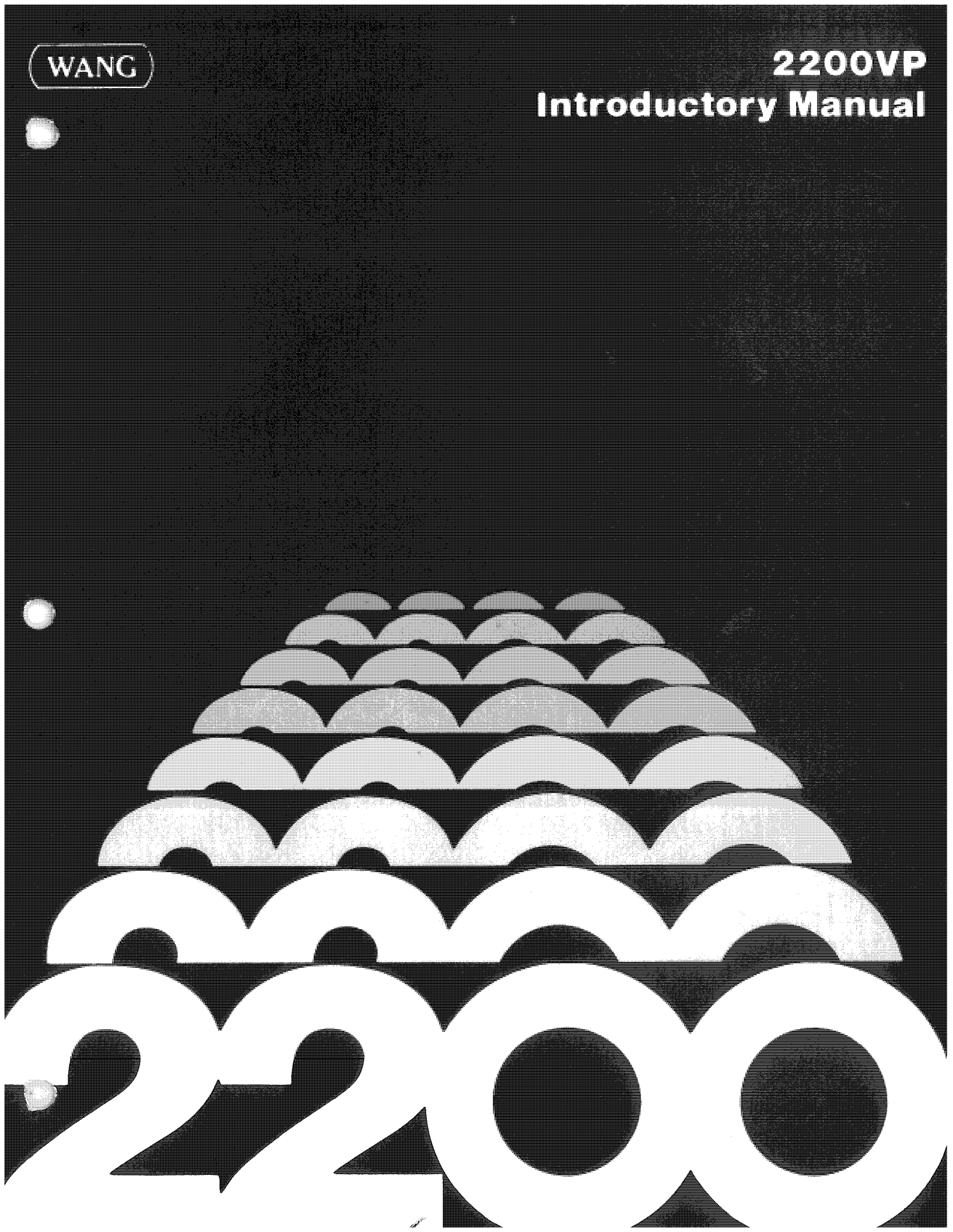
WANG

2200VP
Introductory Manual



2200VP INTRODUCTORY MANUAL

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HOW TO USE THIS MANUAL

This manual introduces the Wang 2200VP System to the user. It contains a description of the basic system and each of its integral components: the 2200VP CPU, the CRT display, the keyboard, and the disk drive. The routine maintenance procedures, Master Initializing the system, executing the user diagnostics, and backing up the system platter are also discussed.

This manual is intended to be used in conjunction with the following documentation which is supplied with every system:

- Programming in BASIC - Beginner's introduction to BASIC programming on the System 2200.

- The 2200VP/MVP BASIC-2 Language Reference Manual - Provides complete descriptions of the system's operational features, documents the extensive set of system commands, and describes in detail each instruction in the BASIC-2 instruction set.

- The 2200VP/MVP Disk Reference Manual - Describes loading and operating procedures for all 2200 series disk drives, and documents the complete set of disk I/O instructions.

In addition to these manuals, a separate reference manual is provided for each peripheral device attached to the system.

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CHAPTER 1: INTRODUCTION

1.1 SYSTEM OVERVIEW

The Wang 2200VP is a versatile, single-user, disk-based system which offers simplicity of operation and high-performance processing capability in a readily expandable, modular design. The basic 2200VP system components are:

- The 2200VP CPU with 16 to 64K bytes of user memory
- The System CRT and Keyboard (typically an integrated console unit)
- The Disk Drive (typically diskette)

The System Memory

Control memory and user memory are separate and distinct areas within the 2200VP CPU. Control memory is used exclusively by the operating system and BASIC-2 interpreter and cannot be utilized by the user or the user's programs. The user's programs and data are stored in user memory. The "memory size" of a system always refers to the size of user memory; for example, a 16K system contains 16K bytes of user memory, in addition to approximately 48K of control memory. A small portion of user memory (about 3K bytes) is reserved for system "housekeeping" operations, however, and cannot be used by the user's application programs or data. Thus, for example, the total available user memory in a 16K system actually is 16K-3K, or approximately 13K bytes.

The System Disk

The 2200VP operating system and BASIC-2 interpreter are loaded from disk into the control memory instead of hardwired. This allows the 2200VP operating system and interpreter to be easily upgraded without hardware modification. The system disk shipped with each 2200VP contains the BASIC-2 interpreter and operating system, and a variety of hardware diagnostic routines. The system disk 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 contains a discussion of how to load the operating system from the system disk into control memory, and suggested procedures for backing up the system disk.

The System Console

The user is free to configure any Wang CRT and keyboard with the 2200VP CPU. A 24 x 80 CRT with an audio signal is recommended, because the 2200VP utilizes the audio signal to indicate a variety of error conditions.

System Expandability

The system's modular design makes it easy to add memory and peripheral devices. The 2200VP CPU supports extension of user memory up to 64K bytes, and operating system upgrade to a 2200MVP (which supports multiple users). High-speed printers (up to 600 lmp), IBM diskette and 9-Track magnetic tape compatibility, telecommunications and special instrument controllers are also available. Appendix B contains a list of peripheral devices which can be added to the system. Up to four (4) Wang CPU's (any combination of 2200 Series CPU's except 2200VS) can be multiplexed to a common disk unit, allowing full independent remote access to and processing of a common disk data base.

2200VP BASIC-2 Language Features

The 2200VP is a general-purpose interactive system which can be programmed and controlled from the system keyboard using an enhanced version of the popular English-like BASIC language called "BASIC-2". The operator can interactively enter, modify, trace, renumber, and step through programs, and generate comprehensive program listings as well as individual cross-reference listings for variables, program and subroutine branches, and special function references.

Numeric operations are carried to 13 digits of accuracy for most operations, and the user may specify whether results are to be rounded or truncated at 13 digits. The dynamic range is:

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

The 2200VP supports both numeric and alphanumeric scalar and array variables. Depending upon the amount of memory available, the maximum number of elements in one-dimensional arrays is 65,536 and 255 x 255 in two-dimensional arrays. Each alphanumeric array element or alpha scalar variable can be from one 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 BASIC-2 language contains instructions for data testing and manipulation, and logical operations at the bit and byte levels which are comparable in scope to those available in many assembler languages. Special features have been added to better support formatting printed output for forms-filling applications (PRINTUSING, PRINTUSING TO), and formatting the CRT display for data entry operations (LINPUT, PRINT AT). Many general programming tasks are also supported including passing common data between overlayed program modules (COM, COM CLEAR), passing multiple arguments to a subroutine (GOSUB'), and testing for multiple conditions in a single statement (IF...THEN). Many data operation statements can support both numeric and alphanumeric expressions, and can operate on all or part of alphanumeric arrays, thus enhancing the system's data handling capability.

In addition to an extensive set of tailored I/O statements which support standard peripherals such as disks, printers, plotters, card readers, etc., two general-purpose I/O statements, $GIO and $IF ON/OFF enable the programmer to write custom-tailored I/O routines, to control non-standard I/O devices and to support special interfacing requirements such as telecommunications. Special statements are also provided to perform the complex task of converting data from one format to another, either for the purpose of interpreting information in a foreign format, or for packing data into a more efficient form for storage.

