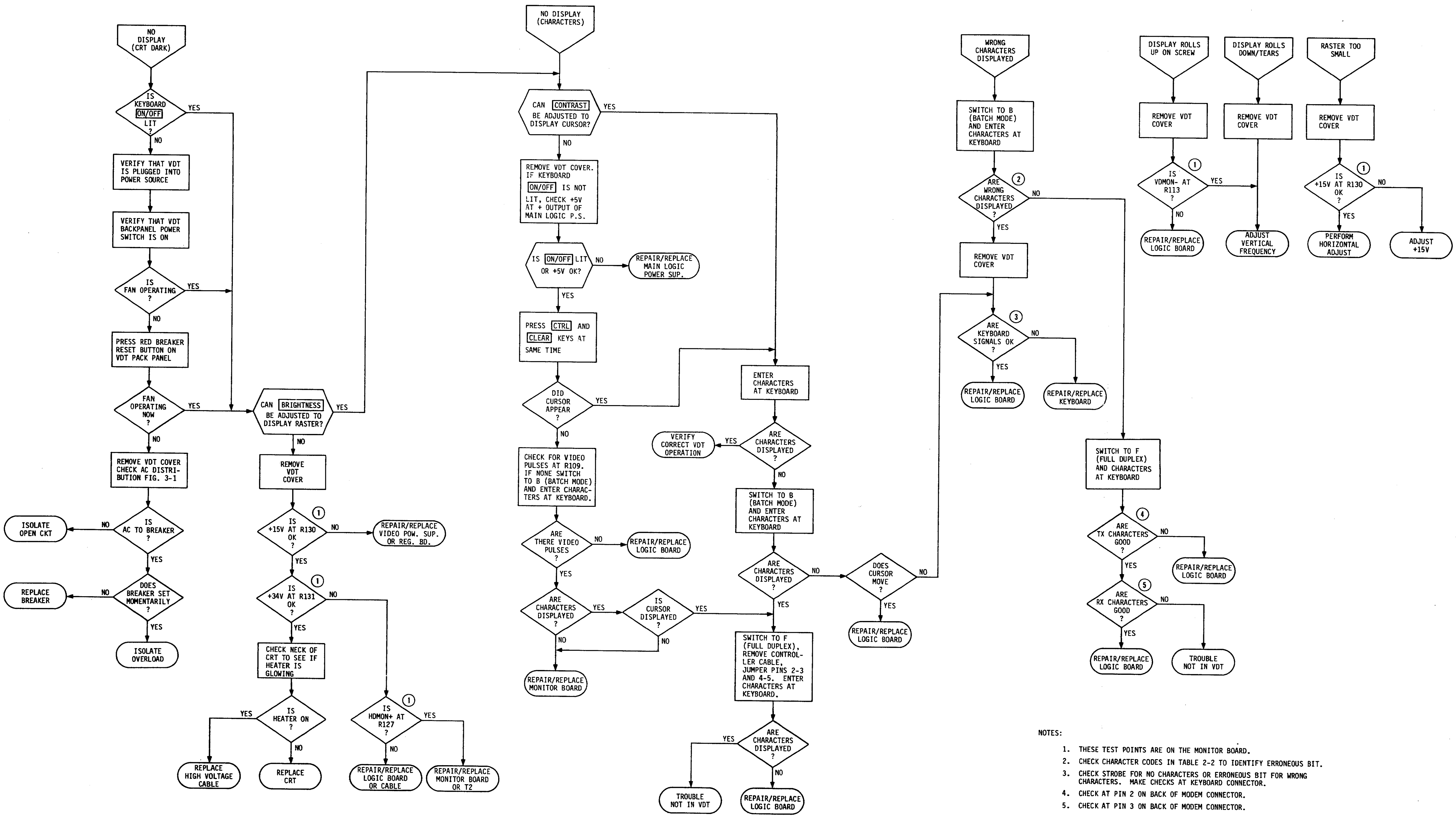


Figure 3-5. Tri-State Bus



NOTES:

1. THESE TEST POINTS ARE ON THE MONITOR BOARD.
2. CHECK CHARACTER CODES IN TABLE 2-2 TO IDENTIFY ERRONEOUS BIT.
3. CHECK STROBE FOR NO CHARACTERS OR ERRONEOUS BIT FOR WRONG CHARACTERS. MAKE CHECKS AT KEYBOARD CONNECTOR.
4. CHECK AT PIN 2 ON BACK OF MODEM CONNECTOR.
5. CHECK AT PIN 3 ON BACK OF MODEM CONNECTOR.

Figure 3-6. VDT Troubleshooting Flow Chart

Section 4

PARTS LISTS

4.1 SCOPE

This section contains assembly drawings of circuit cards and parts lists organized by reference designator (symbol) number.

Parts List for Chassis Mounted Components, figure 4-1

Reference Designator	Part Number	Part Name	Quantity
B1	3-15-2450 (Howard)	Blower	1
C1,C2	5HK-S10 (Sprague)	Capacitor, .01, 1000V	2
CB1	81504.5 (Littlefuse)	Circuit Breaker	1
S1	TA101-TWB (Carling)	Power Switch	1
T1	19204	Power Transformer (PK1057)	1
	11T0028	Power Transformer (w/21A0005)	1
CR2	H510	Diode, High Voltage Rectifier	1
L1	6-003-0321 (Ball)	Vertical Choke	1
LS	S2-200	Speaker	1
T2	6-003-0320 (Ball)	Transformer, High Voltage	1
V1	1-014-0737 (Ball)	Cathode Ray Tube	1

