4810 & 4860

INDUSTRIAL TERMINALS

Printed in the United States of America
Part Number 90804-001

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XYCOM REVISION RECORD

Revision	*Description*	*Date*
A	Manual Released	8/86
B	Manual Updated and Released incorporated Firmware Revision level 5..2	6/87
C	Manual Updated and Released	6/89

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Part Number: ***90804-001 C***

TABLE OF CONTENTS

TABLE OF CONTENTS cont.

TABLE OF CONTENTS cont.

CHAPTER TITLE PAGE

TABLE OF CONTENTS cont.

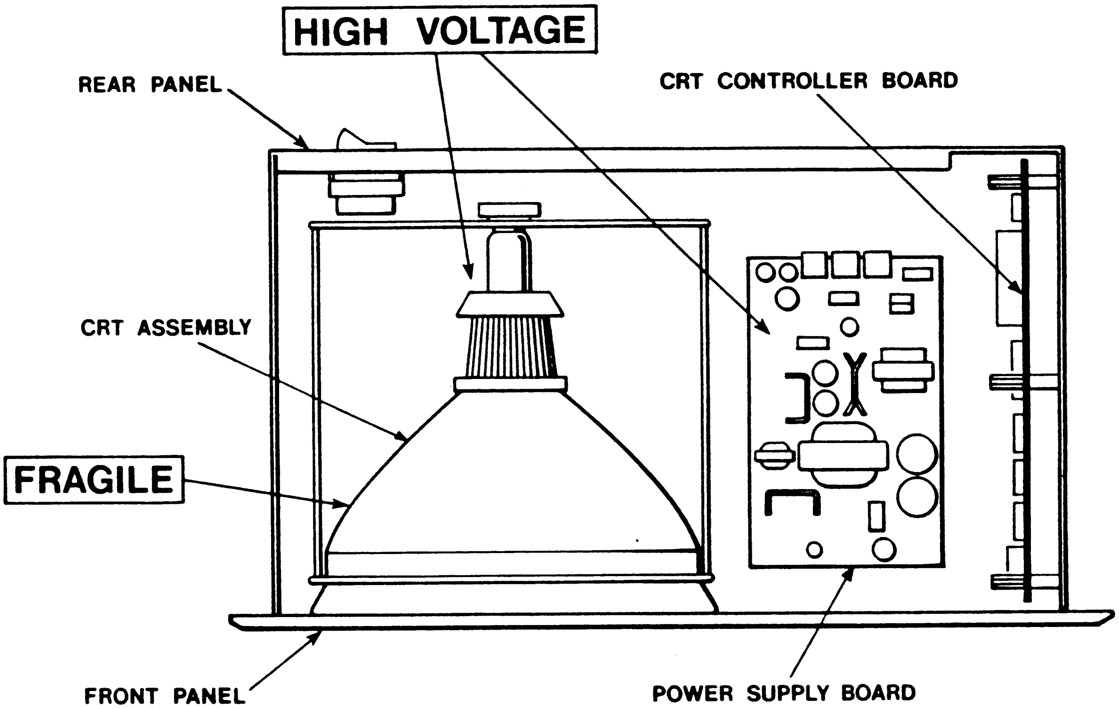
LIST OF FIGURES

TABLE OF CONTENTS cont.

LIST OF TABLES

WARNING
Dangerous voltages are present within all Xycom Industrial Terminals. These voltages will linger after all electrcal power is turned off. Use cation whenever the front panel is opened. Avoid touching high-voltage areas within the terminal. Do not work alone.

WARNING
The FRAGILE Cathode Ray Tube (CRT) is exposed when the front panel is opened. Wear safety glasses incase of accidental breakage. Internal coating of CRT is extremely TOXIC. If exposed RINSE IMMEDIATELY and consult a physician.



Chapter 1

INTRODUCTION

1.1 INTRODUCTION

The Xycom 4810 and 4860 Industrial Monochrome Terminals are designed and built to be economical interfaces that meet the environmental and reliability demands of industry. They serve as rugged operator interfaces anywhere that a person must communicate with an automated machine or process, thriving in installations where fragile office terminals simply would not survive. The terminals provide meaningful information and instructions to equipment operators. With built-in keypads and context-sensitive operator menu displays, the Xycom terminal gives a system designer extreme flexibility as well as functionality.

The 4810 and 4860 are intelligent terminals, which means that they can execute special remote commands transmitted by the host computer (or stored in the terminal's own memory if an option module such as a 4800-E1 is installed). These commands can format the screen and draw a variety of figures, such as lines, boxes, and high-resolution bar graphs.

The 4810 and 4860 terminals are functionally very similar to each other. Each is menu-configurable to emulate either a Hazeltine 1500 or DEC VT100/220 terminal (ANSI Standard X3.64). The 4860 terminal enclosure houses a 12" diagonal monochrome video display, while the 4810 has a 9" diagonal screen. Both contain internal terminal control electronics, power supply, RS-232C communications port, and 28-key sealed membrane keypad. A detachable full-size keyboard is available. An RS-422 or 20mA current loop interface can optionally replace the RS-232C port.

The 4810 comes in three versions: the 4810E, 4810ER, and the 4810ER/DC. The 4810E has a plain faceplate, and seals to NEMA 4/12 standards when panel mounted. The 4810ER has special handles and cutouts on the faceplate for rack-mounting in a standard 19" EIA rack. The 4810ER/DC is identical to the 4810ER, except that it has a 24 VDC input instead of the AC input.

The 4860 comes in two versions: the 4860 and 4860A. The 4860A version is identical to the 4860, except that a 10-key, sealed-membrane function keypad has been added to the front panel beneath the video display. This is to give the user easy and quick access to familiar routines. The 4860 can be mounted in a standard EIA 19" equipment rack or panel-mounted to meet NEMA 4/12 specifications.

The Xycom Industrial Terminals use a unique, open-ended design, allowing the user to configure them in any number of different ways. Xycom also produces a variety of expansion and enhancement modules to adapt the terminals to virtually any environment or function. The list on the next page is only a partial list of the Xycom modules that can be added to the base terminal.

EXPANSION MODULES:

4800-E1 ———— Provides 16K battery-backed CMOS RAM for storage of screen programs, plus an additional RS-232 serial port.

4800-E2 ———— Provides 16K battery-backed CMOS RAM, plus an RS-485 serial port for multidrop.

EXPANSION MODULES with OIL:

(Xycom's Operator Interface Language)

OIL architecture includes

- Intelligence based on OIL
- Time-Of-Day Clock/Calendar
- 16K bytes of program/data memory, expandable to 40K or 55K

4800-E3 ———— OIL architecture, an added parallel port for digital interface with programmable controllers, freeing the terminal port for printer or other peripheral

4800-E4 ———— OIL architecture and a second serial port for interface to another computer or programmable controller

4800-E5 ———— OIL architecture and a multidrop serial interface (RS-485) for up to 31 terminals on one line.

4800-E6 ———— OIL architecture and Allen-Bradley Data Highway interface (RS-232)

4800-E7 ———— OIL architecture and Modicon Modbus interface (RS-232)

4800-E8 ———— OIL architecture and Texas Instruments Series 500 PLC interface (RS-232)

4800-E10 ———— OIL architecture and Square D SY/MAX Network interface (RS-422)

4800-E11 ———— OIL architecture and Westinghouse PLC interface (RS-232)

4800-E12 ———— OIL architecture and General Electric PLC interface (RS-232 or RS-485)

More expansion modules are still in the design process.

1.2 MANUAL STRUCTURE

This first chapter is an overview, introducing the user to general specifications and functional capabilities. The later chapters discuss installation and operation in greater detail.

The chapters in this manual are structured in the following manner:

Chapter One - a general discussion of the Industrial Terminal, including functional and environmental specifications.

Chapter Two - installation, configuration, and start-up information, including step-by-step instructions on connecting the terminal to outside sources. Also, important menu information is provided.

Chapter Three - keypad and keyboard information, including programming details.

Chapter Four - all of the information on the video display is contained in this chapter. Includes data on graphics, characters, and manipulation of images.

Chapter Five - complete instruction set and listing of the remote commands.

Chapter Six - detailed information on the communications capability of the terminal, including a description of the ports.

Chapter Seven - contains diagnostics information for the terminal, for use in troubleshooting and testing.

Appendix A - detailed mounting instructions for the terminal.

Appendix B - DEC VT100/220 codes not supported by the terminal.

Appendix C - a complete listing of all 256 graphics characters, in all modes.

Appendix D - instructions on the installation of optional modules.

Appendix E - saving, loading, and verifying screen programs on tape.

Appendix F - a quick reference guide, including all of the important informational tables contained in the manual.

1.3 SPECIFICATIONS

Table 1-1 lists the specifications for the 4810 and 4860 Industrial Terminals.

Table 1-1 Specifications

CHARACTERISTIC	SPECIFICATION
Mechanical	
Mounting	fits in standard EIA 19" rack
Front-panel seal	meets NEMA 4 and NEMA 12 specifications when panel-mounted (4810E and 4860 only)
Dimensions	
4810E	Height - 10.4" (265mm) Width - 19.0" (483mm) Depth - 10.25" (260mm)
4810ER	Height - 8.75" (222mm) Width - 19.0" (483mm) Depth - 10.25" (260mm)
4860	Height - 12.2" (310mm) Width - 19.0" (483m) Depth - 15.75" (400mm)
Monitor	
4810	9" CRT P-31 green phosphor
4860	12" CRT P-134 amber phosphor
Keypads	
4810, 4860	28-key, sealed membrane
4860A	28-key and 10-key, sealed membrane
Backplane	5 slots 4 PC/AT type 1 PC/XT type

Table 1-1 Specifications cont.

CHARACTERISTIC	SPECIFICATION
Electrical	
Power Requirements	115 VAC @ 60 Hz (0.7 Amps) 230 VAC @ 50 Hz (0.35 Amps) 37 Watts
Fuse	1.5 Amp Slo-Blo @ 115 VAC 0.75 Amp Slo-Blo @ 230 VAC
Environmental	
Temperature	
Operating	32°to 122°F(0°to 50°C)
Non-operating	-40°to 149°F(-40°Cto 65°C)
Humidity	5 to 80% relative, non-condensing
Shock (.5 SINE Shock Pulse)	
Operational	15g Peak Acceleration ±11 msec Duration
Non-operational	30g Peak Acceleration ±11 msec Duration
Vibration (5 to 2KHz Frequency Range)	
Operational	0.006" Peak-to-Peak Displacement
Vibration Amplitude	1.0g Peak Acceleration
Non-operational	0.015" Peak-to-Peak Displacement
Vibration Amplitude	2.5g Peak Acceleration

Chapter 2

INSTALLATION

2.1 INTRODUCTION

Installation of each industrial color terminal involves:

- choosing a suitable location
- connecting electrical power to the terminal
- connecting the serial port to a host computer or modem

Each terminal must be installed in a location that meets with the environmental specifications given in Chapter One (temperature of 0° to 50°Cand relative humidity 5% to 80% non-condensing). The terminal can be either rack- or panel-mounted. If rack-mounted, it can be installed in a standard 19" EIA equipment rack. If not, Appendix A gives the front panel and cutout dimensions required for panel-mounting.

If one or more Xycom Expansion Modules have been purchased for the terminal, the documentation accompanying each module will give a detailed explanation on installation. Some expansion modules change the operational "personality" of the terminal when they are installed. Refer to the expansion module manual for configuration, programming, and operating instructions that may have to be used instead of the instructions included in this base terminal manual.

Each Industrial Terminal has a single RS-232C communications port (Figure 2-1). A second serial port is available as an option (e.g., options 4800-E1 or 4800-E4). The type of cable connector required for the terminal RS-232C communications port is a 25-pin male D-type connector. See Section 6.7 for communication port pin definitions.

The terminal is interfaced to the host device by installing a data cable from the terminal communications port to the host device RS-232C communications port. Alternately, the terminal can be connected to a modem which is in turn connected to the host device.

For detailed information on the terminal communications port, see Chapter 6.

2.2 INSTALLATION

> **WARNING**
> Before connecting electrical power to the terminal, ensure that the ON/OFF switch is set to OFF.
>
> The power cable must be connected to a properly grounded outlet. DO NOT use an adapter plug that prevents the terminal from being properly grounded through its power cable.

1. Install any expansion modules or other circuit boards in the terminal.
2. Secure the terminal in a suitable mounting position.
3. Select the correct voltage with the 115/230 VAC selector switch, located on the rear panel of the terminal.
4. Slide the plastic cover on the electrical power receptacle to cover the power receptacle. Check the fuse for serviceability and correct rating per line voltage (1.5 amp for 115 VAC and 0.75 amp for 230 VAC). Replace unserviceable fuses.
5. Slide the plastic cover over the fuse receptacle. Connect the female end of the power cable to the terminal receptacle.
6. Connect any host device or other peripheral to the appropriate port.

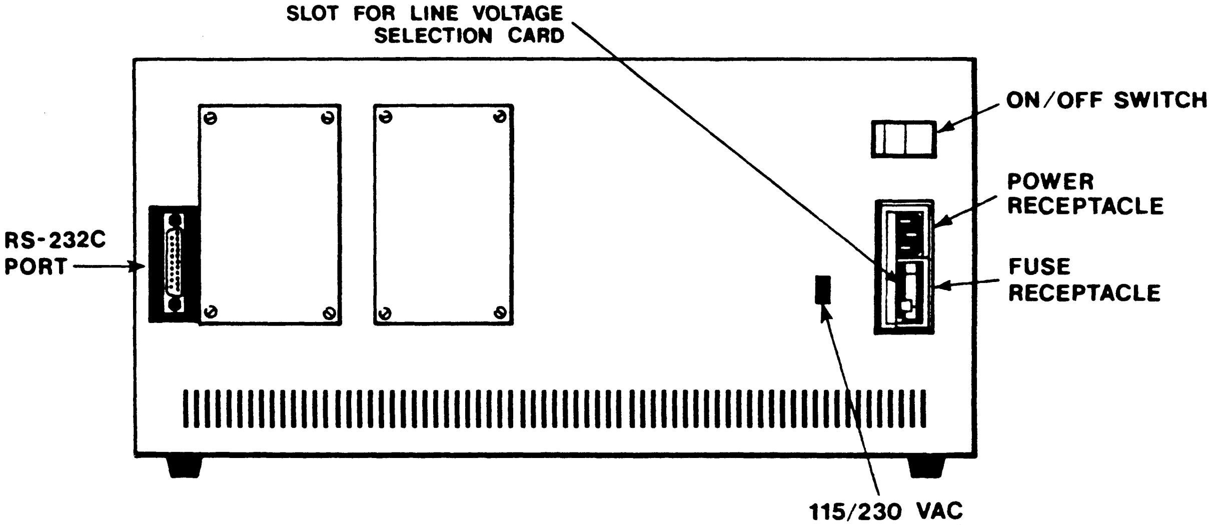

SLOT FOR LINE VOLTAGE SELECTION CARD
ON/OFF SWITCH
POWER RECEPTACLE
RS-232C PORT
FUSE RECEPTACLE
115/230 VAC SELECTOR SWITCH

Figure 2-1 Rear Panel

2.2.1 Connecting the Optional Keyboard

To install an optional full-size XYCOM 4810-KYB or IBM PC/XT compatible keyboard, unscrew the protective cap on the lower right corner of the front panel and connect the cable from the keyboard to the receptacle (Figure 2-2). When the full-size keyboard is not in use, the protective cap should be installed.

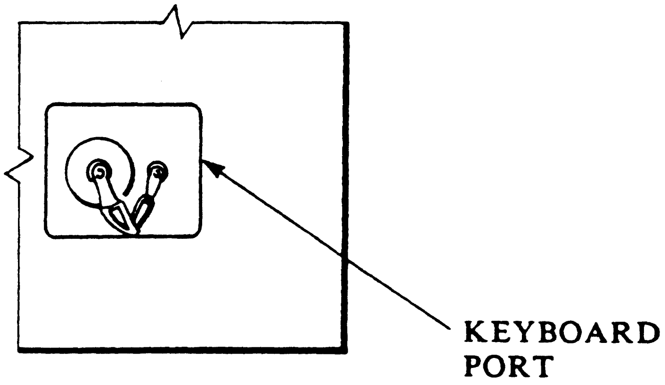


Figure 2-2 Location of Keyboard Receptacle

A switch on the terminal controller circuit board is used to specify which type (XYCOM 4810-KYB or IBM PC/XT compatible) of keyboard is to be used (see Figure 2-3). Placing the switch in the "key" position configures the terminal for operation with the 4810-KYB. The "PC" position is for an IBM PC/XT keyboard. (Connecting in the wrong style keyboard for the switch position will not harm either the keyboard or the terminal -- it will simply give improper data until the switch position is corrected.)

A permanent external full-sized sealed keyboard (Xycom 4800-K1) is also supported.

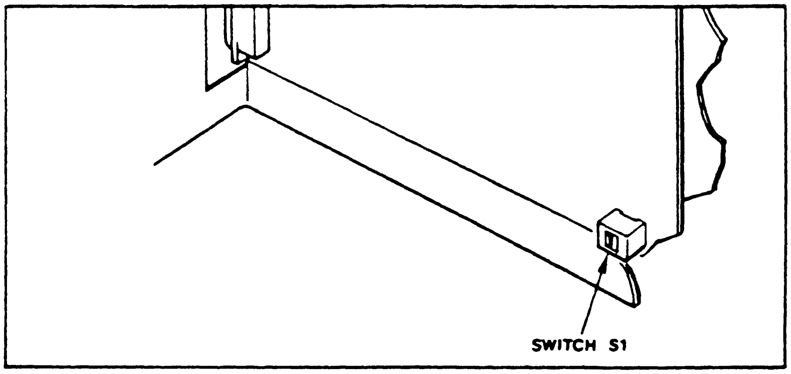


Figure 2-3 Keyboard Switch

2.3 POWER-UP

The terminal is turned on by setting the power switch to ON. The video display will require a brief warmup period -- about 10 seconds -- after which time the cursor will appear in the top left corner of the screen. The terminal is now in Operating Mode.

The terminal is always in one of two modes: Operating Mode or Set-up Mode. It is in Operating Mode whenever a menu or prompt is not being displayed on the screen. It automatically enters Operating Mode when it is powered up. The terminal must be in Operating Mode to receive any commands over the serial port.

However, to configure the terminal, the Set-up Mode must be used.

To exit the Operating Mode, do any of the following:

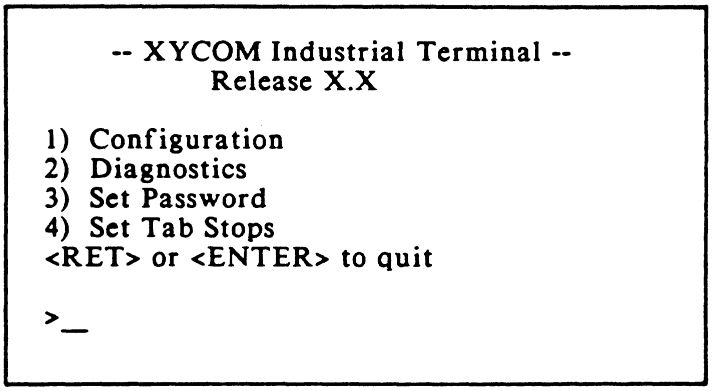
- On the keyboard, press "F10" twice, or
- On the keypad, press "F1" and "-->" simultaneously (4810E and 4860)
- On the keypad, press "A" and "IV" simultaneously (4810ER)

Neither of these will work if the password has been enabled (see Section 2.4.2), the user will be prompted to type a 3-letter password. Only if the password has been correctly entered will the Main Menu be displayed on the screen.

To force the terminal into Operating Mode, press the <Return> key while the Main Menu is displayed.

2.4 MAIN MENU

The Main Manu should look like the following:



```
        -- XYCOM Industrial Terminal --
                Release X.X

1) Configuration
2) Diagnostics
3) Set Password
4) Set Tab Stops
<RET> or <ENTER> to quit

>_
```

Figure 2-4 Main Menu

2.4.1 Configuration

Selecting this option will prompt the Configuration Menu to appear. This is discussed in detail in Section 2.5.

2.4.2 Diagnostics

Selecting this option will prompt the diagnostics function. This is discussed in detail in Chapter 7.

2.4.3 Password and Keypad Menu Lockout

The terminal provides two ways of "tamper-proofing" the terminal's configuration: a password and a keypad menu lockout. (If an expansion module has been installed, the password and keypad menu lockout can also protect programs stored in the terminal memory.)

Password

Upon leaving the Operating Mode (see the previous section), if a password has been selected the following prompt will be displayed:

Enter password (3 characters) or <RET> or <ENTER> to quit:

The password consists of 3 alphanumeric characters. If the correct 3-character sequence is entered, the Main Menu will be displayed. If an incorrect password is entered, the terminal goes back into Operating Mode.

The password can be changed or disabled by selecting item 3 from the Main Menu. There are three possible responses to the prompt "Enter new password":

- To change the password, type any three alphanumeric characters on the keyboard, then press the <Return or Enter> key (the password will not be accepted until <Return or Enter> key is pressed). The password has now been changed. If a character was unintentionally pressed, you may use the backspace (before the <Return or Enter> key is pressed) key to erase one or all three characters.

- To disable the password, just press the <ESC> key on the keyboard, without typing any other characters. (The password can be subsequently re-enabled by re-selecting item 3 from the Main Menu.)

- To not change the password, just press the <Return or Enter> key without typing any characters.

If the password is forgotten, the user can do either of the following:

- The remote command RETURN PASSWORD will return the password to the host computer (see Chapter 5).

- The option board can be removed if installed, or installed if currently removed. The firmware then will not recognize the password as valid. If the user then goes in and stores a password, the original unknown password will be invalidated.

Keypad Menu Lockout

There is an option in the Configuration Menu to lock out entry from the keypad and sealed keyboard. If the keypad is locked out, the password prompt can only be invoked by pressing "F10" twice on the full-stroke keyboard that plugs into the terminal front panel. This has the effect of preventing the user from entering Set-up Mode from the keypad.

2.4.4 Tab Stops

> NOTE
> The tab stops are in effect only when the terminal is in ANSI mode, not in Hazeltine 1500 mode.

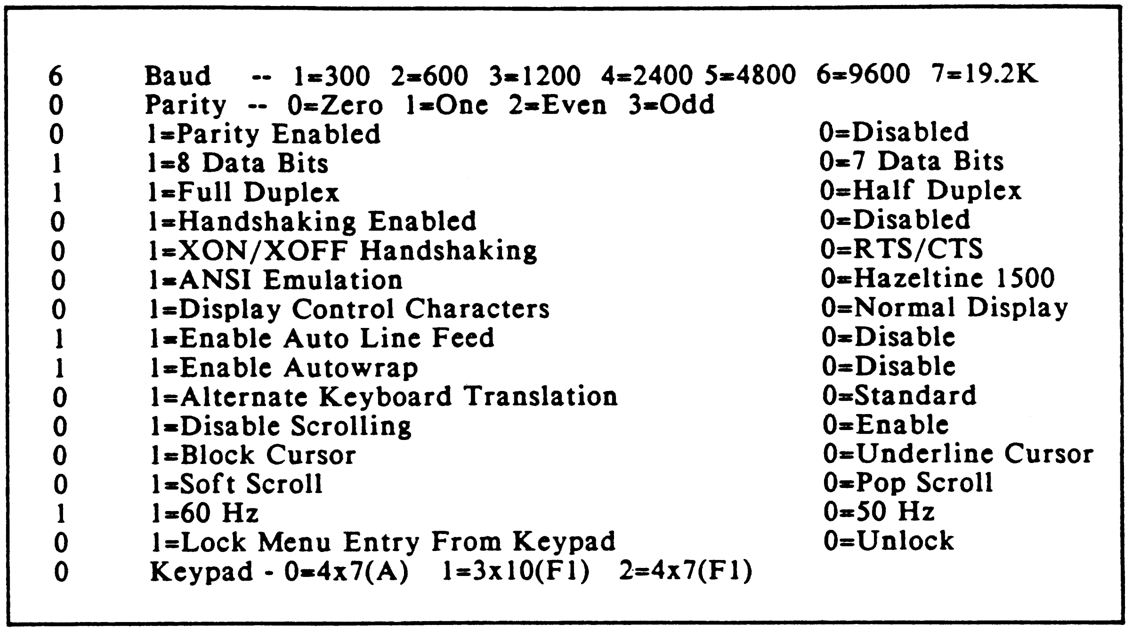
By pressing the "4" key when the Main Menu is displayed, the tab stops currently in effect will be displayed on the screen. Pressing the <TAB> key you will send the cursor to the next tab stop.

The first row of numbers in the display are the column numbers. Below these column numbers (0 to 9 eight times, or a total of 80 columns) are the tab settings. An "S" below a number indicates a tab stop at that particular column position, while a blank beneath a number indicates no tab stop at that position. Tab settings at any column can be entered by using the cursor keys to move the cursor under the desired column, then typing S. Tab settings can be removed by moving the cursor to the desired column and typing a space. Up to 80 tabs (one for each column) can be entered.

If ANSI remote commands are used to change the tab stops, these changes will not be saved if the terminal is powered-down or reset. The terminal will be reinitialized to the settings in the Configuration Menu.

2.5 CONFIGURATION MENU

Pressing the "1" key on the keyboard or keypad when the Main Menu is displayed will invoke the Configuration Menu. It will look like the following:



```
6    Baud  -- 1=300 2=600 3=1200 4=2400 5=4800 6=9600 7=19.2K
0    Parity -- 0=Zero 1=One 2=Even 3=Odd
0    1=Parity Enabled                          0=Disabled
1    1=8 Data Bits                             0=7 Data Bits
1    1=Full Duplex                             0=Half Duplex
0    1=Handshaking Enabled                     0=Disabled
0    1=XON/XOFF Handshaking                    0=RTS/CTS
0    1=ANSI Emulation                          0=Hazeltine 1500
0    1=Display Control Characters              0=Normal Display
1    1=Enable Auto Line Feed                   0=Disable
1    1=Enable Autowrap                         0=Disable
0    1=Alternate Keyboard Translation          0=Standard
0    1=Disable Scrolling                       0=Enable
0    1=Block Cursor                            0=Underline Cursor
0    1=Soft Scroll                             0=Pop Scroll
1    1=60 Hz                                   0=50 Hz
0    1=Lock Menu Entry From Keypad             0=Unlock
0    Keypad - 0=4x7(A)  1=3x10(F1)  2=4x7(F1)
```

Figure 2-5 Configuration Menu

The first column of Figure 2-5 lists the current settings of all the configuration options. The available options and their corresponding settings are listed to the right.

To change a configuration option, first move the cursor to the row containing the value which is to be changed. This is done by pressing the up-arrow and down-arrow keys. When the cursor is properly positioned, press a number key to select the desired option. After all changes are made, press the "ENTER" or "RETURN" key. When the Main Menu is subsequently displayed, select "Return to terminal mode" by pressing the "ENTER" or "RETURN" key. The terminal will then be in Operating Mode using the configuration options you selected.

2.5.1 Considerations for Selecting Configuration Options

NOTE
Certain options in the Configuration are not allowed, their selection will be ignored by the terminal. They are:

- Soft Scroll cannot be selected for the 4860
- 50 MHz cannot be selected for the 4860
- Autowrap cannot be disabled in Hazeltine mode
- Handshaking cannot be disabled when in half-duplex

The first seven configuration options affect the communication characteristics of the terminal. These configuration options should be set to accommodate the communications characteristics of the host device:

Baud. The baud rate of the terminal should be set to match the baud rate of the host device. The terminal transmits and receives data at the same baud rate.

Parity. Should match the host computer's parity.

NOTE
Selection of disable parity is not allowed with seven data bits per character.

Data Bits Per Character. The number of data bits per character can be set to seven or eight, and should match the number of data bits per character used by the host device. Eight data bits per character are required for use of thin-line and block graphics characters (see Sections 4.7 and 4.8).

NOTE
Selection of seven data bits per character is not allowed with parity disabled. If the terminal is configured for 7 bits and no parity, it will use 8 bits and no parity instead.

Full/Half Duplex. If the connected device is capable of simultaneous two-way communications and is set up for echoing, the terminal should be used in full-duplex mode. If echoing is not used or the host is not capable of simultaneous two-way communications, select half-duplex mode.

> NOTE
> When the unit is configured for half-duplex, the RTS line takes on a special function.

When a character is transmitted from the terminal, RTS will go high and remain high until one of the terminating characters are transmitted:

<CR>	Carriage Return ASCII 13 (decimal)
<ETX>	End of Text ASCII 3 (decimal)
<EOT>	End of Transmission ASCII 4 (decimal)

If DSR is high the character is not transmitted until CTS goes high.

When the termination character is transmitted, RTS will go low and remain there until the next non-termination character is transmitted.

Handshaking Enabled. Must be set to 1 to enable either RTS/CTS or XON/XOFF handshaking.

> NOTE
> You can not enable handshaking and half-duplex.

If handshaking is enabled with half-duplex selected, the terminal will ignore handshaking and disable it when you leave the Configuration Menu. In addition, if full-duplex is selected and handshaking disabled, RTS will always be high in ANSI mode, and after the first key is typed in Hazeltine 1500 mode after entering Operational Mode.

RTS/CTS Handshaking, XON/XOFF.

1 =	RTS/CTS handshaking
0 =	XON/XOFF generation

RTS/CTS Handshaking enabled. Handshaking is accomplished through hardware in the following manner:

RTS (Request To Send) is an output from the terminal. It will be asserted (High) when it is OK for an external device to send data to the terminal. When RTS is inactive (Low), the sending unit should not attempt to send data. This protects the terminal from input buffer overflow.

