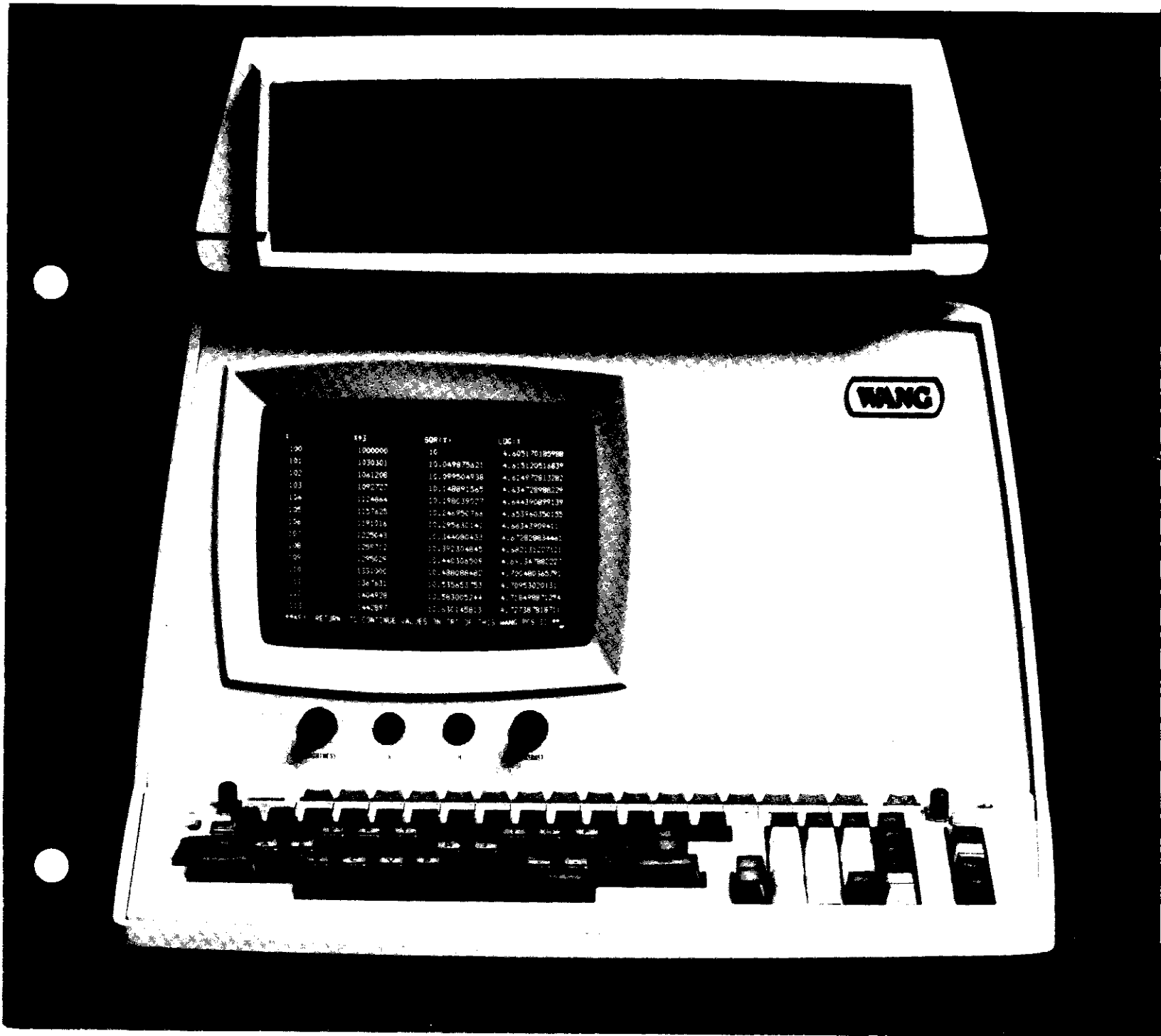
WANG

PCS-II INTRODUCTION

SYSTEM 2200



PCS-II
INTRODUCTION

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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.

HOW TO USE THIS MANUAL

This manual has been written to introduce the new user to the Wang PCS-II. It contains a description of the unit, turn-on procedures, and information on the operation and programming of the PCS-II.

Along with your unit and this manual, you will receive the following documents:

- Wang BASIC Language Reference Manual
- System 2200 Disk Memory Reference Manual
- Matrix Statements Reference Manual
- General I/O Instruction Set Reference Manual
- Sort Statements Reference Manual
- Programming in BASIC
- 2200 Device Address Guide (card)
- System 2200 Summary (card).

If separate peripherals, such as a printer or plotter, are ordered with the PCS-II, each is supplied with a supporting user manual; if you also have Wang-supported software packages, each is accompanied by an operator's manual.

If you are using your PCS-II solely for running a pre-programmed software package, it is recommended that you read this manual, skipping the details of programming the PCS-II, but perusing carefully the section on running software packages, and then proceed directly to the documentation provided with your package. If you wish to do your own programming on the PCS-II, you must become thoroughly familiar with the Wang BASIC Language which is described in several of the additional manuals you have received. For your convenience a list of BASIC statements and the documents in which each is described is provided in Appendix A. Syntax only of all Wang BASIC statements is collected on the System 2200 Summary Card.

TABLE OF CONTENTS

		Page
CHAPTER 1	INTRODUCTION.	1
1.1	Installation.	2
1.2	Environment	2
CHAPTER 2	THE PCS-II.	4
2.1	Introduction.	4
2.2	The System Keyboard	4
	The Alphanumeric Zone.	5
	The Numeric Zone	5
	The Special Function Keys.	6
	The Edit Keys.	6
	The System Command Keys.	6
	The RESET Button	6
	The RETURN(EXEC) Keys.	6
2.3	The Display	6
	The CRT Cursor	7
	Cleaning the CRT Screen.	7
	The Audio Alarm.	7
2.4	The Minidiskette Unit	8
2.5	Attaching Optional Peripherals.	8
CHAPTER 3	OPERATION OF THE PCS-II	10
3.1	Master Initialization (Power-On Procedure).	10
3.2	The RETURN(EXEC) Key.	11
3.3	Preparation of Minidiskettes.	12
	Mounting and Formatting a Minidiskette	13
	Scratching a Minidiskette.	14
3.4	Using the PCS-II as a Calculator.	16
3.5	Running Software Packages	16
3.6	Stopping Program Execution.	18
3.7	Edit Mode	18
CHAPTER 4	PROGRAMMING THE PCS-II.	21
4.1	Writing Programs in Wang BASIC	21
4.2	Spacing	21
4.3	Program Mode.	22
4.4	Terms Used in Wang BASIC.	22
	BASIC Keyword.	22
	BASIC Statement.	23
	BASIC Command.	23
	BASIC Function	23
4.5	Getting Started	24
	Entering Program Lines	24
	Executing a Program.	24
4.6	Editing Programs.	25
	Deleting a Program Line.	25
	Replacing and Changing a Line.	25
	Editing a Stored Program Line.	25

4.7 Listing Programs. 26
Listing a Program on the CRT 26
Listing a Program on a Printer 26
4.8 Debugging 26
Immediate Mode GOTO Statement. 27
RUN Command with Line Number 28
TRACE Mode 28
4.9 Summary 31

APPENDIX A PCS-II SUPPORTING LITERATURE 32
APPENDIX B PCS-II OPTIONS AND PERIPHERALS. 33
APPENDIX C PROGRAMMING CURSOR MOVEMENT 34
APPENDIX D PCS-II SPECIFICATIONS 35

CHAPTER 1 INTRODUCTION

The PCS-II is an easy-to-use desk-top computer powerful enough to meet the specialized demands of engineers, laboratory technicians and scientists, yet flexible enough to meet the data processing needs of students, accountants, businessmen and administrators. Within a single compact unit, the PCS-II combines a keyboard, video display unit, central processing unit, minidiskette drive and peripheral controllers. The PCS-II contains a standard 8192 bytes (8K) of user memory (expandable to 32K) and Wang's Extended BASIC Language.

