

**PRODUCT  
DESCRIPTION  
MANUAL  
# 852-03**

## **SERIES 400**

**SERIAL, POLLING,  
BUFFERED, MESSAGE ORIENTED**

**DATA-SCREEN™ Terminals**

**Model 420: 1000 Character Display, 50 Characters/line x 20 lines**

**Model 425: 1920 Character Display, 80 Characters/line x 24 lines**

**Model 426: 960 Character Display, 40 Characters/line x 24 lines**



*OLDEST INDEPENDENT COMMERCIAL  
CRT TERMINAL MANUFACTURER*

20 APRIL 1978

\$5.00

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COMMITTED TO AFFIRMATIVE ACTION –  
A TEC, INCORPORATED CORPORATE POLICY

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DATA-SCREEN<sup>®</sup>, DATA-PANEL<sup>®</sup>, ARE INFORMATION DISPLAY AND CONTROL  
PRODUCTS MANUFACTURED BY TEC, INCORPORATED

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## SECTION I

### INTRODUCTION

TEC, Incorporated has been a leader in the display and communications field for over a decade. DATA-SCREEN Terminals have been operating throughout the United States, Canada, Europe and the Far East for several years. During this time TEC has intensively studied and evaluated numerous user applications and incorporated many important features in the Series 400.

Series 400 Displays are a fourth generation family of CRT displays manufactured by TEC. The technology and history accrued on the earlier models plus latest state-of-the-art developments, proved reliability, and handsome styling make the Series 400 one of the finest displays available today.

Series 400 DATA-SCREEN Terminals are self-contained, desk-top or rack mounted units designed to operate with a processor in interactive time-sharing applications.

This manual is designed to acquaint operators, programmers and engineers with the features of Models 420, 425, & 426 DATA-SCREEN Terminals.

#### SYSTEM COMPATIBILITY

Series 400 DATA-SCREEN Terminals provide a versatile, economical operator-oriented input/output station. The operator may interact with the processor or remove the Terminal from computer control to compose or edit a message for subsequent transmission. Sixty-four ASCII graphic characters and four special symbols may be displayed using a 5 x 7 dot matrix.

A variety of standard interface control features and page formats assure compatibility with most systems and display requirements. The RS-232 or TTL level serial I/O interface allows direct connection to a processor for use as a local terminal; up to 1000 feet away; or connected to modems for unlimited distances.



FIGURE 1. DESK TOP MODEL WITH MONITOR

## MODEL DESCRIPTION

Three models are available and may be ordered with or without monitor or keyboard and with or without enclosure. See Figures 1 through 3.

The three models differ in character display capacity:

Model 420 1000 character display, 50 characters/line x 20 lines.

Model 425 1920 character display, 80 characters/line x 24 lines.

Model 426 960 character display, 40 characters/line x 24 lines.

See Figures 40-42 for actual size photographs of these screen capacities.

## OPTIONS & ACCESSORIES

All models have the following basic options:

- Display or blank Carriage Return symbol
- Display or blank Cursor
- Enable or disable Automatic Line Feed
- Enable or disable Automatic Roll-Up
- Enable or disable End of Line/Page Bell signal
- Enable or disable Operator Lock Over-ride
- EOT, Message or Poll transmit modes.
- Set: Parity, Stop bits, Baud rate
- Displays white on black or black on white.

All models have the capability of adding on the following accessories:

- Printer Adaptor (20 ma current drive or TTL direct drive)
- Slave Monitors (one or more can be connected in series from the BNC, VIDEO OUT, connector on the back panel). No adjustments are required in the Terminal.

All models with integral monitor may include optional fixed message indicators (DATA-PANEL Display).

All models have an addressing option to allow them to be used in multi-drop communications systems.

## SECTION II

### INSTALLATION

The Series 400 Terminal has been carefully packed to insure its arrival in operating condition; however, damage may have occurred during shipment or handling, therefore the following procedures should be used to establish the mechanical condition of the unit and prepare it for operation.

#### UNPACKING

- Inspect the shipping carton for external damage, note any damage on the Bill of Lading prior to opening the carton.
- As the equipment is unpacked, check for signs of damage or missing parts (refer to Spare Parts List for parts identification). Note, any damage or missing parts on the Bill of Lading for possible claims.
- Check inside the unit for foreign materials, loose nuts, screws, bent pins, shorted or broken connectors, broken wires, etc..

To remove the top enclosure on desk top model with monitor, undo the three,  $\frac{1}{4}$  turn fasteners on the back panel, pull back the two slide latches (at the bottom rear corners) and push forward and upward (enclosure rotates from the bottom front).

To remove the top enclosure on desk top model without monitor, undo the  $\frac{1}{4}$  turn fasteners on each end and lift straight up.

- Check to see that the high voltage lead on the side of the CRT and the connections to the power supply terminal boards are firmly attached.

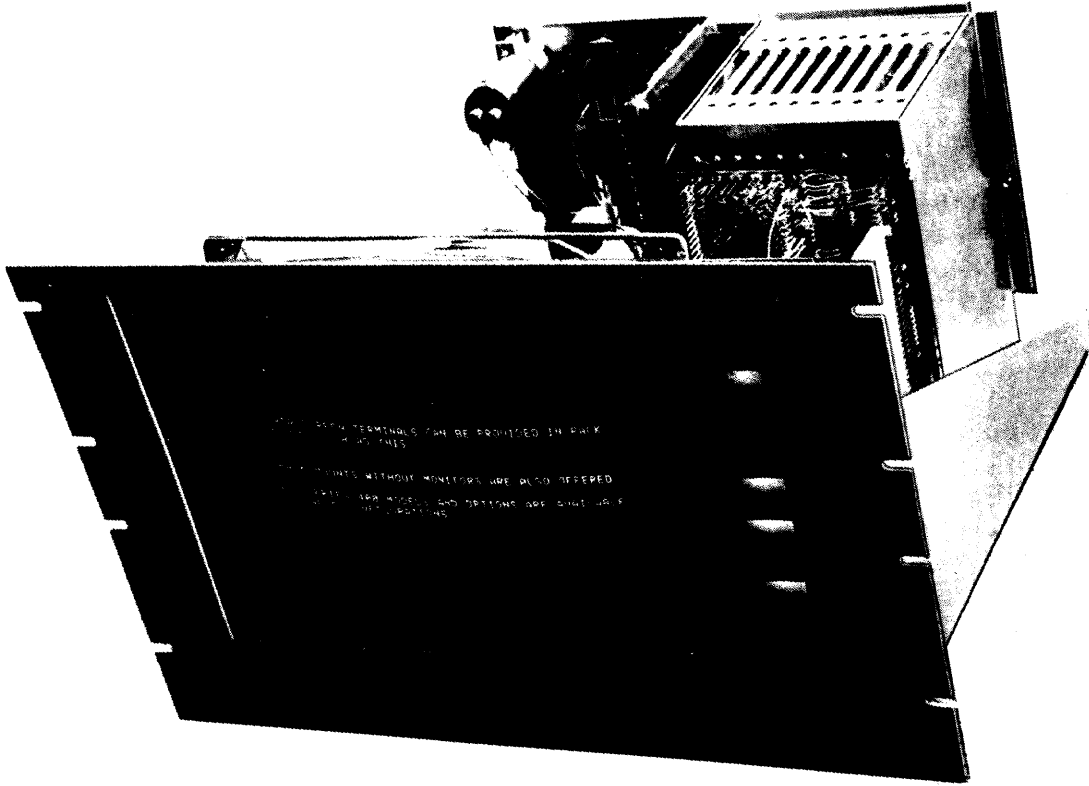


FIGURE 2. RACK MOUNT MODEL WITH MONITOR



## **EQUIPMENT PLACEMENT**

DATA-SCREEN Terminals are available in four configurations:

- a. Desk top; with logic, power supplies and TV monitor. See Figures 1 and 41.
- b. Desk top; without TV monitor but with logic and power supplies. For use with remote TV monitors. See Figures 2 and 41.
- c. Rack mount (for standard 19-inch rack) with 12 ¼" high front panel. Consists of TV monitor, logic and power supplies. See Figures 2 and 42.
- d. Rack mount (for standard 19-inch rack) with 10 ½" high front panel. Accomodates logic and power supplies only. Designed for use with remote monitors. See Figures 3 and 42.

## **DESK MOUNTING**

Two desk-mount Series 400 Terminals are self-contained and include an attractive enclosure and non-scuffing rubber feet for protection of desk and table tops. Connectors are provided for power (2-wire plus ground), detachable keyboard, video output for remote TV monitor and communication line (telephone-modem or direct connection to computer). Clearance is required for convection cooling of electronics.

## **RACK MOUNTING**

Two rack mounting options are available for mounting DATA-SCREEN Terminals in standard RETMA 19-inch racks. When 12-inch TV monitor is included, the rack panel is 12 ¼" high and cutout to accomodate the tube face and DATA-PANEL Display, if provided. When a TV monitor is not provided in the assembly, the rack panel is 10 ½" high. All power, keyboard and signal connections are made at the rear of the units. Clearance is required for convection cooling of the electronics.

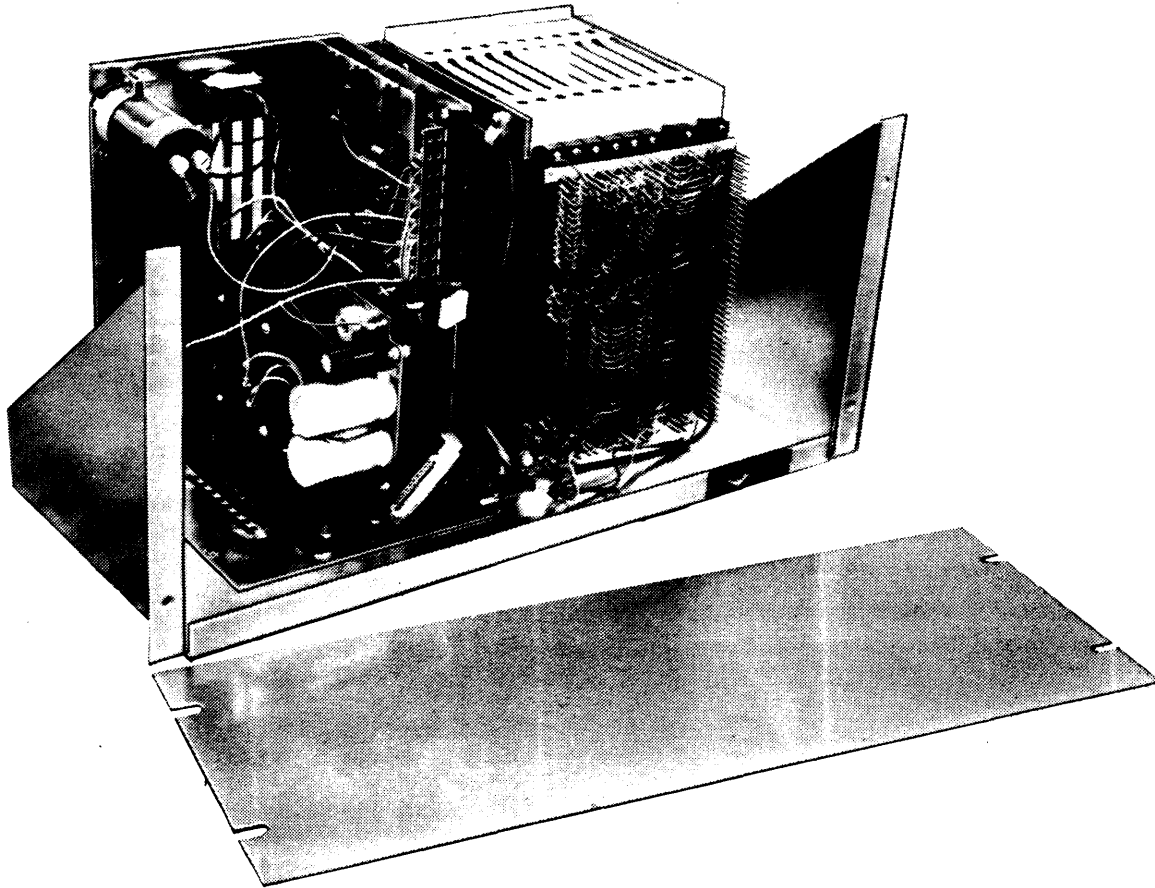


FIGURE 3. RACK MOUNT MODEL WITHOUT MONITOR  
(panel not provided)

## **PCB OPTION SETTINGS See Section V**

Optional features that are enabled by switches or jumper wires are preset at the factory. To insure that these features meet your requirements, remove printed circuit boards LM & CB (position 2), CONTROL (position 4), PARA I/O (position 6) and DSA INTFC (position 8) from the card cage. Refer to Figures 27 thru 31 for switch and jumper wire locations. Set switches and install jumpers accordingly.

**40/50 CHARACTER LINE SWITCH MUST BE SET TO 40 CHARACTER LINE FOR MODEL 426 AND 50 CHARACTER LINE FOR MODEL 420. ALTERNATE SETTING WILL SHIFT CHARACTER SCANNING AND DISPLAY "GARBAGE".**

Replace the four PCB's and check the remaining PCB's for card guide alignment and socket engagement.

## **POWER ON/ADJUSTMENT (Refer to FIGURE 5)**

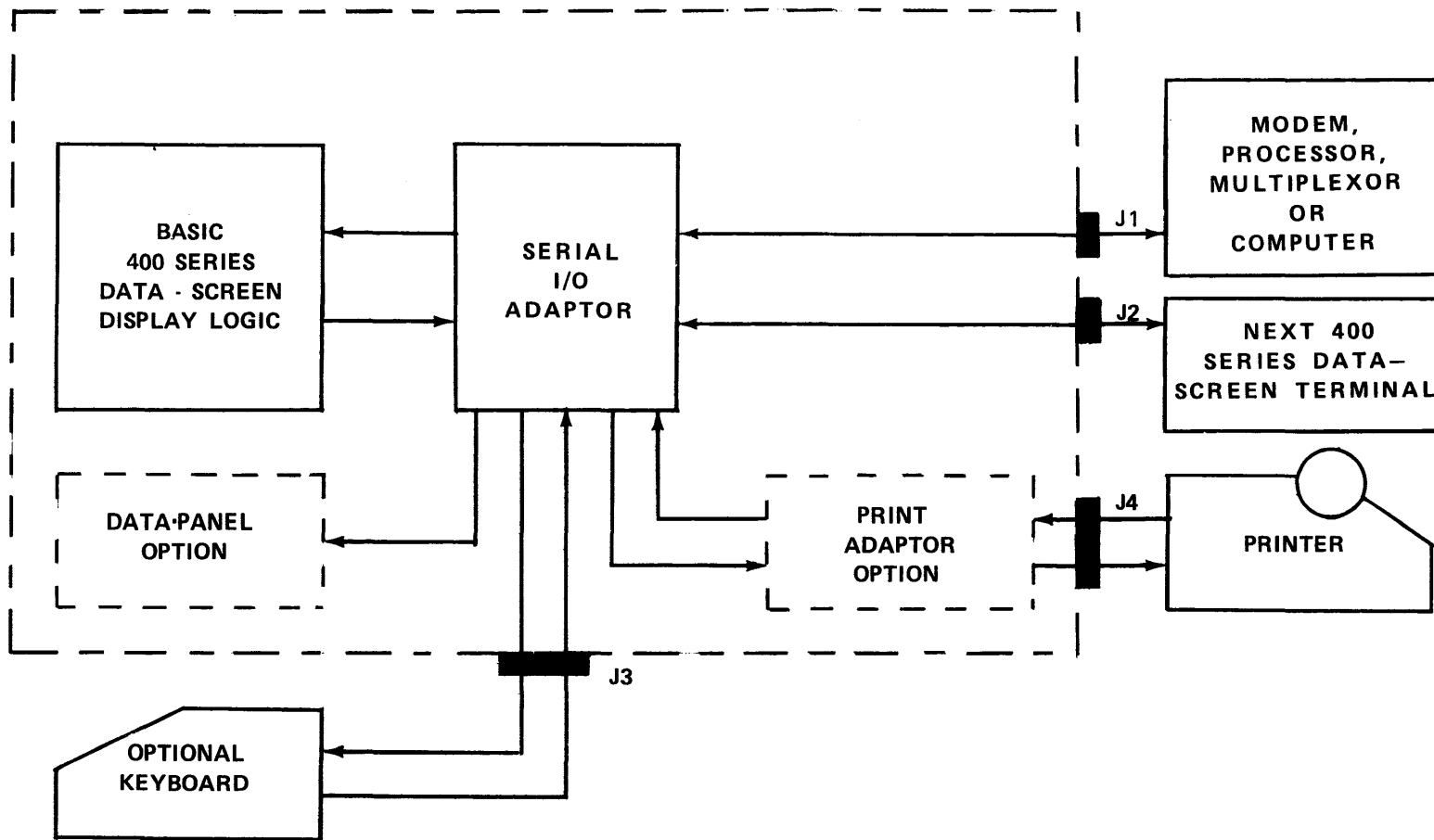
Before applying power to the Terminal:

- Turn the POWER switch on the backpanel to OFF.
- Plug the keyboard cable into KB-J3 on the backpanel.
- Attach the power cord to the POWER CONNECTOR on the backpanel and to a standard 115VAC, 60Hz 3-hole grounded outlet, (or to 240VAC if so ordered).

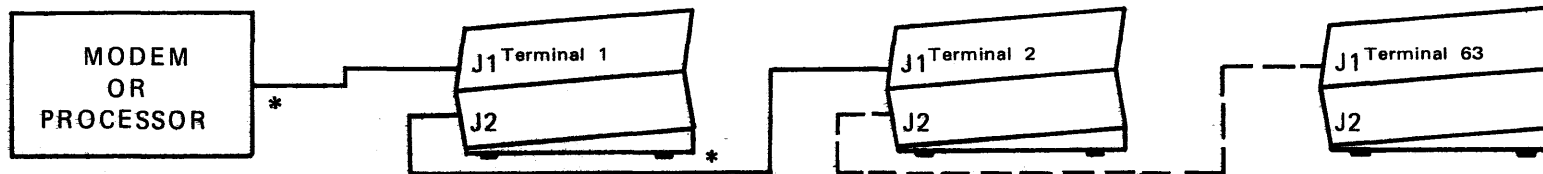
**CUTTING THE SAFETY GROUND PIN ON THE POWER CORD FOR USE WITH A 2 HOLE SOCKET WILL PRESENT A SHOCK HAZARD. USE A 3 PRONG ADAPTER WITH SAFETY GROUND PROPERLY CONNECTED.**

Turn the POWER switch to ON. When power is applied to the unit, the POWER switch and the POWER indicator on the keyboard are illuminated. If the switch fails to light, check the 2 amp fuse on the backpanel. If the keyboard indicator fails to light, but the power switch is illuminated, check the keyboard cable connection.

FIGURE 4. SYSTEM DIAGRAM—MODELS 420, 425, 426

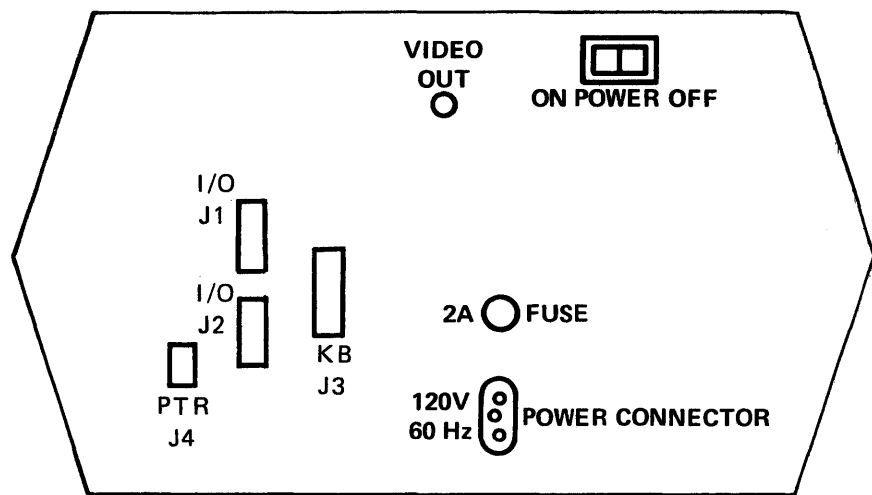


MULTI-DISPLAY SYSTEM (FULL DUPLEX ONLY)

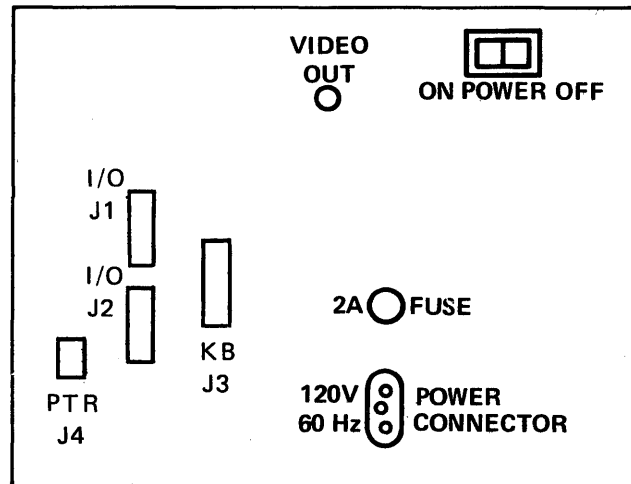


\*1000 ft. max.

**DESK TOP  
MODEL  
With Monitor**



**RACK MOUNT  
MODELS  
With & Without  
Monitors**



**FIGURE 5. BACKPANEL CONNECTORS**

**NOTE: LEAVING THE BRIGHTNESS POT ADJUSTED TO HIGH  
MAY RESULT IN DAMAGING THE PHOSPOR OF THE CRT.**

- Allow approximately one minute for the CRT filament to warm up. The blinking cursor should appear in the upper left corner of the screen, if it does not, adjust the BRIGHTNESS control on the front panel below the screen. If cursor still does not appear, refer to Section V, Figures 27 & 28 for setting of CURSOR DISPLAY option switch. If cursor does not appear with cursor display switch properly set, a malfunction is indicated. See Section VII, Trouble Shooting Procedure.
- Depress each of the standard alphanumeric keys to verify that the correct character is displayed. Repeat with the SHIFT key to display upper-keyboard characters. Depress the REPEAT key and any alphanumeric key together. The character will advance from left to right, sounding a bell near the end of each line and at the beginning of the last line. When the page is filled, the character will appear on the top line, erasing other characters as it advances.
- Disconnect power before mounting the unit in its final location.

Connect the processor I/O cable to I/O-J1 and the next display I/O cable to I/O-J2 on the backpanel. See Processor I/O Connections Figures 5 & 24.

The terminal is ready to operate except for connecting optional accessory equipment i.e., Slave Monitors or Hard Copy Printer. Defer their connection until the terminal processor interaction is verified. Refer to the OPTIONS Section for connecting and operating instructions.

## SECTION III

### OPERATING INSTRUCTIONS

The bench check out procedures will have prepared the DATA-SCREEN Terminal for on-line operation however, the operator should familiarize himself with the keyboard keys and their functions, especially those used for control, editing and message composition.

#### KEYBOARD FAMILIARIZATION (Refer to FIGURE 6)

The Series 400 keyboards are easy to operate because a standard keyboard arrangement is used. To practice, turn on power (POWER switch on backpanel). Allow approximately one minute for the CRT to warm up. Depress the LOCAL switch on the keyboard (LOCAL indicator will light) to "lock out" the processor and prevent terminal/processor interaction.

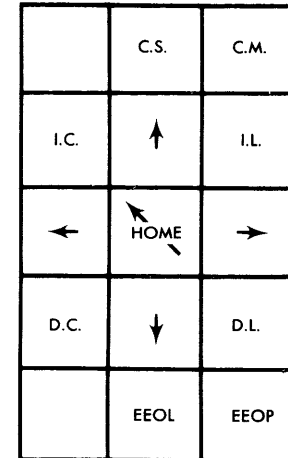
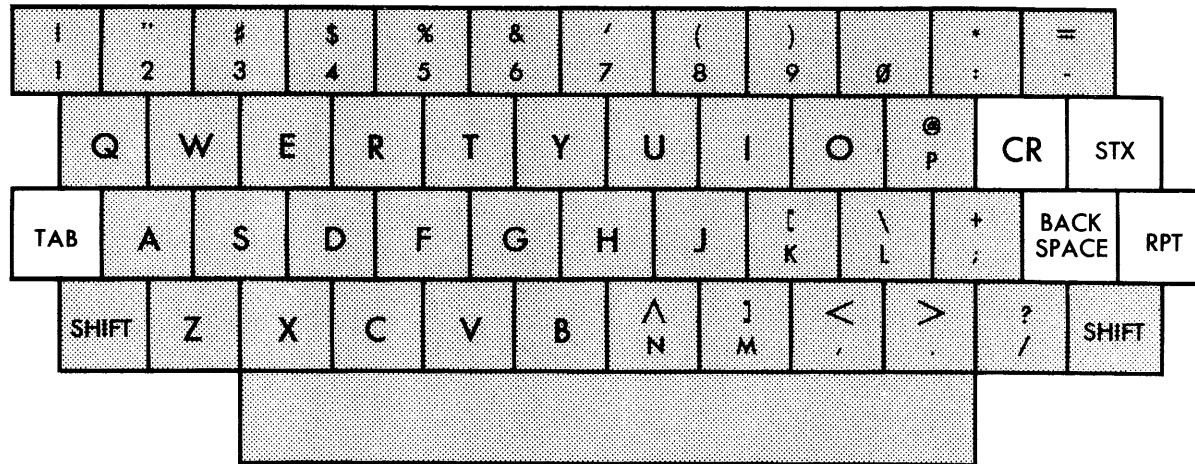
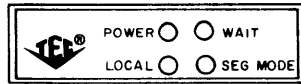
IF THE KEYBOARD APPEARS TO BE INOPERATIVE (WAIT INDICATOR ON) TOGGLE THE POWER SWITCH TO OFF-ON. THIS WILL RELEASE THE KEYBOARD FROM PROCESSOR CONTROL.

#### Program note

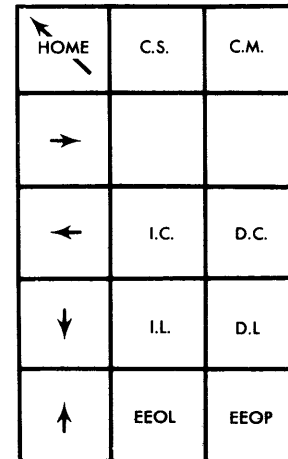
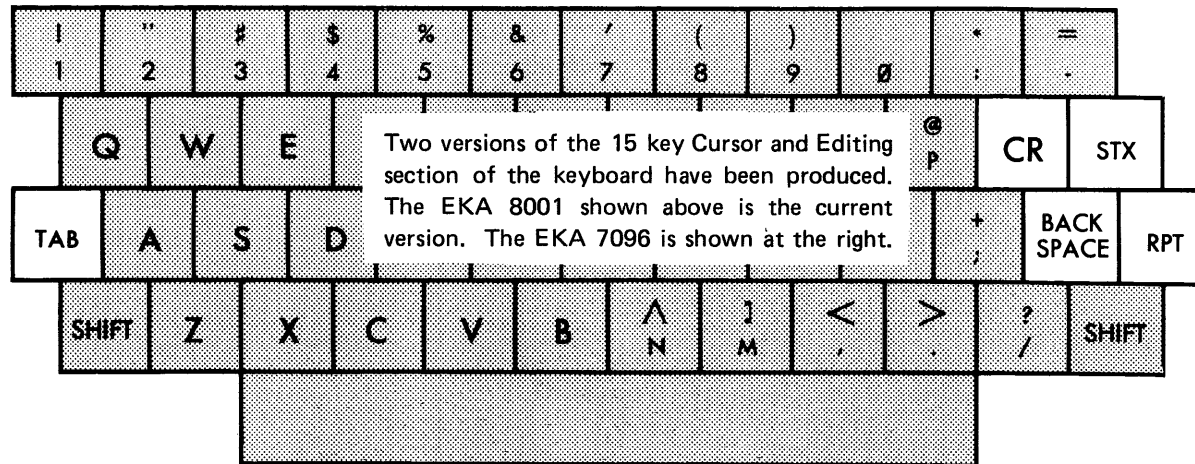
Any of the functions described for the keyboard except LOCAL, REMOTE & REPEAT can be implemented by the processor by outputting the proper codes. See Figures 12 & 13. Those functions controlled exclusively by the processor are described under Computer Command Functions beginning on page 22.

