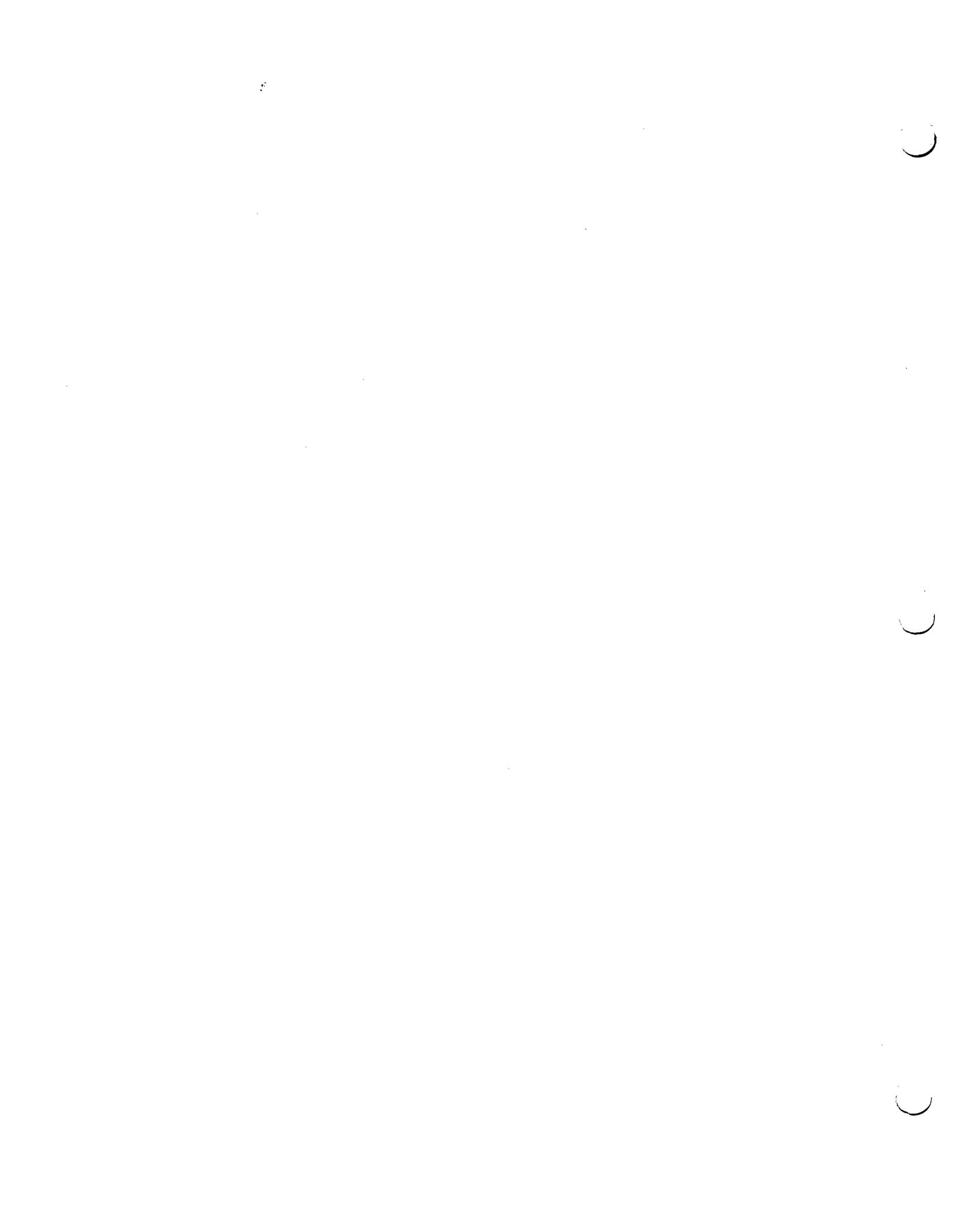


WANG

**2200 LVP  
Introductory  
Manual**



**2200**



# 2200LVP Introductory Manual

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## PREFACE

This manual introduces the Wang 2200LVP System to the user. It describes the features of the basic system and its nominal components: the 2200LVP CPU, the 2236DE interactive terminal with business graphics capabilities, the system diskette drive which uses dual-sided double-density diskettes, and the optional fixed disk drive. Master initializing the system, multiprogramming configuration (partition generation), backing up the system platter, executing the user diagnostics, and routine maintenance procedures are also discussed.

This manual should be used in conjunction with the following documentation supplied with every system.

- The *BASIC-2 Language Reference Manual* — Describes the system's operational features, documents the set of system commands, and describes in detail each statement in the BASIC-2 instruction set.
- The *Wang BASIC-2 Disk Reference Manual* — Describes the complete set of BASIC-2 disk I/O instructions for all 2200 series disk drives.
- *Programming in BASIC* — Beginner's introduction to BASIC programming and the utilization of peripherals that are frequently used with the 2200 system.

Additionally, a separate reference manual is provided for each optional peripheral device attached to the system.



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# CHAPTER 1

## INTRODUCTION

### 1.1 SYSTEM OVERVIEW

Wang's 2200LVP is a versatile, disk-based computer system that concurrently supports multiple users programming in the Wang BASIC-2 language. Up to 12 terminals can run up to 16 jobs with the excellent response time characteristic of single-user interactive systems. The following components constitute a basic 2200LVP system.

- A 2200LVP Central Processing Unit (CPU) with 32K to 256K bytes of user memory
- One to twelve Model 2236DE-type terminals with business graphics capabilities
- A system diskette drive (dual-sided, double-density)
- A fixed disk drive (Winchester technology)

The 2200LVP provides true multiprogramming, a feature usually available only on larger systems, yet is as easy to use as small single-user systems. The operating system executes several programs concurrently by sharing a single CPU among several users. A terminal can control more than one program, allowing foreground (interactive) and background (noninteractive) processing. Global (reentrant) programs and variables can be shared by users, greatly reducing the memory required to perform multiuser applications. The system overlaps processing and I/O to efficiently use the memory and peripherals, supporting a variety of applications.

The system is simple to program and operate, using BASIC-2, a variety of powerful system commands, and application software available from Wang and other vendors. Since the user at each terminal may access all system resources directly from the keyboard, no special personnel are required to oversee system operation. This direct access saves programming, job turnaround, and operating time.

Modular design of the system makes it economical and permits easy expansion and physical relocation of the system's components. Connection between the CPU and each terminal can be either local or remote (RS-232-C/CCITT V.24), allowing the system to be adapted to a wide variety of applications and configurations. Each terminal supports a terminal printer.

Allocation (configuration) of system resources can be redefined as needed by the primary system operator. When security requirements exist, the 2200LVP provides the capability to selectively restrict access to the system's resources.

The features of this system are discussed in greater detail in the *BASIC-2 Language Reference Manual* (700-4080D).

## Typical System Configuration

A 2200LVP CPU may be configured with a variety of peripheral devices and options. An average system might include a 2200LVP CPU with 64K bytes of user memory; two Model 2236DE terminals for interactive communication with the CPU; a dual-sided double-density diskette drive unit for software loading and system interfacing, and a Winchester-style fixed disk drive for program and data storage (both mounted directly in the system housing); and a Model 2231W matrix impact printer for hard copy output.

## System Memory

The 2200LVP utilizes two distinct types of memory: control memory, for system needs; and user memory, for user programs and data. Control memory contains the operating system, BASIC-2 interpreter, and other system data; it is inaccessible to the user or the user's programs and data. User memory contains user programs and data as well as some system control information. The size of the user memory, which can range from 32K bytes to 128K bytes, determines the size of the particular 2200LVP.

User memory is organized into "banks"; up to 4 banks may be contained in a 2200LVP. The first bank may contain either 32K or 64K bytes of memory while the remaining banks must contain 64K bytes. User memory in each bank is distinct from memory in any other bank, and programs and data in one bank cannot generally access programs and data in the other bank. However, the first 5K bytes of available memory in Bank 1 constitute a universal global area; programs stored in this area of memory can be accessed by any other program in the system.

User memory can be divided into as many as 16 separate partitions, each of which can be used for a separate program. A global partition, however, contains programs accessible to several or all users on the system. Up to twelve terminals can access the memory partitions concurrently. Each partition is assigned to either one terminal on the system or to the null terminal during configuration of the system by the operator. However, each partition is controlled by only one terminal at any time, giving each user essentially a stand-alone system with the power and capabilities of a 2200V. Each terminal may control more than one partition simultaneously, and ownership of these partitions can be changed during system operation without reconfiguration. (Refer to Section 3.3 for information on partitioning and terminal assignment.)

## The System Platter

The operating system, BASIC-2 interpreter, system utilities, and other system programs are contained on a system platter. The operating system and interpreter are loaded from the system platter into the control memory when the system is master initialized. The system platter shipped with each 2200LVP also contains a utility program used to generate, execute, and save system configurations as well as a variety of hardware diagnostic routines. The system platter must be handled with *extreme care*, and a *backup copy* should be made at the earliest opportunity to protect against accidental loss or destruction.

Chapter 3 describes how to load the operating system and the partition generator utility from the system platter. Chapter 3 also suggests procedures for creating a backup copy of the system platter. Chapter 5 discusses the procedure for loading and executing the diagnostic routines from the system platter. Appendix J explains the 2200LVP system utilities.

## **Interactive Terminals**

The Model 2236DE terminals enable each user to communicate with the system and to control it easily. Up to twelve Model 2236DE-type terminals can be configured with the 2200LVP CPU. The terminal consists of a 24-line, 80 character-per-line, Cathode Ray Tube (CRT) and displays a full 128-character set. Its keyboard contains a 10-key numeric keypad and 34 user-definable Special Function keys. The Model 2236DE is capable of both box and character graphics, as well as the display of special character attributes such as bright, blinking, underlined, and reverse video (dark characters on a light background). Special features of the Model 2236DE also include an audio signal to indicate a variety of error conditions, repeating keys, and the capacity to support a screen dump to its own terminal printer. The features of the Model 2236DE terminal are detailed in Chapter 2.

## **Disk Drives**

The dual-sided, double-density system diskette drive, which can store over one megabyte of data, is a standard feature of the 2200LVP. An additional option is the 2-, 4-, or 8-megabyte fixed disk drive, which uses Winchester technology. Both the system diskette drive and the Winchester disk drive are mounted directly in the 2200LVP's compact office-style cabinet. Chapter 2 discusses the features of the disk drives and Chapter 3 discusses their operating instructions.

## **System Expansion**

Because of the 2200LVP's modular design, it is easy to add memory and peripheral devices. The 2200LVP CPU supports extension of user memory up to 256K bytes. The CPU can be configured with up to twelve terminals, several disk models, high-speed printers (up to 600 lpm), and industry-compatible nine-track magnetic tape. Appendix B contains a list of peripheral devices that can be added to the system.

The 2200LVP also supports telecommunications. This extra cost option allows the system to share information, either locally or remotely over phone lines and modems, with another Wang system or a host computer.

## **BASIC-2 Language Features**

The 2200LVP, running either the MVP or the VP operating system, supports the BASIC-2 language, whose flexible capabilities provide for a wide range of applications. The BASIC-2 language is compatible with earlier versions of Wang BASIC. Thus, most Wang software that has been developed for 2200-series systems can be run on a 2200LVP with minimal changes.

The BASIC-2 language contains instructions for data testing, manipulation, and logical operations at the bit and byte levels, comparable in scope to those of many assembler languages. Many data operation statements can support both numeric and alphanumeric expressions and can operate on all or part of alphanumeric arrays, enhancing the system's data-handling capability. System commands give the operator complete control over system operations from the keyboard and also serve as powerful debugging tools. Statements exist to facilitate common programming tasks such as decision-making, branching, looping, passing data to subroutines, overlaying program modules, and accepting and processing operator-entered data. A variety of instructions are provided for controlling disks and plotters, and for formatting output to the printer and CRT displays. Several groups of special-purpose statements perform operations such as code conversion, sorting, matrix arithmetic, and customized I/O control. Additionally, in the MVP operating system, a number of statements are implemented to support interpartition sharing of programs and variables, temporary control of shared devices by one partition, specification of multiuser system-configuration parameters, and other multi-programming features.

Numeric operations are carried to 13 digits of accuracy for most operations. The user may specify whether results are to be rounded or truncated at 13 digits. When full precision is not required, numeric data can be packed from eight bytes to as few as one byte. Trigonometric arguments can be specified in degrees, radians, or gradians.

BASIC-2 supports numeric variables and alphanumeric string variables (both scalar and array). The maximum number of elements in one-dimensional arrays is 65,535 and 255 by 255 in two-dimensional arrays. Each alphanumeric array element or alpha-scalar-variable can be from 1 to 124 bytes in length. Alphanumeric arrays can be used in data manipulation statements as scalar variables (element boundaries are ignored), providing a convenient technique for manipulating extremely long character strings.

### The Operating System

The 2200LVP runs BASIC-2 with the multi-user MVP operating system that supports up to 16 concurrent programs. MVP BASIC-2 is also utilized by the 2200MVP system.

The 2200LVP can also operate BASIC-2 under the single-user VP operating system used by the 2200VP and 2200SVP systems. VP BASIC-2, which configures the 2200LVP as a single-user one partition system, is generally more restrictive than MVP BASIC-2 and is, thus, not normally used with the 2200LVP.

The general instruction set for the 2200LVP is discussed in the *BASIC-2 Language Reference Manual*. Disk I/O instructions are covered in the *Wang BASIC-2 Disk Reference Manual*. Instructions used to control all other I/O devices are described in the reference manual for the particular device.

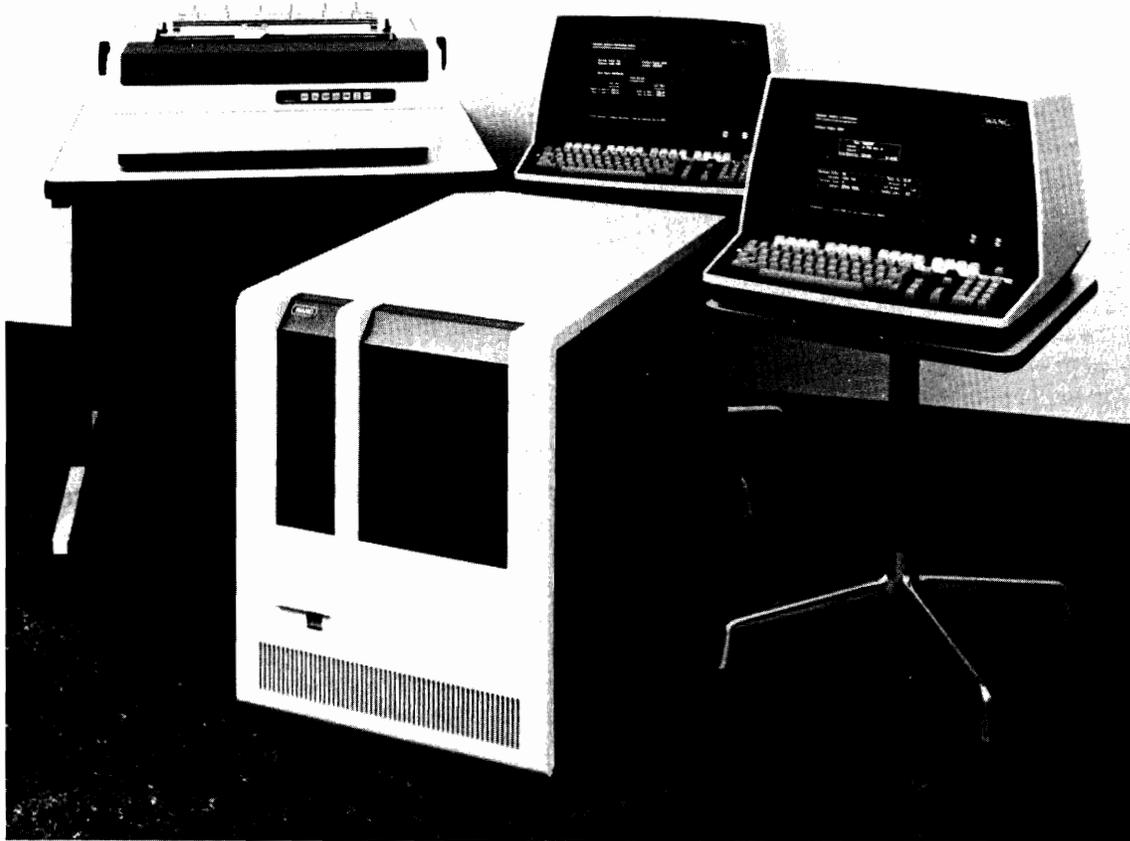


Figure 1-1. Typical 2200LVP Configuration

## **1.2 ENVIRONMENTAL CONSIDERATIONS**

Although the 2200LVP is designed to operate in most office environments, the environment should be designed to encourage optimal system performance. An ideal environment is one in which the temperature and humidity are controlled and airborne contaminants are minimal. The AC power source must be grounded, and should be adequate for present and proposed system needs, regulated, and noise free. The room should have space for future expansion and be easily accessible to operating personnel, yet sufficiently removed from the main traffic flow to permit the system to operate smoothly. A general rule of thumb is "an environment comfortable for the operator will be acceptable for the system." (Refer to Appendix C for further information.)

## **1.3 UNPACKING, INSPECTION AND INSTALLATION**

Special factory packing techniques require that the 2200LVP be unpacked, inspected, and installed by a Wang Service Representative. When the system arrives, call the Wang Customer Engineering Office and request that this service be performed. Failure to follow this procedure voids the warranty.

The Wang Service Representative will check that all equipment has been delivered, inspect each unit for shipping damage, connect each device in the system and perform tests to verify the proper operation of all system components.

If modems and telephone lines are to be used, this equipment should be installed before the Wang equipment is delivered. The Wang Service Representative will connect the Wang equipment to the modems. The modem vendor or phone company, however, must connect all modems to the proper transmission lines.



## CHAPTER 2 SYSTEM COMPONENTS

### 2.1 THE CENTRAL PROCESSING UNIT (CPU)

The 2200LVP Central Processing Unit contains the processor, interpreter, memory, and system logic necessary to resolve and execute programs, perform arithmetic operations, and control the input and output of data. The standard 2200LVP CPU contains 32K bytes (1K=1024 bytes) of user memory and three I/O slots (controller boards for peripheral devices are plugged into the I/O slots). User memory is expandable to a maximum of 256K bytes.

On systems larger than 64K bytes, data memory is divided into 64K byte banks. The hardware maps the first 8K addresses in each bank onto the first bank. In this shared 8K byte area is stored 3K bytes of control information. In the remaining 5K bytes, the user may create one or more partitions that have the special property of being accessible to all banks. Partitions created in the remaining 56K bytes of each bank may share data and program text within their bank, but are isolated from partitions in other banks.

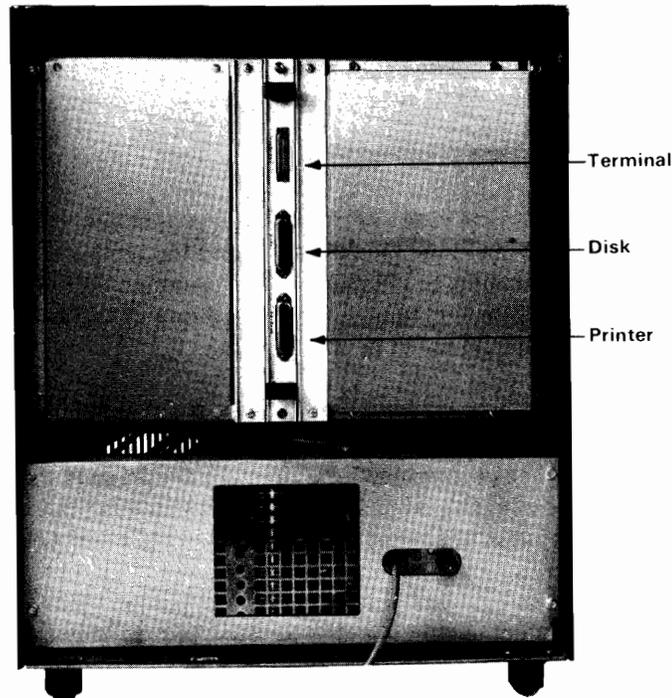
The CPU and operating system employ many techniques to maintain optimum memory integrity and efficiency. The 2200LVP provides overlapped I/O and program execution, significantly shortening the overall processing time of foreground (interactive) and background (noninteractive) jobs. All programs are stored in a condensed form to save memory. Multistatement lines can also be used to conserve memory, speed program execution, and logically group related statements.

Programmable device selection allows increased flexibility for I/O operations. One user can programmably "hog" the devices allocated to all users during system configuration to secure exclusive access to those devices. (Refer to the *BASIC-2 Language Reference Manual* for further information.)

System diagnostics automatically verify proper CPU operation whenever the system is master initialized. Additionally, hardware and software errors detected during any system operation are signalled by an audible tone and a code identifying the error and its approximate position. System response to many types of errors can be suppressed and the errors handled under program control. Debugging facilities provide complete program, variable, and subroutine cross-reference listings. Additionally, they allow the programmer to step through the execution of a program one statement at a time, observing variable assignments and program transfers as they occur. The programmer can also interactively edit program lines, immediate mode lines, and input data values both during and after entry.

## I/O Controllers

The standard 2200LVP CPU has three I/O controller slots, but can be expanded to contain four additional I/O slots for a total of seven. Each I/O slot holds an I/O controller board used to manage one or more peripheral devices. Some controllers possess front end intelligence that allows the controller to perform I/O processing and CPU processing concurrently.



**Figure 2-1. LVP I/O Slots**

The controller for every peripheral device attached to the CPU is identified by a unique device-address consisting of three hexadecimal digits. The second and third digits of the address represent the hardware address set on the controller which is used by the system to electronically identify that device when information is to be transmitted to or from it. The first digit of the device-address is used by the operating system to identify what type of I/O routines are to be used to control the device.

The 2236MXD terminal processor requires one I/O slot and can support up to four Model 2236DE terminals. A maximum of three 2236MXD controllers can be attached to a system to support up to twelve terminals. (Refer to Appendix F for a description of how to set the 2236MXD terminal processor device-address.) Unlike the device-addresses set on most peripheral processors, the physical device-address set on the 2236MXD terminal processor is not used to access the terminals. Instead, the program address of all CRTs, keyboards and terminal printers is the same for all terminals on the system. The operating system automatically translates the program addresses into the appropriate physical address for the processor port being utilized. Thus, each program in each partition addresses its terminal and terminal printer as if they were the only ones on the system. The last 2 digits of the device-address of the CRT are always 05. The device-address of the keyboard is always 001. The last two digits of the device-address of a terminal printer (i.e., printer directly attached to a terminal) are always 04. A printer attached to the CPU is normally addressed 215 and plotters are normally addressed 413 or C13.

The LVP fixed disk drive normally has an address of D11 while the LVP dual-sided double-density diskette drive has an address of D10. However, for purposes of software compatibility, the device address 310 may also be used to address the fixed disk drive and the address B10 may be used to address the DSDD diskette drive. The procedures for addressing a disk when more than one drive unit is contained in the system are discussed in the *2200 BASIC-2 Disk Reference Manual*. For a more complete discussion of device-addresses, refer to the *BASIC-2 Language Reference Manual*.

Each 2236DE terminal is connected to a 2236MXD terminal processor or a 22C32 triple controller that controls data input and output at the terminals. Hard copy printout to a terminal printer can be created concurrently with CRT displays at each terminal. The terminal processor and triple controller collect keystrokes into lines of text, and buffer the CRT and terminal printer output to contend with the speed discrepancies between the asynchronous line, the CRTs, and terminal printers. Buffering allows the CPU to be more fully devoted to the execution of programs than would be possible if it had to pause frequently to test the ready status of I/O devices.

Line handling between the CPU and each terminal is asynchronous and full-duplex. Since the Model 2236DE terminals and the Model 2236MXD terminal processors are RS-232-C/CCITT V.24 compatible, local and long-distance terminal placement are possible. Local terminals can be placed up to 2,000 feet away from the 2200LVP CPU, while unlimited distance is available for remote terminals using telephone lines and modems.

Any combination of local, extended-local, and remote connections may be used. However, the terminal connected to 2236MXD Port 1 should reside in the same area as the CPU because it acts as the system console for Master Initialization when the system is turned on. This terminal, known as the master terminal, also reports system errors. Allowable configurations of the terminals relative to the CPU and 2236MXD processor are as follows.

