WANG

Model 2110A Asynchronous Workstation User's Guide

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PREFACE

This manual provides the information you need to operate the Wang 2110A Asynchronous Workstation. Several sections of this manual are intended for people with knowledge of computer programming. The manual is divided into the following chapters and appendixes.

Chapter 1 describes the supported configurations, presents general, information on the controllers and the terminal, and informs different types of users on how to use the manual.

Chapter 2 provides instructions for installing and setting terminal operating characteristics.

Chapter 3 describes the 2110A's main port and aux port communications environment.

Chapter 4 describes the 2110A when used as a Wang terminal.

Chapter 5 describes the 2110A when used as a non-Wang terminal. This chapter is useful for system administrators and programmers.

Chapter 6 describes the special terminal functions and operating procedures available.

Chapter 7 provides you with troubleshooting information to correct common operating problems. This chapter also provides a self-test used to locate terminal hardware problems.

Appendix A presents the 2110A workstation's specifications.

Appendix B presents the poweron state and default values.

Appendix C presents the available keyboard layouts.

Appendix D describes the differences between the 2110A and the 2110.

Appendix E describes the differences between the 2110A and Digital's VT-102 asynchronous terminal.

Appendix F provides a glossary of terms.

It is helpful if readers of the technical sections are familiar with the National Standards Institute (ANSI) X3.4, X3.41, and X3.64 standards.

Throughout this manual, the 2110A workstation is also referred to as a terminal.

CHAPTER 1
INTRODUCTION

1.1 OVERVIEW

This chapter provides an overview of the 2110A Asynchronous Workstation. It describes the major characteristics, capabilities, and operating modes of the 2110A.

The 2110A is capable of communicating with Wang and non-Wang host systems. The 2110A supports the subset of the American National Standards Institute (ANSI) X3.64 and X3.41 standards and the Wang private extensions compatible with those standards. This compatibility enables the 2110A to be used as a workstation on non-Wang host systems that communicate using the ANSI protocol. In addition, the terminal provides a number of features that provide flexibility and ease of use while operating in Wang and non-Wang environments. These features include:

- Direct-connect transmission across 2000 feet of RS-232-C-compatible cable
- Menu-driven screen selectable workstation characteristics
- XON/XOFF pacing
- Transmit and receive buffering
- Auxiliary port for local printing
- Error character substitute for received parity errors

The 2110A can be used in place of ANSI terminals such as Digital Equipment Corporation's VT-102 when special features of such terminals (e.g., alternate character sets) are not required. The 2110A enables users to send any required 7-bit ASCII codes and to respond to ANSI standard and Wang private ANSI-compatible host commands that are described in Chapter 5.

The 2110A supports the following functions:

- Sends all ASCII codes in the range 00 through 7F
- Optionally uses 8-bit extensions of ANSI protocol to send or receive control codes and display characters
- Sends control codes with a single modifier key
- Sends escape codes via a single keystroke
- Sends by a single 2110A keystroke, many of the escape sequences generated by single keystrokes on the DEC VT-102 terminal
- Displays the ASCII character set
- Displays an extended 256-character set consisting of the WISCII character set and special graphics characters in response to ANSI-defined shift commands sent from the host
- Host downloadable 256-character set
- Supports up to 512 additional displayable characters (via cartridge), giving the terminal access to 1024 displayable characters for screen display

1.2 SUPPORTED CONFIGURATIONS

Figures 1-1 and 1-2 show the configurations supported by the 2110A.

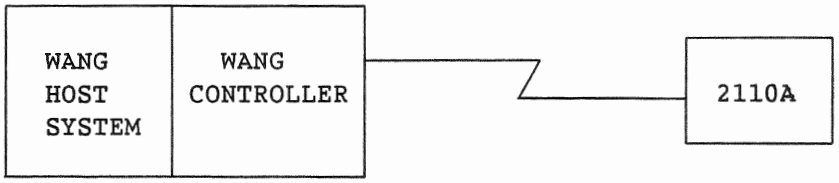

Figure 1-1. Wang 2110A Workstation Attached to Wang Host System via Controller

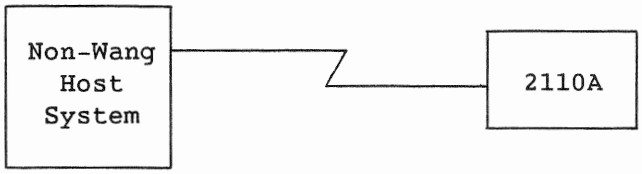

Figure 1-2. Wang 2110A Workstation Attached to Non-Wang Host System

Both configurations provide local and remote connections between the terminal and the host system. Communication between the terminal and the host system occurs over an RS-232-C-compatible cable and, in the case of remote connections, a digital communications line or an analog line and modems. See Section 2.8 for connection details.

1.2.1 2110A Workstation, Controller, Wang Host System

Once the 2110A is configured as a Wang workstation, operation is relatively simple. The compatibility between the controller and the terminal's capabilities is ensured. The controller recognizes it as an ANSI terminal and requests device attributes. The 2110A identifies itself as a Wang 2110A Workstation. The controller then uses an extended set of host-to-terminal commands (Wang private extensions compatible with ANSI X3.64) that allow the 2110A to function as a Wang workstation.

1.2.2 2110A Workstation, Non-Wang Host System

For detailed information on configuring the 2110A as an ANSI terminal on a non-Wang host system, refer to Chapters 2 and 5 and Appendixes A and B. This information may also be used by a system or application programmer who wants to adapt host software to use the special features of the 2110A. Chapter 5 provides information on:

- The supported ANSI X3.64 and X3.41 standard features
- The Wang private extensions implemented in accordance with the ANSI specifications.
- ANSI escape and control sequences generated by single 2110A keystrokes and their compatibility with those generated by VT-102 keys.

The following steps must be performed (by your system administrator or support person) before using the 2110A with a non-Wang host system.

1. Set the communications characteristics of the workstation (See Chapter 2), if necessary, to correspond to the workstation characteristics required by the host.
2. Define the terminals using the appropriate host system configuration facilities.
3. Connect the 2110A to the port(s) on the host system (see Section 2.8).

4. Referring to Chapter 5, construct a reference list for using the keystroke sequences required to perform various host system functions from the 2110A.

You can now use the 2110A to perform host functions, referring primarily to the reference list and to the information presented in Chapter 5.

1.3 WANG CONTROLLERS

A Wang controller is a controller board (that you must order separately) that is installed in the host chassis. The controller maintains a screen image and performs keyboard handling for each of the terminals attached to it. The controller communicates with the terminal using an asynchronous protocol and the ANSI-compatible control and display character set and extensions (refer to Figure 1-3). There are several models of controllers to choose from depending upon the Wang host system you are connected to.

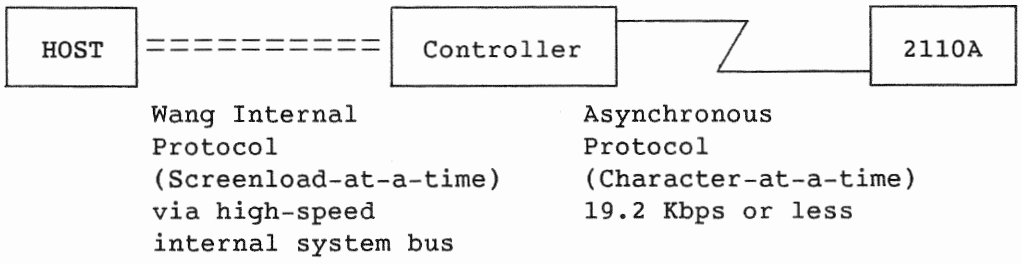

Figure 1-3. Communication Between the 2110A Workstation and Wang Host via a Controller

The controller performs any data and protocol conversions required to allow the host to send and receive data as if it were communicating with a standard host terminal via the Wang proprietary coaxial cable protocol. Similarily, the controller enables the terminal to communicate with the host by sending and receiving an ANSI-style data stream similar to that used by some computer vendors as the native host-terminal protocol.

The controller allows the host system to handle terminal I/O efficiently. The controller receives character-by-character transmissions from each terminal in the screen image buffer associated with each terminal. The host is interrupted for terminal I/O only when either the host has data to send or the terminal operator presses an Attention Identifier (AID) key: ENTER, HELP, or any of the 16 shifted or unshifted function keys.

1.4 OPERATING STATES

The 2110A workstation has three major operating states:

- SETUP
- ONLINE
- LOCAL

1.4.1 Setup

Setup Mode allows you to select the terminal's operating characteristics from a series of menu selections. See Section 2.6 for more information on Setup Mode.

1.4.2 Online

The online state (selected through Setup Mode) is used to let the terminal communicate with a host computer. When the terminal is online, data entered at the keyboard is transmitted to the host. Data received from the host is displayed on the monitor. A local echo feature (also selected through Setup Mode) routes data entered at the keyboard to the monitor as well as to the host.

1.4.3 Local Mode

Local Mode allows the terminal to operate independently of the host. Data in the terminal's main transmit buffer is transferred into the main port receive buffer. No data is transmitted from the terminal's main port. Data received by the terminal's main port is ignored.

1.5 COMMUNICATIONS ENVIRONNMENT

A summary of the major communications features is as follows:

- Asynchronous communications to 19.2K bits per second
- EIA RS-232-C host main port
- EIA RS-232-C auxiliary port
- 7- and 8-bit character format
- Modem support

CHAPTER 2
INSTALLATION AND SETUP INSTRUCTIONS

2.1 OVERVIEW

This chapter provides you with instructions for unpacking, installing, and setting terminal characteristics for your 2110A workstation. This chapter also provides a procedure to clean the terminal components.

The 2110A workstation is a two-piece unit comprised of a display monitor and a detachable keyboard. The equipment is shipped to you in two boxes. See Figure 2-1.

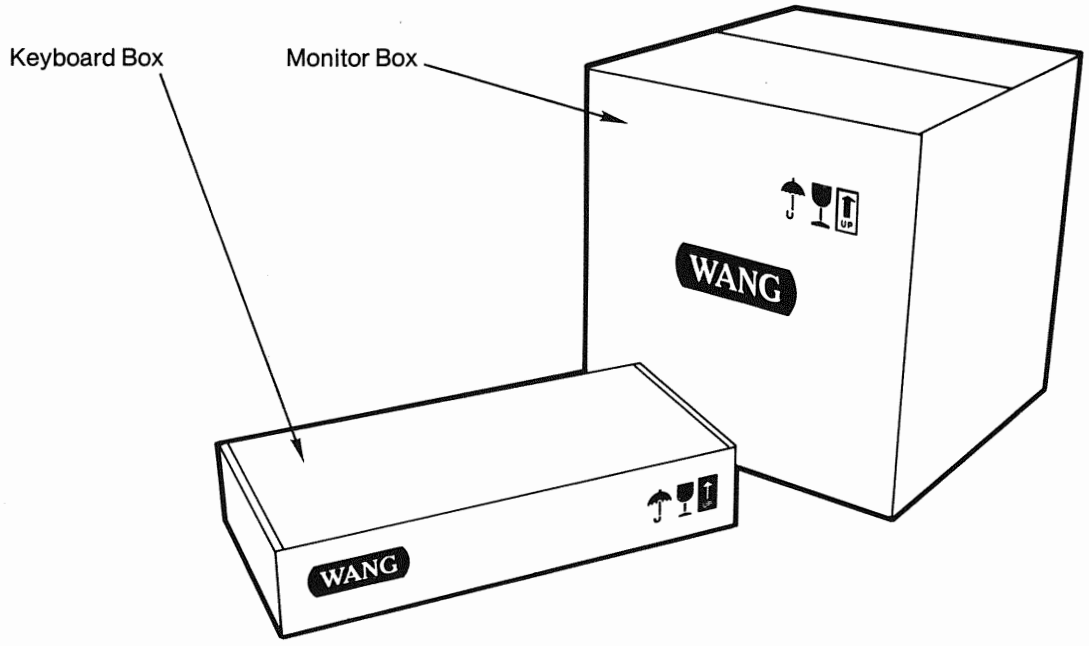

Figure 2-1. Keyboard and Monitor Boxes

2.2 UNPACKING AND CONNECTING THE COMPONENTS

1. Unpack the monitor box and the keyboard boxes. See Figure 2-2 to make sure you have the following items:

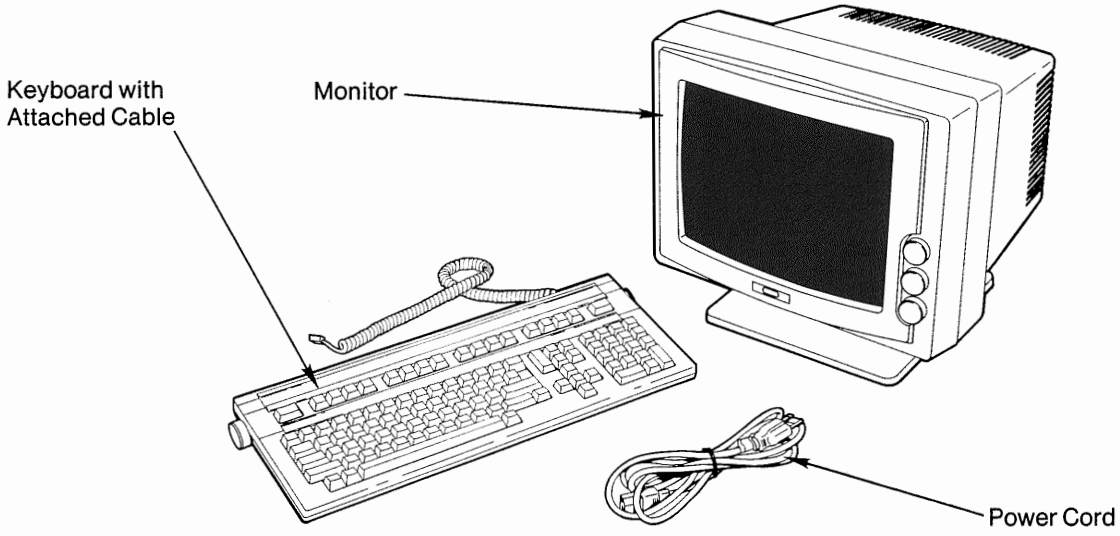

Figure 2-2. Keyboard, Monitor, and Power Cord

In order to complete the installation of the 2110A workstation, you must connect the terminal to your host system with a system cable. This cable is ordered separately. Which cable you order depends on the distance between your terminal and host system and to what system it is being connected. This cable comes in lengths of 25, 50, 100, 500, 1000, and 2000 feet. If you have not yet obtained a system cable, you can order it from WangDirect at 1-800-225-0234. If you have any questions, contact your Wang representative.

Note: *Any cable greater than 50 feet in length requires a Wang Customer Engineer to configure a logic board jumper to enable 'enhanced' main port transmission functionality.*

2. Connect the coiled keyboard cable to the port marked K.B. on the back of the monitor. See Figure Figure 2-3.

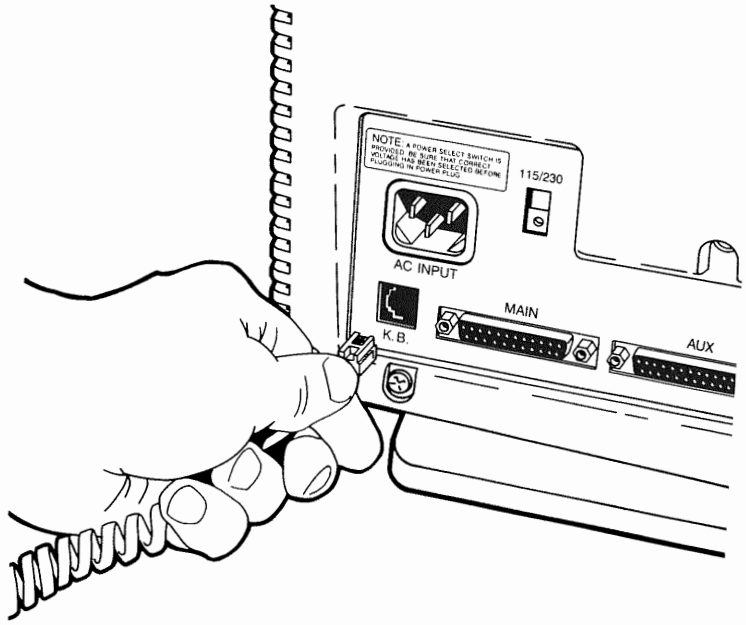

Figure 2-3. Connecting the Keyboard Cable

3. Connect the system cable (not supplied with unit) to be used with the 2110A workstation to the port on the back of the monitor marked MAIN. Tighten the screws. See Figure 2-4.

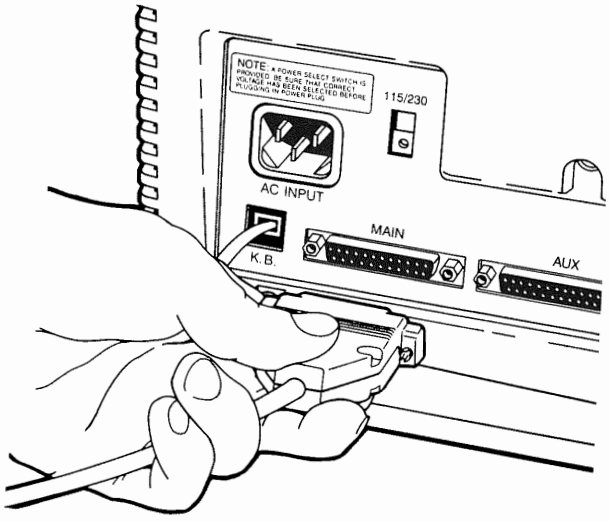

Figure 2-4. Connecting the System Cable

4. If the 2110A workstation is installed at the host site, connect the other end of the system cable to the host system. The cable connects to the RS-232-C port on the controller board back panel. Tighten the screws.

If the 2110A workstation is installed at a remote site, connect the other end of the system cable to the data communications equipment (for example, a modem) according to the instructions supplied with the device. See Section 2.8 for information on local and remote connections.

5. Find the On/Off knob on the front of the monitor. Turning the On/Off knob counterclockwise turns the monitor off; turning the On/Off knob clockwise turns the monitor on. The knob clicks once when the monitor is turned on or off. See Figure 2-5.

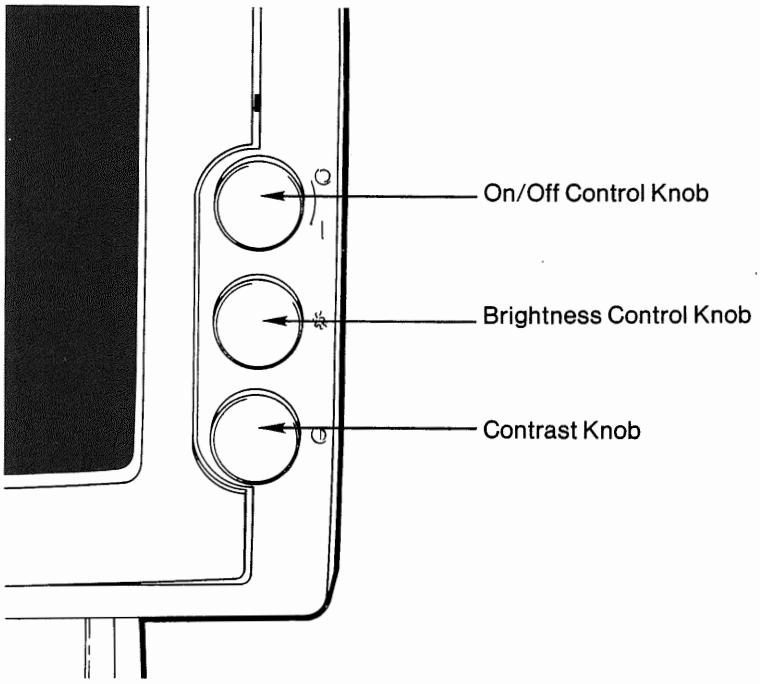

Figure 2-5. Monitor Control Knobs

6. Make sure the monitor is off.

7. Read the Note that is located above the ac power connector on the back of the monitor.

8. Find the voltage switch on the back of the monitor. Make sure the switch setting (either 115V or 230V) matches the power supplied to your work area. Failure to match the setting can damage the equipment. When 115V is visible, the switch is set for 115 volts. When 230V is visible, the switch is set for 230 volts. To change the switch setting from 115V to 230V, insert a ballpoint pen into the slot and push down. See Figure 2-6.

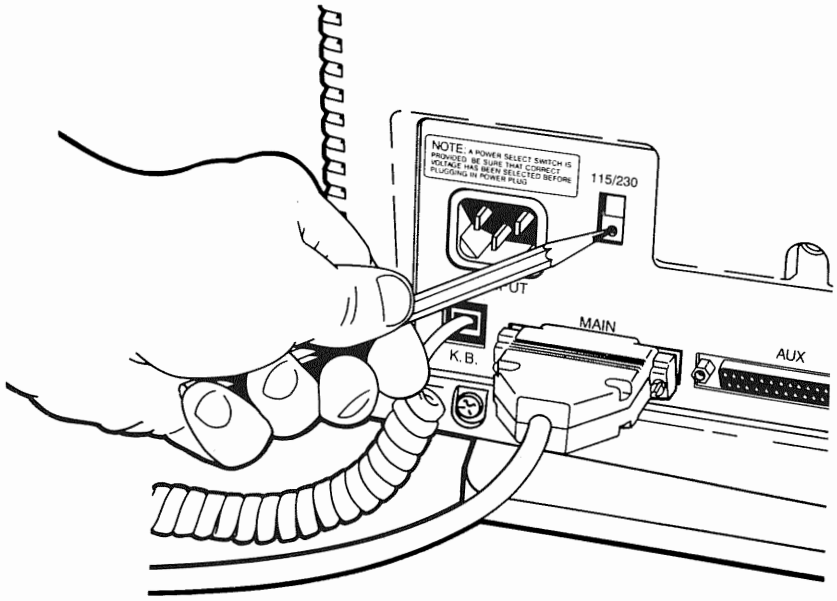

Figure 2-6. Setting the Voltage Switch

9. Read the label that is located across the power cable outlet before removing it. Connect the power cable to the port that is labeled AC INPUT. See Figure 2-7.

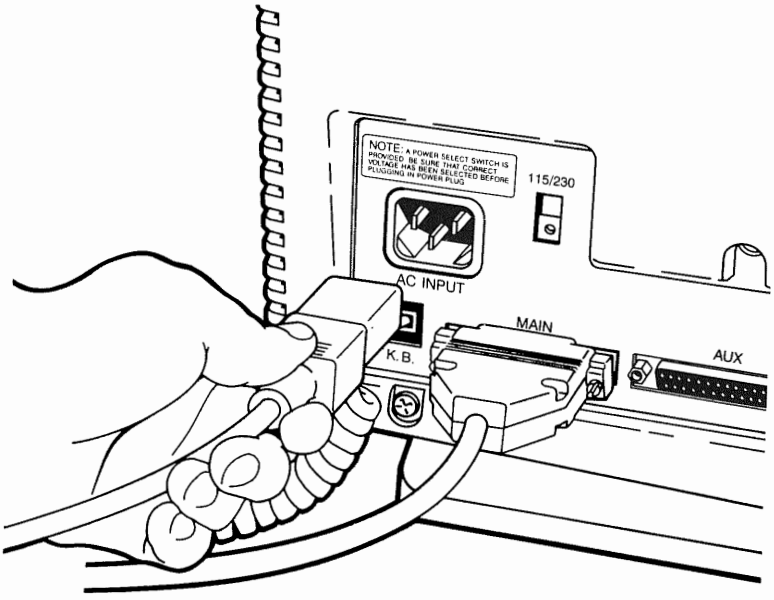

Figure 2-7. Connecting the Power Cable

10. Plug the power cable into an electrical outlet.

2.3 TURNING THE MONITOR ON

To turn the monitor on, turn the On/Off knob on the front of the monitor clockwise. The knob clicks once when you turn the monitor on. After the monitor is turned on:

1. The keyboard responds with one short beep.

2. A screen or cursor appears on the monitor depending upon the host system the terminal is connected to.

3. Adjust the brightness control knob and the contrast knob. See Figure 2-5.

If no screen appears, and a cursor appears in the upper left-hand corner of the monitor screen, the system cable is not correctly connected to the system. Turn the monitor off, re-connect the cable, and tighten the screws on the connector.

If nothing happens when you turn the monitor on, check that,

- The monitor is plugged into an electrical outlet.
- All the cables are correctly connected.
- All the cables are tightly connected.

If the screen or cursor still does not appear on your monitor screen, contact your Wang customer service representative for assistance.

The data transmission rate, communications protocol, power line frequency, communications mode, and keyboard configuration are determined by a series of menu screen selections via Setup Mode.

The default settings are listed in Section 2.6.4 under Setup Mode Screen Descriptions. If your application requires different settings, refer to this section for alternate settings which are located under the default settings. If you need additional information, contact your system administrator.

2.4 TURNING THE MONITOR OFF

To turn the monitor off, turn the On/Off knob on the front of the monitor counterclockwise. The knob clicks once when you turn the monitor off.

Caution: *After turning the monitor off, you must wait at least four seconds before turning it in again. If you turn the monitor on without waiting at least four seconds, the screen will not be restored.*

2.5 CLEANING THE TERMINAL COMPONENTS

Caution: *Before cleaning the terminal, make sure that the monitor is off and the power cable is unplugged from the electrical outlet. If the monitor is not off when you clean the monitor screen, you may receive a static discharge.*

To clean the terminal:

1. Turn the monitor off.
2. Unplug the power cable from the electrical outlet.
3. Dust the keyboard with a soft bristled brush.
4. Clean the monitor screen with a good quality glass cleaner and a lint-free cloth.
5. Dampen a lint-free cloth with a mild soap and water solution; wipe the outside of the monitor.
6. Use another lint-free cloth to dry the monitor.
7. Plug the power cable into an electrical outlet.
8. Turn the monitor on.

2.6 SETUP MODE

Setup Mode allows you to select your terminal's characteristics to match host communications, auxiliary devices, the local power environment, modem support, and to select the keyboard layout.

These characteristics are selcted from a series of menu screens. Each screen displays information which is pertinent to that particular screen and allows you to retain or change that information. Each Setup screen contains the screen title and the various fields (action, parameter, Text entry).

2.6.1 Screen Title

The screen title identifies the current Setup screen. There are six setup screens:

1. Main Menu
2. Main Port Communications
3. Aux Port Communications
4. Keyboard Configuration
5. Modem Support
6. Text entry (accessible only through a Text entry field)

2.6.2 Fields

The fields on each screen are blocks of text describing current operating characteristics. There are three types of fields:

1. Action Field

   An action field has only one value. When an action field is selected, and the EXEC key is depressed, the action is performed.

2. Parameter Field

   A parameter field contains self-describing text that has two or more values. When a parameter field is selected, and the EXEC key is depressed, the current value of the field is replaced with the next value.

3. Text entry Field

   Direct entry of text is accomplished by typing the value from the keyboard. Follow these steps to select a Text entry field:

   a. Use the cursor control keys to highlight the Text entry field.

   b. Press EXEC to enter the Text entry field. Entry to a Text entry field consists of the following:

      1) The current menu and cursor position within the current menu are saved for later restoration.

      2) The Text entry screen is displayed in the Setup Mode area of the screen. See Figure 2-8. The current text string, if any, is displayed with the cursor under the last position of the current string.

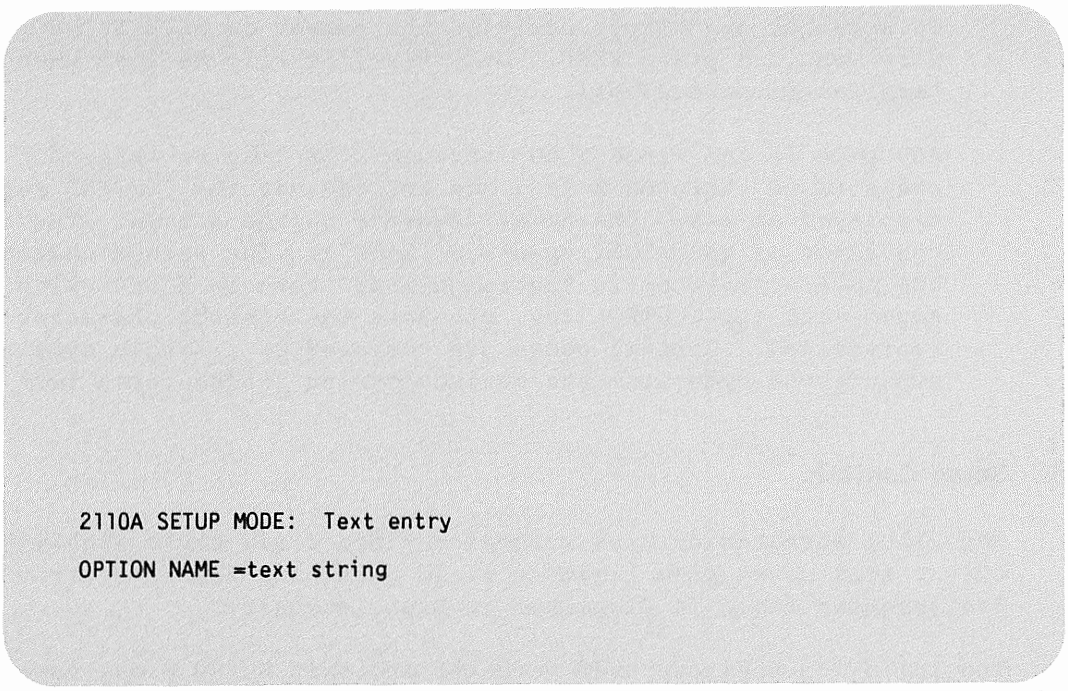

Figure 2-8. The Text Entry Field

3) Type the value or text you want entered as the new value. The first key other than EXEC, CANCEL, or DELETE keyed while in text entry mode, causes the contents of the text string under the cursor to be updated. The keyed character becomes the next character of the new text string, and the cursor is moved one position the right. Every following character keyed causes the representation of the character to be displayed and the cursor advanced. If the limit for text entry is reached while entering text, any additional characters are ignored and the terminal beeps.

4) Press EXEC to update the contents of the text string with the new value(s). After EXEC is keyed, the original Setup menu is restored to the screen and the cursor position is restored.

If you make an error, press DELETE to erase the last character displyed. To erase the entire line, press SHIFT+DELETE. If you want to abort the entry without changing the original value, press CANCEL which returns you to the menu screen.

To save the new entry, position the cursor on SAVE SETUP from the Main Menu and press EXEC. Otherwise, it will be lost when the terminal is powered off.

Any code in the range X'00' through X'7E' may be entered. Control codes (X'00' through X'1F') are entered via the CONTROL key, and displayed as a two-character sequence on the screen. The first character is the ASCII up-arrow (X'5E'). The second character is the ASCII character in the range X'40' through X'5F' which, when keyed with the CONTROL key, produces the control character being represented. Control codes are restored as a single byte and only consume one byte from the maximum string length for a text string.

2.6.3 Setup Controls

The 2110A workstation uses a reverse video field style highlighted cursor that moves from field to field using the keyboard arrow keys. The selected field is displayed in high intensity.

The following keys are used to enter and exit Setup Mode, move the cursor from field to field, and to change the terminal operating characteristics.

CONTROL+SHIFT+HELP	Pressing these keys causes the terminal to enter or exit Setup Mode.

CURSOR CONTROL KEYS

The cursor control keys move the cursor within the option fields.

The east cursor (right arrow)	Moves from left to right on the same line. If it is on the last field, it moves to the first field on the same line.
The west cursor (left arrow)	Moves from right to left on the same line. If it is on the first field, it moves to the last field on the same line.
The north cursor (up arrow)	Moves up to the closest filed on the next line up. If it is on the first option line, it does not move.
The south cursor (down arrow)	Moves down to the closest field on the next line down. If it is on the bottom option line, it does not move.

NEXT key	Causes the display of the next Setup menu.
PREV key	Causes the display of the previous Setup menu.
EXEC key	Activates the function at the currently selected field position. If an action field is selected, EXEC causes the described action to be performed. If a parameter field is selected, pressing EXEC changes the value of the field. The EXEC key can be used to "toggle" through the range of field values. The value displayed at any given time is the current value invoked.

2.6.4 Setup Mode Screen Descriptions

The fields for the various menus are listed below. The default factory settings for each option are located next to the option field. The alternate settings are listed below each field.

Main Menu

The Main Menu is displayed immediately upon entering Setup Mode. This screen allows you access to each of the following menus and allows you to select general terminal operating characteristics. Figure 2-9 shows you the Main Menu with factory default settings.

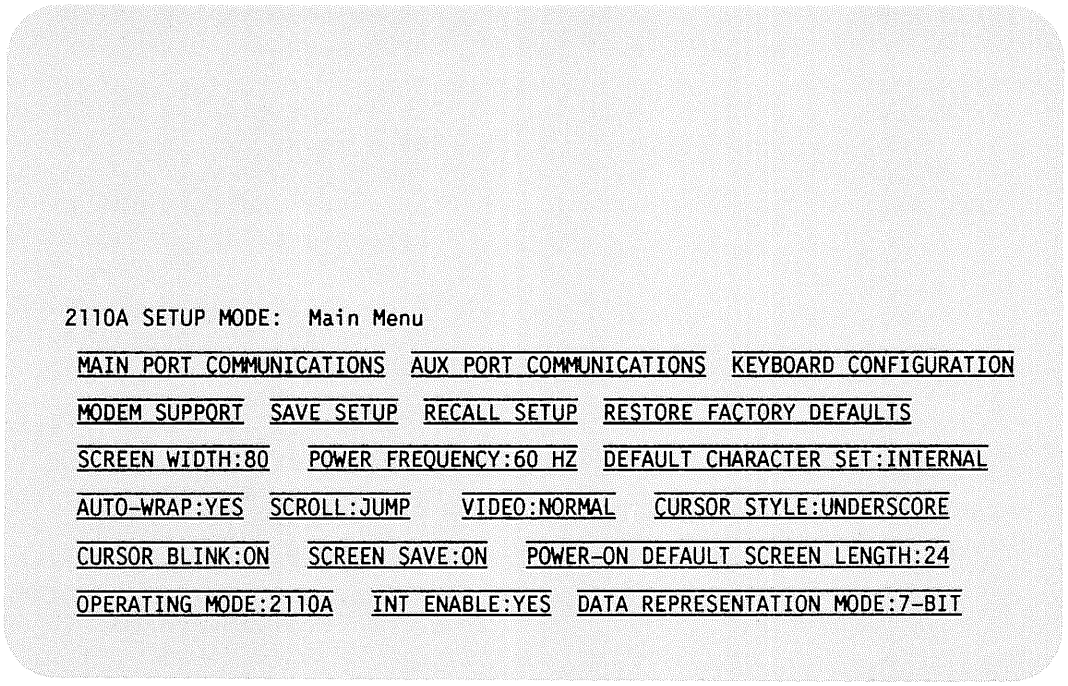

Figure 2-9. The Main Menu

MAIN PORT COMMUNICATIONS action field	Replaces the Main Menu with the Main Port Communications menu.
AUX PORT COMMUNICATIONS action field	Replaces the Main Menu with the Aux Port Communications menu.
KEYBOARD CONFIGURATION action field	Replaces the Main Menu with the Keyboard Configuration menu.
MODEM SUPPORT action field	Replaces the Main Menu with the Modem Support menu.
SAVE SETUP action field	Saves current Setup characteristics from all Setup screens into non-volatile memory.
RECALL SETUP action field	Replaces "working" Setup characteristics with "saved" values.

RESTORE FACTORY DEFAULTS action field	Restores factory installed terminal characteristics as working characteristics.
SCREEN WIDTH: 80 132	Selects an 80 or 132 column screen display for text.
POWER FREQUENCY: 60 HZ 50 HZ	Allows you to select compatibility with local power line frequency.
DEFAULT CHARACTER SET: INTERNAL EXTERNAL	Displays an internal character set or an optional cartridge based external character set.
AUTO-WRAP: YES NO	If enabled, causes a received character after the right margin to be automatically displayed in the first character position of the next line. If disabled, causes received characters after the right margin to be overwritten into the last character position of the current line.
SCROLL: JUMP SMOOTH	Selecting SMOOTH vertical scroll allows text to be scrolled at a smooth and steady pace. Selecting JUMP vertical scroll causes instantaneous text line display updates.
VIDEO: NORMAL INVERSE	Displays either a normal (light character on dark field) or inverse character (dark character on light field).
CURSOR STYLE: UNDERSCORE BLOCK	Highlights the pixels in the bottom two rows of the character cell for underscore. Highlights the entire character cell for BLOCK.

CURSOR BLINK:	ON OFF	The cursor may be displayed as blinking or steady.
SCREEN SAVE:	ON OFF	If enabled, allows the terminal to automatically reduce CRT brightness after 20 minutes of inactivity.
DEFAULT SCREEN LENGTH:	24 25	Selects a 24 or 25 line display for text.
OPERATING MODE:	2110A 2110 VT-102	Selects the current terminal operating mode.
INT ENABLE:	YES NO	Enable Interrupt Control. Allows the user to enable or disable the immediate processing of the INT control sequence.
DATA REPRESENTATION MODE:	7-BIT 8-BIT	Selects the control sequence expression format used for terminal:host communication. 8-Bit data representation may not be selected when the terminal:host data format (See Data Bits under Main Port Communications Menu) currently selected is 7 bits.

Main Port Communications

The Main Port Communications menu allows you to select terminal characteristics to match host communications. Figure 2-10 shows you the Main Port Communications menu with factory default settings.

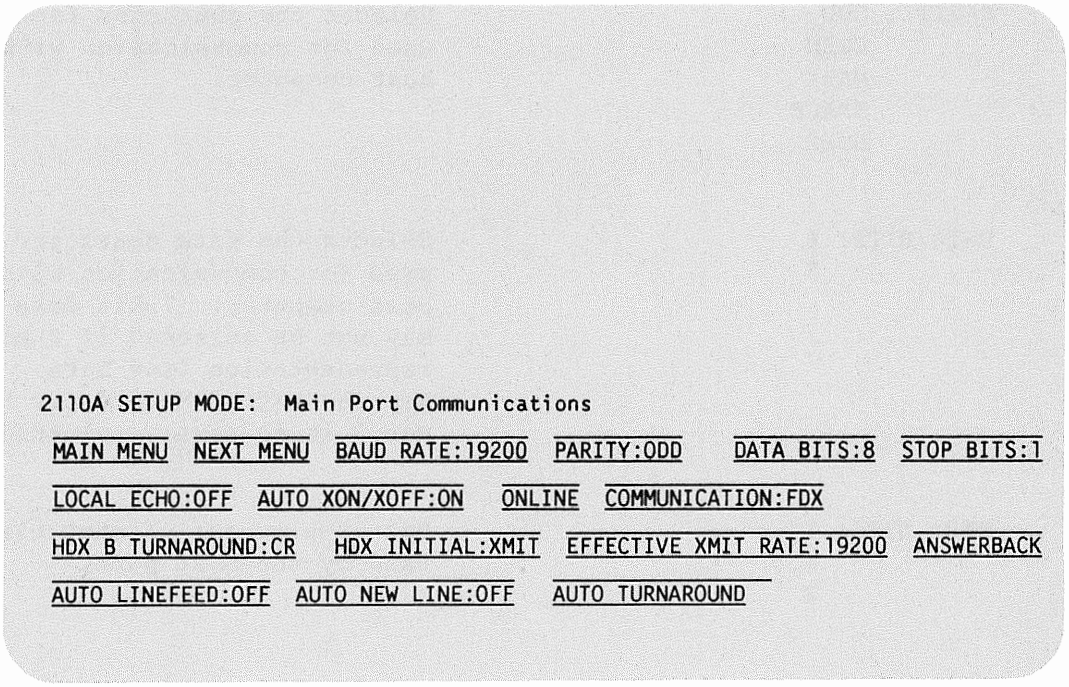

Figure 2-10. The Main Port Communications Menu

MAIN MENU action field	Replaces the Main Port Communications menu with the Main Menu.
NEXT MENU action field	Replaces the Main Port Communications menu with the next menu.
BAUD RATE: 19200 75 110 134.5 150 300 600 1200 1800 2000 2400 4800 9600	Selects the speed at which data is transmitted and received.