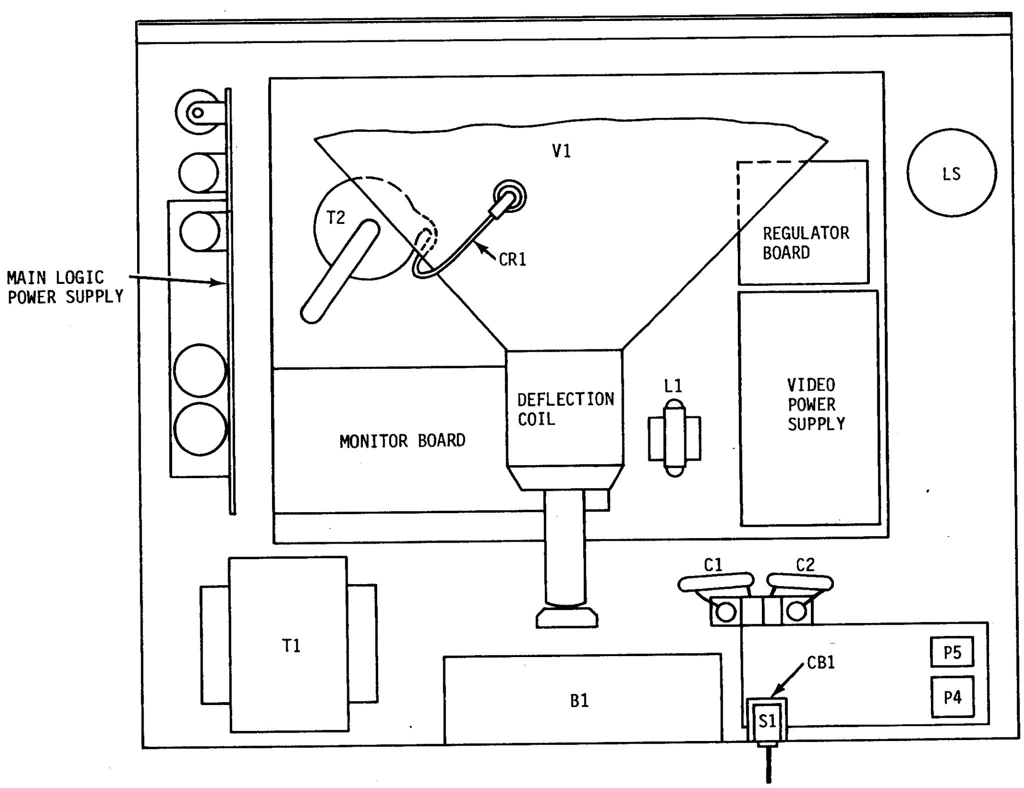
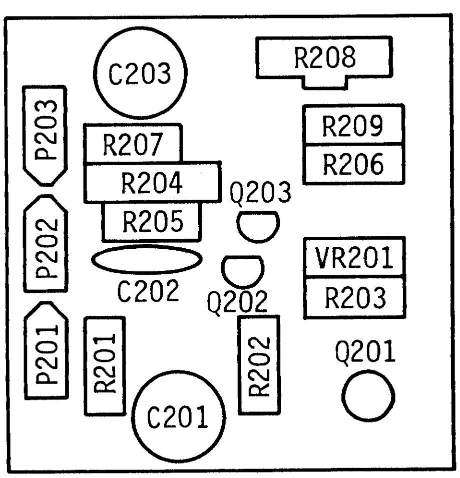


Figure 4-1. Chassis Mounted Components

Parts List for Video Power Supply and Regulator Board, figure 4-2

Reference Designator	Part Number	Part Name	Quantity
REGULATOR BOARD	MM170003		
C201,C203	1-012-2157	Capacitor, 50µf, 50V	2
C202	1-012-0780	Capacitor, 0.01µf, ±20%, 1000V	1
Q201	1-015-1143	Transistor, 2N3053	1
Q202,Q203	1-015-1132	Transistor, 2N3903	2
R201,R202	1-011-2270	Resistor, 1K, ±5%, 1/2w	2
R203	1-011-2294	Resistor, 10K, ±5%, 1/2w	1
R204	1-011-2217	Resistor, 0.68Ω, ±10%, 2w	1
R205	1-011-2274	Resistor, 1.5K, ±5%, 1/2w	1
R206,R207,R209	1-011-2262	Resistor, 470Ω, ±5%, 1/2w	3
R208	1-011-5604	Resistor, Variable, 500Ω, ±20%, 1/5w	1
POWER SUPPLY	MM170004		
C1	1-012-2156	Capacitor, 3300µf, 60V	1
CR1	1-021-0413	Rectifier, bridge, VS148	1
Q1	1-015-1134	Transistor, 2N5067 or 2N3055	1
T1	1-017-5390	Transformer, Power	1
	Commercial	Cable feed through	2
	Commercial	Terminal strip	1
	1-022-0427	Socket, CRT	1
	1-028-0210	Fuseholder	1
	6-004-0321	Deflection coil assembly	1
	6-004-0630	Cable assembly	1



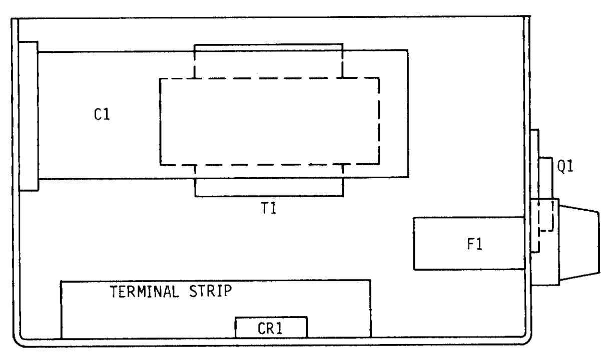


Figure 4-2. Video Power Supply and Regulator Board

Parts List for Main Logic Power Supply, 46074B, figure 4-3

Reference Designator	Part Number	Part Name	Quantity
C1,C2,C8,C9	32-13006-002	Capacitor, 470μf, 15V	4
C3,C4	32-13007-001	Capacitor, 9000pf, 15V	2
C5,C7	32-13006-001	Capacitor, 1μf, 50V	2
C6	31-13005-008	Capacitor, .001μf, 100V	1
CR1,CR2,CR8	11-13009-001	Diode, S1-2	3
CR3 thru CR6,CR10	11-13010-001	Diode, 351S	5
CR9	12-13025-006	Diode, Zener, 1N751A	1
F1	63-16045-013	Fuse, 15A	1
Q1	10-13019-001	Transistor, 2N2222A	1
Q2	10-13159-002	Transistor, 13159-2	1
Q3	10-13002-003	Transistor, 13002-3	1
Q4	10-13020-001	Transistor, 2N2907A	1
Q5	13-13015-001	SCR, 2N4441	1
R1,R2	20-13004-042	Resistor, 51, ±5%, 1/2w	2
R3	21-13050-239	Resistor, 3.01K	1
R4	21-13050-251	Resistor, 4.02K	1
R5	20-13004-113	Resistor, 47K, ±5%, 1/2w	1
R6,R9,R18,R19,R20	20-13004-073	Resistor, 1K, ±5%, 1/2w	5
R8	20-13004-085	Resistor, 3.3K, ±5%, 1/2w	1
R10	22-13049-001	Resistor, 0.05, 5w	1
R11	23-13016-004	Resistor, Variable, 100	1
R13	20-13004-066	Resistor, 510, ±5%, 1/2w	1
R14	23-13032-006	Resistor, Variable, 1.5K	1
R16	21-13050-210	Resistor, 1.5K	1
R17	20-13004-049	Resistor, 100, ±5%, 1/2w	1
R22	23-13016-007	Potentiometer, 500	1
R23,R24	20-13004-025	Resistor, 10, ±5%, 1/2w	2
U1	14-13034-001	Integrated Circuit 723CE	1