1. Local — For distances up to 25 feet (7.6 meters), transmission rates of 19.2K baud are available with direct four-wire connection using a Wang-supplied cable. (This is the standard configuration.)
2. Extended Local — For distances from 25 feet (7.6 meters) to 2000 feet (610 meters), optional Wang-supplied cables, which are available in lengths up to 2000 feet (610 meters), provide direct extended-local connection at speeds of 19.2K baud.
3. Remote — For distances greater than 2000 feet, two asynchronous, full-duplex, RS-232-C compatible modems operating at the same baud rate and suitable transmission lines must be used to provide the communication link. One modem is plugged into the terminal and the other is plugged into the terminal processor. The following two types of remote configurations are possible, depending upon the distances involved.
  - a. Distances up to 5 miles (8 kilometers) — Short-haul modems using private, voice-grade lines with four-wire connection between modems may be employed.
  - b. Distances exceeding 5 miles (8 kilometers) — Private (dedicated) or switched (dial-up) voice-grade telephone lines provide the connection between telecommunication modems. The modem selected determines whether these lines must be two-wire or four-wire.

Line speeds ranging from a minimum of 300 to a maximum of 19.2K baud may be selected (19.2K baud equals about 1900 characters per second). Baud rates of 300, 600, 1200, 2400, 4800, 9600, and 19,200 are supported. The Model 2236MXD terminal processor and the Model 2236DE terminal each have a set of switches for setting the transmission speed. Both the Model 2236MXD terminal processor and the terminal connected to it must be set at the same baud rate. Special cables for modem connections of Wang equipment are required; they are available in 12-foot (3.7 meters), 25-foot (7.6 meters), and 50-foot (15.2 meters) lengths. Modems must also be set at the same baud rate as the terminal and terminal processor. The procedure for setting the baud rates on the Model 2236DE terminal and 2236MXD terminal processor is discussed in Appendix E, "Changing the Transmission Speed of the Model 2236DE Terminal and the 2236MXD Terminal Processor."

## CPU Partitions

The MVP operating system, which the LVP uses, supports multiuser operations utilizing a fixed-partition memory approach. In the first bank of user memory, approximately 3K bytes are required for system overhead. In each subsequent bank, 8K bytes of memory are required. Thus, a 128K-byte 2200LVP contains 117K bytes of memory available for partitions. This memory can be divided into a maximum of 16 partitions. Each partition's size is specified in 256-byte (0.25K-byte) increments, with a minimum partition size of 1.25K bytes required and a maximum size consisting of remaining available memory in any one bank. However, no partition may be specified that contains memory from more than one bank. Approximately 1K bytes are needed in each partition for overhead, leaving the remaining memory available for user programs and data.

The system configuration, i.e., number and sizes of partitions, the terminals and peripherals attached to each partition, et cetera, is defined by a procedure called "partition generation." The allocation of system resources (system configuration) can be changed whenever necessary by the primary system operator. Since a number of different system configurations can be generated, named, and stored on the system disk, partition generation can be made similar to loading a program and can even be performed automatically. The process of system configuration and the parameters that can be modified by the user during system configuration, i.e., background/foreground partitions, disabled programming mode, bootstrap programs, et cetera, are described in Chapter 3.

Each user has a distinct memory area, or partition, for program and variable storage. There is, however, only one central processor. The central processor executes the program in each partition sequentially in a "round-robin" fashion. By bypassing inactive partitions, overlapping I/O with CPU processing, and switching between users frequently, the system assures good response time for each user. This interleaving of the execution of the programs in the system causes the user programs to appear to be executing simultaneously, creating the appearance of a single-user system for each user.

The MVP partitioning scheme imposes some programming constraints on system users because timing considerations of the operating system must be considered. Unbuffered, time-dependent software and associated devices cannot be used with the operating system. For a discussion of programming considerations and BASIC-2 language enhancements for multiprogramming, refer to Chapter 16 of the *BASIC-2 Language Reference Manual*. If time-dependency is required, the LVP can use the VP operating system; the same hardware, at different times, supports both systems.

The system supports up to 16 partitions, but only 12 terminals at the same time. A single terminal can therefore control more than one partition. Partitions that are currently attached to a terminal (running an interactive job, for example) are said to be running in the foreground. Those partitions that are not currently attached to a terminal (running noninteractive jobs, for example) are said to be running in the background.

A terminal that controls several partitions can be switched from one partition to the next to initiate program execution and to permit any necessary user/program interaction. When a program running in a background partition attempts to communicate with a shared terminal but the terminal is attached to another partition, program execution is suspended until the terminal is released by the current partition. A terminal can be released to a specific partition or made available to any waiting partition, by the operator or under program control. For each partition, only the terminal assigned to the partition can list the program in the partition, release the terminal to that partition, or modify the program executing in the partition. A partition assigned to the null terminal, however, can be attached to any terminal upon request. Partitions may be assigned to the null terminal at any time during system operation.

Each partition functions independently of the others in a manner similar to a separate single-user system. However, any partition may declare itself global, thus making its subroutines and specially labeled global variables accessible to other partitions within its bank. Since BASIC-2 program text in a global partition is reentrant, two or more partitions may simultaneously execute the same statement in a shared subroutine. Global variables can be interrogated and modified by several users, providing a convenient mechanism for interpartition communication. Although other partitions can access and modify global variables, they cannot modify global programs. The special features of global partitions in many cases also speed throughput and allow several users to concurrently process several related applications at each of the terminal sites, sharing the application programs instead of requiring their duplication. Refer to the *BASIC-2 Language Reference Manual* for a detailed discussion of global programming capabilities.

Programming and Immediate mode operations can be inhibited for any partition(s). In the Disabled Programming mode, the operator is kept under BASIC-2 software control, preventing inadvertent or unauthorized use of certain data files and programs. The operator can only load and execute a program called START, which can provide a menu of operations to be performed and cause other software to be loaded.

## **2.2 DISK STORAGE**

The 2200LVP can contain two disk units mounted directly within the system casing: the system diskette drive, a dual-sided double-density (DSDD) diskette drive which is included as standard equipment with the 2200LVP, and an optional fixed disk drive, which uses Winchester disk technology. When both disk drives are present, it is recommended that the system diskette drive be used primarily as a back-up medium and for transferring system software and applications packages obtained on DSDD diskettes. The fixed disk drive should be used for storage of programs and data that are used regularly.

Disks are generally shared devices; however, for certain file updates and major file maintenance operations, one partition may require exclusive use of the disk. The disk can be permanently assigned to a specific partition during Master Initialization as part of the partition generation process or temporarily assigned during the execution of a BASIC-2 program by executing a \$OPEN statement. \$CLOSE releases the temporarily assigned disk.

There is no separate power switch for the disk units. When the main CPU is powered on, both disk drives are also powered on.

### **The System Diskette Drive**

The system diskette drive reads and records data on dual-sided, double density (DSDD) system diskettes. The system diskette drive, by doubling the density at which data is now recorded on new diskettes and providing dual-sided recording, quadruples the normal 250-kilobyte storage capacity of previous single-sided, single-density diskettes.

There are three different types of Wang diskettes, two of which can be used by the LVP system diskette drive. The characteristics of the three types of diskettes are as follows.

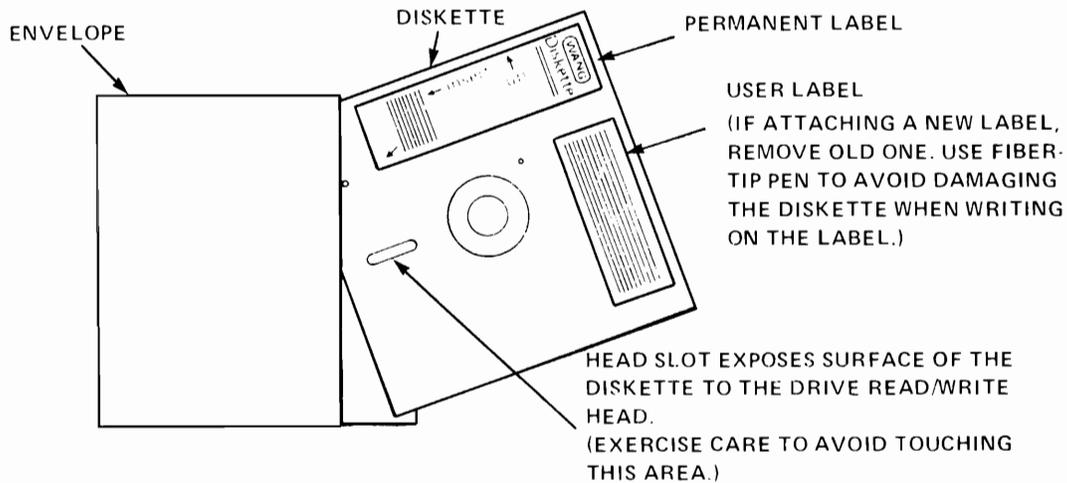
1. *Wang DSDD Soft-Sector Diskette* (red label — Part 177-0070-1): This is the standard 2200LVP dual-sided, double density system diskette, as described below.
2. *IBM-Compatible SSSD Soft-Sector Diskette* (green label — Part 177-0074-1): This single-sided, single density diskette is compatible with both the LVP system diskette drive and the Model 2270A Diskette Drive. Thus, using the Move File utility, this diskette can be used as a means of data transfer between the two diskette drives. (Refer to Appendix J.)
3. *Wang SSSD Hard-Sector Diskette* (white label — Part 177-0063-1): This is the standard diskette for the Wang 2270 and 2270A diskette drives. The LVP system diskette drive cannot use a diskette of this format.

As a safety feature, the front access door on the system diskette drive cannot be opened when a diskette is installed in the drive and the heads have been loaded. This door remains locked for five seconds after a diskette has been accessed by the system (for example, through a LIST DC command). Pressing RESET following such a command overrides this delay and allows for immediate diskette removal.

The system diskette drive is compatible with IBM 3741 and DSDD diskettes. However, the catalog structure and character sets differ between Wang and IBM, and special software must be used to enable compatible diskettes to be made. (Refer to Appendix H for more details concerning IBM compatibility.)

### The System Diskette

As indicated on the permanent label attached to each diskette, a diskette is protected from accidental over-writing when the write-protect notch is uncovered. (Refer to Figure 3-1.) To write programs or data on a diskette, the notch must be covered to disable the write-protect feature. Adhesive tabs are provided for this purpose.



**Figure 2-2. A System Diskette**

The recording surface of a DSDD system diskette includes 149 double-density tracks. Each track is divided into 26 sectors for a total of 3,874 sectors, each of which can store 256 bytes of data or program text and control information. During formatting, the system writes a header as well as 256 bytes of (zero) data into each sector. Normal writing does not rewrite the header, but uses it to assure reliable positioning of the data.

In addition to the 149 double-density tracks, there is one single-density track whose 26 sectors each contain only 128 bytes of storage. The purpose of this track is only to allow for IBM 3741 Diskette compatibility. (Refer to Appendix H for information regarding this feature.)

### Fixed Disk Drive (Winchester-Style)

The optional Winchester-style disk drive is permanently contained within the LVP system casing. It utilizes an 8-inch disk that cannot be removed by the user. Because this disk is housed in a fixed, sealed environment, the disk can be kept dust-free and the the disk drive heads can fly close to the disk surface. The resulting decreased air gap permits greater data density than was previously possible, enabling the user to access data quickly and store a large amount of data in a small space. Additionally, Winchester technology incorporates a decrease in head loading force as well as lubricated disk surfaces that permit the head to "take-off" and "land" on the platter surface during the power-up and power-down procedures. This technology greatly reduces the possibility of a head crash, insuring the integrity of the data.

When a 2200LVP is ordered with the fixed-disk option, the Winchester disk is already sealed within the fixed disk drive. It must be formatted and scratched before it can be used, as described in section 3.6

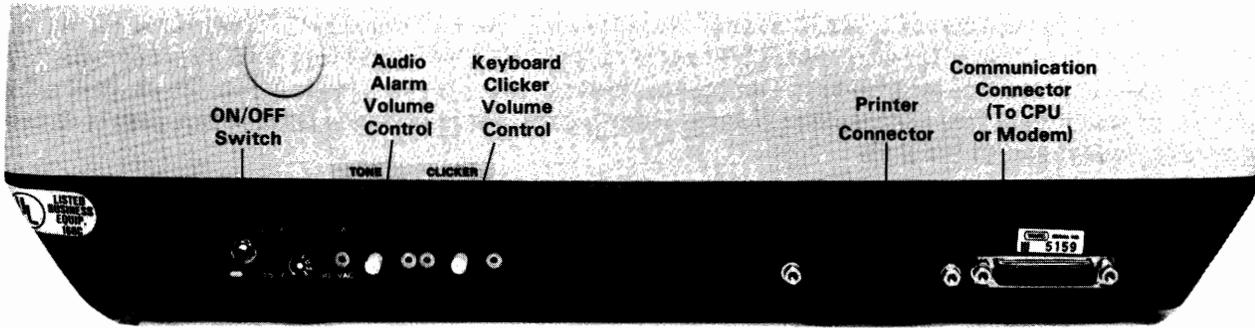
The fixed disk drives are available as system options in 2-, 4-, or 8-megabyte capacities. The storage capacity of each disk is outlined in Table 2-1.

**Table 2-1. Winchester Disk Storage Capacities**

	<b>Number of Tracks</b>	<b>Number of Sectors per Track</b>	<b>Number of Total Sectors</b>
2-Megabyte	254	32	8128
4-Megabyte	510	32	16320
8-Megabyte	1020	32	32640

## 2.3 THE MODEL 2236DE INTERACTIVE TERMINAL

The Model 2236DE terminal is the user's principal means of controlling the system. The terminal's power switch is located in the lower left corner on the back of the terminal. Figure 2-3 shows the location of the two-position power switch. In the up position (as shown), the Interactive Terminal's power is on. Turning the power on causes the terminal microprocessor to perform a self-diagnostic to ensure proper functioning of the terminal. After successful completion of the diagnostic, a message is displayed at the top of the screen indicating the current version of the terminal microprogram, communication rate, and communication character format.



**Figure 2-3. Controls on the Back Panel of the Model 2236DE Terminal**

Also located on the rear panel are volume controls for the keyboard clicker and audio alarm. Clockwise motion of the volume controls increases the volume of the audio alarm and keyboard clicker. Turning these controls counterclockwise decreases the volume.

The terminal connected to Port 1 of the primary 2236MXD terminal processor board serves as the primary system console. (Refer to Appendix F for a discussion of how to determine the location of Port 1 if it is not labeled on the terminal processor.) Only the operator at Terminal 1 may master initialize the system and establish the configuration scheme desired. (Refer to chapter 3 for instructions on how to master initialize the system.) All system error displays and corrective procedures are taken at Terminal 1. Upon completion of Master Initialization and partition generation, or after the correction of any system error, the primary terminal functions like the other terminals. Only Terminal 1 can function as both the primary (system) console and a standard terminal in the system.

### **Cathode Ray Tube (CRT)**

The terminal's 12-inch (30.4 cm) diagonal-measure Cathode Ray Tube (CRT) and typewriter-like keyboard are the principal means of communicating information between the operator and the CPU. Up to 1920 uppercase/lowercase characters can be displayed on the CRT on 24 lines containing 80 characters each. Lines are displayed sequentially on the screen; if more than 24 lines need to be displayed at any time, the new line is displayed at the bottom of the screen, and all previously displayed lines move up one line. Screen brightness and contrast can be adjusted by the operator.

The CRT displays the complete keyboard character set as well as some foreign-language characters, special symbols, and underlined versions of the keyboard characters. In addition, the CRT displays an alternate set of graphic characters that may be used to construct geometric figures on the terminal screen. Special features of the 2236DE also include a programmable audio signal that can be used to indicate a variety of errors and special conditions, repeating keys, and the capacity to support a screen dump to a terminal printer.

The Model 2236DE terminal defines a character display attribute for each position on the CRT display. By using special codes before displaying a character or string of characters, the programmer can cause output to be displayed in bright or normal intensity, blinking or nonblinking, underlined, or in reversed video (dark characters on a light background). Both the regular and alternate character sets may be displayed using one or more of the character display attributes.

Another feature of the 2236DE terminal is its capacity to produce box graphics. A special BASIC 2 statement, the PRINT BOX statement, can be used to draw any size box beginning at the current cursor location on the screen. Box graphics may be used in a variety of ways when creating charts and diagrams: for example, to increase the readability of a dense display without greatly reducing the capacity of that display.

Refer to the *Model 2236DE User Manual* for a detailed description of character display attributes and box graphic capabilities. Illustrations of both CRT character sets appear in Appendix F of the *BASIC-2 Language Reference Manual*.

A special display character resembling an underscore is used to indicate the location in the display where the next character entered will appear. This special character is called the cursor. As characters are entered into the display, the cursor automatically advances to the next character entry position. In Edit mode, the cursor can be positioned to any location in the display where character insertion or deletion will occur. Cursor movement can also be controlled by the programmer. The available cursor control codes are listed in Appendix C of the *Model 2236DE User Manual*.

The screen should be cleaned periodically with a mild soap and water, using a soft cloth. *Do not use* alcohol or an abrasive compound that could cause damage to the screen and adjacent areas.

**WARNING**

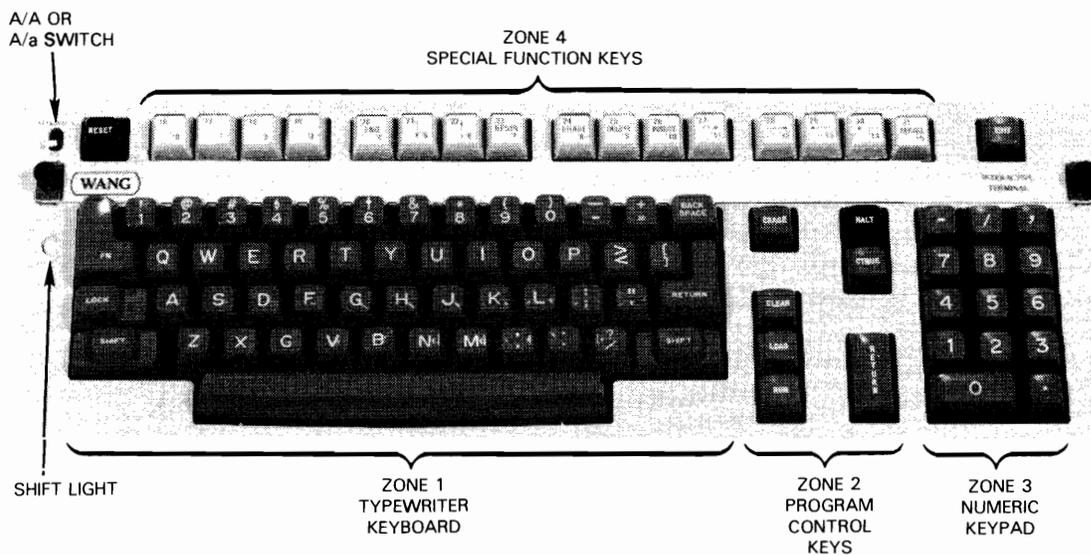
Due to the danger of high voltage, do not attempt to remove the cover of your console for any reason. Call your Wang Service Representative if any maintenance is required.

### Terminal Keyboard

The terminal is designed for users who are already familiar with a standard typewriter keyboard and numeric keypad. The keyboard is illustrated in Figure 2-4. The keyboard is the operator's means of interactively communicating with and controlling the system. It permits the operator to enter data, write programs, perform calculations, and perform command processing. An adjustable keyboard clicker that provides audio feedback when a key is sufficiently depressed, and other hardware features, e.g., lockout and n-key roll-over, eliminate errors that occur when more than one key is pressed at a time.

The keyboard has two modes of operation, selected by means of a toggle switch that is labeled "A/A" and "A/a" and located in the upper-left corner of the keyboard. (Refer to Zone 4.) In the A/A mode, all alphabetic characters are produced as uppercase whether shifted or unshifted, and the other keys function in the "A/a" mode. In "A/a" mode, the keyboard functions as a standard typewriter, producing uppercase when shifted and lowercase in unshifted operation. Whenever the SHIFT key is pressed, the SHIFT indicator lamp to the left of Zone 1 illuminates. In addition to the standard typewriter-like keyboard for the rapid entry of alphanumeric expressions, the Model 2236DE contains a 10-key numeric pad, a system-commands key area, and 34 user-definable Special Function keys. The Special Function keys can be used to start program or subroutine execution or be customized for entry of characters not found on the keyboard. Additionally, the Special Function keys access the system-defined EDIT Mode functions for changing lines of program text recalled from memory or data currently input and displayed on the CRT.

The RESET key, located to the right of the Mode switch in the upper left-hand corner of the keyboard, immediately stops program execution, listing, and I/O operations; clears the CRT; homes the cursor; signals ready; and returns control to the console user (Console Input mode). RESET is also used during Master Initialization and hardware diagnostic operations. RESET is an undesirable means of terminating execution and generally should not be used to end program execution; HALT/STEP should be used for this purpose.



**Figure 2-4. Model 2236DE Keyboard**

The keyboard is divided into four zones as follows.

**Zone 1 — The Alphanumeric Zone**

The alphanumeric zone is designed for rapid entry of alphanumeric and special-character expressions. Similar to a standard typewriter, this zone contains alphanumeric and special characters (e.g., #, \$, %), the numeric operators (+, \*, /, -), and the FN, RETURN, and SHIFT keys. The RETURN key is equivalent to the EXEC key on some other Wang keyboard models. The FN key provides Special Function '126 when unshifted and '127 when shifted. (Refer to the description of Zone 4 below.)

**Zone 2 — Program Control Keys**

System commands directly control system operations from the keyboard. The command keys provide single keystroke entry of some of the more commonly used command verbs, e.g., HALT/STEP, RUN, LOAD, CONTINUE, CLEAR, and RETURN. Note that system operations such as CLEAR and RESET affect only the partition currently attached to the terminal where they are executed.

**Zone 3 — The Numeric Zone**

The numeric zone is designed like a standard 10-key numeric pad for rapid entry of numeric characters. The numeric keys are grouped here for convenience. Digits may be entered by using the numeric keys in the numeric zone or those in the alpha zone.

**Zone 4 — Special Function/EDIT Keys**

Across the top of the keyboard are 16 Special Function keys. These keys are user programmable. Since each of these keys may be pressed in conjunction with the SHIFT key, an effective total of 32 Special Function keys is available. The keys are numbered '0—'15 (lowercase) and '16—'31 (uppercase). Simultaneously pressing a key numbered '0—'15 along with SHIFT accesses a key from '16—'31. A Special Function key must be defined by the user with a DEFFN' statement in the currently loaded program if it is to be used to start program or subroutine execution or display a text string, etc. The Special Function keys are also used during Master Initialization to load the BASIC-2 interpreter and operating system.

The Special Function keys when used as Edit mode keys are described in the following section.

## **Entering Data into the LVP**

The BASIC-2 editor is field oriented (although, under some conditions, it is possible for a BASIC-2 program to input and validate data character by character). The location of the beginning of the field to be entered may be readily identified by the position of the cursor. As a character is entered, the cursor automatically advances to the next character entry position.

Data entry may be confined to a specific field on the CRT screen. A BASIC-2 program may also make the operator aware of the size of the field by displaying a series of underscores within the field. Attempting to type beyond the end of the specified field sounds the audio alarm. The BACKSPACE key, located to the top right of Zone 1 on the keyboard, is used to move the cursor one position to the left and erase the character in that position. The ERASE key, located to the right of the BACKSPACE key, erases the entire field and positions the cursor at the beginning of the field.

The RETURN key is usually used to terminate the entry of a data item and signal the 2200LVP CPU to process the entered data. The Special Function keys may also be used to terminate an entry, if so defined by the BASIC-2 program. Touching an undefined Special Function key sounds the audio alarm, but does not otherwise affect system operation.

Pressing the EDIT key places the system in Edit mode, as indicated by a blinking cursor. In Edit mode, the rightmost Special Function keys become system-defined EDIT keys. The remaining Special Function keys, with the exception of the FN key, are disabled. Edit mode provides the operator with powerful capabilities for editing fields, such as inserting and deleting characters at various positions in the field. These functions are described in Table 2-2. Text entry and editing are still confined to the field being edited to preserve display integrity. Terminating the entry of the field by pressing RETURN or pressing EDIT again causes the system to leave Edit Mode and reactivates the user-defined Special Function keys. Edit mode may also be entered under program control.

**Table 2-2. Edit Mode Keys and Their Functions.**

<b>Key</b>	<b>Function</b>
EDIT	Used to enter Edit mode
RECALL	Used to recall a program line, field value, or Immediate mode statement from memory for editing
<----	Moves the cursor five spaces to the left
<	Moves the cursor a single space to the left
---->	Moves the cursor five spaces to the right
->	Moves the cursor a single space to the right
INSERT	Expands a line for additional text and data entry by inserting a space character at the current CRT cursor position
DELETE	Deletes the character at the current CRT cursor position
ERASE	Erases that portion of the line from the current CRT cursor position to the end of the line
BEGIN	Moves the cursor to the beginning of the current text line or field
END	Moves the cursor to the end of the current text line or field
↑	Moves the cursor up to the previous CRT line. Current text must occupy more than one line on the CRT.
↓	Moves the cursor down to the next line on the CRT. Current text must occupy more than one line on the CRT.