PARITY: ODD EVEN MARK SPACE NONE	Selects the character format used for communication with the host computer.
DATA BITS: 8 7	Selects the data character format used for communication with the host computer. 7-bit data format may not be selected if 8-bit data representation (see Data Representation Mode under the Main Menu) is currently selected.
STOP BITS: 1 1.5 2	Sets the number of stop bits used by the host port.
LOCAL ECHO: OFF ON	Enables or disables the Local Echo feature. If enabled, every code with the exception of XON and XOFF that is transmitted from the terminal is displayed on the screen.
AUTO XON/XOFF: ON OFF	Paces data transmission between the host and the terminal. If enabled, allows the terminal to automatically prevent buffer overflow.
ONLINE LOCAL	Allows the terminal to communicate with the host (ONLINE) or to operate independentely (LOCAL).
COMMUNICATION: FDX HDX A HDX B	Allows you to select the main port communication mode.
HDX B TURNAROUND: CR ETX FF DC3 EOT	Allows you to select a particular single byte code that the terminal can recognize as the turnaround character.

HDX INITIAL: XMIT RECV	Allows the terminal to either initiate or receive transmission of data when HDX B is enabled.
EFFECTIVE XMIT RATE: 19200 75 110 134.5 150 300 600 1200 1800 2000 2400 4800 9600	Selects the effective data rate used for data transmission to the host.
ANSWERBACK direct text entry	Allows answerback message entry, up to 32 bytes.
AUTO LINEFEED: OFF ON	Allows you to select whether or not the cursor automatically moves down one line when RETURN is received.
AUTO NEW LINE: OFF ON	Allows you to select whether the keyboard RETURN key generates a carriage return only or a carriage return and a line feed. Also, received linefeeds are interpreted as carriage return+linefeed.
AUTO TURNAROUND MANUAL TURNAROUND	If enabled, the terminal automatically transmits the turnaround character when RETURN is keyed.

Aux Port Communications

The Aux Port Communications menu lets you select terminal characterisicts to match auxiliary devices. Figure 2-11 shows you the Aux Port Communications menu with factory default settings.

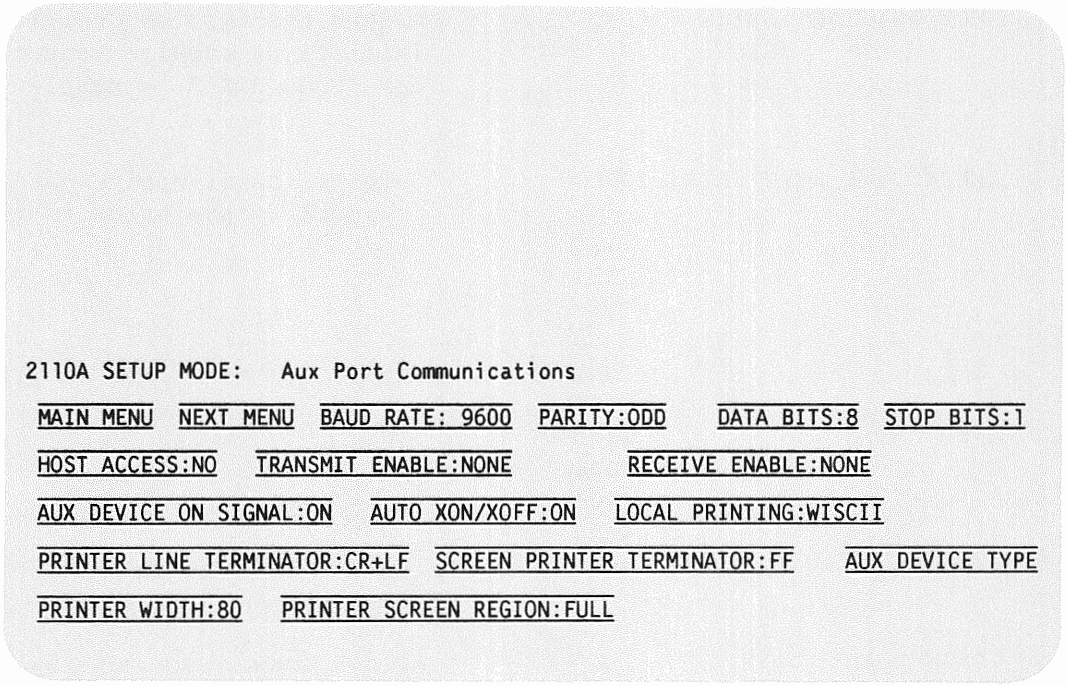

Figure 2-11. The Aux Port Communications Menu

MAIN MENU action field	Replaces the Aux Port Communications menu with the Main Menu.
NEXT MENU action field	Replaces the Aux Port Communications menu with the next menu.
BAUD RATE: 9600 75 110 134.5 150 300 600 1200 1800 2000 2400 2800 19200	Selects the transmission speed between the terminal and an auxiliary device.

PARITY: ODD EVEN MARK SPACE NONE	Selects the character format used for communication with the auxiliary device. See Data Bits.
DATA BITS: 8 7	Selects the character format used for communication with the auxiliary device. See Parity.
STOP BITS: 1 1.5 2	Selects the number of stop bits used by the aux port.
HOST ACCESS: NO YES	Allows you to disable or enable host access to the aux port.
TRANSMIT ENABLE: NONE DSR DRS+CTS DSR+CTS+DCD DSR+CTS-DCD	Allows you to select the aux port signal that enables the terminal to transmit data to the aux device.
RECEIVE ENABLE: NONE RTS	Allows you to select whether or not the terminal may pace the aux device via the RTS signal level.
AUX DEVICE ON SIGNAL: ON DSR	Determines whether or not a signal is needed in order for the terminal to establish the ON/OFF status of the aux device. The device is assumed on if ON is selected.
AUTO XON/XOFF: ON OFF	Enables software pacing of transmission between the auxiliary device and the terminal. If enabled, it allows the terminal or printer to automatically prevent buffer overflow.

LOCAL PRINTING:	WISCII ASCII	Allows you to select Wang WISCII or a non-Wang ASCII character set for local printing.
PRINT LINE TERMINATOR:	CR+LF CR	Selects either a carriage return or a carriage return and a line feed to be output to the printer at the end of a print line as part of Print-Line and Print-Page functions.
SCREEN PRINTER TERMINATOR:	FF NONE	Selects whether or not a terminator (form feed) is sent at the end of a Print-Page operation.
AUX DEVICE TYPE direct text entry, limit 6 characters		Allows you to specify the terminal's response to the host regarding the type of auxiliary device being used.
PRINTER WIDTH:	80 132 40	Selects 40, 80, or 132 characters per line for printing.
PRINT SCREEN REGION:	FULL HOST	Selects how much of the screen (the full screen or a host defined region) is to be printed during a Print-Page operation.

Keyboard Configuration

The Keyboard Configuration menu defines the keyboard's characteristics. Figure 2-12 shows you the Keyboard Configuration menu with factory default settings.

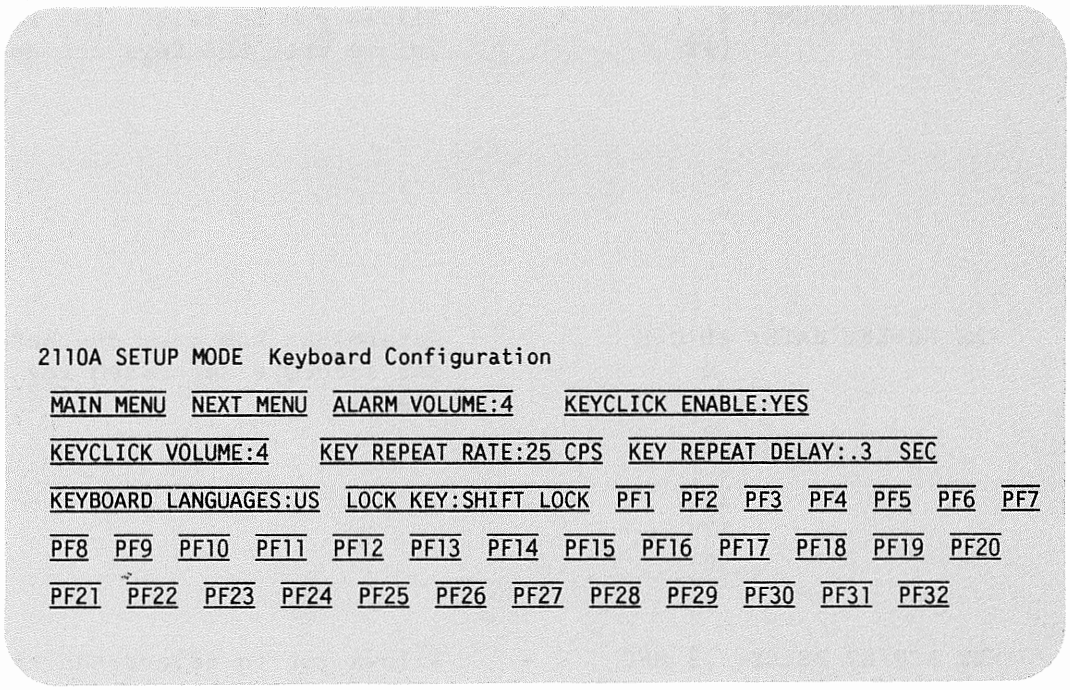

Figure 2-12. The Keyboard Configuration Menu

MAIN MENU action field	Replaces the Keyboard Configuration menu with the Main Menu.
NEXT MENU action field	Replaces the Keyboard Configuration menu with the next menu.
ALARM VOLUME: 4 OFF 1 2 3 5 6 7	Allows you to select the volume at which the terminal responds with a beep.
KEYCLICK ENABLE: YES NO	Allows you to select whether or not the keyboard generates a "click" sound each time a key is pressed.

KEYCLICK VOLUME: 4 OFF 1 2 3 5 6 7	Allows you to select the keyclick volume when the keys are depressed.
KEY REPEAT RATE: 25 CPS 6 7 8 10 12 17 50	Determines how many characters per second a depressed key will generate.
KEY REPEAT DELAY: .3 SEC .1 .15 .2 .25 .35 .4 .45	Allows you to select the time it takes for a depressed key to begin repeating.
KEYBOARD LANGUAGE: US	Allows you to select the correct terminal operation for the particular keyboard you are using.

Keyboard Mnemonic	***Description***
US	USA
AE	AZERTY English
AZ	AZERTY
CA	Canadian English
CF	Canadian French
DV	Dvorak
FL	Flemish
IT	Italian
SE	South African
SP	Spanish European
SL	Spanish Latin American
UK	United Kingdom
WL	World Languages

Keyboard Mnemonic	*Description* (continued)
EDA	Expanded Danish
EFI	Expanded Finnish
EGE	Expanded German
EIC	Expanded Icelandic
ENL	Expanded Dutch
ENO	Expanded Norwegian
EPO	Expanded Portuguese
ESF	Expanded Swiss French
ESG	Expanded Swiss German
ESW	Expanded Swedish
ETU	Expanded Turkish
LOCK KEY: SHIFT LOCK CAPS LOCK	SHIFT LOCK allows you to generate shifted data for all keys. The locked state is entered by pressing the LOCK key. SHIFT LOCK can be cleared by pressing the SHIFT key. CAPS LOCK generates only the uppercase alphabetic keys. The locked state is toggled by pressing the LOCK key.
PF Keys (1 - 32)	Allows you to input text or control codes which can be accessed at any time by depressing the appropriate PF key. See Section 5.2.7 for the default function key strings.

Modem Support

The Modem Support menu lets you select the characteristics of the terminal to match those of a modem device. Figure 2-13 shows you the Modem Support menu with factory default settings.

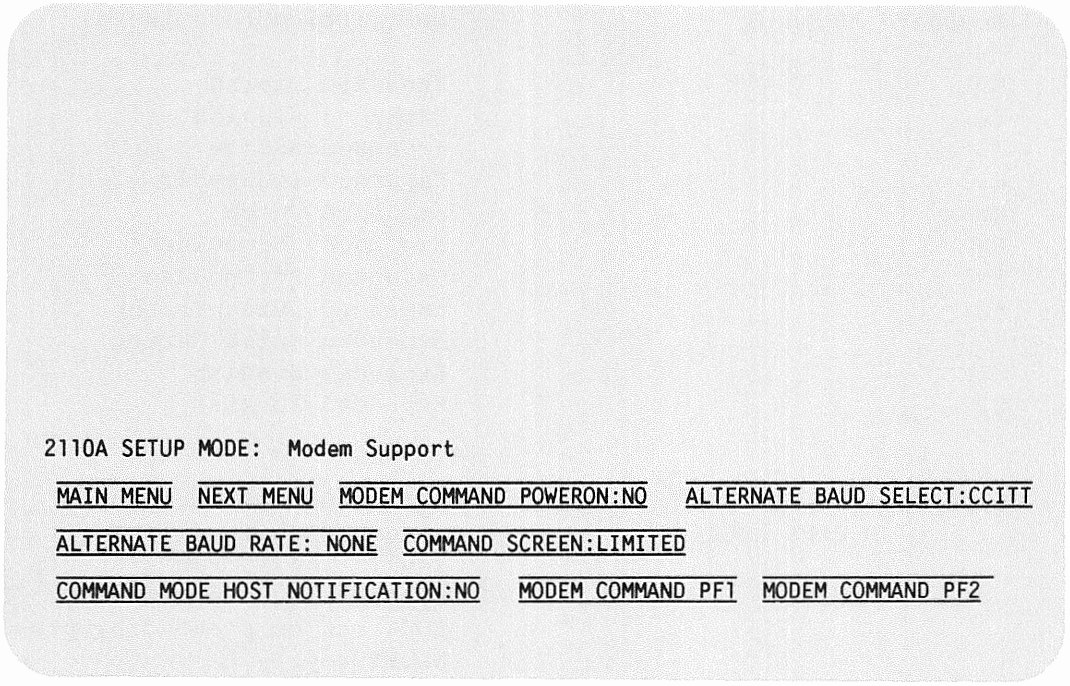

Figure 2-13. The Modem Support Menu

MAIN MENU action field		Replaces the Modem Support menu with the Main Menu.
NEXT MENU action field		Replaces the Modem Support menu with the next menu.
MODEM COMMAND POWERON:	NO YES	If enabled, allows automatic entry into the Modem Command Mode at the completion of power-on or terminal reset.
ALTERNATE BAUD SELECT:	CCITT BELL	CCITT: pin 23 used to enable an alternate baud rate. BELL: pin 12 used to enable an alternate baud rate.

ALTERNATE BAUD RATE: NONE 75 110 134.5 150 300 600 1200 1800 2000 2400 4800 9600 19200	Allows you to select an alternate host port baud rate.
COMMAND SCREEN: LIMITED FULL	If FULL is selected, Terminal Reset is performed on entry/exit to Modem Command Mode. Full screen area is made available. If LIMITED is selected, Terminal Reset is not performed; original screen contents are not lost. A limited screen area is available for terminal:modem dialog.
COMMAND MODE HOST NOTIFICATION: NO YES	Selects whether or not the host is notified of entry into or exit from Modem Command Mode.
MODEM COMMAND PF1	Direct text entry up to 32 bytes.
MODEM COMMAND PF2	Direct text entry up to 32 bytes.

2.6.5 Additional Technical Notes

When the terminal is operating, there are always two copies of Setup options. One copy is stored in non-volatile (NV) RAM. Another copy, the actual current Setup options, is stored in working RAM. Setup Mode directly changes only the copy in working RAM, but gives you the ability to copy the current working Setup options to NV RAM for later recall.

In addition to being stored in NV RAM, the factory default settings of the Setup options are stored in program ROM for possible recall. When recalled they replace the current working copy of Setup options.

Upon entry to Setup Mode, the following occurs:

1. If the terminal is operating ONLINE, COMMUNICATION=FDX, and AUTO XON/XOFF is enabled for the main port, the terminal transmits XOFF to the host.

2. The Main Menu is displayed. Setup Mode display is always in 80-column format, regardless of the current terminal operating mode.

Upon exiting from Setup Mode, the following occurs:

1. The former screen contents are restored. Current page(s) contents, viewports, and page:viewport mapping are the same as before entry to Setup Mode unless a Setup option change affects display.

2. The newly selected options in Setup Mode are now the current working Setup options.

3. If the terminal is ONLINE, COMMUNICATION=FDX, and AUTO XON/XOFF is enabled for the main port, the terminal transmits XON to the host if the flow from the host to the terminal is currently enabled according to normal flow control rules. If not, the terminal does not transmit XON until the main port receive buffer (and aux port transmit buffer if routing is to aux port) becomes sufficiently empty to enable flow from the host to the terminal.

In cases where the Setup option corresponds to a host alterable value (such as modes), the default value after RIS or power-on is determined by the saved Setup option, and the current value is set to the Setup option value whenever the Setup option is changed. Also, when the host changes a value with a corresponding Setup option, the current Setup option value becomes the value set by the host. Value changes by the host do not alter Setup option values saved in NV RAM (unless the operator later manually saves new current Setup options).

The power on default states of modes that are affected by Setup Mode are made equivalent to those currently stored in NV-RAM.

In order to avoid undesirable effects while communications options are being toggled, the selection of the Setup option for COMMUNICATION (FDX, HDX A, HDX B, LOCAL) should not not take effect until exiting from Setup Mode. Changes in this mode, or any other mode, does not cause the terminal to execute RIS when exiting Setup Mode.

When exiting Setup Mode, if COMMUNICATION has been changed from FDX to LOCAL, the terminal will transmit XOFF to host if it has not already done so. When exiting Setup Mode, if COMMUNICATION has been changed from LOCAL to FDX, the terminal will transmit XON to the host to re-enable transmission if the terminal is ready to resume receiving host data (main port receive buffer not full, etc.). Implementation of Setup changes between LOCAL and FDX should be such that the operator may enter/exit Local Mode without loss of host data, provided that the host is responsive to XON/XOFF controls.

While in Modem Command Mode with RIS not enabled (the modem command screen limited to seven 80 column rows), you can still enter Setup Mode. However, the current contents of the modem command page area are lost. When exiting Setup Mode, Modem Command Mode is restored. On return to Modem Command Mode, the command page display area is cleared except for the last line on the screen which displays the centered text "*** MODEM COMMAND MODE ***".

The PRINT SCREEN REGION selection available from the Aux Port Communications menu in Setup Mode allows you to enable/disable use of the host defined local print region. When FULL is selected, the local print screen operation always prints the full screen contents regardless of current host-defined print-screen region. However, the boundaries of the host-defined local print region continue to be maintained in the terminal and may be re-enabled for use at a later time via Setup Mode.

Any attempt to change the option SCREEN WIDTH from 80 to 132 is rejected unless there is sufficient page pool memory available to widen all defined non-null pages to a minimum of 132 columns. If there is not enough page pool memory available, the terminal beeps once and flashes the message "*** INSUFFICIENT DISPLAY MEMORY ***" on the top line of the Setup menu. The message is removed when the next keystroke is keyed.

2.7 SET TAB MODE

Set Tab Mode is a special terminal operating mode allowing user access for setting and clearing tab stops. You can enter Set Tab Mode at any time except while in Setup Mode. Figure 2-14 shows you the format of Set Tab Mode.

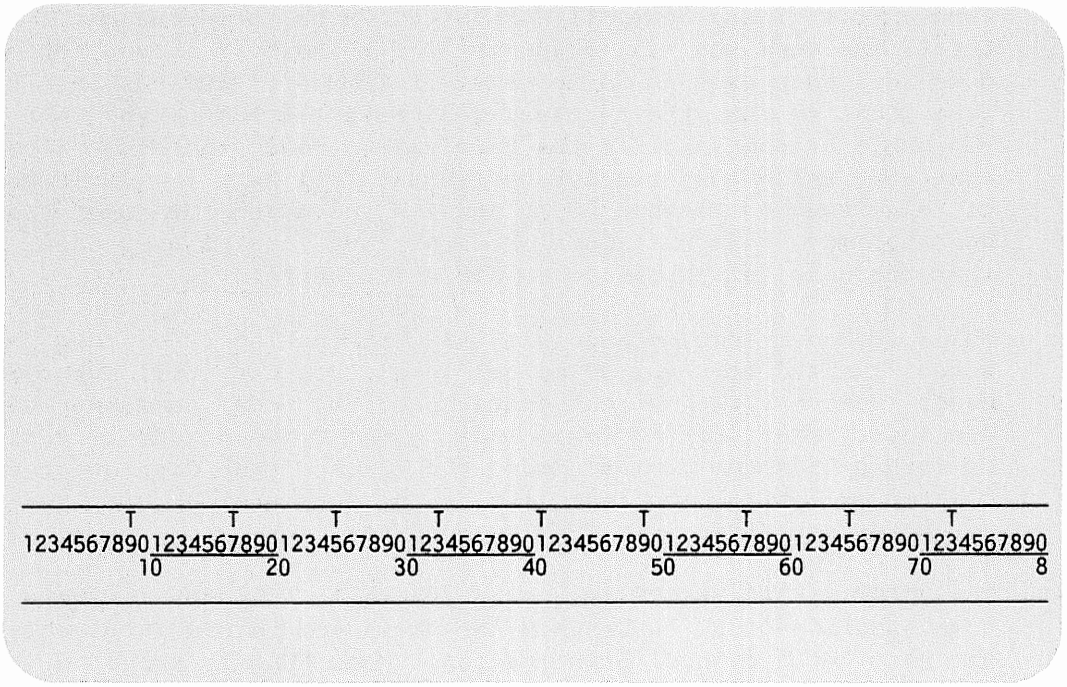

Figure 2-14. The Set Tab Mode Screen

2.7.1 Entering Set Tab Mode

To enter Set Tab Mode, press CONTROL+SHIFT+TAB. Entry to Set Tab Mode consists of the following:

- The current 23rd, 24th, and 25th lines of the physical screen are saved and replaced with the Set Tab display. Figure 2-14 represents the 3-line display, occupying lines 23, 24, and 25.

- There are 255 available tab stop positions. Each screenload displays 80 tab stop positions. The current tab stops are indicated by "T". Other positions are displayed as spaces.

- The cursor moves only on the 23rd line.

- Line 23 is displayed in reverse video. Positions on line 24 alternate between normal and reverse video. In Figure 2-10, the underlined numbers indicate the portions of line 24 that are displayed in reverse video. Line 25 is displayed in normal video.

The following keys can be used while in Set Tab Mode.

EAST CURSOR	Causes the cursor to move left to right on the 23rd line.
WEST CURSOR	Causes the cursor to move right to left on the 23rd line.
INSERT	Sets tab stop at the current cursor position. The cursor does not move.
DELETE	Removes tab stop at the current cursor position. The cursor does not move.
SHIFT+DELETE	Removes tab stops from all positions (1 through 255).
SHIFT+INSERT	Restores the default tab stops (1 through 255). The tab stops are set every eight columns with the first tab stop in column 9.
CANCEL	Restores the display of the current working tab stops to the 23rd line..

2.7.2 Exiting Set Tab Mode

To exit from Set Tab Mode, press CONTROL+SHIFT+TAB. Exiting Set Tab Mode consists of the following:

- The 25th line is replaced by the query "Save TABS (Y/N)".
- Enter either "Y" or "N" (shifted or unshifted) to exit from Set Tab Mode. The new tab stop settings replace the current working tab stops. In addition, if "Y" is keyed, the new tab stop settings are saved in NV RAM.
- The screen and terminal are restored to their previous state immediately prior to entering Set Tab Mode.

2.8 CONNECTING THE 2110A WORKSTATION TO THE HOST SYSTEM

In order to connect the 2110A to the host system, you must ensure that a compatible circuit exists between the terminal's main port communication serial interface and the host's communication serial interface. Table 2-1 shows the pins used by the terminal's main port communication serial interface for generating RS-232-C standard signals.

Table 2-1. 2110A Main Port RS-232-C Pin Usage

Pin	Mnemonic	Definition
1	PG	Protective Ground
2	TXD	Transmitted Data
3	RXD	Received Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	SG	Signal Ground
8	DCD	Data Carrier Detect
12	SCF	Secdondary Received Line Signal Detector
20	DTR	Data Terminal Ready
23	CH/CI	Data Signal Rate Detector

2.8.1 Local Connections

The 2110A workstation is either connected to the host system via a pair of RS-232-C-compatible cables joined by a null modem or by a single length of null modem cable. The null modem or null modem cable connects the signals between appropriate pins at the source and destination connectors.

Null modem cables must be ordered separately from WangDirect and are available in the following lengths: 25 feet, 50 feet, 100 feet, 500 feet, 1000 feet, and 2000 feet. Figure 2-15 shows the connections between pins in a typical Wang null modem cable.

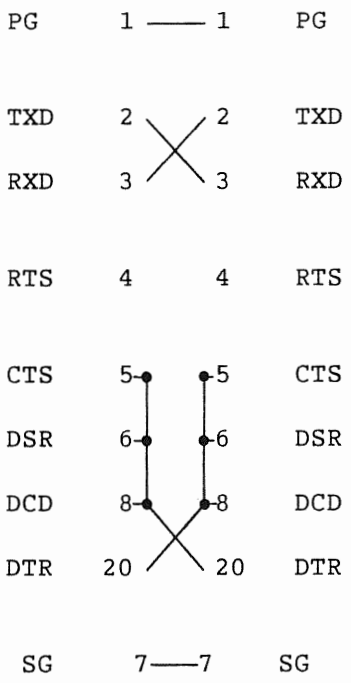

Figure 2-15. Pin Pairings in a Typical Null Modem Cable

The RS-232-C specification recommends that the local link via RS-232-C cables and a null modem or via null modem cable be limited to 50 feet or less. However, the 2110A and the Wang controllers designed to be used with the 2110A support transmission across 2000 feet of RS-232-C-compatible cable. Therefore, you can connect a local 2110A workstation up to 2000 feet from a Wang host system (provided a Wang Customer Engineer has configured the terminal for 2000 foot operation).

The distance supported for local connections between the 2110A and a non-Wang host depends on the host's transmission limitations, but can be up to 2000 feet if the host can transmit to this distance across RS-232-C-compatible cable.

2.8.2 Remote Connections

You can connect a remote 2110A workstation to a host system by using compatible asynchronous modems to interface the RS-232-C cable from the terminal and the RS-232-C cable from the the host system to opposite ends of an analog communications line. The RS-232-C specification recommends that neither cable to the modem should exceed 50 feet.

If the communications line is digital, rather than analog, the connection is made using an appropriate interface device other than a modem. For example, RS-232-C cable is connected to a digital PBX using a data module (called a data adaptor, data interface unit, or other name depending on the PBX vendor) that adapts the RS-232-C signals to the PBX vendor's environment.

Note: *Null modem cable, because of its crossed pin signals, must not be used for the host-to-modem (controller-to-modem on the Wang host) or terminal-to-modem connections that are required for remote links.*

CHAPTER 3
COMMUNICATIONS

3.1 OVERVIEW

The 2110A workstation is equipped with a main port and aux port for communicating with the host and auxiliary devices. This chapter describes the 2110A's main and auxiliary communications environment.

3.2 MAIN PORT

The main port is the communications link between the terminal and the host. The terminal's main port interface is a standard 25-pin RS-232-C. The main port can be configured (via a logic PC board jumper) to permit communication to a maximum of 2000 feet. Table 2-1 lists the pins used by the terminal's main port communication serial interface for generating RS-232-C standard signals. The main port supports three communications modes:

- Full Duplex (FDX) Mode
- Half Duplex A (HDX A) Mode
- Half Duplex B (HDX B) Mode

3.2.1 Full Duplex Mode Operation

Transmission can be carried on in both directions at the same time. When powering up, the following sequence oocurs:

1. Power is applied to the unit.

2. Data Terminal Ready (DTR) and Request To Send (RTS) are held in the unasserted state.

3. The terminal completes initialization.

4. The terminal asserts DTR. When DSR is asserted, the terminal asserts RTS.

5. The terminal monitors state of Data Set Ready (DSR), Data Carrier Detect (DCD), and Clear to Send (CTS).

6. When the inputs DSR and DCD are asserted, the terminal assumes the ability to receive data. When the inputs DSR and CTS are asserted, the terminal assumes the ability to transmit data.

The terminal continuosly monitors the state of DSR, DCD, and CTS. If any one of these signals drops, the terminal considers the receive and/or the transmission mode(s) disabled. The terminal's response is detailed below:

- When DSR is in the de-asserted state, the terminal ceases both the transmission and receipt of data.

- When DCD is in the de-asserted state, the terminal ceases the receipt of data.

- When CTS is in the de-asserted state, the terminal ceases the transmission of data.

When receive mode is disabled, characters already received are processed normally. If the receive buffer contains an incomplete control sequence, the terminal suspends interpretation of the control sequence until receipt of data is re-enabled. While transmit mode is not enabled, keycodes generated by the keyboard continue to go into the buffer. If a keystroke cannot be buffered because the buffer is full, the terminal beeps. At all times, the terminal continues to process local key sequences identified by SHIFT+CONTROL+GL.

When transmit and/or receive modes are re-enabled, the terminal continues where it was interrupted. New received characters are considered to follow the last character received before the connection dropped and processing continues. Keyboard processing and transmission resumes from where it was interrupted.

3.2.2 Half Duplex Mode Operation

Transmission can only be carried on in one direction at a time; the direction can be reversed. There are two types of half duplex operations - Half Duplex A and Half Duplex B.

AUTO XON/XOFF (See Section 3.3.2) is not supported as flow control in either of the half-duplex modes. The terminal queues XON for transmission at the completion of the VT-102 mode confidence test. With the exception of the case where DC3 is used as a turnaround character, received XON and XOFF codes are completely ignored in Half Duplex Mode.

Half Duplex A Mode Operation

When powering up, the following sequence occurs:

1. Power is applied to the unit.

2. DTR and RTS are held in the unasserted state.

3. The terminal completes initialization.

4. The terminal asserts DTR.

5. The terminal monitors the state of DSR. When DSR is detected, the terminal assumes the connection is established.

   Note: *At all times, the terminal monitors the state of DSR. If this signal drops, the terminal considers the connection broken and exits transmit or receive mode until connection is re-established.*

6. The terminal enters the 'idle state'. The idle state is defined as that condition where DSR is asserted and neither transmit (RTS is de-asserted) nor receive (DCD is de-asserted) modes are enabled. Entry into transmit mode or receive mode is always from the idle state.

The terminal exits the idle state and enters and remains in receive mode, whenever, and as long as, the following are true. Note that RTS is always de-asserted, and may not be asserted while in receive mode.

- DSR is asserted
- DCD is asserted
- CTS is unasserted

If any one of these conditions fails to be true, receive mode is terminated following the receipt of the current character (if any). The terminal returns to the idle state as long as DSR is asserted.

When the terminal has character(s) to transmit, the terminal attempts to enter transmission mode from the idle state as follows:

1. The terminal insures that CTS and DCD are de-asserted. If either are asserted, the terminal returns to the idle state.

2. The terminal asserts RTS.

3. The terminal waits for CTS to be asserted. If DCD is asserted during this time, RTS is de-asserted and the terminal returns to the idle condition to allow entry to receive mode.

4. When CTS is asserted, the terminal begins transmitting. The terminal stops transmitting and de-asserts RTS when either 20 bytes have been transmitted, or when the transmit buffer is empty. The terminal then returns to the idle state for the next operation (if any).

Note: *A delay exists between the terminal's de-asserting RTS and the modem's deasserting CTS.*

The Setup Mode option LOCAL ECHO (See Section 2.6.4 under the Main Port Communications menu) is normally selected together with Half-Duplex operation. However, you always have the option to disable LOCAL ECHO via Setup Mode. When LOCAL ECHO is enabled together with Half Duplex operation, data in the transmit buffer is echoed after data is transmitted.

While in Half Duplex operation, the terminal ignores DCD when CTS is asserted. Also, the state of DSR is not considered before asserting DTR.

Half-Duplex B Mode Operation

Operation in Half Duplex B Mode is the same as described for Half Duplex A operation except for the following:

- In addition to Half Duplex A restrictions, the terminal waits for the receipt of the turn-around character before attempting to shift from receive to transmit state (asserting RTS, etc). The exception to this is immediately following power-on or RIS when the initial host:terminal communication direction default is defined as 'transmit' via Setup Mode.

- The terminal begins communication with the host in transmit mode if the Setup Mode option HDX INITIAL=XMIT (See Section 2.6.4 under the Main Port Communications menu) and provided Half Duplex A transmit requirements are met.

- Except as noted, the terminal transmits the turnaround character selected in Setup Mode immediately prior to exiting transmit mode. Once the terminal enters transmit mode, the terminal remains in transmit mode until one of the following occurs:

  - The terminal completes transmission of an answerback message.

  - The terminal completes transmission of a cursor position report.

  - The terminal completes transmission of a device status report.

  - The terminal completes transmission of any of the Device Attributes sequences.

- MANUAL TURNAROUND is selected via Setup Mode and the terminal completes transmission of turn-around character. If the turn-around character is defined as CR, CR is sent only once. Unlike HDX A Mode, while in HDX B Mode, the terminal remains in the transmit state until transmission of the current turnaround character. The '20 byte transmit limit and the transmit buffer empty condition do not cause the terminal to exit the transmit state.

- AUTO TURNAROUND is selected via Setup Mode and CR is keyed. The terminal transmits the turnaround character and exits the transmit state whenever CR is keyed.

- While in transmit mode, if DSR or CTS becomes de-asserted, the terminal exits transmit mode immediately. While in transmit mode, DCD is ignored. Note that you are responsible for disconnecting the telephone link by manually keying the "Suspend Processing and De-assert DTR" local key sequence.

3.2.3 Main Port Transmit and Receive Buffering

The terminal's main port receive buffer is 256 characters in size. When enabled via Setup Mode, XON/XOFF transmission for flow control is implemented as follows:

- When host-to-terminal routing is enabled, transmission is suspended when the remaining main port receive buffer capacity is less than 64 bytes (XOFF sent only once). Transmission is resumed when less than 32 characters remain in the main port receive buffer.

- When host-to-aux-port routing is enabled, transmission is suspended when the remaining main port receive buffer capacity is less than 64 bytes or the remaining aux port transmit buffer capacity is less than 96 bytes (XOFF sent only once). Transmission is resumed when both the main port receive buffer and the aux port transmit buffer each contain less than 32 bytes.

The terminal's main port transmit buffer is 256 characters in size. When enabled via Setup Mode, received XON/XOFF characters start/stop transmission by the terminal. When the transmit buffer becomes full and additional keycodes cannot be put into the buffer, the terminal beeps each time a keycode must be discarded. However, the terminal still monitors for keystrokes associated with local terminal functions such as entry to Setup Mode or the SHIFT+CONTROL+GL keystroke indicating the start of a locally-processed keystroke. All local keystroke sequences are processed immediately.

When an error occurs on received data (parity, overrun, or framing errors), the terminal writes the character located in the Internal CG ROM position X'1E at the current active position. The terminal does not beep on received data errors. It is possible that the parity error character may not be visible since the current page:viewport mapping may not provide for the display of the position it is written to.

3.2.4 Modem Selected Baud Rate Support

Main port hardware supports the continuous monitoring of the state of pins 12 and 23 as inputs when use of alternate transmit rate is enabled via Setup Mode. When alternate transmit rate is enabled, the state of these pins has the following effect:

- Whenever input to pin 23 (or pin 12 when enabled via Setup Mode) is de-asserted, the terminal's main port uses the default transmit/receive rate.

- Whenever input to pin 23 is enabled via Setup Mode (CCITT control selected from ALTERNATE BAUD RATE under the Modem Support menu), the asserted state of pin 23 enables alternate transmit/receive baud rate; input to pin 12 is ignored. Whenever input to pin 12 is enabled via Setup Mode (BELL control selected), the asserted state of pin 12 enables alternate transmit/receive baud rate; input to pin 23 is ignored.

Modem selectable baud rate is supported in both full and half duplex operating modes.

Implementation of modem selection of baud rate occurs during the vertical retrace period. The terminal does not attempt to change the current baud rate until the transmission of the current byte, if any, is complete. The terminal is not responsible for loss of received data due to baud rate change. To avoid loss of data, the host is expected to allow enough time for the terminal to complete baud rate change before resuming transmission.

3.3 AUX PORT

The aux port is the communications link between the terminal and an auxiliary device. The terminal supports full duplex communication to the aux device. The terminal may also be configured to provide a bi-directional data path between the host and the aux device.

The terminal's aux port interface is a standard 25-pin EIA RS-232-C asynchronous port. Transmission rates can be selected through Setup Mode (see Section 2.6). Communication flow control is selectable through Setup Mode. The aux port allows for local print functions. It supports either a generic (ASCII) non-Wang printer or a standard WANG (WISCII) printer. Table 3-1 lists the RS-232-C signals implemented on the terminal's aux communication port serial interface.

Table 3-1. 2110A Aux Port RS-232-C Pin Usage

Pin	Mnemonic	Definition
1	PG	Protective Ground
2	TXD	Transmitted Data
3	RXD	Received Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	SG	Signal Ground
8	DCD	Data Carrier Detect
12	SCF	Secdondary Received Line Signal Detector
20	DTR	Data Terminal Ready

3.3.1 Aux Port Communication Handling

The aux port transmit and receive buffers are each 256 bytes in size. Aux port communication operates only in Full Duplex Mode. The terminal asserts DTR and RTS outputs following power-on initialization.

Depending upon current Setup Mode selections, the terminal determines the aux device to be "ON" as follows:

- The aux device is always assumed to be "ON".
- The aux device is "ON" when DSR input is asserted.

When the aux device state changes from "OFF" to "ON", the terminal re-enables the XON/XOFF status with respect to data being transmitted from the aux port.

The terminal receives data from the aux device whenever the state of the aux device is "ON". If the state is not "ON", received aux data is ignored. If the Setup Mode option RECEIVE ENABLE=RTS (located under the Aux Port Communications menu) is active, the terminal de-asserts RTS output, as necessary, to request that the aux device stop transmitting data to the terminal.