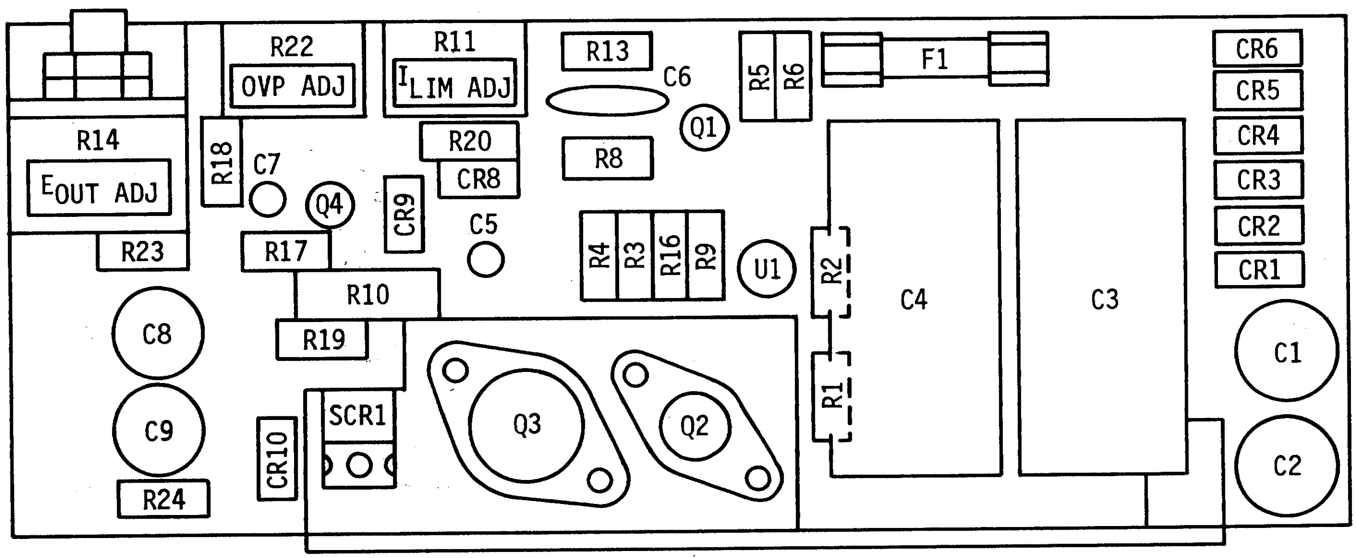


Figure 4-3. Main Logic Power Supply (46074B)

Parts List for Main Logic Power Supply, P/N 21A0005, figure 4-4

Reference Designator	Part Number	Part Name	Quantity
C1,C2	35C0023	Capacitor, 9000µf, 15V	2
C3	36C0002	Capacitor, 1000µf, 16V	1
C5,C6	11C0002	Capacitor, .1µf, 100V	2
C7	35C0002	Capacitor, 10µf, 25V	1
C8	26C0002	Capacitor, 1µf, 35V	1
C9	11C0001	Capacitor, .01µf, 100V	1
C10	15C0002	Capacitor, .001µf, 500V	1
C11	35C0004	Capacitor, 100µf, 25V	1
CR1,CR6	13D0002	Diode, 1N4002	2
CR2 thru CR5	13D0001	Diode, 3A70	4
CR7	14D0001	SCR, 2N4441	1
CR8	12D0003	Diode, 1N751A	1
Q1,Q2	15Q0011	Transistor, TIP33	2
Q3	15Q0003	Transistor, TIP29A	1
Q4	14Q0001	Transistor, 2N2905	1
Q5	12Q0001	Transistor, 2N3906	1
R1,R10,R12	13R0102	Resistor, 1K	3
R2,R3	56R0109	Resistor, .1Ω, 3w, ±10%	2
R4	13R0510	Resistor, 51Ω, 1/2w, ±5%	1
R5	13R0472	Resistor, 4.7K, 1/2w, ±5%	1
R6	13R0181	Resistor, 180Ω, 1/2w, ±5%	1
R7	13R0751	Resistor, 750Ω	1
R8,R13,R16	74R0501	POT, 500Ω	3
R9	13R0101	Resistor, 100Ω, 1/2w, ±5%	1
R11	13R0471	Resistor, 470Ω	1
R14	13R0750	Resistor, 75Ω	1
R15	42R1651	Resistor, 1.65K, 1/4w, ±1%	1
R17	42R7870	Resistor, 787Ω, 1/4w, ±1%	1
Z1	60Q0001	I. C. Regulator	1
--	D41P0002	P. C. Board	Ref
--	15N0039	Bracket-Heatsink	1
--	00Q0003	Transistor Pads	1
--	00E0007	Shorting Bar	2
--	35H0016	Spacer	4
--	84H0002	1/32 Washer	3
--	41E0003	Spade-Standoff	3