CTS (Clear To Send) is an input to the terminal. If this line is asserted (High) the terminal assumes that it is Okay to transmit data to an external device. When CTS is inactive (Low) the terminal will stop transmitting data to an external device. This keeps the terminal from overflowing the input buffers on an external device.

XON/XOFF Handshaking enabled. Handshaking is accomplished through software in the following manner:

An XOFF (DC3 ASCII, 19 decimal) will be sent by the terminal when the sending device should stop sending data.

An XON (DC1 ASCII, 17 decimal) will be sent by the terminal when it is OK for the external device to resume sending data after it is once sent an XOFF.

If an XOFF is received by the terminal, it will stop sending data until an XON is received.

If an XON is received by the terminal, it will assume that it is OK to send data to an external device.

Care should be taken when using XON/OFF handshaking. If the data stream being transmitted contains the XOFF (ASCII 19 or DC3) character, you could inadvertently disable communications.

Display Control Codes/Normal Display. During normal operation, the terminal executes control codes that it receives such as carriage return, linefeed, etc. In addition to this mode, the terminal can be made to simply display control codes and <u>not</u> execute them. When the terminal displays a control code, it shows a two-letter abbreviation of the ASCII control code (see Table 2-1) in a single character space. Displaying control codes is useful when installing and testing communications.

Table 2-1 Two-letter Abbreviations of ASCII Control Codes

Hexadecimal Code	ASCII Code	Two-letter Abbreviation
00	NUL	NL
01	SOH	SH
02	STX	SX
03	ETX	EX
04	EOT	ET
05	ENQ	EQ
06	ACK	AK
07	BEL	BL
08	BS	BS
09	HT	HT
0A	LF	LF
0B	VT	VT
0C	FF	FF
0D	CR	CR
0E	SO	SO
0F	SI	SI
10	DLE	DL
11	DC1 (XON)	D1
12	DC2	D2
13	DC3 (XOFF)	D3
14	DC4	D4
15	NAK	NK
16	SYN	SY
17	ETB	EB
18	CAN	CN
19	EM	EM
1A	SUB	SB
1B	ESC	EC
1C	FS	FS
1D	GS	GS
1E	RS	RS
1F	US	US

Block Cursor/Underline Cursor. Either an underline or a block cursor can be chosen. Both types of cursors are blinking. The block cursor is more visible than the underline cursor.

Enable Automatic Linefeed/Disable. If automatic linefeed is enabled, the cursor will automatically perform a linefeed after it receives and executes a carriage return. Linefeeds are ignored. If disabled, only a carriage return will be executed when a carriage return is received (linefeeds are executed as linefeeds).

Alternate Keyboard Translation/Standard. The term "keyboard translation" refers to the character(s) transmitted by the terminal whenever a key on the keyboard is pressed. The configuration menu offers two keyboard translation options:

0 = Standard
1 = Alternate

The only difference between the two translation options is in the character sequences transmitted when the following keys are pressed on the keyboard:

CTRL-Q, CTRL-R, CTRL-S, CTRL-T
the four arrow keys
F1, F2, F3, F4

Table 3-5 lists the characters generated by all the above keys.

All other keys are interpreted identically (see Tables 3-1, 3-2, 3-3 and 3-4).

The alternate translation option is useful with programs (such as CP/M) which expect CTRL-Q, CTRL-R, CTRL-S, or CTRL-T to produce the corresponding control codes.

ANSI Emulation/Hazeltine 1500. The terminal can emulate either a Hazeltine 1500 terminal or an ANSI x3.64 terminal. Hazeltine 1500 and ANSI emulation differ in the character sequences which must be transmitted to the terminal to execute a remote command. For example, to perform the remote command Cursor On, a terminal configured as a Hazeltine 1500 must be sent the character sequence "7EH 02H" (or the ASCII characters ~<STX>). However, if configured as an ANSI terminal, the same command requires the character sequence "<ESC> [= 1 h" (ASCII). Chapter 5 lists both the Hazeltine 1500 and ANSI character sequences which must be transmitted to the terminal to perform any available remote command.

Another difference is the character(s) transmitted when one of the cursor control keys is pressed. See Table 3-5 for a list of the characters generated by the cursor control keys.

ANSI emulation provides support for most DEC VT100/220 remote commands. The VT100/220 commands which are supported are listed in Chapter 5, while VT100/220 commands not supported are listed in Appendix B.

Enable Autowrap/Disable. If autowrap is enabled, lines more than 80 characters long will wrap around to the next line. If disabled, any character issued after column 80 will be printed in column 80. Autowrap is automatically enabled if Hazeltine 1500 emulation is selected in the previous line of the Configuration Menu.

Disable Scrolling/Enable. If scrolling is disabled, moving the cursor below the last line in the screen will cause the cursor to wrap to the top of the screen.

Lock Menu Entry From Keypad/Unlock. If menu entry is locked from the keypad and sealed keyboard, only pressing the F10 key twice on the full-stroke keyboard will exit Operating Mode into Set-up Mode. If menu entry is unlocked, the menus can also be entered from the keypad and sealed keyboard (see Section 2.2.1).

Soft Scroll/Pop Scroll. Soft Scroll selects a smooth, slower scroll. Pop Scroll selects a line-at-a-time rapid scroll.

50/60 Hz. This option must be set to match the frequency of the AC power source (usually 60Hz in the U.S.A.).

3x10/4x7 Keypad. All versions of the keypad have 28 keys total. The 4810E and 4810ER use the 4x7 format, and the 4860 has a 3x10 layout. In the configuration menu (Figure 2-5), the keypads are referred to by their column/row layout and the upper-left corner key as follows:

0 = 4x7(A) for the 4810ER
1 = 3x10(F1) for the 4860 and 4860A
2 = 4x7(F1) for the 4810E

See Figure 2-6.

NOTE

Certain options in the configuration menu are not allowed. You can select these options but when you return to the Configuration Menu they will be changed. These options are:

- Autowrap cannot be disabled in Hazeltine mode.
- Handshaking cannot be enabled when in half-duplex.

In addition to the 3x10 keypad layout, the 4860A has a program function (PF) keypad, with 10 keys below the video display.

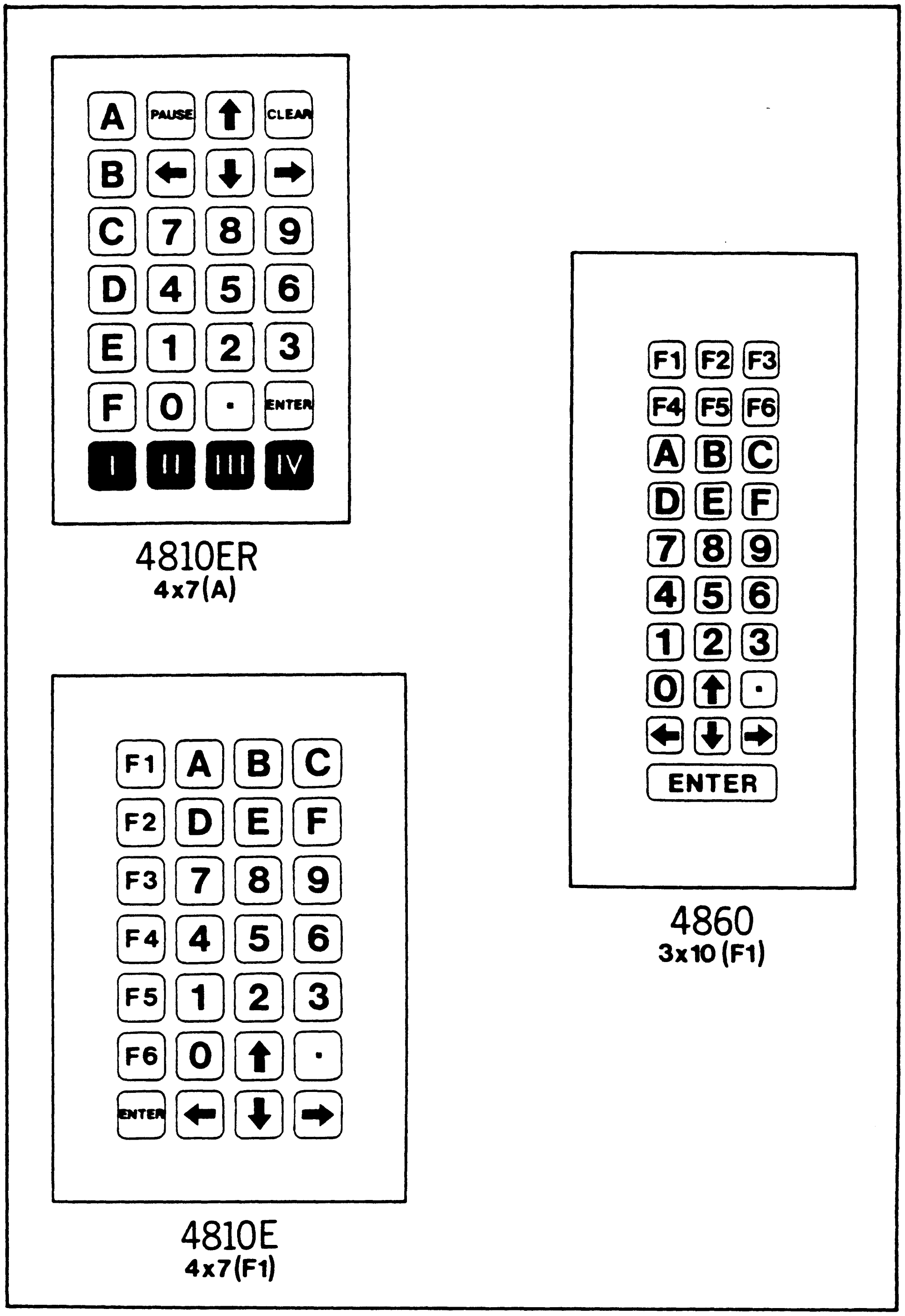


Figure 2-6 Keypads for 4810ER, 4810E, and 4860

Chapter 3

KEYPAD AND KEYBOARD

3.1 INTRODUCTION

The Xycom Industrial Terminals provide three ways for an operator to enter data and commands: through the built-in sealed membrane keypad (and function keypad below the video display in the case of the 4860A), through the optional sealed keyboard, or through the optional full-stroke keyboard. Generally, only the sealed membrane keypad (and when using the 4860A, the function keypad below the video display) will be used when the terminal is serving as a plant-floor operator interface. A full-stroke full-size keyboard is usually used for programming and supervisory operations.

The keypad and keyboards generate ASCII codes when a key or combination of keys is pressed. The terminal handles the codes in different ways depending on whether it's being used in full or half-duplex mode.

3.2 KEYPAD AND CODES

All of the terminals have a built-in 28-key sealed membrane keypad, either 3 columns by 10 rows or 4 columns by 7 rows, and the 4860A has a single row of 10 function keys below the video display (see Figure 2-6).

Whenever a keypad or function key is pressed, the terminal will sound an audible tone to provide operator feedback. The tone is not generated when the full-stroke keyboard keys are pressed.

3.2.1 Application Mode

The ANSI and Hazeltine remote commands Enable Application Mode (the ANSI two-character sequence <ESC>=, and the Hazeltine sequence 7EH 2EH) and Disable Application Mode (the ANSI two-character sequence <ESC>>, and the Hazeltine sequence 7EH 2FH) determine the codes which are transmitted whenever a keypad key is pressed (see Table 5-2). At power-up or reset (and when going from set-up mode to operating mode), the keypad is automatically put in normal mode. In normal mode, the keypad keys transmit codes listed in Table 3-1.

> NOTE
>
> Normal and Application Modes do not affect characters transmitted when a keyboard key is pressed. These modes only affect keypad keys (and the function keys below the video display in the case of the 4860A).

Table 3-1 Membrane Keypad ASCII Codes
(4810E and 4860) Normal Mode

Key	Hexadecimal Code	ASCII Code	Notes
0	30	0	
1	31	1	
2	32	2	
3	33	3	
4	34	4	
5	35	5	
6	36	6	
7	37	7	
8	38	8	
9	39	9	
A	41	A	
B	42	B	
C	43	C	
D	44	D	
E	45	E	
F	46	F	
F1	47	G	
F2	48	H	
F3	49	I	
F4	4A	J	
F5	4B	K	
F6	4C	L	
PF1	4D	M	4860A ONLY
PF2	4E	N	
PF3	4F	O	
PF4	50	P	
PF5	51	Q	
PF6	52	R	
PF7	53	S	
PF8	54	T	
PF9	55	U	
PF10	56	V	
.	2E	.	
ENTER	0D	<CR>	
	<u>Hazeltine</u>	<u>ANSI</u>	
↑	7E 0C	<ESC>[A	In Hazeltine half-duplex, this key sends no code, but does move cursor on screen.
↓	0A	<ESC>[B	
←	08	<ESC>[D	
→	10	<ESC>[C	In Hazeltine half-duplex, this key sends no code, but does move cursor on screen.

Table 3-1A. Membrane Keypad ASCII Codes
(4810ER only) Normal Mode

Key	Hexadecimal Code	ASCII Code	Notes
0	30	0	
1	31	1	
2	32	2	
3	33	3	
4	34	4	
5	35	5	
6	36	6	
7	37	7	
8	38	8	
9	39	9	
A	41	A	
B	42	B	
C	43	C	
D	44	D	
E	45	E	
F	46	F	
I	47	G	
II	48	H	
III	49	I	
IV	4A	J	
.	2E	.	
	Hazeltine	ANSI	Alternate Keyboard Translation Selected (1) (ANSI or Hazeltine)
↑	7E 0C	<ESC>[A	11H
↓	0A	<ESC>[B	14H
←	08	<ESC>[D	12H
→	10	<ESC>[C	13H
PAUSE	50	P	
CLEAR	7E 1C	~<FS>	
ENTER	0D	<CR>	

NOTES

1 In the Hazeltine half-duplex mode, if the alternate keyboard is not selected all cursor keys will continue to move on the screen. However, the "up" and "right" cursor will not return codes.

If the alternate keyboard is selected, the codes shown will be returned.

After the remote command Enable Application Mode is executed, the keypad is put in Application Mode. In this mode, the host computer can distinguish between keys pressed on the keypad from those pressed on the keyboard. The terminal remains in Application Mode until a Disable Application Mode command is executed, the terminal is reset or powered-up again, or the user goes from Set-up Mode to Operating Mode. In Application Mode, the keypad keys transmit different codes for Hazeltine 1500 or ANSI emulation. If the keypad is in Application Mode and the terminal is configured for half-duplex, the codes produced by the keypad keys are not echoed on the screen. They are only transmitted out the serial port. Table 3-2 lists the codes transmitted under Application Mode.

Table 3-2 Membrane Keypad Codes
(4810E and 4860) Application Mode

Key	Hexadecimal Code[1] (Hazeltine 1500 Emulation)	ASCII Code[2] (ANSI Emulation)	
0	B0	<ESC>Op	
1	B1	<ESC>Oq	
2	B2	<ESC>Or	
3	B3	<ESC>Os	
4	B4	<ESC>Ot	
5	B5	<ESC>Ou	
6	B6	<ESC>Ov	
7	B7	<ESC>Ow	
8	B8	<ESC>Ox	
9	B9	<ESC>Oy	
A	C1	<ESC>Oa	
B	C2	<ESC>Ob	
C	C3	<ESC>Oc	
D	C4	<ESC>Od	
E	C5	<ESC>Oe	
F	C6	<ESC>Of	
F1	C7	<ESC>Og	
F2	C8	<ESC>Oh	
F3	C9	<ESC>Oi	
F4	CA	<ESC>Oj	
F5	CB	<ESC>Ok	
F6	CC	<ESC>Ol	
PF1	CD	<ESC>Om	4860A ONLY
PF2	CE	<ESC>ON	
PF3	CF	<ESC>OO	
PF4	D0	<ESC>OP	
PF5	D1	<ESC>OQ	
PF6	D2	<ESC>OR	
PF7	D3	<ESC>OS	
PF8	D4	<ESC>OT	
PF9	D5	<ESC>OU	
PF10	D6	<ESC>OV	
.	AE	<ESC>On	
↑	91	<ESC>OA	
↓	94	<ESC>OB	
←	92	<ESC>OD	
→	93	<ESC>OC	
ENTER	8D	<ESC>OM	

NOTES

[1] Same as Table 3-1, except that bit 7 is set to 1, and the arrow codes differ.
[2] Same as the codes returned by a VT-100 keypad in Application Mode.

Table 3-2A. Membrane Keypad Codes
(4810ER) Application Mode

Key	Hexadecimal Code (1)(3) (Hazeltine 1500 Emulation)	ASCII Code(2) (ANSII Emulation)
0	B0	<ESC>Op
1	B1	<ESC>Oq
2	B2	<ESC>Or
3	B3	<ESC>Os
4	B4	<ESC>Ot
5	B5	<ESC>Ou
6	B6	<ESC>Ov
7	B7	<ESC>Ow
8	B8	<ESC>Ox
9	B9	<ESC>Oy
A	C1	<ESC>Oa
B	C2	<ESC>Ob
C	C3	<ESC>Oc
D	C4	<ESC>Od
E	C5	<ESC>Oe
F	C6	<ESC>Of
I	C7	<ESC>Og
II	C8	<ESC>Oh
III	C9	<ESC>Oi
IV	CA	<ESC>Oj
CLEAR	84	<ESC>Ok
PAUSE	D0	<ESC>Ol
.	AE	<ESC>On
↑	91	<ESC>OA
↓	94	<ESC>OB
←	92	<ESC>OD
→	93	<ESC>OC
ENTER	8D	<ESC>OM

NOTES

1 Same as Table 3-1A, except that bit 7 is set to 1, and the CLEAR code and arrows key codes differ.

2 Same as the codes returned by a VT100 keypad in application mode.

3 See Table 3-1 for alternate keyboard translations for cursor keys.

3.2.2 Programming the Keypad Keys (4800-E1 and 4800-E2 Options Only)

If the terminal has option 4800-E1 (screen memory) or option 4800-E2 (Multidrop) installed, keypad keys can also be programmed to return a user-defined sequence whenever pressed. Whenever a keypad key is pressed, the contents of a specified screen program will be transmitted. See the 4800-E1 or 4800-E2 manual.

3.3 KEYBOARD AND CODES

Two detachable full-size keyboards are optionally available for the industrial color terminal. One is a standard full-stroke keyboard, the other is a sealed keyboard. Both return identical codes.

> NOTE
> When the Menu Entry 'Lockout is enabled, the sealed keyboard F10 key will not respond.

The ASCII codes generated by both full-size keyboards are listed in Tables 3-3, 3-4 and 3-5.

Table 3-3 Codes for Keyboard Alphanumeric Keys
(Full and Half-duplex)

	no CTRL, no SHIFT		no CTRL, SHIFT		CTRL, no SHIFT		CTRL, SHIFT	
Key	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
A	61	a	41	A	01	<SOH>	01	<SOH>
B	62	b	42	B	02	<STX>	02	<STX>
C	63	c	43	C	03	<ETX>	03	<ETX>
D	64	d	44	D	04	<EOT>	04	<EOT>
E	65	e	45	E	05	<ENQ>	05	<ENQ>
F	66	f	46	F	06	<ACK>	06	<ACK>
G	67	g	47	G	07	<BEL>	07	<BEL>
H	68	h	48	H	08	<BS>	08	<BS>
I	69	i	49	I	09	<HT>	09	<HT>
J	6A	j	4A	J	0A	<LF>	0A	<LF>
K	6B	k	4B	K	0B	<VT>	0B	<VT>
L	6C	l	4C	L	0C	<FF>	0C	<FF>
M	6D	m	4D	M	0D	<CR>	0D	<CR>
N	6E	n	4E	N	0E	<SO>	0E	<SO>
O	6F	o	4F	O	0F	<SI>	0F	<SI>
P	70	p	50	P	10	<DLE>	10	<DLE>
Q	71	q	51	Q				
R	72	r	52	R	See Table 3-5			
S	73	s	53	S				
T	74	t	54	T				
U	75	u	55	U	15	<NAK>	15	<NAK>
V	76	v	56	V	16	<SYN>	16	<SYN>
W	77	w	57	W	17	<ETB>	17	<ETB>
X	78	x	58	X	18	<CAN>	18	<CAN>
Y	79	y	59	Y	19	<EM>	19	<EM>
Z	7A	z	5A	Z	1A	<SUB>	1A	<SUB>
1	31	1	21	!	31	1	21	!
2	32	2	40	@	32	2	00	<NULL>
3	33	3	23	#	33	3	23	#
4	34	4	24	$	34	4	24	$
5	35	5	25	%	35	5	25	%
6	36	6	5E	^	36	6	1E	<RS>
7	37	7	26	&	37	7	26	&
8	38	8	2A	*	38	8	2A	*
9	39	9	28	(	39	9	28	(
0	30	0	29	)	30	0	29	)
Backspace	08	<BS>	08	<BS>	08	<BS>	08	<BS>

Table 3-3 Codes for Keyboard Alphanumeric Keys cont.
(Full and Half-duplex)

	no CTRL, no SHIFT		no CTRL, SHIFT		CTRL, no SHIFT		CTRL, SHIFT	
Key	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
ESC	1B	<ESC>	1B	ESC	1B	<ESC>	1B	<ESC>
-	1F	-	5F	_	1F	-	1F	-
SPACE	20		20		20			20
’	27	’	22	"	27	’	22	"
*								
PRT SCN	2A	*	AA	N/A	2A	*	AA	N/A
,	2C	,	3C	<	2C	,	3C	<
-	2D	-	5F	_	1F	<US>	1F	<US>
.	2E	.	3E	>	2E	.	3E	>
/	2F	/	3F	?	2F	/	3F	?
;	3B	;	3A	:	3B	;	3A	:
=	3D	=	2B	+	3D	=	2B	+
[	5B	[	7B	{	1B	<ESC>	1B	<ESC>
\	5C	\	7C	|	1C	<FS>	1C	<FS>
]	5D	]	7D	}	1D	<GS>	1D	<GS>
‘	60	‘	7E	~	60	‘	7E	~
<DEL>	7F	<DEL>	2E	.	7F	<DEL>	2E	.

Table 3-3A Codes for Keyboard and Alphanumeric Keys - IBM PC/XT type

These codes are for the same keys as in Table 3-3, but differ on a PC/XT type keyboard in the codes that are sent.

Key	CTRL, no SHIFT	CTRL, SHIFT
1	<DC1>	<SOH>
2	<DC2>	
3	<DC3>	<ETX>
4	<DC4>	<EOT>
5	<NAK>	<ENQ>
6	<SYN>	
7	<ETB>	<ACK>
8	<CAN>	<LF>
9	<EM>	<BS>
0	<DLE>	<HT>
SPACE	<NU>	<NU>
'	<BEL>	<STX>
PRT SCN	<LF>	<LF>
,	<CR>	<FS>
-	<CR>	
.	<SO>	<RS>
/	<SI>	<US>
;	<ESC>	<SUB>
=	<OS>	<VT>
‘	<NU>	<SO>

Table 3-4 Codes for Keyboard Control Keys

Key	Hex	ASCII	Hex	ASCII	Notes
TAB	09	<HT>	09	<HT>	
BACK SPACE	08	<BS>	08	<BS>	
DEL		See Table 3-3			
RETURN	0D	<CR>	OD	<CR>	
ENTER	0D	<CR>	0D	<CR>	
<left arrow>					
<right arrow>	See Table 3-5				
<up arrow>					
<down arrow>					
BREAK[1]	00	<NUL>	00	<NUL>	
ESC	1B	<ESC>	1B	<ESC>	
HOME			7E 12	~<DC2>	Haz. emulation[2]
			1B 5B 48	<ESC>[H	ANSI emulation
F1					
F2		See Table 3-5			
F3					
F4					
F5 (CLEAR)			7E 1C	~<FS>	Haz.emulation[2]
			1B 4F 50	<ESC>OP	ANSI emulation
F6 (CLEAR FOREGROUND)			7E 1D	~<GS>	Haz.emulation[2]
			1B 4F 51	<ESC>OQ	ANSI emulation
F7 (CLEAR TO END OF LINE)			7E 0F	~<SI>	Haz.emulation[2]
			1B 4F 52	<ESC>OR	ANSI emulation
F8 (CLEAR TO END OF SCREEN WITH FOREGROUND SPACES)			7E 18	~<CAN>	Haz. emulation[2]
			1B 4F 53	<ESC>OS	ANSI emulation
F9	88			88	
F10[3]					

NOTES

1 The communications line is held low (0) for 200-250 milliseconds.
2 This is not transmitted when in Hazeltine half-duplex mode.
3 Does not transmit a character.

Table 3-5 Cursor Control and "F" Keys on Keyboard
(Full-duplex)

	Standard[1] Hazeltine 1500		Alternate[1] Hazeltine 1500		Standard[1] ANSI		Alternate[1] ANSI	
Key	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
CNTL-Q	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A	11	<DC1>
CNTL-R	08	<BS>	12	<DC2>	1B 5B 44	<ESC>[D	12	<DC2>
CNTL-S	10	<DLE>	13	<DC3>	1B 5B 43	<ESC>[C	13	<DC3>
CNTL-T	0A	<LF>	14	<DC4>	1B 5B 42	<ESC>[B	14	<DC4>
up arrow	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A	11	<DC1>
left arrow	08	<BS>	12	<DC2>	1B 5B 44	<ESC>[D	12	<DC2>
right arrow	10	<DLE>	13	<DC3>	1B 5B 43	<ESC>[C	13	<DC3>
down arrow	0A	<LF>	14	<DC4>	1B 5B 42	<ESC>[B	14	<DC4>
F1[2]	11	<DC1>	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A
F2[2]	12	<DC2>	0A	<LF>	12	<DC2>	1B 5B 42	<ESC>[B
F3[2]	13	<DC3>	08	<BS>	13	<DC3>	1B 5B 44	<ESC>[D
F4[2]	14	<DC4>	10	<DLE>	14	<DC4>	1B 5B 43	<ESC>[C

NOTES

1 The difference between standard and alternate is discussed in Section 2.5.1, "Alternate Keyboard Translation".

2 Do not confuse the keyboard keys with F1-F6 keys on the keypad.

Table 3-6 Numeric Pad (with NUM LOCK Off)[1]

Key	no SHIFT		SHIFT	
	Hex	ASCII	Hex	ASCII
0	B0		30	0
1	B1		31	1
2	see down arrow (Table 3-5)		32	2
3	B3		33	3
4	see left arrow (Table 3-5)		34	4
5	B5		35	5
6	see right arrow (Table 3-5)		36	6
7[2]	see home (Table 3-4)		37	7
8	see up arrow (Table 3-5)		38	8
9	B9		39	9

NOTES

1 With NUM LOCK on, ASCII numbers from 0 through 9 will be generated, and the SHIFT will have no effect. CTRL has no effect on the numeric keypad keys.

2 In the "NO SHIFT" mode, Key 7 is "HOME".

Chapter 4

VIDEO DISPLAY

4.1 VIDEO DISPLAY FORMAT

Screen size:	12" diagonal (4860), 9" diagonal (4810)
Screen phosphor:	Green P-31 (4810), amber P-134 (4860)
Screen capacity:	25 rows x 80 columns (standard characters) 25 rows x 40 columns (double-wide characters) 12 rows x 80 columns (double-high characters) 12 rows x 40 columns (double-wide/double-high characters) 6 rows x 16 columns (quad-size characters)
Cell size:	10 pixels wide by 12 pixels high
Character size:	1 cell (regular characters) 5 cells wide by 4 cells high (quad-size characters) 4 cells wide by 4 cells high (process-control characters)
Character set:	See Appendix C for graphic characters
Character attributes:	blink underline double-wide high-intensity quad-size double-high reverse video
Remote commands:	Variety of commands to draw boxes, and vertical or horizontal lines, and high-resolution bars.
Cursor:	blinking underline, blinking block, or none.

4.2 CURSOR ADDRESSING

Each terminal provides two cursor-addressing commands: Cursor To and Return Cursor Position. One of these -- Cursor To X,Y -- allows the cursor to be positioned anywhere on the video display. The other -- Return Cursor Position -- allows the current position of the cursor to be read.

The video display has a coordinate system for cursor positioning. A diagram of the coordinate system listing row and column coordinates for each possible cursor position is given in Figures 5-1 and 5-2. Row and column coordinates begin with 0 in Hazeltine mode, with 1 in ANSI mode. When the cursor address is read, the system will return its column and row coordinate. Those coordinates are also used to move the cursor.

> NOTE
>
> The coordinates for Hazeltine and ANSI emulation are in reverse order. In Hazeltine, the column coordinate precedes the row coordinate (x, y), while in ANSI the row coordinate precedes the column (y, x).
>
> Also, column and row coordinates are different for Hazeltine and ANSI emulation.

The character sequence required to execute the Cursor To X,Y and Return Cursor Position commands depends upon whether the terminal is configured for Hazeltine or ANSI emulation. Chapter 5 contains the all of the commands.

4.3 STATUS LINE

The 25th row of the video display is used as a status line. The status line is not affected by the action of the normal display area (i.e., it does not scroll and the status line is not cleared when the screen is cleared). In order to write to the status line, a Cursor to X,Y remote command must be sent to the terminal to move the cursor to the twenty-fifth row. It is also true that while positioned on the status line, remote commands will not affect the normal display area. Therefore, a clear screen command executed while on the status line will only clear the status line.