Figure 1.1 The PCS-II

1.1 INSTALLATION

The PCS-II must be unpacked, inspected and installed by a Wang Service Representative. When you receive your system, notify your Service Representative to perform this service. Failure to do so will void your warranty. Your Service Representative will ensure that any peripheral connectors are correctly attached to your unit and that your unit is properly attached to a power line.

> CAUTION:
>
> The PCS-II is equipped with an exhaust fan on the right side and entry vents on the left (see Figure 1.1). The vents and fan must not be obstructed. To ensure proper cooling of the PCS-II, do not place it adjacent to vertical surfaces, such as file cabinets, that would impede air flow.

1.2 ENVIRONMENT

The quality of the local environment can affect the performance of the PCS-II. Therefore, it is important to examine the location of your unit, with particular attention to four things:

- humidity
- temperature
- cleanliness
- AC power line.

The temperature of the room should be maintained within the recommended range of 65° to 75° F, although the allowable range is 50° to 90° F. Where these temperatures are exceeded, component failure rates are likely to increase.

Humidity must similarly be maintained within the recommended range of 35% to 65% relative humidity, although 20% to 80% is allowable. It should be noted that particularly during the winter months when buildings are heated, the indoor humidity can become extremely low and fall outside the recommended range. Furthermore, a carpeted floor can generate a significant amount of static electricity, particularly when the humidity is low. Carpeting is, therefore, not recommended.

Dust and air-borne dirt can cause equipment malfunctions and should be kept to a minimum with filters installed in heating, cooling and ventilating units.

The power line used for the PCS-II must be noise free, and voltage on the line must be regulated to within ±10%. If the voltage is not sufficiently regulated, a constant voltage transformer should be installed. If the PCS-II does not have its own "dedicated" power line, it may be necessary to install a line conditioner or isolation transformer on the line.

If electrical interference, or "noise", occurs in the power line, its source must be established and eliminated. Such interference can enter the unit by conduction along wiring and cabling or by direct radiation, and can be caused by adjacent office machines, air conditioners, electric motors, arc welders and so on. To minimize such interference, the AC power line should be dedicated to the unit, it should be properly installed in steel conduit and the conduit must be properly connected to junction boxes. Your Wang Service Representative is equipped to help you set up your PCS-II for trouble-free operation.

CHAPTER 2 PCS-II SYSTEM COMPONENTS

2.1 INTRODUCTION

The PCS-II consists of the following standard components, housed in one compact console unit:

- A central processing unit (CPU) with 8K of user memory and approximately 42.5K of control memory.
- A CRT display.
- A system keyboard.
- A single minidiskette drive.

A variety of optional additions are available, including a second minidiskette drive, expansion of user memory to a maximum of 32K, and a wide range of peripheral devices such as printers and plotters. (The complete list of available peripheral devices is provided in Appendix B.)

2.2 THE SYSTEM KEYBOARD

The keyboard is the operator's means of interactively controlling the PCS-II. It permits the operator to enter data, perform quick calculations, issue commands to the processor, write programs, and initiate program execution. The keyboard contains keys with a variety of different functions, grouped by function into several distinct "zones."

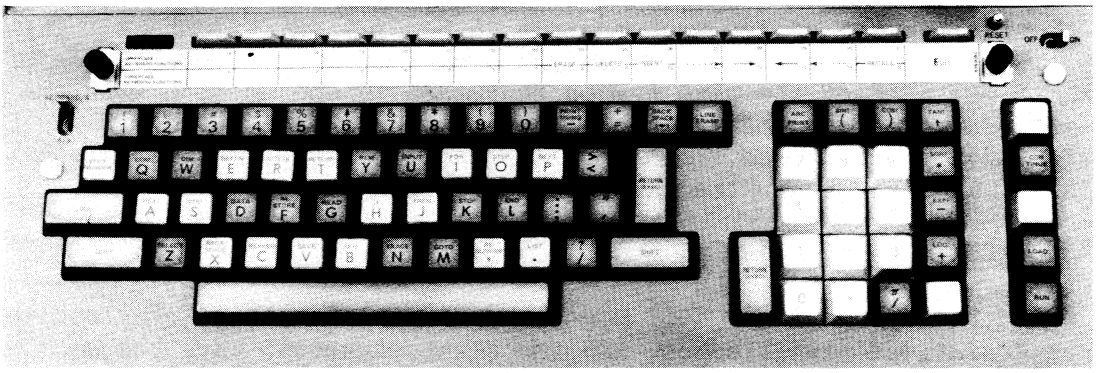


Figure 2.1. The PCS-II System Keyboard

The Alphanumeric Zone

The alphanumeric zone of the keyboard is similar in design to a standard typewriter keyboard. It provides two modes of operation, selected by means of the toggle switch labeled "KEYWORD/A" and "A/a", at the left of the keyboard (see Figure 2-1 above).

The "KEYWORD/A" mode is specifically designed for use in program creation. When the keyboard is in the "KEYWORD/A" mode, the words that appear atop the alphabetic character keys can be entered by simply depressing SHIFT and the desired key. (These words are the principal words used in the BASIC-2 language, and are known as "keywords.") In the "KEYWORD/A" mode, uppercase alphabetic characters are produced without shifting. "KEYWORD/A" mode is convenient whenever you wish to use only uppercase characters.

In the "A/a" mode the alphanumeric keyboard works just like a typewriter in generating uppercase and lowercase characters; uppercase is obtained by depressing the character key while SHIFT is depressed.

It is important to note that only those alphabetical keys with keywords on them are affected by the keyboard mode switch.

The Numeric Zone

The numeric zone of the keyboard is designed for rapid entry of numeric data or expressions. The PRINT key in the upper left corner facilitates the use of the system as a powerful, on-line calculator. The numeric keys are grouped here for convenience only; digits may be entered either by using the numeric keys in the numeric zone, or by using the numeric keys across the top of the alphanumeric zone.

The Special Function Keys

Across the top of the keyboard are 16 Special Function Keys. These keys can be programmed by the user to perform a variety of different types of tasks. Since each of the keys may be depressed in conjunction with the SHIFT key, an effective total of 32 Special Function Keys is available. The Special Function Keys are numbered, on a special function strip, 0 - 15 and 16 - 31, with SHIFT used to obtain the latter range.

The EDIT Keys

When the system is in EDIT mode, the Special Function Keys lose their program-designated significance, and the eight rightmost keys become system-defined edit keys. The EDIT key, to the right of the Special Function Keys, is used to enter EDIT mode. EDIT mode provides powerful one-line editing capabilities for program creation and data entry operations. (Use of EDIT mode is discussed in Chapter 3 of this manual.)

The System Command Keys

The column of command keys at the right side of the keyboard provides single-keystroke entry of some of the most commonly used system commands. (The commands are covered in the BASIC Reference Manual.)

The RESET Button

The RESET button provides a "last resort" means of terminating program execution. When depressed, it immediately ends program execution, clears the CRT, and displays the message:

```
READY
:
```

The RETURN (EXEC) Keys

On the PCS-II keyboard, there are three keys labeled

RETURN
(EXEC)

All three keys may be used interchangeably; they are in separate locations merely for convenience. RETURN(EXEC) is the standard entry-terminator key. It is used to signal that a keyboard response, or entered program line, is complete. The RETURN(EXEC) key is usually referred to simply as (EXEC).