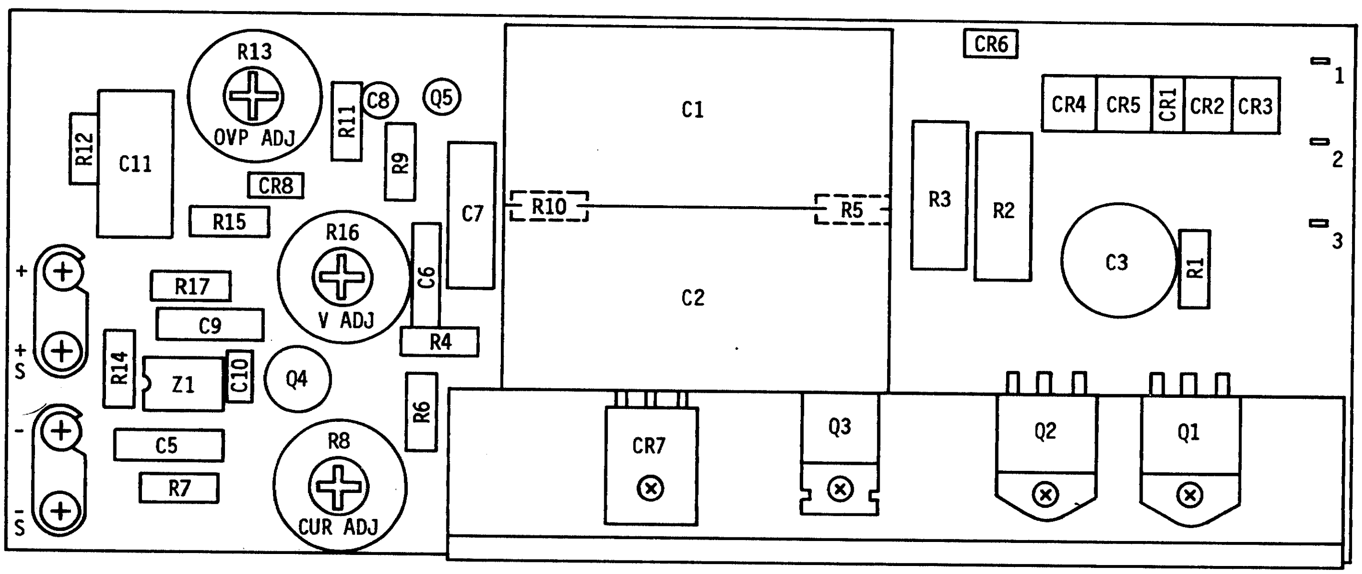


Figure 4-4. Main Logic Power Supply (21A0005)

Parts List for Monitor Board, figure 4-5

Reference Designator	Part Number	Part Name	Quantity
C101,C102,C103	1-012-0112	Capacitor, 0.01µf, 1000V	3
C104,C120	1-012-0540	Capacitor, 0.01µf, 1000V, ±20%	2
C105,C106	1-012-1005	Capacitor, 0.47µf, 100V, ±10%	2
C107	1-012-2158	Capacitor, 500µf, 6V	1
C108	1-012-2160	Capacitor, 100µf, 6V	1
C109	1-012-0800	Capacitor, 0.022µf, 400V, ±10%	1
C110	1-012-0870	Capacitor, 0.1µf, 200V, ±10%	1
C111	1-012-0780	Capacitor, 0.02µf, 1000V, ±20%	1
C112	1-012-2157	Capacitor, 50µf, 50V	1
C113	1-012-1130	Capacitor, 10µf, 63V, ±10%	1
C114	1-012-2159	Capacitor, 200, 25V	1
C115	1-012-2165	Capacitor, 50µf, 25V	1
C116	1-012-1260	Capacitor, 20µf, 150V	1
C118	1-012-0482	Capacitor, 820pf, 500V, ±5%	1
C119	1-012-2193	Capacitor, 25µf, 50V	1
CR101,CR102,CR108	1-021-0410	Diode, 1N3605	3
CR103	1-021-0360	Diode, 1N4785	1
CR104,CR105,CR106, CR107	1-021-0380	Diode, 1N3279	4
L101	1-016-0303	Coil, Width	1
Q101	1-015-1172	Transistor, 2N5830	1
Q102	1-015-1157	Transistor, D13T1	1
Q103	1-015-1158	Transistor, MPSA14	1
Q104	1-015-1156	Transistor, MJE3055	1
Q105	1-015-1159	Transistor, MPS-V05	1
Q106	1-015-1160	Transistor, SP2597/MP3731	1
Q107	1-015-1139	Transistor, 2N4127	1
R101,R128	1-011-2280	Resistor, 2.7K, ±5%, 1/2w	2
R103,R115	1-011-2316	Resistor, 82K, ±5%, 1/2w	2
R104,R106,R119	1-011-2318	Resistor, 100K, ±5%, 1/2w	3
R107	1-011-5566	Resistor, Variable, 2.5M, ±20%, 1/8w	1
R109,R111	1-011-2238	Resistor, 47, ±5%, 1/2w	2
R110	1-011-2268	Resistor, 820, ±5%, 1/2w	1
R112	1-011-2254	Resistor, 220, ±5%, 1/2w	1
R113,R127	1-011-2262	Resistor, 470, ±5%, 1/2w	2
R114,R123	1-011-2250	Resistor, 150, ±5%, 1/2w	2
R116	1-011-5435	Resistor, Variable, 100K, ±20%, 1/8w	1
R117	1-011-2286	Resistor, 5.6K, ±5%, 1/2w	1
R118	1-011-2292	Resistor, 8.2K, ±5%, 1/2w	1
R120	1-011-2264	Resistor, 560, ±5%, 1/2w	1
R121	1-011-5312	Resistor, Variable, 10K, ±20%, 1/8w	1
R122	1-011-2250	Resistor, 4.7K, ±5%, 1/2w	1
R124	1-011-5095	Resistor, Variable, 100, ±20%, 1/8w	1
R125	1-011-1571	Resistor, 3.3, ±10%, 2w	1
R126	1-011-2260	Resistor, 390, ±5%, 1/2w	1
R129	1-011-2218	Resistor, 5.6, ±5%, 1/2w	1
R130	1-011-1395	Resistor, 1.2, ±10%, 3w	1

Parts List for Monitor Board, figure 4-5 (continued)

Reference Designator	Part Number	Part Name	Quantity
R131	1-011-2282	Resistor, 3.3K, ±5%, 1/2w	1
R132	1-011-2375	Resistor, 82, ±10%, 3w	1
R133	70-16-0472	Resistor, 4.7K, ±5%, 1/4w	1
R135,R136	70-16-0223	Resistor, 22K, ±5%, 1/4w	2
R137	1-011-2448	Resistor, 33K, ±5%, 1w	1
T101	1-017-5338	Transformer, Horiz Driver	1
VR101	1-021-0180	Voltage Regulator, 1N758	1