## **CHAPTER 3**

### **MASTER INITIALIZING THE SYSTEM**

#### **3.1 MASTER INITIALIZATION**

Master Initialization is the process of powering up components of the system, loading the operating system and BASIC-2 interpreter, and exercising the CPU to determine if any malfunctions exist. In the 2200LVP, a small "bootstrap" area of the control memory contains the only resident (hardwired) microcode. The bootstrap area is the only portion of control memory that is functional as soon as the CPU is turned on. Neither user memory nor the remainder of control memory contains any information when the system is first powered up. Before any operations can be performed by the system, the operating system and BASIC-2 interpreter must be loaded from the system disk into the remainder of control memory to manage the processes of interpreting and executing the BASIC text, overseeing variable and program storage in user memory, and controlling I/O.

The 2200LVP can be master initialized only at Terminal 1 (the terminal attached to the primary 2236MXD terminal processor at Port 1). For this reason, Terminal 1 should be located at the central system site as near as possible to the CPU and system disk drive.

The bootstrap routines are invoked automatically whenever the system is powered up or whenever the operator at Terminal 1 executes the Immediate mode \$INIT "password" command (either to reconfigure the system or to respond to certain CPU malfunctions). During execution of the bootstrap routines, the operator need only verify that the system disk is properly mounted and inform the bootstrap routines, through the RESET button and Special Function keys, which disk address to access and which system program to load.

Both user memory and control memory, except for the bootstrap area, are cleared when the system is powered down. Therefore, the system must be master initialized following any power-down operation or whenever the system resources are to be reallocated. Occasionally, it may be necessary to power off and master initialize to recover from an error condition. Always save any desired programs or data residing in memory prior to powering off the system.

Perform the following procedures to master initialize the 2200LVP.

1. Power up the CPU, the system disk, each terminal, and any other device to be used. Always power the system up prior to mounting the system platter.

If the system is already running and Master Initialization is required to reconfigure the system, it is not necessary to power down and then power up the system components. The Immediate mode form of \$INIT (\$INIT "password"), when executed at Terminal 1, causes the system to initiate the bootstrap routines as if it had just been powered up.

2. Mount the system platter, which contains the BASIC-2 interpreter and operating system as well as a variety of hardware diagnostics and other system programs.

3. Use the RESET and Special Function keys to load the operating system and BASIC-2 interpreter from the system platter into control memory.

Each of these procedures is described in detail in the following paragraphs.

### System Power Up

To power up the system, first turn on the CPU's POWER switch. Powering up the 2200LVP CPU automatically powers up the system diskette drive and the fixed disk drive. Then turn on the CRT and printers. As soon as the CRT warms up (15 seconds), the CRT displays a self-identification message as follows.

```
2236DE      R01      19200BPS      8+O      (USA)
```

where:

2236DE is the model number.

R01 is the revision number of terminal firmware.

19200BPS is the data rate.

8+O is the number of data bits (7 or 8); E is even parity, O is odd parity, N is no parity.

(USA) is the version of the keyboard and CRT character set.

Press the RESET key. The following message should then appear on the CRT display of Terminal 1.

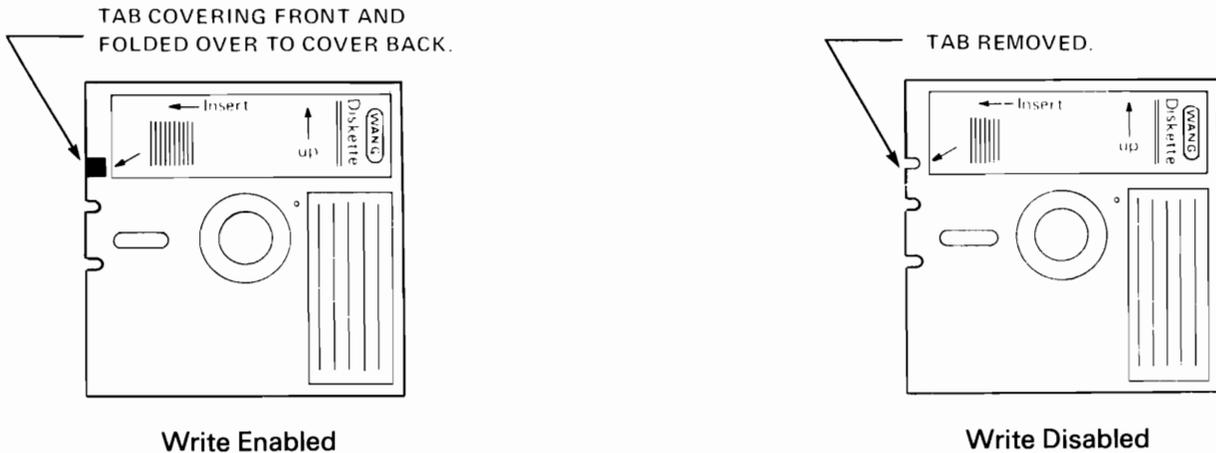
```
MOUNT SYSTEM PLATTER  
PRESS RESET
```

If the MOUNT SYSTEM PLATTER PRESS RESET display does not occur or if it is incomplete, an error has been detected by the bootstrap diagnostics. Master initialize the system again. If the second attempt fails, refer to Section 5.1. If Master Initialization still cannot be performed, call your Wang Service Representative.

### Mounting the System Platter

The following procedure applies to the DSDD diskette drive and should be followed when the system platter is first mounted. It is recommended that the system files be copied onto the fixed disk and mounted from there at each Master Initialization, and that the system platter be used solely as backup. (Refer to Section 3.5 for backup procedure.)

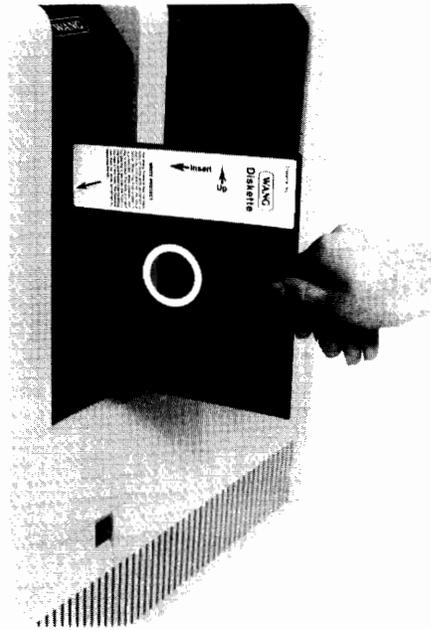
1. Remove the system platter from its envelope, and check to ensure that the platter moves freely in the jacket and the write-protect notch in the diskette jacket is *uncovered*. (Refer to Figure 3-1.) When the notch is uncovered, no information can be written on the diskette because the diskette is now protected against accidental destruction by overwriting. Conversely, information can be saved onto a diskette only when the notch is covered.



**Figure 3-1. Diskette Showing the Write-Protect Feature**

Figure 3-1 illustrates a diskette showing the write-protect notch covered (writing on the disk is permitted) and uncovered (writing on the disk is not permitted). The system platter should be *uncovered*, except when saving information on the diskette.

2. Open the door of the system diskette drive by pressing the door latch directly to the left of the door. The door will spring open.
3. Insert the diskette into the drive, paying careful attention to the arrows on the diskette jacket that indicate the proper orientation for insertion. (Refer to Figure 3-2.) If the diskette is not mounted properly, an error will be signalled when the system attempts to read from the diskette. Push the diskette into the drive slot until it catches and holds in the slot.



**Figure 3-2. Inserting/Removing a Diskette**

**CAUTION**

Once it catches in the slot, *do not* attempt to remove the diskette manually; this can result in serious damage to the drive and to the diskette. To remove the diskette, close the door until it latches, then press the release button to eject the diskette. As a safety feature, the front access door of the DSDD drive cannot be opened when a diskette is installed in the drive and the heads are engaged or are in the process of being loaded. This door remains locked for five seconds after a diskette has been accessed by the system, for example, through a LIST DC command. Pressing the RESET key following such a command overrides this delay and permits immediate diskette removal.

4. Close the drive door by sliding it to the left until it locks in place.
5. Once loaded, the system platter can be removed by pressing the drive door latch. The door will spring open, and the diskette will be ejected about halfway out of the drive slot. The diskette should immediately be placed in its protective envelope.

### **Loading the System Programs**

When the system platter is properly mounted, press the RESET key, which is located in the upper-left corner of the keyboard. The following prompt is displayed at Terminal 1.

KEY SF' ?

A Special Function key must now be pressed to specify the disk address where the system files are located. (The Special Function keys are arrayed across the top of the keyboard; refer to Section 2.3.) The following options are available for loading BASIC-2 from the system platter.

- SF Key '00 = Load from disk address D11 (or 310)
- SF Key '01 = Load from disk address D10 (or B10)
- SF Key '02 = Load from disk address D21 (or 320)
- SF Key '03 = Load from disk address D20 (or B20)
- SF Key '04 = Load from disk address D31 (or 330)
- SF Key '05 = Load from disk address D30 (or B30)

The bootstrap routines also allow the default file name "@@" to be overridden by entering the file name immediately before pressing the Special Function key. The name of the file to load must begin with "@" and can be no more than four characters in length. This feature allows more than one operating system to functionally reside on a platter.

Normally, the LVP fixed disk drive is assigned address D11, and the LVP DSDD drive is assigned address D10. If there is an additional disk unit on the system, the platters on this unit are usually addressed D20 and D21.

Approximately 15 seconds are required for the BASIC-2 interpreter and operating system to be loaded into control memory from diskette. While they are loading, the following message will appear.

Loading: MVP (Multiuser) BASIC-2 Release X.X

Where X.X will be the number of the release being used.

If the wrong Special Function key was pressed (e.g., if the system platter is mounted at address D10, but the operator presses Special Function key '00), an error message of the following form is displayed.

\*\*\* SYSTEM ERROR (DISK 00XX)\*\*\*

PRESS RESET

It is generally easy to recover by simply pressing RESET and pressing the correct Special Function key. If RESET fails, turn the system off, wait at least five seconds, turn the system on again, and repeat the Master Initialization sequence. If this approach fails, refer to Section 5.1. If Master Initialization still cannot be completed, call your Wang Service Representative.

When the operating system is loaded, the system loads and runs the @GENPART program from the system platter. @GENPART will allow the user to interactively create a system configuration or automatically execute any configuration stored on the system disk. @GENPART will also allow other programs resident on the system disk to be loaded into the partitions and executed automatically when the system is configured, with no further operator intervention.

If @GENPART is not on the system disk, the system is configured into a limited 2200LVP system in which Terminal 1, the default disk drive, and any terminal printer attached to Terminal 1 are ready for limited use and the READY (BASIC-2) message is displayed. The other terminals and system resources can be utilized (i.e., are enabled) only after configuring the system.

## 3.2 PARTITION GENERATION (SYSTEM CONFIGURATION)

Partition generation (system configuration) divides the resources of the 2200LVP system among the various users. This section discusses the use of the @GENPART utility program to create, save, and execute system configurations. @GENPART is supplied with every system on the system platter.

### User-Specified System Configuration Parameters

The user can specify the following ten parameters when configuring a system.

1. The number of partitions
2. The number of terminals
3. The size of each partition
4. The terminal associated with each partition
5. The programmability of each partition
6. The bootstrap program for each partition
7. The addresses of the peripherals attached to the system
8. The access to peripherals
9. The system message
10. The system reconfiguration password

### System Configuration Using @GENPART

The process of Master Initialization, as described in Section 3.1, creates a limited 2200LVP system having a single partition with all of user memory controlled by Terminal 1. Only Terminal 1, any terminal printer attached to it, and the system disk drive are operative at this time. No other system devices are available until a configuration is executed. As a part of Master Initialization, the system microcode will automatically load and run the BASIC program file @GENPART from the system platter if such a file exists. (@GENPART is always assumed by the system to be the name of the system configuration program, whether Wang-supplied or user-written.) If @GENPART is not on the system platter, the READY message is displayed at Terminal 1. When @GENPART is first executed, the parameters from the previous configuration (called "current") are loaded; a list of previously saved configurations is displayed along with a prompt inquiring if a different configuration is to be loaded; and the list of @GENPART options is displayed.

The user then proceeds to enter responses to the prompts displayed by each option and uses the Special Function keys to advance from option to option. Refer to the example of this general procedure in Section 3.3.

The standard Wang @GENPART program allows users two basic options. The general procedure for each of these options follows.

1. *Creating configurations to be executed or stored for future use.* If the user is creating a configuration for the first time or wishes to modify a previously defined one, the Special Function keys can be used to load and modify the old configuration or to create a new definition, execute it, and/or store the configuration for future use.
2. *Loading and executing previously defined configurations.* The user may wish to execute a system configuration that has been previously defined and stored in the configuration file on the system platter without making modifications to it. To do this, the user may select from the list of configuration names displayed on the screen and manually execute the configuration. It is also possible to *modify* the @GENPART utility program so that a specified configuration is loaded and executed automatically when the system is master initialized. Refer to Section 3.3, "Customizing @GENPART."

## @GENPART Options

- '00 Clear Partitions      Clears the partition configuration parameters currently in memory; allows the user to specify the total number of terminals and the number of partitions in each bank; then advances to SF'04 (EDIT Partitions). The number of partitions permitted in each bank can range from one to sixteen; however, there must be at least one partition in each bank that is to be used. Memory partitions must be contiguous, i.e., there must be no memory remaining for partitions in Bank 1 before a partition may be specified in Bank 2. Any number of terminals from one to twelve may be specified. The Master Device Table is not altered when this function is selected.
- '01 Clear Device Table      Clears the Master Device Table currently in memory; resets the peripheral default values to /215, /310, /320 and allocates these devices to all users; then advances to SF'05 (EDIT Device Table). The default device addresses can be edited if necessary.
- '02 Divide Memory Evenly      Divides the remaining memory in a bank equally among all partitions in that bank not yet allocated memory. By default, this division will be performed for all banks.
- '04 EDIT Partitions      Displays and allows editing of partition parameters such as memory size, terminal assigned, programmability, and name of bootstrap program. SF'04 does not allow addition of new partitions or deletion of defined ones for an existing configuration.

The partition editing options are as follows.

*Partition Size:* Memory quantity is specified in 256-byte (1/4K) increments.

*Terminal Assignment:* Any terminal number from 0 to 12 is valid. Terminal zero is the null terminal; a partition assigned to the null terminal is always available to any requesting terminal. Any partition may be assigned to any terminal (a terminal can support several partitions), but *all partitions must be assigned* to a terminal, even if they are to contain background jobs that never print on the CRT or require keyboard entry. In general, the lowest numbered partition(s) assigned to a terminal should contain the foreground (interactive) job(s) for that terminal. Background jobs should be placed in the higher numbered partitions. Only the terminal to which a partition is assigned can list or modify the program in that partition. Although other partitions can access global program text and modify global variables, it is not possible for other partitions to list or modify the program text in a global partition.

*Programmability:* Any partition can be specified for Disabled Programming mode. The terminals connected to Disabled Programming partition(s) are inhibited from entering or modifying program text or performing a number of other system operations. Thus, the operator is prevented from inadvertent or unauthorized use of certain programs and data. (Refer to the *BASIC-2 Language Reference Manual*, Section 16.6.)

*Bootstrap Programs:* One or more programs that reside on the system disk, can be loaded into the partitions, and run automatically without operator intervention when a configuration is executed. This feature is particularly useful for setting up background and global partitions and forcing terminals to execute particular BASIC software. When no bootstrap program is specified for a partition, the READY display will appear on the CRT of the terminal currently attached to that partition when the configuration is executed.

'05 EDIT Device Table

Displays and allows editing of the device-addresses and allocation of all peripherals attached to the system. The Master Device Table default values are read from disk and displayed on the screen. All peripherals attached to the system (other than the terminals and terminal printers attached to them) must be specified in the Master Device Table. By default, all peripheral devices are available to all partitions. However, devices can be assigned exclusively to one partition until the next system configuration is executed, by entering the number of the partition that is to have control of the device in the Master Device Table. Console device addresses, i.e., /005 CRT, /001 keyboard, /204 terminal printers, are not specified in the Master Device Table. For disk controllers that respond to more than one address, only the primary address must be specified (i.e., /310 but not /B10, et cetera). For all other multiaddress controllers, all valid addresses must be listed. For addresses that will differ by the first digit only (device type), only the normal address must be specified. The default table values are the values of the saved configuration that was last used by the system. However, if the system platter was write-protected at that time, the default values are the ones used during the previous system configuration.

'06 EDIT \$MSG

Displays and allows editing of a user-defined broadcast message that will be displayed on each terminal's CRT whenever the READY message is displayed. The user-defined message is displayed on line 0 of the CRT immediately above the READY message.

'08 Load Configuration

Loads a configuration from the system configuration file on the system platter. To modify and/or execute any previously defined configuration other than the most recently executed configuration (configuration "current"), this option must be used to load the named configuration from the system platter.

'09 Save Configuration	Saves a system configuration in the system configuration file on the system platter under a user-specified name. The name has a maximum length of eight characters. If the user specifies a configuration name already used, @GENPART will verify that the user desires to replace the old configuration with the configuration currently in memory. Note that the system disk must have a write-tab (unprotected) in order to save configurations on it. The values of the Master Device Table currently stored in memory are saved to disk and may be used as default values during future Master Initializations (Refer to '05 - EDIT Device Table).
'10 Delete Configuration	Deletes a configuration from the disk configuration file.
'15 Execute Configuration	Allows the operator to review and then execute a configuration. This configuration will automatically be saved in the configuration file on disk, under the name "current", when the configuration is executed if the disk platter has a tab (not write-protected). Once a configuration has been executed, the system may be reconfigured again whenever the system is powered up, or when proper execution of the Immediate mode form of the \$INIT statement occurs. The configuration scheme, except for requested partition/terminal assignment change, will remain in effect until the system is reinitialized.
FN - Help -	Displays @GENPART operating instructions.

### 3.3 GENERATING A SAMPLE CONFIGURATION

The following example illustrates how @GENPART could be used to configure a system. A 2200LVP with 128K bytes of memory, three terminals, and a telecommunications option is to be configured. The configuration, named SAMPLE, will have four partitions. A 16K-byte telecommunications program will be designated for automatic bootstrapping as a background job sharing Terminal 1. Disabled programming will be specified for this partition so it cannot be inadvertently modified. The remaining memory will be divided equally among the other three partitions.

In general, the order of executing options is as follows.

1. SF'08 to load a configuration
2. SF'00 to modify this configuration by adding or deleting partitions
3. SF'04 to create the new partition parameters
4. SF'05 to create the Master Device Table
5. SF'06 to create the broadcast message
6. SF'09 to save the configuration with a name other than "current"
7. SF'15 to execute the configuration
8. SF'10 to delete the configuration.

In the example that follows, these options are discussed in the probable order of use.

### Load a Configuration (SF'08)

When @GENPART is first executed, the following display occurs without pressing SF'08.

LIST OF STORED CONFIGURATIONS (#PARTITIONS)  
current (1)

CONFIGURATION "current" LOADED. NAME OF CONFIGURATION TO LOAD?-----

The last configuration executed, called "current", is automatically loaded. To load any other configuration, enter its name, then press RETURN. Since a completely new configuration is to be created, i.e., the total number of partitions in a previously defined configuration is to be modified, press SF'00 (Clear Partitions).

### Clear Partitions (SF'00)

The program responds with a display that first requests the number of terminals attached to the system. Prompts requesting the operator to specify the number of partitions in each bank of memory appear next. The amount of available memory in each bank is also calculated and displayed. The figures are then automatically updated after allocation of memory for each partition. Note that in the following display, the system has subtracted the 3K bytes of system overhead from the available memory in Bank 1 and the unavailable 8K bytes from the figure displayed for Bank 2. The display appears as follows.

AVAILABLE USER MEMORY = 61.00K 56.00K  
REMAINING USER MEMORY = 61.00K 56.00K  
NUMBER OF TERMINALS?3  
NUMBER OF PARTITIONS IN BANK 1?2  
NUMBER OF PARTITIONS IN BANK 2?\_

In this display, the operator has already specified three terminals attached to the system and two partitions in the first bank. To complete this phase of partition generation, the operator should enter "2" in response to the last prompt since there will be four partitions total, and press RETURN. The program automatically invokes option SF'04 (EDIT Partitions) to allow the editing of partition parameters.

### EDIT Partitions (SF'04)

This option displays the default parameters for all partitions and initiates a cycle of prompts for altering these parameters. The cycle recurs continuously until another option is selected. The user can modify the parameters for each partition. The display, which is updated each time an item is entered, appears as follows.

PARTITION	SIZE (K)	TERMINAL	PROGRAMMABLE	PROGRAM
1	___	1	Y	
2	___	2	Y	
-----				
3	___	3	Y	
4	___	1	Y	

EDIT WHICH PARTITION (default = 1)?

In this example, the telecommunications program will be run in Partition 2. Begin by editing the parameters for Partition 2. Enter 2, then press RETURN. An asterisk (\*) appears beside the number of the partition whose parameters are being edited, and the following series of prompts is displayed in succession at the bottom of the screen.

PARTITION SIZE (default = X.XXK)?

Any value greater than 1.25K and less than the amount of remaining user memory in the bank is a valid response. (A partition size of 0 is legal whenever the remaining memory is to be divided evenly.) If a partition in Bank 1 is specified such that it resides entirely within the universal global area, a "u" will appear next to the displayed partition number to indicate this condition. Running the telecommunications program in this partition requires 16k bytes of memory. To allocate 16K bytes of memory to Partition 2, enter 16 and then press RETURN. The following prompt is then displayed.

TERMINAL (default = 2)?

The telecommunications program will be a background job controlled by Terminal 1. To assign Partition 2 to Terminal 1, enter 1 and press RETURN. The following prompt then occurs.

ENABLE PROGRAMMING (Y or N)?

By default, programming is allowed for all partitions. Disabled programming will be specified for Partition 2, however, to prevent inadvertent modification of the telecommunications program. To specify Disabled Programming mode for this partition, enter N, then press RETURN. The name of a program to be automatically loaded into this partition is now requested as follows.

NAME OF PROGRAM TO LOAD?

The name of the telecommunications program that will be run in Partition 2 is TELE-COM. Enter TELE-COM and press RETURN. When the configuration is executed, the telecommunications program TELE-COM will be automatically loaded from the system disk into Partition 2 and run.

At this point, editing of the parameters for Partition 2 is complete. Partitions 1, 3, and 4 require further modification, however. The remaining memory will be divided evenly among the remaining partitions. Press SF'02 (Divide Memory Evenly) and the system responds with the following prompt.

DIVIDE MEMORY EVENLY IN WHICH BANK (default = all)?

Since memory is to be divided evenly in all banks, press RETURN.

The system returns to the initial EDIT WHICH PARTITION? prompt. Finally, the user must assign Terminal 2 to Partition 4. Enter this value into the table for Partition 4. Upon completion of this operation, the table display appears as follows.

<b>PARTITION</b>	<b>SIZE (K)</b>	<b>TERMINAL</b>	<b>PROGRAMMABLE</b>	<b>PROGRAM</b>
1	45.00	1	Y	
2	16.00	1	N	TELE-COM
-----				
3	28.00	3	Y	
4	28.00	2	Y	

Once all partitions have been edited, SF'05 (Edit Device Table) is used to leave the EDIT Partitions cycle and invoke the EDIT Master Device Table option. Note that it is legal to exit the EDIT Partitions Cycle (SF'04) without answering all prompts.

### EDIT Device Table (SF'05)

This option displays the default values in the Master Device Table, which appear on the CRT screen as follows. Note that by default, devices are available to all users.

DEVICE	PARTITION	DEVICE	PARTITION
1. /215	all	17.	
2. /310	all	18.	
3. /320	all	19.	
.		.	
.		.	
.		.	
16.		32.	

EDIT WHICH ENTRY (default = 1)?

In this sample configuration a fourth device, the telecommunications controller, is used in addition to the three default devices. The device-address of this controller is /01C. To add this device to the Master Device Table, enter "4" and then press RETURN. An asterisk (\*) will appear beside the number "4" in the table. Several prompts are now displayed in succession on the bottom of the screen, and the table is updated each time an item is edited. First, the user is requested to enter the device-address with the following prompt.