4.4 SCROLLING

The video display will scroll up whenever any of the following conditions exist:

- the cursor is in the last character position of the bottom line (line 24), when scrolling is enabled, autowrap is enabled, and a displayable ASCII code is received
- the cursor is in the bottom line, auto linefeed is enabled, and a carriage return <CR> code is received
- the cursor is in the bottom line, auto linefeed is disabled, and a linefeed code is received
- any "move cursor with scrolling" commands are received

When the display scrolls up, the top line of the display is removed, all lines on the display except the status line shift up one line, a blank line is added immediately above the status line, and the cursor is moved to the new line. This new line consists of background spaces. Note that if scrolling is turned off (either through the Configuration Menu or a remote command), the video display will not scroll.

4.5 ATTRIBUTES

The appearance of characters on the display can be enhanced by assigning attributes to characters. In addition, the attributes can be used to select alternate character sets or sizes of characters. Attributes that can be assigned to characters are:

- blinking characters
- underline
- regular, double-wide, double-high, double-sized, or quad-sized characters
- high-intensity
- process graphics symbols
- reverse video
- utility graphics

Attributes are assigned by sending an attribute command to the terminal immediately before the character string that is to be displayed. All characters subsequently received by the terminal will be displayed with that attribute until the assigned attribute is changed by sending a different attribute command to the terminal. Chapter 5 contains all command information.

4.6 CHARACTER SIZE CONSIDERATIONS

Each terminal is capable of displaying five sizes of characters: regular-size, double-wide, double-high, double-wide and double-high, and quad-size. Different size characters can be shown on the video display simultaneously.

The relative sizes of the field for the different sizes of characters are shown in Figure 4-1. Note that larger characters occupy fields that are multiples of the regular-size character field.

Care must be exercised in positioning the cursor when using the larger characters. This is because, in general, the cursor moves a single regular-size character field at a time. The exception to this rule is when a character is being written to the video display. In this case the cursor will advance the proper number of regular-size character fields automatically after the character is displayed, so that it is ready to accept another character of the same size. In addition, the cursor will do a carriage return followed by the proper number of linefeeds to start a new line if a character is received when the cursor is in the last column of a line. The cursor is also sensitive to character size when a linefeed, backspace, or carriage return is received. When cursor movement other than a linefeed, backspace, or carriage return is attempted within a large character field, the cursor may disappear. Cursor movement is explained in detail with the help of diagrams on the following pages.

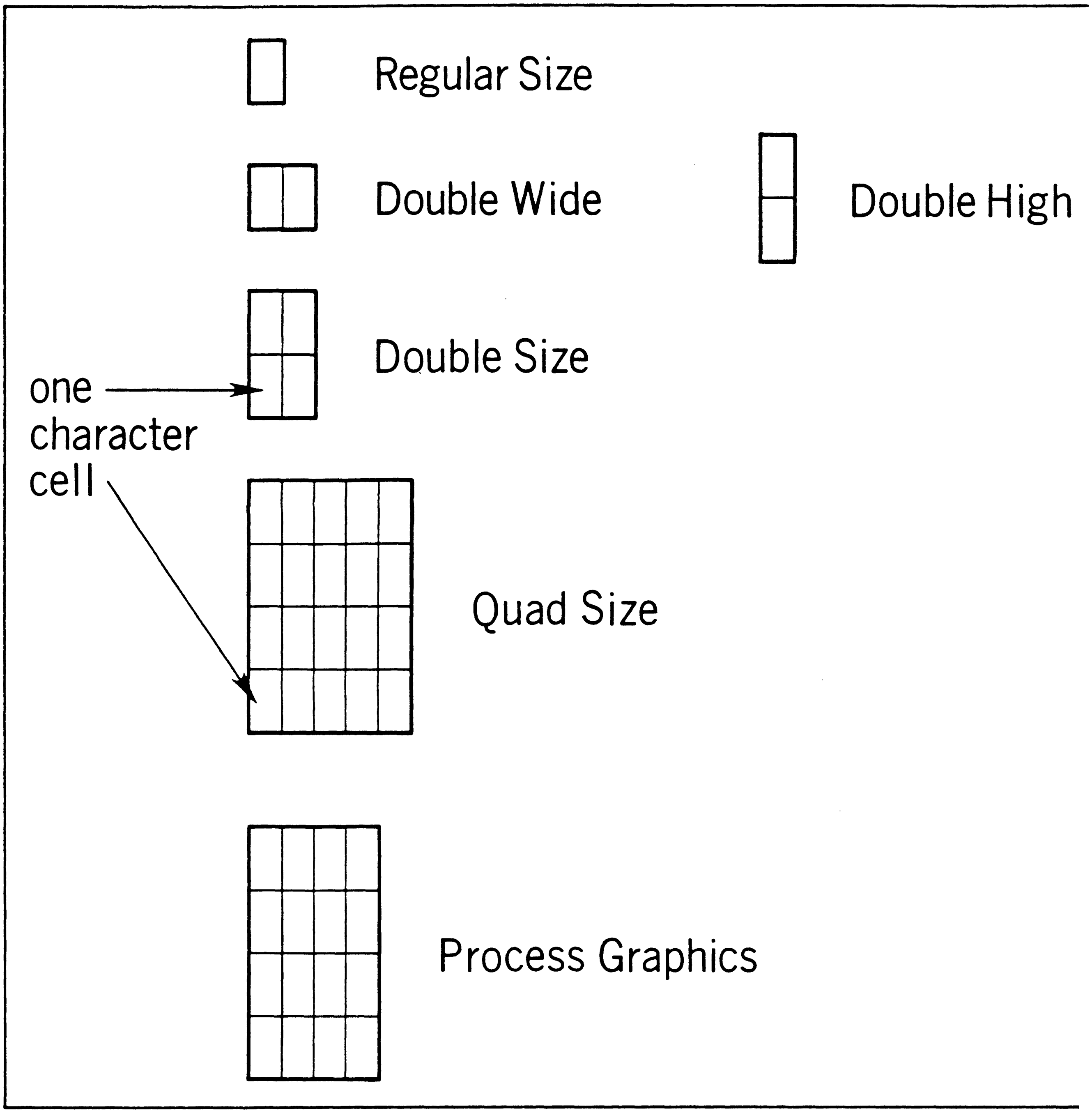
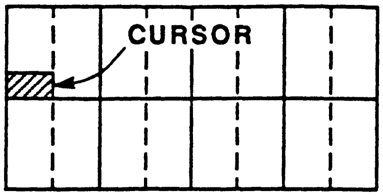
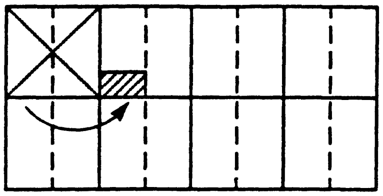


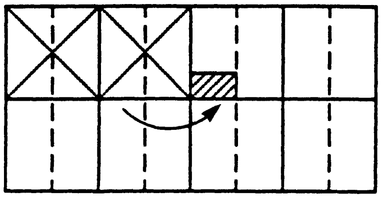
Figure 4-1 Relative Sizes of Character Fields



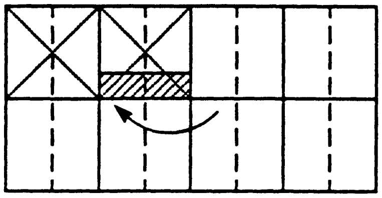
a) Character Size is Double-Wide with underline cursor positioned as shown. Note that cursor underlines only half of the double-wide character field.



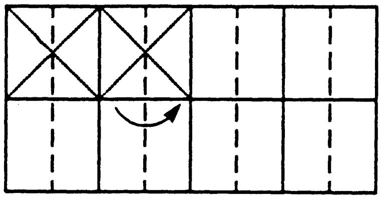
b) The character X is received and displayed and the cursor automatically advances two regular-size character fields to the next double-wide character field.



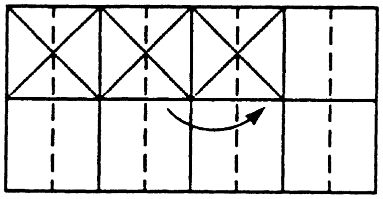
c) Another character X is received and displayed and the cursor advances again.



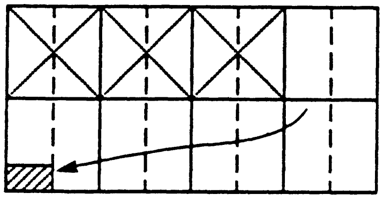
d) A single backspace command has been received and executed so the cursor is "pointing" to the left-hand regular-size character field of the second X, but now the cursor appears double-wide beneath the second X.



e) If a cursor right command is received and executed, the cursor moves to the position indicated and disappears.



f) If another X were received with the cursor located as in (e), the X would be displayed and the cursor would still be invisible.



g) If a carriage return and a linefeed or only a carriage return with automatic linefeed enabled is received, the cursor moves to the start of the first double-wide character field on the next line.

See Diagrams, Figure 4-2.

a) Character Size is Double-High with underline cursor positioned as shown. Note that the cursor is in the middle of the first double-high character field.

b) The character X is received and displayed and the cursor automatically advances one regular-size character field to the middle of the next double-high character field.

c) Another character X is received and displayed and the cursor advances again.

d) Here, a single backspace command has been received and executed and the cursor moves left one regular-size character field to the middle of the second X.

e) If a cursor right command is received and executed, the cursor moves back to the position it was at in (c).

f) Another character X is received and displayed and the cursor advances.

g) If a carriage return and a linefeed, or only a carriage return with automatic linefeed enabled is received, the cursor moves to the next line and is in the proper position to receive another character.

h) Another character X is received and displayed, and the cursor advances.

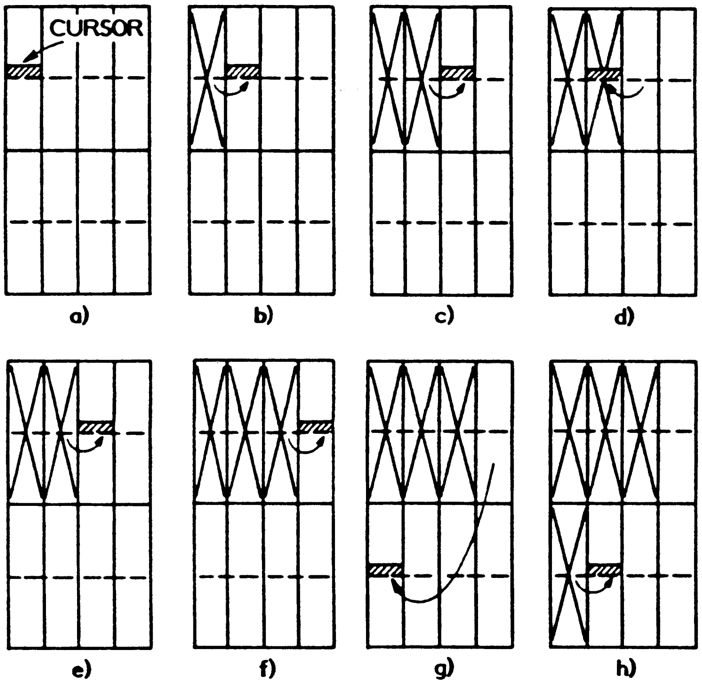


Figure 4-2 DOUBLE HIGH

See Diagrams, Figure 4-3.

a) Character size is Double-High/Double-Wide with underline cursor positioned as shown. The cursor is in the middle of the double-high/double-wide character field and underlines only the first regular-size character field.

b) The character X is received and displayed and the cursor automatically advances two regular-size character fields to the middle of the next double-high/double-wide character field.

c) Another character X is received and displayed and the cursor advances again.

d) Single backspace command has been received and executed so the cursor is "pointing" to the upper left-hand regular-size character field of the second X.

e) If a cursor right command is received and executed and the cursor moves to the position indicated at (e) and disappears.

f) If another X were received with the cursor located as in (e), the X would be displayed and the cursor would still be invisible.

g) If a carriage return and a linefeed or only a carriage return with automatic linefeed enabled is received, the cursor moves to the proper position to write the next row of double-high/double-wide characters. In this position, the cursor underlines only the upper left-hand regular-size character field.

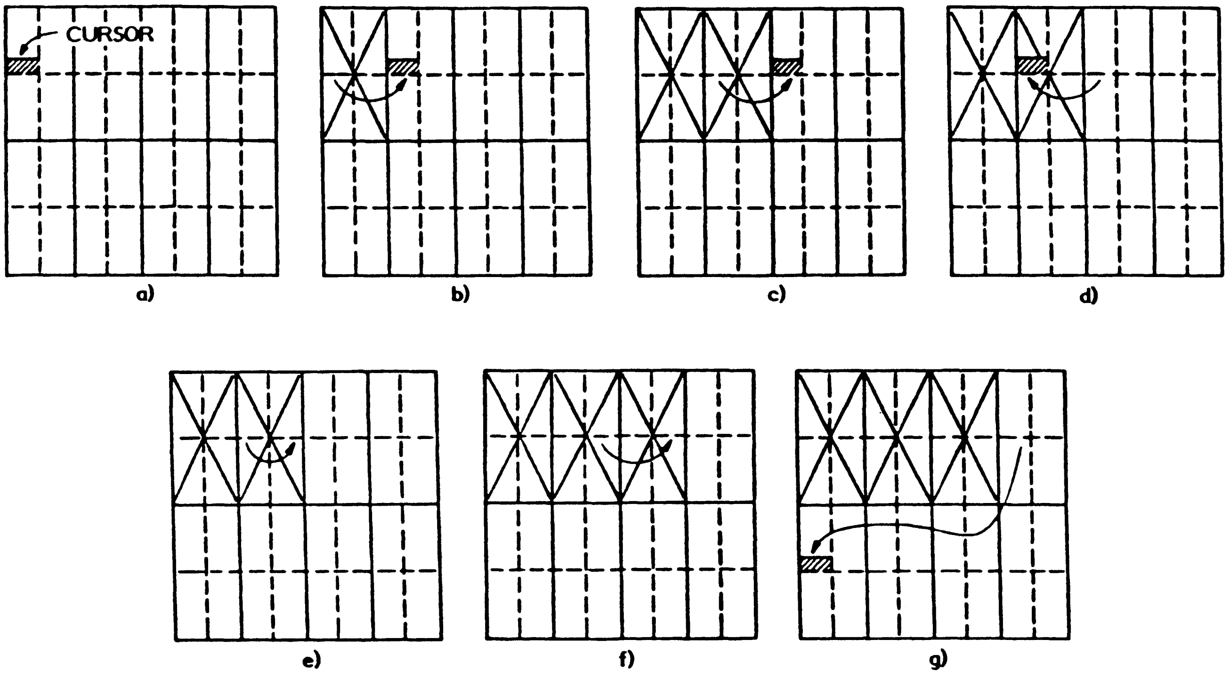


Figure 4-3 DOUBLE HIGH/DOUBLE WIDE Character Cursor Movement

See Diagrams, Figure 4-4.

a) Character size is Quad-Size with underline cursor starting in position 1.

The character X is received and displayed and the cursor automatically advances to the start of the next quad-size character at 2. To move the cursor back to position 1 requires one backspace command. To move the cursor from 1 to 2 without writing a character requires five cursor right commands.

When moving within a quad-size character field, the cursor is always visible and remains a regular-size character.

b) To move the cursor from position 2 to the start of the first quad-size character field at 3, type a carriage return and linefeed, or only a carriage return with automatic linefeed enabled will move the cursor to 3.

If another displayable character code were received with the cursor within a displayed quad-size character, the new character would overwrite all or a portion of the existing character depending on the position of the cursor.

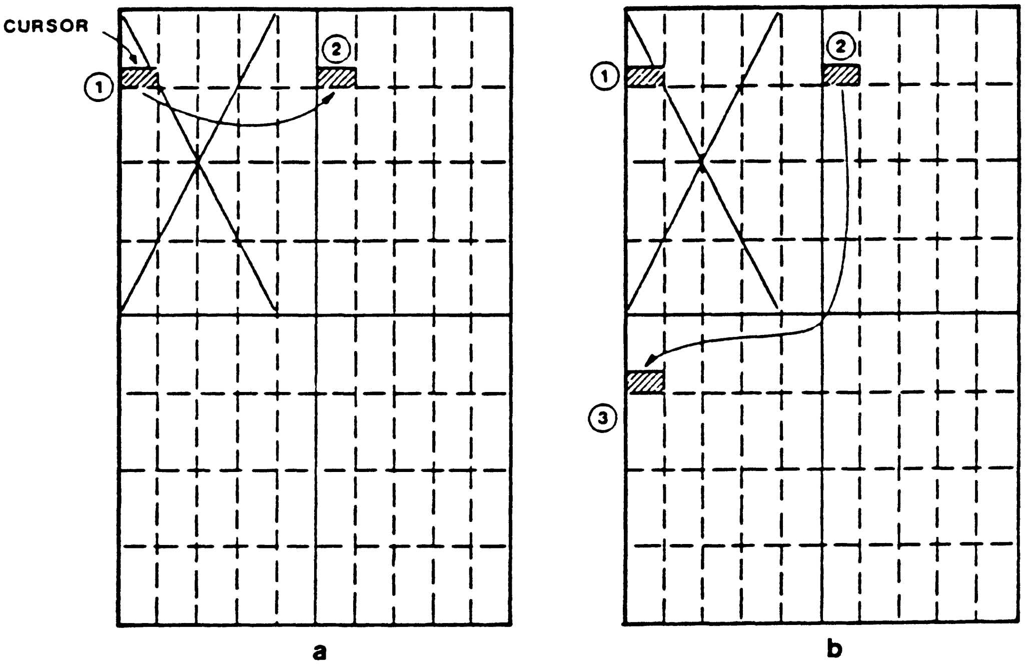


Figure 4-4 QUAD SIZE Character Cursor Movement

4.7 THIN-LINE GRAPHICS

Each terminal can display 16 different thin-line graphics characters (regular size and double wide only). These characters can be used, for example, to display diagrams on the video display. To display thin-line graphics characters, character set bits 0-2 of attribute byte No. 2 must be set to 000 (specifying regular characters).

The diagrams in Appendix C, character codes 128-143 decimal (80-8F hexadecimal), show the appearance of the 16 thin-line graphics characters.

NOTE
The terminal must be configured for 8 bits per character in order to display these codes via the serial port.

4.8 BLOCK GRAPHICS

The terminal can display 16 different regular-size and double wide block graphics characters. These characters can be used in combination, for example, to display diagrams and characters that are larger than quad-size. Appendix C contains character codes 144-207 decimal (90-CF hexadecimal), and shows all the block graphics characters.

Each block graphics character is made up of pixels. The different block graphics characters are made up by turning on different combinations of these pixels.

NOTE
The terminal must be configured for 8 bits per character in order for these characters to be displayed via codes from the serial port.

4.9 SPECIAL BAR GRAPHICS CHARACTERS

Special graphic characters are provided to draw solid character cells of specified heights and widths. These special bar graphics characters are regular or double size bits 0-2 of attribute byte No. 2 must be set to 00). There are four types of special bar graphics characters:

- Vertical bar up characters, which draw bars of varying heights, all beginning at the bottom of the character cell. See Appendix C, characters codes 209 - 220 decimal (D1 - DC hexadecimal).

- Vertical bar down characters, which begin at the top of the character cell and extend downwards. See Appendix C, character codes 225 - 236 decimal (E1 - EC hexadecimal).
- Horizontal bar right characters, which begin at the left edge of the character cell and extend to the right. See Appendix C, character codes 240 - 244 decimal (F0 - F4 hexadecimal).
- Horizontal bar left characters, which begin at the right edge of the character cell and extend to the left. See Appendix C, character codes 248 - 252 decimal (F8 - FC hexadecimal).

4.10 PROCESS GRAPHIC SYMBOLS

If the Character Set bits 0-2 of attribute byte No. 2 are zero when a displayable character is typed, the character printed on the key is displayed on the terminal screen. (These bits are automatically set to the default value 0 whenever the terminal is powered up or reset.) However, process graphic symbols can be selected by setting the Character Set bits to the following value:

Attribute Byte No. 2

Bit 2	Bit 1	Bit 0	Attribute
0	1	1	process graphic symbols

If process graphic symbols are selected, the character <u>transmitted</u> by the terminal will not change (see Chapter 3). However, certain characters codes sent to the display will cause graphic symbols to be displayed. For example, in process graphics mode, typing an uppercase "M" will still cause the character 4DH (hex value of "M") to be transmitted, but if an "M" is received, a small box instead of "M" will be displayed.

Table 4-1 lists all the process graphic symbols and the characters which will generate each one.

Appendix C shows what these symbols look like.

Table 4-1 Process Graphic Symbols

Hex Value	ASCII Character	Process Control Symbol
20H		4x4 space
21H	!	motor in 4x3 cell
22H	"	not used
23H	#	left tank top in 4x1 cell
24H	$	right tank top in 4x1 cell
25H	%	small diamond in 4x2 cell
26H	&	left tank bottom in 4x1 cell
27H	'	right tank bottom in 4x1 cell
28H	(	left arrow in 4x2 cell
29H	)	right arrow in 4x2 cell
2AH	*	small box in 4x2 cell
2BH	+	up valve in 4x2 cell
2CH	,	right/left facing valve in 4x2 cell
2DH	-	pump/compressor in 4x2 cell
2EH	.	up arrow in 4x2 cell
2FH	/	down arrow in 4x2 cell
30H	0	small circle in 4x2 cell
31H	1	circuit breaker type 1 in 2x4 cell
32H	2	fuse in 2x4 cell
33H	3	disconnect in 3x4 cell
34H	4	pump/blower in 4x2 cell
35H	5	circuit breaker type 2 in 4x2 cell
36H	6	left turbine in 3x2 cell
37H	7	right turbine in 3x2 cell
38H	8	left medium box in 4x2 cell
39H	9	right medium box in 4x2 cell
3AH	;	left medium circle in 4x3 cell
3BH	:	right medium circle in 4x3 cell
3CH	<	mini circle in 2x1 cell
3DH	=	mini left arrow in 2x1 cell
3EH	>	mini right arrow in 2x1 cell
3FH	?	mini up arrow in 2x1 cell
40H	@	mini down arrow in 2x1 cell
41H	A	motor
42H	B	large circle (left)
43H	C	large circle (right)
44H	D	tank top (left)
45H	E	tank top (right)
46H	F	small diamond
47H	G	large diamond (left)
48H	H	large diamond (right)
49H	I	tank bottom (left)
4AH	J	tank bottom (right)
4BH	K	left arrow
4CH	L	right arrow

Table 4-1 Process Graphic Symbols cont.

Hex Value	ASCII Character	Process Control Symbol
4DH	M	small box
4EH	N	up facing valve
4FH	O	right/left facing valve
50H	P	pump/compressor
51H	Q	up arrow
52H	R	down arrow
53H	S	small circle
54H	T	transformer
55H	U	circuit breaker (type 1)
56H	V	fuse
57H	W	disconnect
58H	X	pump/blower
59H	Y	circuit breaker (type 2)
5AH	Z	turbine (left)
5BH	[	turbine (right)
5CH	\	large box (left)
5DH	]	large box (right)
5EH	^	medium box (left)
5FH	_ (underscore)	medium box (right)
60H	`(grave)	medium circle (left)
61H	a	medium circle (right)
62H	b	top left 1/4 of large circle in 4x2 cell
63H	c	top right 1/4 of large circle in 4x2 cell
64H	d	bottom left 1/4 of large circle in 4x2 cell
65H	e	bottom right 1/4 of large circle in 4x2 cell
66H	f	top left 1/4 of small circle in 2x1 cell
67H	g	top right 1/4 of small circle in 2x1 cell
68H	h	bottom left 1/4 of small circle in 2x1 cell
69H	i	bottom right 1/4 of small circle in 2x1 cell
6AH	j	small tank top in 4x1 cell
6BH	k	small tank bottom in 4x1 cell
6CH	l	mini tank top in 2x1 cell
6DH	m	mini tank bottom in 2x1 cell
6EH	n	mini diamond in 2x1 cell
6FH	o	mini box in 2x1 cell
70H	p	mini right valve in 2x1 cell
71H	q	mini up valve in 2x1 cell
72H	r	mini motor in 2x2 cell
73H	s	mini pump/blower in 2x1 cell
74H	t	mini transformer in 2x2 cell
75H	u	mini circuit breaker type 1 in 1x2 cell
76H	v	mini fuse in 1x2 cell

Table 4-1 Process Graphic Symbols cont.

Hex Value	ASCII Character	Process Control Symbol
77H	w	mini disconnect in 1x2 cell
78H	x	mini blower/compressor in 2x1 cell
79H	y	mini circuit breaker type 2 in 2x1 cell
7AH	z	mini left turbine in 1x1 cell
7BH	(	mini right turbine in 1x1 cell

If the terminal is in process graphic mode and a character not in the above table is typed or received, nothing will be displayed.

The process graphic symbols are shown in Appendix C.

4.11 UTILITY GRAPHICS

If the character set bits (bits 0-2 of attribute byte No. 2) are set to the value 111, the terminal will be in utility graphics mode. In this mode, receiving certain alphabetic characters will cause pieces of process control symbols to be displayed. The terminal uses these pieces to construct the process graphics symbols. You may be able to use these pieces to construct your own graphics, or to connect process graphic characters.

Note that this mode affects only the character/symbol displayed when certain character codes are sent to the display. It does not change the character transmitted by the terminal when the key is pressed (see Chapter 4).

Table 4-2 describes the utility graphics available (see Appendix C for the complete chart of graphics characters available).

Table 4-2 Utility Graphics

Utility Graphics	Description
32-79 (20-4F Hex)	Process Graphics Pieces
80-87 (50-57 Hex)	Process Graphic Connectors (Thin)
88-95 (58-5F Hex)	Process Graphic Connectors (Thick)
96-111 (60-6F Hex)	Thick Line Graphics
112-175 (70-AF Hex)	Process Graphic Pieces
176-187 (B0-BB Hex)	Miscellaneous Connectors

4.12 GRAPHIC SHADING CHARACTERS

The shading characters can be used to create varying shades of grey (or texture) as used in bar chart shading.

Appendix C, character codes 221, 222 and 237, 238 decimal (DD, DE and ED, EE hexadecimal), shows the shading graphic symbols.

Chapter 5

REMOTE COMMANDS

5.1 INTRODUCTION

Remote commands allow the terminal to be controlled by the host device. Remote commands require lead-in character(s) to be received by the terminal immediately before the command code is received. In Hazeltine 1500 emulation, the lead-in character is ~ (7EH), called a tilde. In ANSI emulation, the lead-in character is ESC (1BH), or the two-character sequence ESC [(1BH 5BH). The lead-in code does not affect the display when received by the terminal.

If the code following the lead-in character is not a valid command code requiring a lead-in character, both the lead-in character and the code that follows it will be ignored by the terminal.

Configuration changes performed with remote commands are not saved when the terminal is turned off or reset.

CAUTION

Configuration changes performed with remote commands are not saved when the terminal is turned off or reset.

If a remote command has been issued to change the current configuration, the new configuration is lost on power-down or reset. To save the new configuration, it is only necessary to enter the Configuration Menu, then exit it (without having to change the Configuration Menu). This will save the new configuration in EEPROM, and consequently upon power-up or reset, the new configuration will be brought up.

See Tables 5-1 & 5-2 for a list of remote commands the terminal can receive from a host device.

5.2 HAZELTINE 1500 EMULATION

For a detailed description of the available Remote Commands, see Section 5.4. Cursor Addressing is described in Section 4.2.

In Table 5-1, parameters such as <attr-1> or <xstart> are single bytes in the range 00H through FFH.

Table 5-1 Remote Commands
(Hazeltine 1500 Emulation)

REMOTE COMMANDS	ASCII	HEX
<u>Control Characters</u>		
Bell	<BEL>	07
Backspace	<BS>	08
Cursor to Next Foreground Field	<HT>	09
Linefeed	<LF>	0A
Carriage Return	<CR>	0D
<u>Configuration Commands</u>		
Enable Application Mode	~ .	7E 2E
Disable Application Mode	~ /	7E 2F
Cursor Off	~<SOH>	7E 01
Cursor On	~<STX>	7E 02
Scrolling Off	~<BEL>	7E 07
Scrolling On	~<BS>	7E 08
Unlock Keyboard	~<ACK>	7E 06
Lock Keyboard	~<NAK>	7E 15
<u>Attribute Commands</u>		
Set/Reset Attributes	~6<attribute#>	7E 36 <attribute #>
Change Char. Attributes	~<ETX> <attr-1> <attr-2>	7E 03 <attr-1> <attr-2>
<u>Cursor Movement Commands</u>		
Cursor Right (no scroll)	<DLE>	10
Return Cursor Position	~<ENQ>	7E 05
Cursor Down (no scroll)	~<VT>	7E 0B
Cursor Up	~<FF>	7E 0C
Cursor to X,Y	~<DC1> X Y	7E 11 X Y
Home Cursor	~<DC2>	7E 12

Table 5-1 Remote Commands cont.
(Hazeltine 1500 Emulation)

REMOTE COMMANDS	ASCII	HEX
Clear Commands		
Clear to EOL with Background Spaces	~<SI>	7E 0F
Clear to EOS with Background Spaces	~<ETB>	7E 17
Clear to EOS with Foreground Spaces	~<CAN>	7E 18
Clear Foreground	~<GS>	7E 1D
Clear Screen	~<FS>	7E 1C
Background Field Follows	~<EM>	7E 19
Foreground Field Follows	~<US>	7E 1F
Delete Commands		
Delete Line	~<DC3>	7E 13
Insert Line	~<SUB>	7E 1A
Draw Commands		
Draw Box	~<HT> <char> <xstart> <ystart> <xend> <yend>	7E 09 <char> <xstart> <ystart> <xend> <yend>
Draw Vertical Line (upward)	~<LF> <char> <xstart> <ystart> <length>	7E 0A <char> <xstart> <ystart> <length>
Draw Horizontal Line (left to right)	~<CR> <char> <xstart> <ystart> <length>	7E 0D <char> <xstart> <ystart> <length>
Draw Bar Chart	~<S0> <xstart> <ystart> <length1> <length2>	7E 0E <xstart> <ystart> <length1> <length2>
Draw Bar Chart Down	~<space> <xstart> <ystart> <length1> <length2>	7E 20 <xstart> <ystart> <length1> <length2>
Draw Bar Chart Right	~! <xstart> <ystart> <length1> <length2>	7E 21 <xstart> <ystart> <length1> <length2>
Draw Bar Chart Left	~" <xstart> <ystart> <length1> <length2>	7E 22 <xstart> <ystart> <length1> <length2>
Additional Commands		
Pause	~ # <time>	7E 23 <time>
Return Password	~ %	7E 25
Plot Point	~0XY	7E 30 X Y
Unplot Point	~1XY	7E 31 X Y

5.3 ANSI EMULATION

In ANSI mode, the parameters are one or more ASCII characters. Most parameters are numbers, with characters in the range 30H (the character "0") through 39H (the character "9").