#### ENCODING KEYS AND FUNCTIONS

There are 65 encoding keys and two encoding switches on the keyboard used for the Series 400 terminals. They generate 84 ASCII codes, (referred to in hexadecimal notation in this manual - See Figures 12 & 13) that are transmitted to the processor or used by the terminal to edit or display 64 graphic characters and three special symbols.



CURRENT KEYBOARD EKA-8001



EARLIER KEYBOARD EKA-7096

FIGURE 6. KEYBOARD MODELS 420, 425, 426

## GRAPHIC KEYS

Sixty-four graphic characters including space are displayable from a possible 95 ASCII characters. The 64 characters are contained in the center four columns of USAS X3.4-1967, USASCII and are generated by the shaded keys shown in FIGURE 6. The SHIFT key has the standard function of selecting upper keyboard characters. It has no effect on single character keys.

## CONTROL KEYS

Several control functions are generated by keys on the main keyboard. They are CR, REPEAT & TAB.

CR (Carriage Return) KEY - When the CR key is depressed, ASCII code 0D is generated. The CR symbol (↵) will be displayed at the cursor position unless it is disabled. The cursor will move to the beginning of the next line unless the Auto-Line Feed option is disabled, causing the cursor to move to the beginning of the same line.

REPEAT KEY - This key is used in conjunction with another character or control function key to repeat the character or control function at a 15 Hz rate for as long as both keys are depressed.

TAB (Field Tab) KEY - When the TAB key is depressed, ASCII code 09 is generated. The cursor moves to the position immediately following the next tab stop. If no tab stops are present, the cursor moves to the Home position (top left corner of the screen).

TAB STOP CODES (EPS CODE—ASCII 7A) ARE GENERATED BY THE PROCESSOR, NOT THE KEYBOARD.



## CURSOR CONTROL KEYS

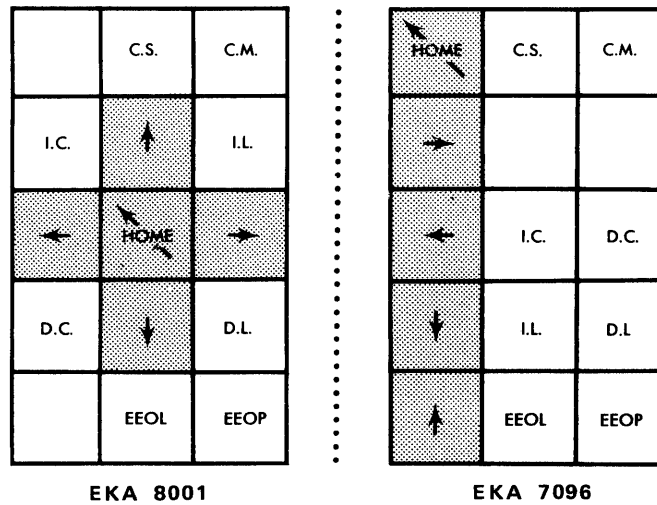


FIGURE 7. CURSOR CONTROLS AND EDIT KEYS

The five shaded keys shown in FIGURE 7 are located to the right of the main keyboard. They are used to manually position the cursor on the screen. The arrows on the keys indicate the direction of the movement when the key is depressed. Use of the REPEAT key with a cursor control key will speed positioning of the cursor.

HOME (↖) KEY - Moves the cursor from any position on the screen to the top line, first column.

UP (↑) KEY - Moves the cursor up one line, in the same column. When on the top line, cursor moves to the same column on the bottom line.

DOWN ( ↓ ) KEY - Moves the cursor down one line, in the same column. When on the bottom line, cursor moves to the same column on the top line. Auto-Roll-Up is by passed.

LEFT ( ← ) KEY - Moves the cursor left one position. When in the first column, cursor moves to the last column of the line above. When in the Home position, cursor moves to last column of bottom line.

BACKSPACE KEY - Identical to LEFT ( ← ) KEY

RIGHT ( → ) KEY - Moves the cursor right one position. When in the last column, cursor moves to first column of line below. When in the last column of the bottom line, cursor moves to Home position.

## TEXT EDITING KEYS

The eight unshaded keys shown in FIGURE 7 are located to the right of the main keyboard. They are used to simplify text editing and corrections. Characters or lines of characters can be inserted and any or all characters deleted. The terminal also has the capability of assisting the operator to edit or compose messages by blinking characters and preventing the alteration (format protect) or characters. See Computer Command Functions.

To prevent an edit function from being accidentally enabled, the editing keys must be depressed in conjunction with a SHIFT key.

CS (Clear Screen) KEY - When the CS & SHIFT keys are depressed, spaces (ASCII code 20) appear in all character positions except those that are protected (See Computer Command Functions - Format Protect). The cursor moves to the Home position or the first unprotected position following Home if it is protected.

CM (Clear Memory) KEY - When the CM & SHIFT keys are depressed, spaces (ASCII 20) appear in all positions including protected positions. The screen is completely blank except for the cursor which moves to the Home position.

IC (Insert Character) KEY - When the IC & SHIFT keys are depressed, the character over the cursor and all characters to its right in that line are moved to the right one position. The character in the last column of the line is lost. A space appears at the cursor position allowing a character to be inserted. The IC function is disabled if any position on the screen is protected (See Computer Command Functions - Format Protect).

IL (Insert Line) KEY - When the IL & SHIFT keys are depressed, the line containing the cursor and all lines below it are moved down one line, losing all characters in the bottom line. The cursor moves to the first column of the same line and the line is filled with spaces allowing a new line of characters to be inserted. The cursor can be in any position in the line to perform this function, however the function is disabled if any position on the screen is protected (See Computer Command Functions - Format Protect).

DC (Delete Character) KEY - When the DC & SHIFT keys are depressed, the character in the cursor position is replaced by the character to its right and all characters following it are shifted left one position. A space is inserted in the last column of the line. The cursor remains in the same position to mark the deleted character. The DC function is disabled if any position on the screen is protected (See Computer Command Functions - Format Protect).

DL (Delete Line) KEY - When the DL & SHIFT keys are depressed, the line containing the cursor is replaced by the line below and all lines following it are moved up one line. Spaces are inserted in the bottom line and the cursor moves to the first column of the deleted line. The cursor can be in any position in the line to perform this function, however the function is disabled if any position on the screen is protected (See Computer Command Functions - Format Protect).

EEOL (Erase to End of Line) KEY - When the EEOL & SHIFT keys are depressed, the character in the cursor position and all characters to its right in the line are replaced by spaces, except for those characters that are protected (See Computer Command Functions - Format Protect). The cursor does not move.

EEOP (Erase to End of Page) KEY - When the EEOP & SHIFT keys are depressed, the character in the cursor position and all characters to its right and in the lines below are replaced by spaces, except those characters that are protected (See Computer Command Functions - Format Protect). The cursor does not move.

#### **BLANK FUNCTION KEYS**

Two blank function keys are included in the keyboard and shown in the shaded areas of Figure 8. Blank function key No. 1 is ASCII code 62. Blank function key number 2 is ASCII code 72. These keys are spare function keys not recognized by the terminal in any way.

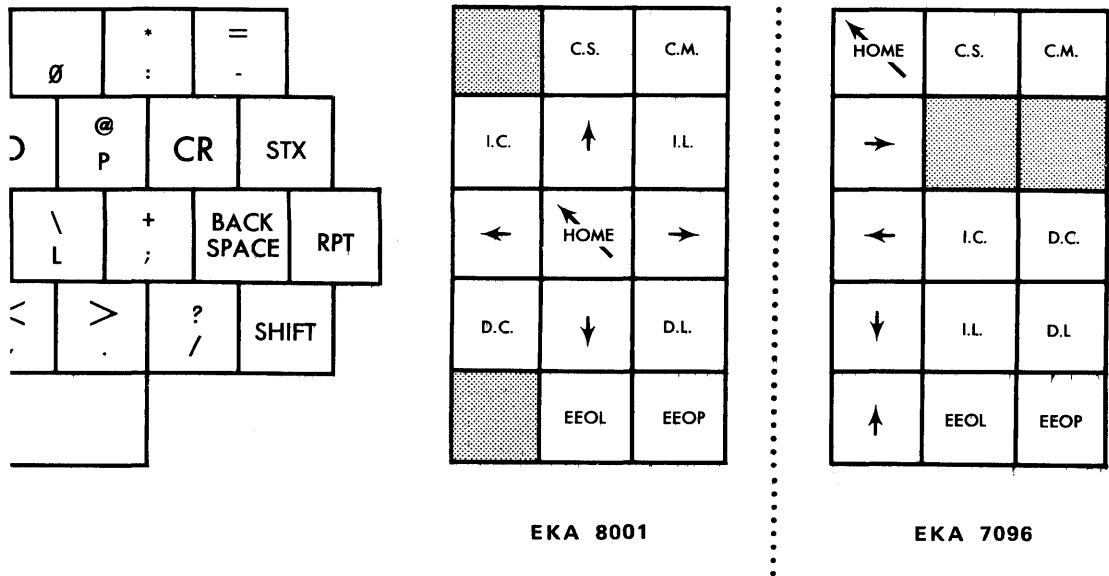


FIGURE 8. BLANK FUNCTION KEYS

### MESSAGE TRANSMISSION KEYS

The three shaded keys shown in FIGURE 9 are used to notify the processor or printer that a message is ready for transmission and to define the limits of that message.

**STX (Start of Text) KEY** - When the STX key is depressed, ASCII code 02 is generated and the symbol (    ) appears in the cursor position to define the beginning of the message to be transmitted if the processor has placed the terminal in SEGMENTED MODE. If the processor has the terminal in PAGE MODE, the STX has no effect on the message (See Computer Command Functions - SEG/PAGE MODE).

X-MIT (Transmit) KEY - When the X-MIT key is depressed an ETX (End of Text) ASCII code 03 is generated and the symbol (␣) appears in the cursor position to define the ending of the message to be transmitted. The cursor moves backwards until an STX position is found (SEGMENTED MODE) or to the Home position (PAGE MODE). See Computer Command Functions - SEG/PAGE MODE. The message is transmitted to the processor via one of three modes; EOT, Message or Poll. See OPTIONS - PCB OPTIONS. The keyboard is disabled until it is released by the processor.

IF THE KEYBOARD APPEARS TO BE INOPERATIVE (WAIT INDICATOR ON) DO NOT TOGGLE POWER SWITCH ON BACKPANEL. LOSS OF POWER WILL CLEAR MEMORY, LOSING ALL DATA. SEE PCB OPTIONS - OPERATOR LOCK OVER - RIDE.

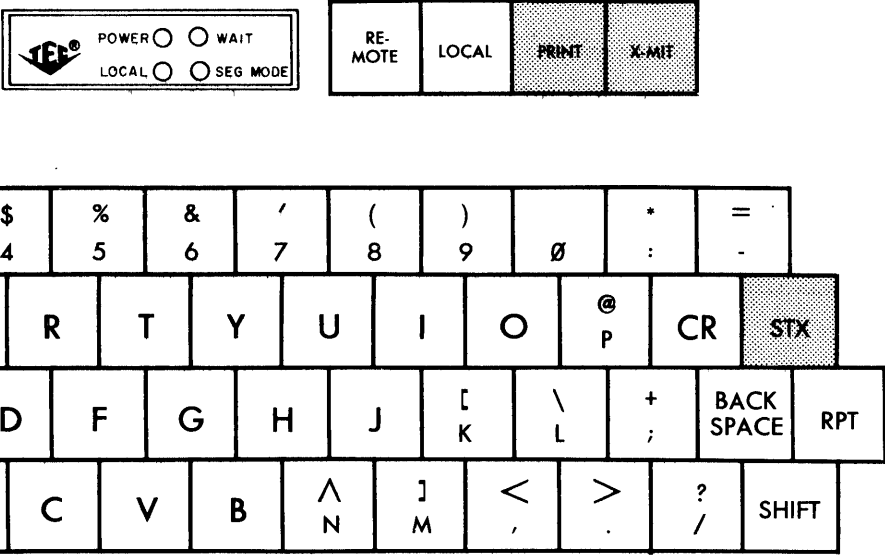
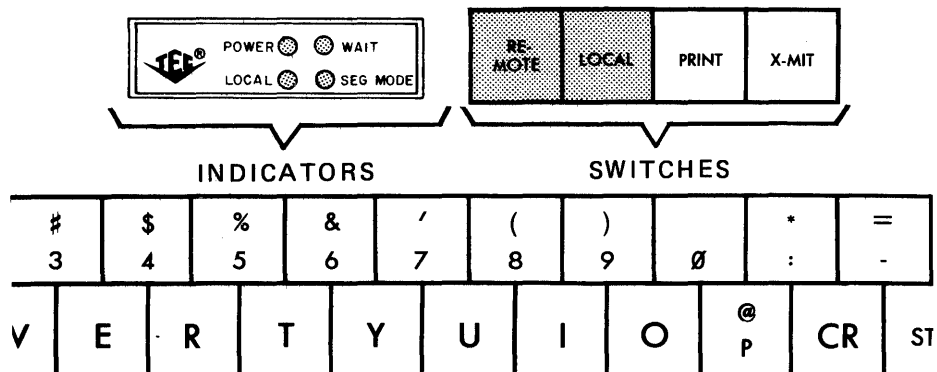


FIGURE 9. MESSAGE TRANSMISSION KEYS

**PRINT KEY** (See Options - Printer Adapter) - When the Print Key is operated, code 60 is generated. If the Printer is not ready or doesn't exist this code is ignored. If the Printer is Ready, the cursor is moved to the first previous STX if the terminal is in SEGMENTED MODE or to Home if in PAGE MODE. Data is then transmitted to the printer excluding only characters to the right of a Carriage Return on a line. Printing will end at ETX in SEGMENTED MODE or the end of the page in PAGE MODE. The keyboard and processor are both locked out during a Print operation. See Options - Printer Adaptor.

**INDICATORS & SWITCHES**



**FIGURE 10 KEYBOARD INDICATORS & SWITCHES**

The shaded indicators and switches shown in FIGURE 10 are used to control and report the communications mode between the terminal and the processor.

**POWER INDICATOR** - When lit, indicates power is applied to the terminal and keyboard.

**WAIT INDICATOR** - When lit, indicates that the keyboard is locked out (terminal is busy communicating with the processor) and the operator must wait until the light goes out to use the keyboard. See PCB OPTIONS - OPERATOR LOCK OVER-RIDE.

**SEG MODE INDICATOR** - When lit, indicates that the processor has placed the terminal in **SEGMENTED MODE**, therefore only those characters between the **STX** (␣ symbol) and **ETX** (␣ symbol) will be transmitted. When the indicator is not lit, the terminal is in the **PAGE MODE** and all unprotected characters on the screen are transmitted.

**LOCAL SWITCH & INDICATOR** - When the **LOCAL** switch is depressed the **LOCAL** indicator is on indicating that the processor is "locked out" (terminal is **OFF-line**). Data can be entered on the screen from the keyboard in **LOCAL** mode. The **X-MIT** key will automatically switch the terminal to **REMOTE** operation.

**REMOTE SWITCH** - When the **REMOTE** switch is depressed the **LOCAL** indicator is extinguished indicating that the terminal is on-line to the processor.

## **COMPUTER COMMAND FUNCTIONS**

Models 420, 425 and 426 **DATA-SCREEN** Terminals have the capability of performing a variety of functions under direct computer control. All data, protected or not, can be changed by computer program, made to blink at a rate to attract attention without impairing readability, protected from operator modification with format protect or keyboard lockout and read by character or message. The computer can also turn fixed message indicators on or off in the **DATA-PANEL** Display option and sound a bell to signal the operator.

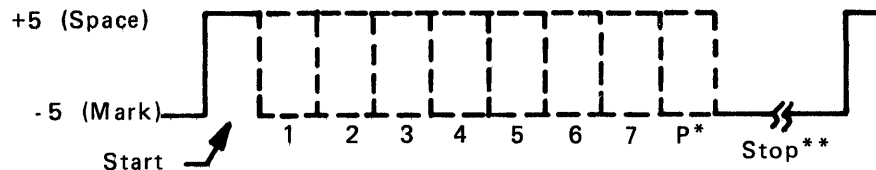
## **COMMUNICATIONS**

All data transferred between the processor and the terminal is in asynchronous start - stop serial format. See **FIGURE 11**.



The START bit is always a "space" or logic "0". The data bits are the ASCII code, bit 1 is least significant. The parity bit optionally makes the total number of "1's" odd or even or is always a MARK (logic "1"). The stop bit or bits are always a MARK or logic "1". There may be optionally 1 or 2 stop bits and the MARK condition between characters may be any length.

The terminal's receiver is normally always on. It can then receive data even while it is transmitting. If a code is received while the terminal is transmitting, the transmission will terminate at the next stop bit. If this feature is undesirable, (in an echo - back system for example) a jumper - wire option on the DSA PCB will disable the receiver during a transmit.



\* Parity - Odd or Even

\*\* One or two bits, minimum, no maximum

FIGURE 11. INTERFACE DATA BIT SEQUENCE

## COMMUNICATION LINE CONTROL

The Serial Interface may be used on a single drop full - or half duplex line or on a multi-drop full duplex line. See Figure 24 for RS-232 signals. Data Terminal Ready (pin 20) is ON whenever the terminal is turned on. Data Set Ready (pin 6) is not used.

When the terminal is commanded to transmit, either by a Read Command from the processor or by the X-mit Key, it will wait for Carrier On (pin 8) signal to go off turn on Request to Send (pin 4), wait for Clear to Send (pin 5), then begin transmitting the message. For full duplex operation, Carrier On must be strapped OFF and clear to Send must be strapped ON or tied to Request to Send.

## OPTIONS - See Figure 31

The baud rate is selectable by a pot and switch S2-A on the Serial adaptor PCB. The rate is continuously variable from 110 to 9600.

The transmitted parity bit (bit 8) can be selected by S1-A for ODD parity, EVEN parity or always a MARK. The received parity can be selected by S1-B to check for ODD, EVEN or no check.

S1-C switches the EIA RS-232 or the TTL input to the receiver circuits.

A 10- or 11- bit (1 or 2 stop bits) character format is selected by S2-B.

On a multi-terminal line it is necessary to use the Addressing option. S3-B selects whether the addressing feature is on or off; when the switch is "OFF" the terminal is always "on line." When the switch is "on" data transfer must be preceded by an addressing header. Each terminal on the line is assigned an address from 01 thru 63 by installing combinations of 6 jumper wires, representing binary digits, on the Serial Adaptor PCB. Data bits 1 thru 6 of the address character are compared to the address assigned. Bit 7 of the address code must be the complement of bit 6. This restricts the address to columns 2 thru 5, the alpha-numeric section, of the ASCII code chart. See FIGURE 13. All terminals will respond to address 00 (NUL or @) so that a message can be broadcast to all terminals. The header sequence begins with SOH (01) code and is followed by the address code. Switch S3-C selects a single - or multi-address mode. In single address mode, the code immediately following the SOH must be the address and will terminate the header. In the multi-address mode, an STX (02) code ends the header and the address may be anywhere between the SOH and STX. This allows a broadcast to a selected group of terminals on the line. A parity error received during a header sequence will nullify that entire header. An SOH code resets the address circuits so that the terminal must be readdressed.

## OPERATING INSTRUCTIONS

**NOTE:** Whenever more than one terminal is addressed in a broadcast mode, the processor must not send a Read command or ENQ code. All Terminals on-line will respond at once resulting in meaningless data to the processor.

### **BLINK COMMANDS**

The Start Blink (SBS - ASCII code 7B) and End Blink (EBS - ASCII code 7C) are used to enclose a single character, groups of characters or the entire screen. The enclosed characters will blink at a 4 Hz rate while the SBS and EBS positions are displayed as spaces.

### **FORMAT PROTECT COMMANDS**

The Start Protect (SPS - ASCII code 79) and End Protect (EPS - ASCII code 7A) are used to enclose a single character, groups of characters or the entire screen (see note).

The enclosed characters can not be moved (IC, IL, DC & DL keys are disabled) or changed by the operator. Attempts to position the cursor in a protected area will automatically cause it to move forward out of the protected area. The SPS and EPS positions, displayed as spaces, are protected when used together. Characters between the SPS-EPS positions are not transmitted to the processor. Only unprotected data will be transmitted. All characters and function codes are erased when a Clear Memory code is received from the keyboard or processor. Only unprotected characters are erased when a Clear Screen code is received.

The EPS code is also used as a TAB STOP. When the TAB key or function is used, the cursor seeks the next EPS on the page. To protect the TAB STOP during a Clear Screen operation, the programmer must precede each EPS code with an SPS code.

AN SPS CODE MUST NOT BE SENT TO THE TERMINAL WHEN THE KEYBOARD IS UNLOCKED SINCE ALL THE FOLLOWING POSITIONS WILL BE PROTECTED AND DATA CAN NOT BE WRITTEN ON THE SCREEN.

TO PREVENT THE SYSTEM FROM "HANGING-UP", AT LEAST ONE POSITION ON THE SCREEN MUST BE LEFT UNPROTECTED.

#### LOCK COMMANDS

The Set Lock (LOCK - ASCII code 7D) command disables the keyboard preventing operator/terminal interaction and inhibits the Format Protect function. To avoid operator interference, it is recommended that the keyboard be locked before outputting data from the processor. The processor may enter data anywhere on the screen including protected areas and all editing functions are operational. Blink, Protect and ETX positions that are within an IC, IL, DC or DL edit function are moved as if they were alphanumeric characters. SPS codes may be entered. Characters or functions moved off the screen are lost.

The Release Lock (REL - ASCII code 70 ) command terminates the locked condition. The keyboard is enabled and Format Protect Sequences are restored.

THE LOCKED CONDITION MAY BE RELEASED MANUALLY BY USE OF THE OPERATOR LOCK OVER-RIDE OPTION. SEE PCB-OPTIONS, SECTION V. TO RELEASE THE KEYBOARD, DEPRESS LOCAL, THEN REMOTE SWITCHES.

#### MODE COMMANDS

The Segmented Mode (SEG - ASCII code 61) is used to start a message transmission at the first STX marker preceding the transmit (ETX) marker.

The Page Mode (PAGE - ASCII code 71) is used to start a message transmission at the Home position. This is the static condition of the Terminal unless instructed otherwise by the processor. It is recommended that either the SEG or PAGE command be used before reading data, to assure proper operation.

The Start of Header (SOH - ASCII code 01) is sent by the processor to start the header sequence. See OPTIONS—PCB OPTIONS.

The Inquire (ENQ - ASCII code 05) is sent by the processor as the final command of the polling sequence to determine if the terminal has data to transmit. If the X-MIT key is not set, an EOT is returned. See OPTIONS—PCB OPTIONS.

The End of Transmission (EOT - ASCII code 04) is sent to the processor as an interrupt signal when the X-MIT key is depressed and when the EOT Transmit Mode option is implemented. EOT is also sent as a response to ENQ if the terminal is not in Poll mode. See OPTIONS—PCB OPTIONS.

## **READ COMMANDS**

The Read Message (READ MSG. - ASCII code 6B) is used to read a message in SEG or PAGE MODE. All data beginning at the cursor position is transferred from the terminal's memory to the processor except, protected data and data following a Carriage Return code on each line. Transmission ends with ETX in SEG MODE or with an End of Memory (ASCII End of Media) after the last character on the page.

The Read Character (READ CHAR. - ASCII code 6A) is used to read a single character at the cursor position. The cursor is then advanced one position.

## **CURSOR ADDRESS COMMANDS**

The cursor address is transmitted in both directions as the one's complement of the binary numbers representing the horizontal and vertical cursor position. The upper left or Home position is column 0, row 0. Illegal addresses are ignored except that unused high order bits are not examined. For example, row address 26 (1100101) will be ignored but (XX10101) will be row (or column) 10.

The Read Cursor Address (RCA - ASCII code 6D) command is used to determine the position of the cursor on the screen. The RCA command causes the terminal to output two characters. The first will be the one's complement of the vertical address.

The Load Cursor Address (LCA - ASCII code 6C) command is used to position the cursor on the screen. The LCA command must be followed by the one's complement of the desired horizontal address and then the one's complement of the desired vertical address.

## **DATA-PANEL DISPLAY COMMANDS**

The Set DATA-PANEL (SDP - ASCII code 6E) command is used to turn on fixed message indicators in the DATA-PANEL DISPLAY (See OPTIONS DATA-PANEL DISPLAY). The SDP command must be followed by the address (1 through 16) of the indicator to be turned on.

The Clear DATA-PANEL (CDP - ASCII code 6F) command is used to turn off fixed message indicators in the DATA-PANEL DISPLAY (See OPTIONS - DATA-PANEL DISPLAY). The CDP command will turn off ALL indicators and must be followed by SDP's to restore those indicators that are to be left on.

## **BELL COMMAND**

The Bell (BEL - ASCII code 07) command may be used to signal the operator by activating a bell mounted in the keyboard.

Bits					0	0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b4	b3	b2	b1	row	column	0	1	2	3	4	5	6	7
0	0	0	0	0				SP	0	@	P	PRINT	
0	0	0	1	1				!	1	A	Q		
0	0	1	0	2	STX			"	2	B	R		
0	0	1	1	3	ETX			#	3	C	S	EEOL	EEOP
0	1	0	0	4				\$	4	D	T	IC	DC
0	1	0	1	5				%	5	E	U	IL	DL
0	1	1	0	6				&	6	F	V	CS	CM
0	1	1	1	7				'	7	G	W	→	←
1	0	0	0	8				(	8	H	X	↓	↑
1	0	0	1	9	TAB			)	9	I	Y	Home	
1	0	1	0	10 (A)				*	:	J	Z		
1	0	1	1	11 (B)				+	;	K	[		
1	1	0	0	12 (C)				,	<	L	\		
1	1	0	1	13 (D)	CR			-	=	M	]		
1	1	1	0	14 (E)				.	>	N	^		
1	1	1	1	15 (F)				/	?	O	_		

FIGURE 12. KEYBOARD CODE CHART  
 For keyboard code summary, See pages 32-34.

Bits					0	0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b4	b3	b2	b1	row	column	0	1	2	3	4	5	6	7
0	0	0	0	0				SP	0	@	P	PRINT	REL
0	0	0	1	1	SOH		!	1	A	Q	SEG	PAGE	
0	0	1	0	2	STX		"	2	B	R			
0	0	1	1	3	ETX		#	3	C	S	EEOL	EEOP	
0	1	0	0	4	EOT		\$	4	D	T	IC	DC	
0	1	0	1	5	ENQ		%	5	E	U	IL	DL	
0	1	1	0	6			&	6	F	V	CS	CM	
0	1	1	1	7	BEL		'	7	G	W	→	←	
1	0	0	0	8			(	8	H	X	↓	↑	
1	0	0	1	9	TAB	EOM	)	9	I	Y	Home	SPS	
1	0	1	0	10 (A)		SUB	*	:	J	Z	READ CHAR	EPS	
1	0	1	1	11 (B)			+	;	K	[	READ MSG	SBS	
1	1	0	0	12 (C)			,	<	L	\	LCA	EBS	
1	1	0	1	13 (D)	CR		-	=	M	]	RCA	LOCK	
1	1	1	0	14 (E)			.	>	N	^	SDP		
1	1	1	1	15 (F)			/	?	O	—	CDP		

FIGURE 13. COMMUNICATIONS CODE CHART


For interface code summary, See pages 32-34.



## KEYBOARD AND COMMUNICATIONS CODE SUMMARY

<u>ABBREVIATION</u>	<u>SUMMARY</u>
SOH	Start of Header (address)
STX	Display Start of Text (␣) symbol.
ETX	Displays End of Text (␣) symbol. Initiates message transmission.
EOT	End of Transmission (no data)
ENQ	Inquire. Used with SOH command.
BEL	Activates bell tone generator in keyboard.
TAB	Horizontal Tab. Cursor moves to next EPS code.
CR	Displays Carriage Return symbol. Cursor moves to first column.
EOM	End of Memory (Media).
SUB	Displays Parity Error (■) symbol.
SP	Space.
ALPHANUMERIC CHARACTERS	Displays symbol shown on keys.
PRINT	Initiates message transmission to printer.
REL	Release Lock. Releases keyboard and re- turns terminal to local.
SEG	Segmented Mode. Limits message between STX and ETX codes.
PAGE	Page Mode. Transmits message between Home and end of page.

