TEC® INCORPORATED

TELETYPE REPLACEABLE
MODEL 440
PRODUCT DESCRIPTION

#832

SERIES 400 DATA-SCREEN™ TERMINALS

PRODUCT DESCRIPTION

MODEL 440

TELETYPEWRITER REPLACEABLE DATA-SCREEN™ Terminal

1920 Character Display, 80 characters/line, 24 lines
1728 Character Display, 72 characters/line, 24 lines

JANUARY, 1973

- 832 -

Price: $7.50

All Specifications Subject to Change Without Notice

INCORPORATED

9800 NORTH ORACLE ROAD

TUCSON, ARIZONA 85704

(602) 297-1111 TWX 910-952-1377

Printed in U.S.A.

TABLE OF CONTENTS

TABLE OF CONTENTS
(cont'd)

ILLUSTRATIONS

ILLUSTRATIONS
(cont'd)

INTRODUCTION

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

The Series 400 Display is 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.

SYSTEM COMPATIBILITY

A variety of standard interface control features and page formats assures compatibility with most systems and display requirements. The Model 440 provides a versatile, economical input/output station. Sixty-four ASCII graphic characters are displayed using a 5 x 7 dot matrix.

Model 440 DATA–SCREEN Terminals are readily adaptable to many standard computer systems and may be connected directly to the computer or located remotely. These units are compatible with, and may replace Teletype ® Models KSR 33 or KSR 35, without automatic answerback response to WRU command.

FIGURE 1 DESK TOP MODEL WITH MONITOR

SECTION I

INSTALLATION

The Model 440 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, 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 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 DESK TOP WITHOUT 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 30.

b. Desk top; without TV monitor but with logic and power supplies. For use with remote TV monitors. See Figures 2 and 30.

c. Rack mount (for standard 19-inch rack) with 12-1/4" high front panel. Consists of TV monitor, logic and power supplies. See Figures 3 and 31.

d. Rack mount (for standard 19-inch rack) for use with 10-1/2" high front panel. Accomodates logic and power supplies only. Designed for use with remote monitors. See Figures 4 and 31.

DESK MOUNTING

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 12-1/4" high with cutout to accomodate the tube face. When a TV monitor is not provided in the assembly, the panel height is 10-1/2" (NOTE: 10-1/2" panel to be provided by customer). All power, keyboard and signal connections are made at the rear of the units. Clearance is required for convection cooling of the electronics.

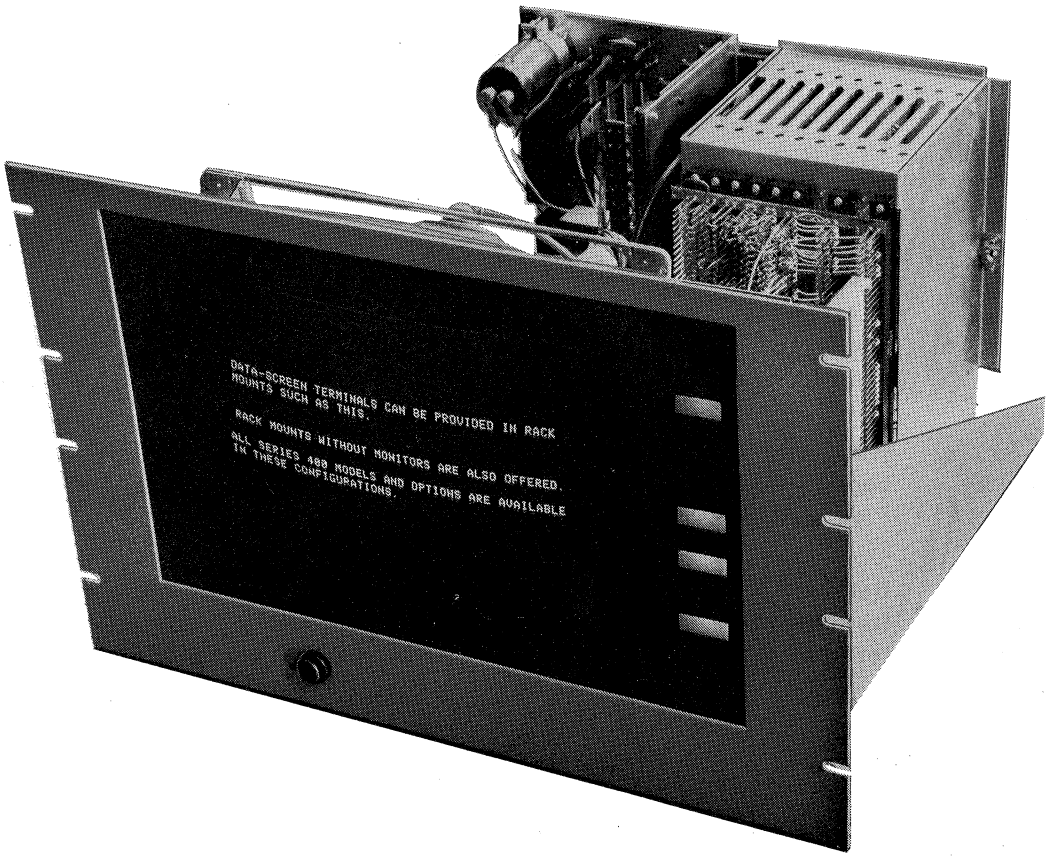


FIGURE 3 RACK MOUNT MODEL WITH MONITOR

PCB OPTION SETTINGS See Section V, Pages 64-68

Optional features that are enabled by switches are preset at the factory. To insure that these features meet your requirements, remove printed circuit board FUNCTION CONTROL (position 5) and TTY INTERFACE (position 6) from the card cage. Refer to Figures 24 and 25 for switch locations. Set switches accordingly.

Replace the two 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, 60 Hz 3-hole grounded outlet (or to 240 VAC 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 is illuminated. If the switch fails to light, check the 2 amp fuse on the backpanel (See Figure 5).

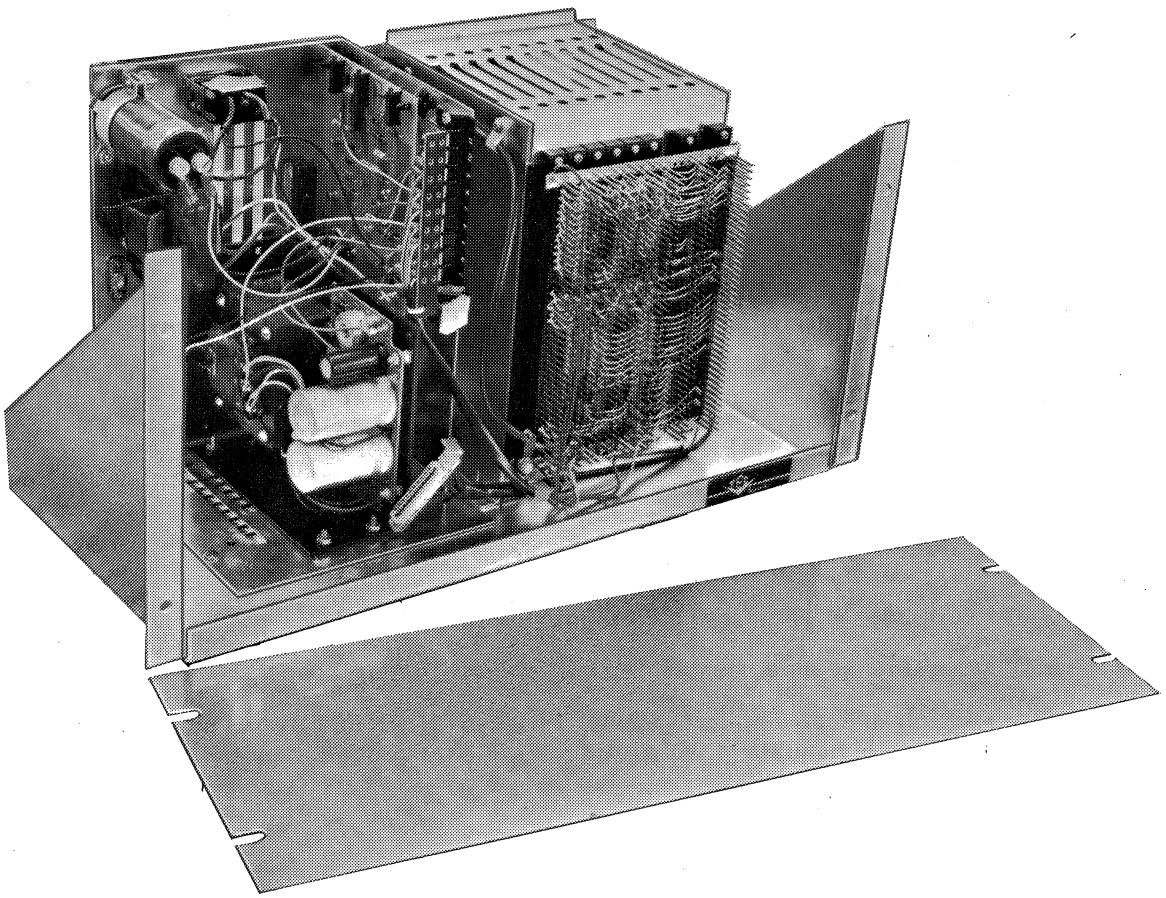


FIGURE 4 RACK MOUNT MODEL WITHOUT MONITOR

(panel not provided)

- Allow approximately one minute for the CRT filament to warm up. The blinking cursor should appear in the lower 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 a malfunction is indicated. See Section VII, Trouble Shooting Guide.

- Depress each of the standard alphanumeric keys to verify that the correct character is displayed. Repeat with the SHIFT key to display shifted characters. Depress the REPEAT key and any alphanumeric key together. The cursor will advance from left to right, loading characters as it moves and sounding a bell near the end of the line.

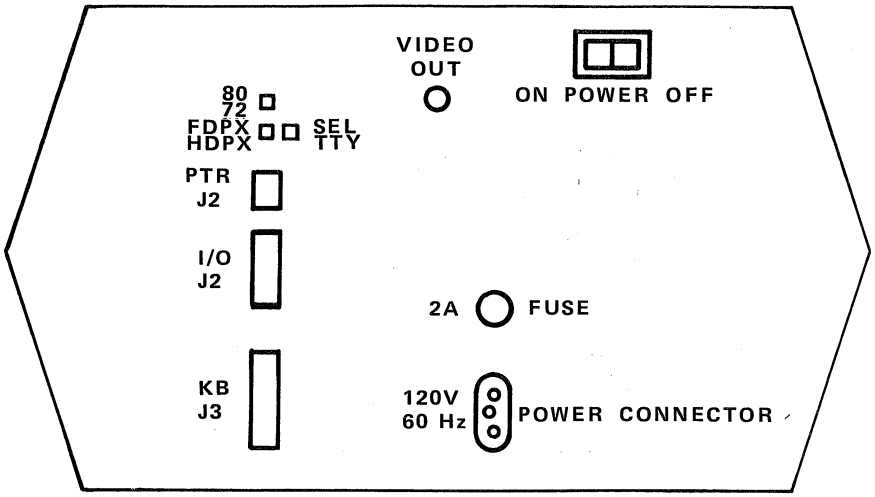
- Disconnect power before mounting the unit in its final location.

The terminal is cooled by convection and sufficient space for air flow must be provided. Rack mounted units should be supported from the sides or bottom when moving.

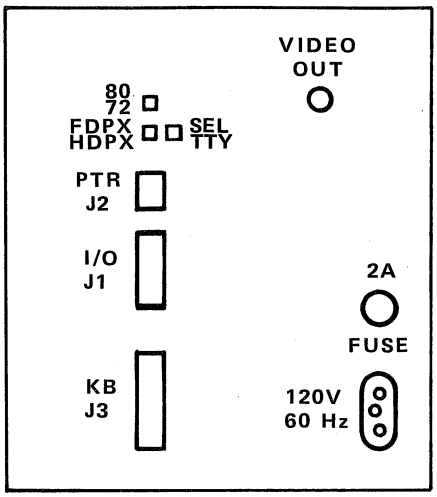
Connect the processor I/O cable to I/O-J1. See Processor I/O Connections Figures 5, 14 & 15.

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.

DESK TOP MODEL
With Monitor



DESK TOP MODEL
Without Monitor



RACK MOUNT MODELS
With & Without Monitors

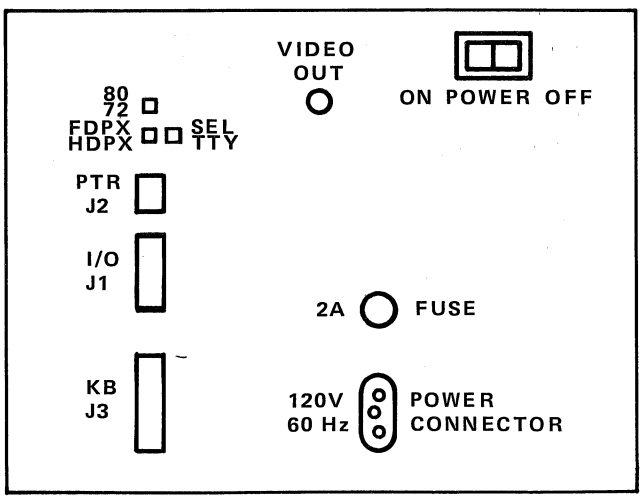


FIGURE 5 BACK PANEL CONNECTOR AND SWITCH LOCATIONS

SECTION II

OPERATING INSTRUCTIONS

KEYBOARD FAMILIARIZATION

Model 440 DATA–SCREEN Terminal utilizes the basic keyboard arrangement of a teletypewriter to simplify operator transition. To practice typing, turn on power, depress the REPEAT key and any displayable character simultaneously. Characters will appear on the bottom line of the screen from left to right. Near the end of a line a bell in the keyboard will ring. At the end of the line, the cursor will automatically move to the beginning (left) of the bottom line and the entire page will move up one line, if the automatic CR–LF option is set to do so (See PCB option settings, Section V, pages 64-68.) If the option is not enabled, depress the CR key followed by the LF key to move the cursor to the beginning of the bottom line.

Depress each of the standard alphanumeric keys and verify that the correct character is displayed on the screen. Depress the shift key and verify that all shifted characters are displayed properly.

KEYBOARD KEYS AND CODE FUNCTIONS

NOTE: All ASCII codes referred to in this manual are in hexadecimal notation. See Code charts, pages 54 & 55.

ALPHANUMERIC KEYS

Sixty-four alphanumeric characters are provided from the 95 possible ASCII graphics. These characters are those contained in the center four columns of USAS X3.4-1967 USASCII and shaded in Figure 6. The shift key selects one of two characters on shiftable keys. Non-shiftable keys generate the same code whether the shift key is depressed or not.

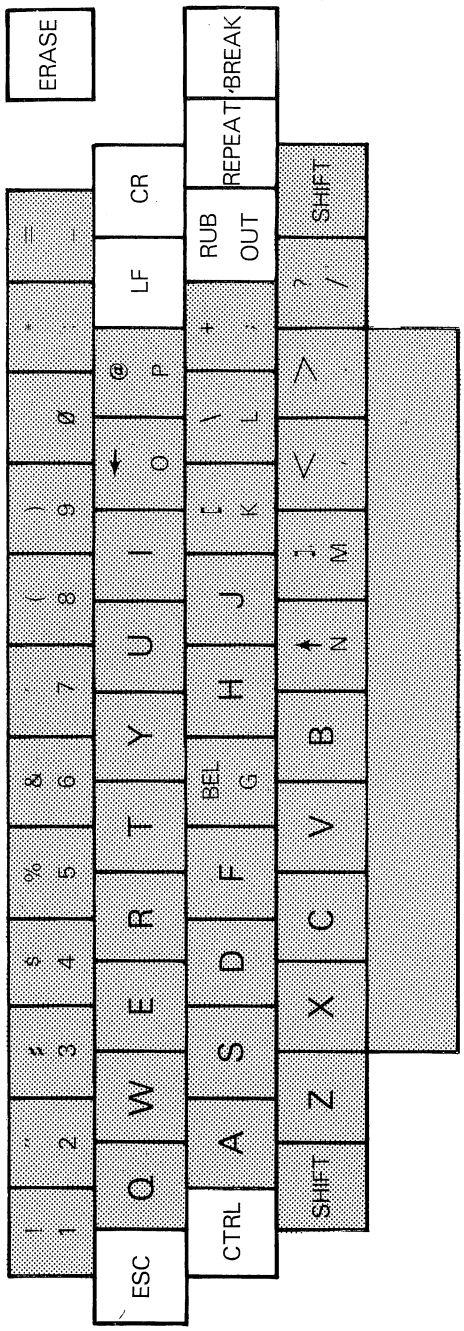


FIGURE 6 MODEL 440 ALPHANUMERIC KEYS

FUNCTION KEYS

In addition to the alphanumeric characters and symbols located on the keyboard, several function keys are provided. These keys are illustrated by the shaded areas of Figure 7.

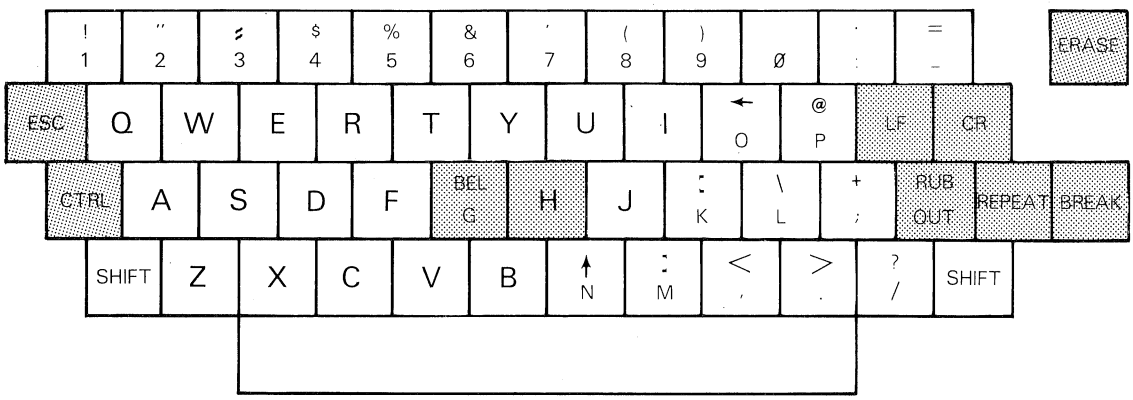


FIGURE 7 FUNCTION KEYS

CARRIAGE RETURN (CR) - - When the Carriage Return key is pressed, the CR code (ØD in the ASCII code set) is transmitted to the processor via the communication line if the unit is in the Remote mode (DSR signal on pin 6 of the communication connector above +3VDC.) When this code is received, the cursor moves from its current location to the left-most column.

OPTION: If the automatic CR–LF option is set (see pages 66 & 68), depressing the CR key will also generate an LF code (ØA) after the CR code. See page 51 for detailed description of the six ways this automatic circuit can function.

LINE FEED (LF) - - Depressing the Line Feed key moves all data on the screen up one line, without affecting the horizontal cursor location on the screen. Data in the top line is lost, and the bottom line will contain all spaces. The LF code (ASCII ØA) is transmitted to the communication line if the unit is in the Remote mode (DSR signal on pin 6 of the communications connector above +3VDC)

NOTE: Refer to Carriage Return (on page 13) and Automatic CR–LF section (pages 51,52) for a complete description of the options regarding generation of the LF code.

REPEAT KEY - - When used in conjunction with another character or function key, the ASCII code for that character or function will be repeatedly transmitted at a maximum rate of 25 hertz. At transfer rates below 300 baud, the Repeat function will occur as fast as the communication line allows. Characters will be stored in memory and displayed at the repeated rate if the communications line is in Half-Duplex mode, or if the characters are "echoed" back to the receiver.