The terminal, however, continues to receive aux port input data. If the aux port buffer is full, any additional received characters are scanned for XON/XOFF flow control bytes (if XON/XOFF flow control is enabled) and then discarded. The terminal always requires that the aux device be "ON" prior to transmitting aux port data. Depending upon Setup Mode selections, the following signal conditions may be required for transmission of data from the aux port:

- None (no signals are required in addition to the "ON" condition).
- DSR is asserted.
- DSR and CTS are both asserted.
- DSR, CTS, and DCD are all asserted.
- DSR and CTS are both asserted, and DCD is de-asserted.

The aux port received errors are ignored to the extent that the character in error is discarded. No indication of aux port receive error is provided to either the operator or the host.

Parity, baud rate, and required number of data bits and stop bits for aux port communication are configured independently of the main port. You configure these characteristics from the Aux Port Communications menu in Setup Mode. When aux port data bits is set to 7, the high bit of data to be transmitted is ignored and the eighth (most significant) bit of received data is set to zero.

When Setup Mode selects AUTO XON/XOFF (see Section 3.3.2), together with the use of hardware signals for TRANSMIT ENABLE, aux port data is transmitted only when both hardware and software flow control mechanisms indicate transmission enabled.

When Setup Mode selects AUTO XON/XOFF together with RECEIVE ENABLE:RTS, the terminal uses both mechanisms when it is necessary to request that the aux device stop transmitting data. The sequence to request the aux device to cease transmitting is to first send XOFF character, and then de-assert RTS. The sequence to inform the aux device that it may resume transmitting is to first assert RTS, and then to output XON character.

3.3.2 Aux Port AUTO-XON/XOFF

When XON/XOFF flow control is selected for the aux port via Setup Mode:

- The terminal continually monitors aux port received data for XON/XOFF codes and interprets them as flow control, regardless of whether aux-to-host routing is enabled. This monitoring continues even if the aux port receive buffer becomes full. When enabled for flow control, these codes are not buffered and, therefore, are not passed on to the host.

- The terminal transmits XON/XOFF codes to the aux device as necessary, regardless of whether host-to-aux routing is enabled.

When XON/XOFF flow control is disabled for the aux port, the terminal continues to monitor for XON/XOFF characters received via the aux port. These characters are buffered as data only if aux port Transparency Mode is enabled. See Section 6.4 for information on Transparency Mode. When Transparency Mode and aux port AUTO XON/XOFF are both disabled, XON/XOFF characters received from the aux device are discarded without being buffered.

3.3.3 Host and Aux Port Data Routing

Host:aux port access support is intended to provide a "pipeline" between the host and a device attached to the terminal's aux port. This section describes the flow of data between the host and auxiliary device via the aux port. The terminal handles flow control and monitors host data for path switching controls, but, otherwise simply passes data between the host and aux device. The host controls the current routing of data through the terminal.

The routing of data received from the host (to the terminal or to the aux device) may be controlled independently of the routing of data being sent to the host (from the terminal or from the aux device). Figure 3-1 outlines the data pathways through the terminal.

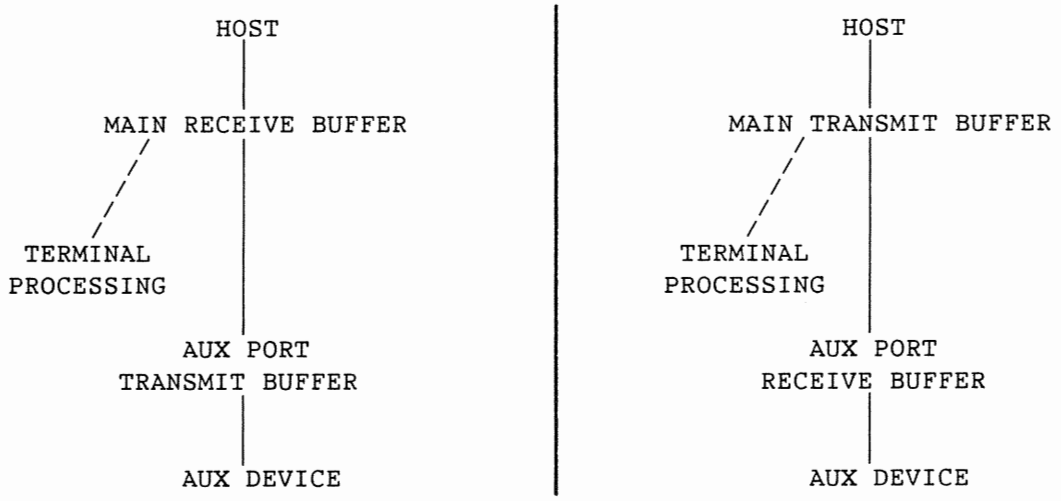

Figure 3-1. Data Pathways

3.3.4 Received Data Pathways

All data comming from the host is received in the terminal's main receive buffer. If current routing for received data is 'to terminal', data passes from the main receive buffer into normal terminal processing. If current routing is 'to aux-device', data passes from the main receive buffer to the aux port transmit buffer. Data in the aux port transmit buffer is output to the aux port device as flow control allows.

3.3.5 Flow Control Within Received Data Pathways

The flow of received data from the host is controlled by the terminal sending XON/XOFF to the host, as necessary, when enabled through Setup Mode.

When host-to-terminal routing is enabled, the enabling of transmission of data from the host is determined solely by the remaining capacity of the main port receive buffer. Receive buffer capacity is 256 bytes. The terminal disables host transmission when the remaining capacity is less than 64 characters. The terminal enables host transmission (XON transmitted) when less than 32 characters remain in the receive buffer. If AUTO XON/XOFF is enabled, XOFF is only sent once to disable the host; it is the host's responsibility to act on the single XOFF control code sent.

When host-to-aux-port routing is enabled, the transmission of data by the host is determined by the states of both the main receive buffer and the aux port transmit buffer. The aux port transmit buffer capacity is 256 bytes.

The terminal suspends transmisssion when either the remaining main port receive buffer capacity is less than 64 characters or the remaining aux port transmit buffer capacity is less than 96 characters.

The terminal resumes transmission only when both the main port receive buffer and the aux port transmit buffer contain less than 32 characters.

When transmission is suspended, due to the aux port transmit buffer condition, the terminal continues to move any data remaining in the main port buffer into the aux port transmit buffer. If the aux port transmit buffer becomes completely full, the movement of data from the main port receive buffer to the aux port transmit buffer ceases. If the main port receive buffer should become completely full, additional received characters (while buffer remains full) are discarded, but only after being tested for XON, XOFF, and INT controls.

The complexities of the flow control are intended to insure, that in normal operation, the host will always be able to switch back to host-to-terminal routing after receiving an XOFF while in host-to-aux routing. A critical assumption to this is that the processing time needed to move characters from the main port receive buffer to the aux port transmit buffer is always insignificant compared to the shortest per character receive time.

Flow control for data transmitted from the aux port transmit buffer to the aux device is determined by the current Setup Mode option selections.

3.3.6 Flow Control Within Transmitted Data Pathways

Regardless of which routing is selected, the flow of data transmitted to the host is controlled by the host sending XON/XOFF, as necessary, when enabled through Setup Mode. When the terminal receives XOFF from the host, the terminal stops transmitting data from the main port transmit buffer. When the terminal receives XON from the host, the terminal resumes transmitting data from the main port transmit buffer when it becomes available.

When terminal-to-host routing is enabled, data from terminal processing (such as query responses and processed keystrokes) is placed into the main port transmit buffer. Main port transmit buffer capacity is 256 bytes. If terminal processing finds the main port buffer full when attempting to add a keycode to the buffer, it discards the keycode and beeps. If terminal processing finds the main port buffer full when attempting to transmit a response to a host command, buffering of the response is suspended until room becomes available in the main port buffer. Responses are not discarded.

When aux-port-to-host routing is enabled, data flows in the following sequence:

1. From the aux device into the aux port receive buffer
2. From the aux port receive buffer to the main transmit buffer
3. From the main transmit buffer to the host

The transfer of data from the aux port receive buffer to the main port transmit buffer occurs only when the main port transmit buffer contains fewer than 32 characters. Therefore, the main port transmit buffer never contains more than 32 characters of data from the aux port path. Aux port receive buffer capacity is 256 bytes. If aux-port-to-host flow control is enabled, the terminal inhibits flow from the aux device when the aux port receive buffer has room for only 64 additional characters.

The terminal re-enables flow from the aux device when the aux port receive buffer empties to only 32 characters. If the aux receive buffer becomes full, further characters received from the aux device are discarded until room becomes available in the aux port receive buffer. When XON/XOFF aux device flow control is enabled, scanning for XON/XOFF characters continues even when received aux device characters are being discarded.

By specifying that the main port transmit buffer never contains more than 32 characters from the aux port device, the host does not have to wait long to obtain keyboard input after switching from aux-port-to-host routing to terminal-to-host routing, even at low transmit speeds. For example, at 300 bps (which is probably the lowest common operating speed) the host would begin receiving pending keystrokes within 1 second after switching.

CHAPTER 4
THE 2110A WORKSTATION AND A WANG HOST

4.1 OVERVIEW

Once your 2110A is installed and configured on the host system, there are only a few additional details which you must be aware of to use the 2110A effectively as a host terminal. Refer to the terminal installation instructions in Chapter 2 for 2110A basic operating and maintenance instructions (e.g., turning the terminal on and off and cleaning the terminal). Read the rest of this chapter for information on the following topics:

- The 2110A keyboard
- Special operating procedures
- Additional technical notes

4.2 THE 2110A KEYBOARD

The 2110A keyboard is composed of typewriter keys, a numeric keypad, a row of function keys, cursor control and editing keys, and additional specialized keys.

The following paragraphs describe the functions you can perform using the keys identified in Figure 4-1 when you are using 2110A as a Wang workstation. Only basic and typical data processing functions are described here (the terminal also supports word processing functions when attached to a Wang controller, specifically an EADC). For complete information on keyboard functionality, refer to the information on workstation characteristics in the appropriate user's manual.

4.2.1 Typewriter Keys and Numeric Keypad

Use these keys to enter the corresponding character, symbol, or number on the screen.

4.2.2 Shift

Use the SHIFT keys as you would on a typewriter. For keys with an upper and lower character on the keycap, use either SHIFT key to select which character to enter.

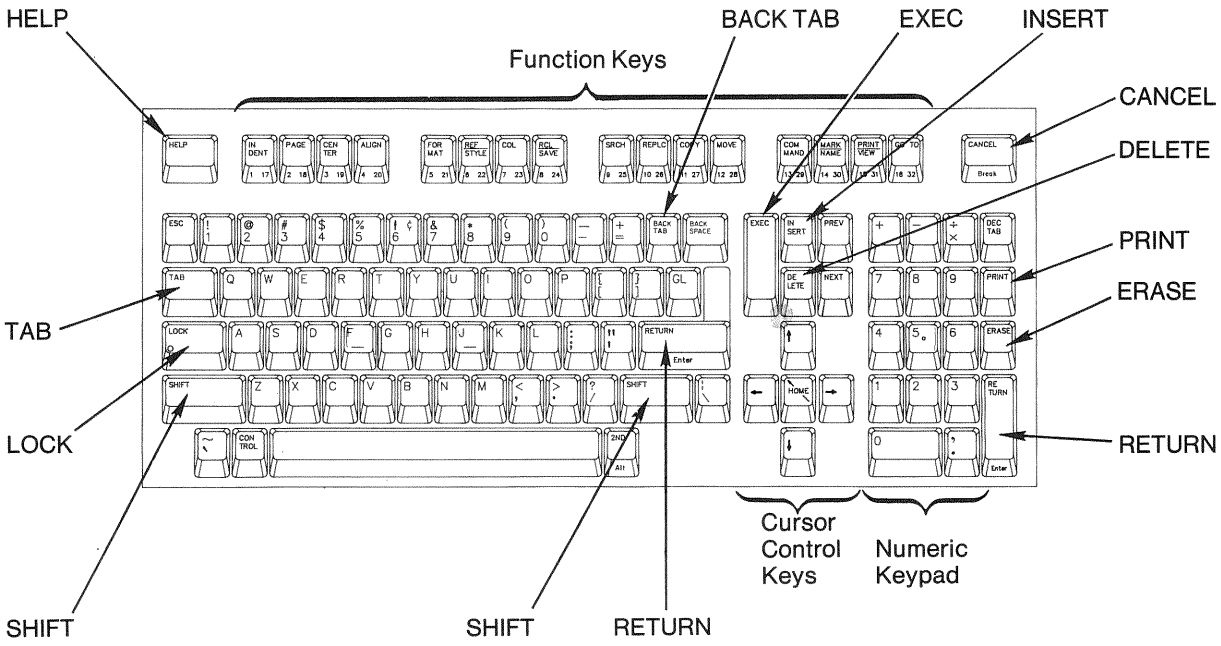

Figure 4-1. 2110A Keyboard

4.2.3 Lock

Use this key to lock all keyboard keys in the uppercase position. The amber light-emitting diode (LED) in the keycap lights when LOCK is in effect. When LOCK is in effect, the keyboard behaves as if the SHIFT key is being pressed continuously. Press either SHIFT key or the LOCK key to unshift the keyboard and turn off the LOCK LED. This is only true if SHIFT LOCK has been previously selected from the Keyboard Configuration menu through Setup Mode. If CAPS LOCK is selected, LOCK remains in effect until the LOCK key is released. SHIFT has no effect.

4.2.4 Return

Use this key to signal the host central processor that you are finished entering data on the current screen or to give an affirmative response to a screen prompt. Pressing RETURN sends an interrupt to the host central processor and identifies RETURN as the key that caused the interrupt. The cursor disappears from the screen after you press RETURN to indicate that the keyboard is locked.

4.2.5 Function Keys

The function keys are F1 through F16 (unshifted) and F17 through F32 (shifted). Normally, these keys are used to select a function from a menu. These keys send an interrupt to the host central processor. The interrupt alerts the host and indicates which key was pressed. The cursor is removed from the screen after you press a function key (the keyboard is locked). In many cases, pressing a function key results in the host reading screen data from the screen image maintained in the controller.

4.2.6 Help

Use this key to interrupt program execution and enter the host Command Processor to perform functions available in the Command Processor, including cancelling the current task. Like the Function keys, HELP interrupts the host's central processor.

4.2.7 Cursor Control Keys

The cursor is the highlighted, blinking underscore that appears below the current screen position. Usually, the cursor simply indicates the starting position for data entry, editing, or cursor movement. On some screens, the cursor may indicate an item you have selected from a list. The cursor usually moves one character position in the direction indicated by the arrow: UP, RIGHT, DOWN, or LEFT (sometimes referred to as NORTH, EAST, SOUTH, and WEST). These cursor control keys and the HOME key are described in the separate sections that follow. TAB, BACK TAB, EXEC (NEW LINE) also move the cursor but are described separately because they are not in the cursor control keypad.

- **Up**

  Press UP to position the cursor in the same column but up one row. If the cursor starts in the first row, it moves to the last row of the same column.

- **Down**

  Press DOWN to position the cursor in the same column but down one row. If the cursor starts in the bottom row of the screen, it moves to the first row of the same column.

- **Left**

  Press LEFT to move the cursor one position left in a row. If the cursor starts at the first position in a row, it moves to the last position in the preceding line. If the cursor is in the first position on the screen, it moves to the last position on the screen.

- **Right**

  Press RIGHT to move the cursor one position right in a row. If the cursor is at the end of a row, it moves to the first position of the next row. If it is at the last position on the screen, it moves to the first position on the screen.

- **Home**

  Press HOME to move the cursor to the first modifiable location on the screen. If there is no modifiable location, the cursor does not move and the terminal beeps.

4.2.8 Tab

Press TAB to move the cursor to the next tab position within a modifiable field, to the next modifiable field, or to a protected numeric-only field. If there are no more modifiable positions, the cursor does not move and the terminal beeps.

4.2.9 Back Tab

Press BACK TAB to position the cursor at the first position of the nearest modifiable field preceding the current cursor location. If the cursor is in a modifiable field, and in other than the first location, the cursor moves to the start of that field. If there is no preceding modifiable location, the cursor does not move and the terminal beeps.

4.2.10 Exec

Press EXEC to advance the cursor to the first modifiable position of the next line or a subsequent line. If there are no modifiable locations following the start of the next line, the cursor does not move and the terminal beeps.

4.2.11 Insert

Use INSERT to insert a blank at the current cursor position. Existing text moves to the right to make room for the blank except when the last character in the field is not a blank or pseudoblank. Pseudoblanks are the characters X'0B' and X'05' in a modifiable format, displayed as a solid square and a decimal tab, respectively. When the last character in the field is nonblank, no screen locations change, the cursor does not move, and the terminal beeps.

4.2.12 Delete

Use DELETE to delete the character at the current cursor position. Subsequent characters in the field move left by one position and a new blank is inserted following the rightmost character. If the cursor is not in a modifiable field, no action takes place and the terminal beeps.

4.2.13 Erase

Use ERASE to erase from the cursor position to the end of the current modifiable field. Blanks fill the erased position. The cursor does not move.

4.2.14 Cancel

Use this key to stop fields from blinking. When keyed together with the 2ND key, CANCEL requests that the controller re-initialize the terminal and rewrite the current screen contents. CANCEL does not cause communication with the host's central processor.

4.2.15 Print

Use PRINT alone or in conjunction with a local keystroke to initiate a printing function.

4.2.16 Auto-Repeating Keys

All 2110A keys except the following auto-repeat. Keys that auto-repeat begin repeating and continue repeating according to the repeat delay and repeat rate selected through Setup Mode.

CANCEL	ERASE
EXECUTE	LEFT SHIFT
GLOSSARY	RIGHT SHIFT
MULTIPLY	LOCK
DIVIDE	CONTROL
2ND	

4.3 SPECIAL OPERATING PROCEDURES

The following sections describe the screen rewrite/terminal re-initialization procedures you can use to clear parity or other screen errors. The procedure to enable or disable keyclick is also described.

4.3.1 Responding to Parity or Other Screen Errors

When a parity error occurs in a received character, the 2110A displays a substitute character consisting of a pattern of equally spaced dots (Position X'1E' in Table 5-6). Usually, a parity error occurs because of an error in the link between the 2110A and the host system. Other line errors or terminal conditions may also cause the screen display to become confused or may cause the terminal to function improperly.

However, the screen image maintained in the controller is unaffected by transmission errors between the controller and the 2110A or by problems within the terminal. The screen image in the controller is still correct (unless, by coincidence, there are unrelated problems in the Wang host or controller). Therefore, you can use the procedures described in the following sections to clear up an inappropriate screen display by rewriting the screen image from the controller to the terminal and re-initializing the terminal hardware.

4.3.2 Performing Hard Re-Initialization for Local Connections

If your 2110A is locally connected to the host and you find it acceptable to turn the terminal off, perform the following steps to clean up a confused screen or restore normal operation of the terminal or both. If your 2110A is remotely connected to the host via a modem, you may also use this procedure but you must first disconnect the communication link (hang up the dial-up connection).

1. Turn the 2110A terminal off.

2. Wait 5 seconds.

3. Turn the terminal back on.

4. Wait for the screen display to be restored. Allow up to ten seconds.

5. If the 2110A is still not operating correctly, press CONTROL+S, wait for any activity on the screen to cease, and then repeat Steps 1 through 4.

Note: *Whenever you turn the 2110A off, be sure to wait at least four seconds before turning it on again. This delay prevents possible inconsistencies between the 2110A and the host system. Refer to Section 4.4.2 for additional information on terminal poweroff.*

4.3.3 Performing Soft Re-Initialization for Remote Connections

If your 2110A is remotely connected to the host via a modem, perform the following steps to clean up a confused screen or restore normal operation of the terminal or both. This procedure enables you to re-initialize the 2110A without turning the terminal off.

1. Press SHIFT+CONTROL+GL.
2. Press the unshifted CANCEL key. Wait 2 seconds.
3. Press CONTROL+L.

4.4 ADDITIONAL TECHNICAL NOTES

This section presents technical information on the following topics intended for Wang host system administrators and application programmers:

- Response time and programming considerations
- Effects of terminal poweroff

4.4.1 Response Time and Programming Considerations

The 2110A's response time is unavoidably slower than that of a native host terminal because of inherent differences in the speed of the terminal-controller link. Native Wang workstations communicate with the host I/O controller (IOP, DA, or IOC) using a Wang-proprietary coaxial cable protocol at 4.27 Mbps. However, the maximum terminal-to-controller link speed is 19.2 Kbps for the asynchronous RS-232-C link between the 2110A and the controller.

To minimize the impact of this speed restriction, observe the following programming guidelines when writing application programs to be run on the 2110A.

- Minimize the number of modifiable bytes of data to be sent to the screen.
- Minimize the number and size of fields changed between screens.
- Minimize the number of individual I/O operations that make up a single interactive exchange between the user and the system.
- Avoid frequent clearing or scrolling operations.

4.4.2 Effects of Terminal Poweroff

The controller provides no notification to the host when a terminal is powered off or disconnected. I/O commands for the terminal continue to be processed normally because the actual screen image is maintained within the controller and is not affected by the condition of the terminal.

If a user later turns on or reconnects the terminal, the controller initializes the terminal and writes the controller's current screen image to the terminal. The terminal must be turned off or disconnected, for at least four seconds, for the initialization and screen rewrite to happen correctly. If necessary, you can correct problems from a too-short poweroff cycle via the terminal re-initialization procedures (refer to Section 4.3).

If the Control Workstations Screen does show a 2110A workstation disconnected, it probably indicates a failure while loading code to the controller board.

If a 2110A user permanently disconnects from the system without logging off, you can use standard procedures for forcing the logoff of the user. Be aware, though, that forcing the logoff of a remote user does not break the modem connection. You must manually disconnect the remote link (e.g., hang up a dial-up connection) if the remote user leaves the line connected.

CHAPTER 5
THE 2110A WORKSTATION AND A NON-WANG HOST

5.1 OVERVIEW

Once you have installed a 2110A workstation on your non-Wang host system (and your system administrator or programmer has verified the suitability of the 2110A to the host applications you need to use), basic operation of the 2110A as a host terminal is simple. First, you need to find out from your system administrator which escape and control sequences the 2110A must send to the host to perform various functions. You can easily generate these required sequences on the 2110A by using the control (CTRL) and escape (ESC) keys or other keys. When 2110A special keys generate the required sequences, you can send the required sequences conveniently with a single keystroke. For your convenience, many 2110A special keys generate the same codes as Digital Equipment Corporation's popular VT-220 terminal. Second, you must learn how to re-initialize the terminal and perform other simple operations. Sections 5.2 and 5.3 provide the information you need for basic operation.

The 2110A also provides an expanded display character set and other features that comply with ANSI standards X3.4, X3.41 and X3.64. Sections 5.4 through 5.12 provide comprehensive information on the Wang Model 2110A workstation's compliance with these standards as well as additional technical information on the 2110A.

5.2 USING THE 2110A KEYBOARD

This section covers the use of the 105-key US domestic version of the 2110A keyboard in ANSI mode. International versions of the 2110A keyboard include different keycap labeling and, in some cases, use expanded 107-key keyboards. The 2110A can also operate in Scan Code Mode. In Scan Code Mode, the 2110A transmits the codes that identify which key was pressed or released by keyboard position (rather than by the ASCII code for the character on the keycap) to the host for host interpretation. Refer to Section 6.9 for more information on Scan Code Mode.

Figure 5-1 shows the US domestic 2110A keyboard with special keys indicated.

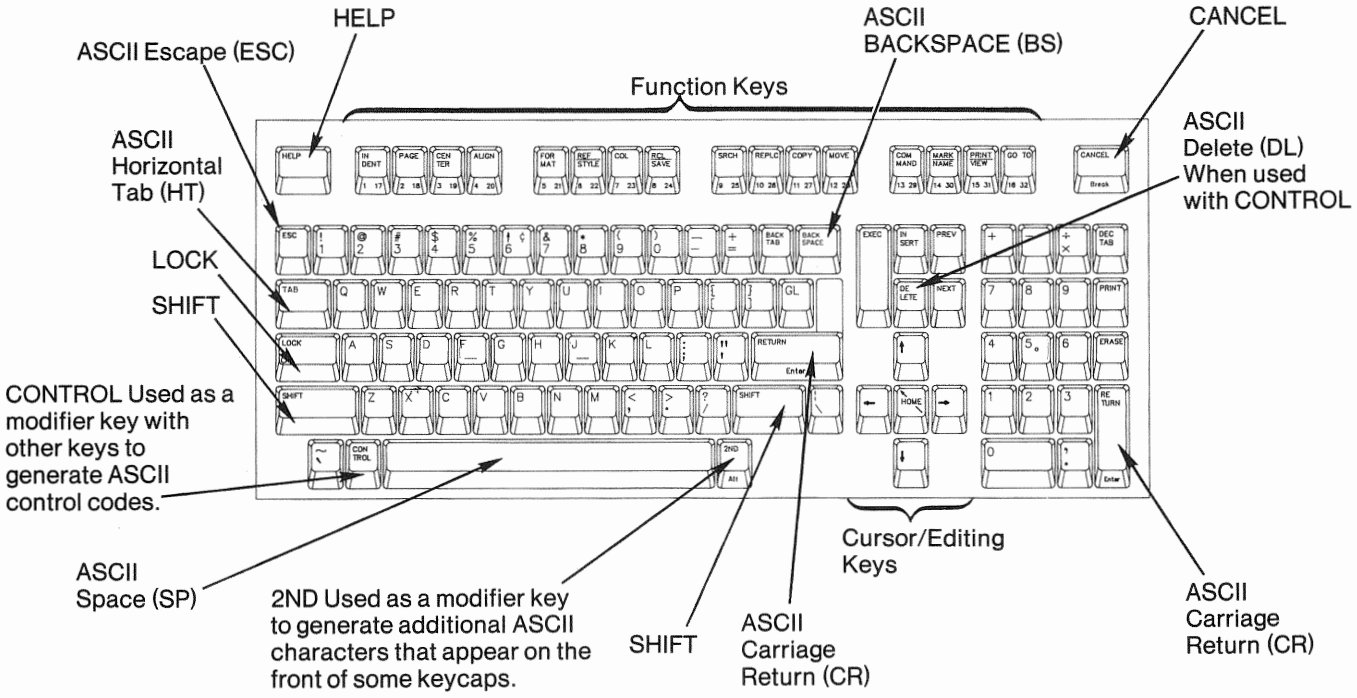

Figure 5-1. 2110A Keyboard

5.2.1 Shift Keys

Holding down either the left or the right SHIFT key causes code corresponding to the upper case version of all keys (letters, symbols, function keys, and other special keys) to be generated and transmitted to the host (with the exceptions described under the various following sections). Some keys, such as TAB and RETURN generate the same code in upper and lower case.

5.2.2 Lock Key

Pressing and releasing the LOCK key has the same effect as continuously holding down the SHIFT key. When SHIFT LOCK is in effect, the red light-emitting diode (LED) on the LOCK key is lit. SHIFT LOCK remains in effect until you press and release either SHIFT key or the LOCK key This is true only if SHIFT LOCK has been selected from the Keyboard Configuration menu via Setup Mode. If CAPS LOCK is selected, SHIFT LOCK remains in effect until the LOCK key is released; SHIFT has no effect.

5.2.3 Auto-Repeating Keys

Most keys on the 2110A keyboard automatically repeat and continue to repeat according to the repeat delay and repeat rate selected through Setup Mode. Refer to Section 4.2.16 for a list of specific keys that do not auto repeat.

5.2.4 Entering ASCII Display Characters Using Labeled Keys

Keys labeled with ASCII display characters transmit to the host the codes corresponding to the character on the keycap. Pressing a key labeled with a non-ASCII graphic (e.g., the Cent sign) does not cause any code to be transmitted to the host.

5.2.5 Entering ASCII Control Codes Using Labeled Keys

Use the indicated keys to generate the most commonly used ASCII control codes (members of the ANSI C0 Control Set) listed in Table 5-1.

Table 5-1. 2110A Keys for ASCII Control Codes

Control Function	Mnemonic	Code	Keystroke(s)
Backspace	BS	X'08'	BACK SPACE
Horizontal Tabulation	HT	X'09'	TAB
Escape	ESC	X'1B'	ESC
Carriage Return	CR	X'0D'	RETURN
Delete	DEL	X'7F'	CONTROL+DELETE
Space	SP	X'20'	Space Bar

5.2.6 Entering ASCII Control Codes Using the CONTROL Key

Use the CONTROL key as a modifier to enter ASCII control codes that are not represented by labeled keys. Hold down the CONTROL key while pressing the indicated key to enter the ASCII control codes in Table 5-2. These control codes are members of the ANSI C0 Control Set. Other combinations of keystrokes with the CONTROL key are inactive (unless exceptions are specifically mentioned in other sections of this chapter).

Table 5-2. ASCII Control Codes Entered with the CONTROL Key

Control Function	Mnemonic	Code	Keystroke(s)
Null	NUL	X'00'	CTRL+@
Start of Header	SOH	X'01'	CTRL+A
Start of Text	STX	X'02'	CTRL+B
End of Text	ETX	X'03'	CTRL+C
End of Transmission	EOT	X'04'	CTRL+D
Enquiry	ENQ	X'05'	CTRL+E
Acknowledgement	ACK	X'06'	CTRL+F
Bell	BEL	X'07'	CTRL+G
Backspace	BS	X'08'	CTRL+H
Horizontal Tabulation	HT	X'09'	CTRL+I
Line Feed	LF	X'0A'	CTRL+J
Vertical Tabulation	VT	X'0B'	CTRL+K
Form Feed	FF	X'0C'	CTRL+L
Carriage Return	CR	X'0D'	CTRL+M
Shift Out	SO	X'0E'	CTRL+N
Shift In	SI	X'0F'	CTRL+O
Data Link Escape	DLE	X'10'	CTRL+P
Device Control 1 (XON)	DC1	X'11'	CTRL+Q
Device Control 2	DC2	X'12'	CTRL+R
Device Control 3 (XOFF)	DC3	X'13'	CTRL+S
Device Control 4	DC4	X'14'	CTRL+T
Negative Acknowledgement	NAK	X'15'	CTRL+U
Synchronous Idle	SYN	X'16'	CTRL+V
End of Transmission Block	ETB	X'17'	CTRL+W
Cancel	CAN	X'18'	CTRL+X
End of Medium	EM	X'19'	CTRL+Y
Substitute	SUB	X'1A'	CTRL+Z
Escape	ESC	X'1B'	CTRL+[
Field Separator	FS	X'1C'	CTRL+\
Group Separator	GS	X'1D'	CTRL+]
Record Separator	RS	X'1E'	CTRL+UpArrow
Unit Separator	US	X'1F'	CTRL+_

5.2.7 ANSI Control Sequences Generated by Cursor, Editing, and Other Special Keys

Table 5-3 lists the ANSI control sequences generated by the 2110A cursor control, editing, function, and other special keys. Refer to Section 5.4 for an explanation of ANSI control sequences. Table 5-3 includes cross-references to the keys on Digital Equipment Corporation's VT-220 terminal that generate the same codes as the indicated 2110A keys.

Table 5-3. ANSI Control Sequences Generated by 2110A Special Keys

Keystroke	Generated Keycode[a]	VT-220 equivalent
CURSOR-UP	CSI A	CURSOR-UP
CURSOR-DOWN	CSI B	CURSOR-DOWN
CURSOR-RIGHT	CSI C	CURSOR-RIGHT
CURSOR-LEFT	CSI D	CURSOR-LEFT
HOME	CSI H	
EXEC	CSI 2 9 tilde	DO
INSERT	CSI 2 tilde	INSERT HERE
DELETE	CSI 3 tilde	REMOVE
PREV	CSI 5 tilde	PREVIOUS SCREEN
NEXT	CSI 6 tilde	NEXT SCREEN
HELP	CSI 2 8 tilde	HELP
CANCEL	CSI 3 7 tilde	
CTRL+CANCEL	CSI 3 8 tilde	
F1[b]	SS3P	PF1
F2[b]	SS3Q	PF2
F3[b]	SS3R	PF3
F4[b]	SS3S	PF4
F5[b]	CSI 1 6 tilde	
F6[b]	CSI 1 7 tilde	F6
F7[b]	CSI 1 8 tilde	F7
F8[b]	CSI 1 9 tilde	F8
F9[b]	CSI 2 0 tilde	F9
F1[b]	CSI 2 1 tilde	F10
F11[b]	CSI 2 3 tilde	F11
F12[b]	CSI 2 4 tilde	F12
F13[b]	CSI 2 5 tilde	F13
F14[b]	CSI 2 6 tilde	F14
F15[b]	CSI 3 5 tilde	
F1[b](shifted)	CSI 3 1 tilde	F17
F2[b](shifted)	CSI 3 2 tilde	F18
F3[b](shifted)	CSI 3 3 tilde	F19
F4[b](shifted)	CSI 3 4 tilde	F20
F5[b]8 (shifted)	(no text)	
F9[b](shifted)	CSI 1 tilde	FIND
F10-15[b](shift)	(no text)	
F16[b](shifted)	CSI 4 tilde	

[a] Refer to Table 5-10 for the codes transmitted for CSI and SS3 depending upon the current data representation mode (7-bit or 8-bit).

[b] F1 (unshifted) - F16 (shifted) show the default text associated with each key. Since these keys are programmable, the default text can be changed through Setup Mode. See Section 2.6 for more information.

5.2.8 Inactive Keys

Table 5-4 lists the 2110A keys that are ignored when the 2110A is used as an ANSI terminal.

Table 5-4. Inactive Keys

Keystroke	Result
BACK TAB	Ignored
ERASE	Ignored
MULTIPLY/DIVIDE (numeric keypad)	Ignored
DEC TAB	Ignored

Note: *In addition to the above keys, any non-ASCII graphic character is ignored.*

5.2.9 2ND KEY

The 2ND key acts as a modifier key to generate additional ASCII characters that appear on the front of some of the keycaps. These keys may have one or two additional characters. The following sequences allow you generate the ASCII character:

- For keys that contain only one additional character, press 2ND+the desired key
- For keys that have two additional characters, press SHIFT+2ND+the desired key to generate the ASCII character to the left
- Press 2ND+the desired key to generate the ASCII character to the right.

2ND key combinations that are not defined are ignored.

Note: *The 2ND key held down with the CANCEL key is used as an alternate means to generate the BREAK condition as defined in the LOCAL KEYSTROKE SEQUENCES (See Section 5.3). This combination is equivalent to SHIFT+CONTROL+GL, SHIFT+CANCEL.*

5.3 LOCAL KEYSTROKE SEQUENCES

You can perform a number of 2110A functions using local keystroke sequences. These keystroke sequences are referred to as local because the keystrokes are processed within the 2110A independently of transmissions received from the host. Most local keystroke sequences perform functions or invoke state changes within the terminal. However, some functions invoked by local keystrokes (such as the Break function) involve transmission to the host.

All local keystroke sequences consist of SHIFT+CONTROL+GL followed by another shifted or unshifted key. The procedure is:

1. Hold down both the SHIFT and CONTROL keys and press the GL key.

2. Release these keys and press the appropriate shifted or unshifted function key.

If the keystroke following SHIFT+CONTROL+GL is an undefined keystroke, the keystroke sequence is ignored and the terminal beeps to indicate an undefined keystroke. You must re-key the entire keystroke sequence to perform the intended function. Table 5-5 summarizes the local keystroke functions. A detailed explanation of each function follows Table 5-5.

Table 5-5. Summary of Local Keystroke Functions

Keystrokes: SHIFT+CONTROL+GL Followed By	**Function**
CANCEL	Reset the terminal
SHIFT+CANCEL	Generate Break condition
F1	Enter Modem Command Mode/Unconditional Notification
SHIFT+F1	Exit Modem Command Mode/Unconditional Notification
F3	Enable Programmer Assist Mode
SHIFT+F3	Disable Programmer Assist Mode
F4	Enter Monitor Mode
SHIFT+F4	Exit Monitor Mode
F5	De-assert DTR and suspend processing
SHIFT+F5	Assert DTR and resume processing
F13	Enter Modem Command Mode/Conditional notification
SHIFT+F13	Exit Modem Command Mode/Conditional notification

Note: *The Wang private Scan Code Mode does not alter the effect of local keystrokes. However, the press and release codes of the SHIFT and CONTROL keys are transmitted to the host when in Scan Code Mode.*

5.3.1 Reset the Terminal

Sequence: SHIFT+CONTROL+GL, then CANCEL

Function: The 2110A resets itself to its poweron state. The effect is the same as turning the terminal off then on again. Refer to the description of the Reset to Initial State (RIS) command under Control Sequences Introduced by ESC in Section 5.7 for details of the effect of resetting the terminal. Resetting the terminal by the local keystroke sequence is a means to locally restore the terminal to ANSI/ASCII keyboard-handling from another mode (e.g., Scan Code Mode) invoked by a host command. Even if Scan Code Mode was previously enabled, the release codes for the SHIFT and CONTROL keys are not sent to the host because of the nature of the reset terminal function.

5.3.2 Generate Break Condition

Sequence: SHIFT+CONTROL+GL, then SHIFT+CANCEL

Function: The 2110A holds the transmit line in the Space (zero) condition for 500 ms (one-half second). Note that the key sequence 2ND+CANCEL, without having been preceded by SHIFT+CONTROL+GL, is defined as a alternate local means to generate the BREAK condition.

5.3.3 Enter Modem Command Mode/Unconditional Notification

Sequence: SHIFT+CONTROL+GL, then F1

Function: The 2110A notifies the host that the terminal is entering Command Mode regardless of the state of COMMAND MODE HOST NOTIFICATION. See Section 6.3 for additional information on Modem Command Mode.

5.3.4 Exit Modem Command Mode/Unconditional Notification

Sequence: SHIFT+CONTROL+GL then, SHIFT+F1

Function: The 2110A informs the host that the 2110A is exiting the Modem Command Mode regardless of the state of COMMAND MODE HOST NOTIFICATION. See Section 6.3 for additional information on Modem Command Mode.

5.3.5 Enable Programmer Assist Mode

Sequence: SHIFT+CONTROL+GL, then F3

Function: Enables operation of the special programmer assist function:

The DEC TAB key functions as a "set high bit" prefix key when ANSI/ASCII keyboard handling is enabled. Keying the "set high Bit" prefix modifies the processing of the next non-modifier key. If the next keystroke normally transmits a single ASCII code in the range X'00" through X'7F', the code buffered for transmission will instead be in the range of X'80' through X'FF' (X'80' bit is set). If the next keystroke is of any other type (i.e., function key), the keystroke is processed normally; the alteration is effectively null. The operation of DEC TAB when Scan Code Mode is enabled is not affected.

5.3.6 Disable Programmer Assist Mode

Sequence: SHIFT+CONTROL+GL, then SHIFT+F3

Function: Disables the special feature associated with Programmer Assist Mode.

5.3.7 Enter Monitor Mode

Sequence: SHIFT+CONTROL+GL, then F4

Function: The 2110A enters Monitor Mode. In Monitor Mode, received data is not interpreted as terminal controls or displayed as ASCII graphics. Instead, every received data character is displayed on the screen as two hexadecimal digits followed by a space using the default display attributes.