In ANSI emulation, if the decimal value of a numeric parameter is greater than 9, two characters are necessary. For example, the decimal number 10 is represented as "1" followed by "0" (hex value 31,30). Likewise, if the decimal value is greater than 99, three characters are necessary.

ANSI values must be between 0-255.

In ANSI mode, parameters are separated by a semicolon, and all characters except <ESC> are displayable ASCII decimal characters.

Appendix E provides a table which converts between ASCII, hexadecimal, and decimal values.

Table 5-2 Remote Commands
(ANSI Emulation)

Control Characters

00	- ignored
07	- ring bell
08	- move cursor left 1 position
09	- go to next tab stop
0A	- linefeed or new line
0B	- same as 0A
0C	- same as 0A
0D	- move cursor to left margin of current line (carriage return)
18	- cancel current ESC sequence
1A	- same as 18
1B	- ESC

Configuration Commands [2,3]

ESC [? 7 h	- enable autowrap
ESC [? 25 h	- cursor on
ESC [? 7 l	- disable autowrap
ESC [? 25 l	- cursor off
ESC [2 h	- lock keyboard
ESC [2 l	- unlock keyboard
ESC [20 h	- enable auto line-feed
ESC [20 l	- disable auto line-feed
ESC [= 1 h	- cursor on
ESC [= 2 h	- scrolling on
ESC [= 3 h	- treat tab as ANSI tab
ESC [= 1 l	- cursor off
ESC [= 2 l	- scrolling off
ESC [= 3 l	- treat tab as Hazeltine tab

Attribute Commands [1]

ESC [1 ;attr1;attr2 p	- change character attributes
ESC [m	- attributes off
ESC [0 m	- attributes off
ESC [4 m	- underline
ESC [5 m	- blink
ESC [7 m	- reverse video
ESC [24 m	- underline disable
ESC [25 m	- blink disable
ESC [30 m	- reverse video off

Table 5-2 Remote Commands cont.
(ANSI Emulation)

Attribute Commands cont.

ESC [50 m	- select regular character set
ESC [51 m	- select double-high characters
ESC [52 m	- select quad-sized characters
ESC [53 m	- select process control symbols
ESC [54 m	- select double-wide characters
ESC [55 m	- select double-size characters
ESC [56 m	- select quad-sized characters
ESC [57 m	- select utility graphics
ESC [;attr1;attr2 p	- change character attributes

Cursor Movement Commands

ESC [pn A	- cursor up pn lines
ESC [pn B	- cursor down pn lines without scroll
ESC [pn C	- cursor right pn characters
ESC [pn D	- cursor left pn characters
ESC [y;x H	- cursor to position x,y
ESC [H	- cursor home (1,1)
ESC [y;x f	- cursor to position x,y
ESC [f	- cursor home (1,1)
ESC D	- cursor down with scroll
ESC M	- cursor up with scroll
ESC E	- cursor to beginning of next line with scroll
ESC 7	- save cursor and attributes
ESC 8	- restore cursor and attributes

Tab Stop Commands [4]

ESC H	- set tab stop at current column
ESC [g	- clear tab stop at current column
ESC [0 g	- clear tab stop at current column
ESC [3 g	- clear all tab stops

Table 5-2 Remote Commands cont.
(ANSI Emulation)

Clear Commands

ESC [pn X	- clear pn characters on current line with background spaces
ESC [K	- clear to end of line with background spaces
ESC [? K	- clear to end of line with background spaces
ESC [0 K	- clear to end of line with background spaces
ESC [? 0 K	- clear to end of line with background spaces
ESC [1 K	- clear to beginning of line with background spaces
ESC [? 1 K	- clear to beginning of line with background spaces
ESC [2 K	- clear entire line with background spaces
ESC [? 2 K	- clear entire line with background spaces
ESC [J	- clear to end of screen with background spaces
ESC [? J	- clear to end of screen with background spaces
ESC [0 J	- clear to end of screen with background spaces
ESC [? 0 J	- clear to end of screen with background spaces
ESC [1 J	- clear to beginning of screen with background spaces
ESC [? 1 J	- clear to beginning of screen with background spaces
ESC [2 J	- clear entire screen with background spaces
ESC [? 2 J	- clear entire screen with background spaces
ESC [8 p	- clear to end-of-screen with foreground spaces
ESC [9 p	- background follows
ESC [10 p	- clear foreground
ESC [11 p	- foreground follows

Insert/Delete Commands

ESC [pn L	- insert pn blank line(s) at current cursor position
ESC [pn M	- delete pn line(s) from cursor position
ESC [pn @	- insert pn space(s) in line at cursor position
ESC [pn P	- delete pn character(s) from line at cursor position

Report Commands

ESC [5 n	- device status report device ok returns - ESC [0 n device not ok returns - ESC [3 n
ESC [6 n	- report cursor x,y position returns - ESC [y;xR
ESC [c	- return options
ESC [0 c	- return options returns - ESC [? 1;0c

Table 5-2 Remote Commands cont.
(ANSI Emulation)

Additional Commands

ESC c	- reset to initial state
ESC =	- select application mode for keypad keys
ESC >	- select normal mode for keypad keys
ESC b	- unlock keyboard
ESC '	- lock keyboard
ESC [18;time p	- pause
ESC [20 p	- return password

Draw Commands

ESC [2 ;char;ystrt;xstrt;yend;xend p	- draw box
ESC [3 ;char;ystrt;xstrt;length p	- draw vertical line
ESC [4 ;char;ystrt;xstrt;length p	- draw horizontal line
ESC [5 ;ystrt;xstrt;len1;len2 p	- draw bar chart up
ESC [15;ystrt;xstrt;len1;len2 p	- draw bar chart down
ESC [16;ystrt;xstrt;len1;len2 p	- draw bar chart right
ESC [17;ystrt;xstrt;len1;len2 p	- draw bar chart left
ESC [25;ycor;xcor p	- plot point
ESC [26;ycor;xcor p	- unplot point

NOTES:

1 Multiple attributes can be selected in a single attribute command:

```
ESC [ 50;40;31m
```

2 Multiple configurations can be specified in a single configuration command.

Example:

```
ESC [ = 1;2;3 h
ESC [ ? 7;25 h
ESC [ 2;20 h
```

3 Configuration options that can be set by both the remote commands and the Configuration Menu are not saved on power-down unless the Configuration Menu is entered and exited.

4 Tab stops set/reset with remote commands are not saved on power-down unless the "Set Tab Stop" menu is entered and exited.

5.3.1 VT100/220 Support

When the terminal is configured for ANSI mode, it emulates the DEC VT100 and VT220 terminals. Some VT100/220 commands are not handled by the terminal. On the other hand, some commands not supported by the VT100/220 are available on the terminal.

The VT100/220 functions not emulated are listed below.

- 132 column mode is not supported
- not all special function keys are supported
- transmit and receive baud rates are not independent and there are fewer available baud rates
- no split screen capability
- different set-up procedure for configuration
- no user controllable LEDs
- no margin bell, key click
- optional DEC character sets and graphics are not supported
- VT52 mode is not supported
- can not invoke confidence tests remotely
- line attributes (double-high, double-wide) supported differently
- application mode supported only on the keypad, not on the keyboard
- insert mode not supported

When codes for these functions are received, they are ignored.

Appendix B lists the VT100/220 codes not supported by the terminal.

5.4 THE AVAILABLE REMOTE COMMANDS

Most of the remote commands listed in Table 5-1 are self-explanatory. However, some of the commands require further information, which is presented below, and some of the commands will affect the terminal's configuration options which are discussed in Chapter 2.

All commands may be entered either in hex or in ASCII, both for Hazeltine 1500 and ANSI emulation. However, hex is typically used in Hazeltine emulation, and ASCII is usual for ANSI emulation. Therefore, the remote commands for Hazeltine emulation are presented in hex in this chapter, while the remote commands for ANSI emulation are presented in ASCII.

Foreground and Background Fields

The following commands are related to the foreground and background fields on the terminal screen:

- Cursor to Next Foreground Field
- Clear to EOL with Background Spaces
- Clear to EOS with Background Spaces
- Clear to EOS with Foreground Spaces
- Background Field Follows
- Clear Foreground
- Foreground Field Follows
- Clear Screen
- Clear Line
- Clear to the Beginning of a Line
- Clear to the Beginning of a Screen
- Clear Characters on a Line

The terminal allows you to define foreground and background fields.

Foreground and background fields may be useful in distinguishing areas on the screen (e.g., column title fields).

Data in a foreground field is displayed as high-intensity video, while data in a background field is displayed in low-intensity video. All data is displayed as either a foreground or background field, depending upon how the field has been most recently defined. The default value is background field.

5.4.1 Cursor to Next Foreground Field

Function: Moves the cursor to the first character in the next foreground field. In ANSI emulation, the TAB character (09H) defaults to "Cursor To Next Tab Stop". The ANSI user must issue ESC[=3l to use tabs to move the cursor to the next foreground field.

Hazeltine emulation: 09H
ANSI emulation: <ESC> [= 3 l (treat tab as Hazeltine tab (and the last character is a lower case "L"))
<HT>

where: ESC = 1BH

The command to treat a TAB as a Hazeltine TAB only needs to be issued once. All subsequent tabs will seek foreground fields. In order to use ANSI TAB stops the command <ESC> [= 3h will have to be sent.

5.4.2 Clear to EOL with Background Spaces

Function: All characters from the current cursor position to the end of the line are cleared to spaces. In addition, all character positions from the current cursor position to end of line are defined as a background field.

Hazeltine emulation: 7EH 0FH
ANSI emulation: <ESC> [K

where: ESC = 1BH

5.4.3 Clear to EOS with Background Spaces

Function: All characters from the current cursor position to the end of screen are cleared to spaces. In addition, all character positions from the current cursor position to end of the screen are defined as a background field.

Hazeltine emulation: 7EH 17H
ANSI emulation: <ESC> [J

where: ESC = 1BH

5.4.4 Clear to EOS with Foreground Spaces

Function: All characters from the current cursor position to the end of the screen are cleared to spaces. In addition, all character positions from the current cursor position to the end of screen are defined as a foreground field.

Hazeltine emulation: 7EH 18H
ANSI emulation: <ESC> [8 p

where: ESC = 1BH

5.4.5 Background Field Follows

Function: All subsequent data is displayed as a background field, until a Foreground Field Follows command is executed.

Hazeltine emulation: 7EH 19H
ANSI emulation: <ESC> [9 p

where: ESC = 1BH

5.4.6 Clear Foreground

Function: All foreground fields on the entire screen are replaced by foreground spaces, and the cursor is moved to the first position of the first foreground field.

Hazeltine emulation: 7EH 1DH
ANSI emulation: <ESC> [10 p

where: ESC = 1BH

5.4.7 Foreground Field Follows

Function: All subsequent data is displayed as a foreground field, until a Background Field Follows command is executed.

Hazeltine emulation: 7EH 1FH
ANSI emulation: <ESC> [11 p

where: ESC = 1BH

5.4.8 Clear Screen with Background Spaces

Function: All characters and data are cleared from the display screen.

Hazeltine emulation: 7EH 1CH
ANSI emulation: <ESC> [2 J

where: ESC = 1BH

5.4.9 Clear Line with Background Spaces

Function: All characters are cleared from the current line the cursor is on.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [K

where: ESC = 1BH

5.4.10 Clear to Beginning of the Line with Background Spaces

Function: All characters are cleared from the current cursor position to the beginning of the current line.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [1 K

where: ESC = 1BH

5.4.11 Clear to the Beginning of the Screen with Background Spaces

Function: All characters are cleared from the current cursor position to the beginning of the screen.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [1 J

where: ESC = 1BH

5.4.12 Clear Characters on a Line with Background Spaces

Function: All specified number of characters are cleared on the current line.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [pn X

where: ESC = 1BH
pn = the number of characters to be cleared

The following example first defines some background fields, leaving the foreground fields blank. Then it homes the cursor and proceeds to fill the previously defined foreground fields with data.

ANSI

Command	Comments
<ESC> [2 J	-- Clear Screen
Weld Station:	-- Message on Screen
<ESC> [11 p	-- Foreground Field Follows
<SPACE>	-- Blank character, required to establish the rest of the line as foreground field
<CR>	-- Carriage Return
<LF>	-- Linefeed
<ESC> [9 p	-- Background Field Follows
Status:	-- Message on Screen
<ESC>[11 p	-- Foreground Field Follows
<SPACE>	-- Blank character
<CR>	-- Carriage Return
<LF>	-- Linefeed
<ESC> [8 p	-- Clear to EOS with Foreground Spaces
<ESC> [= 3 l	-- Treat Tab as Hazeltine Tab
<TAB>	-- Cursor to Next Foreground Field
Carriage Assembly - Left	-- Message on Screen
<TAB>	-- Cursor to Next Foreground Field
Not Operational	-- Message on Screen
<TAB>	-- Cursor to Next Foreground Field
Overcurrent Detected	-- Message on Screen

Hazeltine 1500

Note that the hexadecimal representations of the ASCII characters are listed, not the ASCII characters themselves.

Command	Comments
7EH 1CH	-- Clear Screen
WELD STATION:	-- Message on Screen
7EH 1FH	-- Foreground Field Follows
<SPACE>	-- Blank character, required to establish rest of line as foreground field
<CR>,<LF>	-- Carriage Return, Linefeed
7EH 19H	-- Background Field Follows
STATUS:	-- Message on Screen
7EH 1FH	-- Foreground Field Follows
<SPACE>	-- Blank character
<CR>, <LF>	-- Carriage Return, Linefeed
7EH 18H	-- Clear to EOS with Foreground Spaces
7EH 12H	-- Home Cursor
09H	-- Cursor to Next Foreground Field
Carriage Assembly - Left	-- Message on Screen
09H	-- Cursor to Next Foreground Field
Not Operational	-- Message on Screen
09H	-- Cursor to Next Foreground Field
Overcurrent Detected	-- Message on Screen

5.4.13 **Draw Box**

Function: Draws a box. The coordinates of the upper left and lower right corners are included in the character sequence.

Hazeltine emulation: 7EH 09H <char> <xstart> <ystart> <xend> <yend>
ANSI emulation: <ESC>[2;<char>;<ystart>;<xstart>;<yend>;<xend>p

where:

char -- Hazeltine emulation:

01H = thick-line box
02H = thin-line box
03H = thin-line box using utility graphics characters
04H = thick-line box using utility graphics characters
Any displayable ASCII character = box composed of that character.

-- ANSI emulation:

1(31H) = thick-line box
2(32H) = thin-line box
3(33H) = thin-line box using utility graphics characters
4(34H) = thick-line box using utility graphics characters
Sequence of two ASCII decimal characters = box composed of the ASCII equivalent of the decimal value. For example, to draw a box composed of the character "A"(65) the following two characters are required: 6(36H) and 5(35H).

xstart = x coordinate of upper left corner of box
ystart = y coordinate of upper left corner of box
xend = x coordinate of lower right corner of box
yend = y coordinate of lower right corner of box

> NOTE
> This command will not cause automatic scrolling if a box the size of the screen is drawn.

5.4.14 Draw Vertical Line in Upward Direction

Function: Draws an upward vertical line, beginning at the coordinate included in the command sequence, toward the screen's top edge.

Hazeltine emulation: 7EH 0AH <char> <xstart> <ystart> <length>
ANSI emulation: <ESC>[3;<char>;<ystart>;<xstart>;<length>p

where:

char -- Hazeltine emulation:
01H = thick line
02H = thin line
03H = thin right of cell connector (utility graphic 51H)
04H = thin left of cell connector (utility graphic 53H)
05H = thick right of cell connector (utility graphic 59H)
06H = thick left of cell connector (utility graphic 5BH)
Any displayable ASCII character = line composed of that character.

-- ANSI emulation:
1(31H) = thick line
2(32H) = thin line
3(33H) = thin right of cell connector (utility graphic 51H)
4(34H) = thin left of cell connector (utility graphic 53H)
5(35H) = thick right of cell connector (utility graphic 59H)
6(36H) = thick left of cell connector (utility graphic 5BH)
Sequence of two ASCII decimal characters = line composed of the ASCII equivalent of the decimal value. For example, to draw a line composed of the character "A"(65) the following two characters are required: 6(36H) and 5(35H).

xstart = x coordinate of start of line
ystart = y coordinate of start of line
length = length of line (in units of character cells)

5.4.15 Draw Horizontal Line from Left to Right

Function: Draws a horizontal line (from left to right) starting at the coordinate in the character sequence, toward the right edge of the screen.

Hazeltine emulation: 7EH 0DH <char> <xstart> <ystart> <length>
ANSI emulation: <ESC>[4;<char>;<ystart>;<xstart>;<length>p

where:

char -- Hazeltine emulation:

01H = thick line
02H = thin line
03H = thin top of cell connector (utility graphic 50H)
04H = thin bottom of cell connector (utility graphic 52H)
05H = thick top of cell connector (utility graphic 58H)
06H = thick bottom of cell connector (utility graphic 5AH)
Any displayable ASCII character = line composed of that character.

-- ANSI emulation:

1(31H) = thick line
2(32H) = thin line
3(33H) = thin top of cell connector (utility graphic 50H)
4(34H) = thin bottom of cell connector (utility graphic 52H)
5(35H) = thick top of cell connector (utility graphic 58H)
6(36H) = thick bottom of cell connector (utility graphic 5AH)
Sequence of two ASCII decimal characters = line composed of the ASCII equivalent of the decimal value. For example, to draw a line composed of the character "A"(65) the following two characters are required: 6(36H) and 5(35H).

xstart = x coordinate of start of line
ystart = y coordinate of start of line
length = length of line (in units of character cells)

5.4.16 Draw Bar Up

Function: Draws a high-resolution vertical bar one character wide. The coordinate of the bottom character cell of the bar and its height are included in the character sequence. This command includes a character specifying the height of the bar to be erased before the new bar is drawn, so that bars can be updated dynamically.

Hazeltine emulation: 7EH 0EH <xstart> <ystart> <length1> <length2>
ANSI emulation: <ESC>[5;<ystart>;<xstart>;<length1>;<length2>p

where: xstart = x coordinate of start of bar
ystart = y coordinate of start of bar
length1 = height of column (in units of 1/12 of a character cell)
The height must be in the range 0 through 255. 12 is equivalent to the height of one character, 252 is equal to the height of 21 characters.
length2 = Before the new vertical bar is drawn, a blank bar of length2 is drawn. This erases the previous bar. If length2 is zero, no blank line will be drawn.

5.4.17 Draw Bar Down

Function: Same as Draw Bar Up, except that bar is drawn downward, and <xstart> and <ystart> specify the top character cell of the bar.

Hazeltine emulation: 7EH 20H <xstart> <ystart> <length1> <length2>
ANSI emulation: <ESC>[15;<ystart>;<xstart>;<length1>;<length2>p

where: xstart = x coordinate of start of bar
ystart = y coordinate of start of bar
length1 = height of column (in units of 1/12 of a character cell)
The height must be in the range 0 through 255. 12 is equivalent to the height of one character, 252 is equal to the height of 21 characters.
length2 = Before the new vertical bar is drawn, a blank bar of length2 is drawn. This erases the previous bar. If length2 is zero, no blank line will be drawn.

5.4.18 Draw Bar Right

> NOTE
> For the Draw Bar Right and Draw Bar Left commands, a length of 255 will only be 51 characters wide (there are 80 characters in a line). Multiple bars must be used to span more than 51 characters cells.

Function: Same as Draw Bar Up, except that bar is drawn to the right, and <xstart> and <ystart> specify the left end character cell of the bar.

Hazeltine emulation: 7EH 21H <xstart> <ystart> <length1> <length2>
ANSI emulation: <ESC>[16;<ystart>;<xstart>;<length1>;<length2>p

where: xstart = x coordinate of start of bar
ystart = y coordinate of start of bar
length1 = width (in units of 1/5 of a character cell)
The width must be in the range 0 through 255. 5 is equivalent to the width of one character, 255 is equal to the width of 51 characters.
length2 = Before the new horizontal bar is drawn, a blank bar of length2 is drawn. This erases the previous bar. If length2 is zero, no blank line will be drawn.

5.4.19 Draw Bar Left

Function: Same as Draw Bar Right, except that bar is drawn to the left, and <xstart> and <ystart> specify the right end character cell of the bar.

Hazeltine emulation: 7EH 22H <xstart> <ystart> <length1> <length2>
ANSI emulation: <ESC>[17;<ystart>;<xstart>;<length1>;<length2>p

where: xstart = x coordinate of start of bar
ystart = y coordinate of start of bar
length1 = width of column (in units of 1/5 of a character cell)
The width must be in the range 0 through 255. 5 is equivalent to the width of one character, 255 is equal to the width of 51 characters.
length2 = Before the new horizontal bar is drawn, a blank bar of length2 is drawn. This erases the previous bar. If length2 is zero, no blank line will be drawn.

5.4.20 **Pause**

Function: Causes the terminal to pause for a specified period before retrieving and displaying the next character or command from the serial port (or screen program, if the 4800-E1 option is installed).

Hazeltine emulation: 7EH 23H<time>
ANSI emulation: <ESC>[18;<time>p

where: ESC = 1BH
time = duration of pause (in tenths of a second)

5.4.21 Enable Application Mode

Function: Puts the keypad into application mode (see Section 3.2.1). The keypad remains in application mode until the terminal is reset, powered-up again, or goes from set-up mode to operating mode.

Hazeltine emulation: 7EH 2EH
ANSI emulation: <ESC> =

where: ESC = 1BH

5.4.22 Disable Application Mode

Function: Returns the keypad from application mode to normal mode (see Section 3.2.1).

Hazeltine emulation: 7EH 2FH
ANSI emulation: <ESC> >

where: ESC = 1BH

5.4.23 Cursor Off

> **NOTE**
> Cursor is always ON when the terminal enters Operating Mode (from set-up or power-up).

Function: Makes the cursor invisible.

Hazeltine emulation: 7EH 01H
ANSI emulation: <ESC>[=1l

(these last two characters are the digit "1" followed by a lower case "L")

where: ESC = 1BH

5.4.24 Cursor On

Function: Makes the cursor visible.

Hazeltine emulation: 7EH 02H
ANSI emulation: <ESC>[=1h

where: ESC = 1BH

5.4.25 Scrolling Off

> NOTE
>
> Scrolling can also be turned on or off in the Configuration Menu. The value set with the Scrolling On or Scrolling Off remote commands is not saved at power-up or reset. Instead, the setting in the Configuration Menu is used to set scrolling on/off.

Function: Disables screen scrolling. Any keystroke or serial input that would normally cause the screen to scroll will instead cause the cursor to go to the top of the screen.

Hazeltine emulation: 7EH 07H
ANSI emulation: <ESC>[=2l

(the last character is a lower case "L")

where: ESC = 1BH

5.4.26 Scrolling On

Function: Enables screen scrolling. Used to re-enable scrolling after the Scrolling Off command has been used to disable scrolling.

Hazeltine emulation: 7EH 08H
ANSI emulation: <ESC>[=2h

where: ESC = 1BH

5.4.27 **Insert Line**

Function: Inserts a line (or lines) immediately before the current line, and moves the cursor to the beginning of the inserted line.

Hazeltine emulation: 7EH 1AH
ANSI emulation: <ESC>[pn L

where: pn is the number of blank lines to insert.
ESC = 1BH

5.4.28 **Delete Line**

Function: Deletes the line on which the cursor is positioned.

Hazeltine emulation: 7EH 13H
ANSI emulation: <ESC>[pn M

where: pn is the number of lines to delete.
ESC = 1BH

5.4.29 Plot Point

Function: Turns on one pixel. Each character cell consists of four pixels.

Hazeltine emulation: 7EH 30H <x><y>
ANSI emulation: <ESC>[25;<y>;<x>p

where: ESC = 1BH
x is the horizontal coordinate (0-159)
y is the vertical coordinate (0-71)

(Note that the lower left-hand corner has coordinates 0,0.)

5.4.30 Unplot Point

Function: Turns off one pixel. If the specified pixel is not on, this command has no effect.

Hazeltine emulation: 7EH 31H <x><y>
ANSI emulation: <ESC>[26;<ycor>;<xcor>p

where: ESC = 1BH
xcor is the horizontal coordinate (0-159)
ycor is the vertical coordinate (0-71)

(Note that the lower left-hand corner has coordinates 0,0.)

5.4.31 Return Password

Function: Returns the current password (three characters), followed by a carriage return. If the password is disabled (from the Password Menu -- see Chapter 2, Section 2.2.2), only a carriage return is transmitted.

Hazeltine emulation: 7EH 25H
ANSI emulation: <ESC>[20p

where: ESC = 1BH

5.4.32 Set/Reset Attribute Command

Function: Sets/resets the terminal attributes.

Hazeltine emulation: 7EH 36H xx
ANSI emulation: <ESC>[<dd> m

where: ESC = 1BH
xx = the attribute set/reset hazeltine code:
dd = the attribute set/reset ANSI code:

dd	xx
0	(00H) - attributes off (does not affect colors)
1	(01H) - highlight on
4	(04H) - underscore on
5	(05H) - blink on
7	(07H) - reverse video on
22	(16H) - highlight off
24	(18H) - underscore off
25	(19H) - blink off
27	(1BH) - reverse video off
50	(32H) - select regular characters
51	(33H) - select double-high characters
52	(34H) - select quad-size characters
53	(35H) - select process graphics characters
54	(36H) - select double-wide characters
55	(37H) - select double-size characters
56	(38H) - select quad-size characters
57	(39H) - select utility graphics

5.4.33 Return Cursor Position

Function: To read the cursor position, transmit a Return Cursor Position command to the terminal:

Hazeltine emulation: 7EH 05H
ANSI emulation: <ESC>[6 n

Hazeltine:

The terminal will then transmit the response:

<column coordinate> <row coordinate> CR

where: <column coordinate> will be a hex value between 20H-4FH and 60H-7FH, while <row coordinate> will be a hex value between 60H and 78H. CR is the ASCII character corresponding to 0D (hex).

Figure 5-2 lists the row and column coordinates under Hazeltine emulation

ANSI:

The terminal will then transmit the response:

ESC [<row>;<column>R (ASCII character)

where: the row and column are ASCII decimal values (hex values between 30H and 39H). For example, if the cursor is currently in row 12, column 6, the Return Cursor Position command will return the following sequence of ASCII characters:

ESC [12; 06 R (ASCII character)

Figure 5-1 lists the row and column coordinates under ANSI emulation.

5.4.34 Cursor to X,Y

Function: To move the cursor to column x, row y on the screen.

Hazeltine emulation: 7EH 11H <x> <y>
ANSI emulation: <ESC> [y;x H

where: ESC = 1BH
y = row
x = column

Hazeltine:

To move the cursor to column x, row y, transmit a Cursor to X,Y command to the terminal:

```
7EH 11H      xx        yy
```

where: xx and yy are the hexadecimal equivalents of the decimal values x,y (e.g., position 19=13 hex), and <char x> and <char y> are the ASCII characters corresponding to the hex values xx and yy (e.g., ASCII DC3 corresponds to 13 hex).

Figure 5-2 lists the row and column coordinates under Hazeltine emulation.

ANSI:

To move the cursor to row y, column x, transmit a Cursor to X,Y command to the terminal:

```
ESC [ y;x H
```

> **NOTE**
> The decimal coordinate greater than 9 must be expressed as two decimal ASCII characters. For example, decimal coordinate 10 is expressed as "1" followed by "0" (31H 30H).

Figure 5-1 lists the row and column coordinates under ANSI emulation.