DEVICE ADDRESS (default = /000,/000 to delete entry)?

Enter /01C and then press RETURN. Another prompt now appears as follows, requesting the user to allocate the device to one or all partitions.

ALLOCATE DEVICE TO WHICH PARTITION (default = all)?

Enter 2, then press RETURN to allocate the controller to Partition 2. This cycle will recur to allow the user to edit all entries in the Master Device Table. Since the parameters for all peripherals and partition allocation have been specified, the user can select another Special Function option to exit the EDIT Device Table Cycle.

### Broadcast Message (SF'06)

When SF'06 (Broadcast Message) is pressed, the following display occurs at the bottom of the CRT display.

BROADCAST MESSAGE:

-----

Any message where the number of characters and spaces does not exceed the number of dashes displayed on the CRT is valid. For this example, enter \* \* \* THE SYSTEM WILL GO DOWN AT NOON \* \* \* and then press RETURN. When the broadcast message has been entered, all partition-generation parameters for the sample configuration have been specified. This configuration can now be saved for later use (SF'09) or executed (SF'15). Pressing SF'09 will allow the operator to save this configuration on disk under a unique name. However, the broadcast message is *not* saved on disk.

### Save Configuration (SF'09)

When SF'09 is pressed, the system requests a name for the new configuration by displaying the following prompt.

CHECK CONFIGURATION TO SAVE. CONFIGURATION NAME? -----

#### NOTE

In order to save a configuration on the system disk, the disk must be write-enabled (i.e., the write-protect notch must be covered). An error will result otherwise.

The configuration currently in memory will automatically be saved under the name "current" if the system disk is not write-protected. However, each time a new configuration is executed, its parameters replace the old contents in the "current" file. A configuration should be saved under a unique name so that it can be retrieved for future use. The name to be used for the sample configuration just created is SAMPLE. Enter SAMPLE, then press RETURN. The configuration is saved under the name SAMPLE, and the edited values of the Master Device Table are saved on disk for future use as defaults.

### Execute Configuration (SF'15)

Once all parameters of a configuration have been defined, the system configuration can be executed. To execute a configuration, press SF'15. The configuration table will appear near the bottom of the CRT along with the following prompt.

CHECK CONFIGURATION OK TO EXECUTE (Y or N)?

This prompt requests the operator to verify the configuration parameters being executed. If Y (RETURN) is entered, the following prompt is displayed.

RECONFIGURATION PASSWORD? *SYSTEM*

The password allows the operator at Terminal 1 to reconfigure the system without powering down, while preventing unauthorized reconfiguration. Any alphanumeric string up to eight characters in length is permitted. We will change the reconfiguration password from the default value SYSTEM to some user-defined value. For example, enter SECRET. The configuration is executed and the reconfiguration password is now SECRET. In order to reconfigure the system without powering down, \$INIT "SECRET" would be entered and executed to allow the system to invoke the control bootstrap routines, that are usually invoked just after the system is powered up. If N is entered, the system returns to the beginning of the EDIT Partitions Cycle (SF'04).

### Delete a Configuration (SF'10)

Since this is only a sample configuration, delete it from the configuration file to save more space for actual configurations. The following prompt will request which configuration to delete.

DELETE WHICH CONFIGURATION?

Enter SAMPLE, then press RETURN, and the configuration will be deleted from the configuration file on the system disk.

## Customizing @GENPART

Once they have been initially defined and stored on disk, configuration parameters in a specified system configuration can be passed to the operating system and executed automatically during master initialization. REM statements near the beginning of the @GENPART program will tell the user how to modify the program to operate in this manner.

When the Wang utility @GENPART does not meet a user's needs, it is also possible to create a customized configuration program by using the BASIC-2 statement \$INIT. The discussion of \$INIT in the *BASIC-2 Language Reference Manual* presents various methods for producing a customized configuration program.

### 3.4 USING THE SYSTEM DISKETTE DRIVE

After the system has been initialized, you may use the system diskette drive to store programs or data files on diskettes. A blank, unused diskette, however, must be formatted before it can be used for this. Ordinarily, a used diskette is not formatted before storing additional files since formatting destroys any information previously recorded on the diskette. For this reason, diskettes containing packaged programs must never be formatted or scratched.

#### Formatting a Diskette

As indicated on the permanent label attached to each diskette, a diskette is protected from accidental over-writing when the write-protect notch is uncovered. (Refer to Figure 3-1.) Before programs or data may be written on a diskette, the notch must be covered to disable the write-protect feature. (Adhesive tabs are provided with the diskettes for this purpose.)

Disk formatting is accomplished using the \$FORMAT DISK command in the BASIC-2 language or by running the Wang-supplied Format Disk Platter utility. (Refer to Appendix I.) To format a diskette, proceed as follows.

1. Remove the diskette from its envelope. Cover the write-protect notch.
2. Properly orient the diskette, as indicated by arrows on the label, before inserting it into the diskette drive. (Refer to Figure 3-2). Be sure the diskette is firmly seated in the drive. Then close the drive latch.
3. Press the RESET button on the keyboard.
4. To initiate disk formatting, enter LOAD RUN. A menu of utilities on the system disk will be displayed. Select the Format Platter utility and answer the questions displayed on the screen to format the disk platter.

Alternately, you may use the \$FORMAT DISK command. The general form of the \$FORMAT DISK command is as follows.

```
$FORMAT DISK platter    file #  
                        disk address
```

It takes approximately one minute, 45 seconds to format a DSDD diskette.

Some examples of valid format commands are as follows.

```
$FORMAT DISK T/D10  
$FORMAT DISK T/D11  
$FORMAT DISK T/#3
```

D10 is generally the address of the diskette drive, while D11 is generally the address of the fixed disk drive.

**CAUTION**

Formatting a disk platter overwrites all data previously stored on the platter. To prevent the accidental formatting of the wrong disk platter, it is recommended that the Wang-supplied format utility be used.

5. If formatting is unsuccessful, a format error (ERR 93) is returned. Generally, format errors result from three causes.
  - a. The drive latch is not tightly closed.
  - b. The write-protect notch is not covered.
  - c. The diskette is defective.
6. Remove the diskette from the drive and proceed to format another.

**NOTE**

If a diskette cannot be formatted, it cannot be used for storage and should be discarded.

If the formatting procedure aborts repeatedly with several diskettes, there may be a hardware problem with the diskette drive. Contact your Wang Service Representative .

### **Disk I/O Instructions**

Once a diskette has been formatted to contain the necessary sector identification information, it is ready to be used for storing data and programs. Files can be maintained on dual-sided double-density diskettes in one (or both) of the following two modes.

1. *Automatic File Cataloging mode.* An indirect method where the programmer assigns each program and data file a name. The user may later access the program or data by this name, without reference to its specific location on the disk.
2. *Absolute Sector Addressing mode.* A direct method where the address of each sector to be accessed must be provided explicitly by the programmer.

The Automatic File Cataloging mode is the recommended cataloging method used by most Wang software for maintaining data files. Under Automatic File Cataloging, the operating system maintains a catalog on each disk. It consists of a Catalog Area, where program and data files are stored, and a Catalog Index, which contains the name of each file and its location in the Catalog Area. Whenever a new file is created, the system automatically records the file name and location in the Catalog Area. When a particular file is subsequently accessed, the system automatically looks up the file name in this Index to determine the file's location. Thus, the programmer does not have to remember the exact sector location of each file on a disk. Only the file names need be remembered. A LIST DC statement can be used to obtain the names of existing files.

Absolute Sector Addressing mode is composed of eight BASIC-2 statements and commands that enable the programmer to read or write information in specific sectors on a formatted disk. No catalog or Catalog Index can be established or maintained in this mode, except by user-supplied software, nor is it possible to name programs or data files. Files are identified only by reference to their starting sector addresses. Similarly, individual records must be saved into or loaded from a file by specifying a starting sector address. All file addressing information must be maintained by the programmer; such information is not maintained automatically by the system.

Refer to the *WANG BASIC-2 Disk Reference Manual and Programming in BASIC* for detailed information on both modes of disk addressing.

### Defining a Catalog Index

Before the first program or data file can be stored on a diskette in the Automatic Cataloging mode, the user must create a catalog on the diskette. The process of creating a catalog is called "scratching" the disk because the SCRATCH DISK statement is used to perform the operation. Care must be taken not to scratch a diskette with packaged programs or desired files since a SCRATCH DISK statement overwrites a previous catalog index.

In a SCRATCH DISK statement, the user must specify how many sectors are to be reserved for the Catalog Index and the last sector to be used for the Catalog Area, where the contents of the files are actually stored. The Catalog Index always begins at the first sector on a disk (sector numbering starts with zero), and occupies a number of sequential sectors specified by the user. The Catalog Area begins immediately after the Catalog Index, and occupies all sequential sectors up to and including the user-specified last sector. The end of the Catalog area is usually specified as the last available sector on the disk.

The size of the Catalog Index is defined with the LS parameter in a SCRATCH DISK statement. For example, LS = 10 indicates that 10 sectors are to be reserved for the Catalog Index. If no value is specified, the system-assigned (default) value is 24.

The last sector in the Catalog Area is specified with the END parameter in a SCRATCH DISK statement. For example, END = 3873 indicates that sector 3873 (the last accessible sector on a DSDD diskette, containing a total of 3874 sectors numbered from 0 to 3873) is the last sector to be used for the catalog area.

To scratch a diskette on the LVP system diskette drive, perform the following steps.

1. Insert a formatted diskette in the diskette drive.
2. Enter a statement such as the following.

```
SCRATCH DISK T/D10, LS = 20, END = 3873.
```

Press RETURN. LS = 20 specifies that 20 sectors be reserved for the Catalog Index; END = 3873 specifies that sector 3873 is the last sector to be used by the catalog. The number of sectors allocated for the catalog and data storage may be other values. (Refer to the *Wang BASIC-2 Disk Reference Manual* for further information.)

3. Repeat steps 1 and 2 for any other diskette that must be scratched.

After a diskette is formatted and scratched, it is ready for data and program storage.

**NOTE**

A LIST DC T [/disk address] statement can be used to check the size of the Catalog Index. Entering the statement LIST DC T/D10 after scratching disk D10 in the manner shown above would cause the following to be displayed on the CRT.

```
INDEX SECTORS = 00030
END CAT. AREA = 03873
CURRENT END   = 00029
```

### 3.5 USING THE FIXED DISK DRIVE

Before the fixed disk drive may be used for the first time, the fixed disk must be formatted and scratched. *The fixed disk should be formatted only when it is first used*, since formatting the disk overwrites all information contained on that disk.

#### Formatting a Disk

Disk formatting is accomplished either by running the Wang-supplied @FORMAT utility or by using the \$FORMAT DISK command, as described in Section 3.4. The general form of the \$FORMAT DISK command is as follows.

```
$FORMAT DISK platter file #
                    disk address
```

For example, if the address of the fixed disk is D11, enter a statement of the following form.

```
$FORMAT DISK T/D11
```

It takes approximately nine minutes to format an 8-megabyte fixed disk, four and one-half minutes to format a 4-megabyte fixed disk, and two minutes fifteen seconds to format a 2-megabyte fixed disk.

**CAUTION**

Formatting a disk platter overwrites all data previously stored on the platter. To prevent the accidental formatting of the wrong disk platter, it is recommended that the Wang-supplied format utility be used. **DO NOT FORMAT THE SYSTEM PLATTER.**

## Defining a Catalog Index

The fixed disk drive supports both Automatic File Cataloging and Absolute Sector Addressing to control disk operations. (Refer to the section on "Disk I/O Operations" in Section 3.4.) The Automatic File Cataloging mode is the recommended method for maintaining data files on the fixed disk.

The process of creating a catalog on the fixed disk is identical to that of creating a catalog on the DSDD diskette. Refer to the section on "Defining a Catalog Index" in Section 3.5 for a description of creating a disk catalog. Note that the ending sector of the 2-megabyte fixed disk is 8127, the ending sector of the 4-megabyte fixed disk is 16319, and the ending sector of the 8-megabyte fixed disk is 32,639.

An example of a SCRATCH DISK statement would be as follows, assuming the fixed disk has an address of D11, 25 sectors are desired for the catalog index, and the fixed disk drive contains a 4-megabyte disk.

```
SCRATCH DISK T/D11, LS=25 ,END = 16319
```

The SCRATCH DISK statement is explained in detail in Section 3.5 and in the *BASIC-2 Disk Reference Manual*.

### CAUTION

If a Catalog Index and Catalog Area have previously been established, the SCRATCH DISK statement will destroy the existing information on the specified disk.

## 3.6 BACKING UP THE SYSTEM PLATTER

When the 2200LVP contains the optional fixed disk drive, the user should first load the system programs from the system disk, and next copy the system disk onto a formatted and scratched platter in the LVP fixed disk drive. The user can thereafter load the system programs from the fixed disk drive. *At least one copy should be made of the entire system disk* in case the original is accidentally damaged or destroyed. The original system DSDD diskette can serve as a backup for the system disk. After the system programs have been copied onto the fixed disk they can be recopied onto a separate DSDD diskette to create a duplicate back-up system disk.

The Move System Files utility provided on the system platter can be used to copy system files from the DSDD diskette drive to the fixed disk drive. To use this utility, type LOAD RUN and then press RETURN. Move System Files can be selected from the menu displayed. The program will provide prompts that require the operator to supply the details of the file transfer. The Move System Files utility can only transfer system files; i.e., files with names that begin with the "@" character.

After the system files have been copied onto the fixed disk, extra backup copies of the software can be made by inserting a fresh diskette that has been formatted and scratched into the DSDD diskette drive. Then the system files can be copied onto it from the fixed disk drive.

The Move System Files utility can be used to update system files by overwriting existing system files. The Move System Files utility is recommended for system updates, since it overwrites only the specific files being changed and leaves the remainder of the disk intact.

## CHAPTER 4 OPERATING THE 2200LVP

### 4.1 INTRODUCTION

The 2200LVP is a versatile system that can be used as a programmable data processor and, in addition, can perform powerful calculator functions using the Wang BASIC-2 language. BASIC-2 is an interactive programming language that uses many English words, such as PRINT, READ, and STOP. Although such words are given a special and clearly-defined meaning when used in a BASIC-2 program, their usage and meaning is similar to that of commonly-used English. Detailed information about the BASIC-2 instruction set is presented in the *Wang BASIC-2 Language Reference Manual*. Programming techniques are discussed in detail in *Programming in BASIC*.

This chapter introduces the user to operation of the 2200LVP. It includes general instructions for running preprogrammed software modules and provides information on using the 2200LVP workstation as a calculator. Additionally, this chapter presents a sample BASIC-2 program, along with an explanation of the program itself and the procedures for entering, running, and saving the program.

### 4.2 RUNNING SOFTWARE PACKAGES

Preprogrammed software packages may be run easily on the 2200LVP. First, insert the program diskette in the DSDD drive. Most Wang-developed software packages contain starting modules named START, although some have starting modules with other names. Check the manual supplied with your software package for the required module name.

#### Loading the Starting Module

When software packages contain the file START, enter the following command.

```
LOAD RUN      (RETURN)
```

This will clear memory, load the starting module, and begin program execution.

If the software package does not contain a program module named START, enter the following command.

```
LOAD T [/disk address], "xxxxx"    (RETURN)
```

where "xxxxx" is the name of the starting module.

When a program module has been loaded into memory in this manner, you may begin execution by entering RUN, and then pressing RETURN.

## Entering Data

During program execution, operator prompts usually appear on the CRT. The following facts should be remembered when responding to these prompts.

1. In general, a displayed question mark indicates that the system expects a keyboard entry.
2. If a numeric value is requested, the system permits a maximum of 13 digits, a decimal point, a sign, and a signed 2-digit exponent to be entered. (The program itself may impose more restrictive limits on a response.) The sign of the value must precede the digits; the letter E is used to mark the beginning of the exponent. The following are examples of system-acceptable numeric entries.

```
25.15
-79.5
 4.56E4
+23.2437E-12
```

3. If an alphanumeric response is requested, the system accepts any keyboard characters except for some sequences containing commas and double quotes. (Refer to the INPUT statement in the *Wang BASIC-2 Language Reference Manual*.) Most software packages remove the restrictions imposed by the INPUT statement by using the LINPUT or KEYIN statement.
4. The Edit mode keys may be used to correct a response before entering a response to a prompt. (Refer to Section 2.3.)
5. When a response has been typed in and appears on the display in the desired form, press RETURN to enter the response and terminate keyboard entry.
6. After a response is entered, the system may signal an error condition with a message in the form of ERR Yxx, where Y represents a letter prefix of the error class and xx represents error number. (Refer to Section 5.1 for a discussion of system execution error messages.) The question mark will reappear on the screen. This indicates that the entered response was not acceptable to the system. To continue, check the form of the response and enter another.

### 4.3 USING THE 2200LVP IN IMMEDIATE MODE

The 2200LVP can perform calculator functions when a BASIC-2 statement is entered without a preceding line number. When such a statement is entered and executed, the LVP is in *Immediate mode*. To perform quick calculations, a user can enter unnumbered single or multiple statement lines in Immediate mode, using the PRINT statement to display the results. If the system detects no syntax errors, it executes an Immediate mode statement immediately when the operator presses RETURN. For example:

```
:PRINT 25+273    (RETURN)
298
```

In this case, when the operator presses RETURN, the line is immediately executed; the expression 25+273 is evaluated and the result is displayed. The line is not saved in memory because it was not preceded by a line number when entered.

Multiple statement lines, individual statements separated by colons, are acceptable in the Immediate mode. For example:

```
:PRINT 3+8: PRINT 15/9: PRINT 144/4.2
```

Upon execution, the following is displayed on the screen.

```
11  
1.666666666667  
34.28571428571
```

The Special Function keys along the top of the 2236DE terminal can be used to edit an Immediate mode statement. To activate the editing capabilities of these keys, first press the EDIT key, located in the top right corner of the terminal keyboard. For example, pressing the EDIT key then pressing the RECALL key will cause the most recently entered Immediate mode statement to appear on the screen where it can be edited and re-executed. The capabilities of these keys are explained in Table 2-1.

### Arithmetic Operations

The 2200LVP can operate on numeric quantities as large as  $10^{+100}-1$  and as close to zero as  $10^{-99}$ . The quantities may be positive or negative. Quantities within this range can be represented by a maximum of 13 digits, a decimal point and sign, and a two-digit positive or negative integer exponent. The letter E in a quantity means, "times ten raised to the power of."

The arithmetic symbols, or operators, of BASIC are the following.

- + addition
- subtraction
- \* multiplication
- / division (Read  $5/4$  as "5 divided by 4.")
- ↑ exponentiation (Read  $5 \uparrow 4$  as "5 raised to the 4th power.")

Any number of variables and constants can be linked together by arithmetic symbols in an expression. Some simple expressions using arithmetic symbols are underlined as follows.

```
PRINT 12/7  
PRINT 23*110000*32.1*4  
PRINT 63/22.5E23  
PRINT 4↑23
```

Expressions using the same arithmetic operators are evaluated left to right. For expressions with mixed arithmetic operators, the following priorities of evaluation are observed.

1. All exponentiation (↑) is performed (left to right).
2. All multiplication and division is performed (left to right).
3. All addition and subtraction is performed (left to right).

Not all combinations of constants and variables connected by arithmetic operators are valid expressions. In order for an expression to be valid, it must be capable of being evaluated in the stipulated sequence. This means that at each state of evaluation the operation to be performed must be defined for the given values, and must yield a valid numeric quantity. For example, the expressions in Table 4-1 are invalid for the reasons shown.

**Table 4-1. Invalid Arithmetic Expressions**

Invalid Expression	Reason
(3.4E26↑4)/9.7E17	(3.4E26↑4) yields an invalid numeric quantity $> 10^{100}$
17/((4*5)-20)	After evaluating ((4*5)-20), the system attempts to divide 17 by 0, an undefined operation.
(-3)↑3.5	The exponentiation (↑) operation is undefined for nonreal results

If the result of evaluating an expression, or a portion of an expression, yields a quantity Q in the following range, the value of Q is zero.

$$-10^{-99} < Q < 10^{-99}$$

### BASIC-2 Functions

A BASIC-2 Function is a special type of instruction that accepts a given value as an argument and returns a unique value as a result. The result of a function can be displayed in Immediate mode if the function is included in a PRINT statement. PRINT SQR(55), for instance, prints the square root of 55.

Some BASIC-2 functions that may be useful in Immediate mode are as follows.

ARCCOS	Returns the arc cosine of an expression
ARCSIN	Returns the arc sine of an expression
ARCTAN (or ATN)	Returns the arc tangent of an expression
EXP	Finds the value of "e" raised to the value of the expression
LOG	Returns the natural logarithm of an expression
SIN	Returns the sine of an expression
SQR	Finds the square root of an expression
TAN	Returns the tangent of an expression

Other BASIC-2 functions and keywords are explained in detail in the *Wang BASIC-2 Language Reference Manual*.

### Numeric Variables

When used in Immediate mode, the 2200LVP can assign values to variables and perform operations on those variables. A numeric variable in BASIC is designated by a letter of the alphabet A—Z or a letter followed by a single digit such as A0, A1, A2—A9, B0, B1—B9, C0, C1—Z7, Z8, Z9. The letters in variable designations must be uppercase. Variables such as A and A0 are distinct. There are 286 numeric variables available for use in BASIC. A numeric variable may be assigned any legal numeric value.

Variables retain their values until they are explicitly cleared from memory or assigned new values. The commands CLEAR, RUN, and LOAD RUN are some of the commands that cause variables to be cleared from memory.

Care should be taken when assigning variables in Immediate mode since Immediate mode commands can change the values stored in variables created by a program. Immediate mode operations involving variables should be performed only at times when it is known that potentially disturbing the values stored in the program-created variables will cause no harm. When a program is stored in memory, it is best to refrain from performing Immediate mode calculations that involve variables, unless the author of the program has specifically documented certain Immediate mode operations that will not adversely affect the operation of his program.

For further information on BASIC-2 variables, refer to the *Wang BASIC-2 Language Reference Manual* or *Programming in BASIC*.

#### 4.4 A SIMPLE PROGRAM

It is not difficult to program using BASIC-2 on the 2200LVP. The simple syntactical rules and most frequently used commands can be learned very quickly from reading *Programming in BASIC*. With this knowledge, even a beginner can write simple, functional programs. Further reading and practice will provide facility with the more advanced BASIC-2 commands and features. The *Wang BASIC-2 Language Reference Manual*, the prime source of the wide variety of commands, functions, and statements to which the 2200LVP will respond, discusses the many BASIC-2 programming features that can make programs more powerful and efficient.

This section discusses how to enter and run a simple program, list it on the CRT screen and printer, save it on disk, retrieve it from disk and modify it, and resave it on disk.

##### An Adding Machine Program

A program is a set of instructions enabling a computer to receive data, manipulate it, and return it to the operator in a desired form. The following program has been written to make the system function as a simple calculator. When the program is executing, the user will enter two numbers on the keyboard and indicate the operation to be performed upon them. The system will display the answer on the CRT screen.

A program line is entered by typing in a line number, followed by one or more BASIC-2 statements and their operands. Each line is terminated by pressing RETURN. When RETURN is pressed, the entire line is saved in memory.

It is customary to number program lines in multiples of ten; this enables a programmer to insert new lines between already existing lines by assigning the new line an intermediate statement number. When the operator enters such a line on the keyboard, the computer will place it in its proper place in the program. The computer normally will execute these statements in sequential order, though several BASIC-2 statements allow the operator to change the order of execution.

Type in the following program on the keyboard, pressing RETURN after each line is entered.

```
10 DIM A$1
20 INPUT "WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM", A$
30 INPUT "ENTER FIRST NUMBER", A
40 PRINT A; A$; " ";
50 INPUT B
```

```

60 IF A$ = "+" THEN GOTO 170
70 IF A$ = "-" THEN GOTO 180
80 IF A$ = "X" THEN GOTO 190
90 IF A$ = "/" THEN GOTO 200
100 GOTO 20
110 PRINT A; A$; B; " EQUALS "; C
120 INPUT "DO YOU WANT ANOTHER OPERATION", B$
130 IF STR(B$,1,1)="Y" THEN 20
140 IF STR(B$,1,1)="N" THEN 160
150 GOTO 120
160 END
170 REM ADDITION: C=A+B: GOTO 110
180 REM SUBTRACTION: C=A-B: GOTO 110
190 REM MULTIPLICATION: C=A*B: GOTO 110
200 REM DIVISION: IF B 0 THEN 220
210 PRINT "DIVISION BY ZERO IS AN ILLEGAL OPERATION. START AGAIN PLEASE": GOTO
    20
220 C=A/B: GOTO 110

```

### Listing the Program

To review the program entered in memory, use the LIST command. Enter:

```
LIST
```

This will list the entire program on the CRT. The LIST S command lists the program a screen at a time; the operator must press RETURN when ready to review each subsequent screen. LIST [line number] lists the specified line only; LIST 10, for example, lists only Line 10.