## KEYBOARD AND COMMUNICATIONS CODE SUMMARY

<u>ABBREVIATION</u>	<u>SUMMARY</u>
BFK 1 & 2	Blank keys. Inoperative
EEOL	Erase to End of Line. Erases from cursor to end of line.
EEOP	Erase to End of Page. Erases from cursor to end of page.
IC	Insert Character. Inserts a space at cursor, moves following characters to right.
DC	Delete Character. Deletes character at cursor position, following characters move to left.
IL	Insert Line. Fills cursor line with spaces, lines below move down.
DL	Delete Line. Deletes cursor line, lines below move up.
CS	Clear Screen. Erases all un-protected data on screen.
CM	Clear Memory. Fills entire memory with space codes.
	Cursor Control. Cursor moves on space in direction shown.
HOME	Cursor Control. Cursor moves to Home position.
SPS	Start Protect Sequence. Following characters are protected. Inhibits editing.
EPS	End Protect Sequence. Ends protect sequence, also used as Tab stop.

## KEYBOARD AND COMMUNICATIONS CODE SUMMARY

<u>ABBREVIATION</u>	<u>SUMMARY</u>
READ CHAR	Character at cursor position is read.
READ MSG	Unprotected data from cursor to ETX or EOM is read.
SBS	Start Blink Sequence. Following characters will blink.
EBS	End Blink Sequence. Ends blink sequence.
LCA	Load Cursor Address. Used by processor to position cursor.
RCA	Read Cursor Address. Transmits cursor addresses to processor.
LOCK	Used by processor to lock out the keyboard.
SDP	Set DATA-PANEL. Allows processor to turn on 1 of 16 indicators.
CDP	Clear DATA-PANEL. Used by processor to turn off indicators.

## SECTION IV

### THEORY OF OPERATION

NOTE: All ASCII codes referred to in this manual are in hexadecimal notation  
See code charts in Section V.

#### INTRODUCTION

The Series 400 DATA-SCREEN Terminals consist of three modules: a power supply, a TV monitor and a card cage assembly. The power supply module provides all the necessary voltage inputs for the TV monitor, control and interface electronics, and optional functions. The standard TV monitor is a 12 inch (diagonal) solid-state receiver with a P4 phosphor coated screen. The card cage accommodates up to 10 printed circuit boards. The first five contain the electronics used to operate the basic terminal. The remaining five slots house the PCB's used for the external interface and optional functions.

This Section describes the operation of the basic terminal and its internal options. Operation of the interface is described in the SERIAL I/O ADAPTOR SECTION and optional accessories i.e., DATA-PANEL Display, Print Adaptor, etc., in the OPTIONS Section.

The basic terminal electronics consist of five PCB's: TIMING GENERATOR, LINE MEMORY & CHARACTER GENERATOR, PAGE MEMORY, CONTROL, and COUNTER.

The Timing Generator board contains a basic oscillator and several counter type frequency dividers. It provides timing signals for the terminal.

The Line Memory & Character Generator board stores one row of data and converts ASCII codes to video signals for the monitor. Two switches on the board provide the option of displaying or not displaying the Cursor and Carriage Return symbols.

The Page Memory board stores the entire page of data. Its contents can be read and selectively altered through the keyboard and processor communication lines.

The Control board decodes incoming data and loads the result into the proper place in memory or performs the specified function. The Control board has two jumper wire options for enabling Auto Roll-Up and Line Feed.

The Counter board consists of three counter circuits that are, in effect, address registers containing the current addresses of the next data location, page memory location and cursor location.

Screen display capacity affects the functional description of the five basic boards. Since Models 420, 425 and 426 have different display capacities, the five boards will be discussed separately for each model.

## PRINTED CIRCUIT BOARD FUNCTIONS

Model 420, 1000 Character Display, 50 characters per line x 20 lines.

**TIMING GENERATOR – Board 1. See Functional Diagram, Figure 14.**

### BASIC OSCILLATOR\*

The oscillator frequency is determined as follows:

50	Hz	60	Hz	Refresh rate
<u>x 317</u>		<u>x 264</u>		No. of horizontal scans per frame
15.84	KHz	15.84	KHz	
<u>x 64</u>		<u>x 64</u>		No. of character times per scan
1.01376	MHz	1.01376	MHz	
<u>x 7</u>		<u>x 7</u>		No. of dot times per character
7.09632	MHz	7.09632	MHz	

### DOT COUNTER

The Dot Counter divides the oscillator frequency by seven. Dot count 1 thru 5 are the displayed character and dots 6 and 7 are blanks. The count is octal 1 thru 7. Phase 1 and phase 2 clocks for the Character Generator ROM and clock for the Line Memory are generated from Dot Counter signals.

### CHARACTER COUNTER

The 1 MHz (approx.) character rate is divided by 64 by this 6 stage binary counter. Decoded outputs at count 6 and 56 turn the Line Memory clock on and off providing 50 pulses during each scan. The other 14 counts are horizontal retrace time. Horizontal Sync for the TV monitor(s) begins at count 60.

\*60 Hz Standard, 50 Hz Optional. Text discusses 60 Hz Operation.

## SCAN COUNTER

This 4 stage binary counter is driven by the Horizontal Sync pulse at 15.84 KHz. The counter is reset to zero after the count of ten and therefore divides by eleven. Each scan counter cycle represents one line of displayed characters. The scans are labeled thus:

<u>Count</u>	<u>Binary</u>	<u>Scan</u>	<u>Display</u>
0	0000	C	blank
1-7	0xxx	1-7	characters
8	1000	X	cursor
9	1001	A	blank
10	1010	B	blank

## LINE COUNTER

This counter consists of a divide-by-12 counter and a divide by 2 stage. The outputs are vertical sync for the TV monitor at 60 Hz, a blanking signal during vertical retrace and a counter reset signal used on the counter board.

## BLINK RATE

The 60 Hz is divided by 16 to provide a cursor blink rate of about 4 Hz. This divided by 2 to provide the character blink rate for use in the blink sequences.

## PAGE MEMORY CLOCK GENERATOR

A 2 MHz (approx.) rate is generated by dividing the oscillator frequency by 4. This is the Page Memory Clock rate except during Scan A. The rate then becomes the Line Memory Clock rate or approximately 1 MHz. Stopping of the Page Memory clock for display and for I/O operations is controlled by the circuits on this board. Also included is a timer which prevents the Page Memory clock from being stopped long enough to lose data in the MOS dynamic shift register.

**LINE MEMORY & CHARACTER GENERATOR - Board 2. See Functional Diagram, Figure 15.**

**LINE MEMORY**

This section consists of seven MOS 50 bit dynamic shift registers operated in a bit parallel, character-serial mode. Also included are input/recirculate gates, output gates, voltage level converters, clock generator and driver circuits and load control circuits. The Line Memory stores one line of characters (50) while it is being displayed and is also used as a buffer memory during insert and delete edit functions.

During refresh the Line Memory is loaded with a line of characters from the Page Memory during each Scan A. These are then recirculated during the next 10 scans and displayed during scans 1 thru 7. The cursor code (NUL, all "0's"), is forced into the Line Memory when the Cursor Compare and Cursor Blink Rate signals are both present. The result is an alternating cursor symbol and displayed character at a 4 Hz rate.

During editing the Line Memory is operated at the Page Memory rate so that data can be transferred between the memories. Two discrete component circuits generate phase 1 and phase 2 clock pulses from the leading and trailing edges respectively of the input clock signal.

**CHARACTER GENERATOR**

The Character Generator circuits convert the ASCII code stored in the Line Memory to the 5 X 7 dot matrix pattern for display on the CRT. The standard 64 ASCII displayable symbols (upper case alpha, numbers and punctuation marks), hex codes 20 thru 5F, are converted by a MOS Read Only Memory. This ROM has nine address inputs. Six of these are the ASCII code coming from the Line Memory, less bit 7, and the remaining three addresses are the three low order bits of the Scan Counter. The ROM is inhibited if bits 6 and 7 or the incoming code are alike, or if the Scan Counter is not on a displayable scan. The five outputs are the dot patterns for that ASCII character in that Scan. This data is loaded in parallel into a five bit register and shifted serially at the basic oscillator frequency to form the video signal for the monitor.

The special symbols for STX, ETX, Carriage Return, Substitute and the Cursor are generated by TTL circuits. This data is serialized in another five bit register to compensate for the time delay normally taken thru the ROM.

The video is gated off during editing functions to prevent meaningless display on the CRT when the Line Memory is not being used for refresh.

NTSC composite video & sync is provided on a BNC connector (VIDEO OUT) on the rear panel for driving remote TV monitors.

**PAGE MEMORY - Board 3. See Functional Diagram, Figure 16.**

#### **PAGE MEMORY**

The Page Memory consists of seven 1024 bit MOS serial shift registers connected bit-parallel, character-serial, along with input/recirculate gates, an output register and clock drivers. The switching of the input gates is controlled by the interface via the control board.

Each 1024 bit shift register is actually two 512 bit registers multiplexed. Thus each clock pulse, phase 1 or phase 2, results in a new character at the output and a new character loaded at the input. The clock rate is therefore divided by two and split into a 2 phase clock. Discrete circuit clock drivers provide the required voltage and power amplification. The output register provides properly timed outputs to the rest of the terminal logic. This register adds one character to the memory making 1025 characters of storage.

#### **PROTECT & BLINK CONTROL**

A flip-flop in the protect circuit is set when a Start Protect (SPS Code - ASCII 79) is decoded at the page memory input. The cursor will automatically advance, UNLESS the keyboard is locked out, until and End Protect (EPS Code - ASCII 7A) is decoded causing the protect flip-flop to reset. Therefore, the field of data between the SPS and EPS positions can not be altered from the keyboard.



The system is prevented from "hanging-up" in the event a programming error results in protecting the entire page, i.e., SPS at Home and no EPS in the memory. Under this condition the cursor remains at Home and the Protect function is inhibited. At least one position must be unprotected.

Insert and delete editing functions are inhibited when there is a protect field in the memory.

A flip-flop in the blink circuit is set when the Start Blink (SBS Code - ASCII 7B) is decoded at the page memory input and the character blink signal is present in the high state. The Page Memory character codes are replaced by space codes in the Line Memory when the LM is loaded during Scan A. This causes the characters following the SBS code to blink on and off at a two Hz rate until an End Blink (EBS Code - ASCII 7C) is decoded causing the blink flip-flop to reset.

#### **CONTROL - Board 4. See Functional Diagram, Figure 17.**

All codes received by the terminal from the keyboard interface are sent from the I/O to the control board. The code is examined to determine whether it is a data or a function code. Data codes are loaded into the Page Memory at the present cursor address and the cursor is advanced one position. Function codes are decoded and the function is performed. Codes not recognized as data or a function for this terminal are "dumped".

#### **INPUT SECTION**

Bits 6 & 7 of the codes coming from the I/O are examined to determine if the code is data, columns 2 through 5 or a function, columns 0, 1, 6 & 7 of the ASCII Code Chart. The Load Register pulse from the I/O is then gated to set the Data flip-flop or Function flip-flop. If either flip-flop is set, the terminal is "busy" and no new data can be entered into the Data Bit Register in the interface. CR, SUB, STX and ETX, SPS, EPS, SBS, EBS, functions cause data to be forced into memory.

## **FUNCTION DECODER**

This decoder is enabled when the Function flip-flop is set. The input of a four bit to 1-of-16 decoder indicates which row, 0 thru F, the code is in and combined with column information, forms a discrete signal for each function. Refer to the ASCII code chart.

### **ERASE FUNCTIONS - (Clear Memory, Clear Screen, Erase to End of Line and Erase to End of Page)**

The CM function sends the cursor to the Home position where the erase begins. Format protect functions are inhibited so that the entire memory is erased. The Function flip-flop is cleared and the erase terminated by the End of Memory signal. The CS function sends the cursor to the Home position where the erase begins. Format protect functions are not inhibited so that only unprotected characters are erased. The Function flip-flop is cleared and the erase terminated by the End of Memory signal. The EEOL and EEOP functions begin the erase at the present cursor position. Format protect functions are not inhibited so that only unprotected characters are erased. The cursor remains in its position. The Function flip-flop is cleared and the erase terminated at the End of Line signal for EEOL and at the End of Memory signal for EEOP.

### **LOAD CURSOR ADDRESS FUNCTION**

When the LCA code is received a control flip-flop is set which steers the one's complement of the next code received to the horizontal section of the cursor counter. At that time, the first control is cleared and a second control is set. The one's complement of the next code goes to the vertical section of the cursor counter and the second control is cleared. When either control flip-flop is set, codes can not be interpreted as data or functions.

### **INSERT AND DELETE FUNCTIONS - (Insert Line, Insert Character, Delete Line Delete Character)**

If there is a protected field anywhere in the Page Memory, the Insert and Delete functions are inhibited. The function flip-flop is cleared immediately ending the function before it begins. The following descriptions assume no protected areas.

## INSERT AND DELETE LINE SEQUENCE

Insert and Delete Line functions follow a similar sequence. Both functions move the cursor to the beginning of the line by clearing the Cursor Horizontal Address Counter to zero. Then the Line Memory clock and video are disabled and two control flip-flops set.\* The first flip-flop activates a signal that forces space codes into the Page Memory and the second controls the gating of the Page Memory clock and output to the Line Memory. At the End of Line signal the first flip-flop is cleared. The combination of the first flip-flop cleared and the second flip-flop set, gates the Line Memory output to the Page Memory input. At this point, the Line Memory and Page Memory are in series and one line of spaces has been loaded into the Page Memory. The memories are clocked together until the function is terminated.\*\*

\*A Cursor Compare signal sets the two flip-flops for the Insert Line function while an End of Memory signal is used for the Delete Line function.

\*\*An End of Memory signal terminates the Insert Line function while a Cursor Compare signal is used for the Delete Line function.

## INSERT AND DELETE CHARACTER SEQUENCE

The Insert and Delete Character functions follow a similar sequence. For both functions the Line Memory clock and video are disabled and the Page Memory clock is gated to the Line Memory. The first complete (full line) Cursor Compare Vertical causes the Load Line Memory signal to go active. At the End of Line signal the data in the Line Memory is recirculated. At this point the two functions differ:

Insert Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input. The following Cursor Compare (both vertical and horizontal) loads the Page Memory with a space at the cursor position and inhibits the Line Memory Clock one character time losing the last character in the line.

Delete Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input and loads the Line Memory with a space at the end of the line. The following Cursor Compare (both vertical and horizontal) inhibits the Page Memory Clock one character time losing the deleted character.

Both functions are terminated by the next End of Line signal.

## **COUNTERS - Board 5. See Functional Diagram, Figure 18.**

This board contains 3 binary counters and 2 comparators. All counters are organized by column and line i.e., 50 counts horizontally and 20 counts vertically. A vertical count pulse is generated when the horizontal section rolls over from 49 to 0.

### **PAGE MEMORY COUNTER**

This is a count up only counter which is advanced one count each time the Page Memory is clocked. It therefore contains the address of the character currently being read and loaded into the Page Memory. Since the PM is 1025 characters long, a master reset pulse is generated at vertical count 20 and horizontal count 24 to reset both sections to 0.

### **DISPLAY COUNTER**

This is a count up only counter which is advanced 50 counts during each Scan A and is reset to 0 during vertical retrace. It therefore contains the address of the next character to be loaded into the Line Memory for display.

### **CURSOR COUNTER**

This is a count up, count down and directly presettable counter. It contains the address of the cursor position on the screen. Count down roll over from 0 to 49 horizontal and 0 to 19 vertical is provided by the borrow outputs which preset 49 into the horizontal counter and 19 into the vertical counter. Invalid addresses are detected and inhibit the Load Cursor Address function. An invalid address is "dumped", allowing the display to continue in sequence.

A "Bell" signal is generated when the horizontal section goes from count 43 to 44 or the vertical section goes from count 18 to 19. This signal is used to operate the keyboard bell.

### **COMPARATORS**

The Cursor Comparator indicates coincidence between the Page Memory Counter and the Cursor Counter for loading and reading the Page Memory and for displaying the cursor.

The Display Comparator indicates coincidence between the Page Memory Counter and the Display Counter for entering information into the Line Memory for subsequent display.

## PRINTED CIRCUIT BOARD FUNCTIONS

Model 425, 1920 Character Display, 80 characters per line X 24 lines

**TIMING GENERATOR – Board 1. See Functional Diagram, Figure 14.**

### BASIC OSCILLATOR\*

The oscillator frequency is determined as follows:

50 Hz	60 Hz	Refresh rate
<u>x 312</u>	<u>x 260</u>	No. of horizontal scan per frame
15.60 KHz	15.60 KHz	
<u>x 102</u>	<u>x 102</u>	No. of character times per scan
1.5912 MHz	1.5912 MHz	
<u>x 7</u>	<u>x 7</u>	No. of dot times per character
11.1384 MHz	11.1384 MHz	

### DOT COUNTER

The Dot Counter divides the oscillator frequency by seven. Dot counts 1 thru 5 are the displayed character and dots 6 and 7 are blanks. The count is octal 1 thru 7. Phase 1 and phase 2 clocks for the Character Generator ROM and clock for the Line Memory are generated from Dot Counter signals.

### CHARACTER COUNTER

The 1 MHz (approx.) character rate is divided by 102 by this 7 stage binary counter. Decoded outputs at count 12 and count 92 turn the Line Memory clock on and off providing 80 pulses during each scan. The other 22 counts are horizontal retrace time. Horizontal Sync for the TV monitor(s) begins at count 94.

\*60 Hz Standard, 50 Hz Optional. Text discusses 60 Hz Operation.

## SCAN COUNTER

This 4 stage decade counter is driven by the Horizontal Sync pulse at 15.6 KHz. Each scan counter cycle represents one line of displayed characters. The scans are labeled thus:

<u>Count</u>	<u>Binary</u>	<u>Scan</u>	<u>Display</u>
0	0000	B	blank
1-7	0xxx	1-7	characters
8	1000	X	cursor
9	1001	A	blank

## LINE COUNTER

This counter consists of a divide-by-16 counter and a divide by 2 stage. The outputs are vertical sync for the TV monitor at 60 Hz, a blanking signal during vertical retrace and a counter reset signal used on the counter board. It is reset to 0 at the end of count 25.

## BLINK RATE

The 60 Hz is divided by 16 to provide a cursor blink rate of about 4 Hz. This is divided by 2 to provide the character blink rate used in the character blink sequences.

## PAGE MEMORY CLOCK GENERATOR

A 4 MHz (approx.) rate is generated by dividing the oscillator frequency by 3. This is the Page Memory Clock rate except during Scan A. The rate then becomes the Line Memory Clock rate of approx. 1.6 MHz. Stopping of the Page Memory Clock for display and for I/O operations is controlled by the circuits on this board along with a timer which prevents the Page Memory Clock from being stopped long enough to lose data in the MOS dynamic shift register.

**LINE MEMORY & CHARACTER GENERATOR - Board 2. See Functional Diagram Figure 15.**

**LINE MEMORY**

This section consists of seven MOS 80 bit dynamic shift registers operated in a bit-parallel, character-serial mode. Also included are input/recirculate gates, output gates, voltage level converters, clock generator and driver circuits and load control circuits. The Line Memory stores one line of characters (80) while it is being displayed and is also used as a buffer memory during insert and delete edit functions.

During refresh the Line Memory is loaded with a line of characters from the Page Memory during each Scan A. These are then recirculated during the next 9 scans and displayed during scans 1 thru 7. The cursor code (NUL, all "O's"), is forced into the Line Memory when the Cursor Compare and Cursor Blink Rate signals are both present. The result is an alternating cursor symbol and displayed character at a 4 Hz rate.

During editing the Line Memory is operated at the Page Memory rate so that data can be transferred between the memories. Two discrete component circuits generate phase 1 and phase 2 clock pulses from the leading and trailing edges respectively of the input clock signal.

**CHARACTER GENERATOR**

The Character Generator circuits convert the ASCII code stored in the Line Memory to the 5 x 7 dot matrix pattern for display on the CRT. The standard 64 ASCII displayable symbols (upper case alpha, numbers and punctuation marks), hex codes 20 thru 5F, are converted by a MOS Read Only Memory. This ROM has 9 address inputs. Six of these are the ASCII code coming from the Line Memory, less bit 7, and the remaining three addresses are the three low order bits of the Scan Counter. The ROM is inhibited if bits 6 and 7 or the incoming code are alike, or if the Scan Counter is not on a displayable scan. The five outputs are the dot patterns for that ASCII character in that Scan. This data is loaded in parallel into a 5-bit register and shifted serially at the basic oscillator frequency to form the video signal for the monitor.

The special symbols for STX, ETX, Carriage Return, Substitute and the Cursor are generated by TTL circuits. This data is serialized in another five bit register to compensate for the time delay normally taken thru the ROM.

The video is gated off during editing functions to prevent meaningless display on the CRT when the Line Memory is not being used for refresh.

NTSC composite video and sync is provided on a BNC connector (VIDEO OUT) on the rear panel for driving remote TV monitors.

A switch selectable option allows either normal white-on-black or inverted black-on-white display.

#### **PAGE MEMORY - Board 3. See Functional Diagram, Figure 16.**

#### **PAGE MEMORY**

The Page Memory consists of fourteen 1024 bit MOS serial shift registers connected as seven 2048 bit registers in parallel (operating in bit-parallel, character-serial mode) along with input/recirculate gates, input and output registers and clock drivers. The switching of the input gates is controlled by the interface via the control board.

Each 1024 bit shift register is actually two 512 bit registers multiplexed. Thus each clock pulse, phase 1 or phase 2, results in a new character at the output and a new character loaded at the input. The clock rate is therefore divided by two and split into a 2 phase clock. Discrete circuit clock drivers provide the required voltage and power amplification. The output register provides properly timed outputs to the rest of the terminal logic. This register adds one character to the memory making 2049 characters of storage.



## PROTECT & BLINK

A flip-flop in the protect circuit is set when a Start Protect (SPS Code - ASCII 79) is decoded at the page memory input. The cursor will automatically advance, UNLESS the keyboard is locked out, until the End Protect (EPS Code - ASCII 7A) is decoded causing the protect flip-flop to reset. Therefore, the field of data between the SPS and EPS positions can not be altered from the keyboard.

The system is prevented from "hanging-up" in the event a programming error results in protecting the entire page, i.e., SPS at Home and no EPS in the memory. Under this condition the cursor remains at Home and the Protect function is inhibited. At least one position must be unprotected.

Insert and delete editing functions are inhibited when there is a protected field in the memory.

A flip-flop in the blink circuit is set when the Start Blink (SBS Code - ASCII 7B) is decoded at the page memory input and the character blink signal is present in the high state. The Page Memory character codes are replaced by space codes in the Line Memory when the LM is loaded during Scan A. This caused the characters following the SBS code to blink on and off at a two Hz rate until an End Blink (EBS Code - ASCII 7C) is decoded causing the blink flip-flop to reset.

## CONTROL - Board 4. See Functional Diagram, Figure 17.

All codes received by the terminal from the keyboard interface are sent from the I/O to the control board. The code is examined to determine whether it is data or a function code. Data codes are loaded into the Page Memory at the present cursor address and the cursor is advanced one position. Function codes are decoded and the function is performed. Codes not recognized as data or a function for this terminal are "dumped".

## **INPUT SECTION**

Bits 6 & 7 of the codes coming from the I/O are examined to determine if the code is data, columns 2 through 5 or a function, columns 0, 1, 6 & 7 of the ASCII Code Chart. The Load Register pulse from the I/O is then gated to set the Data flip-flop or Function flip-flop. If either flip-flop is set, the terminal is "busy" and no new data can be entered into the Data Bit Register in the interface. CR, SUB, STX and ETX, & SPS, EPS, SBS, EBS, functions cause data to be forced into memory.

## **FUNCTION DECODER**

This decoder is enabled when the Function flip-flop is set. The input of a four bit to 1-of-16 decoder indicates which row, 0 thru F, the code is in and combined with column information, forms a discrete signal for each function. Refer to the ASCII code chart.

## **ERASE FUNCTIONS - (Clear Memory, Clear Screen, Erase to End of Line and Erase to End of Page)**

The CM function sends the cursor to the Home position where the erase begins. Format protect functions are inhibited so that the entire memory is erased. The function flip-flop is cleared and the erase terminated by the End of Memory signal. The CS function sends the cursor to the Home position where the erase begins. Format protect functions are not inhibited so that only unprotected characters are erased. The Function flip-flop is cleared and the erase terminated by the End of Memory signal. The EEOL and EEOP functions begin the erase at the present cursor position. Format protect functions are not inhibited so that only unprotected characters are erased. The cursor remains in its position. The Function flip-flop is cleared and the erase terminated at the End of Line signal for EEOL and at the End of Memory signal for EEOP.

## **LOAD CURSOR ADDRESS FUNCTION**

When the LCA code is received a control flip-flop is set which steers the one's complement of the next code received to the horizontal section of

the cursor counter. At that time, the first control is cleared and a second control is set. The one's complement of the next code goes to the vertical section of cursor counter and the second control is cleared. When either control flip-flop is set, codes received can not be interpreted as data or functions.

#### **INSERT AND DELETE FUNCTIONS -- (Insert Line, Insert Character, Delete Line, Delete Character)**

If there is a protected field anywhere in the Page Memory, the Insert and Delete functions are inhibited. The function flip-flop is cleared immediately ending the function before it begins. The following descriptions assume no protected areas.

#### **INSERT AND DELETE LINE SEQUENCE**

Insert and Delete Line functions follow a similar sequence. Both functions move the cursor to the beginning of the line by clearing the Cursor Horizontal Address Counter to zero. Then the Line Memory clock and video are disabled and two control flip-flops set.\* The first flip-flop activates a signal that forces space codes into the Page Memory and the second controls the gating of the Page Memory clock and output to the Line Memory. At the End of Line signal the first flip-flop is cleared. The combination of the first flip-flop cleared and the second flip-flop set, gates the Line Memory output to the Page Memory input. At this point, the Line Memory and Page Memory are in series and one line of spaces has been loaded into the Page Memory. The memories are clocked together until the function is terminated.\*\*

\* A Cursor Compare signal sets the two flip-flops for the Insert Line function while an End of Memory signal is used for the Delete Line functions.

\*\*An End of Memory signal terminates the Insert Line function while a Cursor Compare signal is used for the Delete Line function.

## **INSERT AND DELETE CHARACTER SEQUENCE**

The Insert and Delete Character functions follow a similar sequence. For both functions the Line Memory clock and video are disabled and the Page Memory clock is gated to the Line Memory. The first complete (full line) Cursor Compare Vertical causes the Load Line Memory signal to go active. At the End of Line signal the data in the Line Memory is recirculated. At This point the two functions differ:

Insert Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input. The following Cursor Compare (both vertical and horizontal) loads the Page Memory with a space at the cursor position and inhibits the Line Memory Clock one character time losing the last character in the line.

Delete Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input and loads the Line Memory with a space at the end of the line. The following Cursor Compare (both vertical and horizontal) inhibits the Page Memory Clock one character time losing the deleted character.

Both functions are terminated by the next End of Line signal.

**COUNTER - Board 5. See Functional Diagram, Figure 18.**

This board contains 3 binary counters and 2 comparators. All counters are organized by column and line i.e., 80 counts horizontally and 24 counts vertically. A vertical count pulse is generated when the horizontal section rolls over from 79 to 0.

## **PAGE MEMORY COUNTER**

This is a count up only counter which is advanced one count each time the Page Memory is clocked. It therefore contains the address of the character currently being read and loaded into the Page Memory. Since the PM is

2049 characters long, a master reset pulse is generated at vertical count 25 and horizontal count 48 to reset both sections to 0.

### **DISPLAY COUNTER**

This is a count up only counter which is advanced 80 counts during each Scan A and is reset to 0 during vertical retrace. It therefore contains the address of the next character to be loaded into the Line Memory for display.

### **CURSOR COUNTER**

This is a count up, count down and directly presettable counter. It contains the address of the cursor position on the screen. Count down roll over from 0 to 79 horizontal and 0 to 23 vertical is provided by the borrow outputs which preset 79 into the horizontal counter and 23 into the vertical counter. Invalid addresses are detected and inhibit the Load Cursor Address function. An invalid address is "dumped" allowing the display to continue in sequence.

A "Bell" signal is generated when the Horizontal section goes from 68 to 69 or the Vertical section goes from 22 to 23. This signal goes to the interface to operate the keyboard bell.

### **COMPARATORS**

The cursor comparator indicates coincidence between the Page Memory Counter and the Cursor Counter for loading and reading the page memory and for displaying the cursor.

The Display comparator indicates coincidence between the Page Memory Counter and Display Counter for entering information into the Line Memory for subsequent display.

## PRINTED CIRCUIT BOARD FUNCTIONS

Model 426, 960 Character Display, 40 characters per line x 24 lines.