2.3 THE DISPLAY

The cathode ray tube (CRT) display is the system's principal means of conveying information to the operator. It serves as a vital feedback mechanism, displaying the result of each keystroke, and allowing easy review and editing of data and program lines. Its speed, flexibility, and large character capacity make it ideal for interactive problem solving.

The display is available in two models. The standard model has a capacity of 16 lines, with a maximum of 64 characters per line; a second model has a capacity of 24 lines, with a maximum of 80 characters per line. Both CRT models can display the complete keyboard character set; the 24 x 80 display also provides foreign language characters and special symbols, and offers an underlining capability. The complete character set of the display is given in the BASIC Reference Manual. Display brightness and contrast can be adjusted by means of the two controls on the front panel.

The CRT Cursor

A special display character resembling an underscore is used to indicate the location in the display at which the next entered character will appear. This special character is called the CRT cursor. As characters are typed into the display, the cursor is automatically advanced to mark the next character entry position. In Edit Mode, the cursor can be positioned manually to any location in the display where character insertion or deletion is to be performed. (Edit Mode is discussed in Chapter 3.) The cursor also may be moved to any display position under program control, a useful feature when formatting the display for data entry applications. In this case, cursor movement is controlled by the program with a special set of codes called "cursor control codes." The list of cursor control codes is provided in Appendix C.

Cleaning the CRT Screen

The screen of the PCS-II display should be cleaned periodically with a damp cloth using mild soap and water. Do not use alcohol or abrasive compounds.

> WARNING:
>
> Do not attempt to remove the cover of your PCS-II for any reason due to the danger of high voltage. Call your Wang Service Representative if any maintenance is required.

The Audio Alarm

If your system contains the optional Audio Alarm (available as part of Option 60), the hex code 07 activates the alarm tone, a 960 Hz beep. A sequence of 07 codes can be used to produce a longer signal or a series of beeps. The alarm is not automatically activated for system-generated error messages.

2.4 THE MINIDISKETTE UNIT

The minidiskette drive provides the PCS-II with a compact and efficient direct-access storage capability. A minidiskette is a plastic disk about 5 1/4 inches (13.4cm) in diameter, coated on one side with a magnetic recording material; each minidiskette can store up to 89,000 bytes of programs or data. To protect it from dirt and abrasion, the disk is sealed on a tough, flexible plastic jacket, with only enough of the disk surface exposed to permit reading and recording. Only one surface of the disk is coated with the magnetic recording medium; only that surface is used for reading and writing. Typically, one minidiskette is used to store programs while others are used to contain the data needed for use by the program. An unlimited number of such minidiskettes may be used. The procedure for mounting and initializing a minidiskette is described in Chapter 3.

2.5 ATTACHING OPTIONAL PERIPHERALS

The back panel of the PCS-II provides connectors for the optional peripheral devices which may be attached to your system.

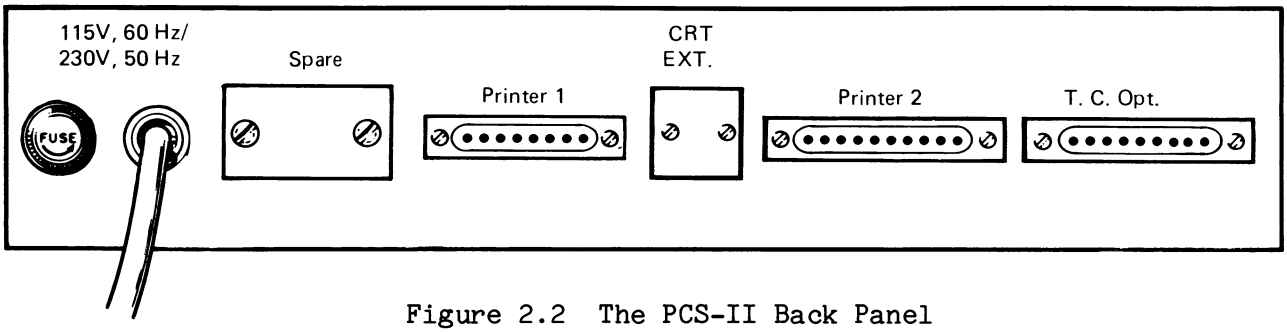


Figure 2.2 The PCS-II Back Panel

The connectors labeled "Printer 1" and "Printer 2" may be used for a number of printers and plotters as follows:

- Model 2221W Line Printer
- Model 2231W or 2231W-2 Line Printer
- Model 2251 Line Printer
- Model 2261W Line Printer
- Model 2263-1 or 2263-2 Printer
- Model 2271 Impact Character Printer
- Model 2281 Line Printer
- Model 2272-1, -2, 2272M-1, -2 Digital Drum Plotters

If the Option 61 Output Writer is used, an additional connector is attached at the location labeled "Spare." This connector may be used only for the Output Writer. If Option 60 is purchased, an auxiliary CRT connector is installed in the back panel at the location labeled "CRT EXT." Telecommunications Options are attached at the location labeled "T.C. Opt."

When connecting peripheral cables, the trapezoidal shape of the connectors permits only one orientation. Little pressure is needed to insert a properly aligned connector. After connecting a cable, press the retaining clips into the claws at the side of the connector (see Figure 2.5). This ensures a solid physical bond.

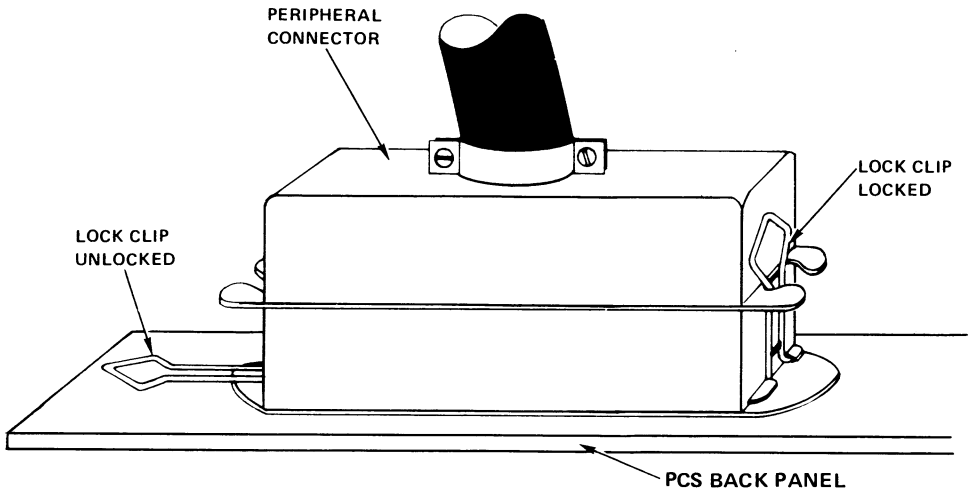


Figure 2.3 Lock Clips and Peripheral Connector

To remove a peripheral cable from the PCS-II, open the lock clips and pull the cable connector out with a slight wiggling motion.

CHAPTER 3 OPERATION OF THE PCS-II

3.1 MASTER INITIALIZATION (POWER-ON) PROCEDURE)

The operation of turning on the PCS-II is called "Master Initialization," because when power is applied to the system, certain critical internal paramaters are initialized to system default values. The power-on procedure is described below.

1. Verify that the PCS-II and all attached peripherals are properly connected and attached to a source of electric power.

2. Turn on the PCS-II (place toggle switch at top right of keyboard in on-position).

3. Turn on any peripherals (if a printer is attached to your system, its SELECT lamp must be backlighted indicating that the printer is on line and subject to control by the system).