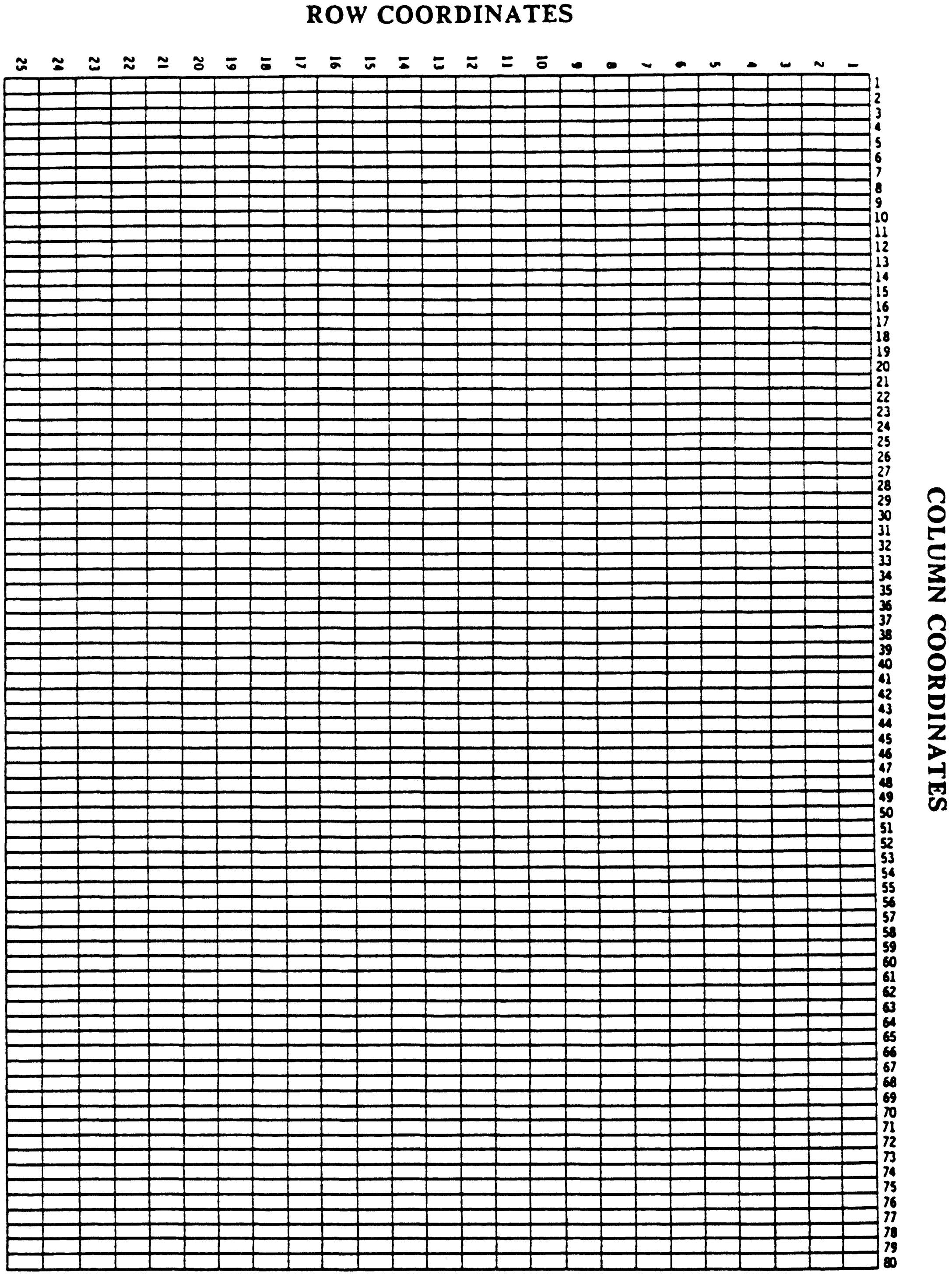


Figure 5-1 Video Display Coordinate System (ANSI Emulation)

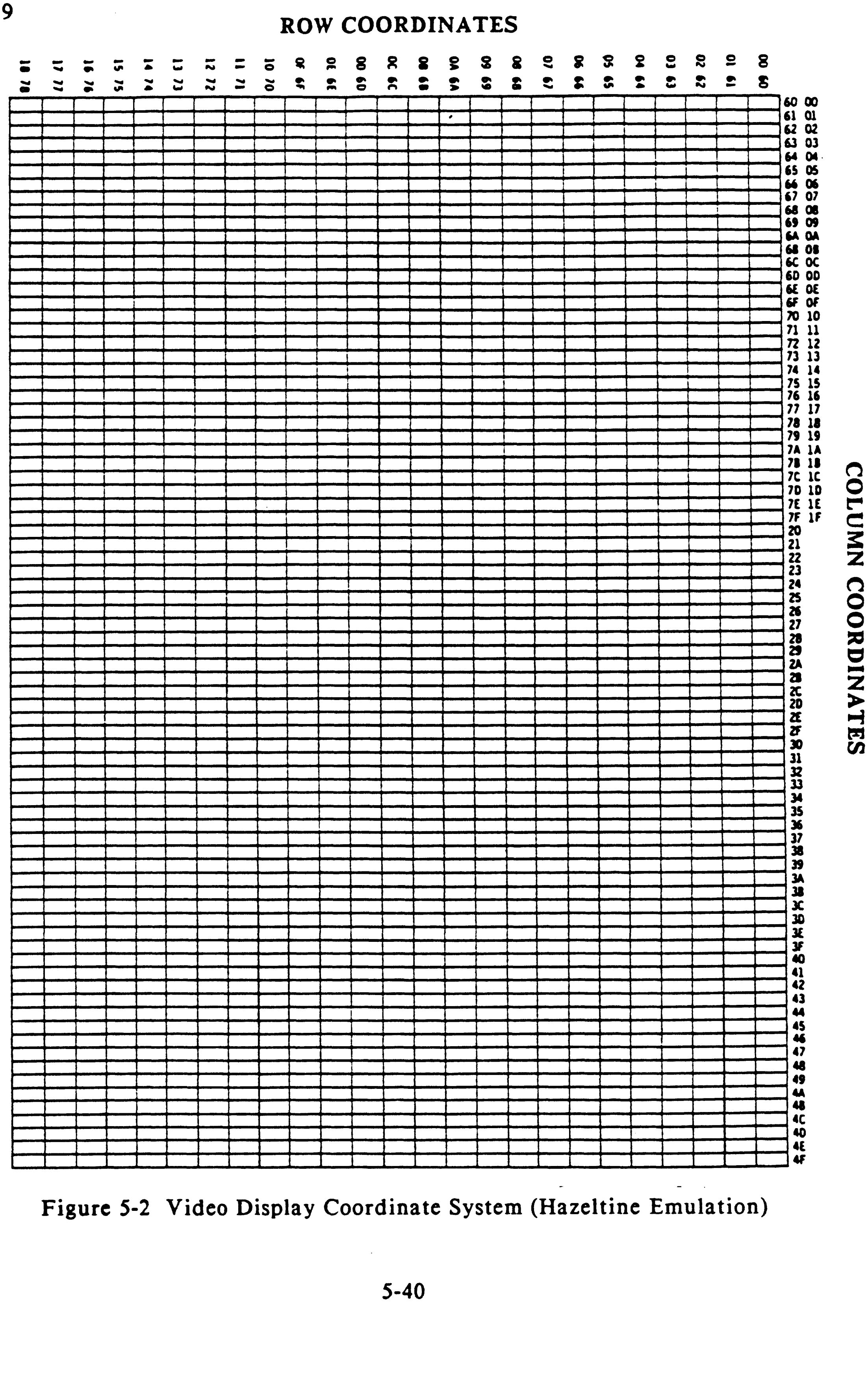


Figure 5-2 Video Display Coordinate System (Hazeltine Emulation)

5.4.35 Change Character Attributes Command

Function: This command (Change Character Attributes) is a remote command used to change a character's attribute.

Hazeltine emulation: 7EH 03H <attribute byte No. 1> <attribute byte No. 2>
ANSI emulation: <ESC> [1;<attribute No. 1>; <attribute No. 2> p

The definition of attribute byte No. 1 for the 4850 is shown in Table 5-3.

Table 5-3 Attribute Byte 1

Bit No.	Attribute
7 (MSB)	not used
6	not used
5	not used
4	double-wide
3	blink
2	underline
1	high-intensity
0 (LSB)	reverse video

The definition of attribute byte No. 2 is shown in Table 5-4.

Table 5-4 Attribute Byte 2

Bit No.	Attribute
7 (MSB)	not used
6	not used
5	not used
4	not used
3	not used
2	character set bit 2
1	character set bit 1
0 (LSB)	character set bit 0

The settings of bits 2 to 0 of attribute byte No. 2 can be any of the following (see Table 5-4).

Bit 2	Bit 1	Bit 0	Attribute
0	0	0	regular character
0	0	1	double-high character
0	1	0	quad-size character
0	1	1	process graphic symbols
1	1	1	utility graphics

5.4.36 Insert Spaces in a Line

Function: This command inserts spaces into a line beginning at the cursor's current position. Any characters from the cursor's current position to the end of the line will be removed.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [pn @

where: ESC = 1BH
pn = the number of spaces to be inserted

5.4.37 Delete Characters in a Line

Function: This command deletes characters from a line at the cursor's current position and inserts spaces at the end of the line.

Hazeltine emulation: N/A
ANSI emulation: <ESC> [pn P

where: ESC = 1BH
pn = the number of characters to be deleted

5.4.38 Saving Cursor Attributes

Function: This command saves the cursor's current position, character set, autowrap flag state, and all attributes.

Hazeltine emulation: N/A
ANSI emulation: <ESC> 7

where: ESC = 1BH

5.4.39 Restoring Cursor Attributes

Function: This command restore's the current cursor position, character set, autowrap flag state, and all attributes.

Hazeltine emulation: N/A
ANSI emulation: <ESC> 8

where: ESC = 1BH

5.5 Sample Screen Display

This example illustrates how to create a simple screen display by transmitting a sequence of characters to the terminal. This display prints the letters "WARNING" in quad size, reverse video inside a box.

ANSI

```
<ESC>[2;1;6;19;12;55p     -- Draw a box<CR>
<ESC>[7;20H               -- Position cursor inside of box<CR>
<ESC>[1;72;18p            -- Select quad size, reverse video<CR>
WARNING
```

Hazeltine 1500

To create the same screen as the ANSI example, send the following characters to the terminal. Note that the hexadecimal representations of the ASCII characters are listed, not the ASCII characters themselves.

```
7E 09 01 12 05            -- Draw a box<CR>
7E 11 13 06               -- Position cursor inside of box<CR>
7E 03 01 02               -- Select quad size, reverse video <CR>
WARNING                   -- Message on screen
```

After one of the above characters is transmitted, the terminal's RTS signal is made low (inactive) and the modem enters the receive mode. The sequence is repeated when data is again entered using the terminal's keypad or optional keyboard.

6.6 INPUT BUFFER OVER FLOW PROTECTION

When the terminal receives a character, it is stored in a large input buffer (size greater than 1500 characters) until processed. In unusual circumstances, if the terminal receives characters faster than it can process them, the input buffer can fill. If the terminal's input buffer becomes full and more characters are received, those additional characters will be lost because there is no room to store them.

One way to prevent this is to operate the terminal/host communications link at a baud rate low enough to give the terminal plenty of time to process a character before another is received.

Another way to prevent input buffer overflow is to send the terminal fill characters between valid data. The <NUL> character (00H) is used as the fill character. When received by the terminal, the <NUL> character is ignored. Commands for operations which require a relatively long time for the terminal to perform should be followed by fill characters if this method is used.

Table 6-1 Commands Whose Use May Require Input Buffer Protection

Clear Screen
Clear Foreground
Clear to End of Line
Clear to End of Screen
Clear to End of Screen (background spaces)
Delete Line
Insert Line
Display of double and quad-size characters
Clear to Beginning of Line
Clear to beginning of Screen
Draw Box
Draw Vertical Line
Draw Horizontal Line
Execute Screen (4800-E1 option installed)
Draw Bar (Up, Down, Left, Right)
Insert Spaces
Delete Characters
Clear Line

A third and preferred method for preventing input buffer overflow is to use either RTS/CTS or XON/XOFF control characters when operating in full-duplex mode. If XON/XOFF generation is enabled, and if there are fewer than 32 free bytes remaining in the input buffer, the XOFF control character will be sent to the host device at this time. When the XOFF signal is received, the host device should stop transmitting. When the buffer again contains more than 1000 free bytes, the XON control character will be sent to the host device. Transmission can then be resumed. The following characters are used as the XON/XOFF characters:

XON = DC1 (11H) XOFF = DC3 (13H)

NOTE
XON/XOFF should not be used in Hazeltine Mode.

If RTS/CTS handshaking is selected (see Configuration Menu, Section 2.2.5), the terminal must have an active CTS before it will transmit any data, and will activate RTS when it is able to receive any data.

6.7 COMMUNICATIONS PORTS

This port may be changed to an RS-422A or 20mA Current Loop port if the RS-232C communications adapter is removed and another communications adapter is installed.

6.7.1 RS-232C Communications Port

The following chart shows pin numbers and signals for the RS-232C communications port. All signals are positive logic (active high).

Table 6-2 RS-232C Signals

Pin	Signal	Function
1	GND	Frame Ground
2	TD	Transmit Data[2]
3	RD	Receive Data[2]
4	RTS	Request To Send (RTS)[1]
5	CTS	Clear To Send (CTS)[1]
6	DSR	Data Set Ready (DSR)[1]
7	SG	Signal Ground[2]
9		Disable Optical Isolation[3]
10		Disable Optical Isolation[3]
20	DTR	Data Terminal Ready (DTR)[1]

[1] Modem Control.

[2] Optically isolated lines.

[3] To use the modem lines, the optical isolation must be defeated by connecting pins 9 and 10 of the RS-232 connector.

According to the EIA RS-232C specifications, there should be no more than 50 feet of cable between the host RS-232C port device and the terminal RS-232C port.

Chapter 6

COMMUNICATIONS

6.1 INTRODUCTION

Each terminal's communications capability allows data to be transferred between the terminal and a host device. The terminal is equipped with an RS-232C communications port as standard equipment. An RS-422 or 20mA adapter and an extra serial printer port are available as options.

6.2 COMMUNICATIONS FORMAT

The communications ports available on the terminal support asynchronous serial data transfer using the ASCII code. Data is transmitted and received at the same baud rate, and this parameter can be set to 300, 600, 1200, 2400, 4800, 9600, and 19200 for each available port.

Each transmitted character includes one start bit, seven or eight data bits, one or no parity bit, and one stop bit (see Figure 6-1). The number of data bits and the parity are selected in the Configuration Menu (see Section 2.5).

START BIT	DATA BIT 0	DATA BIT 1	DATA BIT 2	DATA BIT 3	DATA BIT 4	DATA BIT 5	DATA BIT 6	PARITY BIT	STOP BIT

Seven Data Bits per Character

START BIT	DATA BIT 0	DATA BIT 1	DATA BIT 2	DATA BIT 3	DATA BIT 4	DATA BIT 5	DATA BIT 6	DATA BIT 7	STOP BIT

Eight Data Bits per Character - Parity Disabled

START BIT	DATA BIT 0	DATA BIT 1	DATA BIT 2	DATA BIT 3	DATA BIT 4	DATA BIT 5	DATA BIT 6	DATA BIT 7	PARITY BIT	STOP BIT

Eight Data Bits per Character - Parity Enabled

Figure 6-1 Character Format

Seven data bits per character with parity disabled is not allowed.

The parity condition can be set to one, zero, even, or odd, and the terminal can operate in full or half-duplex modes.

6.3 PARITY CHECKING

The Configuration Menu allows the user to select whether parity will be employed or not. If parity is employed, the user can select the parity condition to be used: always one, always zero, even, or odd.

When the terminal transmits any character (i.e., when a key is pressed), the settings in the Configuration Menu will determine the character format and the value of the parity bit (if any).

The terminal only checks parity on received data if odd or even parity is selected. If a character is received with an incorrect parity bit, a parity error symbol (P_E) will be shown on the video display at the cursor position and an audible alarm (beep) will sound.

6.4 FULL AND HALF-DUPLEX OPERATION

When operating in full-duplex terminal mode, the terminal will only display information and execute commands that are received from the host device. Alternately, information and commands can be entered using the terminal's keypad or optional keyboard, and echoed back to the terminal from the host device. In full-duplex mode, the RTS signal will not go high until a key is pressed on the terminal, unless RTS/CTS handshaking is enabled.

When operating in half-duplex terminal mode, the terminal will display information and execute commands that originate from the host device. Everything typed on the keyboard will be echoed to the screen as well as the serial port. The host should not echo characters back.

6.5 HALF-DUPLEX OPERATION WITH A MODEM

Modem control signals are used if the DSR input to the terminal is high (active). This indicates that the terminal is connected to a modem.

When data is entered using the terminal's keypad or optional keyboard, the terminal's RTS signal to the modem is set high.

If DSR is detected as high (active), the terminal waits for CTS to go high (active) before transmitting the character. If DSR is low (inactive), the character is transmitted immediately. The terminal holds its RTS signal high (active) and entered data is transmitted until one of the following characters is entered from the keyboard or keypad:

CR (0DH)
ETX (03H)
EOT (04H)

6.7.2 Optional RS-422A Communications Port

An RS-422A communications port is optionally available if your terminal must communicate with a host device using an RS-422A. The following chart shows pin numbers and signals for the optional RS-422A communications port:

Table 6-3 RS-422A Signals

Pin	Function	Pin	Function
1	SHLD	20,21	N/C
2,3	N/C	22	SD-
4	SD+	23	N/C
5	N/C	24	RD-
6	RD+	25	RS-
7	RS+	26	N/C
8	N/C	27	CS-
9	CS+	28	N/C
10	N/C	29	DM-
11	DM+	30	TR-
12	TR+	31	RR-
13	RR+	32-37	N/C
14-18	N/C		
19	SG		

6.7.3 Optional 20mA Current Loop Adapter

The optional 20mA current loop adapter provides a passive 20mA current switching interface. The current loop states are "mark" (current flow) or "space" (no current flow). The serial output circuit controls a circuit closure. In the mark condition, the circuit is closed. In the space condition, the circuit is open.

The operational parameters for the 20mA current loop adapter are:

Current: 20mA minimum
Open Loop Voltage: 40 V maximum
Cable Interface: 2000 ft. maximum at 9600 baud

The current source must be provided externally to the terminal.

The pin numbers and signals for the 20mA current loop adapter are as follows:

Pin Number	Designation	Function
5	SILP-	Received Data
6	SIHP+	Received Data
12	SOHP+	Transmitted Data
13	SOL-	Transmitted Data

SOHP means Serial Out High Passive
SOL means Serial Out Low
SIHP means Serial In High Passive
SILP means Serial In Low Passive

Chapter 7

DIAGNOSTICS

7.1 INTRODUCTION

Each terminal is capable of performing self-diagnostic tests when operating in diagnostic mode. In this mode, the terminal displays a menu of diagnostic tests for the operator to select from. If a problem is found, an error message will be shown on the video display.

7.2 DIAGNOSTICS

To enter the Diagnostics Menu, type "2" when the Main Menu is displayed. The Diagnostics Menu can be activated by pressing the appropriate key. When a selected test is completed, the Diagnostics Menu will be re-displayed.

```
          Diagnostics

         1) RAM
         2) ROM Checksum
         3) Character Attributes
         4) Serial Loop Back
         5) CRT Alignment Pattern
         6) CRT Brightness Pattern
         7) Continuous test
         8) Character Generator Test

<RET> or <ENTER> to quit
  >_
```

Figure 7-1 Diagnostics Menu

1) RAM:

If the RAM test is selected, the terminal will check the CPU RAM (8031 RAM). After checking the 8031 RAM the terminal will display one of the following messages:

8031 RAM OK
or
8031 RAM failure

The next test checks the external RAM or the serial input buffer. After testing the external RAM, the terminal displays one of these messages:

External RAM OK
or
External RAM failure ab/cd wxyz

The terminal will then test the display RAM, during which a pattern will be flashed on the video display followed by one of the messages:

Display RAM OK
or
Display RAM failure ab/cd wxyz

where ab is the byte read from the failed memory address, cd is the byte that was written to the failed memory address, and wxyz is the failed memory address. All of these numbers are in hexadecimal format.

The terminal will then test the attribute RAM, again flashing a pattern on the video display followed by one of the messages:

Attribute RAM 0 OK
or
Attribute RAM 0 failure ab/cd wxyz

where ab/cd wxyz has the same meaning as for the display RAM message.

2) ROM checksum:

Shows "ROM checksum is: nnnn Should be: mmmm" on status line. The two checksums listed should match.

3) Character attributes:

The status line shows: Reverse Video, Highlight, Underline, Blink, and Double Wide. Each word or phrase on the status line should be displayed with its corresponding attribute.

4) Serial loop back:

The serial port on the terminal can be tested by selecting #4 from the diagnostic menu "Serial loop back test". In order for the "loop back" test to function properly, the serial port must have certain signals looped-back for signal verification. The recommended means for looping signals is via construction of a loop-back connector using a DB-25 connector, and several jumper wires (or solder bridges). Figure 7-2 shows the jumper configuration for the construction of a loop-back plug which can be used to test the serial port.

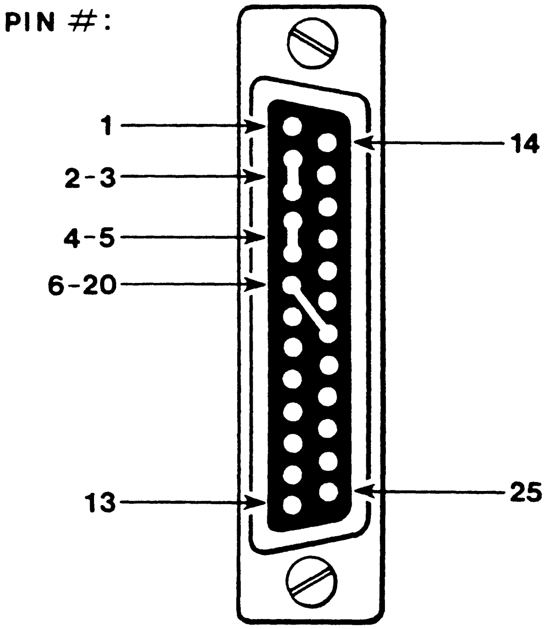


Figure 7-2 Serial Port Test Plug

If the serial port is operating correctly, the terminal will display the message:

Controller serial port OK.

If an error is found, the terminal will display one of the following messages:

Controller port time out err.
Controller port serial data err.
Controller port CTS-RTS err.
Controller port DTR-DSR err.

5) CRT alignment pattern:

Shows alignment grid on video display until a key is pressed.

6) CRT brightness pattern:

Displays foreground spaces on the entire screen.

7) Continuous test:

In this mode, the terminal continuously cycles through the RAM, serial port, and ROM tests. If an error is found, the terminal stops testing and displays an appropriate error message along with the prompt:

Press any key to continue.

If a key is then pressed, testing will continue.

To exit the continuous test mode, press any key several times.

8) Character Generator test:

Displays all displayable characters, including the block and bar graphics characters. Pressing any key will cause the following screens to be displayed:

- double-high characters
- quad-size special characters and numbers
- upper-case quad-size
- lower-case quad-size
- process control graphics (large)
- process control graphics (small)

Appendix A

TERMINAL MOUNTING DIMENSIONS

A.1 PANEL-MOUNTING THE 4810E TERMINAL

Figure A-1 shows how a panel should be cut and drilled to panel-mount a 4810E terminal. Note that the 1/4 inch holes in the panel will accommodate the 10-32 studs on the back of the terminal front panel.

A.2 RACK-MOUNTING THE 4810ER and 4810ER/DC TERMINALS

Figure A-1 shows the locations of the studs on the back of the terminal front panel. Since these studs are threaded, the terminal is designed to be installed in a rack in which the holes are not threaded. If the rack has threaded holes, they must be drilled out. Using a #3 bit (.213 inches) will provide clearance for the 10-32 studs.

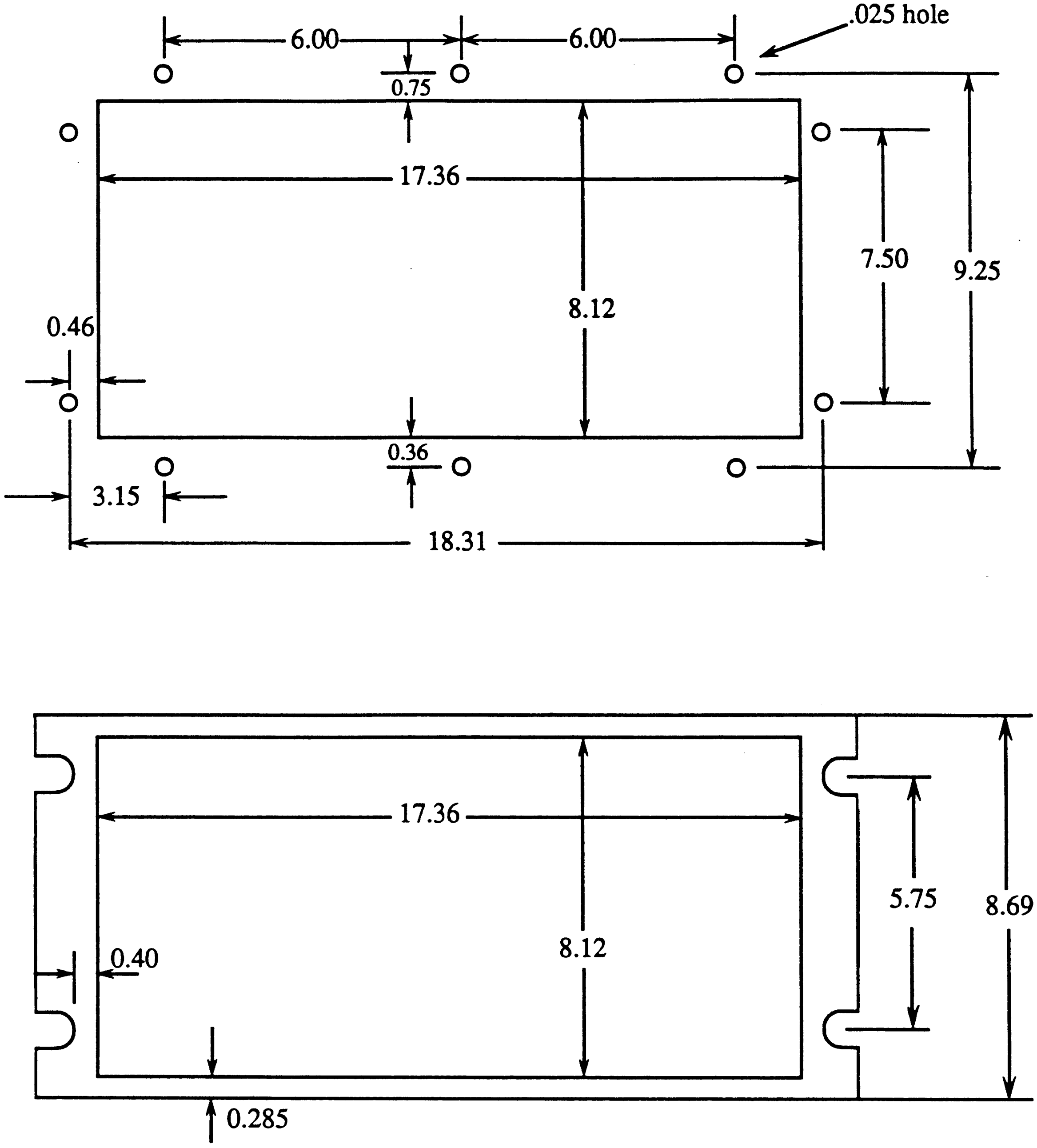


Figure A-1 Panel Cutout and Stud Locations for the 4810

A.3 PANEL-MOUNTING THE 4860 TERMINAL

Figure A-2 shows how a panel should be cut and drilled to panel-mount a 4810E terminal. Note that the 1/4 inch holes in the panel will accommodate the 10-32 studs on the back of the terminal front panel.

A.4 RACK-MOUNTING THE 4860 TERMINALS

Figure A-2 shows the locations of the studs on the back of the terminal front panel. Since these studs are threaded, the terminal is designed to be installed in a rack in which the holes are not threaded. If the rack has threaded holes, they must be drilled out. Using a #3 bit (.213 inches) will provide clearance for the 10-32 studs.