To obtain a hard copy listing of the program on a printer, turn on and manually select the printer by pressing its SELECT switch. When the printer is selected, the SELECT switch indicator lamp is lighted. Then, enter the following statement from the keyboard to select the printer for listing.

```
SELECT LIST 215
```

This statement changes the default output address for the I/O class parameter LIST from the primary address 005 (the CRT) to the address 215 (the system printer). Next, enter LIST and press RETURN. Program listings formerly displayed on the CRT are now listed on the printer. To again obtain program listings on the CRT, enter the following statement.

```
SELECT LIST 005
```

If a terminal printer is attached to the rear of the Model 2236DE Interactive Terminal, it may be accessed at address 204. Further discussion of the SELECT statement and its various parameters can be found in the *Wang BASIC-2 Language Reference Manual* and in the individual printer manuals.

### Running the Program

Once the program is saved in memory, it can be executed by pressing RUN. When RUN is pressed, the screen will display the following.

```
WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM?
```

As an example, enter +. The screen will display the following.

ENTER FIRST NUMBER?

Enter 25. The following will be displayed.

25 + ?

Enter 75. The following appears on the screen.

25 + 75 EQUALS 100  
DO YOU WANT ANOTHER OPERATION?

Enter YES. The program will once again ask, WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM?

The program has been designed to recognize an attempt to divide by zero. Enter /. When the screen displays ENTER FIRST NUMBER? type in 100. The following appears on the screen.

100 / ?

Enter 0. The screen will display the following.

DIVISION BY ZERO IS AN ILLEGAL OPERATION. START AGAIN PLEASE  
WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM?

The program will continue processing until the user enters NO or N to the question, DO YOU WANT ANOTHER OPERATION?

### Explanation of the Program

The adding machine program instructs the computer how and where to store information entered by the operator or produced by processing, send prompts to the operator on the CRT screen, accept operator input from the keyboard, process entered data according to a defined formula, and display results on the screen. The following section examines the program line by line and discusses the use and purpose of each BASIC-2 command.

Line 10:

```
10 DIM A$1
```

The DIM statement in Line 10 is a dimension statement, limiting the length of the information that can be stored in variable A\$. The only reason the program includes this statement is to guarantee that, if an operator entered an inappropriate response such as '+++++++' to the question, WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM?, the adding machine program would not generate a prompt on the screen such as the following.

```
44 ++++++++ ?
```

Because of the dimension statement, the system will cut off the six extra plus signs and store a variable of one character only in length. As a result, the screen shows the following.

```
44 + ?
```

There are many other uses of the DIM statement. Refer to Chapter 8 of *Programming in BASIC* and Chapters 1 and 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the DIM statement.

Lines 20 and 30:

```
20 INPUT "WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM",A$
30 INPUT "ENTER FIRST NUMBER",A
```

The INPUT statements in Lines 20 and 30 are the computer's way of receiving information from an operator. The computer stores the information entered by the operator in variables, such as A\$ and A in this program. A\$ is called an alphanumeric variable. Alphanumeric variable names can be distinguished from numeric variable names by the presence of a dollar sign (\$) immediately following the variable name. Alphanumeric variables may contain any kind of character: letters, digits, or special characters, but may not be used in mathematical computations, because they do not necessarily contain numbers. A\$ in this program is used to store the character +, -, X, or /. (Refer to Chapter 1 of the *Wang BASIC-2 Language Reference Manual* for more information on variables.)

The phrase in quotes is called a literal; here it is used as a prompt to the operator to enter the first number of the arithmetical operation. The INPUT statement automatically displays a question mark following the prompt. BASIC-2 does not require the literal in the INPUT statement. If the literal is omitted, the INPUT statement simply displays a question mark. A lone question mark is of little use to an operator who does not know the program, so it is a good idea to always provide prompts for the operator. The literal in the INPUT statement is one means of doing this.

Refer to Chapter 3 of *Programming in BASIC* and Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the INPUT statement.

Lines 40 and 50:

```
40 PRINT A; A$; " ";
50 INPUT B
```

The PRINT statement causes values and literals to appear on the CRT screen. Additionally, its punctuation can determine the spacing of the printed material. A comma will cause elements to be displayed in zones, each 16 characters wide. This is ideal for charts, where figures must be arranged in columns and rows, but it is not convenient for this program. A semicolon is used in this program, because it causes no additional spaces to be placed between printed elements.

In Line 40 the PRINT statement instructs the computer to display upon the screen the current value of variables A and A\$. As in the INPUT statement, literals (those characters and phrases contained in quotation marks) are displayed on the screen as written in the program line, even if the literal is a blank space as in Line 40.

Refer to Chapter 3 of *Programming in BASIC* and Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the PRINT statement.

The INPUT statement in Line 50, an example of an INPUT statement not containing a literal, causes the question mark to appear on the screen. For example, when the program is run as in the "Running the Program" section above, 25 + ? appears. 25 is the value of A, and + is the value of A\$. The space after the addition sign results from the coding of the literal space, " ", in Line 40. The question mark results from the INPUT statement and is placed immediately after the literal space due to the semicolon in Line 40.

Lines 60-90:

```
60 IF A$ = "+" THEN GOTO 170
70 IF A$ = "-" THEN GOTO 200
80 IF A$ = "X" THEN GOTO 210
90 IF A$ = "/" THEN GOTO 220
```

It is not always desirable to have the computer execute program instructions in statement number sequence. Two ways of altering the sequence of program execution are demonstrated in the adding machine program. Lines 60, 70, 80, and 90 use the IF ... THEN statement to cause execution to be diverted to the portion of the program that handles the appropriate arithmetic operation specified in variable A\$. Another statement, the GOTO statement, is used later in the program to redirect the order of program execution.

Lines 60, 70, 80, and 90 test the value entered for the alphanumeric variable, A\$; that is, they determine what operation the user wishes to perform on the values assigned to variables A and B. This test enables the the computer to branch to a special routine for each operation. There, it can compute the solution of the operation, store it in a variable, and return it to be processed in Line 110 for display upon the screen. When A\$ has a value of +, the program will go to the addition routine at Line 170. When A\$ has a value of -, the program will go to the subtraction routine at Line 180. When A\$ has a value of X, the program will go to the multiplication routine at Line 190. When A\$ has a value of /, the program will go to the division routine at Line 200.

Refer to Chapter 3 of *Programming in BASIC* and Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the GOTO statement.

Line 100:

```
100 GOTO 20
```

If the user enters any value other than +, -, X, or / for A\$. The computer will "fall through" statements 60, 70, 80, and 90 to Line 100, where the GOTO statement will send the program back to Line 20. This GOTO statement ensures that an operational symbol has been entered.

Lines 170-190:

```
170 REM ADDITION: C=A+B: GOTO 110
180 REM SUBTRACTION: C=A-B: GOTO 110
190 REM MULTIPLICATION: C=A*B: GOTO 110
```

These three lines are examples of multistatement lines. In each, three short statements are grouped together, separated by colons. This is done to keep the program from growing too large and to aid in program clarity. The purpose of the REM statement is to document the program. Here, REM ADDITION labels the portion of the program that computes addition problems. A REM statement is a nonexecutable statement ignored by the computer when the program is run, but displayed whenever a program is listed.

Refer to Chapter 3 of *Programming in BASIC* and Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the REM statement.

Lines 200-220:

```
200 REM DIVISION: IF B 0 THEN 220
210 PRINT "DIVISION BY ZERO IS AN ILLEGAL OPERATION. START AGAIN PLEASE": GOTO
    20
220 C=A/B: GOTO 110
```

The division routine is given three lines to ensure that an operator does not enter zero as a divisor. If Lines 200 and 210 did not exist, the computer would cause a Computational error (C62 or C63) to appear on the screen and the program would immediately terminate.

The IF . . . THEN statement is another way by which the programmer can instruct the program to process statements out of sequence. Here, Line 200 tests to determine whether the divisor, B, is greater than or less than zero. If the divisor is not zero, this statement is true, and the program skips to Line 220, where the program computes the quotient and is sent back to Line 110 to display it. If the divisor is zero, this statement is false, and the program will fall through to Line 210, the message will be displayed, and control is sent back to Line 20. Thus, the division computation is not performed.

Refer to Chapter 3 of *Programming in BASIC* and Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the INPUT statement.

Line 110:

```
110 PRINT A; A$; B; "EQUALS "; C
```

In Line 110, as in Line 40, variable values and a literal are included in a PRINT statement. Here, there are three numeric variables (A, B, and C), an alphanumeric (A\$), and a literal ("EQUALS ").

Line 120:

```
120 INPUT "DO YOU WANT ANOTHER OPERATION", B$
```

Line 120 requests a value for alphanumeric variable B\$.

Lines 130-160:

```
130 IF STR(B$,1,1) = "Y" THEN 20
140 IF STR(B$,1,1) = "N" THEN 160
150 GOTO 120
160 END
```

Lines 130 and 140 introduce another function of which BASIC-2 is capable: that is, isolating a particular character from an alphanumeric string. In this case, the program examines the value of the first character in variable B\$ for the character "Y" or the character "N". By examining the first character of the string instead of every character, Lines 130 and 140 enable the user to continue the program by entering the abbreviated answer Y or N as well as the answer YES or NO to the question asked in Line 120.

In short, Line 130 means: if the 1st character from the 1st character of alphanumeric variable B\$ is equal to Y, then go to Line 20. If the operator enters Y or YES (or, because of first character isolation, any word beginning with Y), the first character will be Y, and will send the program back to Line 20. A similar logic is exhibited in Line 140. In this case, if the first character of the response is N, the program is sent to statement 160, an END statement. This causes the program to end.

However, if the first character of B\$ is other than Y or N, the program will fall through to Line 150. There, the program will be sent back to Line 120. This procedure guarantees that the operator responds correctly, at least insofar as the first character of the response is either Y or N.

Refer to Chapter 5 of the *Wang BASIC-2 Language Reference Manual* for more information on the STR function.

## Saving the Program on Diskette

To save this program on the system diskette drive, mount a new diskette in the diskette slot, format it, and establish a catalog as detailed in Chapter 3 of this manual. Enter the command:

```
SAVE T/D10, "ADDING"
```

Then enter the command, LIST DCT. The following will appear on the screen.

```
INDEX SECTORS = 00030
END CAT. AREA = 03873
CURRENT END = 00029
```

NAME	TYPE	START	END	USED	FREE
ADDING	P	00029	00033	00005	00000

Listing the Catalog Index ensures that the program you saved is contained on the disk.

Refer to the *Wang BASIC-2 Disk Reference Manual* for more information on saving programs on disk.

## Retrieving the Program from Diskette

First, type in the command, SELECT DISK D10. The system will select the system diskette drive. Then type the following command.

```
LOAD RUN "ADDING"
```

The adding machine program will first be loaded, and then run.

## Modifying the Program

There are several ways in which the adding machine program can be improved. One of the program's major difficulties occurs when a user enters something other than +, -, X, or / in response to the request to enter the type of operation to be performed. If, for instance, someone entered 999 in response to WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM?, two things occur. First, the last two nines are cut off, due to the DIM statement in Line 10. Secondly, when Line 40 is executed, 9 will actually appear in place of an operational sign on the CRT screen. The program will continue processing until it reaches Line 100. At that point, since the value of A\$ is neither +, -, X, nor /, the program loops back to Line 20 to request the type of operation again.

The LINPUT statement is often used to avoid the first situation, the POS function can rectify the second.

First, replace Line 20 with

```
:20 LINPUT "WHAT TYPE OF OPERATION (+,-,X,/) DO YOU WANT TO PERFORM"-A$
```

Then, insert Line 25:

```
:25 IF POS("+X/"=A$) = 0 THEN GOTO 20
```

Finally, delete Line 100 by typing

```
:100
```

When this version of the program is run, the LINPUT statement in Line 20 causes an underscore to follow the prompt to enter the operational sign. The LINPUT statement also ensures that the operator only enter one character in response to this prompt. This solves the problem of someone entering more than one character.

The POS function causes the system to locate the position of the variable, A\$, in the character string "+ - X / ". If the operator enters + for the variable A\$, POS (" + - X / " = A\$) will equal 1, since + is in the first position of the character string in the POS function. Likewise, -, X, and / will equal 2, 3, and 4, respectively. A character other than one of these has no position in the character string and is equal to 0. If the operator enters such a character, the IF ... THEN statement in Line 25 will cause the program to go back immediately to Line 20 and request the operational sign to be entered again.

Refer to Chapter 11 of the *Wang BASIC-2 Language Reference Manual* for more information on the LINPUT statement. Refer to Chapter 5 of the *Wang BASIC-2 Language Reference Manual* for more information on the POS function.

### **Resaving the Modified Program**

To resave the modified program, the old program must first be scratched. This can be done by first pressing RESET. Then, enter the following command.

```
SCRATCH T/D10, "ADDING"
```

Next, enter the following command.

```
SAVE T/D10, ( ) "ADDING"
```

This will copy the new version of the program called ADDING over the old version, saving it under the same name. Subsequently, when LOAD RUN DCT/D10, "ADDING" is executed, the new version of the adding program will be loaded.

## CHAPTER 5

# SYSTEM ERRORS AND ERROR-RECOVERY PROCEDURES

### 5.1 TYPES OF SYSTEM ERRORS

There are two different types of system errors that may occur on the LVP: CPU hardware errors and general system errors. CPU hardware errors indicate malfunctions in the CPU hardware, e.g., registers, user and control memory, and general system errors indicate that an illegal operation has been attempted or a desired operation cannot be performed. Correspondingly, the 2200LVP CPU performs two different types of system error diagnostics: the CPU/hardware error diagnostics and the general system error diagnostics. The CPU/hardware errors are discussed in this chapter. If a CPU/hardware error occurs, the error display, which always appears on Terminal 1, should be written down. This information will enable the Wang Service Representative to quickly locate the malfunctioning components, if the error cannot be corrected by the general recovery procedures outlined in this chapter or if it recurs intermittently. When the general procedures fail, try the specific procedures discussed in Appendix D. If the procedures in Appendix D fail or error conditions recur, call your Wang Service Representative.

The CPU hardware error diagnostics are designed to detect and report any malfunction that occurs in the CPU hardware. The CPU error-checking routines of the 2200LVP treat the entire CPU as a single unit since memory errors can affect all users of the system. The current configuration scheme does not affect the error-checking routines or error-recovery procedures. Whenever a location in memory is accessed, the system automatically performs a parity check to ensure that the accessed memory contents are valid and the accessed location is not faulty. Additionally, whenever RESET or CLEAR is executed, the entire memory is automatically verified and the operator alerted to any memory error condition. If a hardware error is discovered, all the terminals sound an audible tone and a system error message is displayed at Terminal 1. Although there are several courses of action, the hardware errors require that a corrective procedure be performed at Terminal 1.

General error messages, however, are designed to alert the user that an illegal operation has been attempted or a desired operation cannot be performed. Those general system errors that are not hardware related can be handled under program control in a user-application program. The general error routines are handled separately for each partition. The error message is displayed on the terminal that is currently attached to the partition in which the error occurred. If the error occurs while the partition is running a background job, the error-message display is suppressed until the terminal is released to the background partition. General error messages are signaled by an audible tone and a display on the CRT of the terminal attached to the partition in which they occur. Error messages consist of a two-digit number with a letter prefix accompanied by an arrow that points to the approximate location of the error in an Immediate mode or Program mode line. The types of general error diagnostics that are performed by the system and the techniques for recovering from such errors are described in detail in the *BASIC-2 Language Reference Manual*.

#### CPU Hardware Errors

Several possible system error messages can be reported when CPU/hardware errors occur during

Master Initialization or when the operating system has assumed control of program execution. These hardware errors cannot be handled under program control. Since a hardware error represents a system hardware malfunction that may be transient, any information that the system furnishes or receives after the hardware error has occurred may be invalid. The procedures for recovery from these errors are detailed in the following section.

### Master Initialization Error Recovery

The general procedure to recover from Master Initialization errors appears below. When these general procedures fail, call your Wang Service Representative.

1. When the system's power is turned on, the bootstrap fails to display the complete MOUNT SYSTEM PLATTER PRESS RESET message on the CRT. This condition usually indicates a CPU-related or I/O-related error. Turn the system's power off and check the cabling and device addresses. Wait five seconds, then power the system up again. Do not turn the terminal off when performing this procedure.
2. Having responded to the KEY SF'? message by pressing a Special Function key, the following conditions may exist.
  - a. The hexdigit display of the Special Function key did not appear on the CRT, implying that the Special Function key was not pressed sufficiently or the wrong Special Function key was pressed. Press RESET and then press the desired Special Function key again.
  - b. The KEY SF'? message reappears upon the CRT. This error implies that the specified system file could not be located on the specified disk. Verify that the system platter is properly mounted at the specified address, and press the desired Special Function key again.
  - c. The \*\*\*SYSTEM ERROR (DISK 00XX)\*\*\* PRESS RESET message appears. This error message can imply two things. Either the wrong Special Function key was pressed, or a disk hardware error occurred while the bootstrap was trying to load the disk file specified by the Special Function key. Make sure the platter is properly mounted, and press first RESET and then the desired Special Function key. If the general procedure fails, refer to the table of disk errors in Appendix D for a specific recovery procedure.

### General Hardware Error Recovery

A system error message is reported by an audible tone at each terminal and a display on the CRT of Terminal 1, whenever the operating system detects a memory error during its normal operation. A memory failure causes the following message to appear at Terminal 1.

```
*** SYSTEM ERROR (MMMM XXXX)***  
PRESS RESET
```

```
      AECM — Addressing Error Control Memory  
      AEDM — Addressing Error Data Memory  
      BECM — Bit Error Control Memory  
      BEDM — Bit Error Data Memory  
where MMMM = PECM — Parity Error Control Memory  
             PEDM — Parity Error Data Memory  
             REDM — Read Error Data Memory  
             VECM — Verify Error Control Memory  
             VEDM — Verify Error Data Memory
```

and XXXX = Location and Nature of Error

The general procedure used to recover from system errors in user and/or control memory is shown below. When the general procedure outlined here fails, refer to the table of system and disk errors in Appendix D for more detailed recovery procedures. If the detailed recovery procedures fail or a system error condition recurs, call your Wang Service Representative.

Press RESET in response to the PRESS RESET message on line 1 of the CRT. Then choose one of the following three procedures in response to the "Key SF" message on the CRT.

1. Press SF'16 - '19 to load the diagnostic menu from which you may choose the applicable diagnostic. (Refer to Section 5.2.) Although this procedure is recommended, execute procedure 3 if the current contents of user memory cannot be reproduced, i.e., must be salvaged. If no errors are discovered during the execution of the hardware diagnostics, the error condition can be presumed transient. Proceed with procedure 2. Note that with procedure 2, the contents of user memory are erased.
2. To restart, first power down, then power up, then press SF'00—'03 to load BASIC-2 from disk D11 (310), D10 (B10), D21 (320), or D20 (B20), respectively. This is the recommended procedure when the system validity has been compromised by an unknown system error, but the condition at fault is suspected to be temporary and not requiring execution of a diagnostic routine. For example, the CPU was jarred or a cable was stepped on or shaken loose. This option should be exercised when there is no need to save the current contents of user memory. The LVP must now be reconfigured with the @GENPART utility to resume multiuser operation.
3. Press SF'15 to resume normal operation, using the operating system and application program currently loaded. This option should be exercised when the user-memory contents cannot be duplicated and must therefore be salvaged. The system will be returned (if possible) to Console Input mode and the READY (BASIC-2) message will be displayed. Since user memory was not erased, the user can now determine the point of program execution when the system error was encountered in the current application program by printing out the key variables. However, since a Reset has been performed on one of the partitions, program execution may not be able to be continued from that point, but must be restarted with a Run command. This procedure is undertaken at the user's risk, however, since the hardware error may recur and the operating system may not function properly.

## 5.2 USING THE HARDWARE DIAGNOSTICS

As with Master Initialization, the hardware diagnostics can only be executed at Terminal 1. The hardware diagnostics are a set of programs that exhaustively test the CPU hardware components and attempt to identify any malfunctions. The diagnostics can be run only after Master Initialization or a system error has occurred. The diagnostics run continuously until RESET is pressed or an error is detected. When an error is detected, diagnostic processing stops or an error message is displayed. For a discussion of possible error causes, refer to Appendix D. If a hardware error recurs, call your Wang Service Representative.

A hard copy listing of the diagnostic messages can be obtained by turning on the printer attached to the CPU during diagnostic execution. The printer attached to the CPU must be assigned address 215 or 204 and SELECTed (press SELECT on the printer). A hard copy trace of the diagnostic run should be obtained because it will help your Wang Service Representative locate and correct any problems. If no errors occur, the output will comprise only the name of the current test. When errors occur, they will be printed under the appropriate diagnostic test title.

Since the diagnostic programs destroy the contents of user memory, the user should save all valuable programs and data on disk prior to running the diagnostics.

The diagnostic programs of this system should be executed as follows.

- At least once every 60 to 100 hours of light-to-normal operation.
- Whenever errors cause a hardware malfunction to be suspected.
- Whenever a Wang Service Representative requests their execution.

It is best to execute the diagnostic routines as quickly as possible after observation of a suspected problem to ensure that the environmental conditions of the test most closely resemble those under which the problem occurred.

Random intermittent problems and permanent component failure are often due to static electricity, EMI, temperature and humidity extremes, and excessive airborne dust and dirt. Prolonged operation in a poor environment produces permanent failure. Every effort should be made to secure an environment which, if not optimal, at least provides the operating conditions required for satisfactory system performance.

Table 5-1 provides a functional description of each diagnostic. press RESET and then press the appropriate Special Function key SF'16 - '19 after each diagnostic in order to select another diagnostic. To reselect BASIC-2, press SF'00 - '05.

**Table 5-1. Functions of the User Diagnostics**

Diagnostic	Function
CPU	Tests the 2200LVP Processor
Control Memory	Tests Control Memory
Data Memory	Tests Data Memory

**Loading the Diagnostics Menu**

If the system is on, turn it off. Then, turn the system on, press RESET, and then press one of the following Special Function keys.

- SF Key '16 — Load diagnostics from disk D11 (or 310).
- SF Key '17 — Load diagnostics from disk D10 (or B10).
- SF Key '18 — Load diagnostics from disk D21 (or 320).
- SF Key '19 — Load diagnostics from disk D20 (or B20).

The following display appears upon selection of the diagnostic menu (SF '16, '17, '18, or '19).

```

KEY SF'
                USER DIAGNOSTIC MENU
'00 CPU DIAGNOSTIC          '02 DATA MEMORY DIAGNOSTIC
'01 CONTROL MEMORY DIAGNOSTIC
    
```

Press the appropriate Special Function key to load the desired diagnostic.

### **CPU Diagnostic**

This diagnostic tests the 2200LVP processor. This test runs continuously until either an error occurs (the pass number stops incrementing) or RESET is pressed. If an error occurs, call your Wang Service Representative. When a sufficient number of successful test passes have occurred (at least 5 to 10), press RESET. The diagnostics menu can be restored to the screen, or BASIC-2 can be reloaded by pressing the appropriate Special Function key.

### **Control Memory Diagnostic**

This diagnostic is designed to test the control memory. These control memory diagnostic tests are repeated until RESET is pressed. Error messages will be displayed or printed whenever memory failures are discovered. When a sufficient number of successful test passes have occurred (at least 5 to 10 passes), press RESET. The diagnostics menu can then be restored to the screen, or BASIC-2 can be loaded by pressing the appropriate Special Function key.

### **The Data Memory Diagnostic**

This diagnostic is designed to test data (user) memory. The user memory diagnostic tests are also repeated until RESET is pressed. Error messages will be displayed or printed whenever memory failures are discovered. When a sufficient number of successful test passes have occurred (at least 5 to 10 passes), press RESET. At the completion of the diagnostic tests, the operator can pass control to the BASIC-2 operating system by pressing RESET, then pressing the appropriate Special Function key to load the operating system.



# APPENDIX A SYSTEM SPECIFICATIONS

## A.1 2200LVP CPU SPECIFICATIONS

### CPU Size

Height .....	27.0 in. (68.6 cm)
Width .....	20.4 in. (51.8 cm)
Depth .....	30.0 in. (76.2 cm)

3 I/O Ports with an option for expansion to 7.

### Dynamic Range

$-(10^{100}) < n < = -(10^{-99}), 0, +(10^{-99}) < = n < +(10^{100})$

### Precision

13 digits (standard)

### Memory Size

32K bytes (standard). Expandable to 64K, 128K, 196K, or 256K bytes.