4. This procedure Master Initializes the system. After about 15 seconds, the following display occurs:

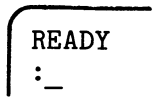


Figure 3.1 The READY Display

This display indicates that your system is ready to receive and execute programs or calculations.

NOTE:

If the READY display does not appear, press the RESET button. If it still does not appear, Master Initialize again. If normal operation is not restored, call your Wang Service representative.

5. Your PCS-II is now ready to use.

When the PCS-II is turned off, all programs and data are cleared from memory. Master Initialization (power on) sets default values for line length and the length of alphanumeric variables and establishes a table containing the default addresses for the following peripherals:

Primary Device	Default Address
Keyboard	001
CRT	005
Minidiskette Drive	310
Plotter	413

The default value for line length is 64 characters; default length for alphanumeric variables is 16 bytes.

Default addresses and line length can be changed with a SELECT statement (see SELECT in the Wang BASIC Language Reference Manual). Unless there are I/O devices other than those listed, there is no need to change the default addresses. To alter the length of specific alphanumeric variables from the default value, a DIM or COM statement is used. Numeric variables are set to zero, and alphanumeric variables are set to spaces when a program is executed, unless specific values are assigned to them.

3.2 THE RETURN(EXEC) KEY

The RETURN(EXEC) Key is the standard means of signalling the termination of operator entry to the system. In this manual it is called the (EXEC) key. When entering a program line, the (EXEC) key is used to store the line in memory.

Example:

```
:10 A=10    (EXEC)
```

As the characters of the program line are entered, they are stored one byte at a time in memory. When (EXEC) is keyed, the line is scanned by the system, and the syntax of the line is checked (if syntax is incorrect, an error message is displayed). The program line is then appended to the program currently in memory; it is not executed until the program itself is run.

When performing a quick calculation, the (EXEC) key is used to execute a line in Immediate Mode. For example:

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

In this case, when (EXEC) is keyed, the line is immediately executed and the expression 25+273 is evaluated and the result displayed. The line is not saved in memory since it was not preceded by a line number when input.

3.3 PREPARATION OF MINIDISKETTES

The minidiskette drive on your system accepts minidiskettes 5 1/4 in. (13.4 cm) on a side.

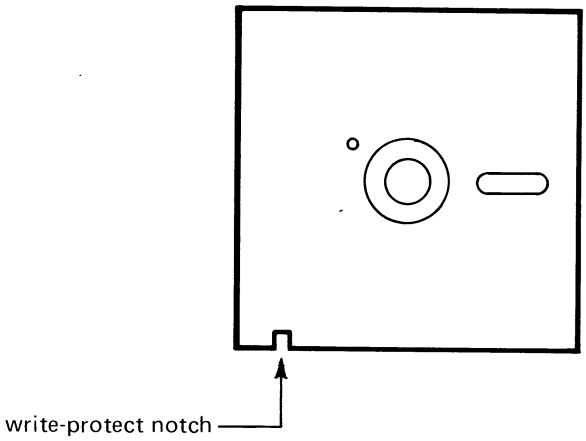


Figure 3.2 A Minidiskette

The minidiskette is protected from accidental over-writing when the write-protect notch is uncovered. To write programs or data on a minidiskette, the write-protect notch must be covered.

When you receive your PCS-II, you may receive minidiskettes containing pre-packaged programs or you may receive only some blank minidiskettes. Blank, unused minidiskettes must be formatted before they can be used. Minidiskettes containing packaged programs must never be formatted or scratched because this process over-writes (and destroys) any information previously recorded on them.

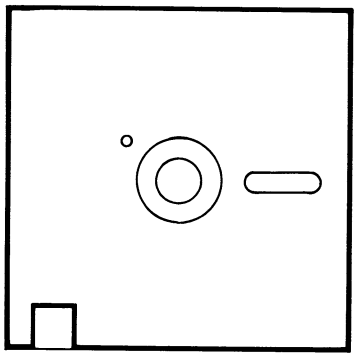
A new, unused minidiskette must be formatted before it can be used. The formatting procedure is executed entirely by the system itself, once initiated by the operator. The recording surface of a minidiskette is divided into 350 sectors, each containing 256 bytes of data (or program text) and control information, as well as two sector-address bytes, and two CRC (cyclic redundancy check) bytes (used for data verification). During formatting, the system writes a sector address and CRC control information in each sector, filling the remainder of the sector with zeroes.

Mounting and Formatting a Minidiskette

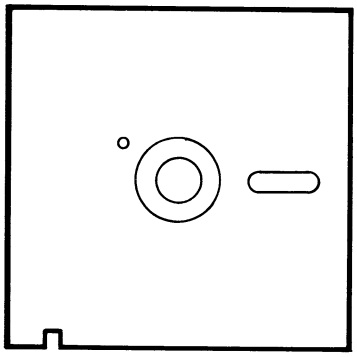
To mount and format a minidiskette, follow these steps:

1. Turn on the PCS-II (place toggle switch at top right of keyboard in ON position). The READY display must appear. If the READY display does not appear, first check the Brightness and Contrast adjustments. If this does not correct the problem, Master Initialize the system again. If the READY display still fails to appear, contact your Customer Service Representative.

2. Remove the minidiskette from its envelope. In order to format the minidiskette, its write-protect notch must be covered. Verify that the minidiskette moves freely in its jacket.



Write-Protect disabled
writing permitted



Write-Protect enabled
writing not permitted

Figure 3.3 Write-Protect Feature

3. Insert the minidiskette into the slot in the left minidiskette drive (see arrows on the minidiskette for proper orientation) and close the drive latch. The write-protect notch must be close to the operator and on the left side of the unit. Be sure the minidiskette is firmly seated in the drive.

4. Key RESET on the keyboard.

5. Depress the FORMAT button located on the web between the two minidiskette drives with a pen or pencil point. (The format switch is recessed to prevent accidental use.)

6. The lamp on the minidiskette unit remains illuminated throughout the formatting operation (45 to 50 seconds). If the lamp continues to remain on, or begins to flash, formatting has not been properly concluded and the minidiskette may not be formattable.

7. Remove the minidiskette from the drive and proceed to format any other minidiskettes.

> NOTE:
>
> A minidiskette that cannot be formatted cannot be used for storage, and should be discarded.

Generally, format errors result from three causes:

a) drive latch not tightly closed.
b) write-protect notch not covered
c) faulty diskette.

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

Scratching a Minidiskette

Once a minidiskette has been formatted to contain the necessary sector identification information, it is ready to be used for storing data and programs. The PCS-II supports two methods of writing information on the minidiskette: a "direct" method, called Absolute Sector Addressing, in which the address of each sector to be accessed must be provided explicitly by the programmer; and a more "indirect" method, called Automatic File Cataloging, in which each program and data file is assigned a name by the programmer, and may be accessed by that name without reference to its actual location on the minidiskette. Under Automatic File Cataloging, the PCS-II operating system maintains a "catalog" on each minidiskette consisting 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 its name and location in the Catalog Index. Whenever the file is subsequently accessed, the system automatically looks up its name in the Index to determine its location. In this way, the programmer is relieved of the task of remembering the exact sector location of each file on the minidiskette; all that must be remembered is the file name.