RUB OUT - - This key generates the ASCII delete code (7F). This code is not recognized by the Terminal but may be used in communicating with the Processor.

ESCAPE - - This key generates the ASCII Escape code (1B). This code is not recognized by the Terminal but may be used in communicating with the Processor.

BREAK - - This key causes the communications line to go to the "Space" level for as long as the key is depressed.

CONTROL KEY (CTRL) - - Used in conjunction with the key or keys that normally generate those codes in columns 4 and 5 of the ASCII Code Set (see Keyboard Code Charts pages 54-55) and causes the code generated to be changed to the corresponding code shown in columns 0 or 1 of the ASCII Code set. This allows the keyboard to generate many additional codes. Most of the codes generated in this way are not used by the Terminal but may be used in communicating with the Processor. Some of the codes generated in this way are redundant. These codes are the Line Feed, Return and Escape codes.

ERASE KEY AND FUNCTION

When the ERASE key is depressed, with the shift key, space codes (code 20) are written into all page memory positions. Simultaneously, the cursor returns to the beginning of the bottom line. No code is transmitted on the communications line, nor will a single code received on the communication line erase the screen. However, 24 Line Feeds and 1 Carriage Return will leave the screen in the same condition as if the ERASE key had been pressed.

BELL FUNCTION (BEL)

The computer may signal the operator by sending a BEL code (ASCII 07) to the Terminal interface and causing the bell located in the keyboard to ring. The Terminal also generates a bell signal when the cursor approaches the end of the line. In the Model 440 eight entry positions remain when the bell sounds. The BEL code may be generated by pressing the CTRL and G keys (G^C).

BACKSPACE FUNCTION

The Model 440 may be backspaced one character at a time up to the left column by using the backspace code (ASCII 08). This code may be generated by the keyboard by using the CTRL key and the letter H (H^C).

SECTION III

THEORY OF OPERATION

NOTE: All ASCII codes referred to in this manual are in hexadecimal notation See code charts, pages 54 & 55.

INTRODUCTION

400 Series DATA–SCREEN Terminals are general purpose CRT display terminals for use in data processing, control and communications systems. Interface options allow direct connection to a processor or various types of remote connection.

The basic DATA–SCREEN Terminal consists of three modules: a power supply, a TV-type monitor and a card cage assembly. The card cage accomodates up to 10-printed circuit boards of which four are used for the basic device and two additional PCB's for interface.

The four basic boards are the Timing Generator, Character Generator, Page Memory and Page Control.

The TIMING GENERATOR board contains a basic oscillator and several counter-type frequency dividers. It provides timing signals to the rest of the display.

The CHARACTER GENERATOR board stores one row of characters and converts from ASCII code to video signals for the monitor.

The PAGE MEMORY board stores the entire page of data. Its contents can be loaded and selectively altered through the interface, which includes keyboard and communications line inputs.

The PAGE CONTROL board consists of three counter circuits. These are, in effect, address registers containing the current addresses of the display (monitor), the Page Memory and the cursor.

PRINTED CIRCUIT BOARD FUNCTIONS

TIMING GENERATOR – Board 1. See Functional Diagram, Figure 8.

BASIC OSCILLATOR

The oscillator frequency of 23.9616 MHz is determined as follows:

50	Hz	60	Hz	Refresh rate (sync. to power line)
x 312		x 260		Scans per frame
15.600		15.600	KHz	Horizontal frequency
x 768		x 768		Dots per scan (128 x 6)
11.9808		11.9808	MHz	Base frequency (12 MHz Nom.)
x 2		x 2		Divider in osc. circuit
23.9616		23.9616	MHz	Crystal frequency (24 MHz Nom.)

DOT COUNTER

There are two dot counters used in the Model 440. The first dot counter divides the 12 MHz base frequency into six segments and these segments are labeled DOT A, B, C, D, E and F. These signals are used in generating the page memory clock and the horizontal synchronization signal.

The second dot counter divides the 12 MHz base frequency into seven equal segments and these segments are labeled DOT 1, 2, 3, 4, 5, 6 and 7. These signals are used to generate the line memory clock signal, the various clocks used in the character generator and the clock for the display character counter.

CHARACTER COUNTER

The display character counter controls the display of characters on the screen and generates blanking pulses to prevent display beyond either end of the line. Two signals are generated by the character counter called Enable - 72 and

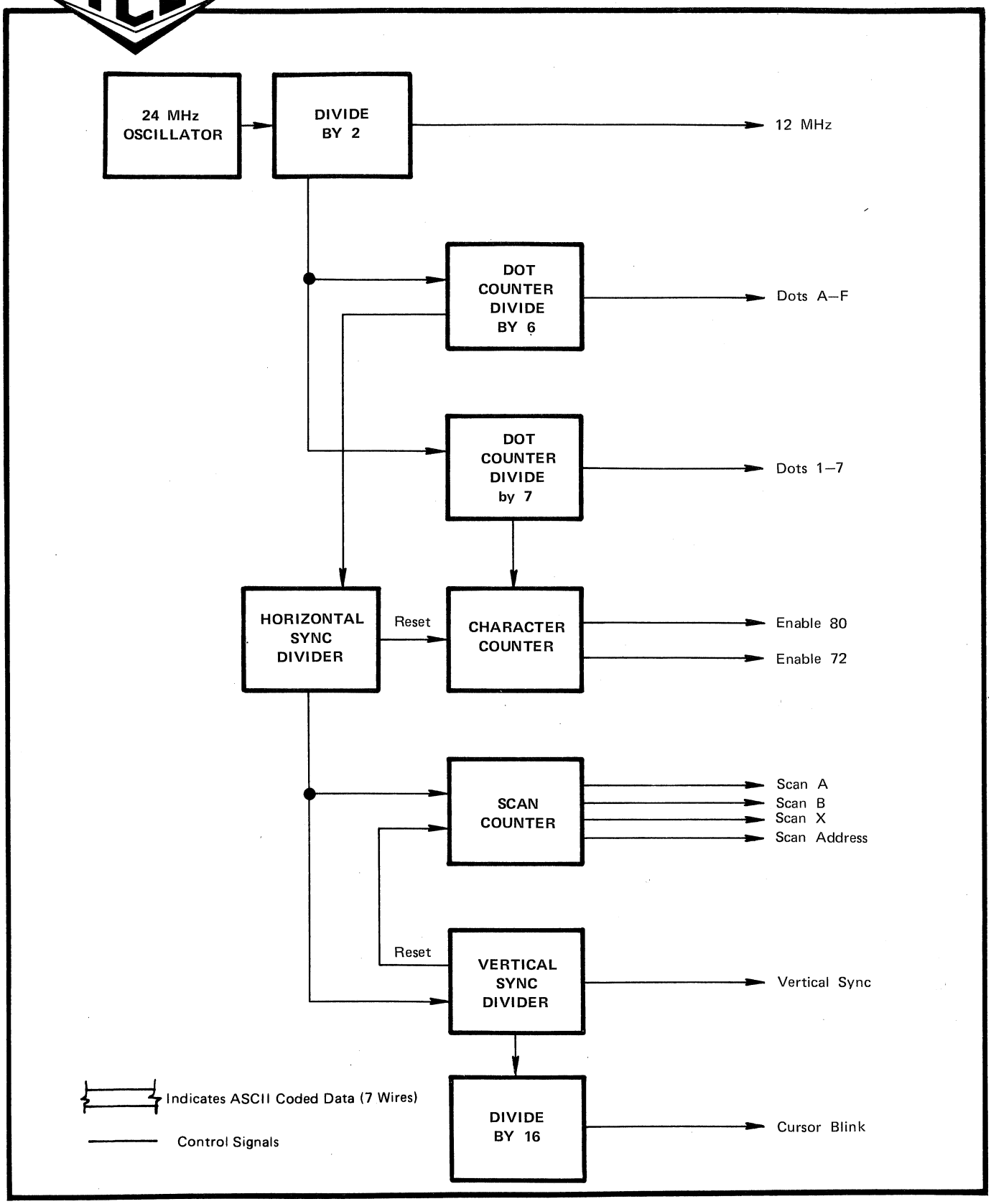


FIGURE 8 FUNCTIONAL DIAGRAM – TIMING GENERATOR

Enable - 80. The first of these is 72 characters in length (504 dots) and the second is 80 characters in length (560 dots). Enable - 80 is used to gate the line memory clock on when the counter reaches binary zero and off as the counter reaches binary eighty (end of count 79), so that the line memory always receives 80 clocks on each horizontal scan.

As the Model 440 is capable of displaying either 72 or 80 characters per line, the appropriate choice between Enable - 72 and Enable - 80 is fed to the blanking gates to restrict display to 72 or 80 characters, as selected.

In addition, the display is centered in the 72 character mode by presetting the character counter to 111, and in the 80 character mode by presetting to 115. Reset to 0 after count 127 then begins the display.

SCAN COUNTER

The scan counter is a modulo 10 divider which counts out a group of 10 horizontal scans assigned to any single line. It is clocked by the horizontal sync pulse and is reset to a known state at the leading edge of the vertical sync pulse. The scans are labeled as follows:

Count	Binary	Scan Name	Display
0	0000	B	Blank
1-7	0xxx	1-7	Character
8	1000	X	Cursor
F(15)	1111	A	Blank

Modulo 10 reset is accomplished by presetting the counter to state F (15) at the conclusion of Scan X.

HORIZONTAL SYNC DIVIDER

The H-Sync divider clocks on one of the divide-by-six dots and divides the rate by 128 to form an H-Sync pulse approximately 4 microseconds long once every 64 microseconds. The H-Sync pulse is used for the monitor sync circuits and in several reset and clock lines within the system to assure that the screen refresh remains stable.

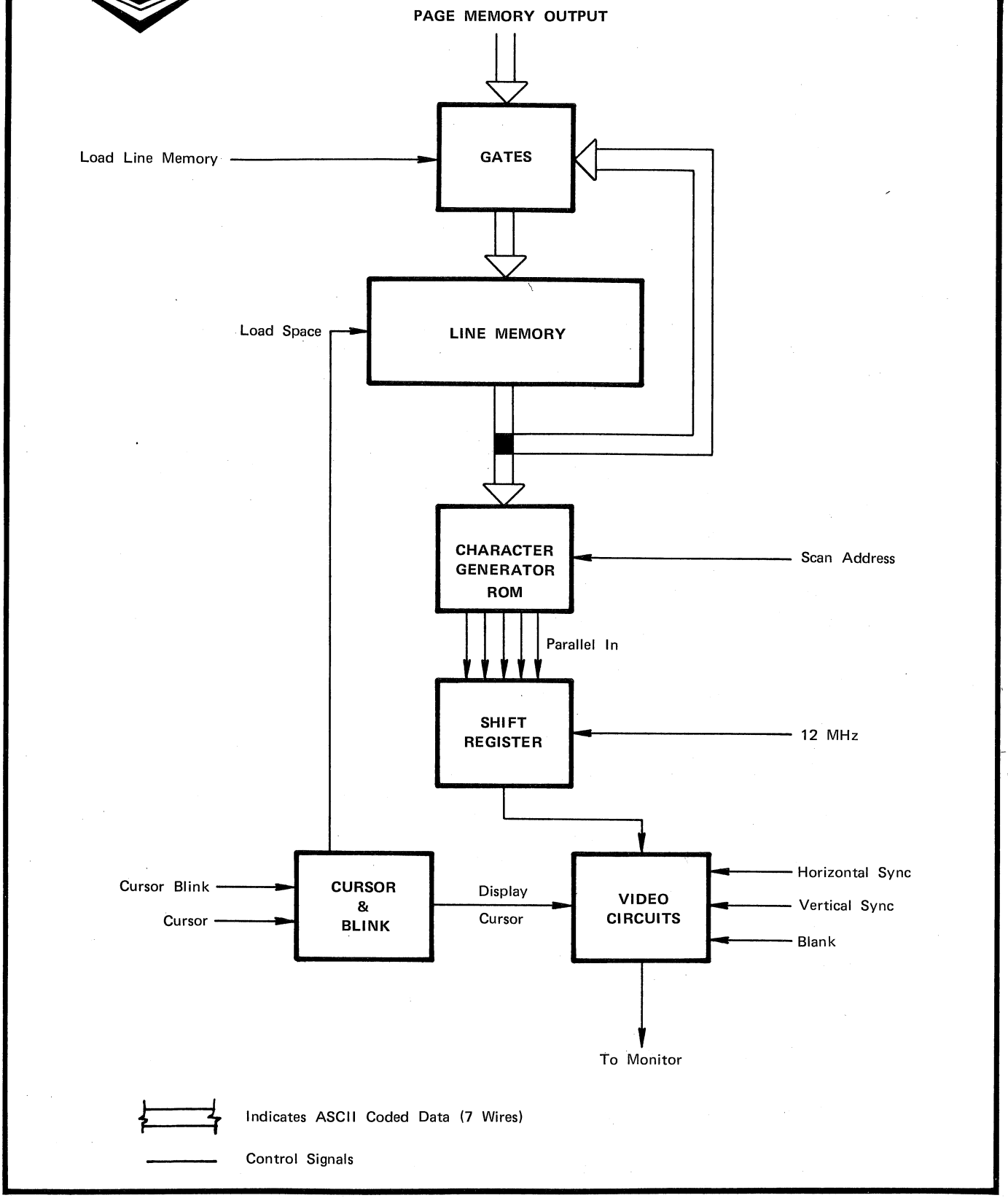


FIGURE 9 FUNCTIONAL DIAGRAM – CHARACTER GENERATOR

VERTICAL SYNC DIVIDER

The V-Sync divider clocks from the H-Sync signal and divides the H-Sync rate by 260 (or 312) to form a V-Sync pulse approximately three scans long every 16.7 millisecond (20 milliseconds for 50 Hz displays). As with the H-Sync pulse, the V-Sync signal is used in the monitor sync circuits and in several internal reset and clock lines to assure stable screen refresh at 60 Hz (or 50 Hz).

BLINK RATE COUNTER

The blink rate counter divides the vertical sync frequency by 16 to cause character blinking alternately with the cursor at 3.75 Hz (3.12 Hz for 50 Hz displays).

CHARACTER GENERATOR – Board 2. See Functional Diagram, Figure 9.

LINE MEMORY

This section of the display consists of two quad-80 bit shift registers operated in bit-parallel, character-serial mode. Seven bits per character are stored in the recirculating shift registers, although only the lowest order 6 bits are used in this application. The line memory stores one line of characters at a time, recirculating the data in step with the character generator to display the full line of characters.

During refresh, the line memory is reloaded with a line of characters from the page memory during Scan A. This data is then recirculated nine times, seven of which are used to display characters (Scans 1 through 7). In cursor display, the desired character is alternately loaded normally or replaced by a "Space" code, depending on the present value of the blink signal. The blink signal is a square wave at approx. 3.75 Hz (See Timing Generator). Whenever the character at the present cursor location is replaced by a space code, the cursor gates are enabled, displaying a solid underline seven dots wide, one scan below the normal bottom line of the characters (i.e. on Scan X).

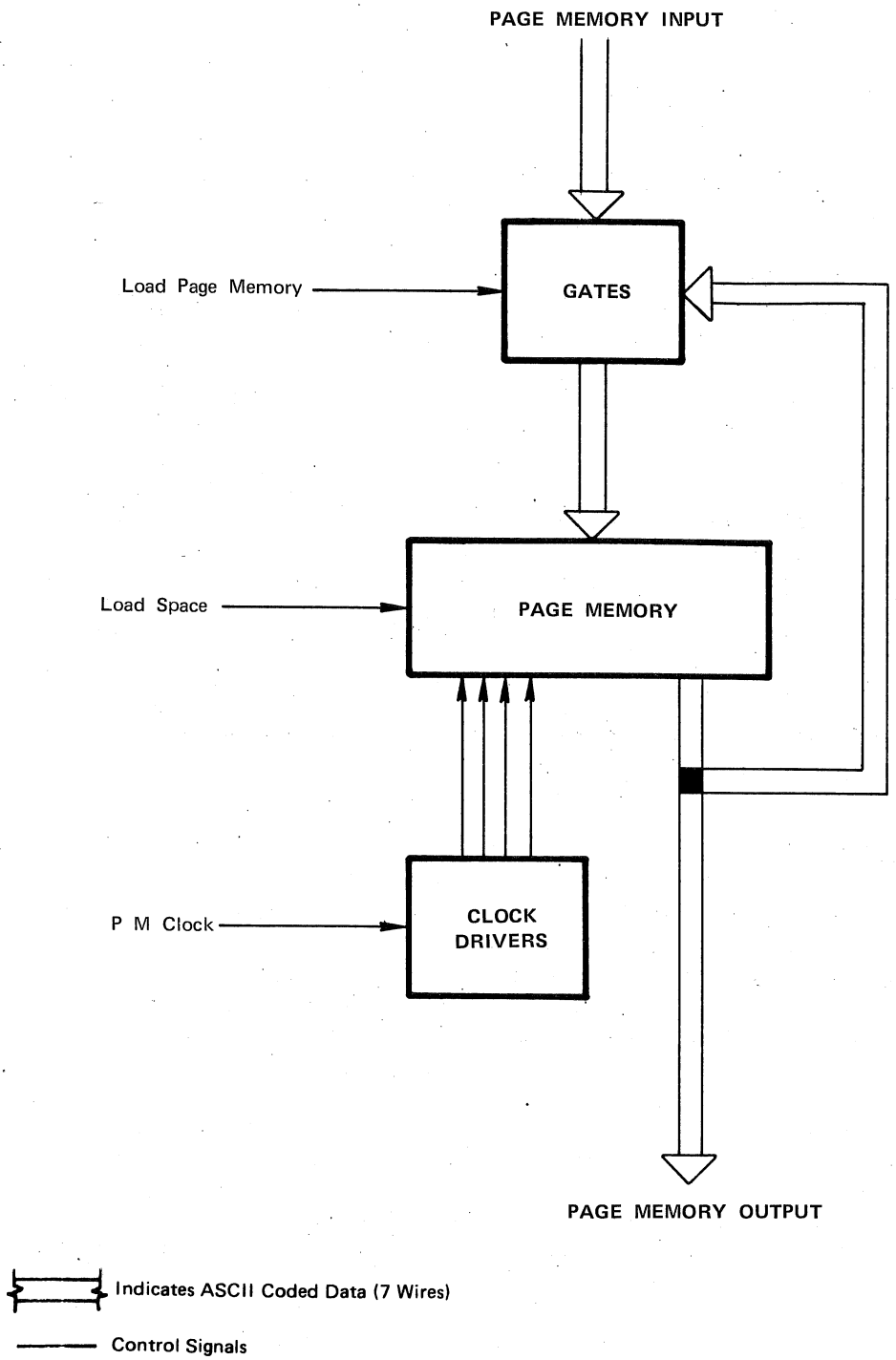


FIGURE 10 FUNCTIONAL DIAGRAM – PAGE MEMORY

READ–ONLY–MEMORY

The Character Generator circuits convert the ASCII code stored in the line memory into the full 5 x 7 dot matrix pattern for display on the monitor. The standard 64 ASCII displayable symbols (slightly modified to correspond to teletypewriter operation) in columns 2, 3, 4 and 5 of the ASCII code chart are converted to displayable dots by an MOS Read-Only-Memory. Since the page memory (see later section) stores only characters in columns 2 thru 5 of the ASCII chart, the Read-Only-Memory is always enabled. Counters control the scan address of the Read-Only-Memory and only the lowest order 6 bits are sent from the line memory to the character generator for character display.

VIDEO GATES

A shift register converts the parallel dot information coming from the Read-Only-Memory to a series of dot pulses for the video output. Various gates blank the output on dots 6 and 7 of each character (the 'dead' area between characters), at the beginning and end of each line, during the three scans between rows (scans X, A and B) and beyond the top and bottom of the displayable rows. In addition, display is inhibited for a short time after line feed to allow the page memory to resynchronize.