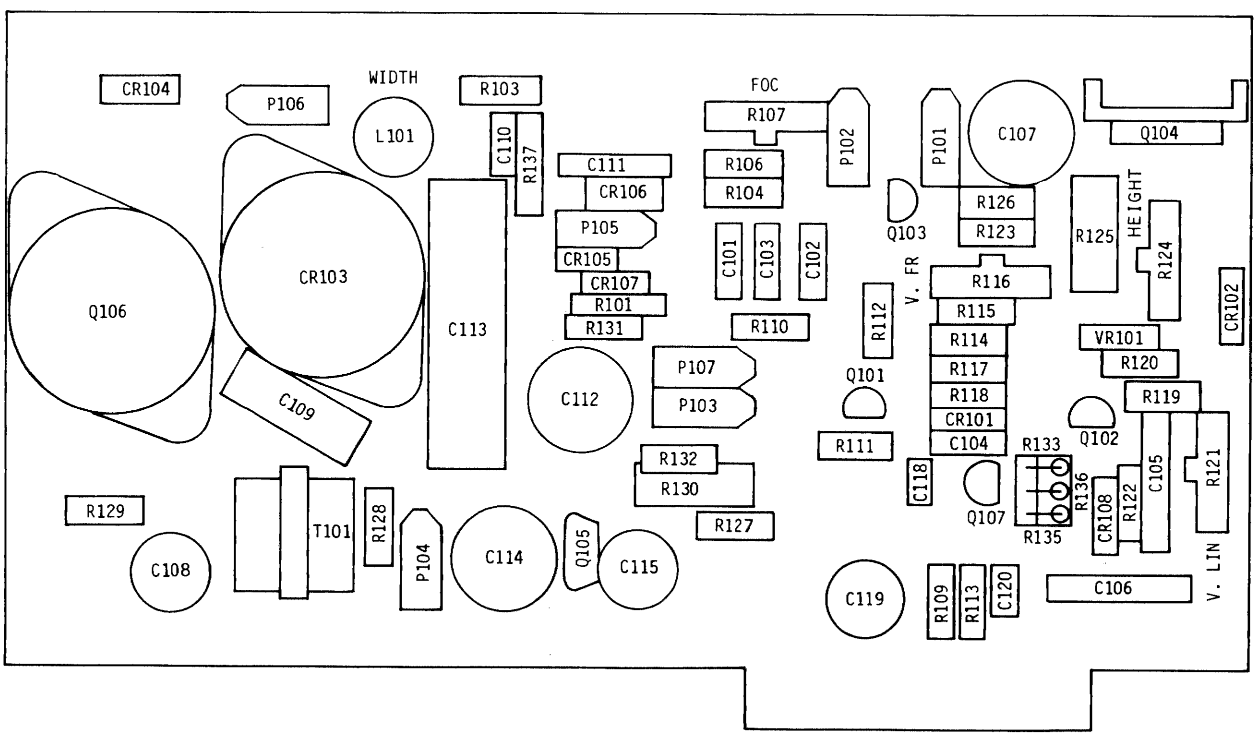


Figure 4-5. Monitor Board

Parts List for Logic Board, P/N 900948, figure 4-6

Reference Designator	Part Number	Part Name	Quantity
C1,C34	196D334X035HA1	Capacitor, 0.33μf, ±10%, 35V	2
C2,C8 thru C18,C32, C33,C49 thru C52	128518-104	Capacitor, 0.1μf, ±5%, 100V	18
C3	128518-271	Capacitor, 270pf, ±5%, 100V	1
C6	128518-225	Capacitor, 2.2μf, ±10%, 25V	1
C7,C21 thru C28,C39, C40,C54	128349-805	Capacitor, 8μf, ±20%, 25V	12
C30,C31	129329-108	Capacitor, 1000μf, ±20%, 35V	2
C55,C56	128349-104	Capacitor, 0.1μf, ±10%, 50V	2
CR1		Diode, 1N9148A	1
CR2,CR3		Diode, 1N914A	2
J1,J2,J3	17-304-01	Connector, Socket	3
J4	09-18-5094	Wafercon	1
J5	09-18-5061	Wafercon	1
R1 thru R3,R17 thru R20,R23,R25,R26,R31 thru R36,R88 thru R90	128533-102	Resistor, 1K, ±5%, 1/4w	19
R8 thru R14	128533-471	Resistor, 470Ω, ±5%, 1/4w	7
R15	128533-151	Resistor, 150Ω, ±5%, 1/4w	1
R16	128533-271	Resistor, 270Ω, ±5%, 1/4w	1
R24	128533-391	Resistor, 390Ω, ±5%, 1/4w	1
R29	128533-103	Resistor, 10K, ±5%, 1/4w	1
R30	128533-393	Resistor, 39K, ±5%, 1/4w	1
R91	128533-122	Resistor, 1.2K, ±5%, 1/4w	1
R92	128533-682	Resistor, 6.8K, ±5%, 1/4w	1
R98	YQ8384-1	Potentiometer, 100K, (BRIGHTNESS)	1
R99	YQ8383	Potentiometer, 500Ω, (CONTRAST)	1
R100	128533-512	Resistor, 5.1K, ±5%, 1/4w	1
S1	MSS-2250R	Switch, Baud Rate (Alco)	1
S2	MSS-4350R	Switch, Duplex (Alco)	1
Y1	800A-1096.0	Crystal, 10962.0KHz	1
Y2	800A-4608.0	Crystal, 4608.0KHz	1
3A	W005	Bridge Rectifier	1
A5A	128348-7812	Integrated Circuit MC7812CP	1
B5A	128348-7912	Integrated Circuit MC7912CP	1
6A	128348-1488	Integrated Circuit MC1488L	1
7A	128348-1489	Integrated Circuit MC1489AL	1
13A,13B,13E	128348-151	Integrated Circuit SN74151N	3
14A,13J,13K,13L,10P	128348-42	Integrated Circuit SN7442N	5
15A,15B,15C,4D thru 6D,15E,1L,2L,A1P,2P	128348-175	Integrated Circuit SN74175N	11
B1B,4B thru 7B,A14B, 1C,4C thru 7C,11C, B14C	128348-125	Integrated Circuit SN74125N	13
8B	128348-1602	Integrated Circuit TR1602	1
14B,9D,1H,11M,8P	128578-10	Integrated Circuit SN7410N	5

Parts List for Logic Board, P/N 900948, figure 4-6 (continued)