On entering Monitor Mode, the 2110A does not clear or alter the screen except by enabling the display of the cursor at the current active position as a blinking underline. When the cursor reaches the end of a line, it wraps around to the beginning of the next line, causing screen scroll-up if at the end of the last accessible line. The terminal modes and options in effect prior to entering Monitor Mode are not altered, but many of these modes or options are ignored while the 2110A operates in Monitor Mode. There is no means provided for the host to cause the 2110A to enter/exit from Monitor Mode.

5.3.8 Exit Monitor Mode

Sequence: SHIFT+CONTROL+GL, then SHIFT+F4

Function: The 2110A exits Monitor Mode and resumes normal processing of received data. The screen is not altered by exiting Monitor Mode except that the cursor on/off state and display style are restored to the settings in effect prior to entering Monitor Mode.

5.3.9 Suspend Processing and De-assert DTR

Sequence: SHIFT+CONTROL+GL, then F5

Function: The 2110A immediately and unconditionally de-asserts the RS-232-C Data Terminal Ready (DTR) and Request to Send (RTS) signals. The 2110A suspends all processing until it senses one of the following:

- The Resume Processing local keystroke sequence
- The Reset Terminal local keystroke sequence
- The Signal Busy and Reset Terminal local keystroke sequence
- A 2110A poweroff followed by poweron

5.3.10 Resume Processing

Sequence: SHIFT+CONTROL+GL, then SHIFT+F5

Function: The 2110A resumes the previously suspended operation. In resuming processing, the 2110A re-asserts DTR and, when appropriate, Request to Send (RTS).

5.3.11 Enter Modem Command Mode/Conditional Notification

Sequence: SHIFT+CONTROL+GL, then F13

Function: Enters the Modem Command Mode. Notifies the host only if COMMAND MODE HOST NOTIFICATION = YES (via Setup Mode). See Section 6.3 for additional information on Modem Command Mode.

5.3.12 Exit Modem Command Mode/Conditional Notification

Sequence: SHIFT+CONTROL+GL, then SHIFT+F13

Function: Exits Modem Command Mode. Notifies the host only if COMMAND MODE HOST NOTIFICATION = YES (via Setup Mode). See Section 6.3 for additional information on Modem Command Mode.

5.4 INTRODUCTION TO 2110A COMPLIANCE WITH ANSI STANDARDS

The Wang Model 2110A workstation complies with the ANSI X3.4, X3.41 and X3.64 standards by supporting:

- The standard ASCII character set
- Selected ANSI standard control sequences
- A Wang private extended character set accessed via an ANSI-compatible protocol
- Wang private control sequences that are extensions to the standard set and are formatted in compliance with the X3.64 standard

The rest of this section provides general information on the structure of ANSI escape and control sequences and the 2110A implementation of them. Sections 5.6 through 5.11 provide details of the Wang Model 2110A compliance with the ANSI standards.

5.4.1 Definition of ANSI Escape and Control Sequences

In the following definitions, C0 refers to the ANSI-defined control codes in the range X'00' through X'1F'. C1 refers to the ANSI-defined control codes in the range X'80' through X'9F'.

Escape sequences begin with ESC and have the following format:

ESC I...I F

ESC The C0 control character X'1B'.

I...I Intermediate characters in the range X'20' through X'2F'. Intermediate characters serve to modify or change the meaning of the final character.

F Final character in the range X'30' through X'7E'. Characters X'30' through X'3F' are reserved for private use. Characters X'40' through X'7E' are defined by ANSI or else reserved for future definition by ANSI.

Control sequences begin with the Control Sequence Introducer (CSI) and have the following format:

CSI P...P I...I F

CSI Control Sequence Introducer character. This is the C1 control character X'9B' which is equivalent to ESC [(X'1B 5B') in 7-bit data representation.

P...P Parameter string. The basic definition of the parameter string is zero or more characters in the range X'30' through X'3F'. All parameter strings whose meanings are defined by ANSI are of the form:

P1 ; P2 ; P3 ; ... ; Pn

Where Pn is a parameter composed of zero or more of the characters X'30' through X'39' and (;) is the parameter delimiter character X'3B'. Leading X'30' characters in a parameter may be ignored. An omitted parameter, or a parameter consisting of only X'30' characters indicates that the default value for that parameter is selected.

The character X'3A' (:) is currently undefined, but reserved for future use in ANSI standard parameter strings.

The characters X'3C' through X'3F' are designated for private use and may not appear in an ANSI standard parameter string. Occurrence of one of these characters as the first character in the parameter string indicates that the entire parameter string is subject to private interpretation.

Note: *Wang private control sequences have X'3E' as the first character in the parameter string.*

I ... I Intermediate characters in the range X'20' through X'2F. Intermediate characters serve to modify or change the meaning of the final character.

F Final character, in the range X'40' through X'7E'. The final character (considered together with intermediate characters if any are present), determines the interpretation of the control sequence. Final characters X'40' through X'6F' are defined or reserved for definition as ANSI standard controls. Final characters X'70' through X'7E' are designated for private use.

Occurrences in a CSI control command of the characters X'00' through X'1F' and X'7F' through X'FF' are undefined.

5.4.2 ANSI-Compatible Extensions Used by Wang Private Sequences

Private extensions to ANSI standard control sequences may be specified by using the ANSI-defined final character and identifying the parameter sequence as private by placing a private parameter introducer character in the range X'3B' through X'3F' as the first character in the parameter sequence.

Other extensions to ANSI standard control sequences may be specified using the private final characters X'70' through X'7E', frequently preceded by an intermediate character. Intermediate characters may be used to provide more private functions. Private control sequences without intermediate characters, because they are shorter in length, are usually conserved for extensions which may be performance-critical.

5.4.3 Restrictions and Clarifications in 2110A Implementation of ANSI Standards

The maximum number of parameters allowed by the 2110A in a control sequence is 32. This restriction limits the maximum number of parameters in any control sequence.

Except where specifically noted, the maximum value supported for any individual parameter received by the terminal in a control sequence introduced by CSI is 255. The result with larger values is undefined.

Unexpected characters received within control and escape sequences are handled by the terminal as follows:

- NUL, XON, and XOFF characters are interpreted and acted upon without disrupting the interpretation of any escape or control sequence in which they happen to occur.
- The ESC character, when received, causes any escape sequence partially received by the 2110A to be aborted and a new escape sequence to be started.
- CAN character causes the current sequence to be aborted.

- Other characters in the set X'00' through X'1F and X'7F' through X'FF' should not occur and are ignored.

- Certain host controls (XON, XOFF, NUL, INT) are immediately processed when received. They are not buffered. The processing of these commands is never suspended or delayed.

- The parameters of a CSI sequence are processed in the order of receipt within control sequences.

5.5 CHARACTER SET SUPPORT

2110A display characters are identified in the following sections by their relative ROM/RAM memory positions within each of the available Character Generator (CG) Memory elements. The terminal can support up to four memory elements as follows:

- Internal CG ROM (always available)
- Internal CG RAM (always available)
- External CG ROM/RAM #1 (cartridge based, optional)
- External CG ROM/RAM #2 (cartridge based, optional)

Each CG Memory element provides storage for the following:

- Up to 256 characters in 80-column format
- Up to 256 characters in 132-column format
- 25-byte CG Memory Identification string

5.5.1 CG Memory Identification String

Each CG Memory element provides for storage of an identification string of up to 25 bytes. The string provides the host with a means of identifying the CG Memory contents. The first byte of the string encountered with a value of X'00' or X'FF' indicates end of string. The terminator bytes are not considered to be part of the string when the string data content is returned to the host. If neither X'00' nor X'FF' bytes are used, the string is assumed to be exactly 25 bytes long. It may be necessary to break up the required string data bytes into pieces in order to fit unused portions of CG Memory.

5.5.2 Display Characters

The 2110A can display up to 256 characters that are defined in its character-generation read-only memory (ROM). Table 5-6 lists these display characters and their ROM positions.

Table 5-6. 2110A Display Characters

Low Order Hex Digit \ High-Order Hex Digit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	┘	▮	SPACE	0	@	P	`	p	°	Â	â	Ğ	ğ	Þ	þ	£
1	┌	|	!	1	A	Q	a	q	♦	À	à	Ij	ij	Đ	ð	*f*
2	┐	|	"	2	B	R	b	r	▶	Á	á	İ	i	Ý	ý	¥
3	└	|	#	3	C	S	c	s	◀	Ä	ä	Î	î	Ş	ş	¼
4	┼	▮	$	4	D	T	d	t	→	Ã	ã	Ì	ì	‘	’	½
5	|	▮	%	5	E	U	e	u	↵	←	→	Í	í	Û	û	¾
6	-	▮	&	6	F	V	f	v	|	A	a	Ï	ï	Ù	ù	^
7	┤	▮	'	7	G	W	g	w	■	↓	†	L·L	I·I	Ú	ú	`
8	├	▮	(	8	H	X	h	x	!!	Æ	æ	Ñ	ñ	Ü	ü	´
9	┬	▮	)	9	I	Y	i	y	↕	Ç	ç	Ô	ô	©	™	¨
A	┴	▮	*	:	J	Z	j	z	↑	‡	□	Ò	ò	®	¤	~
B	_	▮	+	;	K	[	k	{	↓	●	REQUIRED SPACE	Ó	ó	℞	↔	¸
C	▪	▮	,	<	L	\	l	|	←	Ê	ê	Ö	ö	ª	º	˅
D	▪	▚	-	=	M	]	m	}	±	È	è	Õ	õ	«	»	ˇ
E	▮	▒	.	>	N	↑	n	~	¡	É	é	Œ	œ	§	ß	SINGLE SPACE
F	▮	▒	/	?	O	-	o	¢	¿	Ë	ë	Ø	ø	¶	.	SPACE

The 2110A display characters are identified by their relative positions in the Internal Character Generator ROM as shown in Table 5-6. The 256 displayable characters defined in ROM are summarized as follows:

ROM Positions	Characters
X'00' through X'1F'	Special graphics characters
X'20' through X'FF'	Wang WISCII-I character set

5.5.3 Active Character Set

Within the ANSI standards, a character set is defined as a set of 94 graphics which can be mapped into ANSI-defined active character set boundaries. There are two active character sets of 94 characters each, referred to as GL and GR as shown in Figure 5-2.

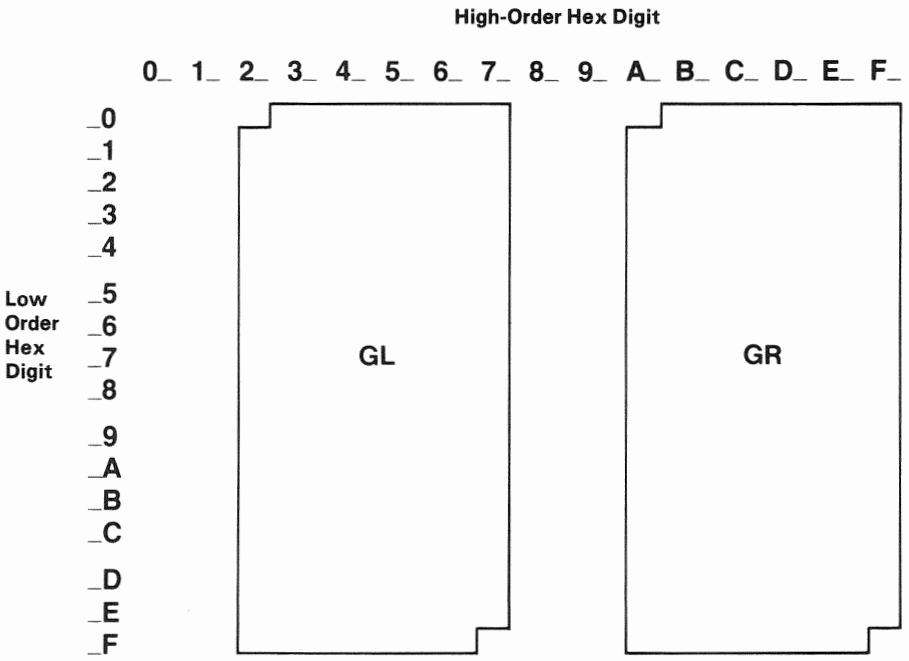

Figure 5-2. Active Character Sets GL and GR

The character set currently active as GL is accessible via codes in the range X'21' through X'7E'

The character set currently active as GR is accessible via codes in the range X'A1' through X'FE'.

An active character set is a set of graphics which can be selected for display by a single-byte code received from the host. Characters in active character set GL are selected by codes in the range X'21' through X'7E'. Characters in active character set GR are selected by codes in the range X'A1' through X'FE'. Therefore, active character set GR is only accessible to the host when 8-bit data representation is enabled.

If the default character set option (selectable through the Main Menu in Setup Mode) = INTERNAL and external memory elements #1 and #2 are installed, the 2110A provides the following characters:

```
Character Set #1:   Internal ROM positions X'21' through X'7E'
Character Set #2:   Internal ROM positions X'7F' through X'DC'
Character Set #3:   Internal ROM positions X'DD' through X'3A'
Character Set #4:   Internal RAM positions X'21' through X'7E'
Character Set #5:   Internal RAM positions X'7F' through X'DC'
Character Set #6:   Internal RAM positions X'DD' through X'3A'
```

```
Character Set #7:   External ROM/RAM #1 positions X'21' through X'7E'
Character Set #8:   External ROM/RAM #1 positions X'7F' through X'DC'
Character Set #9:   External ROM/RAM #1 positions X'DD' through X'3A'
Charatcer Set #10:  External ROM/RAM #2 positions X'21' through X'7E'
Character Set #11:  External ROM/RAM #2 positions X'7F' through X'DC'
Character Set #12:  External ROM/RAM #2 positions X'DD' through X'3A'
```

In character sets #3, 6, 9, and 12, position X'00' is considered to follow position X'FF'.

SPACE (control code X'20') and DEL (control code X'7F') are not included in any character set. ANSI defines these codes as control codes. See description of C0 Control Set for more information (Section 5.6.1).

If the default character set option (selectable through the Main Menu in Setup Mode) = EXTERNAL and external memory element #1 is installed, the 2110A provides the following characters:

```
Character Set #1:   External CG Memory #1 positions X'21' through X'7E'
Character Set #2:   External CG Memory #1 positions X'7F' through X'DC'
Character Set #3:   External CG Memory #1 positions X'DD' through X'3A'
Character Set #4:   Internal CG RAM positions X'21' through X'7E'
Character Set #5:   Internal CG RAM positions X'7F' through X'DC'
Character Set #6:   Internal CG RAM positions X'DD' through X'3A'
Character Set #7:   Internal ROM #1 positions X'21' through X'7E'
Character Set #8:   Internal ROM #1 positions X'7F' through X'DC'
Character Set #9:   Internal ROM #1 positions X'DD' through X'3A'
Charatcer Set #10:  External CG Memory #2 positions X'21' through X'7E'
Character Set #11:  External CG Memory #2 positions X'7F' through X'DC'
Character Set #12:  External CG Memory #2 positions X'DD' through X'3A'
```

5.5.4 Designating Character sets

In order to activate a character set, the character set must first be designated as G0, G1, G2, or G3. The following command is used to designate the character sets available in the 2110A:

ESC Sd Sc Designates character set "Sc" as "Sd". "Sc" may be X'31' through X'3C' indicating one of the character sets #1 through #12.

The values of "Sd' are:

(Designated as G0
) Designated as G1
* Designated as G2
+ Designated as G3

5.5.5 Activating Character Sets

A character set that has been designated as one of G0, G1, G2, or G3 may then be activated as GL or GR by one of the following two methods:

- A designated character set may be permanently activated by one of the Lock Shift commands from the host (refer to Table 5-7). The character set remains activated until displaced by a later Shift command.

Table 5-7. Lock Shift Commands

Mnemonic	Value	Description
LS0 (SI)	X'0E'	Lock Shift G0, Left. Activates designated character set G0 as GL.
LS1 (SO)	X'0F'	Lock Shift G1, Left. Activates designated character set G1 as GL.
LS2	ESC n	Lock Shift G2, Left. Activates designated character set G2 as GL.
LS3	ESC o	Lock Shift G3, Left. Activates designated character set G3 as GL.
LS1R	ESC X'7E'	Lock Shift G1, Right. Activates designated character set G1 as GR.
LS2R	ESC X'7D'	Lock Shift G2, Right. Activates designated character set G2 as GR.
LS3R	ESC X'7C'	Lock Shift G3, Right. Activates designated character set G3 as GR.

- A designated character set may be temporarily activated by one of the Single Shift commands from the host (refer to Table 5-8). The character set activated in this way remains active for only the next received display character. After processing of the next received display character, the character set active prior to the single shift is reactivated. The REP (Repeat) control sequence is an exception to this reactivation rule. The active character set selected by the single shift is retained during successive repetitions of a display character under control of the REP control sequence.

Table 5-8. Single Shift Commands

Mnemonic	7-Bit Representation	8-Bit Representation	Description
SS2	ESC N	X'8E'	Single Shift G2 into GL. Temporarily activates designated character set G2 as GL.
SS3	ESC O	X'8F'	Single Shift G3 into GL. Temporarily activates designated character set G3 as GL.

The preceding definitions imply that the various characters available in the 2110A's character-generation ROM may, for example, be accessed by the following steps:

1. Designates character set #1 as G0.
   Designates character set #2 as G2.
   Designates character set #3 as G3.
   (These character set designations are the 2110A poweron defaults.)

2. Access the indicated ROM positions by sending the following codes from the host.

ROM Position	Host Must Send	
X'21' through X'7E'	ROM position	
X'7F' through X'DC'	SS2, followed by:	ROM position minus X'5E'
X'DD' through X'1F'	SS3, followed by:	ROM position minus X'BC'

5.5.6 Default Values

At 2110A powerup, 2110A character set #1 is activated as character set GL, and 2110A character set #2 is activated as character set GR provided that INTERNAL CG ROM is selected through Setup Mode. Refer to Appendix B for a complete list of powerup default values.

5.5.7 Downloadable Character Sets

Data associated with downloadable character sets is formatted and transferred to the 2110A via the 'Device Control String' (DCS) ANSI control shown below. When font data transfer associated with each DCS control function is complete, the terminal reports 'font load status' to the host via DA Private #2 with Ps=8.

DCS > Pn ; Pi ; Ps ; Pf ; Pl X'7E' data ST

'>' Identifies this as a Wang-private DCS. This is suitable to distinguish this DCS from DCS strings defined by Digital for VT-220. Immediately follows DCS control.

';' Parameter separator.

X'7E' Indicates end of leading parameter string and start of data. Checksum accumulator is cleared and checksum tag counter is set to 0.

Pn: Identifies Character Generator Memory destination of downloaded font data. Default is Pn=2. If Pn specifies a character generator RAM memory that is not currently available, the downloaded font data is discarded. The response via DA Private #2 is returned with Pv1=2, specified memory not available.

Pn=2 Internal CG Ram.
Pn=3 External CG Memory #1.
Pn=4 External CG Memory #2.

Pi: Identifies type of DCS string. Default is 1.

1 = font download to memory element RAM for 80 column mode (cell has 14 scan-lines of 10 pixels each).

2 = font download to memory element RAM for 132 column mode (cell has 14 scan-lines of 6 pixels each).

3 = C.G. Memory Element I.D. String.

Ps: Starting character generator memory position (0 through 255). Default is 0. Ignored if Pi=3.

Pf: Selects first scan-line of each character cell to be written by downloaded pixel data. Range is 1 through 14. Default is 1. Scan-lines above Pf are cleared in each character position which is written by this control. Ignored if Pi=3.

Pl: Bottom writeable scan-line of each character cell. Range is 1 through 14. Default is 14. Scan-lines below Pl are cleared in each character position which is written by this control. Pl must be equal to or greater than Pf. Ignored if Pi=3.

data: If Pi=3, indicating 80 column mode, each scan-line of a character cell is represented by two bytes of the form (B'010a bcde')-1, (B'011e fghi')-1, where "abcde" are the 5 leftmost pixels, and "fghij" are the 5 rightmost pixels of the scan line. Note that logic 1 = pixel on, logic 0 = pixel off. In addition, "data controls" (see below) may be embedded in the data.

If Pi=3, indicating 132 column mode, each scan-line of a cell is represented by one byte of the form (B'01ab cdef')-1 where "abcdef" are the 6 pixels of the scan line. In addition, "data controls" (see below) may be embedded in the data.

If Pi=3, indicating downloaded data is C.C. Memory Element I.D. String, the downloaded data bytes (up to 24 byte limit) are encoded as B'0101abcd' followed by B'0101efgh' where the downloaded I.D. byte value is B'abcdefgh' (h = least significant bit of I.D. byte). "Data controls" are ignored.

"Data Controls" Data controls are special character sequences that may be embedded in the data portion of this DCS string. Data controls are introduced by, and composed of, characters in the range X'21' through X'3E'.

':Pc' Indicates end of a segment of checksummed data. Current checksum accumulator value is compared with the value Pc and checksum is considered valid if the two values are equal. The checksum "Pc" is a decimal parameter in the range 0 to 255 and is the checksum value to be compared to the terminal's current checksum accumulator. After comparing, the terminal transmits the checksum result response using DA Private #2 CSI sequence with identifying parameter=8. After transmitting the response, the checksum accumulator is cleared and checksum tag counter is incremented.

'/' Indicates end of data for current character cell. The remaining writeable scan-lines in the character cell are cleared. Next pixel data applies to the next character cell.

'.Pc' Null scan-line. Pc is a numeric parameter 1 through 255 that indicates the number of null scan-lines to load. If omitted, Pc defaults to 1. This function can extend across character cell boundaries. When loading 80-column fonts, each null scan-line (10 pixels) would otherwise be represented by two data bytes.

'=Pc' Repeat last scan-line. Pc is a numeric parameter 1 through 255 which indicates the number of times to repeat the last scan-line. If omitted, Pc defaults to 1. This repeat function can extend across character cell boundaries.

ST C1 control code used to terminate DCS string. The terminal completes processing of DCS sequence by transmitting the checksum result response using DA Private #2 CSI sequence with identifying parameter=8.

With the exception of NULL, XON, XOFF, and ST, any code out of the range X'21' through X'7E' causes the DCS string to be terminated and an error completion response transmitted. NULL, XON, and XOFF codes do not interrupt DCS processing. Also, the half-duplex turn-around character does not disrupt processing of DCS if operating in Half Duplex B Mode.

Since Pc parameters can range from 0 through 255, Pc parameters appearing in the "data" portion of the DCS string may consist of up to 3 characters in the range X'30' through X'39'. The first character not in this range indicates that the parameter has been completed.

Checksum calculation is applied to all characters received in the DCS string after the '7E' byte with the exception of the ":Pc" characters. Each character included in the checksum calculation is simply added to the checksum accumulator as it is processed.

In all cases, when loading an 80-column character font, if a control (ST, .Pc, etc.) is encountered while expecting the second character of a scan-line, the remainder of the current scan-line is cleared and the control is executed normally.

If the indicated CG memory does not exist, the DCS sequence is still processed, but data is discarded and the status response returned using DA Private #2 CSI sequence with identifying parameter=8 will indicate non-existent memory (Pv1=2). Status response will be transmitted when first ":Pc" data control is processed, and when ST is processed.

5.5.8 Copy Into Download Character Memory

Erase may be performed by copying from what is referred to as the null character memory source. Copy terminates when any one of the following occurs:

- count is satisfied
- next source position would exceed memory position 255
- next destination position would exceed memory position 255

The control sequence for copy onto download character memory is:

CSI Pi ; Pe ; Ps ; Pd ; Pc X'23' v

Pi: Identifies source for copy. Ps=0 indicates null source (used to erase positions). Ps=1 indicates internal CG ROM. Ps=2 indicates internal CG RAM. Ps=3 indicates external CG memory #1, Ps=4 indicates external CG memory #2.

Pe: Identifies destination for copy. Ps=2 indicates internal CG RAM. Ps=3 indicates external CG memory #1, Ps=4 indicates external CG memory #2.

Ps: Specifies source starting position in CG memory (0 through 255). Default is Ps=0.

Pd: Specifies destination starting position CG RAM memory (0 through 5). Default is Pd=0.

Pc: Specifies the number of character positions to copy. Values range from 0 to 255, where 0 indicates copy of 256 positions. Default is Pc=0.

5.6 HOST-TO-TERMINAL PROTOCOL: SUPPORTED ANSI FEATURES

The Wang Model 2110A Workstation supports ANSI terminal-to-host features in the following areas:

- C0 Control Set
- C1 Control Set
- Display characters
- Escape Sequences Introduced by ESC
- Control Sequences Introduced by the Control Sequence Introducer (CSI)

5.6.1 C0 Control Set

Table 5-9 shows the members of the ANSI C0 control set supported by the 2110A workstation. The C0 control set includes the codes in the range X'00' through X'1F'. Table 5-9 also lists the additional control codes Space (X'20') and DEL (X'7F'). These control codes are not, strictly speaking, members of the C0 set but are, like the C0 control codes, accessible using 7-bit encoding without code extension techniques. Other codes in the range X'00' through X'1F' that are not defined in Table 5-9 are ignored.

Table 5-9. Supported Members of the C0 Control Set and Other Miscellaneous Control Codes

Mnemonic	Value	Description
NUL	X'00'	Null. Ignored on input. Not stored in the input buffer. Therefore, an imbedded NUL has no impact on processing of received commands.
ETX	X'03'	End Of Text. May be enabled as the HDX B turnaround character via Setup Mode. Ignored when not enabled as a turnaround character or when the terminal is not operating in Half Duplex B Mode. When operating as a turnaround character, it causes the terminal to try to enter transmit mode.
EOT	X'04'	End Of Transmission. May be enabled as a turnaround character via Setup Mode. Ignored when not enabled as a turnaround character or when the terminal is not operating in Half Duplex B Mode.
ENQ	X'05'	Enquire. Causes the terminal to transmit an operator-defined answerback message via Setup Mode. The terminal adds the turnaround character to the message if in Half Duplex B Mode.
BEL	X'07'	Bell. Causes the 2110A keyboard to beep.
BS	X'08'	Back Space. Moves the cursor one position to the left in the current line. If the cursor is in the first position of the line, the cursor does not move.

(continued)

Table 5-9. Supported Members of the C0 Control Set and Other Miscellaneous Control Codes (continued)

Mnemonic	Value	Description
HT	X'09'	Horizontal Tab. Moves the cursor right to the next tab stop. Moves the cursor to the right margin if there are no more tab stops on the line. If the cursor is already in the last column of a line, the cursor does not move. Default tabs are set in every eight columns (9, 17, 25, ... , 73).
LF	X'0A'	Line Feed. Moves the cursor down one line within the current column. If the cursor is in the last accessible row of the screen, the action taken depends on whether automatic scrolling is in effect: If auto-scroll is enabled, the 2110A scrolls the screen up before executing the Line Feed. If auto-scroll is disabled, the 2110A moves the cursor to the same column in the first row of the screen. Refer to Modes and Options in Section 5.8 for a description of Auto-Scroll Mode.
VT	X'0B'	Vertical Tab. Interpreted as a Line Feed (LF).
FF	X'0C'	Form Feed. The action taken depends upon the setting of the Wang-private Form-Feed Mode: If Reset, the 2110A interprets FF as the control Next Line (NEL), namely, CR followed by LF. If Set, the 2110A erases the screen and homes the cursor. The 2110A erases the screen by writing the space character to each position using default attributes.

(continued)

Table 5-9. Supported Members of the C0 Control Set and Other Miscellaneous Control Codes (continued)

Mnemonic	Value	Description
CR	X'0D'	Carriage Return. The action taken depends upon the setting of Wang-private Received Carriage Return Mode: If Reset, the cursor moves to the first position in the current line. If Set, interpret a received CR as the Next-Line (NEL) command, namely, CR followed by LF.
SO (LS1)	X'0E'	Lock Shift G1, Left. Activates the designated character set G1 as GL.
SI (LS0)	X'0F'	Lock Shift G0, Left. Activates the designated character set G0 as GL.
DC1/XON	X'11'	Device Control 1. Enables transmission from the terminal.
DC3/XOFF	X'13'	Device Control 3. Disables transmission from the terminal until XON is received.
CAN	X'18'	Cancel. Terminates CSI or ESC sequence when received in sequence. Does not alter the page.
SUB	X'1A'	Substitute. See CAN.
ESC	X'1B'	Escape. Indicates the beginning of an escape sequence. If received within a control sequence, the in-progress sequence is aborted and a new sequence begins.
SPACE	X'20'	Space. Displays the space character at the current cursor position and moves cursor one position to the right. See the description of Auto-Wrap Mode for the rules for cursor movement if the SPACE control character is received while the cursor is in the last position of the line.
DEL	X'7F'	Delete. Ignored on input (interpret as NUL).

5.6.2 C1 Control Set

Table 5-10 shows the members of the ANSI C1 control set supported by the 2110A workstation. The C1 control set includes the codes in the range X'80' through X'9F'. Definitions of codes X'A0' and X'FF' are also included with the C1 control. With 7-bit data representation, the C1 control codes are represented by the ESC control character followed by the quantity (8-bit code - X'40'). Other control codes in the range X'80' through X'A0' and the control code X'FF' that are not not defined in Table 5-10 are ignored.

Table 5-10. Supported Members of the C1 Control Set

Mnemonic	7-Bit Value	8-Bit Value	Description
IND	ESC D	X'84'	Index. Equivalent to LF except not affected by LNM Mode.
NEL	ESC E	X'85'	Next Line (New-Line). Interpreted as CR followed by LF. Not affected by LNM Mode.
HTS	ESC H	X'88'	Horizontal Tab Set. Sets a tab stop at the active cursor position.
RI	ESC M	X'8D'	Reverse Index. Moves the active position up one row in the same column. If auto scroll is enabled and the initial location of the active position is in the top row of the page, the page scrolls down.
SS2	ESC N	X'8E'	Single Shift G2 into GL. Temporarily activates designated character set G2 as GL.
SS3	ESC O	X'8F'	Single Shift G3 into GL. Temporarily activates designated character set G3 as GL.
DCS	ESC P	X'90"	Device Control String. Identifies the control string that formats and transfers data associated with downloadable character sets to the terminal.

(continued)

Table 5-10. Supported Members of the C1 Control Set (continued)

Mnemonic	7-Bit Value	8-Bit Value	Description
MW	ESC U	X'95'	Message Waiting. Indicates that currently disabled transmit source has pending data. This control code is only transmitted once. Also, it is only transmitted if Message Waiting Mode is enabled.
CSI	ESC [	X'9B'	Control Sequence Introducer. This control character indicates the start of a control sequence.
ST	ESC \	X'9C'	Terminates a DCS string.

5.6.3 Display Characters

The 2110A displays characters as follows when it receives the indicated character codes. The following descriptions apply when Insertion-Replacement Mode (IRM) is in the poweron default state (Reset). Refer to the description of IRM in Section 5.7 for information on character display when IRM is Set.

X'21' - X'7E' Selects a character from active character set GL and displays it at the current cursor position. Then moves the cursor one position to the right. See the description of Auto-Wrap Mode for the rules for cursor movement if a display character is received while the cursor is in the last position of the line.

X'A1' - X'FE' Selects a character from active character set GR and display it at the current cursor position. Then moves the cursor one position to the right. See the description of Auto-Wrap Mode for the rules for cursor movement if a display character is received while the cursor is in the last position of the line.

5.6.4 Erased Lines or Characters

Throughout this manual, Erased Lines and Erased Characters refer to the SPACE character displayed with the default attributes when the lines or positions are erased. This characteristic of 2110A erasing can affect the following controls (referred to by mnemonics) and terminal operations: ED, EL, IL, DL, DCH, IL private, DL private, Scroll Region, FF when Form Feed Mode is Set, Auto-Scroll operations, and appearance of the 25th line of the physical screen when 25th Line Display Mode is changed from Set to Reset state (2110 mode only).

5.6.5 Escape Sequences Introduced by ESC

The 2110A workstation responds to received escape sequences as follows:

Character Set Support

Code Sequence	*Effect*
ESC (1	Defines G0 as character set #1.
ESC (2	Defines G0 as character set #2.
ESC (3	Defines G0 as character set #3.
ESC) 1	Defines G1 as character set #1.
ESC) 2	Defines G1 as character set #2.
ESC) 3	Defines G1 as character set #3.
ESC * 1	Defines G2 as character set #1.
ESC * 2	Defines G2 as character set #2.
ESC * 3	Defines G2 as character set #3.
ESC + 1	Defines G3 as character set #1.
ESC + 2	Defines G3 as character set #2.
ESC + 3	Defines G3 as character set #3.

Terminal Reset

Code Sequence	*Mnemonic*	*Effect*
ESC a	INT	Interrupt. Immediately aborts any in-progress local print function operation or any host command currently being processed. Clears the main port transmit and receive buffers. Clears the aux port transmit and receive buffers. Enables host-to-terminal routing for data received by the terminal and terminal-to-host routing for data to be transmitted by the terminal. If the communication mode is FDX, the terminal transmits XON to indicate that the main port is now empty.

Code Sequence	*Mnemonic*	*Effect*
ESC a (continued)	INT	The processing of the INT control is allowed when the Enable Interrupt Control Mode is Set. The default value is via Setup Mode. This control is not buffered. It is handled immediately upon receipt.
ESC c	RIS	Reset to Initial State. Resets the terminal without altering the state of DTR output. Does not alter the state of RTS output when in Full Duplex Mode. De-activates RTS output when in Half Duplex Mode. Discards any data in the terminal's transmit and receive buffers. Performs full re-initialization of the keyboard, restoring all terminal settings to those in effect at the end of poweron initialization. Queues the XON character for transmission at the completion of the reset. The RIS is buffered and is only processed on the de-queue end of the main port receive buffer.

Lock Shift Commands

Code Sequence	*Mnemonic*	*Effect*
ESC n	LS2	Lock Shift G2, Left. Activates designated character set G2 as GL.
ESC o	LS3	Lock Shift G3, Left. Activates designated character set G3 as GL.
ESC X'7C'	LS3R	Lock Shift G3, Right. Activates designated character set G3 as GR.
ESC X'7D'	LS2R	Lock Shift G2, Right. Activates designated character set G2 as GR.
ESC X'7E'	LS1R	Lock Shift G1, Right. Activates designated character set G1 as GR.
ESC N (7-Bit)	SS2	Single Shift G2 into GL. Temporarily activates designated character set G2 as GL.
ESC O (7-Bit)	SS3	Single Shift G3 ino GL. Temporarily activates designated character set G3 as GL.

Line Attributes

Code Sequence	*Mnemonic*	*Effect*
ESC # 3	DECDHL	Sets line to double height+double width, top half.
ESC # 4	DECDHL	Sets line to double height+double width, bottom half.
ESC # 5	DECSWL	Sets line to single-width, single height.
ESC # 6	DECDWL	Sets line to single height+double width.

The last positions of lines with double-width and double-width-double-height are undisplayable at any allowed page:viewport column alignment.

When double-width or double-width-double-height attributes are enabled, the undisplayable positions at the end of the line should be erased to spaces with default display attributes.

The effective end-of-line boundary for all operations within lines with double-width or double-width-double-height is the position prior to the last position.

5.6.6 Control Sequences Introduced by CSI

The 2110A supports the following ANSI standard host-to-terminal control sequences introduced by the Control Sequence Introducer (CSI) character. The CSI character is ESC [in 7-bit representation. The CSI character is X'9B' in 8-bit representation.

Cursor Positioning

Code Sequence	*Mnemonic*	*Effect*
CSI Pn A	CUU	Cursor Up. Moves the cursor up Pn lines in the same column. The cursor stops at the top line of the screen. The default is Pn=1.
CSI Pn B	CUD	Cursor Down. Moves the cursor down Pn lines in the same column. The cursor stops at the last accessible line of the screen. The default is Pn=1.

Code Sequence	*Mnemonic*	*Effect*
CSI Pn C	CUF	Cursor Forward. Moves the cursor right Pn character positions in the same line. The cursor stops at the last position of the line. The default is Pn=1.
CSI Pn D	CUB	Cursor Backward. Moves the cursor left Pn character positions. The cursor stops at the first position of the line. The default is Pn=1.
CSI Pr ; Pc H	CUP	Cursor Position. Sets the cursor position to row Pr and column Pc. The first (top) row is 1, and the first (leftmost) column is 1. If Pr is greater than the number of accessible rows, the command executes as if Pr is equal to the number of accessible rows. The defaults are Pr=1, Pc=1.
CSI Pr ; Pc f	HVP	Horizontal and Vertical Position. The 2110 implementation of this control sequence is the same as for CUP. Host programmers are advised to use CUP to avoid compatibility problems with other terminals which may implement HVP with options that the 2110A does not support, such as decipoints.

Erasing

Code Sequence	*Mnemonic*	*Effect*
CSI Ps J	ED	Erase in Display. The cursor position is not altered. The value of Ps determines the portion of the display to erase as follows: 0: Erases from the cursor position through the end of the screen. 1: Erases from the start of the screen through the cursor position. 2: Erases the entire display. Erased positions are written with the Space character using default attributes. The default is Ps=0.

Code Sequence	*Mnemonic*	*Effect*
CSI Ps K	EL	Erase in Line. The cursor position is not altered. The value of Ps determines the portion of the line to erase as follows: 0: Erases the cursor position through the end of the line. 1: Erases from the start of the line through the cursor position. 2: Erases the entire line. Erased positions are written with the Space character using default attributes. The default is Ps=0.
CSI Pn X	ECH	Erase Character. Erases Pn characters starting at the current active position and extending forward. If Pn is greater than the number of positions to the end of the line, the command executes as if Pn is equal to the number of characters to the end of the line. The active position is not altered. Altering the action of this command by ANSI's EBM, SEM, and HEM is not supported. The default is Pn=1.

Display Editing

Code Sequence	*Mnemonic*	*Effect*
CSI Pn L	IL	Insert Lines. Inserts Pn erased lines at the current line. If Vertical Editing Mode (VEM) is Reset, the current and following lines are shifted downward to make room for the inserted lines, and Pn lines at the bottom of the screen are lost. If VEM is Set, the current and preceding lines are shifted up to make room for the inserted lines, and Pn lines at the top of the screen are lost.

Code Sequence	*Mnemonic*	*Effect*
CSI Pn L (Continued)	IL	If Pn is greater than the number of lines in the affected region, the command executes as if Pn were equal to the number of lines in the affected region. Erased positions are written with the Space character using default attributes. The default is Pn=1.
CSI Pn @	ICH	Insert Character. Inserts Pn erased characters starting at the current active position and shift adjacent characters right towards the end of the line. The active position is not altered. If Pn is greater than the number of positions to the end of the line, the command executes as if Pn is equal to the number of characters to the end of the line. Altering the action of this command by ANSI's EBM, SEM, and HEM is not supported. The default is Pn=1.
CSI Pn M	DL	Delete Lines. Deletes Pn lines at the current line. If Vertical Editing Mode (VEM) is Reset, the current line and (Pn-1) lines below the current line are deleted. The lines following the deleted lines are shifted up to replace the deleted lines and Pn erased lines are written at the bottom of the screen. If VEM is Set, the current line and (Pn-1) lines above the current line are deleted. The lines preceding the deleted lines are shifted down to replace the deleted lines and Pn erased lines are written at the top of the screen. If Pn is greater than the number of lines in the affected region, the command executes as if Pn were equal to the number of lines in the affected region. Erased positions are written with the Space character using default attributes. The default is Pn=1.