Composite video and sync, close to NTSC standards, is provided at the BNC connector on the rear panel for driving remote TV monitors.

PAGE MEMORY - Board 3. See Functional Diagram, Figure 10.

PAGE MEMORY

The page memory consists of twelve 1024-bit MOS serial shift registers connected in a bit-parallel, character-serial format, along with input recirculate gates and clock driver. The switching of the input gates is controlled by gates on the Function Control board, in the interface.

Each 1024-bit shift register is actually two 512-bit registers multiplexed. In addition, the two 1024-bit shift registers in each bit position are multiplexed. Thus while the page memory is recirculating at nearly 4 MHz, each bit in the memory is advancing at only 1 MHz, lending to cooler operation than if all bits were required to advance at 4 MHz.

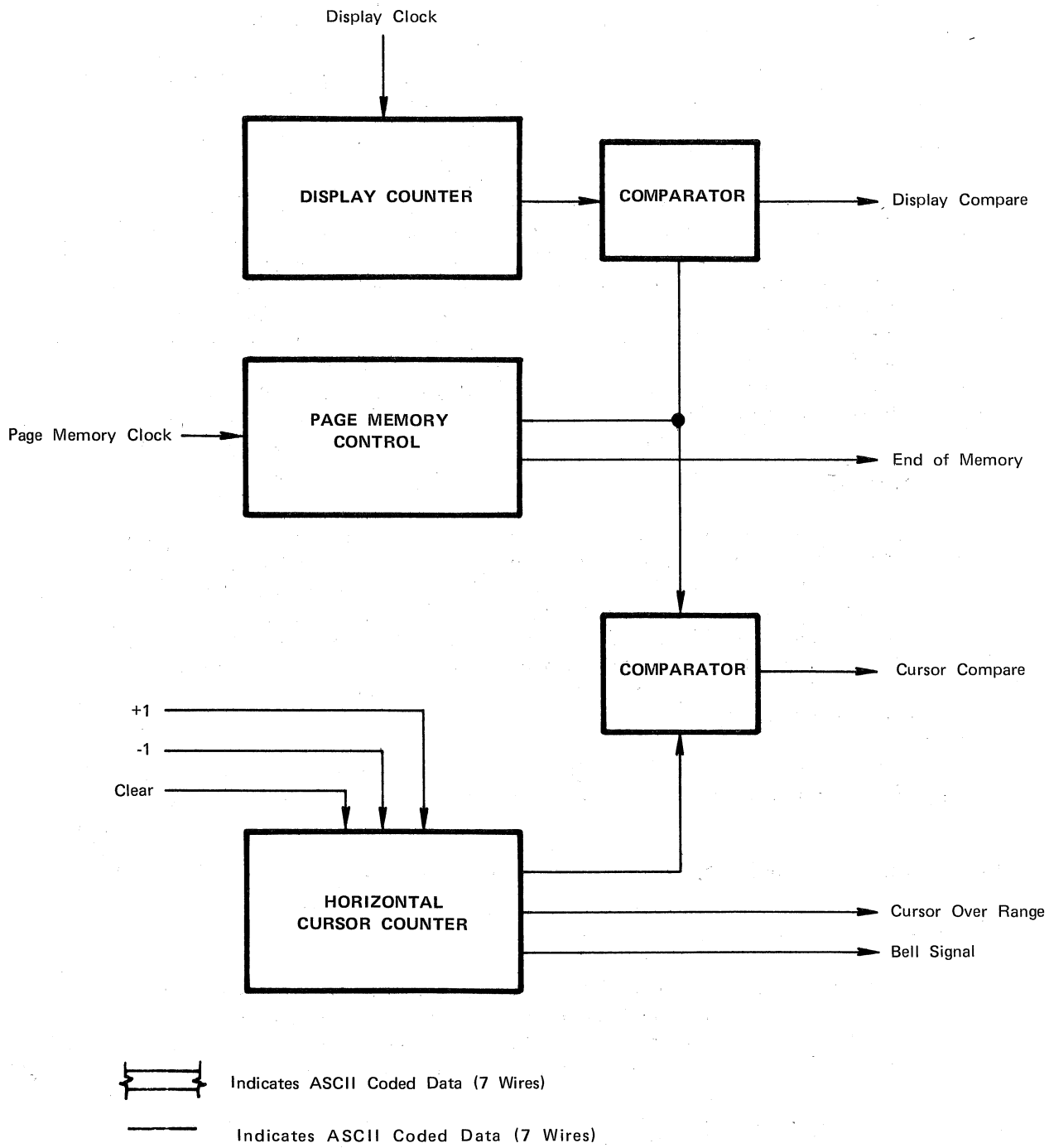


FIGURE 11 FUNCTIONAL DIAGRAM – PAGE CONTROL

The output circuits provide properly timed outputs to the rest of the terminal logic.

Provision is made to utilize a seventh bit in the page memory, but the seventh bit is not used in the Model 440.

Screen erase is provided in the page memory by forcing all data bits to the space code (ASCII hexadecimal code 2Ø). In addition, the small "dead" area at the end of the memory is continually forced to Space codes, so that a new blank line appears during a line feed operation.

Input to the page memory consists of the seven parallel data lines from the receiver and a timed strobe coincident with the comparison between the page memory address and the present cursor location.

PAGE CONTROL – Board 4. See Functional Diagram, Figure 11.

The Page Control board contains the counters and clock gates which control the recirculation of the page memory. This board contains the page memory counters, the cursor counter, the time-out circuit, the display row counter and the page memory clock gates.

PAGE MEMORY COUNTERS

The page memory counters contain the present location of the page memory, i.e. the address of the character that is present on the output lines of the page memory, at each moment. Alternatively, it may be thought of as the address into which a data word would be loaded if the page memory load command were to come along at that instant. The counters are arranged into two sections, horizontal and vertical. Normally, the horizontal section counts 0 through 79 and resets to 0. Each time it resets, a pulse is gated to the vertical section, which counts 0 through 24. Row 24 consists of the extra 128 characters at the end of the memory. During row 24, the horizontal section is required to count 128 characters, instead of the usual 80, through gating. Thus a total of 2048 possible locations, the "length" of the page memory, is accounted for.

CURSOR COUNTER

The cursor counter stores the present cursor location on a single line. The bottom line entry feature of the Model 440 requires only a horizontal cursor address, the vertical address always being Row 24 (at binary count 23). The cursor counter is a seven-stage up-down counter, which is advanced one count each time a character is loaded into the page memory. The counter is updated shortly after a page memory load command.

The cursor counter is capable of backspacing one count at a time up to the left column position. Backspacing is non-destructive, i.e. no characters in memory are altered in a backspace operation. If the cursor appears below a displayable character, the cursor and the character will alternate at a 3.75 Hz rate. The backspace function is initiated in the interface by receiving the ASCII hexadecimal code 08, generated in the keyboard by pressing the Control key (CTRL) and the letter H (H^C, in standard terminology).

The cursor counter generates a signal whenever it reaches a position eight characters before the end of the line for the purpose of ringing the keyboard bell. This occurs at position 64 when the display line switch is set to 72 characters (down) or at position 72 when the switch is set to 80 characters (up).

The cursor counter also generates a signal to indicate when the cursor goes beyond its intended range. Specifically, this signal is generated whenever the cursor is at position 73 in the 72 character mode or position 81 in the 80 character mode. The input to the cursor counter is cut off and the cursor will remain in the over-range condition until a Carriage Return (or a backspace, H^C) occurs. The cursor will not be displayed. The over-range signal is fed to the automatic CR–LF generator in the interface and will cause CR and LF to be transmitted if the option is selected to do so. However, the cursor will not return to the left column position unless and until CR is received. Transmission of characters is not inhibited and will continue so long as keys are being pressed.

TIME OUT CIRCUIT

The page memory shift registers are of such a design that they must be clocked every 100 microseconds or so in order to guarantee that data

will not be lost. The time out circuit sets whenever the time since the last clock pulse approaches the limit. It begins clocking the page memory at a slow rate, until the page memory enters one of its normal states at 4 MHz (full recirculate) or 1.7 MHz (load line memory). The principle function of the time-out and slow recirculate is to aid the page memory in resynchronizing, should the page memory ever get out of step, as normally occurs during line feet operations.

DISPLAY ROW COUNTER

The Display Row Counter contains the line address which is presently being displayed. It is clocked by Scan A as the circuits prepare for the next row to be loaded into the page memory. The V-Sync signal presets this counter to 30 (binary). The count progresses to 31, then 0, and then in order 1 through 23. The counter reaches 24 momentarily at the bottom of the screen.

A gate decodes the output of this counter whenever the count is between 0 and 23, and this signal is used in the character generator, to blank the top and bottom of the screen, and in the page memory clock gates to synchronize the page memory in preparation for the first line.

A comparator between this counter and the page memory counter prepares the page memory to stop at a proper point for loading the next line into the line memory.

PAGE CLOCK GATES

The page clock gates produce the high-speed clocks necessary to recirculate the page memory and switch between the high speed clock and the two low speed clocks, the 1.7 MHz line memory clock with 80 "beats" in one horizontal scan and the time-out clock, once every 32 microseconds.

The clock switch is set to lock the page memory and line memory clocks together during Scans X and A. At the beginning of Scan B, the circuit switches to the high speed clock which then recirculates the page memory until it is required to stop, normally sometime during Scan 7.

The high speed clock circuits generate pulses at 4 MHz to drive the page memory. At the end of every line, an extra long pulse is generated for the purpose of smoothing over the transfer of data between the end and beginning of each line, and to add some delay to the total clock time so that the page memory does not stop before Scan 7. It also serves to make system clocks easier to identify since one pulse on each line is longer than the rest, for diagnostic purposes.

INTERFACE: THEORY OF OPERATION

The interface for the Model 440 is located on two cards in the "card cage", the Function Control (card slot No. 5) and the TTY Interface (card slot No. 6).

The Function Control contains the basic oscillator which determines the interface clock rates for both transmit and receive. It also contains the receiver circuitry, exclusive of the level translators, and the circuits which control the various functions of the display, such as line feed, backspace, bell, etc.

The TTY Interface contains the interface "level converters" in both directions, all of the basic keyboard and transmitter circuitry and the automatic CR–LF circuits.

FUNCTION CONTROL – Board No. 5 See Functional Diagram Figure 12 Page 32

The basic interface timing begins with an 8.0 MHz, crystal - controlled oscillator which drives a binary divider through eight stages. The speed control switches for transmit and receive gate the desired frequency to a clock line, one for the receiver and one for the transmitter. A comparison circuit decides whether or not the speeds for transmit & receive are the same, and if they are not, forces the circuit into the full duplex mode. An exception occurs for the combination of 1200-1800 baud, 4800-7200 baud, 4800-9600 baud and 7200-9600 baud, where the forcing circuitry cannot differentiate between these four combinations. However, the operation of the terminal in half-duplex will show "garbage" if one of these four combinations is used and it is simply corrected by changing the transmission mode switch to full-duplex. In the local mode, the transmitter clock is locked to the receiver clock, so that the local-half-duplex connection will allow proper local operation. Again,

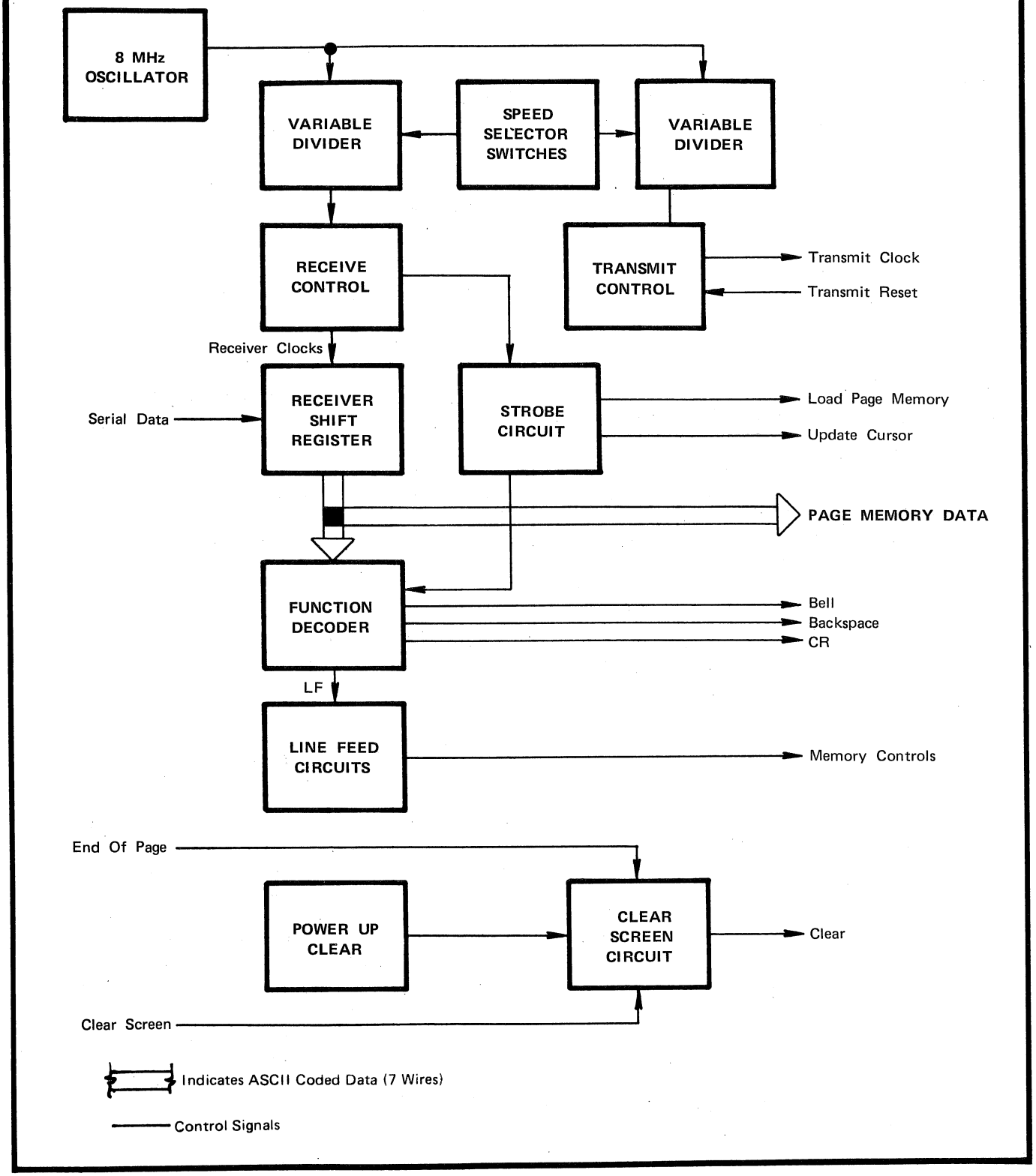


FIGURE 12 FUNCTIONAL DIAGRAM – FUNCTION CONTROL

the same four combinations above plus any split combination with 110 baud will not operate correctly, as evidenced by "garbage" on the screen. The split rate option was designed to favor a transmit speed of 150, 300, or 600 baud together with a receive speed of 600, 1200, or 2400 baud.

The basic oscillator speed is further divided down to the required frequency by programmable dividers, which provide the actual clock pulses used in the receiver and transmitter registers. The transmitter clocks are sent to Board 6 via the backpanel wiring and the receiver clocks are used locally to clock the receiver shift register which changes the incoming serial data into parallel data bits for use within the display. Several functions are decoded directly from the parallel data bits, namely Backspace, Bell, Carriage Return and Line Feed. The backspace signal is fed to the cursor counter on Board 4 which counts down one position for each occurence of this signal until the cursor reaches the left-column position. The Bell signal is sent to the keyboard via Board 6, the TTY interface. The carriage return signal is sent to the cursor counter on Board 4 to reset the counter to zero.

The Line Feed signal actuates some special circuitry which, in effect, causes each row of information in the page memory to move its "vertical address" one row closer to the top of the page. This is accomplished by decrementing the page row address at a known point in time, with respect to the present page memory address, by forcing the page memory to stop at a predetermined address and then allowing it to advance a known number of bits before exercising the decrement function. All in all, each line moves up, with the top line lost and the bottom line blank

The strobe circuitry on Board 5 generates a strobe to load the page memory whenever a displayable character is received and advance the cursor one position after the page memory is loaded. If the received character is a function, the data strobe is cut off and a function strobe generated instead, which is then gated with the various functions to form a clean pulsed signal on the backspace, bell, carraige return and line feed control signals.

Finally, a circuit which clears the page memory and resets counters during power-up is included on Board 5.

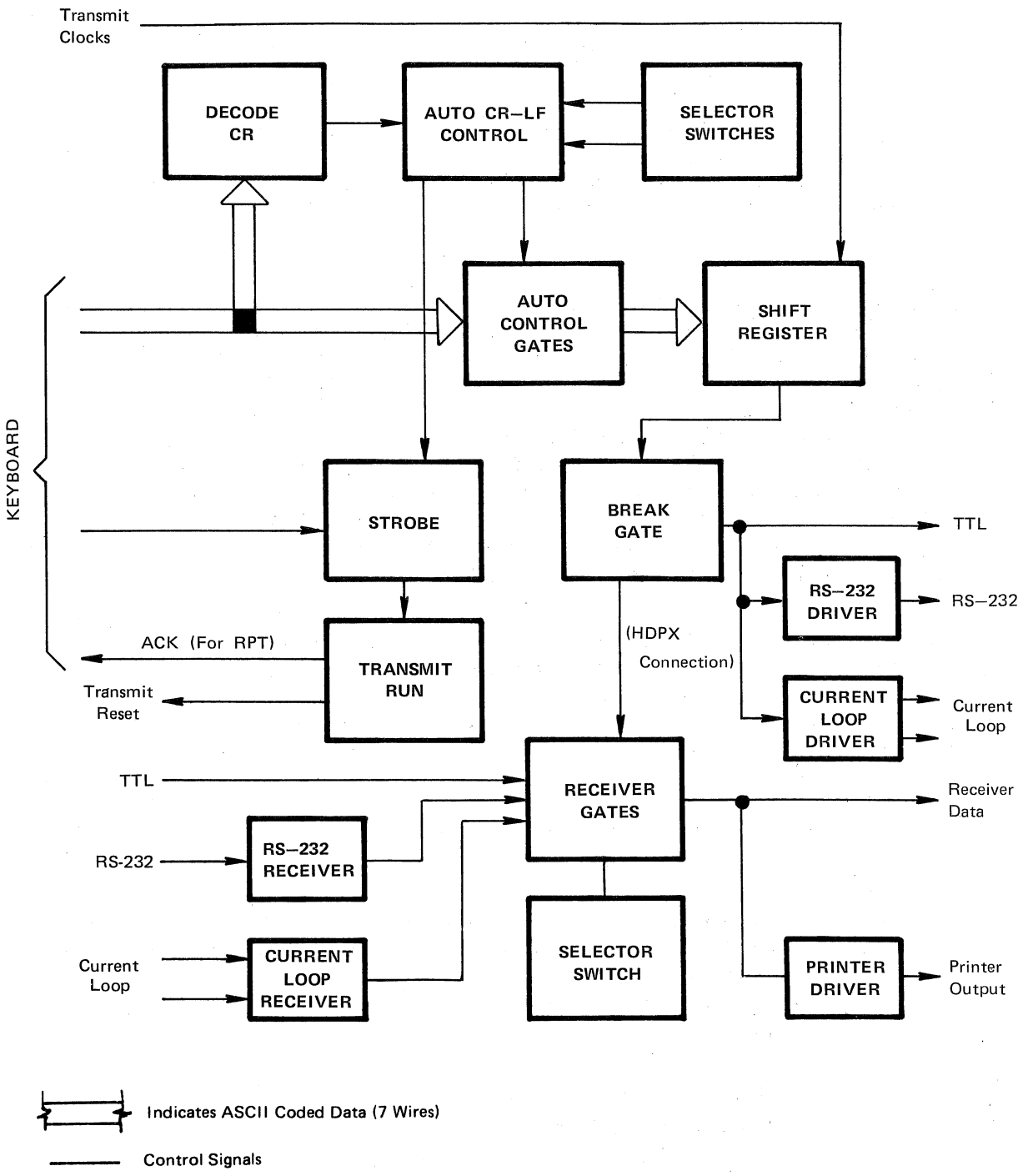


FIGURE 13 FUNCTIONAL DIAGRAM – TTY INTERFACE

TTY INTERFACE – Board No. 6 **See Functional Diagram, Figure 13, Page 34.**

The keyboard inputs parallel data bits to Board 6 and a strobe which are converted to serial form and sent out on the communication line using the clocks generated on Board 5. Before the data is serialized, however, a decoder "looks for" the Carriage Return code, and when it occurs signals the automatic CR–LF circuits to start up. If the option selector switches are set for auto–CR–LF, the auto-control gates are switched to feed CR into the data stream, followed by a LF which then is followed by return of control to the keyboard. Another signal, which indicates that the cursor is beyond its allowed range, will also start the auto–CR–LF circuit if the option switches are so set. Each time a character is transmitted, an acknowledge signal is sent to the keyboard so that it may send another character right away, if the repeat key is pressed down. At 300 baud and higher, the repeat frequency is limited to about 25 char/sec. by delaying the acknowledge signal.