Reference Designator	Part Number	Part Name	Quantity
13C,14F	128348-01	Integrated Circuit SN74H01N	2
A14C,13D,11F,10M,12P	128348-27	Integrated Circuit SN7427	5
1D,15D,8F,15F,4H,9H, 12H,8J,9K,12K,8L,9L, 11L	128578-00	Integrated Circuit SN7400N	13
8D,3F,A7F,5H,3M	128348-32	Integrated Circuit SN7432N	5
11D,11E,10F,2K,7L, 10L,7M,9N,13P,12R	128348-103	Integrated Circuit SN74103N	10
14D,7J,12M,6N,7P	128348-74	Integrated Circuit SN7474N	4
1E,10E,12F,8H,13H, 10J,11N	128578-04	Integrated Circuit SN7404N	7
3E,2F,B7F,2H,6H,6M,8M	128348-08	Integrated Circuit SN7408N	7
4E thru 6E,4J thru 6J	128348-85	Integrated Circuit SN7485N	6
7E	128348-106	Integrated Circuit SN74H106N	1
14E,3H,9P	128578-20	Integrated Circuit SN7420N	3
4F thru 6F	128348-193	Integrated Circuit SN74193N	3
9F,13F,7H,10H,9J,11J, 12J,8K,10K,11K,12L, 7N,12N	128348-02	Integrated Circuit SN7402N	13
14H,15H,1J thru 3J, 8R thru 10R,11S thru 13S	128348-161	Integrated Circuit SN74161N	11
1K,9M,10N,11R	128348-04	Integrated Circuit SN74H04N	4
3K	128348-20	Integrated Circuit SN74H20N	1
4K thru 6K	128348-157	Integrated Circuit SN74157N	3
7K,A1P,5P	128578-30	Integrated Circuit SN74H30N	3
15K	129314-01	Integrated Circuit ROM, 8204	1
4L	129303-01	Integrated Circuit PROM, N82S23	1
3L,5L,6L	128348-83	Integrated Circuit SN7483N	3
15L	129313-01	Integrated Circuit ROM, 8205	1
1M,2M	128348-173	Integrated Circuit SN74173N	2
4M	128348-166	Integrated Circuit SN74166N	1
5M	128348-06	Integrated Circuit SN7406N	1
1N,2N	128348-2532	Integrated Circuit 2532B	2
5N	128348-86	Integrated Circuit SN7486N	1
8N,11P	128348-00	Integrated Circuit SN74H00N	2
3P	128348-2513	Integrated Circuit 2513N/I	1
1R,3R,5R,7R	128348-107	Integrated Circuit LM75107AN	4
13R	128348-123	Integrated Circuit SN74123N	1
1S thru 3S,A4S,B4S, 5S,A6S,B6S,1T thru 3T, A4T,B4T,5T,A6T,B6T	128348-2102	Integrated Circuit P2102 or 4008	16
15S	128348-4024	Integrated Circuit MC4024P	1
7T	128348-7905	Integrated Circuit MC7905CP	1
10T (Model 7230/0973)	100315	Baud Rate Module, 9600 Baud	1
10T/12T	129307-2400	Baud Rate Module, 2400 Baud	1
12T (Model 7220)	129307-300	Baud Rate Module, 300 Baud	1
15T	128348-7805	Integrated Circuit MC7805CP	1

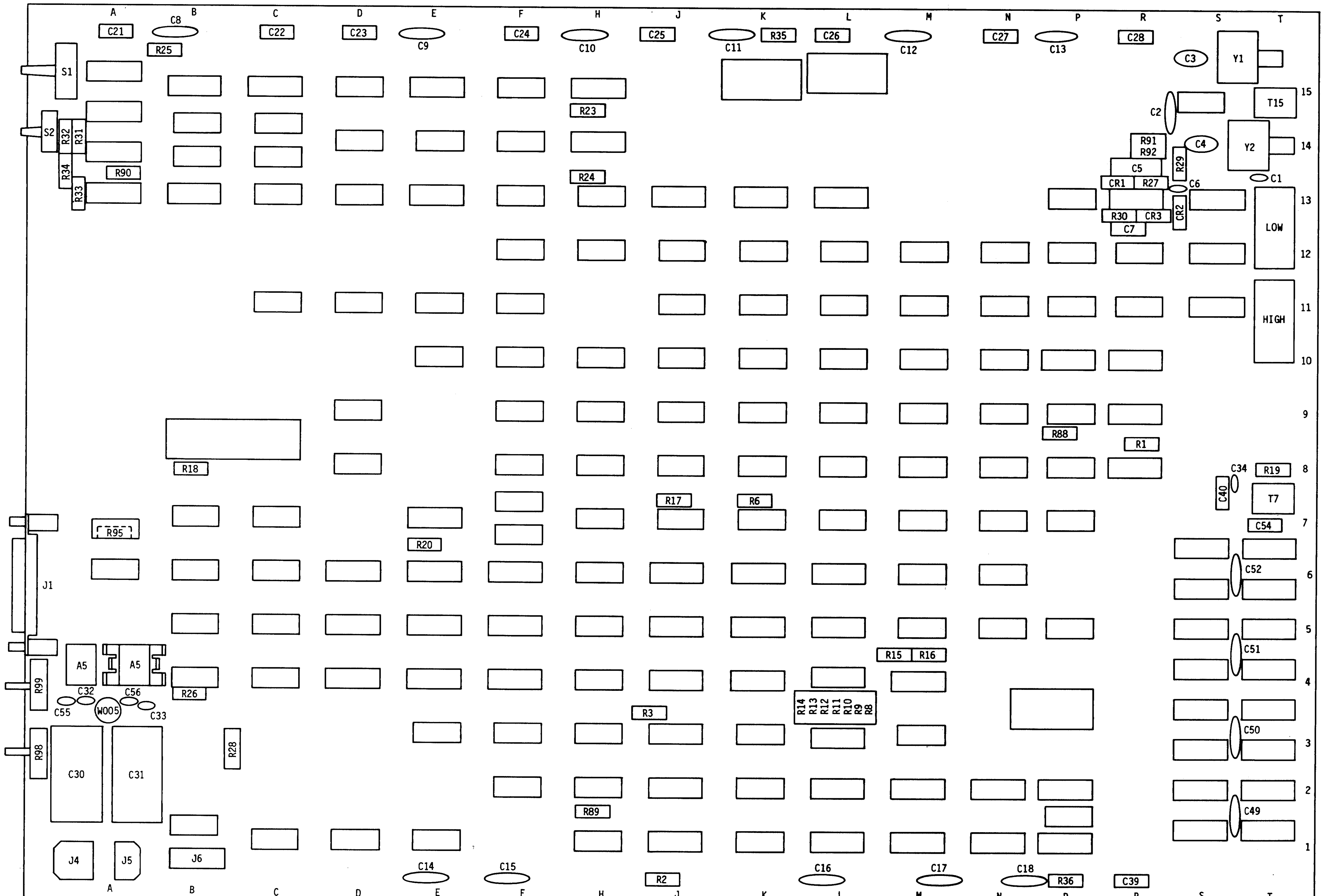


Figure 4-6. Logic Board (P/N 900948)