**TIMING GENERATOR – Board 1. See Functional Diagram, Figure 14.**

### BASIC OSCILLATOR\*

The oscillator frequency is determined as follows:

50 Hz	60 Hz	Refresh rate
<u>x 312</u>	<u>x 260</u>	No. of horizontal scans per frame
15.60 KHz	15.60 KHz	
<u>x 54</u>	<u>x 54</u>	No. of character times per scan
842.4 KHz	842.4 KHz	
<u>x 7</u>	<u>x 7</u>	No. of dot times per character
5.8968 MHz	5.8968 MHz	

### DOT COUNTER

The Dot Counter divides the oscillator frequency by seven. Dot counts 1 thru 5 are the displayed character and dots 6 and 7 are blanks. The count is octal 1 thru 7. Phase 1 and phase 2 clocks for the Character Generator ROM and clock for the Line Memory are generated from Dot Counter signals.

### CHARACTER COUNTER

The 1 MHz (approx.) character rate is divided by 54 by this 6 stage binary counter. Decoded outputs at count 6 and count 45 turn the Line Memory clock on and off providing 40 pulses during each scan. The other 14 counts are horizontal retrace time. Horizontal Sync for the TV monitor(s) begins at count 50.

\*60 Hz Standard, 50 Hz Optional. Text discusses 60 Hz Operation.

## SCAN COUNTER

This 4 stage decade counter is driven by the Horizontal Sync pulse at 15.6 KHz. Each scan counter cycle represents one line of displayed characters. The scans are labeled thus:

<u>Count</u>	<u>Binary</u>	<u>Scan</u>	<u>Display</u>
0	0000	B	blank
1-7	0xxx	1-7	characters
8	1000	X	cursor
9	1001	A	blank

## LINE COUNTER

This counter consists of a divide-by-16 counter and a divide by 2 stage. The outputs are vertical sync for the TV monitor at 60 Hz, a blanking signal during vertical retrace and a counter reset signal used on the counter board. It is reset to 0 at end of count 25.

## BLINK RATE

The 60 Hz is divided by 16 to provide a cursor blink rate of about 4 Hz. This is divided by 2 to provide the character blink rate, used in the character blink sequence.

## PAGE MEMORY CLOCK GENERATOR

A 2 MHz (approx.) rate is generated by dividing the oscillator frequency by 3. This is the Page Memory Clock rate except during Scan A. The rate then becomes the Line Memory Clock rate of approximately .8 MHz. Stopping of the Page Memory clock for display and for I/O operations is controlled by the circuits on this board along with a timer which prevents the Page Memory clock from being stopped long enough to lose data in the MOS dynamic shift register.

**LINE MEMORY & CHARACTER GENERATOR – Board 2. See Functional Diagram  
Figure 15.**

**LINE MEMORY**

This section consists of seven MOS 40 bit dynamic shift registers operated in bit-parallel, character-serial mode. Also included are input/recirculate gates, output gates, voltage level converters, clock generator and driver circuits and load control circuits. The Line Memory stores one line of characters (40) while it is being displayed and is also used as a buffer memory during insert and delete edit functions.

During refresh the Line Memory is loaded with a line of characters from the Page Memory during each Scan A. These are then recirculated during the next 9 scans and displayed during scans 1 thru 7. The cursor code (NUL, all "O's"), is forced into the Line Memory when the Cursor Compare and Cursor Blink Rate signals are both present. The result is an alternating cursor symbol and displayed character at a 4 Hz rate.

During editing the Line Memory is operated at the Page Memory rate so that data can be transferred between the memories. Two discrete component circuits generate phase 1 and phase 2 clock pulses from the leading and trailing edges respectively of the input clock signal.

**CHARACTER GENERATOR**

The Character Generator circuits convert the ASCII code stored in the Line Memory to the 5 x 7 dot matrix pattern for display on the CRT. The standard 64 ASCII displayable symbols (upper case alpha, numbers and punctuation marks), hex codes 20 thru 5F, are converted by an MOS Read Only Memory. This ROM has 9 address inputs. Six of these are the ASCII code coming from the Line Memory, less bit 7, and the remaining three addresses are the three low order bits of the Scan Counter. The ROM is inhibited if bits 6 and 7 of the incoming code are alike, or if the scan counter is not on a displayable scan. The five outputs are the dot patterns for that ASCII character in that Scan. This data is loaded in parallel into a 5 bit register and shifted serially at the basic oscillator frequency to form the video signal for the monitor.



The special symbols for STX, ETX, Carriage Return, Substitute and the Cursor are generated by TTL circuits. This data is serialized in another 5 bit register to compensate for the time delay normally taken thru the ROM.

The video is gated off during editing functions to prevent meaningless display on the CRT when the Line Memory is not being used for refresh.

NTSC composite video & sync is provided at a BNC connector (VIDEO OUT) on the rear panel for driving remote TV monitors.

**PAGE MEMORY – Board 3. See Functional Diagram, Figure 16.**

#### **PAGE MEMORY**

The Page Memory consists of seven MOS 1024 bit serial shift registers connected bit-parallel, character-serial, along with input/recirculate gates, an output register and clock drivers. The switching of the input gates is controlled by the interface via the control board.

Each 1024 bit register is actually two 512 bit registers multiplexed. Thus each clock pulse, phase 1 or phase 2, results in a new character at the output and a new character loaded at the input. The clock rate is therefore divided by two and split into a 2 phase clock. Discrete circuit clock drivers provide the required voltage and power amplification. The output register provides properly timed outputs to the rest of the terminal logic. This register adds one character to the memory making 1025 characters of storage.

#### **PROTECT & BLINK CONTROL**

A flip-flop in the protect circuit is set when a Start Protect (SPS Code - ASCII 79) is decoded at the page memory input. The cursor will automatically advance, UNLESS the keyboard is locked out, until an End Protect (EPS Code - ASCII 7A) is decoded causing the protect flip-flop to reset. Therefore, the field of data between the SPS and EPS positions can not be altered from the keyboard.

The system is prevented from "hanging-up" in the event a programming error results in protecting the entire page, i.e., SPS at Home and no EPS in the memory. Under this condition, the cursor remains at Home and the Protect function is inhibited. At least one position must be unprotected.

Insert and delete editing functions are inhibited when there is a protected field in the memory.

A flip-flop in the blink circuit is set when the Start Blink (SBS Code - ASCII 7B) is decoded at the page memory input and the character blink signal is present in the high state. The Page Memory character codes are replaced by space codes in the Line Memory when the LM is loaded during Scan A. This caused the characters following the SBS code to blink on and off at a two Hz rate until an End Blink (EBS Code - ASCII 7C) is decoded causing the blink flip-flop to reset.

#### **CONTROL – Board 4. See Functional Diagram, Figure 17.**

All codes received by the terminal from the keyboard interface are sent from the I/O to the control board. The code is examined to determine whether it is data or a function code. Data codes are loaded into the Page Memory at the present cursor address and the cursor is advanced on position. Function codes are decoded and the function is performed. Codes not recognized as data or a function for this terminal are "dumped"

#### **INPUT SECTION**

Bits 6 & 7 of the codes coming from the I/O are examined to determine if the code is data, columns 2 through 5 or a function, columns 0, 1, 6 & 7 of the ASCII Code Chart. The Load Register pulse from the I/O is gated to set the Data flip-flop or Function flip-flop. If either flip-flop is set, the terminal is "busy" and no new data can be entered into the Data Bit Register in the interface. CR, SUB, STX and ETX functions cause data to be forced into memory.

## **FUNCTION DECODER**

This decoder is enabled when the Function flip-flop is set. The input of a four bit to 1-of-16 decoder indicates which row, 0 thru F, the code is in and combined with column information, forms a discrete signal for each function. Refer to the ASCII code chart.

## **ERASE FUNCTIONS - (Clear Memory, Clear Screen, Erase to End of Line and Erase to End of Page)**

The CM function sends the cursor to the Home position where the erase begins. Format protect functions are inhibited so that the entire memory is erased. The Function flip-flop is cleared and the erase terminated by the End of Memory signal. The CS function sends the cursor to the Home position where the erase begins. Format protect functions are not inhibited so that only unprotected characters are erased. The Function flip-flop is cleared and the erase terminated by the End of Memory signal. The EEOL and EEOP functions begin the erase at the present cursor position. Format protect functions are not inhibited so that only unprotected characters are erased. The cursor remains in its position. The Function flip-flop is cleared and the erase terminated at the End of Line signal for EEOL and at the End of Memory signal for EEOP.

## **LOAD CURSOR ADDRESS FUNCTION**

When the LCA code is received a control flip-flop is set which steers the one's complements of the next code received to the horizontal section of the cursor counter. At that time, the first control is cleared and a second control is set. The one's complement of the next code goes to the vertical section of the cursor counter and the second control is cleared. When either control flip-flop is set, codes received can not be interpreted as data or functions.

## **INSERT AND DELETE FUNCTIONS - - (Insert Line, Insert Character, Delete Line Delete Character)**

If there is a protected field anywhere in the Page Memory, the Insert and Delete functions are inhibited. The Function flip-flop is cleared immediately ending the function before it begins. The following descriptions assume no protected areas.

## INSERT AND DELETE LINE SEQUENCE

Insert and Delete Line functions follow a similar sequence. Both functions move the cursor to the beginning of the line by clearing the Cursor Horizontal Address Counter to zero. Then the Line Memory clock and video are disabled and two control flip-flops set.\* The first flip-flop activates a signal that forces space codes into the Page Memory and the second controls the gating of the Page Memory clock and output to the Line Memory. At the End of Line signal the first flip-flop is cleared. The combination of the first flip-flop cleared and the second flip-flop set, gates the Line Memory output to the Page Memory input. At this point, the Line Memory and Page Memory are in series and one line of space has been loaded into the Page Memory. The memories are clocked together until the function is terminated.\*\*

\* A Cursor Compare signal sets the two flip-flops for the Insert Line functions while an End of Memory signal is used for the Delete Line function.

\*\* An End of Memory signal terminates the Insert Line Functions while a Cursor Compare signal is used for the Delete Line function.

## INSERT AND DELETE CHARACTER SEQUENCE

The Insert and Delete Character functions follow a similar sequence. For both functions the Line Memory clock and video are disabled and the Page Memory clock is gated to the Line Memory. The first complete (full line) Cursor Compare Vertical causes the Load Line Memory signal to go active. At the End of Line signal the data in the Line Memory is recirculated. At this point the two functions differ:

Insert Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input. The following Cursor Compare (both vertical and horizontal) loads the Page Memory with a space at the cursor position and inhibits the Line Memory Clock one character time losing the last character in the line.

Delete Character - The next Cursor Compare Vertical causes the Line Memory output to become Page Memory input and loads the Line Memory with a space at the end of the line. The following Cursor Compare (both vertical and horizontal) inhibits the Page Memory Clock one character time losing the deleted character.

Both functions are terminated by the next End of Line signal.

## **COUNTERS – Board 5. See Functional Diagram, Figure 18.**

This board contains 3 binary counters and 2 comparators. All counters are organized by column and line i.e., 40 counts horizontally and 24 counts vertically. A vertical count pulse is generated when the horizontal section rolls over from 39 to 0.

### **PAGE MEMORY COUNTER**

This is a count up only counter which is advanced one count each time the Page Memory is clocked. It therefore contains the address of the character currently being read and loaded into the Page Memory. Since the PM is 1025 characters long a master reset pulse is generated at vertical count 25 and horizontal count 24 to reset both sections to 0 (Line "24" is completely blank.)

### **DISPLAY COUNTER**

This is a count up only counter which is advanced 40 counts during each Scan A and is reset to 0 during vertical retrace. It therefore contains the address of the next character to be loaded into the Line Memory for display.

### **CURSOR COUNTER**

This is a count up, count down and directly presettable counter. It contains the address of the cursor position on the screen. Count down roll over from 0 to 39 horizontal and 0 to 23 vertical is provided by the borrow outputs which preset 39 into the horizontal counter and 23 into the vertical counter. Invalid addresses are detected and inhibit the Load Cursor Address function. A invalid address is "dumped" allowing the display to continue in sequence.

A "Bell" signal is generated when the Horizontal section goes from 29 to 30 or the Vertical section goes from 22 to 23. This signal goes to the interface to operate the keyboard bell.

### **COMPARATORS**

The Cursor Comparator indicates coincidence between the Page Memory Counter and the Cursor Counter for loading and reading the page memory and for displaying the cursor.

The Display comparator indicates coincidence between the Page Memory Counter and Display Counter for entering information into the Line Memory for subsequent display.

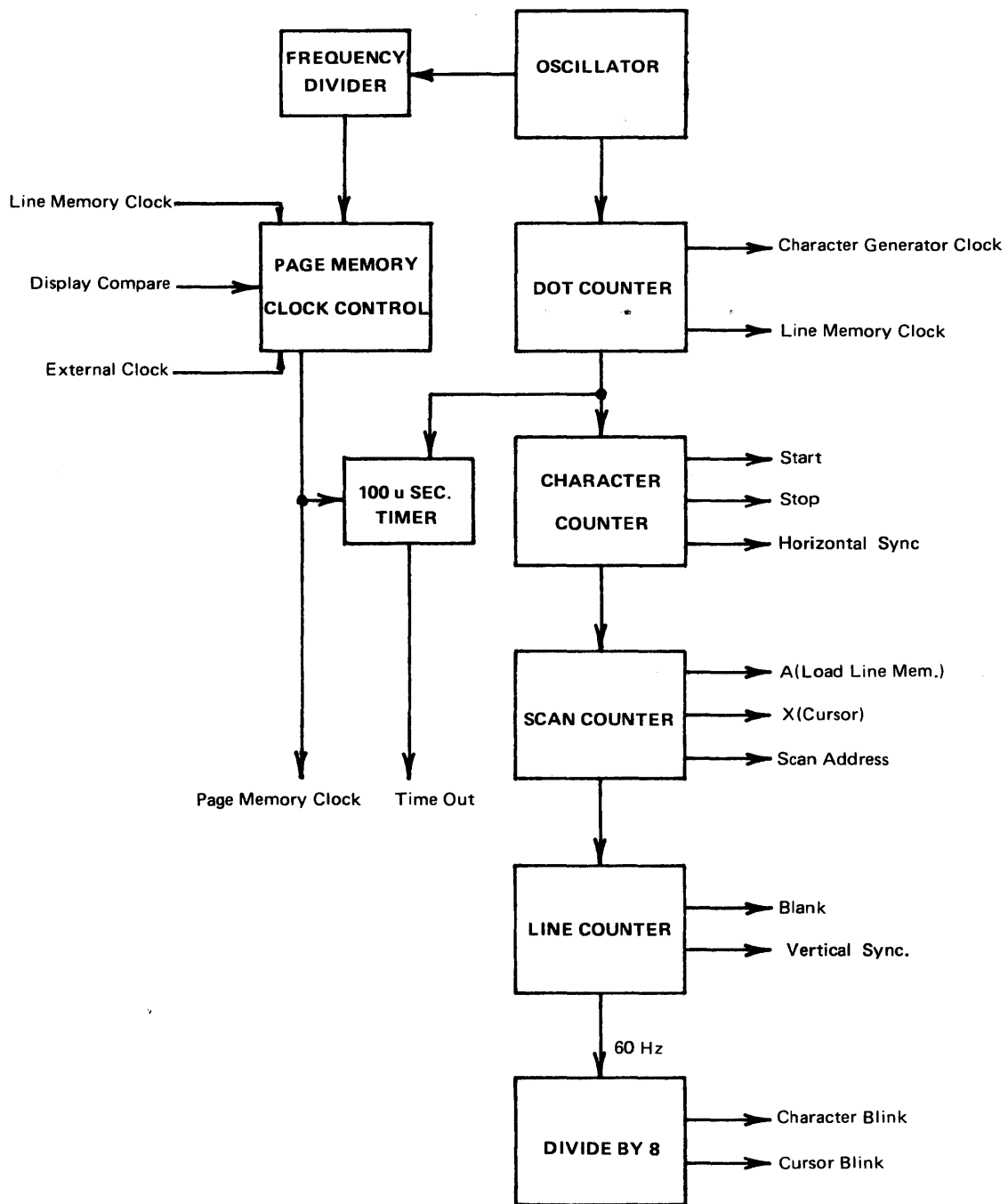
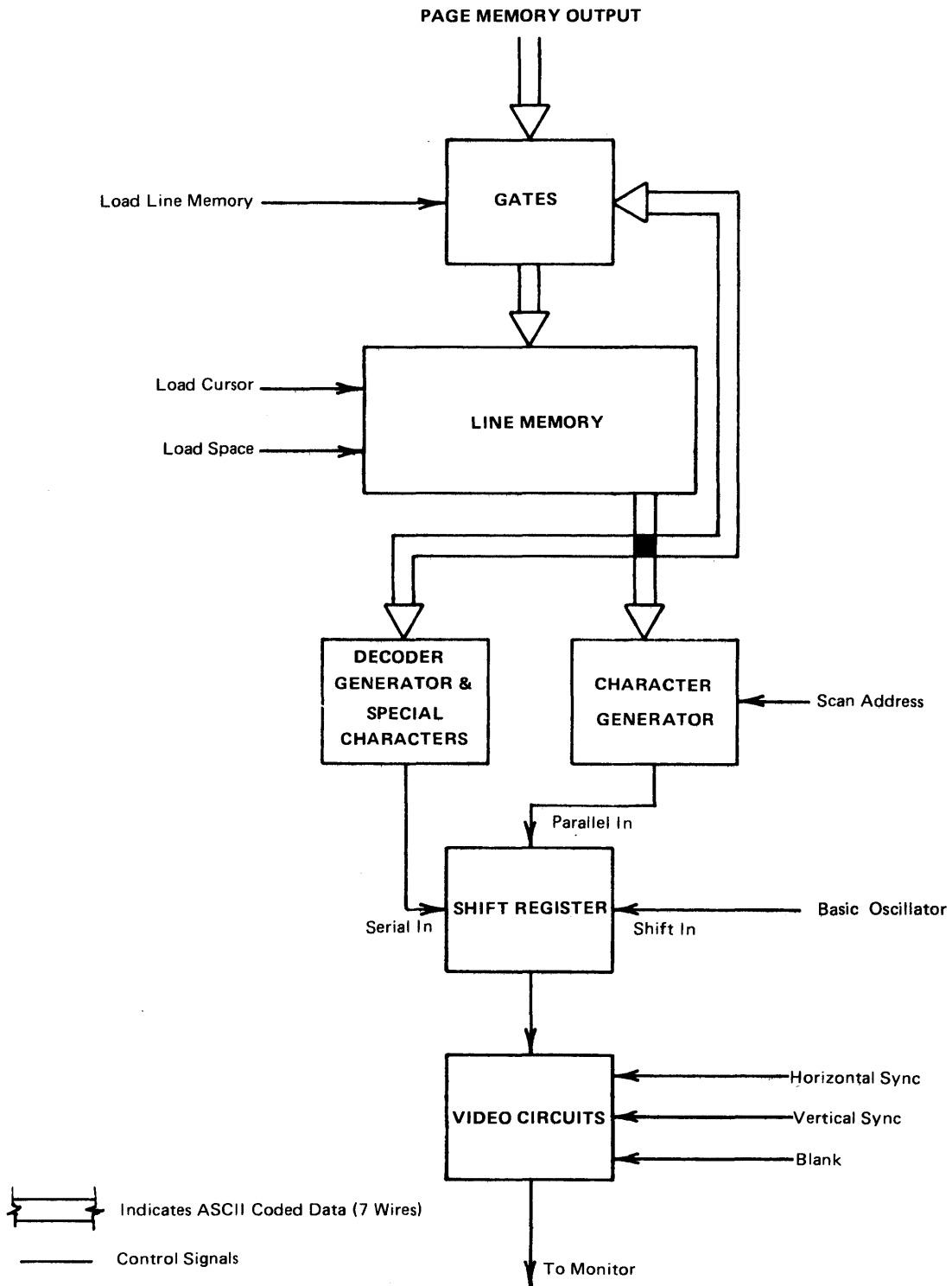


FIGURE 14. FUNCTIONAL DIAGRAM - TIMING GENERATOR PCB



**FIGURE 15. FUNCTIONAL DIAGRAM - LINE MEMORY AND CHARACTER GENERATOR PCB**

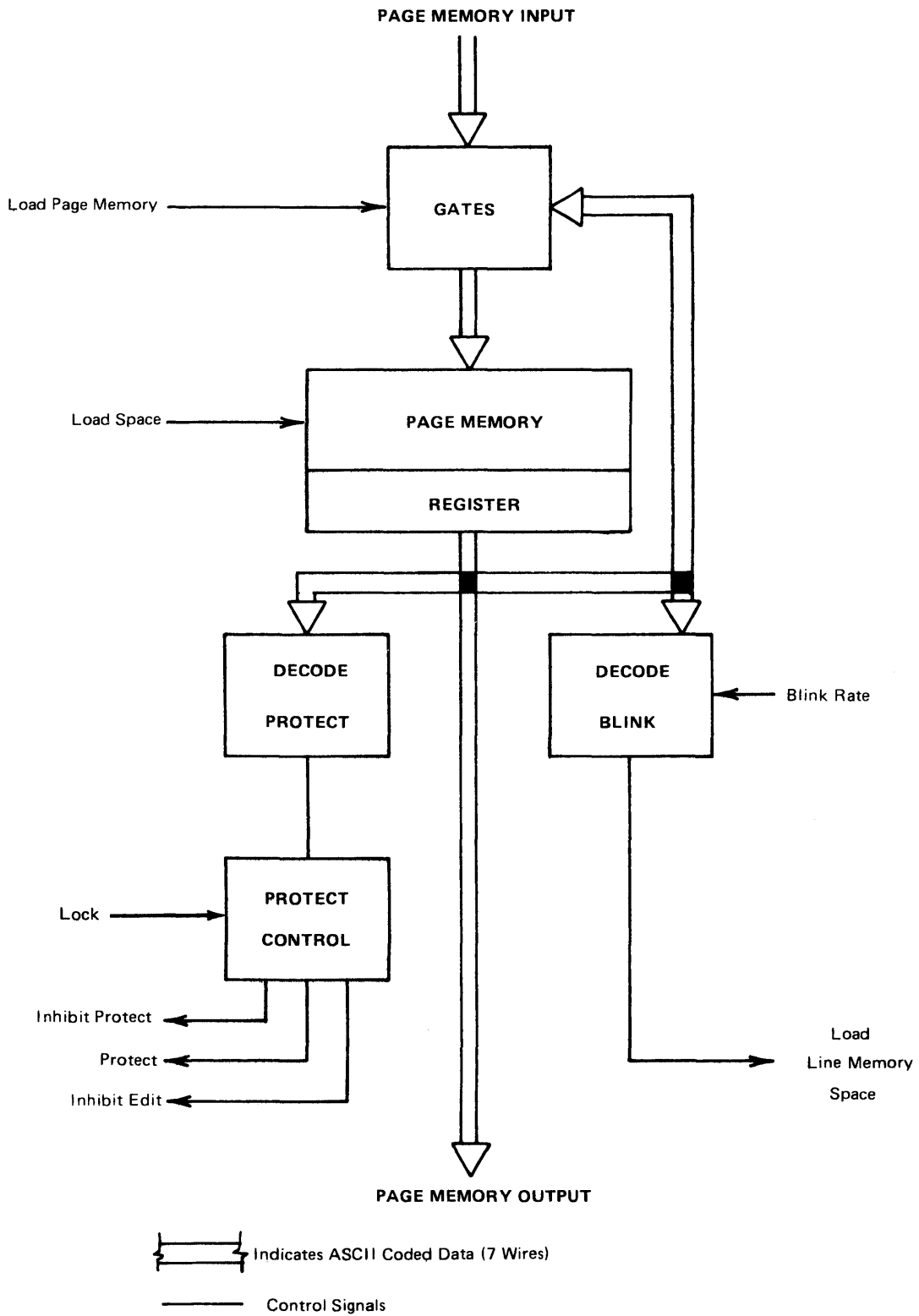


FIGURE 16. FUNCTIONAL DIAGRAM - PAGE MEMORY PCB



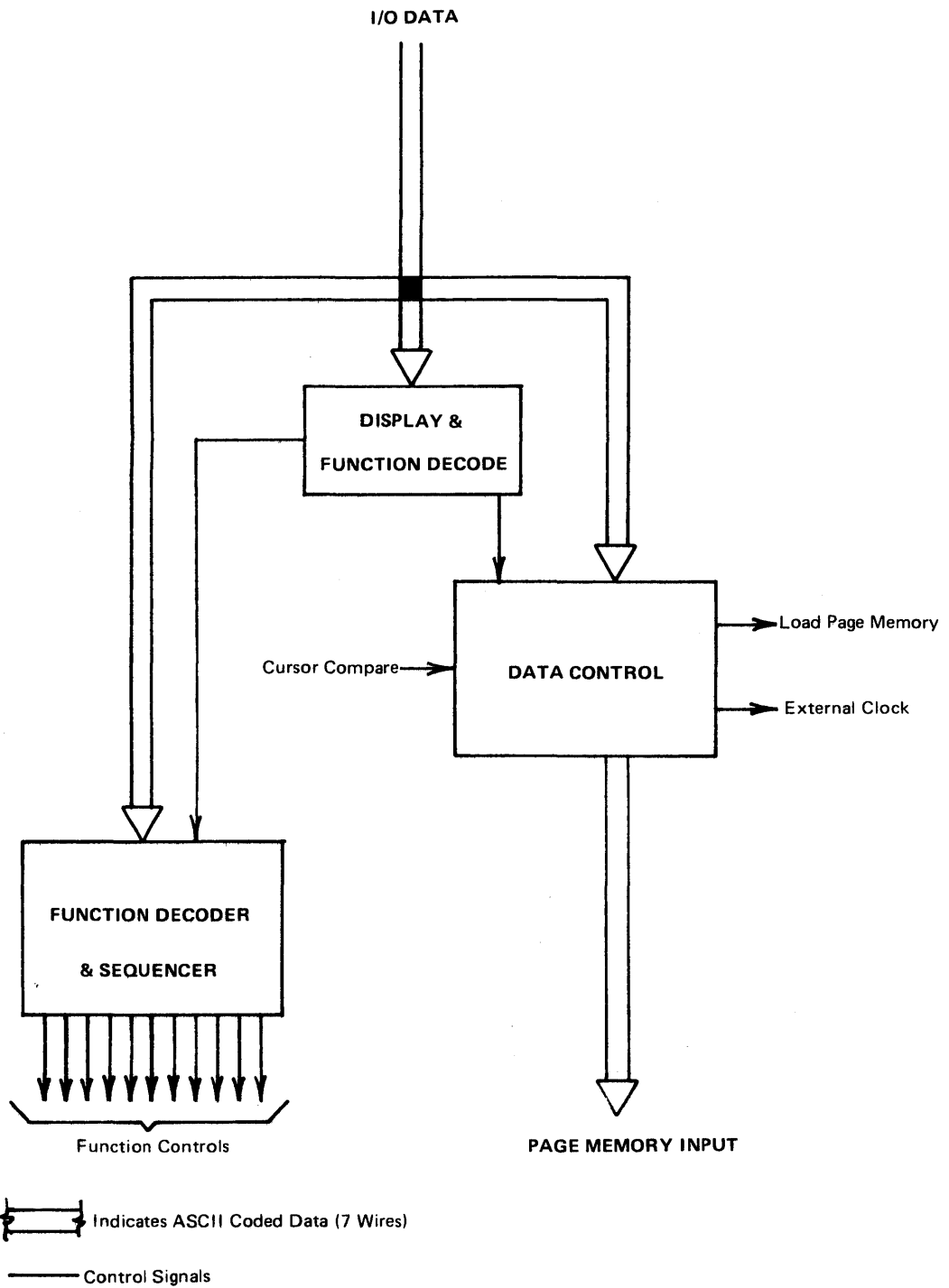
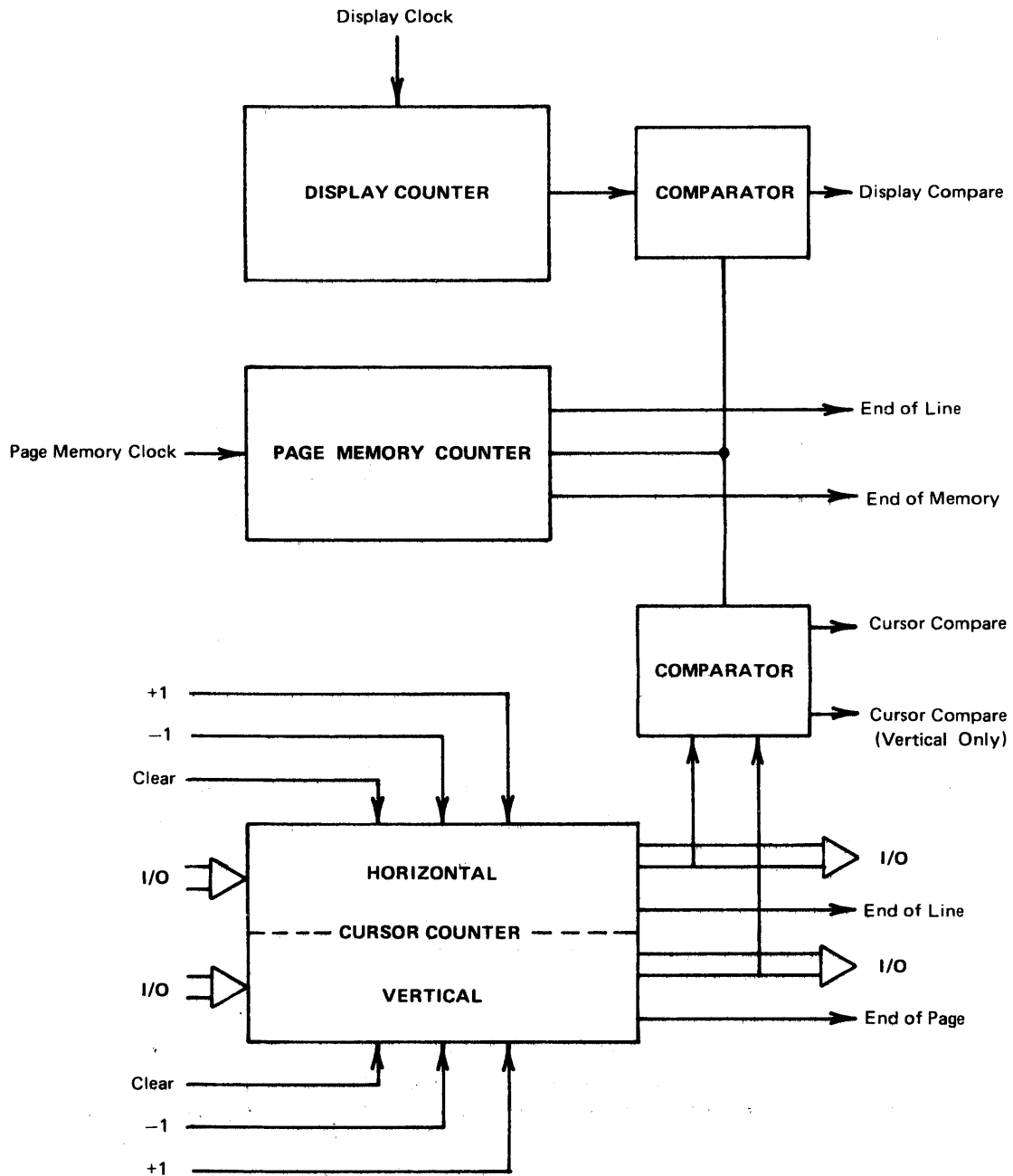


FIGURE 17. FUNCTIONAL DIAGRAM - CONTROL PCB



Indicates ASCII Coded Data (7 Wires)  
 Control Signals

FIGURE 18. FUNCTIONAL DIAGRAM - COUNTER PCB

**PARALLEL I/O ADAPTOR – Board 6. See Functional Diagram, Figure 23.**

The function of the Parallel I/O Adaptor is to control the transfer of data between the terminal's memory and an external device. It can receive and send data at random times with respect to the terminal's internal clock by means of "ready" and "acknowledge" controls. The keyboard connects directly to the Parallel I/O board but connections to the external device are through the Message Oriented Serial I/O Adaptor. See FIGURE 22.