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

1.2 ENVIRONMENTAL CONSIDERATIONS

The 2200VP is designed to operate in normal office environments, but the environment should reflect concern for the effect it can have on the system's performance. An ideal environment is one in which the temperature and humidity are controlled and airborne contaminants are minimal. The AC power source should be grounded, adequate, 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 so as not to interfere with the system's smooth operation. A general rule of thumb would be "an environment comfortable for the operator will be acceptable for the system". Also see Appendix C, "Preventive Maintenance and Environmental Considerations."

1.3 UNPACKING, INSPECTION AND INSTALLATION

Special factory packing techniques require that the 2200VP 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 possible shipping damage, and verify the proper operation of all system components.

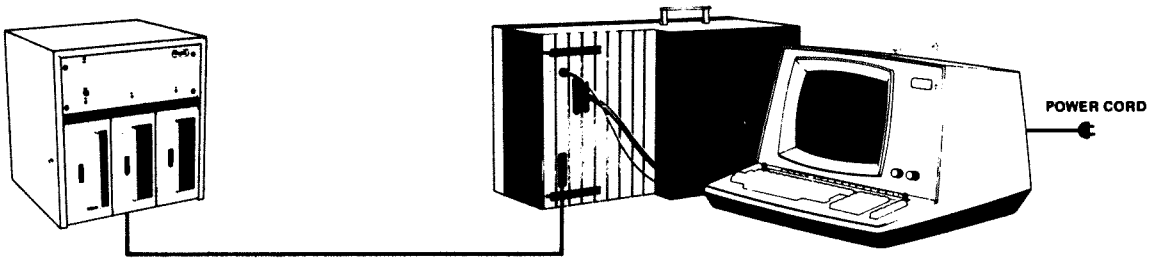


Figure 1-1. Typical 2200VP Configuration

CHAPTER 2: SYSTEM COMPONENTS

2 · THE CPU (CENTRAL PROCESSING UNIT)

The Central Processing Unit contains the logic and memory necessary to resolve and execute programs and perform arithmetic operations. The 2200VP CPU makes efficient use of memory by storing all programs in an "atomized" (condensed) form. The independent control memory uses very little of the user memory for operating overhead. Additionally memory parity is provided throughout user and control memory so most errors are automatically identified. The system permits multi-statement lines, a feature which helps to conserve memory and speed program execution, and also enables the programmer to logically group related statements, thus enhancing program documentation.

The standard 2200VP CPU contains 16K bytes (1K=1024 bytes) of user memory and nine I/O ports. Controller boards for peripheral devices are plugged into the I/O ports. User memory is expandable in 16K increments up to a maximum of 64K bytes. The operating system and BASIC-2 interpreter are loaded from a system disk or diskette into a separate 48K control memory area used exclusively by the operating system. Control memory cannot be accessed by the user or the user's programs. The "memory size" of a system refers to the size of user memory only. About 3K of the user memory is used by the operating system for housekeeping and cannot be used for user programs. Once the operating system has been loaded, the system disk can be removed, and the drive is available for the user's application disks. Some other features of the 2200VP CPU are:

Programmable Interrupt

- Up to eight different external devices can interrupt execution of a BASIC program and initiate a branch to a special routine which performs some interrupt processing. Upon completion of interrupt processing, the system resumes normal program execution immediately following the interruption point. This feature greatly enhances the system's real-time instrument monitoring and control and I/O processing capabilities.

Programmable I/O Device Selection

- Program control of computed or conditional device selection allows increased flexibility for I/O operations.

Error Diagnostics, Editing, Debugging, and Error Control

- System diagnostics automatically verify proper CPU operation whenever the system is Master Initialized. Additional diagnostics are performed to detect non-hardware errors during any system operation. Errors are identified with an error 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, and 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 interactively edit program lines, Immediate Mode lines, and input data values both during and after entry.

Every peripheral device attached to the CPU is identified with a unique device-address consisting of three hexadecimal digits. The device-address of the CRT normally is 005. The device-address of the keyboard normally is 001. If the diskette drive is the only disk unit on the system, the first, or leftmost slot normally has address 310, while the second slot has address B10. The device-address of each device is used by the system to electronically identify that device when information is to be transmitted to or from it. For a more complete discussion of device-addresses, see the BASIC-2 Reference Manual.

2.2 THE CRT

The CRT (cathode ray tube) video display is the system's principle means of displaying information to the operator. The recommended CRT can display up to 1920 characters of programs or data on the screen at any one time, allowing the user to easily review and modify program text or data. The optional audio alarm is used for signaling various information to the operator, and is a recommended CRT option.

Two CRT models are available: A 1024 character display consisting of 16 lines with each line containing 64 characters, and a 1920 character display consisting of 24 lines of 80 characters per line. Both CRT models can display the complete keyboard character set in both upper and lowercase, but the recommended 24 x 80 display additionally offers some foreign language characters, special symbols, and underlining. Lines are displayed sequentially on the screen. If more than the acceptable maximum of lines need to be displayed at any time, the new line is displayed at the bottom of the screen, all previously displayed lines move up one line and the top line leaves the screen.

The CRT display speed is approximately 20 microseconds/character. Display brightness and contrast can be adjusted by means of two controls located on the front panel adjacent to the screen.

A special display character resembling an underscore is used to indicate the location on the display where the next character entered will appear. This special character is called the cursor. As characters are entered, 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 is to take place. The cursor may also be moved to any display position under program control, a useful feature for prompting operator entry of data. In this case, cursor movement is controlled by the programmer with special hexadecimal codes called cursor control codes. The available cursor control codes are listed below:

HEXADECIMAL CODE	COMMAND
01	home cursor
03	clear screen, home cursor
05*	cursor on
06*	cursor off
08	cursor left
09	cursor right
0A	cursor down
0C	cursor up
0D	carriage return

*24 X 80 CRT only.

The CRT screen should be cleaned periodically with a mild soap and water using a soft cloth. Do not use an alcohol pad or abrasive compound which 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.

2.3 THE KEYBOARD

The keyboard is designed for users who are already familiar with standard typewriter keyboards and 10 key numeric keypads. 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 issue commands to the processor. See Figure 2-1.

Most keyboards have two modes of operation, selected by means of a toggle switch labeled "Keyword/A" and "A/a" on the upper left corner of the keyboard (see zone 1). On these keyboards the "Keyword/A" mode is specifically designed for use in program creation. When the keyboard is in "Keyword/A" mode, the BASIC-2 keywords that appear atop the alphabetic characters can be entered with a single keystroke simply by simultaneously depressing SHIFT and the desired key. Uppercase alphabetic characters are produced without shifting. Note that only those keys with keywords are affected by this mode switch.

The "A/a" mode causes the keyboard to function like a standard upper/lowercase keyboard for a typewriter. Depressing SHIFT and the desired character simultaneously yields an uppercase character. A lowercase character is produced if SHIFT is not depressed. This mode must be used if lowercase data entry is desired. Wherever the shift key is depressed the SHIFT indicator lamp to the left of zone 1 illuminates.

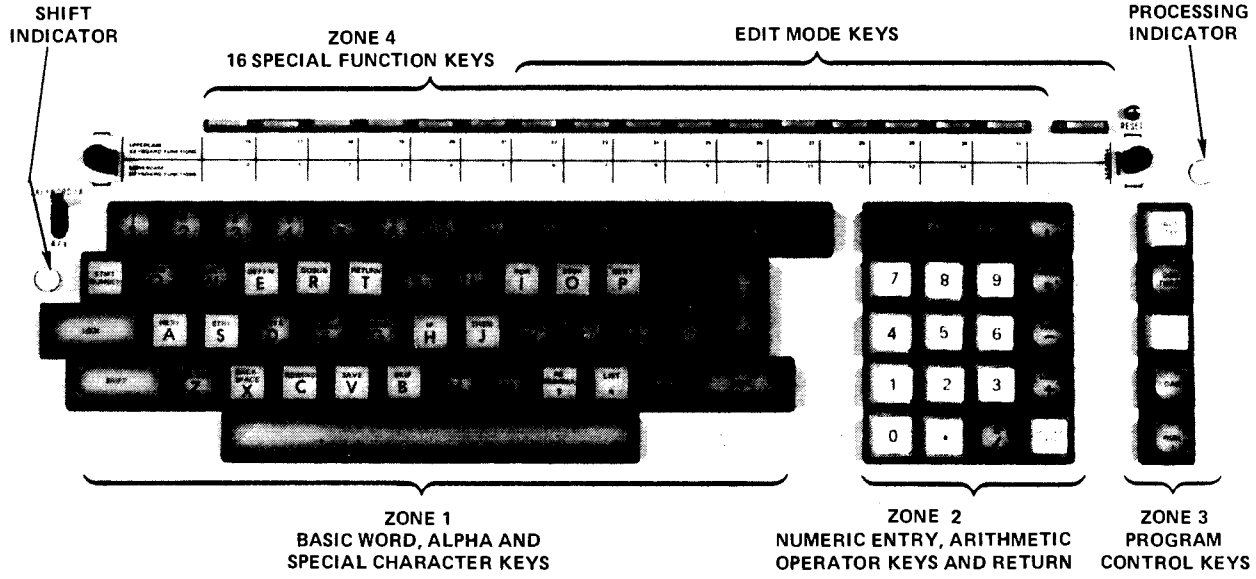


Figure 2-1. Typical Keyboard: Model 2210 and 2226 Consoles

The keyboard is divided into four zones as follows:

Zone 1 - The Alphanumeric Zone

The alphanumeric zone is designed for rapid entry of program text, alphanumeric data, special characters, and expressions. On most keyboards, this zone contains alphanumeric and special characters (e.g., #, $, %, etc.), many BASIC keywords (e.g., DIM, HEX, FOR, etc.) and command keys (e.g., STMT NUMBER, TRACE, RENUMBER, LIST, etc.) as well.