Parts List for Logic Board, P/N 901810 and 901850, figure 4-7 (continued)

Reference Designator	Part Number	Part Name	Quantity
8B,9D,6K,9K,7M,8M, 10M,10N	101633	Integrated Circuit, SN74S157	8
9B,8C,12F,5H,3M,11F	101689	Integrated Circuit, SN74S113	6
10B,1C,2C,3C,6J	101567	Integrated Circuit, SN7493	5
13B	101695	Integrated Circuit, 8334	1
6C,13J,14J,11K,3L,9N	101542	Integrated Circuit, SN7432	6
7C	101546	Integrated Circuit, SN74H21	1
9C,11L.1M	101508	Integrated Circuit, SN7420	3
10C,5D,13F,14F,6H,4K, 12K,15M,2N	101507	Integrated Circuit, SN7400	9
15C,15D,6M,6N,14N	101691	Integrated Circuit, SN74173	5
8D,2J,14K,2P	101506	Integrated Circuit, SN7410	4
10D,1H,13M,3P	101544	Integrated Circuit, SN7427	4
13D,7E,8E,9E,10E,7F, 8F,9F,10F,1J,1K	101700	Integrated Circuit, SN74125	11
5E	100202	Socket, 40 pin	1
6E	101614	Integrated Circuit, S1883	1
14E,15F,15J	101513	Integrated Circuit, SN7442	3
15E,7H,8H,10H,5M,5N, 11N,15N,5P,6P,5R,6R	101549	Integrated Circuit, SN74175	12
4H	101316	Integrated Circuit, SN7406	1
11H,12H,13H,14H,12J, 3N	101502	Integrated Circuit, SN7402	6
15H,15L	101690	Integrated Circuit, SN74173	2
7J,8J,10J,7L,8L,10L	101515	Integrated Circuit, SN7485	6
7K,8K,10K	101691	Integrated Circuit, SN74193	3
12L	101630	Integrated Circuit, SN74S112	1
11M	101315	Integrated Circuit, SN74S00	1
12M,1P	101519	Integrated Circuit, SN7486	2
3H	101501	Integrated Circuit, SN74123	1
8N,4P	101522	Integrated Circuit, SN7430	2
5PA,5RA	101654	Integrated Circuit, 3120	2
7P,7PA,8P,8PA,9P,10P, 10PA,11P,7R,7RA,8R, 8RA,9R,10R,10RA,11R	101687	Integrated Circuit, 2102-A	16
12P	101694	Integrated Circuit, 8205	1
12P,12R,14R	100221	Socket, 24 pin	3
1R	101537	Integrated Circuit, SN74166	1
4R	101688	Integrated Circuit, 2513	1
12R	101693	Integrated Circuit, 8204	1

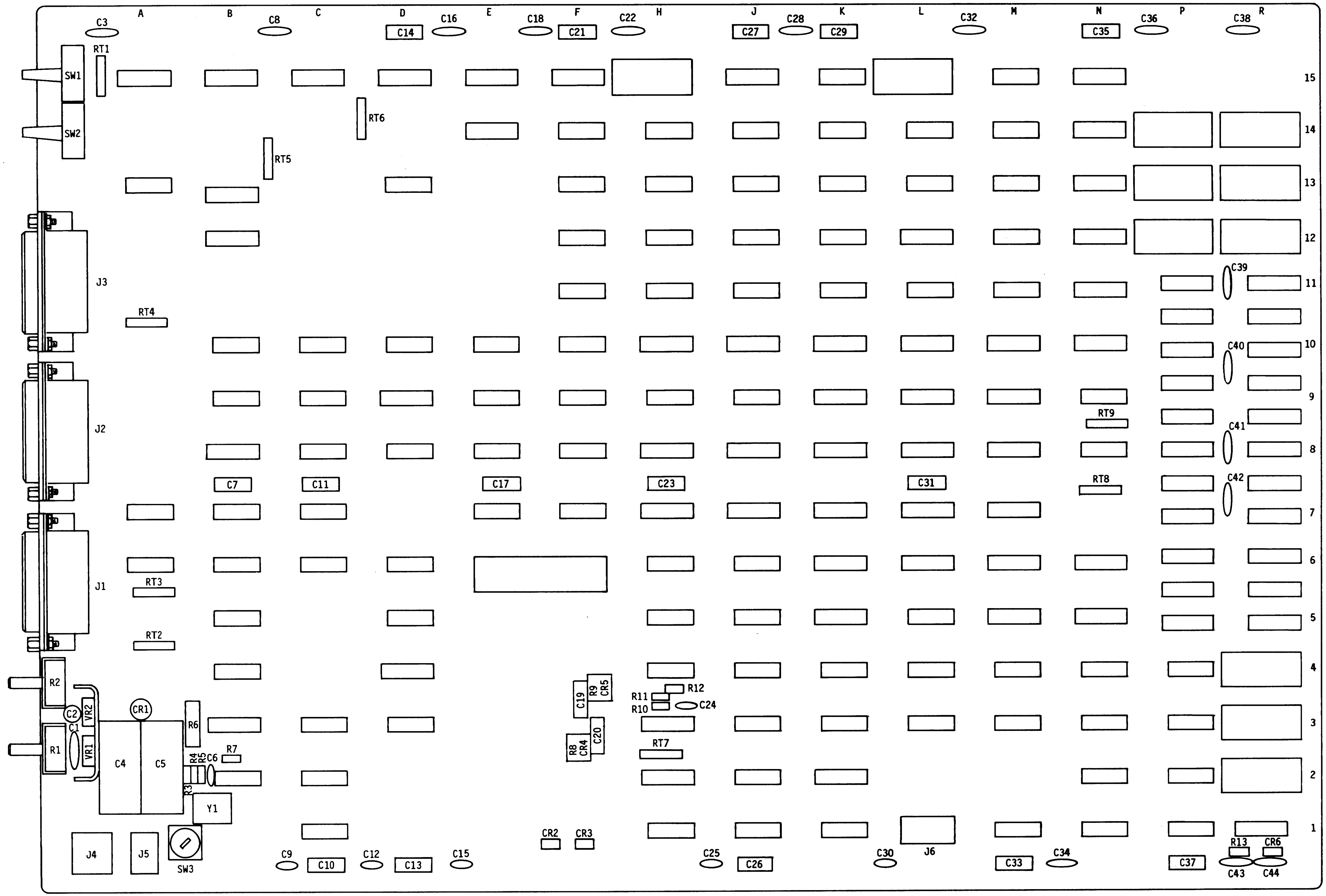


Figure 4-7. Logic Board (P/N 901810 and 901850)