When used with the Message Oriented Serial I/O Adaptor (DSA INTFC) in Models 420, 425 & 426, the Parallel I/O Adaptor is considered part of the basic terminal.

The logic on the Parallel I/O board falls into three sections: Output section, Function section and Input section. NOTE: "Input" and "Output" refer to the external device so that Output Data is to the terminal and Input data is from the terminal.

**OUTPUT SECTION – See Figures 19 & 20.**

The output section consists of two 7-bit registers and controls which prevent ambiguous data if codes are received simultaneously from the interface and the keyboard. The two registers, the Outer Buffer and the Data Register, allow the I/O to receive and store a code while the terminal is busy loading a code into memory or performing a function. The Output Data Request (ODR) is active whenever the last received code is in the Data Register, i.e. the Outer Buffer is empty. The terminal Busy condition inhibits transfer into the Data Register. Because of the slow speed manual operation, codes from the keyboard bypass the Outer Buffer and are loaded directly into the Data Register. Whenever a new code is transferred to the Data Register, a Load Register signal is sent to the Control board Input section.

## FUNCTION SECTION

The Function Decoder is enabled by the Function flip-flop on the Control board (FIGURE 17) and thus operates in parallel with the Function decoder on that board. The functions decoded on the Parallel I/O board include Lock, Release, Print, Page & Seg mode, X-mit (ETX code), Bell, the Read commands and the DATA-PANEL Display commands.

Lock and Release commands merely set and clear, respectively, a flip-flop as do the Seg Mode and Page Mode codes. The Print Command is sent to the Print Adaptor board (FIGURE 35). The Bell signal goes to the keyboard and the Clear DATA-PANEL command is sent to the DATA-PANEL. The Set DATA-PANEL command sets a flip-flop which causes the next Load Register signal to be sent to the DATA-PANEL as a strobe instead of to the Control board.

The ETX code is interpreted as a Transmit command if the Lock is not set. The command is stored until the ETX has been loaded into the Page Memory. Then the function is performed. If the terminal is in Page Mode, the Cursor counters are cleared, moving the cursor to Home. If the terminal is in Segment Mode, a search for STX is initiated. During the search, each Cursor Compare signal generates a CAH-1 (backspace) until an STX is detected at the Page Memory or the Cursor is at Home. After the cursor has been moved, the X-mit flip-flop is set sending the X-mit signal to the external device.

## INPUT SECTION — See Figure 21.

Read functions are controlled on the Parallel I/O board. The Read Fast or Read Slow code remains in the Data Register and the Function flip-flop on the Control board remains set during the entire Read operation. During a Read Slow or Read Fast, the Cursor Compare signal results in a Load Input Register (LdIR) pulse and sets the Input Register Full flip-flop. The LdIR pulse stores the code from the Page Memory in the Input Register. The IR Full controls the Input Data Ready (IDR) signal.

An Input Acknowledge (IA) signal will now turn off IDR, clear the IR Full flip-flop and move the cursor. If the IR does not contain a Carriage Return (CR) code, the cursor counter is advanced one count (CAH + 1). If the code is a CR, the horizontal section is cleared (Cir CAH) and the vertical section is advanced by one (CAV + 1). The next Cursor Compare signal re-starts the sequence. If the Read Fast command is used the Cursor Compare also sets the External Clock flip-flop which stops the Page Memory clock. This flip-flop is cleared immediately after the cursor is moved by the IA. If the cursor was moved only one position the Cursor Compare will be present after only one Page Memory clock pulse and will set the Ext Clock control again. The result is a new character and IDR within a few microseconds after each IA. If 100 microseconds elapses without an IA, a Time Out signal from the Timing Generator clears the Ext flip-flop resuming the normal train of Page Memory clock pulses.

The Cursor Compare is inhibited by Protect so that only unprotected data is read out to the external device.

When the cursor is moved from the last line to the top line, the End of Medium (EM) flip-flop is set. This forces an EOM code (hex 19) into the Input Register and sets the IR Full flip-flop. This code signals the CPU that the last character on the page has been read and the next character to be read is the first one on the page.

The Read function is terminated whenever a new code is loaded into the Outer Buffer from the external device.

The Read Cursor Address command gates the horizontal cursor address to the Input Register and sets a control which causes the vertical address to be loaded next. The IR Full is set, causing IDR to go active. IA will then cause the IR Full to be cleared for one clock cycle, during which the vertical address is loaded into IR. The function terminates automatically with the second IA.

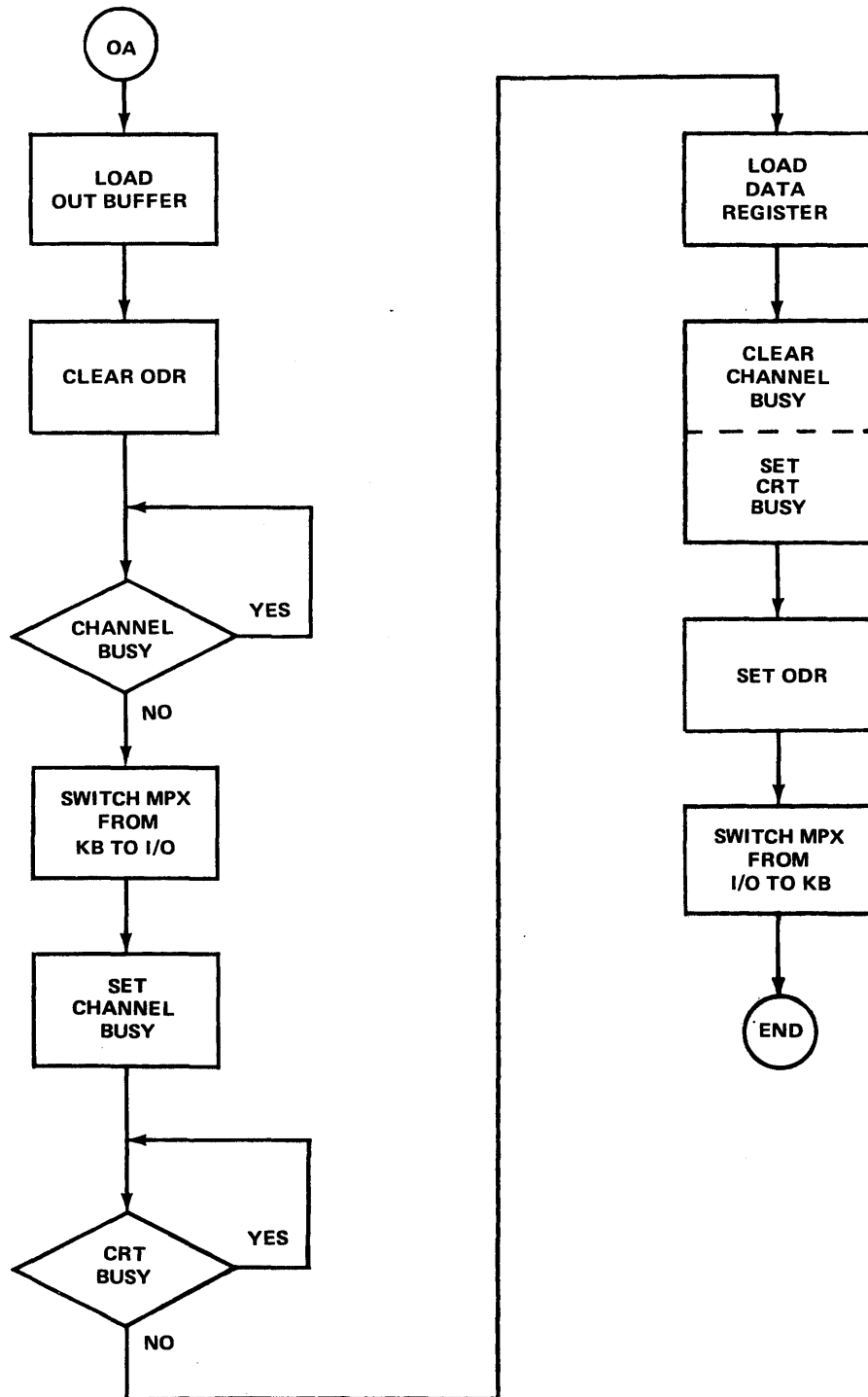


FIGURE 19. OUTPUT ACKNOWLEDGE SEQUENCES

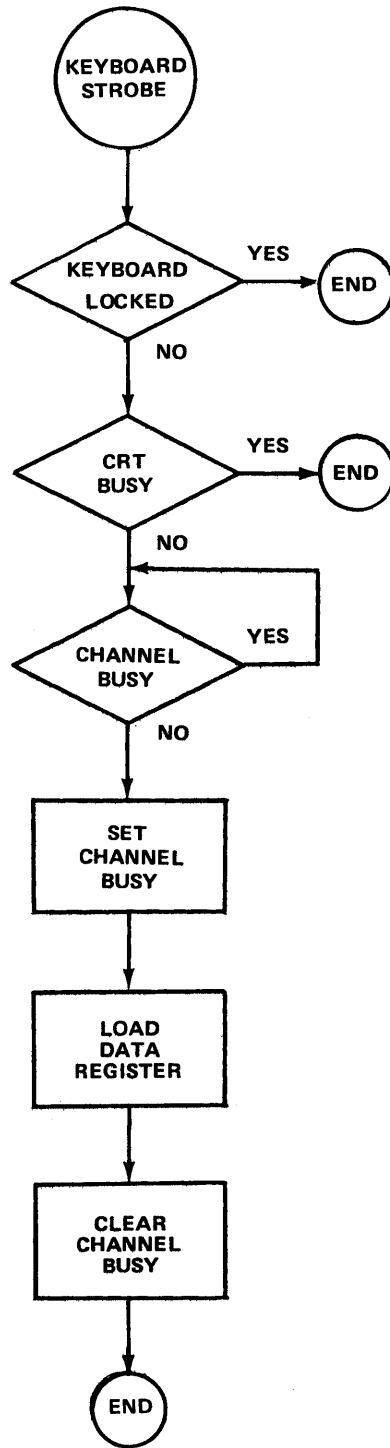


FIGURE 20. KEYBOARD STROBE SEQUENCES

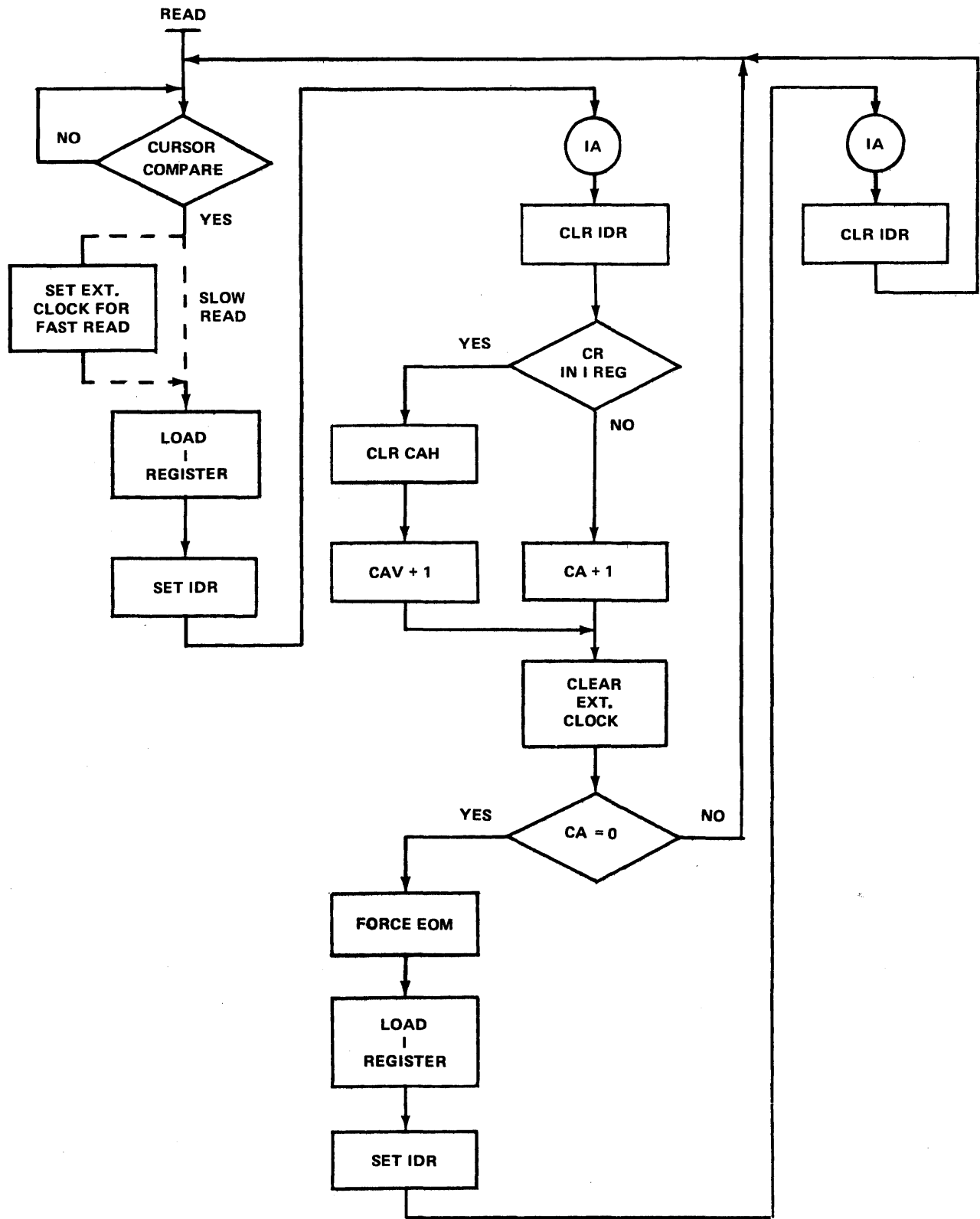


FIGURE 21. INPUT ACKNOWLEDGE SEQUENCES



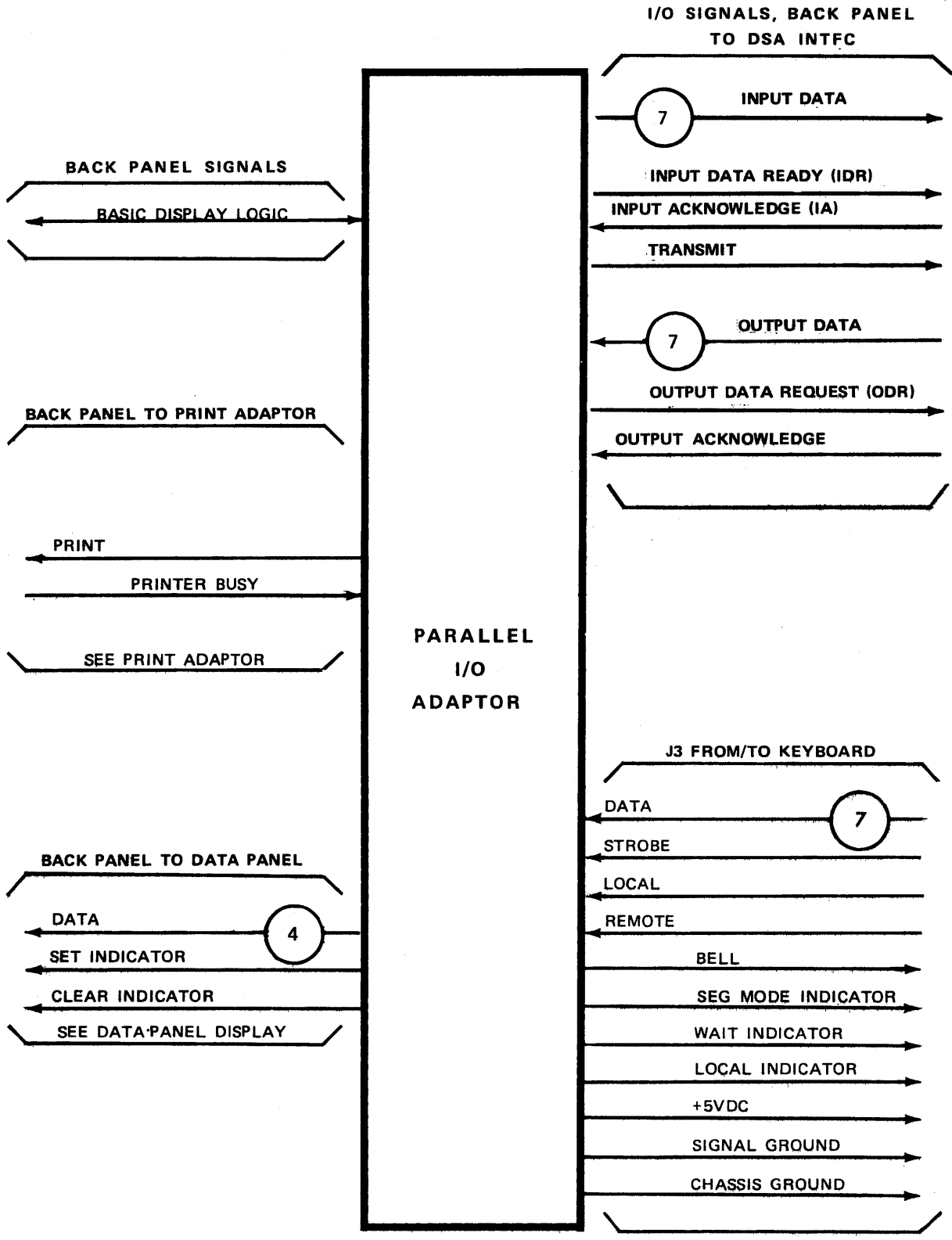


FIGURE 22. PARALLEL I/O ADAPTOR INTERFACE SIGNALS

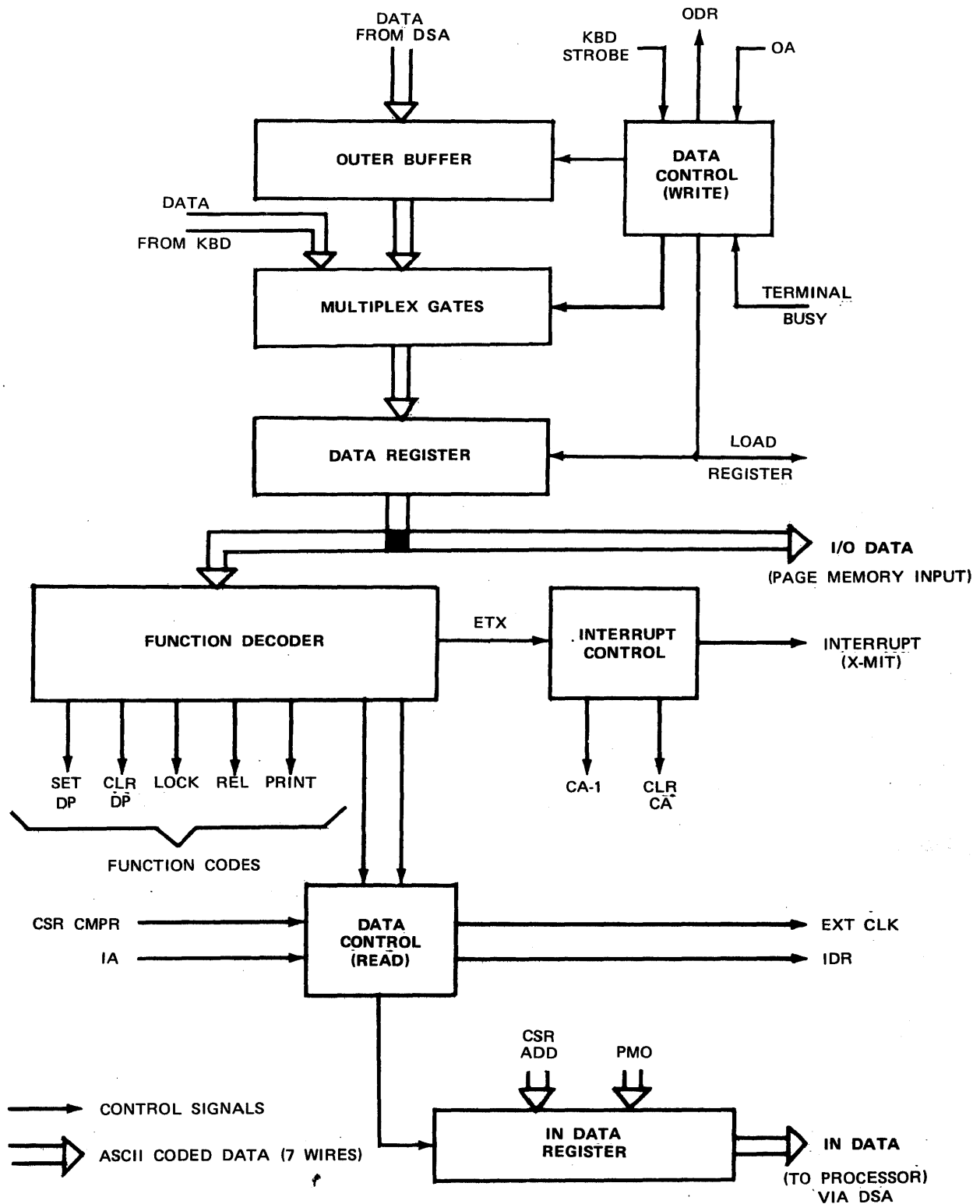


FIGURE 23. FUNCTIONAL DIAGRAM - PARALLEL I/O ADAPTOR PCB

## **MESSAGE ORIENTED SERIAL INTERFACE — Board 8. See Figure 31.**

**NOTE:** The printed circuit board assembly for this interface is labeled DSA - INTFC and occupies Board Position No. 8 in the Terminal's card cage.

The message oriented serial I/O adaptor (DSA INTFC) operates in conjunction with the Parallel I/O adaptor in transferring codes to and from the terminal. External connections are shown in Figure 24.

The Serial Adaptor consists of the following logical sections:

- Oscillator and clock
- Receiver and Assembly Register
- Function Decoder
- Transmitter and Serializer Register
- Addressing

### **OSCILLATOR AND CLOCK**

The oscillator is an astable multi-vibrator. Its frequency is adjustable by a trim-pot over a 100K to 200K Hz range. This rate is divided by six binary stages. Switch S2-A (See FIGURES 30-31) selects one of the resulting seven frequencies to be used as the clock rate. This rate is 16 times the baud rate.

### **RECEIVER AND ASSEMBLY REGISTER**

The receive bit counter is started whenever a Space or logic "0" level is received continuously for 1/2 of a bit time. This is interpreted as a START

bit. Strobe pulses are generated in the middle of this and the next nine bit times. The first 7 of these 9 bits are shifted into a register which presents the data in parallel to the terminal. During the ninth bit time, which corresponds to the stop bit, an Output Acknowledge (OA) is sent to the terminal if the incoming data is at MARK level. Parity is checked during bit 9 and if bad, a SUB code (hex 1A) is loaded in parallel into the register replacing the received code. The receive cycle ends during bit 9 and will not re-start until the next START bit is received.

## **FUNCTION DECODER**

Several function codes must be decoded to set up special conditions in the adaptor. These codes and their functions are:

**SOH (01)** - In the addressing mode this code takes the terminal off-line if it is addressed and starts a new header sequence.

**STX (02)** - This code terminates the header sequence in multi-address mode. When the STX code is received after the terminal is addressed, it is treated as a text character.

**Read Character (6A)** - This code sets a flip-flop which causes the resulting transmission to end after one character. Note that 6A is a Read Slow code to the basic terminal.

**Read Message (6B)** - This code causes a Read Slow (6A) code to be loaded in parallel into the assembly register. This prevents the terminal from going into a Read Fast condition which could cause the screen display to flicker.

**ENQ (05)** - Also causes a (6A) code to be loaded into the register. If the terminal is not in Poll mode, or if the X-mit key has not been operated, the OA is inhibited and a Transmit EOT control is set.

**LCA (6C)** - Load Cursor Address code. This code starts a control sequence which prevents the next two received codes from being interpreted as functions. Thus those two codes can only be cursor addresses even though they may be illegal. See LCA, Section III.

Broadcast Address (00 or 40) - When this code is received in the Header, the terminal will go on-line regardless of the terminal's selected address.

### TRANSMITTER AND SERIALIZER REGISTER

The transmitter section consists of a bit counter, a serial shift register, a parity generator and overall control. The transmitter responds to either an IDR signal from the terminal or a Transmit EOT signal which is generated in the adaptor. The sequence of events is:

- Carrier Detect must be OFF
- Turn on Request to Send
- Wait for Clear to Send
- Start Clock & Bit Counter
- Load Character from terminal into the shift register
- Send IA to terminal
- Transmit the character
- Terminate

Request to Send is controlled by a timing circuit so that RTS will remain on for approximately one milli-second after the transmission is complete. This is a requirement of some modems. Timing component values can be changed to alter or eliminate this delay. For full duplex operation, the Clear to Send input (pins) must be connected to Request to Send (pin 4) or Data Terminal Ready (pin 20). Carrier Detect will be ignored if left open. The RTS is used to inhibit the receiver when that option is selected.