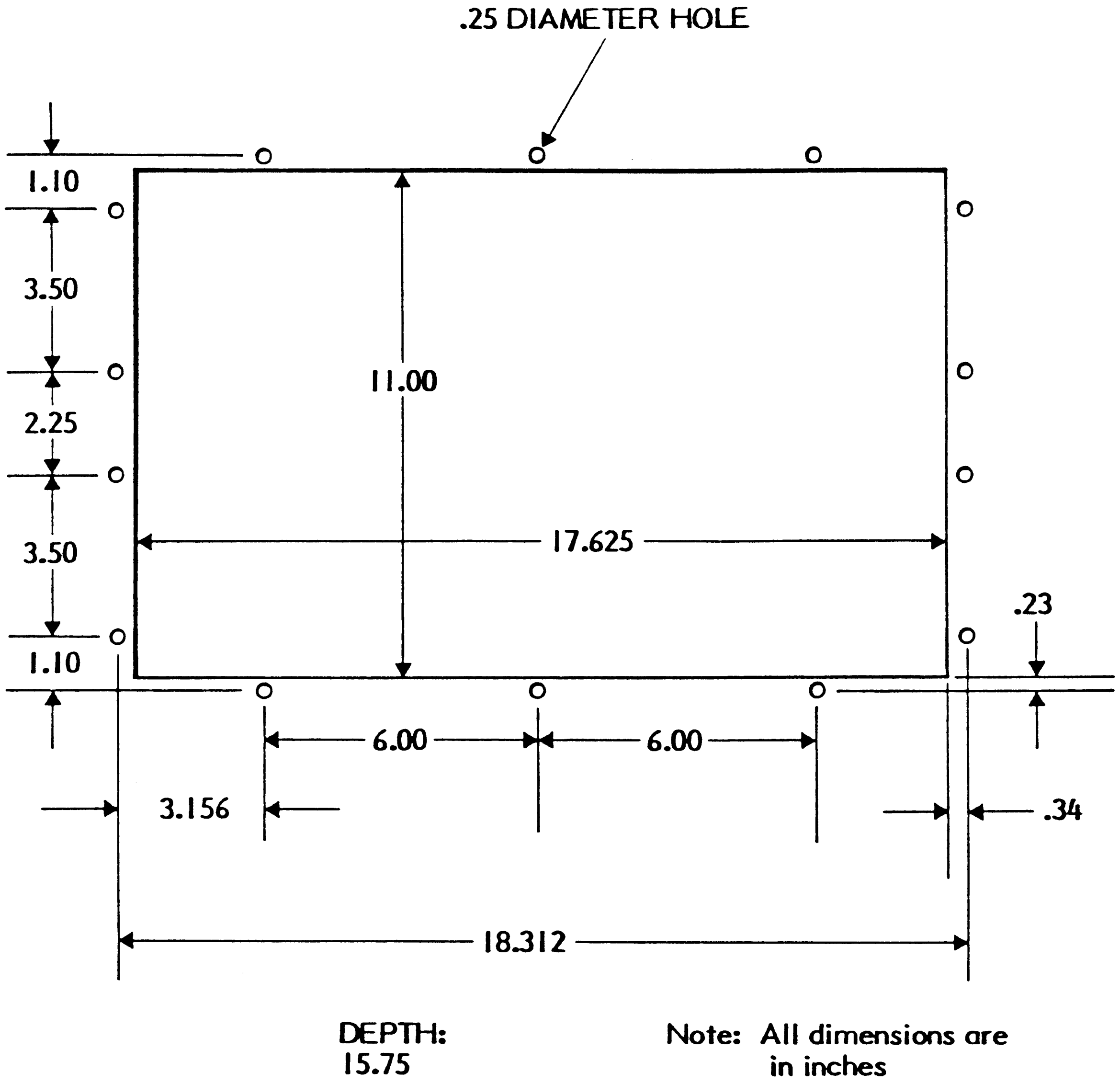


Figure A-2 Panel Cutout and Stud Locations for the 4860

Appendix B

VT100/220 CODES NOT SUPPORTED

The Industrial Terminal supports all VT100 codes except for those listed in this Section. If these codes are received by the terminal, they will be ignored.

Control Characters Not Supported

05	- transmit answer back message
0E	- select G1 character set
0F	- select GO character set

Digital Equipment Corporation Private Configuration Commands Not Supported

ESC [? 1 h	- enable application interp. of cursor keys
ESC [? 2 h	- enable ANSI mode
ESC [? 3 h	- enable 132 column mode
ESC [? 5 h	- enable reverse screen mode
ESC [? 6 h	- enable origin mode
ESC [? 8 h	- enable auto repeat
ESC [? 9 h	- enable interlace
ESC [? 18 h	- print form feed enabled
ESC [? 19 h	- full screen print extent
ESC [? 42 h	- national character set
ESC [? 1 l	- disable application interp. of cursor keys
ESC [? 2 l	- enable VT52 mode
ESC [? 3 l	- enable 80 column mode
ESC [? 5 l	- enable normal screen
ESC [? 6 l	- enable absolute mode
ESC [? 8 l	- disable auto repeat
ESC [? 9 l	- disable interlace
ESC [? 18 l	- print form feed disable
ESC [? 19 l	- scrolling region print extent
ESC [? 42 l	- multinational character set

Configuration Commands Not Supported

ESC [4 h	- insert mode enable
ESC [12 h	- local echo disabled
ESC [4 l	- replace mode enable
ESC [12 l	- local echo enabled

Select Characters Set Codes Not Supported

ESC (A	- UK G0
ESC (B	- US ASCII G0
ESC (0	- special chars and lines G0
ESC (1	- alternate ROM G0
ESC (2	- alternate ROM and special graphics G0
ESC (A	- UK G1
ESC (B	- US ASCII G1
ESC (0	- special chars and lines G1
ESC (1	- alternate ROM G1
ESC (2	- alternate ROM and special graphics G1
ESC N	- single shift 2
ESC O	- single shift 3

Scrolling Region Command Not Supported

ESC [pt;pb r	- Set top and bottom margin

Line Attribute Commands Not Supported

ESC # 3	- double-high top half
ESC # 4	- double-high bottom half
ESC # 5	- single-wide, single-high
ESC # 6	- double-wide, single-high
ESC # 8	- fill screen with e's

Test Commands Not Supported

ESC [1;1 y	- invoke power-up test
ESC [2;2 y	- data loopback test
ESC [2;9 y	- continuous power-up testing
ESC [2;10 y	- continuous loopback test

Keyboard LED Commands Not Supported

ESC [0 q	- all LEDs off
ESC [1 q	- LED 1 on
ESC [2 q	- LED 2 on
ESC [3 q	- LED 3 on
ESC [4 q	- LED 4 on

Aux Keypad Codes in Application Mode Not Generated

-	- ESC 0 m
,	- ESC 0 l

Report Commands Not Supported

ESC [? 15n	- what is printer status
ESC [? 25n	- what is status of user-defined keys
ESC [? 26n	- what is keyboard language

Appendix C

PROCESS GRAPHICS CHART

Appendix C (Table C-2) shows the symbols displayed in the various character set modes.

In general, a character or a number representing a character (character code) is sent to the display. The symbol displayed depends on the character set selected.

The characters and the corresponding character codes are shown along the top axis of the table.

The character set choices are shown along the left axis of the table. The designation of the character set differs depending on whether or not a XYCOM Expansion Module with Operator Interface Language (OIL) is installed in the terminal.

If the OIL option is not installed, the base terminals Character Set is selected. The table's Base Terminal character set is indicated along the left axis using attribute Byte 2, bits 2-0, and attribute byte 1, bit 1 (See Table C-1).

Table C-1

Attribute Bytes 2 and 1
Base Terminal Character Sets

	Attribute Byte 2 Bits 2 - 0	Byte 1 Bit 1	Set/Reset Attribute Code
Regular	000	0	50
Double-Wide	000	1	54
Double-High	001	0	51
Double-Size	001	1	55
Quad-Size	010	0	52
Process Graphics	011	0	53
Utility Graphics	111	0	57

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		00	01	02	03	04	05	06	07	08
DECIMAL		0	1	2	3	4	5	6	7	8
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	NU	SH	SX	EX	ET	EQ	AK	BL	BS
000**[2]	DW	NU	SH	SX	EX	ET	EQ	AK	BL	BS
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

1 - ONLY DISPLAYABLE WHEN CONFIGURATION OPTION "DISPLAY CONTROL CODES" IS ENABLED

2 - NOT POSSIBLE ON BASE TERMINAL

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		09	0A	0B	0C	0D	0E	0F	10	11
DECIMAL		9	10	11	12	13	14	15	16	17
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	$^{H}{}_{T}$	$^{L}{}_{F}$	$^{V}{}_{T}$	$^{F}{}_{F}$	$^{C}{}_{R}$	$^{S}{}_{O}$	$^{S}{}_{I}$	$^{D}{}_{L}$	$^{D}{}_{1}$
000**[2]	DW	$^{H}{}_{T}$	$^{L}{}_{F}$	$^{V}{}_{T}$	$^{F}{}_{F}$	$^{C}{}_{R}$	$^{S}{}_{O}$	$^{S}{}_{I}$	$^{D}{}_{L}$	$^{D}{}_{1}$
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

1 - ONLY DISPLAYABLE WHEN CONFIGURATION OPTION "DISPLAY CONTROL CODES" IS ENABLED

2 - NOT POSSIBLE ON BASE TERMINAL

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		12	13	14	15	16	17	18	19	1A
DECIMAL		18	19	20	21	22	23	24	25	26
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	D_2	D_3	D_4	N_K	S_Y	E_B	C_N	E_M	S_B
000**[2]	DW	D_2	D_3	D_4	N_K	S_Y	E_B	C_N	E_M	S_B
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

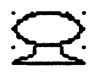
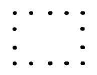
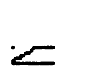
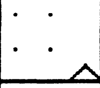
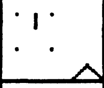
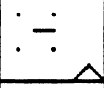
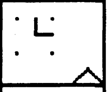
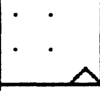
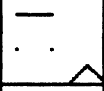
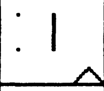
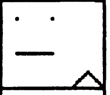
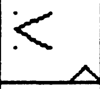
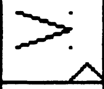
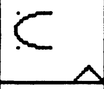
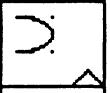
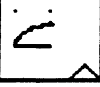
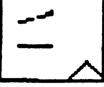
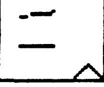
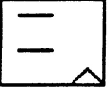
1 - ONLY DISPLAYABLE WHEN CONFIGURATION OPTION "DISPLAY CONTROL CODES" IS ENABLED

2 - NOT POSSIBLE ON BASE TERMINAL

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	SPACE	!	"	#
HEXIDECIMAL		1B	1C	1D	1E	1F	20	21	22	23
DECIMAL		27	28	29	30	31	32	33	34	35
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	E_C (1)	F_S (1)	G_S (1)	R_S (1)	U_S (1)	SPACE	!	"	#
000**[2]	DW	E_C (2)	F_S (2)	G_S (2)	R_S (2)	U_S (2)	SPACE	!	"	#
001	DH						SPACE	!	"	#
001**	DS						SPACE	!	"	#
010	QS						SPACE	!	"	#
011	G1						SPACE			
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

1 - ONLY DISPLAYABLE WHEN CONFIGURATION OPTION "DISPLAY CONTROL CODES" IS ENABLED

2 - NOT POSSIBLE ON BASE TERMINAL

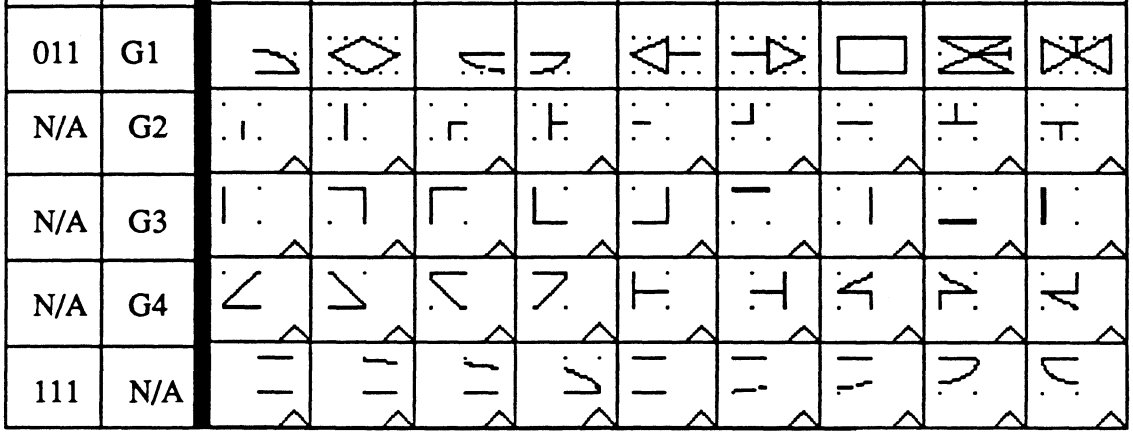
* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		$	%	&	'	(	)	*	+	,
HEXIDECIMAL		24	25	26	27	28	29	2A	2B	2C
DECIMAL		36	37	38	39	40	41	42	43	44
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.	$	%	&	'	(	)	*	+	,
000**$_2$	DW	$	%	&	'	(	)	*	+	,
001	DH	$	%	&	'	(	)	*	+	,
001**	DS	$	%	&	'	(	)	*	+	,
010	QS	$	%	&	'	(	)	*	+	,



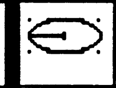
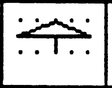
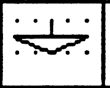
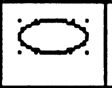
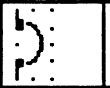
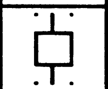
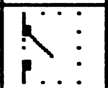
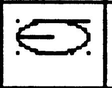
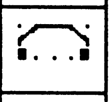
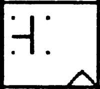
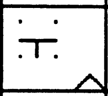
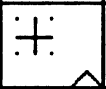
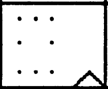
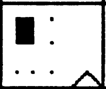
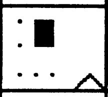
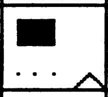
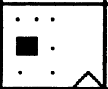
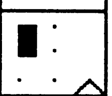
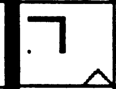
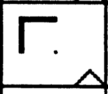
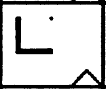
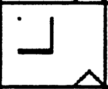
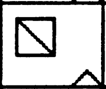
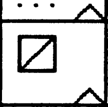
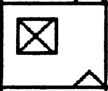
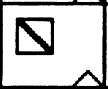
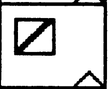
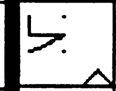
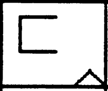
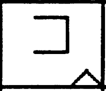
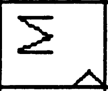
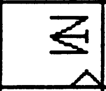
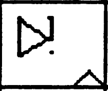
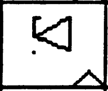
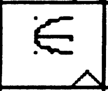
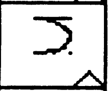
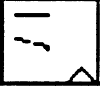
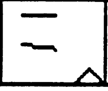
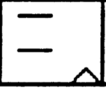
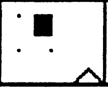
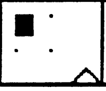
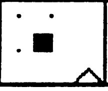
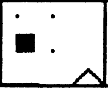
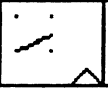
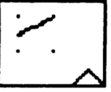
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		-	.	/	0	1	2	3	4	5
HEXIDECIMAL		2D	2E	2F	30	31	32	33	34	35
DECIMAL		45	46	47	48	49	50	51	52	53
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	-	.	/	Ø	1	2	3	4	5
000**[2]	DW	-	.	/	Ø	1	2	3	4	5
001	DH	-	.	/	Ø	1	2	3	4	5
001**	DS	-	.	/	Ø	1	2	3	4	5
010	QS	-	.	/	Ø	1	2	3	4	5
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

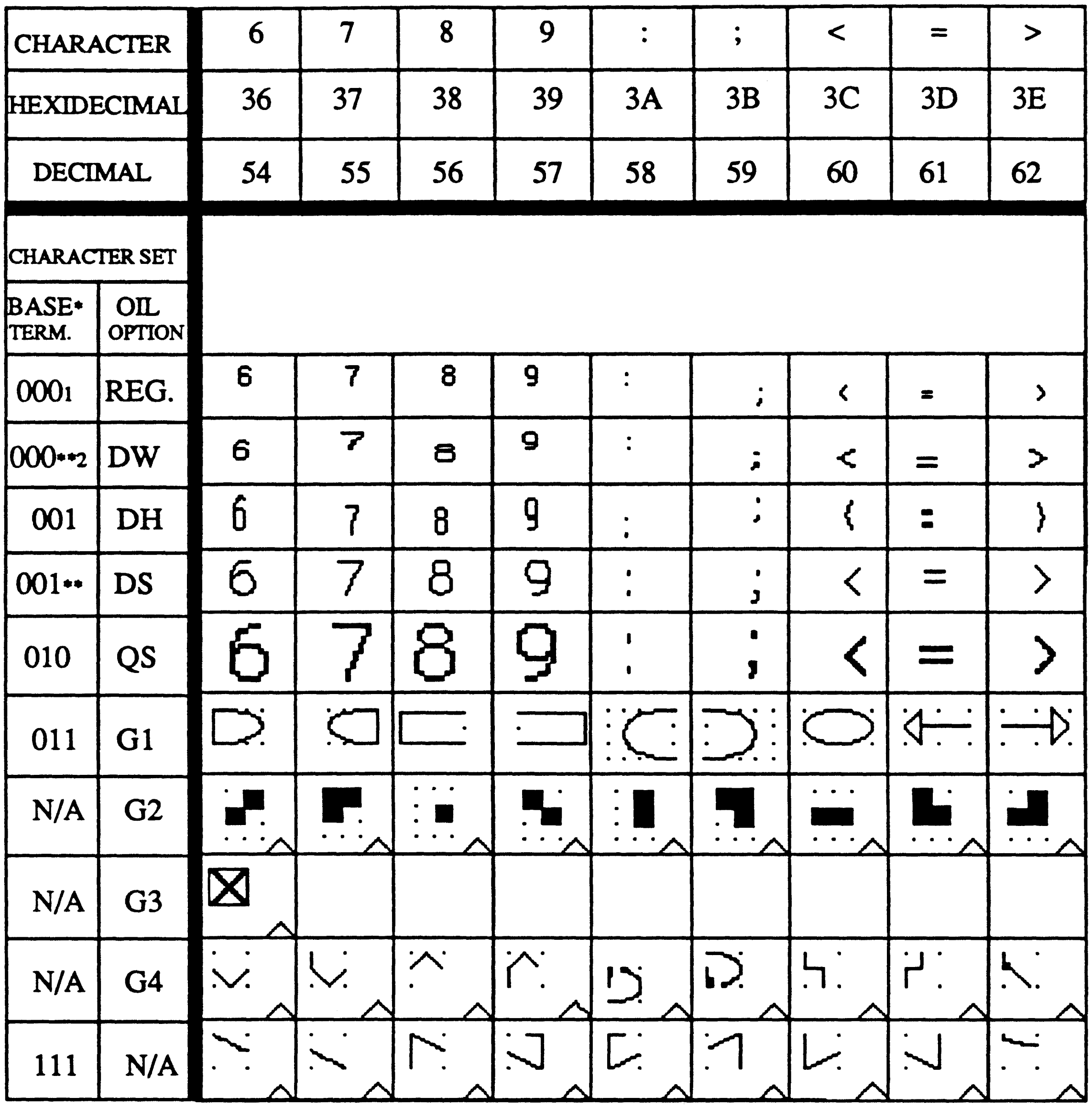
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart



CHARACTER		6	7	8	9	:	;	<	=	>
HEXIDECIMAL		36	37	38	39	3A	3B	3C	3D	3E
DECIMAL		54	55	56	57	58	59	60	61	62
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.	6	7	8	9	:	;	<	=	>
000**2	DW	6	7	8	9	:	;	<	=	>
001	DH	6	7	8	9	:	;	{	:	}
001**	DS	6	7	8	9	:	;	<	=	>
010	QS	6	7	8	9	:	;	<	=	>
011	G1									
N/A	G2									
N/A	G3	☒								
N/A	G4									
111	N/A									

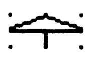
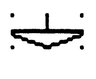
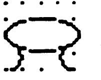
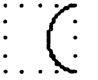
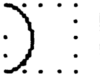
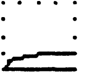
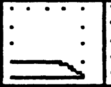
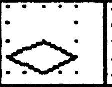
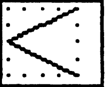
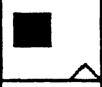
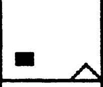
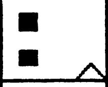
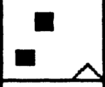
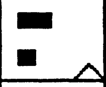
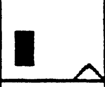
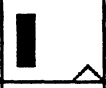
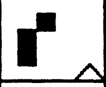
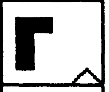
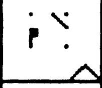
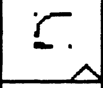
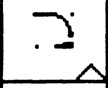
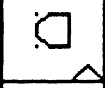
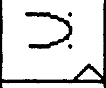
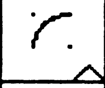
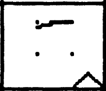
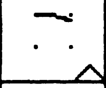
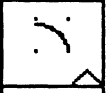
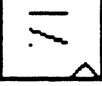
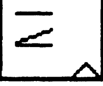
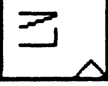
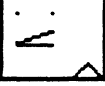
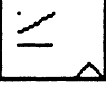
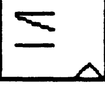
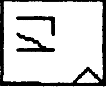
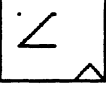
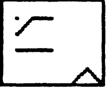
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		?	@	A	B	C	D	E	F	G
HEXIDECIMAL		3F	40	41	42	43	44	45	46	47
DECIMAL		63	64	65	66	67	68	69	70	71
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.	?	@	A	B	C	D	E	F	G
000**2	DW	?	@	A	B	C	D	E	F	G
001	DH	?	@	A	B	C	D	E	F	G
001**	DS	?	@	A	B	C	D	E	F	G
010	QS	?	@	A	B	C	D	E	F	G
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

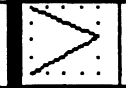
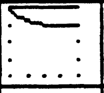
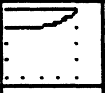
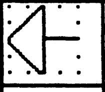
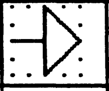
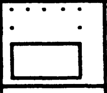
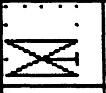
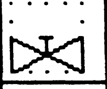
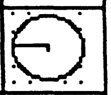
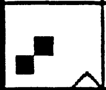
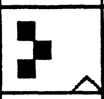
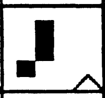
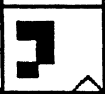
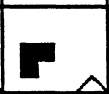
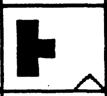
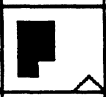
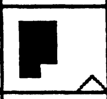
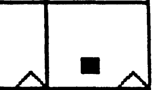
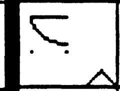
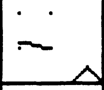
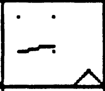
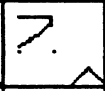
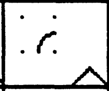
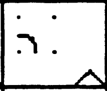
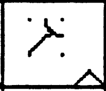
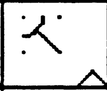
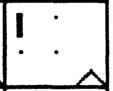
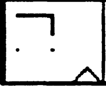
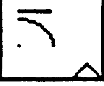
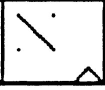
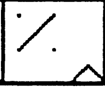
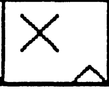
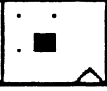
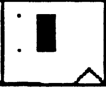
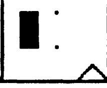
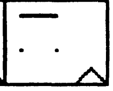
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		H	I	J	K	L	M	N	O	P
HEXIDECIMAL		48	49	4A	4B	4C	4D	4E	4F	50
DECIMAL		72	73	74	75	76	77	78	79	80
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.	H	I	J	K	L	M	N	O	P
000**2	DW	H	I	J	K	L	M	N	O	P
001	DH	H	I	J	K	L	M	N	O	P
001**	DS	H	I	J	K	L	M	N	O	P
010	QS	H	I	J	K	L	M	N	O	P
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

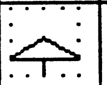
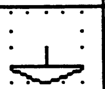
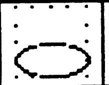
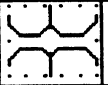
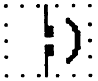
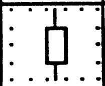
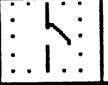
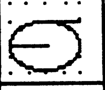
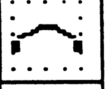
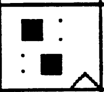
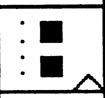
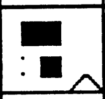
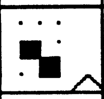
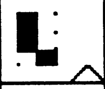
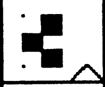
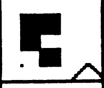
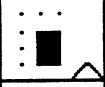
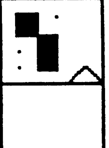
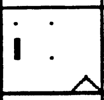
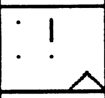
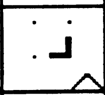
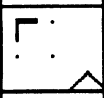
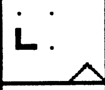
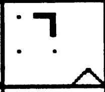
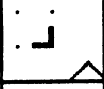
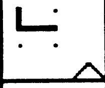
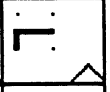
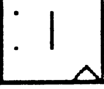
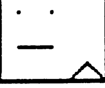
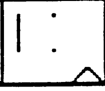
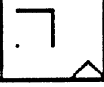
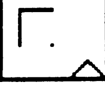
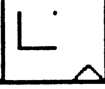
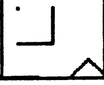
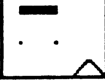
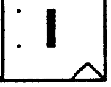
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		Q	R	S	T	U	V	W	X	Y
HEXIDECIMAL		51	52	53	54	55	56	57	58	59
DECIMAL		81	82	83	84	85	86	87	88	89
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.	Q	R	S	T	U	V	W	X	Y
000**$_2$	DW	Q	R	S	T	U	V	W	X	Y
001	DH	Q	R	S	T	U	V	W	X	Y
001**	DS	Q	R	S	T	U	V	W	X	Y
010	QS	Q	R	S	T	U	V	W	X	Y
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

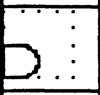
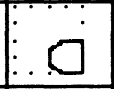
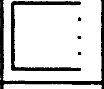
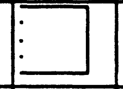
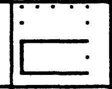
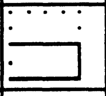
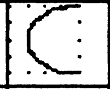
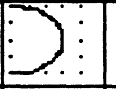
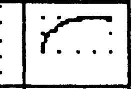
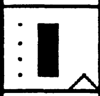
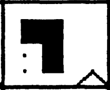
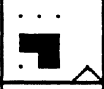
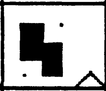
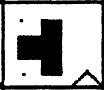
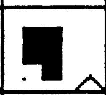
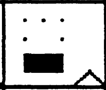
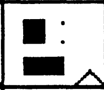
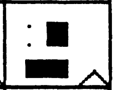
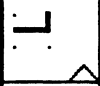
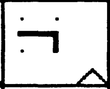
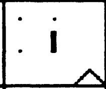
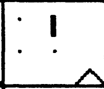
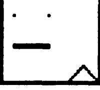
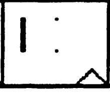
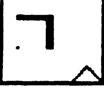
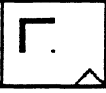
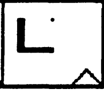
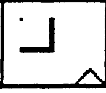
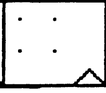
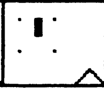
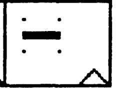
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		Z	[	\	]		_	`	a	b
HEXIDECIMAL		5A	5B	5C	5D	5E	5F	60	61	62
DECIMAL		90	91	92	93	94	95	96	97	98
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.	z	[	\	]	^	_	`	a	b
000**$_2$	DW	z	[	\	]	^	_	`	a	b
001	DH	z	[	\	]	^	_	`	a	b
001**	DS	Z	[	\	]	^	_	`	a	b
010	QS	Z	[	\	]	^	_	`	a	b
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

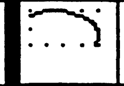
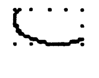
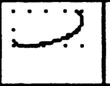
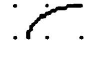
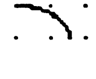
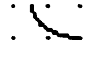
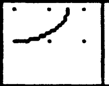
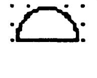
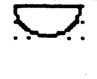
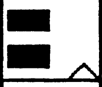
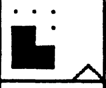
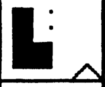
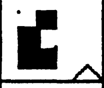
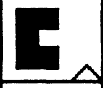
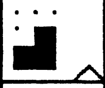
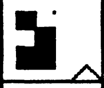
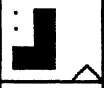
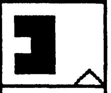
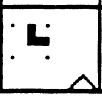
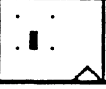
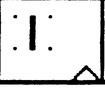
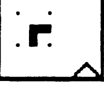
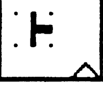
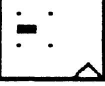
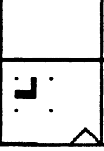
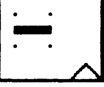
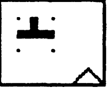
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		c	d	e	f	g	h	i	j	k
HEXIDECIMAL		63	64	65	66	67	68	69	70	71
DECIMAL		99	100	101	102	103	104	105	106	107
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.	c	d	e	f	g	h	i	j	k
000**2	DW	c	d	e	f	g	h	i	j	k
001	DH	c	d	e	f	g	h	i	j	k
001**	DS	c	d	e	f	g	h	i	j	k
010	QS	c	d	e	f	g	h	i	j	k
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

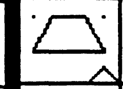
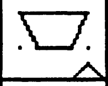
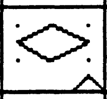
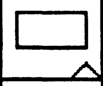
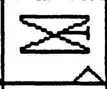
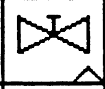
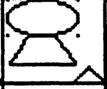
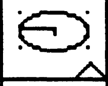
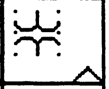
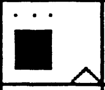
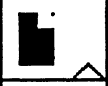
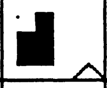
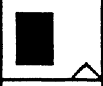
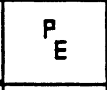
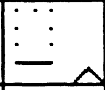
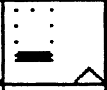
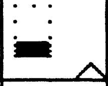
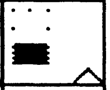
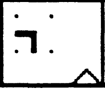
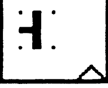
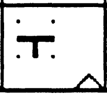
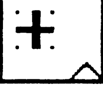
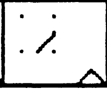
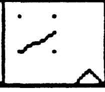
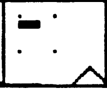
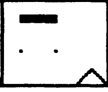
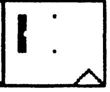
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		l	m	n	o	p	q	r	s	t
HEXIDECIMAL		6C	6D	6E	6F	70	71	72	73	74
DECIMAL		108	109	110	111	112	113	114	115	116
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	l	m	n	o	p	q	r	s	t
000**[2]	DW	l	m	n	o	p	q	r	s	t
001	DH	l	m	n	o	p	q	r	s	t
001**	DS	l	m	n	o	p	q	r	s	t
010	QS	l	m	n	o	p	q	r	s	t
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