Because the Automatic File Cataloging mode of operation is so much easier and more convenient than direct addressing, it is generally preferred by beginning programmers and those not yet familiar with the system. It is also the mode used by all Wang software for maintaining data files. Before a program or data file can be stored on a minidiskette in Catalog mode, however, it is necessary to open a catalog on the minidiskette. The process of opening a catalog is called "scratching" the minidiskette, because a special statement, the SCRATCH DISK statement, is used to perform the operation. In a SCRATCH DISK statement, the user must specify how many sectors are to be reserved for the Catalog Index (where the file names and their locations are recorded), as well as the last sector to be used for the Catalog Area (where the files themselves are stored). The Catalog Index always begins at the first sector on a minidiskette (sector numbering starts with zero rather than one), 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 sector specified as the last, or ending, sector. Cataloged information cannot be stored beyond the end of the Catalog Area; in general, therefore, the end of the Catalog Area is set at the last sector on the minidiskette. The size of the Catalog Index is defined with the "LS" parameter in a SCRATCH DISK statement (the Catalog Index is also sometimes referred to as a "Catalog Library"; "LS" is an abbreviation of "Library Sectors"). For example, the parameter LS = 10 indicates that 10 sectors are to be reserved for the Catalog Index. The last sector in the Catalog Area is specified with the "END" parameter in a SCRATCH DISK statement. For example, the parameter END = 349 indicates that sector #349 (the last sector on a minidiskette, which contains a total of 350 sectors numbered 0-349) is the last sector to be used for the Catalog Area.

To scratch a minidiskette follow these steps:

1. Insert a formatted minidiskette in the left drive of the PCS-II.

2. Enter the following statement:

```
SCRATCH DISK F LS = 10, END = 349
```

   and key (EXEC). This statement establishes a catalog on the minidiskette: "LS=10" specifies that 10 sectors be reserved for the Catalog Index; "END = 349" specifies that sector 349 is the last sector to be used by the catalog (349 is the address of the last sector on a minidiskette, since sectors are numbered starting from 0). The number of sectors allocated for the catalog and data storage may be changed (see your System 2200 Disk Memory Reference Manual, "Automatic File Cataloging Procedures," for more information).

3. Repeat steps 1 and 2 for any other minidiskettes which must be scratched.

Once you have completed the formatting and scratching operations for your minidiskettes, you are ready to run packaged programs or write your own.

3.4 USING THE PCS-II AS A CALCULATOR

The PCS-II is a versatile machine which can be used not only to create and run programs, but also as a stand-alone calculator. When the PCS-II is used as a calculator, it is said to be in "Immediate Mode." In Immediate Mode, BASIC statements and functions are entered without a preceding line number and are not saved in memory. Such Immediate Mode statements are executed immediately when the (EXEC) key is pressed (provided there are no errors). The PRINT statement is used to display the results of Immediate Mode calculations. For example:

```
PRINT SQR(55) (EXEC)
PRINT LOG(X*B↑2) (EXEC)
```

The PCS-II also permits the use of multiple statement lines in Immediate Mode (individual statements must be separated by colons). For example:

```
FOR J=2 TO 10: PRINT J,LOG(J): NEXT J   (EXEC)
```

When this line is executed, nine values of J and log J are displayed.

Immediate Mode is also an extremely useful program debugging tool for interrogating variables while an executing program is temporarily halted (see examples in "Programming the PCS-II").

The following BASIC keywords cannot be used in Immediate Mode:

DATA	IF END THEN	PRINTUSING	STOP
DEFFN	% (Image)	READ	FN
DEFFN'	KEYIN	RESTORE	
GOSUB	ON	RETURN	
IF...THEN	ON ERROR	RETURN CLEAR	

3.5 RUNNING SOFTWARE PACKAGES

Running pre-programmed software packages on the PCS-II is relatively simple. Merely insert the program minidiskette in the drive, and enter the commands:

```
CLEAR   (EXEC)
LOAD DC F "START"   (EXEC)
```

The CLEAR command removes any program text and data currently in memory. If the system has just been turned on (Master Initialized), CLEAR is unnecessary, because memory is cleared automatically by Master Initialization.

The LOAD DC command will load a start program module (named, appropriately enough, "START") into memory, if your program package contains such a module. Some packages have starting modules with names other than START, however; see the manual which you have received with your software package for additional information.

Once a program module is in memory, it may be executed by keying:

RUN (EXEC)

During program execution, operator prompts appear on the video display. A few things should be kept in mind when responding to prompts:

1. In general, a displayed question mark indicates that a keyboard entry is expected.

2. If a numeric value is requested, the system permits a maximum of 13 digits, decimal point, sign, and a signed two-digit exponent to be entered. (However, 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. Some examples of system-acceptable numeric entries are:

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

3. If an alphanumeric response is requested, any keyboard characters are acceptable to the system; however, the program may impose additional restrictions on the response.

4. The Edit keys may be used to correct entries before (EXEC) is keyed.

5. The line erase key (in the upper right corner of the alphanumeric zone) may be used to erase a response, before (EXEC) is keyed. The backspace key (next to the line erase) may be used to erase the previous character in a response, before (EXEC) is keyed.

6. When a response has been keyed in, and appears in the display in its desired form, key (EXEC) to enter the response and terminate the keyboard entry operation.

7. If a message of the form:

   ERRXX

   appears after keying (EXEC) and the question mark reappears, the entered response was unacceptable to the system. Check the form of the response, and reenter the desired value.

8. If your program uses minidiskettes for data storage, you must format and scratch a number of minidiskettes before attempting to store any data on them (see Section 3.3, "Preparation of Minidiskettes").

3.6 STOPPING PROGRAM EXECUTION

If it becomes necessary to stop the execution of a program before normal program termination (and if the program operating instructions do not prescribe a procedure for doing so), key HALT/STEP (at the top of the command keys). HALT/STEP stops execution at the end of the currently executing BASIC statement, and displays the system colon. If, later, you wish to continue the program from the point at which it was HALT'ed, you may do so by keying CONTINUE (EXEC) (provided you haven't done anything that would prevent the program from being continued; see the BASIC Language Reference Manual for actions that prohibit program continuation).

The Reset button also stops program execution, but it should not be used unless HALT/STEP fails to display the system colon. If pressed during program execution, Reset can leave half-written, unreadable information on a minidiskette. Reset also prevents the use of CONTINUE.

3.7 EDIT MODE

Whenever the EDIT key at the right of the keyboard is depressed, the system enters Edit Mode and an asterisk (*) replaces the usual colon at the start of a line. If you enter Edit Mode when inputting values in response to a program prompt followed by a question mark, the asterisk replaces the question mark. In Edit Mode, the normal operation of the Special Function Keys is temporarily inhibited, and the eight Special Function Keys at the right end of the Special Function strip assume the following special meanings as Edit Keys:

Key	Operation
EDIT	used to enter EDIT mode; when this key is pressed, an asterisk replaces the usual colon at the beginning of the current line and the following keys may be used to effect editing operations.
RECALL	used to recall a program line to be edited from memory.
←----	moves the cursor five spaces left.
←	moves the cursor one space left
----→	moves the cursor five spaces right.
→	moves the cursor one space right.
INSERT	expands the current line to accept additional text or data by inserting a space character prior to the current cursor position.
DELETE	deletes the character at the current cursor position.

ERASE — erases all characters in a line from the current cursor position to the end of the line.

> NOTE:
>
> The Edit Mode keys operate as described so long as the CRT is the Console Output (CO) device and is selected with the correct line length (64 or 80; see SELECT in the Wang BASIC Language Reference Manual). These are the usual default parameters and will be different only if changed.

Example #1

```
Enter     :10 PRINT 1A,B1,C1        (EXEC)
                  ↑ERR10
```

(The line is checked for syntax and stored; an error message is displayed because 1A is not a legal BASIC variable.)

To correct the error in line 10, follow the procedure below:

Depress the EDIT key:	*	(To enter Edit Mode.)
Enter the line number:	*10	(Asterisk replaces colon before line number.)
Depress the RECALL key:	*10 PRINT 1A,B1,C1 (To recall the line from memory.)	
Move the cursor with the ← key:	*10 PRINT 1A,B1,C1	
Correct the variable name:	*10 PRINT A1,B1,C1	

Key (EXEC) to store the corrected line and exit from Edit Mode.