### Power Requirements

#### Voltage

115 VAC  $\pm$  10%, 50 or 60 Hz  $\pm$  1 Hz

230 VAC  $\pm$  10%, 50 or 60 Hz  $\pm$  1 Hz

#### Power

317 Watts

#### Fuses

5.0 amps @ 115 V

2.5 amps @ 230 V

### Weight

166 lb (75.5 kg)

### Operating Environment

60°F to 80°F (15°C to 27°C)

40% to 60% relative humidity, recommended

### Heat Output

1084 Btu/hr

## A.2 MODEL 2236DE INTERACTIVE TERMINAL SPECIFICATIONS

### Size

Height .....	13.50 in. (34.3 cm)
Depth .....	20.50 in. (52.1 cm)
Width .....	19.80 in. (50.3 cm)

**Weight**

51 lb (23.1 kg)

**CRT Screen**

Display Size ..... 12 in. diagonal (30.5 cm)  
Capacity ..... 24 lines, 80 characters/line

**Character Size**

Height ..... 0.16 in. (0.41 cm)  
Width ..... 0.09 in. (0.23 cm)

**Character Set**

128 characters, including upper and lowercase letters; each character assigned one or more attributes for high- or low-intensity display, blinking, reverse video, or underlining. Additional, alternate character set consisting of 64 graphic characters. Also capable of displaying line-segment (box) graphics, separate from either character set.

**Keyboard**

Typewriter keyboard that can generate 88 different ASCII characters, including upper- and lowercase letters, numbers, and symbols. A convenient numeric keypad, several Program Control keys, a General Function (FN) key, and 16 Special Function keys are also included.

**Power Requirements**

Voltage  
115 VAC ± 10%, 50 or 60 Hz ± 0.5 Hz  
230 VAC ± 10%, 50 or 60 Hz ± 0.5 Hz  
Power  
40 Watts  
Fuses  
2.0AMP @ 115V  
1.0AMP @ 230V

**Operating Environment**

60° F to 80° F (15° C to 27° C)  
40% to 60% relative humidity, recommended standards

**Cabling**

One 8 ft (2.4 m) cord to power source. One 25 ft (7.6 m) direct-connection cable is provided with each Model 2236DE Interactive Terminal unless an optional direct-connection cable is ordered for that terminal. All direct-connection cables have double male plugs and thus are not extendable. Cables are optionally available in lengths of 25 ft (7.6 m), 50 ft (15.2 m), 100 ft (30.5 m) and thereafter in increments of 100 ft (30.5 m) up to 2000 ft (609.6 m). When a terminal is attached to a modem, special cables are required. Modem cables are optionally available in lengths of 12 ft (3.7 m), with additional extensions of 25 ft (7.6 m) and 50 ft (15.2 m); however, combined cable distance from Wang equipment to modem is 50 ft (15.2 m) maximum, according to EIA.

**Transmission Rates**

300, 600, 1200, 2400, 4800, 9600, or 19.2K baud, user selectable (manual switch)

**A.3 MODEL 2236MXD TERMINAL PROCESSOR SPECIFICATIONS**

**Operating Environment**

Same as for the 2200 CPU

**Power Requirements**

Supplied by CPU

**Communication Modes**

Full-duplex asynchronous for Model 2236DE Interactive Terminals

**Transmission Rates**

300, 600, 1200, 2400, 4800, 9600, or 19.2K baud

**Asynchronous Communication Character Format**

Odd Parity bit, 8 Data bits, 1 Stop bit, and one Start bit

**Number of CPU I/O Slots**

Requires one I/O slot and supports up to four terminals

**A-4 2200LVP SYSTEM DISKETTE DRIVE SPECIFICATIONS**

Tracks	149
Sectors/Track	26
Total Sectors	3874
Bytes/Sector	256
Total Bytes	991,744
Average Access Time	91 msec
Average Latency Time	83.3 msec
Speed	360 rpm
Transfer Rate	500 kilobits/sec

**A-5 FIXED DISK DRIVE SPECIFICATIONS**

**2-Megabyte Disk Drive**

Tracks	254
Sectors/Track	32
Total Sectors	8,128
Bytes/Sector	256
Total Bytes	2,080,768
Average Access Time	70 msec
Average Latency Time	9.6 msec
Speed	3,125 rpm
Transfer Rate	4.34 megabits/sec

**4-Megabyte Disk Drive**

Tracks	510
Sectors/Track	32
Total Sectors	16,320
Bytes/Sector	256
Total Bytes	4,177,920
Average Access Time	70 msec
Average Latency Time	9.6 msec
Speed	3,125 rpm
Transfer Rate	4.34 megabits/sec

**8-Megabyte Disk Drive**

Tracks .....	1020
Sectors/Track .....	32
Total Sectors .....	32,640
Bytes/Sector .....	256
Total Bytes .....	8,335,840
Average Access Time .....	70 msec
Average Latency Time .....	9.6 msec
Speed .....	3,125 rpm
Transfer Rate .....	4.34 megabits/sec

## APPENDIX B

### AVAILABLE PERIPHERALS

The 2200LVP will support most peripheral devices currently listed on the standard products price list except unbuffered and time-dependent devices. For example, some exclusions include certain instrument interfaces, the Model 2209 9-track tape drive, the Model 2210 and 2226 consoles, the Model 2202 printer, and the disk controller 22C31 (Triple Controller). A list of supported devices (as of the publication date of this manual) follows.

Model Number	Description
2209A	Nine-Track Tape Drive (1600 BPI-PE)
2221W	Matrix Line Printer (132 col/200 chars/sec)
2227B	Buffered Asynchronous Communications Controller
2228C	Synchronous/Asynchronous Communications Controller
2230MXA-1, MXB-1	Disk Multiplexer Controllers
2231W	Matrix Line Printers
2231W-1	112 col/120 chars/sec @ 10 pitch
2231W-2	132 col/120 chars/sec @ 10 pitch
2231W-3	132 col/120 chars/sec (2282 Graphic CRT Accessory Printer)
2231W-6	132 col/ 70 chars/sec @ dual pitch
2232B	Digital Flatbed Plotter
2236DE	Interactive Terminal
2236MXD	Interactive Terminal Processor
2260BC	F/R Disk Drives (2.5, 5, 10, or 20 megabytes)
2260C	F/R Disk Drives (2.5, 5, 10, or 20 megabytes)
2261W	Matrix Line Printer (240 lpm)
2263	Chain Line Printers
2263-1	400 lpm/dual pitch
2263-2	600 lpm/dual pitch
2263-3	430 lpm/dual pitch
2270A	Wang IBM 3740 Compatible Diskette Drive
2270A-1D	.25 megabytes
2270A-2D	.50 megabytes
2270A-3D	.75 megabytes
2272-2	Triple Pen Drum Plotter
2273-1	Band Printer (250 lpm)
2273-2	Band Printer (600 lpm)
2280	F/R Disk Drives
2280-1	26.8 megabytes
2280-2	53.6 megabytes
2280-3	80.5 megabytes
2281W	Daisy Printer (30 chars sec)
2281WC	Wide Carriage Daisy Printer

<b>Model Number</b>	<b>Description</b>
2282	Graphic CRT
BFT-1	Bidirectional Forms Tractor for 2281W
BFT-2	Bidirectional Forms Tractor for 2281WC
TSF-20	Twin Sheet Feeder for 2281W (8.5 x 11- or 14-in. paper)
TSF-21	Twin Sheet Feeder for 2281W (8.25 x 11- or 14-in. paper)
TSF 22	Twin Sheet Feeder for 2281WC (8.5 x 11- or 14-in. paper)
TSF 23	Twin Sheet Feeder for 2281WC (8.25 x 11- or 14-in. paper)

## APPENDIX C

### PREVENTIVE MAINTENANCE AND ENVIRONMENTAL CONSIDERATIONS

#### C.1 PREVENTIVE MAINTENANCE

The 2200LVP and disk drives require yearly preventive maintenance; the system peripherals may require more frequent servicing. A Wang Maintenance Agreement is available to assure this servicing automatically. If a Maintenance Agreement is not acquired you must arrange for your equipment to be serviced. A Maintenance Agreement protects your investment and offers the following benefits.

- *Preventive Maintenance*  
Your 2200LVP and disk drives are inspected annually for worn parts, adjusted, lubricated, cleaned, and updated with any required engineering changes. Preventive maintenance minimizes downtime by anticipating repairs before they are necessary.
- *Fixed Annual Cost*  
When you buy a maintenance agreement, you issue only one purchase order for service for an entire year and receive one annual billing. More frequent billing can be arranged, if desired.

Further information regarding maintenance agreements can be acquired from your local Sales-Service Office.

#### NOTE

Wang Laboratories, Inc., neither honors maintenance agreements for nor guarantees any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user.

#### C.2 ENVIRONMENTAL CONSIDERATIONS

When the recommended temperature range is exceeded, component failure rates and loss of data through distortion of data storage materials are likely to increase.

Airborne contaminants can accumulate rapidly on the circuit boards and their components, forming a film that not only prevents adequate heat dissipation from the electronic elements, but also creates leakage paths, causing errors in the system signals. Additionally, dust will cause excessive wear in the disk read/write heads and the oxide coatings of storage media. The filters of all HVAC (heating, ventilating, air conditioning) equipment should be cleaned or replaced regularly. In areas where these filters do not sufficiently remove airborne contaminants, an electrostatic air filter should be installed.

Low humidity increases the probability of static buildup, causes oxide shed in data storage materials, and increases the static charge imparted to carpets and clothing. When the operator comes in contact with the system, the resultant static discharge, which could be several thousand volts, will also cause system errors or destruction of data. High humidity rapidly deteriorates paper stock and magnetic disks and tape. Humidifiers or dehumidifiers should be installed in the environment's heating, ventilating, and air conditioning systems as required.

If carpeting is to be installed, it should be a nonstatic variety. If static carpeting is already installed, it must be treated with nonstatic spray, or an electrically conductive mat should be installed under the system operating area and be properly connected to an earth ground to prevent static buildup.

Computers and peripherals are susceptible to malfunction due to electromagnetic interference (EMI) from radio transmitters, industrial motors, etc. EMI can enter the system by conduction through wiring and cabling or by direct radiation. An illustration of EMI is a television that becomes full of snow when a car with a poorly tuned engine idles outside (radiated EMI) or someone turns on a hair dryer or vacuum cleaner in the next room (conducted EMI). To minimize such interference, the three-prong AC power line should be dedicated to the system, grounded, properly installed in steel conduit, and isolated from interference-generating devices like office machines, fluorescent lighting, motors, HVAC units, etc. If these devices are located near the system area, they must be relocated, repaired, or filtered to ensure that they do not disturb the system. (EMI filters, isolation transformers, and line conditioners should be installed on the system's AC power line.) In cases of high residual EMI, it may also be necessary to shield all peripheral cables.

The 2200LVP CPU requires three (3) amperes @ 115 VAC; therefore, as with most Wang systems, a dedicated 20-ampere, 115-VAC power line properly grounded and regulated to within  $\pm 10\%$  should be installed.

The recommended operating environment is defined by the following parameters.

**Temperature**

60° F to 80° F (15° C to 27° C)

**Relative Humidity**

40% to 60%, noncondensing

**Dust**

No accumulation should be obvious in a 24-hour period

**Power**

Grounded, noise-free, dedicated 115 or 230 VAC  $\pm 10\%$ , 50 or 60 Hz  $\pm 1$ Hz

**Interference**

All sources of static electricity, extreme magnetism, and EMI shall be controlled.

A list of additional considerations that should be heeded follows.

- Keep an accurate service history on all equipment.
- Avoid consuming food and beverages, smoking, and performing any other activity not related to operation of the system while near the equipment.
- Avoid touching magnetic disks and tape or exposing them to direct sunlight, strong magnetic fields, or freezing temperatures. If subjected to extremes, allow the media to return to normal operating conditions before use (24 hours recommended) and test them thoroughly.

- Return the diskette to its storage envelope whenever it is removed from the drive. Replace the storage envelopes when they become worn, cracked, or distorted. The envelopes are designed to protect the diskette.
- Date the media when first used, since media over two years old should be replaced. Use felt-tip pens to write on the media label. Never use an eraser to alter a label; instead, use a new label.
- Always make a duplicate copy (backup) of tapes and diskettes, and then store the backup safely in a different area.

**NOTE**

Most Wang electrical devices are equipped with an exhaust fan and entry vents. These vents and fan should not be obstructed; therefore, never place system equipment immediately adjacent to file cabinets or other surfaces that might impede proper air flow.



## APPENDIX D

### SYSTEM HARDWARE ERROR MESSAGES AND RECOVERY PROCEDURES

#### D.1 DISK ERROR MESSAGES AND RECOVERY

The following discussion explains the significance of each system error and suggests possible recovery procedures. If these procedures fail, call your Wang Service Representative. A system error is usually serious enough to warrant executing a control memory diagnostic. However, it may be possible to resume execution of the currently loaded application program by pressing RESET and then SF '15. If the error is reported again, a memory diagnostic should be run to locate the defective memory location.

Several possible disk errors may occur while trying to load disk information. The recommended recovery procedure involves consulting the following description of each possible disk error to determine if the problem can be corrected and then attempting to reload. Should successive failures occur, call your Wang Service Representative. All disk errors are more fully documented in the *BASIC-2 Disk Reference Manual* and the *2200VP/MVP BASIC-2 Language Reference Manual*.

##### ERR D82

Error: FILE NOT IN CATALOG

Cause: A nonexistent file name was specified, or an attempt was made to load a data file as a program file or a program file as a data file.

Recovery: Make sure the correct file name is being used, the proper disk platter is mounted, and the proper drive is being accessed.

##### ERR I90

Error: DISK HARDWARE ERROR

Cause: The disk did not respond properly to the system at the beginning of a read or write operation; the read or write has not been performed.

Recovery: Key RESET and run the program again. If the error persists, ensure that the disk unit is powered on and that all cables are properly connected. If the error still occurs, contact your Wang Service Representative,

##### ERR I91

Error: DISK HARDWARE ERROR

Cause: A disk hardware error occurred because the disk is not in file-ready position. If the

disk is in a LOAD mode or if the power is not turned on, for example, the disk is not in file-ready position and a disk hardware error is generated.

**Recovery:** Key RESET and run the program again. If the error recurs, check to ensure that the program is addressing the correct disk platter. Be sure the disk is turned on, properly set up for operation, and that all cables are properly connected. Set the disk into the LOAD mode and then back into the RUN mode by using the RUN/LOAD selection switch. If the error persists, call your Wang Service Representative.

**NOTE**

The disk must *never* be left in LOAD mode for an extended period of time when the power is on.

**ERR I92**

**Error:** TIMEOUT ERROR

**Cause:** The device not respond to the system in the proper amount of time (time-out). In the case of the disk, the read or write operation has not been performed.

**Recovery:** Key RESET and run the program again. If the error persists, be sure that the disk platter has been formatted. If the error still occurs, contact your Wang Service Representative.

**ERR I93**

**Error:** FORMAT ERROR

**Cause:** A format error was detected during a disk operation. This error indicates that certain sector-control information is invalid. If this error occurs during a read or write operation, the platter may need to be reformatted. If this error occurs during formatting, there may be a flaw on the platter's surface.

**Recovery:** Format the disk platter again. If the error persists, replace the media. If the error continues, call your Wang Service Representative.

**ERR I94**

**Error:** FORMAT KEY ENGAGED

**Cause:** The disk format key is engaged. The key should be engaged only when formatting a disk.

**Recovery:** Turn off the format key.

**ERR I95**

**Error:** DEVICE ERROR

**Cause:** A device fault occurred indicating that the disk could not perform the requested operation. This error may result from an attempt to write to a write-protected platter.

**Recovery:** If writing, make sure the platter is not write-protected. Repeat the operation. If the error persists, power the disk off and then on, and then repeat the operation. If the error still occurs, call you Wang Service Representative.

#### **ERR I96**

**Error:** DATA ERROR

**Cause:** For read operations, the checksum calculations (CRC or ECC) indicate that the data read is incorrect. The sector read may have been written incorrectly. For disk drives that perform error correction (ECC), the error correction attempt was unsuccessful. For write operations, the LRC calculation indicates that the data sent to the disk was incorrect. The data has not been written.

**Recovery:** For read errors, rewrite the data. If read errors persist, the disk platter should be reformatted. For write errors, the write operation should be repeated. If write errors persist, ensure that all cable connections are properly made and are tight. If either error persists, contact your Wang Service Representative.

#### **ERR I97**

**Error:** LONGITUDINAL REDUNDANCY CHECK ERROR

**Cause:** A longitudinal redundancy check error occurred when reading or writing a sector. Usually, this error indicates a transmission error between the disk and the CPU. However, the sector being accessed may have been previously written incorrectly.

**Recovery:** Run the program again. If the error persists, rewrite the flawed sector. If the error still persists, call your Wang Service Representative.

#### **ERR I98**

**Error:** ILLEGAL SECTOR ADDRESS OR PLATTER NOT MOUNTED

**Cause:** The disk sector being addressed is not on the disk, or the disk platter is not mounted. (The maximum legal sector address depends upon the disk model used.)

**Recovery:** Correct the program statement in error, or mount a platter in the specified drive.

#### **ERR I99**

**Error:** READ-AFTER-WRITE ERROR

**Cause:** The comparison of read-after-writre to a disk sector failed, indicating that the information was not written properly. This error usually indicates that the disk platter is defective.

**Recovery:** Write the information again. If the error persists, try a new platter; if the error still persists, call your Wang Service Representative

## **D.2 SYSTEM (EXECUTION) ERROR MESSAGES**

The system initially checks each text line for various types of errors as the line is entered by the pro-

grammer during program resolution and execution. The system responds to an error condition by producing an audible tone, terminating the current operation immediately, displaying the erroneous line, and presenting beneath it the message "ERR" followed by an error code, with an arrow pointing to the approximate position of the error. Note that the system stops error scanning when the first error is detected. Thus, if a line contains more than one error, only the first is detected and reported by the system. Some errors can be recovered under program control.

The error codes with a two-digit number preceded by a letter prefix (e.g., "A04") are the type that occur once the system program has been given control. The letter identifies the particular class of errors to which the error belongs, while the two-digit number identifies the specific error condition. (For example, an error commonly encountered during text entry is S13, "Missing Comma." The "S" indicates a syntax error, and the "13" identifies the error uniquely as "Missing Comma.") There are seven classes of error conditions, each identified by a unique letter prefix in the error code. These error classes and the letter prefixes that identify them appear as follows.

<b>Class of Errors</b>	<b>Letter Prefix</b>
Miscellaneous Errors	A
Syntax Errors	S
Program Errors	P
Computation Errors	C
Execution Errors	X
Disk Errors	D
I/O Errors	I

A complete list of the errors included in each class and their specific recovery procedures is included in the *BASIC-2 Language Reference Manual*.

Errors in the first three classes listed (Miscellaneous Errors, Syntax Errors, and Program Errors) are detected during text entry or program resolution and cause the system to terminate the current operation and display an error message. The operator then must correct the error before proceeding with further operations. Errors of this kind are called "nonrecoverable" because they cannot be recovered under program control.

Errors in the four remaining classes (Computation Errors, Execution Errors, Disk Errors, and I/O Errors) typically occur during program execution and can be recovered under program control without aborting the program or disrupting the display with an error message. Errors that can be intercepted by the program before the operating system intervenes are called "recoverable" errors. Three BASIC-2 instructions are provided for intercepting and responding to recoverable errors: the SELECT ERROR statement, the ERR function, and the ERROR statement.

Refer to Chapter 9 of the *BASIC-2 Language Reference Manual* for a discussion of error recovery under program control.

# APPENDIX E

## CHANGING THE TRANSMISSION RATE OF THE MODEL 2236DE INTERACTIVE TERMINAL AND THE 2236MXD TERMINAL PROCESSOR

### E.1 INTRODUCTION

#### CAUTION

Wang Laboratories, Inc., does not guarantee any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user. We recommend that only Wang Customer Engineers modify Wang equipment.

With all switch types, one end of the switch will be marked ON (-). The "push-in" type of switch has two white squares, one above and one below each switch's number. When a square at the ON end is pressed in, the switch is on and the opposite square projects out. The "slide" type of switch requires a sliding motion toward either the ON or OFF position. The "rocker" type switch operates similarly to the "push-in" type. When one end of the switch is pushed in, the opposite end projects out. (Refer to Figure E-1 for an illustration of the three types of switches.)

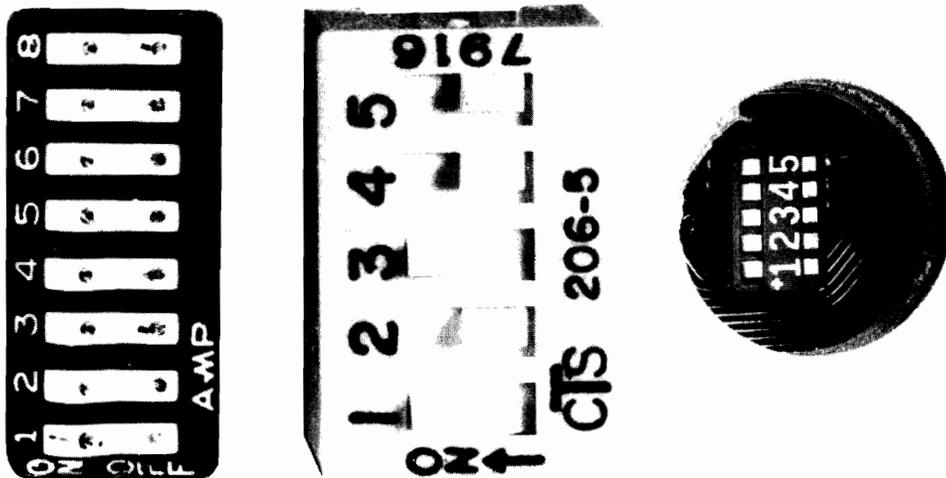


Figure E-1. The Three Types of Switches

**NOTE**

The data transmission rate set at a terminal *must* equal the baud rate set at the terminal processor's plug for that terminal. If a terminal is attached to a modem, the transmission speed of the terminal must be within the range supported by the modem.

**E.2 CHANGING THE TRANSMISSION RATE OF THE MODEL 2236DE TERMINAL**

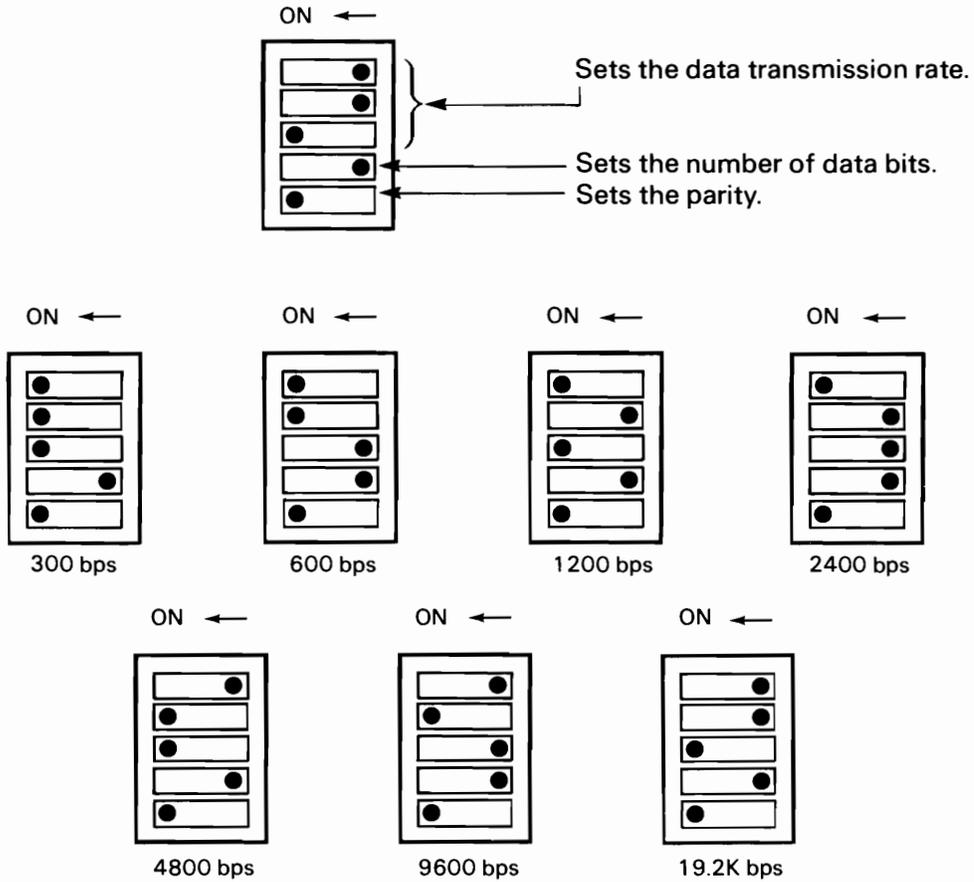
To change the data transmission rate of the 2236DE Interactive Terminal, observe the following procedure.