Parts List for Keyboard, 900387, figure 4-8

Reference Designator	Part Number	Part Name	Qty
C1		Capacitor, 68μf, 15V	1
C2 thru C6,C14		Capacitor, 0.01μf, 50V	7
C7		Capacitor, Elec, 2.2μf, 35V	1
C8,C9	101112	Capacitor, 4.7μf, 10VDC	2
C10		Capacitor, (IEC) 0.020μf, 100V	1
C11		Capacitor, Elec, 10μf, 20V	1
C12,C13		Capacitor, (IEC) 0.068μf, 100V	2
C15		Capacitor, 4.7μf, 50V	1
CR1,CR2	101200	Diode, 1N914	2
R16	21-4148	Resistor, 10K, 1/4w, ±5%	1
R17 thru R22,R27, R30,R31,R33,R35		Resistor, 2K, 1/4w, ±5%	11
R23		Resistor, 180, 1/4w, ±5%	1
R24		Resistor, 20K, 1/4w, ±5%	1
R25		Resistor, 27K, 1/4w, ±5%	1
R29,R32		Resistor, 150, 1/4w, ±5%	2
Z1,Z8,Z16,Z17	SN7400	Integrated Circuit	4
Z2,Z13,Z14	SN7486	Integrated Circuit	3
Z3	SN7402	Integrated Circuit	1
Z4	SN7451	Integrated Circuit	1
Z5,Z11	SN7404	Integrated Circuit	2
Z6	SN74121	Integrated Circuit	1
Z7,Z10	SN7413	Integrated Circuit	2
Z9	SN7410	Integrated Circuit	1
Z12	MM5060AA/D or 22-2521V	Integrated Circuit	1
Z15	SN7405	Integrated Circuit	1
Z18	SN74180	Integrated Circuit	1
Z19,Z24	SN7493	Integrated Circuit	2
Z20,Z22	SN74151	Integrated Circuit	2
Z21	38-0103-02 (898-1-R10K)	Resistor Network	1
Z23	SN7442	Integrated Circuit	1
Z25,Z26	SN7474	Integrated Circuit	2
Diode Reed/Key Matrix	21-4148	Diodes (ITT)	61
ERROR	BNZF-41-E372-07	Error Light	1
LOCAL	BBWW-01-L466-07	Local Switch Key	1
ON/OFF	BBZC-63-0521-07	Power ON/OFF Key	1
CTRL	BBWW-01-C356-07	Control Key	1
SHIFT	BBWW-01-S577-07	Shift Key	1
	BBWW-01-1696-110	Shift Lock Key	1

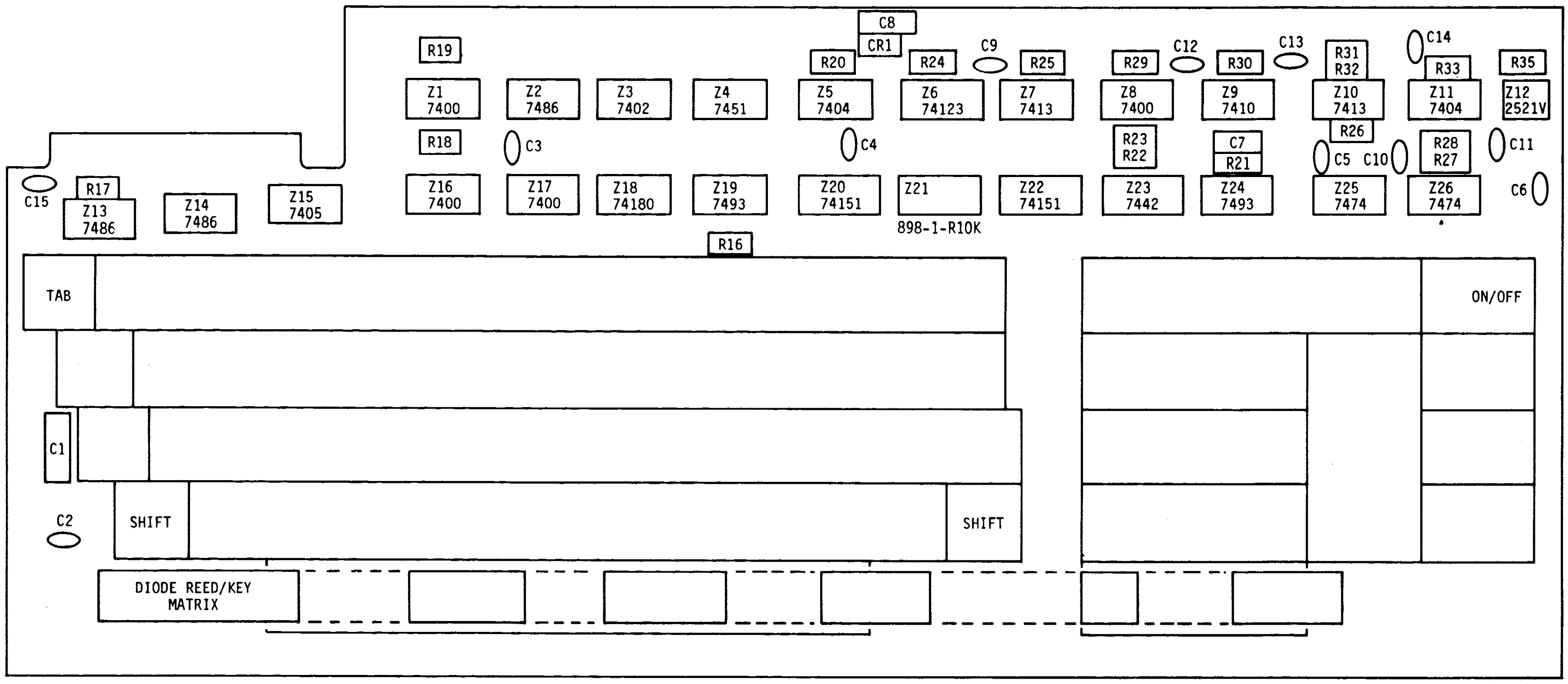


Figure 4-8. Keyboard (900387)