> NOTE:
>
> It does not matter where the cursor is positioned when you exit from Edit Mode; the entire line is stored. To recall the original line, depress the RECALL key again before exiting from Edit Mode.

Example #2

A program contains the following line:

```
10 INPUT "CITY, STATE", A$
```

To run this example, enter the program line and key: RUN (EXEC).

The following prompt appears:

```
CITY, STATE? _
```

Enter a response:

```
CITY, STATE? BOSTON, MASS__
                        ↑
            cursor at end of line which
            is not yet stored in memory
```

Depress the EDIT key:

```
*BOSTON, MASS_
```

> NOTE:
>
> If "BOSTON, MASS" is entered without being enclosed in double quotes ("), all characters after the comma are lost.

Move the cursor under the 'B' with ← the key to insert a space and enter quotes.

```
*BOSTON, MASS
```

Depress the INSERT key to open a space:

```
* BOSTON, MASS
```

Enter the opening quotes ("), and move the cursor to the right to enter the closing quotes.

```
*"BOSTON, MASS"_
```

Key (EXEC) to drop out of Edit mode and continue program execution.

CHAPTER 4 PROGRAMMING THE PCS-II

4.1 WRITING PROGRAMS IN WANG BASIC

Although the PCS-II can function as a convenient and powerful calculator, it is also a versatile small computer programmable in the high-level BASIC language. BASIC is an easy to use, interactive programming language which utilizes many words found in everyday English (such as PRINT, READ, STOP, etc.). Although such words are given a special, and clearly defined, meaning when used in a BASIC program, their functions are similar enough to ordinary usage to make them easily learned by the beginning programmer. The instruction set of the BASIC language is covered in detail in the Wang BASIC Language Reference Manual. The present chapter introduces some general topics related to programming the PCS-II, including BASIC program format, general terminology, entry of program lines, and the assortment of program editing and debugging features available on the PCS-II.

4.2 SPACING

Spaces are customarily used between characters in a line for readability; the system ignores them. For example, 10 READ A, B, C, D is easier to read than 10READA,B,C,D. Both are equally acceptable to the system. The only situation in which spaces have a significance is when they are included within a character string in quotes. For example, the character string "ABC" is different from the string "A B C."

4.3 PROGRAM MODE

In Program Mode, each line must be preceded by a unique line number from 0 to 9999. In this mode, each line entered is saved in memory. Once the line number and program line are entered and the (EXEC) key is depressed, the line is checked for syntax and saved in memory. It is not executed immediately (program lines are executed only when the program itself is run). If a syntax error is discovered, the appropriate error code (ERR..) is displayed; the line has nevertheless been stored in memory. The line can be corrected by re-entering the line number and the corrected line, or by recalling the entered line and correcting it with the Edit Keys.

Program mode makes it possible for the user to enter a complete program line by line into the system. Line numbers identify the lines and specify the order in which the lines are to be executed. Lines do not have to be entered in order; at execution time, the system automatically processes the lines in order according to the line number.

Line numbers should be assigned with suitable increments between them to allow for the insertion of additional lines. Line numbers can be entered automatically by using the Statement Number (STMT NUMBER) key (which generates line numbers in increments of ten). Line numbers do not require leading zeroes (e.g., 0010 can be entered simply as 10), and must not be preceded by spaces.

Examples:

```
:10 FOR J = 2 TO 10    (EXEC)
:20 PRINT J, LOG(J)    (EXEC)
:30 NEXT J             (EXEC)
```

The RENUMBER command can be used to automatically renumber all lines in a stored program in specifiable increments (see the BASIC Language Reference Manual for more details).

4.4 TERMS USED IN WANG BASIC

Several commonly used terms in Wang BASIC are defined below.

BASIC Keyword

A keyword is a BASIC word which can be entered by the depression of a single key on the keyboard. The keyboard contains the entire alphabet, all the decimal digits, and many special characters (such as $, #, %, etc.), along with a set of BASIC words. Thus, an entire BASIC word (such as PRINT or PRINTUSING) can be entered with a single keystroke. (A BASIC word can, of course, always be entered character-by-character as well.) No matter how it is entered, however, a BASIC keyword is compressed by the system into a one-byte code, called a "text atom," before it is stored in memory (a few keywords require two bytes). This conversion process, called "atomization," saves space in memory and speeds up program execution.

BASIC Statement

A BASIC statement is a programmable instruction which serves as the fundamental building block of programs written in Wang 2200 BASIC. A BASIC statement generally includes one or more operands which provide the data used by the statement to perform its operation.

Examples of Wang BASIC Statements:

```
PRINT A, B, C
10 A = 5*B
20 IF A = 100 THEN 90
40 FOR I = 1 TO 20: A(I) = I+5: NEXT I
```

Note that more than one BASIC statement may be placed on the same program line (as in line 40 above). In this case, the individual statements are separated by colons (:).

BASIC Command

A BASIC command is a nonprogrammable instruction which provides the operator with control of a critical system function (such as clearing memory, initiating or terminating program execution, loading a program, etc.) directly from the keyboard.

Examples of Wang BASIC Commands:

```
RUN

CLEAR

LOAD DCF "PROG1"

SAVE DCR "NEW PROG"
```

BASIC Function

A BASIC function is a special type of BASIC instruction which accepts a given value as an argument, and returns a unique value as a result. A BASIC function must appear as an operand within a BASIC statement; it cannot stand alone in a program or in Immediate Mode.

Examples of BASIC Statements with Functions as arguments:

```
30 READ STR(A$,9,9)
40 PRINT HEX(51)
50 PRINT SIN(K*2/C)
```

SIN, STR and HEX are BASIC functions.

Incorrect Examples of Function Use:

```
50 STR(A$,9,9)
60 SIN(K)
```

These are meaningless uses of the STR and SIN functions and produce error messages. Note that if the result of a function is to be displayed in Immediate Mode, the function must be included in a PRINT statement, e.g.:

```
PRINT SQR(55)
```

This statement prints the square root of 55.

4.5 GETTING STARTED

Entering Program Lines

A program line is entered by keying in a line number followed by one or more BASIC statements and their operands. Each line is terminated by keying (EXEC). When (EXEC) is keyed, the entire line is saved in memory.

Executing a Program

Once a program has been saved in memory (and assuming no syntax errors have been found), the program can be run. This is done by executing the RUN command (key RUN (EXEC)).

Example:

```
10 A = 14 + 2          program in
20 PRINT "A=";A        memory
```

Key RUN (EXEC). The program is resolved and executed and the result is displayed as:

```
A= 16
```

(The resolution phase occurs immediately before execution; it consists of scanning the program for syntax errors and invalid line number references, and setting up space for program variables.)

Once execution is underway it is possible for an execution error to occur. In this case, the program line in which the error occurred is displayed, with an ERR code immediately below it pointing to the approximate location of the error. The program must be corrected before it is rerun. For example, suppose a program contains the following lines:

```
10 T = 0
.
.
.
70 A = SIN(B)/T
```

Because division by zero is an illegal operation, an execution error (ERR 03 - Math Error) is signalled when line 70 is executed. The display is:

```
10 A = SIN(B)/T
             ↑ERR 03
```

NOTE:

Note that numeric variables are set to zero and alpha variables are set to spaces at resolution time and retain these default values until assigned specific values by the program.

4.6 EDITING PROGRAMS

Deleting a Program Line

An existing program line can be deleted by entering its line number and keying (EXEC).