The "level converters" for the three interface types are also included on Board 6. The TTL interface is merely a direct connection to a TTL gate, for nearby applications, up to about 15 feet (cable length). The RS-232-C drivers and receiver conform to the voltage and impedance requirements of that specification, and they are most often used for driving modems.

The current loop connection is a solid state loop, isolated from the circuit by optical couplers which must be driven by an outside source of supply. Two current limited +15V supplies and one current-limited -15V supply are available on the I/O connector for use in the current loop locally. Current on all three is limited to approx. 30 mA. The current loop will operate on marking currents between 15 mA and 100 mA, encompassing the two most common standards of 20 mA and 60 mA. Spacing is an open circuit condition. Both the current loop transmitter and receiver have diode bridges to make the external connection points non-polarized, simplifying installation and testing. Each, however has 2 to 3 volts "dropped" in the electronics to accomplish this, which needs to be accounted for in designing a low voltage loop.

The transmit signals are present on all three outgoing interfaces simultaneously, but only one of three receiver circuits is connected at any one time. If RS-232-C or TTL is used as the interface, the receiver of the current loop may be used to indicate "cable connection".

The current loop is usable, untuned, up to about 2400 baud. With special tuning, it can be used at the full 9600 baud.

Various gates are used in the circuit to establish half-or-full duplex connections where appropriate, and to cause a "break" condition on the transmitter side of the communication line whenever the break key is pressed. A selector-magnet drive is provided for RO-33 type printers when the system is operating at 110 baud only.

SECTION IV

TELETYPEWRITER REPLACEABLE
INTERFACE DESCRIPTION
FOR
MODEL 440
DATA–SCREEN TERMINAL

INTRODUCTION

The teletypewriter interface of the Model 440 is an electronic simulation of the mechanical and electrical hardware present in modern teletypewriters. It is compatible with teleprinters and computer systems using full-duplex TTY's with the exclusion of the automatic answer-back feature (i.e. no response to the ENQ or WRU command). In most cases, Model 440 replaces TTY's without requiring major system reprogramming or the use of additional interface hardware.

The TTY Replaceable interface physically consists of two printed circuit boards, the back panel wiring on the card cage, and I/O connector mounted on the PCB for connection to external modems or current loop systems, a printer connector for an external hard copy device and a keyboard connector. See Figure 15 for more detail on modem, printer and keyboard connections and Figure 14 for specification of connector types.

The interface is a data and signal level converter mounted on two printed circuit boards which plug into the Model 440 card cage (See Figures 24 & 25). The interface performs these functions:

1. Transfers and interprets character sequences from a processor to the Terminal, and (if used) the Printer.

2. Transfers data from the terminal keyboard to the processor.

3. Provides an EIA RS-232, current loop, or TTL interface for convenient attachment to a processor or modem.

4. Provides an asynchronous 10 or 11 bit character format; start bit (space), 7 bit USASCII code, parity bit (odd, even or mark) and stop bits (one or two marks).

5. Provides for transfer rates of 110, 150, 300, 600, 1200, 1800, 2400, 4800, 7200 and 9600 baud. The basic oscillator is crystal controlled, and requires a special crystal for non-standard transfer rates.

FUNCTION	CONNECTOR	NO. OF PINS	ADAPTOR CONNECTOR	CABLE CONNECTOR
I/O to/from Modem or Processor	J1	25	781013–003*	781014–003* Cinch DB–25S
Printer	J2	9	781013–001*	781014–001* (Cinch DE–9S)
Keyboard	J3	37	781014–004*	781013–004* (Cinch DC–37P)

* TEC part number

FIGURE 14 CONNECTORS

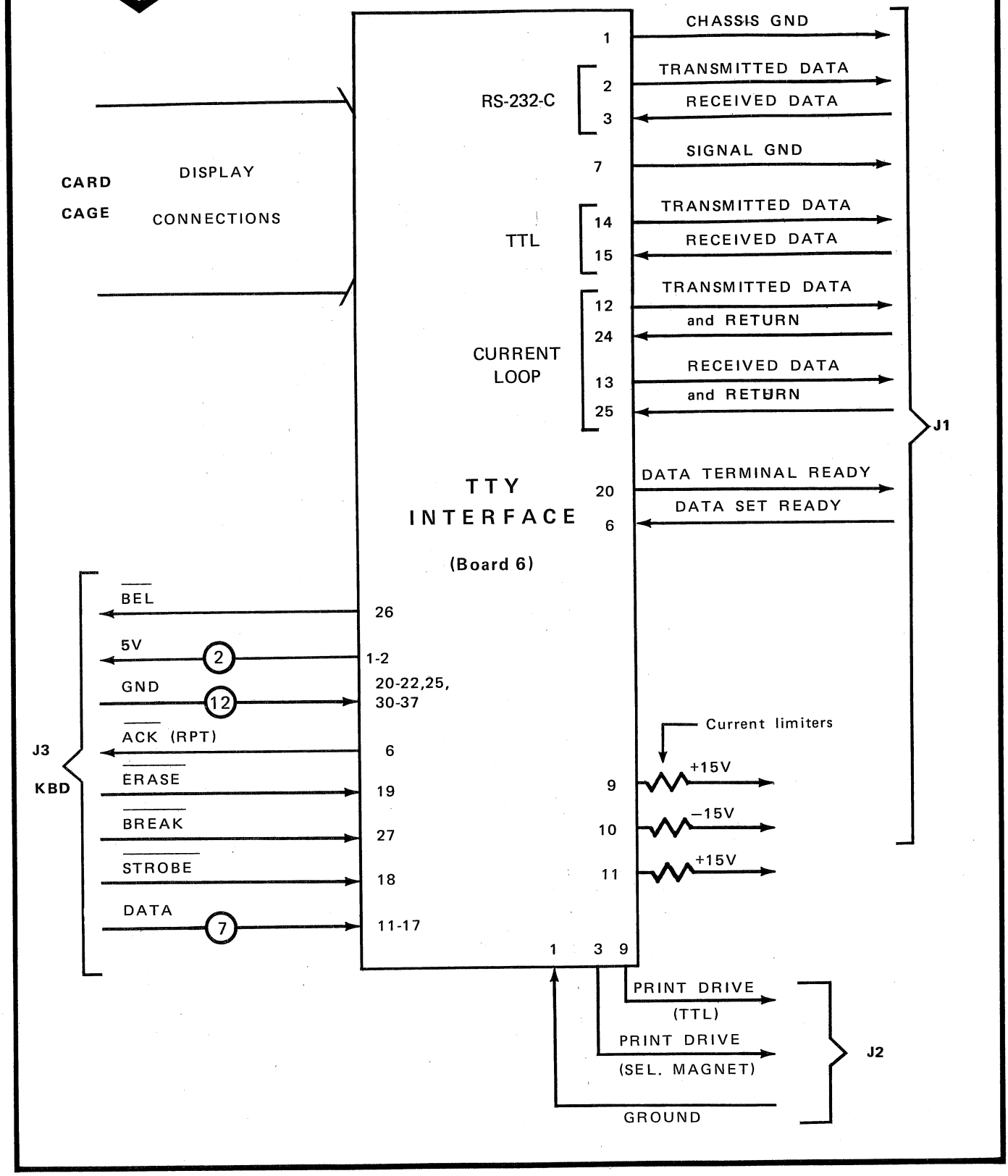


FIGURE 15 MODEL 440 TTY INTERFACE CONNECTIONS

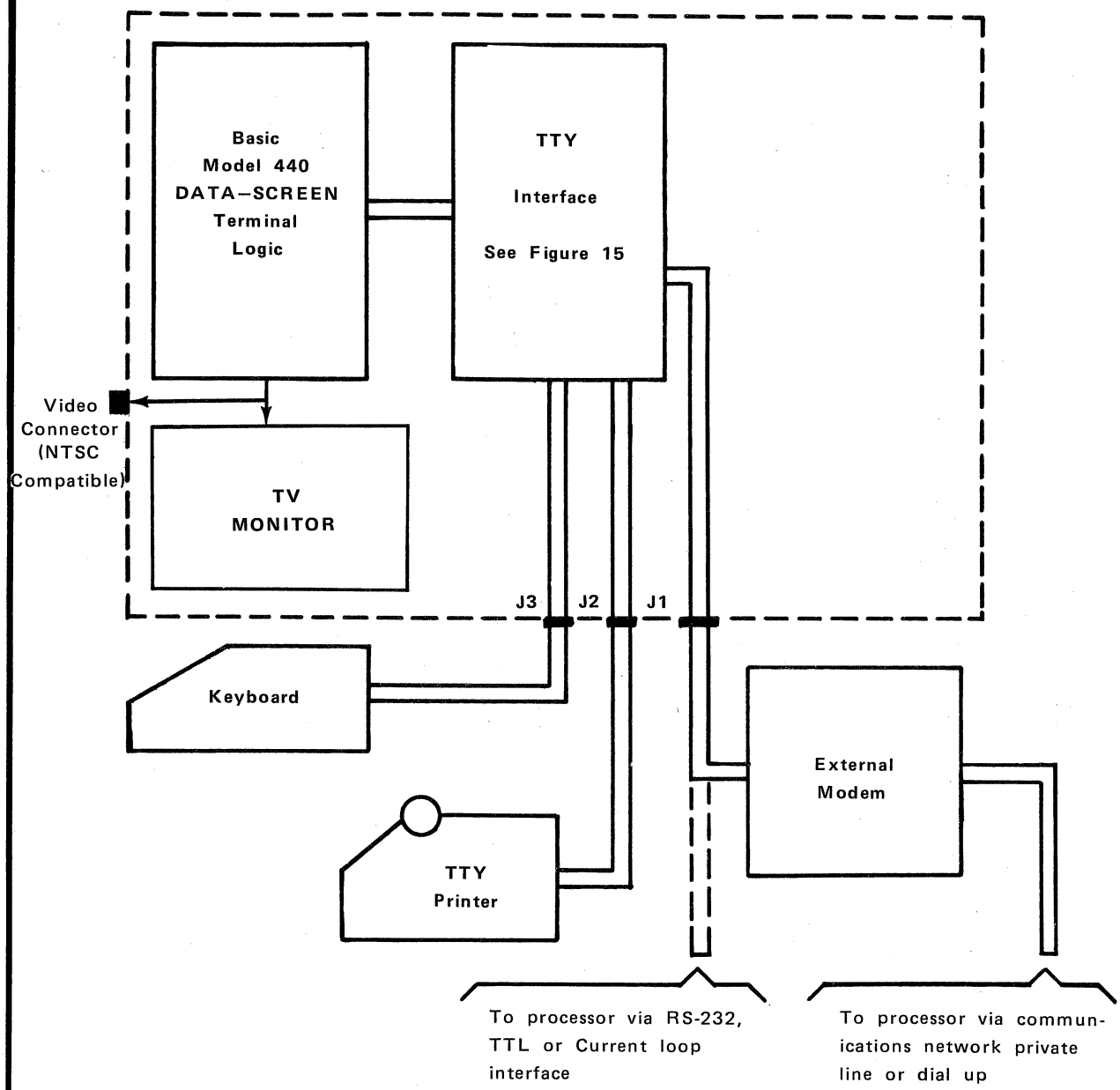


FIGURE 16 SYSTEM DIAGRAM – MODEL 440 DATA–SCREEN TERMINAL

SIGNAL REQUIREMENTS

All signals entering or leaving the interface are shown in Figure 15.

MODEM/TTY INTERFACE SIGNAL DEFINITIONS

Three types of signal interfaces are provided: first, an EIA RS-232 compatible interface for external modems; second a TTL interface for direct connection to systems at TTL logic levels (0 & 5V); and third a DC current loop.

INTERFACE SIGNAL NAME AND FUNCTIONS

Pin Assignment for J1 Communications Connector

PIN	FUNCTION
1	Frame Ground
2	RS-232-C Trans. Data
3	RS-232-C Received Data
4	NC
5	NC
6	Data Set Ready (used to switch from local to remote)
7	Signal Ground
8	NC
9	+15V
10	-15V
11	+15V
12 & 24	Current Loop-Trans. Data (Non-polarized)
13 & 25	Current Loop-Rcv'd. Data (Non-polarized)
14	TTL Trans. Data
15	TTL Rcv'd. Data
16-19	NC
20	Data Terminal Ready ('on' when Model 440 powered up and ready)
21-23	NC

(9, 10, 11: current limited to approx. 30 mA for local current loop use.)

NC = No Connection

NOTE 1: +15V available on pins 9 and 11, and −15V available on pin 10 of the connector limited by resistors. Power is available to drive the local section of the current loop, at approximately 30 mA if no other resistance is added to circuit.

NOTE 2: It is not necessary to observe polarity on either the transmit or receive channel, as full-wave circuits within the interface establish polarity for the internal circuitry. While there is 100% isolation of the current loop circuits from the system power supplies, it is recommended that the terminals of the current loop circuits remain between ±15V for safety.

Female screw-locks are provided on the I/O connector for secure attachment of standard Dataphone hood (Cinch DB-51226-1).

KEYBOARD CONNECTOR SIGNAL DEFINITIONS

The keyboard connector (J3) will accept the matching TTY keyboard (TEC P/N EKA−9100). The connector has the following pin assignments.

PIN	NAME
1,2	+5V power to keyboard
6	$\overline{\text{KYBD ACK}}$ (acknowledge signal for repeat function)
11	BIT 1
12	BIT 2
13	BIT 3
14	BIT 4
15	BIT 5
16	BIT 6
17	BIT 7
18	$\overline{\text{STROBE}}$ (Pulse)

(cont.)

19	Clear Screen
20-22	Ground (for power leads)
25	Ground
26	$\overline{\text{BEL}}$ (negative-going edge trigger bell)
27	$\overline{\text{BREAK}}$
30-37	Signal Grounds (for data bits & signals)

No connection to pins 3, 4, 5, 7, 8, 9, 10, 23, 24, 28, 29.

A slid-lock arrangement is provided on the keyboard connector for secure connection to the keyboard cable hood.

PRINTER CONNECTOR SIGNAL DEFINITIONS

The 9-pin printer connector (J2) provides serial data to a remotely located hard copy device (TTY RO-33 or equivalent). The printer connector pin assignments are:

PIN	NAME
1	Ground
3	20 mA current source (selector magnet drive)
9	TTL level output

No connection to pins 2, 4, 5, 6, 7, 8.

No provision is made for mechanical lock arrangements on the printer connector. Holes are available for secure attachment of a cable connector.

The printer drive signal operates from the same interface logic as the TTY receiver. Any character received on the communication line will be sent to the printer and, if the printer is ON, the character will be printed. The speed is the same as the interface, and it is generally recommended that speeds in excess of 300 baud should not be used with the TTY printer selector magnet drive. The TTL output on pin 9 should be used for high speed printers.

INTERFACE DATA TRANSFER RATE

Transmission and reception on the communication line of the Model 440 may be at speeds of 110, 150, 300, 600, 1200, 1800, 2400, 4800, 7200 or 9600 baud. The transmitter and receiver may be set to different speeds if desired and if this option is selected the interface is forced into the full duplex mode of operation, regardless of the position of the Full–Half Duplex switch. It is recommended that if split rate communications are used the receiver speed be higher than the transmitter speed, but this is not a requirement. (See Section III, page 31 for restrictions)

Speed adjustment is made by rotor switch selections on Board 5, the Function Control board (See PCB Option Setting). Switch S2 controls the receiver clock and switch S3 controls the transmitter clocks. Position '1' on both switches corresponds to 110 baud. Successive positions select increasing speeds, in order, to 9600 baud at position '0'.

Switch S1, mounted on the edge of the board, allows selection of any speed combination when in the UP position and forces the speed controls to 110 baud teletypewriter operation when DOWN. In the down position, the transmitter is forced to 11 bits per character, regardless of the position of the bit selector switch on Board 6.

INTERFACE DATA TRANSFER BIT SEQUENCE

The following bit sequence is used for the transmitted and received data on all interfaces. Each character is composed of a 10 or 11 bit "word" as shown below:

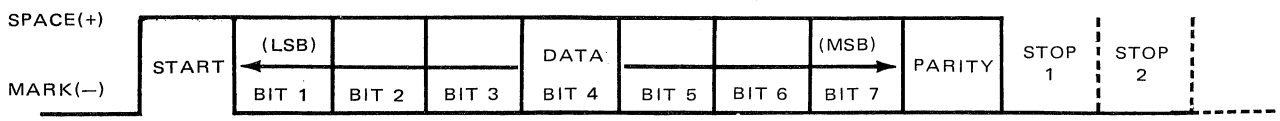


FIGURE 17 – TRANSFER BIT SEQUENCE

The bit sequence on the communications line is left to right in the diagram shown on previous page. The stop bit may have a length of "one" or "two" bit times. The parity bit may be "even" or "odd" or "mark" (no parity).

NOTE: Stop bits and parity are preset to customer specification, but may be field changed by moving a switch rotor. See PCB Option Setting Section V, Figure 25, pages 66 & 67.

Unless otherwise specified, units ordered preset to 110 Baud will be set for 11 bit word-length, and units ordered preset to any other speed will be set for 10 bit word-length.

RS–232–C INTERFACE

The RS–232–C Interface shares all of the timing and control logic with the other two interfaces and converts the serial information to and from logic levels commonly used in modem communications.

The nominal specifications of this interface are:

TRANSMITTER

Marking Level (Logic '1', "OFF")	–10V
Spacing Level (Logic '0', "ON")	+10V

RECEIVER

Input Impedance	5000 ohms nom.
Marking Level	+0.5 to –15 volts
Spacing Level	+2.6 to +15 volts

Open Circuit interpreted as mark.

SIGNALS ENABLED

Transmit: Always present in Remote mode (pin 6, on I/O connector J1 in "ON" condition) with mark–hold in absence of data. Forced into mark–hold condition full time when unit is in Local Mode (pin 6, J1 in "OFF" condition).

Receive: Input enabled only when RS–232 receives option is selected (PC Board No. 6, Switch S3, rotor "C" in position '0'), and unit is in Remote Mode (pin 6, J1 "ON").

TTL INTERFACE

The TTL interface shares all of the timing and control logic with the other two interfaces and transfer the serial information at TTL logic levels.