Zone 2 - The Numeric Zone

The numeric zone is designed as a standard 10 key numeric pad for rapid entry of numeric characters. The PRINT key in the upperleft corner facilitates the use of the system as a powerful calculator to perform Immediate Mode operations. 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. Additionally, the numeric zone contains the mathematical function keys (Arc, Sin, Cos, etc.), the arithmetic (+, -, *, ↑), and a RETURN(EXEC) on some keyboards.

Zone 3 - System Command Keys

The column of command keys at the right permit single-keystroke entry of some of the more commonly used system commands (e.g., HALT/STEP, RUN, LOAD, CONTINUE, and CLEAR). Above these keys slightly to the right is a lamp which illuminates when the processor is in operation.

Zone 4 - Special Function/EDIT Keys

Across the top of the keyboard are 16 user-programmable Special Function Keys. Since each of these keys may be depressed 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 depressing a key numbered 0-15 along with SHIFT accesses the functions from 16-31. Special Function Keys can be used to start program or subroutine execution or display a text string. The Special Function Keys are also used during Master Initialization to load the BASIC-2 Interpreter and operating system.

Depressing the EDIT key (to the right of the special function keys) places the system in EDIT mode. In EDIT mode the rightmost special function keys are changed from user-defined S.F. keys to system-defined EDIT keys. The EDIT mode provides powerful editing capabilities for program lines, Immediate Mode lines, and data. In each case characters can be altered, inserted, or deleted without retyping the entire line. Once the altered text line is entered (by depressing RETURN(EXEC)), the system automatically leaves EDIT mode. EDIT mode can also be entered under program control by executing the LINPUT statement.

EDIT	used to enter EDIT mode. When in EDIT mode, the following edit functions are available on the rightmost Special Function keys.
RECALL	recalls a program line 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.
END	moves the cursor to the end of the current text line.
↑	moves the cursor up to the previous CRT line (current text line 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).

The RESET button is located to the right of the EDIT key. RESET immediately stops the current operation (program execution, listing or I/O operations), clears the CRT, homes the cursor, displays "READY" and returns control to the console user (Console Input Mode). It is a "last resort" means of terminating program execution. RESET is also used during Master Initialization and execution of the hardware diagnostics.

2.4 THE DISKETTE DRIVE

The 2200VP CPU requires at least one Model 2270/2270A diskette drive or minidiskette (Model 2210 console) for loading the operating system. The diskette drive also provides an easily accessible direct-access external storage capability. Updates of the system software (BASIC-2 Interpreter, Operating System, etc.) will be shipped to customers on diskette. In this way the system can be upgraded without extensive hardware changes or additions.

At least two disk drives (any combination of disk, minidiskette or diskette) are recommended to facilitate file backup and processing .

Two diskette models and one minidiskette model are available for the 2200VP. The 2270 series diskette drives support only Wang diskettes. The 2270A series diskette drives support both standard Wang diskettes and IBM 3740 compatible diskettes. A number of larger "hard" disk drives also are available in sizes ranging from 2.5 million bytes to 20 million bytes.

Disk I/O Instructions

In BASIC-2 two types of disk I/O instructions are available to control disk operations: Automatic File Cataloging instructions, and Absolute Sector Addressing instructions. Automatic File Cataloging instructions permit the programmer to establish a catalog on the disk which will contain both program and data files, to save and load program files by name, and to open and access data files by name. (The system itself automatically keeps track of where each file is stored on disk.) A maximum of 16 data files can be open simultaneously for multiple-file processing operations. Additional features of Automatic File Cataloging Mode include the capability to move an entire catalog, or only selected files, from one disk to another; to save programs on disk in a protected format; and to automatically load and run multiple program modules in sequence. Absolute Sector Addressing statements permit the programmer to directly access specified sectors on the disk, and to read or write information in a user-specified format.

For detailed information concerning disk operations and BASIC-2 disk language features, see the 2200VP/MVP Disk Reference Manual. For more information concerning the compatibility features of the 2270A, refer to the IBM 3740 Compatibility Software Manual.

CHAPTER 3: MASTER INITIALIZING THE SYSTEM

3.1 "MASTER INITIALIZATION"

Master Initialization is the process of turning all components of the system ON, loading the operating system and BASIC-2 interpreter, and exercising the CPU to determine if any malfunctions exist. In the 2200VP, a small "Bootstrap" ROM contains the only resident (hardwired) microcode. Neither user memory nor control memory contain any information when the system is simply powered on. Before any meaningful operations can be performed by the system, the operating system and BASIC interpreter must be loaded from disk to control the processes of interpreting and executing the BASIC text, overseeing variable and program storage in user memory, controlling I/O, etc.

The bootstrap performs the functions of loading the operating system. The bootstrap routines are invoked automatically whenever the system is powered on. Essentially, the operator's only job is to make sure that the System Platter is properly mounted in a diskette drive, and to instruct the bootstrap routine, via the Special Function Keys and RESET button, which disk address to access and which system program(s) to load.

3.2 WHEN MASTER INITIALIZATION IS REQUIRED

Both user memory and control memory are cleared when the system is powered off. Therefore, the system must be Master Initialized following any power off operation, but not otherwise. In general, the system is powered off at the end of the working day, and must be Master Initialized only once at the start of the next working day. In rare instances, it may be necessary to power off and Master Initialize to recover from an error condition. Always save any desired programs or data in memory prior to powering off the system.

Because control memory and user memory are separate, it is possible to clear user memory without affecting control memory. This can be done with a CLEAR command. It is not necessary to Master Initialize the system following execution of a CLEAR command, because the contents of control memory are not destroyed.

3.3 THE PROCESS OF MASTER INITIALIZATION

The Master Initialization process can be summarized in the following steps:

1. Power ON the system (always power the system prior to mounting the system diskette).

2. Mount the system diskette.

3. Use the RESET and SF keys to instruct the "Bootstrap" to load the operating system and BASIC-2 interpreter from the system disk into control memory. (The bootstrap routines automatically check to determine that the disk is ready and the file exists on the mounted platter, verify Control and Data Memory parity, perform disk CRC and LRC checksums, and pass control to the system software once it is loaded in the Control Memory.)

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

Power on

To power the system ON, flip the POWER switches on the CPU and various peripheral devices to the ON position. The following message should appear on the CRT display:

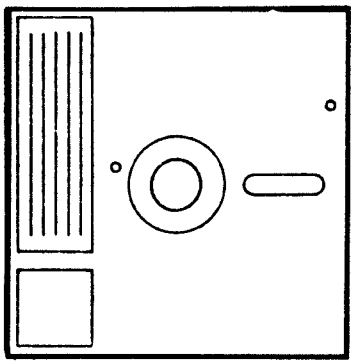
```
MOUNT SYSTEM PLATTER
PRESS RESET

_
```

If this display does not occur, or if it is incomplete, an error has been detected by the system diagnostics. Try Master Initializing the system again. If Master Initialization fails, see the "Master Initialization Error Recoveries" in Section 4.1. If recovery is not possible through these procedures, call Wang Service Personnel.

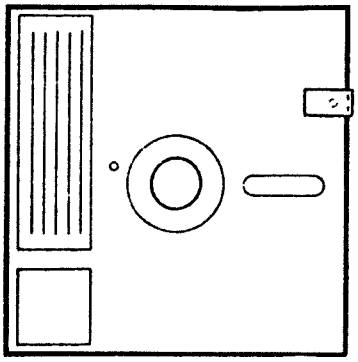
Mounting the System Disk

1. The following discussion applies to the series 2270 and 2270A diskette drives, the most common choices for a system disk unit. For instructions on mounting a minidiskette, see the Model 2210 Console Introductory Manual. With Minidiskettes, the Operating System/Interpreter and Diagnostics will reside on separate platters.