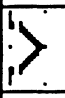
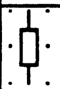
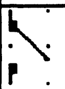
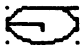
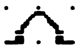
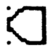
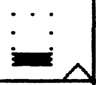
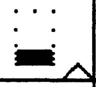
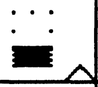
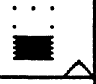
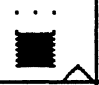
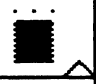
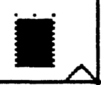
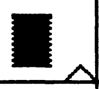
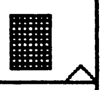
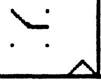
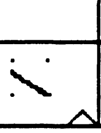
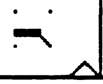
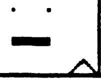
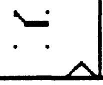
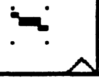
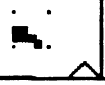
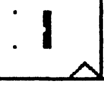
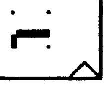
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		u	v	w	x	y	z	{		}
HEXIDECIMAL		75	76	77	78	79	7A	7B	7C	7D
DECIMAL		117	118	119	120	121	122	123	124	125
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.	u	v	w	x	y	z	{	¦	}
000**$_2$	DW	u	v	w	x	y	z	{	|	}
001	DH	u	v	w	x	y	z	{	¦	}
001**	DS	u	v	w	x	y	z	{	¦	}
010	QS	u	v	w	x	y	z	{	¦	}
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		~	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		7E	7F	80	81	82	83	84	85	86
DECIMAL		126	127	128	129	130	131	132	133	134
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.	~			╵ △	– △	└ △	╷ △	| △	┌ △
000**[2]	DW	~			╵	–	└	╷	|	┌
001	DH	~								
001**	DS	~								
010	QS	~								
011	G1									
N/A	G2	▓ △	█ △	█ △	▔ △	▀ △	▀ △	■ △	■ △	■ △
N/A	G3									
N/A	G4									
111	N/A	▄▀ △	▀▀ △	< △	> △	ᗡ △	D △	∠ △	⦣ △	⦦ △

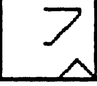
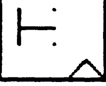
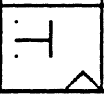
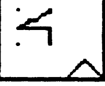
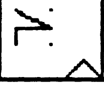
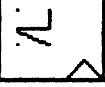
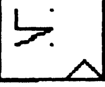
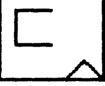
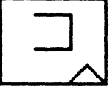
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		87	88	89	8A	8B	8C	8D	8E	8F
DECIMAL		135	136	137	138	139	140	141	142	143
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000₁	REG.	├ △	─ △	┘ △	─ △	┴ △	┐ △	┤ △	┬ △	┼ △
000**₂	DW	├	─	┘	─	┴	┐	┤	┬	┼
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2	▄ △	▄ △	▅ △	▅ △	▆ △	▇ △	▒ △	▦ △	█ △
N/A	G3									
N/A	G4									
111	N/A									

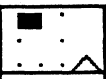
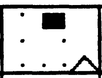
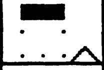
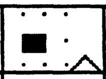
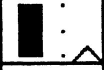
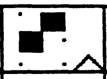
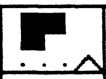
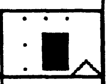
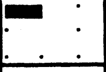
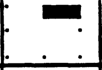
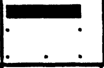
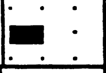
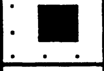
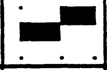
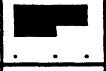
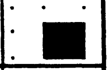
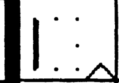
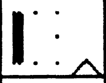
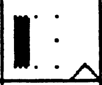
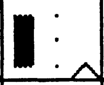
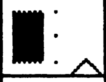
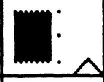
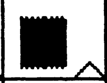
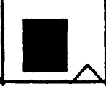
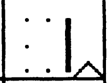
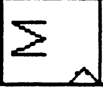
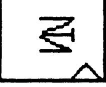
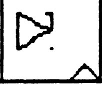
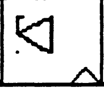
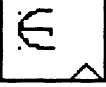
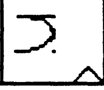
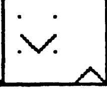
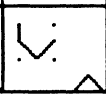
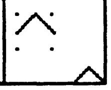
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		90	91	92	93	94	95	96	97	98
DECIMAL		144	145	146	147	148	149	150	151	152
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

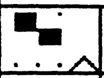
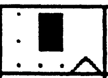
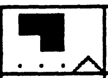
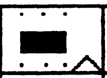
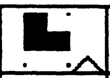
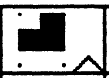
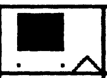
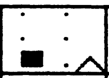
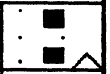
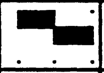
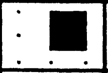
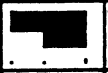
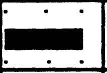
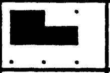
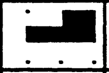
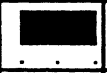
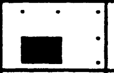
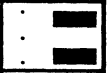
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		99	9A	9B	9C	9D	9E	9F	A0	A1
DECIMAL		153	154	155	156	157	158	159	160	161
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
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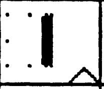
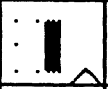
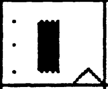
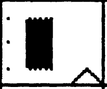
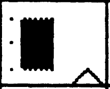
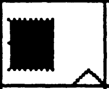
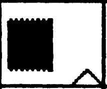
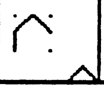
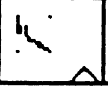
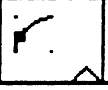
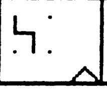
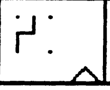
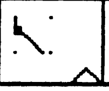
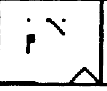
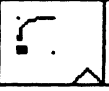
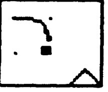
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

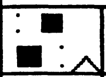
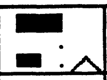
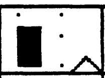
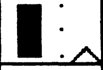
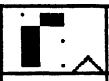
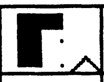
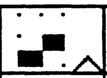
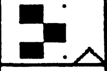
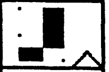
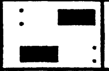
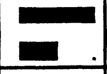
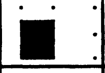
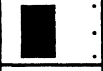
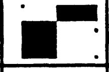
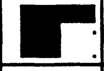
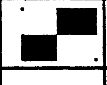
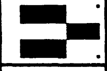
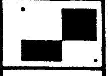
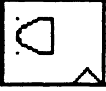
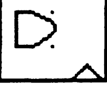
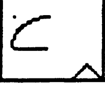
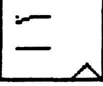
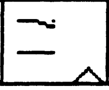
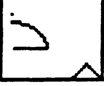
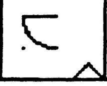
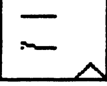
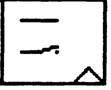
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		A2	A3	A4	A5	A6	A7	A8	A9	AA
DECIMAL		162	163	164	165	166	167	168	169	170
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

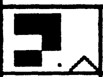
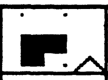
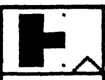
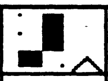
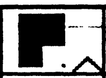
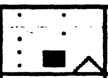
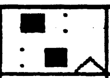
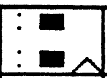
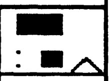
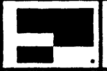
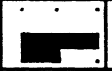
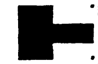
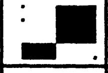
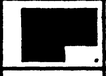
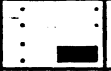
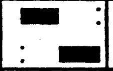
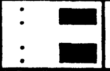
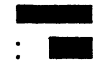
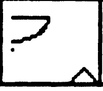
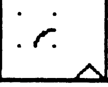
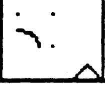
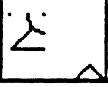
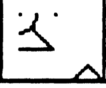
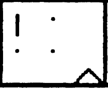
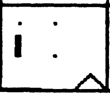
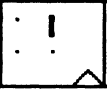
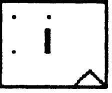
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		AB	AC	AD	AE	AF	BO	B1	B2	B3
DECIMAL		171	172	173	174	175	176	177	178	179
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000_1	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

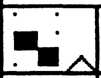
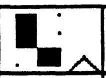
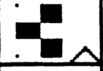
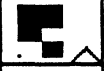
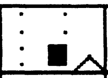
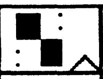
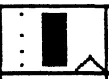
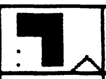
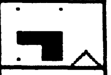
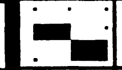
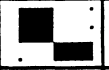
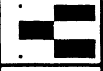
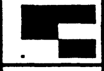
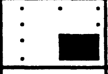
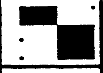
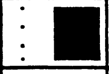
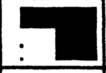
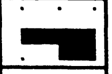
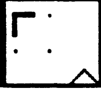
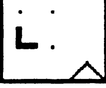
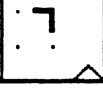
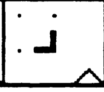
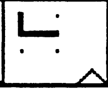
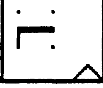
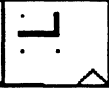
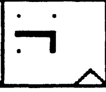
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		B4	B5	B6	B7	B8	B9	BA	BB	BC
DECIMAL		180	181	182	183	184	185	186	187	188
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

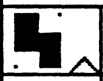
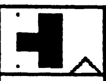
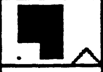
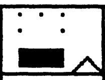
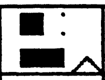
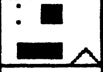
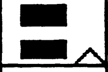
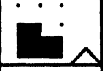
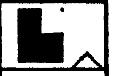
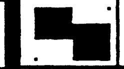
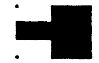
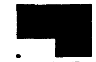
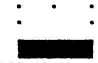
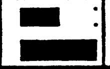
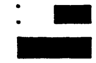
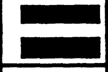
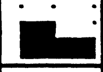
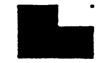
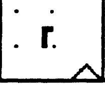
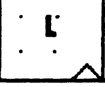
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE.

△ - CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		BD	BE	BF	CO	C1	C2	C3	C4	C5
DECIMAL		189	190	191	192	193	194	195	196	197
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

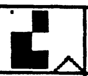
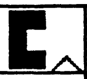
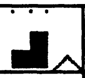
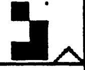
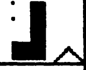
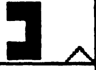
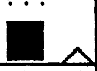
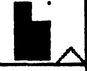
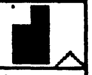
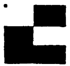
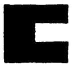
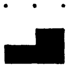
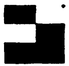
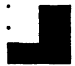
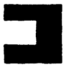
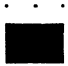
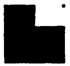
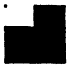
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		C6	C7	C8	C9	CA	CB	CC	CD	CE
DECIMAL		198	199	200	201	202	203	204	205	206
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		CF	D0	D1	D2	D3	D4	D5	D6	D7
DECIMAL		207	208	209	210	211	212	213	214	215
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.	█△	PE	▁△	▂△	▃△	▄△	▅△	▆△	▇△
000**2	DW	█	P E	▁	▂	▃	▄	▅	▆	▇
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

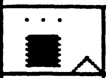
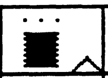
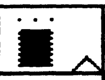
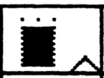
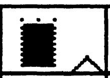
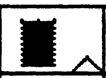
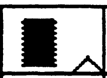
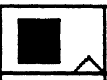
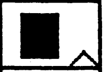
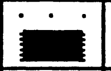
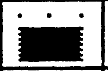
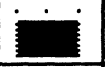
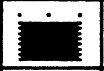
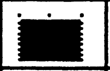
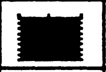
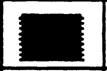
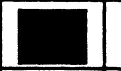
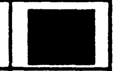
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		D8	D9	DA	DB	DC	DD	DE	DF	E0
DECIMAL		216	217	218	219	220	221	222	223	224
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_1$	REG.									
000**$_2$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

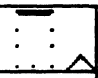
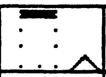
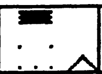
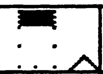
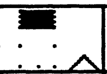
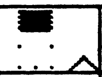
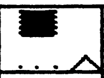
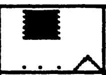
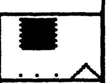
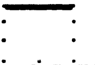
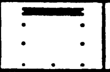
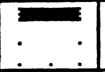
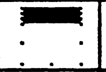
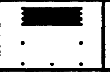
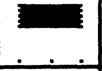
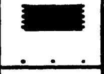
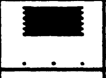
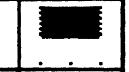
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		E1	E2	E3	E4	E5	E6	E7	E8	E9
DECIMAL		225	226	227	228	229	230	231	232	233
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000[1]	REG.									
000**[2]	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

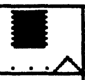
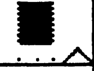
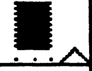
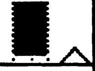
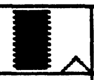
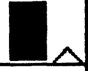
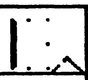
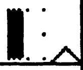
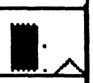
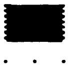
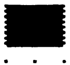
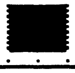
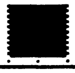
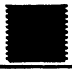
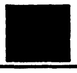
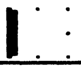
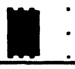
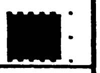
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		EA	EB	EC	ED	EE	EF	F0	F1	F2
DECIMAL		234	235	236	237	238	239	240	241	242
CHARACTER SET										
BASE* TERM.	OIL OPTION									
000$_{1}$	REG.									
000**$_{2}$	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

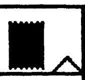
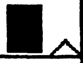
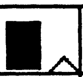
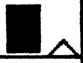
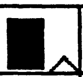
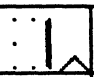
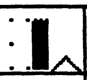
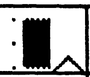
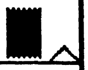
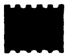
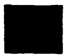
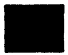
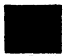
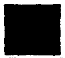
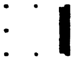
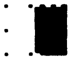
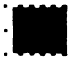
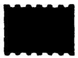
NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
HEXIDECIMAL		F3	F4	F5	F6	F7	F8	F9	FA	FB
DECIMAL		243	244	245	246	247	248	249	250	251
CHARACTER SET										
BASE* TERM.	OIL OPTION									
0001	REG.									
000**2	DW									
001	DH									
001**	DS									
010	QS									
011	G1									
N/A	G2									
N/A	G3									
N/A	G4									
111	N/A									

NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Table C-2 Process Graphics Chart

CHARACTER	NONE	NONE	NONE	NONE					
HEXIDECIMAL	FC	FD	FE	FF					
DECIMAL	252	253	254	255					

CHARACTER SET					
BASE* TERM.	OIL OPTION				
000$_1$	REG.	▮△	▮△	▮△	▮△
000**$_2$	DW	■	■	■	■
001	DH				
001**	DS				
010	QS				
011	G1				
N/A	G2				
N/A	G3				
N/A	G4				
111	N/A				

NOTES:

* - ATTRIBUTE BYTE 2, BITS 2-0

** - ATTRIBUTE BYTE 1, BIT 1 MUST BE SET FOR THIS MODE

△- CHARACTER CELL SHOWN LARGER THAN ACTUAL SIZE

Appendix D

INSTALLATION OF OPTIONS

D.1 INTRODUCTION

This appendix contains the installation information on all of the optional equipment available for the Xycom Industrial Terminals. These include:

- 4800-ME2 Memory Expansion Module
- RS-422 Communication Adapter Module
- RS-485 Communication Adapter Module
- 20mA Current Loop Adapter Module

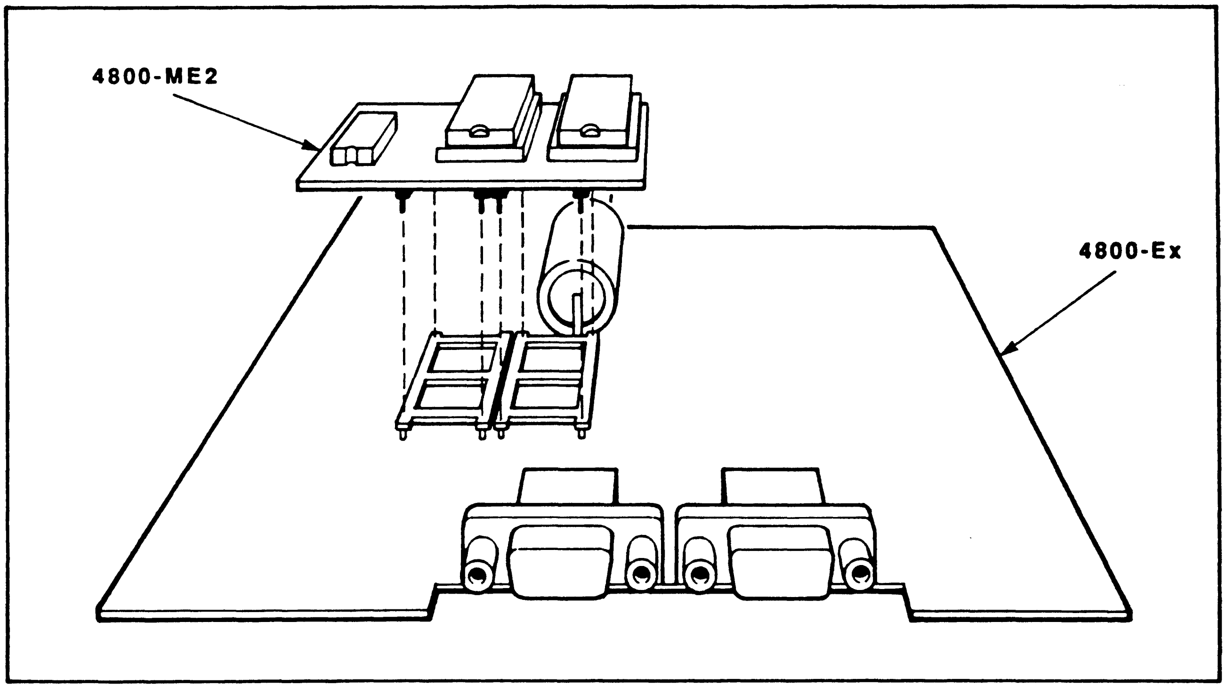
The 4800-series Expansion Modules are optionally available for the 4810 and 4860. The installation instructions can be found in the respective manuals for each product. The 4800-ME2 requires that one of these expansion modules be installed.

CAUTION

Do not kink or twist the ribbon cables involved in any of these installation procedures.

D.2 4800-ME2 MEMORY EXPANSION MODULE

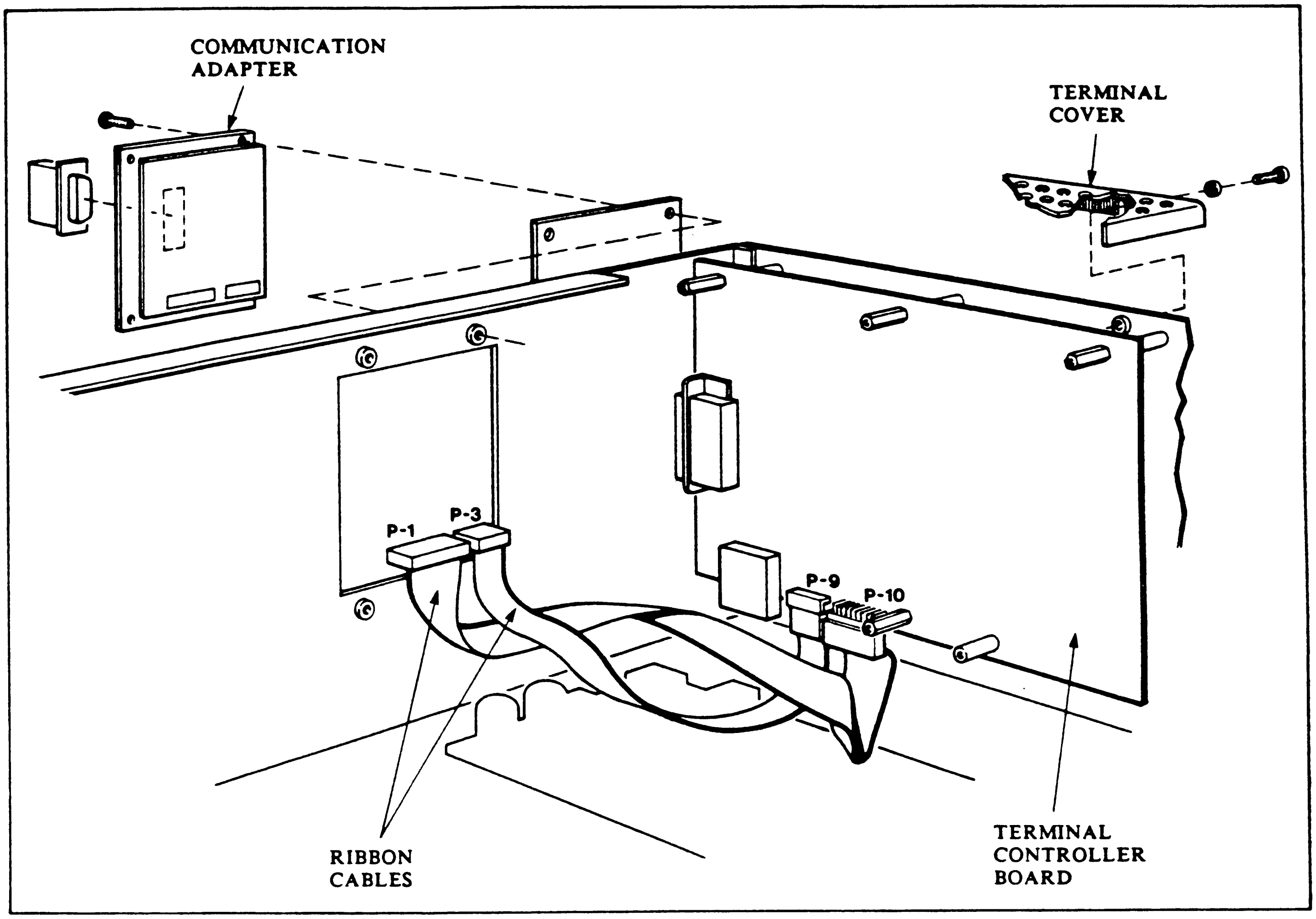
The 4800-ME2 Memory Expansion Module "piggy-backs" onto an existing 4800-series Expansion Modle (e.g., 4800-E8). IC U21 and IC U15 are removed, and the 4800-ME2 is inserted into the open IC sockets. Install per the illustration below.



4800-ME2 Memory Expansion Card Installation

D.3 COMMUNICATION ADAPTER MODULES

The RS-485, RS-422, and 20mA Modules are all installed in the same manner. They attach to the rear wall of the terminal, after the blank is removed. Two ribbon cables are provided with the communication adapter module. Install per the illustration below.



Communication Module Installation

Appendix E

QUICK REFERENCE GUIDE

Table E-1 Membrane Keypad ASCII Codes
(4810E and 4860) Normal Mode

Key	Hexadecimal Code	ASCII Code	Notes
0	30	0	
1	31	1	
2	32	2	
3	33	3	
4	34	4	
5	35	5	
6	36	6	
7	37	7	
8	38	8	
9	39	9	
A	41	A	
B	42	B	
C	43	C	
D	44	D	
E	45	E	
F	46	F	
F1	47	G	
F2	48	H	
F3	49	I	
F4	4A	J	
F5	4B	K	
F6	4C	L	
PF1	4D	M	4860A ONLY
PF2	4E	N	
PF3	4F	O	
PF4	50	P	
PF5	51	Q	
PF6	52	R	
PF7	53	S	
PF8	54	T	
PF9	55	U	
PF10	56	V	
.	2E	.	
ENTER	0D	<CR>	
	Hazeltine	ANSI	
↑	7E 0C	<ESC>[A	In Hazeltine half-duplex, this key sends no code, but does move cursor on screen.
↓	0A	<ESC>[B	
←	08	<ESC>[D	
→	10	<ESC>[C	In Hazeltine half-duplex, this key sends no code, but does move cursor on screen.

Table E-1A. Membrane Keypad ASCII Codes
(4810ER only) Normal Mode

Key	Hexadecimal Code	ASCII Code	Notes
0	30	0	
1	31	1	
2	32	2	
3	33	3	
4	34	4	
5	35	5	
6	36	6	
7	37	7	
8	38	8	
9	39	9	
A	41	A	
B	42	B	
C	43	C	
D	44	D	
E	45	E	
F	46	F	
I	47	G	
II	48	H	
III	49	I	
IV	4A	J	
.	2E	.	
	Hazeltine	ANSI	Alternate Keyboard Translation Selected (1) (ANSI or Hazeltine)
↑	7E 0C	<ESC>[A	11H
↓	0A	<ESC>[B	14H
←	08	<ESC>[D	12H
→	10	<ESC>[C	13H
PAUSE	50	P	
CLEAR	7E 1C	~<FS>	
ENTER	0D	<CR>	

NOTES

1 In the Hazeltine half-duplex mode, if the alternate keyboard is not selected all cursor keys will continue to move on the screen. However, the "up" and "right" cursor will not return codes.

If the alternate keyboard is selected, the codes shown will be returned.

Table E-2 Membrane Keypad Codes
(4810E and 4860) Application Mode

Key	Hexadecimal Code[1] (Hazeltine 1500 Emulation)	ASCII Code[2] (ANSI Emulation)	
0	B0	<ESC>Op	
1	B1	<ESC>Oq	
2	B2	<ESC>Or	
3	B3	<ESC>Os	
4	B4	<ESC>Ot	
5	B5	<ESC>Ou	
6	B6	<ESC>Ov	
7	B7	<ESC>Ow	
8	B8	<ESC>Ox	
9	B9	<ESC>Oy	
A	C1	<ESC>Oa	
B	C2	<ESC>Ob	
C	C3	<ESC>Oc	
D	C4	<ESC>Od	
E	C5	<ESC>Oe	
F	C6	<ESC>Of	
F1	C7	<ESC>Og	
F2	C8	<ESC>Oh	
F3	C9	<ESC>Oi	
F4	CA	<ESC>Oj	
F5	CB	<ESC>Ok	
F6	CC	<ESC>Ol	
PF1	CD	<ESC>Om	4860A ONLY
PF2	CE	<ESC>ON	
PF3	CF	<ESC>OO	
PF4	D0	<ESC>OP	
PF5	D1	<ESC>OQ	
PF6	D2	<ESC>OR	
PF7	D3	<ESC>OS	
PF8	D4	<ESC>OT	
PF9	D5	<ESC>OU	
PF10	D6	<ESC>OV	
.	AE	<ESC>On	
↑	91	<ESC>OA	
↓	94	<ESC>OB	
←	92	<ESC>OD	
→	93	<ESC>OC	
ENTER	8D	<ESC>OM	

NOTES

[1] Same as Table E-1, except that bit 7 is set to 1, and the arrow codes differ.
[2] Same as the codes returned by a VT-100 keypad in Application Mode.