Code Sequence	*Mnemonic*	*Effect*
CSI Pn P	DCH	Delete Characters. Deletes Pn characters starting at the current cursor position and shifts adjacent characters left from the end of the line to fill the positions vacated by the deleted characters. Pn positions at the end of the line are erased. If Pn is greater than the number of positions in the affected region, the command executes as if Pn were equal to the number of characters in the affected region. Altering the action of this command by the following ANSI modes is not supported: Editing Boundary Mode (EBM), Select Editing Extent Mode (SEM), and Horizontal Editing Mode (HEM). Erased positions are written with the Space character using default attributes. The default is Pn=1.

Character Display

Code Sequence	*Mnemonic*	*Effect*
CSI Pn b	REP	Repeat. Repeats the processing of the preceding display character Pn times. Pn is limited to a maximum of 255. The display character is repeated using the active character set in effect when the character was first displayed, even if that character set was only active by means of a single shift (SS2 or SS3) control. The default is Pn=1.

Tab Support

Code Sequence	*Mnemonic*	*Effect*
CSI Ps g	TBC	Tabulation Clear. The cursor position is not altered. The value of Ps determines the horizontal tab stop(s) to be cleared as follows: 0: Clears the horizontal tab stop at the current active position.

Code Sequence	*Mnemonic*	*Effect*
CSI Ps g (continued)	TBC	1: Ignored. 2: Clears all horizontal tab stops. 3: Clears all horizontal Tab stops. The default is Ps=0.

Host Settable Operating Modes

Code Sequence	*Mnemonic*	*Effect*
CSI Ps;...;Ps h	SM	Set Mode. Puts the selected ANSI-defined mode(s) into the Set state. This command cannot be used to set Wang-private modes. The effect of multiple parameters is equivalent to the effect if each parameter was sent alone in the same sequence. The ANSI-defined modes supported by the 2110A are listed later in this section.
CSI Ps;...;Ps l	RM	Reset Mode. Puts the selected ANSI-defined mode(s) into the Reset state. This command cannot be used to reset Wang-private modes. The effect of multiple parameters is equivalent to the effect if each parameter were sent alone in the same sequence. The ANSI-defined modes supported by the 2110 are listed later in this section. The final character in this control sequence is lower case letter l.

Character Attributes

Code Sequence	*Mnemonic*	*Effect*
CSI Ps;...Ps m	SGR	Set Graphic Rendition. Selects the display attributes to be used when new characters are written to the screen.

Code Sequence	*Mnemonic*	*Effect*
CSI Ps;...Ps m (continued)	SGR	The effect of multiple parameters is equivalent to the effect if each parameter were sent alone in the same sequence. The parameters are processed in the order in which they are received. The default value is Ps=0. Allowed parameter values are: 0: Default attributes: Normal intensity, not underlined, not blinking, and normal video. 1: High intensity (bold). 4: Underscore. 5: Blinking. 7: Reverse Video. 8: Concealed characters (sets blank attribute). 21: Double underscore. 22: Normal intensity. 24: Not underlined. 25: Not blinking. 27: Normal video. 28: Revealed characters (removes blank attribute).
CSI Pn X'23' q		Starting at the current cursor position, rewrites Pn display positions with the current attributes. The character displayed at each position is not changed. Other actions (such as cursor movement and scrolling) occur after each position is rewritten as they would occur under the current mode settings if the position has just been written with a new display character. The default is Pn=1.

Host Querries

Code Sequence	*Mnemonic*	*Effect*
CSI Ps c	DA	Device Attributes. The host sends a DA command with Ps=0 to request that the device identify itself by sending a DA control sequence. The default is Ps=0. When the 2110A receives this DA command, it responds by transmitting the "DA Private #1" control sequence (refer to Section 5.11). The DA command is the recommended means for the host to identify the 2110A.
CSI Ps n	DSR	Device Status Report. Requests a status report from the terminal depending on the value of Ps. The 2110A supports the following values of Ps: 0: READY, NO MALFUNCTIONS DETECTED. No response transmitted unless responding to DSR request from host with Ps=5. 2: BUSY, WILL NOTIFY WHEN READY. If enabled via Setup Mode, transmitted on entry to Modem Command Mode. 5: Request status of terminal. Response is always transmitted DSR with Ps=0 (READY, NO MALFUNCTIONS DETECTED). 6: Request cursor position. The terminal responds with Cursor Position Report (CPR) sequence. The row and column that are returned are that of the current active position.

Aux Port/Print Support

Code Sequence	*Effect*
CSI Ps i	Media Copy. This defines the general form for Media Copy control. Controls the transfer of data between the terminal and the auxiliary device. The default is Ps=0.
CSI 5 i	Selects the aux port as the receive destination. Following data received in the main port is routed to the aux port.

Code Sequence		*Effect*
CSI 4 i		Selects the terminal as the receive destination. Data received in the main port is routed to the terminal.
CSI Ps;	Ps X'23' X'7B'	Selectively purges the terminal buffers. The default is Ps=0. Ps=0 Clears the aux port transmit buffer. Ps=1 Clears the aux port receive buffer. Ps=2 Clears the main port transmit buffer. Ps=3 Clears the main port receive buffer.

Multi-Page/Viewport

Code Sequence	*Mnemonic*	*Effect*
CSI Pn U	NP	Next Page. The default is Pn=1. Advances the active page (Pn) pages. If there are not enough defined pages to satisfy Pn, the last page is selected as the current active page. Pn=0 is equivalent to Pn=1. The active position within the page following execution of NP is always row 1 column 1 of the new active page, even if the new active page is same as the old active page. Null pages are not counted. If all pages are null the active position remains in the current null page. The page:viewport mapping and alignment changes, if any, resulting from receipt of this control are a function of the current states of the modes Auto-Map and Auto-Align.
CSI Pn V	PP	Preceding Page. The default is Pn=1. Causes the (Pn)'th preceding page to become the current active page. If there are not enough defined pages to satisfy Pn, the first page is selected. Pn=0 is equivalent to Pn=1. The active position within the page following PP is always row 1 column 1 of the new active page, even if new active page is same as the old active page.

Code Sequence	*Mnemonic*	*Effect*
CSI Pn V (continued)	PP	Null pages are not counted. If all pages are null, the active position remains in the current null page. The page:viewport mapping and alignment changes, if any, resulting from receipt of this control are a function of the current states of the modes Auto-Map and Auto-Align.
CSI Pr2 ; Pr3 ; ... Pr8 X'23' w		Define Viewports. Up to 8 viewports may be defined. Viewport width is always equivalent to the current physical screen width (80/132). Prn is the starting row of the n'th viewport. Pr1 is not included because viewport #1 always starts on row #1. Parameters in "Define Viewport" command should be in ascending order (Prn should always be greater than Prn-1). Modification of viewport mapping occurs during vertical sync period. When this control is used to eliminate currently defined viewport(s) from the screen, any page:viewport assignment associated with deleted viewports is lost. If the viewport is later re-defined, the viewport displays a null page (SPACES with default attributes) until an existing page is assigned to it. Defaults when no parameters are included is to define viewport #1 = entire physical screen.
CSI Pp ; Pv ; Pr ; Pc X'23' z		Map page to viewport. Pp is the page to be displayed in viewport. Pv is the viewport. Pr and Pc indicate the row and column within page to be positioned at upper left corner of viewport. If the page does not extend through the bottom row of the viewport, unoccupied bottom viewport rows are displayed as SPACE characters with default attributes. If column alignment specified for the page would position the rightmost column of the page prior to the rightmost column of the viewport, the column alignment is adjusted so that the rightmost columns of the viewport and the page coincide.

Code Sequence	*Effect*
CSI Pp ; Pv ; Pr ; Pc X'23' z	If Pp=99, the null page (SPACES with default attributes) is displayed in the viewport. Any former mappings involving the specified viewport and page are canceled prior to implementing the new mapping. A viewport that becomes unassigned as a result of the new mapping is mapped to the null page (SPACES with default attributes). A page that becomes unassigned as a result of the new mapping is simply left unassigned. If Auto-Align Mode is enabled and the specified values of Pr, Pc would place the active position outside the viewport, the alignment of the page in the viewport is shifted up/down/left/right the minimum number of rows and/or columns necessary to bring the active position into the viewport. Defaults are Pv=1, Pp=1, Pr=1, Pc=1. If Pr or Pc exceeds the boundaries of the page, the command executes with the maximum row or column number for the page. If Pp is not 1-8 or 99, or if Pv is not currently defined, the command is ignored. Assignment of a null page to a viewport is allowed.
CSI Pn ; Pr ; Pc X'23' y	Define page. Pn is a number 1 through 8 that identifies the page. Pr is the number of rows in the page. Pc is the number of columns in the page. The range of Pr is 0..255 (note that the current display memory pool cannot support Pr greater than 100). The range of Pc is 80/132 through 255 depending on current physical display width. Pr=0 or Pc=0 indicates a null page, and may be used to de-allocate memory assigned to a page. Memory previously assigned to this page is first returned to the available pool and then, where required, new page is allocated and erased (SPACE character with default attributes).

Code Sequence	*Effect*
CSI Pn ; Pr ; Pc X'23' y (continued)	If there is insufficient available display memory to allocate the defined size page, Pn is defined as a null page. If the total available display memory is sufficient for paging request, but there is insufficient contiguous display memory, the terminal moves the storage of currently allocated pages, as necessary, to obtain the required contiguous extent of display memory for new page. The terminal moves page memory assignments only when necessary for definition of a new page. If a page width less than 80 (132 if in 132 column mode) is specified, the parameter Pc is assigned the value of 80 (132 if in 132 column mode). Defaults are Pn=1, Pr=24, Pc=80 (132 if in 132 column mode).
CSI Pd ; Pdr ; Ps ; Psr ; Pex ; Pm X'23' X'7C'	Copy Region. Copy the page memory row contents of an area on page Ps beginning at row Psr to the contents of page Pd beginning at row Pdr. Pex rows (row Psr and below) are copied from page Ps to page Pd. If Pm=0, copied rows replace current rows in Pd. If Pm=1, copied rows are inserted into Pd beginning at row Pdr. The current page data beginning with and extending below Pdr is scrolled downward allowing insertion of copied rows, Pex current rows are lost. Command executes with effective value of Pex equal to the lessor of: 1) specified Pex value, 2) number of rows available in Ps, 3) number of rows available in Pd. If Pd is wider than Ps, rows copied are padded at the end with erased positions. If Ps is wider than Pd, rows are truncated, as necessary, during copy.

Code Sequence	*Effect*
CSI Pd ; Pdr ; Ps ; Psr ; Pex ; Pm X'23' X'7C' (Continued)	In all cases, column 1 of source rows is placed in column 1 of destination rows. Defaults are Pd=1, Pdr=1, Ps=2, Psr=1, Pex=(lessor of number of rows in Pd,Ps), Pm=0. When all parameters are omitted the, result is that contents of Page 2 is replaced with the contents of Page 1. VEM does not affect execution of this control. Implementation sequence shall be: 1. Scroll destination page if insert is selected. 2. Determine starting position in source and destination pages, and effective number of rows. 3. Copy from source to destination, one position at a time, incrementing source and destination pointers left to right, then top to bottom. This implementation guideline is intended to clarify any questions as to what should occur if the source and destination regions are in the same page and, possibly, overlapping.

Keyboard Associated Controls

Code Sequence	*Effect*
SI Pv1 ; Pv2 ; Pv3 X'23' p	Reconfigure Keyboard. Allows the host to force the terminal to redefine keyboard translation to support keyboard type identified by Pv1. Pv1;Pv2;Pv3 are the (upper case) ASCII character values of the keyboard selection abbreviations used in Setup Mode. Pv3 may be omitted if keyboard type abbreviation is two bytes If the parameter string is omitted or specifies an undefined keyboard type, no action is taken.

Code Sequence	*Effect*
SI Pv1 ; Pv2 ; Pv3 X'23' p (continued)	Example: If desired keyboard type is US Domestic, the host sends: "CSI X'35' X'35' ; X'35' X'33' X'23' p"
CSI Pn X'23' r	Controls the keyboard LED ON/OFF state. Changing the state of the LOCK LED also changes the internal LOCK state of the keyboard. Default is Pn=0. Pn=0: Turn off all LED's except LOCK LED. Pn=1: Turn on LED #1 (HELP LED). Pn=6: Turn on LED #6 (NUM LOCK). Pn=7: Turn on LOCK LED. Pn=11: Turn off LED #1 (HELP LED). Pn=16: Turn off LED #6 (NUM LOCK). Pn=17: Turn off LOCK LED. Pn=20: Turn off keyboard LED's (including LOCK LED).
CSI Pf ; Pv X'23' s	Controls the on/off state and frequency of the keyboard tone generator. Default is Pf=0. Pf: Function. Pf=0 turns tone off . Pf=1 turns tone on. Pv: Tone frequency. Ignored except when Pf=1.
CSI Pm ; Ps X'23' t	Sets keyboard pointing device operating mode. Default is Pm=0, Ps=0. Pm=0: Set to mechanical mouse operating mode (X'85' keyboard control). Ps has the following meanings: Ps=0: Mouse cursor mode. Ps=1: Mouse auto-transmit mode. Ps=2: Mouse query mode. Pm=1: Set to "serial Pointing Device" operating mode (X'87' keyboard control). Ps specifies the number of bytes in each data string sent by the by the serial pointing device. Ps may be 1 through 15. The default for Ps is omitted or zero is Ps=1.

5.7 MODES AND OPTIONS

The 2110A supports the ANSI-standard modes and options in the following list. ANSI-defined modes generally affect the interpretation of other commands and control sequences. Modes are in one of two possible states: Set or Reset. Modes can be set or reset by the Set Mode or Reset Mode commands sent from the host. In addition, there is a default value in effect at 2110A powerup. In the following list, the value in the Selector column is the parameter value used in the host Set Mode or Reset Mode command to specify the mode(s) to be affected.

Selector	*Mnemonic*	*Meaning*
2	KAM	**Keyboard Action Mode** Reset state: Keyboard input enabled. Set state. The keyboard input is disabled. The keyboard beeps and discards the keystrokes. The default value is enabled.
4	IRM	**Insertion-Replacement Mode** Reset state: A received display character replaces the character at the current cursor position and advances the cursor. Set state: When a display character is received, characters at and to the right of the cursor position are shifted right towards the end of the line by one position. The former last character on the line is lost. The received display character then replaces the character at the current cursor position. Auto-wrap is inhibited (does not occur) for all operations that would normally cause auto-wrap when IRM is Set, even if Auto-Wrap Mode is currently Set. However, the state of Auto-Wrap Mode is not altered by IRM. The effect does not extend beyond the end of the line regardless of the setting of the Wang-private Auto-Wrap Mode. The default value is Reset.

Selector	*Mnemonic*	*Meaning*
7	VEM	**Vertical Editing Mode** Reset state: The Insert Line (IL) and Delete Line (DL) commands affect the portion of the screen at and below the current line. The IL and DL commands affect the portion of the screen at and above the current line. The default value is Set.
12	SRM	**Send-Receive Mode** Reset state: Local echo is enabled. Set state: Local echo is disabled. The default value is via Setup Mode selection.
18	TSM	**Tabulation Stop Mode** Permanently Reset: Setting and clearing of horizontal tab stops applies to corresponding position of all lines.
20	LMN	**Line Feed/New Line Mode** Reset state: Received LF is interpreted as LF. Set state: Received LF is interpreted as CR+LF. Keyed CR transmits CR+LF to the host. The default value is via Setup Mode selection.

5.8 HOST-TO-TERMINAL PROTOCOL: SUPPORTED WANG PRIVATE EXTENSIONS

The Wang Model 2110A Workstation supports private extensions in the host-to-terminal protocol that are compatible with the ANSI X3.64 standard. Extensions are supported in the following areas:

- Escape sequences introduced by ESC
- Control sequences introduced by the Control Sequence Introducer
- Modes

The following sections describe these categories of extensions.

5.8.1 Escape Sequences Introduced by ESC

The 2110A supports the following Wang private escape sequences:

ESC 7 Saves the current cursor position, cursor on/off state, cursor blink/steady state, cursor underline/block state, and the current page numnber.

ESC 8 Restores the previously saved cursor position, on/off state, blink/steady state, underline/block state, and saved page number.

5.8.2 Control Sequences Introduced by CSI

The 2110A supports the following Wang private control sequences introduced by the Control Sequence Introducer character:

Display Editing Controls

Code Sequence	*Effect*
CSI > Pn ; Pw @	ICH private. Insert Character in Field. Insert Pn erased characters in a field of width Pw. The field begins at the active position and extends Pw positions to the right. Pn erased characters are inserted starting at the active position and the original field contents are shifted to the right towards the end of the field. The rightmost Pn characters of the field are lost. The active position is not altered. If Pw is greater than the number of positions to the end of the line, the command executes with Pw equal to the number of characters to the end of the line. If Pn is greater than Pw, the command executes with Pw=Pw. Altering the action of this command by ANSI's EBM, SEM, and HEM is not supported. The default is Pn=1, Pw= the number of positions from the active position through the end of the line.

Code Sequence	*Effect*
CSI > Pn ; Pw P	DCH private. Delete Character in Field. Deletes Pn chartacters in a field of width Pw. The field begins at the active position and extends Pw positions to the right. The first Pn characters in the field are deleted and the remainder of the field contents is shifted left from the end of the field to fill the positions vacated by the deleted characters. The Pn positions at the end of the field are erased. The active is not altered. If Pw is not greater than the number of positions to the end of the line, the command executes with Pw equal to the number of characters to the end of the line. If Pn is greater that Pw, the command executes with Pn=Pw. Altering the action of this command by ANSI's EBM, SEM, and HEM is not supported. The default is Pn=1, Pw= the number of positions from the active position through the end of the line.
CSI > Pn ; Ps L	IL private. Inserts Pn erased lines at the current line. If Ps=0, the current and following lines are shifted downward to make room for the inserted lines, and Pn lines at the bottom of the screen are lost. If Ps=1, the current and preceding lines are shifted up to make room for the inserted lines, and Pn lines at the top of the screen are lost. If Pn is greater than the number of lines in the affected region, the command executes as if Pn were equal to the number of lines in the affected region. Erased positions are written with the Space character using default attributes. The default is Pn=1, Ps=0.

Code Sequence	*Effect*
CSI › Pn ; Ps M	DL private. Deletes (Pn) lines at the current line. If Ps=0, the current line and (Pn-1) lines below the current line are deleted. The lines following the deleted lines are shifted up to replace the deleted lines and Pn erased lines are written at the bottom of the screen. If Ps=1, the current line and (Pn-1) lines above the current line are deleted. The lines preceding the deleted lines are shifted down to replace the deleted lines and Pn erased lines are written at the top of the screen. If Pn is greater than the number of lines in the affected region, the command executes as if Pn were equal to the number of lines in the affected region. Erased positions are written with the Space character using default attributes. The default is Pn=1, Ps=0.

Aux Port/Print Support

Code Sequence	*Effect*
CSI › Pr ; Pc ; Pl ; Pw r	Specify host defined Print-Screen Region. Specifies the physical screen boundaries of the host defined print-screen region. The host defined Print-Screen Region is used by the Print-Screen operations only when the Setup menu selection (under Aux Port Communications) for PRINT SCREEN REGION= HOST. The Print-Screen Region is ignored when selection for PRINT SCREEN REGION=FULL.
CSI › Ps; Pe; Pc; Pd S	Scroll Region. Defines a scroll region whose uppermost row is Ps and whose lowest row is Pe. If Pd=0, the lower Pc lines of the region are deleted, the remainder of the region is scrolled down Pc lines, and Pc erased lines are inserted at the top of the region.

Code Sequence	*Effect*
CSI > Ps; Pe; Pc; Pd S (continued)	If Pd=1, the upper Pc lines of the region are deleted, the remainder of the region is scrolled up Pc lines, and Pc erased lines are inserted at the bottom of the region. If Pc is greater than the number of lines in the region, the command executes as if Pc were equal to the number of lines in the region. Ps and Pe must be specified. Ps must be less than or equal to Pe. Erased positions are written with the SPACE character using default attributes. The defaults are Pc=1, Pd=0.

Host Settable Operating Modes

Code Sequence	*Effect*
CSI > Ps;...;Ps h	SM private. Set Mode. Puts the selected Wang private mode(s) into the Set state. This command cannot be used to set ANSI-defined modes. The effect of multiple parameters is equivalent to the effect if each parameter were sent alone in the same sequence. The supported Wang private modes are listed later in this section.
CSI > Ps;...;Ps l	RM modified. Reset Mode. Puts the selected Wang private mode(s) into the Reset state. This command cannot be used to reset ANSI-defined modes. The effect of multiple parameters is equivalent to the effect if each parameter were sent alone in the same sequence. The supported Wang private modes are listed later in this section. The final character in this control sequence is the lower case letter "l".

Multi-Page/Viewport

Code Sequence	*Effect*
CSI > Pr ; Pc ; Pp H	CUP private. Sets the active position to row (Pr) and column (Pc) in page (Pp). The first row is 1. The first column is 1. If Pr is greater than the number of accessible rows, the command executes as if Pr is equal to the number of accessible rows. If Pc is greater than the number of accessible columns, the command executes as if Pc is equal to the number of accessaible columns. If Pp is greater than 8, the last page is selected. Page:viewport mapping and alignment may be altered if Auto-Map and/or Auto-Align modes are enabled. If enabled and applicable, Auto-Align actions occur as the last step of this command. Defaults: Pr=1, Pc=1, Pp=1.

Erase Window

Code Sequence	*Effect*
CSI > Pr; Pc; Pl; Pw J	Erase window in current page. Fills assigned rectangle with erased characters (SPACE with default attributes). The active position is not altered. Pr,Pc: Row/column position of upper left corner of rectangular area to be erased. Default is Pr=1. Pl: Length of window (number of rows) to be erased, including row Pr and extending downwards. The default is window extends to the bottom of the page. Pw: Width of window (number of columns) to the right. The default is window extends to the last column of the page.

Note: *In all cases throughout this manual, parameters are processed in the order in which they are received within control sequences.*

Host Querries

Code Sequence	*Effect*
CSI › Ps ; Pv1 c	(DA Private #2) Request/return information from the terminal. Ps identifies the information requested. In certain cases, Pv1 provides additional specification of what information is requested. There is no default for Ps. The default for Pv1 is determined by the meaning of Ps. The supported values of Ps are listed below. The terminal responds with DA Private #2 sequence. "CSI › Ps ; Pv1; ..; Pvn c". See Section 5.11. Ps=1: Request page number containing the active position, character attributes, and C.G. Memory Element enabled for display at active position. Response identifier is Ps=4. Ps=2: Request keyboard ID bytes. Included only for compatibility with the 2110. Response identifier is Ps=5. Ps=3: Request current keyboard layout type Response identifier is Ps=6. Ps=10: Request aux port device type string. Response identifier is Ps=20. Ps=11: Request current Print-Screen boundaries. Response identifier is Ps=21. Ps=12: Request current state of aux port control signal inputs (DSR, CTS, DCD). Response identifier is Ps=22. Ps=13: Request current aux port configuration. Response identifier is Ps=23. Ps=14: Request current printer width. Response identifier is Ps=24.

Code Sequence	*Effect*
CSI > Ps ; Pv1 c (continued)	Ps=15: Request keyboard spec/code revision level and workstation mode state. Response identifier is Ps=25. Ps=16: Request keyboard device type. Response identifier is Ps=26. Ps=17: Request current keyboard LED status. Response identifier is Ps=27. Ps=18: Request device type connected to keyboard. (X'84' keyboard query). Response identifier is Ps=28. Ps=19: Request CG ROM identification string and and current assignment. Default for Pv1=0 or omitted is Pv1=1. Values for Pv1 are: Pv1=1: Internal CG ROM. Pv1=2: Internal CG RAM. Pv1=3: External CG ROM #1. Pv1=4: External CG ROM #2. Response identifier is Ps=29. Ps=30: Request current number of available positions in Page Pool. Response identifier is Ps=40.

5.9 MODES AND OPTIONS

The 2110A supports the following terminal-to-host protocol modes and options. Wang private modes are always in one of two states: Set or Reset. Modes or options have a default state at 2110A poweron (see Appendix B) and can be altered by Wang private host-to-terminal Set Mode and Reset Mode commands. In the following list, the value in the Selector column is the parameter value used in the host Wang private Set Mode or Reset Mode command to specify the mode(s) to be affected.

Selector	*Mode, Description*
2	**Cursor Blink Mode** Reset state: The cursor does not blink. Set state: The cursor blinks.

Selector	*Mode, Description*
3	**Cursor Style** Reset state: The cursor is displayed as an underscore. Set state: The cursor is displayed as a block.
4	**Insert-Replace Mode (IRM)** This Wang private mode provides access to the ANSI-defined Insert-Replace Mode from within the Wang-private Set Mode and Reset Mode commands. This mode is the one exception to the rule that ANSI-defined modes cannot be accessed through the Wang-private Set Mode and Reset Mode control sequences. Refer to the full description of IRM in Section 5.7. Reset state: The ANSI Insert-Replace Mode is placed in Reset state. Set state: The ANSI Insert-Replace Mode is placed in Set state.
5	**Cursor Display Disable** Reset state: The cursor display is on (cursor is visible). Set state: The display of the cursor at the active position is not visible).
8	**Cursor Attach Mode** Reset state: The cursor display is detached from the active position. When in Reset state, the cursor display remains in a fixed position. The cursor display position is unaffected by changes in the active position. The row and column of the cursor display is not affected by scrolling. Set state: The cursor display position corresponds to the current active position.

Selector	*Mode, Description*
9	**Auto-Wrap Mode**

The state of the Auto-Wrap Mode determines the active position's movement after the 2110A writes a display character to the last position of a line. Auto-Wrap Mode also affects the Rewrite Attributes command. Auto-Wrap is inhibited whenever IRM (Insertion-Replacement Mode) is in the Set state. However, the state of Auto-Wrap Mode is not changed by IRM Mode. Therefore, when IRM mode is again put in the the Reset state, the normal effects of the current state of Auto-Wrap once again occur.

Reset state: The cursor does not move after the 2110A writes a display character to the last position of a line.

Set state: The active positin moves to the first position of the next line after the 2110A displays a character on the last position of the preceding line. After the 2110A writes a display character to the last position of the last accessible line of the screen:

If scrolling is enabled, the 2110A scrolls the screen up and positions the cursor at the start of a new line.

If scrolling is not enabled, the 2110A positions the cursor at the Home position. See Auto-Scroll Mode.

20 **Scan Code Keyboard Handling Mode**

Reset state: Keyboard handling is ANSI/ASCII-compatible.

Set state: Keystrokes cause encodings of scan codes to be transmitted (see Section 6.9).

21 **Received Carriage Return Mode**

The state of this mode determines the 2110A's action when it receives the Carriage Return control character (X'0D').

Reset state: The active screen position moves to the first position of the current line.

Set state: The 2110A interprets a received Carriage Return as a Carriage Return followed by a Line Feed (X'0A'), i.e., as a Next Line (NEL) control (also known as New Line).

Selector *Mode, Description*

22 **Form Feed Mode**

This mode determines the 2110A's action when it receives the Form Feed (X'0C') control character.

Reset state: The 2110A treats a received Form Feed as a Next Line (NEL) control character.

Set state: The 2110A erases the screen and homes the cursor when it receives a Form Feed. Erased positions are written with the Space character using default attributes.

23 **25th Line Display Mode**

The state of this mode determines whether or not the 25th line of display data is displayed on the screen. Setting or resetting this mode does not alter the contents of the 25th line of display data stored withing the terminal display memory. This mode is only avalaible while in 2110 Mode. It is ignored in 2110A and VT-102 Modes.

Reset state: The 25th line of display data is not visible on the screen. The 25th line of the screen is displayed as though erased using the Space character with current attributes at the time Reset state is entered. However, the terminal continues to maintain the 25th line of display data internally. The 25th Line Display Mode may not be reset while the 25th Line Access Mode is enabled. Invoking Reset Mode has no effect if 25th Line Display Mode is already in Reset state.

Set state: The 25th line of display data is displayed on the screen.

24 **25th Line Access Mode**

The state of this mode determines whether the 25th line of display data is accessible for cursor positioning and screen modification. The cursor save and restore rules are intended to aid a host application that uses the 25th line as a message line. However, the 25th line is not restricted to being used as a message line. This mode is only avalaible while in 2110 Mode. It is ignored in 2110A and VT-102 Modes.

Selector	*Mode, Description*
24	**25th Line Access Mode** (continued)

Reset state: The 25th line is not accessible. The effective screen size for all operations is limited to lines 1 through 24. When the state is changed from Set to Reset, the cursor position is recalled only if the cursor is in the 25th line immediately prior to entering Reset state. Otherwise the cursor position does not change on entering Reset state.

Set state: The 25th line is accessible. The effective screen size for all operations includes lines 1 through 25. When the 25th line is accessible, the 25th line display Mode is enabled. When the 25th Line Access Mode state is changed from Reset to Set, the cursor position is saved for possible later recall.

25 **Auto-Scroll Mode**

The state of this mode determines whether or not the screen scrolls automatically when the 2110 performs various screen update functions. Refer to the descriptions of individual screen update functions to see how a particular function is affected by Auto-Scroll Mode. Whenever a new line is scrolled onto the screen, the new line is filled wih the SPACE character using current attributes.

Reset state: Automatic scrolling is disabled. The active position moves to the first row, same column, in the current page.

Set state: Automatic scrolling is enabled.

26 **Video Mode**

The state of this mode controls the 2110's interpretation of the normal/reverse video attribute of all screen display positions. Changing this mode does not change the attributes assigned to characters on the screen, but controls the dynamic interpretation of the video attribute by the 2110A's display generator.

Reset state: The 2110A interprets the Normal video attribute as a light character on a dark background. The Reverse video attribute is interpreted as a dark character on a light background.

Selector	*Mode, Description*
26	**Video Mode** (continued) Set state: The 2110A interprets the Normal video attribute as a dark character on a light background. The Reverse video attribute is interpreted as a light character on a dark background.
27	**Data Representation Mode** Refer to Table 5-11 for information on 7-bit versus 8-bit data representation. Reset state: The 2110A uses 7-bit data representation. Set state: The 2110A uses 8-bit data representation in the encoding of control sequences. An attempt to enter Set state while the transmission format is set to 7 data bits is ignored.
28	**Internal/External character set default** Reset: Internal CG ROM 1 defined as character sets #1,2,3. External CG Memory Element #1 is character sets 7,8,9. Set: Internal CG ROM 1 is character sets #7,8,9. External CG Memory Element #1 is character sets 1,2,3.
29	**Auto-Map** Determines whether mapping of page to viewport is affected by moving the active position out of a currently displayed page. Reset: Page:viewport mapping is not altered when the active position moves to a different page.

Selector	*Mode, Description*
29	**Auto-Map** (continued) Set: Page:viewport mapping is changed when the active position is moved to a new page if the active position previously in a displayed page. If Auto-Align is disabled, the new page is mapped to the current viewport with row 1, column 1 corresponding to the upper left corner of the viewport. If Auto-Align is enabled, the terminal first attempts to map the new page with row 1, column 1 corresponding to the upper left corner of the viewport. If this alignment does not bring the active position into the viewport, the viewport is shifted the minimum number of positions vertically and/or horizontally to bring the active position into the viewport.
30	**Aux Port Transparency Mode** Reset: Transparency disabled. Encoding of aux port data with SS2,SS3 prefixes is disabled. Set: Transparency enabled. Encoding of aux port data with SS2 and SS3 prefixes is enabled.
31	**Aux Port Tag Mode** Determines whether changes in source of data transmitted to the host will be tagged. Source of transmitted data may change due to explicit host controls (media copy or Mode changes) or due to automatic switching when aux data interleave is enabled. Reset: No tag placed in transmitted data stream when source of transmitted data changes. Set: Tag (DC2/DC4) placed in transmitted data stream whenever source of transmitted data changes.
32	**Transmit Source Mode** Controls routing of data transmitted from terminal main port. This mode is also changed via the "CSI 5 i","CSI 4 i" control sequences if link routing Mode is Set. Host programmers should note that RM/SM controls cannot be used to alter this mode when routing of received data is currently to the aux device.

Selector	*Mode, Description*
32	**Transmit Source Mode** (continued) Reset: Transmit source is terminal only. If Link Routing Mode is Set, received data destination is also selected to be terminal. Set: Transmit source is aux port. If link routing Mode is Set, received data destination is also selected to be aux port.
33	**Link Routing Mode** Allows routing of main port receive and transmit data paths to be controlled simultaneously. Reset: Routing is not linked. The control of transmit and receive paths are switched independently between terminal or aux port. Set: Routing is linked. Transmit source and receive destination are both terminal or both aux port. Change in Transmit Source Mode alters Receive Source Mode as well. Change in Receive Source Mode alters Transmit Source Mode as well. The control of both the transmit and receive paths are switched together between terminal or aux port.
34	**Aux Data Interleave Mode** Affects the operation of the terminal only when transmit source is selected to be aux port. Does not affect routing of data received by the terminal. Reset: When transmit source is selected to be aux port, only aux port data is transmitted to the host. When this mode is Reset, terminal data is transmitted only when transmit source is set to be "from terminal". Set: When transmit source is selected to be aux port, data from terminal is permitted to interleave with aux port data.

Selector	*Mode, Description*
35	**Message Waiting Enable Mode** Determines if the terminal notifies the host when data becomes pending on a disabled transmit data source. Message Waiting (MW defined in C1 Control Codes) is not transmitted if the source is aux port and aux data interleaving is enabled. Reset: The terminal does not send MW control. Set: The terminal sends MW control when data becomes pending in disabled transmit source.
36	**Auto-Alignment** Determines whether alignment of page to viewport is affected by the movement of the active position. Reset: Viewport mapping is not affected by the movement of the active position. Note that the active position may be in a non-displayed portion of a page. Set: Page:viewport alignment is affected by movement of the active position. Movement of the active position within the current page which attempts to move active position out of viewport causes the page:viewport alignment to shift as necessary to include the new active position (refer to Auto-Alignment definition).
37	**Modem Command Mode 'BUSY/READY' Notification** Reset: BUSY/READY messages are not transmitted on entry to/exit from modem command Mode. SET: BUSY/READY messages are transmitted on entry to/exit from modem command Mode.
38	**PRINT Key Mode** Determines whether PRINT Key invokes local print operations directly or simply transmits keycodes to the host. The host may Reset this mode when it wishes to lock out locally initiated print operations. The state of this mode is ignored unless HOST ACCESS:YES is selected from the Aux Port Communications Menu through Setup Mode.

Selector	*Mode, Description*
38	**PRINT Key Mode** (continued) Reset: PRINT key transmits keycodes to the host. Does not initiate local print operations. Set: PRINT key initiates local print operations directly. Does not transmit keycodes.
39	**Ignore Aux Port Flow Control** Allows the host to specify that the terminal ignore the aux port flow control state when transmitting data from the aux port transmit buffer to the aux device. Both XON/XOFF and hardware signal flow control are ignored when this mode is Set. Reset: Flow control defined in Setup Mode is in effect. If the previous state of this mode was Set, assume that the last XON/XOFF control received from the aux device was XON. Set: Flow control defined in Setup Mode is ignored when transmitting data to aux device. If transmission of pending aux port data has been blocked due to the flow control state, that data will immediately begin to be transmitted when this mode enters the Set state.
40	**Enable Interrupt Control (INT)** Allows the host to enable/disable the immediate processing of the INT control when received. Reset: Any processing associated with the terminal's implementation of the INT control is disabled. The received INT control bytes (ESC a) are buffered if host-to-aux port routing is enabled. Set: Processing associated with the INT control is carried out immediately. Received INT control bytes are not buffered.

Selector	*Mode, Description*
41	**Aux Buffer Empty Notification**

Determines whether the terminal notifies the host of aux port transmit buffer empty condition. For purposes of this notification, the aux port transmit buffer is considered to be in the empty condition when it contains 32 or fewer bytes. When this mode is enabled, the terminal notifies the host by transmitting DA Private #2 sequence with Ps=50.

Reset: Notification not sent.

Set: Notification is sent. Notification is sent when the aux port transmit buffer is in (or enters) the empty condition following either of the events listed below:

a) The state of this mode is changed from Reset to Set and the aux port buffer is empty.

b) The routing of data received from the host is changed from "host-to-aux-port" to "host-to-terminal" and the aux port is empty.

c) The routing of data received from the host is currently "host-to-terminal" and the aux port becomes empty. Note that this implies that the host had formerly routed data to the aux port buffer, and has re-directed host data to terminal processing prior to the terminal having completed the transmission of data in the aux port transmit buffer.

If either "host-to-aux-port" port routing is re-enabled or this mode is Reset before buffer condition becomes empty, notification is not sent. Note that notification is sent immediately when either of the above events occur.

Table 5-11 contrasts various requirements and effects of 7- and 8-bit Data Representation Modes.

Table 5-11. Differences Between 7- and 8-bit Data Representation Modes

7-Bit Data Representation Mode	8-Bit Data Representation Mode
The host sends C1 controls as Escape sequences. C1 controls in the range X'80' through X'9F' are sent by the host as Escape sequences "ESC X'40' through "ESC X'5F'".	The Host sends C1 controls directly as codes in the range X'80' through X'9F'. The terminal still interprets C1 control commands via escape sequences if sent by the host.
The host may not access the active character set GR.	The host may access the active character set GR via codes in the range X'A1' through X'FE'.
The terminal transmits C1 controls as escape sequences. C1 controls in the range X'80 through X'9F' are transmitted by the terminal as escape sequences in the range ESC X'40' through ESC X'5F'.	The terminal transmits all C1 controls directly as codes in in the range X'80' through X'9F'.
In Scan Code Mode, the terminal sends some keycodes using the SS2 prefix. In effect, the terminal treats the host as if the host has a character set designated as G2.	In Scan Code Mode, the terminal sends only one-byte codes for keycodes. Keycodes that would be sent 7-bit mode as sequences in the range SS2 X'21' through SS2 X'67' are sent in 8-bit mode as codes in the range X'A1' through X 'E7'. In effect, the terminal treats the host as if it has an active character set GR defined.

5.10 TERMINAL-TO-HOST PROTOCOL: SUPPORTED ANSI FEATURES

The 2110A can send the following controls to the host:

Mnemonic	*Value*	*Effect*
XON	X'11'	Enables host transmission to the terminal.
XOFF	X'13'	Disables host transmission to the terminal until the terminal sends XON. The host is still allowed to enable or disable terminal transmission by sending XON/XOFF codes after receiving an XOFF from the terminal.
CPR	CSI Pr ; Pc R	Cursor Position Report. The 2110A sends this control sequence only in response to a Device Status Report (DSR) command from the host with Ps=6 (signifying "Please report active position"). Values in the CPR control sequence are Pr=row, Pc=column of the current cursor position.

5.11 TERMINAL-TO-HOST PROTOCOL: SUPPORTED WANG PRIVATE EXTENSIONS

The 2110A can send the following Wang private control sequences to the host.