   Remove the system diskette 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. (Figure 3-1) When the notch is uncovered, no information can be written on the disk, and it is therefore protected against accidental destruction.



Write-Protect Enabled



Write-Protect Disabled

Figure 3-1.

Diskette showing Write-Protect Notch covered (writing on the disk is permitted) and uncovered (writing on the disk not permitted). System diskette notch should be uncovered.

2. Open the door of a diskette drive (at address 310, B10, 320 or B20 only) by depressing the door latch immediately to the left of the door (Figure 3-2.). The door will spring open.

3. Insert the diskette into the drive, paying careful attention to the arrows on the diskette jacket which indicate the proper orientation of the diskette for insertion (Figure 3-3.). If the diskette is not mounted properly, an error will be signalled when the system attempts to read from it. Push the diskette into the drive slot until it catches and holds in the slot. (Once it catches in the slot, do not attempt to remove the diskette manually; this can result in serious damage to both the drive and the diskette To remove the diskette, close the door until it latches, then depress the release button to eject the diskette.).

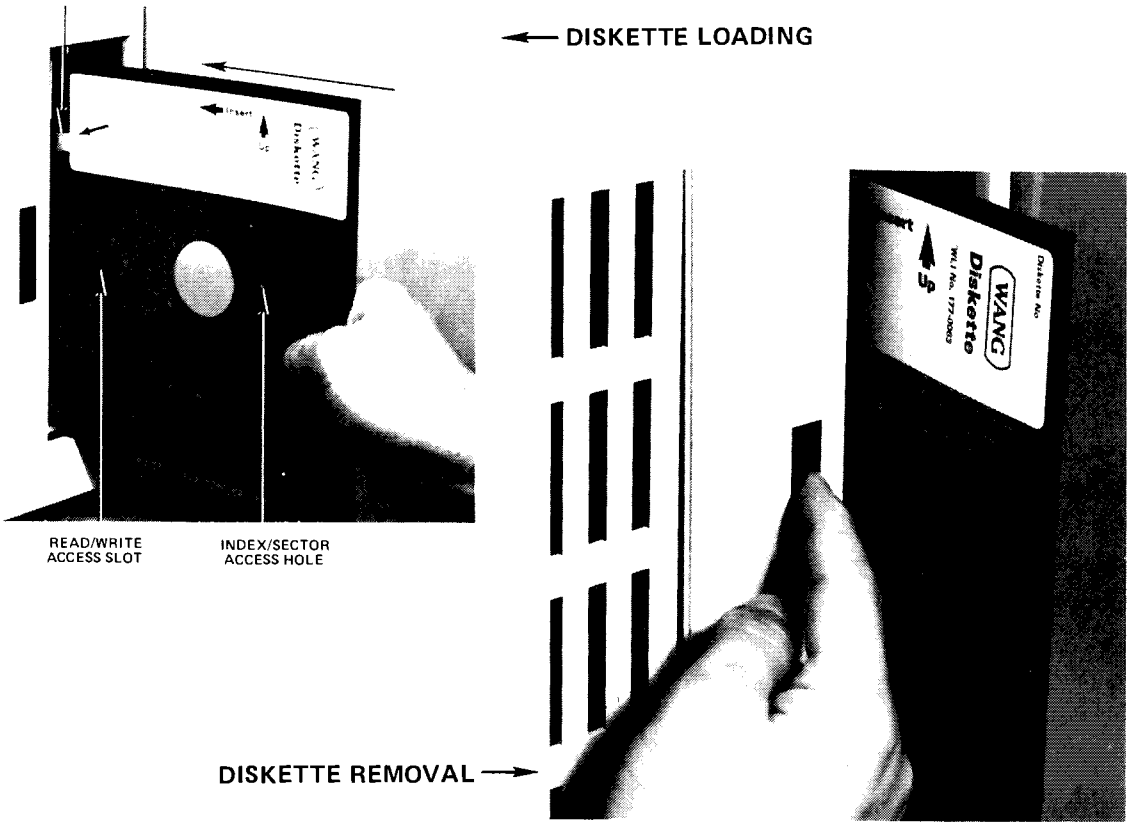


Figure 3-2.
Inserting/Removing a Diskette

4. Close the drive door by sliding it to the left until it locks in place.

5. After the system loading procedure is complete (see Figure 3-2.), the system diskette can be removed by depressing the drive door latch. The door will spring open, and the diskette will be ejected about halfway out of the drive slot.

Loading the System Programs

The system disk contains the BASIC-2 interpreter and operating system, as well as a variety of hardware diagnostics which can be loaded via Special Function Keys during Master Initialization. The use of the diagnostics is discussed in Chapter 4.

When the system disk is properly mounted, press the RESET button (located in the upper right corner of the keyboard). The following prompt is displayed:

```
KEY SF' ?
```

A Special Function Key must be depressed to specify the address of the disk drive in which the system disk is loaded. (The Special Function Keys are arrayed across the top of the keyboard; see Section 2.3.)

The following options are available:

```
SF Key 00 = Load BASIC-2 from disk address 310.
SF Key 01 = Load BASIC-2 from disk address B10.
SF Key 02 = Load BASIC-2 from disk address 320.
SF Key 03 = Load BASIC-2 from disk address B20.
```

Normally, the leftmost slot in the primary or default diskette unit is assigned address 310 and the second slot is assigned address B10. If there are two separate diskette units on the system, the leftmost slot on the second diskette unit is usually assigned address 320, and the second slot assigned address B20.

It takes about 15 seconds for the BASIC-2 interpreter and operating system to be loaded into control memory. While they are loading, the following message will appear:

```
LOADING BASIC-2 RELEASE X.X DATE MM/YY/DD
```

When the loading operation is complete, the system displays the following message:

```
READY (BASIC-2)

:_
```

The system is now ready for use.

If the wrong SF Key is depressed (i.e., if the system disk is mounted at address 310, but the operator depresses SF Key 01), an error message is displayed of the form:

```
*** SYSTEM ERROR DISK 00XX ***

PRESS RESET
```

It is generally easy to recover by simply pressing RESET and depressing the correct Special Function Key. If Reset fails, turn the system "off" then "on" again. Repeat the Master Initialization sequence.

3.4 BACKING UP THE SYSTEM DISK

The user's first act after loading the system programs should be to make a backup copy of the system disk. At least one copy should be made of the entire system disk (on another diskette, minidiskette or to one of the platters in a fixed/removable disk drive) in case of accidental damage to or destruction of the original. The MOVE statement is used for this purpose. The MOVE statement is explained in detail in the 2200VP/MVP Disk Reference Manual; the cursory explanation which follows is intended to provide the reader with only enough information to create a backup copy of the system disk. If only one disk drive is available, the system platter cannot be duplicated.

Copying The Entire System Disk:

1. Be sure the Write-Protect Notch on the backup disk platter (the new disk on which the copy is to be made) is covered. Insert the backup platter into the leftmost slot of the primary disk unit (address 310). Be sure the Write-Protect Notch on the system disk is UNCOVERED and insert the system disk into another drive slot.

2. The backup platter must be formatted before any information can be written on it. To format the diskette, first key RESET on the keyboard. Next, use a pen or pencil to depress the FORMAT button above Drive #1 on the disk control panel. (The FORMAT button is surrounded by a protective ring to prevent accidental activation of the formatting procedure, a safety feature necessary because the formatting operation automatically erases any data stored on the diskette.) The button must be held in for about one-tenth of a second, or until the format lamp above the drive slot illuminates.

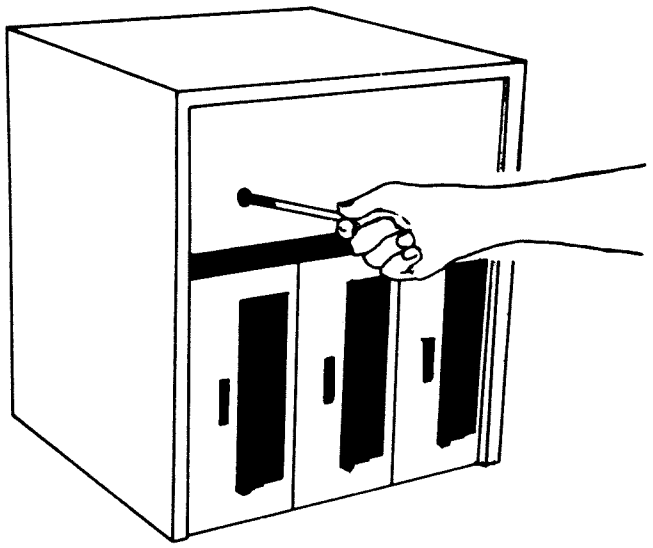


Figure 3-3. Formatting a Diskette

The format lamp remains illuminated throughout the formatting operation, which normally requires between 45 and 50 seconds. At the end of this time, the lamp should extinquish, indicating that the formatting process is complete. If the lamp remains lit for longer than 50 seconds, it is an indication that the system has experienced some difficulty with the format, and is attempting to reformat. If for any reason the diskette cannot be properly formatted, the format lamp will start to blink (refer to Chapter 3 in the 2200VP/MVP Disk Reference Manual). The procedure for formatting a fixed/removable hard disk platter is described in Chapter 2 of the 2200VP/MVP Disk Reference Manual. (The procedure for formatting a diskette or minidiskette is described in detail in Chapter 3 of that manual). The procedure for formatting a minidiskette is described in the Model 2210 Introductory Manual. Note: DO NOT FORMAT THE SYSTEM DISK.