Table E-2A. Membrane Keypad Codes
(4810ER) Application Mode

Key	Hexadecimal Code (1)(3) (Hazeltine 1500 Emulation)	ASCII Code(2) (ANSII Emulation)
0	B0	<ESC>Op
1	B1	<ESC>Oq
2	B2	<ESC>Or
3	B3	<ESC>Os
4	B4	<ESC>Ot
5	B5	<ESC>Ou
6	B6	<ESC>Ov
7	B7	<ESC>Ow
8	B8	<ESC>Ox
9	B9	<ESC>Oy
A	C1	<ESC>Oa
B	C2	<ESC>Ob
C	C3	<ESC>Oc
D	C4	<ESC>Od
E	C5	<ESC>Oe
F	C6	<ESC>Of
I	C7	<ESC>Og
II	C8	<ESC>Oh
III	C9	<ESC>Oi
IV	CA	<ESC>Oj
CLEAR	84	<ESC>Ok
PAUSE	D0	<ESC>Ol
.	AE	<ESC>On
↑	91	<ESC>OA
↓	94	<ESC>OB
←	92	<ESC>OD
→	93	<ESC>OC
ENTER	8D	<ESC>OM

NOTES

1 Same as Table E-1A, except that bit 7 is set to 1, and the CLEAR code and arrows key codes differ.

2 Same as the codes returned by a VT100 keypad in application mode.

3 See Table E-1 for alternate keyboard translations for cursor keys.

Table E-3 Codes for Keyboard Alphanumeric Keys
(Full and Half-duplex)

Key	no CTRL, no SHIFT		no CTRL, SHIFT		CTRL, no SHIFT		CTRL, SHIFT	
	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
A	61	a	41	A	01	<SOH>	01	<SOH>
B	62	b	42	B	02	<STX>	02	<STX>
C	63	c	43	C	03	<ETX>	03	<ETX>
D	64	d	44	D	04	<EOT>	04	<EOT>
E	65	e	45	E	05	<ENQ>	05	<ENQ>
F	66	f	46	F	06	<ACK>	06	<ACK>
G	67	g	47	G	07	<BEL>	07	<BEL>
H	68	h	48	H	08	<BS>	08	<BS>
I	69	i	49	I	09	<HT>	09	<HT>
J	6A	j	4A	J	0A	<LF>	0A	<LF>
K	6B	k	4B	K	0B	<VT>	0B	<VT>
L	6C	l	4C	L	0C	<FF>	0C	<FF>
M	6D	m	4D	M	0D	<CR>	0D	<CR>
N	6E	n	4E	N	0E	<SO>	0E	<SO>
O	6F	o	4F	O	0F	<SI>	0F	<SI>
P	70	p	50	P	10	<DLE>	10	<DLE>
Q	71	q	51	Q				
R	72	r	52	R	See Table E-5			
S	73	s	53	S				
T	74	t	54	T				
U	75	u	55	U	15	<NAK>	15	<NAK>
V	76	v	56	V	16	<SYN>	16	<SYN>
W	77	w	57	W	17	<ETB>	17	<ETB>
X	78	x	58	X	18	<CAN>	18	<CAN>
Y	79	y	59	Y	19	<EM>	19	<EM>
Z	7A	z	5A	Z	1A	<SUB>	1A	<SUB>
1	31	1	21	!	31	1	21	!
2	32	2	40	@	32	2	00	<NULL>
3	33	3	23	#	33	3	23	#
4	34	4	24	$	34	4	24	$
5	35	5	25	%	35	5	25	%
6	36	6	5E	^	36	6	1E	<RS>
7	37	7	26	&	37	7	26	&
8	38	8	2A	*	38	8	2A	*
9	39	9	28	(	39	9	28	(
0	30	0	29	)	30	0	29	)
Backspace	08	<BS>	08	<BS>	08	<BS>	08	<BS>

Table E-3 Codes for Keyboard Alphanumeric Keys cont.
(Full and Half-duplex)

	no CTRL, no SHIFT		no CTRL, SHIFT		CTRL, no SHIFT		CTRL, SHIFT	
Key	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
ESC	1B	<ESC>	1B	ESC	1B	<ESC>	1B	<ESC>
-	1F	-	5F	_	1F	-	1F	-
SPACE	20		20		20			20
'	27	'	22	"	27	'	22	"
*								
PRT SCN	2A	*	AA	N/A	2A	*	AA	N/A
,	2C	,	3C	<	2C	,	3C	<
-	2D	-	5F	_	1F	<US>	1F	<US>
.	2E	.	3E	>	2E	.	3E	>
/	2F	/	3F	?	2F	/	3F	?
;	3B	;	3A	:	3B	;	3A	:
=	3D	=	2B	+	3D	=	2B	+
[	5B	[	7B	{	1B	<ESC>	1B	<ESC>
\	5C	\	7C	|	1C	<FS>	1C	<FS>
]	5D	]	7D	}	1D	<GS>	1D	<GS>
‘	60	‘	7E	~	60	‘	7E	~
<DEL>	7F	<DEL>	2E	.	7F	<DEL>	2E	.

Table E-3A Codes for Keyboard and Alphanumeric Keys - IBM PC/XT type

These codes are for the same keys as in Table E-3, but differ on a PC/XT type keyboard in the codes that are sent.

Key	CTRL, no SHIFT	CTRL, SHIFT
1	<DC1>	<SOH>
2	<DC2>	
3	<DC3>	<ETX>
4	<DC4>	<EOT>
5	<NAK>	<ENQ>
6	<SYN>	
7	<ETB>	<ACK>
8	<CAN>	<LF>
9	<EM>	<BS>
0	<DLE>	<HT>
SPACE	<NU>	<NU>
’	<BEL>	<STX>
PRT SCN	<LF>	<LF>
,	<CR>	<FS>
-	<CR>	
.	<SO>	<RS>
/	<SI>	<US>
;	<ESC>	<SUB>
=	<OS>	<VT>
‘	<NU>	<SO>

Table E-4 Codes for Keyboard Control Keys

Key	Hex	ASCII	Hex	ASCII	Notes
TAB	09	<HT>	09	<HT>	
BACK SPACE	08	<BS>	08	<BS>	
DEL		See Table E-3			
RETURN	0D	<CR>	OD	<CR>	
ENTER	0D	<CR>	0D	<CR>	
<left arrow>					
<right arrow>	See Table E-5				
<up arrow>					
<down arrow>					
BREAK[1]	00	<NUL>	00	<NUL>	
ESC	1B	<ESC>	1B	<ESC>	
HOME			7E 12	~<DC2>	Haz. emulation[2]
			1B 5B 48	<ESC>[H	ANSI emulation
F1					
F2		See Table E-5			
F3					
F4					
F5 (CLEAR)			7E 1C	~<FS>	Haz.emulation[2]
			1B 4F 50	<ESC>OP	ANSI emulation
F6 (CLEAR FOREGROUND)			7E 1D	~<GS>	Haz.emulation[2]
			1B 4F 51	<ESC>OQ	ANSI emulation
F7 (CLEAR TO END OF LINE)			7E 0F	~<SI>	Haz.emulation[2]
			1B 4F 52	<ESC>OR	ANSI emulation
F8 (CLEAR TO END OF SCREEN WITH FOREGROUND SPACES)			7E 18	~<CAN>	Haz. emulation[2]
			1B 4F 53	<ESC>OS	ANSI emulati
F9	88			88	
F10[3]					

NOTES

1 The communications line is held low (0) for 200-250 milliseconds.
2 This is not transmitted when in Hazeltine half-duplex mode.
3 Does not transmit a character.

Table E-5 Cursor Control and "F" Keys on Keyboard
(Full-duplex)

	Standard[1] Hazeltine 1500		Alternate[1] Hazeltine 1500		Standard[1] ANSI		Alternate[1] ANSI	
Key	Hex	ASCII	Hex	ASCII	Hex	ASCII	Hex	ASCII
CNTL-Q	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A	11	<DC1>
CNTL-R	08	<BS>	12	<DC2>	1B 5B 44	<ESC>[D	12	<DC2>
CNTL-S	10	<DLE>	13	<DC3>	1B 5B 43	<ESC>[C	13	<DC3>
CNTL-T	0A	<LF>	14	<DC4>	1B 5B 42	<ESC>[B	14	<DC4>
up arrow	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A	11	<DC1>
left arrow	08	<BS>	12	<DC2>	1B 5B 44	<ESC>[D	12	<DC2>
right arrow	10	<DLE>	13	<DC3>	1B 5B 43	<ESC>[C	13	<DC3>
down arrow	0A	<LF>	14	<DC4>	1B 5B 42	<ESC>[B	14	<DC4>
F1[2]	11	<DC1>	7E 0C	~<FF>	11	<DC1>	1B 5B 41	<ESC>[A
F2[2]	12	<DC2>	0A	<LF>	12	<DC2>	1B 5B 42	<ESC>[B
F3[2]	13	<DC3>	08	<BS>	13	<DC3>	1B 5B 44	<ESC>[D
F4[2]	14	<DC4>	10	<DLE>	14	<DC4>	1B 5B 43	<ESC>[C

NOTES

1 The difference between standard and alternate is discussed in Section 2.5 "Alternate Keyboard Translation".

2 Do not confuse the keyboard keys with F1-F6 keys on the keypad.

Table E-6 Numeric Pad (with NUM LOCK Off)[1]

	no SHIFT		SHIFT	
Key	Hex	ASCII	Hex	ASCII
0	B0		30	0
1	B1		31	1
2	see down arrow (Table E-5)		32	2
3	B3		33	3
4	see left arrow (Table E-5)		34	4
5	B5		35	5
6	see right arrow (Table E-5)		36	6
7 [2]	see home (Table E-4)		37	7
8	see up arrow (Table E-5)		38	8
9	B9		39	9

NOTES

[1] With NUM LOCK on, ASCII numbers from 0 through 9 will be generated, and the SHIFT will have no effect. CTRL has no effect on the numeric keypad keys.

[2] In the "NO SHIFT" mode, Key 7 is "HOME".

Table E-7 Process Graphic Symbols

Hex Value	ASCII Character	Process Control Symbol
20H		4x4 space
21H	!	motor in 4x3 cell
22H	"	not used
23H	#	left tank top in 4x1 cell
24H	$	right tank tope in 4x1 cell
25H	%	small diamond in 4x2 cell
26H	&	left tank bottom in 4x1 cell
27H	'	right tank bottom in 4x1 cell
28H	(	left arrow in 4x2 cell
29H	)	right arrow in 4x2 cell
2AH	*	small box in 4x2 cell
2BH	+	up valve in 4x2 cell
2CH	,	right/left facing valve in 4x2 cell
2DH	-	pump/compressor in 4x2 cell
2EH	.	up arrow in 4x2 cell
2FH	/	down arrow in 4x2 cell
30H	0	small circle in 4x2 cell
31H	1	circuit breaker type 1 in 2x4 cell
32H	2	fuse in 2x4 cell
33H	3	disconnect in 3x4 cell
34H	4	pump/blower in 4x2 cell
35H	5	circuit breaker type 2 in 4x2 cell
36H	6	left turbine in 3x2 cell
37H	7	right turbine in 3x2 cell
38H	8	left medium box in 4x2 cell
39H	9	right medium box in 4x2 cell
3AH	;	left medium circle in 4x3 cell
3BH	:	right medium circle in 4x3 cell
3CH	<	mini circle in 2x1 cell
3DH	=	mini left arrow in 2x1 cell
3EH	>	mini right arrow in 2x1 cell
3FH	?	mini up arrow in 2x1 cell
40H	@	mini down arrow in 2x1 cell
41H	A	motor
42H	B	large circle (left)
43H	C	large circle (right)
44H	D	tank top (left)
45H	E	tank top (right)
46H	F	small diamond
47H	G	large diamond (left)
48H	H	large diamond (right)

Table E-7 Process Graphic Symbols cont.

Hex Value	ASCII Character	Process Control Symbol
49H	I	tank bottom (left)
4AH	J	tank bottom (right)
4BH	K	left arrow
4CH	L	right arrow
4DH	M	small box
4EH	N	up facing valve
4FH	O	right/left facing valve
50H	P	pump/compressor
51H	Q	up arrow
52H	R	down arrow
53H	S	small circle
54H	T	transformer
55H	U	circuit breaker (type 1)
56H	V	fuse
57H	W	disconnect
58H	X	pump/blower
59H	Y	circuit breaker (type 2)
5AH	Z	turbine (left)
5BH	[	turbine (right)
5CH	\	large box (left)
5DH	]	large box (right)
5EH	^	medium box (left)
5FH	_ (underscore)	medium box (right)
60H	`(grave)	medium circle (left)
61H	a	medium circle (right)
62H	b	top left 1/4 of large circle in 4x2 cell
63H	c	top right 1/4 of large circle in 4x2 cell
64H	d	bottom left 1/4 of large circle in 4x2 cell
65H	e	bottom right 1/4 of large circle in 4x2 cell
66H	f	top left 1/4 of small circle in 2x1 cell
67H	g	top right 1/4 of small circle in 2x1 cell
68H	h	bottom left 1/4 of small circle in 2x1 cell
69H	i	bottom right 1/4 of small circle in 2x1 cell
6AH	j	small tank top in 4x1 cell
6BH	k	small tank bottom in 4x1 cell
6CH	l	mini tank top in 2x1 cell
6DH	m	mini tank bottom in 2x1 cell
6EH	n	mini diamond in 2x1 cell
6FH	o	mini box in 2x1 cell
70H	p	mini right valve in 2x1 cell
71H	q	mini up valve in 2x1 cell
72H	r	mini motor in 2x2 cell

Table E-7 Process Graphic Symbols cont.

Hex Value	ASCII Character	Process Control Symbol
73H	s	mini pump/blower in 2x1 cell
74H	t	mini transformer in 2x2 cell
75H	u	mini circuit breaker type 1 in 1x2 cell
76H	v	mini fuse in 1x2 cell
77H	w	mini disconnect in 1x2 cell
78H	x	mini blower/compressor in 2x1 cell
79H	y	mini circuit breaker type 2 in 2x1 cell
7AH	z	mini left turbine in 1x1 cell
7BH	(	mini right turbine in 1x1 cell

Table E-8 Utility Graphics

Utility Graphics	Description
32-79 (20-4F Hex)	Process Graphics Pieces
80-87 (50-57 Hex)	Process Graphic Connectors (Thin)
88-95 (58-5F Hex)	Process Graphic Connectors (Thick)
96-111 (60-6F Hex)	Thick Line Graphics
112-175 (70-AF Hex)	Process Graphic Pieces
176-187 (B0-BB Hex)	Miscellaneous Connectors

Table E-9 Remote Commands
(Hazeltine 1500 Emulation)

REMOTE COMMANDS	ASCII	HEX
<u>Control Characters</u>		
Bell	<BEL>	07
Backspace	<BS>	08
Cursor to Next Foreground Field	<HT>	09
Linefeed	<LF>	0A
Carriage Return	<CR>	0D
<u>Configuration Commands</u>		
Enable Application Mode	~ .	7E 2E
Disable Application Mode	~ /	7E 2F
Cursor Off	~<S0H>	7E 01
Cursor On	~<STX>	7E 02
Scrolling Off	~<BEL>	7E 07
Scrolling On	~<BS>	7E 08
Unlock Keyboard	~<ACK>	7E 06
Lock Keyboard	~<NAK>	7E 15
<u>Attribute Commands</u>		
Set/Reset Attributes	~6<attribute#>	7E 36 <attribute #>
Change Char. Attributes	~<ETX> <attr-1> <attr-2>	7E 03 <attr-1> <attr-2>
<u>Cursor Movement Commands</u>		
Cursor Right (no scroll)	<DLE>	10
Return Cursor Position	~<ENQ>	7E 05
Cursor Down (no scroll)	~<VT>	7E 0B
Cursor Up	~<FF>	7E 0C
Cursor to X,Y	~<DC1> X Y	7E 11 X Y
Home Cursor	~<DC2>	7E 12

Table E-9 Remote Commands cont.
(Hazeltine 1500 Emulation)

REMOTE COMMANDS	ASCII	HEX
Clear Commands		
Clear to EOL with Background Spaces	~<SI>	7E 0F
Clear to EOS with Background Spaces	~<ETB>	7E 17
Clear to EOS with Foreground Spaces	~<CAN>	7E 18
Clear Foreground	~<GS>	7E 1D
Clear Screen	~<FS>	7E 1C
Background Field Follows	~<EM>	7E 19
Foreground Field Follows	~<US>	7E 1F
Delete Commands		
Delete Line	~<DC3>	7E 13
Insert Line	~<SUB>	7E 1A
Draw Commands		
Draw Box	~<HT> <char> <xstart> <ystart> <xend> <yend>	7E 09 <char> <xstart> <ystart> <xend> <yend>
Draw Vertical Line (upward)	~<LF> <char> <xstart> <ystart> <length>	7E 0A <char> <xstart> <ystart> <length>
Draw Horizontal Line (left to right)	~<CR> <char> <xstart> <ystart> <length>	7E 0D <char> <xstart> <ystart> <length>
Draw Bar Chart	~<S0> <xstart> <ystart> <length1> <length2>	7E 0E <xstart> <ystart> <length1> <length2>
Draw Bar Chart Down	~<space> <xstart> <ystart> <length1> <length2>	7E 20 <xstart> <ystart> <length1> <length2>
Draw Bar Chart Right	~! <xstart> <ystart> <length1> <length2>	7E 21 <xstart> <ystart> <length1> <length2>
Draw Bar Chart Left	~" <xstart> <ystart> <length1> <length2>	7E 22 <xstart> <ystart> <length1> <length2>
Additional Commands		
Pause	~ # <time>	7E 23 <time>
Return Password	~ %	7E 25
Plot Point	~0XY	7E 30 X Y
Unplot Point	~1XY	7E 31 X Y

Table E-10 Remote Commands (ANSI Emulation)

Control Characters

00	- ignored
07	- ring bell
08	- move cursor left 1 position
09	- go to next tab stop
0A	- linefeed or new line
0B	- same as 0A
0C	- same as 0A
0D	- move cursor to left margin of current line (carriage return)
18	- cancel current ESC sequence
1A	- same as 18
1B	- ESC

Configuration Commands [2,3]

ESC [? 7 h	- enable autowrap
ESC [? 25 h	- cursor on
ESC [? 7 l	- disable autowrap
ESC [? 25 l	- cursor off
ESC [2 h	- lock keyboard
ESC [2 l	- unlock keyboard
ESC [20 h	- enable auto line-feed
ESC [20 l	- disable auto line-feed
ESC [= 1 h	- cursor on
ESC [= 2 h	- scrolling on
ESC [= 3 h	- treat tab as ANSI tab
ESC [= 1 l	- cursor off
ESC [= 2 l	- scrolling off
ESC [= 3 l	- treat tab as Hazeltine tab

Attribute Commands [1]

ESC [m	- attributes off
ESC [0 m	- attributes off
ESC [1 m	- highlight
ESC [4 m	- underline
ESC [5 m	- blink
ESC [7 m	- reverse video
ESC [22 m	- highlight off
ESC [24 m	- underline disable
ESC [25 m	- blink disable
ESC [27 m	- reverse video off

Table E-10 Remote Commands cont.
(ANSI Emulation)

Attribute Commands cont.

ESC [50 m	- select regular character set
ESC [51 m	- select double-high characters
ESC [52 m	- select quad-sized characters
ESC [53 m	- select process control symbols
ESC [54 m	- select double-wide characters
ESC [55 m	- select double-size characters
ESC [56 m	- select quad-sized characters
ESC [57 m	- select utility graphics
ESC [1 ;attr1;attr2 p	- change character attributes

Cursor Movement Commands

ESC [pn A	- cursor up pn lines
ESC [pn B	- cursor down pn lines without scroll
ESC [pn C	- cursor right pn characters
ESC [pn D	- cursor left pn characters
ESC [y;x H	- cursor to position x,y
ESC [H	- cursor home (1,1)
ESC [y;x f	- cursor to position x,y
ESC [f	- cursor home (1,1)
ESC D	- cursor down with scroll
ESC M	- cursor up with scroll
ESC E	- cursor to beginning of next line with scroll
ESC 7	- save cursor and attributes
ESC 8	- restore cursor and attributes

Tab Stop Commands [4]

ESC H	- set tab stop at current column
ESC [g	- clear tab stop at current column
ESC [0 g	- clear tab stop at current column
ESC [3 g	- clear all tab stops

Table E-10 Remote Commands cont.
(ANSI Emulation)

Clear Commands

ESC [pn X	- clear pn characters on current line with background spaces
ESC [K	- clear to end of line with background spaces
ESC [? K	- clear to end of line with background spaces
ESC [0 K	- clear to end of line with background spaces
ESC [? 0 K	- clear to end of line with background spaces
ESC [1 K	- clear to beginning of line with background spaces
ESC [? 1 K	- clear to beginning of line with background spaces
ESC [2 K	- clear entire line with background spaces
ESC [? 2 K	- clear entire line with background spaces
ESC [J	- clear to end of screen with background spaces
ESC [? J	- clear to end of screen with background spaces
ESC [0 J	- clear to end of screen with background spaces
ESC [? 0 J	- clear to end of screen with background spaces
ESC [1 J	- clear to beginning of screen with background spaces
ESC [? 1 J	- clear to beginning of screen with background spaces
ESC [2 J	- clear entire screen with background spaces
ESC [? 2 J	- clear entire screen with background spaces
ESC [8 p	- clear to EOS with background spaces
ESC [9 p	- background follows
ESC [10 p	- clear foreground
ESC [11 p	- foreground follows

Insert/Delete Commands

ESC [pn L	- insert pn blank line(s) at current cursor position
ESC [pn M	- delete pn line(s) from cursor position
ESC [pn @	- insert pn space(s) in line at cursor position
ESC [pn P	- delete pn character(s) from line at cursor position

Report Commands

ESC [5 n	- device status report device ok returns - ESC [0 n device not ok returns - ESC [3 n
ESC [6 n	- report cursor x,y position returns - ESC [y;xR
ESC [c	- return options
ESC [0 c	- return options returns - ESC [? 1;0c

Table E-10 Remote Commands cont.
(ANSI Emulation)

Additional Commands

ESC c	- reset to initial state
ESC =	- select application mode for keypad keys
ESC >	- select normal mode for keypad keys
ESC b	- unlock keyboard
ESC ‘	- lock keyboard
ESC [18;time p	- pause
ESC [20 p	- return password

Draw Commands

ESC [2 ;char;ystrt;xstrt;yend;xend p	- draw box
ESC [3 ;char;ystrt;xstrt;length p	- draw vertical line
ESC [4 ;char;ystrt;xstrt;length p	- draw horizontal line
ESC [5 ;ystrt;xstrt;len1;len2 p	- draw bar chart up
ESC [15;ystrt;xstrt;len1;len2 p	- draw bar chart down
ESC [16;ystrt;xstrt;len1;len2 p	- draw bar chart right
ESC [17;ystrt;xstrt;len1;len2 p	- draw bar chart left
ESC [25;ycor;xcor p	- plot point
ESC [26;ycor;xcor p	- unplot point

NOTES:

1 Multiple attributes can be selected in a single attribute command:

ESC [50;40;31m

2 Multiple configurations can be specified in a single configuration command.

Example:
ESC [= 1;2;3 h
ESC [? 7;25 h
ESC [2;20 h

3 Configuration options that can be set by both the remote commands and the Configuration Menu are not saved on power-down unless the Configuration Menu is entered and exited.

4 Tab stops set/reset with remote commands are not saved on power-down unless the "Set Tab Stop" menu is entered and exited.

Table E-11 Attribute Byte 1

Bit No.	Attribute
7 (MSB)	not used
6	not used
5	not used
4	double-wide
3	blink
2	underline
1	high-intensity
0 (LSB)	reverse video

Table E-12 Attribute Byte 2

Bit No.	Attribute
7 (MSB)	not used
6	not used
5	not used
4	not used
3	not used
2	character set bit 2
1	character set bit 1
0 (LSB)	character set bit 0

Bit 2	Bit 1	Bit 0	Attribute
0	0	0	regular character
0	0	1	double-high character
0	1	0	quad-size character
0	1	1	process graphic symbols
1	1	1	utility graphics

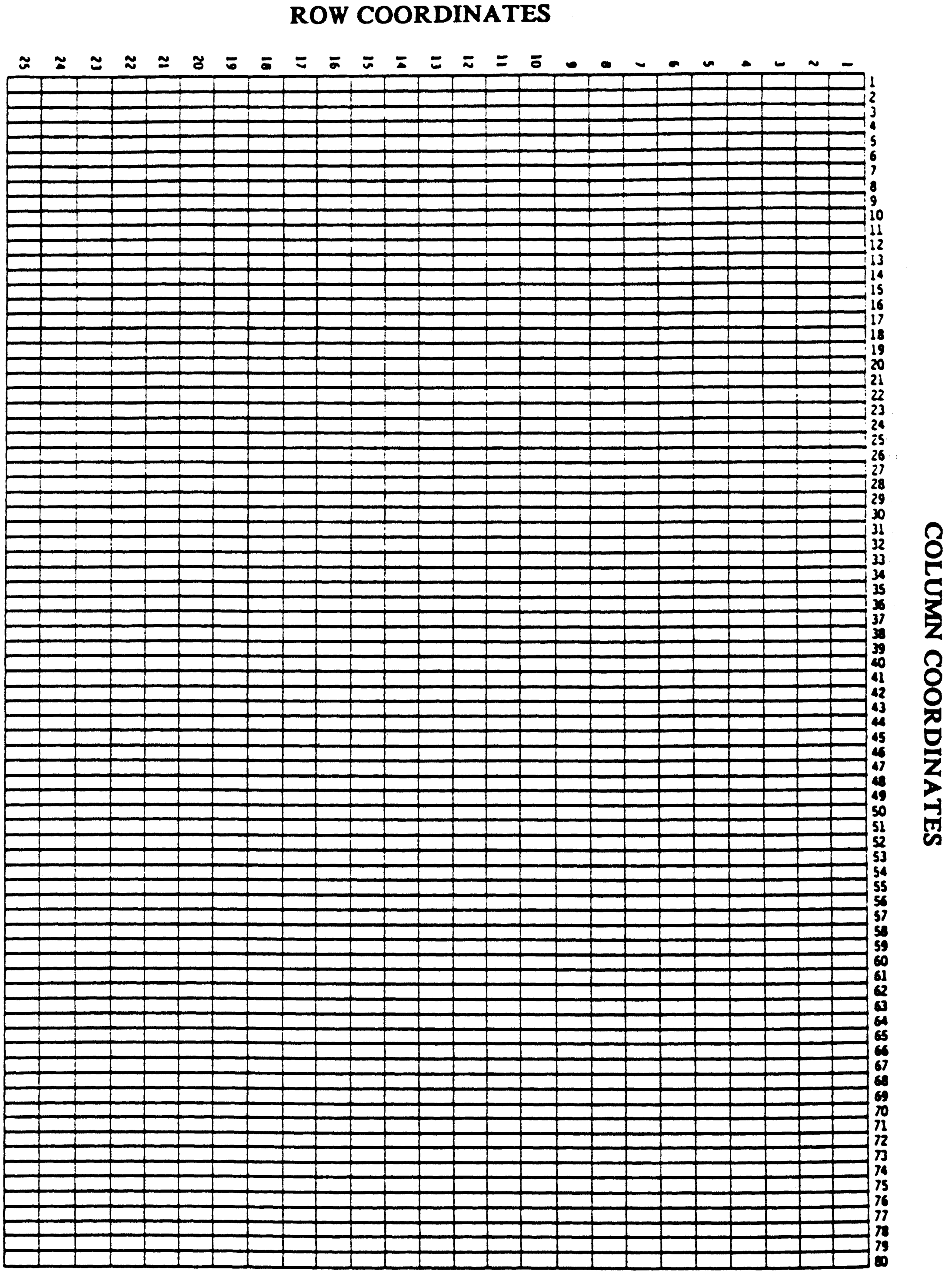


Figure E-1 Video Display Coordinate System (ANSI Emulation)

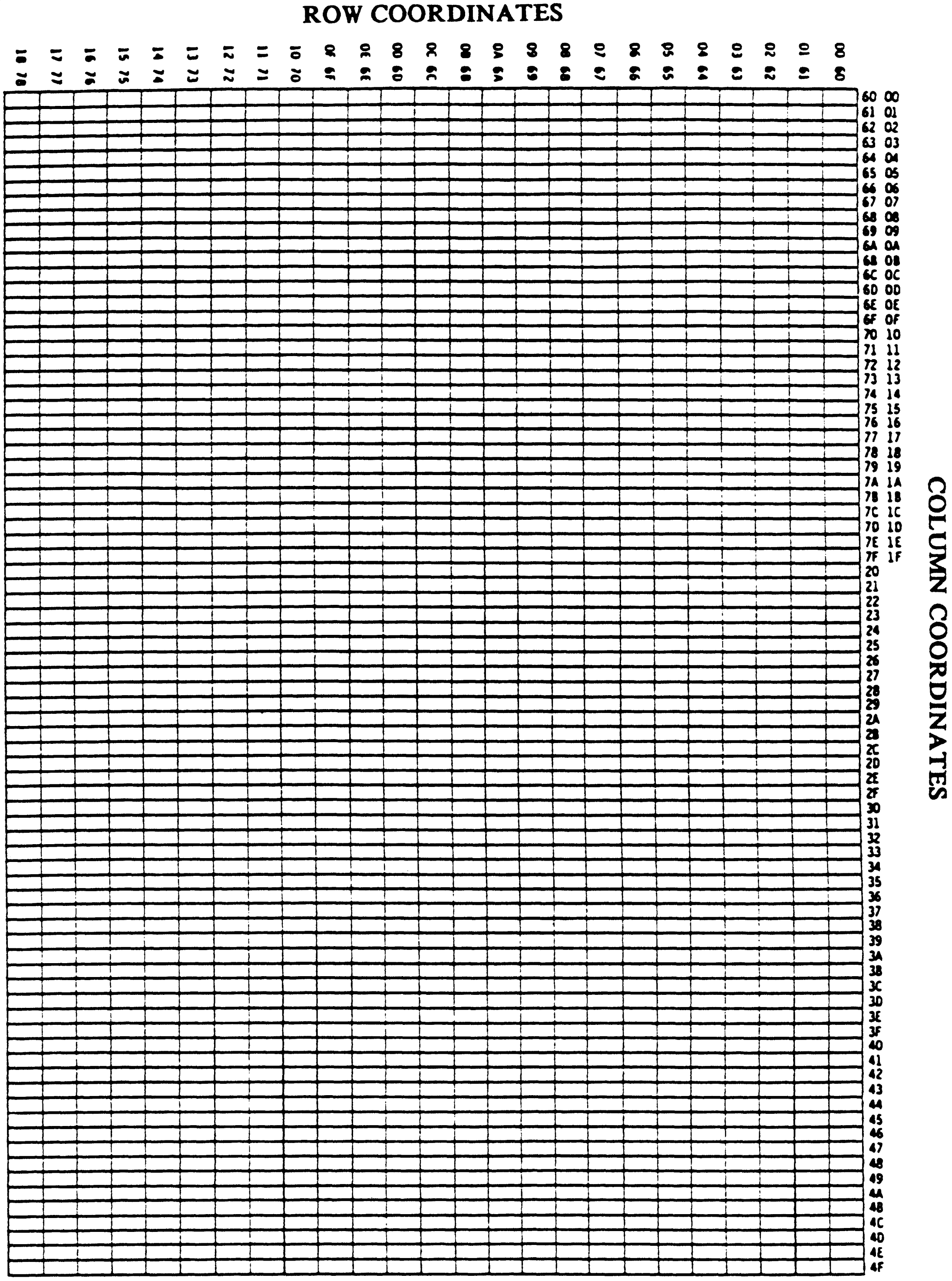


Figure E-2 Video Display Coordinate System (Hazeltine Emulation)