The nominal specifications of this interface are:

TRANSMITTER	
Marking Level	+0.3 Volt nom.
Spacing Level	+4 Volts nom.

RECEIVER	
Marking Level	0V to +0.8 Volt
Spacing Level	+2.6V to +5.5 Volts
Input Circuit	one TTL load plus 4.7K ohm pullup resistor and 1000 pF noise suppression capacitor.

Caution: Open circuit interpreted as SPACING level.

SIGNALS ENABLED

Transmit: Always present in Remote Mode (pin 6, on I/O connector J1 in "ON" condition) with mark–hold in absence of data. Forced into mark–hold condition full-time when unit is in Local mode (pin 6, on J1 in "OFF" condition).

Receive: Input enabled only when TTL receiver option is selected (PC Board No. 6, Switch S3, rotor "C" in position 9) and unit is is Remote mode (pin 6, on J1, "ON").

CURRENT LOOP INTERFACE

The current loop interface shares all of the timing and control logic with the other two interfaces and converts the serial information to and from "open" and "closed" circuit conditions as commonly used in current loop circuits. The signal converters are solid state and the loop may be adjusted to perform at speeds from 100 baud through 9600 baud.

The nominal specifications of the interface are:

TRANSMITTER & RECEIVER

Marking Condition:	'Closed contacts'	10mA	100mA
Spacing Condition:	'Open contacts'	zero	0.1mA
Voltage Drop at 20mA	Receiver	2.0 volts typ.	
	Transmitter	2.0 volts typ.	
Voltage Drop at 60 mA	Receiver	2.5 volts typ.	
	Transmitter	2.5 volts typ.	

SIGNALS ENABLED

Transmit: Always present in Remote Mode (pin 6, on I/O connector J1 "ON" condition) with mark–hold in absence of data.

Forced into mark–hold condition full time when unit is in Local mode (pin 6, J1 in "OFF" condition).

Receive: Input enabled only when Current Loop interface has been selected (PC Board No. 6, Switch S3, rotor "C" in position '8') and unit is in Remote Mode. (pin 6, J1 "ON").

NOTE: The current loop interface may be used from a remote location to determine whether or not a particular terminal is connected to its port, if the current may be monitored on the receive loop during a mark hold condition from the remote processor. (The transmit loop may be monitored, but the processor has no control over the occurence of a mark-hold condition). If the current loop is not used as the communication line, a current between 10 and 100 mA in the "receive" current loop (pins 13 and 25 of the I/O connector) will monitor the connection.

BASIC DISPLAY TERMINAL SIGNAL LEVELS

All signals which are transferred between the TTY interface adaptor and the basic display (first four cards in the card rack) are standard TTL logic levels, as used in Series 74 Integrated Circuits. In general, control signals are idle at logic one and are active at logic zero, while data lines are "true" at logic one.

The same is true of all signal levels between the TTY interface and the keyboard. In addition, however, +5VDC power is fed to the keyboard via the interconnecting cable.

OPERATION OF THE TTY INTERFACE

The TTY-interface is the control and communications link between the basic Model 440 DATA–SCREEN Terminal, the keyboard, a remote printer if used and a full duplex asynchronous communications line or modem with a speed range of 110 to 9600 baud.

FULL or HALF DUPLEX

Operation mode may be switch-selected by the operator to either full duplex or half duplex. In full duplex the keyboard and serial transmitter serve as an independent unit driving the "transmit" side of the communications line. The serial receiver and the basic display (and printer if used) are driven by the "receive" side of the communication line. In order to record keyboard data on the screen in full-duplex mode, the processor at the other end of the communications line must "echo" the character codes back via the "receive" line.

In half-duplex operation, an internal connection is made to receive directly any character transmitted as well as receive any character arriving via the communications line. Thus, any character typed will appear on the screen without "echoing" the character externally. However, if a character is generated internally at or near the same time as one is received via the communications line, the result will be garbage, i.e. some combination of the bits of both characters, OR'ed together.

Split - speed operation must use the full–duplex mode.

LOCAL-REMOTE

The Model 440 is automatically switched between local and remote operation by the presence or absence of an "ON" level on pin 6 of the communications connector (J1). When this level is below +.5Volt, including open circuit, the Model 440 is forced into Local mode. The outputs of all three interfaces are held at the marking condition. The logic is forced into half-duplex operation and the transmitter clocks are locked to the same speed as the receiver clocks. (See Section III, page 31 for restrictions on split-speed systems).

Whenever pin 6 is turned 'ON' by a voltage greater than +3 volts, the terminal is automatically switched into Remote mode. This may be accomplished by turning the modem 'ON', or by plugging in a connector with pin 6 'ON' or by physically connecting pin 6 to a power source which delivers more than +3 volts (a direct connection between pins 6 and 9 on the interface cable connector will accomplish this). In the remote mode, data is present on all three interface outputs, full-duplex operation is allowed if selected, and split rate transmission and reception is enabled if so selected.

INCOMING SIGNAL SEQUENCES

The interface receiver will assemble incoming serial data characters and perform the functions requested. Speed of the terminal does not restrict function sequences. See Section II for description of the functions which can be performed by the terminal.

OUTGOING SIGNAL

The interface will accept keyboard codes, serialize them, add the proper parity bit and place them on the outgoing signal line. See the Keyboard Data Code Chart for the codes that can be generated by the keyboard and transmitted by the adpator.

The "break" key on the keyboard does not generate a code, but causes the outgoing signal to go to the spacing level for as long as the key is depressed. (RS–232: +10V, TTL: +5V, Current Loop: open circuit)

OPERATION TIMING

The speed of the interface and the basic DATA–SCREEN Terminal does not limit the sequence of functions to be performed, except that at 9600 baud an LF should be followed by one Rub Out character. The highest data rate accepted by the terminal is 9600 baud. Using a 10 bit character, this gives a minimum character time of 1.04 milliseconds

on the communications line. The slowest operation performed by the interface and the basic DATA–SCREEN Terminal is Line Feed and it requires less than 1.5 milliseconds.

AUTOMATIC CARRIAGE RETURN & LINE FEED

The Model 440 has the capability of generating an automatic carriage return and line feed if desired. There are basically six ways in which the automatic circuit can function. They are as follows:

1. Automatic CR-LF generated whenever CR key is pressed on keyboard.
2. Automatic CR-LF generated when CR key is pressed but only when unit is in local mode (pin 6 of I/O connector open or below ground potential)
3. Automatic CR-LF generated when cursor goes beyond end of line.
4. Automatic CR-LF generated whenever CR key is pressed or cursor goes beyond end of line (same as 1. + 3.)
5. Automatic CR-LF generated whenever CR key is pressed and unit in local mode, or when cursor goes beyond end of line (same as 2 + 3).
6. Automatic CR-LF diabled. CR key on keyboard generates a CR only, in local or remote. Cursor beyond end of a line causes no function to occur.

For most time sharing applications, option No. 5 is most useful, causing a CR-LF to be transmitted if the cursor overranges but CR only when CR is pressed when communicating to the processor. This allows a Line Feed to be returned by the processor to indicate acceptance of the previous line. Also, an over-filled line will be more obvious by the presence of an extra line feed. In local mode, such as during opeator training, the line feed would be supplied internally upon pressing the CR key.

Option No. 6 represents strict teletypewriter replaceable service, where the operator is on his own regarding end of line hang-ups. The cursor will move off screen, not displaying, but characters will continue to be transmitted on the communication line.

OPTION	DESCRIPTION	Position Rotor A	Position Rotor B
1	Auto CR–LF with CR key, in Local or Remote	1	6
2	Auto CR–LF with CR key in Local only	2	6
3	Auto CR–LF with Cursor over-ranges	1 or 2	4
4	Auto CR–LF with CR key or Cursor over-range	1	5
5	Auto CR–LF with CR key, in Local, or Cursor over range	2	5
6	Disable Auto CR–LF	1 or 2	7

NOTE: Should the automatic CR–LF circuit ever "hang up", the key board will be locked out. Momentary depression of the "BREAK" key will reset the circuit allowing further data entry.

CODE CHARTS

Explanation of Symbols used on Keyboard and Communications Code Charts which follow

SYMBOL	EXPLANATION
BEL	Bell Code. Rings bell in Keyboard when received.
LF	Line Feed. When received, causes Roll-Up from bottom line.
CR	Carriage Return. When received, causes cursor to return to left column. May have option to give automatic Line Feed when transmitted by keyboard or automatically.
ALPHA NUMERIC CHARACTERS	Displayable symbols in columns 2 thru 5 of the ASCII standard code chart.
BS	Backspace. Causes cursor to move one position to left. Disabled when cursor in left column.
ESC	Escape code. Generates ASCII Escape code (1B) and transmits it on communication line. Terminal does not respond to to ESC code.
RUB OUT	Rub Out or Delete Code. When key is pressed, ASCII Delete code is transmitted to communications line. No terminal display or function occurs.

All codes not specifically called out (specifically the remaining codes in columns 0 and 1) do not correspond to terminal functions but may be generated by the use of the CONTROL key with a code from columns 4 and 5 (alphabet, with or without shift as necessary). Blank areas in columns 6 and 7 can neither be generated nor used by the terminal, except for the Rub Out Code (7F) which may be generated but is not used by the terminal.

NOTE: ENQ code same as WRU code.

b7 / b6 / b5 / Bits b4 b3 b2 b1	row \ column	0 (0 0 0)	1 (0 0 1)	2 (0 1 0)	3 (0 1 1)	4 (1 0 0)	5 (1 0 1)	6 (1 1 0)	7 (1 1 1)
0 0 0 0	0	NUL	DLE	SPACE	0	@	P		
0 0 0 1	1	SOH	DC1	!	1	A	Q		
0 0 1 0	2	STX	DC2	"	2	B	R		
0 0 1 1	3	ETX	DC3	#	3	C	S		
0 1 0 0	4	EOT	DC4	$	4	D	T		
0 1 0 1	5	ENQ	NAK	%	5	E	U		
0 1 1 0	6	ACK	SYN	&	6	F	V		
0 1 1 1	7	BEL	ETB	'	7	G	W		
1 0 0 0	8	BS	CAN	(	8	H	X		
1 0 0 1	9	HT	EOM	)	9	I	Y		
1 0 1 0	A	(LF)	SUB	*	:	J	Z		
1 0 1 1	B	VT	(ESC)	+	;	K	[		
1 1 0 0	C	FF	FS	,	<	L	\		
1 1 0 1	D	(CR)	GS	-	=	M	]		
1 1 1 0	E	SO	RS	.	>	N	↑		
1 1 1 1	F	SI	US	/	?	O	←		RUB OUT

Codes in parentheses in columns 0 and 1 are generated directly on the keyboard. The remaining codes may be generated by use of the control (CTRL) key plus the corresponding code in columns 4 and 5 respectively.

(Transmitter)

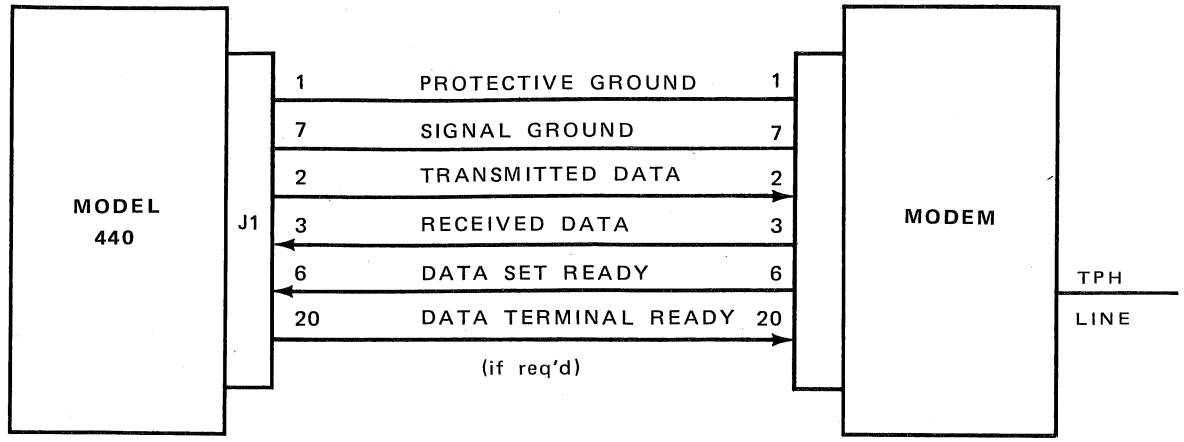
KEYBOARD CODE CHART

b7 → / b6 → / b5 → / 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 ↓	column → / row ↓	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SPACE	0	@	P		
0	0	0	1	1	SOH	DC1	!	1	A	Q		
0	0	1	0	2	STX	DC2	"	2	B	R		
0	0	1	1	3	ETX	DC3	#	3	C	S		
0	1	0	0	4	EOT	DC4	$	4	D	T		
0	1	0	1	5	ENQ	NAK	%	5	E	U		
0	1	1	0	6	ACK	SYN	&	6	F	V		
0	1	1	1	7	(BEL)	ETB	'	7	G	W		
1	0	0	0	8	(BS)	CAN	(	8	H	X		
1	0	0	1	9	HT	EOM	)	9	I	Y		
1	0	1	0	A	(LF)	SUB	*	:	J	Z		
1	0	1	1	B	VT	ESC	+	;	K	[		
1	1	0	0	C	FF	FS	,	<	L	\		
1	1	0	1	D	(CR)	GS	-	=	M	]		
1	1	1	0	E	SO	RS	.	>	N	↑		
1	1	1	1	F	SI	US	/	?	O	←		RUB OUT

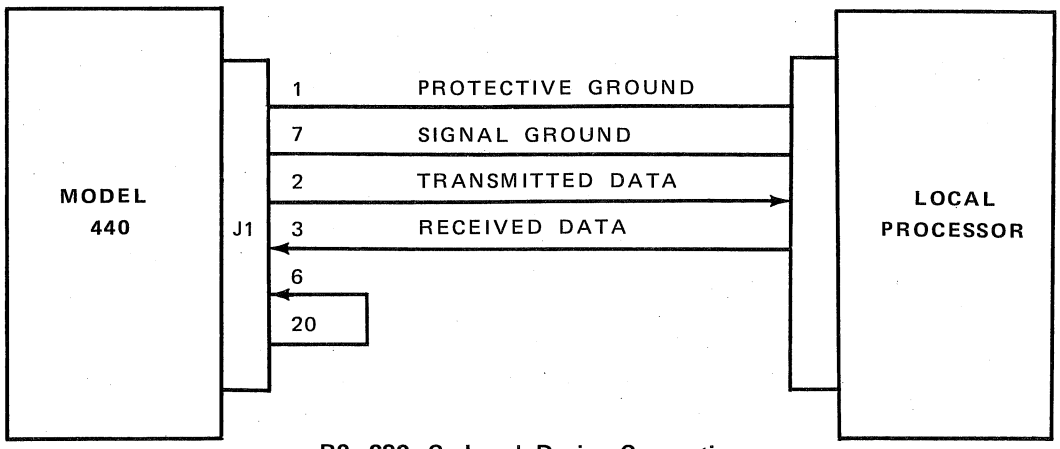
Codes in parentheses in columns 0 and 1 are utilized within the terminal as operable functions. The remaining codes are not recognized by the Model 440 as terminal functions. If received, they will be disregarded.

(Receiver)

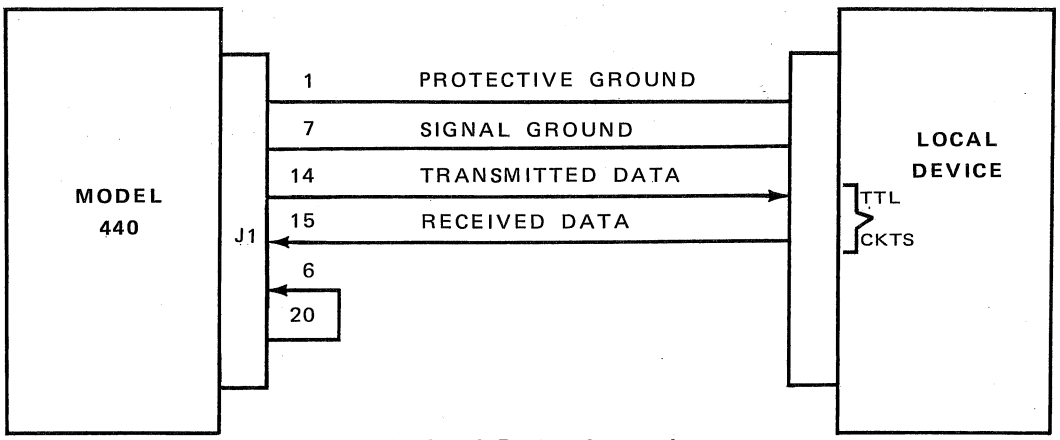
COMMUNICATIONS CODE CHART



RS–232–C, Modem Connection

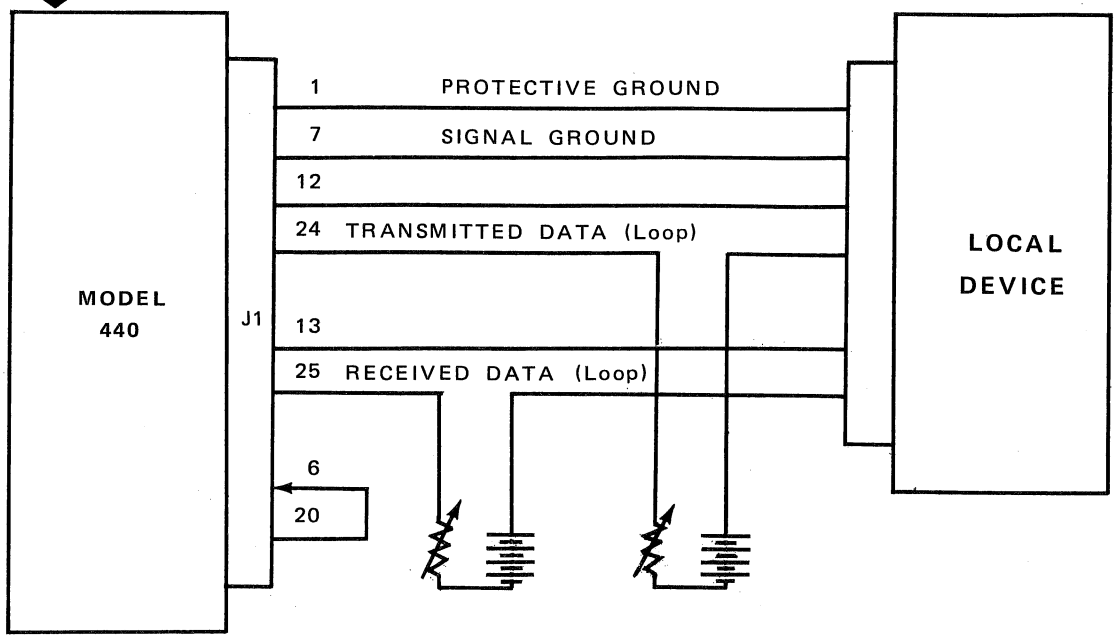


RS–232–C, Local Device Connection



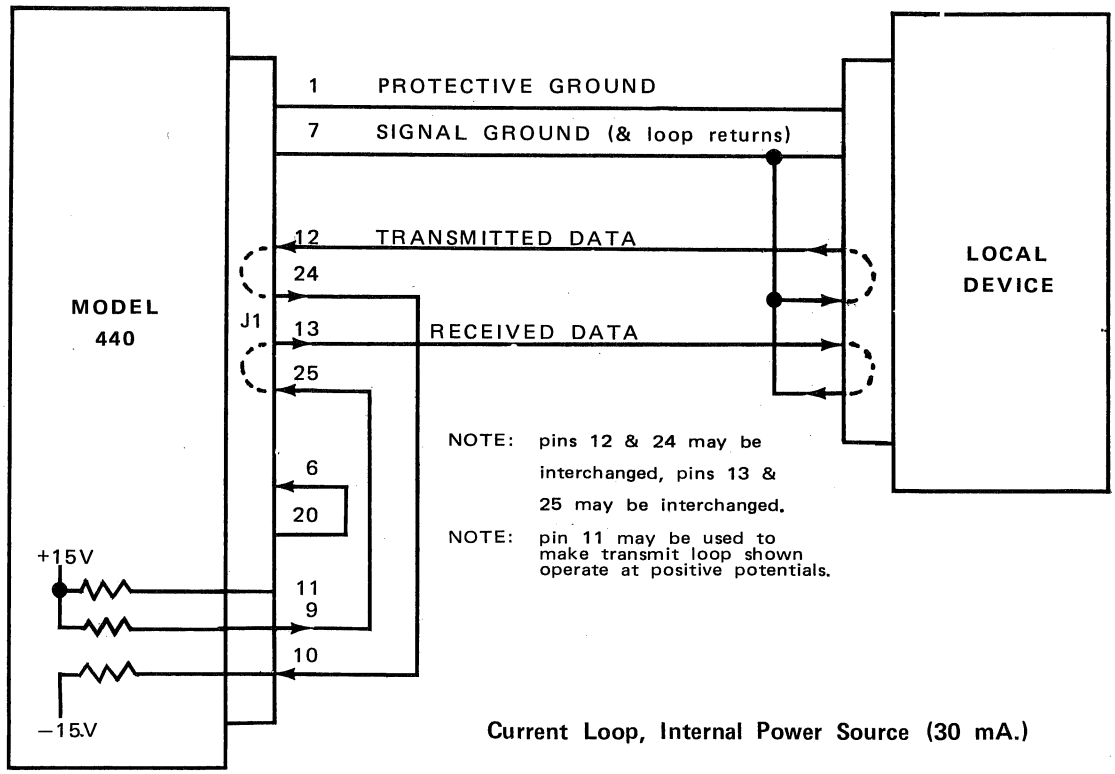
TTL, Local Device Connection

FIGURE 18 TYPICAL INTERFACE CONNECTIONS



NOTE: pins 12 & 14 may be interchanged,
pins 13 & 25 may be interchanged.