3. Be sure that both the system disk and the new platter on which the copy is to be made are properly mounted. The system disk and the new diskette may be mounted in separate drive slots in the same diskette unit or they may be mounted in separate disk units.

4. If BASIC-2 is not currently loaded in system control memory, load it from the system diskette, following the procedure outlined in the previous section "The Process of Master Initialization".

5. Enter a statement of the form:

   MOVE T/xxx, TO T/yyy,

   Where T/xxx, is the address of the system disk, and T/yyy, is the address of the new diskette on which the copy will be made. BE SURE TO SPECIFY THESE ADDRESSES IN THE CORRECT ORDER. For example, assuming the system disk is mounted at address B10 and the new diskette is mounted at address 310, the following statement would be entered:

   MOVE T /B10, TO T /310,

   NOTE: The trailing comma (i.e., T/B10,) is required by BASIC-2 syntax. Failure to specify the comma yields ERR S13 (see Appendix F). For a detailed explanation of the errors which can occur during BASIC-2 operation, consult Appendix A of the BASIC-2 Reference Manual.

6. When the MOVE statement has been correctly entered, key RETURN(EXEC). The CRT colon will disappear while the MOVE operation is in progress. When the colon reappears, the Move is complete. The new copy must now be verified.

7. To ensure that the system programs have been correctly copied to the new platter, the new platter should be verified immediately following the MOVE operation. To verify the platter, a statement of the following form is used:

   VERIFY T /yyy,

   Where /yyy specifies the device address of the platter to be verified. For example, if the system platter has just been copied to a diskette at address 310, the following statement would be used to verify the new copy:

   VERIFY T /310,

   When the VERIFY operation is completed successfully, remove and carefully label the new copy.

   If the VERIFY operation reports an error, repeat the MOVE and VERIFY the platter again. If VERIFY still indicates an error, use a new platter for the copy. If VERIFY continually detects an error on the new platter, contact Wang Service personnel.

Copying a Specific File From The System Disk

The system disk contains a variety of system programs (BASIC-2 interpreter, operating system, and hardware diagnostics). System programs are stored on the disk in "Catalog Mode". (Consult the 2200VP/MVP Disk Reference Manual for an explanation of Catalog Mode.) Since the diagnostics are required infrequently, while the BASIC-2 interpreter and operating system must be loaded each time the system is Master Initialized, it may be convenient to copy the BASIC-2 interpreter and operating system to the fixed platter of a "hard" disk drive so that the system can be Master Initialized from the same location and the operator need not bother to mount a system platter each time.

In order to move a single file from the system disk to another platter, the programmer should have at least a rudimentary understanding of Catalog Mode (in particular, he must be familiar with the procedure for initializing a disk catalog with the SCRATCH DISK statement). It is suggested, therefore, that the programmer not undertake to copy any specific file from the System Platter until he has gained some familiarity with disk operations in Catalog Mode.

Although the system programs are stored in cataloged files, the programs themselves are not coded in BASIC-2; they are coded in 2200VP Assembler Language. For this reason, it is not possible to load them into user memory with the same techniques used for BASIC-2 programs (i.e., LOAD or LOAD DA). In order to copy specific files from the System Platter to another platter, the file-names must be specified one by one in MOVE statements. The BASIC-2 interpreter and operating system are contained in a single file on the system platter, whose file-name is "@@". (The "@" or "at" sign is located on the numeric key '2' in the alphanumeric zone of the keyboard.) This file can be copied to another platter with a statement of the form:

MOVE T/xxx, "@@" TO T /yyy,

Where T/xxx specifies the address of the system diskette (e.g., T/B10), and T/yyy specifies the address of the platter on which the file is to be copied (e.g., T/310). The procedure is identical to that specified in the previous section, except that step 3 will now be to scratch the destination disk (see the 2200VP/MVP Disk Reference Manual for explanations of Catalogue Mode and the SCRATCH DISK statement before attempting this operation). Note: this operation will not be successful unless a catalog has been opened on the destination platter with a SCRATCH DISK statement.

The diagnostics can be copied in a similar manner; however, each will have to be moved separately. Note the file names for programs on the system disk can be displayed by listing the Catalogue Index (i.e. LIST DC).

CHAPTER 4: SYSTEM ERRORS AND ERROR RECOVERIES

4.1 TYPES OF SYSTEM ERRORS

The 2200VP CPU performs two different types of system error diagnostics: the CPU hardware error diagnostics and the general system error diagnostics. General recovery procedures for errors are outlined in this chapter. When these procedures fail, try the more specific procedures discussed in Appendix F.

The CPU hardware error diagnostics are designed to detect and report any malfunction which occurs in the CPU hardware (registers, user and control memory, etc.). Whenever a location in memory is accessed, the system automatically performs a parity check to ensure that the accessed memory contents are valid, and that the accessed location is not faulty. Additionally, whenever RESET or CLEAR is executed, all of memory is automatically verified, and the operator alerted to any error condition. If a hardware error is discovered, a SYSTEM ERROR message is displayed. Although there are several courses of action, the hardware errors require some manually performed corrective procedure.

General error messages, by contrast, are designed to alert the user that an illegal operation has been attempted or to notify the user that a desired operation cannot, for some reason, be carried out. Those general system errors which are not hardware related can be handled under program control in a user-application program. General error messages are signaled by a two-digit number with a letter prefix accompanied by an arrow which points to the approximate location of the error in an Immediate Mode or Program Mode line. The types of general error diagnostics which are performed by the system, and the techniques for recovering from such errors are described in the 2200VP/MVP BASIC-2 Language Reference Manual.

Types of CPU Hardware Errors

There are several possible system error messages that can be reported during Master Initialization or afterward when the operating system is in control. These hardware errors cannot be handled under program control. Since they represent a malfunction in the system hardware which may or may not be transient, hardware errors cast doubt on the validity of any information supplied to or by the system after the point at which they occur. If they persist, such errors require the attention of a Wang Field Service Representative.

Master Initialization Error Recovery

The general procedure to recover from Master Initialization errors is shown below. When the general procedure fails, call the Wang Service Representative.

1. When the power is turned ON, the bootstrap fails to display the complete "MOUNT SYSTEM PLATTER (CR/LF) PRESS RESET" message on the CRT. This condition usually indicates a CPU-related error or an I/O-related error. Check the cabling and device addresses and power on the system again.

2. Having responded to the "KEY SF'?" message by keying a Special Function Key:

   a) The hexdigit display of the Special Function Key did not appear on the CRT. This implies that the Special Function Key was not depressed sufficiently or the wrong key was pressed. Depress RESET, then 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 disk specified. Check to make sure that the system platter is properly mounted at the specified address and depress the desired Special Function Key again.

   c) The "***SYSTEM ERROR DISK 00XX*** PRESS RESET" message appears. This implies that an error occurred while the bootstrap was trying to load the disk file specified by the SF Key. Make sure the platter is properly mounted and depress RESET, then the desired Special Function key. If the general procedure fails, see the table of disk errors in Appendix F for a more specific recovery procedure.