During bit count 0, a start bit (space level) is transmitted. Bits 1 thru 7 are the data. At bit count 8 odd, even or Mark parity is sent as determined by S1-A. Bit 9 is a Stop bit (Mark level). The transmit sequence will terminate at the end of bit 8 or bit 9 as selected by S2-B. One stop bit is always sent after the sequence ends. If IDR is active during that stop bit, another character sequence is initiated.

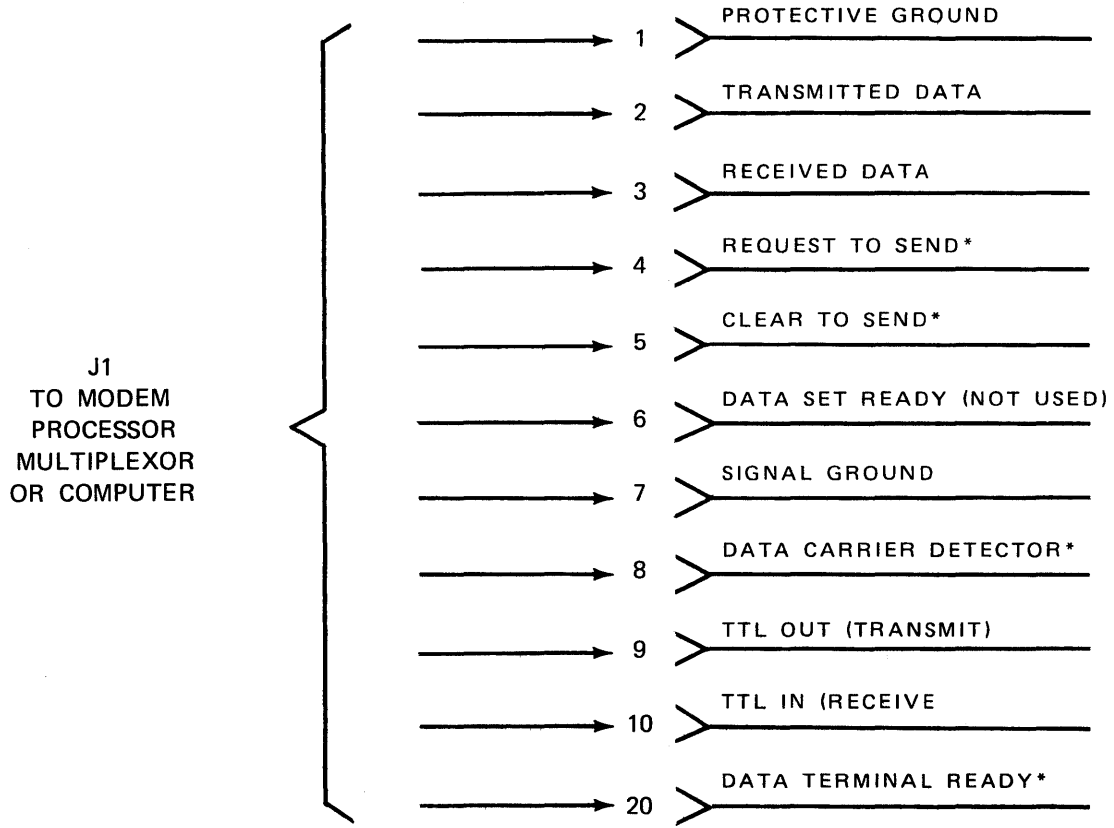
If the character received from the terminal is an ETX (03 code) and the terminal is in Seg Mode or if it is an EOM (19 code), the End Transmit control causes a 0F code to be sent to the terminal. This code is not recognized by the terminal as data or a function, but it will clear the IDR and end the Read mode, thus ending the transmission when the ETX or EOM has been sent.

Switch S3-A selects the adaptor's response to the X-mit signal from the terminal. In Poll mode, the X-mit controls the response to a received ENQ as discussed under Function Decoder above. In Message mode, X-mit causes a 6A code to be sent to the terminal thereby initiating transmission of the Message. In EOT mode, the Transmit EOT control is set causing the adaptor to transmit an EOT (code 04). The EOT is encoded from the bit counter and the shift register output is inhibited during this sequence.

## ADDRESSING

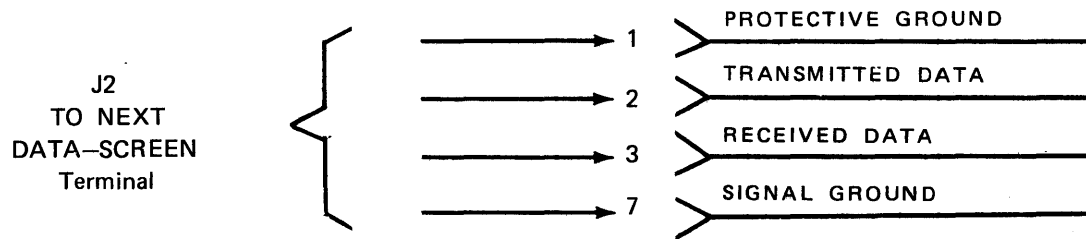
The Addressing Section has a Header flip-flop, an Address flip-flop and a six bit comparator. The Header flip-flop is set by a received SOH. Switch S3-C selects whether it is cleared by the next character received or by a received STX. The Address flip-flop is set when the Header flip-flop has been set and the received code matches the selected address. It is cleared by SOH. When the Header flip-flop is cleared and the Address flip-flop is set, the terminal is on-line. Both flip-flop's are cleared if a code with bad parity is received as part of a header sequence. Switch S3-B can turn off the address feature so that the terminal is always on-line.

The terminal's address is selected by installing combinations of six jumper wires, corresponding to bits 1 thru 6 of the address code, where the address code must be a "one." Comparison is inhibited when bit 7 is the same as bit 6. This restricts the address codes to 20 thru 5F. Bad parity also inhibits the compare.



\*Used in half duplex single display systems only

J1 MATING CONNECTOR:  
TEC P/N 781014-003  
or CINCH DB-25S



J2 MATING CONNECTOR  
TEC P/N 781013-003  
or CINCH DB-25P

FIGURE 24. EXTERNAL INTERFACE CONNECTIONS

## SECTION V

### OPTIONS

#### PCB OPTION SETTINGS

Options for Models 420, 425 & 426 DATA-SCREEN Terminals consist of switch/jumper wire selectable display controls and accessory equipment i.e., keyboard, fixed message indicators, hard copy adaptor and slave monitors. Since the options are either a part of the basic terminal or are modular for each model, the sub-system design and application can vary from simply controlling an output display monitor to multi-station, operator oriented peripheral sub-system (See FIGURE 4). The options and their operating characteristics are:

#### PCB OPTIONS

All models have the following switch/jumper wire options.

- Display or blank Carriage Return symbol
- Display or blank Cursor symbol
- Enable or disable Automatic Line Feed
- Enable or disable Automatic Roll-Up
- Enable or disable End of Line/Page Bell signal
- Enable or disable Operator Lock Over-ride
- EOT Message or Poll transmit mode
- Set Parity, Stop bits, Baud rate and Terminal Address
- Display black on white or white on black.
- Enable or disable receiver during Transmit

The effect these options have on the Display are self-evident except:

Auto-Line Feed moves cursor to first column, next line on CR command.

Auto-Roll-Up moves all lines up one on LF command when cursor is in last line.

Operator Lock Over-ride allows operator to take control from processor by depressing LOCAL switch.

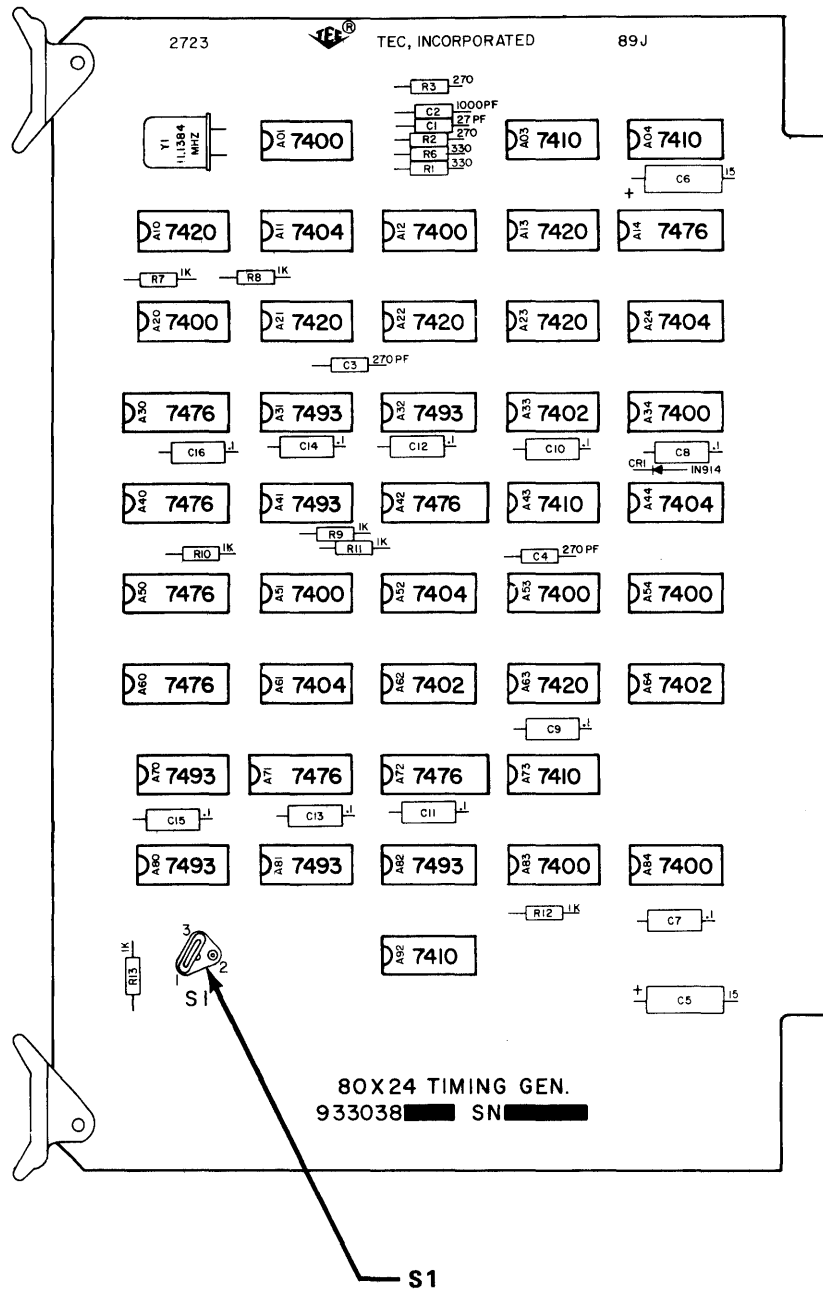
EOT Transmit Mode. The EOT (ASCII code 04) is sent to the processor as an interrupt when the X-MIT key is depressed. The processor responds with a Read Character or Read Message Command.

Message Transmit Mode. This option causes the Terminal to assume the processor is ready and transmits the message in either Seg or Page mode.

Poll Transmit Mode. The processor initiates this option by sending an SOH, display address and ENQ. If the X-MIT key is set, the Terminal transmits the entire message in either Seg or Page mode. If the X-MIT key is not set, the Terminal sends an EOT (ASCII Code 04) to inform the processor that there is no data.

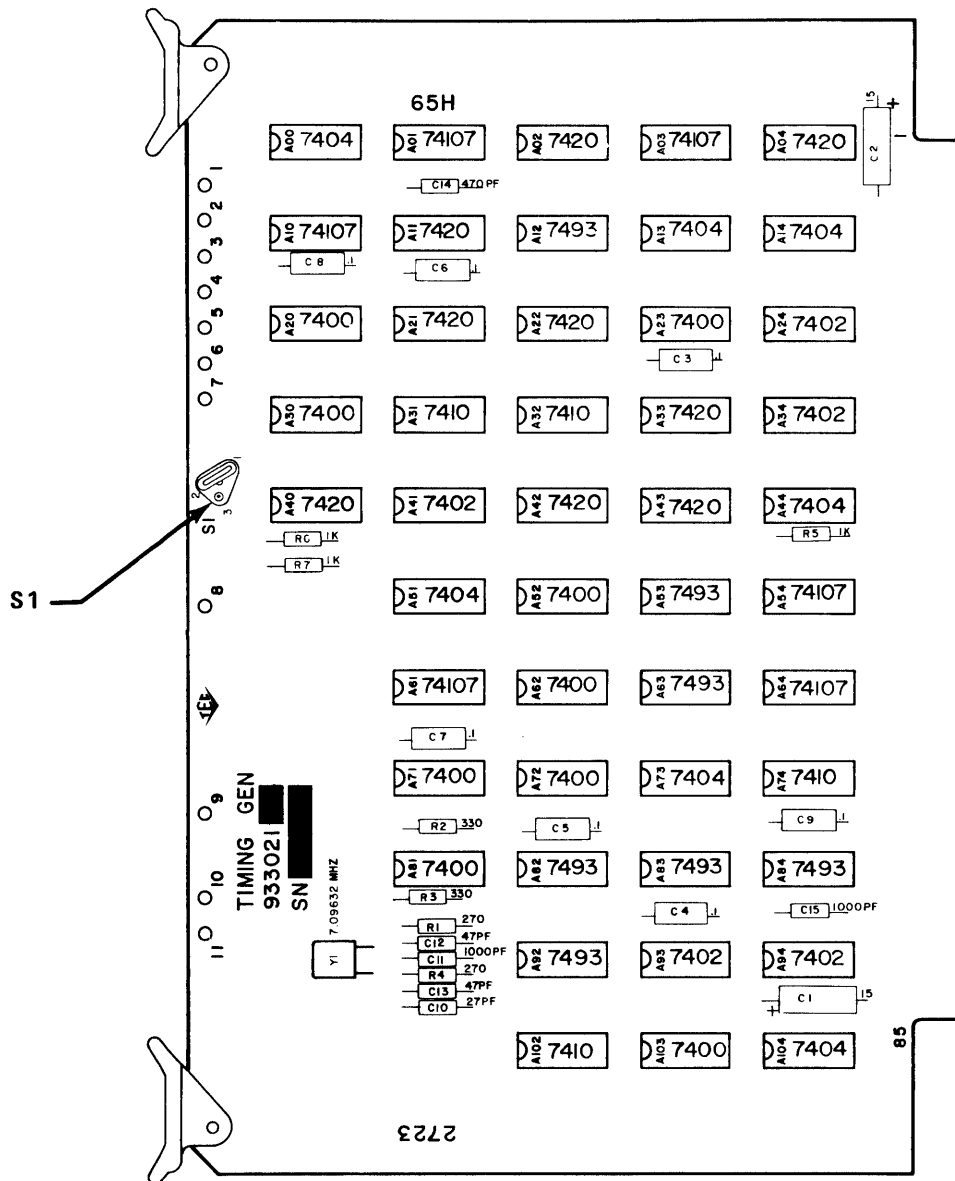
Figures 27 through 31 show the switch/jumper wire locations of the options on their respective Printed Circuit Boards.





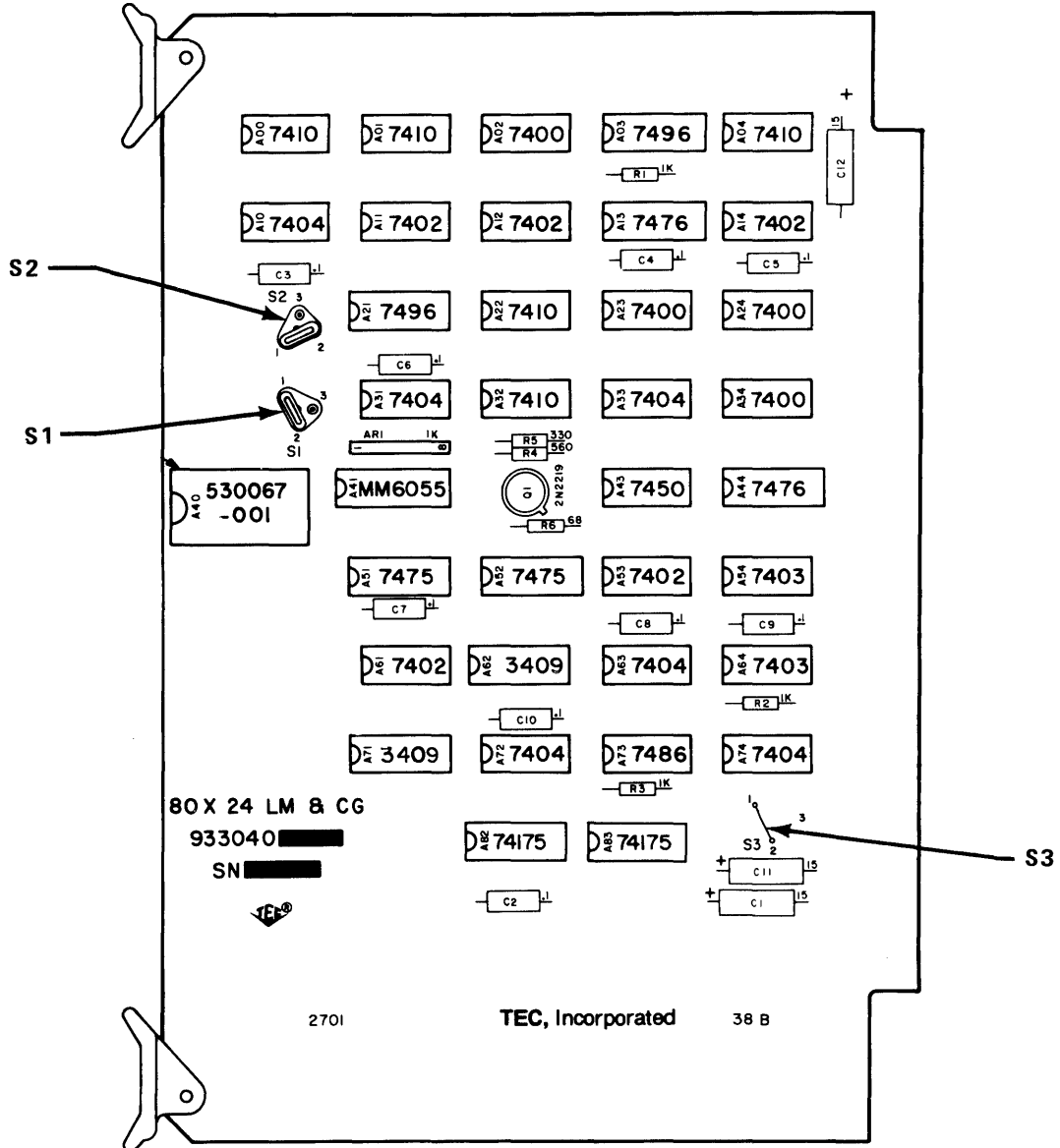
SWITCH FUNCTION CHART		
SWITCH	POSITION	FUNCTION
S1	1-2	SELECT 50HZ OPERATION
	1-3	SELECT 60HZ OPERATION

FIGURE 25. SWITCH OPTIONS ON MODEL 425 TIMING GENERATOR PCB



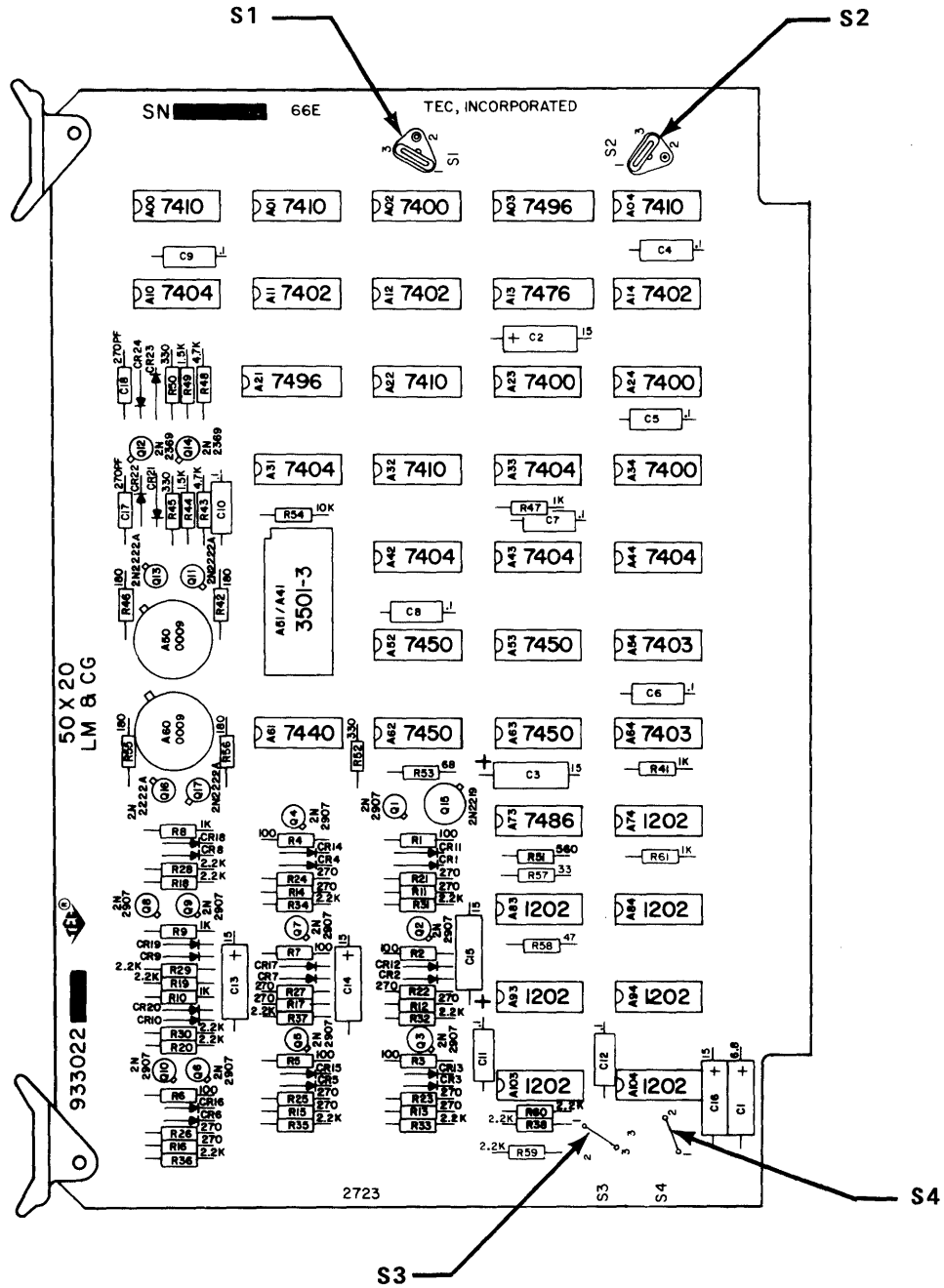
SWITCH FUNCTION CHART		
SWITCH	POSITION	FUNCTION
S1	1 - 2	SELECT 60 HZ OPERATION
	1 - 3	SELECT 50 HZ OPERATION

FIGURE 26. SWITCH OPTIONS ON MODEL 420 TIMING GENERATOR PCB



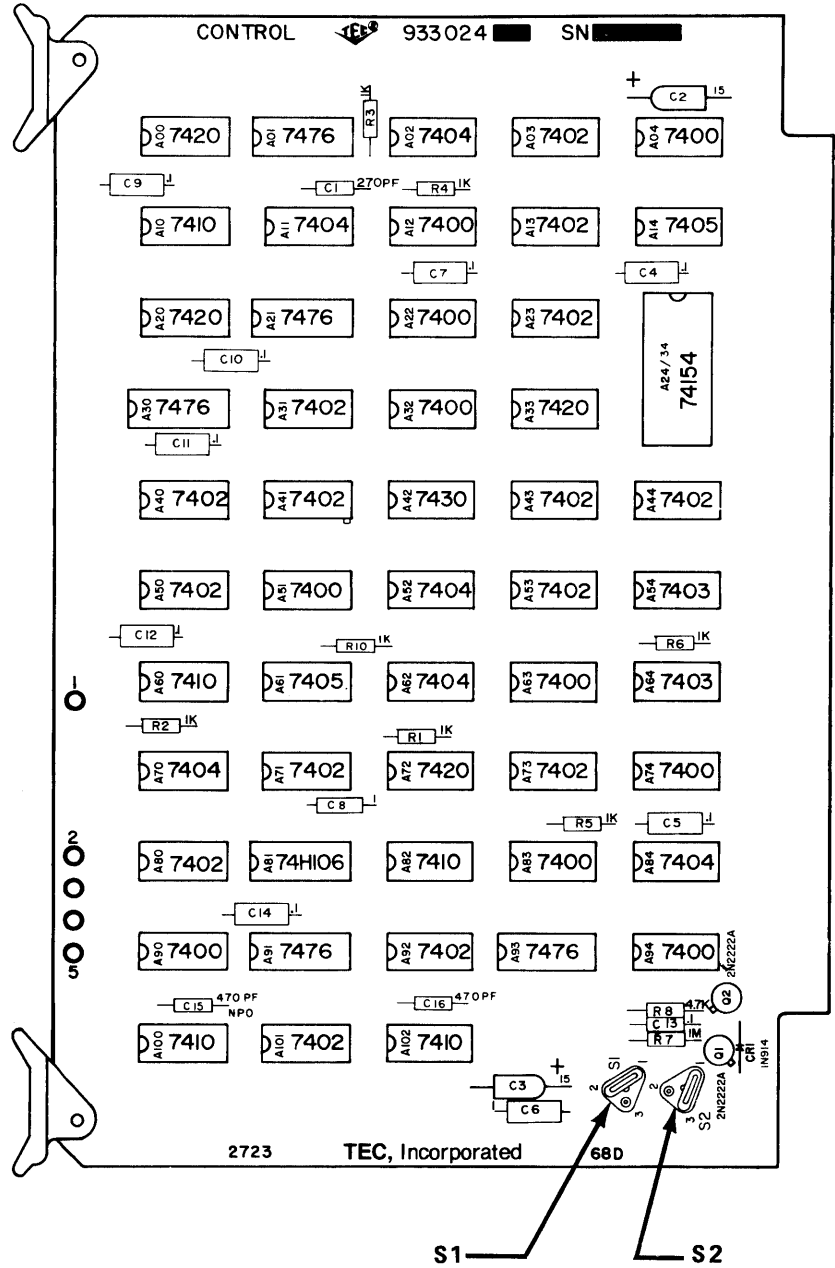
SWITCH FUNCTION CHART			
SWITCH	POSITION	FUNCTION	
S1	1-2	ENABLE	CURSOR SYMBOL
	1-3	DISABLE	DISPLAYED
S2	1-2	ENABLE	CARRIAGE RETURN
	1-3	DISABLE	SYMBOL DISPLAYED
S3	1-2	NORMAL(WHT ON BLK)	VIDEO
	1-3	INVERTED(BLK ON WHT)	SELECT