Example:

```
10 A = 14 + 2
20 PRINT A + 4
30 PRINT A
```

To delete line 30, enter:

```
:30   (EXEC)
```

Replacing and Changing a Line

An existing line can be replaced by entering its line number, followed by the new line and keying (EXEC). The previous version of the line is lost.

Editing a Stored Program Line

Before a program line has been stored in memory with (EXEC), it can be edited with the Edit Mode keys as described in Chapter 3. Once a line has been stored in memory, however, an additional step is required before it can be edited: it must first be recalled to the display with the RECALL key. To recall a stored program line, observe the following procedure:

1) Depress the EDIT key to enter Edit Mode.
2) Enter the the line number of the line to be edited.
3) Depress the RECALL key.

The line is now recalled to the display and may be edited according to the procedure described in Chapter 3.

4.7 LISTING PROGRAMS

Listing a Program on the CRT

When a program has been entered, it can be reviewed by using the LIST command. LIST (EXEC) lists the entire program. LIST S (EXEC) lists the program 15 lines at a time; to see the next 15 lines, key (EXEC) again. LIST line no. (EXEC) lists the specified line only (for example, LIST 10 lists only line 10.)

Listing a Program on a Printer

To obtain a listing of a program on a printer, turn on the printer and SELECT it manually (push the SELECT button). When the printer is selected (i.e., on-line), the SELECT button is backlighted. Enter the following statement from the keyboard to select the printer for listing:

```
SELECT LIST 215  (EXEC)
```

This statement changes the default output address for LIST from the CRT (005) to the printer (215). Next, enter

```
LIST  (EXEC)
```

Program listings formerly displayed on the CRT are now listed on the printer. To return list output to the CRT, enter

```
SELECT LIST 005  (EXEC)
```

Further discussion of the SELECT statement and its various parameters can be found in the Wang BASIC Language Reference Manual and in the individual printer manuals.

4.8 DEBUGGING

The PCS-II supports a number of features to aid in debugging programs.

Immediate Mode permits you to interrogate variables at any time during program execution. For example, enter the following short program:

```
10 A = 10
20 B = B + A
30 GO TO 20
```

To execute the program, key RUN (EXEC).

Since the program is a continuous loop, B is continuously incremented; there is no PRINT statement in the program so no display appears on the CRT. To interrogate the variables A and B,

1) Key HALT/STEP
2) Enter PRINT A,B (EXEC)

Current values of A and B are displayed. The program can be resumed at the point of interruption by keying CONTINUE.

It is also possible to change the current values of a variable in Immediate Mode. For example, after HALTing the previous program, enter the following statement:

```
A = 10.51   (EXEC)
```

Once the value of the variable has been modified, program execution can be resumed with CONTINUE. Note, however, that if a change is made to the program text itself, or a new variable is defined, program execution cannot be resumed with CONTINUE. Instead, the program must be rerun with the RUN command. To continue execution starting with line 20, enter

```
RUN 20   (EXEC)
```

Now key HALT/STEP and print A and B; their new values will be displayed.

Immediate Mode GOTO Statement

An Immediate Mode GOTO can be used to set execution pointers to a particular line when program execution is halted with a STOP statement or a single depression of the HALT/STEP key. The Immediate Mode GOTO does not, however, initiate execution, but must be followed by a CONTINUE command, or a second use of the HALT/STEP key.

> NOTE:
>
> An Immediate Mode GOTO cannot be used unless program execution has been initiated previously with a RUN command; otherwise, an immediate mode GOTO can result in a SYSTEM ERROR! message. Under such circumstances, the results of any execution are not dependable.

As an exercise in using an Immediate Mode GOTO, enter and run the following short program:

```
10 A = 10: B = 25
20 C = A - B
30 D = D + C
40 PRINT A, B, C, D
50 GOTO 20
```

While the program is running, the variable D increments continuously; the first line of output is:

```
 10             25            -15            -15
```

To halt program execution, key HALT/STEP. Next, enter an Immediate Mode GOTO:

```
GO TO 30  (EXEC)
```

This sets the execution pointer at line 30. Key HALT/STEP a second time. Line 30 is displayed and executed:

```
30 D = D + C
```

Key HALT/STEP again; the next line is displayed and executed. (The value in the last column depends on how many loops have been completed.)

```
40 PRINT A, B, C, D
 10            25          -15          -1065
```

To resume normal execution mode, enter CONTINUE (EXEC)

RUN Command with Line Number

The RUN command can be used to start execution at a given program line. For example:

```
RUN 20   (EXEC)
```

This command starts execution at line 20; program resolution occurs normally (that is, all variables are initialized prior to resuming execution).

TRACE Mode

When a program is executed in TRACE Mode, the system automatically displays intermediate values, internal program transfers (i.e. branches in GOTO, GOSUB statements, FOR/NEXT loops, etc.), and, when an alpha function is executed on the left side of an equation, the function name. As an exercise, enter the following program:

PROGRAM LINE	MEANING
10 A$ = "ABCDEF":K = 1	Assigns character string to A$, the value 1 to K.
20 GO TO 40	Branches to line 40.
30 STR (B$, 3, K) = A$	Assigns K characters of A$ to B$ starting at character 3.
40 HEXPRINT A$, B$: K = K+1	Prints hexcodes of characters in A$ and B$; increments K.
50 PRINT A$, B$	Outputs characters of A$ and B$.
60 STOP	Halts program execution.
70 GOTO 30	Branches back to line 30.

When the program has been entered, it can be executed in TRACE Mode. Turn on TRACE Mode by keying TRACE (EXEC). Then RUN the program.

The first display is:

```
TRACE output ------------------> A$ = ABCDEF
TRACE output ------------------> K = 1
TRACE output ------------------> TRANSFER TO 40
program output ---------------> 41424344454620202020202020202020
program output ---------------> 20202020202020202020202020202020
TRACE output ------------------> K = 2
program output ---------------> ABCDEF
program output ---------------> STOP
```

(The STOP statement in line 60 halts program execution.) To proceed, enter:

```
CONTINUE   (EXEC)

                                  TRANSFER TO 30
                                  STR(
                                  B$ = ABCDE
TRACE output                      41424344454620...
                                  20204142202020...
                                  K = 3

                        ABCDEF              AB

                        STOP
                        :_

Key:    CONTINUE   (EXEC)

                        TRANSFER TO 30
                        STR(
TRACE output            B$ = ABCDEF
                        41424344454620...
                        20204142432020...
                        K = 4
                        ABCDEF              ABC
                        STOP
                        :_
                        etc.
```

You can continue to execute the program until K=15 although after K = 7 there are no further changes to A$ or B$ (all six characters of A$ have been used).

NOTE:

Once K = 15, a program error (ERR41) occurs; the error arrow points to the variable K. The error is "illegal STR argument" since the value of line 30 becomes:

```
30 STR(B$, 3, 15)
```

i.e., 17 bytes. B$ contains only 16 bytes (set at RUN time) (see STR and DIM in the Wang BASIC Language Reference Manual).

Programmable Pause can be used with TRACE to review the tracing of a program without operator intervention. For example, using lines 10 through 70 of the previous program, remove line 60. Enter:

```
60   (EXEC)
```

To view the new version of the program, enter:

```
LIST   (EXEC)
```

To turn on TRACE Mode (if TRACE is not already on), key:

```
TRACE   (EXEC)
```

To set a pause of one-half second between the display of each line, enter:

```
SELECT P3   (EXEC)
```

Now RUN the program.

The program executes and TRACE output is displayed with a pause of one-half second between each line. Execution terminates when K = 15 with ERR 41, illegal STR argument (see note for previous example).