3. A SYSTEM ERROR message is reported to the operator on the CRT whenever the operating system detects disk, parity, or verify errors during its normal operation. A memory failure causes the following message to appear:

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

where MMMM = PECM - Parity Error Control Memory
             PEDM - Parity Error Data Memory
             VECM - Verify Error Control Memory
             VEDM - Verify Error Data Memory

       XXXX = Location of Error
```

General Hardware Error Recovery

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, see the table of system and disk errors in Appendix F, "System Error Displays and Recovery Procedures", for more detailed recovery procedures. If these procedures fail or a System Error condition is recurrent, call the Wang Service Representative.

Key RESET in response to the "PRESS RESET" message on line 1 of the CRT, then choose one of the three following courses of actions in response to the "Key SF" message on the CRT.

1. Key SF'16-'19 to load the diagnostic menu, from which you may choose a particular diagnostic. See section 4.2. This is the recommended procedure but should be used only when the current contents of user memory are reproducable. If the current contents of user memory cannot be reproduced, (i.e. must be salvaged) execute procedure 3. If no errors are discovered during the execution of the diagnostics, the error condition can be presumed transient. Proceed with procedure 2. If an error is discovered by the diagnostic, or while attempting procedure 2. or 3. another failure occurs, call the Wang Service Representative.

2. Power OFF then ON. Key SF'0-'3 to load BASIC-2 from disk 310, B10, 320, or B20, respectively, in order to start over again. This option should be exercised when there is no need to save the current contents of user memory. The system will be returned to Console Input Mode and the "READY BASIC-2" message will be displayed. The previous contents of user memory are erased. 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 (the CPU was jarred or a cable was stepped on, or shaken loose, etc.).

3. Key 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 to Console Input mode and the "READY BASIC-2" message will be displayed. At this point the user can determine where the program was when the system error was encountered (by printing out the key variables) since user memory was not erased. However, since a RESET has been performed, program execution cannot be continued from that point, but must be restarted with a RUN command. This procedure is undertaken at the user's risk since the hardware error may recur and the operating system may not function properly. This procedure is not recommended.

4.2 USING THE HARDWARE DIAGNOSTICS

The Hardware Diagnostics are a set of programs which exhaustively test the CPU hardware components and attempt to identify any malfunctions. The diagnostics can be run only after Master Initialization. The diagnostics run continuously until RESET is depressed or an error is detected. When an error is detected, diagnostic processing stops, the loop count is not incremented, and error messages are displayed. For a discussion of possible error causes see Appendix F, "Diagnostic Error Displays." If a hardware error recurs, call Wang Service Personnel.

A hardcopy listing of the diagnostic messages which duplicates the CRT display can be obtained by turning on the printer during diagnostic execution. The printer must be assigned address 215 and SELECTED (depress SELECT on the printer). It is recommended that a hardcopy trace of the diagnostic run be obtained because it will be helpful to the Service Personnel in locating and correcting the problem. If NO errors occur, the output will consist of only the name of the current test. When errors occur, they will be printed under the appropriate text title, for example:

```
MATC&S
ROWPAT TEST -8 BIT RAM
FAILURE AT PC'S 3001 (00/34)
BIT(s) 04 10 20 #0000
```

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:

(1) At least once every 60 to 100 hours of light-to-normal operation.

(2) Whenever errors cause a hardware malfunction to be suspected.

(3) Whenever a Wang Service Representative requests their execution.

It is best to execute 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 attributable to static electricity, EMI environmental problems and excessive airborne dust and dirt. Prolonged operation in a dirty environment produces permanent failure. In general, every effort should be made to secure an environment which, if not optimal, at least falls within the recommended ranges.

Refer to Table 4-1 for a functional description of each diagnostic and its sequence interval. Note that the menu must be reselected (Key RESET, then the appropriate SF' key) after each diagnostic in order to select any other diagnostic. To reselect BASIC-2, key SF'00 to 03.

TABLE 4-1

DIAGNOSTIC	FUNCTION	SEQUENCE INTERVAL
CPU	Tests the 2200VP processor.	3 passes per second
CONTROL MEMORY	Tests Control Memory.	3 minutes per pass
DATA MEMORY	Tests Data Memory.	up to 1.5 minutes per pass

Loading The Diagnostics Menu

Turn the system OFF (if it is ON). Turn the system ON, depress RESET, then depress one of the following SF keys:

SF Key 16 = Load Diagnostics from disk 310.
SF Key 17 = Load Diagnostics from disk B10.
SF Key 18 = Load Diagnostics from disk 320.
SF Key 19 = Load Diagnostics from disk 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
```

The CPU Diagnostic

This diagnostic is designed to test the 2200VP processor.

Depress SF'00 CPU Diagnostic

LOADING CPU DIAGNOSTIC (DATE) AT (TIME) R00

should be displayed for approximately 5 seconds, followed by

```
  CPU DIAG PASS LLLL
IMMED REG XX
REG INSTR XX
X-  REG INSTR XX
MASK BR XX
REG BR XX
IMMED R/W XX
REG R/W XX
AUX/STACK R/W XX
```

where: LLLL = number of completed loops
XX = test number

This test runs continuously until either an error occurs (the pass number stops incrementing) or RESET is keyed. If an error occurs call Wang Service Personnel. When satisfied that a sufficient number of successful test passes have occurred (5 to 10 minutes), key RESET. The Diagnostics menu can be restored to the screen or BASIC-2 can be reloaded by pressing the appropriate SF key.

The Control Memory Diagnostic

These diagnostics are designed to test the control memory by reading control memory and searching for a location which may have been changed by writing its contents into a different location. When the system is unable to execute a particular instruction, the CRT will display the location of the failing instruction.

Depress SF'01 Control Memory Diagnostic

LOADING CONTROL MEMORY DIAG (DATE) AT (TIME) R00

should be displayed for approximately 5 seconds, followed by

```
24 BIT ADDRESSING TEST
#LLLL
```

After this addressing test, the screen should blank out for several seconds (normal operation), following which,

```
24 MATC&S - MEM SIZE = (SSK)
RC =
```

should be displayed. After the MAT C&S (Mat copy and search) test, the display again blanks out for several seconds. The next display is the ROWPAT (Rowpatterns) test:

```
ROWPAT TEST - 24 BIT RAM
#LLLL
```

These SF'01 tests are repeated in sequence until either an error occurs, or RESET is keyed. When satisfied that a sufficient number of successful test passes have occurred (at least 5 to 10 passes), press RESET.

The User Memory Diagnostic

This diagnostic is designed to read from the start of memory to end of memory and vice versa searching for a memory location which may have been changed by writing into a different location.

Depress SF'02 Data Memory Diagnostic

```
LOADING DATA MEMORY DIAG (DATE) AT (TIME) R00
```

should be displayed for approximately 5 seconds. As with the Control Memory diagnostics, the display will be blanked for several seconds between tests.

```
8 BIT ADDRESSING TEST
#LLLL
```

Data Memory addressing is the first test, followed by:

```
MAT C&S - MEM SIZE = (SSK)
RC = 05
#LLLL
```

The third and last Data Memory test is:

```
ROWPAT TEST - 8 BIT RAM
#LLLL
```

SF'02 tests are also repeated in sequence until either an error occurs, or RESET is keyed. When satisfied that a sufficient number of successful test passes have occurred (at least 5 to 10 passes), key RESET.

At the completion of the diagnostic tests, the operator can pass control to the BASIC-2 operating system by depressing RESET then depressing the appropriate special function key to load in the operating system.

APPENDIX A: 2200VP CPU SPECIFICATIONS

Dynamic Range

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

Precision

13 digits standard (variable)

Maximum Data Rate

100,000 bytes/sec

Memory Size

16K bytes (standard). Expandable to a maximum of 64K bytes in 16K increments.

Power Requirements

Voltage	115 VAC $\pm$ 10%, 50 or 60 Hz $\pm$ 1Hz 230 VAC $\pm$ 10%, 50 or 60 Hz $\pm$ 1Hz
Power	230 Watts
Fuses	3ASB @ 115V 1.5ASB @ 230V

CPU Dimensions

Height. . . . . .12.1 in. (30.7 cm)
Width . . . . . .14.5 in. (36.8 cm)
Depth . . . . . .21 in. (53.3 cm)
9 I/O Ports.

Shipping Weight

47 lb (21 kg)

APPENDIX B: AVAILABLE PERIPHERALS

All Wang peripheral devices except the 2214 Manual Card Reader, Teletype, and tape cassette can be supported by the 2200VP:

2200 WS	Disk Work Station CPU . . . . .
2201L	Output Writer (156 col/15 cps). . . . .
2202	Plotting Output Writer (156 col/15 cps) . . . . .
2207A	RS-232-C I/O Controller . . . . .
2209	Nine-track Tape (800 BPI-NRZ1). . . . .
2209A	Nine-track Tape (1600 BPI-PE) . . . . .
2210	Integrated Console (Minidiskette, 12" CRT, keyboard) with(16 x 64) or (24X80) CRT . . . . .
2221M	Printer Multiplexer . . . . .
2221W	Matrix Line Printer (132 col/200 CPS) . . . . .
2226	Integrated Console (12" CRT, keyboard) with (16 x 64) or (24X80) CRT. . . . .
2227B	Buffered Asynchronous Communications Controller. . . . .
2227N	Null Modem for 2227B Controller . . . . .
2228B	Bisynchronous Asynchronous Communications Controller . . . . .
2228N	Null Modem for 2228B Controller . . . . .
2230MXA, MXB	Disk Multiplexer Controllers. . . . .
2231W-1,-2,-3	Matrix Line Printers (W-1 112col/120 cps, W-2 132 col/120 CPS, W-3 132 col/120 cps) . . . .
2232B	Digital Flatbed Plotter (31"X48") . . . . .
2236	Interactive Terminal. . . . .
2236MXC	Interactive Terminal Multiplexers . . . . .
2244A	Hopper Feed Punched/Mark Sense Card Reader. . . . .
2250	8 bit Parallel I/O Interface Controller . . . . .
2251	Matrix line Printer (40 col/110CPS) . . . . .
2252A	Scanning Input Interface Controller (BCD 1-10 digit parallel) . . . . .
2254	IEEE-488 Interface Controller . . . . .
2260B	F/R Disk Drives (2.5, 5, 10 or 20 megabytes). . . . .
2261W	Matrix Line Printer 240 LPM . . . . .
2263-1, -2	Chain Line Printers 400 and 600 LPM . . . . .
2270-1, -2, -3	Wang Diskette Drive (.25, .50, .75 megabytes). . . . .
2270A	Wang IBM 3740 Compatible Diskette Drive (.25, .50, .75 megabytes) . . . . .
2271	Bidirectional Output Writer (15 cps). . . . .
2271P	Bidirectional Plotting Output Writer (15 cps). . . . .
2272-2	Triple Pen Drum Plotter . . . . .
2281	Daisy Output Writer (40 CPS). . . . .
2282	Graphic CRT . . . . .
2290	CPU/Peripheral Stand. . . . .