Current Loop, External Power Source
(Power Sources shown separate - may be shared)



NOTE: pins 12 & 24 may be interchanged, pins 13 & 25 may be interchanged.

NOTE: pin 11 may be used to make transmit loop shown operate at positive potentials.

Current Loop, Internal Power Source (30 mA.)

FIGURE 19 TYPICAL INTERFACE CONNECTIONS (CON'T)

SECTION V

PRINTED CIRCUIT BOARD ASSEMBLIES

OPTION SELECTION

A variety of switch selectable options permit the user to make field changes in Interface Options such as full/half duplex; Interface (RS-232, TTL or 20mA Current Loop); stop bits, parity, and baud rates; and selection of Auto Carriage Return—Line Feed.

Location of option selection switches on affected Printed Circuit Boards are shown in Figures 24 and 25. (pages 64 and 66 respectively)

OUTLINE DRAWINGS

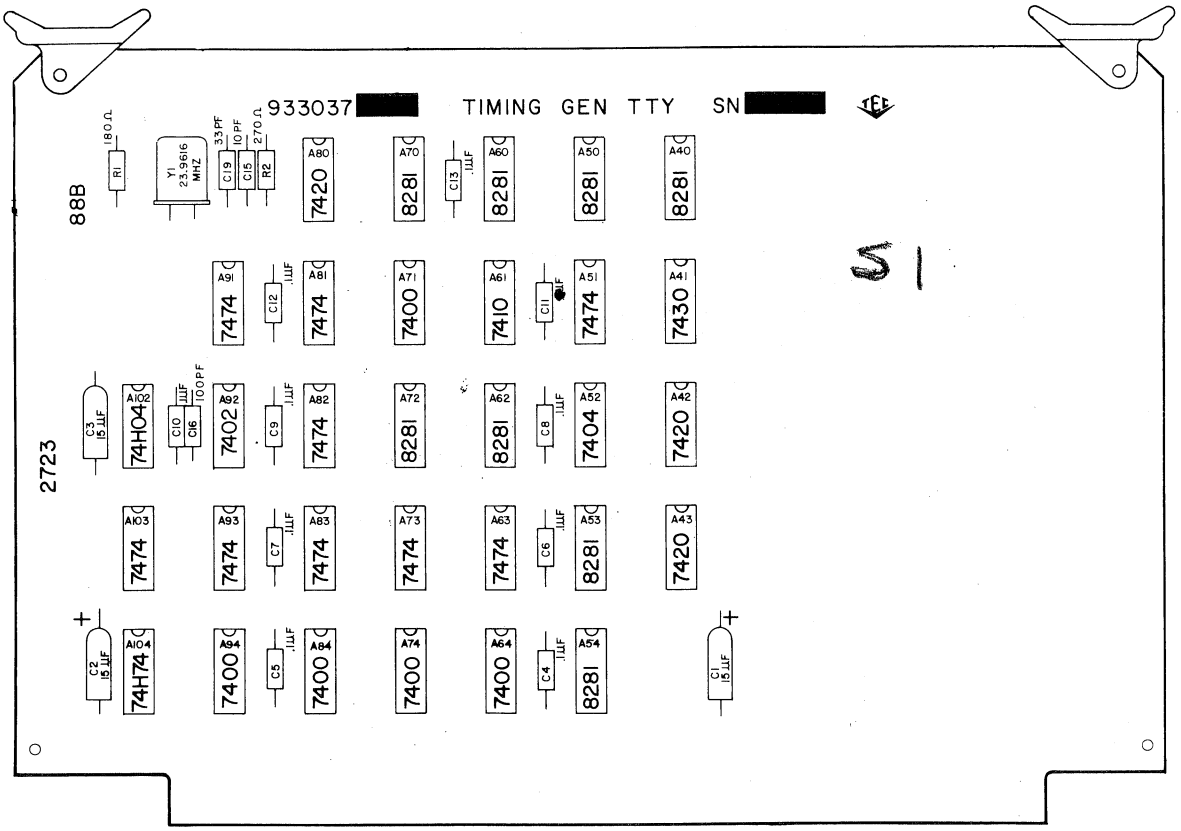


FIGURE 20 MODEL 440 TIMING GENERATOR
PRINTED CIRCUIT BOARD

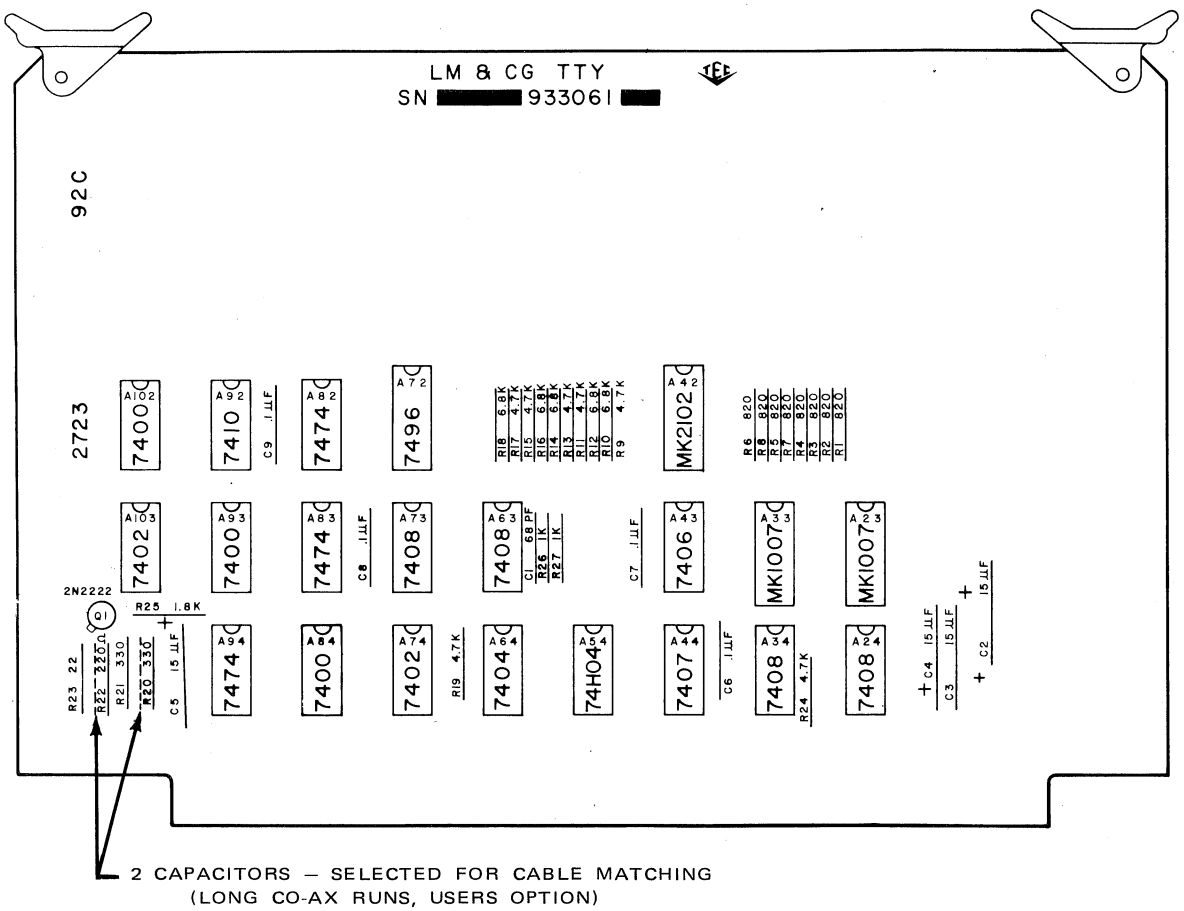
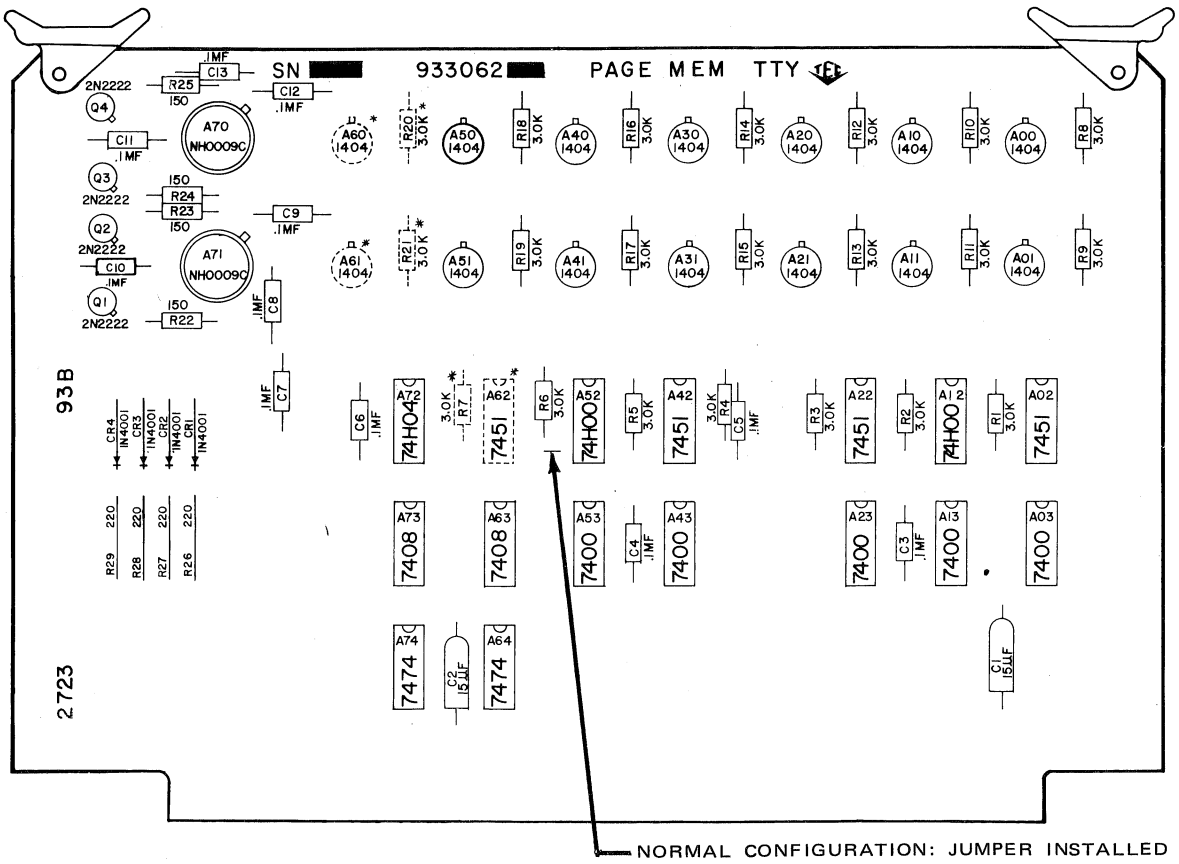


FIGURE 21 MODEL 440 CHARACTER GENERATOR PRINTED CIRCUIT BOARD



*components not installed in Model 440

FIGURE 22 MODEL 440 PAGE MEMORY PRINTED CIRCUIT BOARD

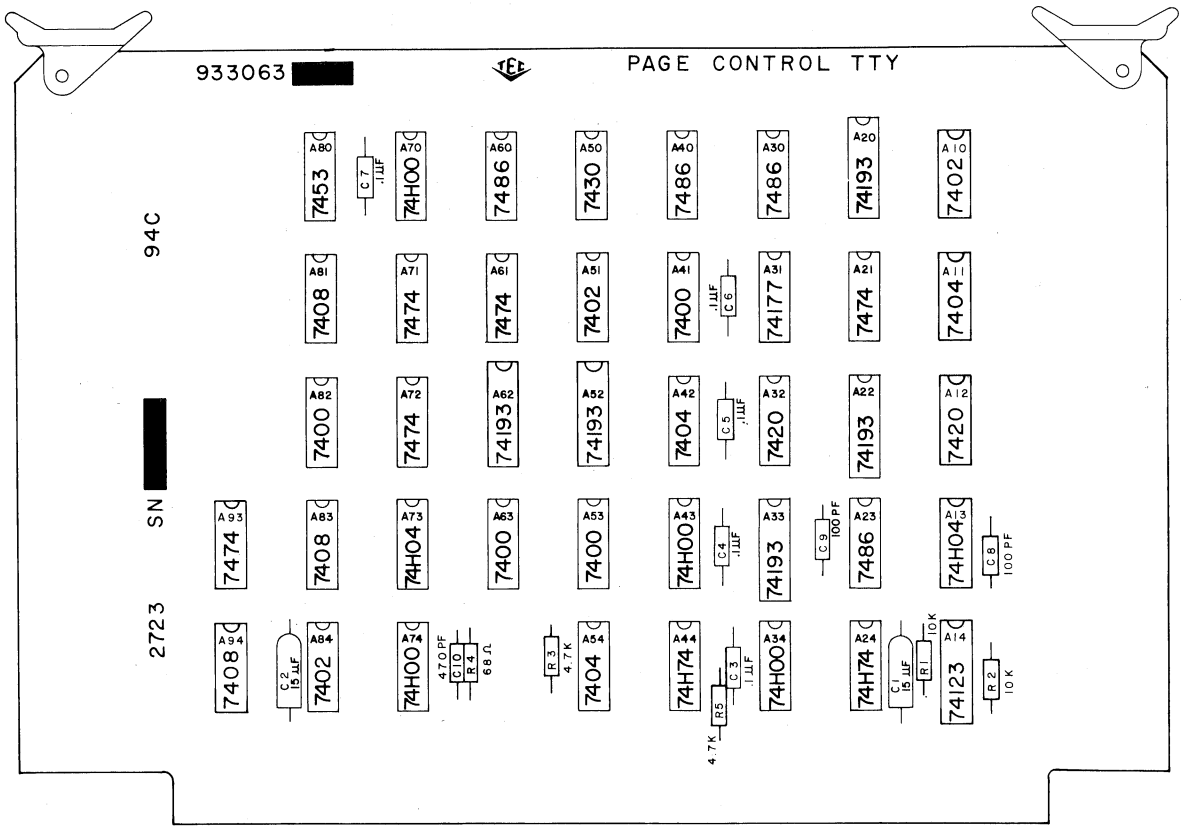
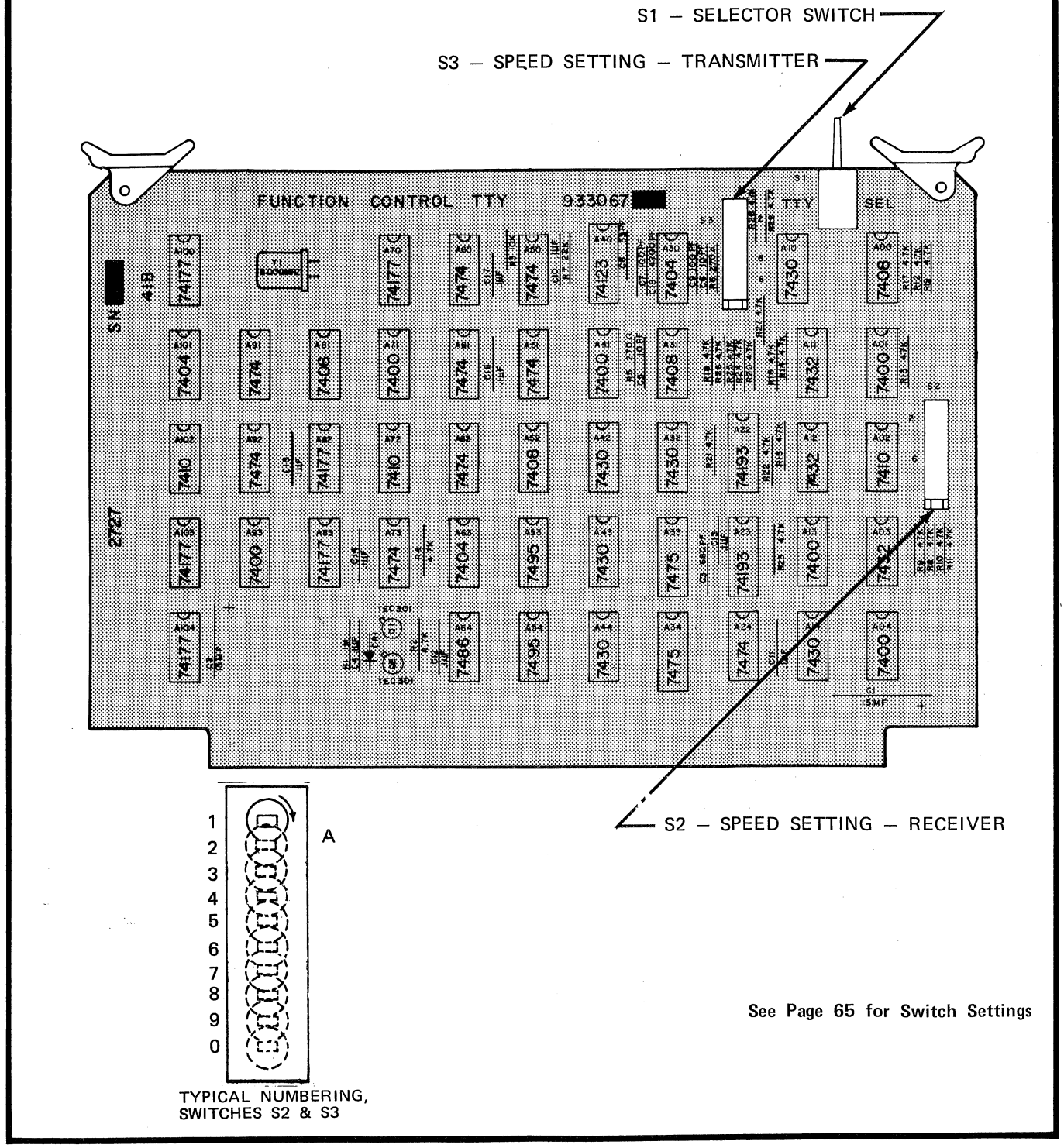