Device Attributes Private Control Sequence No. 1

Format	*Effect*
CSI ? Pc; Pt; Pr c	Device Attributes (DA Private #1). This control sequence is a general identification format that the 2110A transmits to the host in response to the ANSI-standard DA control sequence from the host requesting the terminal's identifying DA sequence "CSI Ps c". The parameter values are as follows: Pc: General terminal class. Pc=77 indicates 21xx class. Pt: Specific terminal type. Pt=1 indicates 2110. Pt=2 indicates 2110A.

Device Attributes Private Control Sequence No. 1 (continued)

Format	*Effect*
CSI ? Pc; Pt; Pr c	Pr: Firmware revision level. Indicates the instaslled firmware level.

Device Attributes Private Control Sequence No. 2

Format	*Effect*
CSI > Ps ; Pv1; ... ; Pvn c	Device Attributes (DA Private #2). The 2110A sends this control sequence to the host in response to a DA Private #2 Wang private host-to-terminal control sequence received from the host. Ps identifies the information being returned. Pv1;..;Pvn is the information being returned. The number of Pv parameters is a function of Ps. The possible responses are: Ps=4: The character and attributes at the current cursor position. Pv1 is a value in the range 0 through 255 that is the character generation ROM position of the character (refer to Table 5-7). Pv2 is a value in the range 0 through 63 that specifies the character attributes. Pv2 is the decimal representation of the 6-bit value defined below: B'00 0001': Blink. Clear if no-blink. Set if blink. B'00 0010': Intensity. Clear if normal intensity. Set if high intensity. B'00 0100': Underline. Clear if no underline. Set if underline.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*
CSI > Ps ; Pv1; ... ; Pvn c	B'00 1000': Video. Clear if normal video. Set for reverse video. B'01 0000': Blank (concealed) attribute. B'10 0000': Double underscore Pv3 is the character generator element currently assigned to the character at the active position encoded as: Pv3=1: Internal CG ROM Pv3=2: Internal CG RAM Pv3=3: External CG ROM #1 Pv3=4: External CG RAM #2 Pv4 is the number (1 through 8) of the page currently containing the active position. Ps=5: Keyboard ID bytes. Pv1; Pv2; Pv3; Pv4 are the keyboard ID bytes received from the keyboard during poweron. The value of each Pv equal 0. Included only for compatibility with the 2110 because the 2110A keyboard does not supply the keyboard ID bytes. Ps=6: Keyboard type. Returns the parameters Pv1, Pv2, and Pv3 (if required) which are the ASCII character byte values of the keyboard language abbreviations used in Setup Mode for keyboard selection type. Values for Pvn range from X'21' to X'7E' according to the keyboard language selection abbreviations used in the Setup menu definition section. Example: if the keyboard type is US Domestic, the 2110A sends the following Wang private DA #2 control sequence: "CSI > 6 ; 55 ; 53 c"

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*	
CSI > Ps ; Pv1; ... ; Pvn c	Ps=7:	(unsolicited) Return data from keyboard pointing device. Pv1 is a value (0 through 15) indicating the number of data bytes received from the pointing device. Pv2, Pv3, .. up to Pv16, are the data bytes received from the pointing device. More specific rules follow depending upon whether keyboard pointing device is currently configured to operate in "mouse" or "serial" Mode. **"Mouse" Mode** The byte X'81' received by the terminal from the keyboard is ignored, as is the following byte. The byte X'82' received by the terminal from the keyboard is interpreted as meaning "no data available from mouse". The terminal transmits the response to the host with Pv1=0 (indicating no data) and Pv2 through Pv16 omitted. The bytes X'83' through X'8F' received by the terminal from the keyboard are interpreted as an introducer byte for a mouse data string of length (n), where (n) is the value of the least significant nibble of the introducer byte. The terminal expects that the next (n) bytes received from the keyboard will be the (n) bytes of the mouse data string.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*
CSI > Ps ; Pv1; ... ; Pvn c	Ps=7: The terminal transmits the response to the host with Pv1 equal to the length (n) of the mouse data string, and Pv2 through Pv(n+1) being the decimal representations of the (n) bytes of the mouse data string. Note the length of mouse data string will probably always be 3. **"Serial" Mode** The bytes X'81' through X'8F' received by the terminal from the keyboard are interpreted as an introducer byte for a serial pointing device data string of length (n), where (n) is the value of the least significant nibble of the introducer byte. The terminal expects that the next (n) bytes received from the keyboard will be the (n) bytes of the serial data string. The terminal transmits the response to the host with Pv1 equal to the length (n) of the serial data string, and Pv2 through Pv(n+1) being the decimal representations of the (n) bytes of the serial data string. Ps=8: Indicates font loading status response. See description of DCS for font loading, especially ":Pc" and "ST" elements. Pv1=0 indicates error-free status. Pv1=1 indicates checksum failure and/or parity error occured. Pv1=2 indicates a character generator RAM memory that is not currently available was specified.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*	
CSI > Ps ; Pv1; ... ; Pvn c	Ps=8:	If a data error error was detected, Pv1=1 and Pv2 is the value of the checksum tag counter at the time of the first error detected during processing the data portion of the DCS string. If no error occurred, or if a nonexisting memory was specified, Pv2 is omitted from the response. This response is always returned as part of processing the ST control terminating the DCS string. This response is also transmitted during processing the first error detected in the data portion of the DCS string. If multiple errors are detected within one DCS string, errors after the first do not generate this response. However, this response is not sent if ST is not received in the context of a DCS string.
	Ps=9:	(unsolicited) Indicates that ACK (X'02') received from keyboard. No Pv parameters present.
	Ps=20:	Return aux port device type string entered in Setup Mode. Pv1..Pv6 are 1-6 parameters which are decimal numbers of ASCII characters.
	Ps=21:	Return current Print-Screen boundaries: Pv1=row number of upper left corner, Pv2=column number of upper left corner, Pv3=number of rows, Pv=number of columns.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*
CSI › Ps ; Pv1; ... ; Pvn c	Ps=22: Return current state of aux port control signal inputs. Pv1 is a value in the range 0 through 7 which specifies the character attributes. Pv1 is the decimal representation of the 3-bit value defined below: B'001': DSR asserted. B'010': CTS asserted. B'100': DCD asserted. Ps=23: Return current aux port configuration. Pv1=baud rate (75, ..., 19200) Pv2=number of data bits (7, 8) Pv3=parity (1=ODD, 2=EVEN, 3=NONE, 4=MARK, 5=SPACE) Ps=24: Return current printer width (Pv1). Ps=25: Return keyboard spec/code revision level and workstation mode state. Pv1 is the decimal representation of the 8-bit byte returned by the keyboard in response to X'09' query. Ps=26: Return current keyboard type. Two bytes sent by the keyboard in response to X'0E' query are returned as Pv1=first byte, Pv2=second byte. With the current version of the keyboard, Pv2 is always 0. Pv1=0 indicates 107 key expanded. Pv1=1 indicates 105 key non-expanded.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*
CSI > Ps ; Pv1; ... ; Pvn c	Ps=27: Return keyboard LED status as value in range 0-255. This is the decimal representation of a byte formed by combining the following bit values: B'0000 0001': Set if LOCK state/LED is ON. B'0000 0010': Set if LED #1 (HELP LED) is ON. B'0000 0100': Set if LED #2 is ON. B'0000 1000': Set if LED #3 is ON. B'0001 0000': Set if LED #4 is ON. B'0010 0000': Set if LED #5 is ON. B'0100 0000': Set if LED NUM LOCK LED is ON. Ps=28: Return device type attached to keyboard. Pv1=response from keyboard (in range 0 through 15). This is the keyboard X'84' query response. Ps=29: Response to request for CG ROM identification string. Pv1: Indicates which memory identification comes from: 1=Internal CG ROM, 2=Internal CG RAM, 3=External CG ROM #1, 4=External CG ROM #2. Pv2: Presence of CG ROM from which id string is requested. 0=present, 1=absent. Pv3: Pv3=1: Character Sets 1,2,3. Pv3=2: Character Sets 4,5,6. Pv3=3: Character Sets 7,8,9. Pv3=4: Character Sets 10,11,12.

Device Attributes Private Control Sequence No. 2 (continued)

Format	*Effect*
CSI > Ps ; Pv1; ... ; Pvn c	Pv4.. (up to Pv27): External CG ROM Identification string. Values may range 1 through 255. Value of 0 will never be returned because first zero byte in ROM indicates end of string. Ps=40: Return current available display memory pool size. Pv1 is the currently available unassigned positions in the display memory pool size. Ps=50: (unsolicited) Aux Buffer Empty Notification. Used by the terminal to notify the host that the aux port transmit buffer is empty. No Pv parameters used. Refer to Aux Buffer Empty Notification Mode for details of when this notification is transmitted.

5.12 ADDITIONAL TECHNICAL NOTES

This section describes terminal error conditions, terminal re-initialization, and terminal identification by the host.

5.12.1 Responding to Parity or Other Screen Errors

When a parity error occurs in a received character, the 2110A displays an error character consisting of a pattern of equally spaced dots (Position X'1E' in Table 5-6). A parity error generally occurs due to an error in the link between the 2110A and the host system. However, frequent errors may indicate a mismatch between terminal characteristics and host communication requirements. Verify that the terminal's main port characteristics match the host requirements (refer to Chapter 2). Asynchronous protocol does not provide error recovery. Basically, a parity error represents unrecoverable lost data unless the host or host application provides a special recovery procedure.

Other line errors or conditions may also cause the screen display to become confused or may cause the terminal to function improperly. For example, if the host sends a command sequence that is not supported by the 2110A, the host and the 2110A may lose coordination with respect to the current terminal screen display and the host's screen display image.

5.12.2 Re-Initializing the 2110A

You can re-initialize the 2110A by doing either of the following:

- Turn the terminal off, allow ten seconds of poweroff, then turn the terminal on again.

- Enter the Local Terminal Reset key sequence SHIFT+CONTROL+GL, then CANCEL.

Be aware that re-initializing the 2110A by either method does not necessarily insure that host/2110A coordination is re-established. Consult information about your host system or host applications to determine if any additional procedures are required to restore host/2110A coordination.

5.12.3 Recommended Means for the Host to Identify the 2110A

It is recommended that the host system and application programs that need to identify the 2110A do so by transmitting the ANSI-standard DA (Device Attributes) request described in Section 5.6 under Control Sequences Introduced by CSI. The 2110A's response is DA Private #1, described in Section 5.11.

CHAPTER 6
SPECIAL OPERATING PROCEDURES

6.1 OVERVIEW

This chapter provides you with some specific terminal functions and operating procedures.

6.2 LOCAL PRINTING

The 2110A's built-in interface (aux port) allows the terminal to perform print functions. The terminal performs several print operations selected from the keyboard and the computer. This section describes the print operations.

Local printing is the ability to print data already in the terminal's display memory. During a local print operation, the terminal, rather than the host, is responsible for formatting data to be printed and outputting it through the aux port.

Local printing may be initiated locally from the keyboard via the PRINT key, or by the host via the Media Copy control sequences. See the Aux Port/Print Support controls under Section 5.6.6 for Media Copy control sequences. Execution of a local print operation is the same regardless of whether it is initiated from the keyboard or by the host. A local print operation is considered complete as soon as all characters to be output by the operation have been placed in the aux port transmit buffer.

Local printing supports both ASCII and WISCII character sets. There are 3 types of local print functions that are supported:

- Print-Line
- Print-Screen
- Shadow-Print

6.2.1 Print-Line

Prints the display line containing the active cursor position. If the page containing the display line is currently mapped to a viewport, the portion of the line to be output begins with the page column number assigned to the upper left corner of the viewport and extends for 80/132 columns.

If the page containing the display line is not mapped to a viewport, the full internal display line is output. Execution of this funtion is complete when the last character to be output is placed in the aux port transmit buffer. Print-Line terminator characters are output after the line according to the current Setup Mode selection.

6.2.2 Print-Screen

Prints the physical screen region. If the Aux Port Communications menu selection (via Setup Mode) indicates PRINT SCREEN REGION:FULL, the entire physical screen region is printed. If the selection indicates PRINT SCREEN REGION:HOST, the current host-defined Print-Screen region is printed.

For each non-null line in the region, the portion of the display line within the region is output followed by the Print-Line terminator characters from Setup Mode.

6.2.3 Shadow-Print

Prints the display line containing the active cursor position only when certain line-exit operations initiate a Shadow-Print. Table 6-1 lists the line-exit operations along with the terminator characters used with each of the line-exit operations.

Table 6-1. Line-Exit Operations

Line Exit Operation	Line Terminator Character
Auto-Line Wrap	Determined by Setup Mode
Line Feed	CR+LF
Vertical Tab	CR+VT
Form Feed	CR+FF

For purposes of processing host commands, the Shadow-Print operation is considered to be part of the line-exit operation that indicates the shadow print. Therefore, processing of subsequent buffered host commands is blocked until all characters to be optput have been moved into the aux port transmit buffer. However, immediate host controls (XON, XOFF, NUL, and INT) continue to be processed immediately.

6.2.4 Enabling Local Print Functions

Local print functions can be initiated in several ways. Table 6-2 lists the keystrokes used to initiate a local print function when ANSI/ASCII keyboard handling is enabled. The actions of these keystrokes are affected by the current state of PRINT Key Mode. See Section 5.9 for information on PRINT Key Mode.

Table 6-2. ANSI/ASCII Print Key Combinations

Keystroke	PRINT Key Mode Set	PRINT Key Mode Reset
PRINT	Initiates a Print-Line	Transmits CSI ? 1 i
SHIFT+PRINT	Initiate a Print-Screen	Transmits CSI 0 i
CTRL+PRINT	Enables/disables Shadow-Print	Transmits CSI ? 4 i (shadow print currently enabled) CSI ? 5 i (shadow print currently disabled)

Table 6-3 lists the keystrokes used to iniate a local print function when Scan Code Mode keyboard handling is enabled. The actions of these keystrokes are affected by the current state of PRINT Key Mode. See Section 5.9 for information on PRINT Key Mode.

Table 6-3. Scan Code Print Key Combinations

Keystroke	PRINT Key Mode Set	PRINT Key Mode Reset
PRINT	Initiates a Print-Line	Transmits scan code
SHIFT+PRINT	Initiate a Print-Screen	Transmits scan code
CTRL+PRINT	Toggles Shadow-Print enable state	Transmits scan code

When Scan Code Mode is enabled and PRINT Key Mode is Reset, the keycode transmitted for the PRINT key is its encoded scan code according to normal Scan Code keyboard handling rules. When Scan Code keyboard handling is enabled, the modifier keys always transmit make/break codes regardless of the state of PRINT Key Mode.

When PRINT Key Mode is Set and an attempt is made to locally initiate the print-line and print-screen functions via the PRINT key, the terminal rejects the PRINT Key combination and beeps if host-to-aux-port routing is currently enabled or if a local print operation is already in progress. No keycode is transmitted.

Keyboard initiated Print-Screen and Print-Line operations are performed between processing of host commands. These local print operations do not interrupt the processing of a host command.

Toggling of the Shadow-Print enable state via CONTROL+PRINT does not affect an in-progress Shadow-Print operation. It only affects whether future line-exits initiate Shadow-Print operations.

6.2.5 Disabling Local Print Operations

The sequence SHIFT+CONTROL+PRINT immediately terminates any in-process local print operation regardless of the state of the PRINT Key Mode. It also flushes the aux port transmit buffer and places the terminator character(s) selected in Setup Mode into the aux port transmit buffer.

6.2.6 Printable Code Range

The printable code range is determined by considering the printer character set type (ASCII/WISCII) selected in Setup Mode and the number of data bits configured for aux port transmission. Table 6-4 shows you the code range available for local printing.

Table 6-4. Local Printing Code Range

Local Printing	Aux Port Configuration	Printable Code Range
ASCII	7 or 8 data bits	X'20' - X'7E'
WISCII	7 data bits	X'20' - X'7F'
WISCII	8 data bits	X'20' - X'FF'

Note: *If WISCII characters X'80' - X'FF' are on the screen and ASCII is selected, codes corresponding to X'80' - X'FF' codes are replaced by the underscore code (X'5F') when output to the printer.*

6.2.7 Interaction of Local Printing with Aux Port

Local print operations are performed by placing output characters into the aux port transmit buffer behind any current aux port transmit data. Both Print-Screen and Shadow-Print suspend operation while aux port buffer-full condition is true. The operation resumes when space is again available in the aux port buffer.

Processing of buffered received data from the host is suspended during processing of any local print operation (print screen, print line, or shadow print), regardless of whether the operation is the result of a host command or a local print key. However, immediate host controls (XON,XOFF,NUL,INT) are always processed when received. The processing of local print operations is considered complete when all characters to be printed have been placed in the aux port transmit buffer. At this time, processing of received data from the host may resume.

The aux port buffer may not be large enough to contain an entire screen dump. Normal terminal:host flow control prevents the host overflowing the main port receive buffer during this time. This means that local print operation blocks further movement of data from the main port to the aux port buffer until processing of local print operation is complete or is aborted.

If data is currently routed from the host to the aux port transmit buffer and "disable local keyboard print functions" is not in effect, local print keys are rejected and the terminal beeps. If "disable local keyboard print functions" is in effect, all local print keys simply cause keycode sequences to be transmitted to the host. There is no interference with host aux port use.

If the printer is not enabled for host control (Setup Mode Aux Port Communications menu selection HOST ACCESS = NO), any attempt by the host to route data to the aux port or to request local print operations is ignored, and the status returned to the host is "OFF" if the host requests status via DSR sequence.

6.2.8 Interactions of HOST ACCESS option and PRINT Key Mode

Table 6-5 defines the relationship between the Setup Mode option "HOST ACCESS", and "PRINT Key Mode" (mode 38).

Table 6-5. Relationship Between HOST ACCESS and PRINT Key Mode

HOST ACCESS	Mode 38	Supported Operations
YES	SET	PRINT key initiates local print operations. The host may invoke local print operations via Media Copy controls (See Aux Port/Print Support under Section 5.6.6). The host may route data to the aux port.
YES	RESET	PRINT key transmits keycodes to the host. Does not attempt to initiate local print operations. The host may invoke local print operations via Media Copy controls (See Aux Port/Print Support under Section 5.6.6). The host may route data to aux port.
NO	(ignored)	PRINT key initiates local print operations. The host may not invoke local print operations. The host may not route data to aux port.

6.3 MODEM COMMAND MODE

Modem Command Mode provides additional functions that the terminal can use to communicate with a host from a remote location via a telephone line. Although Modem Command Mode is not required for remote connections, it does offer some features that make connection easier when "smart" modems are used. Entry to Modem Command mode can occur automatically at the completion of power-on (only if currently enabled via Setup Mode) or at any time by pressing a local key sequence.

6.3.1 Entry to Modem Command Mode

Entry to Modem Command Mode is made by pressing CONTROL+SHIFT+GL, F1. Upon entering Modem Command Mode, the following occurs:

If COMMAND = FULL (Setup Mode), the terminal performs RIS function.

If COMMAND = LIMITED, RIS is not performed but ANSI/ASCII keyboard handling is enabled.

If COMMAND MODE NOTIFICATION = YES (Setup Mode), the terminal alerts the host of entry to Modem Command Mode by transmitting the control sequence "CSI 2 n" which means "BUSY - WILL NOTIFY WHEN READY". The terminal transmits this control sequence regardless of the state of COMMAND MODE HOST NOTIFICATION if entry to Modem Command Mode is through the local keystroke sequence CONTROL+SHIFT+GL, F1.

The terminal ignores the state of DSR and DCD and ceases to monitor these two inputs. Only CTS input is needed to enable the main port functionality. The signals for modem selection of the transmit/receive rate (pin 12 or 23) continue to be used to control the transmit/receive rate if the alternate modem rate control is currently selected through Setup Mode.

If COMMAND SCREEN=LIMITED (Setup Mode), the Setup Mode screen area is activated and cleared. This screen is treated as a page and all modem communication occurs within this area.

The last available line on the screen displays the centered text "***MODEM COMMAND MODE***" at all times while in Modem Command Mode.

6.3.2 Operating in Modem Command Mode

The following operations apply while in Modem Command Mode:

- The terminal operates with the modem as the host.
- PF1 or PF2 keys can be keyed through Setup Mode to transmit a text string. The text string string may contain any character in the range X'20' through X'7E'. The maximum length of each string may be 32 characters long provided that there is sufficient dynamic NV RAM currently available.

If entry to Modem Command Mode was with COMMAND SCREEN = LIMITED, the following restrictions apply:

- The physical screen width is 80 columns.
- Any host commands that would alter the page/viewport mapping or move the active position to another page are ignored by the terminal.

If entry to Modem Command Mode was with COMMAND SCREEN = FULL, all host commands are accepted and processed normally.

6.3.3 Exiting Modem Command Mode

Upon exiting Modem Command Mode, the following occurs:

If COMMAND SCREEN=FULL, the terminal performs RIS function.

If COMMAND SCREEN=LIMITED, the terminal restores the keyboard handling mode (ANSI/ASCII or Scan Code) in effect prior to entry to Modem Command Mode.

If COMMAND SCREEN=LIMITED, the occupied screen area mapped to the Setup screen display memory during Modem Command Mode is restored with the original contents.

The terminal resumes main port monitoring DSR and DCD as well as CTS.

If COMMAND MODE HOST NOTIFICATION=YES, the terminal alerts the host of exit from Modem Command Mode by transmitting the control sequence "CSI 0 n", which means "READY - NO MALFUNCTION DETECTED'. The terminal transmits this control sequence regardless of the state of COMMAND MODE HOST NOTIFICATION if exit from Modem Command Mode is via the local keystroke sequence CONTROL+SHIFT+GL, SHIFT+F1.

6.4 TRANSPARENCY MODE

Aux port Transparency Mode is included as part of 2110A functionality in order to meet the following two needs:

- To provide a mechanism to communicate with an 8 data bit aux port device via a 7-bit data path between the host and terminal.
- To maintain ANSI compatibility on the host data link when controlling aux port devices that are not ANSI compatible.

Transparency mapping for data passing from the aux port to the main port is implemented as shown in Table 6-6.

Table 6-6. Aux Port-to-Main Port Transparency Mapping

Aux Port Code	Main Port Code	Rule
X'20' through X'7E' X'7F' through X'DC' X'DD' through X'1F'	X'20' through X'7E' SS2 X'21' through SS2 X'7E' SS3 X'21' through SS3 X'63'	no change minus X'5E' minus X'BC'

When transparency mapping is enabled, data received from the aux device is mapped into main port transparency encoding as data is moved from the aux port receive buffer to the main transmit buffer. The terminal substitutes SS2 or SS3 prefixed sequences for any codes outside the range X'20' through X'7E'.

Transparency mapping for data passing from the main port to the aux port is implemented as shown in Table 6-7.

Table 6-7. Main Port-to-Aux Port Transparency Mapping

Main Port Code	Aux Port Code	Rule
X'20' through X'7E'	X'20' through X'7E'	no change
SS2 X'21' through SS2 X'7E'	X'7F' through X'DC'	add X'5E'
SS3 X'21' through SS3 X'63'	X'DD' through X'1F'	add X'BC'

When transparency mapping is enabled, data is converted from the main port transparency encoding to the corresponding aux port code as it is moved from the main port receive buffer to the aux port transmit buffer. In order to do this, the terminal delays moving the ESC code into the aux port transmit buffer until the following character is received and the terminal determines whether the ESC is part of the SS2 or SS3 controls.

When aux port Transparency Mode is enabled, the host can still send codes outside of X'20' through X'7E' without using the transparency encoding. However, note that 7- and 8-bit encodings of SS2 and SS3 will be interpreted as transparency prefixes by the terminal and acted upon as such. Also note that the terminal continues to internally process the codes XON, XOFF, NUL, INT, and the sequence "CSI 4 i".

When aux port Transparency Mode is not enabled, the only codes interpreted by the terminal when host-to-aux routing is enabled are: NUL, XON, XOFF, INT, and the sequence "CSI 4 i". All other codes are passed through to the aux port without interpretation. Therefore, no commands are issued to the terminal while host-to-aux routing is enabled except XON, XOFF, "CSI 4 i" and INT. Tables 6-8 and 6-9 data conversion cases for host-to aux port and aux port-to-host routing.

Table 6-8. Data Conversion Cases: Host-to-Aux Routing

Trans-parency Mode	Host Data Length	Preceded by Prefix	Aux Data Length	Data Output to aux
OFF	7	NA	7	0:6.
OFF	7	NA	8	0:6, bit 7 clear.
OFF	8	NA	7	0:6
OFF	8	NA	8	0:7
ON	7	NO	7	0:6.
ON	7	NO	8	0:6, bit 7 clear.
ON	8	NO	7	0:6
ON	8	NO	8	0:7
ON	7	SS2	7	(0:6) + X'5E', discard bit 7
ON	7	SS2	8	(0:6) + X'5E'
ON	8	SS2	7	(0:7) + X'5E', discard bit 7
ON	8	SS2	8	(0:7) + X'5E'
ON	7	SS3	7	(0:6) + X'BC', discard bit 7
ON	7	SS3	8	(0:6) + X'BC'
ON	8	SS3	7	(0:7) + X'BC', discard bit 7
ON	8	SS3	8	(0:7) + X'BC'

NA (Not Applicable) means that SS2/SS3 prefixes received from host are treated as data when Transparency Mode is OFF, and are passed through to the aux port in the same way as any other data received from the host. They do not affect the following received character when Transparency Mode is OFF.

"0:7" means bits 0 throgh 7 of received host data. "0:6" means bits 0 thru 6 of received host data. Bit 0 is least significant, bit 7 is most significant.

Table 6-9. Data Conversion Cases: Aux-to-Host Routing

Trans-parency Mode	Aux Data Length	Aux Data Range	Host Data Length	Data Output to Host
OFF	7	00 through FF	7	0:6.
OFF	7	00 through FF	8	0:6, bit 7 clear
OFF	8	00 through FF	7	0:6, discard bit 7
OFF	8	00 through FF	8	0:7
ON	7	20 through 7E	7	0:6.
ON	7	20 through 7E	8	0:6, bit 7 clear
ON	8	20 through 7E	7	0:6, discard bit 7
ON	8	20 through 7E	8	0:7
ON	7	7F	7	SS2; (0:6-X'5E') discard bit 7
ON	7	7F	8	SS2; (0:6-X'5E')
ON	8	7F through DC	7	SS2; (0:7-X'5E') discard bit 7
ON	8	7F through DC	8	SS2; (0:7-X'5E')
ON	7	00 through 1F	7	SS3; (0:6-X'BC') discard bit 7
ON	7	00 through 1F	8	SS3; (0:6-X'BC')
ON	8	DD through 1F	7	SS3; (0:7-X'BC') discard bit 7
ON	8	DD through 1F	8	SS3; (0:7-X'BC')

"0:7" means bits 0 through 7 of received aux data. "0:6" means bits 0 thru 6 of received aux data. Bit 0 is least significant, bit 7 is most significant.

For purposes of implementation, the same test ranges may be used to determine SS2/SS3 prefix selection regardless of whether received aux data is 7 or 8 bits provided that the most significant bit of received aux data is set to zero when aux port data length is only 7 bits.

6.5 TRANSMITTED DATA INTERLEAVE

When enabled, data transmitted from the terminal may alternate between the terminal and the aux port sources. The rule used by the terminal to determine when to change current transmit source is:

If data waiting to be transmitted from the source is not currently routed to the host, the terminal will change the to-host routing after the sooner of

a) 20 additional bytes have been transmitted from the current source (except that terminal processing may retain routing to the main port transmit buffer for longer than 20 bytes, if necessary, to complete buffering of the current response, keycode, PF key text, ENQ response, etc.).

b) No more bytes pending for transmission from the current source.

When transmit source tagging is enabled, DC2/DC4 codes are transmitted whenever the transmit source alternates between either the terminal or the aux device.

6.6 AUX PORT TAG MODE

If Aux Port Tag Mode is enabled, changes in the source of transmitted data will be tagged. The source of transmitted data may change due to explicit host controls (Media Copy or mode changes) or due to automatic switching when Aux Data Interleave is enabled. Tag code X'12' (DC2) is inserted in data transmitted from the host to indicate that the source of following data is from the terminal. Tag code X'14' (DC4) is inserted in data transmitted to the host to indicate that the source of following data is from the aux device.

6.7 MESSAGE WAITING ENABLE MODE

When enabled, the terminal notifies the host when data becomes pending on a transmit data source not currently routed to the host. Message Waiting is not transmitted if the source is aux port and aux data interleaving is enabled. Notification is via the C1 control "MW".

6.8 DATA REPRESENTATION MODE

Data Representation Mode simply determines the means the terminal uses to represent C1 control codes and some keycodes for transmission to the host. Table 6-10 details the effect of Data Representation Mode.

Table 6-10. Data Representation Mode

7-bit Data Rep. Mode	8-bit Data Rep. Mode
C1 controls generated by the the terminal are transmitted as two byte escape sequences in the range "ESC X'40'" through "ESC X'5F'".	C1 controls generated by the terminal are transmitted indirectly as codes in the range X'80' through X'9F'.
In Scan Code Mode, the terminal sends some keycodes using the SS2 prefix.	In Scan Code Mode, the terminal sends all keycodes as one-byte codes.

Parity, baud rate, and required number of data bits and stop bits for aux port communication are configured independently of the main port. Configuration is determined by the operator in Setup Mode. All data is internally buffered and manipulated in the terminal as 8-bit data. When either port is configured as a 7-bit port, the following conversions apply:

- The high bit of data to be transmitted is ignored.
- A zero bit is added as the most significant (eighth) bit when data is received.

6.9 SCAN CODE MODE

Scan Code Mode is a special Wang private keyboard handling mode in which keyboard translation to ASCII values is not done in the terminal. Instead, the terminal transmits, to the host, an encoding of the keyboard scan code for each keypress and for some key releases.

Scan Code Mode is disabled by default at 2110A poweron. To enter this mode, the host must send the following Wang private Set Mode control sequence to enable Scan Code Mode: "CSI > 20 h". The host may force the terminal to exit Scan Code Mode at any time (and return to ANSI/ASCII keyboard handling) by sending the following Wang private Reset Mode control sequence:

"CSI > 20 l"

In Scan Code Mode, every keypress causes transmission of an encoding of the key's scan code. In addition, the modifier keys (LOCK, LEFT SHIFT, RIGHT SHIFT, CONTROL, and 2ND) transmit an encoded form of their release code (the modifier key's scan code + X'80') when released. The encoding is done to provide data transmission within ANSI-defined data communication rules.

Figure 6-1 shows the 2110A 105-key keyboard with scan codes indicated for each key position. This keyboard is used for US English and many international languages. Figure 6-2 shows the 2110A 107-key keyboard with scan codes indicated for each key position. The expanded keyboard is used for some international languages. Table 6-11 describes the encoding scheme, which applies to both keyboards.

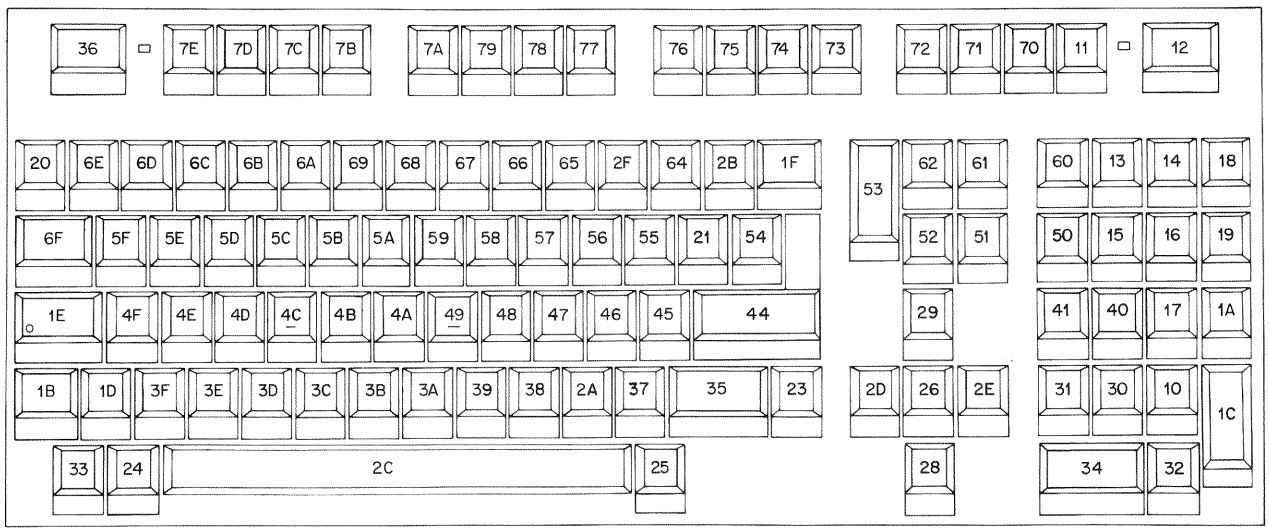

Figure 6-1. 105-Key 2110A Keyboard Scan Codes

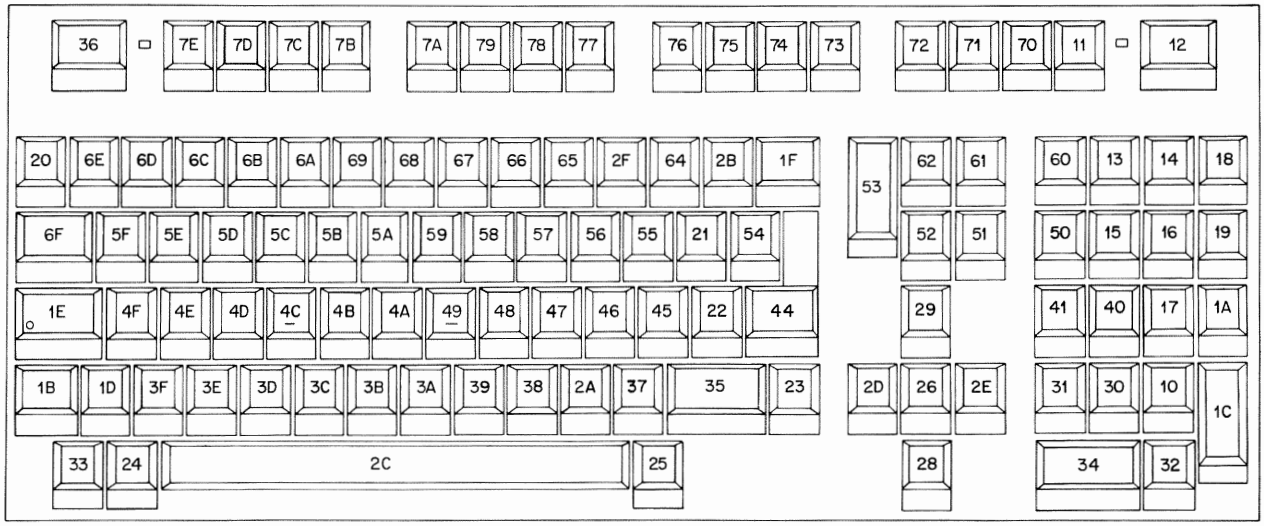

Figure 6-2. 107-Key 2110A Keyboard Scan Codes

Table 6-11. Encoding of Keyboard Scan Codes

Codes Output from the Keyboard	Codes Transmitted to the Host	
	7-bit Representation	8-bit Representation
X'10' through X'6E'	X'20' - X'7E'	X'20' - X'7E'
X'6F' through X'7F'	SS2 X'21' - SS2 X'31'	X'A1' - X'B1'
X'9B' (LEFT SHIFT release)	SS2 X'4D'	X'CD'
X'A5' (LOCK release)	SS2 X'50'	X'D0'
X'B5' (RIGHT SHIFT release)	SS2 X'67'	X'E7'
X'A4' (CONTROL release)	SS2 X'56'	X'D6'
X'A5' (2ND release)	SS2 X'57'	X'D7'

The general rules used for encoding are as follows:

- If the scan code is in the range X'10' through X'6E', transmit a single-byte code having the value (code output from the keyboard + X'10').

- If the scan code is X'6F' or greater and Data Representation Mode is set to 7-bit data representation, transmit SS2 control character followed by the one-byte code having the value (code output from the keyboard - X'4E').

- If the scan code is X'6F' or greater and Data Representation Mode is set to 8-bit data representation, transmit the single-byte code that represents the quantity having the value (code output from the keyboard + X'32').

Only those scan codes above X'80' that are listed in this table are sent as these are the release codes for the modifier keys: LEFT SHIFT, LOCK, CONTROL, 2ND, and RIGHT SHIFT.

In the case of a local keystroke function generated from the keyboard, only the make and release codes of the modifier keys are transmitted. The GL (Glossary) key code, and the next valid function key code (or next invalid key depression code) are not transmitted.

The 2110A keyboard outputs the LOCK key scan code when the LOCK key is pressed and outputs the LOCK key scan code + X'80' when the lock key is released. The terminal is expected to pass along the encoded LOCK key codes to the host as they are received when the terminal is in scan code mode. The host programmer should be aware that the LED goes on when the lock key is pressed and remains on until either SHIFT key is pressed and released.

Any modifier key which is part of a local key sequence transmits its make/break code.

PRINT key transmits its scan code only when PRINT Key Mode is Reset. Any modifier used with the PRINT key always transmits its make/break code.

All keys causing keycodes to be transmitted will auto repeat except the following scan codes listed below.

- X'1B' LEFT SHIFT
- X'35' RIGHT SHIFT
- X'24' CONTROL
- X'25' 2ND
- X'1E' LOCK
- X'12' CANCEL
- X'53' EXECUTE

CHAPTER 7
TROUBLESHOOTING

7.1 OVERVIEW

This chapter describes what to do if a problem arises with the 2110A workstation. It provides a problem solving checklist and describes the terminal diagnostic functions.

7.2 COMMON OPERATING PROBLEMS

Situations can arise in which the 2110A does not perform as expected. The basic remedy in many cases is terminal re-initialization (refer to Section 4.3, 5.3, or 5.12). The following pages present solutions to typical problems. The condition column includes, in parentheses, the configuration(s) in which the condition applies. In describing the configuration, the abbreviation ANSI refers to the 2110A functioning as an ANSI asynchronous terminal.

Condition (Configuration)	*What To Do*
Nothing happens when you power on the terminal. (2110A)	Be sure that the following conditions are met: • The power cord is plugged into a live receptacle and fully plugged into the back of the 2110A. • The keyboard connector is securely inserted in the back of the 2110A. • Then turn the terminal off, wait four seconds, and turn the terminal on again.

Condition (Configuration)	*What To Do*
The cursor is not visible on the 2110A screen. (2110A)	The host may have disabled display of the cursor, as the controller does on the host when the keyboard is considered locked.
Occasional or short bursts of errors occur. (2110A)	The communication line is suspect. Check the modem or cable connections or both. If you are communicating over a dial-up line, you can hang up and re-dial. If the condition persists, consider reducing the line speed to lessen the impact of poor line quality.
A substantial (10% or more) number of errors occur continuously.	Verify that the terminal characteristics (line speed, parity, etc.) match those specified on the host system.
2110A connected to a Wang host does not function and the host control workstations screen lists the terminal as disconnected. (2110A/ANSI)	Probably indicates a failure while loading code to the controller. IPLing again. If the condition persists, contact your Wang support representative for maintenance on the host or controller.
The terminal does not make proper remote connection following powerup. (2110A/ANSI)	Be sure to turn the terminal on before making a dial-up connection via the modem to the controller. Leave the terminal on until you are disconnecting from the host. If, after you make the connection, the screen looks confused or the keyboard does not function as expected, perform the soft terminal re-initialization procedure (refer to Section 4.3 or 5.12).