1. Switch the terminal's power off.
2. Locate the cap in the rear of the terminal. If necessary, the terminal may be moved slightly to provide better access to the cap.
3. Using a screwdriver (as shown in Figure E-2), gently remove the cap by placing the tip of the screwdriver underneath it.
4. The transmission rate switch is now exposed. Note that any of the three switch types may be located on the terminal. When setting the switches, follow the instructions for whatever type of switch is installed in the terminal.



**Figure E-2. Removing the Cap**

- The switch settings that correspond to each possible data transmission rate appear in Figure E-3. Set the three uppermost switches to the appropriate positions for the transmission rate desired.

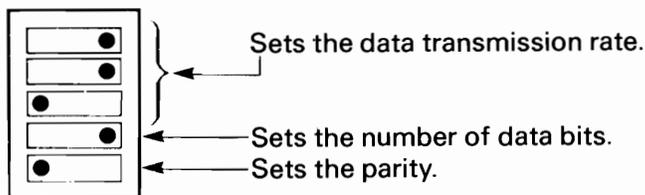


All settings with 8 data bits and odd parity.

**Figure E-3. The Data Transmission Rate Switch Settings on the Model 2236DE Terminal**

- Set the number of data bits to 8 and parity to ODD. All settings in Figure E-3 appear with 8 data bits and odd parity. When using a 2200 system configuration, the number of data bits must be 8 and the parity must be odd.
- After setting the switches, place the cap back into position on the back of the terminal.
- The terminal's power may now be switched on.
- The terminal will display its "power-on" message [2236DE R01 19200BPS 8+0 (USA)] so that the switch settings can be verified. Refer to Section 3.1 for a discussion of this message.

Users are reminded that whenever using a 2200 system, the number of data bits must be 8 and the parity must be odd. However, a user may wish to change the number of data bits or the parity in order to be compatible with other systems. To change either the number of data bits or the parity, perform the following procedure.



To set the number of data bits, move the data bit switch:

- Left for 7 data bits
- Right for 8 data bits

To set the parity, move the parity switch:

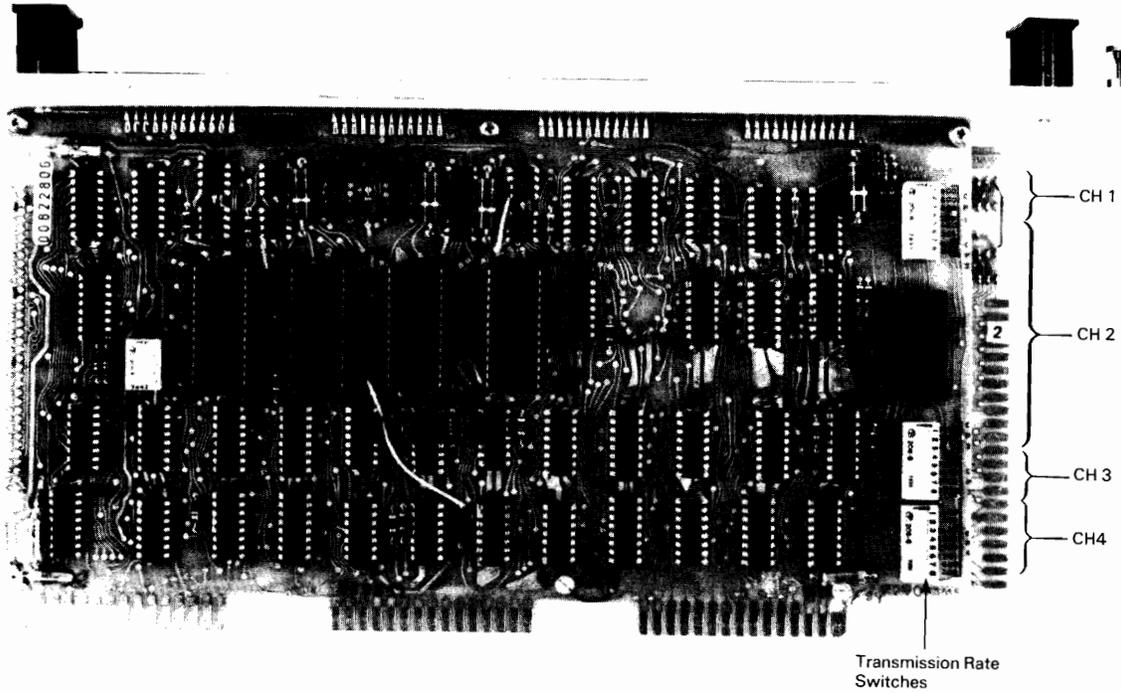
- Left for odd parity with 8 data bits
- Left for odd parity with 7 data bits
- Right for no parity with 8 data bits
- Right for even parity with 7 data bits

### E.3 CHANGING THE TRANSMISSION RATE OF THE 2236MXD TERMINAL PROCESSOR

To change the transmission speed of the Model 2236MXD, perform the following procedure.

1. Power the system down by turning off all terminals and printers, followed by all disk drives, the Disk Processing Unit (DPU), and finally the Central Processing Unit (CPU).
2. Loosen the retaining screws that attach the terminal processor to the CPU. Using the two handles on top of the processor, pull the processor board straight up and out of the CPU I/O port.
3. Locate the three 8-bank switches on the processor board used to set the transmission rate (refer to Figure E-4). Note that any of the three switch types may be located on the processor. Follow the instructions for setting whatever type of switch is installed on the processor.
4. The switch position labeled 4800 baud actually specifies 19.2K bps in normal operation. If 4800 bps operation is required, then the board must be physically modified because the 19.2K bps and 4800 bps rates are mutually exclusive. Contact Wang Customer Service for further details.
5. For each terminal, set the corresponding processor switch to the same data transmission rate set on the terminal. The 24 switches are divided into four sets (one set for each possible terminal). Each set is divided into six switches (one switch for each possible data rate of each terminal). (Refer to Figure E-4.)
6. After setting the switches, replace the terminal processor in the CPU I/O port and tighten the retaining screws.

7. The system may now be powered on. Begin by turning on the CPU, followed by the DPU, all disk drives, and lastly, all printers and terminals.



**Figure E-4. The Data Transmission Rate Switch Settings on the 2236MXD Terminal Processor**



## APPENDIX F SETTING THE DEVICE ADDRESS OF THE 2236MXD TERMINAL PROCESSOR

### CAUTION

Wang Laboratories, Inc., does not guarantee any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user. We recommend that only Wang Customer Engineers modify Wang equipment.

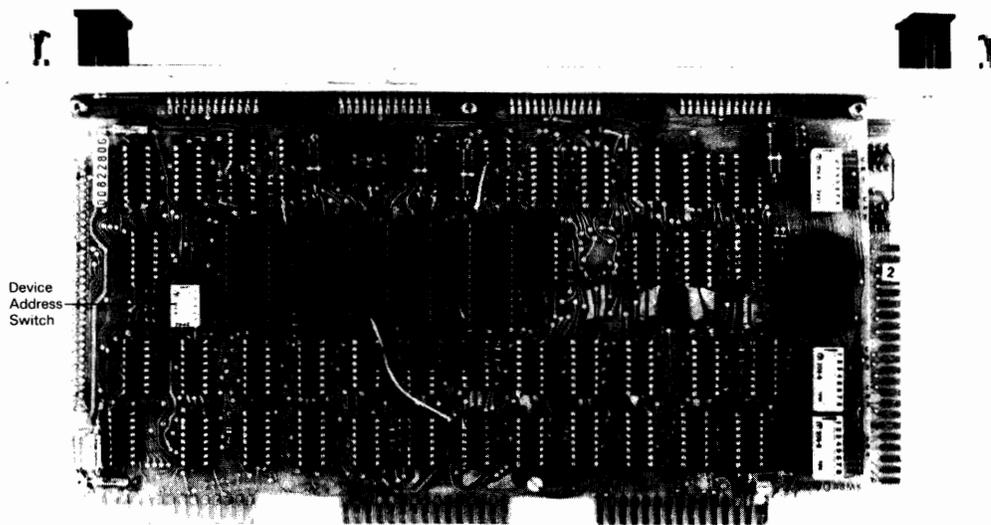
When one to four terminals are configured, one 2236MXD Terminal Processor is used. The 40 bit and 80 bit of the address of this Terminal Processor are always /00 (the Terminal Processor also reserves addresses 01-07). When more than four terminals are configured, refer to Appendix E of the *Model 2236DE Interactive Terminal User Manual* (700-5711A) for instructions on setting the device addresses.

Note that unlike other peripheral processors, the physical device-address set on the 2236MXD Terminal Processor is not the address specified in a program for access to the terminal CRT, keyboard, and terminal printers. The programmable device-addresses for *all* terminals are: CRT /005, keyboard /001, and terminal printers /004. The operating system translates these programmable addresses into the appropriate physical processor address.

With all switch types, one end of the switch will be marked ON (-). The "push-in" type of switch has two white squares, one above and one below each switch's number. When a square at the ON end is pressed in, the switch is on and the opposite square projects out. The "slide" type of switch requires a sliding motion toward either the ON or OFF position. The "rocker" type switch operates similarly to the "push-in" type. When one end of the switch is pushed in, the opposite end projects out. (Refer to Figure E-1 for an illustration of the three types of switches.)

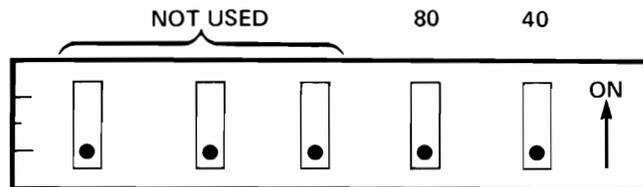
To set the processor's physical device address, perform the following procedure:

1. Power the system down by turning off all terminals and printers, followed by all disk drives, the Disk Processing Unit (DPU), and finally the Central Processing Unit (CPU).
2. Loosen the retaining screws that attach the processor to the CPU. Using the two handles on top of the processor, pull the processor board straight up and out of the CPU I/O port.
3. Locate the five-bank switch on the processor board used to set the device-address (refer to Figure F-1). Note that any of several switch types may occur on the processor: the "slide" type, the "push-in" type, and the "rocker" type. Follow the instructions for setting the type of switch installed on the processor.



**Figure F-1. Device Address Switches on the 2236MXD Terminal Processor**

4. Set the device-address to /00. To do this, place all switches in the off position (Refer to Figure F-2). An address of /00 indicates the primary MXD Terminal Processor that controls terminals 1-4.
5. After setting the address, reinsert the processor in the CPU I/O port and tighten the retaining screws.
6. The system may now be powered on. Begin by turning on the CPU, followed by the DPU, all disk drives, and finally, all printers and terminals.

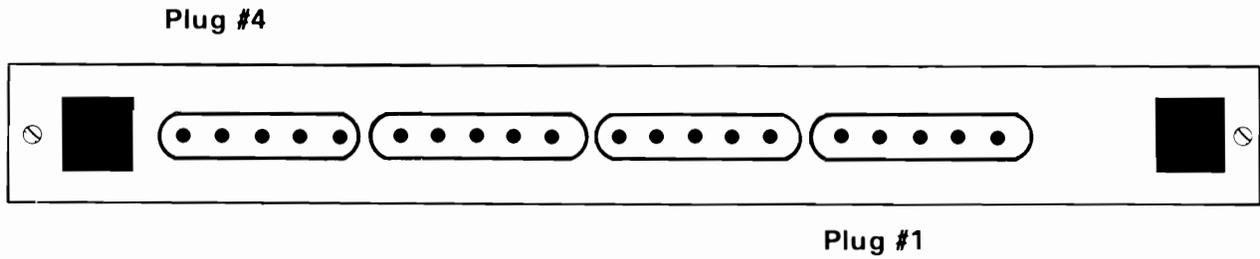


**Figure F-2. Device Address /00**

**NOTE**

Addresses 01-07, 41-47, 81-87, and C1-C7 are reserved for the 2236MXD Terminal Processor and *cannot* be used for any other devices.

If the processor connectors are not numbered, they can be easily distinguished and indentified. The two connectors nearest the handles on top of the processor are always offset such that the plug on one end will be closer to the handle than the plug on the other end of the processor. The jack that is closest to the handle has the highest number. The jack numbers descend sequentially from this end toward the opposite end of the processor board. (Refer to Figure F-3.)



**Figure F-3. Determining the Number Assigned to the Jacks on the 2236MXD Terminal Processor**



## APPENDIX G SETTING THE DEVICE ADDRESSES ON THE 22C32 TRIPLE CONTROLLER

### CAUTION

Wang Laboratories, Inc., does not guarantee any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user. We recommend that only Wang Customer Engineers modify Wang equipment.

The 22C32 Triple Controller has three switch banks for setting the device addresses of the printer, disks, and terminal. The disk switch bank is closest to the cable connectors, the printer is next, and the terminal switch bank is the lowest, with only five switches in the bank. (Refer to Figure G-1.)

With all switch types, one end of the switch will be marked ON(-). The "push-in" type of switch has two white squares, one above and one below each switch's number. When a square at the ON end is pressed in, the switch is on and the opposite square projects out. The "slide" type of switch requires a sliding motion toward either the ON or OFF position. The "rocker" type of switch operates similarly to the "push-in" type. When one end of the switch is pushed in, the opposite end projects out. (Refer to Figure E-1 for an illustration of the three types of switches.)

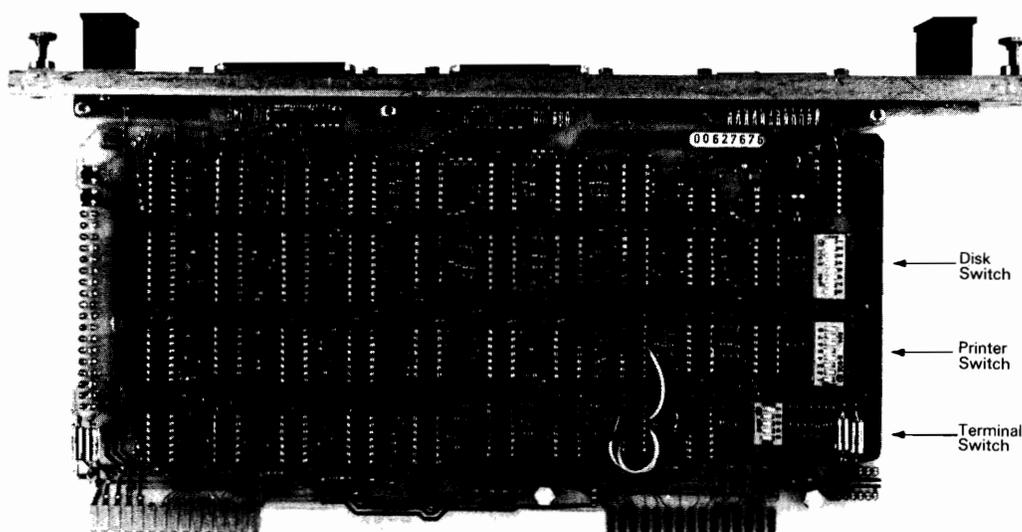
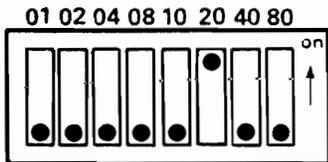


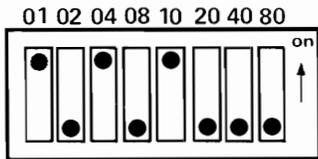
Figure G-1. Device Address Switch  
on the 22C32 Triple Controller

On a 2200LVP, the standard disk address for the 22C32 Triple Controller is 20. However, the address can be set to 10 or 30 by a Wang customer engineer.



**Figure G-2. Disk Address 20 on the 22C32 Triple Controller**

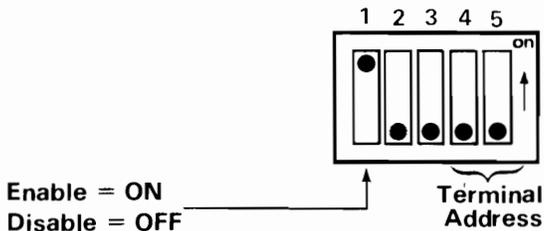
The standard printer address is 15. However, if more than one printer is attached to the CPU, addresses 16 or 17 can be used.



**Figure G-3. Printer Address 15 on the 22C32 Triple Controller**

When setting the address of the terminal, Switch 1 must always be placed in the on position. If Switch 1 is off, the terminal controller is disabled and only the printer and the disk can be used.

On single-terminal systems, the 40 and 80 bits of the terminal address are always in the off position (the controller then responds to addresses 01-07). Refer to Figure G-4. Refer to Appendix F of the *Model 2236DE Interactive Terminal User Manual (700-5711A)* for instructions on setting the terminal addresses for five-terminal and nine-terminal systems.



**Figure G-4. Switches Set for Terminal 1 on the 22C32 Triple Controller**

Note that unlike other peripheral controllers, the physical device address set on the terminal controller is not the address specified in a program for access to the terminal CRT, keyboard, and terminal printers. The programmable device addresses for *all* terminals are: CRT /005, keyboard /001, and terminal printers /004. The operating system translates these programmable addresses into the appropriate physical controller address.

To set the physical device address of the 22C32 Triple Controller, perform the following procedure.

1. Power the system down by turning off all terminals and printers, followed by all disk drives, the Disk Processing Unit (DPU), and finally the Central Processing Unit (CPU).
2. Loosen the retaining screws that attach the controller to the CPU. Using the two handles on top of the controller, pull the controller board straight up and out of the CPU I/O port.

3. Locate the switch on the controller board used to set the device address. Note that any of the three switch types may be located on the controller. Follow the instructions for setting whatever type of switch is installed on the controller.
4. Set the device addresses as desired. (Refer to Figures G-2 to G-4.)
5. After setting the addresses, reinsert the controller in the CPU I/O port and tighten the retaining screws.
6. The system may now be powered up. Begin by turning on the CPU, followed by the DPU, all disk drives, and, finally, all printers and terminals.

**NOTES**

Addresses 01-07, 41-47, 81-87, and C1-C7 are reserved for the 2236MXD Terminal Processor and 22C32 Triple Controller and *cannot* be used for any other devices.

The baud setting on the 22C32 Triple Controller is preset at 19.2 and cannot be modified.



## **APPENDIX H**

### **WANG IBM COMPATIBILITY SOFTWARE FEATURES (OPTIONAL)**

Because of the 2200LVP system diskette drive hardware, IBM 3740 and DSDD diskette compatibility is possible. However, because of the different file formats used by Wang and IBM, either Wang or user-written software must be run to utilize this compatibility feature. Wang optionally supports disk utility programs and subroutines to maintain files in IBM 3740 or DSDD file format. The subroutines, when appended to a user-written program, require about 4.5K bytes. Use of the entire Wang software system requires about 12K bytes. In addition to the extensive set of disk I/O instructions and automatic file management system, Wang offers several optional utility software packages for the creation, sorting, and merging of disk data files, etc.

Wang's 3740 Diskette Compatibility Software, designed for use with the IBM 3740 Compatible Diskette Drive, provides a set of utility programs that implement operations such as the following.

- Displaying a 3740 diskette catalog, thereby providing the names of stored files and the addresses of each file's reserved and used sectors
- Displaying 3740 sector dumps for the sectors in a specified address range
- Performing media conversion of Wang disk/diskette files\* to 3741 diskette files or vice versa
- Producing hardcopy of a specified 3740 diskette file or a Wang diskette file previously converted from a 3740 diskette

\* The 3740 Diskette Compatibility Software processes TC-formatted Wang files (maximum record length 128 bytes).

The software also provides utility subroutines that can be integrated with the user-written BASIC Language application programs where 3740 diskettes are to be accessed directly for file creation or maintenance. The subroutines handle the following types of operations.

- Opening a new or existing file
- Reading, rereading, or writing a sector
- Skipping or backspacing a specified number of sectors
- Writing or updating an end-of-data pointer position
- Closing a file

For detailed information concerning disk operations and BASIC-2 disk language features for all Wang disk models, refer to the *Wang BASIC-2 Disk Reference Manual*. For more information concerning the IBM compatibility features, obtain the IBM 3740 Compatibility Software Package (part no. 195-1030-3), which contains a software diskette (part no. 701-2212) and the *3740 Diskette Compatibility Software User Manual* (part no. 700-4369).

## APPENDIX I

### REMOTE TERMINAL OPERATION

#### I.1 INTRODUCTION

Remote use of 2236DE terminals is possible using the built-in telecommunications capabilities of the 2236MXD terminal processor and the terminal itself. With the addition of the proper modems, the 2200LVP can communicate with 2236DE terminals over virtually unlimited distances. Speeds ranging from 300 to 9600 bps (bits per second) can be attained by using readily available modems and communications lines supplied by various common carriers and modem vendors. This equipment is *not* available from Wang Laboratories, Inc.

#### I.2 MODEMS

When the 2236MXD terminal processor is used to transfer information from the CPU to the terminals over common carrier lines, the digital signals of the multiplexer must be translated into corresponding analog signals at the sending end and returned to digital form at the receiving end. The same transformation must be performed on information transferred from the terminal to the CPU. Data is converted from one form to another by using *modems*, devices that first *modulate* the digital signals and then *demodulate* the resultant analog signals.

Two modems are needed for each terminal that is used remotely. One modem must be located at the site of the 2236MXD terminal processor, and the other modem must be located at the site of the 2236DE terminal. Both modems must be the same model or, if they are different models, must be electrically compatible to permit the remote terminal setup to function. In particular, the speed, type of communication, and number of bits expected to be received must be identical for both modems.

The type of modem used and the speed of transmission depend largely on the distance that the signals will travel between the modems. The distance between two modems in a remote terminal link is regarded as either short-haul or long-haul. Distances from 610 meters (2000 ft) to 8 kilometers (5 miles) are considered to be short-haul; distances greater than 8 km are considered long-haul. However, equipment designed for long-haul applications may also be used to establish a remote terminal link less than 8 km distant.

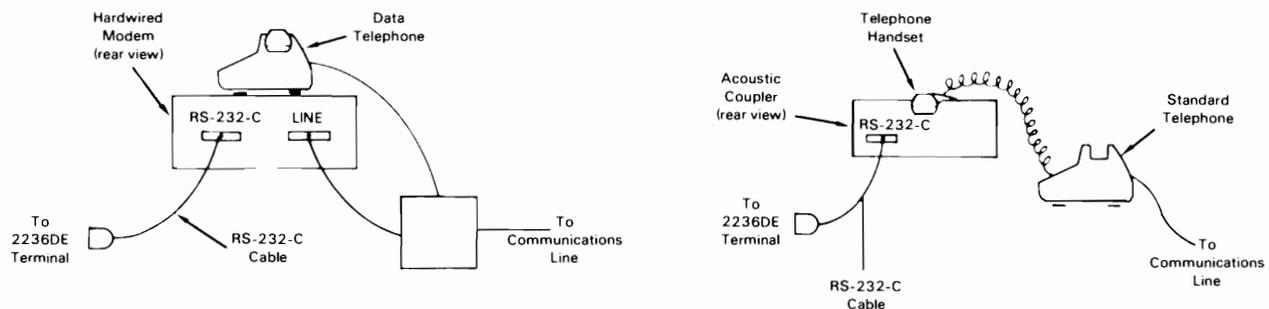
For a short-haul communications link, speeds of up to 9600 bps can be maintained when private lines or leased lines are used. For a long-haul communications link, either switched lines or leased lines can be used for signal transmission. Switched lines are accessed through the common carrier's switching system by telephone dialing. The speed on switched lines is usually limited to 1200 bps because the switching apparatus may introduce noise on the line. A leased line presents a faster but more costly alternative to a switched line. Unlike switched lines, a leased line is a communications line leased from a common carrier in the area for the exclusive use of the customer. When a leased line is used to transmit signals, the line is run directly from the CPU to the terminal location and no switching occurs. Speed on a leased line may be as high as 9600 bps; however, the customer must determine whether the increase in transmission speed justifies the additional expense of a leased line. Information about leased lines and their cost should be obtained from the common carrier in the customer's area.