2291	2232B Plotter Stand . . . . .
2294	WCS Stand . . . . .
2295	2231W Printer Stand . . . . .
FS-2	WCS 20/30 Desk (right hand) . . . . .
FS-2L	WCS 20/30 Desk (left hand). . . . .
DE-1	F/R disk enclosure. . . . .

APPENDIX C: PREVENTIVE MAINTENANCE AND ENVIRONMENTAL CONSIDERATIONS

PREVENTIVE MAINTENANCE

It is recommended that your equipment be serviced semi-annually. A Maintenance Agreement is available to assure this servicing automatically. If no Maintenance Agreement is acquired, any servicing must be arranged for by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

Preventive Maintenance

> Your equipment is inspected semi-annually for worn parts, adjusted, lubricated, cleaned and updated with any 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. does not honor Maintenance Agreements for nor guarantee any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user.

ENVIRONMENTAL CONSIDERATIONS

When the recommended temperatures are 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 which 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 certainty of static build-up and 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 an uncomfortable several thousand volts, might also cause system errors or destruction of data. Humidifiers or dehumidifiers should be installed in the environment's heating, ventilating and air conditioning system as required.

If carpeting is to be installed, it should be a non-static variety. If carpeting already exists, and it is not non-static, it must be treated with non-static 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 build-up.

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 example of EMI is a television, becoming full of "snow" when a car with a poorly tuned engine idles outside (radiated EMI), or when someone turns on a hairdryer 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 in close proximity to the system area they must be relocated, repaired, or filtered to prevent them from disturbing 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 2200VP CPU requires three (3) amperes @ 115 VAC therefore, as with most Wang systems, a 20 ampere, 115 VAC power line properly grounded and regulated to within $\pm$ 10% should be adequate depending upon the other equipment on the line.

The recommended operating environment is defined by the following parameters:

Temperature: 65° to 75°F (18° to 24°C)
Relative Humidity: 35% to 65%, non-condensing
Dust: NO Accumulation should be obvious in a 24 hour period
Power: Grounded, noise-free, dedicated 115 or 230 VAC ±10% 50 or 60 Hz±1Hz
Interference: All sources of static electricity, extreme magnetism and EMI shall be controlled

There are other considerations to keep in mind that do not specifically fall into the major categories:

- Keep an accurate service history on all equipment.
- Food, beverage, smoking and other non related activity is not recommended in the system area.
- 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 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 disk.
- Date the media when you first begin using it, as it is advisable to replace media over two years old. Use felt-tip pens to write on the media label. Never use an eraser to alter a label, use a new label.
- ALWAYS make a duplicate copy (back-up) of tapes and diskettes, then store the back-up in a safe place, preferably 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 which might impede proper air flow.

APPENDIX D - THE 2200VP INSTRUCTION SET

Alphanumeric Data Manipulation and Binary Arithmetic Instructions

Instructions for data manipulation and logical operations, as well as a limited binary and packed decimal arithmetic capability provide the programmer with a facility for testing and modifying the structure of data at the bit and byte levels which is comparable in scope to that of many assembler languages.

Logical Operator and Alphanumeric Functions

AND,OR, XOR	NUM
BOOL	POS
ALL	STR
BIN	VAL
HEX	VER
LEN	

Binary and Packed Decimal Arithmetic Operators

ADD(C)
DAC
DSC
SUB(C)

System-Defined Numeric Functions and Arithmetic Operators

(trigonometric functions are supported in degrees, radians, or grads)

INT	LGT
FIX	LOG
ABS	EXP
SGN	#PI (π)
MOD	SIN
ROUND	COS
RND	TAN
SQR	ARCSIN
MAX	ARCCOS
MIN	ARCTAN

+ Addition	/ Division
- Subtraction	↑ Exponentiation
* Multiplication	

System Commands

System commands directly control system operations from the keyboard. They also provide a number of convenient and powerful debugging features to interactively modify, trace, renumber, and step through programs, and to automatically generate comprehensive program listings as well as cross-reference listings for variables, program and subroutine branches, and special function references.

CLEAR	LOAD	LIST #
CONTINUE	RENUMBER	LIST'
HALT/STEP	RESET	LIST D
LINE NUMBER	RUN	LIST T
LIST	SAVE	
LIST V	TRACE	

Disk Control Instructions

Two types of disk I/O instructions are provided. Automatic File Cataloging instructions permit the programmer to catalog and save on the disk both program and data files. One can save and load program files by name, and open and access data files by name (the system itself automatically keeps track of where each file is stored on disk). A maximum of 16 data files can be open simultaneously for multiple-file processing operations. Automatic File Cataloging Mode includes the capability to move an entire catalog, or only selected files, from one disk to another; to save programs on disk in a protected format; and to automatically load and run multiple program modules in sequence.

Absolute Sector Addressing statements allow the programmer to create a unique file management system by permitting the programmer to directly access explicitly specified sectors on the disk, and to read or write information in a specified format, in addition to providing the programming features of the automatic file mode.

Automatic File Cataloging Instructions

LOAD	DATASAVE DC CLOSE
SAVE	LIST DC
DATASAVE DC OPEN	LIMITS
DATALOAD DC OPEN	MOVE
DATASAVE DC	SCRATCH DISK
DATALOAD DC	SCRATCH
DBACKSPACE	MOVE END
DSKIP	VERIFY

Absolute Sector Addressing Instructions

LOAD DA	DATALOAD BA
SAVE DA	DATASAVE BA
DATALOAD DA	COPY
DATASAVE DA	VERIFY

General-Purpose Statements

Features have been added to better support applications such as formatting printed output for forms-filling applications (PRINTUSING, PRINTUSING TO), and formatting the CRT display for data entry operations (LINPUT, PRINT AT). Many general programming tasks also are supported, including such operations as passing common data between overlayed program modules (COM, COM CLEAR), passing multiple arguments to a subroutine (GOSUB'), and testing for multiple conditions in a program statement (IF ... THEN). Many data operation statements can support both numeric and alphanumeric expressions, and can operate on all or part of alphanumeric arrays, thus enhancing the system's data handling capability.

COM	MAT COPY
COM CLEAR	MAT MOVE
DATA	MAT SEARCH
DEFFN	ON/GOSUB
DEFFN'	ON/GOTO
DIM	ON/SELECT
END	PRINT
FN	PRINT AT
FOR ... TO	PRINT HEXOF
GOSUB	PRINT TAB
GOSUB'	PRINTUSING
GOTO	PRINTUSING TO
IF ... THEN	READ
Image (%)	REM
INPUT	RESTORE
KEYIN	RETURN
LET (Assignment)	RETURN CLEAR
LINPUT	STOP

Data Conversion Statements

This group of instructions is designed to simplify the complex task of converting data from one format to another, either for the purpose of interpreting information in a foreign format, or for packing data into a more efficient form for storage in a data file.

CONVERT	$PACK
$FORMAT	ROTATE
HEXPACK	UNPACK
HEXUNPACK	$UNPACK
PACK	$TRAN

Math Matrix Statements

A set of Linear Algebra statements is provided to perform matrix arithmetic operations.

MAT addition	MAT identity
MAT subtraction	MAT zero
MAT multiplication	MAT constant
MAT scalar multiplication	MAT redimension
MAT inversion	MAT READ
MAT transposition	MAT PRINT
MAT assignment	MAT INPUT

Sort Statements

This group of statements provides high-speed sort and merge capability.

MAT MERGE
MAT MOVE
MAT SORT

Additional I/O Statements

In addition to an extensive set of tailored I/O statements to support standard peripherals such as disks, printers, plotters, half inch tape, and card readers, etc., two special statements provide an extremely versatile general I/O control capability. $GIO is a powerful instruction which enables the programmer to write customer-tailored I/O routines for most buffered peripherals in a language similar to machine language, and execute them within the framework of the high-level BASIC-2 language. Data transfer rates up to 100,000 bytes per second can be achieved in a $GIO routine. $IF ON/OFF can be used to test for device READY/NOT READY condition and branch accordingly. These two statements provide the flexibility to support all types of instrumentation interfacing, as well as special interfacing requirements such as telecommunications.