To remove the system from Trace Mode, enter:

```
TRACE OFF   (EXEC)
```

To deactivate the pause, enter:

```
SELECT P   (EXEC)
```

or

```
SELECT PO   (EXEC)
```

For further information on all these statements and commands, see the Wang BASIC Language Reference Manual.

4.9 SUMMARY

You now have the basic information necessary to Master Initialize the PCS-II and enter and run programs. See the Wang BASIC Reference Manual for information on all BASIC instructions, their syntax and meanings and the System 2200 Summary (card) which provides syntax and error messages in abbreviated form. The Device Address Guide (card) provides further information on addresses used with Wang peripherals. For the inexperienced user, the Wang BASIC Programming Manual is recommended reading.

For further information on using the minidiskette for program and data storage, see the System 2200 Disk Reference Manual.

APPENDIX A PCS-II SUPPORTING LITERATURE

The BASIC Language which is available on your Wang PCS-II is fully documented in the reference manuals which have arrived with your system. The following table contains a list of the available BASIC instructions and the manuals which describe them.

BASIC INSTRUCTIONS	SUPPORTING DOCUMENT
MAT CONVERT, MAT COPY, MAT MERGE, MAT MOVE, MAT SEARCH, MAT SORT	Sort Statements Reference Manual
$GIO, $IF ON, $PACK, $TRAN, $UNPACK	General I/O Instruction Set Reference Manual
MAT+, MAT CON, MAT=, MAT IDN, MAT INPUT, MAT INV, MAT*, MAT PRINT, MAT READ, MAT REDIM, MAT k*, MAT-, MAT TRN, MAT ZER	Matrix Statements Reference Manual
COPY, DATALOAD BA, DATALOAD DA, DATALOAD DC, DATALOAD DC OPEN DATASAVE BA, DATASAVE DA, DATASAVE DC, DATASAVE DC CLOSE, DATASAVE DC OPEN, DBACKSPACE, DSKIP, IF END THEN, LIMITS, LIST DC, LOAD DA, LOAD DC, MOVE, MOVE END, SAVE DA, SAVE DC, SCRATCH, SCRATCH DISK, VERIFY	System 2200 Disk Memory Reference Manual
ABS, ADD, AND, ARCCDS, ARCSIN, ARCTAN, BIN, BOOL, CLEAR, COM, COM CLEAR, CONVERT, COS, DATA, DEFFN, DEFFN', DIM, END, EXP, FN, FOR, GOSUB, GOSUB' GOTO, HEX, HEXPRINT, IF, %(image), INIT, INPUT, INT, KEYIN, LEN, LET, LIST, LOG, NEXT, NUM, ON, ON ERROR, OR, PACK, #PI, PLOT, POS, PRINT, PRINTUSING, READ, REM, RENUMBER, RESTORE, RETURN, RETURN CLEAR, RND, ROTATE, RUN, SELECT, SGN, SIN, SQR, STOP, STR, TAB, TAN, TRACE, UNPACK, VAL, XOR	Wang BASIC Language Reference Manual

APPENDIX B PCS-II OPTIONS AND PERIPHERALS

OPTIONS

OP-60	Keyboard Clicker, Audio Alarm, and Auxiliary CRT Connector
OP-60A	80 x 24 CRT, Keyboard Clicker, Audio Alarm, and Auxiliary CRT Connector
OP-61	Output Writer (156 columns/15 CPS)
OP-62	Asynchronous Telecommunications Controller
OP-62B	Bisynchronous Communications Controller
OP-65	IEEE-488 Standard Interface
OP-67	I/O Interface (8-bit parallel)

PERIPHERALS

2221W	200 CPS Printer, 10 Pitch, 132 Characters/line
2231W-1	120 CPS Printer, 10 Pitch, 112 Characters/line
2231W-2	120 CPS Printer, 12 Pitch, 132 Characters/line
2251	110 CPS Printer, 40 Characters/line
2261W	240 LPM Matrix Printer
2263-1	400 LPM Line Printer
2263-2	600 LPM Line Printer
2271	Bidirectional Output Writer
2272-1	Drum Plotter (Single Pen)
2272-2	Drum Plotter (Three Pens)
2281	40 CPS Daisy Output Writer
2295	2231W Printer Stand

APPENDIX C PROGRAMMING CURSOR MOVEMENT

The CRT cursor can be moved under program control by using the PRINT HEX statement (see the Wang BASIC Language Reference Manual). The hex codes which can be used for this purpose are:

HEX CODE	COMMAND
01	home cursor
03	clear screen and home cursor
08	move cursor left one space
09	move cursor right one space
0A	move cursor down one line
0C	move cursor up one line

For example, PRINT HEX(03) clears the CRT and places the cursor at the home position (upper left of the screen).

The following short program illustrates use of these commands with the cursor. Note that the output produced with this program on the CRT cannot be directly reproduced on a printer or similar printing output device.

```
10 PRINT "AAAAA"
20 PRINT "BBBBB"
30 PRINT HEX(0A):PRINT"ZZZZZ"
40 PRINT "11111"
50 PRINT HEX(09);:PRINT"22222"
60 PRINT "******";:PRINT"&&&&&";
70 PRINTHEX(0808);:PRINT"/"
80 PRINT HEX(0C0C0C09);:PRINT"##"
90 PRINT
```

This routine produces the following output on the CRT:

```
AAAAA
BBBBB

ZZZZZ
1##11
 22222
*****&&&/&
```

APPENDIX D PCS-II SPECIFICATIONS

Unit Size

Height	18.75 in. (47.7 cm)
Depth	20.5 in. (52 cm)
Width	19.75 in. (50.2 cm)

Approximate Net Weight

62 lb (30 kg)

Display

Approx. Size	9 in. (22.9 cm) diagonal
Capacity	16 lines, 64 char/line
Character Size (height and width)	0.125 in.(.32 cm)

Keyboard

Upper/lowercase alphanumeric/BASIC keyword with full typewriter, full numeric key pad, mathematical function keys, arithmetic operators, special function keys and edit keys.

Minidiskette Drive

Storage Capacity (Each Minidiskette)

Total Sectors	350
Tracks	35
Total Bytes	89,600
Sectors/Track	10
Bytes/Sector	256

Performance

Average Access Time	533 ms
Speed	300 rpm
Transfer Rate	125 kilobits/sec

Physical Characteristics

5 1/4 in. (133.3 cm) diameter with write protect notch

Peripheral Capacity

Two connector jacks for printers and plotters, one for TC option and one spare

Central Processor

Standard Random Access Memory (RAM) Size	8K (expandable in 8K increments to 32K)
Largest Line Number	9999

Dynamic Range	$-10^{100} < n <= -10^{-49}, 0, 10^{-99} <= n < 10^{-100}$
Precision	13 significant digits
Variables	
Type	Numeric, numeric array alphanumeric, alphanumeric array
Variable Names	286 each type; 1,144 total
Arrays	One-or two-dimensional, both numeric and alpha-numeric
Maximum size of alphanumeric variable	64 characters

Maximum Nesting

FOR-NEXT loops	45 levels
Subroutines	45 levels

Internal Character Code

ASCII

Size of Byte

8 bits

Type of Arithmetic

Decimal

System Language

Name	Wang Extended BASIC
Commands	13
Statements	110
Functions	22
Error Codes	99

Operating Environment

50° to 90°F (10° to 32°C)
40% to 60% relative humidity, recommended
30% to 70% relative humidity, allowable
dedicated power line

Power Requirements

115 or 230 VAC ± 10%
50 or 60 Hz ± 1 Hz
415W

Fuses

4ASB @ 115V/60 Hz
2ASB @ 230V/50 Hz

Cable

8 ft (2.4m) cord with 3-prong plug to power source

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700-4255A
12-77-2.5M