Condition (Configuration)	*What To Do*
The screen is frozen, appears confusing, or cannot be controlled. (2110A/ANSI)	If you are attached locally via a null modem or null modem cable, perform the hard re-initialization procedure (refer to Section 4.3 or 5.12) or power off the terminal for five seconds then power it back on. If you are attached to a remote host via a modem, perform the soft re-initialization procedure (refer to Section 4.3 or 5.12). There is no need to break the telephone connection unless you re-initialize the terminal using the hard initialization procedure or power off followed by power on. Conditions that may cause the terminal to require re-initialization include the following:
(2110A/ANSI)	• A poweroff of less than four seconds.
(ANSI)	• Entering a local mode or setup mode and altering screen contents, the cursor position, or setup features.
(ANSI)	• A prolonged (30 seconds or longer) XOFF duration caused by either (1) using CONTROL+S/CONTROL+Q or the SCROLL/NO SCROLL keys to freeze the screen; or (2) entering Setup mode or entering Local mode on some terminals.

7.3 Terminal Diagnostics

The 2110A terminal supports the operation of a power-on selftest function. The power-on selftest function is executed as part of the power-on terminal initialization. The operation of the terminal's power-on selftest mode is described below.

7.3.1 Terminal Power-On Selftest

The 2110A executes a selftest executed as part of power-on terminal initialization. In the case where the terminal successfully executes the selftest, the terminal screen is cleared and the cursor is displayed at the HOME position. In the event of a power-on self test failure, the particular test function generating the failure is identified visually (CRT error message display identifying logic board component location) and aurally (via keyboard BEEP sequences). The alternate means of identifying individual selftest failures are included to cover the case where either the terminal keyboard or monitor is disabled. The individual power-on selftest functions and associated error messages are described below in the order in which they are carried out:

a. Program PROM Checksum Verification: A program PROM checksum is generated and compared. The 2110A Program PROM checksum is adjusted (via offset byte value placed in an unused memory location) such that the checksum LSB has the value '00'. In the event of checksum comparision failure:

CRT Display:	"U47 Failure"
Keyboard Bell	2 BEEPs

b. System RAM Verification: The operation of the system RAM memory element designated as U45 is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U45 Failure"
Keyboard Bell	3 BEEPs

c. System RAM Verification: The operation of the system RAM memory element designated as U46 is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U46 Failure"
Keyboard Bell	4 BEEPs

d. Display RAM Verification: The operation of the character display RAM memory element designated as U50 is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U50 Failure"
Keyboard Bell	5 BEEPs

e. Attribute RAM Verification: The operation of the character attribute display RAM memory element designated as U49 is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U49 Failure"
Keyboard Bell	6 BEEPs

f. Internal C.G. RAM Verification: The operation of the RAM memory element associated with the host downloadable character sets is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U51 Failure"
Keyboard Bell	7 BEEPs

g. Non-Volatile Memory Verification: The operation of the non-volatile RAM memory element associated with the terminal SETUP mode is evaluated via Read/Write data testing. In the event that an error is generated:

CRT Display:	"U36 Failure"
Keyboard Bell	8 BEEPs

h. Communications DUART Verification: The communication DUART component associated with the terminals MAIN and AUX ports is verified in the following manner. Read/write access to DUART control registers MRA0, MRA1, MRB0, and MRB1 is checked. In the event that an error is generated:

CRT Display:	"U55 Failure"
Keyboard Bell	9 BEEPs

i. CRT Controller Verification: The terminal CRT Controller device is evaluated via read/write access to the cursor position register. In the event that an error is generated:

CRT Display:	"U26 Failure"
Keyboard Bell	10 BEEPs

j. Keyboard Verification: The correct operation of the keyboard and keyboard interface hardware is verified in the following manner. The terminal transmits the 'Spec/Code Revision Level Query' (X'09') to the 720 keyboard. If the keyboard fails to respond within 150 ms, or if the format of the response is incorrect, an error is generated:

CRT Display:	"K.B. Failure" (screen display: inverse video) (correct keyboard operation required for error notification)
Keyboard Bell	

APPENDIX A
2110A WORKSTATION SPECIFICATIONS

A.1 OVERVIEW

The following are the Wang Model 2110A Workstation specifications in the areas of display characteristics, communications capabilities, power requirements, environmental requirements, physical characteristics, and regulatory compliances.

A.2 DISPLAY CHARACTERISTICS

Display Type	Data is displayed on a 14-inch (35.6 cm) diagonal measure CRT with P42 green phosphor, dark glass, and mechanical etch with a non-glare coating providing enhanced display contrast.
Display Area Size	The nominal size of the display area is 9.10 inches (22.9 cm) wide by 6.50 inches high (15.2 cm), bezel centered.
Display Format	The display area is formatted as 25 lines by 80 columns or 25 lines by 132 columns. The 25th line may be ignored, used as a message line, or used as a normal part of the screen.
Multi-Page Support	The 2110A can store up to 8000 display characters and associated character attributes are available for Multi-Page support. As many as eight host-programmable pages may be assigned for host access. Individual page dimensions may be defined as up to 255 columns wide by as many as 100 rows in length (to the limit of storage available in the 'display memory pool').

Multi-Viewport Support	The physical screen may be divided into as many as eight host-programmable horizontal viewports. The viewports may be individually aligned over individual page contents for display of page data.
Standard Character Set	The internal Character Generator ROM supports 256 displayable characters in both 80 and 132 formats. The 256 characters include the Wang WISCII-I character set along with 32 additional graphics symbols.
Alternate Character Sets	An additional 256 host downloadable displayable characters are available in 80 and 132 column modes. The terminal also supports up to 512 cartridge based additional displayable characters. Fully loaded, the terminal has access to 1024 displayable characters for screen display.
Character Cell	The character cell size is 14 pixels high by 10 pixels wide in 80 column mode with the normal character size being 10 pixels high by 9 pixels wide. In 132 column mode, the character size is 14 pixels high by 6 pixels wide with the normal character being 10 pixels high by 5 pixels wide.
Screen Attributes	Normal (light on dark field) or inverse (dark on light field) whole screen display attribute.
Character Attributes	Characters are individually displayable with any combination of the following attributes: normal or reverse video, normal or high intensity, blink, underscore, double underscore, and blank.
Cursor Style	The cursor styles include steady or blinking, underscore or block type. The cursor is displayed in high intensity.
Vertical Refresh Rate	User-selectable via Setup Mode. The vertical refresh rate option allows display compatibility with local power line frequency (50/60 Hz).

A.3 MAIN PORT COMMUNICATION CAPABILITIES

Operational Modes	Operational modes include Full- and Half-Duplex Online, and Local Mode.
Functional Modes	Functional modes include standard and monitor mode. In monitor mode, received characters are displayed as two hexadecimal digits delimited by spaces.
Interface	The serial asynchronous communications port is a version of EIA RS-232-C port that incorporates a low impedance driver to permit communication over a maximum of 2000 feet of RS-232-C-compatible cable. Current loop is not supported.
Baud Rates	Available baud rates include: 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 4800, 9600, and 19200.
Data Transmission Formats	Data transmission formats of 7 or 8 data bits are supported.
Parity	Parity options include even, odd, mark, space or no parity.
Stop Bits	Options include 1, 1.5, and 2 stop bits.
Pacing	Communication pacing is available via software XON/XOFF support.
Modem Support	The terminal supports the use of intelligent modems.

A.4 AUX PORT COMMUNICATION CAPABILITIES

Operational Mode	The terminal supports Full Duplex communication to the aux device. The aux port may be configured for local print operations only.
Interface	Standard EIA RS-232-C asynchronous port.
Baud Rtaes	Available baud rates include: 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400,4800, 9600, and 19200.
Data Transmission Formats	Data transmission formats of 7 or 8 data bits are supported.

Parity	Parity options include even, odd, mark, space or no parity.
Stop Bits	Options include 1, 1.5, 2 and stop bits.
Pacing	Communication pacing is available via software XON/XOFF support.
Local Printing	Options include Print-Line, Print-Screen and Shadow-Print operations. Local printing supports either a generic (ASCII) non-Wang printer or a standard Wang (WISCII) printer.

A.5 POWER REQUIREMENTS

Setup selection must match the local line frequency.	115 VAC +/- 15%, 50/60 Hz 230 VAC +/- 15%, 50/60 Hz

A.6 ENVIRONMENTAL REQUIREMENTS

Operating	Temperature: 60° to 90°F (15° to 32°C) Relative humidity: 20% to 80%
Storage	Temperature: -40° to 140°F (-40° to 60°C) Relative humidity: 5% to 90%
Maximum Rate of Change	12°F per hour (6.7°C per hour)
Wet Bulb Temperature	75°F (24°C) maximum

A.7 PHYSICAL CHARACTERISTICS

Monitor

Tilt	+10°/-5° from center
Swivel	+30°/-30° from center
Height	13.5 inches (34.3 cm)
Width	15.1 inches (38.6 cm)
Depth	15.0 inches (38.1 cm)
Weight	22.0 lbs (9.9 kg)

Keyboard

Height	1.7 inches (4.3 cm)
Width	18.3 inches (46.5 cm)
Depth	7.8 inches (19.8 cm)
Weight	4.5 lb (2.0 kg)
Cable	2 ft (.61 m) unextended length 6 ft (11.83 m) extended length

A.8 REGULATORY COMPLIANCES

Safety	UL 478, 5th edition CSA C22.2 #154 IEC 380, IEC 435
Emissions	FCC Class A VDE Class A (0871)

APPENDIX B
2110A POWERON STATE AND DEFAULT VALUES

At 2110A poweron, the following states and other defaults are in effect. Any operating characteristics that are controlled through Setup Mode are determined by the Setup option value saved in NV RAM at the time of the power-on or RIS. See Section 2.6 entitled Setup Mode for a list of the factory default operating characteristics and alternate settings.

Mode or Parameter	*Poweron Value or State*
25th Line Access Mode	Setup Mode (See DEFAULT SCREEN LENGTH, 2110 mode only)
25th Line Display Mode	Setup Mode See DEFAULT SCREEN LENGTH, 2110 mode only)
Auto-Alignment	Set
Auto-Map	Reset (auto-map disabled)
Auto-Scroll Mode	Set (auto-scroll enabled)
Auto-Wrap Mode	Setup Mode
Aux Data Interleave Mode	Reset (terminal and aux port data not permitted to interleave when aux port is selected as transmit source)
Aux Port Tag Mode	Reset (tagging disabled)
Aux buffer empty notification	Reset (notification not sent)

Mode or Parameter	*Poweron Value or State*
Aux Port Transparency Mode	Reset (aux port transparency disabled)
Column Mode (DECCOLM)	Setup Mode (See SCREEN WIDTH)
Cursor Attach Mode	Set (cursor display position corresponds to the current active cursor position)
Cursor Blink Mode	Setup Mode
Cursor Display Disable	Reset (cursor display on)
Cursor Position	Page 1, Column 1, Row 1
Cursor Style	Setup Mode
Data Representation Mode	Setup Mode
Enable Interrupt Control (INT)	Setup Mode (See INT ENABLE)
Formfeed Mode	Reset (the active position moves to the first position of the next line)
G0 Designated Character Set	2110A character set #1
G1 Designated Character Set	2110A character set #2
G2 Designated Character Set	2110A character set #2
G3 Designated Character Set	2110A character set #3
GL Active Character Set	Designated character set G0
GR Active Character Set	Designated character set G1
Graphic Rendition	Default attributes
Host-Defined Print-Screen Region	Upper left corner is row 1, column 1. Length is 25 rows. Width is current screen width (80/132 columns).
IRM (Insert Replacement Mode)	Reset (replacement)
Keyboard Action Mode	Reset (Enabled)

Mode or Parameter	*Poweron Value or State*
Line Feed/New Line Mode	Setup Mode (See AUTO NEW LINE)
Monitor Mode	Disabled
Link Routing Mode	Reset (routing of transmit data independent of receive data)
Message Waiting Enable Mode	Reset (Message Waiting control not sent)
Modem Command Mode 'Busy/Ready' Notification	Setup Mode (See COMMAND MODE HOST NOTIFICATION
Monitor Mode	Disabled
PRINT Key Mode	Set (Initiates local print operations)
Printer Form Feed Mode (DECPFF)	Setup Mode (See SCREEN PRINT TTERMINATOR
Received Carriage Return Mode	Setup Mode (See AUTO LINEFEED)
Scan Code Keyboard Handling Mode	Reset (keyboard handling is ANSI/ASCII compatible)
Send-Receive Mode	Setup Mode (See LOCAL ECHO)
Transmit Source Mode	Reset
VEM (Vertical Editing Mode)	Set (Insert Line and Delete Line commands affect the screen at and above the current line)
Video Mode	Setup Mode
Cursor Position	The cursor position at poweron is the home position (row 1, column 1)

APPENDIX C
KEYBOARDS

Illustrations for the following keyboard configurations available for the 2110A workstation are shown in this appendix.

Keyboard Mnemonic	*Description*
US	USA
AE	AZERTY English
AZ	AZERTY
CA	Canadian English
CF	Canadian French
DV	Dvorak
FL	Flemish
IT	Italian
SE	South African
SL	Spanish Latin American
SP	Spanish European
UK	United Kingdom
WL	World Languages
EDA	Expanded Danish
EFI	Expanded Finnish
EGE	Expanded German
EIC	Expanded Icelandic
ENL	Expanded Dutch
ENO	Expanded Norwegian
EPO	Expanded Portuguese
ESF	Expanded Swiss French
ESG	Expanded Swiss German
ESW	Expanded Swedish
ETU	Expanded Turkish