APPENDIX E THE CRT CHARACTER SETS

24 x 80 CRT CHARACTER SET

The following chart shows the character set and control codes for the 24 x 80 CRT of the Model 2210 and 2226 consoles. All characters with hex codes in the range 10 to 7F may be printed with underlining by adding hex 80 to the character's hex value. The 24 x 80 CRT is considered standard in the 2200VP System.

CONTROL CODES

HEX	ACTION	HEX	ACTION	HEX	
00	NULL	06	CURSOR OFF	0A	CURSOR↓
01	HOME CURSOR	07	AUDIBLE TONE	0C	CURSOR↑
03	CLEAR SCREEN, HOME CURSOR	08	BACKSPACE	0D	CARRIAGE RETURN
05	CURSOR ON	09	NON-DESTRUCTIVE SPACE		

CHARACTERS

HEX	CHAR	HEX	CHAR	HEX	CHAR	HEX	CHAR
10	â	30	0	50	P	70	p
11	ê	31	1	51	Q	71	q
12	î	32	2	52	R	72	r
13	ô	33	3	53	S	73	s
14	û	34	4	54	T	74	t
15	ä	35	5	55	U	75	u
16	ë	36	6	56	V	76	v
17	ï	37	7	57	W	77	w
18	ö	38	8	58	X	78	x
19	ü	39	9	59	Y	79	y
1A	à	3A	:	5A	Z	7A	z
1B	è	3B	;	5B	[	7B	ß
1C	ù	3C	<	5C	\	7C	£
1D	Ä	3D	=	5D	]	7D	¢
1E	Ö	3E	>	5E	↑	7E	¿
1F	Ü	3F	?	5F	←	7F	¿
20	SPACE	40	@	60	`	80	NULL
21	!	41	A	61	a	81	♦
22	"	42	B	62	b	82	▶
23	=	43	C	63	c	83	◀
24	$	44	D	64	d	84	→
25	%	45	E	65	e	85	_
26	&	46	F	66	f	86	|
27	'	47	G	67	g	87	¨
28	(	48	H	68	h	88	'
29	)	49	I	69	i	89	`
2A	*	4A	J	6A	j	8A	^
2B	+	4B	K	6B	k	8B	■
2C	,	4C	L	6C	l	8C	‼
2D	–	4D	M	6D	m	8D	↕
2E	.	4E	N	6E	n	8E	β
2F	/	4F	O	6F	o	8F	¶

16 x 64 CRT CHARACTER SET

The following chart shows the character set and control codes for the 16 x 64 of the Model 2210 and 2226 consoles.

High Order Hexadecimal Digit of Code

Low Order Hexadecimal Digit Of Code	0	1	2	3	4	5	6	7
0	NULL		SPACE	Ø	@	P	prime	p
1	HOME (CRT)	X-ON	!	1	A	Q	a	q
2			"	2	B	R	b	r
3	CLEAR SCREEN (CRT)	X-OFF	#	3	C	S	c	s
4			$	4	D	T	d	t
5			%	5	E	U	e	u
6			&	6	F	V	f	v
7	BELL		' (apos)	7	G	W	g	w
8	BACKSPACE (CRT CURSOR ←)		(	8	H	X	h	x
9	HT (TAB) or (CRT CURSOR →)	CLEAR TAB	)	9	I	Y	i	y
A	LINE FEED (CRT CURSOR ↓)	SET TAB	*	:	J	Z	j	z
B	VT (VERTICAL TAB)		+	;	K	[	k	{
C	FORM FEED OR REV. INDEX (CRT CURSOR ↑)		,	< or [	L	\	l	|
D	CR (CARRIAGE RETURN)		-	=	M	]	m	}
E	SO (SHIFT UP)	¢	.	> or]	N	↑ or ^ or !	n	~
F	SI (SHIFT DOWN)	° (DEGREE)	/	?	O	← or _	o	■

APPENDIX F SYSTEM HARDWARE ERROR MESSAGES AND RECOVERY

The following discussion explains each of the SYSTEM ERRORS and what may be done, by the user, to recover from them. When these procedures fail, call the Wang Service Representative.

*** SYSTEM ERROR PECM XXXX ***

This error implies that a parity error was detected while trying to execute an instruction from Control or Bootstrap Memory. It is usually serious enough to warrant the executing of a Control Memory diagnostic. However, it may be possible to try to resume execution of the currently loaded application program by depressing RESET then SF '15. If the error is reported again, a Control Memory diagnostic should be run to locate the defective memory location. Note: Sometimes after a PECM the system will have to be powered "off" and Master Initialized again in order to clear the error condition.

*** SYSTEM ERROR PEDM XXXX ***

This error implies that a parity error was detected during a read of Data Memory. This error is usually serious enough to warrant the executing of a Data Memory diagnostic. However, it may be possible to try to resume execution of the currently loaded application program by depressing RESET then SF'15. If the error is reported again, a Data Memory diagnostic should be run to locate the defective memory location.

*** SYSTEM ERROR VECM XXXX ***

This error implies that the Bootstrap is not as expected, the loading of Control Memory from the disk was not successful, or bad memory locations were detected. It may be possible to try to resume execution of the currently loaded application program by depressing RESET then SF'15. If the error is reported again, the Control Memory Diagnostic should be run to determine if there are any bad memory locations. If no locations are reported defective, a CPU instruction may be failing requiring a CPU diagnostic to be run.

*** SYSTEM ERROR VEDM XXXX ***

This error implies that the area of data memory used for system constants (verb tables, math constants, messages), was not loaded properly when BASIC-2 was loaded, or that bad memory locations were detected. It is possible to try to resume execution of the currently loaded application program by depressing RESET then SF'15. Should successive failures be reported, Data Memory Diagnostics should be run to determine if there are any defective memory locations.

DISK ERROR MESSAGES AND RECOVERY

*** SYSTEM ERROR DISK 00XX ***

There are several possible DISK errors that may occur while trying to load disk information. The recovery procedure is to consult the following description of each possible disk error to see if it is possible to correct the problem, and then attempt to reload and resume execution of the currently loaded application program by depressing RESET, then SF'15. Should successive failures occur call the Wang Service Representative. All disk errors are more fully documented in the 2200VP/MVP Disk Reference and BASIC-2 Language Reference Manuals.

DISK 0090

Error: Disk Hardware Error

Cause: The disk did not recognize or properly respond to the System at the beginning of a read or write operation (the read or write has not been performed).

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0091

Error: Disk Hardware Error

Cause: A disk hardware error occurred; i.e., the disk is not in file-ready position. This could occur, for example, if the F/R disk is in LOAD mode or power is not turned on.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0092

Error: Disk Hardware Error

Cause: The disk did not respond to the system at the beginning of a read or write operation in the proper amount of time (time-out). The read or write has not been performed.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0093

Error: Disk Format Error

Cause: A disk format error was detected during a disk read or write. The disk is not properly formatted. The error can be either in the disk platter or the disk hardware.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0094

Error: Format Key Engaged

Cause: The disk format key is engaged (the key should be engaged only when formatting a disk).

Recovery: Disengage the format key. Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0095

Error: Seek Error

Cause: A disk-seek error occurred; the specified sector could not be found on the disk.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0096

Error: Cyclic Read Error

Cause: A cyclic redundancy check error occurred during a disk read operation; the sector being addressed has never been written to or was incorrectly written. This usually means the disk was never initially formatted.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

DISK 0097

Error: Longitudinal Read Error

Cause: A longitudinal redundancy check error occurred when reading a sector.

Recovery: Make sure the disk unit is on, properly selected, and the SYSTEM PLATTER is properly mounted in the operator specified disk unit. Key RESET, as prompted, and try to reload. If error persists, then try a backup platter. If error still persists, then contact Wang Service Personnel.

SYSTEM (EXECUTION) ERROR MESSAGES

The system initially checks each text line for various types of errors as the line is entered by the programmer, during program resolution, and during program execution. The system response to an error condition, is to immediately terminate the current operation, display the erroneous line, and 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.") In all, there are seven classes of error conditions, each identified by a unique letter prefix in the error code:

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

See the complete list of the errors included in each class and their specific recovery procedures in the 2200VP/MVP Language Reference Manual.

Errors in the first three classes listed (Miscellaneous Errors, Syntax Errors, 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 "non-recoverable" errors, as they cannot be recovered under program control.

Errors in the four remaining classes (Computational 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 which can be intercepted by the program before the system takes over 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.

See Chapter 9 of the 2200VP/MVP Language Reference Manual for a discussion of ERROR Recovery under program control.

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