FIGURE 27. SWITCH/JUMPER OPTIONS ON MODEL 425 LINE MEMORY & CHARACTER GENERATOR PCB



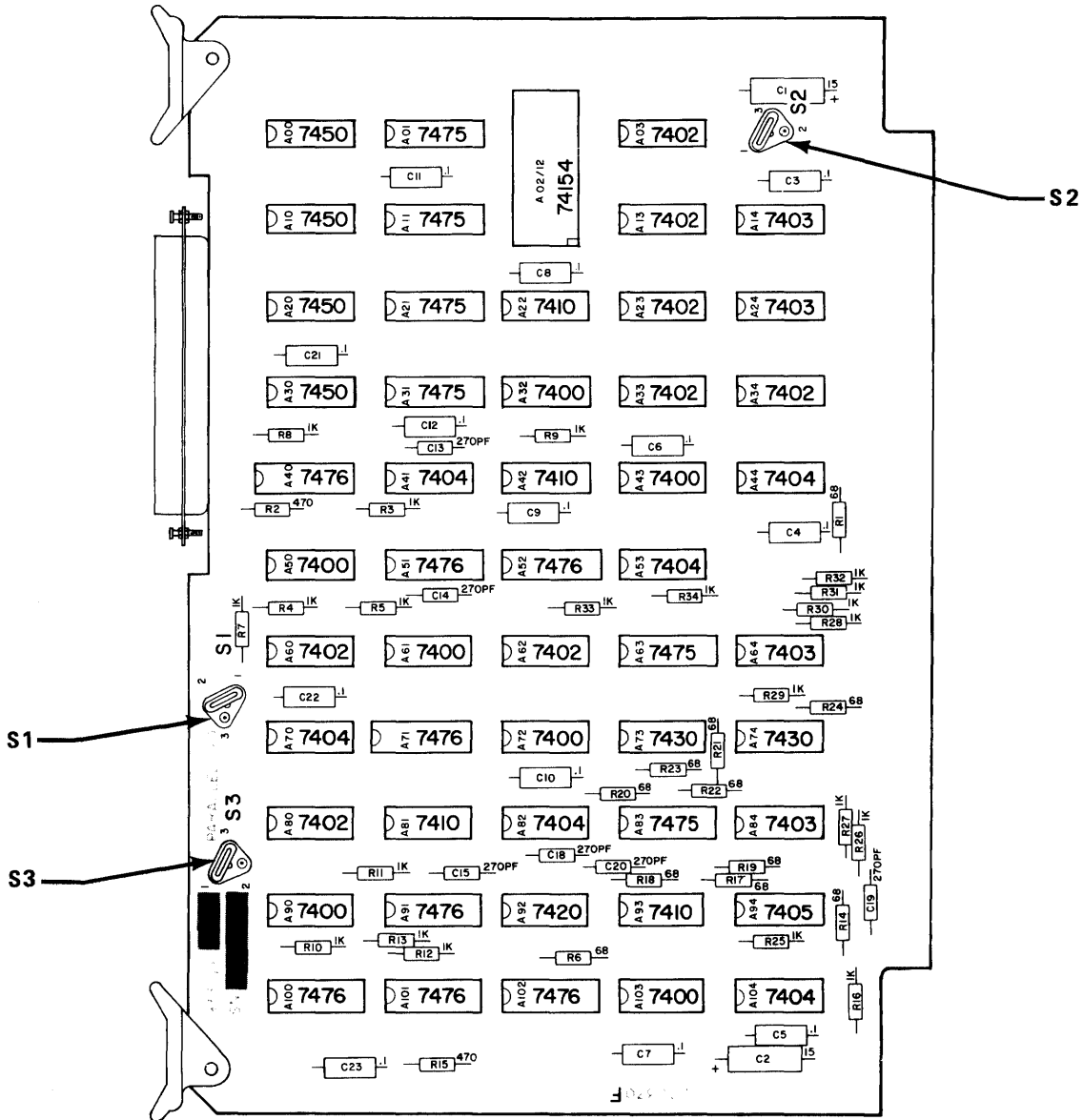
SWITCH FUNCTION CHART			
SWITCH	POSITION	FUNCTION	
S1	1-2	DISABLE	CARRIAGE RETURN SYMBOL DISPLAYED
	1-3	ENABLE	CARRIAGE RETURN SYMBOL DISPLAYED
S2	1-2	DISABLE	CURSOR SYMBOL DISPLAYED
	1-3	ENABLE	CURSOR SYMBOL DISPLAYED
S3	1-2	INVERTED (BLK ON WHT)	VIDEO SELECT
	1-3	NORMAL (WHT ON BLK)	
S4	1-2	50	CHARACTERS PER LINE SELECT
	1-3	40	

FIGURE 28. SWITCH/JUNPER OPTIONS ON MODELS 420 & 426 LINE MEMORY & CHARACTER GENERATOR PCB



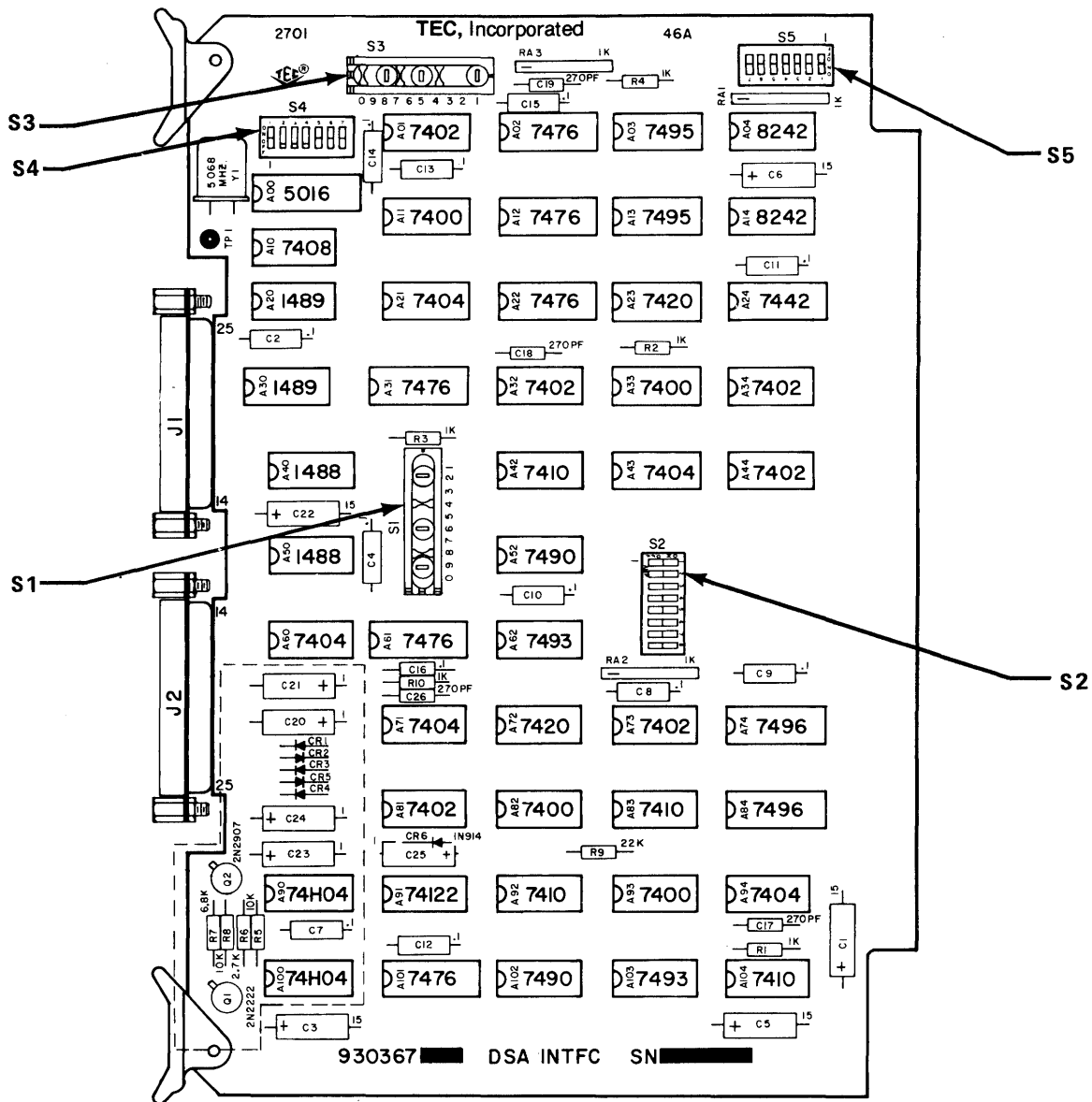
SWITCH FUNCTION CHART			
SWITCH	POSITION	FUNCTION	
S1	1-2	ENABLE	AUTO LINE FEED ON CR
	1-3	DISABLE	
S2	1-2	DISABLE	ROLL UP
	1-3	ENABLE	

FIGURE 29. JUMPER WIRE OPTIONS ON MODELS 420, 425, 426 CONTROL PCB



SWITCH		FUNCTION	CHART
SWITCH	POSITION	FUNCTION	
S1	1-2	ENABLE	END OF LINE
	1-3	DISABLE	AUDIBLE SIGNAL
S2	1-2	ENABLE	OPERATOR LOCK
	1-3	DISABLE	OVERRIDE
S3	1-2	SELECT MODEL 41 X OPERATION	
	1-3	SELECT MODEL 42 X OPERATION	

FIGURE 30. SWITCH/JUMPER OPTIONS ON MODELS 420, 425, 426 PARALLEL I/O PCB



SWITCH FUNCTION CHART				
SWITCH	POSITION	FUNCTION		
S1	1	EVEN	PARITY GENERATED SELECT	
	2	ODD		
	3	MARK		
	5	EVEN	PARITY CHECK SELECT	
	6	ODD		
	7	NONE		
	9	RS-232	INTERFACE SELECT	
	0	TTL		
	S2	1-ON	2-OFF	INTERNAL
1-OFF		2-ON	EXTERNAL	
3-ON		4-OFF	ENABLE	RECEIVE DURING XMIT
3-OFF		4-ON	DISABLE	
5-ON		6-OFF	10 BIT	CHARACTER LENGTH
5-OFF		6-ON	11 BIT	
7 & 8 NOT USED				
S3	1	POLL	TRANSMIT MODE SELECT	
	2	MESSAGE		
	3	EOT	ADDRESS SELECT	
	5	ENABLE		
	6	DISABLE		
8	SINGLE	ADDRESS SELECT		
9	MULTI			

SWITCH FUNCTION CHART					
SWITCH	POSITION 1	POSITION 2	POSITION 3	POSITION 4	FUNCTION
S4	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
BAUD RATE SELECT					
ADDRESS SELECT SWITCH					
S5	NUMBERS CORRESPOND TO CHARACTER BIT POSITION. SWITCH ON EQUALS LOGIC "1". SWITCH OFF EQUALS LOGIC "0".				

FIGURE 31. SWITCH & JUMPER OPTIONS ON MODELS 420, 425 & 426 DSA INTFC PCB

## OPTIONS

### DATA-PANEL DISPLAY

The DATA-PANEL Display option is available on desk or rack mounted terminals with monitors. From one to 16 fixed messages, software actuated indicators can be implemented. The messages appear to the right of the CRT with the CRT shifted left from center to accommodate the assembly. The messages are not visible when extinguished.

See Figure 35 for Ordering Information.

Individual indicators are turned on by issuing a Set Data Panel (SDP - ASCII code 6E) followed by the indicator's address code which is brought into the Terminal through the normal communications channel as serial data codes (See FIGURE 32). Decoding is done by the Terminal logic. All indicators are turned off by issuing a Clear Data Panel (CDP - ASCII code 6F).

The Display assembly is a self-contained modular unit consisting of incandescent lamps, power supply, decoder memory and driver logic to control each indicator. User legends for each indicator are hot stamped in black type in sizes from 10 to 24 points and appear on a 1.375 inch wide by .400 inch high red, orange, green, blue, yellow, or white back ground when lit.

DATA-PANEL Display Connector	Wire Color	Connection P6	Signal Name	Card Cage DPA Edge Connector
1	Red	Pin 1	+5V	1
7	Violet	Pin 17	Bit 1	7
8	Gray	Pin 18	Bit 2	8
3	Brown	Pin 19	Bit 3	3
4	Orange	Pin 20	Bit 4	4
5	Yellow	Pin 25	Strobe	5
6	Blue	Pin 27	Reset	6
9	White	Pin 79	Master Clear	9
K	Black	Pin 85	GND	10

FIGURE 32. DATA-PANEL<sup>®</sup> DISPLAY CONNECTIONS

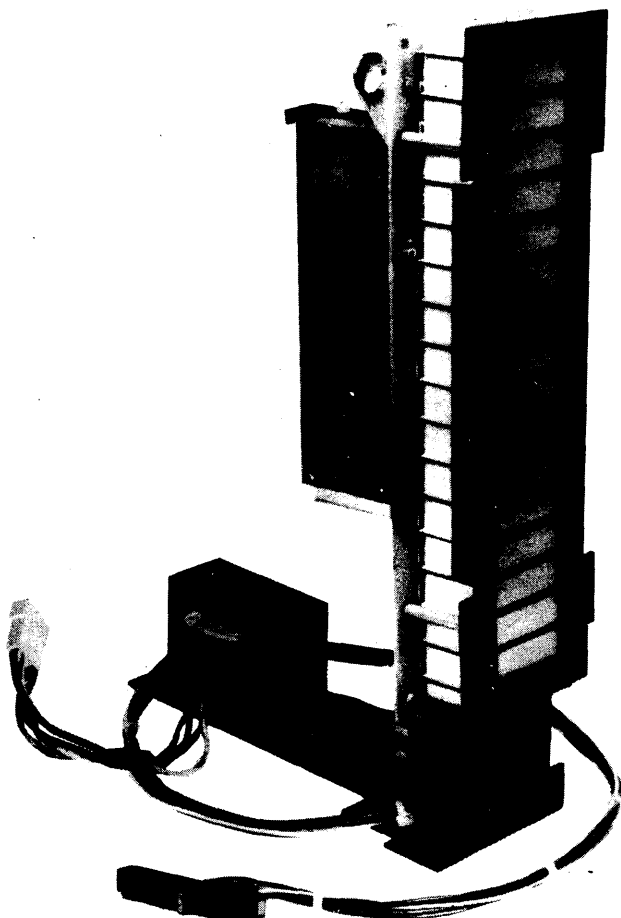


FIGURE 33. DATA-PANEL<sup>®</sup> DISPLAY ASSEMBLY

BITS <sup>1</sup>							FUNCTION
7	6	5	4	3	2	1	
0	1	1	1	1	1	1	DP INDICATOR 1
0	1	1	1	1	1	0	DP INDICATOR 2
0	1	1	1	1	0	1	DP INDICATOR 3
0	1	1	1	1	0	0	DP INDICATOR 4
0	1	1	1	0	1	1	DP INDICATOR 5
0	1	1	1	0	1	0	DP INDICATOR 6
0	1	1	1	0	0	1	DP INDICATOR 7
0	1	1	1	0	0	0	DP INDICATOR 8
0	1	1	0	1	1	1	DP INDICATOR 9
0	1	1	0	1	1	0	DP INDICATOR 10
0	1	1	0	1	0	1	DP INDICATOR 11
0	1	1	0	1	0	0	DP INDICATOR 12
0	1	1	0	0	1	1	DP INDICATOR 13
0	1	1	0	0	1	0	DP INDICATOR 14
0	1	1	0	0	0	1	DP INDICATOR 15
0	1	1	0	0	0	0	DP INDICATOR 16

<sup>1</sup> BITS 7, 6 & 5 may be 010, 011, 100 or 101.

\*Also position of indicators mounted in Terminal.

FIGURE 34. DATA-PANEL<sup>®</sup> DISPLAY CODES



DATA PANEL Display Specifications: (Each of 16 display areas measures 1.375" wide x .400" high). Black letters on colored background.

POSITION	LEGEND	TYPE SIZE PT.	BACKGROUND COLOR	Standard colors: RED, GREEN, BLUE, YELLOW, WHITE.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

**TYPE SIZE CHART**

News Gothic Bold Condensed

10 pt.= .100 high  
Avg. 15 capital letters  
per module, 2 lines max.

12 pt.= .120 high  
Avg. 13 capital letters  
per module, 2 lines max.

14 pt.= .140 high  
Avg. 11 capital letters  
per module, 1 line max.

18 pt.= .182 high  
Avg. 9 capital letters  
per module, 1 line max.

24 pt.= .245 high  
Avg. 7 capital letters  
per module, 1 line max.

---

10 pt. **DATA • PANEL**

12 pt. **DATA • PANEL**

14 pt. **DATA • PANEL**

18 pt. **DATA • PANEL**

24 pt.  
**DATA • PANEL**

FIGURE 35. DATA PANEL DISPLAY ORDERING INFORMATION

## OPTIONS

### PRINT ADAPTOR

The Print Adaptor option is available on all 400 Series DATA-SCREEN™ Terminals. Jumper wire options on the PCB combined with both 20 ma Current Loop and TTL level output allow connection to a variety of printers.

Operation of the Print Adaptor begins upon receipt of a Print Command from the Parallel I/O Adaptor. It then checks the Printer Ready signal line and if the Printer is not ready the command is ignored. If the Printer is ready a Carriage Return code followed by a Line Feed code is sent to initialize the Printer. The Parallel I/O Adaptor is informed of the Printer Ready condition by a Print Busy signal from the Print Adaptor. The Parallel I/O Adaptor then locks out the keyboard and processor. The cursor is moved backwards to the first STX position found (SEG MODE) or the Home position (PAGE MODE). The character in the cursor position is transferred to the Print Adaptor shift register where Start, Parity and Stop bits are appended and then sent serially (least significant bit first) to the TTY Drive logic where it is converted to a 20 ma current for transmission to the Printer. Transmission continues with the Print Adaptor sending a Carriage Return and Line Feed at the end of each line until the ETX position (SEG MODE) is reached or the End of Page position (PAGE MODE) is reached. See FIGURES 33 & 36.

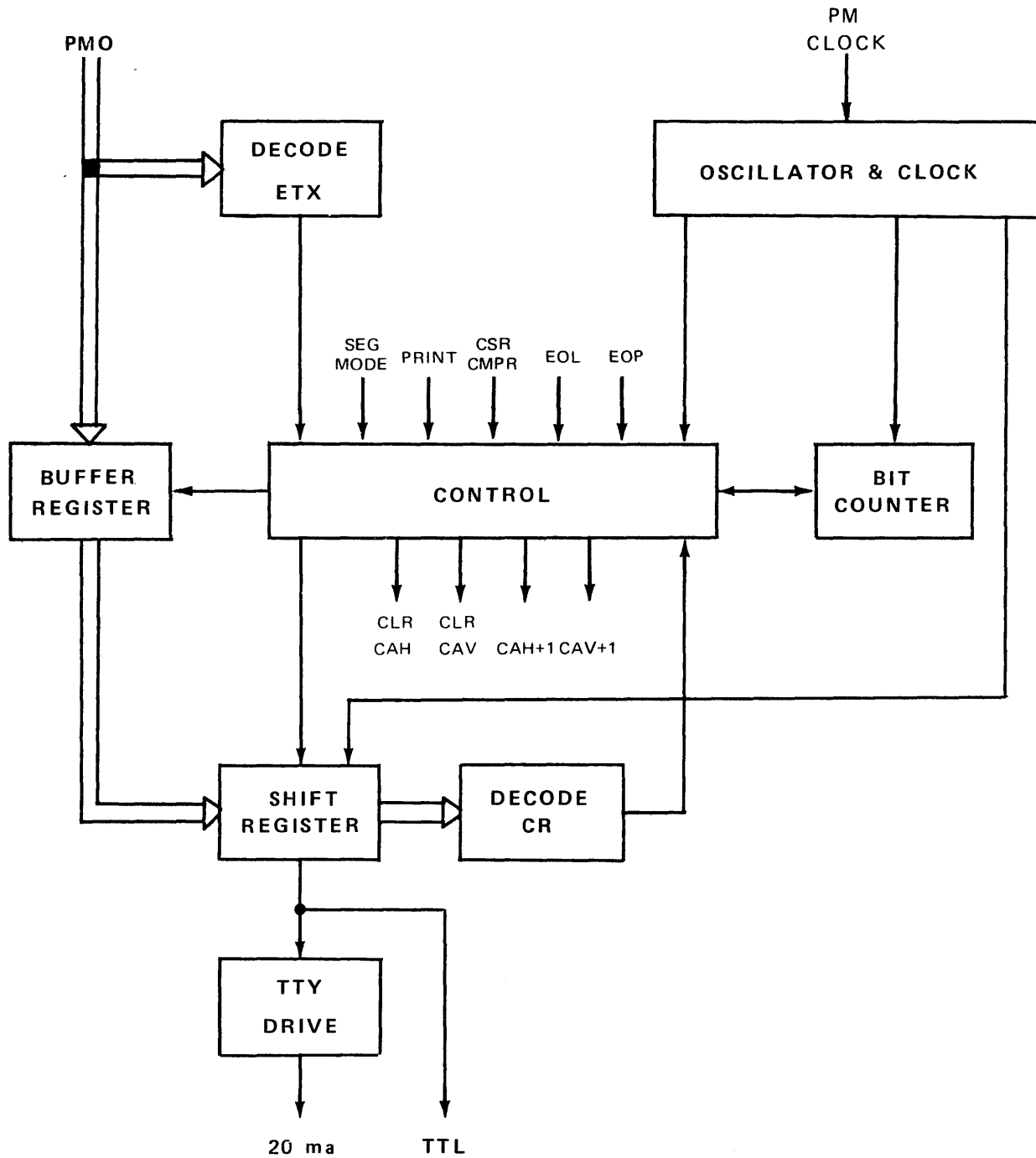
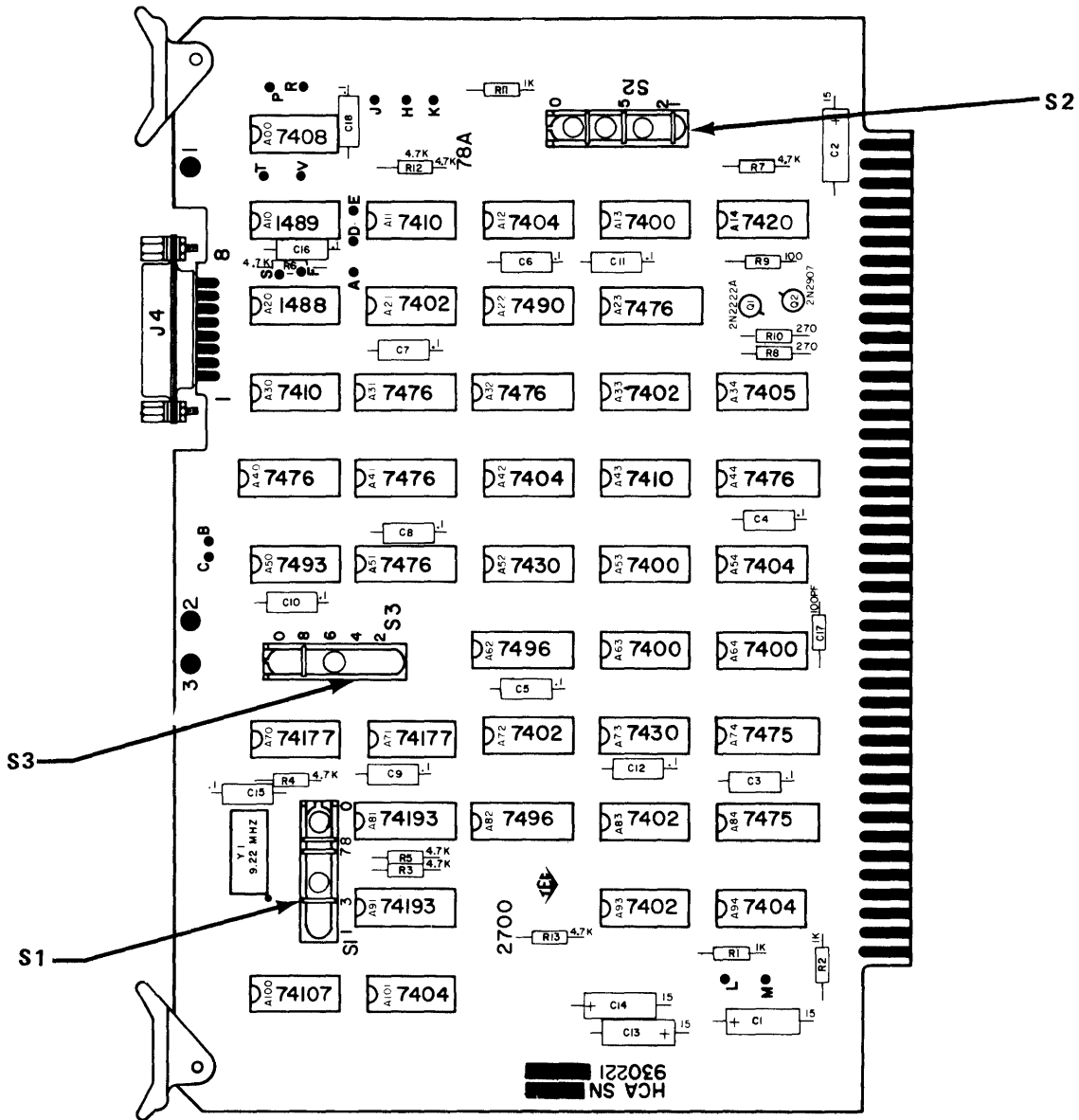


FIGURE 36. FUNCTIONAL DIAGRAM – PRINT ADAPTOR PCB



S1 FUNCTIONS	
POS.	FUNCTION
1	NOT USED
2	NOT USED
3	---
4	4800, 2400, 1200, 600, 300, 150 BAUD
5	3600, 1800 BAUD
6	110 BAUD
7	---
8	---
9	FORCE SEG MODE
0	CONTROLLED SEG MODE

S2 FUNCTIONS	
POS.	FUNCTION
1	---
2	NO PARITY (MARK TRANSMITTED)
3	ODD PARITY
4	EVEN PARITY
5	---
6	PRINTER READY - POS.
7	PRINTER READY - NEG.
8	---
9	PRINTER BUSY - NEG.
0	PRINTER BUSY - POS.

S3 FUNCTIONS	
POS.	FUNCTION
1	4800, 3600 BAUD
2	2400, 1800 BAUD
3	1200, 110 BAUD
4	600 BAUD
5	300 BAUD
6	150 BAUD
7	EXTERNAL OSCILLATOR
8	---
9	NOT USED
0	NOT USED

S1 & S3 BAUD RATE SELECT		
S1 POS.	S3 POS.	BAUD RATE
4	1	4800
5	1	3600
4	2	2400
5	2	1800
4	3	1200
4	4	600
4	5	300
4	6	150
6	3	110
N/A	7	EXTERNAL OSCILLATOR

FIGURE 37. JUMPER WIRE OPTIONS ON MODELS 420, 425, 426 PRINT ADAPTOR PCB.

Jumper wires installed on the Print Adaptor PCB set Baud rate, Parity and Polarity. See Figure 37 for jumper wire locations and install per the following.

Baud Rate Setting - Timing is provided by an oscillator and divide by 16 counter. Adjust the oscillator with R 15 and measure at Test Point 6 for the following Baud Rates.

110 Baud - jumper C to 8, set oscillator to 570 usec  
300 Baud - jumper C to 4,  
600 Baud - jumper C to 2, set oscillator to 416 usec  
1200 Baud - jumper C to 1,

Parity Setting - Test Point 7 has the 7 bit character code in serial form and Test Point 1 has the entire 11 bit character including start, parity and stop bits.

Even Parity - jumper P to E  
Odd Parity - jumper P to O  
Mark Parity - No jumper

Polarity Setting - Jumper wires at B and R accomodate printers having different polarity signals.