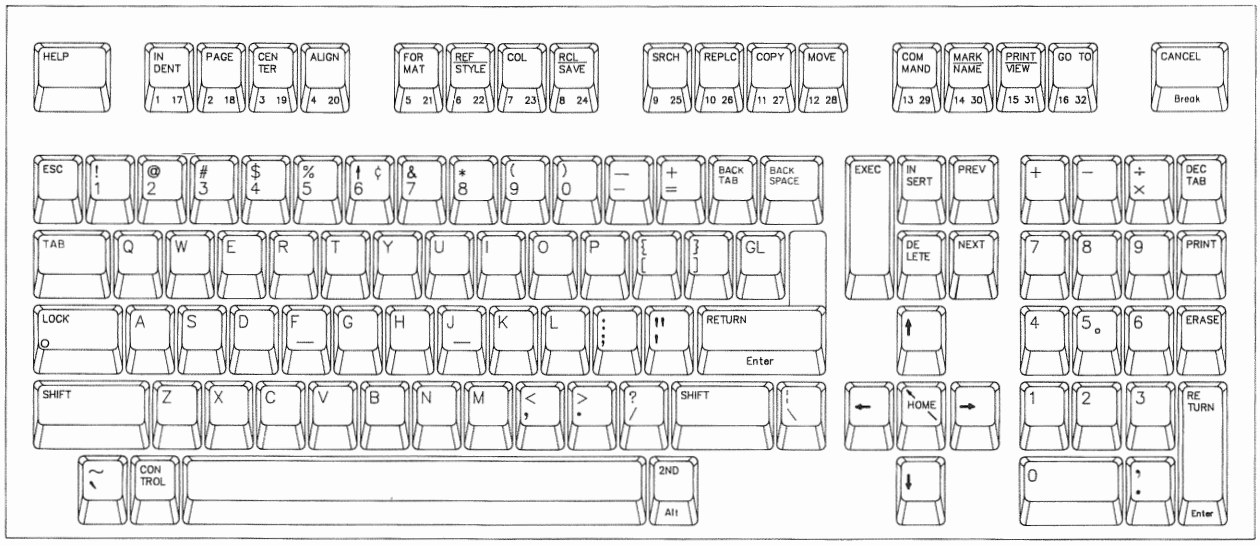

Figure C-1. US Keyboard

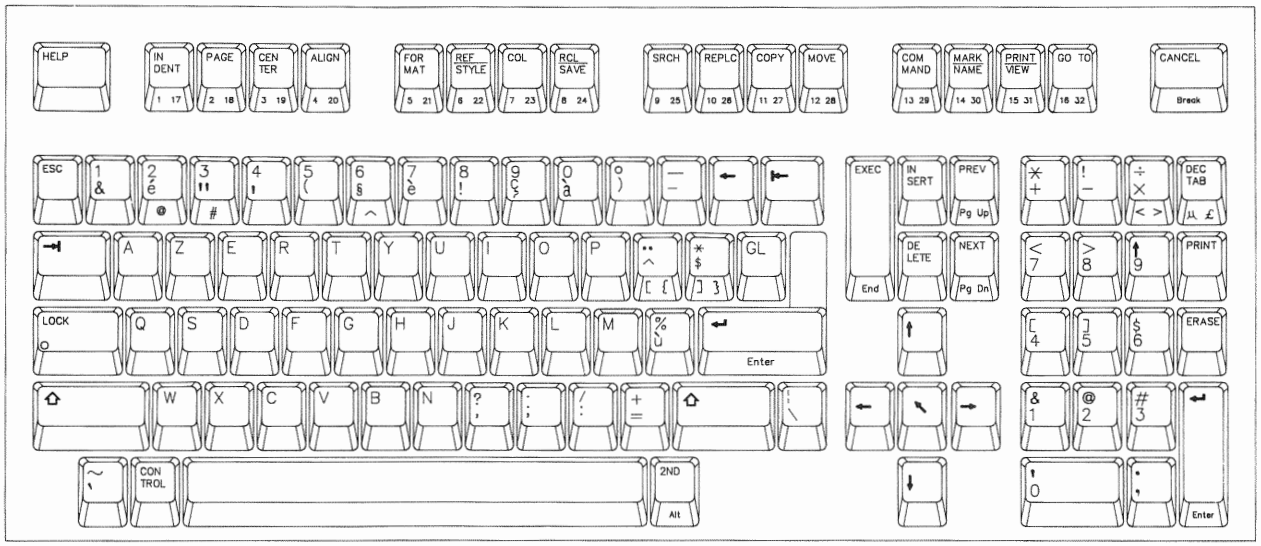

Figure C-2. AZERTY English Keyboard

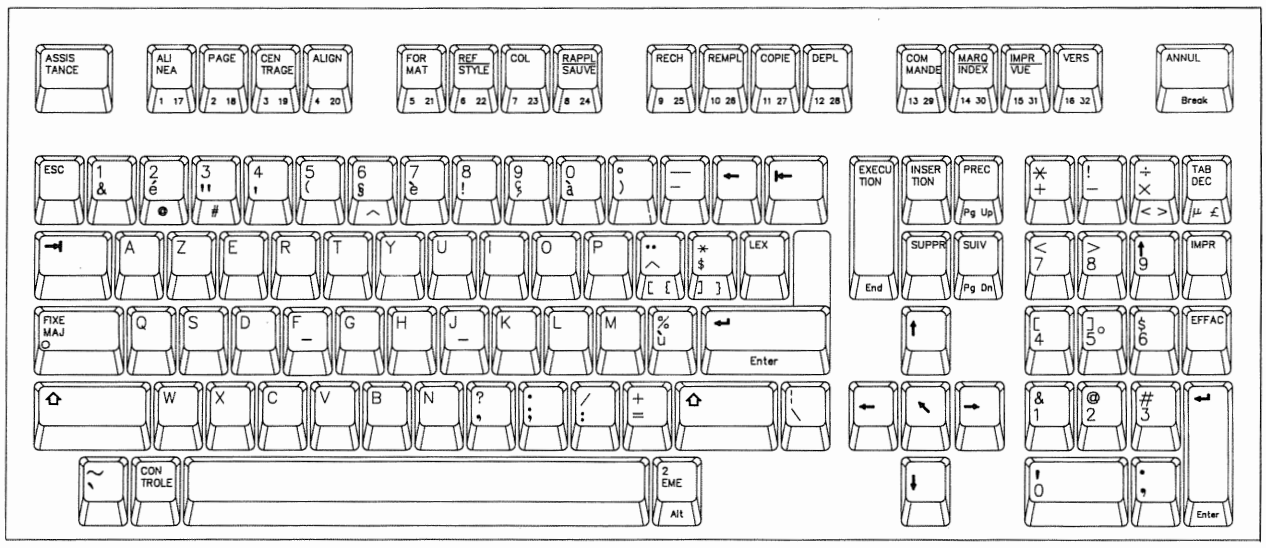

Figure C-3. AZERTY Keyboard

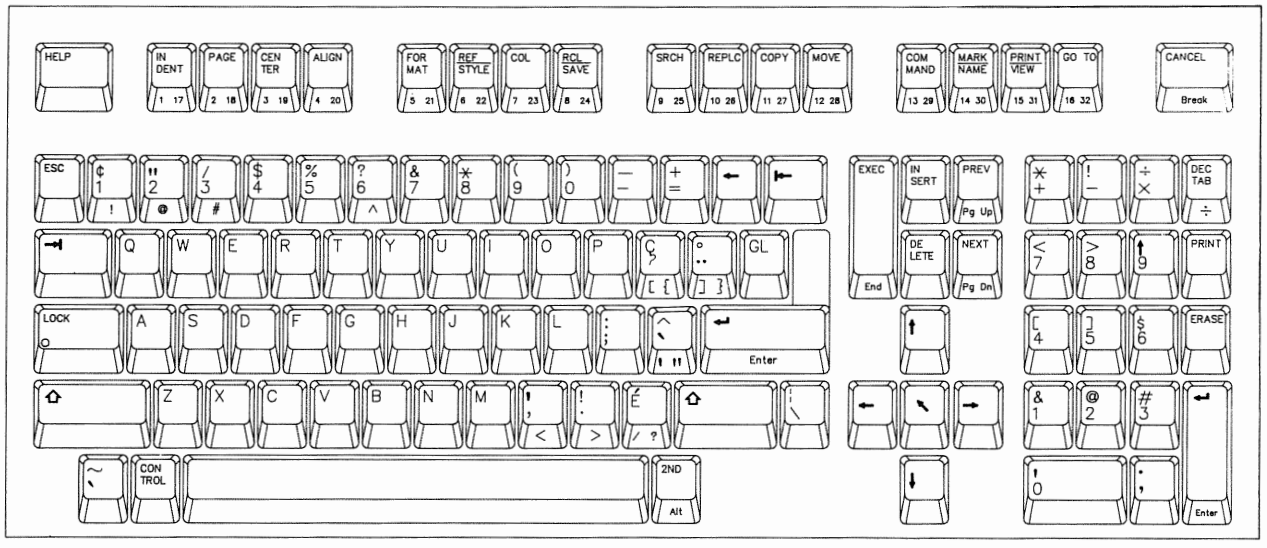

Figure C-4. Canadian English Keyboard

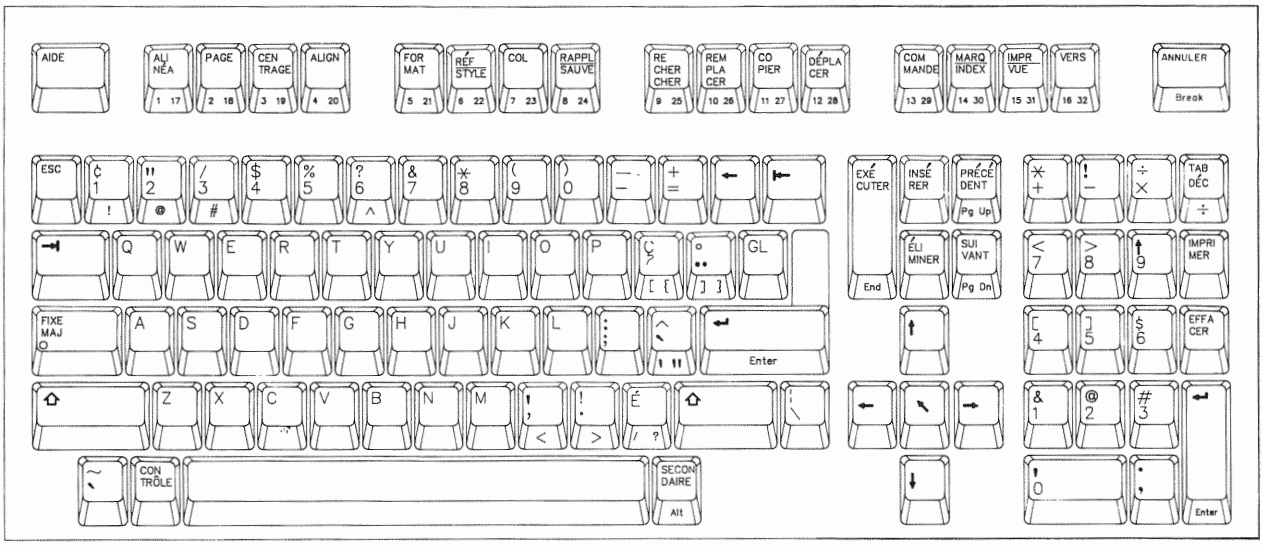

Figure C-5. Canadian French Keyboard

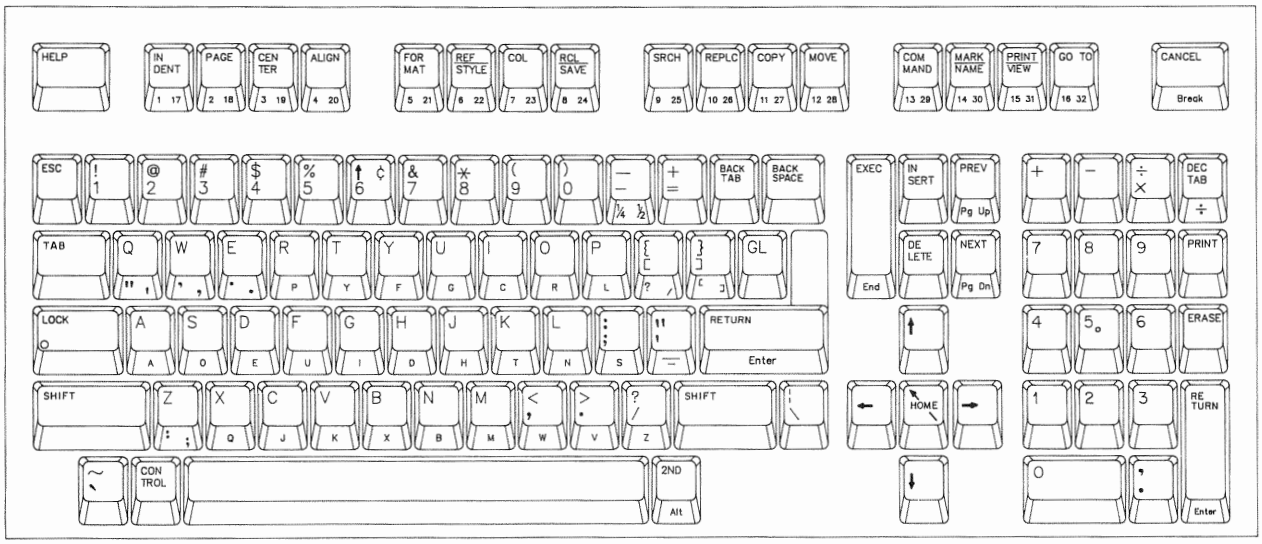

Figure C-6. Dvorak Keyboard

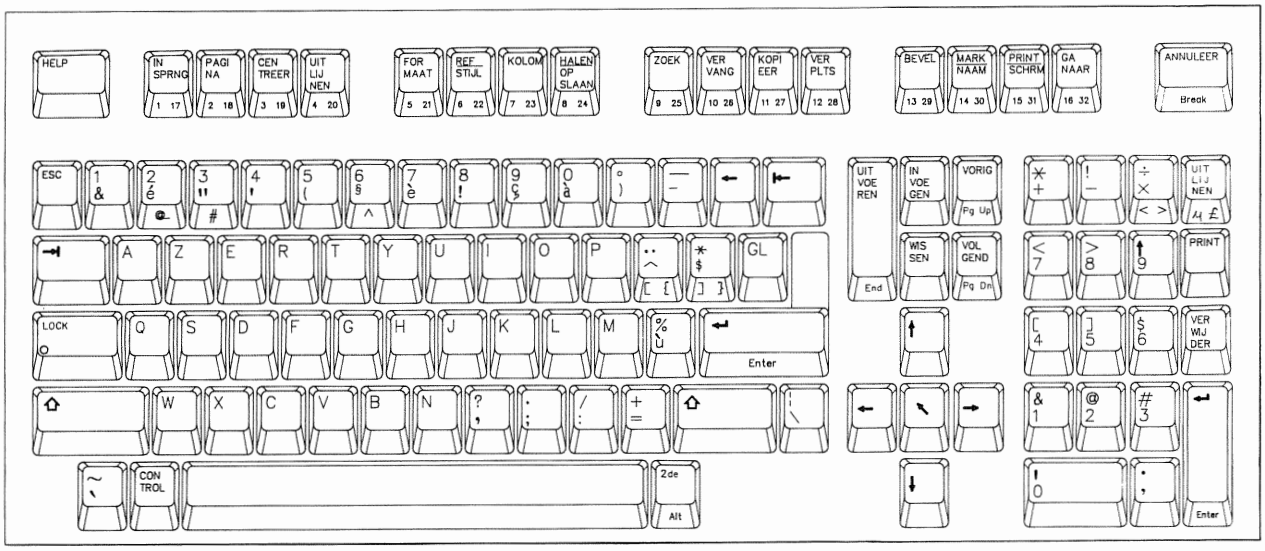

Figure C-7. Flemish Keyboard

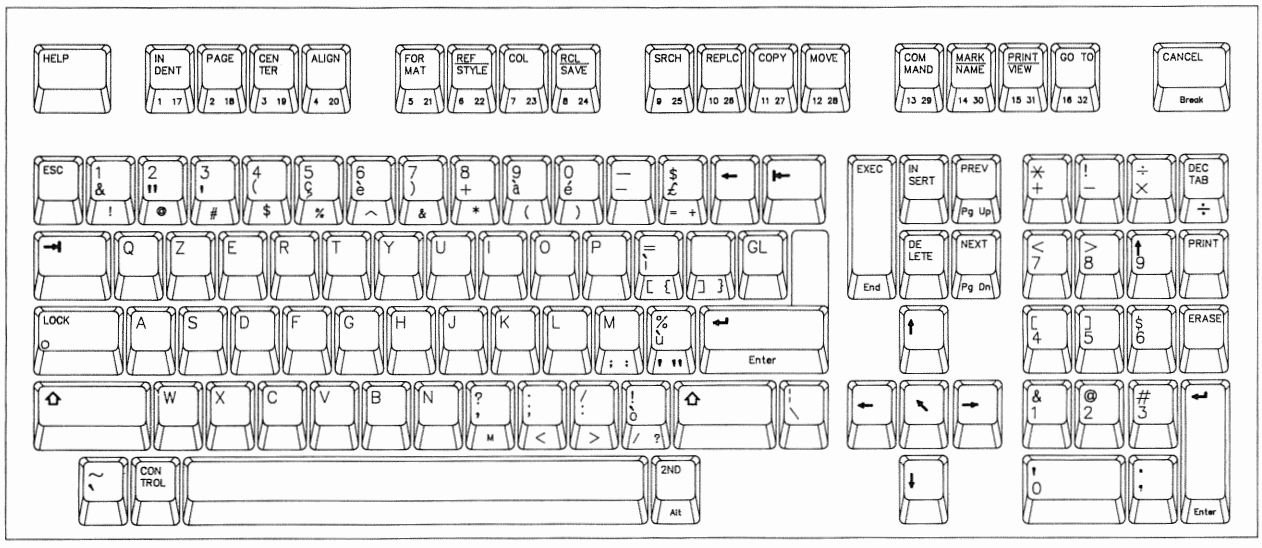

Figure C-8. Italian Keyboard

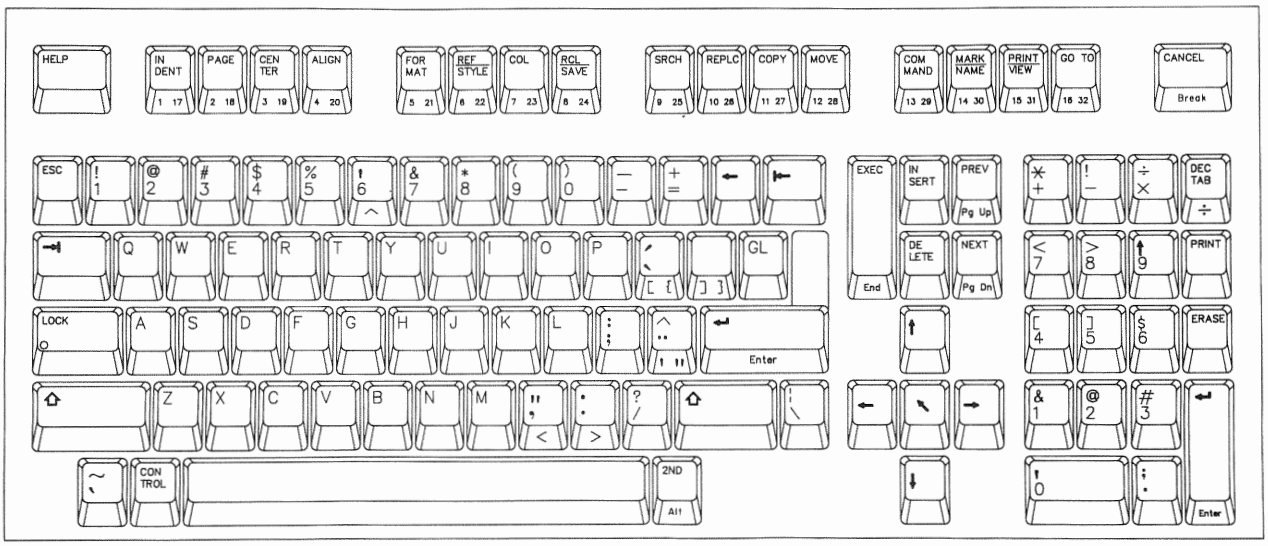

Figure C-9. South African Keyboard

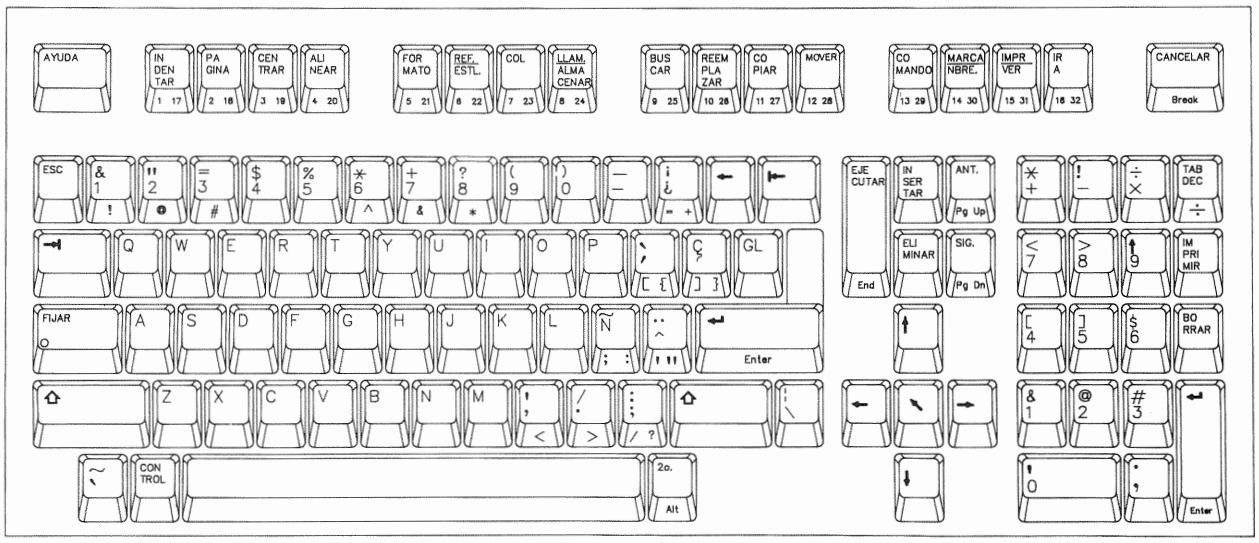

Figure C-10. Spanish Latin American Keyboard

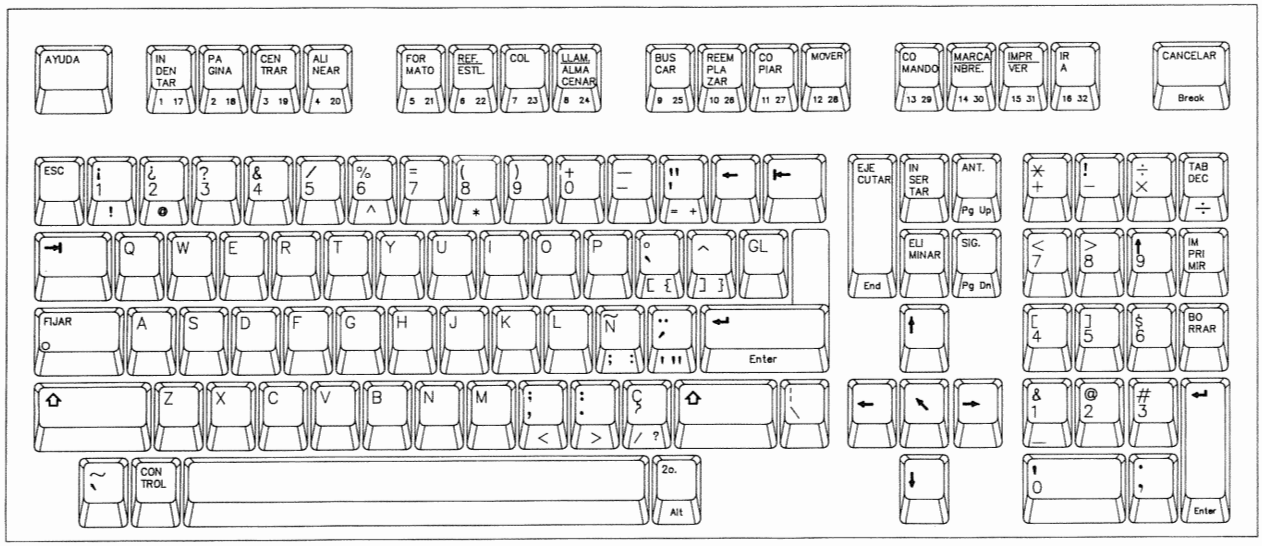

Figure C-11. Spanish European Keyboard

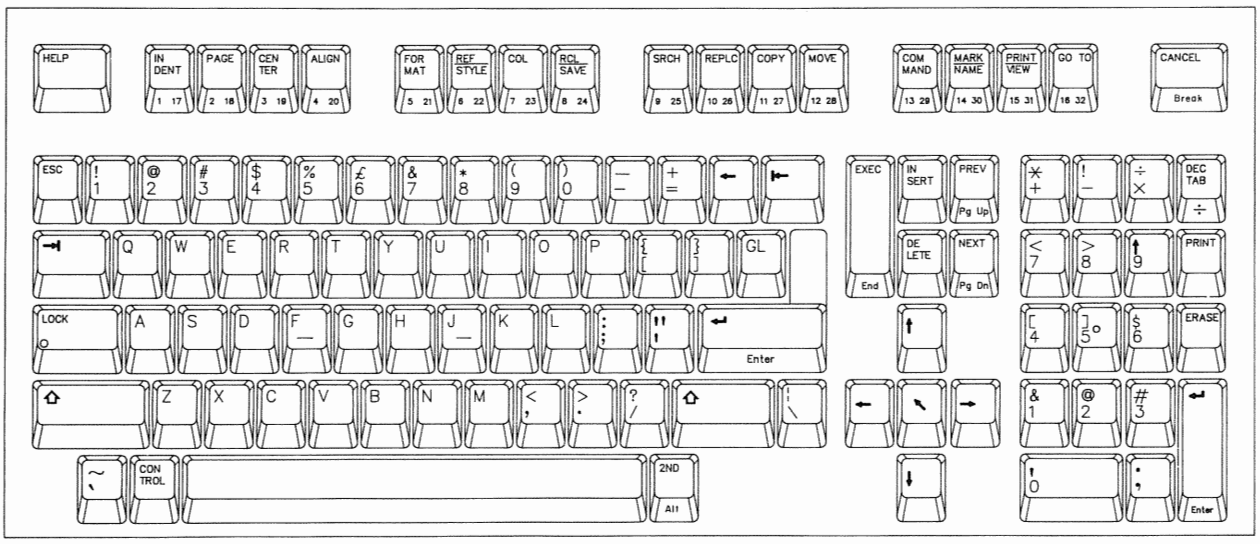

Figure C-12. United Kingdom Keyboard

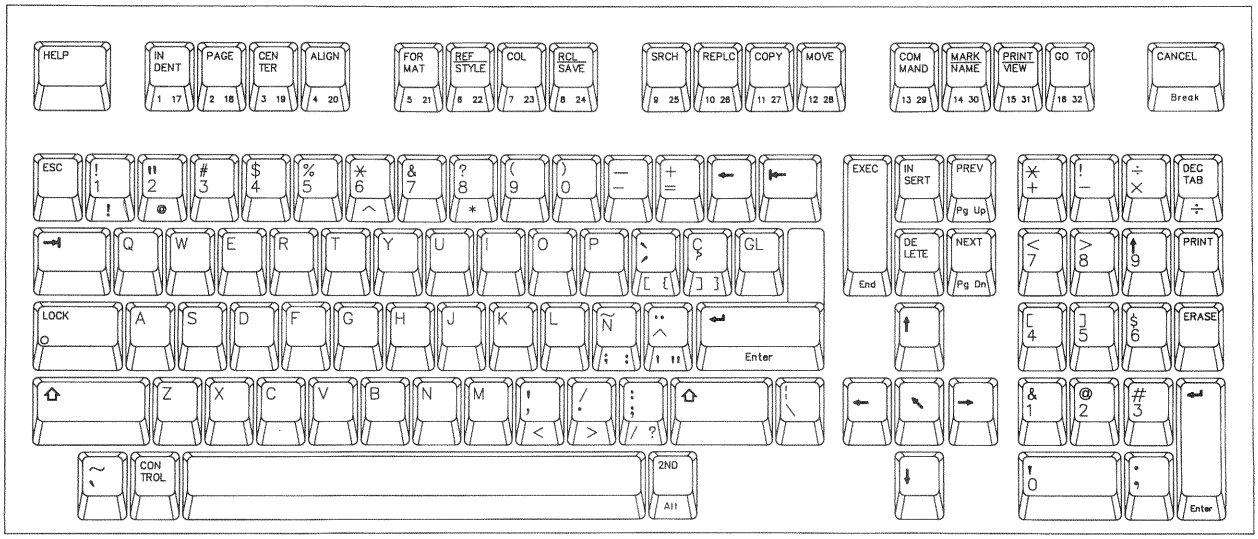

Figure C-13. World Languages Keyboard

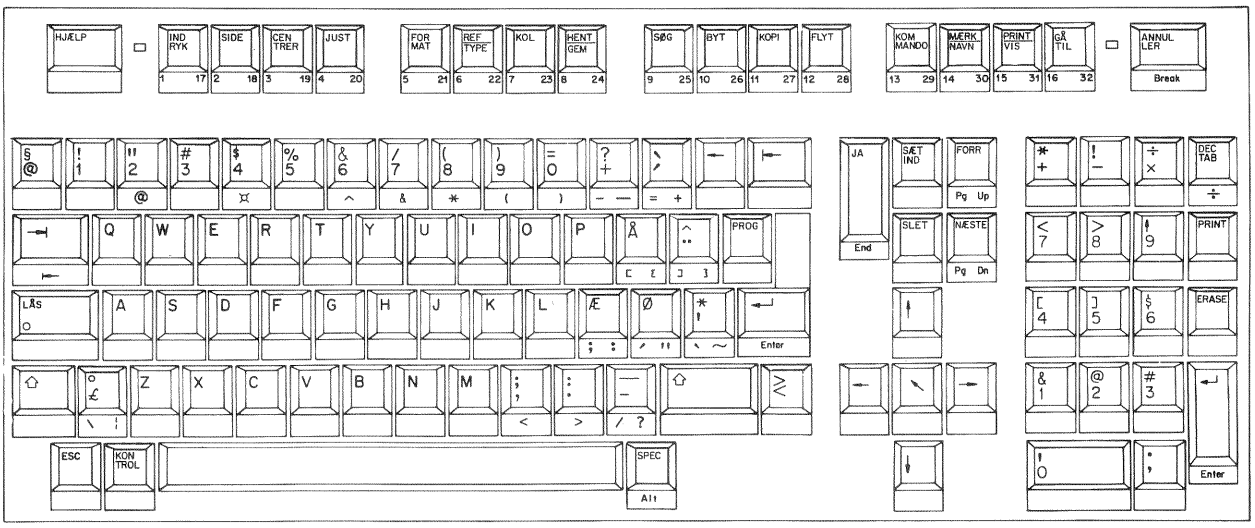

Figure C-14. Expanded Danish Keyboard

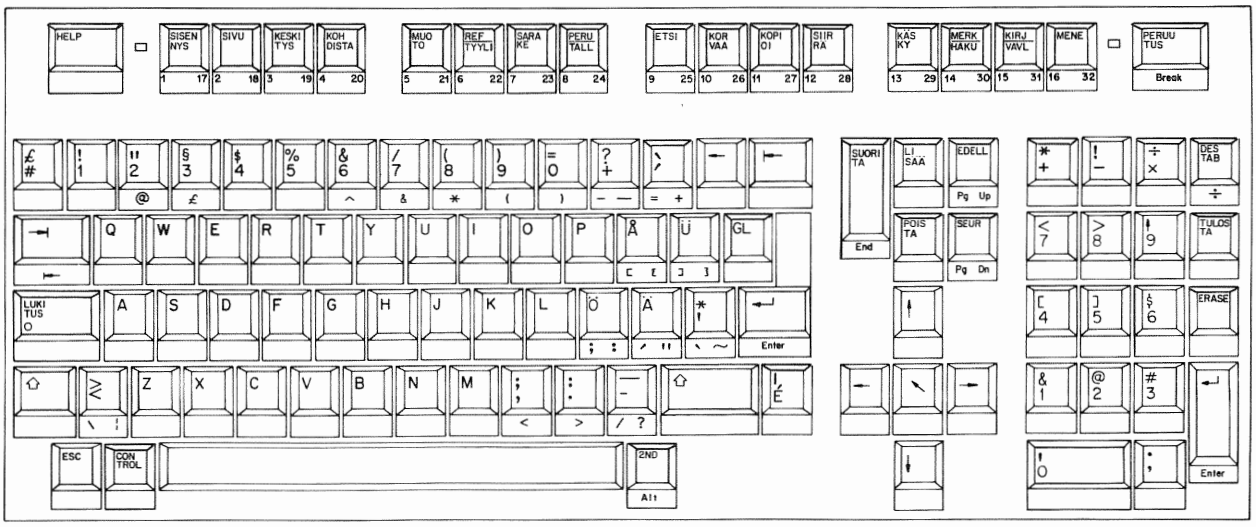

Figure C-15. Expanded Finnish Keyboard

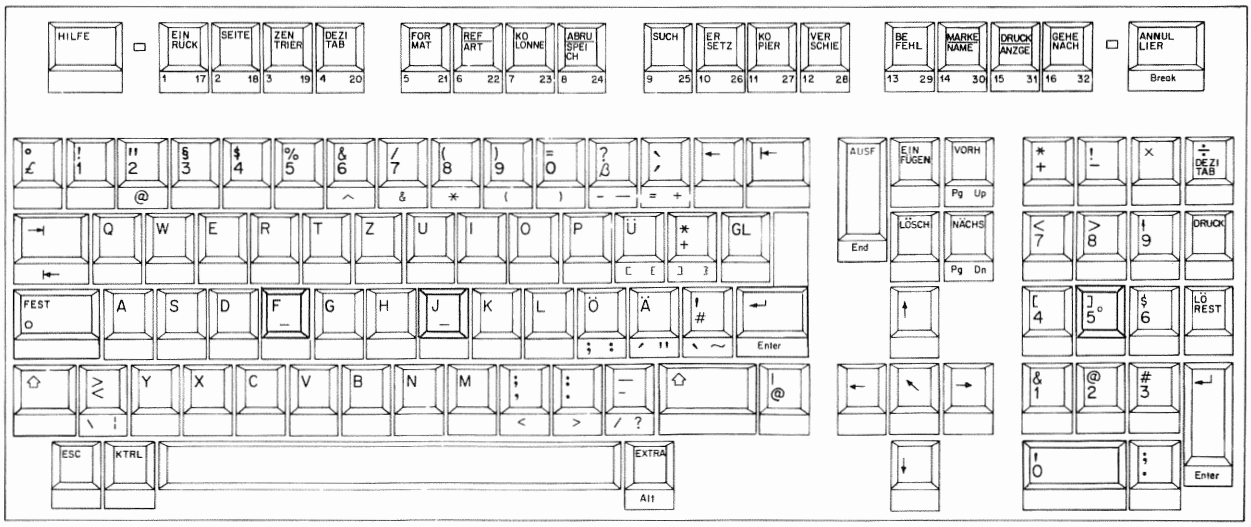

Figure C-16. Expanded German Keyboard

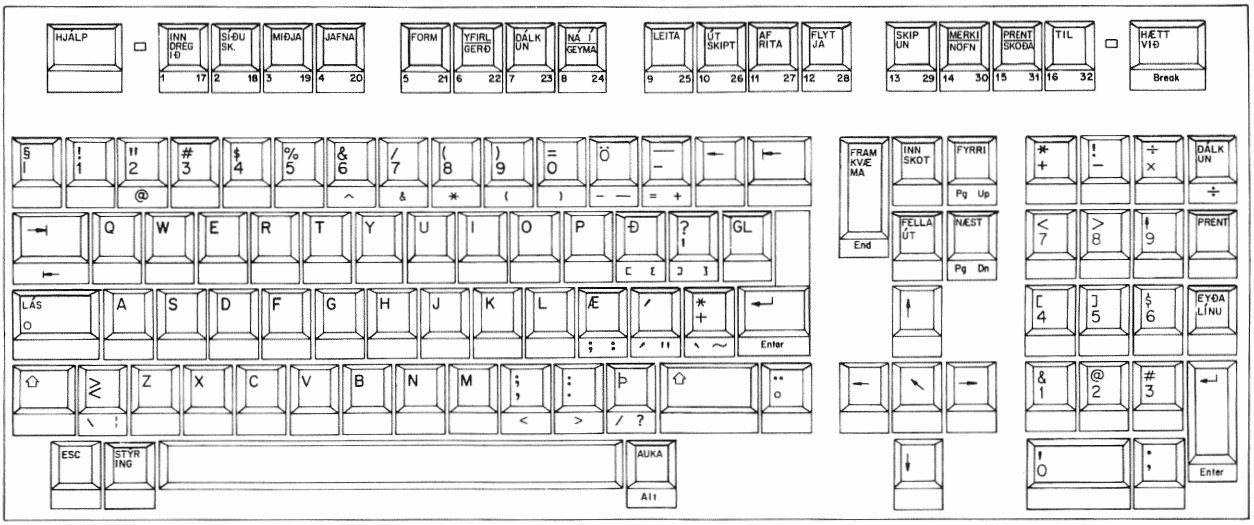

Figure C-17. Expanded Icelandic Keyboard

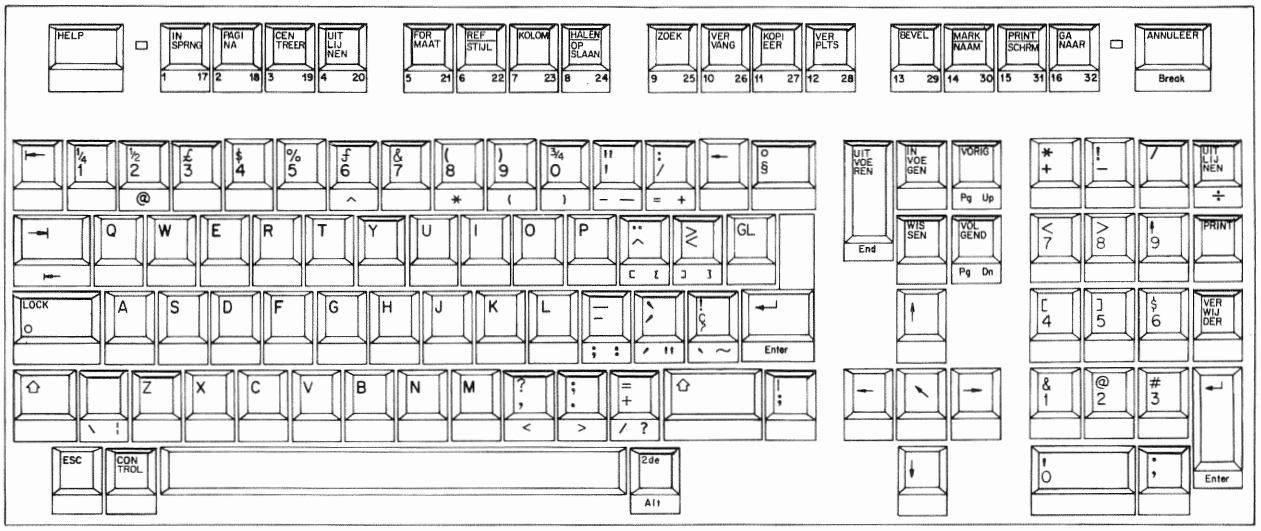

Figure C-18. Expanded Dutch Keyboard

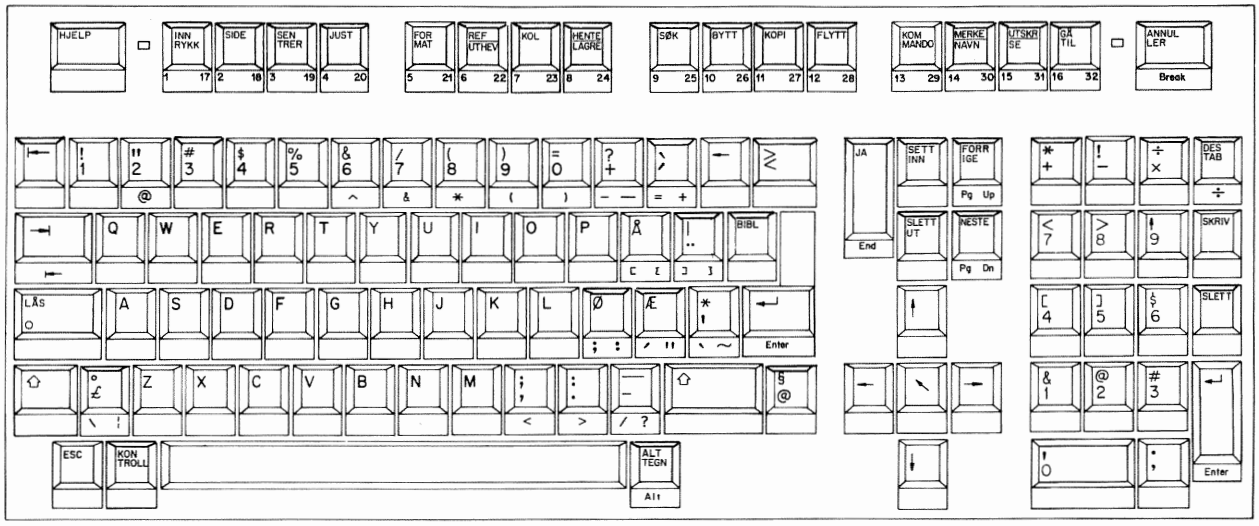

Figure C-19. Expanded Norwegian Keyboard

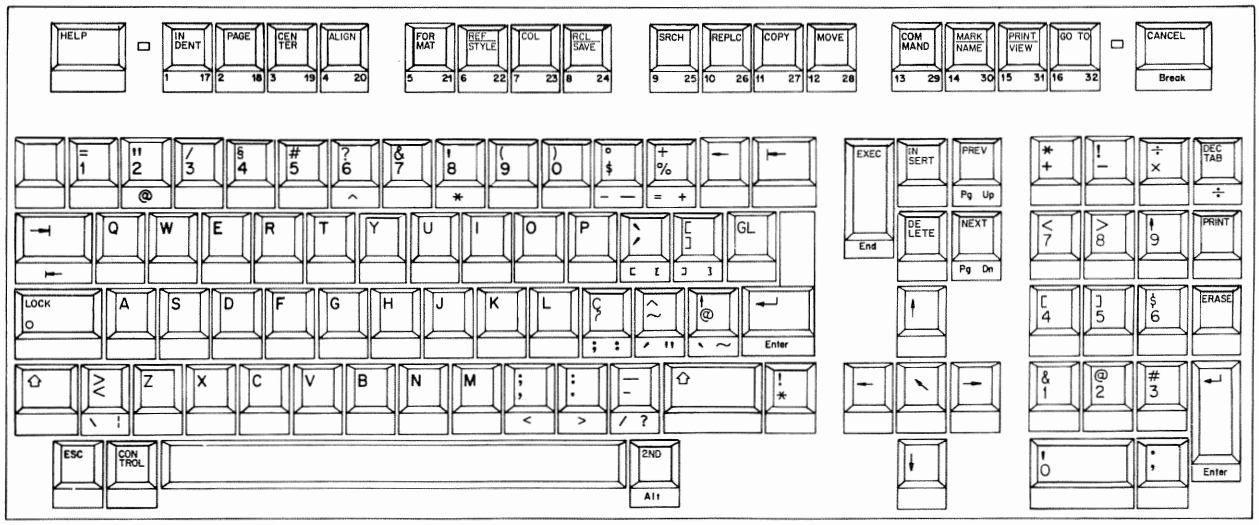

Figure C-20. Expanded Portuguese Keyboard

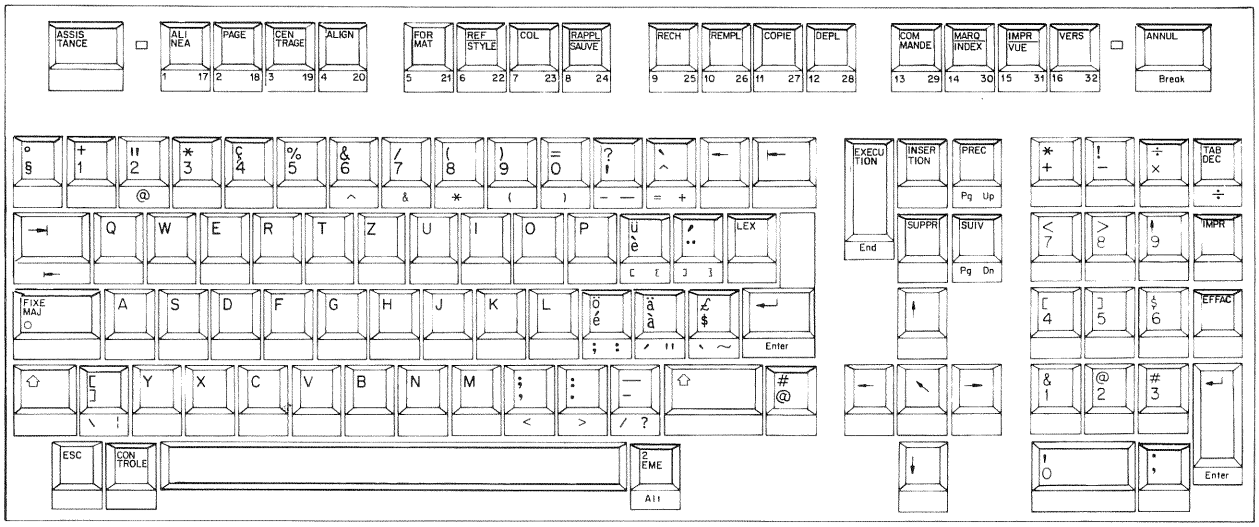

Figure C-21. Expanded Swiss French Keyboard

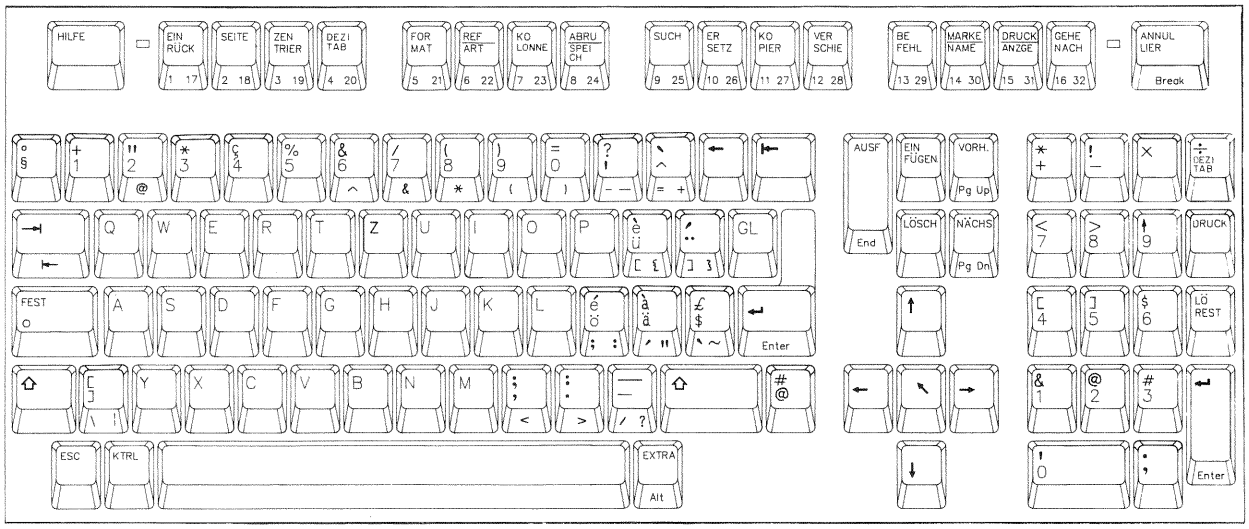

Figure C-22. Expanded Swiss German Keyboard

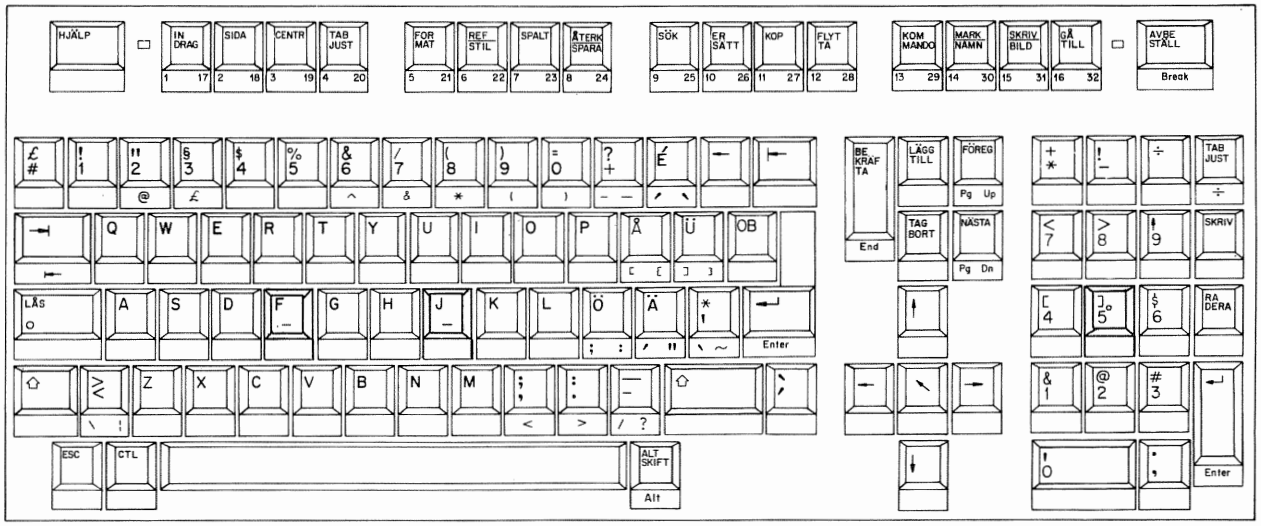

Figure C-23. Expanded Swedish Keyboard

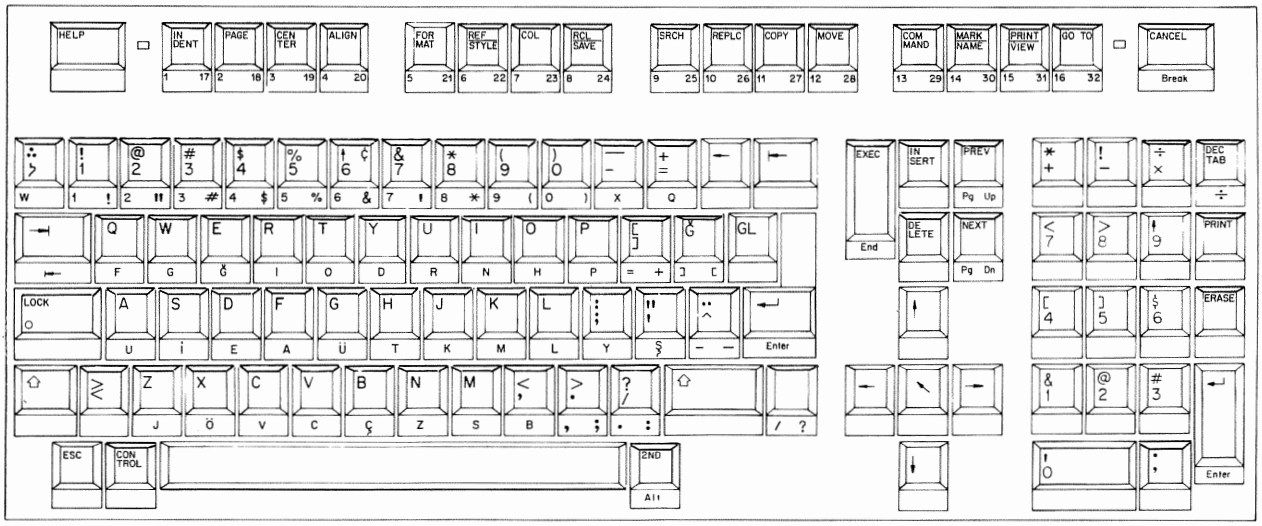

Figure C-24. Expanded Turkish Keyboard

APPENDIX D
2110 EMULATION MODE

D.1 2110 COMPATIBILITY MODE

2110 Compatibility Mode, selectable through Setup Mode, is available for users who are using applications designed for the 2110. This mode utilizes most features found in the 2110. Enhanced 2110A features remain available in this mode except where there is a conflict with 2110 compatiblity. The following section describes incompatibilities between the 2110A and the 2110 workstations.

D.2 INCOMPATIBILITIES

The following list shows you the instances where the 2110A is not strictly compatible with the 2110. This list is helpful to users maintaining host applications that are intended to support both the 2110 and 2110A workstations.

- The 2110 defines Ps=1 of the clear-tabs control as clearing the horizontal tab stop at the current position. The 2110A ignores Ps=1 in TBC (Tabulation Clear) sequence. The 2110A differs because the correct ANSI definition of Ps=1 is to clear the vertical tab stop on the current line.

- The 2110, in the following cases, writes erased/vacated screen positions using the SPACE character with current display attributes:

  - ANSI-standard ED, EL, IL, DL, DCH control sequences

  - Wang-private IL, DL control sequences

  - Scroll region control sequence

  - Auto-scroll

- 25'th line display mode changed from Set to Reset (the terminal erases the 25th line of the screen)

- Form-feed character received with Form-feed mode Set

The 2110A, in the above cases, writes the erased/vacated positions with the SPACE character using default display attributes.

- The 2110 ignores CAN character. The 2110A aborts in-progress ESC and CSI sequences if CAN or SUB characters are received within sequence.

- The 2110 ignores received ENQ character. The 2110A transmits answerback text. 2110A operation is not affected by compatibility mode since it is possible to obtain compatibility by setting the 2110A answerback text to a null string in Setup Mode.

- The 2110, when in Half Duplex operation, does the following:

  - Attempts to transmit XON/XOFF characters for flow control
  - Interprets received XON/XOFF characters as flow control
  - Transmits XON character on completion of power-on and RIS

2110A Half Duplex A operation differs from 2110 Half Duplex operation as follows:

  - Does not transmit XON/XOFF characters for flow control
  - Does not interpret received XON/XOFF characters as flow control
  - Does not transmit XON character at completion of power-on and RIS

- The 2110 Mode, when 7-bit data representation is enabled, clears the most significant bit of received data bytes prior to interpreting them. The 2110A, in 7-bit Data Representation Mode, does not clear the most significant bit of received data bytes and is able to interpret 8-bit data received data even when 7-bit data representation is enabled.

- In 2110, the physical row/column position of the cursor never changes when the cursor is detached. In 2110A, the row/column position of the cursor moves with screen data during scroll operations.

- The following baud rates are supported by the 2110 for host communications but are not supported for 2110A host communications:

  150 450 900 3600 7200

2110A operation is not affected by 2110 compatibility mode because restriction due to hardware differences.

- DA Private #1 identification response for 2110 is:
  CSI ? 77 ; 1 ; Pr c

  Response for 2110A is:
  CSI ? 77 ; 2 ; Pr c

- DA Private #2 response format for "request attributes at current position" is:
  CSI > 4 ; (attributes) c
  (attributes) has a maximum value of 15, since there are 4 visual attributes defined.

  DA Private #2 response format for 2110A is:
  CSI > 4 ; (attributes) ; (CG memory number) ; (active page) c
  (attributes) has a maximum value of 63, since there are 6 visual attributes defined. The first 4 attributes are the same as for the 2110.

- DA Private #2 response format for "request keyboard type" is:
  CSI > 6 ; Pt c
  "Pt" is a parameter of the format "001" thru "027" corresponding to the function key number used to identify the keyboard type in the keyboard selection menu.

  DA Private #2 response format for the 2110A is:
  CSI > 6 ; Pt1 ; Pt2 ; Pt3 c
  "Ptn" is either 2 or 3 parameters which are the ASCII character values of the selection text identifying the current keyboard type. For instance, if the current keyboard type is US domestic, Pt1=55, Pt2=53, and Pt3 is omitted.

- The 2110, while in ANSI/ASCII mode, transmits CSI 38 tilde when 2ND+CANCEL is keyed. The 2110A uses 2ND+CANCEL as an alternate means of access to the local terminal function 'generate the BREAK condition' (access available in any terminal mode). The 2110A transmits the code CSI 38 tilde when CONTROL+CANCEL is keyed.

- The 2110 keyboard LOCK key ON/OFF state can not be locally toggled by the keyboard LOCK key depressions. The ability to locally toggle the LOCK key state is provided as part of the 2110A keyboard functionality.

APPENDIX E
VT-102 EMULATION MODE

The following list shows you the differences between the 2110A and the VT-102 features that are not supported in VT-102 emulation mode:

- The 2110A does not support automatic disconnect on receipt of EOT/DLE+EOT
- The 2110A, while operating in VT-102 mode, does not display the receive character on the screen when CAN is received
- Only the default VT-102/ASCII character set is supported. The alternate character set is not supported
- DECANM (?2) ANSI/VT52 is mode not supported
- DECARM (?8) Mode is not supported; all keys repeat
- DECINLM (?9) Interlace mode is ignored
- DECPEX (?19) Print extent mode (full screen/scroll region). Same as the 2110A except that full screen always means full screen in VT-102

APPENDIX F
GLOSSARY OF TERMS

Active Page

The active page is that page currently containing the active position. Unless otherwise indicated in the description of a control, all controls that alter the page contents or change the current active position are restricted to the boundaries of the current active page. The actions of these controls are not affected by current page:viewport alignment, if any. Only one page is active at any particular time. The active page may be null. Note that the only activity that may occur within a null page is moving the active position in or out of a null page.

Asynchronous

A method of communication which causes a delay between data bytes.

Auto-Align

If the current active page is assigned to a viewport, Auto-Align causes the page:viewport alignment of the active page to be adjusted, whenever necessary, to insure that the current active position is always displayed. Auto-Align has no effect when the current active page is not assigned to a viewport. Because auto-align action is determined solely by the active position, the states of cursor display disable and cursor attach modes have no effect on auto-align action.

Auto-Map

When enabled, Auto-Map occurs when a host command causes the active position to move out of a page which is currently assigned to a viewport. Auto-Map has no effect when the former active page was not assigned to a viewport. The action of auto-map is exactly as specified for execution of a host "map-page-to-viewport" command with the following parameters:

Auto-Map (continued)

Page = New active page.
Viewport = Viewport formerly displaying former active page.
Page Row = 1.
Page column = 1.

Cursor Display

The cursor is displayed at the physical screen position that displays the internal cursor position provided that the following conditions are met:

- Page:viewport mapping causes internal cursor position to be displayed on the physical screen.
- Cursor display disable mode is currently Reset.

Cursor Position

The cursor position is defined as the position within a page where the cursor is currently located. It is an internal position rather than a physical screen position. When cursor attach mode is Set, the cursor position equals the active position . When the cursor attach mode is Reset, the cursor position remains at the page position that was the active position at the time when the Reset state was entered. Note that the cursor position moves with the page data if the page is scrolled up/down while the cursor is detached.

Define Page

The host defines the page by specifying a page number (1 through 8) together with number of rows and columns in page. Tthe terminal first deallocates any display memory formerly assigned to the specified page number, then allocates the new page from the current unassigned portions of the page pool. The terminal is responsible for moving page allocations within memory pool when necessary to provide sufficient contiguous display positions for a newly defined page. The moving of page assignments within the page pool occurs only during execution of a page definition request, and will only be done when the terminal does not otherwise have sufficient contiguous display positions available for the newly defined page. If insufficient display positions are available in the page pool for the newly defined page, the page is defined as null. The newly defined page is erased (filled with SPACE with default attributes).

Horizontal Scrolling

Horizontal scrolling as available in the 2110A refers to the ability to alter the column alignment aspect of a page:viewport mapping. Horizontal scrolling does not affect the contents of the page itself. The visible implementation of the horizontal scroll is "jump" mode, in that the new alignment immediately replaces the old alignment, with no intermediate alignments displayed. See Page:Viewport Mapping for more information. The re-alignment is to be done by the terminal during the vertical interval of the raster refresh cycle. As an example, horizontal scrolling might be used to pan across the contents of a 132 column page when 80 column physical screen format is enabled. Horizontal scrolling is always effectively a jump scroll.

Page

A unit of display data stored in the terminal's memory. Stored data is formatted as a number of rows by a number of columns. Each position in a page contains the code specifying the character to be displayed along with attributes to be used in the display of that character. Display altering and cursor movement controls are restricted to operating on the currently active page unless indicated otherwise in the description of the particular control. The terminal supports the definition of up to 8 pages. Page width may be defined as 0 or 80 through 255 columns (0 or 132 through 255 columns when in 132 column mode). Page length may be defined as 0 through 100 rows. Length and width defined for a particular page is limited by the number of display positions available in the page pool at the time the page is defined. A page is considered null when page length or width is equal to 0.

Page Pool

Internal memory in the terminal that is available for allocation as pages. The size of memory pool is 8000 display positions. Each display position has both character and attributes memory associated with it. The terminal is responsible for allocating from the page pool to form pages when host defines pages. Unassigned portions of the page pool are inaccessible to the host until defined as part of a page.

Page:Viewport Alignment

Page:viewport alignment indicates the positioning of page display data within a viewport. It applies to any page which is assigned to a viewport. It is specified by indicating the page, row, and column position which is to be displayed in the upper left corner of the viewport.

Page:Viewport Assignment

Page:viewport assignment indicates whether a specified page is to be displayed in a specified viewport. A particular page may be assigned to one viewport, or to no viewports. A particular viewport may be assigned to one page, or to no page. When a new assignment is specified any former assignments of the specified page and viewport are lost. Assignment is specified by a page number (1 through 8) and a viewport number (1 through 8).

Page:Viewport Mapping

Page:viewport mapping refers to the mapping of the contents of a page to a viewport for display. Mapping consists of assigning a specified page to be displayed in a specified viewport and specifying the alignment of the page within the viewport. Definition of page:viewport mapping is the combination of page:viewport assignment and page:viewport alignment.

Parity

A mode of asynchronous data transfer that comes immediately after the alst data bit. Its value is either a 0 or 1 depending whether even or odd parity has been selected. For even parity, the bit is set at either a 0 or 1 so that the total number of 1's will be even. For odd parity, the bit is set at 0 or 1 so that the total number of 1' will be odd.

Screen

The physical display area of the terminal. Formatted as 25 rows by 80 columns, or 25 rows by 132 columns.

Vertical Scrolling

Smooth or Jump vertical scrolling is selectable via Setup Mode. When this smooth vertical scroll is selected, smooth scroll occurs only for the following operations:

- The contents of a page are scrolled up/down, and that page is currently displayed in a viewport. Scroll of page contents may be the result of auto-scroll or due to execution of host scroll-region commands.

- Auto-alignment occurs as a result of incremental movements of the active position (CUU, CUD, LF, RI, IND, etc). In this case, the contents of the page are not being altered, only the alignment of the page on the screen is changing.

Vertical Scrolling (continued)

Smooth Scroll Implementation:

It is always possible to assign a page length of only one row. However, if smooth scroll option is selected via Setup Mode and the page to be scrolled is less than 2 rows in length, the terminal will implement the scroll as a jump scroll. When the application requires smooth scroll operation, the application must define the page length to contain at least 2 rows. Note that if the active position is moved to another page:viewport pair whose page contains at least two rows and Setup Mode selection is smooth scroll, scroll activity is smooth.

Viewport

Up to 8 viewports may be defined. Each viewport is defined as a contiguous horizontal region of the physical screen. The assigned width of viewports is always the current physical screen width (80/132 columns). Length of viewport may be 0 to 25 rows. Viewports cannot overlap one another.

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