FIGURE 23 MODEL 440 PAGE CONTROL PRINTED CIRCUIT BOARD



See Page 65 for Switch Settings

FIGURE 24 MODEL 440 OPTION SELECTIONS–
FUNCTION CONTROL PCB

OPTION SETTING
FUNCTION CONTROL PCB — Board 5 (See Figure 24)

SPEED SETTING—RECEIVER (S2)

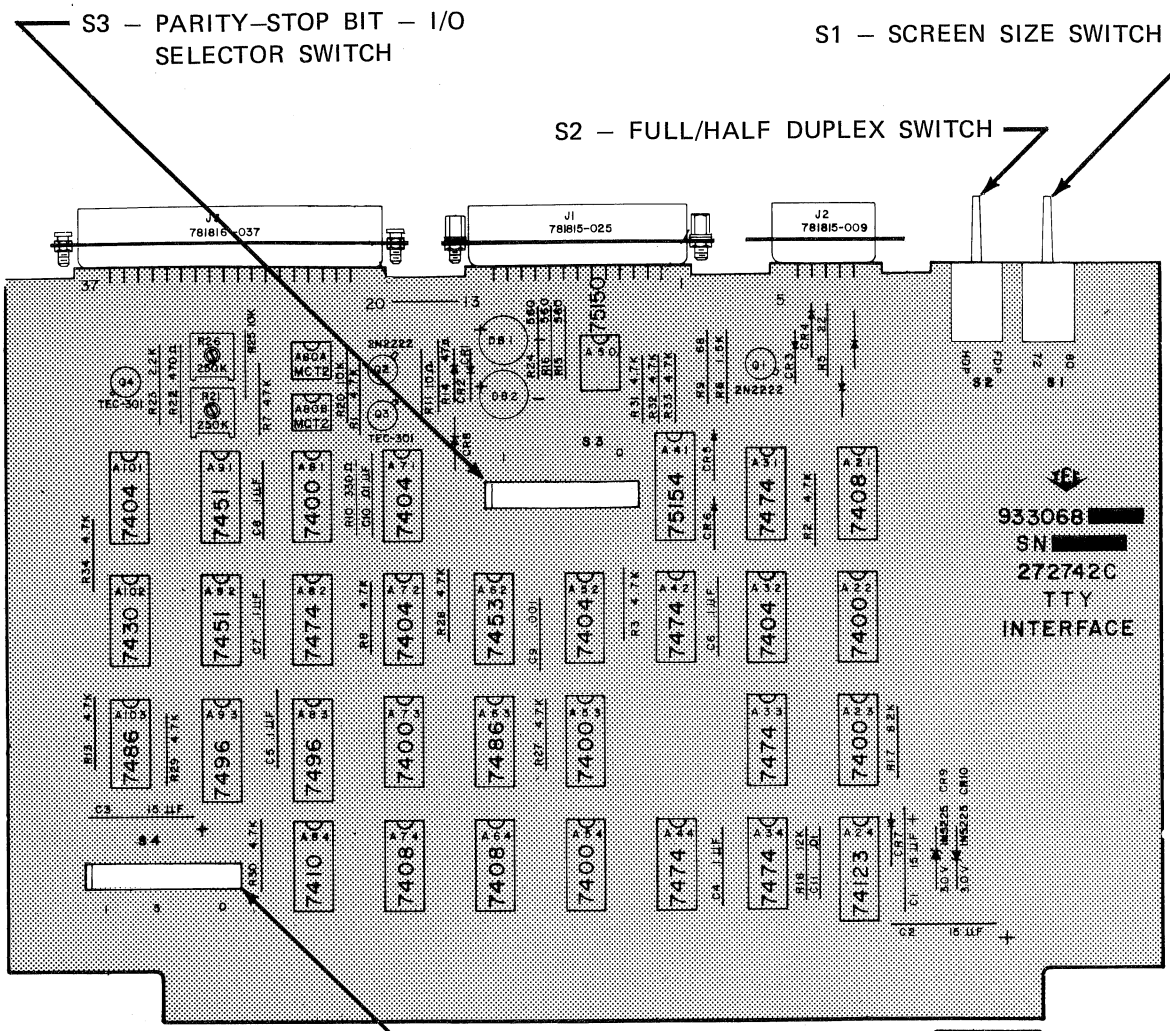
		Switch	Rotor	Position
110 Baud	(9.09 mSec/bit)	S2	A	1
150 Baud	(6.67 mSec/bit)	S2	A	2
300 Baud	(3.33 mSec/bit)	S2	A	3
600 Baud	(1.67 mSec/bit)	S2	A	4
1200 Baud	(833 uSec/bit)	S2	A	5
1800 Baud	(555 uSec/bit)	S2	A	6
2400 Baud	(416 uSec/bit)	S2	A	7
4800 Baud	(208 uSec/bit)	S2	A	8
7200 Baud	(139 uSec/bit)	S2	A	9
9600 Baud	(104 uSec/bit)	S2	A	0

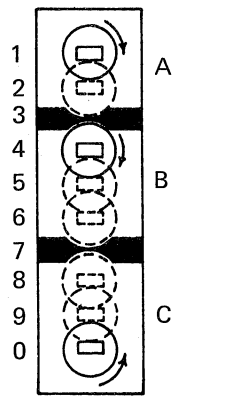
SPEED SETTING—TRANSMITTER (S3)

		Switch	Rotor	Position
110 Baud	(9.09 mSec/bit)	S3	A	1
150 Baud	(6.67 mSec/bit)	S3	A	2
300 Baud	(3.33 mSec/bit)	S3	A	3
600 Baud	(1.67 mSec/bit)	S3	A	4
1200 Baud	(833 uSec/bit)	S3	A	5
1800 Baud	(555 uSec/bit)	S3	A	6
2400 Baud	(416 uSec/bit)	S3	A	7
4800 Baud	(208 uSec/bit)	S3	A	8
7200 Baud	(139 uSec/bit)	S3	A	9
9600 Baud	(104 uSec/bit)	S3	A	0

SELECTOR—SWITCH (S1 — Mounted on Edge of PCB)

TTY: forces 110 Baud, 11 Bit T & R	S1	DOWN
SEL: allows selection of T & R rates, 10 or 11 bits	S1	UP





TYPICAL NUMBERING, SWITCHES S3 & S4

See Pages 67 & 68 for Switch Settings

FIGURE 25 MODEL 440 OPTION SELECTIONS– TTY INTERFACE PCB

OPTION SETTINGS

TTY INTERFACE PCB – Board 6.
(Refer to Figure 25 at left.)

PARITY SETTING (S3) (Transmit Only - Receive Parity not checked)

	Switch	Rotor	Position
Mark only: parity bit always a '1'.	S3	A	1 ✓
Even: even parity transmitted	S3	A	2
Odd: odd parity transmitted	S3	A	3

STOP BITS (S3)

	Switch	Rotor	Position
10 Bits: 10 bits per character, exc. forced TTY mode	S3	B	5 ✓
11 Bits: 11 bits per character	S3	B	6

INTERFACE: (S3)

	Switch	Rotor	Position
Current Loop: 10 to 100 mA	S3	C	8
TTL: 0 & 5V	S3	C	9
RS-232-C : ±15V max.	S3	C	0 ✓

AUTO–CARRIAGE RETURN (S4)

	Switch	Rotor	Position
Both Local & Remote:	S4	A	1
Local only:	S4	A	2 ✓

AUTO CR–LF FUNCTION (S4)

	Switch	Rotor	Position
Cursor - Overrange only	S4	B	4
Both Cursor Overrange & CR*	S4	B	5 ✓
CR only*	S4	B	6
Disabled	S4	B	7

*See Auto Carriage Return, PS1.

AUTO CR–LF REPEAT (S4)

Repeat CR–LF until CR or BS received	S4	C	9
Send CR–LF only once	S4	C	0 ✓

DUPLEX (S2 – Mounted on Edge of PCB)

Half-Duplex (forced in local mode)	S2	DOWN
Full-Duplex (forced if split rate used	S2	UP

SCREEN SIZE (S1 – Mounted on Edge of PCB)

72 Characters	S1	DOWN
80 Characters	S1	UP

Note: UP & DOWN referred to normal position when mounted in card cage.

SECTION VI

GENERAL SPECIFICATIONS

Model 440 DATA–SCREEN Terminal

DISPLAY

Screen Capacity, Characters	1920 - 1728
Characters Per Line (Switch Selectable)	80 - 72
Number of Lines	24
Tube Size (Diagonal)	12-inch
Viewing Area	74 sq in
Character Size (H x W)	.20 x .08
Refresh Rate	60 Hz (50 Hz avail)
Scan Method	Raster
Displayable Characters (incl. space)	64
Character Generation	5 x 7 Dot Matrix
Character Code	ASCII
Cursor	Blinking Underline
Cursor Controls	Backspace only
Automatic Line Feed	Optional
Bottom Line Entry	Yes
Hard Copy Output connector	Yes
Remote Monitor Output Socket (BNC)	Yes

MEMORY

Type	MOS Shift Register
Capacity (6 Bit Characters)	2048

INTERFACE

I/O Asynchronous	TTL RS-232 Current Loop
Serial (Baud Rate)	110-9600
Transmit Mode (Switch Selectable)	Half/Full Duplex
Transmission Format	10/11 Bit Start-stop
Parity:	odd, even, mark

PHYSICAL CONFIGURATION

Desk Mount with Monitor	Std.
Rack Mount with Monitor	Optional
Rack Mount without Monitor	Optional
Desk Mount without Monitor	Optional
Keyboard	Yes

CONTROLS (all models with monitor)

Brightness (Operator Adjustable)

POWER REQUIREMENTS (all models)

(standard) 115 VAC; 60 Hz, 120 watts maximum
(optional) 115 VAC; 50 hz, 120 watts maximum
240 VAC; 60 Hz, 120 watts maximum
240 VAC; 50 Hz, 120 watts maximum

TEMPERATURE RANGE

Operating: $+10^{o}$ C to $+40^{o}$ C @ 80% relative humidity (non-condensing)

Storage: -40^{o} C to $+65^{o}$ C @ 80% relative humidity (non-condensing)

STANDARD FINISHES

Armorhide Blue (a semi-glossy, textured, and tough paint) and Walnut Wood Grained Vinyl bonded to metal.

PHYSICAL SPECIFICATIONS

Dimensions, All models, see Figures 29, 30 & 31.

Shipping Weight:	Desk Mount with Monitor	68 pounds (includes keyboard)
Shipping Weight:	Desk Mount without Monitor	64 pounds (includes keyboard)
Shipping Weight:	Rack Mount with Monitor	65 pounds (includes keyboard)
Shipping Weight:	Rack Mount without Monitor (Rack panel not included)	39 pounds (includes keyboard)
Shipping Weight:	Keyboard (separate)	15 pounds
Shipping Carton:	(with internal padding)	8 pounds typical