Printer Busy (negative signal) - jumper B to ( - )  
Printer Busy (positive signal) - jumper B to ( + )  
Printer Ready (negative signal) - jumper R to ( - )  
Printer Ready (positive signal) - jumper R to ( + )

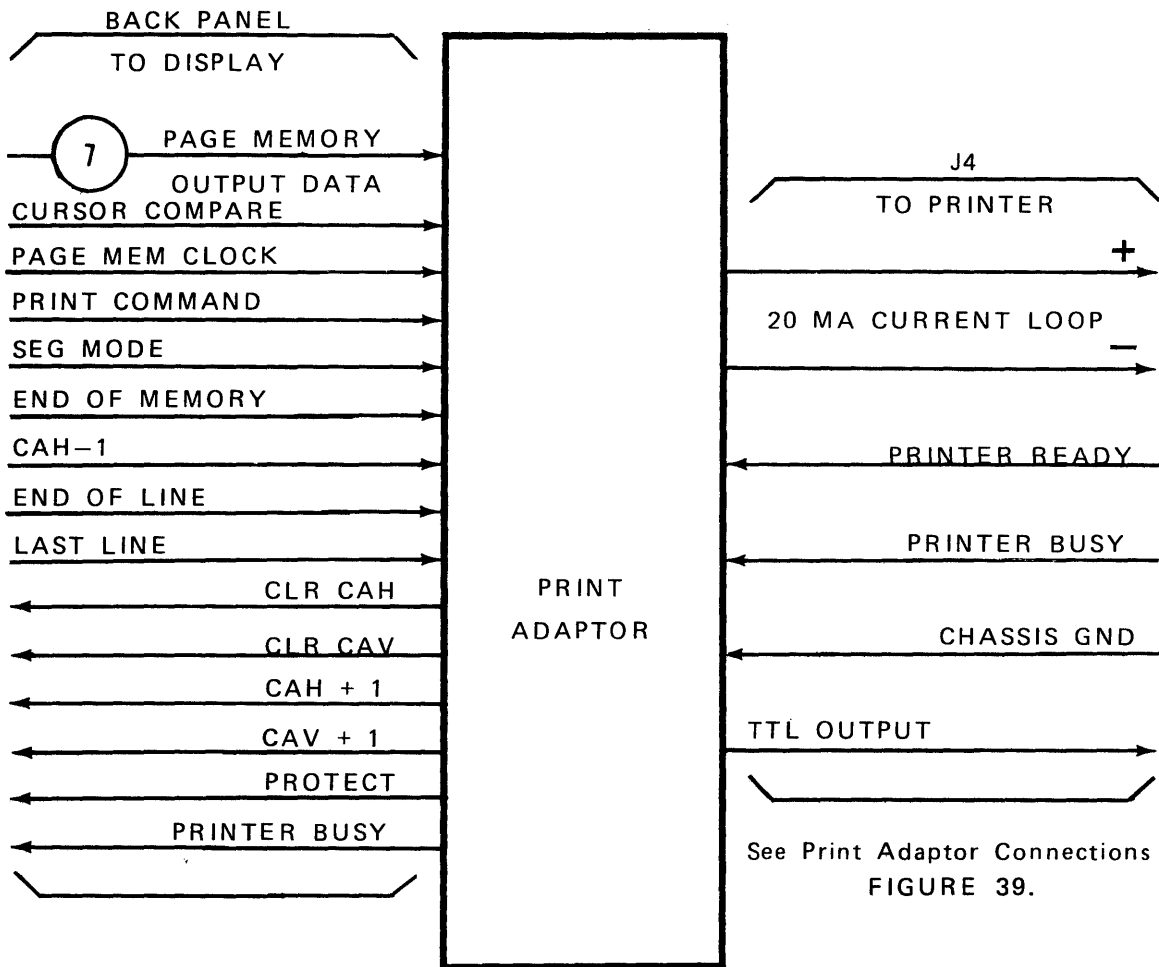


FIGURE 38. PRINT ADAPTOR INTERFACE SIGNALS

The Print Adaptor is a self-contained modular unit consisting of pre-wired card cage connections, a printed circuit board mounting in card position 10 and a 9 pin interface connector (J4) mounted on the rear edge of the PCB. The interconnecting cable and printer logic and motor power is supplied by the User. Connection data is shown in FIGURE 39.

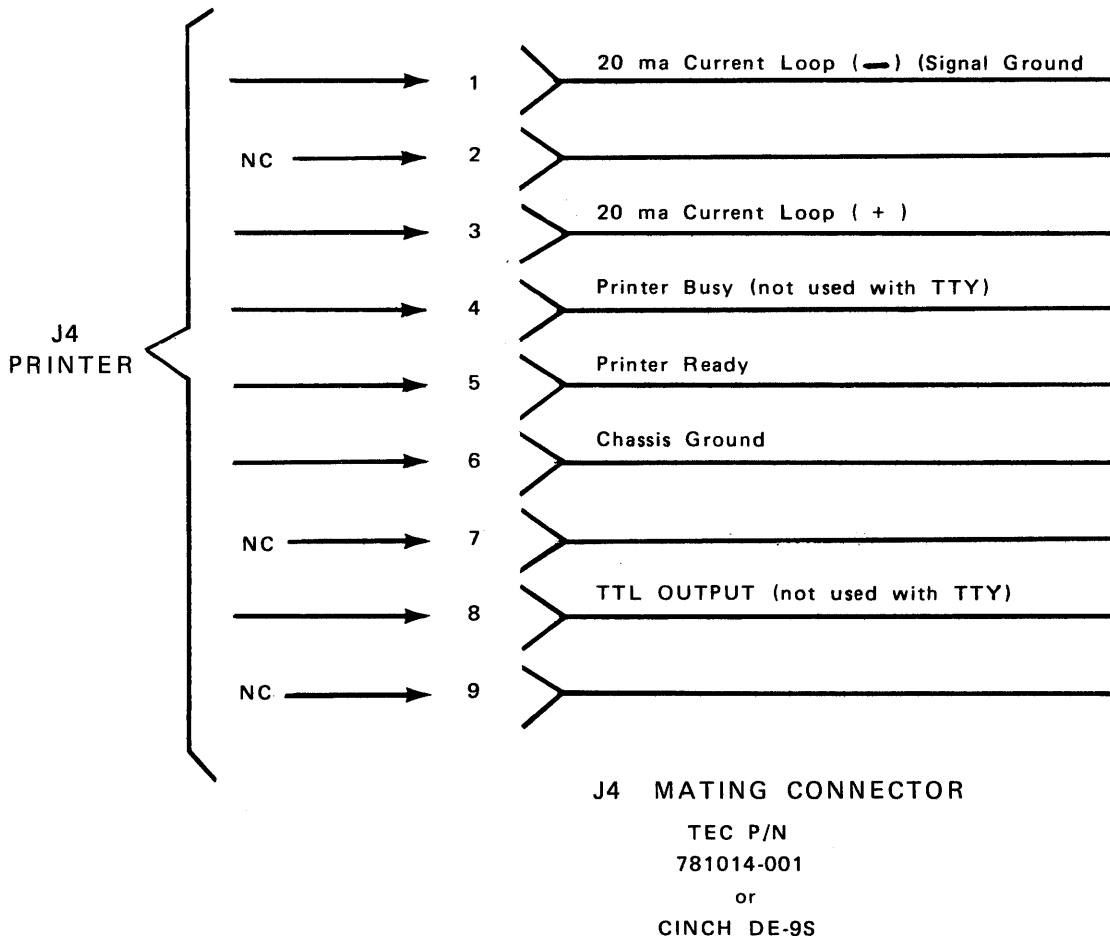


FIGURE 39. PRINT ADAPTOR TO PRINTER CONNECTIONS

## SECTION VI

### SPECIFICATIONS

#### GENERAL

<u>Display</u>	Model 420	Model 425	Model 426
CRT size	12 in.	12 in.	12 in.
Viewing area	74 sq. in.	74 sq. in.	74 sq. in.
Scan method*	Raster	Raster	Raster
Refresh rate	60 Hz STD 50 Hz OPT	60 Hz STD 50 Hz OPT	60 Hz STD 50 Hz OPT
Screen Capacity	1000 char.	1920 char.	960 char.
Characters per line	50	80	40
Line per page	20	24	24
Character size (h x w)	.21 x .15 5 x 7	.20 x .08 5 x 7	.21 x .15 5 x 7
Character generation	Dot Matrix	Dot Matrix	Dot Matrix
Character set	67	67	67
Character codes	ASCII	ASCII	ASCII
Display Black on White	Optional	Optional	Optional
 <u>Format Control Features</u>			
Display CR symbol	Optional	Optional	Optional
Auto Line Feed	Optional	Optional	Optional
Auto Roll-Up			
(Bottom line entry)	Optional	Optional	Optional
Field TAB	STD	STD	STD
Blink characters	STD	STD	STD
Protect characters	STD	STD	STD
Transmit Seg/Page Mode	STD	STD	STD

\*Monitor resolution: Minimum resolution is 750 lines at the center of the CRT screen and 650 lines at the corners as measured in accordance with EIA RS-375.



<u>Edit Control Features</u>	Model 420	Model 425	Model 426
Repeat Character/function	15 Hz rate	15 Hz rate	15 Hz rate
Display Parity Error Symbol (SUB) ■	STD	STD	STD
Insert/Delete Character	STD	STD	STD
Insert/Delete Line	STD	STD	STD
Erase to End of Line	STD	STD	STD
Erase to End of Page	STD	STD	STD
Clear Screen (un-protected areas)	STD	STD	STD
Clear Memory (entire screen)	STD	STD	STD
 <u>Man/Machine Features</u>			
Operator Lock Over-ride	Optional	Optional	Optional
Remote (Display ON-line)	STD	STD	STD
Local (Display OFF-line)	STD	STD	STD
Disable End of Line/Page Bell	Optional	Optional	Optional
Set/Clear DATA-PANEL	STD	STD	STD
 <u>Memory</u>			
Type	MOS S.R.	MOS S.R.	MOS S.R.
Capacity	1000	1920	960
Operation	Serial	Serial	Serial
* Min. Access Time (keyboard locked)	4 usec	4 usec	4 usec
* Max. Access Time (keyboard locked)	696 usec	642 usec	642 usec
* Max. Access Time (keyboard unlocked)	1371 usec	1266 usec	1246 usec

\* 20% longer for 50 Hz systems

<u>Interface</u>	Model 420	Model 425	Model 426
Data Format	10 or 11 bit serial	10 or 11 bit serial	10 or 11 bit serial
Data Transfer Rate	110 to 9600 baud	110 to 9600 baud	110 to 9600 baud
TTL Drivers/Receivers	10 ft. max.	10 ft. max.	10 ft. max.
EIA RS-232 Drivers/Receivers	1000 ft. max.	1000 ft. max.	1000 ft. max.

Printer Interface

* Data Format	8-11 Bit Serial	8-11 Bit Serial	8-11 Bit Serial
Even/Odd Parity	Optional	Optional	Optional
Data Transfer Rate	110-1200 Baud	110-1200 Baud	100-1200 Baud
20 ma Current Loop & TTL Direct	STD	STD	STD

Options

DATA-PANEL Display	w/monitor	w/monitor	w/monitor
Desk Mount with Monitor	YES	YES	YES
Desk Mount without Monitor	YES	YES	YES
Rack Mount with Monitor	YES	YES	YES
Rack Mount without Monitor	YES	YES	YES
Keyboard	YES	YES	YES
Print Adaptor	YES	YES	YES
Slave Monitors	YES	YES	YES

Display Controls

ON – OFF Switch	STD	STD	STD
Brightness	STD	STD	STD

Power Requirements

115 VAC, 60 Hz, 120 w max.	STD	STD	STD
240 VAC, 50 Hz, 120 w max.	Optional	Optional	Optional

\* 8-11 Format: Start bit (space), 7 data bits, Parity bit and two Stop bits (mark)

Physical Specifications (all models)

Dimensions – See FIGURES 40 through 42.

Standard Finish – 3M Nextel Brand Suede Coating, Blue, No. 3101-H46

Operating Temperature – +10°C to +40°C @ 80% relative humidity (non-condensing)

Storage Temperature – -40°C to +65°C @ relative humidity (non-condensing)

Shipping Weights –

Desk Mount with Monitor & keyboard - 68 pounds

Desk Mount with keyboard, without Monitor - 48 pounds

Rack Mount with Monitor & Keyboard, without front panel 65 pounds

Rack Mount with keyboard, without Monitor & front panel 39 pounds

Keyboard – 15 pounds

Shipping carton with internal padding – 8 pounds\*

\*Included in shipping weights

All specifications subject to change without notice.

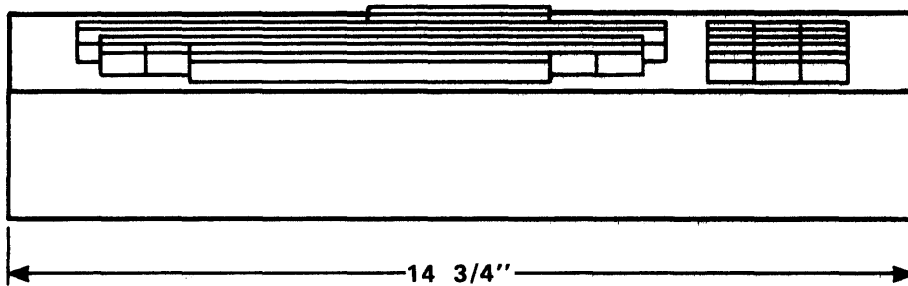
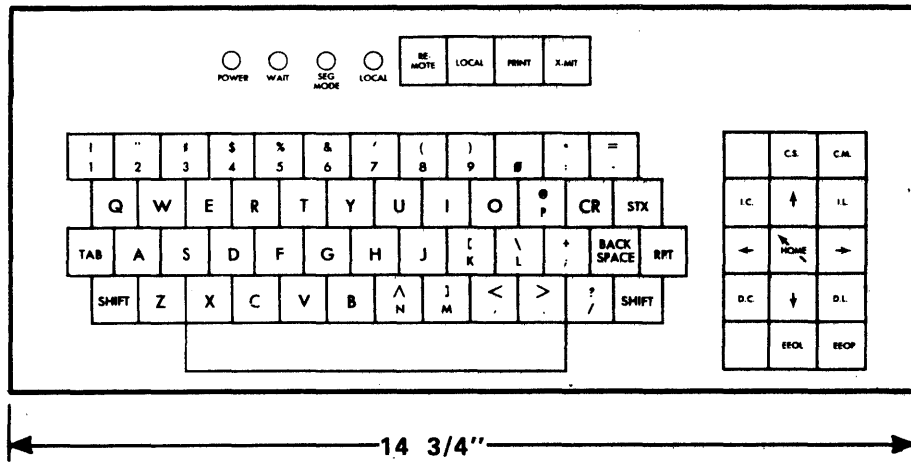
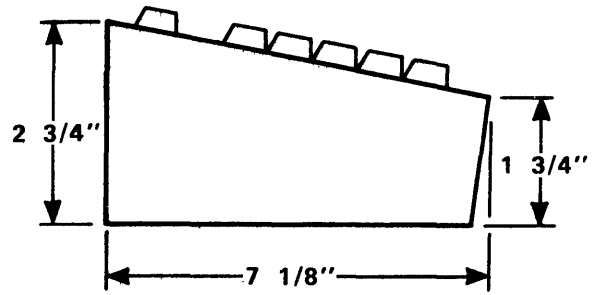
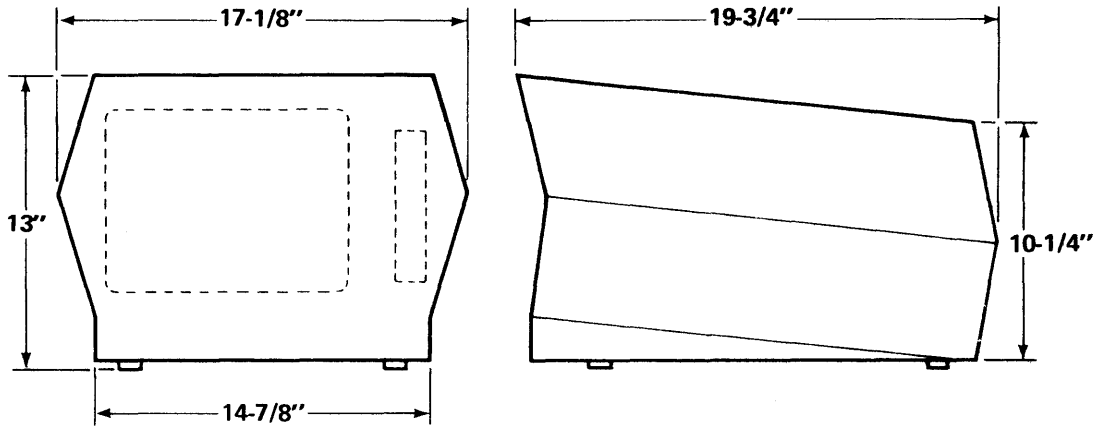


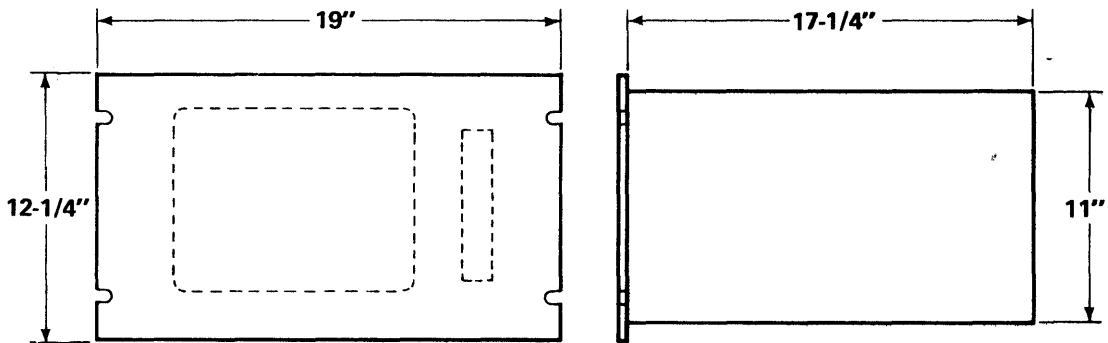
FIGURE 40. KEYBOARD DIMENSIONS

**OUTLINE DRAWINGS**

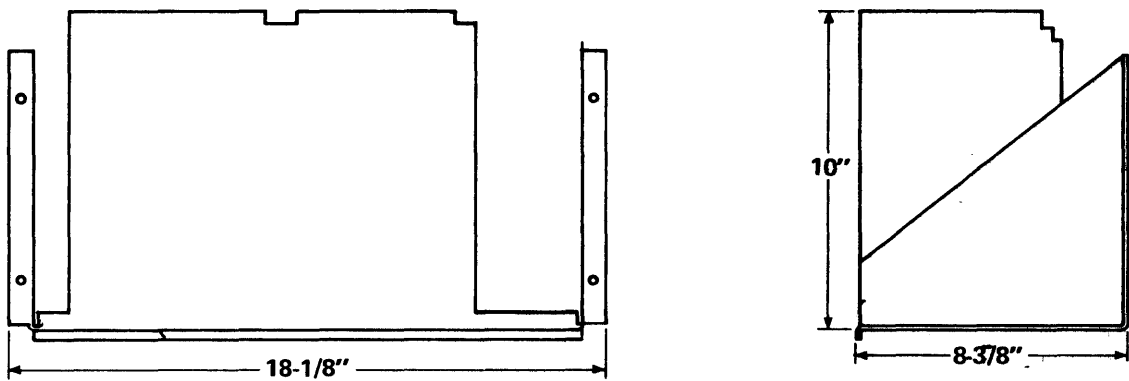


**DESK TOP MODEL WITH MONITOR**

**FIGURE 41. DESK TOP MODEL DIMENSIONS**



**RACK MOUNT MODEL WITH MONITOR**



**RACK MOUNT MODEL WITHOUT MONITOR**

**FIGURE 42. RACK MOUNT MODEL DIMENSIONS**

SPARE PARTS DESCRIPTION		MODEL 420 PART NUMBER	MODEL 425 PART NUMBER	MODEL 426 PART NUMBER
†	TIMING GENERATOR (TG) PCB NO. 1*	933021	933038	930065
†	LINE MEMORY & CHARACTER GENERATOR (LM & CG) PCB NO. 2*	933022	933040	933022
†	PAGE MEMORY (PM) PCB NO. 3*	933023	933039	933023
†	CONTROL PCB NO. 4*	933024	933024	933024
†	CURSOR COUNTER (CC) PCB NO. 5*	933025	933035	930066
†	PARALLEL I/O (PIO) PCB NO. 6*	933026	933026	933026
	DSA PCB	930367	930367	930367
	POWER SUPPLY ASSEMBLY (COMPLETE)	930237	930351	930237
†	POWER SUPPLY REGULATOR PCB*	930172-000	930172-001	930172-000
<b>The following Parts are used on Models 420, 425 &amp; 426</b>				<b>PART NO.</b>
	UNIVERSAL PCB (Prototype board)			933074
†	HCA (HARD COPY ADAPTOR) PCB NO. 10*			930221
	DATA PANEL			930157
	EXTENDER PCB			933030
	KEYBOARD ** COMPLETE WITH 3' CABLE & CONNECTOR (XXX = K/B COVER)		W/O 15 KEY PAD	EKA-8001-XXX
	-008 UNFINISHED	-116 WALNUT WOODGRAIN VINYL	WITH 15 KEY PAD	EKA-8005-XXX
	-054 ARMORHIDE BLUE	-		
	KEYBOARD EXTENSION CABLE (XXX = Length in Inches)			933390-XXX
††	KEY SWITCHES			880031-001
<b>REPLACEMENT MONITOR ASSEMBLY (Monitor replacement must be same as type originally supplied with terminal).</b>				
				<b>MIRATEL</b>
	With P4 (white) phosphor etched face tube			920001-012
	With P31 (green) phosphor etched face tube			920001-014
	CR Tube Only - P4, Etched face			900026-002
	CR Tube Only - P31, Etched face			900026-004
†	MONITOR PCB ASSEMBLY			920006
†	LOW VOLTAGE PCB ASSEMBLY			920011
<b>MISCELLANEOUS TERMINAL PARTS</b>				<b>PART NO.</b>
	MATING CONNECTOR FOR: J1 I/O CONNECTOR = (DB-25S)			781014-003
	Hood For Above (DB-51226-1)			741184-000
	J2 I/O CONNECTOR = (DB-25P)			781014-003
	Hood For Above (DB-51215-1)			741184-000
	J3 KEYBOARD CONNECTOR = (DC-37P)			781013-004
	Hood For Above (DC-51215-1)			741345-000
	J4 PRINTER CONNECTOR = (DA-15P)			781013-002
	Hood For Above (DA-51225-1)			741184-001
	COOLING FAN			740066-000
	PRODUCT DESCRIPTION MANUAL (ADDITIONAL COPIES)			000852-03
	SHIPPING CARTON (WITH INTERNAL PADDING)			211366-000
	SCHMATIC SETS – XXX Refers to Following:			
	-001 Blue Line	-003 Mylar		
	-002 Black Line	-004 Vellum (Sepia)		965031-XXX
	I/O CABLE ASSEMBLY (XXX = length in Inches)			930307-XXX

\*TEC's Printed Circuit Board exchange program permits return of defective, out of warranty PCB's for 50% credit toward the purchase of an exchange PCB of the same type, provided the board returned is not over 12 months old. Exchange PCB's carry the same 90 warranty from date of shipment as new PCB's. Warranty is void on any PCB new or exchange, if TEC Inspection reveals customer attempts to repair or alter the function of the PCB. Contact TEC Peripheral Products Marketing Services Department for board exchange and repair information.

\*\* Keyboard repair - TEC will repair DATA-SCREEN Terminal keyboards provided that the keyboard has not been subjected to excessive shock, heat or other abuse, or if liquids, harmful vapors or abrasive matter have not penetrated the interior to an excessive degree, or if attempts to repair or modify the keyboard's function, or operate it outside its electrical design parameters are not evidenced. Only keyboard parts and components replaced in the repair operation will be warranted for 90 days. Contact TEC Peripheral Products Marketing Services Department for keyboard repair information.

NOTE: TEC's decision as to the condition of parts returned for exchange or repair will be final.

†TEC recommends maintaining one of each as a spare for every 10 terminals per location.

††TEC recommends maintaining five of each as a spare for every 10 terminals per location.

## SECTION VII

### TROUBLE SHOOTING GUIDE

TEC's DATA-SCREEN Terminals have proved exceptionally reliable in field use. It is possible, however, that failures can occur in one of the thousands of interconnections or components used in these complex devices. To reduce terminal downtime to a minimum, this section provides a suggested PCB and subassembly replacement sequence based on malfunctions visible on the screen.

Most problems are caused by failures in one printed circuit board. Such failures do not normally cause "chain reaction" failures of other components on the affected PCB, or on other PCB's in the terminal. By maintaining a spare set of PCB's, the great majority of problems can be repaired in a matter of minutes. Suspect PCB's can be returned to TEC for replacement on an "exchange" plan (see Spare Parts List - page 98).

**NOTE:** Good trouble shooting practice requires that supply voltages be checked to avoid damaging replacement PCB's. Nominal supply voltages are listed behind the rear panel on a label located next to the Power ON-OFF switch. Voltages are measured on the terminal strip labeled 0 to 11 in the power supply assembly.

**CAUTION:** 120 Volt supply is present on this strip. Exercise caution when placing probes at the various test points.

## DISPLAY PROBLEMS

**Displays some Wrong Alphanumerics  
(e.g. B displays as A)**

change LM & CG PCB  
↓  
change PM PCB  
↓  
change CONTROL PCB  
↓  
change P-I/O PCB  
↓  
change DSA INTFC PCB

**Good Cursor, No Characters**

change LM & CG PCB  
↓  
change CC PCB  
↓  
change P-I/O PCB  
↓  
change CONTROL PCB  
↓  
change PM PCB

**No Display, No Sync**

check voltages  
↓  
change TG  
↓  
change LM & CG  
↓  
change monitor

**No Display, No Raster**

check fuses  
↓  
check voltages  
↓  
change monitor

**No Display, Good Raster**

change CC PCB  
↓  
change TG PCB  
↓  
change LM & CG PCB  
↓  
check voltages  
↓  
change monitor

**Distorted Characters**

change LM & CG PCB  
↓  
change TG PCB  
↓  
change monitor

**Good Alphanumerics, No Special Characters**

change LM & CG PCB  
↓  
change TG PCB  
↓  
change CONTROL PCB

**DISPLAY PROBLEMS (cont'd)**

**Good Display, But Rolls**

↓  
check vertical sync on monitor \*  
↓  
change TG PCB  
↓  
change LM & CG PCB

\* See Monitor manufacturers manual.

**Whole Display Moves**

↓  
change CC PCB  
↓  
change TG PCB  
↓  
check voltages

**Comes On With Screen Full of One Character**

↓  
change PM PCB  
↓  
change LM & CG PCB

**Comes On With Screen Full of Random Characters**

↓  
change CONTROL PCB  
↓  
change DSA PCB

**Display Is Wrong Height or Width**

↓  
check monitor  
↓  
change TG PCB

**Display Shows Jagged Lines (may be crackling noise)**

↓  
change monitor

**Little or No Brightness Control**

↓  
check brightness control  
↓  
change monitor

**Characters or bits Added or Dropped on Edit Functions**

↓  
change LM & CG PCB  
↓  
change CONTROL PCB  
↓  
change PM PCB

**Cursor Won't Move in One or More Directions**

↓  
change CONTROL PCB  
↓  
change CC PCB  
↓  
change keyboard

**Cursor Disappears Off End of Display**

↓  
change CC PCB  
↓  
change CONTROL PCB



**Screen Slowly Fills With Spaces or any character**

↓  
check keyboard (stuck key)

**Can't Clear Screen (CS & CM key do not work)**

↓  
change CONTROL  
↓  
change PM PCB  
↓  
change Keyboard

---

**INPUT/OUTPUT PROBLEMS**

**No Input From or Output to CPU**

↓  
change DSA PCB  
↓  
change P-I/O PCB  
↓  
change CC PCB

**One Particular Character Won't Enter from Keyboard**

↓  
change keyboard

**Cursor Won't Move on Input From Keyboard**

↓  
change P-I/O PCB  
↓  
change CC PCB

**Protect or Blink Functions Won't Work**

↓  
change PM PCB  
↓  
change CONTROL PCB

**One or More Lights on DATA PANEL stays on or won't light**

↓  
change DATA PANEL PCB  
↓  
change P-I/O PCB

**Voltage(s) Low or High**

↓  
check fuses

↓  
Pull all PCBs and Recheck Voltage(s)

↙  
**Still bad**

change power Supply

↘  
**Good**

Reinsert PCBs one at a time until voltage(s) go bad. Last PCB inserted is bad.

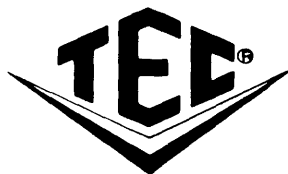
## WARRANTY

The Seller agrees, represents, and warrants that the equipment delivered hereunder shall be free from defects in material and workmanship. Such warranty shall not apply to accessories, parts or material purchased by the Seller unless they are manufactured pursuant to Seller's design, but shall apply to the workmanship incorporated in the installation of such items in the complete equipment.

Seller's obligations under said warranty are conditioned upon the return of the defective equipment, transportation charges prepaid, to the Seller's factory, and the submission of reasonable proof to Seller prior to return of the equipment that the defect is due to a matter embraced within Seller's warranty hereunder. Any such defect in material and workmanship must have become apparent and Buyer must have notified Seller thereof within ninety (90) days after delivery, or ninety (90) days after installation if the installation was accomplished by the Seller.

Said warranty shall not apply if the equipment shall not have been operated and maintained in accordance with the Seller's written instructions applicable to such equipment, or if such equipment shall have been repaired or altered or modified without Seller's written approval; provided, however, that the foregoing limitations of warranty insofar as it relates to repairs, alterations or modifications shall not be applicable to routine preventive and corrective maintenance which normally occurs in the operation of the equipment.

The extent of Seller's liability under said warranty is limited to the repair or replacement of any defective accessory, part or material with a similar item free from defect, and the correction of any defect in workmanship. Said warranty does not extend to loss of use or consequential damages.



**TEC, Incorporated**