Communication between the 2236MXD terminal processor and the 2236DE terminal is full duplex, asynchronous, serial. In this form of communication, data is sent one bit at a time, with each character framed by a number of control bits. The 2236MXD terminal processor and the 2236DE terminal send eleven bits for each character transmitted: one start bit, followed by eight data bits, followed by one parity bit, and ending with one stop bit. The start bit indicates the beginning of the character to be transmitted. The following eight bits represent the character that has been sent and the parity bit serves as an error-checking technique. The 2200LVP utilizes *odd parity*, i.e., the parity bit is set to logical one or zero so that the total number of logical one bits in the character plus the parity bit is always odd. When either the 2236MXD terminal processor or the 2236DE terminal receives a character, a count is made to ensure that the number of logical one bits is odd. If the number of logical one bits is even, the error is recognized and the terminal signals it by displaying a “#” character on the CRT screen or terminal printer and then sounding the audio alarm. (A parity error discovered by the 2236MXD terminal processor results in conversion of the offending character to a “#”, which is then sent to the terminal.) The stop bit indicates the end of the transmitted character.

The modem used at each end of the telecommunications link *must be* asynchronous; synchronous transmission, which is the continuous transmission of characters at a regular frequency, will not function on the 2200LVP. Therefore, the selected modem *must be* capable of asynchronous transmission in order to be used.

In addition, communication between the 2236MXD terminal processor and the remote terminal is *full duplex*, enabling data to travel simultaneously from the 2236MXD terminal processor to the terminal and from the terminal to the 2236MXD terminal processor. Modems utilized in this system must be full duplex; half-duplex modems, which permit transmission in only one direction at a time, cannot be used.

Asynchronous modems may be physically connected to communications lines in two ways: they may be hardwired to these lines or acoustically coupled to them. Hardwired modems are attached directly to the communications line. A hardwired modem may be attached to a telephone used for dialing a switched line, or it may be the sole device attached to a leased line. When a switched line is used, the modem at the central site should be equipped with automatic answer and automatic disconnect capabilities. These features allow communication with remote terminals to be automatically established when the remote station dials the central site and automatically terminated when the remote station hangs up. The acoustic coupler is a free-standing modem that is attached to the communications line by an ordinary telephone. The telephone handset is inserted into cups on the acoustic coupler. The telephone picks up the analog signals generated by the modem as audible tones and transmits these tones to the other modem. When audible signals return to the telephone, the acoustic coupler picks them up and converts them to digital signals. Acoustic couplers are used only with switched lines; hardwired modems can be used with either switched or unswitched lines.



**Figure I-1. Hook-Up of Hardwired Modem (Left) and Acoustic Coupler**

Since transmission is occurring in two directions simultaneously, the two modems must transmit at slightly different tones to prevent confusion of signals. Therefore, one modem is considered to be the originating modem, and the other is the answering modem; each transmits at a different pitch. Although each modem should be able to transmit as either an originating or an answering modem, only one modem of each type is required for the remote terminal setup to function. Typically, the originating modem is located at the remote site and the answering modem at the central site. This setup allows the remote terminal to initiate the communication. It is possible, however, to set modems up in the opposite manner.

To summarize, the modems used must be:

- Asynchronous.
- Full duplex.
- Capable of transmitting at least 11 bits per character: one start bit, eight data bits, one parity bit, and at least one stop bit.
- Capable of the desired transmission speed.

Both modems also must be suitable for the type of line to be used. Some modems, for example, cannot be used on switched lines because the switching apparatus may introduce noise on the line. The modems at each end of the communications link must either be the same model or electrically identical. Both modems must also be set to the same transmission speed, and the multiplexer and terminal must operate at that speed. Failure to ensure speed compatibility among all components in a communications link is one of the most common sources of error encountered in telecommunications.

### I.3 LINE AND MODEM COMBINATIONS

There are four recommended combinations of lines and modems.

- Short-haul line (private cable or leased line, up to 8 km in distance), using short-haul modems at both the remote and central sites; 9600 bps maximum. Refer to Figure I-2.
- Leased line, with hardwired modems at both sites; 9600 bps maximum. Refer to Figure I-3.
- Switched line, with an acoustic coupler at the remote site and a hardwired modem at the central site; 1200 bps maximum. Refer to Figure I-4.
- Switched line, with hardwired modems at both sites; 1200 bps maximum. This combination is the most common option. Refer to Figure I-5.

Although it is possible to use acoustic couplers at both ends of a remote terminal installation, this arrangement is not recommended.

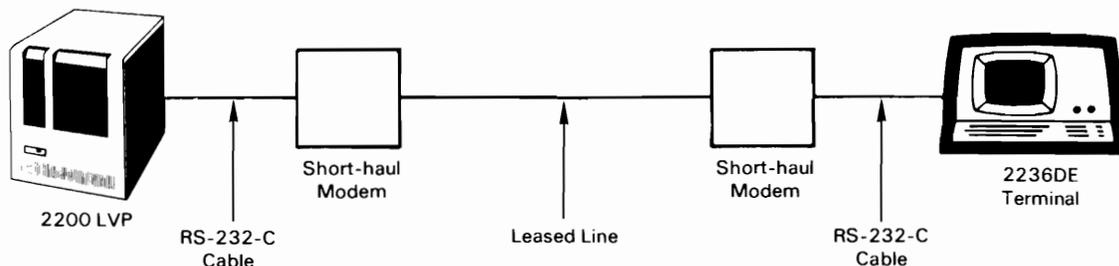
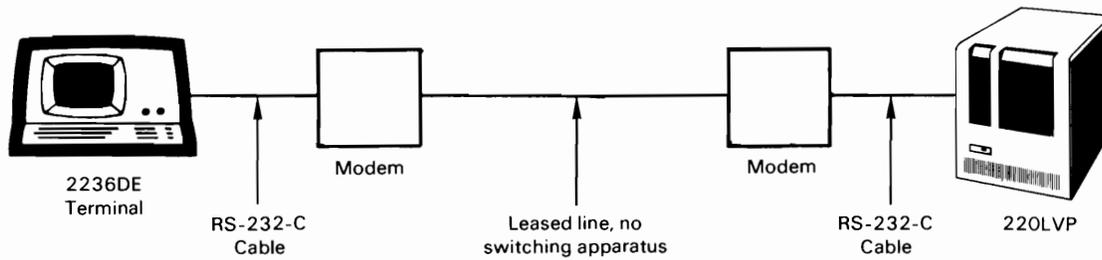
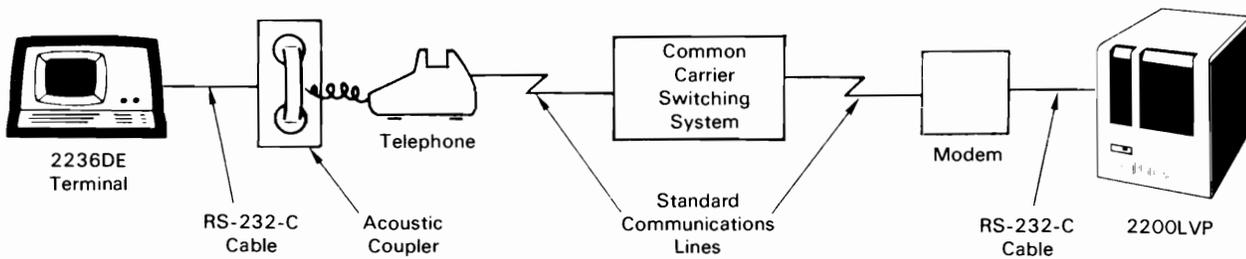


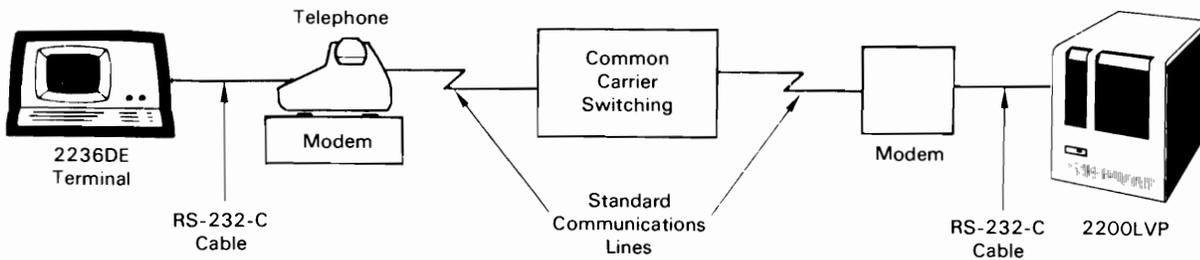
Figure I-2. Short-Haul Line and Short-Haul Modems



**Figure I-3. Leased Line and Hardwired Modems**



**Figure I-4. Switched Line, Acoustic Coupler, and Hardwired Modem**



**Figure I-5. Switched Line and Hardwired Modems**

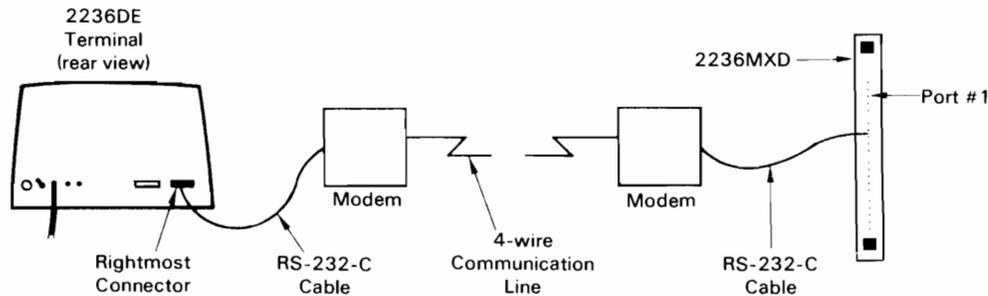
#### I.4 SETTING UP THE DATA LINK

Once the transmission speed, type of line, and location of the remote terminal have been selected, setup of the remote terminal system may begin. A modem must be selected and either purchased, rented, or leased from a vendor. Connecting the modems to the communications line is the responsibility of the modem vendor or the common carrier providing the line; it is not the responsibility of Wang Laboratories, Inc.

When the modems are installed, the customer must contact a Wang Service Representative, who will then connect the 2200LVP and the 2236DE terminal to the modems. The connection must be made using RS-232-C compatible cable and *not* the standard multiplexer/terminal connecting cable. The RS-232-C cable is available in the following lengths.

- 3.70 meters (12 ft, Part 120-2227-12)
- 7.75 meters (25 ft, Part 220-0219)
- 15.50 meters (50 ft, Part 220-0220)

Two cables are required for each remote terminal: one is connected directly between a port on the 2236MXD terminal processor and the modem at the central site, and the second cable is connected between the Model 2236DE terminal and the modem at the remote site. No special communications controller or emulation software is necessary to operate the remote terminal since all appropriate electronics are built into the multiplexer and terminal. Do *not* use Port 1 on the 2236MXD terminal processor to support a remote terminal since the system's controlling terminal should not be located at a remote site.



**Figure I-6. Cable Connections for Remote Terminal Operation**

## I.5 ESTABLISHING COMMUNICATION

Once the installation process is complete and the modems are set for asynchronous, full-duplex operation and once all components are set to the same transmission rate, the remote terminal setup is complete. The next step is to establish communication between the remote terminals and the CPU. Once communication is established, the remote terminal behaves exactly as if it were a locally connected 2236DE terminal.

One common setup involves an acoustic coupler at the remote site, a switched line, and a hardwired modem at the CPU site. To establish communication, the operator at the terminal site turns on the power to all equipment and dials the number of the line to which the 2236MXD terminal processor's modem is attached. If the modem attached to the 2236MXD terminal processor is not an automatic answering model, an operator at the central site must answer the telephone and ready the central site by pressing the telephone button that sets that end of the link to Data mode. Pressing this button allows the modem to begin transmission. If the modem has an automatic answer feature, the line is picked up without operator intervention. In either case, the terminal operator will then hear a high-pitched tone on the telephone. The telephone handset should then be placed in the cups of the acoustic coupler. The orientation of the telephone handset must conform to the explanation noted on the modem itself or contained in the accompanying instructions. A lamp on the acoustic coupler illuminates when a proper connection has been made. The CRT screen should display the "READY (BASIC-2)" message at this point. If it does not, RESET should be keyed; the message will then be displayed.

If hardwired modems are used at both ends of a switched communications link, the procedure for establishing communication between the remote terminals and the CPU resembles the procedure used when an acoustic coupler is located at the remote site. When hardwired modems are located at both sites, however, the operator at the terminal site presses the Talk button before dialing the number, listens for the high-pitched tone, and then presses the button on the telephone for Data Mode to establish communication. A lamp on the modem illuminates when the proper connection has been made. Again, if the modem at the CPU site does not have an automatic answer feature, operator intervention at that site is necessary to establish the link.

In the case of a leased line, the modems are always active and the line is always open. No special procedures are necessary to establish a communications link.

The vendor or common carrier supplying the modem should establish all modem switch settings at the time of installation. Transmission rate switches on the 2236DE terminal and 2236MXD terminal processor should be set by a Wang Service Representative at the time of installation. It should not be necessary to set any switches when the communications link is established.

If a link cannot be established, the following procedures should be observed.

1. Ensure that all power switches at both the remote and central sites are set to ON (including power to modems). Check that the 2200LVP is operational and ensure that its configuration includes at least one partition assigned to the 2236MXD terminal processor port corresponding to the remote terminal. Check that all connections are intact and that the modem at the central site is plugged into the correct port on the 2236MXD terminal processor.
2. Check that the transmission speeds selected for both modems, the 2236MXD terminal processor port to which the central modem is attached, and the 2236DE terminal are in agreement.
3. Examine the indicator lamp on each modem to ensure that a connection was made. If the lamp is not lit, follow the normal procedure for establishing the telecommunications link. If this approach fails, continue with procedure 4.
4. The 2236DE terminal depends on the 2236MXD terminal processor for character echo. Each keyed character is transmitted to the 2236MXD terminal processor, which then sends the same character back to the CRT for display. No screen output will appear on a remote CRT if data is not being sent back to the terminal from the 2236MXD terminal processor. It is therefore useful to isolate the terminal from the 2236MXD terminal processor to determine if the terminal is functioning properly. Most modems have test settings called "local test" or "loop back". These settings allow the terminal to send characters from the keyboard to the modem, which then transmits these characters directly to the CRT. (These tests may be performed by the customer or the modem supplier.) If these tests generate screen output, the line itself or the equipment at the central site may be the source of the problem. If tests at the central site indicate no local trouble, call the common carrier who supplied the communications line. (Procedure 5 outlines tests to be performed at the central site.)

If no echo can be observed at either the remote site or the central site after performing this procedure, the modem supplier should be contacted and the modems tested. The common carrier can test modem operation from a central site and a field visit is not required. If the modems are operational, contact the common carrier and determine whether the communications line is functioning properly.

5. If the remote site is free from problems (refer to procedure 4), both the modem and the 2236MXD terminal processor at the central site should be checked. The modem may be checked as in procedure 4, using a local terminal and the RS-232-C compatible cable. The 2236MXD terminal processor may be tested by configuring the system for four-terminal, four-partition operation and then, using standard terminal cable, attaching a local terminal to each port in succession.

If the modem test fails, contact the modem vendor. If the 2236MXD terminal processor does not function properly, contact a Wang Service Representative.

6. If all other components are functioning properly, yet no link can be established, contact a Wang Service Representative.

## **I.6 MODEM SUPPLIERS**

Modems may be obtained from several sources and may be purchased, rented, or leased. The Bell Telephone Company is the largest supplier of modems in the country. Although not a supplier of short-haul modems, Bell Telephone does supply a number of modems for long-haul applications. The local business office may be contacted for information.

Other manufacturers and suppliers can provide modems for 2200LVP remote terminal operations. The asynchronous modems at both ends of the remote terminal communications link must be RS-232-C/CCITT V.24 compatible and also compatible with each other. Furthermore, the modems must be capable of transmitting data with 11 bits per character (1 start bit, 8 data bits, 1 parity bit, and 1 stop bit).



## APPENDIX J

### LVP SYSTEM UTILITIES

#### J.1 ACCESSING THE UTILITY MENU

Included with the LVP system software are certain programs of general usefulness known as **utilities**. These utilities are intended to simplify such commonly-performed system tasks as backing up a hard disk onto diskettes and moving files.

Utilities can be accessed through a utility menu that is available through the system disk. The following two commands will display this menu.

1. **SELECT DISK xxx (Return)**  
The three-digit hexadecimal number *xxx* is the device address of the disk on which the system utilities reside.
2. **LOAD RUN (Return)**

Utilities that require operator-entered information will display a series of prompts requesting this information. In all cases, type in the necessary response and press RETURN; the utility will then request additional information or perform the required procedure.

#### J.2 THE UTILITY MENU

##### Partition Generator (@GENPART)

This utility creates, saves, and executes system configurations that divide the 2200 resources among the system users. This program is stepped through in Section 3.4 of this manual.

##### Partition Status (@PSTAT)

This program displays a table indicating the current status of each partition in the current configuration. The table consists of the following information: the bank in which the partition resides; the size of the partition; the partition number; what terminal is currently attached to the partition; whether the partition is programmable; whether the partition has been defined as global and if so, what name it has been assigned; if a partition message has been set using the \$PART statement; the number of the partition to which the program, data, and global operator pointers currently point; where the last error was encountered; and the device number of the last I/O operation. Refer to \$PSTAT in the *BASIC-2 Language Reference Manual* for additional information on partition status.

## Move System Files (@MOVE)

The purpose of this utility is to allow for the installation and updating of system files. It does this by moving specified system files (files beginning with the "@" character) from one disk platter to another. The utility moves one file at a time. The Move System Files utility can be used to update system files by overwriting existing system files. The operator is notified if a file existing on the destination platter has the same name as the file to be copied and the utility requests permission to overwrite.

## Format Disk Platter (@FORMAT)

This program formats software formattable disk platters, such as 2260C, 2260BC, 2280 platters, dual-sided double-density diskettes and LVP fixed platters. Running this utility produces the same results as executing a \$FORMAT command. (Refer to the appropriate disk reference manual for detailed formatting information.)

## 2273 Vertical Format Control (@2273VFU)

This utility allows the user to define and edit the vertical format of the Model 2273 Band Printer's Direct Access Vertical Format Unit (DAVFU) without the difficulty of programming long code sequences. The user can create, edit, test, and save format data on disk for later loading into the DAVFU. Each time the utility is run, the user indicates whether to load a previously created format file or create a new one.

In creating a new vertical format, the user responds to operator prompts and specifies the number of lines per page, the number of lines per inch, and the location of the bottom of form. Once this information is supplied, an N x 12 grid appears on the CRT screen: N representing the specified number of lines and 12 being the number of channels of the DAVFU. The operator can edit the format by entering tabs indicating top-of-form in Channel 1 of line 1 and bottom-of-form in Channels 1 and 2 after the last line to be printed. The operator may also set tabs in the channels of other lines to indicate vertical stops.

## Backup Platter (@BACKUP)

The Backup Platter utility provides the ability to copy the contents of a single disk platter to another platter or to a series of smaller platters. The source and destination platter may be from any of the several types of disk drives used on the 2200LVP. The primary purpose of this utility is to allow the 2,4, or 8 megabyte fixed disks on the 2200LVP to be backed up onto several 1 megabyte diskette platters. This utility moves the entire contents of the source platter, including the catalog index if one is present.

This utility overwrites any information already contained on the platter(s) specified for output. Additionally, the backup platter(s) created by this utility stores file names in a data file instead of a copied catalog index and thus cannot be used for direct file access. To retrieve the contents of the backup platter(s), the Retrieve Platter utility must be used.

## Retrieve Platter (@RECOVER)

This utility is the complementary utility to the Backup Platter utility; it retrieves the contents of the platters produced by the Backup Platter utility and writes them onto another platter. The Recover Platter utility provides three options for recovering data.

1. Recover the entire content of the backup platter(s). If an exact copy of the original source platter is required, or if the source was an uncataloged platter, this option must be used.

2. Recover all the active files on the backup platter(s). This option provides an efficient means of removing all scratched files from the backup platter(s).
3. Recover select files from the backup platter(s). This option provides for the recovery of individual files from the backup platter. The files that are recovered may be added to a catalogued disk that need not be identical to the original source platter. This option also provides the ability to enlarge the size of the file if desired.

The Recover Platter utility can only be used to retrieve information from a platter created by the Backup Platter utility. More general file movement can be achieved by using the Move File utility.

#### Move File (@MOVEFIL)

The Move File utility provides a general file move capability. Specified files are moved from one platter to another; if necessary, a file can span more than one output platter. This utility can create a new file, change the new file size of the output file, rename a file, and overwrite an existing file. The Move File utility allows for the transfer of data between the 2200LVP system diskette drive and the 2270A diskette drive by providing a facility for conversion of a file from 256-byte sector format (standard Wang format) to 128-byte sector format (IBM 3741 format) and vice versa. The SSSD soft-sectored diskette (green label) must be used as the transfer medium between the two diskette drives.



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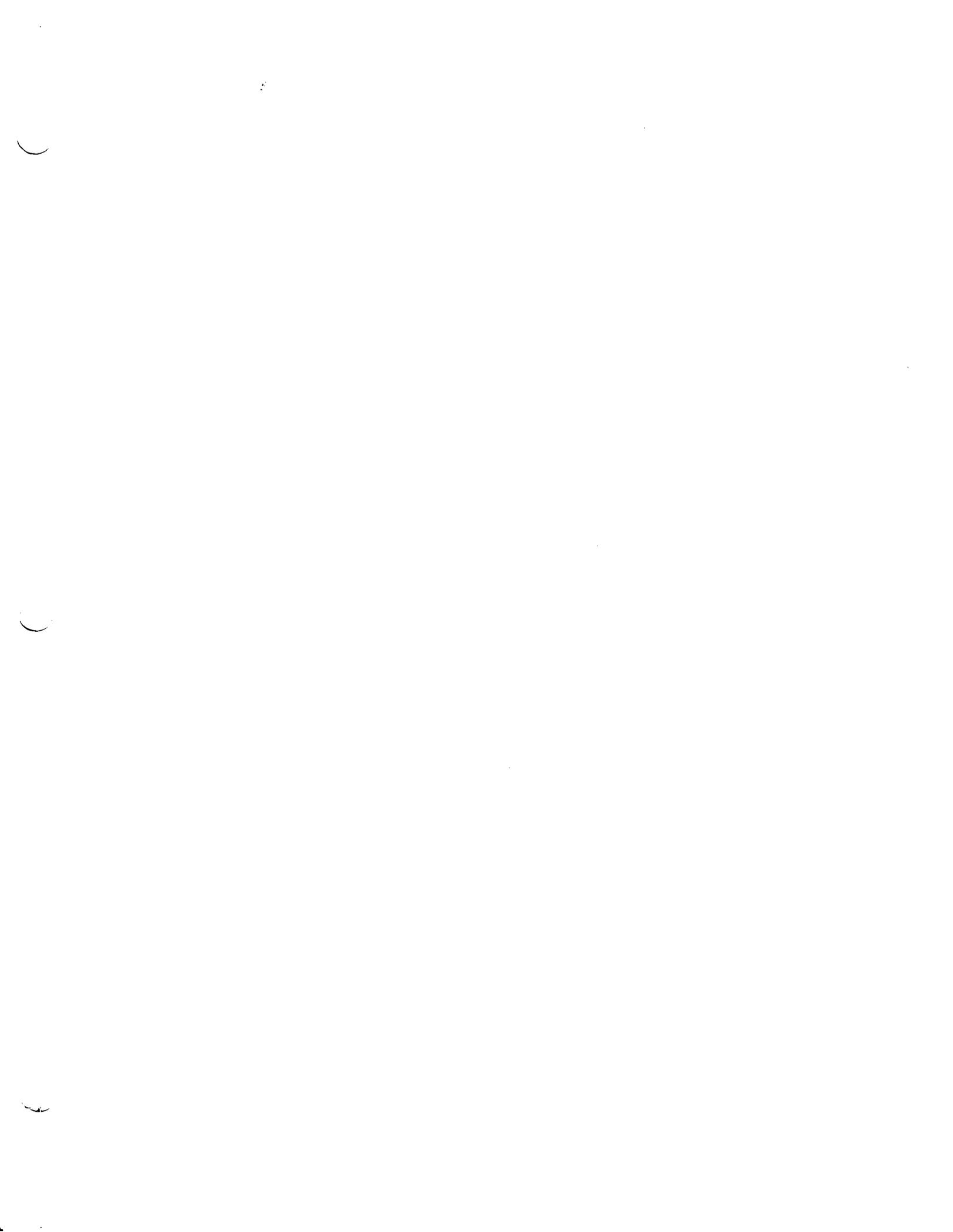
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