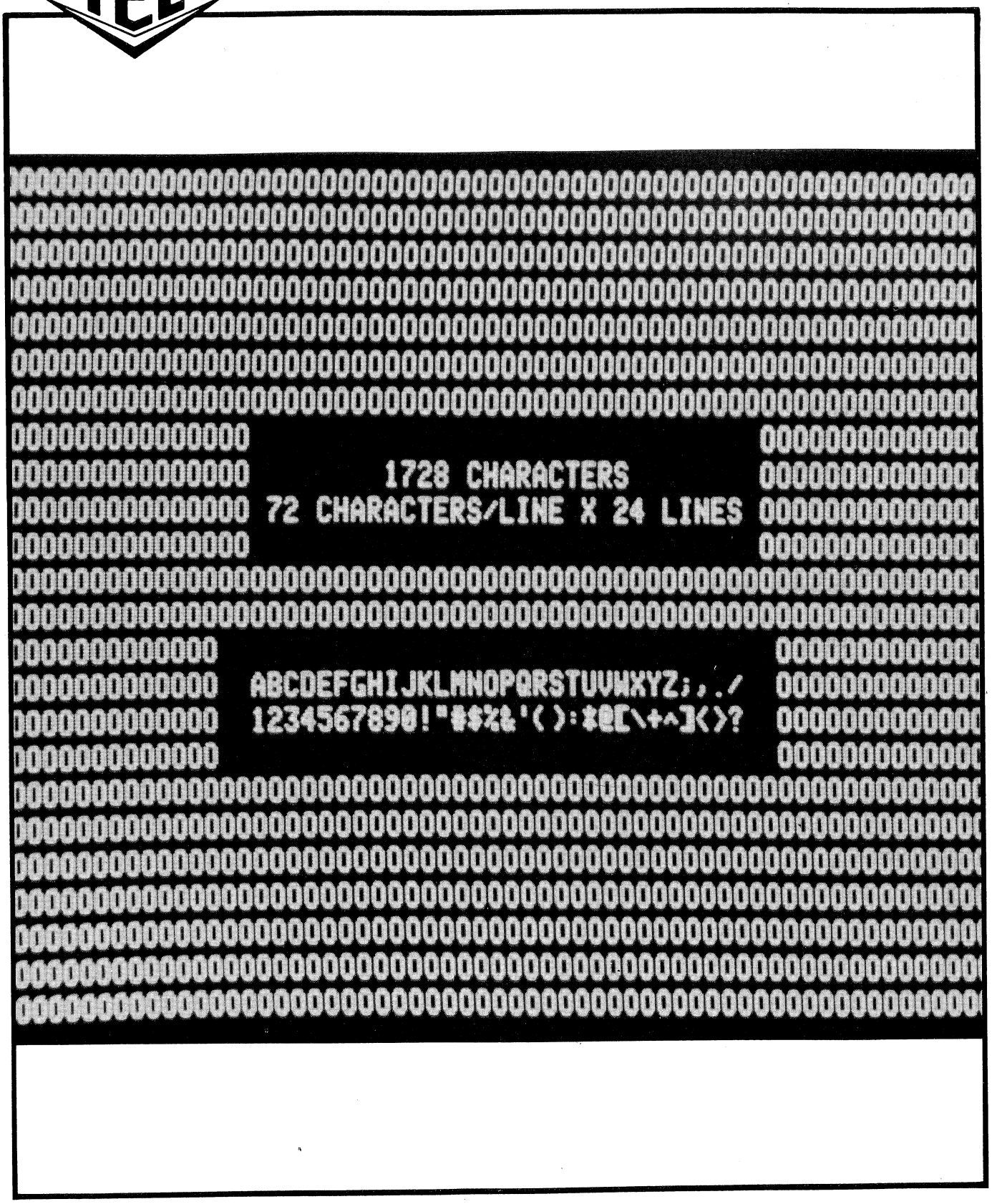


FIGURE 26 PHOTOGRAPH – ACTUAL SIZE – OF
72 CHARACTER LINE OF MODEL 440

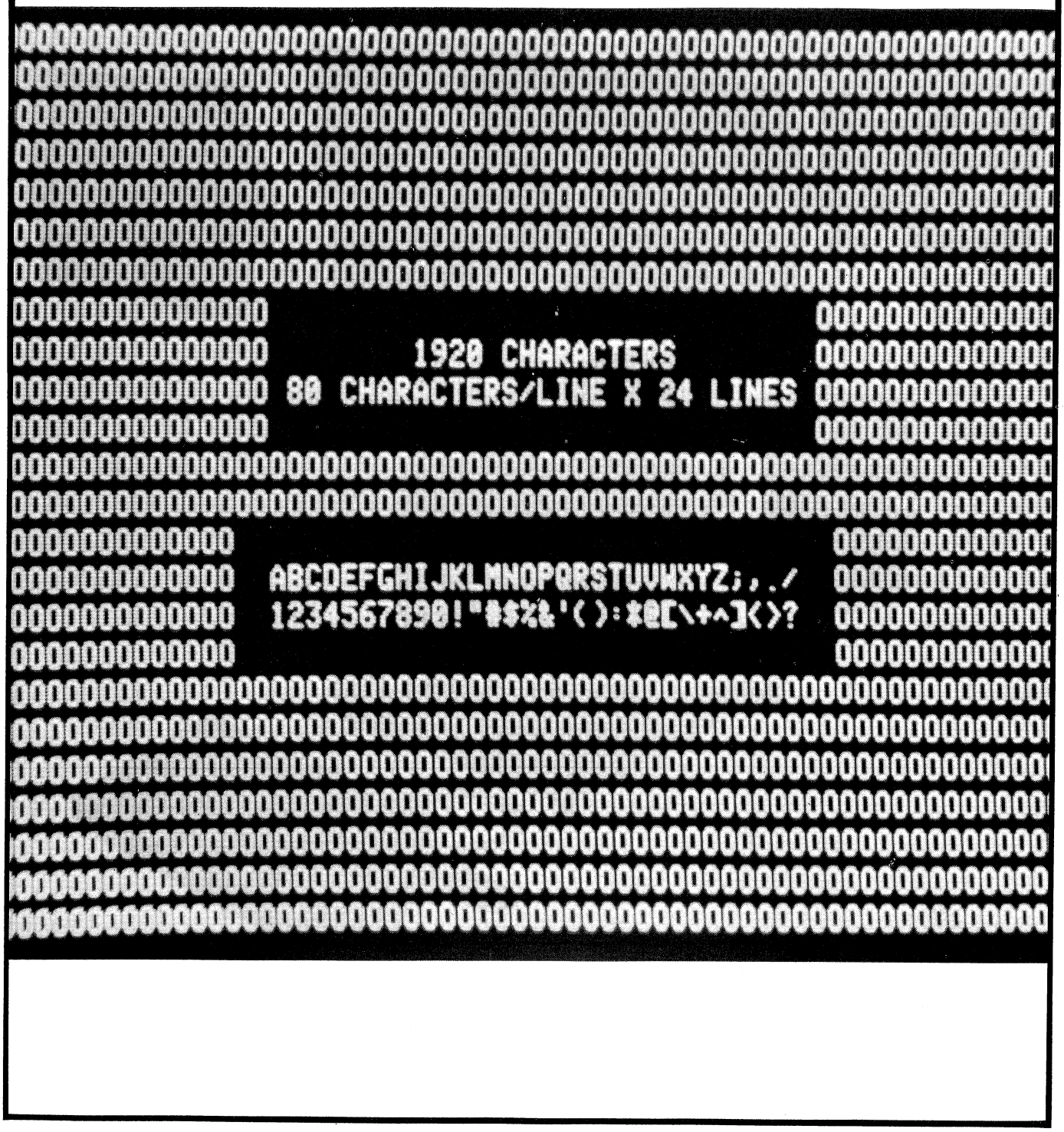


FIGURE 27 PHOTOGRAPH – ACTUAL SIZE – OF
80 CHARACTER LINE OF MODEL 440

FIGURE 28 EXPLODED VIEW – TYPICAL DATA–SCREEN TERMINAL ASSEMBLY

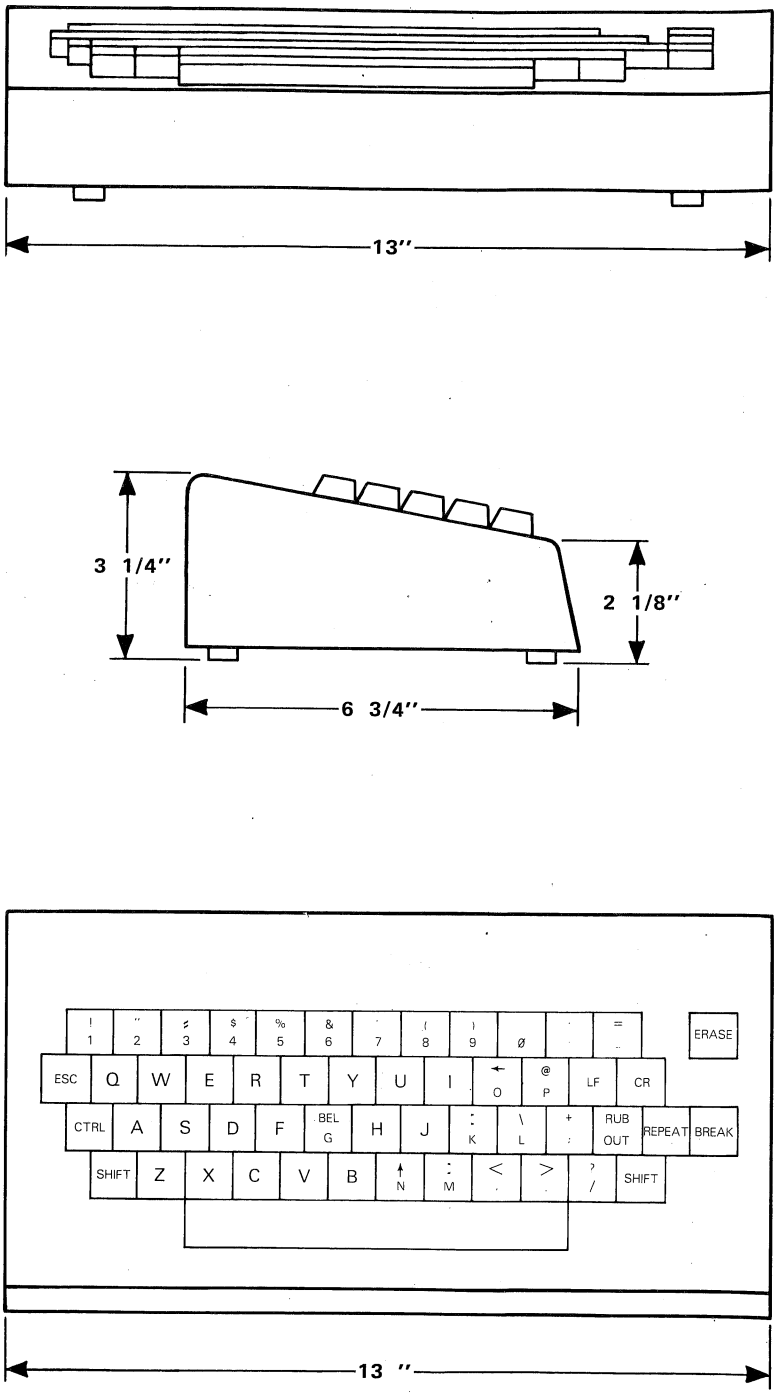
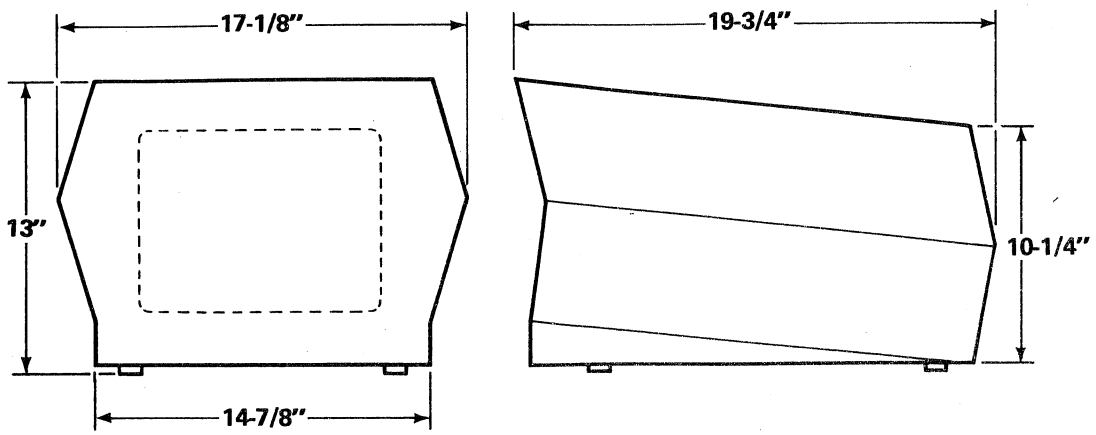
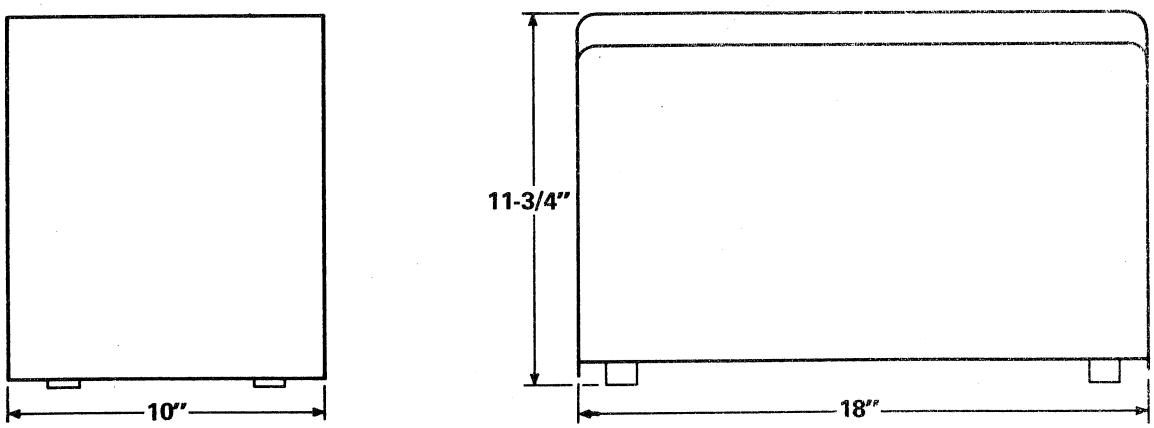


FIGURE 29 DIMENSIONS, MODEL 440 KEYBOARD

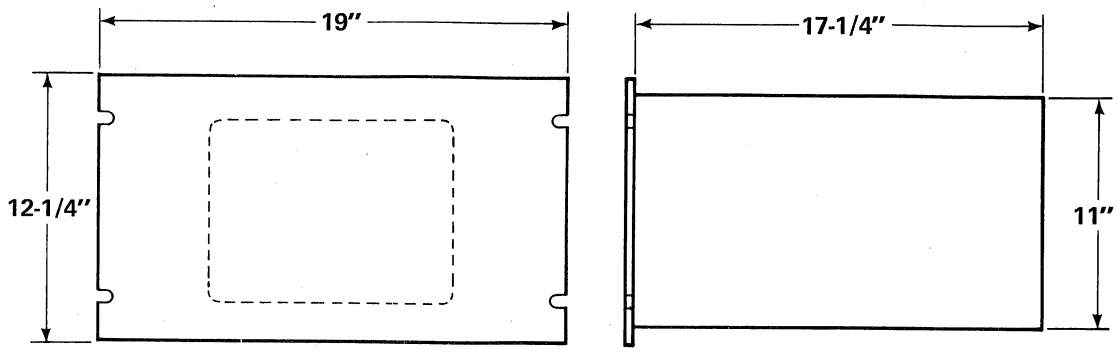


DESK TOP MODEL WITH MONITOR

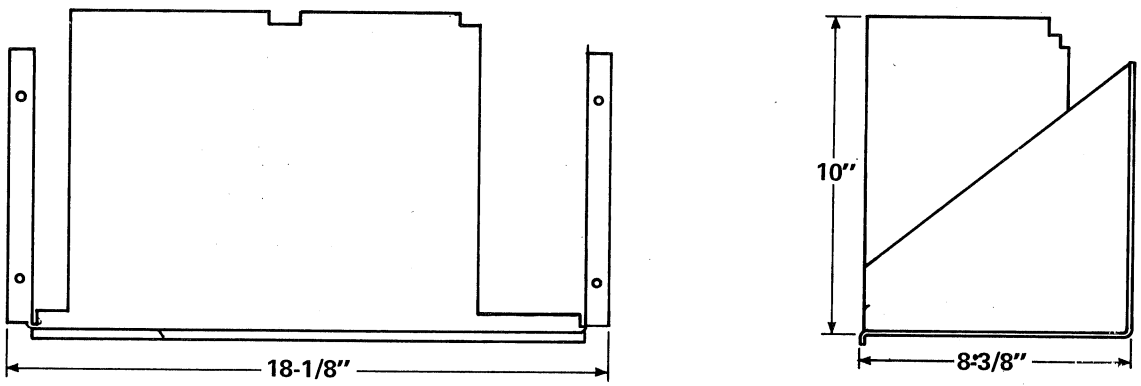


DESK TOP MODEL WITHOUT MONITOR

FIGURE 30 DIMENSIONS, DESK TOP MODELS



RACK MOUNT MODEL WITH MONITOR



RACK MOUNT MODEL WITHOUT MONITOR

FIGURE 31 DIMENSIONS, RACK MOUNT MODELS

SPARE PARTS LIST	MODEL 440	
PARTS DESCRIPTION	PART NUMBER	UNIT PRICE
TIMING GENERATOR (TIMING GEN TTY) PCB	933037 *Exchange	$ 82.00 32.80
CHARACTER GENERATOR (LM & CG TTY) PCB	933061 *Exchange	293.00 117.20
PAGE MEMORY (PAGE MEM TTY) PCB	933062 *Exchange	332.00 132.80
PAGE CONTROL TTY PCB	933063 *Exchange	138.00 55.20
FUNCTION CONTROL TTY PCB	933067 *Exchange	122.00 48.40
TTY INTERFACE PCB	933068 *Exchange	162.00 64.80
EXTENDER PCB	933030	50.00

*TEC's Printed Circuit Board exchange program permits return of defective, out of warranty PCB's for 60% credit toward the purchase of an exchange PCB of the same type. Exchange PCB's carry the same 90 day warranty from the 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 funtion of the PCB.

SPARE PARTS LIST		ALL MODELS	
PARTS DESCRIPTION		**PART NUMBER**	**UNIT PRICE**
CLEAR EPOXY COATED PCB's (for environmental protection)		Price of PCB plus	$20.00/Bd.
105 - 135/210 - 270 VAC 50 - 60 Hz MONITOR ASSEMBLY (includes CRT)	P4 (white) Phosphor CRT P31 (green) Phosphor CRT	740031-001 740031-002	$246.00
EKA 9100 KEYBOARD **		981433-000	$244.00
KEYBOARD EXTENDER CABLE (xxx = length in inches)		933390-xxx	$50 + $1.00/ft.
REPLACEMENT KEYBOARD SWITCHES		881323-001	$1.15
MATING CONNECTORS FOR			
J1 — (Cinch DB-25S) Hood for above (Cinch DB 51226-1)		781014-003 741184-000	$7.50 $1.60
J2 — (Cinch DE-9S) Junction shell for above (Cinch DE 19977-5)		781014-001 740034	$3.30 $1.60
POWER SUPPLY ASSEMBLY (includes Regulator PCB)		930040	$250.00
PRODUCT DESCRIPTION MANUAL (Additional copies)		832	$7.50
SHIPPING CARTON (with internal padding)		211366	$25.00 + FRT.

Prices subject to change without notice. Minimum order $25.00

**Keyboard repair - TEC will repair DATA–SCREEN Terminal keyboards for a fixed charge of $150.00 provided that the keyboard has not be 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.

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

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 Parts & Price List – pages 78 & 79.)

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 1 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. C displays as A etc.)

- change CG
- change PM
- change PC
- change FC
- change TI

No Display, No Raster

- check fuses
- check voltages
- change monitor

No Display, No Sync

- check voltages
- change TG
- change CG
- change monitor

No Display, Good Raster

- check voltages
- change PC
- change TG
- change CG
- change monitor

Good Cursor, No Characters

- change CG
- change PC
- change TI
- change FC
- change PM

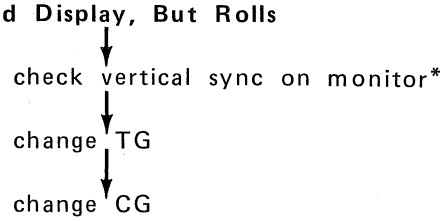
Distorted Characters

- change CG
- change TG
- change monitor

TG = Timing Generator (Bd 1)
CG = Character Generator (Bd 2)
PM = Page Memory (Bd 3)
PC = Page Control (Bd 4)
FC = Function Control (Bd 5)
TI = TTY Interface (Bd 6)

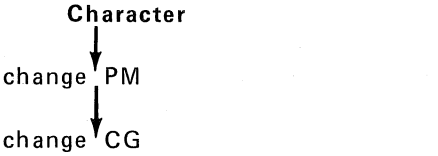
DISPLAY PROBLEMS (cont'd)

Good Display, But Rolls

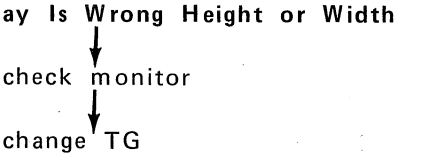


*See Monitor manufacturers manual.

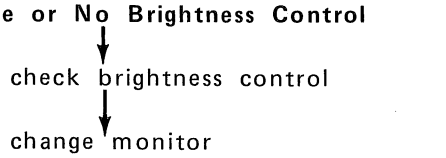
Comes On With Screen Full of One Character



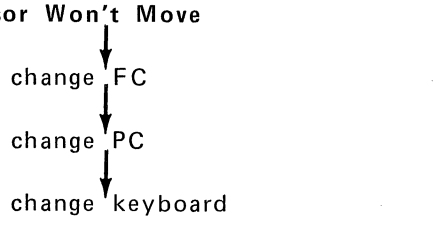
Display Is Wrong Height or Width



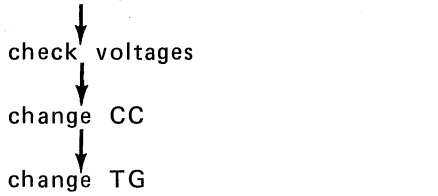
Little or No Brightness Control



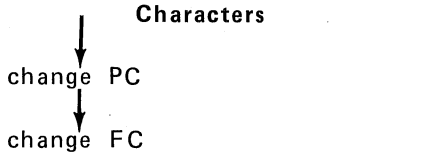
Cursor Won't Move



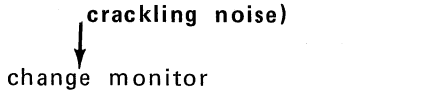
Whole Display Moves



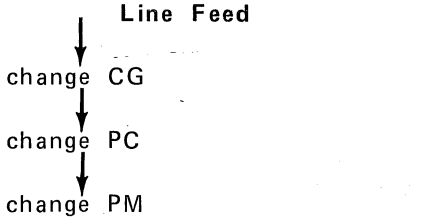
Comes On With Screen Full of Random Characters



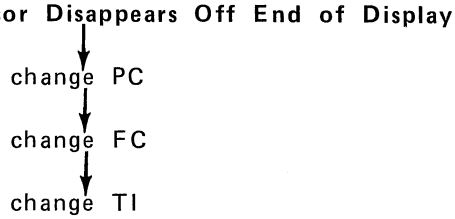
Display Shows Jagged Lines (may be crackling noise)



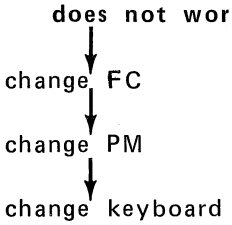
Characters or bits Changed or Move on Line Feed



Cursor Disappears Off End of Display

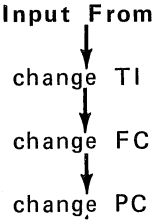


Can't Clear Screen (ERASE key does not work)

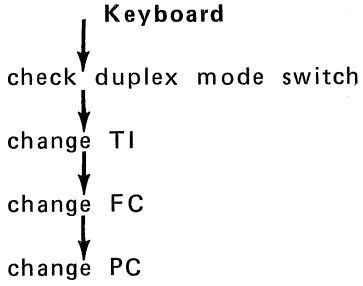


INPUT/OUTPUT PROBLEMS

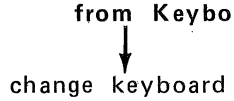
No Input From or Output to CPU

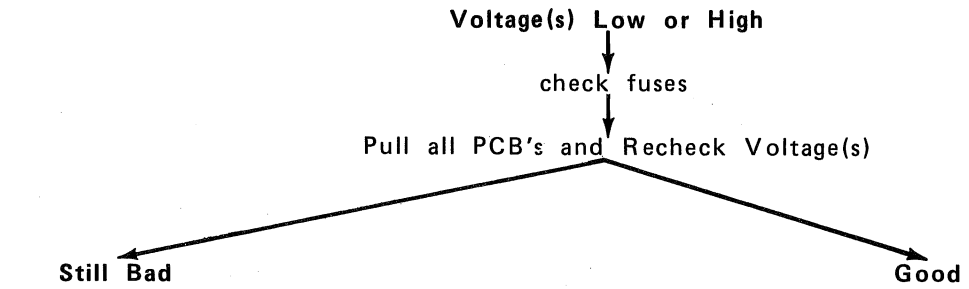


Cursor Won't Move on Input From Keyboard



One Particular Character Won't Enter from Keyboard





change power Supply

Reinsert PCB's one at a time until voltage go bad. Last PCB inserted may be bad or power supply may be current limiting "early". Replace last PCB with another to evaluate problem.

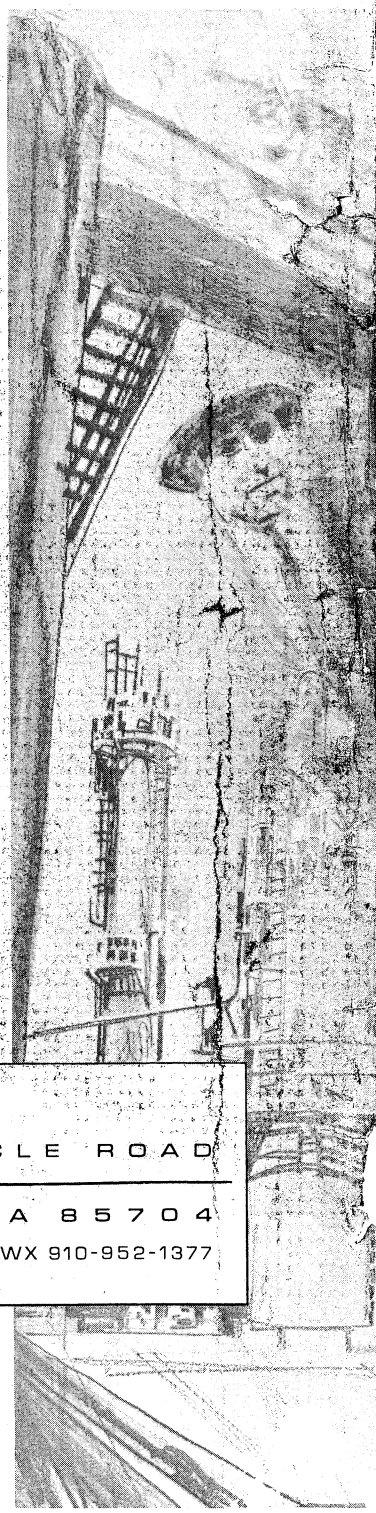
WARRANTY

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 is 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 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

9800 NORTH ORACLE ROAD

TUCSON, ARIZONA 85704

(602) ~~297-1111~~ 792-2230

TWX 910-952-1377

DATA-SCREEN T.M. TEC, INCORPORATED

832 10-72 P

Printed in U